JOHN DEERE
WORLDWIDE COMMERCIAL & CONSUMER EQUIPMENT DIVISION

2195

Gator™ Utility Vehicle
HPX 4X2 and 4X4 Gas and Diesel

TM2195 JANUARY 2006

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

Engine - Gas

Engine - Diesel

Electrical

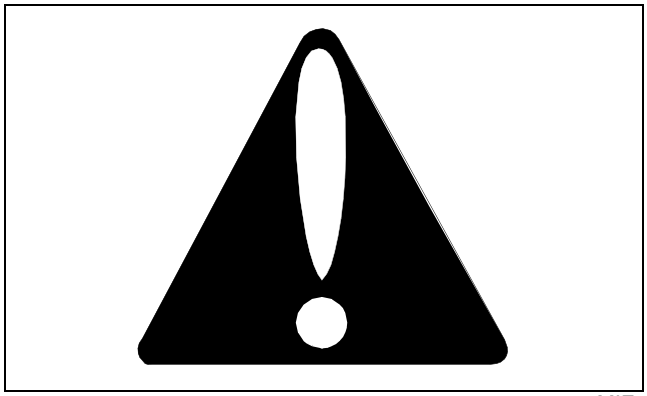
Drive Train

Steering

Brakes

Miscellaneous

Recognize Safety Information



MIF

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

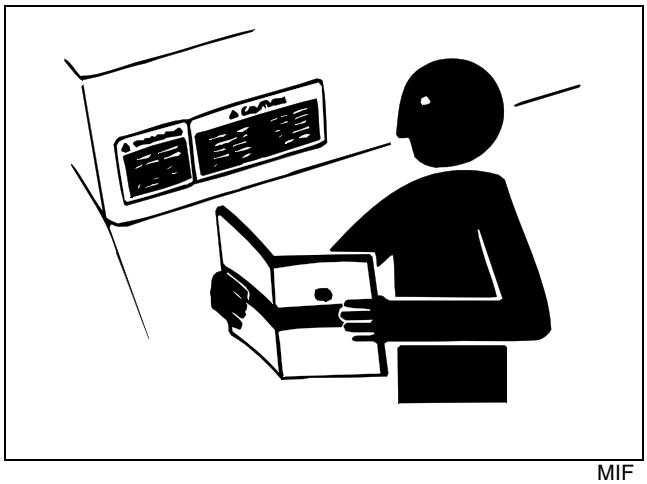
Follow recommended precautions and safe servicing practices.

Understand Signal Words

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

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

Replace Safety Signs



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

Handle Fluids Safely - Avoid Fires

Be Prepared For Emergencies

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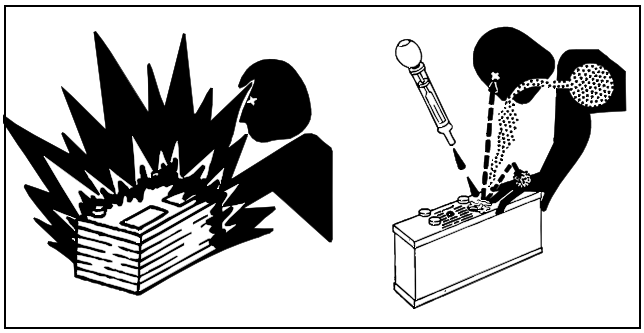
- When you work around fuel, do not smoke or work near heaters or other fire hazards.
- Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.
- Make sure machine is clean of trash, grease, and debris.
- Do not store oily rags; they can ignite and burn spontaneously.
- Be prepared if a fire starts.
- Keep a first aid kit and fire extinguisher handy.
- Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.

Use Care In Handling and Servicing Batteries



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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 volt-meter 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. Use proper jump start procedure.

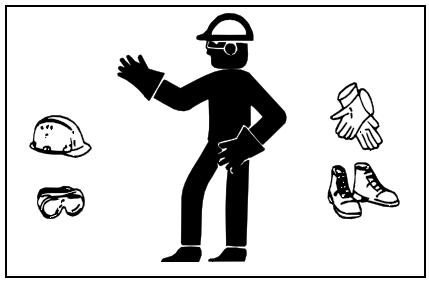
If you spill acid on yourself:

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.

Wear Protective Clothing



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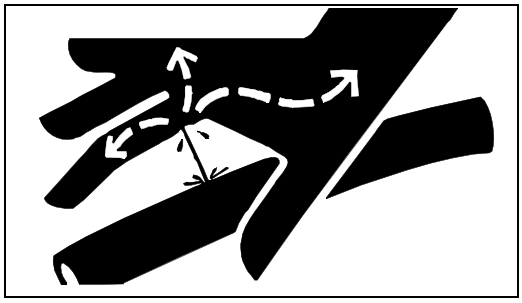
Wear close fitting clothing and safety equipment appropriate to the job.

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

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

Use Care Around High-pressure Fluid Lines

Avoid High-Pressure Fluids



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

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

Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A.

Avoid Heating Near Pressurized Fluid Lines

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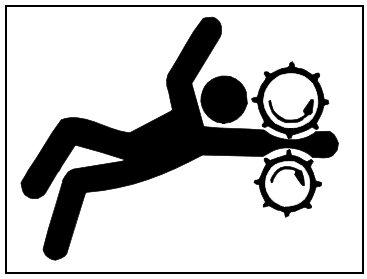
Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can be accidentally cut when heat goes beyond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

Service Machines Safely



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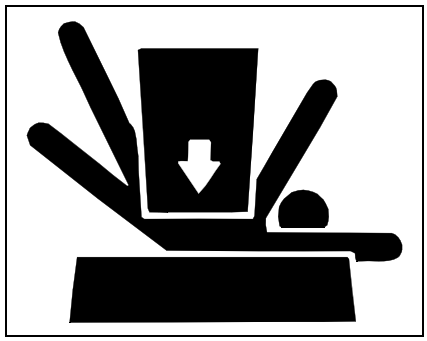
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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

Use Proper Tools

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

Support Machine Properly and Use Proper Lifting Equipment



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

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

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

Work In Clean Area

Before starting a job:

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

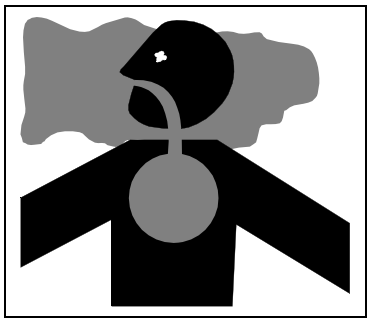
Using High Pressure Washers

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

Illuminate Work Area Safely

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

Work In Ventilated Area



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

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

Warning: California Proposition 65 Warning

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

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

Remove Paint Before Welding or Heating

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

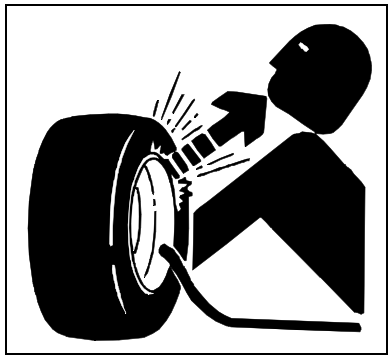
Avoid Harmful Asbestos Dust

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

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

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

Service Tires Safely



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

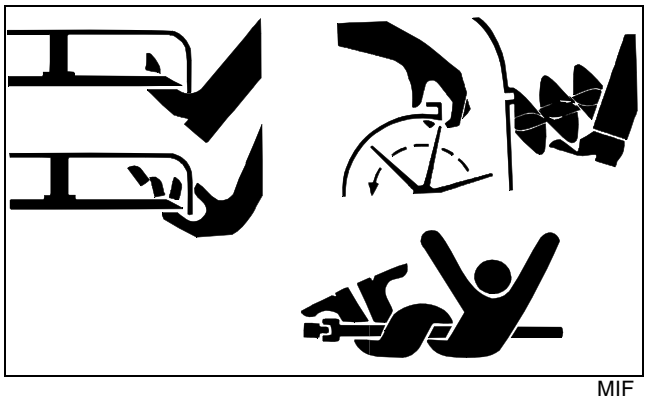
Do not attempt to mount a tire unless you have the proper equipment and experience to perform the job.

Always maintain the correct tire pressure. Do not inflate the tires above the recommended pressure. Never weld or heat a wheel and tire assembly. The heat can cause an increase in air pressure resulting in a tire explosion. Welding can structurally weaken or deform the wheel.

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

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

Avoid Injury From Rotating Blades, Augers and PTO Shafts



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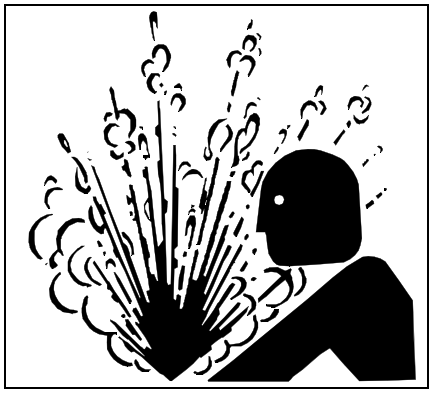
Keep hands and feet away while machine is running. Shut off power to service, lubricate or remove mower blades, augers or PTO shafts.

Service Cooling System Safely



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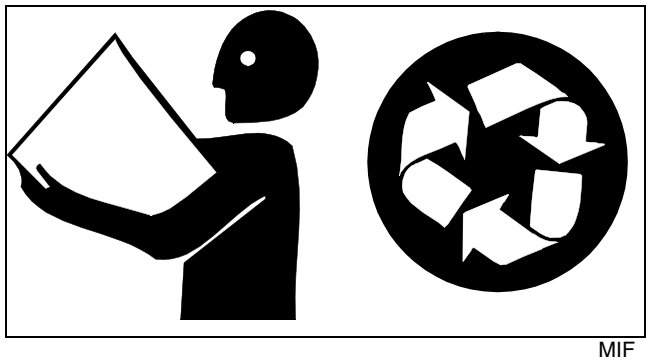
Explosive release of fluids from pressurized cooling system can cause serious burns.

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

Handle Chemical Products Safely



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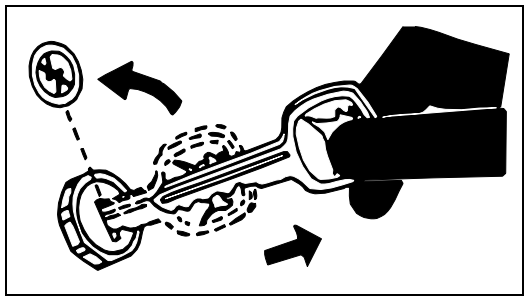
Direct exposure to hazardous chemicals can cause serious injury. Potentially hazardous chemicals used with John Deere equipment include such items as lubricants, coolants, paints, and adhesives.

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

Dispose of Waste Properly

Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include 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.

Parking Safely



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1. Stop machine on a level surface, not on a slope.
2. Disengage and stop attachments.
3. Lower attachments to the ground.
4. Lock park brake.
5. Stop engine.
6. Remove key.
7. Wait for engine and all moving parts to stop before you leave the operator's station.
8. Close fuel shut-off valve, if your machine is equipped.

Live With Safety

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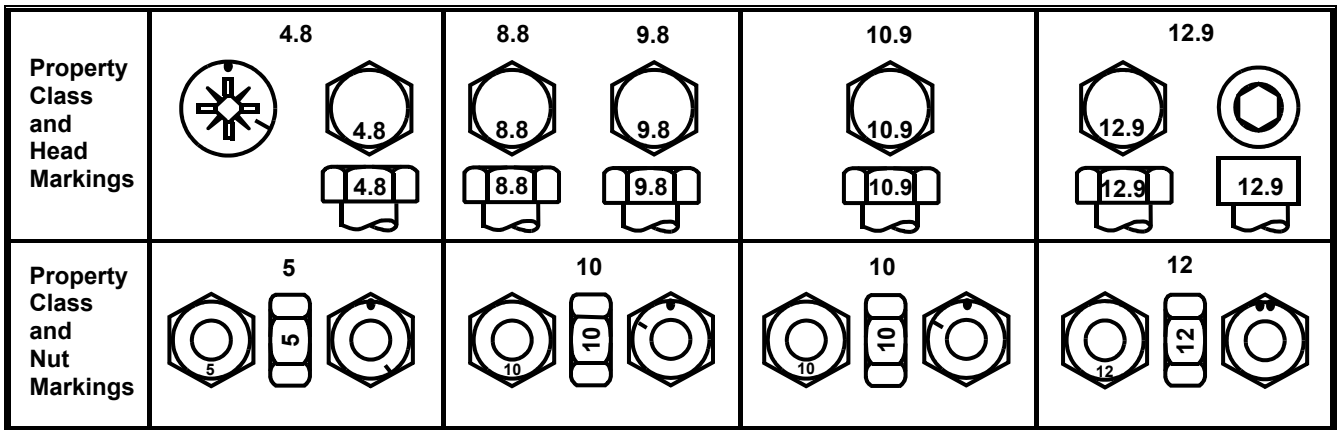
Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

Table of Contents

Specifications

Metric Fastener Torque Values



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	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
	Lubricated a		Dry a		Lubricated a		Dry a		Lubricated a		Dry a		Lubricated a		Dry a	
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

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.

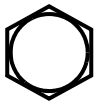
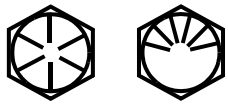
When bolt and nut combination fasteners are used, torque values should be applied to the NUT instead of the bolt head.

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

a *“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*.

Reference: JDS - G200.

Inch Fastener Torque Values

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

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	Grade 1				Grade 2b				Grade 5, 5.1 or 5.2				Grade 8 or 8.2			
	Lubricated a		Dry a		Lubricated a		Dry a		Lubricated a		Dry a		Lubricated a		Dry a	
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

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 lock nuts to the full torque value.

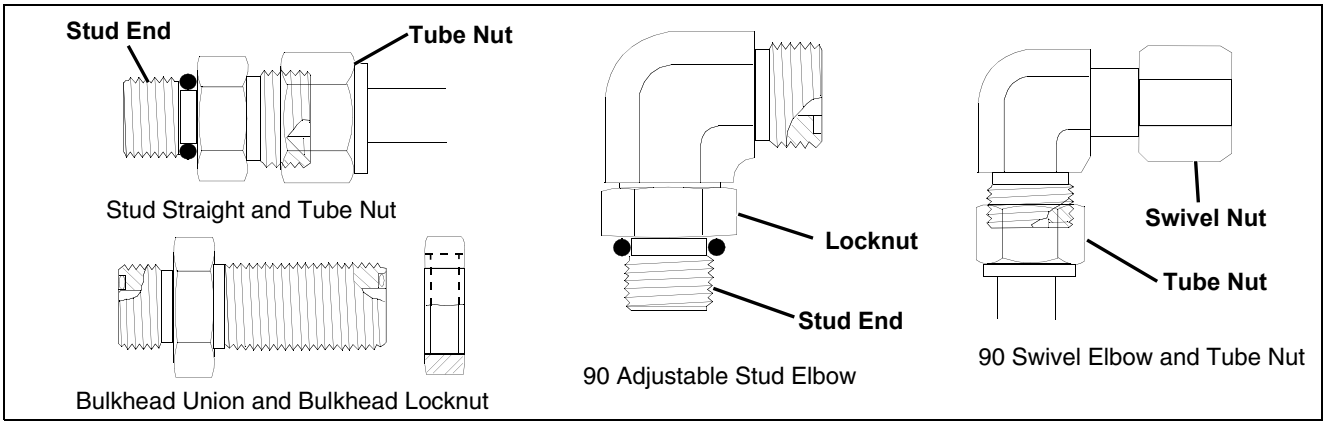
a *“Lubricated” means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. “Dry” means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication*.

b *“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.*

Reference: JDS - G200

O-Ring Seal Service Recommendations

Face Seal Fittings With Inch Stud Ends Torque



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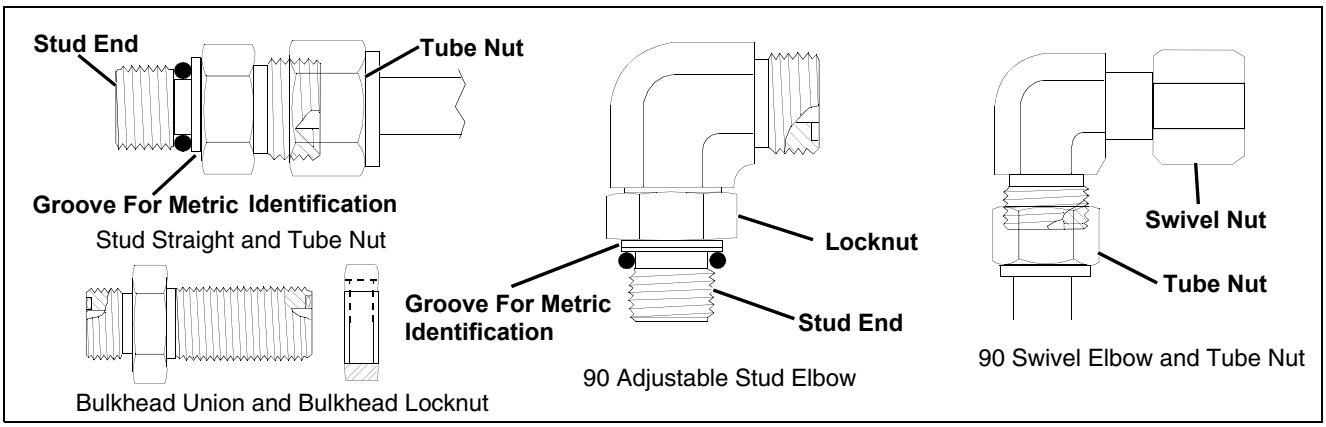
Nominal Tube OD/Hose ID				Face Seal Tube/Hose End					O-Ring Stud Ends		
Metric Tube OD	Inch Tube OD			Thread Size	Tube Nut/ Swivel Nut Torque		Bulkhead Lock Nut Torque		Thread Size	Straight Fitting or Lock Nut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
5	-3	0.188	4.76						3/8-24	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
19	-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

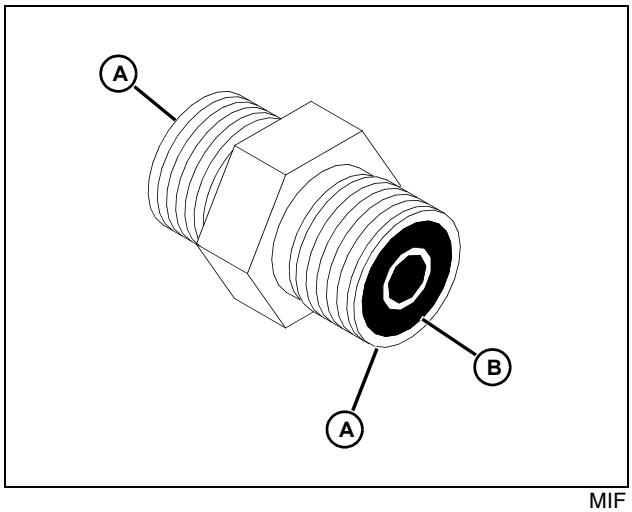


MIF

Nominal Tube OD/Hose ID				Face Seal Tube/Hose End						O-Ring Stud Ends, Straight Fitting or Lock Nut					
Metric Tube OD	Inch Tube OD			Thread Size	Hex Size	Tube Nut/ Swivel Nut Torque		Bulkhead Lock Nut Torque		Thread Size	Hex Size	Steel or Gray Iron Torque		Aluminum Torque	
mm	Dash Size	in.	mm	in.	mm	N•m	lb-ft	N•m	lb-ft	mm	mm	N•m	lb-ft	N•m	lb-ft
6	-4	0.250	6.35	9/16-18	17	16	12	12	9	M12X1.5	17	21	15.5	9	6.6
8	-5	0.312	7.94												
										M14X1.5	19	33	24	15	11
10	-6	0.375	9.52	11/16-16	22	24	18	24	18	M16X1.5	22	41	30	18	13
12	-8	0.500	12.70	13/16-16	24	50	37	46	34	M18X1.5	24	50	37	21	15
16	-10	0.625	15.88	1-14	30	69	51	62	46	M22X1.5	27	69	51	28	21
	-12	0.750	19.05	1-3/16-12	36	102	75	102	75	M27X2	32	102	75	46	34
22	-14	0.875	22.22	1-3/16-12	36	102	75	102	75	M30X2	36				
25	-16	1.000	25.40	1-7/16-12	41	142	105	142	105	M33X2	41	158	116	71	52
28										M38X2	46	176	130	79	58
32	-20	1.25	31.75	1-11/16-12	50	190	140	190	140	M42X2	50	190	140	85	63
38	-24	1.50	38.10	2-12	60	217	160	217	160	M48X2	55	217	160	98	72

NOTE: Torque tolerance is +15%, -20%

O-Ring Face Seal Fittings



MIF

1. Inspect the fitting sealing surfaces (A). They must be free of dirt or defects.

2. Inspect the O-ring (B). It must be free of damage or defects.

3. Lubricate O-rings and install into groove using petroleum jelly to hold in place during assembly.

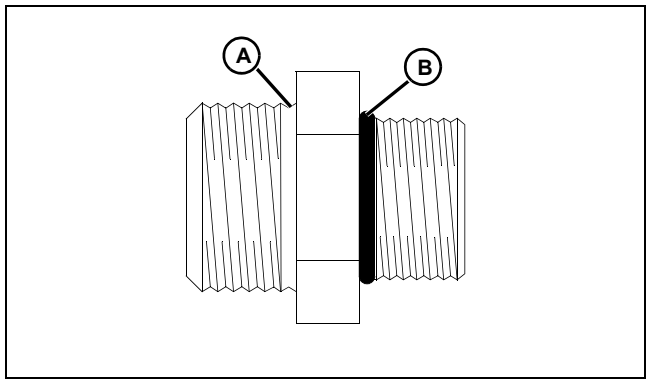
4. Index angle fittings and tighten by hand pressing joint together to insure O-ring remains in place.

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.

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

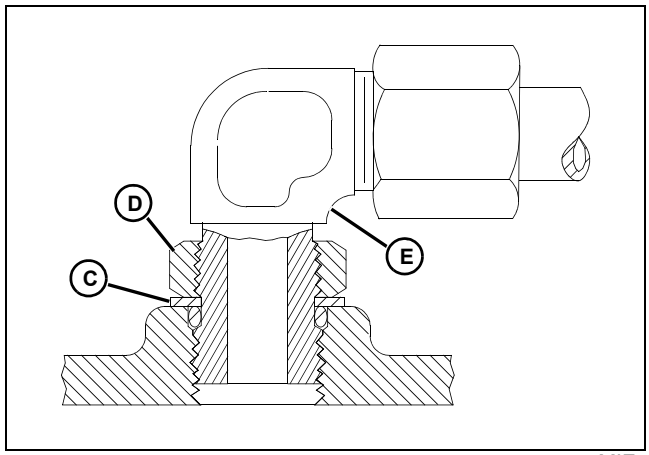
O-Ring Boss Fittings

1. Inspect boss 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.



MIF

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



MIF

3. For angle fittings, loosen special nut (D) and push special washer (C) 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 Torques

Thread Size	Torque[a]		Number of Flats[b]
	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

[a]Torque tolerance is ± 10 percent.

[b]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.

Metric Fastener Torque Value - Grade 7 (Special)

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)

General Information

Gasoline

4 - Cycle Engines

CAUTION: Avoid Injury! Gasoline is HIGHLY FLAMMABLE, handle it with care. DO NOT refuel machine while: indoors, always fill gas tank outdoors; machine is near an open flame or sparks; engine is running, STOP engine; engine is hot, allow it to cool sufficiently first; smoking.
Help prevent fires: fill gas tank to bottom of filler neck only; be sure fill cap is tight after fueling; clean up any gas spills IMMEDIATELY; keep machine clean and in good repair - free of excess grease, oil, debris, and faulty or damaged parts; any storage of machines with gas left in tank should be 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. To prevent fire or explosion caused by STATIC ELECTRIC DISCHARGE during fueling:•ONLY use a clean, approved POLYETHYLENE PLASTIC fuel container and funnel WITHOUT any metal screen or filter.

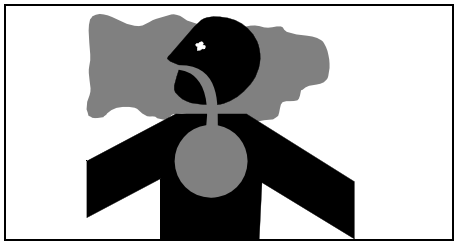
To avoid engine damage:

- DO NOT mix oil with gasoline;
- **ONLY use clean, fresh unleaded gasoline with an octane rating (anti-knock index) of 87 or higher**;
- fill gas tank at the end of each day's operation to help prevent condensation from forming inside a partially filled tank;
- keep up with specified service intervals.

Use of alternative oxygenated, gasohol blended, unleaded gasoline is acceptable as long as:

- the ethyl or grain alcohol blends DO NOT exceed 10% by volume or
- methyl tertiary butyl ether (MTBE) blends DO NOT exceed 15% by volume

RFG (reformulated) gasoline is acceptable for all machines designed for use of regular unleaded fuel. Older machines (that were designed for leaded fuel) may see some accelerated valve and seat wear.



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IMPORTANT: Avoid damage! California Proposition 65 Warning: Gasoline engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

Gasoline Storage

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

Keep gasoline stored in a safe, protected area. Storage of gasoline in a clean, properly marked ("UNLEADED GASOLINE") POLYETHYLENE PLASTIC container WITHOUT any metal screen or filter is recommended. DO NOT use de-icers to attempt to remove water from gasoline or depend on fuel filters to remove water from gasoline. Use a water separator installed in the storage tank outlet. BE SURE to properly discard unstable or contaminated gasoline. When storing the machine or gasoline, it is recommended that you add **John Deere Gasoline Conditioner and Stabilizer (TY15977)** or an equivalent to the gasoline. BE SURE to follow directions on container and to properly discard empty container.

Diesel Fuel

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.

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 (minimum)**

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 air temperature at which diesel fuel **begins to cloud or jell** - at least 5°C (9°F) below the expected low air temperature range.

- **Sulfur Content of 0.05% (maximum)**

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 0.05%, reduce the service interval for engine oil and filter by 50%.**

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

Diesel Fuel 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 de-icers 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 Gasoline Engine Oil

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:

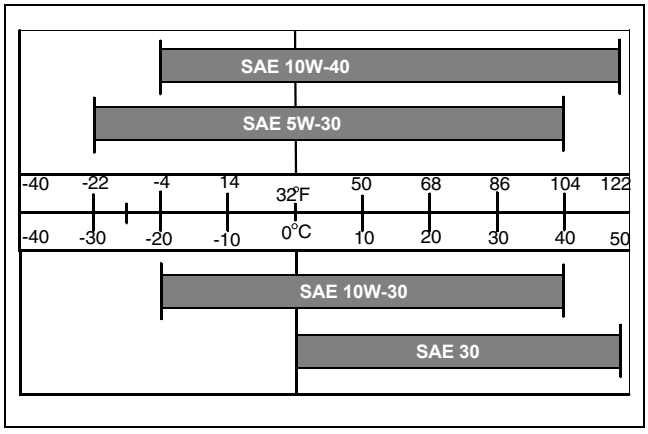
- **PLUS - 4® - SAE 10W-40**;
- **TORQ - GARD SUPREME® - SAE 5W-30**.

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 10W-40 - API Service Classifications SG or higher;
- SAE 5W-30 - API Service Classification SG or higher;
- SAE 10W-30 - API Service Classifications SG or higher;
- SAE 30 - API Service Classification SC or higher.



Break-In Engine Oil - 4-Cycle Gasoline

IMPORTANT: Avoid damage! ONLY use a quality break-in oil in rebuilt or remanufactured engines for the first 5 hours (maximum) of operation. DO NOT use oils with heavier viscosity weights than SAE 5W-30 or oils meeting specifications API SG or SH, these oils will not allow rebuilt or remanufactured engines to break-in properly.

The following John Deere oil is PREFERRED:

- **BREAK - IN ENGINE OIL**.

John Deere BREAK - IN ENGINE OIL is formulated with special additives for aluminum and cast iron type engines to allow the power cylinder components (pistons, rings, and liners as well) to “wear-in” while protecting other engine components, valve train and gears, from abnormal wear. Engine rebuild instructions should be followed closely to determine if special requirements are necessary.

John Deere BREAK - IN ENGINE OIL is also recommended for non-John Deere engines, both aluminum and cast iron types.

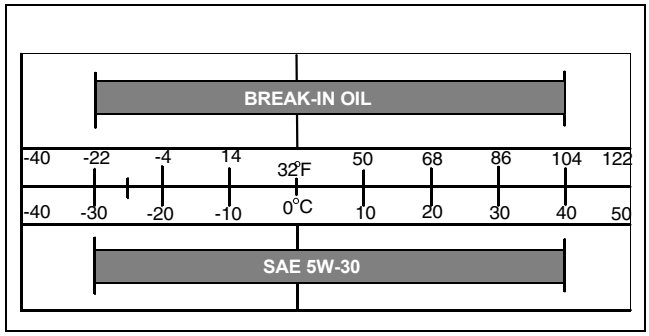
The following John Deere oil is **also recommended**:

- **TORQ - GARD SUPREME® - SAE 5W-30.**

If the above recommended John Deere oils are not available, use a break-in engine oil meeting the following specification during the first **5 hours (maximum)** of operation:

- SAE 5W-30 - API Service Classification SE or higher.

IMPORTANT: Avoid damage! After the break-in period, use the John Deere oil that is recommended for this engine.



4 - Cycle Diesel Engine Oil

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**.

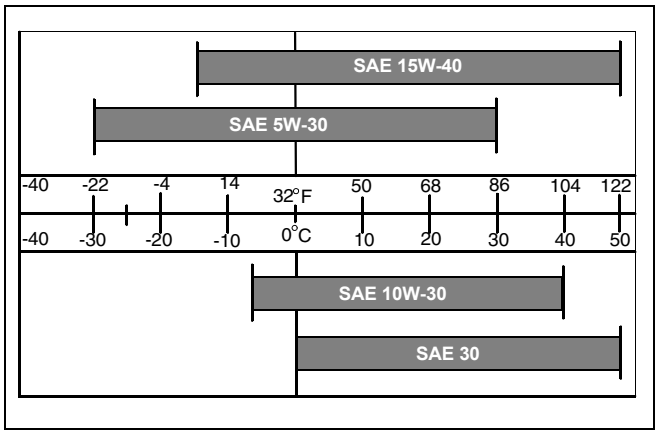
The following John Deere oils are **also** recommended, based on their specified temperature range:

- **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 Classifications 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%.



Break-In Engine Oil - Diesel

IMPORTANT: Avoid damage! ONLY use this specified break-in oil in rebuilt or remanufactured engines for the first 100 hours (maximum) of operation. DO NOT use PLUS - 50®, SAE 15W40 oil or oils meeting specifications API CG - 4 or API CF - 4, these oils will not allow rebuilt or remanufactured engines to break-in properly.

The following John Deere oil is PREFERRED:

- **BREAK - IN ENGINE OIL**.

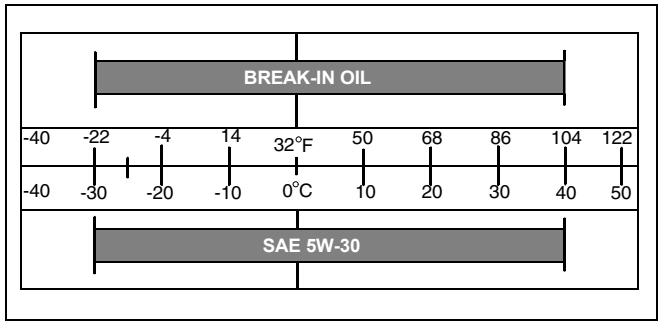
John Deere BREAK - IN ENGINE OIL is formulated with special additives for aluminum and cast iron type engines to allow the power cylinder components (pistons, rings, and liners as well) to “wear-in” while protecting other engine components, valve train and gears, from abnormal wear. Engine rebuild instructions should be followed closely to determine if special requirements are necessary.

John Deere BREAK - IN ENGINE OIL is also recommended for non-John Deere engines, both aluminum and cast iron types.

If this preferred John Deere oil is not available, use a break-in engine oil meeting the following specification during the first 100 hours of operation:

- API Service Classification CE or higher.

IMPORTANT: Avoid damage! After the break-in period, use the John Deere oil that is recommended for this engine.



Transaxle and MFWD Differential Oil

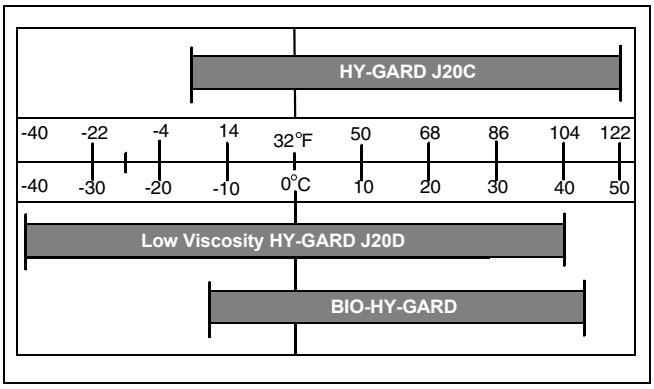
Use the appropriate oil viscosity based on these air temperature ranges. Operating outside of these recommended oil air temperature ranges may cause premature hydrostatic transmission or hydraulic system failures.

IMPORTANT: Avoid damage! Mixing of LOW VISCOSITY HY - GARD™ and HY - GARD™ oils is permitted. DO NOT mix any other oils in this transmission. DO NOT use engine oil or "Type F" (Red) Automatic Transmission Fluid in this transmission.

John Deere J20C HY-GARD™ transmission and hydraulic oil is recommended. John Deere J20D Low Viscosity HY-GARD™ transmission and hydraulic oil may be used, if within the specified temperature range.

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

- John Deere Standard JDM J20C;
- John Deere Standard JDM J20D.



Alternative Lubricants

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, unless otherwise stated on lubricant label.

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

Lubricant Storage

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

Mixing of Lubricants

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

Oil Filters

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

The following John Deere oil filters are PREFERRED:

- AUTOMOTIVE AND LIGHT TRUCK ENGINE OIL FILTERS.

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

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

- ASTB Tested In Accordance With SAE J806.

Brake Fluid

The following John Deere heavy duty brake fluid is PREFERRED for all drum and disc brakes:

- Brake Fluid - DOT3

Other brake fluids may be used if the above John Deere brake fluid is not available and they provide the following:

- DOT3 certified.
- Conforms to Motor Vehicle Safety Standard No. 116.
- Minimum wet boiling point 140°C (284°F).
- Minimum dry boiling point 232°C (450°F) to prevent vapor lock.

Coolant Specifications

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**:

- **COOL-GARD® PRE-DILUTED 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:

- **COOL-GARD® CONCENTRATED SUMMER COOLANT (TY16034).**

If either of above recommended engine coolants are available use any Automobile and Light Duty Engine Service ethylene glycol base coolant, meeting the following specification:

- ASTM D4985 (JDM H24A2) Gas Engines.
- ASTM D3306 (JDM H24C1) Diesel Engines.

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

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

Property	Requirements
Total Solids, Maximum	340 ppm (20 grns/gal)
Total Hardness, Maximum	170 ppm (10 grns/gal)
Chloride (as Cl), Maximum	40 ppm (2.5 grns/gal)
Sulfate (as SO4), Maximum	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.

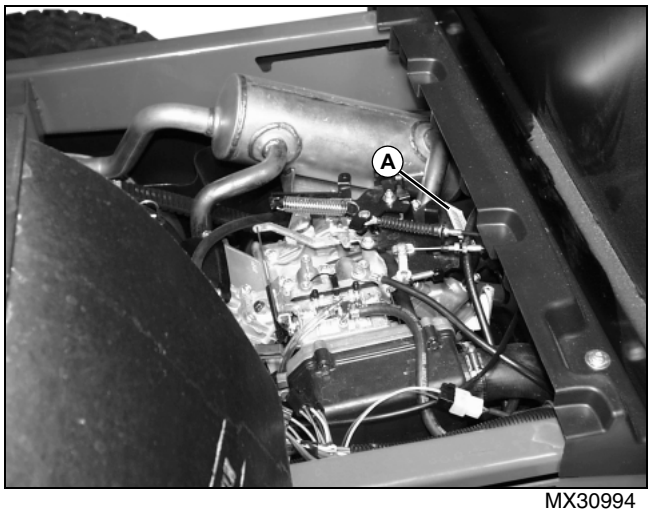
Serial Number Locations

Product Serial Number

MX30993

The 13-digit product identification number (A) is located on the right-hand side frame.

Gasoline Engine Serial Number Location



MX30994

Engine serial number (A) is located on the flywheel cover.

Diesel Engine Serial Number Location

MX31115

Engine serial number (A) is located on valve cover. The model number will designate the engine type.

ENGINE - GAS (LIQUID-COOLED) TABLE OF CONTENTS

Table of Contents

Specifications

General Specifications

Make	Kawasaki
Model	FD620D
Type	4-cycle gas/Liquid Cooled
Power	14.9 kW (20.0 hp)
Cylinders	2
Bore	74 mm (2.900 in.)
Stroke	68 mm (2.660 in.)
Displacement	617 cm^3 (37.7 cu-in.)
Spark Plug	NGK BPR2ES (M138938)
Spark Plug Gap	0.80 mm (0.031 in.)
Fuel Tank	20.0 L (5.25 gal)
Crankcase (with filter)	1.3 L (1.37 qt)
Engine Oil	John Deere PLUS-4® SAE 10W-40
	John Deere TURF-GARD® SAE 10W-40
Cooling system (Including recovery tank)	5.0 L (5.2 qt)

Test and Adjustment Specifications

Engine:

Low Speed Idle (Governed)	1155 ± 75 rpm
High Speed Idle	3750 ± 25 rpm
Oil pressure sensor activates	98 kPa (14.2 psi)
Oil pressure (minimum)	276 kPa (40 psi)
Oil filter bypass valve opening pressure	78.5 - 117.5 kPa (11.4 - 17.1 psi)
Cylinder compression pressure (minimum)	1171 kPa (170 psi)
Maximum compression pressure variation between cylinders	138 kPa (20 psi)
Crankcase vacuum (minimum)	25 mm (1 in.) H2O
Intake and exhaust valve clearance (cold)	0.25 mm (0.01 in.)
Intake and exhaust valve adjustment interval	300 hrs
Valve clearance adjusting nut torque	9 N•m (79 lb-in.)

Fuel/Air System:

Fuel Pump	
Minimum flow	105 ml (3.5 oz) in 15 seconds
Minimum pressure	10 kPa (1.5 psi)
Carburetor SLOW idle stop screw setting	50 rpm less than governed idle setting
Governed SLOW idle stop screw setting	1125 ± 75 rpm
Throttle control arm HIGH idle stop screw setting	3750 ± 75 rpm

Cooling System:

Radiator cap

Maximum test pressure . . . . . 117 kPa (17 psi)
Minimum pressure after 15 seconds . . . . . 90 kPa (13 psi)
Nominal Opening pressure . . . . . 83 - 96 kPa (12 - 14 psi)
Minimum pressure . . . . . 83 kPa (12 psi)

Thermostat

Begin-to-open temperature . . . . . approximately 82°C (180°F)
Full-open temperature . . . . . approximately 96°C (205°F)

Repair Specifications

Cylinder Head:

Cylinder Head Flatness . . . . . 0.06 mm (0.002 in.)
Compression (Minimum) . . . . . 1171 kPa (170 psi)
Cap Screw Torque In Sequence
Initial Torque . . . . . 13 N•m (115 lb-in.)
Final Torque . . . . . 21 N•m (186 lb-in.)
Spark Plug Torque . . . . . 25 N•m (221 lb-in.)
Intake Manifold Cap Screw Torque . . . . . 6 N•m (53 lb-in.)

Rocker Arm:

Minimum Shaft OD . . . . . 11.95 mm (0.470 in.)
Maximum Bearing ID . . . . . 12.07 mm (0.475 in.)
Adjusting Nut Torque . . . . . 9 N•m (79 lb-in.)

Push Rod:

Maximum Bend . . . . . 0.80 mm (0.031 in.)

Valves and Springs:

Valve Clearance . . . . . 0.25 mm (0.010 in.)
Spring Free Length . . . . . 29.70 mm (1.170 in.)
Minimum Valve Stem OD
Intake . . . . . 5.95 mm (0.234 in.)
Exhaust . . . . . 5.92 mm (0.233 in.)
Maximum Valve Guide ID . . . . . 6.05 mm (0.238 in.)
Maximum Valve Stem Bend . . . . . 0.03 mm (0.001 in.)
Standard Valve Seating Surface . . . . . 0.5 - 1.10 mm (0.020 - 0.043 in.)
Valve Seating Width Tolerance . . . . . 2.0 mm (0.08 in.)
Valve Seat and Face Angle . . . . . 45°
Minimum Valve Margin . . . . . 0.60 mm (0.024 in.)
Valve Narrowing Angle . . . . . 30°

ENGINE - GAS (LIQUID-COOLED) SPECIFICATIONS

Crankcase:

Cover Cap Screw Torque	**21 N•m (186 lb-in.)**
Drain Plug Torque	**23 N•m (204 lb-in.)**
Plain Bearing	
Maximum Crankcase Cover ID	**34.07 mm (1.341 in.)**
Maximum Crankcase ID	**34.11 mm (1.343 in.)**
Governor Arm Nut Torque	**8 N•m (72 lb-in.)**

Crankshaft:

Drive Clutch to Crankshaft Cap Screw	**37 N•m (26 lb-ft)**
Minimum Side Journal OD	**33.91 mm (1.335 in.)**
Minimum Connecting Rod Journal	**33.93 mm (1.336 in.)**
Maximum Total Indicated Runout	**0.05 mm (0.002 in.)**

Flywheel:

Flywheel Nut Torque	**108 N•m (80 lb-ft)**
Sheave Half Cap Screw	**15 N•m (130 lb-in.)**

Camshaft:

Minimum End Journals	**25.21 mm (0.993 in.)**
Minimum Lobe OD	
Intake	**25.21 mm (0.993 in.)**
Exhaust	**25.46 mm (1.002 in.)**
Maximum Cover and Crankcase Bearing ID	**16.07 mm (0.633 in.)**

Piston:

Maximum Ring Groove Clearance	
Top Ring	**0.15 mm (0.006 in.)**
Second Ring	**0.12 mm (0.005 in.)**
Oil Ring	**Not Measured**
Ring Thickness (Top, Second)	**1.12 mm (0.044 in.)**
Maximum Ring End Gap (Top, Second)	**1.20 mm (0.050 in.)**
Oil Ring	**1.5 mm (0.06 in.)**
Minimum Pin OD	**16.98 mm (0.668 in.)**
Maximum Pin Bore ID	**17.04 mm (0.671 in.)**
Piston OD (measured at 11 mm (0.433 in.))	
from bottom of piston skirt)	**75.93 - 75.95 mm (2.989 - 2.99 in.)**
Piston-to-Cylinder Bore Clearance	**0.03 - 0.17 mm (0.001 - 0.007 in.)**

Connecting Rod:

Maximum Crankshaft Bearing ID	**34.06 mm (1.341 in.)**
Maximum Piston Pin Bearing ID	**17.05 mm (0.671 in.)**
End-Cap Screw Torque	**21 N•m (186 lb-in.)**

ENGINE - GAS (LIQUID-COOLED) SPECIFICATIONS

Cylinder Bore:	
Standard ID	**75.98 - 76 mm (2.991 - 2.992 in.)**
Maximum ID	**76.07 mm (2.995 in.)**
Out of Round	**0.056 mm (0.0022 in.)**
Cylinder Oversize Diameter:	
0.50 mm	**76.46 - 76.48 mm (3.010 - 3.011 in.)**
Oil Pump:	
Minimum Rotor Shaft OD	**10.92 mm (0.430 in.)**
Maximum Rotor Shaft Bearing ID	**11.07 mm (0.436 in.)**
Minimum Outer Rotor OD	**40.43 mm (1.592 in.)**
Minimum Outer Rotor Bearing ID	**40.80 mm (1.606 in.)**
Minimum Valve Spring Free Length	**19.50 mm (0.768 in.)**
Water Pump:	
Minimum Shaft OD	**9.94 mm (0.391 in.)**
Maximum Pump and Crankcase Housing Bore ID	**10.09 mm (0.397 in.)**
Cap Screw Torque (Bolt M6 all lengths)	**9.5 N•m (84 lb-in.)**
Cap Screw Torque (Bolt M8)	**25 N•m (222 lb-in.)**
Crankcase Cover Cap Screw Torque	**21 N•m (186 lb-in.)**

Special or Essential Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Tachometer	JT05719	Slow idle mixture screw and speed adjustments, and fast idle speed adjustment.
Fuel Pump Pressure Test Kit	JDG356	Fuel pump pressure test.
Compression Gauge Spark Plug Test Tool	JDM-59 JDM-74A-5	Cylinder compression test, and valve clearance adjustment.
Pressure Gauge Assembly Hose Assembly Connector 1/8” BSP Thread	JT05577 JT03017 JT03349	Oil pressure test.
Valve Spring Compressor	JDM70	Cylinder head disassembly and assembly.
Valve Guide Driver Tool	JDG504	Replace valve guides.

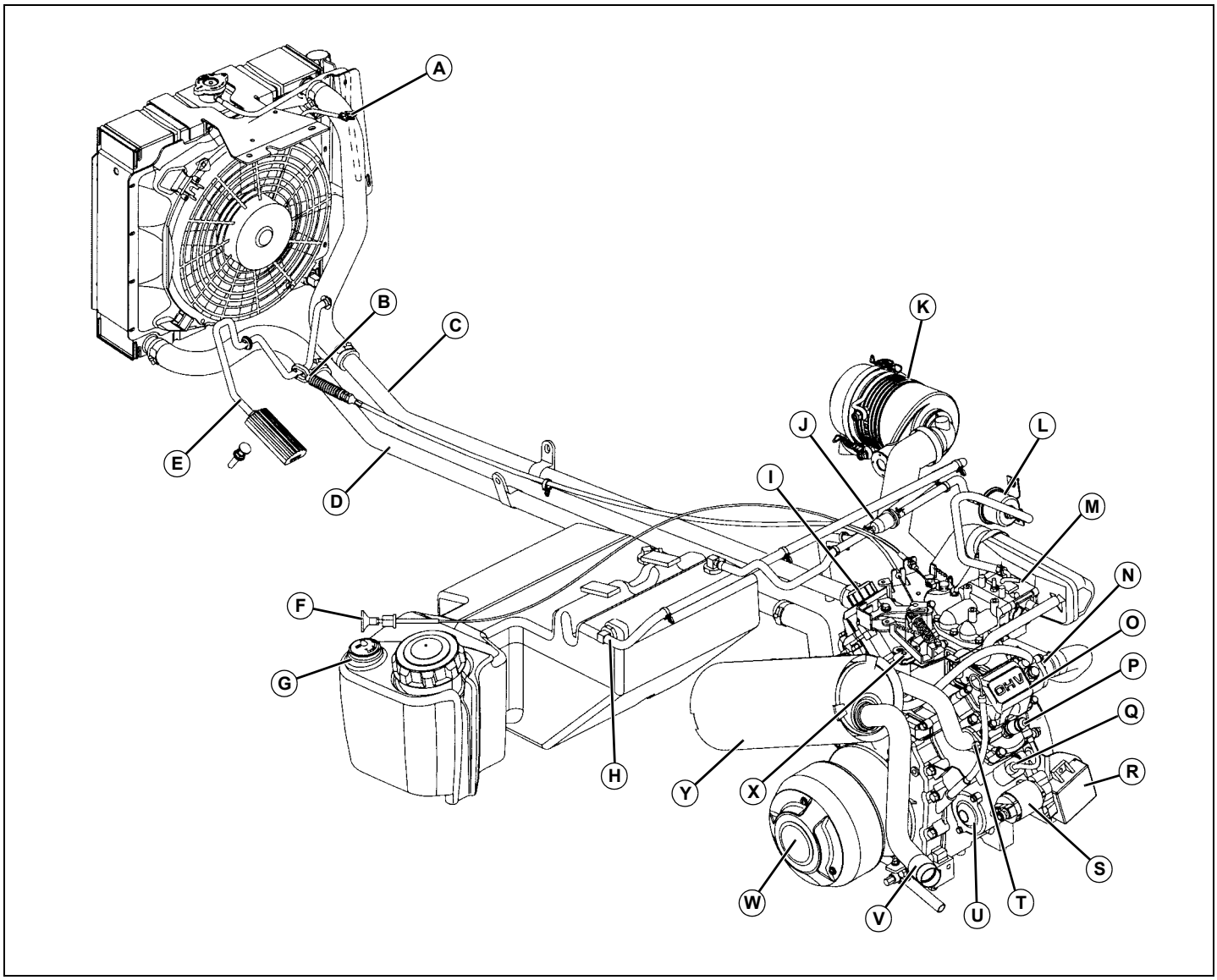
Other Materials

Other Material

Part No.	Part Name	Part Use
	SCOTCH-BRIGHT® Abrasive Sheets/Pads	Clean cylinder head.
	Valve Guide Cleaner	Clean valve guides.
	Stanisol or Kerosene	Finish ream valve guide.
	Prussion Blue Compound	Check valve seat contact.
	Lithium Base Grease	Pack oil seals.
	Zinc Oxide/Wood Alcohol	Check block for cracks.
	Mineral Spirits	Clean electric starter armature.

Component Location

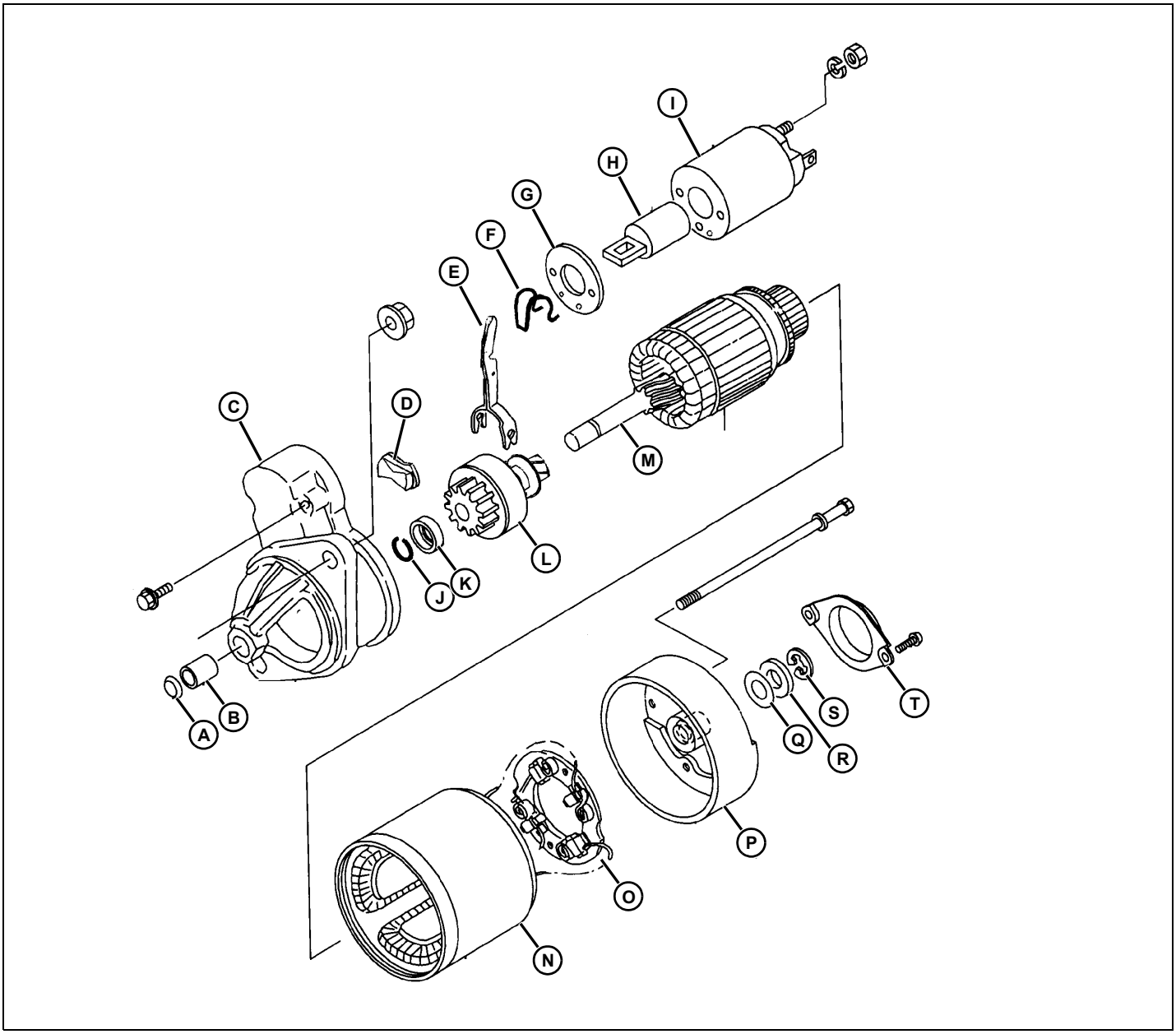
Engine Component Location



MX31637

- **A - Thermostat Connector**
- **B - Throttle Cable**
- **C - Radiator Hose**
- **D - Radiator Return Hose**
- **E - Throttle Pedal**
- **F - Choke Cable Control Knob**
- **G - Fuel Gauge**
- **H - Fuel Line**
- **I - Oil Fill Cap**
- **J - Fuel Filter**
- **K - Air Filter Assembly**
- **L - Fuel Pump**
- **M - Carburetor**
- **N - Water Pump**
- **O - Valve Cover**
- **P - Spark Plug**
- **Q - Igniter**
- **R - Engine Control Module**
- **S - Starting Motor Solenoid**
- **T - Exhaust Port**
- **U - Starting Motor**
- **V - Spark Arrester**
- **W - Drive Clutch**
- **X - Governor Assembly**
- **Y - Muffler**

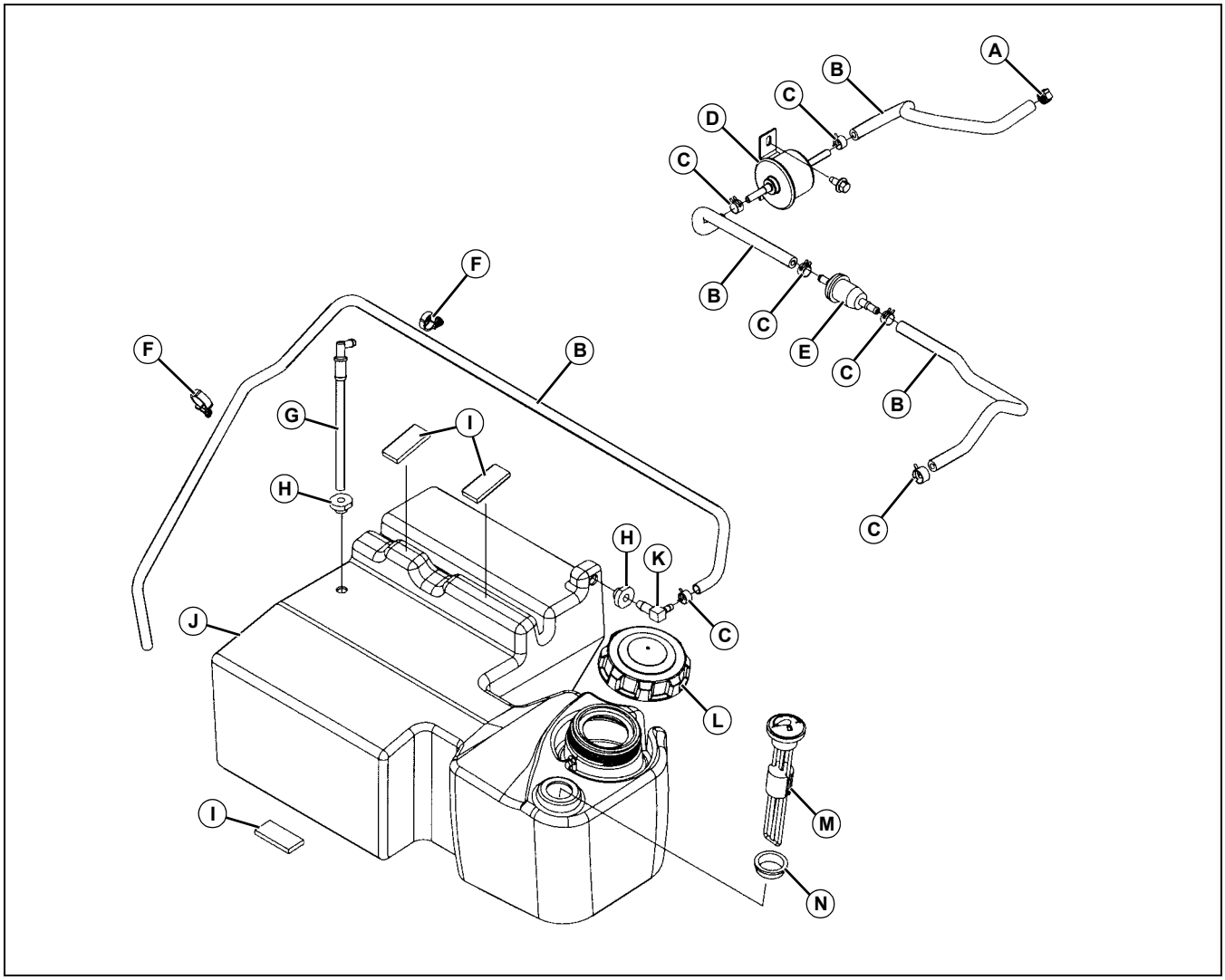
Starting Motor



M76762

- **A - End Cap**
- **B - Cover Bushing**
- **C - End Frame**
- **D - Dust Cap**
- **E - Shift Fork**
- **F - Clutch Fork Pivot**
- **G - Shim Plate**
- **H - Plunger**
- **I - Solenoid**
- **J - Retaining Ring**
- **K - Pinion Stopper**
- **L - Clutch**
- **M - Armature**
- **N - Field Coil Housing**
- **O - Filed Brush Holder**
- **P - Rear Cover**
- **Q - Shim**
- **R - Shim**
- **S - E-Clip**
- **T - Cap**

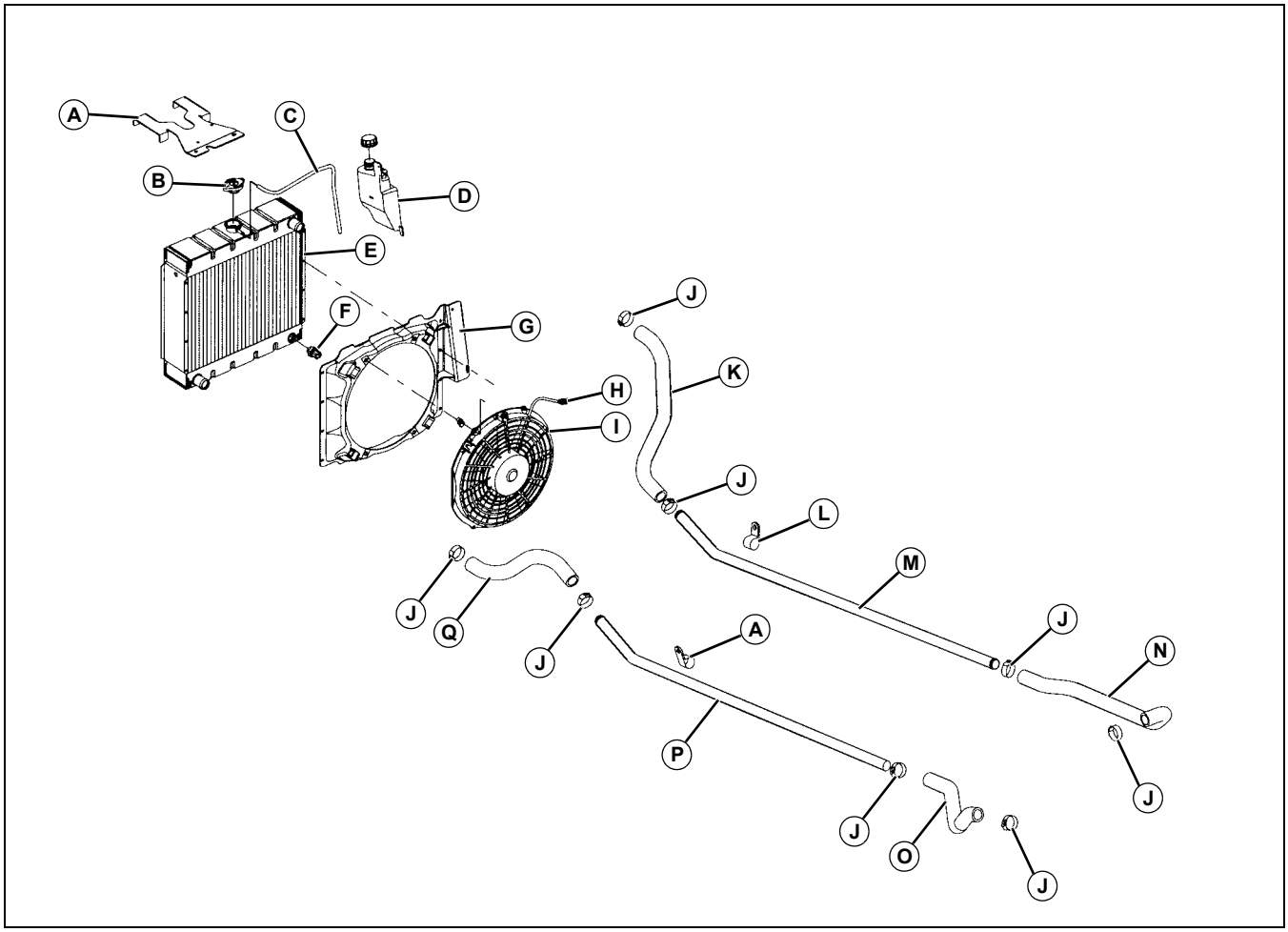
Fuel System Components



MX31875

A - Clamp
B - Hose (TY22551)
C - Clip
D - Fuel Pump
E - Fuel Filter
F - Retainer
G - Pick Up Tube
H - Bushing
I - Pad
J - Fuel Tank
K - Elbow Fitting
L - Filler Cap
M - Fuel Gauge
N - Bushing

Coolant System Components



MX31876

A - Support Bracket
B - Radiator Cap
C - Vent Tube
D - Overflow Reservoir
E - Radiator
F - Temperature Sensor
G - Shroud
H - Cooling Fan Electrical Connector
I - Cooling Fan
J - Clamp
K - Upper Radiator Hose
L - Retainer
M - Coolant Supply Tube
N - Coolant Supply Hose
O - Coolant Return Hose
P - Coolant Return Tube
Q - Lower Radiator Hose

Diagnostics

Engine Troubleshooting Guide

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

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

Test Conditions:

- Operator On Seat
- Transmission in Neutral
- Brake On

Symptom: Engine Doesn't Crank

(1) Are battery cables loose or dirty?

Yes - Tighten or clean.

No - Go to next step.

(2) Is battery fully charged? (See "Battery Test" in the Electrical section.)

No - Charge battery. (See "Charge Battery" in the Electrical section.)

Yes - Go to next step.

(3) Is key switch working correctly?

Yes - Go to next step.

No - Test switch. (See "Cranking Circuit Operation," for the appropriate machine, in the Electrical section.) Replace as needed.

(4) Has engine seized?

Yes - See Engine Repair Section.

No - Go to next step.

(5) Is starting motor or solenoid defective?

Yes - Repair or replace. (See "Starting Motor Solenoid Test" or "Starting Motor No-Load Amperage and RPM Test" in the Electrical section.)

CAUTION: Avoid injury! Keep spark plug as far away from the plug hole as possible. Gasoline spray from the open cylinders may be ignited by ignition spark and cause an explosion or fire.

Symptom: Engine Hard To Start

(1) Is there a strong blue spark?

Yes - Go to step 3.

No - Replace spark plug. Recheck for spark and go to next step.

(2) Is there a strong blue spark?

Yes - Check engine starting.

No - Check if sparks are produced between high tension lead and ignition block. Check high tension lead, ignition coil air gap, pulser coil.

(3) Check compression. See "Cylinder Compression Test" on page 38. Is compression sufficient?

Yes - Make starting attempts a number of times, remove spark plug and observe electrodes. Go to next step.

No - Go to step 5.

(4) After starting attempts, are spark plug electrodes wet?

Yes - Check for excessive use of choke, plugged air cleaner, carburetor float level too high.

No - Check fuel tank and lines.

(5) Compression is low?

Yes - Check piston rings and cylinder for wear. Inspect cylinder head. See "Pistons and Cylinders Removal" on page 53.

Symptom: Engine Runs Erratically

(1) Is fuel delivery correct? See "Fuel Pump Flow Test" on page 38.

Yes - Check for plugged air/fuel passages in carburetor. See "Carburetor Repair" on page 44.

No - Check for contamination, or an air or vapor lock in the fuel tank and lines. Check fuel filter and pump.

Symptom: Engine Malfunctions At Low Speed

(1) Is unusual smoke emitted out of muffler?

Yes - Check choke. See "Choke Cable Adjustment" on page 37.

No - Go to next step.

(2) Does engine rpm drop or engine stall at a certain point when throttle is gradually opened by hand?

Symptom: Engine Malfunctions At Low Speed

Yes - Plugged passage in carburetor, clean carburetor. (See “Carburetor Repair” on page 44.)

No - Go to next step.

(3) Is air sucked through carburetor or intake manifold flanges?

Yes - Tighten manifold flange nuts or replace damaged gasket.

No - Go to next step.

(4) Are valve clearances set correctly? (See “Valve Clearance Adjustment” on page 39.)

No - Adjust valves.

Symptom: Oil Consumption Is Excessive

(1) Check compression. (See “Cylinder Compression Test” on page 38.) Is compression sufficient?

Yes - Check for oil leaks, high oil level, plugged oil ring groove, oil seals, clogged breather valve, plugged drain back hole in breather, incorrect oil viscosity.

No - Check for worn, stuck or broken piston rings, or worn cylinder bore.

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 does not by 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 & Adjustments for further guidance.

Symptom: Starter Does Not Rotate

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

Yes - Repair starting motor. (See “Starting Motor Removal and Installation” on page 60.)

No - Check that all starting conditions are met. Go to next step.

(2) Are battery cables loose or dirty?

Symptom: Starter Does Not Rotate

Yes - Tighten or clean.

No - Go to next step.

(3) Is battery fully charged? (See “Battery Test” in the Electrical section.)

No - Charge battery. (See “Charge Battery” in the Electrical section.)

Yes - Go to next step.

(4) Is key switch working correctly?

Yes - Go to next step.

No - Test switch. (See “Cranking Circuit Operation,” for the appropriate machine, in the Electrical section.) Replace as needed.

(5) Has engine seized?

Yes - See Engine Repair Section.

Symptom: Starter Rotates Slowly

(1) Are battery cables loose or dirty?

Yes - Tighten or clean.

No - Go to next step.

(2) Is battery fully charged? (See “Battery Test” in the Electrical section.)

Yes - Go to next step.

No - Charge battery. (See “Charge Battery” in the Electrical section.)

(3) Has engine seized?

Yes - See Engine Repair Section.

No - Go to next step.

(4) Is starting motor or solenoid defective?

Yes - Repair or replace. (See “Starting Motor Solenoid Test” or “Starting Motor No-Load Amperage and RPM Test” in the Electrical section.)

Tests and Adjustments

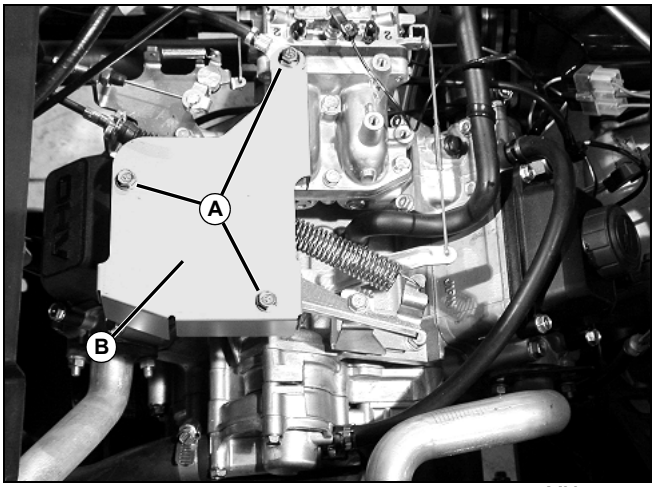
Governor: Static Adjustment

Reason:

To properly position governor arm to governor shaft for proper governor operation.

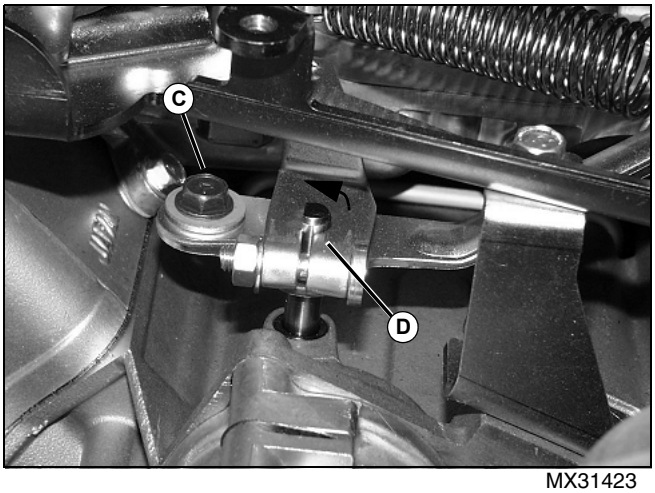
Procedure:

1. Park machine safely. (See Parking Safely in safety section) Raise cargo box.



MX31422

2. Remove three cap screws (A) and throttle control arm cover (B).



MX31423

3. Press accelerator pedal down and place a heavy weight on pedal.

IMPORTANT: Avoid damage! Cap screw has left-hand threads.

4. Loosen cap screw (C) on governor arm. Turn governor shaft and bracket (D) counterclockwise to remove any slack in governor linkage and arm.

IMPORTANT: Avoid damage! DO NOT move throttle control arm by hand, this will kink the wire cable and damage it. Use throttle pedal only.

5. Hold shaft and tighten cap screw (C).

High Idle Speed Adjustment

Reason:

To ensure engine is running at proper high idle speed.

Equipment:

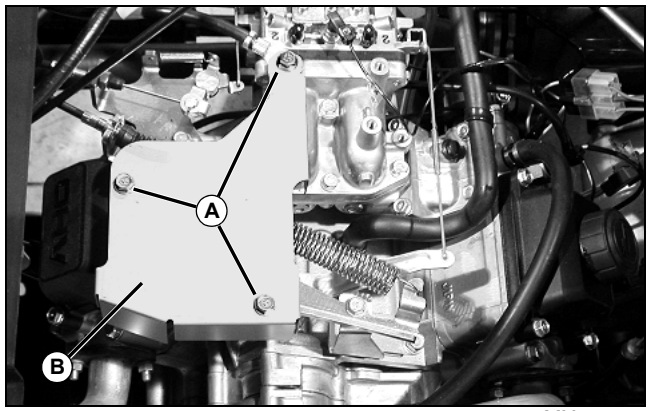
- JT05801 Induction Tachometer

-or-

- JT05719 Digital Tachometer

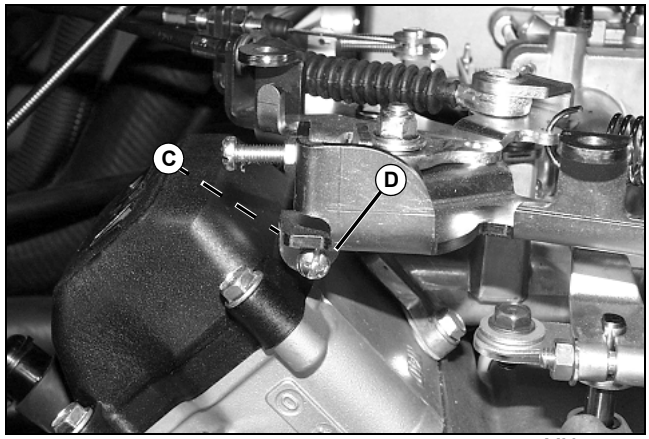
Procedure:

1. Park machine safely and raise cargo box. (See Parking Safely in safety section)



MX31422

2. Remove three cap screws (A) and throttle control arm cover (B).



MX31544

3. Start and warm up engine. Run engine at full throttle and check rpms with tachometer. Record reading.

4. High idle speed should be 3750 ±75 rpm. If rpms are not within specification, loosen jam nut behind bracket (C) and adjust screw (D) until proper rpm is obtained and tighten jam nut.

Slow Idle Mixture and Governed Low Idle Adjustments

Reason:

To ensure correct fuel/air mixture and engine is running at proper slow idle speed

NOTE: Adjust fast idle before slow idle and mixture speed adjustment.

Equipment:

- JT05801 Induction Tachometer

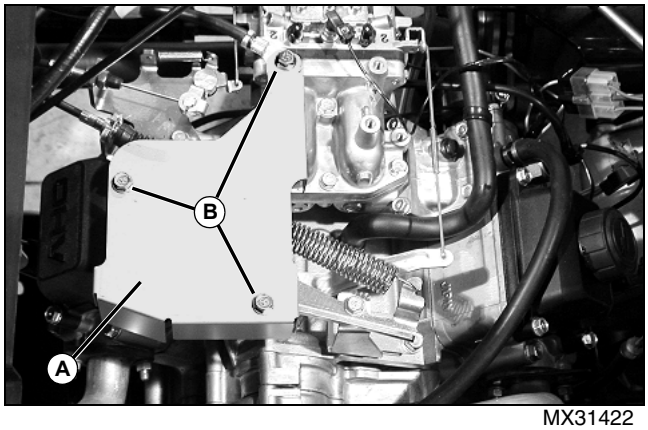
-or-

- JT05719 Digital Tachometer

Procedure:

1. Park machine safely and raise cargo box. (See “Parking Safely” on page 6 in Safety section.)

IMPORTANT: Avoid damage! Do not move the throttle control arm by hand. This will kink the wire cable and damage it. Use throttle pedal only.



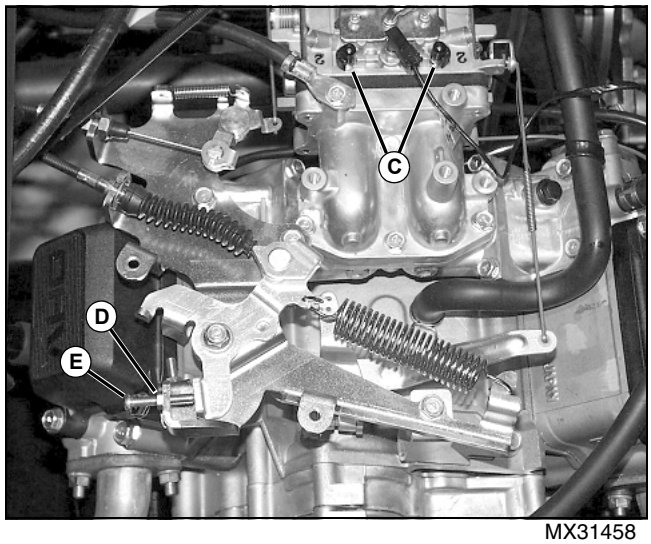
MX31422

2. Remove throttle control arm cover (A) by removing three cap screws (B).

NOTE: When throttle pedal is released, it takes approximately 30 seconds for idle speed to stabilize.

3. Run engine at fast idle until cooling fan starts. Release throttle pedal.

CAUTION: Avoid Injury! Engine components are HOT. Be extra careful not to touch the exhaust pipe or muffler while making adjustments. Wear protective eye glasses and clothing.



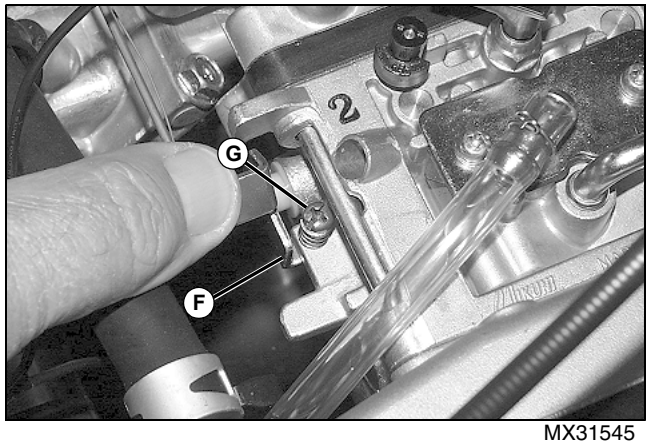
MX31458

4. Check governed idle speed with tachometer. Engine should be idling at 1155 ±75 rpm. If idle speed is not within specification, loosen jam nut (D) and adjust slow idle stop screw (E) until proper idle speed is obtained and tighten jam nut.

NOTE: Do not remove mixture screw limiter caps or force beyond stops.

5. Turn slow idle mixture screws (C), until smoothest idle is obtained.

6. Repeat step 4 if necessary.



MX31545

7. Push and hold throttle so that tab (F) is against slow idle stop screw (G). While checking idle speed with tachometer, adjust screw until engine speed is 100 rpm less than governed idle speed (Step 4).

Throttle Cable Adjustment

Reason:

To ensure that throttle cable is allowing throttle lever on governor to reach full high idle and slow idle positions.

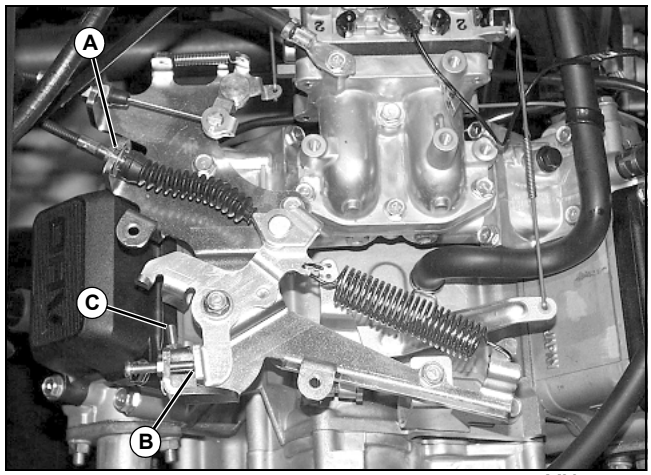
Equipment:

- 1/2 in. Wrenches

Procedure:

1. Park machine safely with park brake locked. See Park Machine Safely in Safety section.

2. Accelerator pedal should have 2-6 mm (0.080 - 0.240 in.) free travel before cable moves.



MX31458

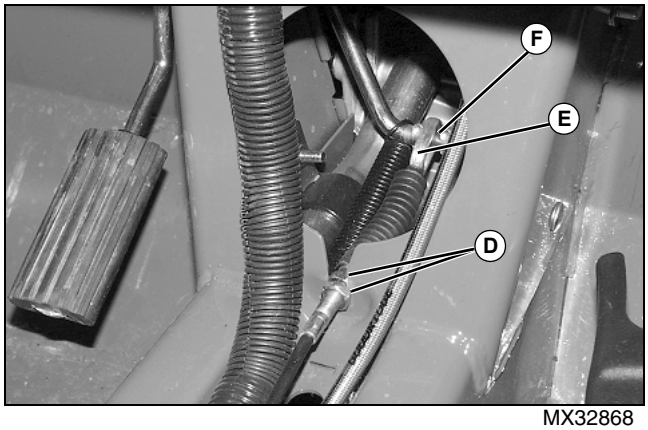
3. Inspect cable and bracket on engine (A).

4. When accelerator pedal is up, make sure the tab on the throttle lever is contacting the idle stop screw (B).

5. Press accelerator pedal all the way down to high speed position. Check that throttle cable is pulling throttle lever all the way to the fast idle stop screw (C).

To Adjust Cable:

1. Remove tunnel cover from machine.

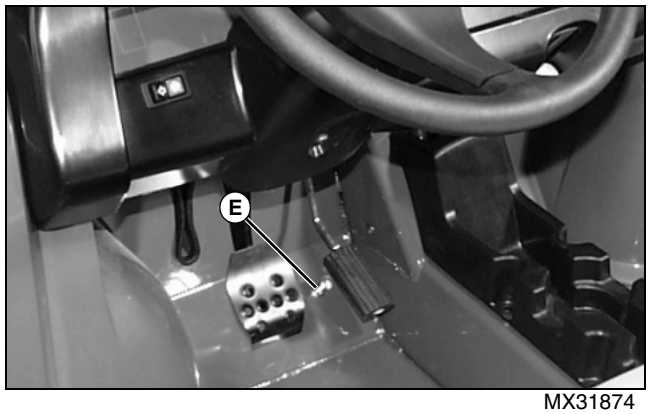


MX32868

1. Pull cable eyelet (E) to get slack out of cable and measure free play between eyelet and pedal rod (F). Gap should be 1-3 mm (0.039 - 0.118 in.).

2. If free play is not 1-3 mm (0.039 - 0.118 in.) loosen nuts (D) and adjust until proper freeplay is obtained.

3. Install tunnel cover.



MX31874

4. Adjust pedal stop (G) to limit pedal travel, preventing throttle cable from being stretched.

- Depress throttle pedal to full FAST idle position (throttle control arm touching fast idle stop screw (C) on engine).

NOTE: Using a five pound weight on pedal will make adjustment easier.

- Loosen jam nus on pedal stop (G) and turn stop bolt until just touching back of pedal.
- Turn pedal stop bolt ONE TURN until there is a 1 to 1-1/2 mm gap between pedal and stop bolt.
- Tighten pedal stop jam nut. Recheck adjustment.

Choke Cable Adjustment

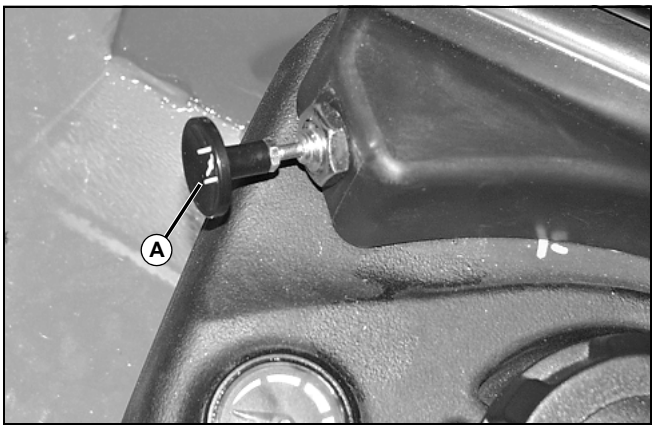
Reason:

To get full choke operation and prolong choke cable life

NOTE: Adjust fast idle, slow idle and mixture, before adjusting choke cable.

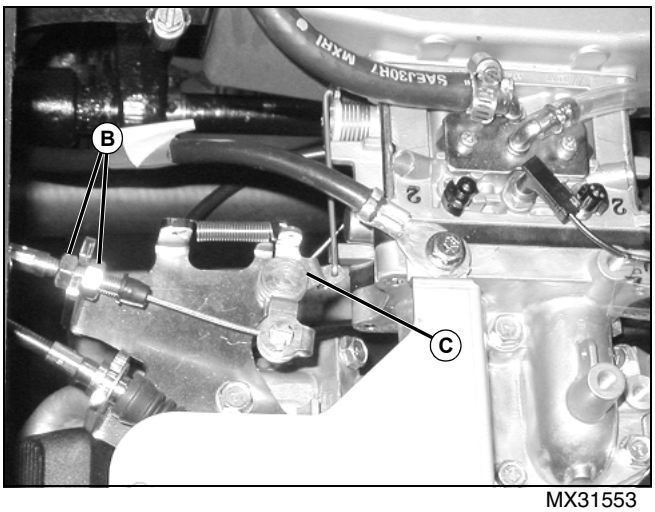
Procedure:

1. Park machine safely. (See Parking Safely in safety section)



MX31546

2. Be sure choke knob (A) is in OFF (pushed in) position.



MX31553

3. Loosen jam nuts (B) and lift choke cable out of the bracket.

4. Make sure choke spring, arm, and linkage (C) operate freely and choke is in open (off) position.

5. Hold cable and jam nuts over bracket and position jam nuts and cable housing to where there is almost no slack in the cable and no movement of the choke linkage. Tighten jam nuts.

6. Re check that choke is completely open when choke knob is in off position.

Fuel Pump Pressure Test

Reason:

To determine condition of fuel pump.

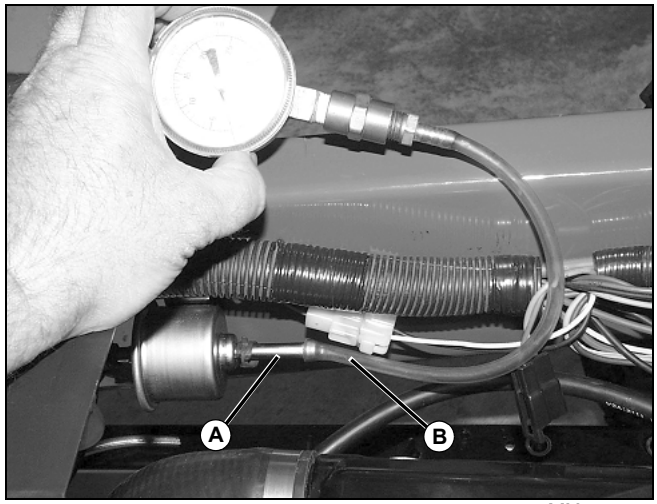
Equipment:

- JDG356 Fuel Pump Pressure Test Kit

Procedure:

1. Park machine safely. (See Parking Safely in safety section)

CAUTION: Avoid Injury! Gasoline vapor is explosive. Do not expose to spark or flame. Serious personal injury can result.



MX31548

2. Disconnect and plug fuel hose from fuel pump outlet (A).

3. Connect hose and gauge (B) to fuel pump outlet.

NOTE: DO NOT start engine.

4. Turn key switch to ON position only.

5. Observe pressure reading, a minimum pressure of 10 kPa (1.5 psi) should be seen.

Results:

- If fuel pressure BELOW minimum, check in-line filter and hoses for debris or restrictions. Replace filter, then test again.
- If pressure is still BELOW minimum, replace fuel pump.

Fuel Pump Flow Test

Reason:

To determine condition of fuel pump.

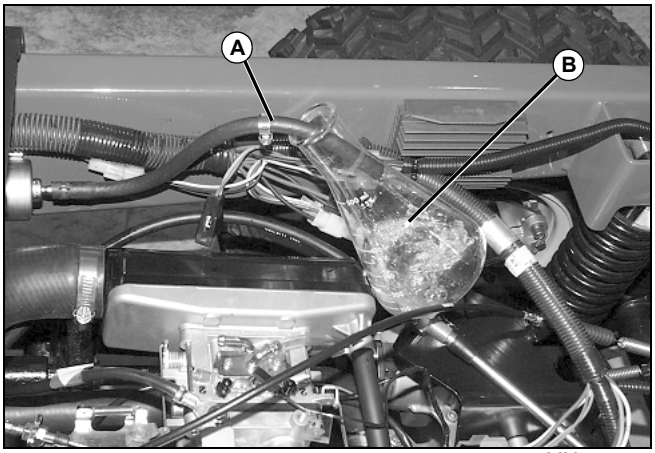
Equipment:

- Graduated container.

Procedure:

1. Park machine safely. (See Parking Safely in safety section)

CAUTION: Avoid Injury! Gasoline vapor is explosive. Do not expose to spark or flame. Serious personal injury can result.



MX31549

2. Disconnect fuel supply hose (A) from carburetor inlet port and put end in a graduated container (B).

NOTE: DO NOT start engine. Watch container DO NOT let it fill to overflowing. Stop test early if necessary.

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

4. The graduated container should show a minimum fuel flow of 105 mL (3.5 oz) in 15 seconds.

Results:

- If fuel pressure BELOW minimum, check in-line filter, hoses, and fuel shutoff valve for debris or restrictions. Replace filter, then test again.
- If pressure is still BELOW minimum, replace fuel pump.

High Altitude Operation

High altitude performance can be improved by installing a smaller diameter main jet in the carburetor; changing the pilot air jets from #56.3 to #60; and readjusting the idle mixture screws. Main jets available: #70 (greater than 2000 m), #72.5 (1000-2000 m) and #75 (less than 1000m).

Cylinder Compression Test

Reason:

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

Equipment:

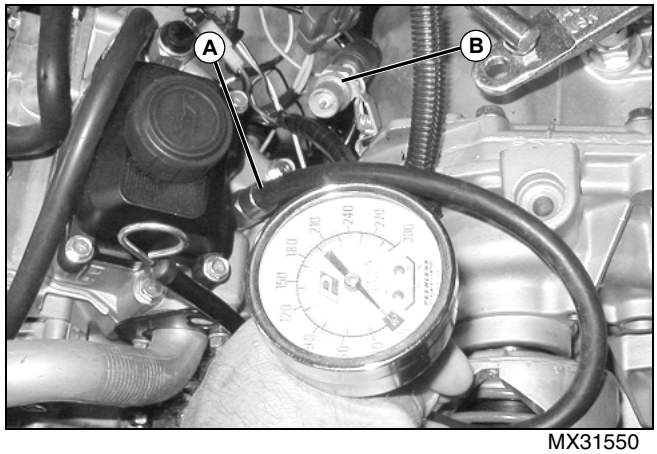
- JDM59 Compression Gauge
- JDM74A-5 Spark Tester (2)

Procedure:

1. Park machine safely. (See Parking Safely in safety section)

2. Adjust valve clearance to 0.25mm (0.010 in.) with engine at top-dead center (TDC) of compression stroke. Engine must be cold (60-85° F).

3. Start and run engine until operating temperature is reached.



MX31550

4. Remove spark plugs and install JDM74-A spark tester (B) on each spark plug wire, or ground spark plug wires to engine block. Install JDM59 Compression Gauge (A) in one cylinder.

5. Move and hold throttle pedal in FAST idle position.

6. Be sure choke is OFF.

IMPORTANT: Avoid damage! DO NOT overheat starting motor during test. Starting motor Duty Cycle is five seconds ON and ten seconds OFF.

7. Crank engine for five to ten compression strokes.

8. Record pressure reading for that cylinder.

   - If pressure reading is BELOW specification, squirt clean engine oil into cylinders through spark plug hole and repeat test.
   - If pressure INCREASES significantly, check piston, rings, and cylinder walls for wear or damage.

- If pressure DOES NOT INCREASE significantly after retest, check for leaking valves, valve seats or cylinder head gasket.

9. Install spark plug.

10. Repeat procedure for second cylinder.

11. Compare readings between cylinders, difference between cylinders should be 140 kPa (20 psi) maximum.

- If difference between cylinders is greater than specification and low cylinder is BELOW minimum compression pressure, check for worn or stuck piston rings, worn cylinder walls, hole in top of piston, leaking valves or seats, or leaking cylinder head gaskets.

Specifications:

Minimum Cylinder Compression:

Throttle Open . . . . . 1171 kPa (170 psi)

Throttle Closed . . . . . 620 - 689 kPa (90 - 100 psi)

Valve Clearance Adjustment

NOTE: Perform valve clearance adjustment when the engine is COLD.

Reason:

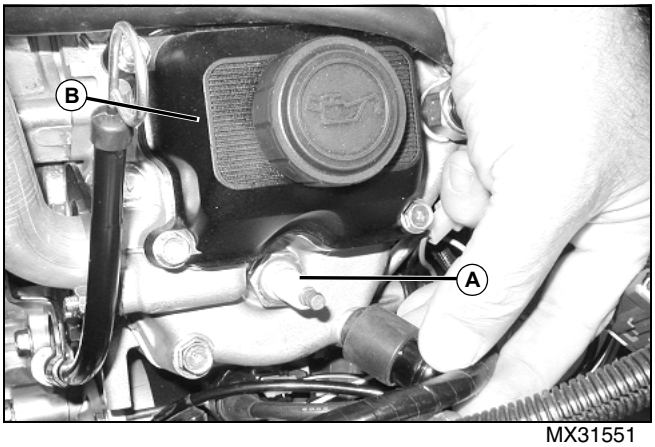
To check and adjust valve clearances for proper engine operation.

Equipment:

- JDM74A-5 Spark Tester
- Flat feeler gauge.

Procedure:

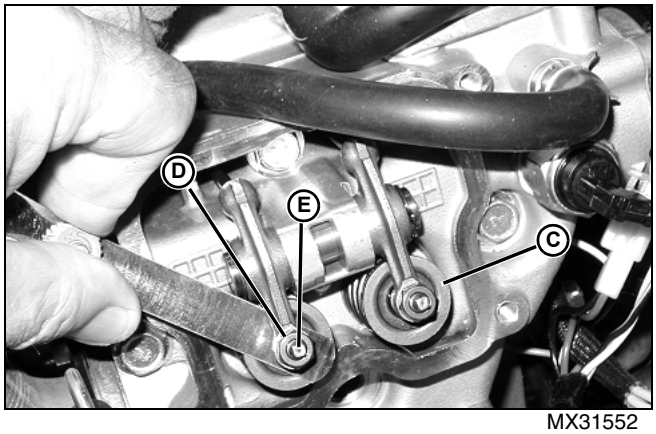
1. Park machine safely. (See Parking Safely in safety section)



MX31551

2. Remove spark plug (A).

3. Remove valve cover (B).



MX31552

4. Find cylinder TDC (Top Dead Center) of compression stroke:

- Turn crankshaft counterclockwise until intake valve (C) opens.
- Put a long, small diameter, wooden dowel into spark plug hole and rest it on top of the piston.
- Continue to turn crankshaft counterclockwise until dowel is at highest point. The piston is at TDC of compression stroke.
- When piston is at TDC, both intake and exhaust valve rocker arms will be loose.
- If either or both rocker arms are tight, the piston is on the exhaust stroke and the crankshaft must be turned counterclockwise another revolution (360 degrees).

5. Use a flat feeler gauge to check that valve clearance is 0.25 mm (0.010 in.).

6. To adjust valve clearance, loosen lock nut (D) and turn adjusting screw (F) to correct clearance.

7. Hold adjusting screw stationary while tightening lock nut to 9 N•m (79 lb-in.).

8. Recheck valve clearance, readjust if necessary.

9. Repeat procedure for other valve.

10. Repeat procedure for other cylinder.

11. Install spark plugs and spark plug leads.

12. Install and tighten valve covers to 6 N•m (53 lb-in.).

Crankcase Vacuum Test

Reason:

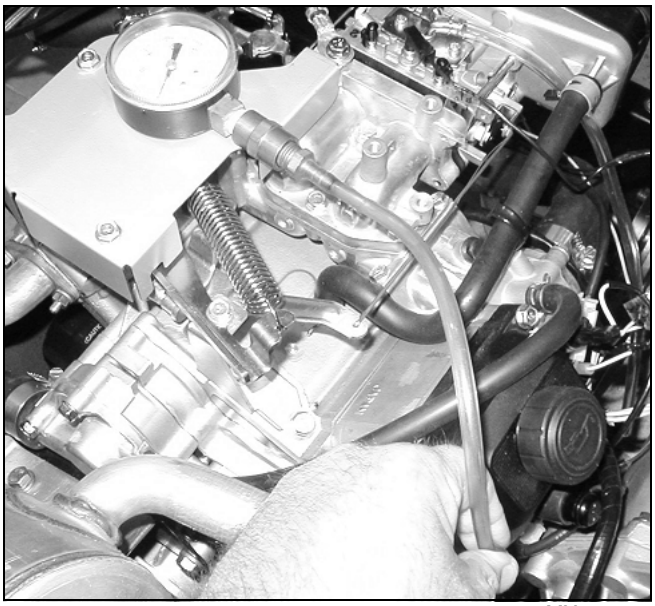
To check operation of breather and condition of seals, gaskets, rings, piston and cylinders walls.

Equipment:

- JT03503 Vacuum Gauge
- JT05703 Barb Fitting
- JT05699 Line

Procedure:

1. Park machine safely. (See Parking Safely in safety section)
2. Remove dipstick and place finger over hole in tube.



MX31554

3. Start engine and run at high idle.
4. Quickly remove finger from dipstick tube and connect gauge to dipstick tube.

IMPORTANT: Avoid damage! DO NOT make connection between gauge and engine line (B) BEFORE engine is running. DO NOT turn engine OFF until line has been disconnected from manometer (D).

5. Record crankcase vacuum reading. Gauge should show a minimum vacuum of 25 mm (1.0 in.) of H2O.
6. Run engine at SLOW idle. DO NOT TURN ENGINE OFF!
7. Disconnect line from dipstick tube and quickly cover tube with finger.
8. Turn engine OFF and install dipstick.

Results:

If crankcase vacuum is LESS than specification, check the following:

- Breather reed valve clearance and condition,
- Seals and gaskets for leakage,
- Valve cover gasket for leakage,
- Rings, piston, and cylinder walls for wear or damage.
- Valve and valve seats for wear or damage.
- Head warpage.

Oil Pressure Test

Reason:

To determine condition of lubrication system.

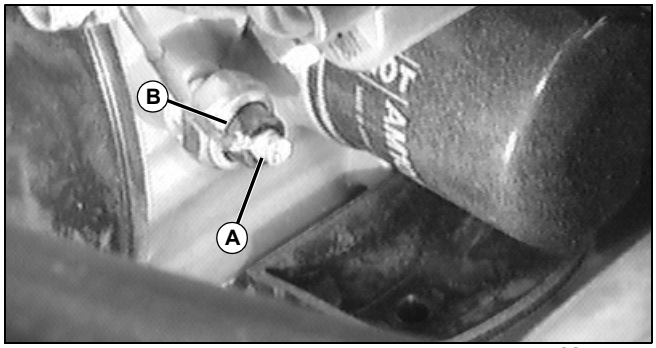
Equipment:

- JT05577 Pressure Gauge Assembly
- JT03017 Hose Assembly
- JT03349 Connector

Procedure:

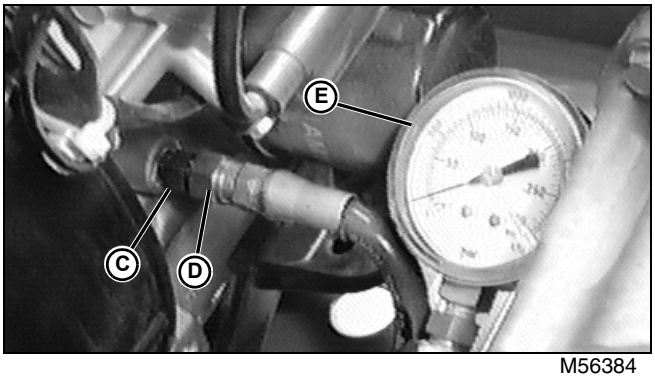
1. Park machine safely. (See Parking Safely in safety section)
2. Check engine oil level, bring level to full mark.
3. Run engine at FAST idle until cooling fan starts.
4. STOP engine

CAUTION: Avoid Injury! Engine components are HOT. Be careful not to touch, especially the exhaust pipe or muffler, while making adjustments. Wear protective eye glasses and clothing.



M56383

5. Disconnect oil pressure switch wiring lead (A).
6. Remove oil pressure switch (B).



M56384

7. Install JT03349 Connector (C).

8. Connect JT03017 Hose Assembly (D) and JT05577 Pressure Gauge Assembly (E).

IMPORTANT: Avoid damage! If pressure reading is below 69 kPa (10 psi), STOP ENGINE IMMEDIATELY and determine cause.

9. Run engine at FAST idle and check. Minimum oil pressure 276 kPa (40 psi).

10.Install oil pressure switch and switch wiring lead. Use John Deere Pipe Sealant with TEFLON (medium strength), or equivalent, on switch threads.

Results:

If oil pressure is BELOW specifications, inspect or replace the following:

- Oil pressure relief valve for broken or worn spring
- Oil pressure relief valve for stuck or damaged valve.
- Worn or damaged oil pump.
- Oil pump suction screen or oil passages plugged.
- Excessive wear of connecting rod and main bearings.

Radiator Cap Pressure Test

Reason:

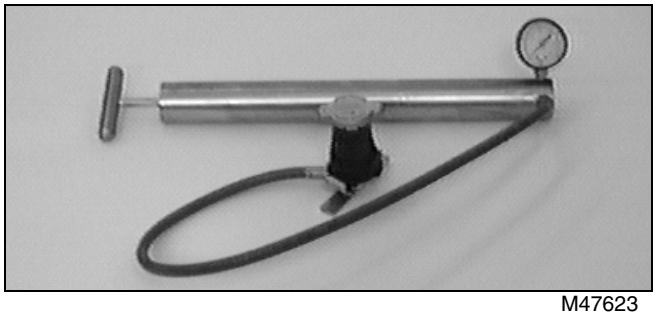
To be sure cap is operating at correct pressures.

Equipment:

- D05104ST Cooling System Pressure Pump
- JDG692 Adaptor

Procedure:

1. Park machine safely. (See Parking Safely in safety section)


M47623

2. Install radiator cap on Pressure Pump.
3. Apply pressure.
4. If cap leaks, retighten and test again.

Results:

- Replace cap if pressure not to specifications.

Specifications:

Cap Specifications:

Maximum. . . . . 83 - 96 kPa (12 - 14 psi)

Minimum . . . . . 76 kPa (11 psi)

Thermostat Test

Reason:

To ensure thermostat opening and closing at specified temperatures.

Equipment:

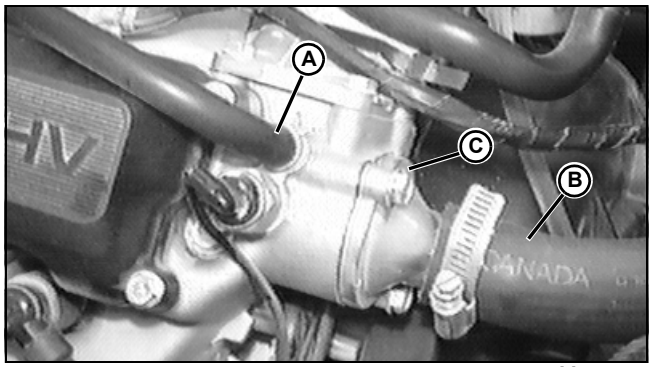
- D-05103ST Thermostat Tester

Procedure:

1. Park machine safely. (See Parking Safely in safety section)

2. Cooling system to completely cool BEFORE testing.

NOTE: Be sure to wipe-up and wash-off any spilled coolant immediately.

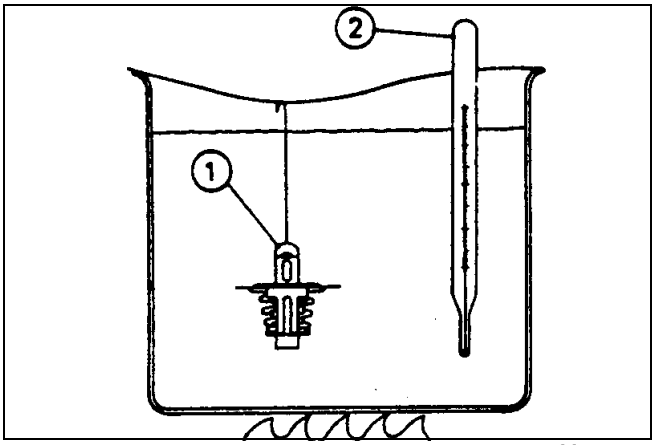


M56403

3. Disconnect bypass hose (A) at thermostat housing, hold as-low-as possible to drain coolant into a clean container. This will drop the coolant level enough to drain the thermostat housing.

4. Disconnect large hose (B), prop it up to prevent coolant leakage.

5. Remove cover (C), gasket, and thermostat.



M56829

6. Place thermostat in filled D-05103ST Tester. Support thermostat in center of tester and away from heat source.

7. Watch thermostat.

8. Install thermostat, new gasket, and cover (C).

9. Connect hoses (A and B) and fill cooling system with properly mixed coolant.

Results:

- If thermostat fails to meet any of these specifications, replace it.

Specifications:

Thermostat specifications:

Begin-to-open . . . . . approximately 82°C (180°F)

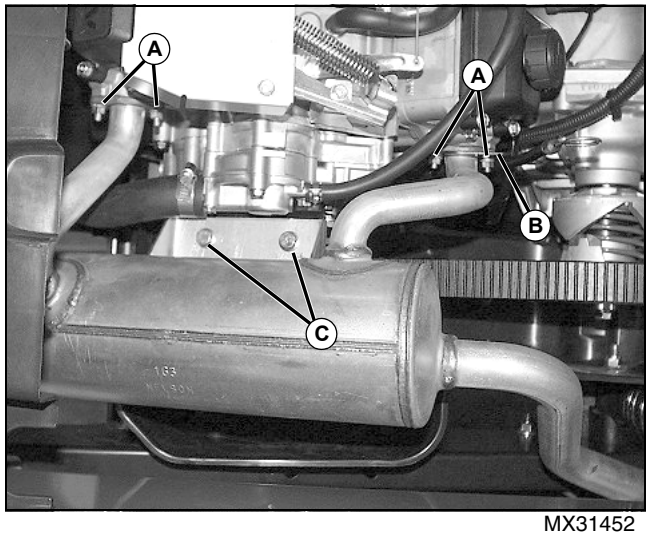
Full-open . . . . . approximately 96°C (205°F)

Repair

Muffler Removal and Installation

CAUTION: Avoid Injury! Muffler may be hot. Allow to cool before removing.

Removal:



MX31452

1. Raise cargo box.

2. Remove four nuts (A) and engine lift bracket (B).

3. Remove muffler support cap screws (C).

4. Remove muffler.

Installation:

1. Clean gasket mating surfaces of old gasket material.

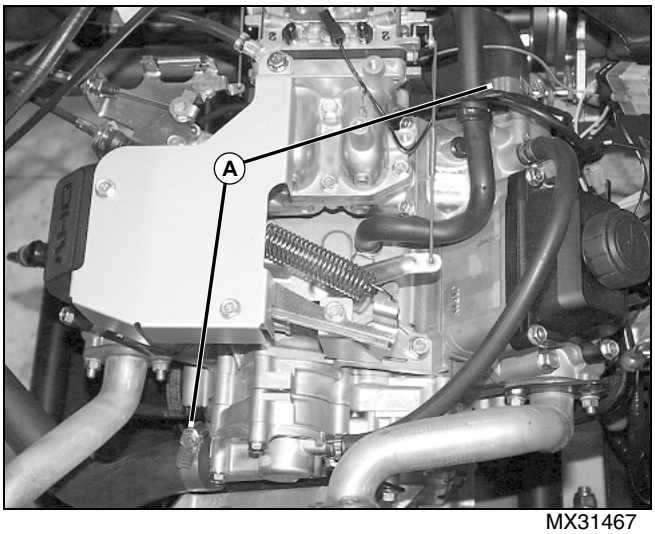
2. Install new gaskets and muffler. Install engine lift bracket (B). Tighten nuts (A) to 11 N•m (98 lb in.).

3. Tighten cap screws (C) to 27 N•m (240 lb in.).

Engine Removal and Installation

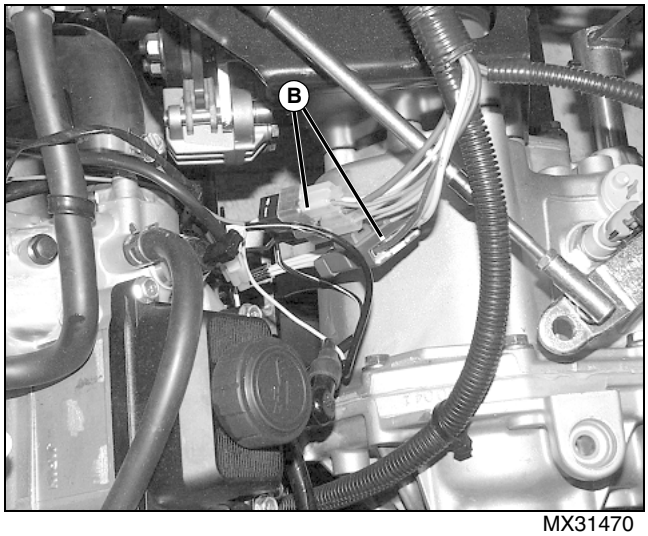
Removal:

1. Disconnect battery negative (-) cable.
2. Remove muffler and drive belt.



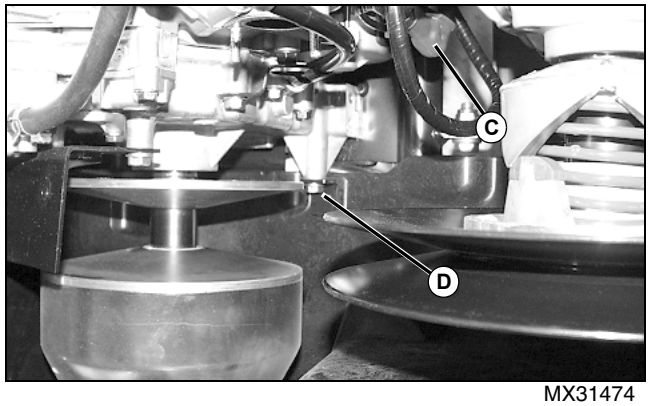
MX31467

3. Place a large drain pan under engine to catch coolant. Loosen radiator cap. Loosen coolant hose clamps (A) and disconnect hoses from engine.



MX31470

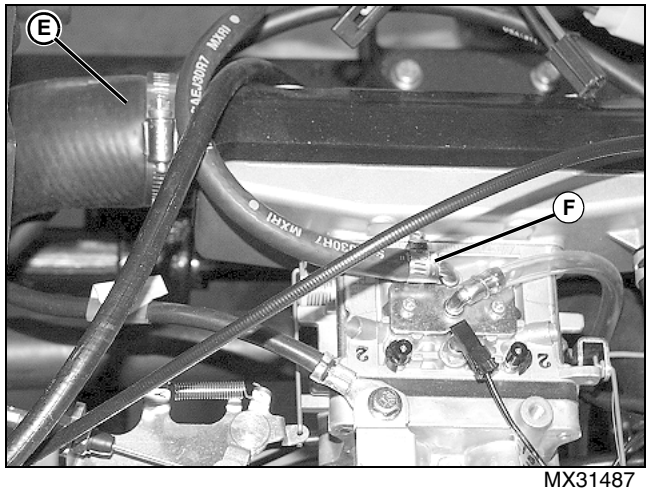
4. Disconnect engine wiring harness connectors (B).



MX31474

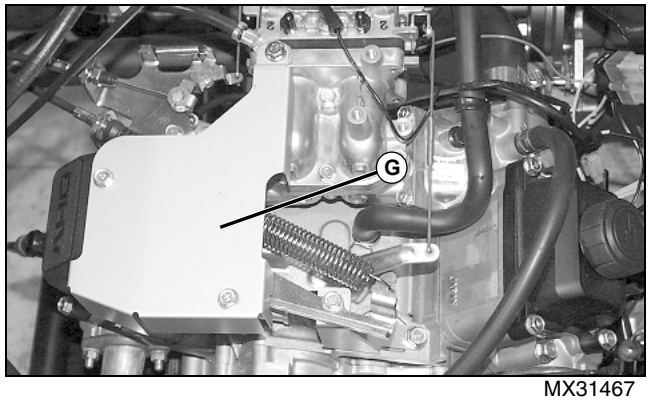
5. Disconnect battery positive (+) cable (C) from starting motor solenoid.
6. Remove cap screw (D) from clutch guard bracket.

CAUTION: Avoid Injury! Gasoline vapor is explosive. Do not expose to spark or flame. Serious personal injury can result.



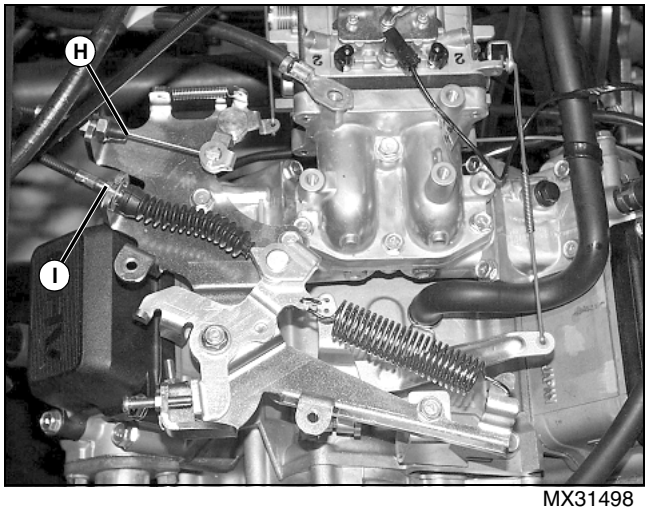
MX31487

7. Remove air cleaner-to-engine hose (E) and fuel supply hose (F).



MX31467

8. Remove three cap screws and governor control cover (G).



MX31498

9. Disconnect choke cable (H) and accelerator cable (I).

MX31500

10.Remove four engine mounting cap screws (J).

11.Attach lift sling to engine mounting brackets. Lift engine slightly and pull slightly to right until oil drain valve clears clutch guard. Continue lifting engine out of machine.

Installation:

Installation is done in the reverse order of removal.

1. Place engine in frame, install mounting bolts.
2. Install components and hardware removed.
   - If removed, install drive clutch and tighten cap screw to specification.

IMPORTANT: Avoid damage! Proper filling of the cooling system is critical. See “Radiator Drain Procedure - Gas” on page 589.

3. Fill cooling system.
4. Fill engine with proper oil. (See Specifications and Information section.)
5. Adjust choke cable.

Specifications:

Torque Specifications:

Drive Clutch to Crankshaft Cap Screw 37 N•m (26 lb-ft)

Engine Mounting Cap Screw. . . . . 40 N•m (30 lb-ft)

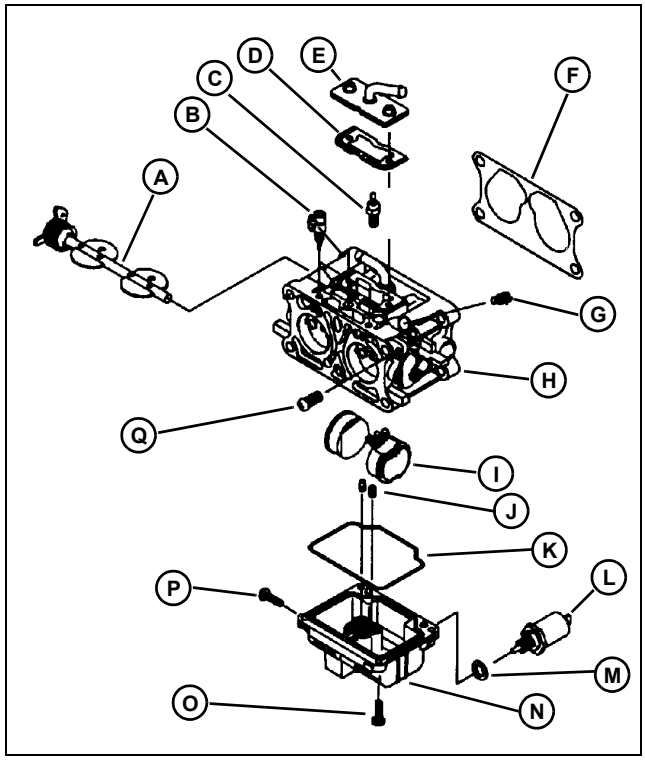
Engine oil capacity:

Without filter . . . . . 1.3 L (2.8 pt)

With filter. . . . . 1.5 L (3.4 pt)

Carburetor Repair

CAUTION: Avoid Injury! Do not attempt to rebuild or adjust carburetor unless you are a factory trained technician with authorization to service California Air Resources Board / Environmental Protection Agency (CARB/EPA) Certified engines.



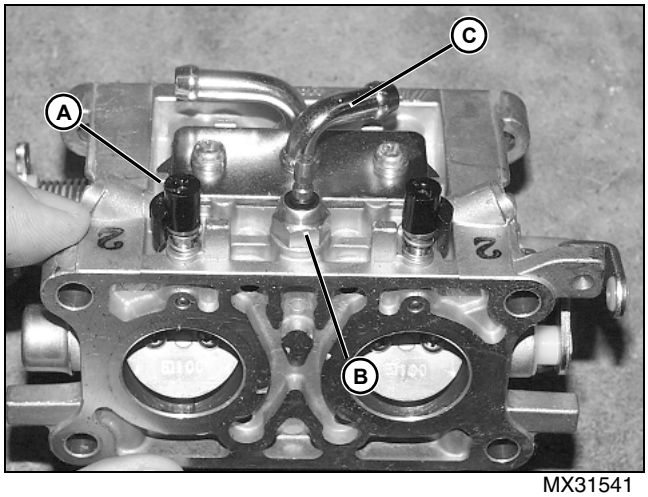
MX31512

A - Choke Valve Assembly
B - Idle Mixture Screw (2)
C - Heater Element
D - Gasket
E - Vent Tube
F - Gasket
G - Pilot Jet
H - Carburetor Body

I - Float
J - Main Jets
K - Gasket
L - Fuel Shutoff Solenoid
M - Gasket
N - Fuel Bowl
O - Screw
P - Bowl Drain Screw
Q - Idle Speed Screw

1. There are a number of plates or ball plugs on/in the carburetor that should not be removed.

NOTE: If all rubber or plastic parts cannot be removed for cleaning, use a solvent, with a high flash point, that will not damage these parts when cleaning.

