JOHN DEERE
WORLDWIDE COMMERCIAL & CONSUMER EQUIPMENT DIVISION

2653A Professional Utility Mower

TM1554 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

Miscellaneous

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.

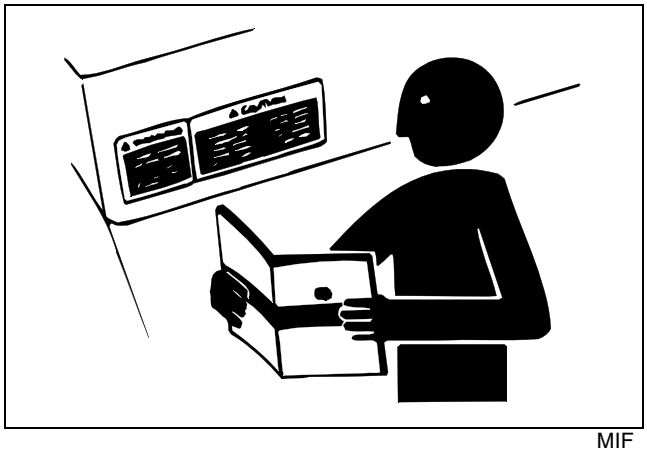
Follow recommended precautions and safe servicing practices.

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

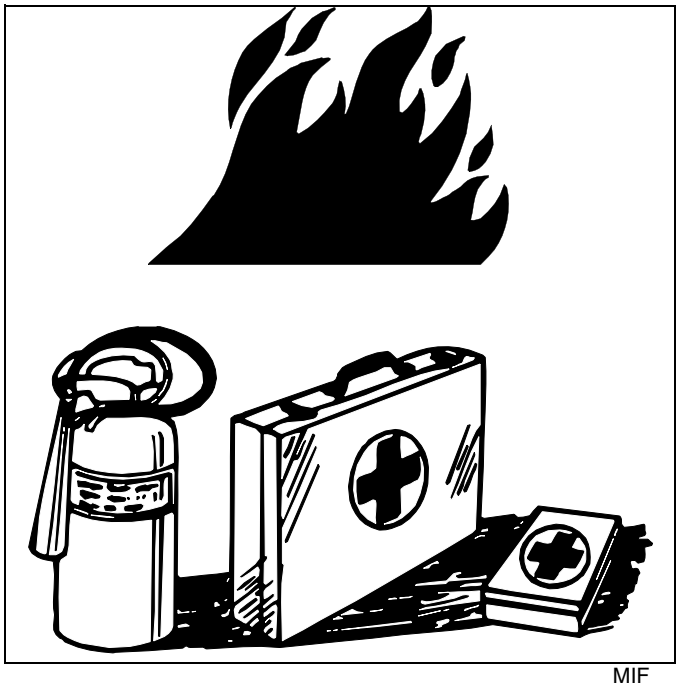


MIF

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.

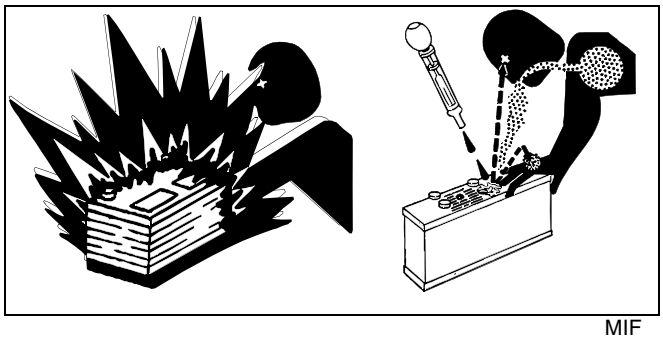
Do not store oily rags; they can ignite and burn spontaneously.

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:

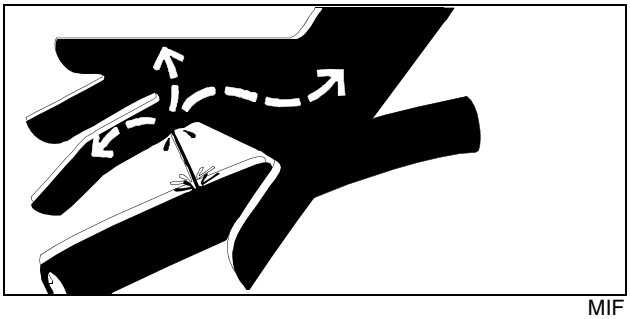
1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 10-15 minutes.
4. Get medical attention immediately.

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



MIF

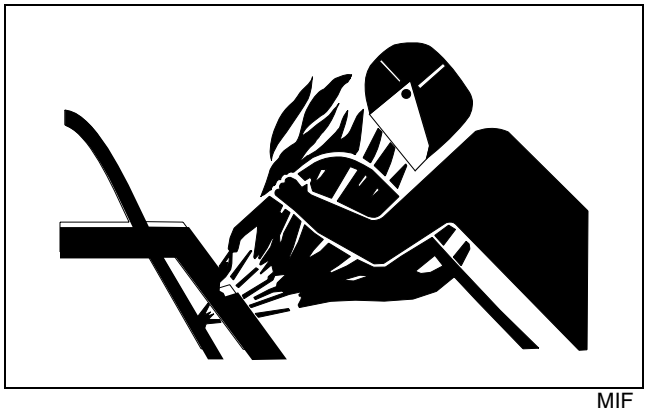
Escaping fluid under pressure can penetrate the skin causing serious injury.

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

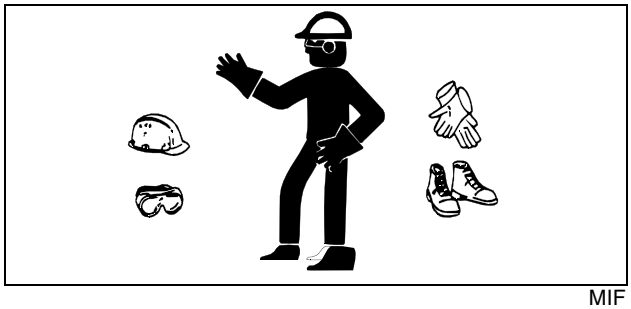


MIF

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



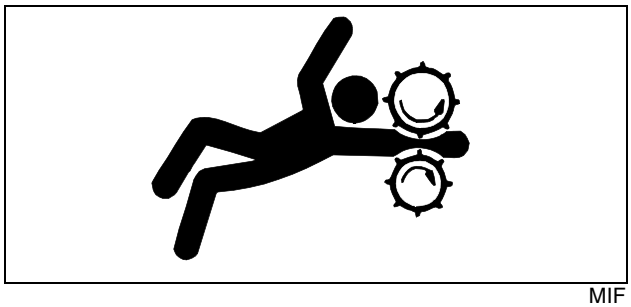
MIF

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



MIF

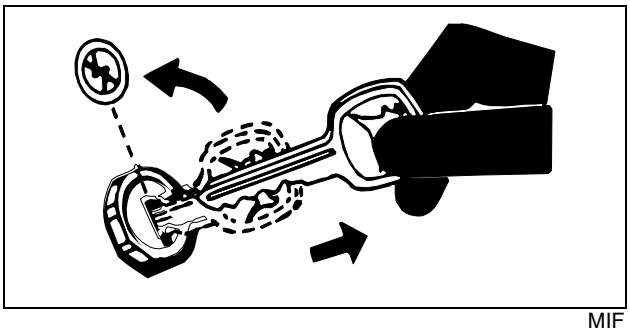
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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

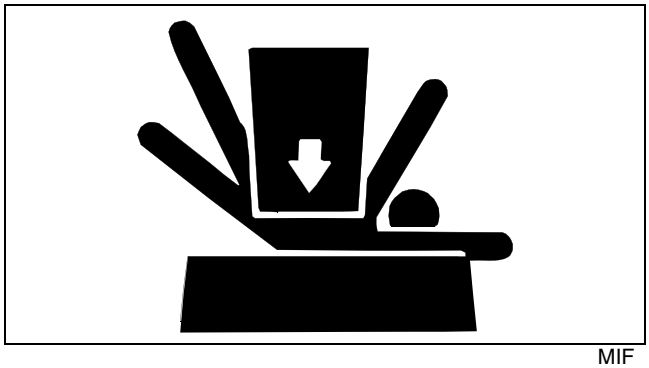


MIF

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



MIF

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

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

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

Work in Clean Area

Before starting a job:

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.

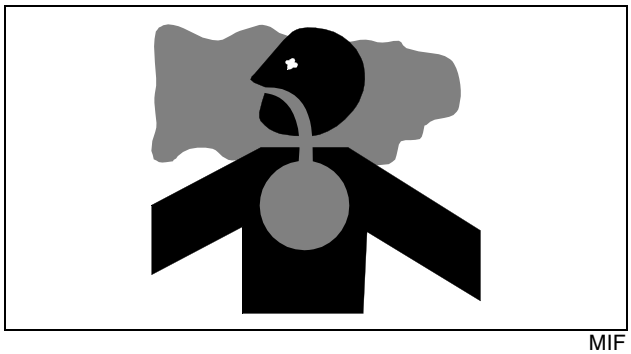
Using High-Pressure Washers

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



MIF

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

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

WARNING: California Proposition 65 Warning

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

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

Remove Paint Before Welding or Heating

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

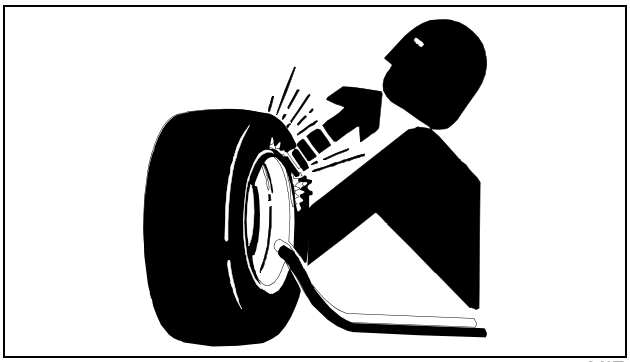
Avoid Harmful Asbestos Dust

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

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

Avoid creating dust. Never use compressed air for cleaning. Avoid brushing or grinding material containing asbestos. When servicing, wear an approved respirator. A special vacuum cleaner is recommended to clean asbestos. If not available, apply a mist of oil or water on the material containing asbestos. Keep bystanders away from the area.

Service Tires Safely



MIF

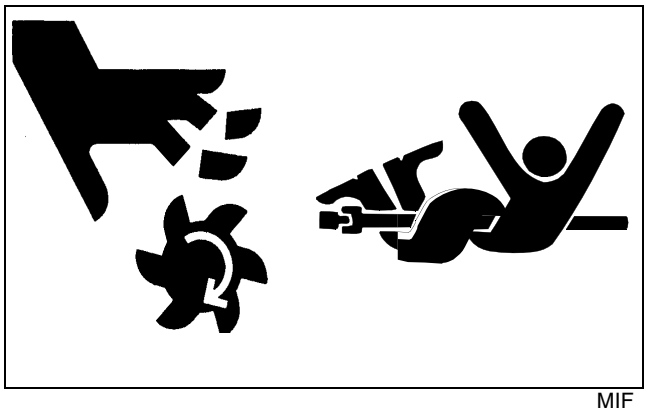
Explosive separation of a tire and rim parts can cause serious injury or death.

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

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

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

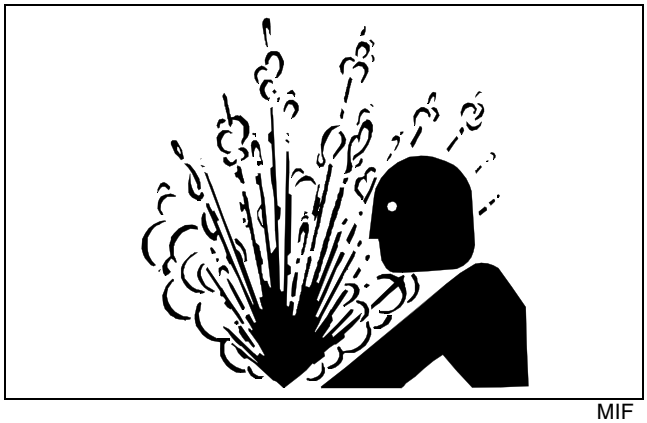
Avoid Injury from Rotating Blades and Drive Shafts



MIF

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

Service Cooling System Safely

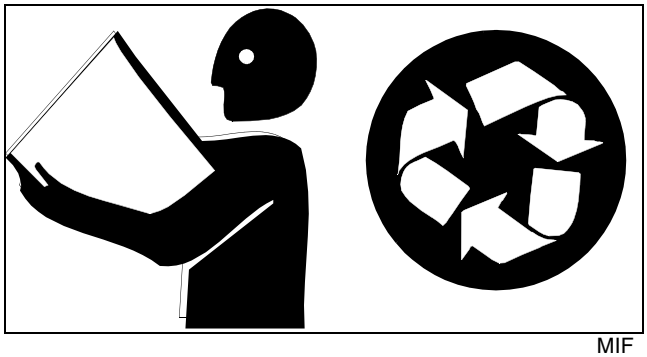


MIF

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

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

Handle Chemical Products Safely



MIF

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

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

Dispose of Waste Properly

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

LIVE WITH SAFETY

MIF

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

Table of Contents

Vehicle Specifications

Engine

Make	Yanmar
Model	3TNE68
Type	4-cycle diesel
Bore	68 mm (2.68 in.)
Stroke	72 mm (2.83 in.)
Cylinders	3
Valves	Overhead
Displacement	0.784 L (47.8 cu in.)
Gross Output Power	13.8 kW (18 hp)
Maximum Torque at 2400 RPM	61.7 N•m (45.5 lb-ft)
Firing Order	1-3-2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Combustion System	Indirect injection type
Compression Ratio	23:1
Oil Capacity with Filter (Approximate)	2.4 L (2.5 qt)
Cooling	Liquid with pump and radiator
Governor	Centrifugal
Slow Idle (No Load)	1450 ± 100 rpm
Fast Idle (No Load)	3225 ± 50 rpm
Fuel Filter/Water Separator	Replaceable element fuel water separator
Air Filter	Dry replaceable primary and secondary elements
Weight (Approximate)	81 kg (179 lb)

Machine

Battery

Voltage	12 VDC
Reserve Capacity @ 25 Amps	80 min.
Cold Cranking Amps @ -18°C (0°F)	480 CCA

Capacities

Crankcase	
W/Filter	2.4 L (2.5 U.S. qt)
Coolant	
Engine and Radiator	4.0 L (4.2 U.S. qt)
Overflow Bottle	0.53 L (1.25 U.S. pt)
Fuel Tank	28 L (7.4 U.S. gal)
Hydraulic Fluid	
Reservoir	20.8 L (5.5 U.S. gal)
System (Excluding Reservoir)	7.6 L (2 U.S. gal approximate)

Brakes

Type Dual Disc (Mechanical)	20.3 cm (8 in.)

Wheels/Tires

Front . . . . . 20 x 10-10
Steer. . . . . 20 x 10-8
Mowing Speed . . . . . 0-8.0 km (0-5 mph)
Transport Speed . . . . . 0-12.8 km (0-8 mph)
Reverse Speed . . . . . 0-8 km (0-5 mph)

Instrumentation

Engine Oil Pressure . . . . . Warning light
Alternator . . . . . Warning light
Hydraulic Oil Temperature. . . . . Warning light
Engine Coolant Temperature. . . . . Warning light
Hour Meter. . . . . Gage

Fuel System

Fuel . . . . . Diesel
Fuel Filter . . . . . Replaceable in-line filter
Fuel Pump . . . . . Mechanical

Weight and Dimensions

Wheel Base . . . . . 140 cm (55 in.)
Tread Width . . . . . 132 cm (52 in.)
Mowing Position Width
26 in. Reels . . . . . 183 cm (72 in.)
30 in. Reels . . . . . 213 cm (84 in.)
Turning Radius Uncut Circle
26 in., Reels. . . . . 50.8 cm (20 in.)
30 in. Reels . . . . . 40.6 cm (16 in.)
Vehicle Weight . . . . . 703 kg (1550 lb)
Full Fluids, No Operator. . . . . 789 kg (1740 lb)
Ground Clearance . . . . . 7.6 cm (3 in.)

Hydraulic System

Reservoir

Capacity. . . . . 20.8 L (5.5 U.S. gal)
Filtration . . . . . 10 micron
Reel Circuit Pressure . . . . . 20 685 kPa (3000 psi)
Maximum Back Pressure . . . . . 1034 kPa (150 psi)
Maximum System Operating Temperature. . . . . 93°C (200°F)

Steering and Lift System

Input Torque (Powered) . . . . . 1.7-2.8 N•m @ 47.5 kPa tank pressure
. . . . . (15-25 lb-in. @ 100 psi tank pressure)
(Non-Powered) . . . . . 81.4 N•m (60 lb-ft)
Rotation Limits . . . . . None

Reel Drive System

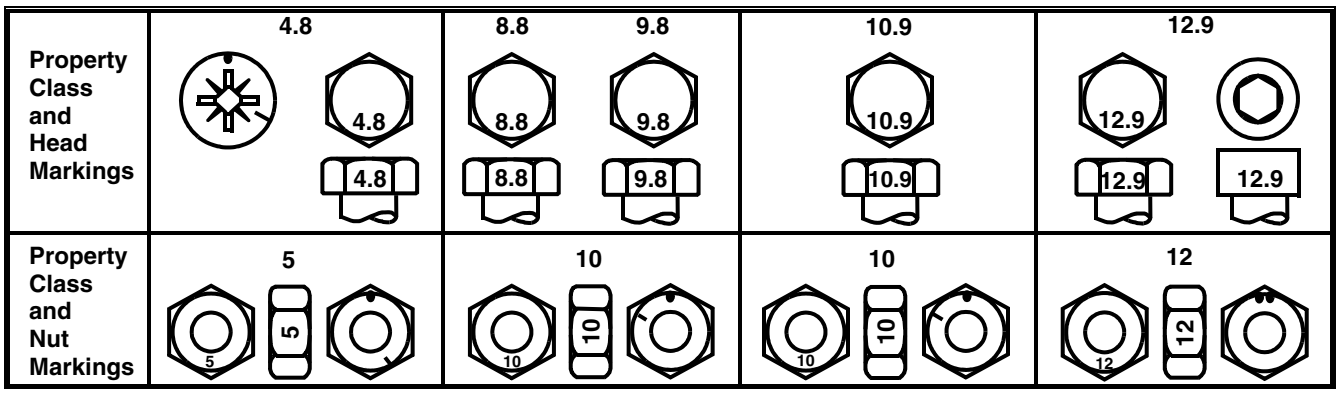
Reel Drive . . . . . **Hydraulic**
Pump . . . . . **Gear**
Reel Control Valves . . . . . **Electro-hydraulic**

Mower

Number **3**
Size (Floating Standard) . . . . . **66 or 76.2 cm (26 or 30 in.)**
Backlapping (Standard) . . . . . **On machine, variable adjustment**
Clip Frequency
5-Blade Cutting Units . . . . . **0.201 mph**
8-Blade Cutting Units . . . . . **0.126 mph**
Front Rollers . . . . . **Optional, grooved or smooth**
Reel Diameter . . . . . **17.8 cm (7 in.)**
Bed Knife or Reel Adjustment . . . . . **Reel-to-bed knife**
Height of Cut . . . . . **9.5 mm-76 mm (3/8-3.00 in.)**
Number of Blades . . . . . **5 or 8**

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.

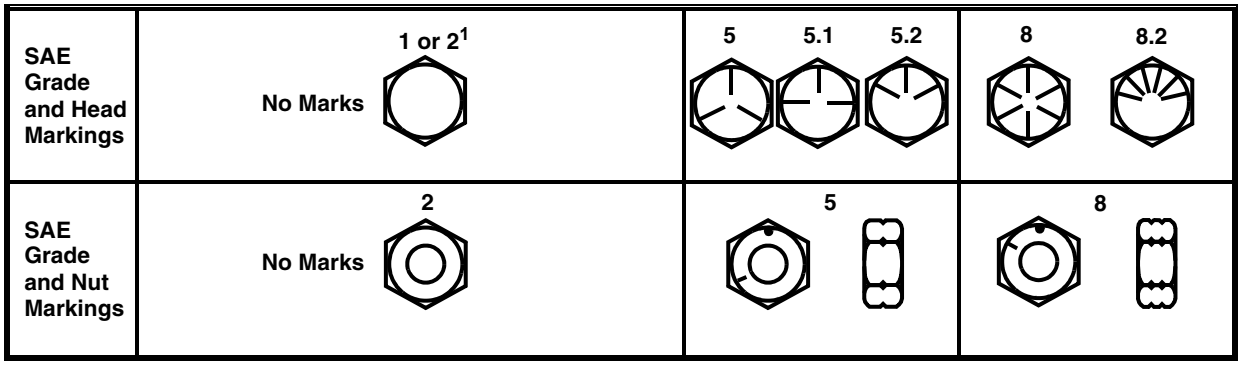
Tighten toothed or serrated-type lock nuts to the full torque value.

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



MIF (TS1162)

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

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

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

DO NOT use these hand torque values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only and include a ±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.

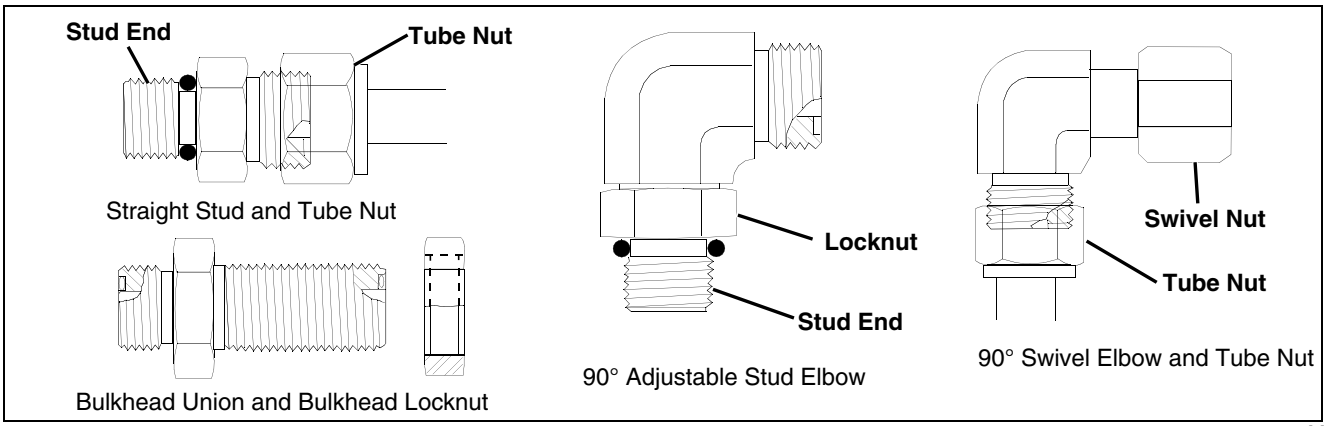
Fasteners should be replaced with the same grade. Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

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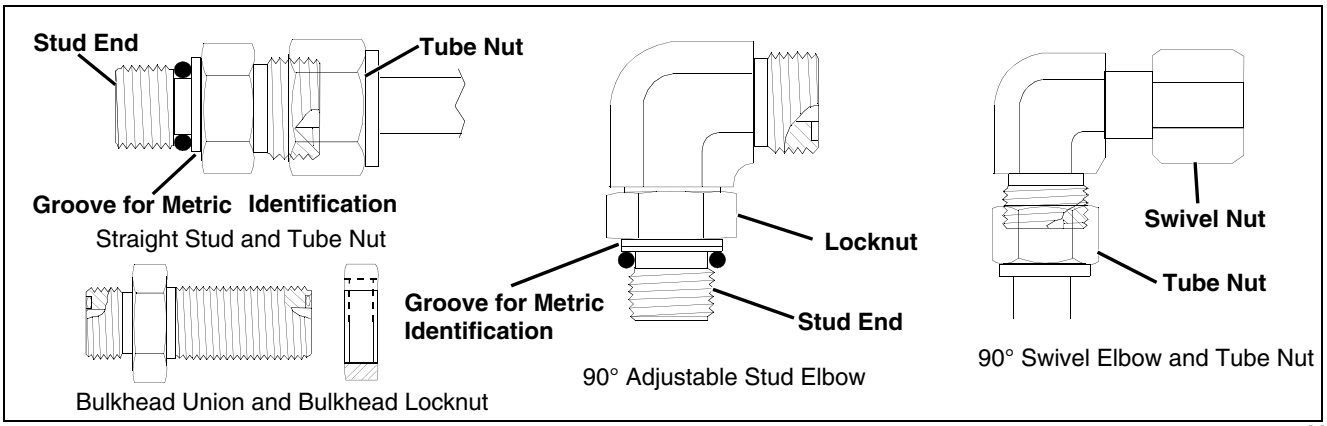
Nominal Tube OD/Hose ID				Face Seal Tube/Hose End					O-Ring Stud Ends		
Metric Tube OD	Inch Tube OD			Thread Size	Tube Nut/ Swivel Nut Torque		Bulkhead Locknut Torque		Thread Size	Straight Fitting or Locknut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
	-3	0.188	4.76						3/8-24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

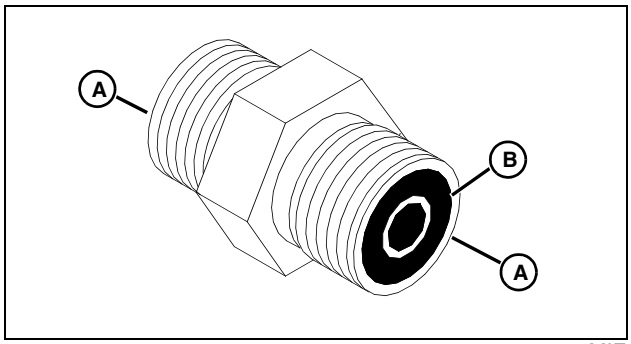


MIF

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-ring and install into groove using petroleum jelly to hold in place.

4. Push O-ring into the groove with plenty of petroleum jelly so O-ring is not displaced during assembly.

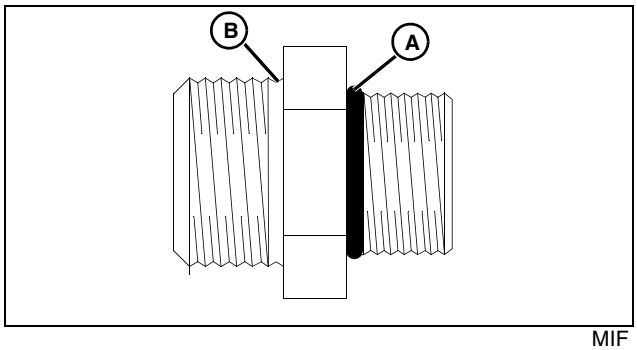
5. Index angle fittings and tighten by hand-pressing joint together to ensure O-ring remains in place.

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

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

O-Ring Boss Fittings

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



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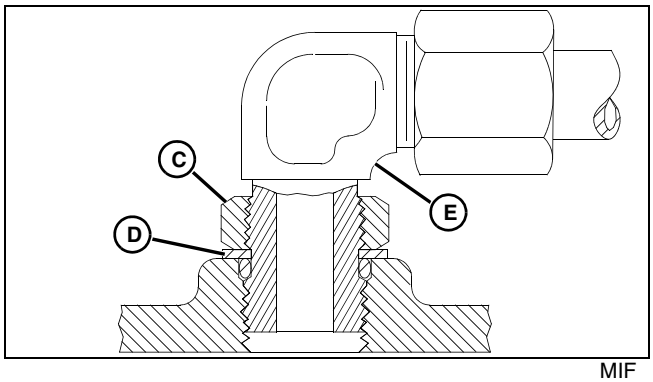
2. Put hydraulic oil or petroleum jelly on the O-ring (A). Place electrical tape over the threads to protect O-ring from nicks. Slide O-ring over the tape and into the groove (B) of fitting. Remove tape.



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3. For angle fittings, loosen special nut (C) and push special washer (D) against threads so O-ring can be installed into the groove of fitting.

4. Turn fitting into the boss by hand until special washer or washer face (straight fitting) contacts boss face and O-ring is squeezed into its seat.

5. To position angle fittings (E), turn the fitting counter-clockwise a maximum of one turn.

6. Tighten straight fittings to torque value shown on chart. For angle fittings, tighten the special nut to value shown in the chart while holding body of fitting with a wrench.

Straight Fitting or Special Nut Torque

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

1. Torque tolerance is ±10 percent.

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

Diesel Fuel - North America

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

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

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

- Cetane Number 40 (Min)

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

- Cold Filter Plugging Point (CFPP)

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

- Sulfur Content of 0.05% (Max)

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

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

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

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

Diesel Fuel - Europe

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

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

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

- Cetane Number 40 (Min)

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

- Cold Filter Plugging Point (CFPP)

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

- Sulfur Content of 0.05% (Max)

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

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

Diesel Fuel Lubricity

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

Diesel Fuel Storage

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

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

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

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

4-Cycle Diesel Engine Oil - North America

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

The following John Deere oils are PREFERRED:

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

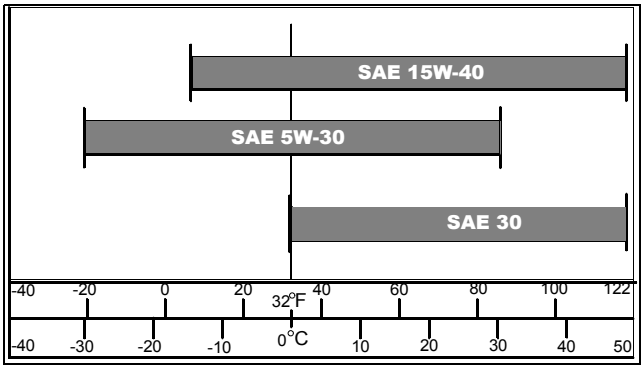
The following John Deere oils are also recommended, based on their specified temperature range:

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

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

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

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



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

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

4-Cycle Diesel Engine Oil - Europe

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

The following John Deere oils are PREFERRED:

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

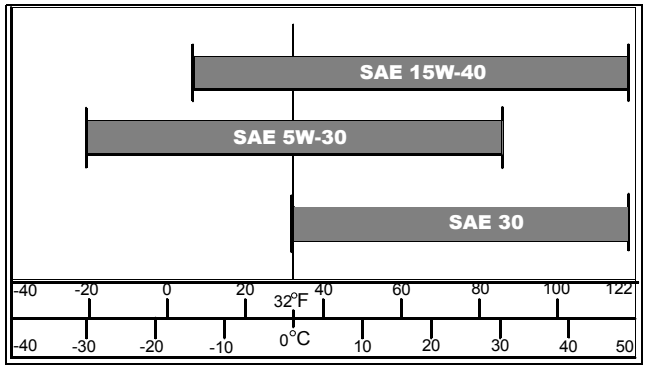
The following John Deere oils are also recommended, based on their specified temperature range:

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

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

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

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



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

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

Hydrostatic Transmission and Hydraulic Oil - North America and Europe

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

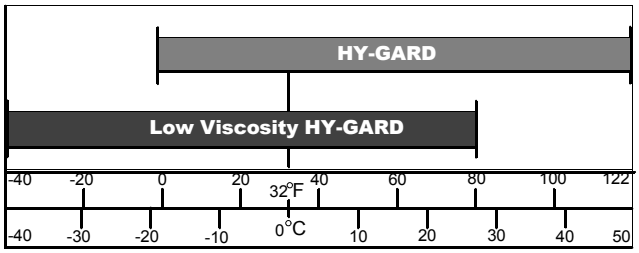
IMPORTANT: Avoid damage! DO NOT use engine oil or "Type F" (Red) Automatic Transmission Fluid in this transmission. DO NOT mix any other oils in this transmission.

The following John Deere transmission and hydraulic oil is PREFERRED:

- **HY-GARD-JDM J20C.™**
- **Low Viscosity HY-GARD®-JDM J20D.™**

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

- John Deere Standard JDM J20C or J20D.



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

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

Reel Support Bearing Grease - North America

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

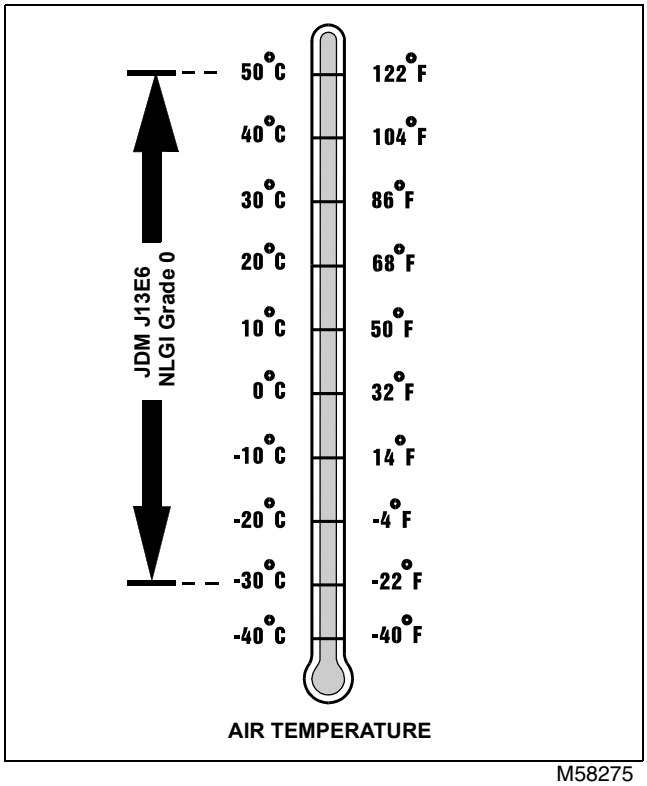
The following John Deere grease is PREFERRED:

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

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

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

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



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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.

Reel Support Bearing Grease - Europe

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

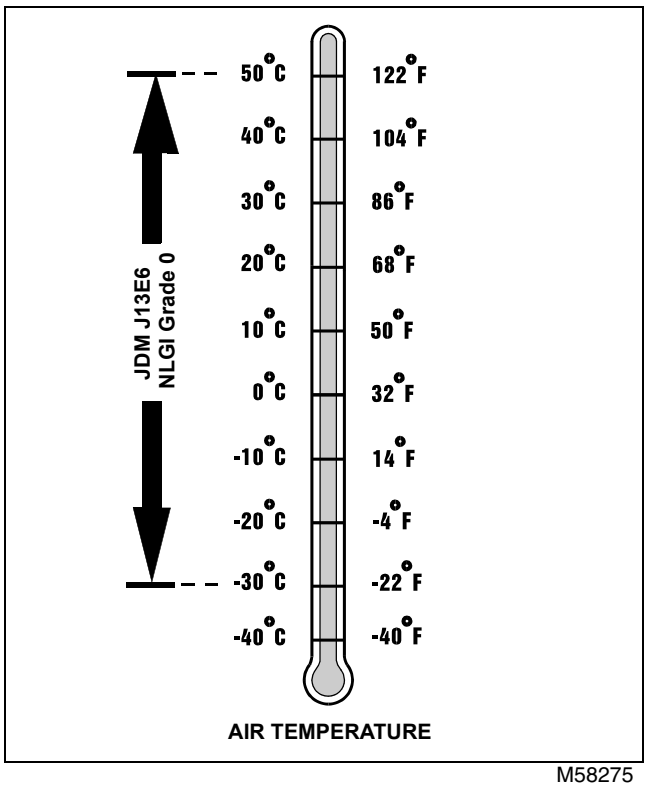
The following John Deere grease is PREFERRED:

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

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

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

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



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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.

Chassis and Roller Water Resistant Grease

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

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

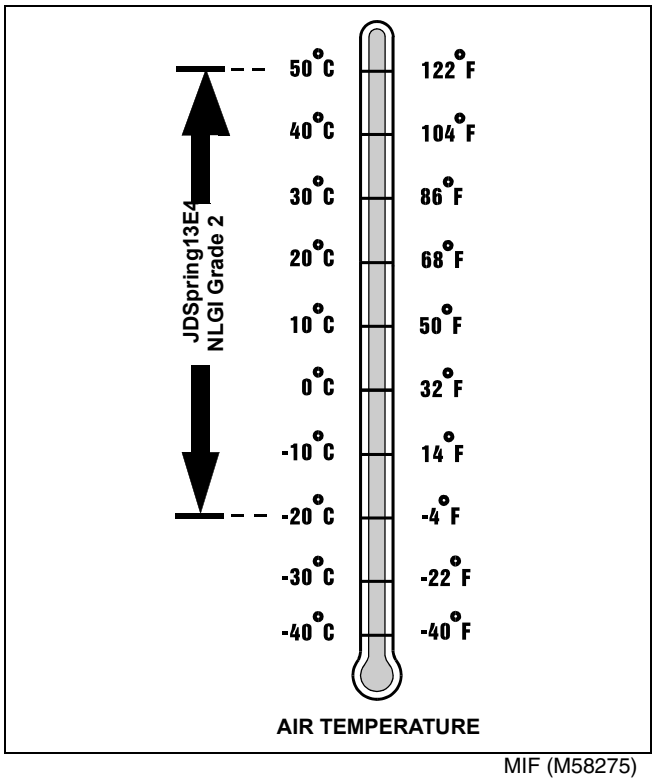
- **Special Purpose HD Water Resistant Grease - TY24425.**

The following water resistant grease may also be used:

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

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

- John Deere Standard JDM J13E4, NLGI Grade 2.



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Alternative Lubricants

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

IMPORTANT: Avoid damage! Use of alternative lubricants could cause reduced life of the component.

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

Synthetic Lubricants

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

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

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

Lubricant Storage

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

Oil Filters

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

The following John Deere oil filters are PREFERRED:

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

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

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

- ASTB Tested in Accordance with SAE J806.

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

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

Engine Coolant

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 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.

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 SO4), 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 -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.

Engine Coolant Drain Interval

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.

ENGINE - DIESEL TABLE OF CONTENTS

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Specifications

General Specifications

Make	Yanmar
Model	3TNE68
Type	4-cycle diesel
Gross Output Power	13.8 kW (18 hp)
Bore	68 mm (2.68 in.)
Stroke	72 mm (2.83 in.)
Cylinders	3
Valves	Overhead
Displacement	0.784 L (47.8 cu in.)
Maximum Torque at 2400 RPM	61.7 N•m (45.5 lb-ft)
Firing Order	1-3-2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Combustion System	Indirect injection type
Compression Ratio	23:1
Oil Capacity with Filter (Approximate)	2.4 L (2.5 qt)
Cooling	Liquid with pump and radiator
Governor	Centrifugal
Slow Idle (No Load)	1450 ± 100 rpm
Fast Idle (No Load)	3225 ± 50 rpm
Fuel Filter/Water Separator	Replaceable element fuel water separator
Air Filter	Dry replaceable primary and secondary elements
Weight (Approximate)	81 kg (179 lb)

Test and Adjustment Specifications

Alternator Drive Belt Deflection at 98 N (22 lb-force)	10-15 mm (0.40-0.60 in.)
Valve Clearance	0.2 mm (0.008 in.)
Cylinder Compression Pressure (Minimum)	2549 kPa (369 psi)
Pressure Difference Between Cylinders (Maximum)	241 kPa (35 psi)
Engine Oil Pressure at Rated Speed	297-393 kPa (43-57 psi)
Fuel Pump Pressure (Minimum)	29 kPa (4.3 psi)
Slow Idle Speed	1450 ± 100 rpm
Fast Idle Speed	3225 ± 50 rpm

Fuel Injection Nozzles

Opening Pressure	**11 722 ± 480 kPa (1700 ± 70 psi)**
Leakage at 11 032 kPa (1600 psi)	**No leakage for 10 seconds (minimum)**

Chatter and Spray Pattern
At 11 722 ± 480 kPa (1700 ± 70 psi)

Slow Hand Lever Movement	**Chatter sound**
Slow Hand Lever Movement	**Fine stream, 5°-10° spray pattern**
Fast Hand Lever Movement	**Fine atomized spray, 5°-10° spray pattern**

Fuel Injector Torque	**51 N•m (38 lb-ft)**
Cooling System Pressure (Maximum Applied)	**177 kPa (17 psi)**
Cooling System Pressure (Minimum after 15 Sec)	**88 ± 15 kPa (12.8 ± 2.2 psi)**
Radiator Cap Valve Opening Pressure	**90 kPa (13 psi)**
Thermostat Begin Opening Temperature	**69.5°-72.5°C (157°-163°F)**
Thermostat Fully Open Temperature	**85°C (185°F)**
Lift Height Above 85°C (185°F) (Minimum)	**4.5 mm (0.177 in.)**
Cylinder Pressure (Maximum Applied)	**2448 kPa (355 psi)**

Repair Specifications

Cooling System Capacity (Approximate)	**3.5 L (3.7 qt)**
Engine Oil Capacity with Filter (Approximate)	**2.4 L (2.5 qt)**

Rocker Arm

Rocker Arm Shaft OD Wear Limit	**9.95 mm (0.391 in.)**
Rocker Arm and Shaft Support ID Wear Limit	**10.09 mm (0.397 in.)**
Rocker Arm and Shaft Support Oil Clearance Wear Limit	**0.14 mm (0.006 in.)**
Push Rod Bend	**0.00-0.03 mm (0.000-0.001 in.)**

Cylinder Head Distortion

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

Valve Seat Width

Intake Standard	**1.15 mm (0.045 in.)**
Intake Wear Limit	**1.65 mm (0.065 in.)**
Exhaust Standard	**1.41 mm (0.056 in.)**
Exhaust Wear Limit	**1.91 mm (0.075 in.)**

Valve Grinding

Intake Valve Face Margin	**0.99-1.29 mm (0.039-0.051 in.)**
Exhaust Valve Face Margin	**0.95-1.25 mm (0.037-0.049 in.)**
Valve Face Margin Wear Limit	**0.50 mm (0.020 in.)**
Intake Valve Face Angle	**30°**
Exhaust Valve Face Angle	**45°**

Valve Stem

Measuring Point (3) Distance	20 mm (0.787 in.)
Measuring Point (4) Distance	40 mm (1.575 in.)
Intake Valve Stem Standard OD	5.46-5.48 mm (0.215-0.216 in.)
Intake Valve Stem OD Wear Limit	5.40 mm (0.213 in.)
Exhaust Valve Stem Standard OD	5.45-5.46 mm (0.214-0.215 in.)
Exhaust Valve Stem OD Wear Limit	5.40 mm (0.213 in.)

Valve Recession

Intake Valve Standard Recession	0.30-0.50 mm (0.012-0.020 in.)
Intake Valve Recession Wear Limit	1.0 mm (0.039 in.)
Exhaust Valve Standard Recession	0.75-0.95 mm (0.030-0.037 in.)
Exhaust Valve Recession Wear Limit	1.0 mm (0.039 in.)

Valve Guides

Valve Guide Standard ID	5.50-5.52 mm (0.216-0.217 in.)
Valve Guide ID Wear Limit	5.58 mm (0.22 in.)
Intake Valve Guide-to-Valve Stem Standard Oil Clearance	0.03-0.06 mm (0.001-0.002 in.)
Exhaust Valve Guide-to-Valve Stem Standard Oil Clearance	0.04-0.07 mm (0.002-0.003 in.)
Valve Guide-to-Valve Stem Oil Clearance Wear Limit (Both)	0.18 mm (0.007 in.)
Valve Guide Knurling Clearance (Maximum)	0.127-0.178 mm (0.005-0.007 in.)
Valve Guide Replacement Clearance	0.20 mm (0.008 in.)
Valve Guide Height	7 mm (0.276 in.)

Valve Springs

Spring Free Length	28 mm (1.102 in.)
Spring Inclination (Maximum)	0.8 mm (0.03 in.)

Piston-to-Cylinder Head Clearance	0.61-0.73 mm (0.024-0.028 in.)

Connecting Rod Bearings

Connecting Rod Bearing ID Wear Limit	39.02 mm (1.536 in.)
Connecting Rod Bearing Standard Oil Clearance	0.033-0.059 mm (0.001-0.002 in.)
Connecting Rod Bearing Oil Clearance Wear Limit	0.15 mm (0.006 in.)

Piston Rings

Top Piston Ring Groove Side Clearance	0.06-0.10 mm (0.002-0.004 in.)
Middle Piston Ring Groove Side Clearance	0.090-0.125 mm (0.004-0.005 in.)
Oil Control Ring Groove Side Clearance	0.020-0.055 mm (0.0008-0.0022 in.)
Piston Ring Standard End Gap (All Except Oil Control Ring)	0.20-0.40 mm (0.008-0.016 in.)
Oil Control Ring Standard End Gap	0.15-0.35 mm (0.006-0.014 in.)
Piston Ring End Gap Wear Limit	1.50 mm (0.059 in.)

Piston Pins

Piston Pin Standard OD	19.99-20.00 mm (0.787-0.787 in.)
Piston Pin OD Wear Limit	19.90 mm (0.783 in.)

Piston Pin Bores

Bore Standard ID	20.00-20.01 mm (0.787-0.788 in.)
Bore ID Wear Limit	20.02 mm (0.789 in.)

Piston Pin Bushings

Bushing Standard ID	20.025-20.038 mm (0.788-0.789 in.)
Bushing ID Wear Limit	20.10 mm (0.791 in.)
Piston Pin-to-Rod Bore Standard Oil Clearance	0.025-0.047 mm (0.001-0.002 in.)
Piston Pin-to-Rod Bore Oil Clearance Wear Limit	0.20 mm (0.008 in.)
Pin-to-Bushing Clearance Wear Limit	0.20 mm (0.008 in.)

Pistons

Diameter Measuring Point (1) Distance	24 mm (0.945 in.)
Standard Size Piston Standard OD	67.94-67.97 mm (2.675-2.676 in.)
Standard Size Piston OD Wear Limit	67.90 mm (2.673 in.)
Oversize Piston Standard OD	68.19-68.23 mm (2.685-2.686 in.)
Oversize Piston OD Wear Limit	68.19 mm (2.685 in.)

Connecting Rods

Side Play	0.40 mm (0.016 in.)
Connecting Rod Bearing ID	39.02 mm (1.536 in.)
Bearing Standard Clearance	0.03-0.06 mm (0.001-0.002 in.)
Bearing Clearance Wear Limit	0.15 mm (0.006 in.)

Cylinder Bore

Piston-to-Cylinder Bore Clearance	0.03-0.06 mm (0.001-0.002 in.)
Cylinder Standard Roundness	0.00-0.01 mm (0.0000-0.0004 in.)
Cylinder Roundness Wear Limit	0.03 mm (0.001 in.)
Cylinder Standard Taper	0.00-0.01 mm (0.0000-0.0004 in.)
Cylinder Taper Wear Limit	0.03 mm (0.001 in.)
Standard Size Cylinder Bore Standard ID	68.00-68.03 mm (2.677-2.678 in.)
Standard Size Cylinder Bore ID Wear Limit	68.20 mm (2.685 in.)
Oversize Cylinder Bore Standard ID	68.25-68.28 mm (2.687-2.688 in.)
Oversize Cylinder Bore ID Wear Limit	68.45 mm (2.695 in.)

Flywheel

Out-of-Flat (Maximum)	0.02 mm (0.001 in.)

Crankshaft and Main Bearings

Crankshaft Bend (Maximum)	0.02 mm (0.001 in.)
Crankshaft Connecting Rod Journal Standard OD	35.97-35.98 mm (1.416-1.417 in.)
Crankshaft Connecting Rod Journal OD Wear Limit	35.91 mm (1.414 in.)
Crankshaft Main Bearing Journal Standard OD	39.97-39.98 mm (1.573-1.574 in.)
Crankshaft Main Bearing Journal OD Wear Limit	39.90 mm (1.571 in.)
Main Bearing Standard Oil Clearance	0.03-0.06 mm (0.001-0.002 in.)
Main Bearing Oil Clearance Wear Limit	0.15 mm (0.006 in.)

Camshaft

Standard Bend	0.02 mm (0.0008 in.)
Bend Wear Limit	0.05 mm (0.002 in.)
Standard Lobe Height	29.97-30.03 mm (1.180-1.182 in.)
Lobe Height Wear Limit	29.75 mm (1.171 in.)
Gear Housing and Flywheel End Journal Standard OD	35.94-35.96 mm (1.415-1.416 in.)

Gear Housing and Flywheel End Journal OD Wear Limit	35.85 mm (1.411 in.)
Intermediate Journal Standard OD	35.91-35.94 mm (1.414-1.415 in.)
Intermediate Journal OD Wear Limit	35.85 mm (1.411 in.)
Camshaft Bushing Standard ID	35.98-36.05 mm (1.417-1.419 in.)
Camshaft Bushing ID Wear Limit	36.05 mm (1.419 in.)
Camshaft Intermediate Bore Standard ID	35.98-36.05 mm (1.417-1.419 in.)
Camshaft Intermediate Bore ID Wear Limit	36.05 mm (1.419 in.)
Camshaft Flywheel-End Bore Standard ID	35.98-36.05 mm (1.417-1.419 in.)
Camshaft Flywheel-End Bore ID Wear Limit	36.05 mm (1.419 in.)
Bore Oil Clearance (Maximum)	0.20 mm (0.008 in.)
Bearing-to-Camshaft Gear Housing End Journal Clearance (Wear Limit)	0.85 mm (0.003 in.)
Bearing-to-Camshaft Intermediate Journals Clearance (Wear Limit)	0.115 mm (0.005 in.)
Bearing-to-Camshaft Flywheel End Journal Clearance (Wear Limit)	0.125 mm (0.005 in.)

Camshaft Followers

Standard OD	17.95-17.97 mm (0.706-0.707 in.)
OD Wear Limit	17.93 mm (0.706 in.)
Bore Standard ID	18.00-18.02 mm (0.708-0.709 in.)
Bore ID Wear Limit	18.05 mm (0.711 in.)
Tappet-to-Bore Standard Oil Clearance	0.03-0.07 mm (0.001-0.003 in.)
Tappet-to-Bore Oil Clearance Wear Limit	0.12 mm (0.005 in.)

Idler Gear

Shaft Standard OD	19.96-19.98 mm (0.786-0.787 in.)
Shaft OD Wear Limit	19.93 mm (0.785 in.)
Idler Gear Bushing Standard ID	20.00-20.02 mm (0.787-0.788 in.)
Bushing ID Wear Limit	20.02 mm (0.789 in.)
Oil Clearance	0.020-0.062 mm (0.0008-0.0024 in.)
Oil Clearance Wear Limit	0.15 mm (0.006 in.)

Oil Pump

Gear Backlash	0.11-0.19 mm (0.004-0.007 in.)
Standard Rotor Shaft OD-to-Housing ID Clearance	0.013-0.043 mm (0.0005-0.0017 in.)
Rotor Shaft OD-to-Housing Clearance Wear Limit	0.2 mm (0.008 in.)
Standard Rotor-to-Pump Housing Side Clearance	0.03-0.9 mm (0.001-0.004 in.)
Rotor-to-Pump Housing Side Clearance Wear Limit	0.13 mm (0.005 in.)
Standard Outer Rotor-to-Pump Body Clearance	0.10-0.16 mm (0.004-0.006 in.)
Outer Rotor-to-Pump Body Clearance Wear Limit	0.25 mm (0.006 in.)
Inner Rotor-to-Outer Rotor Clearance (Maximum)	0.15 mm (0.006 in.)

Fuel Injection Nozzles

Separator Plate Contact Surface	0.10 mm (0.004 in.)

Alternator

Rotor Slip Ring Outside Diameter (Wear Limit)	14 mm (0.55 in.)
Brush Length (Minimum)	4.5 mm (0.17 in.)

Torque Specifications

Cylinder Head Mounting Torque

First	13 N•m (115 lb-in.)
Second	26 N•m (20 lb-ft)
Final	39 N•m (29 lb-ft)

12V Alternator Pulley Retaining Nut Torque	69 N•m (51 lb-ft)
Exhaust Manifold Mounting Cap Screw Torque	28 N•m (240 lb-in.)
Intake Manifold Mounting Cap Screw Torque	11 N•m (97 lb-in.)
Glow Plug Torque	19 N•m (168 lb-in.)
Rocker Arm Cover Special Nut Torque	18 N•m (160 lb-in.)
Rocker Arm Assembly Mounting Nut Torque	26 N•m (226 lb-in.)
Connecting Rod Cap Screw Torque	24 N•m (18 lb-ft)
Flywheel Mounting Cap Screw Torque	83 N•m (61 lb-ft)
Flywheel Adapter Plate Cap Screw Torque	68 N•m (50 lb-ft)
Crankshaft Pulley Cap Screw Torque	88 N•m (65 lb-ft)
Main Bearing Cap Screw Torque	54 N•m (40 lb-ft)
Camshaft Thrust Plate Cap Screw Torque	11 N•m (96 lb-in.)
Timing Gear Cover Mounting Cap Screw Torque	9 N•m (78 lb-in.)
Timing Gear Housing Mounting Cap Screw Torque	11 N•m (96 lb-in.)
Oil Pan Cap Screw Torque	4.8 N•m (42 lb-in.)
Fuel Pump Cap Screw Torque	11 N•m (96 lb-in.)
Oil Pressure Regulating Valve Retaining Nut Torque	30 N•m (22 lb-ft)

Fuel Injection Nozzles

Injection Nozzle Body Torque	51 N•m (37 lb-ft)
Leak-Off Fitting Nut Torque	32 N•m (24 lb-ft)

Tools and Materials

Special or Required Tools

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

Special or Required Tools

Tool Name	Tool No.	Tool Use
0-700 kPa (0-100 psi) Pressure Gage	JT07034	Used for engine oil pressure test.
Adapter	JDG472	Used for cylinder compression check and radiator bubble test.
Adapter Set	D01110AA	Used for fuel injection nozzle test.
Belt Tension Gage	JDG529 or JDST28	Used to adjust the coolant pump/alternator drive belt tension.
Bushing, Bearing, and Seal Driver Set	NA	Used for removing and installing bushings, bearings, and seals.
Compression Gage Assembly	JT01682	Used for cylinder compression check.
Connector	JT03349	Used for engine oil pressure test.
Cooling System Pressure Pump	D05104ST	Used for cooling system pressure test.
Cylinder Leakdown Tester	JT03502	Used to test cylinders for compression pressure leakdown.
Dial Indicator with Magnetic Base	NA	Used to measure valve lift, end play, and backlash.
Fuel Control Screw Adjustment Tool	JDG1060	Used to adjust fuel control screw.
Spring	M72632	Used to compress governor spring.
Diesel Fuel Injection Nozzle Tester	D01109AA	Used for fuel injection nozzle test.
Fuel Injection Timing Tool	DFMZ1A	Used to set injection pump timing.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Pulse Tachometer	JT07270	Used to set slow idle speed and check fast idle speed.
Flex Hone (with 180-Grit Stone)	NA	Used to deglaze cylinder bores.
Fuel Pump Pressure Test Kit	JDG356	Used for fuel pump pressure test.
Hose Assembly	JT03017	Used for engine oil pressure test.
Lifting Bracket (2 used)	JT01748	Used with hoist for removing and installing cylinder head and flywheel.
Magnetic Follower Holder Kit	D15001NU	Used to hold cam followers when removing and installing camshaft.
Nozzle Cleaning Kit	JDF13	Used to clean fuel injection nozzles.
PLASTIGAGE® Bearing Clearance Measurement Tool	NA	Used to measure clearances.
Radiator Pressure Test Kit (Adapters)	JDG692	Used for cooling system pressure test.
Ridge Reamer	NA	Used to remove ridges from cylinder bore.
Rigid Hone (with 300-Grit Stone)	NA	Used with drill press to rebore cylinder to use oversize pistons and rings.
Straightedge		Used to measure drive belt deflection.
Straight Adapter	23622	Used for fuel injection nozzle test.
Valve Guide Driver	JDE504	Used to install valve guides in cylinder head.
Valve Guide Knurler	D-20019WI	Used to knurl inside diameter of valve guides.
Valve Guide Reamer	D-20021WI	Used to ream out valve guides.
Valve Spring Compressor	JDE138	Used to remove valves.

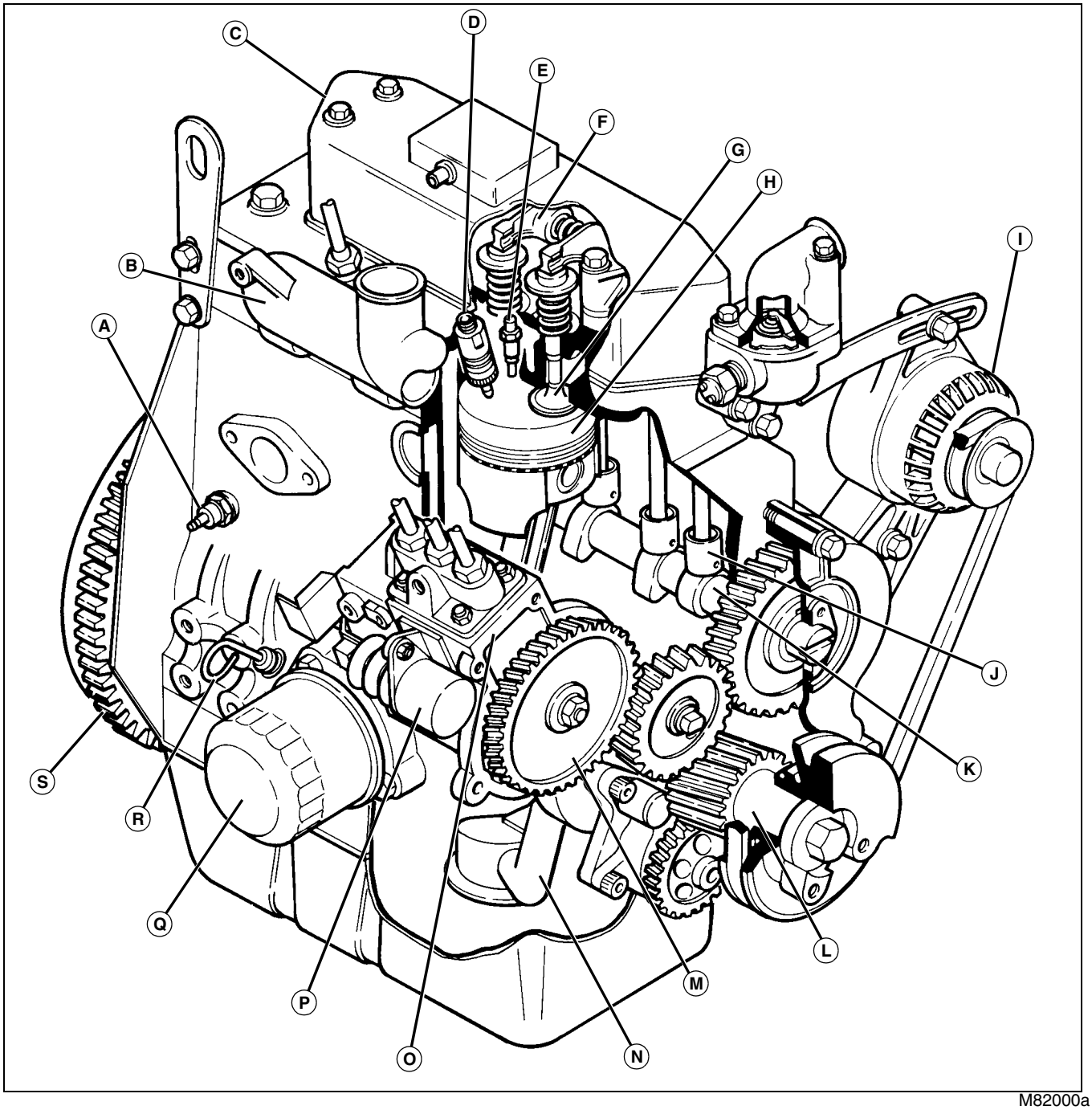
Other Material

Other Material

Part No.	Part Name	Part Use
TY16021 (U.S.)/ TY9484 (Canada)	John Deere High-Flex Form-in-Place Gasket	Used to seal crankcase extension housing, rear oil seal case, and flywheel housing to engine block. Used to seal oil pan to timing gear housing and engine block.
T43512 (U.S.)/ TY9473 (Canada)	Thread Lock and Sealer (Medium Strength)	Applied to threads of crankshaft sheave cap screws before installation.
TY9375 (U.S.)/ TY9480 (Canada)	Pipe Sealant	Applied to threads of dual temperature coolant switch before installation.

Component Location

Engine



M82000a

A - Oil Pressure Switch
B - Intake Manifold
C - Rocker Arm Cover
D - Fuel Nozzle
E - Glow Plug
F - Rocker Arm
G - Valves
H - Piston
I - Alternator
J - Tappets
K - Camshaft
L - Crankshaft
M - Injector Pump Drive Gear
N - Oil Sump

O - Fuel Injection Pump
P - Fuel Shutoff Solenoid
Q - Oil Filter
R - Oil Dipstick
S - Flywheel

Theory of Operation

Cooling System Operation

Function

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

Theory of Operation

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

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

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

From the block, coolant is then directed through the cylinder head, and into thermostat housing. With the thermostat open, 82° C (180° F), warm engine coolant passes through the housing into the top of the radiator where it is circulated to dissipate heat.

When coolant system pressure exceeds 48 kPa (7 psi), a valve in the radiator cap opens to allow coolant to discharge into the coolant recovery tank.

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

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

Lubrication System Operation

Function

A full pressure system lubricates engine parts with clean oil.

Theory of Operation

The pressure lubrication system consists of 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 are provided to direct oil to the camshaft bearings.

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

Oil passages direct from the main oil galley, through external oil lines, route lubricating oil to the fuel injection pump.

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

Fuel And Air System Operation

Function

Fuel system supplies fuel to injection nozzles.

The air intake system filters air needed for combustion.

Fuel System

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

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

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

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

The injection nozzle prevents flow until high pressure is reached, opening the valve and spraying atomized fuel into the combustion chamber. Injection lines have trapped fuel whenever injection is not taking place.

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

Air System

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

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

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) 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.

(5) Correct type of fuel being used?

Yes - Go to step (6).

No - Drain and replace fuel.

(6) Engine oil of correct viscosity and type?

Yes - Go to step (7).

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

(7) No water in fuel?

Yes - Go to step (8).

No - Drain and replace fuel.

(8) Fuel filter not clogged?

Yes - Go to step (9).

No - Replace fuel filter.

Symptom: Engine Will Not Start

(9) No air leak in fuel system?

Yes - Go to step (10).

No - Repair fuel system.

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

Yes - Go to step (11).

No - Repair or replace fuel lines as needed.

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

Yes - Go to step (12).

No - Replace fuel transfer pump.

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

Yes - Go to step (13).

No - Adjust valve clearance. (See "Adjust Valve Clearance" on page 49.)

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

Yes - Go to step (14).

No - Replace valve and check valve guide. (See "Recondition Cylinder Head" on page 86.)

(14) Piston rings not broken or seized?

Yes - Go to step (15).

No - Replace rings. Check piston and cylinder. (See "Remove and Install Piston and Connecting Rod" on page 91. See "Cylinder Bore" on page 99.)

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

Yes - Go to step (16).

No - Replace piston and/or rings. Bore or hone cylinder. (See "Remove and Install Piston and Connecting Rod" on page 91. See "Cylinder Bore" on page 99.)

(16) Crankshaft pin or bearing not seized?

Yes - Go to step (17).

No - Regrind crankshaft and replace bearings. (See "Crankshaft and Main Bearings" on page 102.)

(17) Is injection pump timing correct?

No - See "Injection Pump Static Timing" on page 63.

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

(1) Correct type of fuel being used?

Yes - Go to step (2).

No - Drain and replace fuel.

(2) Engine oil of proper viscosity and type?

Yes - Go to step (3).

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

(3) Fuel filter not clogged?

Yes - Go to step (4).

No - Replace fuel filter.

(4) No air leak in fuel system?

Yes - Go to step (5).

No - Repair fuel system.

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

Yes - Go to step (6).

No - Repair or replace fuel lines as needed.

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

Yes - Go to step (7).

No - Replace fuel transfer pump.

(7) Valve clearance correct?

No - Adjust valve clearance. (See “Adjust Valve Clearance” on page 49.)

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

(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.

(3) Fuel filter not clogged?

Yes - Go to step (4).

No - Replace fuel filter.

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

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

Yes - Go to step (5).

No - Repair as necessary. (See “Recondition Cylinder Head” on page 86.)

(5) Piston rings not broken or seized?

Yes - Go to step (6).

No - Replace rings. Check piston and cylinder. (See “Remove and Install Piston and Connecting Rod” on page 91. See “Cylinder Bore” on page 99.)

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

No - Replace piston and/or rings. Bore or hone cylinder. (See “Remove and Install Piston and Connecting Rod” on page 91. See “Cylinder Bore” on page 99.)

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) Fuel filter not clogged?

Yes - Go to step (3).

No - Replace fuel filter.

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

Yes - Go to step (4).

No - Clean or replace fuel lines.

(4) No air leakage into fuel system?

Yes - Go to step (5).

No - Repair fuel supply system.

(5) Proper volume of fuel to injection pump?

Yes - Go to step (6).

No - Check or replace fuel transfer pump.

(6) Intake and exhaust valve clearance correct?

Yes - Go to step (7).

No - Adjust valve clearance. (See “Adjust Valve Clearance” on page 49.)

Symptom: Low Engine Output - Exhaust Color NORMAL

(7) Intake or exhaust valves not leaking compression?

Yes - Go to step (8).

No - Grind valves and seats. (See “Recondition Cylinder Head” on page 86.)

(8) Intake or exhaust valves not seized?

Yes - Go to step (9).

No - Replace valve and check valve guide. (See “Recondition Cylinder Head” on page 86.)

(9) Cylinder head gasket not leaking compression?

No - Replace head gasket. (See “Remove and Install Cylinder Head” on page 84.) Resurface head and block if necessary. (See “Cylinder Head Distortion” on page 90.)

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 injector pump or fuel injectors.

(4) Proper spray pattern from injectors?

Yes - Go to step (5).

No - Clean or replace fuel injector nozzles. (See “Remove, Inspect, and Install Fuel Injection Nozzle” on page 122.)

(5) Intake or exhaust valve stems not worn?

Yes - Go to step (6).

No - Replace valve guides and valves. (See “Recondition Cylinder Head” on page 86.)

Symptom: Low Engine Output - Exhaust Color WHITE

(6) Is injection pump timing correct?

Yes - Go to step (7).

No - See “Injection Pump Static Timing” on page 63.

(7) Piston rings installed correctly?

Yes - Go to step (8).

No - Install piston rings correctly. (See “Remove and Install Piston and Connecting Rod” on page 91.)

(8) Piston ring ends staggered?

Yes - Go to step (9).

No - Stagger piston ring ends. (See “Remove and Install Piston and Connecting Rod” on page 91.)

(9) Piston rings, piston 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 91. See “Cylinder Bore” on page 99.)

(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 91. See “Cylinder Bore” on page 99.)

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.

Symptom: Low Engine Output - Exhaust Color BLACK

(4) Exhaust pipe not clogged?

Yes - Go to step (5).

No - Clean exhaust pipe.

(5) Engine running cool enough?

Yes - Go to step (6).

No - Check thermostat. (See “Test Thermostat” on page 67.) Replace if faulty. Adjust fan belt tension. (See “Check and Adjust Alternator Drive Belt Tension” on page 49.)

(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 injector pump or fuel injectors.

(8) Correct pattern from fuel injectors?

Yes - Go to step (9).

No - Clean or replace fuel injector nozzles. (See “Remove, Inspect, and Install Fuel Injection Nozzle” on page 122.)

(9) Is injector pump timing correct?

Yes - Go to step (10).

No - See “Injection Pump Static Timing” on page 63.

(10) Intake or exhaust valves not leaking compression?

Yes - Go to step (11).

No - Grind valves and seats. (See “Recondition Cylinder Head” on page 86.)

(11) Intake or exhaust valve not seized?

No - Replace valve and check valve guide. (See “Recondition Cylinder Head” on page 86.)

Symptom: Exhaust Color WHITE Under Load

(1) Correct type of fuel?

Yes - Go to step (2).

No - Drain and replace fuel.

Symptom: Exhaust Color WHITE Under Load

(2) No water in fuel?

Yes - Go to step (3).

No - Drain and replace fuel.

(3) Engine not running too cool?

Yes - Go to step (4).

No - Check thermostat. (See “Test Thermostat” on page 67.) Replace if faulty.

(4) Correct volume of fuel being injected?

Yes - Go to step (5).

No - Replace faulty fuel injector pump.

(5) Correct pattern from fuel injectors?

Yes - Go to step (6).

No - Clean or replace fuel injector nozzles. (See “Remove, Inspect, and Install Fuel Injection Nozzle” on page 122.)

(6) Is injector pump timing correct?

Yes - Go to step (7).

No - See “Injection Pump Static Timing” on page 63.

(7) Piston rings installed correctly?

Yes - Go to step (8).

No - Install piston rings correctly. (See “Remove and Install Piston and Connecting Rod” on page 91.)

(8) Pistons rings, piston 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 91. See “Cylinder Bore” on page 99.)

(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 91. See “Cylinder Bore” on page 99.)

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.

Symptom: Exhaust Color BLACK Under 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.

(5) Even volume of fuel being injected?

Yes - Go to step (6).

No - Replace faulty fuel injector pump or fuel injectors.

(6) Correct volume of fuel being injected?

Yes - Go to step (7).

No - Replace faulty fuel injector pump or fuel injectors.

(7) Proper spray pattern from injectors?

Yes - Go to step (8).

No - Clean or replace fuel injector nozzles. (See “Remove, Inspect, and Install Fuel Injection Nozzle” on page 122.)

(8) Is injector pump timing correct?

Yes - Go to step (9).

No - See “Injection Pump Static Timing” on page 63.

(9) Intake or exhaust valves not leaking compression?

Yes - Go to step (10).

No - Grind valves and seats. (See “Recondition Cylinder Head” on page 86.)

(10) Intake or exhaust valves not seized?

No - Replace valve and check valve guide. (See “Recondition Cylinder Head” on page 86.)

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.

Symptom: Exhaust Temperature Too High

(2) Engine running cool enough?

Yes - Go to step (3).

No - Check thermostat. (See “Test Thermostat” on page 67.) Replace if faulty. Adjust fan belt tension. (See “Check and Adjust Alternator Drive Belt Tension” on page 49.)

(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 injector 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 49.)

(6) Intake or exhaust valves not leaking compression?

Yes - Go to step (7).

No - Grind valves and seats. (See “Recondition Cylinder Head” on page 86.)

(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 91. See “Cylinder Bore” on page 99.)

Symptom: Engine Runs Rough - Misfiring

(1) No water in fuel?

Yes - Go to step (2).

No - Drain and replace fuel.

(2) Intake or exhaust valve clearance correct?

Yes - Go to step (3).

No - Adjust valve clearance. (See “Adjust Valve Clearance” on page 49.)

(3) Correct volume of fuel being injected?

Yes - Go to step (4).

No - Replace faulty fuel injector pump or fuel injectors.

Symptom: Engine Runs Rough - Misfiring

(4) Is injector pump timing correct?

Yes - Go to step (5).

No - See “Injection Pump Static Timing” on page 63.

(5) Backlash of timing gear not excessive?

Yes - Go to step (6).

No - Repair gears as needed. (See “Timing Gear Backlash Check” on page 110.)

(6) Combustion chambers clean of foreign matter?

Yes - Go to step (7).

No - Clean combustion chambers. (See “Remove and Install Cylinder Head” on page 84.)

(7) Intake or exhaust valves not leaking compression?

Yes - Go to step (8).

No - Grind valves and seats. (See “Recondition Cylinder Head” on page 86.)

(8) Intake or exhaust valves not seized?

Yes - Go to step (9).

No - Replace valve and check valve guide. (See “Recondition Cylinder Head” on page 86.)

(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 91. See “Cylinder Bore” on page 99.)

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) Air filter elements not clogged?

Yes - Go to step (4).

No - Clean or replace air filter elements.

Symptom: Engine Runs Rough - Uneven Combustion Sound

(4) Exhaust pipe not clogged?

Yes - Go to step (5).

No - Clean exhaust pipe.

(5) Intake and exhaust valve clearance correct?

Yes - Go to step (6).

No - Adjust valve clearance. (See “Adjust Valve Clearance” on page 49.)

(6) Even volume of fuel being injected?

Yes - Go to step (7).

No - Replace faulty fuel injector pump or fuel injectors.

(7) Proper spray pattern from injectors?

No - Clean or replace fuel injector nozzles. (See “Remove, Inspect, and Install Fuel Injection Nozzle” on page 122.)

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 injector pump or fuel injectors.

(3) Intake and exhaust valve clearance correct?

Yes - Go to step (4).

No - Adjust valve clearance. (See “Adjust Valve Clearance” on page 49.)

(4) Proper spray pattern from injectors?

Yes - Go to step (5).

No - Clean or replace fuel injector nozzles. (See “Remove, Inspect, and Install Fuel Injection Nozzle” on page 122.)

(5) Intake or exhaust valves not seized?

Yes - Go to step (6).

No - Replace valve and check valve guide. (See “Recondition Cylinder Head” on page 86.)

Symptom: Engine Runs Rough - Engine Surges DURING IDLING

(6) Piston rings not broken or seized?

No - Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See “Remove and Install Piston and Connecting Rod” on page 91. See “Cylinder Bore” on page 99.)

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 injector pump or fuel injectors.

(3) Proper spray pattern from injectors?

Yes - Go to step (4).

No - Clean or replace fuel injector nozzles. (See “Remove, Inspect, and Install Fuel Injection Nozzle” on page 122.)

(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 91. See “Cylinder Bore” on page 99.)

Symptom: Engine Runs Rough - Excessive Engine Vibration

(1) Even volume of fuel injected?

Yes - Go to step (2).

No - Replace faulty fuel injector pump or fuel injectors.

(2) Proper spray pattern from injectors?

Yes - Go to step (3).

No - Clean or replace fuel injector nozzles. (See “Remove, Inspect, and Install Fuel Injection Nozzle” on page 122.)

Symptom: Engine Runs Rough - Excessive Engine Vibration

(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 91. See “Cylinder Bore” on page 99.)

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

Yes - Go to step (5).

No - Regrind crankshaft and replace bearings. (See “Crankshaft and Main Bearings” on page 102.)

(5) Connecting rod bolts torqued properly?

No - Replace damaged components. (See “Remove and Install Piston and Connecting Rod” on page 91.)

Symptom: Excessive Fuel Consumption

(1) Engine not running too cool?

Yes - Go to step (2).

No - Check thermostat. (See “Test Thermostat” on page 67.) Replace if faulty.

(2) Correct volume of fuel being injected?

Yes - Go to step (3).

No - Replace faulty fuel injector pump or fuel injectors.

(3) Correct pattern from fuel injectors?

Yes - Go to step (4).

No - Clean or replace fuel injector nozzles. (See “Remove, Inspect, and Install Fuel Injection Nozzle” on page 122.)

(4) Intake or exhaust valves not leaking compression?

No - Grind valves and seats. (See “Recondition Cylinder Head” on page 86.)

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.

Symptom: Excessive Oil Consumption

(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 "Recondition Cylinder Head" on page 86.)

(4) Piston rings installed correctly and properly staggered?

Yes - Go to step (5).

No - Install piston rings correctly. (See "Remove and Install Piston and Connecting Rod" on page 91.)

(5) Pistons rings, piston 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 91. See "Cylinder Bore" on page 99.)

(6) Piston rings not broken or seized?

No - Replace rings. Check piston and cylinder. (See "Remove and Install Piston and Connecting Rod" on page 91. See "Cylinder Bore" on page 99.)

Symptom: Fuel Oil in Crankcase

(1) Correct volume of fuel being injected.

Yes - Go to step (2).

No - Replace faulty fuel injector 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 "Recondition Cylinder Head" on page 86.)

(3) Piston rings not broken or seized?

Yes - Go to step (4).

No - Replace rings. Check piston and cylinder. (See "Remove and Install Piston and Connecting Rod" on page 91. See "Cylinder Bore" on page 99.)

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

No - Replace pistons and rings, bore or hone cylinders. (See "Remove and Install Piston and Connecting Rod" on page 91. See "Cylinder Bore" on page 99.)

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" on page 84.)

(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 and Install Oil Pressure Regulating Valve" on page 117.)

(5) Crankshaft pin or bearing not worn?

Yes - Go to step (6).

No - Regrind crankshaft and replace bearings. (See "Crankshaft and Main Bearings" on page 102.)

(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 and Install Oil Pump" on page 115.)

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.

Symptom: Engine Is Overheating

(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.

(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” on page 67.) Replace if faulty. Adjust fan belt tension. (See “Check and Adjust Alternator Drive Belt Tension” on page 49.)

(6) Is lower radiator hose not collapsed?

Yes - Go to step (7).

No - Replace lower radiator hose.

(7) Is cylinder head gasket not leaking?

Yes - Go to step (8).

No - Replace head gasket. Resurface head and block if necessary. (See “Remove and Install Cylinder Head” on page 84. See “Recondition Cylinder Head” on page 86.)

(8) 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” on page 67.) Replace if faulty.

Symptom: Low Compression

(1) Intake or exhaust valves not leaking compression?

Yes - Go to step (2).

No - Grind valves and seats. (See “Recondition Cylinder Head” on page 86.)

(2) Intake or exhaust valve not seized?

Yes - Go to step (3).

Symptom: Low Compression

No - Replace valve guides and valves. (See “Recondition Cylinder Head” on page 86.)

(3) Piston rings, piston, or cylinders not worn or seized?

Yes - Go to step (4).

No - Replace pistons and rings. Bore or hone cylinders. (See “Remove and Install Piston and Connecting Rod” on page 91. See “Cylinder Bore” on page 99.)

(4) Piston rings installed correctly and properly staggered?

No - Install piston rings correctly. (See “Remove and Install Piston and Connecting Rod” on page 91.)

Starting Motor Troubleshooting Guide

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

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

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

Symptom: Starter Does Not Rotate

(1) Is there a click sound from starter solenoid?

Yes - Go to step (2).

No - Check that all starting conditions are met.

(2) Are battery cables clean and tight?

Yes - Go to step (3).

No - Tighten or clean as necessary.

(3) Is battery fully charged? (See "Battery Test" on page 256.)

Yes - Go to step (4).

No - Charge battery. (See "Charge Battery" on page 257.)

(4) Does crankshaft rotate freely?

Yes - Go to step (5).

No - See "Crankshaft and Main Bearings" on page 102.

(5) Are starting circuit and key switch working correctly?

No - Repair as necessary. (See "Cranking Circuit Diagnosis S.N. (-050071)" on page 183. See "Cranking Circuit Diagnosis S.N. (050072-060000)" on page 189. See "Cranking Circuit Diagnosis S.N. (060001-)" on page 196)

Symptom: Starter Rotates Slowly

(1) Are battery cables clean and tight?

Yes - Go to step (2).

No - Tighten or clean as necessary.

Symptom: Starter Rotates Slowly

(2) Is battery fully charged? (See "Battery Test" on page 256.)

Yes - Go to step (3).

No - Charge battery. (See "Charge Battery" on page 257.)

(3) Does crankshaft rotate freely?

Yes - Go to step (4).

No - See "Crankshaft and Main Bearings" on page 102.

(4) Are starting motor and solenoid functioning correctly?

No - Repair or replace. (See "Starter No-Load Amperage Draw and RPM Test" on page 269. See "Starter Loaded Amperage Draw Test" on page 270. See "Starter Solenoid Test" on page 270.)

Symptom: Starter Rotates but Does Not Crank

(1) Does the pinion mesh with ring gear?

Yes - Faulty starter drive. Replace.

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

Tests and Adjustments

Check and Adjust Alternator Drive Belt Tension

Reason

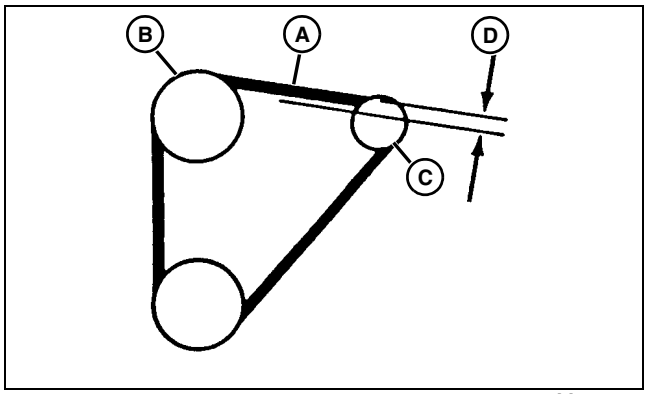
To maintain correct alternator drive belt tension.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Belt Tension Gage	JDG529 or JDST28	Used to measure drive belt deflection.
Straightedge		Used to measure drive belt deflection.

Check Procedure

1. Park machine safely.
2. Remove engine cover.
3. Disconnect battery negative (-) cable.



M54014

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

Check Results

If deflection is not within specification, perform adjustment procedure.

Adjustment Procedure

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

Specifications

Alternator Drive Belt Deflection at 98 N (22 lb-force) . . . . . 10-15 mm (0.40-0.60 in.)

Adjust Valve Clearance

Reason

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

Special or Required Tools

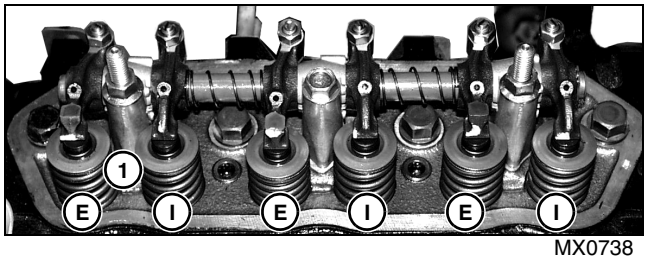
Tool Name	Tool No.	Tool Use
Feeler Gage	NA	Used to check valve clearance.
10 mm End Wrench	NA	Used to loosen and tighten lock nut.
Flat Blade Screwdriver	NA	Used to hold and turn adjusting screw.
17 mm Wrench	NA	Used to turn crankshaft pulley.

Procedure

1. Engine must be cool (room temperature) before valve clearance is checked.
2. Be sure ignition is off and key is removed before attempting to turn engine by hand.
3. Remove rocker arm cover. (See “Remove and Install Rocker Arm Cover” on page 81.)

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

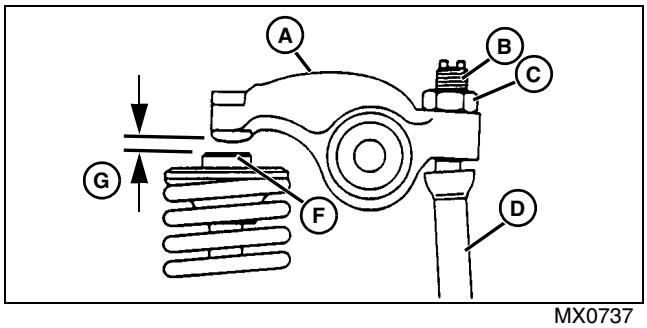
No. 1 cylinder is located closest to the flywheel.



MX0738

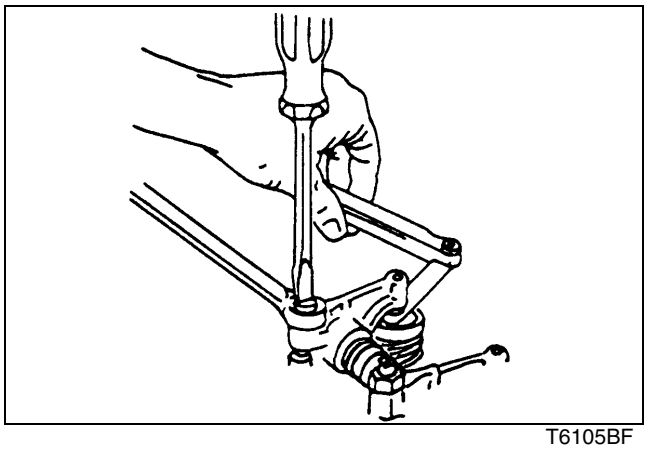
Picture Note: "E" identifies the exhaust valves; "I" identifies the intake valves.

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



MX0737

5. Try to move rocker arms (A) and push rods (D) for the cylinder to be adjusted. If both rocker arms and push rods are loose, the piston is near TDC on the compression stroke and you may proceed to step 8.



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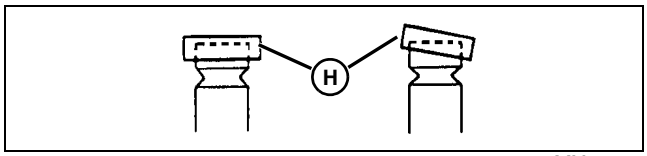
6. Slide feeler gage of appropriate size between valve cap (F) and rocker arm. There should be a slight drag on the feeler gage when the clearance (G) is to specification.

7. To adjust a valve, loosen locknut (C) and turn adjusting screw (B) until blade of feeler gage has a slight drag when inserted between rocker arm and valve cap. Hold adjusting screw while tightening locknut.

8. Recheck valve clearance after tightening locknut.



MX5696

Picture Note: Left valve cap shows normal position.

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

10. Repeat steps 4 through 9 for cylinders No. 2 and No. 3.

11. Install rocker arm cover.

Specifications

Valve Clearance . . . . . 0.2 mm (0.008 in.)

Check Valve Lift

Reason

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

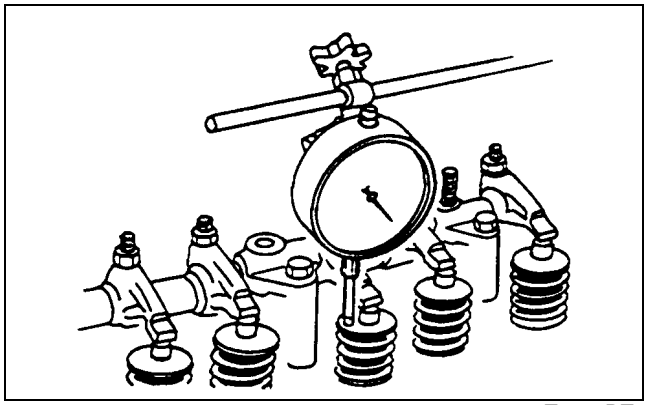
Special or Required Tools

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

Procedure

1. Remove rocker arm cover. (See "Remove and Install Rocker Arm Cover" on page 81.)

2. Check that valve clearance is within specification. Adjust if necessary. (See "Adjust Valve Clearance" on page 49.)



T6333DT

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

4. Set the dial indicator to zero.

5. Rotate crankshaft while observing dial indicator as valve is moved to full open (down) position.

6. 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 "Camshaft" on page 107.) If camshaft, followers, and push rods are within specification, remove and inspect the cylinder head. (See "Remove and Install Cylinder Head" on page 84.)

Test Cylinder Compression

Reason

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

Special or Required Tools

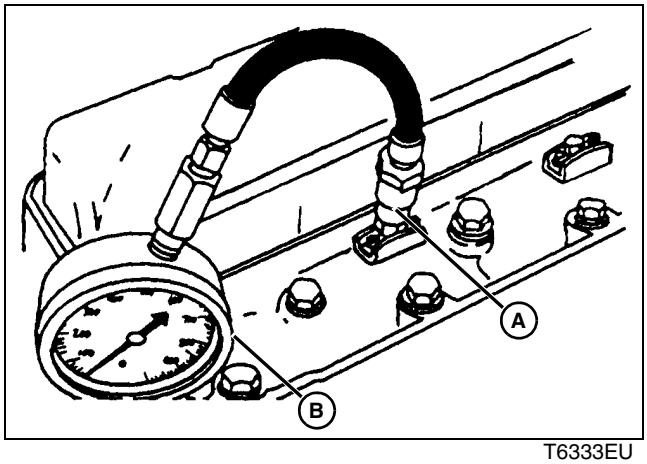
Tool Name	Tool No.	Tool Use
Compression Gage Assembly	JT01682	Used to measure cylinder compression.
Adapter	JDG472	Used to install gage assembly.

Procedure

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

2. Move fuel shutoff valve on fuel filter to OFF position.

3. Remove injection nozzles. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 122).



T6333EU

4. Install JDG472 Adapter (A).

5. Install JT01682 Compression Gage Assembly (B).

6. Disconnect the fuel control solenoid connector.

IMPORTANT: Avoid damage! Do not overheat the starting motor during this test.

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

8. Record the pressure reading for each cylinder. Compare the pressure readings with specifications.

Results

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

Specifications

Cylinder Compression Pressure (Standard) . . . . . 3234 kPa (469 psi)
Cylinder Compression Pressure (Minimum) . . . . . 2549 kPa (369 psi)
Pressure Difference Between Cylinders (Maximum) . . . . . 241 kPa (35 psi)

Test Engine Oil Pressure

Reason

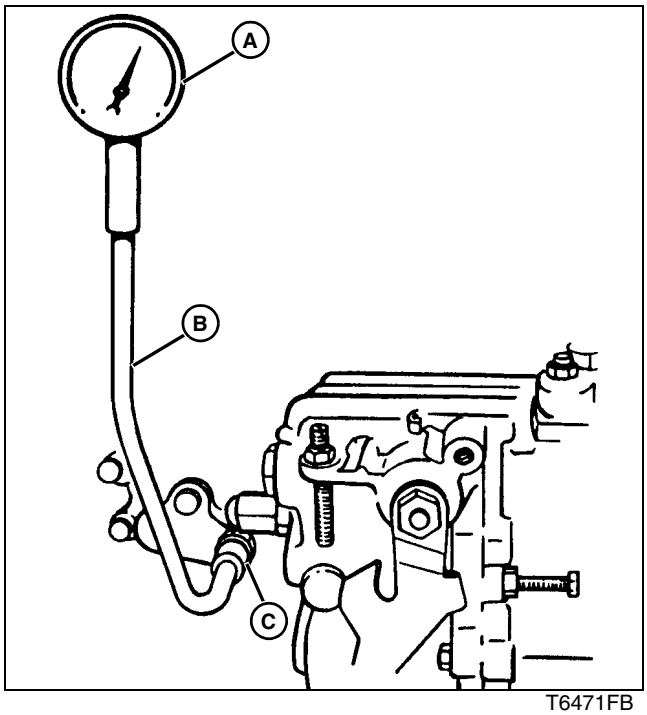
To determine if the engine bearings or the lubrication system components are worn.

Special or Required Tools

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

NOTE: The connector, hose assembly, and gage are found in other SERVICEGARD™ test kits.

Procedure



T6471FB

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

IMPORTANT: Avoid damage! Do not run the engine if there is insufficient oil pressure!

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

Results

- If oil pressure is not within specification, inspect the oil pump and oil pressure regulating valve for wear or damage. Replace parts as needed. (See “Removal” on page 115. See “Remove and Install Oil Pressure Regulating Valve” on page 117.)
- If oil pump is within specifications, the engine may have parts worn beyond specification. (See “Diagnostics” on page 39 for more information.)

Specifications

Engine Oil Pressure
at Rated Speed . . . . . 297-393 kPa (43-57 psi)

Fast Idle Speed. . . . . 3400 + 25 (-150) rpm
Slow Idle Speed . . . . . 1400 + 150 (-25) rpm

Leak Test Air Intake System

Reason

Check for leaks in the air intake system.

Special or Required Tools

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

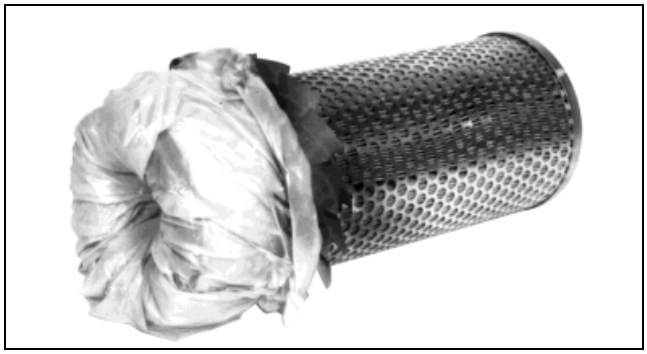
Procedure

MX22730

1. Remove the air filter restriction indicator (A) and install the test fitting.

2. Connect the air pressure regulator to the manifold using the hose and fitting from the air cleaner.

3. Remove the air cleaner cover and the main filter element.



M82124

4. Put a large plastic bag into and over the end of the main filter element. Install the main filter element and cover.

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

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

Results

Find leaks and repair or replace parts as necessary.

Test Fuel Pump Pressure

Reason

To determine supply pump operating pressure.

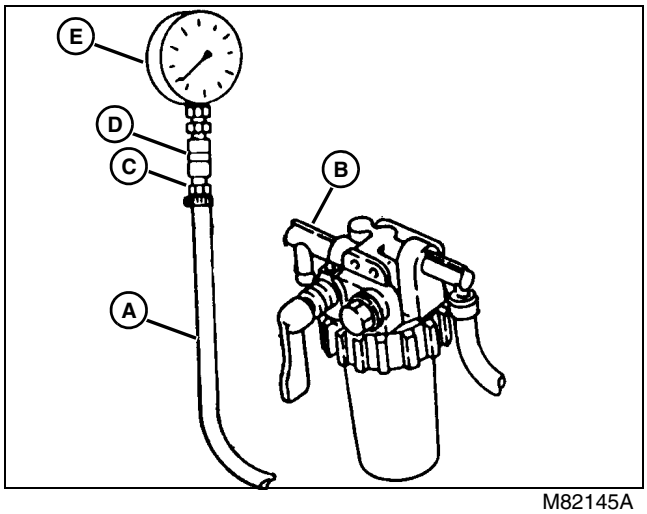
Special or Required Tools

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

Procedure

1. Park machine safely.

2. Remove engine cover.



M82145A

3. Disconnect supply pump-to-filter hose (A) at fuel filter (B).

4. Assemble hose coupling (C), coupling reducer (D), and gage (E).

5. Connect gage/fitting assembly to supply pump-to-filter hose.

6. Disconnect wire connector to fuel shutoff solenoid.

IMPORTANT: Avoid damage! Do not run starting motor for more than ten seconds at a time.

7. Crank engine using the starting motor. Compare reading on gage to specification.

Results

If pressure is below specification, replace fuel pump.

Specifications

Fuel Pump Pressure (Minimum) . . . . . 29 kPa (4.3 psi)

Leak Test Fuel System

Reason

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

Procedure

1. Park machine safely.
2. Remove engine cover.
3. Disconnect the fuel supply line and return line at the fuel tank.
4. Place the fuel return line into a suitable container to catch drained fuel.

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

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

Results

Find leaks and repair or replace parts as necessary.

Bleed Fuel System

Reason

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

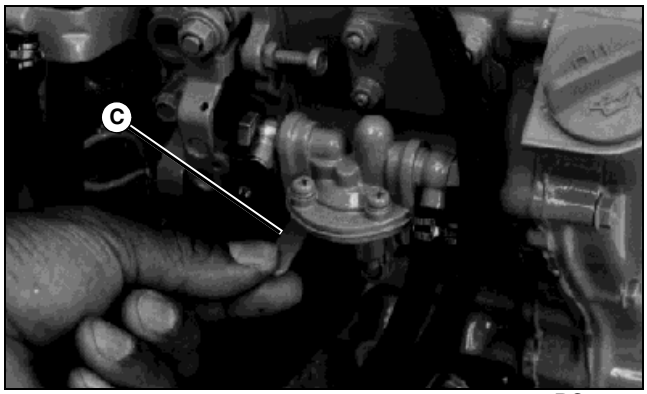
Procedure

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

1. Park machine safely.
2. Remove engine cover.
3. Verify that all fuel line connections are tight.
4. Turn fuel filter shutoff valve to OPEN position.
5. Turn key switch to RUN position.

M73915

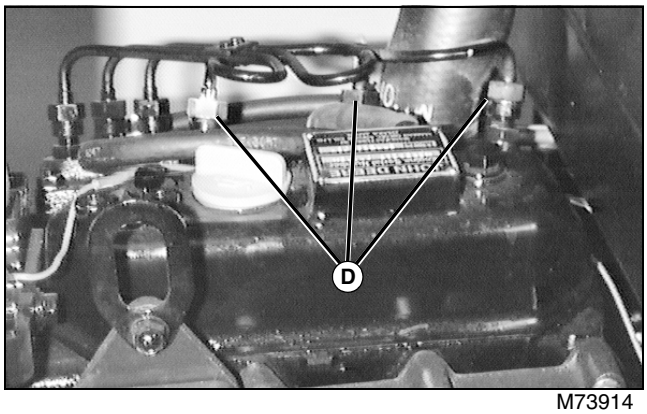
6. Loosen bleed screws (A) and (B).



RG6595

7. Operate hand primer lever (C) on the fuel supply pump for approximately one minute to bleed most of the air back to the tank through the fuel return lines.
8. Tighten bleed screws.
9. Start engine. If engine does not start after several attempts, proceed to step 10.

10.Remove air cleaner assembly. (See “Remove and Install Air Cleaner Assembly” on page 72.)



M73914

11.Loosen all three injector line nuts (D). Be sure not to loosen bottom nut of injector.

12.Crank engine over with starting motor.

13.When fuel appears at nozzles, tighten line nuts.

14.Start engine. If engine does not start, repeat entire bleed procedure.

Adjust Slow Idle Speed

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

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

Reason

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

Special or Required Tools

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

Procedure

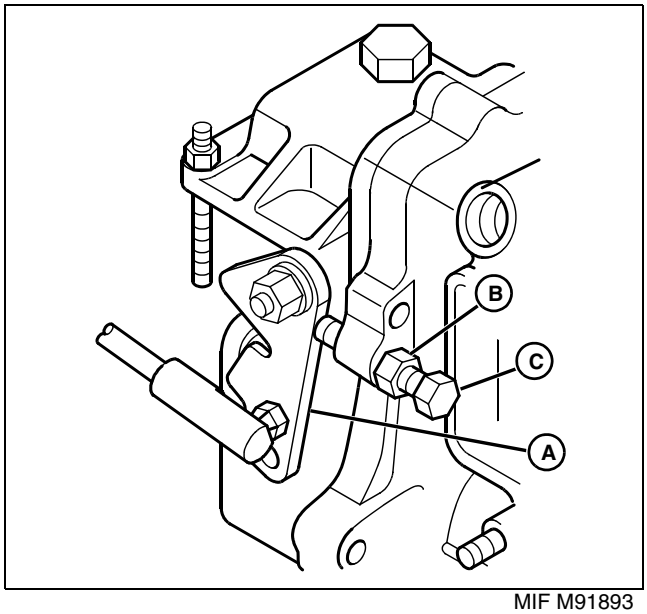
1. Park machine safely.

2. Start engine and run for five minutes to bring machine to operating temperature.

3. Remove engine cover.

4. Move throttle lever to slow idle position.

5. Use JT07270 Digital Pulse Tachometer to check engine speed at crankshaft pulley.



MIF M91893

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

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

8. After slow idle speed adjustment, adjust throttle cable. (See “Adjust Throttle Cable” on page 56.)

Specifications

Slow Idle Speed . . . . . .1450 ± 100 rpm

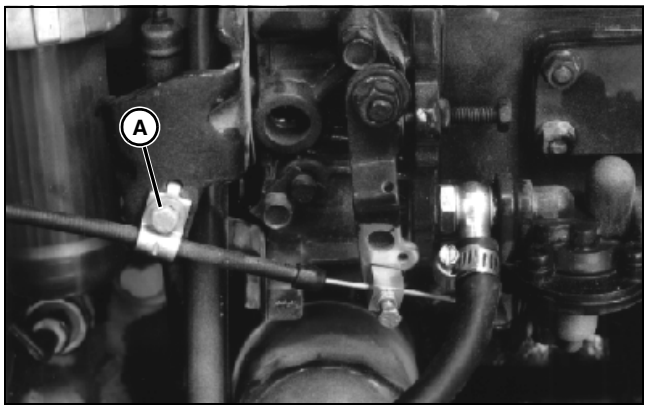
Adjust Throttle Cable

Reason

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

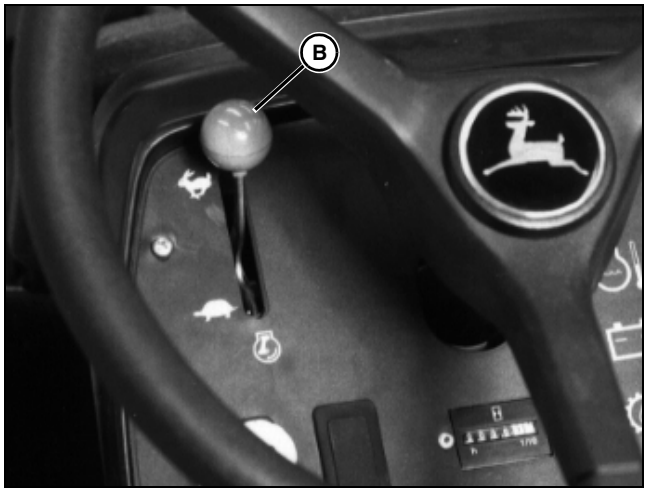
Procedure

1. Park machine safely.
2. Remove engine cover.
3. Remove plenum air duct.



MX5415

4. Loosen throttle clamp screw (A).



M56180

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

Check and Adjust Fast Idle-CARB/EPA Engines

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

NOTE: For engines WITH California Air Resources Board/Environmental Protection Agency (CARB/EPA) Emissions Controls.

Special or Required Tools

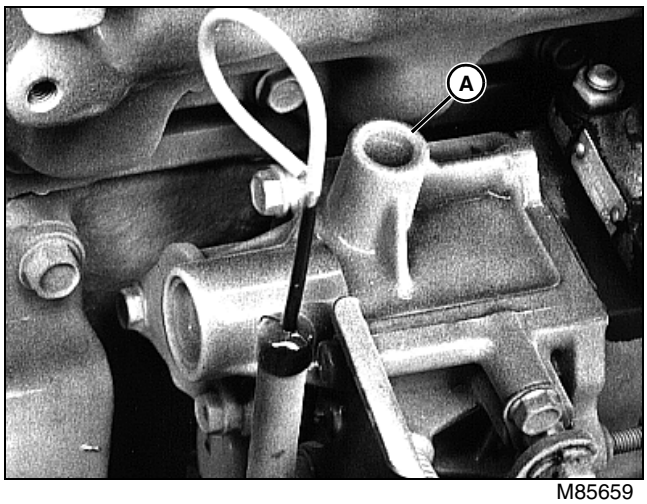
Tool Name	Tool No.	Tool Use
Digital Pulse Tachometer	JT07270	Used to set fast idle speed.
Fast Idle Adjustment Tool	JDG991	Used to adjust fast idle speed.

Procedure

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

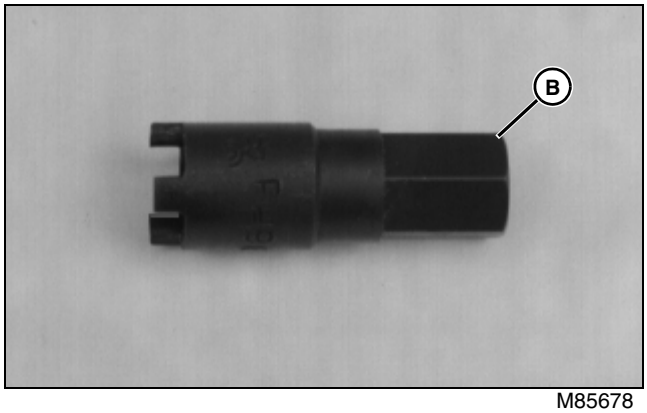
NOTE: Make sure air cleaner is clean and not restricted. Replace air cleaner element as necessary.

2. Start engine and run for 5 minutes to obtain normal operating temperature.
3. Move throttle lever to fast idle position.
4. Use a digital tachometer to check engine speed at crankshaft pulley.
5. Turn engine OFF.

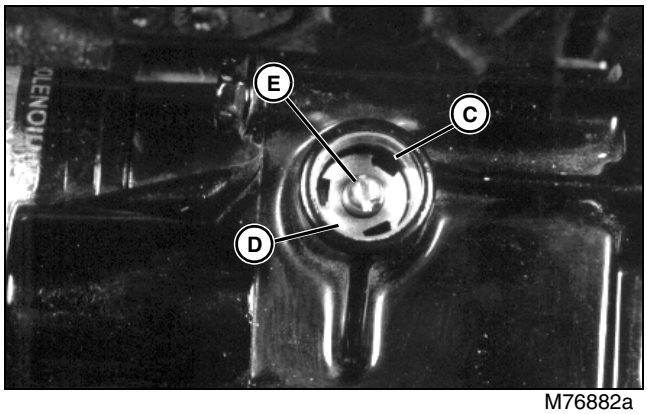


M85659

6. If fast idle speed DOES NOT meet specification, remove plug (A) from fast idle adjustment screw hole.



M85678



M76882a

7. Loosen lock nut by aligning tabs of JDG99l Fast Idle Adjustment Tool (B) with slots (C) of lock nut (D).

8. Start engine and move throttle lever to FAST idle position.

9. Use a flat blade screwdriver to turn fast idle adjustment screw (E) until fast idle speed is within specification. Adjust throttle cable, if necessary.

10.While holding fast idle adjustment screw stationary, tighten lock nut with essential adjustment tool to specification. 4 N•m (35 lb-in.).

11.Check fast idle speed again (steps 2—5).

12.Install a new plug into the fast idle adjustment screw hole.

Results

• If engine DOES NOT adjust to meet fast idle speed specification, have injection pump inspected by an Authorized Diesel Service (ADS) center. After injection pump has been serviced by an ADS center, the fuel control screw MUST BE adjusted. (See “Adjust Fuel Control Screw-CARB/EPA Engines” on page 57.)

Specifications

Fast Idle Speed . . . . . 3425 ± 25 rpm
Fast Idle Screw Torque. . . . . 4 N•m (35 lb-in.)

Adjust Fuel Control Screw-CARB/EPA Engines

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

Adjust fuel control screw ONLY when governor assembly or any of it’s individual components are replaced and/or fuel injection pump is serviced by an Authorized Diesel Service (ADS) center or it’s control rack alignment mark has been recalibrated.

NOTE: For engines WITH California Air Resources Board/Environmental Protection Agency (CARB/EPA) Emissions Controls.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Fuel Control Screw Adjustment Tool	JDG1060	Used to adjust fuel control screw.
Spring	M72632	Used to compress governor spring.

Procedure

1. Remove fuel shutoff solenoid. (See “Remove and Install Fuel Shutoff Solenoid” on page 125.)

2. Remove air cleaner assembly and intake hose. (See “Remove and Install Air Cleaner Assembly” on page 72.)

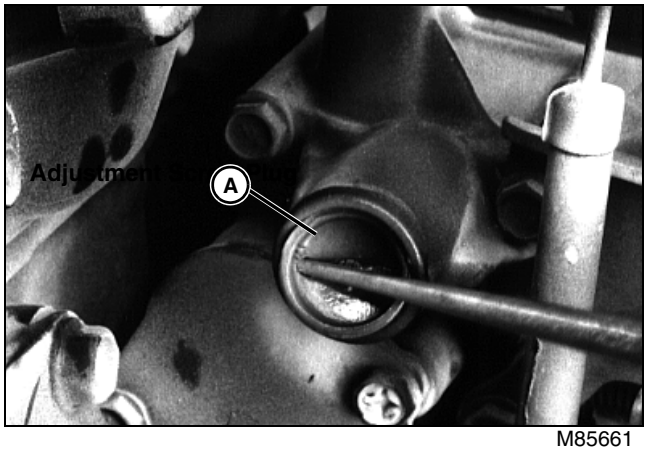
3. Disconnect throttle cable from throttle lever.

4. Remove fuel filter from bracket WITHOUT disconnecting fuel lines.

5. Remove any additional components to allow easy access to the governor assembly

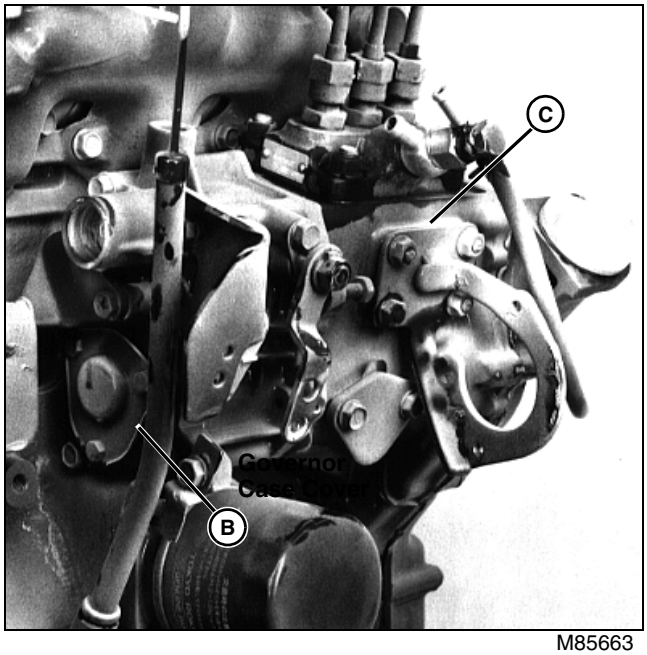
IMPORTANT: Avoid damage! Make sure punch is used at inside edge of plug or damage to the internal components may occur.

NOTE: CARB/EPA engines use a plug to cover the fuel control screw instead of an acorn nut.



M85661

6. Use a sharp pointed punch and hammer to drive punch through the inside edge of plug (A). Pry plug out, being careful not to damage the case or internal components. Check that internal E-shaped snap ring and washer(s) have not become dislodged, re-install if necessary.

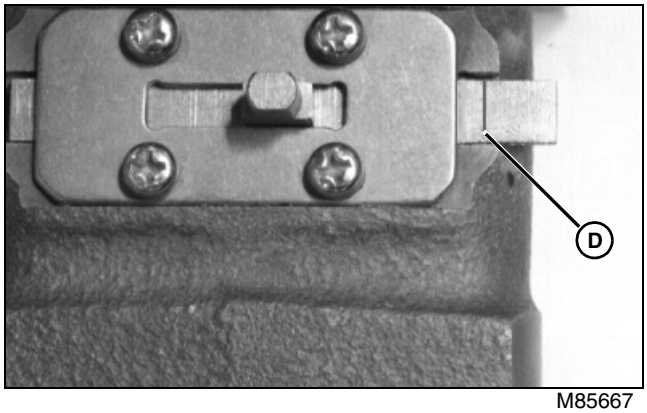


M85663

7. Remove governor case cover (B) and fuel injection pump rack cover (C).

IMPORTANT: Avoid damage! Fuel injection rack should have an alignment mark on it. If rack is NOT MARKED, fuel injection pump MUST BE sent to an Authorized Diesel Service (ADS) center to be calibrated and re-marked. Instruct ADS technician that there must be only one distinguishable alignment mark on rack.

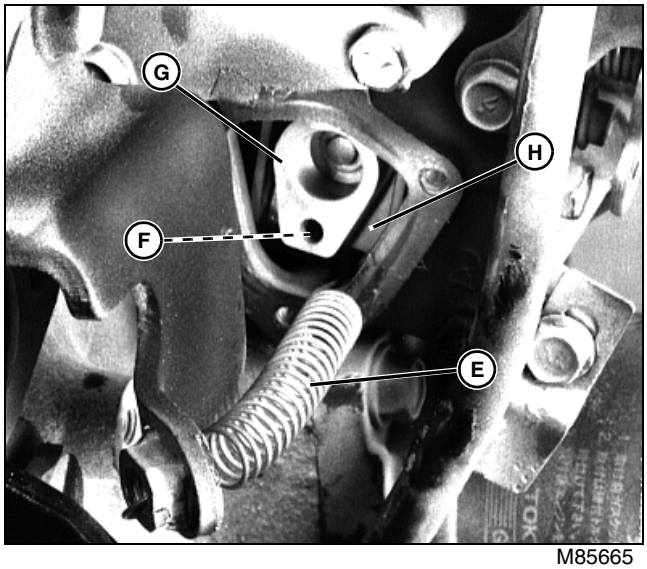
Always replace shims between fuel injection pump and injection pump housing whenever pump has been removed.



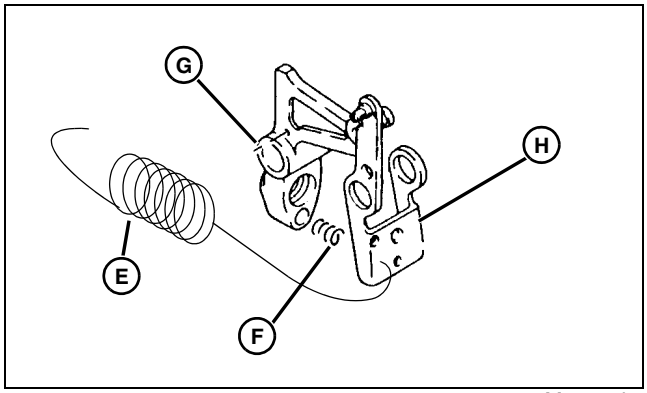
M85667

8. Find rack alignment mark (D) before adjusting fuel control screw. Correct mark is approximately 9 mm (11/32-in.) from right edge of rack.

NOTE: Ends of spring may have to be bent to fit behind governor lever and attach to fuel filter bracket

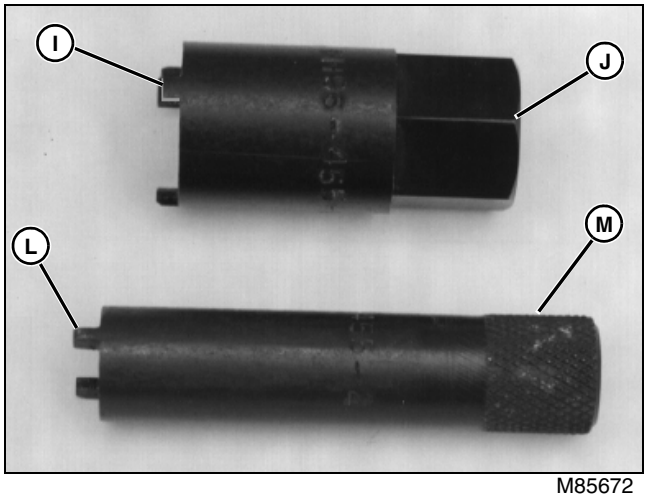


M85665

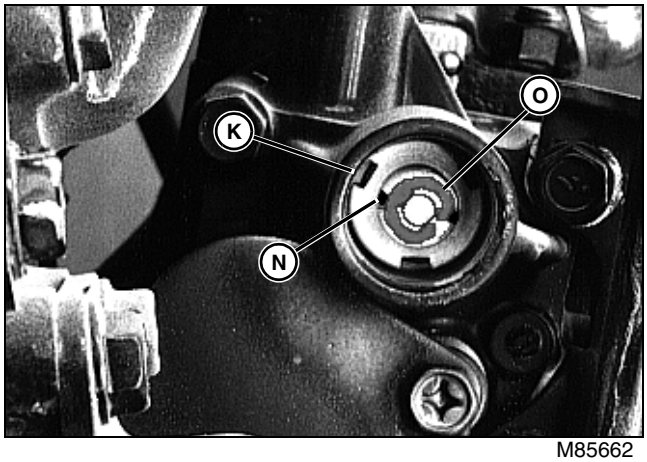


M82321b

9. Install M72632 spring (E) to compress governor spring (F) between tension lever (G) and governor lever (H).

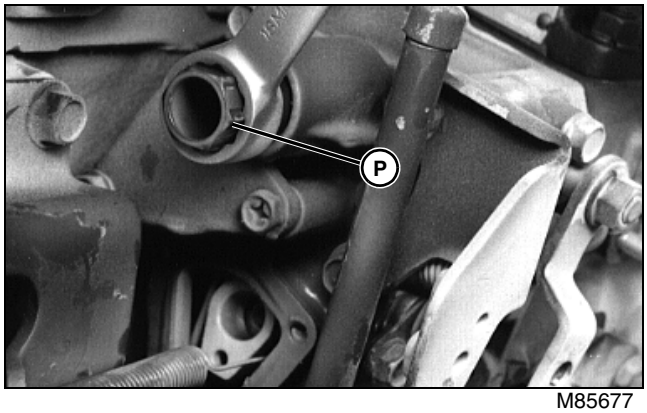


M85672



M85662

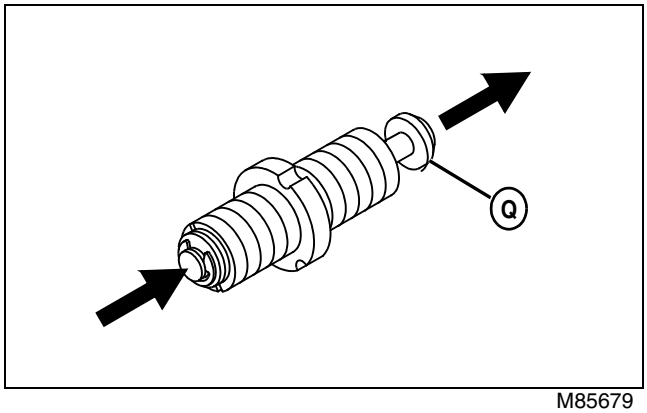
10.Use tabs (I) on outer tool (J) in slots (K) of lock nut and tabs (L) on inner tool (M) in slots (N) of adjustment screw. Check that E-shaped snap ring (O) and washer(s) are not damaged and installed properly.



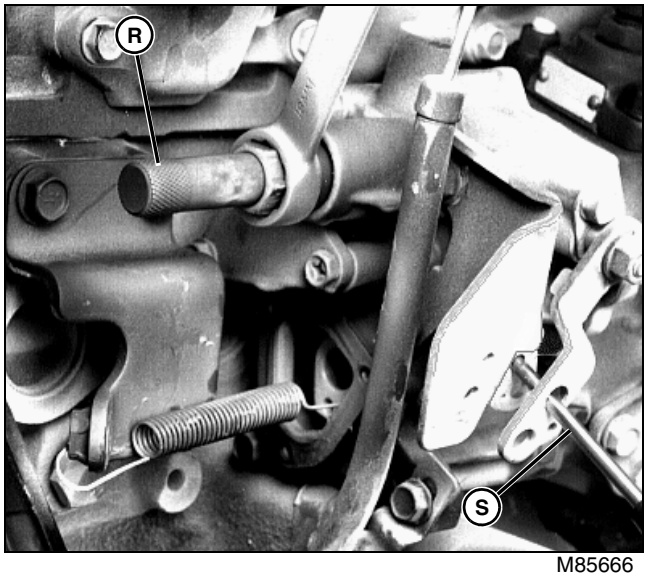
M85677

11.Insert outer tool (P) in lock nut chamber and rotate slowly until tabs seat into slots on lock nut. Loosen lock nut which then allows adjustment of fuel control screw.

IMPORTANT: Avoid damage! Fuel control screw plunger (Q) MUST BE fully forward any time adjustment is made. Inner tool has been design to accomplish this when properly installed in slots of adjustment screw.



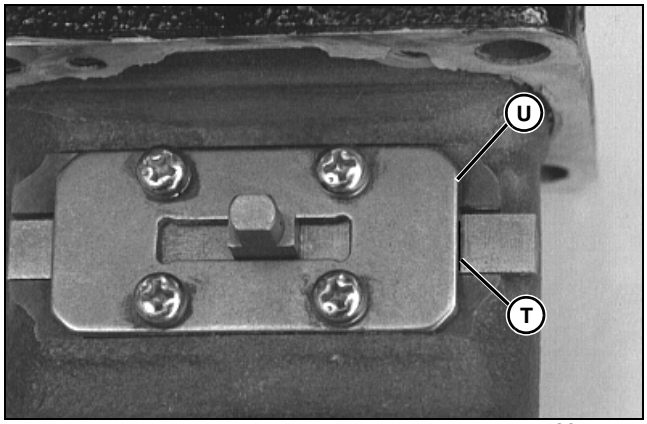
M85679



M85666

12.Install adjustment screw inner (R) tool and rotate slowly until tabs seat into slots of adjustment screw.

13.Have helper hold outer tool and lock nut stationary and maintain tension on fuel shut-off lever and throttle lever with punch (S).



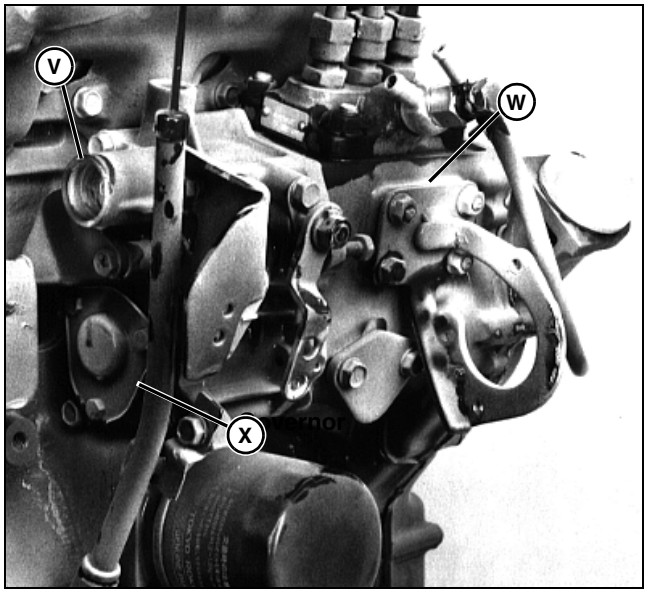
M85669

14.While turning inner tool and adjustment screw, watch for alignment of mark (T) on fuel injection pump rack with right edge of rack plate (U).

15.Have helper tighten lock nut with outer tool while you keep inner tool and adjustment screw from moving.

16.Check that tightening lock nut DID NOT change adjustment.

17.Remove inner and outer tools, spring, and punch (or wire retainers).



18.Install new fuel control screw plug (V).

IMPORTANT: Avoid damage! BE SURE to install new gaskets on governor case cover (W) and fuel injection pump rack cover (X) (part of solenoid mounting bracket).

19.Assemble parts in reverse order of removal.

Check and Adjust Fast Idle-Non CARB/EPA Engines

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Pulse Tachometer	JT07270	Used to adjust fast idle speed.

Procedure

1. Park machine on level surface.
2. Move Mow/Transport lever to TRANSPORT position.
3. Lower cutting units to the ground.
4. Place travel pedals in NEUTRAL.
5. Engage parking brake.
6. Start engine and run for five minutes.
7. Raise hood.
8. Remove plenum air duct.
9. Place throttle control lever in fast idle position.

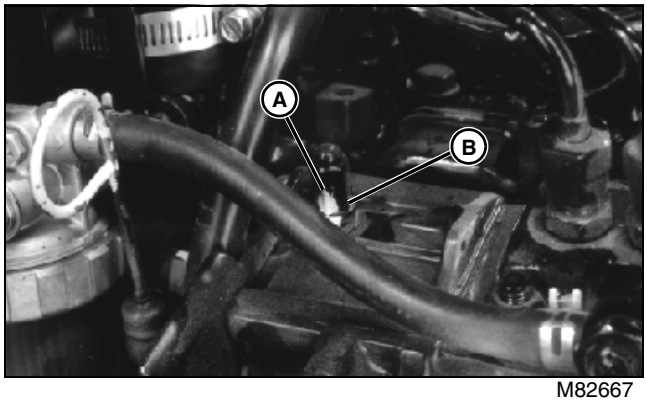
10.Use JT07270 Digital Pulse Tachometer to check engine speed at crankshaft pulley.

11.Push against injection pump throttle lever to insure it is against the fast idle stop screw. Check fast idle speed, fast idle speed should be within specifications.

12.After fast idle speed adjustment, adjust throttle cable. (See “Adjust Throttle Cable” on page 56.)

Results

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



M82667

- If fast idle rpm is not according to specifications, remove cap nut (A), loosen nut (B) and turn screw. After adjustment, tighten nut and install cap nut.
- If engine still does not meet fast idle speed specifications after adjustment, have injection pump inspected by a diesel injection service.

Specifications

Fast Idle Speed . . . . . 3425 ± 25 rpm

Test Fuel Injection System

CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.

Reason

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

Special or Required Tools

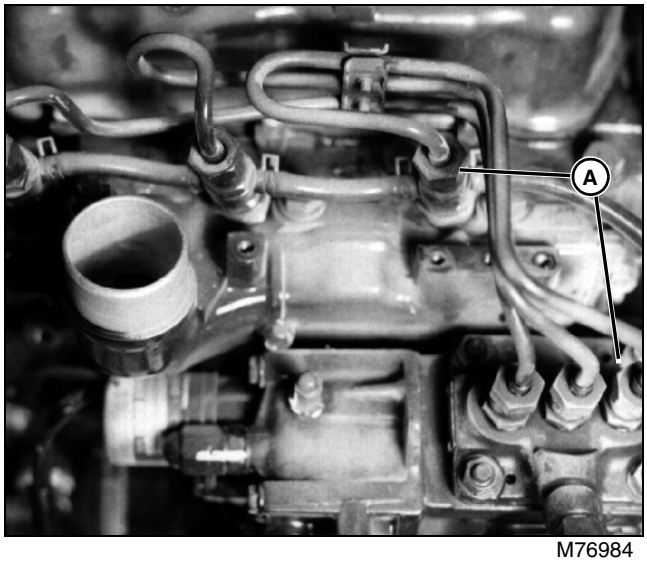
Tool Name	Tool No.	Tool Use
17 mm Open End Wrench (2 used)	NA	Used to loosen nut on high-pressure fuel injector line.

Procedure

1. Park machine on level surface with park brake on and transmission in neutral.

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

2. Start engine and run at slow idle.



M76984

3. Using two 17 mm open end wrenches, loosen nut (A) on one high-pressure fuel injector line, either at the injector nozzle or at injection pump, while holding lower nut stationary with second wrench. Loosen nut only 1/8 of a turn (45°).

4. Listen for engine speed to drop and exhaust noise to change.

5. Tighten nut and allow engine to return to original speed before loosening next cylinder's fuel line nut.

6. Compare sound and speed of each cylinder as it is disabled.

7. Tighten fuel line nuts and stop engine.

Results

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

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

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

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

- Fuel injector nozzle opening pressure, spray pattern, and leakage for that cylinder. (See "Test Fuel Injection Nozzle" on page 62,)
- Cylinder compression or cylinder leakage. (See "Test Cylinder Compression" on page 51.)
- Fuel supply pump pressure.
- Fuel shutoff solenoid opening fully.

- Fuel control and governor linkage flyweights allowing full fuel flow to injector pump.
- Injection pump timing correct.

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

Test Fuel Injection Nozzle

Reason

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

Special or Required Tools

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

Connections

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

M35913

Connect fuel injection nozzle to D01109AA Diesel Injection Nozzle Tester using parts from D01110AA Adapter Set and 23622 Straight Adapter.

Pressure Test Procedure

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

Pressure Test Results

If pressure reading does not meet specification, disassemble injection nozzle and inspect nozzle assembly for contamination or stuck valve. (See "Remove, Inspect, and Install Fuel Injection Nozzle" on page 122.) If necessary, add or remove shims to change opening pressure.

Leakage Test Procedure

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

1. Dry nozzle completely using a lint-free cloth.
2. Pressurize nozzle to 11 032 kPa (1600 psi).
3. Watch for leakage from nozzle spray orifice. Keep track of time elapsed before leakage begins. Compare to specification.

Leakage Test Results

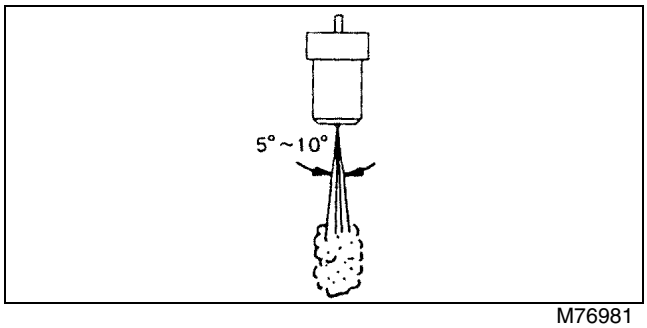
If leakage time does not meet specification, disassemble injection nozzle and inspect nozzle assembly for contamination. Replace nozzle assembly if necessary. (See “Remove, Inspect, and Install Fuel Injection Nozzle” on page 122.)

Chatter and Spray Pattern Test Procedure

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

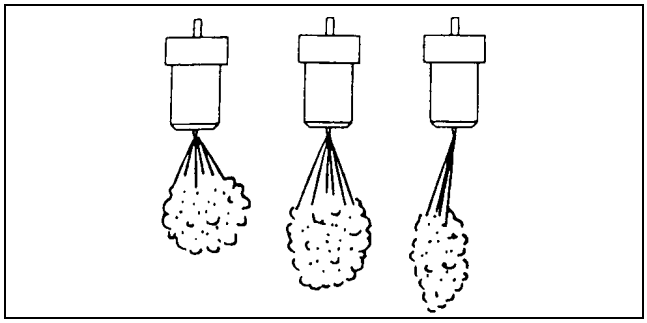
1. Pressurize nozzle until nozzle opening pressure is reached.
2. Listen for “chatter” sound and watch spray pattern.

Chatter and Spray Pattern Test Results



M76981

Picture Note: Correct spray pattern.



M76985

Picture Note: Incorrect spray patterns.

- If nozzle chatter or spray pattern does not meet specifications, disassemble injection nozzle and inspect nozzle assembly for contamination. Inspect valve seating surface. Replace nozzle assembly if necessary. (See “Remove, Inspect, and Install Fuel Injection Nozzle” on page 122.)
- If there is excessive difference in spray angle or injection angle, incomplete atomizing, or sluggish starting/stopping of injection, disassemble injection nozzle and inspect nozzle assembly for contamination. Replace nozzle assembly if necessary. (See “Remove, Inspect, and Install Fuel Injection Nozzle” on page 122.)

Specifications

Fuel Injection Nozzle

Nozzle Opening
Pressure . . . . . 11 722 ± 480 kPa (1700 ± 70 psi)
Leakage at 11 032 kPa
(1600 psi). . . . . No leakage for 10 sec (Minimum)

Chatter and Spray Pattern
at 11 722 ± 480 kPa (1700 ± 70 psi)

Slow Hand Lever Movement . . . . . Chatter sound
Slow Hand Lever Movement . Fine stream, 5°-10° spray pattern
Fast Hand Lever Movement. . . . . Fine atomized spray, 5°-10° spray pattern

Injection Pump Static Timing

Reason

To ensure that the injection pump timing is set to the correct specifications.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Fuel Injection Timing Tool	DFMZ1A	Used to set injection pump timing.

Check Procedure

1. Park machine on a level surface.
2. Turn key switch to STOP position, and allow engine to cool.
3. Engage park brake.
4. Raise engine cover.

IMPORTANT: Avoid damage! Injection pump timing should be correct. Once timing is set, it will not normally change during the life of the engine, unless it was altered.

Check and adjust timing only as the last option. Check fuel, fuel supply system, nozzles, air intake system, and cylinder compression before continuing.

NOTE: Never steam clean or pour cold water on injection pump while the pump is running or warm. Doing so can damage the pump.

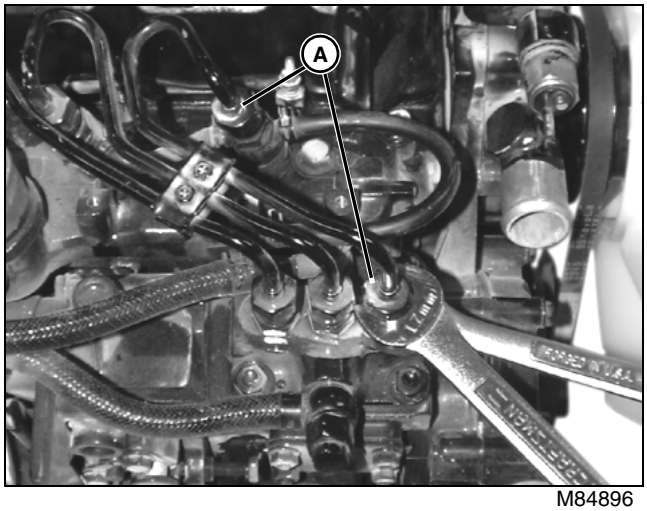
5. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner.

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

- **Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.**
- **If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. In the United States and Canada only, this information may be obtained by calling 1-800-822-8262.**

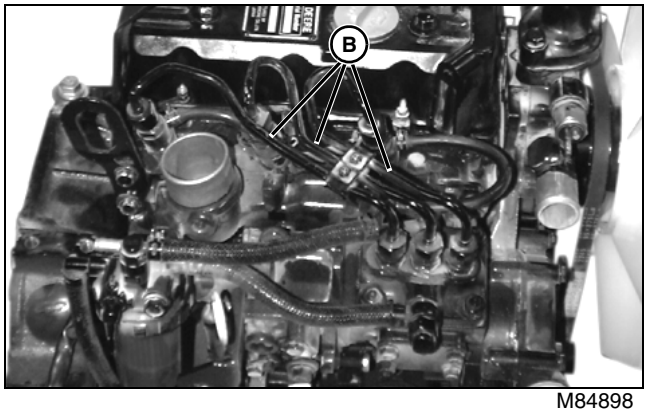
IMPORTANT: Avoid damage! When removing injection lines, DO NOT turn pump delivery valve fittings. Turning fittings may damage pump internally.

NOTE: Nozzles are matched to the cylinders. If removing more than one nozzle, tag each nozzle according to the cylinder from which it was removed.



M84896

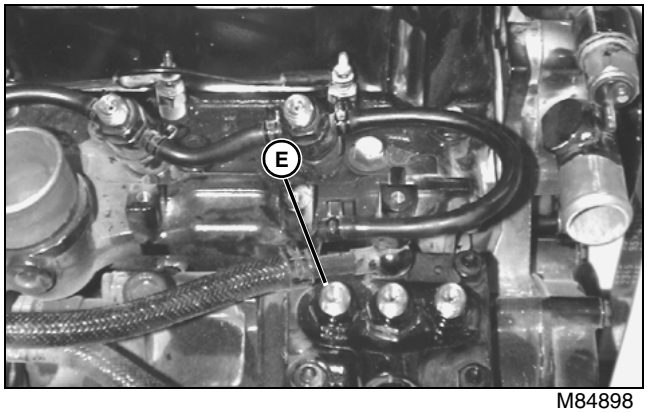
6. Loosen fuel injector line connectors (A) (on fuel injection pump and fuel injectors) slightly to release pressure in the fuel system. When loosening connectors, use another wrench to keep delivery valves from loosening.



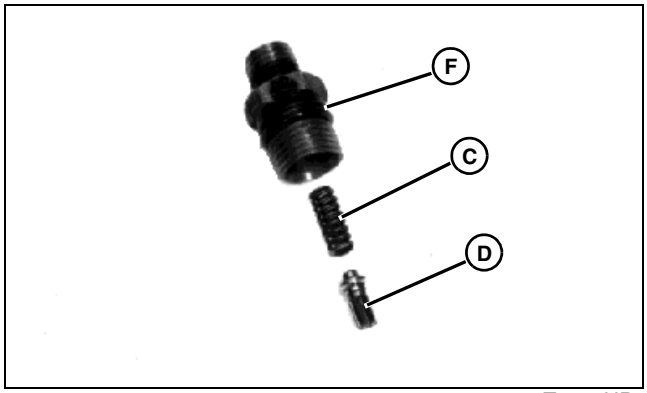
M84898

7. Remove fuel injection lines (B).

NOTE: The engine rotates counterclockwise (as viewed from the flywheel end). The cylinders are numbered from the flywheel end (No. 1 cylinder located nearest to the flywheel).



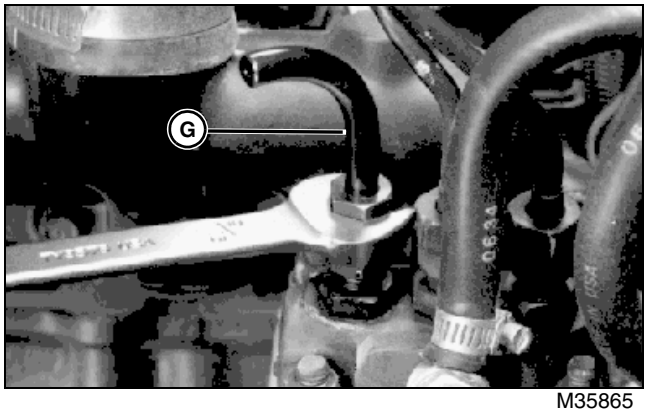
M84898



T6333HP

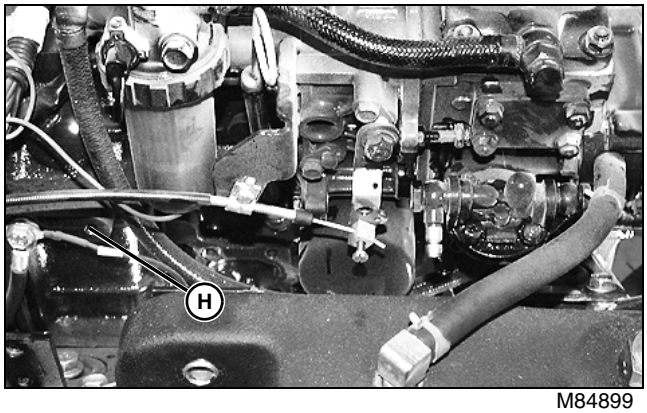
8. Remove the spring (C) and delivery valve (D) from the No. 1 fuel injection nozzle assembly (E). DO NOT remove the delivery valve seat.

9. Install the delivery valve fitting (F) and tighten to specification.



M35865

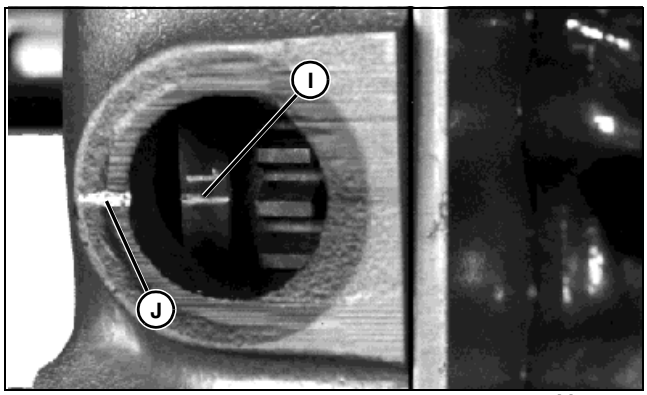
10.Install DFMX1A Fuel Injector Timing Tool (G).



M84899

11.Remove plug (H) from flywheel housing.

12.Remove glow plugs to aid turning crankshaft pulley. (See “Remove and Install Glow Plug” on page 80.)



M37500

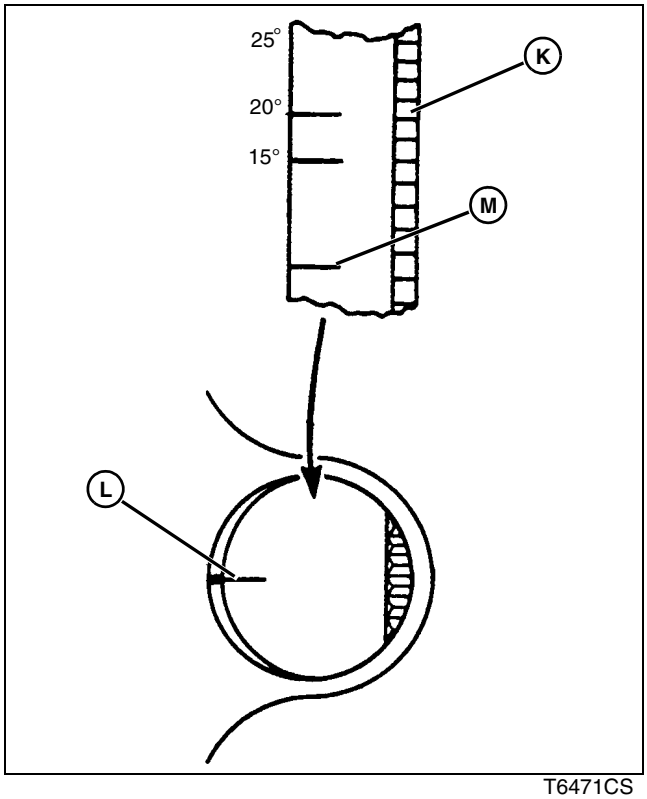
13.Rotate the engine clockwise by rotating the crankshaft pulley until the No. 1 cylinder mark (I) aligns with the index mark (J) on the flywheel housing.

14.Place a container under the timing tool to collect any fuel.

15.Rotate the flywheel clockwise (as viewed from the flywheel end) until fuel flows in a stream.

NOTE: If the fuel flow does not stop, the No. 1 cylinder is on the exhaust stroke instead of the compression stroke. Rotate the flywheel one complete revolution and repeat steps 13-15.

16.Slowly rotate the flywheel counterclockwise until fuel flow changes from a stream and then stops completely. This is the point of injection timing at which the pump is set.



T6471CS

17.Check the timing on the flywheel (K). The index mark (L) must align with the 14° mark before top dead center (M) on the flywheel.

If Timing Is Correct

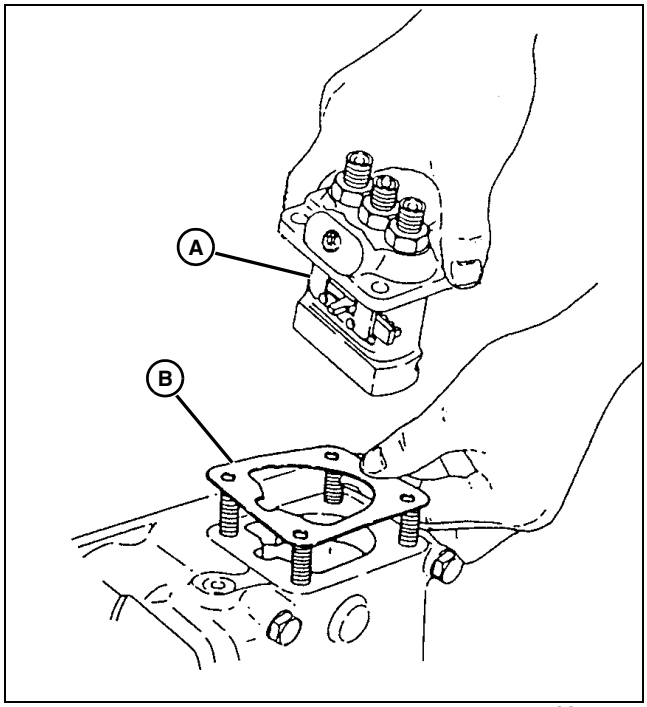
1. Install rubber plug in flywheel housing.
2. Remove timing tool.
3. Remove delivery valve fitting.
4. Install delivery valve and spring.
5. Install new O-ring and delivery valve fitting. Tighten to specification.
6. Install fuel injection lines.

Results

- If the injection timing does not meet specifications, perform adjustment procedure.
- If engine performance is poor, check air cleaners, fuel filter, fuel supply, nozzles, and cylinder compression before removing pump for service. Check all timing gears for wear. Retest performance.
- If performance did not change, have pump tested by a diesel injection service.

Adjustment Procedure

NOTE: Injection pump timing is set by a shim pack between pump body and housing.



M99032

1. Remove fuel injection pump (A).
2. Adjust the fuel injection timing by adding or removing the number of shims (B):
   - **To delay the injection pump**: increase the number of shims.
   - **To advance the injection timing:** remove shims.
3. Install fuel injection pump.
4. Recheck injection pump timing. (See “Check Procedure” on page 63.)

Specifications

Fuel Injector Torque . . . . . 51 N•m (37 lb-ft)

Pressure Test Cooling System

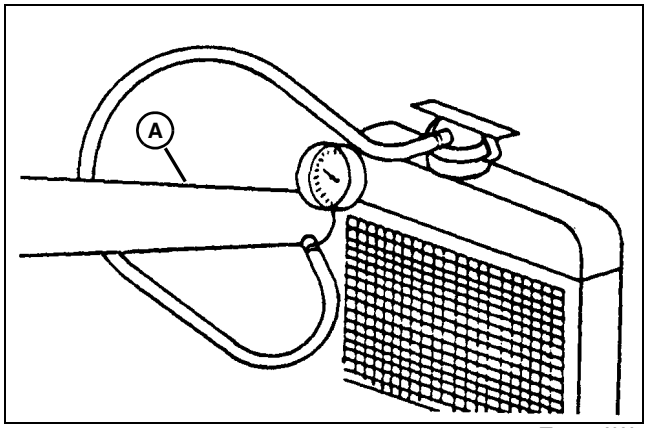
Reason

Inspect the cooling system for leaks.

Special or Required Tools

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

Procedure



T6333AW

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

Results

- Pressure should hold to minimum specification. If pressure decreases, check for leaks. Repair leaks or replace parts as necessary.
- If the pressure test still indicates leakage after all external leaks have been stopped, a defective head gasket, cracked block, or cylinder head may be the cause. (See “Test Cylinder Leakage” on page 68.)

Specifications

Cooling System Pressure (Maximum Applied) . . . . . 117 kPa (17 psi)

Pressure Test Radiator Cap

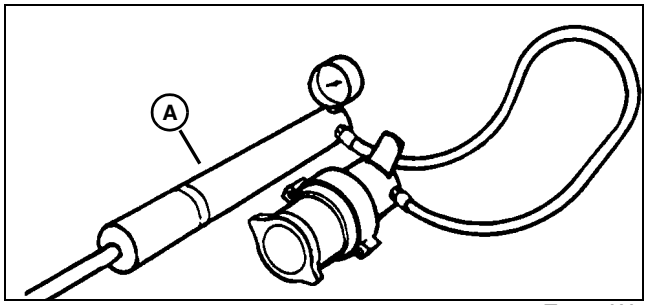
Reason

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

Special or Required Tools

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

Procedure



T6333AX

1. Install the radiator cap on the pressure pump (A).

2. Apply pressure. Pressure valve in the cap should open at specification.

Results

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

Specifications

Radiator Cap Valve
Opening Pressure. . . . . 90 kPa (13 psi)

Test Thermostat

Reason

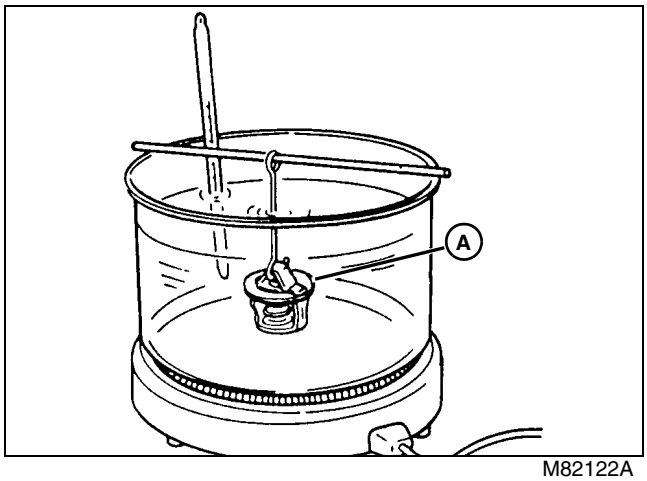
To determine opening temperature of thermostat.

Special or Required Tools

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

Procedure

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



M82122A

1. Suspend thermostat (A) and thermometer in a container of water.

2. Heat and stir the water. Observe opening action of thermostat and compare temperatures with specifications.

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

Results

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

Specifications

Thermostat Begin-Opening Temperature . . . . . 69.5°-72.5°C (157°-163°F)
Thermostat Fully-Open Temperature . . . . 85°C (185°F)

Test Coolant Temperature Switch

Reason

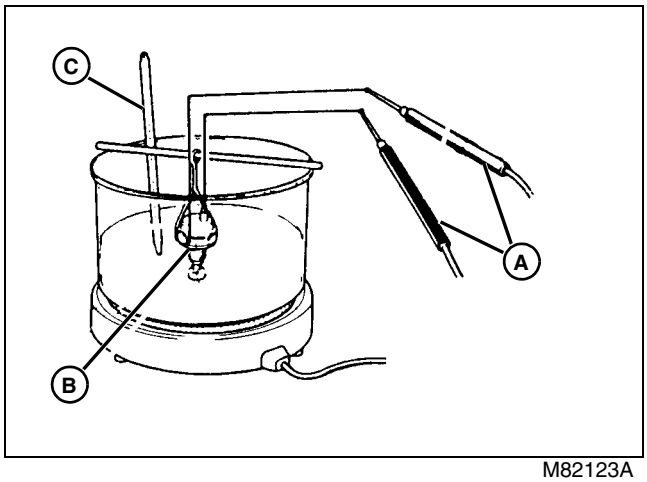
To determine opening temperature of thermostat.

Special or Required Tools

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

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.



M82123A

1. Connect lead wires from ohmmeter probes (A) to switch terminal and body.

2. Suspend switch (B) and a thermometer (C) in a container of water.

3. Heat and stir the water. Observe water temperature when continuity occurs. Compare temperature with specifications.

Results

- If continuity does not occur within specifications, replace switch.

Specifications

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

Test Cylinder Leakage

Reason

To determine if compression pressure is leaking from the cylinder.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Cylinder Leakdown Tester	JT03502	Used to test cylinder for compression pressure leakage.
Adapter	JDG472	Used to install gage assembly.

Procedure

1. Park machine safely.

2. Remove engine cover.

3. With coolant at proper level and radiator cap tight, run engine for five minutes to bring to operating temperature.

4. Remove cap from recovery tank.

5. Check for bubbles coming from overflow hose at bottom of tank. If bubbles are present, isolate source of compression leak.

   a. Remove fuel injection nozzles. (See “Remove, Inspect, and Install Fuel Injection Nozzle” on page 122.)

   b. Install JDG472 Adapter in injection port of cylinder to be tested.

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

   d. Connect hose from JT03502 Cylinder Leakdown Tester to adapter.

   e. Apply 2448 kPa (355 psi) maximum air pressure into cylinder.

   f. Check for bubbles in recovery tank or air escaping from muffler, air cleaner, or oil dipstick tube.

6. Repeat for each cylinder.

Results

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

Repair

Remove and Install Alternator Drive Belt

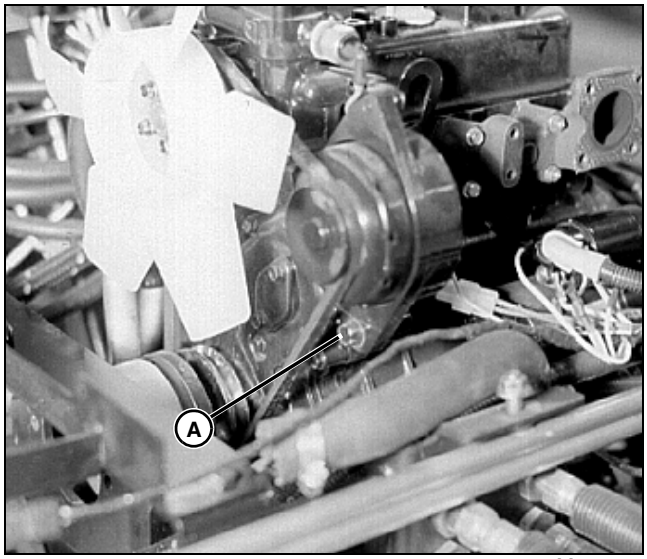
Removal

1. Park machine on level surface.
2. Move Mow/Transport lever to TRANSPORT position.
3. Lower cutting units to the ground.
4. Turn Ignition switch OFF.
5. Lock park brake.
6. Disconnect battery negative (-) cable.

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

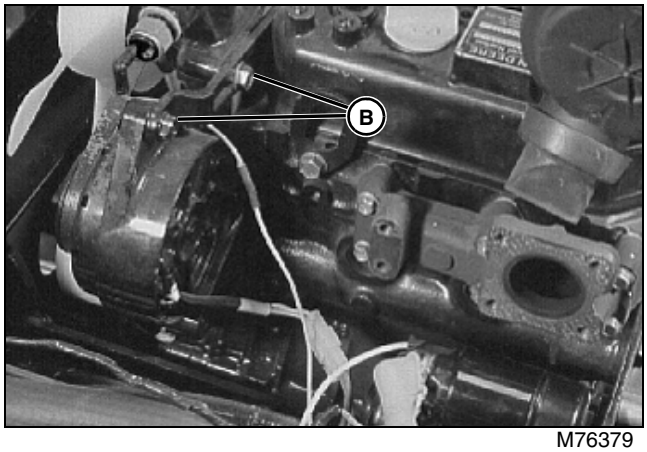
7. Remove radiator. (See “Remove, Inspect and Install Radiator” on page 71.)

8. Remove hydraulic pumps. (See “Remove Hydrostatic Pump” on page 296.)



M76394

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



M76379

10. Loosen cap screws (B) on top mounting bracket of alternator.

11. Swing alternator towards engine.

12. Remove belt.

Installation

1. Install alternator drive belt. Installation is done in the reverse order of removal.

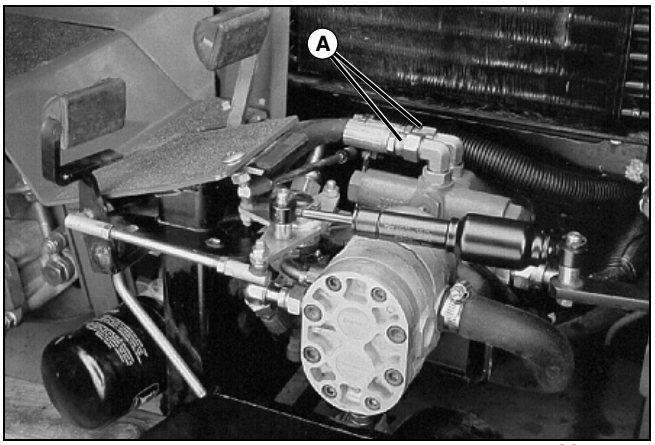
2. Adjust belt tension. (See “Check and Adjust Alternator Drive Belt Tension” on page 49.)

Remove, Inspect and Install Radiator

Removal

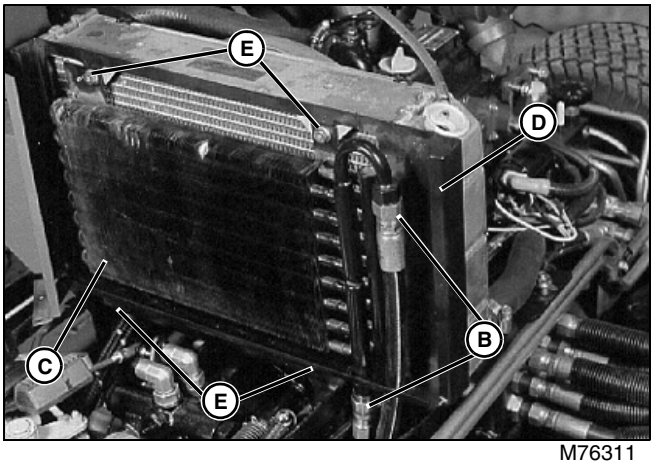
CAUTION: Avoid injury! Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Remove filler cap only when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

1. Park machine safely.
2. Remove engine cover.
3. Remove plenum/air duct.
4. Disconnect negative battery cable.
5. Remove hood if required for further servicing.
6. Place a 10-gallon container below the hydraulic sump and drain oil.



M76276

7. Disconnect two hydraulic lines (A) to top of hydrostatic pump.

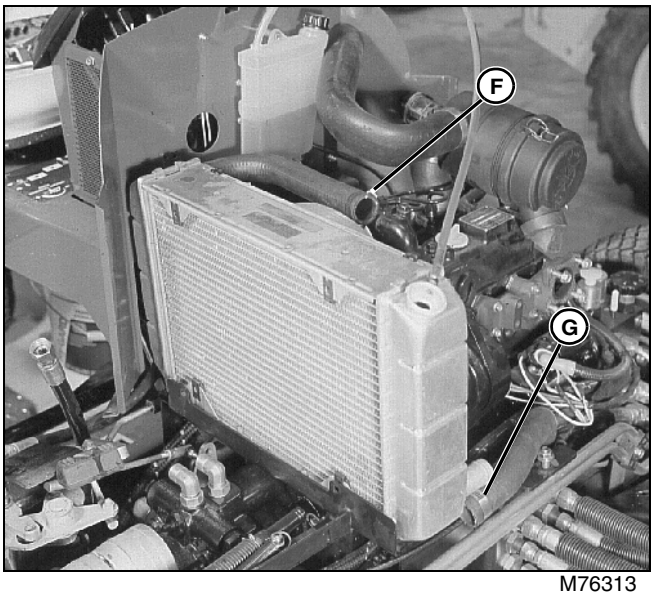


M76311

8. Disconnect oil cooler lines (B). Remove oil cooler (C) and frame (D) by detaching four cap screws (E).

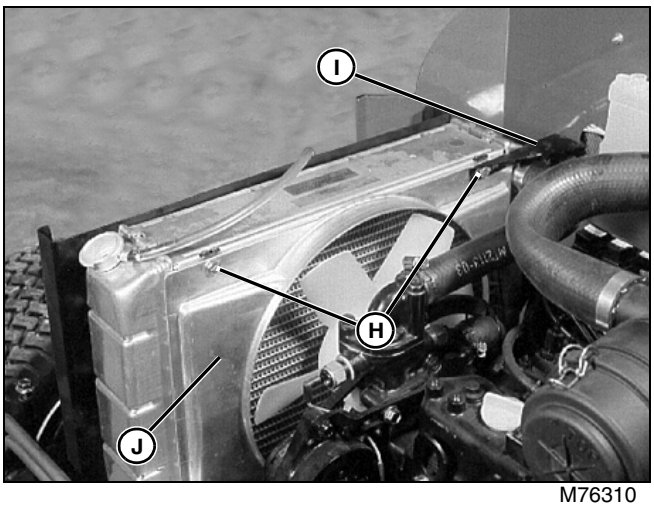
CAUTION: Avoid injury! Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

9. Drain coolant from radiator/engine. Drain cock is located under frame on lower left side of radiator.



M76313

10. Disconnect upper radiator hose (F) and lower radiator hose (G).
11. Pull hose from recovery tank.



M76310

12. Remove cap screws (H) securing radiator support (I) to firewall.
13. Remove radiator and fan shroud (J).

Inspection

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

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

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

Installation

Installation is done in the reverse order of removal.

- Make sure radiator flange fits inside mounting bracket.
- Close drain cock on bottom of radiator and fill radiator with proper mix of coolant.
- Run engine and check for leaks at coolant and hydraulic hoses. Add coolant to recovery tank and hydraulic oil to reservoir as necessary.

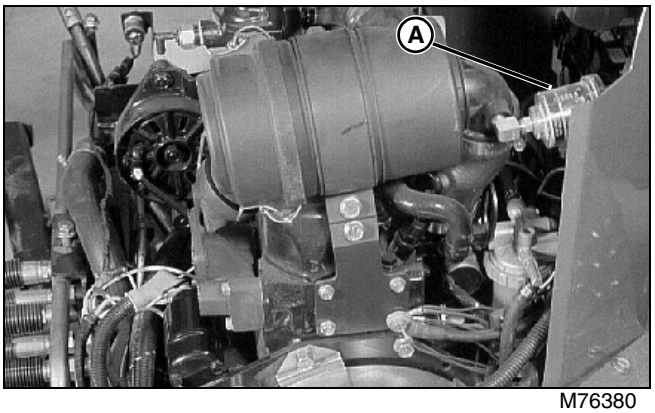
Specifications

Cooling System Capacity (Approximate) . . . . . 4 L (4.2 qt)

Remove and Install Air Filter Restriction Indicator

Removal

1. Park machine safely.
2. Remove engine hood.



M76380

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

Installation

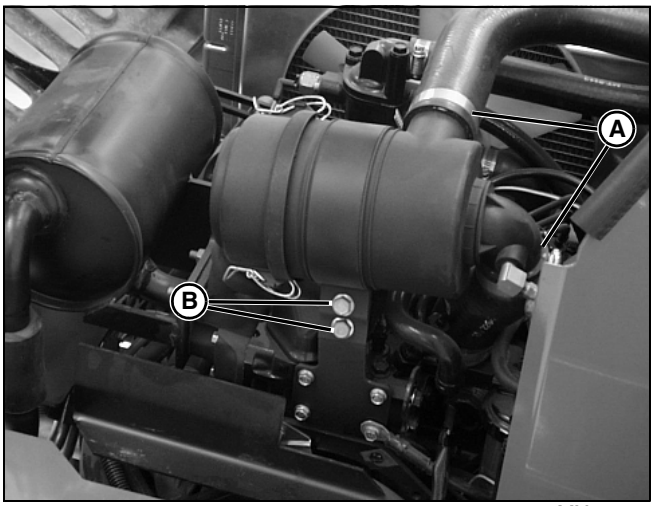
Installation is done in the reverse order of removal.

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

Remove and Install Air Cleaner Assembly

Removal

1. Park machine safely.
2. Remove engine cover.



MX3594

3. Loosen hose clamps (A).
4. Remove air cleaner bracket bolts (B) and remove air cleaner.
5. Inspect all parts for wear or damage. Replace as needed.
6. Inspect hoses for cracking or damage. Replace as needed.

Installation

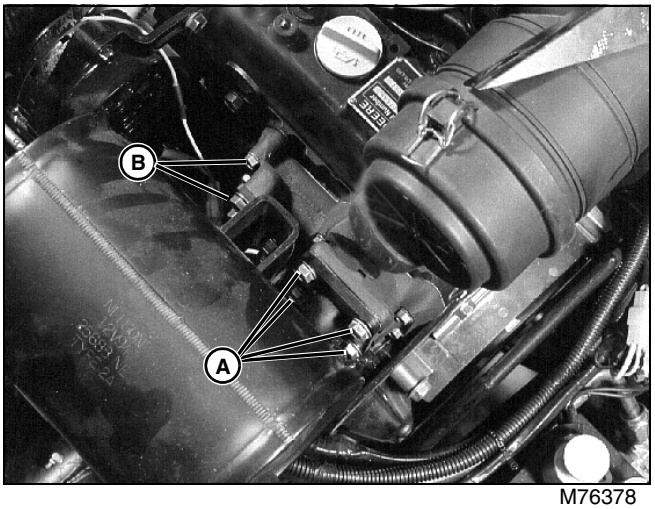
Installation is done in the reverse order of removal.

Remove and Install Muffler

Removal

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

1. Park machine safely.
2. Remove engine cover.



M76378

3. Remove four flange head bolts (A) securing muffler flange to manifold flange.
4. Remove two flange head bolts (B) securing muffler support to manifold.
5. Remove muffler and gasket.

Installation

Installation is done in the reverse order of removal.

- Install new gasket on exhaust manifold with metal side of gasket facing out.
- Tighten manifold nuts to specification.

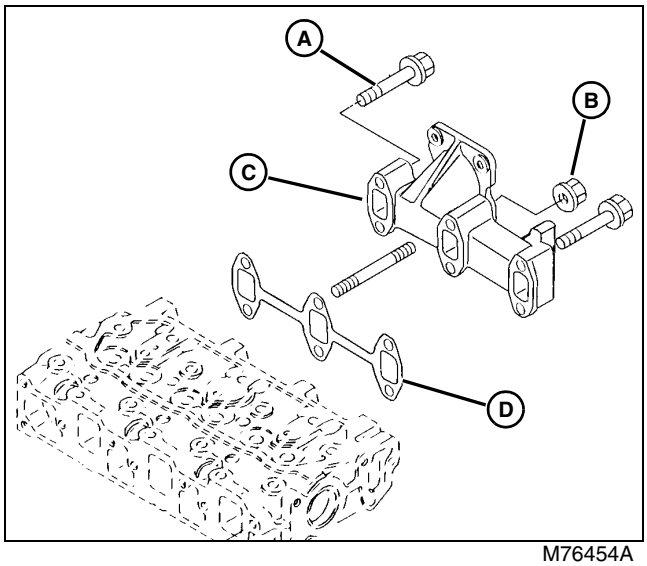
Specifications

Manifold Nut Torque . . . . . 28 N•m (240 lb-in.).

Remove and Install Exhaust Manifold

Removal

1. Remove muffler and gasket. (See “Remove and Install Muffler” on page 73.)



M76454A

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

Installation

Installation is done in the reverse order of removal.