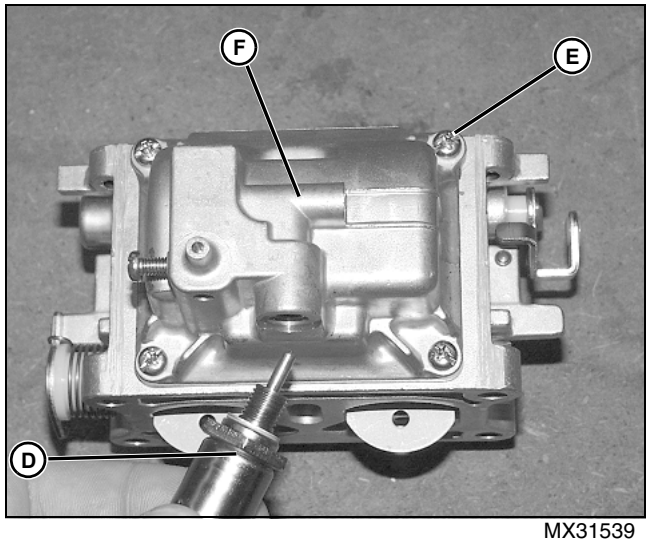


MX31541

2. Remove limiter caps (A) on slow idle mixture screws, turn mixture screws in counting number of turns required to lightly seat screw. Remove screw. Remove and test heater element (B). See “Carburetor Heater Test (Gas Engine)” on page 352 in the Electrical section.

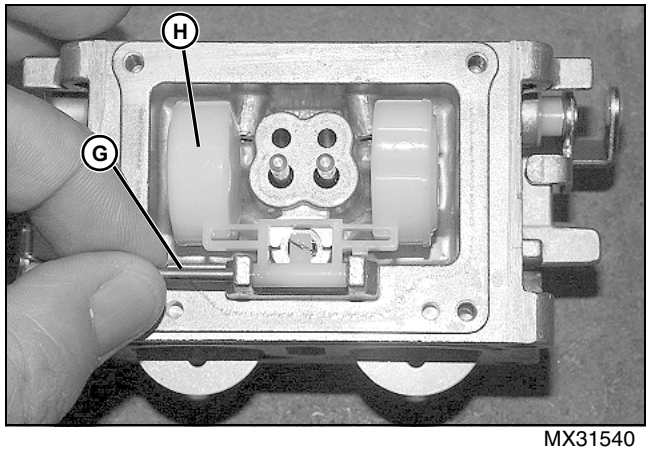
3. Remove two screws and vent elbow (C).

CAUTION: Avoid Injury! Gasoline is extremely flammable. do not smoke. Always work in a ventilated area away from open flame or spark producing equipment, this includes equipment that utilizes pilot lights.



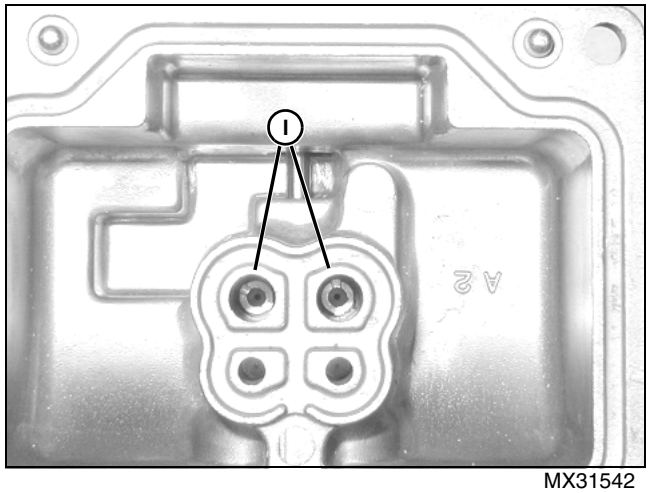
MX31539

4. Remove fuel shutoff solenoid (D), the four float bowl screws (E), and float bowl (F).



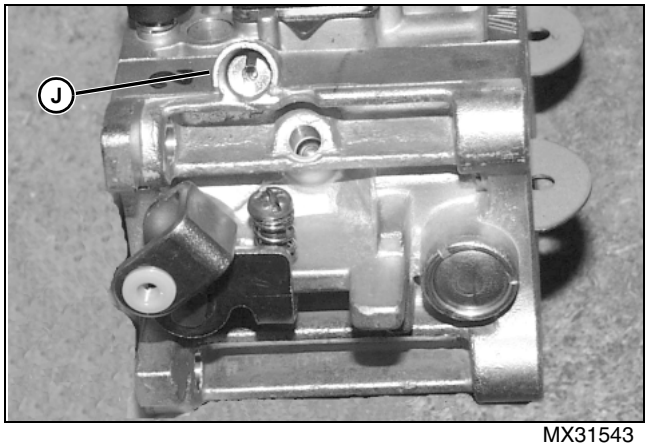
MX31540

5. Remove float hinge pin (G) and float (H).



MX31542

6. Remove jets (I) from float bowl.



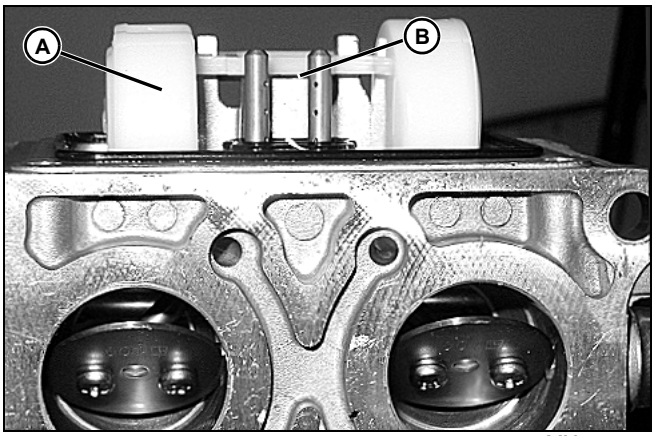
MX31543

7. Remove pilot jet (J) from each side of carburetor.

8. Spray carburetor passages with carburetor cleaner. Rinse the parts in water and dry with compressed air, do not use rags or paper to dry parts. Lint can plug the tiny passages in the carburetor.

9. Inspect body for damage. Ensure sealing surfaces and flanges are smooth, free of nicks and burrs.

10.Inspect inlet needle for wear or damage. The tip should be smooth, no grooves or scratches. If worn or damaged, replace the float assembly and carburetor body as a set.



MX31510

11.Hold carburetor upside down at eye level with float assembly (A) installed.

12.With the float resting on the needle, there should be a slight gap (B) between the plastic connecting the floats and the carburetor body.

13.Float is plastic and is not adjustable, if level is not correct replace float and needle valve.

14.Ensure the throttle and choke valves move freely and that the shaft bosses are not elongated or worn. If shaft bosses have any of these conditions, replace the carburetor.

15.Inspect slow idle mixture screws for wear or damage, replace it if necessary.

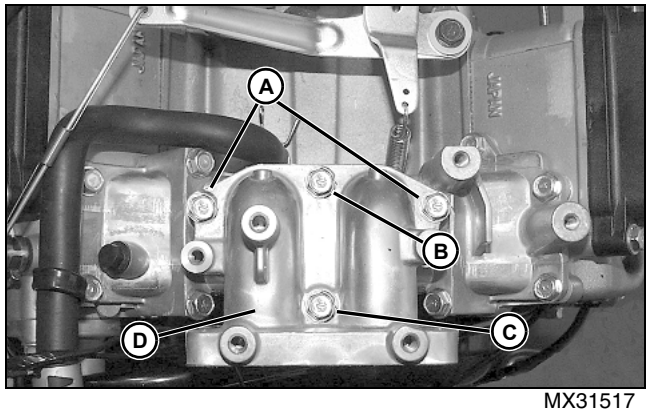
16.Install slow idle mixture screws until lightly seated, and back out the number of turns counted at disassembly.

Intake Manifold Removal and Installation

Removal:

1. Drain coolant.

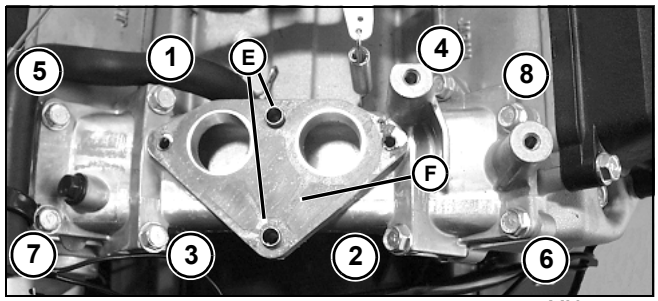
2. Remove carburetor.



MX31517

3. Remove cap screws (A,B, and C). Note the different lengths of cap screws for reassembly.

4. Remove carburetor elbow (D).



MX31516

5. To avoid warping manifold, loosen manifold bolts **1/4 turn** at a time in sequence shown until all bolts are loose.

6. Remove alignment sleeves (E) and gasket (F). Visually inspect manifold passages for corrosion or deposits and clean as necessary.

7. Inspect manifold for cracks or a porous casting.

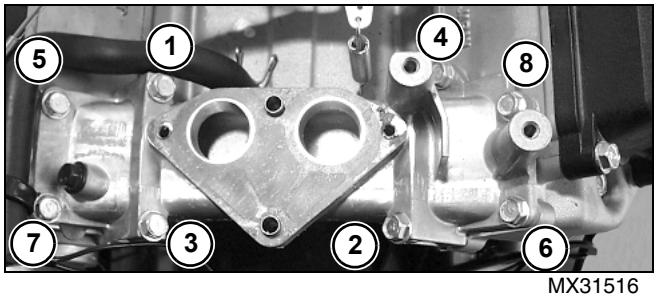
NOTE: Cracks not visible to the eye may be detected by coating suspected area with a mixture of 25% kerosene and 75% light engine oil. Wipe area dry and immediately apply a coat of zinc oxide dissolved in wood alcohol. If cracks are present, the coating will become discolored at the crack location.

8. If cracks are present, replace manifold.

Installation:

NOTE: Before installing manifold, install cylinder heads if they were removed and tighten head bolts in sequence to half the rated torque value.

IMPORTANT: Avoid damage! Check manifold gaskets when installing to insure correct orientation or coolant could leak into cylinders.



MX31516

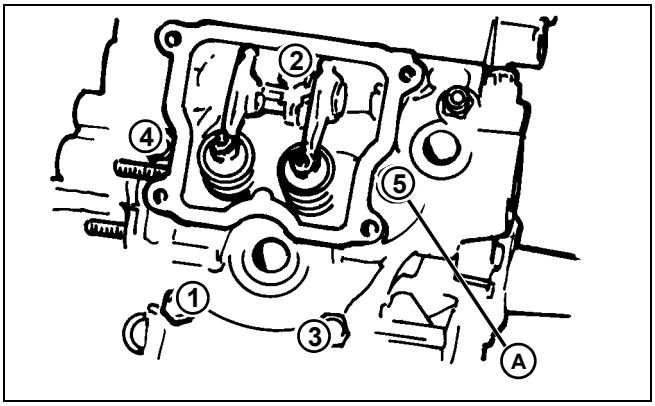
1. Install intake manifold and tighten bolts in sequence shown in two steps to a final torque of 6 N•m (52 lb-in.).

2. If cylinder heads were removed, finish tightening cylinder head bolts to 21 N•m (15 lb-ft).

Cylinder Head Removal and Installation

Removal:

1. Loosen cylinder head bolts 1/4 turn at a time, in the sequence shown, to avoid warping the cylinder head.

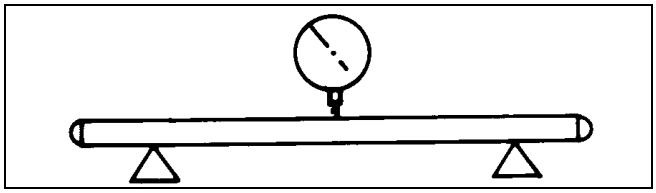


M46437

2. Make note of the special bolt (A) location for reinstalling cylinder head.

3. Mark push-rods so they can be reinstalled in their original positions during assembly. (See “Cylinder Head Disassembly and Inspection” on page 48 for disassembly and inspection procedures.)

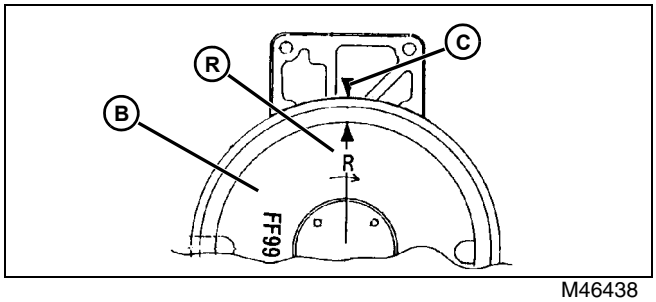
Push Rod Inspection:


M50044

- Place push rod on V-blocks and measure run-out. If runout exceeds 0.8 mm (0.03 in.), replace push rod.

Installation:

CAUTION: Avoid Injury! Use a torque wrench when tightening cylinder head bolts.



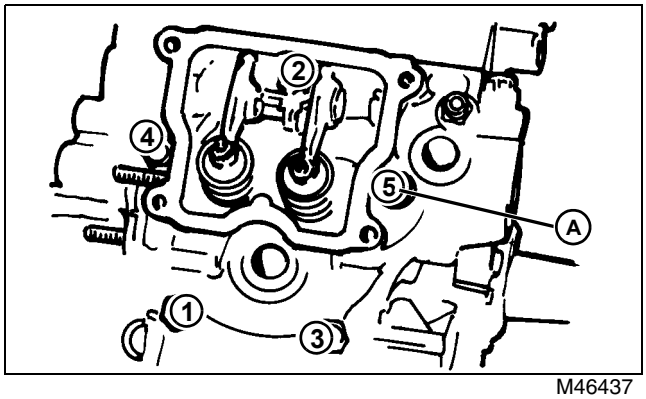
M46438

1. Turn flywheel (B) clockwise to align mark (R) over triangular timing mark (C) on breather chamber.

2. Visually check to ensure the cam lobes are at their lowest position, if not, turn flywheel 360° and align timing marks again.

3. Install the push-rods in their original positions by sliding them down the inside wall of the crankcase and positioning push rod on the tappet.

IMPORTANT: Avoid damage! Handle head gaskets carefully to avoid removing the sealing agents from the surface during handling.



M46437

4. Install head and bolts, make sure special bolt is in proper location (A).

NOTE: Torque should be applied in 3 N•m (27 lb-in.) increments.

5. Tighten head bolts in sequence shown.

   • Tighten cylinder head bolts to half the required torque. Install intake manifold before applying a final torque of 21 N•m (186 lb-in.).

Cylinder Head Disassembly and Inspection

Disassembly:

NOTE: Note position of all valve train parts so they can be reinstalled in their original position.

1. Remove spark plugs. Remove circlips from rocker arm shafts and push shafts out the same side the circlip was removed from.

2. Remove spring retainers by applying pressure with your thumbs and sliding the retainer over to a side hole on the retainer.

3. Remove stem seals and bottom spring retainers.

Cleaning and Inspection:

NOTE: Use tools for cleaning that will not gouge or damage the cylinder head.

1. Scrape heads to remove carbon deposits or use a decarbonizing agent. Clean with a suitable solvent and dry with compressed air.

2. Lay a straight edge along the sealing surface of head and measure warpage with a thickness gauge at several different points. If warpage exceeds 0.06 mm (0.002 in.), repair or replace cylinder head.

3. Check cylinder head for cracks.

NOTE: Cracks not visible to the eye can be found by coating head with a mixture of 25% kerosene and 75% light engine oil. Wipe area dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If cracks are present, coating will become discolored at the defective area.

4. Clean and measure diameter of rocker arm shaft with a micrometer at several points. If outside diameter is less than 11.95 mm (0.470 in.), replace shaft.

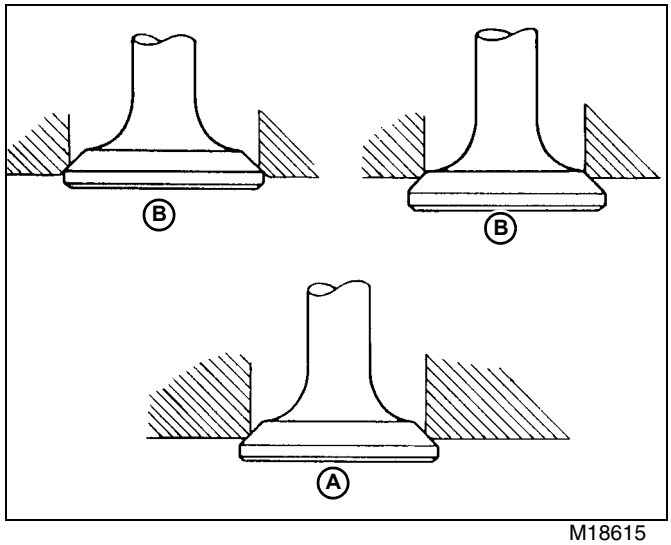
5. Clean and inspect rocker arm where it contacts push rod and valve stem. If the contact points are worn or damaged, replace rocker arm.

6. Measure inside diameter of rocker arm bearing at several points using a dial bore gauge or inside micrometer. If the diameter is more than 12.07 mm (0.475 in.), replace the rocker arm.

NOTE: Ensure all carbon deposits are removed from valve guide before taking any measurements.

7. Measure valve guide inside diameter in three places down the length of the guide with a small bore gauge. If the measurement on any guide is more than 6.05 mm (0.238 in.) replace cylinder head.

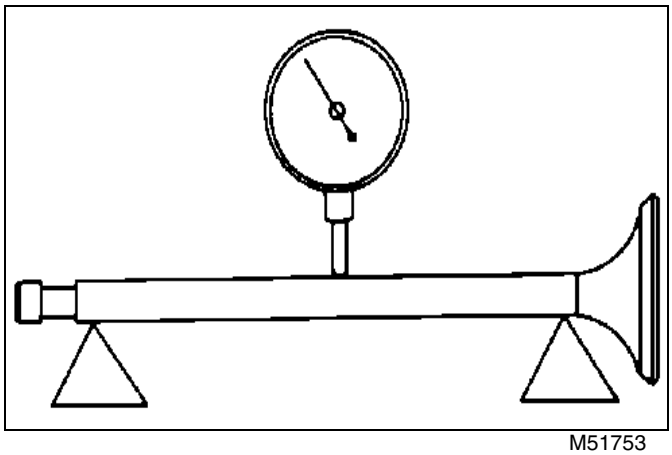
8. Inspect valve seats for damage. If seats are warped or distorted beyond reconditioning, replace cylinder head.



M18615

9. Check valve seating pattern for correct width and evenness all the way around (A). Valve seat width should be between 0.5 - 1.1 mm (0.02 - 0.043 in.). If incorrect (B), lap valves to seats.

10. Clean and measure valve stem at three points along length of stem. If intake valve is not at least 5.945 mm (0.2341 in.) and exhaust valve is not at least 5.925 mm (0.2332 in.), replace.

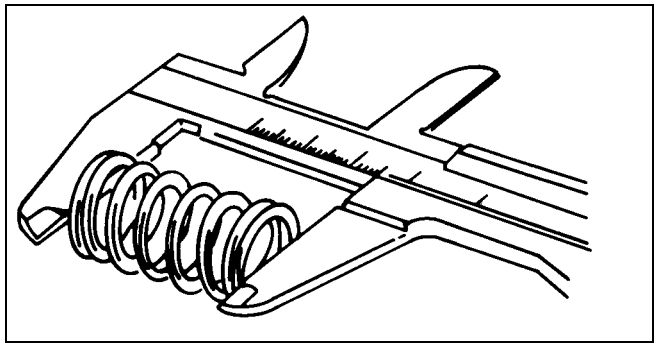


M51753

11. Place valve on V-blocks and measure runout, if not within 0.05 mm (0.002 in.), replace.

12. Measure valve head thickness (valve margin). If not within 0.6 mm (0.024 in.), replace.

13.If grinding the valve and valve seat is necessary, follow tool manufacturer's instructions carefully. Lap valves after grinding with lapping compound and recheck valve seating surface for correct width and evenness of seating pattern.



M50036

14.Inspect valve spring for pitting, rust and burrs. Measure spring free length. Minimum valve spring free length should be 29.70 mm (1.17 in.).

15.Apply clean engine oil to all contact surfaces and assemble cylinder head.

Specifications:

Maximum Cylinder Head Warpage . 0.06 mm (0.002 in.)

Minimum Rocker Shaft OD . . . . . 11.95 mm (0.470 in.)

Maximum Rocker Arm ID . . . . . 12.07 mm (0.475 in.)

Valve Guide Inside Diameter:
Intake or Exhaust (Maximum) . . . . . 6.05 mm (0.238 in.)

Valve Seating Width . . . . . 0.5 - 1.1 mm (0.02 - 0.043 in.)

Minimum Valve Stem Diameter:
Intake . . . . . 5.95 mm (0.234 in.)

Exhaust . . . . . 5.92 mm (0.233 in.)

Maximum Valve Stem Runout . . . . . 0.05 mm (0.002 in.)

Valve Margin . . . . . 0.6 mm (0.024 in.)

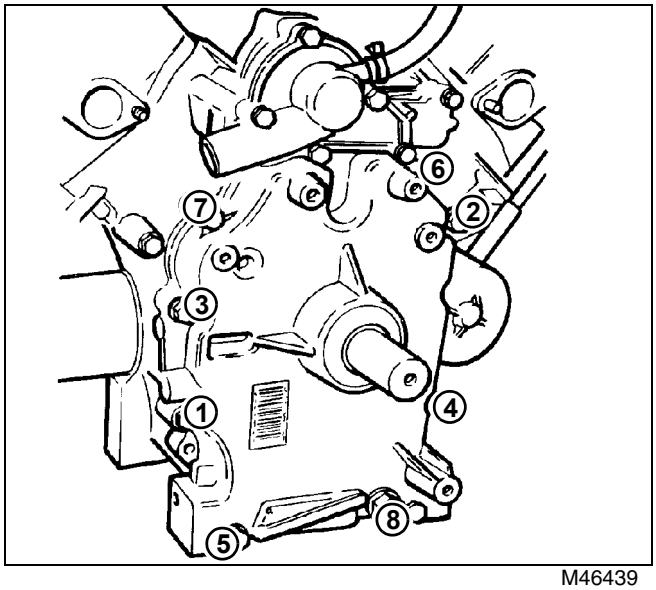
Minimum Valve Spring Free Length 29.70 mm (1.17 in.)

Crankcase Cover Removal and Installation

Removal:

Remove the Following:

- Muffler
- Throttle Control Panel
- Radiator Hoses, Bypass Tube
- Oil Drip Tray



M46439

1. Unscrew mounting bolts in order shown. Remove crankcase cover from crankcase.

NOTE: There are two knock pins on crankcase mating surface. A wooden or plastic mallet may be used to gently tap cover loose.

Inspection:

1. Clean cover with a suitable solvent and dry with compressed air.

2. Measure inside diameter of the crankshaft bearing at several points. If the measurement is not within serviceable limits (see specifications below), replace cover.

3. Measure inside diameter of camshaft bearing on the crankcase cover at several points. Replace crankcase cover if measurement is out of serviceable limits (see specifications below).

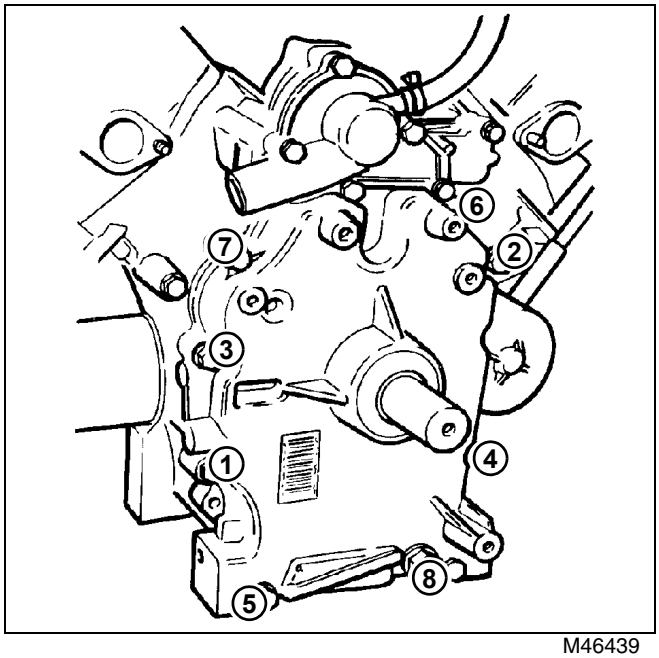
Specifications:

Crankshaft Bearing Inside Diameter
Service Limit. . . . . 34.07 mm (1.341 in.)

Camshaft Bearing Inside Diameter
Service Limit. . . . . 16.07 mm (0.633 in.)

Installation:

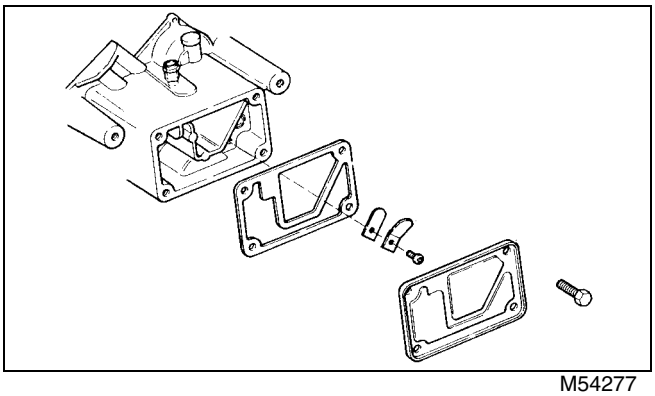
IMPORTANT: Avoid damage! Do Not force cover into position.

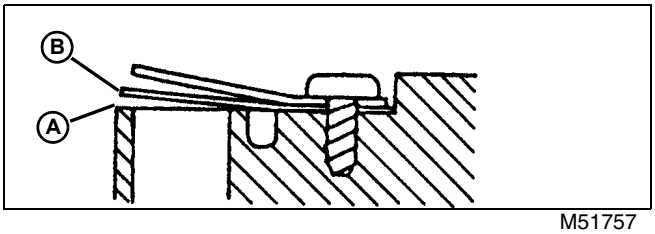


M46439

1. Install gasket, cover and mounting bolts. Tighten bolts in sequence shown to 25 N•m (18.5 lb-ft).

Crankcase Breather Inspection


M54277



M51757

1. Inspect reed valve (B) for breakage, hairline cracks or distortion, replace if necessary.

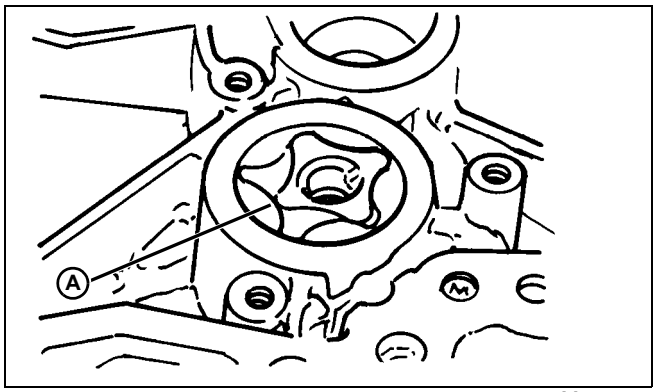
2. Check breather reed valve tip air gap (A) of 0.2 mm (0.008 in.).

3. Inspect the back plate for damage or a rough contact surface, replace if necessary.

4. Inspect the valve seating surface for damage, repair if necessary.

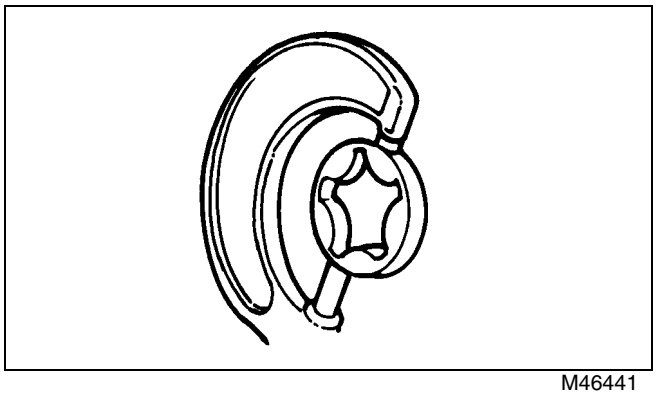
Oil Pump Inspection

1. Visually inspect the pump gear, inner rotor and cover plate. If there is any sign of uneven wear or damage, replace them.



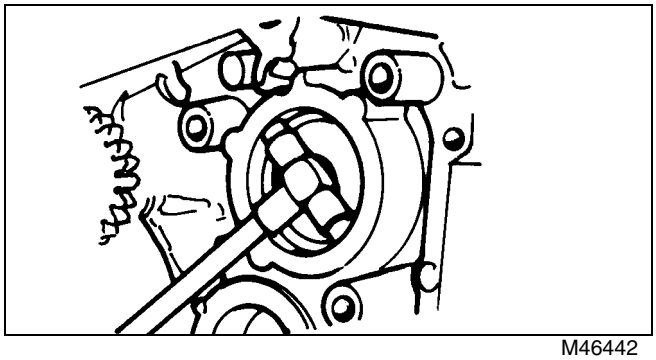
M46440

2. Check clearance between inner and outer rotor (A) with a feeler gauge. Measure clearance between high point of the inner rotor and the high point of outer rotor. If measurement exceeds 0.3 mm (0.012 in.), replace both rotors as a set.


M46441

3. Measure outside diameter of outer rotor with a micrometer at several points. If rotor diameter is less than 40.47 mm (1.593 in.), replace both rotors as a set.

4. Measure thickness of outer rotor at several points. If measurement is less than 9.830 mm (0.387 in.), replace both rotors as a set.


M46442

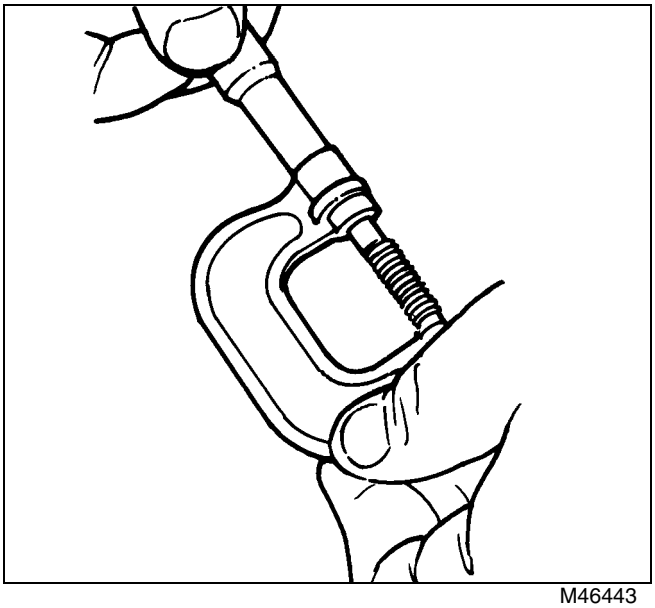
5. Measure inside diameter of the pump housing at several points. If inside diameter is more than 40.80 mm (1.606 in.), replace cover.

6. Measure depth of pump housing at several points. If the measurement exceeds 10.23 mm (0.403 in.), replace cover.

7. Measure inside diameter of pump shaft bearing at several points. If inside diameter is more than 11.07 mm (0.436 in.), replace cover.

8. Measure outside diameter of pump shaft at several points. If diameter is less than 10.92 mm (0.430 in.), replace pump shaft.

9. Visually inspect relief valve spring, steel ball and valve seat in the cover. Remove any varnish deposits with a suitable solvent. If the ball is deformed or has any rough spots that could prevent a perfect seal, replace valve parts.



M46443

10.Measure valve spring free length. If free length is less than 19.50 mm (0.77 in.), replace valve spring.

Specifications:

Inner and Outer Rotor Clearance
Service Limit . . . . . 0.3 mm (0.012 in.)

Outer Rotor:

Diameter Service Limit. . . . . 40.47 mm (1.593 in.)

Thickness Service limit . . . . . 9.83 mm (0.387 in.)

Pump Housing Inside Diameter
Service Limit . . . . . 40.80 mm (1.606 in.)

Pump Housing Depth
Service Limit . . . . . 10.230 mm (0.403 in.)

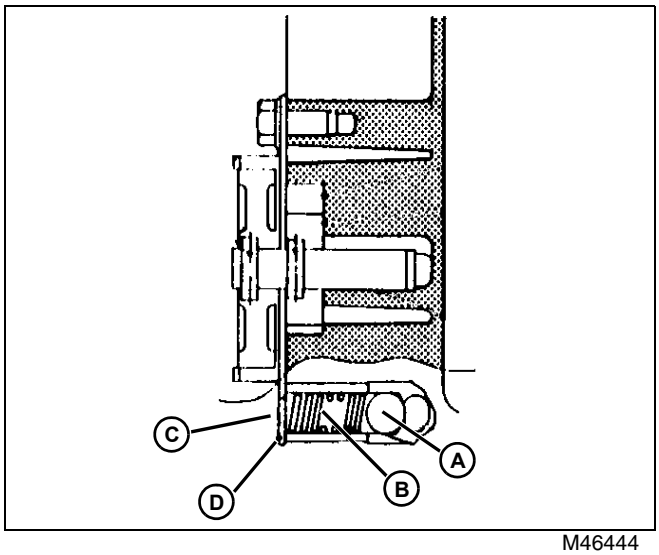
Inside Diameter of Pump Shaft Bearing
Service Limit . . . . . 11.07 mm (0.436 in.)

Pump Shaft Diameter
Service Limit. . . . . 10.92 mm (0.430 in.)

Valve Spring Free Length
Service Limit. . . . . 19.50 mm (0.77 in.)

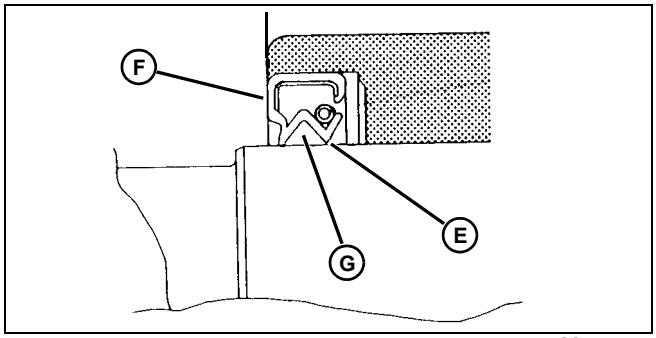
Oil Pump Installation

1. Fill rotor housing with engine oil for initial lubrication.



M46444

2. Install relief valve ball (A) and spring (B) and then pump assembly (ensure the 6 mm hole (C) in the cover plate (D) is aligned with center of the relief valve).



M46445

3. Remove crankshaft oil seal and press in a new seal with spring loaded lip (E) towards inside of the engine and outside edge of seal (F) flush with flange surface.

4. Pack space (G) between seal lip and dust lip with high temperature grease.

5. Ensure cam gear meshes with governor gear and oil pump gear meshes with crank gear when installing cover.

Camshaft Removal

NOTE: See "Crankcase Cover Removal and Installation" on page 49 before starting this procedure.

1. Align punch mark on crank gear with projection on cam gear.

2. Turn crankcase upside down to let the tappets fall away from cam lobes.

3. Pull camshaft out of crankcase.

Camshaft Inspection

1. Inspect camshaft gear for pitting, fatigue cracks, burrs or evidence of improper tooth contact. Replace shaft if necessary.

2. Inspect cam lobes for wear, uneven contact or burrs. Replace if necessary.

3. Measure height of each cam lobe. Replace if less than the service limit (see specifications below).

4. Measure both camshaft journals at several points. is less than the service limit, replace camshaft (see specifications below).

5. Measure inside diameter of camshaft bearing at several points. Replace if the diameter exceeds service limit (see specifications below).

Specifications:

Cam Lobe Height Service Limit:

Intake . . . . . 25.21 mm (0.993 in.)

Exhaust . . . . . 25.46 mm (1.002 in.)

Journal Diameter Service Limit:

PTO Side . . . . . 15.91 mm (0.626 in.)

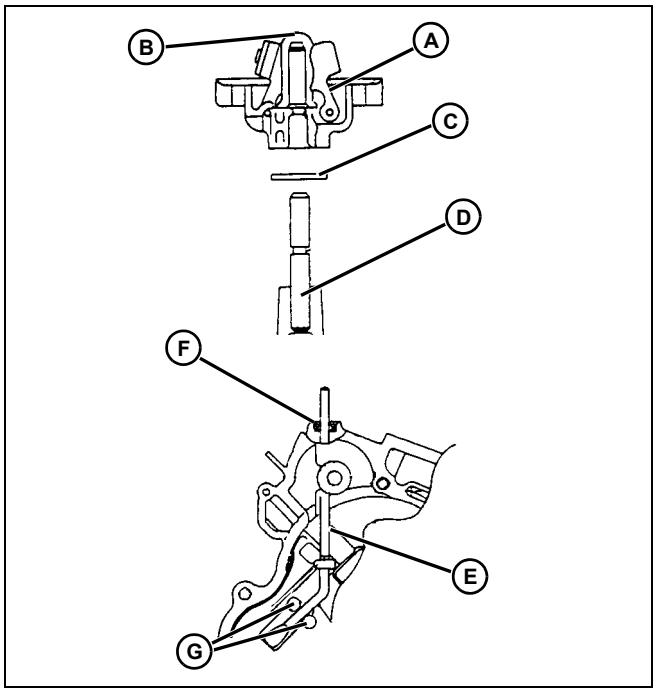
Flywheel Side . . . . . 15.92 mm (0.627 in.)

Camshaft Bearing Inside Diameter Service Limit . . . . . 16.07 mm (0.633 in.)

Governor Removal and Installation

CAUTION: Avoid Injury! Do not remove governor or governor shaft unless damaged. Removal damages the assembly.

1. Remove camshaft.



M46446

2. Use two suitable screwdrivers to pry gear/flyweight assembly (A), sleeve (B), and thrust washer (C) from shaft (D). Do Not damage crankcase sealing surfaces.

3. Turn governor shaft (E) 1/4 turn clockwise to remove shaft.

4. Replace shaft seal (F).

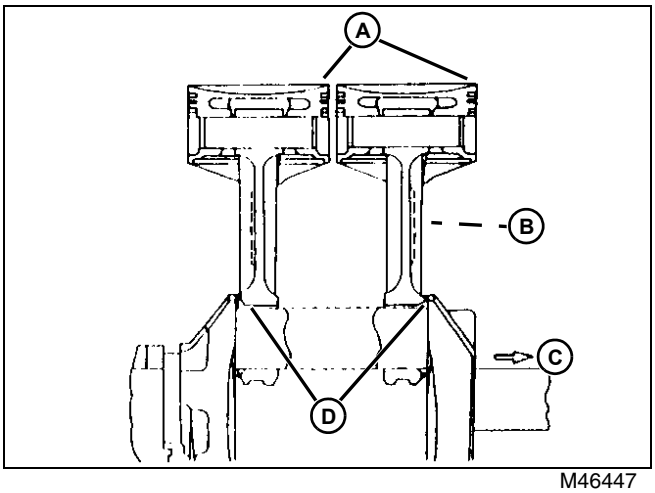
5. Press seal in (lip towards inside of engine) and 1.0 mm (0.04 in.) below crankcase surface.

6. Install governor shaft by properly positioning it between the two projections (G) on crankcase.

NOTE: Install thrust washer on shaft. Place sleeve into governor and install as an assembly.

7. Push assembly onto shaft until it snaps into place. Check assembly for freedom of movement.

Pistons and Cylinders Removal



M46447

IMPORTANT: Avoid damage! Note location of the arrow match mark (A) on the piston head in relation to "made in Japan" marking (B) on the connecting rod. Match marks are to face flywheel end of engine (C). Number 1 piston/rod orientation is opposite number 2. Large chamfers (D) in connecting rod journals face away from each other. Keep parts together as a set.

1. Turn crankshaft to expose connecting rod end caps. Mark end caps for reassembly in the same position as removed.

2. Remove carbon and/or ridge from the top of the cylinder bore with a suitable ridge remover, then remove piston and connecting rod through top of cylinder bore.

NOTE: Withdraw piston pin from the same side as the piston pin retaining ring is removed.

3. Remove piston pin retaining ring and pin.

4. Scrape carbon off piston without damaging the piston surfaces.

CAUTION: Avoid Injury! Be careful not to widen ring grooves when cleaning. Damaged grooves will require piston replacement.

5. Clean ring grooves with a suitable ring groove cleaner.

Piston Inspection

Analyzing Piston and Ring Wear:

Rings of the wrong size or rings having improper end gaps will not conform to the shape of the cylinder. This results in high oil consumption and excessive blow-by.

Ring end gaps should be staggered on the piston during installation. End gaps in alignment can cause oil consumption and blow-by.

Light scuffing or scoring of both rings and piston occurs when unusually high friction and combustion temperatures approach the melting point of the piston material.

When this condition exists, it is due to one or more of the following probable causes:

- Engine overheating
- Lack of cylinder lubrication
- Improper combustion
- Wrong bearing or piston clearance
- Too much oil in crankcase causing fluid friction.

The engine operating at abnormally high temperatures may cause varnish, lacquer or carbon deposits to form in the piston grooves causing the rings to stick. When this happens, excessive oil consumption and blow-by will occur.

Engine overheating is usually the result of one or more of these conditions:

- Overloading
- Incorrect ignition timing
- Lean fuel mixture
- Lack of coolant
- Incorrect oil
- Low oil supply
- Stale fuel.

Vertical scratches across the piston rings are due to an abrasive in the engine. Abrasives may be airborne, may have been left in the engine during overhaul, or lead and carbon deposits may have broken loose.

When this condition exists, check for one or more of the following causes:

- Damaged, collapsed or improperly installed air cleaner
- Loose connection or damaged gasket between air cleaner and carburetor
- Intake manifold leak
- Leak around carburetor throttle shaft or choke shaft
- Failure to remove abrasives from cylinder
- Air entering through breather tube.

Dirt in the oil will cause scratches on the oil control ring resulting in high oil consumption.

Oil control ring inner spacer wear or distortion may result in one of these conditions:

- High oil consumption
- Increased deposits in combustion chamber
- Sticking compression rings.

Detonation, commonly called preignition, carbon knock, spark knock, pinging or timing knock, is an uneven ignition of the fuel/air mixture across the combustion chamber. Severe damage to piston valves and cylinder heads can result from detonation. The following is a list of possible causes for detonation:

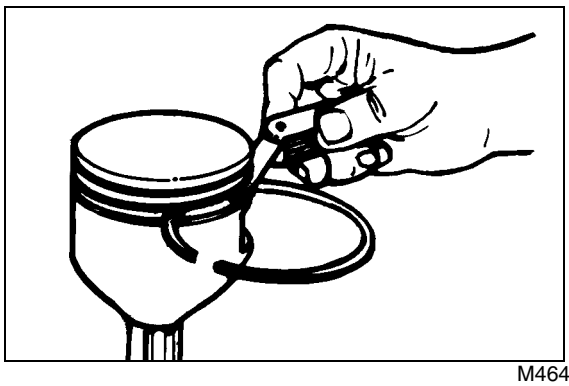
- Lean fuel mixture
- Low octane fuel
- Advanced ignition timing
- Incorrect spark plug (wrong heat range)
- Broken spark plug
- Sharp edges on valves or in combustion chamber
- Overloading
- Higher than normal compression (a result of excessive deposits in the combustion chamber
- Incorrect cylinder head or milling of cylinder head (resulting in high compression).

Improper ring contact or piston contact with the cylinder wall can result from incorrect rod or piston alignment, and / or a bent connecting rod. Diagonal wear patterns and excessive wear on the ring grooves are evidence of this condition. This problem will cause:

- Rapid piston wear
- Uneven piston wear
- Excessive oil consumption
- Catastrophic engine failure.

A broken piston pin retaining ring can cause severe damage in the combustion chamber. Common causes are:

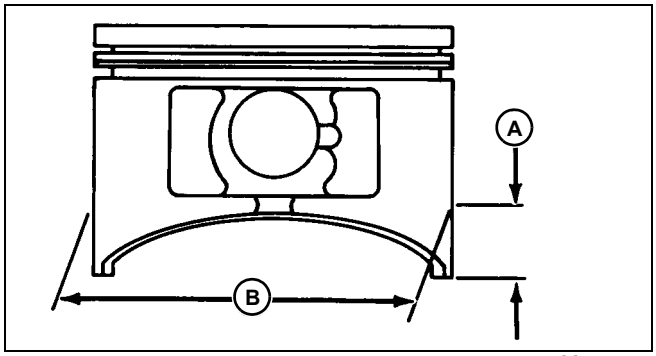
- Misaligned or bent connecting rod
- Excessive crankshaft end-play
- Crankshaft journal taper
- Weak retaining rings
- Incorrectly installed retaining rings.



M46449

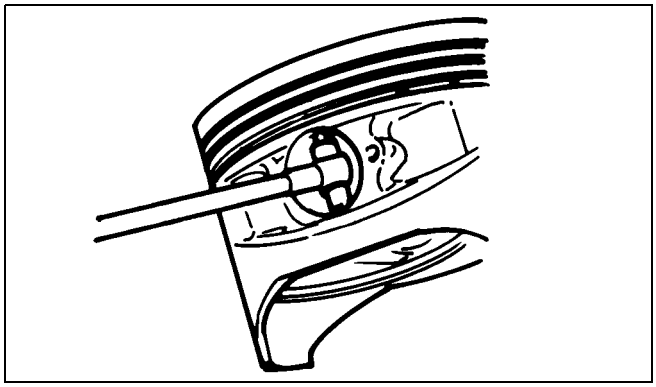
1. Measure the top and second ring groove clearance by inserting a new piston ring in the groove at several locations and measuring the gap between the ring and the ring land with a thickness gauge. Replace piston if the gap exceeds 0.15 mm (0.006 in.) for the top groove and 0.12 mm (0.005 in.) for the second groove.

NOTE: The oil ring is a three piece assembled ring. It is too difficult to measure the ring groove clearance, visually inspect only.



M53955

2. Measure outside diameter (B) of piston 11 mm (0.43 in.) (A) up from the bottom of piston at a right angle to the direction of piston pin hole. If less than 75.88 mm (2.987 in.), replace piston.



M46450

3. Measure inside diameter of piston pin hole at several locations using a dial bore gauge. If not within 17.04 mm (0.671 in.), replace piston.

4. Measure inside diameter of small end of connecting rod at several points. If more than 17.05 mm (0.671 in.), replace connecting rod.

5. Measure outside diameter of piston pin at several points. If less than 16.975 mm (0.668 in.), replace piston pin.

6. Measure ring thickness at several points. If less than 1.12 mm (0.044 in.) for top ring and second rings, replace the entire set of rings.

7. Deglaze cylinder bore with rigid hone, using 250 to 300 grit stone. Finish hone using 600 to 100 grit stone. Hone to obtain a 40° - 60° crosshatch pattern.

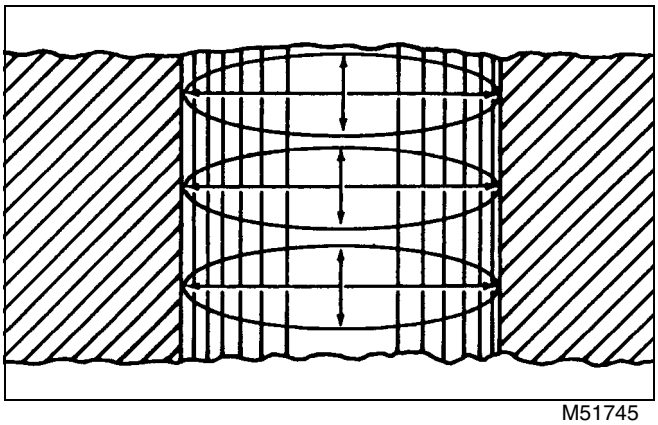
IMPORTANT: Avoid damage! Do Not use solvents to remove abrasives from cylinder wall.

8. Use hot soapy water to wash the cylinder and rinse with clean water. Wipe dry with a clean, lint free white cloth until the cloth shows no sign of discoloration. Apply clean engine oil to the cylinder after cleaning.

9. Position each ring (one at a time) near the bottom of the cylinder bore, use a piston to square the ring in the cylinder.

IMPORTANT: Avoid damage! Piston ring end gap must be checked, even when using new rings.

10.Measure gap between ends of ring. If greater than 1.2 mm (0.05 in.) for top and second ring gap and 1.5 mm (0.06 in.) for the oil ring gap, replace the entire set of rings. If new, obtain the proper size rings.



M51745

11.Measure cylinder bore parallel with crankshaft and at right angles to crankshaft. Measure at the top, middle and bottom of the ring travel.

12.Replace crankcase or rebore cylinder if not within service limits (see cylinder bore specifications below).

Specifications:

Piston/Ring Groove Clearance:

Top . . . . . 0.15 mm (0.006 in.)

Second . . . . . 0.12 mm (0.005 in.)

Piston Diameter Service Limit . . . 75.88 mm (2.987 in.)

Piston Pin Hole Inside Diameter
Service Limit . . . . . 17.04 mm (0.671 in.)

Connecting Rod Small End Inside Diameter
Service Limit . . . . . 17.05 mm (0.671 in.)

Piston Pin Outside Diameter
Service Limit . . . . . 16.98 mm (0.668 in.)

Piston Ring Thickness
Top and Second Rings . . . . . 1.12 mm (0.044 in.)

Piston Ring End Gap:

Top, Second . . . . . 1.2 mm (0.05 in.)

Oil . . . . . 1.5 mm (0.06 in.)

Cylinder Bore Specifications:

Standard . . . . . 75.98 - 76.00 mm (2.991 - 2.992 in.)

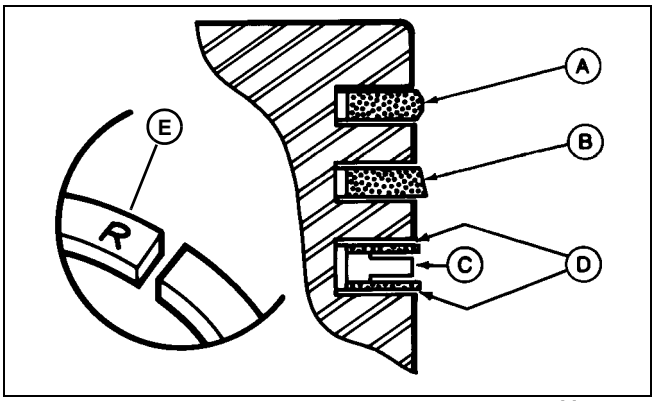
Wear Limit . . . . . 76.07 mm (2.995 in.)

0.50 mm Over Size . . . . . 76.50 mm (3.012 in.)

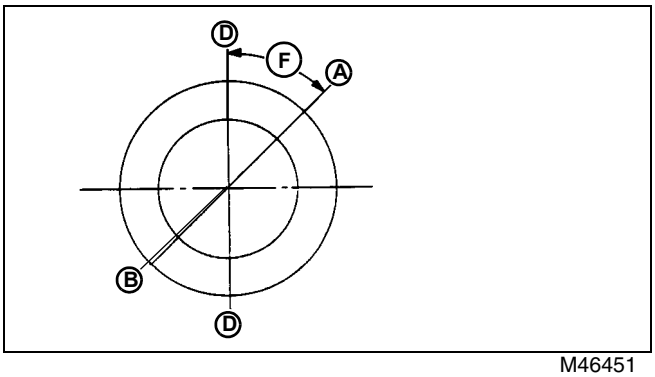
Wear Limit . . . . . 76.57 mm (3.014 in.)

Piston Ring Installation

IMPORTANT: Avoid damage! Be sure the piston has been properly cleaned, inspected and the correct size rings and pistons are obtained before proceeding with this procedure.



M38074



M46451

1. Install spacer (C) in the oil ring groove first and ensure the spacer ends butt together.

2. Install the steel rails (D) above and below the spacer with the end gaps positioned 180° apart.

3. Install chrome-plated top ring (A) and second ring (B) with the mark (E) facing up. Align the top ring and second ring end gaps 180° apart, the steel rail end gaps 180° apart and 45° apart (F) from the top ring end gap.

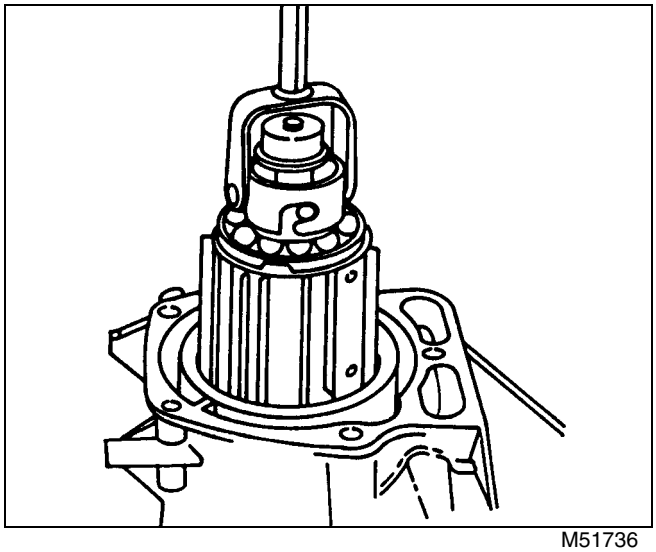
Cylinder Boring

Tips:

- Always resize to exactly 0.5 mm (0.02 in.) over the standard bore size. if this is done accurately, the stock oversize rings and pistons will fit perfectly and the proper clearance will be maintained.
- Resizing the cylinder bore can be done by a reliable repair shop or by using a drill press and honing tool. Machine bore the cylinder first to the initial bore diameter. Use a hone to hone out to finished dimension. Course finish using 600 then finish using 1000 grit stones.

Procedure:

1. Clean cylinder to remove burrs and any pieces of gasket that may be left after removing the head gasket.



M51736

2. Securely anchor the cylinder to the drill press table.

3. Align the center of the cylinder bore to the press center. Set press to operate at 200 - 250 rpm.

4. Connect the hone to the drive shaft. Set the stop on the drill press so the hone can only extend 20 - 25 mm (3/4 - 1.0 in.) above the top or below the bottom of the cylinder bore.

5. Rotate the adjusting nut (knob) on the hone until the stone just contacts the cylinder wall at the narrowest point. (if the hone cannot be turned by hand, it is too tight and must be loosened)

6. Ensure that the hone and cylinder centers are aligned with the drill press and drive shaft centers. Pour honing oil inside the cylinder while honing. Start the drill press and move the hone up and down approximately 20 cycles per minute

7. Check the diameter of the cylinder often during the honing process. (See specifications below.)

8. Hone the cylinder until it is about 0.007 - 0.009 mm (0.0003 - 0.0004 in.) larger to allow for shrinkage when the cylinder cools.

IMPORTANT: Avoid damage! Do Not use solvents to remove the abrasives from the cylinder wall.

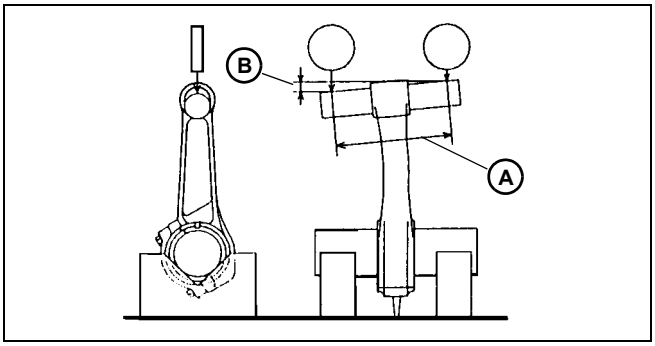
9. Use hot soapy water to wash the cylinder and rinse with clean water. Wipe dry with a clean, lint free white cloth until the cloth shows no sign of discoloration. Apply clean engine oil to the cylinder after cleaning.

Specifications:

Initial Bore Diameter
(0.50 mm oversize) . . . . . 76.48 - 76.46 mm
. . . . . (3.011 - 3.010 in.)

Final Bore Diameter
(0.50 mm oversize) . . . . . 76.50 - 76.48 mm
. . . . . (3.012 - 3.011 in.)

Connecting Rod Bend and Twist Inspection

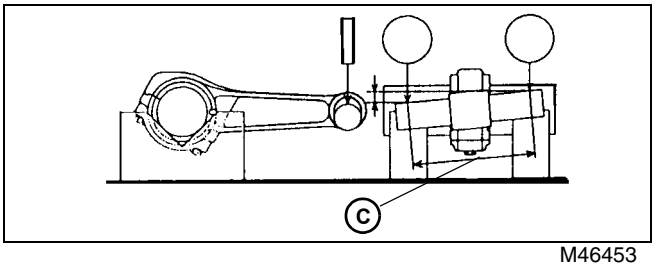


M46452

1. Select a shaft of the same diameter as the connecting rod big end, insert it and place the shaft on V-blocks that rest on a surface plate.

2. Select a shaft 100 mm (3.94 in.) long (A), the same diameter as the piston pin.

3. With the shafts installed and the connecting rod held vertically, measure the difference in height of the small end shaft above the surface plate over a 100 mm (3.94 in.) length to determine the amount of bend (B) in the connecting rod. If the connecting rod bend exceeds the service limit, the connecting rod must be replaced.



M46453

4. With the big end still on the V-blocks, hold the connecting rod horizontally and measure the amount that the small end shaft varies from being parallel with the surface plate over a 100 mm (3.94 in.) length (C) of the shaft to determine the amount of connecting rod twist. (See specifications below.)

5. Measure the connecting rod big end width, if less than service limits (see specifications below), replace connecting rod.

6. Assemble the connecting rod and end cap and tighten end 3cap cap screws to 21 N•m (186 lb-in.).

7. Measure inside diameter of the big end at several points. If larger than service limit (see specification below), replace connecting rod.

Specifications:

Connecting Rod (Over 100 mm (3.94 in.)):

Twist Service Limit. . . . . 0.15 mm (0.006 in.)

Bend Service Limit. . . . . 0.15 mm (0.006 in.)

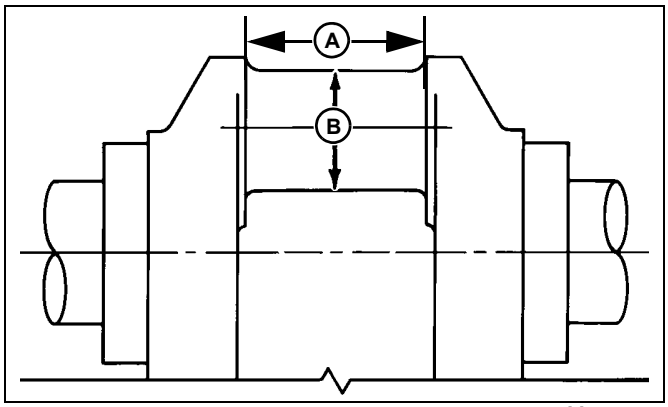
Connecting Rod Big End:

Width Service Limit . . . . . 21.20 mm (0.83 in.)

End ID Service Limit . . . . . 34.06 mm (1.341 in.)

Connecting Rod
Cap Screw Torque . . . . . 21 N•m (186 lb-in.)

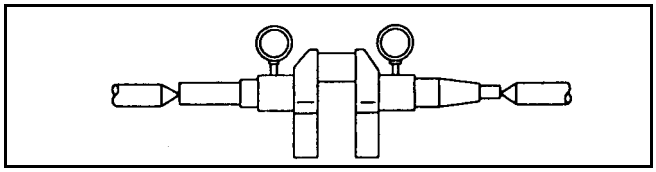
Crankshaft Inspection



M38036

1. Measure the crankpin journal at several points. If less than 33.927 mm (1.3357 in.) (B), replace crankshaft.

2. Measure the crank pin width (A). If greater than 44.5 mm (1.75 in.), replace crankshaft.

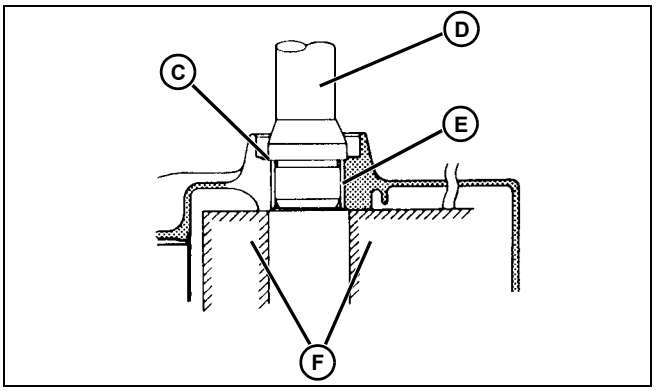

M46454

3. Set the crankshaft in alignment jig or on V-blocks. Place a dial gauge on both bearing journals.

4. Turn the crankshaft slowly and record the highest and lowest dial gauge readings. The difference between the highest and lowest readings (TIR), is the amount of runout. If the measurement exceeds 0.05 mm (0.002 in.), replace crankshaft.

5. Measure inside diameter of the crankshaft journal bearing at several points on the crankcase. If greater than 34.11 mm (1.343 in.), replace journal bearing.

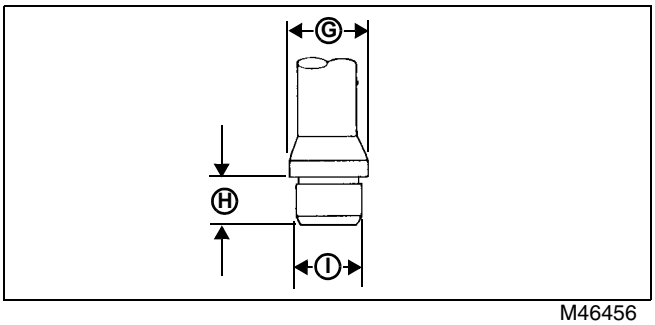
Journal Bushing Replacement:



M46455

- The service bushing is to be reinstalled using a bushing tool (D) as shown.
- Use a support block (F) under engine block.
- Coat the bushing (E) and flange surface (C) with a light film of oil, Press in the new bushing flush with the flange surface.
- No finish reaming is required

To Design a Bushing Tool:



M46456

Bushing Tool Dimensions:

(G) . . . . . 40 mm (1.575 in.)
(H). . . . . 26 mm (1.024 in.)
(I) . . . . . 33.8 mm (1.331 in.)

Specifications:

Crank Pin:

OD Service Limit. . . . . 33.93 mm (1.3358 in.)
Width Service Limit . . . . . 44.5 mm (1.75 in.)

Crankshaft:

Runout Service Limit . . . . . 0.05 mm (0.002 in.)
Bearing Journal ID (Crankcase) Service Limit. . . . . 34.11 mm (1.343 in.)

Crankshaft Installation

IMPORTANT: Avoid damage! Be sure your work area is clean, dirt in an engine will shorten the life expectancy and result in expensive repairs. Use “lint free” shop rags and have plenty of clean engine oil available when assembling the engine.

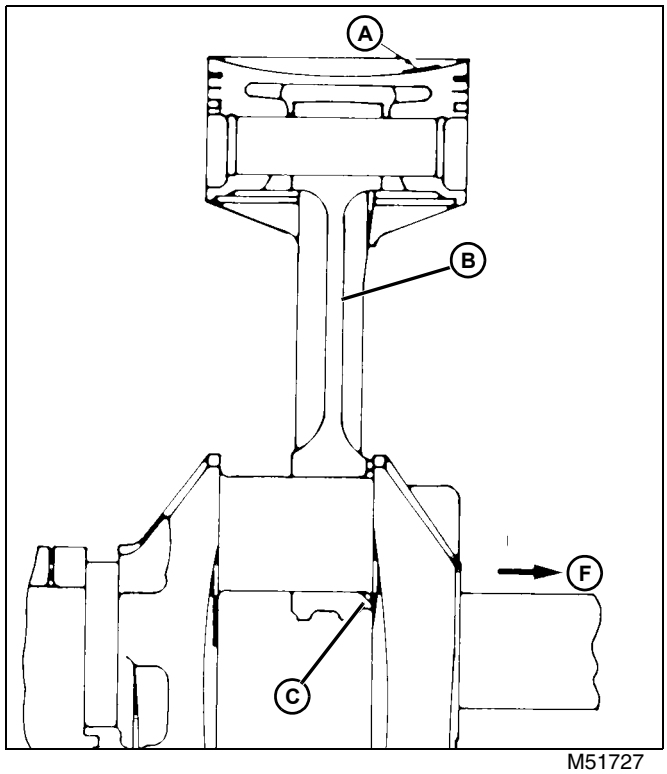
1. Pack high temperature grease into oil seal of crankcase.
2. Apply engine oil to journal and bearing.
3. Carefully insert crankshaft flywheel end into main bearing and oil seal, being careful not to damage oil seal.
4. Install crankshaft woodruff key into crankshaft taper.

Connecting Rod Assembly and Installation

IMPORTANT: Avoid damage! Be sure your work area is clean, dirt in an engine will shorten the life expectancy and result in expensive repairs. Use “lint free” shop rags and have plenty of clean engine oil available when assembling the engine.

CAUTION: Avoid Injury! Never re-use piston pin snap-rings. Removal weakens and deforms them.

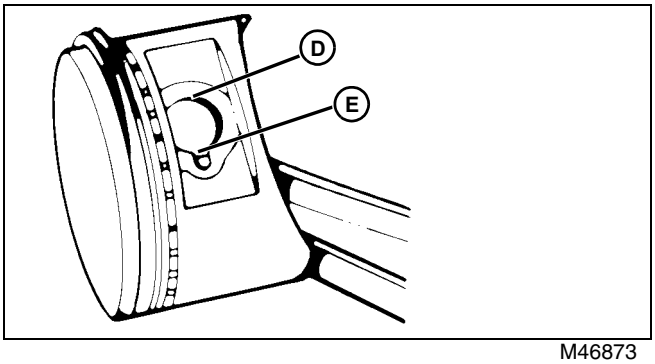
1. Apply engine oil to piston pins and assemble pistons to connecting rods as follows.



M51727

- Align arrow match mark (A) on No. 1 piston head with the raised letters “MADE IN JAPAN” (B) on connecting rod.
- Align arrow match mark (A) on No. 2 piston head opposite the letters “MADE IN JAPAN” (B) on connecting rod.

NOTE: Compress piston pin snap-rings just enough to install it and no more.



M46873

2. Install piston pin snap-rings. Be sure snap-ring opening (D) does not coincide with the notch (E) in the edge of the piston pin hole.

3. Apply engine oil to the piston skirt and the cylinder bore.

NOTE: Compress piston rings just enough to install the pistons and no more. Lightly tap the piston with a plastic mallet.

4. Using a piston ring compressor, insert piston and connecting rod into cylinder (Arrow match mark (A) facing the flywheel (F) side).

5. Apply a light film of oil to cap bearing surface and cap screws. Install connecting rod cap with chamfer (C) facing crank web. Tighten cap screws alternately to 21 N•m (186 lb-in.).

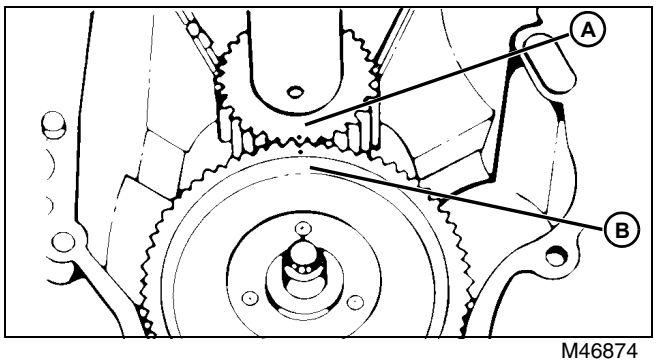
Tappet and Camshaft Installation

IMPORTANT: Avoid damage! Be sure your work area is clean, dirt in an engine will shorten the life expectancy and result in expensive repairs. Use “lint free” shop rags and have plenty of clean engine oil available when assembling the engine.

1. Lubricate and install tappets in their original positions.

Apply Engine Oil To The Following:

- Tappet Journal
- Camshaft Journal
- Cam Lobe Surface
- Camshaft Gear.



M46874

2. Install camshaft and align the punch mark on crank gear (A) with the projection on the cam gear (B).

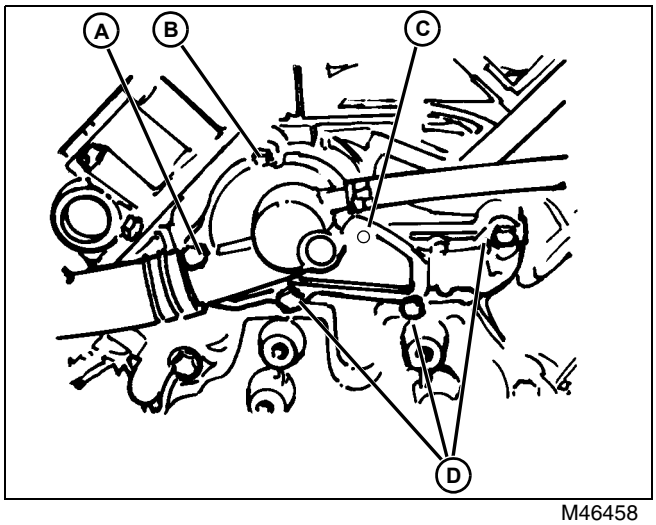
Water Pump Removal and Installation

1. Drain coolant from radiator just below level of water pump assembly. See “Radiator Drain Procedure - Gas” on page 589 for draining procedure.

2. Remove inlet and outlet hoses from water pump and remove cap screws and water pump assembly. Inspect parts for wear or damage and replace as necessary. (See “Water Pump Parts Inspection” on page 60.)

NOTE: Ensure water pump gear meshes with cam gear when aligning the pump for installation.

3. Use a new gasket and position the pump onto the engine.



M46458

4. Install water pump bolts in positions shown and tighten to correct specification in two increments.

Bolt Dimensions:

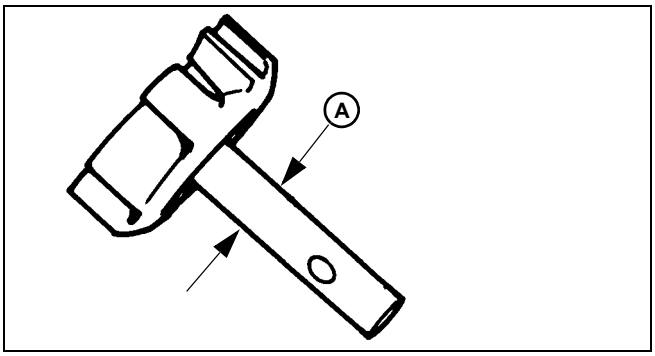
A. Bolt M6 . . . . . 75 mm (2.95 in.)
B. Bolt M6 . . . . . 65 mm (2.56 in.)
C. Bolt M8 . . . . . 70 mm (2.76 in.)
D. Bolt M6 . . . . . 45 mm (1.77 in.)

Bolt Torque:

A. Bolt M6 . . . . . 9.5 N•m (84 lb-in.)
B. Bolt M6 . . . . . 9.5 N•m (84 lb-in.)
C. Bolt M8 . . . . . 25 N•m (222 lb-in.)
D. Bolt M6 . . . . . 9.5 N•m (84 lb-in.)

Water Pump Parts Inspection

- Clean all metal parts in solvent and dry with compressed air.
- Clean all rubber and plastic parts with a mixture of detergent and water.
- Inspect the pump housing for damage. Mating surfaces should be smooth and free of burrs and nicks.
- Check the pump mechanical seal for damage. If damaged, coolant will leak from the pump body. Replace if necessary.



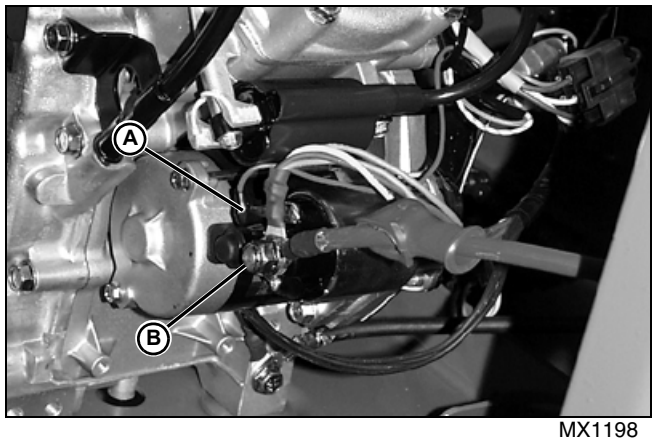
M46457

- Inspect the impeller for missing blades and corrosion. Measure the impeller shaft (A) at several points with a micrometer, minimum shaft diameter is 9.94 mm (0.391 in.). If damage or wear is noted, replace all internal pump parts.

Starting Motor Removal and Installation

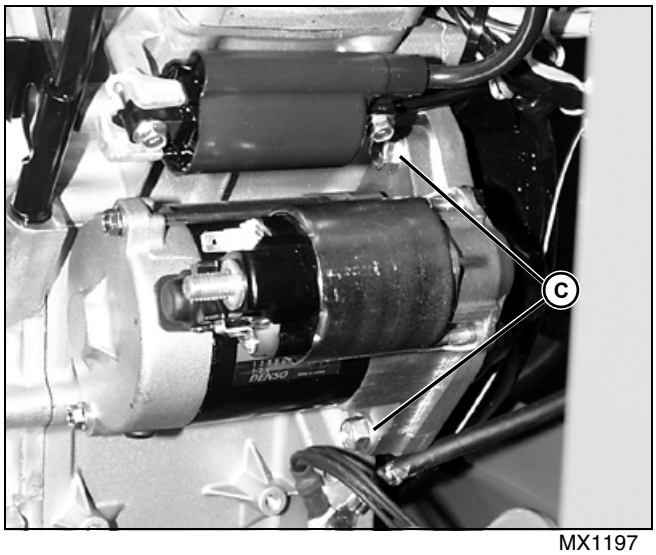
Removal:

1. Disconnect both the battery negative (-) and positive (+) cables from the battery and remove the battery.



MX1198

2. Disconnect single (purple) wire (A) connector from starting motor solenoid.
3. Disconnect battery positive (+) cable and wire lead (B) from starting motor solenoid.



MX1197

4. Remove the two cap screws (C) securing the starting motor to the engine block and remove the starting motor.

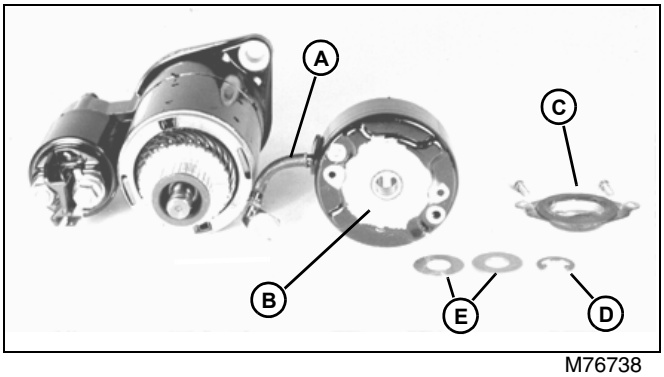
Installation:

Installation is done in the reverse order of removal.

1. Place starting motor in engine frame, install mounting bolts and tighten evenly.
2. Install wires to the proper terminals.
3. Install battery and connect positive (+) and negative (-) battery cables.

Starting Motor Disassembly and Inspection

Disassembly and Inspection:

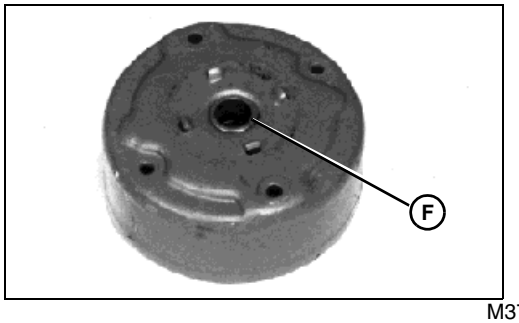


M76738

1. Disconnect field lead (A).
2. Remove two cap screws and two screws from rear cover (B).
3. Pry off cap (C).
4. Remove e-clip (D), shims (E) and rear cover.
5. Inspect rear cover bushing for wear or damage. Replace if necessary. (For complete disassembly breakdown, see “Starting Motor” on page 29.)

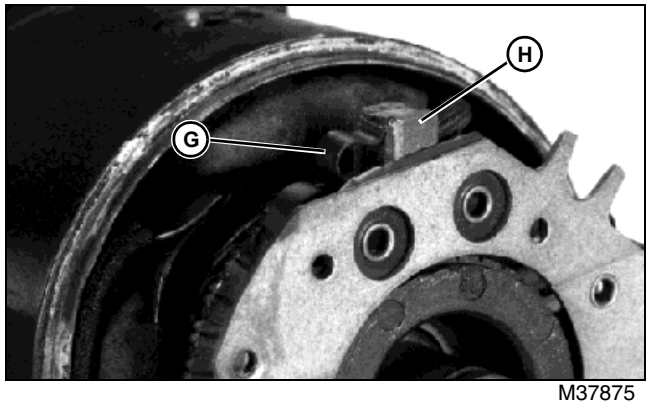
To Replace Bushing:

Remove bushing using a blind-hole puller set. Install new bushing until it bottoms in cover bore using a driver set.



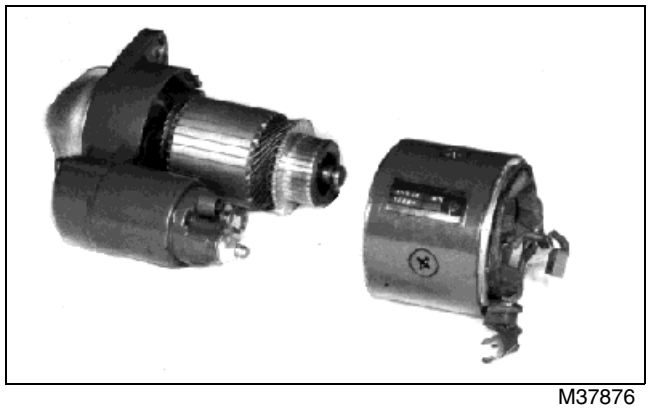
M37874

1. Ream out bushing (F) to 12.50 - 12.53 mm (0.492 - 0.493 in.).
2. Remove field coil brushes from brush holder.



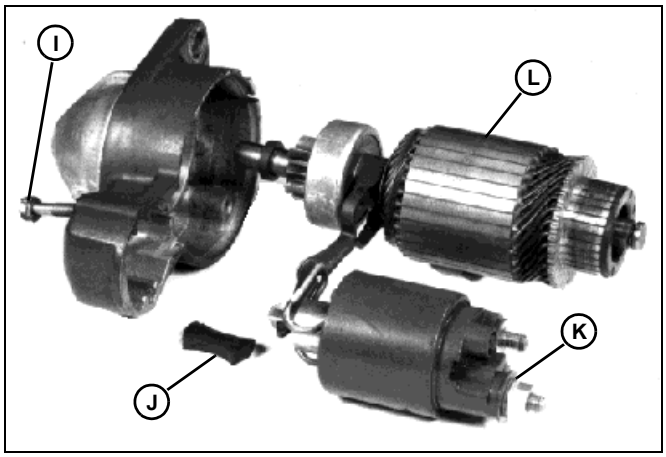
M37875

3. Pry brush springs (G) away and pull negative brushes (H) up enough to allow spring to hold brush in place.
4. Remove brush holder.



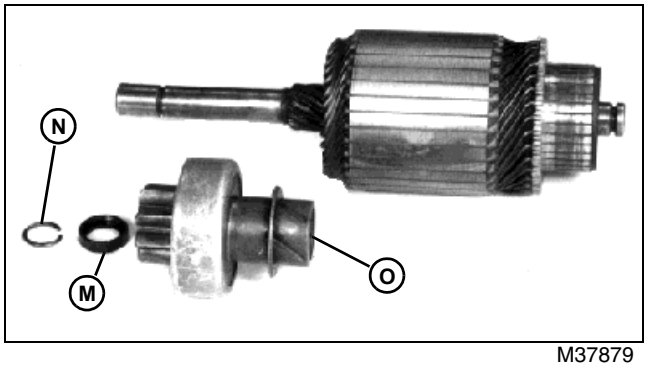
M37876

5. Remove field coil housing from armature/solenoid assembly.



M37877

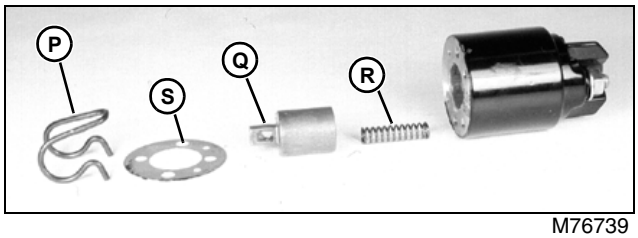
6. Remove two cap screws (I).
7. Remove dust cover (J).
8. Remove solenoid (K) and armature (L) assemblies from end frame.
9. Inspect end frame bushing for wear or damage. Replace if necessary.



M37879

10.Slide pinion stopper (M) away from retaining wire (N) using a piece of pipe or deep socket. Remove retaining wire, pinion stopper, and clutch assembly (O) from armature shaft.

11.Inspect clutch assembly for wear or damage. Gear should rotate in one direction only. Replace if necessary.



M76739

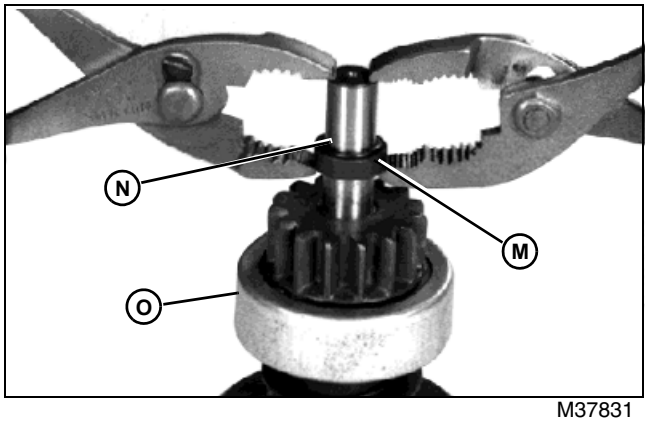
12.Remove clutch fork pivot (P), plunger (Q), spring (R) and shim plate (S) from solenoid.

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

14.Inspect and test brushes, holder, field coil and armature. (See “Test:” on page 62.)

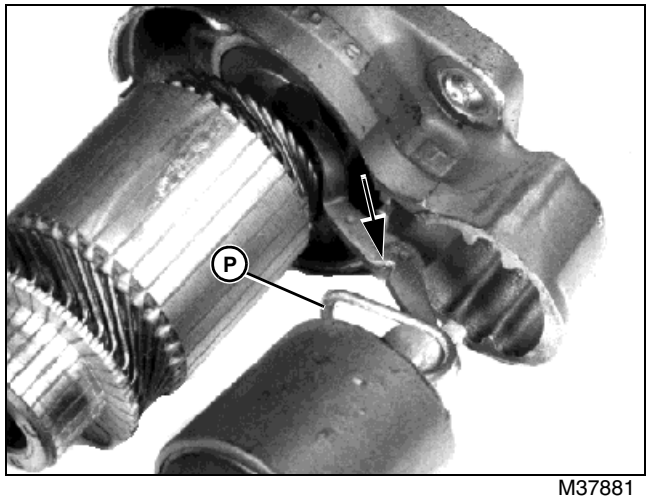
Assembly:

Assembly is done in the reverse order of disassembly.



M37831

- After installing clutch assembly (O), pinion stopper (M) and retaining wire (N) on armature shaft; use two pliers to press pinion stopper over retaining wire.



M37881

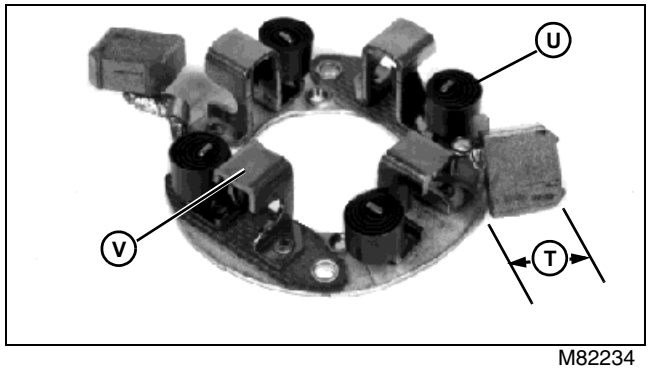
- When installing solenoid and armature assemblies into end frame, make sure fork pivot seats in notch on clutch fork.

IMPORTANT: Avoid damage! When installing rear cover, be sure field coil brush wires do not touch cover. Turn brush holder slightly to take up slack in brush wires. Press wires inward to clear rear cover.

Test:

1. Measure holder and field coil brush lengths. Minimum brush length is 7.70 mm (0.303 in.) (T). Replace brush holder or field coil if brush length is below minimum.

NOTE: Test brush holder using an ohmmeter or test light.



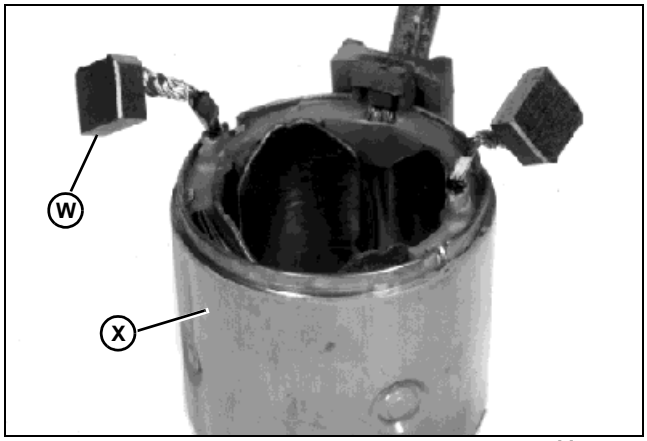
M82234

2. Test brush holder:

   - Touch one probe of tester to negative brush holder (U) and other probe to field brush holder (V). If there is continuity, replace the brush holder.

3. Inspect springs for wear or damage. Replace if necessary.

NOTE: Test field coil using an ohmmeter or test light.

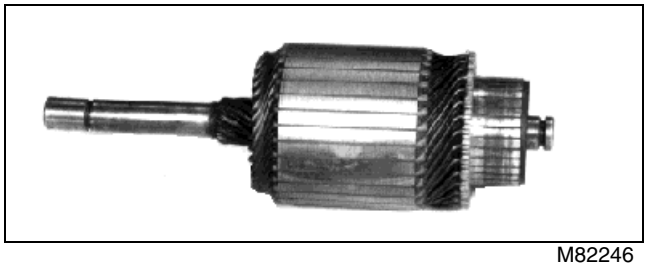


M82235

4. Test for grounded field winding:
Touch one probe of tester to field coil brush (W) and other probe to field coil housing (X). Be sure the brush lead is not touching the frame. If there is continuity, the coil is grounded and the field coil housing assembly must be replaced.

5. Test for open field coil:
Touch one probe of tester to each field coil brush. If there is no continuity, the field coil is open and the field coil housing assembly must be replaced.

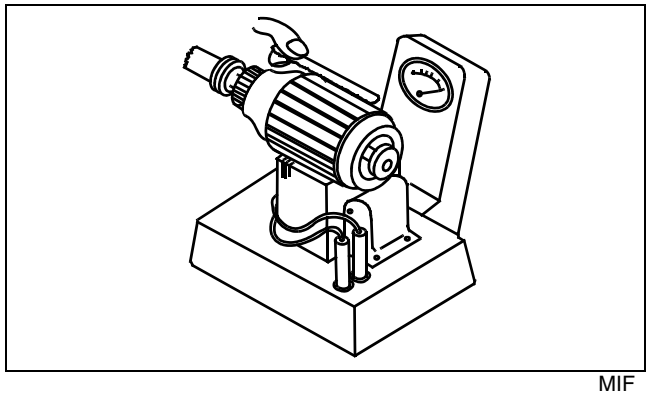
IMPORTANT: Avoid damage! Do not clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush or an electrical contact cleaner.


M82246

6. Inspect armature. Look for signs of dragging against pole shoes.

7. Inspect commutator. Look for roughness, burned bars, or any material which might cause short circuits between bars. If necessary, clean and touch up with 400 sandpaper. NEVER use emery cloth. Clean all dust from armature when finished.

NOTE: Test armature windings using an ohmmeter or test light.


MIF

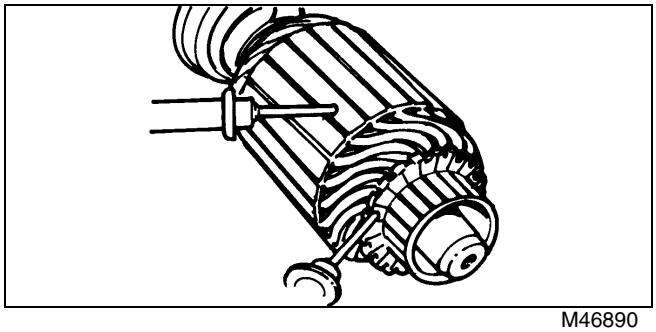
8. Test for short circuited windings using a growler. Put armature in a growler and hold a hacksaw blade above each slot while slowly rotating armature.

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.

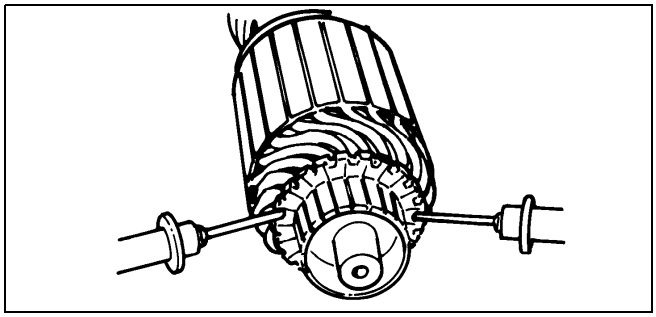
9. If test indicates short circuited windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.

NOTE: Test for grounded windings using an ohmmeter or test light.


M46890

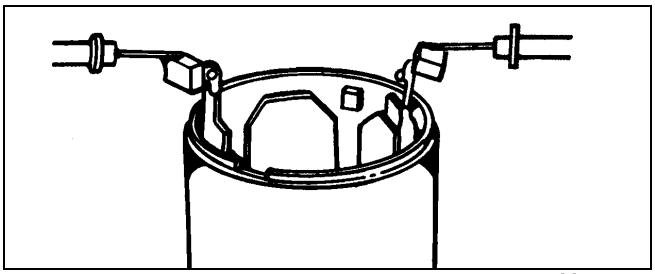
10.Armature windings are connected in parallel, so each commutator bar must be checked.

11.If the test shows continuity, a winding is grounded and the armature must be replaced.


M46891

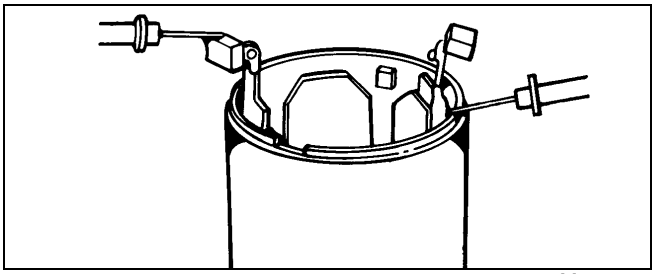
12.Test for open circuits in the windings. If the test shows no continuity, the armature has an open circuit and must be replaced.

IMPORTANT: Avoid damage! The coil frame is a tie point for twelve separate field coils. It may be difficult to detect one bad coil. If rpm was slow and armature tests are normal, replace the field coil assembly.



M46897

Picture Note: Continuity (Brush to Brush) = Continuity



M46894

Picture Note: Continuity (Brush to Housing) = Continuity

13.Perform continuity tests on field coil. Replace the coil if not within specifications

ENGINE - DIESEL TABLE OF CONTENTS

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Specifications - 3TNE68

Engine Specifications

Make	Yanmar
Model	3TNE68
Type	4-cycle Diesel
Cylinders	3
Bore	68 mm (2.67 in.)
Stroke	72 mm (2.84 in.)
Displacement	0.784 L (47.84 cu. in.)
Firing Order	1 - 3 - 2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Combustion System	Indirect Injection Type
Compression Ratio	23 to 1
Lubrication	Full Pressure
Oil Filter	Spin On
Oil Capacity (Approximately):	
Without Filter	2.0 L (2.1 qt)
With Filter	2.2 L (2.3 qt)
Cooling	Liquid
Cooling Capacity	5 L (5.2 qt)
Governor	Centrifugal
Slow Idle (no-load)	1050 ± 25 rpm
High Idle (no-load)	3650 ± 25 rpm

Fuel System

System Type	Indirect Fuel Injection
Injection Pump	In-Line w/Electric Shutoff Solenoid
Fuel Type	Diesel
Fuel Tank Capacity	20.0 L (5.25 gal)
Fuel Filter	Fuel Water Separator with Disposable Paper Element

Repair Specifications

Rocker Arm Cover:	
Special Nut Torque	18 N•m (160 lb-in.)
Rocker Arm Assembly:	
Mounting Cap Screw and Nut Torque	26 N•m (226 lb-in.)
Rocker Arm Shaft OD	
Standard	9.97 - 9.99 mm (0.3925 - 0.3933 in.)
Wear Limit	9.95 mm (0.3920 in.)
Rocker Arm and Shaft Support ID's	
Clearance	0.14 mm (0.005 in.)
Standard	10.00 - 10.02 mm (0.3937 - 0.3945 in.)
Wear Limit	10.09 mm (0.3972 in.)
Push Rod Bend Wear Limit	0.03 mm (0.001 in.)

ENGINE - DIESEL SPECIFICATIONS - 3TNE68

Cylinder Head:

Mounting Cap Screw Torque:
First . . . . . 13.6 N•m (120 lb-in.)
Second. . . . . 27 N•m (240 lb-in.)
Final . . . . . 41 N•m (30 lb-ft)
Piston-to-Cylinder Head Clearance . . . . . 0.45 - 0.75 mm (0.023 - 0.029 in.)
Cylinder Head Distortion
Standard . . . . . 0.05 mm (0.002 in.) or less

Intake and Exhaust Valves:

Intake Valve Seat Width
Standard . . . . . 1.15 mm (0.045 in.)
Wear Limit . . . . . 1.65 mm (0.065 in.)
Exhaust Valve Seat Width
Standard . . . . . 1.41 mm (0.056 in.)
Wear Limit . . . . . 1.91 mm (0.075 in.)
Valve Seat Surface Angles
Exhaust Valve . . . . . 45°
Intake Valve . . . . . 30°
Lower Seat Surface . . . . . 70°
Upper Seat Surface . . . . . 15°
Valve Faces
Minimum Margin . . . . . 0.50 mm (0.020 in.)
Exhaust Angle. . . . . 45°
Intake Angle . . . . . 30°
Valve Stem O.D.
Intake Valve
Standard . . . . . 5.46 - 5.48 mm (0.2149 - 0.2157 in.)
Wear Limit . . . . . 5.40 mm (0.2126 in.)
Exhaust Valve
Standard . . . . . 5.44 - 5.46 mm (0.2142 - 0.2149 in.)
Wear Limit . . . . . 5.40 mm (0.2126 in.)
Valve Recession
Intake Valve . . . . . 0.30 mm - 0.50 mm (0.012 in. - 0.020 in.)
Exhaust Valve . . . . . 0.75 mm - 0.95 mm (0.030 in. - 0.037 in.)
Wear Limit . . . . . 1.0 mm (0.039 in.)
Valve Lift . . . . . 7.5 mm (0.300 in.)

Valve Guides:

Valve Guide ID
Maximum Clearance. . . . . 0.18 mm (0.007 in.)
Standard . . . . . 5.50 - 5.52 mm (0.216 - 0.217 in.)
Wear Limit . . . . . 5.58 mm (0.220 in.)
Valve Guide Height . . . . . 7 mm (0.276 in.)

Valve Springs:

Spring Free Length
Wear Limit . . . . . 28 mm (1.102 in.)
Maximum Spring Inclination . . . . . 0.80 mm (0.032 in.)

Exhaust Manifold:

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

Intake Manifold:

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

Connecting Rod Bearing ID:

Standard . . . . . 35.970 - 35.980 mm (1.416 - 1.417 in.)
Wear Limit . . . . . 35.91 mm (1.414 in.)
Oil Clearance (Maximum) . . . . . 0.16 mm (0.006 in.)
Connecting Rod Cap Screw Torque . . . . . 25 N•m (220 lb-in.)

Piston Ring Groove Clearance:

First Compression Ring
Standard . . . . . 0.060 - 0.100 mm (0.002 - 0.004 in.)
Wear Limit . . . . . 0.20 mm (0.0079 in.)
Second Compression Ring
Standard . . . . . 0.090 - 0.125 mm (0.004 - 0.005 in.)
Wear Limit . . . . . 0.20 mm (0.0079 in.)
Oil Ring
Standard . . . . . 0.020 - 0.055 mm (0.0008 - 0.0022 in.)
Wear Limit . . . . . 0.20 mm (0.0079 in.)

Piston Ring End Gap:

First Compression Ring and Oil Ring . . . . . 0.10 - 0.25 mm (0.004 - 0.010 in.)
Second Compression Ring . . . . . 0.15 - 0.35 mm (0.006 - 0.014 in.)
Wear Limit . . . . . 1.50 mm (0.059 in.)

Piston Pin:

Pin OD
Standard . . . . . 19.991 - 20.00 mm (0.787 - 0.788 in.)
Wear Limit . . . . . 19.975 mm (0.786 in.)
Bore ID
Clearance . . . . . 0.045 mm (0.0018 in.)
Standard . . . . . 20.00 - 20.008 mm (0.787 - 0.788 in.)
Wear Limit . . . . . 20.02 mm (0.788 in.)
Bushing ID
Clearance . . . . . 0.110 mm (0.0043 in.)
Standard . . . . . 20.025 - 20.038 mm (0.788 - 0.789 in.)
Wear Limit . . . . . 20.10 mm (0.781 in.)

Piston OD:

Standard Size Piston
Standard . . . . . 67.940 - 67.970 mm (2.675 - 2.676 in.)
Wear Limit . . . . . 67.90 mm (2.673 in.)
0.25 mm (0.010 in.) Oversize Piston
Standard . . . . . 68.19 - 68.22 mm (2.685 - 2.686 in.)
Wear Limit . . . . . 66.15 mm (2.683 in.)

ENGINE - DIESEL SPECIFICATIONS - 3TNE68

Cylinder Bore ID:

Standard . . . . . 68.00 - 68.03 mm (2.677 - 2.678 in.)
Wear Limit . . . . . 68.20 mm (2.685 in.)
0.25 mm (0.010 in.) Oversize Bore
Standard . . . . . 68.25 - 68.28 mm (2.687 - 2.688 in.)
Wear Limit . . . . . 68.453 mm (2.695 in.)
Deglazing. . . . . 30 - 40° cross-hatch pattern
Reboring . . . . . 30 - 40° cross-hatch pattern

Crankshaft Rear Oil Seal:

Seal Case-to-Block Cap Screw Torque. . . . . 11 N•m (96 lb-in.)
Oil Pan-to-Seal Case Cap Screw Torque . . . . . 9 N•m (78 lb-in.)

Crankshaft and Main Bearings:

Drive Clutch to Crankshaft Cap Screw. . . . . 37 N•m (26 lb-ft)
Main Bearing Cap Screw Torque. . . . . 54 N•m (40 lb-ft)
Crankshaft Maximum Bend . . . . . 0.02 mm (0.001 in.)
Connecting Rod Journal OD
Standard . . . . . 35.97 - 35.98 mm (1.4161 - 1.4165 in.)
Wear Limit . . . . . 35.91 mm (1.414 in.)
Main Bearing Journal OD
Standard . . . . . 39.97 - 39.98 mm (1.5736 - 1.5740 in.)
Wear Limit . . . . . 39.90 mm (1.571 in.)
Main Bearing ID
Oil Clearance (Maximum). . . . . 0.15 mm (0.0059 in.)
Standard . . . . . 40.00 - 40.042 mm (1.575 - 1.577 in.)
Wear Limit . . . . . 40.07 mm (1.578 in.)

Flywheel:

Maximum Distortion . . . . . 0.2 mm (0.008 in.)
Flywheel Mounting Cap Screw Torque. . . . . 83 N•m (61 lb-ft)

Camshaft:

Thrust Plate Cap Screw Torque . . . . . 11 N•m (96 lb-in.)
Camshaft Side Gap
Standard . . . . . 0.05 - 0.25 mm (0.002 - 0.010 in.)
Maximum Camshaft Bend . . . . . 0.02 mm (0.001 in.)
Lobe Height
Standard . . . . . 29.97 - 30.03 mm (1.180 - 1.182 in.)
Wear Limit . . . . . 29.75 mm (1.171 in.)
Journal OD
Gear Housing and Flywheel Ends
Standard . . . . . 35.94 - 35.96 mm (1.4150 - 1.4157 in.)
Wear Limit . . . . . 35.85 mm (1.4114 in.)
Bushing ID
Clearance . . . . . 0.18 mm (0.007 in.)
Standard . . . . . 36.00 - 36.065 mm (1.417 - 1.420 in.)
Wear Limit . . . . . 36.10 mm (1.421 in.)

Bore ID
Clearance . . . . . 0.18 mm (0.007 in.)
Standard . . . . . 36.00 - 36.025 mm (1.417 - 1.418 in.)
Wear Limit . . . . . 36.10 mm (1.421 in.)
Standard . . . . . 35.91 - 35.94 mm (1.4138 - 1.4150 in.)
Wear Limit . . . . . 35.85 mm (1.4114 in.)

Cam Followers:

OD
Standard . . . . . 17.950 - 17.968 mm (0.7067 - 0.7074 in.)
Wear Limit . . . . . 17.93 mm (0.706 in.)
Bore ID
Clearance . . . . . 0.032 - 0.068 mm (0.0013 - 0.0027 in.)
Standard . . . . . 18.00 - 18.018 mm (0.7087 - 0.7094 in.)
Wear Limit . . . . . 18.05 mm (0.711 in.)

Timing Gear Cover:

Cover Mounting Cap Screw Torque . . . . . 9 N•m (78 lb-in.)
Crankshaft Pulley Cap Screw Torque . . . . . 115 N•m (85 lb-ft)

Idler Gear:

Shaft OD
Standard . . . . . 19.959 - 19.980 mm (0.786 - 0.787 in.)
Wear Limit . . . . . 19.93 mm (0.785 in.)
Bushing ID
Clearance . . . . . 0.15 mm (0.0059 in.)
Standard . . . . . 20.00 - 20.021 mm (0.787 - 0.788 in.)
Wear Limit . . . . . 20.08 mm (0.791 in.)

Timing Gear Housing Cap Screw Torque:

Housing-to-Aluminum . . . . . 9 N•m (78 lb-in.)
Housing-to-Cast Iron . . . . . 11 N•m (96 lb-in.)

Oil Pan and Strainer Mounting Cap Screw Torque:

Oil Pan-to-Block . . . . . 11 N•m (96 lb-in.)
Oil Pan-to-Seal Case . . . . . 9 N•m (78 lb-in.)
Oil Pan-to-Timing Gear Housing . . . . . 9 N•m (78 lb-in.)
Oil Strainer-to-Block . . . . . 11 N•m (96 lb-in.)

Oil Pump:

Rotor Shaft OD-to-Backing Plate ID Clearance
Standard . . . . . 0.013 - 0.043 mm (0.001 - 0.002 in.)
Wear Limit . . . . . 0.20 mm (0.0078 in.)
Rotor Recess Wear Limit . . . . . 0.13 mm (0.005 in.)
Outer Rotor-to-Pump Body Clearance
Standard . . . . . 0.10 - 0.16 mm (0.004 - 0.006 in.)
Wear Limit . . . . . 0.25 mm (0.010 in.)
Inner-to-Outer Rotor Clearance Wear Limit . . . . . 0.15 mm (0.0059 in.)

Oil Pressure Regulating Valve:

Spring
Compressed Length . . . . . 14.70 mm (0.580 in.) @12 N (2.7 lb-force)
Free Length . . . . . 21.90 - 24.50 mm (0.860 - 0.960 in.)
Housing-to-Valve Body Retaining Nut Torque . . . . . 30 N•m (22 lb-ft)

Fuel Injection Pump:

Mounting Nut Torque . . . . . 20 N•m (180 lb-in.)

Fuel Injection Pump Camshaft:

Bearing Retaining Screw Torque . . . . . 20 N•m (180 lb-in.)
Minimum Lobe Height . . . . . 30.90 mm (1.217 in.)

Fuel Control and Governor Linkage:

Governor Shaft OD (Minimum) . . . . . 7.90 mm (0.311 in.)
Governor Shaft Bore ID
Wear Limit . . . . . 8.15 mm (0.321 in.)
Clearance . . . . . 0.18 mm (0.007 in.)
Sleeve ID (Maximum) . . . . . 8.20 mm (0.323 in.)
Injection Pump Camshaft OD
Clearance . . . . . 0.15 mm (0.006 in.)
Wear Limit . . . . . 7.90 mm (0.311 in.)

Fuel Injection Nozzles:

Mounting Nut Torque . . . . . 51 N•m (37 lb-ft)
Nozzle Fitting Torque . . . . . 40 N•m (30 lb-ft)
Nozzle Torque . . . . . 51 N•m (37 lb-ft)
Separator Plate Nozzle Contact Surface Maximum Wear . . . . . 0.10 mm (0.0039 in.)

Starting Motor - Hitachi 0.8 kW:

Cover Bushing (Reamed Out. . . . . 12.50 - 12.53 mm (0.492 - 0.493 in.)
Minimum Brush Length . . . . . 7.70 mm (0.303 in.)

Alternator - Nipondenso 40 Amp:

Flywheel Assembly-to-Coil Plate Assembly Nut Torque . . . . . 27 N•m (20 lb-ft)

Checks, Tests and Adjustments:

Valve Clearance . . . . . 15 - 25 mm (0.006 - 0.010 in.)
Connecting Rod Side Play
Clearance . . . . . 0.20 - 0.40 mm (0.0079 - 0.0157 in.)
Connecting Rod Bearing Clearance
Standard Clearance . . . . . 0.033 - 0.059 mm (0.001 - 0.002 in.)
Wear Limit . . . . . 0.15 mm (0.0059 in.)
Crankshaft End Play. . . . . 0.090 - 0.271 mm (0.004 - 0.011 in.)
Crankshaft Main Bearing Clearance
Main Bearing Cap Screw Torque. . . . . 54 N•m (40 lb-ft)
Standard Clearance . . . . . 0.033 - 0.059 mm (0.001 - 0.002 in.)
Wear Limit . . . . . 0.15 mm (0.0059 in.)
Valve Lift (Intake and Exhaust) . . . . . 7.5 mm (0.300 in.)
Camshaft End Play . . . . . 0.05 - 0.25 mm (0.002 - 0.010 in.)

Timing Gear Backlash	
All Except Crankshaft Gear-to-Oil Pump Gear	**0.04 - 0.12 mm (0.0016 - 0.0047 in.)**
Crankshaft Gear-to-Oil Pump Gear	**0.11 - 0.19 mm (0.0043 - 0.0075 in.)**
Fuel Injection Nozzle:	
Opening Pressure	**11722 ± 480 kPa (1700 ± 70 psi)**
Leakage at 11032 kPa (1600 psi)	**Minimum of 10 Seconds**
Chatter and Spray Pattern at 11722 ± 480 kPa (1700 ± 70 psi)	
Slow Hand Lever Movement	**Chatter Sound**
Slow Hand Lever Movement	**Fine Stream Spray Pattern**
Fast Hand Lever Movement	**Fine Atomized Spray Pattern**
Thermostat:	
Begin Opening	**71° C (160°F)**
Fully Open	**85° C (184° F)**
Minimum Lift Height	**8 mm (0.310 in.)**
Coolant Temperature Switch (On Engine):	
Continuity	**109° ± 1° C (228° ± 2° F)**
Starter No-Load Amp Draw/RPM:	
Maximum Starter Amperage	**60 Amps at 7000 rpm**
Minimum Starter RPM	**7000 rpm**
Fuel Injection Pump Static Timing:	
Injection Pump Timing	**17°±1.5° BTDC (Before Top Dead Center)**
Standard Shim Pack Thickness (New Shims)	**0.8 mm (0.031 in.)**
Delivery Valve Fitting Torque	**42 N•m (31 lb-ft)**
Water Pump/Alternator Drive Belt Tension:	
Applied Force	**98 N (22 lb-force)**
Deflection	**10 - 15 mm (0.400 - 0.600 in.)**
Operational Tests:	
Radiator Bubble Test	
Maximum Air Pressure Into Cylinder	**2448 kPa (355 psi)**
Cooling System	
Maximum Pressure	**117 kPa (15 psi)**
Minimum Pressure after 15 Seconds	**90 kPa (13 psi)**
Radiator Cap	
Valve Opening Pressure	**83 - 96 kPa (12 - 14 psi)**
Cylinder Compression Pressure	**3236 ± 100 kPa (469 ± 15 psi)**
Minimum Compression Pressure	**2448 kPa (355 psi)**
Maximum Difference Between Cylinders	**490 kPa (71 psi)**
Engine Idle Speed	
Fast Idle	**3650 ± 25 rpm**
Slow Idle	**1050 ± 25 rpm**
Engine Oil Pressure (At High Idle)	**245 - 343 kPa (35 - 49 psi)**

Specifications - 3TNV70

Engine Specifications

General Specifications:

Make	Yanmar
Model	3TNV70
Injection Type	Indirect
Type	4-Cycle Diesel
Number of Cylinders	3
Bore	70 mm (2.76 in.)
Stroke	74 mm (2.91 in.)
Displacement	0.854 L (52.11 cu in.)
Firing Order	1 - 3 - 2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Combustion System	Indirect Injection Type
Compression Ratio	23.4: 1
Cooling	Liquid
Cooling System Pressure	88.2 kPa (12.8 psi)
Oil Capacity (w/filter)	2.2 L (2.3 qt)
Governor	Centrifugal
Slow Idle (no-load)	1450 ±25 rpm
High Idle (no-load)	3425 ±25 rpm

Operational Tests

Cylinder Compression Pressure (@250 RPM Cranking Speed)	3432 kPa (498 psi)
(Minimum)	2746 kPa (398 psi)
Difference Between Cylinders	245 kPa (36 psi)

Cooling System:

Radiator Cap Opening Pressure	0.9 ± 0.15 kg/cm^2, 88.3 ± 14.7 kPa, (12.8 ± 2.2 psi)
Cooling System Pressure Test	0.9 ± 0.15 kg/cm^2, 88.3 ± 14.7 kPa, (12.8 ± 2.2 psi)
Thermostat Opening Temperature	69.5 - 72.5 °C (157 - 163 °F)
Thermostat Minimum Lift Height above 85 °C (185 °F)	8 mm (0.315 in.)

Oil Pressure:

Rated Speed	290 - 440 kPa (42 - 63 psi)
Slow Idle (Minimum)	60 kPa (9 psi)
Oil Pressure Switch Opening Pressure	3 - 4 kPa (6 - 9 psi)

ENGINE - DIESEL SPECIFICATIONS - 3TNV70

Tests and Adjustment Specifications

Specifications:

Valve Clearance . . . . . 0.15 - 0.25 mm (0.006 - 0.010 in.)
Connecting Rod Side Play . . . . . 0.2 - 0.4 mm (0.008 - 0.016 in.)
Connecting Rod Bearing Clearance . . . . . 0.02 - 0.05 mm (0.001 in.)
Crankshaft End Play . . . . . 0.11 - 0.25 mm (0.004 - 0.001 in.)
Crankshaft Main Bearing Clearance . . . . . 0.02 - 0.05 mm (0.001 - 0.001 in.)
Camshaft End Play . . . . . 0.05 - 0.15 mm (0.002 - 0.006 in.)
Alternator Drive Belt Deflection (@98 N (22 lb) Applied Force) . . . . . 10 - 15 mm (0.4 - 0.6 in.)

Fuel Injection Nozzle:

Opening Pressure . . . . . 11800 - 12800 kPa (1711 - 1856 psi)
Leakage at 11032 kPa (1600 psi) . . . . . .None for a minimum of 10 seconds
Chatter and Spray Pattern at 11800 - 12800 kPa (1711 - 1856 psi):
Slow Hand Lever Movement . . . . . Chatter Sound

Repair Specifications

Valve Train:

Rocker Arm Shaft OD . . . . . 11.97 - 11.98 mm (0.471 - 0.472 in.)
Wear Limit . . . . . 11.95 mm (0.470 in.)
Rocker Arm and Shaft Support Bushings ID . . . . . 12.00 - 12.02 mm (0.472 - 0.473 in.)
Wear Limit . . . . . 12.07 mm (0.475 in.)
Oil Clearance . . . . . 0.02 - 0.05 mm (0.001 - 0.002 in.)
Wear Limit . . . . . 0.13 mm (0.005 in.)
Push Rod Bend (maximum) . . . . . 0.0 - 0.03 mm (0.0 - 0.001 in.)

Cylinder Head:

Cylinder Head Flatness . . . . . 0.000 - 0.05 mm (0.000 - 0.002 in.)
Service Limit . . . . . 0.15 mm (0.006 in.)

Valve Seat Angles:

Exhaust Valve . . . . . .45°
Intake Valve . . . . . .30°
Lower Seat Surface . . . . . .70°
Upper Seat Surface . . . . . .15°
Intake Valve Head Margin . . . . . 0.9 - 1.1 mm (0.035 - 0.043 in.)
Exhaust Valve Head Margin . . . . . 1.0 - 1.2 mm (0.039 - 0.047 in.)
Wear Limit . . . . . 0.50 mm (0.02 in.)

Valve Recession:

Intake and Exhaust . . . . . 0.40 - 0.60 mm (0.016 - 0.024 in.)
Wear Limit Intake . . . . . 0.9 mm (0.035 in.)
Wear Limit Exhaust . . . . . 0.8 mm (0.031 in.)
Valve Stem Diameter:
Intake . . . . . 5.96 - 5.98 mm (0.234 - 0.235 in.)
Exhaust . . . . . 5.95 - 5.96 mm (0.234 - 0.235 in.)
Wear Limit (Intake and Exhaust) . . . . . 5.90 mm (0.232 in.)

Valve Guides:

Valve Guide ID. . . . . 6.0 - 6.01 mm (0.236 - 0.237 in.)
Valve Guide Wear Limit . . . . . 6.08 mm (0.239 in.)
Valve Guide Installed Height . . . . . 9.8 - 10 mm (0.386 - 0.394 in.)

Valve Stem-To-Guide Oil Clearance:

Intake . . . . . 0.03 - 0.05 mm (0.001 - 0.002 in.)
Exhaust . . . . . 0.04 - 0.07 mm (0.002 - 0.003 in.)
Wear Limit . . . . . 0.17 mm (0.007 in.)

Valve Springs:

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

Connecting Rod:

Large End Bearing ID . . . . . 41.98 - 42.00 mm (1.653 - 1.654 in.)
Large End Bearing Thickness . . . . . 1.50 - 1.51 mm (0.059 - 0.059 in.)
Large End Bearing Oil Clearance . . . . . 0.02 - 0.06 mm (0.001 - 0.002 in.)
Large End Bearing Wear Limit . . . . . 0.12 mm (0.005 in.)
Connecting Rod Side Play . . . . . 0.20 - 0.40 mm (0.008 - 0.016 in.)
Twist and Parallelism . . . . . 0.00 - 0.03 mm per 100 mm (0.00 - 0.001 in. per 6 in.)
Wear Limit . . . . . 0.08 mm per 100 mm (0.005 in. per 6 in.)

(For Connecting Rod Small End Specifications, See “Piston Pin” Below)

Top Piston Ring Specifications:

Ring Groove Width . . . . . 1.55 - 1.57 mm (0.061 - 0.062 in.)
Ring Width. . . . . 1.47 - 1.49 mm (0.058 - 0.059 in.)
Side Clearance . . . . . 0.06 - 0.10 mm (0.002 - 0.004 in.)
Ring End Gap . . . . . 0.15 - 0.30 mm (0.006 - 0.012 in.)
Ring End Gap Wear Limit . . . . . 0.39 mm (0.015 in.)

2nd Piston Ring Specifications:

Piston Groove Width . . . . . 1.58 - 1.60 mm (0.062 - 0.063 in.)
Ring Width. . . . . 1.43 - 1.45 mm (0.056 - 0.057 in.)
Side Clearance . . . . . 0.01 - 0.17 mm (0.001 - 0.005 in.)
Ring End Gap . . . . . 0.18 - 0.33 mm (0.007 - 0.013 in.)
Ring End Gap Wear Limit . . . . . 0.42 mm (0.017 in.)

Oil Control Ring Specifications:

Piston Groove Width . . . . . 3.01 - 3.03 mm (0.118 - 0.119 in.)
Ring Width. . . . . 2.97 - 2.99 mm (0.117 - 0.118 in.)
Minimum Side Clearance . . . . . 0.02 - 0.06 mm (0.001 - 0.002 in.)
Ring End Gap . . . . . 0.20 - 0.35 mm (0.006 - 0.014 in.)
Ring End Gap Wear Limit . . . . . 0.54 mm (0.021 in.)

Piston:

Piston Pin OD	**21.99 - 22.00 mm (0.866 in.)**
Wear Limit	**21.97 mm (0.865 in.)**
Piston Pin Bore (In Piston) ID	**22.00 - 22.01 mm (0.866 - 0.867 in.)**
Wear Limit	**22.04 mm (0.868 in.)**
Connecting Rod Bushing ID	**22.03 - 22.04 mm (0.867 - 0.868 in.)**
Wear Limit	**22.07 mm (0.869 in.)**
Piston Pin-To-Rod Bushing Oil Clearance	**0.03 - 0.05 mm (0.001 - 0.002 in.)**
Wear Limit	**0.11 mm (0.004 in.)**
Piston Pin-To-Piston Oil Clearance	**0.00 - 0.01 mm (0 - 0.001 in.)**
Wear Limit	**0.07 mm (0.003 in.)**

Piston (Measured 24 mm (0.945 in.) up from bottom of piston skirt):

Standard Piston OD	**69.96 - 69.99 mm (2.754 - 2.756 in.)**
Wear Limit	**69.91 mm (2.752 in.)**

Cylinder Bore:

Standard ID	**70.01 - 70.03 mm (2.756 - 2.757 in.)**
Wear Limit	**70.20 mm (2.764 in.)**
Clearance (Piston-To-Cylinder)	**0.04 - 0.06 mm (0.001 - 0.002 in.)**
Cylinder Roundness	**0.00 - 0.01 mm (0.000 in.)**
Cylinder Roundness Wear Limit	**0.03 mm (0.001 in.)**
Cylinder Taper	**0.00 - 0.01 mm (0.000 - 0.001 in.)**
Cylinder Taper Wear Limit	**0.03 mm (0.001 in.)**
Deglazing	**30 - 40° crosshatch pattern**
Reboring	**30 - 40° crosshatch pattern**

Crankshaft:

Connecting Rod Crankpin Journal:

OD	**41.95 - 41.96 mm (1.652 in.)**
Wear Limit	**41.90 mm (1.650 in.)**

Connecting Rod Bearing:

Inside Diameter	**41.98 - 42.00 mm (1.653 - 1.654 in.)**
Thickness	**1.50 - 1.51 mm (0.059 in.)**
Oil Clearance	**0.02 - 0.05 mm (0.001 - 0.002 in.)**
Wear Limit	**0.11 mm (0.004 in.)**

Main Bearing Journal:

Outside Diameter	**46.95 - 46.96 mm (1.848 - 1.849 in.)**
Wear Limit	**46.90 mm (1.846 in.)**

Main Bearing:

Insert Thickness	**2.01 mm (0.079 in.)**
Oil Clearance	**0.02 - 0.05 mm (0.001 - 0.002 in.)**
Wear Limit	**0.12 mm (0.005 in.)**

Thrust Bearing:

Thrust Bearing Insert Thickness . . . . . 1.93 - 1.98 mm (0.076 - 0.078 in.)
Crankshaft Maximum Bend . . . . . 0.02 mm (0.001 in.)
Crankshaft End Play . . . . . 0.11 - 0.25 mm (0.004 - 0.010 in.)

Camshaft:

Camshaft End Play . . . . . 0.05 - 0.15 mm (0.002 - 0.006 in.)
Maximum Camshaft Bend . . . . . 0 - 0.02 mm (0 - 0.001 in.)
Limit . . . . . 0.05 mm (0.002 in.)

Front Journal

OD (Camshaft Gear Side) . . . . . 39.94 - 39.96 mm (1.572 - 1.573 in.)
Wear Limit . . . . . 39.91 mm (1.571 in.)
Oil Clearance . . . . . 0.04 - 0.14 mm (0.002 - 0.005 in.)

Intermediate Journals:

OD . . . . . 39.91 - 39.94 mm (1.571 - 1.572 in.)
Wear Limit . . . . . 39.88 mm (1.569 in.)
Oil Clearance . . . . . 0.07 - 0.12 mm (0.003 - 0.005 in.)

Rear Journal:

OD (Flywheel Side) . . . . . 39.94 - 39.96 mm (1.572 - 1.573 in.)
Wear Limit . . . . . 39.91 mm (1.571 in.)
Oil Clearance . . . . . 0.04 - 0.09 mm (0.002 - 0.003 in.)

Bushing:

ID . . . . . 40.0 - 40.08 mm (1.574 - 1.577 in.)
Wear Limit . . . . . 40.15 mm (1.581 in.)
Clearance . . . . . 0.04 - 0.14 mm (0.002 - 0.005 in.)

Cam Lobes:

Lobe Height (Intake and Exhaust Lobes) . . . . . 34.14 - 34.27 mm (1.343 - 1.349 in.)
Wear Limit . . . . . 33.89 mm (1.334 in.)

Tappets:

OD . . . . . 20.93 - 20.96 mm (0.824 - 0.825 in.)
Wear Limit . . . . . 20.90 mm (0.823 in.)
Cylinder Block Guide Hole ID . . . . . 21.00 - 21.02 mm (0.827 - 0.828 in.)
Wear Limit . . . . . 21.04 mm (0.828 in.)
Oil Clearance . . . . . 0.04 - 0.09 mm (0.002 - 0.004 in.)
Wear Limit . . . . . 0.13 mm (0.005 in.)

Timing Gear Backlash:

All Gears . . . . . 0.06 - 0.12 mm (0.002 - 0.005 in.)
Wear Limit . . . . . 0.14 mm (0.006 in.)

Idler Gear:

Shaft Outside Diameter	**45.95 - 45.98 mm (1.809 - 1.810 in.)**
Shaft Wear Limit	**45.90 mm (1.807 in.)**
Bushing Inside Diameter	**46.0 - 46.08 mm (1.811 - 1.813 in.)**
Oil Clearance	**0.03 - 0.08 mm (0.001 - 0.003 in.)**
Oil Clearance Wear Limit	**0.18 mm (0.007 in.)**

Oil Pump:

Outer Rotor-to-Gear Case Cover Clearance	**0.12 - 0.21 mm (0.005 - 0.008 in.)**
Wear Limit	**0.30 mm (0.012 in.)**
Inner Rotor-to-Outer Rotor Clearance Wear Limit	**0.16 mm (0.006 in.)**
Inner and Outer Rotor-to-Cover Plate Side Clearance	**0.02 - 0.07 mm (0.001 - 0.003 in.)**
Inner and Outer Rotor-to-Cover Plate Side Clearance Wear Limit	**0.12 mm (0.005 in.)**

Fuel Transfer Pump:

Fuel Pump Pressure	**29 kPa (4.3 psi)**
Fuel Pump Flow Volume	**118 cc/minute (4 ounces/minute)**

Cooling System:

Continuity (Closing) Temperature	**107 - 113 °C (225 - 235 °F)**

Tightening Torques

Cylinder Head Bolts (First Step Lubricating Oil Applied)	**26 - 30 N•m (19 - 22 lb-ft)**
Cylinder Head Bolts (Second Step)	**53.9 - 57.9 N•m (39.7 - 42.7 lb-ft)**
Connecting Rod Bolts (Lubricating Oil Applied)	**22.6 - 27.5 N•m (16.6 - 20.2 lb-ft)**
Flywheel Mounting Bolts (Lubricating Oil Applied)	**80.4 - 86.4 N•m (59.3 - 63.7 lb-ft)**
Main Bearing Bolts (Lubricating Oil Applied)	**75.5 - 81.5 N•m (55.6 - 60 lb-ft)**
Crankshaft Pulley Cap Screw (Lubricating Oil Applied)	**113 - 123 N•m (83 - 90 lb-ft)**
Fuel Injector Nozzle Nut	**49 - 53 N•m (36 - 39 lb-ft)**
Glow Plugs	**15 - 20 N•m (11 - 15 lb-ft)**
Governor Weight Support Nut	**69 - 74 N•m (51 - 55 lb-ft)**
Fuel Injector Line Nuts	**29.4 - 34.4 N•m (22 - 25 lb-ft)**
Valve Cover	**11 N•m (97 lb-in.)**
Rocker Arm Shaft Support Cap Screws	**22.5 - 28.4 N•m (17 - 21 lb-ft)**
Fan Mounting Cap Screw	**11 N•m (97 lb-in.)**
Timing Cover Mounting Cap Screw	**9 N•m (79 lb-in.)**
Injector Pump-to-Timing Cover Cap Screw	**22.5 - 28.4 N•m (17 - 21 lb-ft)**
Exhaust Manifold Mounting Cap Screw and Nut	**25 N•m (221 lb-in.)**
Rear Crankcase Oil Seal Case-to-Block Cap Screw	**11 N•m (97 lb-in.)**
Oil Pan and Spacer to Engine Block Cap Screw	**22.5 - 28.4 N•m (17 - 21 lb-ft)**
Oil Pan and Spacer to Timing Gear Housing Cap Screw	**18 - 23 N•m (13 -17 lb-ft)**
Fuel Injection Line Nuts	**29.4 - 34.4 N•m (22 - 25 lb-ft)**
Fuel Injection Nozzle Torque	**49 - 53 N•m (36- 39 lb-ft)**
Engine Back Plate Mounting Cap Screw	**91 N•m (67 lb-ft)**
Oil Strainer-to-Block	**11 N•m (97 lb-in.)**

Special or Essential Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Tachometer	JTO5719	Used to set slow idle engine rpm and check fast idle rpm
Diesel Fuel Injection Nozzle Tester Adapter Set Straight Adapter	D01109AA D01110AA 23622	Used for fuel injection nozzle test
Nozzle Cleaning Kit	JDF13	Used to clean fuel injection nozzles
Fuel Pump Pressure Test Kit	JDG356	Used for fuel transfer pump pressure test
Compression Gauge Assembly Adaptor	JTO1682 JDG472	Used for cylinder compression check
Belt Tension Gauge	JDG529, or JDST28	Either used to adjust the water pump/alternator drive belt tension
Adaptor	JDG472	Used for radiator bubble test
Cooling System Pressure Pump Radiator Pressure Test Kit Adapters	DO5104ST JDG692	Used for cooling system pressure test
Hose Assembly Pressure Gauge (100 psi) Connector	JTO3017 JTO5577 JTO3349	Used for engine oil pressure test
PLASTIGAGE®	N/A	Used for bearing clearance measurements
Dial Indicator	N/A	Used for valve lift check, end play tests, gear backlash

Other Materials

Other Material

Part No.	Part Name	Part Use
TY15130 LOCTITE® No. 395	John Deere Form-In-Place Gasket	Seals crankcase extension housing, rear oil seal case and flywheel housing to engine block. Seals oil pan to timing gear housing and engine block.

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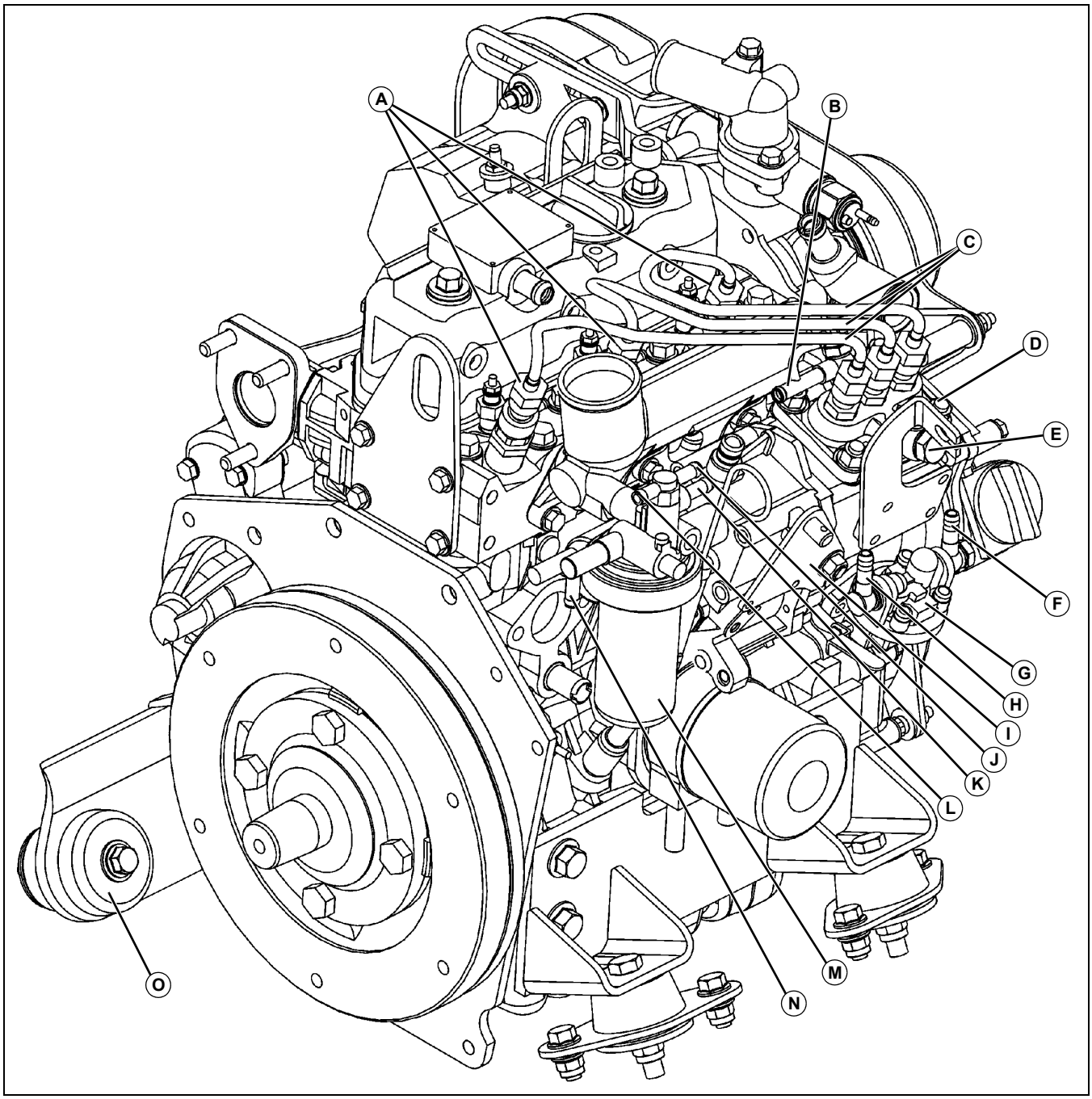
LOCTITE® is a registered trademark of the Loctite Corp.

Component Location

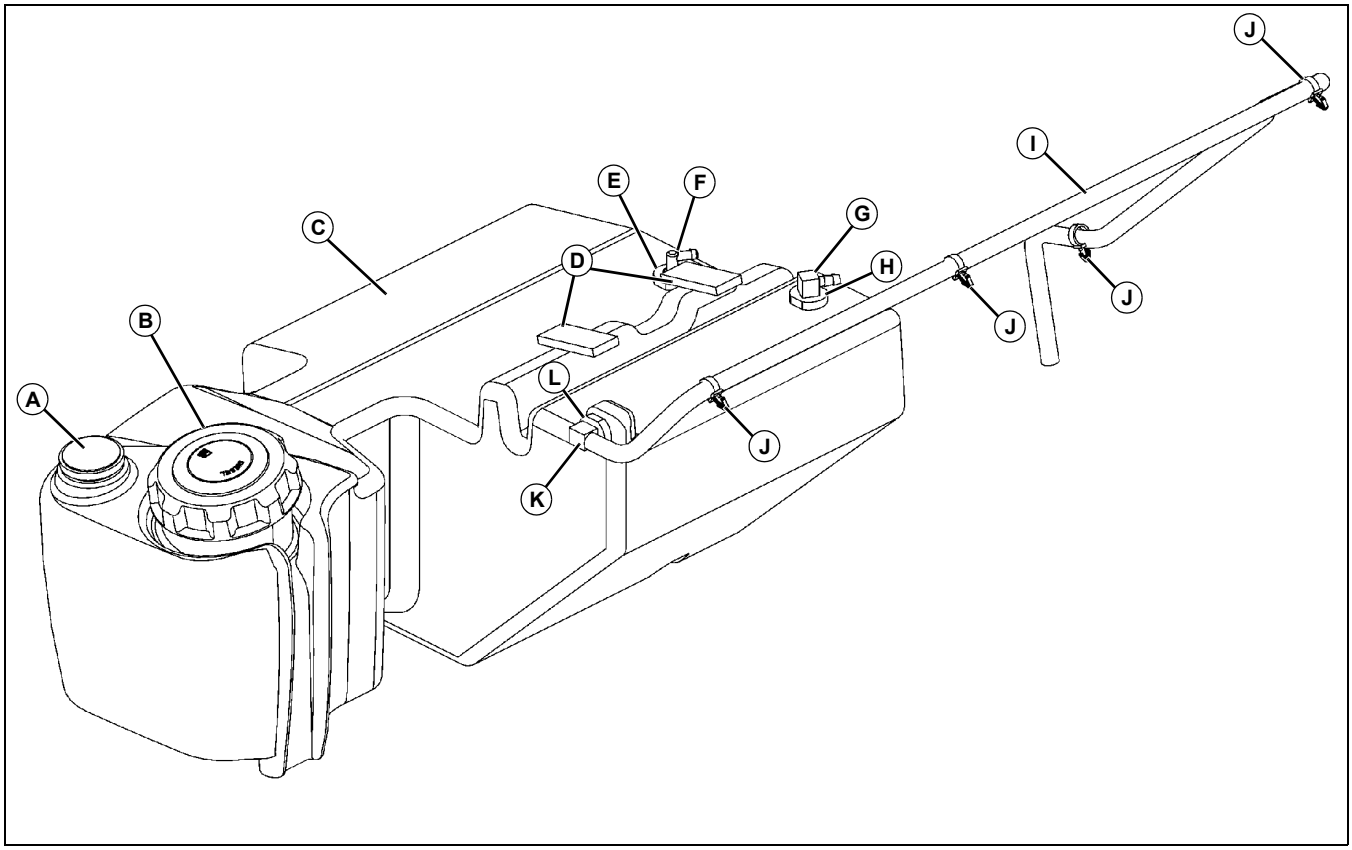
Engine Fuel System



MX32947

A - Fuel Injector Nozzles
B - Fuel Outlet - Injector Pump to Filter (Air Bleed)
C - High Pressure Fuel Injector Lines
D - Fuel Injector Pump
E - Fuel Inlet - Filter to Injector Pump
F - Fuel Outlet - Transfer Pump to Filter
G - Fuel Transfer Pump
H - Fuel Inlet Line to Transfer Pump
I - Throttle Pivot Plate
J - Fuel Outlet - Filter to Injector Pump
K - Fuel Inlet - Injector Pump to Filter (Air Bleed)
L - Fuel Outlet - Fuel Filter to Tank
M - Fuel Filter/Water Separator
N - Fuel Inlet - Transfer Pump to Filter
O - 5th Isolator

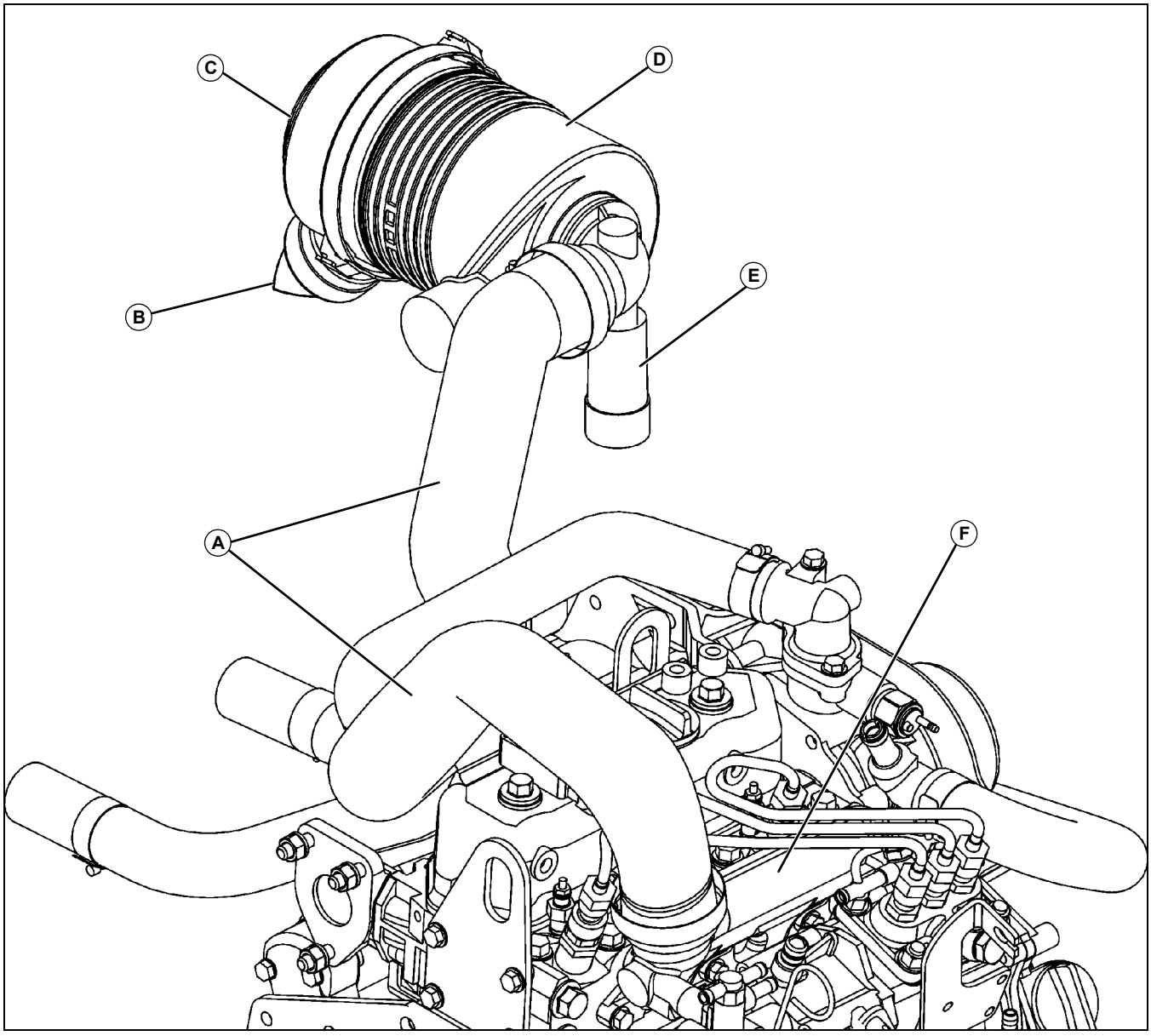
Fuel System Components



MX32948

A - Fuel Gauge
B - Filler Cap
C - Fuel Tank
D - Pad
E - Bushing
F - Pick Up Tube
G - Elbow Fitting
H - Bushing
I - Vent Hose
J - Retainer
K - Elbow Fitting
L - Bushing

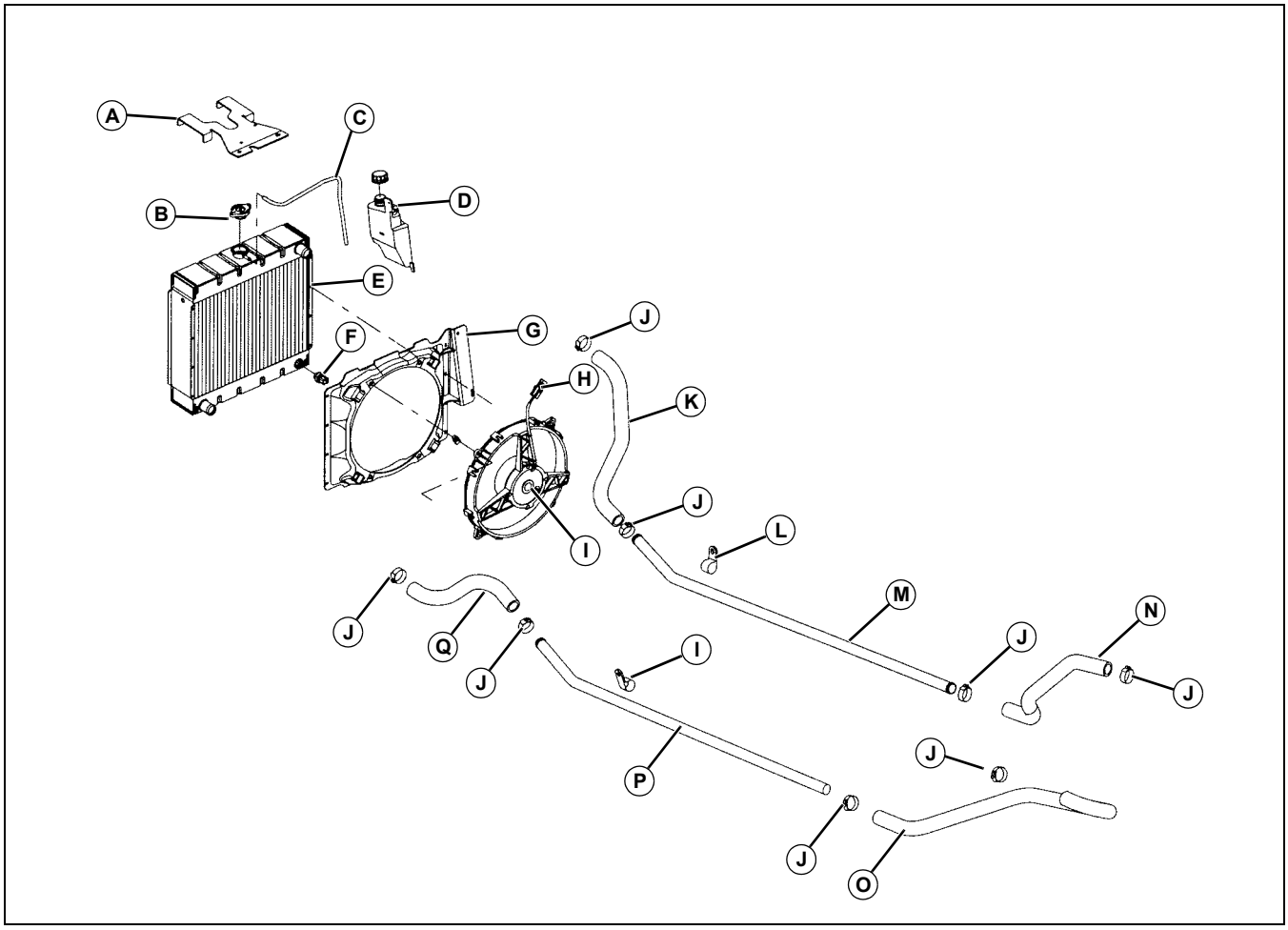
Air Filter and Intake Components



MX32949

A - Air Intake Tube
B - Rubber Dust Unloading Valve
C - Air Filter Cover
D - Air Filter Body
E - Air Restriction Indicator
F - Air Intake Manifold

Coolant System Components

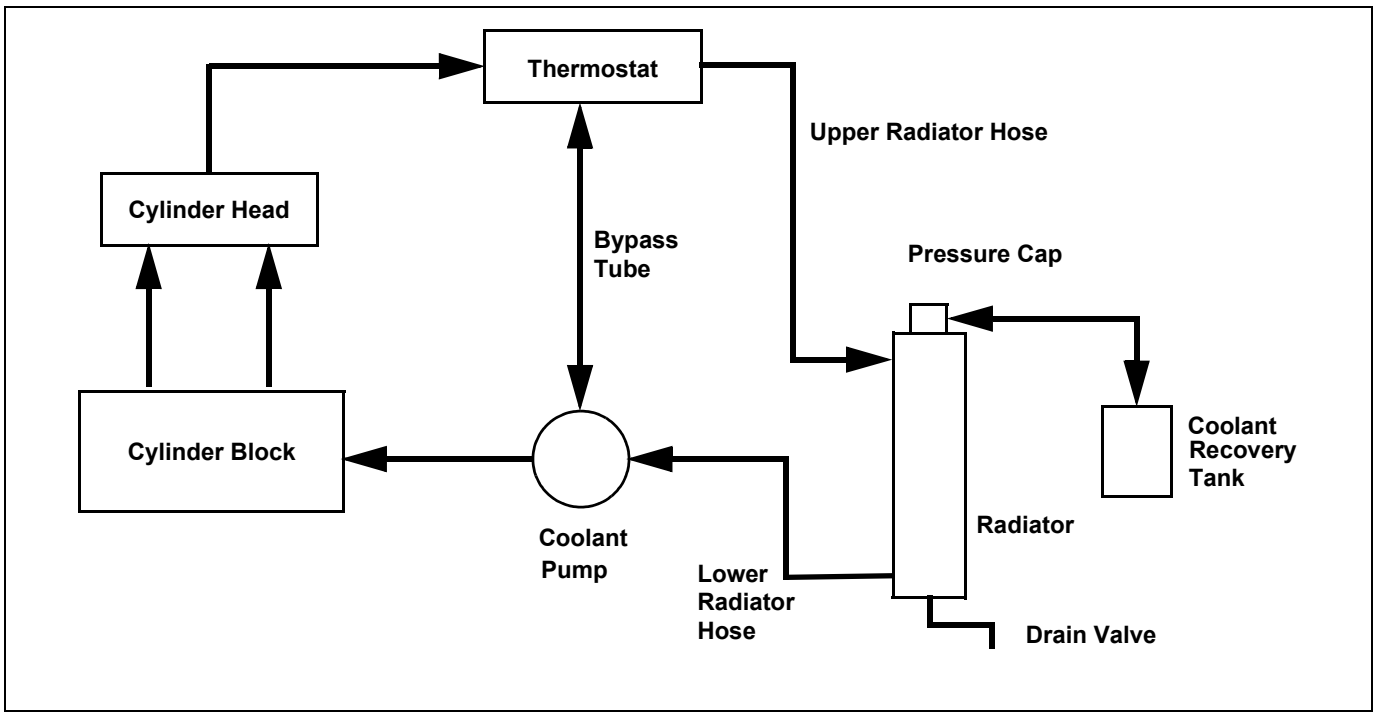


MX32913

A - Support Bracket
B - Radiator Cap
C - Vent Tube
D - Overflow Reservoir
E - Radiator
F - Temperature Sensor
G - Shroud
H - Cooling Fan Electrical Connector
I - Cooling Fan
J - Clamp
K - Upper Radiator Hose
L - Retainer
M - Coolant Supply Tube
N - Coolant Supply Hose
O - Coolant Return Hose
P - Coolant Return Tube
Q - Lower Radiator Hose

Theory of Operation

Cooling System Theory of Operation



MIF

Function:

The cooling system allows the engine to rise to full operating temperature when engine is started cold, but keeps the engine from overheating once engine reaches operating temperature. The thermostat opens when operating temperature has been reached, circulating coolant from the hot engine to the radiator to prevent engine overheating. The cooling system is pressurized, which raises the boiling point of the coolant, and allows more heat to be carried away from the engine.

Theory of Operation:

The cooling system includes the following components: radiator, radiator cap, upper and lower radiator hoses, coolant pump, fan, thermostat, coolant recovery tank, drain hoses and drain valve.

When the engine is started cold, the thermostat is closed. The impeller type coolant pump pulls coolant from the cylinder head and through the bypass tube inside the water pump housing. The water pump then pushes the coolant into the cylinder block water jacket. The coolant absorbs heat from the cylinder walls, and is then pushed up into the cylinder head, and sucked back into the water pump. This provides a fast warm-up period, as engine heat is retained and evenly distributed throughout the engine.

As the engine reaches operating temperature, **69.5 - 72.5°C (157 - 163°F)**, the thermostat opens, and the hot coolant from the cylinder head passes through the thermostat and into the top tank of the radiator. As coolant flows down through the tubes of the radiator core, heat is transferred from the coolant to the air stream being drawn through the core by the engine fan. When the coolant reaches the bottom radiator tank, it is sucked through the lower radiator hose and into the water pump, and pushed back into the cylinder block.

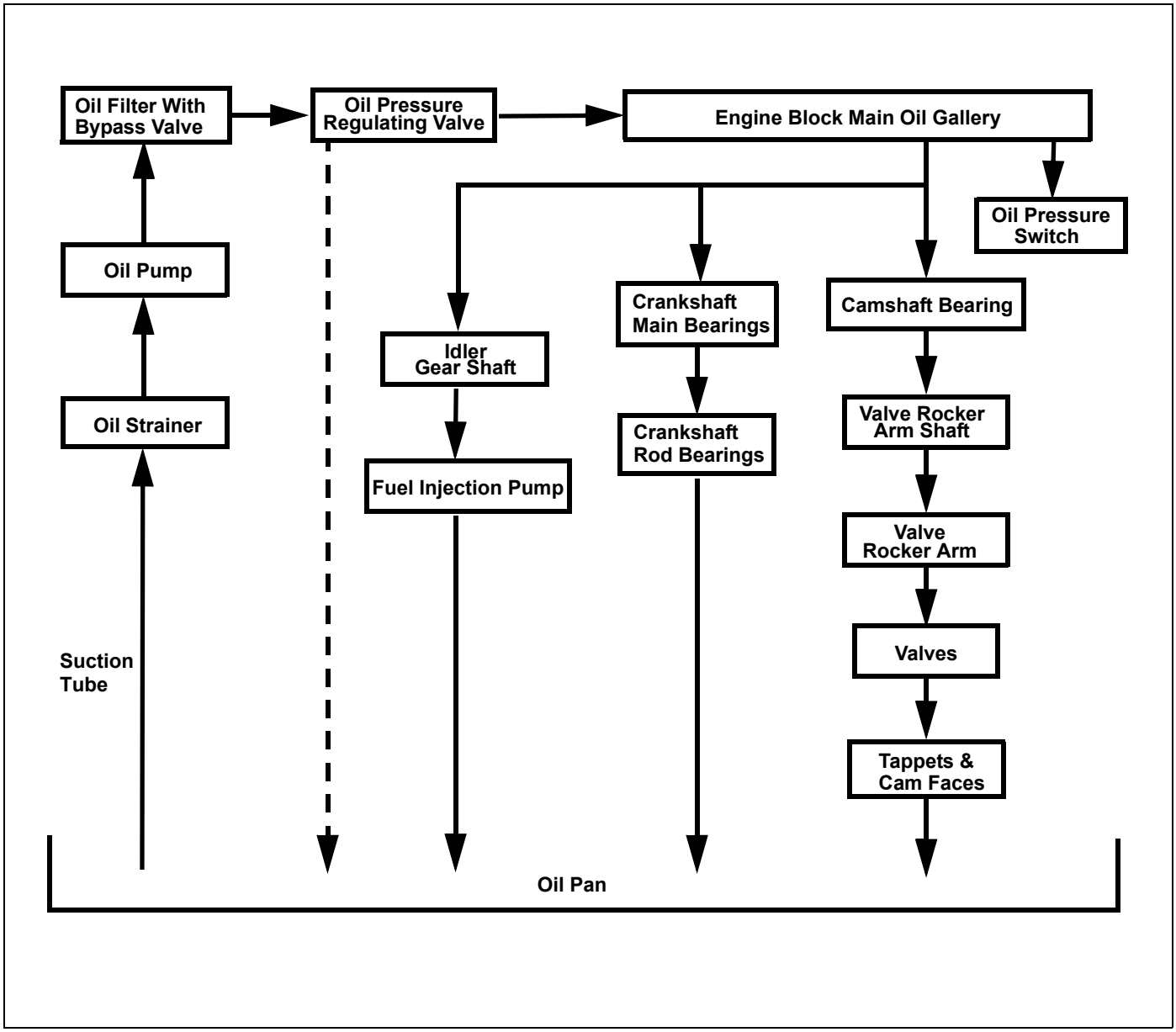
When coolant system pressure exceeds **88.3 ± 14.7 kPa (12.8 ± 2.2 psi)**, the spring in the radiator cap pushes open to allow coolant to discharge into the coolant recovery tank. As the engine cools after shutdown, a vacuum is produced in the cooling system, and coolant is drawn back out of the coolant recovery tank through a small valve in the bottom of the radiator cap.

Air is pulled by the engine fan through a removable debris guard on the front of the radiator, through the radiator and fan, and back over engine block. The engine fan belt drives both the water pump and the cooling fan.

An electrical coolant temperature switch is located in the thermostat housing. As the engine coolant temperature rises, a variable resistance sensor sends a signal to the control panel. The control panel temperature gauge operates from the sensor

The radiator can be drained with a drain valve on the lower right corner of the radiator. The engine block can be drained through the drain port on the left side of the engine near the front, next to the oil pressure switch. The coolant recovery tank can be removed and drained.

Lubrication System Theory of Operation



MIF

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 oil pressure warning switch.

The oil pump is mounted on the front plate of the engine, under the engine front cover, and is driven by the crankshaft. The oil pump draws oil from the oil pan through the strainer and suction tube. The oil is then pumped through an oil passage to the oil filter, oil pressure regulating valve, and through the engine block main oil gallery.

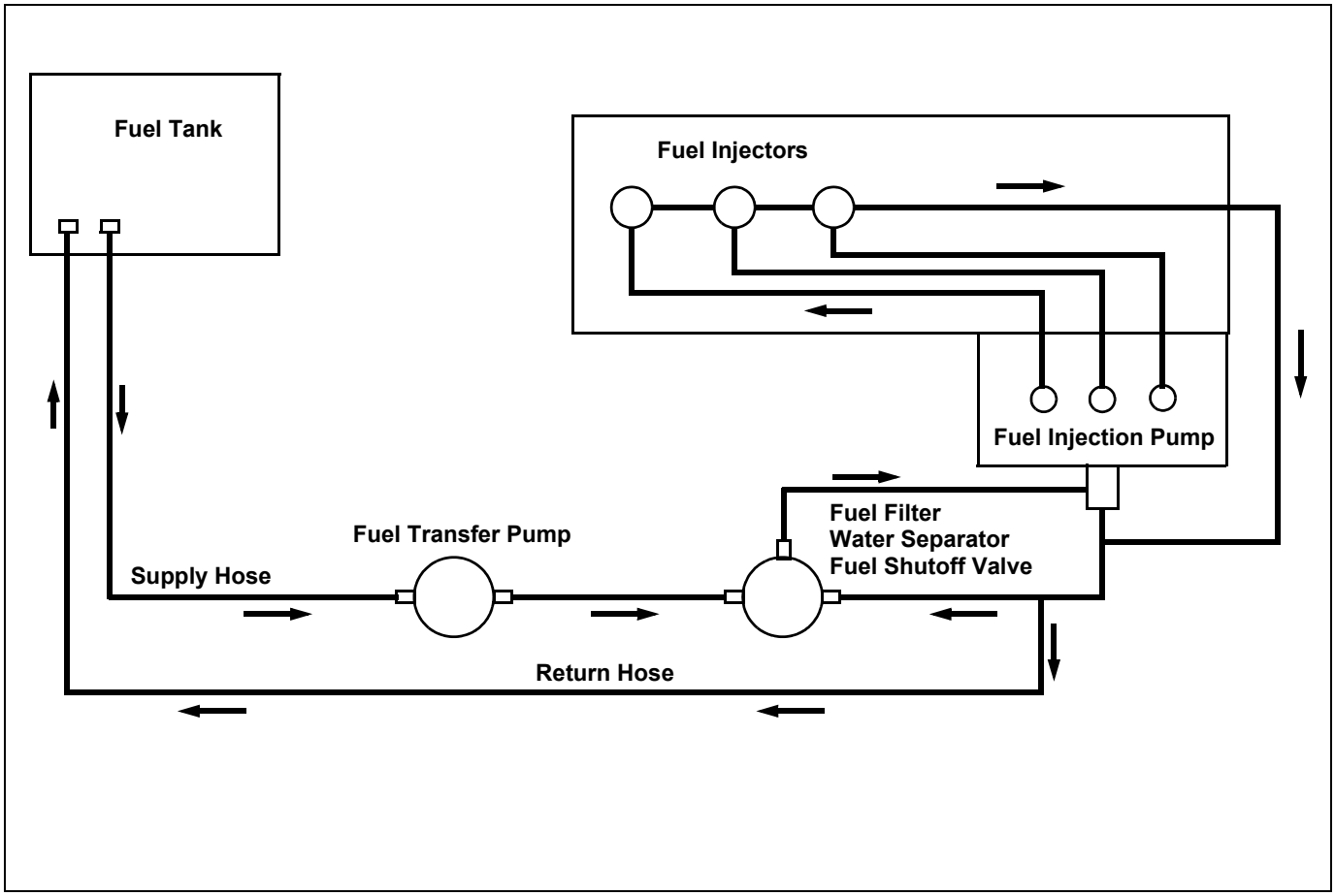
From the main oil gallery, oil is pushed to the crankshaft main bearing journals and idler gear shaft. Drilled cross-passages in the crankshaft distribute the oil from the main bearings to the connecting rod bearing journals.

Lube oil holes in the main bearing oil grooves send oil through drilled passages 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 rocker shaft distributes oil to the rocker arms, tappets and valves.

If oil pressure drops below specification, a pressure switch activates the engine oil pressure light to alert the operator to shut down the engine.

Fuel System Theory of Operation



MIF

Function:

The fuel system supplies clean fuel to injection pump and nozzles, and circulates unused fuel back to the tank. An instrument panel mounted electric fuel gauge shows the operator amount of fuel remaining.

Theory of Operation:

The engine driven mechanical fuel transfer pump draws fuel from the tank and pumps it to the combination glass bowl fuel filter/water separator/fuel shutoff valve. If the fuel valve is on, fuel flows to the fuel injection pump. After the injection pump housing is full, excess fuel is recirculated, along with excess leakoff fuel from the injectors, through the fuel filter. Excess fuel is returned to the fuel tank.

The engine speed is controlled by the hand throttle lever. The throttle linkage is connected to the injection pump/ governor control lever.

The fuel shutoff solenoid controls the flow of fuel inside the injection pump. When the solenoid is energized (ignition key to START position), the solenoid pulls in and allows fuel to be pumped to the injectors. When the key is turned off, return springs extend the solenoid to the shutoff position. The solenoid stops the flow of fuel inside the fuel injector pump by forcing the governor rack linkage to the NO FUEL position, causing the fuel injector pump to stop supplying fuel to the injectors.

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 pre-combustion swirl chamber. Injection lines have trapped fuel inside whenever injection is not taking place.

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

A float-type fuel level sensor mounted in the tank drives a instrument panel mounted gauge, informing the operator of the fuel level.

The fuel shutoff solenoid has two coils inside; one pull-in, and one hold-in coil. The hold-in coil is energized whenever the key switch is in the ON or START position. The pull-in coil is energized only when in the START position and start criteria are met.

Air System Theory of Operation

Function:

The air intake system filters air needed for combustion. The system components include: air inlet tube, air cleaner housing and cover, unloader valve (and rubber clean-out valve), primary air filter element, secondary (or safety) air cleaner element, air cleaner restriction indicator, and outlet tube.

Theory of Operation:

Air enters the air cleaner inlet tube and into the air cleaner housing, and is directed into the side of a shield. This starts a high-speed centrifugal motion of air which continues around the element until it reaches the far end of the air cleaner housing, to an unloader valve.

Most of the dust is separated from the air by centrifugal force that causes heavy dust particles to enter the opening at the top of the unloader valve. The air flows through the primary air filter element. The primary filter element filters the larger dirt particles before the air enters the secondary air filter element. The finer dirt particles are filtered out by the secondary air filter before the air enters the intake manifold.

The dirt that is deposited in the unloader valve is removed through the rubber diaphragm at the base of the air cleaner. When the engine is running, a pulsing action is created in the intake system by each intake stroke of the engine. This pulsing action causes the rubber diaphragm to open and close, thus emptying the unloader valve. The operator can squeeze the valve to let the large particles out.

The difference in pressure between the intake manifold and air cleaner is monitored by the Air Cleaner Restriction Indicator. As the air filters become clogged, and intake manifold vacuum increases, the restriction indicator piston is pulled down against spring tension, and is shows when it’s time to change air cleaner.

Diagnostics

Engine Troubleshooting

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

Engine

Symptom: Engine Will Not Start

(1) Starting procedure being used is correct for conditions.

Yes - Go to next step.

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

(2) Battery 12.7 VDC or higher?

Yes - Go to next step.

No - Charge and check battery. See "Battery Test" on page 335 in the Electrical section.

(3) Open circuits in wiring?

Yes - Repair or replace as needed. See "Common Circuit Tests" on page 334 in the Electrical section.

No - Go to next step.

(4) Starting motor functioning properly?

Yes - Go to next step.

No - Repair or replace starting motor.

(5) Alternator output correct?

Yes - Go to next step.

No - Repair or replace alternator.

(6) Engine oil of correct viscosity and type?

Yes - Go to next step.

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

(7) Water in fuel?

Yes - Drain and replace fuel.

No - Go to next step.

(8) Fuel filter clogged?

Yes - Replace fuel filter. See "Fuel Filter Removal and Installation" on page 163.

No - Go to next step.

(9) Air leak in fuel system?

Symptom: Engine Will Not Start

Yes - Repair fuel system.

No - Go to next step.

(10) Fuel lines plugged, pinched or cracked?

Yes - Repair or replace fuel lines as needed.

No - Go to next step.

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

Yes - Go to next step.

No - Replace fuel transfer pump. See "Fuel Transfer Pump - 3TNE68" on page 165.

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

Yes - Go to next step.

No - Adjust valve clearance.

(13) Timing between injection pump, intake and exhaust valves proper?

Yes - Go to next step.

No - Adjust valve clearance. Check valve timing.

(14) Intake and/or exhaust valve seized?

Yes - Replace valve and check valve guide.

No - Go to next step.

(15) Piston rings broken or seized?

Yes - Replace rings. Check piston and cylinder.

No - Go to next step.

(16) Piston rings, piston or cylinder worn?

Yes - Replace piston and/or rings, bore or hone cylinder.

No - Go to next step.

(17) Crankshaft pin or bearing seized?

Yes - Regrind crankshaft and replace bearings.

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

(1) Engine oil of proper viscosity and type.

Yes - Go to next step.

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

(2) Fuel filter clogged?

Yes - Replace fuel filter. See "Fuel Filter Removal and Installation" on page 163.

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

No - Go to next step

(3) Air leak in fuel system?

Yes - Repair fuel system.

No - Go to next step.

(4) Fuel lines plugged, pinched or cracked?

Yes - Repair or replace fuel lines as needed.

No - Go to next step.

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

Yes - Go to next step.

No - Replace fuel transfer pump. See “Fuel Transfer Pump - 3TNE68” on page 165.

(6) Valve clearance proper?

Yes - Go to next step.

No - Adjust valve clearance.

(7) Crankshaft pin or bearing seized?

Yes - Regrind crankshaft and replace bearings.

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

(1) Water in fuel?

Yes - Drain and replace fuel.Go to next step if problem continues.

No - Go to next step.

(2) Fuel filter clogged?

Yes - Replace fuel filter. See “Fuel Filter Removal and Installation” on page 163.

No - Go to next step.

(3) Intake and/or exhaust valve seized?

Yes - Replace valve and check valve guide.

No - Go to next step.

(4) Piston rings broken or seized?

Yes - Replace rings. Check piston and cylinder.

No - Go to next step.

(5) Piston rings, piston or cylinder worn?

Yes - Replace piston and/or rings, bore or hone cylinder.

Symptom: Low Engine Output - Exhaust color Normal

(1) Correct type of fuel being used?

Yes - Go to next step.

No - Drain and replace fuel.

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

Yes - Go to next step.

No - Replace engine oil and filter.

(3) Fuel filter clogged?

Yes - Replace fuel filter.

No - Go to next step.

(4) Fuel lines clogged, cracked or pinched?

Yes - Clean or replace fuel lines.

No - Go to next step.

(5) Air leakage into fuel system?

Yes - Repair fuel supply system.

No - Go to next step.

(6) Proper volume of fuel to injection pump?

Yes - Go to next step.

No - Check or replace fuel transfer pump.

(7) Intake and exhaust valve clearance correct?

Yes - Go to next step.

No - Adjust valve clearance.

(8) Intake or exhaust valves leaking compression?

Yes - Grind valves and seats.

No - Go to next step.

(9) Intake or exhaust valves seized?

Yes - Replace valve and check valve guide.

No - Go to next step.

(10) Cylinder head gasket leaking compression?

Yes - Replace head gasket, Resurface head and block if necessary.

No - Go to next step.

(11) Crankshaft pin or bearing worn?

Yes - Grind crankshaft and replace bearings.

Symptom: Low Engine Output - Exhaust color White

(1) Correct type of fuel?

Yes - Go to next step.

No - Drain and replace fuel.

(2) Water in fuel?

Yes - Drain and replace fuel.

No - Go to next step.

(3) Even volume of fuel being injected?

Yes - Go to next step.

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

(4) Proper spray pattern from injectors?

Yes - Go to next step.

No - Clean or replace fuel injector nozzles.

(5) Intake or exhaust valve stems worn?

Yes - Replace valve guides and valves.

No - Go to next step.

(6) Timing proper between injection pump, intake and exhaust valves?

Yes - Go to next step.

No - Adjust valve clearance.

(7) Piston rings installed correctly?

Yes - Go to next step.

No - Install piston rings correctly.

(8) Piston ring ends staggered?

Yes - Go to next step.

No - Stagger piston ring ends.

(9) Piston, rings, or cylinder worn?

Yes - Replace pistons and rings, bore or hone cylinders.

No - Go to next step.

(10) Piston rings broken or seized?

Yes - Replace rings. Replace pistons if damaged. Bore cylinder if damaged.

Symptom: Low Engine Output - Exhaust color Black

(1) Engine being run under high altitude or high temperature conditions.

Symptom: Low Engine Output - Exhaust color Black

(2) Correct type of fuel?

Yes - Go to next step.

No - Drain and replace fuel.

(3) Air filter elements clogged?

Yes - Clean or replace air filter elements.

No - Go to next step.

(4) Exhaust pipe clogged?

Yes - Clean exhaust pipe.

No - Go to next step.

(5) Engine overheating?

Yes - Check thermostat, replace if faulty. Check electric fan operation.

No - Go to next step.

(6) Cooling system filled to correct level?

Yes - Go to next step.

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

(7) Correct volume of fuel being injected?

Yes - Go to next step.

No - Replace faulty fuel injector pump or fuel injectors.

(8) Correct pattern from fuel injectors?

Yes - Go to next step.

No - Clean or replace fuel injector nozzles.

(9) Proper timing between injection pump, intake and exhaust valves?

Yes - Go to next step.

No - Adjust valve clearance.

(10) Intake or exhaust valves leaking compression?

Yes - Grind valves and seats.

No - Go to next step.

(11) Intake or exhaust valve seized?

Yes - Replace valve and check valve guide.

No - Go to next step.

Symptom: Exhaust color White under load

(1) Correct type of fuel?

Symptom: Exhaust color White under load

Yes - Go to next step.

No - Drain and replace fuel.

(2) Water in fuel?

Yes - Drain and replace fuel.

No - Go to next step.

(3) Engine reaching normal operating temperature?

Yes - Go to next step.

No - Check thermostat, replace if faulty.

(4) Correct volume of fuel being injected?

Yes - Go to next step.

No - Replace faulty fuel injector pump or fuel injectors.

(5) Correct pattern from fuel injectors?

Yes - Go to next step.

No - Clean or replace fuel injector nozzles.

(6) Proper timing between injection pump, intake and exhaust valves?

Yes - Go to next step.

No - Adjust valve clearance.

(7) Piston rings installed correctly?

Yes - Go to next step.

No - Install piston rings correctly.

(8) Piston, rings or cylinder worn?

Yes - Replace pistons and rings, bore or hone cylinders.

No - Go to next step.

(9) Piston rings broken or seized?

Yes - Replace rings. Check pistons and cylinders.

No - Go to next step.

Symptom: Exhaust color Black under load

(1) Correct type of fuel?

Yes - Go to next step.

No - Drain and replace fuel.

(2) Air filter elements clogged?

Yes - Clean or replace air filter elements.

No - Go to next step.

Symptom: Exhaust color Black under load

(3) Exhaust pipe clogged?

Yes - Clean exhaust pipe.

No - Go to next step.

(4) Correct volume of fuel being injected?

Yes - Go to next step.

No - Replace faulty fuel injector pump or fuel injectors.

(5) Proper spray pattern from injectors?

Yes - Go to next step.

No - Clean or replace fuel injector nozzles.

(6) Timing proper between injection pump, intake and exhaust valves?

Yes - Go to next step.

No - Adjust valve clearance.

(7) Intake or exhaust valves leaking compression?

Yes - Grind valves and seats.

No - Go to next step.

(8) Intake or exhaust valves seized?

Yes - Replace valve and check valve guide.

No - Go to next step.

Symptom: Exhaust temperature too high

(1) Cooling system filled to correct level?

Yes - Go to next step.

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

(2) Engine overheating?

Yes - Check thermostat, replace if faulty. Check electric fan operation.

No - Go to next step.

(3) Exhaust pipe clogged?

Yes - Clean exhaust pipe.

No - Go to next step.

(4) Even volume of fuel being injected?

Yes - Go to next step.

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

(5) Correct volume of fuel being injected?

Yes - Go to next step.

Symptom: Exhaust temperature too high

No - Replace faulty fuel injector pump or fuel injectors.

(6) Intake or exhaust valve clearance correct?

Yes - Go to next step.

No - Adjust valve clearance.

(7) Intake or exhaust valves leaking compression?

Yes - Grind valves and seats.

No - Go to next step.

(8) Piston rings broken or seized?

Yes - Replace rings. Replace pistons if damaged. Bole cylinder if damaged.

Symptom: Engine Runs Rough - Misfiring

(1) Intake or exhaust valve clearance correct?

Yes - Go to next step.

No - Adjust valve clearance.

(2) Timing between injection pump, intake and exhaust valves proper?

Yes - Go to next step.

No - Adjust valve clearance. Check valve timing.

(3) Backlash of timing gear excessive?

Yes - Repair gears as needed.

No - Go to next step.

(4) Combustion chambers clean of foreign matter?

Yes - Go to next step.

No - Clean combustion chambers.

(5) Intake or exhaust valves leaking compression?

Yes - Grind valves and seats.

No - Go to next step.

(6) Intake or exhaust valves seized?

Yes - Replace valves and check valve guide.

No - Go to next step.

(7) Piston rings broken or seized?

Yes - Replace rings, Check pistons and cylinders.

No - Go to next step.

(8) Crankshaft pin or bearing worn or seized?

Yes - Grind crankshaft and replace bearings.

No - Go to next step.

Symptom: Engine Runs Rough - Misfiring

(9) Connecting rod bolts tightened properly?

No - Replace damaged components. Torque to correct specification.

Symptom: Engine Runs Rough - Uneven combustion sound

(1) Correct type of fuel being used?

Yes - Go to next step.

No - Drain and replace fuel.

(2) Water in fuel?

Yes - Drain and replace fuel.

No - Go to next step.

(3) Even volume of fuel being injected?

Yes - Go to next step.

No - Repair or replace fuel injector pump and fuel injectors.

(4) Proper spray pattern from injectors?

Yes - Go to next step.

No - Clean or replace fuel injector nozzles.

(5) Air filter elements clogged?

Yes - Clean or replace air filter elements.

No - Go to next step.

(6) Exhaust pipe clogged?

Yes - Clean exhaust pipe.

Symptom: Engine Runs Rough - Engine surges During Idling

(1) Water in fuel?

Yes - Drain and replace fuel.

No - Go to next step.

(2) Even volume of fuel injected?

Yes - Go to next step.

No - Repair or replace fuel injector pump and fuel injectors.

(3) Proper spray pattern from injectors?

Yes - Go to next step.

No - Clean or replace fuel injector nozzles.

(4) Piston rings broken or seized?

Yes - Replace rings, Check pistons and cylinders.

Symptom: Engine Runs Rough - Engine surges During Idling

No - Go to next step.

(5) Crankshaft pin or bearing worn or seized?

Yes - Grind crankshaft and replace bearings.

Symptom: Engine Runs Rough - Engine surges Under Load

(1) Water in fuel?

Yes - Drain and replace fuel.

No - Go to next step.

(2) Even volume of fuel injected?

Yes - Go to next step.

No - Repair or replace fuel injector pump and fuel injectors.

(3) Proper spray pattern from injectors?

Yes - Go to next step.

No - Clean or replace fuel injector nozzles.

(4) Piston rings broken or seized?

Yes - Replace rings, Check pistons and cylinders.

No - Go to next step.

(5) Crankshaft pin or bearing worn or seized?

Yes - Grind crankshaft and replace bearings.

Symptom: Engine Runs Rough - Excessive Engine Vibration

(1) Even volume of fuel injected?

Yes - Go to next step.

No - Repair or replace fuel injector pump and fuel injectors.

(2) Proper spray pattern from injectors?

Yes - Go to next step.

No - Clean or replace fuel injector nozzles.

(3) Piston rings broken or seized?

Yes - Replace rings, Check pistons and cylinders.

No - Go to next step.

(4) Crankshaft pin or bearing worn or seized?

Yes - Grind crankshaft and replace bearings.

No - Go to next step.

(5) Connecting rod bolts tightened properly?

Symptom: Engine Runs Rough - Excessive Engine Vibration

No - Replace damaged components. Torque to correct specification.

Fuel Consumption

Symptom: Excessive Fuel Consumption

(1) Engine reaching normal operating temperature?

Yes - Go to next step.

No - Check thermostat, replace if faulty.

(2) Correct volume of fuel being injected?

Yes - Go to next step.

No - Replace faulty fuel injector pump or fuel injectors.

(3) Correct pattern from fuel injectors?

Yes - Go to next step.

No - Clean or replace fuel injector nozzles.

(4) Intake or exhaust valves leaking compression?

Yes - Grind valves and seats.

Lubrication

Symptom: Excessive oil consumption

(1) Engine oil of correct viscosity and type?

Yes - Go to next step.

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

(2) External or internal oil leak?

Yes - Repair as needed.

No - Go to next step.

(3) Intake or exhaust valve stems worn?

Yes - Replace valve guides and valves.

No - Go to next step.

(4) Piston rings installed correctly?

Yes - Go to next step.

No - Install piston rings correctly.

(5) Piston ring ends staggered?

Yes - Go to next step.

No - Stagger piston ring ends.

Symptom: Excessive oil consumption

(6) Piston, rings or cylinder worn?

Yes - Replace pistons and rings, bore or hone cylinders.

No - Go to next step.

(7) Piston rings broken or seized?

Yes - Replace rings. Check pistons and cylinders.

No - Go to next step.

(8) Foreign matter in combustion chamber?

Yes - Clean head and top of piston. Check for damage.

Symptom: Fuel oil in crankcase

(1) Correct volume of fuel being injected?

Yes - Go to next step.

No - Replace faulty fuel injector pump or fuel injectors.

(2) Intake or exhaust valve seized or broken?

Yes - Replace valve and check valve guide.

No - Go to next step.

(3) Piston rings broken or seized?

Yes - Replace rings and check pistons and cylinders.

No - Go to next step.

(4) Piston rings, piston or cylinder worn?

Yes - Replace piston and or rings. Bore or hone cylinder.

Symptom: Water in crankcase

(1) Cylinder head gasket leaking?

Yes - Replace head gasket, Resurface head and block if necessary.

No - Go to next step.

(2) Water jacket cracked?

Yes - Repair or replace water jacket.

Symptom: Low oil pressure

(1) Oil at correct level?

Yes - Go to next step.

No - Add oil.

(2) Engine oil of correct viscosity and type?

Symptom: Low oil pressure

Yes - Go to next step.

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

(3) External or internal oil leak?

Yes - Repair as needed.

No - Go to next step.

(4) Oil filter clogged.

Yes - Replace oil filter and oil.

No - Go to next step.

(5) Oil pressure relief valve worn or damaged?

Yes - Clean, adjust or replace relief valve.

No - Go to next step.

(6) Crankshaft pin or bearing worn?

Yes - Grind crankshaft and replace bearings.

No - Go to next step.

(7) Connecting rod bolts tightened properly?

Yes - Go to next step.

No - Replace damaged components. Torque to correct specification.

CAUTION: Avoid injury! Engine radiator fluid is extremely hot during operation.

Coolant

Symptom: Overheating

(1) Cooling system filled to correct level?

Yes - Go to next step.

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

(2) Engine still overheats?

Yes - Check thermostat, replace if faulty. Check electric fan operation.

No - Go to next step.

(3) Correct volume of fuel being injected?

Yes - Go to next step.

No - Replace faulty fuel injector pump or fuel injectors.

(4) Cylinder head gasket leaking?

Symptom: Overheating

Yes - Replace head gasket, Resurface head and block if necessary.

No - Go to next step.

(5) Piston rings broken or seized?

Yes - Replace rings. Check pistons and cylinders.

No - Go to next step.

(6) Water jacket cracked?

Yes - Repair or replace water jacket.

Symptom: Low water temperature

(1) Thermostat is operating correctly?

No - Replace thermostat.

Compression

Symptom: Low compression

(1) Engine oil of correct viscosity and type?

Yes - Go to next step.

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

(2) Oil filter clogged?

Yes - Replace oil filter.

No - Go to next step.

(3) Correct volume of fuel being injected?

Yes - Go to next step.

No - Replace faulty fuel injector pump or fuel injectors.

(4) Intake or exhaust valves leaking compression?

Yes - Grind valves and seats.

No - Go to next step.

(5) Intake or exhaust valve stems worn?

Yes - Replace valve guides and valves.

No - Go to next step.

(6) Foreign matter in combustion chamber?

Yes - Clean head and top of piston. Check for damage.

No - Go to next step.

(7) Intake or exhaust valve seized?

Yes - Replace valve and check valve guide.

Symptom: Low compression

No - Go to next step.

(8) Piston rings broken or seized?

Yes - Replace rings. Check pistons and cylinders.

No - Go to next step.

(9) Piston, rings or cylinder worn?

Yes - Replace pistons and rings, bore or hone cylinders.

No - Go to next step.

(10) Crankshaft pin or bearing worn?

Yes - Grind crankshaft and replace bearings.

No - Go to next step.

(11) Piston rings installed correctly?

Yes - Go to next step.

No - Install piston rings correctly.

(12) Piston ring ends staggered?

No - Stagger piston ring ends.

Diagnostics

Test Conditions:

- Machine parked on level surface.
- Park brake locked.
- Key switch off unless indicated otherwise.

Test/Check Point	Normal	If Not Normal
Engine dipstick and exterior engine surface - Engine Oil Check	Oil level between “L” and “H” marks. Oil not burnt, or contaminated with metal particles, fuel, or coolant. No external leakage, filter clean.	Change oil and inspect for source of contamination. Check gaskets, seals, plugs, cylinder head, block, and intake manifold and breather. Change oil filter.
Coolant tank and radiator - Cooling System Check	Coolant level between marks on tank when engine is warm. Coolant in radiator full to top.	Add proper coolant mix.
	Coolant not contaminated with oil, fuel or discolored brown.	Drain and flush system. Check for source of contamination.
	Radiator screen free of debris.	Clean or replace.
	Hoses not cracked or leaking, clamps and radiator cap tight.	Pressure test radiator and cap.
	Water pump/alternator belt tight, not glazed or cracked.	Replace and adjust belt tension.
	Electric fan operates as needed. Fan blades not damaged or warped.	Repair or replace fan controls and/or fan.
Fuel tank, pump, lines, filter, filter shutoff valve - Fuel System Check	Fuel level correct, not contaminated, correct grade of fuel, no water or debris in filter bowl/ water separator.	Drain and clean fuel tank. Add fresh fuel. Replace filters.
	Fuel tank and filter shutoff valves both in “on” position.	Move to “on” position.
	Fuel hoses not cracked or leaking.	Replace hoses.
	Fuel hose clamps tight.	Replace or tighten clamps.
	Fuel tank does not have vacuum.	Replace fuel tank cap.
Air filter and air intake - Air Intake System Check	Air filter hose not cracked, clamps tight.	Replace and tighten clamps.
	Element not plugged. Air filter housing sealed, no dirt tracking inside filter element.	Replace element or housing.
Fuel shutoff solenoid. (Key in run position.)	Fuel shutoff solenoid must pull in and stay in. Listen for clicking as key is cycled.	If solenoid will not pull in and hold in, See “Fuel Shutoff Solenoid Test (Diesel Engine)” on page 350 in Electrical section.

Test/Check Point	Normal	If Not Normal
Fuel filter/water separator.	Fuel level visible in filter bowl.	Pump lever on side of fuel transfer pump to prime pump and fuel bowl.
	Fuel bowl not full of water.	Drain water from bowl.
	Fuel present at injector pump inlet hose.	Replace fuel filter. Recheck. Test fuel pump.
Throttle pedal and cable.	Cable not binding and stop adjusted correctly.	Repair, replace or adjust throttle cable and check/adjust pedal stop.
Intake and exhaust valves	Valve clearance within specification (engine cold).	Adjust valves. See “Valve Clearance Adjustment” on page 102.
	Valves not sticking.	Check valve guides and stems.
Fuel is reaching injectors.	Crack fuel injection lines at injectors. Crank engine. (Be sure fuel shutoff solenoid has pulled in.). Fuel leaks out.	No fuel present: Check both fuel shutoff valves are open, fuel level, inspect filter/ separator element. Test fuel pump.
Injectors are working properly	Injector spray pattern is normal and cracking pressure is within specifications.	Check spray pattern and cracking pressure. See “Fuel Injection Nozzle Test” on page 108. Replace injectors.
Engine compression tested at fuel injector ports.	Cylinder compression within specification. Pressure difference between cylinders within specification.	Perform cylinder compression test. See “Cylinder Compression Test” on page 103.
Flywheel and starting motor	Minimum cranking rpm within specification.	See “Starting Motor Amperage Draw Test” in Electrical section.
Injection pump timing inspection (Key in run position, Engine off)	Timing should be correct. (Remove pump as the last possible solution.)	Have injection pump static timing adjustment performed by a qualified Service Repair Shop. See Tests and Adjustments in this section.
Injection pump slow idle speed (Engine running)	Engine runs at 1050 ± 25 rpm.	See “Slow Idle Adjustment” on page 100.
Injection pump fast idle speed (Engine running)	Engine runs at 3650 ± 25 rpm.	See “Fast Idle Speed Adjustment” on page 100.
Governor	Engine runs smooth throughout rpm range with low smoke and good power.	Have governor torque capsule adjusted by a certified CARB/EPA service center.
Oil pressure sender port	Oil pressure in specification.	Test engine oil pressure. See “Engine Oil Pressure Test” on page 107.
Thermostat	Opening temperature within specification.	Perform thermostat opening test. See “Thermostat Test” on page 105.
Muffler	Not restricted.	Replace muffler.

Tests and Adjustments

Air Restriction Indicator Test

Reason:

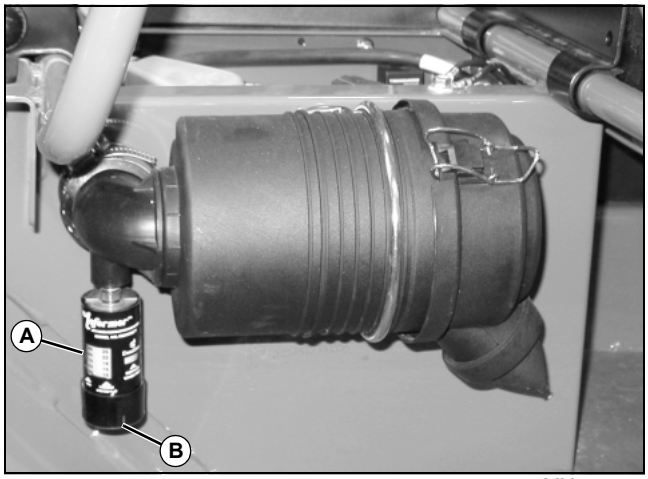
To check operation of air restriction indicator and check air intake system for leaks, restrictions, or obstructions.

Procedure (Normal Operation):

1. Park machine safely. See Parking Safely in the Safety Section.

2. Raise passenger seat.

NOTE: Indicator will not function correctly if plastic indicator housing is damaged.



MX36648

3. Locate and check air restriction indicator.

   - If window (A) is clear, no air cleaner service is required.
   - If window (A) shows fully red, air cleaner requires immediate service.

NOTE: The air restriction indicator operation can be checked by unscrewing indicator from air filter outlet tube and sucking on the indicator's vacuum port with your mouth. The indicator window (A) should show easy movement of indicator moving into the red zone and hold there until the release button (B), on top of indicator, is depressed.

4. Service air cleaner elements if needed.

5. Push yellow reset button on top of air restriction indicator.

Results:

If red indicator is still visible after resetting button:

- Replace primary (large) filter element.
- Reset air restriction indicator button, and retest.

If red indicator is still visible after retest:

- Replace secondary (small) filter element.
- Reset air restriction indicator button, and retest.

If red indicator is still visible after retest:

- Check air filter housing, outlet and inlet tubes, unloader valve diaphragm.
- Run with both filter elements removed and recheck.

Procedure (Simulated Excess Restriction):

1. Make sure park brake is ON. Start and run engine at SLOW idle.

MX36649

2. Cover the air cleaner intake tube (A) with a piece of cardboard.

3. Watch air restriction indicator. The indicator should move into the red area.

4. Remove cardboard and stop engine.

5. Push indicator reset button, indicator should clear.

Results:

If restriction indicator DID NOT move, or moved very little, check for:

- Loose or damaged hose clamps.
- Air leaks in air filter to intake manifold hose.
- Air leaks in intake manifold.
- Air leaks at indicator mounting threads.
- Cracked indicator housing or diaphragm.
- Clogged screen inside indicator mounting nipple.

Slow Idle Adjustment

Reason:

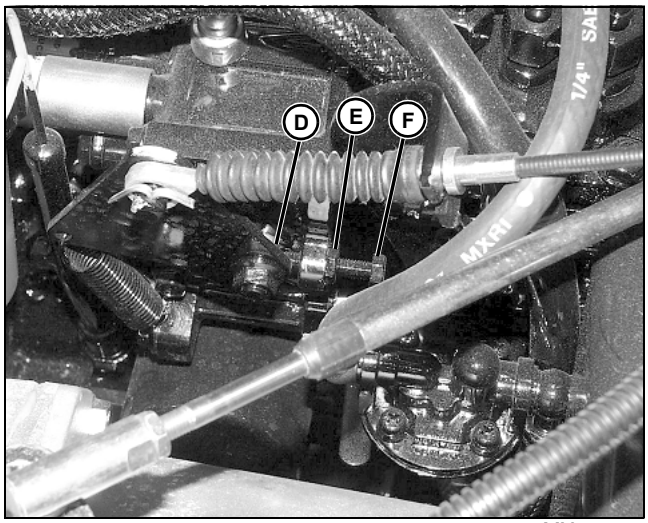
To achieve proper slow idle rpm setting. Provides adequate rpm to keep engine running smoothly without stalling.

Equipment:

- JT05719 Digital Tachometer
- (2) 10 mm Box End Wrenches

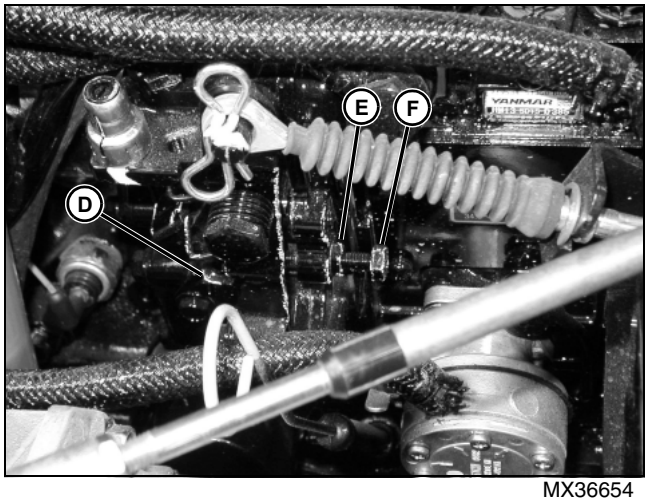
Procedure:

1. Place a small piece of reflective tape on flywheel.
2. Start engine and run for five minutes until thermostat opens.



MX32865

Picture Note: 3TNE68



MX36654

Picture Note: 3TNV70

3. Check that tab (D) on governor throttle lever is against slow idle stop screw. If not, adjust throttle cable (see Throttle Cable Adjustment in this section).
4. Use JT05719 Hand Held Digital Tachometer to check engine speed at flywheel.

Specifications:

Slow Idle Speed . . . . . 1050 ± 25 rpm

- If slow idle rpm is not according to specifications, loosen lock nut (E) and adjust slow idle stop screw (F). After adjustment, tighten lock nut, and recheck engine slow idle speed.

Fast Idle Speed Adjustment

IMPORTANT: Avoid damage! The fast idle adjustment is pre-set by the engine manufacturer to comply with strict California Air Resources Board/ Environmental Protection Agency (CARB/EPA) emissions requirements and is not adjustable. Tampering with the fast idle adjustment may result in severe fines or penalties.

IMPORTANT: Avoid damage! Do not attempt to adjust the fast idle setting. It is not adjustable.

If it is determined that either the fuel injection pump or governor assembly are in need of repair, they must be replaced only as complete assemblies. Only an authorized factory trained technician is allowed to remove and install these assemblies. If replacement is necessary, remove and install the fuel injection pump and/or governor assembly as complete, individual assemblies.

Because the fast idle speed is not adjustable, the throttle cable adjustment becomes very critical to proper engine operation. Therefore, first make sure that the throttle cable obtains its full range of motion, stop-to-stop, before performing any diagnostic procedures.

Reason:

To verify proper fast idle speed setting. This checks that the engine is running at proper rpm's for peak performance.

Equipment:

- JT05719 Digital Tachometer

Procedure:

1. Place a small piece of reflective tape on the flywheel.

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

2. Start engine and run for 5 minutes to obtain normal operating temperature.
3. Move throttle lever to fast idle position.

4. Use JT05719 Digital Tachometer to check engine speed at flywheel.

Specifications:

Fast Idle Speed . . . . . .3650 ± 25 rpm

Results:

- If engine still does not meet fast idle speed specifications, have governor inspected by an EPA authorized diesel service (ADS) center.

Throttle Cable Adjustment

Reason:

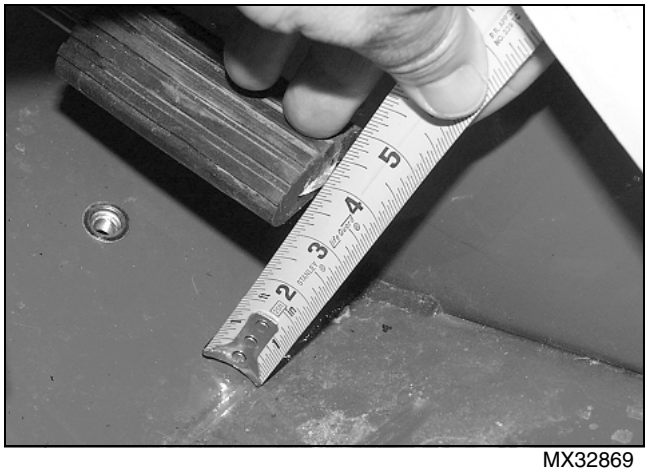
To ensure that throttle cable is allowing throttle lever on governor to reach full high idle and slow idle positions.

Equipment:

- 1/2 in. Wrenches

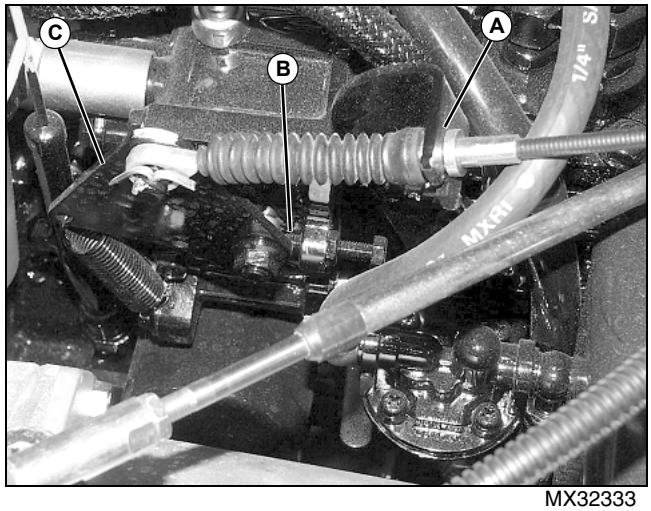
Procedure:

1. Park machine safely with park brake locked. See Park Machine Safely in Safety section.



MX32869

2. Accelerator pedal should have 2-6 mm (0.080 - 0.240 in.) free travel before cable moves.



MX32333

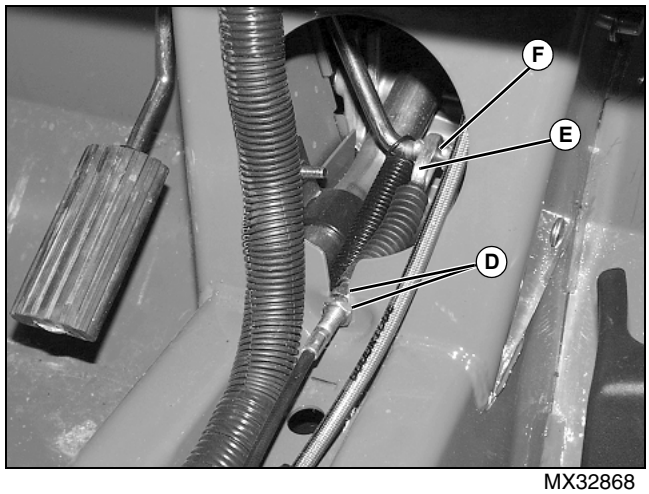
3. Inspect cable and bracket on engine (A).

4. When accelerator pedal is up, make sure the tab on the throttle lever is contacting the idle stop screw (B).

5. Press accelerator pedal all the way down to high speed position. Check that throttle cable is pulling throttle lever (C) on the injector pump all the way to the its travel stop inside the governor.

To Adjust Cable:

1. Remove tunnel cover from machine.



MX32868

1. Pull cable eyelet (E) to get slack out of cable and measure free play between eyelet and pedal rod (F). Gap should be 1-3 mm (0.039 - 0.118 in.).

2. If free play is not 1-3 mm (0.039 - 0.118 in.) loosen nuts (D) and adjust until proper freeplay is obtained.

3. Install tunnel cover.

Valve Clearance Adjustment

Reason:

To maintain proper clearance between valves and rocker arms for maximum compression and valve train life.

Equipment:

- Feeler Gauge
- Open End Wrench
- Flat Blade Screwdriver

Procedure:

1. Park machine safely. See Parking Safely in the Safety Section.

2. Engine must be cool (room temperature) before valve clearance is checked.

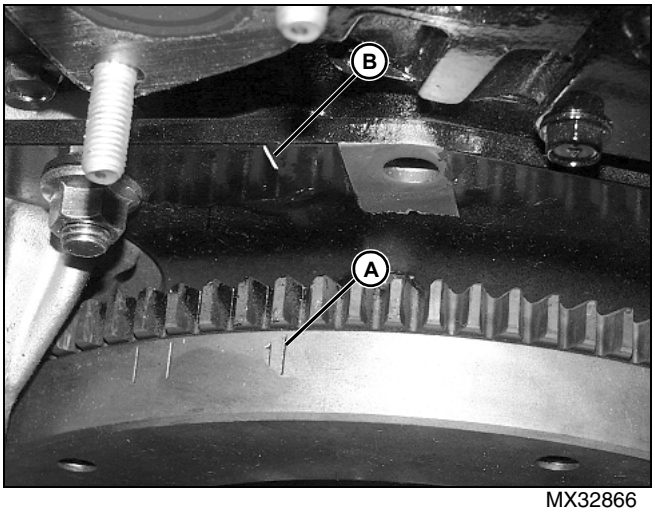
3. Raise and lock cargo box.

4. Be sure key switch is off with key removed before attempting to turn engine by hand.

5. Remove air cleaner assembly, air cleaner bracket, and rocker arm cover.

6. Remove valve cover. See “Rocker Arm Cover Removal and Installation - 3TNE68” on page 119.

NOTE: “Top Dead Center (TDC)” is when the piston is at it’s highest point of travel in the cylinder on either the compression or exhaust stroke.
No. 1 cylinder is the closest to the flywheel.



MX32866

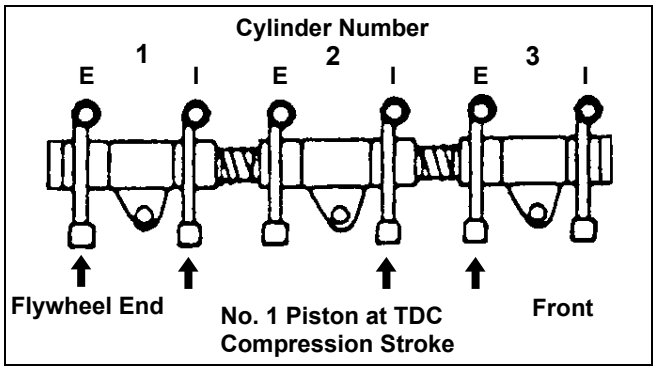
Picture Note: Muffler removed for clarity of photo. Muffler does not have to be removed to align marks.

7. Rotate flywheel counterclockwise until No. 1 cylinder TDC mark on flywheel (A) is aligned with mark on engine backplate (B).

NOTE: There are three marks on flywheel for each cylinder. The mark with the cylinder number stamped next to it is the TDC mark for that cylinder.

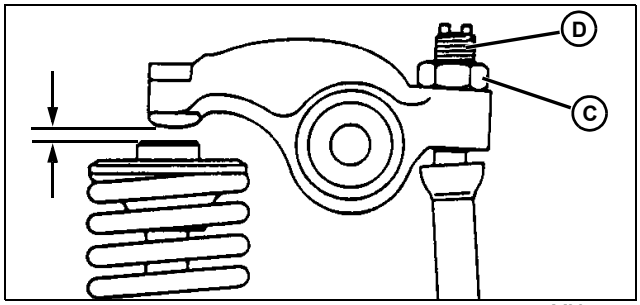
8. Try to move intake and exhaust rocker arms and/or push rods for No. 1 cylinder:

- If rocker arm and push rod are loose, the piston is at TDC on the compression stroke and you may proceed to step 5.
- If rocker arms and/or push rods are not loose, rotate flywheel one revolution (360°), and recheck rocker arm and push rods.



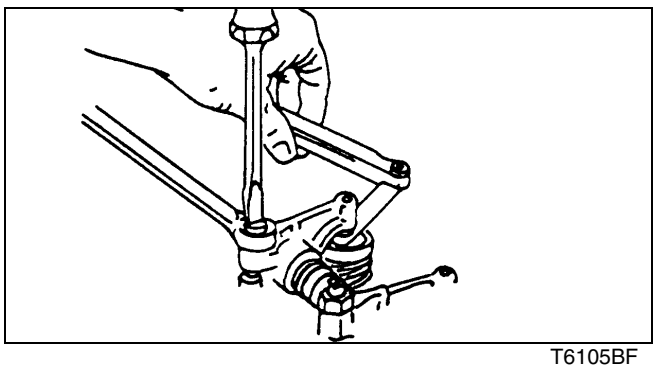
M82327A

9. Measure and adjust valve clearance only on the four valves indicated above with black arrows while No. 1 piston is at TDC on compression stroke.



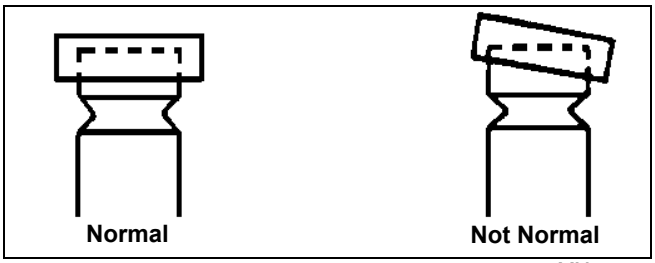
MX0553

10. To adjust valves, loosen lock nut (C) and turn adjusting screw (D) until 0.20 mm (0.008 in.) feeler gauge can be inserted between rocker arm and valve cap. Hold adjusting screw while tightening lock nut.



T6105BF

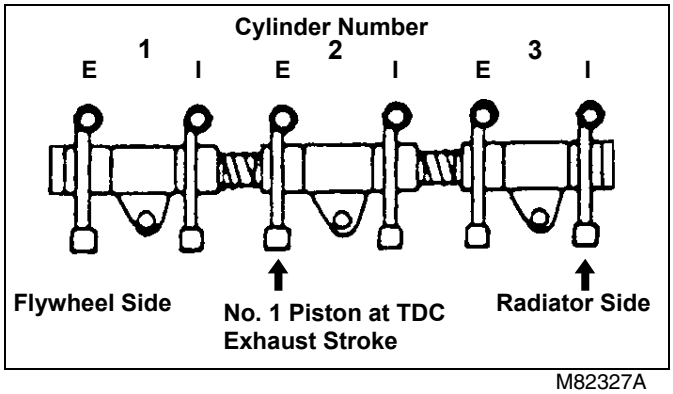
11.Recheck valve clearance after tightening lock nut.



MX0554

12.Check that valve cap on end of valve stem remained seated on valve and inside valve spring retainer.

13.Turn crankshaft pulley one revolution (360°). This puts the piston in No. 1 cylinder at TDC on the exhaust stroke.



M82327A

14.Measure and adjust valve clearance on the last two valves (black arrows) with No. 1 piston at TDC of exhaust stroke.

Specification:

Valve Clearance . . . . . 0.15 - 0.25 mm (0.006 - 0.010 in.)
Rocker Cover Bolt Torque . . . . . 11 N•m (97 lb-in.)

Valve Lift Check

Reason:

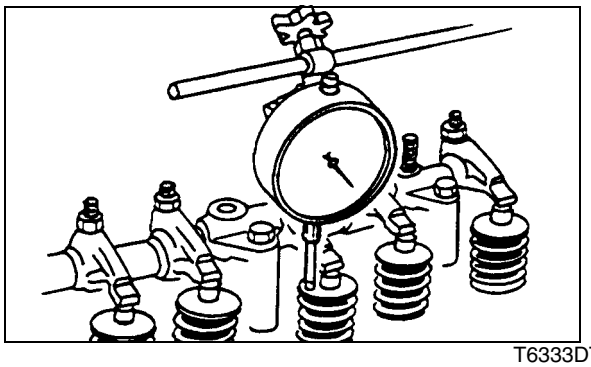
To test for excessive wear on camshaft lobes, cam followers, bent push rods, worn rocker arms, or worn valve stems.

Equipment:

- Dial Indicator

Procedure:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Allow engine to cool.
3. Raise hood.
4. Remove rocker arm cover.
5. Adjust valve clearance. See “Valve Clearance Adjustment” on page 102.


T6333DT

6. Fasten dial indicator to engine and position indicator tip on valve retainer. Valve must be fully closed and rocker arm must move freely.
7. Zero the dial indicator.
8. Rotate crankshaft towards front of machine while observing dial indicator as valve is moved to the full open (down) position. Compare measurement to specification.
9. Repeat for each valve.

Specification:

Valve Lift . . . . . 7.5 mm (0.300 in.)

Results:

- If valve lift is less than specification, remove and inspect camshaft, camshaft followers, push rods, and/or rocker arms for wear or damage.

Cylinder Compression Test

Reason:

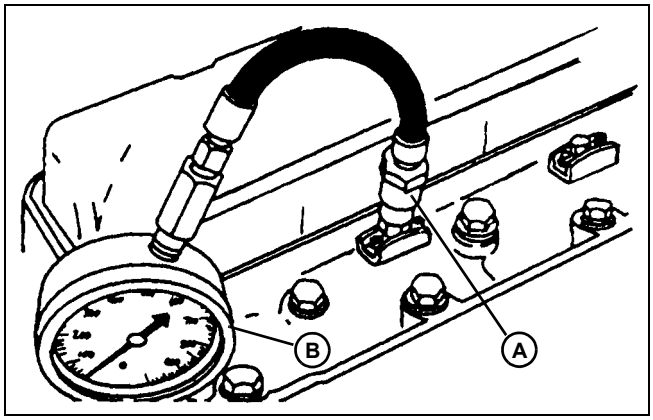
To determine the condition of the pistons, rings, cylinder walls and valves.

Equipment:

- JT01682 Compression Gauge Assembly
- JDG472 Adapter

Procedure:

1. Run engine for 5 minutes to bring to operating temperature. Shut off engine.
2. Remove injection nozzles.



T6333EU

3. Install heat protector from end of injector and install on JDG472 adapter (A).

4. Install JT01682 Compression Gauge Assembly (B) and JDG472 Adapter in injection port.

5. Disconnect fuel shutoff solenoid electrical connector on top of engine.

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

6. Crank engine for three seconds with starting motor.

7. Record pressure reading for each cylinder.

Compression Pressure Specifications - 3TNE68:

Standard Compression Pressure . . . . . 3236 ± 100 kPa (469 ± 15 psi)
Minimum Compression Pressure . . . 2448 kPa (355 psi)
Maximum difference between cylinders . . . . . 490 kPa (71 psi)
Minimum cranking speed . . . . . .250 rpm

Compression Pressure Specifications - 3TNV70:

Standard Compression Pressure . . . . . 3432 kPa (498 psi)
Minimum Compression Pressure . . . 2746 kPa (398 psi)
Maximum Difference Between Cylinders . . . . . 245 kPa (36 psi)
Minimum Cranking Speed . . . . . .250 rpm

NOTE: Pressure listed is for 300m (1000 ft) above sea level. For naturally aspirated engines, reduce specification an additional 4% for each 300m (1000 ft) of altitude.

Results:

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

Water Pump/Alternator Drive Belt Adjustment

Reason:

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

Equipment:

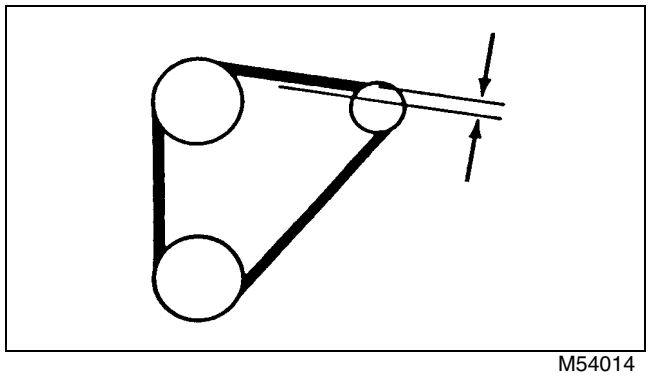
- JDG529 or JDST28 Belt Tension Gauge
- Straight Edge

Procedure:

1. Park machine safely. See Parking Safely in the Safety Section.

2. Allow engine to cool.

3. Raise and lock cargo box.


M54014

4. Remove water pump/alternator belt cover.

5. Check belt tension between water pump and alternator using Belt Tension Gauge and a straight edge.

Specifications:

Applied Force . . . . . 98 N (22 lb-force)
Deflection . . . . . 10 - 15 mm (0.4 - 0.6 in.)

Results:

If deflection is not within specifications:

- Loosen top and bottom alternator mounting cap screws/nuts.
- Apply force to side of alternator housing until tension is correct.
- Tighten alternator mounting hardware.
- Install water pump/alternator belt cover.

Thermostat Test

Reason:

To determine opening temperature of thermostat.

Equipment:

- Thermometer
- Glass Container
- Heating Unit

Procedure:

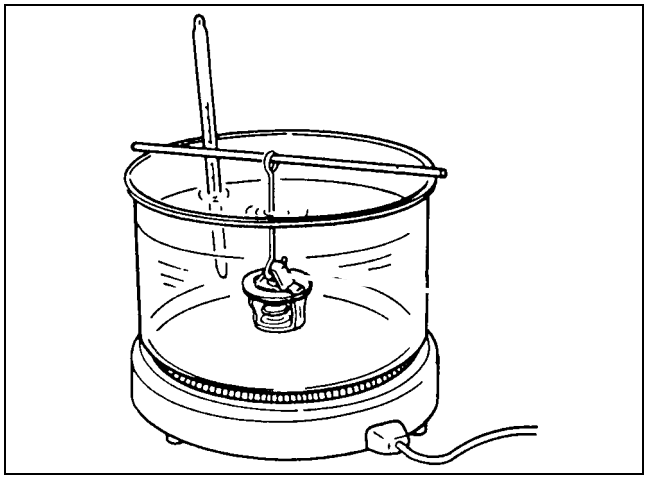
1. Park machine safely. See Parking Safely in the Safety Section.

2. Allow engine to cool.

3. Raise and lock cargo box.

4. Remove thermostat. See “Thermostat Removal and Installation” on page 162.

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

5. Suspend thermostat and a thermometer in a container of water.

6. Heat and stir the water. Observe opening action of thermometer and compare temperatures with specifications.

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

Specifications:

Begin Opening . . . . . 71° C (160° F)
Fully Open . . . . . 85° C (184° F)
Minimum Lift Height . . . . . 8 mm (0.310 in.)

Results:

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

Radiator Bubble Test

Reason:

To determine if compression pressure is leaking from combustion chamber or cylinder into cooling system.

Equipment:

- JDG472 Adapter

Procedure:

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

2. Remove cap from recovery tank.

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

If bubbles are present, isolate source of compression leak:

- Remove injection nozzles.
- Install JDG472 Adapter in injection port of cylinder to be tested.
- Move piston to bottom of stroke with intake and exhaust valves closed.
- Connect hose from compressed air source to adapter. Do not exceed rated pressure of hoses and tools being used. Do not exceed 355 psi pressure.
- Check for bubbles in coolant recovery tank, or air escaping from muffler, air cleaner or oil fill opening.
- Repeat for each cylinder.

Results:

If bubbles are present:

- 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 fill:

- Check for worn piston rings.

Cooling System Pressure Test

Reason:

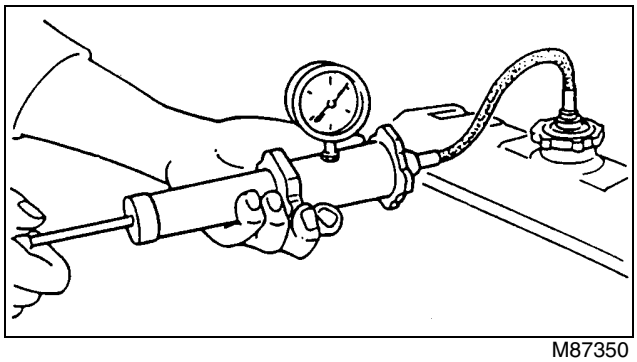
To inspect cooling system for leaks.

Equipment:

- D05104ST Cooling System Pressure Pump
- JDG692 Radiator Pressure Test Kit (Adapters)

Procedure:

CAUTION: Avoid Injury! Coolant may be above boiling temperature and under pressure in cooling system. Do not remove pressure cap when system is hot. Escaping steam will burn unprotected skin. Always wear protective clothing and goggles when servicing cooling system.



M87350

1. Check cooling system is cool and squeeze top radiator hose to check system pressure has dropped.
2. Remove cap. Top off coolant if low. Attach cooling system pressure pump to hose.
3. Pressurize system with tester to 100 kPa (15 psi).
4. Check for leaks throughout cooling system.

Specifications:

Maximum Pressure. . . . . 117 kPa (17 psi)
Minimum Pressure after 15 Seconds. . . . . 90 kPa (13 psi)

Results:

- Pressure should hold to specifications. If pressure decreases, check for leaks. Repair leaks or replace parts as necessary.
- If leakage continues after all external leaks have been stopped, a defective head gasket, cracked block, or cylinder head may be the cause.

Radiator Cap Pressure Test

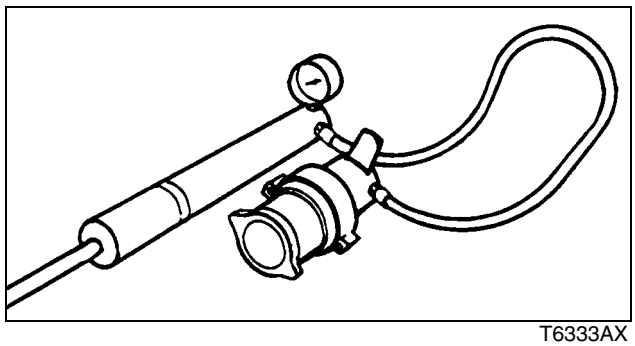
Reason:

To test radiator cap spring and seal for correct opening pressure range.

Equipment:

- D05104ST Cooling System Pressure Pump
- JDG692 Radiator Pressure Test Kit (Adapters)

Procedure:



T6333AX

1. Install radiator cap on appropriate adapter.
2. Attach adapter to D05104ST pressure pump.
3. Apply pressure. Pressure valve in cap should open according to specifications.

Specifications:

Valve Opening Pressure . . . . . 83 - 96 kPa (12 - 14 psi)

Results:

- If cap leaks, relieve pressure and re-tighten cap. Test again. Replace cap if pressure is not within specification.

Engine Oil Pressure Test

Reason:

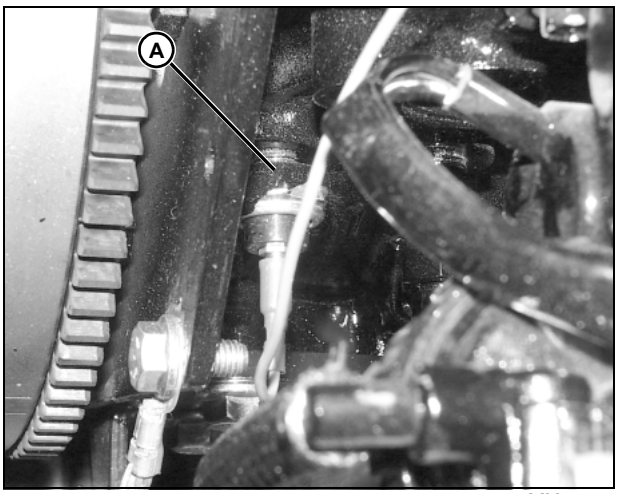
To determine if engine bearings or lubrication system components are worn.

Equipment:

- JT03017 Hose Assembly
- JT05577 Pressure Gauge (100 psi)
- JT03349 Connector

Procedure:

1. Park machine in safely with park brake locked. See Park Machine Safely in Safety section.
2. Allow engine to cool.
3. Raise and lock cargo box.



MX32336

4. Remove wire to oil pressure switch.
5. Unscrew oil pressure switch (A) from block.
6. Install JT03349 Connector into block.
7. Connect Hose Assembly and Pressure Gauge.

IMPORTANT: Avoid damage! Stop running engine if no oil pressure is present.

8. Start engine. If pressure reading is below 69 kPa (10 psi), stop engine.
9. Run engine approximately five minutes to heat oil, then check oil pressure at fast idle.
10. When test is complete:
    a. STOP engine and allow engine to cool.
    b. Remove Hose Assembly and Pressure Gauge.
    c. Remove JT03349 Connector from block.
    d. Install oil pressure switch and switch wiring lead. Use John Deere Pipe Sealant with TEFLON (medium strength), or equivalent, on switch threads.

Specifications:

Fast Idle Speed . . . . . 3650 ± 25 rpm
Engine Oil Pressure . . . . . 245 - 343 kPa (35 - 49 psi)

Results:

- If oil pressure is not within specifications, inspect oil pressure regulating valve parts for wear or damage. Add or remove shims as necessary. See Lubrication System in this section.
- If oil pressure does not increase, see “Engine Has Low Oil Pressure” in Diagnosis group.

Injection Pump Timing (EPA Engines)

EPA engines have EPA compliance sticker on rocker arm cover.

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

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

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

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

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

Specification - 3TNE68:

Injection Timing . . . . . 17° ± 1.5°

Specification - 3TNV70:

Injection Timing . . . . . 18° ± 1°

Fuel Injection Nozzle Test

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

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable source. Such information is available from the Deere & Company Medical Department in Moline, Illinois, U.S.A.

Reason:

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

Equipment:

- D01109AA Diesel Fuel Injection Nozzle Tester
- D01110AA Adapter Set
- 23622 Straight Adapter
- Container

Connections:

M35913

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

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

Procedure 1:

Test fuel injection nozzle opening pressure following the Nozzle Tester manufacturer's instructions.

Specifications - 3TNE68:

Fuel Injection Nozzle Opening Pressure
. . . . . 11722 + 480 - 0 kPa (1700 + 70 - 0 psi)

Specification - 3TNV70:

Fuel Injection Nozzle Opening Pressure
. . . . . 11800 - 12800 kPa (1712 - 1856 psi)

Results:

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

Procedure 2:

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

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

2. Pressurize nozzle to 11032 kPa (1600 psi).

3. Watch for leakage from nozzle spray orifice. Leakage time should be a minimum of 10 seconds.

Results:

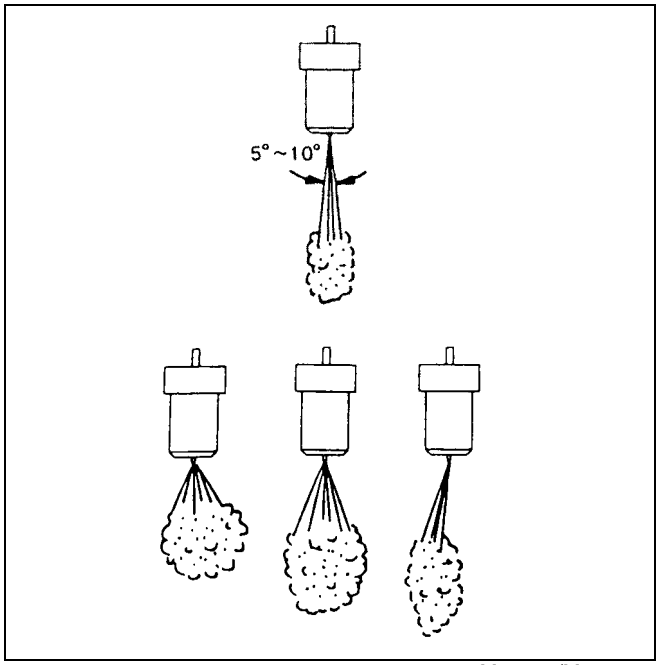
- If leakage time does not meet specification, disassemble injection nozzle and inspect nozzle assembly for contamination. Inspect valve seating surface. Replace nozzle assembly if necessary.

Procedure 3:

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

1. 3TNE68 - Pressurize nozzle to 11722 ± 480 kPa (1700 ± 70 psi).

2. 3TNV70 - Pressurize nozzle to 11800 - 12800 kPa (1712 - 1856 psi).



M76981/M76985

Picture Note: Top = Correct spray pattern; Bottom = Poor spray pattern

3. Listen for “chatter” sound and watch spray pattern.

Specifications:

Slow Hand Lever Movement
. . . . . Chatter Sound with Fine Stream Spray Pattern
Fast Hand Lever Movement
. . . . . Fine Atomized Spray Pattern

Results:

- If nozzle chatter or spray pattern does not meet specifications, disassemble injection nozzle and inspect nozzle assembly for contamination. See “Fuel Injection Nozzle” on page 166 for inspection procedure.
- Inspect valve seating surface. Replace nozzle assembly if necessary.
- If there is excessive difference in spray angle or injection angle, incomplete atomization or sluggish starting/stopping of injection, disassemble injection nozzle and inspect nozzle assembly for contamination. See Fuel Injection Nozzle Repair section. Replace nozzle assembly if necessary.

Fuel Injection System Tests

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

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable source. Such information is available from the Deere & Company Medical Department in Moline, Illinois, U.S.A.

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.

Equipment:

- (2) 17 mm Open End Wrenches

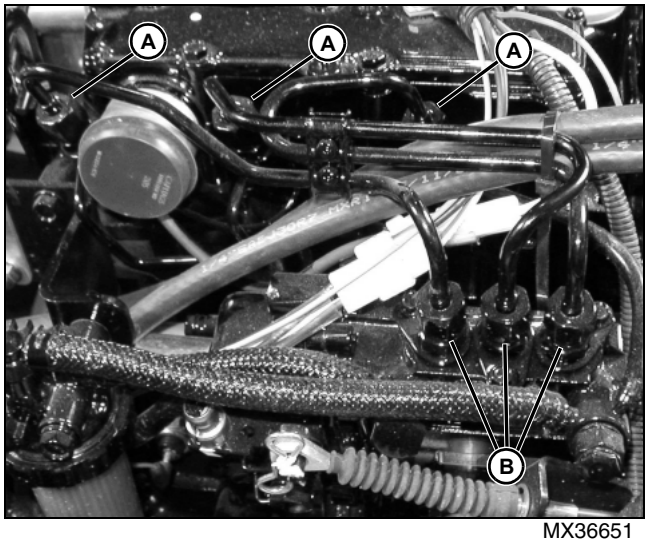
Procedure:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Open hood and disconnect and remove air cleaner.

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.

3. Start engine and run at slow idle.

IMPORTANT: Avoid damage! Air intake hose removed for photo. Do not operate engine without proper air filtration in place.



MX36651

Picture Note: Air intake hose removed for photo clarity. Do not operate engine without proper air filtration in place.

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

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

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

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

8. 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 rough, 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 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 and for that cylinder. See "Fuel Injection Nozzle Test" on page 108.
- Cylinder compression or cylinder leakage test.
- Fuel supply pump pressure.
- Fuel shutoff solenoid is 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.

Injection Pump Static Timing Check

Reason:

To make sure that the injection pump timing is set to manufacturers specification.

Equipment:

- Timing Tool (Made from high pressure pipe, nut and a clear plastic straw**)

** straw from WD40, carburetor cleaner, brake parts cleaner, etc.

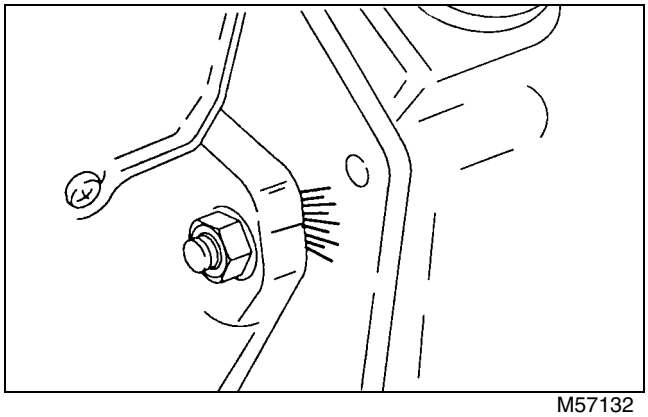
- External fuel supply

Procedure:

IMPORTANT: Avoid damage! The injection pump timing should be correct. The timing is set at the factory, and will not normally change during the life of the engine. Check and adjust the timing only as the last option, or if there is reason to believe the timing has been altered.
Check the fuel, fuel supply system, injectors, air intake system and cylinder compression before continuing.

1. Park machine safely with park brake locked.
2. Remove hood.
3. Remove air cleaner assembly.
4. If injector pump was removed, align the arrow or line on the injection pump flange on the mark noted during pump removal.

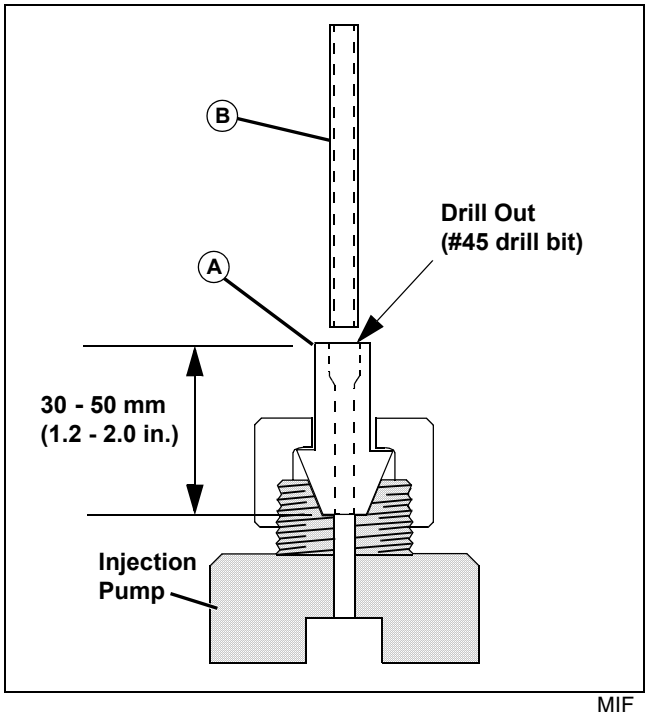
NOTE: Normal rotation, as viewed from the flywheel end, is counterclockwise. The number one fuel injection line is closest to flywheel.



M57132

5. Clean areas around injectors and top of injector pump and remove the fuel injector lines.

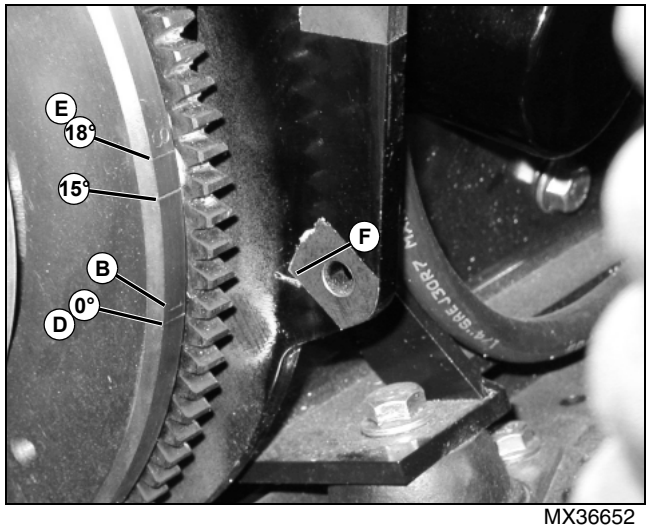
6. Cover openings on injectors and the number two and three delivery valves on injector pump to keep dirt from entering system.



MIF

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

8. Pump primer lever on the fuel transfer pump to make sure injector pump is full of fuel.



MX36652

Picture Note: 3TNV70 shown, 3TNE68 similar.

9. Identify which set of timing marks are for number one cylinder (C) and mark flywheel accordingly. See “Valve Clearance Adjustment” on page 102.

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

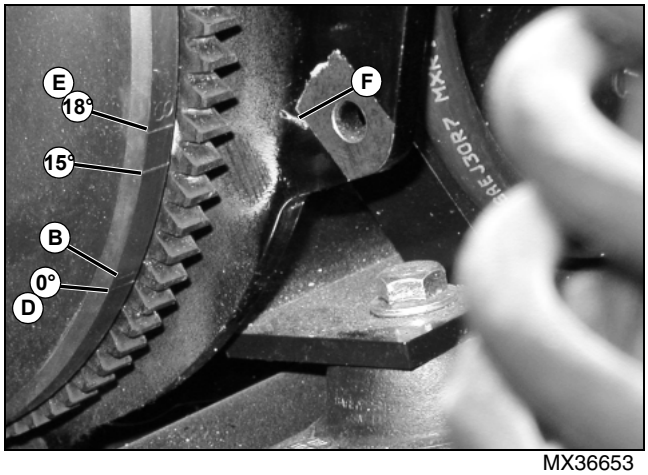
11. Turn the flywheel counterclockwise (as viewed from the flywheel end) until the timing tool straw shows fuel movement.

12. Turn the crankshaft pulley clockwise (back) until the No. 1 cylinder top dead center (TDC) mark (D) and pump timing marks (E) have gone past the mark on the flywheel guard (F) by at least 50 mm (2 in.).

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

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

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



MX36653

Picture Note: 3TNV70 shown, 3TNE68 similar.

15.Check the injection pump timing marks on the flywheel. The 17° (3TNE68) or 18° (3TNV70) mark on the flywheel must line up with the center of the timing mark (F) on flywheel plate.

Results:

- If the timing is not within specifications, loosen the three pump mounting nuts and turn the pump toward the engine block to retard the timing or away from the block to advance the timing. Recheck the timing.
If the timing did not change, remove pump and have tested by an authorized diesel injection service shop.
- If the timing is correct, remove timing tool, install injector lines, install air cleaner assembly and hood.

Specification - 3TNE68:

Injection Timing . . . . . .17° ± 1.5°

Specification - 3TNV70:

Injection Timing . . . . . 18° ± 1°

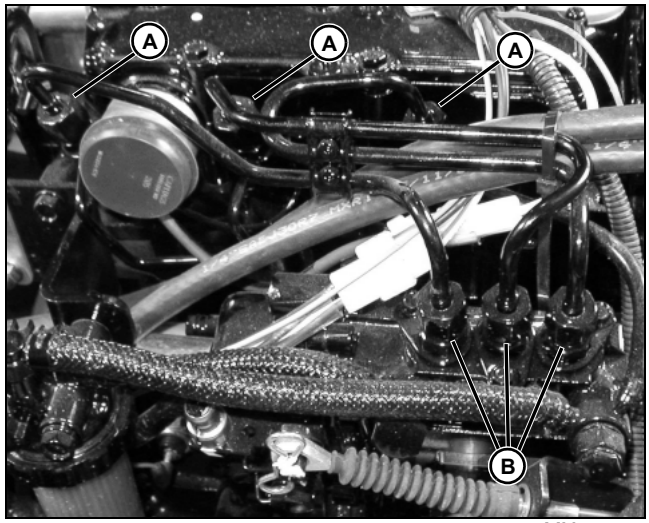
Fuel System Air Bleeding

Reason:

The machine incorporates a self bleeding fuel system which forces air out of the fuel filter, injection pump, and injection nozzles, and vents it back to the fuel tank. Fuel system bleeding is usually not necessary after a repair. If the system is completely drained and will not self-prime without overheating the starter, proceed as follows:

Procedure:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Raise hood.
3. Be sure fuel tank is not empty, and fuel valve on fuel filter is in OPEN (“O”) position.
4. Remove air intake hose from intake manifold and plug intake port to prevent debris from entering manifold.



MX36651

5. Using a 17 mm open end wrench, loosen high pressure line nuts (A) on top of fuel injector nozzles 1/4 turn.
6. Crank engine until fuel is seen seeping from all three injector fittings.
7. Tighten fittings and install air intake hose.

Fuel Transfer Pump Flow Test

Reason:

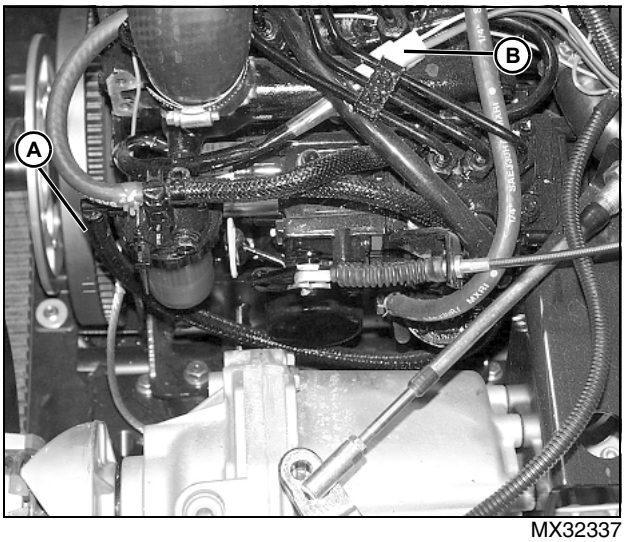
To determine fuel transfer pump output volume.

Equipment:

- Graduated container

Procedure:

1. Park machine safely with park brake locked. See Park Machine Safely in Safety section.
2. Allow engine to cool.
3. Raise and lock cargo box.



MX32337

Picture Note: 3TNE68 shown, 3TNV70 similar.

4. Disconnect fuel supply hose (A) from fuel filter.
5. Disconnect fuel shutoff solenoid connector (B).

CAUTION: Avoid Injury! Keep away from flywheel and clutch parts while cranking engine!

NOTE: Be sure fuel tank is not empty, fuel lines are not pinched or kinked, and battery is fully charged. Do not crank starter for long periods of time or overheating of starter windings will occur.

6. Place end of fuel hose into a graduated container and crank engine for 15 seconds.
7. Measure volume of fuel and multiply by four for a per minute value.

Specification:

Fuel Pump Flow Volume . . . . . 118 cc/min (4 oz/min)

Results:

- If fuel volume is below specification, check that fuel lines are not pinched, kinked, or obstructed.
- If fuel lines are ok, replace fuel transfer pump.

Fuel Transfer Pump Pressure Test

Reason:

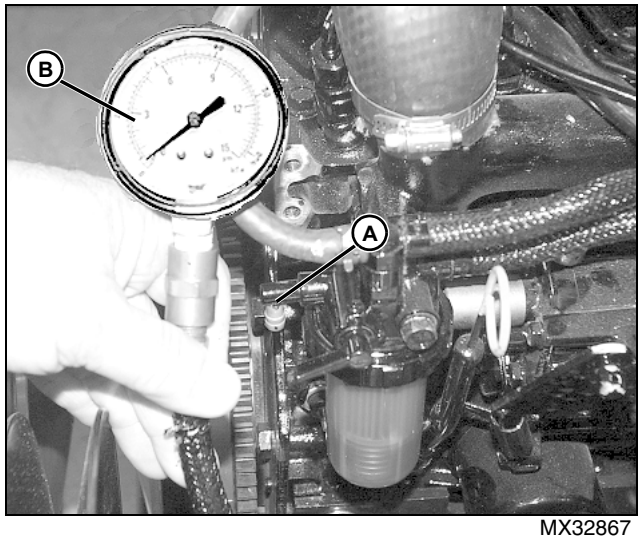
To determine transfer pump operating pressure.

Equipment:

- JDG356 Fuel Pump Pressure Test Kit, includes:
  - JDZ27 Pressure Gauge (0-15 psi)
  - JTO3247 Reducer
  - JTO1609 Hose Coupler

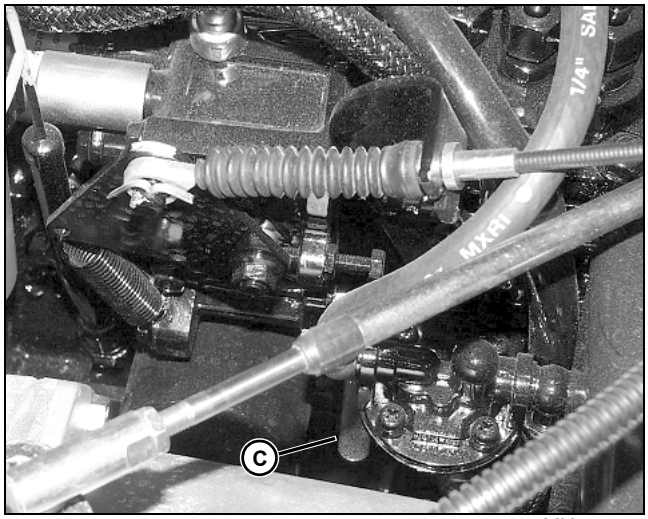
Procedure:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Allow engine to cool.
3. Raise and lock cargo box.



MX32867

4. Disconnect transfer pump outlet hose from inlet of fuel filter (A).
5. Install gauge (B) to transfer pump hose.



MX32855

Picture Note: 3TNE68 shown, 3TNV70 similar.

6. Use manual pump lever (C) located on fuel transfer pump to pressurize test gauge.

7. Disconnect electrical connector from fuel shutoff solenoid to keep engine from starting.

8. Crank engine with starter for 5 - 10 seconds while watching test gauge. Do not overheat starter.

Specifications:

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

Results:

- If pressure is below specification, replace fuel transfer pump.