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

Specifications

Manifold Mounting Cap Screw and Nut Torque . . . . . 11 N•m (97 lb-in.).

Remove and Install Intake Manifold

Removal

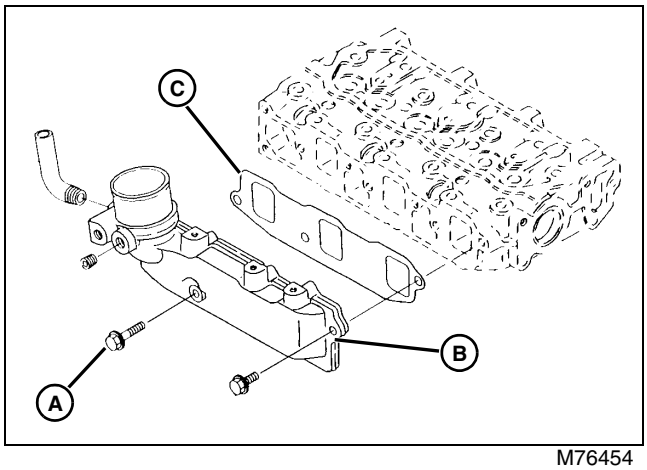
1. Remove fuel filter/water separator. (See “Remove and Install Fuel Filter and Water Separator Assembly” on page 118.)

IMPORTANT: Avoid damage! When removing injection lines, DO NOT turn pump delivery valve fittings. Turning fittings may damage pump internally.

2. Loosen fuel injection line connectors (on fuel injection pump and fuel injectors) slightly to release pressure in the fuel system. When loosening connectors, use another wrench to keep delivery valves from loosening.

3. Remove fuel injection lines.

4. Disconnect leak-off hose at fuel injector.



M76454

5. Remove three cap screws (A).

6. Remove intake manifold (B) and gasket (C).

Installation

Installation is done in the reverse order of removal.

- Install new gasket between intake manifold and cylinder head.
- Tighten mounting cap screws to specification.

Specifications

Manifold Mounting Cap Screw Torque . . . . . 11 N•m (97 lb-in.).

Remove and Install Thermostat

Removal

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

1. Park machine safely.

2. Turn key switch to stop position and allow the engine to cool.

3. Remove engine cover.

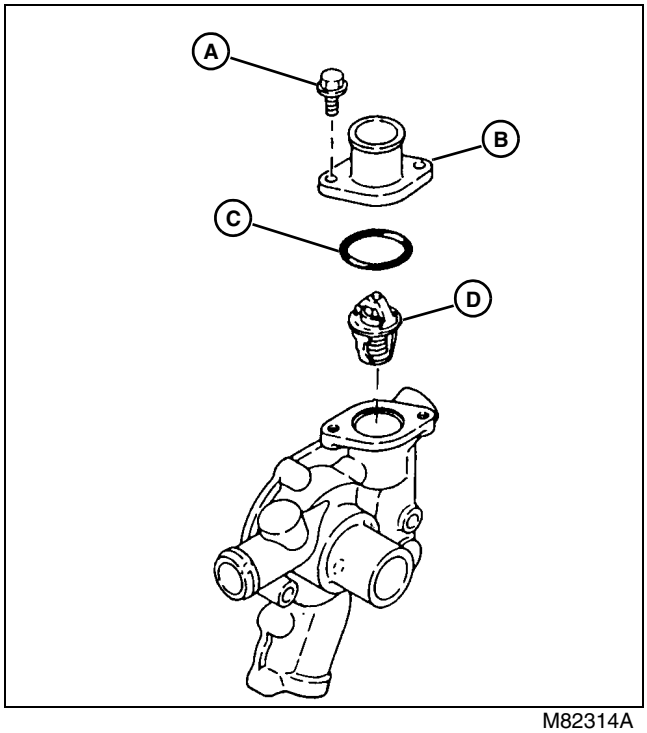
4. Loosen radiator cap to first stop to relieve pressure.

5. Remove radiator cap.

6. Attach a 12-inch hose to drain valve located on lower left side of radiator.

7. Drain coolant from radiator/engine into container large enough to hold full capacity of cooling system.

8. Remove radiator hose from thermostat housing.



M82314A

9. Remove two cap screws (A).

10. Remove thermostat housing (B) and O-ring (C).

11. Remove thermostat (D).

12. If thermostat is to be reinstalled, test thermostat. (See “Test Thermostat” on page 67.)

Installation

Installation is done in the reverse order of removal.

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

Specifications

Cooling System Capacity (Approximate) . . . . . 4.0 L (4.2 qt)

Remove and Install Coolant Temperature Switch

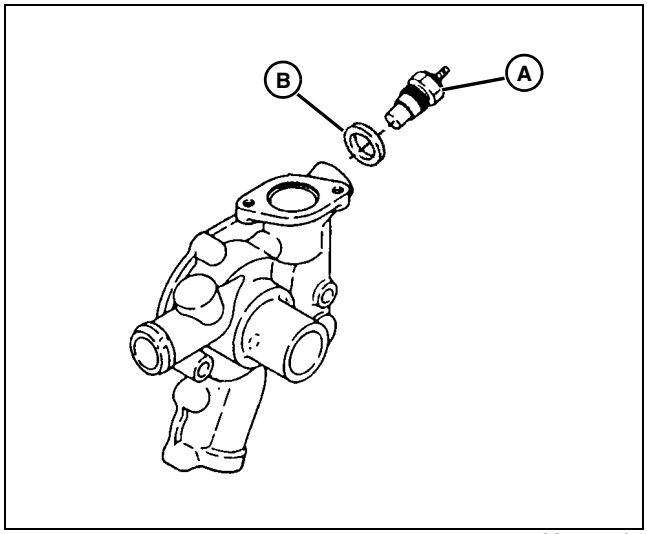
Other Material

Part No.	Part Name	Part Use
TY9375 (U.S.)/ TY9480 (Canada)	Pipe Sealant	Applied to threads of dual temperature coolant switch before installation.

Removal

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

1. Park machine safely.
2. Turn key switch to stop position and allow the engine to cool.
3. Remove engine cover.
4. Loosen radiator cap to first stop to relieve pressure.
5. Remove radiator cap.
6. Remove air cleaner assembly.
7. Attach a 12-inch hose to drain valve located on lower left side of radiator.
8. Drain coolant from radiator/engine into container large enough to hold full capacity of cooling system.
9. Disconnect electrical connector.



M82674A

10. Remove switch (A) and copper washer (B).
11. Test switch. (See “Test Coolant Temperature Switch” on page 68.)

Installation

Installation is done in the reverse order of removal.

- Apply TY9375 Pipe Sealant to coolant temperature switch threads.
- Fill cooling system to specifications.
- Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.

Specifications

Cooling System Capacity (Approximate) . . . . . 4.0 L (4.2 qt)

Remove Engine

Removal

1. Park machine on a hard, level surface. Lock park brake.

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

2. Jack and block machine to provide a minimum of 18in. of clearance between the floor and the bottom of the frame of the machine at the engine.
3. Move mow/transport lever to TRANSPORT position.
4. Lower cutting units to the ground.
5. Turn ignition switch OFF.
6. Lock park brake.

7. Disconnect battery negative (-) cable.

8. Close fuel shut-off valves located on right side of fuel tank.

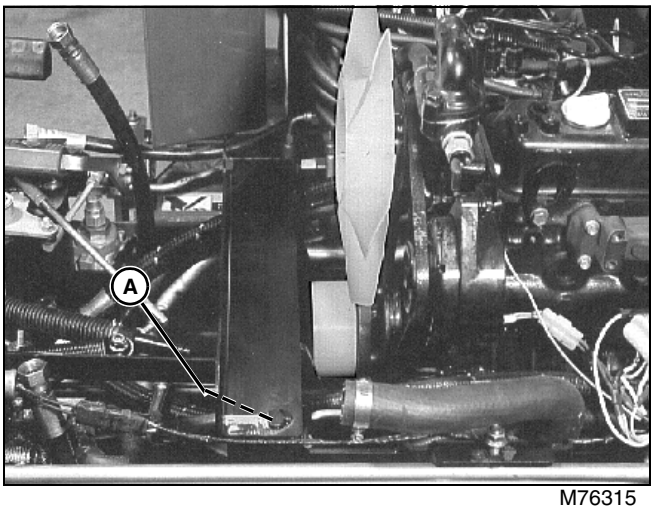
9. Place 5 gallon container under sump and drain hydraulic fluid.

10.Remove hood.

11.Remove plenum air duct.

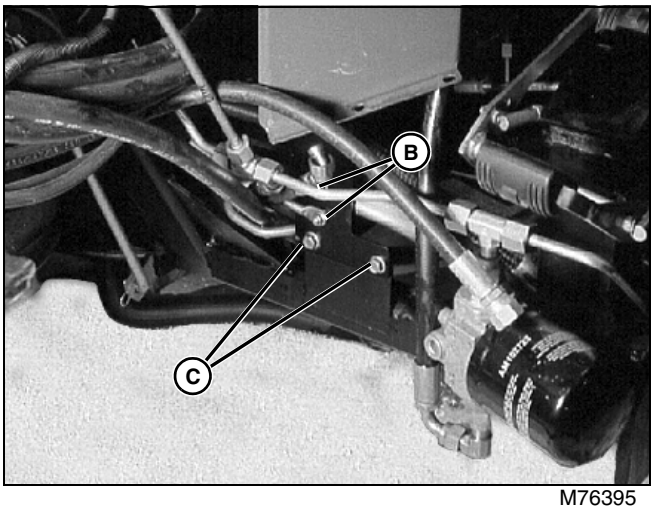
12.Remove front bumper assembly.

13.Remove radiator. (See “Remove, Inspect and Install Radiator” on page 71.)



M76315

14.Remove nut (A) from welded stud on underside of radiator support crossmember.



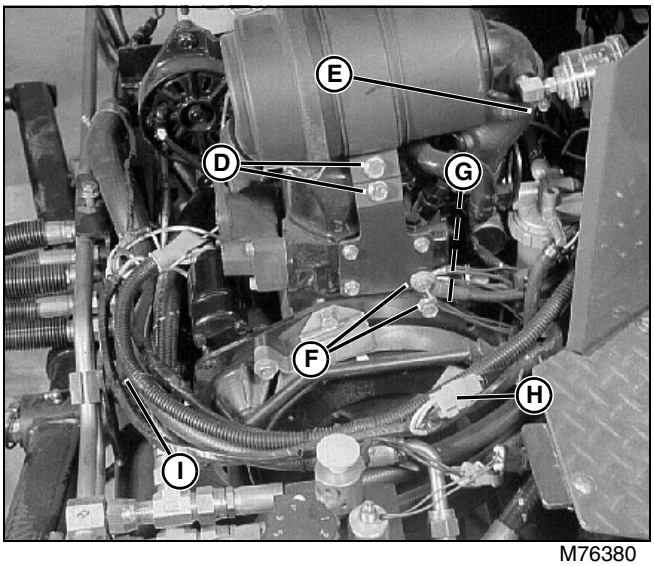
M76395

15.Remove two flange head bolts (B) securing tube clamp to frame.

16.Remove two flange head bolts (C) retaining lower end of radiator support to frame.

17.Swing radiator support bracket out of the way of the front of the engine subframe.

18.Remove hydraulic pumps. (See “Remove Double Pump” on page 349.)

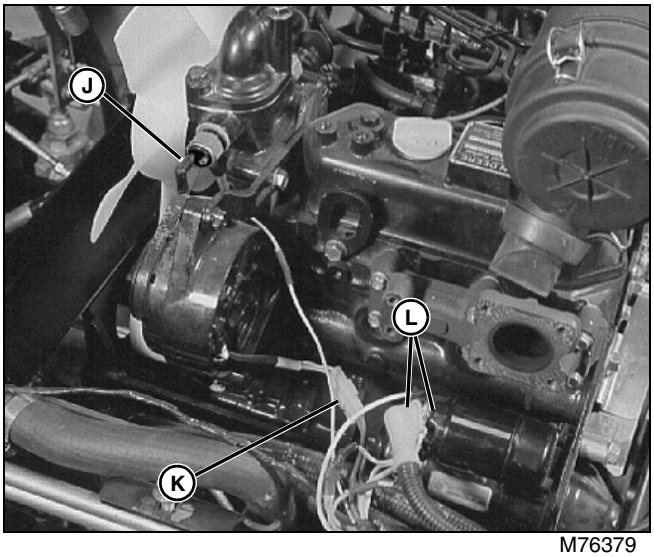


M76380

19.Remove air cleaner bracket bolts (D) and intake hose (E), and remove air cleaner.

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

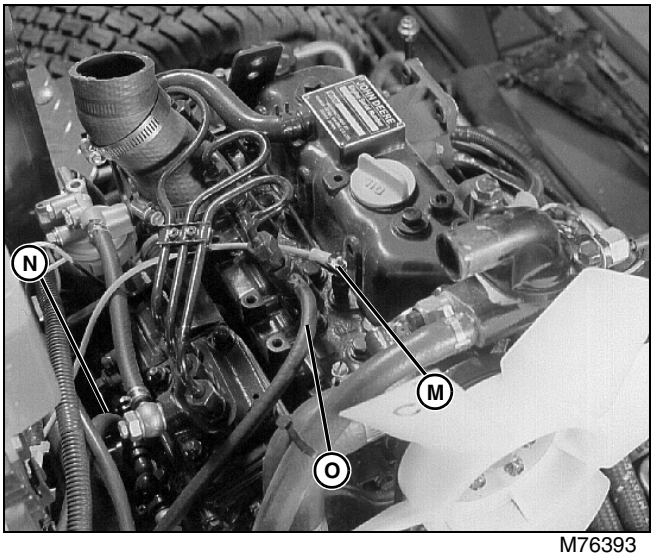
- Wire leads (F) from engine ground connection.
- Oil pressure sending unit wire lead (G).
- Fuel shutoff solenoid wire connector (H).
- Engine-to-frame ground strap (I).



M76379

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

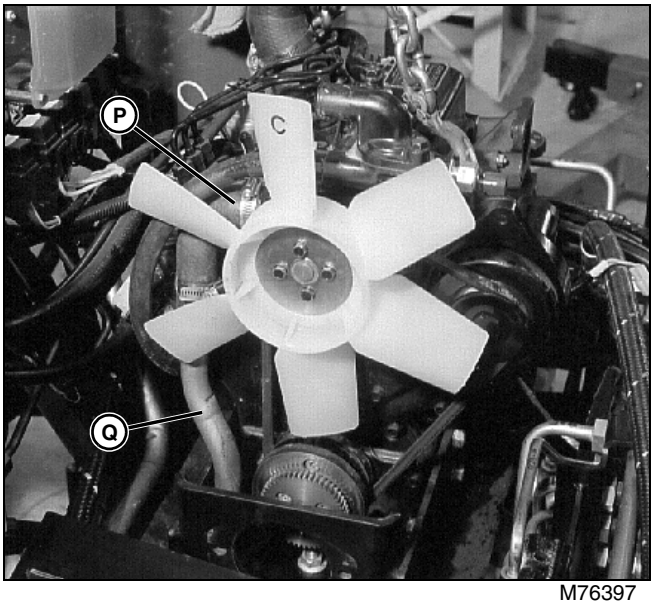
- Coolant temperature sensor lead (J).
- Alternator wire harness (K).
- Starter connections (L).



M76393

22.On firewall side of engine, label and disconnect the following:

- Glow plug lead (M).
- Fuel supply line (N).
- Fuel return line (O).



M76397

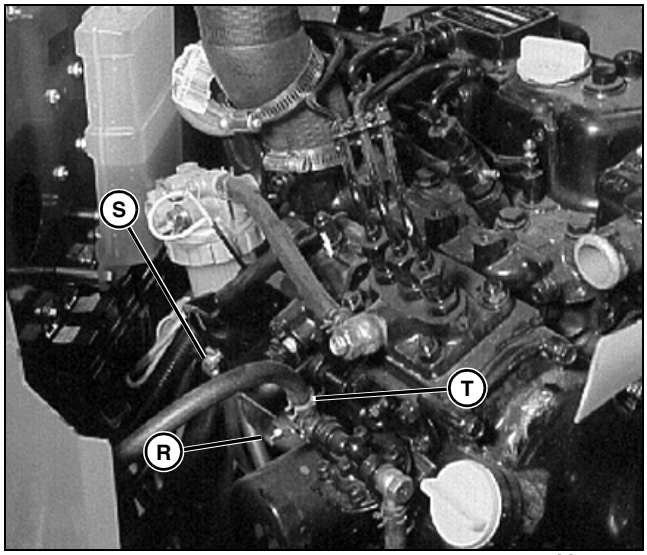
23.Remove short hose (P) connecting coolant pickup tube (Q) and water pump housing.

24.Remove coolant pickup tube through the bottom of the vehicle frame.

25.Remove engine mount cap screws and flat washers.

26.Connect a hoist to lifting eyes on engine.

27.Lift engine until it is clear of the frame and can be rotated slightly.



M76396

28.Loosen throttle cable lock screw (R) and clamp (S). Move throttle cable away from engine.

29.If fuel supply line (T) has not been previously disconnected, disconnect now.

30.Raise engine the rest of the way and remove from vehicle.

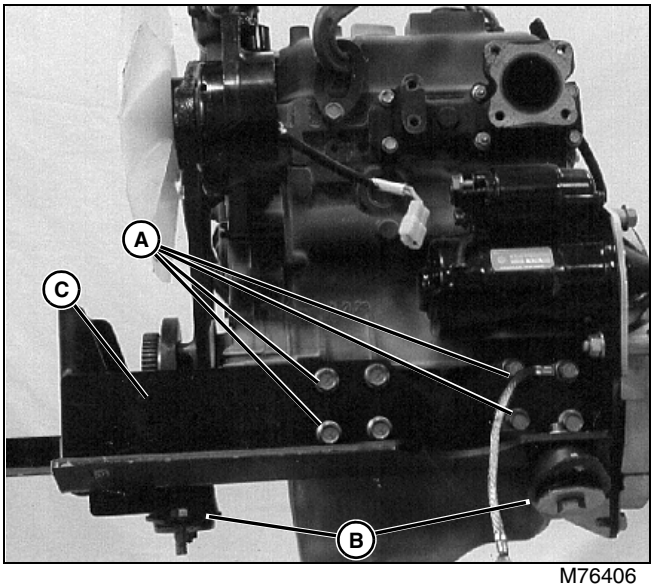
Subframe Removal

Other Material

Part No.	Part Name	Part Use
T43512 (U.S.) TY9473 (Canada)	Thread Lock and Sealer (Medium Strength)	Applied to threads of Engine Mounting Cap Screws.

1. Remove engine. (See “Remove Engine” on page 75.)

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



M76406

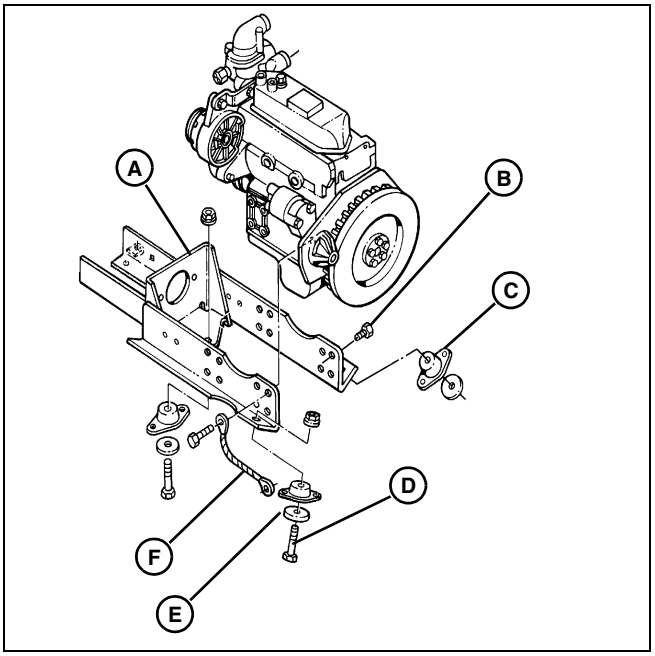
2. Remove engine-to-frame cap screws (A).

3. Inspect three rubber vibration isolators (B) on subframe (C) for wear or damage. Replace as necessary.

NOTE: Location of braided ground strap is on the upper bolt which is on the left hand side of subframe.

Subframe Installation

IMPORTANT: Avoid damage! Thread lock and sealer MUST be used on the sixteen M10 x 20 cap screws securing subframe to engine block. Cap screws must be torqued to 89 N•m (59 lb-ft.).



M76405A

A - Subframe

B - Engine-to-Frame Cap Screw (16) M10 x 20

C - Vibration Isolator

D - Engine Mount Cap Screw (3) 1/2 in. x 2.5 in.

E - Heavy Washer

F - Ground Strap

1. Install new vibration isolators, if required, and torque to specifications.

NOTE: Install ground strap as shown in illustration. An alignment tool is required to properly install subframe to engine.

2. Secure subframe to engine block with sixteen M10 x 20 cap screws and torque to specifications.

Specifications

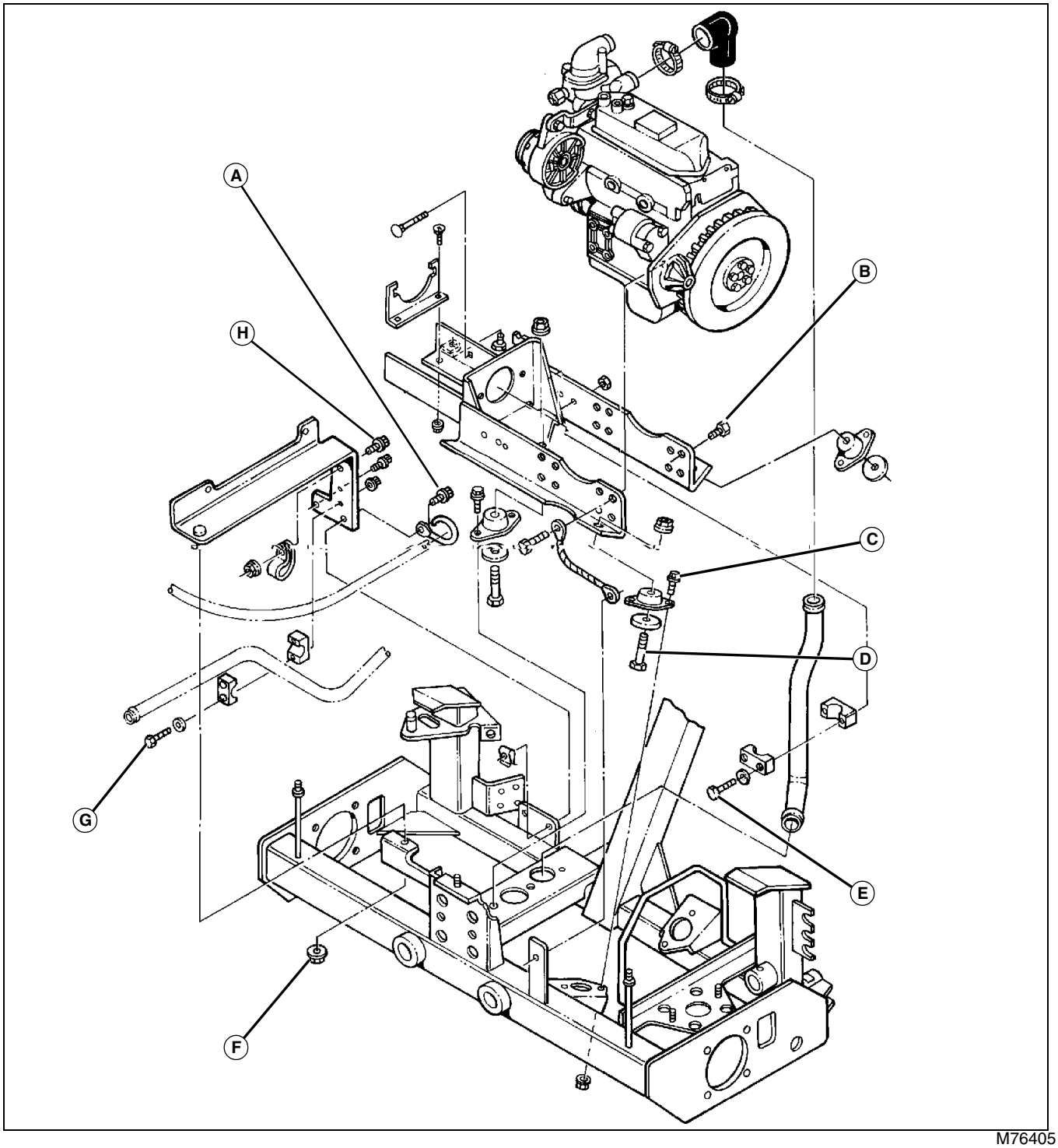
Engine-to-Frame Cap Screw
(Apply Thread Lock and Sealer) . . . . . 80 N•m (59 lb-ft.)
Engine Mount Cap Screw
(Apply Thread Lock and Sealer) . . . . . 85 N•m (63 lb-ft.)

Hydraulic Coupler

The hydraulic coupler transfers power from the engine to the hydrostatic pump assembly. Installation and adjustment procedures can be found in Hydrostatic Power Train section See “Assemble Hydrostatic Pump” on page 303. See “Install Hydrostatic Pump” on page 307.

Install Engine

Installation



M76405

A - Hose Hanger Cap Screw M8x25
B - Engine-to-Frame Cap Screw (16) M10x20
C - Mount Cap Screw (6) 3/8 in. x 1 in.
D - Engine Mount Cap Screw (3) 1/2 in. x 2.5 in.
E - Tube Clamp Cap Screw (2) M6x55
F - Cross Brace Stud Nut M12
G - Tube Clamp Cap Screw (2) M6x50
H - Cap Screw (2) M8x20

1. Install subframe.
2. Install engine in reverse order from removal.
3. Install hydraulic pumps. (See “Remove Double Pump” on page 349.)

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

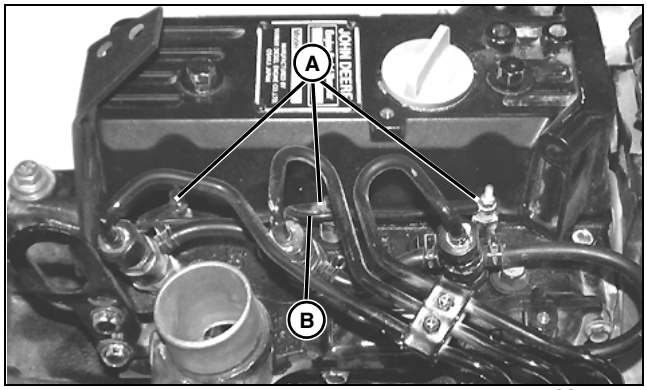
4. Replace fluids, hydraulic, coolant, and engine oil.
5. Connect battery.
6. Perform throttle adjustment. (See “Adjust Throttle Cable” on page 56.)
7. Bleed fuel system. (See “Bleed Fuel System” on page 54.)
8. Replace front bumper, hood, and plenum.
9. Remove vehicle from jack stands.

Specifications

Engine Oil Capacity with Filter (Approximate) . . . . . 2.4 L (2.5 qt)
Cooling System Capacity (Approximate) . . . . . 4.0 L (4.2 qt)
Total Hydraulic System Capacity with Reservoir (Approximate) . . . . . 28.4 L (7.5 gal)
Hose Hanger Cap Screw Torque . . . . . 28 N•m (20 lb-ft.)
Engine-to-Frame Cap Screw Torque . . 28 N•m (20 lb-ft.)
Mount Cap Screw Torque. . . . . 44 N•m (33 lb-ft.)
Engine Mount Cap Screw Torque . . . . 85 N•m (63 lb-ft.)
Tube Clamp Cap Screw Torque . . . . . 11 N•m (8 lb-ft.)
Cross Brace Stud Nut Torque . . . . . 11 N•m (8 lb-ft.)
M8 x 20 Cap Screw Torque . . . . . 28 N•m (20 lb-ft.)

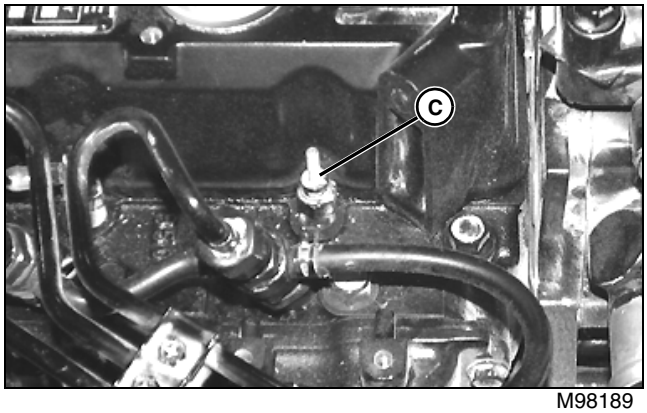
Remove and Install Glow Plug

Removal



M98188

1. Remove nut (A), lock washer, and flat washer from each glow plug.
2. Remove wiring harness (B).



M98189

3. Remove glow plugs (C).
4. Test glow plugs. (See “Test Glow Plug - Diesel” on page 258.)

Installation

Installation is done in the reverse order of removal.

- Tighten glow plugs to specifications.

Specifications

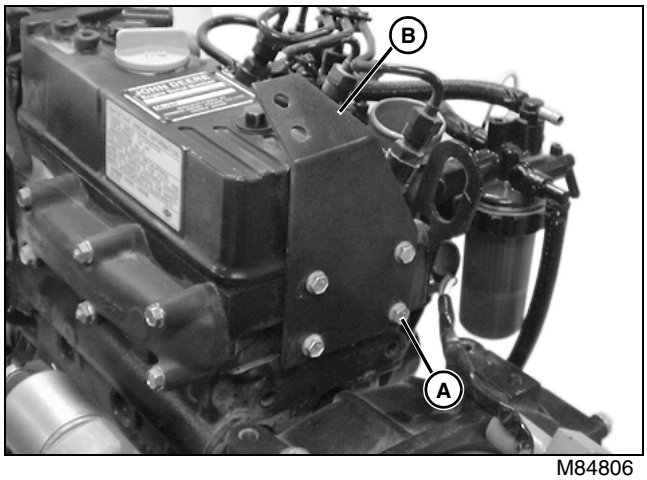
Glow Plug Torque. . . . . 19 N•m (168 lb-in.)

Remove and Install Rocker Arm Cover

Removal

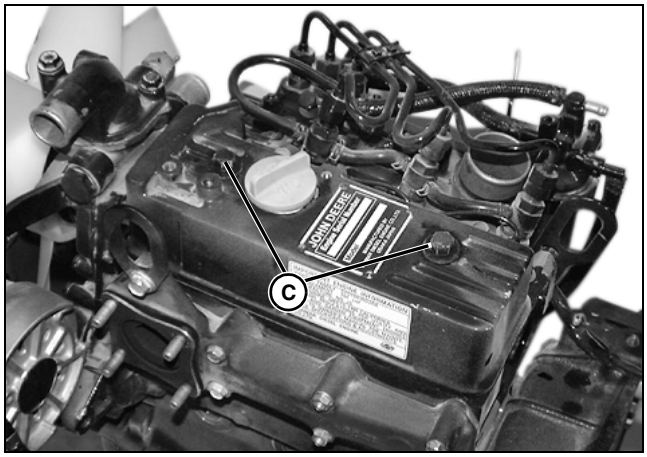
NOTE: If the rocker arm cover is to be removed with the engine installed in the machine, to perform valve clearance check and adjustment procedure, remove the air cleaner assembly. (See "Remove and Install Air Cleaner Assembly" on page 72 .)

1. Park machine safely.
2. Remove engine cover.



M84806

3. Remove four cap screws (A).
4. Remove air cleaner mounting bracket (B).



M84807

5. Remove two special nuts (C) securing cover to cylinder head.
6. Remove the rocker arm cover.

Installation

IMPORTANT: Avoid damage! Do not overtighten the special nuts securing rocker arm cover to engine.

Installation is done in the reverse order of removal.

- Clean the cylinder head surface and install the rocker arm cover to the cylinder head.
- Inspect the rocker arm cover O-ring before reinstalling the rocker arm cover. Replace if damaged.
- Tighten the special nuts to specification.

Specifications

Rocker Arm Cover
Special Nut Torque. . . . . 18 N•m (160 lb-in.)

Remove and Install Rocker Arm Assembly

Removal

1. Remove rocker arm cover. (See "Remove and Install Rocker Arm Cover" on page 81.)
2. Remove three M8 rocker arm mounting nuts.
3. Pull rocker arm assembly straight up off mounting studs on cylinder head.

IMPORTANT: Avoid damage! Be sure valve caps are in place on end of valve stems before installing rocker arms.

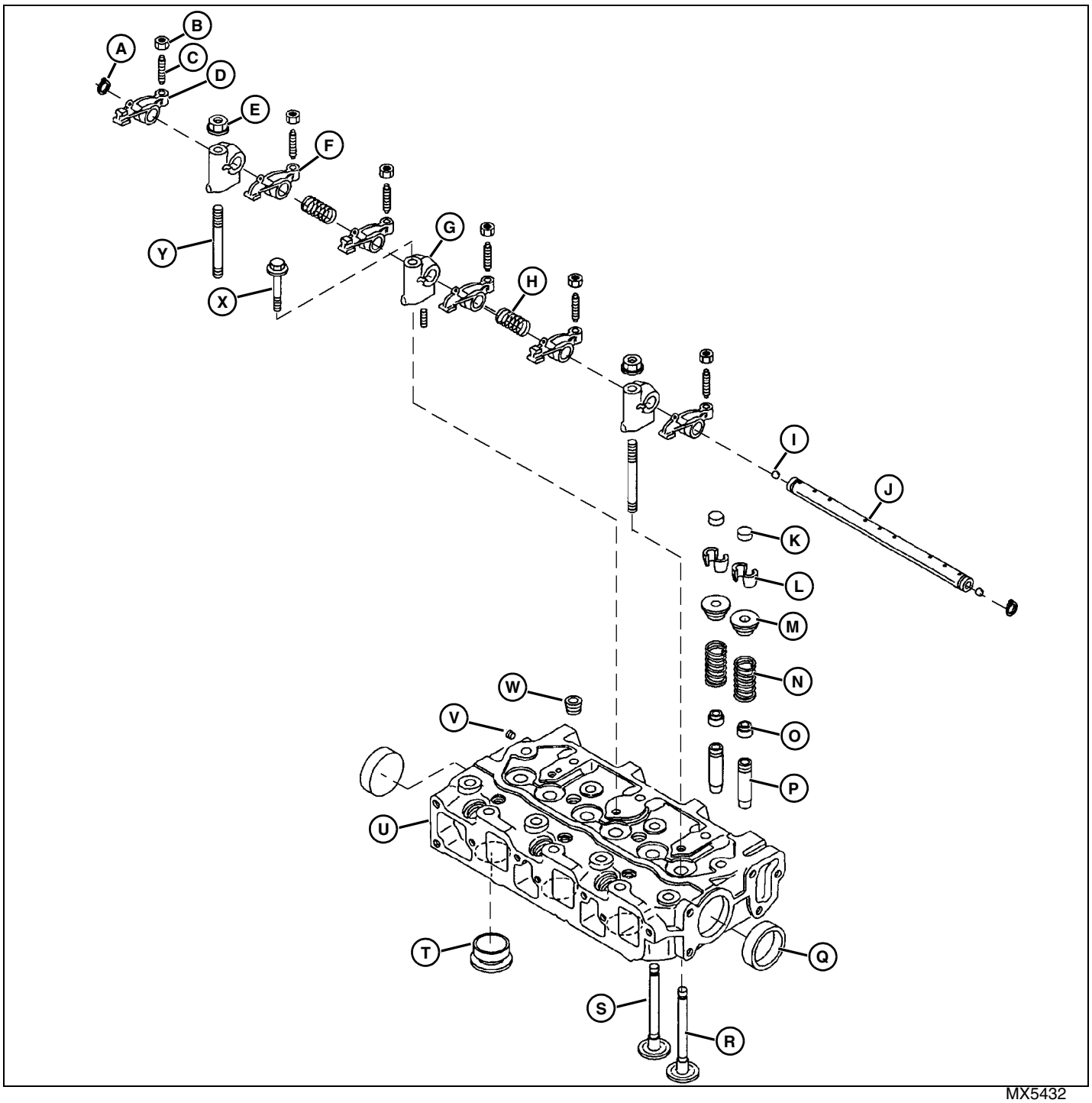
4. Align rocker arm supports with studs on cylinder head. Align rockers with valve stems.
5. Install push rods in block and align into rocker arms.
6. Install mounting nuts on rocker arm supports and evenly tighten nuts to pull rocker assembly to head. Tighten nuts to specification.
7. Adjust valve clearance. (See "Adjust Valve Clearance" on page 49.)
8. Install rocker arm cover. (See "Remove and Install Rocker Arm Cover" on page 81.)

Specifications

Rocker Arm Assembly Mounting Nut Torque . . 26 N•m (226 lb-in.)

Disassemble and Assemble Rocker Arm

Disassembly



MX5432

- **A - Snap Ring (2 used)**
- **B - Nut (6 used)**
- **C - Stud (6 used)**
- **D - Rocker Arm (3 used)**
- **E - Nut (2 used)**
- **F - Rocker Arm (3 used)**
- **G - Rocker Arm Support (3 used)**
- **H - Spring (2 used)**
- **I - Ball (2 used)**
- **J - Shaft**
- **K - Cap (6 used)**
- **L - Collet (6 used)**

M - Retainer (6 used)
N - Spring (6 used)
O - Seal (6 used)
P - Valve Guide (6 used)
Q - Plug (2 used)
R - Intake Valve (3 used)
S - Exhaust Valve (3 used)
T - Plug (3 used)
U - Cylinder Head
V - Plug
W - Plug (2 used)
X - Cap Screw
Y - Stud (2 used)

1. Mark all parts for location before disassembly to aid assembly.

2. Remove end retaining rings and slide components off rocker shaft.

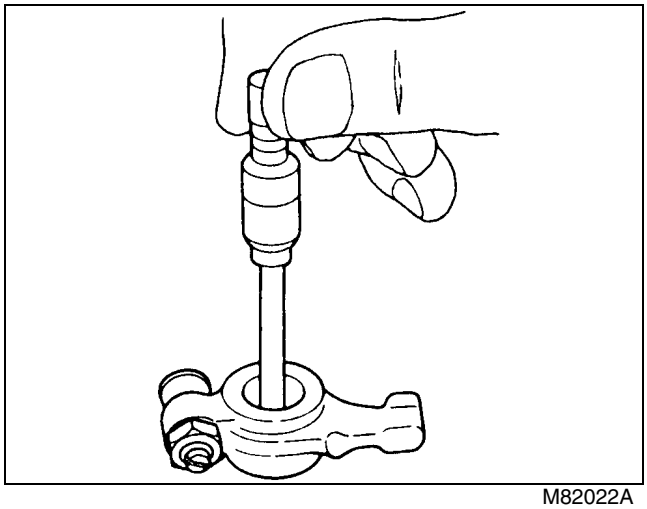
3. Remove set screw from center support. Remove rocker shaft from center support.

4. Clean all parts of varnish and oil.

Rocker Arm Inspection

M35262

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

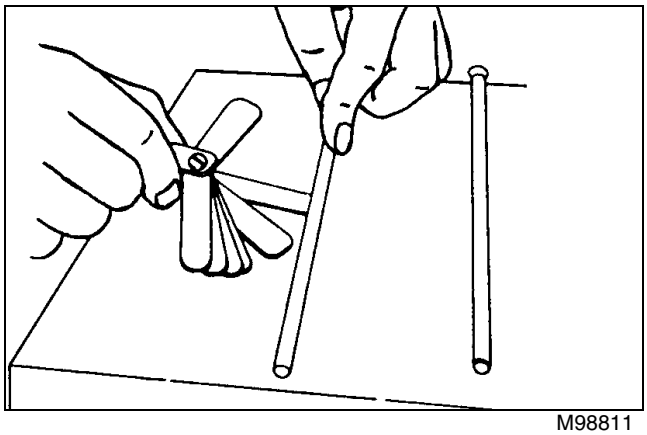


M82022A

2. Measure inside diameter of rocker arms and rocker shaft supports. Replace rocker arms or supports if inner diameter is more than wear limit.

3. If shaft and support/arm clearance (support/arm ID minus shaft OD) exceeds wear limit, replace all parts.

Push Rod Inspection



M98811

1. Lay push rod on flat surface and roll while checking for a gap under center of rod. Use feeler gage to check dimension.

2. Check the surface of the adjusting screw that contacts the push rod for wear. Replace push rod or adjusting screw if worn.

3. Check the rocker arm-to-valve stem cap contact surface for wear. Replace rocker arm if worn.

Assembly

1. Assemble rocker arm shaft into center support, aligning set screw hole in support with hole in rocker arm shaft.

2. Be sure rocker arms are installed in the same order as removed.

Specifications

Rocker Arm Shaft OD Wear Limit . . 9.95 mm (0.391 in.)
Rocker Arm and Shaft Support ID Wear Limit. . . . . 10.09 mm (0.397 in.)
Rocker Arm and Shaft Support Oil Clearance Wear Limit. . . . . 0.14 mm (0.006 in.)
Push Rod Bend. . . . . 0.00-0.03 mm (0.000-0.001 in.)

Remove and Install Cylinder Head

Special or Required Tools

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

Removal

1. Park machine on level surface with park brake locked and engine off.

2. Disconnect negative (-) battery cable from battery.

3. Shut off fuel valve on fuel filter/water separator.

4. Allow engine to cool, and cooling system pressure to return to zero. Drain coolant from engine and radiator.

5. Remove pipe from exhaust manifold. (See “Remove and Install Muffler” on page 73.)

6. Remove upper and lower radiator hoses from coolant pump.

7. Disconnect wiring from coolant temperature sensor.

8. Remove upper alternator bracket and belt from coolant pump.

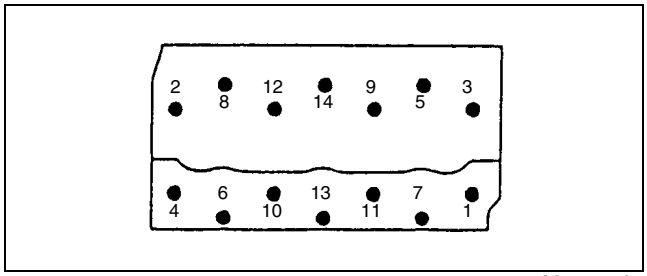
9. Remove coolant pump. (See “Remove and Install Coolant Pump (Thermostat Included)” on page 117.)

10.Remove high-pressure fuel lines and fuel leak-off line running from fuel injection pump to nozzles.

11. Disconnect glow plug wiring harness from engine harness.

12.Remove rocker arm cover. (See “Remove and Install Rocker Arm Cover” on page 81.)

13.Remove rocker arm assembly, push rods, and valve caps from cylinder head. (See “Remove and Install Rocker Arm Assembly” on page 81.)



M82260A

Picture Note: Top of drawing is exhaust manifold side, bottom is intake manifold side

14.Remove cylinder head cap screws in the order shown.

15.Using JT01748 Lifting Brackets and hoist, pull head straight up from block.

16.Remove exhaust and intake manifolds. (See “Remove and Install Exhaust Manifold” on page 73. See “Remove and Install Intake Manifold” on page 74.)

17.Disassemble and inspect cylinder head and valves. (See “Recondition Cylinder Head” on page 86.)

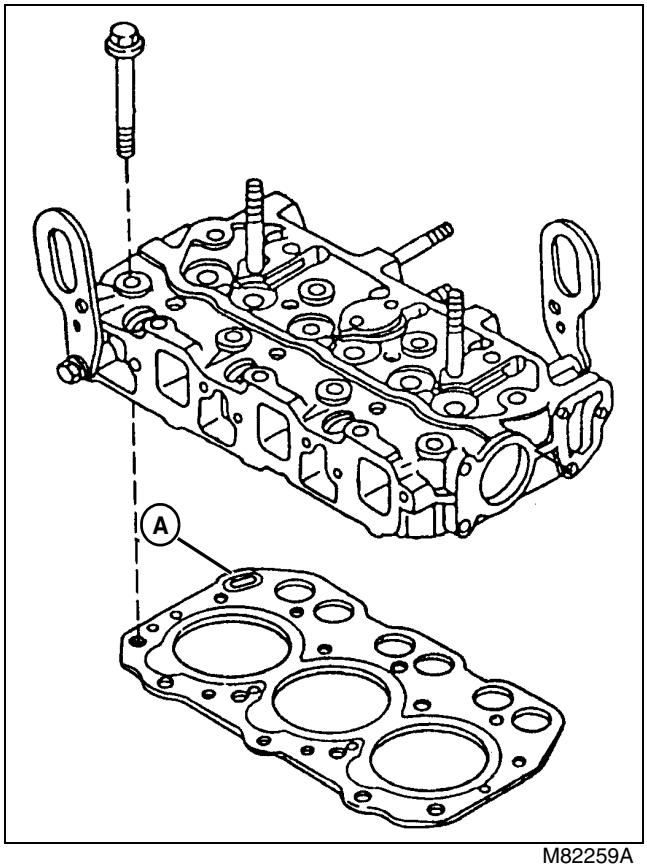
Installation

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

2. Clean top of cylinder block and check for flatness.

IMPORTANT: Avoid damage! Oil passage in gasket must be located over oil passage (A) in cylinder block.

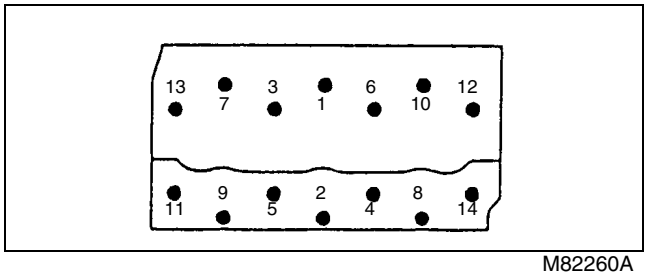
If cylinder head was resurfaced, check piston-to-cylinder head clearance.



M82259A

3. Place a new cylinder head gasket on cylinder block with locating pins on front and rear of block inside holes in gasket. Line up oil passage (A) on left rear of block with oil passage in gasket. If cylinder head was resurfaced, check piston-to-cylinder head clearance. (See "Remove and Install Piston and Connecting Rod" on page 91.)

4. Clean threads of cylinder head cap screws and dip in clean oil before installing. Install all cap screws finger tight before tightening with wrench.



M82260A

Picture Note: Top of drawing is exhaust manifold side, bottom is intake manifold side

5. Tighten cylinder head cap screws to specification in sequence shown above in three steps of torque from table below.

6. Install rocker arm assembly, push rods, and valve caps. (See "Remove and Install Rocker Arm Assembly" on page 81.)

7. Install rocker arm cover. (See "Remove and Install Rocker Arm Cover" on page 81.)

8. Connect fuel lines, radiator hoses, and wires.

9. Install coolant pump. (See "Remove and Install Coolant Pump (Thermostat Included)" on page 117.)

10. Install exhaust pipe to manifold. (See "Remove and Install Muffler" on page 73.)

11. Install upper alternator bracket and belt.

Specifications

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

First . . . . . 13 N•m (115 lb-in.)
Second . . . . . 26 N•m (20 lb-ft)
Final . . . . . 39 N•m (29 lb-ft)

Recondition Cylinder Head

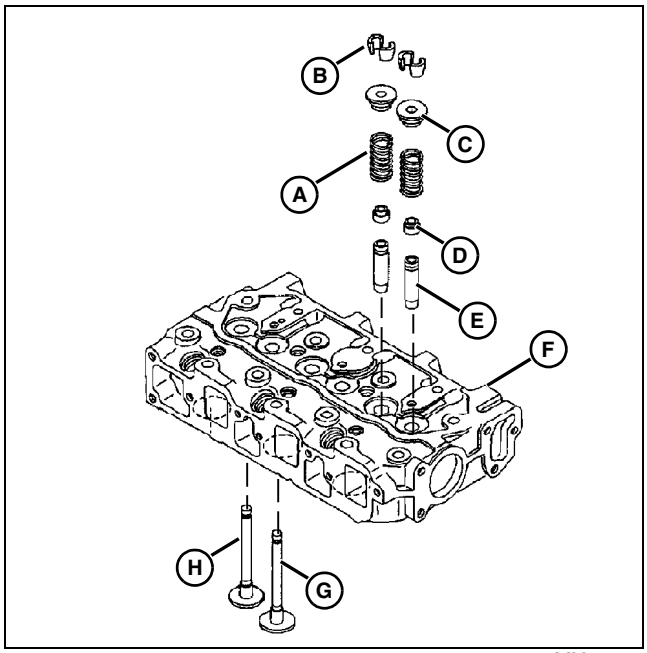
Special or Required Tools

Tool Name	Tool No.	Tool Use
Valve Spring Compressor	JDE138	Used to remove valves.
Valve Guide Driver	JDE504	Used to install valve guides in cylinder head.
Valve Guide Knurler	D-20019WI	Used to knurl inside diameter of valve guides.
Valve Guide Reamer	D-20021WI	Used to ream out valve guides.

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

Disassembly/Assembly

1. Check valve recession before disassembly. (See "Valve Recession Measurement" on page 88.)



MX5433

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

NOTE: It may be necessary to tap on valve spring retainer (C) while initially operating compressor to break retainer free from valve stem.

3. Remove collet halves (B) from retainer.

4. Slowly release compressor and valve spring.

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

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

NOTE: Valve seats are not replaceable.

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

7. Inspect all parts for wear or damage. Clean all carbon deposits and measure all parts for proper clearances.

8. Apply clean engine oil to intake and exhaust valve stems during assembly.

9. Install springs with smaller pitch end or paint mark toward cylinder head.

10. Use valve spring compressor to compress spring and retainer, and install collet as removed.

11. After valve has been assembled, tap on top of valve stem with a plastic hammer to seat retainer.

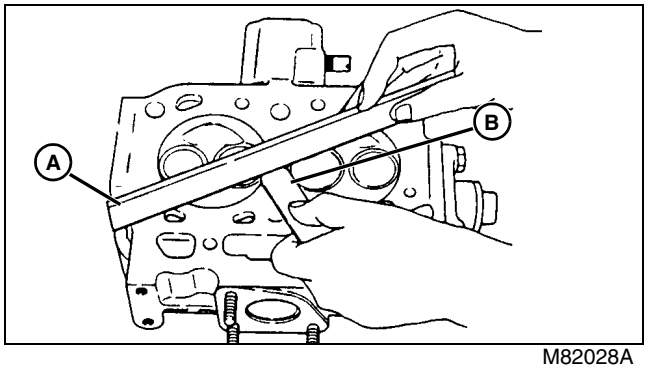
12. Repeat for remaining valves.

13. Measure valve recession if new valves were installed. (See "Valve Recession Measurement" on page 88.)

Inspection/Replacement

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

Cylinder Head



M82028A

1. Measure cylinder head flatness. Place a straightedge (A) along each of the four sides and each diagonal. Measure clearance between straightedge and gasket surface with a feeler gage (B).

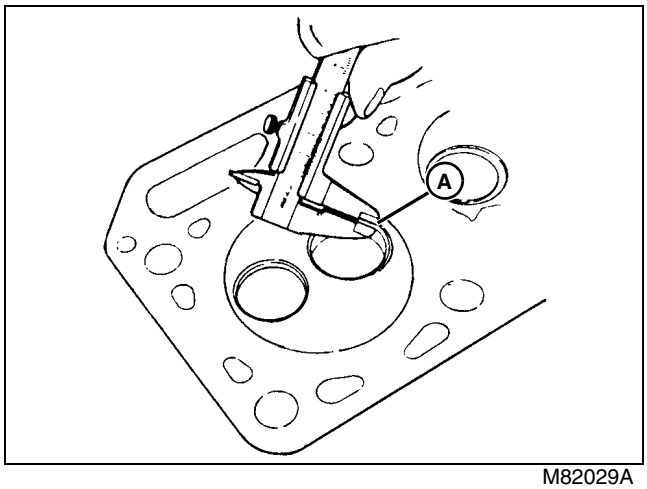
2. If distortion exceeds the wear limit, resurface or replace cylinder head. Remove only enough metal to make cylinder head flat, but do not remove more than maximum amount specified.

3. Inspect for cracks or other damage.

4. Inspect condition of valve seats and measure valve seat width. (See “Valve Seat Width” on page 87.)

5. If cylinder head was resurfaced, measure valve recession. (See “Valve Recession Measurement” on page 88.)

Valve Seat Width

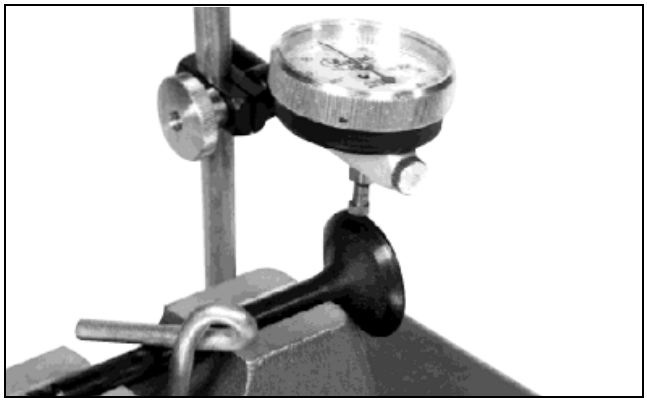


M82029A

1. Measure valve seat width (A) for intake and exhaust valves and compare to specification.

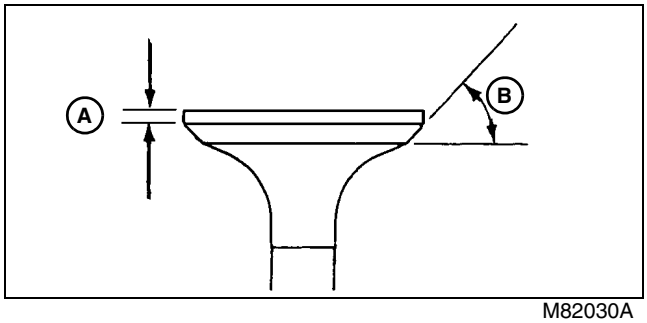
2. If necessary, grind valve seats to meet specification. (See “Valve Seat Grinding” on page 89.)

Intake and Exhaust Valves



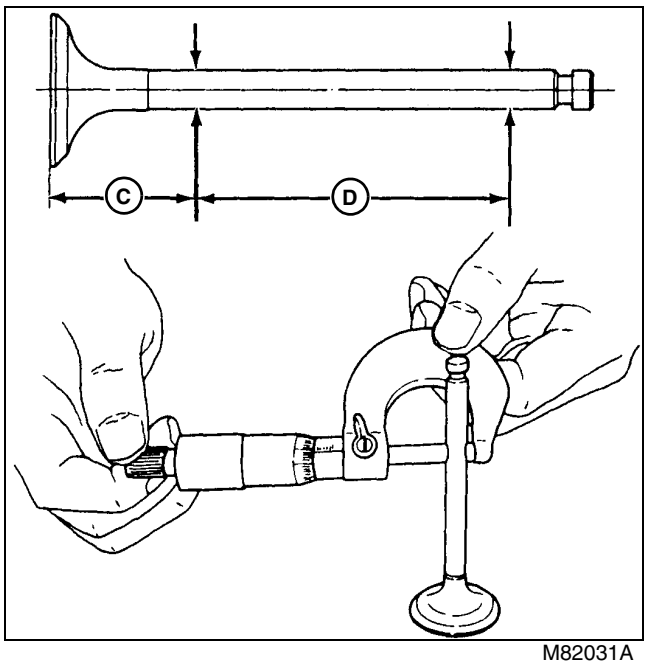
M35307

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



M82030A

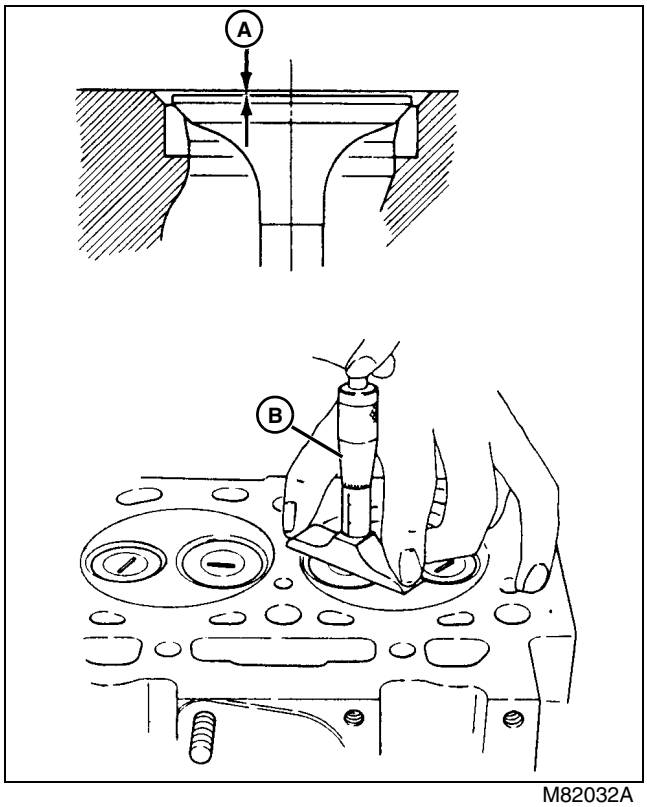
2. If valve faces are worn, burned, or pitted, grind valves to proper face angle (B). If valve face margin (A) is less than specification after grinding, replace valve.



M82031A

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

Valve Recession Measurement



M82032A

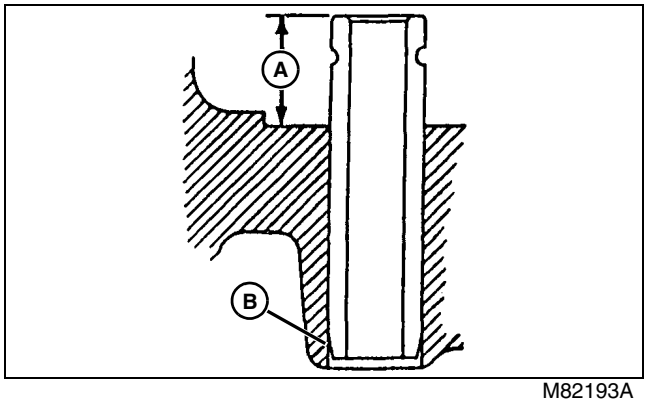
Measure valve recession (A) using a depth gage (B). Replace valve or cylinder head if measurement exceeds wear limit.

Valve Guide Measurement

1. Clean valve guides using a valve guide brush.

2. Measure valve guide inside diameter using a ball or telescoping snap gage.

- If valve guide inside diameter exceeds wear limit, knurl or replace guide.
- If valve guide inside diameter is less than wear limit, determine guide-to-stem clearance (valve guide diameter minus valve stem diameter).
- If clearance exceeds knurl specification, knurl valve guides using a 7 mm or 12 mm valve guide knurling tool.
- If clearance exceeds replacement specification, replace valve guides.

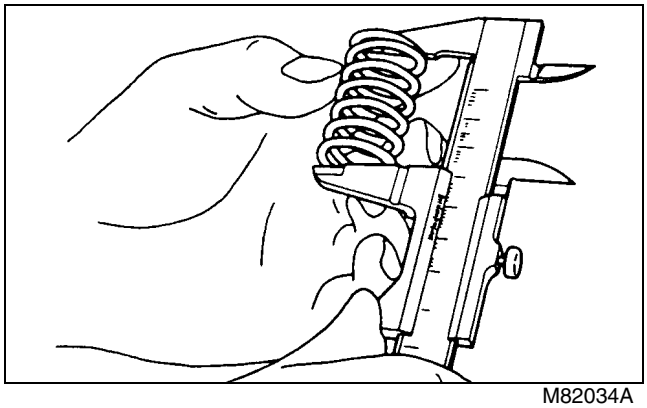


M82193A

3. Install valve guides with tapered end (B) down using JDE504 Valve Guide Driver. Push valve guides down until tops of valve guides are projecting the specified height (A) from the valve spring seat in the cylinder head.

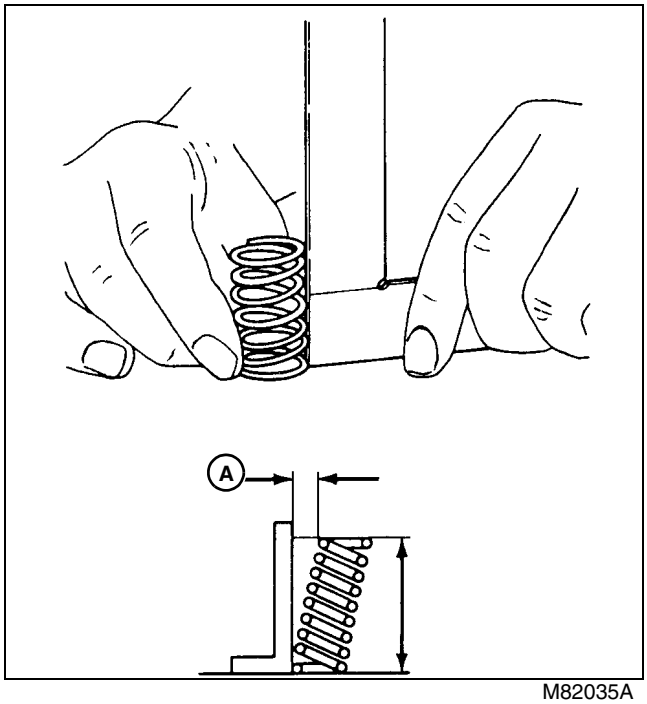
4. Ream inside diameter of valve guides using a 7 mm valve guide reamer.

Valve Springs



M82034A

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

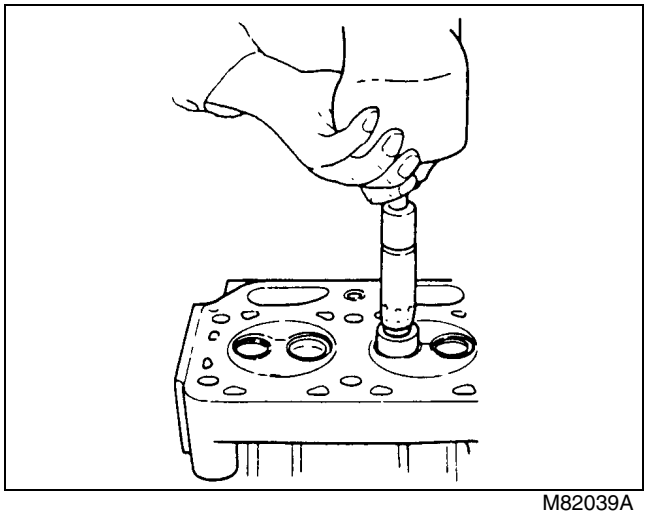


M82035A

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

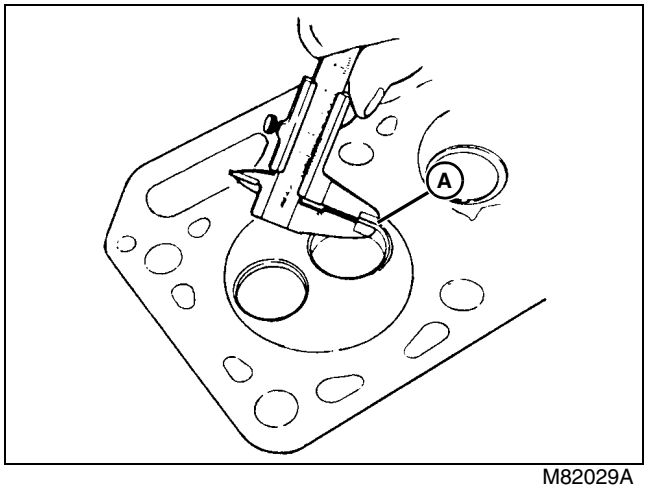
Valve Seat Grinding

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



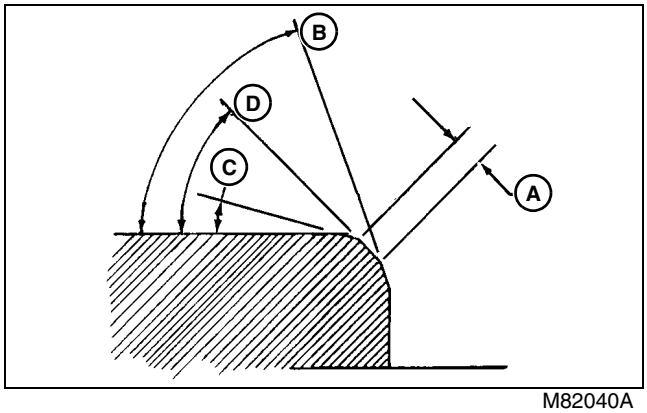
M82039A

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



M82029A

2. Measure valve seat width (A) after grinding.



M82040A

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

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

5. Dimension (D) is 30° for intake and 45° for exhaust seat.

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

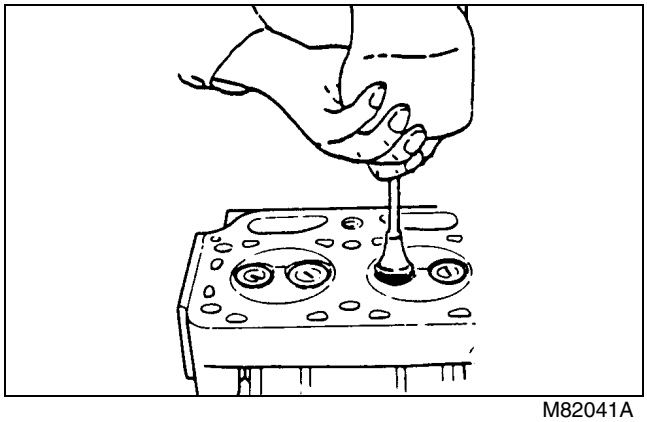
6. If valve seats are ground, measure valve recession and check contact pattern between the seat and valve with bluing dye.

7. Lap valves. (See "Valve Lapping" on page 90.)

Valve Lapping

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

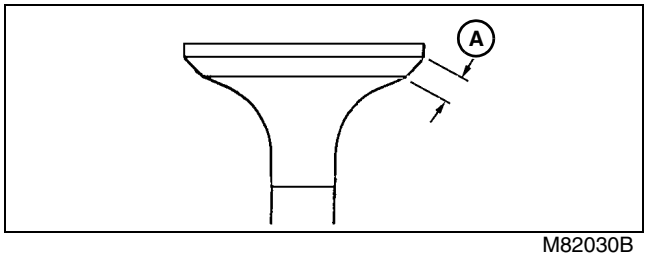
If seat does not make proper contact, lap the valve into the seat.



M82041A

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

2. Turn valve to lap valve to seat.



M82030B

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

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

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

Specifications

Cylinder Head Distortion

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

Valve Seat Width

Intake Standard. . . . . 1.15 mm (0.045 in.)
Intake Wear Limit . . . . . 1.65 mm (0.065 in.)
Exhaust Standard . . . . . 1.41 mm (0.056 in.)
Exhaust Wear Limit . . . . . 1.91 mm (0.075 in.)

Valve Grinding

Intake Valve
Face Margin . . . . . 0.99-1.29 mm (0.039-0.051 in.)
Exhaust Valve
Face Margin . . . . . 0.95-1.25 mm (0.037-0.049 in.)
Valve Face Margin Wear Limit. . . . . 0.50 mm (0.020 in.)
Intake Valve Face Angle . . . . . 30°
Exhaust Valve Face Angle. . . . . 45°

Valve Stem

Measuring Point (3) Distance . . . . . 20 mm (0.787 in.)
Measuring Point (4) Distance . . . . . 40 mm (1.575 in.)
Intake Valve Stem OD Wear Limit . . 5.40 mm (0.213 in.)
Exhaust Valve Stem
OD Wear Limit . . . . . 5.40 mm (0.213 in.)

Valve Recession

Intake Valve Recession Wear Limit . 1.0 mm (0.039 in.)
Exhaust Valve Recession
Wear Limit. . . . . 1.0 mm (0.039 in.)

Valve Guides

Valve Guide
Standard ID. . . . . 5.50-5.52 mm (0.275-0.276 in.)
Valve Guide ID Wear Limit. . . . . 5.58 mm (0.22 in.)
Intake Valve Guide-to-Valve Stem Standard Oil Clearance . . . . . 0.03-0.06 mm (0.001-0.002 in.)
Exhaust Valve Guide-to-Valve Stem Standard Oil Clearance . . . . . 0.040-0.070 mm (0.002-0.003 in.)
Valve Guide-to-Valve Stem Oil Clearance Wear Limit (Both). . . . . 0.18 mm (0.007 in.)
Valve Guide Knurling Clearance (Maximum) . . . . . 0.127-0.178 mm (0.005-0.007 in.)
Valve Guide Replacement Clearance . . . . . 0.20 mm (0.008 in.)
Valve Guide Height. . . . . 7 mm (0.276 in.)

Valve Springs

Spring Free Length . . . . . 28 mm (1.102 in.)
Spring Inclination (Maximum). . . . . 0.8 mm (0.03 in.)

Measure Piston-to-Cylinder Head Clearance

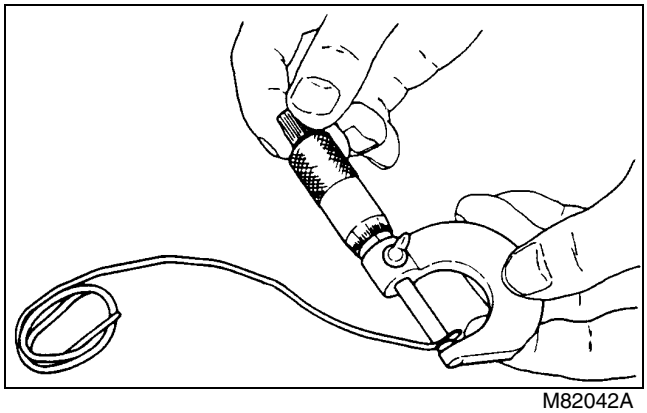
Procedure

1. Place three 10 mm (0.4 in.) long pieces of 1.5 mm (0.06 in.) diameter soft wire in three positions on the flat part of the piston head.

2. Install the cylinder head and old gasket. Install cylinder head cap screws and tighten in proper sequence. (See “Remove and Install Cylinder Head” on page 84.)

3. Slowly turn the crankshaft one complete revolution.

4. Remove the cylinder head and gasket.



M82042A

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

6. If clearance is less than specification, replace cylinder head. (See “Remove and Install Cylinder Head” on page 84.)

Specifications

Piston-to-Cylinder Head Clearance . . . . . 0.61-0.73 mm (0.024-0.028 in.)

Remove and Install Piston and Connecting Rod

Special or Required Tools

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

Removal

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

1. Remove the oil pan and oil pickup tube. (See “Oil Pan and Strainer” on page 115.)

2. Remove the cylinder head. (See “Remove and Install Cylinder Head” on page 84.)

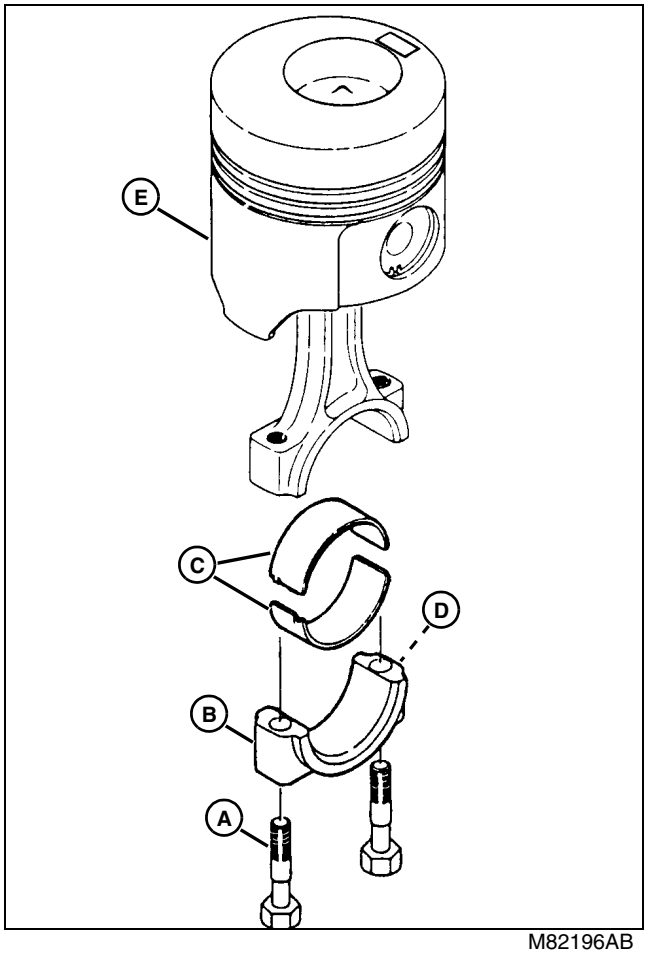
3. Check the cylinder bore for ridges. These ridges can cause damage to piston if ridge is not removed. If necessary, remove any ridge from top of cylinder bore using a ridge reamer.

4. Measure the connecting rod side play. (See “Check Connecting Rod Side Play” on page 97.)

5. Measure the crankshaft end play.

6. Measure the connecting rod bearing clearance. (See “Check Connecting Rod Bearing Clearance” on page 98.)

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



M82196AB

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

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

8. Note the connecting rod stamped number (D) in relation to the cylinders. Start at the flywheel end with No. 1 cylinder, then No. 2 C, etc.

9. Push the piston and connecting rod (E) out of the cylinder bore using a wooden dowel.

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

11. Inspect cylinder bore. (See “Cylinder Bore” on page 99.)

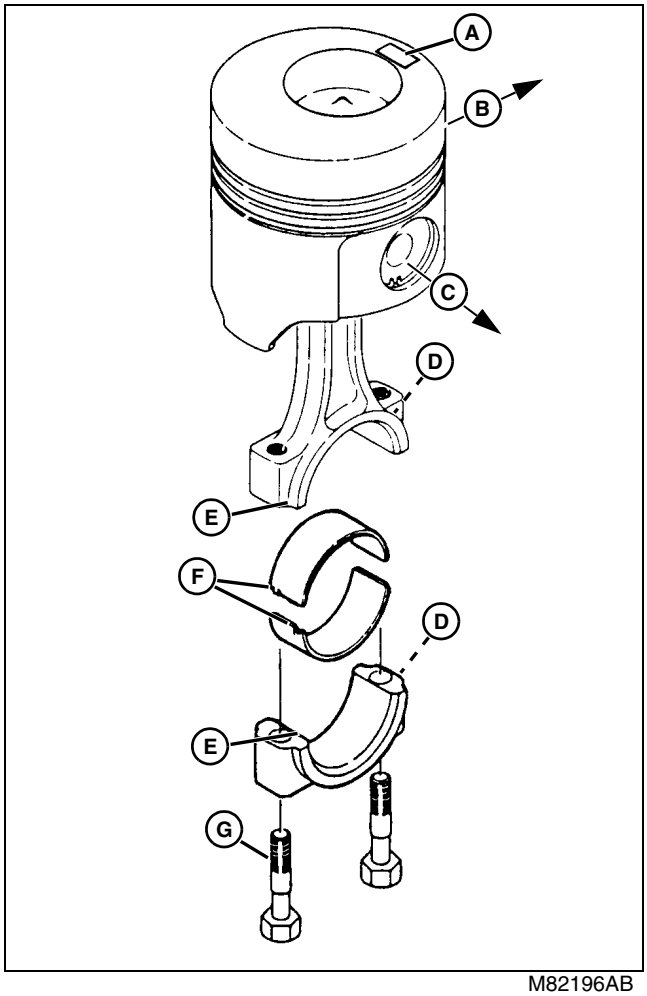
Installation

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

2. Always replace the connecting rod cap screws. Do not reuse the bolts.

3. Assemble the piston and connecting rod. (See “Assembly” on page 94.)

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.



M82196AB

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

4. Install the piston and connecting rod into the cylinder from which it was removed. The stamped number (D) on the connecting rod or the piston recess (A) on top of piston should point toward the fuel injection pump.

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

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

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

6. Match the connecting rods to caps using stamped numbers (D). Install the rod caps.

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

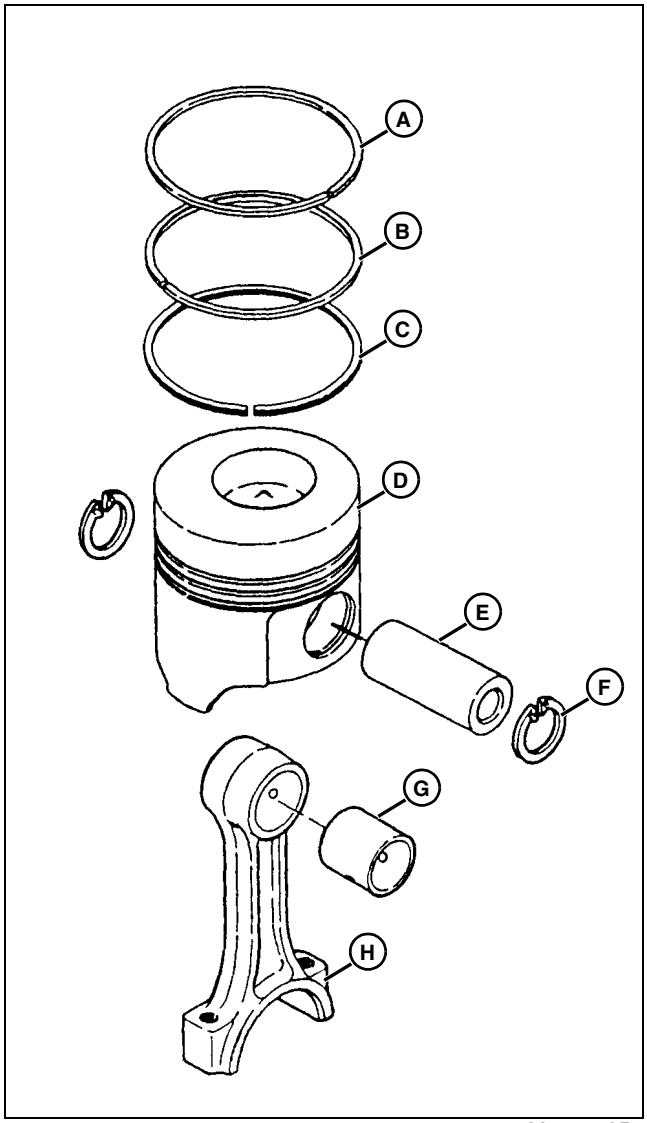
8. If a new piston and connecting rod were installed, stamp a number corresponding to the cylinder number on the connecting rod and rod cap.

9. Install the cylinder head. (See “Remove and Install Cylinder Head” on page 84.)

10.Install the oil pan and oil pickup tube. (See “Oil Pan and Strainer” on page 115.)

Disassembly

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



M82197AB

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

1. Put a mark on each piston and connecting rod to aid in assembly.

2. Remove piston rings (A-C), starting with the first compression ring, by gently spreading them open just enough to clear the outside diameter of the piston. This can be done by hand or with a ring expander.

3. Remove piston pin retaining rings (F).

4. Remove piston pin (E). Excessive pressure should not be necessary to remove piston pin.

NOTE: The piston pin bushing (G) is press fit in the connecting rod. Remove the bushing only if replacement is necessary. (See "Piston Pin Bushing" on page 96.)

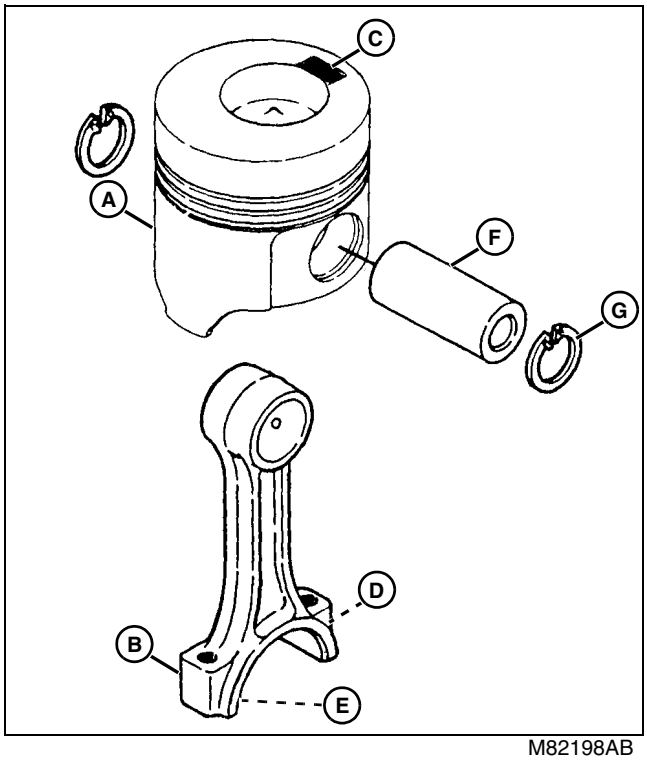
5. Inspect all parts for wear or damage. Replace as necessary.

Assembly

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

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

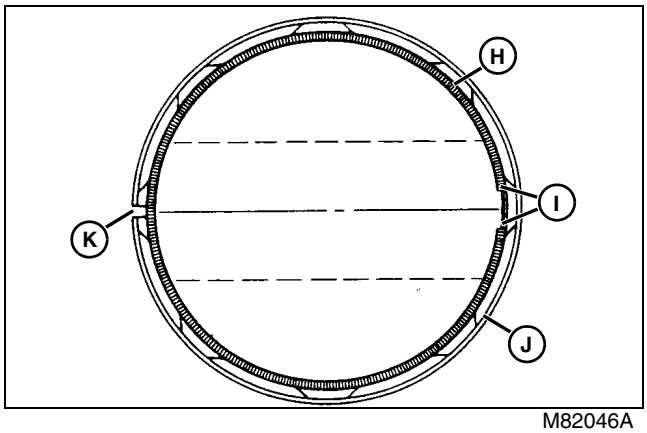
2. Install piston pin bushing in connecting rod with oil holes aligned.



M82198AB

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

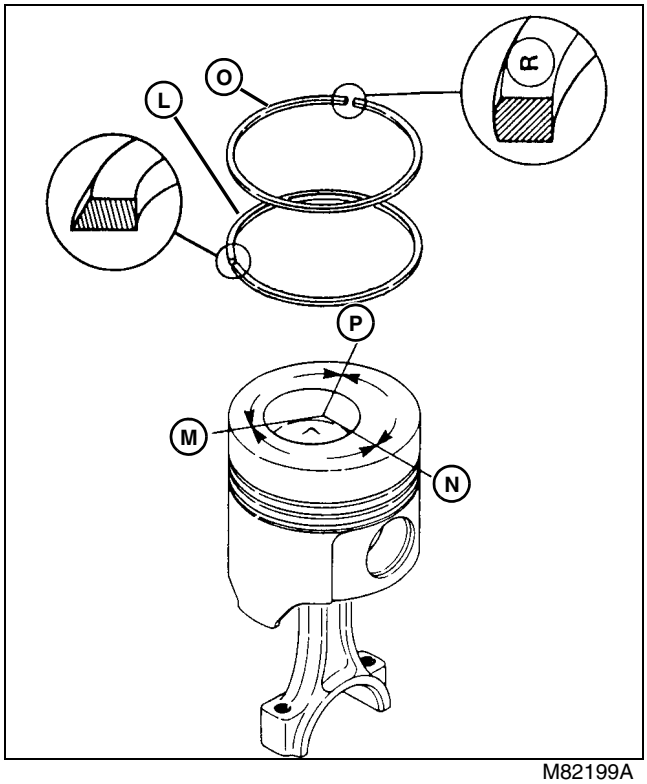
4. Install piston pin (F) and snap rings (G).



M82046A

5. Install an oil ring expander (H) in the bottom ring groove of the piston, with the ends (I) above either end of the piston pin.

6. Install oil ring (J) over the expander with the ring gap (K) opposite (180°) the expander ends.



M82199A

7. Install the middle piston ring (L), with the small diameter of taper toward top of piston, in the middle groove. Turn the ring until the middle piston ring gap (M) is 120° away from the oil ring gap (N).

8. Install the top piston ring (chrome plated) (O), 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 top piston ring gap (P) is 120° away from the middle ring gap (M).

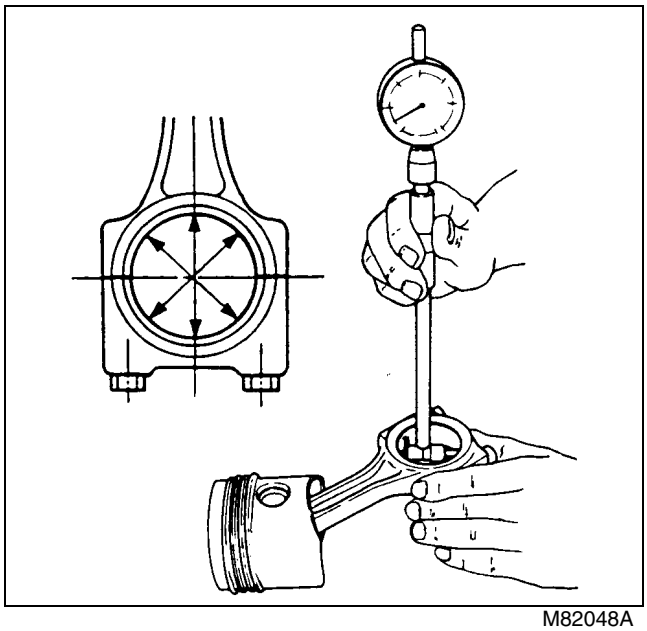
Inspection/Replacement

1. Inspect all parts for wear or damage. Replace as necessary. (See Connecting Rod Bearing, Piston Ring Groove, Piston Ring End Gap, Piston Pin Bore, Piston Pin Bushing, and Piston Diameter procedures below.)

2. Measure the crankshaft connecting rod journal diameter. (See “Crankshaft and Main Bearings” on page 102.)

Connecting Rod Bearing

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



M82048A

2. Measure the connecting rod bearing diameter. Replace the bearing inserts if bearing diameter is not within specification.

3. Measure the oil clearance between the bearing inserts and the crankshaft, and verify that the clearance is within specification. If the bearing oil clearance exceeds the wear limit, grind the crankshaft connecting rod journals and install undersized bearing inserts, or replace the bearing inserts and the crankshaft.

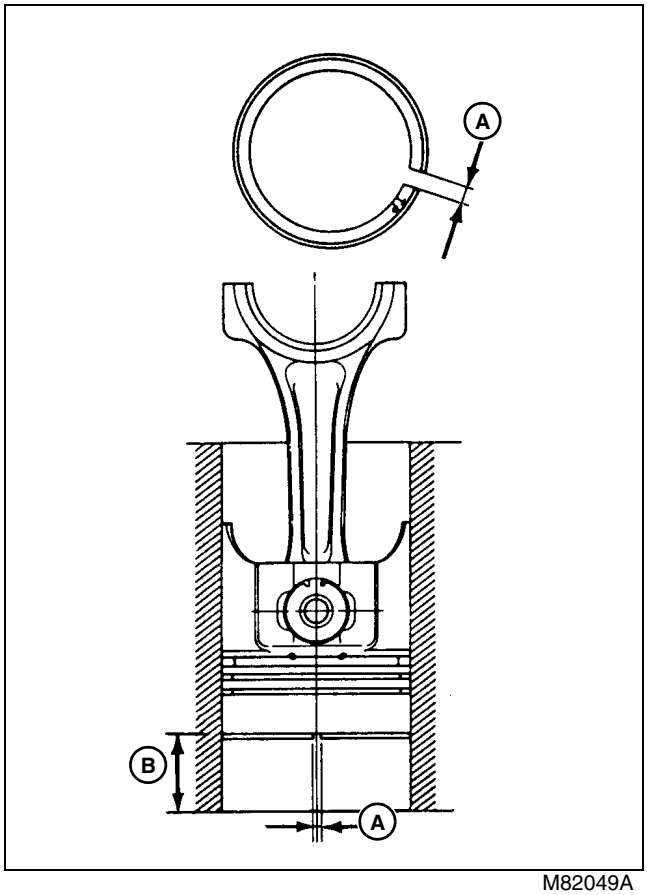
Piston Ring Groove

M35360

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

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

Piston Ring End Gap

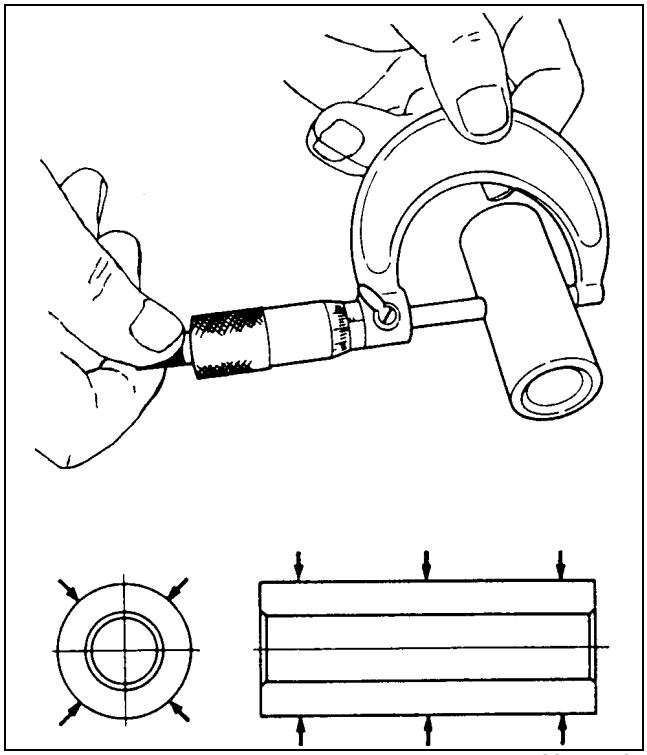


M82049A

1. Push ring into cylinder bore, using a piston, until ring installed depth (B) is approximately 30 mm (1.18 in.) from bottom of cylinder bore.

2. Measure piston ring end gap (A). If ring end gap exceeds wear limit, replace ring.

Piston Pin



M82050A

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

Piston Pin Bore

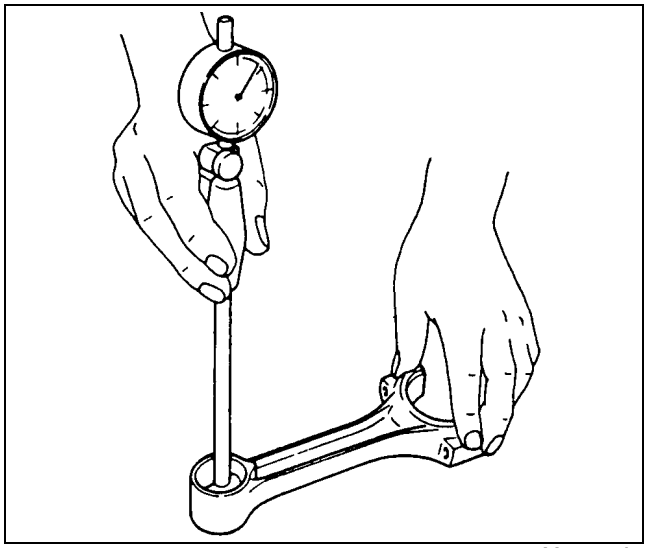
M37683

1. Measure the pin bore diameter in the piston. If the piston pin bore exceeds the wear limit, replace the piston.

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

Piston Pin Bushing

NOTE: The piston pin bushing is 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.



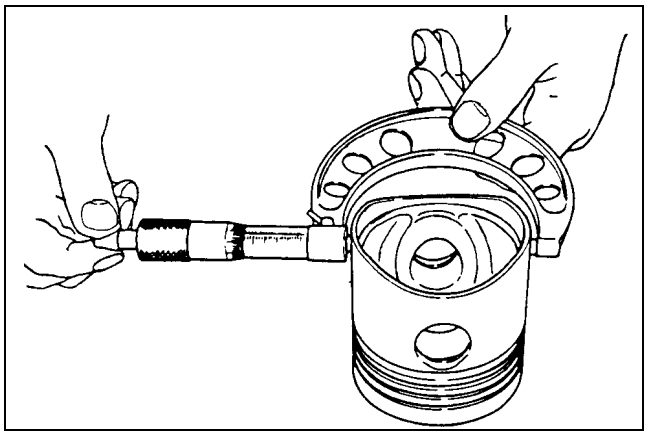
M82051A

1. Measure the piston pin bushing diameter in the connecting rod. If the bushing diameter exceeds the wear limit, replace bushing.

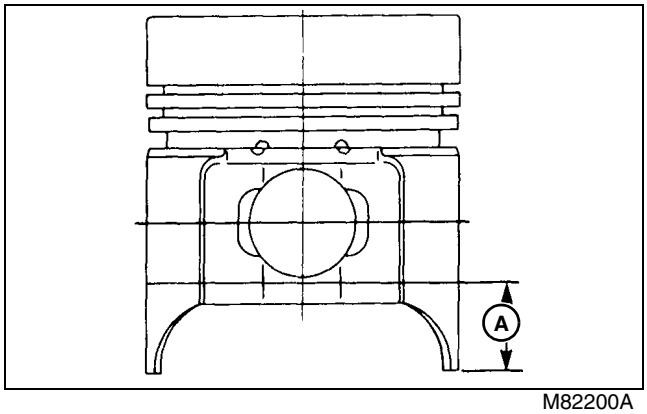
2. If piston pin-to-rod bore oil clearance (bushing ID minus pin OD) exceeds specification, replace the bushing or the piston pin.

Piston Diameter

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



M82052A



M82200A

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

Specifications

Connecting Rods

Connecting Rod
Cap Screw Torque . . . . . 24 N•m (18 lb-ft)

Connecting Rod Bearings

Connecting Rod
Bearing ID . . . . . 39.02 mm (1.536 in.)
Connecting Rod Bearing Oil Clearance
Wear Limit . . . . . 0.15 mm (0.006 in.)

Piston Rings

Top Piston Ring Groove
Side Clearance . . . . . 0.06-0.10 mm (0.002-0.004 in.)
Middle Piston Ring Groove
Side Clearance . . . . . 0.090-0.125 mm (0.004-0.005 in.)
Oil Control Ring Groove
Side Clearance . . . . 0.020-0.055 mm (0.0008-0.0022 in.)
Piston Ring Standard End Gap (All Except Oil Control Ring) . . . . . 0.20-0.40 mm (0.008-0.016 in.)
Oil Control Ring
Standard End Gap . . . . . 0.15-0.35 mm (0.006-0.014 in.)
Piston Ring End Gap Wear Limit. . . 1.50 mm (0.059 in.)

Piston Pins

Piston Pin OD Wear Limit . . . . . 19.90 mm (0.783 in.)

Piston Pin Bores

Bore ID Wear Limit . . . . . 20.02 mm (0.789 in.)

Piston Pin Bushings

Bushing ID Wear Limit. . . . . 20.10 mm (0.79 in.)
Piston Pin-to-Rod Bore Oil Clearance
Wear Limit. . . . . 0.20 mm (0.007 in.)
Pin-to-Bushing Clearance Wear Limit . . . . . 0.20 mm (0.008 in.)

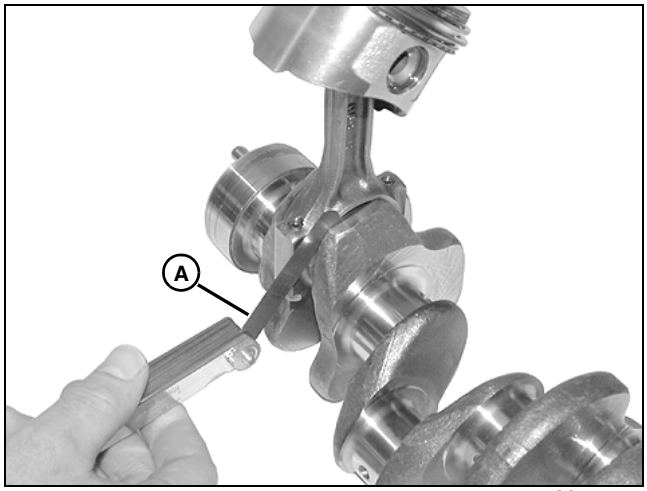
Pistons

Diameter Measuring Point Distance (1) . . . . . 24 mm (0.945 in.)
Standard Size Piston
OD Wear Limit . . . . . 67.90 mm (2.673 in.)
Oversize Piston OD Wear Limit . . 68.19 mm (2.685 in.)

Check Connecting Rod Side Play

1. Remove crankshaft from cylinder block. (See “Crankshaft and Main Bearings” on page 102.)

2. Install connecting rod on crankshaft. Tighten connecting rod cap screws to specification.



M98862

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

Specifications

Connecting Rod
Side Play . . . . . 0.40 mm (0.016 in.)
Connecting Rod
Cap Screw Torque . . . . . 24 N•m (18 lb-ft)

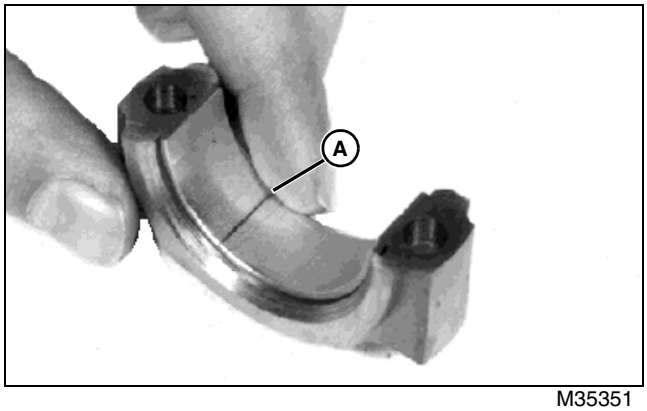
Check Connecting Rod Bearing Clearance

Special or Required Tools

Tool Name	Tool No.	Tool Use
PLASTIGAGE® Bearing Clearance Measurement Tool (or equivalent)	NA	Used between bearing insert and crankshaft journal to measure clearance.

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

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



M35351

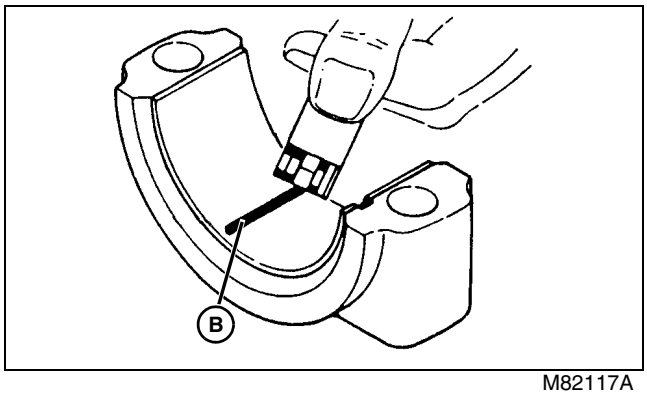
3. Put a piece of PLASTIGAGE (A), or an equivalent, along the full width of the bearing insert approximately 6 mm (0.25 in.) off center.
4. Turn crankshaft approximately 30° from bottom dead center.

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

NOTE: Lightly lubricate bolts with engine oil before installing.

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

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



M82117A

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

Specifications

Connecting Rod End Cap
Cap Screw Torque . . . . . 24 N•m (18 lb-ft)
Connecting Rod Bearing
Clearance Wear Limit. . . . . 0.15 mm (0.006 in.)

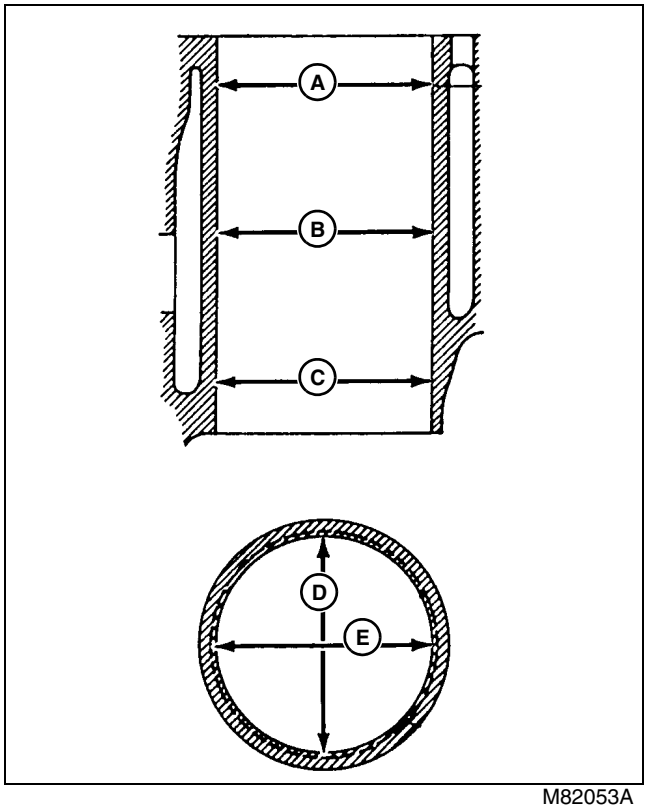
Cylinder Bore

Special or Required Tools

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

Inspection

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



M82053A

1. Measure cylinder bore diameter at three positions: top (A), middle (B), and bottom (C). At these three positions, measure in both directions: along crankshaft centerline (D) and direction of crankshaft rotation (E).

2. If cylinder bore inner diameter exceeds wear limit, have cylinder rebored. (See “Reboring” on page 99.)

3. If cylinder is rebored, oversize pistons and rings must be installed.

4. If cylinder bore exceeds oversize bore inner diameter, replace the cylinder block.

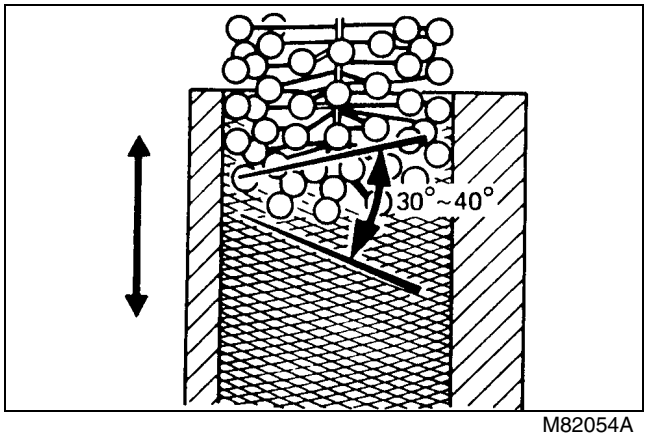
5. If clearance (cylinder bore ID minus piston OD) exceeds specification, replace cylinder block, piston, or both; or rebore cylinder and install oversize pistons and rings.

6. Slightly uneven wear, flaws, or minor damage may be corrected by deglazing. (See “Deglazing” on page 99.)

Deglazing

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

1. Deglaze cylinder bores using a flex hone with 180-grit stone.



M82054A

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

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

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

Reboring

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

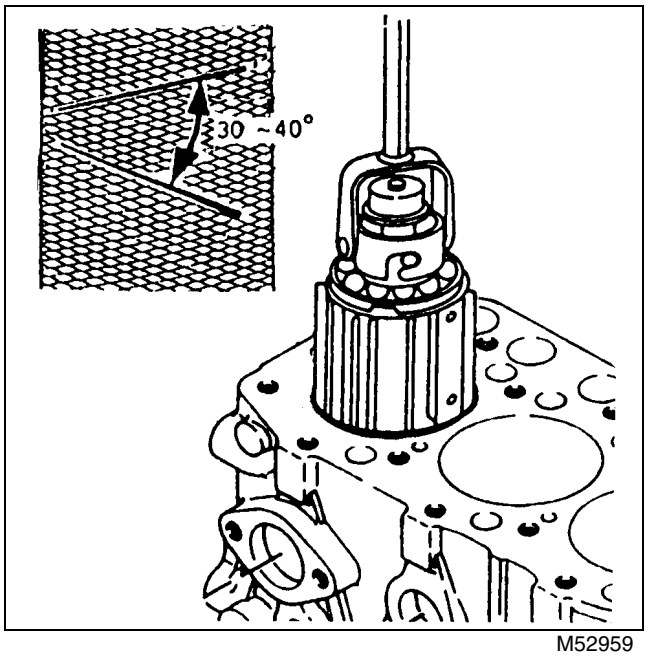
1. Align center of bore to drill press center.

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

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

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

4. Coat cylinder with honing oil. Rigid hone should turn by hand. Adjust if too tight.



M52959

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

NOTE: Measure bore when cylinder is cool.

6. Stop press and check cylinder diameter.

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

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

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

9. Check bore for size, taper, and out-of-round. (See “Inspection” on page 99.)

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

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

Specifications

Piston-to-Cylinder Bore Clearance . . . . . 0.03-0.06 mm (0.001-0.002 in.)
Cylinder Standard Roundness . . . . . 0.00-0.01 mm (0.0000-0.0004 in.)
Cylinder Roundness Wear Limit . . . 0.03 mm (0.001 in.)
Cylinder Standard Taper . . . . . 0.00-0.01 mm (0.0000-0.0004 in.)
Cylinder Taper Wear Limit . . . . . 0.03 mm (0.001 in.)
Standard Size Cylinder Bore Standard ID . . . . . 68.00-68.03 mm (2.677-2.678 in.)
Standard Size Cylinder Bore ID Wear Limit . . . . . 68.20 mm (2.685 in.)
Oversize Cylinder Bore Standard ID . . . . . 68.25-68.28 mm (2.687-2.688 in.)
Oversize Cylinder Bore ID Wear Limit . . . . . 68.45 mm (2.695 in.)

Crankshaft Rear Oil Seal

Special or Required Tools

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

Other Material

Part No.	Part Name	Part Use
TY16021 (U.S.)/ TY9484 (Canada)	John Deere High-Flex Form-in-Place Gasket	Applied to seal case-to-engine block mating surfaces before installing seal case.

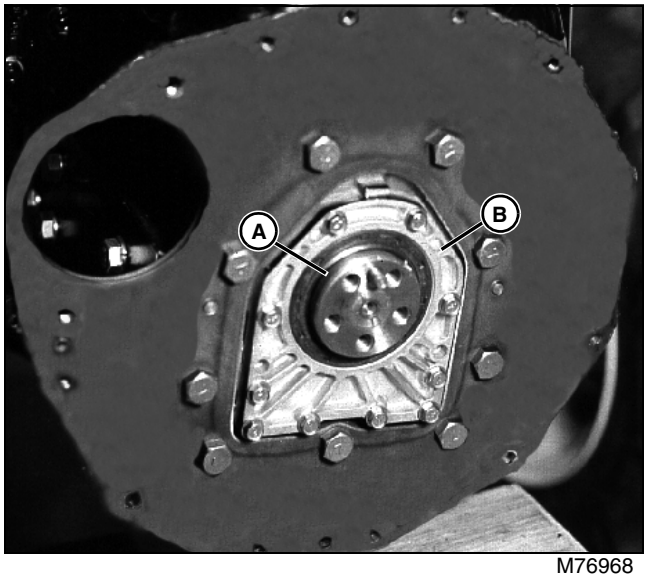
Rear Oil Seal Removal and Installation

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

NOTE: Engine removal is not necessary to replace rear oil seal.

1. Remove flywheel. (See “Remove and Install Flywheel” on page 106.)

NOTE: It is not necessary to remove oil seal case (B) to remove oil seal (A).



M76968

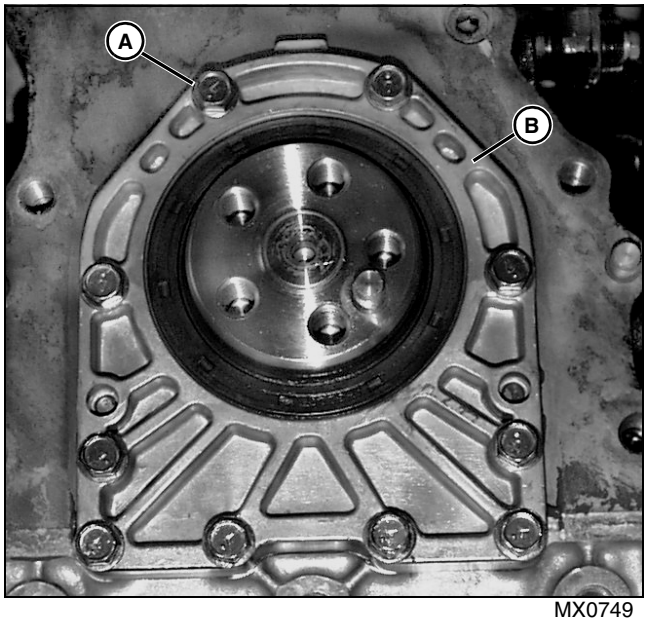
2. Carefully pry oil seal (A) from oil seal case (B).

NOTE: Oil seal is normally installed flush with surface of oil seal case. If oil seal has worn a groove in crankshaft at oil seal contact point, seal can be installed 3 mm (0.120 in.) deeper into oil seal case.

3. Replace oil seal using a driver set. Install seal with lip toward cylinder block. Install seal flush with surface of oil seal case.

Rear Oil Seal Case Removal and Installation

NOTE: It is not necessary to remove oil seal case to remove oil seal. It is not necessary to remove oil seal to remove oil seal case.



MX0749

1. Remove oil seal case-to-cylinder block cap screws (A).
2. Pry oil seal case (B) from engine block.
3. Clean all old gasket material from oil seal case and engine block.
4. Apply TY16021 John Deere High-Flex Form-in-Place Gasket to seal case-to-engine block mating surfaces. Install seal case.
5. Install new oil seal after oil seal case is installed.
6. Install flywheel onto crankshaft, aligning crankshaft pin into flywheel mounting flange. Tighten mounting cap screws to specification.
7. Install flex plate with longer center hub facing out.
8. Install drive shaft.

Specifications

Flywheel Mounting Cap Screw
Torque . . . . . .83 N•m (61 lb-ft)

Crankshaft Front Oil Seal

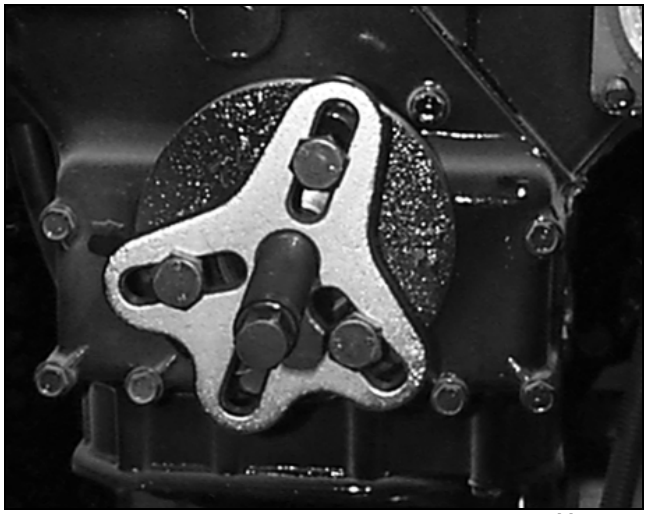
Special or Required Tools

Tool Name	Tool No.	Tool Use
Pulley Puller	NA	Used to remove crankshaft sheave.
Bushing, Bearing, and Seal Driver Set	NA	Used to install crankshaft front oil seal.

Procedure

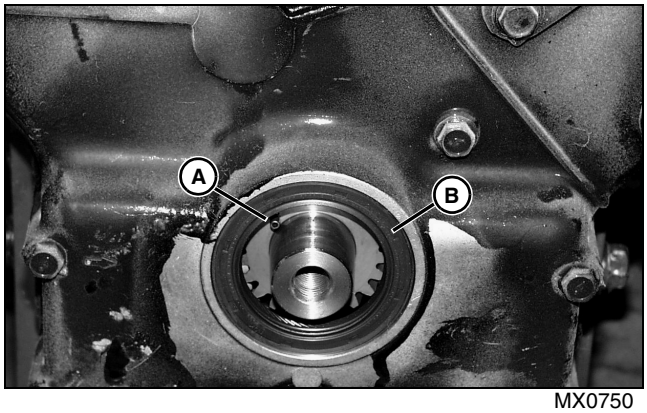
1. Park machine with engine off and park brake locked.

2. Remove alternator belt. (See “Check and Adjust Alternator Drive Belt Tension” on page 49.)



M89691

3. Remove crankshaft sheave cap screw. Install puller to crankshaft sheave and remove sheave.



MX0750

4. Carefully pry oil seal (B) from timing gear cover.

5. Install new oil seal using a bushing, bearing, and seal driver set. Install seal with lip toward engine. Install seal flush with surface of cover.

6. Coat lip of seal with clean engine oil.

7. Install crankshaft sheave on crankshaft, lining up pin (A) on crankshaft timing gear with hole in crankshaft sheave.

8. Install flat washer and cap screw. Tighten cap screw to specification.

9. Install alternator belt and adjust belt. (See “Check and Adjust Alternator Drive Belt Tension” on page 49.)

Specifications

Crankshaft Pulley
Cap Screw Torque . . . . . 88 N•m (65 lb-ft)

Crankshaft and Main Bearings

Special or Required Tools

Tool Name	Tool No.	Tool Use
Knife-Edge Puller	NA	Used with press to remove gear from crankshaft.
Press	NA	Used with knife-edge puller to remove gear from crankshaft.
Dial Indicator	NA	Used with V-blocks to inspect crankshaft for bend.
V-Block (2 used)	NA	Used with dial indicator to inspect crankshaft for bend.

Removal

1. Check crankshaft end play.

2. Remove oil pan and strainer. (See “Oil Pan and Strainer” on page 115.)

3. Remove flywheel. (See “Remove and Install Flywheel” on page 106.)

4. Remove rear oil seal case. (See “Crankshaft Rear Oil Seal” on page 100.)

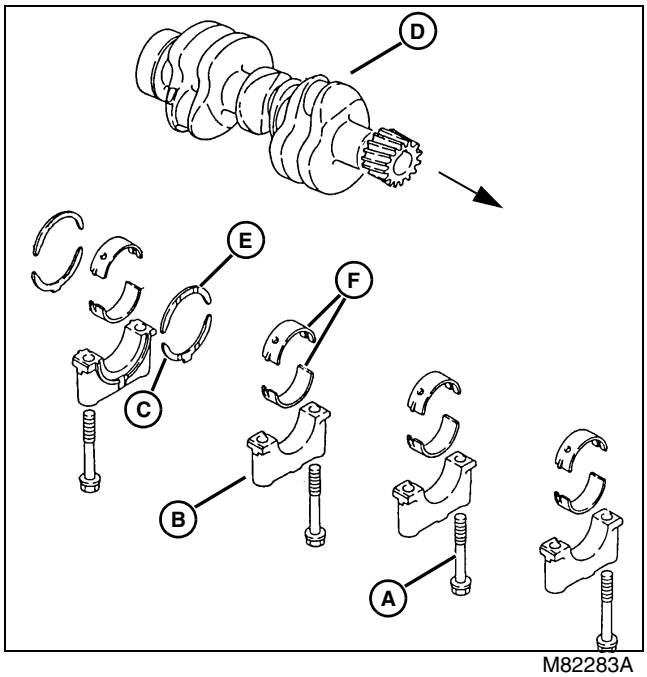
5. Remove timing gear cover, timing gears, timing gear housing, and flywheel of engine.

6. Check crankshaft bearing clearance. (See “Inspection/ Replacement” on page 104.)

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

7. Remove connecting rod cap screws and end caps. Push pistons and connecting rods away from crankshaft.

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



M82283A

Picture Note: Arrow points to front of engine.

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

9. Remove crankshaft (D).

10.Remove block thrust bearings (E) and main bearing inserts (F).

11.Inspect all parts for wear or damage. (See “Inspection/ Replacement” on page 104.)

Installation

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

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

2. Install bearing inserts drilled with oil passage in cylinder block bearing bores, aligning tangs with slots in bores.

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

NOTE: Main bearing caps have raised arrows that are stamped with numbers. Both correspond to their location on the engine block. The number “1” main bearing bore is at flywheel end. Install bearing caps beginning with number 1, then 2, etc. The main bearing cap at gear train end does not have a number. Also install bearing caps with the arrow toward the flywheel end.

4. Install crankshaft.

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

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

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

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

8. Dip entire main bearing cap screws in clean engine oil. Install cap screws and tighten. Do not tighten to specification at this time.

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

10.Tighten main bearing cap screws to specification. When tightening, start at center main bearing cap and work your way out, alternating to the ends. Turn crankshaft by hand. If it does not turn easily, disassemble the parts and find the cause.

IMPORTANT: Avoid damage! The connecting rod caps must be installed on the same connecting rods from which they were removed. Never reuse connecting rod cap screws. Replace with new.

11.Match the connecting rod caps to the rods using stamped numbers. Install the caps to the rods.

12.Dip entire connecting rod cap screws in clean engine oil. Install new cap screws to the rods, and tighten to specification.

13.Install the rear oil seal. (See “Crankshaft Rear Oil Seal” on page 100.)

14.Install the flywheel. (See “Remove and Install Flywheel” on page 106.)

15.Install the timing gear cover. (See “Remove and Install Timing Gear Cover” on page 111.)

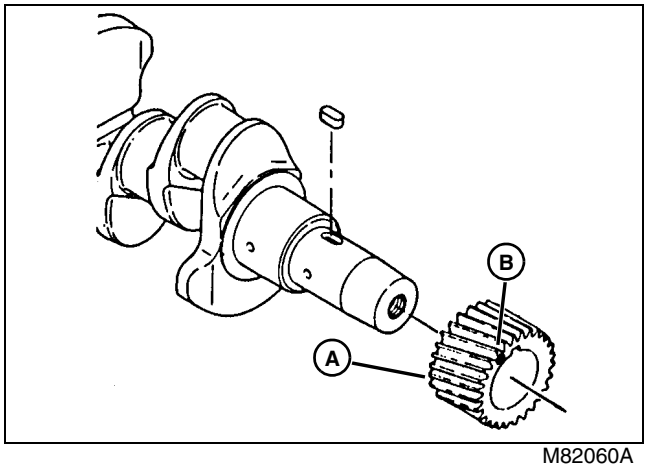
16.Install the front oil seal. (See “Crankshaft Front Oil Seal” on page 102.)

17.Install the oil pan. (See “Oil Pan and Strainer” on page 115.)

Inspection/Replacement

1. Inspect crankshaft gear for chipped or broken teeth. If replacement is necessary, remove gear from crankshaft using a knife-edge puller and a press.

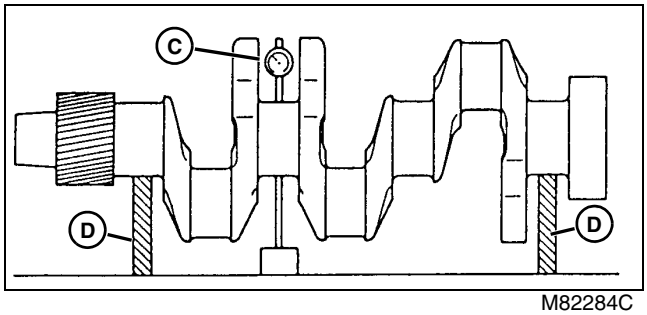
CAUTION: Avoid injury! Do not heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.



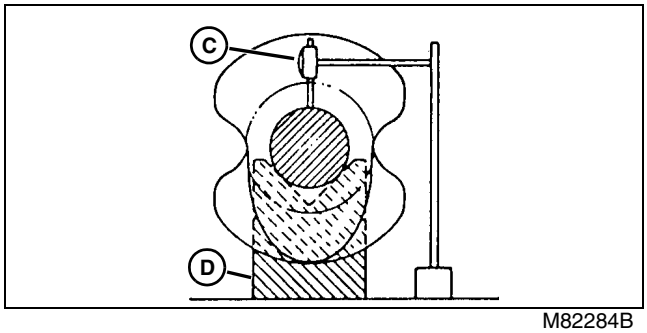
M82060A

2. Heat gear to approximately 150°C (300°F). Install gear (A) with timing mark (B) toward press table.

3. Align slot in gear with key in shaft. Press crankshaft into gear until gear is tight against crankshaft shoulder.



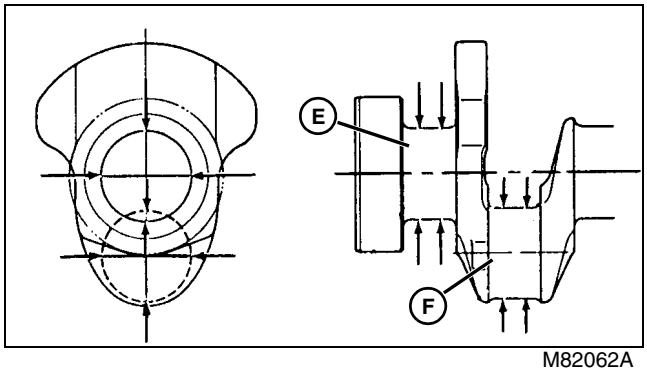
M82284C



M82284B

4. Inspect crankshaft for bend using V-blocks (D) and a dial indicator (C). Turn crankshaft slowly and read variation on indicator. If variation is greater than specification, replace crankshaft.

NOTE: If engine has had a previous major overhaul, journals may have been ground and undersize bearing inserts installed.



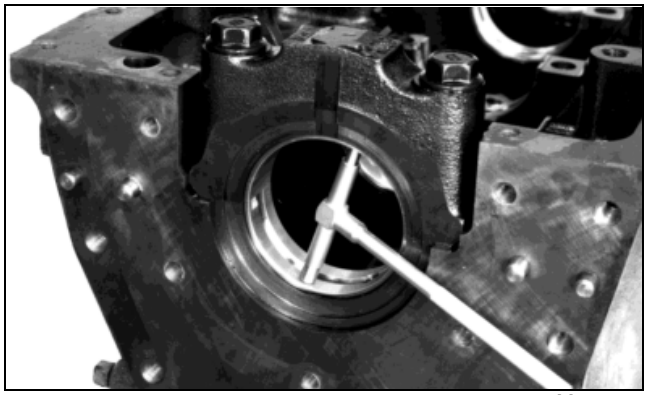
M82062A

5. Measure crankshaft connecting rod journals (F) and main bearing journal (E) diameters. Measure several places around each journal.

6. If journal diameter is less than wear limit, replace crankshaft or have journals ground undersize by a qualified machine shop.

7. If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.

8. Install bearing inserts and main bearing cap on main bearing. Tighten main bearing cap screws to specification.


M82063

9. Measure main bearing diameter.

10.Subtract the crankshaft main bearing journal outer diameter from the main bearing inner diameter to obtain the main bearing oil clearance.

- If crankshaft is within specification but main bearing oil clearance exceeds the wear limit, replace the bearing inserts.
- If crankshaft is not within specification, have crankshaft journals ground undersize by a qualified machine shop and install undersize bearing inserts.
- If crankshaft is worn past the wear limit, replace the crankshaft.

11.Clean and inspect oil passages in main bearing journals, connecting rod journals, and main bearing bores in cylinder block.

12.Inspect crankshaft for cracks or damage. Replace if necessary.

Specifications

Connecting Rod
Cap Screw Torque . . . . . 24 N•m (18 lb-ft)
Main Bearing
Cap Screw Torque . . . . . 54 N•m (40 lb-ft)
Crankshaft Bend (Maximum). . . . . 0.02 mm (0.001 in.)
Crankshaft Connecting Rod Journal
Standard OD . . . . . 35.97-35.98 mm (1.416-1.417 in.)
Crankshaft Connecting Rod Journal
OD Wear Limit. . . . . 35.91 mm (1.414 in.)
Crankshaft Main Bearing Journal
Standard OD . . . . . 39.97-39.98 mm (1.573-1.574 in.)
Crankshaft Main Bearing Journal
OD Wear Limit. . . . . 39.90 mm (1.571 in.)
Main Bearing Standard Oil
Clearance . . . . . 0.03-0.06 mm (0.001-0.002 in.)
Main Bearing Oil Clearance
Wear Limit . . . . . 0.15 mm (0.006 in.)

Check Crankshaft Main Bearing Clearance

Special or Required Tools

Tool Name	Tool No.	Tool Use
PLASTIGAGE®	NA	Used to measure main bearing clearance.

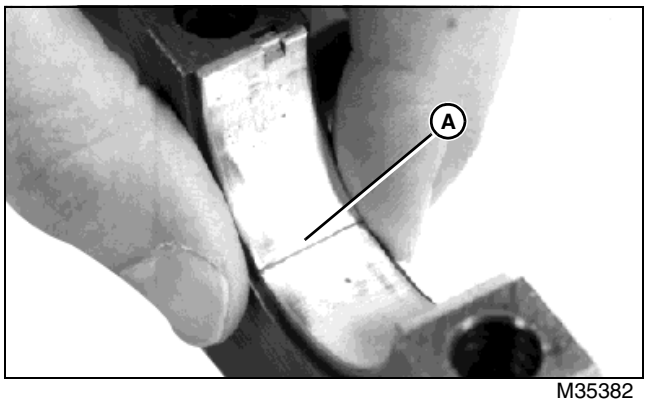
NOTE: The engine must be removed from the vehicle to perform this test.

1. Remove the oil pan, oil pickup, crankcase extension, and balancer assembly.

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

2. Remove the main bearing cap.

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



M35382

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

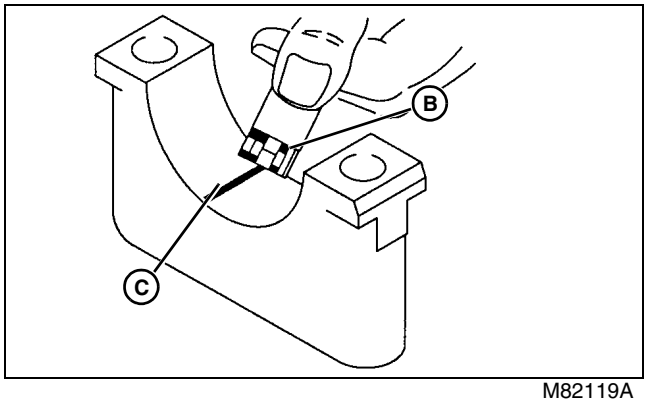
IMPORTANT: Avoid damage! Rotating the crankshaft will cause PLASTIGAGE to smear, resulting in a false reading. Do not allow crankshaft to rotate after installing bearing cap.

NOTE: Lightly lubricate bolts with engine oil before installing.

5. Install main bearing cap and bolts. Tighten bolts to specification.

6. Remove bolts and main bearing cap.

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



M82119A

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

8. If clearance exceeds specification, replace main bearing.

9. Remove PLASTIGAGE.

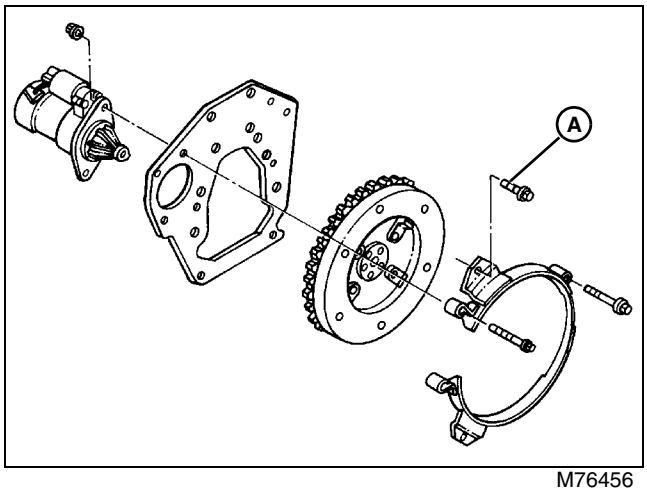
Specifications

Main Bearing
Cap Screw Torque . . . . . 54 N•m (40 lb-ft)
Main Bearing Oil Clearance
Wear Limit . . . . . 0.15 mm (0.006 in.)

Remove and Install Flywheel

Removal

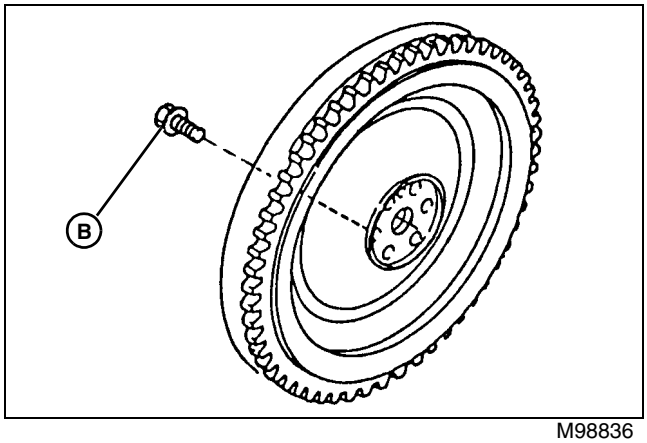
1. Remove starting motor. (See “Remove and Install Starting Motor” on page 126.)



M76456

2. Remove flywheel guard mounting cap screws (A).

IMPORTANT: Avoid damage! Always install new flywheel mounting cap screws.



M98836

3. Remove the flywheel mounting cap screws (B).

4. Remove flywheel.

IMPORTANT: Avoid damage! Flywheel surface must be absolutely clean and free off all paint, corrosion or dirt before measuring.


M35337

5. Measure flywheel flatness. Place a straight edge across flywheel surface opposite of ring gear. Measure clearance between straight edge and flywheel surface with a feeler gauge. If clearance exceeds specification, replace flywheel.

Installation

Installation done in the reverse order of removal.

IMPORTANT: Avoid damage! Always install new flywheel mounting cap screws.

- Install the flywheel. Apply lubrication oil to the mounting cap screws and tighten to specification.
- Install flywheel guard. Tighten cap screws to specification.

Specifications

Flywheel Mounting Cap Screw Torque. 83 N•m (61 lb-ft)
Flywheel Guard Cap Screw Torque . . . 40 N•m (30 lb-ft)
Flywheel Out-of-Flat (Maximum). . . 0.02 mm (0.001 in.)

Camshaft

IMPORTANT: Avoid damage! Always replace camshaft followers when installing a new camshaft. Always replace camshaft when replacing camshaft followers. The components wear as a set and replacing only one will accelerate the wear of the other.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Magnetic Follower Holder Kit	D15001NU	Used to hold cam followers away from camshaft.
Knife-Edge Puller	NA	Used with arbor press for removing gear from camshaft.
Arbor Press	NA	Used with knife-edge puller for removing gear from camshaft.
V-Block (2 used)	NA	Used to hold camshaft during inspection.
Dial Indicator	NA	Used to measure camshaft bend.
Micrometer	NA	Used to measure camshaft lobe height.
Bushing Driver Set	NA	Used to replace worn camshaft bushing.

Other Material

Part No.	Part Name	Part Use
TY16021 (U.S.)/ TY9484 (Canada)	John Deere High-Flex Form-in-Place Gasket	Applied to camshaft bore plug before reinstallation.

Camshaft Removal

1. Remove engine. (See “Remove Engine” on page 75.)

2. Remove rocker arm assembly and push rods. (See “Remove and Install Rocker Arm Assembly” on page 81.)

3. Remove timing gear cover. (See “Remove and Install Timing Gear Cover” on page 111.)

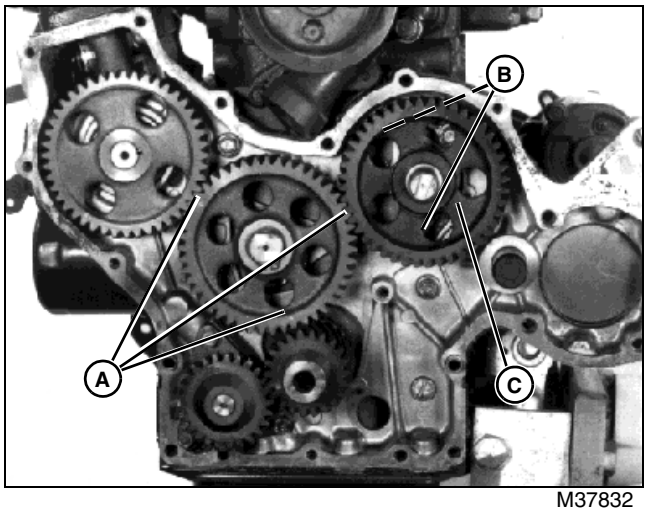
4. Check camshaft end play. (See “Camshaft End Play Check” on page 109.)

5. Check backlash of timing gears. (See “Timing Gear Backlash Check” on page 110.)

NOTE: If camshaft is being removed with cylinder head installed, use a magnetic follower holder tool, or turn engine until oil pan is upward, to hold cam followers away from camshaft.

6. Hold cam followers away from camshaft using D15001NU Magnetic Follower Holder Kit or equivalent.

NOTE: Due to the odd number of teeth on the idler gear, timing marks will align only periodically.



M37832

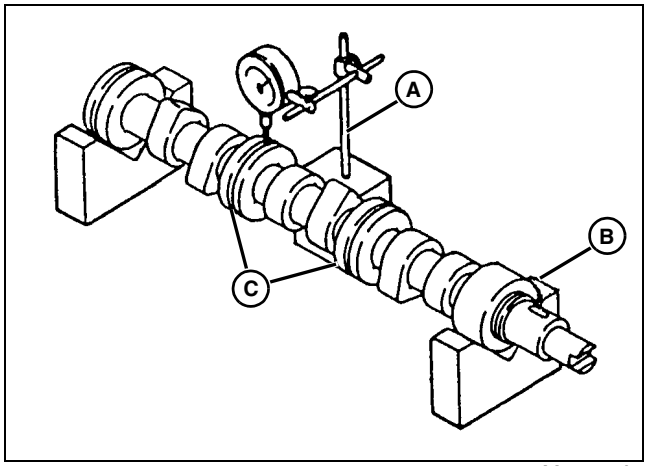
7. Rotate the crankshaft and align the timing marks (A).

IMPORTANT: Avoid damage! Do not allow camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces can be damaged.

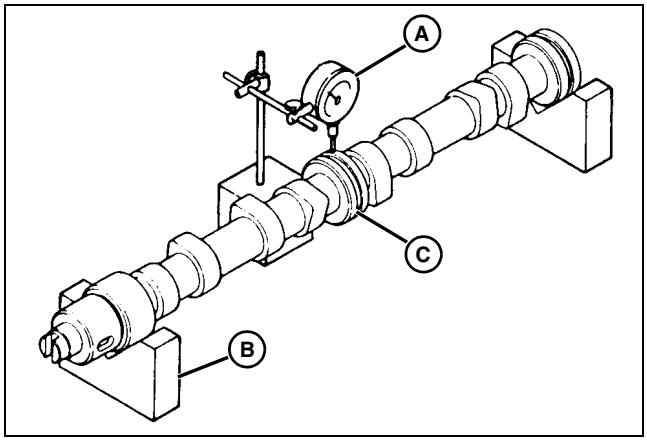
8. Remove two thrust plate mounting cap screws (B), the thrust plate, and the camshaft (C).

9. Inspect all parts for wear or damage. (See “Camshaft Inspection” on page 107.)

Camshaft Inspection

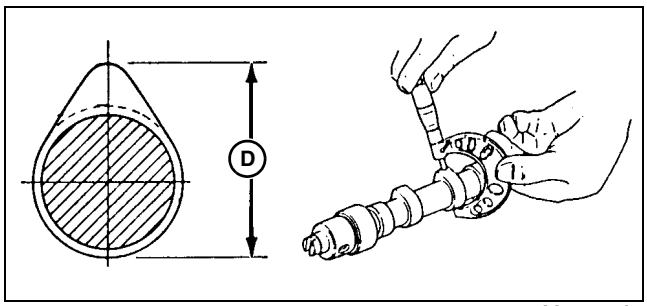


M82291A



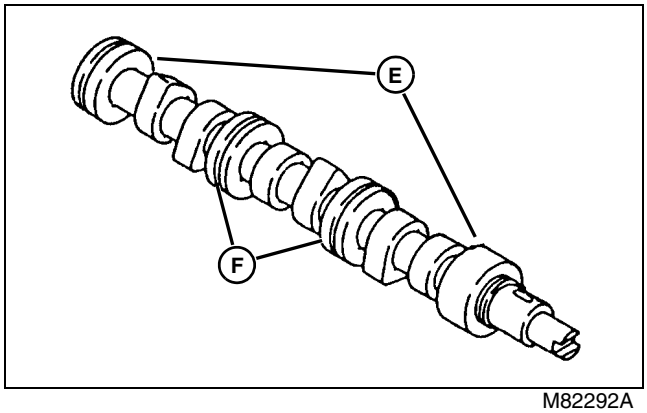
M82069A

1. Inspect camshaft for bend by using a pair of V-blocks (B) and a dial indicator (A). Turn camshaft slowly and read variation of camshaft bearing journals (C) on indicator. If variation is greater than wear limit, replace camshaft.



M82070A

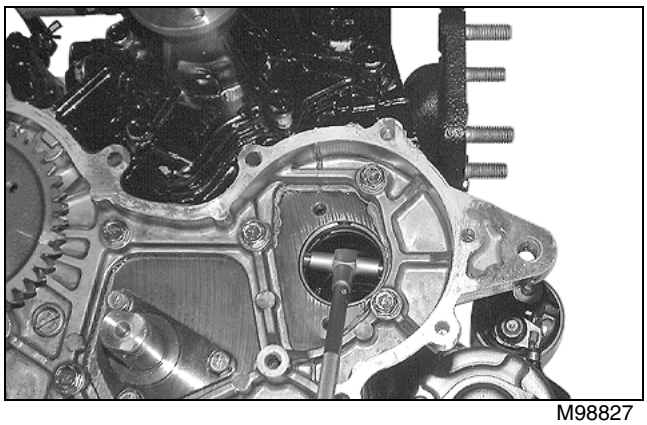
2. Measure camshaft lobe height (D) using a micrometer. If lobe height is less than wear limit, or if there are chips or scratches in lobes or bearing journals, replace camshaft.



M82292A

3. Measure camshaft end journal (E) and intermediate journal (F) outside diameters. If journal diameters are less than wear limit, replace camshaft.

IMPORTANT: Avoid damage! Camshaft bearing journals must be measured and found to be within specifications before camshaft bushings can be determined serviceable or unserviceable.

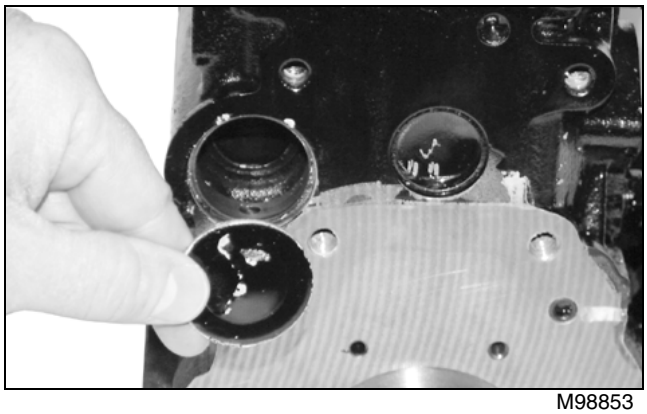

M98827

4. Measure camshaft bushing diameter at gear housing end. If bushing diameter exceeds wear limit, replace bushing using a driver set.

5. Subtract camshaft journal outside diameter from gear housing end bushing inside diameter to determine clearance. If clearance exceeds specifications, replace bushings.

6. Measure intermediate and flywheel end camshaft bushing diameter using the following procedures:

7. Remove flywheel. (See “Remove and Install Flywheel” on page 106.)


M98853

8. Remove plug using a long wooden dowel. Insert wooden dowel through gear housing side.

9. Measure flywheel end and intermediate bearing inside diameters with telescoping gage and micrometer.

10.Subtract camshaft journal outside diameter from intermediate clearance. If clearance exceeds specification, replace bushings.

11.Subtract camshaft journal outside diameter from flywheel end bushing inside diameter to determine clearance. If clearance exceeds specification, replace bushings.

12.Apply TY16021 John Deere High-Flex Form-in-Place Gasket, or equivalent, on outer edge of plug. Install plug until it bottoms in bore.

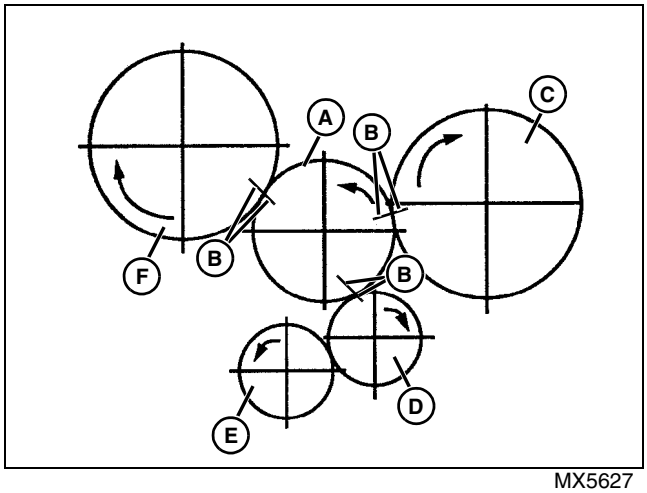
13.Install engine backplate.

Camshaft Installation

IMPORTANT: Avoid damage! Do not allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces can be damaged.

NOTE: Apply clean engine oil on all parts during installation.

The fuel injection drive gear, camshaft gear, and crankshaft gear all must be correctly timed to the idler gear. It is not necessary to time the oil pump gear. Due to the odd number of teeth on the idler gear, timing marks will align only periodically. (See "Timing Gear Backlash Check" on page 110.)



MX5627

Picture Note: Arrows indicate direction of rotation (viewed from gear case).

A - Idler Gear
B - Timing Marks
C - Camshaft Gear
D - Crankshaft Gear
E - Oil Pump Gear
F - Fuel Injection Drive Gear

1. Rotate the crankshaft to align the timing marks.

2. Install the camshaft.

3. Install the thrust plate and cap screws. Tighten to specification.

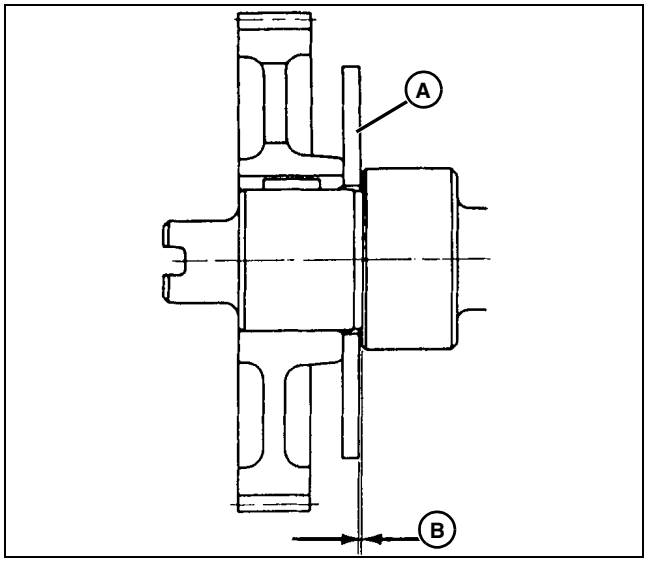
4. Install timing gear cover. (See "Remove and Install Timing Gear Cover" on page 111.)

5. If cam followers were removed, replace into same holes as removed.

6. Install push rods and rocker arm assembly. (See "Remove and Install Rocker Arm Assembly" on page 81.)

Camshaft End Play Check

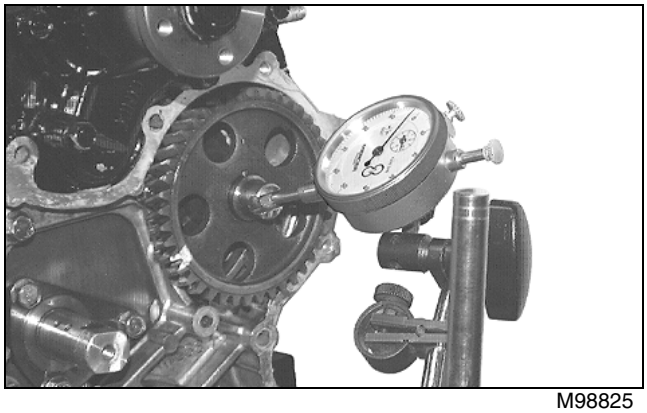
NOTE: Follow this procedure if camshaft is installed in cylinder block. If camshaft is removed from cylinder block, check end play (B) using a feeler gage between camshaft thrust plate (A) and front side of first camshaft bearing journal.



M82067A

1. Remove timing gear cover. (See "Remove and Install Timing Gear Cover" on page 111.)

2. Remove idler gear. (See "Remove and Install Idler Gear" on page 113.)



M98825

3. Fasten dial indicator base to cylinder block and position indicator tip on end of camshaft.

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

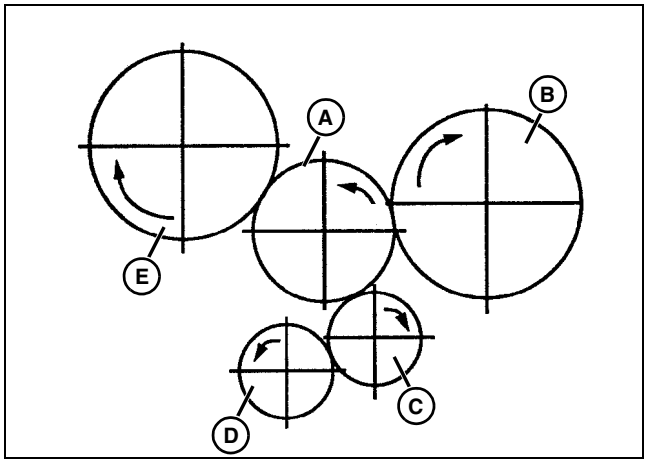
5. Set the dial indicator to zero.

6. Pull camshaft forward as far as possible.

7. If camshaft end play exceeds specification, remove camshaft and inspect thrust plate, camshaft, and camshaft gear for wear. Replace parts as needed.

Timing Gear Backlash Check

1. Remove timing gear cover. (See “Remove and Install Timing Gear Cover” on page 111.)



MX5627

Picture Note: Arrows indicate direction of rotation (viewed from gear case).

A - Idler Gear
B - Camshaft Gear
C - Crankshaft Gear
D - Oil Pump Gear
E - Fuel Injection Drive Gear

2. Place dial indicator magnetic base on cylinder block with tip of indicator on tooth of gear being measured.

3. Holding opposite gear stationary, move measured gear back and forth while measuring backlash between meshing gears.

4. If backlash exceeds specifications, replace worn gears as a complete set: idler gear, camshaft gear, crankshaft gear, oil pump gear, and fuel injection drive gear.

Camshaft Gear Removal

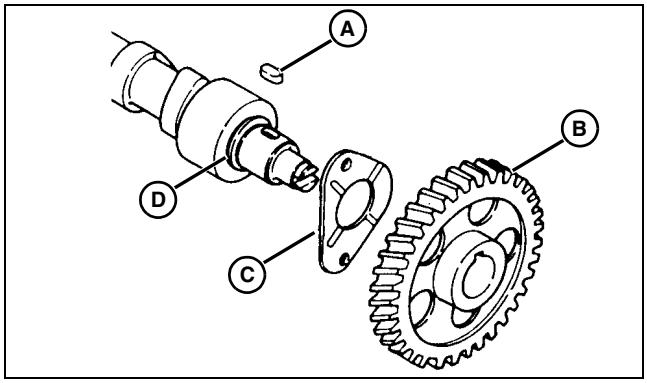
1. Remove gear from camshaft using a knife-edge puller and an arbor press. Place thicker side of puller against camshaft gear.

2. Inspect gear for chipped or broken teeth. Replace if necessary.

Camshaft Gear Installation

CAUTION: Avoid injury! Do not heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

1. Heat gear to approximately 150°C (300°F).



M82068A

2. Install key (A) into slot of camshaft.

3. Install thrust plate (C) onto camshaft, centering onto stepped shoulder (D). (Thrust plate has no “front” or “rear” side.)

IMPORTANT: Avoid damage! Be sure thrust plate is not trapped between camshaft gear and stepped shoulder while gear is being pressed on.

4. Install heated camshaft gear (B) with longer hub of camshaft gear facing camshaft. Align slot in gear with key in shaft. Press camshaft into gear until hub of gear is tight against camshaft shoulder. Thrust plate must spin freely on camshaft.

Specifications

Camshaft Thrust Plate
Cap Screw Torque . . . . . 11 N•m (96 lb-in.)
Camshaft Bend Wear Limit . . . . . 0.02 mm (0.001 in.)
Camshaft Lobe Height
Wear Limit. . . . . 29.75 mm (1.171 in.)
Gear Housing and Flywheel End Journal
OD Wear Limit . . . . . 35.85 mm (1.411 in.)
Intermediate Journal
OD Wear Limit . . . . . 35.85 mm (1.411 in.)
Bearing-to-Camshaft Gear Housing End Journal
Clearance (Wear Limit) . . . . . 0.85 mm (0.003 in.)
Bearing-to-Camshaft Intermediate Journals Clearance
(Wear Limit) . . . . . 0.115 mm (0.005 in.)

Bearing-to-Camshaft Flywheel End Journal Clearance (Wear Limit). . . . . 0.125 mm (0.005 in.)

Remove, Inspect, and Install Camshaft Follower

Special or Required Tools

Tool Name	Tool No.	Tool Use
Magnetic Pick-Up Tool	NA	Used to remove cam followers from cylinder block.

Removal

1. Remove cylinder head. (See "Remove and Install Cylinder Head" on page 84.)

IMPORTANT: Avoid damage! Cam followers must be installed in the same bores from which they were removed. Put a mark on each cam follower and cylinder block bore to aid in installation.

Always replace camshaft when replacing cam followers. Always replace cam followers when installing new camshaft. The components wear as a set and replacing only one will accelerate the wear of the other.

2. Remove cam followers from cylinder block with magnetic pick-up tool.

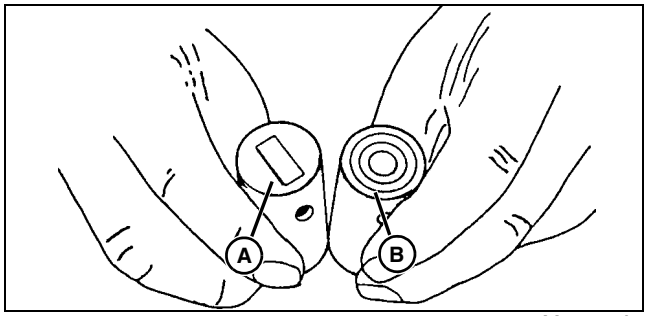
3. Inspect all parts for wear or damage. (See inspection procedure below.)

Installation

Installation is done in the reverse order of removal.

- Apply clean engine oil on all parts during installation.
- Install cam followers after camshaft is installed. Install followers with the flat contact surface toward the camshaft.

Inspection



M82293A

1. Inspect cam follower contact surface for abnormal wear (A). Normal wear (B) has light circular lines and flat surface.


M35268

2. Measure cam follower diameter. If outside diameter is less than wear limit, replace cam follower.

3. Use a straightedge and place it on the contact surface perpendicular to the wear mark across cam follower. Replace if surface appears to "valley" on wear mark.

4. Measure cam follower bore diameter in cylinder block. If cam follower bore diameter exceeds wear limit, replace cylinder block.

5. If tappet-to-bore oil clearance (bore ID minus follower OD) exceeds specification, replace cam follower, cylinder block, or both.

Specifications

Cam Follower OD Wear Limit . . . . 17.93 mm (0.706 in.)
Cam Follower Bore ID Wear Limit. 18.05 mm (0.711 in.)
Tappet-to-Bore Oil Clearance Wear Limit. . . . . 0.12 mm (0.005 in.)

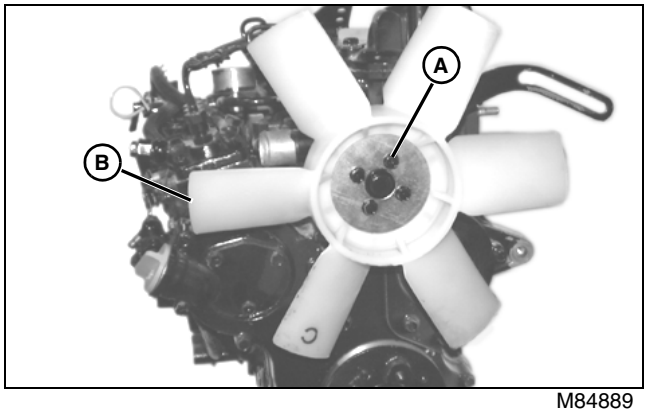
Remove and Install Timing Gear Cover

Other Material

Part No.	Part Name	Part Use
TY16021 (U.S.)/ TY9484 (Canada)	John Deere High-Flex Form-in-Place Gasket	Applied to timing cover before installation.

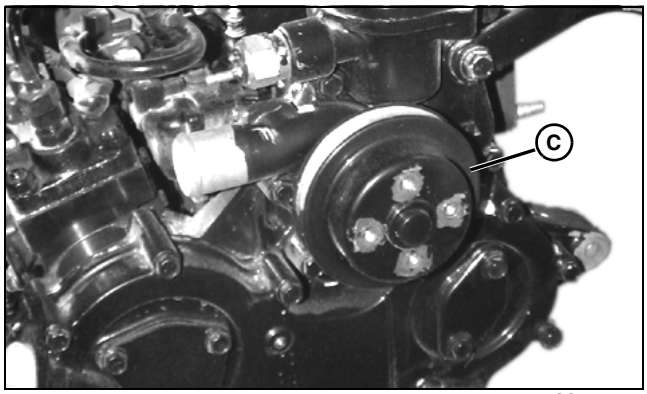
Removal

1. Remove alternator. (See "Check and Adjust Alternator Drive Belt Tension" on page 49.)



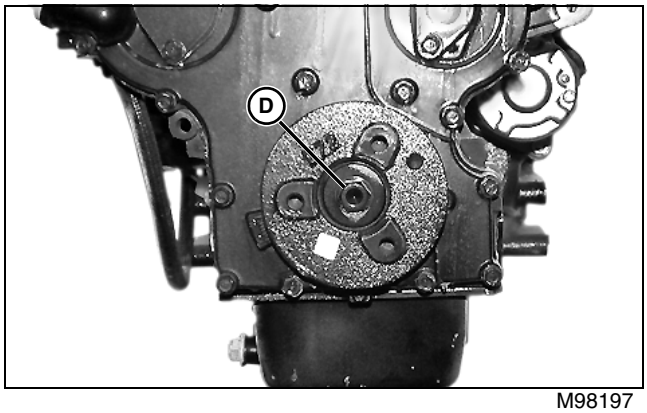
M84889

2. Remove four cap screws (A).
3. Remove fan (B).



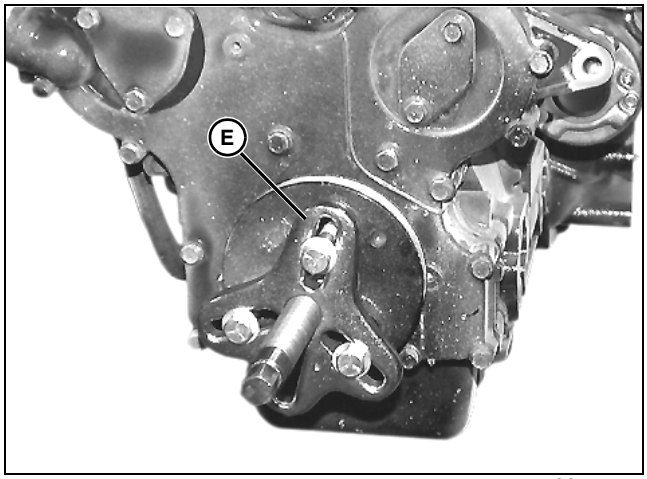
M84890

4. Remove pulley (C).



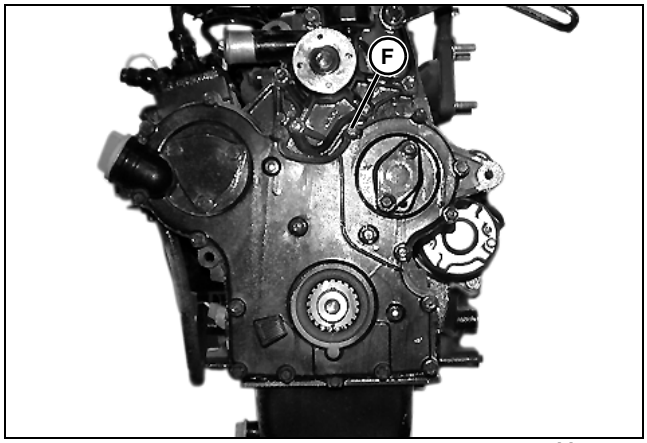
M98197

5. Remove crankshaft sheave mounting cap screw and washer (D).



M89691

6. Install puller (E) to crankshaft pulley and remove pulley.



M98199

7. Remove timing gear cover mounting cap screws (F).

IMPORTANT: Avoid damage! Use extreme care in removal of cover. Cover is aluminum and easily damaged, broken, or bent by prying. DO NOT hammer on cover at any time.

8. Remove timing gear cover.
9. Clean all old gasket material from timing gear cover and timing gear cover housing on block.

Installation

Installation is done in the reverse order of removal.

- Apply a thin bead of TY16021 John Deere High-Flex Form-in-Place Gasket to timing gear cover prior to installation.
- Tighten all timing gear cover mounting cap screws to specification.
- Adjust belt tension. (See “Check and Adjust Alternator Drive Belt Tension” on page 49.)

Specifications

Timing Gear Cover Mounting
Cap Screw Torque . . . . . 9 N•m (78 lb-in.)
Crankshaft Pulley
Cap Screw Torque . . . . . 88 N•m (65 lb-ft)

Remove and Install Idler Gear

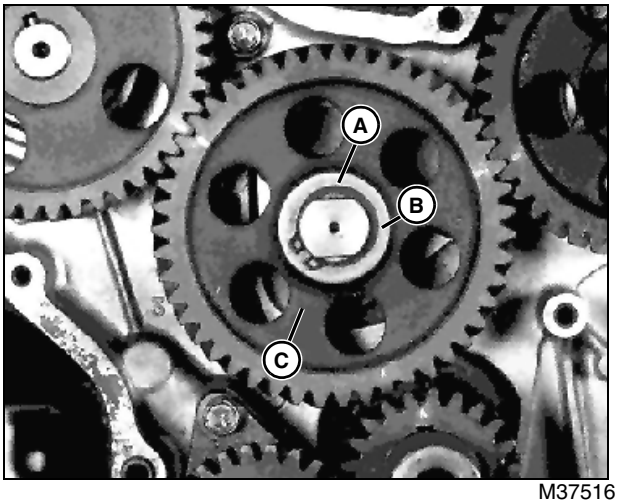
Special or Required Tools

Tool Name	Tool No.	Tool Use
Bushing Driver Set	NA	Used to replace worn idler gear bushing.

Removal

1. Remove timing gear cover. (See “Remove and Install Timing Gear Cover” on page 111.)

2. Check backlash of timing gears. (See “Timing Gear Backlash Check” on page 110.)



M37516

3. Rotate crankshaft and align timing marks.

NOTE: Timing mark on crankshaft gear is on front of tooth used for timing, but since gear is spiral cut, it will appear to not be aligned with mark on idler gear.

4. Remove snap ring (A), washer (B), and gear (C).

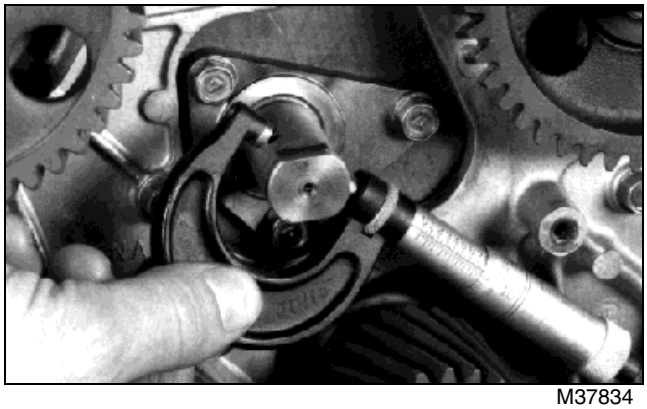
5. Inspect all parts for wear or damage. (See “Inspection/ Replacement” on page 113.)

Installation

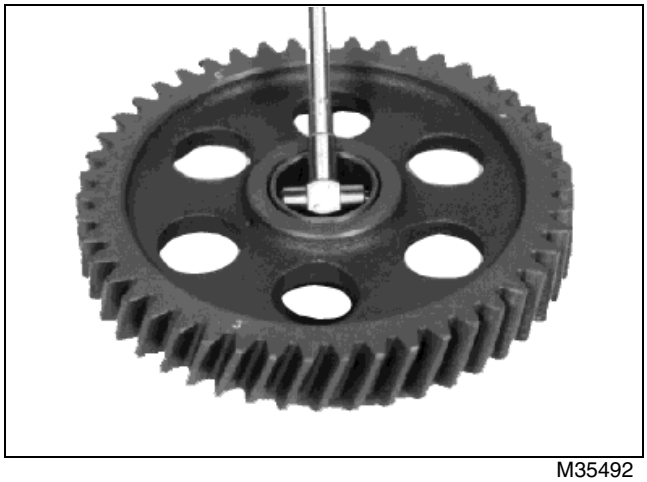
Installation is done in the reverse order of removal. It is not necessary to time oil pump gear.

Inspection/Replacement

1. Inspect gear for chipped or broken teeth. Replace if necessary.


M37834

2. Measure idler gear shaft diameter. If shaft diameter is less than wear limit, replace idler gear shaft.


M35492

3. Measure idler gear bushing diameter. If bushing diameter exceeds wear limit, replace bushing using a driver set.

   a. Align oil holes in bushing and idler gear.

   b. Install bushing flush with surface of idler gear.

4. If bushing oil clearance (bushing ID minus shaft OD) exceeds specification, replace bushing, shaft, or both.

Specifications

Idler Gear Shaft
Standard OD . . . . . 19.96-19.98 mm (0.786-0.787 in.)
Idler Gear Shaft OD Wear Limit. . . 19.93 mm (0.785 in.)
Idler Gear Bushing
Standard ID . . . . . 20.00-20.02 mm (0.787-0.788 in.)
Oil Clearance . . . . . 0.020-0.062 mm (0.0008-0.002 in.)
Oil Clearance Wear Limit . . . . . 0.15 mm (0.006 in.)

Remove and Install Timing Gear Housing

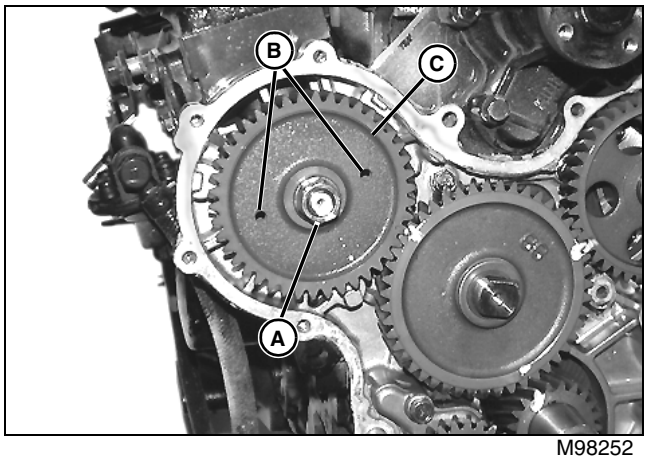
Other Material

Part No.	Part Name	Part Use
TY16021 (U.S.)/ TY9484 (Canada)	John Deere High-Flex Form-in-Place Gasket	Applied to timing gear housing before installation.