Repair

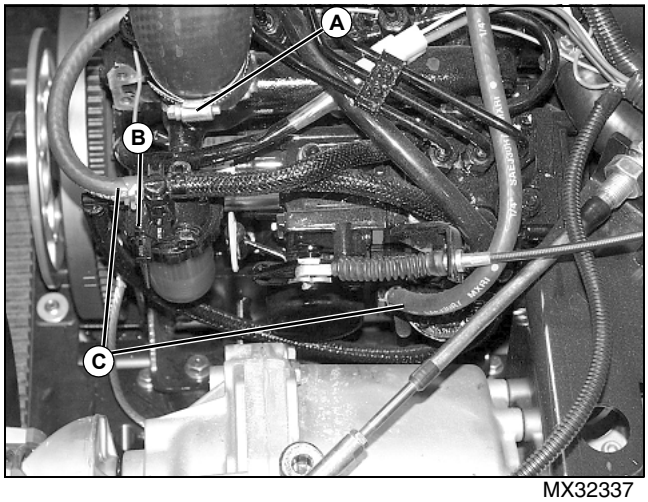
Engine Removal and Installation

Special or Required Tools

- JDG1749 Center Distance Gauge

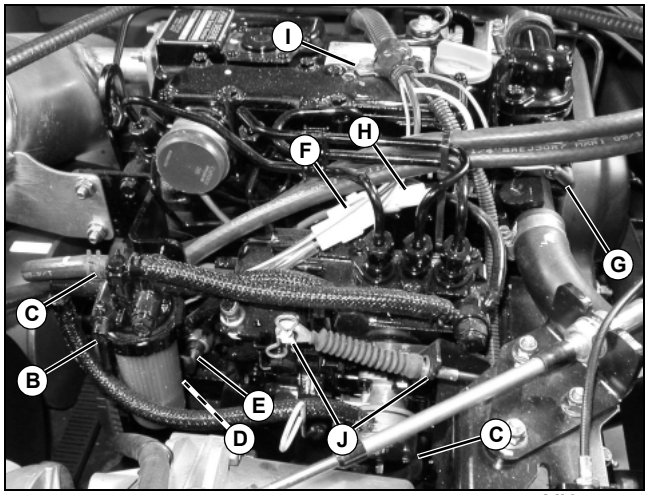
Removal:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Disconnect battery negative (-) cable.
3. Remove cargo box. See “Cargo Box Removal and Installation” on page 586.
4. Allow muffler to cool, or wear protective gloves before working on muffler. Remove muffler. See “Muffler Removal and Installation” on page 119.
5. Remove drive belt.



MX32337

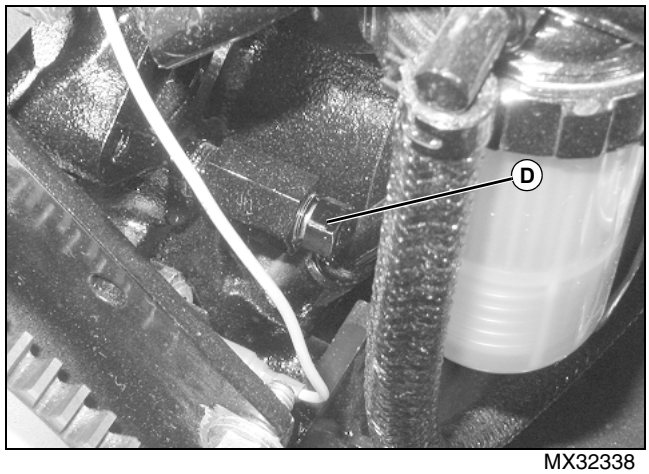
Picture Note: 3TNE68



MX36657

Picture Note: 3TNV70

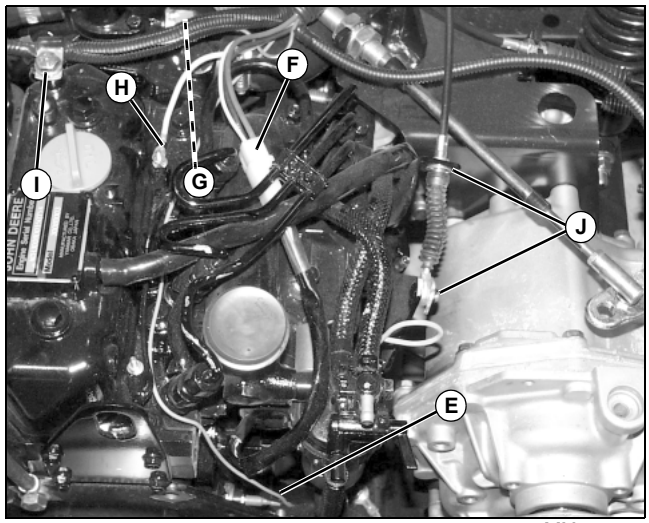
6. Loosen clamp on air intake hose (A) and disconnect hose. Cover opening on intake manifold.
7. Shut off valve on fuel filter (B). Mark fuel hoses (C) for proper reinstallation. Disconnect and plug ends of fuel hoses.



MX32338

Picture Note: 3TNE68 shown, 3TNV70 similar.

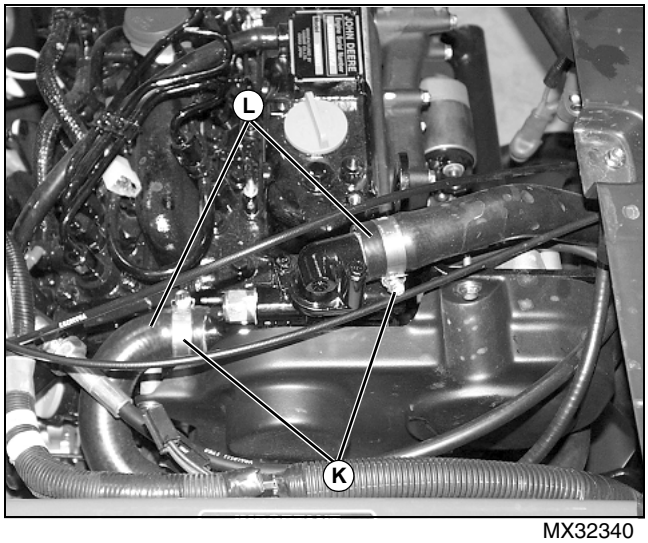
8. Loosen radiator cap. Place container under engine block drain valve (D). Open drain valve and drain coolant from engine.



MX32339

Picture Note: 3TNE68 shown, 3TNV70 similar.

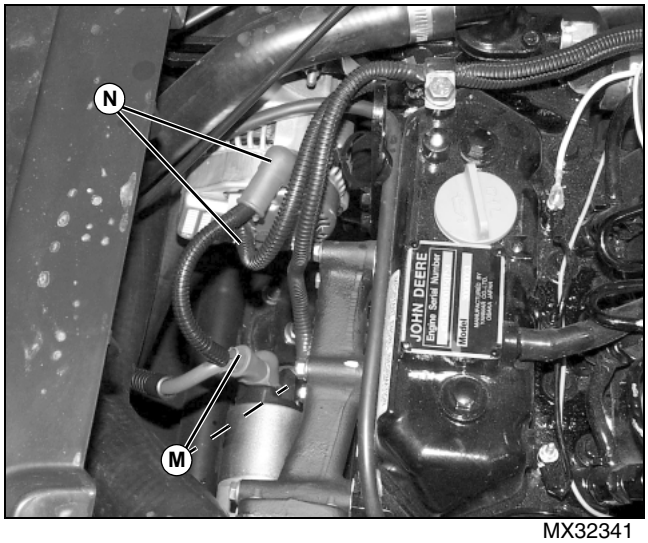
9. Disconnect oil switch wire (E), fuel shutoff solenoid connector (F), coolant temperature switch (G), glow plug wire (H), and remove bolt from wire harness clamp (I).
10. Disconnect throttle cable (J).



MX32340

Picture Note: 3TNE68 shown, 3TNV70 similar.

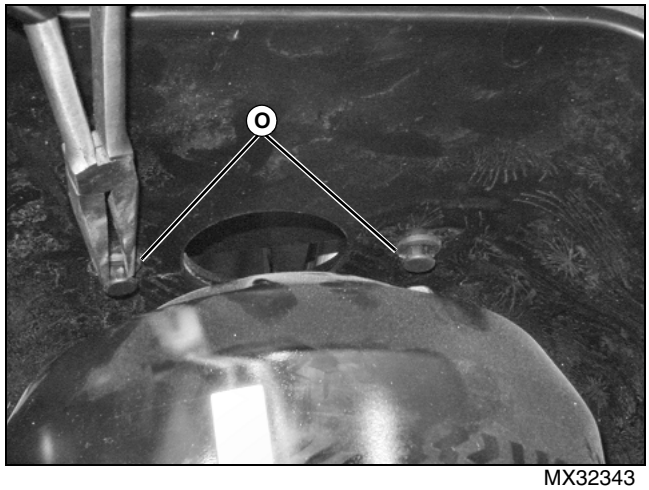
11.Loosen coolant hose clamps (K) and disconnect radiator hoses (L).



MX32341

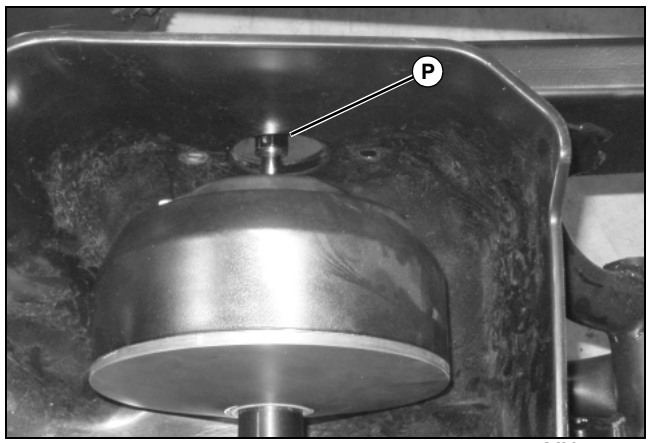
Picture Note: 3TNE68 shown, 3TNV70 similar.

12.Disconnect wiring from starting motor (M), and alternator (N).



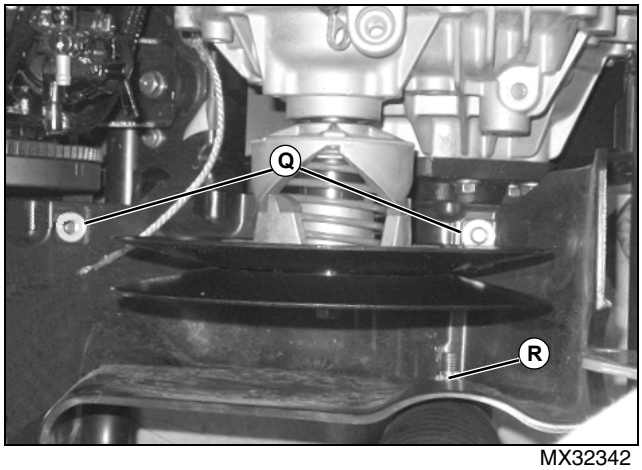
MX32343

13.Remove two plastic rivets (O) next to clutch access hole from left side of belt guard.



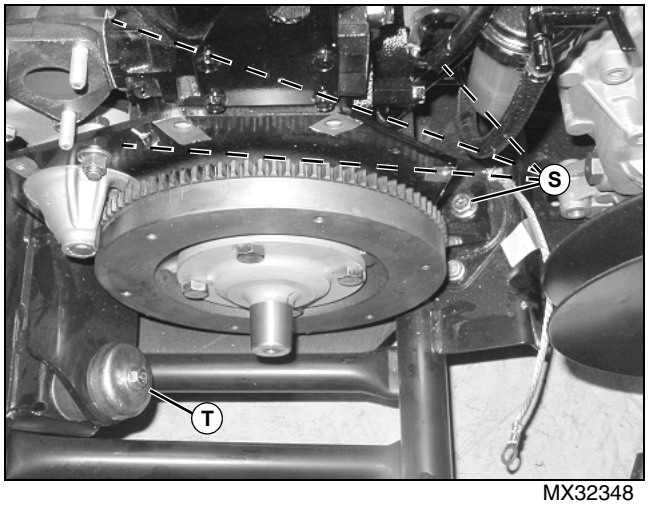
MX32862

14.Remove plastic plug from clutch cover. Remove clutch retaining bolt. Install JDG 1641 clutch removal tool (P) and remove clutch.



MX32342

15.Remove two bolts (Q) securing bottom of belt guard. Remove nut from left lower shock bolt (R) and pull bolt out enough to clear guard. Pull up front of guard or remove guard completely to access engine mounts.



MX32348

16.Remove cap screws from four engine isolators (S), and fifth engine isolator (T).

17.Attach safe lifting device to lift brackets on top of engine and remove engine from machine.

Installation:

Installation is done in reverse order of removal.

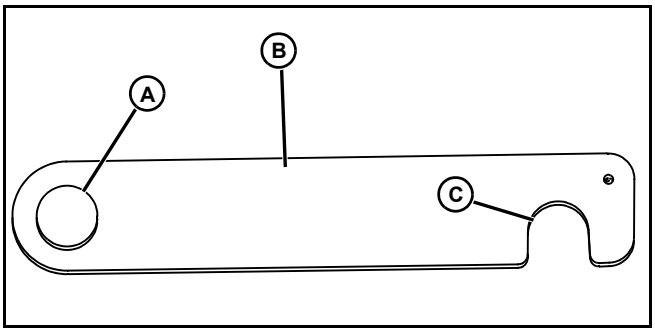
1. Place engine in frame, loosely install four main mounting cap screws through main isolators and engine mounting brackets.

2. Lift engine 5 - 10 mm (0.2 - 0.4 in.) to release strain on isolators.

3. Lower engine fully onto isolators. Tighten four main mounting cap screws to **50 N•m (37 lb-ft)**.

4. Install belt guard without fasteners.

5. Install clutch and tighten cap screw to 37 N•m (26 lb ft).



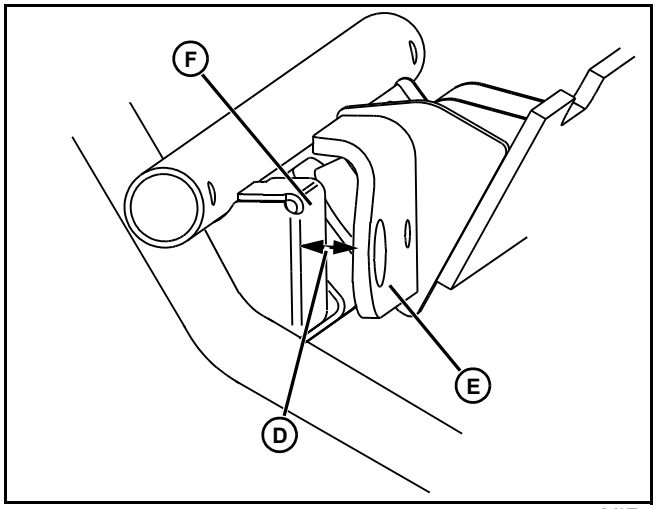
MIF

6. Place the closed end (A) of clutch center distance gauge (B) (JDG1749) over the end of the secondary clutch. Position the open end (C) over the center shaft of the engine drive clutch.

NOTE: The engine may need to be pushed toward the driven clutch to allow the gauge to drop onto the clutch shaft.

7. Make sure closed end (A) is seated completely over bushing end at transaxle driven clutch.

NOTE: The gap is defined as the distance between the frame and engine snubber brackets when the center distance tool is in place and properly positioning the engine relative to the driven clutch. Isolator parts are not installed during this measurement.



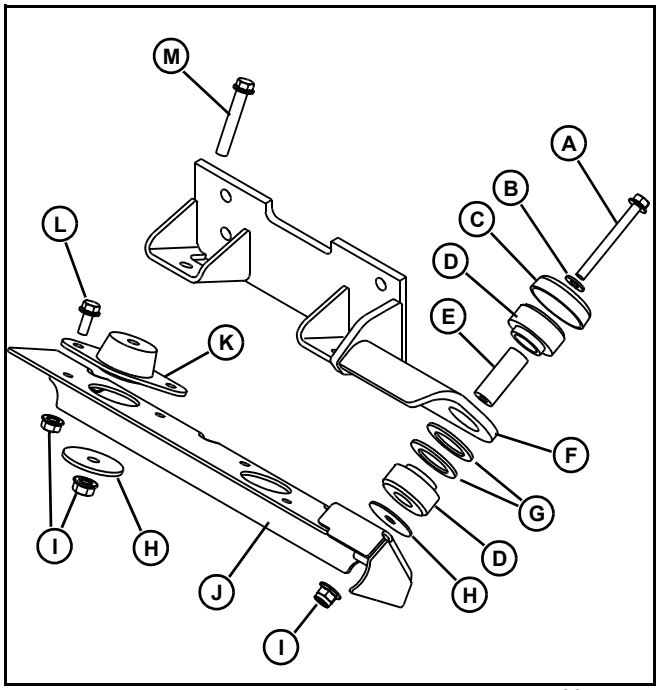
MIF

8. Measure the distance (D) between front surface of engine isolator bracket (E) and the rear surface of the frame bracket (F).

9. Compare the measurement with the GAP column of the Diesel Engine Isolator Shim Washer Chart below. This will determine the number of shim washer(s) to be installed with the isolator mounting hardware.

Diesel Engine Isolator Shim Washers	
Gap (mm)	**Number of Shims**
21.10 - 22.75 mm	0
22.75 - 24.40 mm	1
24.40 - 26.05 mm	2
26.05 - 27.70 mm	3
27.70 - 29.35 mm	4

10.Remove center distance gauge.



M76770

- **A - Capscrew**
- **B - Washer**
- **C - Metal Cup**
- **D - Rubber Mount**
- **E - Bushing**
- **F - Engine Mount**
- **G - Shim Washer(s)**
- **H - Washer**
- **I - Flange Nut**
- **J - Frame Mount**
- **K - Isolator (4 used)**
- **L - Cap Screw**
- **M - Cap Screw**

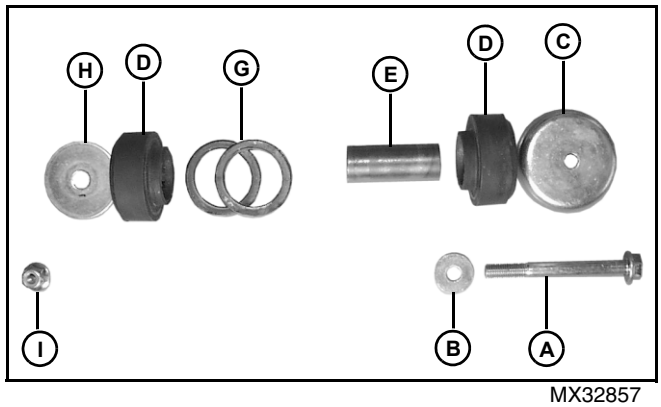
11.Install fifth isolator parts in order shown above.

IMPORTANT: Avoid damage! If the center distance is too long the drive belt may drop into secondary clutch and wear on the rivets. More shimming is required.

If the center distance is too short, performance will suffer. Less shimming is required.

12.Install correct number shim washer(s) (G) as determined above.

13.The washer (H), one rubber mounting (D), and shim washer(s) (G), and are installed between the frame mounting bracket (J) and engine mounting bracket (F).



MX32857

14.Assemble bushing (E), rubber mount (D), metal cup (D), washer (B) and cap screw (A) onto engine mount (F).

15.Install second rubber mount, metal cup (C), washer (B), and fifth isolation mounting cap screw (A). Install nut (I).

16.Tighten fifth isolation mounting cap screw (A) and nut (I) to **37 ± 7 N•m (27 ± 5 lb-ft)**.

17.Verify center distance again by placing the center distance gauge on the primary clutch first and verify that the closed end of the gauge easily slips onto the secondary clutch bearing. Remove or add shims as necessary.

18.Install cap screws and plastic rivets in belt guard.

19.Connect all electrical wires.

20.Connect fuel lines and throttle cable.

21.Connect air cleaner hose to intake manifold.

22.Install drive belt.

23.Fill cooling system with approved coolant.

24.If drained, fill engine with proper oil. Refer to Specifications section. Engine oil capacity with filter is approximately 2.2 L (2.3 qt).

25.Connect battery negative (-) cable.

Muffler Removal and Installation

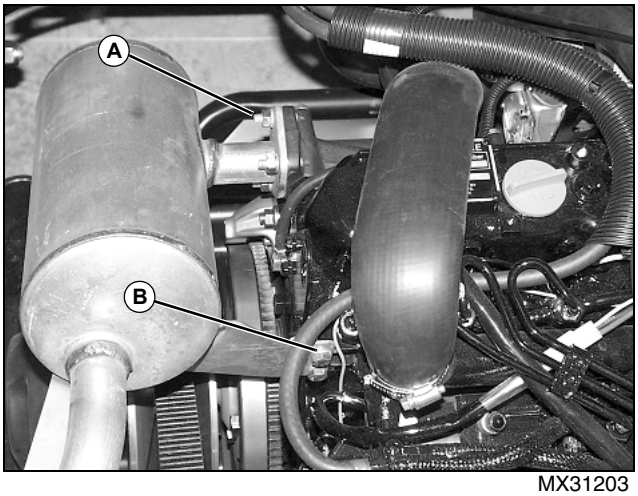
Removal:

CAUTION: Avoid injury! Muffler may be hot. Allow muffler to cool before removing.

1. Park machine safely. See Parking Safely in the Safety Section.

2. Raise and lock cargo box.

3. Allow muffler to cool, or wear protective gloves before working on muffler.



MX31203

4. Remove three nuts (A) holding muffler flange to exhaust manifold. Remove two cap screws (B) from muffler bracket to cylinder head. Remove muffler.

5. Inspect studs on exhaust manifold. Replace if worn.

Installation:

Installation is done in the reverse order of removal.

- Clean sealing surfaces of muffler flange and exhaust manifold and replace gasket before installation.
- Install muffler on exhaust manifold studs and tighten mounting nuts (A) to specification.
- Install and tighten muffler bracket cap screws (B).

Torque Specifications:

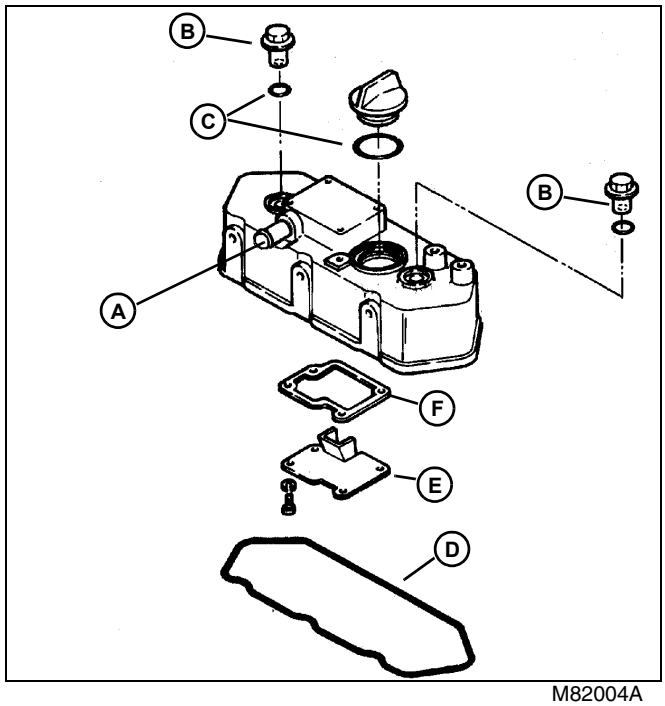
Muffler Mount Nuts . . . . . 28 N•m (248 lb-in.)

Rocker Arm Cover Removal and Installation - 3TNE68

Removal:

1. Park machine safely. See Parking Safely in the Safety Section.

2. Raise and lock cargo box.



M82004A

3. Disconnect intake air hose from intake manifold.

4. Remove crankcase breather tube from breather fitting (A) on rocker cover.

5. Remove two special nuts (B) securing cover to cylinder head.

6. Remove rocker cover.

NOTE: If cover has not been removed recently, it may be necessary to lightly tap side of cover with soft faced hammer.

7. Inspect O-ring seals (C) for wear or damage. Replace if necessary. Inspect O-ring type rocker cover seal (D) for damage, replace if necessary.

8. Disassemble breather baffle (E) and clean all parts thoroughly. replace gasket (F).

Installation:

Installation is done in the reverse order of removal.

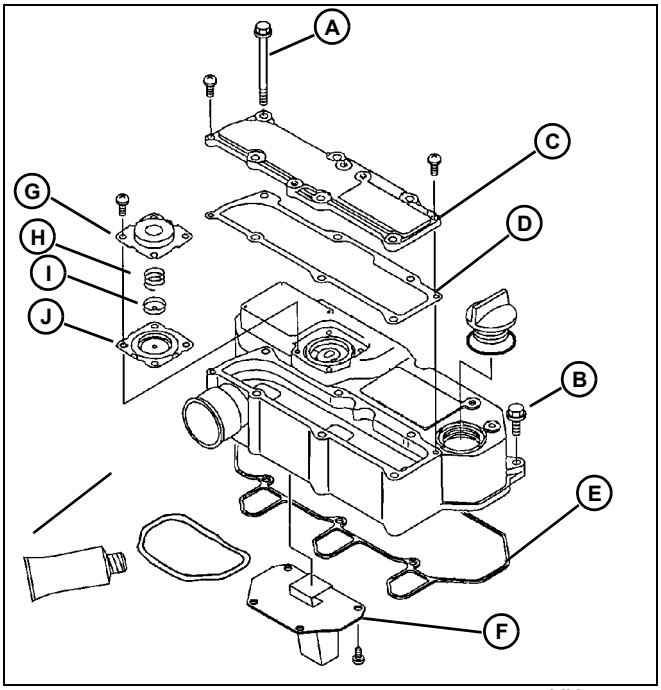
Specification:

Rocker Arm Cover Bolt Torque. . . . . 18 N•m (159 lb-in.)

Rocker Arm Cover Removal and Installation - 3TNV70

1. Park machine safely. See Parking Safely in the Safety Section.

2. Raise and lock cargo box.



MX34135

3. Remove muffler. See “Muffler Removal and Installation” on page 119.

4. Loosen hose clamps from air cleaner hose and remove air cleaner.

5. Remove six long (A) and three short bolts (B) securing valve cover to cylinder head.

6. Remove valve cover.

7. Remove intake cover (C) and clean off mating surfaces and replace gasket (D).

8. Remove and disassemble breather baffle (F) and clean or replace mesh media.

9. Remove diaphragm cover (G), spring (H), center plate (I), and diaphragm (J).

10.Inspect diaphragm, spring, and center plate for wear or damage. Diaphragm must not have any cracks or tears and must not leak. Replace parts showing any wear.

- Clean all parts.
- Reassemble valve arm cover using new gaskets.
- Use John Deere Form in Place Gasket between breather baffle and valve cover.
- Tighten valve cover bolts to specification during installation.

Specification:

Rocker Arm Cover Bolt Torque. . . . . 11 N•m (97 lb-in.)

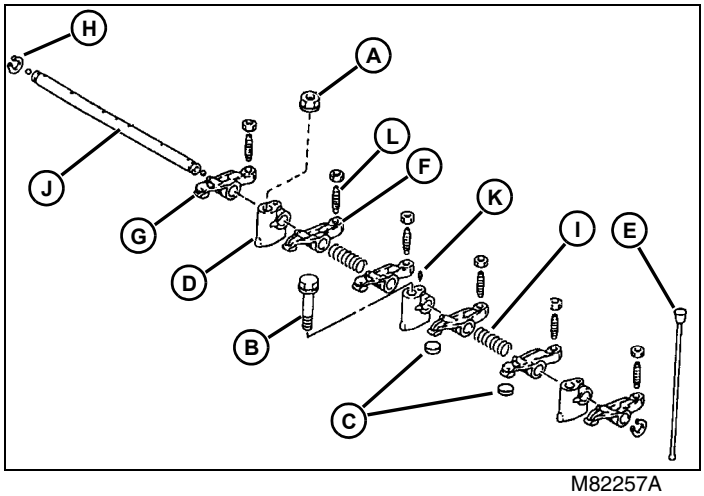
Rocker Arm and Push Rods - 3TNE68

Removal:

1. Park machine safely. See Parking Safely in the Safety Section.

2. Raise and lock cargo box.

3. Remove rocker arm cover. See “Rocker Arm Cover Removal and Installation - 3TNE68” on page 119.



M82257A

4. Remove two M8 rocker arm mounting nuts (A) from end arm supports and one M8 cap screw (B) from center support.

5. Pull rocker arm assembly straight up off of mounting studs on cylinder head.

6. Inspect all parts for wear. (See Inspection procedure below.)

Installation:

1. Be sure valve caps (C) are in place on end of valve stems before installing rocker arms.

2. Align rocker arm supports (D) with studs on cylinder head. Align rockers with valve stems.

3. Install push rods (E) in block and align into rocker arms.

4. Install mounting nuts (A) and cap screw (B) on rocker arm supports and evenly tighten nuts to pull rocker assembly to head.

5. Tighten mounting nuts and cap screw to **26 N•m (226 lb-in.)**.

6. Adjust valve clearance. See “Valve Clearance Adjustment” on page 102.

7. Install rocker arm cover. See “Rocker Arm Cover Removal and Installation - 3TNE68” on page 119.

Inspection:

1. Remove rocker arm cover and rocker arm assembly.

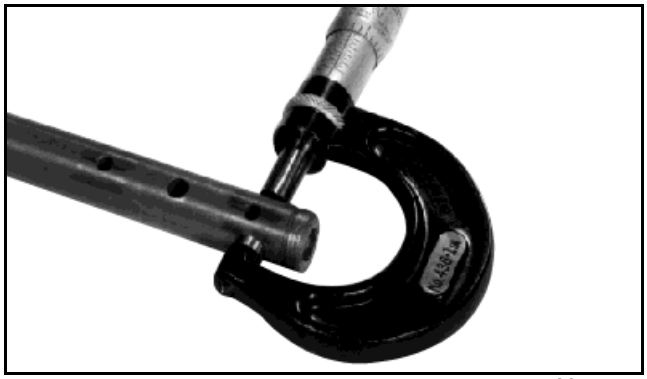
2. Mark all parts before tear-down to aid assembly. Intake (F), and exhaust (G), rocker arms are different.

3. Remove end retaining rings (H) and slide rocker arms, springs (I), and outer supports (D) off of rocker shaft (J).

4. Remove set screw (K) from center support. Remove rocker shaft from center support.

5. Inspect push rod ends of adjuster screws (L) for wear. Replace if necessary.

Measure Outer Diameter Of Rocker Arm Shaft:



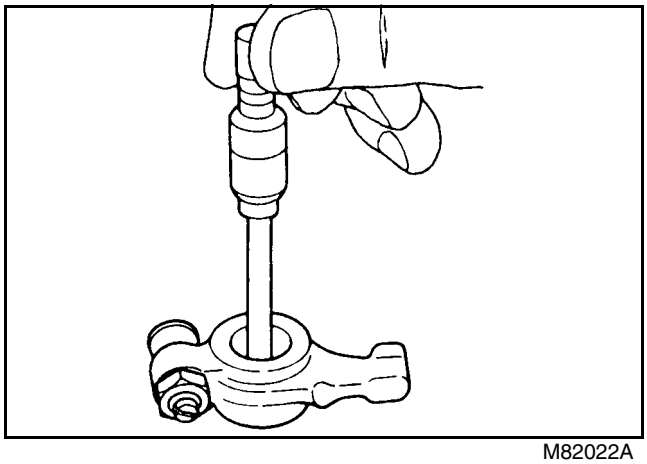
M35262

Replace rocker arm shaft if diameter is less than wear limit.

Rocker Arm Shaft OD:

Standard . . . . . 9.97 - 9.99 mm (0.392 - 0.393 in.)
Wear Limit . . . . . 9.95 mm (0.392 in.)

Measure Inside Diameter Of Rocker Arms and Supports:



M82022A

Replace rocker arms or supports if ID is more than wear limit.

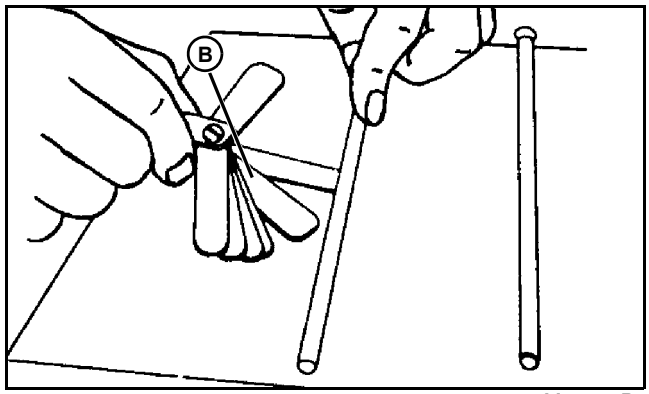
If shaft and support/arm clearance (support/arm ID minus shaft OD) exceed wear limit, replace all parts.

Rocker Arm and Shaft Support ID's:

Standard . . . . . 10.00 - 10.02 mm (0.394 - 0.395 in.)
Wear Limit. . . . . 10.09 mm (0.397 in.)
Clearance . . . . . 0.14 mm (0.005 in.)

Measure Push Rod Straightness:

- Check the surface of the adjusting screw that contacts the push rod for wear, replace push rod or adjusting screw if worn.
- Check the rocker arm to valve stem cap contact surface for wear. Replace rocker arm if worn.



M82023B

Replace push rod if not within specifications.

Push Rod:

Bend (Maximum) . . . . . 0.08 mm (0.003 in.)

Rocker Arm Assembly:

1. Clean all parts of varnish and oil.

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

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

Rocker Arm and Push Rods - 3TNV70

Rocker Arm Removal:

1. Park machine safely. See Parking Safely in the Safety Section.

2. Raise and lock cargo box.

3. Remove valve cover. See "Rocker Arm Cover Removal and Installation - 3TNV70" on page 120.

4. Remove three M8 rocker arm mounting nuts.

5. Pull rocker arm assembly straight up off of mounting studs on cylinder head.

6. Inspect all parts for wear. (See Inspection procedure below.)

Rocker Arm Disassembly:

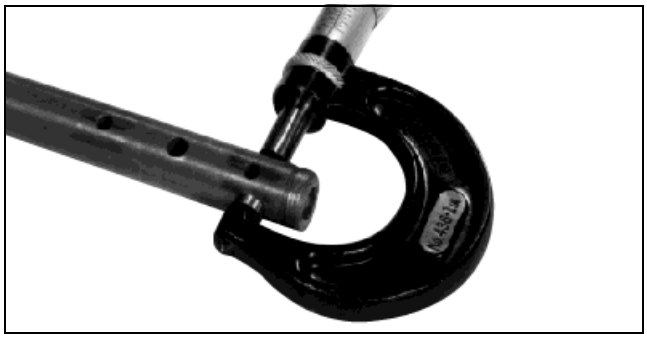
1. Before disassembly mark all parts for location to aid reassembly.

2. Remove end retaining rings and slide components off of 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

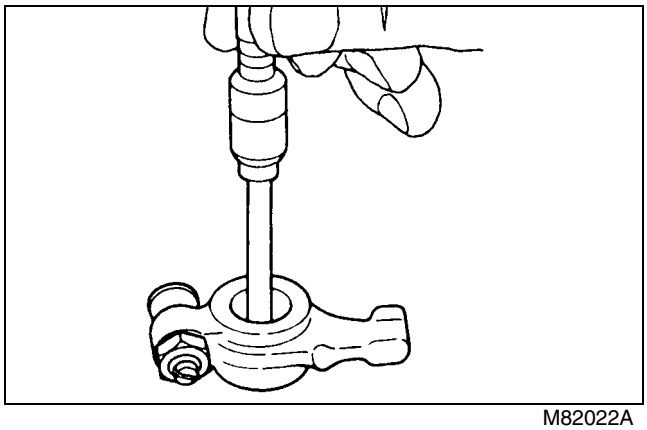
1. Measure outer diameter of rocker arm shaft:

Rocker Arm Shaft OD Specification:

Standard . . . . . 11.97 - 11.98 mm (0.471 - 0.472 in.)

Wear Limit . . . . . 11.95 mm (0.470 in.)

- Replace rocker arm shaft if less than wear limit.



M82022A

2. Measure inside diameter of rocker arms, and rocker shaft supports:

Rocker Arm and Shaft Support ID Specifications:

Standard . . . . . 12.00 - 12.02 mm (0.472 - 0.473 in.)

Wear Limit . . . . . 12.09 mm (0.476 in.)

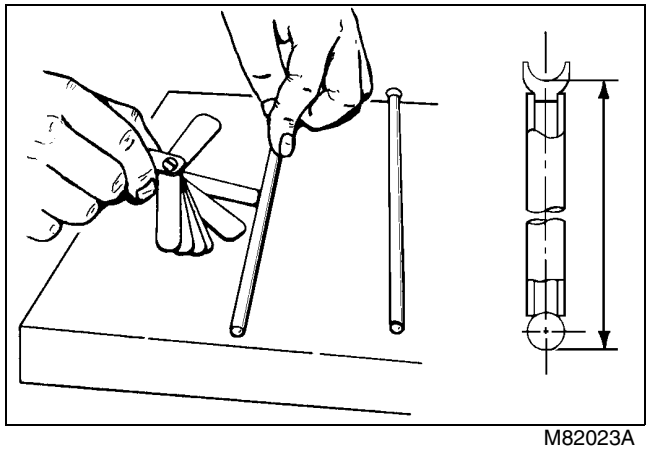
Oil Clearance. . . . . 0.02 - 0.05 mm (0.001 - 0.002 in.)

Wear Limit . . . . . 0.13 mm (0.005 in.)

- Replace rocker arms or supports if ID is more than wear limit.

- If shaft and support/arm clearance (support and/or arm ID minus shaft OD) exceed wear limit, replace all parts.

Push Rod Inspection:



M82023A

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

Specifications:

Push Rod Length . . . . . 114 - 115 mm (4.488 - 4.528 in.)

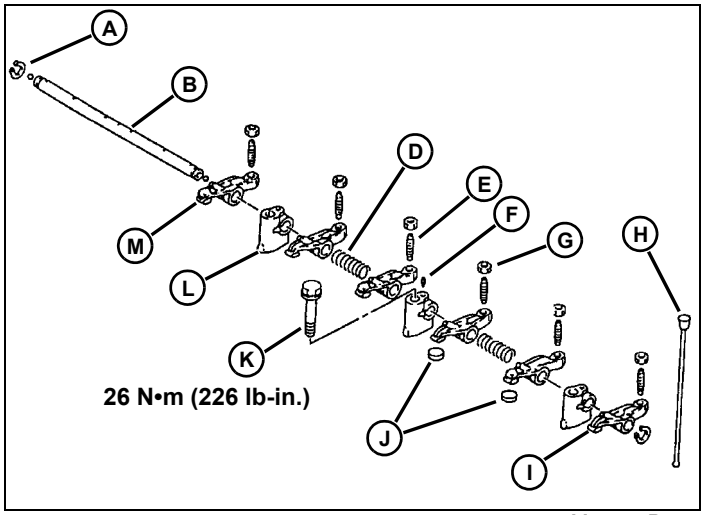
Push Rod Bend . . . . . 0 - 0.03 mm (0.0 - 0.001 in.)

Replace push rod if not within specifications.

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.

Rocker Arm Assembly:



M82257B

A - Retaining Ring
B - Rocker Arm Shaft
C - Mounting Nut (3) M8
D - Rocker Arm Shaft Spring
E - Set Screw
F - Adjusting Screw
G - Nut
H - Push Rod
I - Intake Valve Rocker Arm
J - Valve Caps
K - Mounting Cap Screw (3) M8 X 45
L - Rocker Arm Support (3)
M - Exhaust Valve Rocker Arm

1. Assemble rocker shaft (B) into center support, aligning set screw hole (E) in support with hole in rocker shaft.

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

Rocker Arm Installation:

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

1. Align rocker arm supports with holes in cylinder head. Align rockers with valve stems.

2. Install push rods (H) in block and align into rocker arms.

3. Install mounting bolts (K) in rocker arm supports and evenly tighten bolts to pull rocker assembly to head. Tighten to specification.

4. Adjust valve clearance. See “Valve Clearance Adjustment” on page 102.

5. Install valve cover. See “Rocker Arm Cover Removal and Installation - 3TNV70” on page 120.

Specification:

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

Cylinder Head Removal and Installation - 3TNE68

Removal:

NOTE: Cylinder head may be removed with engine installed in machine chassis. Engine removal will allow easier access to cylinder head.

1. Park machine safely. See Parking Safely in the Safety Section.

2. Raise and lock cargo box.

3. Disconnect negative battery cable from battery.

4. Remove air cleaner hose from intake manifold and plug opening.

5. Remove muffler, rocker arm cover, rocker arm assembly, push rods and valve caps.

6. Drain cooling system.

7. Remove water pump.

8. Shut off fuel valve at fuel filter.

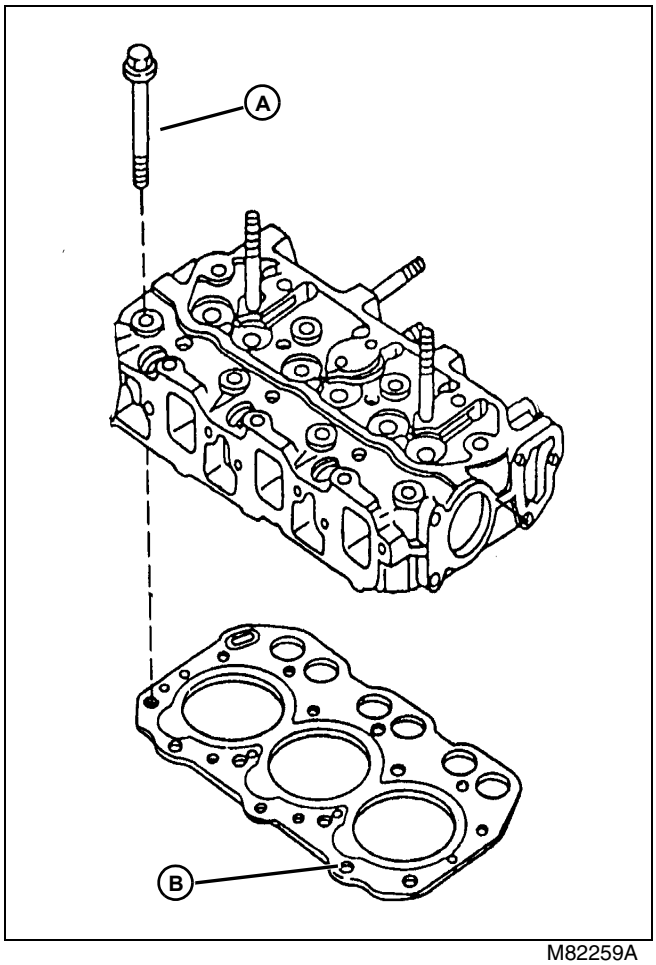
9. Remove fuel injector lines from injection pump to nozzles.

10. Remove fuel injection nozzles from cylinder head.

11. Disconnect glow plug wire.

12. Disconnect coolant temperature switch.

13. Loosen and remove cylinder head bolts (A).



M82259A

14. Using lift bracket and hoist, pull head straight up from block.

15. Remove exhaust and intake manifolds. See “Intake Manifold Removal and Installation - 3TNE68” on page 125.

16. Disassemble and inspect cylinder head and valves. See “Cylinder Head Recondition” on page 126.

Installation:

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

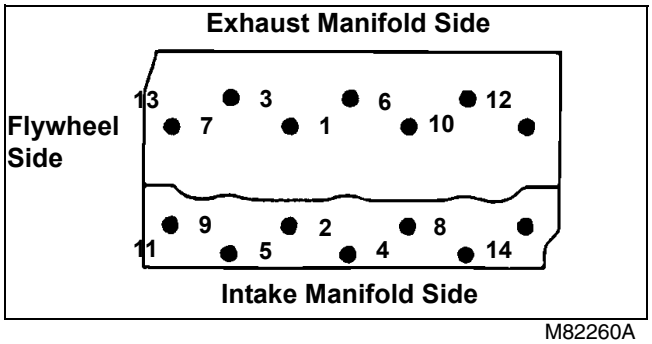
2. Place new cylinder head gasket on block with oil passage (B) lined up with oil port in block.

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

3. Position cylinder head on gasket.

NOTE: Dip cylinder head bolts in clean oil before installing.

4. Install all cylinder head bolts and start all threads before tightening any one bolt.



M82260A

5. Tighten cylinder head bolts in the sequence shown, in three stages of gradually-increasing torque.

Torque Sequence Specifications:

First . . . . . 13.6 N•m (120 lb-in.)
Second. . . . . 27 N•m (240 lb-in.)
Final . . . . . 41 N•m (30 lb-ft)

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

Cylinder Head Removal and Installation - 3TNV70

Removal:

1. Park machine safely. See Parking Safely in the Safety Section.

2. Raise and lock cargo box.

3. Disconnect negative battery cable from battery.

4. Shut off fuel valve on fuel filter.

5. Remove air cleaner and air cleaner mounting bracket from valve cover.

6. Allow engine to cool, and cooling system pressure to return to zero. Drain coolant from drain valve under right side of machine.

7. Remove muffler and tailpipe from exhaust manifold. See “Muffler Removal and Installation” on page 119.

8. Remove coolant recovery tank and mounting bracket from cylinder head.

9. Remove upper and lower radiator hoses from water pump.

10. Remove coolant temperature sensor wire from sensor.

11. Remove upper alternator bracket and fan belt from water pump.

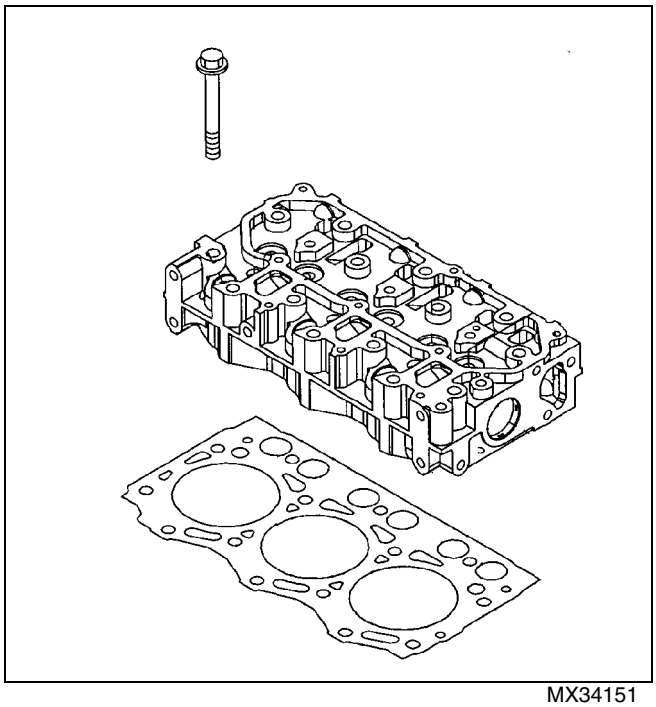
12. Remove water pump. See “Water Pump Removal and Installation” on page 162.

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

14. Disconnect glow plug wiring harness from engine harness.

15. Remove valve cover See “Rocker Arm Cover Removal and Installation - 3TNV70” on page 120.

16. Remove rocker arm assembly, push rods, and valve caps from cylinder head See “Rocker Arm and Push Rods - 3TNV70” on page 121.



MX34151

17. Loosen and remove cylinder head bolts.

18. Using lift brackets and hoist, pull head straight up from block.

19. Remove exhaust manifold.

20. Disassemble and inspect cylinder head and valves. See “Cylinder Head Recondition” on page 126.

Installation:

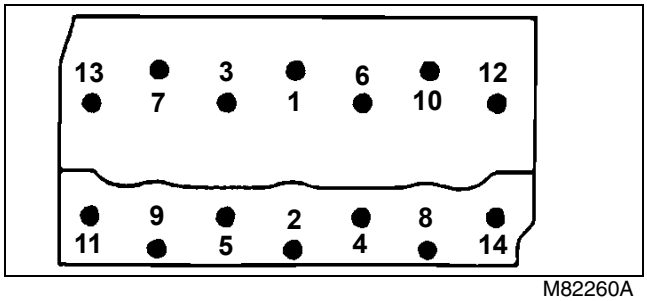
1. Clean all threads in top of cylinder block with a flat bottom tap, and blow debris from hole.

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

3. Place a new cylinder head gasket on cylinder block with locating pins on front and rear of block inside holes in gasket. Lineup oil port on left rear of block with oil port in gasket.

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

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



M82260A

5. Tighten cylinder head bolts in sequence shown above in three steps of torque from table below.

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

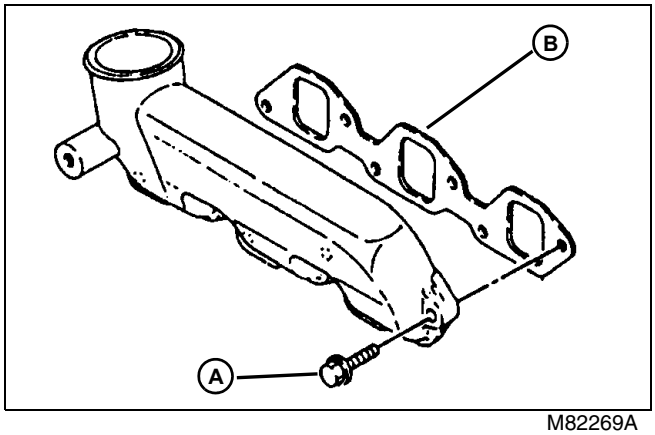
Torque Specifications:

First . . . . . 27 N•m (20 lb-ft)
Second. . . . . 41 N•m (30 lb-ft)
Final . . . . . 53.9 - 57.9 N•m (39.7 - 42.7 lb-ft)

Intake Manifold Removal and Installation - 3TNE68

Removal:

1. Remove cylinder head. See “Cylinder Head Removal and Installation - 3TNE68” on page 123.



M82269A

2. Remove four M6 x 20 intake manifold mounting cap screws (A).

3. Remove gasket (B) and clean mating surfaces. Check flange for flatness with straight edge.

Installation:

- Install new gasket.
- Tighten mounting cap screws to 11 N•m (97 lb-in.).

Exhaust Manifold Removal and Installation

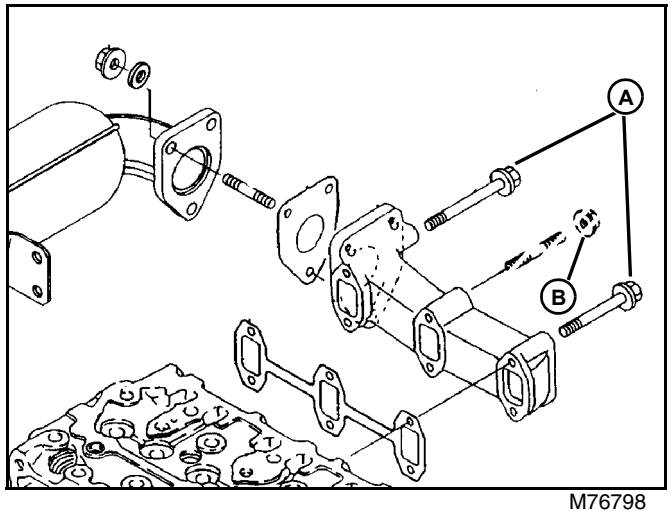
Removal:

1. Park machine safely. See Parking Safely in the Safety Section.

2. Raise and lock cargo box.

3. Allow muffler to cool, or wear protective gloves before working on exhaust.

4. Remove muffler and gasket. See “See “Muffler Removal and Installation” on page 119.



M76798

5. 3TNE68 Shown - Remove four cap screws (A) and two flange nuts (B) holding manifold to cylinder head.

6. 3TNV70 Similar - Remove six cap screws (A) holding exhaust manifold to cylinder head.

Installation:

- Clean mating surfaces and install new gaskets.
- Tighten manifold to cylinder head cap screws to **11 N•m (97 lb-in.)**.
- Tighten muffler mounting nuts to **28 N•m (240 lb-in.)**.

Torque Specifications:

Cap Screws . . . . . 22.5 - 28.4 N•m (17 - 21 lb-ft)
Muffler Mount Nuts . . . . . 28 N•m (248 lb-in.)

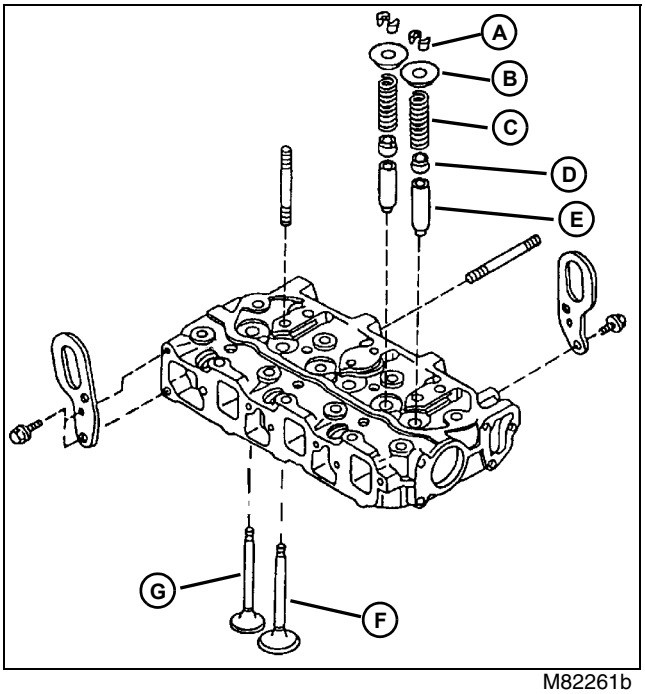
Cylinder Head Recondition

Special or Essential Tools

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

- JDE138 Valve Spring Compressor
- JDE504 Valve Guide Driver

Disassembly:



M82261b

1. Compress valve springs (C) using JDE138 valve spring compressor

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

2. Remove collet halves (A) from retainer (B).

3. Slowly release compressor and valve spring.

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

5. Intake and exhaust valve guides (E) and seats are press fit. Remove guides only if replacement is necessary. See “Valve Guides:” later in this procedure.

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

Assembly:

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

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

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

NOTE: If new valves are installed, measure valve recession. See “Valve Recession Measurement”.

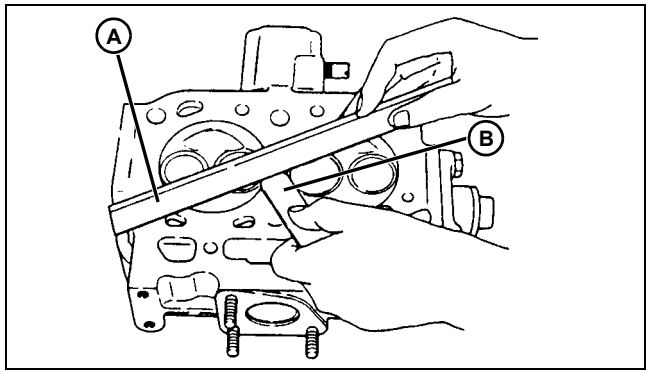
3. Use valve spring compressor to compress spring and retainer, and install collet as removed.

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

Inspection/Replacement:

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

Cylinder Head:



M82028A

- Measure cylinder head flatness. Place a straight-edge (A) along each of the four sides and each diagonal. Measure clearance between straight edge and combustion surface with a feeler gauge (B).

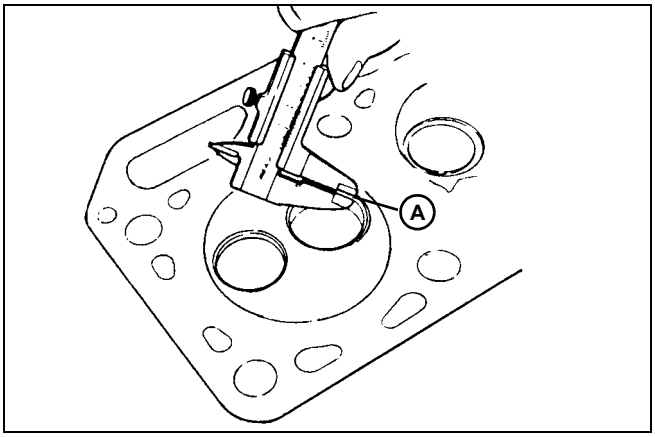
Cylinder Head Distortion:

Standard . . . . . 0.05 mm (0.002 in.) or less
Wear Limit . . . . . 0.15 mm (0.006 in.)

If distortion exceeds the wear limit, resurface or replace cylinder head. Remove only enough metal to make cylinder head flat; but not more than 0.20 mm (0.008 in.).

If Cylinder Head Was Resurfaced:

- Measure piston-to-cylinder head clearance. See "Piston-To-Cylinder Head Clearance" on page 145.
- Measure valve recession. See procedure in this group.



M82029A

- Measure valve seat width (A).

Intake Valve Seat Width Specifications:

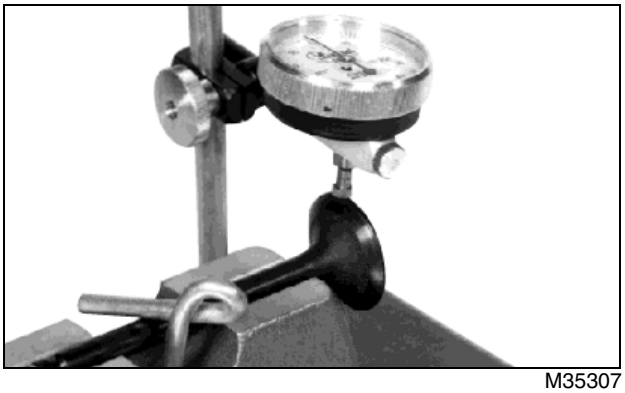
Standard . . . . . 1.15 mm (0.045 in.)
Wear Limit . . . . . 1.65 mm (0.065 in.)

Exhaust Valve Seat Width Specifications:

Standard . . . . . 1.41 mm (0.056 in.)
Wear Limit . . . . . 1.91 mm (0.075 in.)

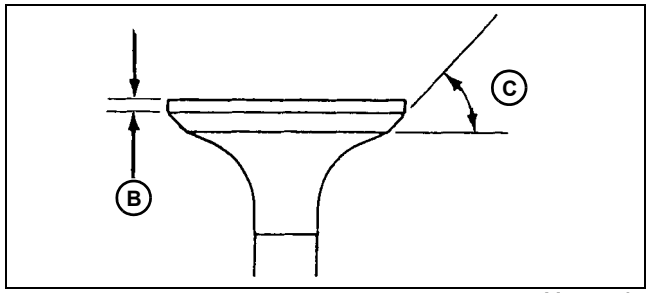
If necessary, grind valve seats to meet specifications. See "Valve Seat Grinding:" on page 129.

Intake and Exhaust Valves:



M35307

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

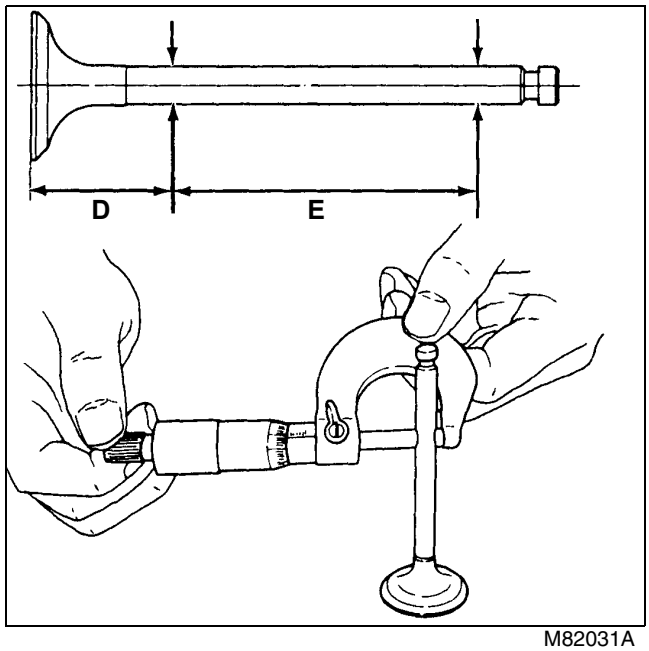


M82030A

- If valve faces are worn, burned or pitted, grind valves to proper face angle. If valve face margin (B) is less than 0.51 mm (0.020 in.) after grinding, replace valve.
- Valve face angle (C) is 30° on intake valves, and 45° on exhaust valves.

Valve Grinding Specifications:

Valve Face Margin (B):
Intake . . . . . 0.9 - 1.1 mm (0.035 - 0.043 in.)
Exhaust . . . . . 1.0 - 1.2 mm (0.039 - 0.047 in.)
Wear Limit (Both) . . . . . 0.50 mm (0.02 in.)
Valve Face Angle (C):
Intake . . . . . 30°
Exhaust . . . . . 45°



M82031A

2. Measure valve stem diameter at two locations shown. Replace valve if measurement is less than wear limit.

Valve Stem Measurement Location:

Valve Stem OD Measurement Locations:
Location Distance D. . . . . 20 mm (0.787 in.)
Location Distance E. . . . . 40 mm (1.575 in.)

Valve Stem Diameter - 3TNE68:

Intake Valve Stem OD: . . . . . .
Standard . . . . . 5.46 - 5.48 mm (0.2149 - 0.2157 in.)

Wear Limit . . . . . 5.40 mm (0.2126 in.)

Exhaust Valve Stem OD:
Standard . . . . . 5.44 - 5.46 mm (0.2142 - 0.2149 in.)

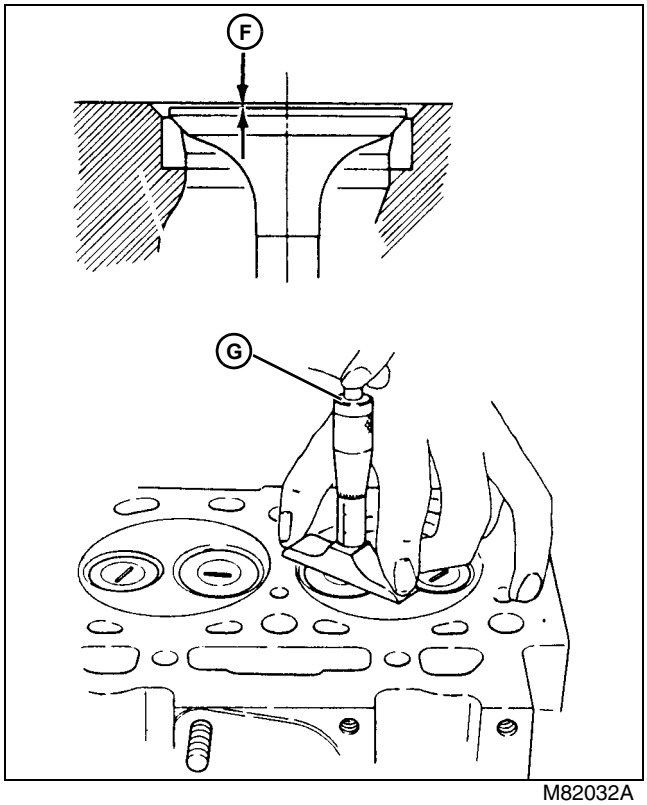
Wear Limit . . . . . 5.40 mm (0.2126 in.)

Valve Stem Diameter - 3TNV70:

Intake . . . . . 5.96 - 5.98 mm (0.234 - 0.2355 in.)

Exhaust . . . . . 5.95 - 5.97 mm (0.234 - 0.235 in.)

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



M82032A

3. Measure valve recession (F) using a depth gauge (G). Replace valve or cylinder head if measurement exceeds specifications.

Valve Recession Specifications - 3TNE68:

Intake Valve . . . . . 0.40 mm (0.016 in.)

Exhaust Valve . . . . . 0.85 mm (0.033 in.)

Valve Recession Specifications - 3TNV70:

Intake and Exhaust . . . 0.40 - 0.60 mm (0.016 - 0.024 in.)

Wear Limit Intake . . . . . 0.09 mm (0.04 in.)

Wear Limit Exhaust . . . . . 0.08 mm (0.03 in.)

Valve Guides:

1. Clean valve guides using a valve guide brush.

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

Valve Guide ID - 3TNE68:

Standard . . . . . 5.50 - 5.52 mm (0.216 - 0.217 in.)

Wear Limit . . . . . 5.58 mm (0.220 in.)

Valve Guide ID - 3TNV70:

Standard . . . . . 6.0 - 6.01 mm (0.236 - 0.237 in.)

Wear Limit . . . . . 6.08 mm (0.239 in.)

- If diameter exceeds wear limit, knurl or replace guide.
- If diameter is less than wear limit, determine guide-to-stem clearance (guide diameter minus stem diameter).
- If clearance exceeds 0.15 mm (0.006 in.) but is less than 0.17 mm (0.007 in.), knurl valve guides using a 5.50 mm Valve Guide Knurler.
- If clearance exceeds 0.17 mm (0.007 in.), replace valve guide.

Valve Guide Measurements:

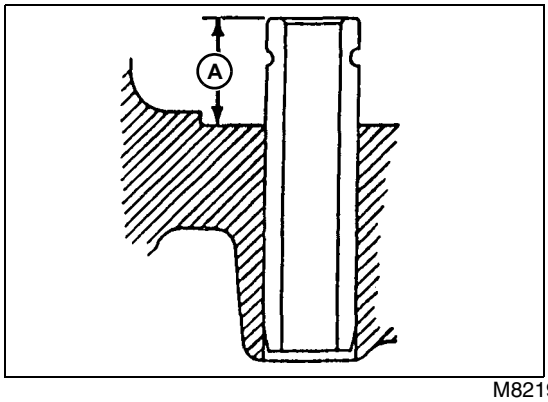
Valve Guide-to-Valve Stem Oil Clearance:

Intake . . . . . 0.03 - 0.05 mm (0.001 - 0.002 in.)
Exhaust . . . . . 0.04 - 0.07 mm (0.002 - 0.003 in.)
Wear Limit (Both) . . . . . 0.17 mm (0.007 in.)

Valve Guide Replacement:

- Use JDG504 Valve Guide Driver.

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



M82193A

1. Install valve guides with tapered ends down. Push valve guides down until top of valve guides are set to distance (A) from top of cylinder head.

3TNE68

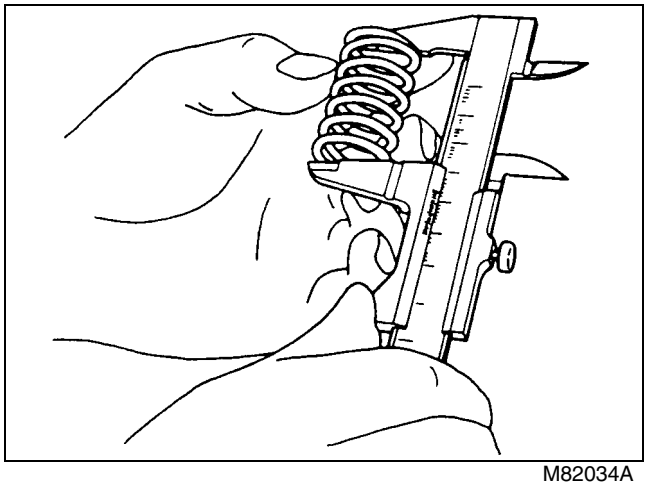
Valve Guide Height "A" . . . . . 7 mm (0.276 in.)

3TNV70

Valve Guide Height (A) . . . . 9.8 -10 mm (0.386-0.394 in.)

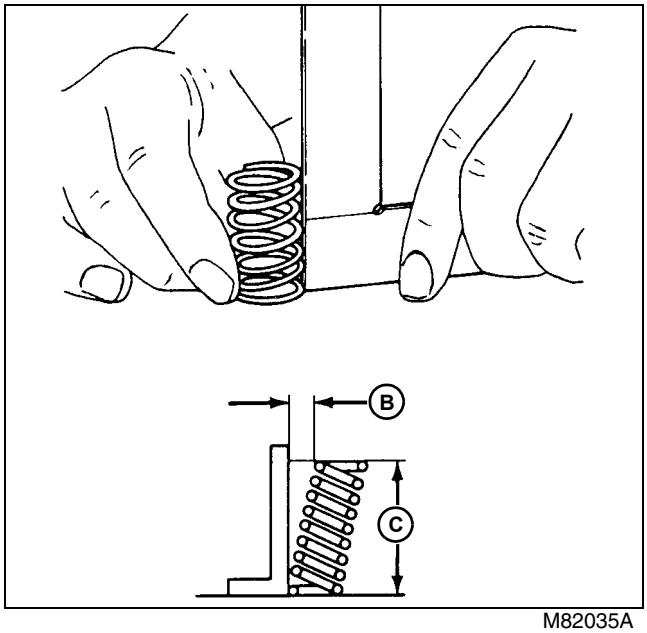
2. Ream inside diameter of valve guides using 5.50 mm Valve Guide Reamer.

Valve Springs:



M82034A

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



M82035A

2. Measure spring inclination (B). Replace spring if measurement exceeds specification.

Spring Specifications - 3TNE68:

Spring Free Length (C). . . . . 28 mm (1.102 in.)

Maximum Inclination (B) . . . . . 0.80 mm (0.032 in.)

Spring Specifications - 3TNV70:

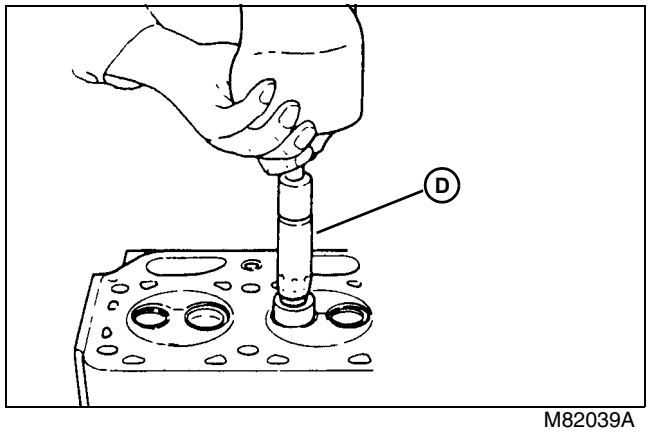
Valve Spring Free Length (C) . . . . . 37.8 mm (1.488 in.)

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

Valve Seat Grinding:

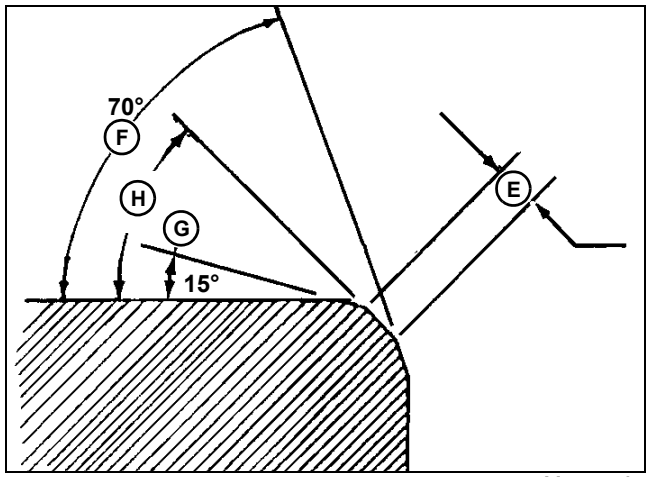
IMPORTANT: Avoid damage! Valve seats should never be cut. Cutting a valve seat can damage its sealing surface, which may result in leaks or valve/ seat failure. Valve seats should be ground and lapped.

NOTE: LIGHTLY grind valve seats only for 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 (D), and exhaust valve seat using a 45° seat grinder. Follow tool manufacturers instructions.



M82040A

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

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

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

5. If valve seats (H) are ground, measure valve recession and check contact pattern between the seat and valve with bluing dye.

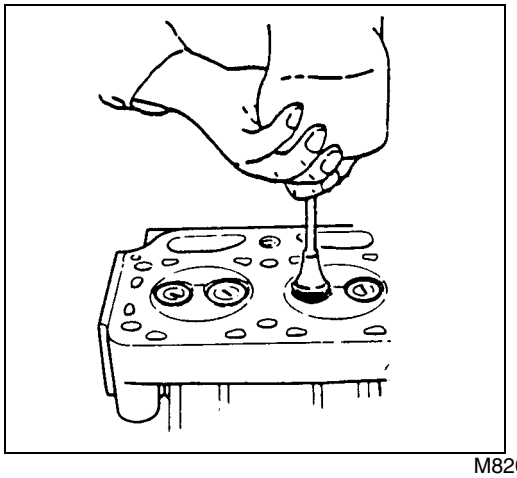
6. Lap valves. See procedure in this group.

NOTE: If valve recession exceeds maximum specifications or seats cannot be reconditioned, replace valves and/or cylinder head.

Valve Lapping:

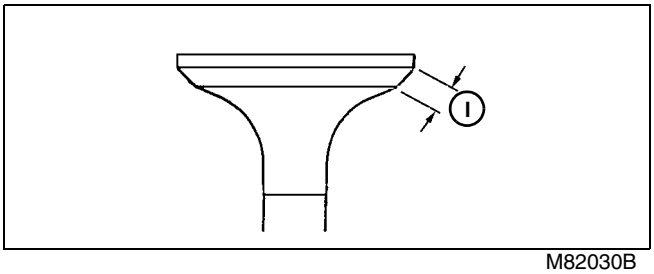
NOTE: Use a rubber type lapping tool for valves without a lapping tool groove slit.

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.



M82030B

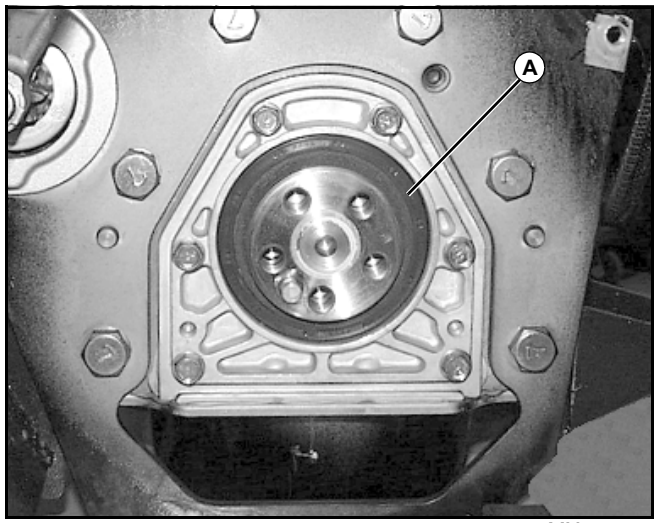
2. Turn valve to lap valve to seat.

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

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.

Crankshaft Rear Oil Seal



MX32344

Picture Note: 3TNE68 shown 3TNV70 similar.

1. Remove flywheel.

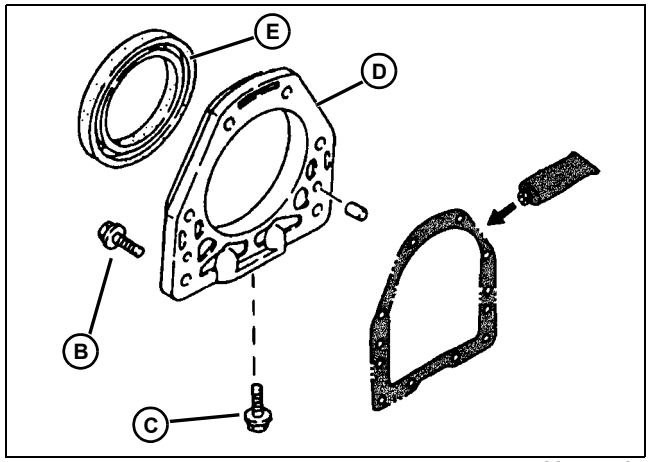
2. Carefully pry oil seal (A) from oil seal case.

3. Replace oil seal using a driver set. Install seal with lip toward cylinder block. Install seal flush with surface of oil seal case.

NOTE: If oil seal has worn a groove in crankshaft at oil seal contact point, seal can be installed 3 mm (0.120 in.) farther into oil seal case.

Rear Oil Seal Case:

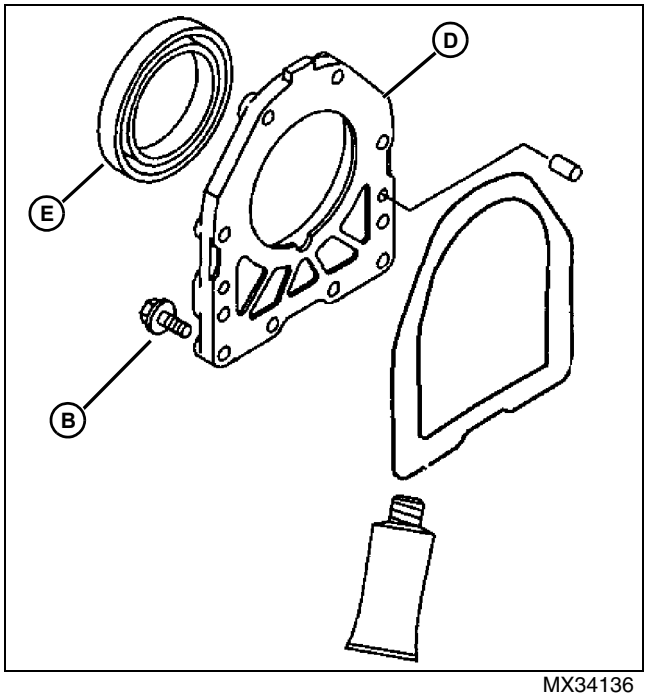
NOTE: It is not necessary to remove oil seal case to remove oil seal, nor is it necessary to remove oil seal to remove oil seal case.



M82279A

Picture Note: 3TNE68

1. Remove six oil seal case-to-block cap screws (B), and two oil pan-to-seal case cap screws (C).



MX34136

Picture Note: 3TNV70

2. Remove ten oil seal case-to-cylinder block cap screws (C).

3. Pry oil seal case (D) from block and oil pan. Note positions of two alignment pins.

4. Clean all old gasket material from seal case and oil pan.

5. Install seal case with form-in-place gasket sealer on mating surfaces to block and to oil pan. Tighten cap screws to specification.

6. Install new oil seal (E) after oil seal case is installed.

7. Install flywheel and tighten five cap screws to specification.

8. Install clutch stub shaft.

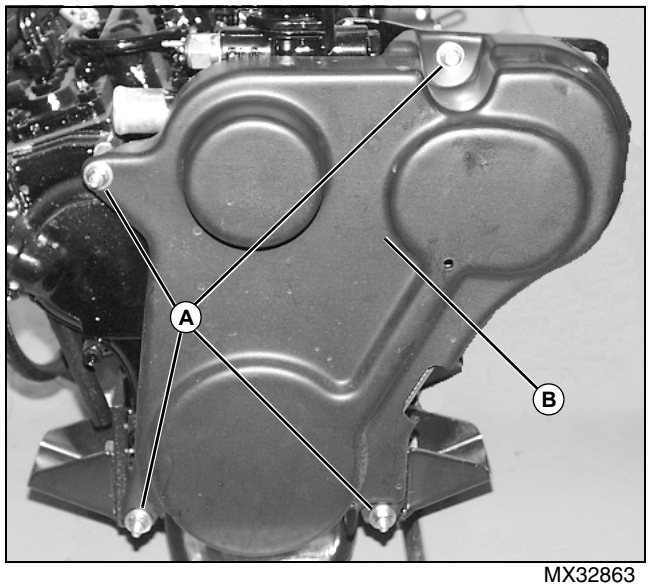
9. Install clutch.

Torque Specifications:

Seal Case-to-Block Cap Screws . . . . . 11 N•m (96 lb-in.)
Flywheel Cap Screws . . . . . 83 N•m (61 lb-ft)
Stub Shaft-to-Flywheel Cap Screws . . 59 N•m (44 lb-ft)
Clutch Mounting Bolt . . . . . 37 N•m (26 lb-ft)

Crankshaft Front Oil Seal

1. Remove engine from machine.



MX32863

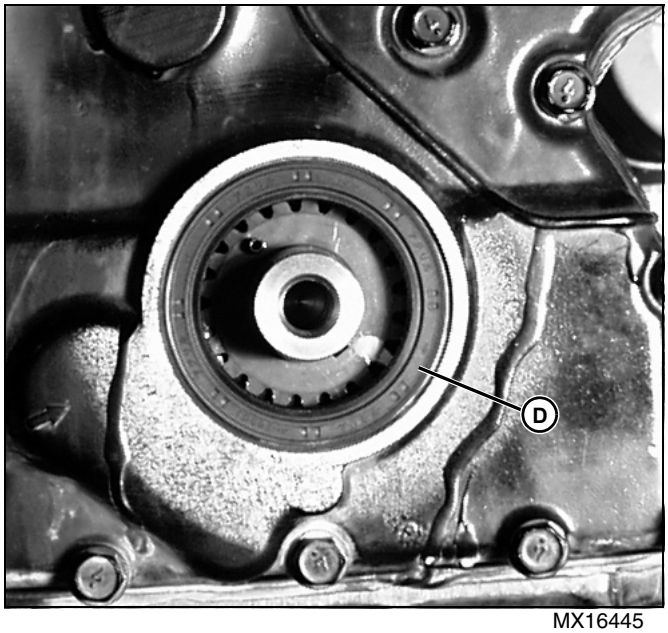
2. Remove fasteners (A) and alternator belt cover (B).

3. Loosen alternator mounts and remove belt.

4. Remove crankshaft pulley mounting bolt and washer.

M89691

5. Install puller to crankshaft sheave and remove sheave (C).



MX16445

6. Carefully pry oil seal (D) from timing cover.

7. Install new oil seal using a driver set. Install seal with lip toward engine. Install seal flush with surface of cover.

8. Coat lip of seal with clean engine oil.

9. Install crankshaft sheave on crankshaft, lining up pin on crankshaft timing gear with hole in crankshaft sheave. Tighten cap screw to specification.

10.Install alternator/water pump belt and adjust belt tension.

11.Install belt cover.

Torque Specification:

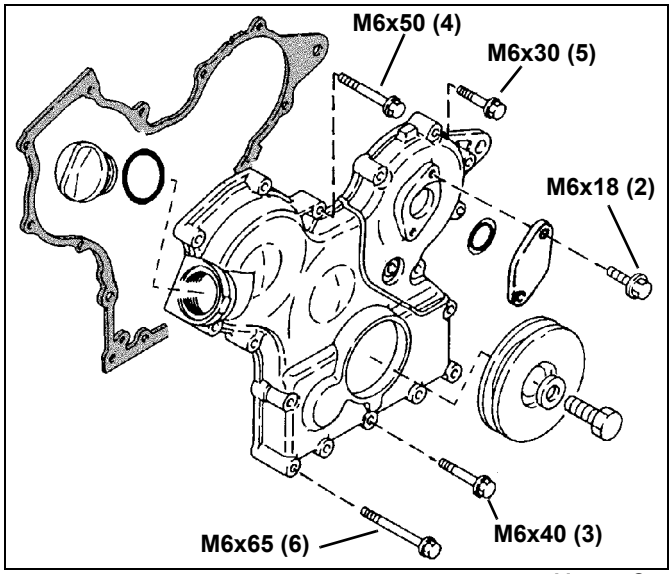
Crankshaft Pulley Cap Screw
. . . . . 113 - 123 N•m (83 - 90 lb-ft)

Timing Gear Cover - 3TNE68

Removal/Installation

1. Remove engine from machine See “Engine Removal and Installation” on page 115.

2. Remove alternator belt cover. Loosen alternator mounting screws and remove alternator/water pump belt.



M82295C

3. Remove crankshaft pulley mounting bolt and washer.

4. Using a puller, remove crankshaft pulley from crankshaft.

NOTE: It is not necessary to remove end cover or end cover o-ring to remove timing gear cover.

5. Remove mounting cap screws and timing gear cover.

6. Clean all old gasket material from timing cover and timing cover housing on block.

7. Apply John Deere Form-In-Place Gasket Sealer to timing cover prior to installation

8. Tighten all cover mounting cap screws to 9 N•m (78 lb-in.).

9. Install crankshaft pulley and tighten cap screw to 88 N•m (65 lb-ft).

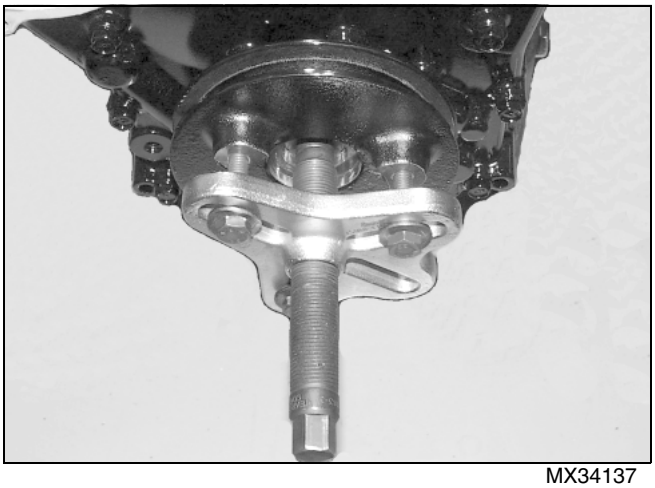
10.Adjust alternator drive belt tension.

11.Install belt cover.

Timing Gear Cover - 3TNV70

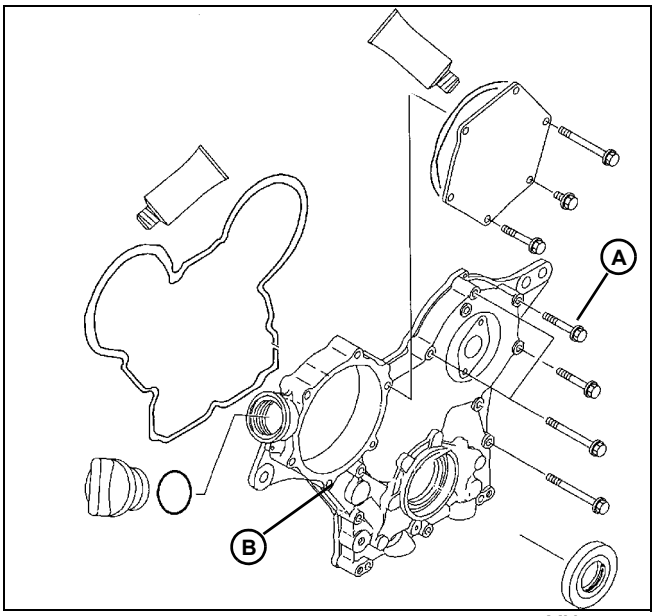
Removal and Installation:

1. Remove alternator.
2. Remove fan, spacer, and sheave from water pump.
3. Remove crankshaft pulley mounting bolt and washer.



MX34137

4. Install puller to crankshaft sheave and remove sheave.



MX34152

5. Remove timing cover mounting cap screws (A).
6. Remove timing gear cover (B) from timing gear housing.
7. Clean all old gasket material from timing gear cover, and timing gear housing on block.
8. Apply a thin bead of John Deere Form-In-Place Gasket Sealer to timing gear cover prior to installation
9. Tighten all timing gear cover mounting cap screws to specification.
10. Install crankshaft pulley, carefully lining up flats on pulley with flats on oil pump rotor and key on crankshaft. Install flat washer with new o-ring. Tighten to specification.
11. Install water pump sheave and fan.
12. Install alternator and drive belt. Adjust belt tension.

Torque Specifications:

Timing Cover Cap Screws . . . . . 9 N•m (79 lb-in.)
Crankshaft Pulley Cap Screw
. . . . . 113 - 123 N•m (83 - 90 lb-ft)

Camshaft End Play Check

Reason:

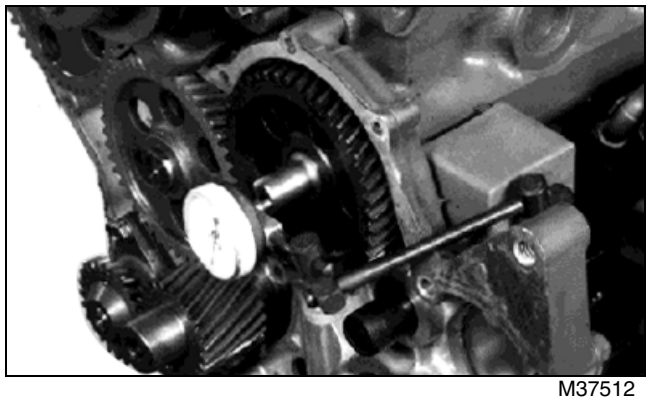
To determine proper side clearance between camshaft gear and camshaft thrust plate, to prevent excessive camshaft-to-camshaft follower wear.

Equipment:

- Dial Indicator

Procedure:

1. Remove timing gear cover.



M37512

2. Fasten dial indicator to engine and position indicator tip on end of camshaft.
3. Push camshaft toward the rear as far as possible.
4. Zero the dial indicator.
5. Pull camshaft forward as far as possible.

End Play Specifications:

Standard . . . . . 0.05 - 0.25 mm (0.002 - 0.010 in.)

Results:

- If end play exceeds specification, remove camshaft and replace thrust plate. See “Camshaft - 3TNE68” on page 137.

Timing Gear Backlash Check

Reason:

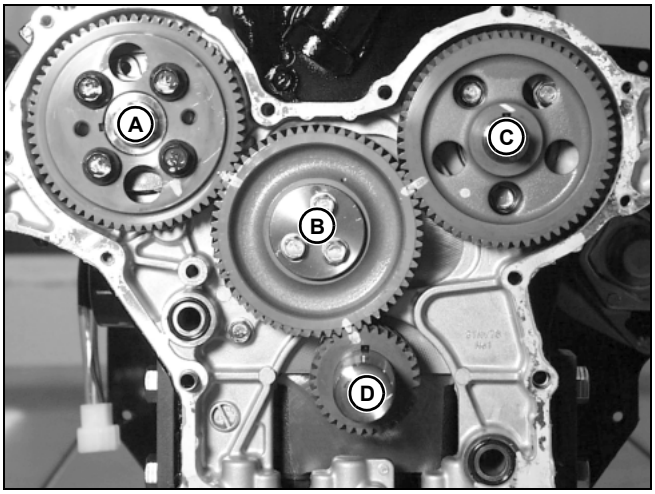
To check for wear between meshing gears, resulting in excessive noise and poor engine performance.

Equipment:

- Dial Indicator

Procedure:

1. Remove timing gear cover.



MX34139

A - Fuel Injection Pump Drive Gear
B - Idler Gear
C - Camshaft Gear
D - Crankshaft 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.

Specifications:

Standard Backlash For All Gears (Except Crankshaft Gear-to-Oil Pump Gear):

Standard . . . . . 0.04 - 0.12 mm (0.002 - 0.005 in.)

Crankshaft Gear-to-Oil Pump:

Gear . . . . . 0.11 - 0.19 mm (0.004 - 0.0075 in.)
Wear Limit . . . . . 0.20 mm (0.008 in.)

Results:

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

Idler Gear, Camshaft Gear, Crankshaft Gear, Oil Pump Gear and/or Idler Gear, Fuel Injection Pump Gear.

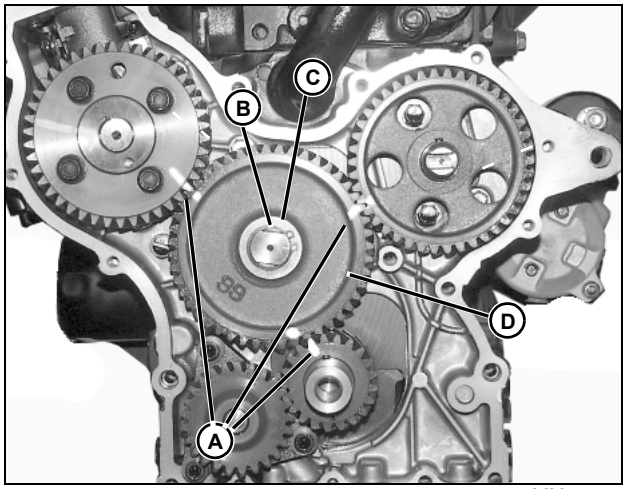
Idler Gear - 3TNE68

Removal:

1. Remove timing gear cover. See “Timing Gear Cover - 3TNE68” on page 132.

2. Check backlash of timing gears. See “Timing Gear Backlash Check” on page 134.

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically. When all timing marks on gears align, the piston closest to the water pump (No. 3) is at TDC on compression stroke. (No. 1 cylinder is closest to the flywheel.)



MX16442

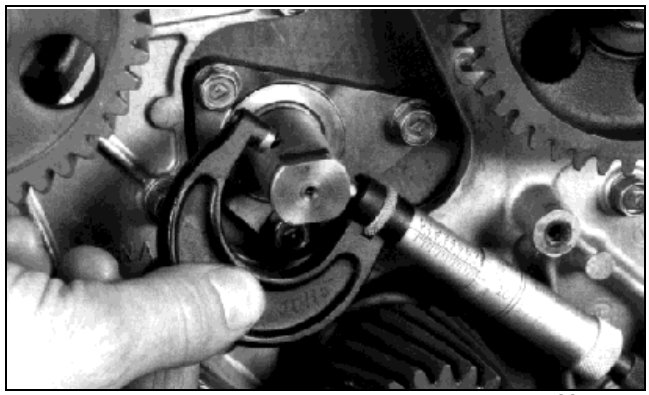
3. Rotate crankshaft and align timing marks (A).

4. Remove snap ring (B), washer (C), and gear (D).

5. Inspect all parts for wear or damage. See Inspection/ Replacement procedures.

Inspection/Replacement:

1. Inspect gear for chipped or broken teeth. Replace if necessary.



M37834

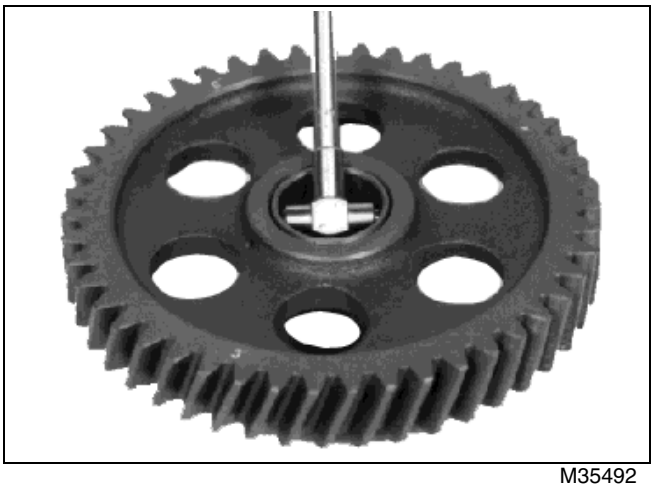
2. Measure idler gear shaft diameter.

Idler Gear Shaft OD:

Standard . . . . . 19.96 - 19.98 mm (0.786 - 0.787 in.)

Wear Limit . . . . . 19.93 mm (0.785 in.)

- If shaft diameter is less than wear limit, replace idler gear shaft.



M35492

3. Measure idler gear bushing diameter.

Idler Gear Bushing ID:

Standard . . . . . 20.00 - 20.021 mm (0.787 - 0.788in.)

Wear Limit . . . . . 20.08 mm (0.791 in.)

Clearance . . . . . 0.15 mm (0.0059 in.)

- If bushing diameter exceeds wear limit, replace bushing.

To replace bushing:

- Replace bushing using a driver set.
- Align oil holes in bushing and idler gear. Install bushing flush with surface of idler gear.
- If bushing clearance (bushing ID minus shaft OD) exceeds specification, replace bushing, shaft or both.

Installation:

Installation is done in the reverse order of removal.

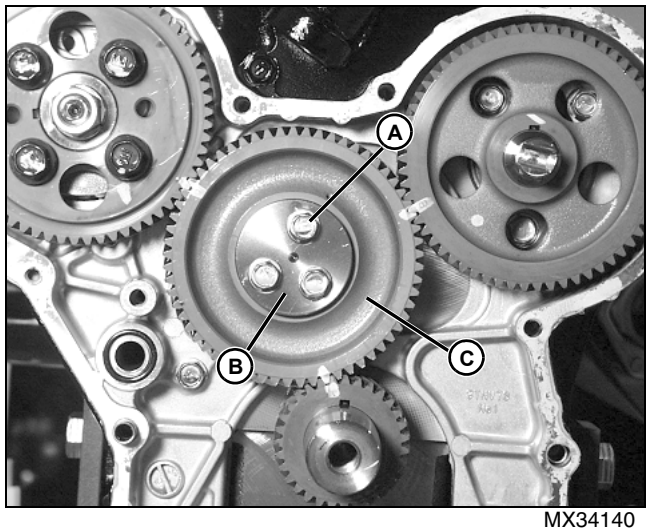
Idler Gear - 3TNV70

Removal and Installation:

1. Remove timing gear cover. See “Timing Gear Cover - 3TNV70” on page 133.

2. Check backlash of timing gears. See “Timing Gear Backlash Check” on page 134.

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically. When all timing marks on gears align, the piston closest to the water pump (No. 3) is at TDC on compression stroke. (No. 1 cylinder is closest to the flywheel.)



MX34140

3. Rotate crankshaft and align timing marks.

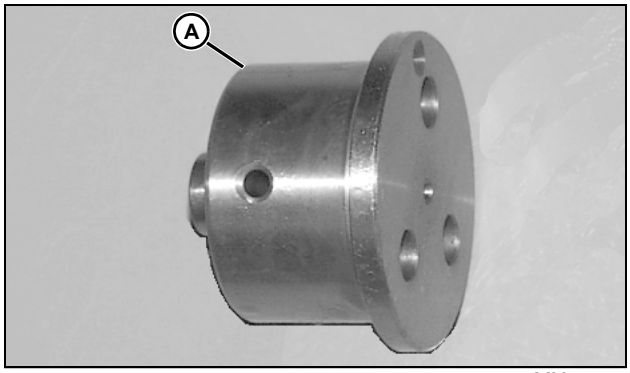
4. Remove three bolts (A), shaft (B) and idler gear (C).

5. Inspect all parts for wear or damage. (See Inspection/ Replacement procedures.)

6. Installation is done in the reverse order of removal.

Inspection/Replacement:

- Inspect gear for chipped or broken teeth. Replace if necessary.
- Measure idler gear shaft diameter.



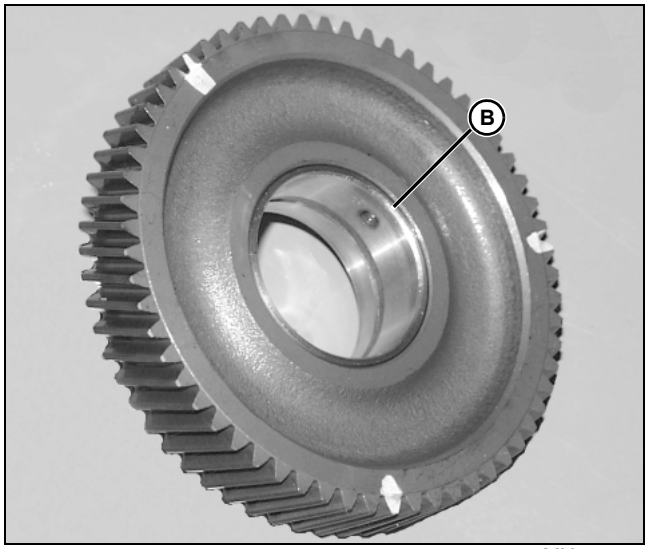
MX34142

Idler Gear Shaft Outside Diameter:

Standard . . . . . 45.95 - 45.98 mm (1.809 - 1.810 in.)
Wear Limit . . . . . 45.90 mm (1.807 in.)

If shaft diameter is damaged or less than wear limit, replace idler gear shaft.

- Measure idler gear bushing diameter.



MX34141

Idler Gear Bushing Inside Diameter (B):

Standard . . . . . 46.0 - 46.08 mm (1.811 - 1.813 in.)
Oil Clearance. . . . . 0.03 - 0.08 mm (0.001 - 0.003 in.)
Wear Limit . . . . . 0.18 mm (0.007 in.)

If bushing diameter exceeds wear limit, replace bushing.

To replace bushing:

- Replace bushing using a driver set. Align oil holes in bushing and idler gear. Install bushing flush with surface of idler gear.

If bushing oil clearance (bushing ID minus shaft OD) exceeds specification, replace bushing, shaft or both.

Cam Followers

Removal:

1. Remove cylinder head. See “Cylinder Head Removal and Installation - 3TNE68” on page 123.

IMPORTANT: Avoid damage! Cam followers must be installed in the same bores from which they were removed.

2. Put a mark on each cam follower and cylinder block bore to aid in installation.

3. Remove cam followers from cylinder block with magnetic pick-up tool.

4. Inspect all parts for wear or damage. See Inspection procedures.

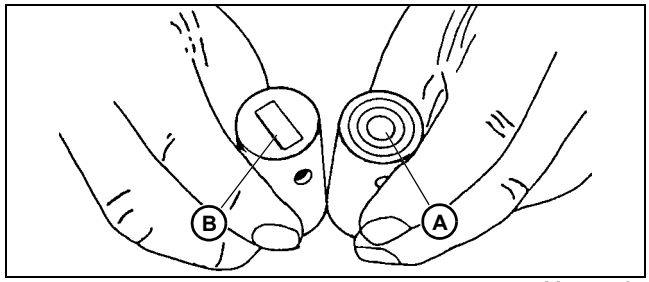
Installation:

Installation is done in the reverse order of removal.

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

2. Install cam followers after camshaft is installed.

Inspection:



M82293A

1. Inspect cam follower contact surface for abnormal wear. Normal wear (A) has circles around the lifter base and base has flat surface. Abnormal wear (B) occurs when cam follower does not spin in the bore and the cam starts wearing away the follower. Replace if necessary.

NOTE: Camshaft and lifters should be replaced as a set.


M35268

2. Measure cam follower diameter.

Cam Follower OD Specifications - 3TNE68:

Standard . . . . . 17.95 - 17.97 mm (0.707 - 0.708 in.)
Wear Limit. . . . . 17.93 mm (0.706 in.)

Cam Follower OD Specifications - 3TNV70:

Standard . . . . . 20.93 - 20.96 mm (0.824 - 0.825 in.)
Wear Limit. . . . . 20.90 mm (0.823 in.)

IMPORTANT: Avoid damage! Always replace all camshaft followers when installing a new camshaft. Always replace camshaft when installing new followers.

- If stem diameter is less than wear limit, replace cam follower.

3. Measure cam follower bore diameter in cylinder block.

Cam Follower Bore ID Specifications - 3TNE68:

Standard . . . . . 18.000 - 18.018 mm (0.7087 - 0.7094 in.)

Wear Limit . . . . . 18.05 mm (0.711 in.)

Clearance . . . . . 0.032 - 0.068 mm (0.0013 - 0.0027 in.)

Cam Follower Bore ID Specifications - 3TNV70:

Standard . . . . . 21.00 - 21.02 mm (0.827 - 0.828 in.)

Wear Limit . . . . . 21.04 mm (0.828 in.)

- If cam follower bore diameter exceeds wear limit, replace cylinder block.
- If bore clearance (bore ID minus follower stem OD) exceeds specification, replace cam follower, cylinder block or both.

Follower-to-Bore Oil Clearance:

Standard . . . . . 0.04 - 0.09 mm (0.002 - 0.004 in.)

Wear Limit . . . . . 0.13 mm (0.005 in.)

Camshaft - 3TNE68

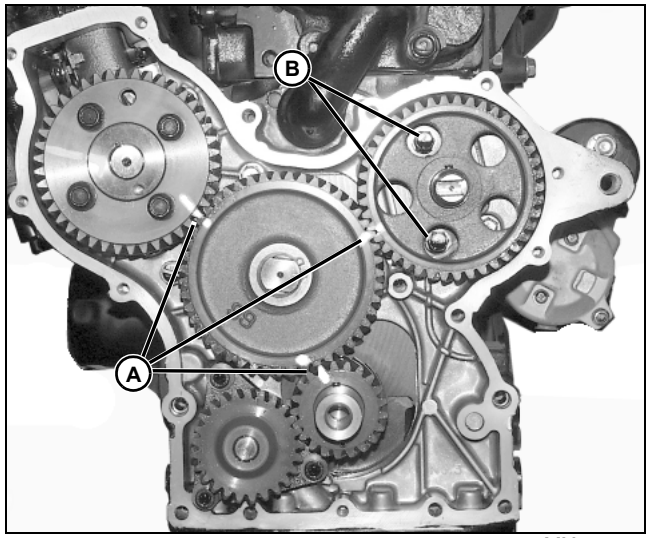
Removal:

1. Remove rocker arm assembly and push rods. See “Rocker Arm and Push Rods - 3TNE68” on page 120.
2. Remove timing gear cover. See “Timing Gear Cover - 3TNE68” on page 132.
3. Check camshaft end play. See “Camshaft End Play Check” on page 133.
4. Check backlash of timing gears. See “Timing Gear Backlash Check” on page 134.

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.

5. Hold cam followers away from camshaft using a magnetic follower holder kit such as D15001NU.

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically.



MX16442

6. Rotate crankshaft and align timing marks (A).

IMPORTANT: Avoid damage! Do not allow camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces can be damaged.

7. Remove two cap screws (B) holding camshaft mounting flange to block (through holes in camshaft gear).
8. Inspect all parts for wear or damage. See Inspection/ Replacement procedures.

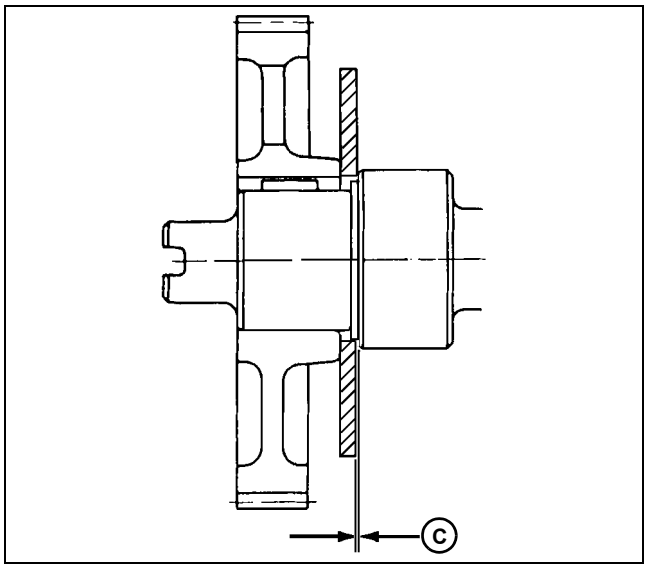
Installation:

- Apply clean engine oil on all parts during installation.

IMPORTANT: Avoid damage! Do not allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces can be damaged.

1. Rotate crankshaft to align timing marks.
2. Install camshaft.
3. Install and tighten mounting cap screws to 11 N•m (96 lb-in.).
4. Install timing gear cover. See “Timing Gear Cover - 3TNE68” on page 132.
5. Install push rods and rocker arm assembly. See “Rocker Arm and Push Rods - 3TNE68” on page 120.

Inspection/Replacement:



M82067A

1. Check camshaft side gap (C) between thrust plate and camshaft using a feeler gauge.

Camshaft Side Gap:

Standard . . . . . 0.05 - 0.25 mm (0.002 - 0.010 in.)

- If side gap is at wear limit, remove gear and replace thrust plate.

2. Inspect gear for chipped or broken teeth. Replace if necessary.

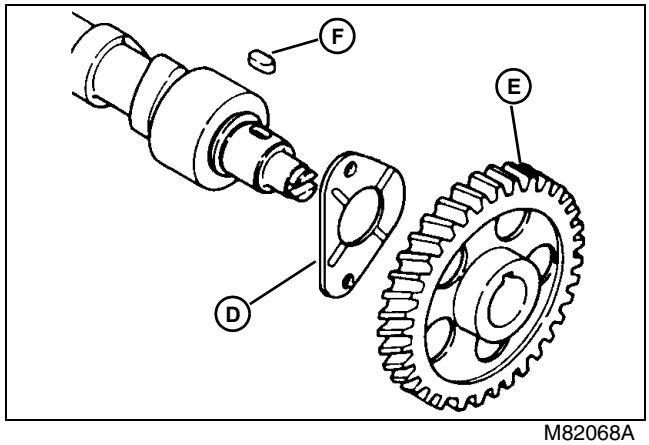
To Remove/Replace Gear:

1. Remove gear from camshaft using a knife-edge puller and a press.

CAUTION: Avoid Injury! Do not heat oil over 182° C (360° F). Oil fumes or oil can ignite above 193° C (380° F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

2. Heat gear to approximately 150°C (300°F).

IMPORTANT: Avoid damage! Be sure thrust plate is not between camshaft gear and camshaft shoulder while installing gear.

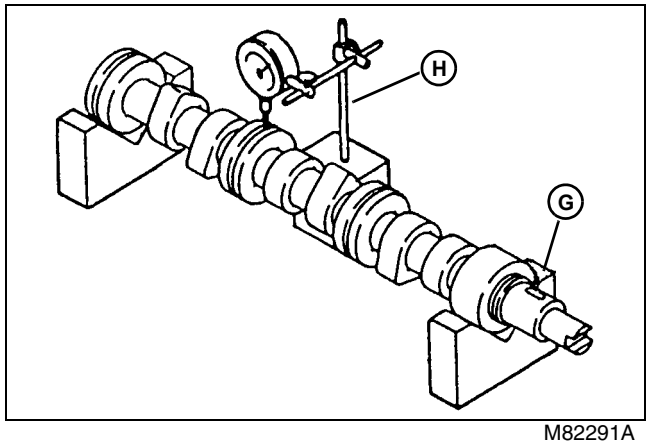


M82068A

3. Install thrust plate (D) if removed. Install gear (E) with timing mark “C” side toward press table.

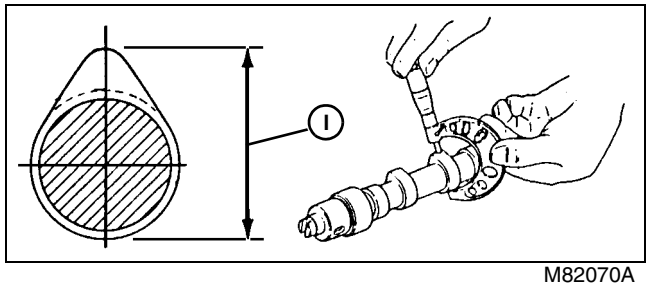
4. Align slot in gear with key (F) in shaft. Press camshaft into gear until gear is tight against camshaft shoulder.

NOTE: Thrust plate must spin freely on camshaft.



M82291A

5. Inspect camshaft for bend using V-blocks (G) and a dial indicator (H). Turn camshaft slowly and read variation on indicator. If variation is greater than 0.02 mm (0.001 in.), replace camshaft.



M82070A

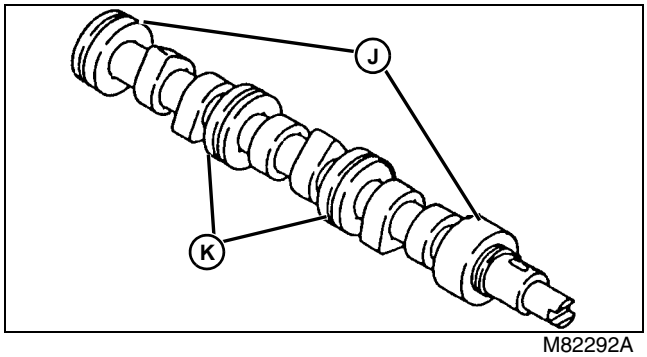
6. Measure camshaft lobe height (I).

Lobe Height Specifications:

Standard . . . . . 29.97 - 30.03 mm (1.180 - 1.182 in.)

Wear Limit. . . . . 29.75 mm (1.171 in.)

- If lobe height is less than wear limit, replace camshaft.



M82292A

7. Measure camshaft end (J) and intermediate journal (K) diameters.

Camshaft Journal OD Specifications:

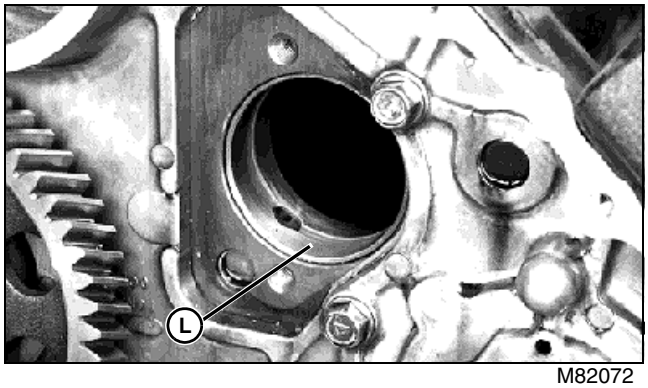
Gear Housing and Flywheel Ends
Standard . . . . . 35.94 - 35.96 mm (1.415 - 1.416 in.)

Wear Limit . . . . . 35.85 mm (1.411 in.)

Intermediate Journal OD
Standard . . . . . 35.91 - 35.94 mm (1.414 - 1.415 in.)

Wear Limit . . . . . 35.85 mm (1.411 in.)

- If journal diameters are less than wear limit, replace camshaft.



M82072

8. Measure diameter of camshaft bushing (L) at gear housing end.

Camshaft Bushing ID Specifications:

Standard . . . . . 36.00 - 36.065 mm (1.417 - 1.420 in.)

Wear Limit . . . . . 36.10 mm (1.421 in.)

Clearance . . . . . 0.18 mm (0.007 in.)

- If bushing diameter exceeds wear limit, replace bushing.
- If bushing clearance (bushing ID minus camshaft journal OD) exceeds specification, replace bushing, camshaft or both.

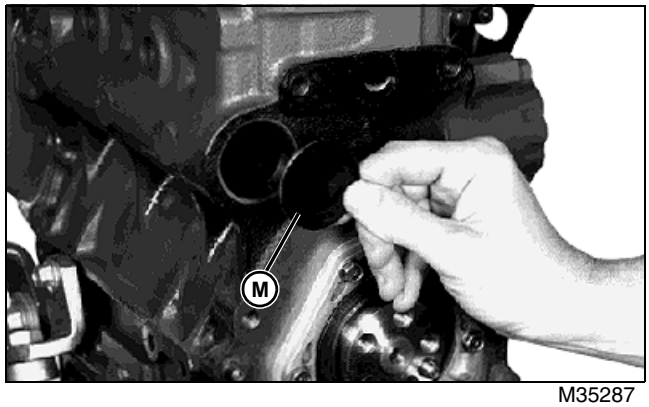
To Replace Bushing:

1. Remove and replace bushing using a bushing driver. Be careful not to push bushing inside of engine. Align oil holes in new bushing and cylinder block.

NOTE: Engine back plate must be removed to measure camshaft intermediate and flywheel end bearing diameters.

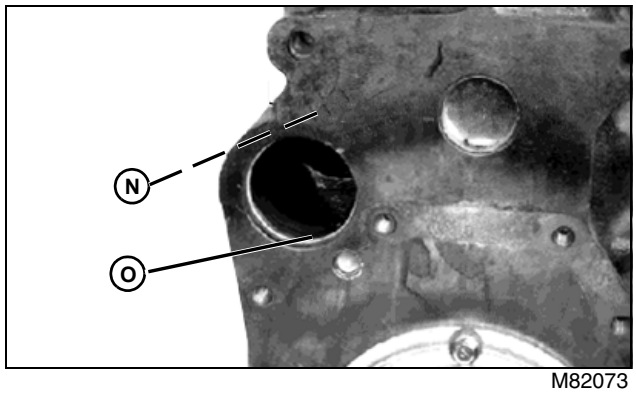
2. Measure intermediate and flywheel end camshaft bore diameters using the following procedures:

- Remove engine back plate.



M35287

- Remove plug (M) using a long wooden dowel. Insert wooden dowel through gear housing side.



M82073

- Measure intermediate (N) and flywheel end (O) camshaft bore diameters.

Camshaft Bore ID Specifications:

Standard . . . . . 36.00 - 36.025 mm (1.417 - 1.418 in.)

Wear Limit . . . . . 36.10 mm (1.421 in.)

Clearance . . . . . 0.18 mm (0.007 in.)

- If bore diameter exceeds wear limit, replace cylinder block.
- If bore clearance (bore ID minus camshaft journal OD) exceeds specification, replace camshaft, cylinder block or both.

3. Apply John Deere Form-In Place Gasket, or an equivalent, on outer edge of plug. Install plug until it bottoms in bore.

4. Install engine back plate.

Camshaft - 3TNV70

IMPORTANT: Avoid damage! Always replace all camshaft followers when installing a new camshaft. The components wear as a set and replacing only one of the components will accelerate wear on the other.

Camshaft Removal:

1. Remove rocker arm assembly and push rods. See “Rocker Arm and Push Rods - 3TNV70” on page 121.

2. Remove timing gear cover. See “Timing Gear Cover - 3TNV70” on page 133.

3. Check camshaft end play. See “Camshaft End Play Check” on page 133.

4. Check backlash of timing gears. See “Timing Gear Backlash Check” on page 134.

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.

5. Hold cam followers away from camshaft using a magnetic follower holder kit such as D15001NU.

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically.

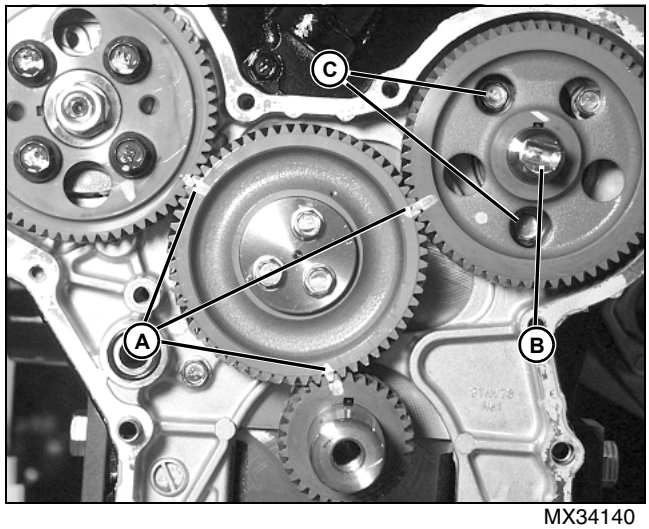
6. Rotate crankshaft and align timing marks.

IMPORTANT: Avoid damage! DO NOT allow camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces can be damaged.

7. Remove two cap screws (C) holding camshaft mounting flange to block (through holes in camshaft gear).

8. Inspect all parts for wear or damage. See “Camshaft Inspection:” on page 141.

Camshaft Installation:



MX34140

- Apply clean engine oil on all parts during installation.

IMPORTANT: Avoid damage! DO NOT allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces can be damaged.

1. Rotate crankshaft to align timing marks (A).

2. Install camshaft (B) into cylinder block, being careful not to allow camshaft lobes to scratch camshaft bushings. Align camshaft gear timing marks with timing marks on idler gear.

3. Install two camshaft thrust plate cap screws (C) through holes in cam gear. Tighten to specification.

4. Install timing gear cover. See “Timing Gear Cover - 3TNV70” on page 133.

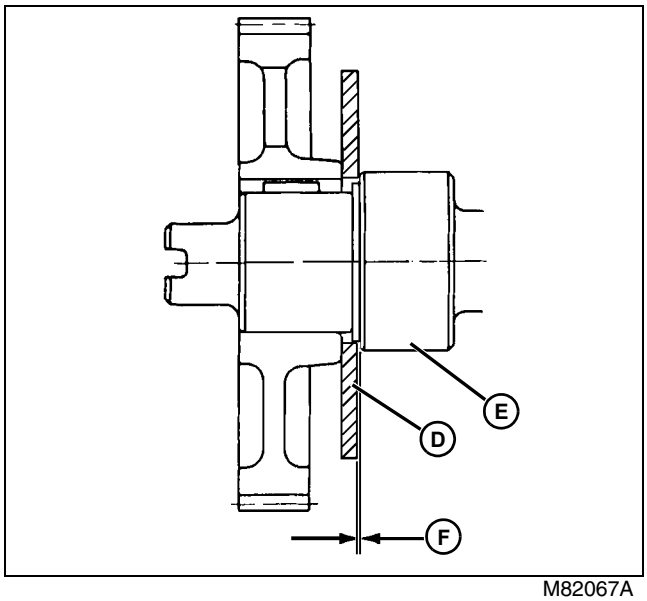
5. If cam followers were removed, replace into same holes as removed.

6. Install push rods and rocker arm assembly. See “Rocker Arm and Push Rods - 3TNV70” on page 121.

Torque Specification:

Camshaft Cap Screws . . . . . 11 N•m (97 lb-in.)

Camshaft Side Gap Measurement:



M82067A

1. Check camshaft end play while camshaft is installed in cylinder block using a dial indicator, as described in See "Camshaft End Play Check" on page 133.

Check camshaft side gap while camshaft is removed from cylinder block using a feeler gauge between camshaft thrust plate (D) and front side of first camshaft bearing journal (E), as shown below.

Camshaft Side Gap (F):

Standard . . . . . 0.05 - 0.15 mm (0.002 - 0.006 in.)

- If side gap is excessive, remove gear and replace thrust plate.

Camshaft Gear Removal:

1. Inspect gear for chipped or broken teeth. Replace if necessary.

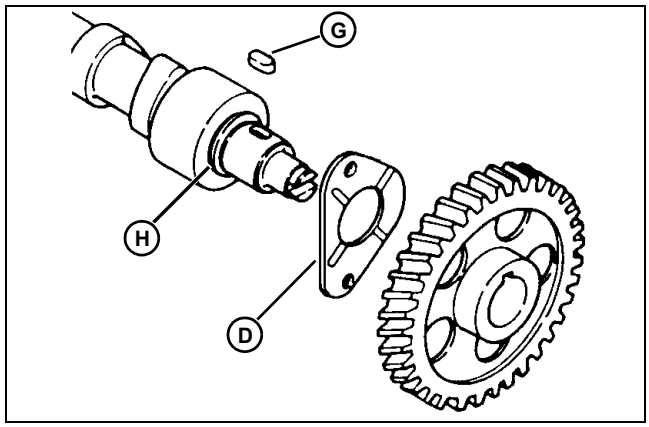
2. Remove gear from camshaft using a knife-edge puller and an arbor press. Place flat side of puller against camshaft gear.

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)**.

IMPORTANT: Avoid damage! Be sure thrust plate is not trapped between camshaft gear and stepped shoulder while gear is being pressed on.



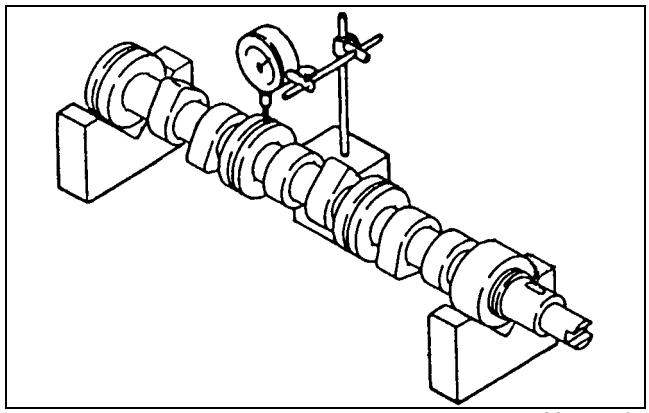
M82068A

2. Install key (G) into slot of camshaft.

3. Install thrust plate (D) onto camshaft, centering onto stepped shoulder (H). (Thrust plate has no "front" or "rear" side.)

4. Install heated camshaft gear 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. See "Important" above. Thrust plate must spin freely on camshaft.

Camshaft Inspection:

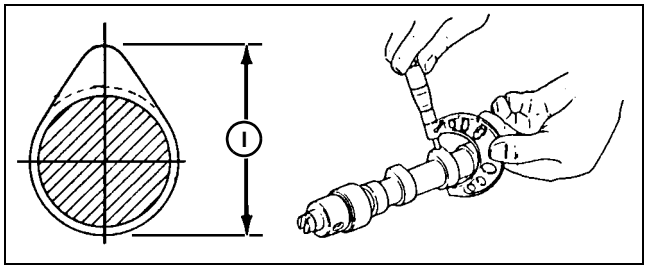

M82291A

1. Inspect camshaft for bend by using a pair of V-blocks and a dial indicator. Turn camshaft slowly and read variation on indicator. If variation is greater than wear limit, replace camshaft.

Camshaft Bend Specification:

Standard . . . . . 0.00 - 0.02 mm (0.00 - 0.001 in.)

Wear Limit. . . . . 0.05 mm (0.002 in.)



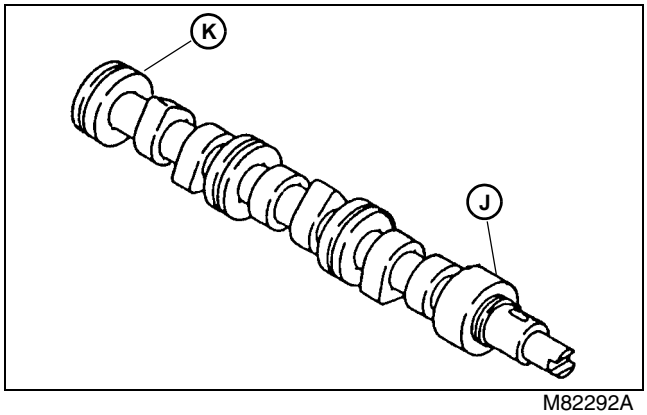
M82070A

2. Measure camshaft lobe height (I) 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.

Camshaft Lobe Height:

Standard . . . . . 34.14 - 34.27 mm (1.343 - 1.349 in.)

Wear Limit . . . . . 33.89 mm (1.334 in.)



M82292A

3. Measure camshaft end journals and intermediate journal outside diameters.

Camshaft Bearing Journal Specifications:

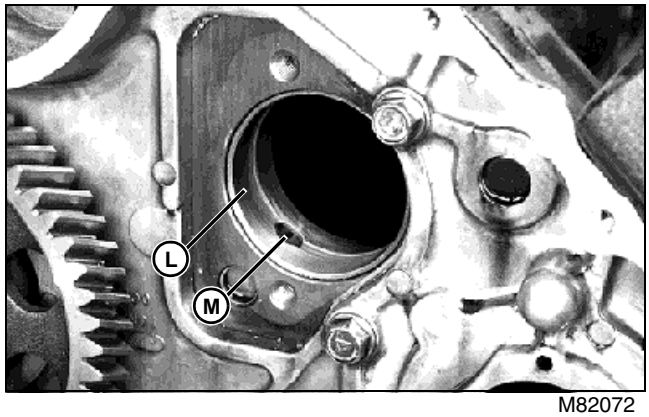
Gear Side (J) and Flywheel (K) End Journals:
Standard . . . . . 39.94 - 35.96 mm (1.572 - 1.573 in.)

Wear Limit . . . . . 39.91 mm (1.571 in.)

Intermediate Journal OD:
Standard . . . . . 39.91 - 39.94 mm (1.571 - 1.572 in.)

Wear Limit . . . . . 39.88 mm (1.569 in.)

If journal diameters are less than wear limit, replace camshaft.



M82072

4. Measure camshaft bushing (L) diameter at gear housing end.

Camshaft Bushing ID:

Standard . . . . . 40.0 - 40.08 mm (1.575 - 1.578 in.)

Wear Limit . . . . . 40.15 mm (1.580 in.)

Oil Clearance . . . . . 0.04 - 0.14 mm (0.002 - 0.005 in.)

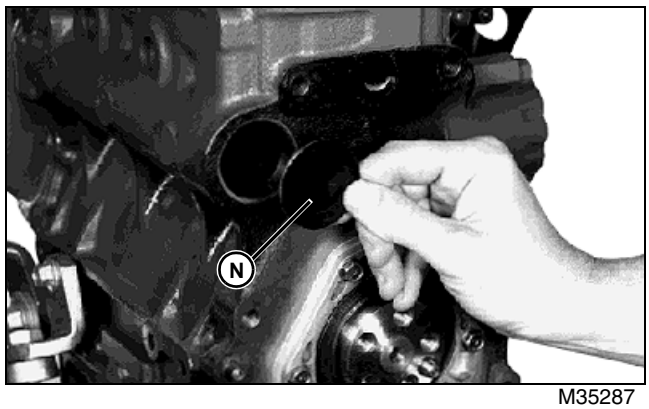
- If bushing diameter exceeds wear limit, replace bushing.
- If bushing oil clearance (bushing ID minus camshaft journal OD) exceeds specification, replace bushing, camshaft or both.
- To replace bushing:

  Remove and replace bushing using a bushing driver. Be careful not to push bushing inside of engine. Align oil holes (M) in new bushing and cylinder block.

NOTE: Engine back plate must be removed to measure camshaft intermediate and flywheel end bearing diameters.

5. Measure intermediate and flywheel end camshaft bore diameters using the following procedures:

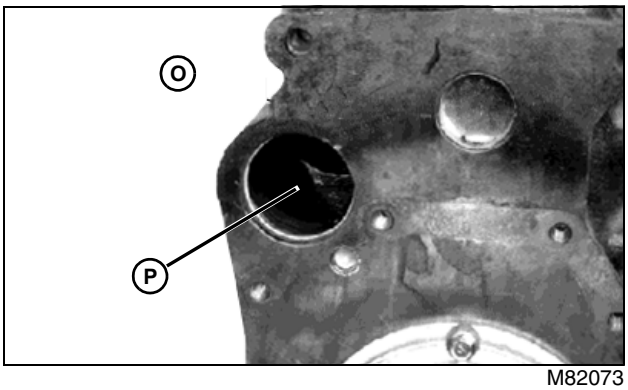
- Remove engine back plate.



M35287

- Remove plug (N) using a long wooden dowel. Insert wooden dowel through gear housing side.

• Measure intermediate (O) and flywheel end camshaft bore (P) diameters.



M82073

Camshaft Intermediate Bore ID's:

Standard . . . . . 40.0 - 40.03 mm (1.575 - 1.576 in.)
Wear Limit . . . . . 40.1 mm (1.579 in.)
Oil Clearance. . . . . 0.07 - 0.12 mm (0.003 - 0.005 in.)

Camshaft Flywheel-End Bore ID's:

Standard . . . . . 40.0 - 40.03 mm (1.575 - 1.576 in.)
Wear Limit . . . . . 40.1 mm (1.579 in.)
Oil Clearance. . . . . 0.04 - 0.09 mm (0.002 - 0.003 in.)

If bore diameter exceeds wear limit, replace cylinder block.

If bore clearance (bore ID minus camshaft journal OD) exceeds specification, replace camshaft, cylinder block or both.

• Apply John Deere Form-In Place Gasket, or an equivalent, on outer edge of plug. Install plug until it bottoms in bore.

• Install engine back plate.

Oil Pan and Strainer

Removal:

1. Drain engine oil.

2. Remove cap screws securing oil pan. Remove oil pan and remove old gasket material.

3. Remove cap screws securing oil strainer. Remove oil strainer.

Installation:

1. Clean gasket mating surfaces and apply thin bead of John Deere Form-In Place Gasket on both sides of oil pan spacer.

2. Install oil strainer with new O-ring and tighten cap screws to specification.

3. Install oil pan and tighten cap screws to specification.

Oil Pan Torque Specifications:

Pan-to-Engine. . . . . 11 N•m (96 lb-in.)

Pan-to-Oil Seal Case . . . . . 9 N•m (78 lb-in.)

Pan-to-Timing Gear Housing . . . . . 9 N•m (78 lb-in.)

4. Install drain plug with new washer.

5. Fill crankcase to proper lever with correct engine oil. See "Specifications - 3TNE68" on page 67.

Connecting Rod Side Play Check

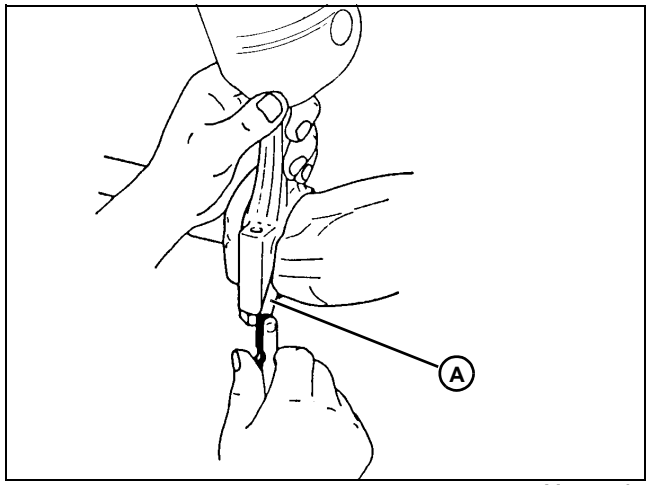
Reason:

To determine proper side clearance between crankshaft and connecting rod.

Equipment:

• Feeler Gauge

Procedure:



M82116A

1. Measure between connecting rod cap and crankshaft with a feeler gauge (A). Compare measurement with specification below.

Specifications:

Standard
Clearance . . . . . 0.20 - 0.40 mm (0.008 - 0.016 in.)

Results:

• If side play exceeds specification, replace connecting rod and connecting rod cap.

Crankshaft End Play Check

Reason:

To determine condition of thrust bearings for proper side clearance between crankshaft and engine block.

Equipment:

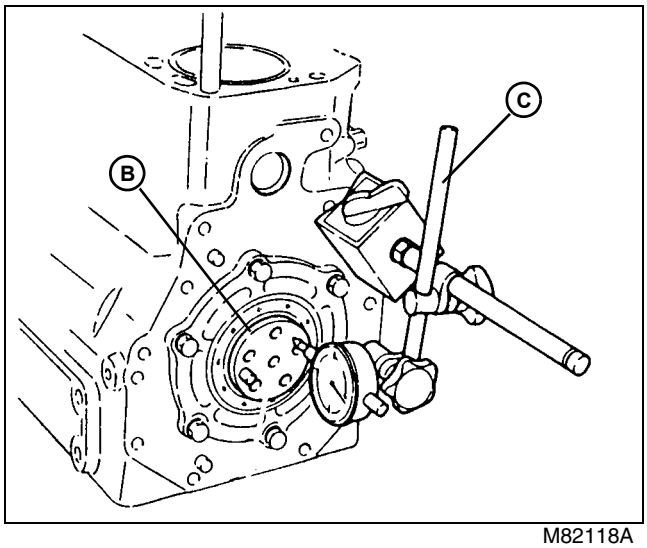
- Dial Indicator

Procedure:

NOTE: Crankshaft end play can be measured at front end or rear end of crankshaft.

1. Fasten dial indicator to engine and position indicator tip on end of crankshaft.

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



M82118A

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

Crankshaft End-Play Specifications - 3TNE68:

End Play . . . . . 0.090 - 0.271 mm (0.004 - 0.011 in.)

Crankshaft End-Play Specifications - 3TNV70:

End Play . . . . . 0.11 - 0.25 mm (0.004 - 0.010 in.)

Results:

If end play exceeds wear limit, replace thrust bearings.

Connecting Rod Bearing Clearance Check

Reason:

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

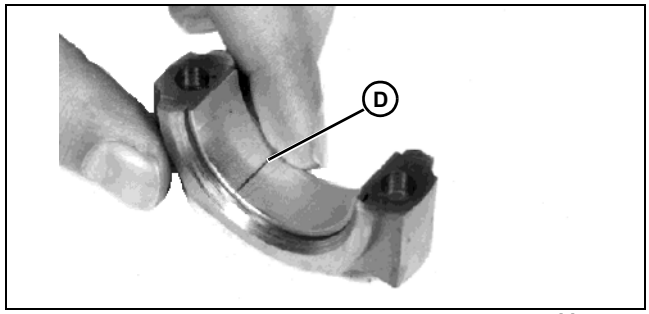
Equipment:

- PLASTIGAGE®

Procedure:

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.

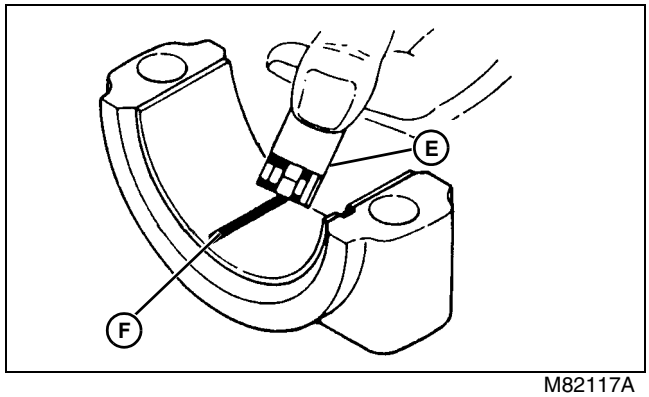
1. Remove connecting rod cap.
2. Wipe oil from bearing insert and crankshaft journal.



M35351

3. Put a piece of PLASTIGAGE®, (D) or an equivalent, along the full length of the bearing insert approximately 6 mm (0.25 in.) off center.
4. Turn crankshaft approximately 30° from bottom dead center.
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 crankshaft journal.



M82117A

7. Use the graduation marks on the envelope (E) to compare the width of the flattened PLASTIGAGE® (F) at its widest point.

8. Determine bearing clearance. The number within the graduation marks indicates the bearing clearance in inches or millimeters depending on which side of the envelope is used.

9. Remove PLASTIGAGE®.

Specifications:

Rod Cap Bolts . . . . . 22.6 - 27.5 mm (16.6 - 20.2 lb-ft)
Standard . . . . . 0.02 - 0.07 mm (0.001 - 0.002 in.)
Wear Limit . . . . . 0.15 mm (0.006 in.)

Results:

- If clearance exceeds specification, replace bearing inserts.

Crankshaft Main Bearing Clearance Check

Reason:

To measure oil clearance between main bearing and crankshaft journal.

Equipment:

- PLASTIGAGE®

PLASTIGAGE® is a registered trademark of the DANA Corporation.

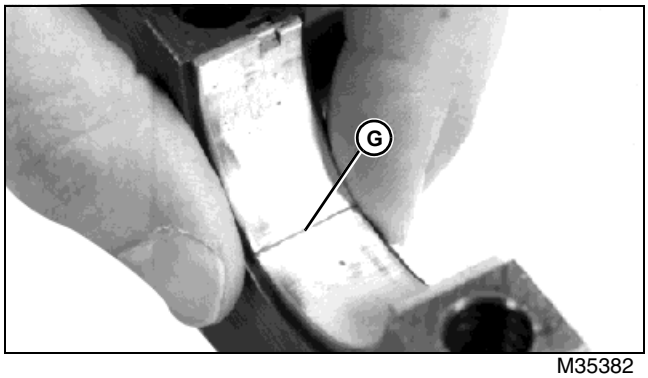
Procedure:

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

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

1. Remove main bearing cap.

2. Wipe oil from bearing insert and crankshaft journal.



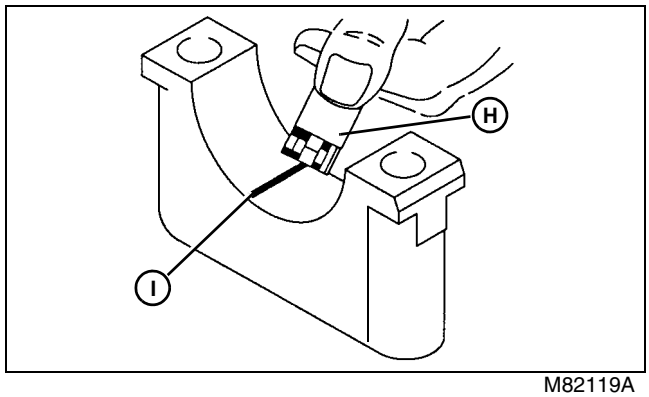
M35382

3. Place a piece of PLASTIGAGE®, (G) or an equivalent, along the full length of the bearing insert approximately 6 mm (0.250 in.) off center.

4. Install main bearing cap and cap screws. Tighten cap screws to specification.

5. Remove cap screws and main bearing cap.

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



M82119A

6. Use the graduated marks on the envelope (H) to compare the width of the flattened PLASTIGAGE® (I) at its widest point.

7. Determine main bearing clearance. The number within the graduation marks indicates the bearing clearance in inches or millimeters depending on which side of the envelope is used.

8. Remove PLASTIGAGE®.

Specifications:

Main Bearing Cap Screws
. . . . . 75.5 - 81.5 N•m (55.6 - 60 lb-ft)
Standard Clearance . . 0.02 - 0.07 mm (0.001 - 0.003 in.)
Wear Limit . . . . . 0.15 mm (0.006 in.)

Results:

- If clearance exceeds specification, replace bearing inserts.

Piston-To-Cylinder Head Clearance

1. Place small pieces of solder or clay in three positions on the flat part of the piston head.

2. Install cylinder head and old gasket. Install cylinder head cap screws and tighten in proper sequence to specified torque. See “Cylinder Head Removal and Installation - 3TNE68” on page 123 or See “Cylinder Head Removal and Installation - 3TNV70” on page 124.

3. Slowly turn crankshaft one complete revolution.

4. Remove cylinder head and gasket.

5. Measure thickness of flattened pieces of solder. Calculate average thickness of solder pieces to obtain piston-to-cylinder head clearance specification.

Piston-to-Cylinder Head Specification - 3TNE68:

Clearance . . . . . 0.59 - 0.74 mm (0.023 - 0.029 in.)

Piston-to-Cylinder Head Specification - 3TNV70:

Standard . . . . . 0.82 ± 0.07 mm (0.032 ± 0.003 in.)

Results:

- If clearance is less than specifications, replace cylinder head.

Connecting Rod Repair

Removal:

1. Remove oil pan and strainer tube. See “Oil Pan and Strainer” on page 143.

2. Remove cylinder head. See “Cylinder Head Removal and Installation - 3TNE68” on page 123 or See “Cylinder Head Removal and Installation - 3TNV70” on page 124.

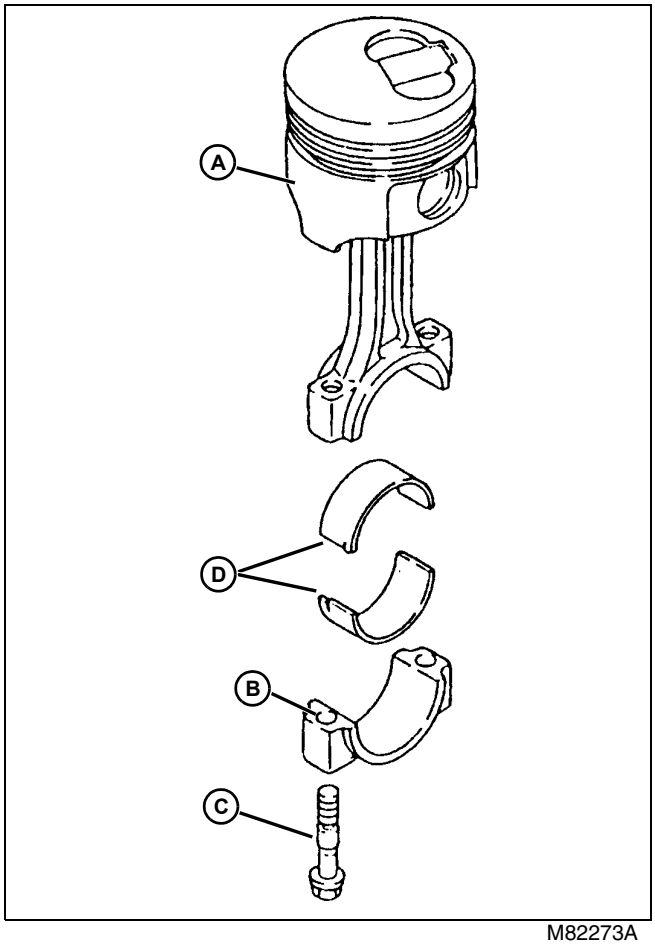
3. Check cylinder bore for ridges. These ridges can cause damage to piston if ridge is not removed.

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

5. Measure connecting rod side play. See “Connecting Rod Side Play Check” on page 143.

6. Measure connecting rod bearing clearance. See “Connecting Rod Bearing Clearance Check” on page 144.

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



M82273A

7. Remove two cap screws (C) and connecting rod cap (B).

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

8. Note connecting rod alignment mark in relation to the cylinders. Starting at flywheel end with cylinder number one, then two, etc.

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

10. Remove bearing inserts (D).

11. Disassemble and inspect all parts for wear or damage. See Disassembly and Inspection/Replacement procedures.

Inspection/Replacement:

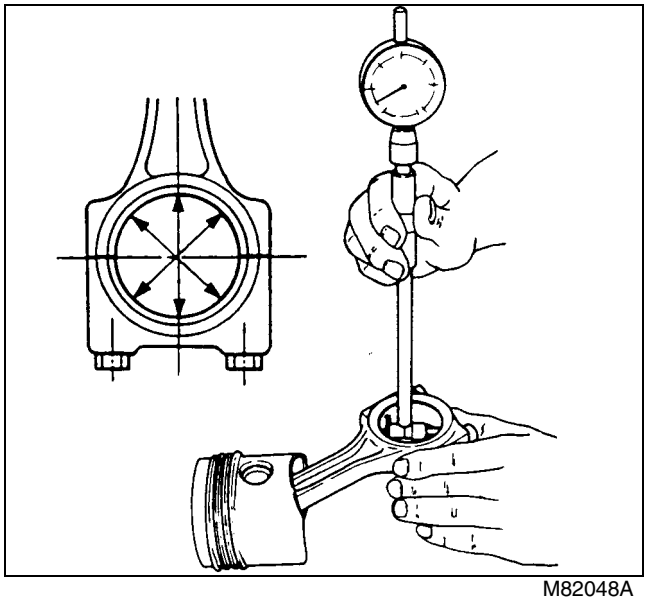
1. Inspect all parts for wear or damage. Replace as necessary.

2. Measure crankshaft connecting rod journal diameter. See Crankshaft, Main Bearings and Flywheel in this section.

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

Torque Specification:

Connecting Rod Cap Screw
. . . . . 22.6 - 27.5 N•m (16.6 - 20.2 lb-ft.)



M82048A

4. Measure connecting rod bearing diameter.

Connecting Rod Bearing ID - 3TNE68:

Standard . . . . . 35.970 - 35.980 mm (1.417 - 1.419 in.)

Wear Limit . . . . . 35.91 mm (1.414 in.)

Clearance . . . . . 0.16 mm (0.006 in.)

Connecting Rod Bearing ID - 3TNV70:

Standard . . . . . 41.98 - 42.00 mm (1.653 - 1.654 in.)

Bearing Thickness . . . . . 1.50 - 1.51 mm (0.059 in.)

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

Clearance Wear Limit . . . . . 0.11 mm (0.004 in.)

- If bearing diameter exceeds wear limit, replace bearing inserts.
- If bearing clearance (bearing ID minus crankshaft journal OD) exceeds specification, grind crankshaft connecting rod journals and install undersized bearing inserts, or replace bearing inserts and crankshaft.

5. With rings installed on piston, measure piston ring groove clearance. Measure several places around each piston.

Installation:

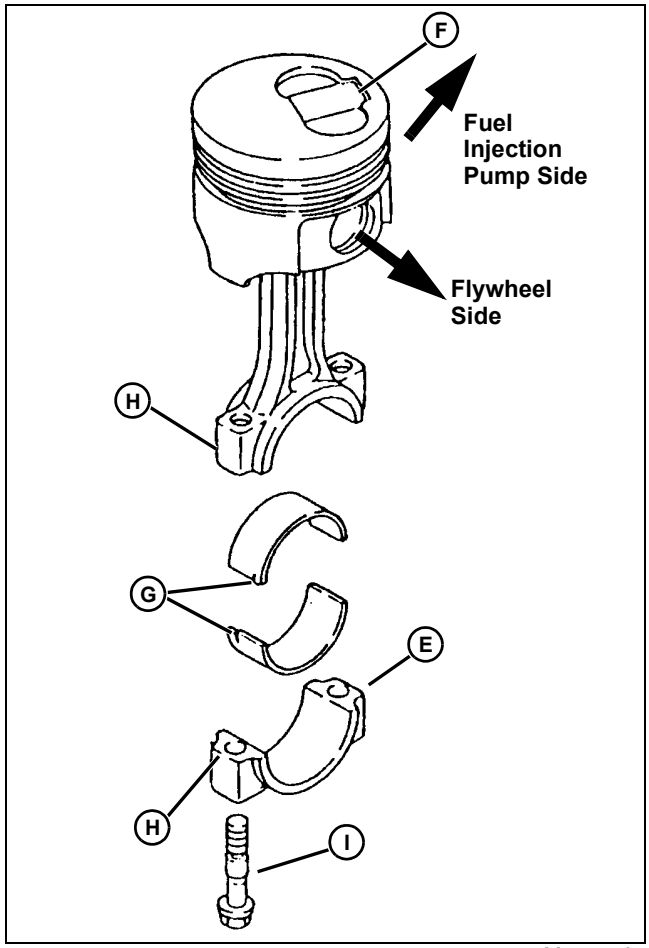
Installation is done in reverse order of removal.

- Apply clean engine oil on all parts during installation.
- Never reuse connecting rod cap screws, replace with new cap screws.

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

1. If new piston rings are being installed, deglaze cylinder bore. See “Deglazing:” on page 152.

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



M82273A

2. Install bearing inserts on connecting rod and rod cap, aligning tangs (G) with grooves.

3. Install piston and connecting rod into the cylinder from which it was removed, with alignment mark (E) on connecting rod and/or with piston size mark (F) on top of piston toward fuel injection pump.

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

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

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

Torque Specification:

Connecting Rod Cap Screw
. . . . . 22.6 - 27.5 N•m (16.6 - 20.2 lb-ft.)

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

6. Install cylinder head. See “Cylinder Head Removal and Installation - 3TNE68” on page 123 or See “Cylinder Head Removal and Installation - 3TNV70” on page 124.

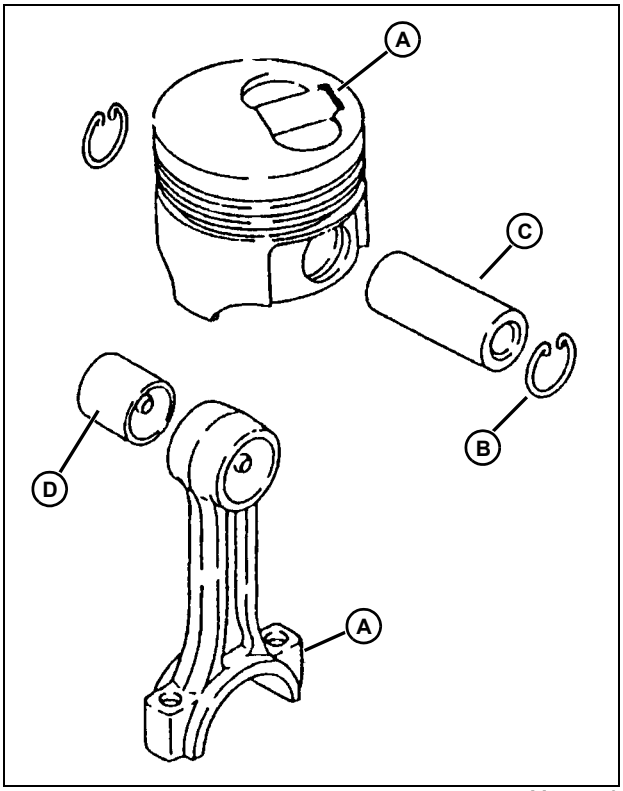
7. If a new piston and connecting rod were installed, stamp a number corresponding to the cylinder number on the connecting rod cap and connecting rod.

8. Install oil pan and strainer tube.

Pistons

Disassembly:

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



M82275A

- Note mark on each piston and connecting rod (A) to aid in assembly.
- Remove piston pin retainer (B) and piston pin (C).
- Piston pin bushing (D) is press fit in connecting rod. Remove bushing only if replacement is necessary. See Inspection/Replacement procedures.
- Inspect all parts for wear or damage. Replace as necessary.

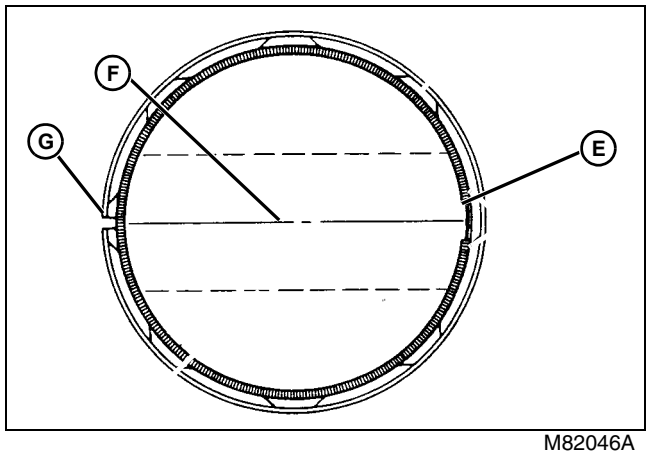
Assembly:

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

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

2. Assemble piston to connecting rod with piston size mark on same side as connecting rod “punched” alignment mark. If a new connecting rod is used, assemble piston to connecting rod with piston size mark opposite connecting rod bearing insert groove.

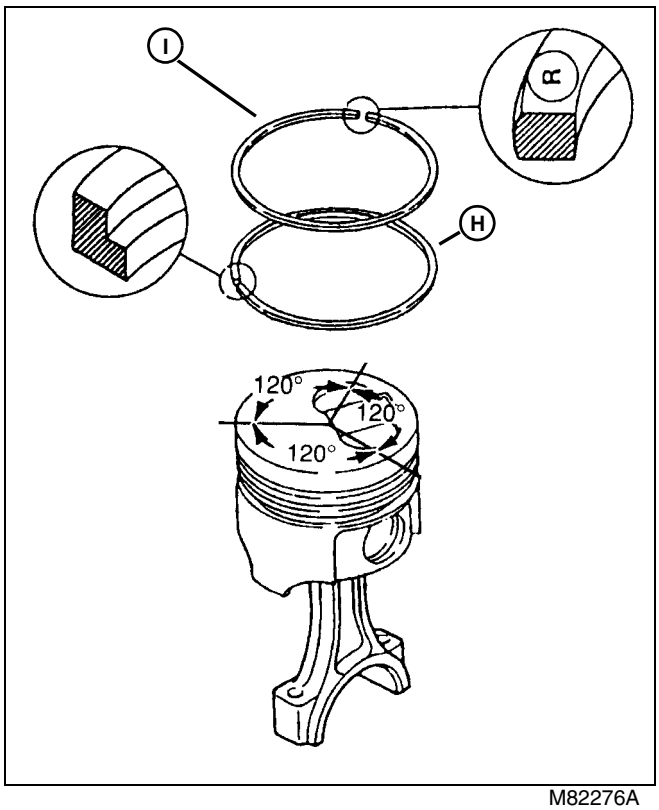
3. Install piston pin and retaining rings.



M82046A

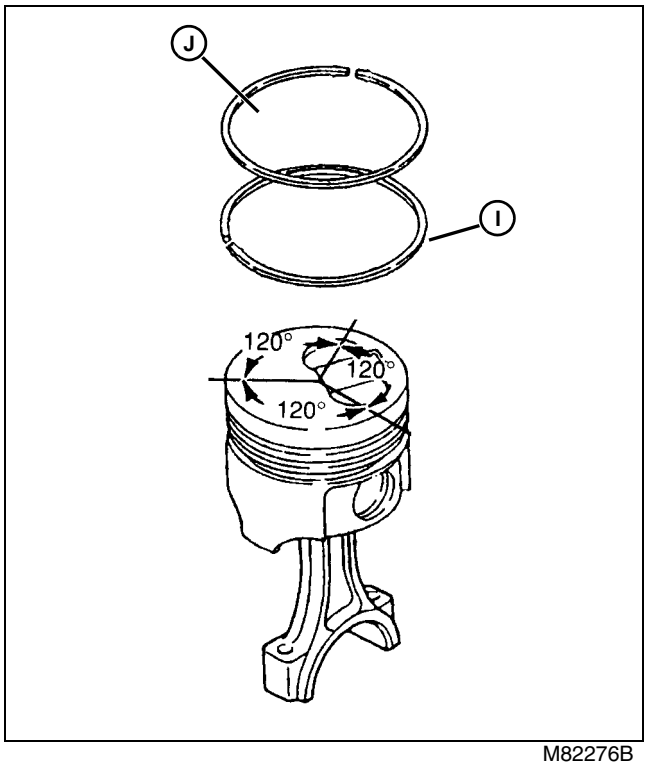
4. Install oil ring expander (E) in bottom ring groove of piston with ends aligned with center of piston pin (F).

5. Install oil ring over expander with ring gap (G) (180o) opposite of expander ends.



M82276A

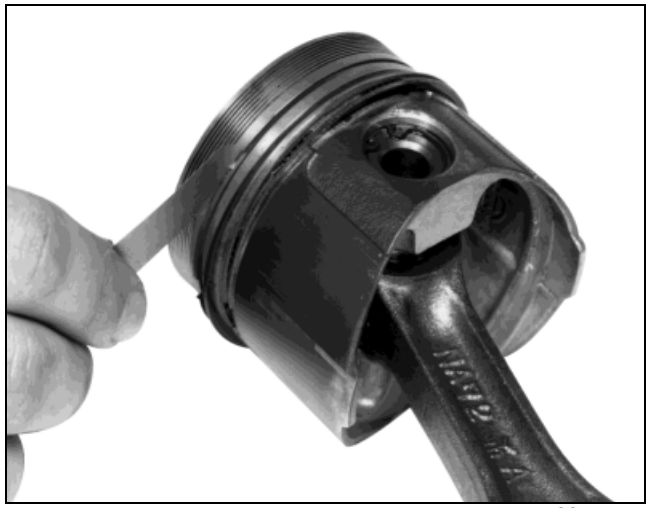
6. Install second compression ring (H), with small diameter of taper toward top of piston, in middle groove. Turn ring until gap is 120° away from oil ring gap.



M82276B

7. Install second compression ring (I). Turn ring until gap is 120° away from oil ring gap.

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



M35360

9. Measure piston ring groove clearance with a feeler gauge.

Piston Ring Groove Clearance:

First Compression Ring
Standard . . . . . 0.06 - 0.10 mm (0.002 - 0.004 in.)

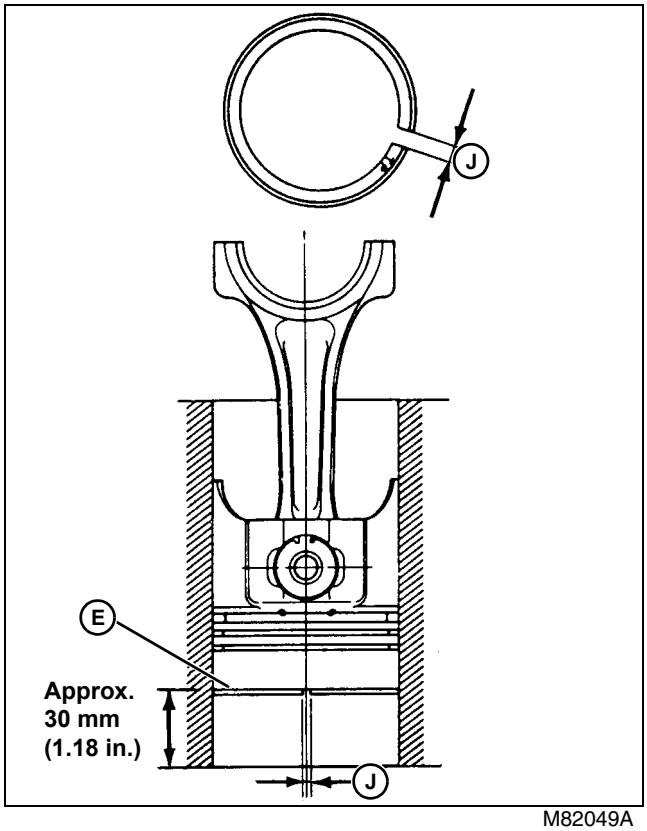
Wear Limit. . . . . 0.20 mm (0.0079 in.)

Second Compression Ring
Standard . . . . . 0.07 - 0.125 mm (0.003 - 0.005 in.)

Wear Limit. . . . . 0.20 mm (0.008 in.)

Oil Ring
Standard . . . . . 0.02 - 0.055 mm (0.001 - 0.002 in.)

- If clearance exceeds maximum limit, replace rings or piston.



M82049A

10.To measure piston ring end gap (J), use a piston to push ring into cylinder bore until ring is approximately 30 mm (1.18 in.) from bottom of cylinder bore.

11.Measure end gap with a feeler gauge.

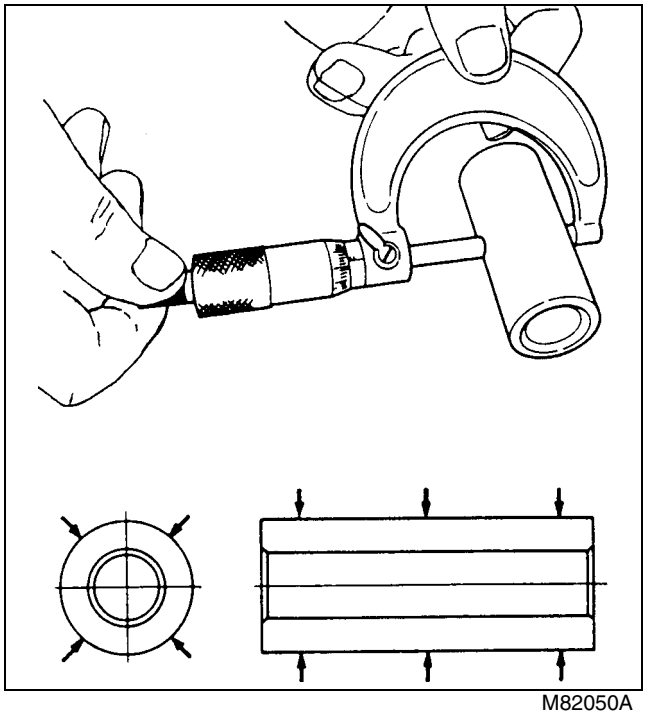
Standard Piston Ring End Gap:

First Compression Ring and Oil Ring
. . . . . 0.10 - 0.25 mm (0.004 - 0.010 in.)

Second Compression Ring
. . . . . 0.15 - 0.35 mm (0.006 - 0.014 in.)

Wear Limit . . . . . 1.50 mm (0.059 in.)

- If end gap exceeds wear limit, replace rings.
- If end gap is less than minimum, file end of ring until it meets specification.


M82050A

12.Measure piston pin diameter. Measure diameter at six places.

Piston Pin OD Specifications - 3TNE68:

Standard . . . . . 19.991 - 20.00 mm (0.787 - 0.788 in.)

Wear Limit. . . . . 19.975 mm (0.786 in.)

Piston Pin OD Specifications - 3TNV70:

Standard . . . . . 22.00 mm (0.866 in.)

Wear Limit. . . . . 22.07 mm (0.869 in.)

- If pin diameter is less than wear limit, replace pin.


M37683

13.Measure piston pin bore diameter in piston.

Piston Pin Bore ID Specifications - 3TNE68:

Standard . . . . . 20.00 - 20.008 mm (0.787 - 0.788 in.)

Wear Limit. . . . . 20.02 mm (0.788 in.)

Clearance . . . . . 0.045 mm (0.0018 in.)

Piston Pin Bore ID Specifications - 3TNV70:

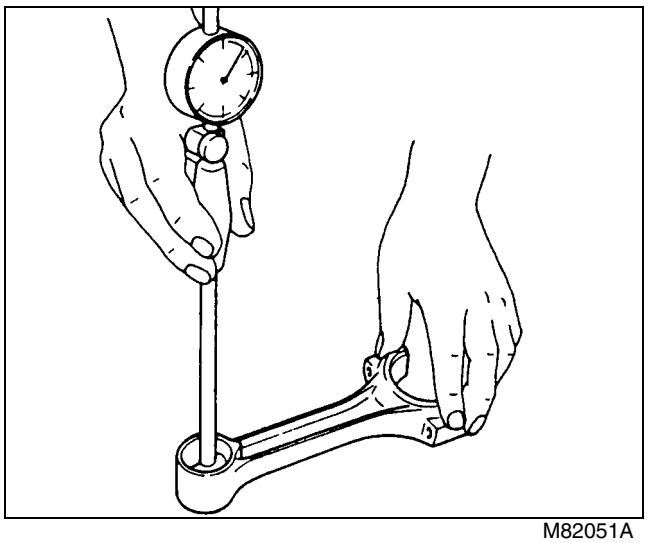
Standard . . . . . 22.00 - 22.01 mm (0.866 - 0.867 in.)

Wear Limit . . . . . 22.04 mm (0.868 in.)

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

Wear Limit . . . . . 0.11 mm (0.004 in.)

- If piston pin bore exceeds wear limit, replace piston.
- If bore clearance (bore ID minus pin OD) exceeds specification, replace piston, piston pin or both.



M82051A

14.Measure piston pin bushing diameter in connecting rod.

Piston Pin Bushing ID Specifications - 3TNE68:

Standard . . . . . 20.025 - 20.038 mm (0.788 - 0.789 in.)

Wear Limit . . . . . 20.10 mm (0.781 in.)

Clearance . . . . . 0.11 mm (0.0043 in.)

Piston Pin Bushing ID Specifications - 3TNV70:

Standard . . . . . 22.03 - 22.04 mm (0.867 - 0.868 in.)

Wear Limit . . . . . 22.07 mm (0.869 in.)

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

Wear Limit . . . . . 0.11 mm (0.004 in.)

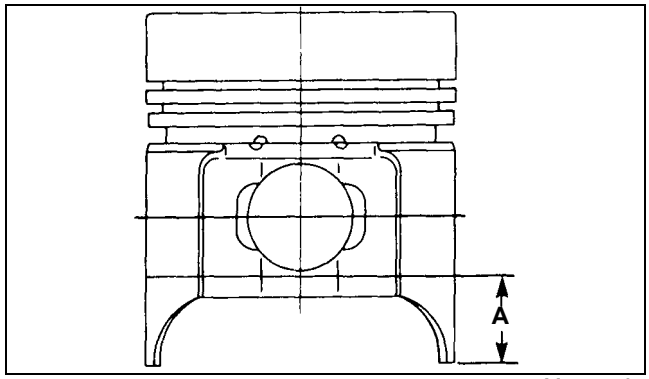
- If bushing diameter exceeds wear limit, replace bushing.

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

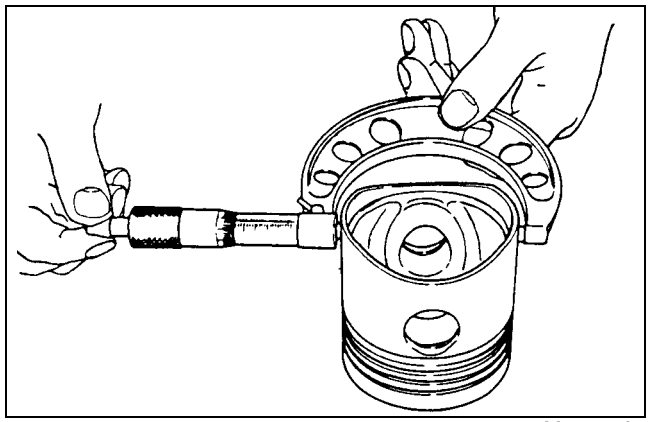
- If bushing clearance (bushing ID minus pin OD) exceeds specification, replace bushing, piston pin or both.

NOTE: If engine has had a previous major overhaul, oversize pistons and rings may have been installed.

Pistons and rings are available in 0.25 mm (0.010 in.) oversize.



M82200A



M82052A

15.Measure piston diameter perpendicular to piston pin bore at distance A.

Specifications - 3TNE68:

Piston OD (Distance A) . . . . . 5 mm (0.197 in.)

Standard Size Piston
Standard . . . . . 67.940 - 67.970 mm (2.675 - 2.676 in.)

Wear Limit. . . . . 67.90 mm (2.673 in.)

Oversize Piston - 0.25 mm (0.010 in.)
Standard . . . . . 68.19 - 68.22 mm (2.685 - 2.686 in.)

Wear Limit. . . . . 68.148 mm (2.602 in.)

Specifications - 3TNV70:

Piston OD (Distance A) . . 22 - 25 mm (0.866 - 0.984in.)

Standard Size Piston:

Standard . . . . . 69.96 - 69.99 mm (2.754 - 2.756 in.)

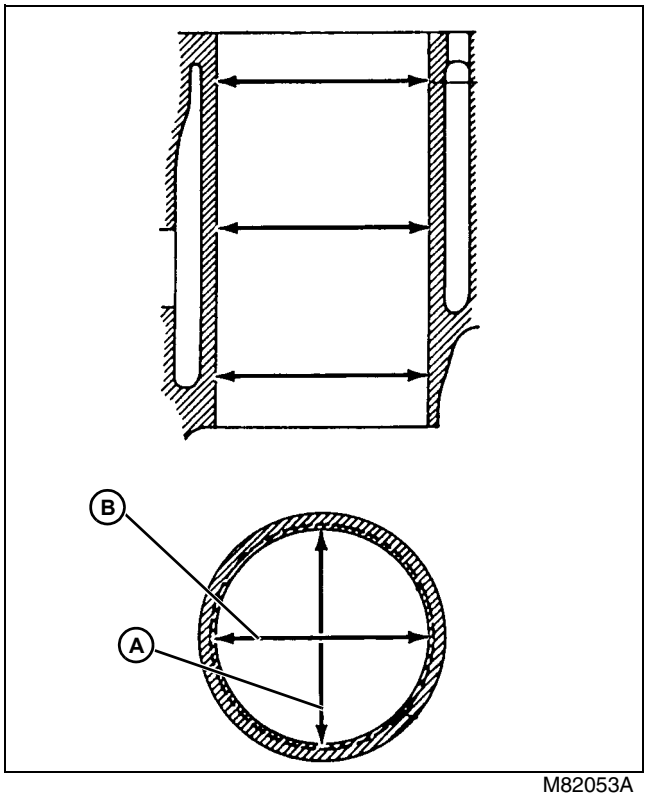
Wear Limit. . . . . 69.91 mm (2.752 in.)

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

16.Measure cylinder bore diameter. See procedure in this group.

Cylinder Bore

Inspection:



M82053A

1. Measure cylinder bore diameter at three positions; top, middle, and bottom. At these three positions, measure in both directions; along crankshaft center line (A) and direction of crankshaft rotation (B).

NOTE: If engine has had a previous major overhaul, oversize pistons and rings may have been installed.

Cylinder Bore ID Specifications - 3TNE68:

Standard Size Bore
Standard . . . . . 68.00 - 68.03 mm (2.677 - 2.678 in.)
Wear Limit . . . . . 68.20 mm (2.685 in.)
Piston to Cylinder Clearance. . . . . 0.25 mm (0.010 in.)
Cylinder Roundness. . . . . 0.01 mm (0.0003 in.)
Wear Limit . . . . . 0.03 mm (0.001 in.)
Oversize Bore
Standard . . . . . 68.25 - 68.28 mm (2.687 - 2.688 in.)
Wear Limit . . . . . 68.45 mm (2.695 in.)

Cylinder Bore ID Specifications - 3TNV70:

Standard Size Bore
Standard . . . . . 70.01 - 70.02 mm (2.756 - 2.757 in.)
Wear Limit . . . . . 70.20 mm (2.764 in.)
Piston-to-Cylinder Clearance
. . . . . 0.03 - 0.06 mm (0.001 - 0.002 in.)
Cylinder Roundness . . . . 0.00 - 0.01 mm (0 - 0.001 in.)
Wear Limit. . . . . 0.03 mm (0.001 in.)
Cylinder Taper . . . . . 0.00 - 0.01 mm (0 - 0.000 in.)
Wear Limit. . . . . 0.03 mm (0.001 in.)

- If cylinder bore exceeds wear limit, replace cylinder block or have cylinder rebored. See “Reboring:” on page 153.
- If cylinder is rebored, oversize pistons and rings must be installed. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.
- If clearance (cylinder bore ID minus piston OD) exceeds specification, replace cylinder block, piston or both; or rebore cylinder and install oversize piston and rings.

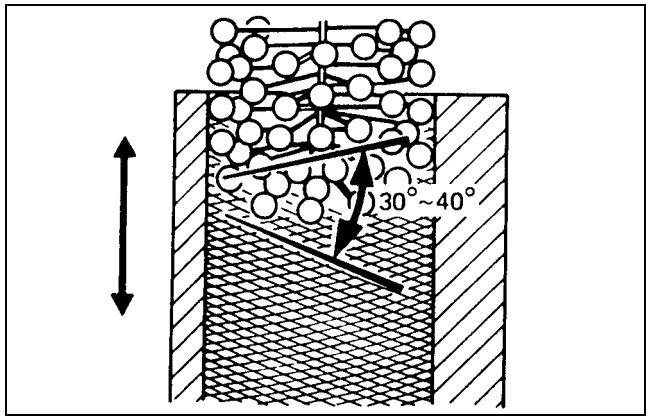
Deglazing:

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 stones.

2. Use flex-hone as instructed by manufacturer to obtain a 30 - 40° cross-hatch 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.



M82054A

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. See this group for cylinder bore ID specifications.

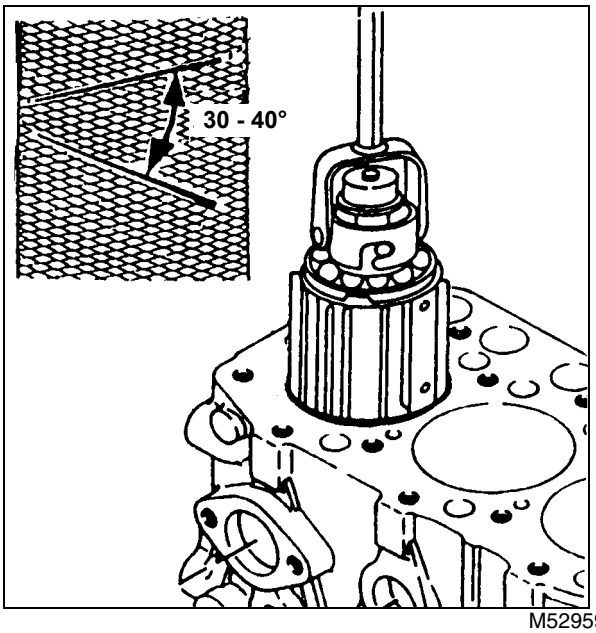
1. Align center of bore to drill press center.

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

2. Adjust 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. Hone should turn by hand. Adjust if too tight.



M52959

5. Run drill press at about 250 RPM. Move 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 stones for honing to final size.

9. Check bore for size, taper and out-of-round. See Inspection procedures.

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.

11. Dry cylinder and apply engine oil.

Crankshaft and Main Bearings

Removal:

1. Check crankshaft end play. See “Crankshaft End Play Check” on page 144.

2. Remove flywheel. See “Flywheel Removal and Installation” on page 156.

3. Remove rear oil seal case. See “Crankshaft Rear Oil Seal” on page 130.

4. Remove timing gear cover, timing gears, timing gear housing, and flywheel of engine.

5. Check crankshaft bearing clearance. See “Crankshaft Main Bearing Clearance Check” on page 145.

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

6. Remove connecting rod cap screws and end caps.

7. 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.

8. Remove main bearing cap screws, caps and cap thrust bearings.

9. Remove crankshaft.

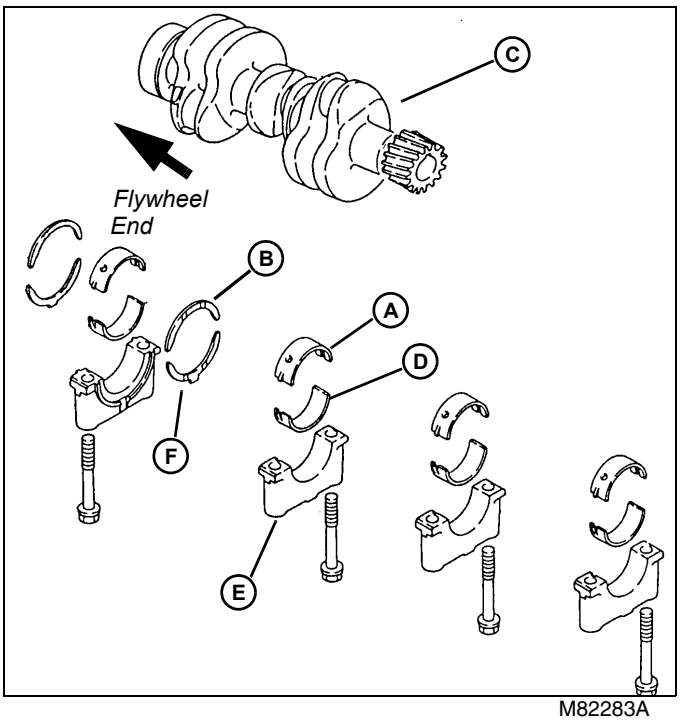
10. Remove block thrust bearings and main bearing inserts.

11. Inspect all parts for wear or damage. See Inspection/ Replacement procedure.

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 surface.



M82283A

2. Install bearing inserts drilled with oil passage (A) in cylinder block bearing bores, aligning tangs with slots in bores.

3. Install block thrust bearings (B) with oil grooves facing away from engine block.

NOTE: Main bearing caps (E) have "raised arrows" marked "FW" and 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. with the arrow pointing toward the flywheel.

4. Install crankshaft (C).

5. Install smooth bearing inserts (D) in main bearing caps (E), aligning tangs with slots in caps.

6. Install cap thrust bearings (F), 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 specifications.

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

10. Tighten main bearing cap screws to specifications. 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.

Torque Specification - 3TNE68:

Main Bearing Cap Screws . . . . . 54 N•m (40 lb-ft)

Torque Specifications - 3TNV70:

Main Bearing Cap Screws
. . . . . 75.5 - 81.5 N•m (55.6 - 60 lb-ft)

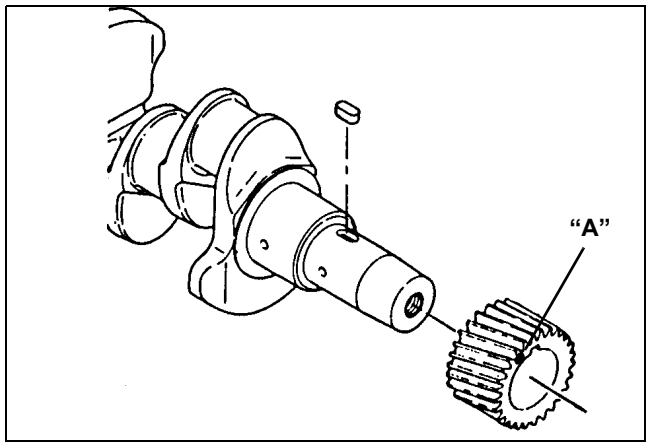
Inspection/Replacement:

1. Inspect crankshaft gear for chipped or broken teeth. Replace if necessary.

To replace gear:

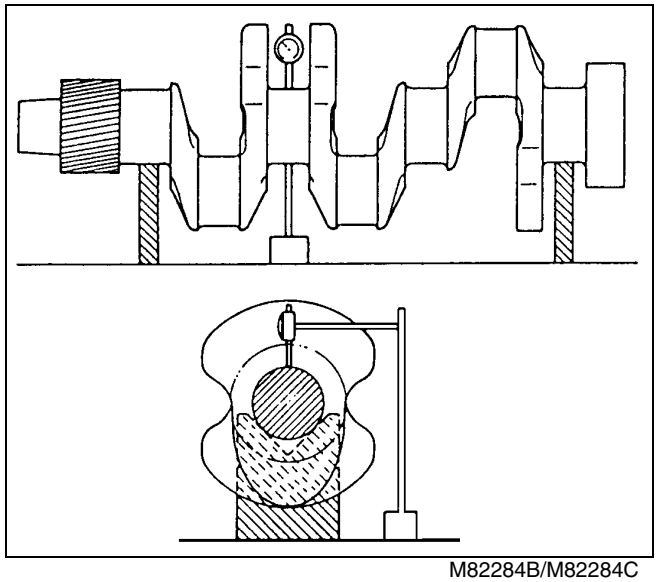
- Remove gear from crankshaft using a knife-edge puller and a press.

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

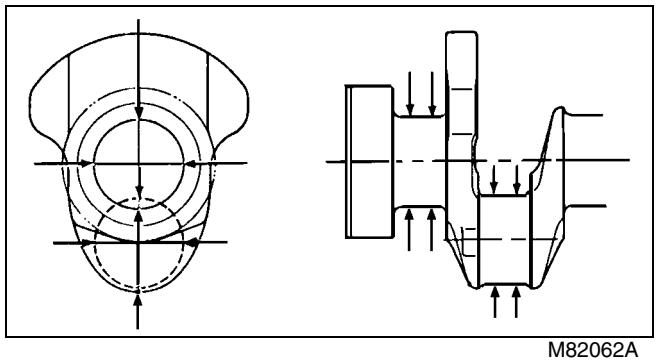
- Heat gear to approximately 150°C (300°F). Install gear with timing mark "A" toward press table. Align slot in gear with key in shaft. Press crankshaft into gear until gear is tight against crankshaft shoulder.



M82284B/M82284C

2. Inspect crankshaft for bend using v-blocks and a dial indicator. Turn crankshaft slowly and read variation on indicator. If variation is greater than 0.02 mm (0.001 in.), replace crankshaft.

NOTE: If engine has had a previous major overhaul, journals may have been ground and undersized bearing inserts installed.



M82062A

3. Measure crankshaft connecting rod journal and main bearing journal diameters. Measure several places around each journal.

Connecting Rod Journal OD Specifications - 3TNE68:

Standard . . . . . 35.97 - 35.98 mm (1.4161 - 1.4165 in.)

Wear Limit . . . . . 35.91 mm (1.414 in.)

Main Bearing Journal OD Specifications - 3TNE68:

Standard . . . . . 39.97 - 39.98 mm (1.5736 - 1.5740 in.)

Wear Limit . . . . . 39.90 mm (1.571 in.)

Crankshaft Connecting Rod Journal OD - 3TNV70:

Standard . . . . . 41.95 - 41.96 mm (1.652 in.)

Wear Limit . . . . . 42.90 mm (1.650 in.)

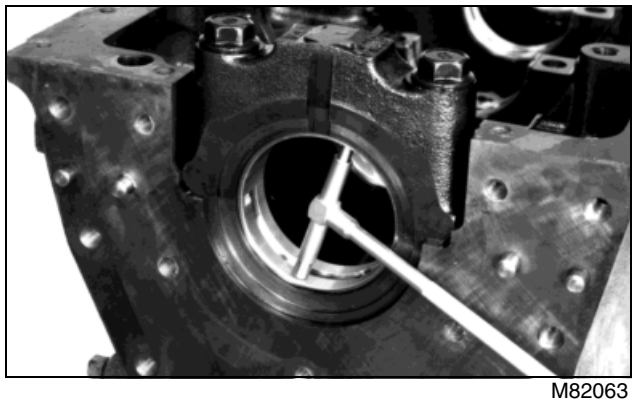
Crankshaft Main Bearing Journal OD - 3TNV70:

Standard . . . . . 46.95 - 46.96 mm (1.848 - 1.849 in.)

Wear Limit . . . . . 46.90 mm (1.846 in.)

- If journal diameter is less than wear limit, replace crankshaft or have journals ground undersize by a qualified machine shop.
- If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.

4. Install bearing inserts and main bearing cap on main bearing. Tighten main bearing cap screws to a minimum of 54 N•m (40 lb-ft) to compress main bearing for measurement.



M82063

5. Measure main bearing diameter.

Main Bearing ID Specifications - 3TNE68:

Standard . . . . . 40.000 - 40.042 mm (1.575 - 1.577 in.)

Wear Limit . . . . . 40.07 mm (1.578 in.)

Clearance . . . . . 0.15 mm (0.0059 in.)

Main Bearing ID Specifications - 3TNV70:

Standard ID . . . . . 46.98 - 47.00 mm (1.849 - 1.85 in.)

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

Wear Limit . . . . . 0.11 mm (0.004)

Main Bearing Insert Thickness . . . . 2.01 mm (0.079 in.)

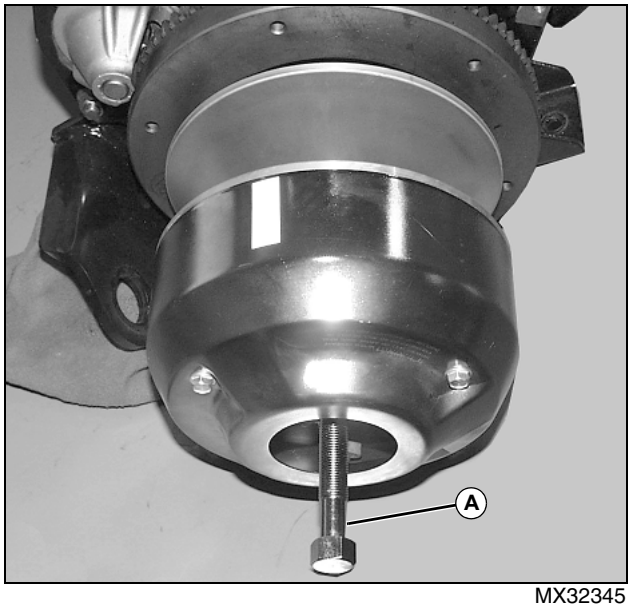
- If bearing diameter exceeds wear limit, replace bearing inserts.
- If bearing clearance (bearing ID minus crankshaft main bearing journal OD) exceeds specification, replace bearing inserts and crankshaft or have crankshaft journals ground undersize by a qualified machine shop and install undersized bearing inserts.
- Bearing inserts are available in 0.25 mm (0.010 in.) undersize.

6. Clean and inspect oil passages in main bearing journals, connecting rod journals and main bearing bores in cylinder block.

7. Inspect crankshaft for cracks or damage. Replace if necessary.

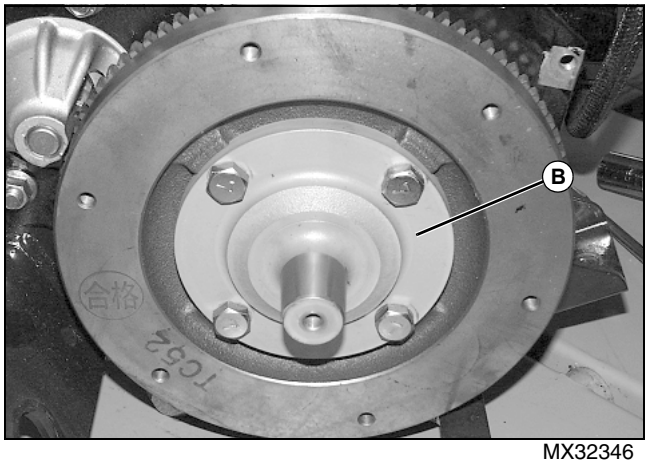
Flywheel Removal and Installation

Removal:



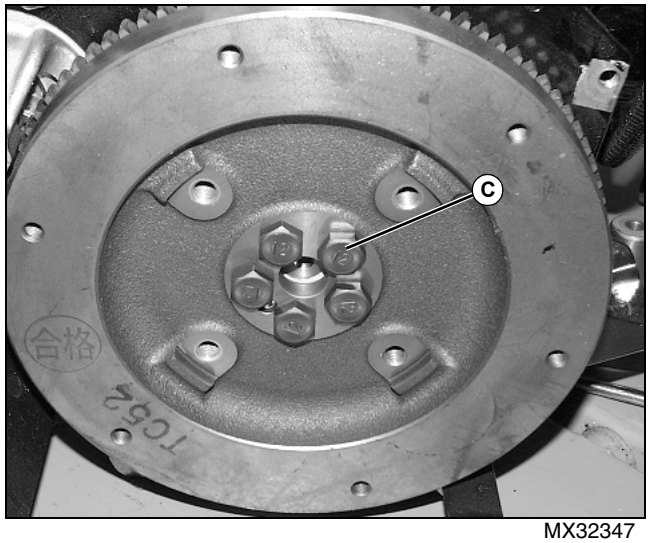
MX32345

1. Remove clutch using JDG 1641 clutch removal tool (A).



MX32346

2. Remove the four bolts and clutch stub shaft (B).



MX32347

3. Remove five flywheel mounting cap screws (C) from flywheel to crankshaft.

4. Pull flywheel from crankshaft alignment pin.

IMPORTANT: Avoid damage! Never reuse flywheel mounting cap screws. Always install new.

5. Inspect flywheel ring gear teeth for wear or chips. Replace worn parts.

Installation:

1. Align flywheel on dowel pin and install five new flywheel mounting cap screws. Tighten cap screws to specification.

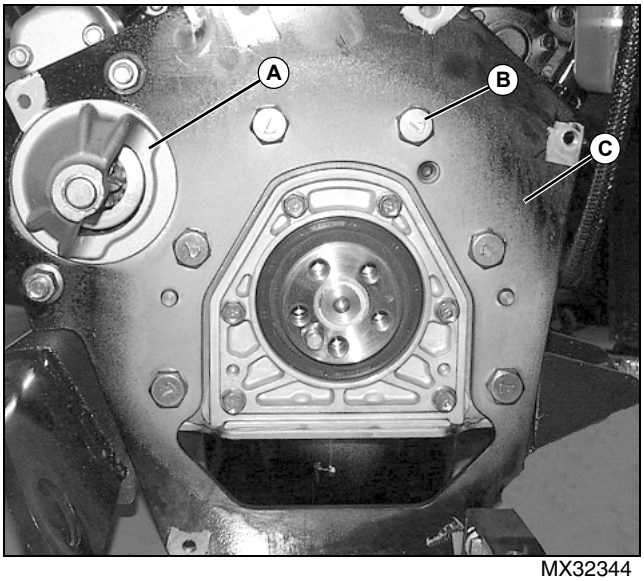
Torque Specification:

Flywheel Bolts . . . . . 80.4 - 86.4 N•m (59 - 63 lb-ft)

Flywheel Plate

Removal:

1. Remove flywheel.



MX32344

Picture Note: 3TNE68 shown, 3TNV70 similar.

2. If desired, remove starting motor (A).

3. Remove six mounting cap screws (B) and flywheel plate (C).

Installation:

Installation is done in reverse order of removal.

- Tighten mounting cap screws to 49 N•m (36 lb-ft).

Timing Gear Housing

Removal:

1. Remove engine. See “Engine Removal and Installation” on page 115.

2. Remove timing gear cover. See “Timing Gear Cover - 3TNE68” on page 132 or See “Timing Gear Cover - 3TNV70” on page 133.

3. Remove fuel injector lines from engine. See “Fuel Injection Nozzle” on page 166.

4. Remove engine camshaft. See “Camshaft - 3TNE68” on page 137 or See “Camshaft - 3TNV70” on page 140.

5. Remove idler gear. See “Idler Gear - 3TNV70” on page 135.

6. Remove water pump. See “Water Pump Removal and Installation” on page 162.

7. Remove oil dipstick tube.

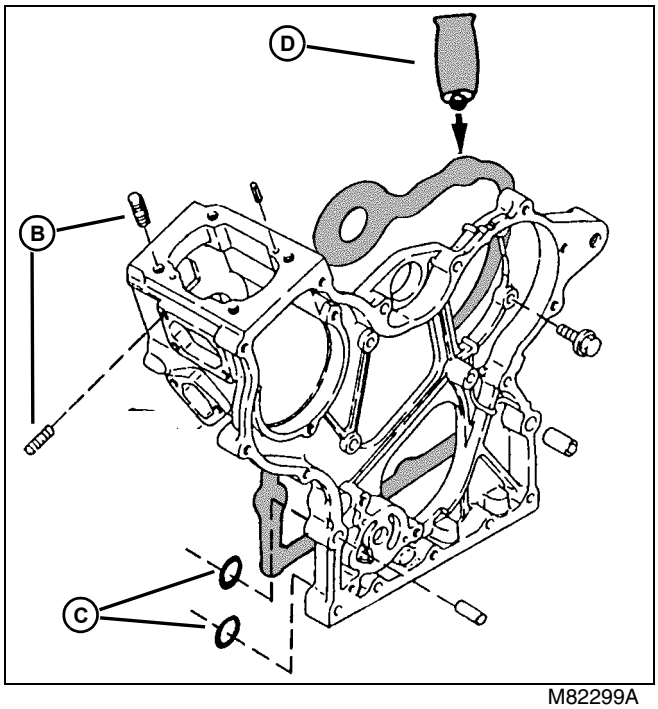
8. Remove oil pan. See “Oil Pan and Strainer” on page 143.

9. Remove timing gear housing mounting cap screws and remove housing from cylinder block.

10. Remove fuel injection pump if replacing timing housing.

Installation - 3TNE68:

Installation is done in the reverse order of removal.



M82299A

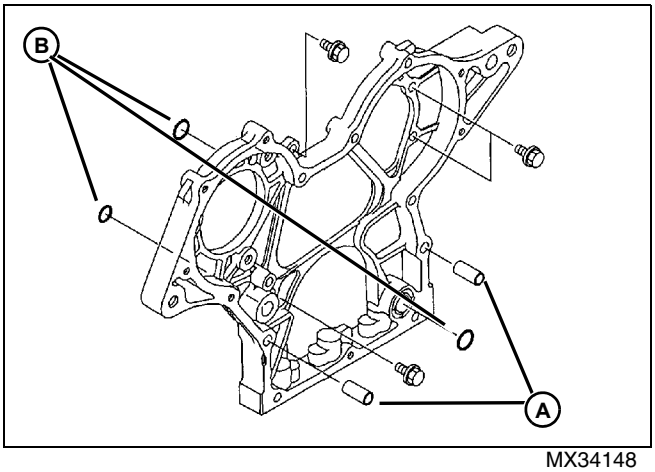
- Apply low strength thread lock to studs (B) before installing into timing gear housing.
- Replace O-rings (C).
- Apply John Deere form in place gasket (D) on cover
- Tighten timing gear housing mounting cap screws to specification.

Torque Specification:

Mounting Cap Screws . . . . . 11 N•m (97 lb-in.)

Installation - 3TNV70:

Installation is done in the reverse order of removal.



MX34148

1. Clean all parts of old gasket sealer, gasket material, oil, and dirt before attempting installation.

2. Install alignment dowels (A) in timing housing.

3. Replace O-rings (B).

4. Apply form-in-place gasket to timing housing when installing to cylinder block.

5. Tighten mounting cap screws (C) to specification.

6. Apply thread lock (low strength) to injector pump studs and install (if removed).

Torque Specification:

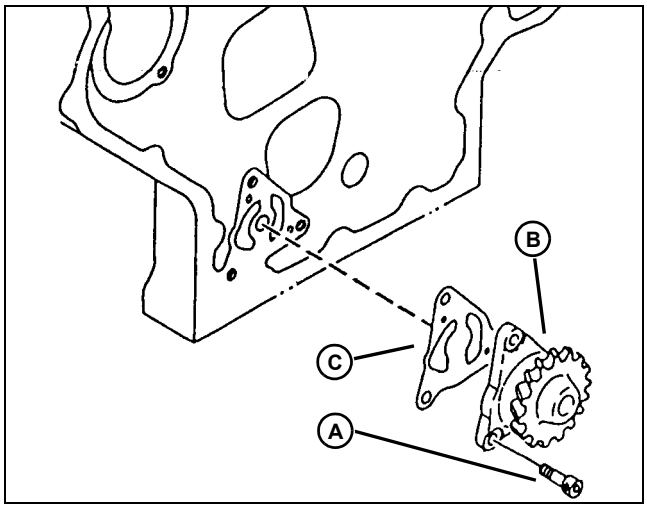
Mounting Cap Screws . . . . . 11 N•m (97 lb-in.)

Oil Pump Removal and Installation - 3TNE68

Removal/Installation

1. Remove timing gear cover. See “Timing Gear Cover - 3TNE68” on page 132.

2. Check oil pump gear backlash. Replace entire oil pump assembly if backlash is more than 0.25 mm (0.010 in.).



M82309A

3. Remove three mounting cap screws (A), oil pump (B) and gasket (C).

4. Inspect all parts for wear or damage. See Disassembly/ Assembly procedure below.

Installation:

Tighten mounting cap screw to 25 N•m (220 lb-in.).

Disassembly/Assembly:

1. Remove gear using a knife edge puller and a press. Gear is press fit on rotor shaft.

2. Inspect parts for wear or damage. See Inspection procedures.

3. Coat all parts with clean engine oil.

4. Install outer rotor with identification mark facing toward rotor shaft assembly.

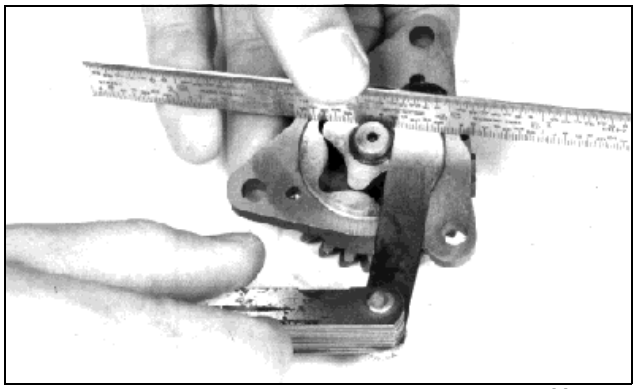
Inspection:

1. Check rotor shaft outer diameter and the shaft hole diameter in backing plate. If clearance is more than wear limit, replace entire assembly.

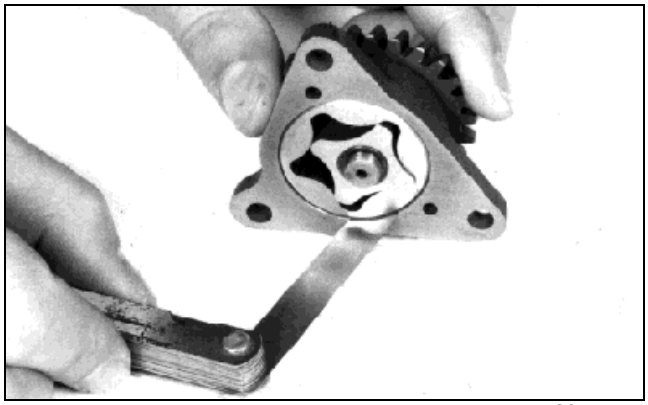
Rotor Shaft and Plate Clearance:

Standard . . . . . 0.013 - 0.043 mm (0.001 - 0.002 in.)

Wear Limit . . . . . 0.20 mm (0.008 in.)


M37775

2. Check rotor recess. If rotors are below face of pump housing more than 0.13 mm (0.005 in.), replace rotor assembly.



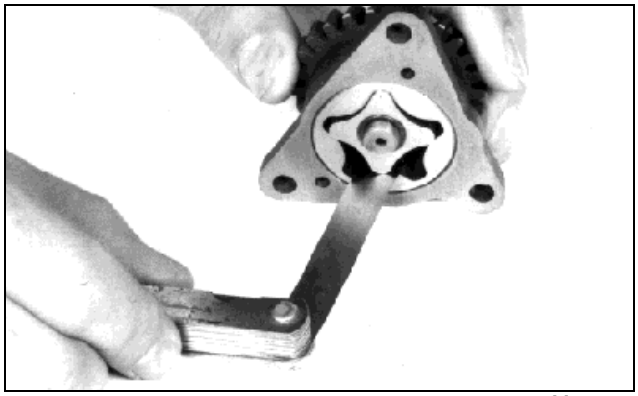
M37776

3. Check outer rotor-to-pump body clearance. If clearance is more than wear limit, replace entire assembly.

Outer Rotor-to-Pump Body Clearance:

Standard . . . . . 0.10 - 0.16 mm (0.004 - 0.006 in.)

Wear Limit . . . . . 0.25 mm (0.010 in.)



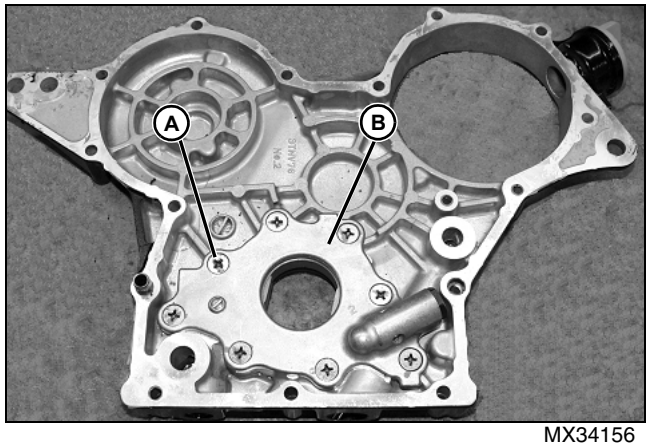
M37777

4. Check inner-to-outer rotor clearance. If clearance is more than 0.15 mm (0.0059 in.), replace rotor assembly.

Oil Pump Removal and Installation - 3TNV70

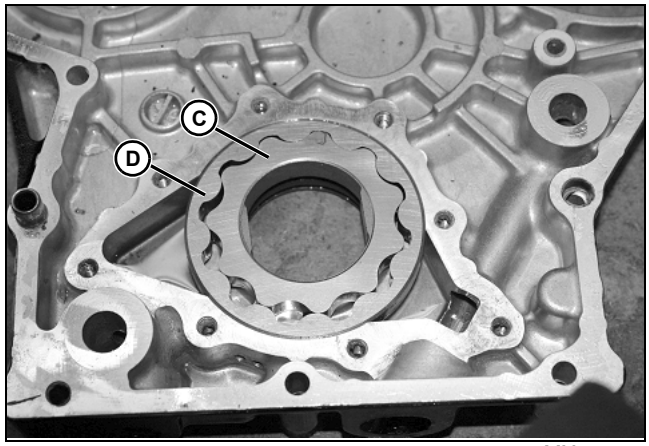
Removal/Installation

1. Remove timing gear cover.



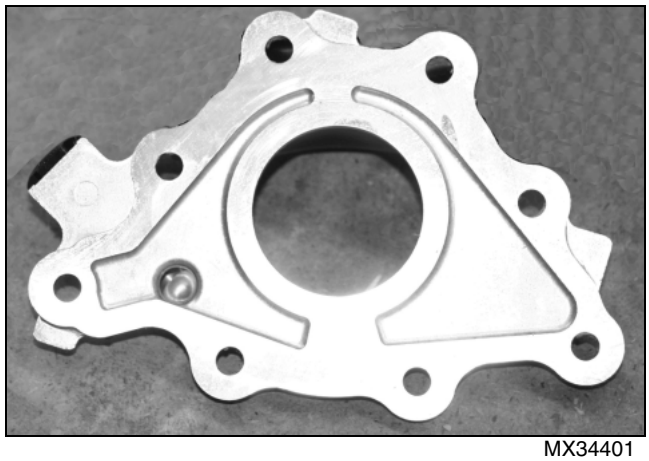
MX34156

2. Remove the eight screws (A) from oil pump cover (B) and remove cover.



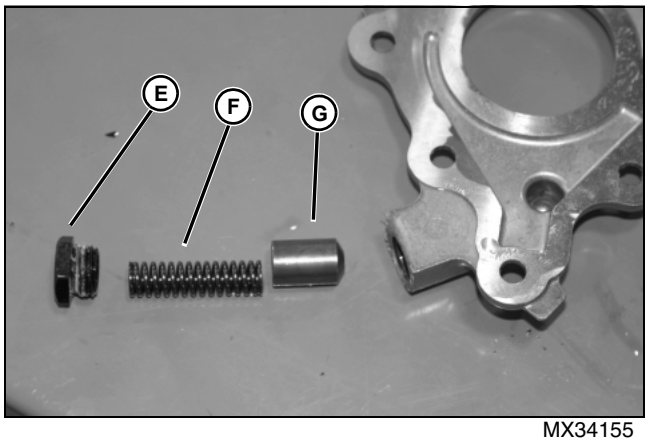
MX34157

3. Remove inner rotor (C) and outer rotor (D) and check for wear or damage. Check inside of cover for wear or deep scratches. Replace any worn or damaged parts.



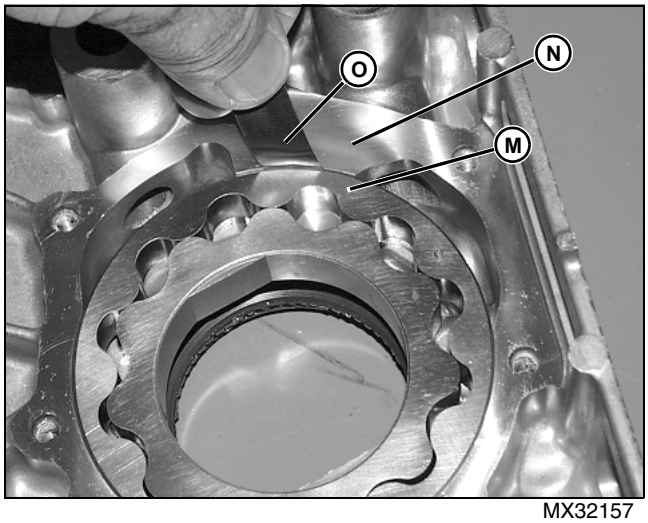
MX34401

4. Inspect inside of oil pump cover for grooves or deep scratches. Replace cover if worn or damaged.



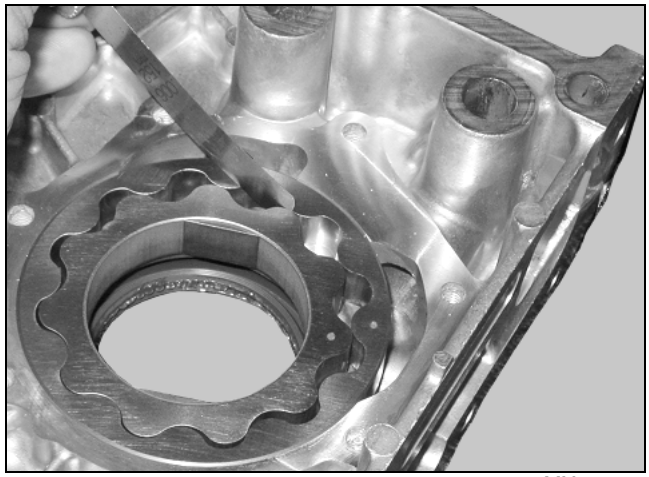
MX34155

5. Remove relief valve cap (E), spring (F), and valve (G). Inspect all parts for wear or damage. Replace any worn or damaged parts

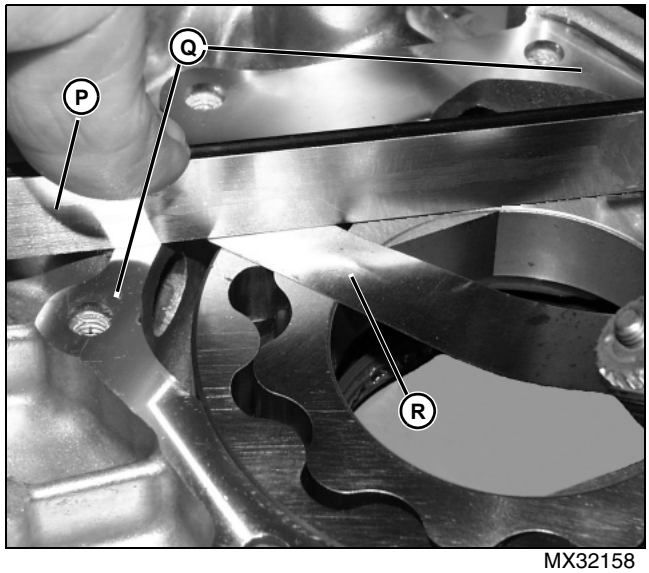


MX32157

6. Measure clearance between outer rotor (M) and timing cover (N) with a feeler gauge (O). Standard clearance is **0.12 - 0.21 mm (0.005 - 0.008 in.)**. Wear limit is **0.30 mm (0.012 in.)**. If clearance exceeds wear limit, replace timing cover and both rotors.


MX32329

7. Measure between high spots of inner and outer rotors with a feeler gage. If clearance exceeds 0.16 mm (0.006 in.) replace rotors.



MX32158

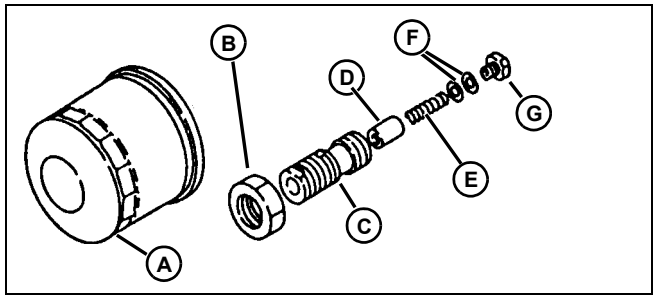
8. Place a straight edge (P) across timing gear cover bosses (Q) and measure gap between edge of timing gear cover and the rotors with a feeler gauge (R). Standard gap is **0.02 - 0.07 mm (0.001 - 0.003 in.)**. Wear limit is **0.12 mm (0.005 in.)**. If clearance exceeds wear limit replace timing gear cover and rotors.

9. Assemble in the reverse order of disassembly.

10. Apply medium strength thread locking compound to oil pump cover screws and relief valve cap when installing.

Oil Pressure Regulating Valve

Removal:



M82311B

1. Remove oil filter (A).
2. Remove retaining nut (B) and valve assembly (C).

NOTE: Valve components are not serviced individually. Replace complete regulating valve if any components are defective.

Inspection:

1. Remove cap (G), shims (F), spring (E), and plunger (D). Inspect parts for wear or damage. Replace complete valve if any wear or damage is found.
2. Check spring free and compressed length.
3. If valve is reassembled for use, after tightening cap, stake it in place with a center punch.

Spring Specifications:

Free Length . . . . . 21.90 - 24.50 mm (0.860 - 0.960 in.)
Compressed Length . . . . . 14.70 mm (.580 in.)
. . . . . @12 N (2.7 lb-force)

Installation:

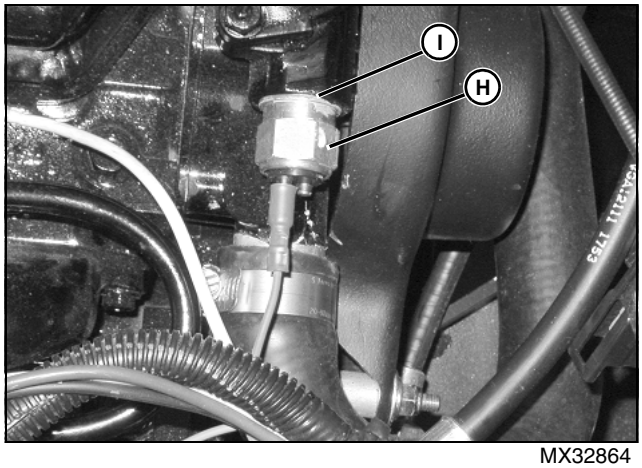
Installation is done in the reverse order of removal.

- Tighten retaining nut to 30 N•m (22 lb-ft).

Coolant Temperature Switch

Removal:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Allow engine to cool.
3. Raise and lock cargo box.
4. Open engine drain valve to drain coolant level to below coolant sensor level.
5. Disconnect wiring lead.



MX32864

6. Remove sensor (H) and washer (I).
7. Test sensor. See “Engine Coolant Temperature Sensor Test” on page 251 in the Electrical section.

Installation:

Installation is done in reverse order of removal.

- Replace copper washer.

Thermostat Removal and Installation

Removal:

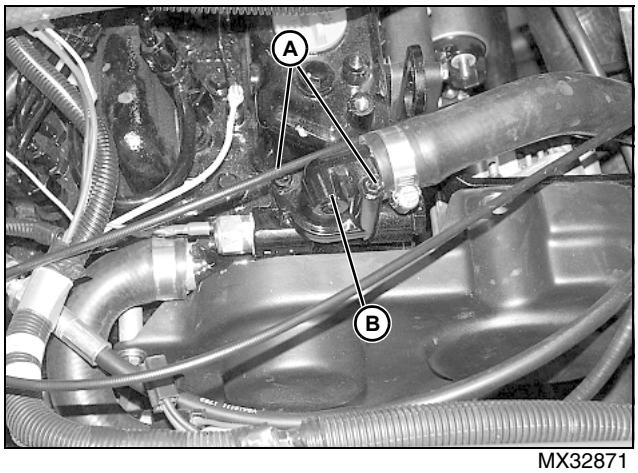
1. Park machine safely. See Parking Safely in the Safety Section.

2. Allow engine to cool before servicing cooling system.

3. Raise and lock cargo box.

4. Squeeze top radiator hose to verify the system pressure has dropped before opening radiator cap.

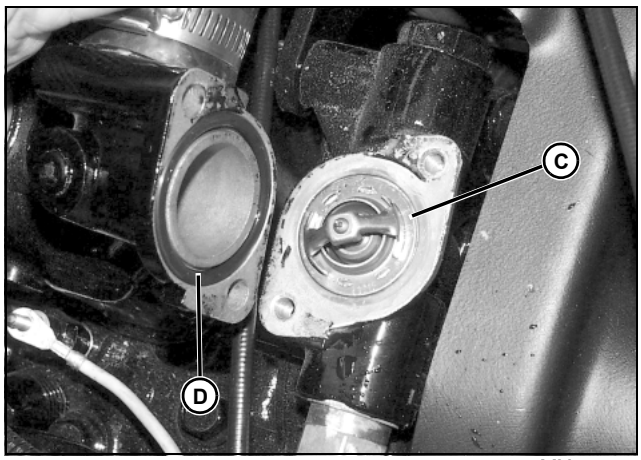
5. Place container under cooling system drain and open valve. Open radiator cap to speed up draining. Drain only enough coolant to lower coolant level below thermostat housing.



MX32871

6. Remove two cap screws (A) and remove thermostat housing (B).

NOTE: It may be necessary to lightly tap the housing with a soft-faced hammer.



MX32872

7. Remove two cap screws holding thermostat housing to water pump. Pull up housing to remove thermostat.

8. Remove thermostat (C) from water pump. See “Thermostat Test” on page 105.

Installation:

- Clean mating surfaces of water pump and thermostat housing. Install new O-ring (D) when installing thermostat.
- Tighten cap screws to specification.
- Fill cooling system with approved coolant.

Torque Specification:

Cover Cap Screws . . . . . 9 N•m (80 lb-in.)

Water Pump Removal and Installation

Removal:

1. Park machine safely. See Parking Safely in the Safety Section.

2. Allow engine to cool and pressure in cooling system to drop before working on water pump.

3. Raise and lock cargo box.

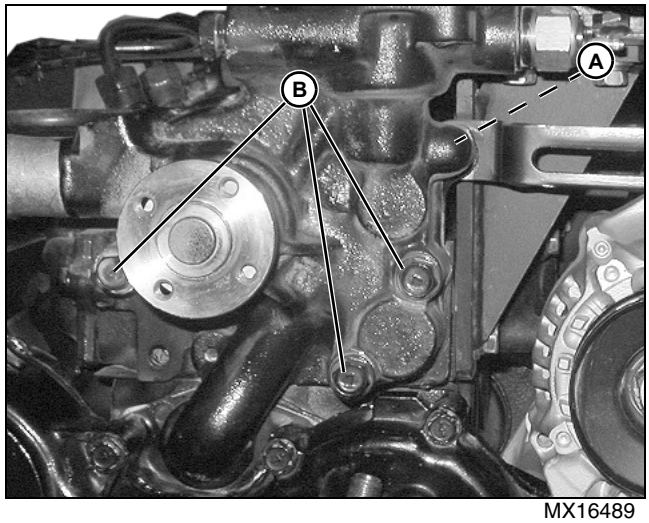
4. Open engine drain valve to drain coolant from cylinder block.

5. Disconnect coolant temperature switch lead.

6. Disconnect upper and lower radiator hoses and remove radiator. See “Engine Removal and Installation” on page 115.

7. Remove water pump/alternator drive belt.

8. Remove four cap screws retaining water pump pulley.



MX16489

9. Remove cap screw (A) from alternator bracket.

10. Remove three pump mounting cap screws (B), and remove water pump.

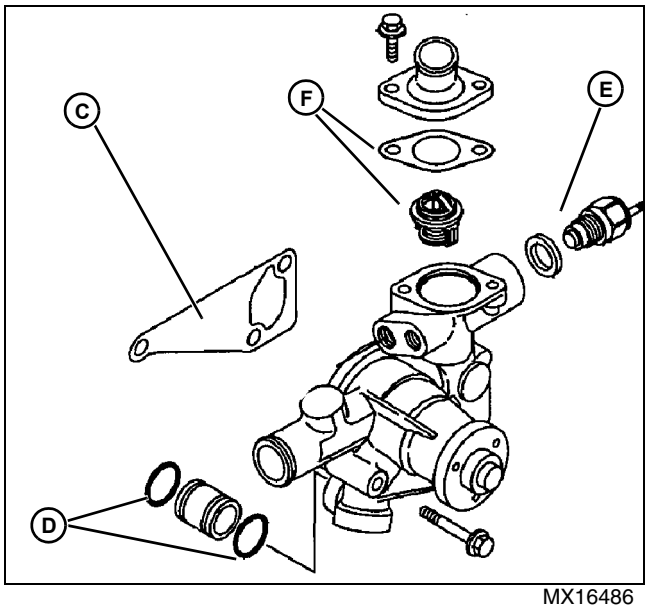
11. Inspect all parts for wear or damage.

12. Clean cylinder block mating surfaces of all old gasket material.

Installation:

Installation is done in the reverse order of removal.

1. Clean cylinder block mating surfaces of all old gasket material.



MX16486

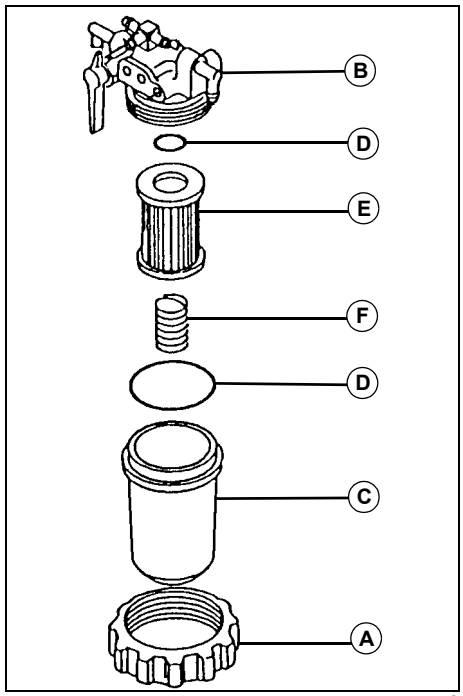
2. Install new gasket (C) and O-rings (D).
3. Tighten mounting cap screws to specification.
4. Install coolant temperature switch and sealing washer (E).
5. Install thermostat and gasket (F).
6. Install water pump pulley and spacer.
7. Install radiator and hoses, fill with coolant.
8. Adjust water pump/alternator drive belt tension.

Torque Specification:

Pump Mounting Cap Screws . . . . . 25 N•m (221 (lb-in.)

Fuel Filter Removal and Installation

1. Park machine safely. See Parking Safely in the Safety Section.
2. Raise and lock cargo box.



M82370B

3. Remove the retaining ring (A) from the mounting base (B) while holding on to the filter cover (C).
4. Remove the filter cover from the mounting base.
5. Remove and replace the O-rings (D) and filter element (E).
6. Be sure the spring (F) is in the filter cover and place the filter element (E) in the filter cover.
7. Before installing the filter cover and element in the mounting base, verify the O-ring (D) is in the groove inside the mounting base.
8. Install the filter cover and the element in the mounting base.

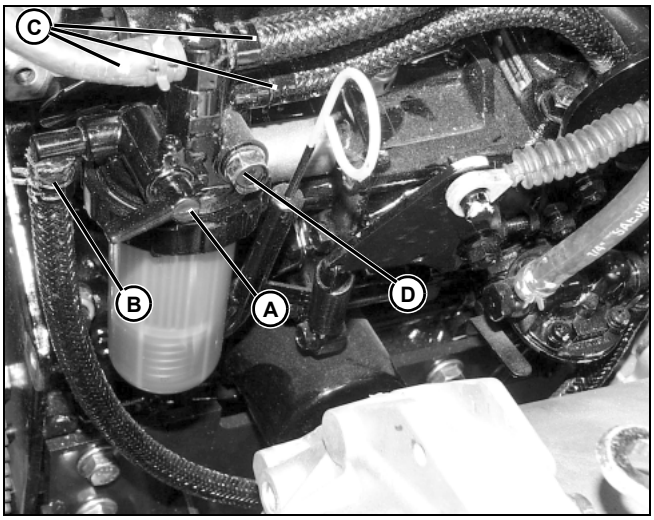
IMPORTANT: Avoid damage! Tighten only enough to keep the filter assembly from leaking. Overtightening the retaining nut may damage the filter cover or retaining ring.

9. Place the retaining ring (A) over filter cover and screw on the mounting base to retain filter cover to mounting base.

Fuel Filter Assembly Removal and Installation

Removal:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Allow engine to cool.
3. Raise and lock cargo box.



MX32873

Picture Note: 3TNE68 shown, 3TNV70 similar.

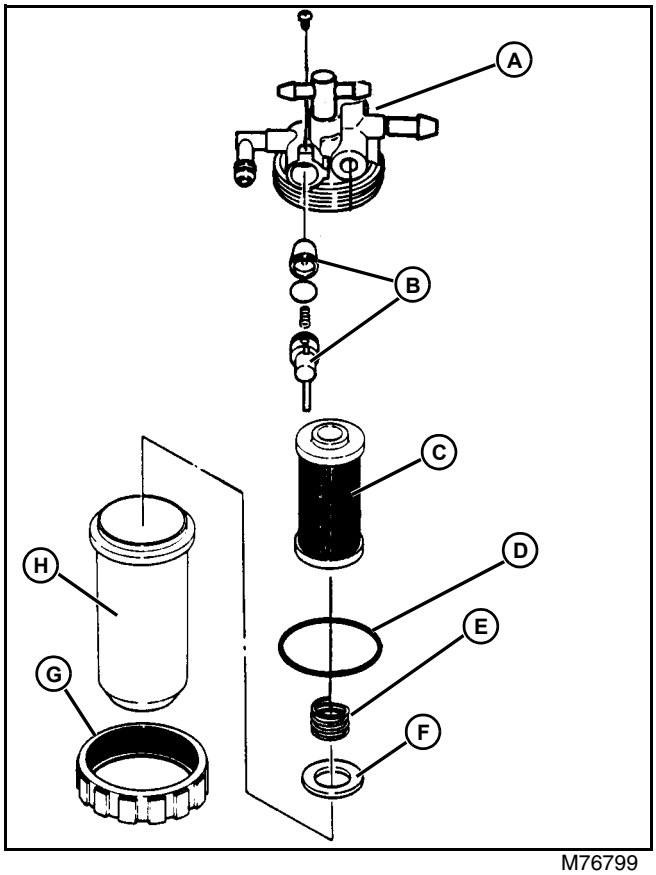
4. Close fuel shut off valve (A).

NOTE: When disconnecting hoses (B) from fuel filter assembly, be sure to cap hoses or catch draining fuel in a clean container.

5. Remove and plug fuel line (B).
6. Mark, remove, and plug fuel lines (C) from fuel filter assembly.
7. Remove cap screw (D) securing filter assembly to mounting bracket.
8. Remove fuel filter assembly.

Installation:

Installation is done in the reverse order of removal.



M76799

A - Filter Housing
B - Shut Off Assembly
C - Filter Element
D - O - Ring
E - Spring
F - Water Indicator Ring
G - Bowl Nut
H - Bowl

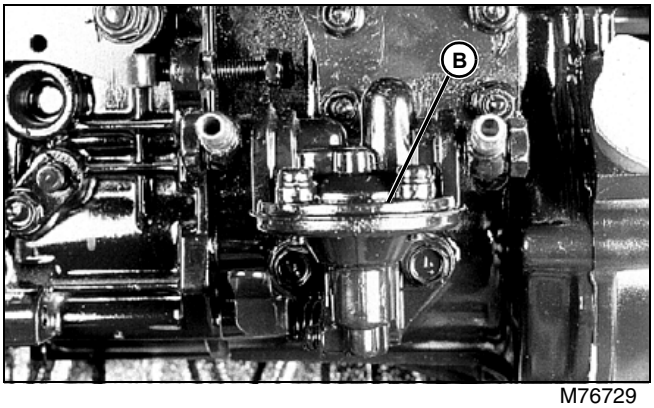
- Replace filter.

Fuel Transfer Pump - 3TNE68

Removal:

CAUTION: Avoid Injury! Diesel fuel is flammable! Never work on fuel system near open flames or sparks. Close fuel filter/water separator shutoff valve before disconnecting any fuel lines from pumps.

1. Park machine safely. See Parking Safely in the Safety Section.
2. Allow engine to cool.
3. Raise and lock cargo box.
4. Close fuel shutoff valve at filter.



M76729

5. Remove inlet and outlet hose clamps at fuel transfer pump (B) and disconnect hoses.
6. Disconnect two cap screws securing fuel pump assembly to frame.
7. Remove all old gasket material from mating surfaces before installation.
8. Installation is done in the reverse order of removal.

Installation:

Installation is done in the reverse order of removal.

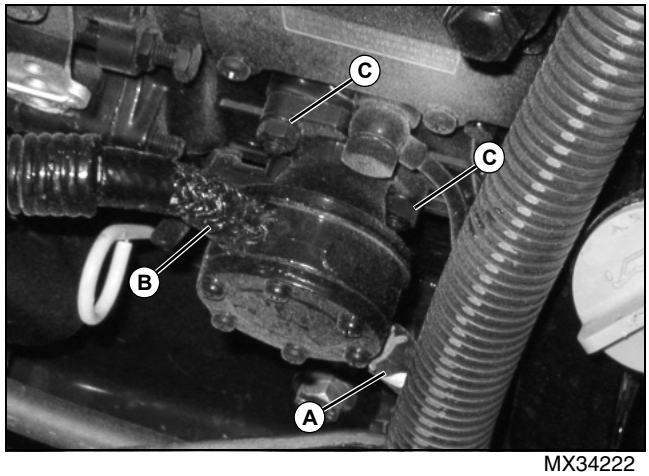
- Install new gasket.

Fuel Transfer Pump - 3TNV70

Removal:

CAUTION: Avoid Injury! Diesel fuel is flammable! Never work on fuel system near open flames or sparks. Close fuel filter/water separator shutoff valve before disconnecting any fuel lines from pumps.

1. Park machine safely. See Parking Safely in the Safety Section.
2. Allow engine to cool.
3. Raise and lock cargo box.
4. Close fuel shutoff valve at fuel filter/water separator.



MX34222

5. Remove inlet (A) and outlet (B) hose clamps at fuel transfer pump and disconnect hoses.
6. Remove two fuel pump mounting cap screws (C).
7. Remove all old gasket material from mating surfaces before installation.

Installation:

Installation is done in the reverse order of removal.

- Install new gasket.

Fuel Injection Nozzle

Removal:

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

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

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

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.

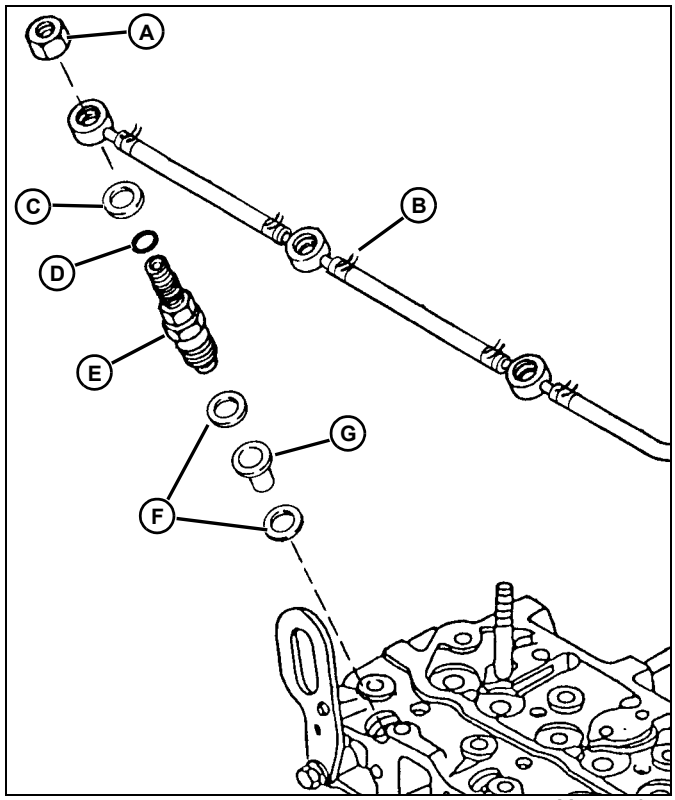
1. Park machine safely. See Parking Safely in the Safety Section.
2. Allow engine to cool.
3. Raise and lock cargo box.
4. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner.

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.

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

M91230

5. Loosen fuel line connectors at injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench to prevent delivery valves from turning.
6. Loosen fuel line clamp, and remove fuel lines.



M82323A

7. Remove nuts (A) and leak-off hose assembly (B).
8. Remove bronze washers (C) and O-rings (D).
9. Remove injection nozzle (E), washers (F), and heat protector (G).
10. Test injection nozzles. See “Fuel Injection Nozzle Test” on page 108.

Installation:

Installation is done in reverse order of removal.

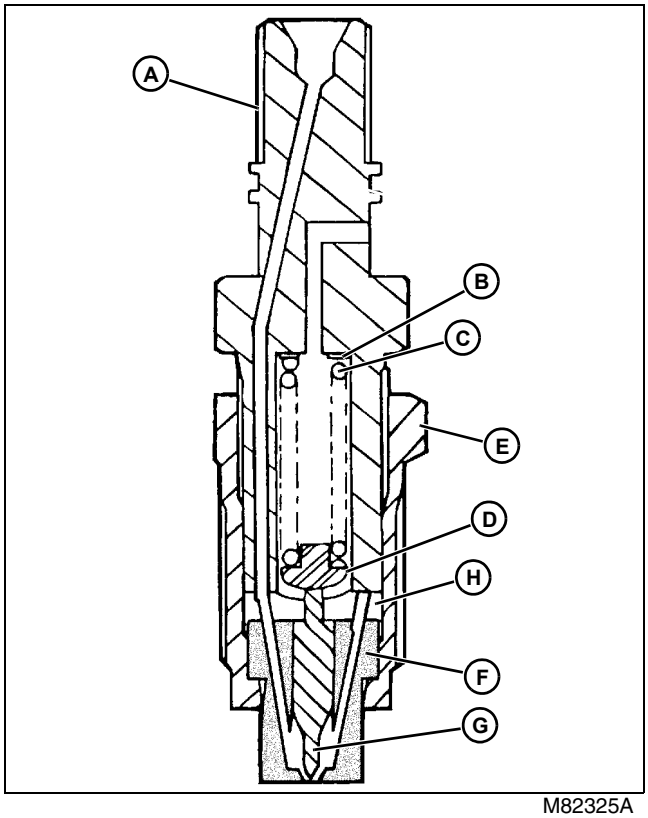
- Replace bronze washers.

- Replace heat protectors.
- Tighten injection nozzle to 50 N•m (37 lb-ft).
- Tighten leak-off hose nuts to 40 N•m (30 lb-ft).

Repair:

NOTE: If servicing more than one nozzle, keep parts for each nozzle separate from one another.

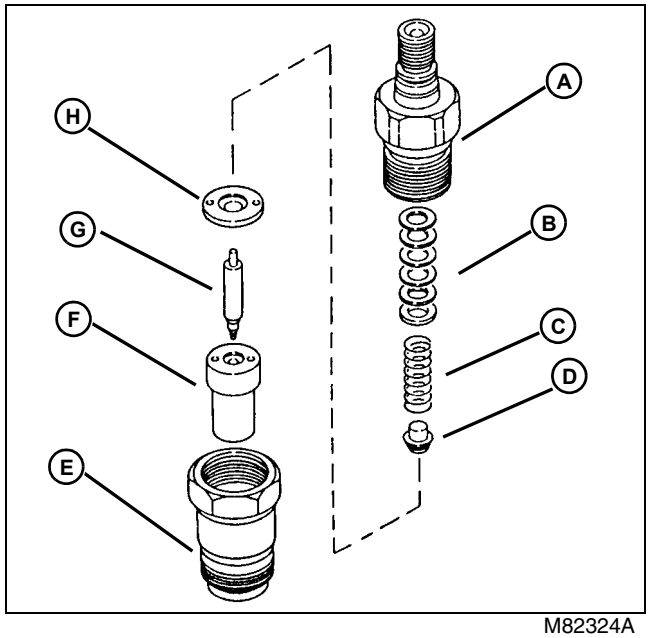
IMPORTANT: Avoid damage! If injection nozzles are disassembled to be cleaned, the same number and thickness of shims must be installed.



M82325A

Picture Note: Injection Nozzle Cross Section

A - Injector Body
B - Pressure Adjusting Shims
C - Nozzle Spring
D - Nozzle Spring Seat
E - Nozzle Fitting
F - Nozzle Body
G - Nozzle Valve
H - Valve Stop Spacer



M82324A

A - Injector Body
B - Pressure Adjusting Shims
C - Nozzle Spring
D - Nozzle 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 167.
- After assembly is complete, test injection nozzle. See “Fuel Injection Nozzle Test” on page 108.

Cleaning and Inspection:

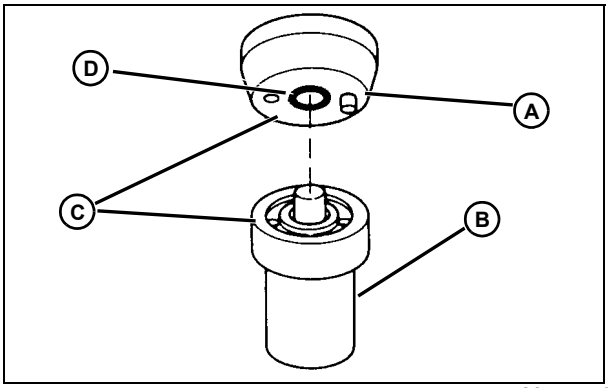
NOTE: To clean nozzles properly, JDF13 Nozzle Cleaning Kit is recommended. The Cleaning Kit is available through the John Deere SERVICEGARD™ Catalog.

1. Remove anticorrosive 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 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

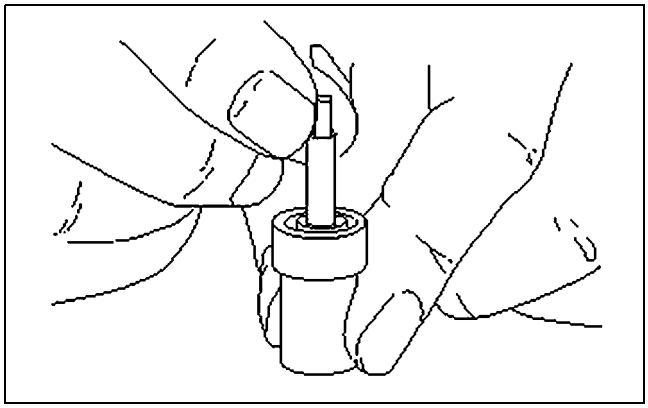
4. Inspect condition of separator plate (A) and nozzle body (B). Contact area of separator plate (both parts) must not be scored or pitted. Use an inspection magnifier (No. 16487 or equivalent) to aid in making the inspection.

5. Check nozzle contact surface on separator plate (D) for wear. If contact surface is more than 0.10 mm (0.0039 in.), replace nozzle assembly.

6. Inspect the piston (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. Use the following procedure:

- Dip the nozzle valve in clean diesel fuel. Insert valve in nozzle body.
- Hold nozzle vertical, and pull valve out about 1/3 of its engaged length.



MX34262

- 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.

Fuel Injection Pump - 3TNE68

CAUTION: Avoid Injury! Do not attempt to remove the CARB/EPA Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service CARB/ EPA Certified Emissions engines.

MX1339

Picture Note: Engine emission compliance sticker located on rocker arm cover.