Removal

1. Remove engine. (See “Remove Engine” on page 75.)

2. Remove timing gear cover. (See “Remove and Install Timing Gear Cover” on page 111.)



M98252

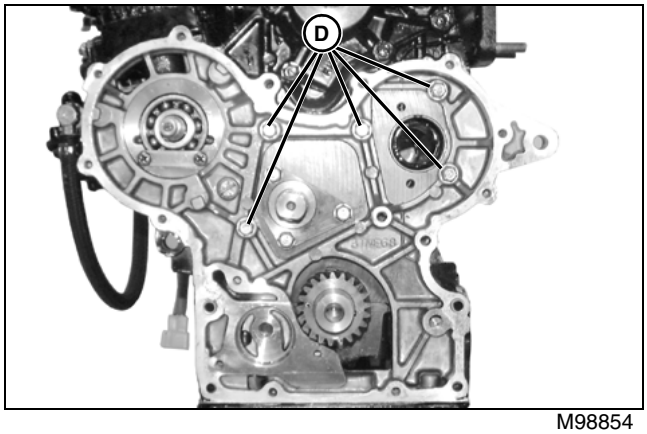
3. Remove nut and washer (A).

4. If gear has threaded holes (B), remove the gear using an H-bar puller. If gear (C) is spoked, remove using a suitable puller.

5. Remove engine camshaft. (See “Camshaft” on page 107.)

6. Remove coolant pump. (See “Remove and Install Coolant Pump (Thermostat Included)” on page 117.)

7. Remove oil pan. (See “Oil Pan and Strainer” on page 115.)



M98854

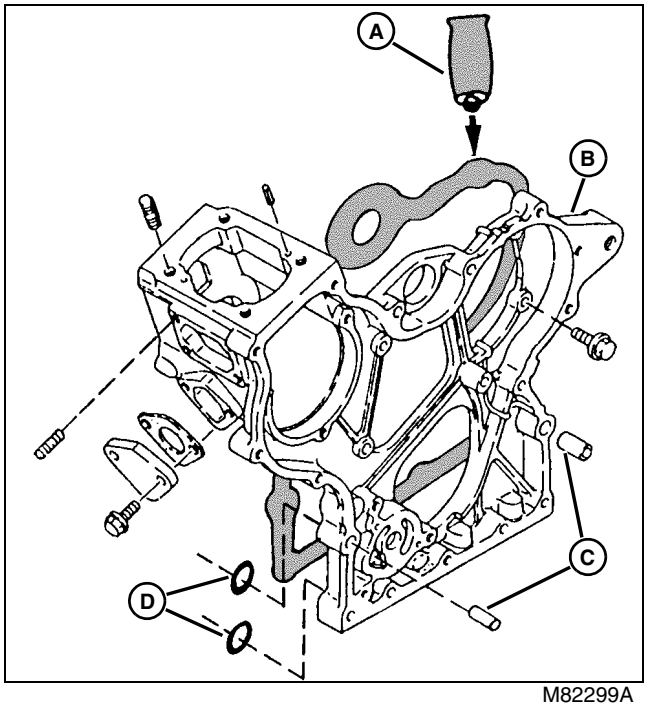
8. Remove timing gear housing mounting cap screws (D) and remove housing from cylinder block.

9. If replacing timing housing, remove fuel injection pump and governor.

Installation

Installation is done in the reverse order of removal.

- Clean all parts of old gasket sealer, gasket material, oil, and dirt before attempting installation.



M82299A

- Install alignment dowels (C) in timing gear housing (B).
- Replace O-rings (D) behind oil pump.
- Apply TY16021 John Deere High-Flex Form-in-Place Gasket (A) to timing gear housing when installing to cylinder block.
- Tighten mounting cap screws to specification.

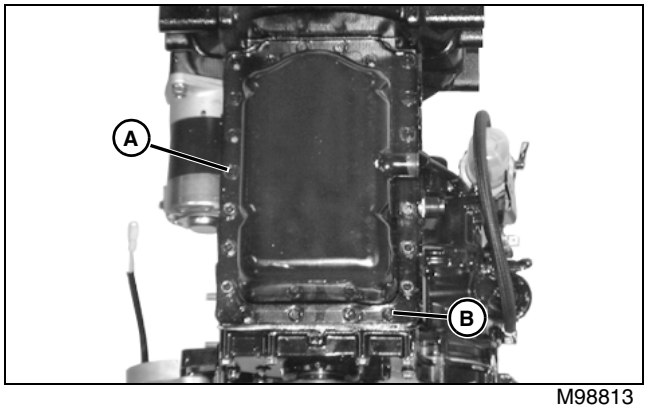
Specifications

Timing Gear Housing Mounting Cap Screw Torque . . . . . 11 N•m (96 lb-in.)

Oil Pan and Strainer

Removal

1. Drain engine oil into a suitable container.

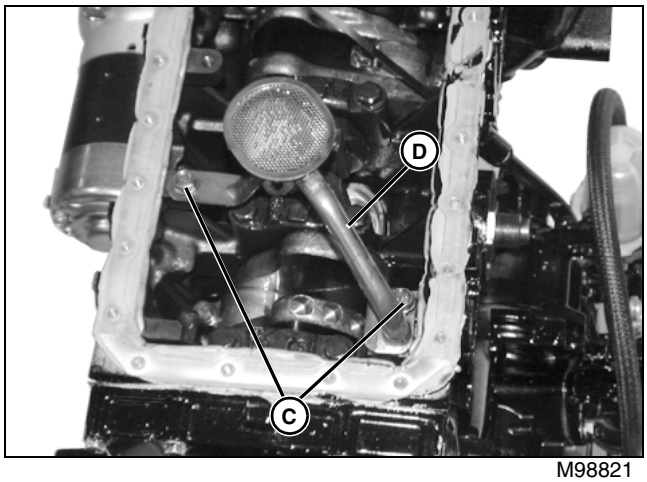


M98813

2. Remove 16 cap screws (A) and six cap screws (B).

IMPORTANT: Avoid damage! DO NOT use a screwdriver to pry oil pan from engine block. Oil pan or engine block may be damaged.

3. Carefully tap on oil pan with a soft-faced mallet to loosen oil pan from engine block.



M98821

4. Remove cap screws (C) from strainer.

5. Remove oil strainer (D) and discard O-ring. Replace O-ring before installation.

6. Remove sealant residue from oil pan engine block mating surfaces.

Installation

Installation is done in reverse order of removal.

- Apply RTV silicone sealant to oil pan sealing surface.
- Tighten oil pan cap screws to specification.
- Fill engine to proper level with oil of correct specifications. (See “4-Cycle Diesel Engine Oil - North America” on page 19.)

Specifications

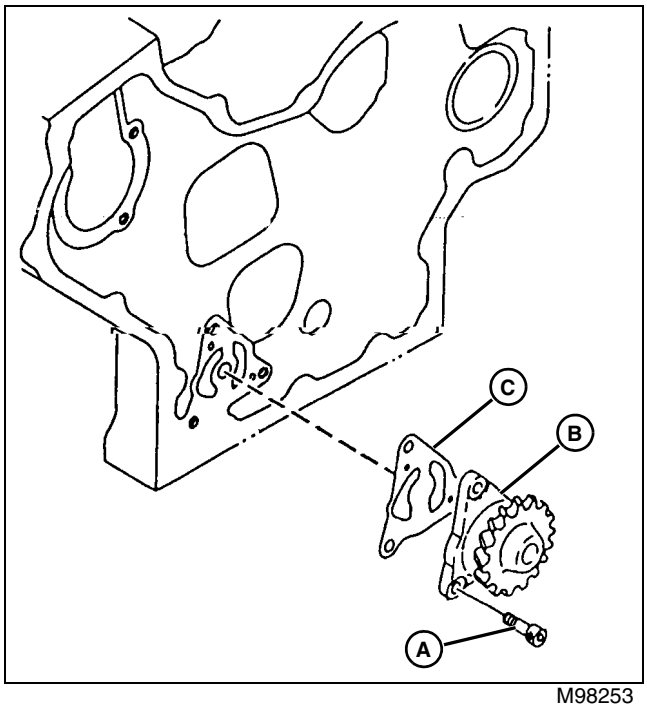
Oil Pan Cap Screw Torque. . . . . 9 N•m (78 lb-in.)

Remove and Install Oil Pump

Removal

1. Remove timing gear cover. (See “Remove and Install Timing Gear Cover” on page 111.)

2. Check oil pump gear backlash. Replace entire oil pump assembly if backlash exceeds specification.



M98253

3. Remove three mounting cap screws (A).

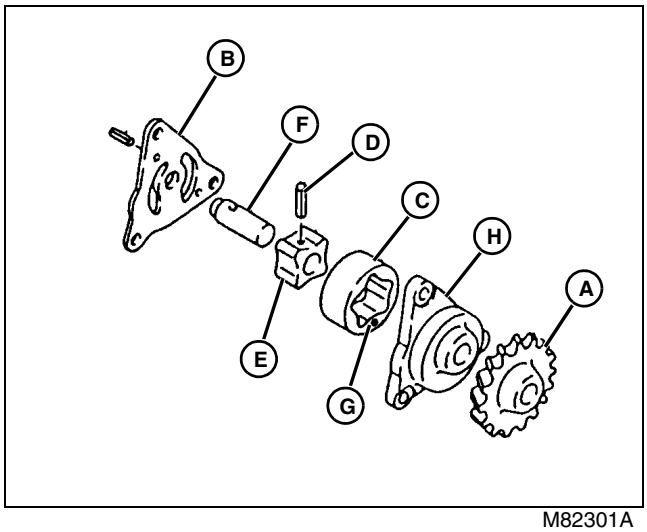
4. Remove oil pump (B) and gasket (C).

5. Inspect all parts for wear or damage. (See “Inspect Oil Pump” on page 116.)

Installation

Installation is done in the reverse order of removal.

Disassemble and Assemble Oil Pump



M82301A

NOTE: The oil pump drive gear is press-fit to the shaft.

1. Remove drive gear (A) using a knife-edge puller and a press.
2. Remove backing plate (B)
3. Remove outer rotor (C).
4. Remove pin (D) and inner rotor (E).
5. Remove rotor shaft (F).
6. Inspect all parts for wear or damage.

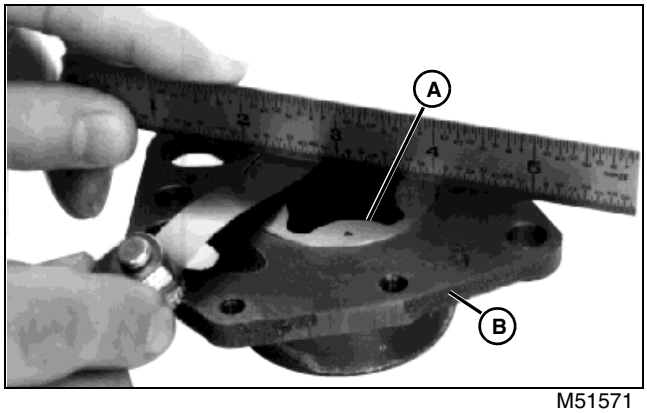
Assembly

Assembly is done in the reverse order of disassembly.

- Coat all parts with a light coat of clean engine oil before assembly.
- Install the outer rotor with the alignment mark (G) facing toward the pump body (H).

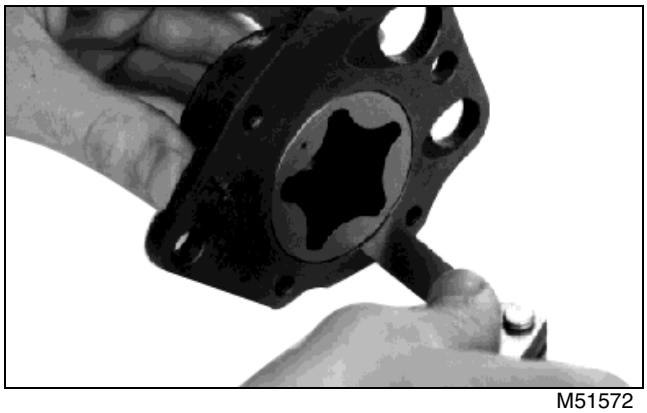
Inspect Oil Pump

1. Measure the rotor shaft outside diameter. Record the measurement.
2. Measure the inside diameter of the rotor shaft bore. Record the measurement.
3. Subtract the rotor shaft outside diameter from the rotor shaft bore inside diameter to determine the rotor shaft-to-bore clearance. Replace the pump if the clearance is greater than specification.



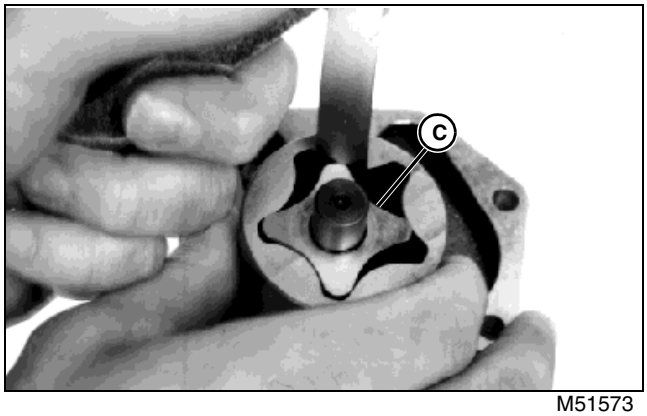
M51571

4. Install outer rotor (A) in pump body (B).
5. Place a straightedge across the pump body mounting surface and measure outer rotor recess using a feeler gauge. Replace the entire pump if clearance is greater than specification.



M51572

6. Check outer rotor-to-pump body clearance using a feeler gauge. Replace the entire pump if clearance is greater than specification.



M51573

7. Install the inner rotor (C) in the outer rotor.
8. Check clearance between the tip of the inner rotor and the outer rotor. Replace the entire pump if clearance is greater than specification.

Specifications

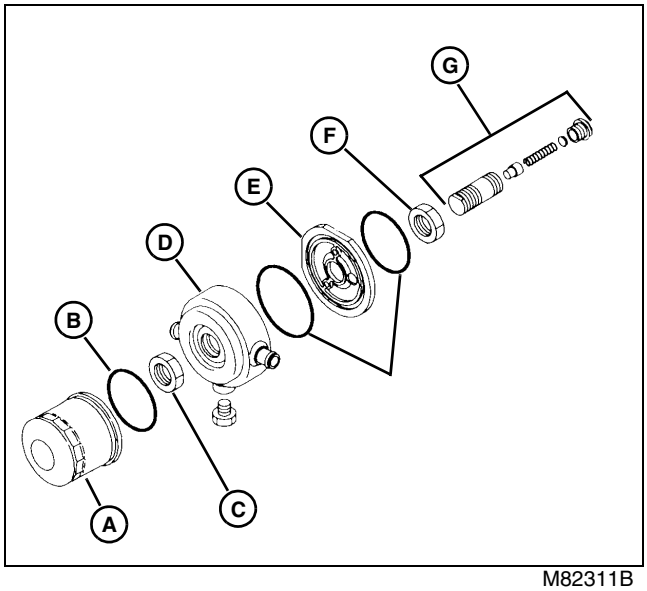
Outer Rotor-to-Pump Housing Clearance Wear Limit . . . . . 0.25 mm (0.006 in.)

Inner Rotor-to-Outer Rotor Clearance (Maximum) . . . . . 0.15 mm (0.006 in.)

Rotor-to-Pump Housing Side Clearance Wear Limit . . . . . 0.13 mm (0.005 in.)

Remove and Install Oil Pressure Regulating Valve

Removal



M82311B

1. Remove oil filter (A) and O-ring (B).
2. Remove retaining nut (C), oil cooler (D) and baseplate (E).
3. Remove retaining nut (F) and valve assembly (G).

NOTE: Valve components (G) are not serviced individually. Replace complete regulating valve if any components are defective.

4. Inspect all parts for wear or damage. Replace complete valve if any parts are bad.

Installation

Installation is done in the reverse order of removal.

- Tighten retaining nuts to specification.

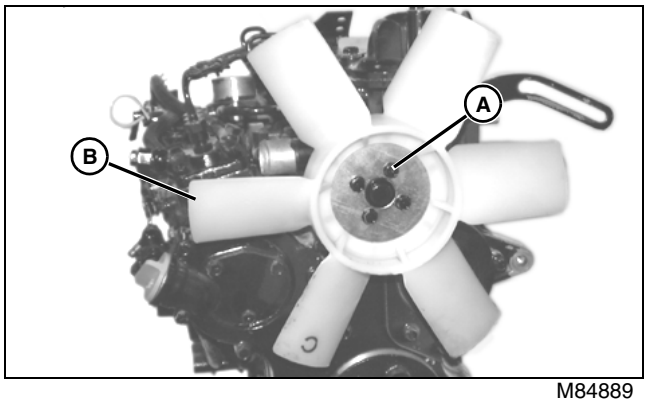
Specifications

Oil Pressure Regulating Valve Retaining Nut Torque . . . . . 30 N•m (22 lb-ft)

Remove and Install Coolant Pump (Thermostat Included)

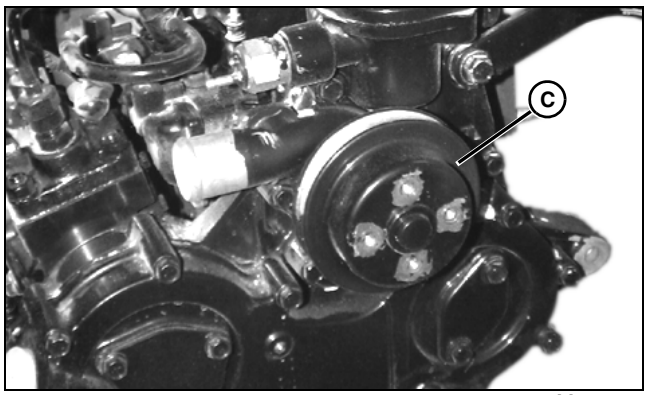
Removal

1. Park machine on level surface with park brake locked.
2. Allow engine to cool and pressure in cooling system to drop before working on coolant pump.
3. Disconnect battery negative (-) cable from battery.
4. Remove alternator. (See “Check and Adjust Alternator Drive Belt Tension” on page 49.)



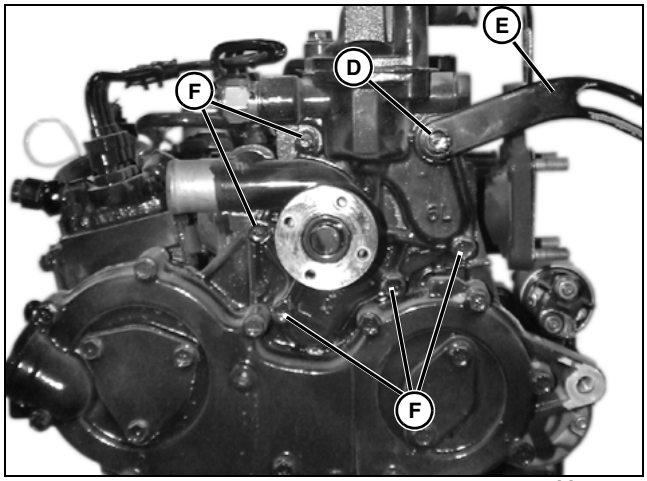
M84889

5. Remove four cap screws (A).
6. Remove fan (B).
7. Loosen alternator mounting cap screws and remove coolant pump/alternator drive belt.



M84890

8. Remove pulley (C).



M84891

9. Remove cap screw (D) and alternator bracket (E).

10.Remove coolant pump cap screws (F).

11.Remove coolant pump.

12.If the coolant pump is to be replaced, remove the coolant temperature switch and thermostat. (See “Remove and Install Coolant Temperature Switch” on page 75. See “Remove and Install Thermostat” on page 74.)

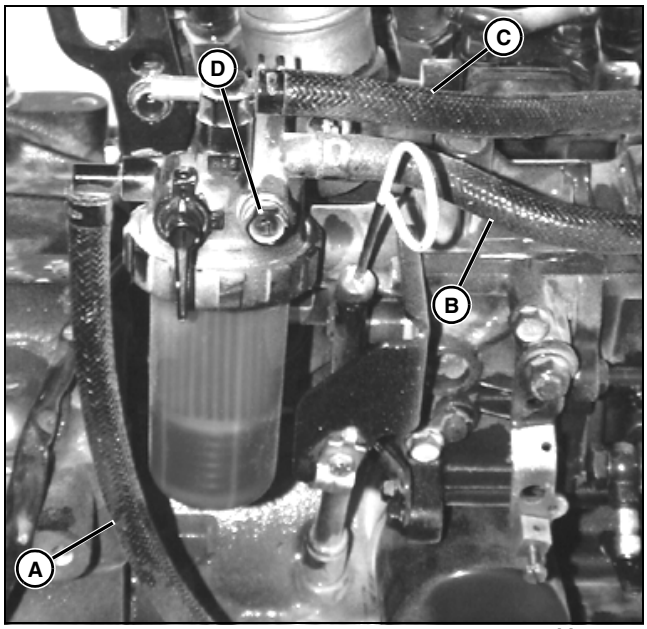
Installation

Installation is done in the reverse order of removal.

- Remove gasket residue from mating surfaces of coolant pump and timing gear cover. Use a new gasket for installation.
- Adjust coolant pump/alternator drive belt tension. (See “Check and Adjust Alternator Drive Belt Tension” on page 49.)

Remove and Install Fuel Filter and Water Separator Assembly

Removal



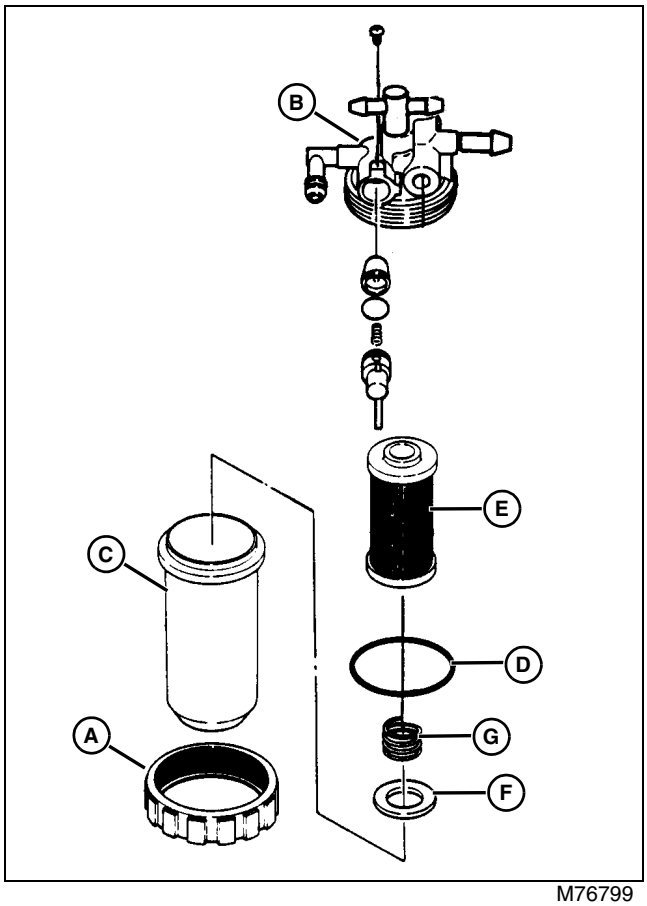
M84895

1. Disconnect fuel filter-to-fuel pump hose (A).
2. Disconnect leak-off hose (B).
3. Disconnect fuel filter-to-injection pump hose (C).
4. Remove mounting cap screw (D).
5. Remove fuel filter and water separator assembly.

Installation

Installation is done in the reverse order of removal.

Assemble Fuel Filter and Water Separator



M76799

1. Remove the retaining ring (A) from the mounting base (B) while holding on to the filter cover (C).
2. Remove the filter cover from the mounting base.
3. Remove and replace O-ring (D) and filter element (E).
4. Be sure the ring (F) and spring (G) are in the filter cover.

IMPORTANT: Avoid damage! Tighten retaining nut only enough to keep the filter assembly from leaking. Overtightening the nut may damage the filter cover or retaining ring.

5. Place the filter element on mounting base.
6. Install the filter cover and retaining ring.

Remove and Install Fuel Injection Pump

Removal

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

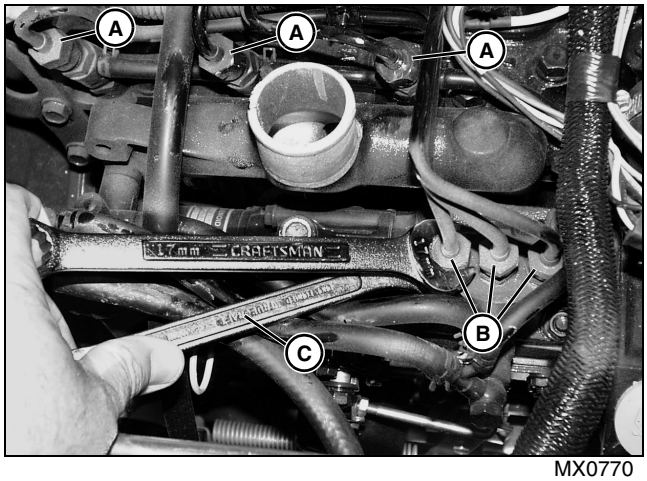
- **Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.**
- **If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. In the United States and Canada only, this information may be obtained by calling 1-800-822-8262.**

CAUTION: Avoid injury! Do not attempt to remove the EPA/CARB Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service EPA/CARB Certified Emissions engines.

IMPORTANT: Avoid damage! Never steam clean or pour cold water on injection pump while pump is running or engine is warm. Doing so can damage the pump.

1. Park machine on level surface with park brake locked and key switch off.
2. Turn the fuel shut-off valve on the fuel filter/water separator to the closed position.
3. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner (cold engine).
4. Remove air cleaner hose.

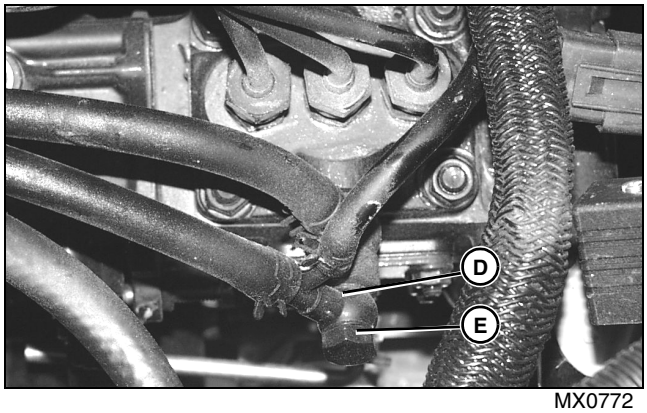
IMPORTANT: Avoid damage! When removing injection lines, do not turn pump delivery valve fittings. Turning fittings may damage pump internally. Always use a backup wrench when removing lines.



MX0770

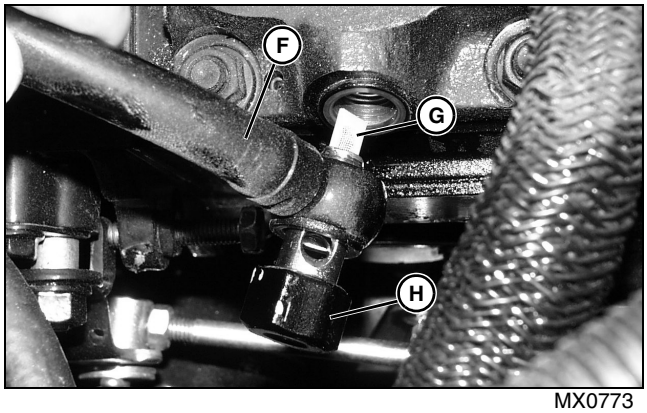
5. Loosen fuel line nuts at fuel injection pump (B) and on the injector nozzles (A). When loosening connectors on the injector pump, use a backup wrench (C) to keep delivery valves from loosening.

6. Remove injector lines.



MX0772

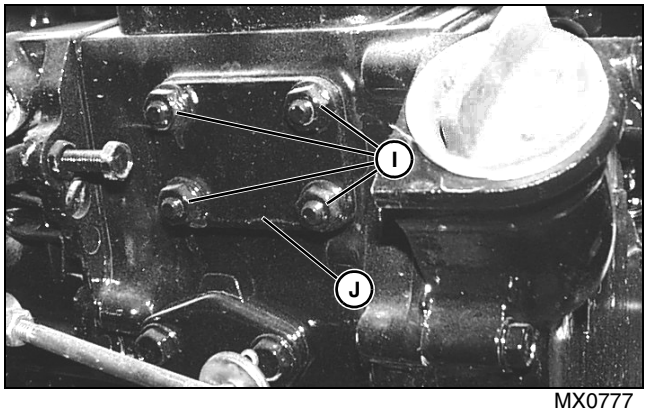
7. Remove cap screw (E) and return line fitting (D) from injection pump.



MX0773

8. Remove special cap screw (H) and fuel supply line (F). Be careful not to damage screen (G).

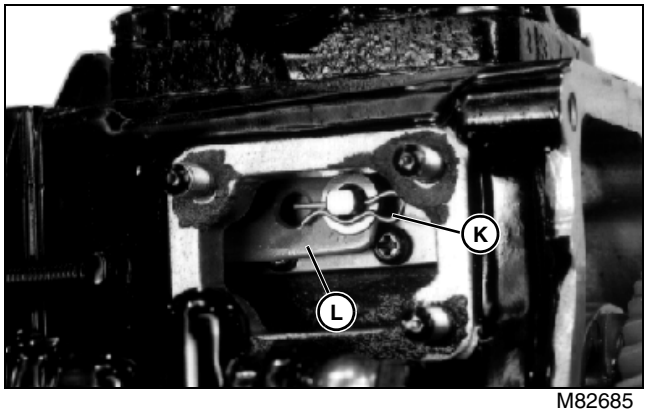
NOTE: Note location of copper washers on each side of both fittings.



MX0777

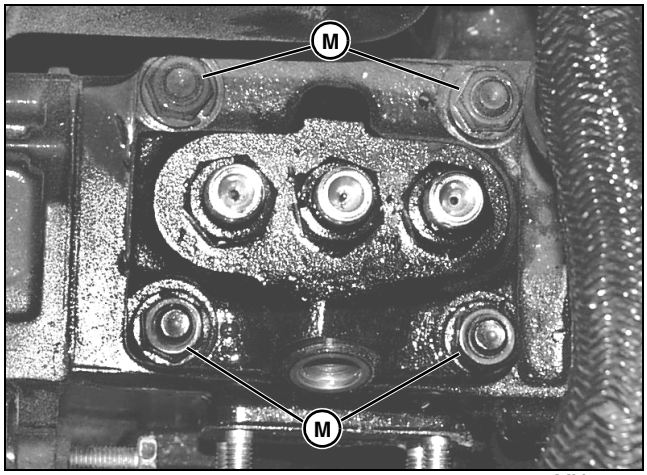
9. Remove four cap screws (I) and cover (J).

NOTE: Washer may or may not be fixed to linkage. Do not drop pin or washer during removal.



M82685

10.Remove spring pin (K) and washer, if removable. Disconnect governor linkage (L) from injection pump.

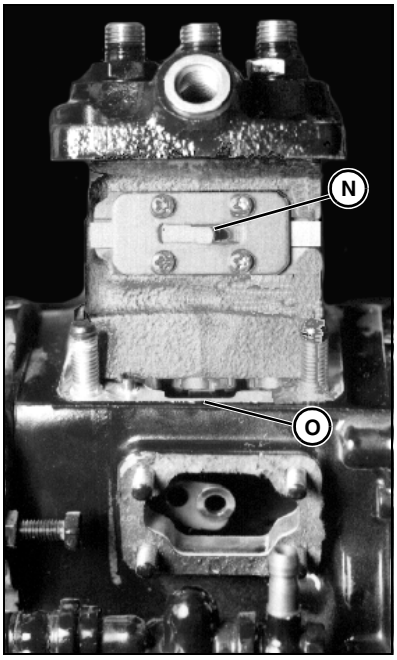


MX0774

11.Remove four cap screws (M) and washers from injector pump mounting flange.

CAUTION: Avoid injury! Do not attempt to adjust the EPA/CARB Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service EPA/ CARB Certified Emissions engines.

IMPORTANT: Avoid damage! Do not pry fuel injection pump from governor housing with sharp edge tool. Timing shims and/or housing may be damaged. Make sure rack pin is lined up with notch in center of housing, or it may catch and break pin.



M76983

12.Carefully pull injector pump straight up from governor housing. Ensure pin (N) is in line with notch in housing (O).

Installation

CAUTION: Avoid injury! Do not attempt to adjust the EPA/CARB Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service EPA/ CARB Certified Emissions engines.

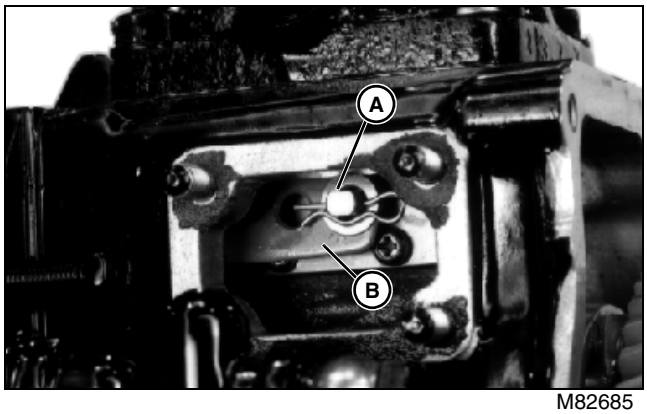
IMPORTANT: Avoid damage! If serviced or replacement fuel injection pump is installed, measure old shim thickness and install new shims of the same thickness.

NOTE: Governor linkage has two holes. Connect governor linkage to injection pump rack at hole in end of linkage.

Do not drop pin or washer into housing during installation. Place a small amount of engine assembly grease on washer to help it stick in place while assembling.

1. Install fuel injection pump. Installation is done in the reverse order of removal.

2. Install shims on top of governor housing to match thickness of original shims.



M82685

3. When connecting governor linkage (B) to injection pump rack (A), attach link to rack at hole in end of linkage.

4. If new injection pump is being installed, check and adjust injection pump timing. (See “Injection Pump Static Timing” on page 63.)

Remove, Inspect, and Install Fuel Injection Nozzle

Special or Required Tools

Tool Name	Tool No.	Tool Use
Nozzle Cleaning Kit	JDF13	Used to clean fuel injection nozzles.

Removal

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

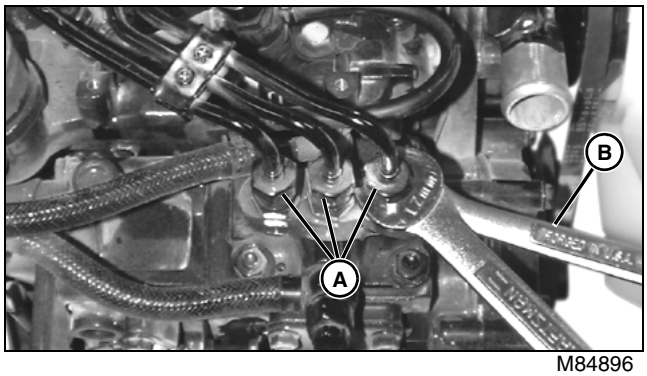
- **Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.**
- **If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. In the United States and Canada only, this information may be obtained by calling 1-800-822-8262.**

IMPORTANT: Avoid damage! Never steam clean or pour cold water on injection pump while the pump is running or engine is warm. Doing so can damage the pump.

When removing injection lines, do not turn pump delivery valve fittings. Turning fittings may damage pump internally. Always use a backup wrench when removing lines.

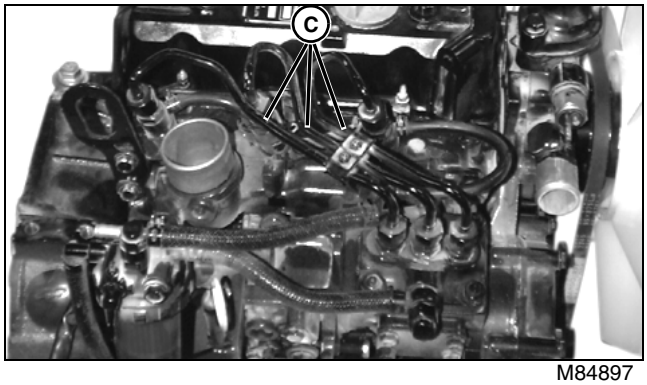
1. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner (cold engine).

NOTE: Nozzles are matched to the cylinders. If removing more than one nozzle, tag each nozzle according to the cylinder from which it was removed.



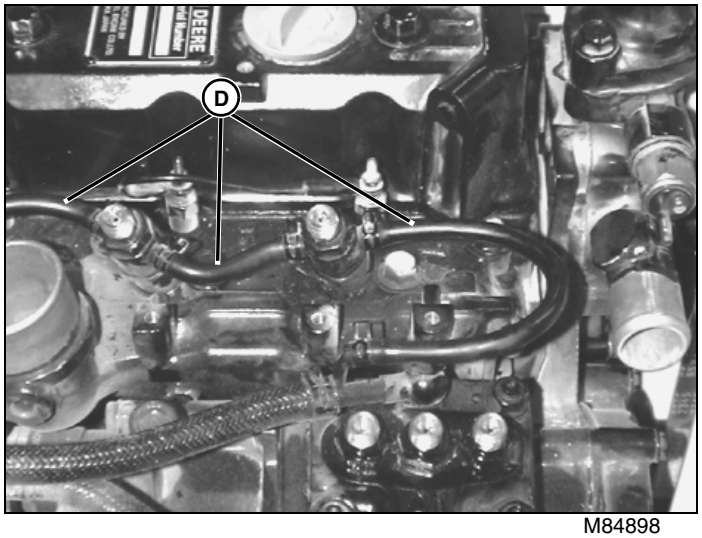
M84896

2. Loosen fuel line connectors (A) at injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench (B) to prevent delivery valves from turning.



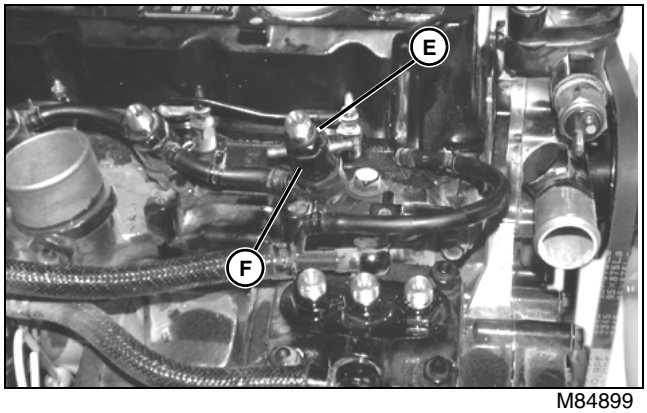
M84897

3. Remove fuel line nuts at injector nozzles and remove injector lines (C).



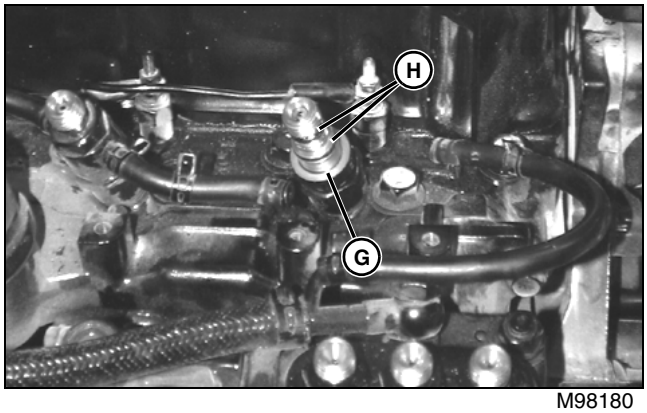
M84898

4. Remove leak-off hoses (D).



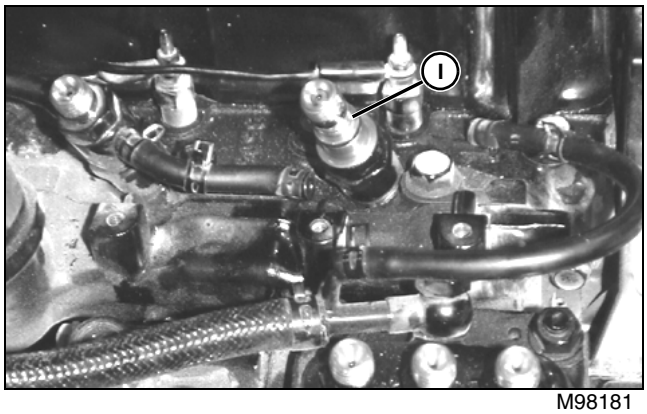
M84899

5. Remove three nuts (E) and fittings (F).



M98180

6. Remove bronze washers (G) and O-rings (H).



M98181

7. Remove injection nozzle (I), washers, and heat protector.

8. Test injection nozzles. (See “Test Fuel Injection Nozzle” on page 62.)

Installation

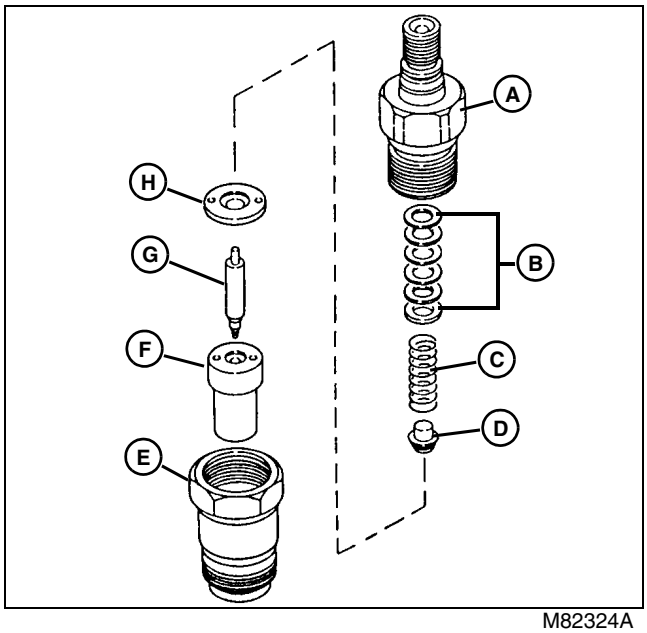
Installation is done in the reverse order of removal.

- Replace heat protectors, washers, and O-rings.
- Tighten injector nozzle body to specification.
- Tighten leak-off fitting nut to specification.

Repair

IMPORTANT: Avoid damage! If injection nozzles are disassembled to be cleaned, the same number and thickness of shims must be installed.

NOTE: If servicing more than one nozzle, keep parts for each nozzle separate from one another.

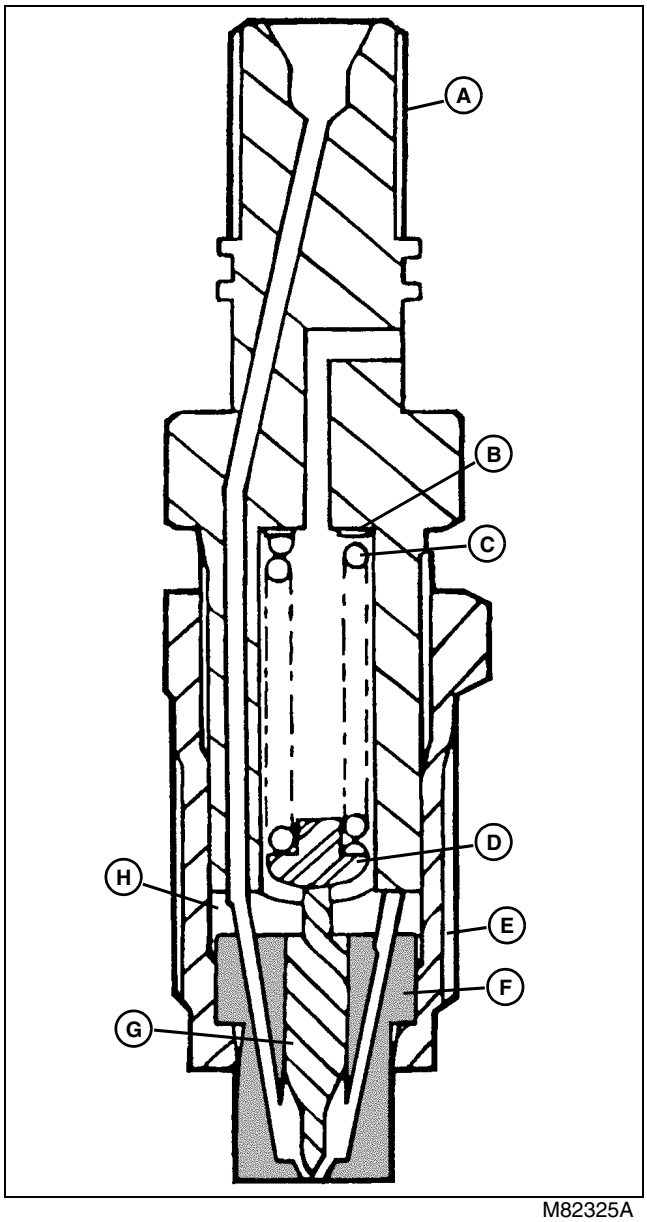


M82324A

A - Injector Body
B - Shims (as required)
C - Spring
D - Spring Seat
E - Nozzle Fitting
F - Nozzle Body
G - Nozzle Valve
H - Separator Plate

- Clean and inspect nozzle assembly. (See “Cleaning and Inspection” on page 124.)
- After assembly is complete, test injection nozzle. (See “Test Fuel Injection Nozzle” on page 62.)

Injection Nozzle Cross Section



M82325A

A - Injector Body
B - Shims (as required)
C - Spring
D - Spring Seat
E - Nozzle Fitting
F - Nozzle Body
G - Nozzle Valve
H - Separator Plate

Cleaning and Inspection

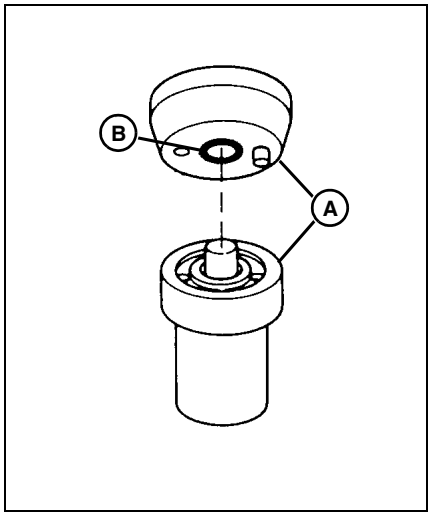
NOTE: To clean nozzles properly, JDF13 Nozzle Cleaning Kit is recommended. The cleaning kit is available through the John Deere SERVICEGARD™ Catalog.

1. Remove anti-corrosive grease from new or reconditioned nozzles by washing them thoroughly in diesel fuel.

IMPORTANT: Avoid damage! Never use a steel brush to clean nozzles as this will distort the spray hole.

2. Remove carbon from used nozzles, and clean by washing in diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush (supplied in JDF13 Nozzle Cleaning Kit).

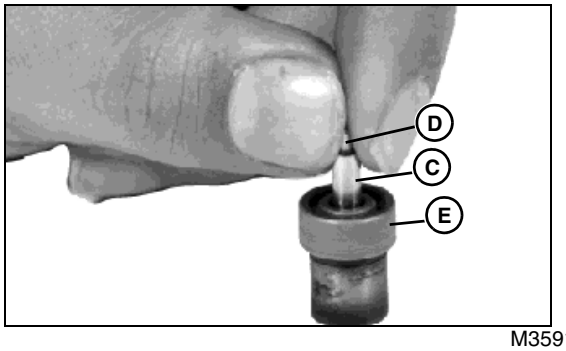
3. After removing carbon or lacquer from the exterior of nozzle, inspect sealing surfaces between separator plate and nozzle body for nicks or scratches.



M82326A

4. Inspect condition of separator plate and nozzle body. Contact area of separator plate (A) (both parts) must not be scored or pitted. Use an inspection magnifier (No. 16487 or equivalent) to aid in making the inspection.

5. Check nozzle contact surface (B) on separator plate for wear. If contact surface is more than the specified measurement, replace nozzle assembly.



M35919

6. Inspect the piston (C) (large) part of nozzle valve to see that it is not scratched or scored and that lower (tip) end of valve is not broken. If any of these conditions are present, replace the nozzle assembly.

7. Further inspect the nozzle assembly by performing a slide test.

- Dip the nozzle valve (D) in clean diesel fuel. Insert valve in nozzle body (E).
- Hold nozzle vertical, and pull valve out about 1/3 of its engaged length.
- Release valve. Valve should slide down to its seat by its own weight.

Replace nozzle assembly if the valve does not slide freely to its seat.

Specifications

Injection Nozzle Body Torque . . . . . 51 N•m (37 lb-ft)
Leak-Off Fitting Nut Torque . . . . . 32 N•m (24 lb-ft)
Separator Plate Contact Surface. . . 0.10 mm (0.004 in.)

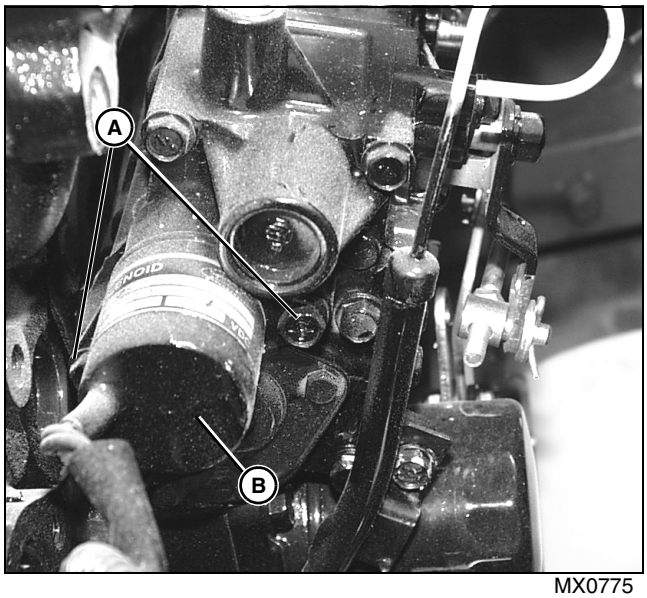
Remove and Install Fuel Shutoff Solenoid

Removal

1. Park machine on level surface with park brake locked and key switch in off position.

2. Clean around the fuel shutoff solenoid using a parts cleaning solvent or steam cleaner.

3. Disconnect the electrical lead to the fuel shutoff solenoid.



MX0775

4. Disconnect electrical lead and remove fuel shutoff solenoid.

5. Remove the two solenoid mounting cap screws (A) and remove solenoid (B) from governor housing.

6. Test fuel solenoid. (See “Fuel Shutoff Solenoid Test - Diesel Engine” on page 261.)

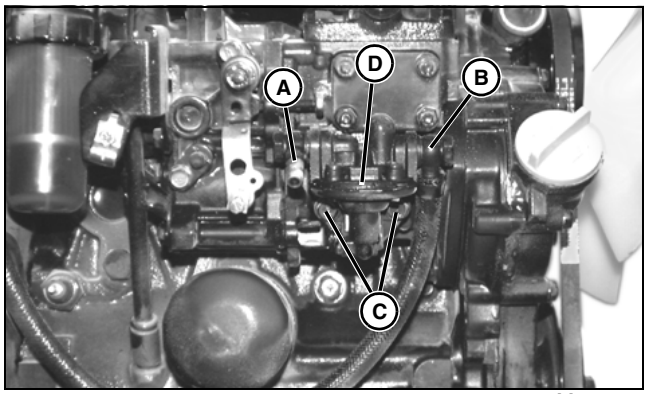
Installation

NOTE: Check condition of O-ring on solenoid before installing.

Install fuel shutoff solenoid. Installation is done in the reverse order of removal.

Remove and Install Fuel Pump

Removal



M84894

1. Disconnect fuel supply line (A).
2. Disconnect fuel hose from fuel filter (B).
3. Remove two cap screws (C).
4. Remove fuel pump (D).

Installation

Installation is done in the reverse order of removal.

IMPORTANT: Avoid damage! Replace all copper washers. Damaged or used washers may leak.

- Remove gasket residue from fuel pump and fuel injection pump mating surfaces.
- Use a new gasket for installation.
- Tighten cap screws to specification.
- Bleed air from fuel system. (See “Bleed Fuel System” on page 54.)

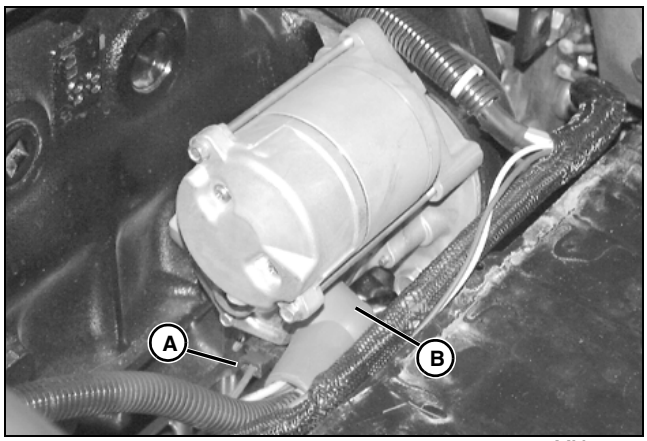
Specifications

Fuel Pump Cap Screw Torque . . . . . 11 N•m (96 lb-in.)

Remove and Install Starting Motor

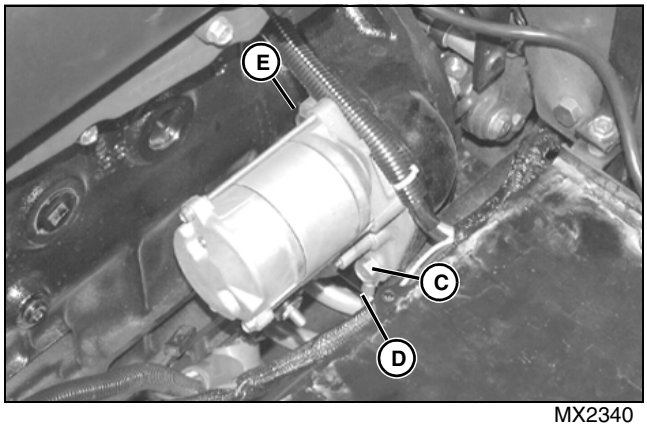
Removal

1. Park machine safely. (See “Park Machine Safely” on page 3.)
2. Raise engine cover.
3. Disconnect battery negative (-) cable.
4. Disconnect white wire from starter solenoid.



MX2339

5. Disconnect violet wire (A) from solenoid.
6. Disconnect wires (B) from solenoid battery terminal.



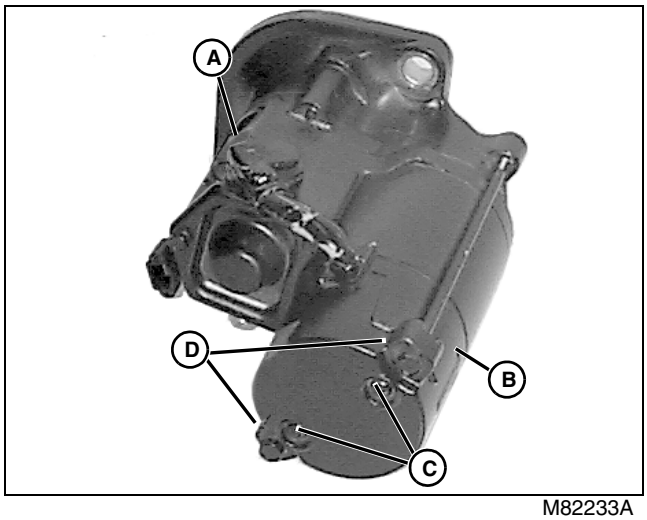
MX2340

7. Remove lower cap screw (C) and ground strap (D).
8. Remove upper cap screw (E).
9. Remove starting motor.

Installation

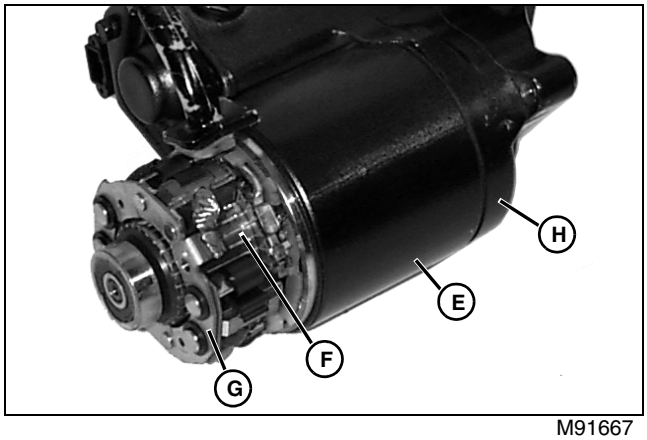
Installation is done in the reverse order of removal.

Disassemble and Assemble Starting Motor



M82233A

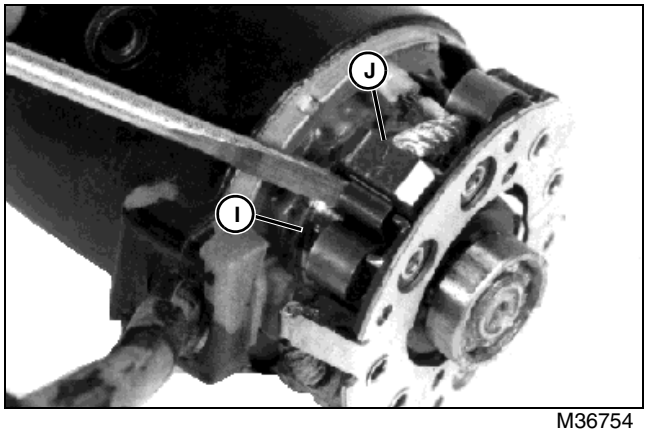
1. Disconnect field lead (A).
2. Remove two cover cap screws (C).
3. Remove two clutch housing-to-motor cap screws (D).
4. Remove rear cover (B).



M91667

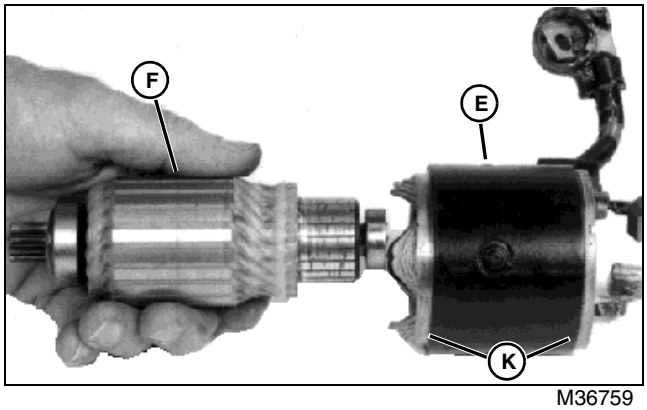
5. Remove field coil housing (E), armature (F), and brush holder (G) as a unit from the clutch housing (H).

NOTE: Brushes are not serviced separately. If brushes require replacement, the entire brush holder with brushes attached must be replaced.



M36754

6. Pry the brush springs (I) away, and pull negative brushes (J) up enough to hold the brush in place.
7. Remove brush holder.



M36759

8. Remove armature from field coil housing.
9. Inspect O-rings (K) on field coil housing. Replace as needed.
10. Inspect all parts for wear or damage. Replace parts as needed.

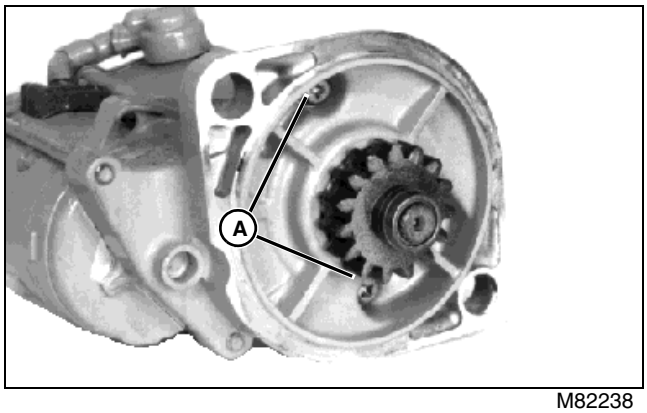
Assembly

Assembly is done in the reverse order of disassembly.

IMPORTANT: Avoid damage! When installing the rear cover, do not let field brush wires touch cover. Turn the brush holder slightly to take up slack in brush wires. Press wires inward to clear rear cover.

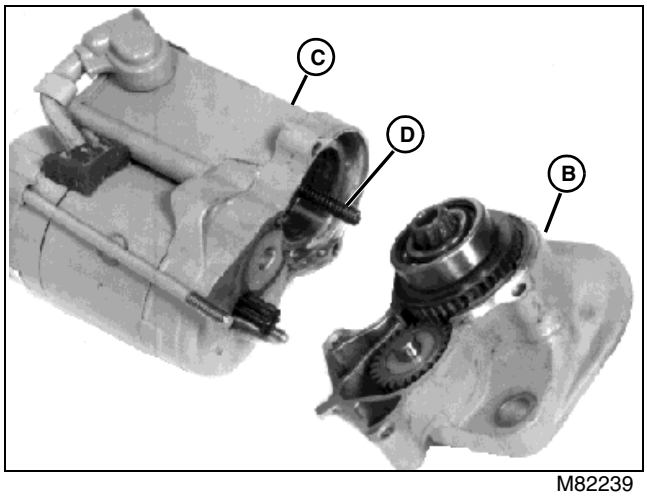
Apply multi-purpose grease to bearing cup inside rear cover.

Disassemble and Assemble Clutch Housing Assembly



M82238

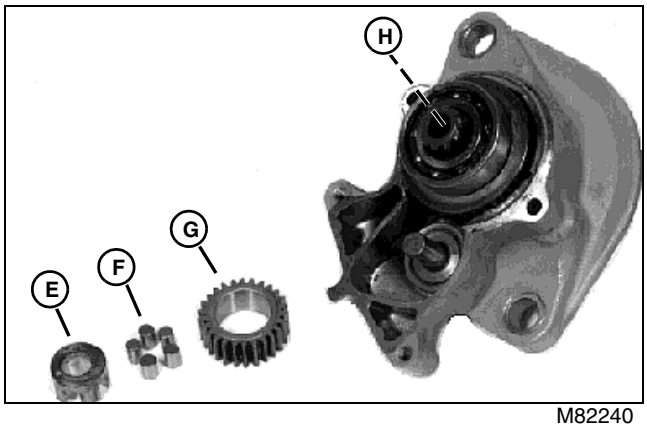
1. Remove two cap screws (A).



M82239

2. Separate the clutch housing (B) from the solenoid/motor assembly (C).

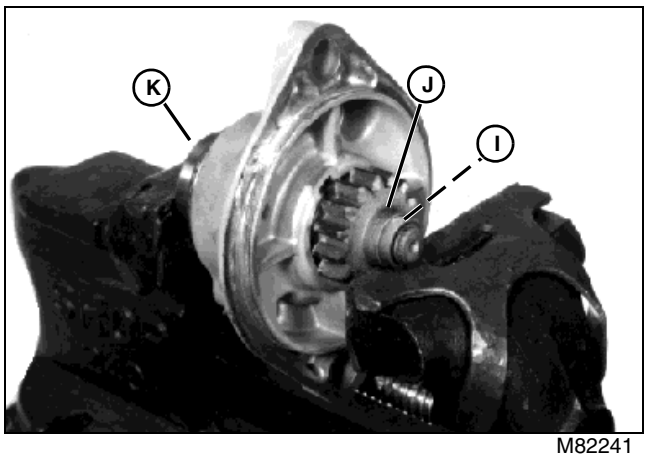
3. Remove plunger spring (D).



M82240

4. Remove retainer (E), five rollers (F), and pinion gear (G).

5. Remove steel ball (H).



M82241

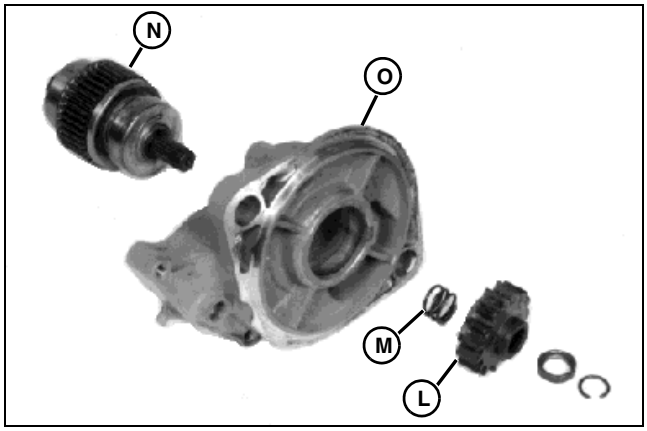
6. Place clutch housing assembly (K) in a soft-jawed vise as shown.

7. Tighten vise slowly, until the drive gear spring is fully compressed.

8. Remove circlip (I) and retainer (J).

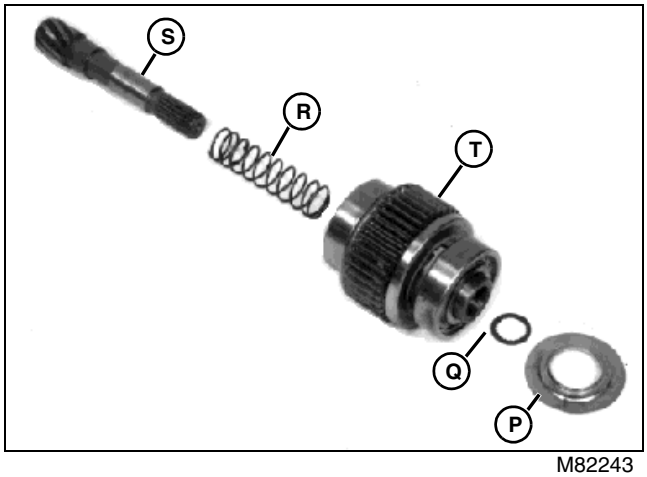
CAUTION: Avoid injury! RELEASE TENSION SLOWLY. Shaft could be propelled from clutch with considerable force if the spring is not allowed to extend fully while in the vise.

9. While holding the clutch assembly (K), slowly open the vise until the spring is fully extended.



M82242

10. Remove drive gear (L), spring (M), and clutch assembly (N) from clutch housing (O).



M82243

11.Remove large washer (P), toothed washer (Q), spring (R), and clutch shaft (S) from housing (T).

12.Inspect all parts for wear or damage. Replace parts as needed.

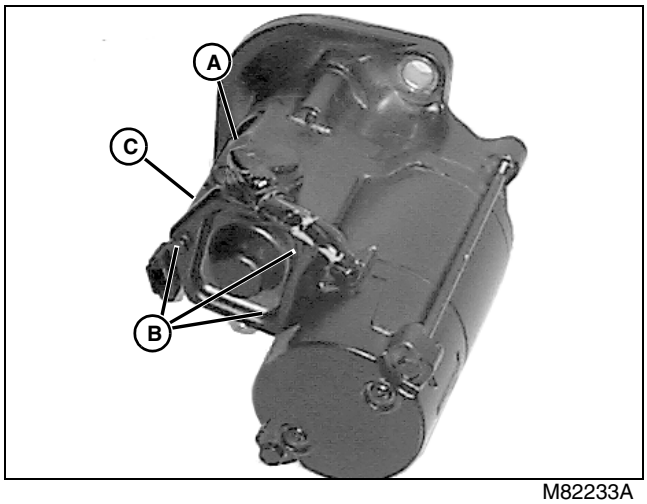
Assembly

Assembly is done in the reverse order of disassembly.

- Apply multi-purpose grease to clutch shaft (S), springs (M and R), pinion gear (G), retainer (E), rollers (F), and steel ball (H).
- Install large washer (P) with flat side toward clutch assembly.
- Install retainer (E) with cupped side away from clutch assembly.

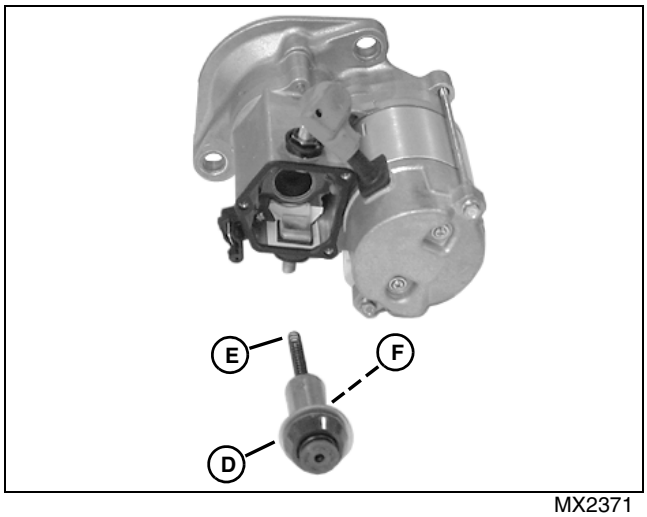
Disassemble and Assemble Solenoid

NOTE: The solenoid can be serviced without disassembling the motor/clutch housing assembly.



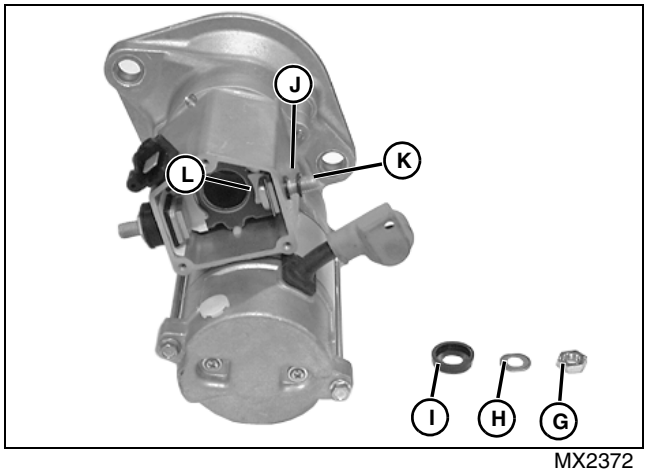
M82233A

1. Disconnect field lead (A).
2. Remove three cover cap screws (B).
3. Remove cover (C) and gasket.



MX2371

4. Remove plunger (D) and spring (E).
5. Inspect copper washer (F) for signs of excessive burning or pitting. Clean burned areas to improve contact. Replace the entire solenoid if burnt or pitted areas cannot be cleaned.



MX2372

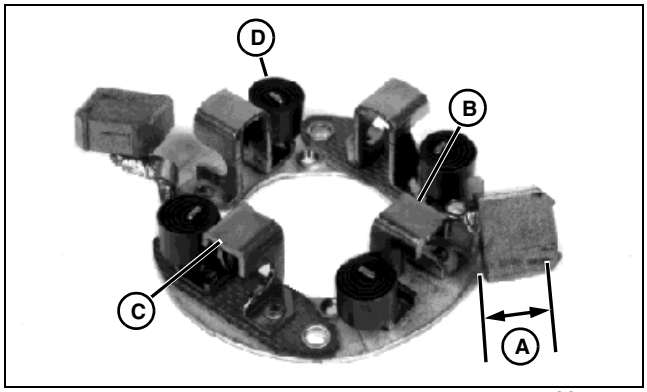
6. Remove nut (G), washer (H), insulator (I), and O-ring (J) (both sides).
7. Remove terminal bolt (K) and contact plate (L) (both sides).
8. Inspect contact plates (L) for signs of excessive burning or pitting. Clean burnt areas to improve contact. Replace the entire solenoid if burnt or pitted areas cannot be cleaned.

Assembly

Assembly is done in the reverse order of disassembly.

Inspect Starting Motor Component

Brush Holder



M82234

1. Measure brush lengths (A). Minimum brush length is 8.5 mm (0.335 in.). Replace brush if length is below minimum.

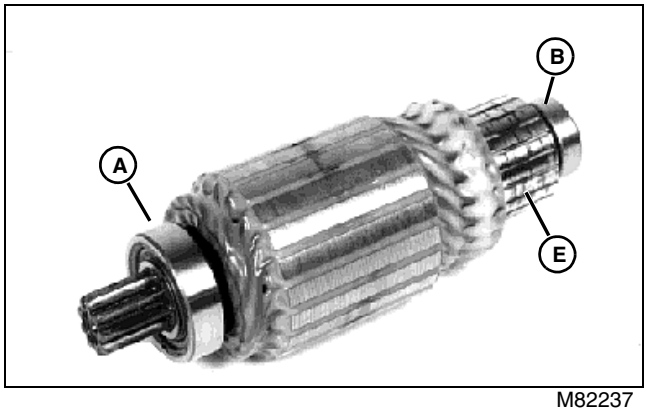
NOTE: Test brush holder using an ohmmeter or test light.

2. Test brush holder: Touch one probe of tester to negative brush holder (B) and other probe to field brush holder (C). If there is continuity, replace the brush holder.

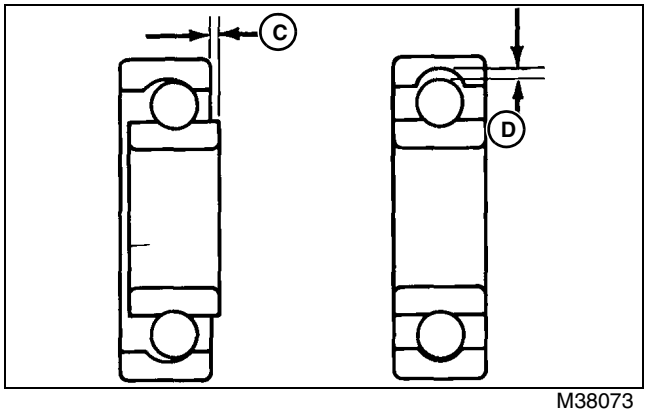
3. Inspect springs (D) for wear or damage. Replace if necessary.

Armature Assembly

IMPORTANT: Avoid damage! DO NOT clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.



M82237



M38073

1. Inspect armature. Look for signs of dragging against pole shoes.

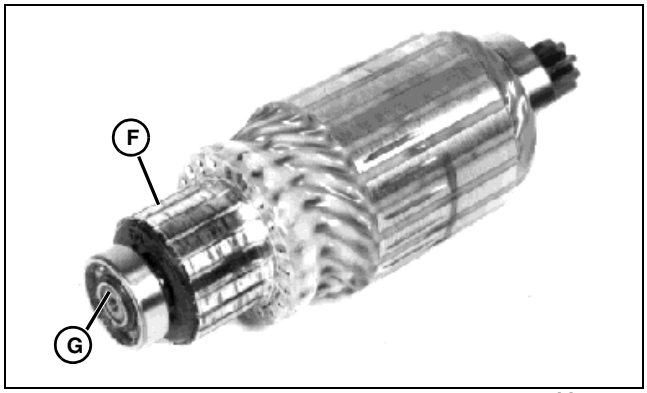
2. Inspect bearings (A and B) for axial (C) and/or radial (D) free play or rough movement. Replace bearings as needed.

IMPORTANT: Avoid damage! NEVER use emery cloth to clean commutator.

3. Inspect commutator (E). 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. Clean all dust from armature when finished.

NOTE: Test armature windings using an ohmmeter or test light.

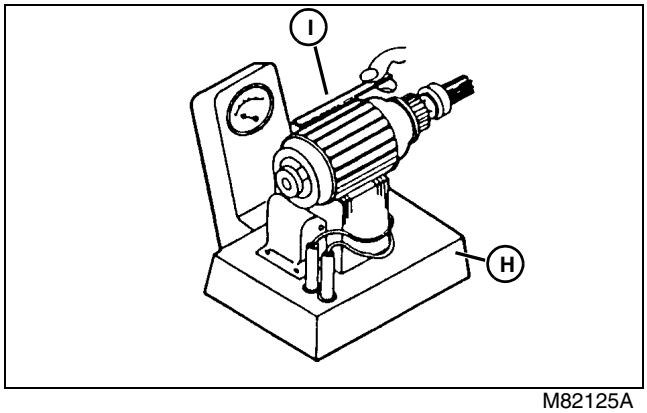
Armature windings are connected in series, so only one commutator bar needs to be checked. If the test shows continuity, a winding is grounded and the armature must be replaced.



M82236

4. Test for grounded windings. Touch one meter probe to a commutator bar (F) and the other to the armature shaft (G). If continuity is present, replace the armature.

5. Test for open circuits in the windings. Touch the meter probes to two commutator bars. If the test shows no continuity, the armature has an open circuit and the armature must be replaced.



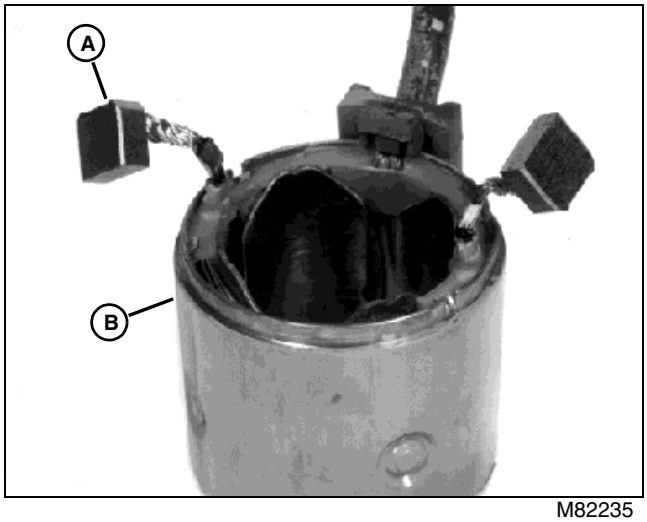
M82125A

6. Test for short circuited windings using a growler (H). Put armature in growler and hold a hacksaw blade (I) 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.

7. If test indicates short circuited windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.

Field Coil and Housing



M82235

NOTE: Test field coil using an ohmmeter or test light.

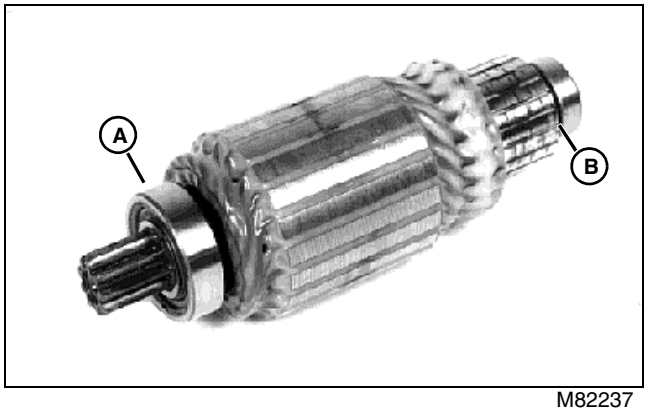
Be sure the field coil brush is not touching the housing.

1. Test for grounded field winding. Touch one meter probe to the field coil brush (A) and the other meter probe to the field coil housing (B). If continuity is present, replace the field coil.

2. Test for open field coil. Touch one meter probe to one field coil brush (A). Touch the other meter probe to the remaining field coil brushes.

3. If continuity is not read between any two brushes, the field coil is open and the entire field coil housing must be replaced.

Armature Bearing Replacement



M82237

1. Remove bearings (A and B) using a knife-edge puller.

IMPORTANT: Avoid damage! Press on bearing race only. Applying pressure to bearing outer diameter will damage bearing.

NOTE: Install both bearings with seal side toward armature.

2. Install new bearings using a press until the bearings are tight against the shoulder of the shaft.

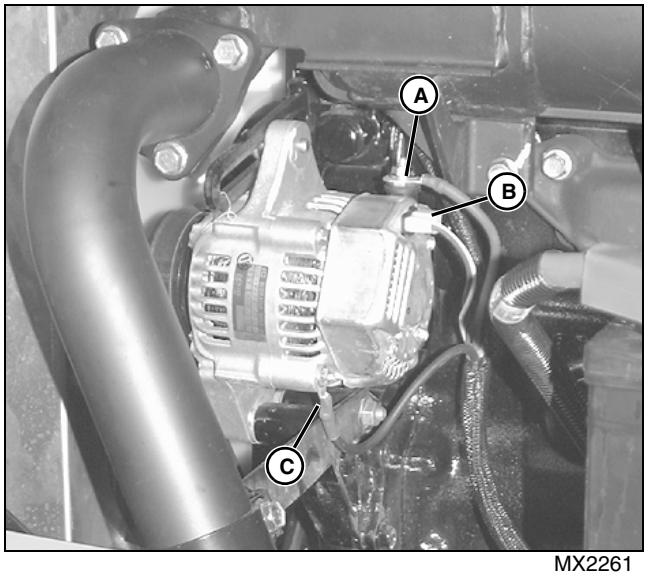
Remove and Install 12V Alternator

Removal

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

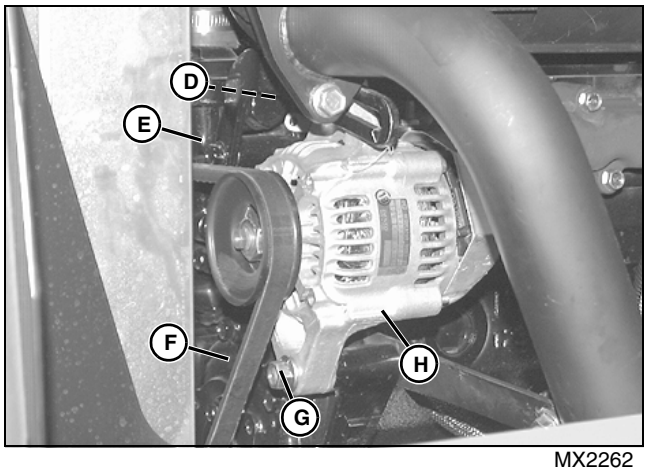
2. Raise hood.

3. Disconnect negative (-) battery cable.



MX2261

4. Disconnect red wire (A) from alternator.
5. Disconnect wiring connector (B).
6. Disconnect black wire (C).



MX2262

7. Loosen top cap screw (D) and mounting bracket cap screw (E) and push alternator toward engine to loosen belt.
8. Remove drive belt (F) from alternator pulley.
9. Remove lower cap screw (G).
10. Remove top cap screw (D).
11. Remove alternator (H).

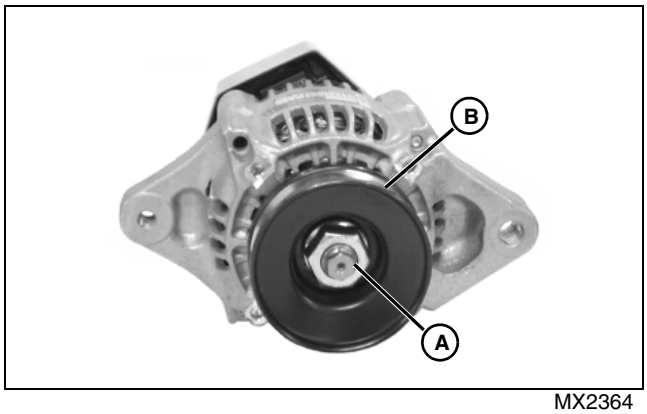
Installation

Installation is done in the reverse order of removal.

Adjust belt tension.

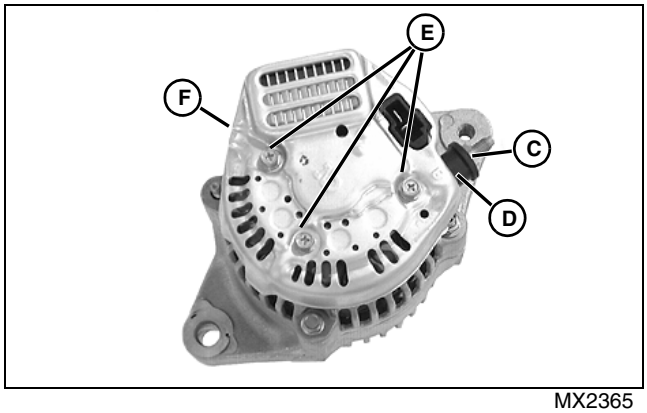
Disassemble and Assemble 12v Alternator

NOTE: Clamp pulley in a soft-jawed vise and use an air impact wrench to remove pulley nut.



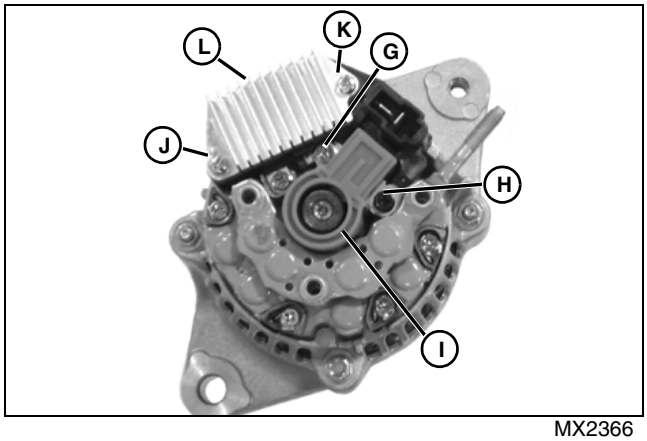
MX2364

1. Remove nut (A).
2. Remove pulley (B) using a puller.



MX2365

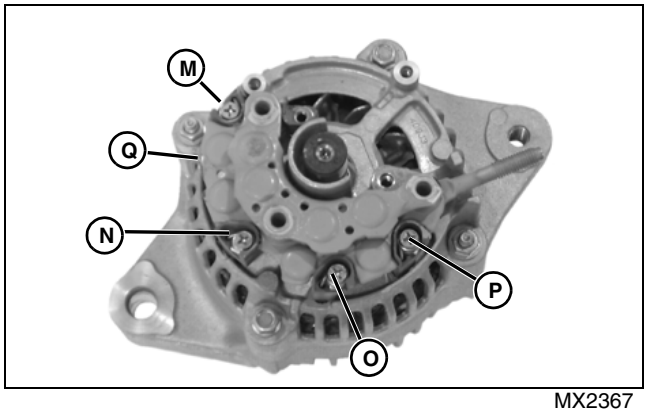
3. Remove nut (C) and insulator (D) from battery terminal post.
4. Remove three screws (E) securing the cover to the body.
5. Remove cover (F).



MX2366

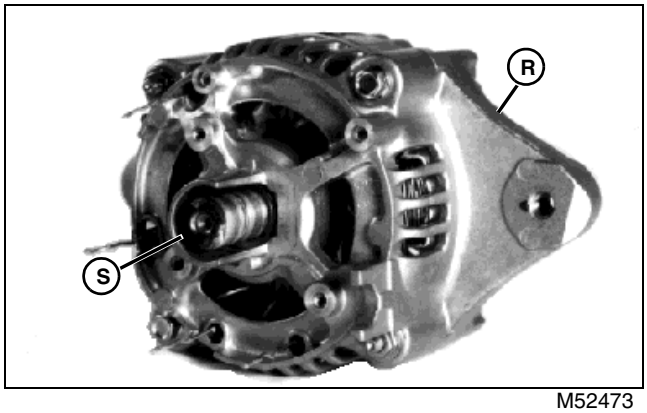
6. Remove two screws (G, short, and H, long).

7. Remove brush holder and cover (I).
8. Remove two screws (J and K).
9. Remove regulator (L).



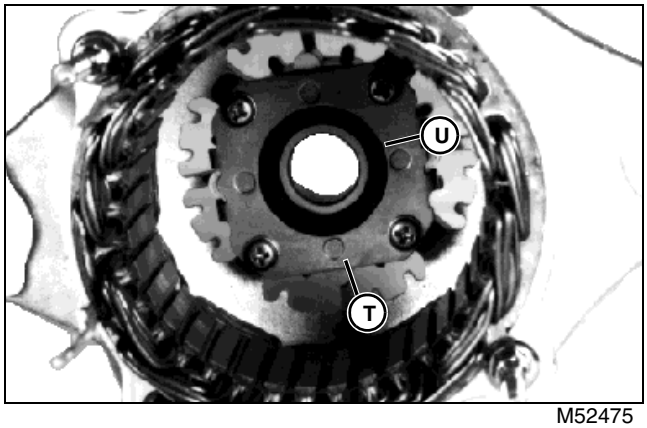
MX2367

10. Remove screws (M-P).
11. Straighten wires below each screw.
12. Remove rectifier (Q).



M52473

13. Remove rear frame (R).
14. Press rotor shaft (S) from rear frame.

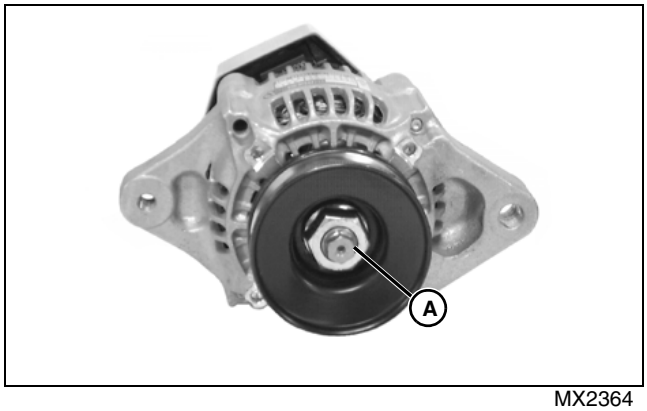


M52475

15. Remove retainer plate (T).
16. Press bearing (U) from case.

Assembly

Assembly is done in the reverse order of disassembly.



MX2364

Tighten pulley retaining nut (A) to specification.

Specifications

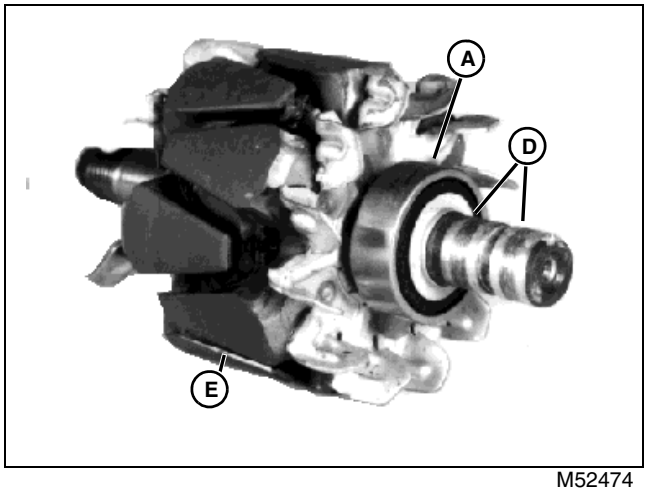
12V Alternator Pulley Retaining Nut Torque . . . . . 69 N•m (51 lb-ft)

Inspect 12V Alternator Component

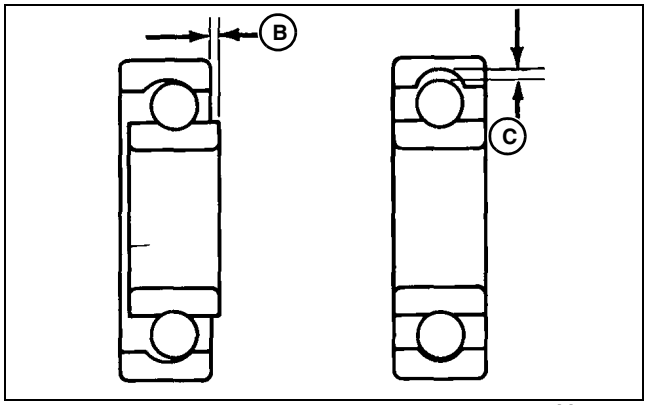
Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter or Continuity Tester	NA	Used to check for continuity during component inspection.

Rotor



M52474



M38073

1. Inspect bearing (A) for axial (B) and/or radial (C) free play or rough movement. Replace bearings as needed.

2. Inspect slip rings (D) for dirt or rough spots. If necessary, use No. 00 sandpaper or 400-grit silicone carbide paper to polish rings.

3. Measure the outer diameter of the slip rings. Replace the rotor if the diameter measures less than specification.

4. Check continuity between slip rings using an ohmmeter or continuity tester. Replace rotor if there is no continuity.

5. Check continuity between slip rings and rotor core (E). Replace rotor if there is no continuity.

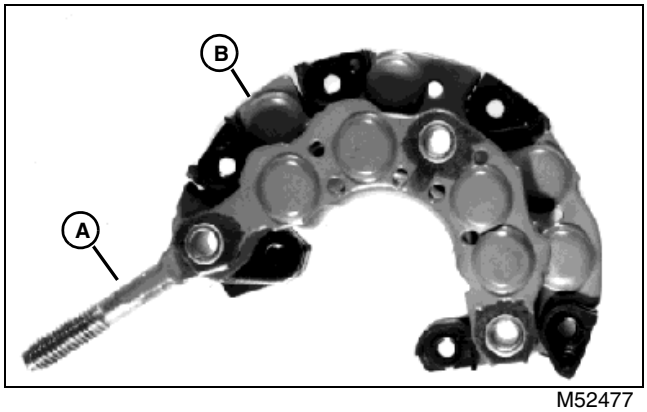
Stator

1. Inspect stator for defective insulation, discoloration, or a burned odor. Replace the stator as needed.

NOTE: Use an ohmmeter that is sensitive to 0-1 ohm.

2. Check for continuity between each stator lead and body. Replace the stator if there is no continuity.

Diodes

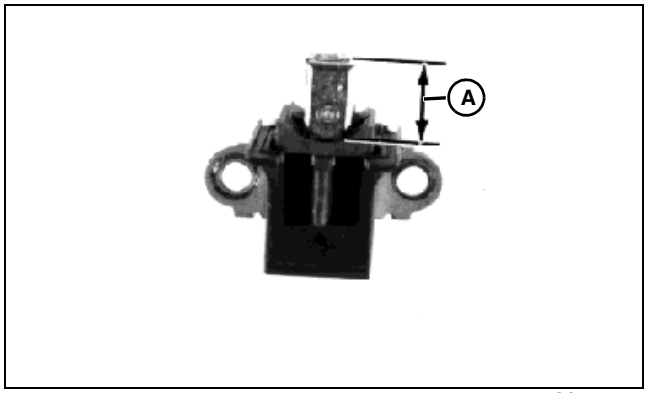


M52477

NOTE: Set ohmmeter to K-ohm range.

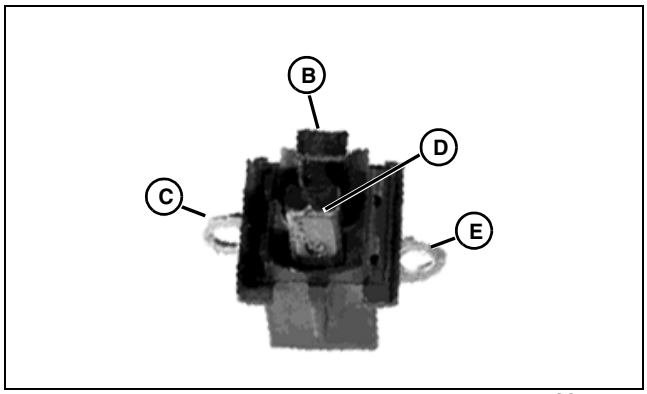
Check continuity between main lead (A) and each diode lead (B). Reverse ohmmeter leads and recheck. There should be continuity in one direction, but there should not be continuity when the leads are reversed. Replace the entire holder assembly if continuity is not correct.

Brushes



M52478

1. Measure the length of brush protruding from holder (A). The maximum length of brush protruding from the holder is 10.5 mm (0.41 in.). Replace brushes if worn to less than specification.



M52479

2. Check continuity between the brush (B) and terminal (C). Check continuity between the brush (D) and terminal (E). There should be no continuity between any other points. Replace brush if continuity is not correct.

Specifications

Rotor Slip Ring Outside Diameter
(Wear Limit) . . . . . 14 mm (0.55 in.)
Brush Length (Minimum). . . . . 4.5 mm (0.17 in.)

ELECTRICAL TABLE OF CONTENTS

Table of Contents

Specifications

General Specifications

Stator

Amperage, Unregulated . . . . . 15 amps @ 3400 rpm
Voltage, Unregulated . . . . . 26 VAC @ 3400 rpm
Voltage, Regulated . . . . . 12.2-14.7 VDC @ 3400 rpm
Stator Winding Resistance . . . . . 0.11-0.18 Ohm

Battery

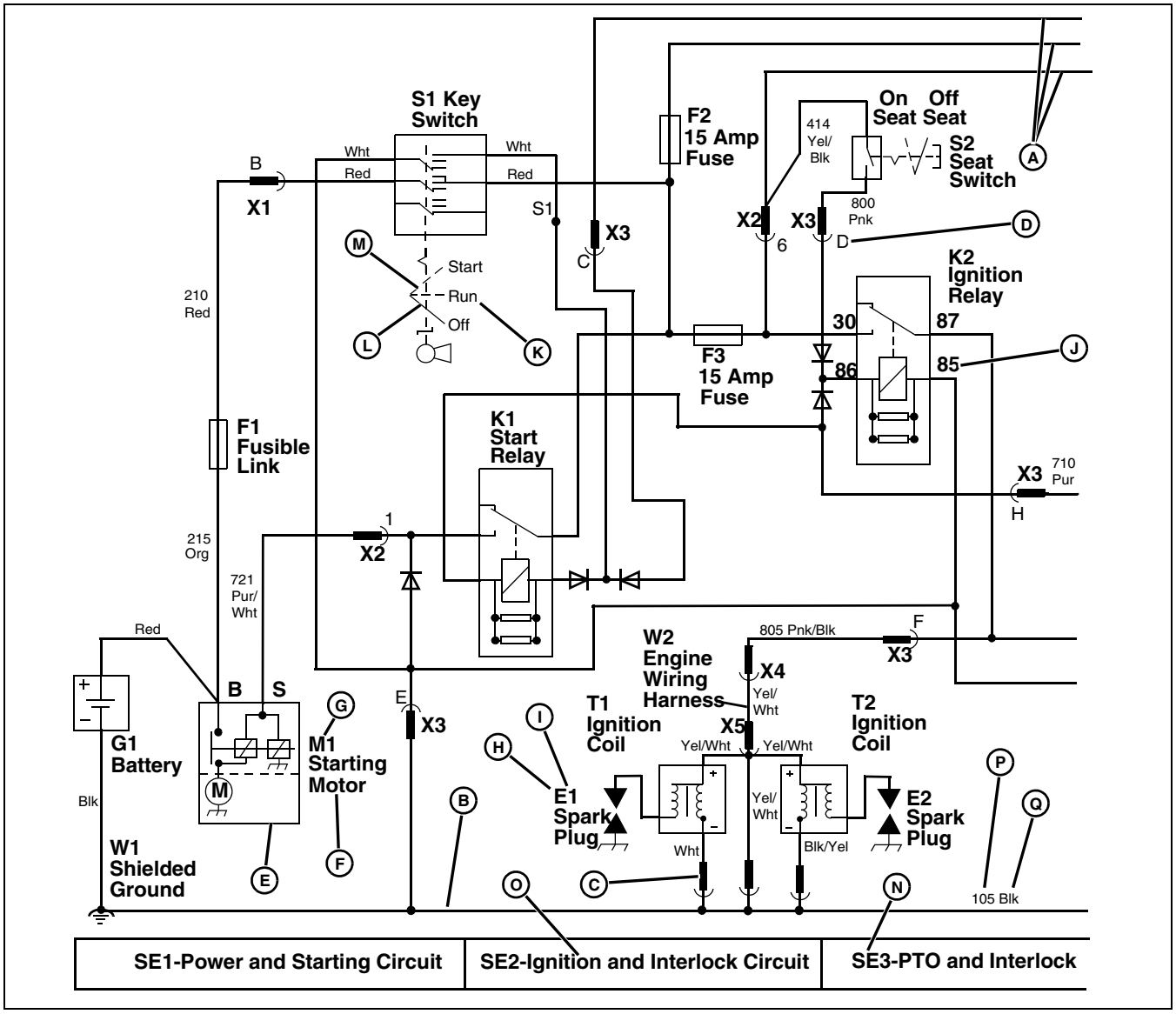
Voltage . . . . . 11.8-13.2 VDC
Reserve Capacity @ 25 Amps . . . . . 80 min.
Cold Cranking Amps @ -18°C (0°F) . . . . . 430 CCA

Electric Starter

Minimum Brush Length . . . . . 6 mm (0.240 in.)
Commutator Groove Depth . . . . . 0.2 mm (0.008 in.)
Commutator Diameter . . . . . 2.7 mm (1.06 in.)
Commutator Run Out . . . . . 0.4 mm (0.016 in.)
Maximum No-Load Starter Current Draw S.N. (-060554) . . . . . 30 amps @ 6000 rpm
Maximum No-Load Starter Current Draw S.N. (060555-120960) . . . . . 60 amps @ 6000 rpm
Starter Current Draw, Loaded S.N. (-060554) . . . . . 72 Amps
Starter Current Draw, Loaded S.N. (060555-120960) . . . . . 200 Amps

General Information

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) are shown directly next to the wire path.

The same component name and identification code are used consistently on all diagrams in this section. Components can be easily cross-referenced.

Theory of Operation Information

The theory of operation stories divide the electrical system into individual circuits by function. Each circuit is isolated from the main wiring schematic and only shows the components that are used in it. The story contains information on function, operating conditions, and theory of operation. The circuit schematics are drawn with the components in the operating position, with the power, or battery positive, into them across the top and the ground, or battery negative, across the bottom.

Diagnostic Information

The diagnostic procedures are used to test the complete circuit regardless of the problem or complaint. Select a circuit or symptom from Circuit Operation and Diagnosis and follow the test procedures under that heading.

The diagnostic procedure lists:

- Test conditions
- Test location
- A question regarding the normal reading
- Check or test to perform based on the test results

When performing the test or check, be sure to set your machine up to the test conditions listed and follow the sequence carefully.

The top frame of a step indicates the location of the test.

The middle frame gives the reading or condition that should be obtained when performing the test or check, posed in the form of a question.

The lower frame contains yes and no answers for the question posed in the middle frame.

Wire Color Abbreviation Chart

Blk	**Black**
Blu	**Blue**
Brn	**Brown**
Gry	**Gray**
Org	**Orange**
Pnk	**Pink**
Pur	**Purple**
Red	**Red**
Tan	**Tan**
Wht	**White**
Yel	**Yellow**
Blk/Wht	**Black/White**
Blu/Wht	**Blue/White**
Brn/Wht	**Brown/White**
Brn/Yel	**Brown/Yellow**
Dk Blu	**Dark Blue**
Dk Brn/Lt Grn	**Dark Brown/Light Green**
Dk Brn/Red	**Dark Brown/Red**
Dk Brn/Yel	**Dark Brown/Yellow**
Dk Grn	**Dark Green**
Lt Blu	**Light Blue**
Lt Grn	**Light Green**
Org/Wht	**Orange/White**
Pnk/Blk	**Pink/Black**
Pur/Wht	**Purple/White**
Red/Blk	**Red/Blk**
Red/Wht	**Red/Wht**
Wht/Blk	**White/Black**
Wht/Red	**White/Red**
Yel/Blk	**Yellow/Black**
Yel/Red	**Yellow/Red**
Yel/Wht	**Yellow/White**

Common Circuit Tests

Shorted Circuit

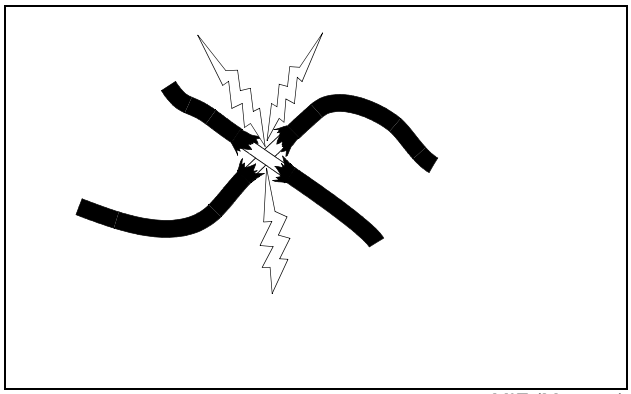
A shorted circuit may result in the wrong component operating (i.e., improper wire-to-wire contact). To test for a shorted or improperly wired circuit:

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.



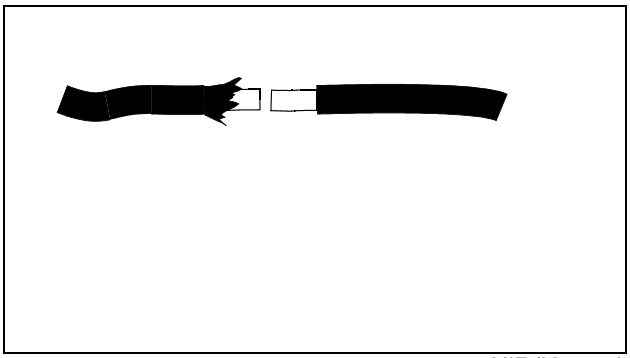
MIF (M85600)

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.

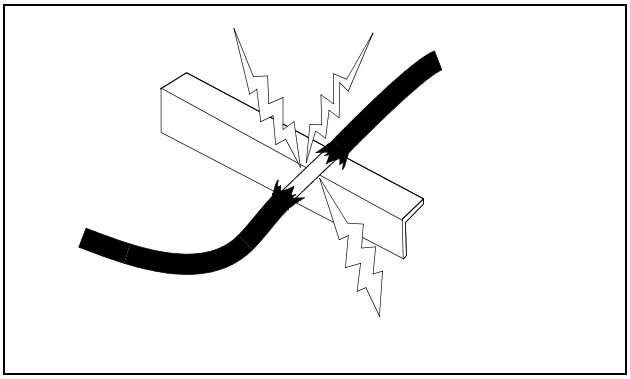
2. If terminals are not corroded or loose, the problem is in the component or wiring.



MIF (M85601)

Grounded Circuit

Grounded circuits usually result in no component operation or a blown fuse.



Conductors for 12-Volt Circuits

Stranded Conductors For 12 Volt Circuits						
Sae Wire Size (Gauge)	20	18	16	14	12	10
Metric Wire Size (MM)	0.5	0.8	1.0	2.0	3.0	5.0
Typical Stranding	7 X 28	16 X 30	19 X 29	19 X 27	19 X 25	19 X 23
Minimum Conductor Area In Circular Mils	1072	1537	2336	3702	5833	9343

Tools and Materials

Special or Essential Tools

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

Special or Required Tools

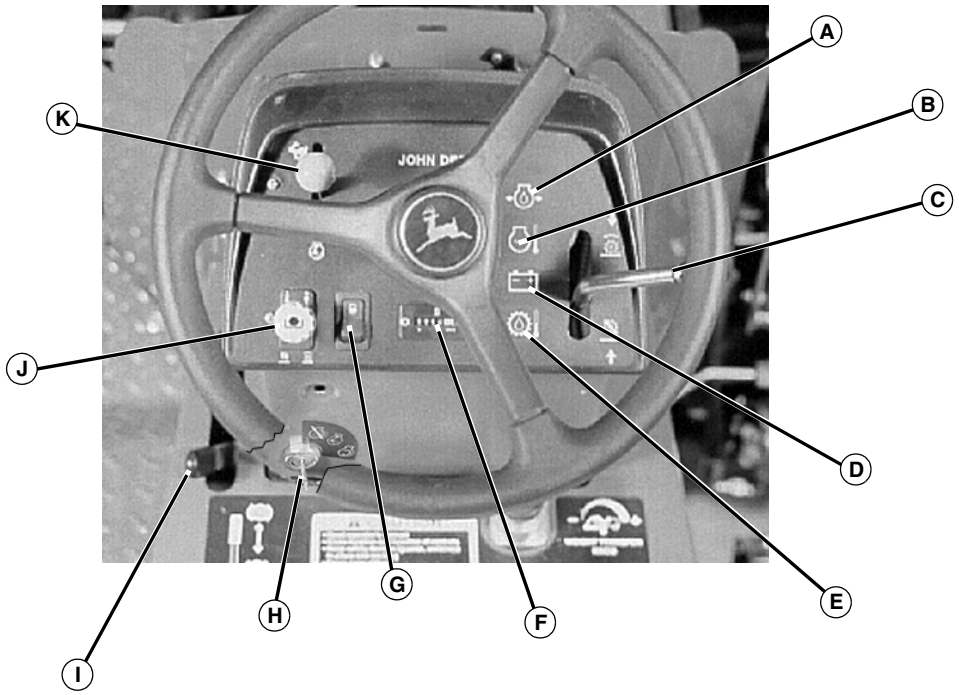
Tool Name	Tool No.	Tool Use
Spark Tester	D-05351ST	Used to check overall condition of ignition system.
Digital Multi-meter	JT05791	Electrical tests.
Battery Tester	JT05685	Test battery condition.
Hydrometer	NA	Used to check specific gravity of battery.
12V Test Light	NA	Used to check for voltage.
Current Gun	JT05712	Used to measure current from stator.
Current Clamp	JT02153	Used with multimeter to test current draw.
Handheld Digital Tachometer	JT05719	Used to measure starting motor rpm.
Jumper Cables	NA	Used to provide power to starting motor.
Jumper Wire	NA	Used to jump starting motor solenoid terminal.
Terminal Removal Tool	JDG777	Used to remove terminal from connector body.
Electrician's Pliers	JDG145	Used to strip insulation from wire.
Wire Crimper	JDG776	Used to crimp terminals on wire.

Other Material

Part No.	Part Name	Part Use
N/A	Dielectric Grease	Seal connections.

Component Location

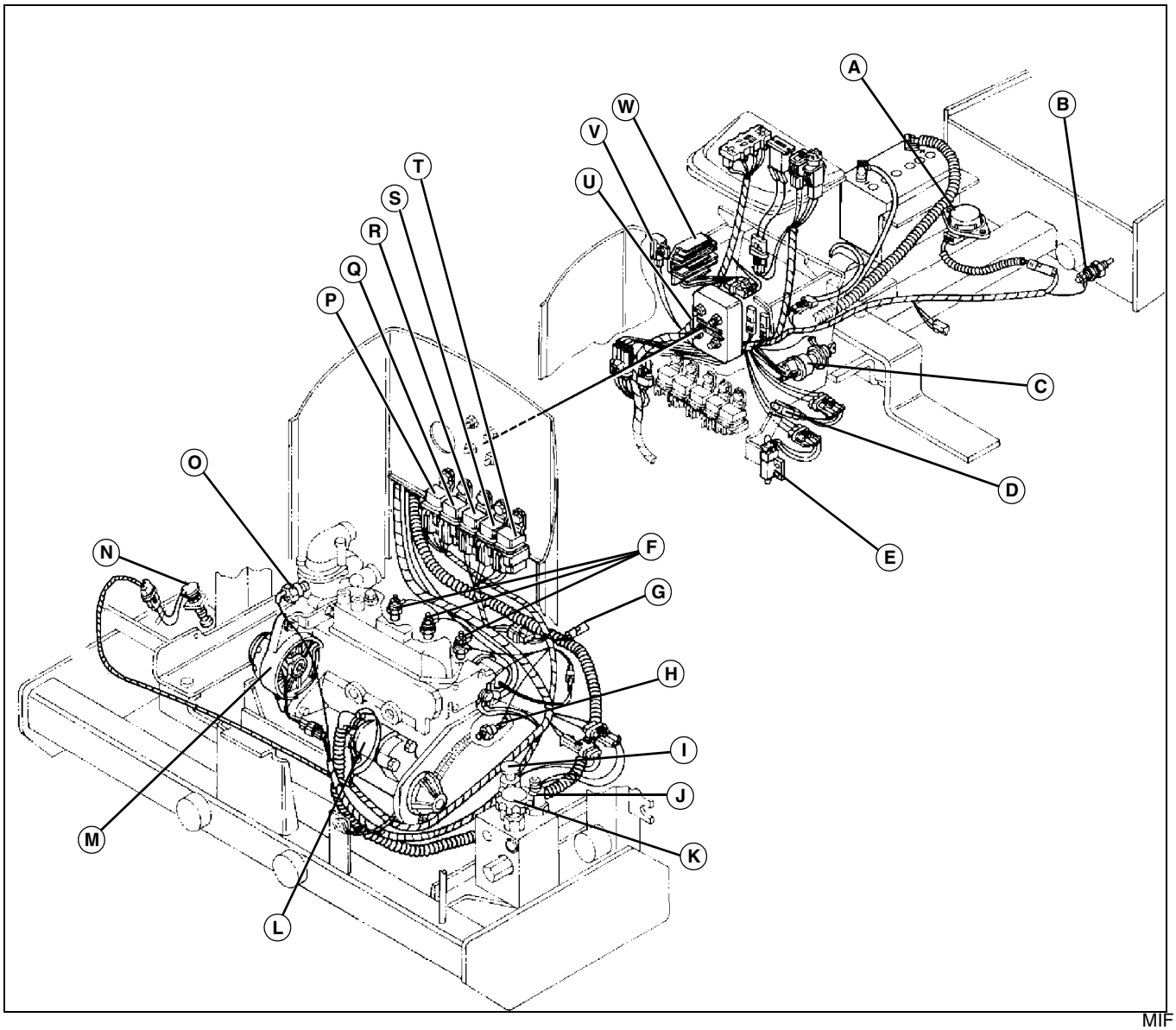
Electrical Components



TIF

A - Engine Oil Pressure Indicator (H3)
B - Engine Coolant Temperature Indicator (H2)
C - Raise/Lower Switch (S8)
D - Battery Discharge Indicator (H4)
E - Hydraulic Oil Temperature Indicator (H1)
F - Hour Meter (P1)
G - Glow Plug Switch (S2)
H - Key Switch (S1)
I - Park Brake Switch (S5)
J - Mow Switch (S6)
K - Throttle Lever

ELECTRICAL COMPONENT LOCATION



MIF

A - Seat Switch (S4)
B - Hydraulic Oil Temperature Switch (B1)
C - Key Switch (S1)
D - Park Brake Switch (S5)
E - Raise/Lower Switch (S8)
F - Glow Plugs (R1)
G - Diode (V4)
H - Engine Oil Pressure Switch (B3)
I - Backlap Valve
J - Mow Valve Solenoid (Y2)
K - Reel Speed Control
L - Starting Motor (M1)
M - Alternator (G2)
N - Neutral Switch (S3)
O - Engine Coolant Temperature Switch (B2)
P - Glow Plug Relay (K2)
Q - Fuel Pull-in Relay (K5)
R - Start Relay (K1)
S - Mow Valve Relay (K4)
T - Defeat Relay (K3)
U - Control Module (A1)
V - Main Fuse (F1)
W - Voltage Regulator (N1)

Schematics and Harnesses

Schematic and Harness Legend

Components

A1 - Control Module

A2 - Off Delay Timer Module (If Equipped)

B1 - Hydraulic Oil Temperature Switch

B2 - Engine Coolant Temperature Switch

B3 - Engine Oil Pressure Switch

E1 - Headlight (Optional)

F1 - Main Fuse (15A) S.N. (-050071)

F1 - Main Fuse (20A) S.N. (050072-)

F2 - Fusible Link

F3 - Fusible Link

F4 - 15A Fuse

G1 - Battery

G2 - Alternator

H1 - Hydraulic Oil Temperature Indicator

H2 - Engine Coolant Temperature Indicator

H3 - Engine Oil Pressure Indicator

H4 - Battery Discharge Indicator

K1 - Start Relay

K2 - Glow Plug Relay

K3 - Defeat Relay

K4 - Mow Valve Relay

K5 - Fuel Pull-In Relay

M1 - Starting Motor

M2 - Fuel Pump (If Equipped) S.N. (-060554)

N1 - Voltage Regulator

P1 - Hour meter

R1 - Glow Plugs (3 used)

S1 - Key Switch

S2 - Glow Plug Switch

S3 - Neutral Switch

S4 - Seat Switch

S5 - Park Brake Switch

S6 - Mow Switch

S7 - Forward/Reverse Switch

S8 - Raise/Lower Switch

V1 - Diode S.N. (050072-)

V2 - Diode

V3 - Diode

V4 - Diode

V5 - Diode S.N. (120691-)

W1 - Battery Ground

W2 - Frame Ground

W3 - Frame Ground S.N. (-060000)

W4 - Main Harness

W5 - Engine Harness S.N. (-060000)

W6 - Seat Switch Harness

W7 - Park Brake Switch Harness

X1 - Main Harness-to-Engine Harness Connector S.N. (-060000)

X2 - Control Module 8-Pin Connector

X3 - Control Module 2-Pin Connector

X4 - Seat Switch Connector

X5 - Park Brake Switch Connector

X6 - Headlight Connector S.N. (050072-)

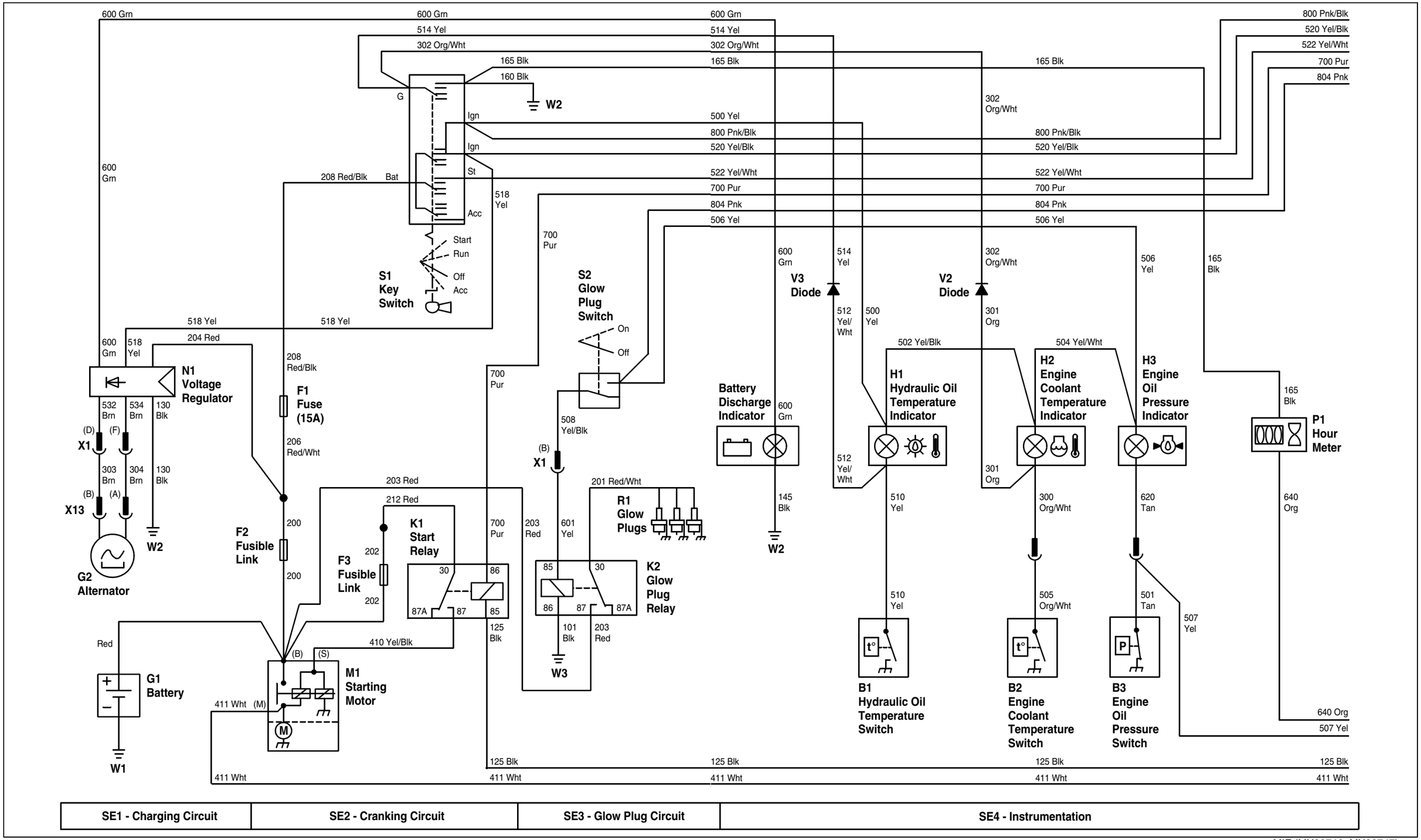
Y1 - Third Wheel Drive Solenoid

Y2 - Mow Valve Solenoid

Y3 - Fuel Shutoff Solenoid

Y4 - Mow Shutoff Solenoid (If Equipped)

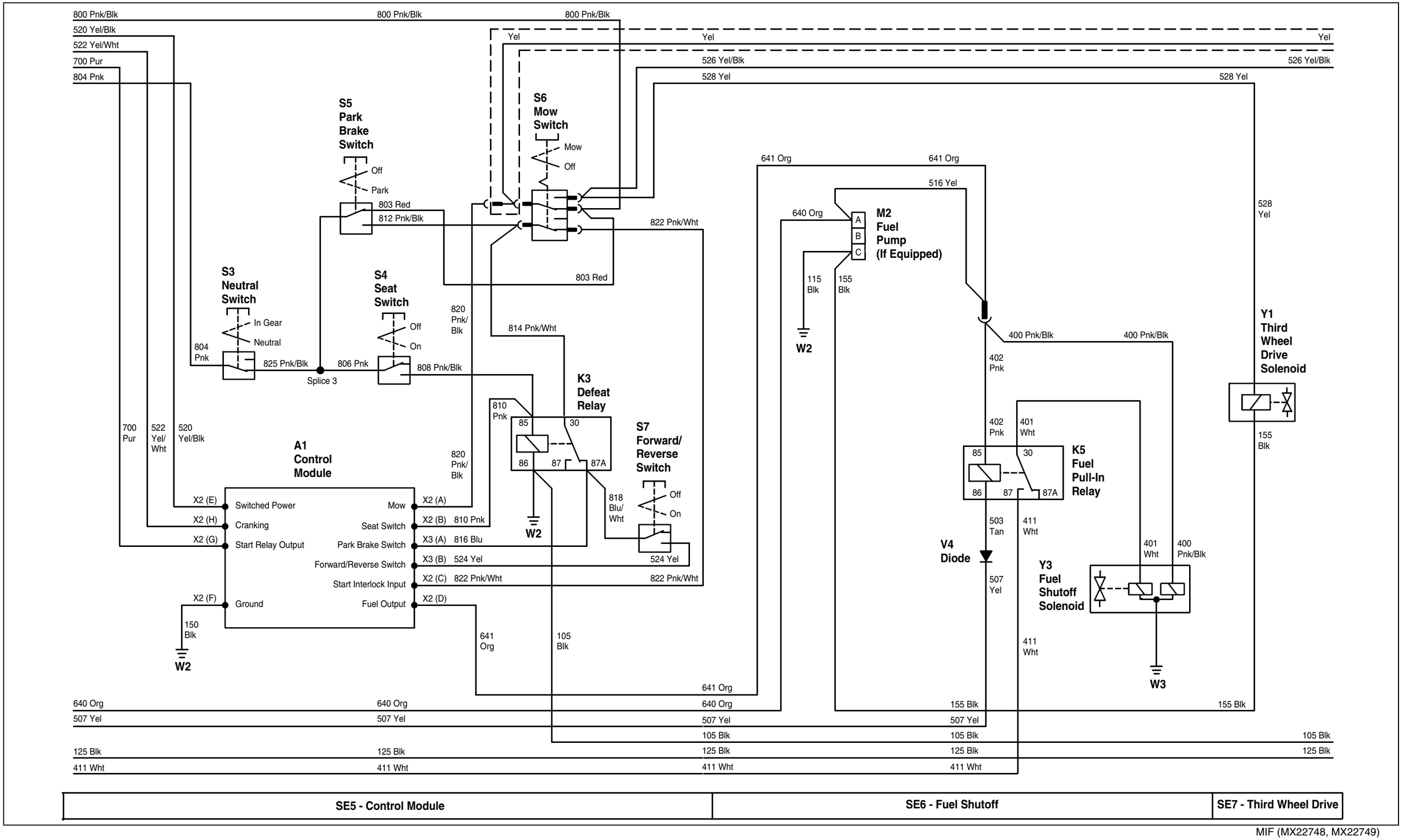
Electrical Schematic S.N. (-050071) (Sheet 1of 3)



SE1 - Charging Circuit	SE2 - Cranking Circuit	SE3 - Glow Plug Circuit	SE4 - Instrumentation

MIF (MX22746, MX22747)

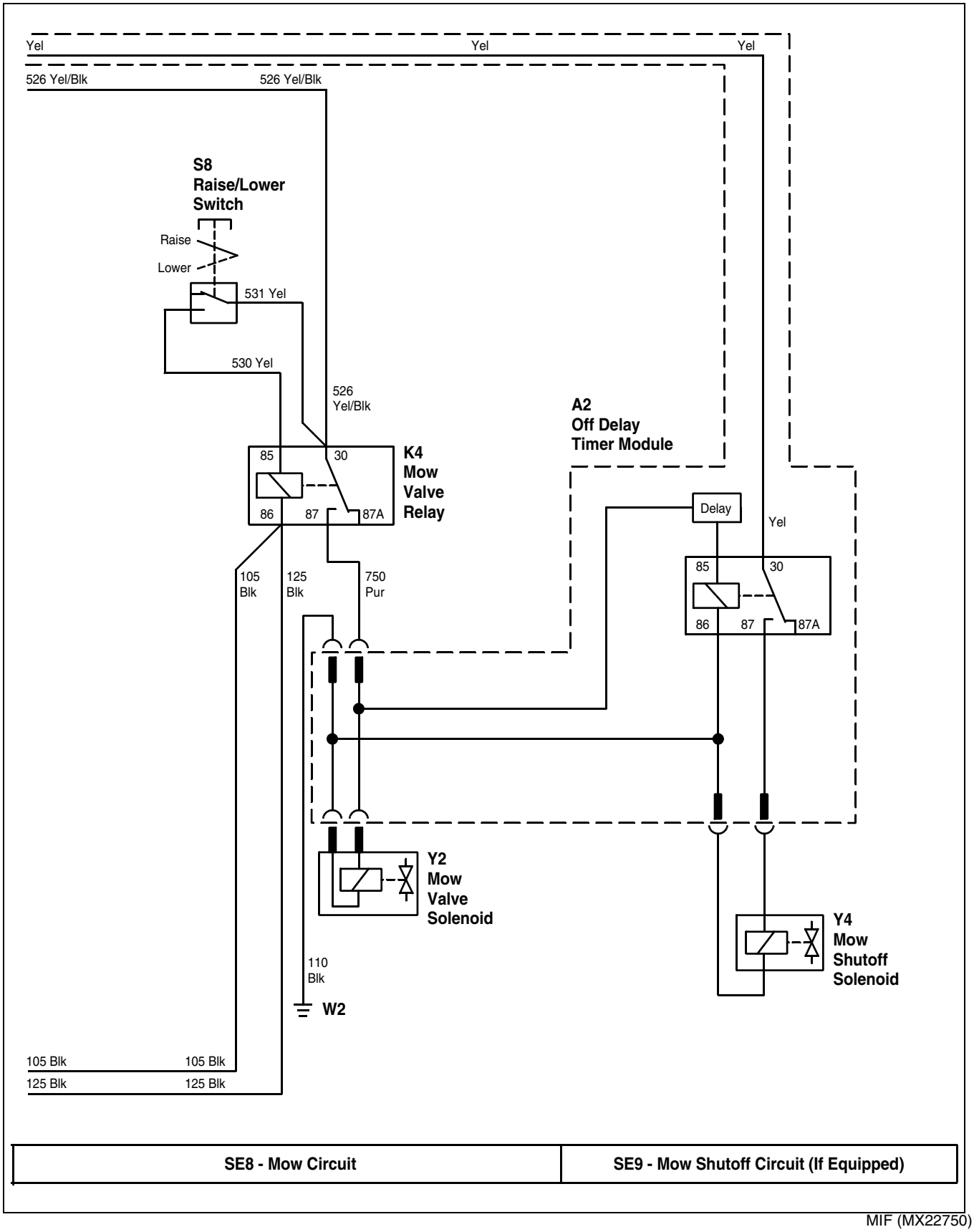
Electrical Schematic S.N. (-050071) (Sheet 2 of 3)



SE5 - Control Module	SE6 - Fuel Shutoff	SE7 - Third Wheel Drive

MIF (MX22748, MX22749)

Electrical Schematic S.N. (-050071) (Sheet 3of 3)



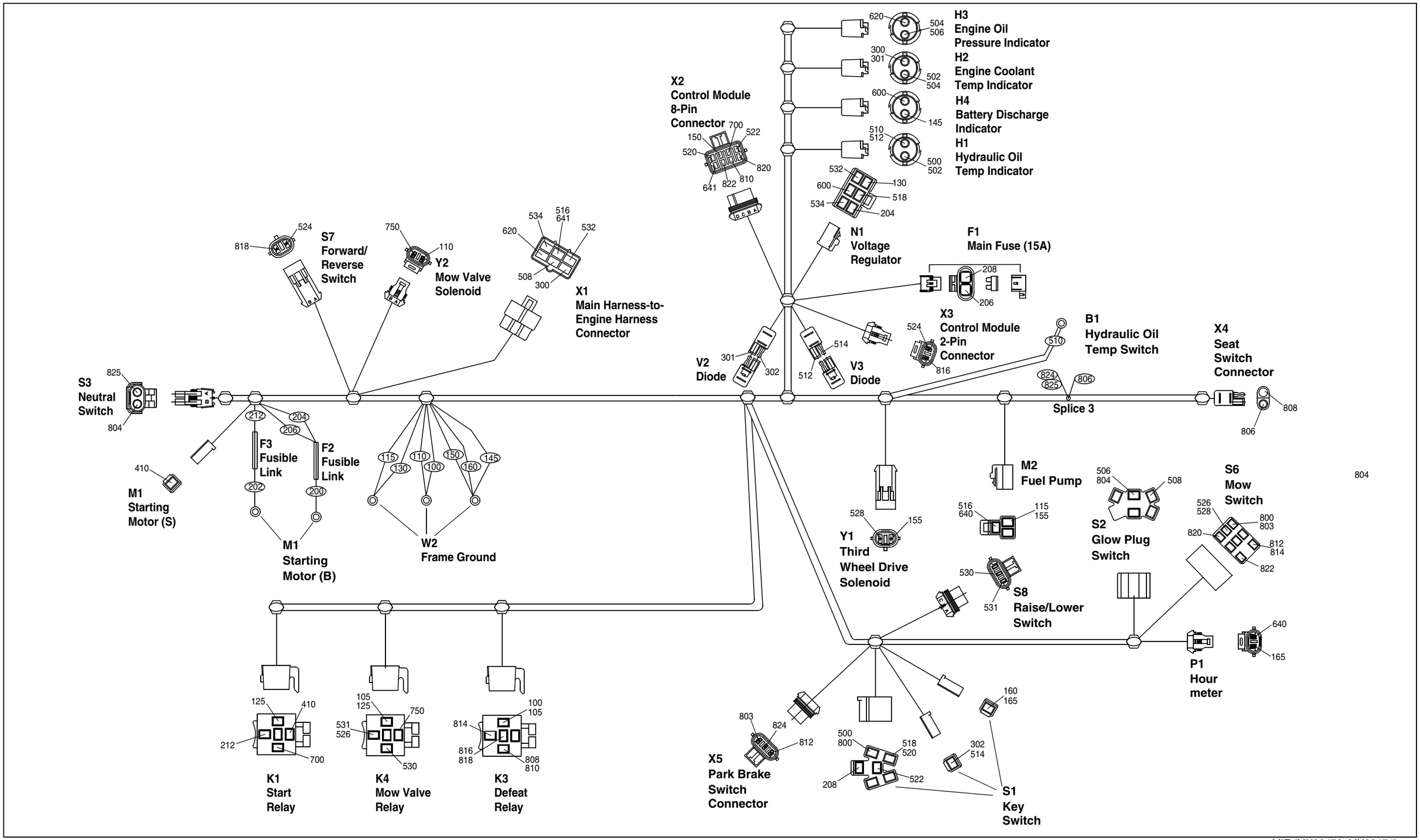
MIF (MX22750)

W4 - Main Harness Wire Code Table S.N. (-050071)

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
100	0.8	Blk	K3, W2
105	0.8	Blk	K4, K3
110	0.8	Blk	Y2, W2
115	0.8	Blk	M2, W2
125	0.8	Blk	K4, K1
130	3.0	Blk	N1, W2
145	0.8	Blk	H4, W2
150	0.8	Blk	X2, W2
155	0.8	Blk	Y1, M2
160	0.8	Blk	S1, W2
165	0.8	Blk	P1, S1
200	0.8	Fusible Link	M1, F2
202	0.8	Fusible Link	M1, F3
204	3.0	Red	F2, N1
206	2.0	Red/Wht	F2, F1
208	2.0	Red/Blk	F1, S1
212	2.0	Red	K1, F3
300	0.8	Org/Wht	H2, X1
301	0.8	Org	H2, V2
302	0.8	Org/Wht	V2, S1
410	2.0	Yel/Blk	K1, M1
500	0.8	Yel	S1, H1
502	0.8	Yel/Blk	H2, H1
504	0.8	Yel/Wht	H2, H3
506	0.8	Yel	S2, H3
508	0.8	Yel/Blk	S2, X1
510	0.8	Yel	B1, H1
512	0.8	Yel/Blk	H1, V3
514	0.8	Yel	V3, S1
516	0.8	Yel	M2, X1
518	0.8	Yel	S1, N1
520	0.8	Yel/Blk	S1, X2
522	0.8	Yel/Wht	X2, S1
524	0.8	Yel	S7, X3
526	0.8	Yel/Blk	S6, K4
528	0.8	Yel	S6, Y1
530	0.8	Yel	K4, S8
531	0.8	Yel	K4, S8
532	3.0	Brn	N1, X1
534	3.0	Brn	N1, X1
600	0.8	Grn	H4, N1
620	0.8	Tan	X1, H3
640	0.8	Org	P1, M2
641	0.8	Org	X2, X1
700	0.8	Pur	X2, K1
750	0.8	Pur	Y2, K4
800	0.8	Pnk/Blk	S6, S1
803	0.8	Pnk	X5, S6
804	0.8	Pnk	S2, S3
806	0.8	Pnk	Splice 3, X4
808	0.8	Pnk/Blk	K3, X4
810	0.8	Pnk	K3, X2
812	0.8	Pnk/Blk	S6, X5
814	0.8	Pnk/Wht	K3, S6
816	0.8	Blu	K3, X3
818	0.8	Blu/Wht	S7, K3
820	0.8	Pnk/Blk	X2, S6
822	0.8	Pnk/Wht	S6, X2
824	0.8	Pnk/Wht	Splice 3, X5
825	0.8	Pnk/Blk	Splice 3, S3

ELECTRICAL SCHEMATICS AND HARNESSES

W4 - Main Harness S.N. (-050071)

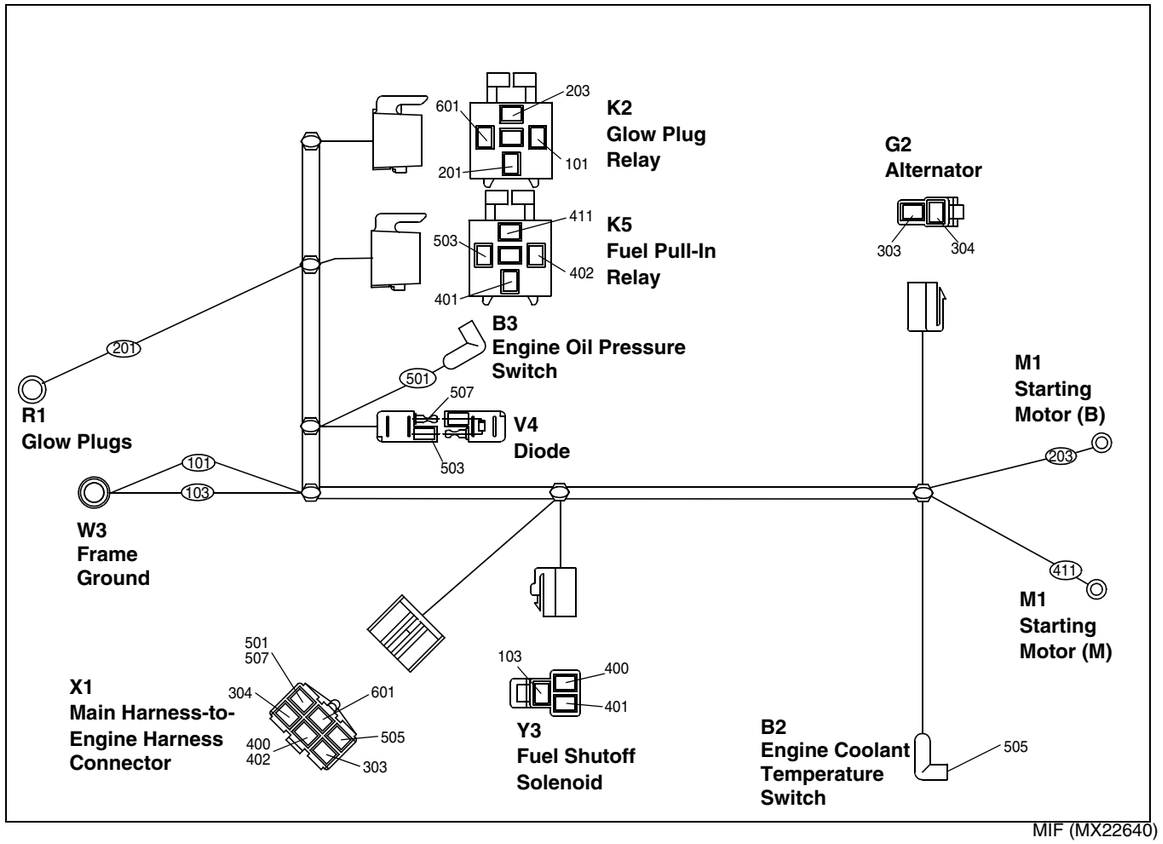


MIF (MX22473, MX22474)

W5 - Engine Harness Wire Code Table S.N. (-060000)

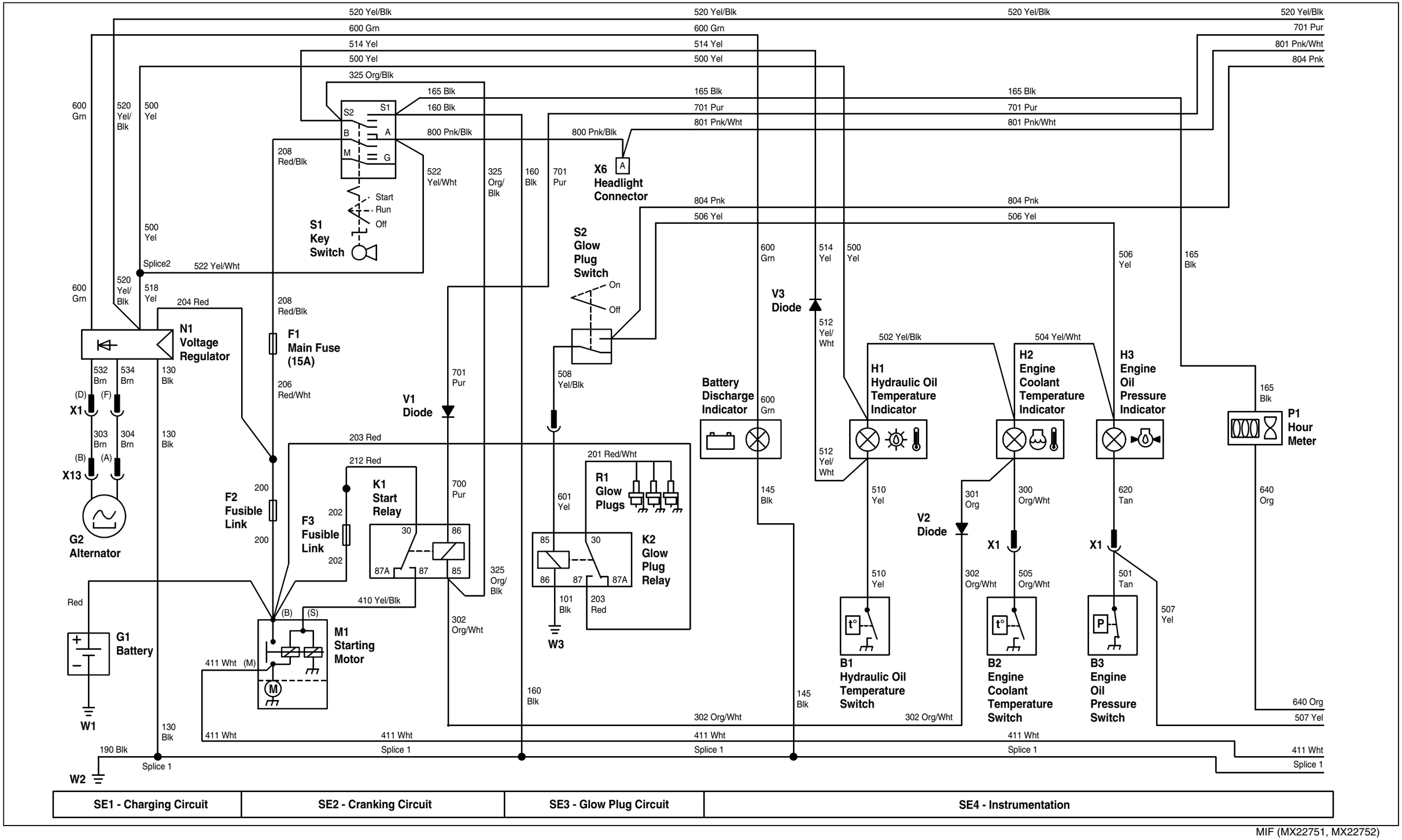
Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
101	0.8	Blk	K2, W3
103	1.0	Blk	Y3, W3
201	3.0	Red/Wht	K2, R1
203	3.0	Red	K2, M1
303	3.0	Brn	G2, X1
304	3.0	Brn	G2, X1
400	1.0	Pnk/Blk	X1, Y3
401	3.0	Wht	Y3, K5
402	0.8	Pnk	K5, X1
411	3.0	Wht	K5, M1
501	0.8	Tan	X1, B3
503	0.8	Tan	V4, K5
505	0.8	Org/Wht	X1, B2
507	1.0	Yel	X1, V4
601	0.8	Yel	K2, X1
506	0.8	Yel	S2, H3

W5 - Engine Wiring Harness S.N. (-060000)



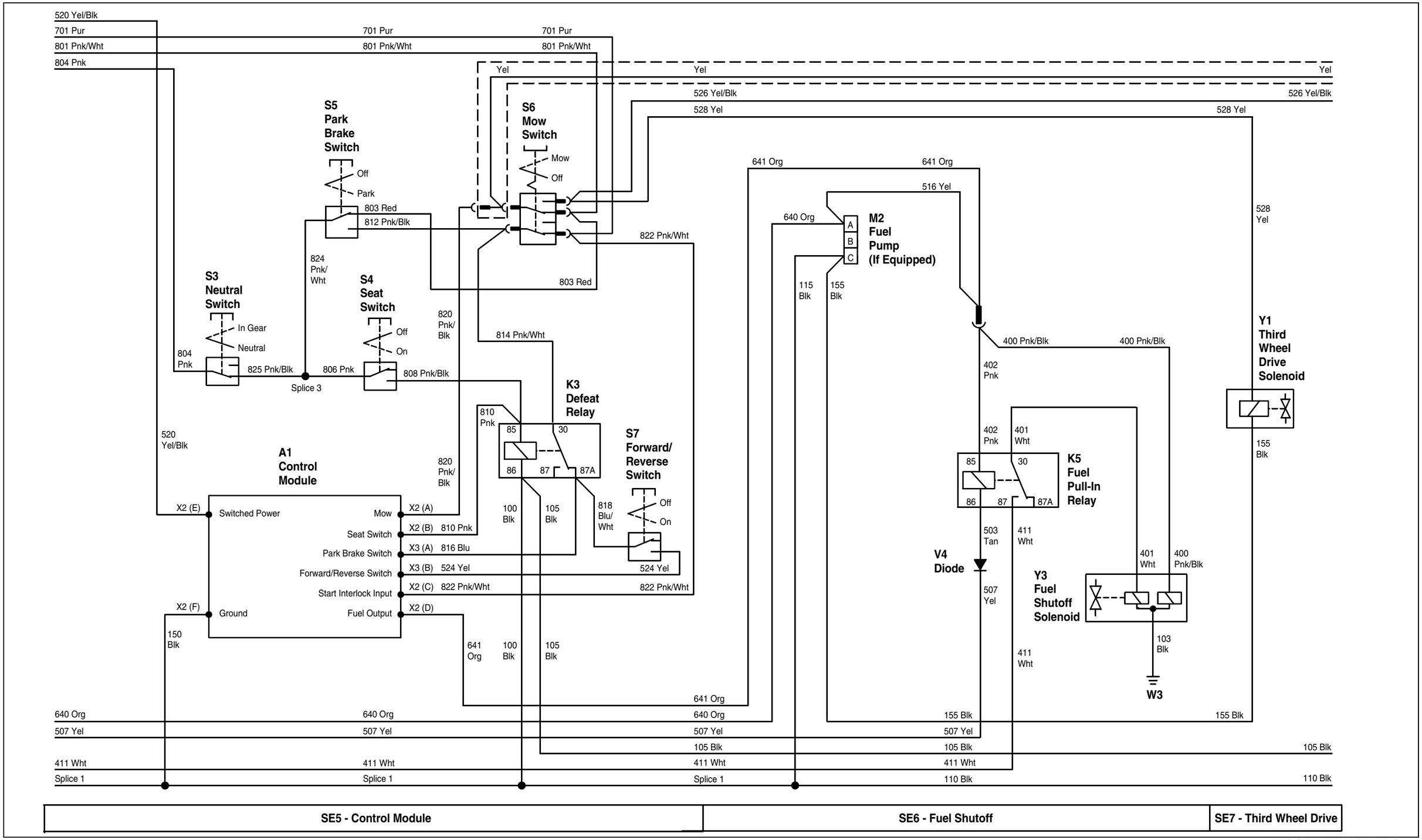
MIF (MX22640)

Electrical Schematic S.N. (050072-060000) (Sheet 1 of 3)



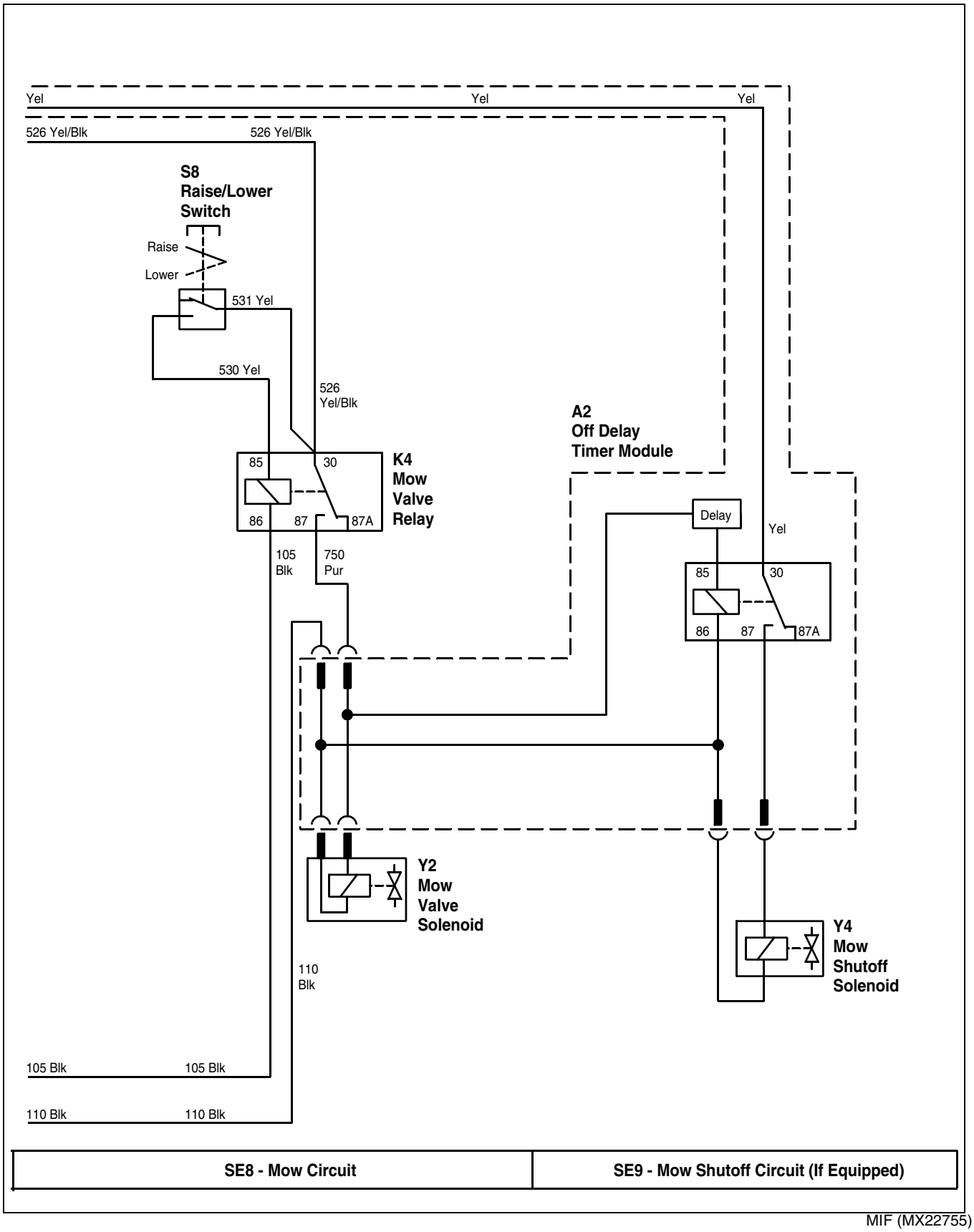
MIF (MX22751, MX22752)

Electrical Schematic S.N. (050072-060000) (Sheet 2 of 3)



MIF (MX22753, MX22754)

Electrical Schematic S.N. (050072-060000) (Sheet 3 of 3)



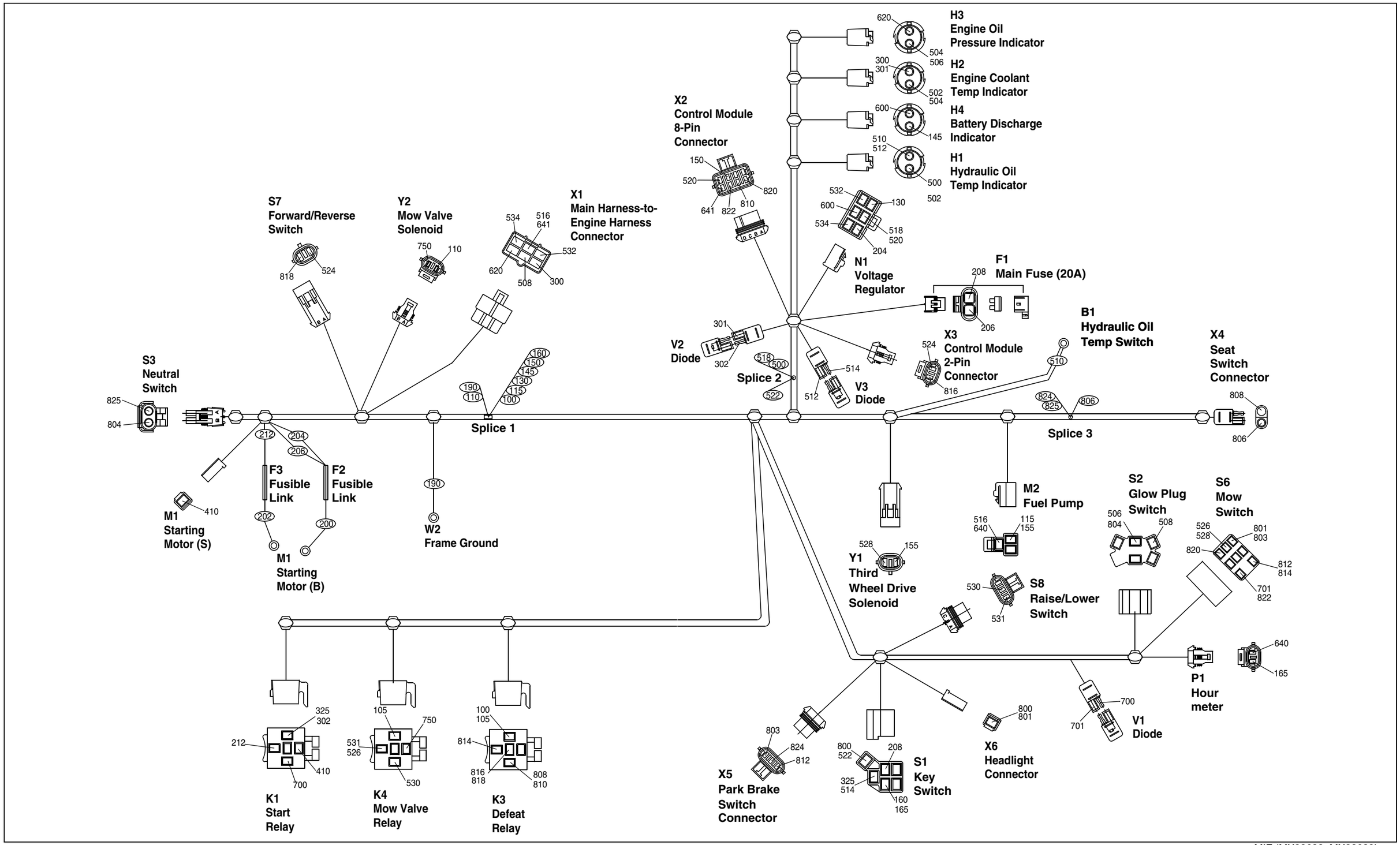
SE8 - Mow Circuit	SE9 - Mow Shutoff Circuit (If Equipped)

MIF (MX22755)

W4 - Main Harness Wire Code Table S.N. (050072-060000)

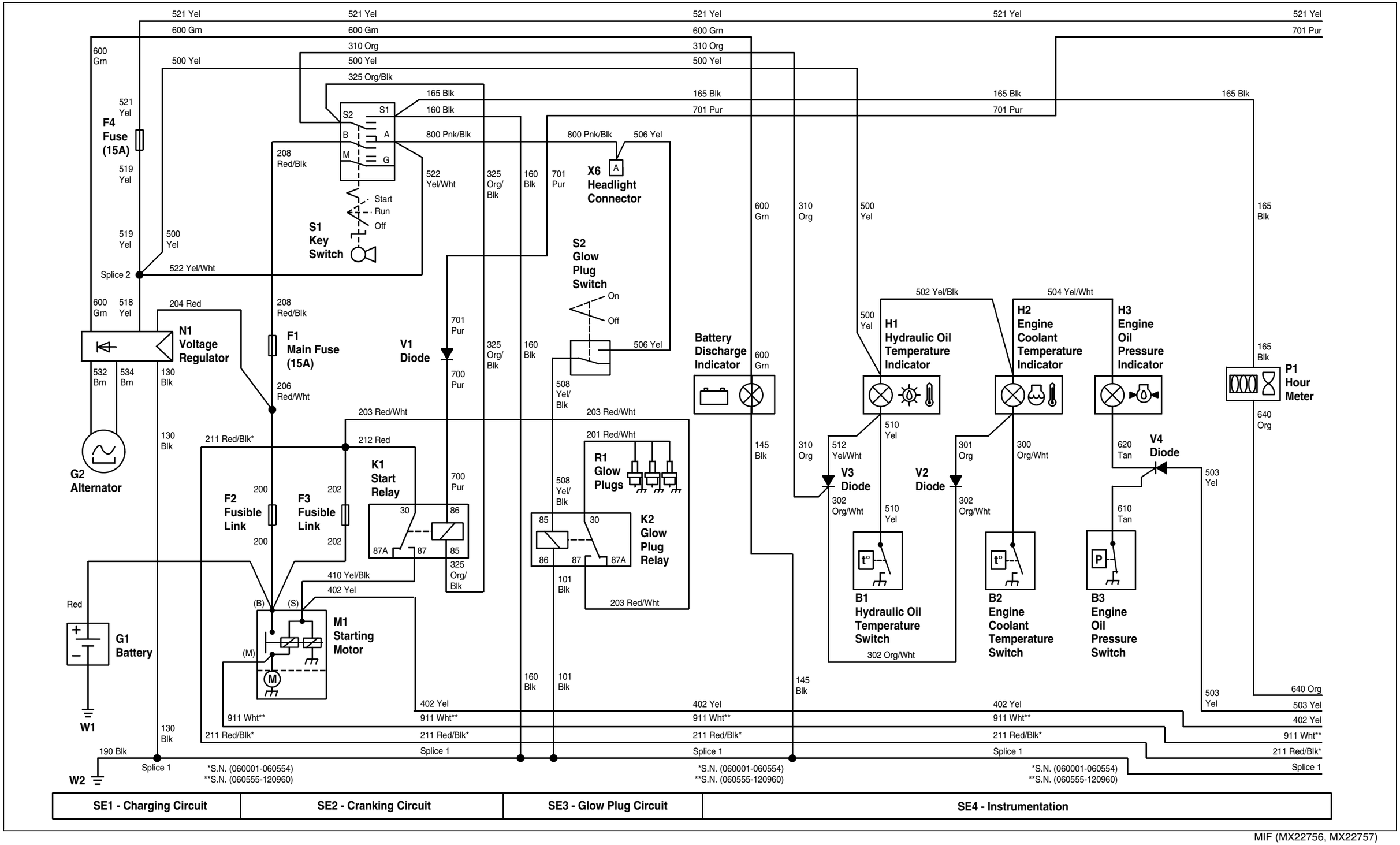
Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
100	0.8	Blk	K3, Splice 1
105	0.8	Blk	K4, K3
110	0.8	Blk	Y2, Splice 1
115	0.8	Blk	M2, Splice 1
125	0.8	Blk	K4, K1
130	3.0	Blk	N1, Splice 1
145	0.8	Blk	H4, Splice 1
150	0.8	Blk	X2, Splice 1
155	0.8	Blk	Y1, M2
160	0.8	Blk	S1, Splice 1
165	0.8	Blk	P1, S1
190	5.0	Blk	W2, Splice 1
200	0.8	Fusible Link	M1, F2
202	0.8	Fusible Link	M1, F3
204	3.0	Red	F2, N1
206	2.0	Red/Wht	F2, F1
208	2.0	Red/Blk	F1, S1
212	2.0	Red	K1, F3
300	0.8	Org/Wht	H2, X1
301	0.8	Org	H2, V2
302	0.8	Org/Wht	V2, K1
325	0.8	Org/Blk	K1, S1
410	2.0	Yel/Blk	K1, M1
500	0.8	Yel	Splice 2, H1
502	0.8	Yel/Blk	H2, H1
504	0.8	Yel/Wht	H2, H3
506	0.8	Yel	S2, H3
508	0.8	Yel/Blk	S2, X1
510	0.8	Yel	B1, H1
512	0.8	Yel/Blk	H1, V3
514	0.8	Yel	V3, S1
516	0.8	Yel	M2, X1
518	0.8	Yel	Splice 2, N1
520	0.8	Yel/Blk	N1, X2
522	0.8	Yel/Wht	Splice 2, S1
524	0.8	Yel	S7, X3
526	0.8	Yel/Blk	S6, K4
528	0.8	Yel	S6, Y1
530	0.8	Yel	K4, S8
531	0.8	Yel	K4, S8
532	3.0	Brn	N1, X1
534	3.0	Brn	N1, X1
600	0.8	Grn	H4, N1
620	0.8	Tan	X1, H3
640	0.8	Org	P1, M2
641	0.8	Org	X2, X1
700	0.8	Pur	V1, K1
701	0.8	Pur	V1, S6
750	0.8	Pur	Y2, K4
800	0.8	Pnk/Blk	X6, S1
801	0.8	Pnk/Wht	X6, S6
803	0.8	Pnk	X5, S6
804	0.8	Pnk	S2, S3
806	0.8	Pnk	Splice 3, X4
808	0.8	Pnk/Blk	K3, X4
810	0.8	Pnk	K3, X2
812	0.8	Pnk/Blk	S6, X5
814	0.8	Pnk/Wht	K3, S6
816	0.8	Blu	K3, X3
818	0.8	Blu/Wht	S7, K3
820	0.8	Pnk/Blk	X2, S6
822	0.8	Pnk/Wht	S6, X2
824	0.8	Pnk/Wht	Splice 3, X5
825	0.8	Pnk/Blk	Splice 3, S3

W4 - Main Harness S.N. (050072-060000)



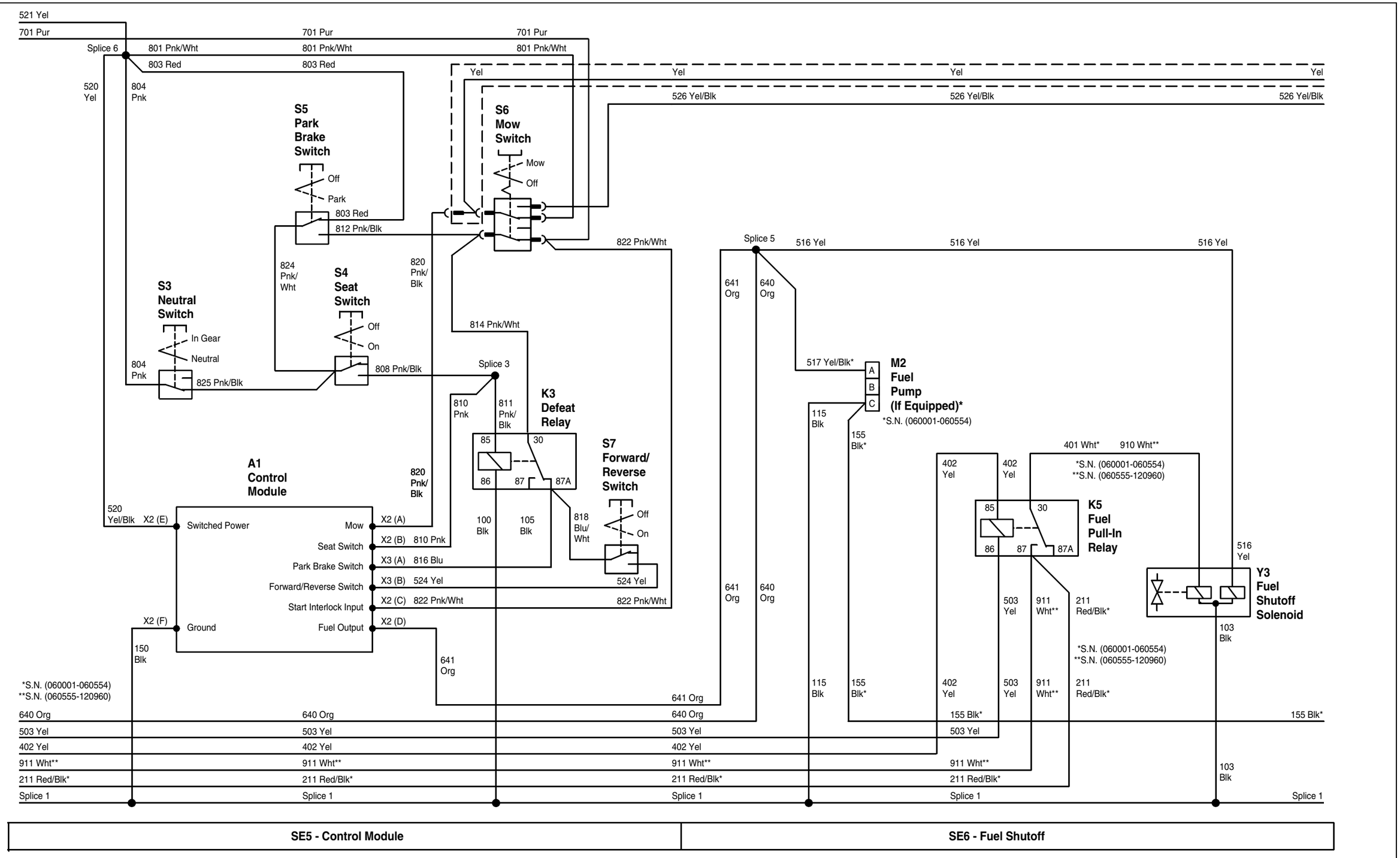
MIF (MX22638, MX22639)