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

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

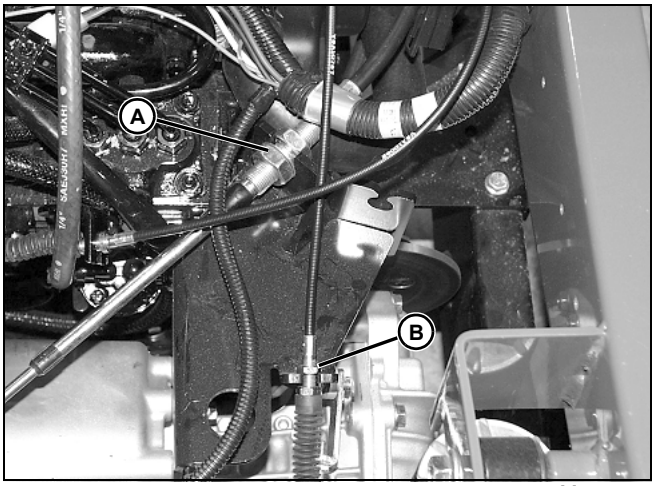
Such information is available from the Deere & Company Medical Department in Moline, Illinois, U.S.A. In the United States and Canada only, this information may be obtained by calling 1-800-822-8262

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.

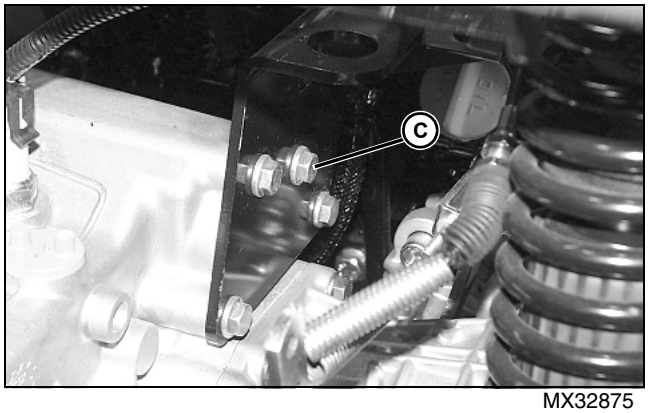
Removal:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Allow engine to cool.
3. Raise and lock cargo box.
4. Turn the fuel shut-off valve on the fuel filter/water separator to the CLOSED (“C”) position.
5. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner.
6. Remove the air cleaner assembly.



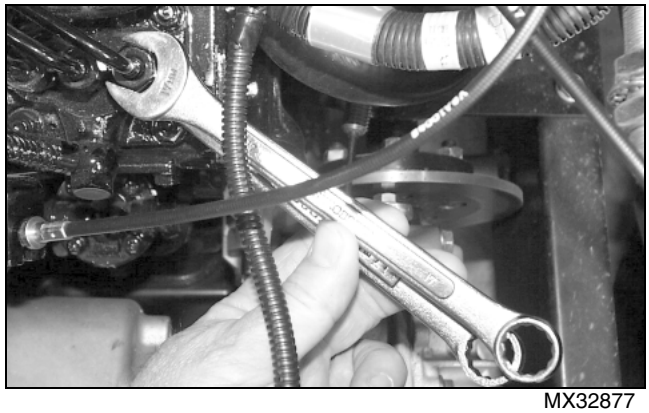
M32874

7. Loosen jam nuts on shift cable (A) and differential lock cable (B) and slide cables out of bracket.

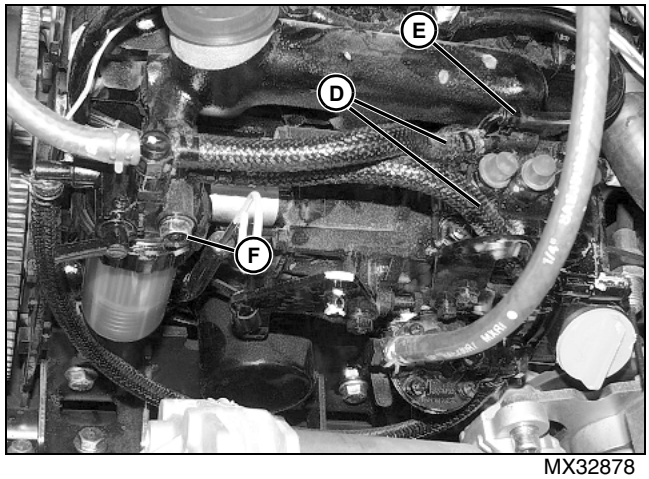


MX32875

8. Remove four cap screws (C) from the cable bracket and remove bracket.
9. Disconnect hose from air cleaner to intake manifold and cover opening in intake manifold.

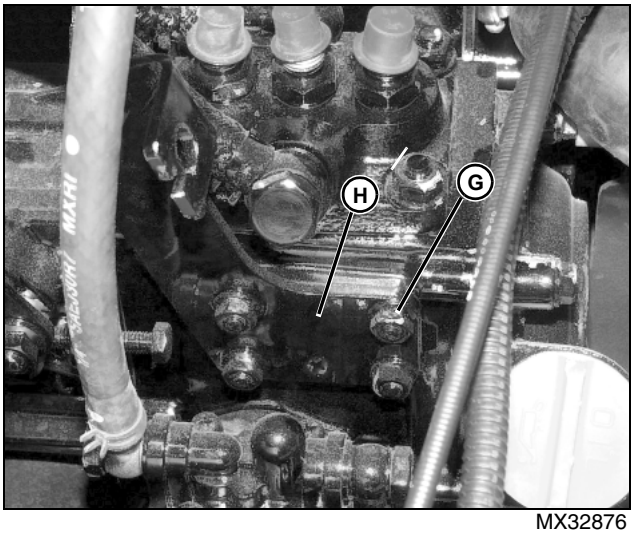

MX32877

10. Remove fuel injector lines from injector pump and injector nozzles. Use a backup wrench to keep delivery valves from loosening.



MX32878

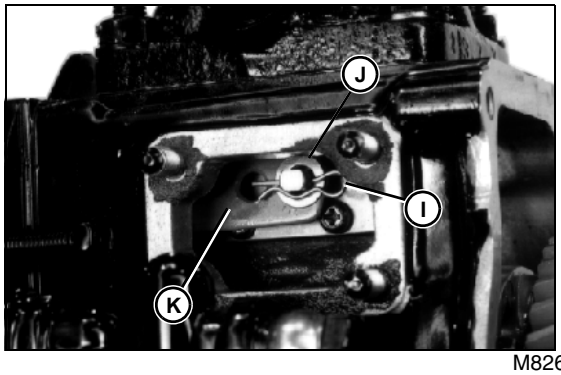
11. Mark and disconnect fuel lines (D) and (E). Remove cap screw (F) from fuel filter and move filter assembly aside.
12. Disconnect hoses from fuel injection pump.



MX32876

13.Remove four nuts (G) and cover (H).

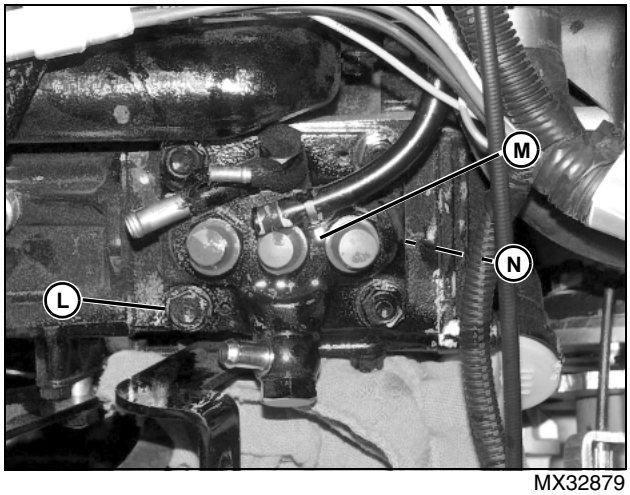
NOTE: Washer may be fixed to linkage. Do not drop pin during removal.



M82685

14.Remove pin (I) and washer (J) if not fixed to arm (K). Disconnect governor linkage (K).

IMPORTANT: Avoid damage! If injection pump is being removed to be serviced or replaced, a new 0.8 mm (0.031 in.) shim must be installed between injector pump and housing.



MX32879

15.Remove four nuts (L) to remove fuel injection pump (M) and shim (N).

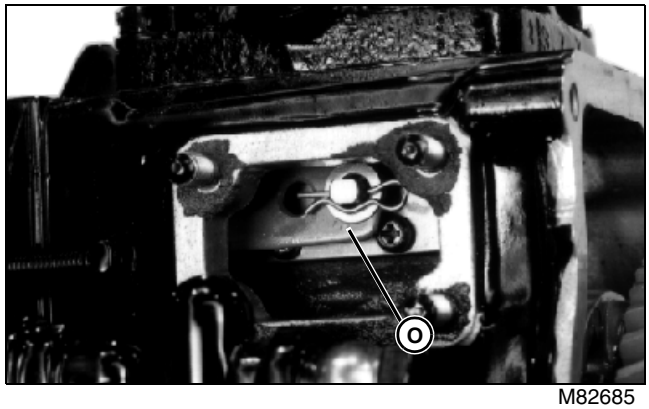
Installation:

Installation is done in the reverse order of removal.

IMPORTANT: Avoid damage! If injection pump is being removed to be serviced or replaced, a new 0.8 mm (0.031 in.) shim must be installed between injector pump and housing.

NOTE: Governor linkage has two holes. Connect governor linkage to injection pump rack using hole closest to injection pump gear.

NOTE: Do not drop pin or washer during installation.



M82685

- When connecting governor linkage to injection pump rack (O), attach link to rack at hole closest to injection pump gear.
- Bleed the fuel system.
- Tighten injection body nuts to 20 N•m (180 lb-in.).
- Tighten injection nozzle to 50 N•m (37 lb-ft).
- Tighten leak-off hose nuts to 40 N•m (30 lb-ft).

Fuel Injection Pump - 3TNV70

Removal:

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

CAUTION: Avoid Injury! DO NOT attempt to remove the CARB/EPA Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions engines.

IMPORTANT: Avoid damage! Never steam clean or pour cold water on injection pump while 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. Park machine safely. See Parking Safely in the Safety Section.

2. Allow engine to cool.

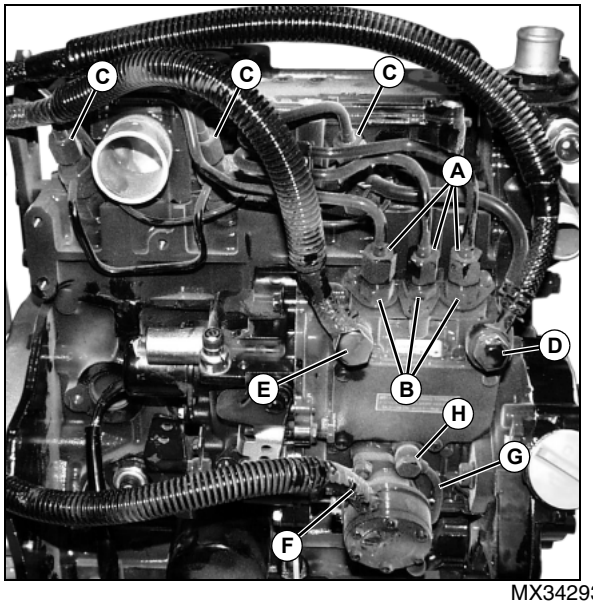
3. Remove hood.

4. Turn the fuel shut-off valve on the fuel filter/water separator to the CLOSED (“C”) position.

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

6. Remove the intake hose from the intake manifold.

7. Remove the engine. See “Engine Removal and Installation” on page 115.



MX34293

8. Slowly loosen fuel line connectors (A) at injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench to prevent delivery valves (B) from turning.

9. Loosen fuel line nuts (C) at fuel injector nozzle.

10. Remove fuel line connector nuts at the injection pump and the injector nozzles and remove fuel lines.

11. Cover ends of injectors, delivery valves, and fuel lines with plastic caps to prevent dirt from entering system.

12. Disconnect the leakoff hose (D).

13. Disconnect the fuel input hose (E).

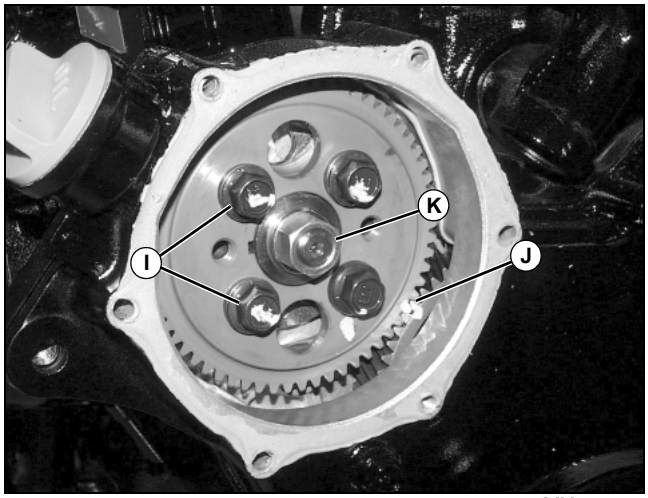
14. Remove outlet hose clamps at fuel transfer pump and disconnect hose (F).

15. Remove the injector lubrication line (G) by removing the upper (H) and lower banjo bolts.

16. Remove injector pump gear cover on front of timing gear cover.

IMPORTANT: Avoid damage! DO NOT loosen four cap screws (I) attaching gear to hub! This gear/hub assembly times the injector pump camshaft in relation the crankshaft for precise timing of EPA engines. This procedure is done at the pump manufacturing plant and cannot be duplicated in the field!

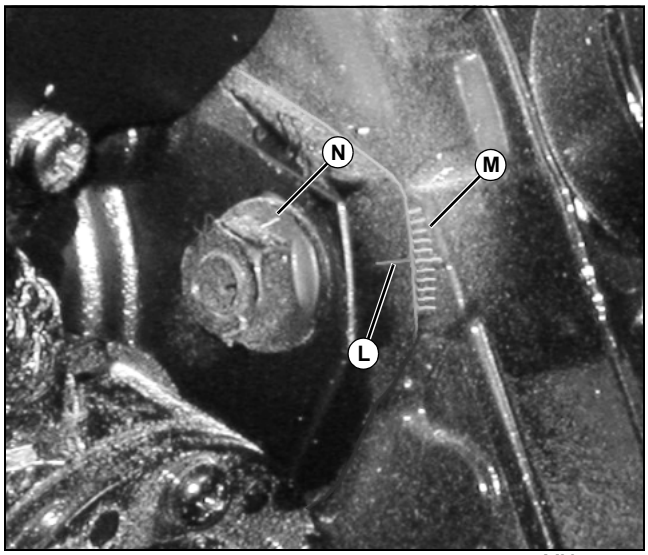
NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically. When all timing marks on gears align, the piston closest to the water pump (No. 3) is at TDC on compression stroke. (No. 1 cylinder is closest to the flywheel.)



MX34294

17.Rotate crankshaft and align timing marks (J).

18.Remove the lock nut (K) and using a puller, remove the injector pump gear.



MX34295

19.Note the location of the injector pump timing mark (L) as related to the timing gear housing timing marks (M). The replacement pump will need to be installed in the exact same location.

20.Remove the three mounting nuts (N) securing the injector pump to the crank case and remove the injector pump.

Installation:

Installation is done in the reverse order of removal.

CAUTION: Avoid injury! DO NOT attempt to adjust the ARB/EPA Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service CARB/ EPA Certified Emissions engines.

- Install and tighten injector pump, aligning the timing mark to the same mark on the timing gear housing as noted during removal.
- Install and tighten the three cap screws to specification.
- Align the timing gear marks and install injector pump gear and lock nut and tighten to specification.
- Install injector pump gear cover.
- Install the outlet hoses to the fuel transfer pump.
- Install the injector lubrication line and secure with banjo bolts.
- Install the fuel input hose and injector nozzle leakoff hose to the injector pump.
- Install fuel lines at the injection pump and the injector nozzles and tighten the connector nuts to specification. When tightening connectors, use a backup wrench to prevent delivery valves from turning.
- Install and connect the fuel shutoff solenoid.
- Install the engine. See “Engine Removal and Installation” on page 115.
- Install the air intake hose to the intake manifold.
- Turn the fuel shut-off valve on the fuel filter/water separator to the OPEN (“O”) position.
- Bleed the fuel system.

Torque Specifications:

Injector Gear Cover Cap Screws . . . . 11 N•m (97 lb-in.)
Injector Pump Drive Gear Nut . . . . . 58 - 68 N•m (43 - 50 lb-ft)
Injector Pump Mounting Nuts . . . . . 22.5 - 28.4 N•m (17 - 21 lb-ft)
Fuel Line-to-Injection Pump Nuts . . . . . 29.4 - 34.4 N•m (22 - 25 lb-ft)
Fuel Line-to-Injector Nozzle Nuts . . . . . 29.4 - 34.4 N•m (22 - 25 lb-ft)

Fuel Injection Pump Camshaft - 3TNE68

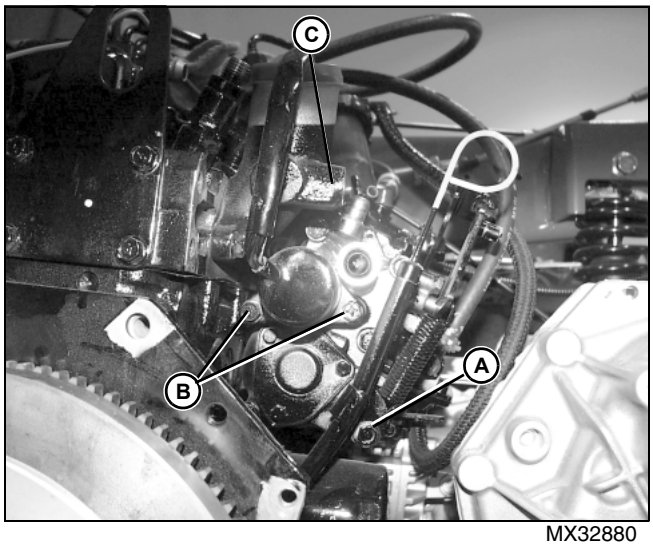
IMPORTANT: Avoid damage! Do not loosen four bolts on injector pump camshaft gear!

Removal:

1. Remove timing gear cover. See “Timing Gear Cover - 3TNE68” on page 132.

2. Remove fuel injection pump. See “Fuel Injection Pump - 3TNE68” on page 168.

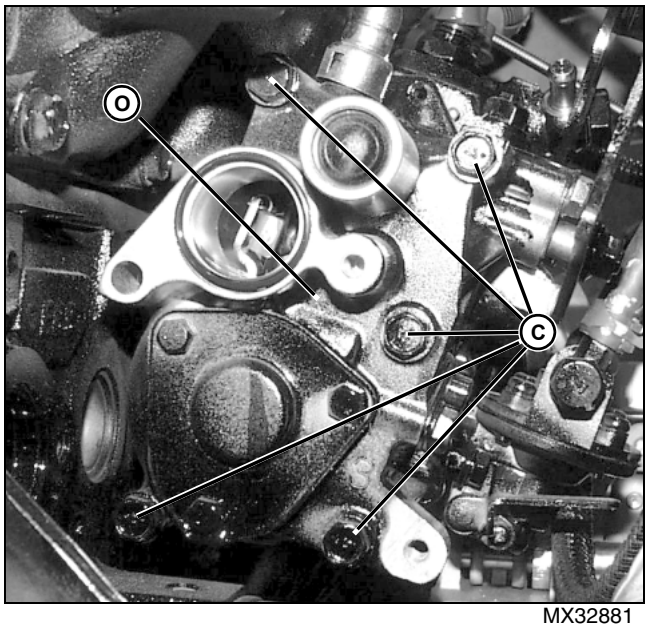
3. Remove fuel transfer pump. See “Fuel Transfer Pump - 3TNE68” on page 165.



MX32880

4. Remove cap screw (A) and dipstick tube.

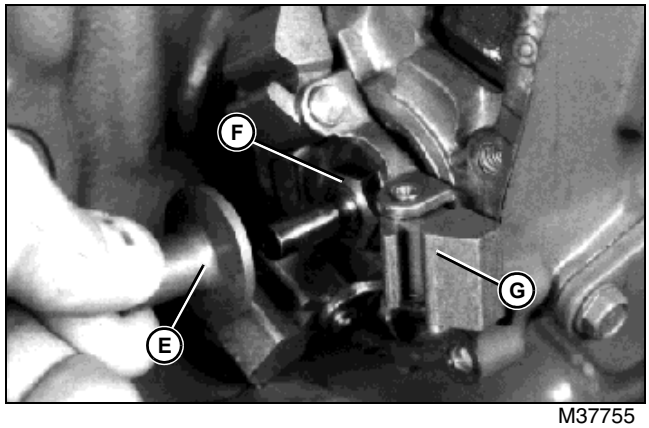
5. Remove two cap screws (B). Disconnect and remove fuel shutoff solenoid.



MX32881

6. Remove five remaining cap screws (C) attaching governor assembly (D) to timing gear housing.

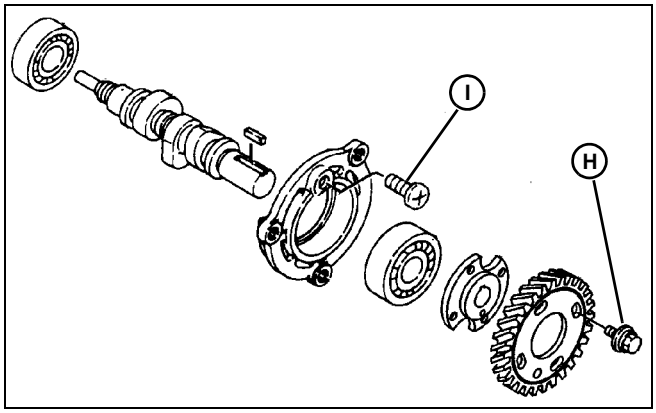
7. Remove governor assembly (D).



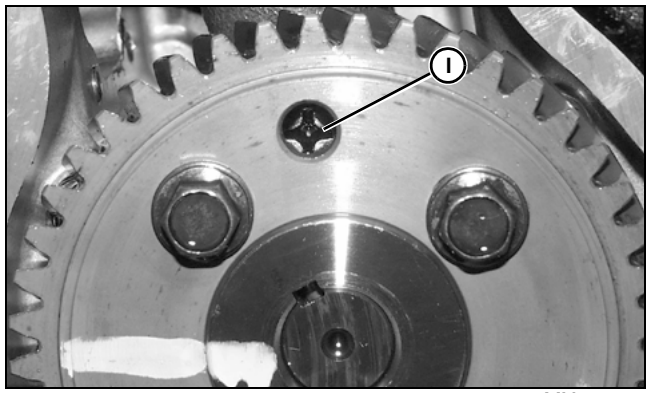
M37755

8. Remove sleeve (E), nut (F) and governor weights (G) from end of injection pump camshaft.

IMPORTANT: Avoid damage! The injection pump camshaft has a gear with four slots bolted to a hub on the camshaft. Do not loosen the bolts (H) securing the gear or camshaft timing will be altered.



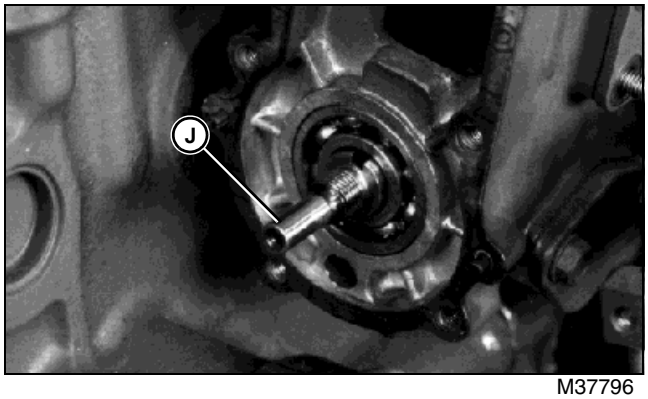
MX1341



MX14181

9. Remove bearing retaining screw (I).

IMPORTANT: Avoid damage! Do not allow fuel injection pump camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces may be damaged.



M37796

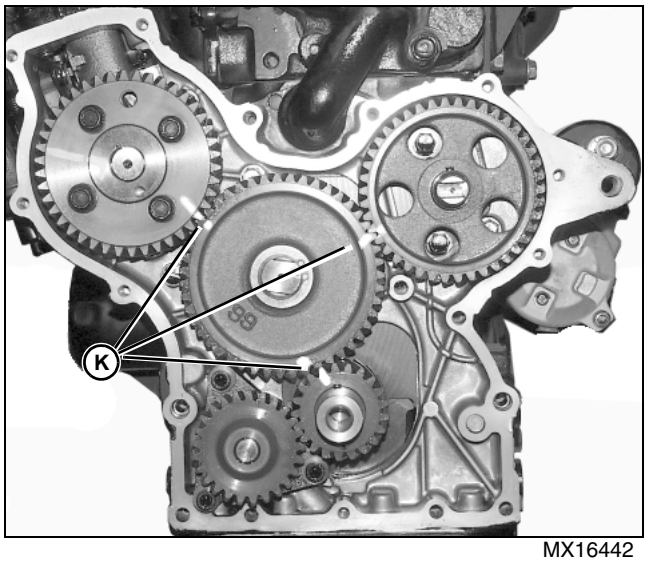
10.Carefully tap the rear of camshaft (J) with plastic hammer to remove from housing.

11.Disassemble and inspect all parts for wear or damage. See Fuel Injection Pump Camshaft Inspection.

Installation:

Installation is done in reverse order of removal.

- After installing camshaft assembly into housing, tap on end of camshaft gear with a plastic hammer to seat bearings in bores.
- Tighten bearing retainer screw (I) to 20 N•m (180 lb-in.).



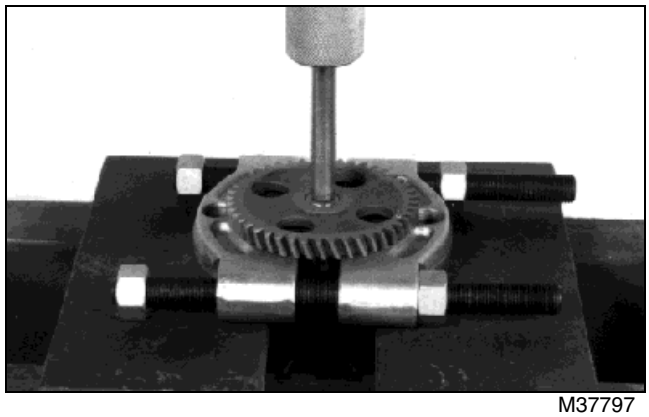
MX16442

- Align timing marks (K) on all timing gears and idler gear when installing camshaft.

Disassembly:

NOTE: Gear and bearings are press fit on shaft.

IMPORTANT: Avoid damage! Hold camshaft while removing gear and bearings. Shaft can be damaged if dropped.



M37797

1. Remove gear using knife edge puller and a press.
2. Remove key.
3. Remove bearings using a knife edge puller and a press.
4. Inspect all parts for wear or damage. See Fuel Injection Pump Camshaft Inspection.

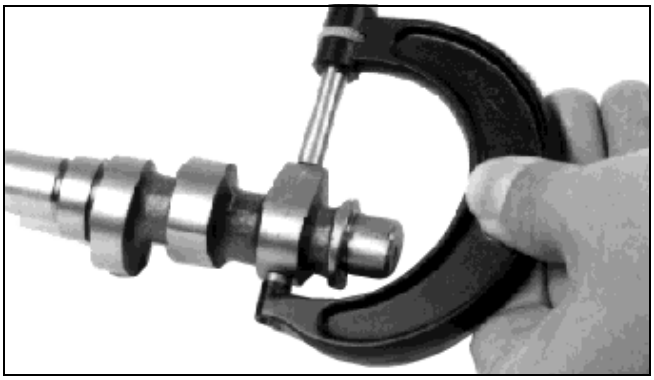
Assembly:

NOTE: Install large bearing on gear end.

IMPORTANT: Avoid damage! When pressing bearings apply pressure on the inner bearing race only

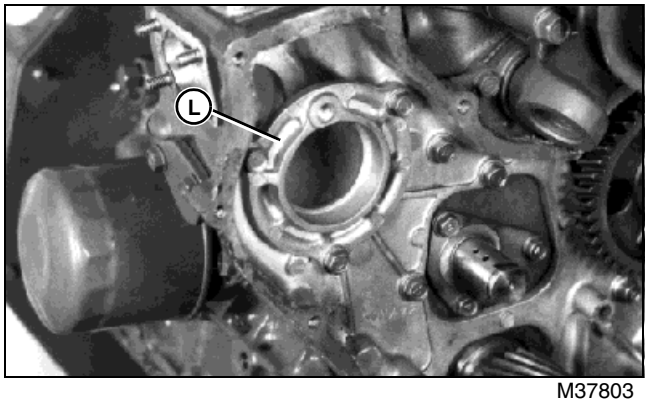
1. Install bearings on ends of camshaft using a 3/4 inch deep well socket and a press. Press until bearing races bottom on camshaft shoulders.
2. Install key.
3. Put camshaft gear on a flat surface and press camshaft assembly into gear. Press until gear shoulder butts up against inner bearing race.

Inspection:



M35905

1. Measure height of each camshaft lobe. Replace camshaft if lobe height is less than 30.90 mm (1.217 in.).



M37803

2. Inspect camshaft bearing supports in timing gear housing. Check for cracks, damage or indications that bearings have spun in support.

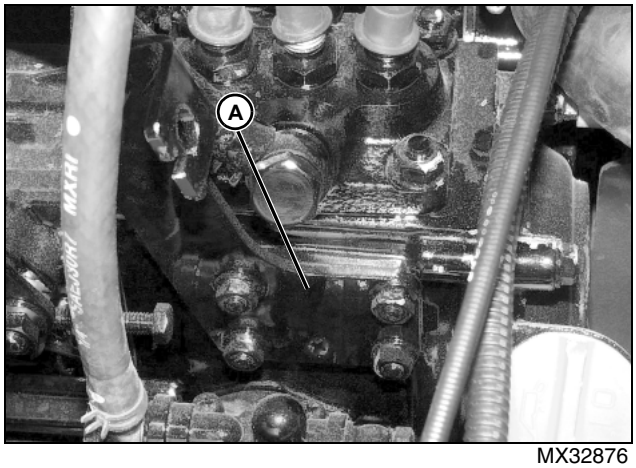
- If rear bearing bore is damaged, replace timing gear housing.
- If front bearing bore (L) is damaged, remove three cap screws and replace support.

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

Governor - 3TNE68

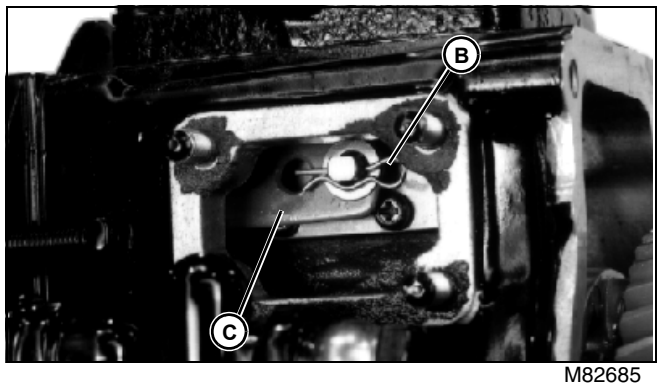
Removal:

1. Remove rocker arm cover breather hose.



MX32876

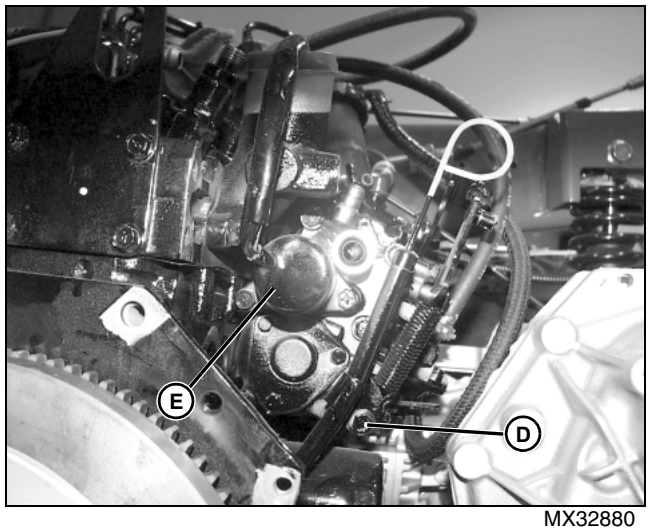
2. Remove throttle cable and governor linkage cover (A).



M82685

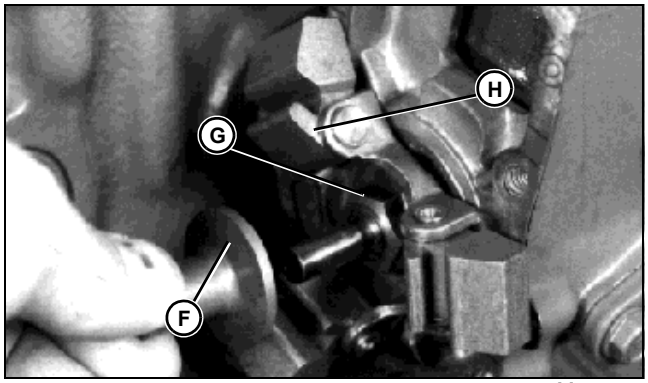
Picture Note: Washer may be fixed to linkage. Do not drop pin during removal.

3. Remove pin (B) and washer to disconnect governor linkage (C).



MX32880

4. Remove cap screw (D) and dipstick tube.
5. Remove two cap screws and fuel shutoff solenoid (E).
6. Remove remaining cap screws, and governor housing.



M37755

7. Remove sleeve (F).
8. Remove nut (G) and governor weight assembly (H).
9. Disassemble and inspect all parts for wear or damage.

Installation:

Installation is done in the reverse order of removal.

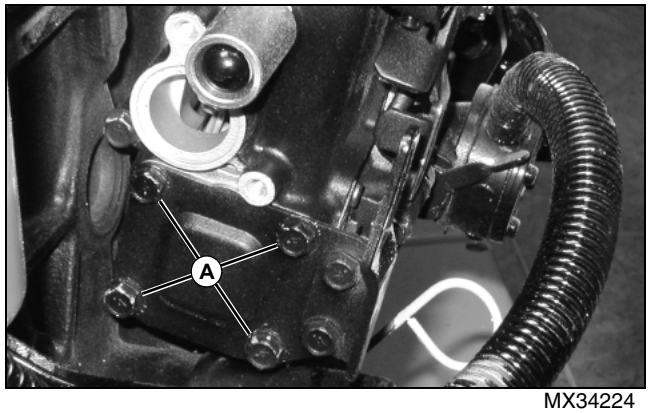
- Clean all gasket material from mating surfaces and install new gasket.
- Governor linkage has two holes. Connect governor linkage to injection pump rack using hole at end of linkage.
- Check and adjust slow idle settings. See “Slow Idle Adjustment” on page 100.

Fuel Control and Governor Linkage - 3TNV70

Removal:

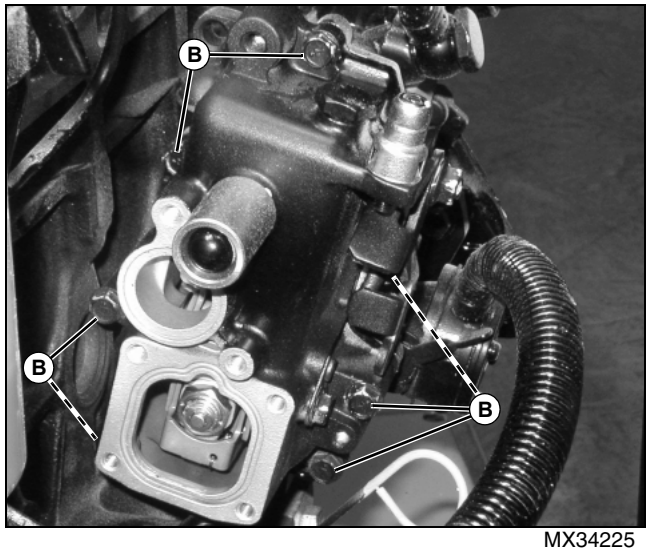
1. Park machine safely. See Parking Safely in the Safety Section.
2. Allow engine to cool.
3. Remove hood.
4. Remove the air cleaner assembly.
5. Loosen the throttle cable retaining clamp and disconnect throttle cable.
6. Disconnect and remove fuel shutoff solenoid.

NOTE: Pooled oil will drain out when the governor cover is removed. Use suitable container to catch oil.



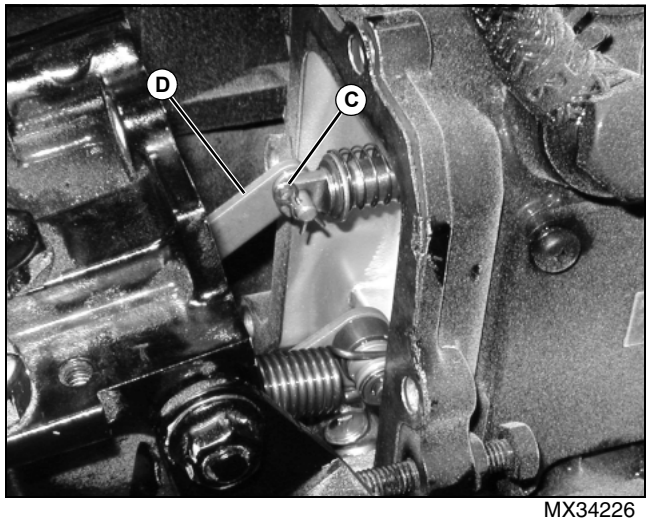
MX34224

7. Remove the four cap screws (A) and governor cover.



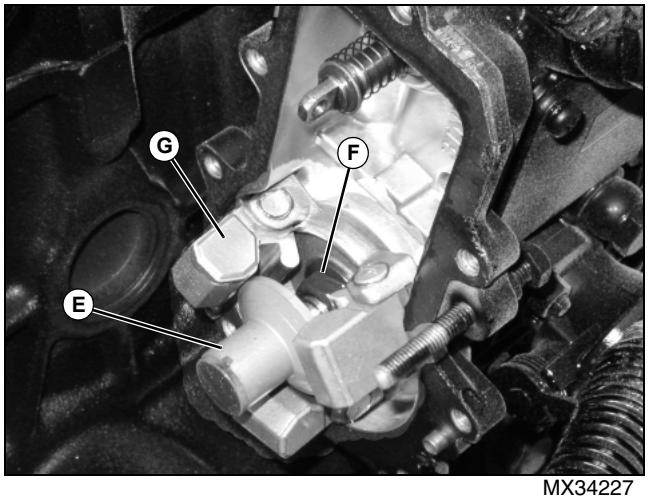
MX34225

8. Remove seven cap screws (B) attaching governor housing to injector pump body.



MX34226

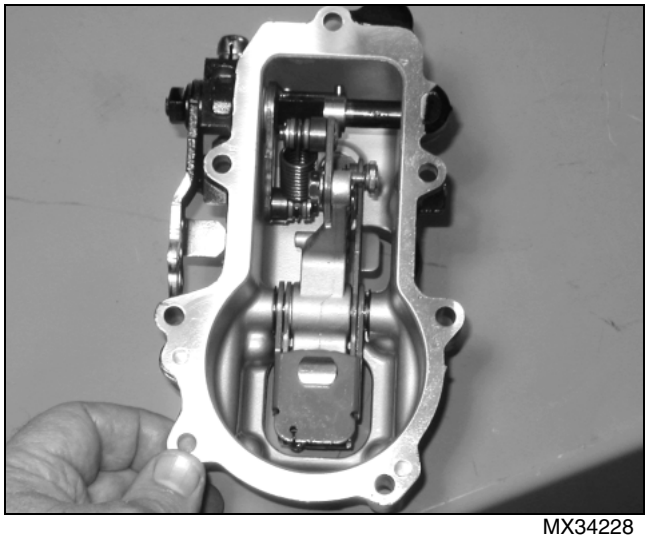
9. Pull governor housing and gasket away from the injector pump enough to access the governor linkage.
10. Remove pin (C) and disconnect governor linkage (D).



MX34227

11.Remove sleeve (E).

12.Remove nut (F) and governor weights (G).


MX34228

13.inspect all parts for wear or damage.

Installation:

Installation is done in the reverse order of removal.

- Check and adjust slow idle settings. See “Slow Idle Adjustment” on page 100.

Fuel Shutoff Solenoid Removal and Installation

1. Park machine safely. See Parking Safely in the Safety Section.

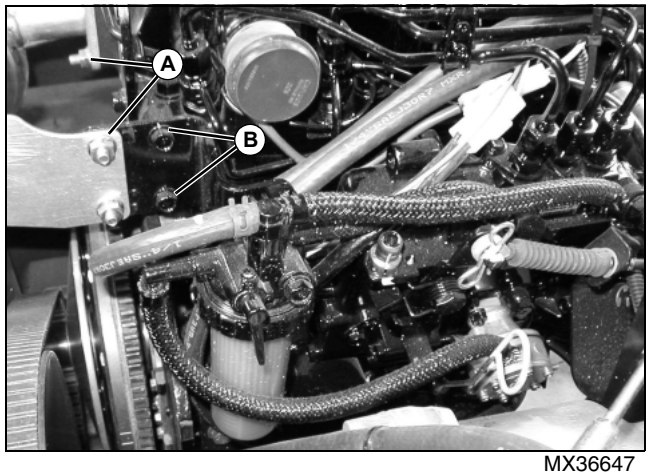
2. Allow engine to cool.

3. Raise and lock the cargo box.

4. Turn the fuel shut-off valve on the fuel filter/water separator to the CLOSED (“C”) position.

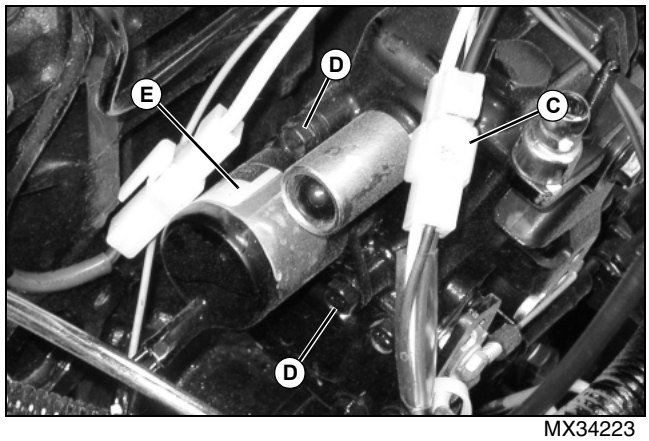
5. Remove the air intake hose from the intake manifold.

6. Clean around the fuel shutoff solenoid using a parts cleaning solvent or steam cleaner.



MX36647

7. Remove the muffler. See “Muffler Removal and Installation” on page 119.



MX34223

8. Disconnect the electrical connector (C) to the fuel shutoff solenoid.

9. Remove the two solenoid mounting cap screws (D) and remove solenoid (E) from governor housing.

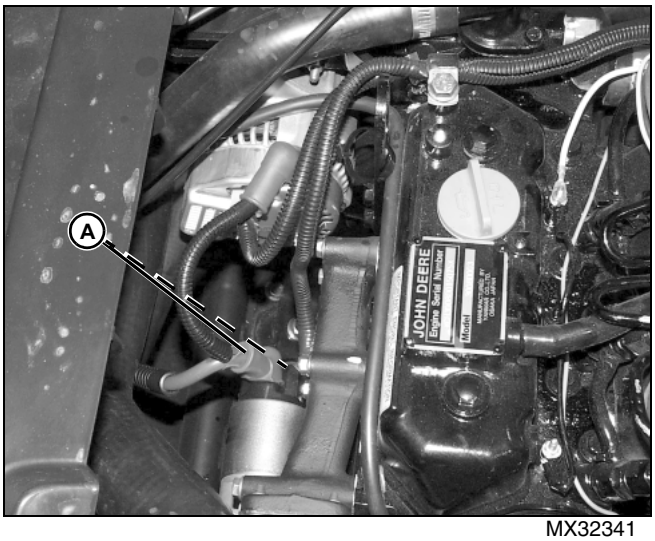
10.Test fuel solenoid. See “Fuel Shutoff Solenoid Tests” in Electrical section.

11.Installation is in reverse of removal. Check condition of O-ring on solenoid before installing.

Starting Motor Removal and Installation

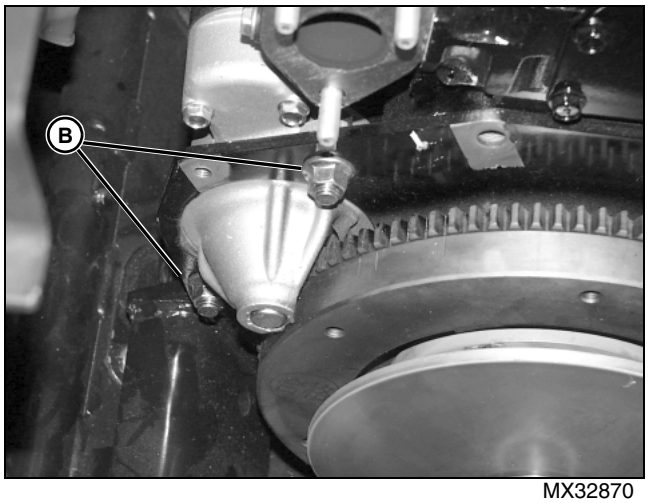
Removal:

1. Park machine in safely with park brake locked. See Park Machine Safely in Safety section.
2. Disconnect negative battery cable.



MX32341

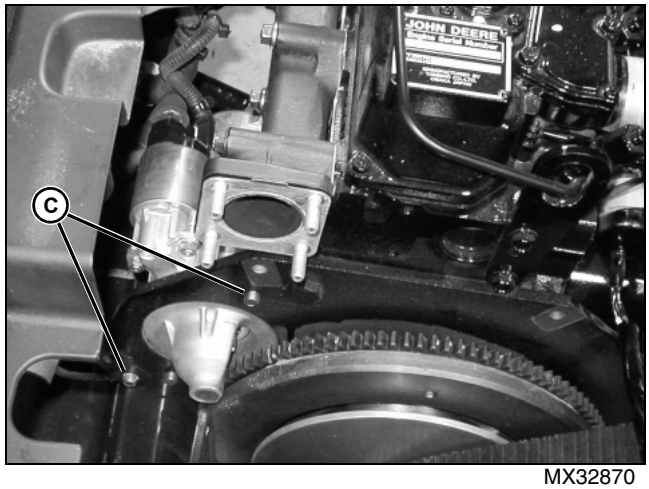
3. Remove battery cable and solenoid wire (A) from starting motor.



MX32870

Picture Note: 3TNE68

4. 3TNE68 - Remove two nuts (B) from starting motor studs, and remove starting motor.



MX32870

Picture Note: 3TNV70

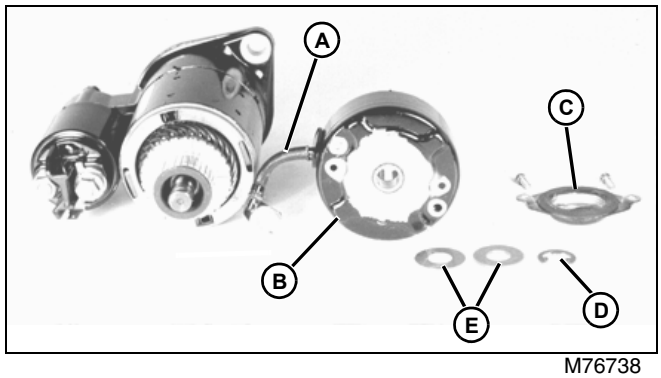
5. 3TNV70 - Remove two cap screws (C) securing starting motor to flywheel plate, and remove starting motor.

Installation:

1. Install starting motor to engine backplate as removed and tighten mounting bolts to 28 N•m (20 lb-ft).
2. Install battery cable and solenoid wire.
3. Reconnect negative battery lead to battery.

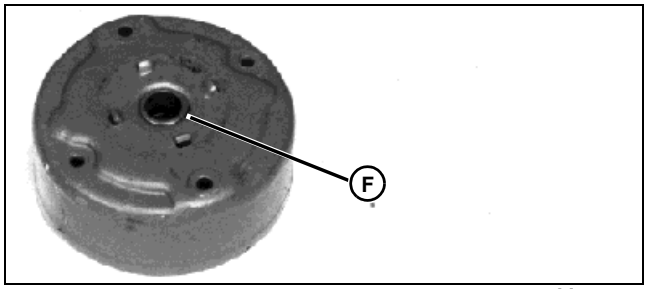
Starting Motor Repair

Disassembly and Inspection:



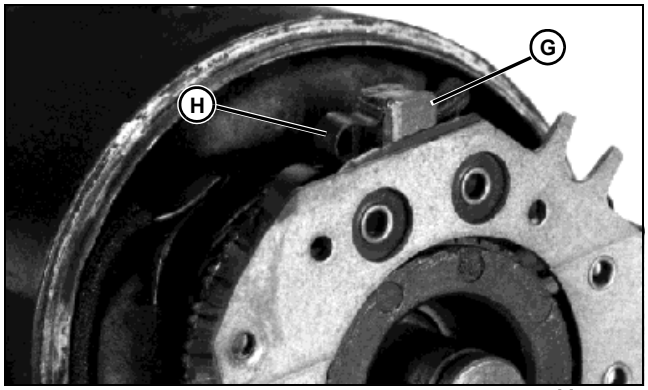
M76738

1. Disconnect field lead (A).
2. Remove two cap screws and two screws from rear cover (B).
3. Pry off cap (C).
4. Remove E-clip (D), shims (E) and rear cover.
5. Inspect rear cover bushing for wear or damage.
   - To replace rear cover bushing:
     Remove bushing using a blind-hole puller set. Install new bushing until it bottoms in cover bore using a driver set.



M37874

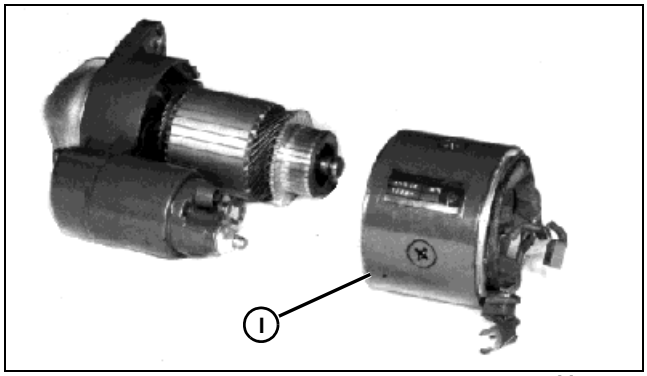
6. Ream bushing (F) to 12.50 - 12.53 mm (0.492 - 0.493 in.).



M37875

7. Remove field coil brushes (G) from brush holder.

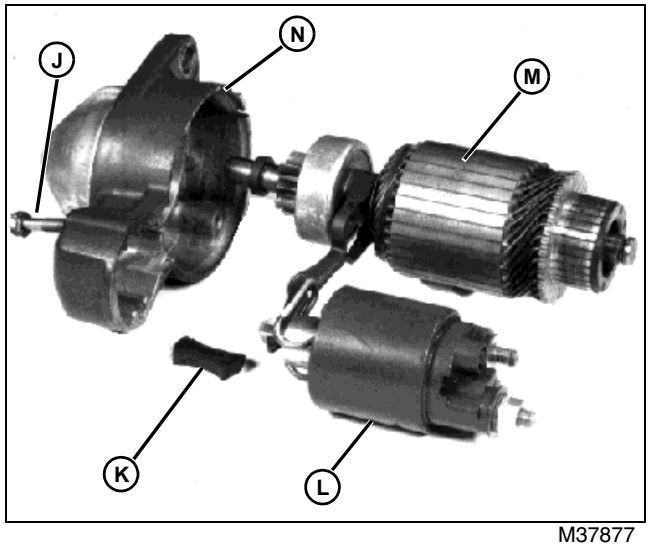
8. Pry brush springs (H) away and pull negative brushes up enough to allow spring to hold brush in place.



M37876

9. Remove brush holder.

10.Remove field coil housing (I) from armature/solenoid assembly.



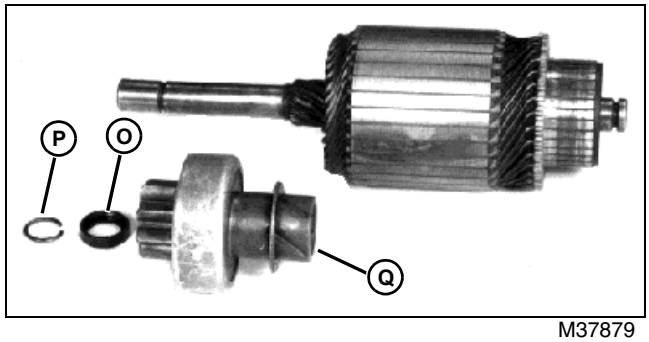
M37877

11.Remove two cap screws (J).

12.Remove dust cover (K).

13.Remove solenoid (L) and armature assembly (M) from end frame (N).

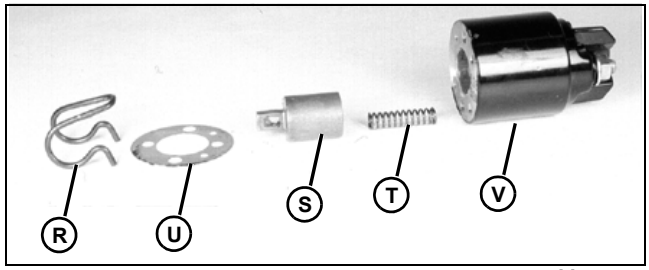
14.Inspect end frame bushing for wear or damage. Replace if necessary.



M37879

15.Slide pinion stopper (O) away from retaining wire (P) using a piece of pipe or deep socket. Remove retaining wire, pinion stopper, and clutch assembly (Q) from armature shaft.

16.Inspect clutch assembly for wear or damage. Gear should rotate in one direction only. Replace if necessary.



M76739

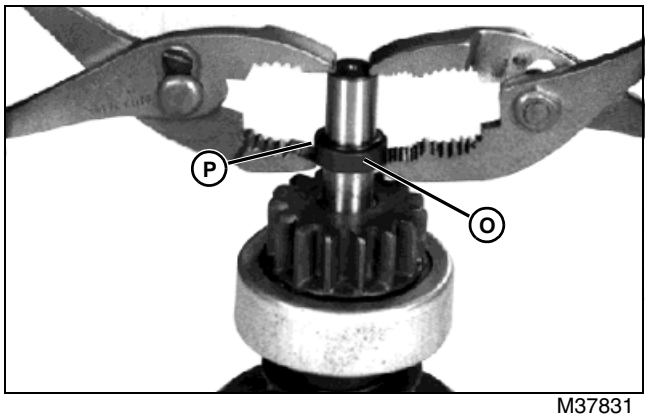
17.Remove clutch fork pivot (R), plunger (S), spring (T) and shim(s) (U) from solenoid (V).

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

19.Inspect and test brushes, holder, field coil and armature. See Starting Motor Component Testing procedures.

Assembly:

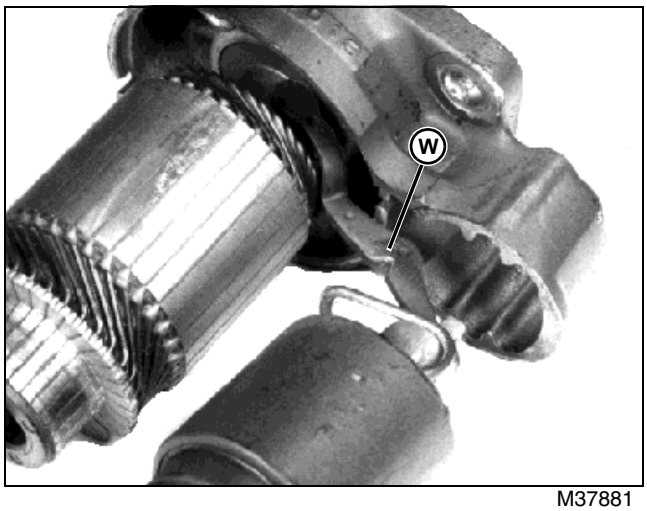
Assembly is done in the reverse order of disassembly.



M37831

• After installing clutch assembly, pinion stopper (O) and retaining wire (P) on armature shaft, use two pliers to press pinion stopper over retaining wire.

IMPORTANT: Avoid damage! When installing rear cover, be sure field coil brush wires do not touch cover. Turn brush holder slightly to take up slack in brush wires. Press wires inward to clear rear cover.



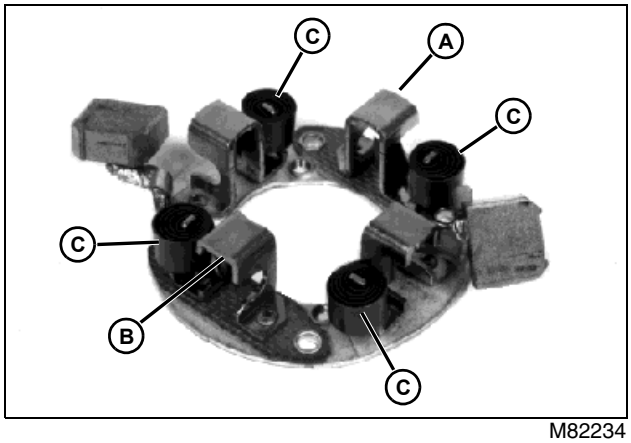
M37881

• When installing solenoid and armature assemblies into end frame, make sure fork pivot seats in notch (W) on clutch fork.

Starting Motor Component Testing:

1. Measure holder and field coil brush lengths. Minimum brush length is 7.70 mm (0.303 in.). Replace brush holder or field coil if brush length is below minimum.

NOTE: Test brush holder using an ohmmeter or test light.

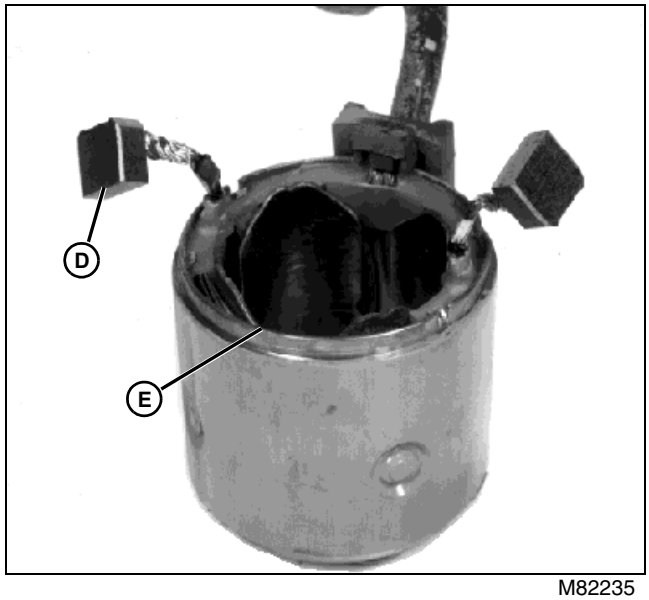


M82234

2. Test brush holder:
Touch one probe of tester to negative brush holder (A) and other probe to field brush holder (B). If there is continuity, replace the brush holder.

3. Inspect springs (C) for wear or damage. Replace if necessary.

NOTE: Test field coil using an ohmmeter or test light.

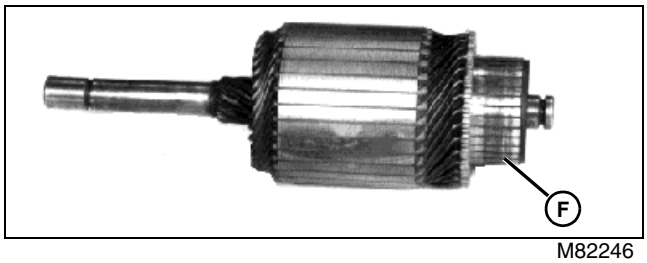


M82235

4. Test for grounded field winding:
Touch one probe of tester to field coil brush (D) and other probe to field coil housing (E). Be sure the brush lead is not touching the frame. If there is continuity, the coil is grounded and the field coil housing assembly must be replaced.

5. Test for open field coil:
Touch one probe of tester to each field coil brush. If there is no continuity, the field coil is open and the field coil housing assembly must be replaced.

IMPORTANT: Avoid damage! Do not clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.



M82246

6. Inspect armature. Look for signs of dragging against pole shoes.

7. Inspect commutator (F). Look for roughness, burned bars, or any material which 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.

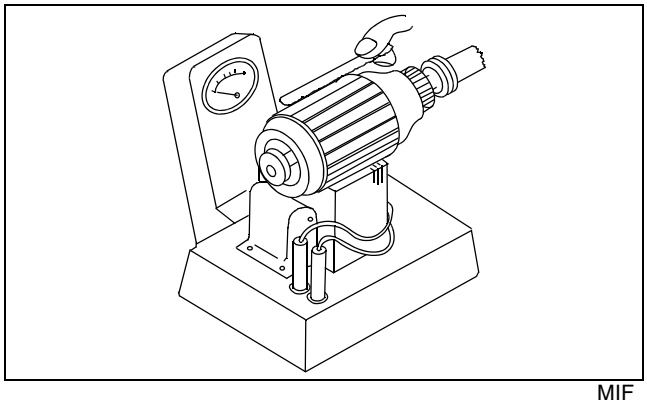
NOTE: Test armature windings using an ohmmeter or test light.

8. Test for grounded windings:
Touch probes on one commutator bar and armature shaft. Armature windings are connected in series, so only one commutator bar needs to be checked.

If test shows continuity, a winding is grounded and the armature must be replaced.

9. Test for open circuited windings:
Touch probes on two different commutator bars.

If test shows no continuity, there is an open circuit and the armature must be replaced.


MIF

10.Test for short circuited windings using a growler. Put armature in a growler and hold a hacksaw blade above each slot while slowly rotating armature.

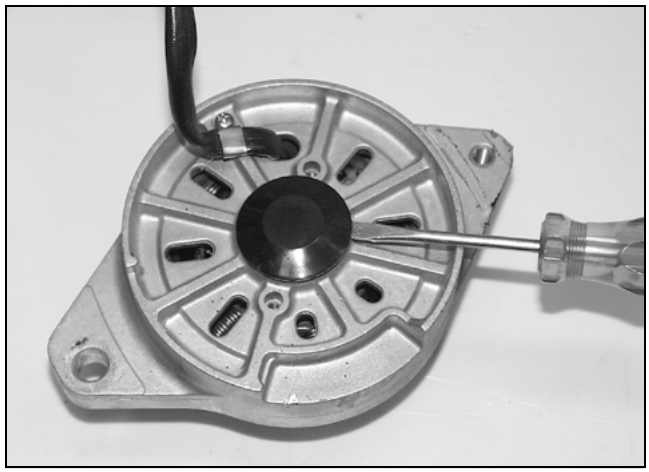
If coil is shorted, the blade will vibrate on the slot.

NOTE: A short circuit most often occurs because of copper dust or filings between two commutator segments.

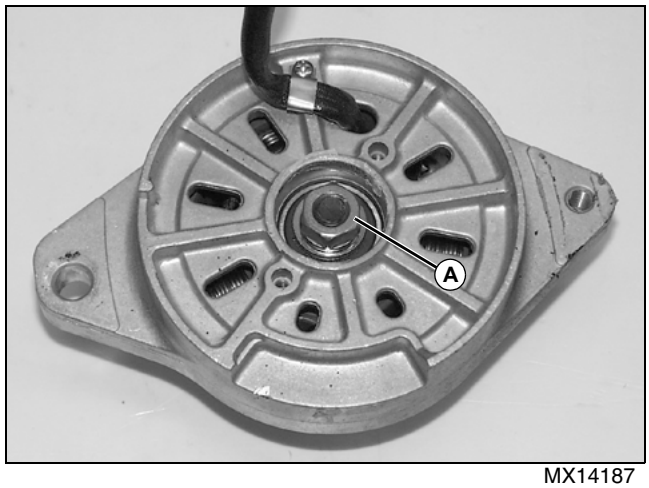
11.If test indicates short circuited windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.

20 Amp Alternator

Disassembly/Inspection:

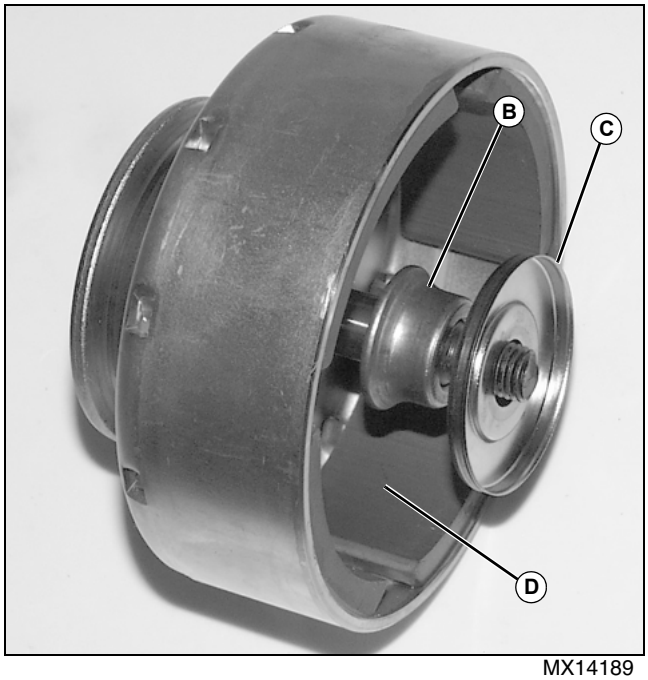

MX14186

1. Pry plastic cover from back of alternator.



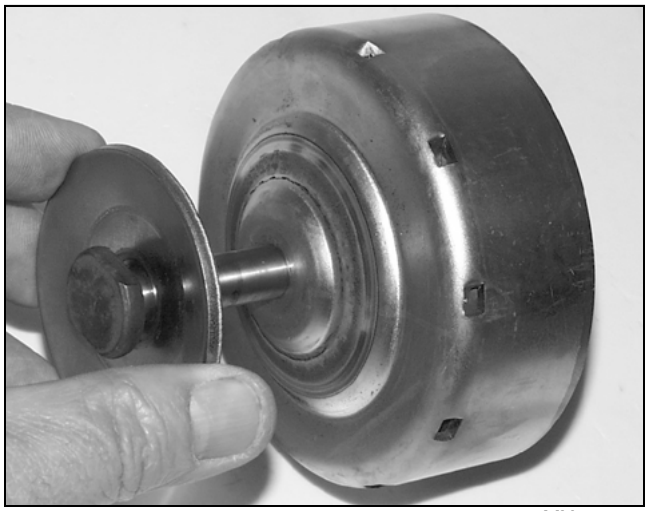
MX14187

2. Remove nut, lockwasher, and flatwasher.



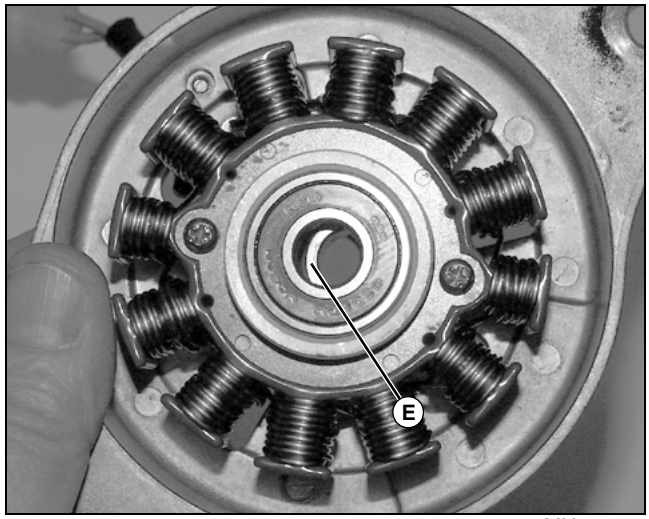
MX14189

3. Remove the rotor assembly. Note orientation of spacer (B) and dust cover (C). Check magnets (D) for cracks and good magnetism.



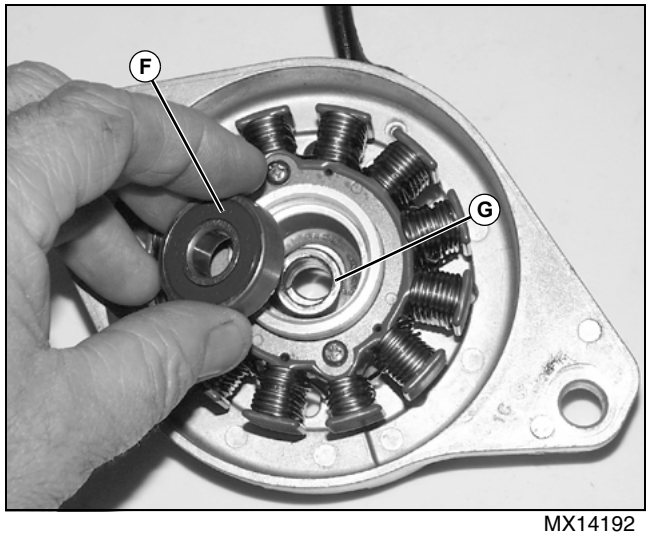
MX14188

4. Remove outer sheave and shaft (bolt). Inspect parts for wear or damage.



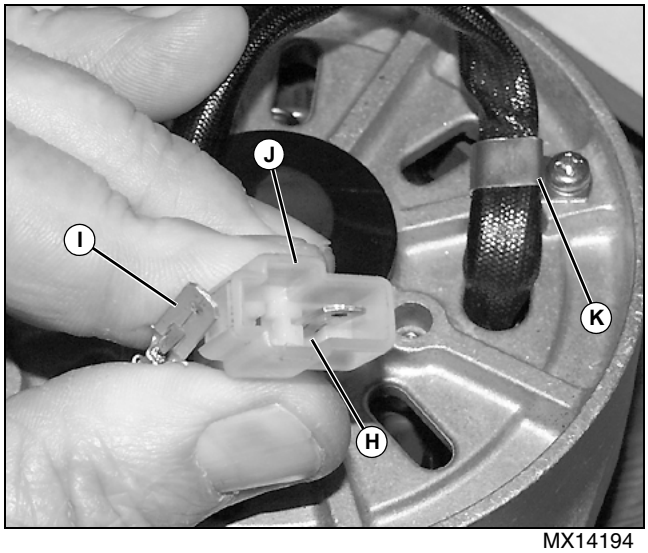
MX14190

5. To replace bearings, slide the spacer between the bearings over to the side (E) and press or drive out the first bearing with the spacer.



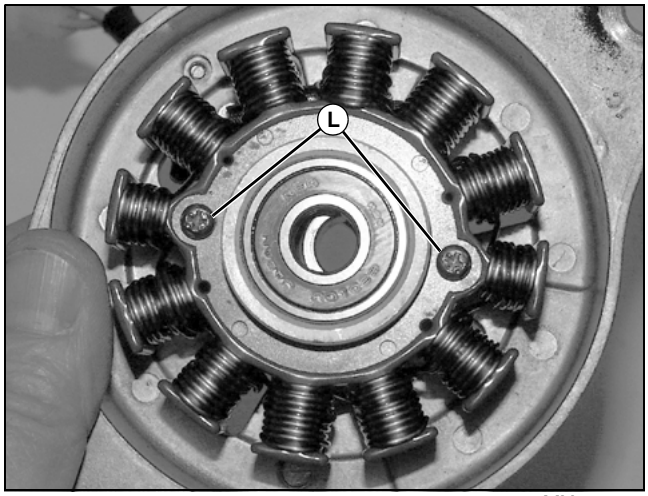
MX14192

6. Remove bearing and spacer, then drive out the other bearing.



MX14194

7. If replacing stator use a small screwdriver to bend tangs (H) in to release wire terminals (I) from connector plug (J). Remove wire clamp (K).



MX14190

8. Remove screws (L) and remove stator.

9. Inspect all parts and replace any worn or damaged parts.

Assembly:

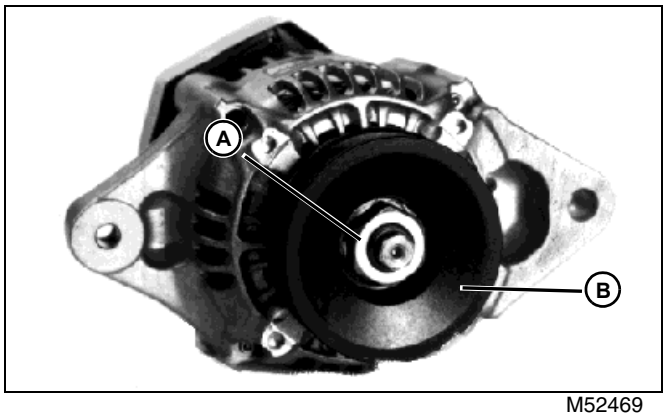
Assembly is done in the reverse order of disassembly.

40 Amp Alternator

Equipment:

- Volt-Ohm-Amp Meter
- Bearing Puller Set

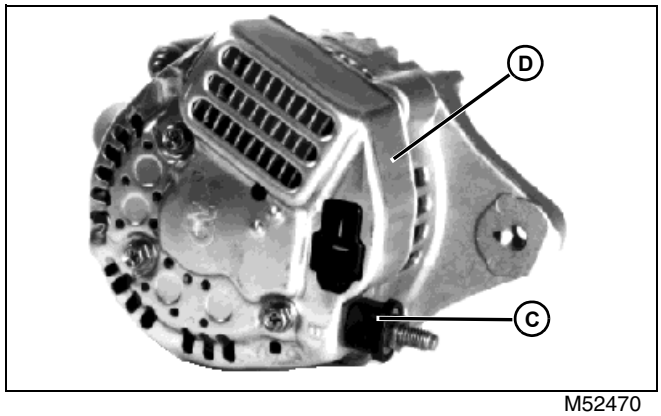
Disassembly:



M52469

1. Clamp sheave in a soft jaw vise and remove sheave nut (A).

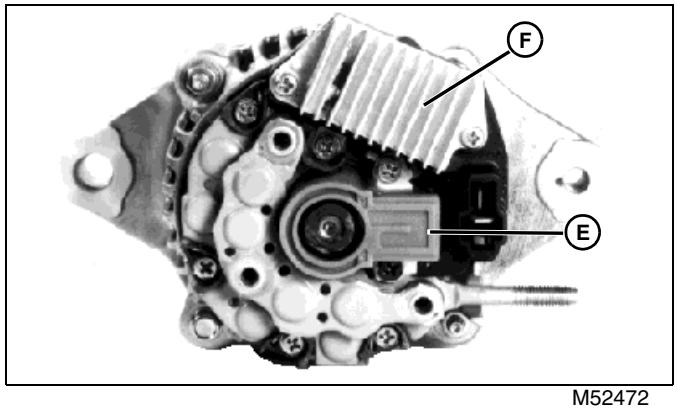
2. Use puller to remove sheave (B).



M52470

3. Remove insulator (C).

4. Remove cover (D).

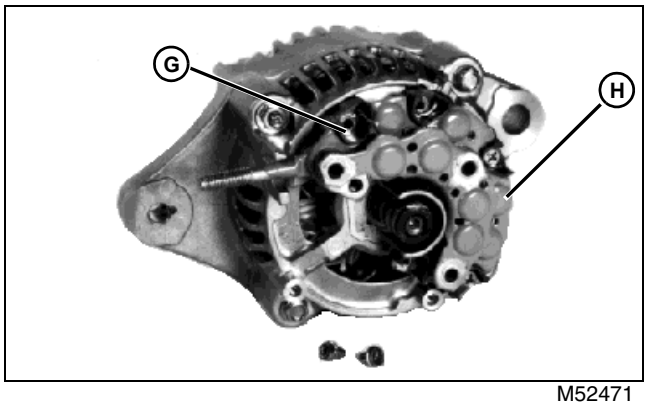


M52472

5. Remove brush holder and cover (E).

6. Remove regulator (F).

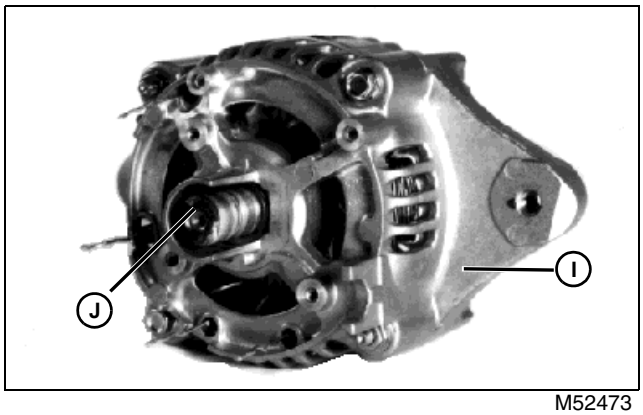
NOTE: Remember location of short screw on regulator tab.



M52471

7. Remove screw and straighten wire leads (G).

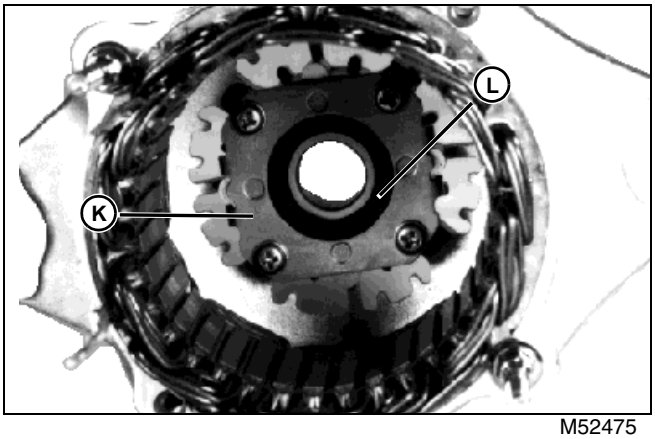
8. Remove rectifier (H).



M52473

9. Remove rear case assembly (I).

10. Press rotor shaft (J) from rear case.

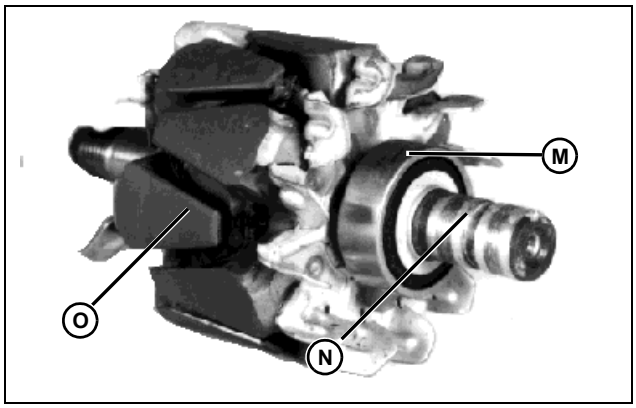


M52475

11. Remove retainer plate (K).

12. Press bearing (L) from case.

Inspection:



M52474

1. Inspect bearing (M) for smooth rotation. Replace if necessary.

2. Inspect slip rings (N) for dirt or rough spots. If necessary, use No. 00 sandpaper or 400-grit silicon carbide paper to polish rings.

3. Measure outer diameter of slip rings (N). Replace rotor if less than specification.

4. Check continuity between slip rings (N) using ohmmeter or continuity tester. Replace rotor assembly if there is no continuity.

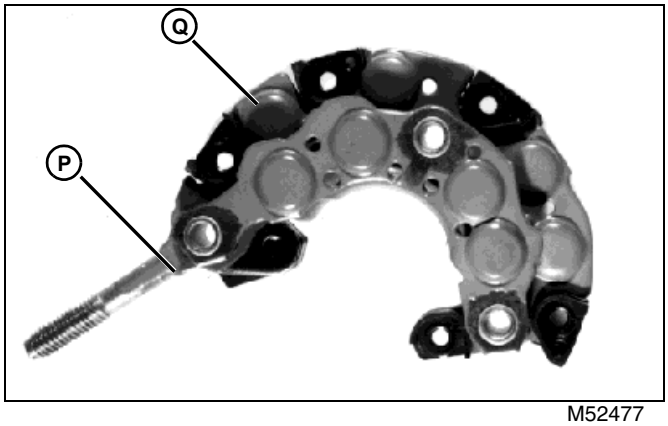
5. Check continuity between slip rings and rotor core (O). Replace rotor assembly if there is continuity.

NOTE: Use an ohmmeter that is sensitive to 0 - 1 ohm.

6. Inspect stator for defective insulation, discoloration, or burned odor.

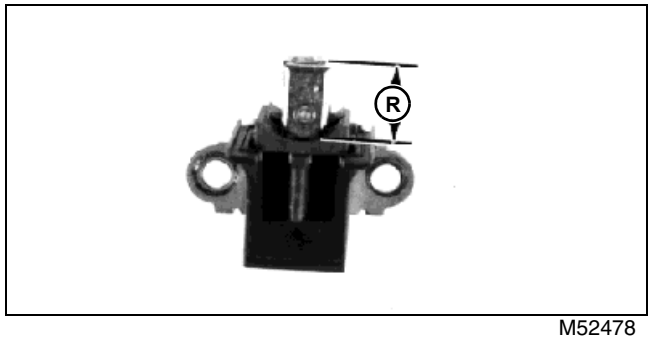
7. Check for continuity between each stator lead and body. Replace stator if there is continuity.

NOTE: Set ohmmeter to the K ohm range.



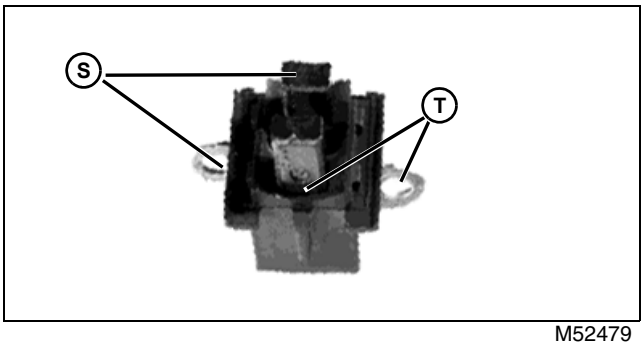
M52477

8. Check continuity between lead (P) and each diode lead (Q). Reverse ohmmeter leads and recheck. There should be continuity in one direction, but not the other. Replace diodes or rectifier plate if bad.



M52478

9. Measure length of brush protruding from holder. Dimension (R) should be within specification. Replace brushes if worn below minimum.



M52479

10.Check continuity between brush and terminal (S). Check continuity between brush and terminal (T). There should be continuity only at these points.

Specification:

Slip Ring Diameter (Minimum) . . . . . 14 mm (0.55 in.)

Brush Length Specifications:

Exposed Brush Length (Minimum) . . . 4.5 mm (0.17 in.)
Exposed Brush Length (Maximum) . 10.5 mm (0.41 in.)

Assembly:

1. Press new bearing (L) into case.
2. Install retainer plate (K).

NOTE: Check that rotor fan does not contact case and that rotor assembly turns smoothly in bearing.

3. Press rotor shaft (J) into rear case.
4. Install rear case assembly (I).
5. Install rectifier (H).
6. Install screws through loop formed in wire leads (G).

IMPORTANT: Avoid damage! Check that short screw is installed in regulator tab. Longer screw will contact frame and will cause damage to the charging system.

7. Install regulator (F).
8. Install brush holder (E).
9. Install regulator cover (D).
10. Install insulator (C) and nut.
11. Install sheave (B).
12. Clamp sheave in soft jaw vise. Install sheave nut (A) and tighten to 69 N•m (51 lb-ft).

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General Information

Operation and Diagnostics

The operation and diagnostics 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 schematic s 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 is used to test the complete circuit regardless of the problem or complaint. Select a symptom or system from the quick check or troubleshooting chart and follow the test procedures under that heading.

The diagnostic procedure lists:

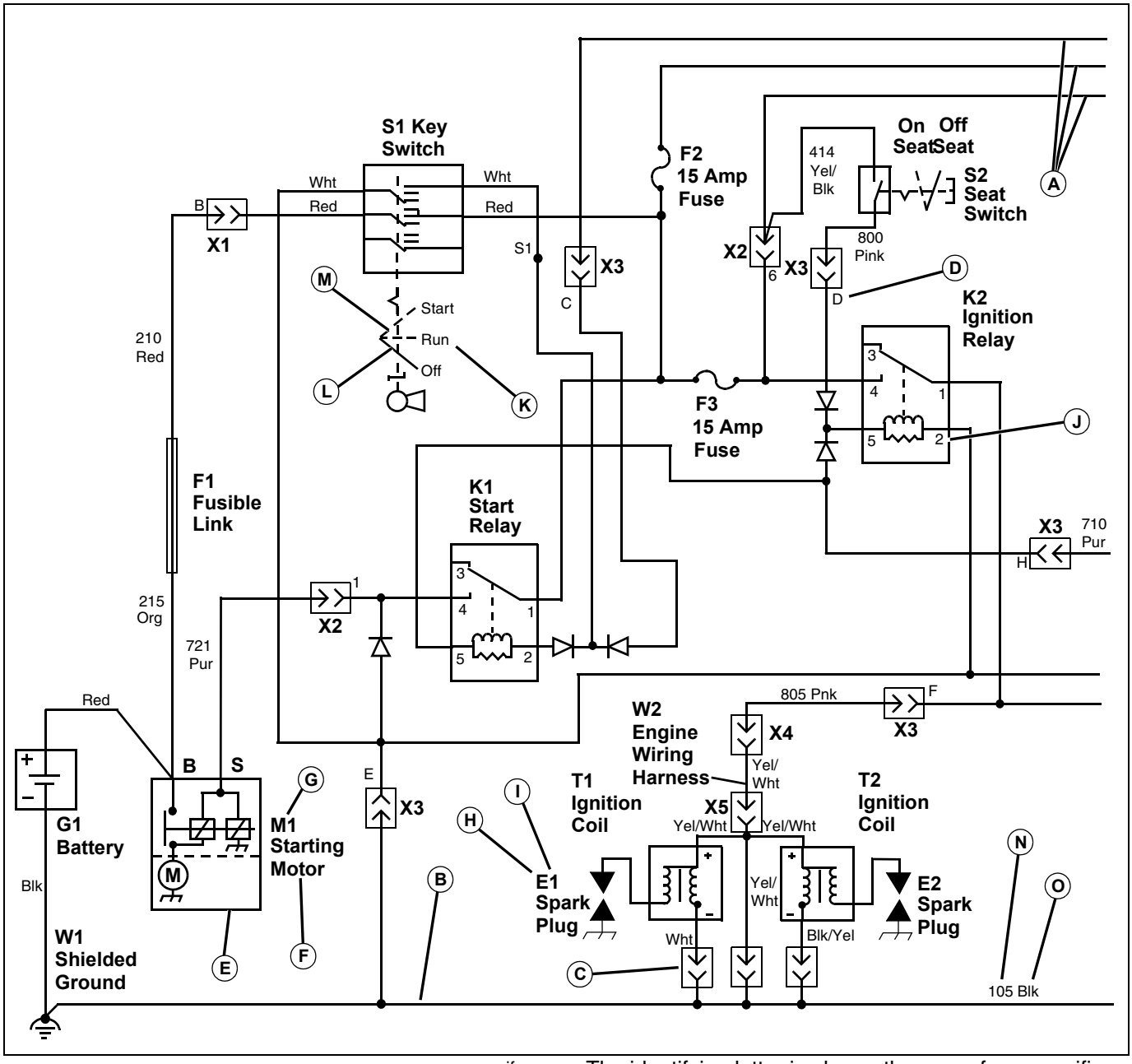
- Test conditions
- Test sequence
- Test location
- Normal reading
- Check or test to perform if reading is not normal

When performing the test or check, be sure to set your machine up to the test conditions listed and follow the sequence carefully. performing the test or check. If the results of the test or check are not normal, perform the test, The diagram that accompanies each test procedure is drawn to resemble machine components. The key letter on the art matches the letter in the procedure and the leader line points to the exact point the test is to be made.

Wire Color Abbreviation Chart

Blk	**Black**
Blu	**Blue**
Brn	**Brown**
Grn	**Green**
Gry	**Gray**
Org	**Orange**
Pnk	**Pink**
Pur	**Purple**
Red	**Red**
Tan	**Tan**
Wht	**White**
Yel	**Yellow**
Lt Blue	**Light Blue**
Lt Grn	**Light Green**
Org/Wht	**Orange/White**

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.

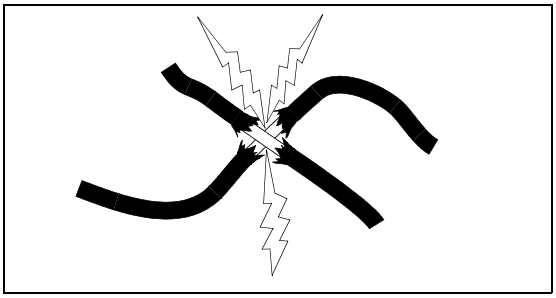
Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I). The identifying letter is always the same for a specific component, but the identifying numbers are numbered consecutively from upper left to lower right. The terminal designation (J) is placed directly inside or outside the symbol next to the connecting wire path. Switch positions (K) are also placed directly inside or outside the symbol. The solid line (L) shows the position the switch is currently in and dash lines (M) represent other switch positions.

The circuit number (N) and wire color (O) of the wires are shown directly next to the wire path.

The same component name and identification code are used consistently on all diagrams in this section. Components can be easily cross-referenced.

Common Circuit Tests

Shorted Circuit:



mif

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:

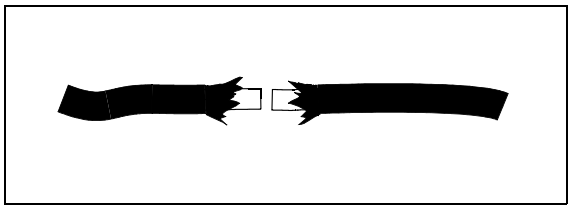
1. Turn component switch on.

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.

High Resistance or Open Circuit:



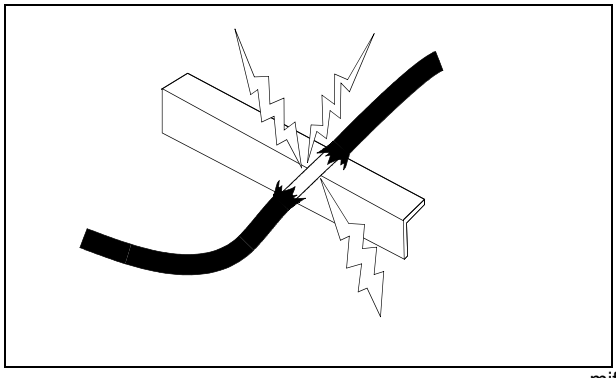
mif

1. 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:

2. Check all terminals and grounds of the circuit for corrosion.

3. If terminals are not corroded or loose, the problem is in the component or wiring.

Grounded Circuit:



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Grounded circuits usually result in no component operation or a blown fuse.

Conductors for 12 Volt Circuits

Standard 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

Specifications

Gasoline Engine Gators

Electrical System

Type . . . . . **12 Volt**
Battery Size . . . . . **340 Cold Cranking Amps @ -18°C (0°F)**
Alternator . . . . . **12 Amp at 1100 rpm, 21 Amp at 3200 rpm**
Spark Plug Gap . . . . . **0.80 mm (0.031 in.)**
Spark Plug Torque . . . . . **25 N•m (206 lb-in.) (18 lb-ft)**
Instrument Panel Bulb **AR62407**
Headlight Bulb . . . . . **37.5 W**
Radiator Fan Temperature Switch (Closing Temperature) . . . . . **93° ± 3° C (199° ± 5° F)**
Radiator Fan Temperature Switch Torque . . . . . **24 ± 3 N•m (212 ± 27 lb-in.)**
Engine Coolant Temperature Light Switch (Closing Temperature) . . . . . **111° ± 3° C (232° ± 5° F)**
Pulser Coil Resistance . . . . . **188 ohms ± 5 ohms**

Diesel Engine Gators

Electrical System

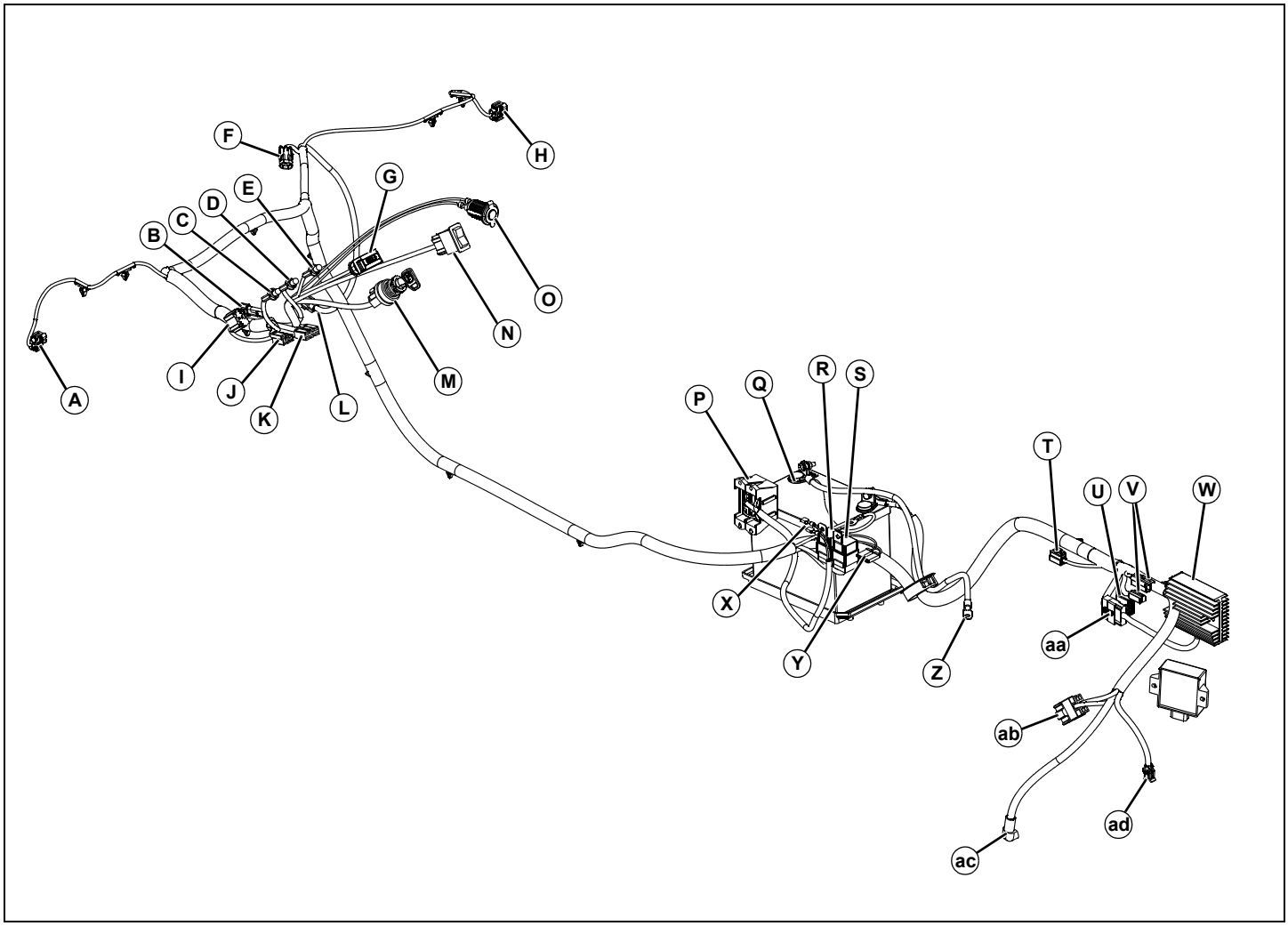
Type . . . . . **12 Volt**
Battery Size . . . . . **480 Cold Cranking Amps @ -18°C (0°F)**
Alternator . . . . . **40 Amp Regulated**
Regulator . . . . . **Solid State**

Fuses

Position	Circuit	Fuse Size
F1	Starting Motor Solenoid Circuit	30 amp
F2	Cooling Fan Motor Circuit (Gas)	15 amp
F2	Cooling Fan Motor Circuit (Diesel)	25 amp
F3	Charging Circuit (Gas)	25 amp
F3	Glow Plug Circuit (Diesel)	30 amp
F4	Rear Attachments Circuit	40 amp
F5	Accessory Power Plug	10 amp
F6	Ignition Switch ON Circuit‘	15 amp
F7	Front Attachments Circuit	40 amp
F8		Open

Component Location (SN -40000)

Electrical Components - Gas Engines



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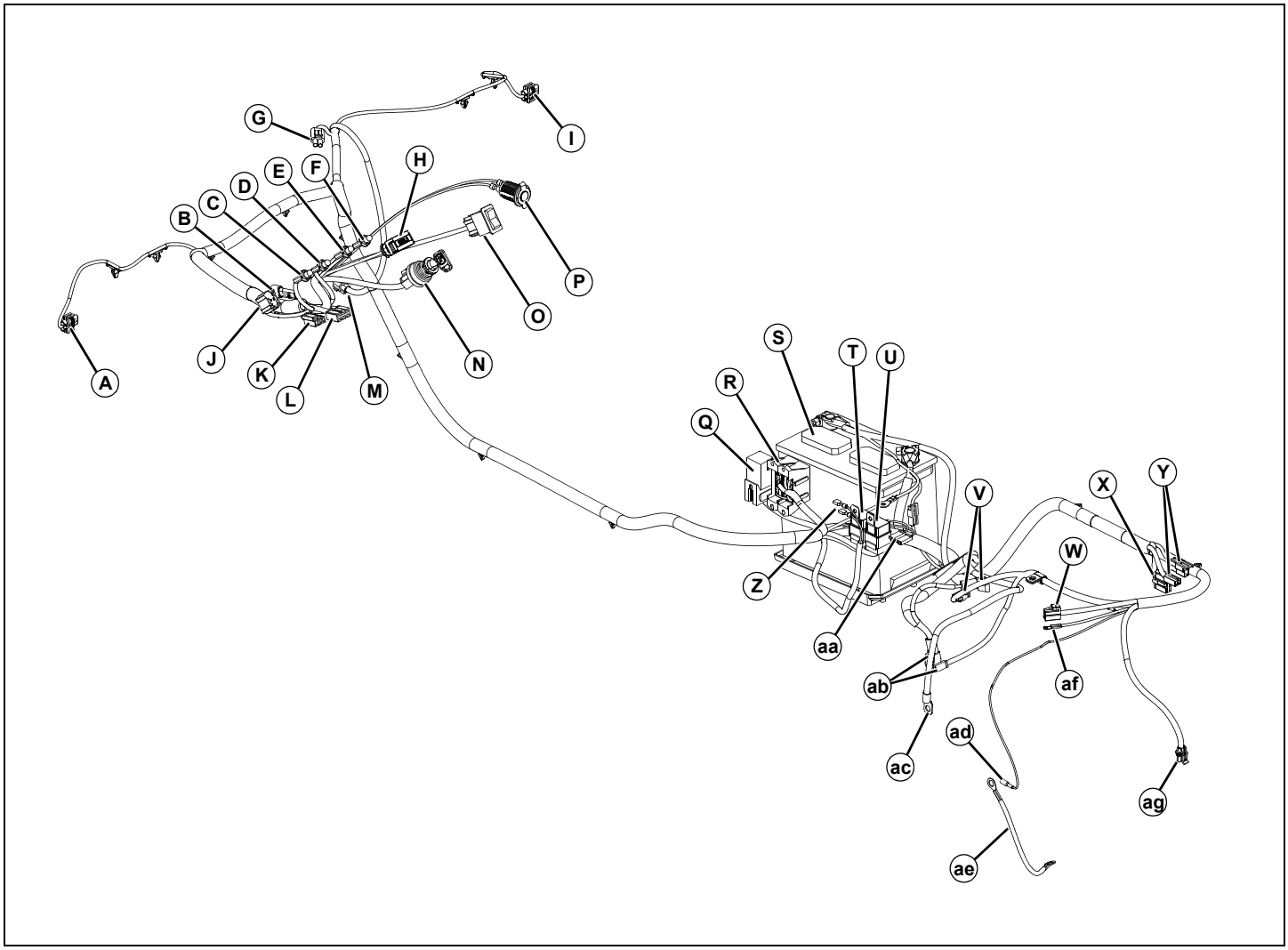
Picture Note: Shown from left rear

A - E3 Left Headlight
B - V1 Diode
C - H3 Oil Pressure Light
D - H2 Engine Temperature Light
E - H1 Park Brake Light
F - X5 Radiator Fan Connector
G - P1 Hourmeter
H - E4 Right Headlight
I - X9 Lift Switch Connector (Option)
J - X14 Front Power Connector
K - X15 Front Light Harness Connector
L - B1 Radiator Temperature Switch
M - S1 Key Switch
N - S4 Light Switch
O - X13 12VDC Power Port
P - Fuse Blocks
Q - G1 Battery
R - K1 Start Relay
S - K2 Radiator Fan Relay
T - X2 Fuel Pump Connector
U - X16 Rear Lights Harness Connector
V - X17 Rear Power Connector
W - N1 Voltage Regulator/Rectifier
X - S3 Park Brake Switch Connectors
Y - X8 Accessory Connectors
Z - Engine Ground
AA- X3 Voltage Regulator/Rectifier Connector
AB- X1 and X4 Engine Wiring Harness Connectors
AC- M1 Starting Motor
AD- S2 Neutral Start Switch

Electrical Components - Diesel Engines



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Picture Note: Shown from left rear

A - E3 Left Headlight
B - V1 Diode
C - H3 Engine Oil Pressure Light
D - H2 Engine Temperature Light
E - H1 Park Brake Light
F - H4 Discharge Light
G - X5 Radiator Fan Connector
H - P1 Hourmeter
I - E4 Right Headlight
J - X9 Lift Switch Connector (Option)
K - X14 Front Power Connector
L - X15 Front Light Harness Connector
M - B1 Radiator Temperature Sensor
N - S1 Key Switch
O - S4 Light Switch
P - X13 12VDC Power Port
Q - A1 Glow Plug Module
R - Fuse Blocks
S - G1 Battery
T - K1 Start Relay
U - K2 Radiator Fan Relay
V - G2 Alternator Connectors
W - X2 Fuel Solenoid Connector
X - X16 Rear Lights Harness Connector
Y - X17 Rear Power Connector
Z - S3 Park Brake Switch Connectors
AA- X8 Accessory Connectors
AB- M1 Starting Motor Connectors
AC- Engine Ground
AD- B4 Engine Oil Pressure Switch Connector
AE- Engine to Frame Ground Cable
AF- Glow Plugs Connector
AG- S2 Neutral Start Switch

Electrical Schematic and Wiring Harness Legend (Gas and Diesel Engines)

Electrical Components:

A1 - Igniter Module (Gas Engines)

A1 - Glow Plug Module (Diesel Engines)

B1 - Radiator Temperature Sensor

B2 - Pulser Coil (Gas Engines)

B3 - Engine Coolant Temperature Switch

B4 - Engine Oil Pressure Switch

E1 - Spark Plug (Gas Engines)

E2 - Spark Plug (Gas Engines)

E3 - Left Headlight

E4 - Right Headlight

F1 - Start Relay and Motor Fuse (30A)

F2 - Radiator Fan Fuse (15A) (Gas Engines)

F2 - Radiator Fan Fuse (25A) (Diesel Engines)

F3 - Voltage Regulator Fuse (25A) (Gas Engines)

F3 - Glow Plugs Fuse (30A) (Diesel Engines)

F4 - Rear Unswitched Options Fuse (40A)

F5 - Accessory Power Port Fuse (10A)

F6 - Switched Power Fuse (15A)

F7 - Front Unswitched Options Fuse (40A)

F8 - Not Used

G1 - Battery

G2 - Stator (Gas Engines)

G2 - Alternator (Diesel Engines) (Option for Gas Engines)

H1 - Park Brake Light

H2 - Engine Coolant Temperature Light

H3 - Engine Oil Pressure Light

H4 - Discharge Light (Diesel Engines)

K1 - Start Relay

K2 - Fan Relay

M1 - Starting Motor

M2 - Radiator Fan Motor

N1 - Voltage Regulator/Rectifier (Gas Engines)

P1 - Hourmeter

R1 - Carburetor Heater (Gas Engines)

R1 - Glow Plug (Diesel Engines)

R2 - Glow Plug (Diesel Engines)

R3 - Glow Plug (Diesel Engines)

S1 - Key Switch

S2 - Neutral Start Switch

S3 - Park Brake Switch

S4 - Light Switch

S5 - Cargo Box Control Switch (Option)

T1 - Ignition Coil (Gas Engines)

T2 - Ignition Coil (Gas Engines)

V1 - Diode

W1 - Shielded Ground

Y1 - Starting Motor Solenoid

Y2 - Fuel Pump (Gas Engines)

Y3 - Fuel Shutoff Solenoid

Connectors:

X1 - Main Wiring Harness to W2 Engine Wiring Harness Connector (Gas Engines)

X2 - Main Wiring Harness to Y2 Fuel Pump (Gas Engines)

X3 - Main Wiring Harness to N1 Voltage Regulator/Rectifier (Gas Engines)

X3 - Main Wiring Harness to Y3 Fuel Shutoff Solenoid (Diesel Engines)

X4 - N1 Voltage Regulator/Rectifier to G2 Alternator (Gas Engines)

X4 - Main Wiring Harness to G2 Alternator

X5 - Main Wiring Harness to M2 Radiator Fan Motor

X6 - W2 to W3 Engine Wiring Harnesses

X6a - Engine Wiring Harness to B2 Pulser Coil (Gas Engines)

X7 - Main Wiring Harness Optional Attachments Connector (Front) Switched Power

X8 - Main Wiring Harness Optional Attachments Connector (Mid) Switched Power

X9 - Main Wiring Harness to Cargo Box Control Switch (Option)

X10 - Main Wiring Harness to Cargo Box Raise/Lower Motor (Option)

X11 - Main Wiring Harness to Left Headlight

X12 - Main Wiring Harness to Right Headlight

X13 - Main Wiring Harness to Accessory Power Port

X14 - Main Wiring Harness Optional Attachments Connector (Front) Unswitched Power

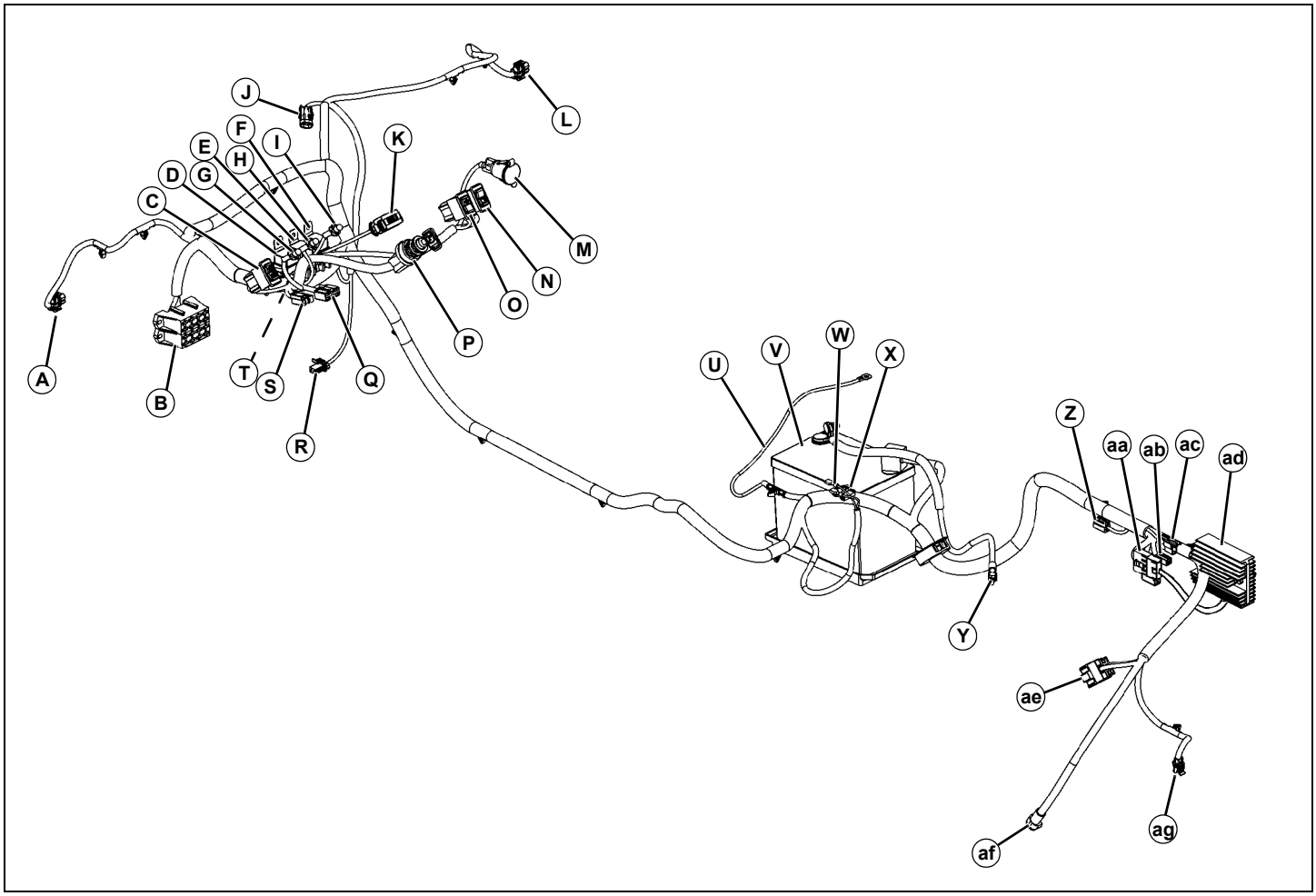
X15 - Main Wiring Harness to Front Lights Harness (Option)

X16 - Main Wiring Harness to Rear Lights Harness (Option)

X17 - Main Wiring Harness Optional Attachments Connector (Rear) Unswitched Power

Component Location (SN 40001-)

Electrical Components - Gas Engines



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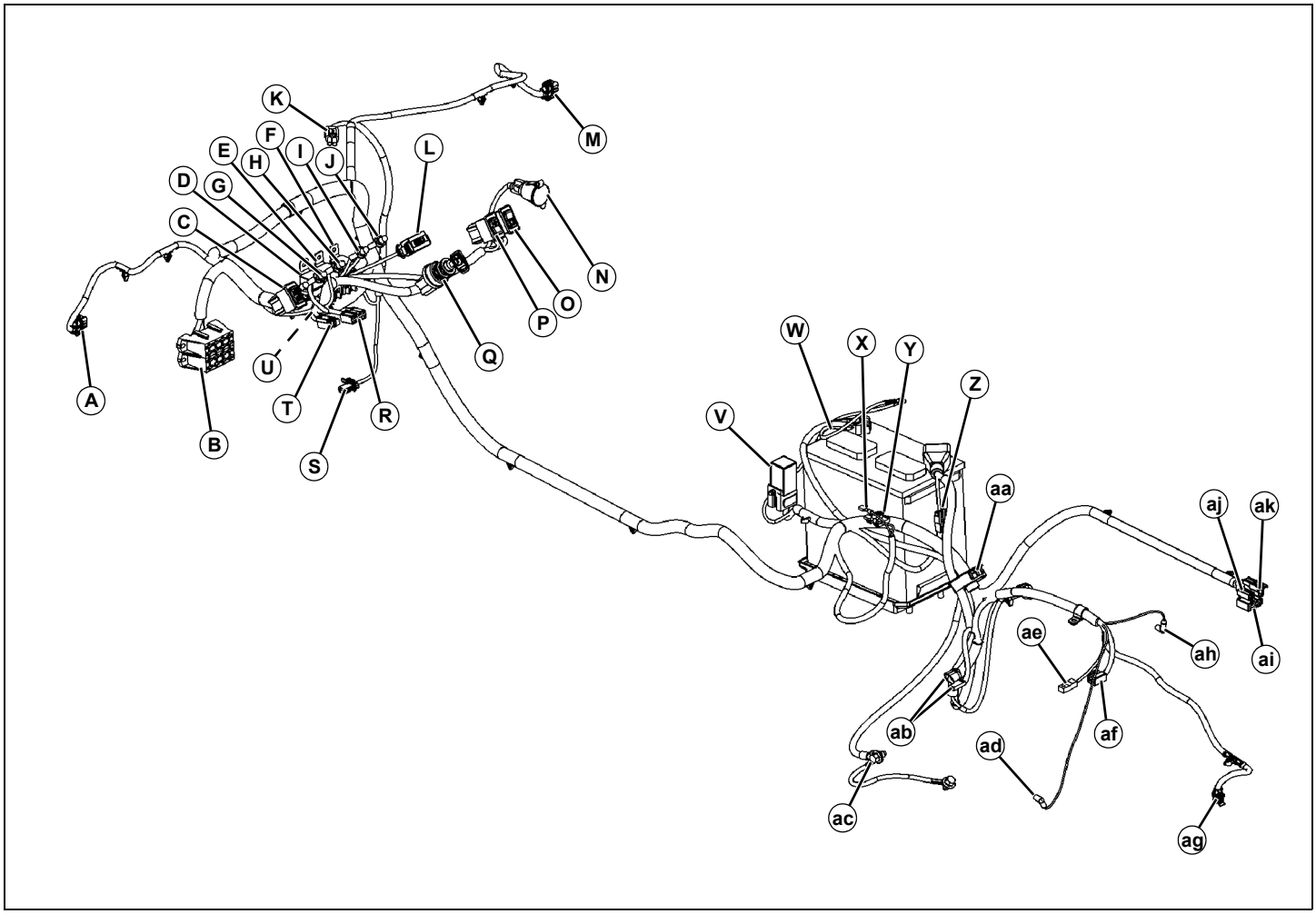
Picture Note: Shown from left rear

A - E3 Left Headlight
B - Fuse Blocks
C - S5 Cargo Box Lift Switch (Option)
D - K1 Start Relay
E - K2 Radiator Fan Relay
F - K3 4WD Interlock Relay
G - H3 Oil Pressure Light
H - H2 Engine Temperature Light
I - H1 Park Brake Light
J - X5 Radiator Fan Connector
K - P1 Hourmeter
L - E4 Right Headlight
M - X13 12VDC Power Port
N - S4 Light Switch
O - S5 4WD Switch
P - S1 Key Switch
Q - X15 Front Light Harness Connector
R - X18 4WD Clutch
S - X14 Front Power Connector
T - V1 Diode
U - Frame Ground Wire
V - G1 Battery
W - S3 Park Brake Switch Connectors
X - X8 Accessory Connectors
Y - Engine Ground
Z - X2 Fuel Pump Connector
AA- X3 Voltage Regulator/Rectifier Connector
AB- X17 Rear Power Connector
AC- X16 Rear Lights Harness Connector
AD- N1 Voltage Regulator/Rectifier
AE- X1 and X4 Engine Wiring Harness Connectors
AF- M1 Starting Motor
AG- S2 Neutral Start Switch

Electrical Components - Diesel Engines



MX36673

Picture Note: Shown from left rear

A - E3 Left Headlight
B - Fuse Blocks
C - S5 Cargo Box Lift Switch (Option)
D - K1 Start Relay
E - K2 Radiator Fan Relay
F - K3 4WD Interlock Relay
G - H3 Engine Oil Pressure Light
H - H2 Engine Temperature Light
I - H1 Park Brake Light
J - H4 Discharge Light
K - X5 Radiator Fan Connector
L - P1 Hourmeter
M - E4 Right Headlight
N - X13 12VDC Power Port
O - S4 Light Switch
P - S5 4WD Switch
Q - S1 Key Switch
R - X15 Front Light Harness Connector
S - X18 4WD Clutch
T - X14 Front Power Connector
U - V1 Diode
V - A1 Glow Plug Module
W - G1 Battery
X - S3 Park Brake Switch Connectors
Y - X8 Accessory Connectors
Z - X1 Fusible Link Connector
AA- G2 Alternator Connector
AB- M1 Starting Motor Connectors
AC- Engine Ground
AD- B4 Engine Oil Pressure Switch Connector
AE- Glow Plugs Connector
AF- X2 Fuel Solenoid Connector
AG- S2 Neutral Start Switch
AH- B3 Coolant Temperature Switch Connector
AI - X17 Rear Power Connector
AJ- X10 Cargo Box Lift Connector (Option)
AK- X16 Rear Lights Harness Connector

Electrical Schematic and Wiring Harness Legend (Gas and Diesel Engines)

Electrical Components:

A1 - Igniter Module (Gas Engines)

A1 - Glow Plug Module (Diesel Engines)

B1 - Radiator Temperature Sensor

B2 - Pulser Coil (Gas Engines)

B3 - Engine Coolant Temperature Switch

B4 - Engine Oil Pressure Switch

E1 - Spark Plug (Gas Engines)

E2 - Spark Plug (Gas Engines)

E3 - Left Headlight

E4 - Right Headlight

F1 - Start Relay and Motor Fuse (30A)

F2 - Radiator Fan Fuse (15A) (Gas Engines)

F2 - Radiator Fan Fuse (25A) (Diesel Engines)

F3 - Voltage Regulator Fuse (25A) (Gas Engines)

F3 - Glow Plugs Fuse (30A) (Diesel Engines)

F4 - Rear Unswitched Options Fuse (40A)

F5 - Accessory Power Port Fuse (10A)

F6 - Switched Power Fuse (15A)

F7 - Front Unswitched Options Fuse (40A)

F8 - Not Used

G1 - Battery

G2 - Stator (Gas Engines)

G2 - Alternator (Diesel Engines) (Option for Gas Engines)

H1 - Park Brake Light

H2 - Engine Coolant Temperature Light

H3 - Engine Oil Pressure Light

H4 - Discharge Light (Diesel Engines)

K1 - Start Relay

K2 - Fan Relay

K3 - 4WD Interlock Relay

M1 - Starting Motor

M2 - Radiator Fan Motor

N1 - Voltage Regulator/Rectifier (Gas Engines)

P1 - Hourmeter

R1 - Carburetor Heater (Gas Engines)

R1 - Glow Plug (Diesel Engines)