Electrical Schematic S.N. (060001-120960) (Sheet 1 of 3)



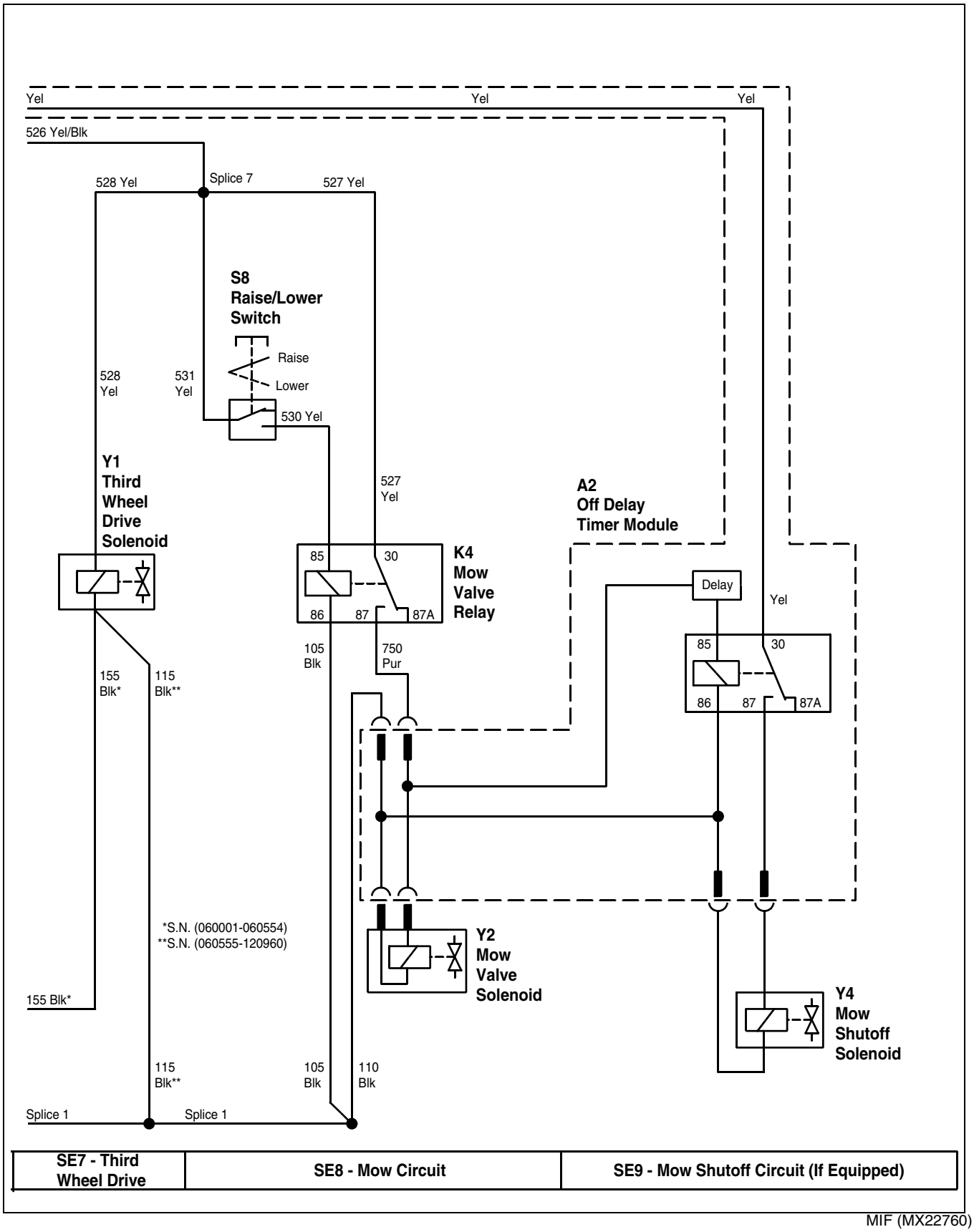
MIF (MX22756, MX22757)

Electrical Schematic S.N. (060001-120960) (Sheet 2 of 3)



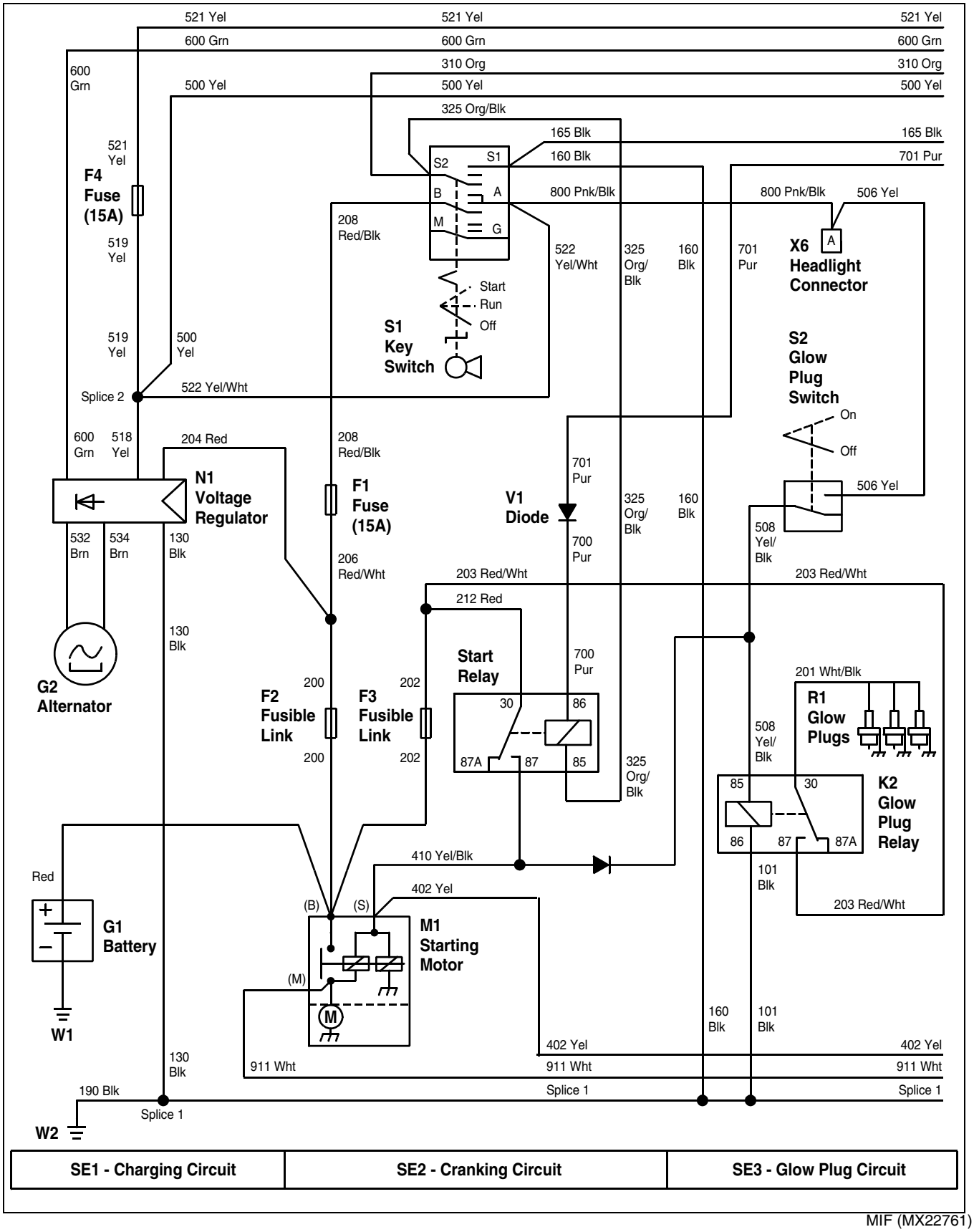
MIF (MX22758, MX22759)

Electrical Schematic S.N. (060001-120960) (Sheet 3 of 3)



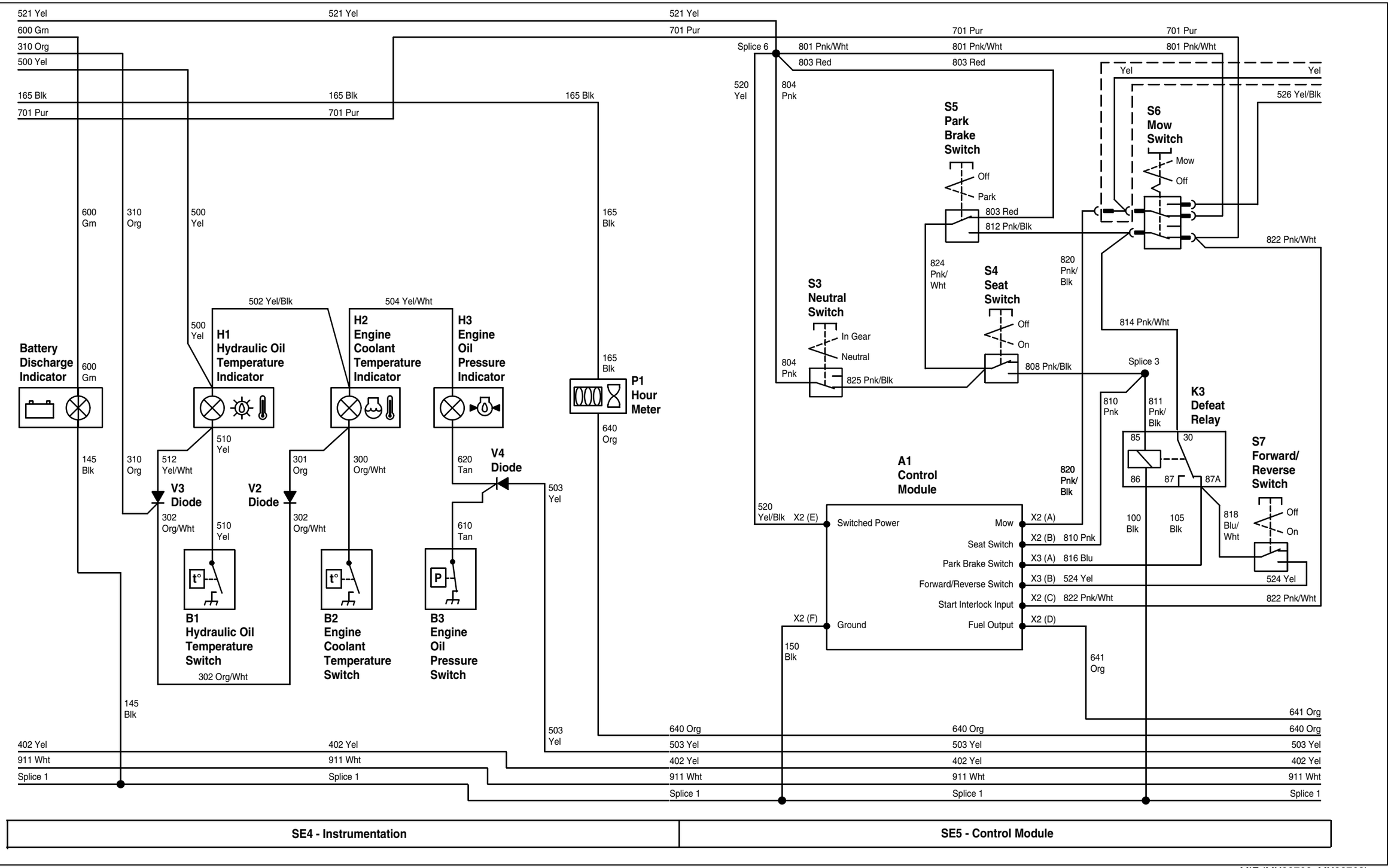
MIF (MX22760)

Electrical Schematic S.N. (120961-) (Sheet 1 of 3)



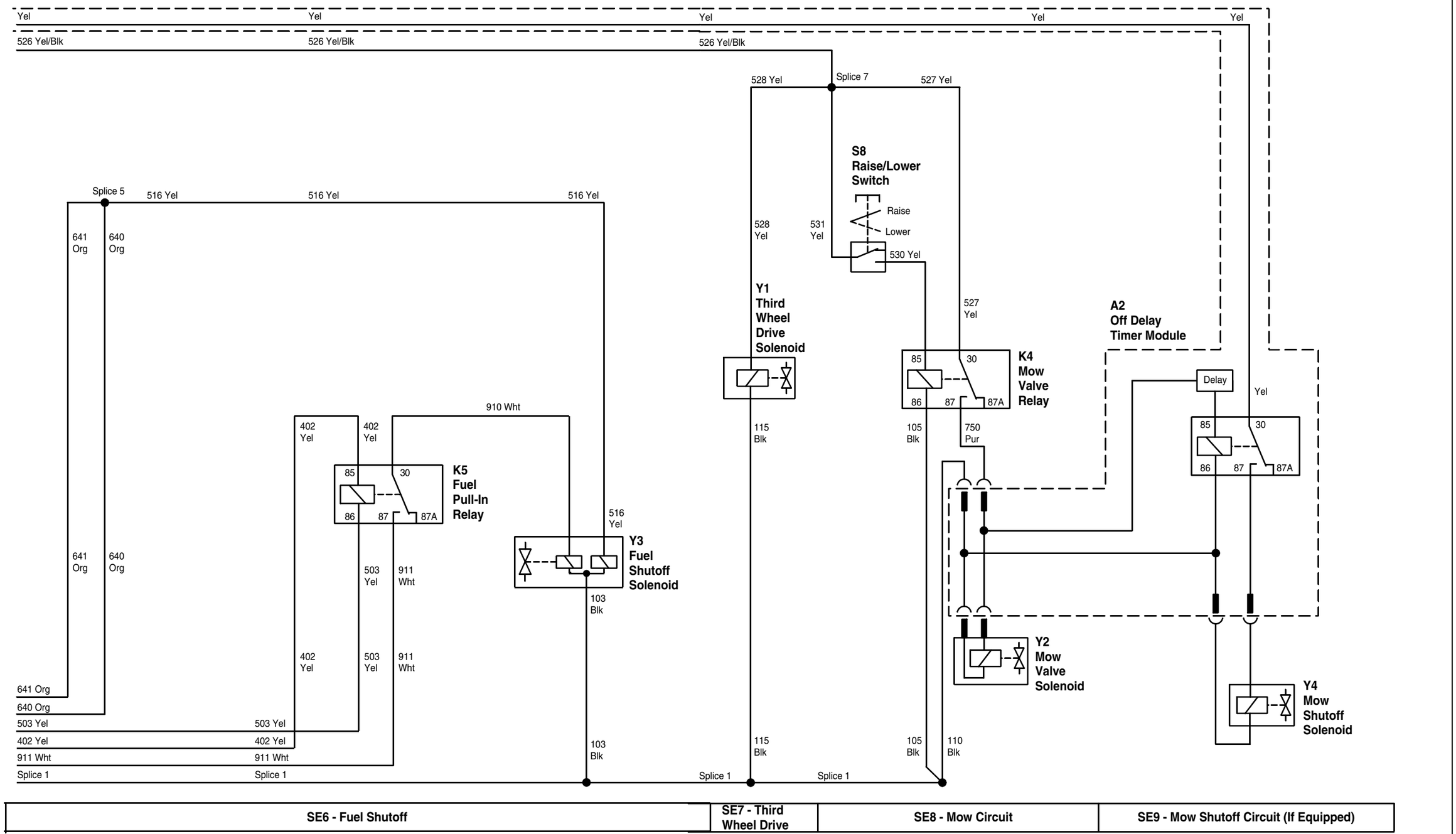
MIF (MX22761)

Electrical Schematic S.N. (120961-) (Sheet 2 of 3)



MIF (MX22762, MX22763)

Electrical Schematic S.N. (120961-) (Sheet 3 of 3)



SE6 - Fuel Shutoff	SE7 - Third Wheel Drive	SE8 - Mow Circuit	SE9 - Mow Shutoff Circuit (If Equipped)

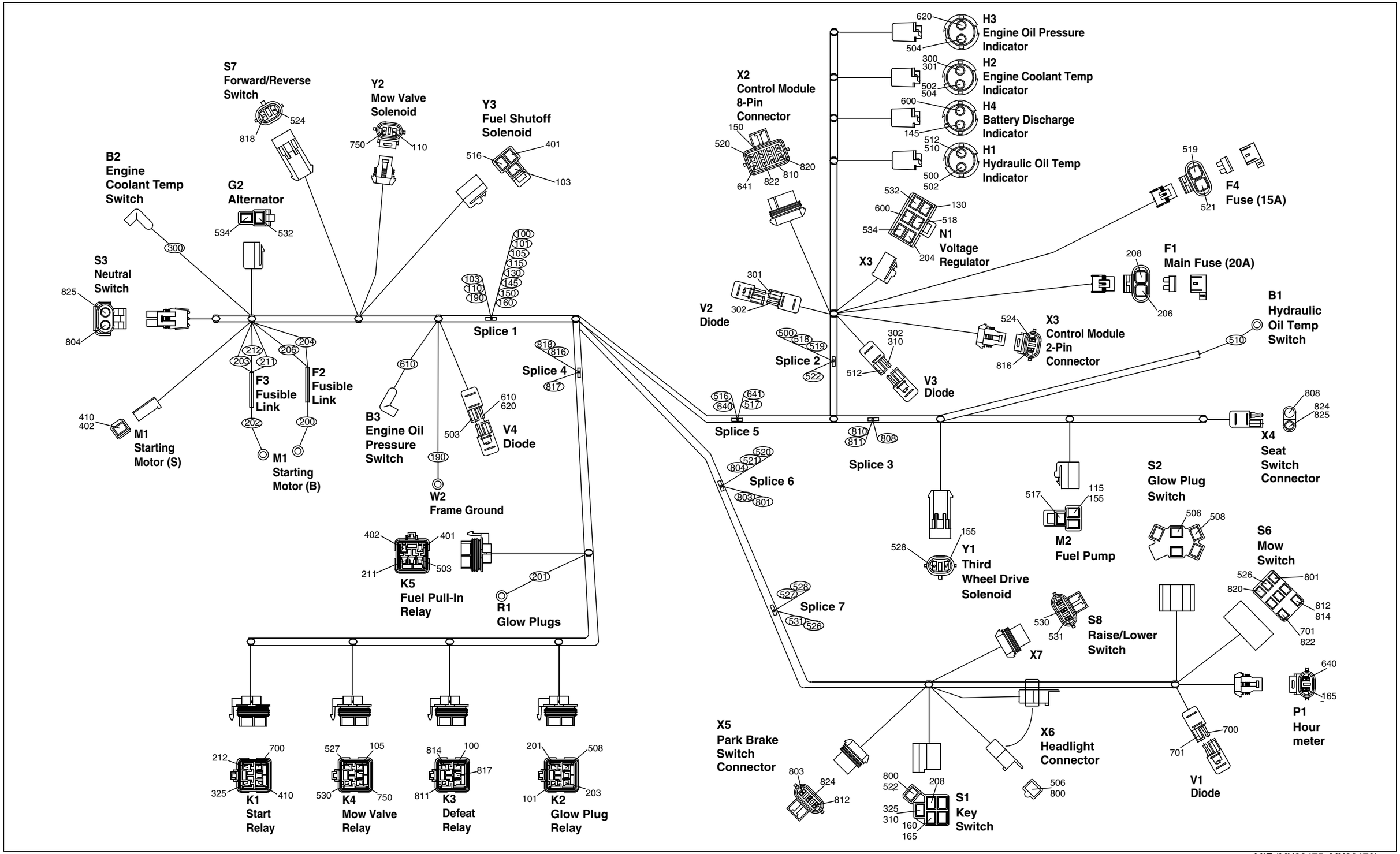
MIF (MX22764, MX22765)

W4 - Main Harness Wire Code Table S.N. (060001-060554)

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
100	0.8	Blk	K3, Splice 1
101	0.8	Blk	K2, Splice 1
103	0.8	Blk	Y3, Splice 1
105	0.8	Blk	K4, Splice 1
110	0.8	Blk	Y2, Splice 1
115	0.8	Blk	M2, Splice 1
130	3.0	Blk	N1, Splice 1
145	0.8	Blk	H4, Splice 1
150	0.8	Blk	X2, Splice 1
155	0.8	Blk	Y1, M2
160	0.8	Blk	S1, Splice 1
165	0.8	Blk	P1, S1
190	5.0	Blk	W2, Splice 1
200	0.8	Fusible Link	M1, F2
201	3.0	Wht/Blk	R1, K2
202	0.8	Fusible Link	M1, F3
203	3.0	Red/Wht	F3, K2
204	3.0	Red	F2, N1
206	2.0	Red/Wht	F2, F1
208	2.0	Red/Blk	F1, S1
211	2.0	Red/Blk	K5, F3
212	1.0	Red	K1, F3
300	0.8	Org/Wht	H2, B2
301	0.8	Org	H2, V2
302	0.8	Org/Wht	V2, V3
310	0.8	Org	V3, S1
325	0.8	Org/Blk	K1, S1
401	2.0	Wht	Y3, K5
402	0.8	Yel	K5, M1
410	1.0	Yel/Blk	K1, M1
500	0.8	Yel	Splice 2, H1
502	0.8	Yel/Blk	H2, H1
503	0.8	Yel	K5, V4
504	0.8	Yel/Wht	H2, H3
506	0.8	Yel	S2, X6
508	0.8	Yel/Blk	S2, X1
510	0.8	Yel	B1, H1
512	0.8	Yel/Wht	H1, V3
516	0.8	Yel	Y3, Splice 5
517	0.8	Yel/Blk	M2, Splice 5
518	0.8	Yel	Splice 2, N1
519	1.0	Yel	Splice 2, F4
520	0.8	Yel/Blk	N1, X2
521	1.0	Yel	Splice 6, F4
522	0.8	Yel/Wht	Splice 2, S1
524	0.8	Yel	S7, X3
526	0.8	Yel/Blk	S6, Splice 7
527	0.8	Yel	K4, Splice 7
528	0.8	Yel	Splice 7, Y1
530	0.8	Yel	K4, S8
531	0.8	Yel	Splice 7, S8
532	3.0	Brn	N1, G2
534	3.0	Brn	N1, G2
600	0.8	Grn	H4, N1
610	0.8	Tan	B3, V4
620	0.8	Tan	V4, H3
640	0.8	Org	P1, Splice 5
641	0.8	Org	Splice 5, X2
700	0.8	Pur	V1, K1
701	0.8	Pur	V1, S6
750	0.8	Pur	Y2, K4
800	0.8	Pnk/Blk	X6, S1
801	0.8	Pnk/Wht	Splice 6, S6
803	0.8	Pnk	Splice 6, X5
804	0.8	Pnk	Splice 6, S3
808	0.8	Pnk/Blk	Splice 3, X4
810	0.8	Pnk	Splice 3, X2
811	0.8	Pnk/Blk	Splice 3, K3

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
812	0.8	Pnk/Blk	S6, X5
814	0.8	Pnk/Wht	K3, S6
816	0.8	Blu	Splice 4, X3
817	0.8	Pnk	Splice 4, K3
818	0.8	Blu/Wht	S7, Splice 4
820	0.8	Pnk/Blk	X2, S6
822	0.8	Pnk/Wht	S6, X2
824	0.8	Pnk/Wht	X4, X5
825	0.8	Pnk/Blk	X4, S3

W4 - Main Harness S.N. (060001-060554)



MIF (MX22475, MX22476)

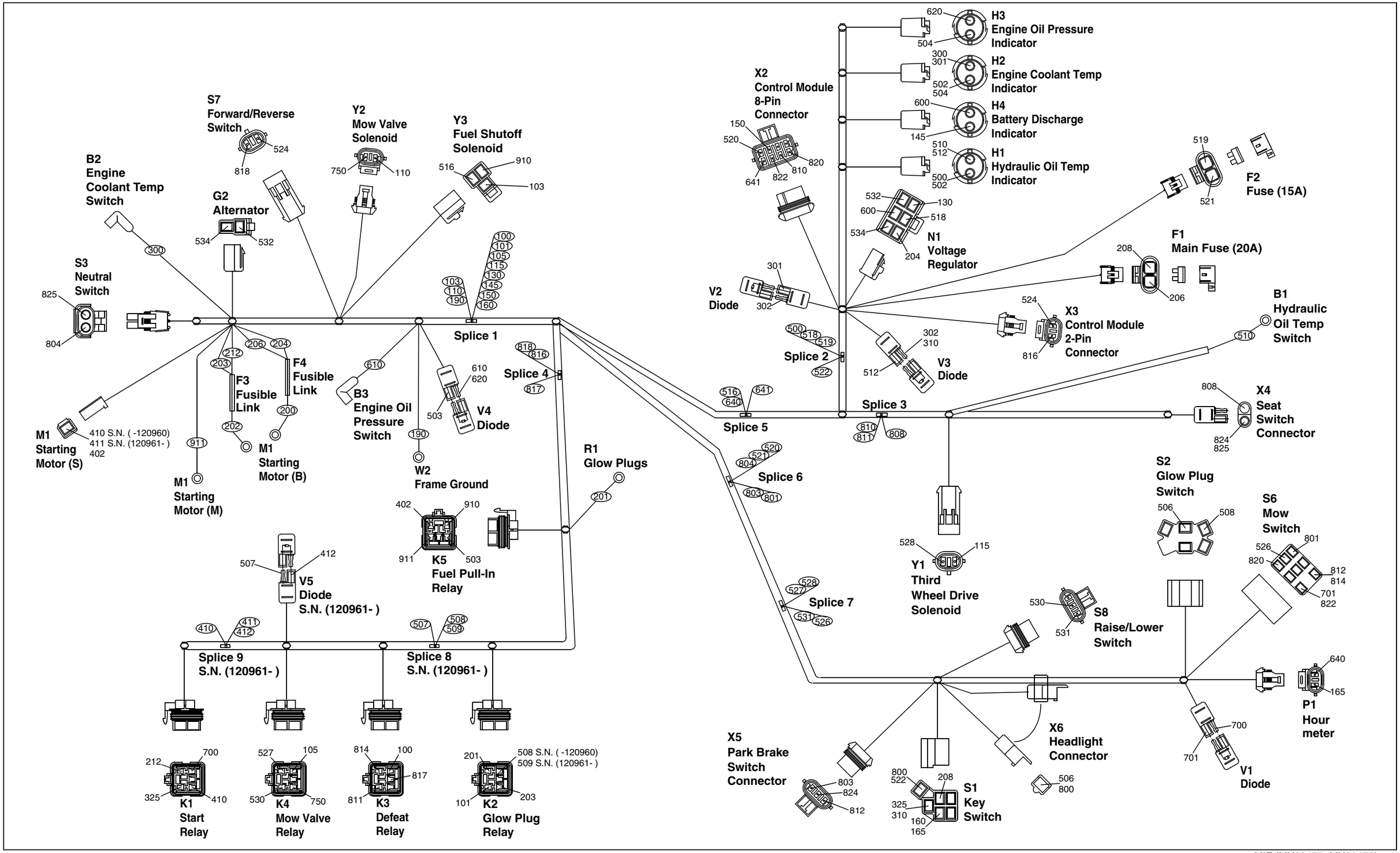
W4 - Main Harness Wire Code Table
S.N. (060555-)

Main Harness (W4) Color Code Table

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
100	0.8	Blk	K3, Splice 1
101	0.8	Blk	K2, Splice 1
103	2.0	Blk	Y3, Splice 1
105	0.8	Blk	K4, Splice 1
110	0.8	Blk	Y2, Splice 1
115	0.8	Blk	Y1, Splice 1
130	3.0	Blk	N1, Splice 1
145	0.8	Blk	H4, Splice 1
150	0.8	Blk	X2, Splice 1
160	0.8	Blk	S1, Splice 1
165	0.8	Blk	P1, S1
190	5.0	Blk	W2, Splice 1
200	0.8	Fusible Link	M1, F2
201	3.0	Wht/Blk	R1, K2
202	0.8	Fusible Link	M1, F3
203	3.0	Red/Wht	F3, K2
204	3.0	Red	F2, N1
206	2.0	Red/Wht	F2, F1
208	2.0	Red/Blk	F1, S1
212	1.0	Red	K1, F3
300	0.8	Org/Wht	H2, B2
301	0.8	Org	H2, V2
302	0.8	Org/Wht	V2, V3
310	0.8	Org	V3, S1
325	0.8	Org/Blk	K1, S1
402	0.8	Yel	K5, M1
410	1.0	Yel/Blk	K1, M1 S.N. (060555-120960)
410	1.0	Yel/Blk	K1, Splice 9 S.N. (120961-)
411	1.0	Yel	Splice 9, M1 S.N. (120961-)
412	1.0	Yel	Splice 9, V5 S.N. (120961-)
500	0.8	Yel	Splice 2, H1
502	0.8	Yel/Blk	H2, H1
503	0.8	Yel	K5, V4
504	0.8	Yel/Wht	H2, H3
506	0.8	Yel	S2, X6
507	1.0	Blu	V5, Splice 8 S.N. (120961-)
508	0.8	Yel/Blk	S2, K2 S.N. (060555-120960)
508	0.8	Yel/Blk	S2, Splice 8 S.N. (120961-)
509	1.0	Blu	K2, Splice 8 S.N. (120961-)
510	0.8	Yel	B1, H1
512	0.8	Yel/Wht	H1, V3
516	0.8	Yel	Y3, Splice 5
518	0.8	Yel	Splice 2, N1
519	1.0	Yel	Splice 2, F4
520	0.8	Yel/Blk	Splice 6, X2
521	1.0	Yel	Splice 6, F4
522	0.8	Yel/Wht	Splice 2, S1
524	0.8	Yel	S7, X3
526	0.8	Yel/Blk	S6, Splice 7
527	0.8	Yel	K4, Splice 7
528	0.8	Yel	Splice 7, Y1
530	0.8	Yel	K4, S8
531	0.8	Yel	Splice 7, S8
532	3.0	Brn	N1, G2
534	3.0	Brn	N1, G2
600	0.8	Grn	H4, N1
610	0.8	Tan	B3, V4
620	0.8	Tan	V4, H3

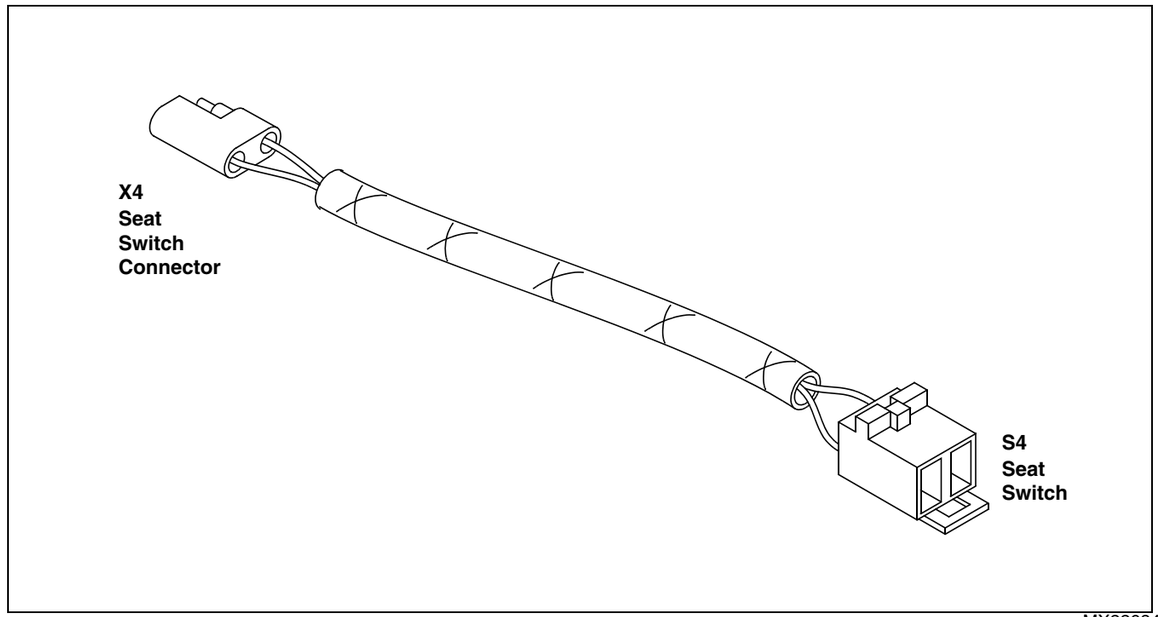
Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
640	0.8	Org	P1, Splice 5
641	0.8	Org	Splice 5, X2
700	0.8	Pur	V1, K1
701	0.8	Pur	V1, S6
750	0.8	Pur	Y2, K4
800	0.8	Pnk/Blk	X6, S1
801	0.8	Pnk/Wht	Splice 6, S6
803	0.8	Pnk	Splice 6, X5
804	0.8	Pnk	Splice 6, S3
808	0.8	Pnk/Blk	Splice 3, X4
810	0.8	Pnk	Splice 3, X2
811	0.8	Pnk/Blk	Splice 3, K3
812	0.8	Pnk/Blk	S6, X5
814	0.8	Pnk/Wht	K3, S6
816	0.8	Blu	Splice 4, X3
817	0.8	Pnk	Splice 4, K3
818	0.8	Blu/Wht	S7, Splice 4
820	0.8	Pnk/Blk	X2, S6
822	0.8	Pnk/Wht	S6, X2
824	0.8	Pnk/Wht	X4, X5
825	0.8	Pnk/Blk	X4, S3

W4- Main Harness S.N. (060555-)



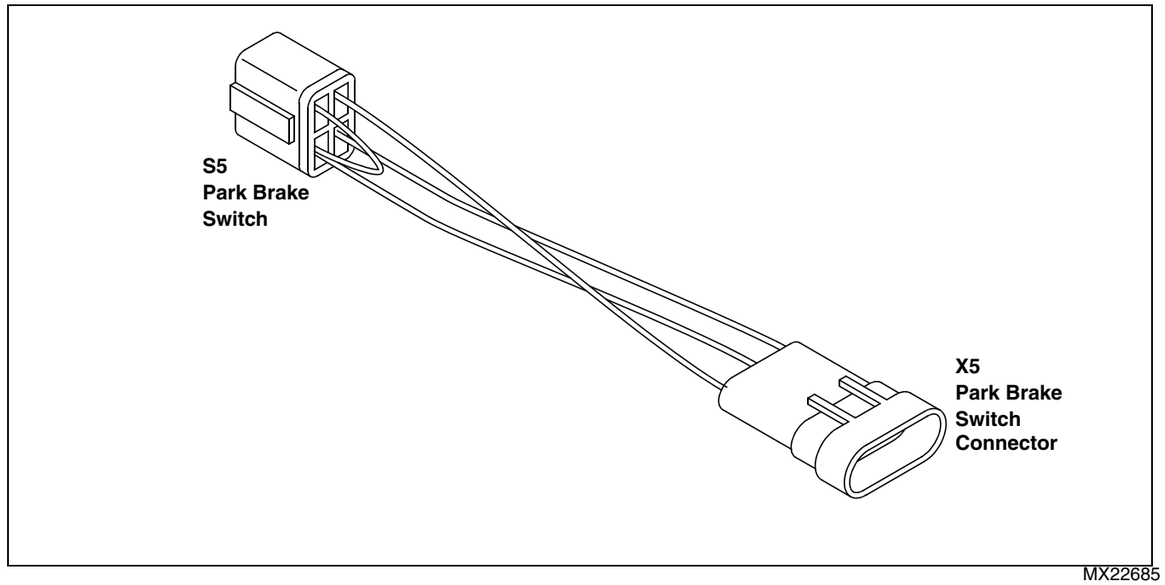
MIF (MX22475, MX22476)

W6 - Seat Switch Harness



MX22684

W7 - Park Brake Switch Harness



MX22685

Operation and Diagnostics

Cranking Circuit Operation S.N. (-050071)

Function

Engage the starting motor and momentarily activate the fuel shutoff solenoid.

Operating Conditions

- Key switch (S1) in START position.
- Neutral switch (S3) in NEUTRAL position.
- Park brake switch (S5) in PARK position.
- Mow switch (S6) in OFF position.

Theory of Operation

Unswitched power from battery (G1) is available at the following components:

- Starting motor (M1) - terminal B
- Fusible link (F2) - wire 200 red
- Main fuse (F1) - wire 206 red/wht
- Key switch (S1) - wire 208 red/blk
- Fusible link (F3) - wire 202 red
- Start relay (K1) - wire 212 red

When the key switch is in the RUN position, switched power is available at the following components:

- Control module (A1) - wire 520 yel/blk
- Hydraulic oil temperature indicator (H1) - wire 500 yel
- Engine coolant temperature indicator (H2) - wire 502 yel/blk
- Engine oil pressure indicator (H3) - wire 504 yel
- Glow plug switch (S2) - wire 506 yel
- Neutral switch (S3) - wire 804 pnk

Control module (A1) allows the cranking circuit to operate when current flows to control module start interlock input terminal. Current flows to control module start interlock input terminal through the following components and circuits:

- Neutral switch (S3) - wire 825 pnk/blk
- Wire 824 pnk/wht
- Park brake switch (S5) - wire 812 pnk/blk
- Mow switch (S6) - wire 822 pnk/wht

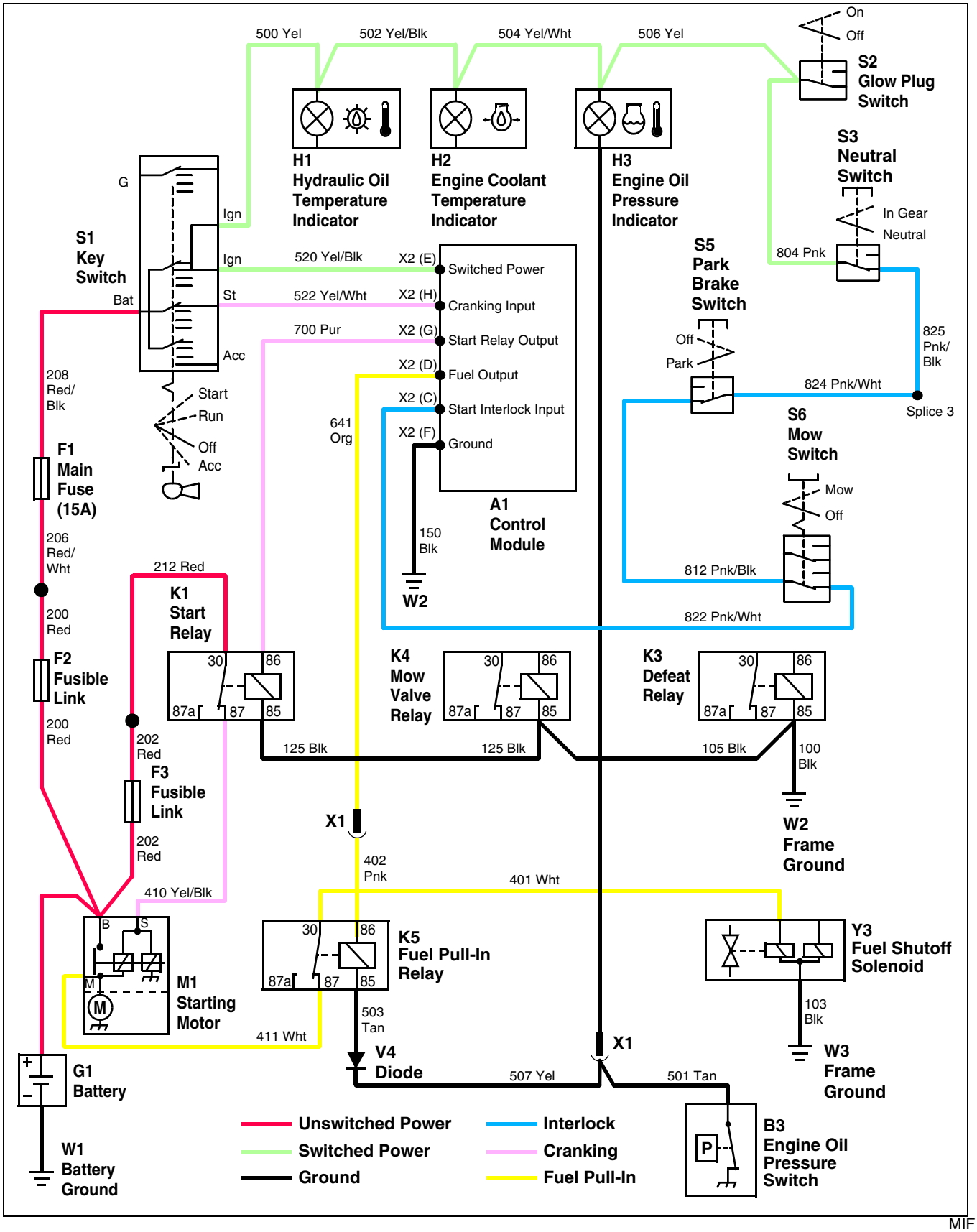
With current flowing to start interlock input terminal, control module (A1) provides voltage to fuel output terminal. When engine oil pressure switch (B3) is closed, ground is provided to fuel pull-in relay (K5). With engine oil pressure switch (B3) closed, current flows from fuel output terminal to fuel pull-in relay (K5), energizing the relay.

When key switch (S1) is in the START position, current flows from key switch terminal ST to control module cranking input.

With current flowing to control module cranking and start interlock inputs, current flows from control module start relay output terminal to start relay (K1), energizing the relay. With start relay energized, current flows between start relay terminals (30 and 87) to the solenoid of starting motor (M1), engaging the starting motor.

At the same time, voltage is available from starting motor terminal M to fuel pull-in relay terminal 30 through wire 411 wht. With fuel pull-in relay (K5) energized, current flows between fuel pull-in relay terminals (87 and 30) to the fuel shutoff pull-in coil, momentarily energizing the fuel shutoff pull-in coil.

Cranking Circuit Schematic S.N. (-050071)



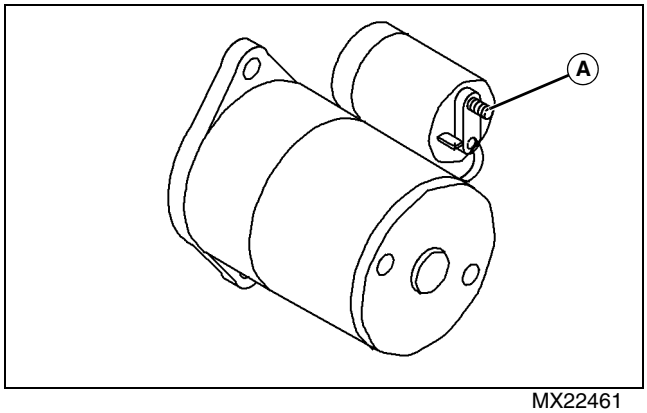
MIF

Cranking Circuit Diagnosis S.N. (-050071)

Test Conditions:

- Mow switch in OFF position.
- Key switch in RUN position.
- Park brake switch in PARK position.
- Neutral switch in NEUTRAL position.

System: Cranking Circuit

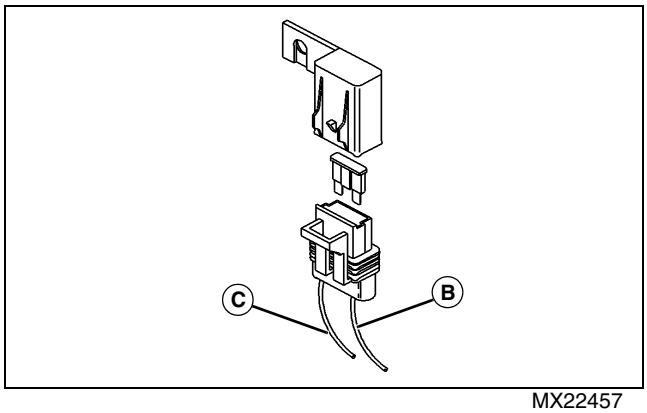


MX22461

(1) Measure voltage at starting motor battery terminal (A). Is battery voltage present?

Yes - Go to step (2).

No - Test battery and connections. (See “Battery Test” on page 246.)



MX22457

(2) Measure voltage at main fuse (F1) - wire 206 red/wht (B). Is battery voltage present?

Yes - Go to step (3).

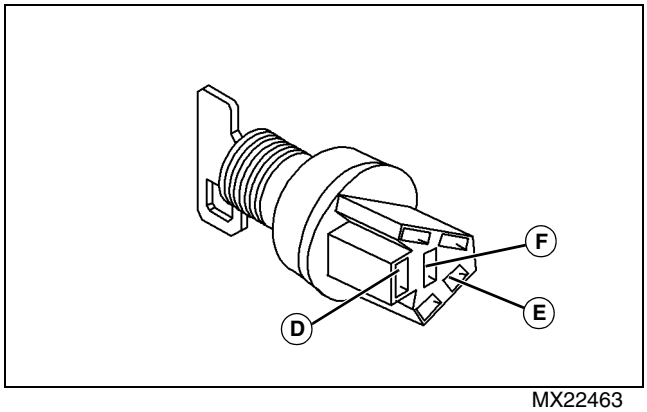
No - Test wire 206 red/wht. Test fusible link (F2) - wire 200 and connections.

System: Cranking Circuit

(3) Measure voltage at main fuse (F1) - wire 208 red/blk (C). Is battery voltage present?

Yes - Go to step (4).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



MX22463

(4) Measure voltage at key switch (S1) - wire 208 red/blk (D). Is battery voltage present?

Yes - Go to step (5).

No - Test wire 208 red/blk and connections.

(5) Measure voltage at key switch (S1) - wire 520 yel/blk (E). Is battery voltage present?

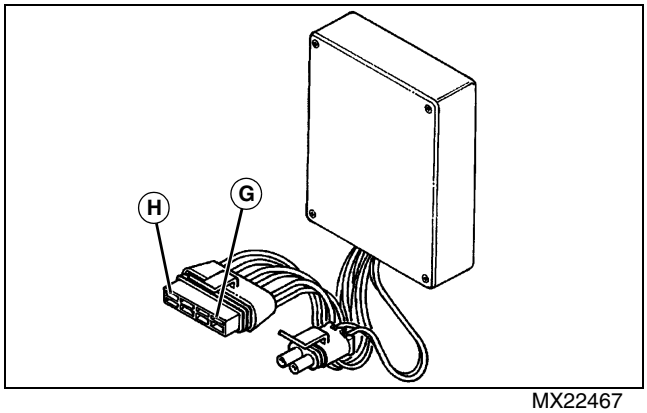
Yes - Go to step (6).

No - Replace key switch.

(6) Turn key switch (S1) to START position and measure voltage at key switch (S1) - wire 522 yel/wht (F). Is battery voltage present?

Yes - Go to step (7).

No - Replace key switch.



MX22467

(7) Measure voltage at control module (A1) - wire 520 yel/blk (G). Is battery voltage present?

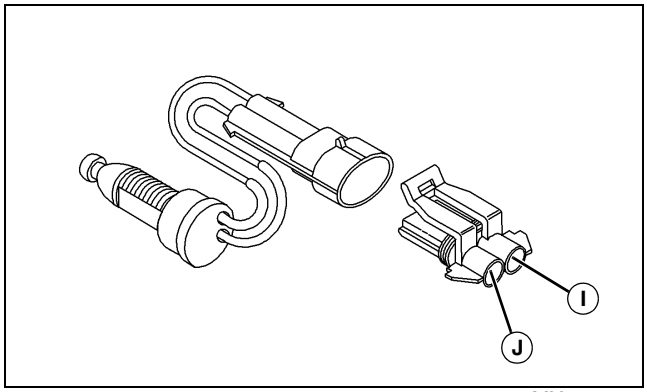
Yes - Go to step (8).

No - Test wire 520 yel/blk and connections.

(8) Turn key switch (S1) to START position and measure voltage at control module (A1) - wire 522 yel/wht (H). Is battery voltage present?

Yes - Go to step (9).

No - Test wire 522 yel/wht and connections.



MX22466

(9) Measure voltage at neutral switch (S3) - wire 804 pnk (J). Is battery voltage present?

Yes - Go to step (10).

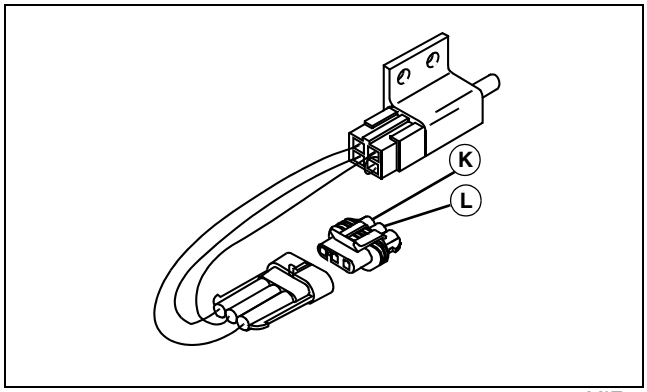
No - Test wire 804 pnk between neutral switch (S3) and glow plug switch (S2). Test wire 506 yel between glow plug switch (S2) and engine oil pressure indicator (H3). Test wire 504 yel between engine oil pressure indicator (H3) and engine coolant temperature indicator (H2).

No - Test wire 502 yel/blk between engine coolant temperature indicator (H2) and hydraulic oil temperature indicator (H1). Test wire 500 yel between hydraulic oil temperature indicator (H1) and key switch (S1) and connections.

(10) Measure voltage at neutral switch (S3) - wire 825 pnk/blk (I). Is battery voltage present?

Yes - Go to step (11).

No - Test neutral switch. (See “Neutral Switch Test” on page 253.)



MIF

(11) Measure voltage at park brake switch (S5) - wire 824 pnk/wht (L). Is battery voltage present?

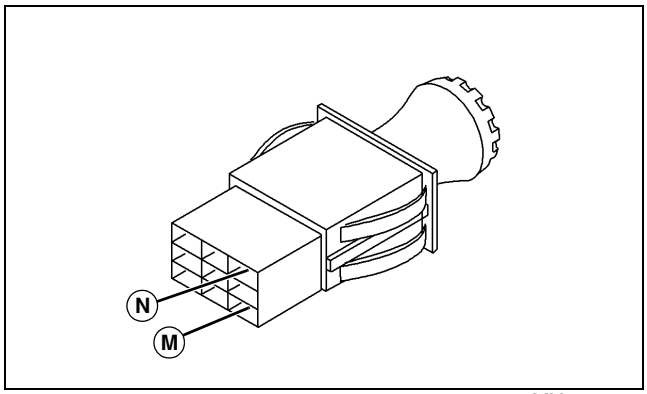
Yes - Go to step (12).

No - Test wires 825 pnk/blk and 824 pnk/wht.

(12) Measure voltage at park brake switch (S5) - wire 812 pnk/blk (K). Is battery voltage present?

Yes - Go to step (13).

No - Test park brake switch. (See “Park Brake Switch Test” on page 253.)



MX22464

(13) Measure voltage at mow switch (S6) - wire 812 pnk/blk (M). Is battery voltage present?

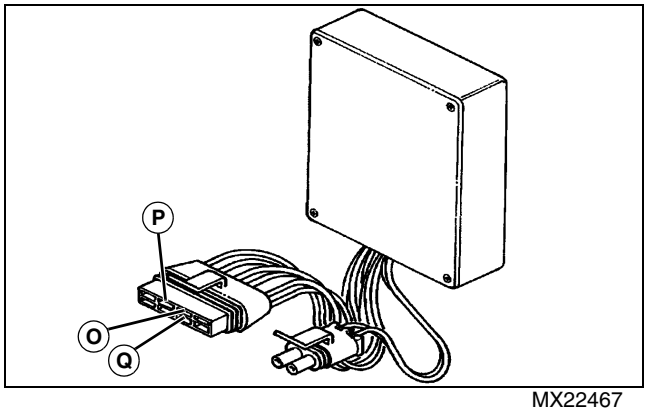
Yes - Go to step (14).

No - Test wire 812 pnk/blk and connections.

(14) Measure voltage at mow switch (S6) - wire 822 pnk/wht (N). Is battery voltage present?

Yes - Go to step (15).

No - Test mow switch. (See “Mow Switch Test” on page 252.)



MX22467

(15) Measure voltage at control module (A1) - wire 822 pnk/wht (Q). Is battery voltage present?

Yes - Go to step (16).

No - Test wire 822 pnk/wht and connections.

(16) Check ground circuit resistance at control module (A1) - wire 150 blk (O). Is there less than 0.1 ohm of resistance?

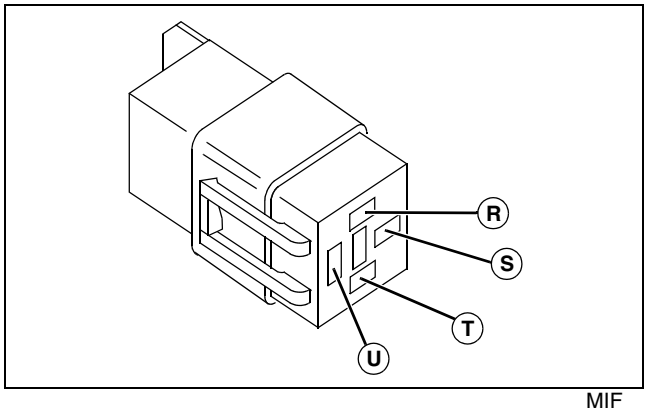
Yes - Go to step (17).

No - Test wire 150 blk and frame ground terminals (W2).

(17) Measure voltage at control module (A1) - wire 700 pur (P). Is battery voltage present?

Yes - Go to step (18).

No - Test control module (A1) and connections. (See “Control Module Test” on page 255.)



MIF

(18) Measure voltage at start relay (K1) - wire 700 pur (T). Is battery voltage present?

Yes - Go to step (19).

No - Test wire 700 pur and connections.

(19) Check ground circuit resistance at start relay (K1) - wire 125 blk (R). Is there less than 0.1 ohm of resistance?

Yes - Go to step (20).

No - Test wires 125, 105, and 100 blk. Test frame ground terminals (W2) and connections. (See “Ground Circuit Tests” on page 245.)

(20) Measure voltage at start relay (K1) - wire 212 red (S). Is battery voltage present?

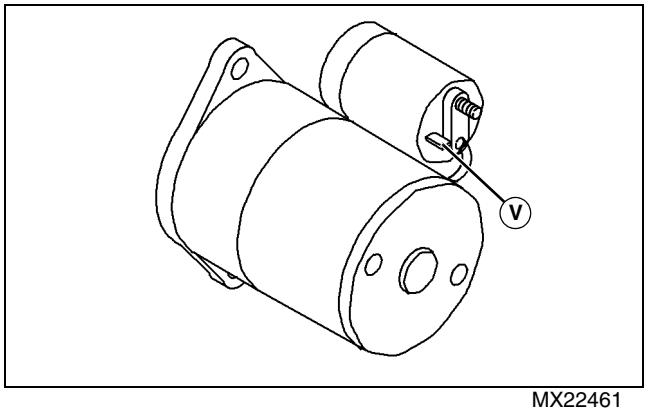
Yes - Go to step (21).

No - Test wire 212 red. Test fusible link (F3) - wire 202 and connections.

(21) Measure voltage at start relay (K1) - wire 410 yel/blk (U). Is battery voltage present?

Yes - Go to step (22).

No - Test start relay. (See “Relay Test” on page 252.)



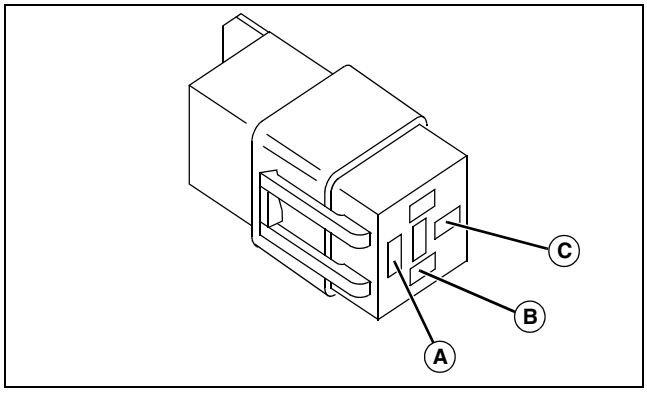
MX22461

(22) Measure voltage at starting motor solenoid - wire 410 yel/blk (V). Is battery voltage present?

Yes - Test starting motor and solenoid. (See “Starter No-Load Amperage Draw and RPM Test” on page 259.) (See “Starter Solenoid Test” on page 260.)

No - Test wire 410 yel/blk and connections.

System: Fuel Shutoff Solenoid Circuit



(1) Measure voltage at fuel pull-in relay (K5) - wire 402 pnk (B). Is battery voltage present?

Yes - Go to step (2).

No - Test wire 402 pnk, engine connector (X1), wire 641 org, and connections.

No - Test control module (A1). (See “Control Module Test” on page 255.)

(2) Turn key switch (S1) to START position and measure voltage at fuel pull-in relay (K5) - wire 411 wht (A). Is battery voltage present?

Yes - Go to step (3).

No - Test wire 411 wht and connections.

(3) Turn key switch between OFF and RUN positions and check fuel pull-in relay (K5) for audible click. Does fuel pull-in relay (K5) energize with an audible click?

Yes - Go to step (4).

No - Test diode (V4) and connections. (See “Diode Test” on page 251.) Test wires 503, 507, and 501 tan.

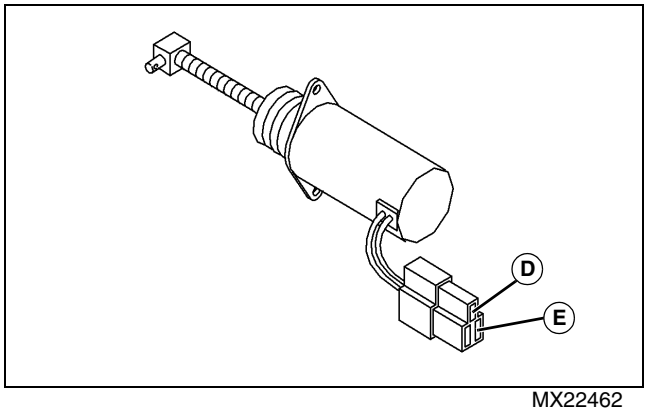
No - Test fuel pull-in relay. (See “Relay Test” on page 252.) Test engine oil pressure switch (B3). (See “Engine Oil Pressure Switch Test” on page 250.)

(4) Turn key switch (S1) to START position and measure voltage at fuel pull-in relay (K5) - wire 401 wht (C). Is battery voltage present?

Yes - Go to step (5).

No - Test fuel pull-in relay. (See “Relay Test” on page 252.)

System: Fuel Shutoff Solenoid Circuit



MX22462

(5) Turn key switch (S1) to START position and measure voltage at fuel shutoff solenoid (Y3) - wire 401 wht (E). Is battery voltage present?

Yes - Go to step (6).

No - Test wire 401 wht and connections.

(6) Check ground circuit resistance at fuel shutoff solenoid (Y3) - wire 103 blk (D). Is there less than 0.1 ohm of resistance?

Yes - Replace fuel shutoff solenoid.

No - Test wire 103 blk, frame ground (W3), and connections.

Cranking Circuit Operation S.N. (050072-060000)

Function

Engage the starting motor and momentarily activate the fuel shutoff solenoid.

Operating Conditions

- Key switch (S1) in START position.
- Neutral switch (S3) in NEUTRAL position.
- Park brake switch (S5) in PARK position.
- Mow switch (S6) in OFF position.

Theory of Operation

Unswitched power from battery (G1) is available at the following components:

- Starting motor (M1) - terminal B
- Fusible link (F2) - wire 200 red
- Main fuse (F1) - wire 206 red/wht
- Key switch (S1) - wire 208 red/blk
- Fusible link (F3) - wire 202 red
- Start relay (K1) - wire 212 red

When the key switch is in the RUN position, switched power is available at the following components:

- Control module (A1) - wire 520 yel/blk
- Hydraulic oil temperature indicator (H1) - wire 500 yel
- Engine coolant temperature indicator (H2) - wire 502 yel/blk
- Engine oil pressure indicator (H3) - wire 504 yel
- Glow plug switch (S2) - wire 506 yel
- Neutral switch (S3) - wire 804 pnk

Control module (A1) provides voltage to fuel output terminal when current flows to control module start interlock input terminal. Current flows to control module start interlock input terminal through the following components and circuits:

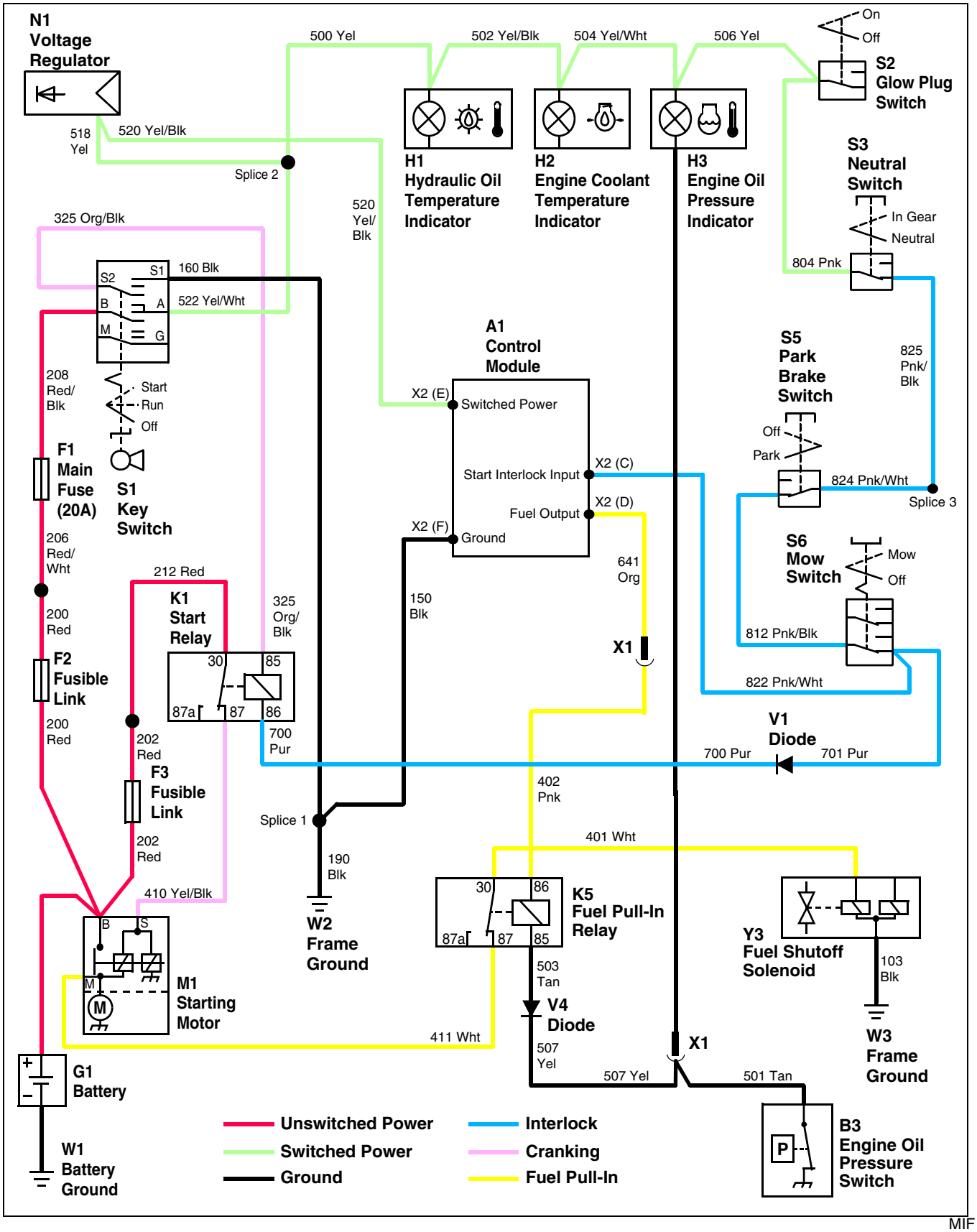
- Neutral switch (S3) - wire 825 pnk/blk
- Wire 824 pnk/wht
- Park brake switch (S5) - wire 812 pnk/blk
- Mow switch (S6) - wire 822 pnk/wht

When engine oil pressure switch (B3) is closed, ground is provided to fuel pull-in relay (K5). With engine oil pressure switch (B3) closed and voltage available to fuel output terminal, current flows from fuel output terminal to fuel pull-in relay (K5), energizing the relay.

Voltage is also available to start relay terminal 86 from mow switch (S6) through diode (V1). When key switch (S1) is in the START position, ground is provided to start relay terminal 85 between key switch terminals (S1 and S2), energizing the relay. With start relay energized, current flows between start relay terminals (30 and 87) to the solenoid of starting motor (M1), engaging the starting motor.

At the same time, voltage is available from starting motor terminal M to fuel pull-in relay terminal 30 through wire 411wht. With fuel pull-in relay (K5) energized, current flows between fuel pull-in relay terminals (87 and 30) to the fuel shutoff pull-in coil, momentarily energizing the fuel shutoff pull-in coil.

Cranking Circuit Schematic S.N. (050772-060000)



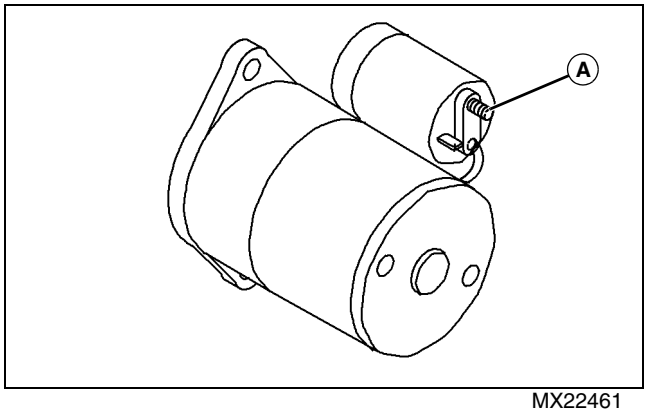
MIF

Cranking Circuit Diagnosis S.N. (050072-060000)

Test Conditions:

- Mow switch in OFF position.
- Key switch in RUN position.
- Park brake switch in PARK position.
- Neutral switch in NEUTRAL position.

System: Cranking Circuit

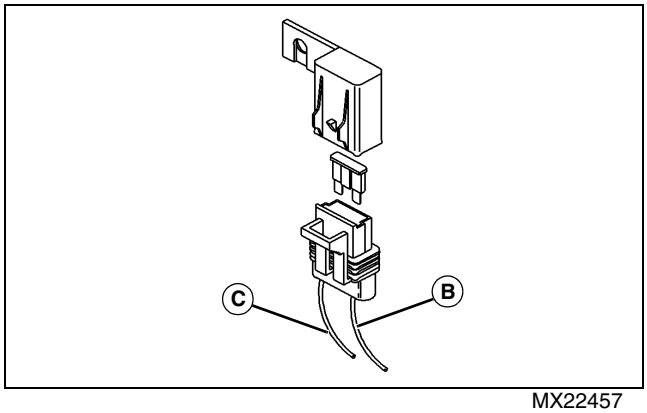


MX22461

(1) Measure voltage at starting motor battery terminal (A). Is battery voltage present?

Yes - Go to step (2).

No - Test battery and connections. (See “Battery Test” on page 246.)



MX22457

(2) Measure voltage at main fuse (F1) - wire 206 red/wht (B). Is battery voltage present?

Yes - Go to step (3).

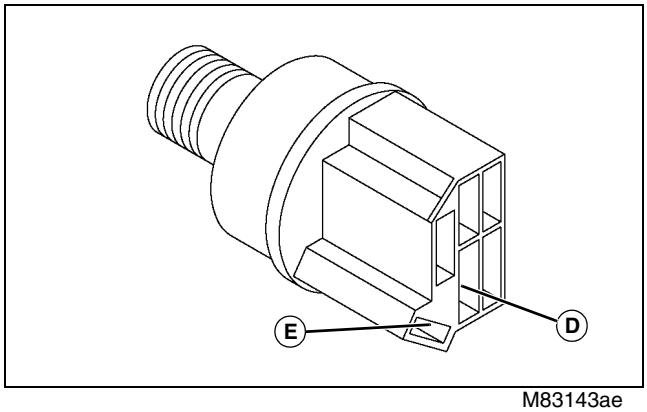
No - Test wire 206 red/wht. Test fusible link (F2) - wire 200 and connections.

System: Cranking Circuit

(3) Measure voltage at main fuse (F1) - wire 208 red/blk (C). Is battery voltage present?

Yes - Go to step (4).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



M83143ae

(4) Measure voltage at key switch (S1) - wire 208 red/blk (D). Is battery voltage present?

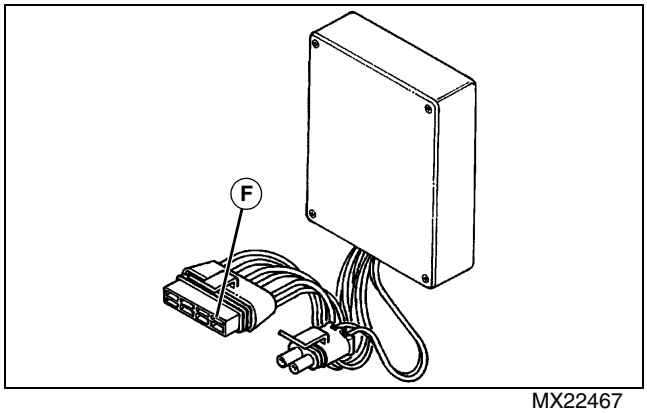
Yes - Go to step (5).

No - Test wire 208 red/blk and connections.

(5) Measure voltage at key switch (S1) - wire 522 yel/wht (E). Is battery voltage present?

Yes - Go to step (6).

No - Test key switch and connections. (See “Key Switch Test” on page 249.)

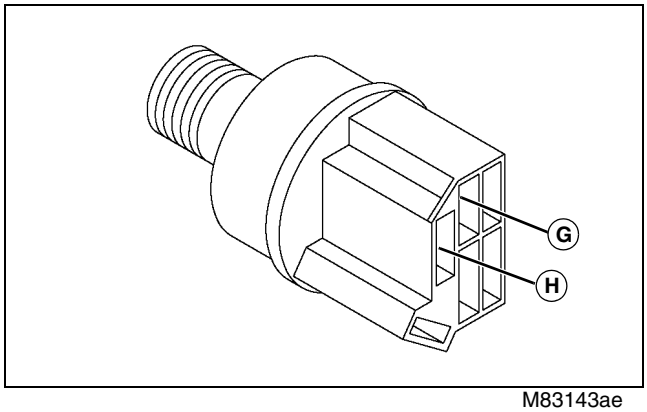


MX22467

(6) Measure voltage at control module (A1) - wire 520 yel/blk (F). Is battery voltage present?

Yes - Go to step (7).

No - Test wire 520 yel/blk between control module and voltage regulator. Test wire 518 yel between voltage regulator and splice 2. Test wire 522 yel/wht between splice 2 and key switch.



M83143ae

(7) Check ground circuit resistance at key switch (S1) - wire 160 blk (G). Is there less than 0.1 ohm of resistance?

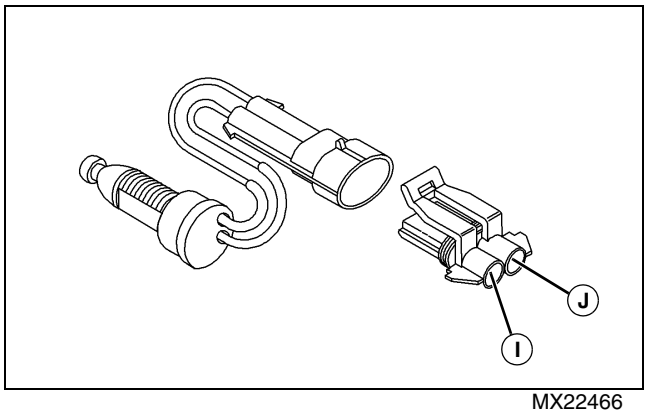
Yes - Go to step (8).

No - Test wire 160 blk between key switch and splice 1. Check wire 190 blk between splice 1 and frame ground (W2) and connections.

(8) Turn key switch (S1) to START position and check ground circuit resistance at key switch (S1) - wire 325 org/blk (H). Is there less than 0.1 ohm of resistance?

Yes - Go to step (9).

No - Test key switch and connections. (See “Key Switch Test” on page 249.)



MX22466

(9) Measure voltage at neutral switch (S3) - wire 804 pnk (I). Is battery voltage present?

Yes - Go to step (10).

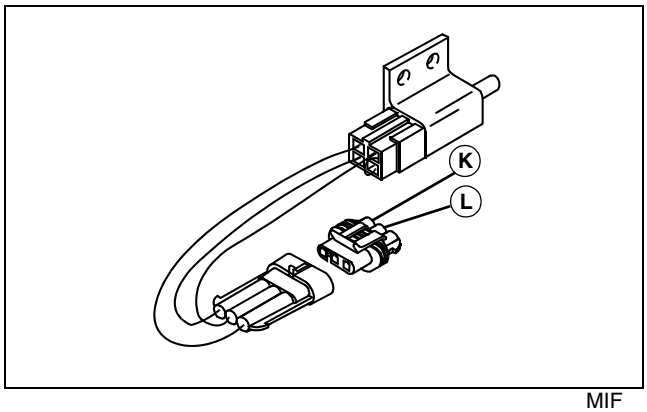
No - Test wire 804 pnk between neutral switch (S3) and glow plug switch (S2). Test wire 506 yel between glow plug switch (S2) and engine oil pressure indicator (H3). Test wire 504 yel between engine oil pressure indicator (H3) and engine coolant temperature indicator (H2).

No - Test wire 502 yel/blk between engine coolant temperature indicator (H2) and hydraulic oil temperature indicator (H1). Test wire 500 yel between hydraulic oil temperature indicator (H1) and key switch (S1) and connections.

(10) Measure voltage at neutral switch (S3) - wire 825 pnk/blk (J). Is battery voltage present?

Yes - Go to step (11).

No - Test neutral switch. (See “Neutral Switch Test” on page 253.)



MIF

(11) Measure voltage at park brake switch (S5) - wire 824 pnk/wht (L). Is battery voltage present?

Yes - Go to step (12).

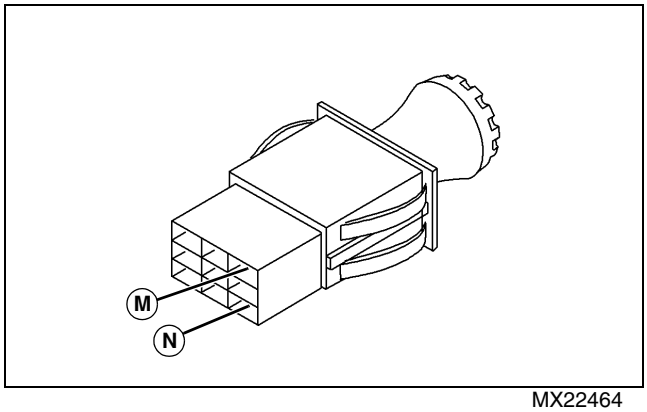
No - Test wires 825 pnk/blk and 824 pnk/wht.

(12) Measure voltage at park brake switch (S5) - wire 812 pnk/blk (K). Is battery voltage present?

Yes - Go to step (13).

No - Test park brake switch. (See “Park Brake Switch Test” on page 253.)

System: Cranking Circuit



MX22464

(13) Measure voltage at mow switch (S6) - wire 812 pnk/blk (N). Is battery voltage present?

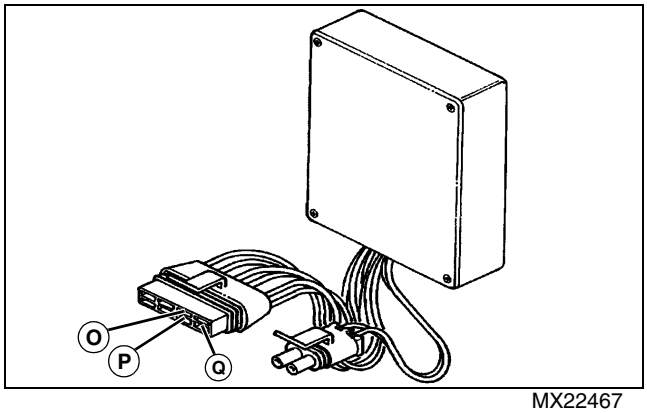
Yes - Go to step (14).

No - Test wire 812 pnk/blk and connections.

(14) Measure voltage at mow switch (S6) - wire 822 pnk/wht (M). Is battery voltage present?

Yes - Go to step (15).

No - Test mow switch. (See “Mow Switch Test” on page 252.)



MX22467

(15) Measure voltage at control module (A1) - wire 822 pnk/wht (P). Is battery voltage present?

Yes - Go to step (16).

No - Test wire 822 pnk/wht and connections.

(16) Check ground circuit resistance at control module (A1) - wire 150 blk (O). Is there less than 0.1 ohm of resistance?

Yes - Go to step (17).

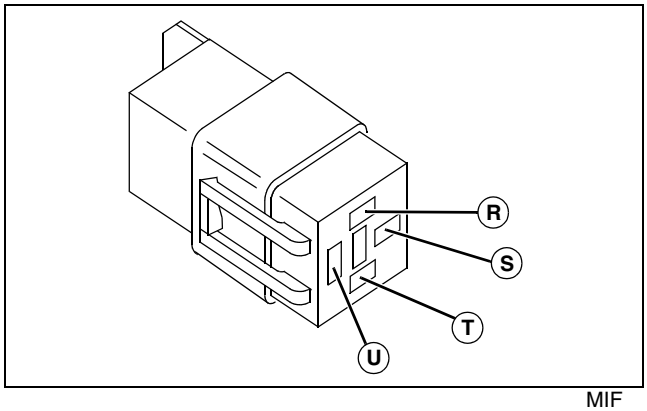
No - Test wire 150 blk and frame ground terminals (W2).

System: Cranking Circuit

(17) Measure voltage at control module (A1) - wire 641 pur (Q). Is battery voltage present?

Yes - Go to step (18).

No - Test control module (A1) and connections. (See “Control Module Test” on page 255.)



MIF

(18) Measure voltage at start relay (K1) - wire 700 pur (T). Is battery voltage present?

Yes - Go to step (19).

No - Test wire 700 pur between start relay and diode (V1). Test wire 701 pur between diode (V1) and mow switch. Test diode (V1). (See “Diode Test” on page 251.)

(19) Turn key switch to START position and check ground circuit resistance at start relay (K1) - wire 325 org/blk (R). Is there less than 0.1 ohm of resistance?

Yes - Go to step (20).

No - Test wire 325 org/blk between start relay and key switch.

(20) Measure voltage at start relay (K1) - wire 212 red (S). Is battery voltage present?

Yes - Go to step (21).

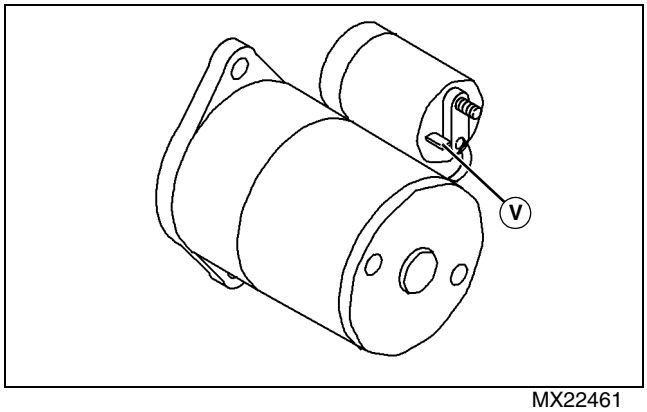
No - Test wire 212 red. Test fusible link (F3) - wire 202 and connections.

(21) Measure voltage at start relay (K1) - wire 410 yel/blk (U). Is battery voltage present?

Yes - Go to step (22).

No - Test start relay. (See “Relay Test” on page 252.)

System: Cranking Circuit



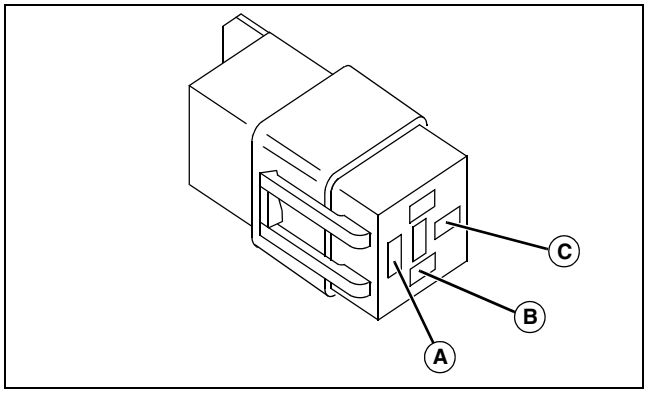
MX22461

(22) Measure voltage at starting motor solenoid - wire 410 yel/blk (V). Is battery voltage present?

Yes - Test starting motor and solenoid. (See “Starter No-Load Amperage Draw and RPM Test” on page 259.) (See “Starter Solenoid Test” on page 260.)

No - Test wire 410 yel/blk and connections.

System: Fuel Shutoff Solenoid Circuit



(1) Measure voltage at fuel pull-in relay (K5) - wire 402 pnk (B). Is battery voltage present?

Yes - Go to step (2).

No - Test wire 402 pnk, engine connector (X1), wire 641 org, and connections.

(2) Turn key switch (S1) to START position and measure voltage at fuel pull-in relay (K5) - wire 411 wht (A). Is battery voltage present?

Yes - Go to step (3).

No - Test wire 411 wht and connections.

System: Fuel Shutoff Solenoid Circuit

(3) Turn key switch between OFF and RUN positions and check fuel pull-in relay (K5) for audible click. Does fuel pull-in relay (K5) energize with an audible click?

Yes - Go to step (4).

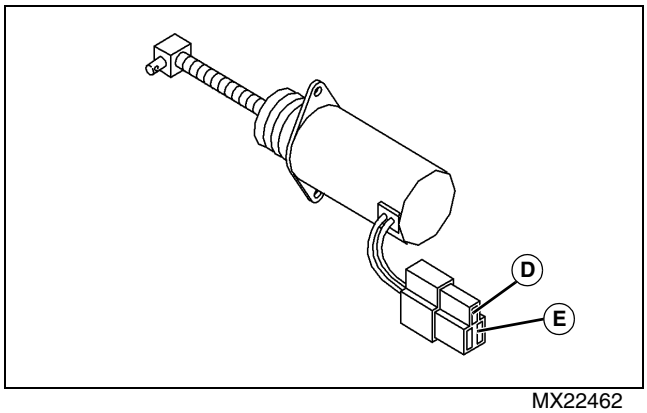
No - Test diode (V4) and connections. (See “Diode Test” on page 251.) Test wires 503, 507, and 501 tan.

No - Test fuel pull-in relay. (See “Relay Test” on page 252.) Test engine oil pressure switch (B3). (See “Engine Oil Pressure Switch Test” on page 250.)

(4) Turn key switch (S1) to START position and measure voltage at fuel pull-in relay (K5) - wire 401 wht (C). Is battery voltage present?

Yes - Go to step (5).

No - Test fuel pull-in relay. (See “Relay Test” on page 252.)



MX22462

(5) Turn key switch (S1) to START position and measure voltage at fuel shutoff solenoid (Y3) - wire 401 wht (E). Is battery voltage present?

Yes - Go to step (6).

No - Test wire 401 wht and connections.

(6) Check ground circuit resistance at fuel shutoff solenoid (Y3) - wire 103 blk (D). Is there less than 0.1 ohm of resistance?

Yes - Replace fuel shutoff solenoid.

No - Test wire 103 blk between fuel shutoff solenoid and splice 1. Test wire 190 blk between splice 1 and frame ground (W2) and connections.

Cranking Circuit Operation S.N. (060001-)

Function

Engage the starting motor and momentarily activate the fuel shutoff solenoid.

Operating Conditions

- Key switch (S1) in START position.
- Neutral switch (S3) in NEUTRAL position.
- Park brake switch (S5) in PARK position.
- Mow switch (S6) in OFF position.

Theory of Operation

Unswitched power from battery (G1) is available at the following components:

- Starting motor (M1) - terminal B
- Fusible link (F2) - wire 200 red
- Main fuse (F1) - wire 206 red/wht
- Key switch (S1) - wire 208 red/blk
- Fusible link (F3) - wire 202 red
- Start relay (K1) - wire 212 red
- Fuel pull-in relay (K5) - wire 211 red/blk S.N. (060001-060554)

When the key switch is in the RUN position, switched power is available to neutral switch (S3) through the following circuits:

- Key switch (S1) - terminal A
- Wire 522 yel/wht
- Splice 2
- Wire 519 yel
- Fuse (F4)
- Wire 521 yel
- Splice 6
- Wire 804 pnk

Voltage is made available to start relay terminal 86 through the following components and circuits:

- Neutral switch (S3) - wire 825 pnk/blk
- Wire 825 pnk/wht
- Park brake switch (S5) - wire 812 pnk/blk
- Mow switch (S6) - wire 701 pur
- Diode (V1) - wire 700 pur

When key switch (S1) is in the START position, ground is provided to start relay terminal 85 between key switch terminals (S1 and S2), energizing the relay. With start relay energized, current flows between start relay terminals (30 and 87) to the solenoid of starting motor (M1), engaging the starting motor.

S.N. (060001-060554)

Voltage is available from the unswitched power circuit to fuel pull-in relay terminal 30 through wire 211 red/blk.

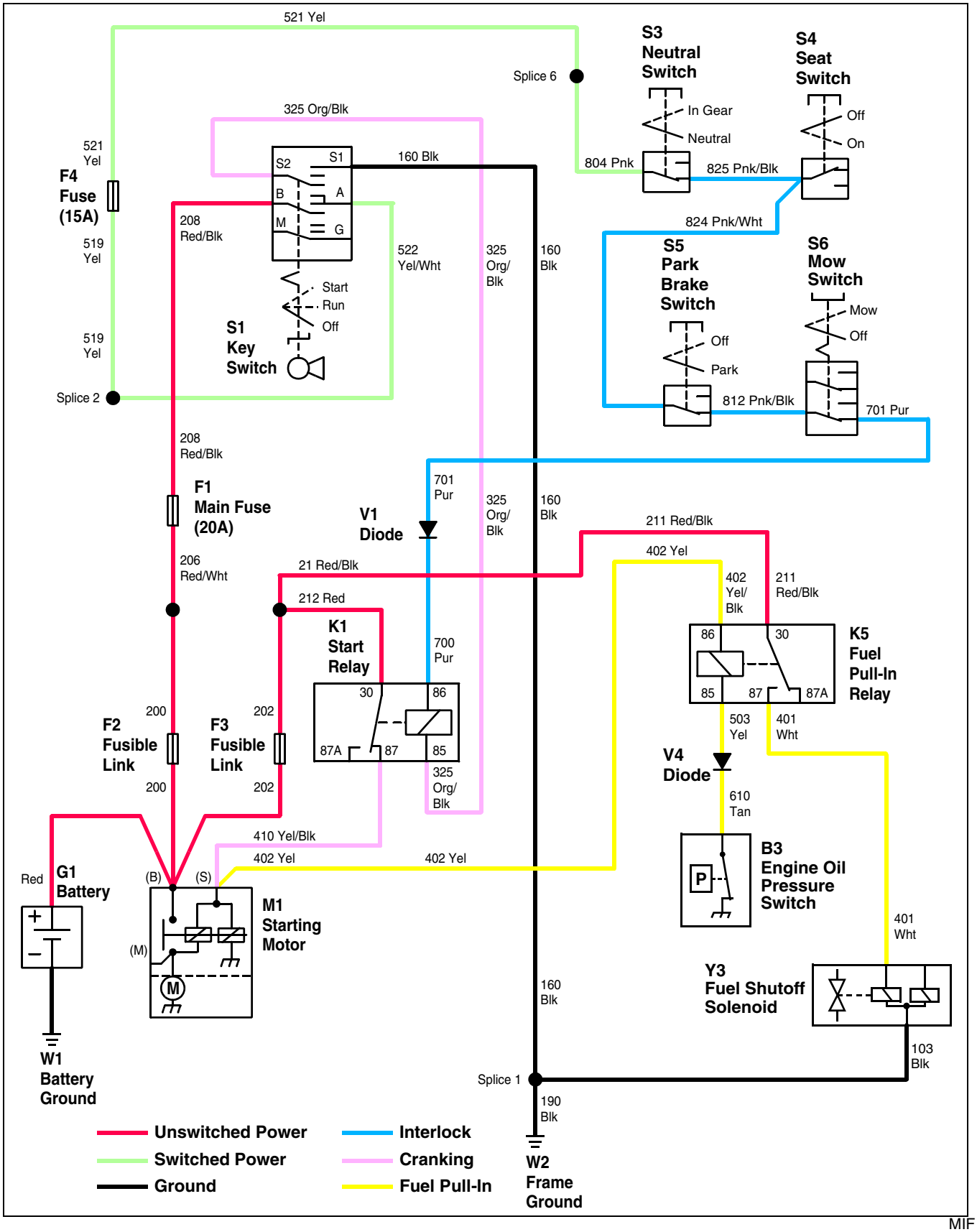
Ground is provided to fuel pull-in relay (K5) when engine oil pressure switch (B3) contacts are closed. With engine oil pressure switch (B3) closed and start relay (K1) energized, current flows from starting motor solenoid terminal S to fuel pull-in relay (K5), energizing the relay. With fuel pull-in relay (K5) energized, current flows between fuel pull-in relay terminals (87 and 30) to the fuel shutoff pull-in coil through wire 401 wht, momentarily energizing the fuel shutoff pull-in coil.

S.N. (060555-)

With starting motor solenoid energized, voltage is available from starting motor terminal M to fuel pull-in relay terminal 30 through wire 911 wht.

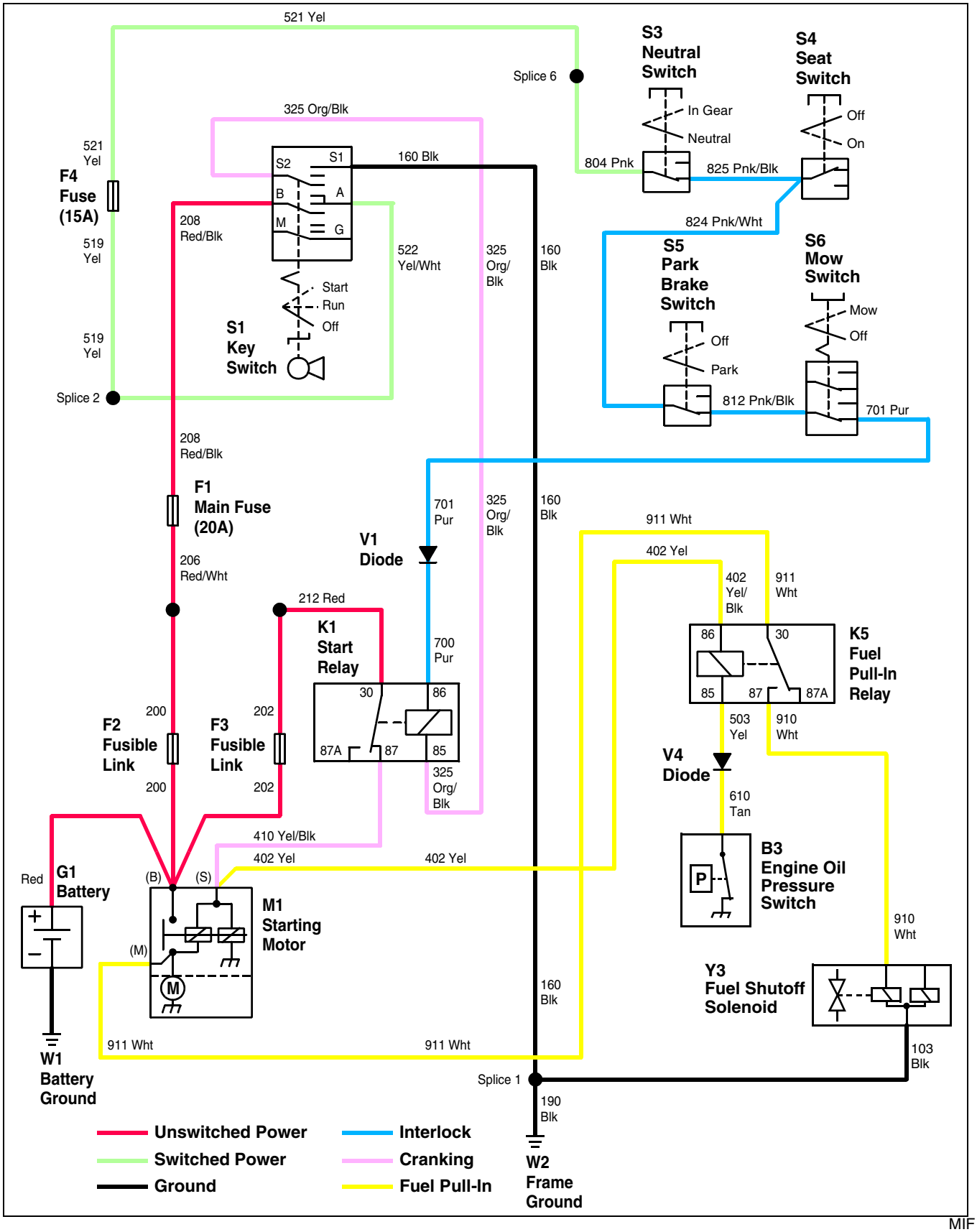
Ground is provided to fuel pull-in relay (K5) when engine oil pressure switch (B3) contacts are closed. With engine oil pressure switch (B3) closed and start relay (K1) energized, current flows from starting motor solenoid terminal S to fuel pull-in relay (K5), energizing the relay. With fuel pull-in relay (K5) energized, current flows between fuel pull-in relay terminals (87 and 30) to the fuel shutoff pull-in coil through wire 910 wht, momentarily energizing the fuel shutoff pull-in coil.

Cranking Circuit Schematic S.N. (060001-060554)



MIF

Cranking Circuit Schematic S.N. (060555-)



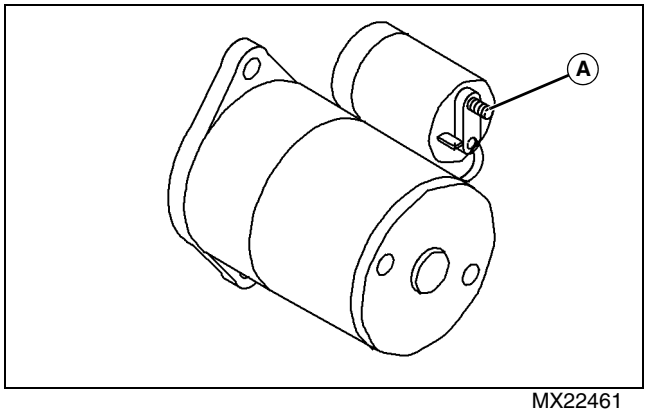
MIF

Cranking Circuit Diagnosis S.N. (060001-)

Test Conditions:

- Mow switch in OFF position.
- Key switch in RUN position.
- Park brake switch in PARK position.
- Neutral switch in NEUTRAL position.

System: Cranking Circuit

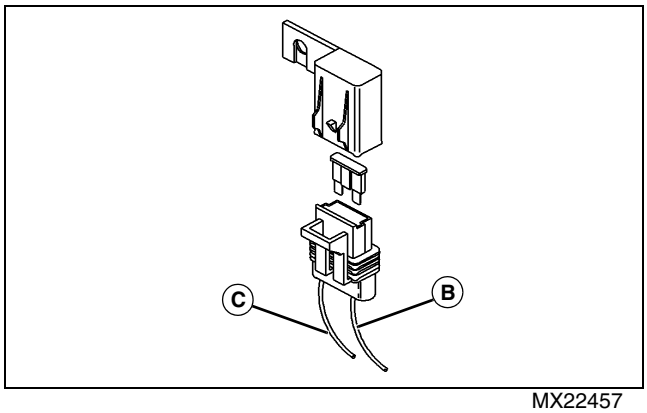


MX22461

(1) Measure voltage at starting motor battery terminal (A). Is battery voltage present?

Yes - Go to step (2).

No - Test battery and connections. (See “Battery Test” on page 246.)



MX22457

(2) Measure voltage at main fuse (F1) - wire 206 red/wht (B). Is battery voltage present?

Yes - Go to step (3).

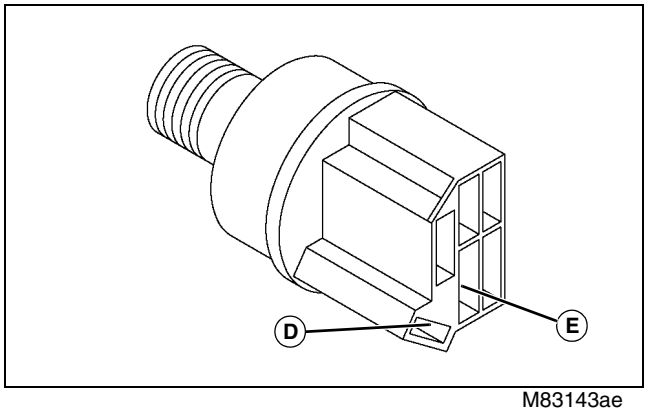
No - Test wire 206 red/wht. Test fusible link (F2) - wire 200 and connections.

System: Cranking Circuit

(3) Measure voltage at main fuse (F1) - wire 208 red/blk (C). Is battery voltage present?

Yes - Go to step (4).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



M83143ae

(4) Measure voltage at key switch (S1) - wire 208 red/blk (D). Is battery voltage present?

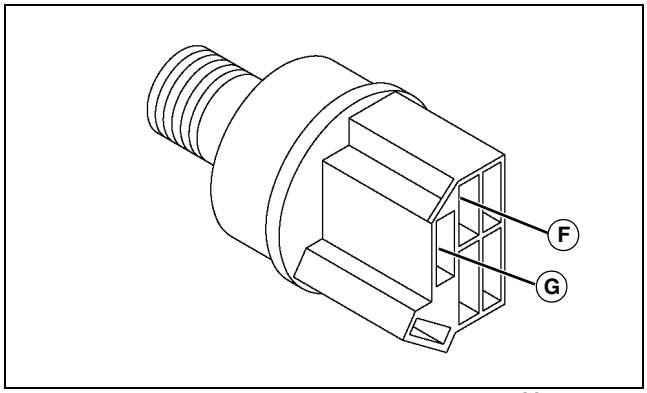
Yes - Go to step (5).

No - Test wire 208 red/blk and connections.

(5) Measure voltage at key switch (S1) - wire 522 yel/wht (E). Is battery voltage present?

Yes - Go to step (6).

No - Test key switch and connections. (See “Key Switch Test” on page 249.)



M83143ae

(6) Check ground circuit resistance at key switch (S1) - wire 160 blk (F). Is there less than 0.1 ohm of resistance?

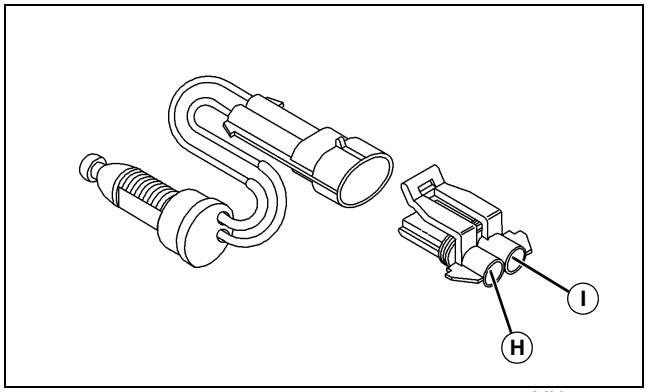
Yes - Go to step (7).

No - Test wire 160 blk between key switch and splice 1. Check wire 190 blk between splice 1 and frame ground (W2) and connections.

(7) Turn key switch (S1) to START position and check ground circuit resistance at key switch (S1) - wire 325 org/blk (G). Is there less than 0.1 ohm of resistance?

Yes - Go to step (8).

No - Test key switch and connections. (See “Key Switch Test” on page 249.)



MX22466

(8) Measure voltage at neutral switch (S3) - wire 804 pnk (H). Is battery voltage present?

Yes - Go to step (9).

No - Test wire 804 pnk between neutral switch (S3) and glow plug switch (S2). Test wire 506 yel between glow plug switch (S2) and engine oil pressure indicator (H3). Test wire 504 yel between engine oil pressure indicator (H3) and engine coolant temperature indicator (H2).

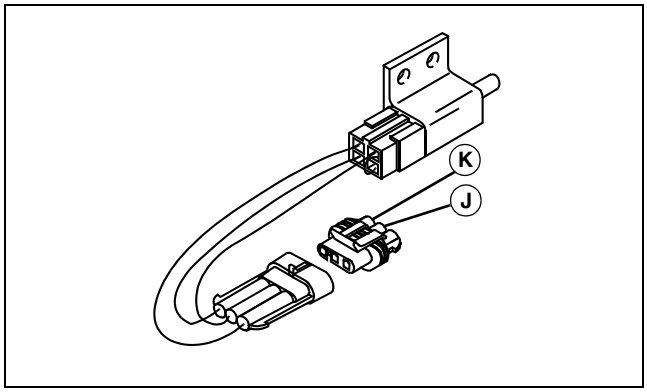
No - Test wire 502 yel/blk between engine coolant temperature indicator (H2) and hydraulic oil temperature indicator (H1). Test wire 500 yel between hydraulic oil temperature indicator (H1) and key switch (S1) and connections.

(9) Measure voltage at neutral switch (S3) - wire 825 pnk/blk (I). Is battery voltage present?

Yes - Go to step (10).

No - Test neutral switch. (See “Neutral Switch Test” on page 253.)

System: Cranking Circuit



(10) Measure voltage at park brake switch (S5) - wire 824 pnk/wht (J). Is battery voltage present?

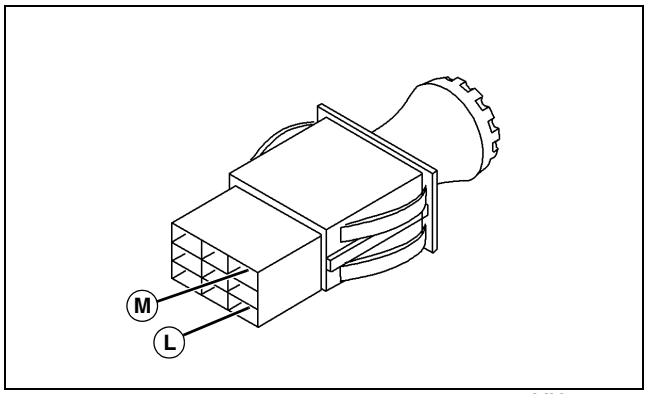
Yes - Go to step (11).

No - Test wires 825 pnk/blk and 824 pnk/wht.

(11) Measure voltage at park brake switch (S5) - wire 812 pnk/blk (K). Is battery voltage present?

Yes - Go to step (12).

No - Test park brake switch. (See “Park Brake Switch Test” on page 253.)



MX22464

(12) Measure voltage at mow switch (S6) - wire 812 pnk/blk (L). Is battery voltage present?

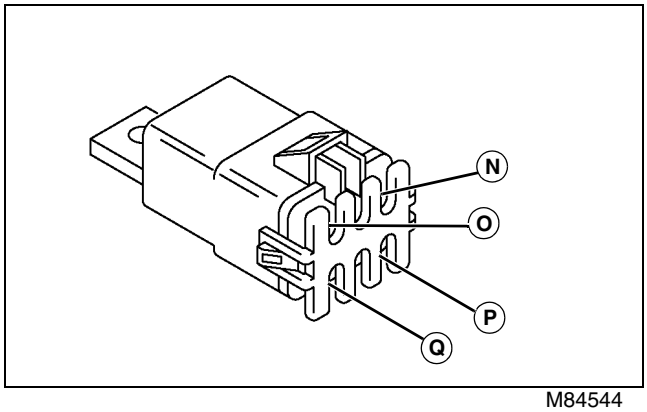
Yes - Go to step (13).

No - Test wire 812 pnk/blk and connections.

(13) Measure voltage at mow switch (S6) - wire 822 pnk/wht (M). Is battery voltage present?

Yes - Go to step (14).

No - Test mow switch. (See “Mow Switch Test” on page 252.)



M84544

(14) Measure voltage at start relay (K1) - wire 700 pur (N). Is battery voltage present?

Yes - Go to step (15).

No - Test wire 700 pur between start relay and diode (V1). Test wire 701 pur between diode (V1) and mow switch. Test diode (V1). (See “Diode Test” on page 251.)

(15) Turn key switch to START position and check ground circuit resistance at start relay (K1) - wire 325 org/blk (Q). Is there less than 0.1 ohm of resistance?

Yes - Go to step (16).

No - Test wire 325 org/blk between start relay and key switch.

(16) Measure voltage at start relay (K1) - wire 212 red (O). Is battery voltage present?

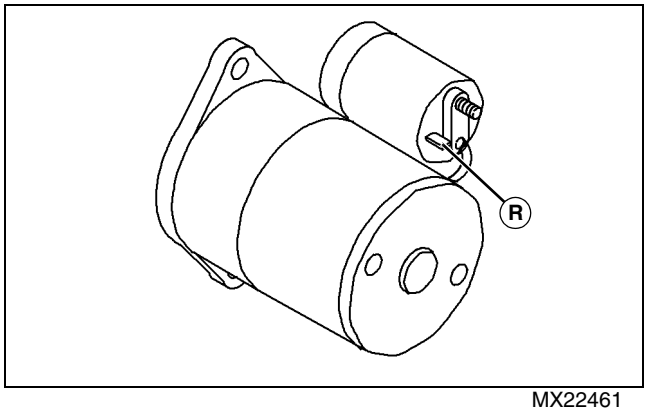
Yes - Go to step (17).

No - Test wire 212 red. Test fusible link (F3) - wire 202 and connections.

(17) Turn key switch to START position and measure voltage at start relay (K1) - wire 410 yel/blk (P). Is battery voltage present?

Yes - Go to step (18).

No - Test start relay. (See “Relay Test” on page 252.)



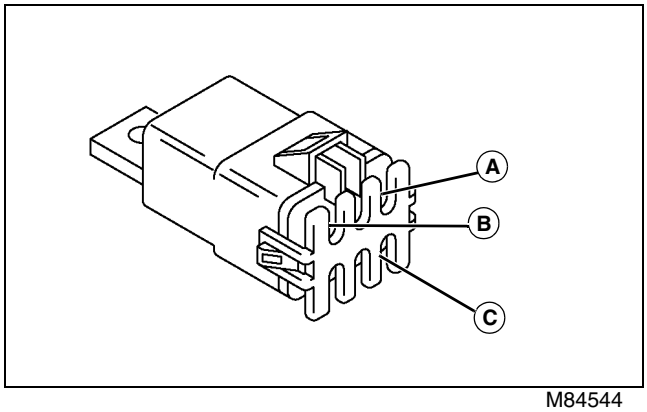
MX22461

(18) Turn key switch to START position and measure voltage at starting motor solenoid - wire 410 yel/blk (R). Is battery voltage present?

Yes - Test starting motor and solenoid. (See “Starter No-Load Amperage Draw and RPM Test” on page 259.) (See “Starter Solenoid Test” on page 260.)

No - Test wire 410 yel/blk and connections.

System: Fuel Shutoff Solenoid Circuit



M84544

(1) Measure voltage at fuel pull-in relay (K5) - wire 402 Yel (A). Is battery voltage present?

Yes - Go to step (2).

No - Test wire 402 yel and connections.

(2) Turn key switch (S1) to START position and measure voltage at fuel pull-in relay (K5) - wire 211 red/blk S.N. (060001-060554) or wire 911 wht S.N. (060555-) (B). Is battery voltage present?

Yes - Go to step (3).

No - S.N. (060001-060554): Test wire 211 red/blk and connections.

No - S.N. (060555-): Test wire 911 wht and connections.

(3) Turn key switch between OFF and RUN position and check fuel pull-in relay (K5) for audible click. Does fuel pull-in relay (K5) energize with an audible click?

Yes - Go to step (4).

No - Test diode (V4) and connections. (See “Diode Test” on page 251.) Test wires 503 and 510 tan.

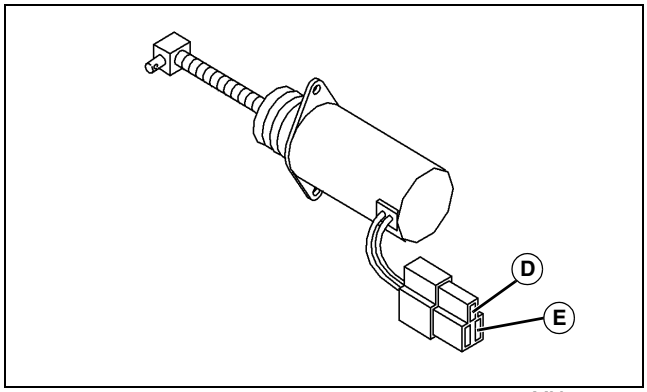
No - Test fuel pull-in relay. (See “Relay Test” on page 252.) Test engine oil pressure switch (B3). (See “Engine Oil Pressure Switch Test” on page 250.)

System: Fuel Shutoff Solenoid Circuit

(4) Turn key switch (S1) to START position and measure voltage at fuel pull-in relay (K5) - wire 401 wht S.N. (060001-060554) or wire 910 wht S.N. (060555-) (C). Is battery voltage present?

Yes - Go to step (5).

No - Test fuel pull-in relay. (See “Relay Test” on page 252.)



MX22462

(5) Turn key switch (S1) to START position and measure voltage at fuel shutoff solenoid (Y3) - wire 401 wht S.N. (060001-060554) or wire 910 wht S.N. (060555-) (E). Is battery voltage present?

Yes - Go to step (6).

No - S.N. (060001-060554): Test wire 401 wht and connections.

No - S.N. (060555): Test wire 910 wht and connections.

(6) Check ground circuit resistance at fuel shutoff solenoid (Y3) - wire 103 blk (D). Is there less than 0.1 ohm of resistance?

Yes - Replace fuel shutoff solenoid.

No - Test wire 103 blk between fuel shutoff solenoid and splice 1. Test wire 190 blk between splice 1 and frame ground (W2) and connections.

Run Circuit Operation - Operator On Seat S.N. (-050071)

Function

To allow the engine to run with the operator on the seat.

Operating Conditions

- Key switch in RUN position.
- Operator ON seat.
- Park brake in OFF position.

Theory of Operation

Unswitched power from battery (G1) is available at the following components:

- Starting motor (M1) - terminal B
- Fusible link (F2) - wire 200 red
- Main fuse (F1) - wire 206 red/wht
- Key switch (S1) - wire 208 red/blk

When the key switch is in the RUN position, switched power is available to the following components and circuits:

- Control module (A1) - wire 520 yel/blk
- Wire 800 pnk/blk
- Park brake switch (S5) - wire 803 red

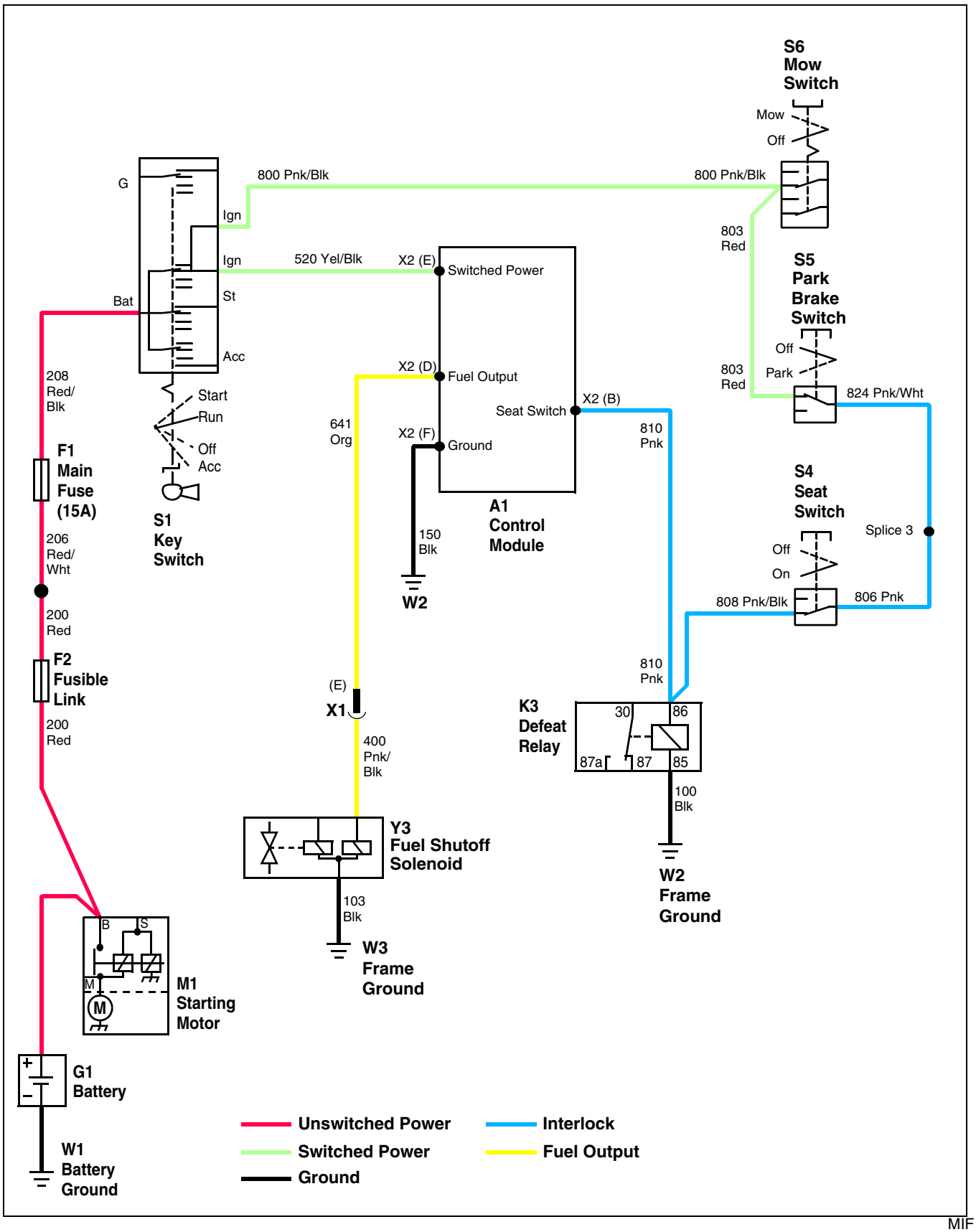
When current flows to control module seat switch terminal, control module (A1) provides voltage to control module fuel output terminal. Current flows to seat switch terminal through the following components and circuits:

- Park brake switch (S5) - wire 824 pnk/wht
- Splice 3
- Wire 806 pnk
- Seat switch - wire 808 pnk/blk
- Wire 810 pnk

With voltage available to control module fuel output terminal, current flows to fuel shutoff solenoid hold-in coil, energizing the hold-in coil. With the hold-in coil energized, fuel is allowed to flow and the engine continues to operate.

When current stops flowing to control module seat switch terminal, control module (A1) deactivates the fuel output terminal and the hold-in coil de-energizes. With the hold-in coil de-energized, fuel is prevented to flow and the engine stops operating. Control module (A1) provides a 0.5-second delay before deactivating the fuel output terminal to compensate for seat switch bounce.

Run Circuit Schematic - Operator On Seat S.N. (-050071)



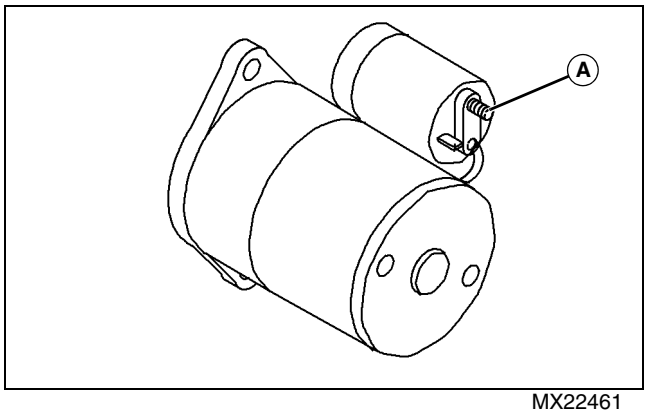
MIF

Run Circuit Diagnosis - Operator On Seat S.N. (-050071)

Test Conditions:

- Key switch in RUN position.
- Park brake switch in OFF position.
- Operator ON seat.

System: Run Circuit - Operator On Seat

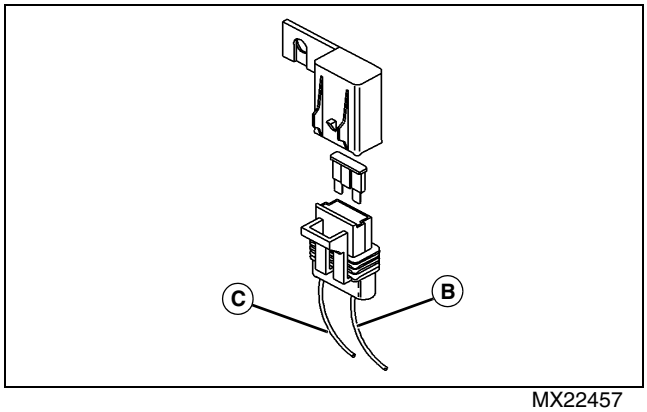


MX22461

(1) Measure voltage at starting motor battery terminal (A). Is battery voltage present?

Yes - Go to step (2).

No - Test battery and connections. (See “Battery Test” on page 246.)



MX22457

(2) Measure voltage at main fuse (F1) - wire 206 red/wht (B). Is battery voltage present?

Yes - Go to step (3).

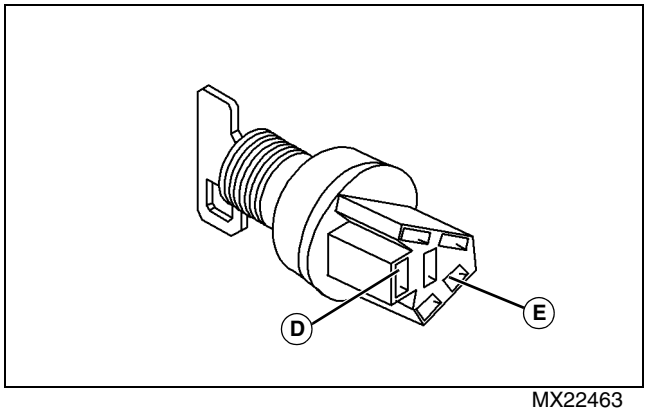
No - Test wire 206 red/wht. Test fusible link (F2) - wire 200 and connections.

System: Run Circuit - Operator On Seat

(3) Measure voltage at main fuse (F1) - wire 208 red/blk (C). Is battery voltage present?

Yes - Go to step (4).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



MX22463

(4) Measure voltage at key switch (S1) - wire 208 red/blk (D). Is battery voltage present?

Yes - Go to step (5).

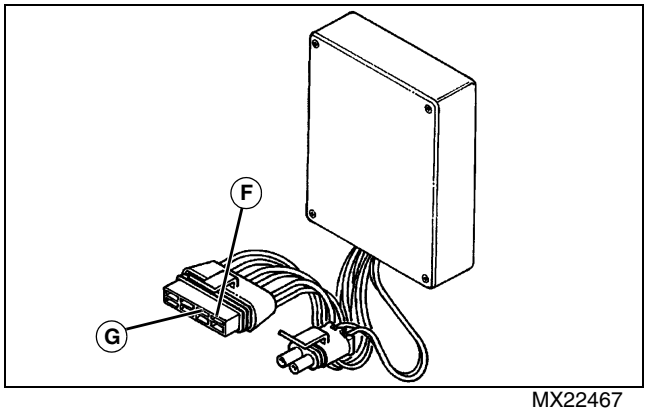
No - Test wire 208 red/blk and connections.

(5) Measure voltage at key switch (S1) - wire 520 yel/blk (E). Is battery voltage present?

Yes - Go to step (6).

No - Replace key switch.

System: Run Circuit - Operator On Seat



MX22467

(6) Measure voltage at control module (A1) - wire 520 yel/blk (F). Is battery voltage present?

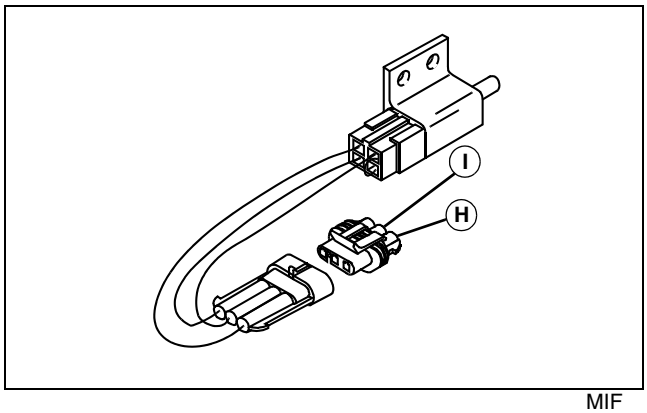
Yes - Go to step (7).

No - Test wire 520 yel/blk and connections.

(7) Check ground circuit resistance at control module (A1) - wire 150 blk (G). Is there less than 0.1 ohm of resistance?

Yes - Go to step (8).

No - Test wire 150 blk and frame ground terminals (W2).



MIF

(8) Measure voltage at park brake switch (S5) - wire 803 red (H). Is battery voltage present?

Yes - Go to step (9).

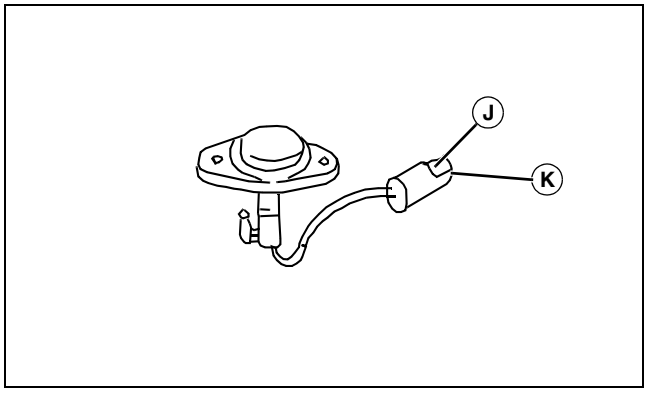
No - Test wire 803 red and connections.

(9) Measure voltage at park brake switch (S5) - wire 824 pnk/wht (I). Is battery voltage present?

Yes - Go to step (10).

No - Test park brake switch. (See “Park Brake Switch Test” on page 253.)

System: Run Circuit - Operator On Seat



(10) Measure voltage at seat switch connector (X4) - wire 806 pnk (J). Is battery voltage present?

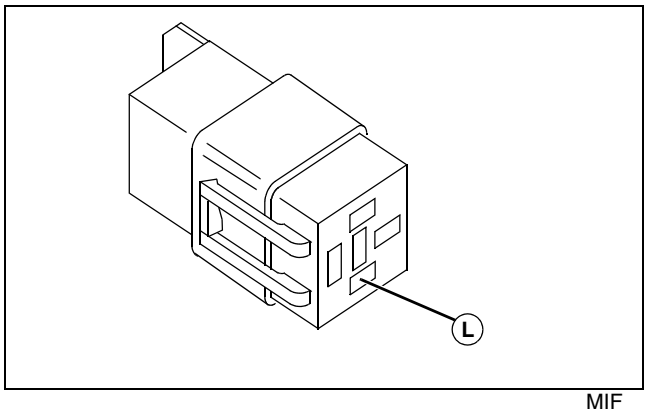
Yes - Go to step (11).

No - Test wires 806 pnk and 824 pnk/wht.

(11) Measure voltage at seat switch connector (X4) - wire 808 pnk/blk (K). Is battery voltage present?

Yes - Go to step (12).

No - Replace seat switch.



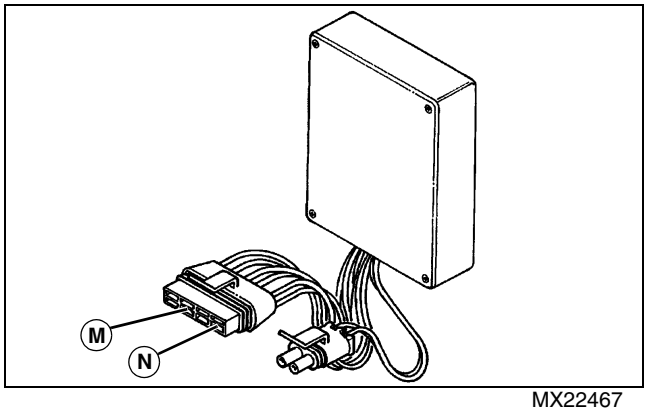
MIF

(12) Measure voltage at defeat relay (K3) - wire 808 pnk/blk (L). Is battery voltage present?

Yes - Go to step (13).

No - Test wire 808 pnk/blk and connections.

System: Run Circuit - Operator On Seat



MX22467

(13) Measure voltage at control module (A1) - wire 810 pnk (M). Is battery voltage present?

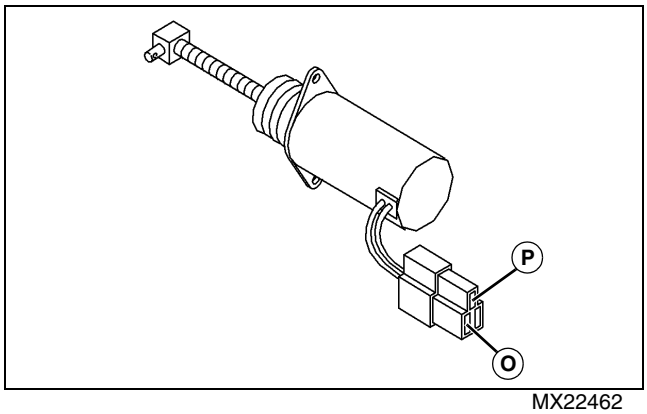
Yes - Go to step (14).

No - Test wire 810 pnk and connections.

(14) Measure voltage at control module (A1) - wire 641 org (N). Is battery voltage present?

Yes - Go to step (15).

No - Test control module. (See “Control Module Test” on page 255.)



MX22462

(15) Measure voltage at fuel shutoff solenoid (Y3) - wire 400 pnk/blk (O). Is battery voltage present?

Yes - Go to step (16).

No - Test wires 400 pnk/blk and 641 org.

(16) Check ground circuit resistance at fuel shutoff solenoid (Y3) - wire 103 blk (P). Is there less than 0.1 ohm of resistance?

Yes - Replace fuel shutoff solenoid.

No - Test wire 103 blk, frame ground (W3), and connections.

Run Circuit Operation - Operator On Seat S.N. (050072-060000)

Function

To allow the engine to run with the operator on the seat.

Operating Conditions

- Key switch in RUN position.
- Operator ON seat.
- Park brake in OFF position.

Theory of Operation

Unswitched power from battery (G1) is available at the following components:

- Starting motor (M1) - terminal B
- Fusible link (F2) - wire 200 red
- Main fuse (F1) - wire 206 red/wht
- Key switch (S1) - wire 208 red/blk

When the key switch is in the RUN position, switched power is available to control module (A1) through the following circuits:

- Wire 522 yel/wht
- Splice 2
- Wire 518 yel
- Wire 520 yel/blk

Switched power is also available to park brake switch (S5) through the following circuits:

- Wire 800 pnk/wht
- Wire 801 pnk/wht
- Wire 803 red

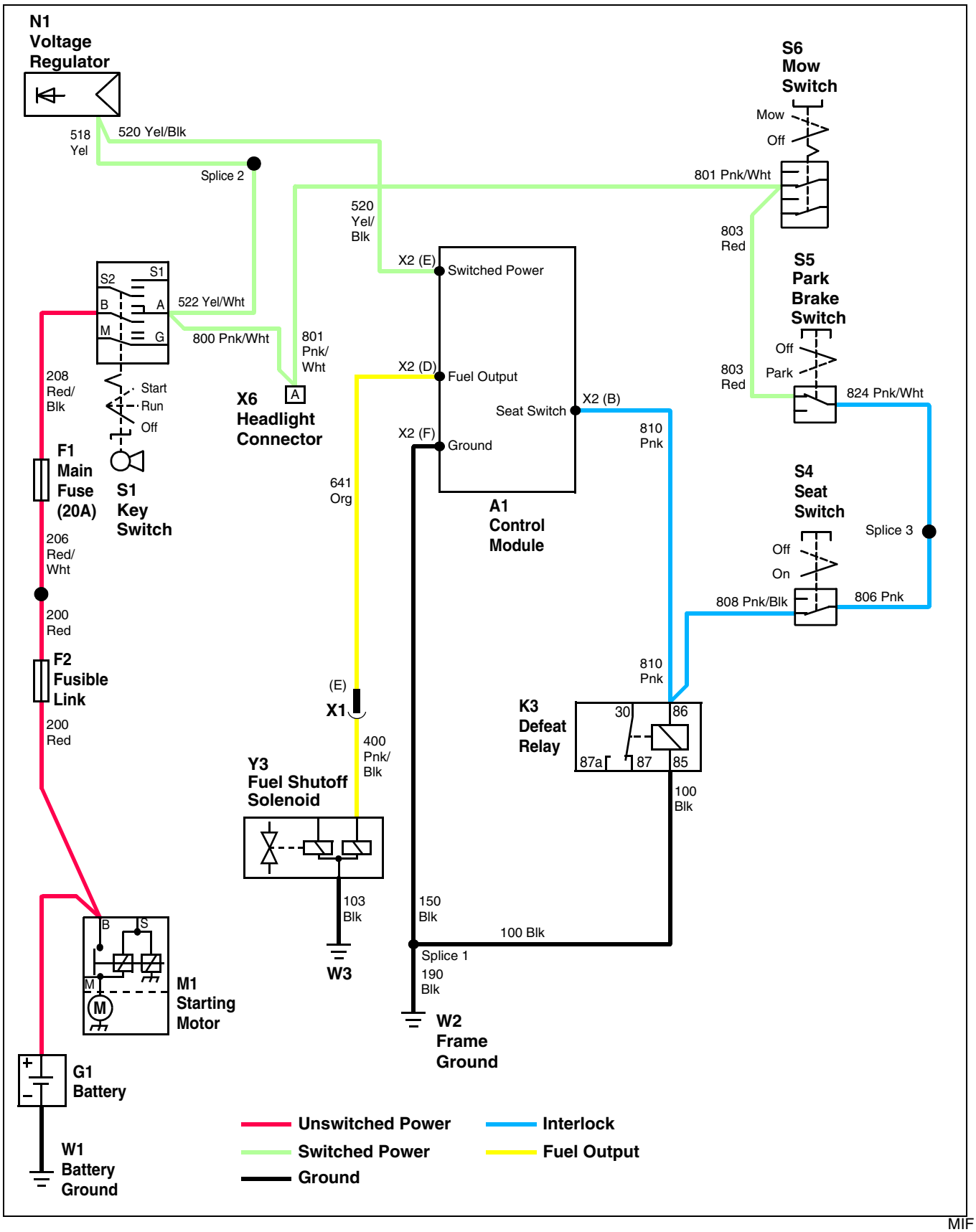
When current flows to control module seat switch terminal, control module (A1) provides voltage to control module fuel output terminal. Current flows to seat switch terminal through the following components and circuits:

- Park brake switch (S5) - wire 824 pnk/wht
- Splice 3
- Wire 806 pnk
- Seat switch - wire 808 pnk/blk
- Wire 810 pnk

With voltage available to control module fuel output terminal, current flows to fuel shutoff solenoid hold-in coil, energizing the hold-in coil. With the hold-in coil energized, fuel is allowed to flow and the engine continues to operate.

When current stops flowing to control module seat switch terminal, control module (A1) deactivates the fuel output terminal and the hold-in coil de-energizes. With the hold-in coil de-energized, fuel is prevented to flow and the engine stops operating. Control module (A1) provides a 0.5-second delay before deactivating the fuel output terminal to compensate for seat switch bounce.

Run Circuit Schematic - Operator On Seat S.N. (050072-060000)



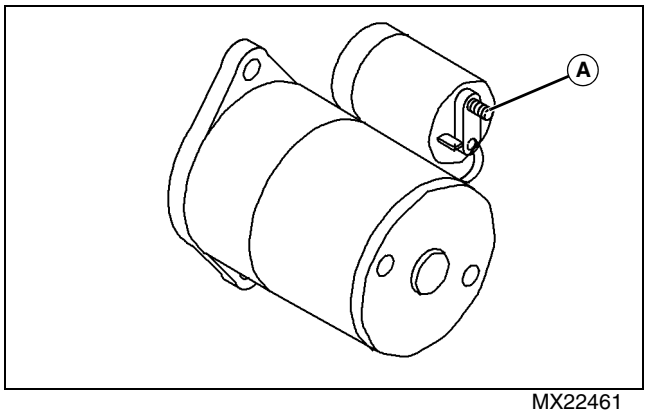
MIF

Run Circuit Diagnosis - Operator On Seat S.N. (050072-060000)

Test Conditions:

- Key switch in RUN position.
- Park brake switch in OFF position.
- Operator ON seat.

System: Run Circuit - Operator On Seat

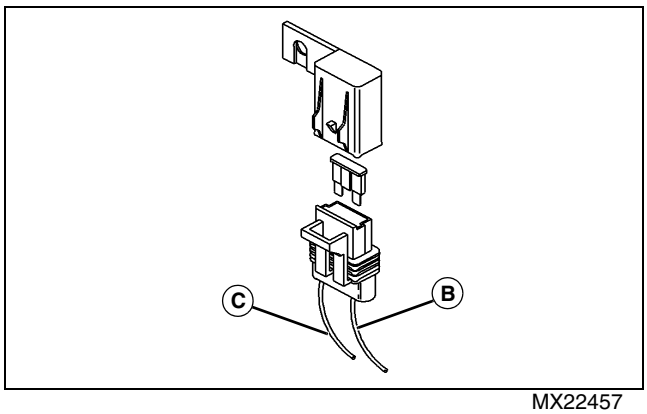


MX22461

(1) Measure voltage at starting motor battery terminal (A). Is battery voltage present?

Yes - Go to step (2).

No - Test battery and connections. (See “Battery Test” on page 246.)



MX22457

(2) Measure voltage at main fuse (F1) - wire 206 red/wht (B). Is battery voltage present?

Yes - Go to step (3).

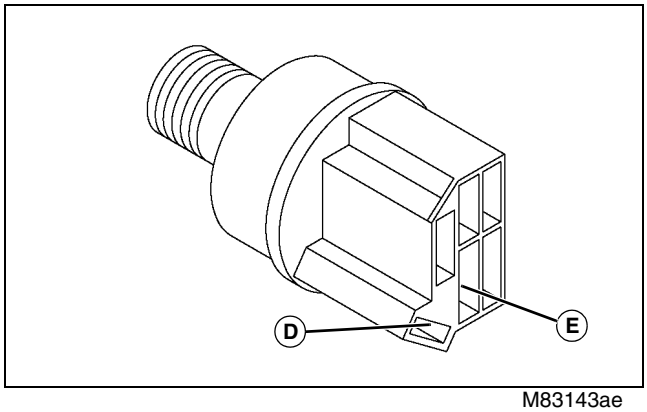
No - Test wire 206 red/wht. Test fusible link (F2) - wire 200 and connections.

System: Run Circuit - Operator On Seat

(3) Measure voltage at main fuse (F1) - wire 208 red/blk (C). Is battery voltage present?

Yes - Go to step (4).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



M83143ae

(4) Measure voltage at key switch (S1) - wire 208 red/blk (D). Is battery voltage present?

Yes - Go to step (5).

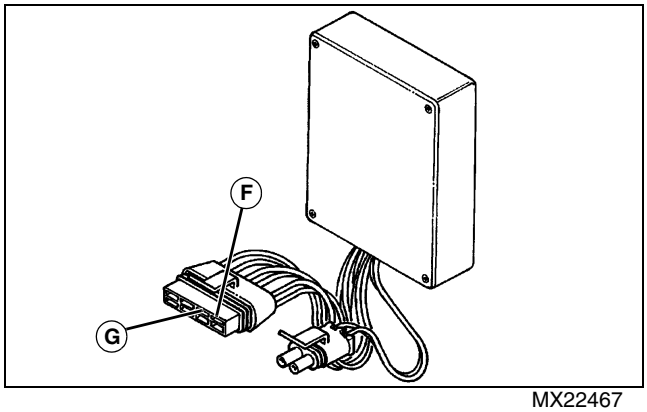
No - Test wire 208 red/blk and connections.

(5) Measure voltage at key switch (S1) - wire 522 yel/wht (E). Is battery voltage present?

Yes - Go to step (6).

No - Test key switch and connections. (See “Key Switch Test” on page 249.)

System: Run Circuit - Operator On Seat



MX22467

(6) Measure voltage at control module (A1) - wire 520 yel/blk (F). Is battery voltage present?

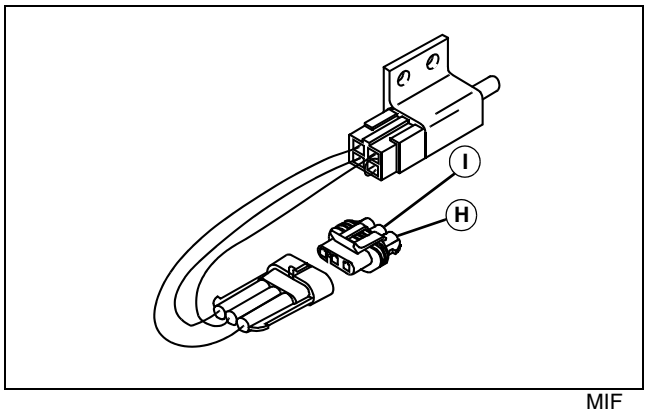
Yes - Go to step (7).

No - Test wires 520 yel/blk, 518 yel, and 522 yel/wht.

(7) Check ground circuit resistance at control module (A1) - wire 150 blk (G). Is there less than 0.1 ohm of resistance?

Yes - Go to step (8).

No - Test wires 190 and 150 blk. Check frame ground terminal (W2).



MIF

(8) Measure voltage at park brake switch (S5) - wire 803 red (H). Is battery voltage present?

Yes - Go to step (9).

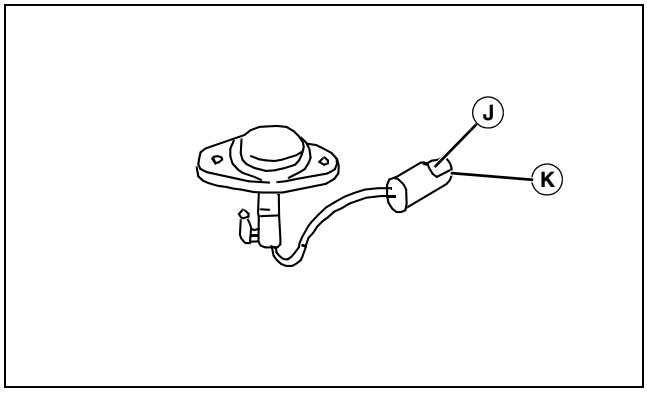
No - Test wire 803 red and connections. Test wires 801 and 800 pnk/wht.

(9) Measure voltage at park brake switch (S5) - wire 824 pnk/wht (I). Is battery voltage present?

Yes - Go to step (10).

No - Test park brake switch. (See “Park Brake Switch Test” on page 253.)

System: Run Circuit - Operator On Seat



(10) Measure voltage at seat switch connector (X4) - wire 806 pnk (J). Is battery voltage present?

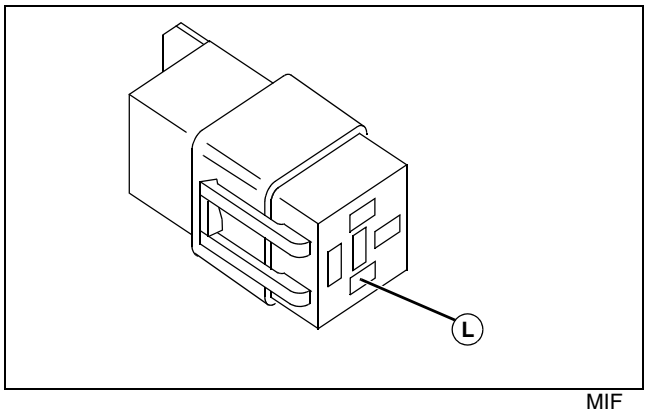
Yes - Go to step (11).

No - Test wires 806 pnk and 824 pnk/wht.

(11) Measure voltage at seat switch connector (X4) - wire 808 pnk/blk (K). Is battery voltage present?

Yes - Go to step (12).

No - Replace seat switch.



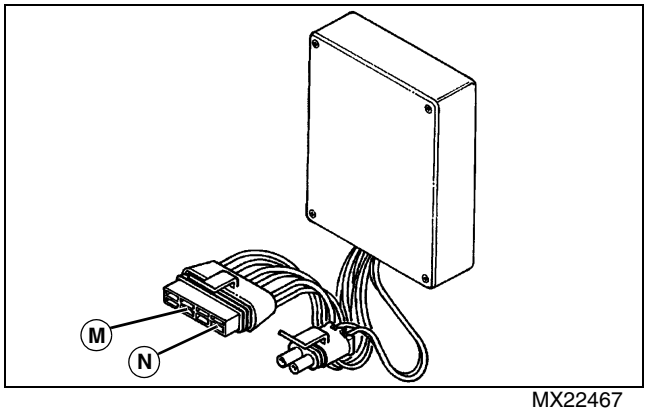
MIF

(12) Measure voltage at defeat relay (K3) - wire 808 pnk/blk (L). Is battery voltage present?

Yes - Go to step (13).

No - Test wire 808 pnk/blk and connections.

System: Run Circuit - Operator On Seat



MX22467

(13) Measure voltage at control module (A1) - wire 810 pnk (M). Is battery voltage present?

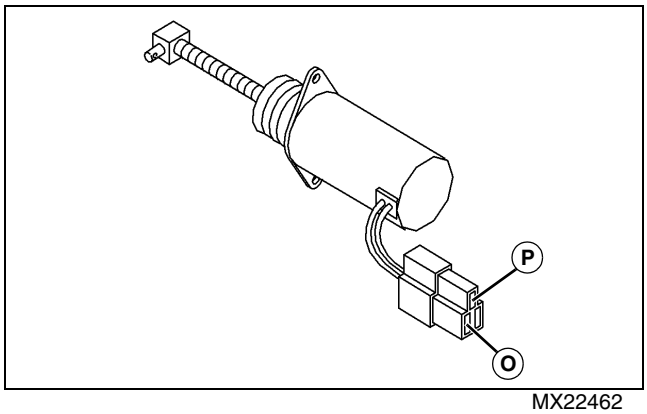
Yes - Go to step (14).

No - Test wire 810 pnk and connections.

(14) Measure voltage at control module (A1) - wire 641 org (N). Is battery voltage present?

Yes - Go to step (15).

No - Test control module. (See “Control Module Test” on page 255.)



MX22462

(15) Measure voltage at fuel shutoff solenoid (Y3) - wire 400 pnk/blk (O). Is battery voltage present?

Yes - Go to step (16).

No - Test wires 400 pnk/blk and 641 org.

(16) Check ground circuit resistance at fuel shutoff solenoid (Y3) - wire 103 blk (P). Is there less than 0.1 ohm of resistance?

Yes - Replace fuel shutoff solenoid.

No - Test wire 103 blk, frame ground (W3), and connections.

Run Circuit Operation - Operator On Seat S.N. (060001-)

Function

To allow the engine to run with the operator on the seat.

Operating Conditions

- Key switch in RUN position.
- Operator ON seat.
- Park brake in OFF position.

Theory of Operation

Unswitched power from battery (G1) is available at the following components:

- Starting motor (M1) - terminal B
- Fusible link (F2) - wire 200 red
- Main fuse (F1) - wire 206 red/wht
- Key switch (S1) - wire 208 red/blk

When the key switch is in the RUN position, switched power is available to control module (A1) through the following circuits:

- Wire 522 yel/wht
- Splice 2
- Wire 519 yel
- Fuse (F4)
- Wire 521 yel
- Splice 6
- Wire 520 yel/blk

Switched power is also available to park brake switch (S5) from splice 6 through wire 803 red.

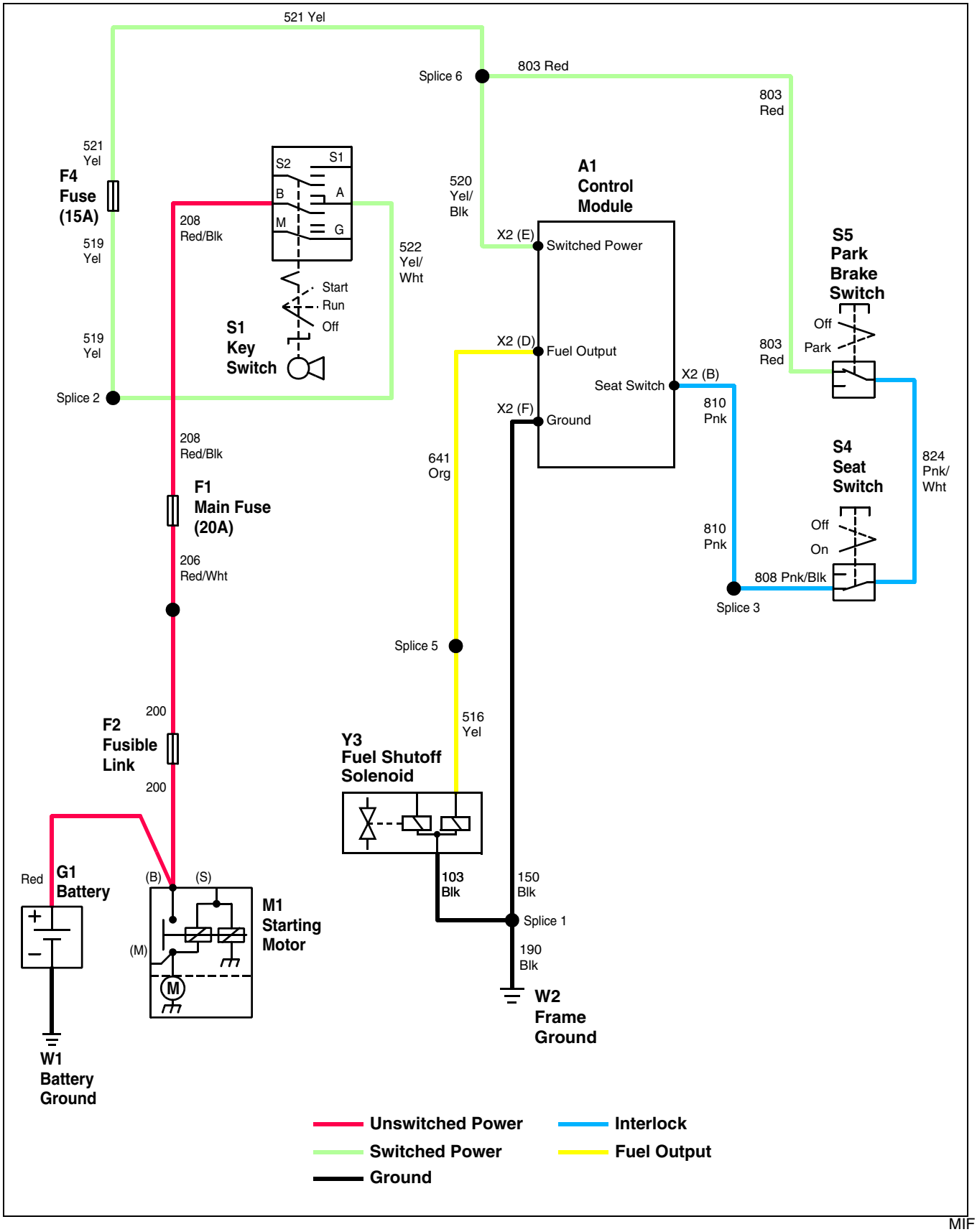
When current flows to control module seat switch terminal, control module (A1) provides voltage to control module fuel output terminal. Current flows to seat switch terminal through the following components and circuits:

- Park brake switch (S5) - wire 824 pnk/wht
- Splice 3
- Wire 806 pnk
- Seat switch - wire 808 pnk/blk
- Wire 810 pnk

With voltage available to control module fuel output terminal, current flows to fuel shutoff solenoid hold-in coil, energizing the hold-in coil. With the hold-in coil energized, fuel is allowed to flow and the engine continues to operate.

When current stops flowing to control module seat switch terminal, control module (A1) deactivates the fuel output terminal and the hold-in coil de-energizes. With the hold-in coil de-energized, fuel is prevented to flow and the engine stops operating. Control module (A1) provides a 0.5-second delay before deactivating the fuel output terminal to compensate for seat switch bounce.

Run Circuit Schematic - Operator On Seat S.N. (060001-)



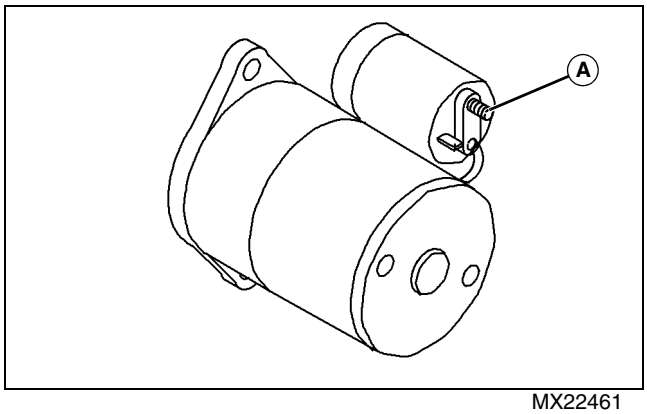
MIF

Run Circuit Diagnosis - Operator On Seat S.N. (060001-)

Test Conditions:

- Key switch in RUN position.
- Park brake switch in OFF position.
- Operator ON seat.

System: Run Circuit - Operator On Seat



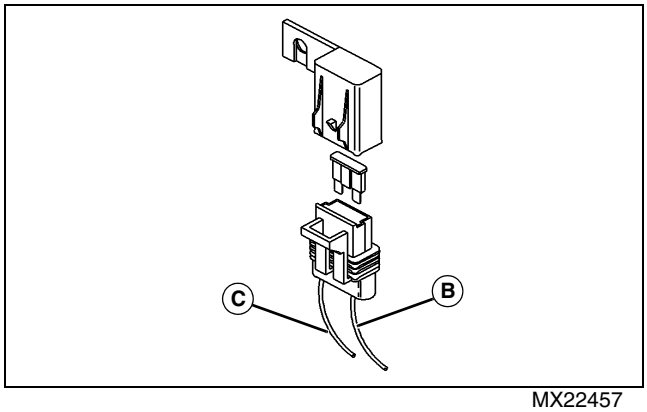
MX22461

(1) Measure voltage at starting motor battery terminal (A). Is battery voltage present?

Yes - Go to step (2).

No - Test battery and connections. (See “Battery Test” on page 246.)

System: Run Circuit - Operator On Seat



MX22457

(2) Measure voltage at main fuse (F1) - wire 206 red/wht (B). Is battery voltage present?

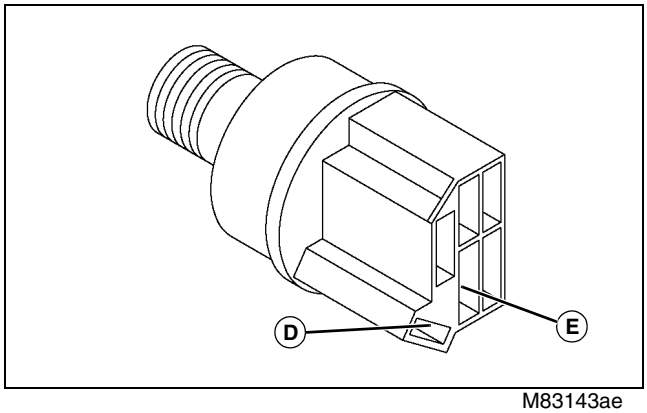
Yes - Go to step (3).

No - Test wire 206 red/wht. Test fusible link (F2) - wire 200 and connections.

(3) Measure voltage at main fuse (F1) - wire 208 red/blk (C). Is battery voltage present?

Yes - Go to step (4).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



M83143ae

(4) Measure voltage at key switch (S1) - wire 208 red/blk (D). Is battery voltage present?

Yes - Go to step (5).

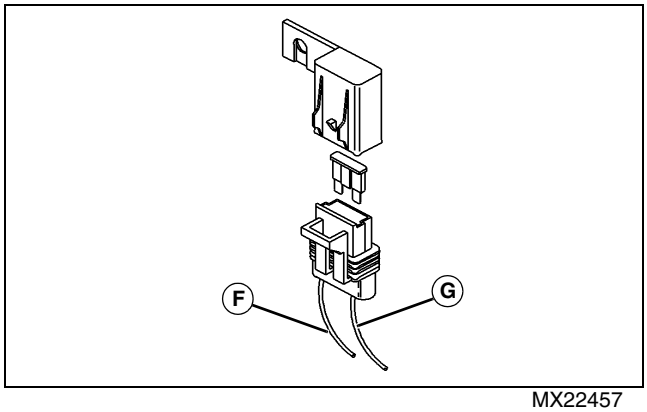
No - Test wire 208 red/blk and connections.

(5) Measure voltage at key switch (S1) - wire 522 yel/wht (E). Is battery voltage present?

Yes - Go to step (6).

No - Test key switch and connections. (See “Key Switch Test” on page 249.)

System: Run Circuit - Operator On Seat



MX22457

(6) Measure voltage at fuse (F4) - wire 519 yel (F). Is battery voltage present?

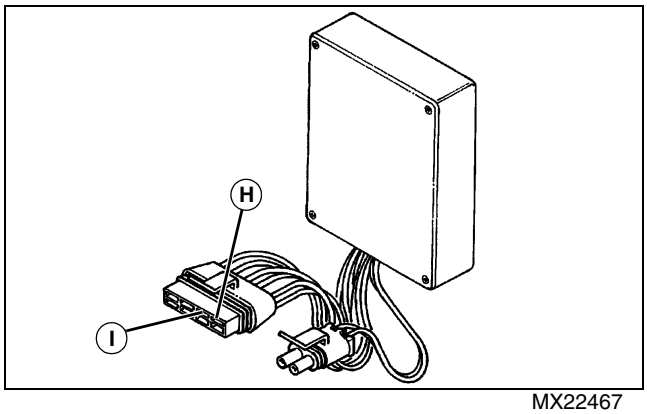
Yes - Go to step (7).

No - Test wires 519 yel and 522 yel/wht.

(7) Measure voltage at fuse (F4) - wire 521 yel (G). Is battery voltage present?

Yes - Go to step (8).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



MX22467

(8) Measure voltage at control module (A1) - wire 520 yel/blk (H). Is battery voltage present?

Yes - Go to step (9).

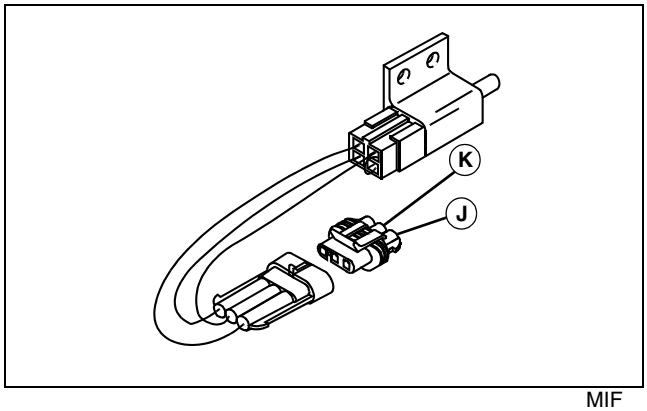
No - Test wires 520 yel/blk and 521 yel.

(9) Check ground circuit resistance at control module (A1) - wire 150 blk (I). Is there less than 0.1 ohm of resistance?

Yes - Go to step (10).

No - Test wires 150 and 190 blk. Check frame ground (W2).

System: Run Circuit - Operator On Seat



MIF

(10) Measure voltage at park brake switch (S5) - wire 803 red (J). Is battery voltage present?

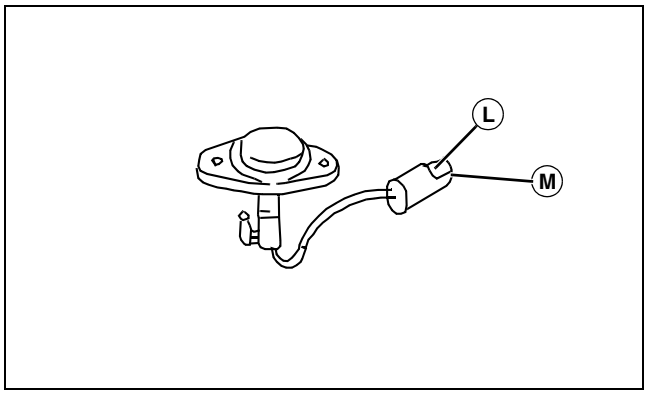
Yes - Go to step (11).

No - Test wire 803 red and connections.

(11) Measure voltage at park brake switch (S5) - wire 824 pnk/wht (K). Is battery voltage present?

Yes - Go to step (12).

No - Test park brake switch. (See “Park Brake Switch Test” on page 253.)



(12) Measure voltage at seat switch connector (X4) - wire 824 pnk/wht (L). Is battery voltage present?

Yes - Go to step (13).

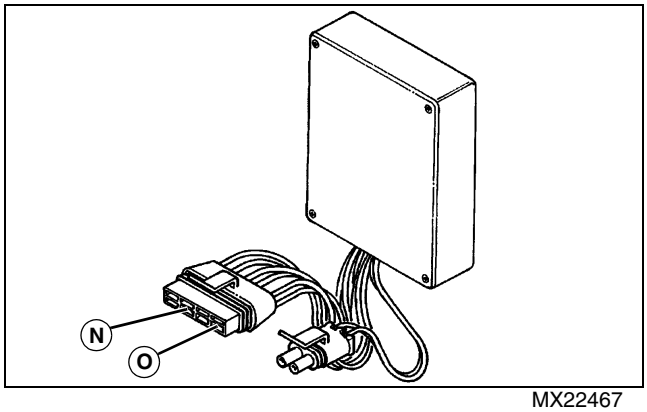
No - Test wire 824 pnk/wht and connections.

(13) Measure voltage at seat switch connector (X4) - wire 808 pnk/blk (M). Is battery voltage present?

Yes - Go to step (14).

No - Replace seat switch.

System: Run Circuit - Operator On Seat



MX22467

(14) Measure voltage at control module (A1) - wire 810 pnk (N). Is battery voltage present?

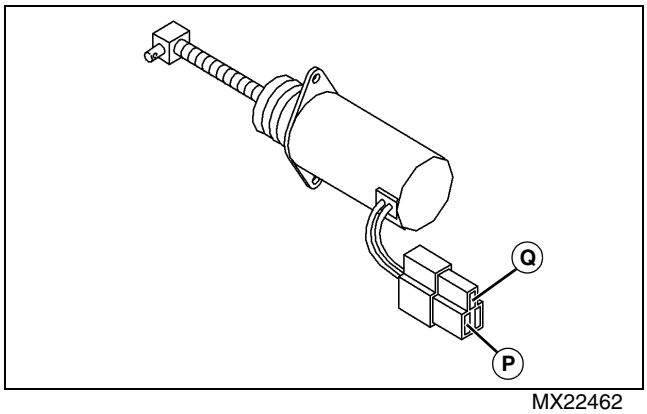
Yes - Go to step (15).

No - Test wire 810 pnk and connections.

(15) Measure voltage at control module (A1) - wire 641 org (O). Is battery voltage present?

Yes - Go to step (16).

No - Test control module. (See “Control Module Test” on page 255.)



MX22462

(16) Measure voltage at fuel shutoff solenoid (Y3) - wire 516 yel (P). Is battery voltage present?

Yes - Go to step (17).

No - Test wires 516 yel and 641 org.

(17) Check ground circuit resistance at fuel shutoff solenoid (Y3) - wire 103 blk (Q). Is there less than 0.1 ohm of resistance?

Yes - Replace fuel shutoff solenoid.

No - Test wires 103 and 190 blk. Check frame ground (W2).

Run Circuit Operation - Operator Off Seat S.N. (-050071)

Function

To allow the engine to run with the operator off the seat.

Operating Conditions

- Key switch in RUN position.
- Operator OFF seat.
- Park brake in PARK position.
- Neutral switch in NEUTRAL position.

Theory of Operation

Unswitched power from battery (G1) is available at the following components:

- Starting motor (M1) - terminal B
- Fusible link (F2) - wire 200 red
- Main fuse (F1) - wire 206 red/wht
- Key switch (S1) - wire 208 red/blk

When the key switch is in the RUN position, switched power is available at the following components:

- Control module (A1) - wire 520 yel/blk
- Hydraulic oil temperature indicator (H1) - wire 500 yel
- Engine coolant temperature indicator (H2) - wire 502 yel/blk
- Engine oil pressure indicator (H3) - wire 504 yel
- Glow plug switch (S2) - wire 506 yel
- Neutral switch (S3) - wire 804 pnk

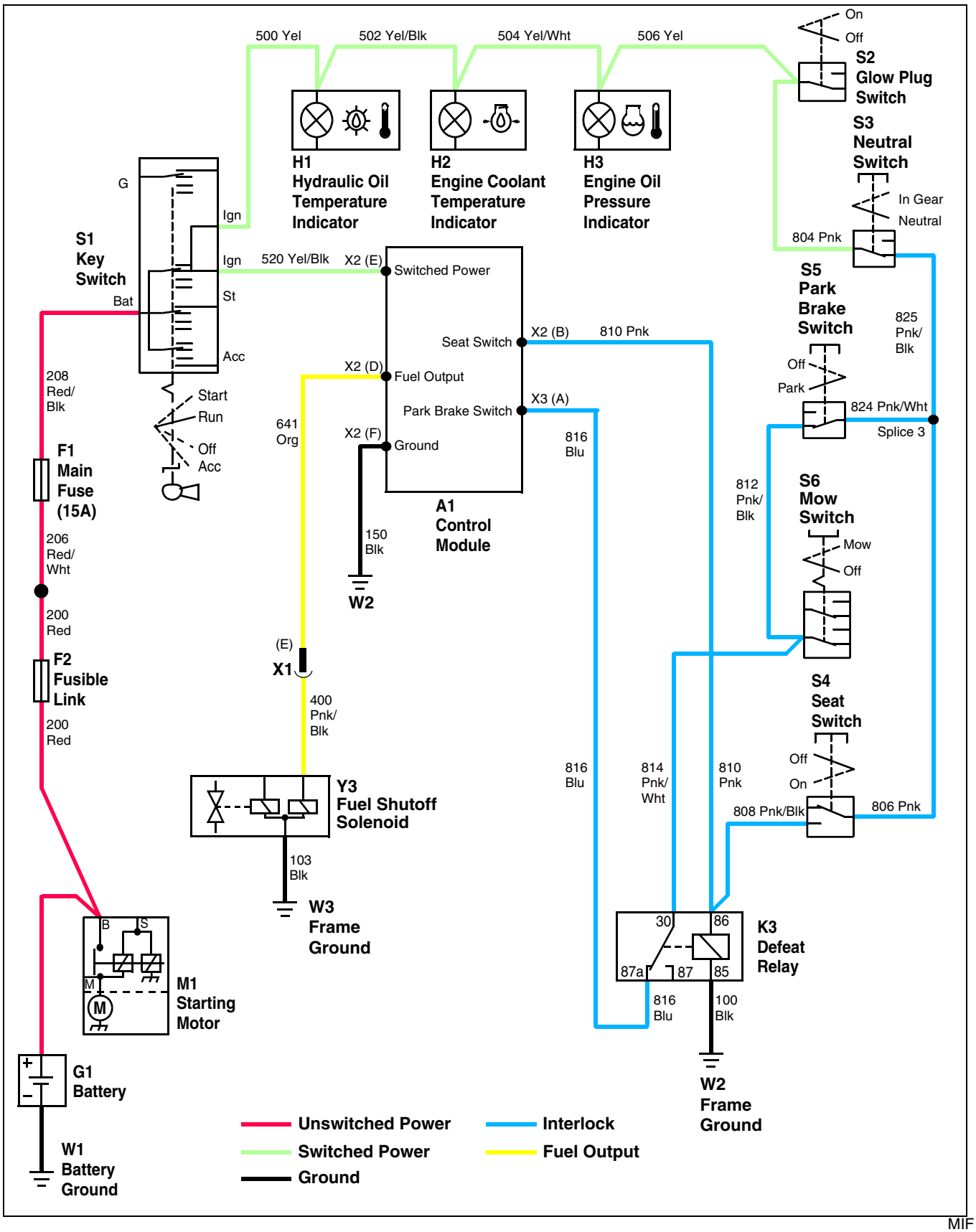
When current flows to control module park brake switch terminal, control module (A1) provides voltage to control module fuel output terminal. Current flows to park brake switch terminal through the following components and circuits:

- Neutral switch (S3) - wire 825 pnk/blk
- Wire 824 pnk/wht
- Park brake switch (S5) - wire 812 pnk
- Wire 814 pnk/wht
- Defeat relay (K3) - terminals (30 and 87A)
- Wire 816 blu

With voltage available to control module fuel output terminal, current flows to fuel shutoff solenoid hold-in coil, energizing the hold-in coil. With the hold-in coil energized, fuel is allowed to flow and the engine continues to operate.

When current stops flowing to control module park brake switch terminal, control module (A1) deactivates the fuel output terminal and the hold-in coil de-energizes. With the hold-in coil de-energized, fuel is prevented to flow and the engine stops operating.

Run Circuit Schematic - Operator Off Seat S.N. (-050071)



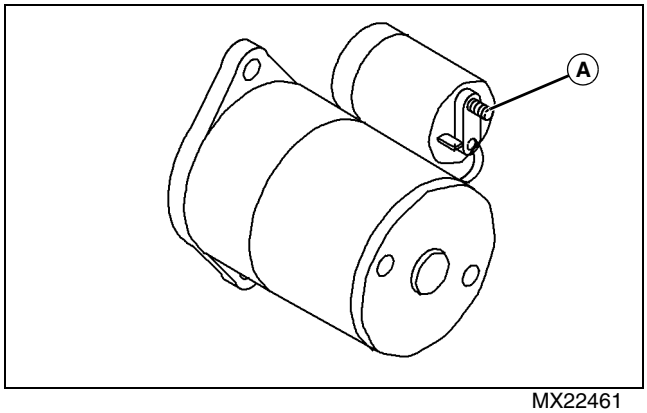
MIF

Run Circuit Diagnosis - Operator Off Seat S.N. (-050071)

Test Conditions:

- Mow switch in OFF position.
- Key switch in RUN position.
- Park brake switch in PARK position.
- Neutral switch in NEUTRAL position.

System: Run Circuit - Operator Off Seat

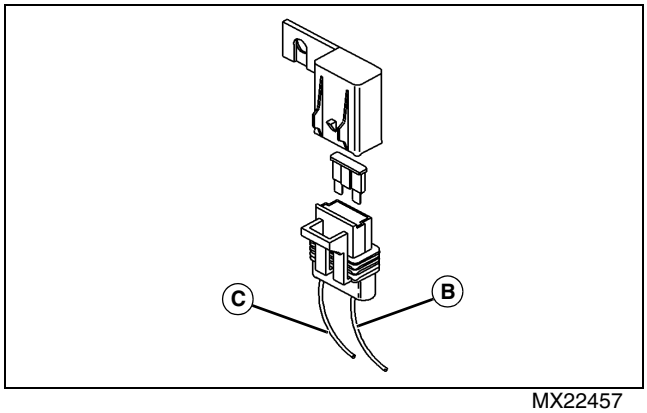


MX22461

(1) Measure voltage at starting motor battery terminal (A). Is battery voltage present?

Yes - Go to step (2).

No - Test battery and connections. (See “Battery Test” on page 246.)



MX22457

(2) Measure voltage at main fuse (F1) - wire 206 red/wht (B). Is battery voltage present?

Yes - Go to step (3).

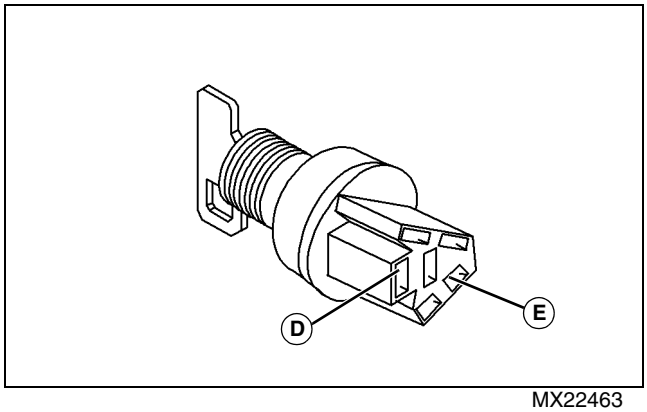
No - Test wire 206 red/wht. Test fusible link (F2) - wire 200 and connections.

System: Run Circuit - Operator Off Seat

(3) Measure voltage at main fuse (F1) - wire 208 red/blk (C). Is battery voltage present?

Yes - Go to step (4).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



MX22463

(4) Measure voltage at key switch (S1) - wire 208 red/blk (D). Is battery voltage present?

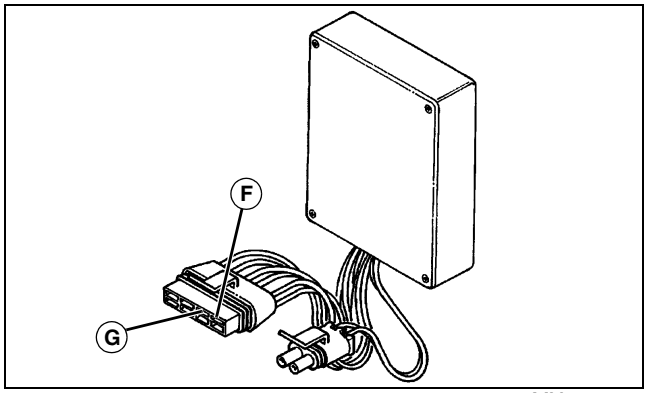
Yes - Go to step (5).

No - Test wire 208 red/blk and connections.

(5) Measure voltage at key switch (S1) - wire 520 yel/blk (E). Is battery voltage present?

Yes - Go to step (6).

No - Replace key switch.



MX22467

(6) Measure voltage at control module (A1) - wire 520 yel/blk (F). Is battery voltage present?

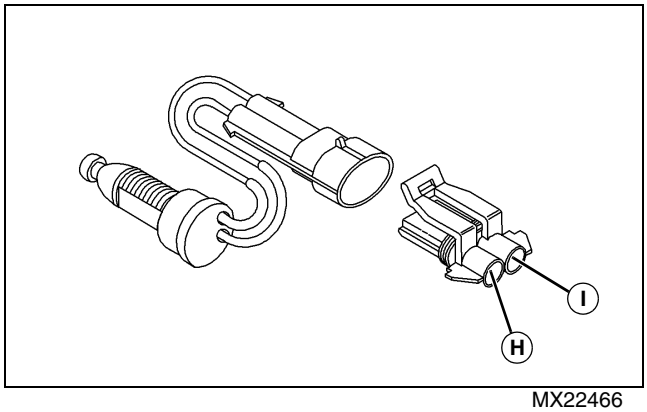
Yes - Go to step (7).

No - Test wire 520 yel/blk and connections.

(7) Check ground circuit resistance at control module (A1) - wire 150 blk (G). Is there less than 0.1 ohm of resistance?

Yes - Go to step (8).

No - Test wire 150 blk and connections. Check frame ground terminals (W2).



MX22466

(8) Measure voltage at neutral switch (S3) - wire 804 pnk (H). Is battery voltage present?

Yes - Go to step (9).

No - Test wire 804 pnk between neutral switch (S3) and glow plug switch (S2). Test wire 506 yel between glow plug switch (S2) and engine oil pressure indicator (H3). Test wire 504 yel between engine oil pressure indicator (H3) and engine coolant temperature indicator (H2).

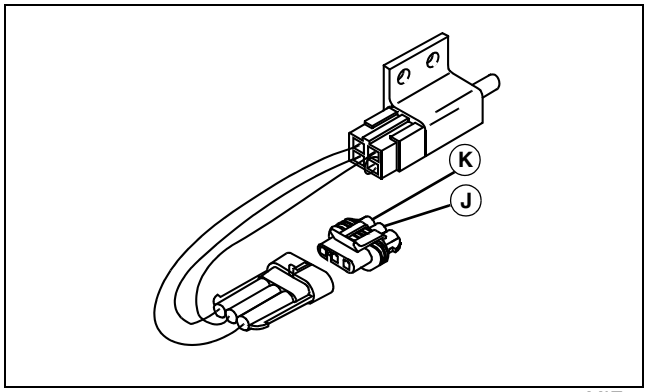
No - Test wire 502 yel/blk between engine coolant temperature indicator (H2) and hydraulic oil temperature indicator (H1). Test wire 500 yel between hydraulic oil temperature indicator (H1) and key switch (S1) and connections.

(9) Measure voltage at neutral switch (S3) - wire 825 pnk/blk (I). Is battery voltage present?

Yes - Go to step (10).

No - Test neutral switch. (See “Neutral Switch Test” on page 253.)

System: Run Circuit - Operator Off Seat



MIF

(10) Measure voltage at park brake switch (S5) - wire 824 pnk/wht (J). Is battery voltage present?

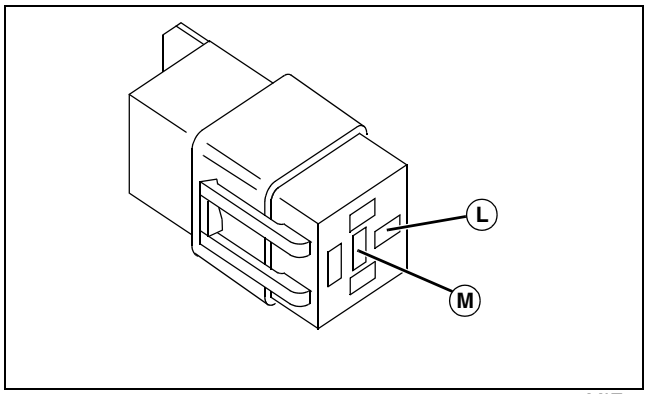
Yes - Go to step (11).

No - Test wires 825 pnk/blk and 824 pnk/wht.

(11) Measure voltage at park brake switch (S5) - wire 812 pnk/blk (K). Is battery voltage present?

Yes - Go to step (12).

No - Test park brake switch. (See “Park Brake Switch Test” on page 253.)



MIF

(12) Measure voltage at defeat relay (K3) - wire 814 pnk/wht (L). Is battery voltage present?

Yes - Go to step (13).

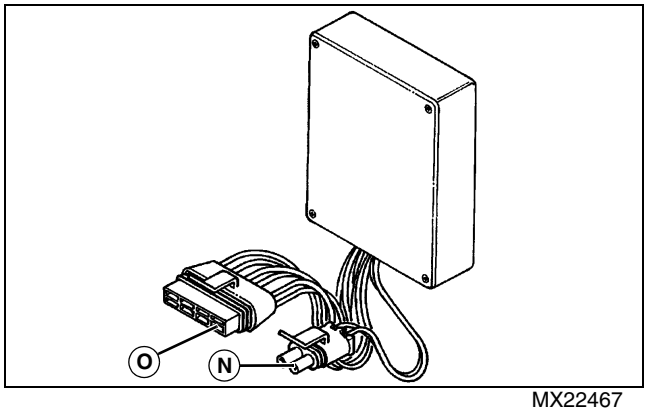
No - Test wires 814 pnk/wht and 812 pnk/blk.

(13) Measure voltage at defeat relay (K3) - wire 816 blu (M). Is battery voltage present?

Yes - Go to step (14).

No - Test defeat relay. (See “Relay Test” on page 252.)

System: Run Circuit - Operator Off Seat



MX22467

(14) Measure voltage at control module (A1) - wire 816 blu (N). Is battery voltage present?

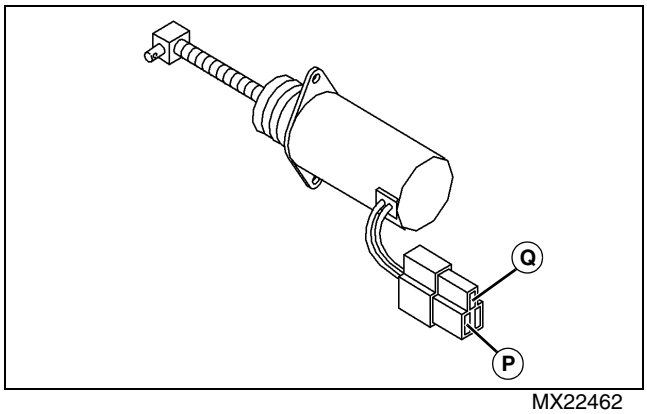
Yes - Go to step (15).

No - Test wire 816 blu and connections.

(15) Measure voltage at control module (A1) - wire 641 org (O). Is battery voltage present?

Yes - Go to step (16).

No - Test control module. (See “Control Module Test” on page 255.)



MX22462

(16) Measure voltage at fuel shutoff solenoid (Y3) - wire 400 pnk/blk (P). Is battery voltage present?

Yes - Go to step (17).

No - Test wires 400 pnk/blk and 641 org.

(17) Check ground circuit resistance at fuel shutoff solenoid (Y3) - wire 103 blk (Q). Is there less than 0.1 ohm of resistance?

Yes - Replace fuel shutoff solenoid.

No - Test wire 103 blk and frame ground (W3).

Run Circuit Operation - Operator Off Seat S.N. (050072-060000)

Function

To allow the engine to run with the operator off the seat.

Operating Conditions

- Key switch in RUN position.
- Operator OFF seat.
- Park brake in PARK position.
- Neutral switch in NEUTRAL position.

Theory of Operation

Unswitched power from battery (G1) is available at the following components:

- Starting motor (M1) - terminal B
- Fusible link (F2) - wire 200 red
- Main fuse (F1) - wire 206 red/wht
- Key switch (S1) - wire 208 red/blk

When the key switch is in the RUN position, current flows to control module (A1) through the following circuits:

- Wire 522 yel/wht
- Splice 2
- Wire 518 yel
- Wire 520 yel/blk

When the Key Switch is in the RUN position, switched power is available at the following components:

- Control module (A1) - wire 520 yel/blk
- Hydraulic oil temperature indicator (H1) - wire 500 yel
- Engine coolant temperature indicator (H2) - wire 502 yel/blk
- Engine oil pressure indicator (H3) - wire 504 yel
- Glow plug switch (S2) - wire 506 yel
- Neutral switch (S3) - wire 804 pnk

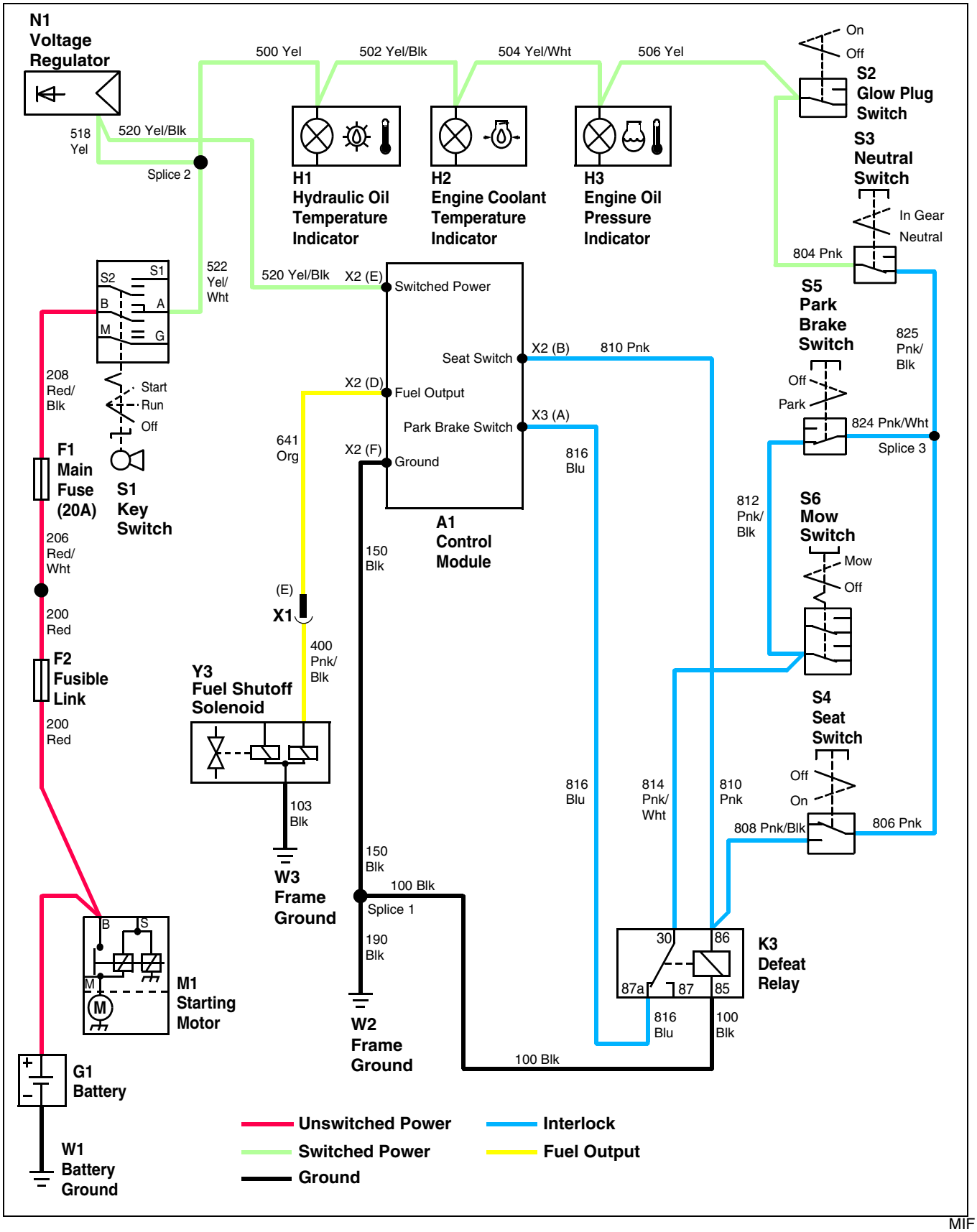
When current flows to control module park brake switch terminal, control module (A1) provides voltage to control module fuel output terminal. Current flows to park brake switch terminal through the following components and circuits:

- Neutral switch (S3) - wire 825 pnk/blk
- Wire 824 pnk/wht
- Park brake switch (S5) - wire 812 pnk
- Wire 814 pnk/wht
- Defeat relay (K3) - terminals (30 and 87A)
- Wire 816 blu

With voltage available to control module fuel output terminal, current flows to fuel shutoff solenoid hold-in coil, energizing the hold-in coil. With the hold-in coil energized, fuel is allowed to flow and the engine continues to operate.

When current stops flowing to control module park brake switch terminal, control module (A1) deactivates the fuel output terminal and the hold-in coil de-energizes. With the hold-in coil de-energized, fuel is prevented to flow and the engine stops operating.

Run Circuit Schematic - Operator Off Seat S.N. (050072-060000)



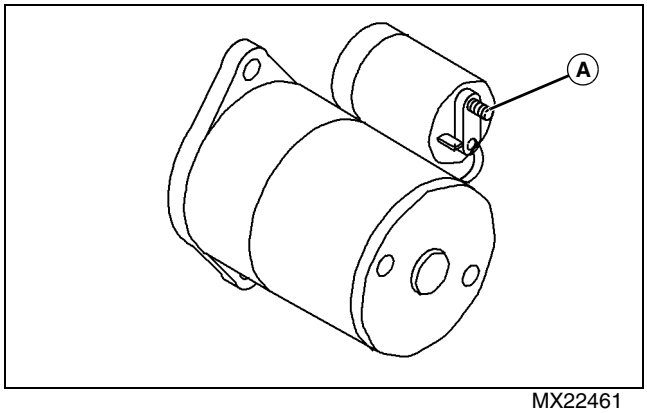
MIF

Run Circuit Diagnosis - Operator Off Seat S.N. (050072-060000)

Test Conditions:

- Mow switch in OFF position.
- Key switch in RUN position.
- Park brake switch in PARK position.
- Neutral switch in NEUTRAL position.

System: Run Circuit - Operator Off Seat

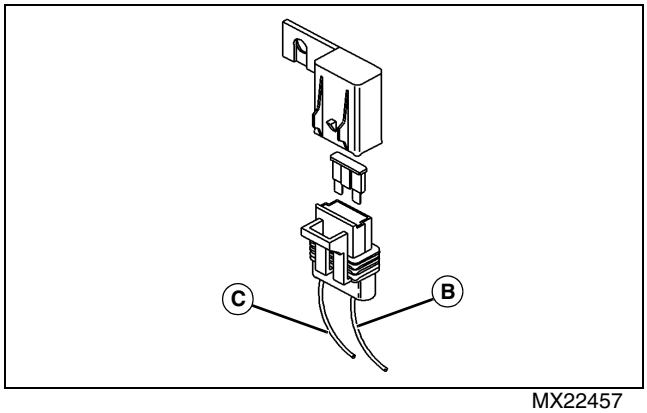


MX22461

(1) Measure voltage at starting motor battery terminal (A). Is battery voltage present?

Yes - Go to step (2).

No - Test battery and connections. (See “Battery Test” on page 246.)



MX22457

(2) Measure voltage at main fuse (F1) - wire 206 red/wht (B). Is battery voltage present?

Yes - Go to step (3).

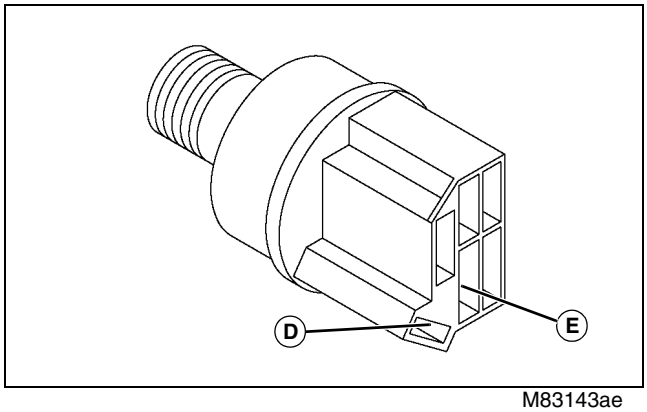
No - Test wire 206 red/wht. Test fusible link (F2) - wire 200 and connections.

System: Run Circuit - Operator Off Seat

(3) Measure voltage at main fuse (F1) - wire 208 red/blk (C). Is battery voltage present?

Yes - Go to step (4).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



M83143ae

(4) Measure voltage at key switch (S1) - wire 208 red/blk (D). Is battery voltage present?

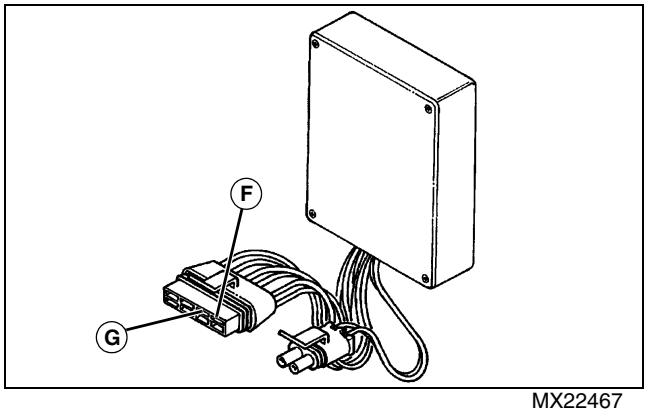
Yes - Go to step (5).

No - Test wire 208 red/blk and connections.

(5) Measure voltage at key switch (S1) - wire 522 yel/wht (E). Is battery voltage present?

Yes - Go to step (6).

No - Test key switch and connections. (See “Key Switch Test” on page 249.)



MX22467

(6) Measure voltage at control module (A1) - wire 520 yel/blk (F). Is battery voltage present?

Yes - Go to step (7).

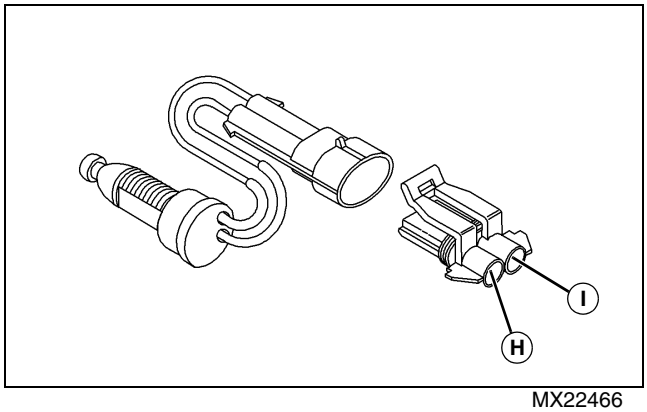
No - Test wires 520 yel/blk, 518 yel, and 522 yel/wht.

System: Run Circuit - Operator Off Seat

(7) Check ground circuit resistance at control module (A1) - wire 150 blk (G). Is there less than 0.1 ohm of resistance?

Yes - Go to step (8).

No - Test wires 190 and 150 blk. Check frame ground terminal (W2).



MX22466

(8) Measure voltage at neutral switch (S3) - wire 804 pnk (H). Is battery voltage present?

Yes - Go to step (9).

No - Test wire 804 pnk between neutral switch (S3) and glow plug switch (S2). Test wire 506 yel between glow plug switch (S2) and engine oil pressure indicator (H3). Test wire 504 yel between engine oil pressure indicator (H3) and engine coolant temperature indicator (H2).

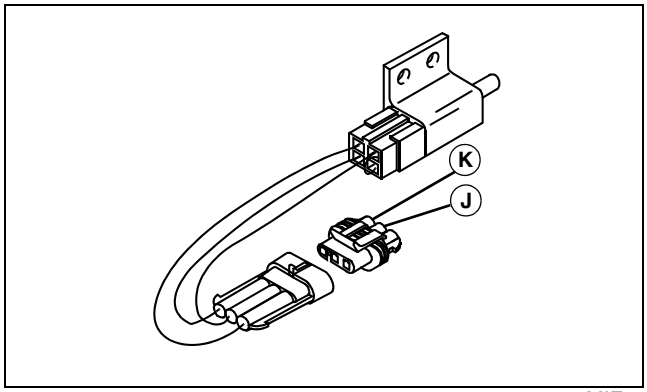
No - Test wire 502 yel/blk between engine coolant temperature indicator (H2) and hydraulic oil temperature indicator (H1). Test wire 500 yel between hydraulic oil temperature indicator (H1) and key switch (S1) and connections.

(9) Measure voltage at neutral switch (S3) - wire 825 pnk/blk (I). Is battery voltage present?

Yes - Go to step (10).

No - Test neutral switch. (See “Neutral Switch Test” on page 253.)

System: Run Circuit - Operator Off Seat



MIF

(10) Measure voltage at park brake switch (S5) - wire 824 pnk/wht (J). Is battery voltage present?

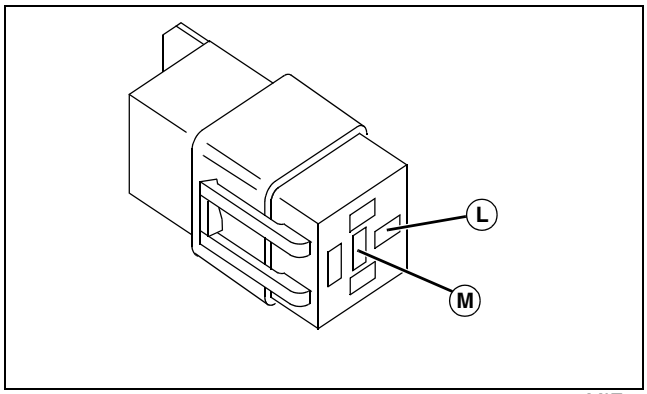
Yes - Go to step (11).

No - Test wires 825 pnk/blk and 824 pnk/wht.

(11) Measure voltage at park brake switch (S5) - wire 812 pnk/blk (K). Is battery voltage present?

Yes - Go to step (12).

No - Test park brake switch. (See “Park Brake Switch Test” on page 253.)



MIF

(12) Measure voltage at defeat relay (K3) - wire 814 pnk/wht (L). Is battery voltage present?

Yes - Go to step (13).

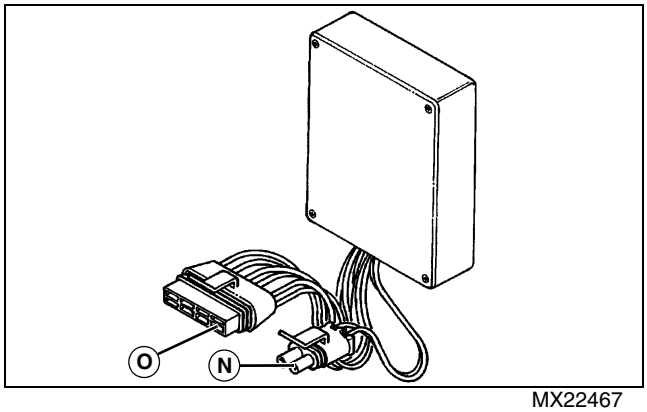
No - Test wires 814 pnk/wht and 812 pnk/blk.

(13) Measure voltage at defeat relay (K3) - wire 816 blu (M). Is battery voltage present?

Yes - Go to step (14).

No - Test defeat relay. (See “Relay Test” on page 252.)

System: Run Circuit - Operator Off Seat



MX22467

(14) Measure voltage at control module (A1) - wire 816 blu (N). Is battery voltage present?

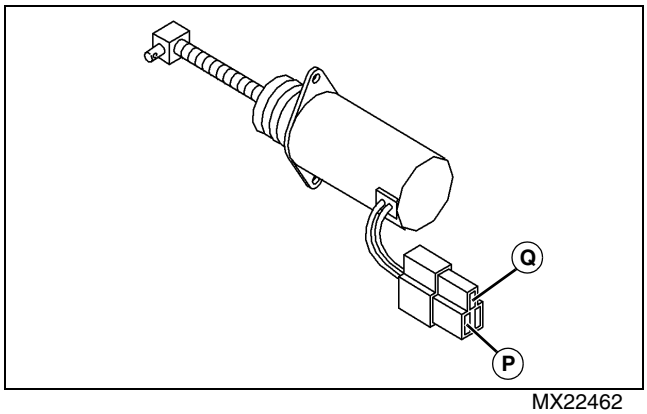
Yes - Go to step (15).

No - Test wire 816 blu and connections.

(15) Measure voltage at control module (A1) - wire 641 org (O). Is battery voltage present?

Yes - Go to step (16).

No - Test control module. (See “Control Module Test” on page 255.)



MX22462

(16) Measure voltage at fuel shutoff solenoid (Y3) - wire 400 pnk/blk (P). Is battery voltage present?

Yes - Go to step (17).

No - Test wires 400 pnk/blk and 641 org.

(17) Check ground circuit resistance at fuel shutoff solenoid (Y3) - wire 103 blk (Q). Is there less than 0.1 ohm of resistance?

Yes - Replace fuel shutoff solenoid.

No - Test wire 103 blk and frame ground (W3).

Run Circuit Operation - Operator Off Seat S.N. (060001-)

Function

To allow the engine to run with the operator off the seat.

Operating Conditions

- Key switch in RUN position.
- Operator OFF seat.
- Park brake in PARK position.
- Neutral switch in NEUTRAL position.

Theory of Operation

Unswitched power from battery (G1) is available at the following components:

- Starting motor (M1) - terminal B
- Fusible link (F2) - wire 200 red
- Main fuse (F1) - wire 206 red/wht
- Key switch (S1) - wire 208 red/blk

When the key switch is in the RUN position, current flows to control module (A1) through the following circuits:

- Wire 522 yel/wht
- Splice 2
- Wire 519 yel
- Fuse (F4)
- Wire 521 yel
- Splice 6
- Wire 520 yel/blk

Switched power is also available to neutral switch (S3) from splice 6 through wire 804 pnk.

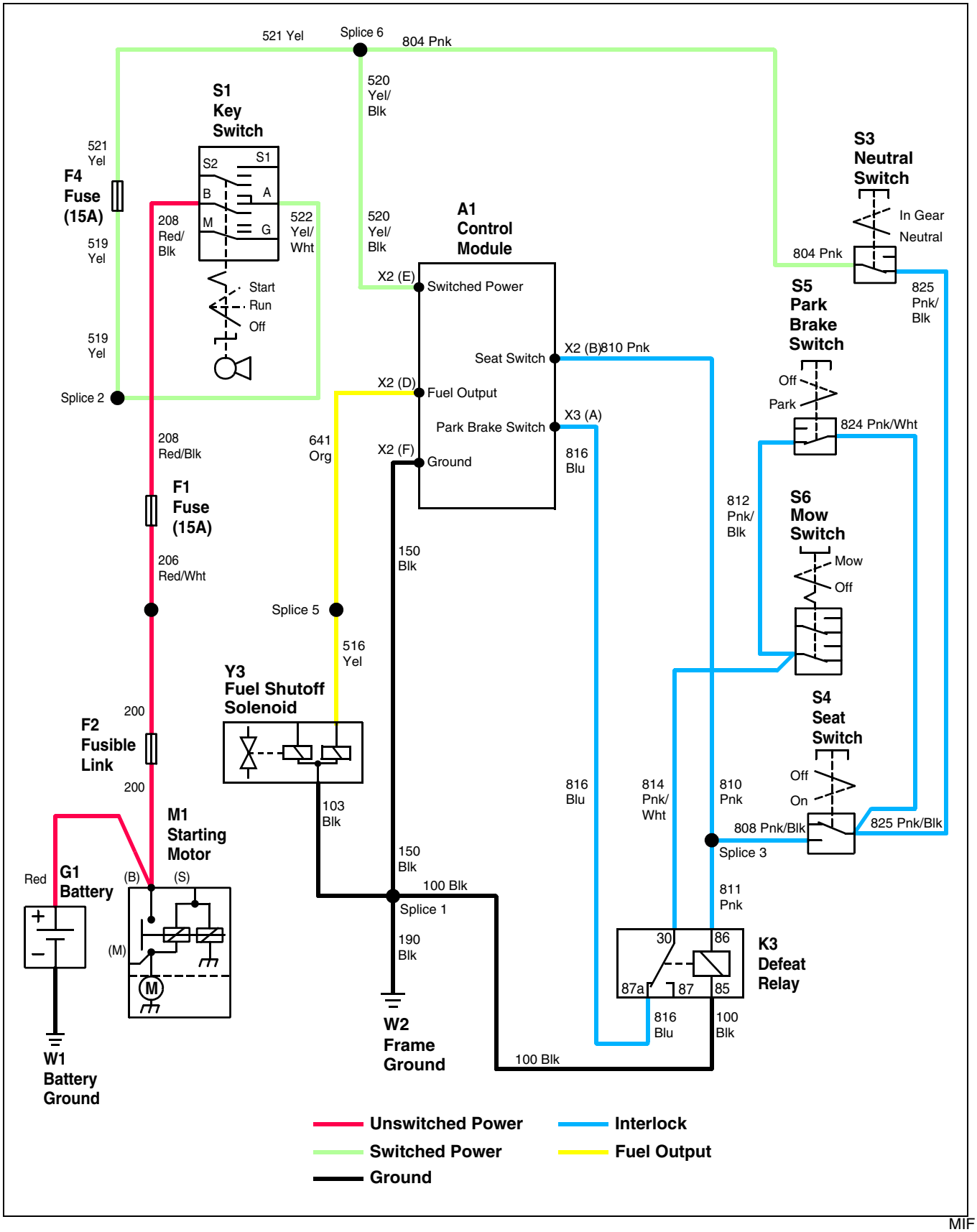
When current flows to control module park brake switch terminal, control module (A1) provides voltage to control module fuel output terminal. Current flows to park brake switch terminal through the following components and circuits:

- Neutral switch (S3) - wire 825 pnk/blk
- Wire 824 pnk/wht
- Park brake switch (S5) - wire 812 pnk
- Wire 814 pnk/wht
- Defeat relay (K3) - terminals (30 and 87A)
- Wire 816 blu

With voltage available to control module fuel output terminal, current flows to fuel shutoff solenoid hold-in coil, energizing the hold-in coil. With the hold-in coil energized, fuel is allowed to flow and the engine continues to operate.

When current stops flowing to control module park brake switch terminal, control module (A1) deactivates the fuel output terminal and the hold-in coil de-energizes. With the hold-in coil de-energized, fuel is prevented to flow and the engine stops operating.

Run Circuit Schematic - Operator Off Seat S.N. (060001-)



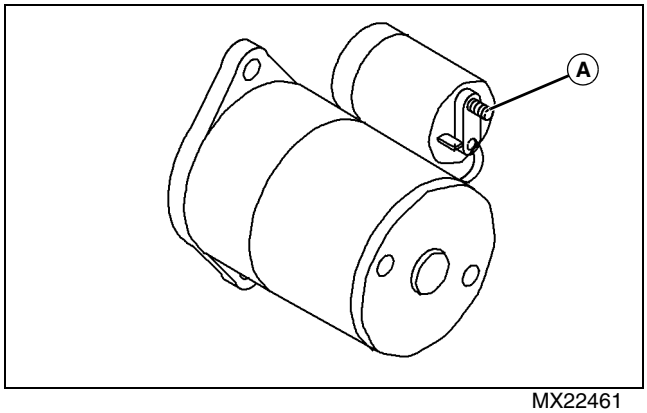
MIF

Run Circuit Diagnosis - Operator Off Seat S.N. (060001-)

Test Conditions:

- Mow switch in OFF position.
- Key switch in RUN position.
- Park brake switch in PARK position.
- Neutral switch in NEUTRAL position.

System: Run Circuit - Operator Off Seat



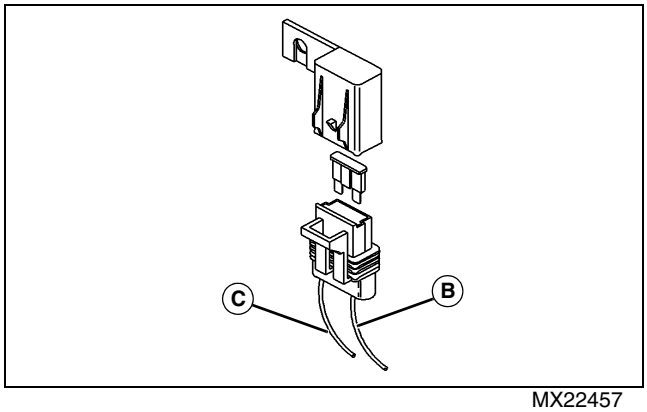
MX22461

(1) Measure voltage at starting motor battery terminal (A). Is battery voltage present?

Yes - Go to step (2).

No - Test battery and connections. (See “Battery Test” on page 246.)

System: Run Circuit - Operator Off Seat



MX22457

(2) Measure voltage at main fuse (F1) - wire 206 red/wht (B). Is battery voltage present?

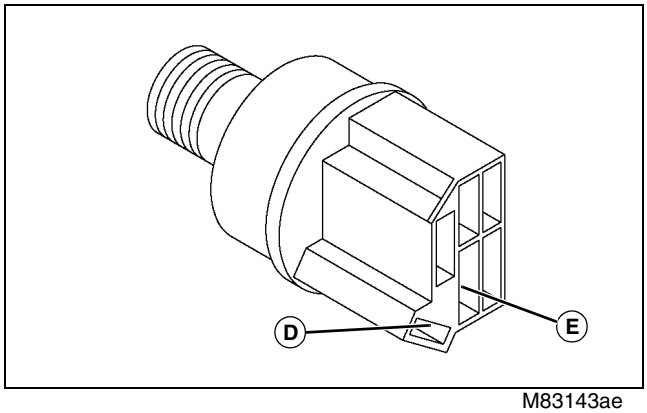
Yes - Go to step (3).

No - Test wire 206 red/wht. Test fusible link (F2) - wire 200 and connections.

(3) Measure voltage at main fuse (F1) - wire 208 red/blk (C). Is battery voltage present?

Yes - Go to step (4).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



M83143ae

(4) Measure voltage at key switch (S1) - wire 208 red/blk (D). Is battery voltage present?

Yes - Go to step (5).

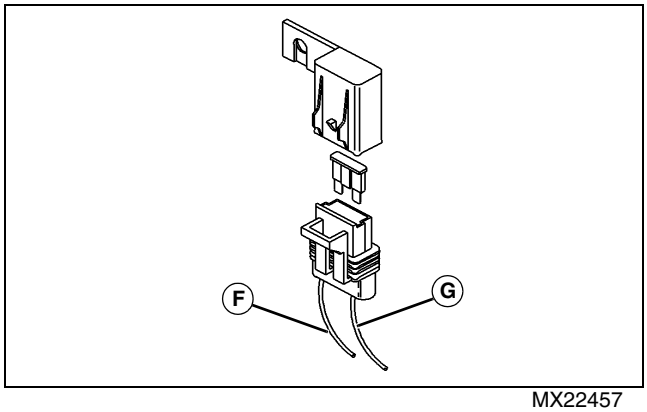
No - Test wire 208 red/blk and connections.

(5) Measure voltage at key switch (S1) - wire 522 yel/wht (E). Is battery voltage present?

Yes - Go to step (6).

No - Test key switch and connections. (See “Key Switch Test” on page 249.)

System: Run Circuit - Operator Off Seat



MX22457

(6) Measure voltage at fuse (F4) - wire 519 yel (F). Is battery voltage present?

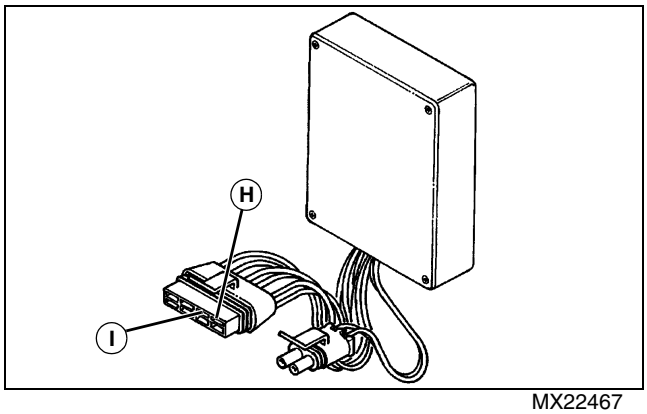
Yes - Go to step (7).

No - Test wires 519 yel and 522 yel/wht.

(7) Measure voltage at fuse (F4) - wire 521 yel (G). Is battery voltage present?

Yes - Go to step (8).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



MX22467

(8) Measure voltage at control module (A1) - wire 520 yel/blk (H). Is battery voltage present?

Yes - Go to step (9).

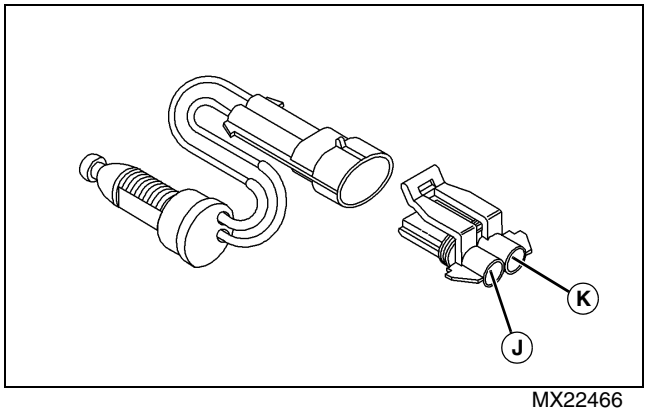
No - Test wires 520 yel/blk and 521 yel.

(9) Check ground circuit resistance at control module (A1) - wire 150 blk (I). Is there less than 0.1 ohm of resistance?

Yes - Go to step (10).

No - Test wires 150 and 190 blk. Check frame ground terminal (W2).

System: Run Circuit - Operator Off Seat



MX22466

(10) Measure voltage at neutral switch (S3) - wire 804 pnk (J). Is battery voltage present?

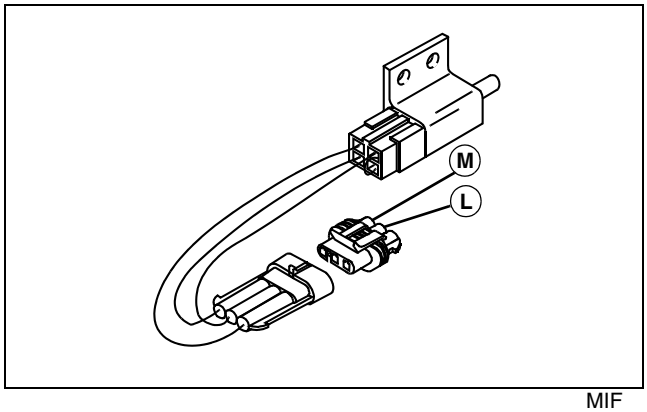
Yes - Go to step (11).

No - Test wire 804 pnk between neutral switch and splice 6.

(11) Measure voltage at neutral switch (S3) - wire 825 pnk/blk (K). Is battery voltage present?

Yes - Go to step (12).

No - Test neutral switch. (See “Neutral Switch Test” on page 253.)



MIF

(12) Measure voltage at park brake switch (S5) - wire 824 pnk/wht (L). Is battery voltage present?

Yes - Go to step (13).

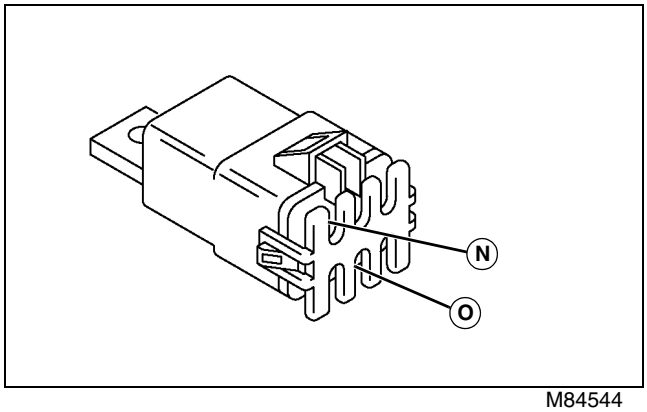
No - Test wires 825 pnk/blk and 824 pnk/wht.

(13) Measure voltage at park brake switch (S5) - wire 812 pnk/blk (M). Is battery voltage present?

Yes - Go to step (14).

No - Test park brake switch. (See “Park Brake Switch Test” on page 253.)

System: Run Circuit - Operator Off Seat



M84544

(14) Measure voltage at defeat relay (K3) - wire 814 pnk/wht (N). Is battery voltage present?

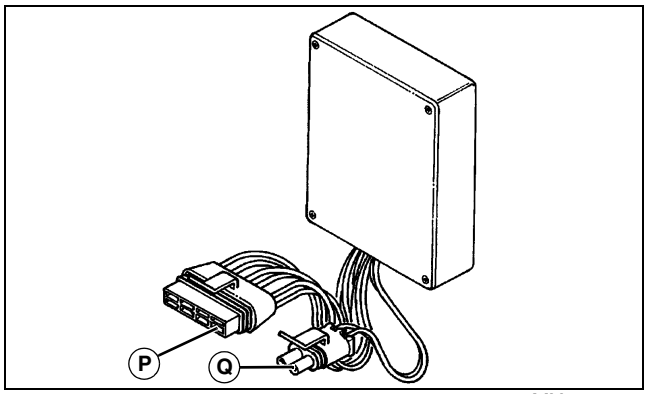
Yes - Go to step (15).

No - Test wires 814 pnk/wht and 812 pnk/blk.

(15) Measure voltage at defeat relay (K3) - wire 816 blu (O). Is battery voltage present?

Yes - Go to step (16).

No - Test defeat relay. (See “Relay Test” on page 252.)



MX22467

(16) Measure voltage at control module (A1) - wire 816 blu (Q). Is battery voltage present?

Yes - Go to step (17).

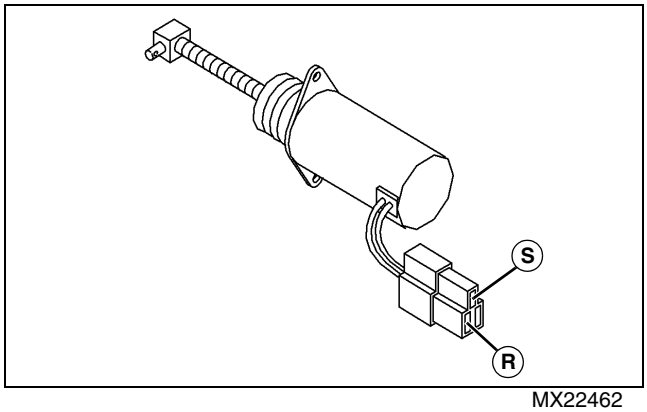
No - Test wire 816 blu and connections.

(17) Measure voltage at control module (A1) - wire 641 org (P). Is battery voltage present?

Yes - Go to step (18).

No - Test control module. (See “Control Module Test” on page 255.)

System: Run Circuit - Operator Off Seat



MX22462

(18) Measure voltage at fuel shutoff solenoid (Y3) - wire 400 pnk/blk (R). Is battery voltage present?

Yes - Go to step (19).

No - Test wires 400 pnk/blk and 641 org.

(19) Check ground circuit resistance at fuel shutoff solenoid (Y3) - wire 103 blk (S). Is there less than 0.1 ohm of resistance?

Yes - Replace fuel shutoff solenoid.

No - Test wires 103 and 190 blk. Check frame ground (W2).

Mow Circuit Operation

Function

To allow the operator to energize or de-energize the mow valve solenoid and third wheel drive solenoid.

Operating Conditions

- Key switch in RUN position.
- Operator ON seat.
- Park brake in OFF position.

Theory of Operation

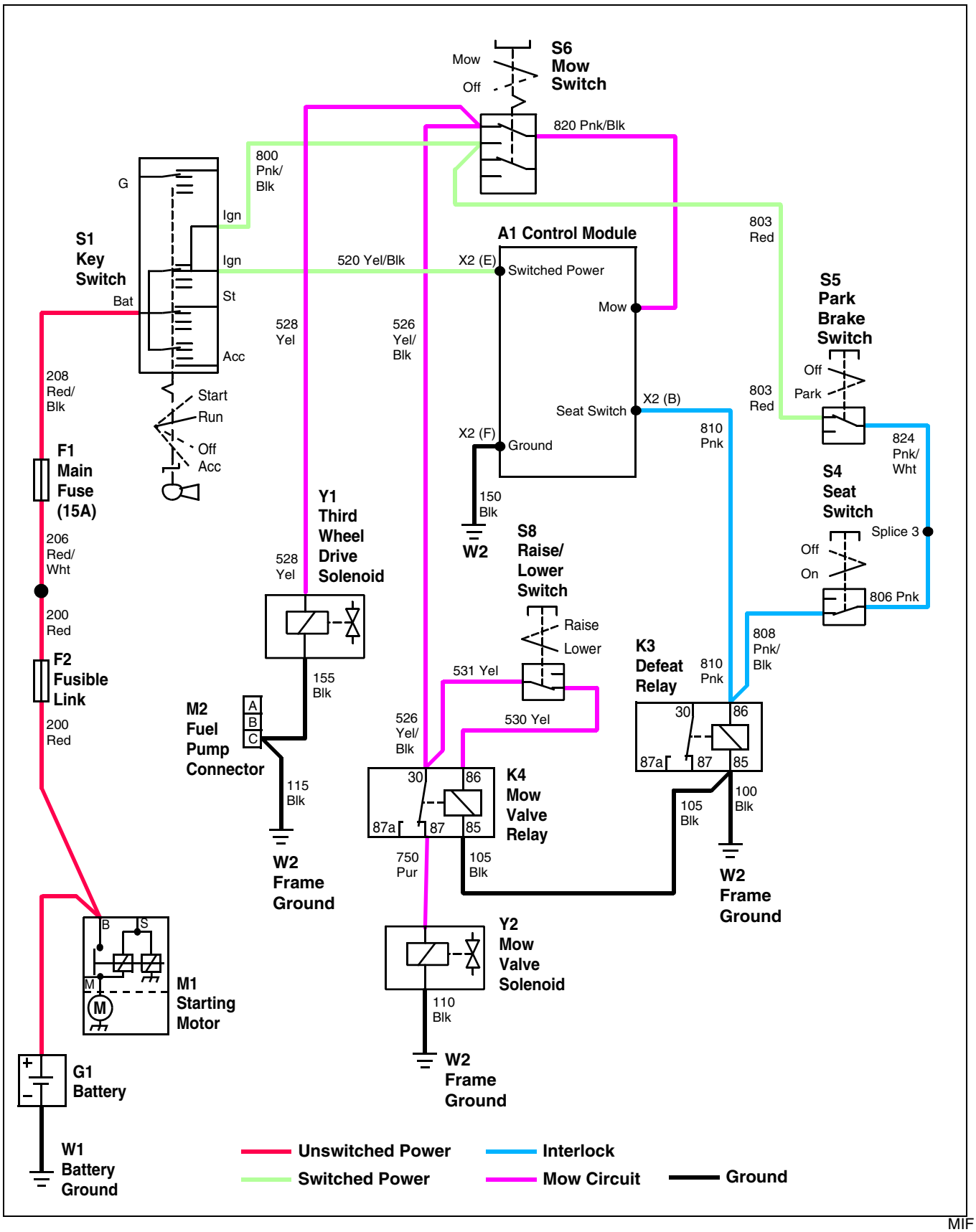
Control module mow terminal has two functions, as an input terminal and then an output terminal. When mow switch (S6) is in the OFF position, voltage is available to control module mow terminal. When current flows to control module seat switch terminal, an internal latch circuit is activated and provides voltage to control module mow terminal. This is to ensure that mow switch is in the OFF position before power is provided to the mow terminal. Current flows to control module seat switch terminal when park brake switch (S5) is in the OFF position and seat switch (S4) is in the ON position.

When mow switch (S6) is in the MOW position and with voltage available to control module mow terminal, current flows to third wheel drive solenoid (Y1). Voltage is also available to mow valve relay terminal 30 and to raise/lower switch (S8).

When raise/lower switch is in the LOWER position, current flows to mow valve relay terminal 86, energizing the relay. With mow valve relay energized, current flows between mow vale relay contacts (30 and 87) to mow valve solenoid (Y2), activating the solenoid.

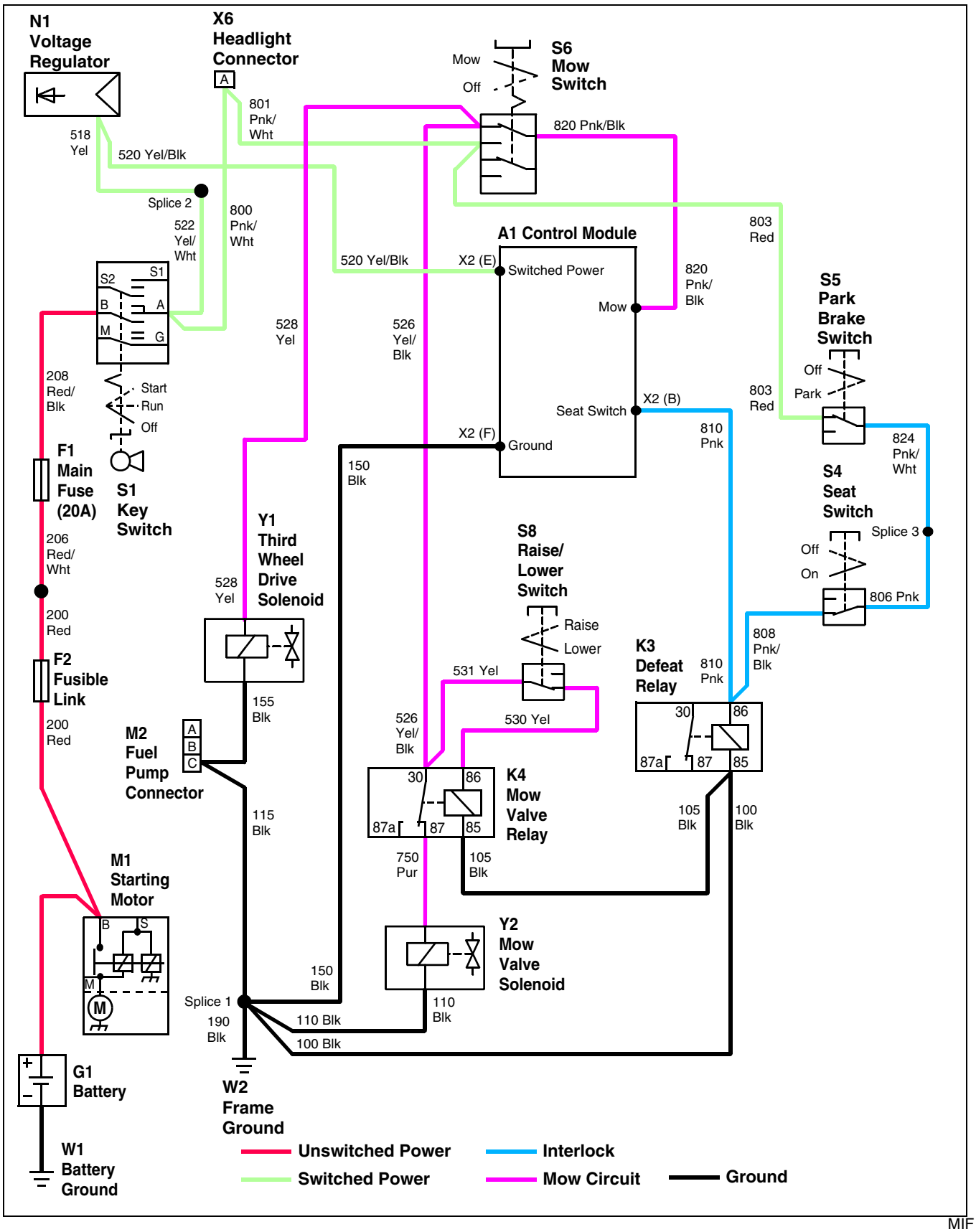
Control module (A1) provides a 0.7-second delay before deactivating power to the mow circuit to compensate for seat switch bounce.

Mow Circuit Schematic S.N. (-050071)



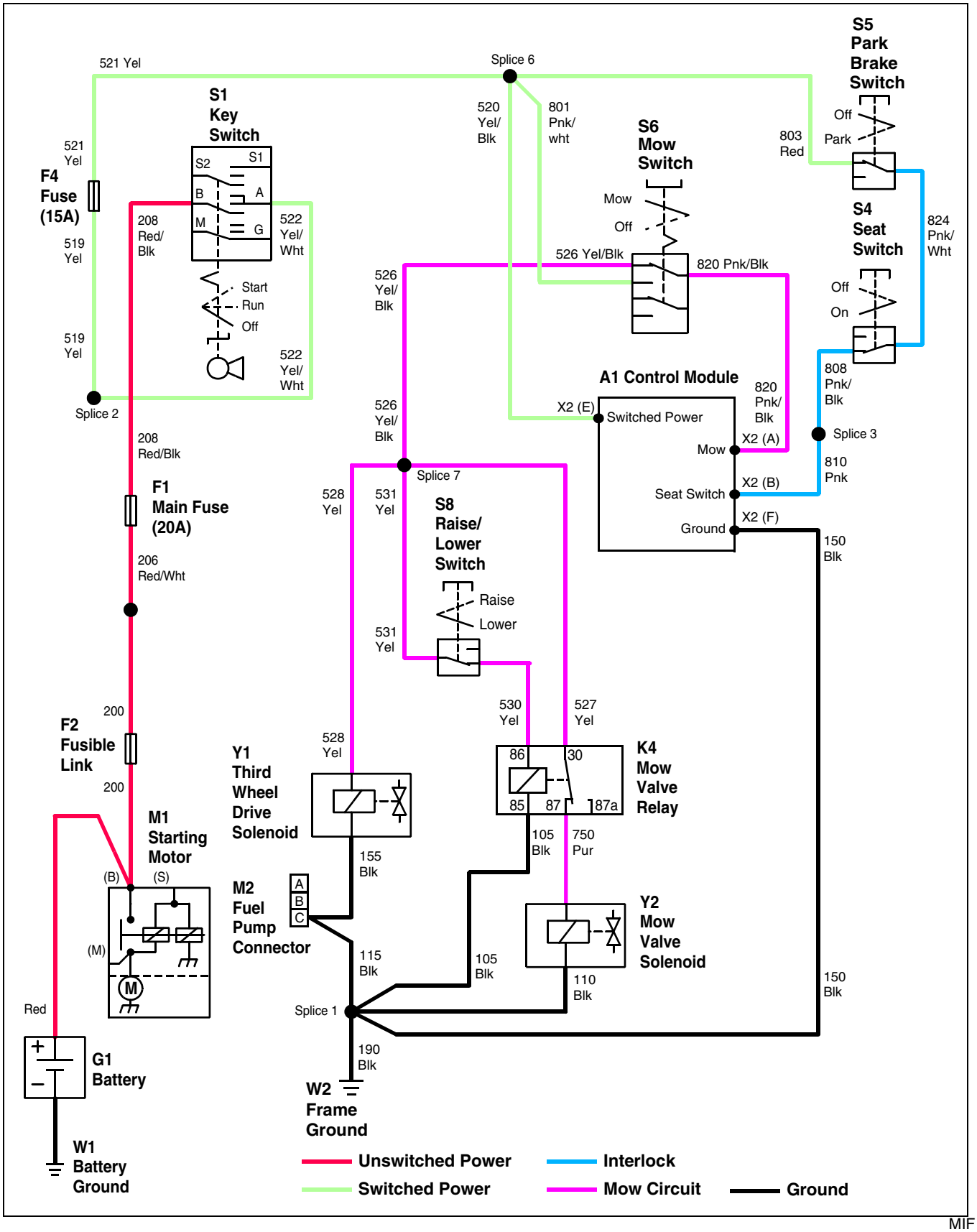
MIF

Mow Circuit Schematic S.N. (050072-060000)



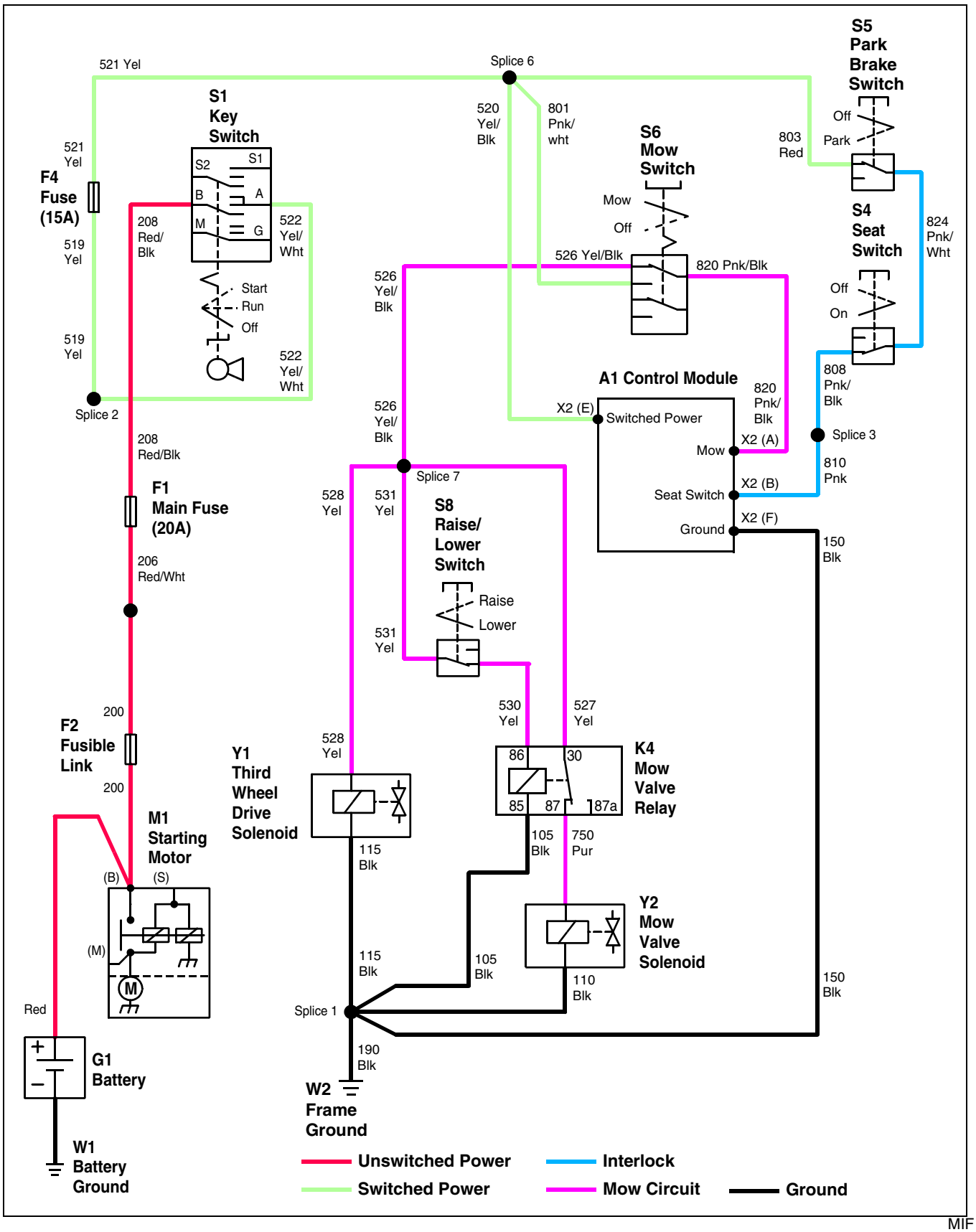
MIF

Mow Circuit Schematic S.N. (060001-060554)



MIF

Mow Circuit Schematic S.N. (060555-)



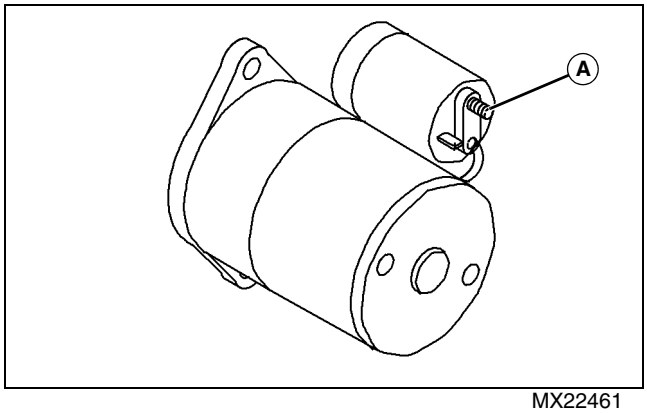
MIF

Mow Circuit Diagnosis S.N. (-060000)

Test Conditions:

- Key switch in RUN position.
- Park brake switch in OFF position.
- Operator OFF seat.
- Mow switch in OFF position.

System: Mow Circuit

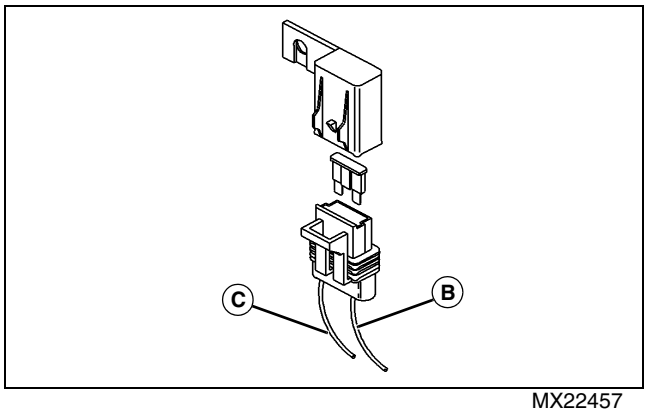


MX22461

(1) Measure voltage at starting motor battery terminal (A). Is battery voltage present?

Yes - Go to step (2).

No - Test battery and connections. (See “Battery Test” on page 246.)



MX22457

(2) Measure voltage at main fuse (F1) - wire 206 red/wht (B). Is battery voltage present?

Yes - Go to step (3).

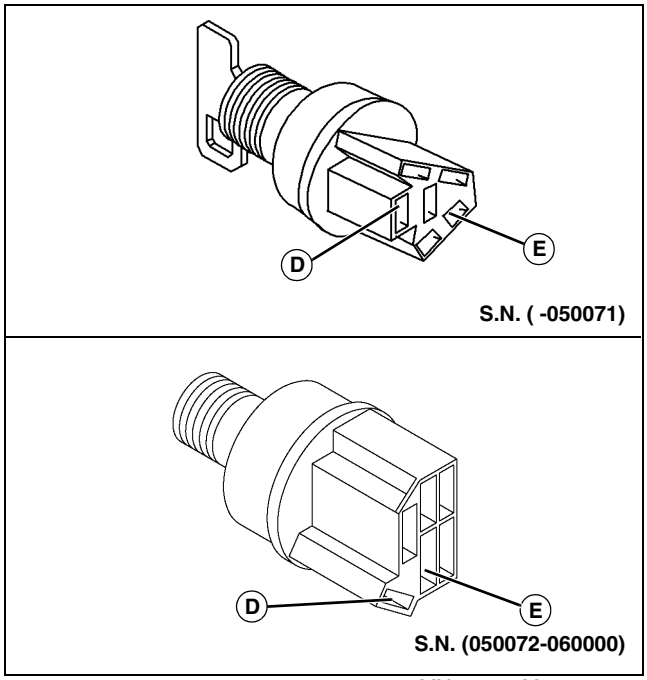
No - Test wire 206 red/wht. Test fusible link (F2) - wire 200 and connections.

System: Mow Circuit

(3) Measure voltage at main fuse (F1) - wire 208 red/blk (C). Is battery voltage present?

Yes - Go to step (4).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



MX22463, M83143ae

(4) Measure voltage at key switch (S1) - wire 208 red/blk (D). Is battery voltage present?

Yes - Go to step (5).

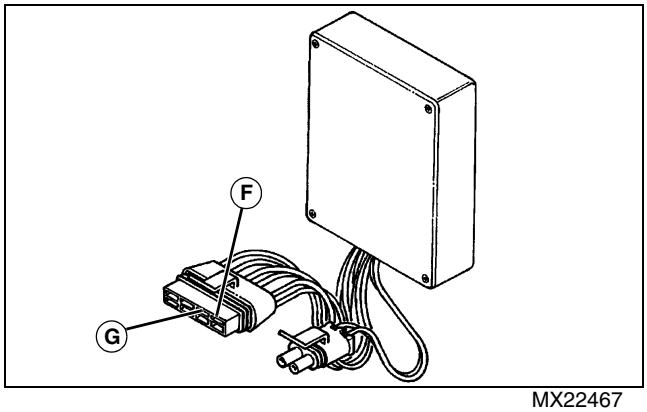
No - Test wire 208 red/blk and connections.

(5) Measure voltage at key switch (S1) - wire 520 yel/blk (E). Is battery voltage present?

Yes - Go to step (6).

No - Replace key switch.

System: Mow Circuit



MX22467

(6) Measure voltage at control module (A1) - wire 520 yel/blk (F). Is battery voltage present?

Yes - Go to step (7).

No - S.N. (-050071): Test wire 520 yel/blk and connections.

No - S.N. (050072-060000): Test wires 520 yel/blk, 518 yel, and 522 yel.

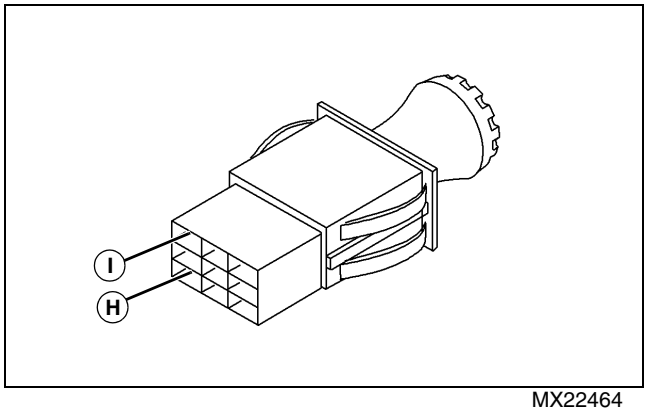
(7) Check ground circuit resistance at control module (A1) - wire 150 blk (G). Is there less than 0.1 ohm of resistance?

Yes - Go to step (8).

No - S.N. (-050071): Test wire 150 blk and frame ground terminals (W2).

No - S.N. (050072-060000): Test wires 150 and 190 blk. Check frame ground terminal (W2).

System: Mow Circuit



MX22464

(8) Measure voltage at mow switch (S6) - terminal (H). Is battery voltage present?

Yes - Go to step (9).

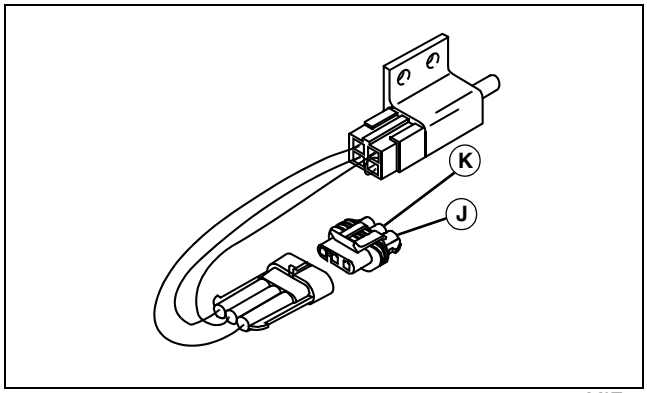
No - S.N. (-050071): Test wire 800 pnk/blk and connections.

No - S.N. (050072-060000): Test wires 801 pnk/wht and 800 pnk/blk.

(9) Measure voltage at mow switch (S6) - wire 820 pnk/blk (I). Is battery voltage present?

Yes - Go to step (10).

No - Test mow switch. (See “Mow Switch Test” on page 252.)



MIF

(10) Measure voltage at park brake switch (S5) - wire 803 red (J). Is battery voltage present?

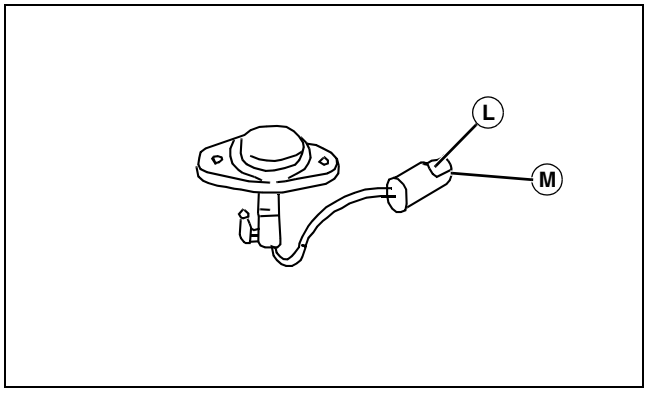
Yes - Go to step (11).

No - Test wire 803 red between park brake switch and mow switch.

(11) Measure voltage at park brake switch (S5) - wire 824 pnk/wht (K). Is battery voltage present?

Yes - Go to step (12).

No - Test park brake switch. (See “Park Brake Switch Test” on page 253.)



(12) Measure voltage at seat switch connector (X4) - wire 806 pnk (L). Is battery voltage present?

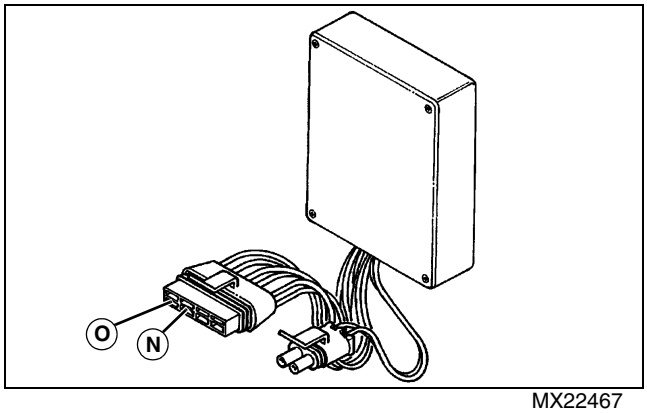
Yes - Go to step (13).

No - Test wires 806 pnk and 824 pnk/wht.

(13) Measure voltage at seat switch connector (X4) - wire 808 pnk/blk (M). Is battery voltage present?

Yes - Go to step (14).

No - Replace seat switch.



MX22467

(14) Place seat switch in ON position for the remainder of test procedure. Measure voltage at control module (A1) - wire 810 pnk (N). Is battery voltage present?

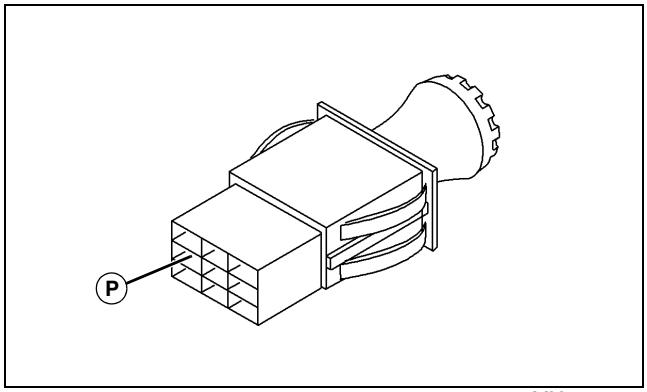
Yes - Go to step (15).

No - Test wires 810 pnk and 808 pnk/blk.

(15) Place mow switch in MOW position for the remainder of test procedure. Measure voltage at control module (A1) - wire 820 pnk/blk (O). Is battery voltage present?

Yes - Go to step (16).

No - Test control module. (See “Control Module Test” on page 255.)

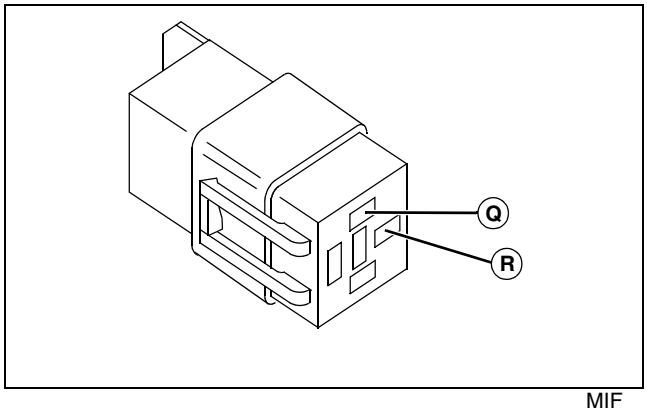


MX22464

(16) Measure voltage at mow switch (S6) - wires 526 yel/blk and 528 yel (P). Is battery voltage present?

Yes - Go to step (17).

No - Test mow switch. (See “Mow Switch Test” on page 252.)



MIF

(17) Check ground circuit resistance at mow valve relay (K4) - wire 105 blk (Q). Is there less than 0.1 ohm of resistance?

Yes - Go to step (18).

No - S.N. (-050071): Test wires 105 and 100 blk.

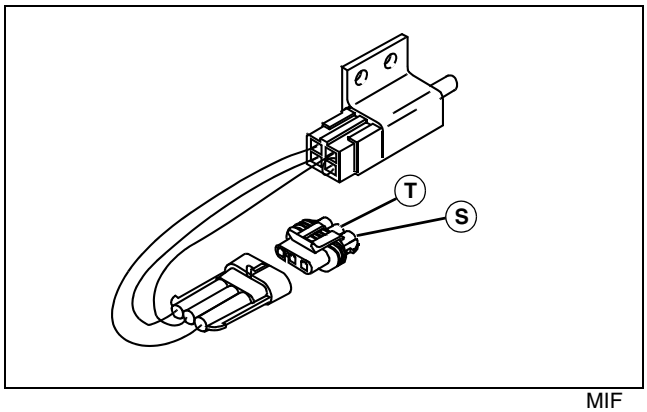
No - S.N. (050072-060000): Test wires 105, 100, and 190 blk.

System: Mow Circuit

(18) Measure voltage at mow valve relay (K4) - wire 526 yel/blk (R). Is battery voltage present?

Yes - Go to step (19).

No - Test wire 526 yel/blk and connections.



MIF

(19) Measure voltage at raise/lower switch (S8) - wire 531 yel (S). Is battery voltage present?

Yes - Go to step (20).

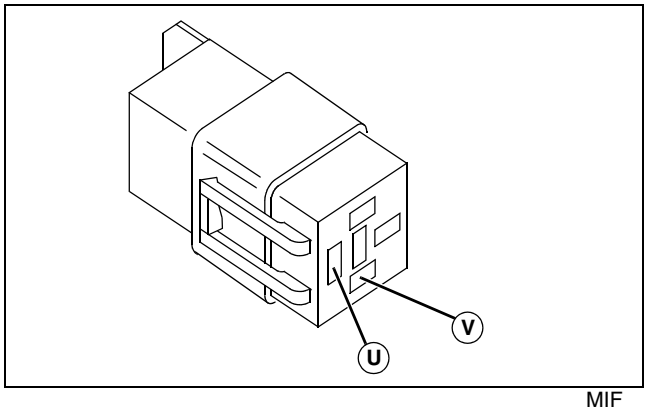
No - Test wire 531 yel and connections.

(20) Measure voltage at raise/lower switch (S8) - wire 530 yel (T). Is battery voltage present?

Yes - Go to step (21).

No - Test test switch. (See “Raise/Lower Switch Test” on page 254.)

System: Mow Circuit



MIF

(21) Measure voltage at mow valve relay (K4) - wire 530 yel (V). Is battery voltage present?

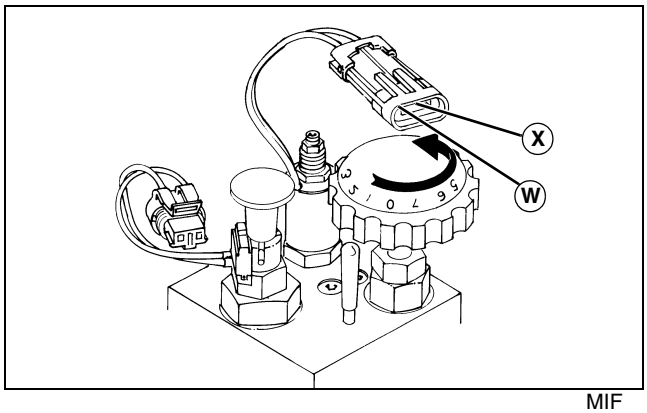
Yes - Go to step (22).

No - Test wire 530 yel and connections.

(22) Measure voltage at mow valve relay (K4) - wire 750 pur (U). Is battery voltage present?

Yes - Go to step (23).

No - Test relay. (See “Relay Test” on page 252.)



MIF

(23) Measure voltage at mow valve solenoid (Y2) - wire 750 pur (W). Is battery voltage present?

Yes - Go to step (24).

No - Test wire 750 pur and connections.

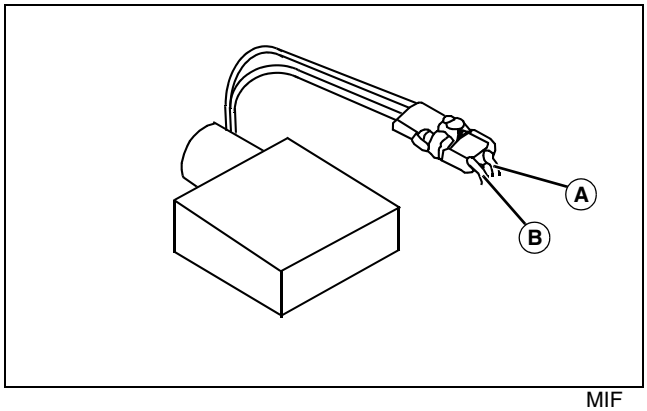
(24) Check ground circuit resistance at mow valve solenoid (Y2) - wire 110 blk (W). Is there less than 0.1 ohm of resistance?

Yes - Replace mow valve solenoid.

No - S.N. (-050071): Test wire 110 blk and connections.

No - S.N. (050072-060000): Test wires 110 and 190 blk.

System: Third Wheel Drive Solenoid



MIF

(1) Measure voltage at third wheel drive solenoid (Y1) - wire 528 yel (A). Is battery voltage present?

Yes - Go to step (2).

No - Test wire 528 yel and connections.

(2) Check ground circuit resistance at third wheel drive solenoid (Y1) - wire 115 blk (B). Is there less than 0.1 ohm of resistance?

Yes - Replace third wheel drive solenoid.

No - S.N. (-050071): Test wires 155 and 115 blk.

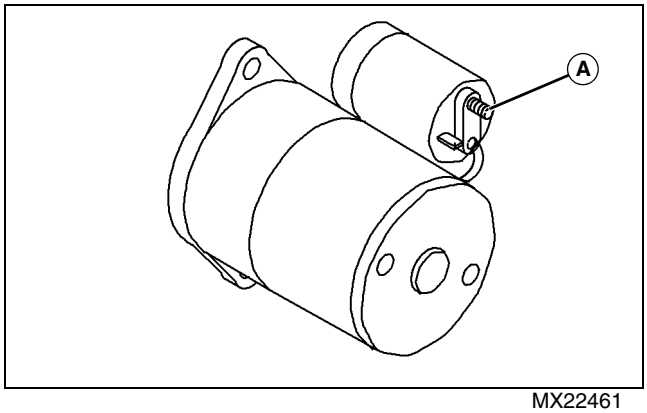
No - S.N. (050072-060000): Test wires 155, 115, and 190 blk.

Mow Circuit Diagnosis S.N. (060001-)

Test Conditions:

- Key switch in RUN position.
- Park brake switch in OFF position.
- Operator OFF seat.
- Mow switch in OFF position.

System: Mow Circuit

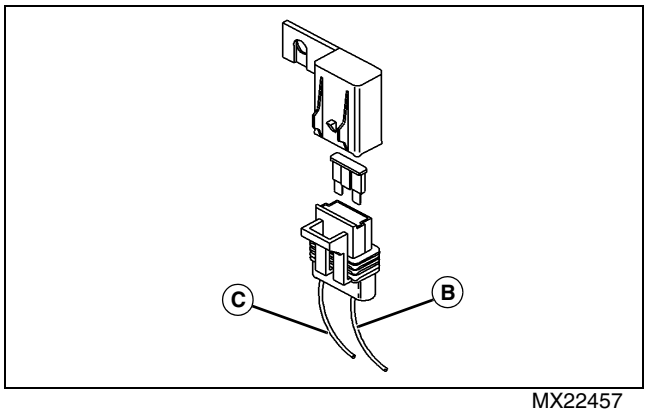


MX22461

(1) Measure voltage at starting motor battery terminal (A). Is battery voltage present?

Yes - Go to step (2).

No - Test battery and connections. (See “Battery Test” on page 246.)



MX22457

(2) Measure voltage at main fuse (F1) - wire 206 red/wht (B). Is battery voltage present?

Yes - Go to step (3).

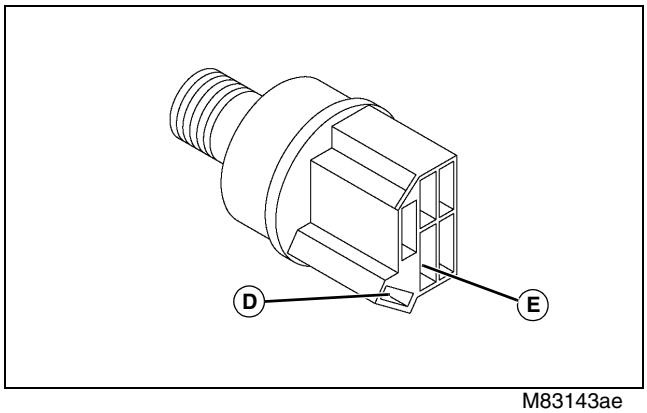
No - Test wire 206 red/wht. Test fusible link (F2) - wire 200 and connections.

System: Mow Circuit

(3) Measure voltage at main fuse (F1) - wire 208 red/blk (C). Is battery voltage present?

Yes - Go to step (4).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



M83143ae

(4) Measure voltage at key switch (S1) - wire 208 red/blk (D). Is battery voltage present?

Yes - Go to step (5).

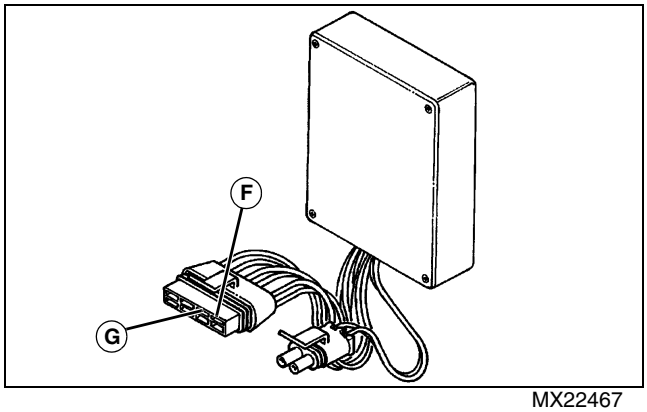
No - Test wire 208 red/blk and connections.

(5) Measure voltage at key switch (S1) - wire 520 yel/blk (E). Is battery voltage present?

Yes - Go to step (6).

No - Replace key switch.

System: Mow Circuit



MX22467

(6) Measure voltage at control module (A1) - wire 520 yel/blk (F). Is battery voltage present?

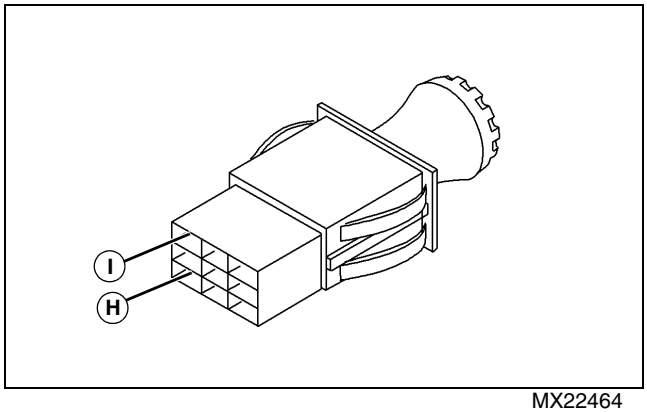
Yes - Go to step (7).

No - Test wires 520 yel/blk and 521 yel. Test fuse (F4). Test wires 519 yel and 522 yel/wht.

(7) Check ground circuit resistance at control module (A1) - wire 150 blk (G). Is there less than 0.1 ohm of resistance?

Yes - Go to step (8).

No - Test wires 150 and 190 blk. Test frame ground terminal (W2).



MX22464

(8) Measure voltage at mow switch (S6) - wire 800 pnk/blk (H). Is battery voltage present?

Yes - Go to step (9).

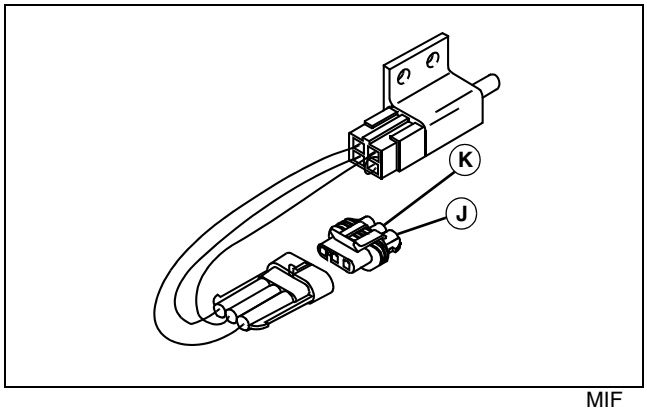
No - Test wire 801 pnk/wht.

(9) Measure voltage at mow switch (S6) - wire 820 pnk/blk (I). Is battery voltage present?

Yes - Go to step (10).

No - Test mow switch. (See “Mow Switch Test” on page 252.)

System: Mow Circuit



MIF

(10) Measure voltage at park brake switch (S5) - wire 803 red (J). Is battery voltage present?

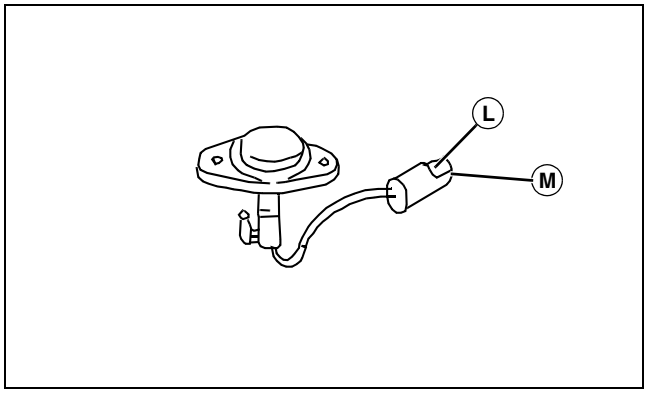
Yes - Go to step (11).

No - Test wire 803 red and connections.

(11) Measure voltage at park brake switch (S5) - wire 824 pnk/wht (K). Is battery voltage present?

Yes - Go to step (12).

No - Test park brake switch. (See “Park Brake Switch Test” on page 253.)



(12) Measure voltage at seat switch connector (X4) - wire 824 pnk/wht (L). Is battery voltage present?

Yes - Go to step (13).

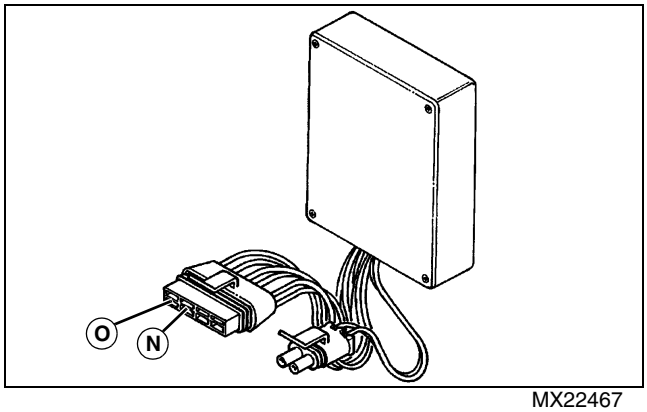
No - Test wire 824 pnk/wht and connections.

(13) Measure voltage at seat switch connector (X4) - wire 808 pnk/blk (M). Is battery voltage present?

Yes - Go to step (14).

No - Replace seat switch.

System: Mow Circuit



MX22467

(14) Place seat switch in ON position for the remainder of test procedure. Measure voltage at control module (A1) - wire 810 pnk (N). Is battery voltage present?

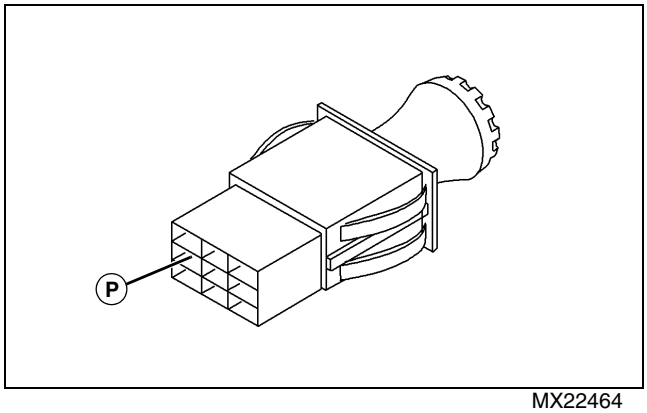
Yes - Go to step (15).

No - Test wires 810 pnk and 808 pnk/blk.

(15) Place mow switch in MOW position for the remainder of test procedure. Measure voltage at control module (A1) - wire 820 pnk/blk (O). Is battery voltage present?

Yes - Go to step (16).

No - Test control module. (See “Control Module Test” on page 255.)



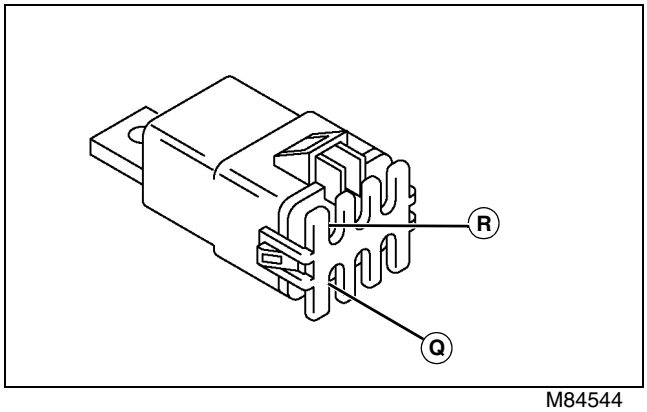
MX22464

(16) Measure voltage at mow switch (S6) - wire 526 yel/blk (P). Is battery voltage present?

Yes - Go to step (17).

No - Test mow switch. (See “Mow Switch Test” on page 252.)

System: Mow Circuit



M84544

(17) Check ground circuit resistance at mow valve relay (K4) - wire 105 blk (Q). Is there less than 0.1 ohm of resistance?

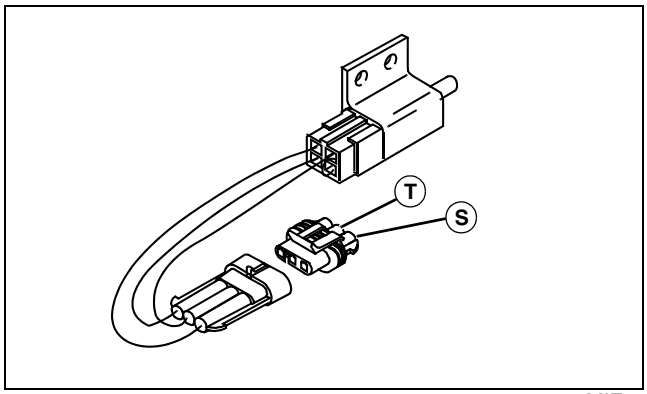
Yes - Go to step (18).

No - Test wires 105 and 190 blk.

(18) Measure voltage at mow valve relay (K4) - wire 527 yel (R). Is battery voltage present?

Yes - Go to step (19).

No - Test wires 527 yel and 526 yel/blk.



MIF

(19) Measure voltage at raise/lower switch (S8) - wire 531 yel (S). Is battery voltage present?

Yes - Go to step (20).

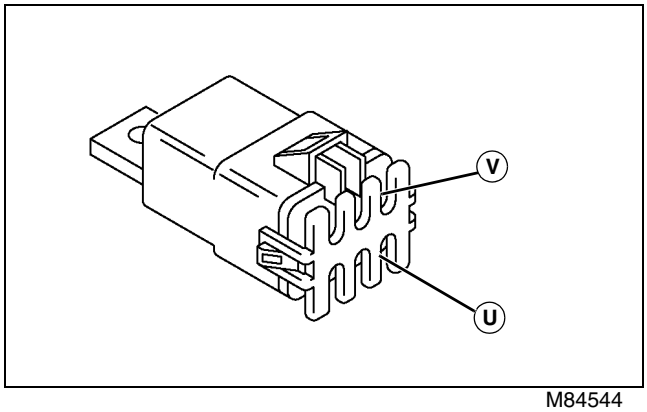
No - Test wire 531 yel and connections.

(20) Measure voltage at raise/lower switch (S8) - wire 530 yel (T). Is battery voltage present?

Yes - Go to step (21).

No - Test test switch. (See “Raise/Lower Switch Test” on page 254.)

System: Mow Circuit



M84544

(21) Measure voltage at mow valve relay (K4) - wire 530 yel (V). Is battery voltage present?

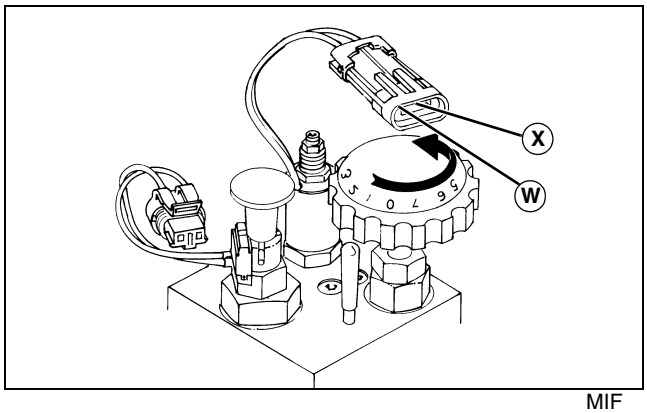
Yes - Go to step (22).

No - Test wire 530 yel and connections.

(22) Measure voltage at mow valve relay (K4) - wire 750 pur (U). Is battery voltage present?

Yes - Go to step (23).

No - Test relay. (See “Relay Test” on page 252.)



MIF

(23) Measure voltage at mow valve solenoid (Y2) - wire 750 pur (W). Is battery voltage present?

Yes - Go to step (24).

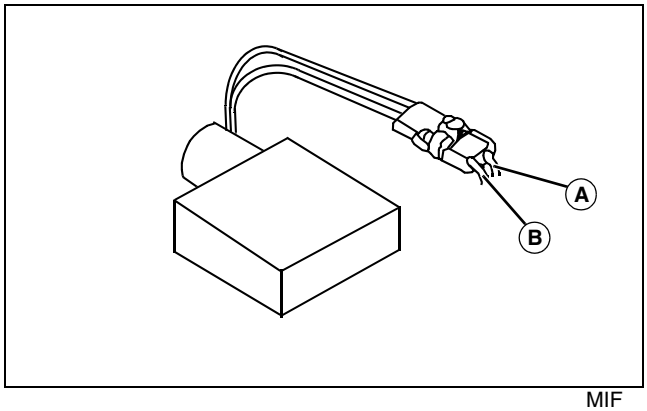
No - Test wire 750 pur and connections.

(24) Check ground circuit resistance at mow valve solenoid (Y2) - wire 110 blk (W). Is there less than 0.1 ohm of resistance?

Yes - Replace mow valve solenoid.

No - Test wires 110 and 190 blk.

System: Third Wheel Drive Solenoid



MIF

(1) Measure voltage at third wheel drive solenoid (Y1) - wire 528 yel (A). Is battery voltage present?

Yes - Go to step (2).

No - Test wire 528 yel and connections.

(2) Check ground circuit resistance at third wheel drive solenoid (Y1) - wire 115 blk (B). Is there less than 0.1 ohm of resistance?

Yes - Replace third wheel drive solenoid.

No - S.N. (060000-060554): Test wires 155, 115, and 190 blk.

No - S.N. (060555-): Test wires 115 and 190 blk.

Backlap Circuit Operation

Function

To allow the operator to energize or de-energize the mow valve solenoid while off the seat during backlapping.

Operating Conditions

- Key switch in RUN position.
- Operator OFF seat.
- Park brake in OFF position.

Theory of Operation

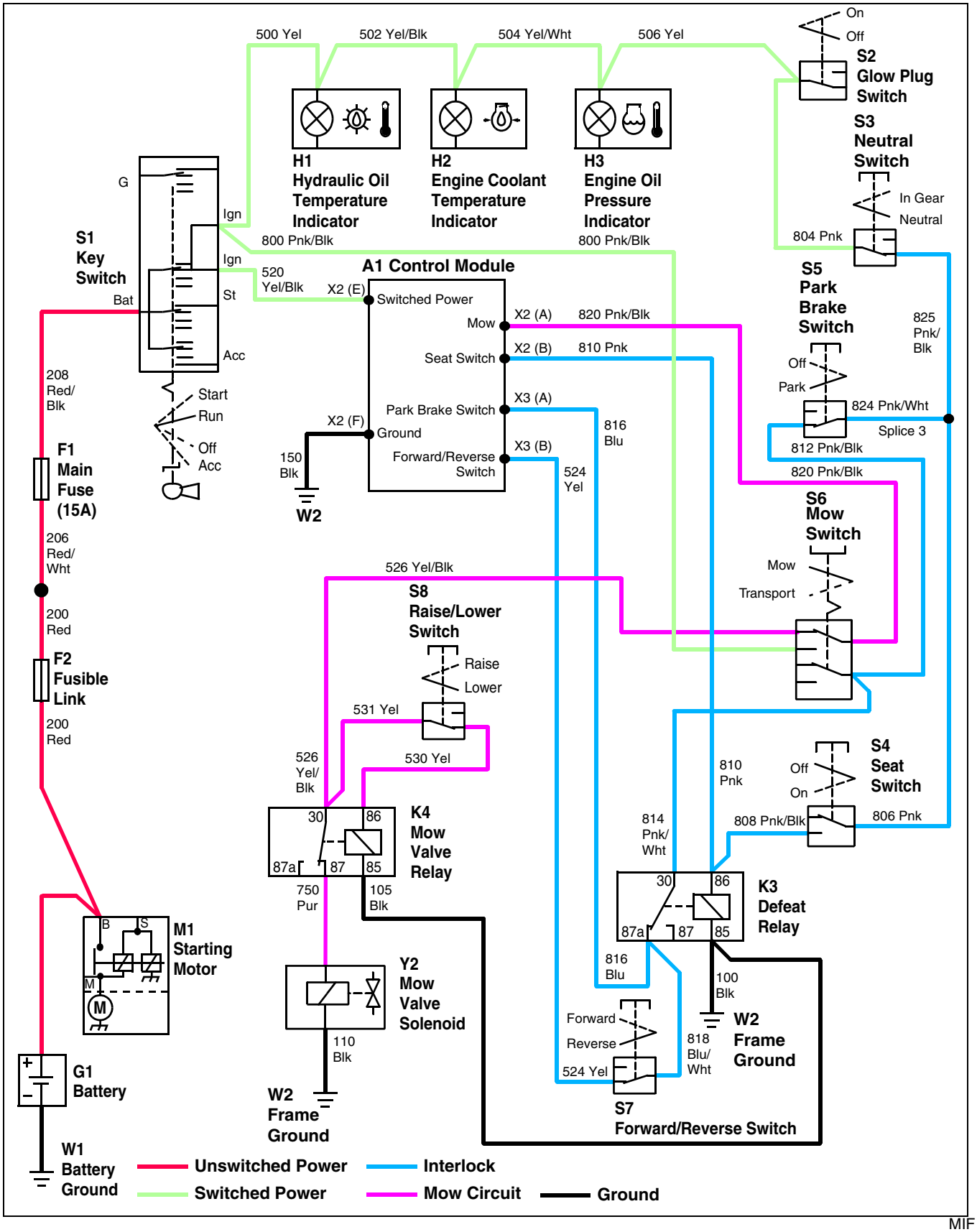
Control module mow terminal has two functions, as an input terminal and then an output terminal. When mow switch (S6) is in the OFF position, voltage is available to control module mow terminal. When current flows to control module forward/reverse switch terminal, an internal latch circuit is activated and provides voltage to control module mow terminal. This is to ensure that mow switch is in the OFF position before power is provided to the mow terminal.

Current flows to control module forward/reverse switch terminal when forward/reverse switch (S7) is in the REVERSE position.

With voltage available to control module mow terminal and mow switch (S6) is in the MOW position, voltage is available to mow valve relay terminal 30 and to raise/lower switch (S8).

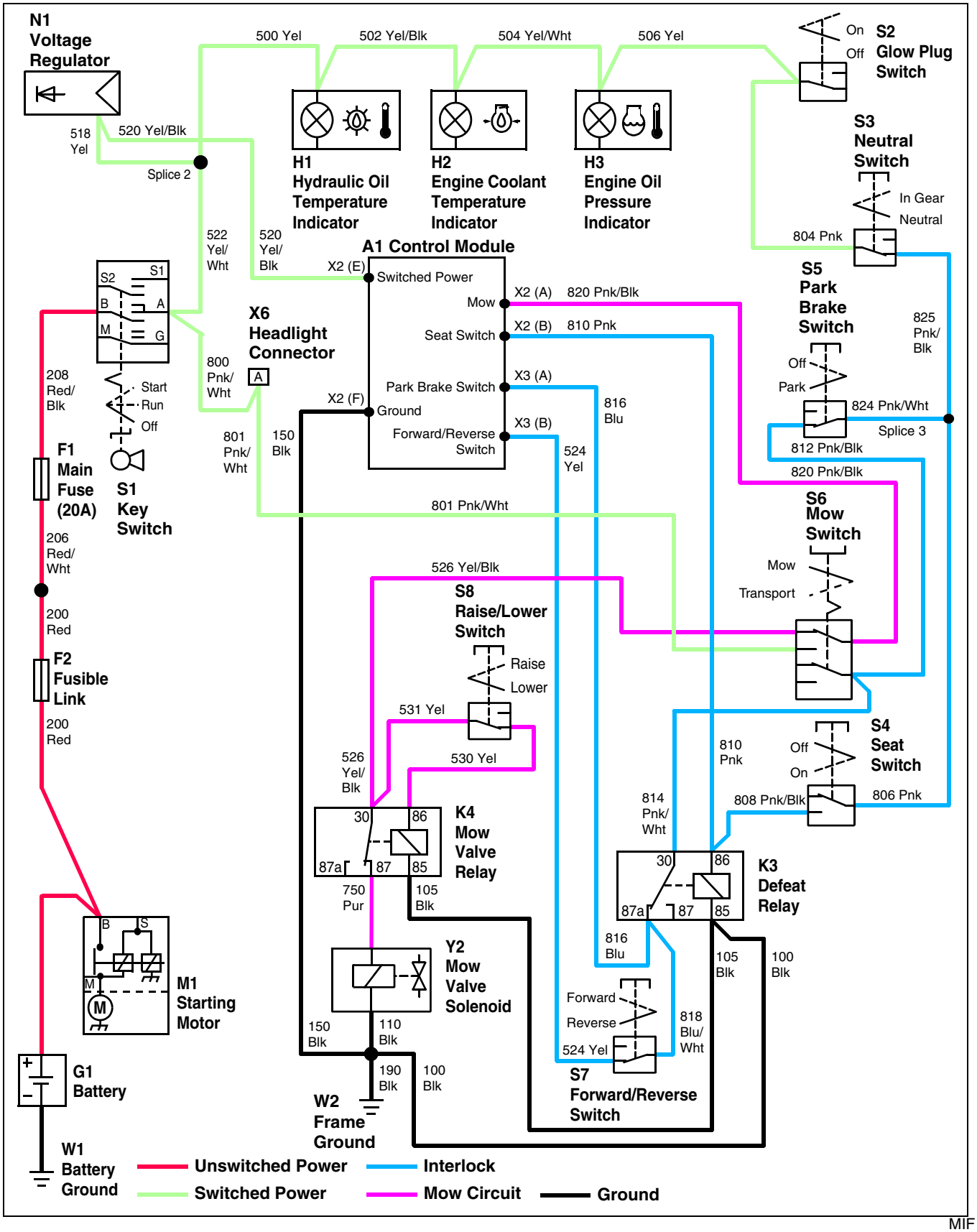
When raise/lower switch is in the LOWER position, current flows to mow valve relay terminal 86, energizing the relay. With mow valve relay energized, current flows between mow vale relay contacts (30 and 87) to mow valve solenoid (Y2), activating the solenoid.

Backlap Circuit Schematic S.N. (-050071)



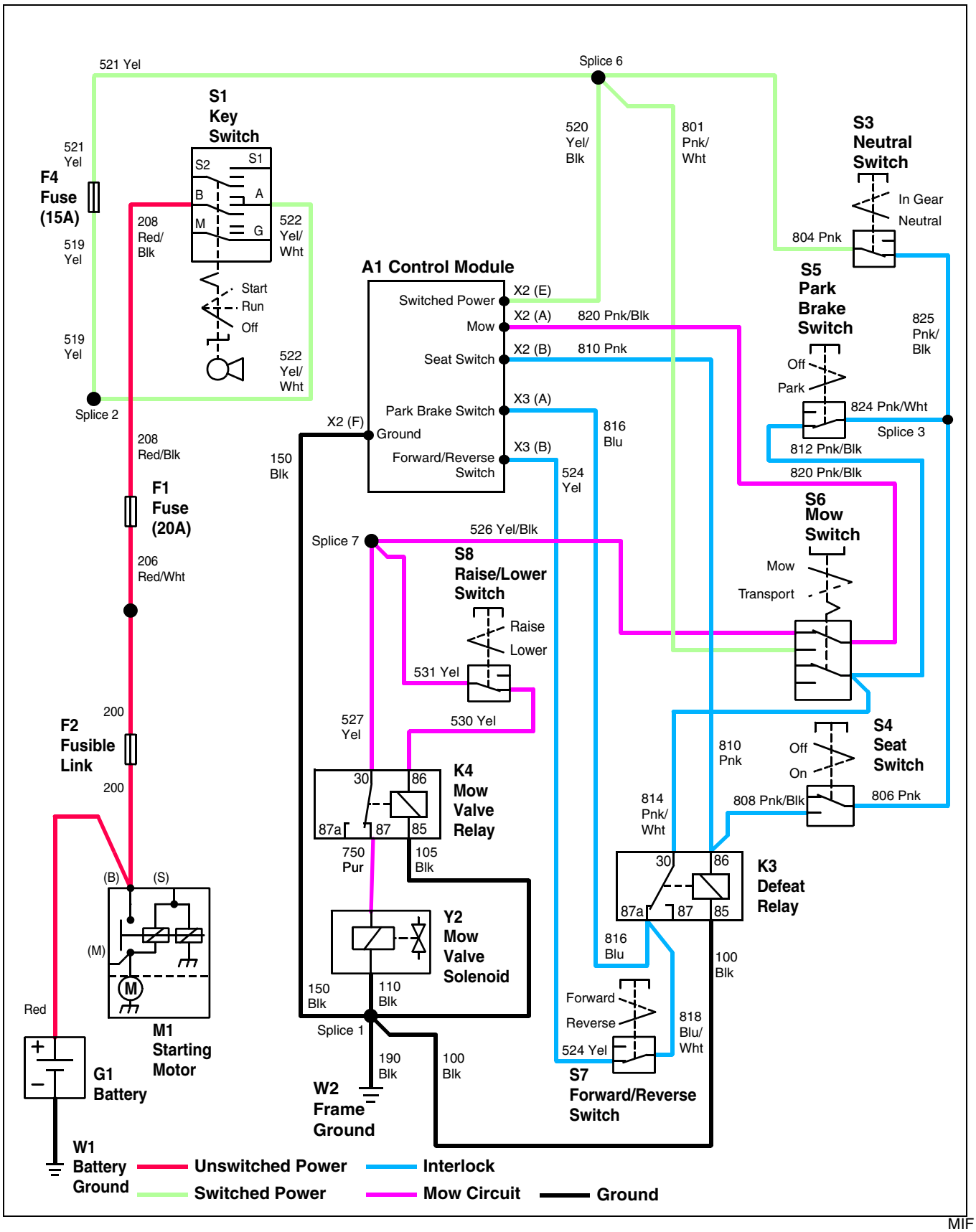
MIF

Backlap Circuit Schematic S.N. (050072-060000)



MIF

Backlap Circuit Schematic S.N. (060001-)



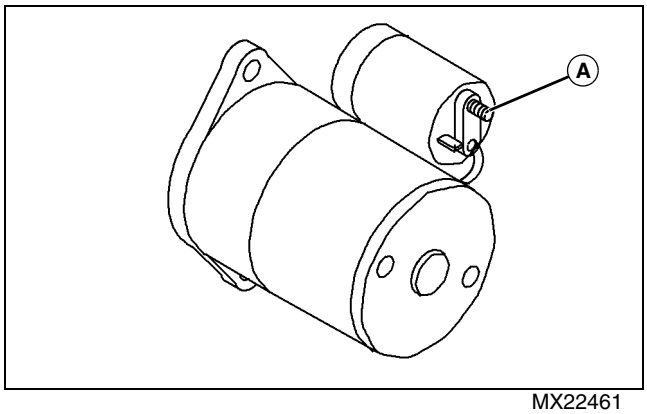
MIF

Backlap Circuit Diagnosis S.N. (-060000)

Test Conditions:

- Mow switch in OFF position.
- Key switch in RUN position.
- Park brake switch in PARK position.
- Neutral switch in NEUTRAL position.
- Forward/reverse switch in FORWARD position.

System: Backlap Circuit

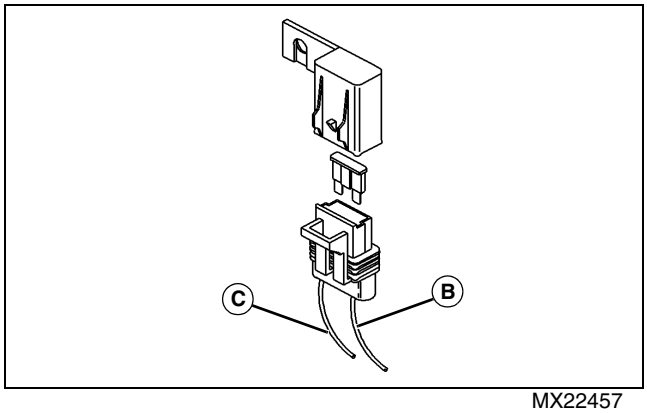


MX22461

(1) Measure voltage at starting motor battery terminal (A). Is battery voltage present?

Yes - Go to step (2).

No - Test battery and connections. (See “Battery Test” on page 246.)



MX22457

(2) Measure voltage at main fuse (F1) - wire 206 red/wht (B). Is battery voltage present?

Yes - Go to step (3).

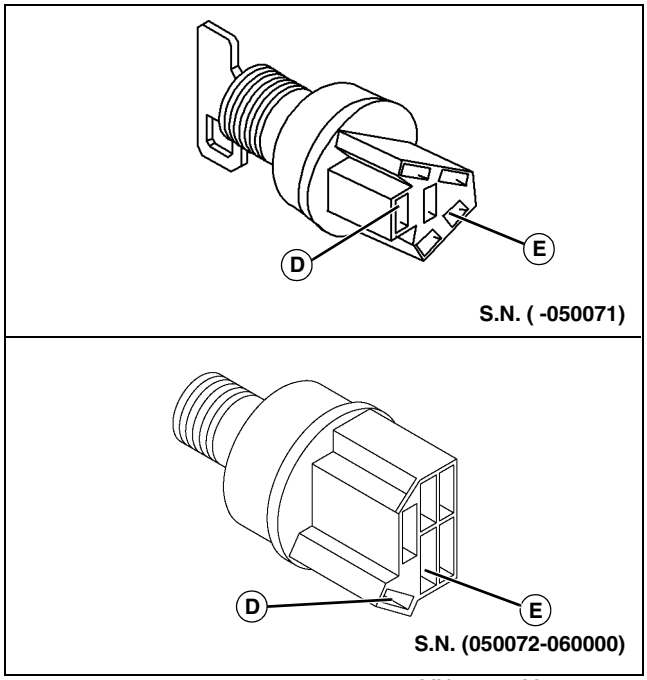
No - Test wire 206 red/wht. Test fusible link (F2) - wire 200 and connections.

System: Backlap Circuit

(3) Measure voltage at main fuse (F1) - wire 208 red/blk (C). Is battery voltage present?

Yes - Go to step (4).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



MX22463, M83143ae

(4) Measure voltage at key switch (S1) - wire 208 red/blk (D). Is battery voltage present?

Yes - Go to step (5).

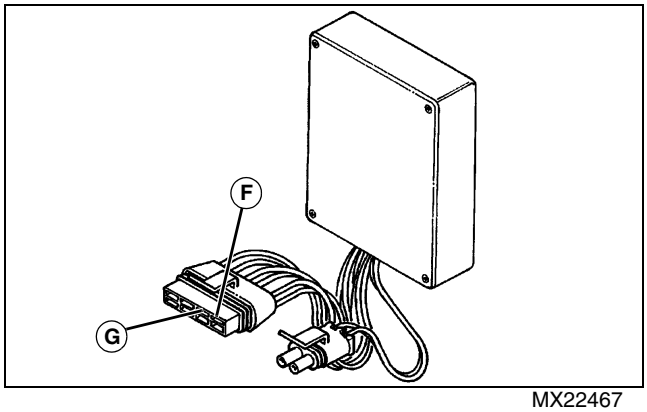
No - Test wire 208 red/blk and connections.

(5) Measure voltage at key switch (S1) - wire 520 yel/blk (E). Is battery voltage present?

Yes - Go to step (6).

No - Replace key switch.

System: Backlap Circuit



MX22467

(6) Measure voltage at control module (A1) - wire 520 yel/blk (F). Is battery voltage present?

Yes - Go to step (7).

No - S.N. (-050071): Test wire 520 yel/blk and connections.

No - S.N. (050072-060000): Test wires 520 yel/blk, 518 yel, and 522 yel.

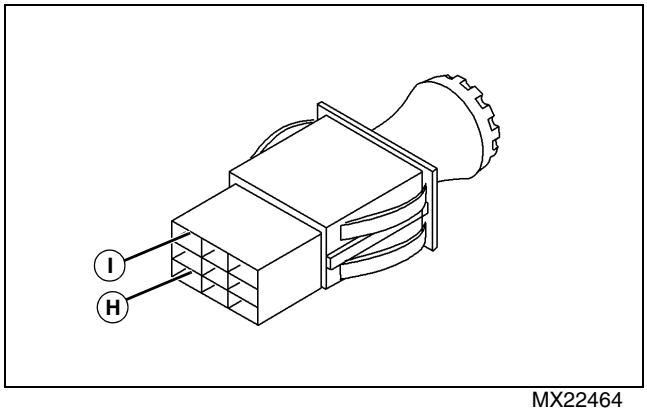
(7) Check ground circuit resistance at control module (A1) - wire 150 blk (G). Is there less than 0.1 ohm of resistance?

Yes - Go to step (8).

No - S.N. (-050071): Test wire 150 blk and frame ground terminals (W2).

No - S.N. (050072-060000): Test wires 150 and 190 blk. Check frame ground terminal (W2).

System: Backlap Circuit



MX22464

(8) Measure voltage at mow switch (S6) - terminal (H). Is battery voltage present?

Yes - Go to step (9).

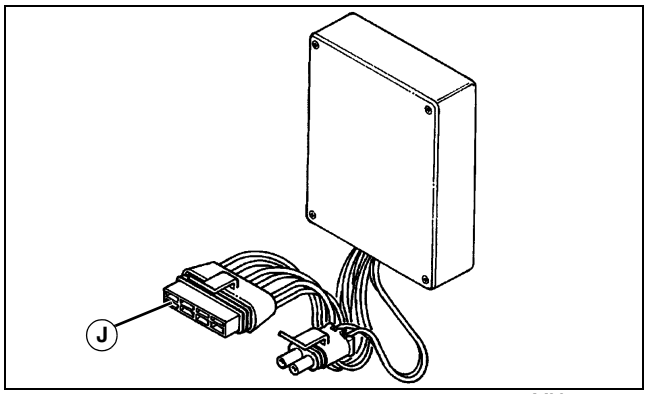
No - S.N. (-050071): Test wires 800 pnk/blk and connections.

No - S.N. (050072-060000): Test wires 801 pnk/wht and 800 pnk/blk.

(9) Measure voltage at mow switch (S6) - wire 820 pnk/blk (I). Is battery voltage present?

Yes - Go to step (10).

No - Test mow switch. (See “Mow Switch Test” on page 252.)

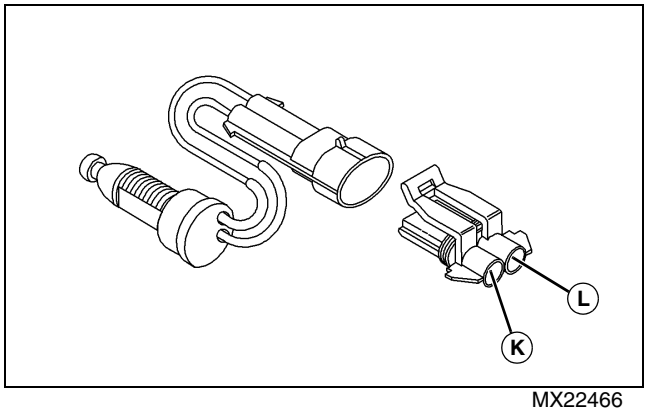


MX22467

(10) Measure voltage at control module (A1) - wire 820 pnk/blk (J). Is battery voltage present?

Yes - Go to step (11).

No - Test wire 820 pnk//blk.



MX22466

(11) Measure voltage at neutral switch (S3) - wire 804 pnk (K). Is battery voltage present?

Yes - Go to step (12).

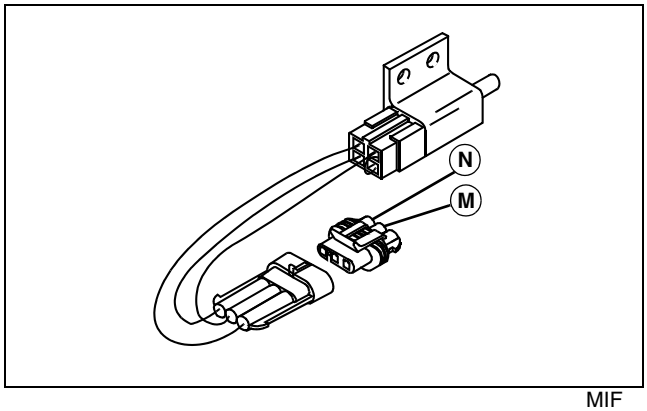
No - Test wire 804 pnk between neutral switch (S3) and glow plug switch (S2). Test wire 506 yel between glow plug switch (S2) and engine oil pressure indicator (H3). Test wire 504 yel between engine oil pressure indicator (H3) and engine coolant temperature indicator (H2).

No - Test wire 502 yel/blk between engine coolant temperature indicator (H2) and hydraulic oil temperature indicator (H1). Test wire 500 yel between hydraulic oil temperature indicator (H1) and key switch (S1) and connections.

(12) Measure voltage at neutral switch (S3) - wire 825 pnk/blk (L). Is battery voltage present?

Yes - Go to step (13).

No - Test neutral switch. (See “Neutral Switch Test” on page 253.)



MIF

(13) Measure voltage at park brake switch (S5) - wire 824 pnk/wht (M). Is battery voltage present?

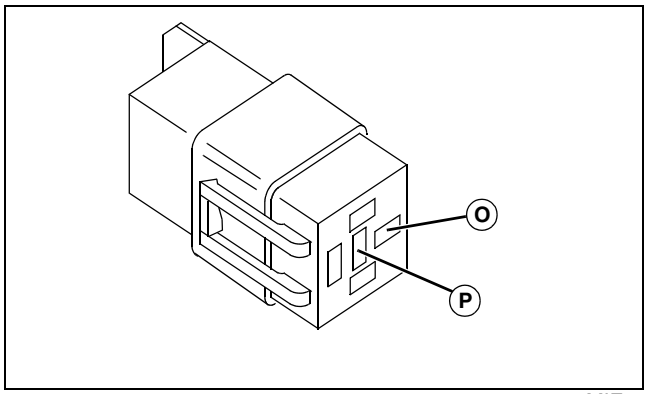
Yes - Go to step (14).

No - Test wires 825 pnk/blk and 824 pnk/wht.

(14) Measure voltage at park brake switch (S5) - wire 812 pnk/blk (N). Is battery voltage present?

Yes - Go to step (15).

No - Test park brake switch. (See “Park Brake Switch Test” on page 253.)



MIF

(15) Measure voltage at defeat relay (K3) - wire 814 pnk/wht (O). Is battery voltage present?

Yes - Go to step (16).

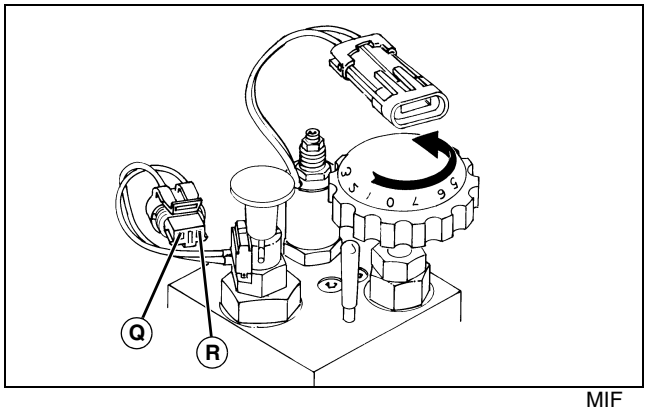
No - Test wires 814 pnk/wht and 812 pnk/blk.

(16) Measure voltage at defeat relay (K3) - wire 816 blu (P). Is battery voltage present?

Yes - Go to step (17).

No - Test defeat relay. (See “Relay Test” on page 252.)

System: Backlap Circuit



MIF

(17) Measure voltage at forward/reverse switch (S7) - wire 818 blu/wht (R). Is battery voltage present?

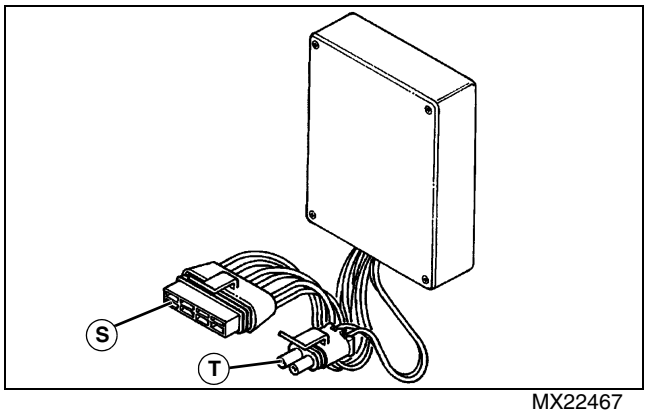
Yes - Go to step (18).

No - Test wire 818 blu/wht and connections.

(18) Measure voltage at forward/reverse switch (S7) - wire 524 yel (Q). Is battery voltage present?

Yes - Go to step (19).

No - Replace forward/reverse switch.



MX22467

(19) Place forward/reverse switch in REVERSE position for the remainder of test procedure. Measure voltage at control module (A1) - wire 524 yel (T). Is battery voltage present?

Yes - Go to step (20).

No - Test wires 810 pnk and 808 pnk//blk.

(20) Place mow switch in MOW position. Measure voltage at control module (A1) - wire 820 pnk/blk (S). Is battery voltage present?

Yes - Test complete.

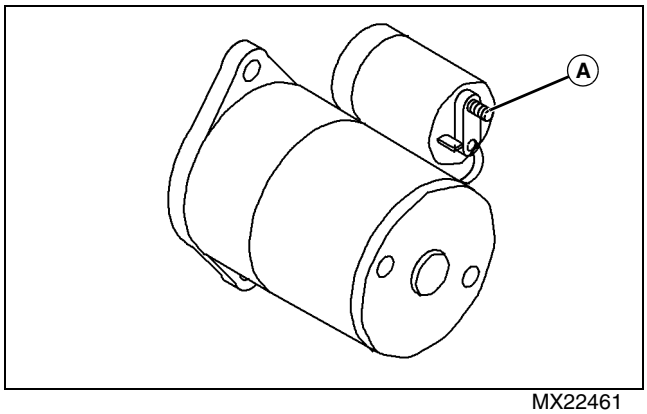
No - Test control module. (See “Control Module Test” on page 255.)

Backlap Circuit Diagnosis S.N. (060001-)

Test Conditions:

- Mow switch in OFF position.
- Key switch in RUN position.
- Park brake switch in PARK position.
- Neutral switch in NEUTRAL position.
- Forward/reverse switch in FORWARD position.

System: Backlap Circuit

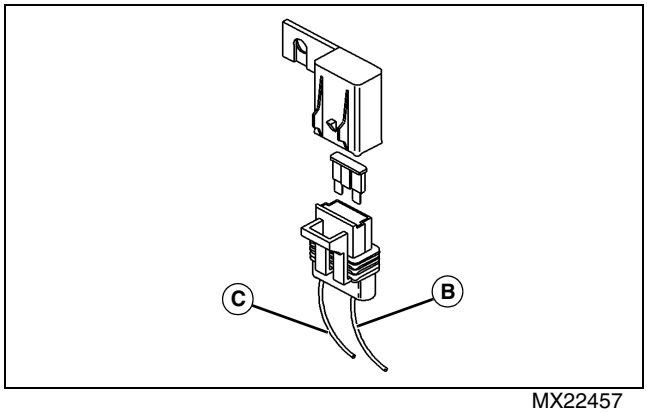


MX22461

(1) Measure voltage at starting motor battery terminal (A). Is battery voltage present?

Yes - Go to step (2).

No - Test battery and connections. (See “Battery Test” on page 246.)



MX22457

(2) Measure voltage at main fuse (F1) - wire 206 red/wht (B). Is battery voltage present?

Yes - Go to step (3).

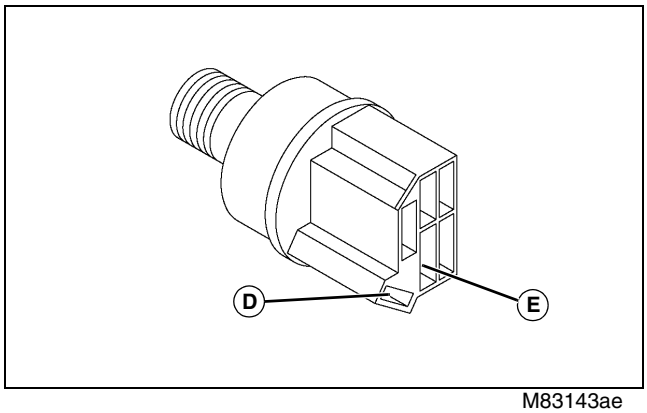
No - Test wire 206 red/wht. Test fusible link (F2) - wire 200 and connections.

System: Backlap Circuit

(3) Measure voltage at main fuse (F1) - wire 208 red/blk (C). Is battery voltage present?

Yes - Go to step (4).

No - Test fuse and connections. (See “Fuse Test” on page 249.)



M83143ae

(4) Measure voltage at key switch (S1) - wire 208 red/blk (D). Is battery voltage present?

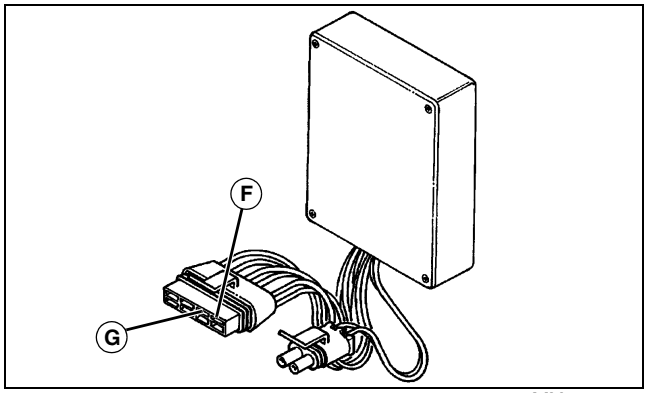
Yes - Go to step (5).

No - Test wire 208 red/blk and connections.

(5) Measure voltage at key switch (S1) - wire 520 yel/blk (E). Is battery voltage present?

Yes - Go to step (6).

No - Replace key switch.



MX22467

(6) Measure voltage at control module (A1) - wire 520 yel/blk (F). Is battery voltage present?

Yes - Go to step (7).

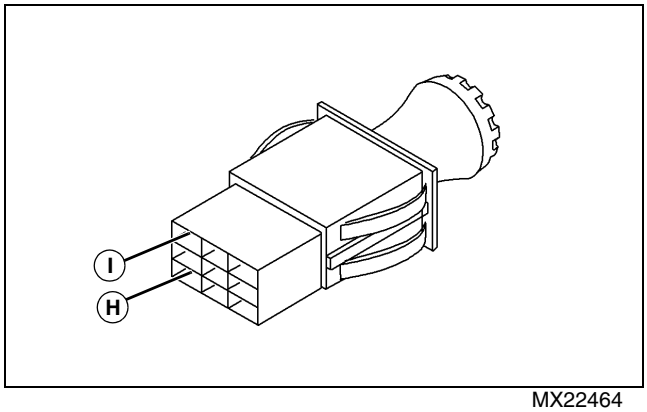
No - Test wires 520 yel/blk and 521 yel. Test fuse (F4). Test wires 519 yel and 522 yel/wht.

System: Backlap Circuit

(7) Check ground circuit resistance at control module (A1) - wire 150 blk (G). Is there less than 0.1 ohm of resistance?

Yes - Go to step (8).

No - Test wires 150 and 190 blk. Check frame ground terminal (W2).



MX22464

(8) Measure voltage at mow switch (S6) - wire 800 pnk/blk (H). Is battery voltage present?

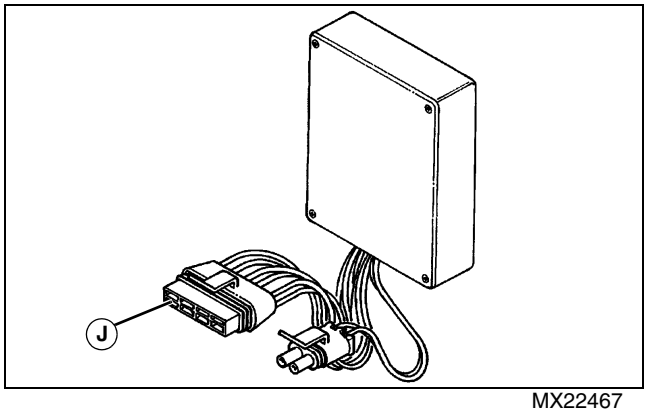
Yes - Go to step (9).

No - Test wire 801 pnk/wht.

(9) Measure voltage at mow switch (S6) - wire 820 pnk/blk (I). Is battery voltage present?

Yes - Go to step (10).

No - Test mow switch. (See “Mow Switch Test” on page 252.)



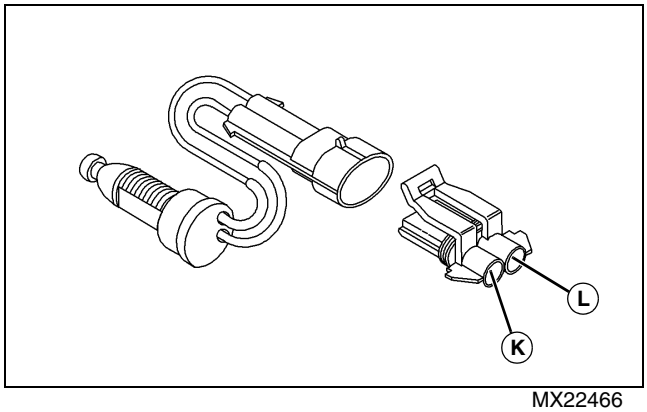
MX22467

(10) Measure voltage at control module (A1) - wire 820 pnk/blk (J). Is battery voltage present?

Yes - Go to step (11).

No - Test wire 820 pnk//blk.

System: Backlap Circuit



MX22466

(11) Measure voltage at neutral switch (S3) - wire 804 pnk (K). Is battery voltage present?

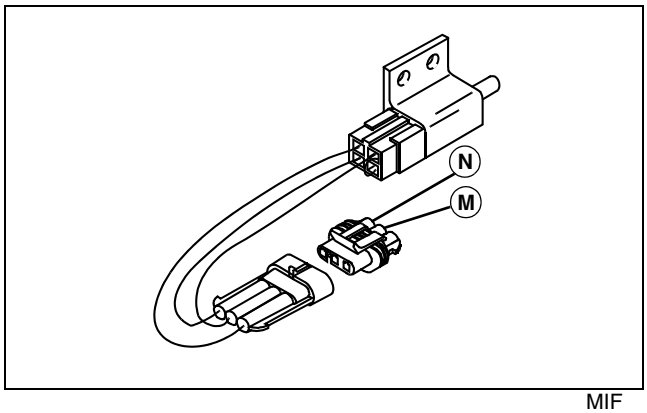
Yes - Go to step (12).

No - Test wire 804 pnk and connections.

(12) Measure voltage at neutral switch (S3) - wire 825 pnk/blk (L). Is battery voltage present?

Yes - Go to step (13).

No - Test neutral switch. (See “Neutral Switch Test” on page 253.)



MIF

(13) Measure voltage at park brake switch (S5) - wire 824 pnk/wht (M). Is battery voltage present?

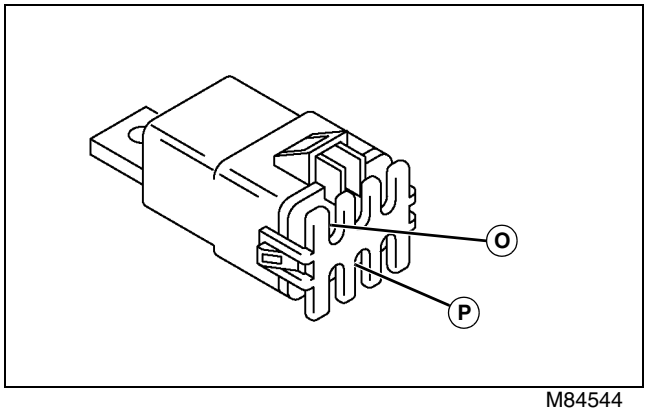
Yes - Go to step (14).

No - Test wires 825 pnk/blk and 824 pnk/wht.

(14) Measure voltage at park brake switch (S5) - wire 812 pnk/blk (N). Is battery voltage present?

Yes - Go to step (15).

No - Test park brake switch. (See “Park Brake Switch Test” on page 253.)



M84544

(15) Measure voltage at defeat relay (K3) - wire 814 pnk/wht (O). Is battery voltage present?

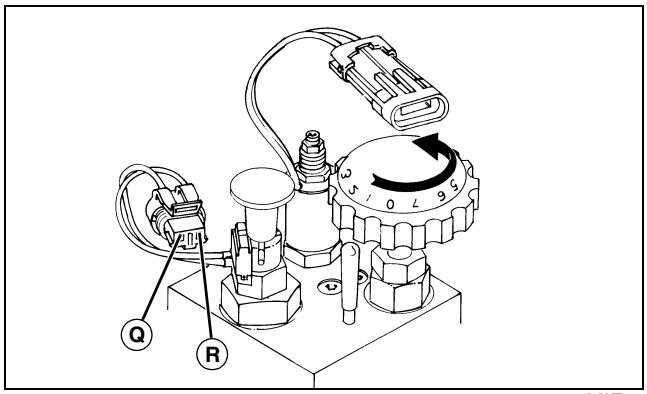
Yes - Go to step (16).

No - Test wires 814 pnk/wht and 812 pnk/blk.

(16) Measure voltage at defeat relay (K3) - wire 816 blu (P). Is battery voltage present?

Yes - Go to step (17).

No - Test defeat relay. (See “Relay Test” on page 252.)



MIF

(17) Measure voltage at forward/reverse switch (S7) - wire 818 blu/wht (R). Is battery voltage present?

Yes - Go to step (18).

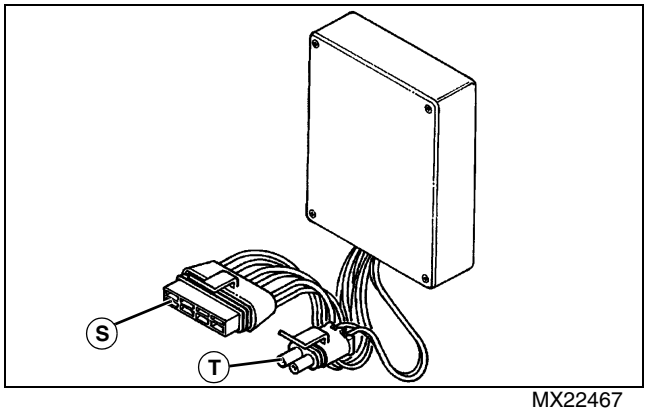
No - Test wire 818 blu/wht and connections.

(18) Measure voltage at forward/reverse switch (S7) - wire 524 yel (Q). Is battery voltage present?

Yes - Go to step (19).

No - Replace forward/reverse switch.

System: Backlap Circuit



MX22467

(19) Place forward/reverse switch in REVERSE position for the remainder of test procedure. Measure voltage at control module (A1) - wire 524 yel (T). Is battery voltage present?

Yes - Go to step (20).

No - Test wires 810 pnk and 808 pnk//blk.

(20) Place mow switch in MOW position. Measure voltage at control module (A1) - wire 820 pnk/blk (S). Is battery voltage present?

Yes - Test complete.

No - Test control module. (See “Control Module Test” on page 255.)

Tests and Adjustments

Ground Circuit Tests

Reason

To check for opens, loose terminal wire crimps, poor connections, or corrosion in the ground circuit. The voltmeter method checks ground connections under load.

Equipment

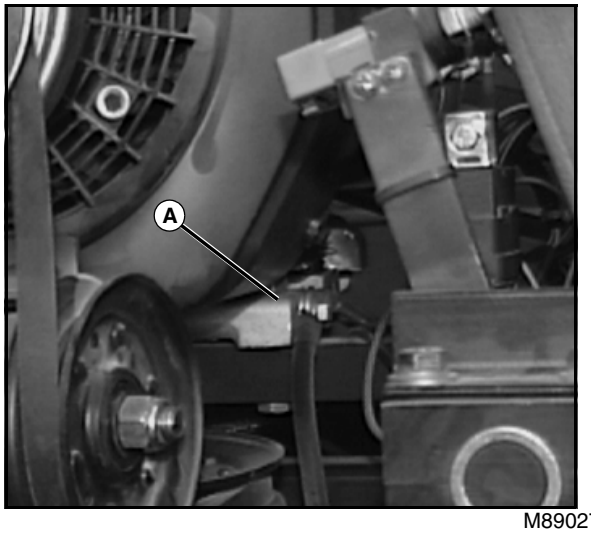
- Ohmmeter or voltmeter

Procedure

Ohmmeter Method

1. Turn ignition switch to OFF position. Lock park brake.

2. Connect ohmmeter negative (black) lead to negative (-) terminal of battery. Put meter positive (red) lead on negative (-) terminal of battery and record reading.



M89027

3. Put meter red lead on ground terminal (A) of circuit or component to be tested that is closest to the battery negative (-) terminal. Resistance reading must be very close to or the same as the battery negative terminal reading. Work backwards from the battery on the ground side of the problem circuit until the resistance reading increases above 0.1 ohm. The problem is between the last two test points. If a problem is indicated, disconnect the wiring harness connector to isolate the wire or component and check resistance again. Maximum allowable resistance in the circuit is 0.1 ohm. Check both sides of connectors closely as disconnecting and connecting may temporarily solve problem.

Voltmeter Method

1. Put transmission in neutral. Lock park brake. Put traction clutch lever in OFF position. Turn ignition switch to ON position.

2. Connect voltmeter negative (black) lead to negative terminal of battery.

3. Put meter positive (red) lead on ground terminal of component to be tested. Be sure the component circuit is activated (ignition on, switches closed) so voltage will be present at the component. Record voltage. Voltage must be greater than 0 but less than 1 volt. Some components will have a very small voltage reading on the ground side and still be operating correctly.

Results

- If resistance is above 0.1 ohm, check for open wiring, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.
- If voltage is 0, the component is open.
- If voltage is greater than 1 volt, the ground circuit is bad. Check for open wiring, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

Battery Test

Reason

To check condition of battery and determine battery voltage.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hydrometer	NA	Used to check specific gravity.
Digital Multimeter	JT05791	Used to check battery voltage.
Battery Tester	JT05685	Used to check battery condition.

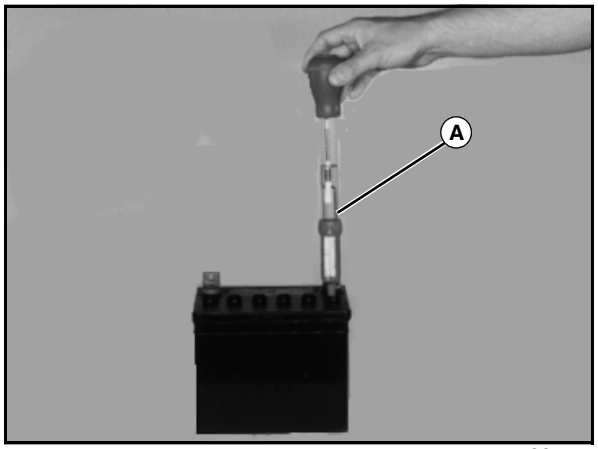
Procedure

1. Clean battery terminals and top of battery.

2. Inspect battery terminals and case for breakage or cracks.

3. Check electrolyte level in each battery cell. Add clean, soft water as needed. If water was added, charge battery for 20 minutes at 10 amps.

4. Remove surface charge by placing a small load on the battery for 15 seconds.



M49596

5. Check specific gravity of each cell with a hydrometer (A).

6. Check battery voltage with voltmeter or JT05685 Battery Tester.

Specifications

Minimum Specific Gravity 1.265
Minimum Battery Voltage. . . . . .12.4 VDC

Results

- Battery voltage less than 12.4 VDC, charge battery.
- Battery voltage more than 12.4 VDC, test specific gravity.
- All cells less than 1.175, charge battery at 10-amp rate.
- All cells less than 1.265 with less than 50-point variation, charge battery at 10-amp rate.
- All cells more than 1.265 with less than 50-point variation, load test battery.
- More than 50-point variation: replace battery.

Charge Battery

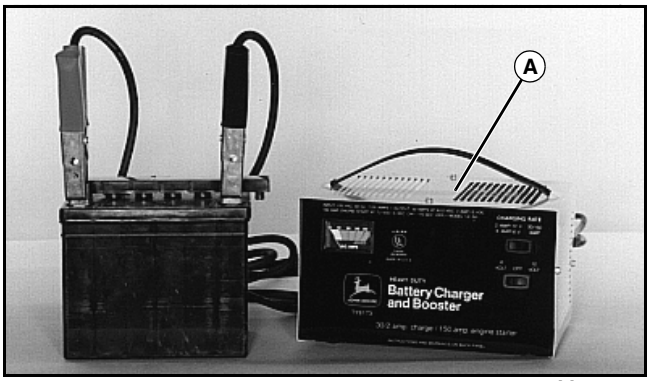
Reason

To increase battery charge after battery has been discharged.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Charger (Variable Rate)	NA	Used to charge battery.

Procedure A



M49598

1. Connect variable rate charger (A) to battery. Maximum charge time at boost setting is 10 minutes. Allow additional 5 minutes for each 10° below 21°C (70°F). Test battery before charging.

2. 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.

3. Check if battery is accepting a 10-amp charge after 10 minutes at boost setting.

Results

- Battery will not accept 10-amp charge after 10 minutes at boost setting, replace battery.
- Battery is accepting 10-amp charge after 10 minutes at boost setting, and battery did not need water, go to Procedure C.
- 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 Procedure B.

Procedure B

1. Set charger at 15-25 amps.

IMPORTANT: Avoid damage! Decrease charge rate if battery gases or bubbles excessively or becomes too warm to touch. If battery was discharged at slow or unknown rate, charge at 10-15 amps for 6-12 hours. (Maintenance-free battery: 12-24 hours.) If battery was discharged at fast rate, charge at 20-25 amps for 2-4 hours. (Maintenance-free battery: 4-8 hours.)

2. Check specific gravity after 30 minutes (60 minutes for maintenance-free battery).

Results

- More than 50-point variation between cells, replace battery.
- Less than 50-point variation between cells, Go to Procedure C.

Procedure C

1. Continue charging battery until specific gravity is 1.230-1.265 points.

2. Load test battery.

Battery Load Test

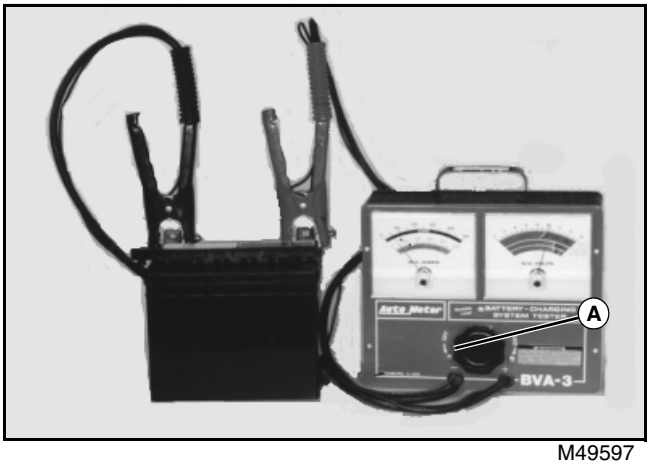
Reason

To check condition of battery under load.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hydrometer	NA	Used to check specific gravity.
Digital Multimeter	JT05791	Used to check battery voltage.
Battery Tester	JT05685	Used to check battery condition.

Connections



M49597

1. Turn load knob (A) of tester counterclockwise to OFF.
2. Connect tester positive cable to battery positive (+) terminal.
3. Connect tester negative cable to battery negative (-) terminal.

Procedure

1. Turn load knob of tester clockwise until amperage reading is equal to:

a. Cold cranking amperage rating (use blue scale).

- or -

b. Three times ampere hour rating (use black scale).

2. Hold for 15 seconds and turn load knob of tester OFF.
3. Repeat procedure steps 1 and 2 from above and read condition of battery at DC Volts scale.

Results

- If the battery does not pass the test and has not been charged, charge battery and retest.
- If the battery does not pass the test and has been charged, replace the battery.

Test Glow Plug - Diesel

Reason

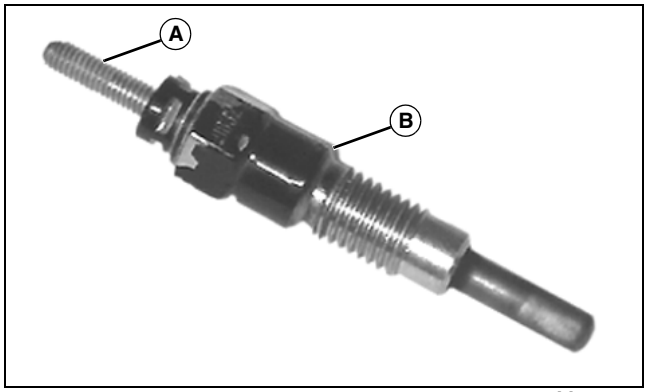
To test the condition of the glow plug.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Multimeter	JT05791	Used to measure glow plug resistance.

Procedure

1. Remove glow plug(s). (See “Remove and Install Glow Plug” on page 80.)



M98190

2. Check resistance across terminal (A) and glow plug body (B).

Specifications

Glow Plug Resistance . . . . . .1.35-1.65 ohms

Results

If the glow plug does not have the correct resistance, replace the glow plug.

Fuse Test

Reason

To determine if fuse has failed.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure fuse continuity.

Procedure

1. Remove fuse to be tested.
2. Set ohmmeter to ohms function.
3. Measure continuity between fuse terminals.

Results

If there is no continuity between fuse terminals, replace fuse.

Key Switch Test

Reason

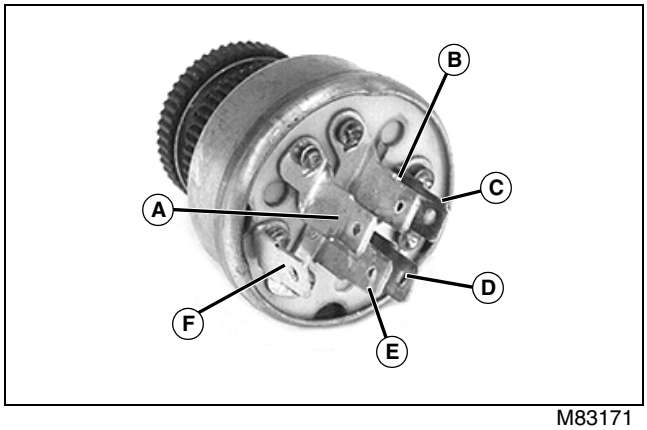
To verify that the key switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Move control levers to NEUTRAL position.
3. Turn key switch to OFF position.
4. Lock park brake.
5. Remove right-side control console cover.
6. Disconnect key switch connector.



M83171

7. Use an ohmmeter or continuity tester to test switch continuity in OFF, RUN, and START positions.

NOTE: DO NOT refer to markings if stamped on terminals. Identify by callouts on art above ONLY. Terminal combinations other than those listed should not have continuity.

Key Switch Continuity:

Switch Position	Terminal Continuity
OFF	C and D
RUN	E and F
START	E and F; A and B

Results

- If any continuity is NOT correct, replace the switch.

Hydro/Engine Overtemp Indicating Lights Test

Reason

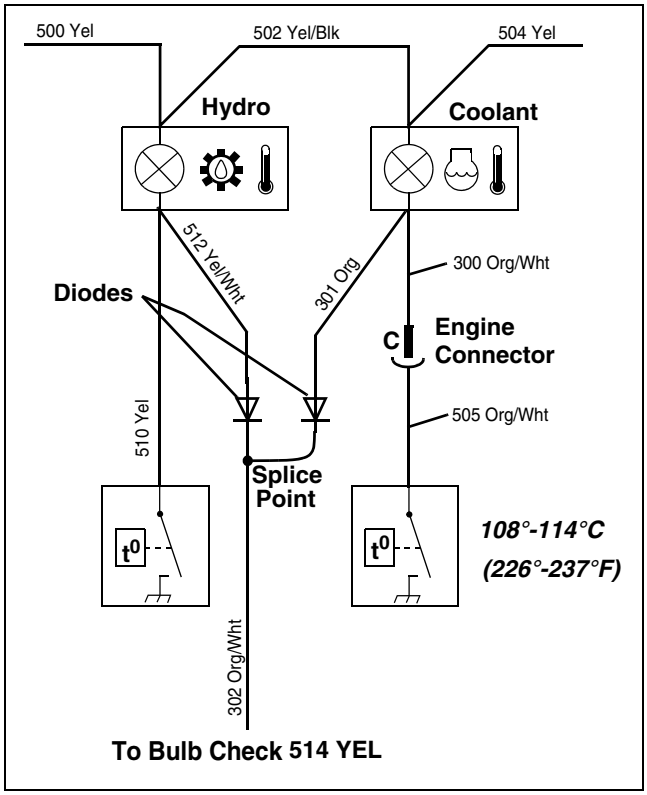
To test the operation of the hydro/engine overtemp indicating lights and circuits.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure continuity and voltage in the overtemp indicator light circuit.

Procedure

NOTE: If both indicators illuminate at the same time, except for in the START position, test the diodes, located near the bulb receptacles, for proper operation.



1. To test the continuity of the hydraulic and coolant over temperature circuit, position the ignition switch to the START position and observe the indicator lights for illumination.

2. If both indicator lights illuminate, the circuit is good and no further tests are needed.

3. If only one indicator light illuminates, test or replace the bulb and try again. If the bulb still fails to illuminate, check for battery current at the bulb receptacle (500 yel, 502 yel/blk, 504 yel) with the ignition switch in the RUN position. Repair or replace wiring or bulb receptacle as needed. If current is being supplied to the indicator light, follow wire 512 yel/wht (for the hydraulic temperature light) or wire 301 Org (for the coolant temperature light) to a splice point and look for a open in the wire before or at the splice point.

4. If neither indicator bulb illuminates, remove the diode, plugged into the wiring harness near the indicator bulb receptacle, and test.

5. If diodes test good, ground wire 512 Yel/Wht (for the hydraulic circuit) or wire 301 Org (for the coolant circuit). Place the Ignition switch to the START position and observe the indicator light for illumination. If the light illuminates, check the wiring to the ignition switch to ground for an open circuit. Repair the wiring or replace the ignition switch as necessary.

Engine Low Oil Pressure Light Test

Reason

To test the operation of the engine low oil pressure indicating light and circuit.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure continuity and voltage in the engine low oil pressure indicator light circuit.

1. Remove the lead at the oil pressure switch and ground it. Position the ignition switch to the RUN position and observe the indicator light for illumination.

- If the indicator light illuminates, the warning circuit, from the battery to the switch, is good. Test oil pressure switch and connections.
- If the indicator light fails to illuminate, check for battery current at the bulb receptacle. If current is available at the receptacle, replace the indicator bulb and repeat the test.
- If the indicator light fails to illuminate, inspect the wiring and engine connector for an open circuit. Repair or replace as necessary.

2. If no current is available at the bulb receptacle, check for illumination of the water temperature indicator light by placing the ignition switch to the START position. If the water temperature light illuminates, inspect the power lead from the water temperature indicator to the oil pressure indicator for a faulty connection. Repair or replace as necessary.

Engine Oil Pressure Switch Test

Reason

To verify the proper operation of the oil pressure switch.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure continuity between engine oil pressure switch and ground.

1. Park machine on a level surface.

2. Turn key OFF and lock park brake.

3. Check for continuity between switch terminal and engine block.

4. Start and run engine at fast idle.

5. Check for continuity between 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. (See “Test Engine Oil Pressure” on page 52.)

- If engine oil pressure is to specifications and there is continuity with the engine running, replace engine oil pressure switch.

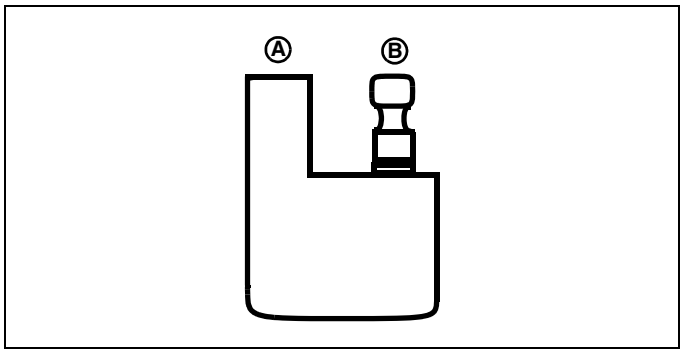
Diode Test

Reason

To verify that diode has proper continuity.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure continuity at the diode.



1. Remove the diode from the electrical harness.

2. Using an ohmmeter connect the black test lead to A and the red test lead to B and check continuity.

3. Reverse the test leads and check continuity.

Results

- If continuity is noted in both steps, the diode is defective and must be replaced.

- If continuity is noted in step 2 and not in step 3, the diode is good.

Fuel Shutoff Solenoid Test - Diesel Engine

Reason:

To verify proper fuel shutoff solenoid operation.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to measure resistance of fuel shutoff solenoid coils.

Procedure:

1. Park machine safely on a level surface.

2. Disengage PTO.

3. Turn key switch to STOP position.

4. Move travel pedals to NEUTRAL position.

5. LOCK park brake.

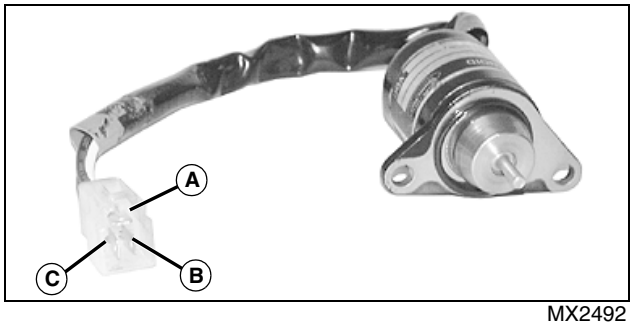
6. Turn key switch to RUN position. A click should be heard as the solenoid engages.

Results:

- If a click is not heard, proceed to next step.

7. Open engine cover.

8. Disconnect the solenoid connector from the harness.



MX2492

9. Using an ohmmeter, check resistance across terminals (A) and (B). Resistance should be within specification for fuel shutoff solenoid pull-in coil.

10. Using an ohmmeter, check resistance across terminals (A) and (C). Resistance should be within specification for fuel shutoff solenoid hold-in coil.

Results:

- If resistance is not to specifications, replace solenoid.