R2 - Glow Plug (Diesel Engines)

R3 - Glow Plug (Diesel Engines)

S1 - Key Switch

S2 - Neutral Start Switch

S3 - Park Brake Switch

S4 - Light Switch

S5 - Cargo Box Control Switch (Option)

S5 - 4WD Switch

T1 - Ignition Coil (Gas Engines)

T2 - Ignition Coil (Gas Engines)

V1 - Diode

W1 - Shielded Ground

Y1 - Starting Motor Solenoid

Y2 - Fuel Pump (Gas Engines)

Y3 - Fuel Shutoff Solenoid

Y4 - 4WD Clutch

Connectors:

X1 - Main Wiring Harness to W2 Engine Wiring Harness Connector (Gas Engines)

X2 - Main Wiring Harness to Y2 Fuel Pump (Gas Engines)

X3 - Main Wiring Harness to N1 Voltage Regulator/Rectifier (Gas Engines)

X3 - Main Wiring Harness to Y3 Fuel Shutoff Solenoid (Diesel Engines)

X4 - N1 Voltage Regulator/Rectifier to G2 Alternator (Gas Engines)

X4 - Main Wiring Harness to G2 Alternator

X5 - Main Wiring Harness to M2 Radiator Fan Motor

X6 - W2 to W3 Engine Wiring Harnesses

X6a - Engine Wiring Harness to B2 Pulser Coil (Gas Engines)

X7 - Main Wiring Harness Optional Attachments Connector (Front) Switched Power

X8 - Main Wiring Harness Optional Attachments Connector (Mid) Switched Power

X9 - Main Wiring Harness to Cargo Box Control Switch (Option)

X10 - Main Wiring Harness to Cargo Box Raise/Lower Motor (Option)

X11 - Main Wiring Harness to Left Headlight

X12 - Main Wiring Harness to Right Headlight

X13 - Main Wiring Harness to Accessory Power Port

X14 - Main Wiring Harness Optional Attachments Connector (Front) Unswitched Power

X15 - Main Wiring Harness to Front Lights Harness (Option)

X16 - Main Wiring Harness to Rear Lights Harness (Option)

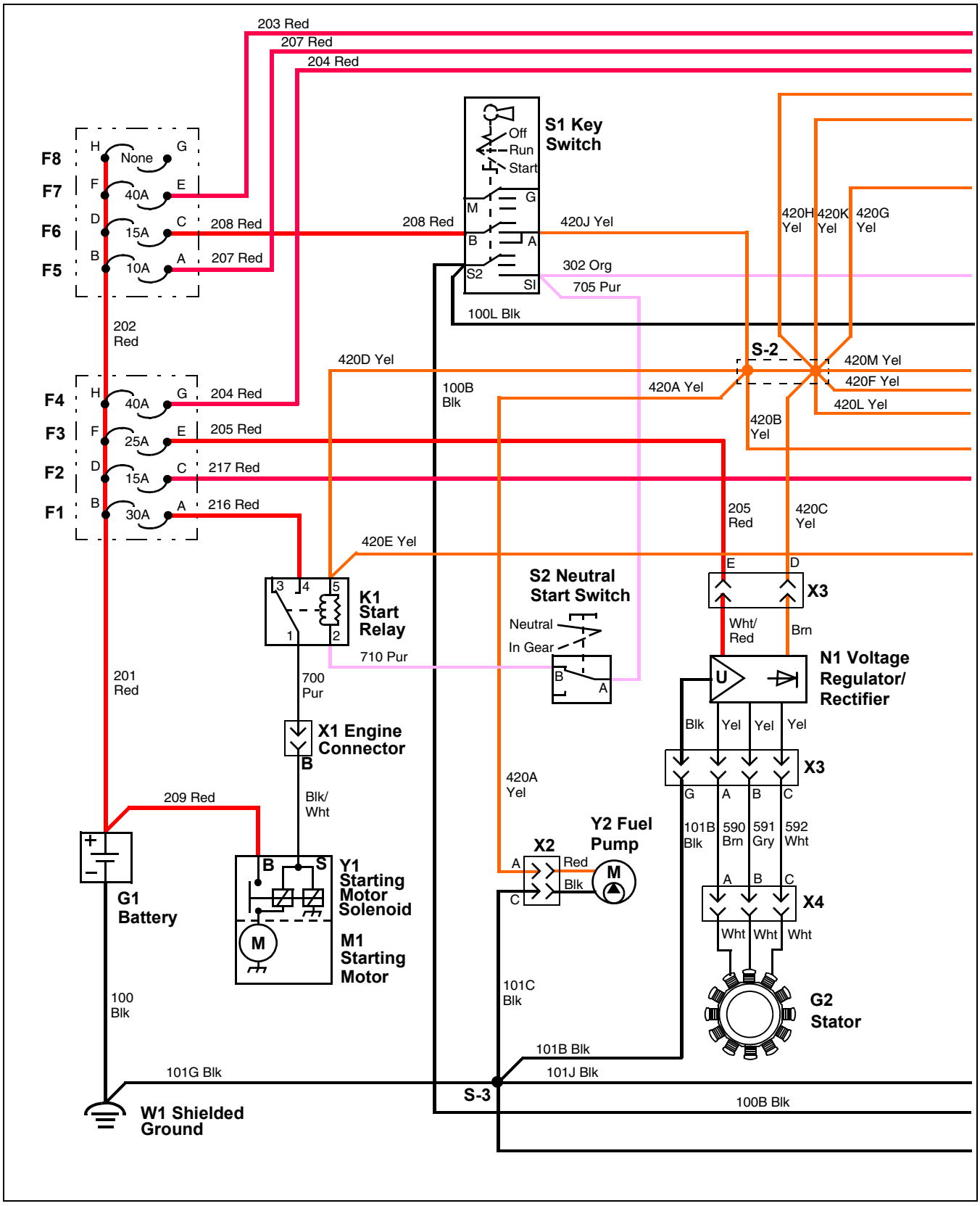
X17 - Main Wiring Harness Optional Attachments Connector (Rear) Unswitched Power

X18 - Main Wiring Harness to 4WD Clutch

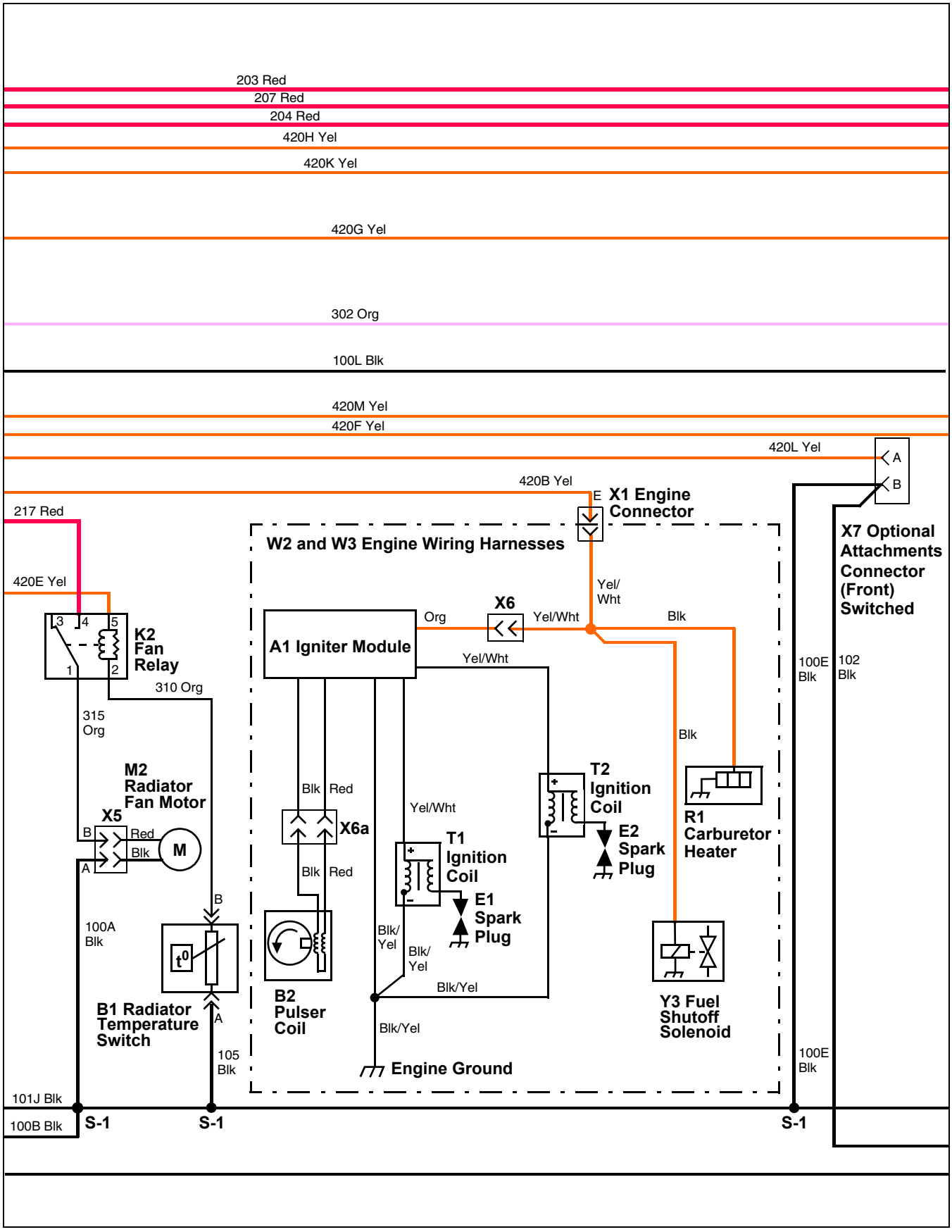
Schematics and Harnesses (SN -40000)

Schematic 1 of 4

Main Schematic (Gas Engine)



Schematic 2 of 4



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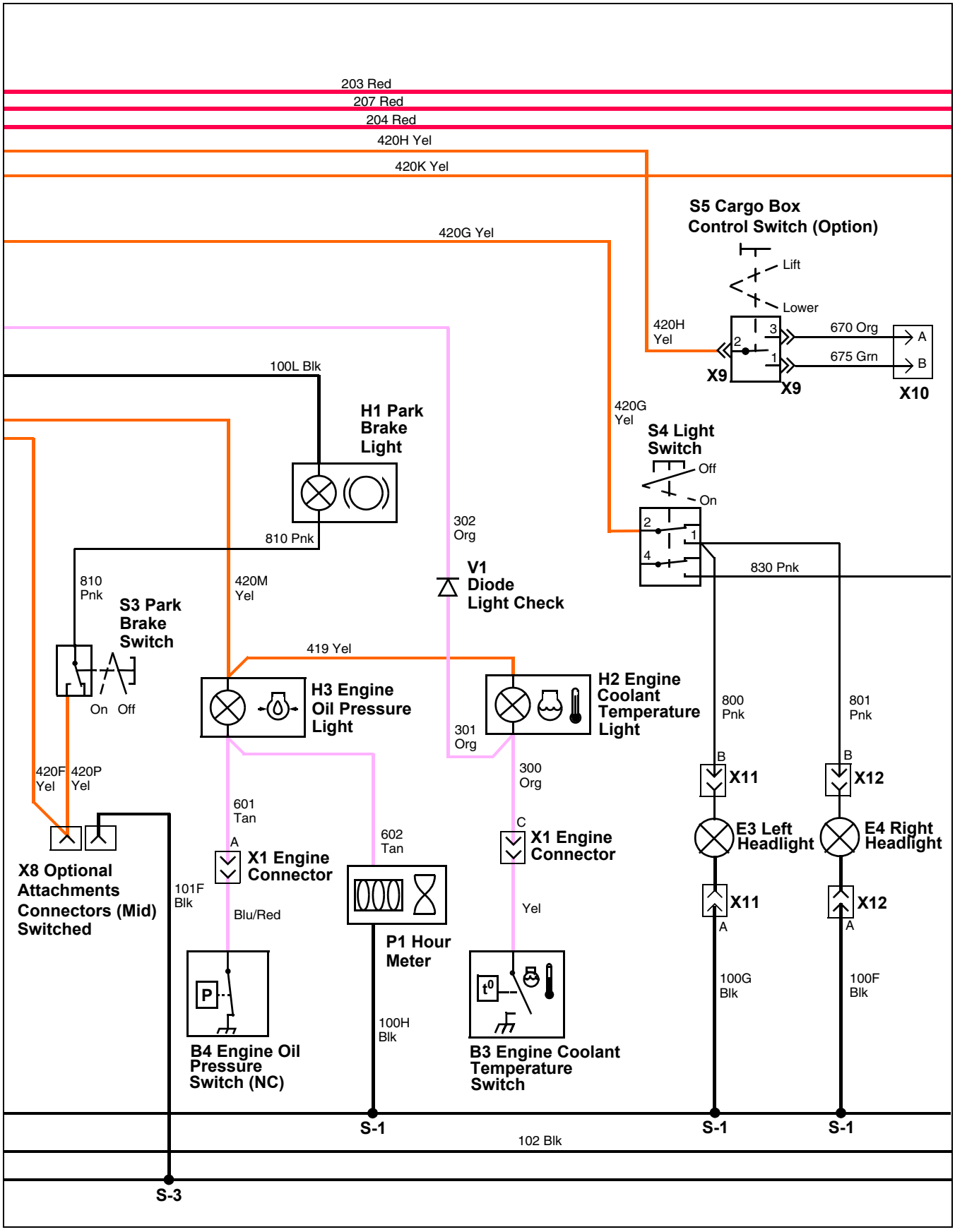
Schematic 3 of 4



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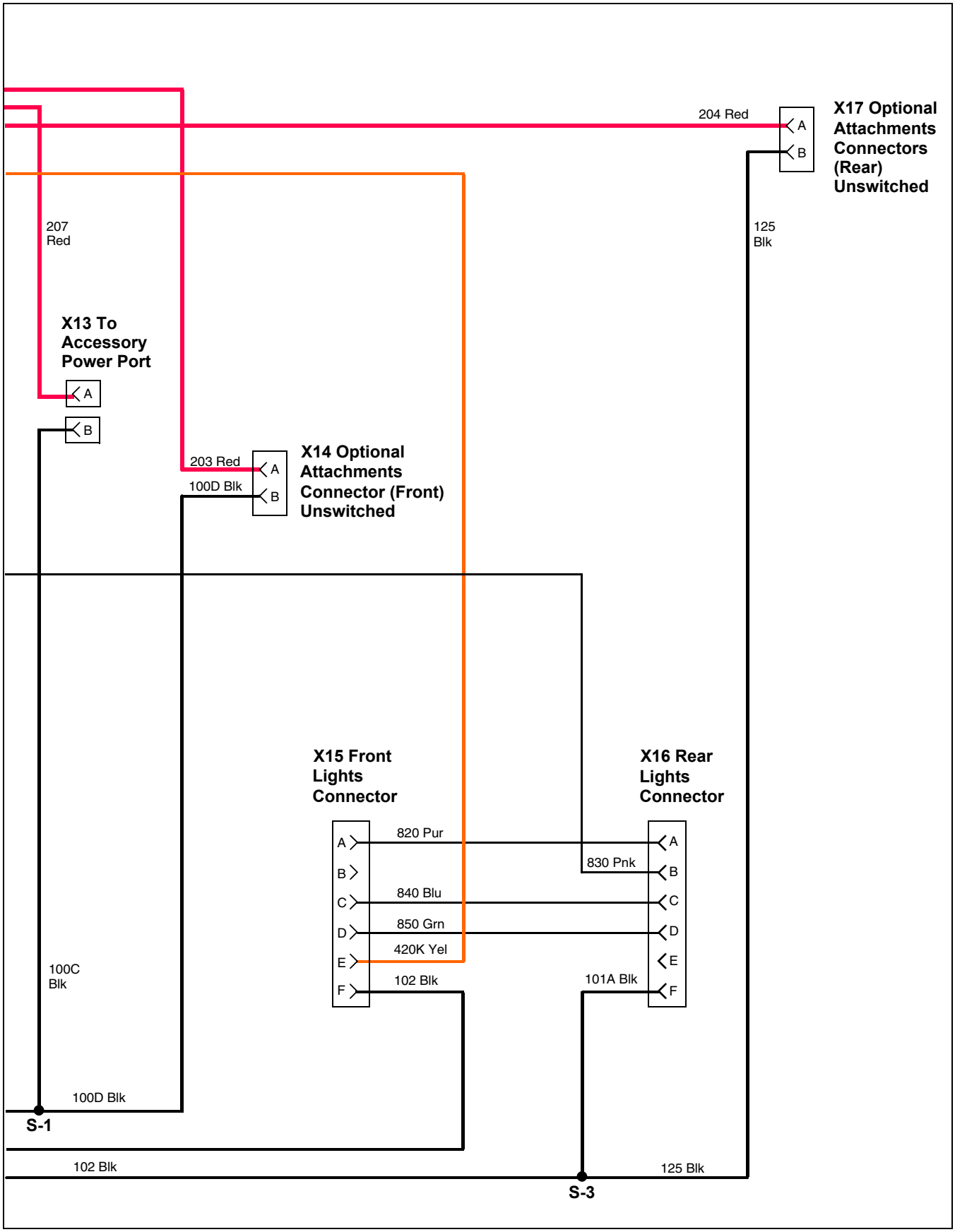
Schematic 4 of 4



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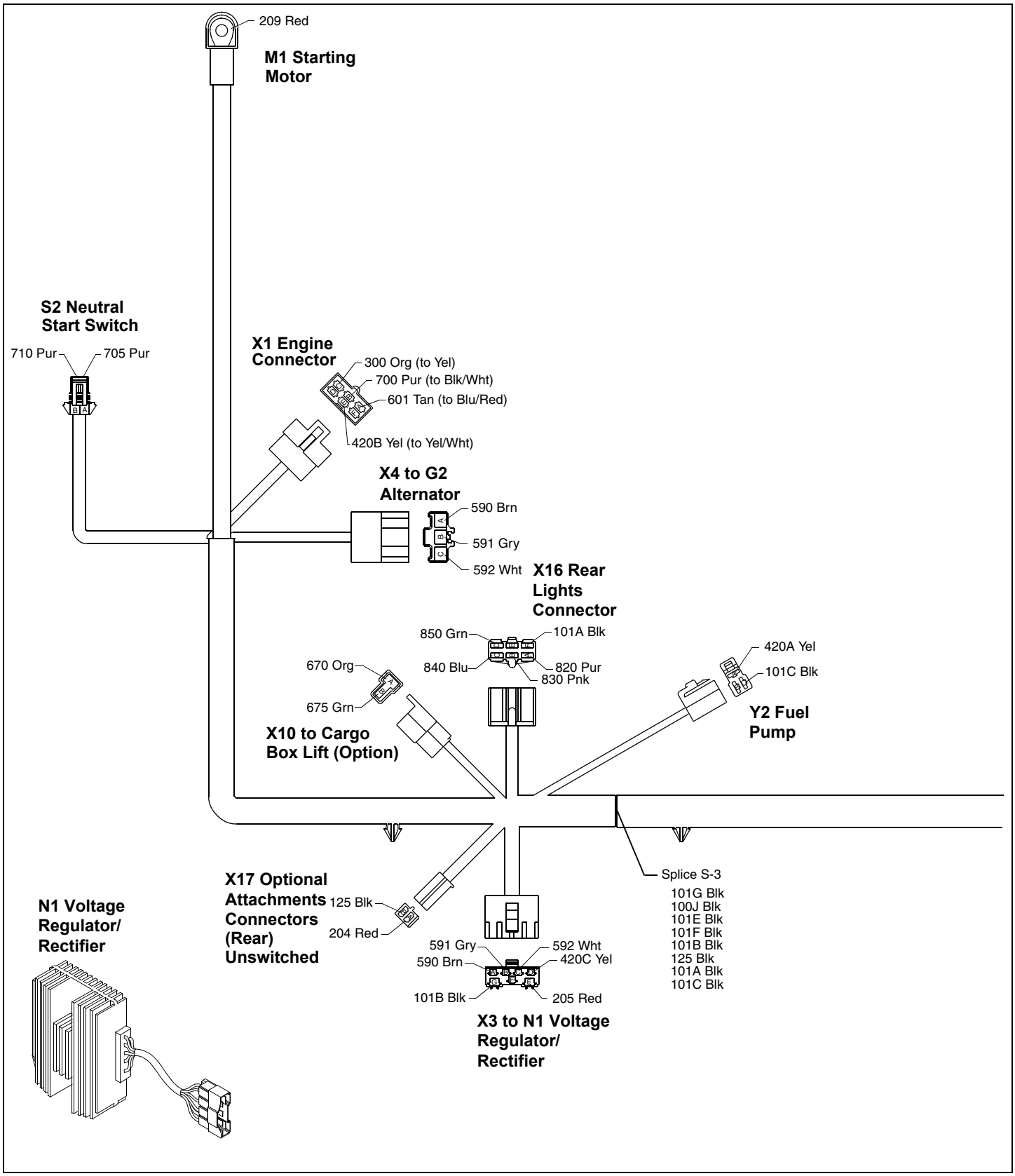
Main Wiring Harness (Gas Engine)

Main Harness 1 of 4



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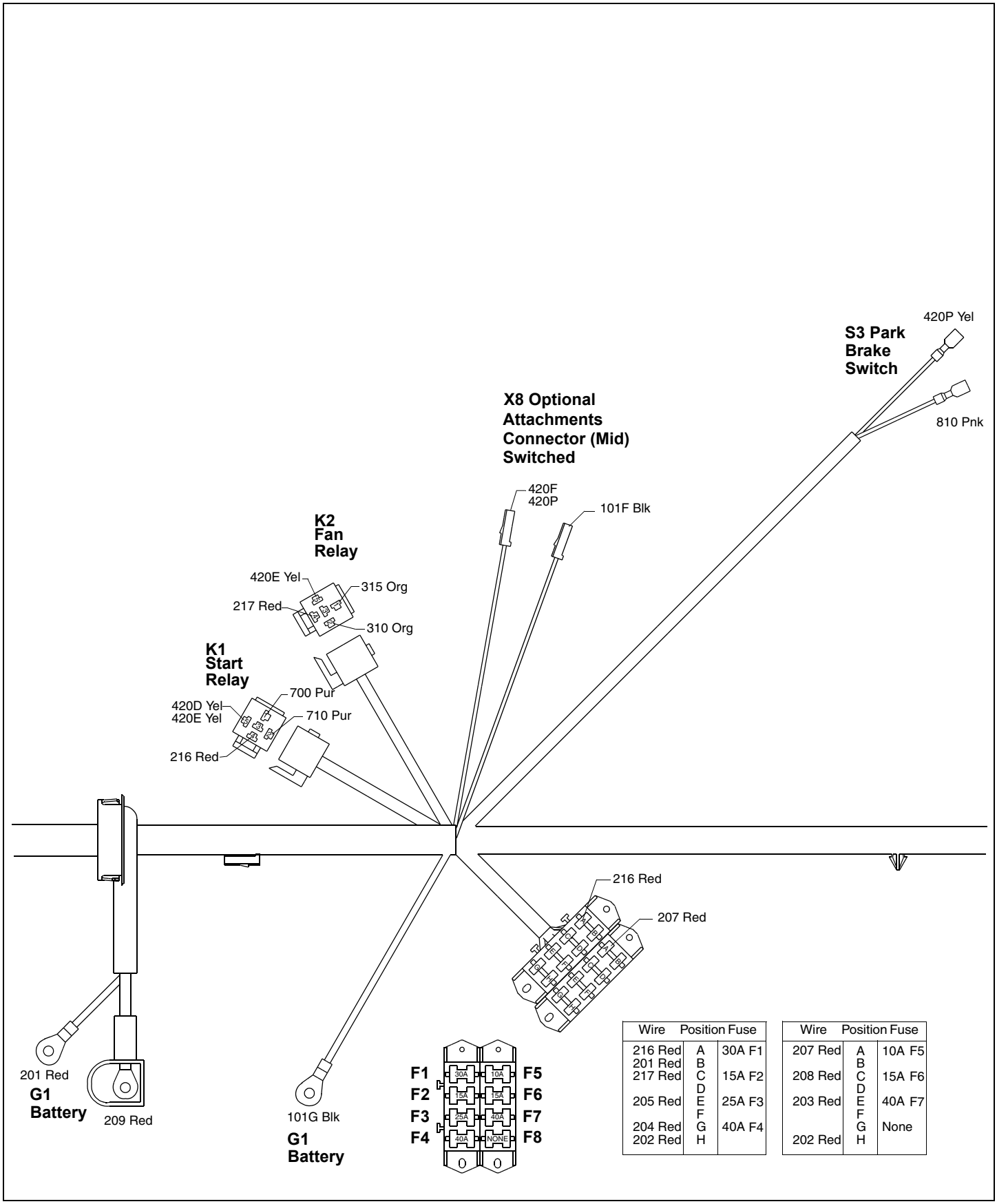
Main Harness 2 of 4



Wire	Position	Fuse
216 Red	A	30A F1
201 Red	B	
217 Red	C	15A F2
	D	
205 Red	E	25A F3
	F	
204 Red	G	40A F4
202 Red	H	

Wire	Position	Fuse
207 Red	A	10A F5
	B	
208 Red	C	15A F6
	D	
203 Red	E	40A F7
	F	
	G	None
202 Red	H	

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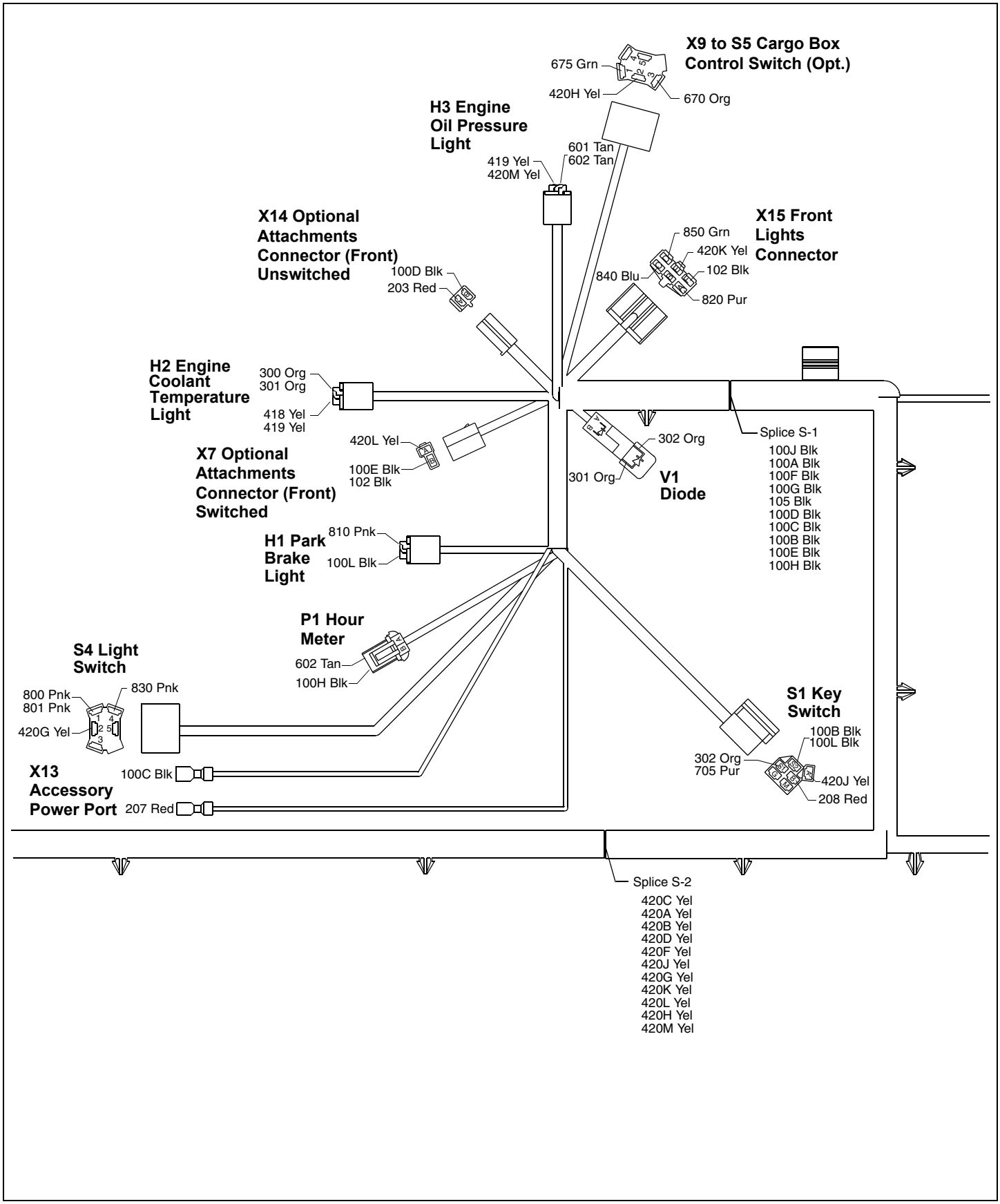
Main Harness 3 of 4



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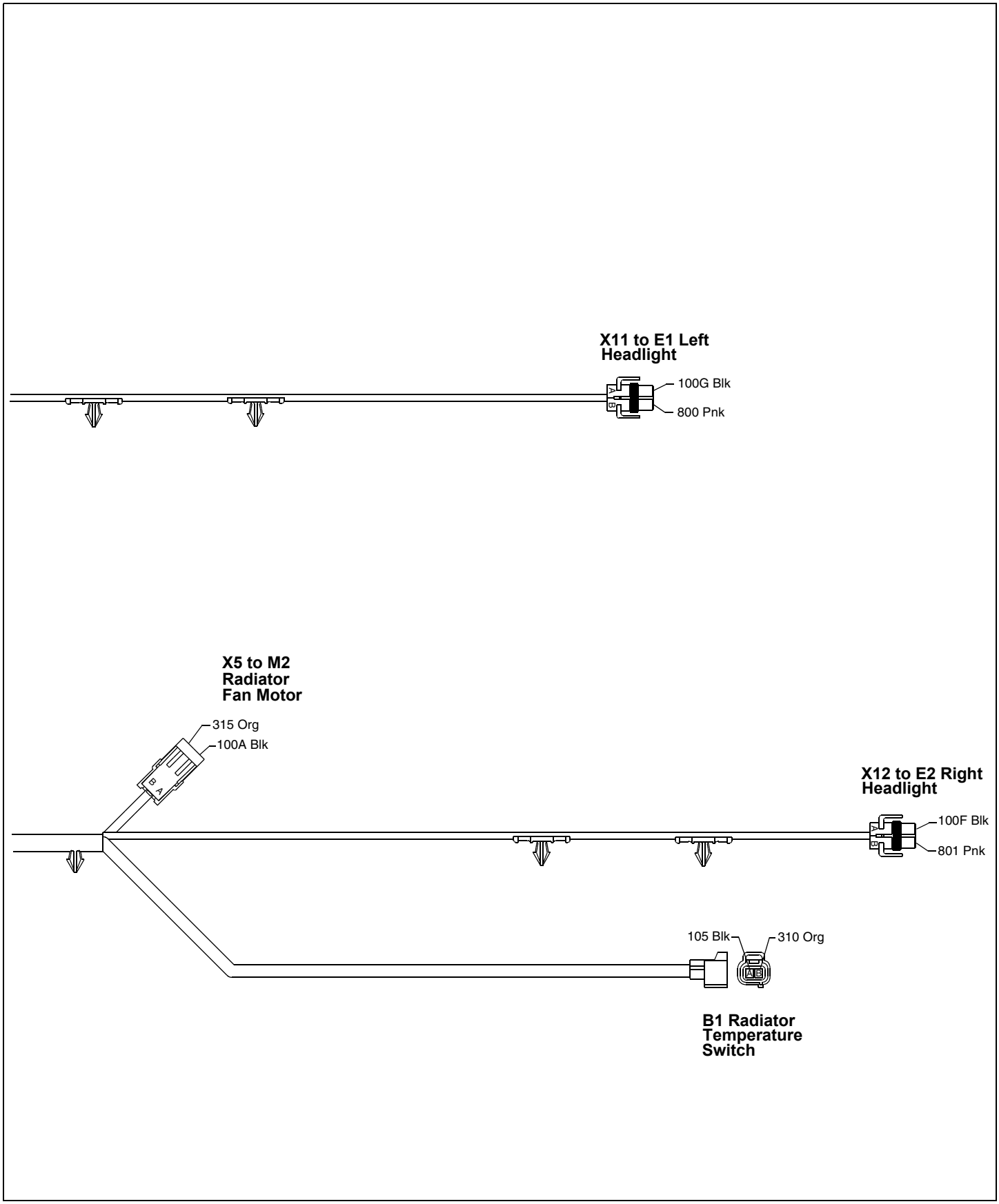
Main Harness 4 of 4



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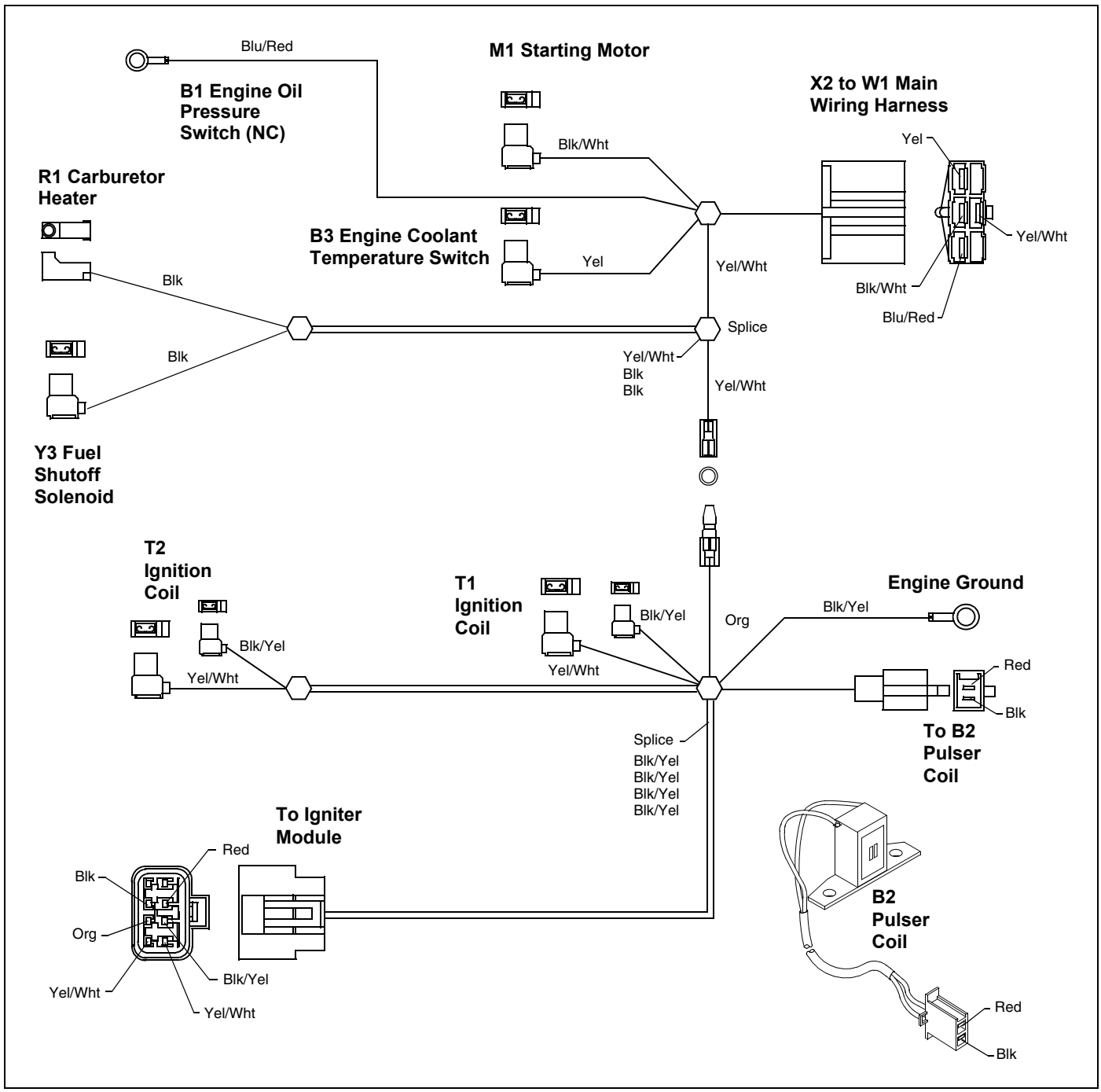
Main Harness Wire Color Codes (Gas Engine)

Size/No./Color	Wire Connection Points
2.0 100A Blk	Splice 1, X5[A] (M2)
1.0 100B Blk	S1[S2], Splice 1
2.0 100C Blk	X13, Splice 1
3.0 100D Blk	Splice 1, X14[B]
1.0 100E Blk	Splice 1, X7[B]
0.8 100F Blk	Splice 1, X12[A]
0.8 100G Blk	Splice 1, X11[A]
0.8 100H Blk	P1[B], Splice 1
3.0 100J Blk	Splice 1, Splice 3
3.0 100L Blk	H1, S1[S2]
1.0 101A Blk	Splice 3, X16[F]
3.0 101B Blk	Splice 3, X3[G] (N1)
0.8 101C Blk	Splice 3, X2[C] (Y2)
0.8 101F Blk	X8, Splice 3
5.0 101G Blk	W1, Splice 3
1.0 102 Blk	X7[B], X15[F]
0.8 105 Blk	Splice 1, B1[A]
3.0 125 Blk	Splice 3, X17[B]
5.0 201 Red	G1, Fuse Block
2.0 202 Red	Fuse Block Jumper
3.0 203 Red	F7, X14[A]
3.0 204 Red	F4, X17[A]
3.0 205 Red	F3, X3[E] (N1)
2.0 207 Red	F5, X13 (Power Port)
2.0 208 Red	F6, S1[B]
6.0 209 Red	G1, M1
3.0 216 Red	F1, K1[4]
2.0 217 Red	F2, K2[4]
0.8 300 Org	X1[C], H2
0.8 301 Org	H2, V1[B]
0.8 302 Org	V1[A], S1[S1]
0.8 310 Org	K2[2], B1[B]
2.0 315 Org	K2[1], X5[B] (M2)
0.8 419 Yel	H3, H2
0.8 420A Yel	Splice 2, X2[A] (Y2)
0.8 420B Yel	Splice 2, X1[E]
1.0 420C Yel	Splice 2, X3[D] (N1)
0.8 420D Yel	Splice 2, K1[5]
0.8 420E Yel	K1[5], K2[5]
0.8 420F Yel	Splice 2, X8
1.0 420G Yel	Splice 2, S4[2]
0.8 420H Yel	Splice 2, X9[2] (S5)
2.0 420J Yel	S1[A], Splice 2
1.0 420K Yel	Splice 2, X15[E]
1.0 420L Yel	Splice 2, X7[A]
0.8 420M Yel	Splice 2, H3
0.8 420P Yel	X8, S3
2.0 590 Brn	X4[A] (G2), X3[A] (N1)
2.0 591 Gry	X4[B] (G2), X3[B] (N1)
2.0 592 Wht	X4[C] (G2), X3[C] (N1)
0.8 601 Tan	H3, X1[A] (B4)
0.8 602 Tan	H3, P1[A]
1.0 670 Org	X9[3] (S5), X10[A]
1.0 675 Grn	X9[1] (S5), X10[B]
3.0 700 Pur	K1[1], X1[B] (Y1)
0.8 705 Pur	S2[A], S1[S1]
0.8 710 Pur	K1[2], S2[B]
0.8 800 Pnk	S4[1], X11[B] (E3)
0.8 801 Pnk	S4[1], X12[B] (E4)
0.8 810 Pnk	S3, H1
1.0 820 Pur	X15[A], X16[A]
1.0 830 Pnk	S4[4], X16[B]
1.0 840 Blu	X15[C], X16[C]

Size/No./Color	Wire Connection Points
1.0 850 Grn	X15[D], X16[D]

W2 Engine Wiring Harnesses (Gas Engine)



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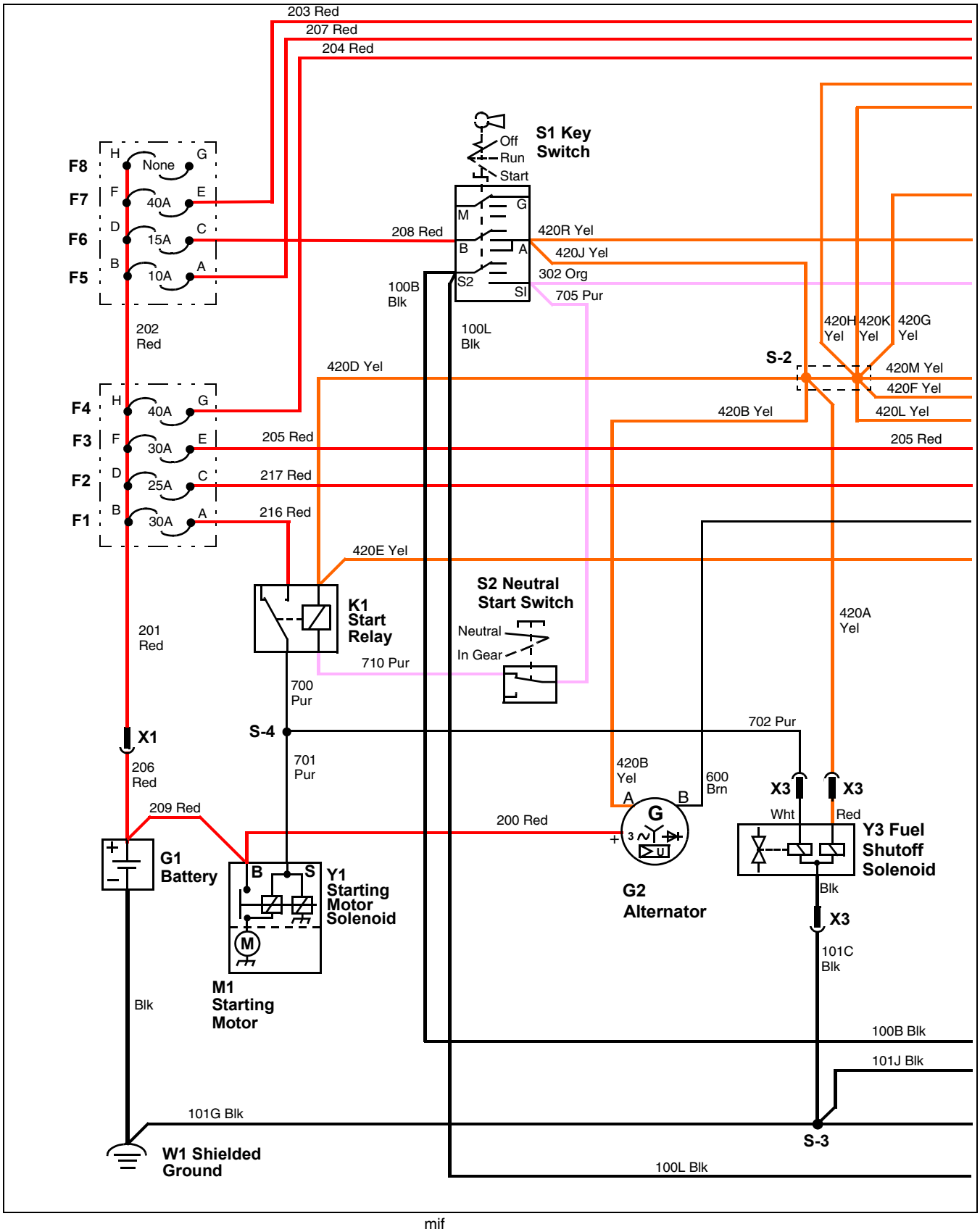
Main Schematic (Diesel Engine)

Schematic 1 of 4



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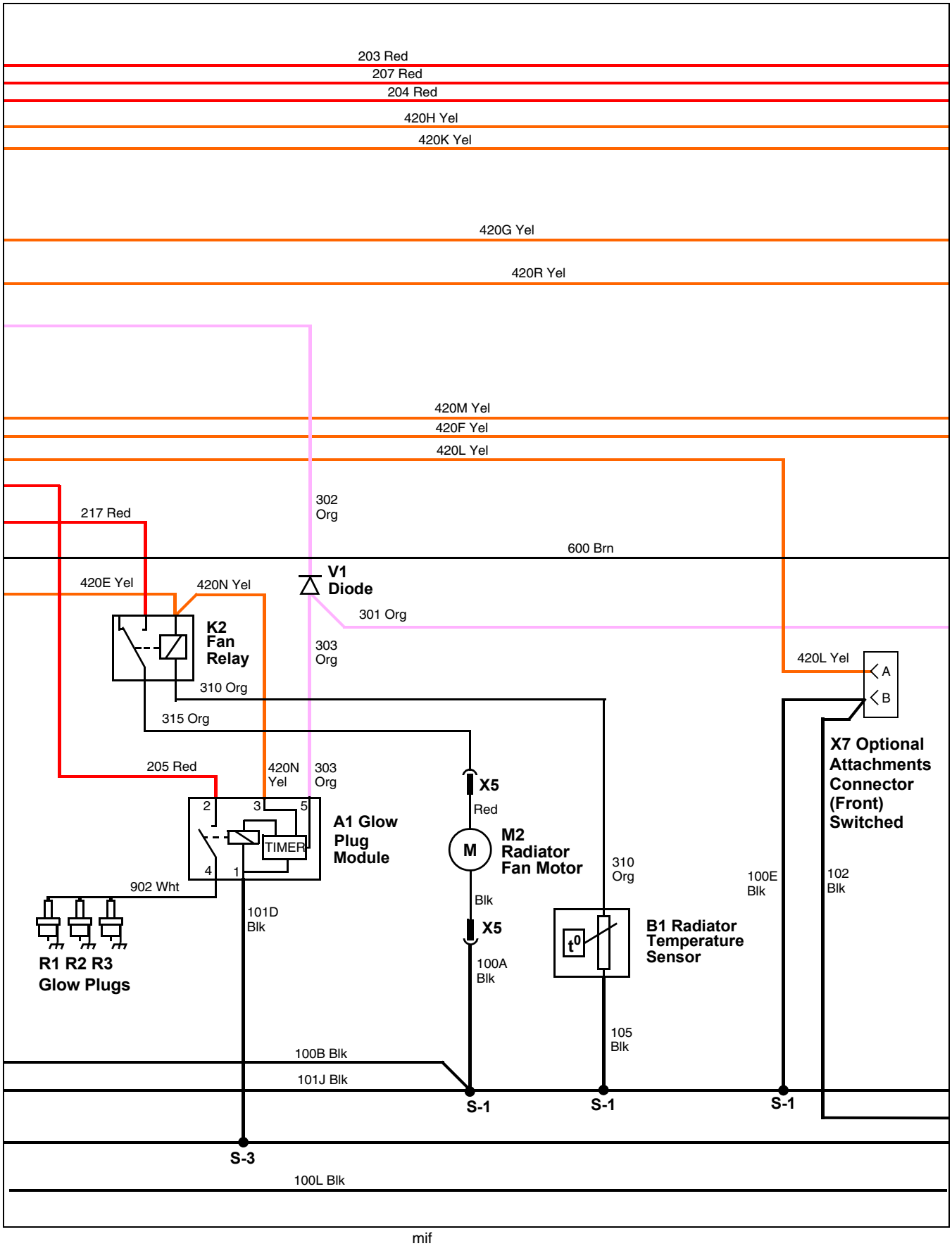
Schematic 2 of 4



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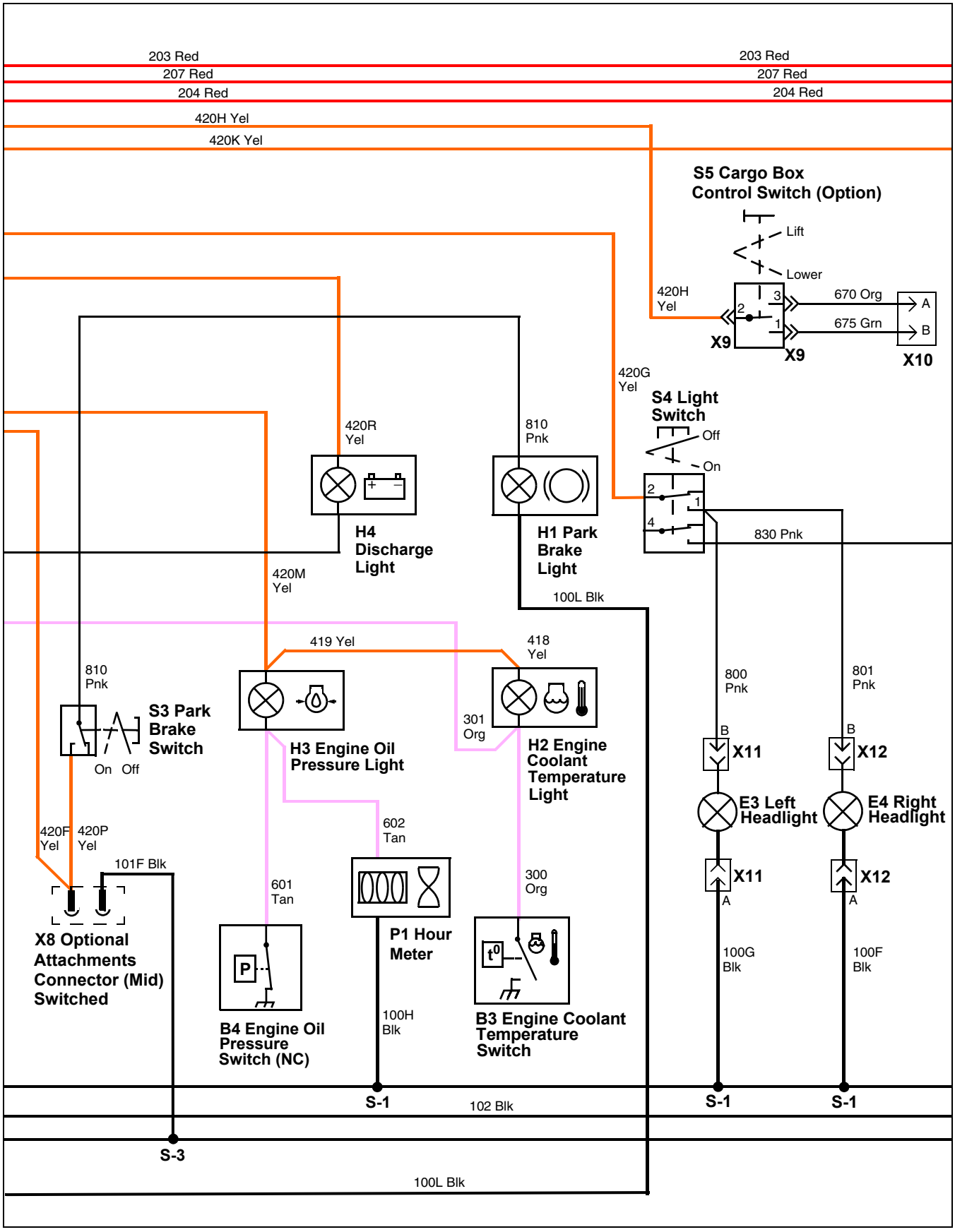
Schematic 3 of 4



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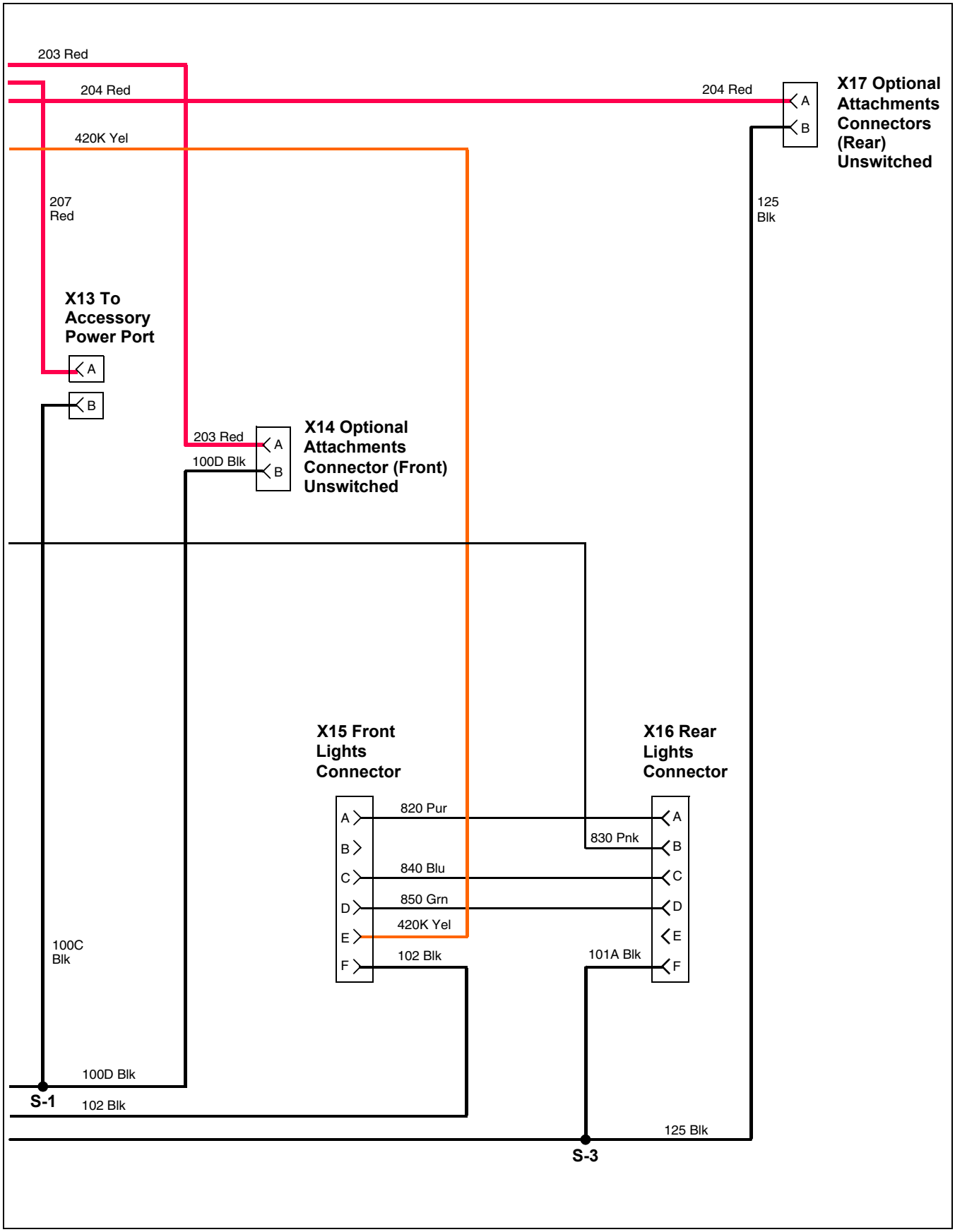
Schematic 4 of 4



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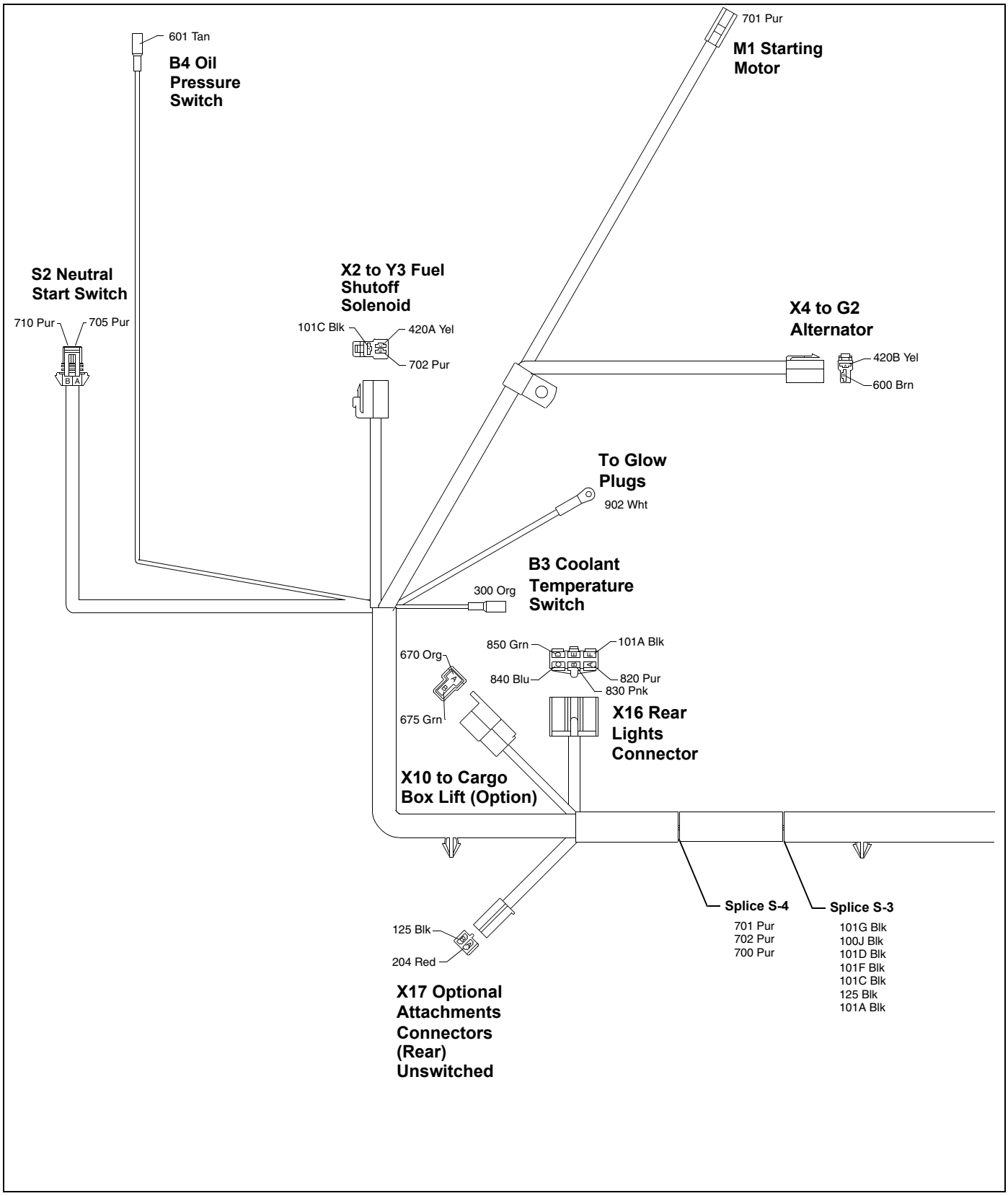
Main Wiring Harness (Diesel Engine)

Wiring Harness 1 of 4



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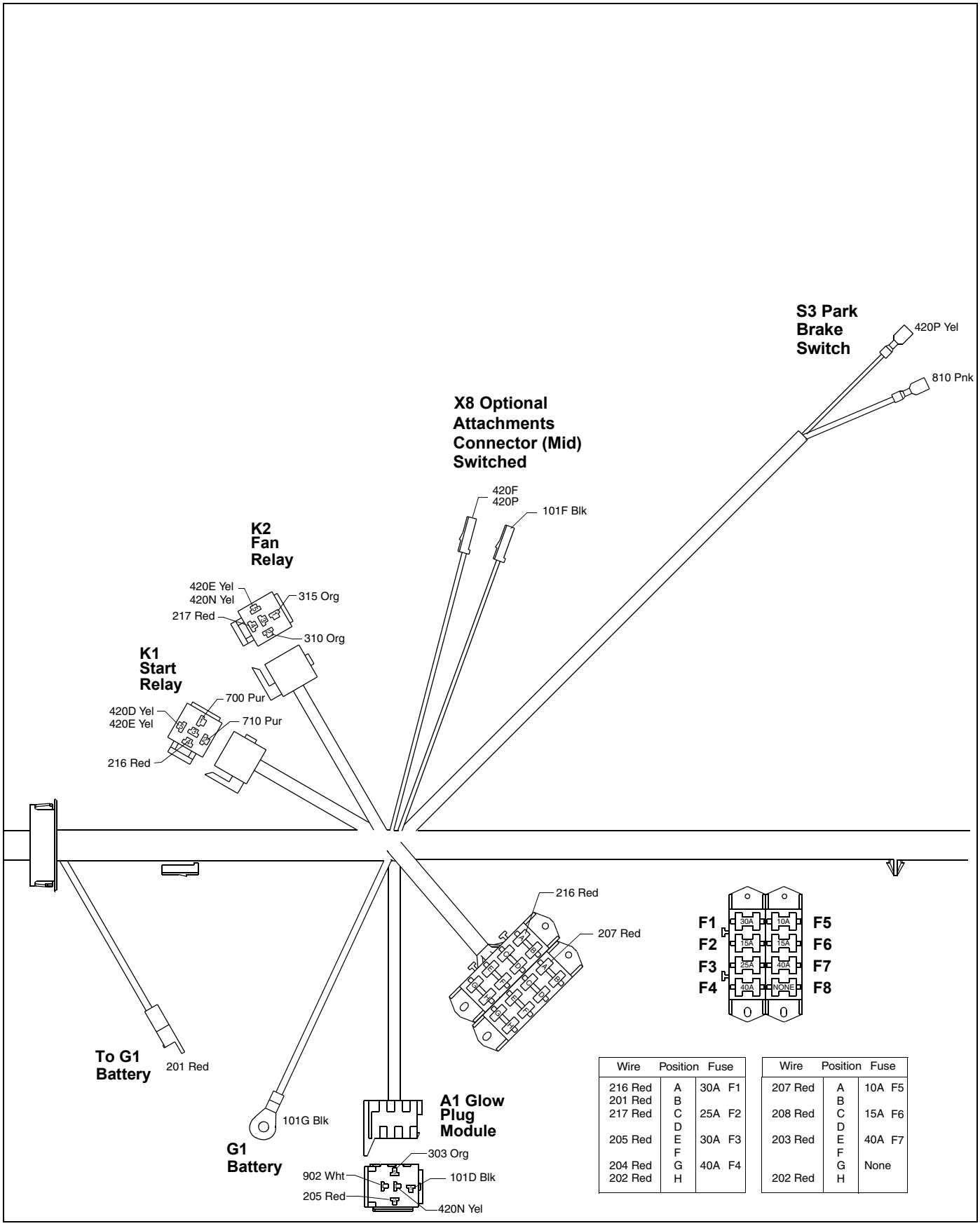
Wiring Harness 2 of 4



Wire	Position	Fuse
216 Red	A	30A F1
201 Red	B	
217 Red	C	25A F2
	D	
205 Red	E	30A F3
	F	
204 Red	G	40A F4
202 Red	H	

Wire	Position	Fuse
207 Red	A	10A F5
	B	
208 Red	C	15A F6
	D	
203 Red	E	40A F7
	F	
	G	None
202 Red	H	

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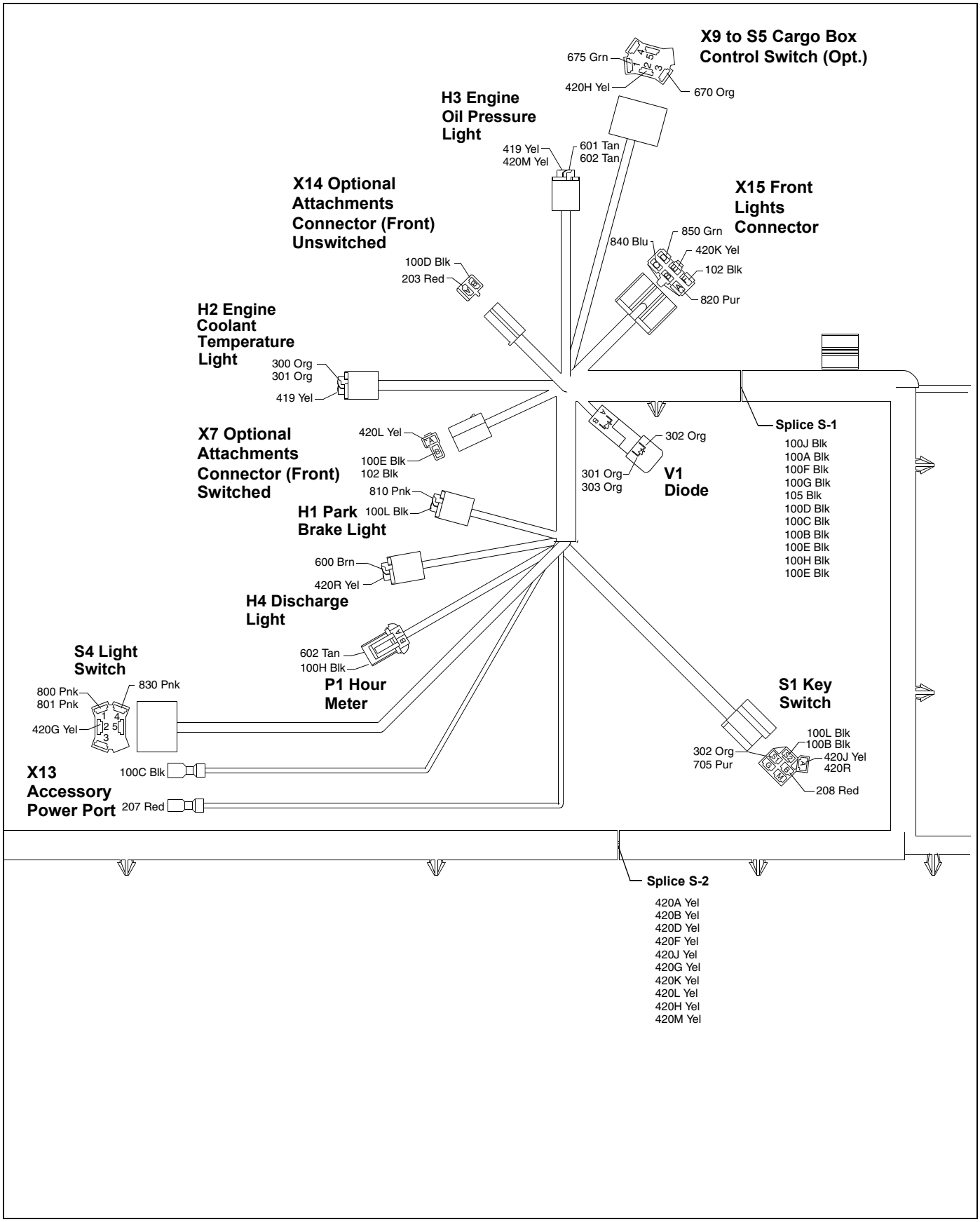
Wiring Harness 3 of 4



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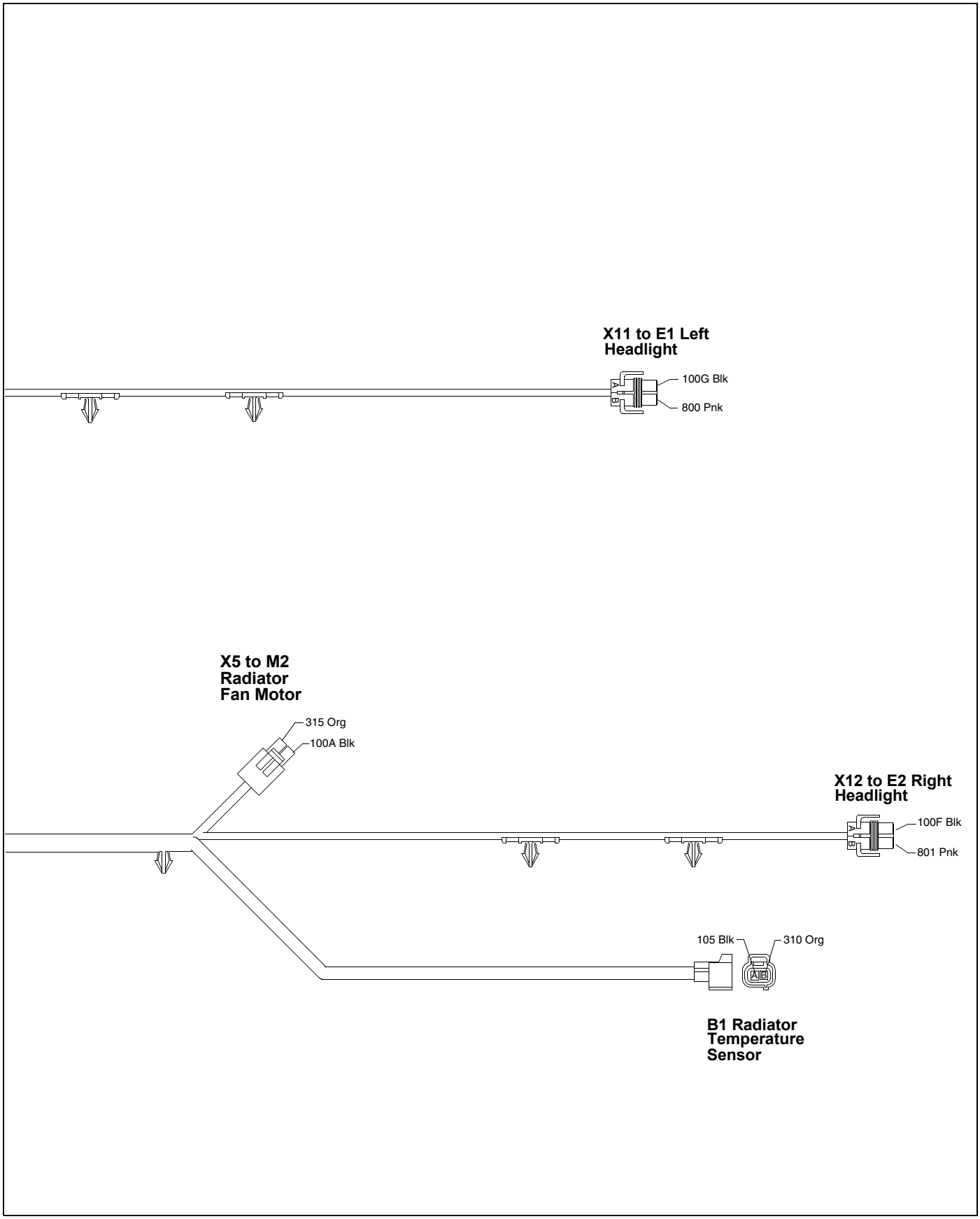
Wiring Harness 4 of 4



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Main Harness Wire Color Codes (Diesel Engine)

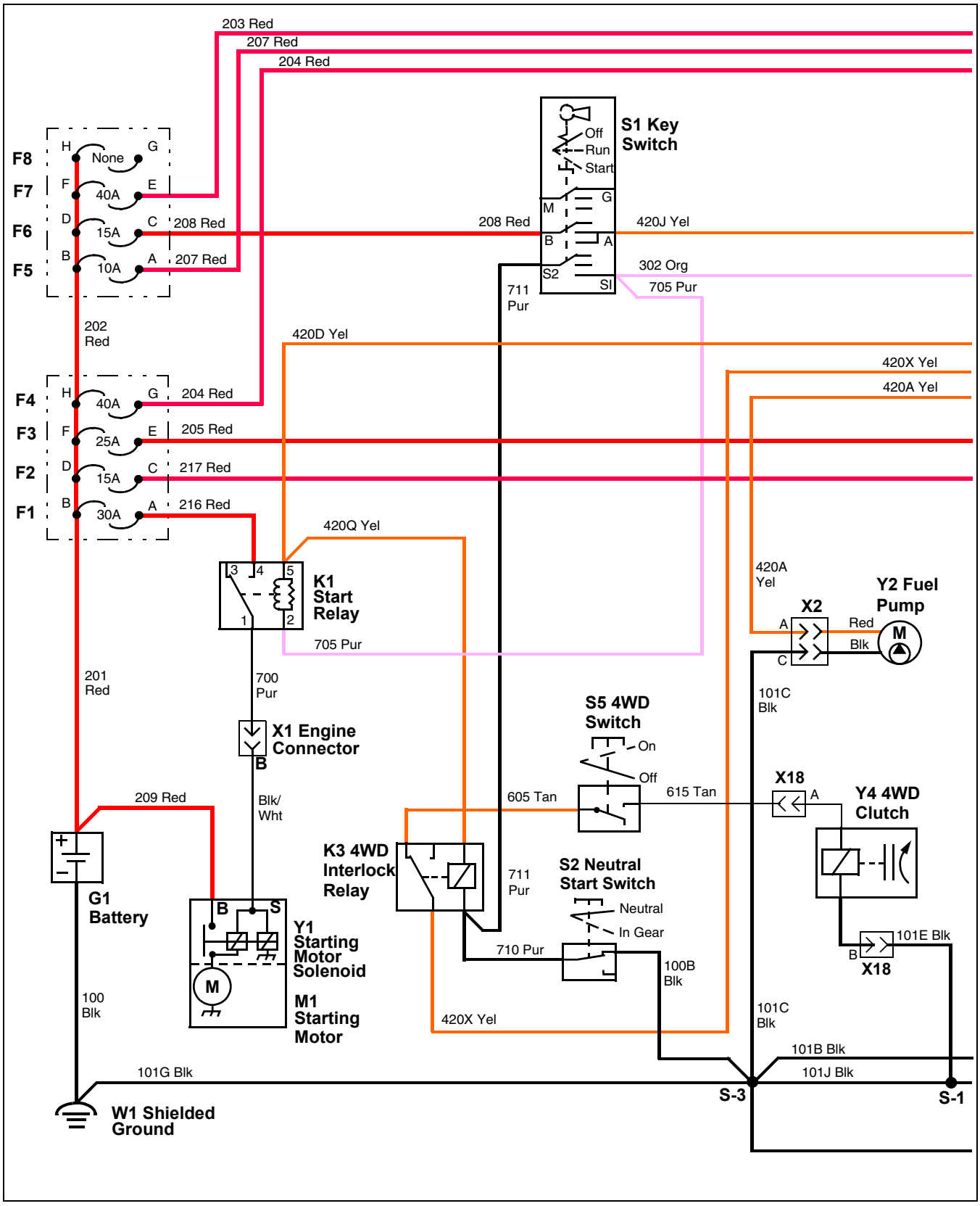
Size/No./Color	Wire Connection Points
2.0 100A Blk	Splice 1, X5[A] (M2)
1.0 100B Blk	S1[S2], Splice 1
2.0 100C Blk	X13 (Power Port), Splice 1
3.0 100D Blk	Splice 1, X14[B]
1.0 100E Blk	Splice 1, X7[B]
0.8 100F Blk	Splice 1, X12[A] (E4)
0.8 100G Blk	Splice 1, X11[A] (E3)
0.8 100H Blk	P1[B], Splice 1
3.0 100J Blk	Splice 1, Splice 3
0.8 100L Blk	S1, H1
1.0 101A Blk	Splice 3, X16[F]
0.8 101C Blk	Splice 3, X2[A] (Y2)
0.8 101D Blk	Splice 3, A1[1]
0.8 101F Blk	X8, Splice 3
5.0 101G Blk	W1, Splice 3
1.0 102 Blk	X7[B], X15[F]
0.8 105 Blk	Splice 1, B1[A]
3.0 125 Blk	Splice 3, X17[B]
5.0 201 Red	X1, Fuse Block
2.0 202 Red	Fuse Block Jumper
3.0 203 Red	F7, X14[A]
3.0 204 Red	F4, X17[A]L
3.0 205 Red	F3, A1[2]
2.0 206 Red	G1, X1
2.0 207 Red	F5, X13 (Power Port)
2.0 208 Red	F6, S1[B]
3.0 209 Red	G1, M1
3.0 216 Red	F1, K1[4]
2.0 217 Red	F2, K2[4]
0.8 300 Org	H2, B3
0.8 301 Org	V1[B], H2
0.8 302 Org	V1[A], S1[S1]
0.8 303 Org	V1[B], A1[5]
0.8 310 Org	K2[2], B1[B]
2.0 315 Org	K2[1], X5[B] (M2)
0.8 419 Yel	H3, H2
0.8 420A Yel	Splice 2, X2[B] (Y2)
0.8 420B Yel	Splice 2, G2[A]
0.8 420D Yel	Splice 2, K1[5]
0.8 420E Yel	K1[5], K2[5]
0.8 420F Yel	Splice 2, X8
1.0 420G Yel	Splice 2, S4[2]
0.8 420H Yel	Splice 2, X9[2] (S5)
2.0 420J Yel	S1[A], Splice 2
1.0 420K Yel	Splice 2, X15[E]
1.0 420L Yel	Splice 2, X7[A]
0.8 420M Yel	Splice 2, H3
0.8 420N Yel	K2[5], A1[3]
0.8 420P Yel	S3, X8
0.8 420R Yel	S1, H1
0.8 600 Brn	H4, G2[B]
0.8 601 Tan	H3, B4
0.8 602 Tan	H3, P1[A]
1.0 670 Org	X9[3] (S5), X10[A]
1.0 675 Grn	X9[1] (S5), X10[B]
3.0 700 Pur	Splice 4, K1[1]
3.0 701 Pur	Splice 4, Y1
3.0 702 Pur	Splice 4, X2[C] (Y2)
0.8 705 Pur	S2[A], S1[S1]
0.8 710 Pur	K1[2], S2[B]
0.8 800 Pnk	S4[1], X11[B] (E3)
0.8 801 Pnk	S4[1], X12[B] (E4)

Size/No./Color	Wire Connection Points
0.8 810 Pnk	S3, H1
1.0 820 Pur	X15[A], X16[A]
1.0 830 Pnk	S4[4], X16[B]
1.0 840 Blu	X15[C], X16[C]
1.0 850 Grn	X15[D], X16[D]
3.0 902 Wht	A1[4], R1-R2-R3

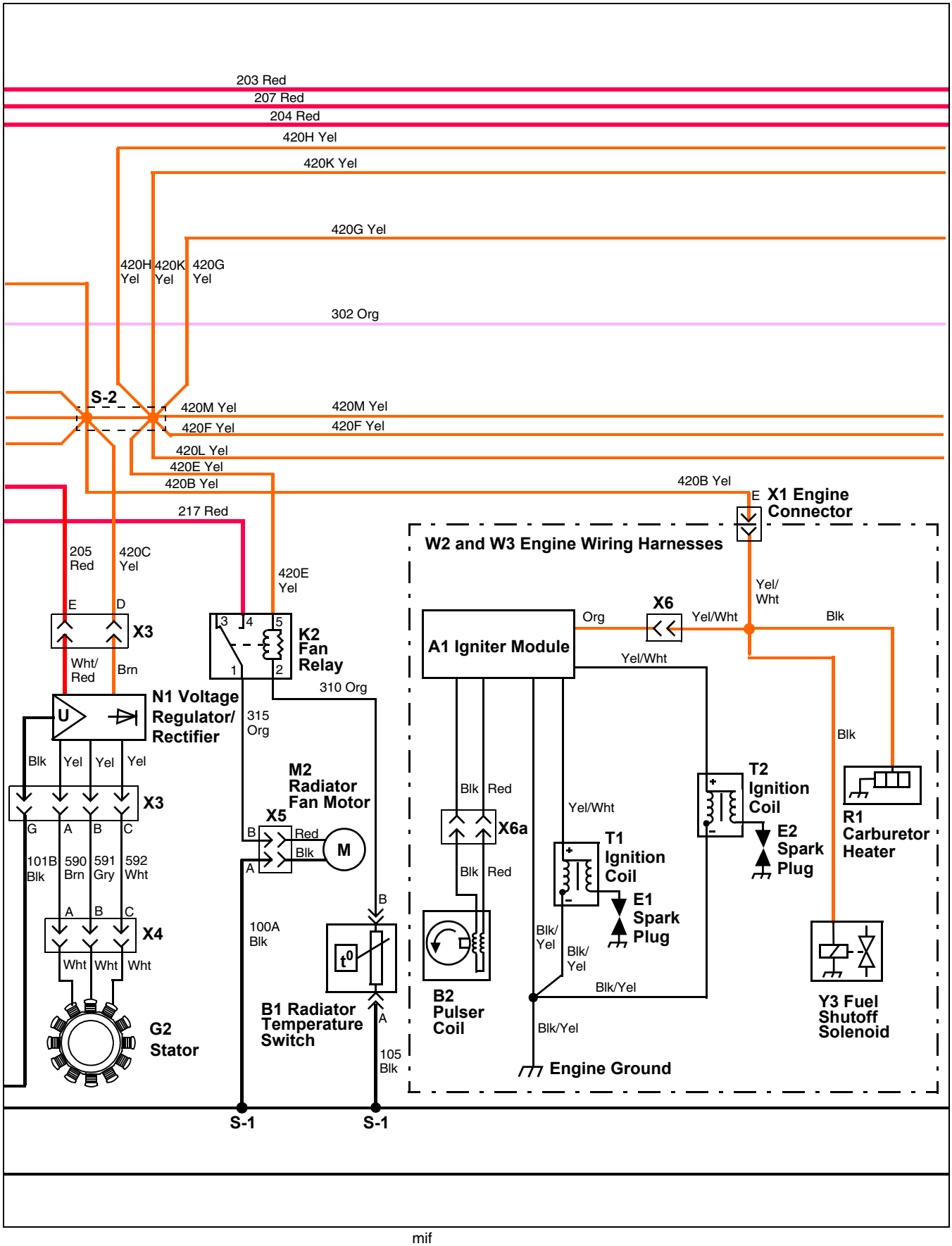
Schematics and Harnesses (SN 40001-)

Schematic 1 of 4

Main Schematic (Gas Engine)



Schematic 2 of 4



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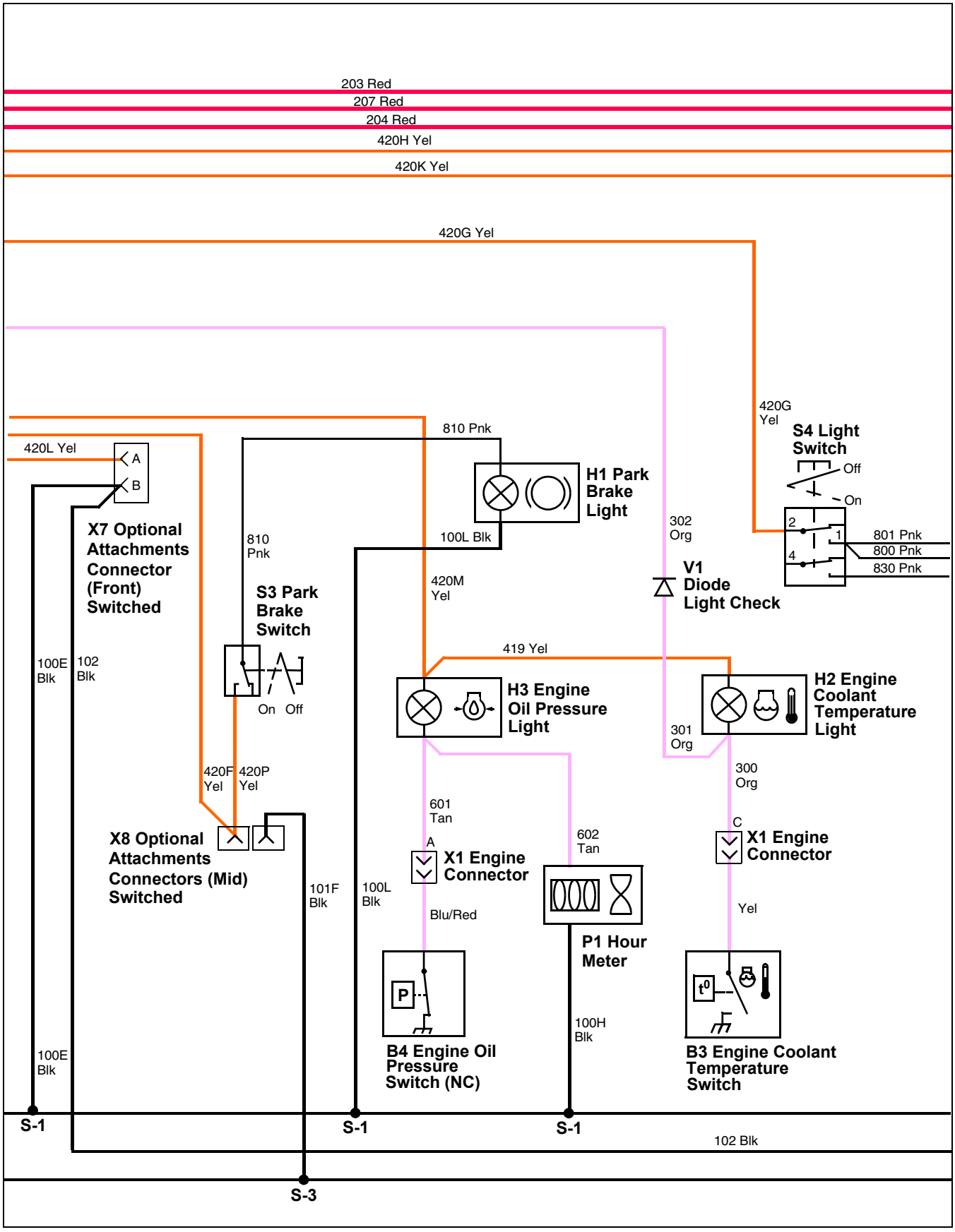
Schematic 3 of 4



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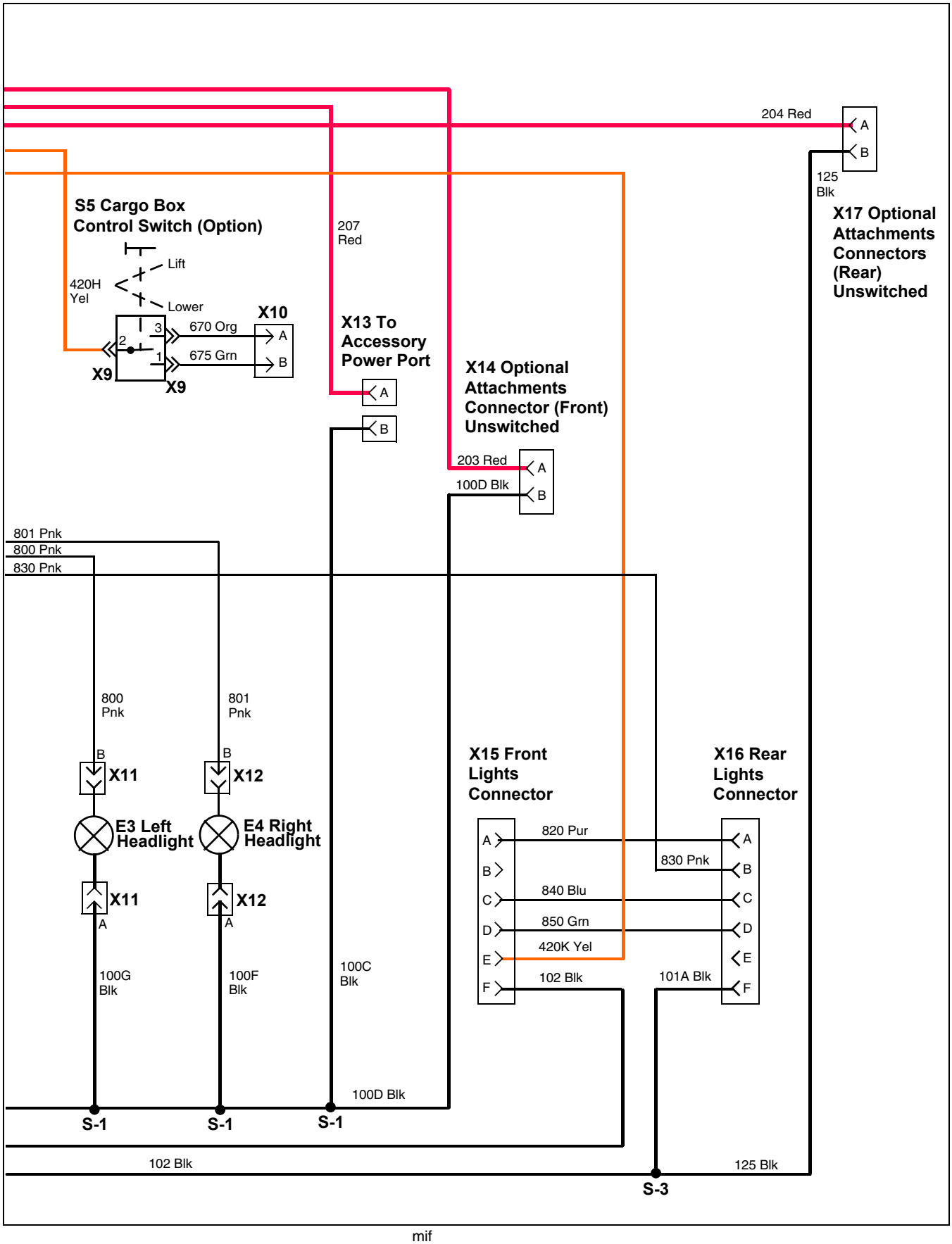
Schematic 4 of 4



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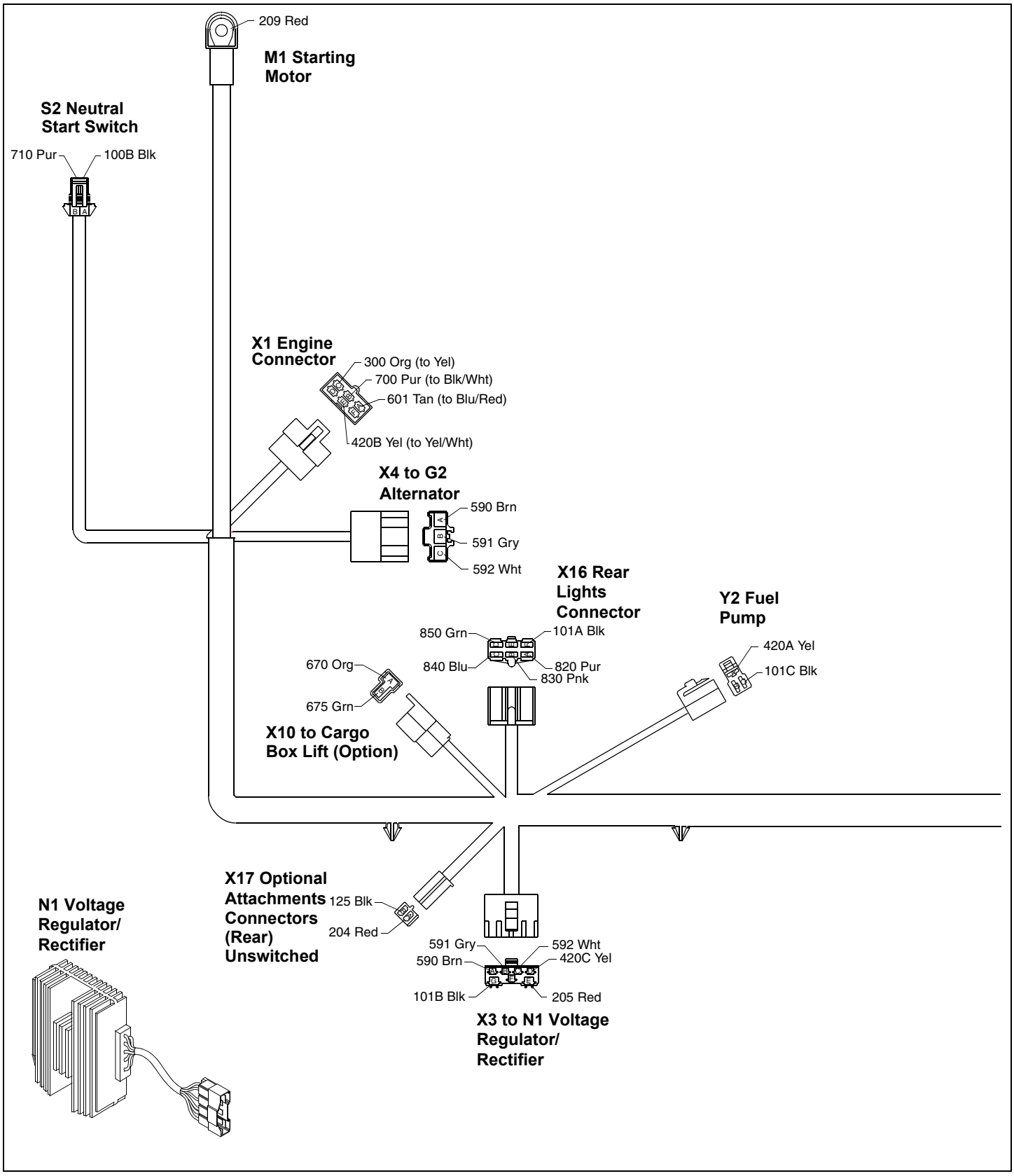
Main Wiring Harness (Gas Engine)

Main Harness 1 of 4



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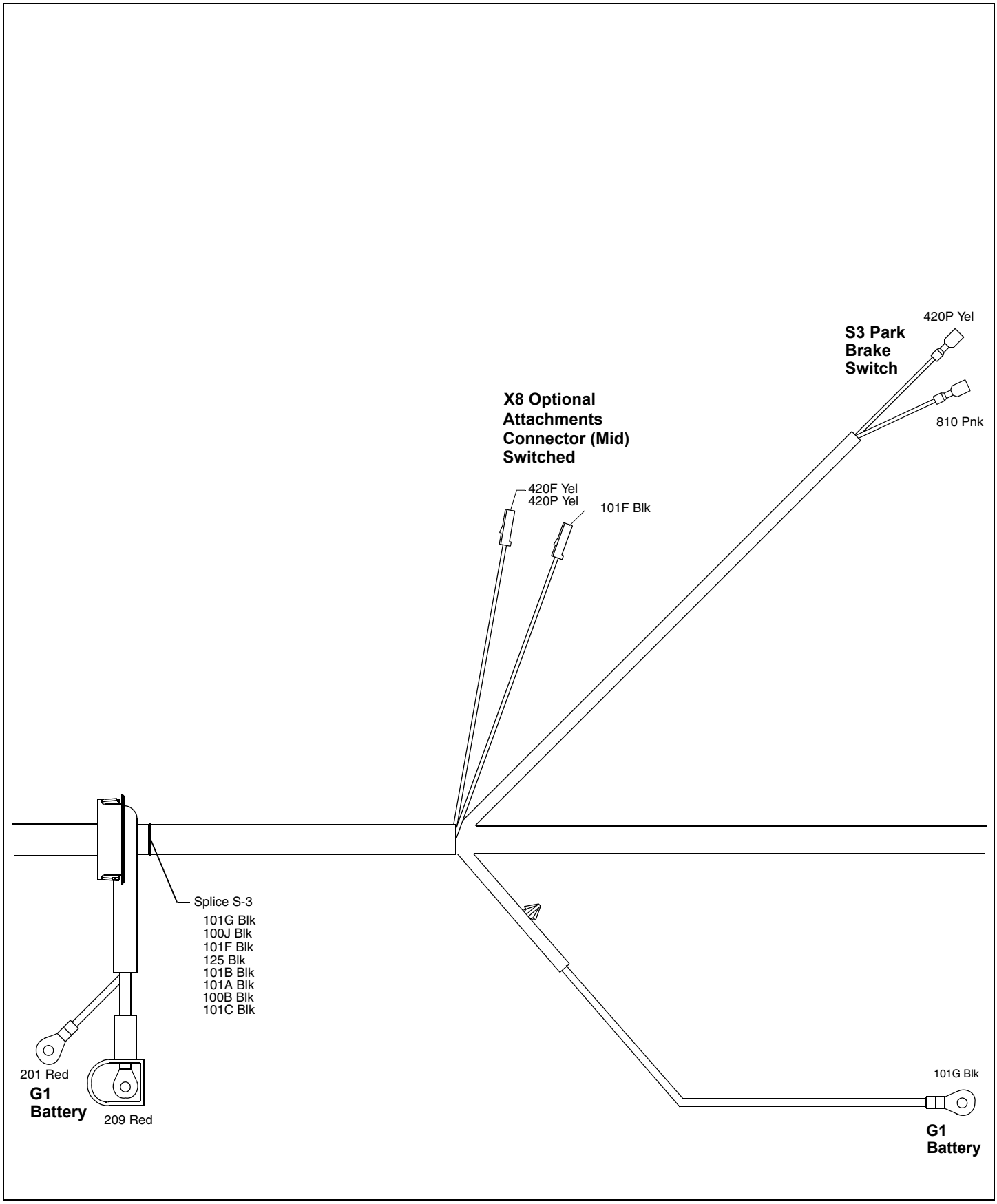
Main Harness 2 of 4



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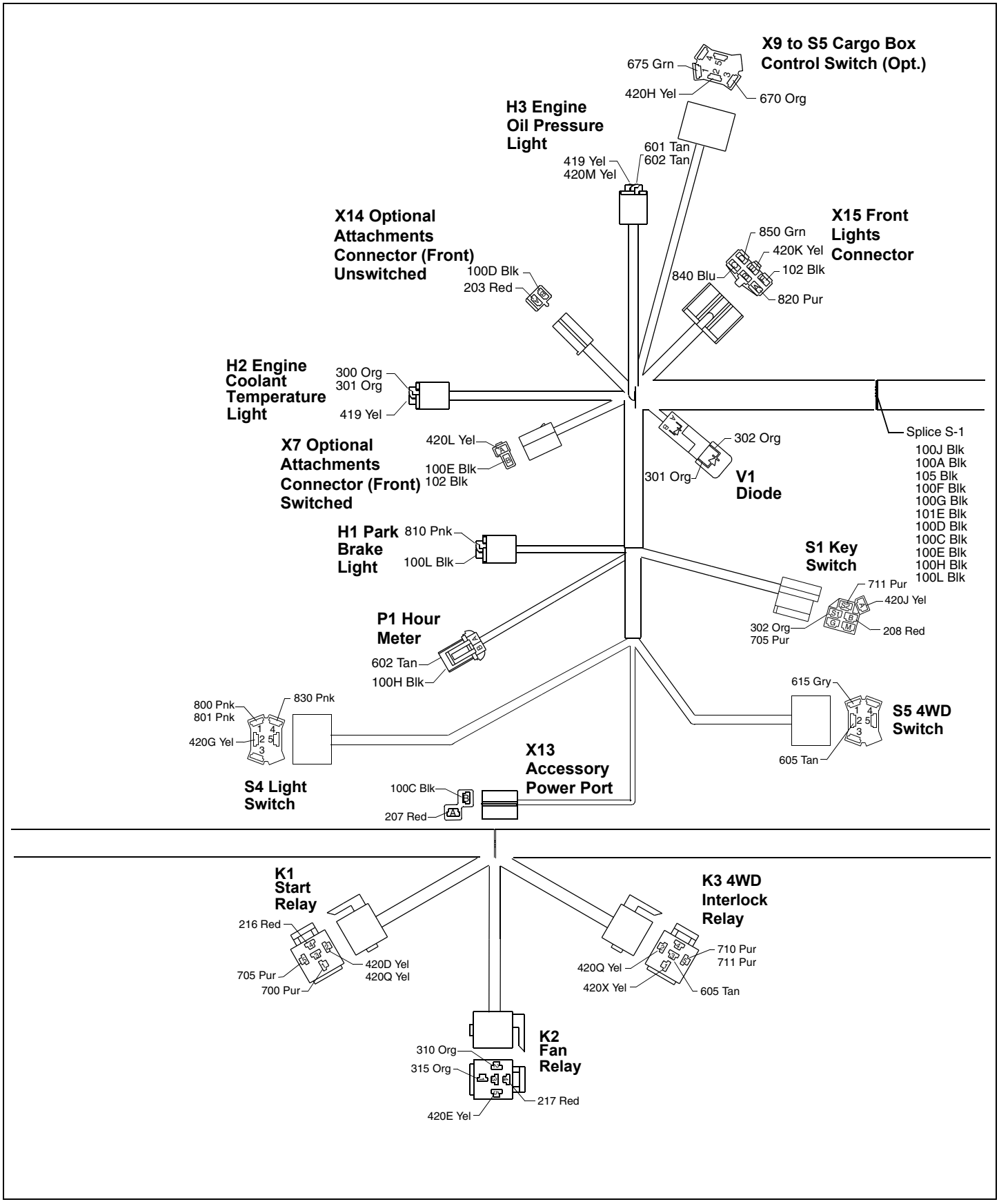
Main Harness 3 of 4



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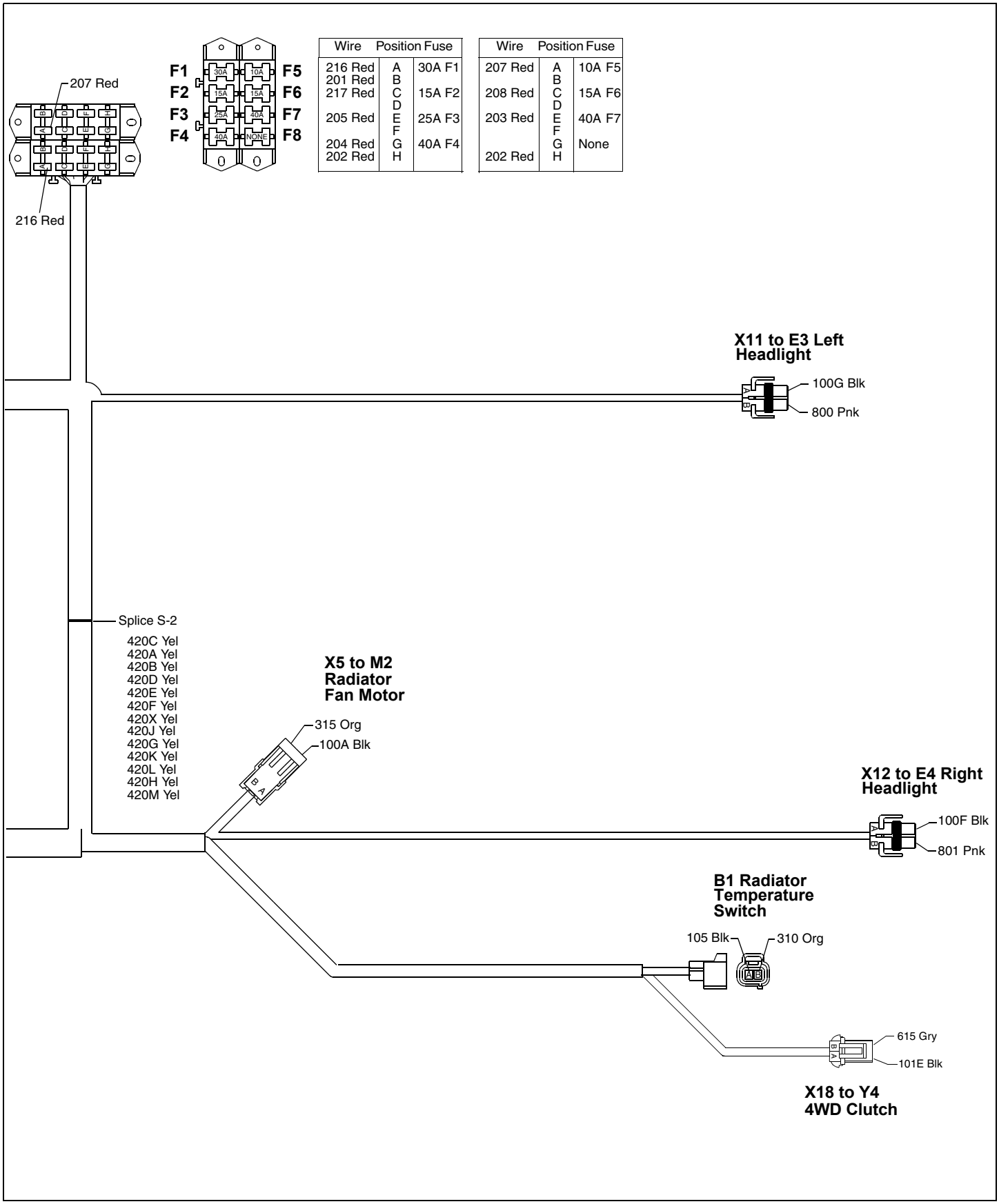
Main Harness 4 of 4



Wire	Position	Fuse
216 Red	A	30A F1
201 Red	B	
217 Red	C	15A F2
	D	
205 Red	E	25A F3
	F	
204 Red	G	40A F4
202 Red	H	

Wire	Position	Fuse
207 Red	A	10A F5
	B	
208 Red	C	15A F6
	D	
203 Red	E	40A F7
	F	
	G	None
202 Red	H	

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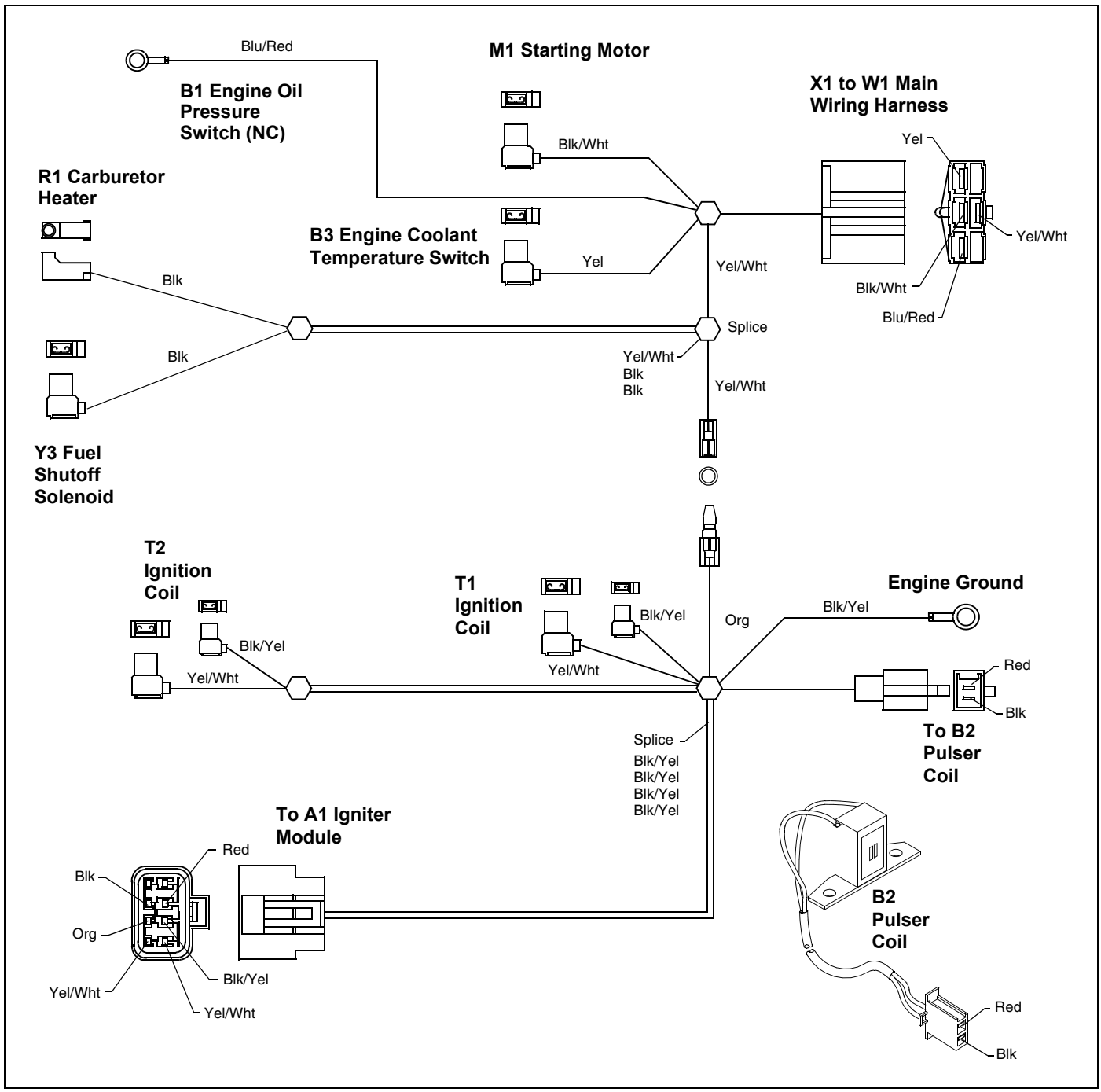
Main Harness Wire Color Codes (Gas Engine)

Size/No./Color	Wire Connection Points
2.0 100A Blk	Splice 1, X5[A] (M2)
1.0 100B Blk	S2[A], Splice 3
2.0 100C Blk	Splice 1, X13[B] (Power Port)
3.0 100D Blk	Splice 1, X14[B]
1.0 100E Blk	Splice 1, X7[B]
0.8 100F Blk	Splice 1, X12[A] (E4)
0.8 100G Blk	Splice 1, X11[A] (E3)
0.8 100H Blk	P1[B], Splice 1
3.0 100J Blk	Splice 1, Splice 3
3.0 100L Blk	H1[B], Splice 1
1.0 101A Blk	Splice 3, X16[F]
3.0 101B Blk	Splice 3, X3[G] (N1)
0.8 101C Blk	Splice 3, X2[C] (Y2)
0.8 101E Blk	Splice 3, X18[B] (Y4)
0.8 101F Blk	X8, Splice 3
5.0 101G Blk	W1, Splice 3
1.0 102 Blk	X7[B], X15[F]
0.8 105 Blk	Splice 1, B1[A]
3.0 125 Blk	Splice 3, X17[B]
5.0 201 Red	G1, Fuse Block
2.0 202 Red	Fuse Block Jumper
3.0 203 Red	F7[E], X14[A]
3.0 204 Red	F4[G], X17[A]
3.0 205 Red	F3[E], X3[E] (N1)
2.0 207 Red	F5[A], X13[A] (Power Port)
2.0 208 Red	F6[C], S1[B]
6.0 209 Red	G1, M1
3.0 216 Red	F1[A], K1[4]
2.0 217 Red	F2[C], K2[4]
0.8 300 Org	X1[C], H2[A]
0.8 301 Org	H2[A], V1[B]
0.8 302 Org	V1[A], S1[S1]
0.8 310 Org	K2[2], B1[B]
2.0 315 Org	K2[1], X5[B] (M2)
0.8 419 Yel	H3[B], H2[B]
0.8 420A Yel	Splice 2, X2[A] (Y2)
0.8 420B Yel	Splice 2, X1[E]
1.0 420C Yel	Splice 2, X3[D] (N1)
0.8 420D Yel	Splice 2, K1[2]
0.8 420E Yel	Splice 2, K2[5]
0.8 420F Yel	Splice 2, X8
1.0 420G Yel	Splice 2, S4[2]
0.8 420H Yel	Splice 2, X9[2] (S5)
2.0 420J Yel	S1[A], Splice 2
1.0 420K Yel	Splice 2, X15[E]
1.0 420L Yel	Splice 2, X7[A]
0.8 420M Yel	Splice 2, H3[B]
0.8 420P Yel	X8, S3
0.8 420Q Yel	K1[2], K3[2]
0.8 420X Yel	Splice 2, K3[1]
2.0 590 Brn	X4[A] (G2), X3[A] (N1)
2.0 591 Gry	X4[B] (G2), X3[B] (N1)
2.0 592 Wht	X4[C] (G2), X3[C] (N1)
0.8 601 Tan	H3[A], X1[A] (B4)
0.8 602 Tan	H3[A], P1[A]
0.8 605 Tan	S5[2], K3[3]
0.8 615 Gry	S5[1], X18[B] (Y4)
1.0 670 Org	X9[3] (S5), X10[A]
1.0 675 Grn	X9[1] (S5), X10[B]
3.0 700 Pur	K1[1], X1[B] (Y1)
0.8 705 Pur	S1[S1], K1[5]
0.8 710 Pur	K3[5], S2[B]
0.8 711 Pur	K3[5], S1[S2]

Size/No./Color	Wire Connection Points
0.8 800 Pnk	S4[1], X11[B] (E3)
0.8 801 Pnk	S4[1], X12[B] (E4)
0.8 810 Pnk	S3, H1[A]
1.0 820 Pur	X15[A], X16[A]
1.0 830 Pnk	S4[4], X16[B]
1.0 840 Blu	X15[C], X16[C]
1.0 850 Grn	X15[D], X16[D]

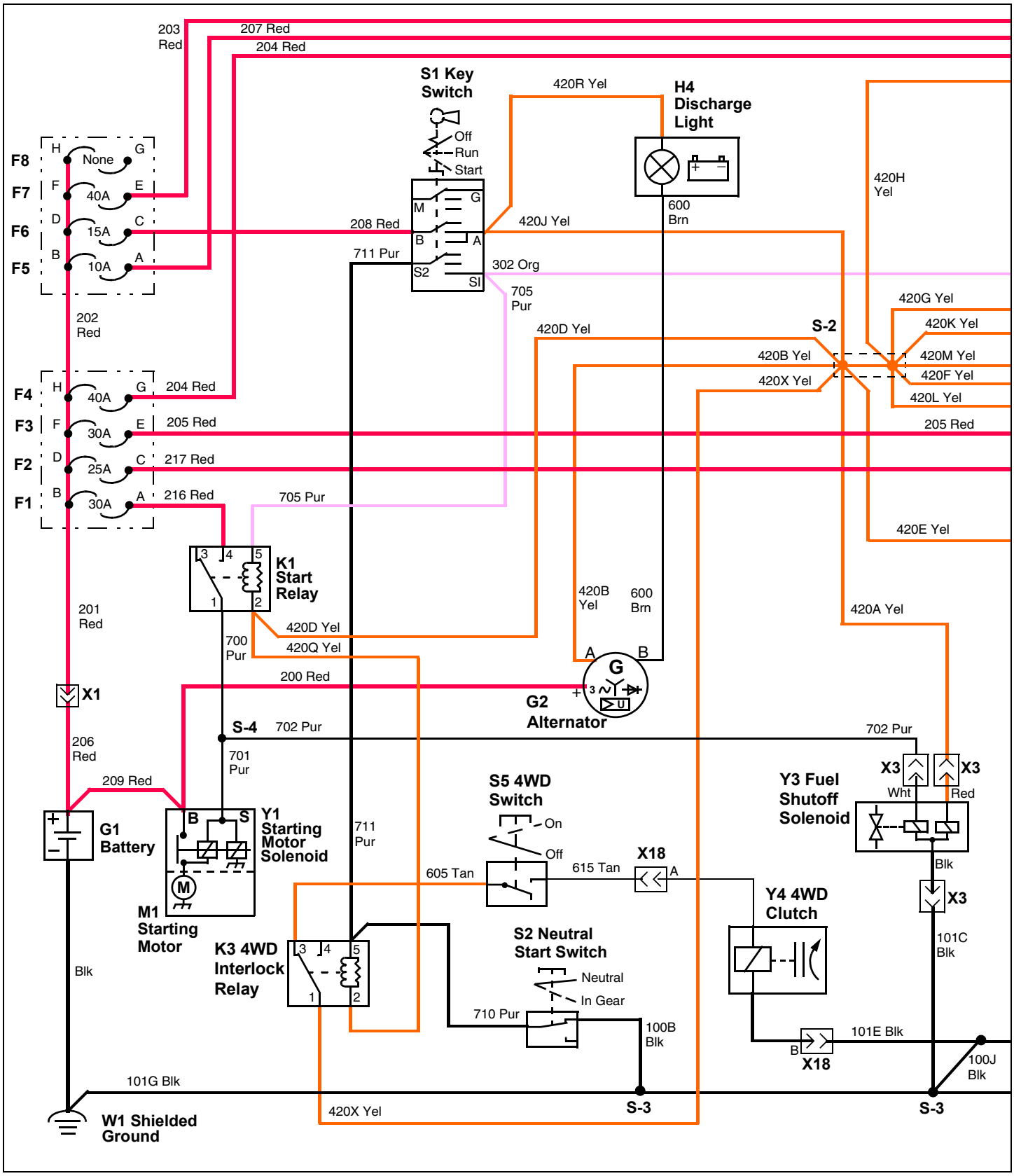
W2 Engine Wiring Harnesses (Gas Engine)



MIF

Main Schematic (Diesel Engine)

Schematic 1 of 3



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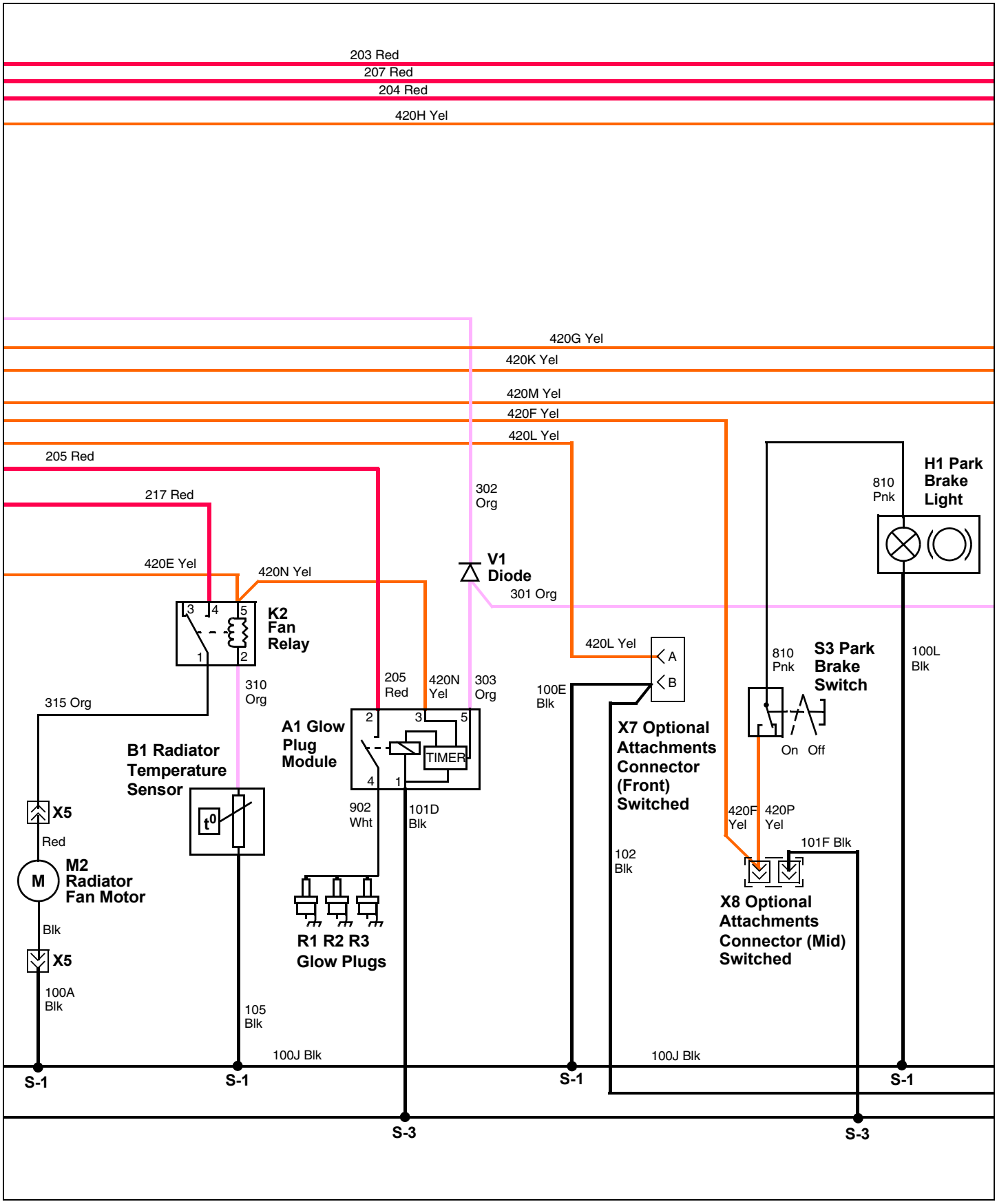
Schematic 2 of 3