Specifications:

Fuel Shutoff Solenoid Resistance

Pull-In Coil . . . . . 0.4 ohms
Hold-In Coil . . . . . 23.6 ohms

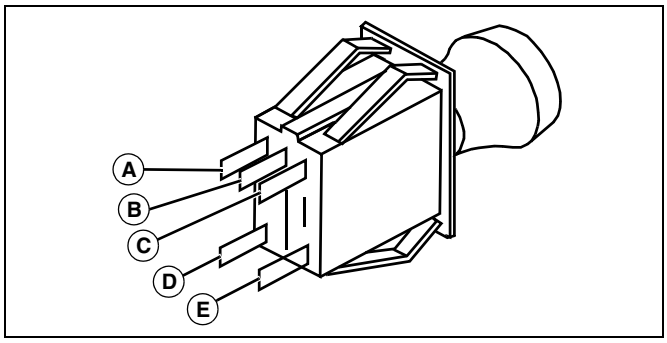
Mow Switch Test

Reason

To verify that mow switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure continuity at mow switch terminals.



1. Remove the mow switch and perform the following tests with an ohmmeter.

2. With the mow switch OFF (pushed in), check for continuity between (A and C) and (D and E).

3. With the mow switch ON (pulled out), check for continuity between (B and C).

4. If the mow switch fails any of these tests, replace it.

Relay Test

Reason

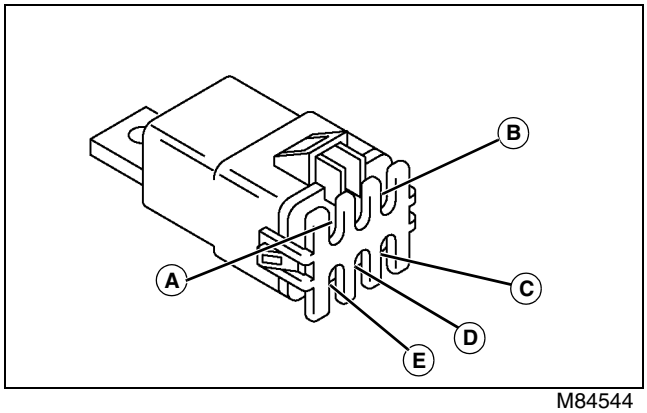
To determine if electrical relay coils are actuating correctly and resistance of relay contact points is correct.

Special or Required Tools

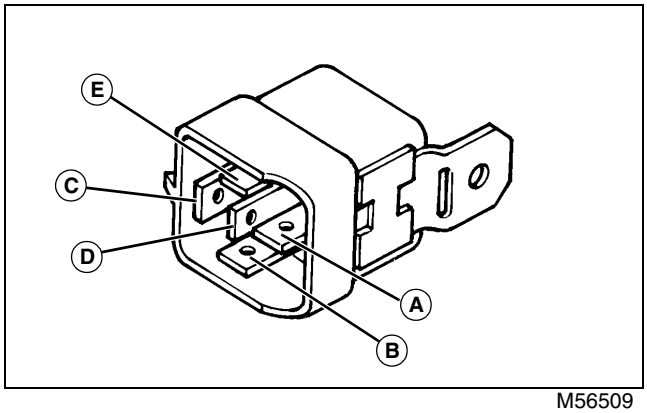
Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test relays.
Jumper Wires (2)	NA	Used to test relays.
12-Volt Battery	NA	Used to test relays.

Procedure

NOTE: Refer to the appropriate illustration for relay being tested.



M84544



M56509

1. With relay de-energized:

   - Check continuity between terminals 30 (A) and 87A (D). There should be continuity.
   - Check continuity between terminals 30 (A) and 87 (C). There should not be continuity.

2. Energize relay by connecting a jumper wire from battery positive (+) terminal to relay terminal 85 (E) and a jumper wire from relay terminal 86 (B) to ground (-).

3. With relay energized:

   - Check continuity between terminals 30 (A) and 87 (C). There should be continuity.
   - Check continuity between terminals 30 (A) and 87A (D). There should not be continuity.

Results

If continuity is not correct, replace relay.

Neutral Switch Test

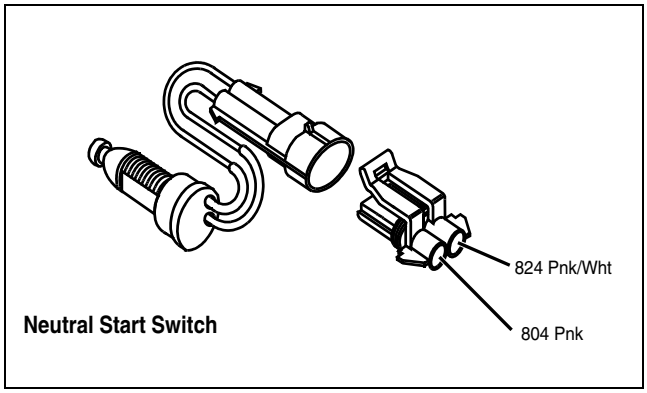
Reason

To verify neutral switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure continuity of neutral switch.

Procedure



1. Remove the switch and inspect the plunger for flat spots and freedom of movement. Replace the switch if plunger end is rough or worn, or if plunger does not move smoothly.

2. Connect an ohmmeter to the contacts of the switch.

3. There should be NO continuity with the plunger extended.

4. Depress plunger. Continuity should be indicated when the plunger reaches the midway point of full travel and should indicate continuity through the rest of the plunger travel. Replace the switch if it fails this test.

Park Brake Switch Test

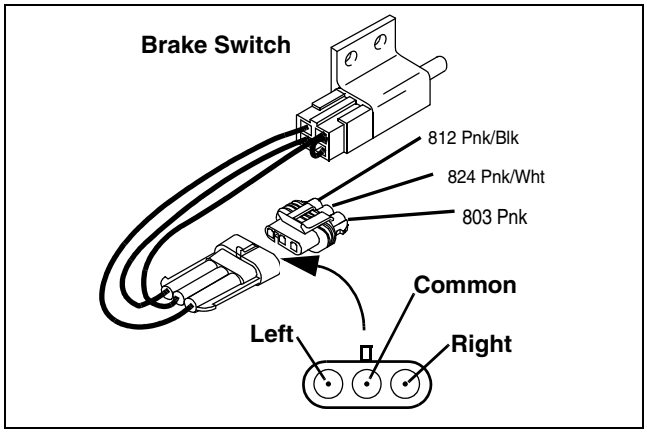
Reason

To verify proper operation of park brake switch.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure continuity of park brake switch.

Procedure



1. Remove the switch and inspect the plunger for flat spots and freedom of movement. Replace the switch if plunger end is rough or worn, or if plunger does not move smoothly.

2. Using an ohmmeter, place one lead of the ohmmeter on the center terminal and touch the other lead to the Right outside terminal (looking at the end of the three terminal connector; see illustration). The ohmmeter SHOULD NOT have continuity until the switch is actuated. Continuity should be indicated until the lever is released. If not, replace switch.

3. Reverse the lead to the Left outside terminal (looking at the end of the three terminal connector; see illustration). The ohmmeter SHOULD have continuity with the switch in the extended position. Depress plunger, thus breaking the circuit. Continuity should not be indicated until the plunger is released. If it does, replace switch.

Raise/Lower Switch Test

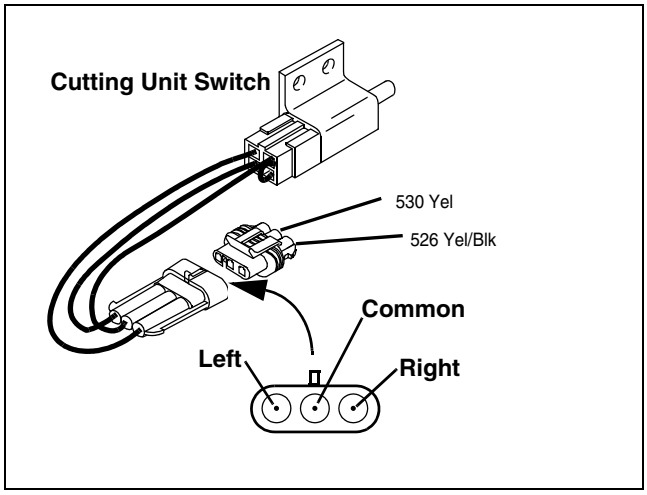
Reason

To verify proper operation of raise/lower switch.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure continuity of raise/ lower switch.

Procedure



1. Remove the switch and inspect the plunger for flat spots and freedom of movement. Replace the switch if plunger end is rough or worn, or if plunger does not move smoothly.

2. Using an ohmmeter, place one lead of the ohmmeter on the center terminal and touch the other lead to the Right outside terminal (looking at the end of the three terminal connector; see illustration). The ohmmeter SHOULD NOT have continuity until the switch is actuated. Continuity should be indicated until the lever is released. If not, replace switch.

3. Reverse the lead to the Left outside terminal (looking at the end of the three terminal connector; see illustration). The ohmmeter SHOULD have continuity with the switch in the extended position. Depress plunger, thus breaking the circuit. Continuity should not be indicated until the plunger is released. If it does, replace switch.

Cutting Unit Raised Switch Adjustment

Reason

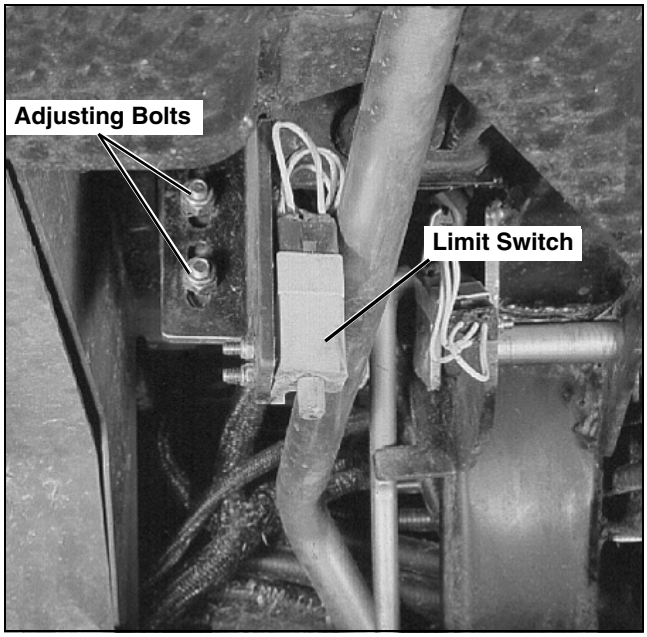
To adjust cutting unit raise limit switch for proper operation.

Procedure

1. Park machine on level surface, reels raised, park brake on, engine off.

2. Block wheels to prevent inadvertent movement of the machine.

3. Loosen two bolts securing lift arm switch bracket to frame.



4. Slide lift arm switch bracket up or down as required to ensure that switch is fully actuated when lift arm is in up position.

NOTE: There should be approximately 1.59 mm (1/16 in.) between lift arm switch bracket lift arm when switch is properly adjusted.

Control Module Test

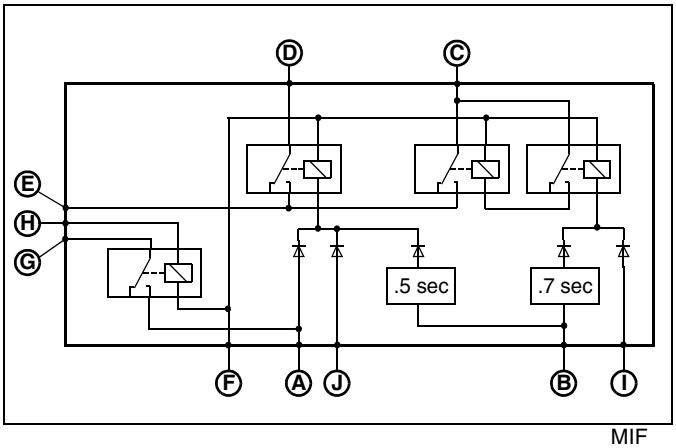
Reason

To verify proper operation of control module.

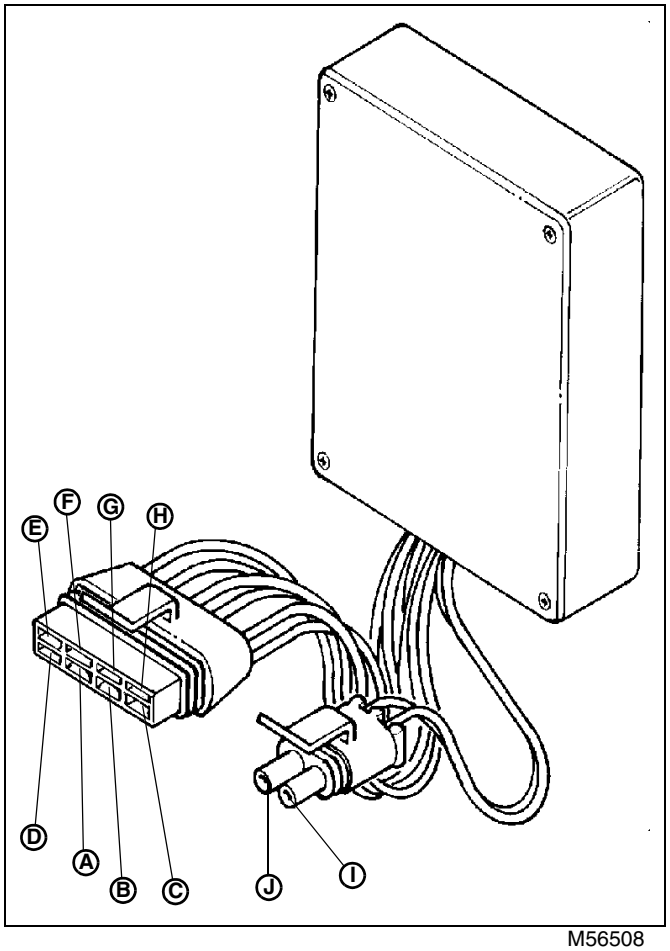
Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test continuity of control module circuits.
12V Test Light	NA	Used to check for voltage.
12-volt battery	NA	Used to power control module.

Procedure



MIF



M56508

A - 822 Pnk/Wht (Start Interlock Input)
B - 810 Pnk (Seat Switch)
C - 820 Pnk/Blk (Mow)
D - 641 Org (Fuel Output)
E - 520 Yel/Blk (Switched Power)
F - 150 Blk (Ground)
G - 700 Pur (Start Relay Output)
H - 522 Yel/Wht (Cranking)
I - 524 Yel (Forward/Reverse Switch)
J - 816 Blu (Park Brake Switch)

Control Module - Start Relay

1. Remove the control module for bench testing.

2. Connect an ohmmeter between terminals (A and G).

3. Connect battery POS (+) lead to terminal (H). Connect battery NEG (-) to terminal (F).

Results

- With no battery power present, there should not be continuity between terminals (A and G).

- With battery power present, there should be continuity between terminals (A and G).

- If the control module fails any of these tests, replace it.

Control Module - Fuel Output

1. Connect an ohmmeter to terminals (E and D).

2. Connect the battery negative (-) lead to terminal (F) and, one at a time, connect the battery positive (+) lead to terminals (A, J, and B).

Results

- With no battery power present, there should be no continuity between terminals (E and D).

- There should be continuity between terminals (E and D) with a 0.5-sec release delay when battery positive lead is removed from terminal (B).

- If control module fails any of these tests, replace it.

Control Module - Mow Circuit (Seat Switch)

1. Connect battery negative (-) lead to terminal (F).

2. With three jumper wires, connect battery positive (+) lead to terminals (E, C, and B).

3. Disconnect jumper wire from terminal (C).

4. Ground the test light lead to terminal (F) and test for voltage at terminal (C).

5. Disconnect jumper wire from terminal (B).

6. Test for voltage at terminal (C).

Results

- With battery positive lead connected to terminals (E, C, and B), and then with jumper wire disconnected from terminal (C), there should be voltage present at terminal (C).

- With battery positive lead connected to terminal (B), there should be voltage present at terminal (C) with a 0.7-sec release delay when voltage is removed.

- If the control module fails any of these tests, replace it.

Control Module - Mow Circuit (Forward/Reverse Switch)

1. Connect battery negative (-) lead to terminal (F).

2. With three jumper wires, connect battery positive (+) lead to terminals (E, C, and I).

3. Disconnect jumper wire from terminal (C).

4. Ground the test light lead to terminal (F) and test for voltage at terminal (C).

5. Disconnect jumper wire from terminal (I).

6. Test for voltage at terminal (C).

Results

- With battery positive lead connected to terminals (E, C, and B), and then with jumper wire disconnected from terminal (C), there should be voltage present at terminal (C).

- With jumper wire disconnected from terminal (I), there should not be voltage present at terminal (C).

- If the control module fails any of these tests, replace it.

Charging System Operational Inspection

Reason

To verify correct operation of charging system.

NOTE: Always check battery condition before condemning other parts of the charging system. The battery must be fully charged in order to conduct accurate charging system tests.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure voltage at battery.

Procedure

1. Start the engine and allow it to reach normal operating temperature.

2. Connect a voltmeter across the battery terminals.

3. The readings should show nearly battery voltage at slow engine speeds and should rise as the engine speed increases not to exceed 15 VDC.

Results

- If the readings do not rise as the engine speed increases, the regulator is defective or the alternator output is insufficient for the loads.

Specifications

Regulated Voltage Output . . . . . 12.7-15 VDC

Stator Unregulated Output Test

Reason

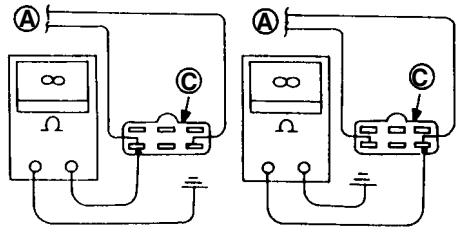
To verify correct operation of stator.

Special or Required Tools

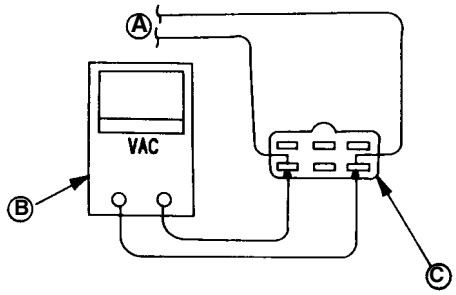
Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure resistance and voltage at stator terminals.

Procedure

1. Disconnect the engine wiring harness at the 6-pin connector and connect multimeter to the stator pins.



Stator Pin and Ground (Infinite Ohm)



Unregulated Stator Output, 26 VAC/3000 RPM

M72871

A - To stator
B - Multimeter
C - 6-pin connector

2. Measure resistance between stator terminal (A) and engine ground.

3. Measure resistance between stator terminals (A).

4. Start and run engine at fast idle (3400 rpm). Voltage reading should be a minimum of 26 VAC.

Results

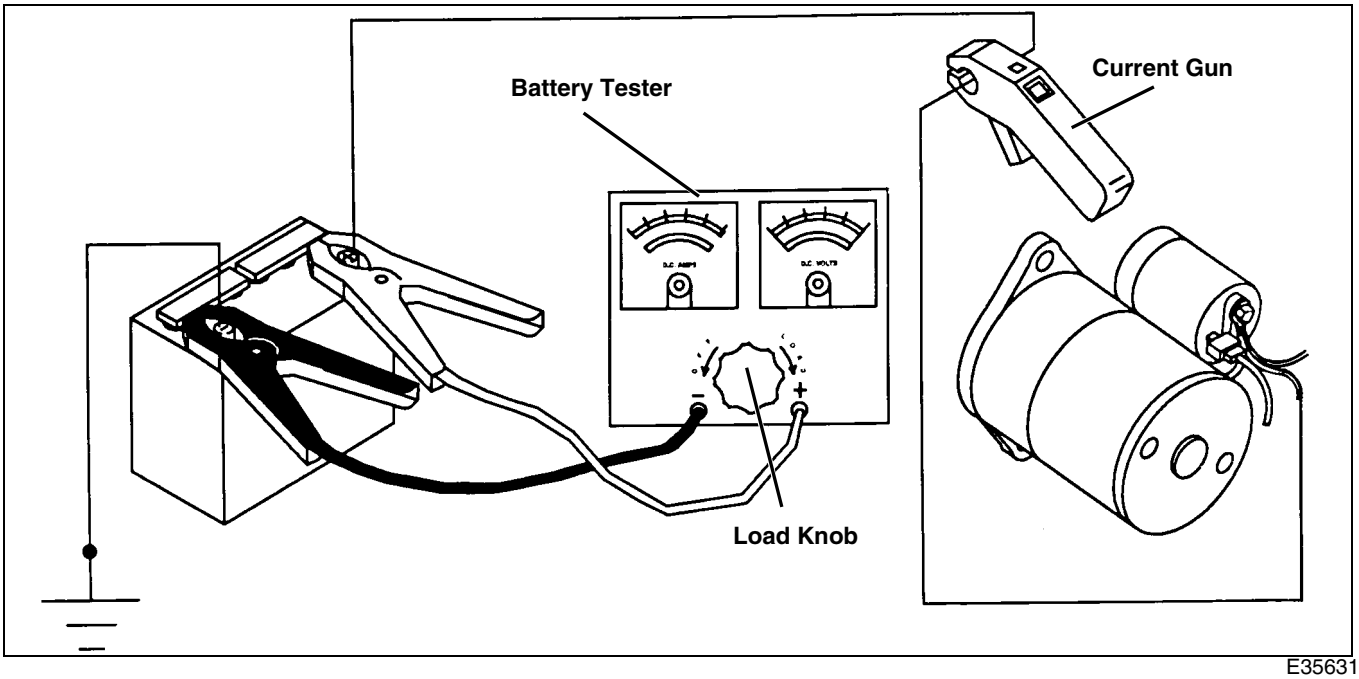
- If stator resistances are not within specifications, replace stator.

- If unregulated voltage is less than specified and stator coil resistances are good, replace rotor.

Specifications

Stator Unregulated Voltage Output . . . . . .26 VAC
Stator Coil Resistance. . . . . .0.11-0.18 ohms
Stator Coil to Ground Resistance. . . . . .Infinite

Regulated Amperage and Voltage Tests



Reason

To verify proper operation of charging system.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Current Gun	JT05712	Used to measure current from stator.
Battery Tester	JT05685	Used to load charging system.

Procedure

1. Park machine on level surface.
2. Place mow switch in OFF position.
3. Lower cutting units to the ground.
4. Turn ignition switch OFF.
5. Lock park brake.
6. Raise hood.
7. Disconnect pin connector from stator.

NOTE: Battery must be in a good state of charge.

8. Put JTO5712 Current Gun around positive (red) battery cable going to starter so current-flow arrow cable points toward battery. Set current gun for DC current.

IMPORTANT: Avoid damage! Turn load knob fully counterclockwise (out) into OFF position BEFORE making any test connections.

9. Connect battery tester to battery.

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

10. Turn load knob clockwise (in) until voltage on voltage tester scale reads 11 volts for 5 seconds only to partially drain battery.

11. Quickly turn load knob completely counterclockwise (out) to OFF position.

12. Start and run engine at fast idle (3400 rpm). Battery voltage should read between 12.2 and 14.7 volts DC.

13. Turn load knob clockwise (in) until voltage on voltage tester scale reads 11 volts and look at current gun for a minimum reading of 13.5 amps.

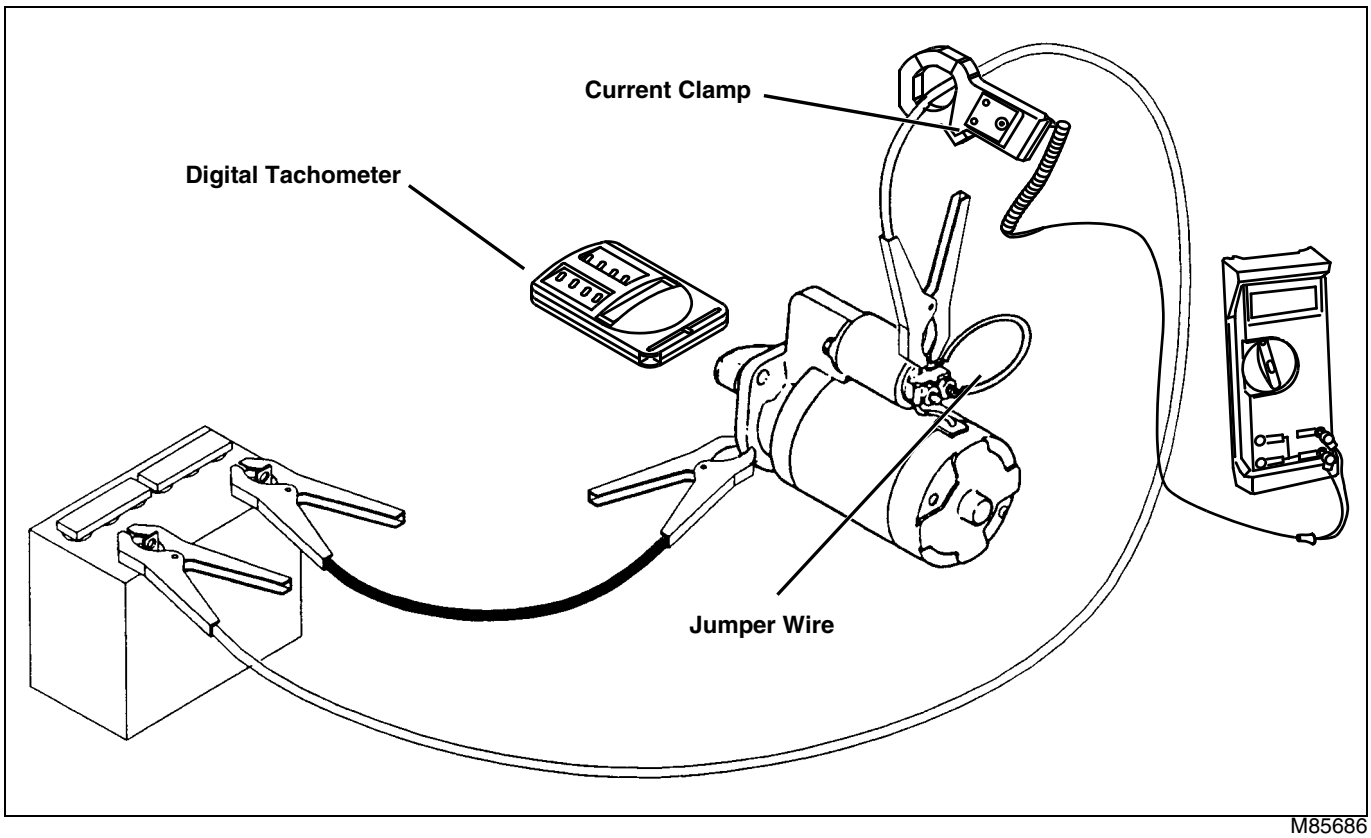
14. Quickly turn load knob completely counterclockwise (out) to OFF position.

15. After load test, voltmeter should return to a maximum of 14.7 volts DC.

Results

- If current gun amp reading is BELOW specification, test for unregulated voltage output. If unregulated voltage output test meets specifications and you have verified voltage to ground to regulator/rectifier, replace regulator/rectifier.
- If at any time voltage increase exceeds 14.7 volts DC, replace regulator/rectifier.

Starter No-Load Amperage Draw and RPM Test



M85686

Reason

To verify proper starting motor operation.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used with current clamp to measure current draw.
Current Clamp	JT02153	Used with multimeter to test current draw.
Handheld Digital Tachometer	JT05719	Used to measure starting motor rpm.
Jumper Cables	NA	Used to provide power to starting motor.
Jumper Wire	NA	Used to jump starting motor solenoid terminal.

Procedure

NOTE: Check that battery is fully charged and of proper size to ensure accuracy of test.

1. Remove starter assembly from mower and place starter in vice.
2. Connect jumper cables to a 12-volt battery.
3. Connect positive (+) cable to solenoid battery terminal on starter.
4. Connect negative (-) cable to starter body.
5. Attach current clamp around positive (+) cable.

IMPORTANT: Avoid damage! Complete this test in 20 seconds or less to prevent starter damage.

6. Use jumper wire to briefly connect positive (+) starter terminal to solenoid battery terminal. Starter should engage and run.
7. Read and record amperage and rpm. 1 mV = 1 amp.

Results

- If solenoid “clicks” or chatters and motor does not turn, replace solenoid.
- If pinion gear engages and motor does not turn, repair or replace starter.
- If starter engages and runs, but amperage is more than 30 amps at 6000 rpm, repair or replace starter.

• If free-running rpm is less than 6000 rpm, repair or replace starter.

Starter Loaded Amperage Draw Test

Reason

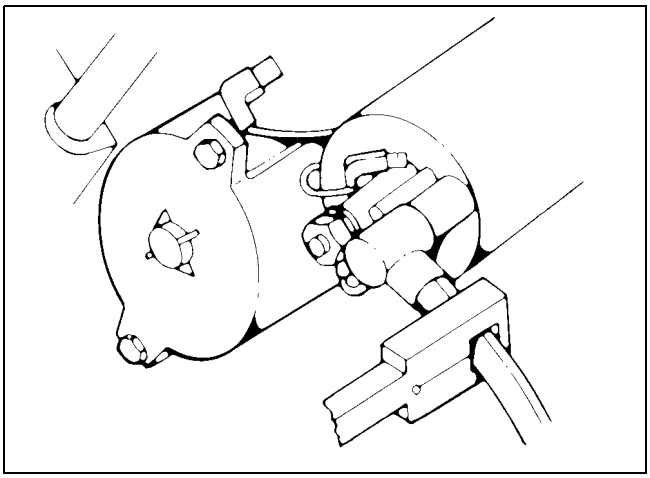
To determine the amperage required to crank the engine under load.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used with current clamp to measure current.
Current Clamp	JT02153	Used to test fuel shut-off solenoid.

Procedure

1. Lock park brake.
2. Test ground connections and battery.
3. Disconnect fuel shutoff solenoid connector.



M46863

4. Connect red lead from current clamp to meter VW connection and black lead to meter Common or ground connection.
5. Set current clamp slide switch to 200 Amp.
6. Set multimeter to 300 mV range.
7. Crank engine and read voltage. 1 mV = 1 amp.

Results

• If amperage is greater than 72 amps, test starter no-load rpm and amperage to determine if the starter is binding or damaged.

• If the starter is good, check internal engine components for binding or damage.

Starter Solenoid Test

Reason

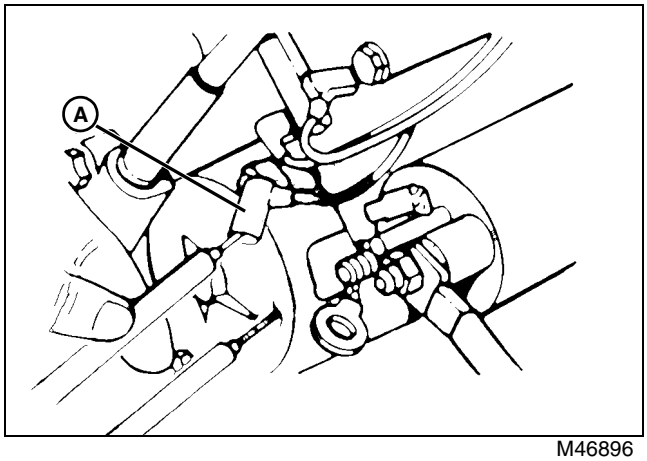
To determine if starter solenoid is defective.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test starter solenoid and circuit.

Procedure

1. Lock park brake.
2. Raise hood.
3. Disconnect fuel shutoff solenoid wire connector.



M46896

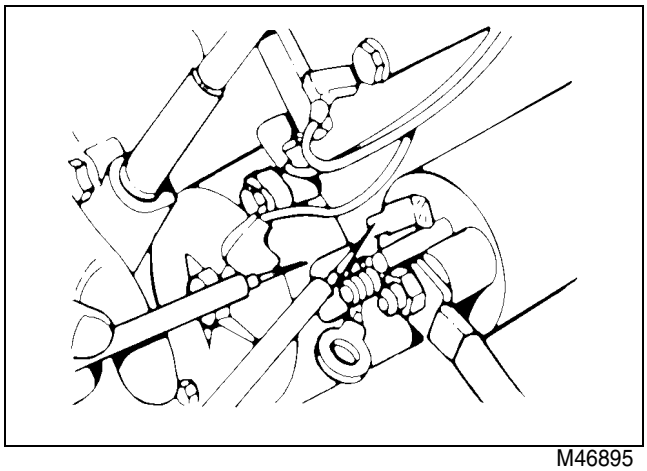
4. Disconnect wire 410 yel/blk from starter solenoid terminal (A).
5. With the ignition switch in the START position check for voltage at wire 410 yel/blk.

Results

• If the meter reads battery voltage, the circuit is good.

• If not, inspect the wiring to and from the ignition switch for damage or breaks. Test ignition switch.

Procedure



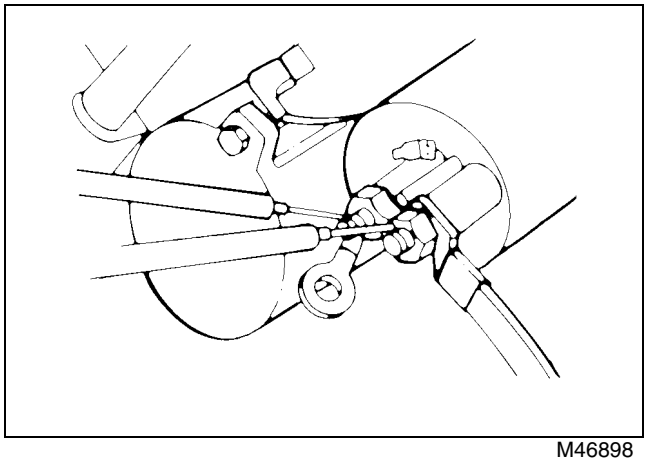
M46895

1. Measure the resistance between the solenoid starter terminal and ground with an ohmmeter. Resistance should be zero or close to it.

Results

- If circuit is open, replace solenoid.
- If resistance is zero or close to it, go to next step.

Procedure



M46898

1. Disconnect the starter lead from the starter solenoid and keep it away from the solenoid.

2. Check resistance across the large terminals of the starter with the ignition switch in the START position. Resistance should be zero or close to it, a clicking sound should be heard, and the pinion gear should engage the flywheel.

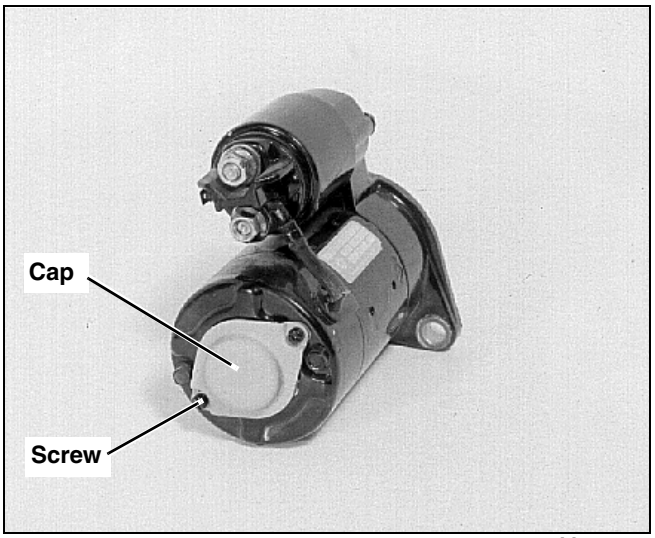
Results

- If all tests are good, test the starter motor.
- If not, replace the solenoid.

Repair

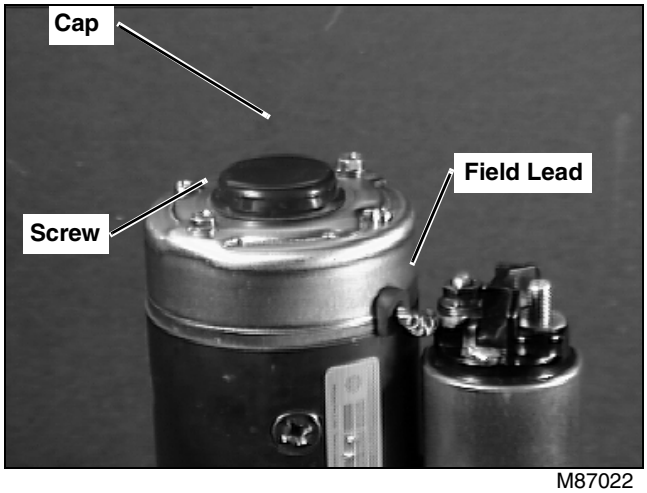
Starter - Hitachi 0.8 kW

Disassembly



M76457

Picture Note: Early Style Starter



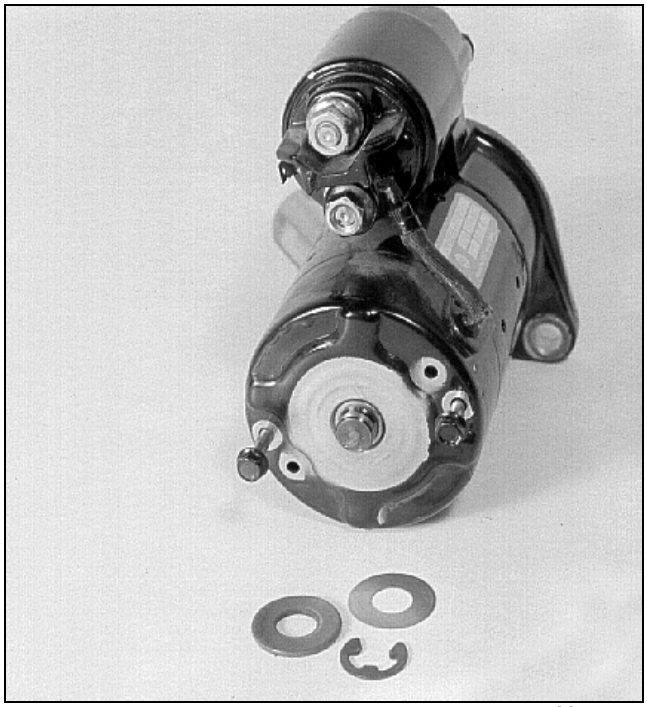
M87022

Picture Note: Late Style Starter

1. Disconnect field lead.

2. Pry rubber end cap off using a screw driver and remove cap (late style).

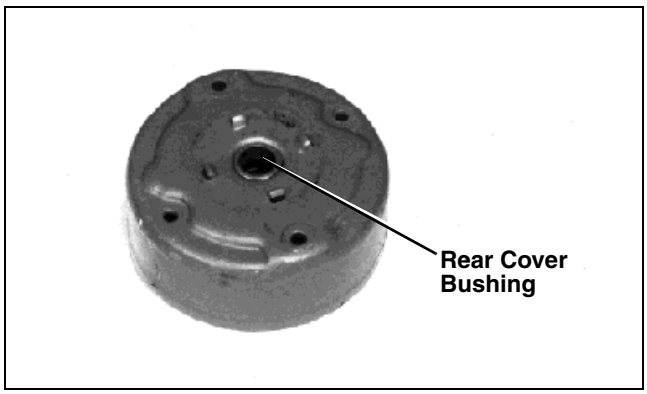
3. Remove two screws from end cap and remove cap.



M76459

4. Remove E-clip, washer, and shims (If included).

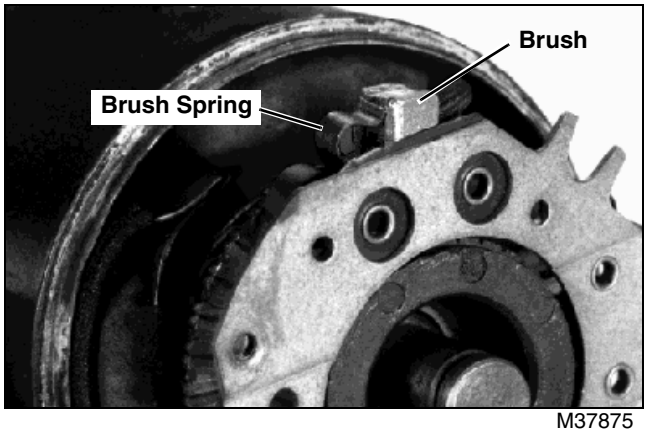
5. Remove two cap screws holding rear cover on field housing.



M37874

6. Inspect cover bushing for wear or damage. Measure inside diameter of bushing, which should not exceed 12.53 mm (0.493 in.). Replace if necessary. To replace bushing:

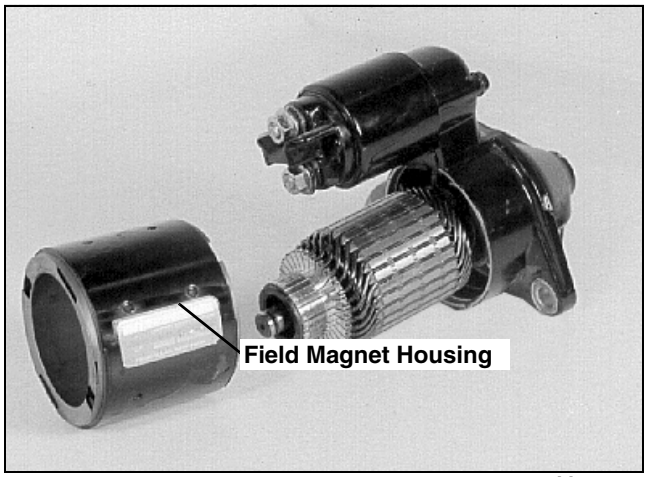
   - Remove bushing using a blind-hole puller set. Install new bushing until it bottoms in cover bore using a driver set.
   - Ream out bushing to **12.50-12.53 mm (0.492-0.493 in.)**



M37875

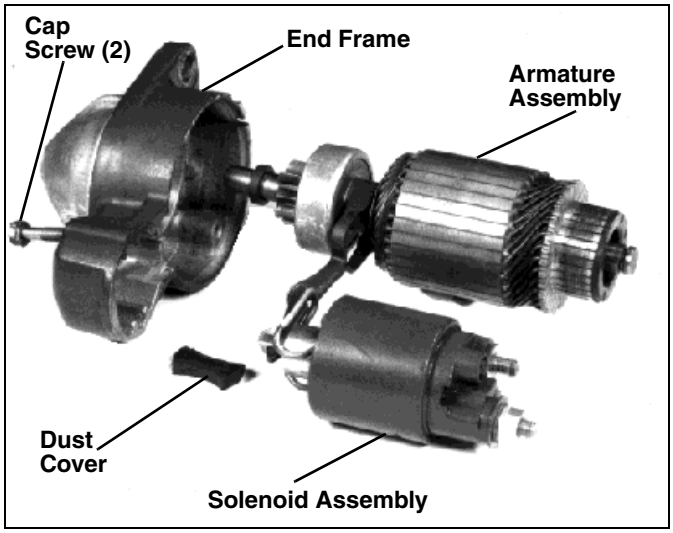
7. Pry brush springs away and pull brushes up enough to allow spring to hold brush in place.

8. Remove brush holder.



M76460

9. Remove field magnet housing from armature/solenoid assembly.

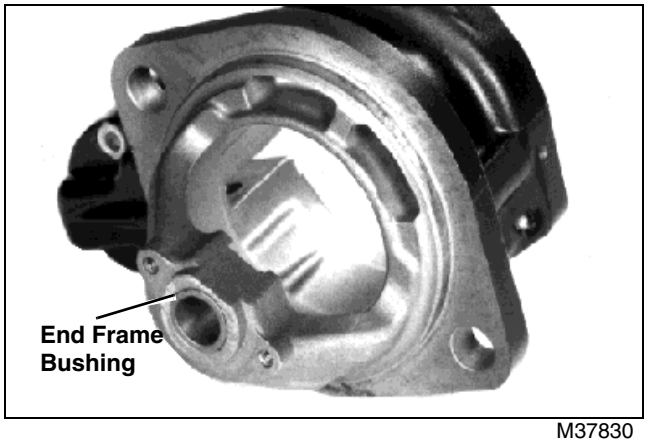


M37877

10. Remove two cap screws and pivot bolt, if equipped.

11. Remove dust cover.

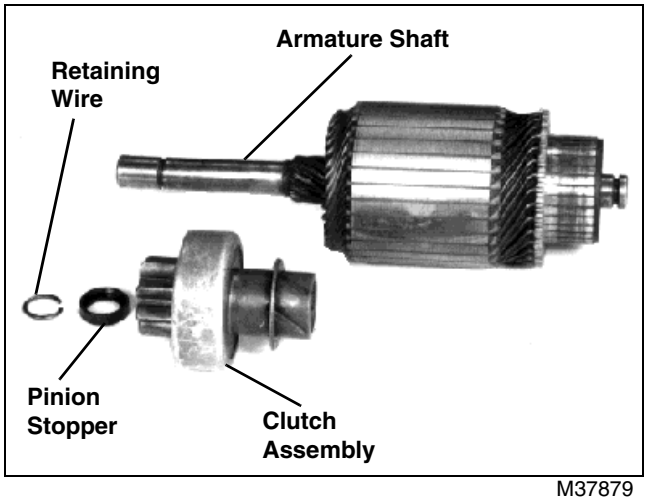
12. Remove solenoid and armature assemblies from end frame.



M37830

13. Inspect end frame bushing for wear or damage. Replace if necessary. To replace bushing:

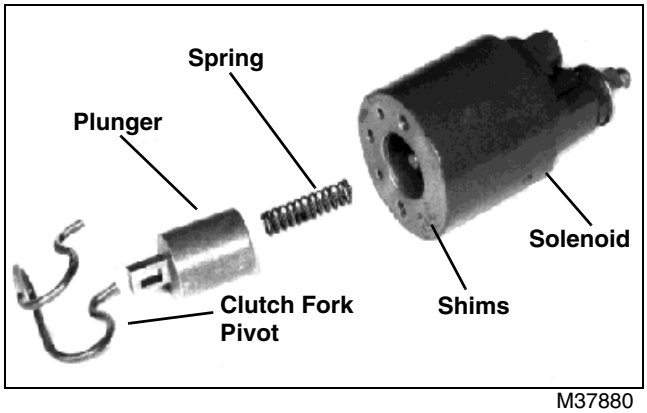
- Replace bushing using a driver set. Install bushing flush with face of housing.



M37879

14. Slide pinion stopper away from retaining wire using a piece of pipe or deep socket. Remove retaining wire, pinion stopper, and clutch assembly from armature shaft.

15. Inspect clutch assembly for wear or damage. Gear should rotate in one direction only. Replace if necessary.



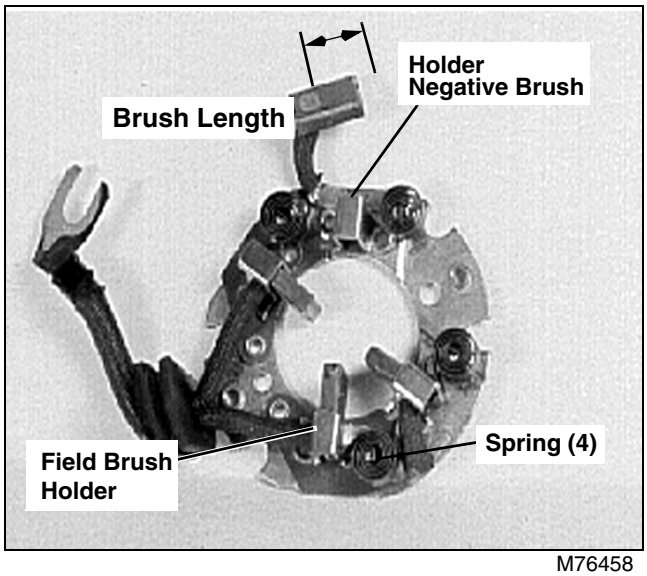
M37880

16. Remove clutch fork pivot, plunger, spring, and shims from solenoid.

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

18. Inspect and test brushes, holder, field coil and armature. (See *Test* procedures.)

Inspection



M76458

1. Measure brush lengths. Minimum brush length is **7.70 mm (0.303 in.)**. Replace brush if length is below minimum.

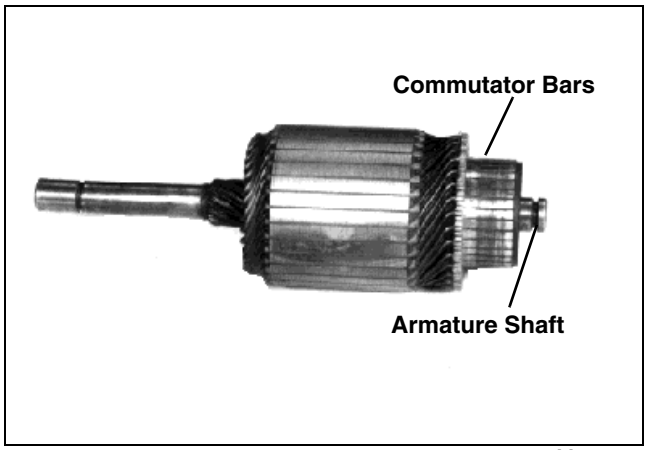
NOTE: Test brush holder using an ohmmeter or test light.

2. Test brush holder: Touch one probe of tester to negative brush holder and other probe to field brush holder. If there is continuity, replace the brush holder.

3. Inspect springs for wear or damage. Replace if necessary.

IMPORTANT: Avoid damage! Do not clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.

4. Inspect armature. Look for signs of dragging against pole shoes.



M82246

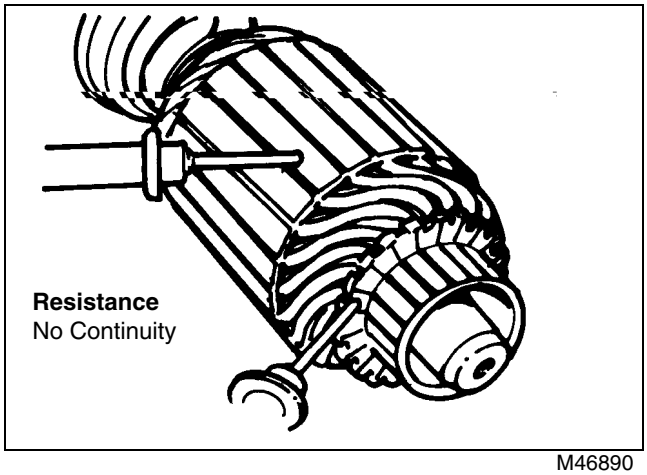
5. Inspect commutator. Look for roughness, burned bars, or any material that might cause short circuits between bars. If necessary, clean and touch up with 400 sandpaper. NEVER use emery cloth. Clean all dust from armature when finished. Test for grounded windings using an ohmmeter or test light.

6. Armature windings are connected in parallel, so each commutator bar must be checked.

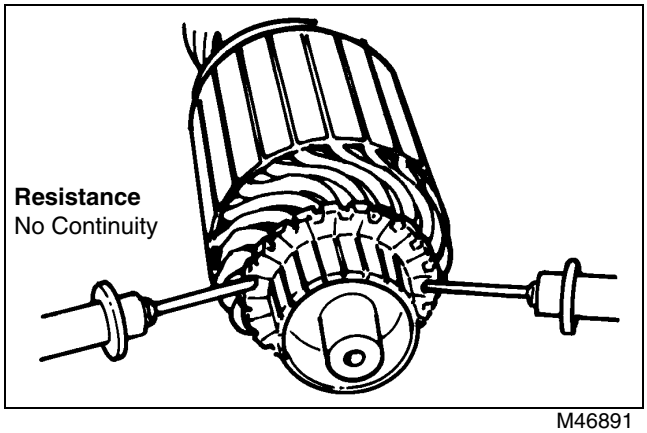
7. If the test shows continuity, a winding is grounded and the armature must be replaced.

8. Test for open circuits in the windings. If the test shows no continuity, the armature has an open circuit and must be replaced.

NOTE: Test armature windings using an ohmmeter or test light.



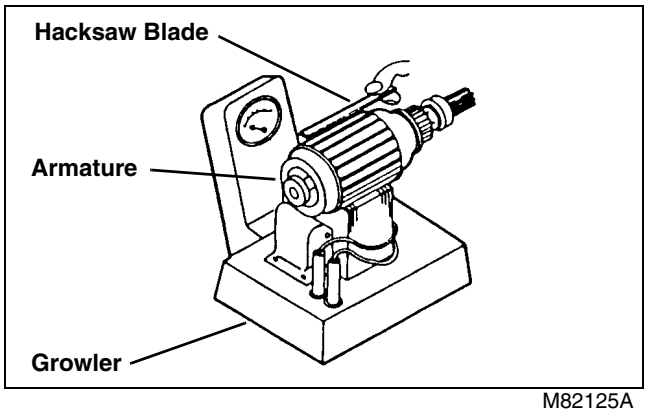
M46890



M46891

9. Touch probes on one commutator bar and armature shaft. Armature windings are connected in parallel, so only one commutator bar needs to be checked. If test shows continuity, a winding is grounded and the armature must be replaced.

10. Touch probes on two different commutator bars. If test shows no continuity, there is an open circuit and the armature must be replaced.



M82125A

11. Test for short circuited 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.

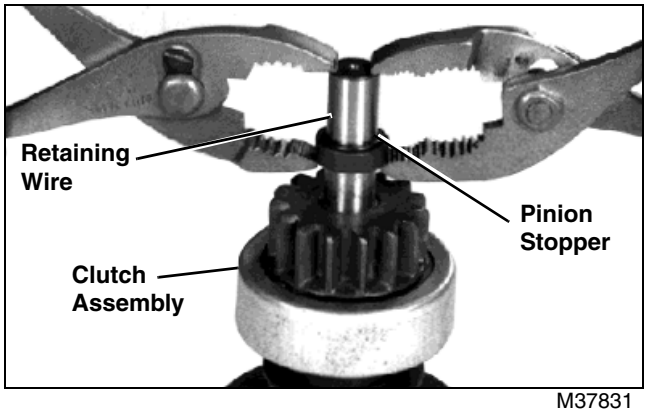
12. If test indicates short-circuited windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.

NOTE: Field uses permanent magnets that are not serviceable. Visually inspect for broken magnets or damage to housing.

13. If rpm was slow and armature tests are normal, replace the field coil assembly.

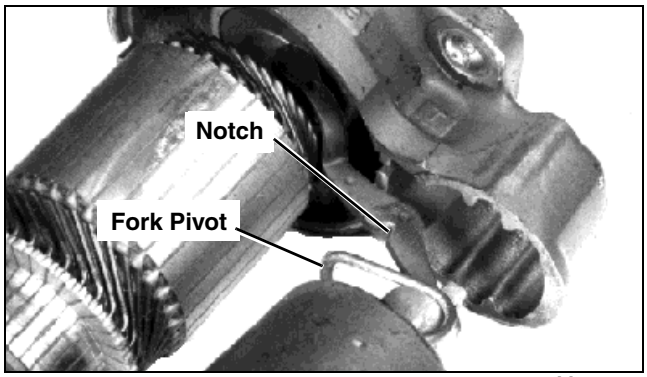
Assembly

Assembly is done in the reverse order of disassembly.



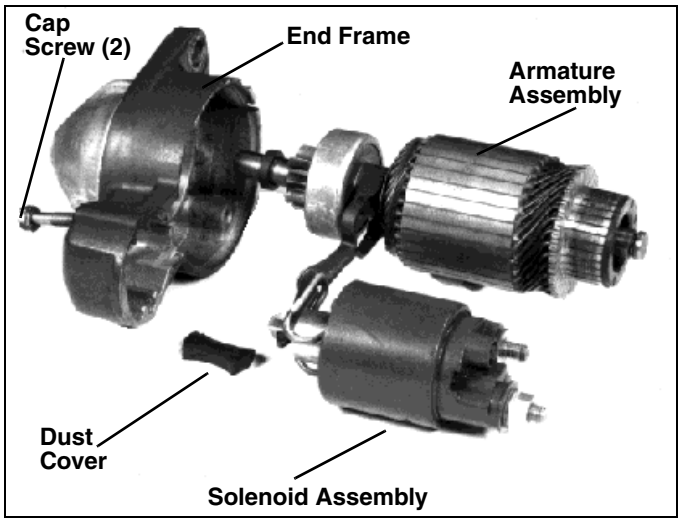
M37831

1. After installing clutch assembly, pinion stopper and retaining wire on armature shaft, use two pliers to press pinion stopper over retaining wire.



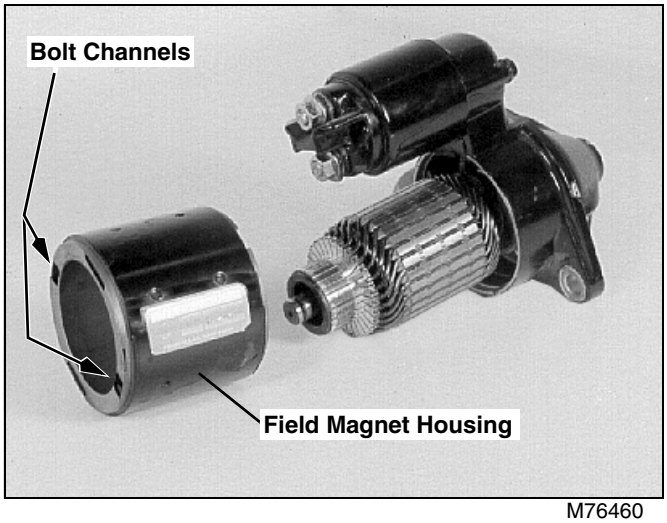
M37881

2. When installing solenoid and armature assemblies into end frame, make sure fork pivot seats in notch on clutch fork.



M37877

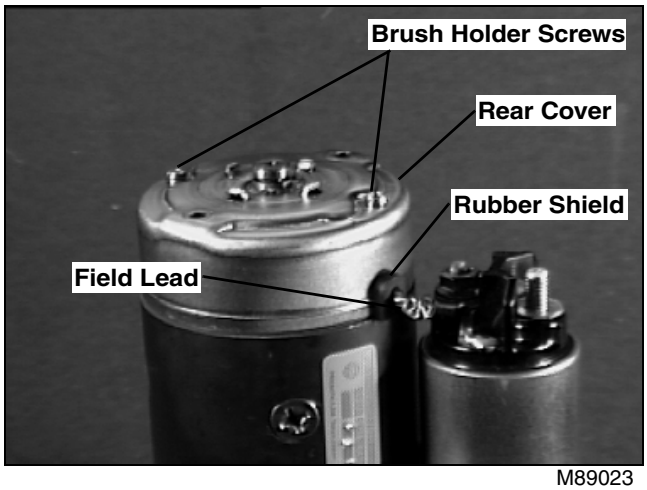
3. Be sure to install dust cover in recess between end frame and solenoid assembly.



M76460

4. When installing field magnet housing be sure to align threaded bolt holes in end cap with channels in housing (early style).

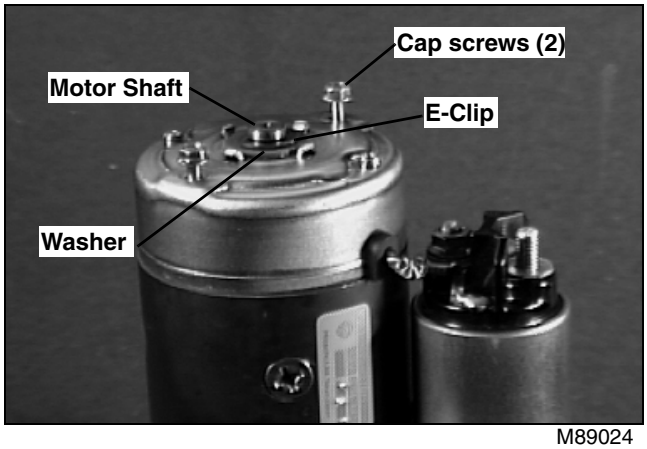
IMPORTANT: Avoid damage! When installing rear cover, be sure wires do not touch cover. Press wires inward to clear rear cover.



M89023

5. Install field lead, washer and nut on solenoid.

6. Place rear cover over rubber shield and align cover with brush holder screw holes. Install screws in rear cover.(late style).



M89024

7. Install cap screws through end cap.

8. In order to install the washer and E-ring, it may be necessary to push up on the motor shaft to expose the E-ring groove. Install shims (if included), washer and E-ring.

9. Install rubber end cap.

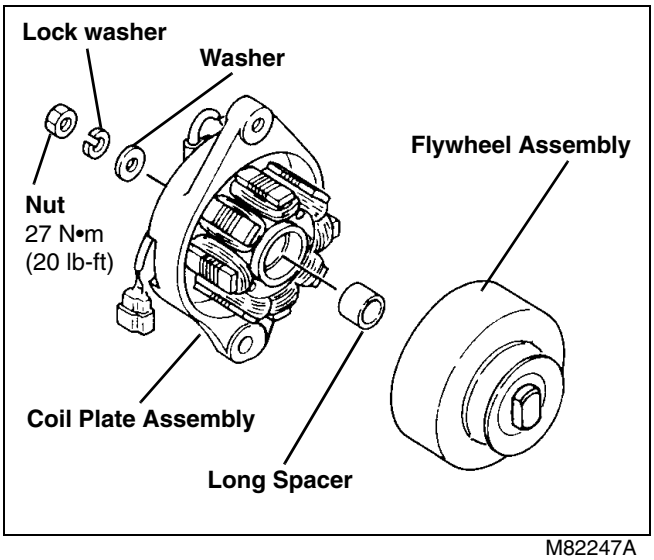
Alternator - Kokosan 20A

Disassembly and Inspection

1. Remove nut and washers.

2. Tap on end of shaft with a soft-faced hammer to separate flywheel assembly from coil plate assembly.

3. Remove long spacer.



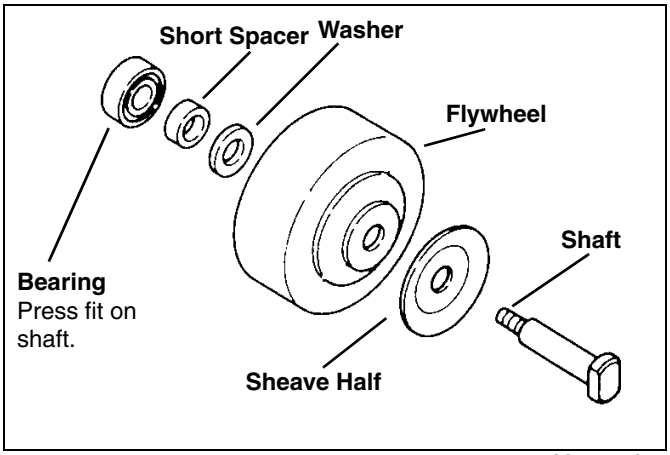
M82247A

4. Remove shaft from bearing, short spacer, washer, flywheel, and sheave half, using a press.

NOTE: Bearing and flywheel are press fit on shaft.

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

NOTE: Remove bearing only if replacement is necessary.



M81148A

6. Inspect bearing in coil plate for wear or damage. Replace if necessary. To replace bearing:
   - Remove bearing using a spark plug socket and a press. Install bearing into coil plate until it bottoms in bore using a 1 in. socket.
7. Remove wire clamp.
8. Remove connector from harness leads.
9. Remove two screws and stator.
10. Inspect all parts for wear or damage. Replace as necessary.

Alternator Assembly

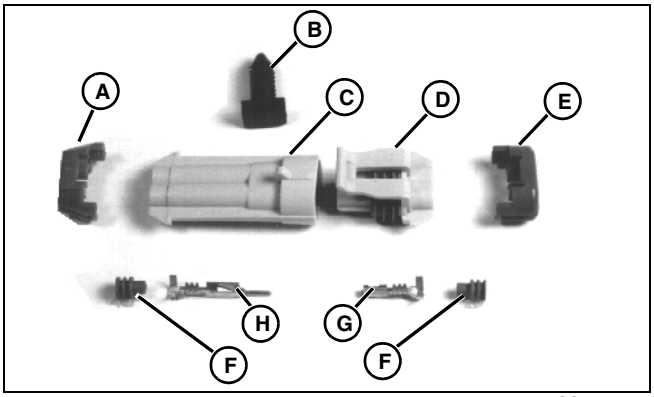
Assembly is done in the reverse order of disassembly.

- With sheave half on shaft, press shaft into flywheel until sheave half bottoms on flywheel face.
- With washer and short spacer installed, press new bearing onto shaft until it bottoms on spacer.

Remove METRI-PACK™ Connector

Special or Required Tools

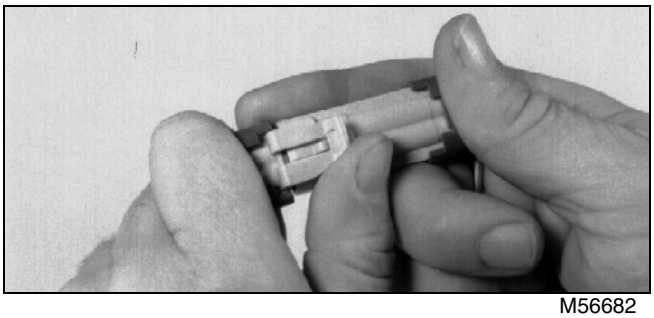
Tool Name	Tool No.	Tool Use
Terminal Removal Tool	JDG777	Used to remove terminal from connector body.
Electrician's Pliers	JDG145	Used to strip insulation from wire.
Wire Crimper	JDG776	Used to crimp terminals on wire.



M56685

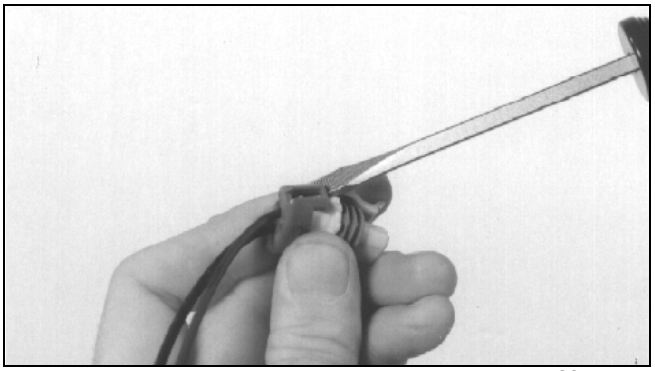
A - Wire Retainer
B - Mounting Post
C - Pin Body
D - Sleeve Body
E - Wire Retainer
F - SHURE-Seal
G - Sleeve
H - Pin

IMPORTANT: Avoid damage! Identify wire number/color locations with connector terminal letters.



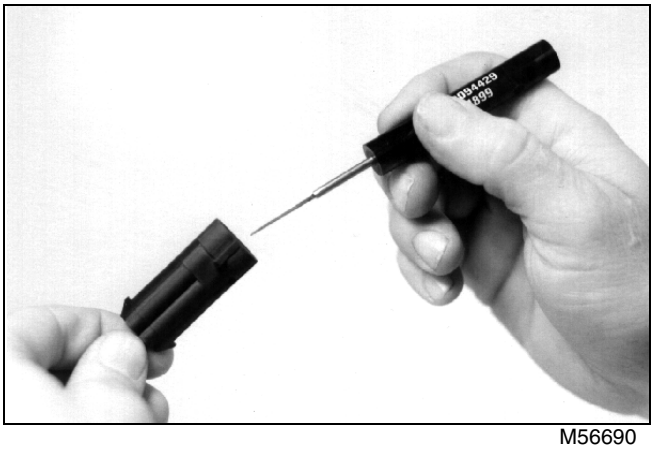
M56682

1. Open connector body.

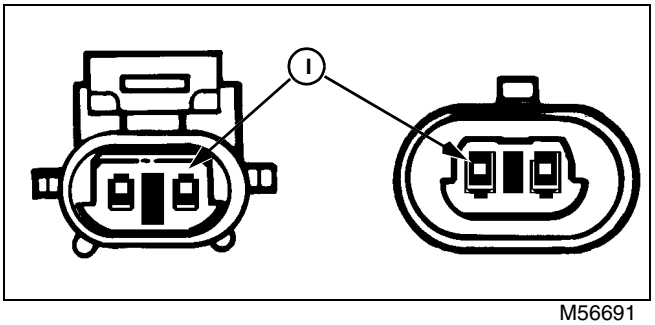


M56684

2. Remove retainer on wire end of connector with a screwdriver.



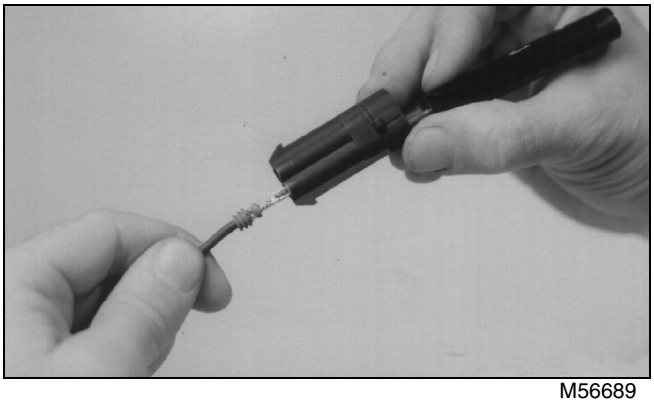
M56690



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.

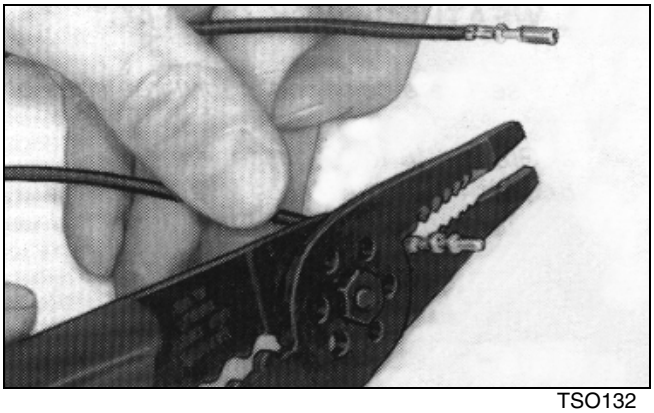


M56689

4. Hold the removal tool fully seated and pull wire from connector body.

Replace METRI-PACK™ Connector

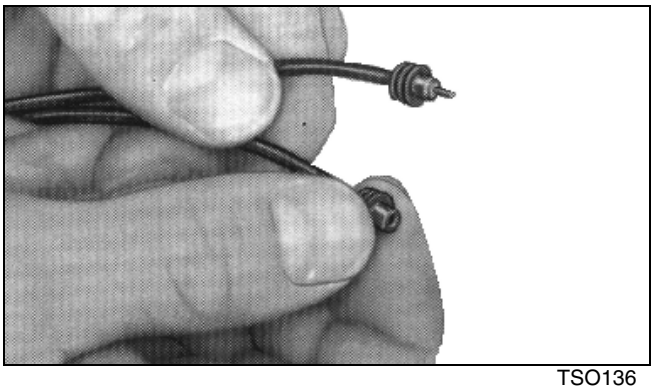
1. Remove wire from connector body as described above.



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.

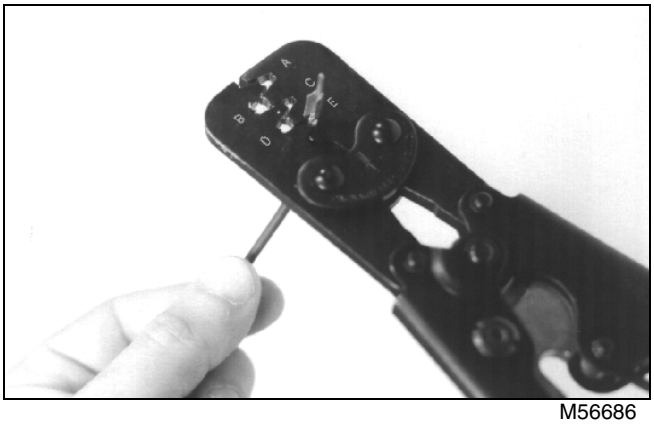


TSO136

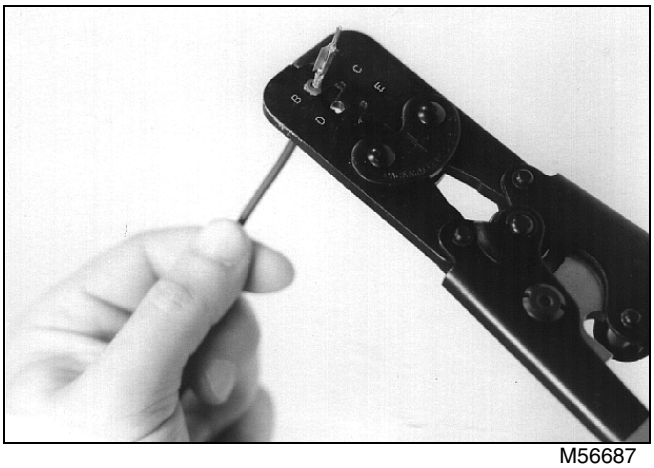
3. Install correct size cable seal on wire.

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

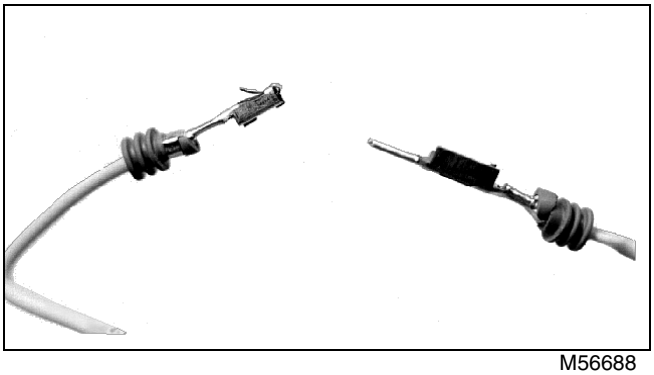
5. Place proper size contact on wire and use JDG776 Crimper to crimp contact in place with a “W” type crimp.

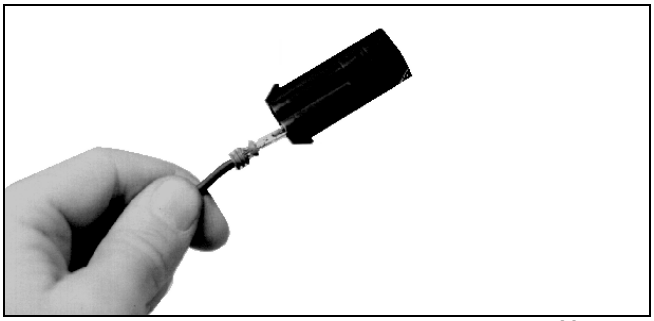

M56687

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.

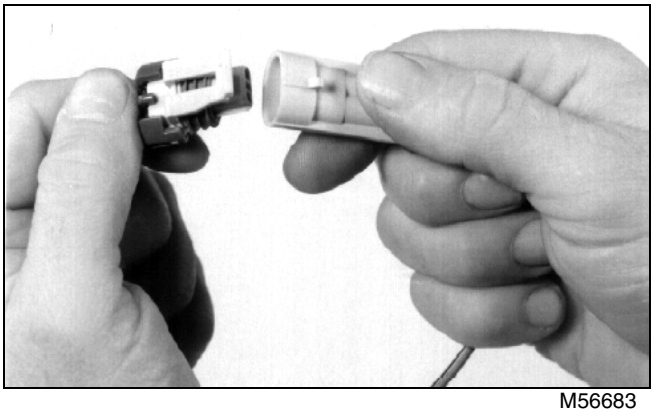

M56688


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

Charge Pump

Make	Danfoss
Model / Series	YC
Type	Gear, positive displacement
Displacement	19 482 cc/min
Flow @ 3400 rpm	19.5 L/min (5.15 gpm)
Relief Valve Setting in Steering Valve	6205 kPa (900 psi)
Required Pressure at Hydrostatic Input	689-758 kPa (100-110 psi)

Filter

Type	Spin on
Clogged Filter By-Passes Fluid-to-Tank At	345 kPa (25 psi)
Filter Bypass Light Comes ON At	276 kPa (40 psi)

Hydrostatic Transmission

Make	Eaton
Model	70145
Type	Rotating piston, variable flow
Operating Pressure	20 684 kPa (3000 psi)
Main Relief Valve Setting	None
Required Pressure at Hydrostatic Input	689-758 kPa (100-110 psi)

TORQMOTOR™

Make	Parker Ross TORQMOTOR™
Model	1MB120208

Miscellaneous

Spring Nut	2 N•m (20 lb-in.)

Repair Specifications

Hydrostatic Transmission

Camplate Trunnion Seal Screws	5 N•m (38 lb-in.)
Valve Caps	135 N•m (100 lb-ft)
Tow Valve	39 N•m (30 lb-ft)
Housing-to-Backplate Mounting Bolts	25 N•m (18 lb-ft)
Coupler Socket Head Cap Screw	61 N•m (45 lb-ft)

TORQMOTOR™

Case Drain Plug	6 N•m (50 lb-in.)
Output Shaft Nut	725 N•m (140 lb-ft)
Wheel Nuts	142 N•m (105 lb-ft)
Valve Housing Bolts	50 N•m (38 lb-ft)

Tools and Materials

Special or Required Tools

Tool Name	Tool No.	Tool Use
In-Line Hydraulic Tester	D01074AA	Used to check hydrostatic pump flow.
Hose (2) - 3/4" Male NPT on hose ends	JT03377	Used to check hydrostatic pump flow.
Connector (2) - 3/4" Female NPT x 1-1/16" Female 37° Flare Swivel	JT03012	Used to check hydrostatic pump flow.
Connector - 1-1/16"-12 Male 37° Flare x 1"-14 F ORFS	JT05689	Used to check hydrostatic pump flow.
Connector - 3/4"-14 F NPT x 1-7/16"-12 M ORFS	JT03492	Used to check hydrostatic pump flow.
Connector - 1"-14 M ORFS x 1-7/16"-12-F ORFS	JT03493	Used to check hydrostatic pump flow.
Hand Held Digital Tachometer	JT05719	Used to verify proper rpm setting.
Hose	AMT846	Pressure check.
Hose 34,473 kPa (5,000 psi)	JT03017	Pressure check.
Female Quick Coupler	RE48122	Pressure check.
Male Quick Coupler 11/16-16 F ORFS	RE43774	Pressure check.
T-Fitting, 11/16-16 F ORFS x 11/16-16 M ORFS x 11/16-16 M ORFS	31H1031	Pressure check.
Connector 1/4" M NPT x 7/16" M 37°	JT05486	Pressure check.

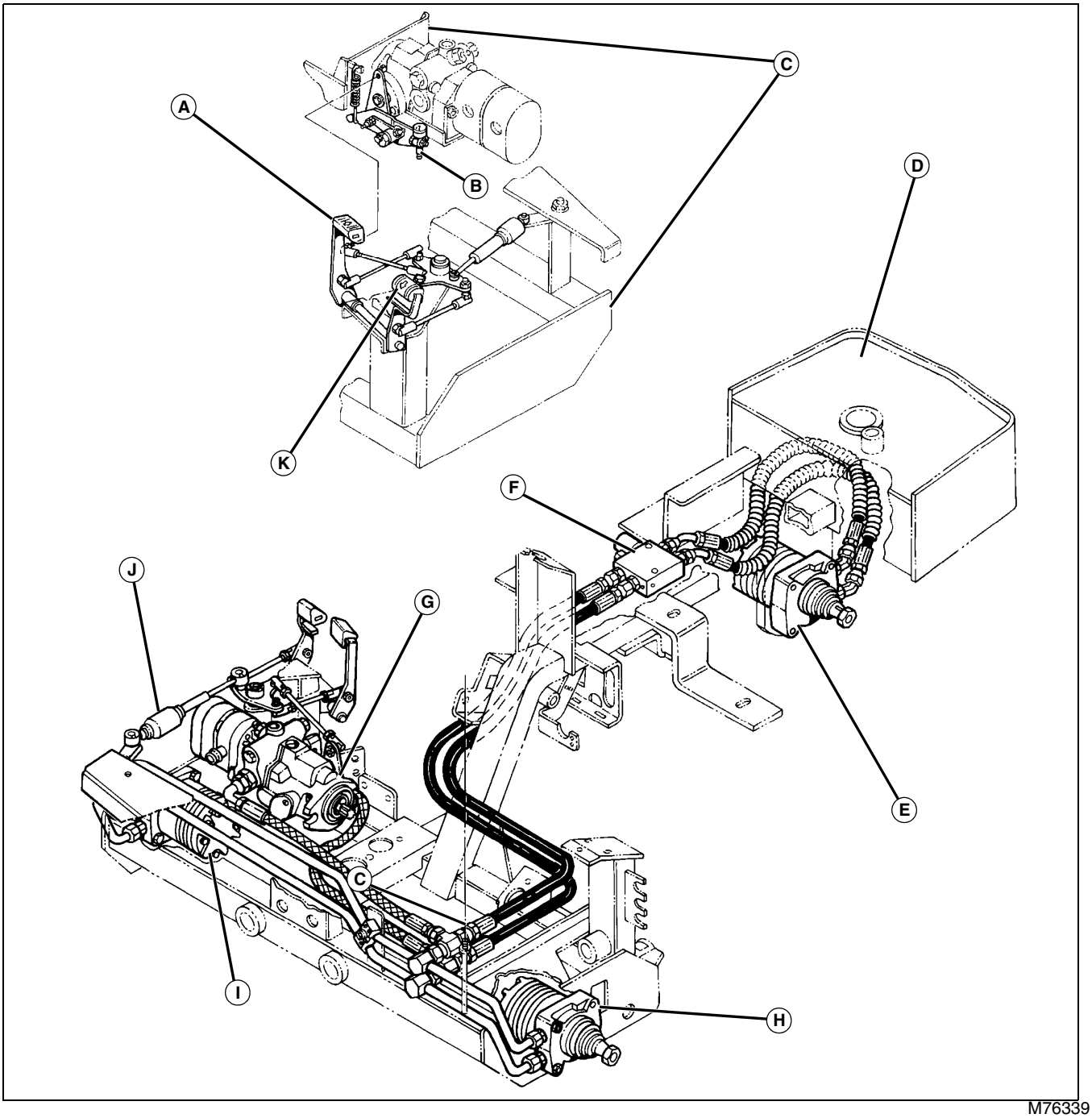
Special or Required Tools

Tool Name	Tool No.	Tool Use
Gage w/Quick Coupler,0- 2000 kPa (0-300 psi).	JT05474	Pressure check.
Flow Tester	JT05984	Check flow.
Wheel Stop Bracket	Fabricated	Stop wheel from moving.
Photo Tachometer	N/A	Measure rpm.
Feeler Gage	N/A	Measure gap.
Torque Wrench	N/A	Tighten cap screws.

Other Material

Part No.	Part Name	Part Use
N/A	Etching Ink	Mark mating surface.
N/A	Clean Hydraulic Fluid	Replacement fluid.

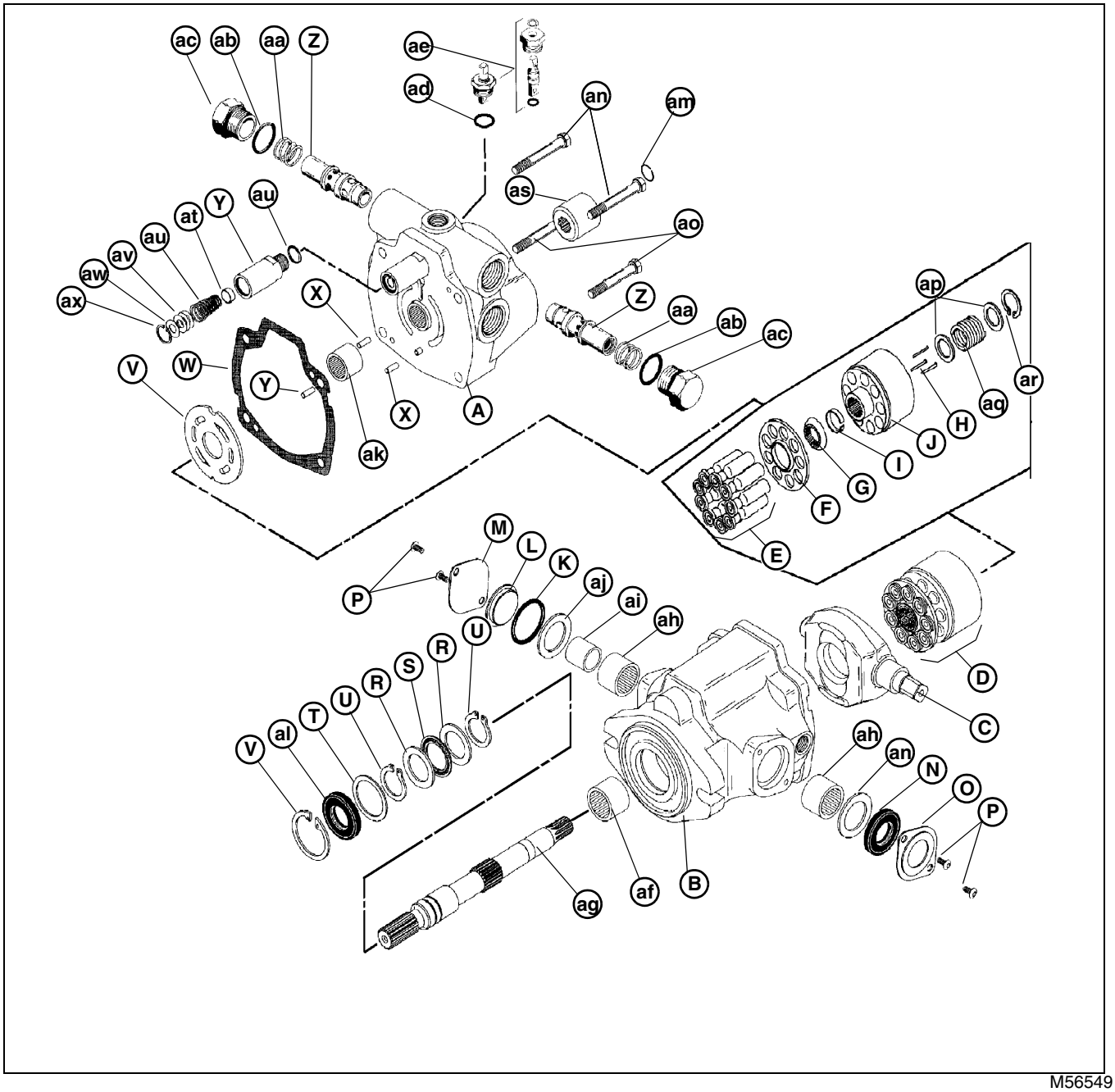
Component Location



M76339

A - Forward Pedal
B - Neutral Switch
C - Hydrostatic Pump Centering Mechanism
D - Reservoir
E - Third Wheel Drive Motor
F - Third Wheel Drive Solenoid
G - Hydrostatic Pump
H - Left Drive TORQMOTOR™
I - Right Drive TORQMOTOR™
J - Damper
K - Reverse Pedal

Hydrostatic Pump

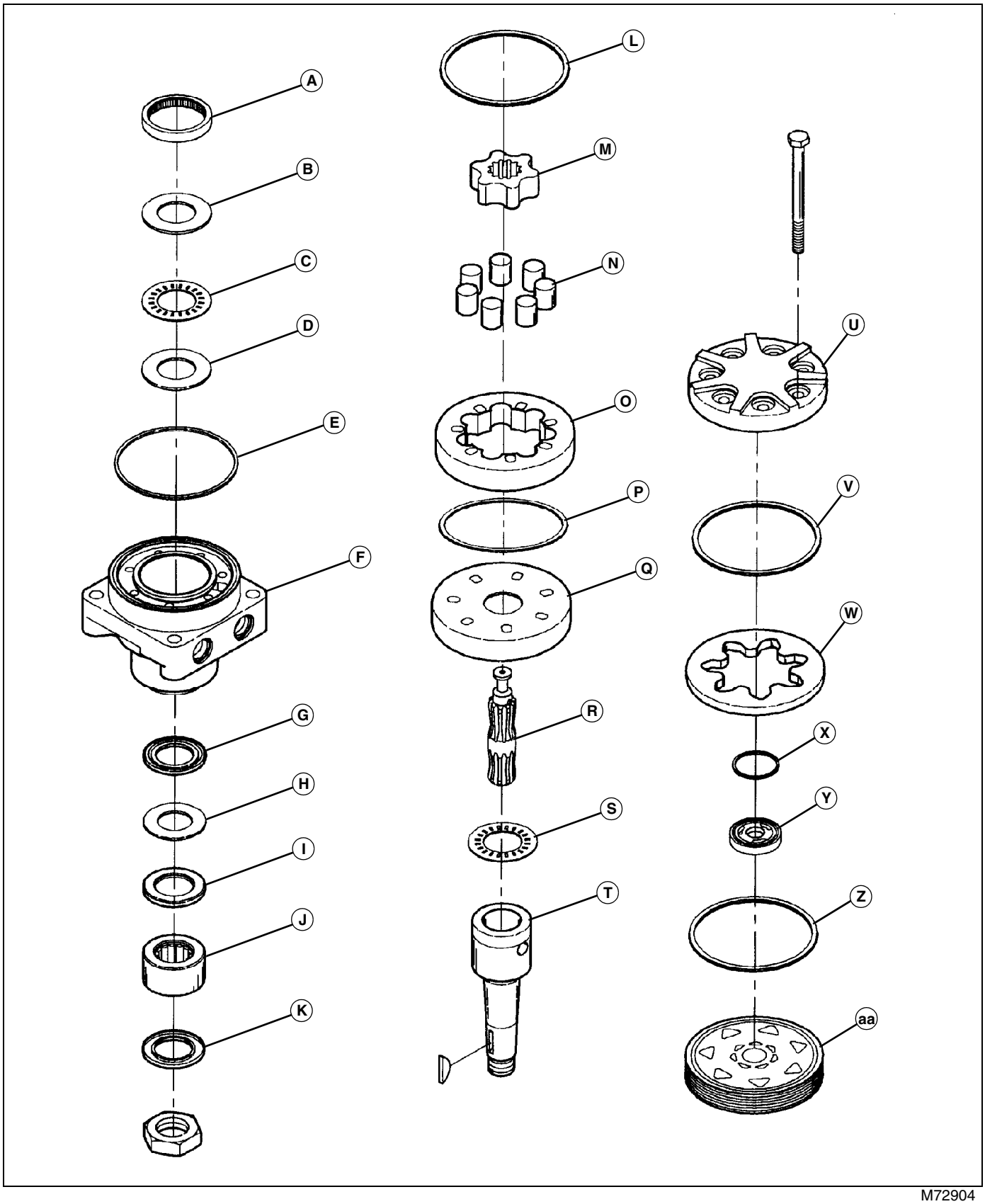


M56549

A - Backplate
B - Body
C - Camplate
D - Rotating Assembly
E - Piston Assembly
F - Spider
G - Spider Pivot
H - Pin
I - Pin Retainer
J - Piston Block
K - O-Ring
L - O-Ring Cover
M - Trunnion Cover
N - Trunnion Seal
O - Seal Cover
P - Cover Screws
Q - Snap Ring
R - Thrust Washer
S - Thrust Bearing
T - Washer
U - Retaining Ring
V - Valve Plate

W - Gasket
X - Pin
Y - Housing
Z - Plug Seat
AA- Spring
AB- O-ring
AC- Plug
AD- O-ring
AE- Tow Valve
AF- Bearing, Body
AG- Shaft, Front Pump
AH- Trunnion Bearing
AI - Bearing Race
AJ- Washer
AK- Bearing, Backplate
AL- Seal, Main Shaft
AM- O-ring
AN- Cap Screws
AO- Cap Screws
AP- Washer
AQ- Spring
AR- C-Clip
AS- Coupler
AT- Poppet
AU- Spring
AV- Shims
AW- Washer
AX- Snap Ring

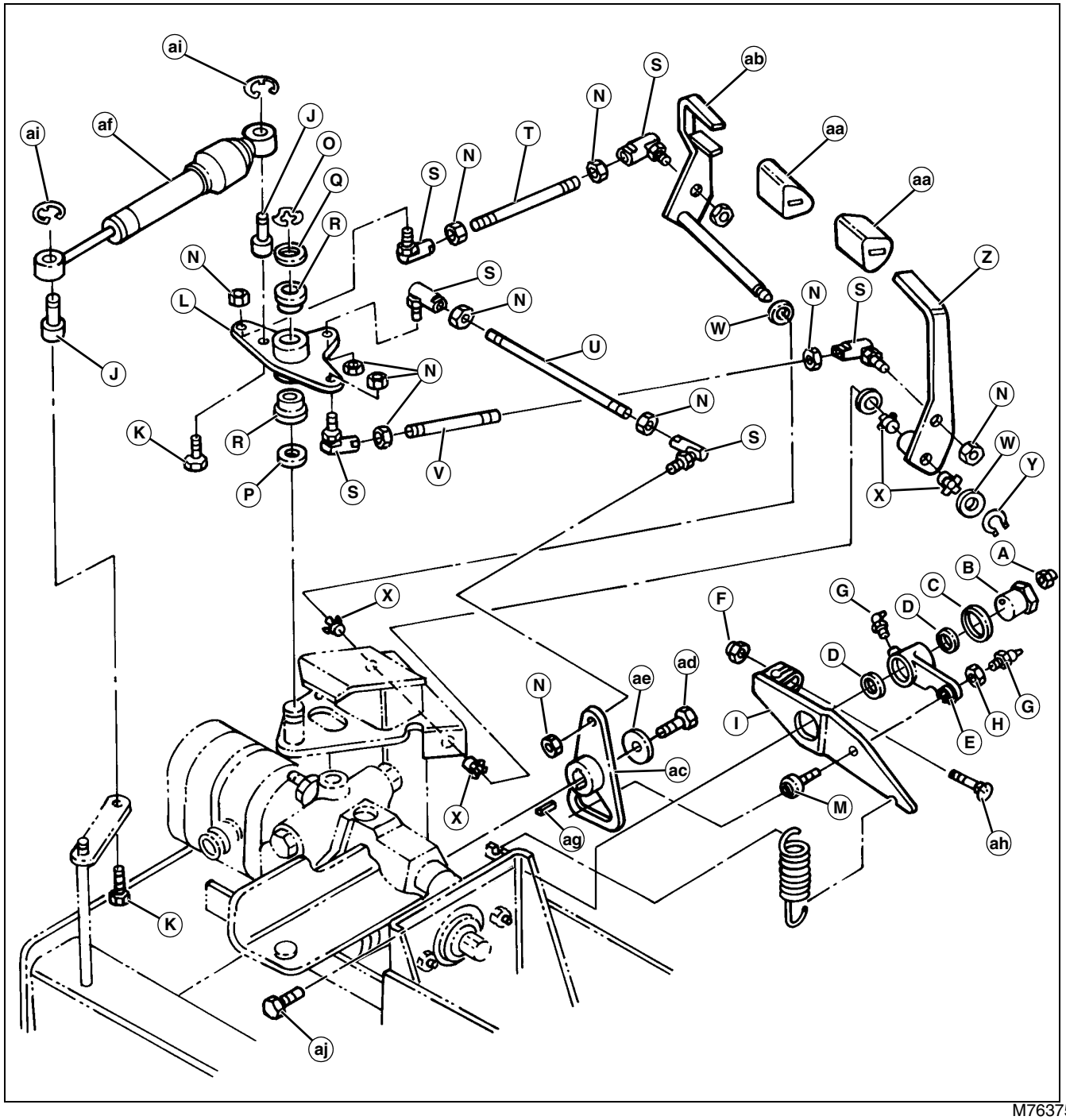
TORQMOTOR™



M72904

A - Bearing
B - Thrust Washer
C - Thrust Bearing
D - Thrust Washer
E - Seal Ring
F - Housing
G - Seal
H - Flat Washer
I - Chamfered Washer
J - Bearing
K - Seal
L - Seal Ring
M - Rotor
N - Vanes
O - Stator
P - Seal Ring
Q - Wear Plate
R - Drive Link
S - Thrust Bearing
T - Coupling Shaft
U - End Cover
V - Seal Ring
W - Commutator Ring
X - Seal Ring
Y - Commutator
Z - Seal Ring
AA- Manifold

Pump Control Mechanism



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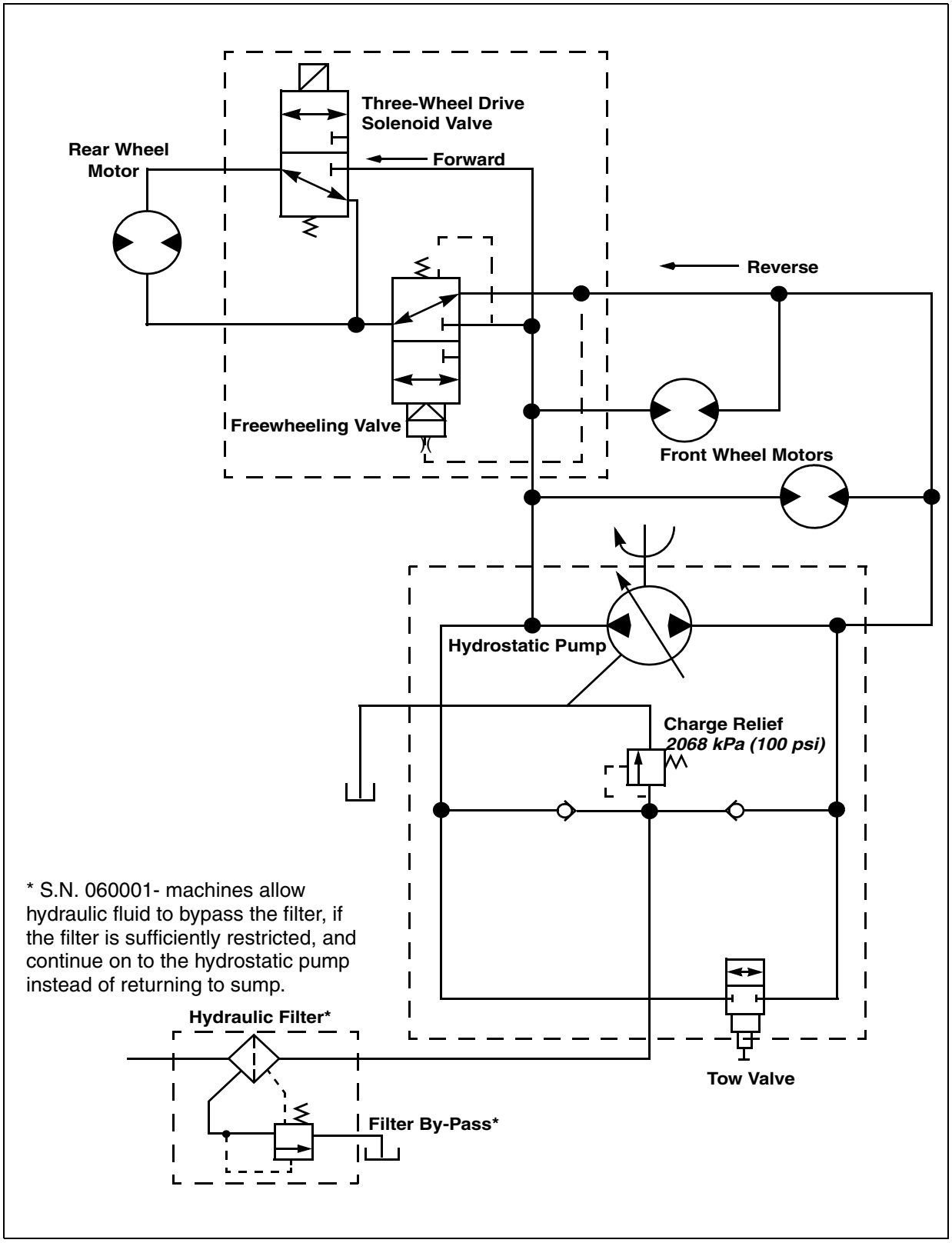
A - Nylock Nut
B - Eccentric
C - Washer
D - Fiber Washer
E - Arm
F - Nylock Nut
G - Grease Fitting
H - Nut
I - Switch Arm
J - Stud
K - Cap Screw
L - Control Plate
M - Cam Follower
N - Nut
O - Spring Clip
P - Washer

Q - Washer
R - Bushing
S - Rod End
T - Rod Reverse
U - Rod Pump
V - Rod Forward
W - Washer
X - Bushing
Y - Retaining Ring
Z - Forward Pedal
AA- Rubber Tread
AB- Reverse Pedal
AC- Pintle Plate
AD- Cap Screw
AE- Fender Washer
AF- Damper
AG- Key
AH- Carriage Bolt
AI - C-Clip
AJ- Cap Screw

Schematic

Hydrostatic Power Train Schematic



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Theory of Operation

Hydrostatic Power Train

Function

The hydrostatic drive system provides a means of propelling the vehicle with 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 three (three wheel drive) Geroler motors. Speed and direction are controlled by two foot pedals.

Hydrostatic Pump

The pump is an Eaton Model 70144 axial piston, manually variable displacement pump. The pump is direct driven by a coupler attached to the engine crank balancer. The pump, or hydrostatic transmission, is mounted transversely in the main frame under the radiator system.

Directional control, forward or reverse, is controlled by varying the direction of fluid flow through the hydrostatic pump by varying the direction of rotation of the swash plate in the pump. Control of the rotation is provided by two foot pedals. The left pedal controls forward motion; the right pedal controls reverse motion.

Speed is controlled by the angle of the swash plate. The greater the displacement of the swash plate from the vertical position, neutral, the greater the volume of fluid the pump will displace, and the faster the vehicle will travel. Speed is governed by depressing the foot pedals.

The hydrostatic pump provides hydraulic fluid to the Motors though hydraulic lines and fittings. The hydraulic fluid in the power train circulates in a closed loop. Fluid leaves the pump, flows through the motor and is returned to the pump, not the reservoir. Fluid that leaves this closed loop circuit, such as case drain, is replenished by fluid from the charge pump located on the end of the double pump assembly. (See Hydraulic section.)

Wheel Motors

The wheel motors are Parker Ross, positive displacement Geroler motors.

The motors for the front wheels are mounted on the “T” frame. The motor for the rear wheel, with rear-wheel drive option only, is mounted on the end of the third wheel steering yoke.

Each motor has a tapered keyed output shaft on which the wheel hubs are mounted. The two front wheel hubs incorporate a park brake disk.

Three-Wheel Drive Solenoid Valve

The three wheel drive solenoid valve is an electrically operated, spring return shuttle valve. The solenoid is energized whenever the mow switch is engaged. When energized, fluid from the forward side of the hydrostatic pump is directed to the rear wheel motor for added traction. When de-energized, fluid in the rear motors and lines circulates in a closed loop allowing the rear wheels to freewheel.

Freewheeling Valve (Four-Wheel Drive Units Only)

The freewheeling valve is a differential pressure pilot operated, spring return shuttle valve.

During three-wheel drive operation and while descending inclines, it is possible to build higher pressures in the return lines of the rear wheel motor. 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 free-wheeling 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 three wheel drive again.

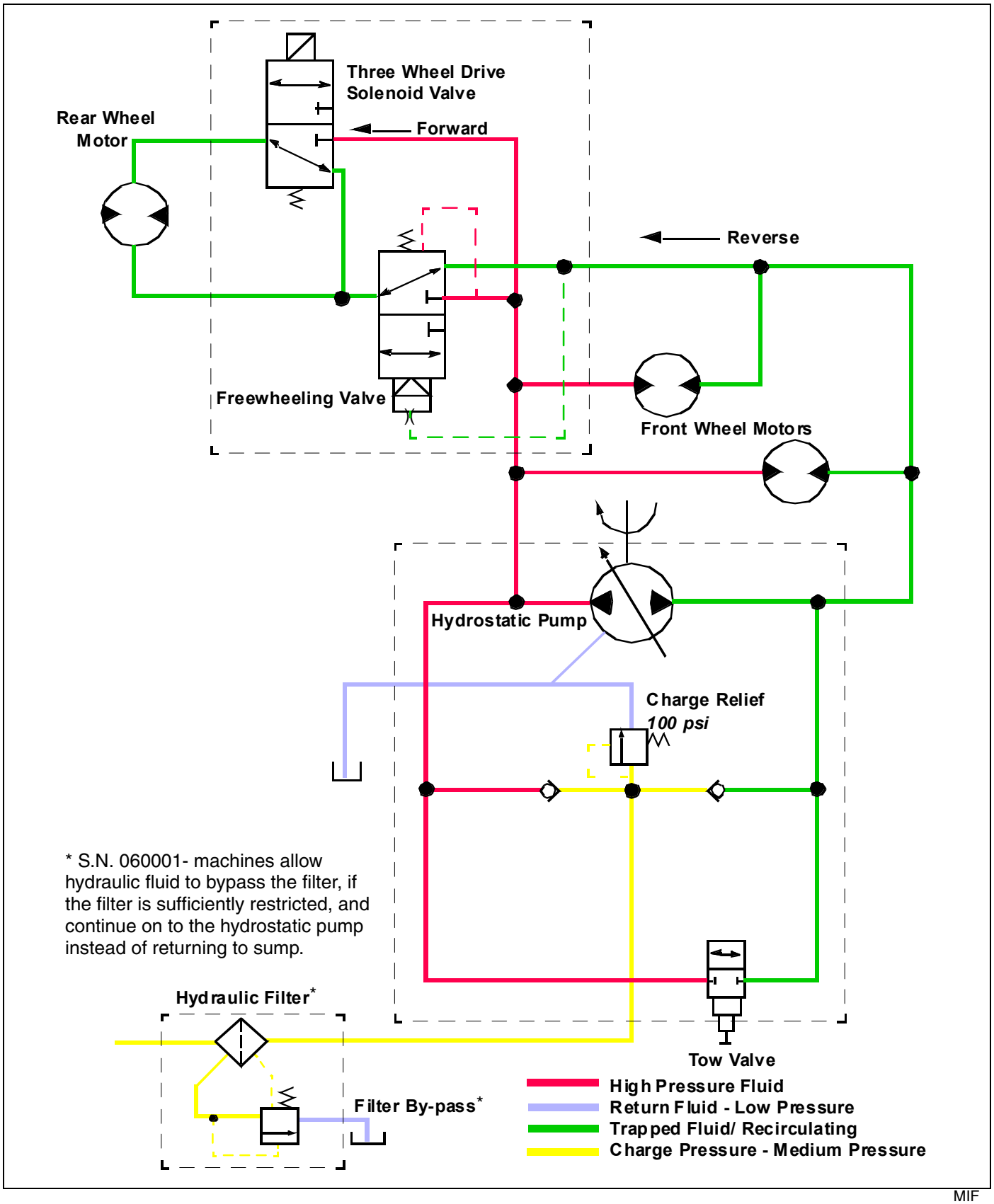
Troubleshooting Hints

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 Hydraulic section.) Once you are satisfied that charge pressure is sufficient, test the hydrostatic pump efficiency (forward and reverse), with a flowmeter. If the hydrostatic pump is delivering the required flow at full output pressure, it is probably safe to assume that the problem is with a wheel motor.

Forward without Three-Wheel Drive



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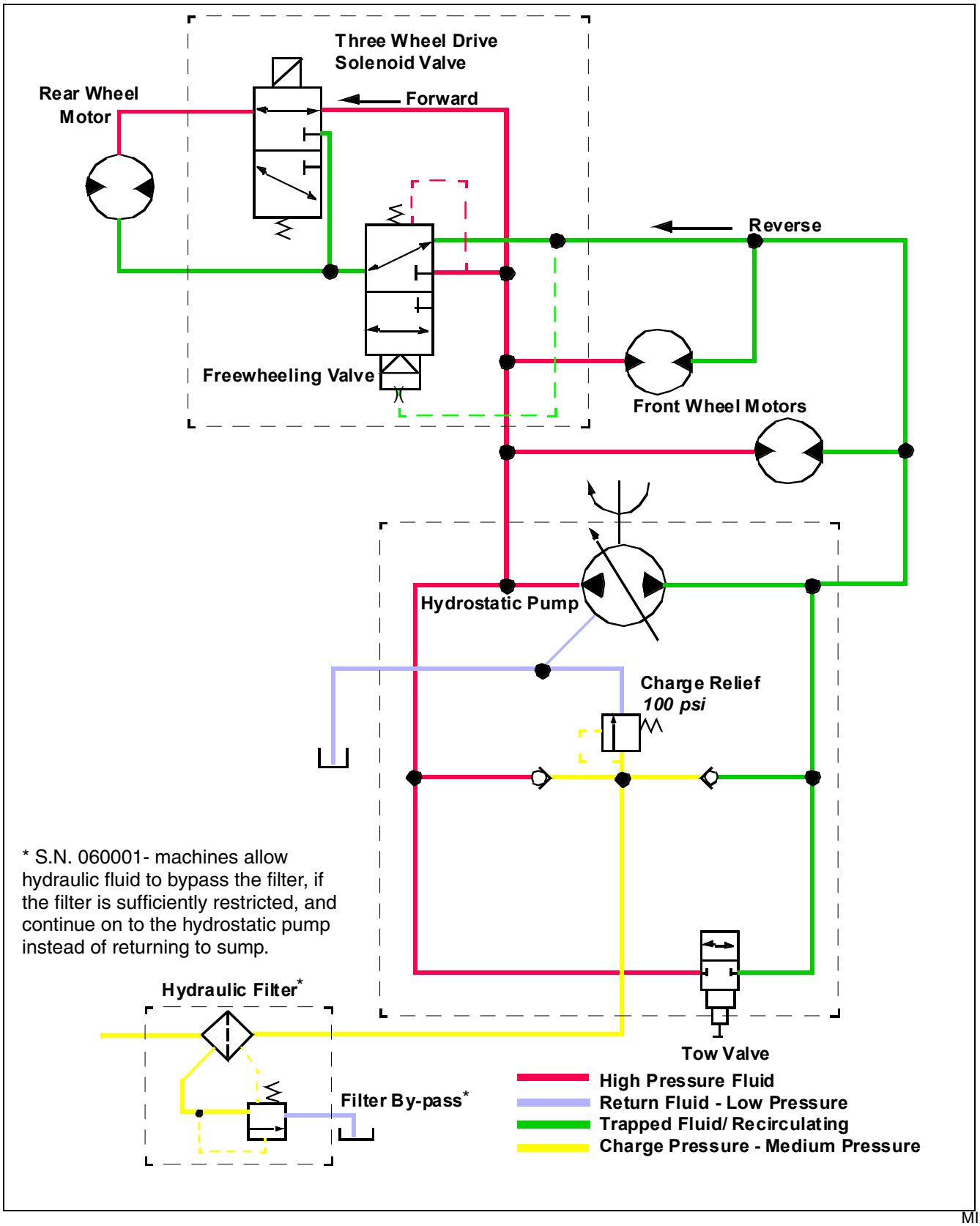
Forward with Three-Wheel Drive



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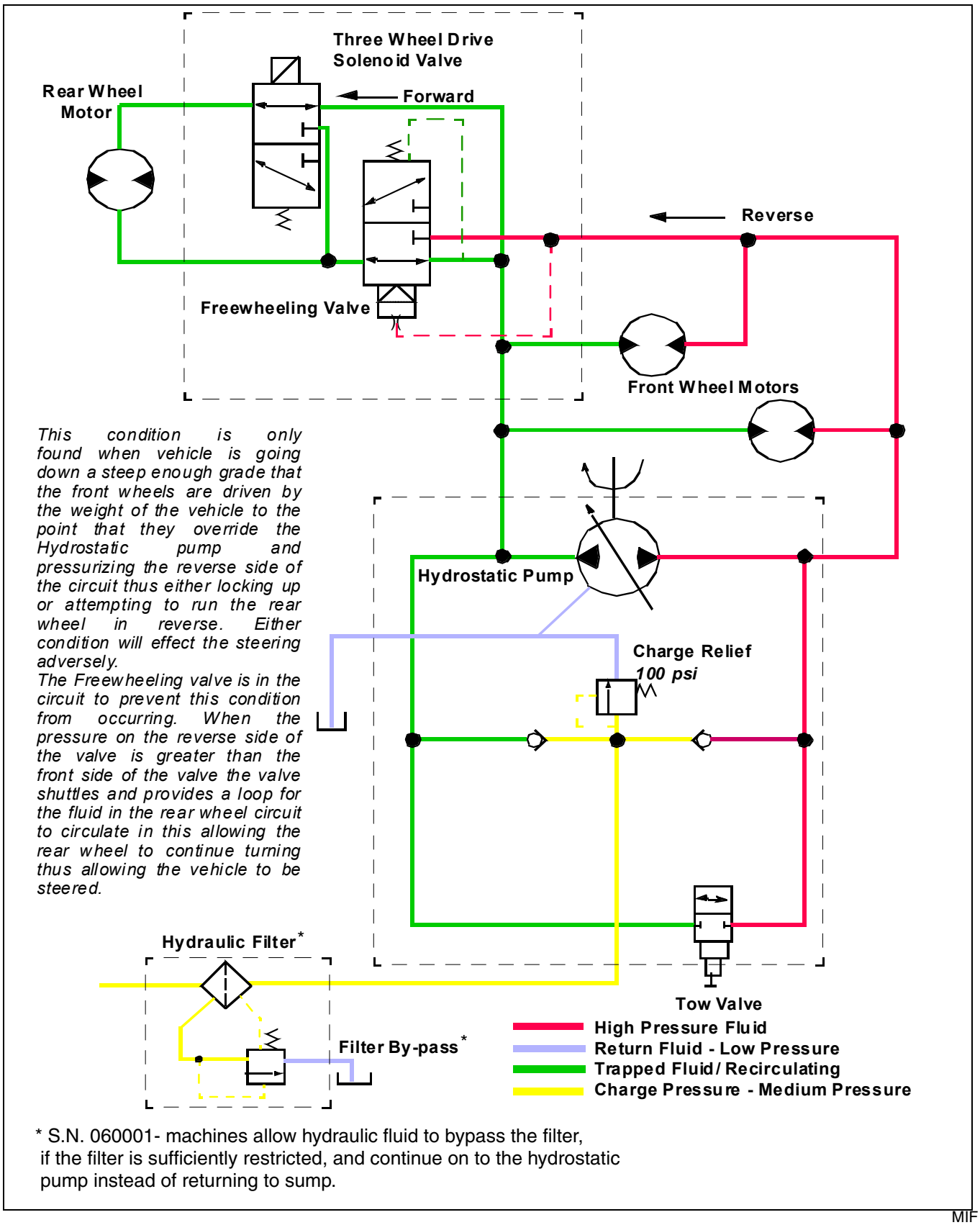
Forward with Three-Wheel Drive and Rear Wheels Freewheeling



This condition is only found when vehicle is going down a steep enough grade that the front wheels are driven by the weight of the vehicle to the point that they override the Hydrostatic pump and pressurizing the reverse side of the circuit thus either locking up or attempting to run the rear wheel in reverse. Either condition will effect the steering adversely.
The Freewheeling valve is in the circuit to prevent this condition from occurring. When the pressure on the reverse side of the valve is greater than the front side of the valve the valve shuttles and provides a loop for the fluid in the rear wheel circuit to circulate in this allowing the rear wheel to continue turning thus allowing the vehicle to be steered.

* S.N. 060001- machines allow hydraulic fluid to bypass the filter, if the filter is sufficiently restricted, and continue on to the hydrostatic pump instead of returning to sump.

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Diagnostics

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 tow valve closed?

Yes - Go to step (4).

No - Close tow 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 oil filter clean (free from restrictions)?

Yes - Go to step (6).

No - Replace filter. Find source of any excess contamination.

(6) Check charge pressure. See "Check Charge Pressure" on page 290. Is charge pressure within specifications?

Yes - Go to step (7).

No - If pressure does not meet specification, follow results of procedure.

(7) Perform hydrostatic transmission flow test. See "Test Hydrostatic Transmission Flow" on page 289. Are hydrostatic transmission flow and pressure within specifications?

Yes - Go to step (8).

No - Check and/or replace relief valves. Repair or replace pump as necessary.

(8) Is the drive shaft secure?

No - Secure, repair or replace drive shaft.

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 tow valve closed?

Yes - Go to step (4).

No - Close tow 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 oil filter clean (free from restrictions)?

Yes - Go to step (6).

No - Replace filter. Find source of any excess contamination.

(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 "Check Charge Pressure" on page 290. Is charge pressure within specifications?

Yes - Go to step (8).

No - If pressure does not meet specification, follow results of procedure.

(8) Perform hydrostatic transmission flow test. See "Test Hydrostatic Transmission Flow" on page 289. Are hydrostatic transmission flow and pressure 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 TORQMOTOR™" on page 310.

No - 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 tow valve closed?

Yes - Go to step (4).

No - Close tow valve.

(4) Is oil filter clean (free from restrictions)?

Yes - Go to step (5).

No - Replace filter. Find source of any excess contamination.

(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 "Check Charge Pressure" on page 290. Is charge pressure within specifications?

Yes - Go to step (7).

No - If pressure does not meet specification, follow results of procedure.

(7) Perform hydrostatic transmission flow test. See "Test Hydrostatic Transmission Flow" on page 289. Are hydrostatic transmission flow and pressure 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.

Symptom: Hydrostatic System Operating Hot

(3) Check charge pressure. See "Check Charge Pressure" on page 290. 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 "Forward without Three-Wheel Drive" on page 284. See "Hydrostatic Power Train" on page 283. 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 tow valve closed?

Yes - Go to step (3).

No - Close tow valve.

(3) Is hydraulic fluid free from air bubbles?

Yes - Go to step (4).

No - Check suction line for air leaks. Repair as necessary.

(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 "Forward with Three-Wheel Drive" on page 285. See "Hydrostatic Power Train" on page 283. 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" on page 297 and See "Inspect Hydrostatic Pump" on page 300. Was any damage found?

No - Repair or replace as necessary.

Tests and Adjustments

Test Hydrostatic Transmission Flow

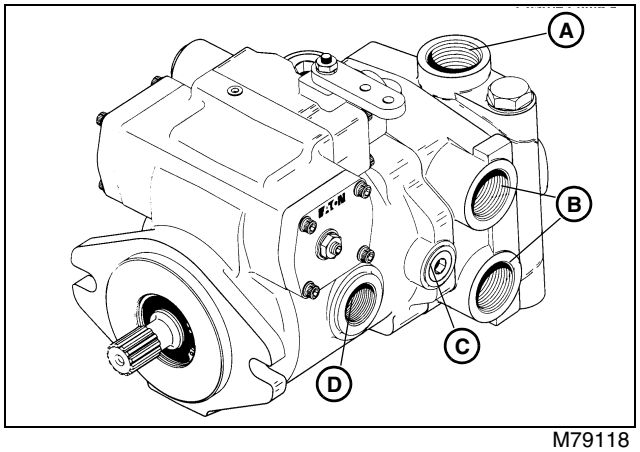
Reason

To verify that hydrostatic pump is operating at optimum efficiency.

Special or Required Tools

Tool Name	Tool No.	Tool Use
In-Line Hydraulic Tester	D01074AA	Used to check hydrostatic pump flow.
Hose (2) - 3/4” Male NPT on hose ends	JT03377	Used to check hydrostatic pump flow.
Connector (2) - 3/4” Female NPT x 1-1/16” Female 37° Flare Swivel	JT03012	Used to check hydrostatic pump flow.
Connector - 1-1/16”-12 Male 37° Flare x 1”-14 F ORFS	JT05689	Used to check hydrostatic pump flow.
Connector - 3/4”-14 F NPT x 1-7/16”-12 M ORFS	JT03492	Used to check hydrostatic pump flow.
Connector - 1”-14 M ORFS x 1-7/16”-12-F ORFS	JT03493	Used to check hydrostatic pump flow.
Hand Held Digital Tachometer	JT05719	Used to verify proper rpm setting.

Recommended Gage Locations



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Recommended Gages

- Inlet vacuum gage: 0-207 kPa (0-30 psi)
- System pressure gage: 68 948 kPa (10,000 psi)
- Charge pressure gage: 0-4137 kPa (0-600 psi)
- Case pressure gage: 0-2068 kPa (0-300 psi)

Test Locations

Charge pump suction port (A) tee in-line to check inlet vacuum.

Pressure ports (B) tee in-line to check system pressure.

Auxiliary port (C) check charge pressure.

Drain port (D) tee in-line to check case pressure.

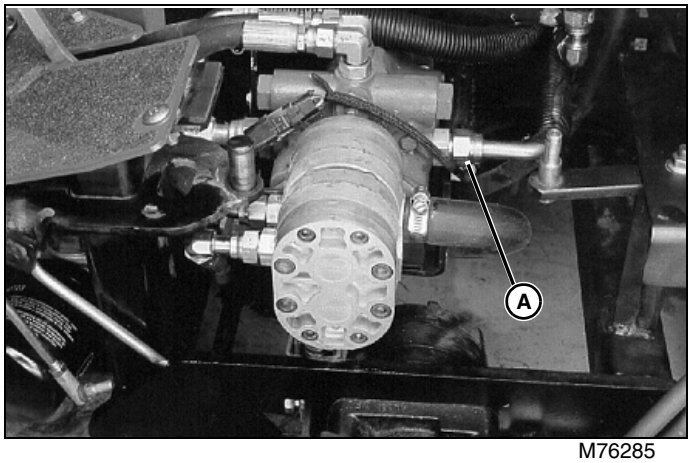
Procedure

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.
To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

1. Park machine on level surface, reels lowered, park brake on, engine off.

2. Chock wheels to prevent inadvertent movement of vehicle during test.

3. Place drip pan under double pump to catch oil that will leak out when lines are disconnected.



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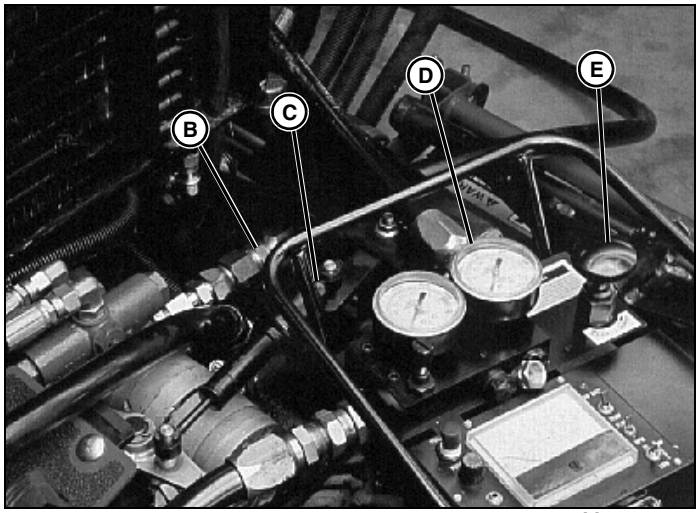
4. Disconnect hydraulic hose (A) going into forward side of hydrostatic pump.



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5. Connect JT03377 Hose to motor using JT03492 and JT05689 Connectors (B). Connect another JT03377 Hose to Hose (A) disconnected from hydrostatic pump using JT03012 and JT03493 Connectors (C).

6. Connect JT03377 Hose from pump into inlet port of D1074AA Hydraulic Tester (D). Install second hose into outlet port.

NOTE: Make sure that pressure control valve on tester is screwed out to a non-restrictive setting. Be careful not to screw handle completely out of valve.

7. Turn tester control knob (E) out (counterclockwise) completely.

8. Start engine.

9. Using JT05719 Hand Held Digital Tachometer set throttle at 3000 rpm.

10.Depress forward pedal fully.

NOTE: Accuracy in recording readings is very important!

11.Record flow reading. Note flow reading for efficiency calculation at end of test.

12.Turn hydraulic tester load valve until pressure is 20 684 kPa (3000 psi).

13.Record reading. Note flow reading.

14.Return load valve to full flow position and turn off engine.

15.Divide reading recorded at 20 684 kPa (3000 psi) by free flow reading to determine pump efficiency.

Example:

Pump Free Flow 12.5 gpm

Pump Flow with 13 790 kPa (2000 psi) load. (12 gpm)

Pump Efficiency:12 ÷ 12.5 = 0.96 or 96 percent.

NOTE: Pump efficiency must not be less than 80 percent.

Results

- If pump flow or efficiency is below the minimum requirements, rebuild and/or replace pump.
- Flow at 20 684 kPa (3000 psi) must be at least 40.6 L/min (10.73 gpm). If not, replace or rebuild pump.

Specifications

Hydraulic Tester Load . . . . . .20 684 kPa (3000 psi)
Flow Rate . . . . . 40.6 L/min (10.73 gpm)

Check Charge Pressure

Reason

To Insure that there is sufficient pressure to keep the Hydrostatic pump properly charged.

NOTE: For further charge pump tests and diagnostics see Lift sections.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hose	AMT846	Pressure check.
Hose 34,473 kPa (5,000 psi)	JT03017	Pressure check.
Female Quick Coupler	RE48122	Pressure check.
Male Quick Coupler 11/16-16 F ORFS	RE43774	Pressure check.
T-Fitting, 11/16-16 F ORFS x 11/16-16 M ORFS x 11/16-16 M ORFS	31H1031	Pressure check.
Connector 1/4” M NPT x 7/16” M 37°	JT05486	Pressure check.
Gage w/Quick Coupler,0- 2000 kPa (0-300 psi).	JT05474	Pressure check.

Procedure

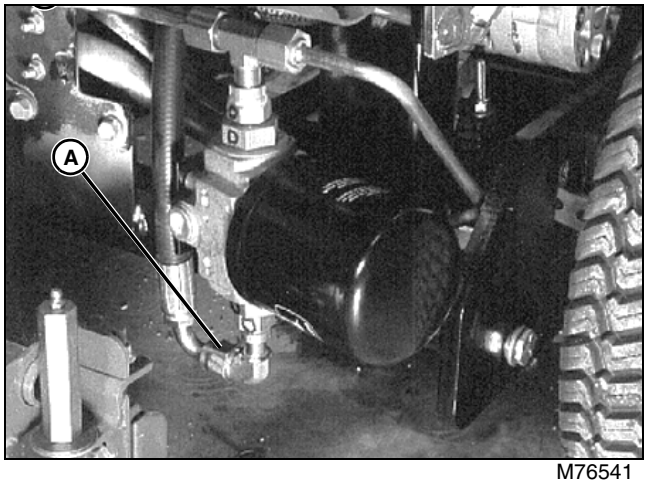
CAUTION: Avoid injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls

1. Park machine on level surface, reels lowered, park brake on, engine off.

2. Chock wheels to prevent inadvertent movement of vehicle during test.

3. Place drain pan under oil filter.

NOTE: Do not remove elbow fitting.



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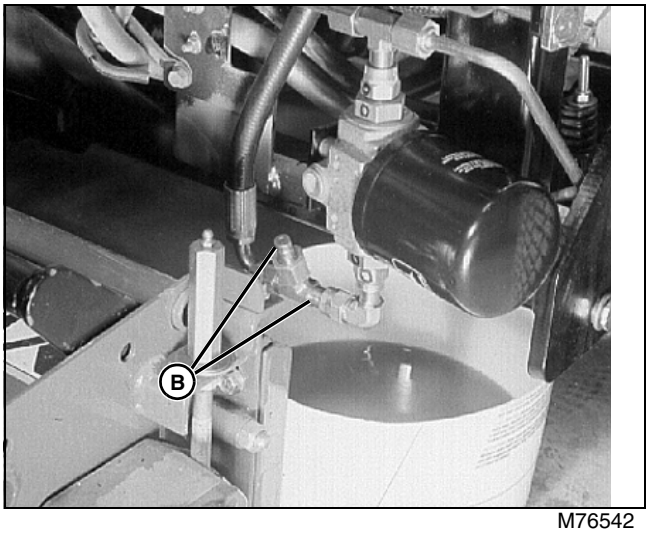
4. Disconnect hose fittings at lower oil filter port (A).



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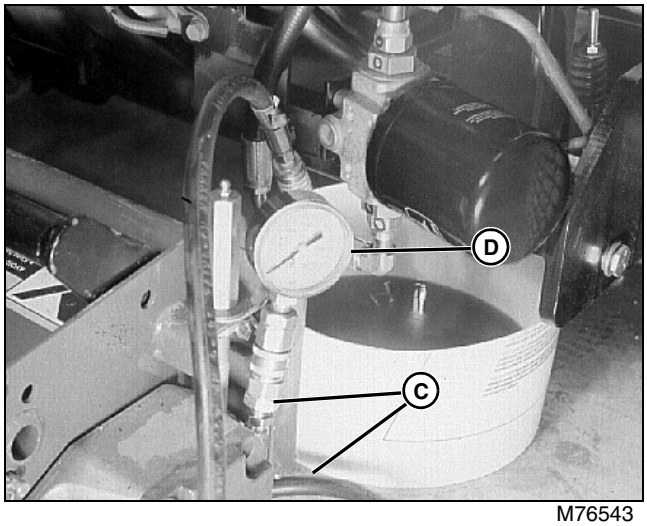
5. Connect 31H1031 T-Fitting and RE43774 Male Quick Coupler (B) to lower end filler port.



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6. Connect AMT846 Hose and RE48122 female quick Coupler.

7. Connect JT03017 Hose assembly with JT05486 Connector (C).

8. Insert JT05474 Gage with Quick Connector (D) into JT05486 connector and fasten other quick coupler to test port.

9. Apply the park brake.

10. Start engine and set throttle to 2000 rpm (min).

NOTE: If the engine stalls while performing this test, set the throttle to full speed and repeat test.

11. Step on reverse pedal to full travel position.

12. Observe pressure gage. Pressure should be within specifications. If relief valve does not meet specifications replace relief valve.

Specification

Charge Pressure . . . . . 689 ± 130 kPa (100 ± 20 psi)

Adjust Transmission Neutral Creep

Reason

To ensure that the transmission neutral mechanism is operating properly.

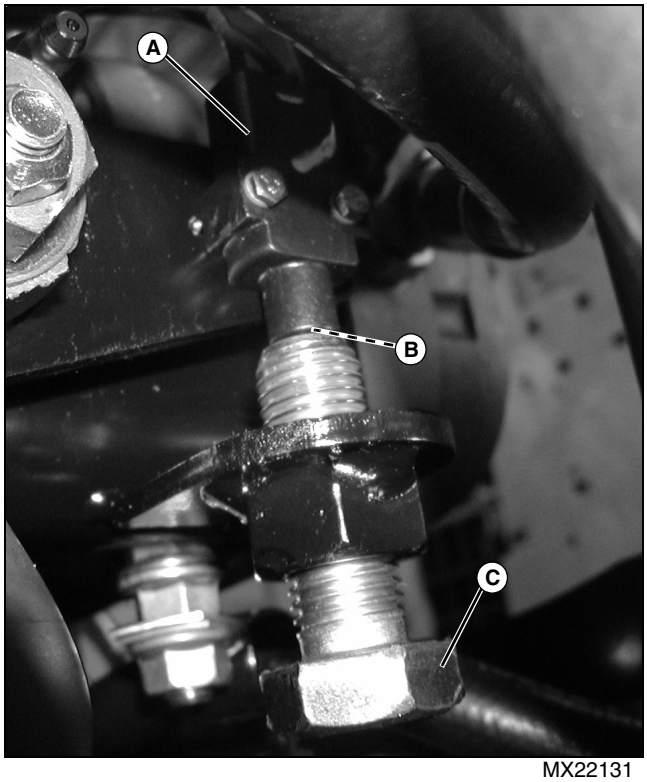
Procedure

IMPORTANT: Avoid damage! Neutral start switch adjustment must be performed after this procedure has been completed.

CAUTION: Avoid injury! Raise the machine safely and support it with suitable jackstands. Ensure all wheels are off the ground (three-wheel drive units). Drive wheels are free to spin during this adjustment, stay clear and keep other people clear of drive wheels during adjustment.

Never work on machine while supported only on mechanical or hydraulic jack.

1. Park vehicle on a level surface.
2. Lift and support machine with jackstands.
3. Operate lift control and allow cutting units to settle on ground.
4. Before making any adjustment, perform a thorough visual inspection of linkages and return springs for damage. Repair or replace as necessary.



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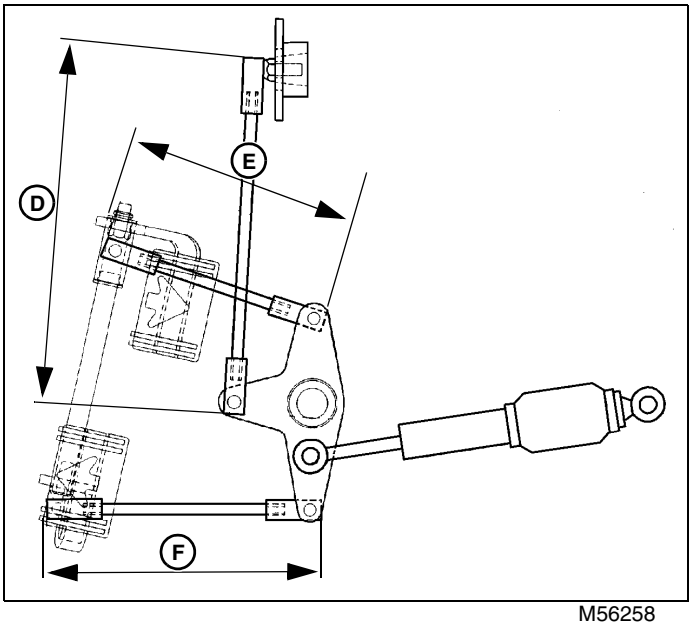
5. Locate transmission neutral switch (A) and insure that switch plunger (B) is not “bottoming out”. Adjust bolt (C) accordingly.



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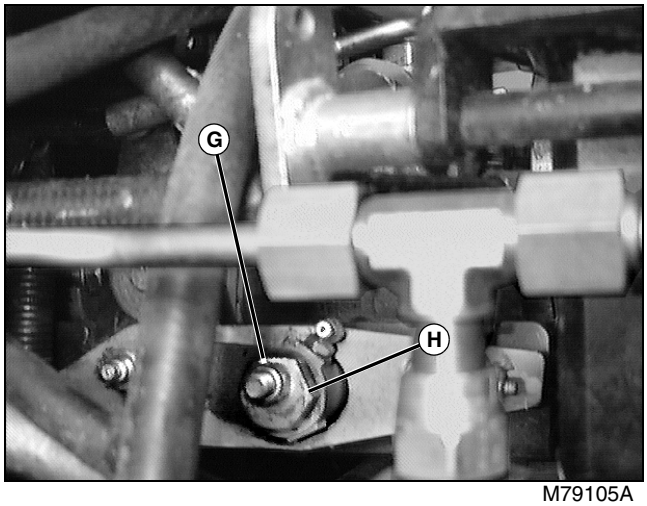
6. Check transmission link (D) to ensure that it is within specification from end of rod end to end of rod end. If not, adjust.
7. Set forward pedal link (E) to specification.
8. Set reverse pedal link (F) to specification.
9. Start engine and run at slow idle.

10.With an operator in the operator's seat, release the park brake.



M79105A

11.Loosen eccentric locknut (G).

12.Rotate eccentric (H) forward or backward until drive wheels stop turning. Tighten eccentric locknut while holding eccentric in position.

13.Have the operator depress the drive pedals in both directions and release.

14.Drive wheels should stop turning when pedals are released. If not, repeat adjustment.

15.Adjust reverse pedal Link until reverse pedal lines up with forward pedal.

NOTE: Adjust neutral start switch after this procedure has been completed.

Specifications

Transmission Link Overall Length . . . . 235 mm ± 5 mm (9.252 in. ±0.2 in.)

Forward Pedal Link 152 mm ± 5 mm (5.984 in. ± 0.2 in.)

Reverse Pedal Link 185 mm ± 5 mm (7.283 in. ± 0.2 in.)

Adjust Transmission Neutral Start Switch

Reason

To ensure that the neutral switch is properly set.

Procedure

IMPORTANT: Avoid damage! Transmission neutral mechanism adjustment (previous section) should be performed before this adjustment is made.

NOTE: Before performing this procedure, check switch for proper operation.

1. Park vehicle on a level surface

CAUTION: Avoid injury! Raise the machine safely and support it with suitable jackstands. Ensure all wheels are off the ground (three-wheel drive units). Drive wheels are free to spin during this adjustment, stay clear and keep other people clear of drive wheels during adjustment.

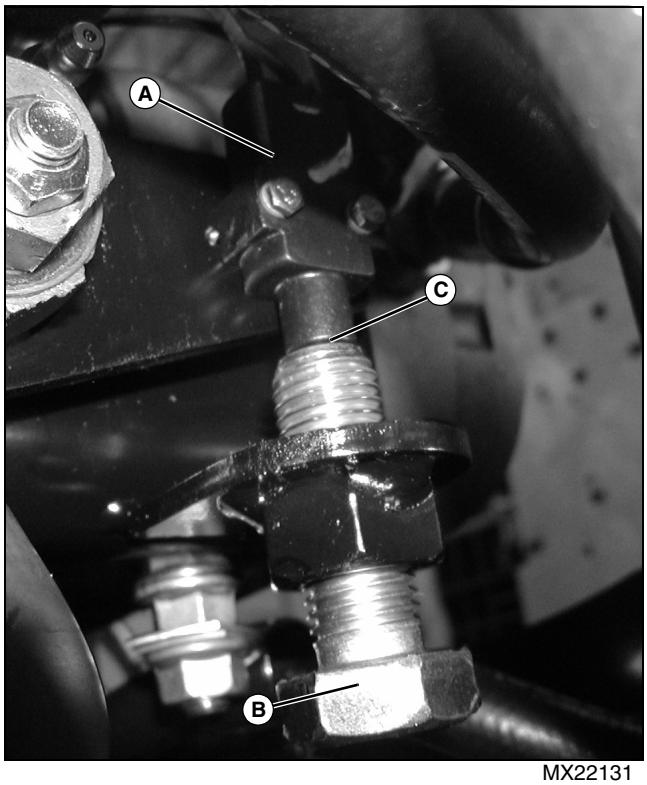
Never work on machine while supported only on mechanical or hydraulic jack.

2. Lift and support machine with jackstands.
3. Operate lift control and allow cutting units to settle on ground.
4. Start engine and run at slow idle.
5. Move hydrostatic control forward pedal.
6. Move hydrostatic control reverse pedal.

Result

- Engine should stop within first inch of pedal travel.

Adjust Neutral Switch



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1. Inspect switch (A).

2. With engine stopped off turn bolt (B) until it lightly presses the plunger (C).

3. Start engine.

NOTE: If engine fails to start, tighten bolt so it presses more on the plunger and repeat Step.

4. Repeat test procedure to insure that engine kills in the first inch of pedal travel.

5. When switch is properly set remove vehicle from jack stands.

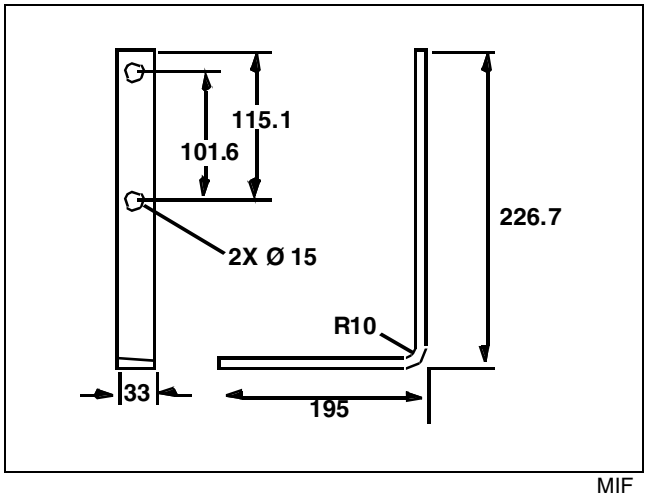
Test TORQMOTOR™ Efficiency

Reason

To determine if the TORQMOTOR is operating at peak efficiency.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Tester	JT05984	Check flow
Wheel Stop Bracket	Fabricated	Stop wheel from moving
Photo Tachometer		Measure rpm



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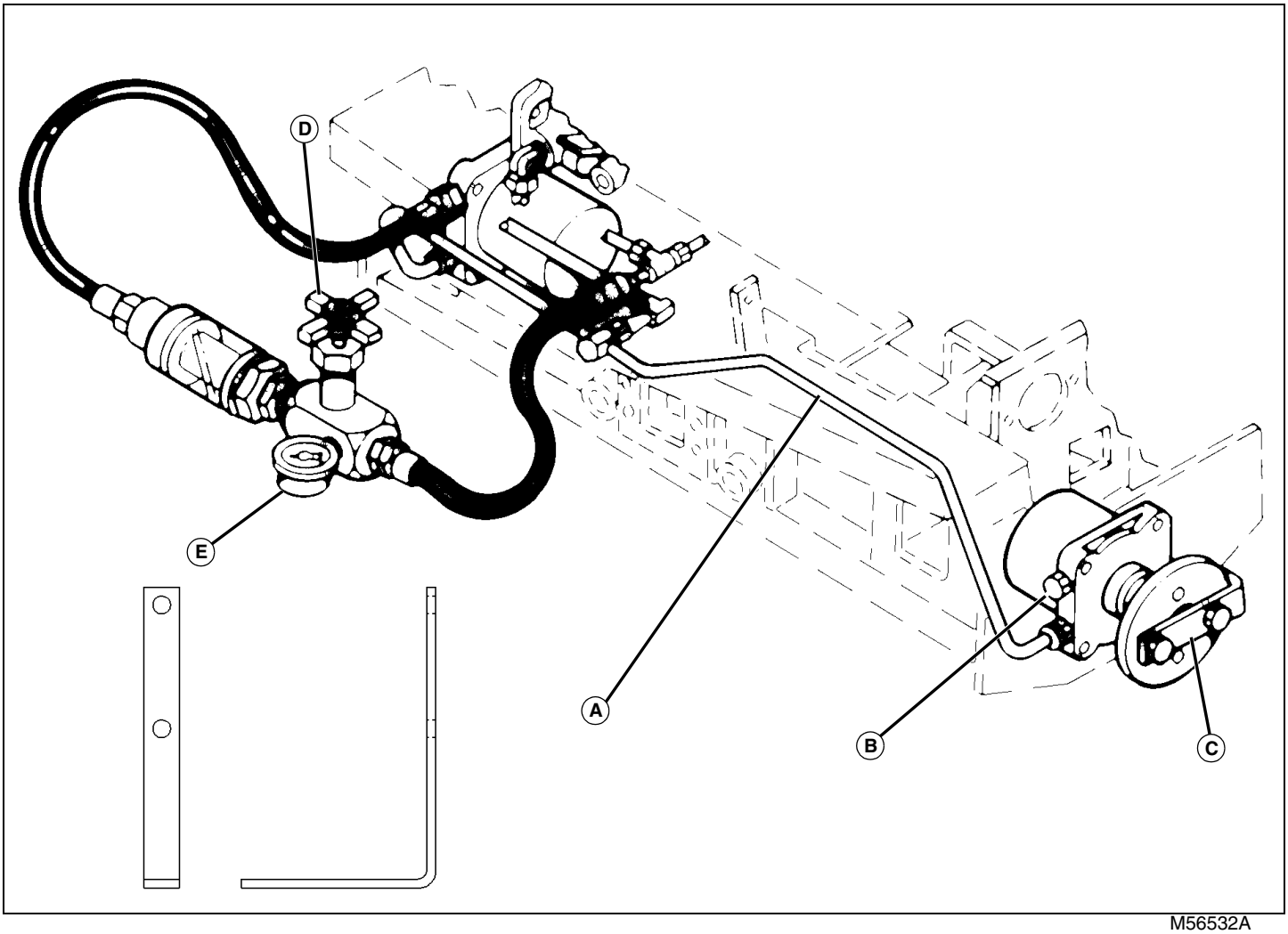
- Fabricated wheel stop bracket dimensions.

Connections

NOTE: Install the wheel stop bracket (C) on the front wheel not being tested as shown.



M56532A

Picture Note: Shown without wheel for clarity

1. Remove the upper hydraulic line (A) (forward operation) and install a flow tester capable of handling 30 gpm at 3000 psi on the wheel being tested.

2. Install a cap (B) on the wheel not being tested.

3. Ensure the mow switch is OFF when testing a front wheel motor and ON when testing the rear wheel motor.

Procedure

1. Start engine and allow it to reach normal operating temperature.

2. Depress foot pedal to full forward position.

3. Slowly build up pressure with the shutoff valve (D) until 1500 psi is indicated on the pressure gage (E).

4. Using a photo tachometer, measure the rpm of the wheel being tested.

5. Indicated rpm should be at least 300 rpm. If not, disassemble and repair the TORQMOTOR™.

6. Remove test equipment and reconnect hydraulic lines. Replenish hydraulic reservoir.

Repair

Remove Hydrostatic Pump

1. Park vehicle on a level surface and block wheels to prevent inadvertent movement of the machine.
2. Move mow/transport lever to TRANSPORT position.
3. Lower cutting units to the ground.
4. Turn key switch OFF.
5. Engage park brake.
6. Disconnect battery negative (-) cable

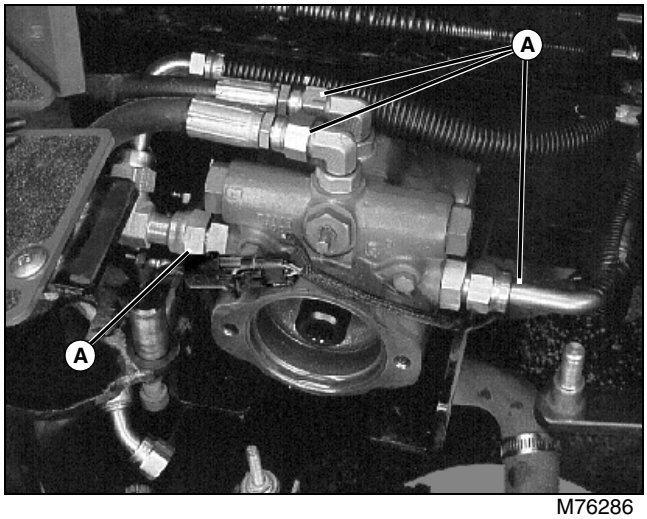
CAUTION: Avoid injury!

- **Raise machine safely and support it with suitable jackstands.**
- **Never work on machine while supported only on mechanical or hydraulic jack.**

7. Lift and support machine with jackstands
8. Remove hood. (See “Hood” on page 407.)
9. Remove plenum.
10. Remove right wheel.

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.
To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

11. Place a 40 qt. (10-gallon) container below the hydraulic sump and drain oil.
12. Remove double pump assembly. (See “Remove Double Pump” on page 349.)
13. Clean port areas of the hydrostatic pump with a suitable solvent.
14. Place drip pan under double pump to catch oil that will leak out when lines are disconnected.
15. Identify lines for assembly purposes.

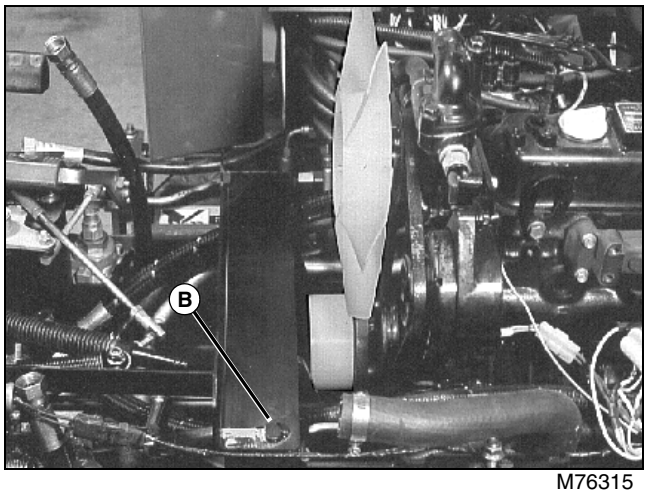


M76286

16. Disconnect all hydraulic lines (A) connected to the hydrostatic pump. Close all lines and fittings using caps and plugs.

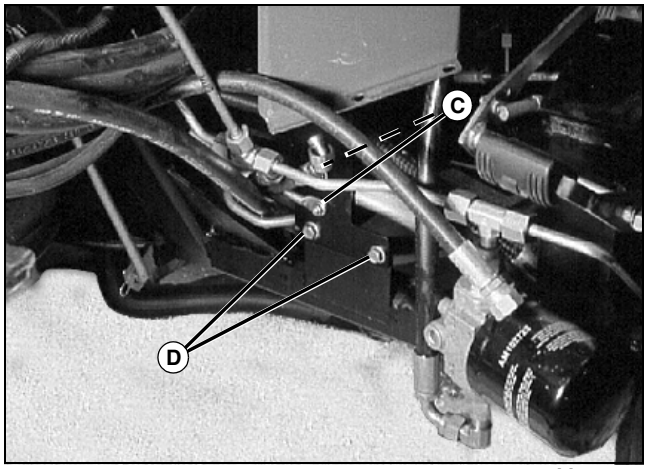
CAUTION: Avoid injury! Explosive release of fluids from pressurized cooling system can cause serious burns. Stop engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

17. Remove radiator. (See “Remove, Inspect and Install Radiator” on page 71.)



M76315

18. Remove nut (B) from welded stud on underside of radiator support cross member.

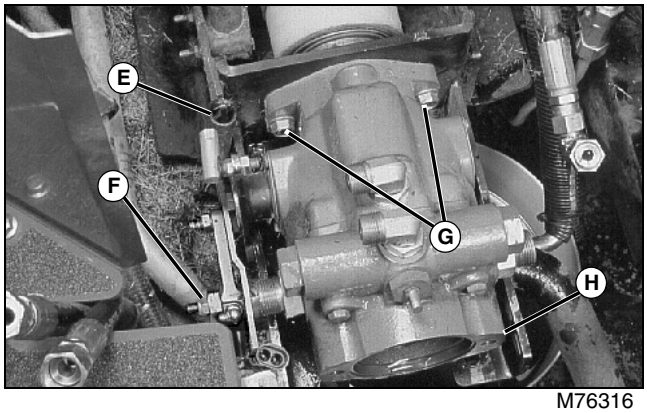


M76395

19.Remove two flange head bolts (C) securing tube clamp to frame.

20.Remove two flange head bolts (D) retaining lower end of radiator support to frame.

21.Remove radiator support cross member.



M76316

22.Unhook spring (E) from frame hook.

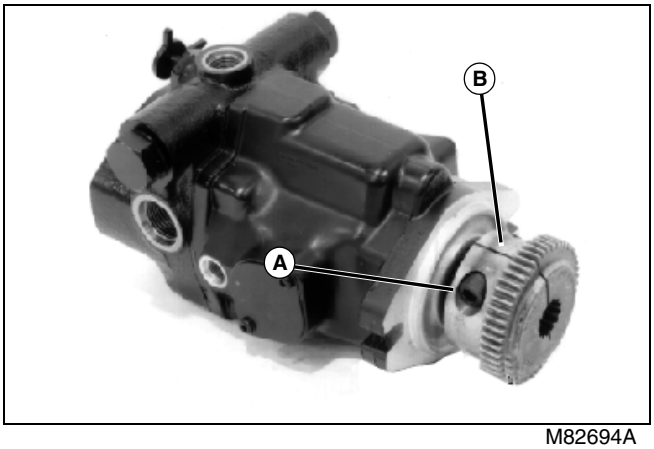
23.Remove neutral mechanism eccentric and spring arm assembly by removing locknut (F).

24.Remove flange head cap screws (G) and nuts securing the hydraulic pump unit to the engine subframe.

25.Remove hydrostatic pump (H).

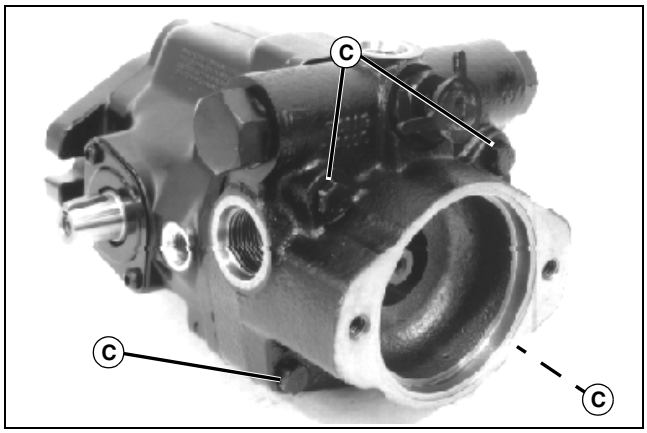
Disassemble Hydrostatic Pump

IMPORTANT: Avoid damage! Plug all ports and thoroughly clean the outside of the pump. Remove plugs and drain oil.



M82694A

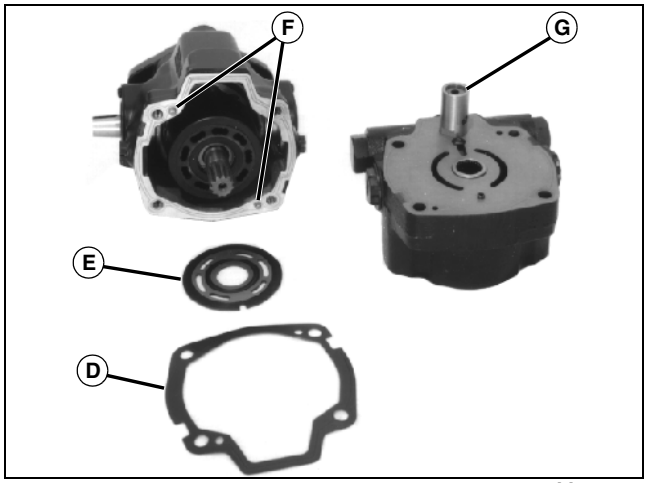
1. Loosen socket head cap screw (A) and remove driven coupler (B).



M82695

2. Remove four cap screws (C) from the backplate.

3. Tap backplate with a plastic mallet to loosen, then pull the backplate straight up to remove.

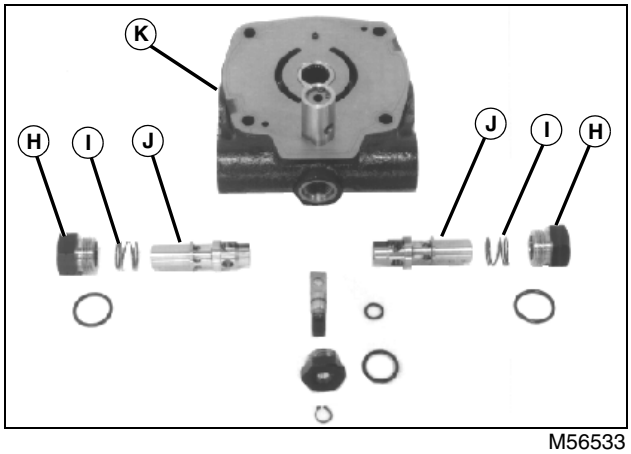


M82696

4. Remove gasket (D) and valve plate (E).

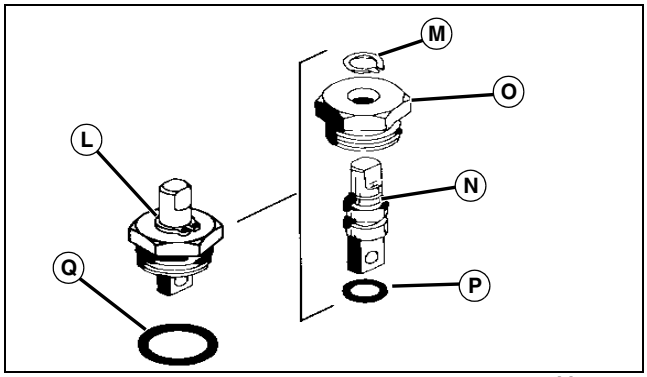
5. Inspect dowel pins (F) for wear or damage. Replace if necessary.

6. Remove charge relief valve (G).



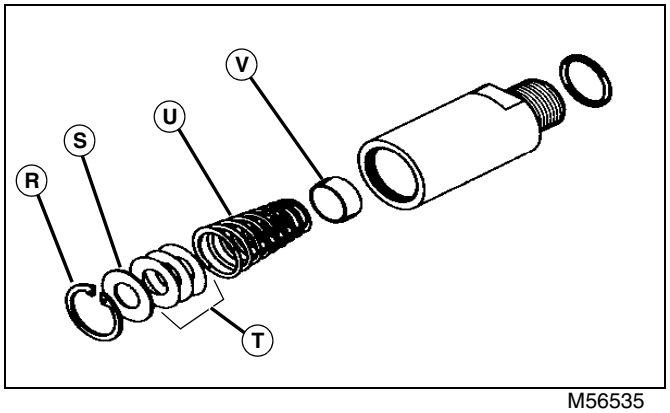
M56533

7. Remove plugs (H), springs (I) and plug seats (J) from backplate (K).



M56542

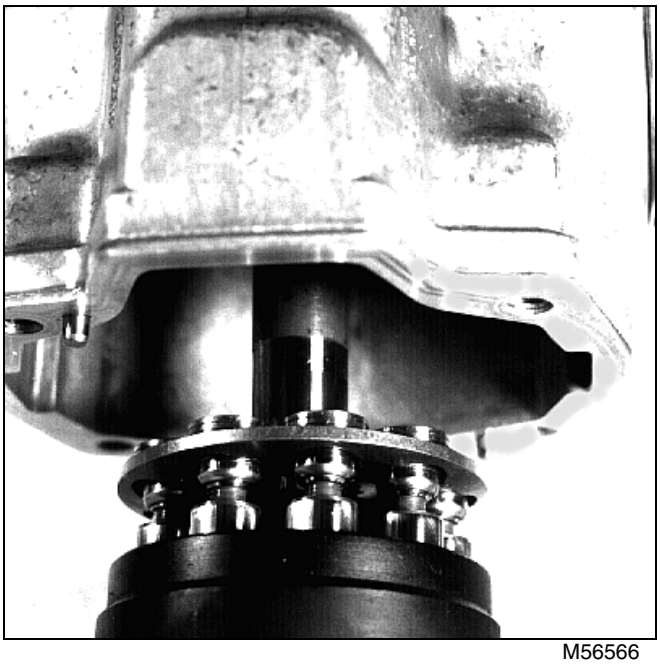
8. Remove and disassemble tow valve (L) by removing the retaining ring (M) and pulling the spreader (N) from the spreader plug (O) taking care not to damage O-rings (P) and (Q).



M56535

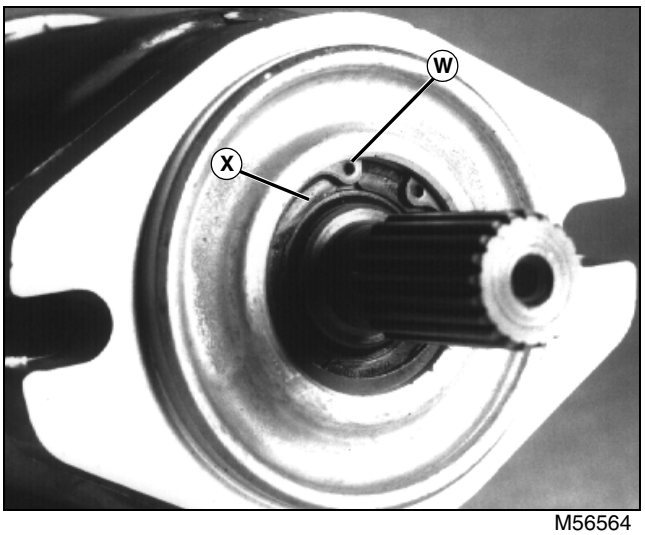
9. Disassemble charge relief valve by removing retaining ring (R), washer (S), shim(s) (T), conical spring (U) and plunger (V). Make note of the number of shims removed for reassembly. Inspect parts for wear or damage. Replace if necessary

IMPORTANT: Avoid damage! Try to keep the pistons and piston block together as an assembly when removing the rotating assembly.

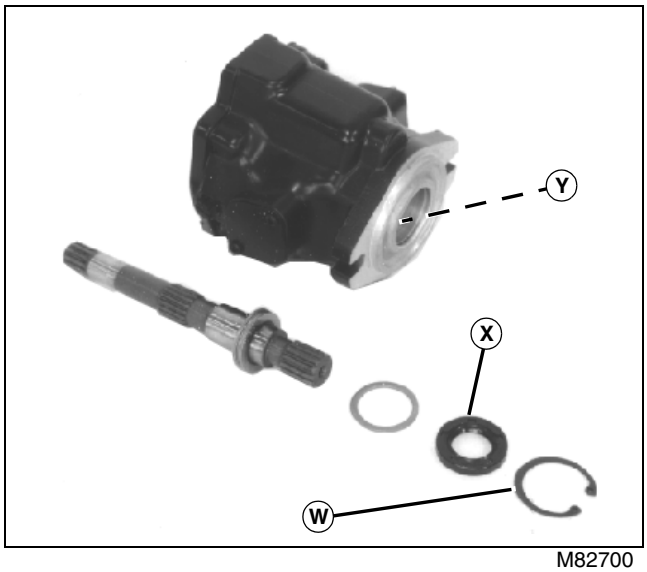


M56566

10.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

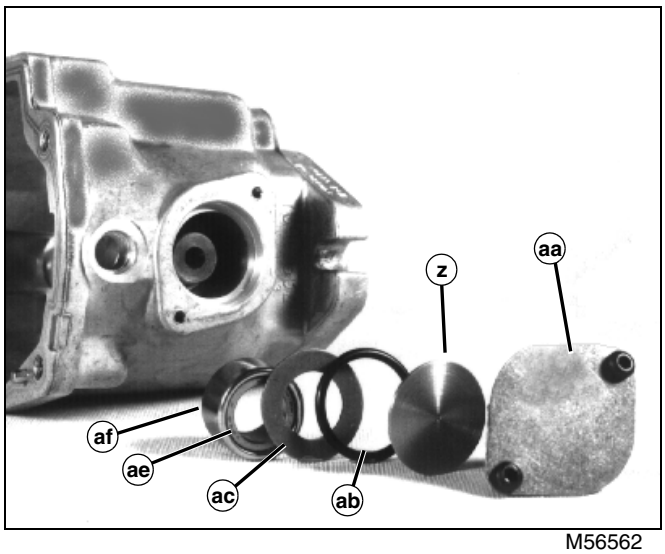


M82700

11.Remove snap ring (W) and tap the shaft and oil seal (X) from the housing with a soft-faced mallet.

NOTE: Bearing is press fit in housing. Remove bearing only if replacement is necessary

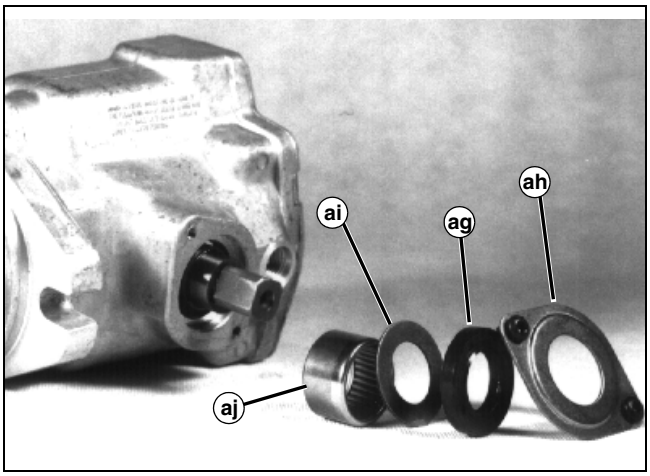
12.Inspect bearing (Y) for wear or damage. If necessary, remove bearing using a blind-hole puller.



M56562

13.Remove trunnion cover (aa).

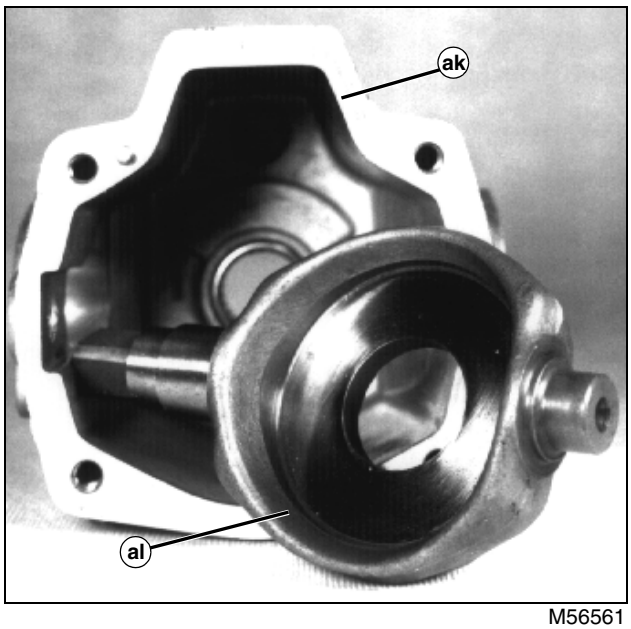
14.Tap on square end of camplate shaft to remove plate (z), O-ring (ab), washer (ac, bearing (af) and race (ae).



M56565

15.Remove seal cover (ah).

16.Seal (ag), washer (ai) and bearing (aj) can be removed by tapping on opposite end of camplate shaft to drive seal out of housing.

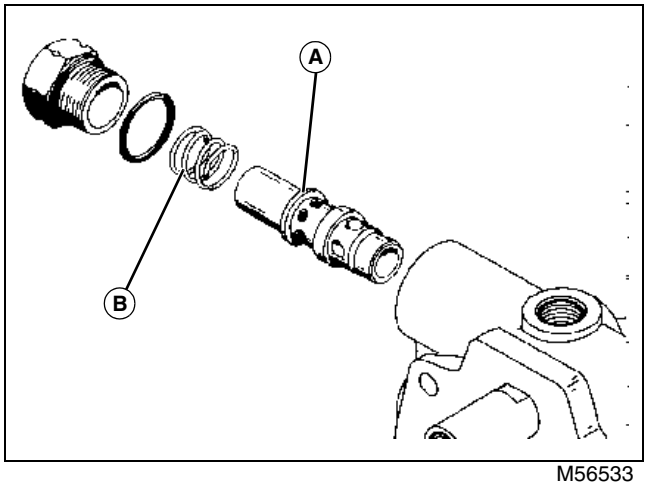


M56561

17.Remove camplate (al) from housing (ak).

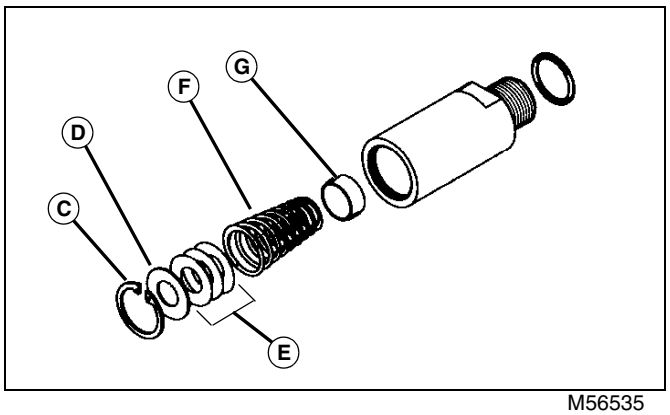
Inspect Hydrostatic Pump

IMPORTANT: Avoid damage! Keep work area clean and use lint-free cloth and mineral spirits to clean parts for inspection.



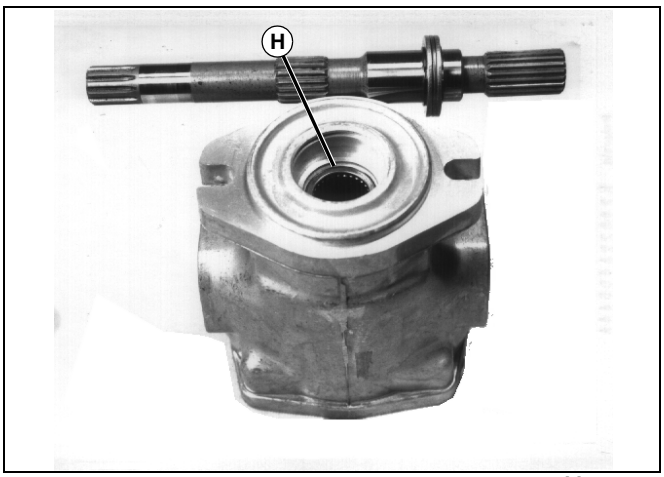
M56533

1. Inspect the plug seats (A) and springs (B) for condition and wear. Replace if necessary.



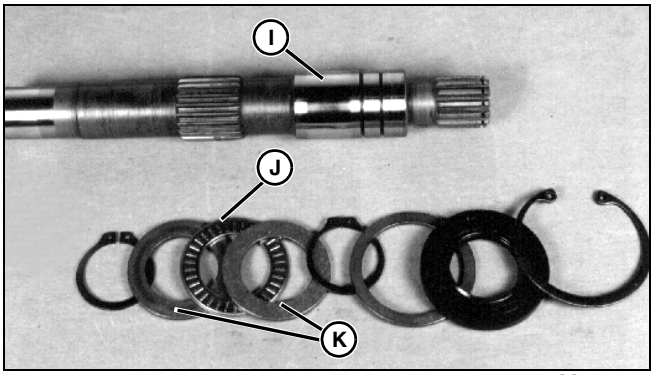
M56535

2. Inspect the charge relief valve retaining ring (C), washer (D), shim(s) (E), conical spring (F) and plunger (G). Make note of the number of shims removed for reassembly. Inspect parts for wear or damage. Replace the entire relief valve if worn.



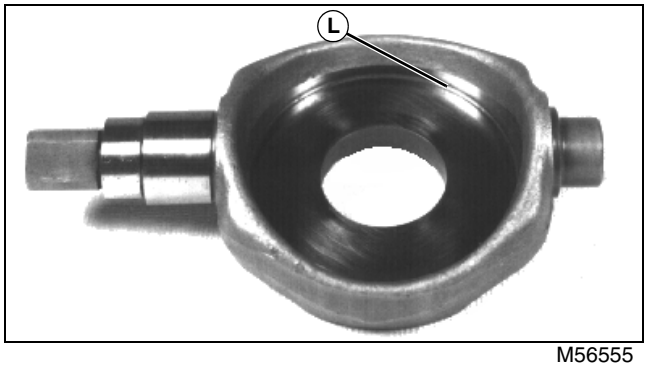
M56557

3. Inspect the needle bearings (H) in the housing assembly, making sure bearings remain in bearing cage.



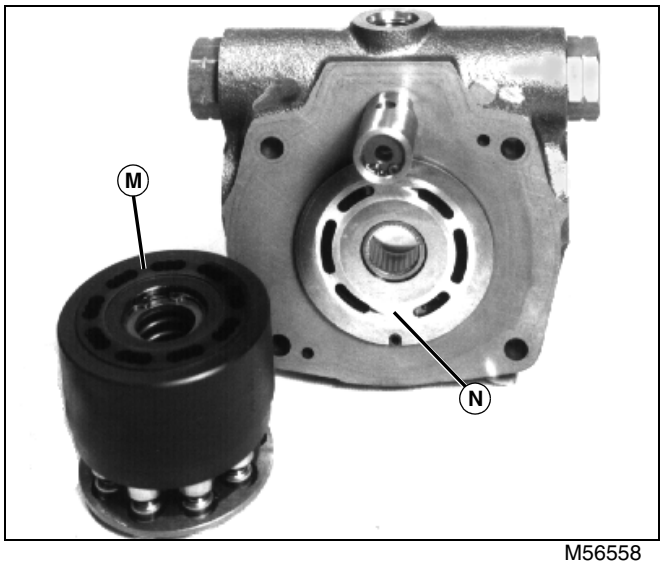
M76112

4. Inspect the complete shaft (I), thrust bearing (J) and thrust washers (K) for wear.



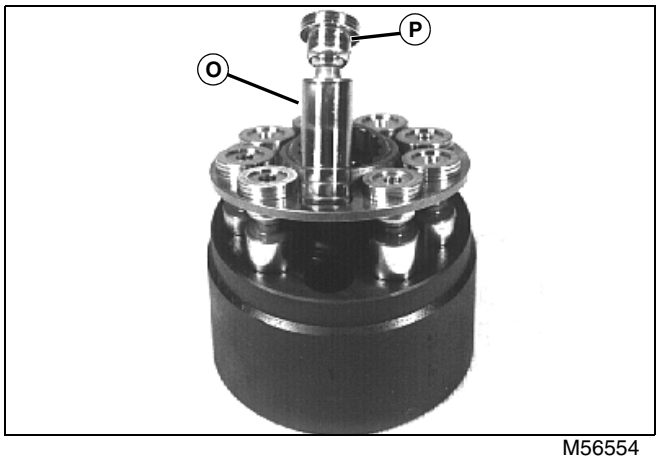
M56555

5. Inspect the polished surface (L) of the camplate for scoring, galling or fretting. Replace if necessary.



M56558

6. Inspect the piston block surface (M) and the camplate (N) for scoring or wear. Replace if necessary.

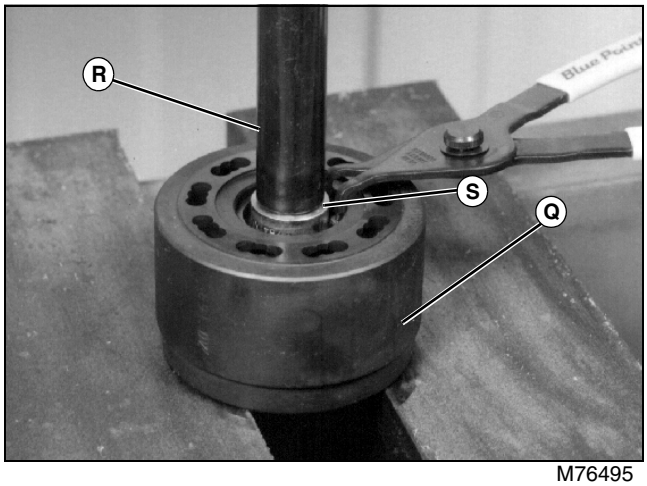


M56554

7. Examine the outside diameter of each piston (O) for finish condition. They should not show wear or deep scratches. Inspect each shoe (P) 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.

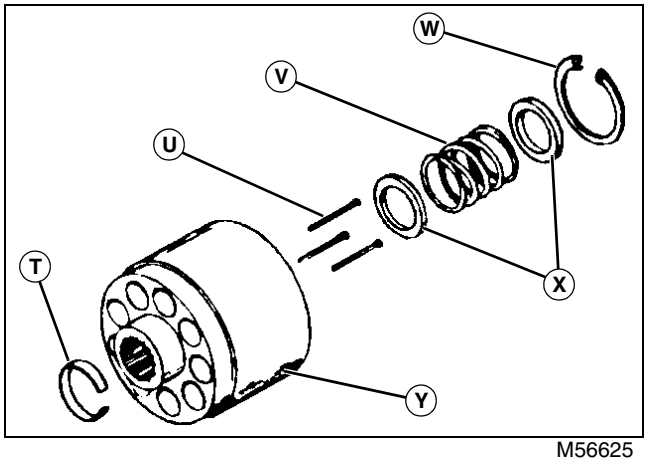


M76495

8. Place piston block (Q) 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 (R) to compress snap ring (S) inside piston block.



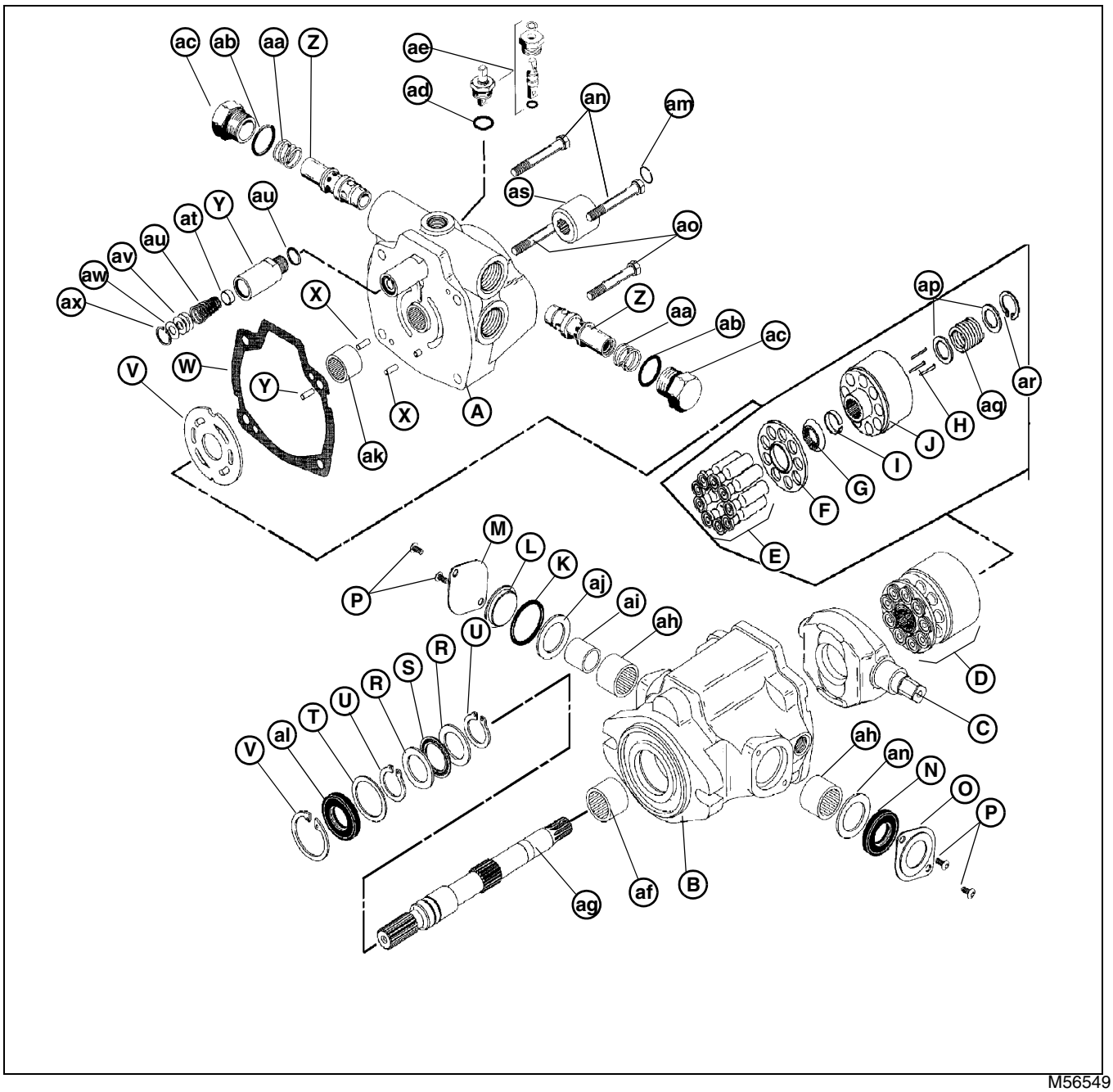
M56625

10.Remove snap ring (W), washers (X), spring (V), pins (U) and pin retainer (T) from piston block (Y).

M56556

11.Inspect the needle bearings and sleeve of the camplate trunnion bearings for wear or galling, keeping the needle bearings in the cage.

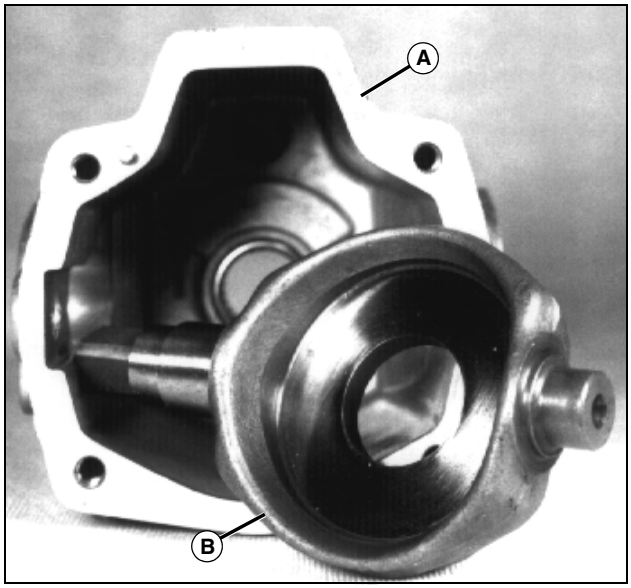
Assemble Hydrostatic Pump



M56549

A - Backplate
B - Body
C - Camplate
D - Rotating Assembly
E - Piston Assembly
F - Spider
G - Spider Pivot
H - Pin
I - Pin Retainer
J - Piston Block
K - O-Ring
L - O-Ring Cover
M - Trunnion Cover
N - Trunnion Seal
O - Seal Cover
P - Cover Screws
Q - Snap Ring
R - Thrust Washer
S - Thrust Bearing
T - Washer

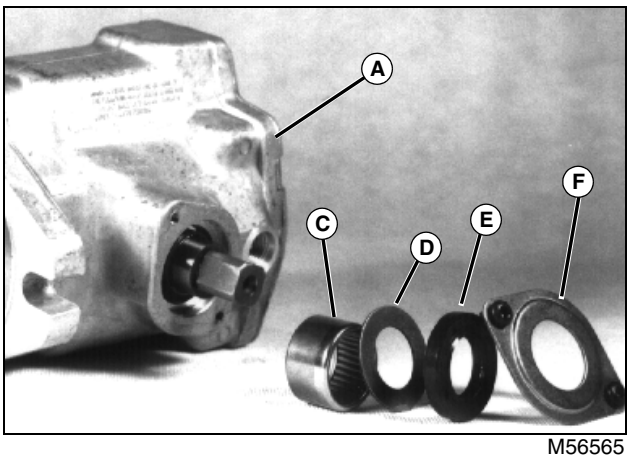
U - Retaining Ring
V - Valve Plate
W - Gasket
X - Pin
Y - Housing
Z - Plug Seat
AA- Spring
AB- O-ring
AC- Plug
AD- O-ring
AE- Tow Valve
AF- Bearing, Body
AG- Shaft, Front Pump
AH- Trunnion Bearing
AI - Bearing Race
AJ- Washer
AK- Bearing, Backplate
AL- Seal, Main Shaft
AM- O-ring
AN- Cap Screws
AO- Cap Screws
AP- Washer
AQ- Spring
AR- C-Clip
AS- Coupler
AT- Poppet
AU- Spring
AV- Shims
AW- Washer
AX- Snap Ring



M56561

1. Place camplate (B) in housing (A), long end first.

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.

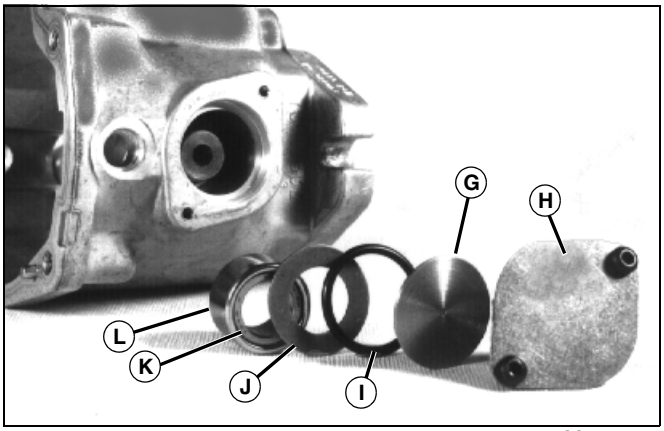


M56565

2. Install bearing (C), washer (D), seal (E) and seal cover (F). Use plenty of hydraulic fluid to lubricate bearings and to aid in seal installation.

3. Use a large socket to drive seal (E) into housing (A).

4. Tighten seal cover screws to specification.

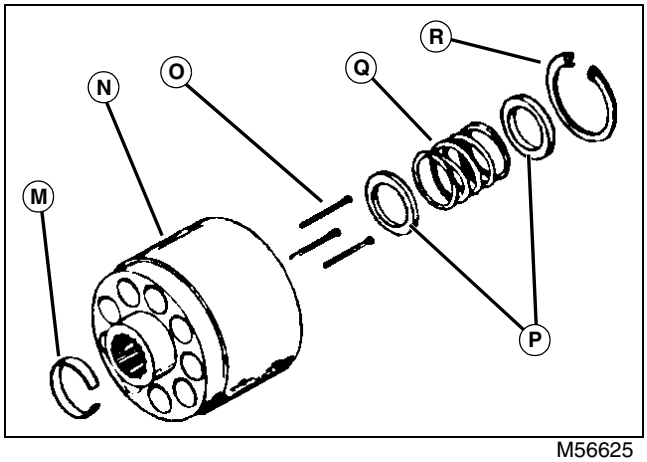


M56562

5. Install bearing race (K) with bevel toward camplate.

6. Assemble bearing (L), washer (J), O-ring (I), plate (G) and trunnion cover (H). Use plenty of hydraulic fluid to lubricate bearings and O-ring. Ensure camplate has full travel and moves freely.

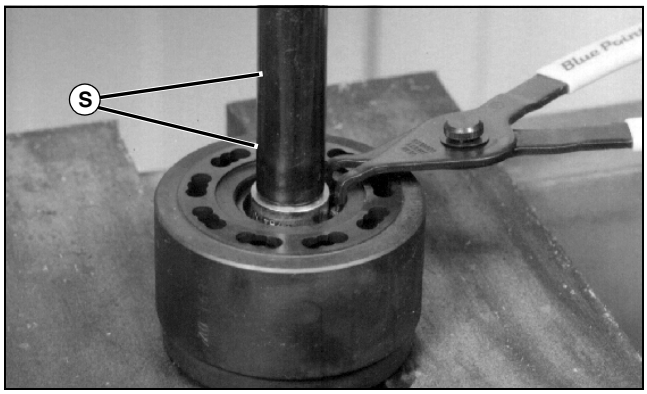
7. Tighten trunnion cover screws to specification.



M56625

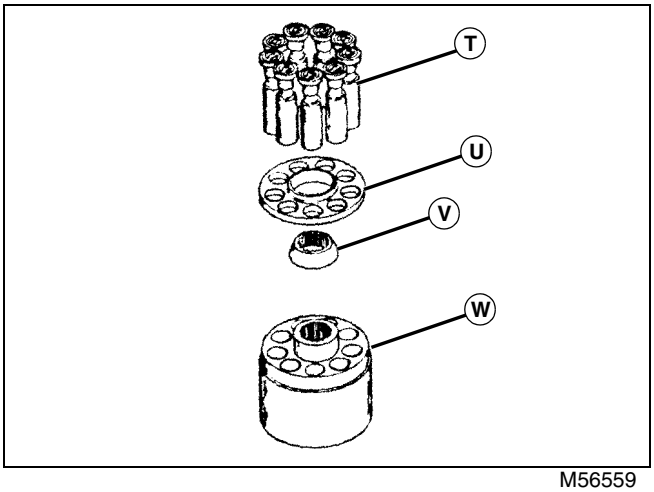
8. If the piston block assembly was disassembled, complete the following.

- Compress the pin retainer (M) and install in the spline of the piston block (N).
- Install the three pins (O) with the head end to the inside of the block and install in the special grooves of the piston block spline.
- Install the washer (P), spring (Q) and second washer (P) in the piston block.



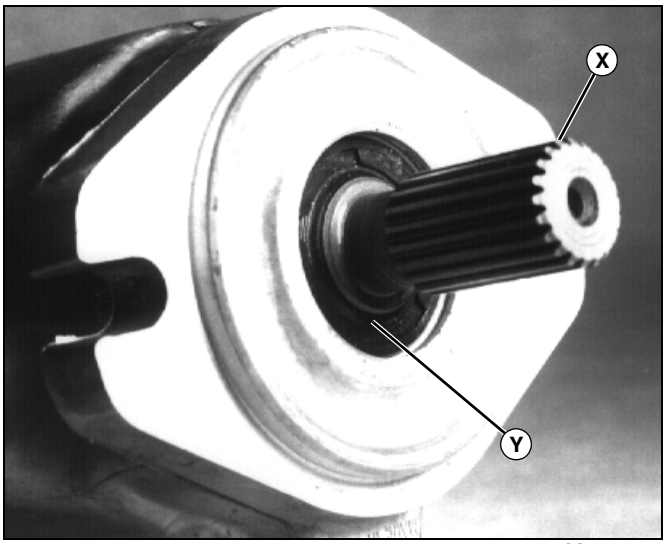
M76495

- Compress the spring with the arbor press and seal driver (S) used to compress the spring during disassembly.
- Install the retaining ring. Ensure the sharp edge of the retaining ring faces away from the spring.
- Assemble the rotating assembly as shown.



M56559

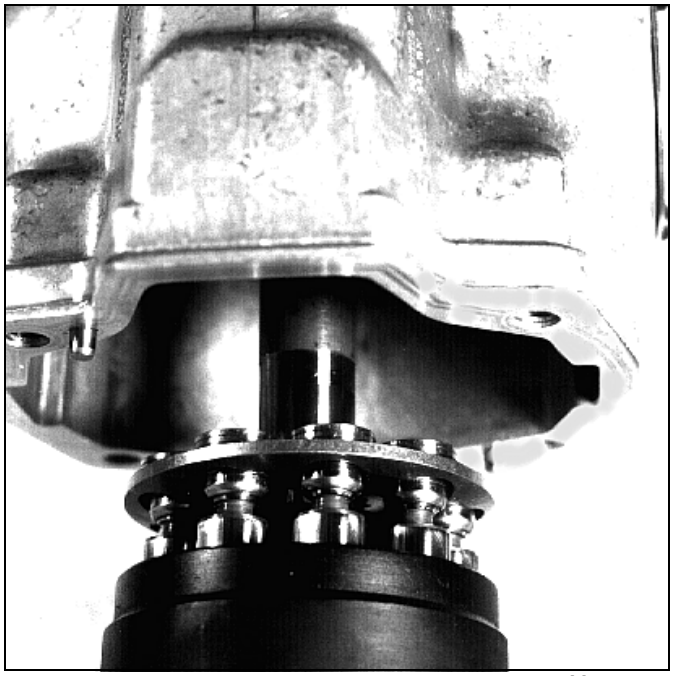
9. Assemble spider pivot (V), spider plate (U) and pistons (T) to piston block (W).



M56560

10.Install shaft (X) and shaft seal (Y). Use hydraulic fluid liberally to avoid damaging the seal during installation. Ensure seal is positioned below the retaining ring groove. Use 1-1/8” deep well socket to drive seal into pump housing.

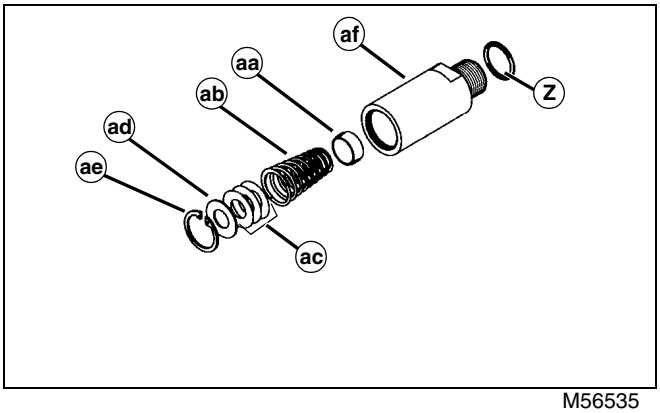
11.Install retaining ring with sharp edge of ring facing the outside of the case. The sharp edge can be felt with your finger.



M56566

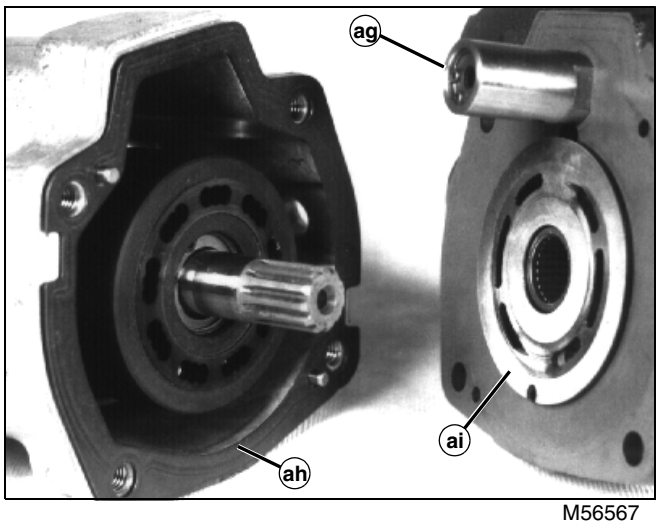
12.Hold the housing upside down and install the rotating assembly. Make sure the rotating assembly shoes are seated against the camplate.

NOTE: Install the same number and thickness of shims as removed.



M56535

13.Assemble O-ring (Z), plunger (aa), spring (ab), shim(s) (ac), washer (ad) and retaining ring (ae) into relief valve body (af).

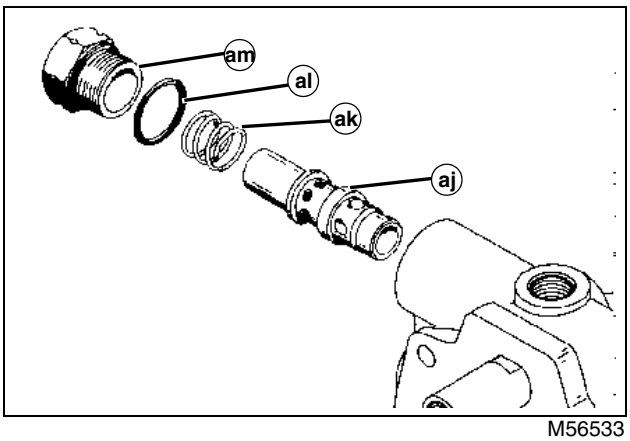


M56567

14.Install charge relief valve (ag), gasket (ah) and valve plate (ai). Be sure valve plate bronze side faces piston block. Tighten relief valve to specification.

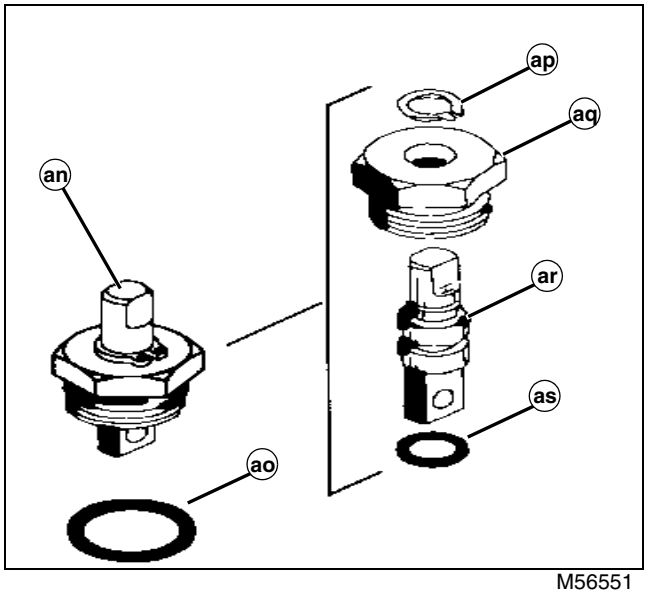
IMPORTANT: Avoid damage! DO NOT use the bolts to force the parts to mate when assembling backplate to housing.

15.Assemble the backplate and housing. Install four cap screws and tighten to specifications.



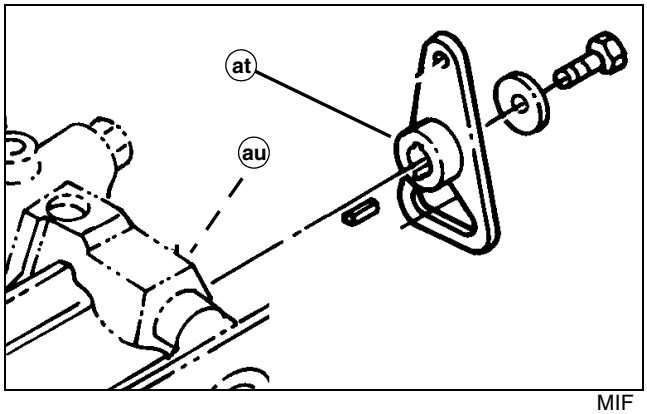
M56533

16.Install each plug seat (aj), spring (ak), O-ring (al) and plug (am) into backplate. Tighten plug to specifications.



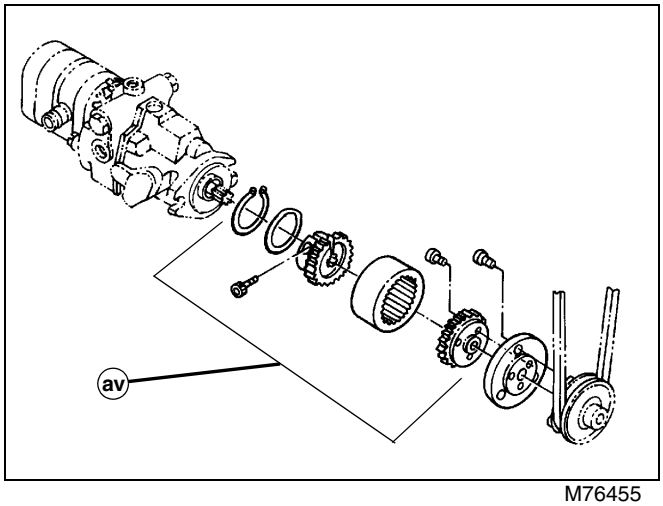
M56551

17.Assemble and install tow valve parts (an-as) and tighten to specifications.



MIF

18.Install camplate (at) on end of pintle shaft (au). Torque cap screw to specification.

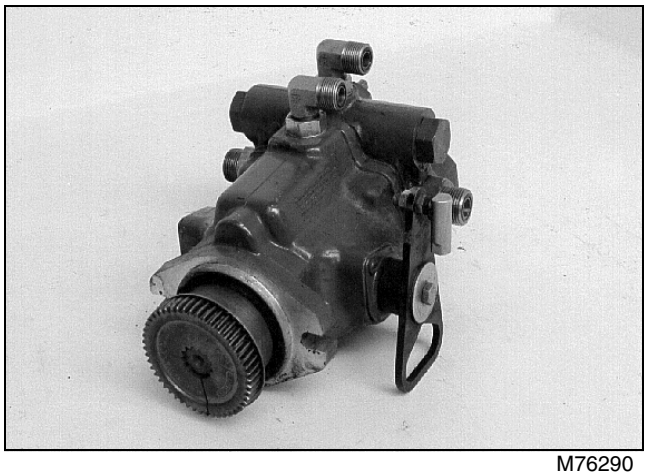


M76455

19.Inspect nylon coupler (av) for wear or damage to internal teeth. Replace if damaged.

NOTE: Do not tighten socket head cap screw at this time.

20.Install coupler on to end of hydrostatic input shaft, ensuring that washer is held in place by large C-clip.



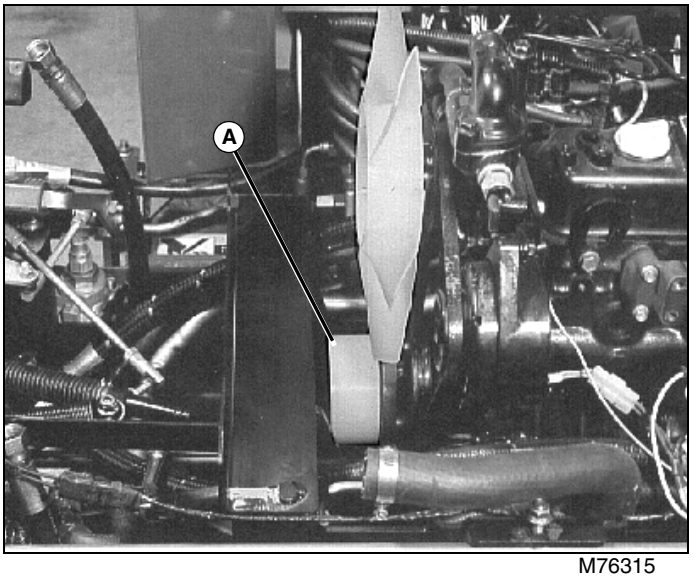
M76290

21.Install fittings in hydrostatic pump if previously removed.

Specification

Camplate Cap Screw . . . . . 50 N•m (35 lb-ft)
Seal Cover Screw Torque . . . . . 4-5 N•m (35-48 lb-in.)
Plug Seat Torque . . . . . 135 N•m (100 lb-ft)
Backplate-to-Housing Cap Screw Torque . . . . . 23-27 N•m (17-20 lb-ft)
Charge Relief Valve Torque . . . . . 37-40 N•m (27-30 lb-ft)
Trunnion Cover Screw Torque . . 4-5 N•m (35-48 lb-in.)

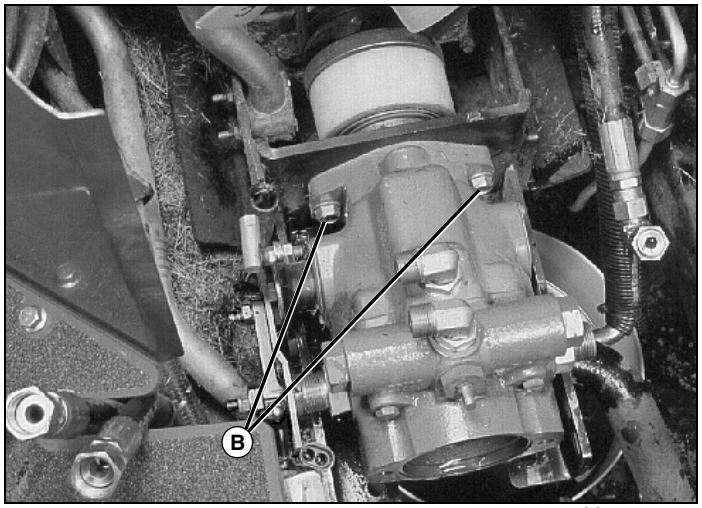
Install Hydrostatic Pump



M76315

1. Place nylon connector (A) on coupler on engine. Ensure that socket head cap screw on pump half of connector is loose and connector is free to move on pump shaft.

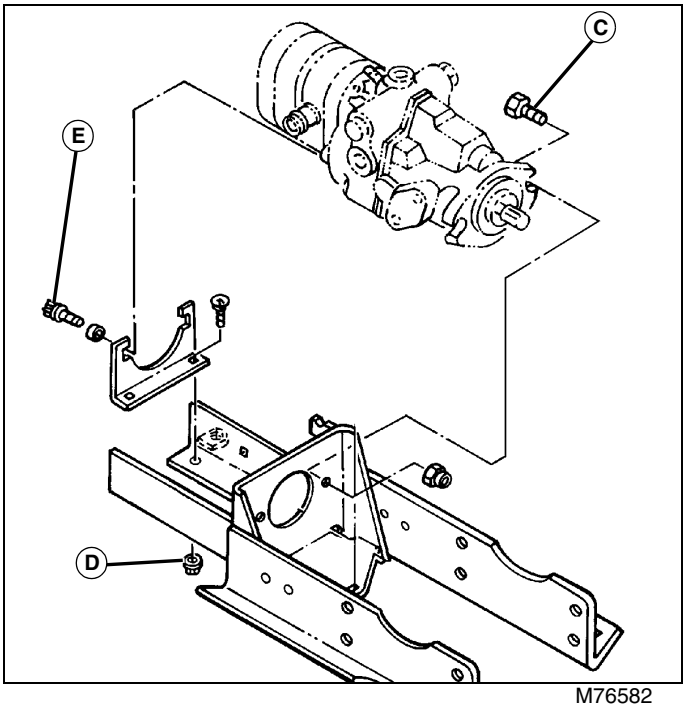
IMPORTANT: Avoid damage! DO NOT torque any pump mounting hardware until all components - hydrostatic pump, double pump, and support bracket - are in place. Torque fasteners only in order specified in the following instructions.



M76316

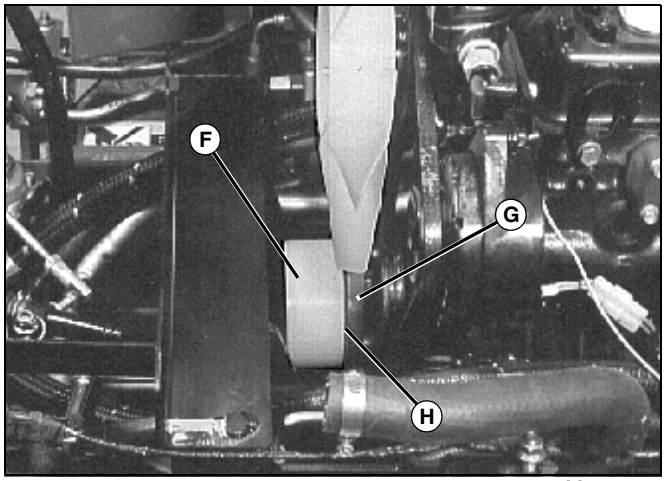
2. Slide the hydrostatic pump into position to connect the drive shaft coupler. Secure hydrostatic pump to vehicle frame with M10 x 35 flange head cap screws (B) and flange locknuts. Finger tighten only at this time.

3. Install double pump and support.



M76582

4. After all components are in place, tighten to specifications in the following order: hydrostatic pump-to-subframe bolts (C), support bracket-to-frame nuts (D), double pump mounting bolts (E).

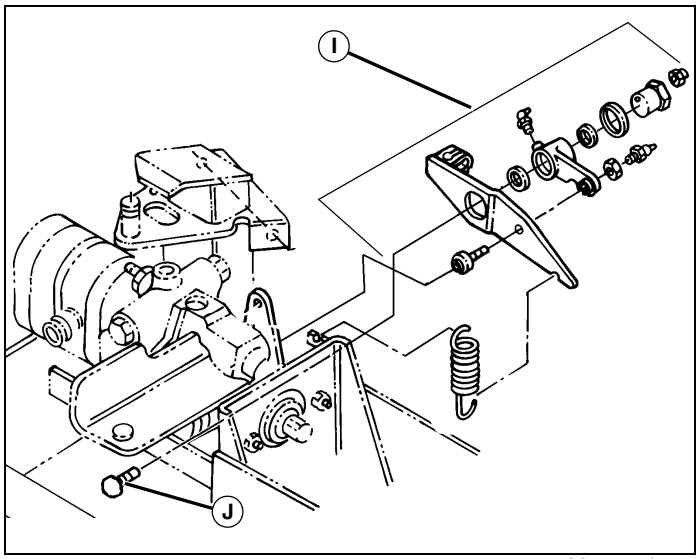


M76315

5. Adjust nylon connector (F) by shifting pump coupler section (G) until there is 1.5 mm (0.062 in.) gap (H) between coupler and nylon connector.

NOTE: Nylon connector must be free to move on coupler. If nylon connector binds and cannot be shifted by hand, realign pumps and/or engine.

6. Tighten socket head cap screw on pump half of connector to specification.

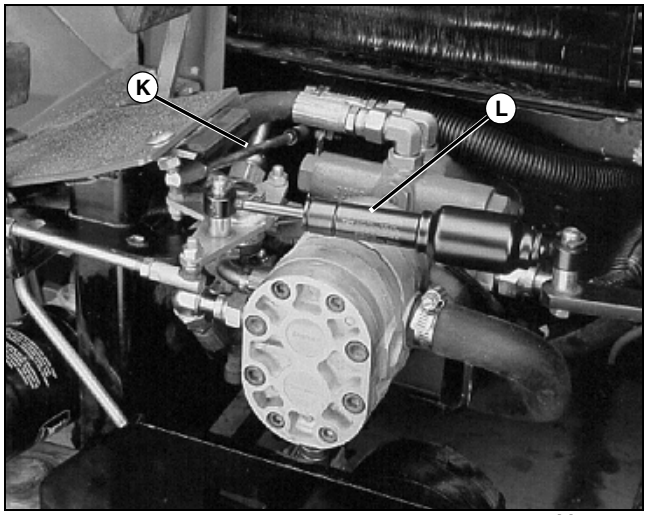


M76375A

7. Assemble eccentric mechanism (I) and install with carriage bolt (J) to subframe.

8. Connect linkage at the hydrostatic transmission.

9. Install cam lever linkage.



M76276

Picture Note: S.N. -130000 shown (dampers may vary in appearance on your machine)

10.Install linkage (K), damper (L) and all hydraulic lines to the double pump assembly.

11.Install radiator. Fill with coolant.

12.Install drain plug in hydraulic reservoir and fill to specification with hydraulic fluid

CAUTION: Avoid injury! Because transmission mechanism has been disturbed, vehicle may move when engine is started if wheels are on ground. Neutral adjustment must be performed before unit is lowered to ground.

13.Connect battery.

NOTE: Perform start-up procedure before returning machine to service. (See "Start-Up Procedure" on page 312)

14.Perform transmission neutral adjustment. (See "Adjust Transmission Neutral Creep" on page 292.)

Specifications

Hydrostatic Pump-to-Subframe . . . . . 55 N•m (40 lb-ft)
Support Bracket-to-Frame . . . . . 55 N•m (40 lb-ft)
Double Pump Mounting Bolts . . . . . 50 N•m (35 lb-ft)
Pump Half Socket Head Cap Screw . . . 61 N•m (45 lb-ft)
Pump Coupler Gap . . . . . 1.5 mm (0.062 in.)

TORQMOTOR™ Removal

1. Park vehicle on a level surface.

2. Operate lift control and allow cutting units to settle on ground.

3. Disconnect battery.

4. Place a 40 quart (10-gallon) container below the hydraulic sump and drain oil.

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

- **Raise machine safely and support it with suitable jackstands.**

5. Lift and support machine with jackstands.

6. Remove wheel.

7. Disconnect and remove brake caliper.

8. Remove brake disk.

CAUTION: Avoid injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

9. Disconnect hydraulic lines to motor.

10.Remove four cap screws securing motor to frame.

11.Remove motor.

Disassemble TORQMOTOR™

Special or Required Tools

Tool Name	Tool No.	Tool Use
Feeler Gage	N/A	Measure gap.
Torque Wrench	N/A	Tighten cap screws
Etching Ink	N/A	Mark mating surface.
Clean Hydraulic Fluid	N/A	Replacement fluid.

CAUTION: Avoid injury! If the TORQMOTOR is not held firmly in a vise, it could be easily dislodged during the service procedure, fall, and cause severe personal injury.

- **Do not weld, braze, solder or otherwise alter any TORQMOTOR component.**
- **Replace any component that is damaged or questionable.**
- **Do not force any coupling onto the TORQMOTOR coupling shaft, as this could damage the motor internally.**
- **Do not cold straighten, hot straighten or bend any TORQMOTOR component.**

IMPORTANT: Avoid damage! Marking all rotor components and mating spline components for exact repositioning at assembly will ensure maximum wear life and performance of rotor set and TORQMOTOR.

1. Place the TORQMOTOR in a soft-jawed vise, with the coupling shaft pointed down and the vise jaws clamping firmly on the sides of the housing, mounting flange or port bosses.

2. Scribe an alignment mark down and across the TORQMOTOR components from end cover to housing to facilitate reassembly orientation where required.

3. Remove the seven end cover bolts, and remove the components one by one. Make notes, of the orientation each piece as they are removed.

Follow These Notes

- The manifold is constructed of plates bonded together to form an integral component not subject to further disassembly for service. Compare configuration of both sides of the manifold to ensure that the same surface is reassembled against the rotor set.
- The rotor set components may become disassembled during service procedures. Marking the surface of the rotor and stator that is facing “UP” with etching ink or grease pencil before removal from TORQMOTOR will ensure correct reassembly of rotor into stator and rotor set into TORQMOTOR.
- Remove seal and backup washers from housing by working them around unseated thrust washers and thrust bearing.
- Do Not remove the main shaft bearings. Removing these bearings will destroy them and replacement bearings are not available.

Inspect TORQMOTOR™ Component

1. A polished pattern (not scratches) on the cover from rotation of the commutator is normal. Discoloration would indicate excess fluid temperature, thermal shock, or excess speed. This would require system investigation for cause and close inspection of end cover, commutator, manifold, and rotor set.

2. Inspect commutator for cracks or burrs, wear, scoring, spalling or brinelling. If any of these conditions exist, replace TORQMOTOR.

3. Inspect manifold for cracks, surface scoring, brinelling or spalling. Replace TORQMOTOR.

4. Inspect the rotor set in its assembled form for nicks, scoring, or spalling on any surface and for broken or worn splines. If the rotor set component requires replacement, the complete TORQMOTOR must be replaced.

5. Place rotor set and wear plate on a flat surface.Center rotor in stator to position the two rotor lobes 180° apart and the roller vane centerline on the same stator centerline. Check the rotor lobe-to-rotor vane clearance with a feeler gage at this common centerline. If there is more than clearance than specification, replace TORQMOTOR.

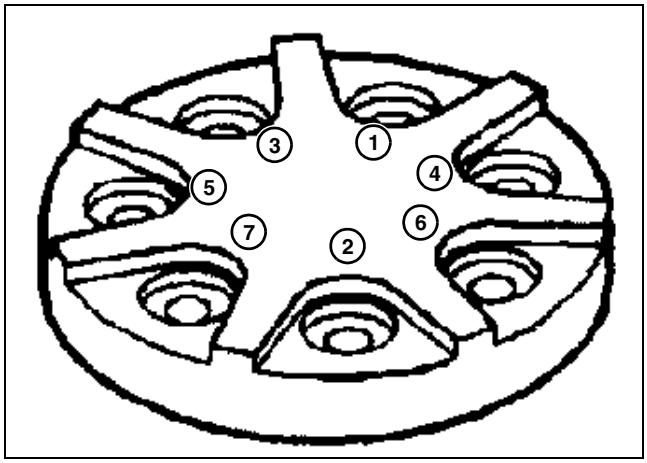
6. Inspect the wear plate for cracks, brinelling, or scoring.

7. Inspect drive link for cracks and worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts.

8. Inspect thrust bearing for wear, brinelling, corrosion and a full compliment of retained rollers.

9. Inspect coupling shaft, seal surfaces and bearing for spalling, nicks, grooves, severe wear or corrosion and discoloration. Inspect for damaged or worn internal and external splines or keyway. Minor shaft wear in seal area is permissible. If wear exceeds specification replace TORQMOTOR.

A slight “polish” is permissible in the shaft bearing areas. Anything more would require TORQMOTOR replacement.



M56513

13.Install a new seal ring onto the end cover and install end cover. Torque cap screws in sequence shown in two steps to final torque specification.

Specification

End Cover Cap Screw Torque . . 61-75 N•m (45-55 lb-ft)

TORQMOTOR™ Final Checks

1. Pressurize the TORQMOTOR with 100 PSI dry air or nitrogen and submerge in solvent to check for external leaks.

2. Check TORQMOTOR for rolling drag. Torque required to rotate the coupling shaft should not be more than specification.

NOTE: Pressure port with "B" cast under it on housing is for clockwise rotation and port "A" is for counterclockwise rotation.

3. Use test stand if available, to check for proper operation of the TORQMOTOR.

NOTE: Perform start-up procedure before returning machine to service. (See "Start-Up Procedure" on page 312)

Specification

Rolling Drag Torque . . . . . 68 N•m (50 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.

Table of Contents

Specifications

General Specifications

Charge Pump

Make	Danfoss
Model / Series	YC
Type	Gear, positive displacement
Displacement	5.73 cc/rev (0.35 cu-in./rev)
Flow @ 3400 RPM	19.5 L/min (5.15 gpm)
Relief Valve Setting in Steering Valve	6200 kPa (900 psi)
Relief Valve Setting in Hydrostatic Pump	600 kPa (90 psi)

Reel Pump

Make	Danfoss
Model / Series	(YC
Type	Gear, Positive Displacement
Displacement	8.19cc/rev L/min (0.50 cu-in./rev)
Minimum Flow @ 3400 RPM	27.86 L/min (7.36 gpm
Case Drain Flow	Not to exceed 6.3 ml/sec (1 gpm)

Reel Motor

Make	Danfoss
Type	Gear, with case drain flow

Front Inboard and Rear Lift Cylinders

Stroke	101.6 mm (4 in.)
Compressed Length	203.2 mm (8 in.)

Hydraulic Filter

Type	Spin on
Clogged Filter Bypasses Fluid to Tank At	340 kPa (50 psi)

Repair Specifications

Double Pump

Reel Pump End Plate Hex Head Bolts (3/8 in.)	40.7 - 43 N•m (360 - 380 lb-in.)
End Pump to Center Pump Housing Hex Head Bolts (5/16 in.	21.5 - 23.7 N•m (190 - 210 lb-in.)
Reel Pump End Plate Hex Head Bolts (3/8 in.)	40.7 - 43 N•m (360 - 380 lb-in.)
Charge Pump to Reel Pump Assembly Hex Head Bolts (5/16 in.)	21.5 - 23.7 N•m (190 - 210 lb-in.)
Hydrostatic Pump to Support Flange TORX Head Bolts	50 N•m (35 lb-ft)
Support Bracket to Frame Carriage Bolt Nuts	55 N•m (40 lb-ft)

Heavy Duty (YC Series) Reel Motor

Cover to Housing Hex Head Bolt (5/16 in.)	21.5 - 23.7 N•m (190 - 210 lb-in.)

Mow Valve with Backlapping Capability

Solenoid Coil	**31 N•m (22 lb-ft)**
Solenoid Plunger	**95 N•m (70 lb-ft)**
Flow Control Valve	**65 N•m (47 lb-ft)**
Pressure Relief Valve	**65 N•m (47 lb-ft)**
Forward/Reverse Valve	**237 N•m (175 lb-ft)**
Forward/Reverse Switch	**17 N•m (12 lb-ft)**

Tools and Materials

Tools

Special or Required Tools

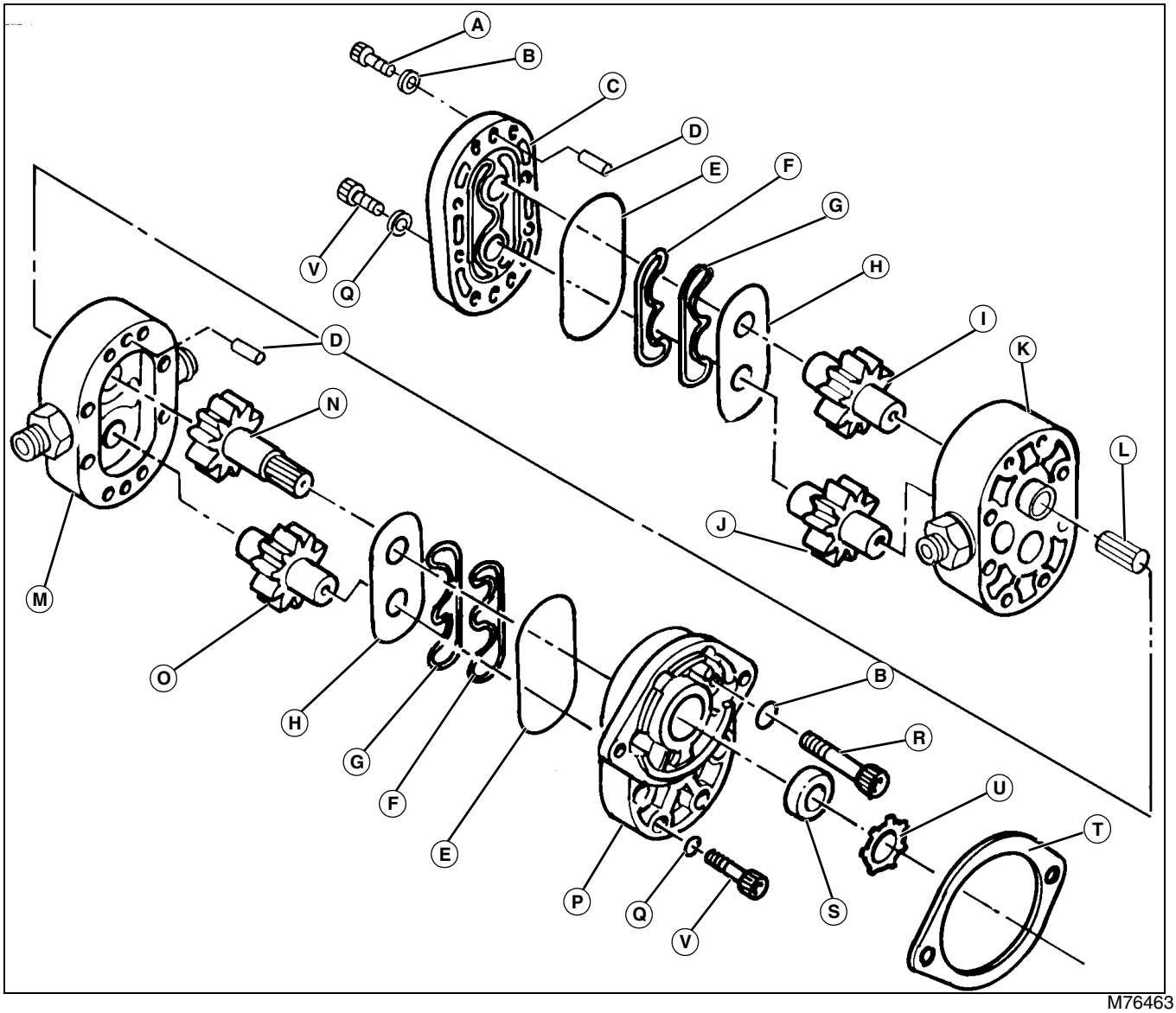
Tool Name	Tool No.	Tool Use
Swivel T-Fitting	38H1030	Used to test reel motors pressure relief. Used to test lift system relief valve pressure. Part of BM18319 Diagnostic Kit.
Hose	AMT846	Used to test reel motors pressure relief. Used to test lift system relief valve pressure. Part of BM18319 Diagnostic Kit.
In-Line Hydraulic Tester	D01074AA	Used to test reel pump flow. Used to measure reel motor case drain.
Connector 3/4 in. F NPT x 1-1/16 in. F 37° (2)	JT03012	Used to test reel pump flow. Used to measure reel motor case drain.
Hose 34 474 kPa (5000 psi)	JT03017	Used to test lift system relief valve pressure.
Gage 20 684 kPa (3000 psi)	JT03345	Used to test lift system relief valve pressure.
Gage 70 000 kPa (10,000 psi)	JT03362	Used to read front reel motor pressure.
120 in. Hydraulic Test Hoses (2)	JT03377	Used to test reel pump flow. Used to measure reel motor case drain.
Connector 1-1/16 in. M 37° x 1-3/16 in. M ORFS	JT03483	Used to test reel pump flow. Used to measure reel motor case drain.
Connector 1-3/16 in. F ORFS x 13/16 in. M ORFS	JT03484	Used to test reel pump flow. Used to measure reel motor case drain.
Connector 1/4 in. M NPT x 7/16 in. M 37°	JT05486	Used to test reel motor relief pressure. Used to test lift system relief valve pressure.
Connector 1-1/16 in. M 37° x 13/16 in. F ORFS	JT05688	Used to test reel pump flow. Used to measure reel motor case drain.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Quick Disconnect Fitting	MT1531	Used to test reel motors pressure relief. Part of BM18319 Diagnostic Kit. Used to test lift system relief valve pressure.
Female Quick Coupler	RE48122	Used to test reel motors relief pressure. Used to test lift system relief valve pressure. Part of BM18319 Diagnostic Kit.
1/2 in. ID Hose 24 in. long (2)	NA	Used to measure reel motor case drain.
Lift Arm Bushing Installer	JDG892	Used to install lift arm bushing.
Plug, 13/16 in. M ORFS	JT03392	Used to plug port on reel motor.

Component Location

Pumps



M76463

- A - Socket Head Cap Screw 5/16 in. x 1-1/4 in.
- B - Washer, Plain, 5/16 in.
- C - End Cap
- D - Dowel
- E - O-Ring, Formed
- F - Gasket, Formed
- G - Gasket, Formed
- H - Wear Plate
- I - Drive Gear
- J - Driven Gear
- K - Body
- L - Shaft, Splined Coupler
- M - Body
- N - Input Gear
- O - Driven Gear
- P - Front Cap
- Q - Washer, Plain 3/8 in.
- R - Socket Head Cap Screw 5/16 in. x 2-3/4 in.
- S - Bearing
- T - Gasket
- U - Keeper
- V - Socket Head Cap Screw 3/8 in. x 1-1/2 in.

10.Inspect housing for cracks, the machined surfaces for nicks, burrs, brinelling or corrosion. Remove burrs that can be removed without changing the dimensional characteristics. Inspect tapped holes for thread damage. If the housing is defective in these areas, replace TORQMOTOR.

Specifications

Rotor Lobe-to-Rotor Vane Clearance . .0.13 mm (0.005 in.)

Shaft Wear Limit . . . . . 0.51 mm (0.020 in.)

Assemble TORQMOTOR™

CAUTION: Avoid injury! Always wear safety glasses when using a press or compressed air to prevent serious personal injury.

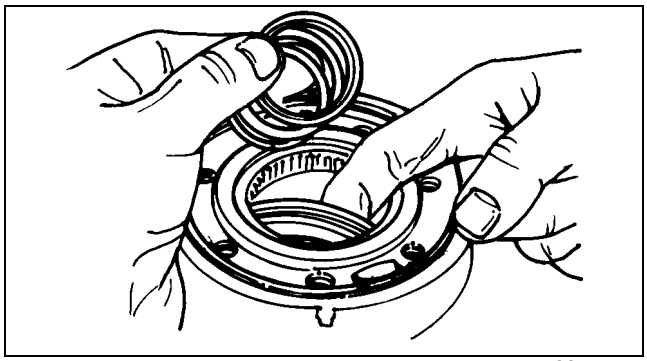
IMPORTANT: Avoid damage! Always use new seals and seal rings when reassembling the TORQMOTOR.

- **Unless otherwise indicated, do not oil or grease parts before assembly.**
- **Wash all components in clean petroleum-based solvents before assembly. Blow them dry with compressed air.**
- **Remove any paint chips from mating surfaces of the end cover, commutator set, manifold rotor set, wear plate and housing and from port and sealing surfaces.**

1. Thoroughly coat the outer bearings with clean corrosion-resistant grease.

2. Install chamfered washer, flat washer and lip seal (lip facing out) past the unseated washers and thrust bearing.

NOTE: Apply masking tape to the threaded portion of the shaft to prevent damage to seal.



M72906

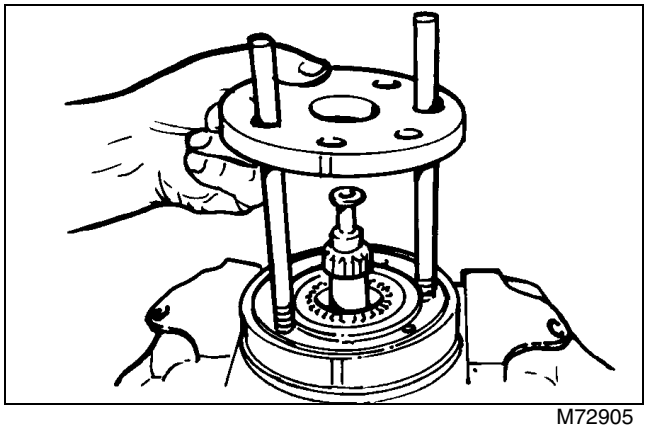
3. Install the coupling shaft into the housing, seating it against the thrust bearing. The coupling shaft must rotate freely against the thrust bearing when installed.

4. Install thrust bearing onto the end of coupling shaft.

5. Apply a small amount of clean grease to a new seal ring and insert it into the housing seal ring groove.

NOTE: One or two alignment studs screwed finger tight into the housing bolt holes 180° apart, will facilitate the assembly and alignment of components as required in the following procedures. The studs can be made by cutting off the heads of 3/8-24 UNF 2A bolts that are at least 0.500 in. longer than the bolts used on the TORQMOTOR.

6. Install drive link (long splined end down and previously marked when disassembled) to engage the coupling shaft splines



M72905

7. Install wear plate.

8. Apply a small amount of clean grease to the seal ring and install seal ring.

9. Install the assembled rotor set onto wear plate with rotor counter-bore and seal ring down.

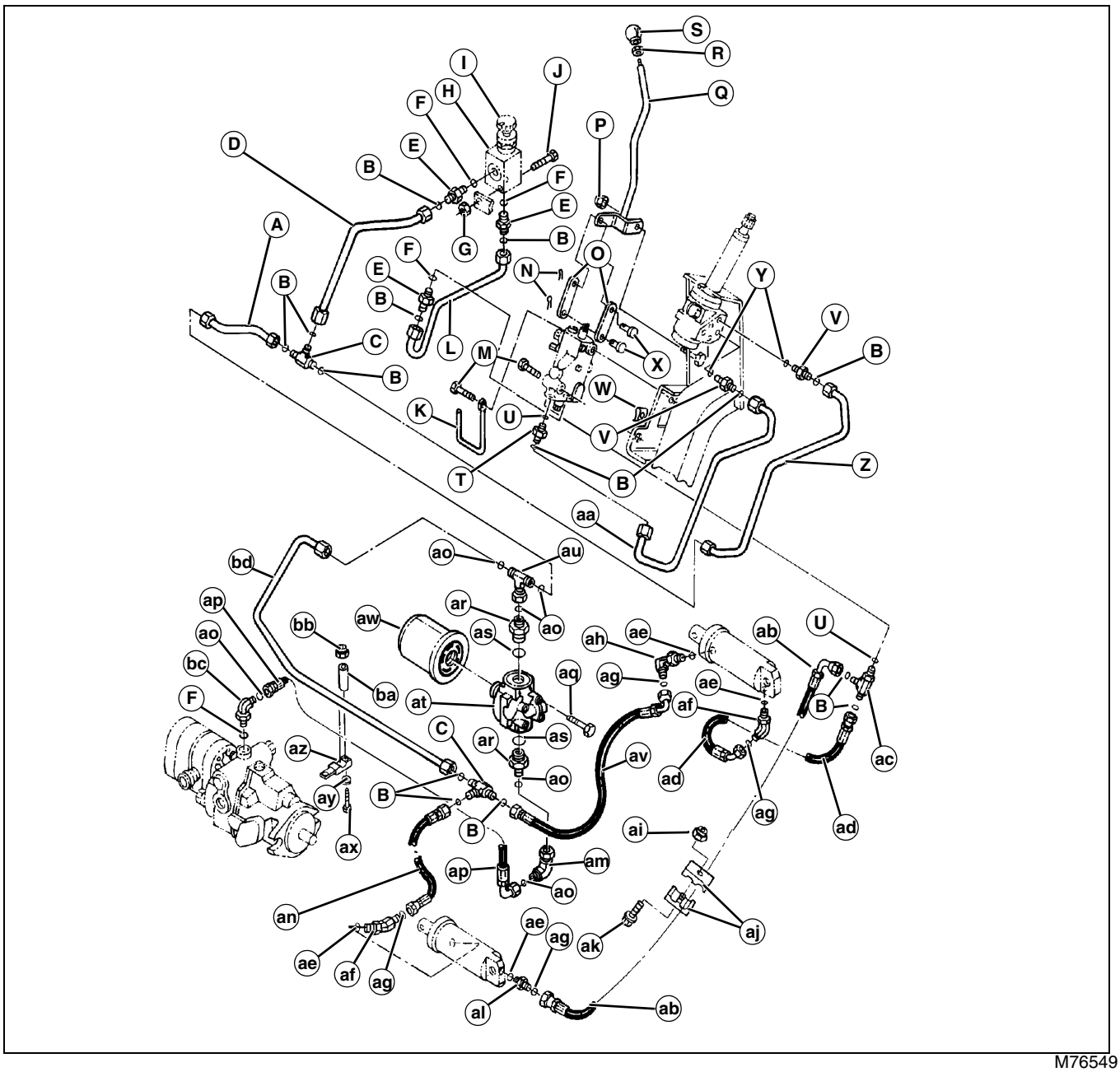
NOTE: The manifold surface that must contact the rotor set has a set of irregular shaped cavities on the largest circumference or circle around the inside diameter. This surface may appear polished from contact with the rotor set.

10.Apply clean grease to a new seal and install it into the manifold. Place the manifold onto the assembly rotor set, contact side down.

11.Install a new seal and the commutator ring.

12.Install a new seal ring (flat side up) on the commutator and install on the assembly (seal side up).

Lift System Hydraulic (S.N. -060844)



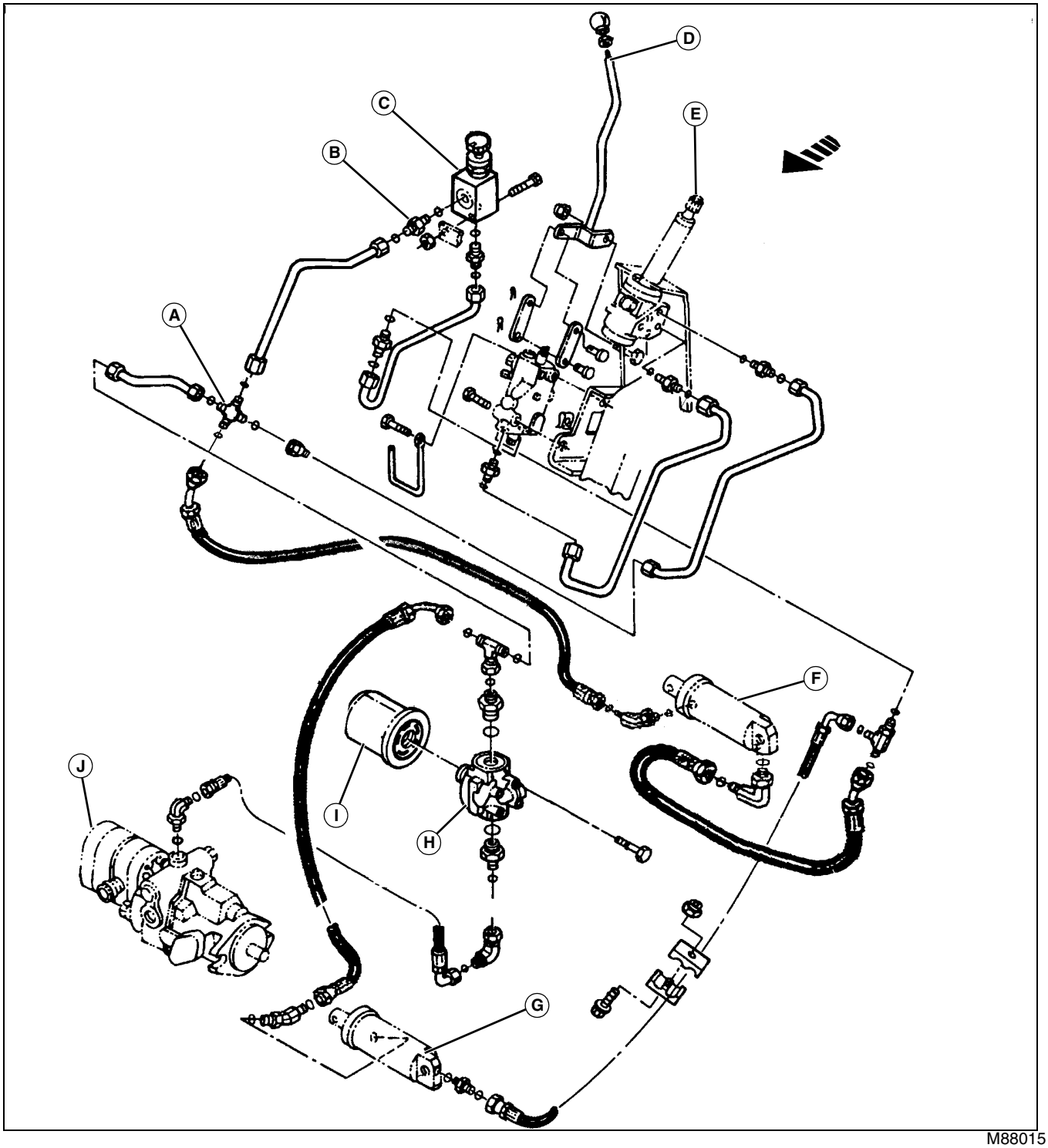
M76549

- A - Tube
- B - O-Ring
- C - T-Fitting
- D - Tube
- E - Fitting
- F - O-Ring
- G - Nut
- H - Body, Down Pressure
- I - Weight Transfer Valve
- J - Cap Screw
- K - Bracket, Hose
- L - Tube
- M - Cap Screw
- N - Hairpin Clip
- O - Link
- P - Lock Nut
- Q - Lever
- R - Lock Nut
- S - Knob
- T - Fitting
- U - O-Ring
- V - Fitting

W - Sheet Metal Nut
X - Pin
Y - O-Ring
Z - Tube
AA- Tube
AB- Hose, Front Lift, Up
AC- T-Fitting
AD- Hose, Rear Lift, Up
AE- O-Ring
AF- 45° Fitting
AG- O-Ring
AH- Elbow
AI - Nut
AJ- Hose Clamp
AK- Cap Screw
AL- Fitting
AM- Elbow
AN- Hose, Front Lift, Down
AO- O-Ring
AP- Hose, Charge
AQ- Cap Screw
AR- Fitting
AS- O-Ring
AT- Adapter
AU- T-Fitting
AV- Hose, Rear Lift, Down
AW- Filter
AX- Cap Screw
AY- Washer
AZ- Tube Clamp
BA- Spacer
BB- Nut
BC- Elbow
BD- Tube

Lift System Hydraulic (S.N. 060845-)

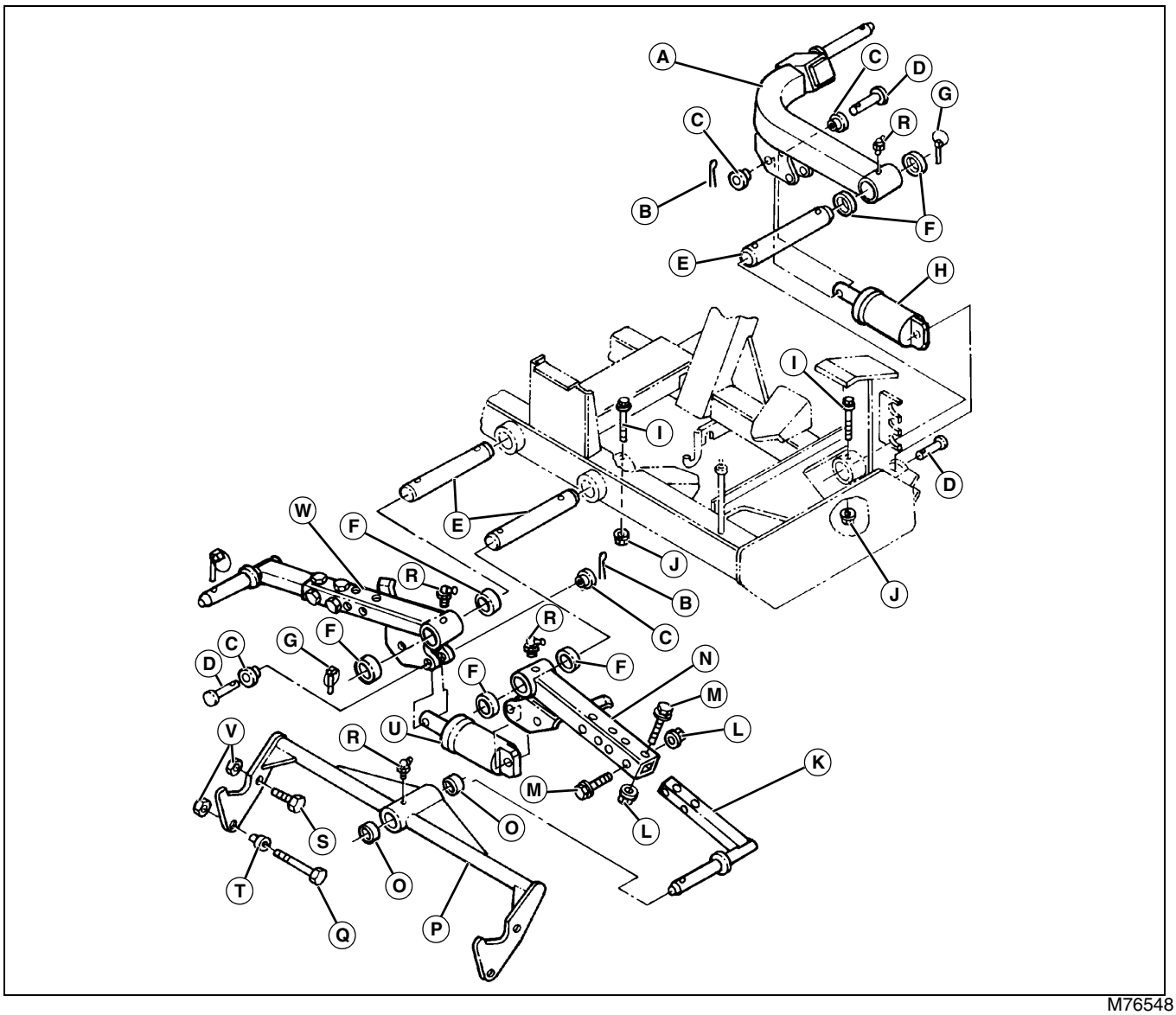
(And those units modified with AMT1899 Ground Following Kit)



M88015

A - Cross Fitting
B - Flow Restrictor
C - Weight Transfer Valve
D - Lift Lever
E - Steering Valve
F - Rear Lift Cylinder
G - Front Lift Cylinder
H - Filter Mount
I - Hydraulic Oil Filter
J - Pump Assembly

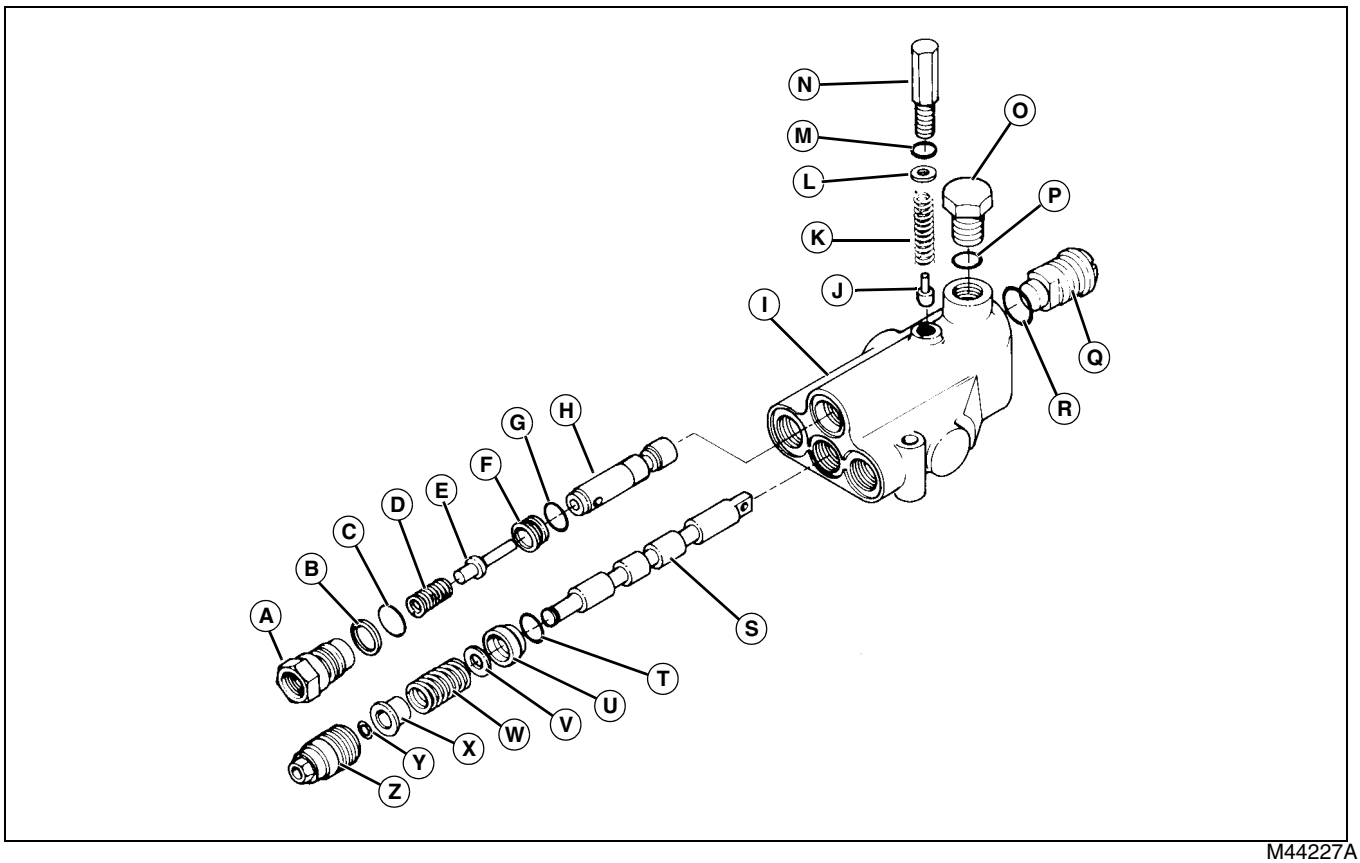
Lift Arms and Cylinders



M76548

A - Rear Lift Arm
B - Cotter Pin
C - Bushing, Flange
D - Pin
E - Pin
F - Bushing, Lift Arm
G - Lynch Pin
H - Cylinder, Rear Lift
I - Cap Screw
J - Nut
K - Lift Arm Extension
L - Nut, Flanged
M - Cap Screw
N - Left Lift Arm
O - Bushing, Yoke
P - Yoke
Q - Cap Screw
R - Grease Fitting
S - Cap Screw
T - Bushing
U - Cylinder, Front Lift
V - Nut
W - Right Lift Arm

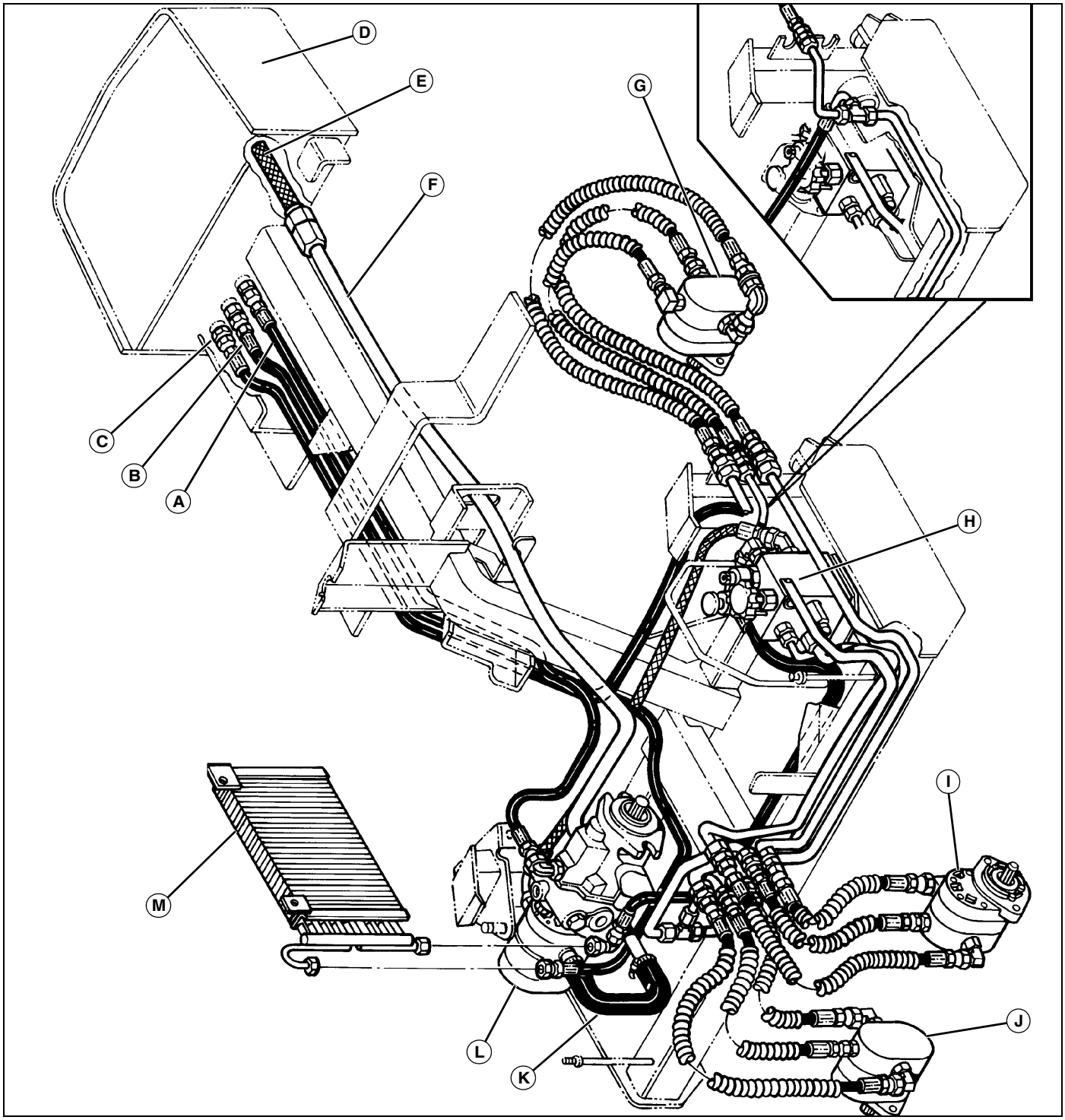
Lift Valve



M44227A

A - Fitting
B - Backup Washer
C - O-Ring
D - Spring
E - Actuator
F - Orifice
G - O-Ring
H - Detent Spool
I - Valve Body
J - Detent Plunger
K - Spring
L - Gasket
M - O-Ring
N - Spring Housing
O - Plug
P - O-Ring
Q - Screw Cap
R - O-Ring
S - Control Spool
T - O-Ring
U - Cup
V - Washer
W - Spring
X - Keeper
Y - Circlip
Z - Cap

Component Location

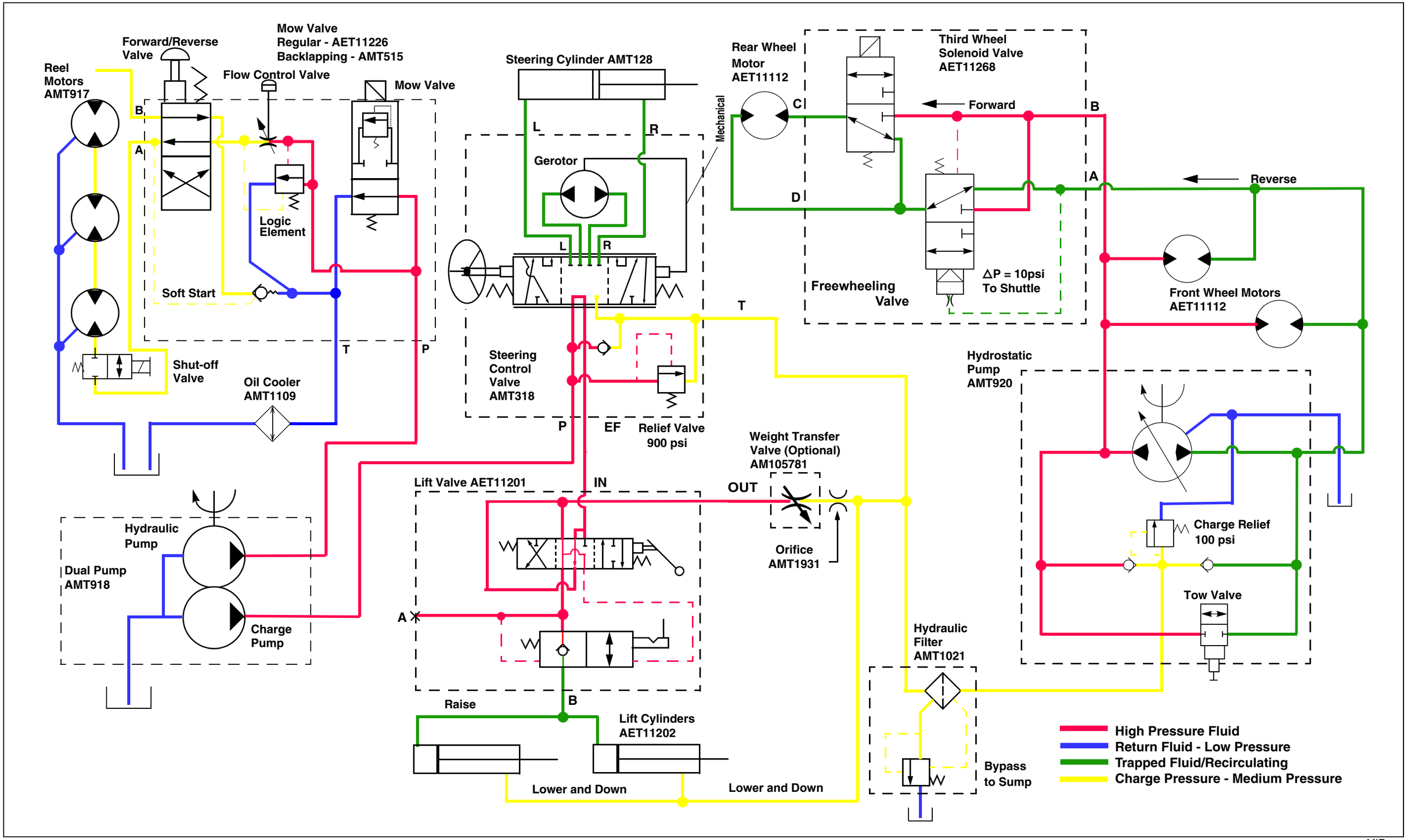


M76427

A - Return Line - Hydrostatic Pump
B - Return Line - Hydraulic Radiator
C - Return Line - Reel Motors Case Drain
D - Hydraulic Fluid Reservoir
E - Hydraulic Fluid Intake Filter
F - Hydraulic Fluid Supply Line
G - Rear/Center Reel Motor
H - Backlap Valve Assembly
I - Left Reel Motor
J - Right Reel Motor
K - Suction Line From Reservoir
L - Hydraulic Pump
M - Hydraulic Radiator

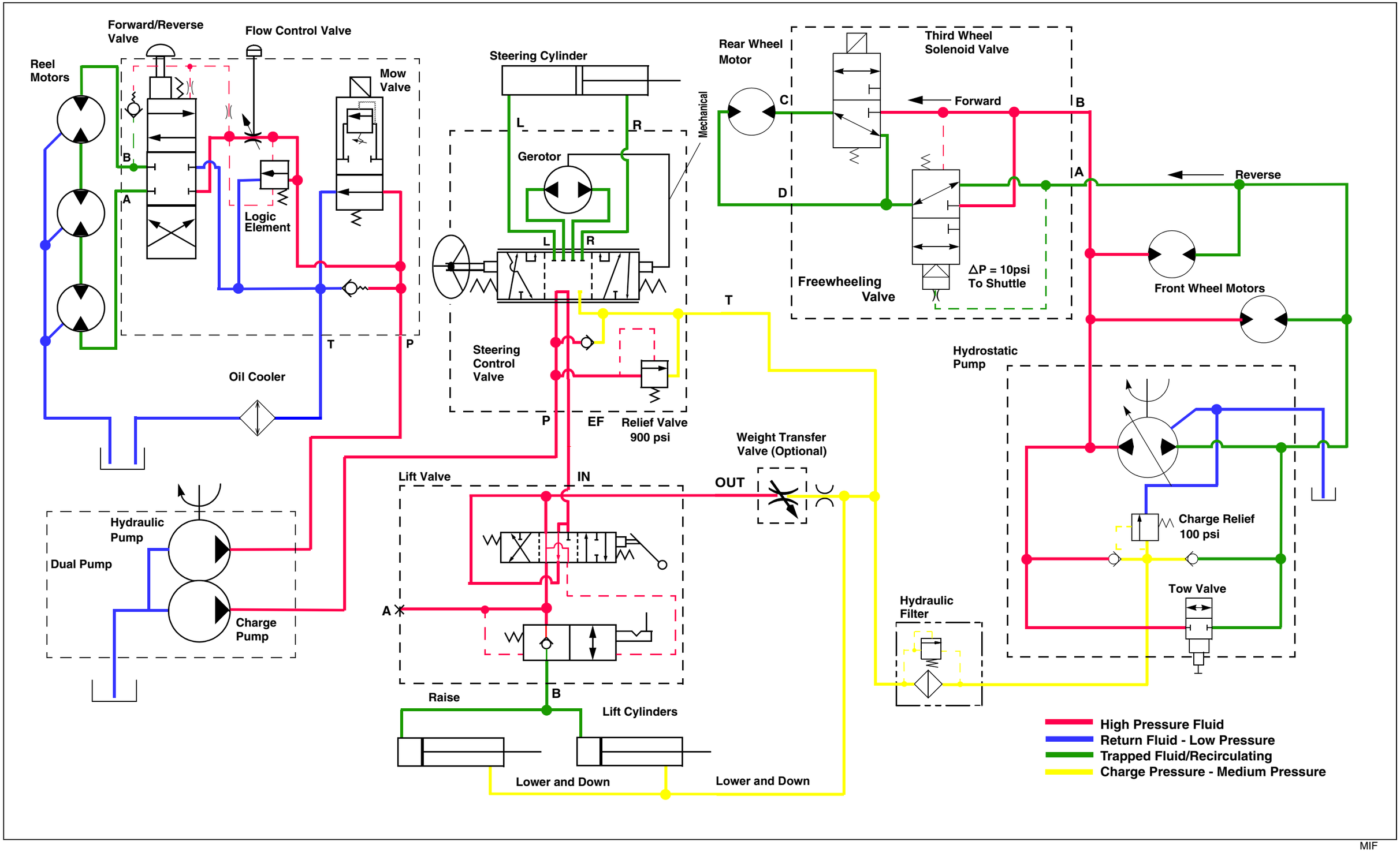
HYDRAULICS SCHEMATICS AND HARNESSES

Hydraulic Schematic - S.N. -060000



MIF

Hydraulic Schematic - S.N. 060001-



MIF

Operation and Diagnostics

Reel Drive System

System Function

Rotates the cutting reels for forward mowing and, if equipped, reverses for backlapping operations.

Reel Pump

The reel pumps are Danfoss Series YC, positive displacement gear pumps rated at 26.5 L/min (7 gpm). The pump is located between the hydrostatic transmission and the steering and lift system pump.

Mow Valve

The mow valve is a solenoid actuated, pressure limiting shuttle valve. It is used to control the flow to the reel motors. The mow valve is energized through the time delay control (TDC) module during mowing operations. It limits pressure in the reel drive circuit to 20684 kPa (3000 psi). The mow valve is contained within the backlapping valve assembly.

NOTE: European models may not have a backlapping valve assembly installed. If not, the mow valve is located in a valve block.

Flow Control Valve

The flow control valve, located in the backlapping valve assembly, is a manually operated flow restrictor. It is used to control reel speed when backlapping or in normal mode. It is adjusted by rotating the knob clockwise to restrict and counterclockwise to increase flow.

Backlapping Valve

The backlapping valve, located in the backlapping valve assembly, is a manually operated, two-position (three position for S.N. 060001-), push-pull valve that changes fluid flow direction. The knob, when pushed in, directs the fluid flow to the motors for forward cutting. When pulled out, the cutting units will reverse direction for backlapping, and a switch is actuated to allow the mow valve solenoid to be energized with the operator off the seat and the mow/transport switch in the mow position.

Shut-off Valve

The shut-off valve, installed in-line prior to the first reel motor, is a solenoid operated shut-off valve used to stop the flow of hydraulic fluid to the cutting units and prevent “reel creep.” An off delay timer provides a one-second delay before closing the shut-off valve. This delay allows the reels to slow down before shutting off hydraulic fluid flow to prevent the reel motors from cavitating.

Theory (Units With a Backlapping Valve)

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 20684 kPa (3000 psi) at a maximum flow rate of 26.5 L/min (7 gpm).

Pressure and flow are now routed to the flow control valve and logic element. The flow control valve determines the rpm of the reels. Pressure in the reel circuit will vary according to the amount of resistance that the cutting units are generating.

The logic element, a pilot operated dump valve, compares pressure at the inlet and outlet ports of the flow control valve. As the flow is restricted, pressure builds on the input side of the flow control valve to a value higher than that on the output side. This forces the logic element to open and dump excess flow to the tank. As flow returns to the reservoir, pressure to the input side of the flow control valve drops and the logic element closes. The logic element will continue this cycle as needed to equalize pressure on both sides of the flow control valve.

After leaving the flow control valve, fluid enters the forward/reverse valve, where it is directed to the forward or reverse side of the reel motors. The forward/reverse valve is equipped with a detent to hold the valve in the forward position.

A soft start feature is used in the mow valve to prevent damage to the cutting units from full pressure start-ups.

After leaving the backlapping valve, flow is directed to the forward or reverse side of the reel motors. The reel motors are connected in series beginning with the left front, the center, and the right front cutting unit motor.

Theory (Units Without a Backlapping Valve)

When the mow solenoid is energized, the pressure regulating part of the mow valve shifts to regulate pressure in the mow circuit to a maximum of 20684 kPa (3000 psi) and a maximum flow rate of 26.5 L/min (7 gpm).

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 mow valve, flow is directed to the forward side of the reel motors. The front reel motors are connected in series starting with the left front, the center, and the right front motor.

Lift System

Function

Provides a means to raise or lower the cutting units for three operating modes:

- Transport
- Mowing
- Service and Backlapping

Charge Pump

The charge pump is a Danfoss model YC direct drive, positive displacement gear pump capable of displacing 4.25 gpm at 1500 psi and it is the forward pump of the double pump assembly. The charge pump operates in an “open center series” type hydraulic system consisting of the steering, lift, and hydrostatic drive systems. Each system has a controlling valve with an open center that allows fluid flow, in series, to operate each system in the order mentioned above. Also, in this type of circuit, the first controlling valve (steering) takes priority over the next valve downstream in the circuit.

Raise/Lower Spool Valve

The lift valve is a manually positioned (raise/lower) spool valve that is spring loaded to the center position (float).

Positioning the lift valve to raise the cutting units directs pressure to a float valve inside the lift valve. This valve allows pressure to the raise side of the lift cylinders through a one-way check valve that is held in position by a spring. This one-way check valve prevents fluid from leaving the lift cylinders, forming a liquid lock that keeps the cutting units raised when the manual lift lever is released.

Positioning the lift valve to lower the cutting units directs pressure to the float valve, positioning it to the float side of the valve. This float side of the valve is held in position by a detent ball and spring, and allows fluid flow in or out of the lift cylinders when the manual lift lever is released.

Weight Transfer Valve

The weight transfer valve is used by dialing the weight transfer knob clockwise; the weight of the cutting unit is transferred to the wheels, thus increasing traction. If dialed far enough, the cutting units will lift off the ground. The valve is manually operated and controlled by the operator. Hydraulic pressure is routed through the neutral position of the lift valve, and to the valve.

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 raise/lower is a manually operated spring centered valve that controls the up/down movement of the cutting units. Moving the lever to the raise position raises the cutting units to the full up position for transport or servicing operations.

Moving the lever to the down position lowers the cutting units completely to the ground for cutting or backlapping operations.

The cutting units may be lifted slightly for turning by momentarily activating the lift valve until the units clear the ground. The units will be held at this height until they are lowered again.

Reel Drive Troubleshooting

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” on page 393.)

(2) Are cutting unit bearings in good condition?

Yes - Go to step (3).

No - Replace cutting unit bearings.

(3) Is reel drive motor operating properly?

No - See “Test Reel Motors Case Drain” on page 334.

Symptom: All Reels in One System Are Turning Slowly

(1) Is system relief valve operating properly?

Yes - Go to step (2).

No - Perform reel motors pressure relief test. See “Test Reel Pump Pressure Relief” on page 332.

(2) Is first reel motor in series operating properly?

Yes - Go to step (3).

No - See “Test Reel Motors Case Drain” on page 334.

(3) Is first cutting unit in series operating properly?

Yes - Go to step (4).

No - Check cutting reel for binding. Adjust or replace worn or damaged parts. See Attachments section for disassembly and inspection procedures.

(4) Is reel drive pump operating properly?

Yes - Go to step (5).

No - Check pump for wear. See “Test Reel Pump Flow” on page 333.

(5) Is flow control valve open fully?

Yes - Go to step (6).

No - Move flow control valve to the fully open position.

Symptom: All Reels in One System Are Turning Slowly

(6) Is mow solenoid operating properly?

Yes - Go to step (7).

No - Check if solenoid is energized.

No - Check if solenoid is stuck open.

(7) Is backlapping valve in the down position?

No - Place backlapping valve in the down position.

Symptom: Second and Third Reels Turn Slowly

(1) Is middle cutting unit, 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” on page 393.)

(2) Are middle cutting unit bearings operating properly?

No - Replace cutting unit bearings.

Symptom: One Cutting Unit Is Not Turning

(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” on page 393.)

(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?

Yes - Go to step (4).

No - See “Test Reel Motors Case Drain” on page 334.

(4) Is coupler between motor and cutting unit in place and in good condition?

No - Repair or replace as necessary.

Symptom: One System Will Not Backlap

(1) Is mow solenoid operating?

Yes - Go to step (2).

No - Check if solenoid valve is stuck open.

(2) Is flow control valve fully open?

Yes - Go to step (3).

No - Move control valve to the fully open position.

(3) Is backlapping valve in the up position?

No - Place backlapping valve in the up position.

Symptom: Pump 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?

No - Check pump for wear. See “Test Reel Pump Flow” on page 333.

Lift System Troubleshooting

Symptom: Front and Rear Lift Arms Will Not Lower

(1) Is lift valve operating properly?

Yes - Go to step (2).

No - Repair or replace lift valve as required.

(2) Is weight transfer valve adjusted properly?

No - Adjust weight transfer valve.

Symptom: Front and Rear Lift Arms Will Not Rise

(1) Is engine speed to specification?

Yes - Go to step (2).

No - Perform fast idle adjustment.

(2) Is steering system leakage within specification?

Yes - Go to step (3).

No - Perform steering system leakage test. See “Test System Leakage” on page 361.

Symptom: Front and Rear Lift Arms Will Not Rise

(3) Is lift system free of air?

Yes - Go to step (4).

No - Start engine and cycle lift arms to purge air from system.

(4) Are lift system hydraulic fittings tight and free from leaks?

Yes - Go to step (5).

No - Tighten fittings and replace O-rings as needed.

(5) Is lift valve operating properly?

No - Repair or replace as needed.

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 -

No - Repair or replace lift valve as needed.

Symptom: Rear Lift Arms Will Not Rise

(1) Is engine speed to specification?

Yes - Go to step (2).

No - Perform fast idle adjustment.

(2) Is lift system free of air?

Yes - Go to step (3).

No - Start engine and cycle lift arms to purge air from system.

(3) Are lift system hydraulic fittings tight and free from leaks?

Yes - Go to step (4).

No - Tighten fittings and replace O-rings as needed.

(4) Is steering system leakage within specification?

Yes - Go to step (5).

No - Perform steering system leakage test. See “Test System Leakage” on page 361.

Symptom: Rear Lift Arms Will Not Rise

(5) Is rear lift cylinder delay orifice free from obstructions?

Yes - Go to step (6).

No - See “Repair” on page 336.

(6) Is lost motion linkage on rear lift cylinder operating properly?

No - See “Remove Lift Cylinder” on page 352.

Symptom: Rear Tilt Arms Will Not Lower

(1) Is rear lift cylinder delay orifice free from obstructions?

Yes - Go to step (2).

No - See “Repair” on page 336.

(2) Is lost motion linkage on rear lift cylinder operating properly?

No - See “Remove Lift Cylinder” on page 352.

Symptom: Rear Tilt Arms Rise Too High

(1) Is rear lift arm stop in the down position?

No - Move stop into the down position.

Tests and Adjustments

Test Reel Pump Pressure Relief

Reason

To ensure that reel pressure relief valve is operating properly.

Special or Required Tools

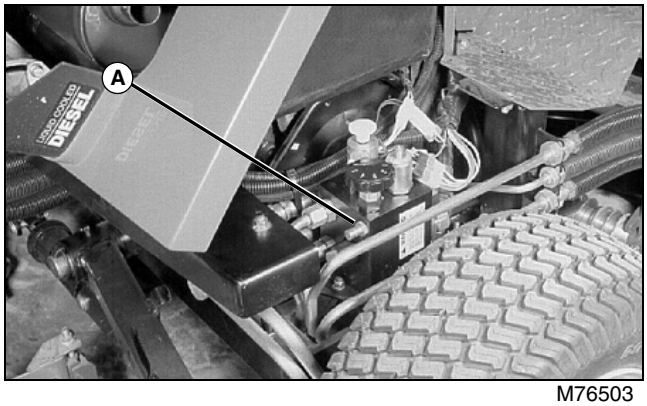
Tool Name	Tool No.	Tool Use
Connector 1/4 in. M NPT x 7/16 in. M 37°	JT05486	Used to attach pressure gage.
Hose	AMT846	Used to attach pressure gage.
Hose 34474 kPa (5000 psi)	JT03017	Used to attach pressure gage.
Swivel T-Fitting	38H1030	Used to attach pressure gage.
Female Quick Coupler	RE48122	Used to attach pressure gage.
Gage 70 000 kPa (10,000 psi)	JT03362	Used to read front reel motor pressure.

Procedure

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

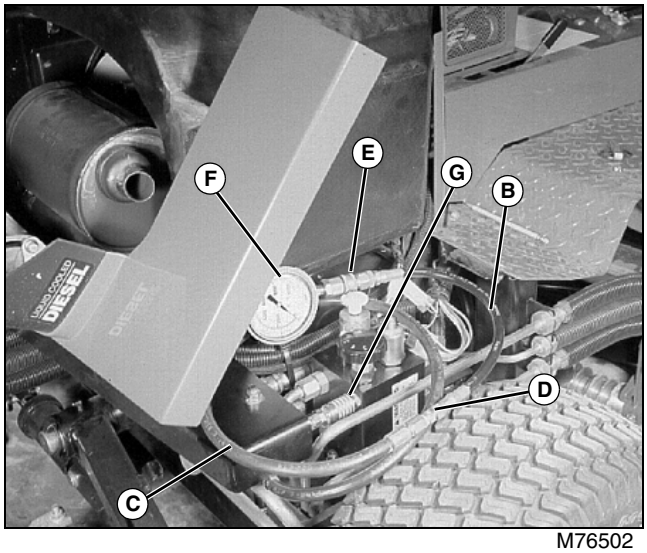
IMPORTANT: Avoid damage! Check and adjust service brake, if necessary, prior to performing this test.

1. Test is performed by reading system pressure at test fitting provided in mow/backlapping valve.



M76503

2. Locate Test fitting (A) in the mow/backlapping valve.



M76502

3. Connect AMT846 hose (B) to JT03017 hose (C) with JT05086 connector (D) and attach RE48122 Quick Coupler (E) on end of hose assembly.

4. Insert Gage JT03362 (F) in one quick coupler and fasten other quick coupler (G) to test port.

5. Lock park brake.

6. Check and top off hydraulic reservoir.

7. With cutting units lowered to ground, block all three reels with small wooden blocks.

8. Start engine and set throttle to 2000 rpm (min).

NOTE: If the engine stalls while performing this test, set the throttle to full speed and repeat test.

9. Set mow/transport lever to mow.

10. Note reading on gage.

Corrections

If relief valve does not meet specifications, replace relief valve or try to adjust by turning hex head screw on top of solenoid: tighten to increase, loosen to decrease.

Specifications

Reel Pump Relief Pressure

. . . . . 20 684 ± 1034 kPa (3000 ± 150 psi)

Test Reel Pump Flow

Reason

To determine if reel pump is worn by testing hydraulic flow at reel motors.

Special or Required Tools

Tool Name	Tool No.	Tool Use
In-Line Hydraulic Tester	D01074AA	Used to attach pressure gage. Part of BM18319 Diagnostic Kit.
120 in. Hydraulic Test Hoses (2)	JT03377	Used to attach pressure gage. Part of BM18319 Diagnostic Kit.
Connector 3/4 in. F NPT x 1-1/16 in. F 37° (2)	JT03012	Used to attach pressure gage. Part of BM18319 Diagnostic Kit.
Connector 1-1/16 in. M 37° x 13/16 in. F ORFS	JT05688	Used to attach pressure gage. Part of BM18319 Diagnostic Kit.
Connector 1-1/16 in. M 37° x 1-3/16 in. M ORFS	JT03483	Used to attach pressure gage. Part of BM18319 Diagnostic Kit.
Connector 1-3/16 in. F ORFS x 13/16 in.M ORFS	JT03484	Used to attach pressure gage.

Procedure

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

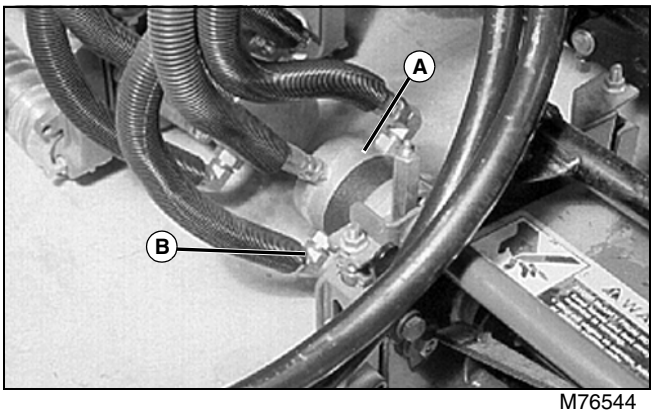
IMPORTANT: Avoid damage! Check and adjust service brake, if necessary, prior to performing this test.

1. Park machine on level surface, reels lowered, park brake locked, engine off.

2. Block wheels to prevent inadvertent movement of the machine.

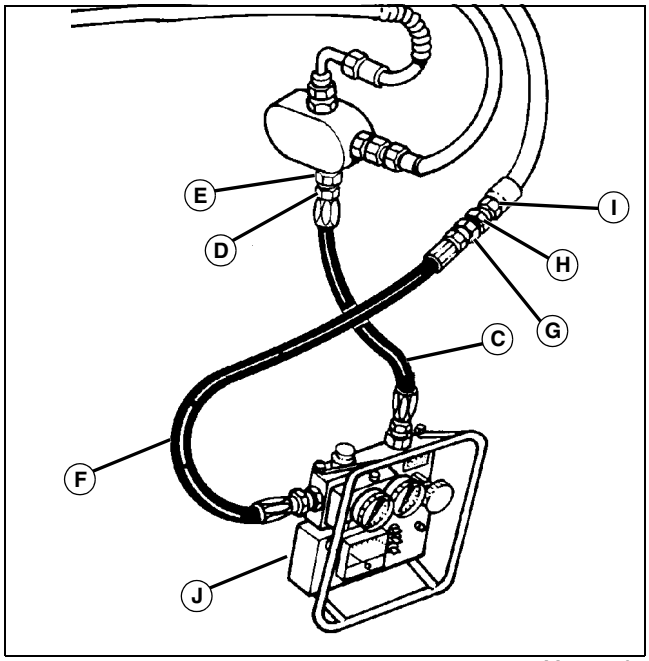
3. Check and top off hydraulic reservoir.

CAUTION: Avoid injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls. Lower cutting units to the ground prior to removing any hydraulic lines or fittings.



M76544

4. Place drain pan under left front reel motor (A). Clean hydraulic hose fittings and disconnect hose fitting at elbow (B).



M76571A

5. Connect JT03377 Hose (C) to motor using JT03012 (D) and JT05688 Connectors (E). Connect another JT03377 Hose (F) to hose from backlap valve using JT03012 (G), JT03483 (H) and JT03484 (I) Connectors.

6. Connect JT03377 Hose (F) from backlap valve into inlet port of D01074AA Hydraulic Tester (J). Install hose from reel motor into outlet port.

7. Turn tester control knob out (counterclockwise) completely.

8. Set front backlapping valve to forward (mow) position.

9. Start machine and run at full throttle.

10.Slowly turn tester control knob in (clockwise) and note flow and maximum pressure.

11.Turn out control knob and stop engine.

Results

If reel pump flow is not within specifications, replace or rebuild pump as necessary.

IMPORTANT: Avoid damage! After completing test check top off hydraulic reservoir.

Specifications

Reel Pump Flow . . . . . 20 687 kPa @3000 psi
. . . . . (22.7 L/m @3000 psi)

Test Reel Motors Case Drain

Reason

To test the reel motor bypass to case drain. As the motor gears wear, more fluid is bypassed to the hydraulic reservoir.

Special or Required Tools

Tool Name	Tool No.	Tool Use
In-Line Hydraulic Tester	D01074AA	Used to test hydraulic motor.
120 in. Hydraulic Test Hoses (2)	JT03377	Used to connect hydraulic tester to motor.
Connector 3/4 in. F NPT x 1-1/16 in. F 37° (2)	JT03012	Used to connect hydraulic tester to motor.
Connector 1-1/16 in. M 37° x 13/16 in. F ORFS (2)	JT05688	Used to connect hydraulic tester to motor.
Connector 1-1/16 in. M 37° x 1-3/16 in. M ORFS	JT03483	Used to connect hydraulic tester to motor.
Connector 1-3/16 in. F ORFS x 13/16 in. M ORFS	JT03484	Used to connect hydraulic tester to motor.
Plug, 13/16 in. M ORFS	JT03392	Used to plug port on reel motor.

Special or Required Tools

Tool Name	Tool No.	Tool Use
1/2 in. ID hose 24 in. long (2)	NA	Used to measure reel motor case drain.

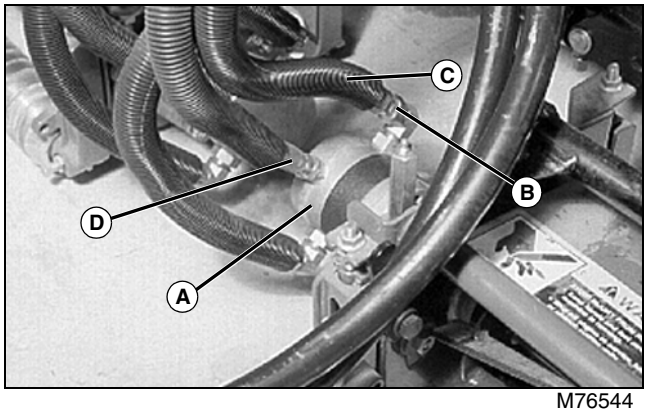
Procedure

CAUTION: Avoid injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.
Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Park machine on level surface, reels lowered, park brake locked, engine off.

2. Block wheels to prevent inadvertent movement of the machine.

3. Check and top off hydraulic reservoir.



M76544

4. Place drain pan under reel motor (A) to be tested. Clean hydraulic hose fittings and remove top/rear hose from elbow (B) on motor.

5. Connect JT03377 Hose to motor using JT03012 and JT05688 Connectors. Connect another JT03377 Hose to hose from backlap valve using JT03012, JT03483, and JT03484 Connectors.

6. Connect JT03377 Hose connected to return line (C) into inlet port of D01074AA Hydraulic Tester. Install hose from reel motor (A) into outlet port.

7. Remove case drain hose (D) from motor. Plug hose with JT03392 Plug (A).

8. Place a 1/2 in. ID hose on center port fitting of both rear reel motors and place other end into a clean container.

9. Turn tester control knob out (counterclockwise) completely.

10.Set rear backlapping valve to forward (mow) position (knob pushed in).

11.Have a helper technician start machine, run at full throttle and engage reels.

12.Turn tester control knob in (clockwise) until pressure reaches 17 236 kPa (2500 psi). Hold for 15 seconds.

13.Turn control knob out and stop engine.

14.Measure amount of oil in each container.

15.Multiply volume of oil in each container by 4 to arrive at amount of case drain in one minute.

Results

IMPORTANT: Avoid damage! After completing test check top off hydraulic reservoir.

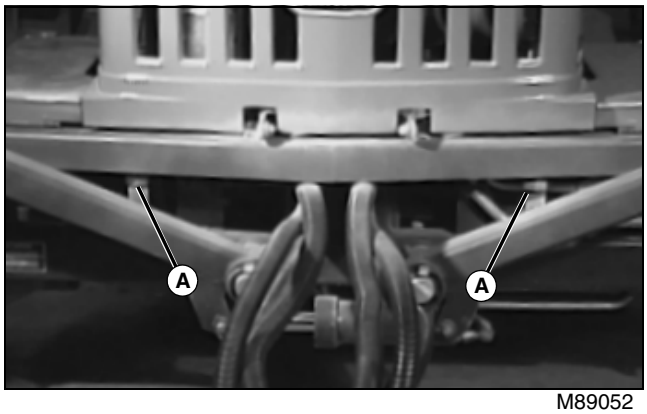
Reel motor case drain should not exceed 3.78 L/m (1 gpm). If case drain exceeds specifications, rebuild or replace motors.

Specifications

Reel Motor Case Drain @ 17 236 kPa (2500 psi) (Maximum). . . . . 3.78 L/m (1 gpm)

Adjust Front Lift Arm

Adjustment



M89052

1. Push down on one of the lift arms.

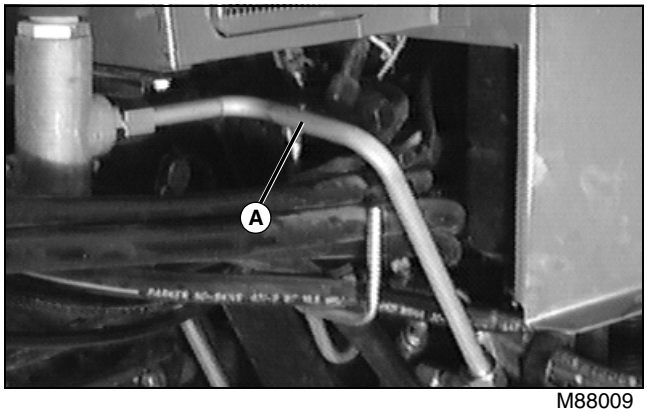
2. Measure the distance between the lift arm stop and the adjustment bolt head (A).

3. Turn the adjustment bolts equally in or out until total clearance between the adjustment bolt and the lift arm stop meets specification.

Front Lift Arm Bolt Clearance . . . . . 6 mm (0.236 in.)

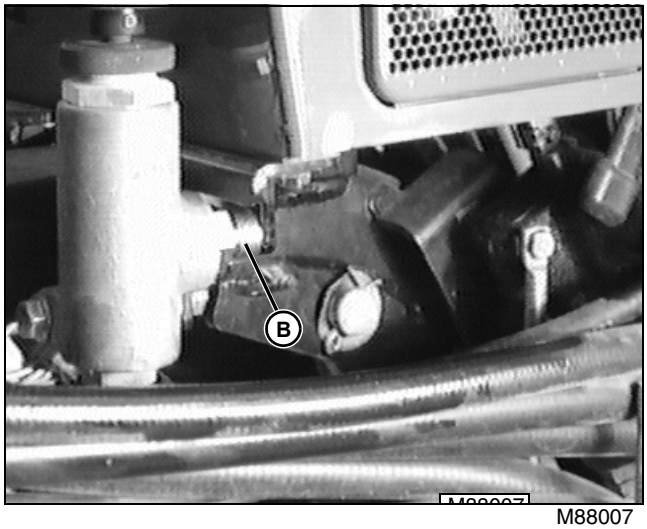
Repair

Install AMT1931 Orifice Fitting



M88009

1. Remove oil line (A).



M88007

2. Remove straight adapter fitting (B) from weight transfer valve and replace with AMT 1931 Orifice Fitting .

3. Replace oil line (A) making sure all O-rings are in place.

Remove Double Pump

CAUTION: Avoid injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls. Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

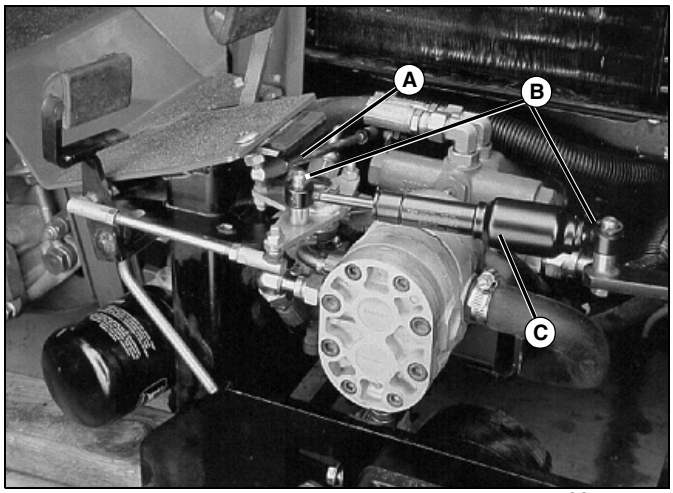
1. Park vehicle on a level surface, reels lowered, park brake locked, engine off.

2. Block wheels to prevent inadvertent movement of the machine.

3. Disconnect battery.

4. Place a 10-gallon container below the hydraulic sump and drain oil.

5. Drain coolant from radiator/engine. Drain cock is located under frame on lower left side of radiator.

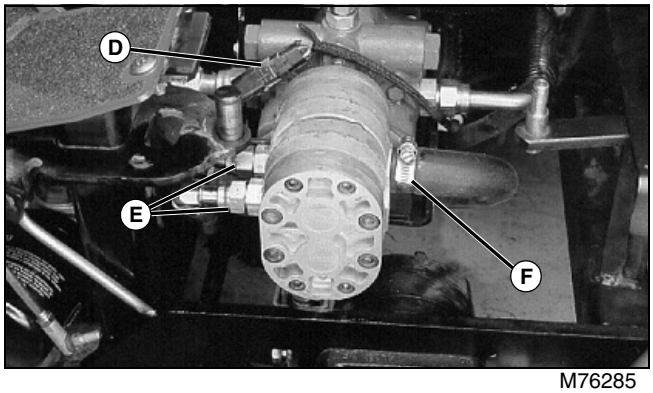


M76276

6. Remove neutral linkage (A) by disconnecting the link from the cam plate and the pintle lever.

7. Remove E-clips (B) from damper mounting studs and remove damper (C).

8. Clean port areas of the double pump assembly and hydrostatic pump with a suitable solvent.

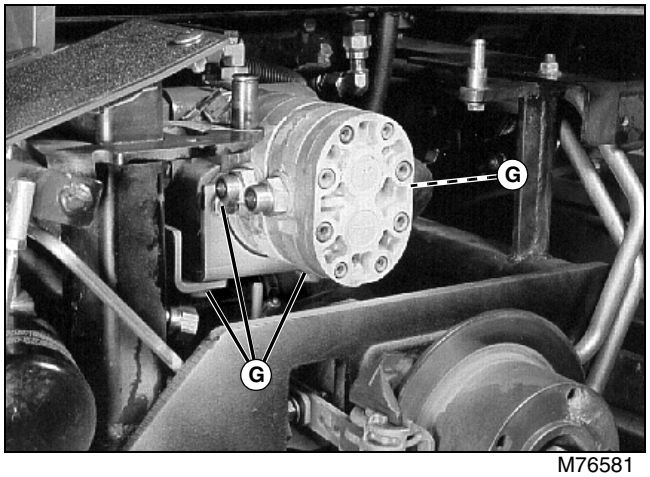


M76285

9. Separate electrical connector (D) for the neutral switch.

10.Place drip pan under double pump to catch oil that will leak out when lines are disconnected.

11.Mark for reinstallation and disconnect hydraulic lines (E) and pump intake line (F) connected to the double pump assembly.



M76581

12.Remove TORX head bolts (F) securing the double pump to hydrostatic pump.

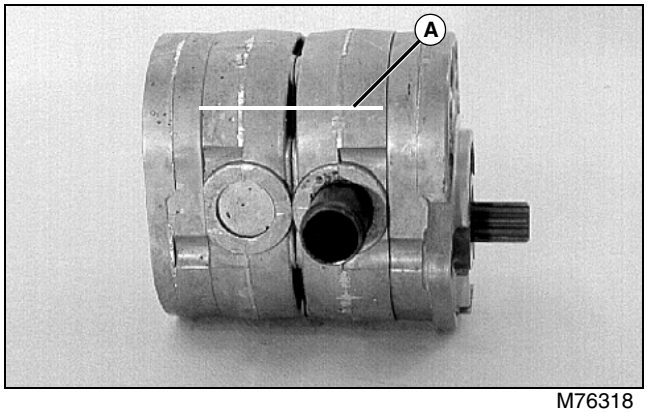
13.Remove bolts securing pump support bracket to subframe.

14.Pull double pump assembly from hydrostatic pump by sliding forward to disengage spline shaft.

Disassemble Double Pump

Separate Double Pumps

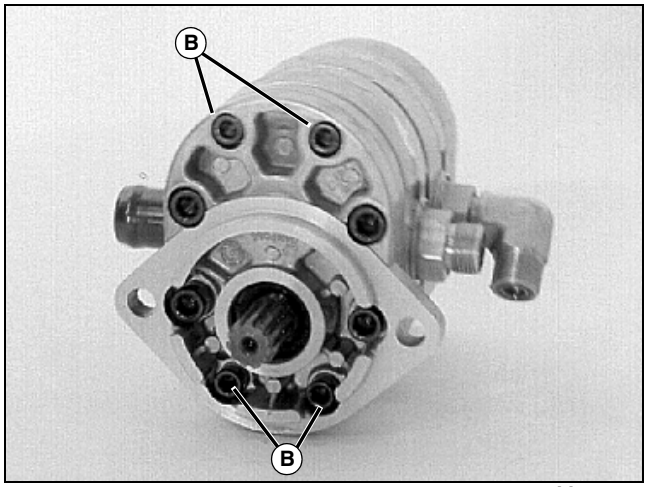
CAUTION: Avoid injury! Pump components are aluminum. Use extreme care in cleaning all machine surfaces of old gasket materials. Use of steel pry bars, etc., can severely damage the machined surfaces of the pumps.



M76318

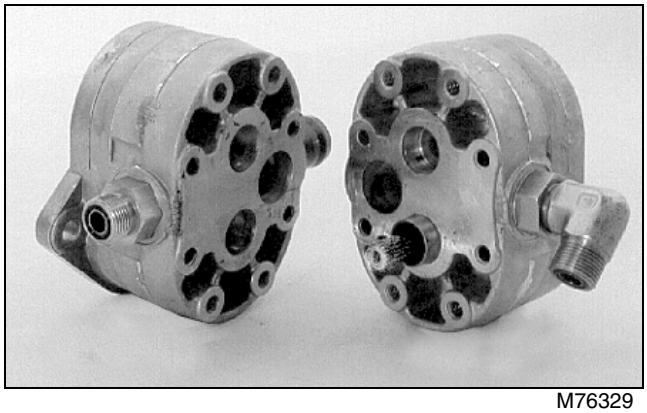
1. Mark pump housing (A) with solvent resistant marker or paint to guide reassembly.

NOTE: Make sure to keep washers with bolts.



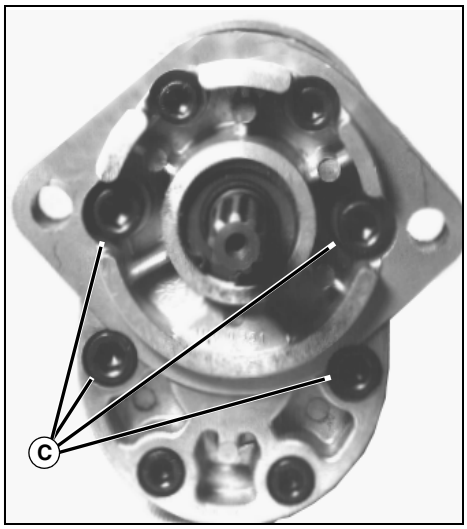
M76319

2. Remove four 5/16 in. hex head bolts (B) that hold center section of double pump together.


M76329

3. Separate center section of pump into halves.

Disassemble Reel Pump (First Pump)

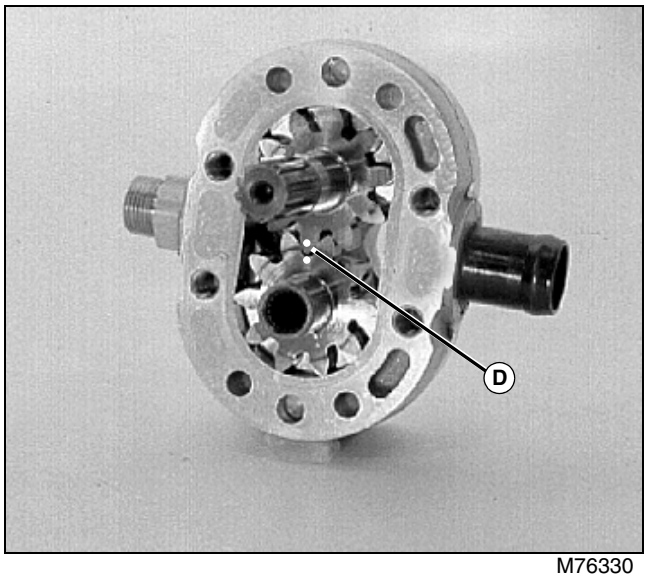


M56647

1. Remove four 3/8 in. hex head bolts (C) holding end plate to pump body

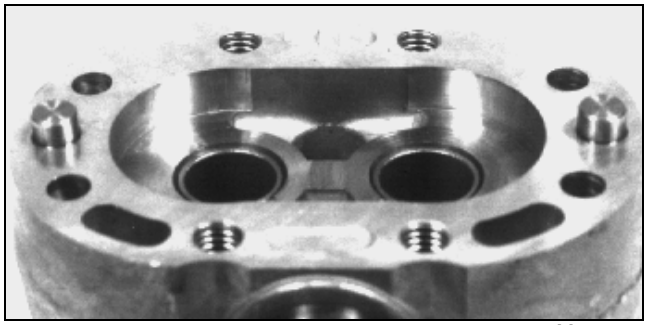
NOTE: It may be necessary to tap lightly on the end of the drive shaft with a soft-faced hammer to assist in separating the pump halves.

2. Carefully separate pump halves.



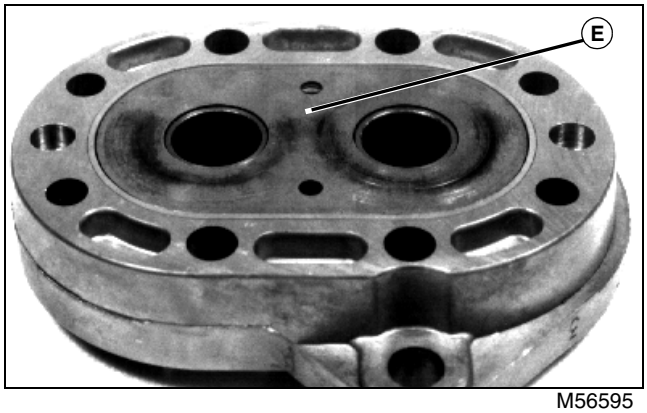
M76330

3. Place alignment marks (D) on gear mating teeth and remove gears from assembly.



M56598

4. Inspect housing and shaft bearings for scratches, scoring, or fretting. Replace individual pump section if worn.

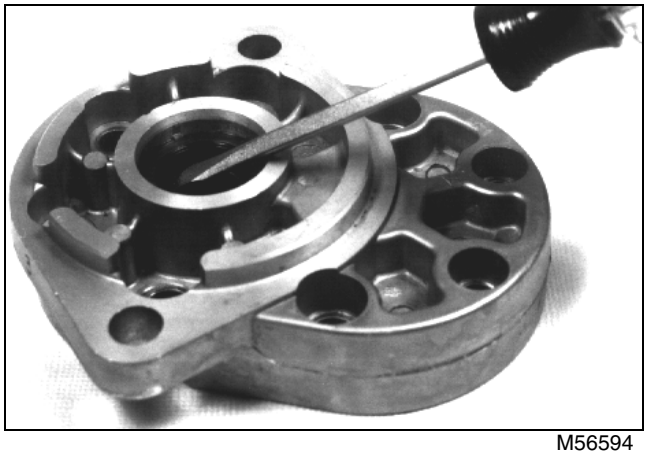


M56595

5. Remove the wear plate (E).

M56596

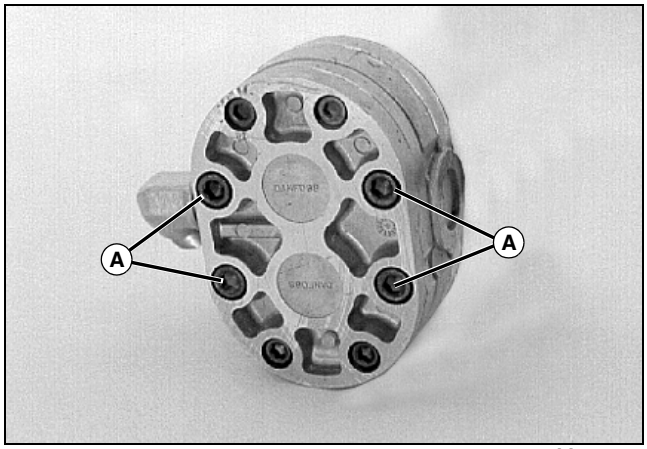
6. Remove blue seal (F), black seal (G) and O-ring (H).



M56594

7. Remove the shaft seals.

Disassemble Charge Pump (Second Pump)



M76328

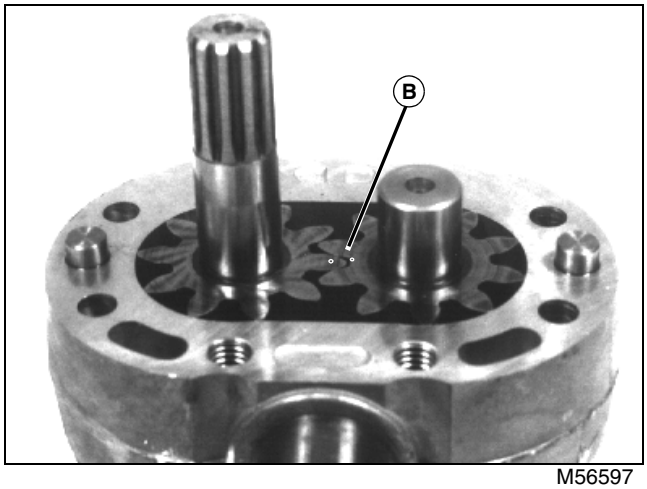
1. Remove hex head bolts (A) holding end plate to pump body.

2. Carefully separate end plate of center pump from other pump housing.

CAUTION: Avoid injury! Pump components are aluminum. Use of steel scrapers, etc., can severely damage the machined surfaces of the pumps. Use extreme care in cleaning all machine surfaces of old gasket materials.
Extreme caution must be used when using a vise to avoid distorting any parts.

3. Clean old gasket from pump housings.

4. Separate end plate from pump body.



M56597

5. Place alignment marks (B) on gear mating teeth and remove gears from assembly.

6. Inspect housing and shaft bearings for scratches, scoring or fretting. Replace individual pump section if worn.

Assemble Double Pump

CAUTION: Avoid injury! Pump components are aluminum. Use of steel scrapers, etc., can severely damage the machined surfaces of the pumps. Use extreme care in cleaning all machine surfaces of old gasket materials.
Extreme caution must be used when using a vise to avoid distorting any parts.

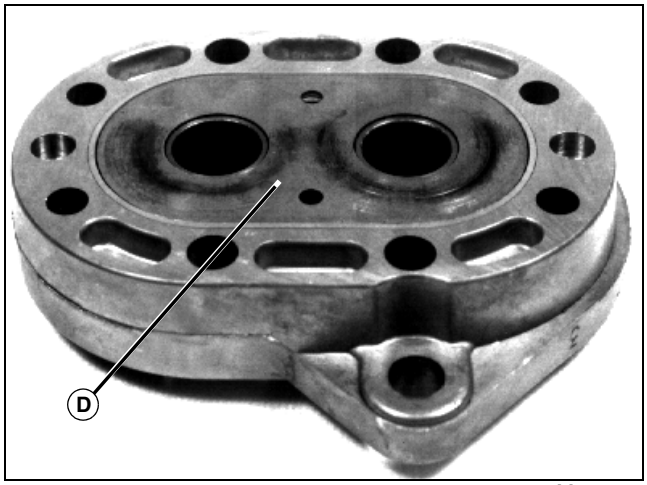
NOTE: Always use new wear plates, gaskets, and seals when rebuilding hydraulic components.

Assembly procedure for both pumps is the same.

1. Clean all components of old gasket material and debris with suitable solvent and blow dry.

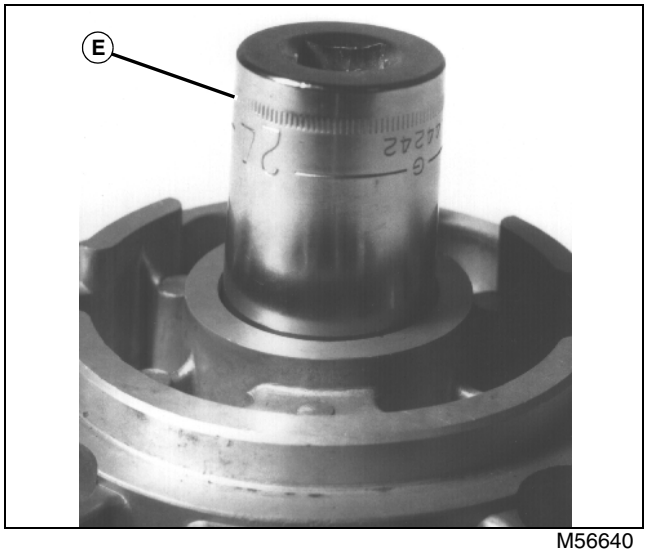
M56596

2. Install black seal (A), blue seal (B) and O-ring (C) on flat end plate of pumps.



M56595

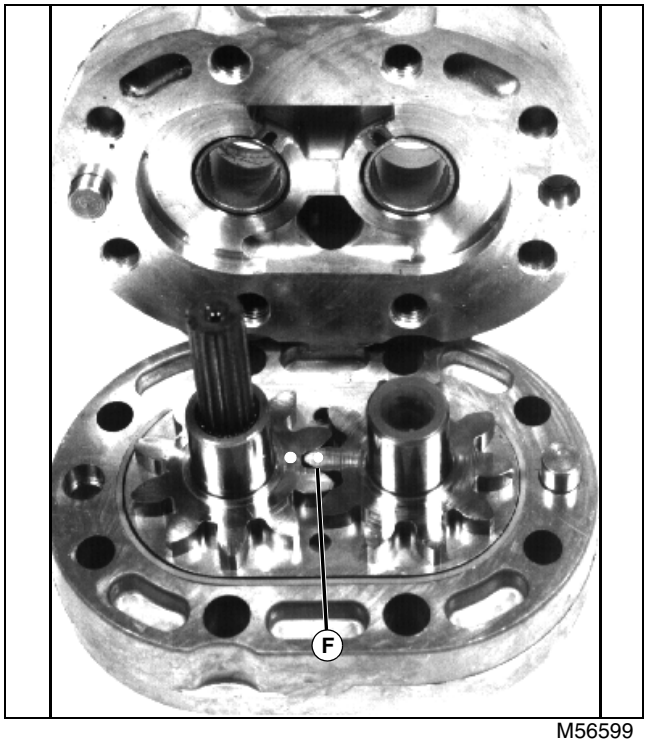
3. Lubricate wear plate (D) and install with bronze side facing gears.



M56640

4. Install new shaft seals on flanged pump housing using suitable seal driver (E). Lubricate inner seal lip with grease.

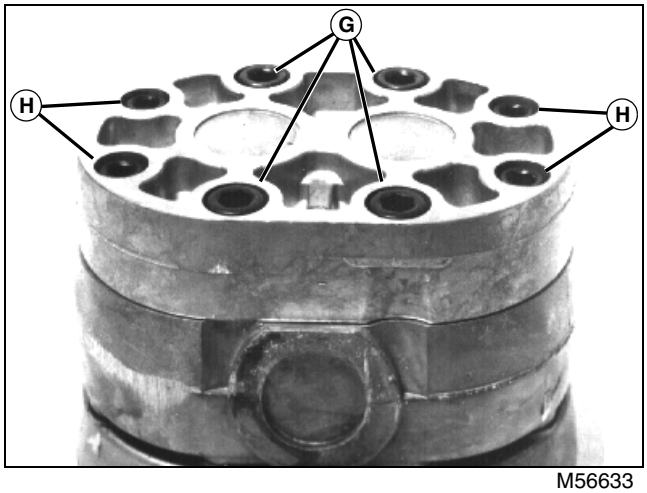
5. Lubricate wear plate and install with bronze side facing gears.



M56599

6. Install gears with alignment marks (F) lined up.

7. Install dowel pins if removed.

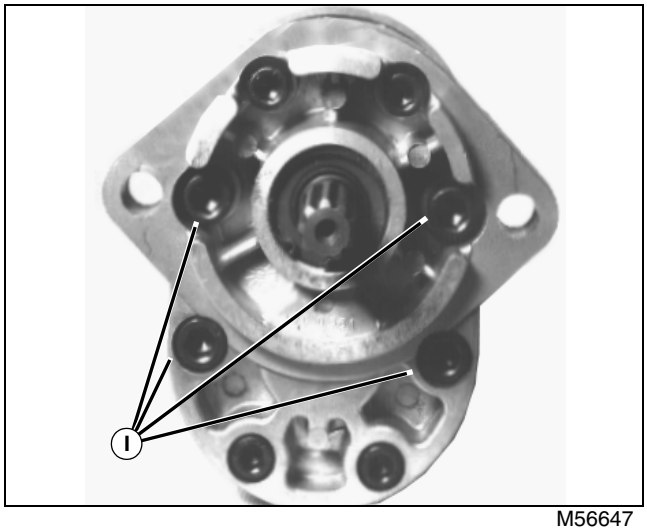


M56633

8. Install charge pump end plate. Loosely install four 3/8 in. hex bolts (G). Rotate drive shaft to be sure pump is not binding. Tighten bolts in an alternating pattern to specifications.

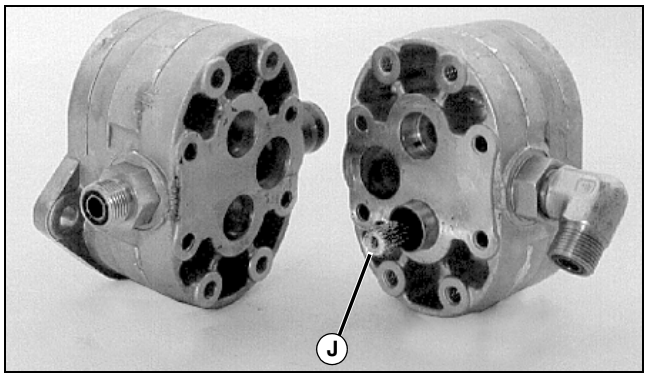
9. Install four 5/16 in. x 3 in. hex head bolts (H) to hold end pump to center pump housing. Tighten bolts in an alternating pattern to specifications.

10. Install reel pump end plate.



M56647

11.Loosely install four 3/8 in. hex head bolts (I). Rotate drive shaft to be sure pump is not binding. Tighten bolts in an alternating pattern to specifications.

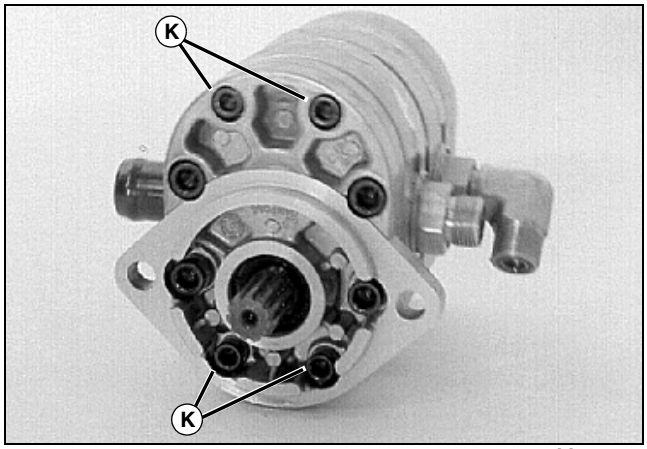


M76329

12.Install splined stub shaft (J) in charge pump drive gear shaft.

13.Install gasket on end pump.

14.Place charge pump body on reel pump assembly, aligning bolt and shaft holes.



M56647

15.Loosely install four 5/16 in. x 4 in. hex head bolts (K).

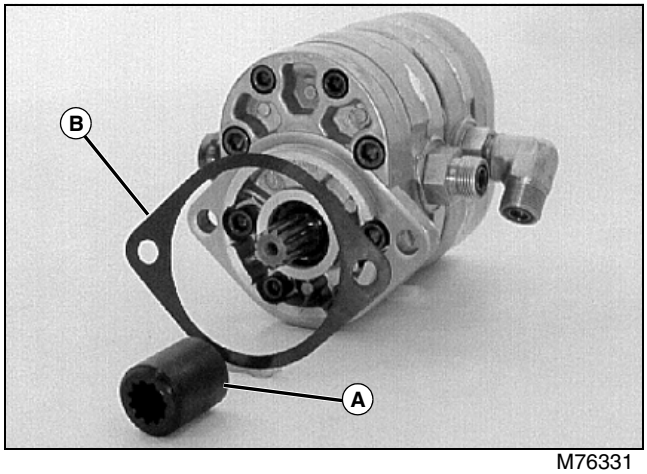
16.Rotate drive shaft to check for binding.

17.Tighten bolts in an alternating pattern to specifications.

Specifications

Reel Pump End Plate
Hex Head Bolt (3/8 in.) . . . . 40.7-43 N•m (360-380 lb-in.)
End Pump-to-Center Pump Housing
Hex Head Bolt (5/16 in.) . 21.5-23.7 N•m (190-210 lb-in.)
Reel Pump End Plate
Hex Head Bolt (3/8 in.) . . . . 40.7-43 N•m (360-380 lb-in.)
Charge Pump-to-Reel Pump Assembly
Hex Head Bolt (5/16 in.) . 21.5-23.7 N•m (190-210 lb-in.)

Install Double Pump

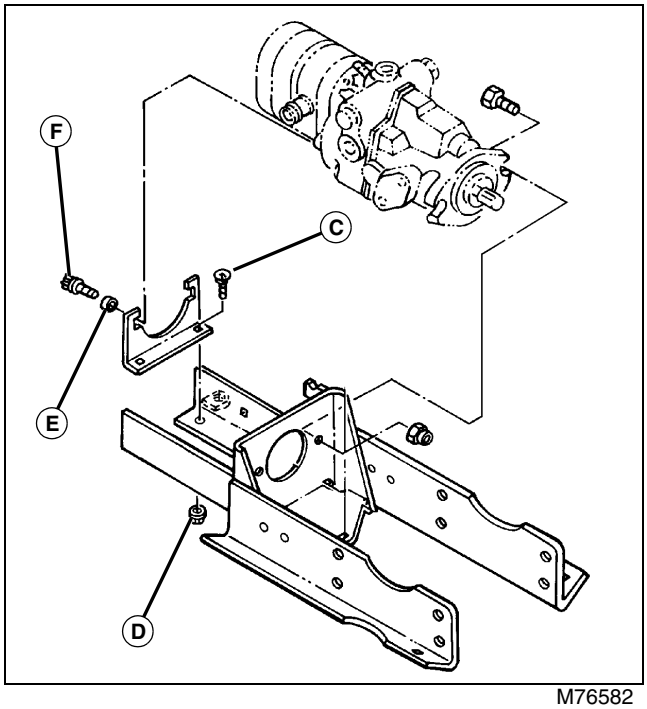


M76331

1. Install coupler (A) onto drive shaft.

2. Place gasket (B) on pump flange.

3. Set double pump in place, lining up coupler splines and mounting holes on hydrostatic pump.

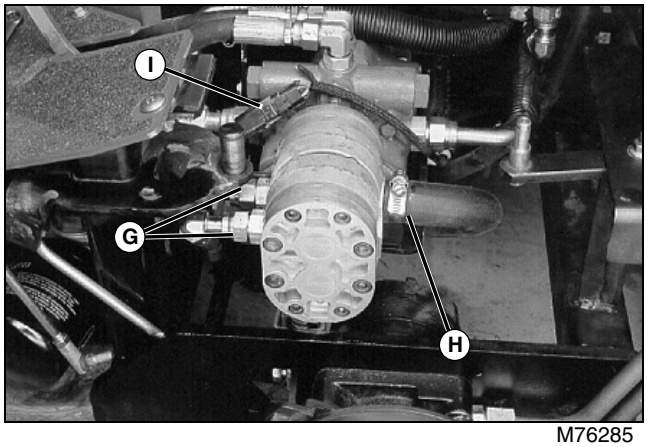


M76582

4. Locate pump support bracket and attach to frame with two carriage bolts (C) and nuts (D). Tighten finger tight at this time.

5. Place heavy washer (E) on TORX head bolts (F) and install bolts through pump support bracket slots, double pump mounting flange, and into hydrostatic pump.

6. Torque all mounting bolts at this time to the following specifications.

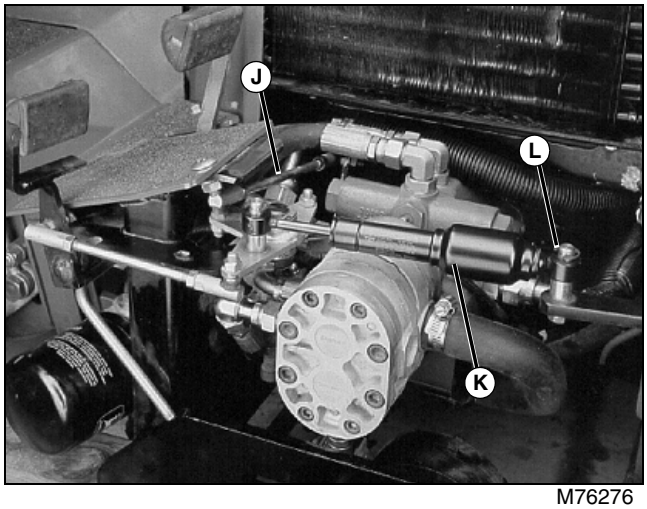


M76285

7. Install two high-pressure hoses (G) to left side of double pump.

8. Install pump intake line (H) from reservoir to right side of double pump.

9. Connect neutral switch connector (I).



M76276

10.Install neutral link (J), place damper (K) on mounting studs and secure with “E” clips (L).

Specifications

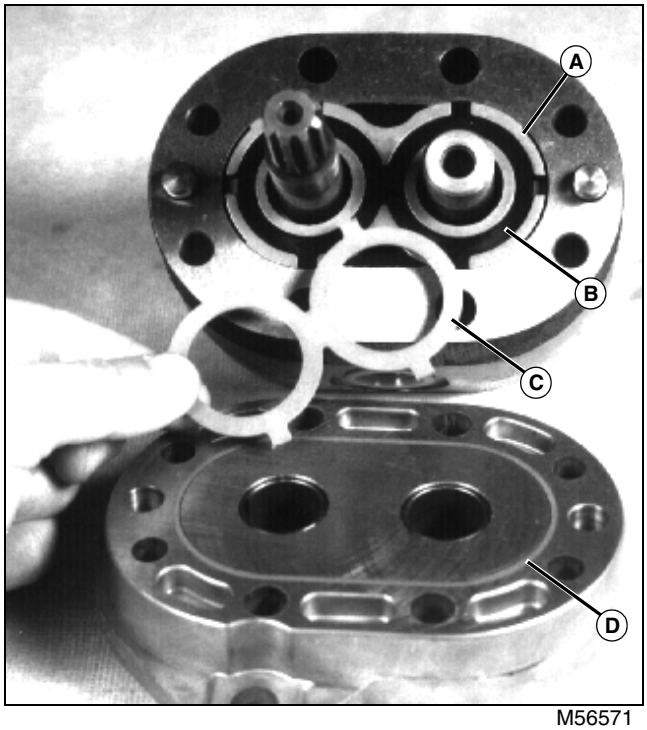
Hydrostatic Pump-to-Support Flange
TORX Head Bolts . . . . . 50 N•m (35 lb-ft)
Support Bracket-to-Frame
Carriage Bolt Nuts . . . . . 55 N•m (40 lb-ft)

Disassemble Heavy Duty (YC Series) Reel Motor

CAUTION: Avoid injury! Never pry components apart. Light tapping with a plastic hammer on drive shaft will separate components without burring.

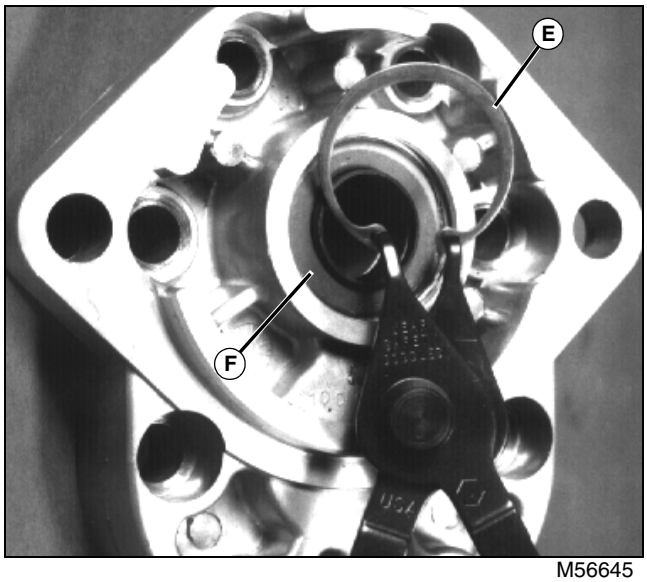
IMPORTANT: Avoid damage! Be careful not to drop any parts or disengage gear mesh when separating assemblies.

1. Remove eight hex head bolts and separate the cover from the gear housing.



M56571

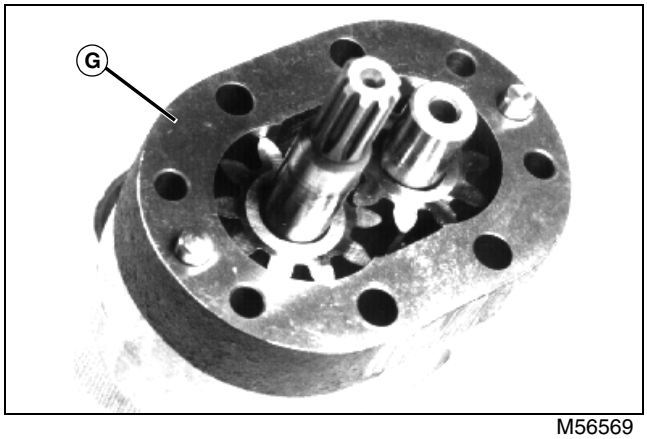
2. Remove wear plate (A), black seal (B), blue seal (C) and O-ring (D).



M56645

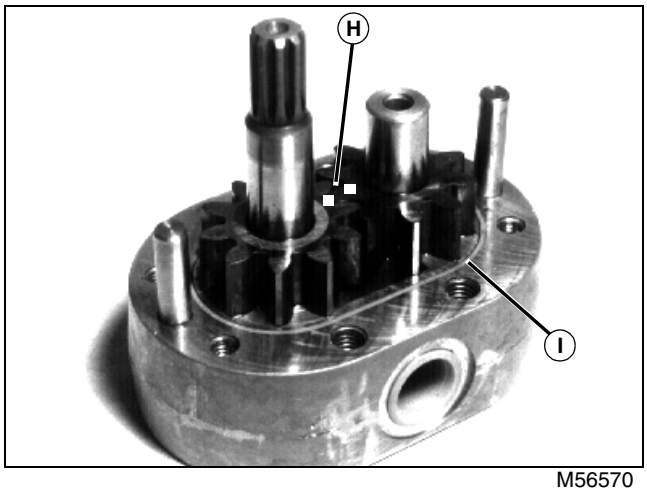
3. Remove internal snap ring (E) from shaft seal.

4. Remove shaft seal (F) using a two jaw puller.



M56569

5. Remove center bore section (G). Do not disturb gears.

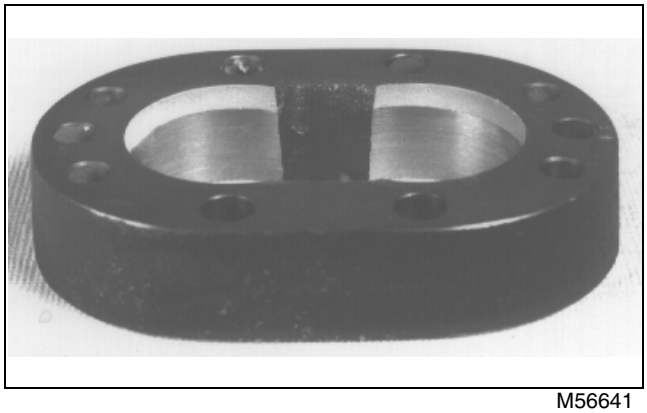


M56570

6. Place alignment marks (H) on gear mating teeth for assembly.

7. Remove O-ring (I).

8. Remove gears. Inspect for scoring, burrs, fretting, or uneven wear patterns. Replace pump assembly if gears are worn.

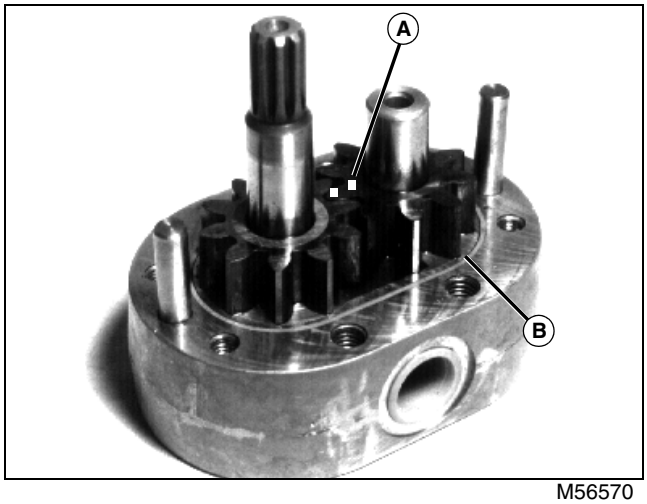


M56641

9. Inspect bore area for scoring, burrs, fretting, or uneven wear patterns. Replace pump assembly if worn.

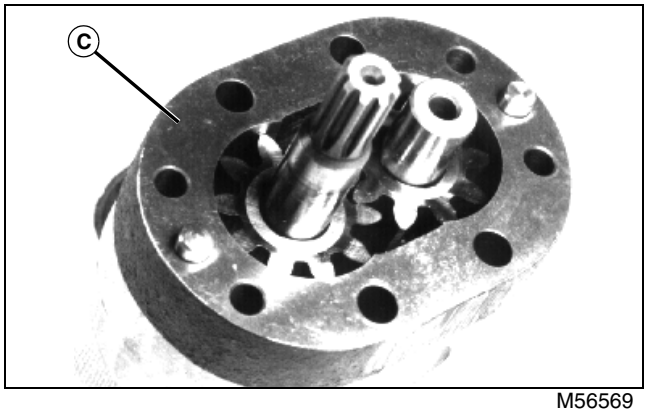
Assemble Heavy Duty (YC Series) Reel Motor

1. Clean all parts with suitable solvent. Blow dry.



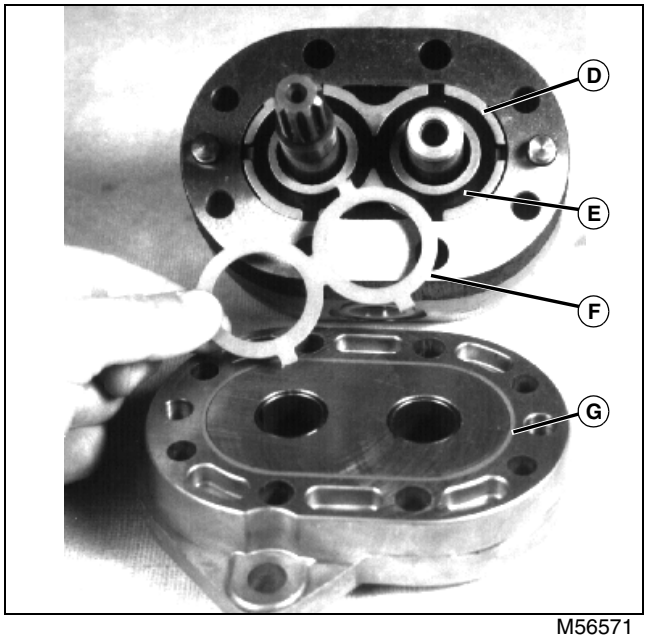
M56570

2. Install gears. Be sure gear teeth are matched to alignment marks (A).
3. Install dowel pins if removed.
4. Install new O-ring seal (B).



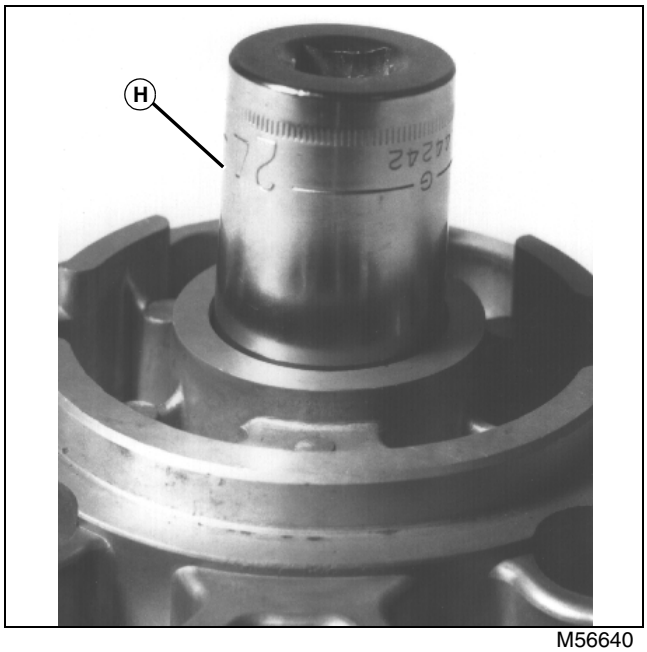
M56569

5. Install center bore section (C).



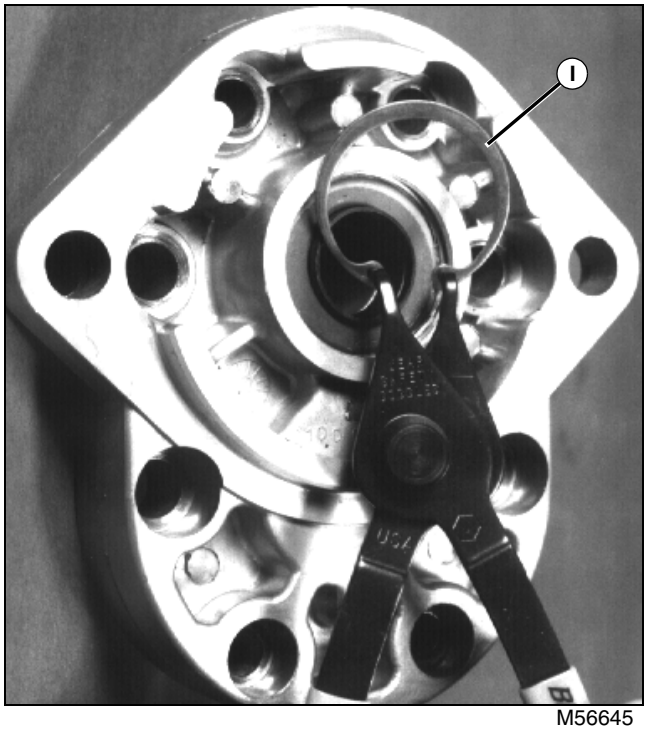
M56571

6. Install wear plate (D), black seal (E), blue seal (F), and O-ring (G).



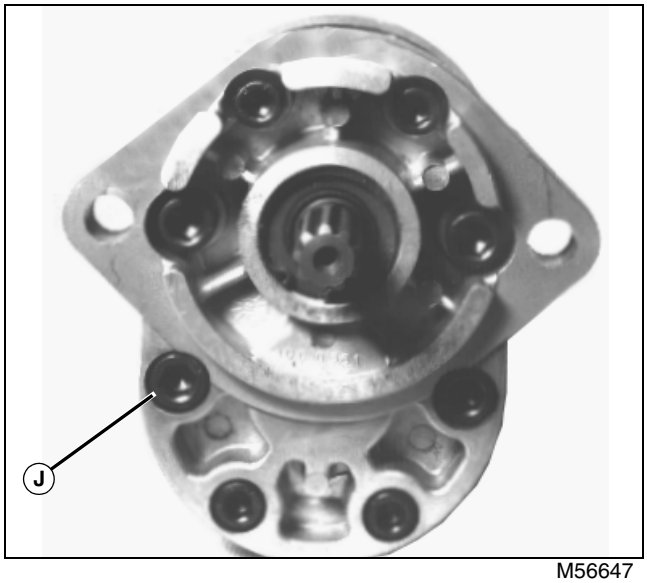
M56640

7. Press in shaft seal (metal side facing out) using a suitable seal driver (H).



M56645

8. Install snap ring (I); ensure sharp edge of ring faces out.



M56647

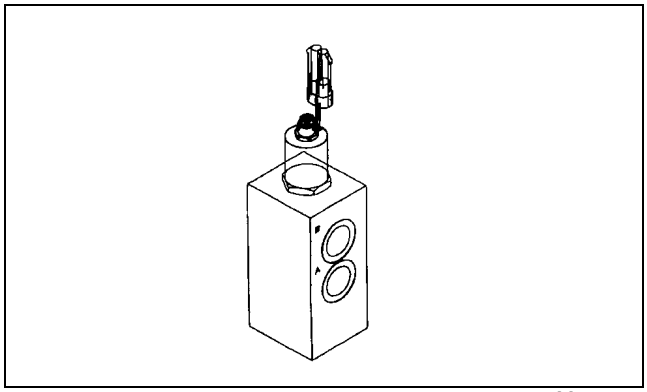
9. Install eight 5/16 in. hex head bolts (J) and tighten in an alternating pattern to specification.

Specifications

Cover-to-Housing Hex Head Bolt (5/16 in.) . . . . . **21.5-23.7 N•m (190-210 lb-in.)**

Mow Valve

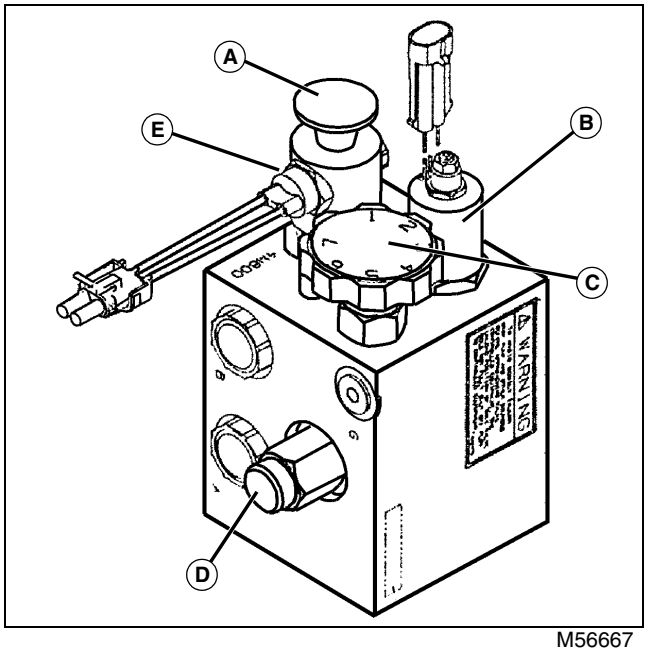
Standard Mow Valve



M89021

NOTE: See Mow Valve Solenoid Plunger to replace O-rings.

Mow Valve with Backlapping Capability

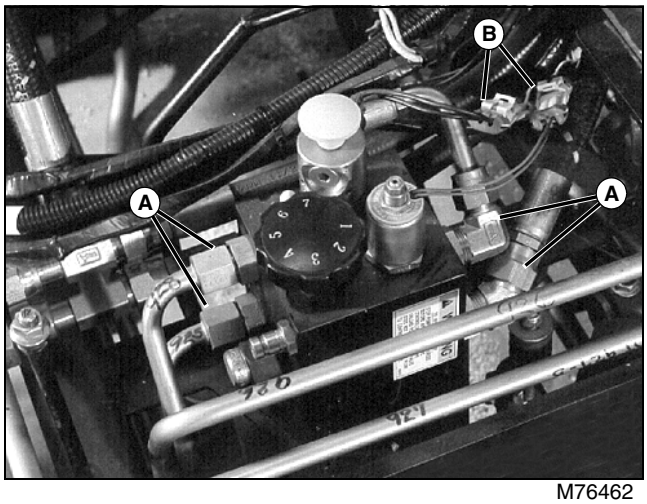


M56667

A - Forward/Reverse Valve
B - Mow Valve Solenoid
C - Flow Control Valve
D - Logic Element
E - Switch

Remove Mow Valve

1. Place drain pan under mow valve.



M76462

2. Label and remove four hydraulic lines (A) from valve body.

3. Remove two electrical connectors (B) from harness.

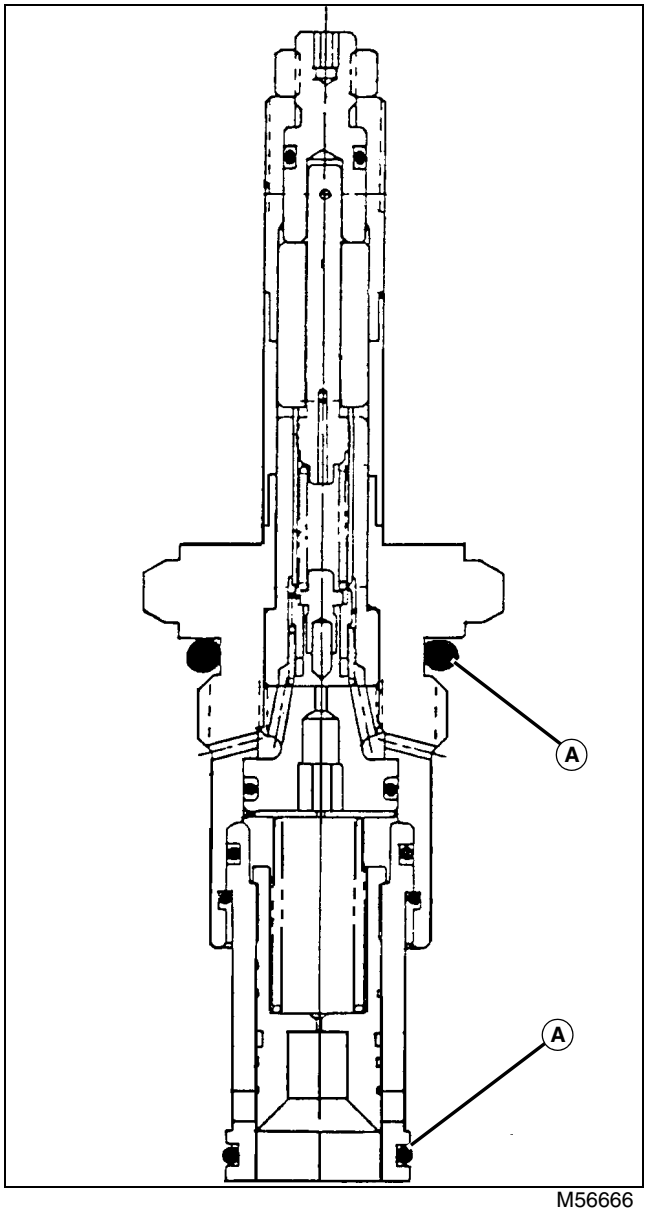
4. Remove two mounting bolts holding valve body to frame.

Disassemble and Assemble Mow Valve

The valve body is a single machined block. The valves may be removed and inspected for wear, and seals replaced. The following diagrams show seal placement for individual components.

NOTE: If the standard mow valve is being repaired, follow procedures for Mow Valve Solenoid Plunger for O-ring replacement.

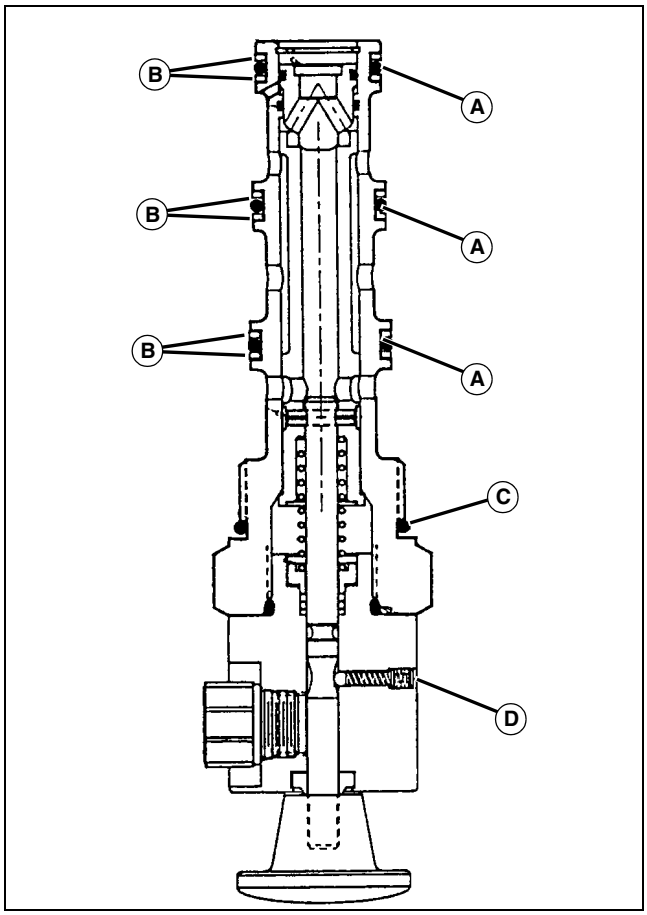
Mow Valve Solenoid Plunger



M56666

1. Ensure O-rings (A) are installed and lubricated before installing plunger.

Forward and Reverse Valve



M56665

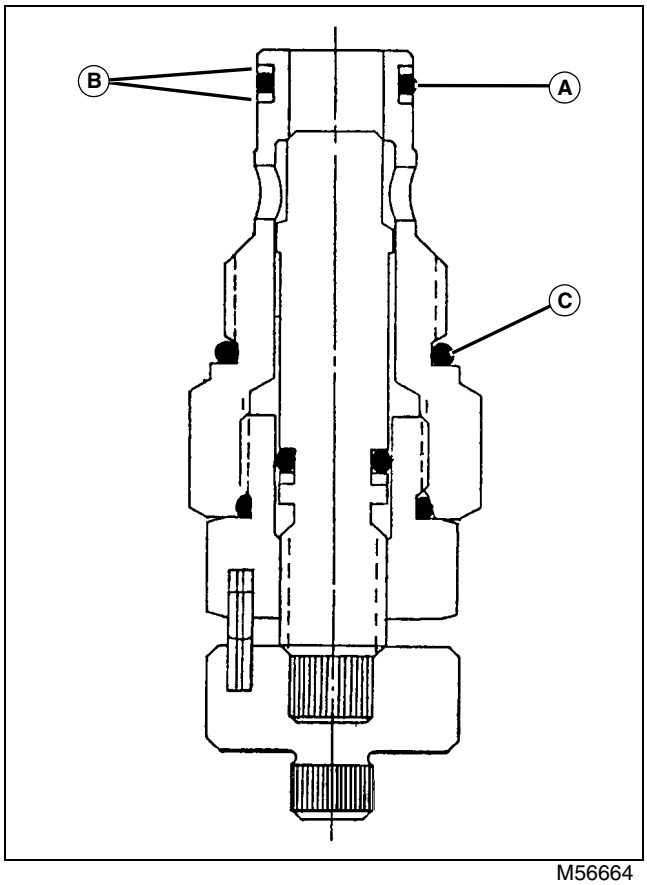
1. Ensure O-ring (A) is installed between backup washers (C). Install O-ring (C). Lubricate O-rings and backup washers before installing valve.

2. Install detent ball and spring (D), secure with hex head retainer.

NOTE: Detent ball and spring must be adjusted with machine running and system under pressure.

3. Adjust detent tension with system under pressure. Proper tension is achieved when the forward/reverse knob stays IN with the system pressurized.

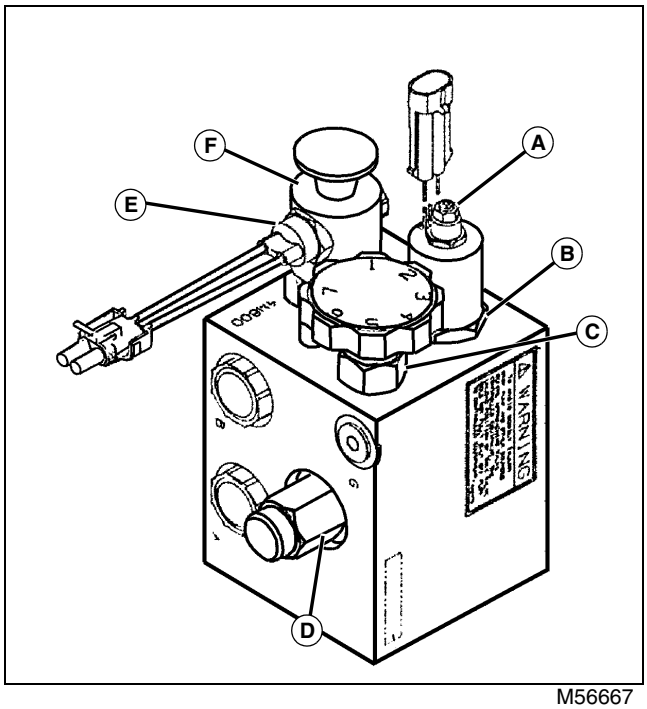
Flow Control Valve



M56664

1. Ensure small O-ring (A) is installed between backup washers (B). Install large O-ring (C). Lubricate O-rings (A and C) and backup washers (B) before installing flow control valve.

Assemble Mow Valve



M56667

A - Mow Valve Solenoid Coil
B - Mow Valve Solenoid Plunger
C - Flow Control Valve
D - Logic Element
E - Switch
F - Forward/Reverse Valve

• Tighten components to specification when assembling components into the backlapping valve.

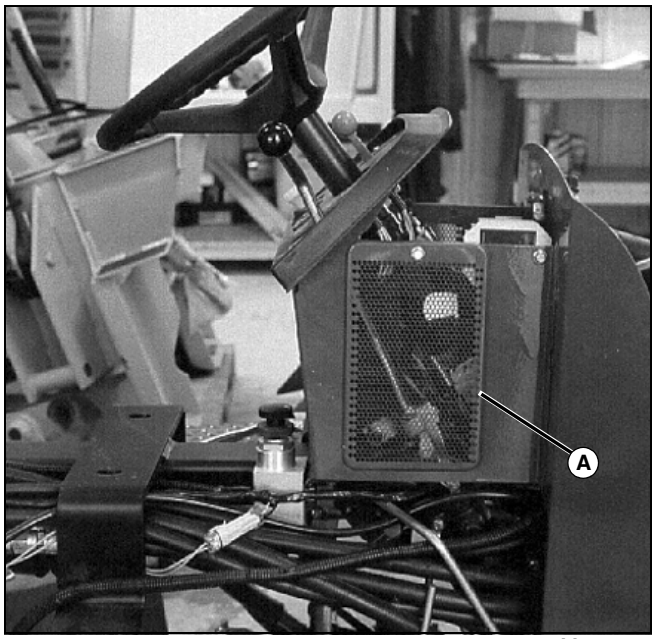
Specifications

Mow Valve Solenoid Plunger	**95 N•m (70 lb-ft)**
Mow Valve Solenoid Coil	**31 N•m (22 lb-ft)**
Flow Control Valve	**65 N•m (47 lb-ft)**
Logic Element	**65 N•m (47 lb-ft)**
Forward/Reverse Valve	**237 N•m (175 lb-ft)**
Switch	**17 N•m (12 lb-ft)**
SAE Plug #2	**58 N•m (42 lb-ft)**
SAE Plug #4	**12 N•m (9 lb-ft)**
SAE Plug #6	**28 N•m (21 lb-ft)**

Remove Lift Valve

CAUTION: Avoid injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Remove four carriage bolts securing tunnel panel to frame. Remove tunnel panel with seat.



M76332

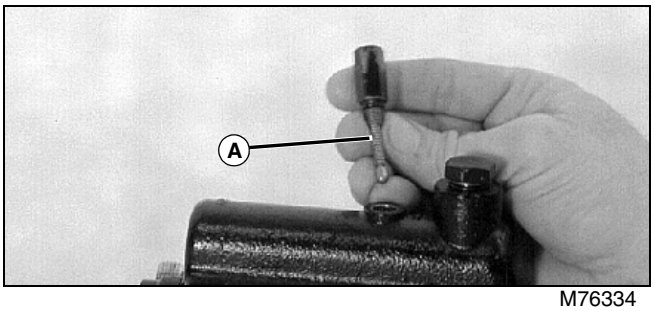
2. Remove inspection grille (A) on right side of steering housing to gain access to lift valve.

3. Disconnect hydraulic lines at lift valve.

4. Remove link connecting the lift valve to the lift handle. Remove two bolts securing lift valve to instrument cluster frame. Remove valve.

Disassemble Lift Valve

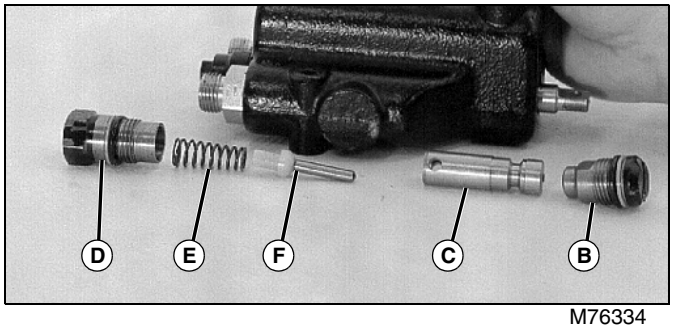
NOTE: Plug all ports and wash valve assembly with a suitable solvent before disassembly.



M76334

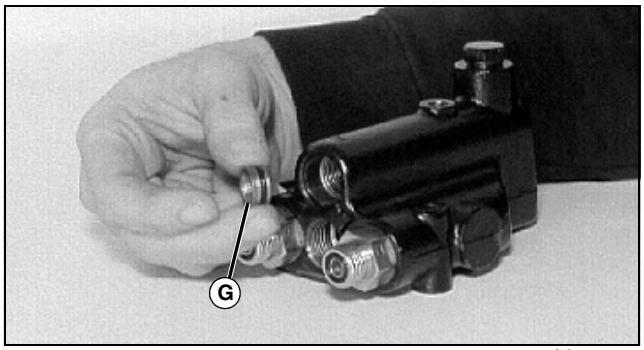
1. Remove detent plunger and spring (A).

IMPORTANT: Avoid damage! Detent plunger must be removed prior to removal of the spools. Failure to do so will damage detent plunger and/or spool.



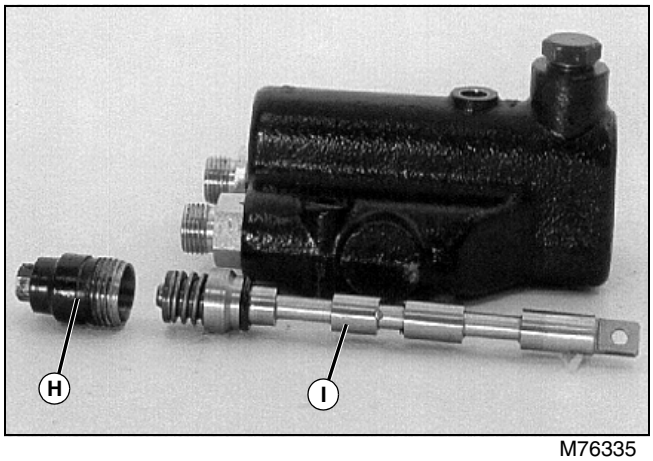
M76334

2. Remove plug (B) and spool (C) from one end of valve, and cap (D), spring (E), and plunger (F) from other end.



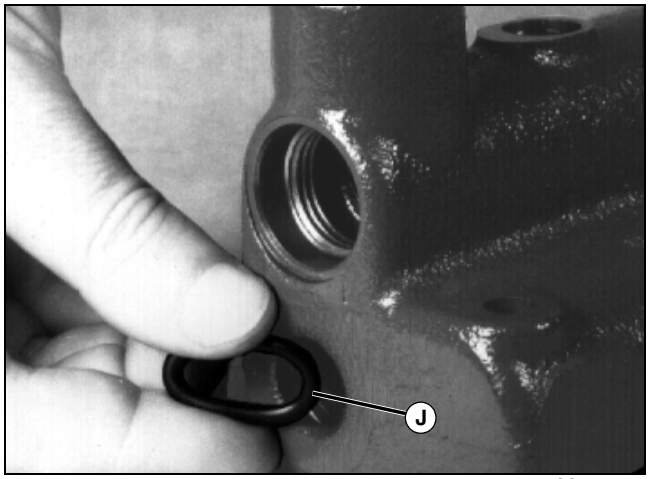
M76338

3. Remove orifice (G) from top center bore. Push out from back side with brass rod.



M76335

4. Remove cap (H) and spool assembly (I) from lower center port.



M56648

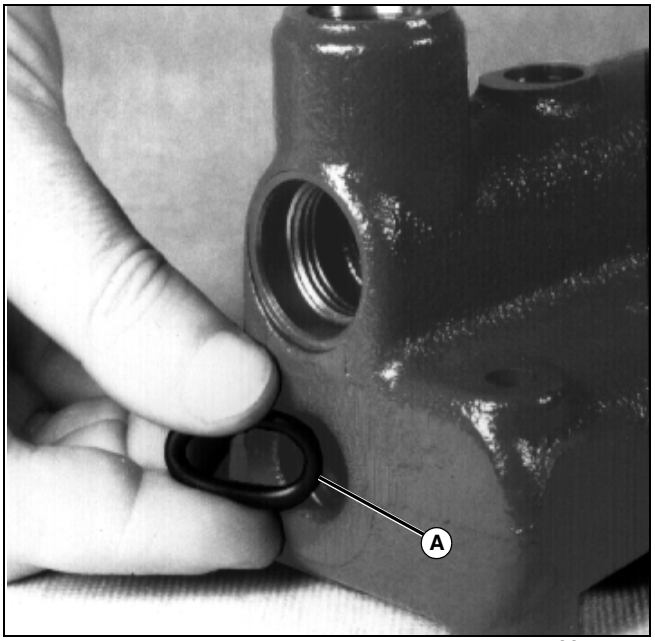
5. Remove O-ring (J) from lower spool port.

Inspect Lift Valve

- Clean all parts with a suitable solvent; clean bores with a brush hone and solvent.
- Inspect bores in valve housing for scoring.
- Inspect spools for scoring, fretting, and straightness.
- Check all springs for breakage.
- Replace all seals and O-rings.
- If any parts are worn, the valve assembly must be replaced.

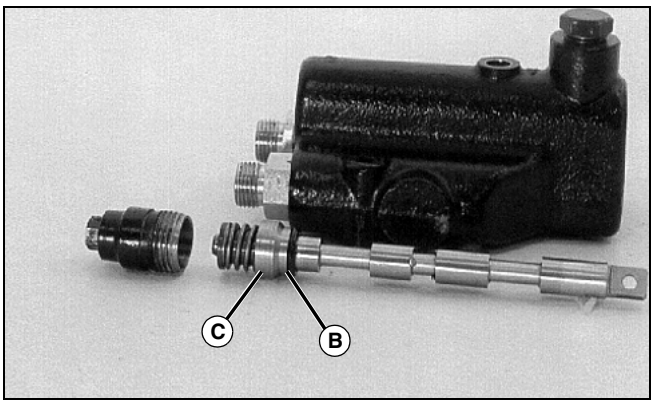
Assemble Lift Valve

IMPORTANT: Avoid damage! Use plenty of fresh hydraulic oil to lubricate parts during assembly.



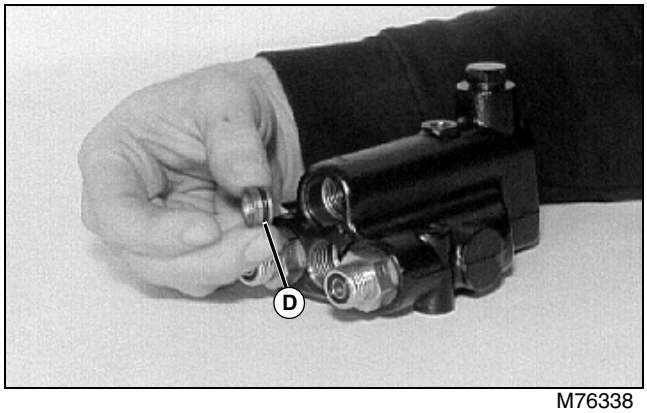
M56648

1. Lubricate and install O-ring (A) into cavity of housing.



M76335

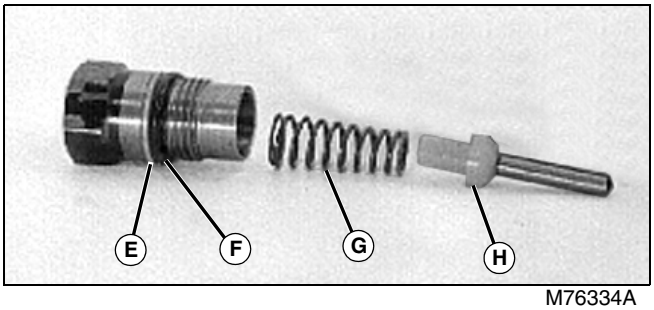
2. Lubricate O-ring (B) and cup (C). Slide cup and O-ring onto spool and install spool into housing.



M76338

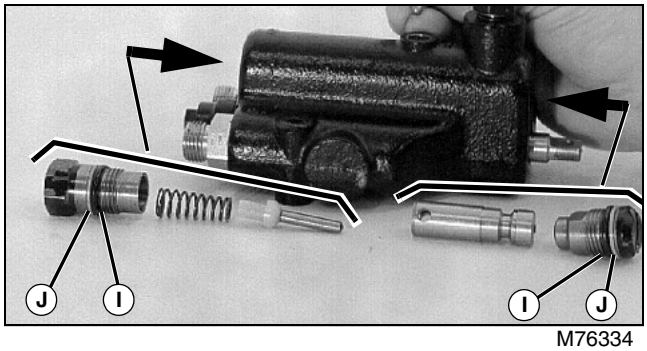
3. Install new O-ring (D) on orifice plate and push plate into top center bore with tapered pocket facing out.

NOTE: Spring is tapered. Install larger end in body of fitting.



M76334A

4. Lubricate and install backup washer (E) and O-ring (F). Assemble spring (G) and return plunger (H) as shown.

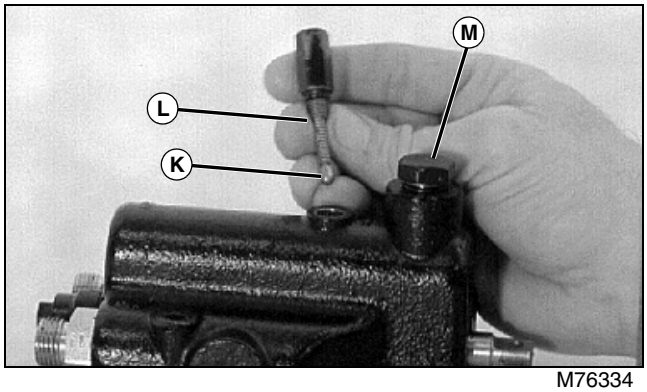


M76334

5. Replace O-rings (I) and backup washers (J) on both caps.

6. Install end fitting and plunger assembly. Tighten to specification.

7. Install detent plunger and screw cap. Tighten to specification.



M76334

8. Install detent plunger (K), spring (L), and body.
9. Replace O-ring on plug (M).

Specifications

End Fitting	**44 N•m (33 lb-ft)**
Screw Cap	**44 N•m (33 lb-ft)**
Detent Plunger	**4 N•m (35 lb-in.)**
Lift Valve Plug	**14 N•m (10 lb-ft)**

Install Lift Valve

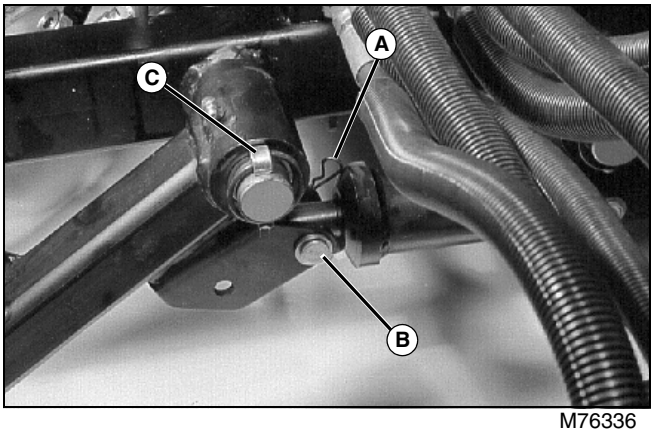
1. Secure valve to frame with two cap screws.
2. Connect hydraulic lines.
3. Install control link.

Specifications

Lift Valve-to-Brake Cap Screw	**4 N•m (40 lb-in.)**

Remove Lift Arm

1. Remove cutting units from lift arm being serviced.
2. Remove hydraulic hoses from hose support (if applicable) on top of lift arm by unwinding from support spiral.

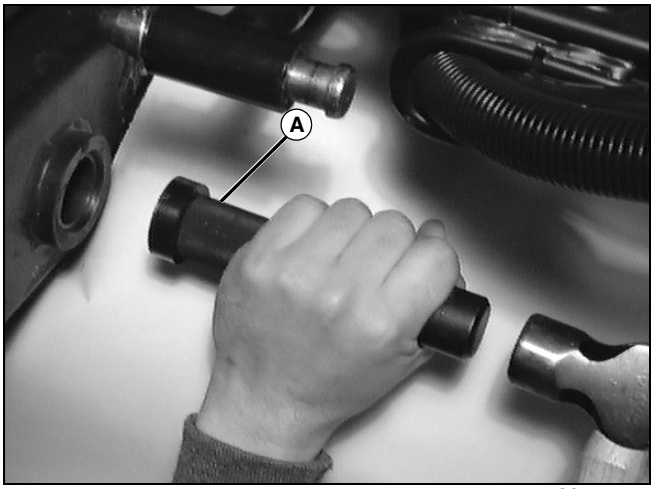


M76336

3. Remove hairpin clip (A) from hydraulic cylinder attachment pin (B) and remove pin from lift arm yoke.
4. Secure cylinder to frame with wire to keep work area clear.
5. Remove retaining lynch pin (C) from lift arm pivot.
6. Remove lift arm shaft from frame pivot pin.

Remove Lift Arm Bushing

1. Remove lift arm. (See “Remove Lift Arm” on page 351.)



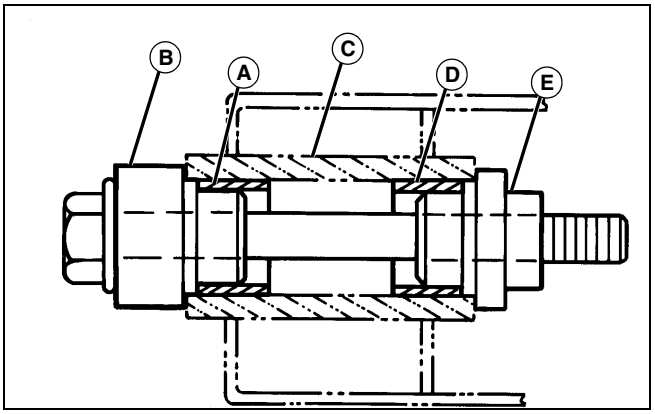
M57766

2. Using 1-5/8 in. bearing driver, drive front and rear bushings out back of lift arm mounting tube.

Install Lift Arm Bushing

Special or Required Tools

Tool Name	Tool No.	Tool Use
Lift Arm Bushing Installer	JDG892	Used to install lift arm bushing.

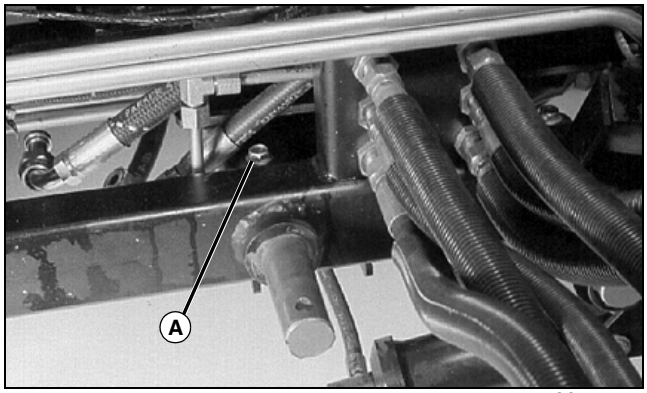


MIF M57769

1. Place rear bushing (A) on threaded end of JDG892 Lift Arm Bushing Installer (B) and place on back of lift arm frame tube (C). Place front bushing (D) on front half (E) of tool and thread bolt from front to rear of tool.

2. Tighten bolt on tool to pull bushings into frame tube until bearing face is flush with face of tube.

Replace Lift Arm Pin



M76337

1. Remove cap screw (A) retaining pin in vehicle frame.

2. Inspect pin for scoring or excessive wear. Replace if necessary.

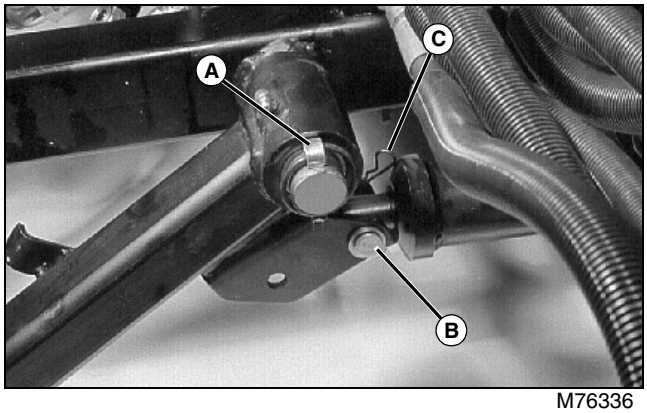
3. Replace pin and secure with cap screw (A).

Install Lift Arm

1. Clean old grease from lift arm and frame tube.

2. Inspect bushings for wear. Replace if necessary.

3. Place lift arm pivot on lift arm pivot shaft.



M76336

4. Install lynch pin (A) on end of lift arm pivot shaft.

IMPORTANT: Avoid damage! Cylinder pin (B) should always be installed from the reel side of the bracket (as shown).

5. Lift cylinder end into place and secure with attachment pin (B) and hairpin clip (C).

Remove Lift Cylinder

1. Park machine on level surface, reels lowered, park brake locked, engine off.

2. Block wheels to prevent inadvertent movement of the machine.

CAUTION: Avoid injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls. Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

3. Remove hydraulic hoses.

4. Remove cotter keys and washers at end of hydraulic cylinder mounting pins.

5. Remove mounting pins and cylinders.

NOTE: Lift cylinders are not rebuildable. If a cylinder is defective, replace entire unit.

6. Replace cylinder.

7. Check and top off hydraulic reservoir.

Table of Contents

STEERING TABLE OF CONTENTS

Specifications

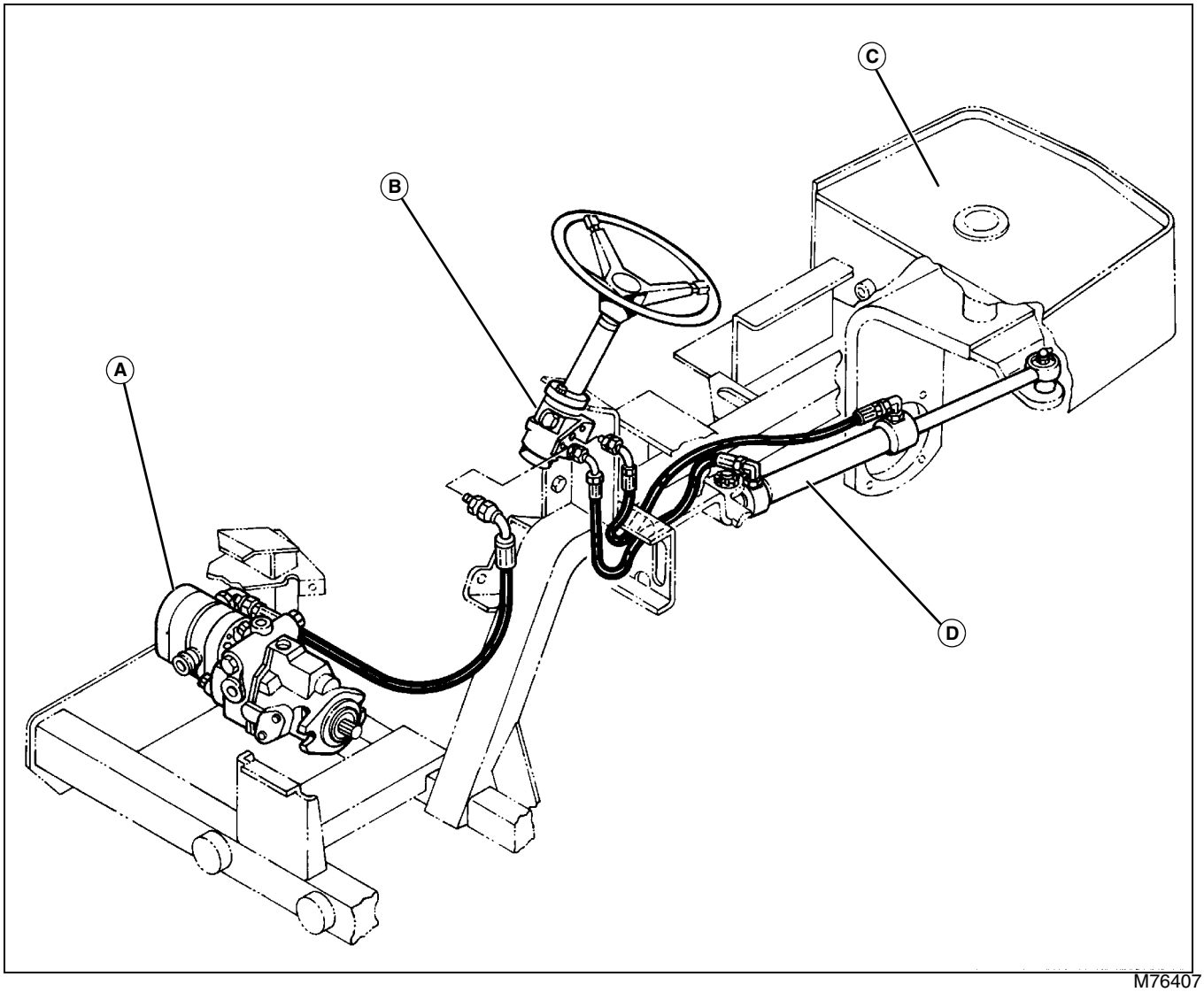
General Specifications

Steering Control Unit

Make	Eaton
Type	Char-Lynn® 2 Series
Maximum Operating Pressure	6895 kPa (1000 psi)
Maximum Back Pressure	1034 kPa (150 psi)
Maximum Operating Temperature	93°C (200°F)
Maximum Flow	15 L/min (4 gpm)
Maximum Differential Temperature (Between Steering Unit and System Temperature)	28°C (50°F)
Input Torque (Powered)	15-25 lb-in. @ 100 psi Tank Pressure
(Non-Powered)	81 N•m (60 lb-ft)
Check Valve for Limited Manual Steering	Yes

Component Location

Steering Components



M76407

A - Charge Pump
B - Steering Valve
C - Reservoir
D - Steering Cylinder

Theory of Operation

Steering System

Function

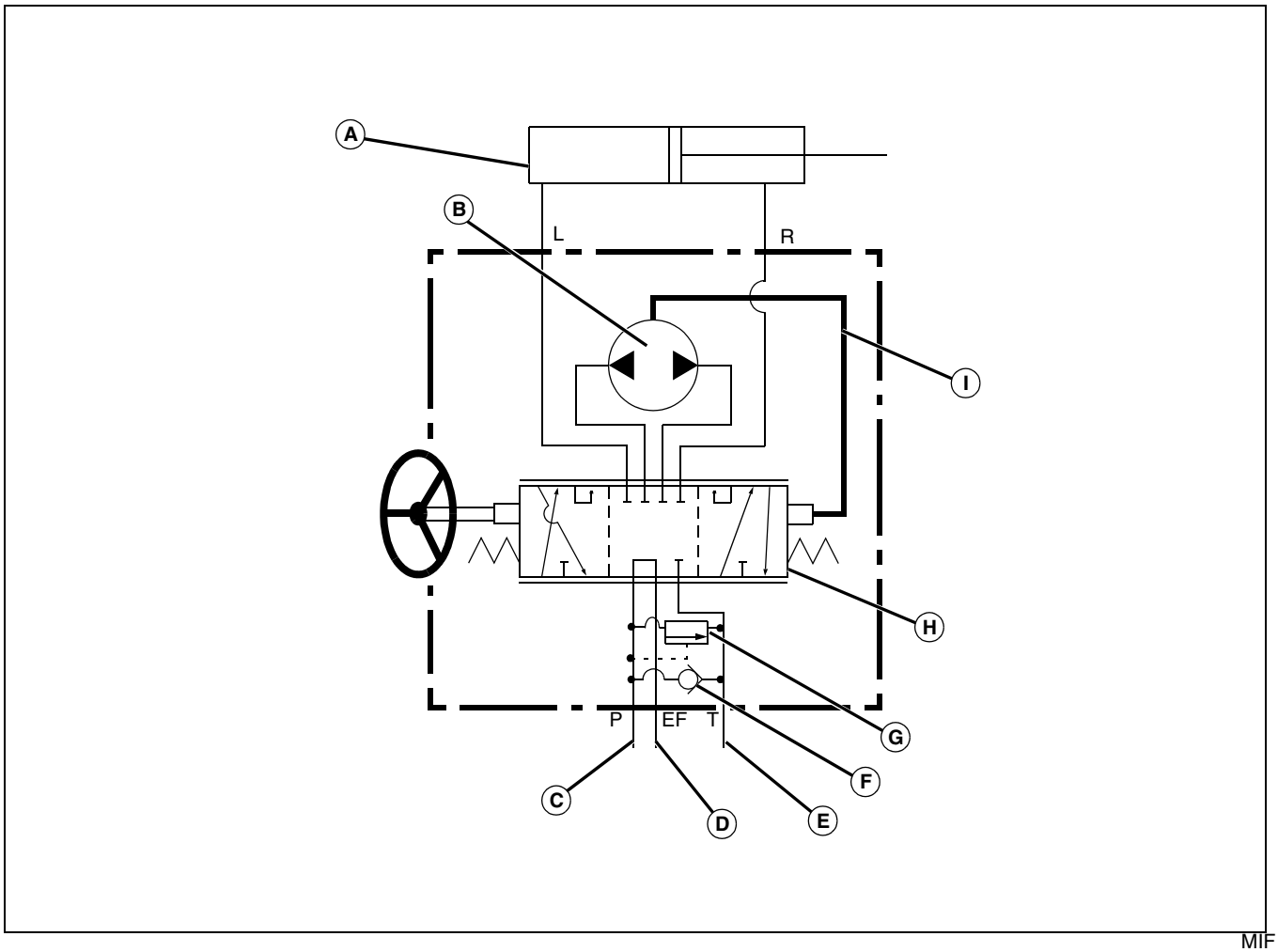
Controls oil flow to and from the steering cylinder for hydraulic or manual steering.

Theory of Operation

Hydraulic pressure to operate the steering system is provided by the charge pump. The charge pump has two functions:

- Maintains a pressure of 7 bar (100 psi) on the low-pressure side of the circuit to supercharge the variable displacement pump (hydrostatic pump).
- Maintains a pressure of 4.25 bar (50-900 psi) at 1.7-5.7 LPM (0.4-1.5 GPM) on the auxiliary side of the circuit for steering and lift system operation.

Pressure from the charge pump is routed to the Steering Control Unit (SCU). The SCU utilizes an open center control valve that gives priority to the steering of the machine when turns are initiated, and routes pressure to the lift system when the steering wheel is not being turned. In the event that the charge pump should fail or the engine stops running, a gerotor motor, located inside the SCU and mechanically linked to the steering wheel, will act as a pump and supply fluid to the steering cylinder to steer the machine. Fluid supply to the gerotor motor enters the motor through an inlet check valve in the SCU.



MIF

A - Steering Cylinder
B - Gerotor
C - From Charge Pump (Inlet Pressure)
D - Lift Valve Pressure Line
E - Charge Pressure to Hydrostatic Pump
F - Inlet Check Valve
G - Relief Valve
H - Spool Valve
I - Mechanical Link

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 tire with tires of proper type. Inflate tire(s) 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 System Leakage" on page 361.) Is test within specifications?

No - Perform steering valve leakage test. (See "Test Steering Valve Leakage" on page 361.) 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 Speed" on page 55. See "Check and Adjust Fast Idle-CARB/EPA Engines" on page 56.)

(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?

Symptom: Sluggish Steering Response

Yes - Go to step (7).

No - Replace filter as needed.

(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 System Leakage" on page 361.) Is test within specifications?

No - Perform steering valve leakage test. (See "Test Steering Valve Leakage" on page 361.) 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?

Yes - Go to step (4).

No - Secure steering valve.

(4) Disassemble and inspect steering control unit. (See "Disassemble Steering Control Unit (SCU)" on page 365.) Is SCU in good condition with no noticeable damage?

No - Repair or replace steering control unit as needed.

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 System Leakage" on page 361.) Is test within specifications?

Symptom: High Steering Effort in One Direction

Yes - Go to step (3).

No - Perform steering valve leakage test. (See "Test Steering Valve Leakage" on page 361.) Follow results of test.

(3) Disassemble and inspect steering control unit. (See "Disassemble Steering Control Unit (SCU)" on page 365.) Is SCU in good condition with no noticeable damage?

No - Repair or replace steering control unit as needed.

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 tire with tires of proper type. Inflate tire(s) 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 double pump (charge pump). Is there sufficient hydraulic fluid flow?

Yes - Go to step (6).

No - Repair or replace pump as necessary.

(6) Perform steering system leakage test. (See "Test System Leakage" on page 361.) Is test within specifications?

Yes - Go to step (7).

No - Perform steering valve leakage test. (See "Test Steering Valve Leakage" on page 361.) Follow results of test.

Symptom: High Steering Effort in Both Directions

(7) Disassemble and inspect steering control unit. (See "Disassemble Steering Control Unit (SCU)" on page 365.) Is SCU in good condition with no noticeable damage?

No - Repair or replace steering control unit as needed.

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 Speed" on page 55. See "Check and Adjust Fast Idle-CARB/EPA Engines" on page 56.)

(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) 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) Are hydraulic lines and oil cooler free from any restrictions?

Yes - Go to step (6).

No - Clear lines or cooler of restrictions. Replace parts as needed.

(6) Is steering rod free of damage, not bent?

Yes - Go to step (7).

No - Replace steering cylinder.

(7) Is steering clevis free of damage, not bent?

Yes - Go to step (8).

No - Repair or replace steering clevis.

(8) Test double pump (charge pump). Is there sufficient hydraulic fluid flow?

Symptom: Steering Cylinder Will Not Fully Extend or Retract

Yes - Go to step (9).

No - Repair or replace pump as necessary.

(9) Perform steering system leakage test. (See "Test System Leakage" on page 361.) Is test within specifications?

Yes - Go to step (10).

No - Perform steering valve leakage test. (See "Test Steering Valve Leakage" on page 361.) Follow results of test.

(10) Disassemble and inspect steering control unit. (See "Disassemble Steering Control Unit (SCU)" on page 365.) Is SCU in good condition with no noticeable damage?

No - Repair or replace steering control unit as needed.

Symptom: Wheels Continue to Turn After Steering Wheel Is Stopped

(1) Disassemble and inspect steering control unit. (See "Disassemble Steering Control Unit (SCU)" on page 365.) Is SCU in good condition with no noticeable damage?

No - Repair or replace steering control unit as needed.

Tests and Adjustments

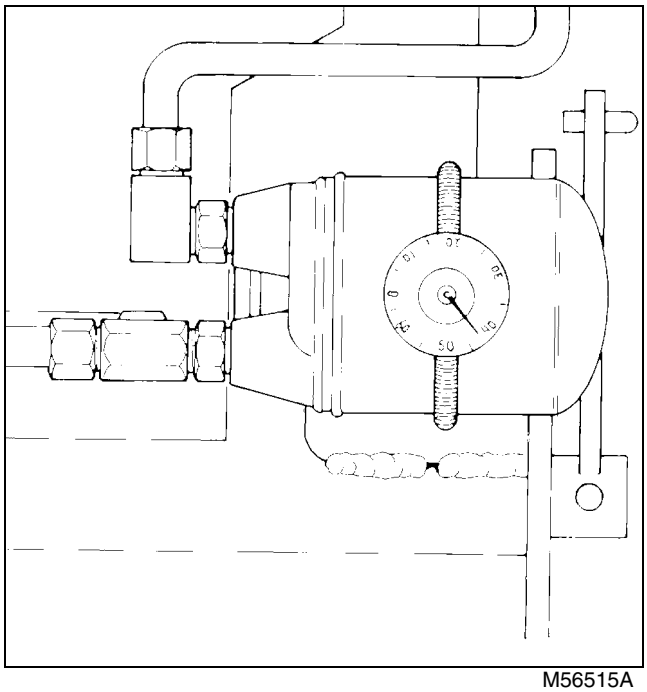
Test System Leakage

Reason

To determine if steering system has excessive internal leakage.

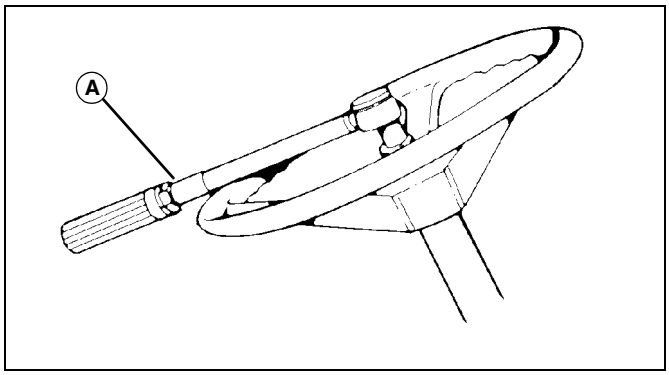
Procedure

NOTE: Ensure hydraulic fluid temperature is 43°C (110°F) or above.



M56515A

1. Place thermometer on oil filter and run system until oil temperature reaches 43°C (110F°).
2. Start engine and set throttle to slow idle.



M46864A

3. With steering wheel at a 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 the steering wheel at a maximum left turn position.

Results

- If rpm/min exceeds specification, perform the steering valve leakage test. (See “Test Steering Valve Leakage” on page 361.)

Specifications

Steering Wheel Turns per Minute at 6 N•m (72 lb-in.) Constant Torque. . . . . 6 Maximum

Test Steering Valve Leakage

Reason

To determine if leakage is in steering valve or in steering cylinder.

Procedure

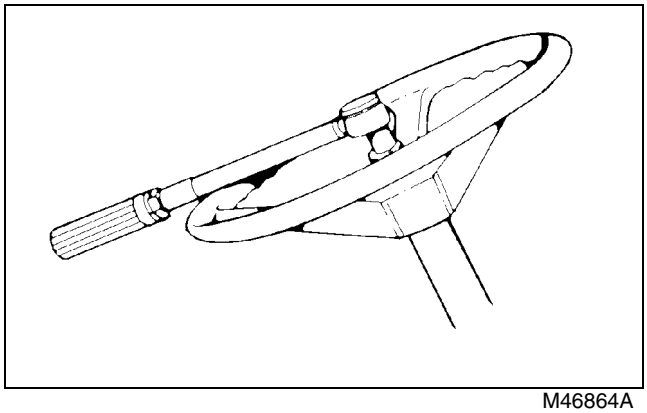
NOTE: Ensure hydraulic fluid temperature is 43°C (110°F) or above.

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.

1. Disconnect and cap the lines at the steering cylinder.
2. Start engine and set throttle to slow idle.



M46864A

3. 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.

4. Repeat step 3 with the steering wheel at a maximum left turn position.

Results

- If rpm/min. exceeds specification, repair the steering valve.
- If rpm/min. is less than specification, replace the steering cylinder.

Specifications

Steering Wheel Turns per Minute at 6 N•m (72 lb-in.) Constant Torque . . . . . .6 Maximum

Test Steering System Relief Valve Pressure

Reason

To determine if the charge pump is producing enough pressure to operate lift system.

Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hose	AMT846	Connect pressure gage for steering and lift system relief valve pressure test.
T-Fitting, 9/16-16 F ORFS x 9/16-16 M ORFS x 9/16-16 M ORFS	AMT1043	Connect pressure gage for steering and lift system relief valve pressure test.
Pressure Gage 0-40 000 kPa (0-6000 psi)	JT07047	Connect pressure gage for steering and lift system relief valve pressure test.
Male Quick Coupler, 11/16-16 F ORFS	RE43774	Connect pressure gage for steering and lift system relief valve pressure test.
Female Quick Coupler	RE48122	Connect pressure gage for steering and lift system relief valve pressure test.

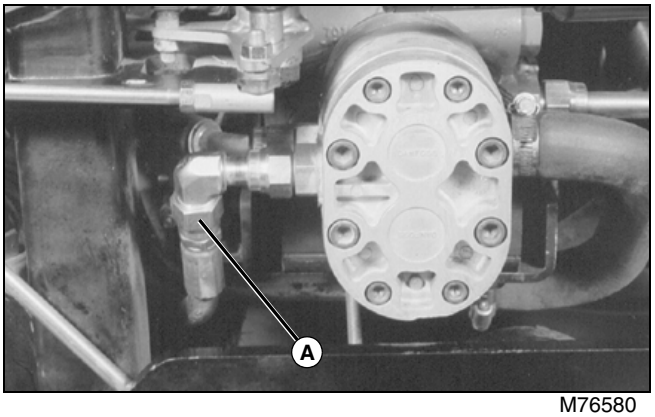
Procedure

Test is performed by reading system pressure between rear section of double pump (charge pump) and steering valve.

1. Park machine on level surface, lock park brake, lower cutting units to ground, engine off.

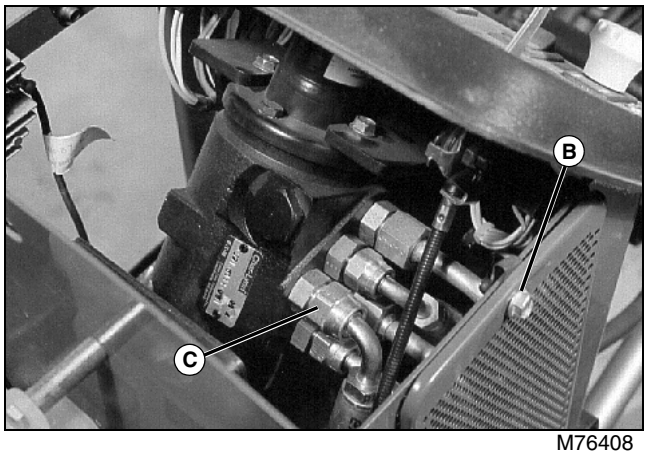
CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body 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.



M76580

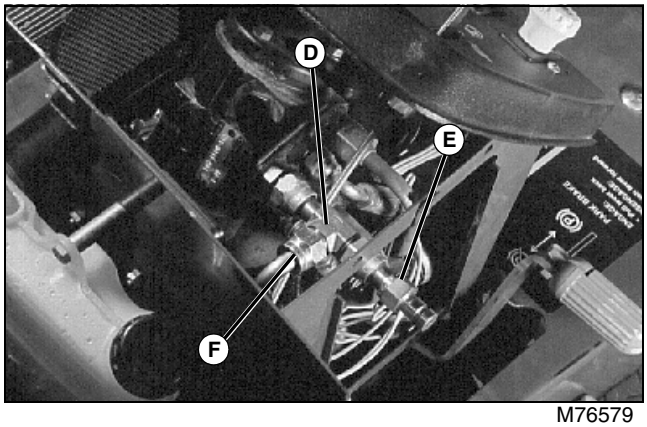
2. Loosen hose fitting (A), at charge pump outlet, to allow hose to rotate.



M76408

3. Remove screw (B) securing screen to side of steering housing. Remove screen.

4. Disconnect hose fitting (C) on forward port as shown.



M76579

5. Install AMT1043 T-Fitting (D) and RE43774 Male Quick Coupler (E).

6. Connect charge pump hose (F) to AMT1043 T-Fitting.

7. Assemble AMT846 Hose, RE48122 Female Quick Coupler and JT07047 Gage. Connect to test fitting.

CAUTION: Avoid injury! Do Not Use A Test Pressure Gage Rated Lower Than Recommend. Do Not Move Steering Wheel Or Lift Levers While Test Is In Progress.

8. Lock park brake.

9. Set raise/lower lever to lower position.

IMPORTANT: Avoid damage! DO NOT turn steering wheel or operate lift system while performing this test. Doing so will result in readings above the pressure setting because of system back pressure.

10. Start engine and run at full throttle.

11. Note reading on gage.

Corrections

- If charge pump does not meet specifications, rebuild or replace charge pump.

Specifications

Steering System Relief Valve Pressure . . . 2930.27 kPa (900 psi)

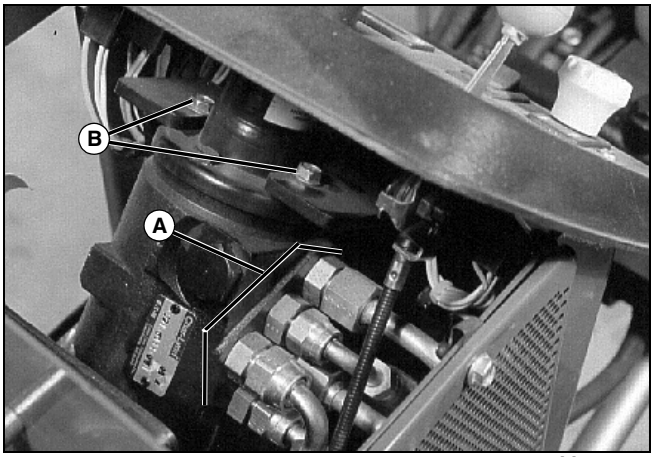
Repair

Remove Steering Control Unit (SCU)

1. Park vehicle on a level surface.
2. Move mow/transport lever to TRANSPORT position.
3. Lower cutting units to the ground.
4. Turn key switch OFF.
5. Lock park brake.
6. Disconnect battery negative (-) cable.
7. Chock front wheels to prevent inadvertent movement of vehicle.
8. Raise hood and secure in the upright position.

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.

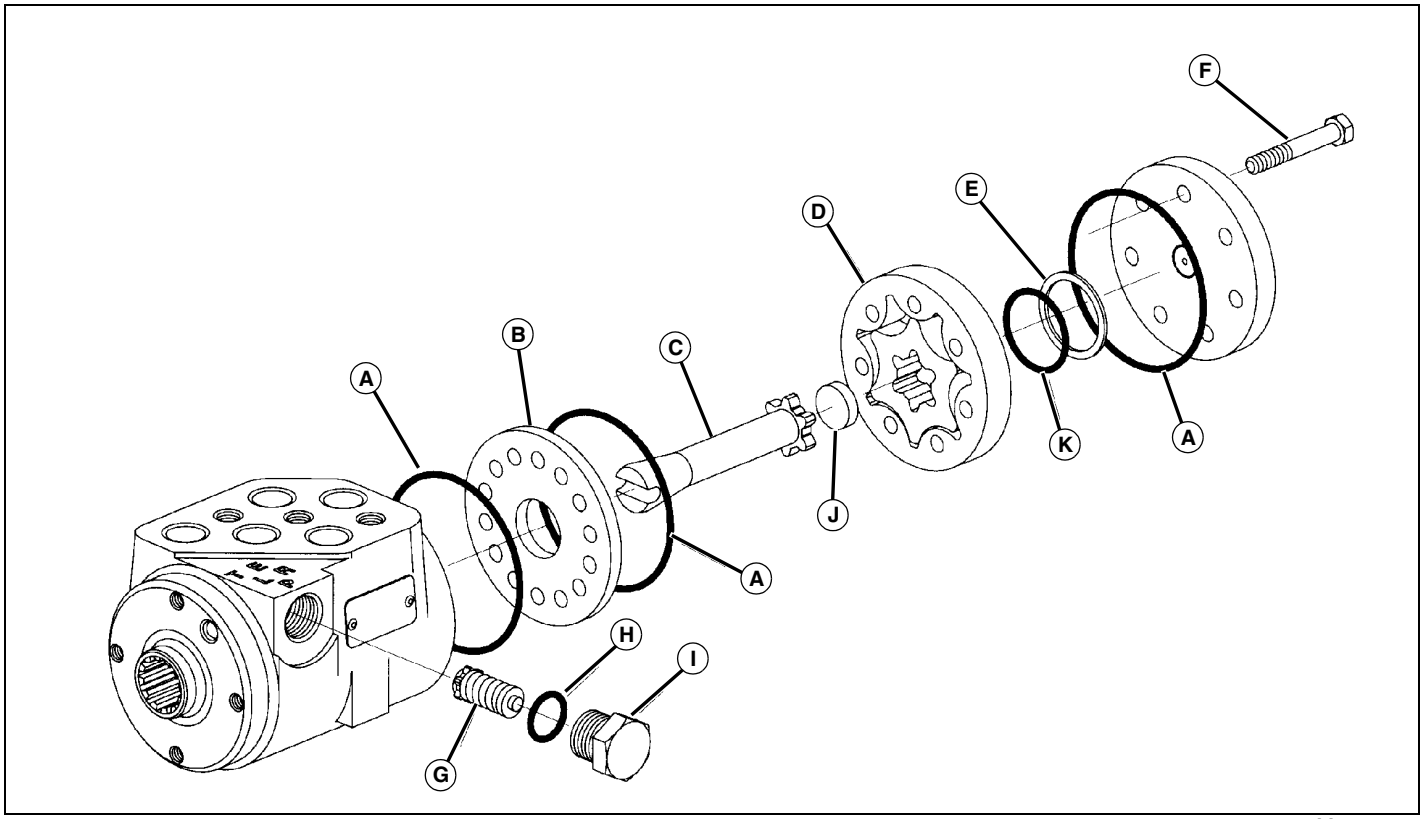


M76408

9. Remove hydraulic connections (A) from side of SCU.
10. Remove steering wheel.
11. Remove two cap screws (B) securing SCU to vehicle frame.
12. Remove SCU.

Disassemble Steering Control Unit (SCU)

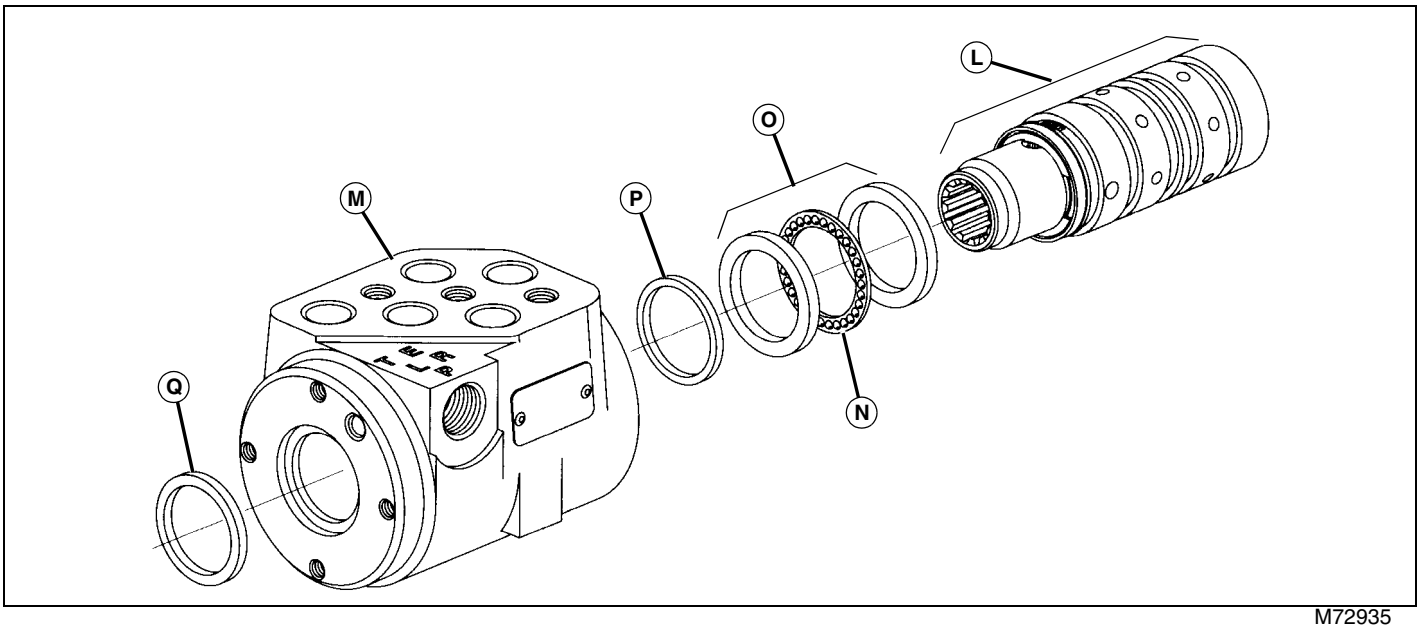
IMPORTANT: Avoid damage! Cleanliness is extremely important when repairing the hydraulic Steering Control Unit (SCU). Before disconnecting the hydraulic lines, clean the port area of the SCU, then drain the fluid and plug all ports. Clean the exterior of the SCU thoroughly and protect the machined surfaces during the repair procedure.



M72934

- **A - O-Ring Seal**
- **B - Wear Plate**
- **C - Drive**
- **D - Gerotor**
- **E - Seal Ring**
- **F - Cap Screw (7 used)**
- **G - Manual Steering Check/Relief Valve**
- **H - O-Ring**
- **I - Plug**
- **J - Spacer**
- **K - O-Ring**

1. Remove the 7 cap screws (F) and disassemble the SCU as shown.



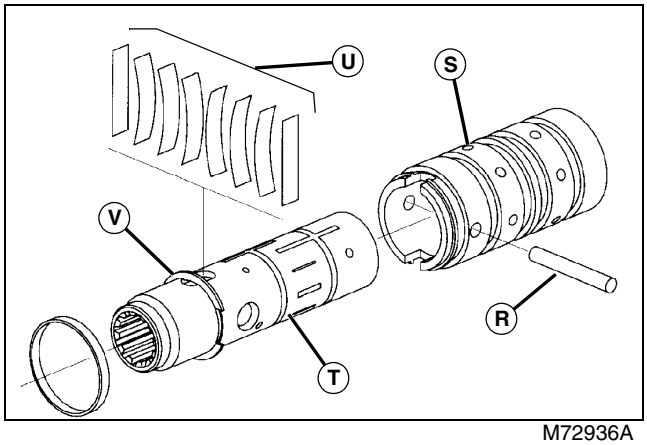
M72935

2. Slide the spool and sleeve (L) from the housing (M). Remove the thrust bearing (N) and bearing races (O).

3. Remove the quad seal (P).

IMPORTANT: Avoid damage! Do not damage the dust seal seat.

4. Remove dust seal (Q).



M72936A

5. Remove the pin (R) that holds the spool and sleeve (S) together.

6. Carefully slide the spool (T) out of the sleeve. The springs (U) and retaining ring (V) will stay with the spool when it is removed.

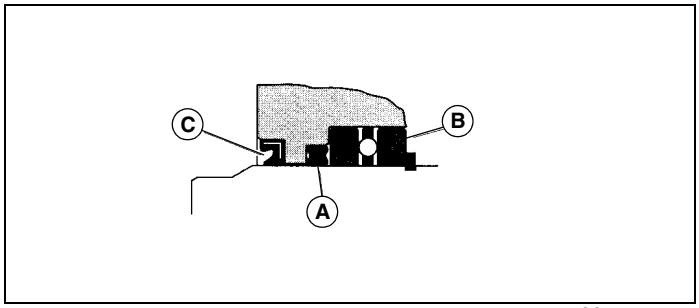
CAUTION: Avoid injury! The centering springs are under tension. Remove the retaining ring carefully.

7. Remove the retaining ring (V) and springs (U).

Assemble Steering Control Unit (SCU)

IMPORTANT: Avoid damage! Check all mating surfaces. Replace any parts with scratches or burrs that could cause leakage. Wash all metal parts in clean solvent. Blow them dry with compressed air. DO NOT dry with paper towels or cloth. Lint in a hydraulic system will cause damage.

NOTE: Always use new seals when reassembling the hydraulic steering control unit. During reassembly, lubricate the new seals with petroleum jelly. Also lubricate the machined surfaces and bearings with clean hydraulic fluid.



M72937

1. Install the quad seal (A):

   - Put one of the bearing races (B) and sleeve into the housing.
   - Together, the housing and bearing race (B) create a groove into which the quad seal (A) will be installed.

- Hold the bearing race (B) tightly against the input end of the housing by pushing on the gerotor end of the sleeve.
- Fit the quad seal (A) into its seat through the input end of the housing. Ensure the seal is not twisted.

2. Remove the sleeve and bearing race (B).

3. Lubricate and install the dust seal (C) using a seal driver. Position the seal as shown above.

4. Install the centering springs in the spool. It is best to install the two flat pieces first. Next, install the curved pieces, three at a time.

5. Fit the retaining ring over the centering springs.

6. Apply a light coat of clean hydraulic fluid to the spool and slide it into the sleeve. Ensure the centering springs fit into the notches in the sleeve.

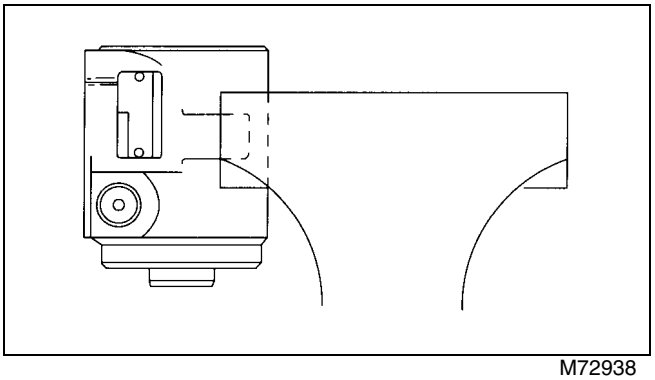
7. Install the pin.

8. Apply a light coat of petroleum jelly to the inner edge of the dust and quad seals.

9. Put the thrust bearing and races into the housing. The thrust bearing goes between the two races.

IMPORTANT: Avoid damage! DO NOT damage the dust or quad seals while installing spool and sleeve assembly. Slight back and forth rotation while installing spool and sleeve will help to prevent damage to seals.

10.Apply a light coat of clean hydraulic fluid to the spool and sleeve assembly and slide it into the housing. Be sure pin is installed in spool and sleeve before installing in housing.



M72938

11.Clamp the housing in a vise, using just enough clamping force to hold the housing secure.

12.Lubricate and install a new O-ring seal in the groove in the housing.

13.Install the wear plate (J) and align the holes in the wear plate with the threaded holes in the housing.

NOTE: The holes in the wear plate are symmetrical.

14.Install the drive, ensuring that the slot in the drive engages the pin.

15.Lubricate and install a new O-ring seal in the groove of the wear plate.

16.Install the gerotor and align the screw holes.

17.Lubricate and install a new O-ring and seal ring in the groove of the gerotor star.

18.Install the spacer.

19.Install the end cap and seven cap screws. Tighten cap screws in alternating pattern to specification.

Specifications

Steering Control Unit
Cap Screw Torque . . . . . 17 N•m (150 lb-in.)

Remove Steering Clevis

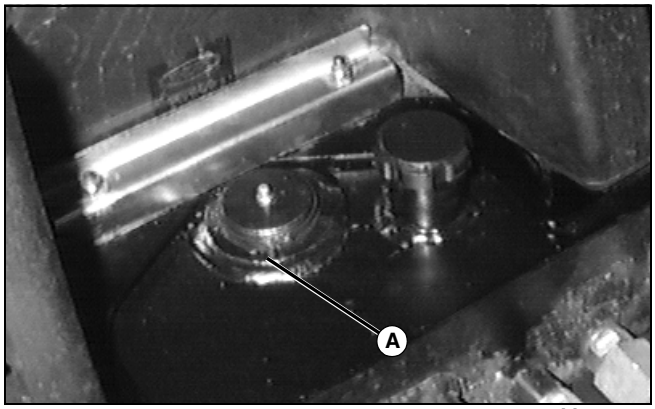
1. Disconnect seat switch and fuel line.

2. Remove the four nuts that secure the seat platform to the vehicle frame and remove the platform.

3. Block the front wheels and support the rear of the vehicle with stands.

4. Remove the third wheel and wheel motor, if equipped.

5. Place support stands under the third wheel support.

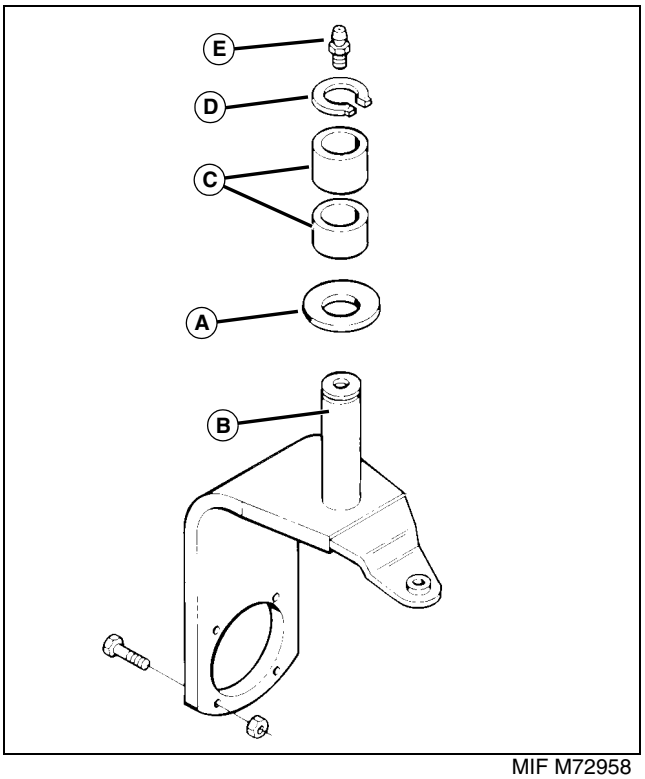


M72954

6. Remove snap ring (A) and lower the third wheel support to the ground.

7. Inspect third wheel support shaft and bushings, replace parts as necessary.

Install Steering Clevis



MIF M72958

1. Install thrust washer (A) on third wheel support shaft (B)
2. Apply a light film of grease to the third wheel support shaft and bushings (C).
3. Carefully guide the third wheel support into the shaft housing, being careful not to damage the bushings.
4. Install the snap ring (D) with the sharp edge of the snap ring up. Be sure it is locked in the groove.
5. Reinstall the wheel motor and wheel.
6. Reinstall the seat platform, and connect the fuel line and seat switch.
7. Grease the third wheel support shaft at the grease fitting (E).

Rear Wheel TORQMOTOR™ Repair

The drive motor on the rear wheel is identical to the front wheel drive motors. (See “TORQMOTOR™ Removal” on page 309. See “Disassemble TORQMOTOR™” on page 310. See “Inspect TORQMOTOR™ Component” on page 310. See “Assemble TORQMOTOR™” on page 311. See “TORQMOTOR™ Final Checks” on page 312.)

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BRAKES TABLE OF CONTENTS

BRAKES SPECIFICATIONS

Specifications

General

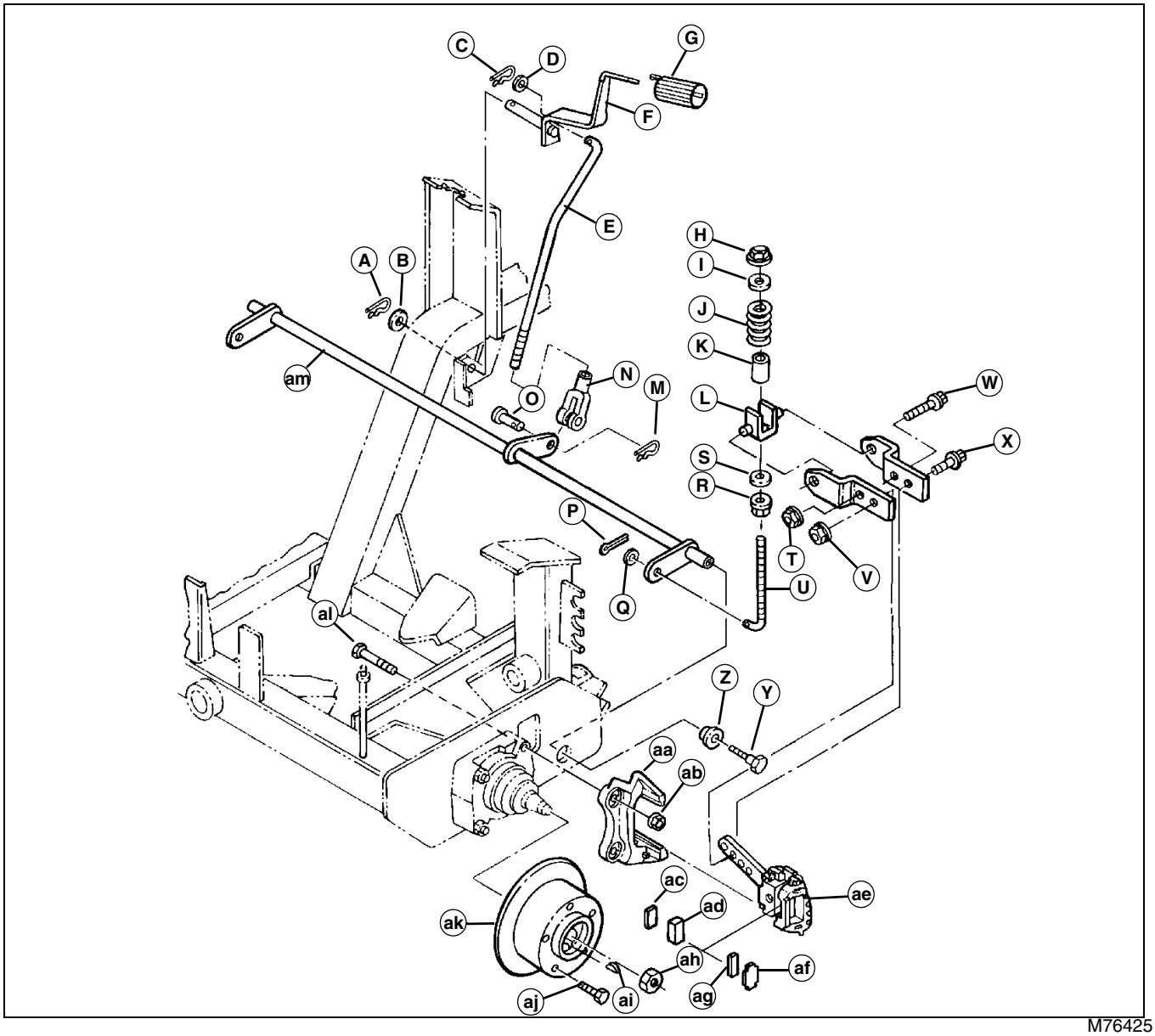
Brake Type	**Mechanical**
Rotor Diameter (Nominal)	**203.835 mm (8.025 in.)**
Rotor Thickness (New)	**4.775 mm (0.188 in.)**
Rotor Minimum Thickness	**3.556 mm (0.140 in.)**
Rotor Run-Out	**0.635 mm (0.025 in.)**
Pad Thickness, Usable	**3.429 mm (0.135 in.)**

Torque Specifications

Wheel Motor Bolt Torque	**725 N•m (540 lb-ft)**

Component Location

Brake Components



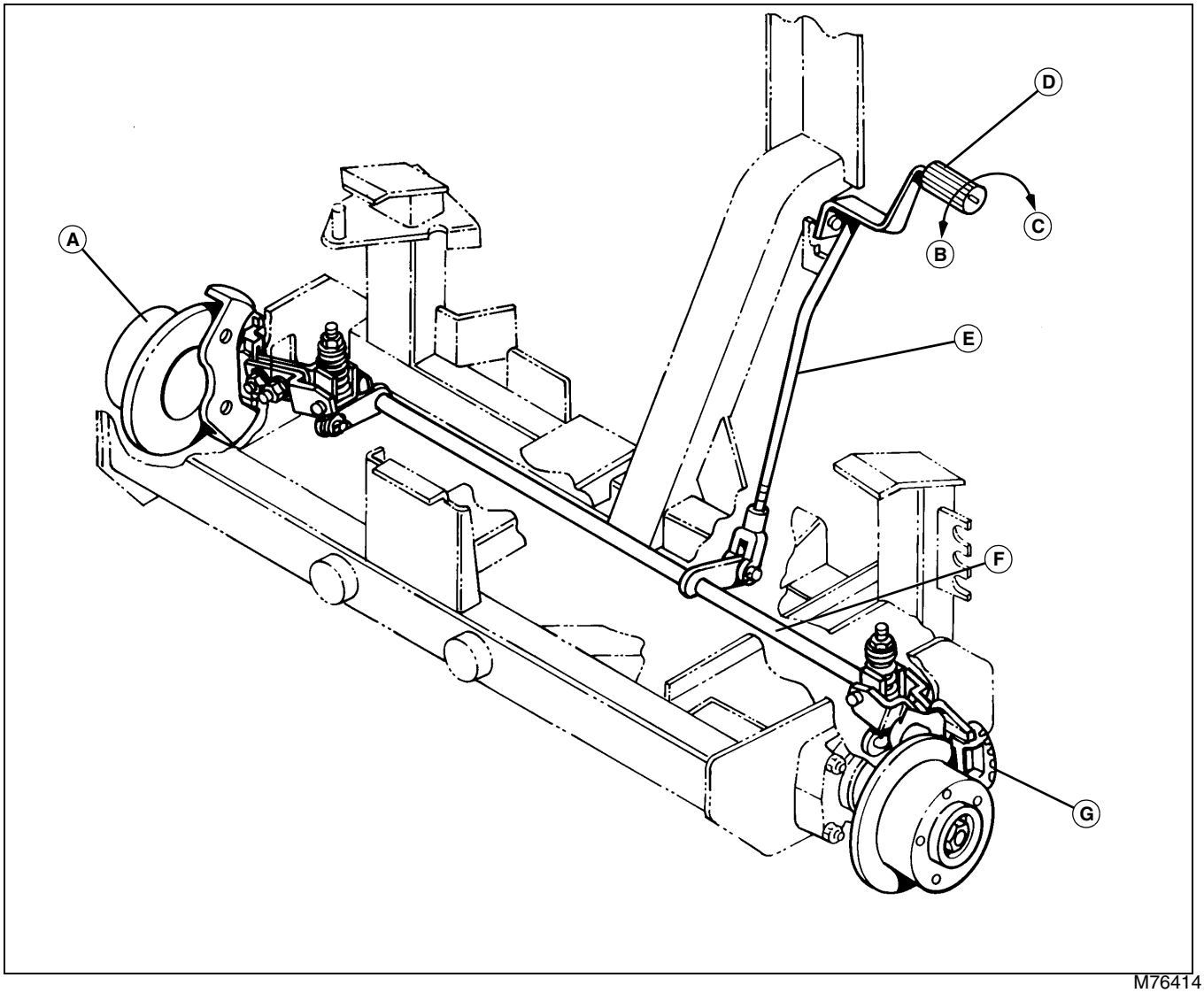
M76425

A - Cotter Pin
B - Shim
C - Cotter Pin
D - Washer
E - Rod
F - Handbrake Lever
G - Knob
H - Flange Nut
I - Washer
J - Spring
K - Spacer
L - Clevis
M - Cotter Pin
N - Yoke
O - Pin Fastener
P - Cotter Pin
Q - Washer
R - Flange Nut
S - Washer
T - Flange Nut
U - Hook Bolt
V - Flange Nut

W - Cap Screw
X - Cap Screw
Y - Cap Screw
Z - Bushing
AA- Bracket
AB- Nut
AC- Backing Plate
AD- Brake Pad, Thick
AE- Caliper LH
AF- Backing Plate
AG- Brake Pad, Thin
AH- Nut
AI - Key
AJ- Lug Bolt
AK- Hub
AL- Bolt
AM- Shaft

Theory of Operation

Brake System



M76414

Function

The park brake is used to prevent movement when the mower is not in use. The brake is not intended for use in controlling speed or stopping the mower while it is in motion. Primary braking is accomplished by the back pressure in the hydrostatic transmission.

The brake interlock switch will stop the engine if the operator attempts to move the unit with the brake engaged or leaves the seat without engaging the brake.

Theory

When the brake lever (D) is pulled toward (C) the operator, the link rod (E) rotates the pivot rod (F), which in turn actuates the caliper link, which causes the brake caliper (G) to force the brake pads against the brake disc (A). This prevents the unit from moving. Operating the brake lever also operates the brake interlock switch, which will stop the engine under certain circumstances.

The brake is automatically locked by moving the park brake lever fully toward the operator. It is unlocked by pushing the lever to the top of the slot (B). When the park brake lever is engaged, the brakes will remain engaged until the lever is disengaged.

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 376.)

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 376.)

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 376.)

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 376.)

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

To ensure brake linkage is adjusted properly.

Procedure

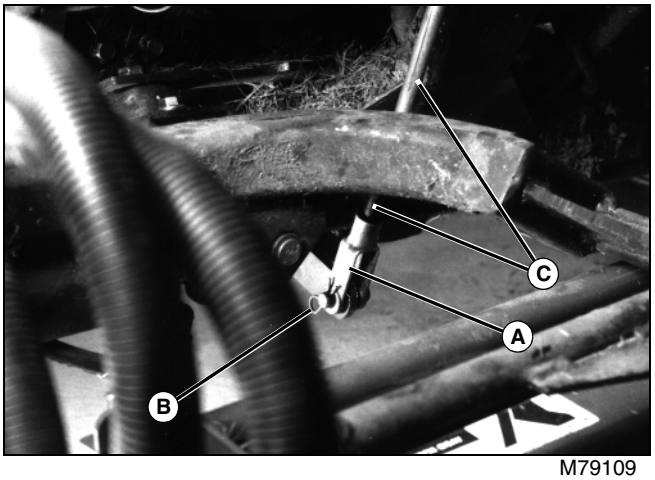
1. Park machine on level surface and turn engine off.
2. Block rear wheels and unlock park brake lock.

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

3. Use jack stands to support the front wheels off the ground.
4. Inspect all rods and linkage for wear or other damage. Replace if required.

NOTE: There are two pads in each caliper. The inboard one (closest to actuator) is approximately 1/2 in. thick when new. The outboard pad is approximately 3/8 in. thick when new.

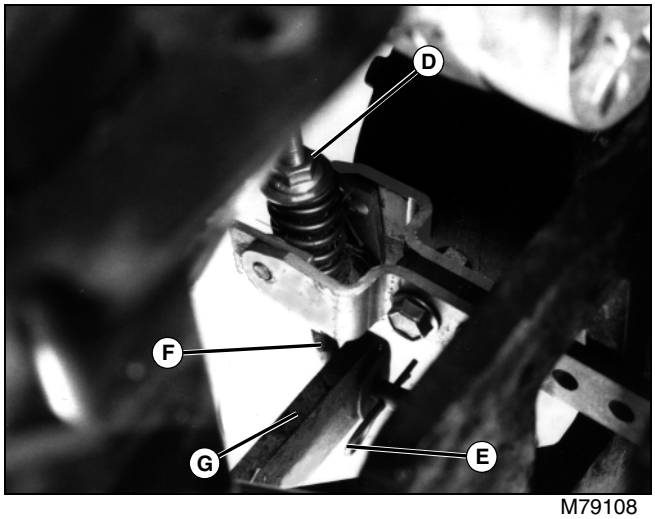
5. Check brake pads for excessive wear. Replace both pads if either is less than specifications.



M79109

6. Adjust clevis (A) by removing hairpin clip (B) from pin, removing pin from clevis, and screwing clevis up or down on rod (C) until the threads on the rod are flush with the inside of the clevis.
7. Reassemble clevis, pin, and hairpin clip.

IMPORTANT: Avoid damage! Do not loosen top nut until spring is loose. If top nut is backed off too far spacer on inside of spring may jump out of hole in spring bracket and bind up brake when top nut is tightened.



M79108

8. Loosen top nut (D) approximately 1/4 inch.
9. Remove hairpin clip (E) from end of “J” rod.
10. While holding caliper arm, with spring assembly, up as far as possible, adjust “J” rod (F) until end of rod aligns with hole in brake lever arm (G).
11. Reassemble “J” rod, washer, and hairpin clip.
12. Tighten top nut until it contacts spacer. Torque to specifications.

IMPORTANT: Avoid damage! Ensure that spring bracket is sliding on spacer when brake is engaged.

13. Engage park brake and ensure that spring is compressing and that spacer is protruding through bottom of spring bracket.
14. Repeat steps 6 through 14 on other wheel.
15. Remove jack stands.

Specifications

Brake Pad Minimum Thickness . . . . . 3 mm (0.125 in.)
Top Nut Torque . . . . . 10 N•m (7 lb-ft)

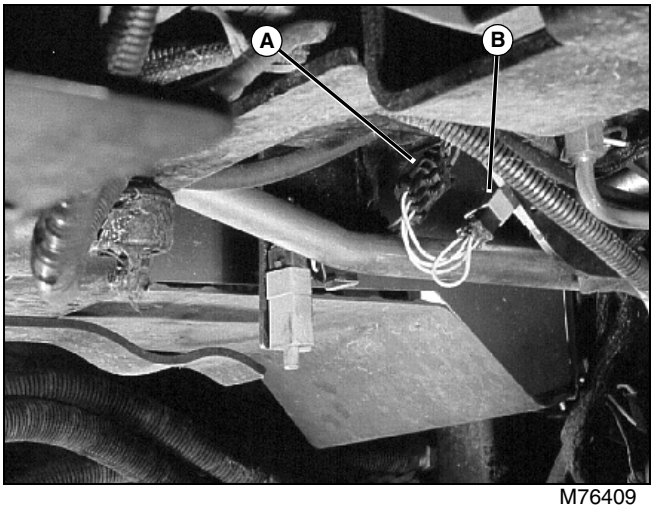
Test Brake Switch

Reason

To ensure that park brake switch is operating properly.

Procedure

1. Release park brake lock lever. Make sure brake is completely off.



M76409

2. Locate connector (A) to brake switch (B). Disconnect.

M76413

Picture Note: Sheet metal removed for photo clarity.

3. Use test meter (C) to test continuity from center lead to either side. One contact will be on, the other off.

4. Rotate brake lever until brake switch is completely depressed.

5. Use test meter to test continuity from center lead to either side. The opposite contacts should be on/off from step 3. If not, replace switch.

Results

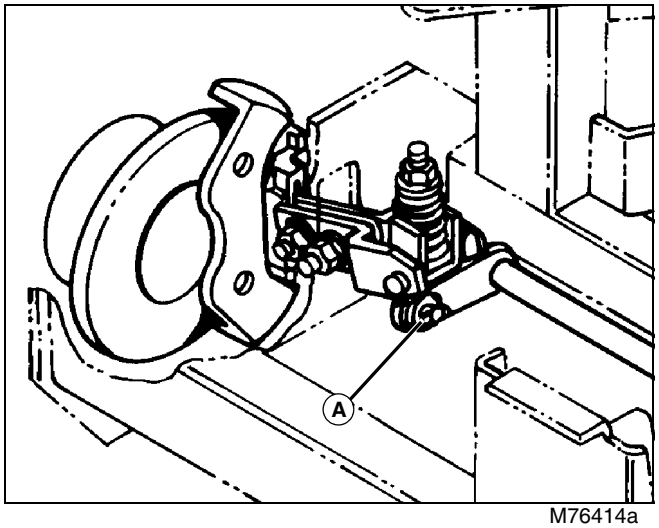
- Engine should start and run under normal operating conditions.

Repair

Replace Brake Pad

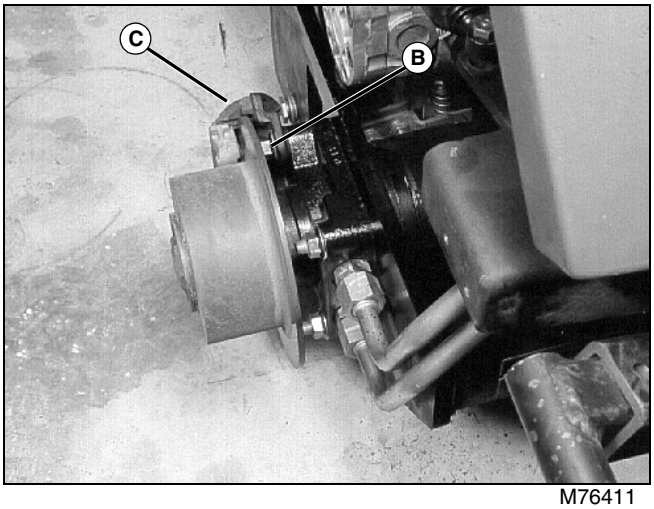
IMPORTANT: Avoid damage! Complete pad replacement on one side of vehicle at a time. Right and left units are different internally. *Do Not* reverse units.

1. Park vehicle on a level surface.
2. Jack and block front of machine to provide clearance between the floor and bottom of tires.
3. Move mow/transport lever to TRANSPORT position.
4. Lower cutting units to the ground.
5. Turn key switch OFF.
6. Unlock park brake.
7. Disconnect battery negative (-) cable.
8. Raise hood and block in upright position.
9. Remove wheel and tire.



M76414a

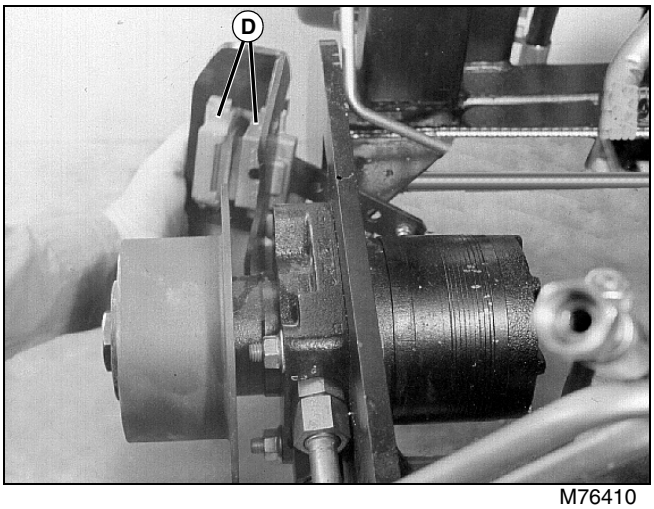
10. Remove cotter pin (A) from spring linkage arms.



M76411

11. Remove two cap screws (B) securing caliper bracket (C) to frame.
12. Rotate spring linkage assembly and remove complete brake assembly from frame.

NOTE: There are two pads in each caliper. The inboard one (closest to actuator) is approximately 1/2 in. thick when new. The outboard pad is approximately 3/8 in. thick when new.

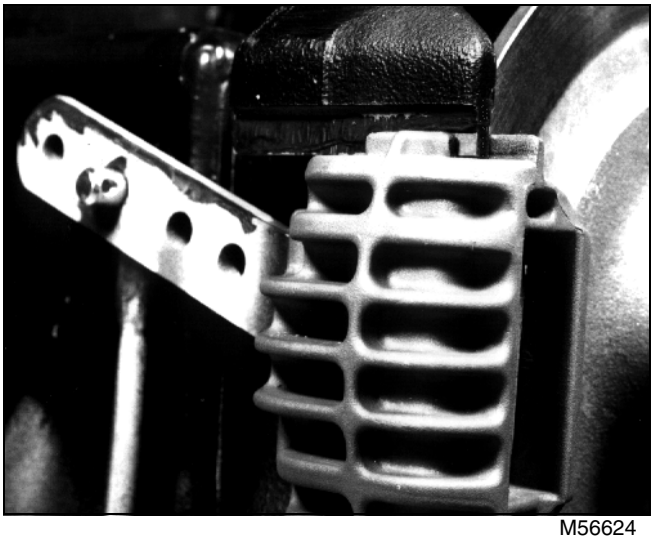


M76410

13. Replace pads (D).
14. Inspect caliper housing for damage or wear. Make sure that caliper slides easily on bracket.

IMPORTANT: Avoid damage! Ensure caliper assemblies are positioned on sliders as shown.

Complete pad replacement on one side of vehicle at a time. Right and left units are different internally. *Do Not* reverse units.



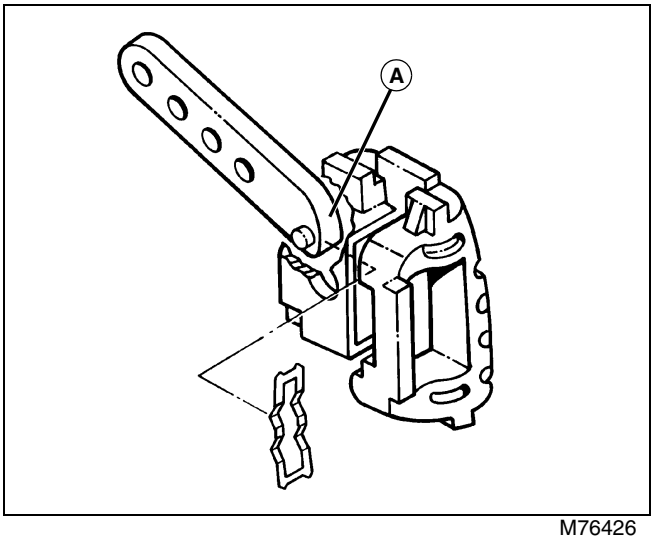
M56624

15. Install calipers in reverse order of removal.
16. Install linkage arms and secure with cotter pins.
17. Install wheel and tire assembly.
18. Adjust brakes. (See “Adjust Brakes” on page 376.)

Replace Caliper

1. Remove brake caliper. (See “Replace Brake Pad” on page 378.)

NOTE: Pay special attention to orientation of actuator arm cam surface (A). Pins should be in top slot in caliper body.



M76426

Picture Note: Left caliper shown.

2. Assemble new caliper as shown.
3. Install brakes. (See “Replace Brake Pad” on page 378.)

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Specifications

General Specifications

Make	John Deere
Size	66 cm (26 in.)
Size	76.2 cm (30 in.)
Backlapping	On machine variable speed (standard)
Clip Ratio	
5-Blade	0.201 mph
8-Blade	0.126 mph
Front Rollers	Optional (smooth or grooved)
Reel Diameter	17.8 cm (7 in.)
Bed Knife Adjustment	Reel-to-bed knife
Height-of-Cut	(3/8 - 1-5/8 in.) (1-1/2 - 3-1/2 in.)
Number of Blades	(5 or 8)
Cutting Unit Drive	Hydraulic
Options	
Rear Solid Roller Scraper	Optional

Repair Specifications

Bed Knife Top Surface	5° Relief angle
Front Surface	5° Relief angle
Reel	Spin grind with 20° Relief angle
Roller	Smooth, grooved
Bed Knife Support	
Mounting Bolts	63 N•m (63 lb-ft)
Mounting Screws	47 N•m (35 lb-ft)
Reel Mounting	
Pivot Arm	
(Forward)	47 N•m (35 lb-ft)
(Rear)	81 N•m (60 lb-ft)
Shaft Rotation Torque	0.80 N•m (7 lb-ft) w/ET 15755 Grease
Roller Mounting	
Bolts	47 N•m (35 lb-ft)
Shaft End Play	0.152 mm (0.006 in.)
Reel/Bed Knife Clearance	
Range	0.025-0.076 mm (0.001-0.003 in.)

Tools and Materials

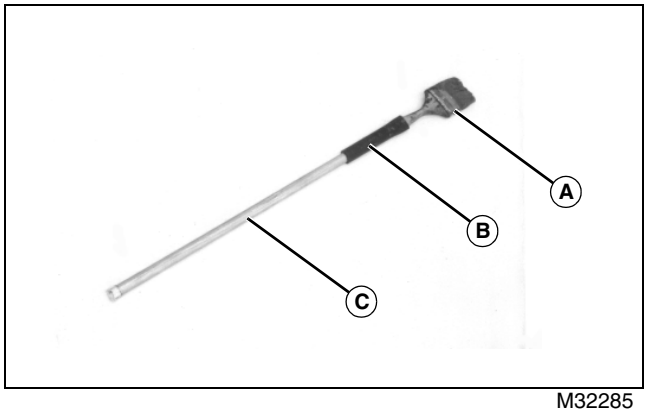
Special or Required Tools

Tool Name	Tool No.	Tool Use
Height-of-Cut Gage Bar	TCU13823	Used to adjust cutting height.
Feeler Gage, 0.051 mm (0.002 in.)	NA	Used to measure reel-to-bed knife clearance.

Other Material

Part No.	Part Name	Part Use
NA	Lapping Compound	Used to perform backlapping procedure.
TY25083	John Deere Golf and Turf Cutting Unit Grease	Used to lubricate mower bearings and seals.
TY24425	John Deere Special Purpose HD Water Resistant Grease	Used to lubricate roller shaft bearing.
TY24811	NEVER-SEEZ®	Applied to bed knife support mounting bolts.

Dealer Fabricated Tools



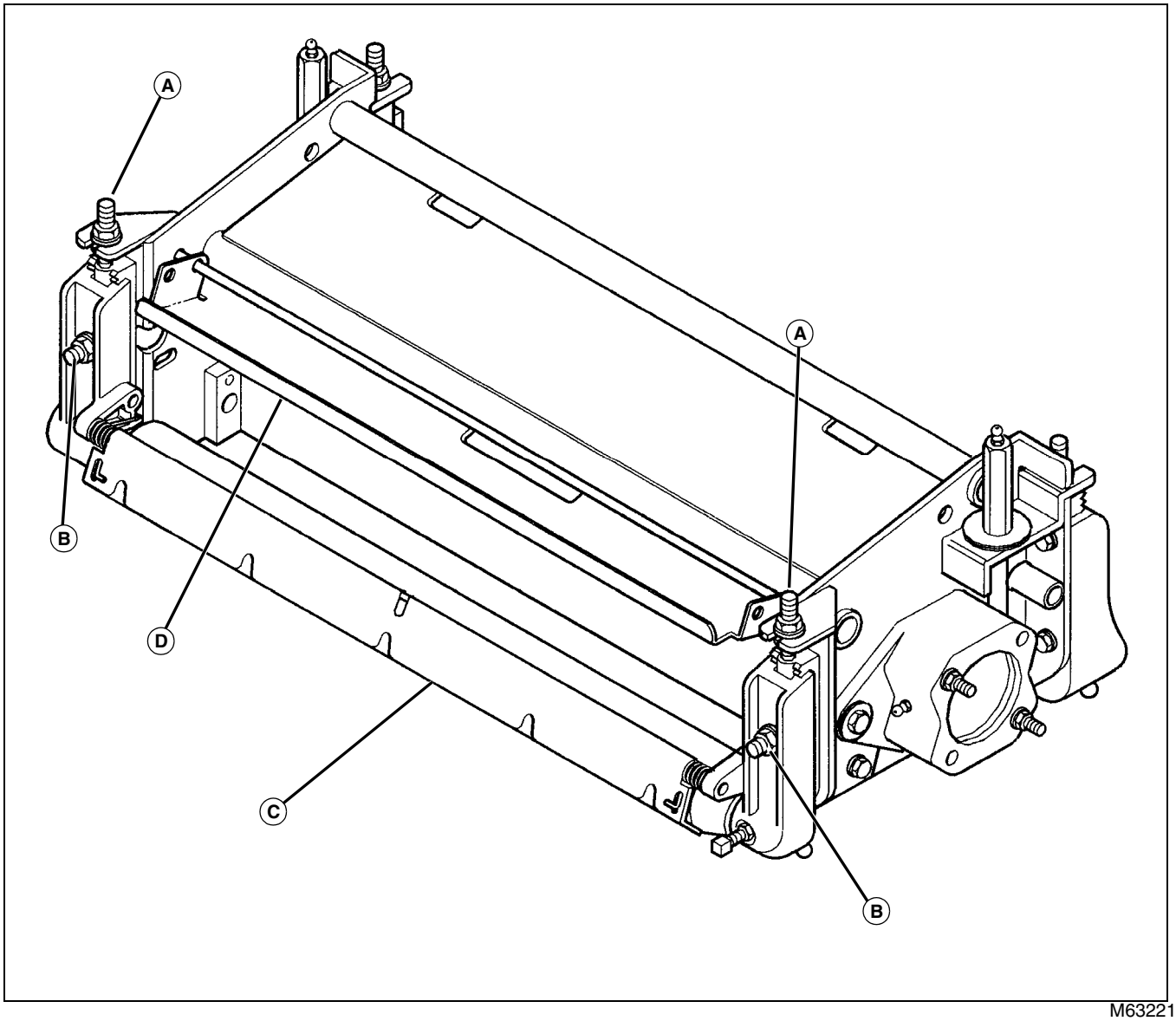
M32285

Attach a piece of rubber hose (B) and additional handle (C) to a paint brush (A) to extend its length. This is used to apply lapping compound.

Component Location

26-Inch Standard Cutting Unit

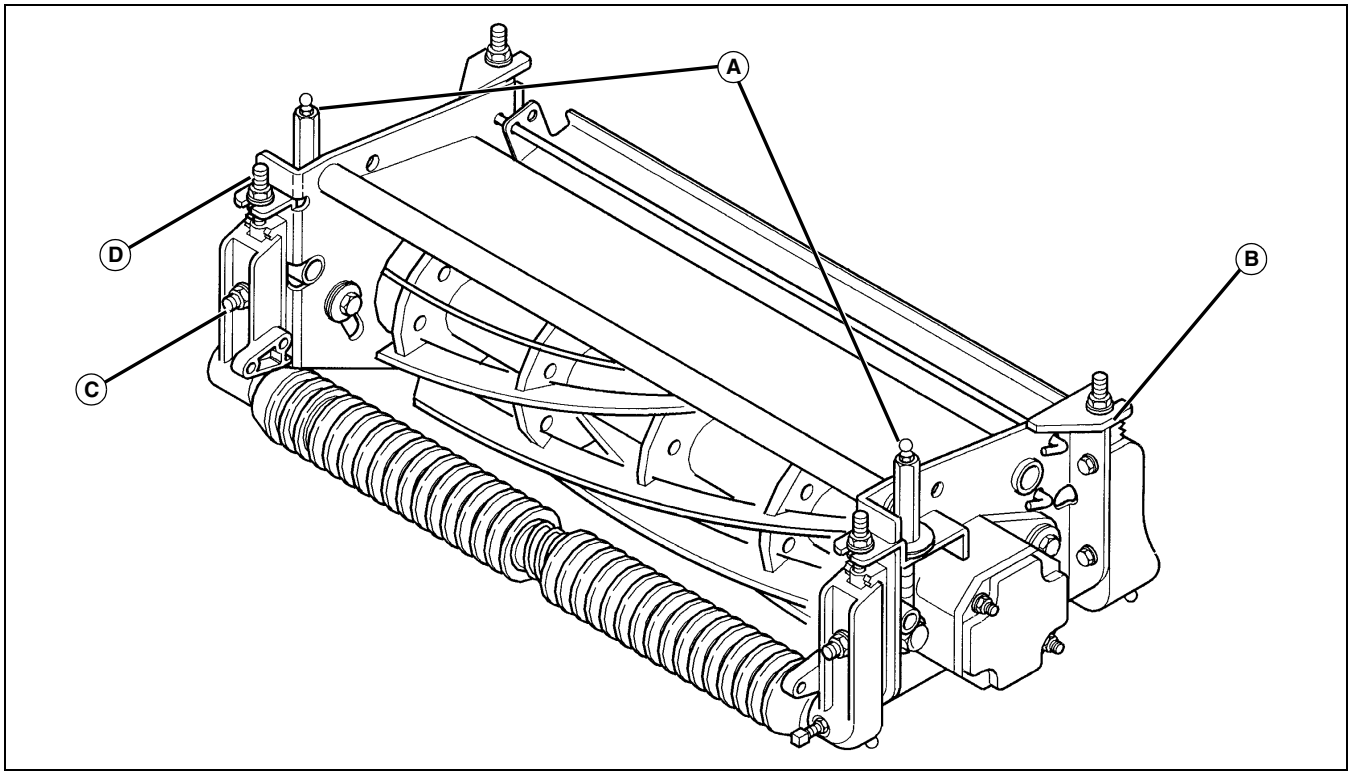
View from Rear



M63221

A - Rear Roller Fine Adjustment
B - Rear Roller HOC Adjustment
C - Rear Roller Scraper
D - Rear Deflector

View from Front



M63220

A - Reel-to-Bed Knife Clearance Adjustment
B - Ratchet Teeth
C - Front Roller Fine Adjustment
D - Front Roller HOC Adjustment

Theory of Operation

Reel and Bed Knife Grinding

Reel and Bed Knife Relationship

Reel mowers are precision machines requiring daily maintenance to maintain the well-groomed appearance of turfgrass. The scissor-like shearing action, which only a reel mower is capable of achieving, is 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).

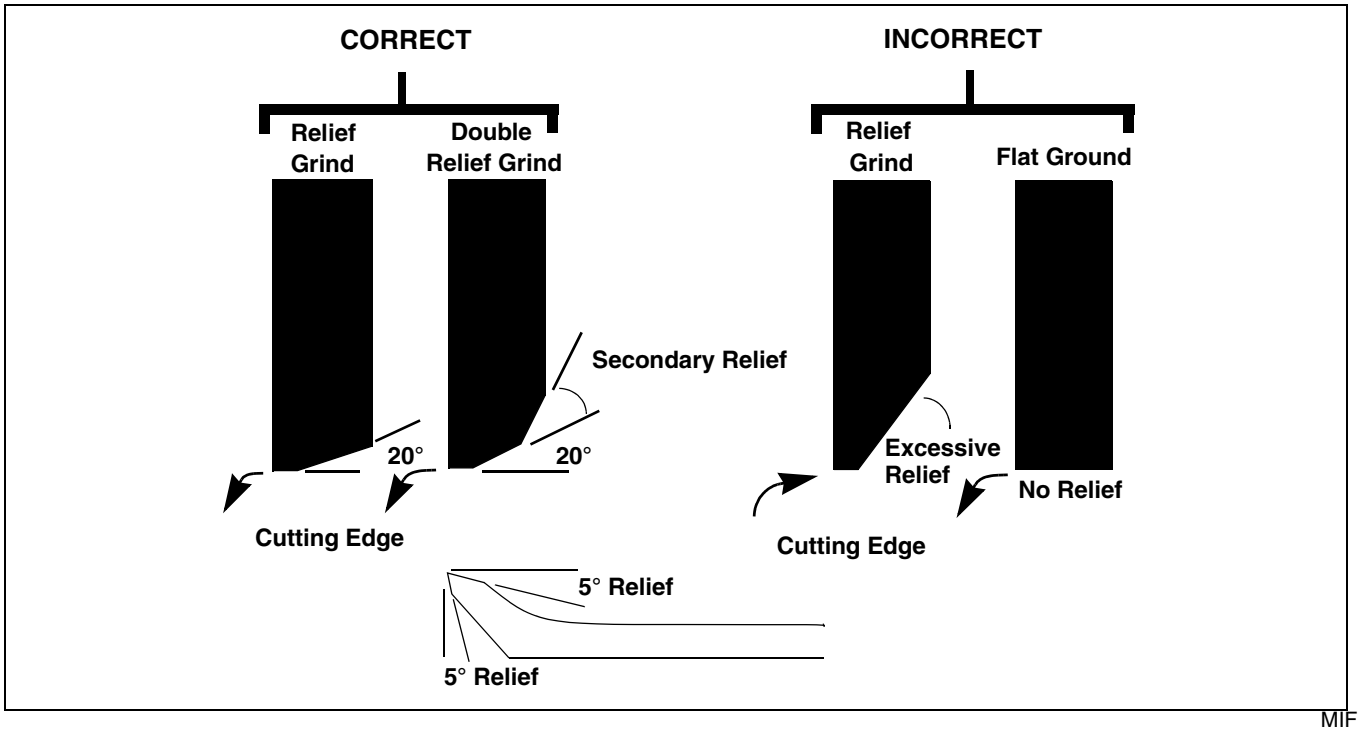
Cutting action begins as the bed knife positions the grass to be cut at the cutting edge. The reel then pulls the grass toward the bed knife, where it is sheared by the cutting edges as they pass one another.

In order for the grass to be cut at the proper height, it must contact the bed knife at the cutting edge. This is accomplished by grinding a 5° relief angle on the front face of the bed knife. Without a relief angle, the blade of grass will contact the lower edge of the bed knife and be bent over at too much of an angle prior to being cut. In the case of mowing greens, where very small cuts are being taken, the reel may not capture the grass at all, and no grass will be cut.

Although some 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

This procedure is used to sharpen the cutting edges when grinding is not necessary. See “Reel and Bed Knife Grinding” on page 387, to determine if grinding is necessary.

Backlapping, when compared to grinding, removes a very small amount of metal, requires less time, and will effect a smooth, clean cut.

The backlapping procedure is accomplished by spinning the reel backwards while applying special abrasive compounds to the reel. Usually course compounds are used initially followed by a finer abrasive for final honing. Recommended grits for fairways and roughs are 60, 80, and 120. Reel sharpening compounds should not be toxic, oily, or greasy.

The cutting unit should be inspected, backlapped, adjusted, and checked daily for a uniform cut along the complete length of the bed knife. It is important that the adjustment allows the reel to turn freely without dragging against the bed knife. Metal-to-metal contact will generate heat, causing the reel to expand and intensifying the dragging that produces more heat. This vicious cycle will quickly “shut down” the mower.

Smooth Roller

The roller is used as a ground sensing device to detect changes in the contour of the turf as the mower moves forward.

A smooth roller is generally used on the rear of a cutting unit to establish the cutting height range. (Under certain circumstances, grooved rollers are used on the rear.)

A front roller used in conjunction with a rear roller is needed to achieve more exact cutting heights under 1 inch.

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, lowering the effective cutting height and possibly scalping the turf.

Performance Variables

Three performance variables that affect the quality of cut are these:

- Number of reel blades
- Reel rpm
- Ground speed of machine

NOTE: When discussing performance variables, we must assume that other factors such as rate of growth, mowing frequency, mowing patterns, soil fertility, and equipment condition have been considered and are not affecting the quality of cut.

To apply performance variables to a formula, we need to understand three terms:

- Shear point - A single point of cutting contact between the cutting unit and the turf. Due to the reel mower design, there are an infinite number of shear points across the bed knife.
- Clip Ratio (CR) - The forward distance traveled between successive cutting contacts at any one shear point.
- Cutting Height (CH) - The distance above the soil line that grasses are clipped.

The most uniform cut occurs when the Clip Ratio (CR) equals the Cutting Height (CH). If CR is greater than CH, marcelling (a wavy, rib-like appearance) occurs. If CH is greater than CR, the rotating blades create a fanning effect that blows the grass down without cutting it. CR is controlled by the performance variables (the number of blades selected, ground speed, and reel speed).

Of these performance variables, only two, in most cases, are we able to change. We can use a reel with a different number of blades, and/or we can change the vehicle ground speed.

Since we know the number of blades the reel has, what the reel speed is, the cutting height, and the clip ratio (since CR must equal CH), let's find the vehicle ground speed.

Here's the formula:

MPH = (Reel rpm) x (CR or CH) x (Number of Reel Blades) ÷ 1056

Example

Using:

- 2653 Professional Utility Mower at a tested reel speed of 1000-1050 rpm
- 8-blade reel on an E.S.P. cutting unit
- CH = CR (0.58)

Find: MPH (Vehicle Speed)

NOTE: To calculate MPH, multiply 0.68148 x ft traveled/sec. Another way to calculate speed is to measure off an 88-ft distance, record the length of time (in seconds) it takes to travel that distance, and divide 60 by that time.

Diagnostics

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 389.)

(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” on page 393. See “Adjust Reel-to-Bed Knife” on page 393.)

(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 389.)

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” on page 393.)

(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 387.)

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.

Symptom: Height-of-Cut (HOC) Changes

(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)” on page 395.)

(6) Are the rollers concentric (not out-of-round)?

Yes - Go to step (7).

No - Replace roller. (See “Remove Front Roller” on page 398. See “Install Front Roller” on page 399.)

(7) Are the roller bearings in good condition (not worn)?

No - Replace roller bearings. (See “Disassemble and Inspect Roller” on page 398.)

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” on page 393.)

(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” on page 393.)

Symptom: Reel Does Not Rotate

(1) Is the machine operating properly?

Yes - Go to step (2).

No - See 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" on page 393.)

(3) Are the roller bearings in good condition (not worn or seized)?

No - Replace roller bearings. (See "Disassemble and Inspect Roller" on page 398.)

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.

(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 389.)

(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 389.)

(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" on page 393. See "Adjust Reel-to-Bed Knife" on page 393.)

(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" on page 393.)

Tests and Adjustments

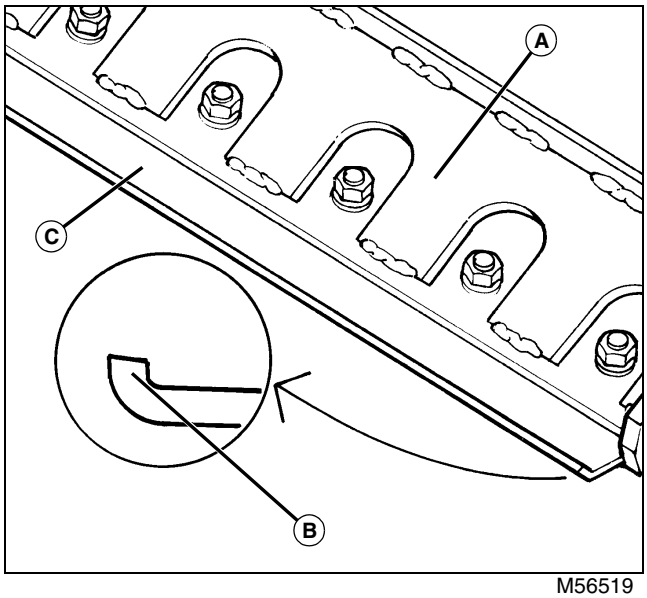
Backlapping and Reel-to-Bed Knife

It is best to think of backlapping and reel-to-bed knife adjustments as one procedure. Although backlapping removes only a small amount of metal, the clearance between the reel and bed knife will be increased and must be readjusted.

Another very important point to remember is that adjustments can 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.

Inspect Reel and Bed Knife

CAUTION: Avoid injury! Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.
Never allow more than one person at a time to work on any one cutting unit. Never allow work to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.



M56519

A - Bed Knife Support
B - Land
C - Bed Knife

1. Visually inspect cutting unit for damage. Chipped paint, dents, or gouges may indicate the need for a closer look at the frame for distortion, broken weldments, or other damage that could prevent proper adjustment. Repair or replace parts as necessary.

2. Inspect for vertical or lateral movement in the reel or bearings supporting the reel. Repair or replace as necessary.

3. While rotating the reel in the reverse direction by hand, inspect each blade cutting edge for nicks, gouges, or distortion. Ensure the cutting edge land (B) does not exceed more than 3/4 of the blade thickness. See “Reel and Bed Knife Grinding” on page 387 to restore the relief angle and cutting edge before continuing with this procedure.

4. Inspect the bed knife (C) cutting edge for nicks, gouges, or distortion.

5. Inspect the bed knife for uneven wear (indicated by uneven land width across the length of the bed knife). Ensure 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.

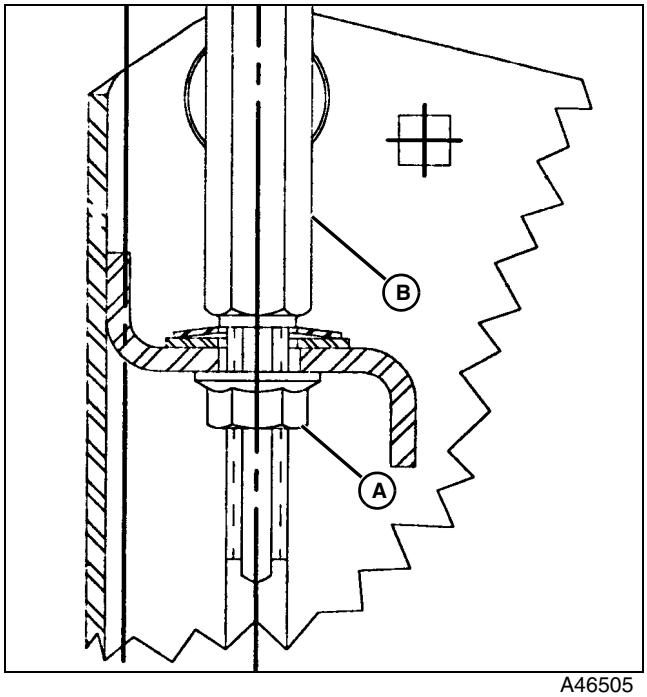
Adjust Reel-to-Bed Knife

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. The lower adjusting nut (A) will lower the reel when turned counterclockwise (as viewed from the top of the unit) and the upper adjusting nut (B) will raise the reel when turned clockwise.

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 0.051 mm (0.002 in.) feeler gage along the entire length of the bed knife. It should not go in anywhere. If the clearance exceeds 0.051 mm (0.002 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 . . . . 0.025 mm (0.001 in.)

Backlapping Procedure

(With Standard Backlapping Valve)

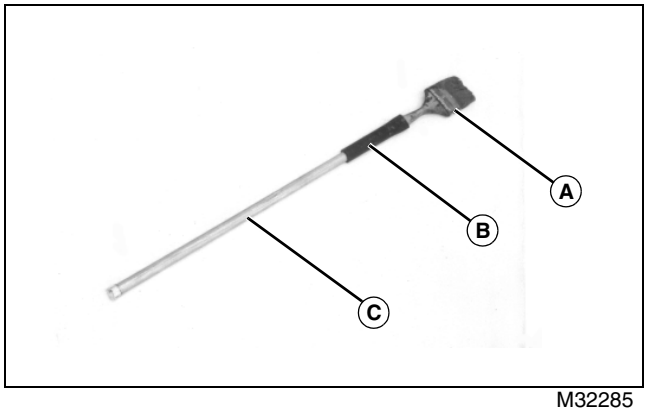
Reason

To provide a consistent cutting action and prolong reel life.

Other Material

Part No.	Part Name	Part Use
NA	Lapping Compound	Used in backlapping procedure.

Dealer Fabricated Tools



M32285

Attach a piece of rubber hose (B) and additional handle (C) to a paint brush (A) to extend its length. This is used to apply lapping compound.

Procedure

CAUTION: Avoid injury! Avoid injury from rotating blades. Keep hands and feet away from blades while machine is running.

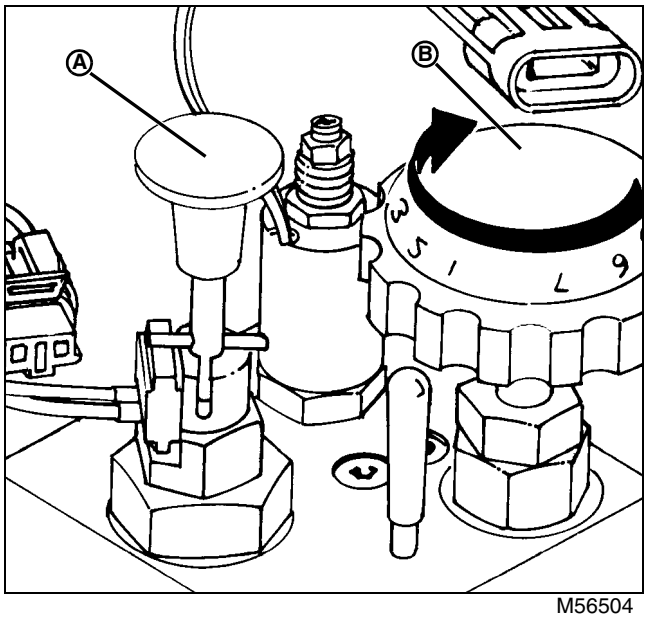
Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

Never allow more than one person at a time to work on any one cutting unit. Never allow work to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

NOTE: Perform reel-to-bed knife adjustment before performing backlapping procedure.

1. Prior to starting, be sure limit is set with a 0.002 in.-0.003 in. clearance.

2. Set the park brake and start the engine. Lower the cutting units to the ground.



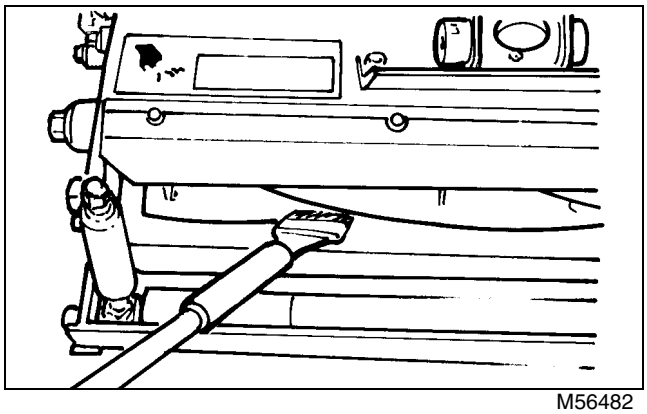
M56504

3. Lift the hood to expose the backlapping valve. Pull up the forward/reverse knob (A).

4. Engage the PTO. (The reels should now be rotating in the reverse direction.)

5. Using the flow control knob (B), adjust machine speed to rotate reels at 100-200 rpm, or slow enough to prevent the backlapping compound from being thrown from the reel blades.

NOTE: Apply 60- to 80-grit compound for units with extended service time, and 120-grit compound for new, newly ground reels or when applied on a weekly basis.



M56482

6. Apply lapping compound to the rotating reel evenly from one side to the other and back again using a long-handled brush.

7. Allow the reel to spin until quiet. If desired, follow with a 120-grit compound to achieve a smoother finish.

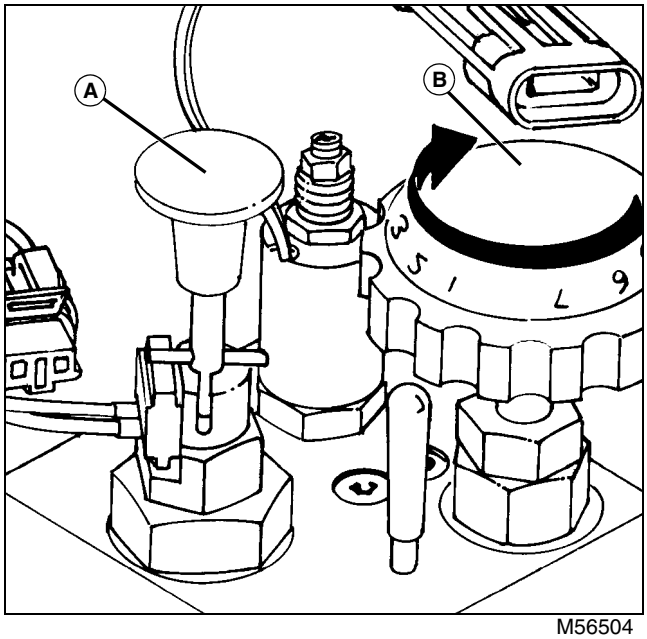
CAUTION: Avoid injury! Avoid injury from rotating blades. Keep hands and feet away from blades while machine is running.

Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

Never allow more than one person at a time to work on any one cutting unit. Never allow work to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

IMPORTANT: Avoid damage! Never operate cutting unit in the forward direction until abrasive compounds are removed from the cutting unit. The abrasive compound will dull the cutting edge.

8. Rinse the lapping compound completely off the cutting unit with water.



M56504

9. Disengage PTO switch and shut off the engine. Turn the flow control knob (B) fully counterclockwise.

10.Push forward/reverse knob (A) down.

11.Check reel-to-bed knife clearance. (See “Adjust Reel-to-Bed Knife” on page 393.)

Results

Reel and bed knife should be sharp and free from minor nicks and scratches.

Adjust Height-of-Cut (HOC)

Reason

To set desired cutting height.

Special or Required Tools

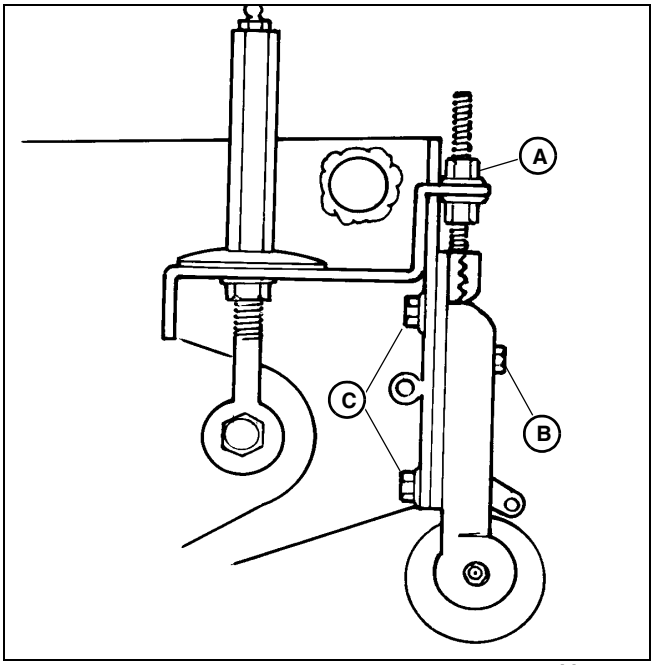
Tool Name	Tool No.	Tool Use
Height-of-Cut Gage Bar	NA	Used to adjust cutting height.

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.

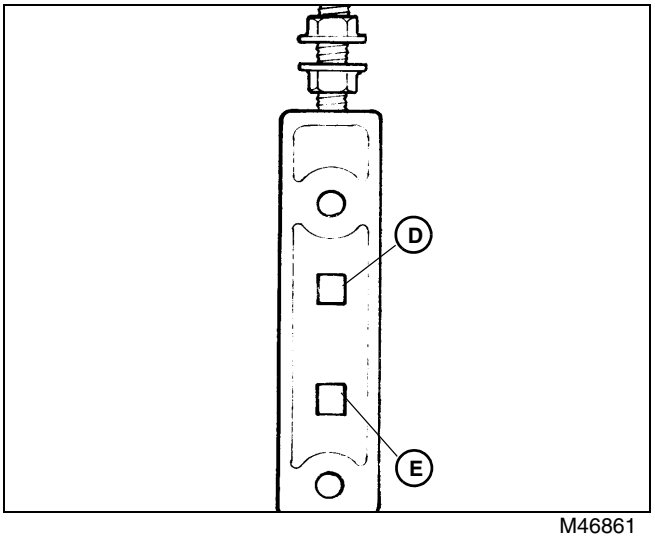
Never allow more than one person at a time to work on any one cutting unit. Never allow adjustments to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

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

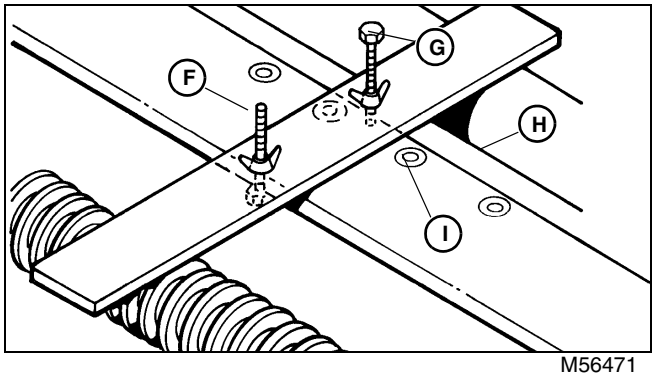
2. For cutting heights of 9.5-41 mm (3/8 - 1-5/8 in.), position carriage bolt into the upper square opening (D). For cutting heights of 38-90 mm (1-1/2 - 3-1/2 in.), position carriage bolt into the lower square opening (E).

IMPORTANT: Avoid damage! Ensure the rear bolt (G) on the gage 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 gage bar. Forcing the gage bar into position will bend it and result in an inaccurate height adjustment.

Ensure the rear bolt on the gage bar rests on the bed knife support, and not on a bed knife mounting bolt.

Gage bar should be positioned near the end of the solid roller, but not on the end cap.



M56471

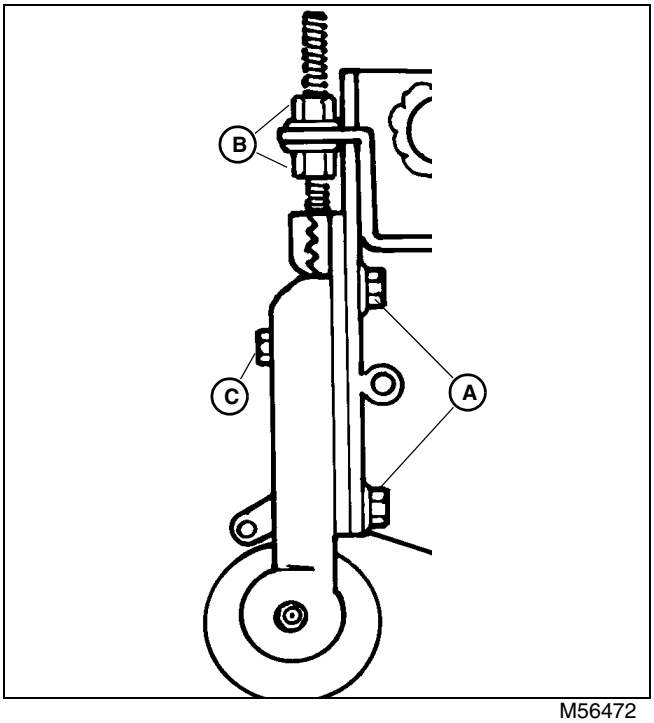
Picture Note: Cutting unit shown upside down for clarity.

3. Adjust gage 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 gage 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

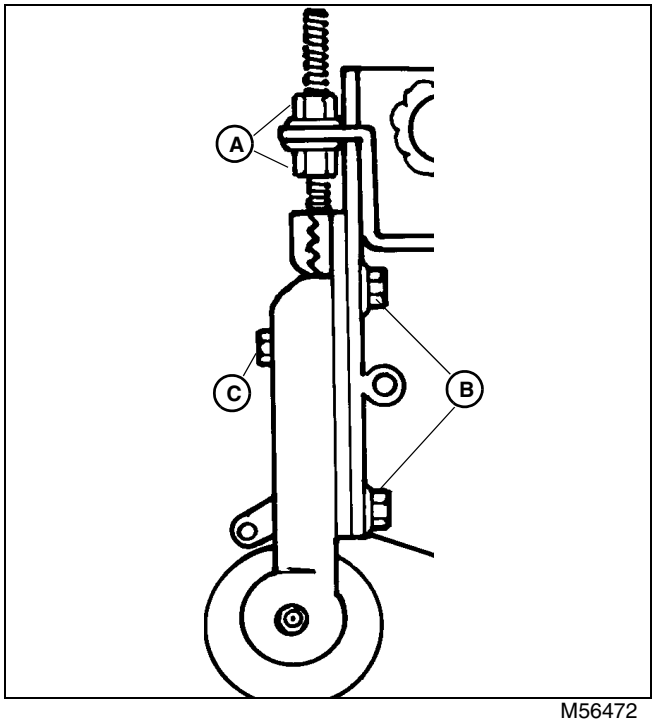
1. Loosen bolts (A) and adjustment nuts (B) (both sides) on the rear roller and slide the roller up or down to center the bolts (A) in the slot. Tighten bolts and adjustment nuts.

2. Loosen nut (C) (both sides) and position the roller as close to the gage 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 (A) and adjustment nuts (B) and slide the roller down until it just touches the gage bar. Repeat on opposite end. Recheck the adjustment for the opposite side and readjust if necessary.

Adjust Front 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 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 an HOC gage to ensure setting did not change.

3. Loosen nut (C) (both sides) and position the roller as close to the gage bar as possible without touching it. Tighten nuts (C). Ensure the same number of ratchet teeth are exposed at each end of the roller (settings for front and rear rollers should be the same.)

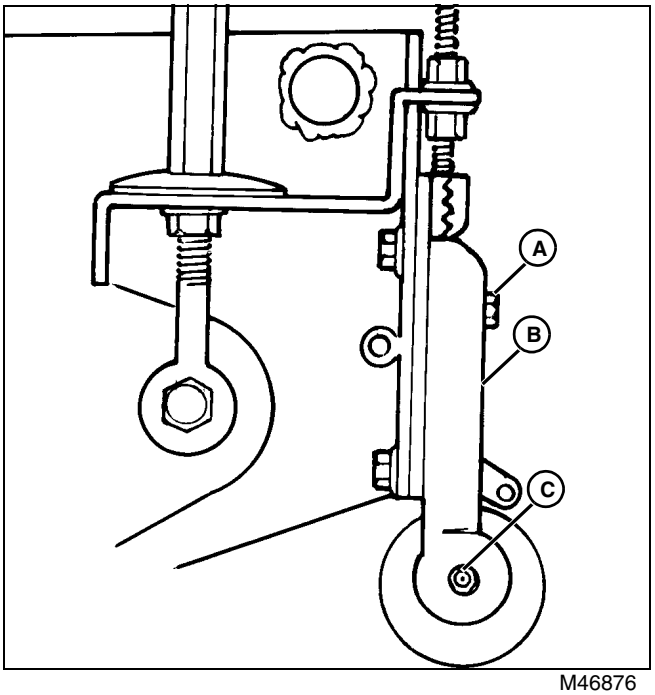
4. Loosen bolts (B) and adjustment nuts (A) and slide the roller down until it just touches the gage bar. Repeat on opposite end. Recheck the adjustment for the opposite side and readjust if necessary.

Results

Height-of-cut should be adjusted to desired level, consistently across cutting unit.

Repair

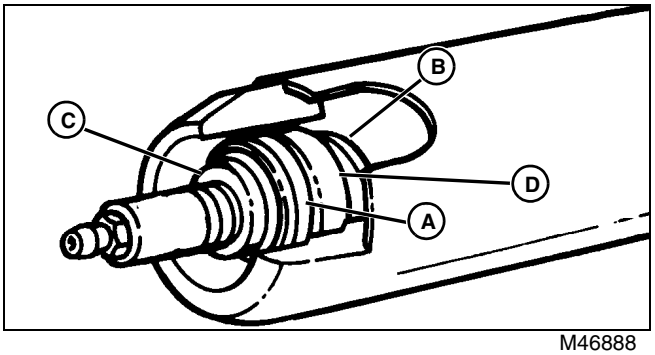
Remove Front Roller



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



M46888

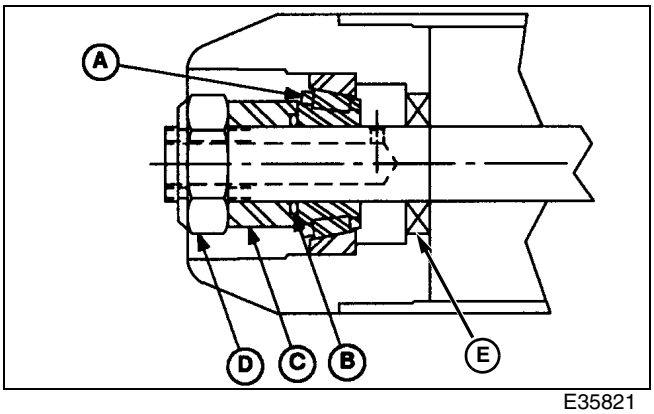
1. Remove locknuts from each end of the roller.
2. Press roller shaft out of roller.
3. Remove seals (A) (B, smooth roller only), spacer (C) and bearings (D). Clean bearings and end caps with a suitable solvent.
4. Inspect bearings and bearing cups for pitting, scoring, and bluing from overheating. Replace bearings and bearing cups as necessary.

Assemble Front Roller

Other Material

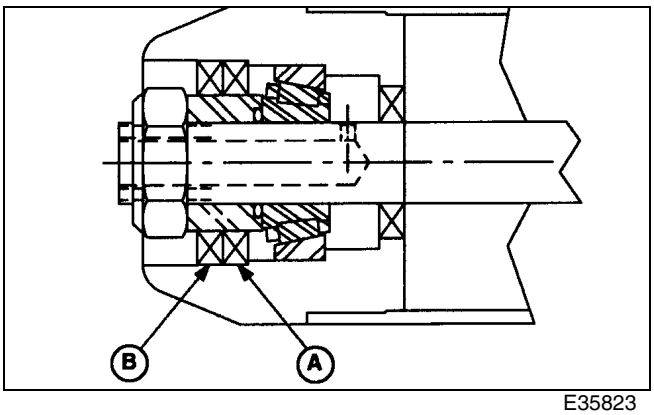
Part No.	Part Name	Part Use
TY24425	John Deere Special Purpose HD Water Resistant Grease	Used to lubricate roller shaft bearing.

1. Install bearing cup. Install shaft into roller.



E35821

2. Apply grease to seal lip and install seal (E) with lip of seal facing out.
3. Pack bearing (A) with grease and install into bearing cup.
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

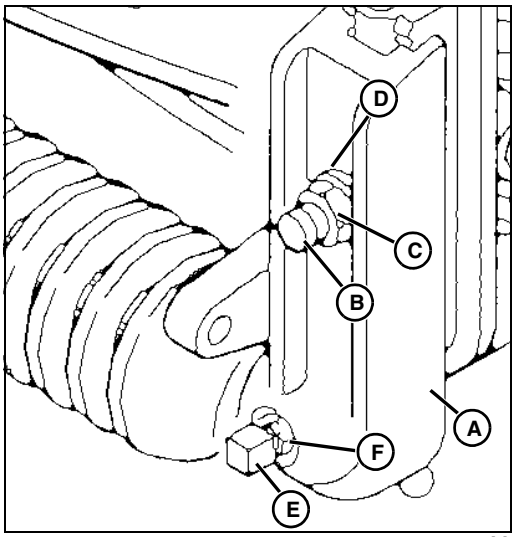
6. Apply grease to lips of seals (A and B) and install with seal lips facing away from bearing.
7. Repeat steps 1 through 6 on opposite end.
8. Install self-locking nut (D) on each end and tighten until snug. Back off slightly and retighten to specifications.

9. Install grease fittings and lubricate.

Specifications

Self-Locking Nut Torque . . . . 0.35-0.79 N•m (3-7 lb-in.)

Install Front Roller



M56473

1. Slide adjustment brackets (A) onto roller shaft (bracket with setscrew on left side).

2. Secure each bracket to frame with cap screw (B), nut (C), and washer (D).

3. Center the roller between the brackets and tighten setscrew (E). Tighten jam nut (F).

4. See “Adjust Height-of-Cut (HOC)” on page 395.

Remove Bed Knife and Support

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. 0.25 mm (0.010 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.

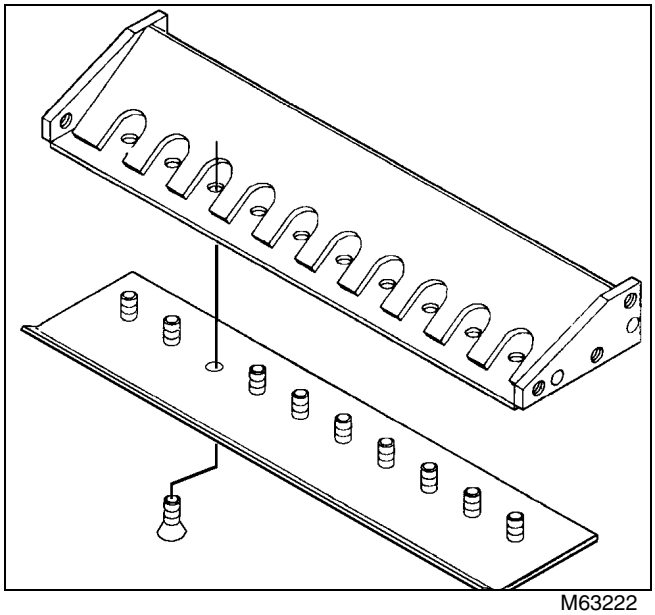
5. Remove dirt and corrosion from bed knife mounting surface.

6. Inspect support for straightness. Repair or replace if necessary.

Install Bed Knife and Support

Other Material

Part No.	Part Name	Part Use
TY24811	NEVER-SEEZ®	Applied to bed knife support mounting bolts.



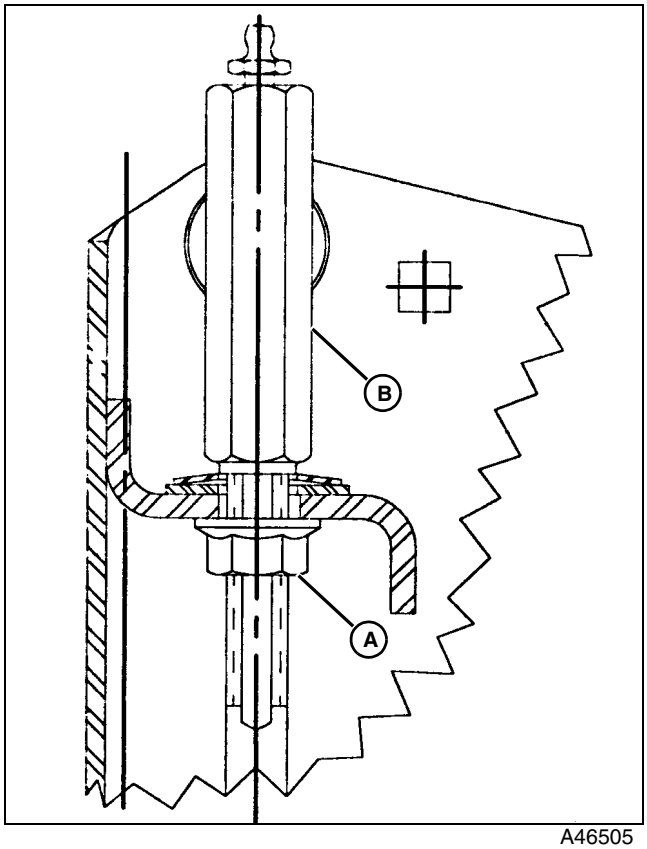
M63222

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.



A46505

5. Raise reel, by turning nut (A) counterclockwise and reel adjusting nut (B) clockwise, until the knife can be installed.

6. Position the bed knife support in the frame and snug the cap screws (6) on both ends of the support.

7. Tap both ends of the bed knife support with a brass hammer to remove any play.

8. See “Adjust Reel-to-Bed Knife” on page 393.

9. See “Backlapping and Reel-to-Bed Knife” on page 392.

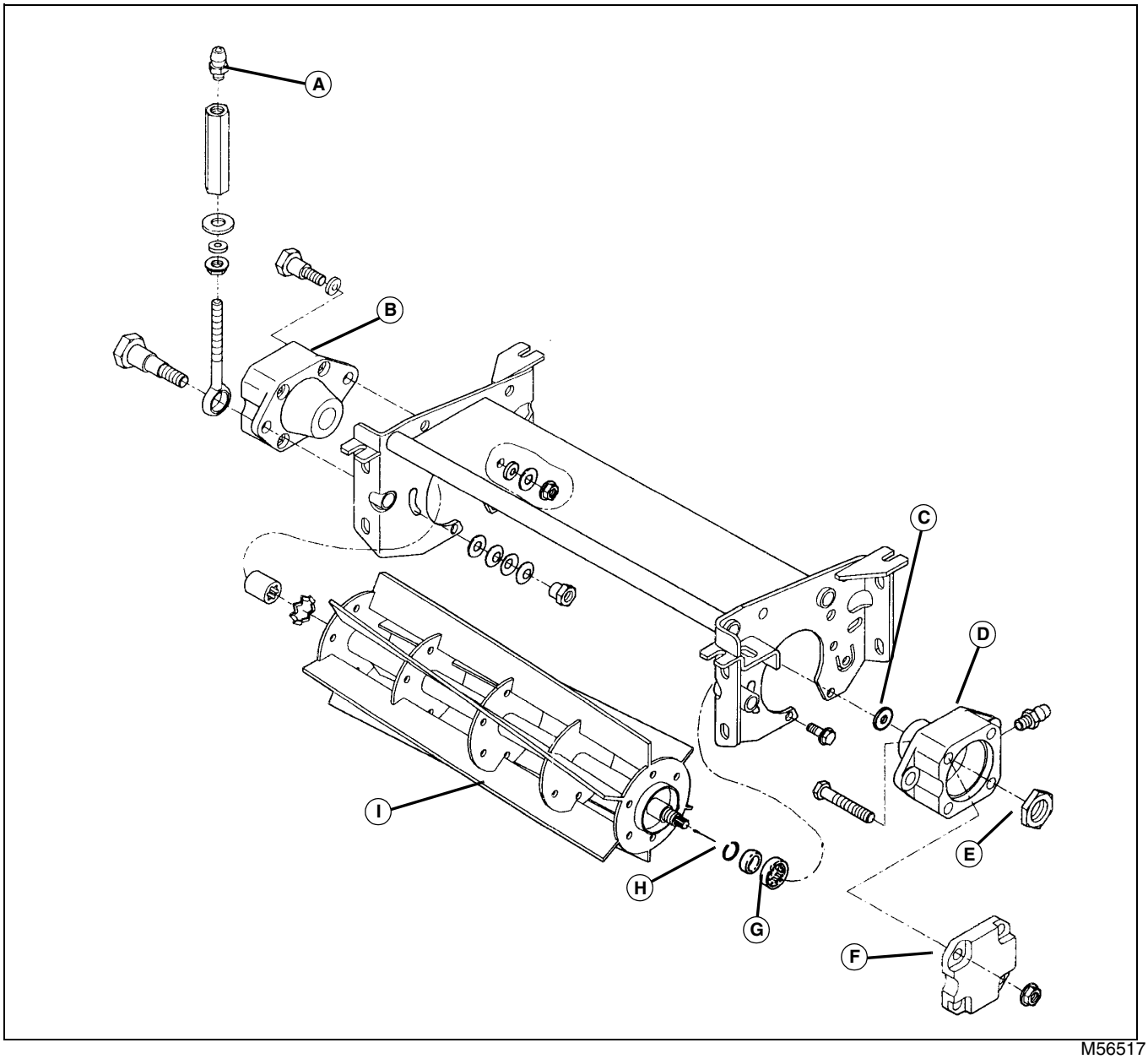
10. See “Adjust Height-of-Cut (HOC)” on page 395.

Specifications

Hex Screw Torque (Initial) . . . . . 26 N•m (19 lb-ft)
Hex Screw Torque (Final). . . . . 51 N•m (38 lb-ft)
Bed Knife/ Support Mounting
Bolt Torque (Minimum). . . . . 45 N•m (33 lb-ft)
Bed Knife Support-to-Cutter Frame
Bolt Torque . . . . . 43 N•m (32 lb-ft)

Remove Reel

CAUTION: Avoid injury! Always wear protective gloves when handling reels. Serious personal injury can result from contact with the sharp cutting edges of the reel.



M56517

1. See “Remove Bed Knife and Support” on page 399 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

CAUTION: Avoid injury! Never spin bearings with compressed air. Bearings can separate from their cage at high velocity and cause injury.

1. Remove bearing cup, wave spring, and seal from the right side.

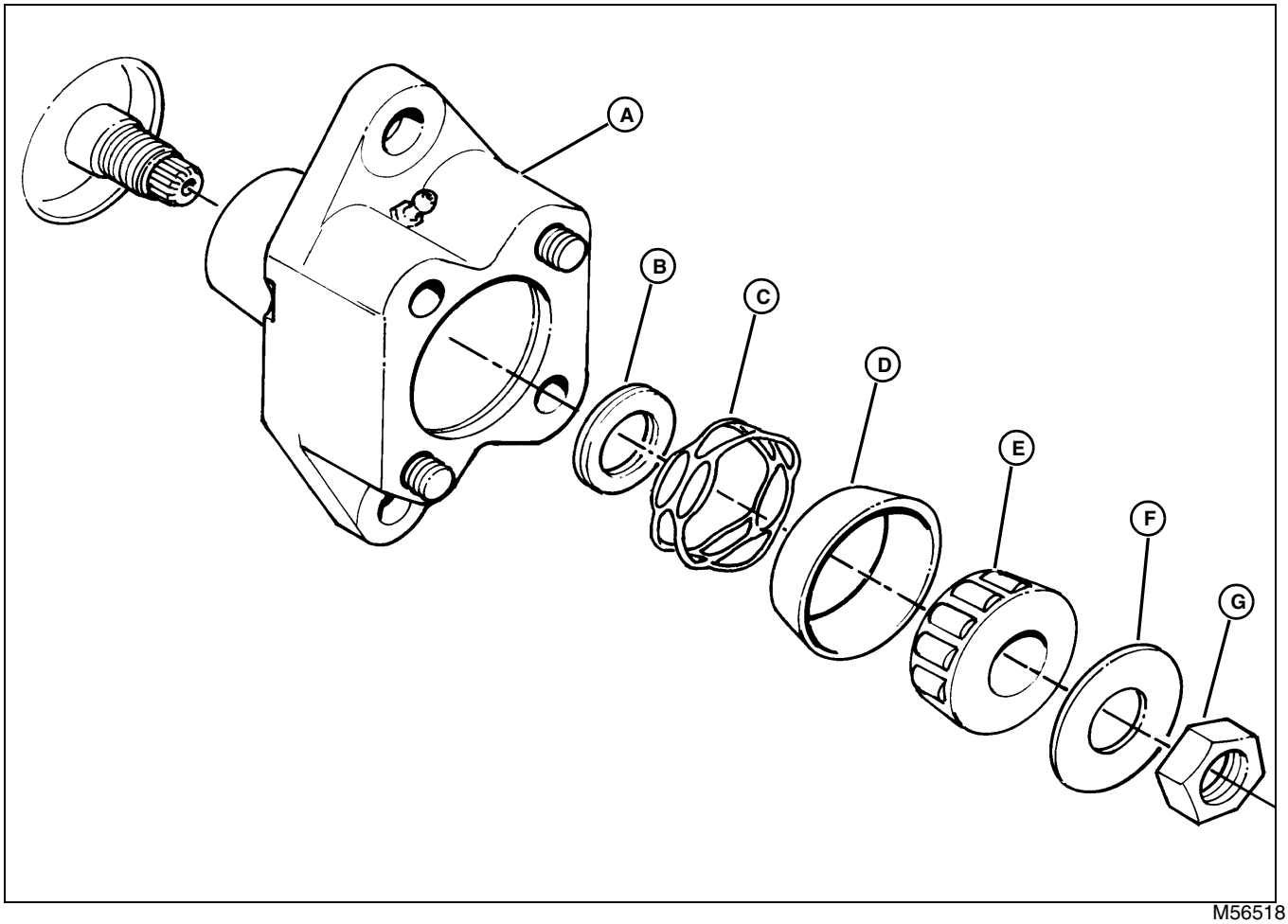
2. Clean parts with mineral spirits.

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 if necessary.

4. Inspect wave spring for distortion or wear. Replace if worn.

Assemble Pivot Arm



M56518

A - Pivot Arm
B - Seal
C - Wave Spring (Right Side Only)
D - Bearing Cup
E - Bearing Cone
F - Washer
G - Nut

1. Install seals (flush with pivot arm housing).

NOTE: Left side housing uses an internal snap ring instead of a wave spring.

2. Install wave spring (right side only) on end of reel where the “V” between reel and knife is pointed at spring.

3. Install bearing cup.

Install Reel

Other Material

Part No.	Part Name	Part Use
TY25083	John Deere Golf and Turf Cutting Unit Grease	Used to lubricate mower bearings and seals.

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. Fill housing with grease to prevent a pocket for moisture to accumulate.

7. See “Adjust Reel-to-Bed Knife” on page 393.

Specifications

Reel Attachment Nut Torque . . . . 68 N•m (50 lb-ft) min

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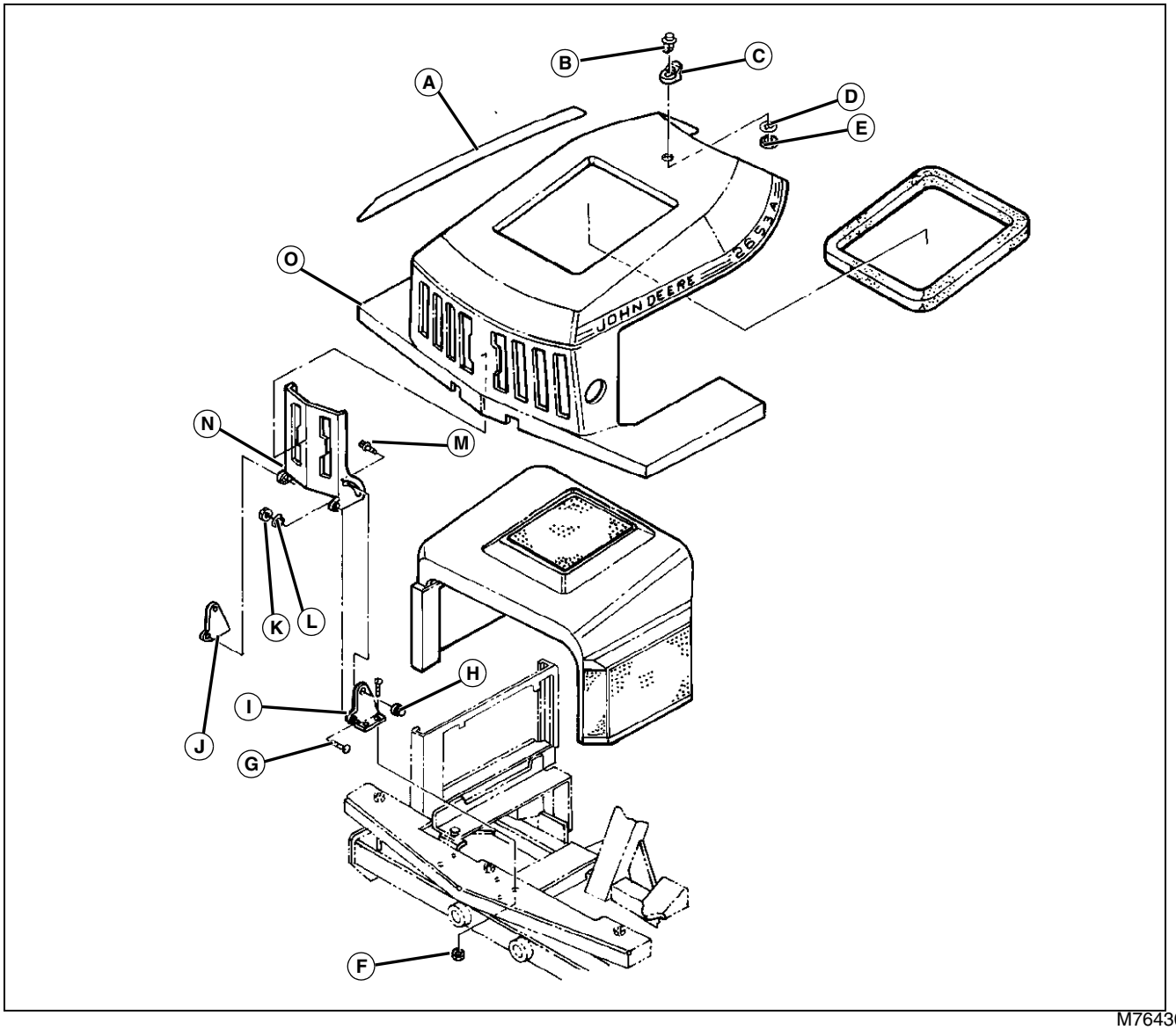
Component Location

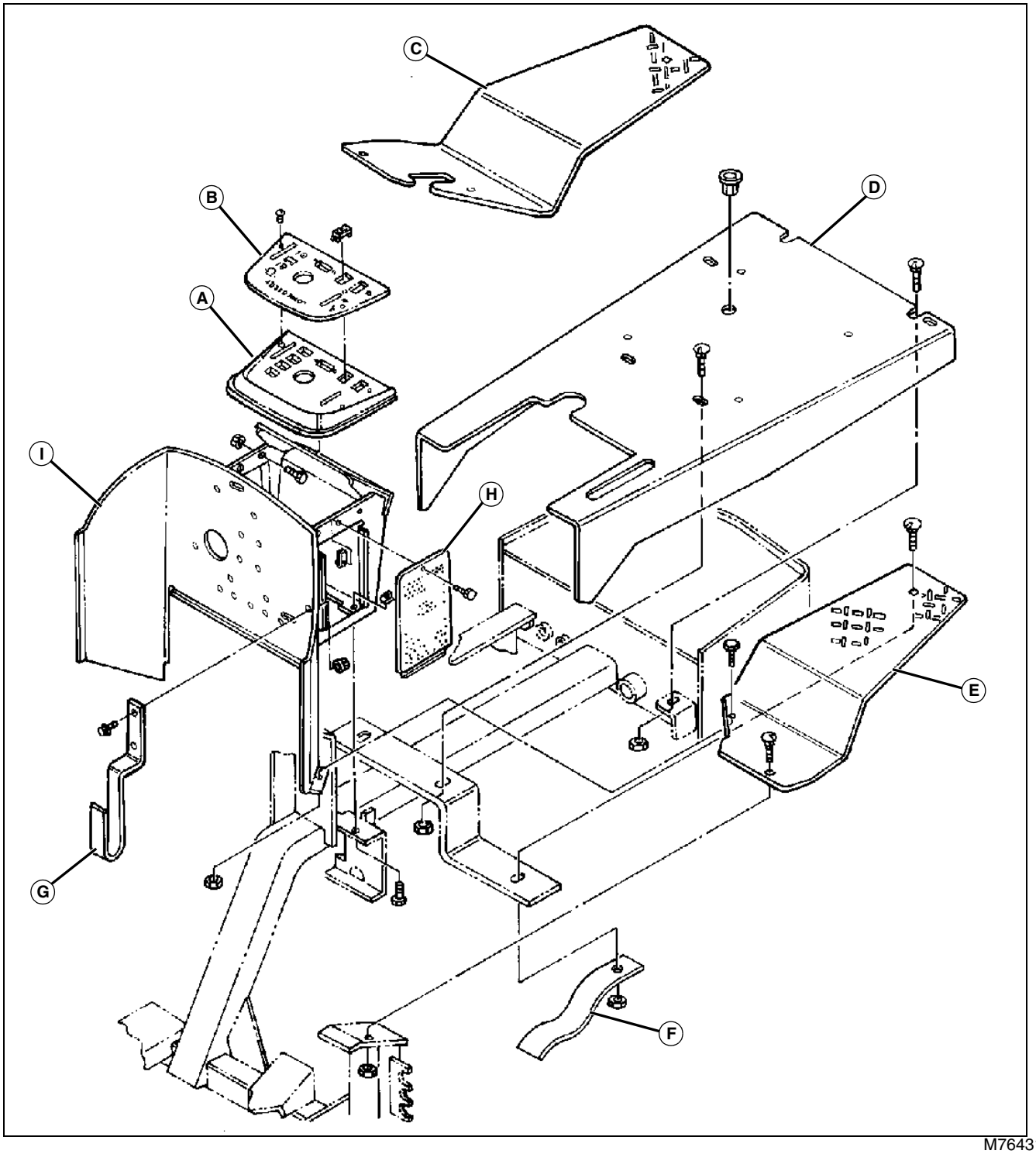
Hood



M76430

A - Decal
B - Hood Latch
C - Thumb Grip
D - Lockwasher
E - Nut
F - Nut
G - Carriage Bolt
H - Locknut
I - LH Hinge
J - RH Hinge
K - Nut
L - Powdermetal Spacer
M - Flange Bolt
N - Hinge Plate
O - Hood

Body Panels



M76431

A - Instrument Panel
B - Decal
C - Footrest RH
D - Seat Support
E - Footrest LH
F - Leaf Support
G - Hose Support
H - Pedestal
I - Screen

Numerics

A

B

C

D

E

F

G

H

I

K

S

T

V

W