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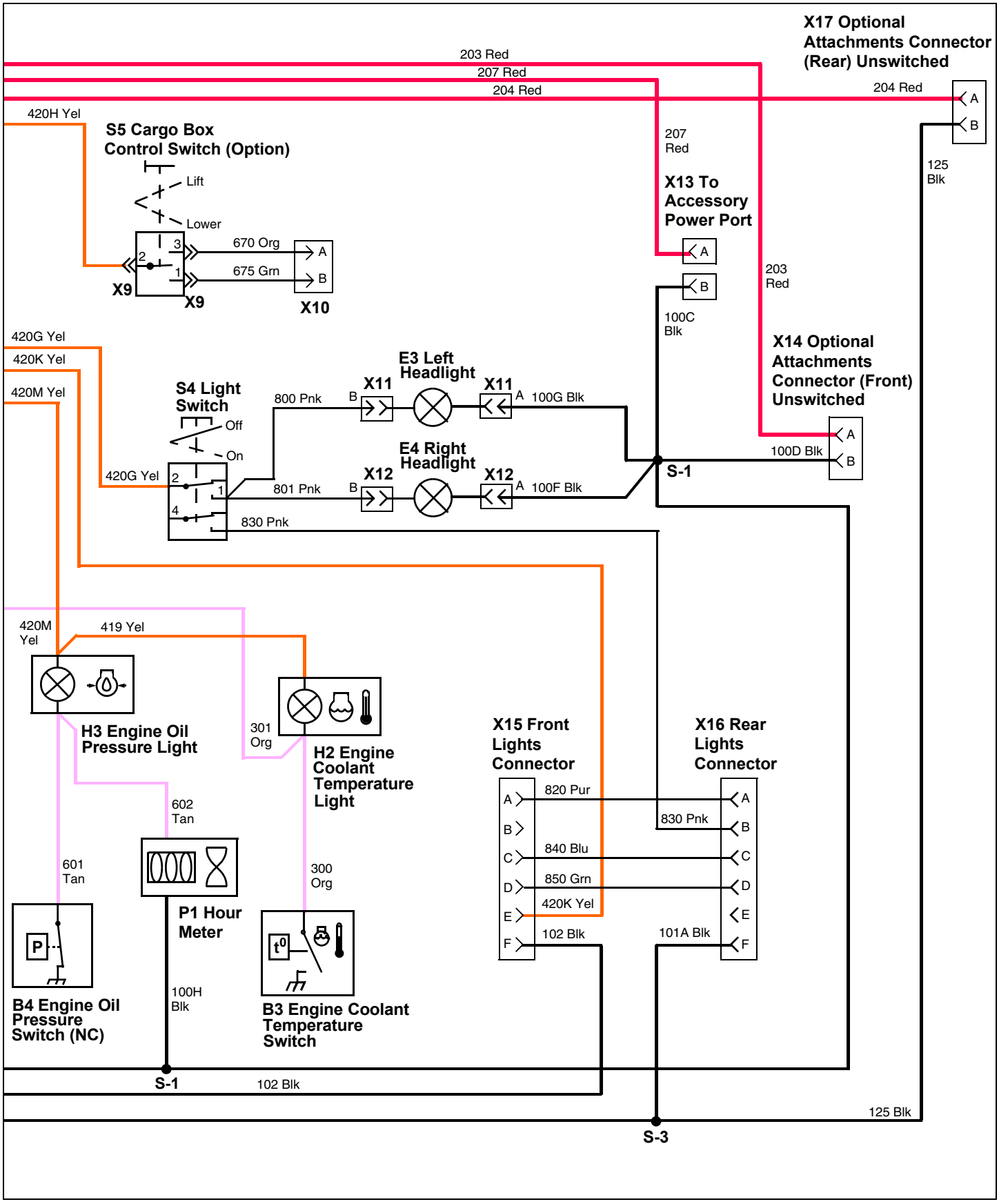
Schematic 3 of 3



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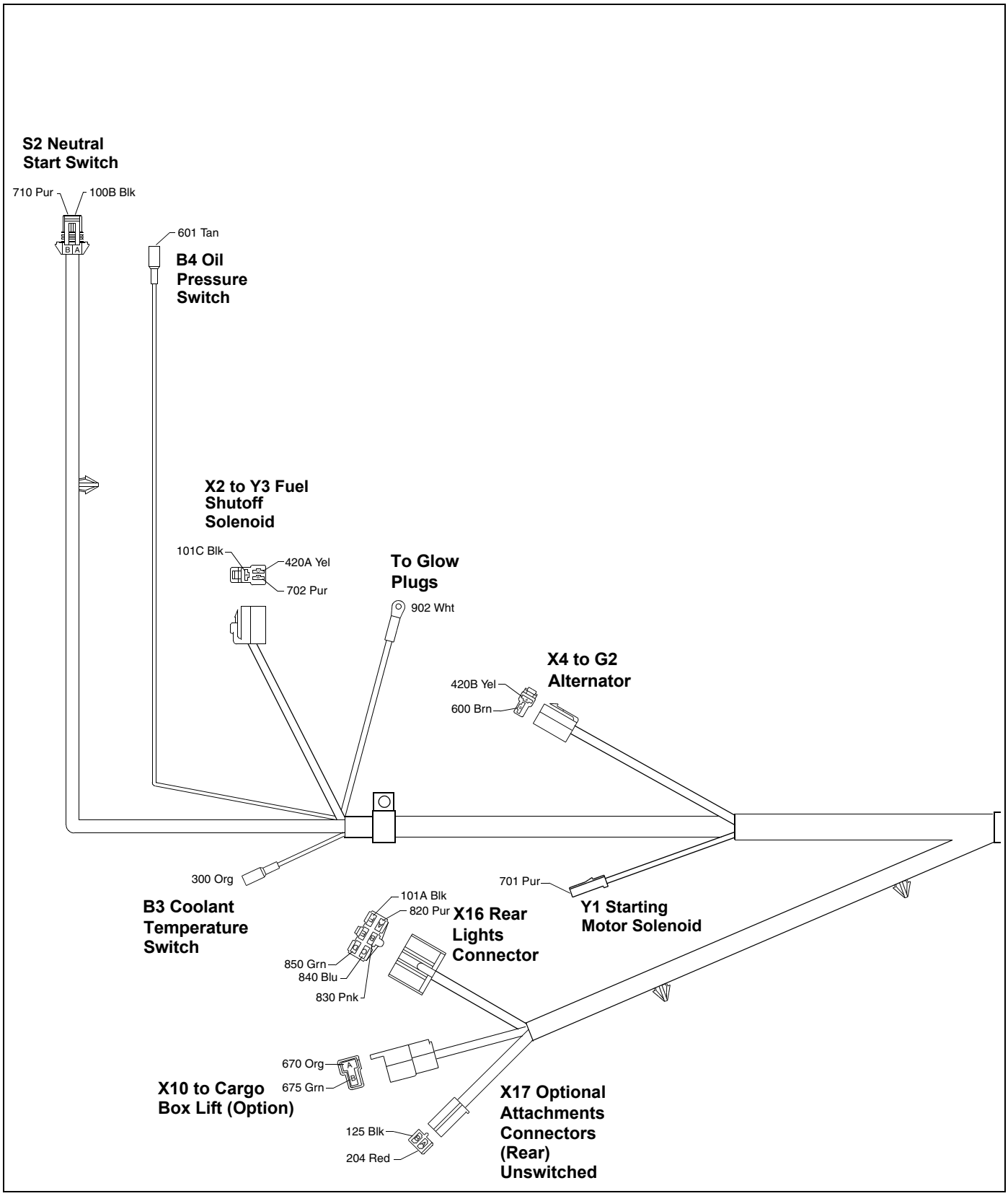
Main Wiring Harness (Diesel Engine)

Wiring Harness 1 of 4



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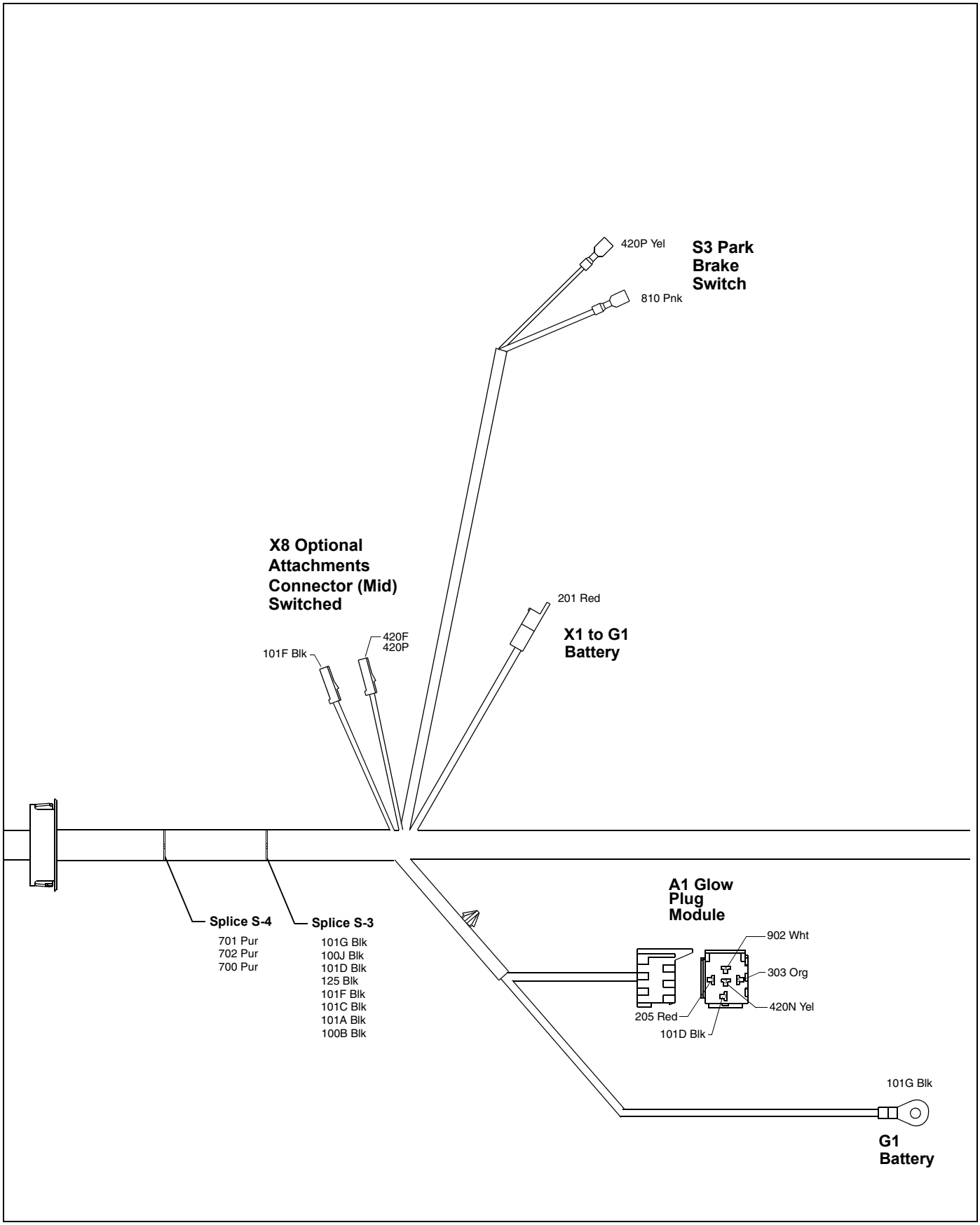
Wiring Harness 2 of 4



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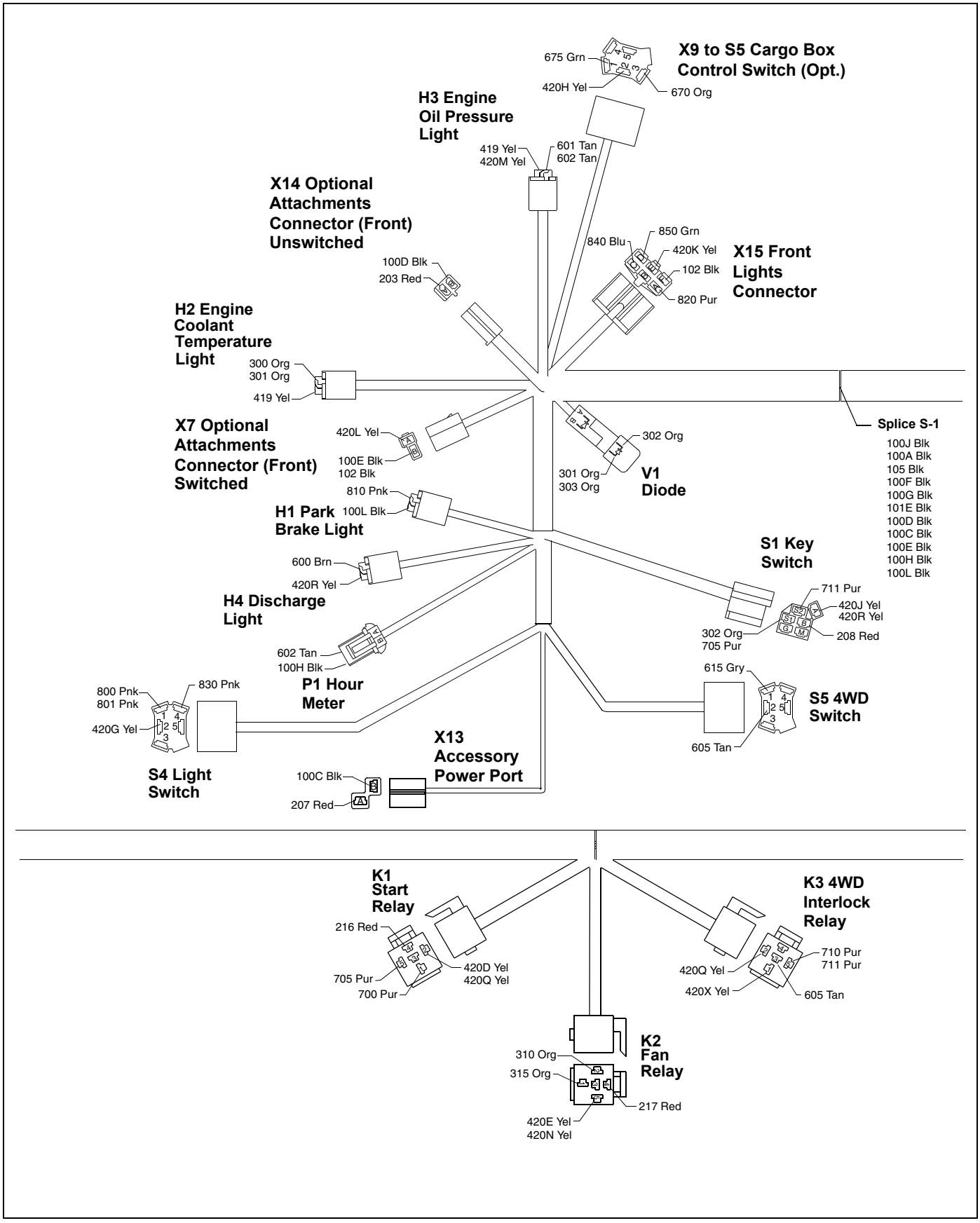
Wiring Harness 3 of 4



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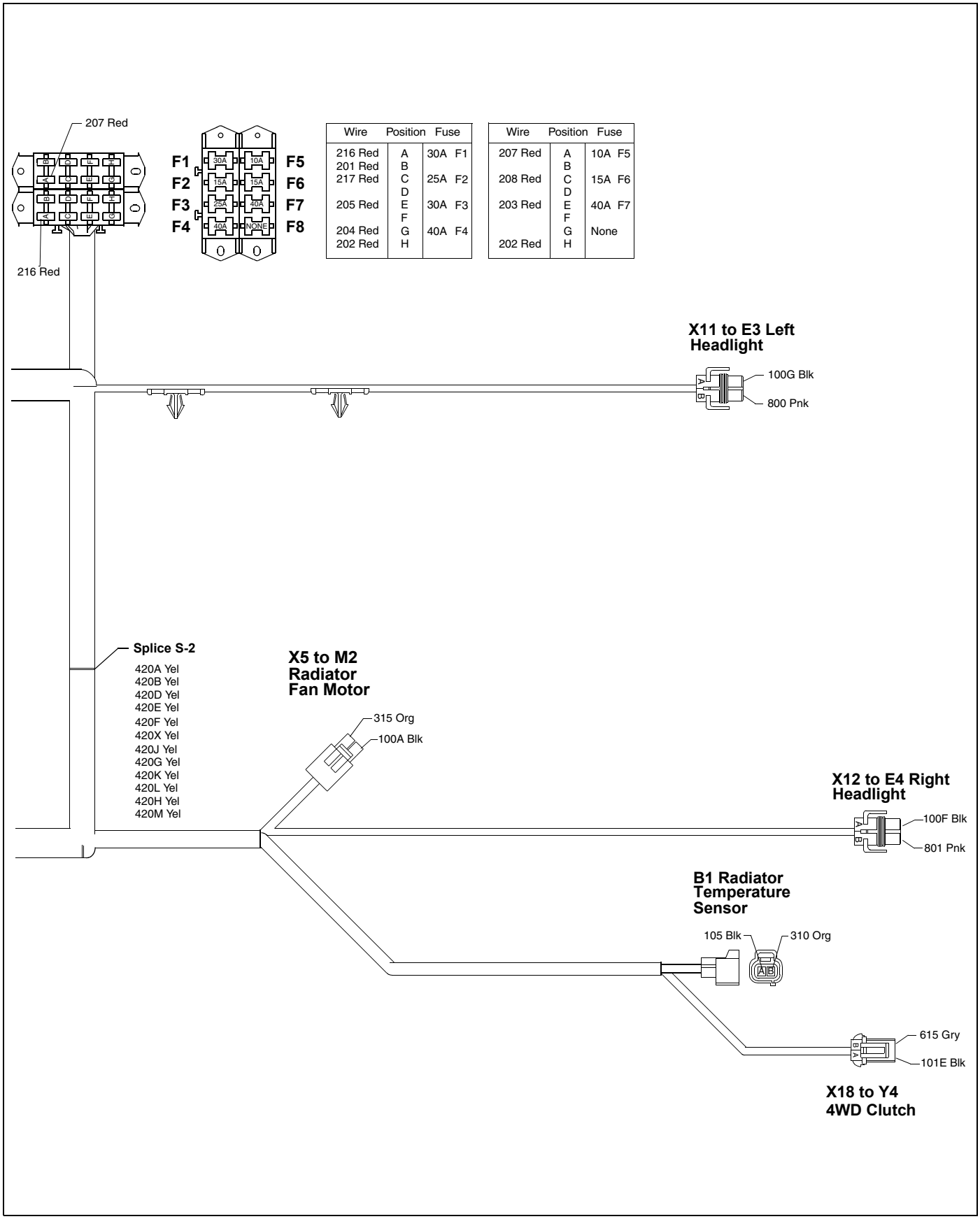
Wiring Harness 4 of 4



Wire	Position	Fuse
216 Red	A	30A F1
201 Red	B	
217 Red	C	25A F2
	D	
205 Red	E	30A F3
	F	
204 Red	G	40A F4
202 Red	H	

Wire	Position	Fuse
207 Red	A	10A F5
	B	
208 Red	C	15A F6
	D	
203 Red	E	40A F7
	F	
	G	None
202 Red	H	

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Main Harness Wire Color Codes (Diesel Engine)

Size/No./Color	Wire Connection Points
2.0 100A Blk	Splice 1, X5[A] (M2)
1.0 100B Blk	Splice 3, S2
2.0 100C Blk	Splice 1, X13[B] (Power Port)
3.0 100D Blk	Splice 1, X14[B]
1.0 100E Blk	Splice 1, X7[B]
0.8 100F Blk	Splice 1, X12[A] (E4)
0.8 100G Blk	Splice 1, X11[A] (E3)
0.8 100H Blk	Splice 1, P1[B]
3.0 100J Blk	Splice 1, Splice 3
0.8 100L Blk	Splice 1, H1[B]
1.0 101A Blk	Splice 3, X16[F]
0.8 101C Blk	Splice 3, X2[A] (Y2)
0.8 101D Blk	Splice 3, A1[1]
0.8 101E Blk	Splice 1, X18[A] (Y4)
0.8 101F Blk	Splice 3, X8
5.0 101G Blk	W1, Splice 3
1.0 102 Blk	X7[B], X15[F]
0.8 105 Blk	Splice 1, B1[A]
3.0 125 Blk	Splice 3, X17[B]
5.0 201 Red	X1, Fuse Block
2.0 202 Red	Fuse Block Jumper
3.0 203 Red	F7[E], X14[A]
3.0 204 Red	F4[G], X17[A]
3.0 205 Red	F3[E], A1[2]
2.0 206 Red	G1, X1
2.0 207 Red	F5[A], X13[A] (Power Port)
2.0 208 Red	F6[C], S1[B]
3.0 209 Red	G1, Y1[B]
3.0 216 Red	F1[A], K1[4]
2.0 217 Red	F2[C], K2[4]

Size/No./Color	Wire Connection Points
0.8 300 Org	H2[A], B3
0.8 301 Org	V1[B], H2[A]
0.8 302 Org	V1[A], S1[S1]
0.8 303 Org	V1[B], A1[5]
0.8 310 Org	K2[2], B1[B]
2.0 315 Org	K2[1], X5[B] (M2)
0.8 419 Yel	H3[B], H2[B]
0.8 420A Yel	Splice 2, X2[B] (Y3)
0.8 420B Yel	Splice 2, X4[A] (G2)
0.8 420D Yel	Splice 2, K1[2]
0.8 420E Yel	Splice 2, K2[5]
0.8 420F Yel	Splice 2, X8
1.0 420G Yel	Splice 2, S4[2]
0.8 420H Yel	Splice 2, X9[2] (S5)
2.0 420J Yel	S1[A], Splice 2
1.0 420K Yel	Splice 2, X15[E]
1.0 420L Yel	Splice 2, X7[A]
0.8 420M Yel	Splice 2, H3[B]
0.8 420N Yel	K2[5], A1[3]
0.8 420P Yel	S3, X8
0.8 420R Yel	S1[A], H4[B]
0.8 420Q Yel	K1[2], K3[2]
0.8 420X Yel	Splice 2, K3[1]
0.8 600 Brn	H4[A], X4[B] (G2)
0.8 601 Tan	H3[A], B4
0.8 602 Tan	H3[A], P1[A]
0.8 605 Tan	S5[2], K3[3]
0.8 615 Gry	S5[1], X18[B] (Y4)
1.0 670 Org	X9[3] (S5), X10[A]
1.0 675 Grn	X9[1] (S5), X10[B]
3.0 700 Pur	Splice 4, K1[1]
3.0 701 Pur	Splice 4, Y1[B]

Size/No./Color	Wire Connection Points
3.0 702 Pur	Splice 4, X2[C] (Y3)
0.8 705 Pur	K1[5], S1[S1]
0.8 710 Pur	K3[5], S2[A]
0.8 711 Pur	K3[5], S1[S2]
0.8 800 Pnk	S4[1], X11[B] (E3)
0.8 801 Pnk	S4[1], X12[B] (E4)
0.8 810 Pnk	S3, H1[A]
1.0 820 Pur	X15[A], X16[A]
1.0 830 Pnk	S4[4], X16[B]
1.0 840 Blu	X15[C], X16[C]
1.0 850 Grn	X15[D], X16[D]
3.0 902 Wht	A1[4], R1-R2-R3

Operation and Diagnostics

Power Circuit Operation (Gas Engine) (SN -40000)

Function:

Provides unswitched and switched power to the primary components whenever the battery is connected and the key switch is in the run position.

Operating Conditions Unswitched Circuits:

- Battery fully charged and properly connected to the wiring harness.
- Ground circuit properly connected to the wiring harness.

Battery voltage must be present at the following components with the key switch “OFF”:

- Battery Positive Terminal
- Y1 Starting Motor Solenoid “B” Terminal 209 Red wire
- K1 Start Relay 216 Red wire
- K2 Fan Relay 217 Red wire
- N1 Voltage Regulator/Rectifier “E” terminal 205 Red wire
- X17 Rear Optional Attachments Connector “A” terminal 204 Red wire
- X13 Accessory Power Port Connector “A” terminal 207 Red wire
- S1 Key Switch “B” terminal 208 Red wire
- X14 Front Optional Attachments Connector “A” terminal 203 Red wire

Unswitched Circuit Operation:

The positive battery cable connects the battery to the Y1 starting motor solenoid. Power is also directly run from the battery positive terminal to two fuse blocks. These fuse blocks distribute power to all unswitched circuits, with the exception of the Y1 starting motor solenoid. The individual fuses in the blocks protect the components and wiring from damage by preventing a high current circuit overload.

The battery cable and fuse block connections must be in good condition for the machine’s electrical system to work properly.

The ground cable and connections are equally important. Proper operation depends on these cables and connections to carry the power necessary for operation.

Operating Conditions Switched Circuits:

- Unswitched circuits functioning properly.
- Key switch in the RUN position.

Battery voltage must be present at the following locations:

- Y2 Fuel Pump 420A Yel wire
- N1 Voltage Regulator 420C Yel wire
- K1 Start Relay 420D Yel wire
- K2 Fan Relay 420E Yel wire
- X15 Front Lights Connector “E” terminal 420K Yel wire
- S4 Light Switch 420G Yel wire
- S5 Cargo Box Control Switch (option) 420H Yel wire
- H3 Engine Oil Pressure Light 420M Yel wire
- H2 Engine Coolant Temperature Light 419 Yel wire
- X8 Mid Optional Attachments Connector 420F Yel wire
- S3 Park Brake Switch 420P Yel wire
- X7 Front Optional Attachments Connector “A” terminal 420L Yel wire
- Battery voltage must also be present at these locations connected through the X1 Engine Connector “E” terminal 420B Yel wire:
  - R1 Carburetor Heater
  - Y3 Fuel Shutoff Solenoid
  - X6 Connector of A1 Ignitor Module

Switched Circuit Operation:

Power supplied by the battery, through a fuse block is supplied to the S1 key switch. When the key switch is in the ON position, power is routed to a central splice. This splice distributes power to the switched components through individual circuits and grounds.

Static Switched Circuits:

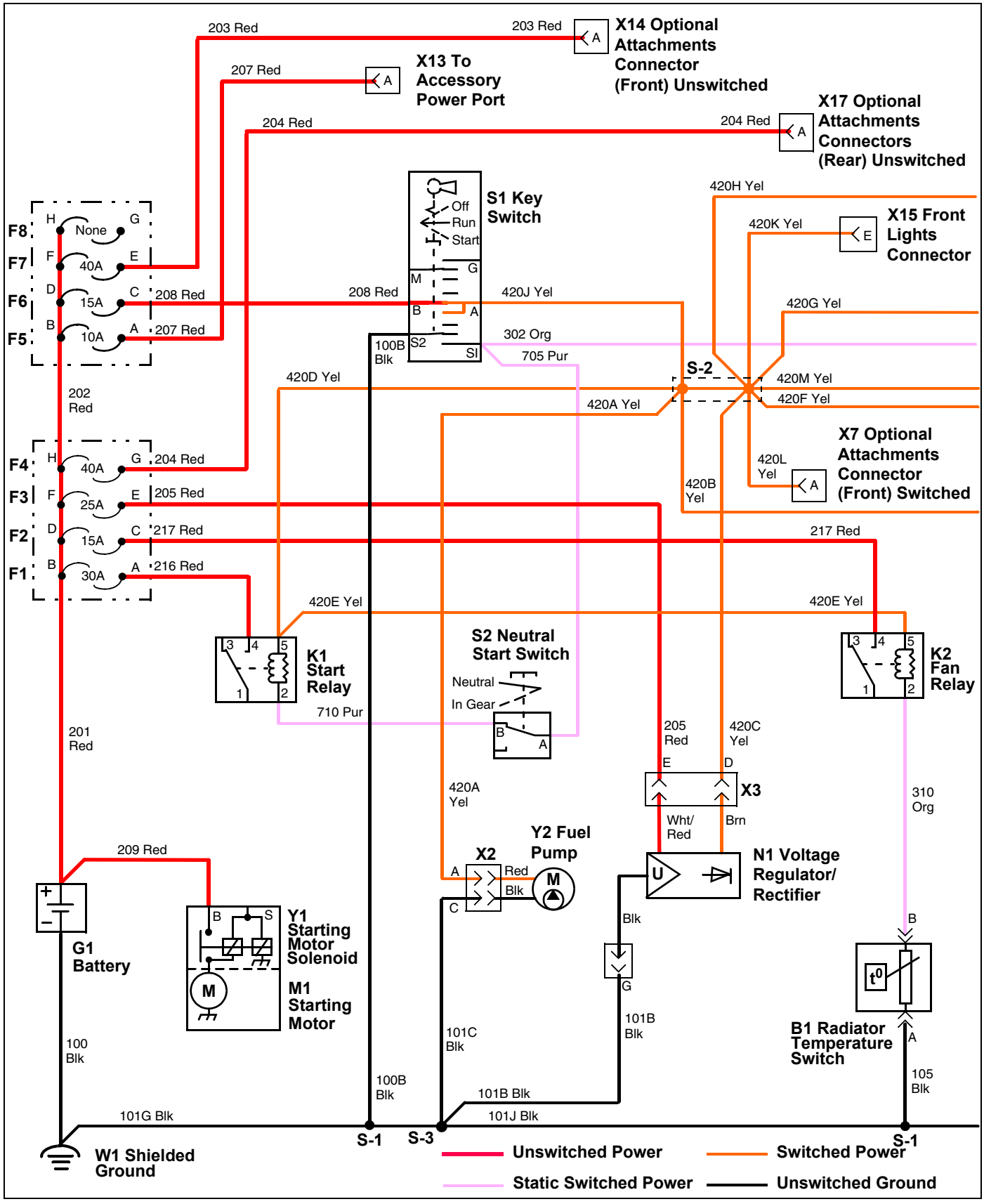
- Switched circuits functioning properly.

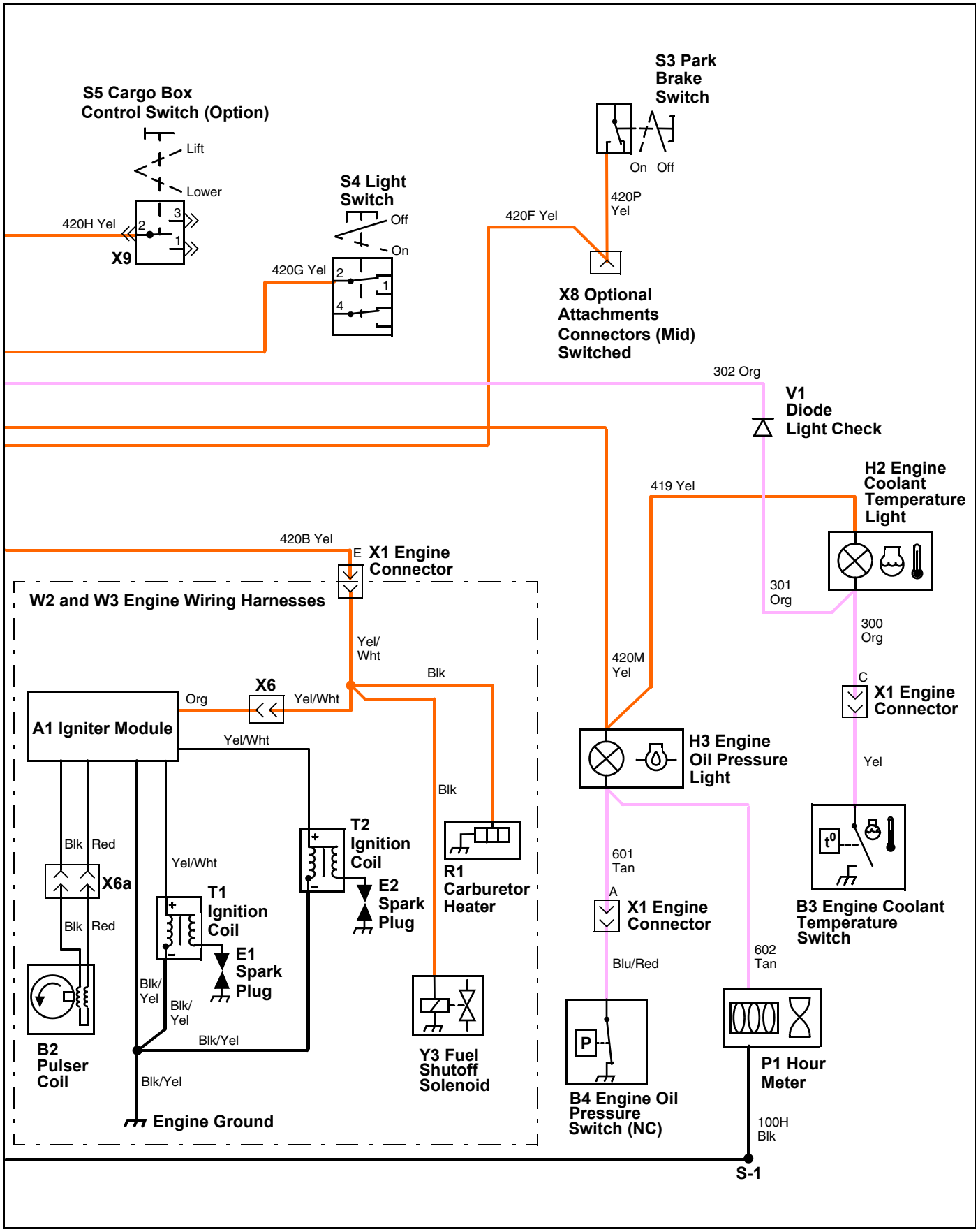
As a result of the key switch being placed in the run position, battery voltage passes through several components and is switched on the ground side to activate the component. These wires will have battery voltage present when not be used and will become a ground circuit when the function is activated.

Battery voltage must be present at the following locations:

- B1 Radiator Temperature Switch 310 Org wire
- B3 Engine Coolant Temperature Switch 300 Org wire
- V1 Light Check Diode 301 and 302 Org wires
- S1 Key Switch “S1” terminal 302 Org and 705 Pur wires
- S2 Neutral Start Switch 705 and 710 Pur wires
- B4 Engine Oil Pressure Switch 601 Tan wire
- P1 Hour Meter 602 Tan wire

Power Circuit Schematic (Gas Engine) (SN -40000)




S5 Cargo Box Control Switch (Option)
Lift
Lower
420H Yel
X9
S4 Light Switch
Off
On
420G Yel
S3 Park Brake Switch
On Off
420P Yel
420F Yel
X8 Optional Attachments Connectors (Mid) Switched
302 Org
V1 Diode Light Check
H2 Engine Coolant Temperature Light
419 Yel
420B Yel
E X1 Engine Connector
W2 and W3 Engine Wiring Harnesses
Yel/ Wht
Blk
X6
Org
Yel/Wht
A1 Igniter Module
Yel/Wht
Blk
Red
X6a
Blk
Red
T1 Ignition Coil
E1 Spark Plug
T2 Ignition Coil
E2 Spark Plug
R1 Carburetor Heater
Blk/ Yel
Blk/ Yel
Blk/Yel
Blk/Yel
B2 Pulser Coil
Y3 Fuel Shutoff Solenoid
Engine Ground
301 Org
300 Org
C
X1 Engine Connector
Yel
420M Yel
H3 Engine Oil Pressure Light
601 Tan
A
X1 Engine Connector
Blu/Red
602 Tan
B3 Engine Coolant Temperature Switch
P
B4 Engine Oil Pressure Switch (NC)
P1 Hour Meter
100H Blk
S-1

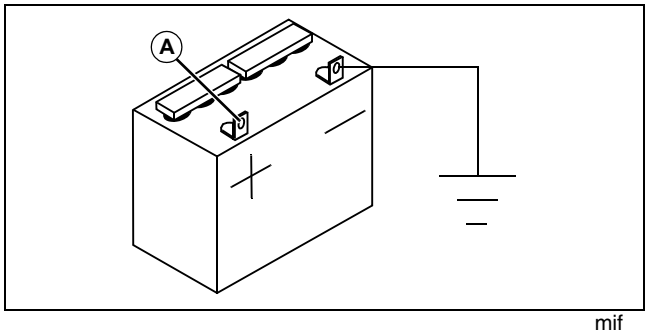
Power Circuit Diagnosis (Gas Engine) (SN -40000)

Test Procedure A

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Key switch in the off position.
- Cargo box raised and locked.
- Battery fully charged.
- Negative (Blk) lead of voltmeter placed on battery negative (-) terminal or suitable frame ground.
- Voltmeter positive (Red) placed on designated test point.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.

System: Battery Circuit

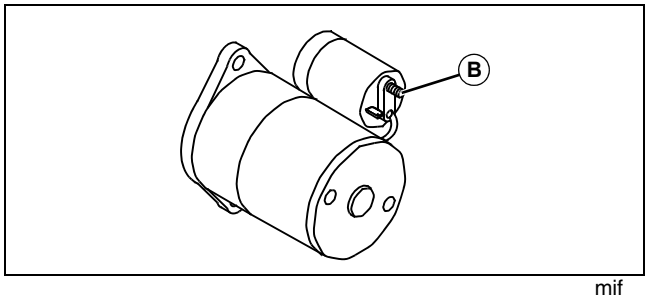


mif

(1) Is 12.4 volts or above present at battery positive terminal (A)?

Yes - Go to next step.

No - Test battery. See “Battery Load Test” on page 336.



mif

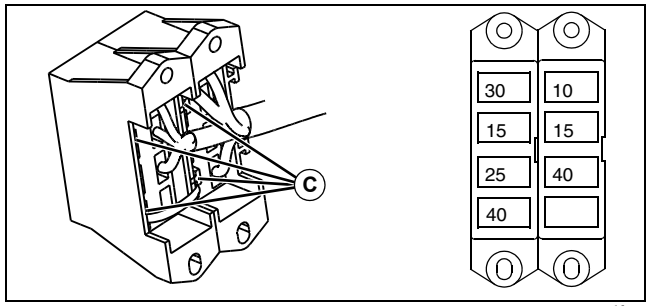
(2) Is battery voltage present at battery terminal of starter solenoid (B)?

System: Battery Circuit

Yes - Go to next step.

No - Check 209 Red cable and connections.

System: Unswitched Circuit Wiring

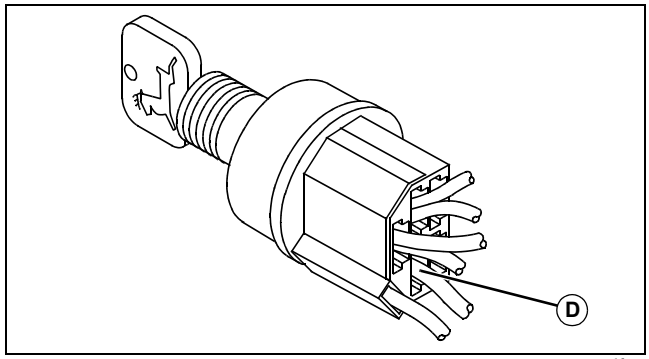


mif

(1) Is battery voltage present at both sides of all fuses (F1 - F7) (C)?

Yes - Go to next step.

No - Check 201 Red wire, 202 Red wire (behind fuse blocks), and all fuses.

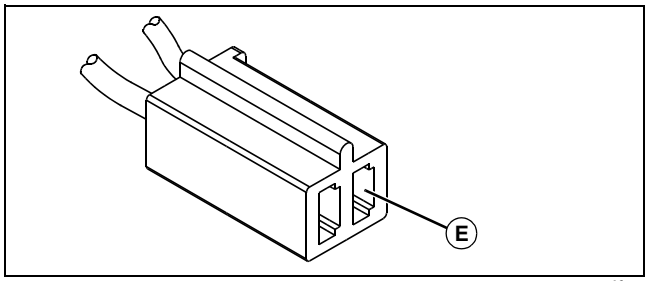


mif

(2) Is battery voltage present at the B terminal of switch connector, 208 Red wire (D)?

Yes - Connect switch. Go to next step.

No - Test F6 fuse. Test battery and positive (+) battery cable. Check 201 and 202 Red wires and connections. Check 208 Red wire and connections.

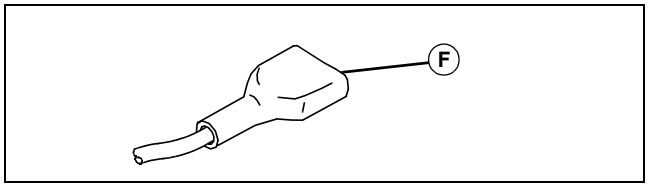


mif

(3) Is battery voltage present at pin A of X14 front optional attachments connector, 203 Red wire (E)?

Yes - Go to next step.

No - Check 203 Red wire.

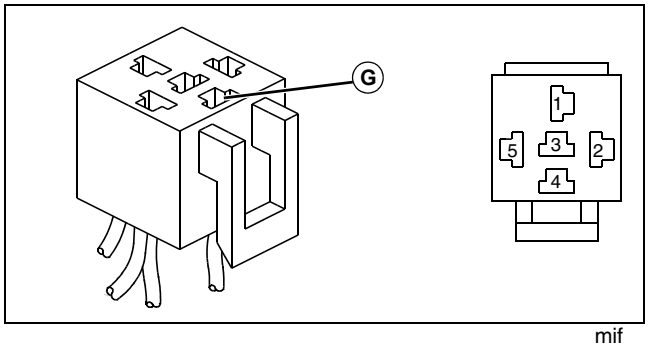


mif

(4) Is battery voltage present at X13 accessory power port, 207 Red wire (F)?

Yes - Go to next step.

No - Check 207 Red wire.

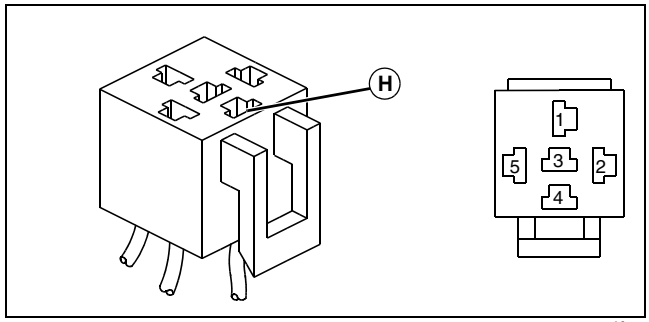


mif

(5) Remove K1 start relay. Is battery voltage present at terminal 4 (87) of relay connector, 216 Red wire (G)?

Yes - Install relay Go to next step.

No - Check 216 Red wire.

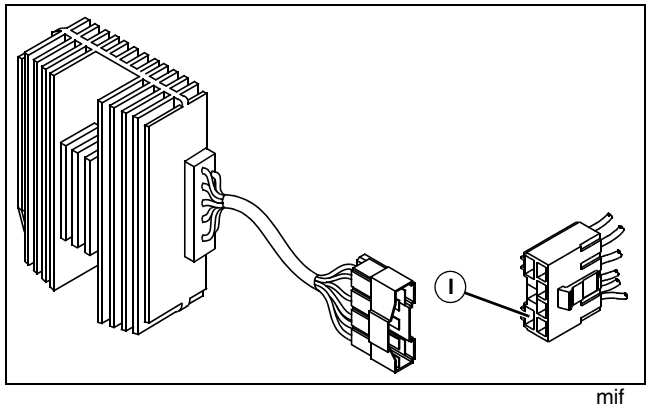


mif

(6) Remove K2 fan relay. Is battery voltage present at terminal 4 (87) of relay connector, 217 Red wire (H)?

Yes - Install relay. Go to next step.

No - Check 217 Red wire.

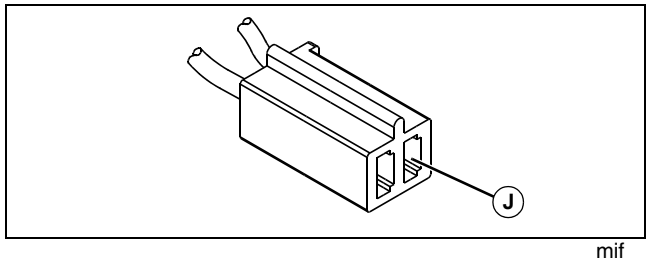


mif

(7) Disconnect N1 voltage regulator/rectifier. Is battery voltage present at pin E of X3 connector, 205 Red wire (I)?

Yes - Connect regulator/rectifier. Go to next step.

No - Check 205 Red wire.



mif

(8) Is battery voltage present at pin A of X17 rear optional attachments connector, 204 Red wire (J)?

Yes - Test complete or go to switched power circuit tests.

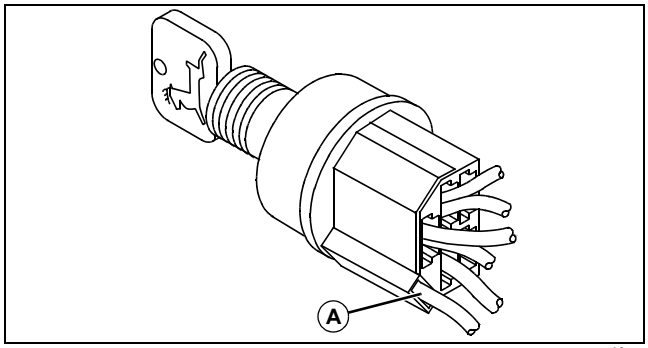
No - Check 204 Red wire.

Test Procedure B

Test Conditions:

- Unswitched power circuits OK.
- Machine parked safely. See “Parking Safely” in the Safety section.
- Key switch in run position with engine not running.
- Negative (Blk) lead of voltmeter placed on battery negative (-) terminal or suitable frame ground.
- Voltmeter positive (Red) placed on designated test point.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.

System: Switched Circuit Wiring

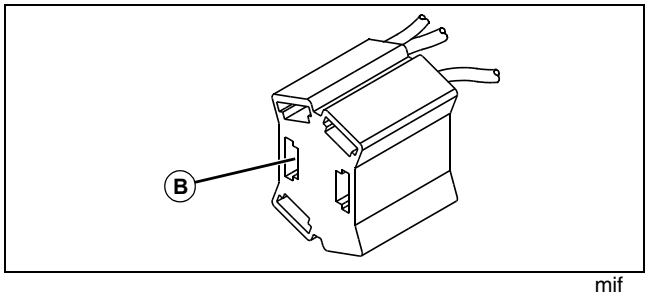


mif

(1) Is battery voltage present at pin A of S1 key switch, 420J Yel wire (A)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341.



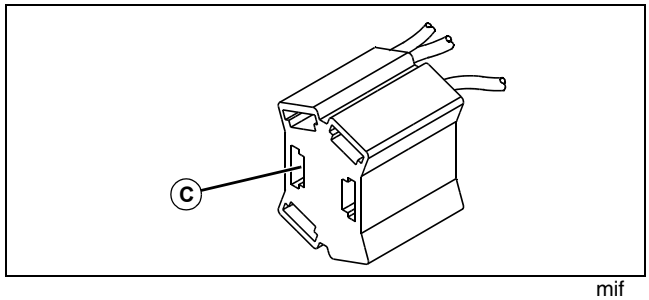
mif

(2) Disconnect S4 light switch. Is battery voltage present at pin 2 of switch connector, 420G Yel wire (B)?

Yes - Connect switch. Go to next step.

System: Switched Circuit Wiring

No - Check 420J and 420G Yel wires, and connections.

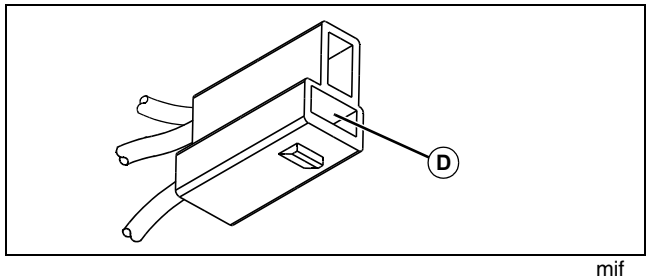


mif

(3) Disconnect S5 cargo box lift switch. Is battery voltage present at pin 2 of switch connector, 420H Yel wire (C)?

Yes - Connect switch. Go to next step.

No - Check 420J and 420H Yel wires, and connections.

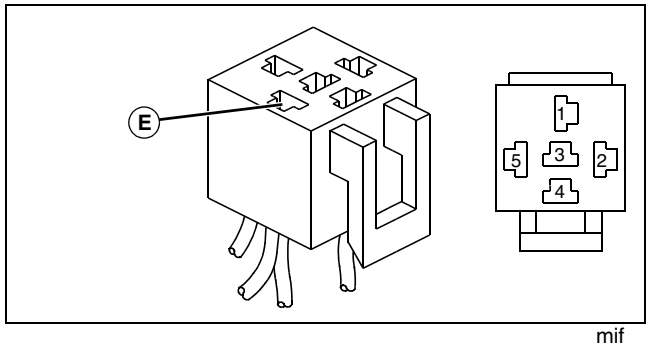


mif

(4) Is battery voltage present at pin A of X7 front optional attachments connector, 420L Yel wire (D)?

Yes - Go to next step.

No - Check 420J and 420L Yel wires, and connections.

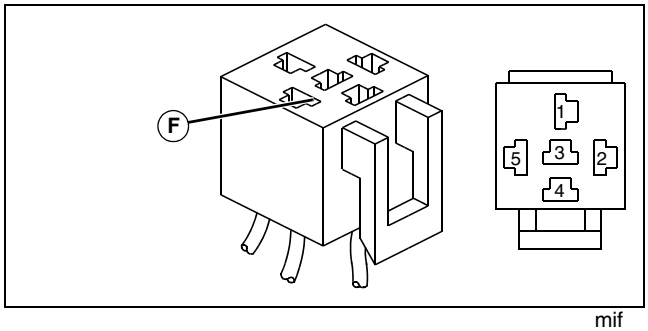


mif

(5) Remove relay. Is battery voltage present at terminal 5 (86) of K1 start relay connector, 420D Yel wire (E)?

Yes - Install relay. Go to next step.

No - Check 420D Yel wire.

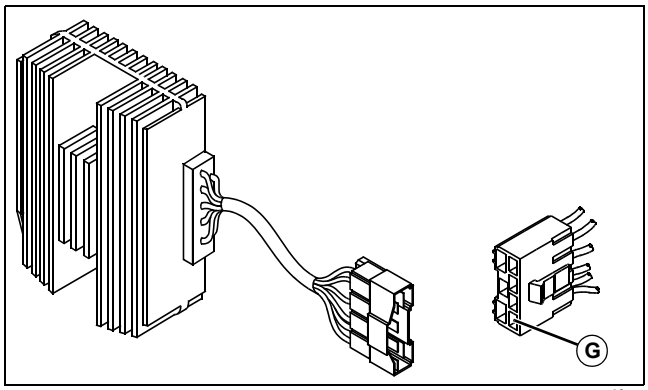


mif

(6) Remove relay. Is battery voltage present at terminal 5 (86) of K2 fan relay connector, 420E Yel wire (F)?

Yes - Install relay. Go to next step.

No - Check 420E Yel wire.

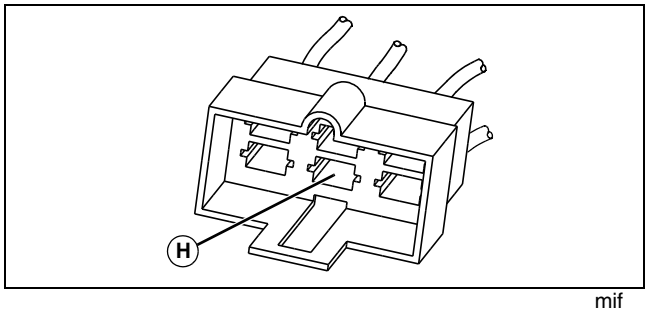


mif

(7) Disconnect N1 voltage regulator/rectifier. Is battery voltage present at pin D of X3 connector, 420C Yel wire (G)?

Yes - Connect regulator/rectifier. Go to next step.

No - Check 420C Yel wire.



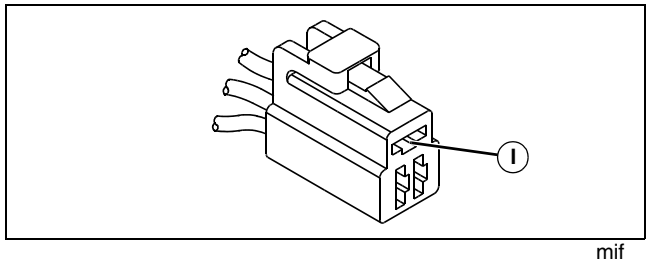
mif

(8) Disconnect engine connector. Is battery voltage present at pin E of X1 engine connector, 420B Yel wire (H)?

Yes - Connect engine wiring harness. Go to next step.

System: Switched Circuit Wiring

No - Check 420B Yel wire.



mif

(9) Disconnect fuel pump connector. Is battery voltage present at pin A of Y2 fuel pump connector, 420A Yel wire (I)?

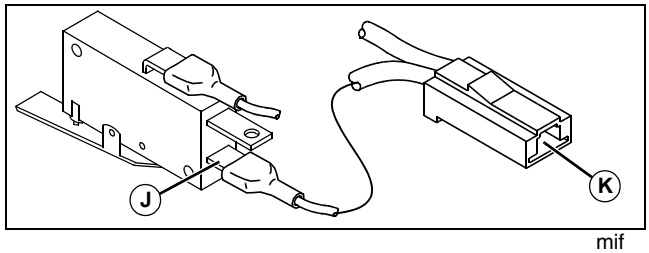
Yes - Connect fuel pump. Go to next step.

No - Check 420A Yel wire.

(10) Is park brake light illuminated?

Yes - Go to step (12).

No - Go to next step.

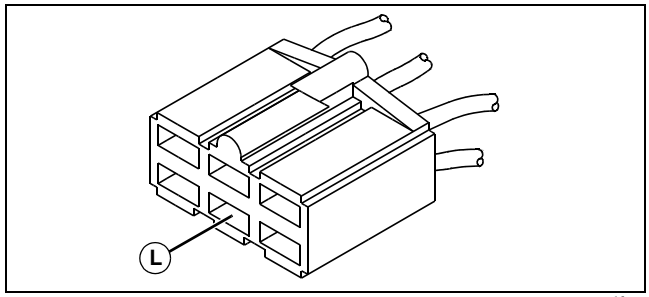


mif

(11) Is battery voltage present at S3 park brake switch, 420P Yel wire (J)?

Yes - Go to next step. Test park brake switch.

No - Check 420P and 420F Yel (K) wires.



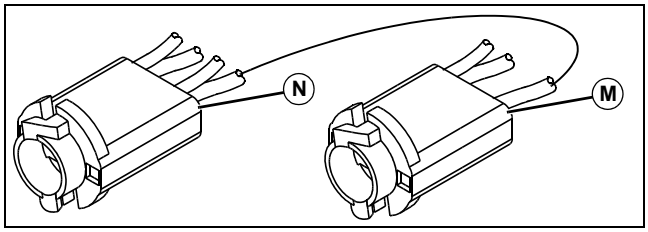
mif

(12) Is battery voltage present at pin E of X15 front lights connector, 420K Yel wire (L)?

Yes - Go to next step.

No - Check 420K Yel wire.

System: Switched Circuit Wiring



mif

(13) Is battery voltage present at H2 engine coolant temperature light socket, 419 Yel wire (M)? Is H3 engine oil pressure light illuminated?

Yes - Go to next step.

No - Check 419 and 420M (N) Yel wires.

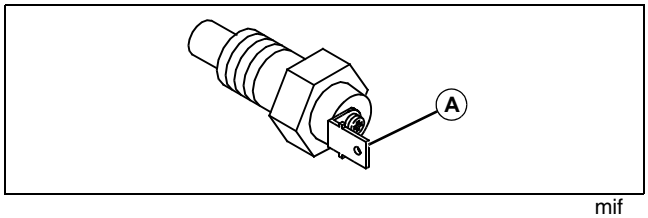
No - Check 419 and 420M (N) Yel wires. Test H3 engine oil pressure bulb.

Test Procedure C

Test Conditions:

- Unswitched power circuits OK.
- Machine parked safely. See “Parking Safely” in the Safety section.
- Key switch in run position with engine not running.
- Negative (Blk) lead of voltmeter placed on battery negative (-) terminal or suitable frame ground.
- Voltmeter positive (Red) placed on designated test point.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.

System: Static Switched Circuit Wiring



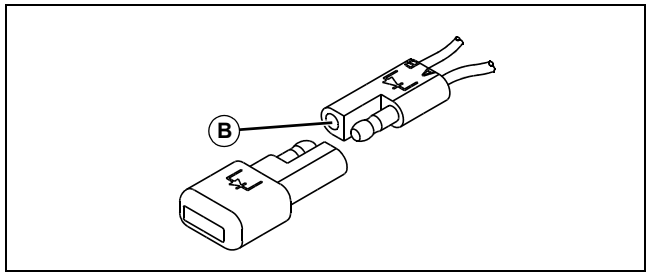
mif

(1) Is battery voltage present at B3 engine coolant temperature switch, Yel wire (A)?

Yes - Go to next step.

No - Test H2 engine coolant temperature bulb. Check 300 org wire and Yel engine wire and connections.

System: Static Switched Circuit Wiring

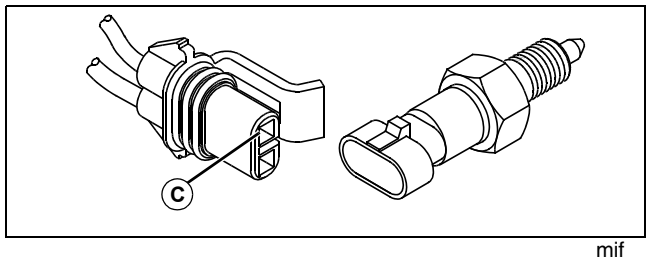


mif

(2) Disconnect V1 diode. Is battery voltage present at V1 diode 301 Org wire (B)?

Yes - Install diode. Go to next step.

No - Test H2 engine coolant temperature bulb. Check 301 org wire and connections.

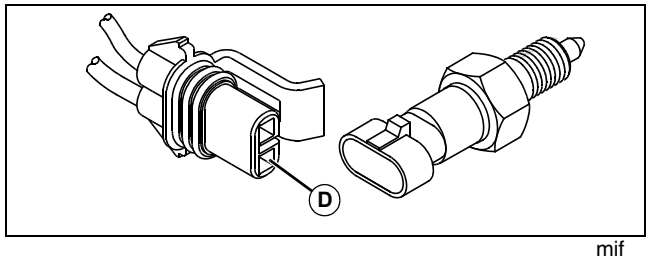


mif

(3) Disconnect S2 neutral start switch connector. Is battery voltage present at pin A of S2 neutral start switch, 705 Pur wire (C)?

Yes - Go to next step.

No - Test V1 diode. Check 302 Org and 705 Pur wires and connections.



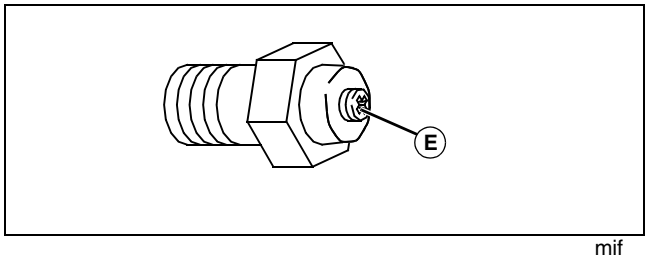
mif

(4) Disconnect S2 neutral start switch connector. Is battery voltage present at pin B of S2 neutral start switch, 710 Pur wire (D)?

Yes - Connect switch. Go to next step.

No - Test K1 start relay. Check 710 Pur wire and connections.

System: Static Switched Circuit Wiring

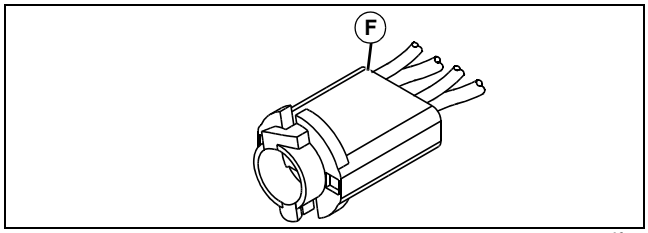


mif

(5) Is continuity to ground present at B4 engine oil pressure switch, Blu/Red wire (E)?

Yes - Go to next step.

No - Test B4 engine oil pressure switch. Check engine ground wire and connections.



mif

(6) Is continuity to ground present at B3 engine oil pressure light, 601 Tan wire (F)?

Yes - Test complete.

No - Check 601 Tan and engine Blu/Red wires and connections. Test complete.

Power Circuit Operation (Gas Engine) (SN 40001 -)

Function:

Provides unswitched and switched power to the primary components whenever the battery is connected and the key switch is in the run position.

Operating Conditions Unswitched Circuits:

- Battery fully charged and properly connected to the wiring harness.
- Ground circuit properly connected to the wiring harness.

Battery voltage must be present at the following components with the key switch “OFF”:

- Battery Positive Terminal
- Y1 Starting Motor Solenoid “B” Terminal 209 Red wire
- K1 Start Relay 216 Red wire
- K2 Fan Relay 217 Red wire
- N1 Voltage Regulator/Rectifier “E” terminal 205 Red wire
- X17 Rear Optional Attachments Connector “A” terminal 204 Red wire
- X13 Accessory Power Port Connector “A” terminal 207 Red wire
- S1 Key Switch “B” terminal 208 Red wire
- X14 Front Optional Attachments Connector “A” terminal 203 Red wire

Unswitched Circuit Operation:

The positive battery cable connects the battery to the Y1 starting motor solenoid. Power is also directly run from the battery positive terminal to two fuse blocks. These fuse blocks distribute power to all unswitched circuits, with the exception of the Y1 starting motor solenoid. The individual fuses in the blocks protect the components and wiring from damage by preventing a high current circuit overload.

The battery cable and fuse block connections must be in good condition for the machine’s electrical system to work properly.

The ground cable and connections are equally important. Proper operation depends on these cables and connections to carry the power necessary for operation.

Operating Conditions Switched Circuits:

- Unswitched circuits functioning properly.
- Key switch in the RUN position.

Battery voltage must be present at the following locations:

- Y2 Fuel Pump 420A Yel wire
- X1 Engine Connector “E” terminal 420B Yel wire:
  - R1 Carburetor Heater
  - Y3 Fuel Shutoff Solenoid
  - X6 Connector of A1 Ignitor Module
- N1 Voltage Regulator 420C Yel wire
- K1 Start Relay 420D Yel wire
- K2 Fan Relay 420E Yel wire
- X8 Mid Optional Attachments Connector 420F Yel wire
- S4 Light Switch 420G Yel wire
- S5 Cargo Box Control Switch (option) 420H Yel wire
- X15 Front Lights Connector “E” terminal 420K Yel wire
- X7 Front Optional Attachments Connector “A” terminal 420L Yel wire
- H3 Engine Oil Pressure Light 420M Yel wire
- S3 Park Brake Switch 420P Yel wire
- K3 4WD Interlock Relay 420Q Yel wire
- K3 4WD Interlock Relay 420X Yel wire
- H2 Engine Coolant Temperature Light 419 Yel wire

Switched Circuit Operation:

Power supplied by the battery, through a fuse block is supplied to the S1 key switch. When the key switch is in the ON position, power is routed (420J Yel wire) to a central splice. This splice distributes power to the switched components through individual circuits and grounds.

Static Switched Circuits:

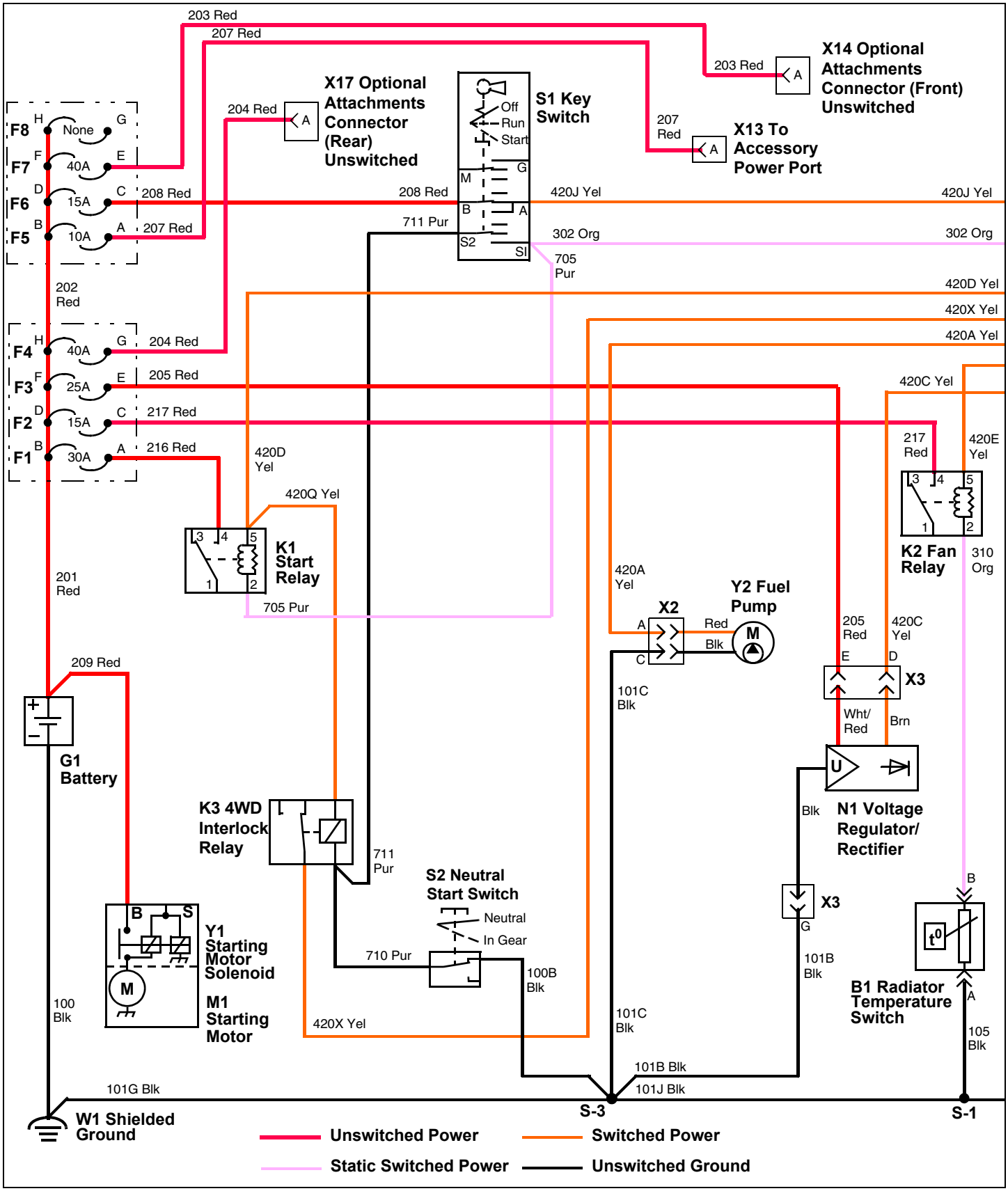
- Switched circuits functioning properly.

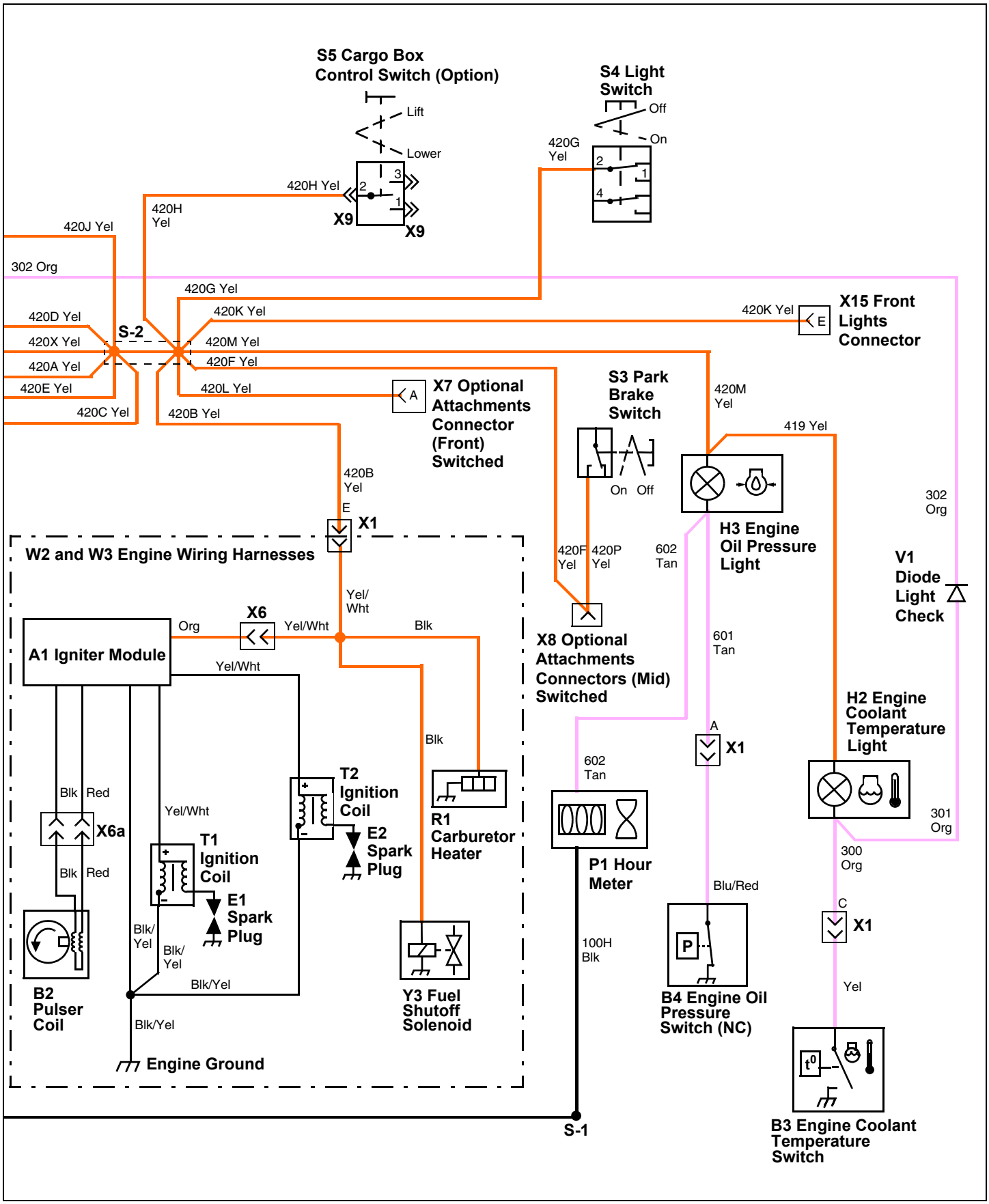
As a result of the key switch being placed in the run position, battery voltage passes through several components and is switched on the ground side to activate the component. These wires will have battery voltage present when not being used and will become a ground circuit when the function is activated.

Battery voltage must be present at the following locations:

- B1 Radiator Temperature Switch 310 Org wire
- B3 Engine Coolant Temperature Switch 300 Org wire
- V1 Light Check Diode 301 and 302 Org wires
- S1 Key Switch “S1” terminal 302 Org and 705 Pur wires
- K1 Start Relay 705 Pur wire
- B4 Engine Oil Pressure Switch 601 Tan wire when engine oil pressure is within operating range.
- P1 Hour Meter 602 Tan wire when engine oil pressure is within operating range.

Power Circuit Schematic (Gas Engine) (SN 40001 -)




S5 Cargo Box Control Switch (Option)
Lift
Lower
420H Yel
420H Yel
X9
X9
S4 Light Switch
Off
On
420G Yel
420J Yel
302 Org
420G Yel
420K Yel
420K Yel
X15 Front Lights Connector
420D Yel
420X Yel
420A Yel
420E Yel
420C Yel
S-2
420M Yel
420F Yel
420L Yel
420B Yel
X7 Optional Attachments Connector (Front) Switched
S3 Park Brake Switch
On Off
420M Yel
419 Yel
420B Yel
X1
H3 Engine Oil Pressure Light
302 Org
V1 Diode Light Check
W2 and W3 Engine Wiring Harnesses
420F Yel
420P Yel
602 Tan
X8 Optional Attachments Connectors (Mid) Switched
Yel/Wht
A1 Igniter Module
Org
X6
Yel/Wht
Blk
601 Tan
Yel/Wht
Blk
602 Tan
A
X1
H2 Engine Coolant Temperature Light
T2 Ignition Coil
R1 Carburetor Heater
Blk Red
X6a
Yel/Wht
E2 Spark Plug
P1 Hour Meter
301 Org
Blk Red
T1 Ignition Coil
E1 Spark Plug
300 Org
Blu/Red
C
X1
Blk/Yel
Blk/Yel
100H Blk
P
B4 Engine Oil Pressure Switch (NC)
Yel
B2 Pulser Coil
Blk/Yel
Y3 Fuel Shutoff Solenoid
Blk/Yel
Engine Ground
S-1
B3 Engine Coolant Temperature Switch

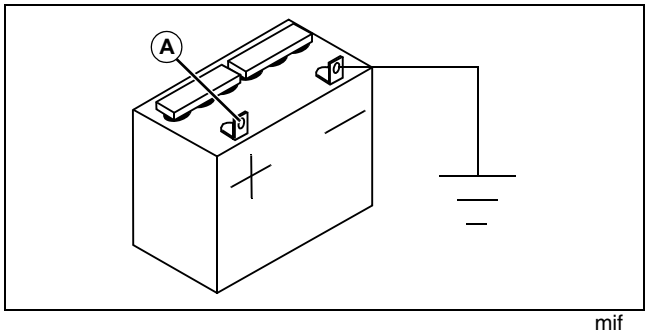
Power Circuit Diagnosis (Gas Engine) (SN 40001 -)

Test Procedure A

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Key switch in the off position.
- Cargo box raised and locked.
- Battery fully charged.
- Negative (Blk) lead of voltmeter placed on battery negative (-) terminal or suitable frame ground.
- Voltmeter positive (Red) placed on designated test point.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.

System: Battery Circuit

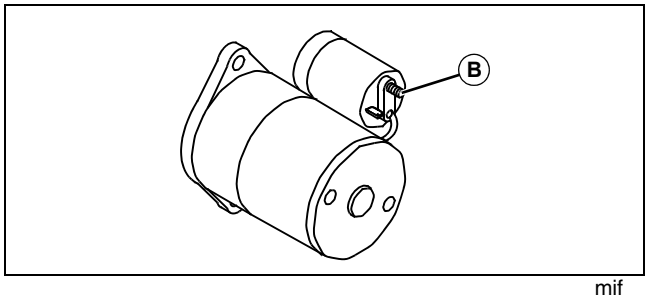


mif

(1) Is 12.4 volts or above present at battery positive terminal (A)?

Yes - Go to next step.

No - Test battery. See “Battery Load Test” on page 336.



mif

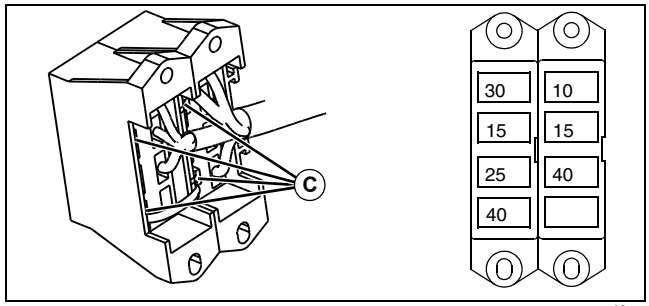
(2) Is battery voltage present at battery terminal of starter solenoid (B)?

System: Battery Circuit

Yes - Go to next step.

No - Check 209 Red cable and connections.

System: Unswitched Circuit Wiring

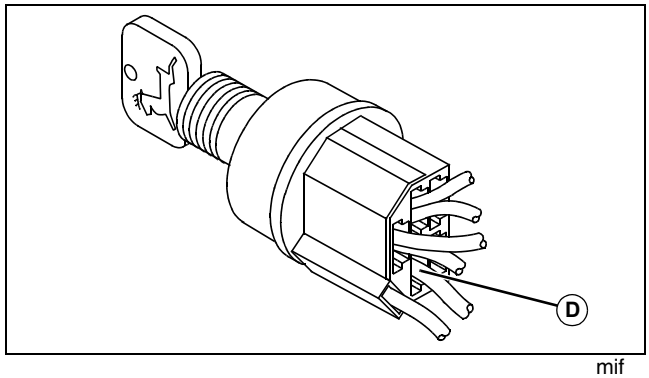


mif

(1) Is battery voltage present at both sides of all fuses (F1 - F7) (C)?

Yes - Go to next step.

No - Check 201 Red wire, 202 Red wire (behind fuse blocks), and all fuses.



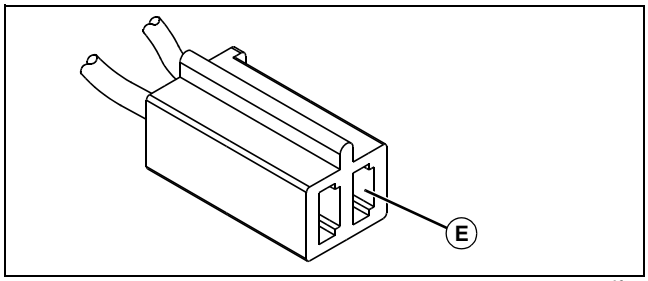
mif

(2) Is battery voltage present at the B terminal of switch connector, 208 Red wire (D)?

Yes - Connect switch. Go to next step.

No - Test F6 fuse. Test battery and positive (+) battery cable. Check 201 and 202 Red wires and connections. Check 208 Red wire and connections.

System: Unswitched Circuit Wiring

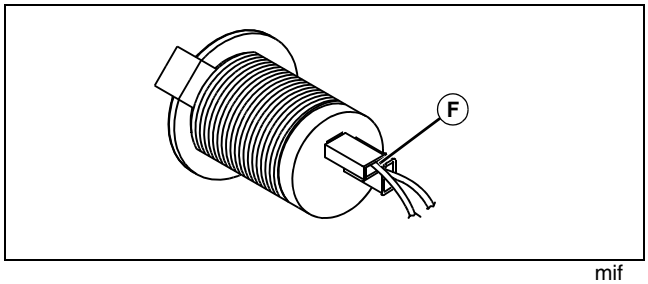


mif

(3) Is battery voltage present at pin A of X14 front optional attachments connector, 203 Red wire (E)?

Yes - Go to next step.

No - Check 203 Red wire.

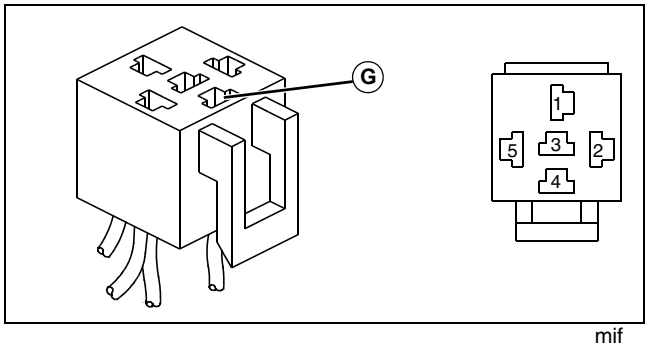


mif

(4) Is battery voltage present at X13 accessory power port, 207 Red wire (F)?

Yes - Go to next step.

No - Check 207 Red wire.



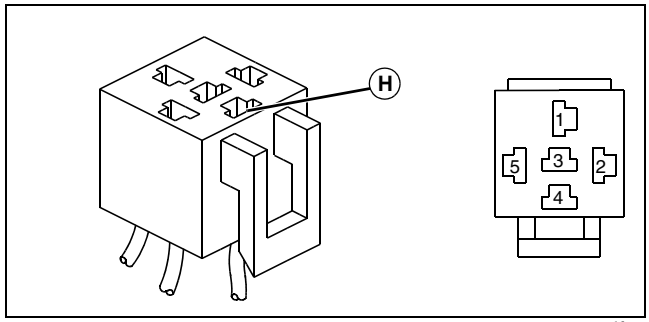
mif

(5) Remove K1 start relay. Is battery voltage present at terminal 4 (87) of relay connector, 216 Red wire (G)?

Yes - Install relay Go to next step.

No - Check 216 Red wire.

System: Unswitched Circuit Wiring

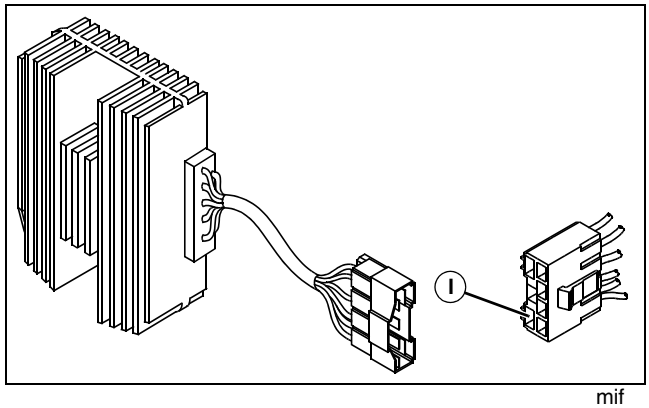


mif

(6) Remove K2 fan relay. Is battery voltage present at terminal 4 (87) of relay connector, 217 Red wire (H)?

Yes - Install relay. Go to next step.

No - Check 217 Red wire.

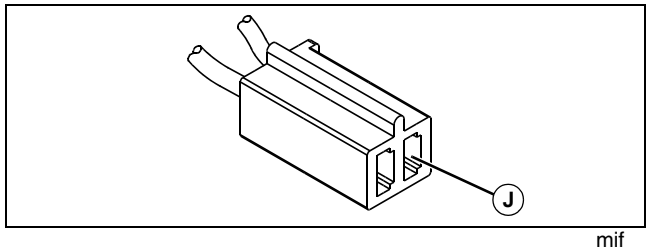


mif

(7) Disconnect N1 voltage regulator/rectifier. Is battery voltage present at pin E of X3 connector, 205 Red wire (I)?

Yes - Connect regulator/rectifier. Go to next step.

No - Check 205 Red wire.



mif

(8) Is battery voltage present at pin A of X17 rear optional attachments connector, 204 Red wire (J)?

Yes - Test complete or go to switched power circuit tests.

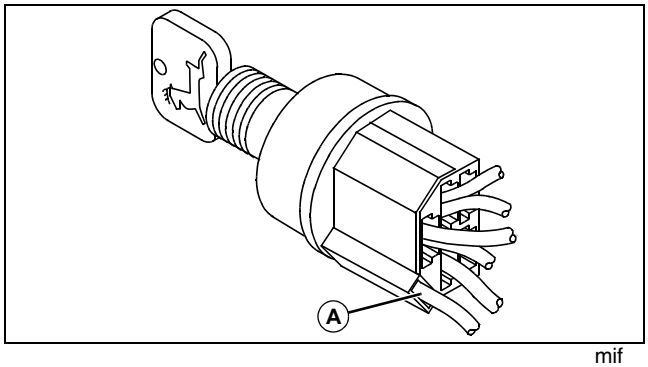
No - Check 204 Red wire.

Test Procedure B

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Unswitched power circuits OK.
- Key switch in run position with engine not running.
- Negative (Blk) lead of voltmeter placed on battery negative (-) terminal or suitable frame ground.
- Voltmeter positive (Red) placed on designated test point.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.

System: Switched Circuit Wiring

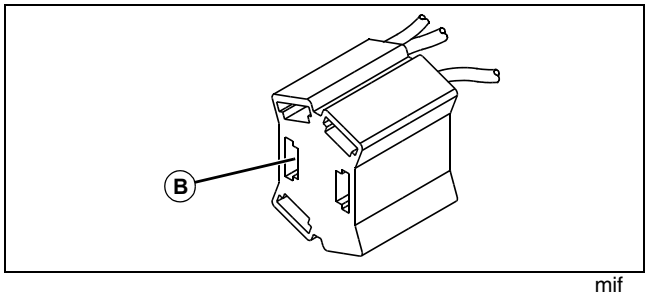


mif

(1) Is battery voltage present at pin A of S1 key switch, 420J Yel wire (A)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341.



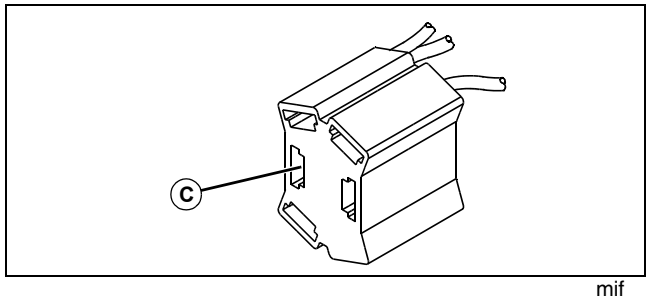
mif

(2) Disconnect S4 light switch. Is battery voltage present at pin 2 of switch connector, 420G Yel wire (B)?

Yes - Connect switch. Go to next step.

System: Switched Circuit Wiring

No - Check 420J and 420G Yel wires, and connections.

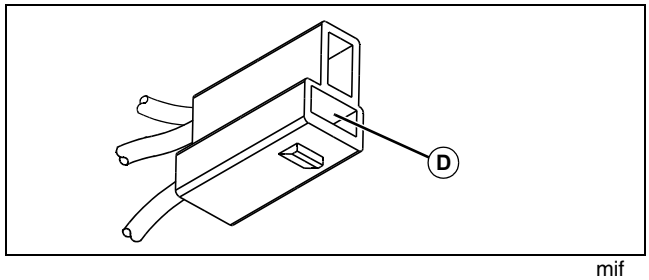


mif

(3) Disconnect S5 cargo box lift switch. Is battery voltage present at pin 2 of switch connector, 420H Yel wire (C)?

Yes - Connect switch. Go to next step.

No - Check 420J and 420H Yel wires, and connections.

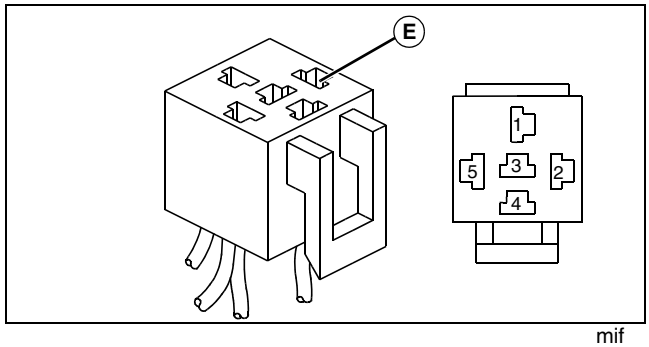


mif

(4) Is battery voltage present at pin A of X7 front optional attachments connector, 420L Yel wire (D)?

Yes - Go to next step.

No - Check 420J and 420L Yel wires, and connections.

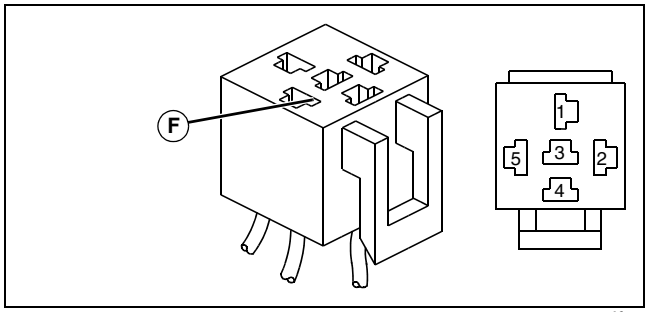


mif

(5) Remove relay. Is battery voltage present at terminal 2 (85) of K1 start relay connector, 420D Yel wire (E)?

Yes - Install relay. Go to next step.

No - Check 420D Yel wire.

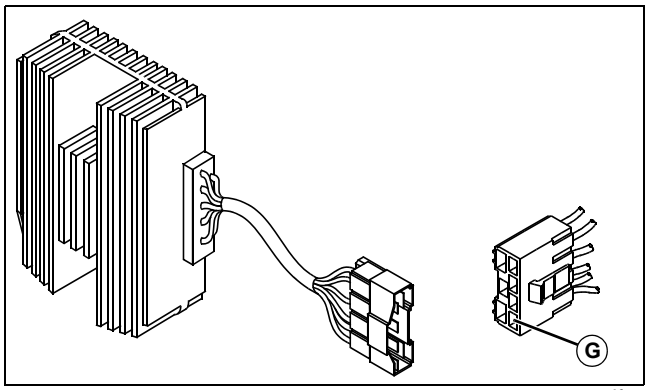


mif

(6) Remove relay. Is battery voltage present at terminal 5 (86) of K2 fan relay connector, 420E Yel wire (F)?

Yes - Install relay. Go to next step.

No - Check 420E Yel wire.

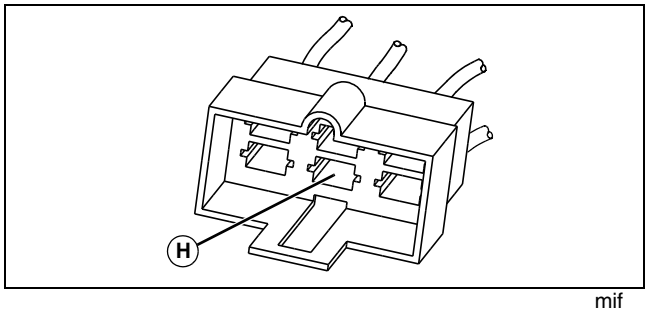


mif

(7) Disconnect N1 voltage regulator/rectifier. Is battery voltage present at pin D of X3 connector, 420C Yel wire (G)?

Yes - Connect regulator/rectifier. Go to next step.

No - Check 420C Yel wire.



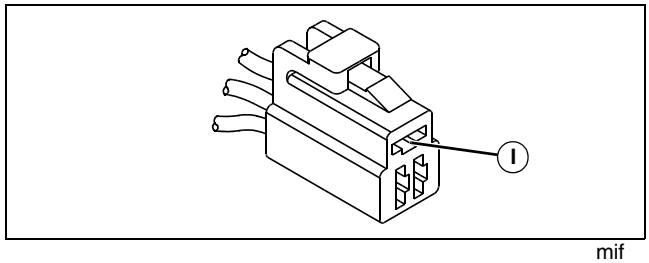
mif

(8) Disconnect engine connector. Is battery voltage present at pin E of X1 engine connector, 420B Yel wire (H)?

Yes - Connect engine wiring harness. Go to next step.

System: Switched Circuit Wiring

No - Check 420B Yel wire.



mif

(9) Disconnect fuel pump connector. Is battery voltage present at pin A of Y2 fuel pump connector, 420A Yel wire (I)?

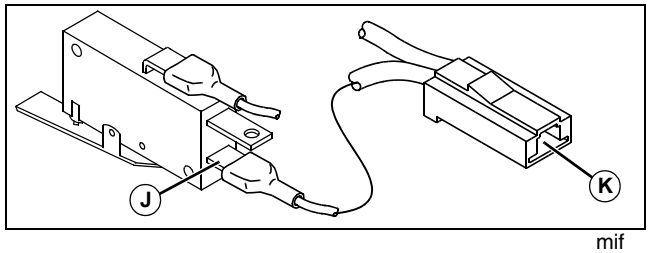
Yes - Connect fuel pump. Go to next step.

No - Check 420A Yel wire.

(10) Is park brake light illuminated?

Yes - Go to step (12).

No - Go to next step.

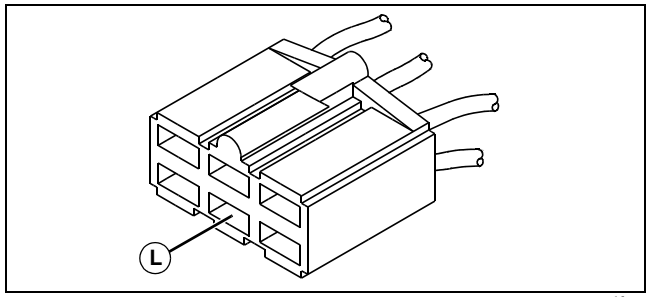


mif

(11) Is battery voltage present at S3 park brake switch, 420P Yel wire (J)?

Yes - Go to next step. Test park brake switch.

No - Check 420P and 420F Yel (K) wires.



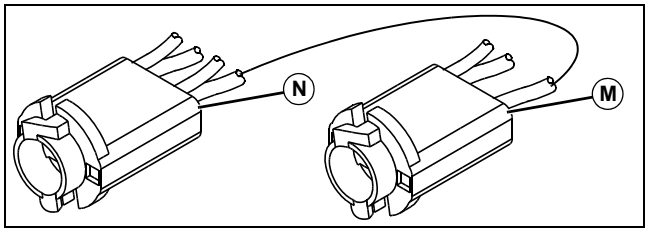
mif

(12) Is battery voltage present at pin E of X15 front lights connector, 420K Yel wire (L)?

Yes - Go to next step.

No - Check 420K Yel wire.

System: Switched Circuit Wiring



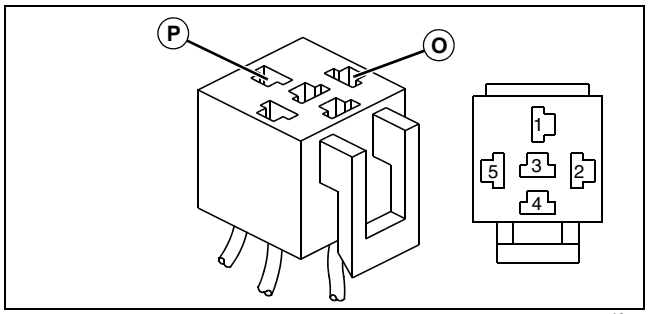
mif

(13) Is battery voltage present at H2 engine coolant temperature light socket, 419 Yel wire (M)? Is H3 engine oil pressure light illuminated?

Yes - Go to next step.

No - Check 419 and 420M (N) Yel wires.

No - Check 419 and 420M (N) Yel wires. Test H3 engine oil pressure bulb.



mif

(14) Remove relay. Is battery voltage present at terminal 2 (85) of K3 4WD interlock relay connector, 420Q Yel wire (O)?

Yes - Go to next step.

No - Check 420Q and 420D Yel wires.

(15) Is battery voltage present at terminal 1 (30) of K3 4WD interlock relay connector, 420X Yel wire (P)?

Yes - Install relay. Test complete.

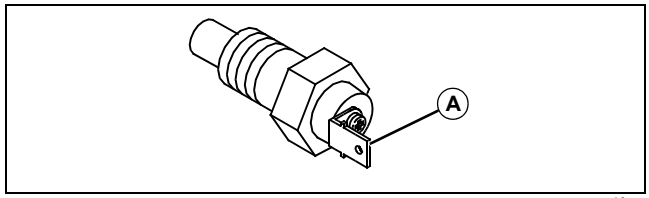
No - Check 420X Yel wire.

Test Procedure C

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Unswitched power circuits OK.
- Switched power circuits OK.
- Key switch in run position with engine not running.
- Negative (Blk) lead of voltmeter placed on battery negative (-) terminal or suitable frame ground.
- Voltmeter positive (Red) placed on designated test point.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.

System: Static Switched Circuit Wiring

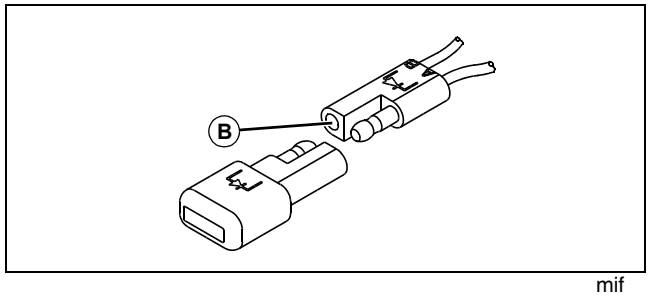


mif

(1) Is battery voltage present at B3 engine coolant temperature switch, Yel wire (A)?

Yes - Go to next step.

No - Test H2 engine coolant temperature bulb. Check 300 org wire and Yel engine wire and connections.



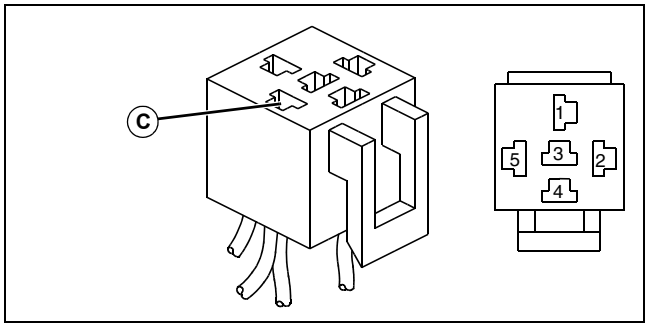
mif

(2) Disconnect V1 diode. Is battery voltage present at V1 diode 301 Org wire (B)?

Yes - Install diode. Go to next step.

No - Test H2 engine coolant temperature bulb. Check 301 org wire and connections.

System: Static Switched Circuit Wiring

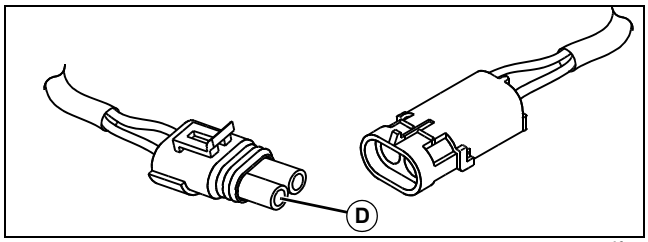


mif

(3) Remove relay. Is battery voltage present at terminal 5 (86) of K1 start relay connector, 705 Pur wire (C)?

Yes - Install relay. Go to next step.

No - Test V1 diode. Check 302 Org and 705 Pur wires.

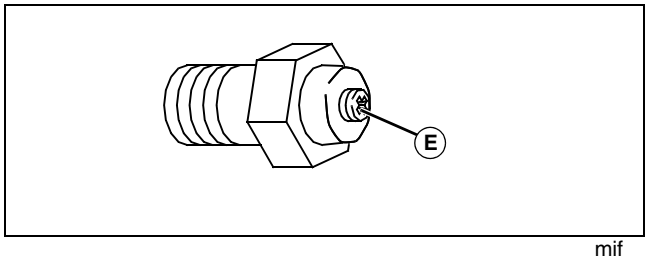


mif

(4) Disconnect B1 radiator temperature switch connector. Is battery voltage present at pin B of main wire harness, 310 Org wire (D)?

Yes - Connect switch. Go to next step.

No - Test K2 fan relay. Check 310 Org wire and connections.



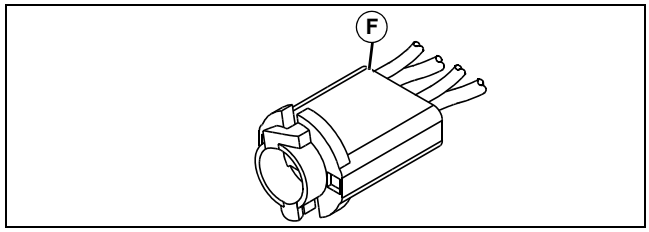
mif

(5) Is continuity to ground present at B4 engine oil pressure switch, Blu/Red wire (E)?

Yes - Go to next step.

No - Test B4 engine oil pressure switch. Check engine ground wire and connections.

System: Static Switched Circuit Wiring



mif

(6) Is continuity to ground present at B3 engine oil pressure light, 601 Tan wire (F)?

Yes - Test complete.

No - Check 601 Tan and engine Blu/Red wires and connections. Test complete.

Power Circuit Operation (Diesel Engine) (SN -40000)

Function:

Provides unswitched and switched power to the primary components whenever the battery is connected and the key switch is in the run position.

Operating Conditions Unswitched Circuits:

- Battery fully charged and properly connected to the wiring harness.
- Ground circuit properly connected to the wiring harness.

Battery voltage must be present at the following components with the key switch “OFF”:

- Battery Positive Terminal
- Y1 Starting Motor Solenoid “B” Terminal 209 Red wire
- K1 Start Relay 216 Red wire
- K2 Fan Relay 217 Red wire
- G2 Alternator positive 200 Red wire
- X17 Rear Optional Attachments Connector “A” terminal 204 Red wire
- X13 Accessory Power Port Connector “A” terminal 207 Red wire
- S1 Key Switch “B” terminal 208 Red wire
- X14 Front Optional Attachments Connector “A” terminal 203 Red wire
- A1 Glow Plug Module 205 Red wire

Unswitched Circuit Operation:

The positive battery cable connects the battery to the Y1 starting motor solenoid. Power is also directly run from the battery positive terminal to two fuse blocks. These fuse blocks distribute power to all unswitched circuits, with the exception of the Y1 starting motor solenoid. The individual fuses in the blocks protect the components and wiring from damage by preventing a high current circuit overload.

The battery cable and fuse block connections must be in good condition for the machine’s electrical system to work properly.

The ground cable and connections are equally important. Proper operation depends on these cables and connections to carry the power necessary for operation.

Operating Conditions Switched Circuits:

- Unswitched circuits functioning properly.
- Key switch in the RUN position.

Battery voltage must be present at the following locations:

- K1 Start Relay 420D Yel wire
- K2 Fan Relay 420E Yel wire
- A1 Glow Plug Module 420N Yel wire
- X15 Front Lights Connector “E” terminal 420K Yel wire
- S4 Light Switch 420G Yel wire
- S5 Cargo Box Control Switch (option) 420H Yel wire
- H3 Engine Oil Pressure Light 420M Yel wire
- H2 Engine Coolant Temperature Light 419 Yel wire
- X8 Mid Optional Attachments Connector 420F Yel wire
- S3 Park Brake Switch 420P Yel wire
- X7 Front Optional Attachments Connector “A” terminal 420L Yel wire
- G2 Alternator 420B Yel wire
- Y3 Fuel Shutoff Solenoid 420A Yel wire

Switched Circuit Operation:

Power supplied by the battery, through a fuse block is supplied to the S1 key switch. When the key switch is in the ON position, power is routed to a central splice. This splice distributes power to the switched components through individual circuits and grounds.

Static Switched Circuits:

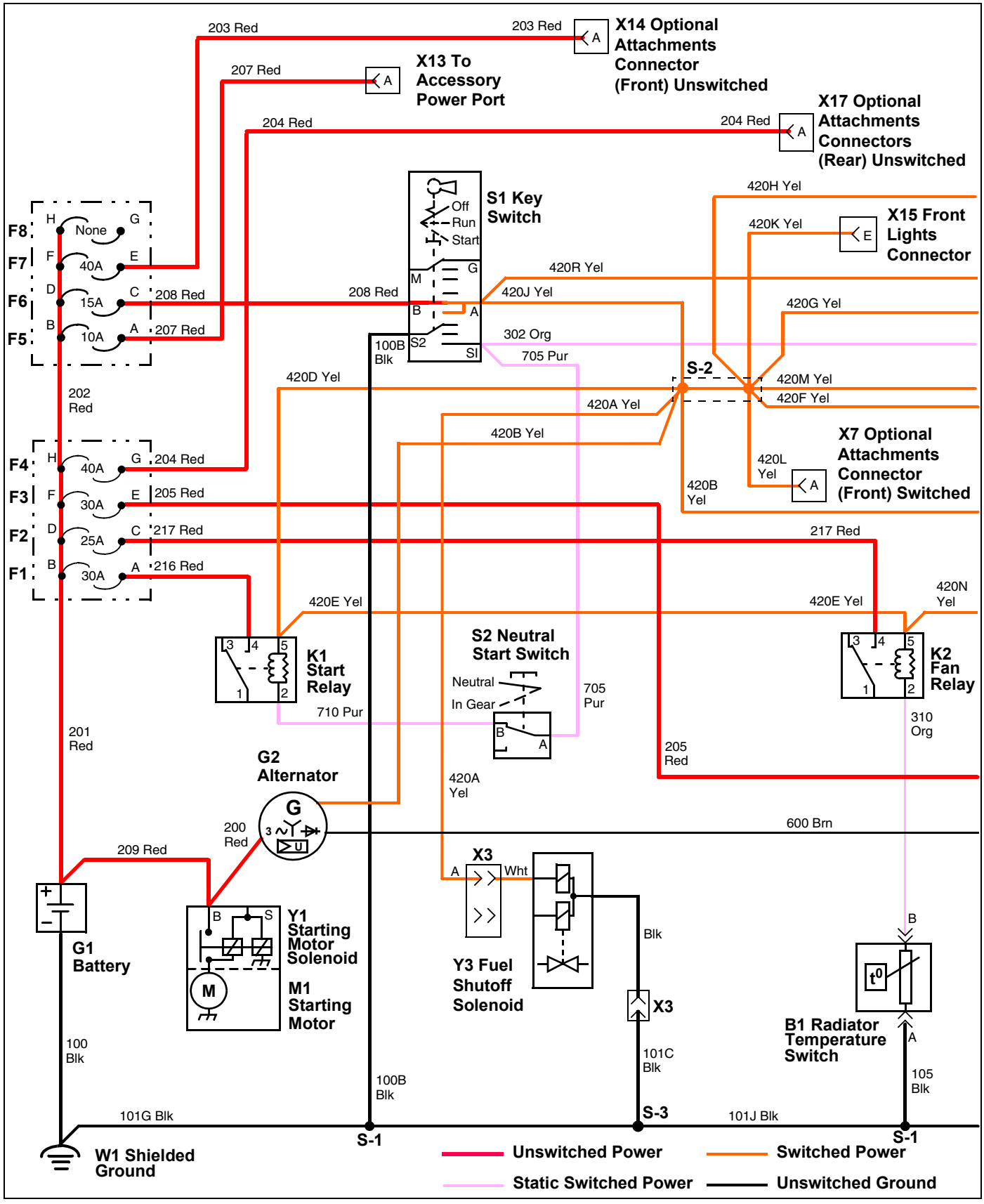
- Switched circuits functioning properly.

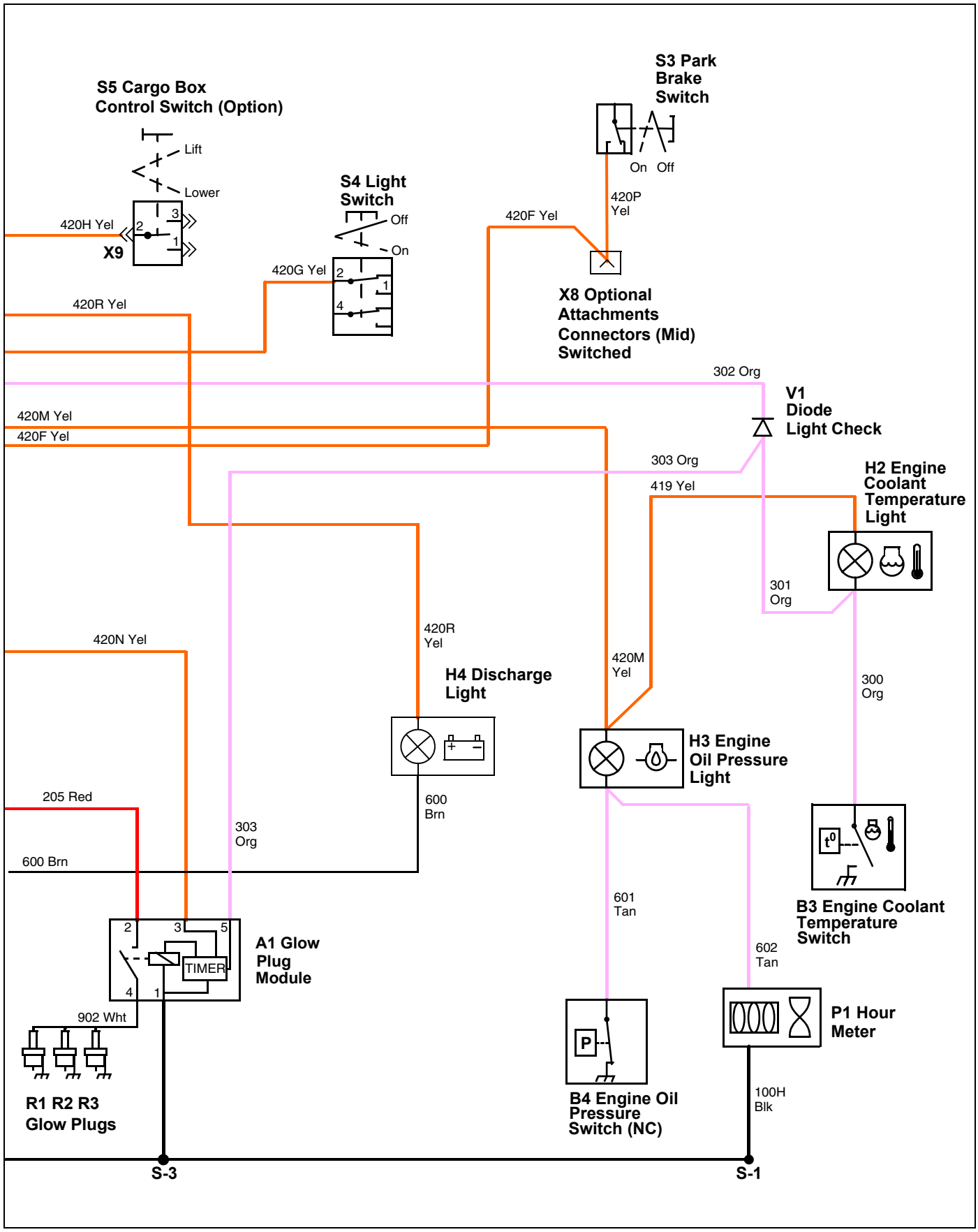
As a result of the key switch being placed in the run position, battery voltage passes through several components and is switched on the ground side to activate the component. These wires will have battery voltage present when not being used and will become a ground circuit when the function is activated.

Battery voltage must be present at the following locations:

- B1 Radiator Temperature Switch 310 Org wire
- B3 Engine Coolant Temperature Switch 300 Org wire
- V1 Light Check Diode 301 and 302 Org wires
- S1 Key Switch “S1” terminal 302 Org and 705 Pur wires
- S2 Neutral Start Switch 705 and 710 Pur wires
- B4 Engine Oil Pressure Switch 601 Tan wire
- P1 Hour Meter 602 Tan wire

Power Circuit Schematic (Diesel Engine) (SN -40000)




S5 Cargo Box Control Switch (Option)
Lift
Lower
420H Yel
X9
S4 Light Switch
Off
On
420G Yel
420R Yel
S3 Park Brake Switch
On Off
420P Yel
420F Yel
X8 Optional Attachments Connectors (Mid) Switched
302 Org
V1 Diode Light Check
420M Yel
420F Yel
303 Org
419 Yel
H2 Engine Coolant Temperature Light
301 Org
420N Yel
420R Yel
H4 Discharge Light
420M Yel
300 Org
H3 Engine Oil Pressure Light
205 Red
600 Brn
303 Org
600 Brn
601 Tan
B3 Engine Coolant Temperature Switch
602 Tan
A1 Glow Plug Module
TIMER
902 Wht
P1 Hour Meter
R1 R2 R3 Glow Plugs
B4 Engine Oil Pressure Switch (NC)
100H Blk
S-3
S-1

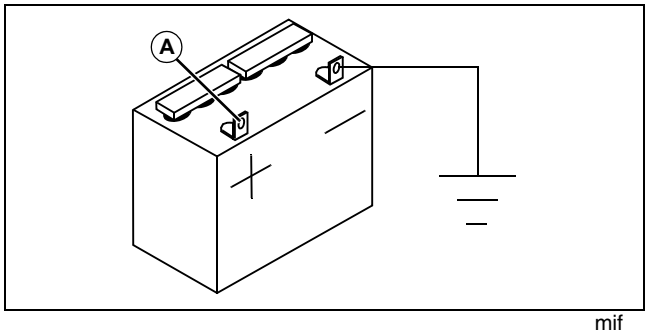
Power Circuit Diagnosis (Diesel Engine) (SN -40000)

Test Procedure A

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Key switch in the off position.
- Cargo box raised and locked.
- Battery fully charged.
- Negative (Blk) lead of voltmeter placed on battery negative (-) terminal or suitable frame ground.
- Voltmeter positive (Red) placed on designated test point.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.

System: Battery Circuit

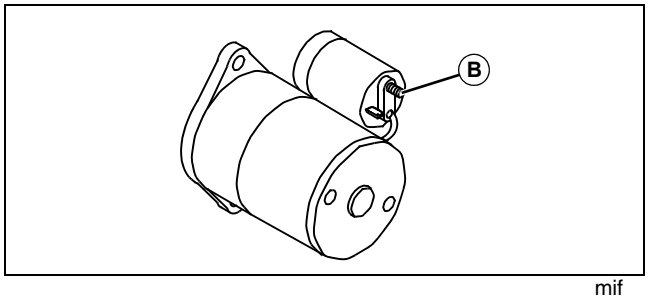


mif

(1) Is 12.4 volts or above present at battery positive terminal (A)?

Yes - Go to next step.

No - Test battery. See “Battery Load Test” on page 336.



mif

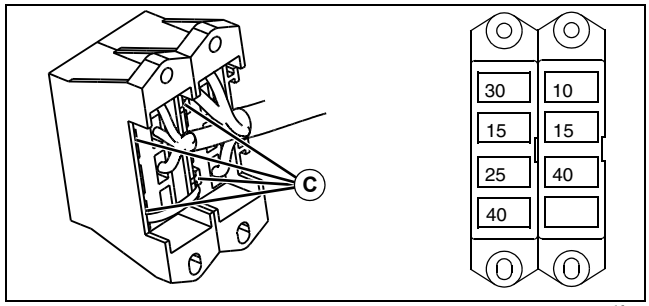
(2) Is battery voltage present at battery terminal of starter solenoid (B)?

System: Battery Circuit

Yes - Go to next step.

No - Check 209 Red cable and connections.

System: Unswitched Circuit Wiring

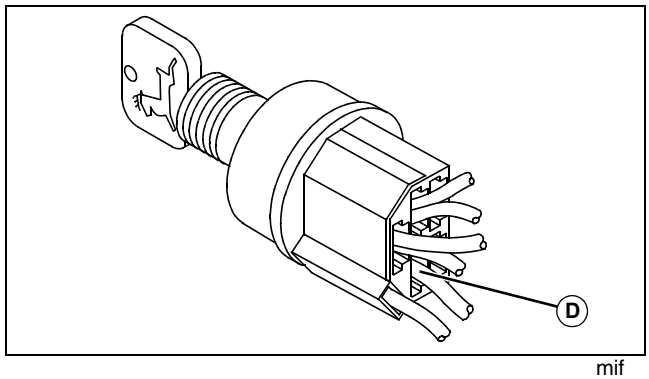


mif

(1) Is battery voltage present at both sides of all fuses (F1 - F7) (C)?

Yes - Go to next step.

No - Check 206 Red wire, X1 connector, 201 Red wire, 202 Red wire (behind fuse blocks), and all fuses.



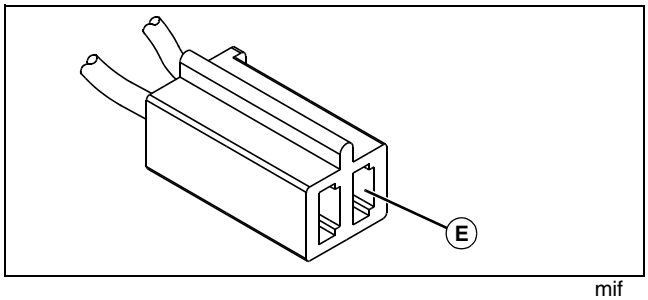
mif

(2) Is battery voltage present at the B terminal of S1 key switch connector, 208 Red wire (D)?

Yes - Connect switch. Go to next step.

No - Test F6 fuse. Test battery and positive (+) battery cable. Check 201 and 202 Red wires and connections. Check 208 Red wire and connections.

System: Unswitched Circuit Wiring

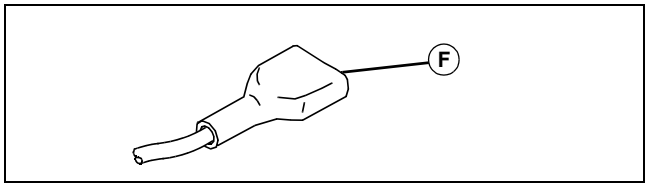


mif

(3) Is battery voltage present at pin A of X14 front optional attachments connector, 203 Red wire (E)?

Yes - Go to next step.

No - Check 203 Red wire.

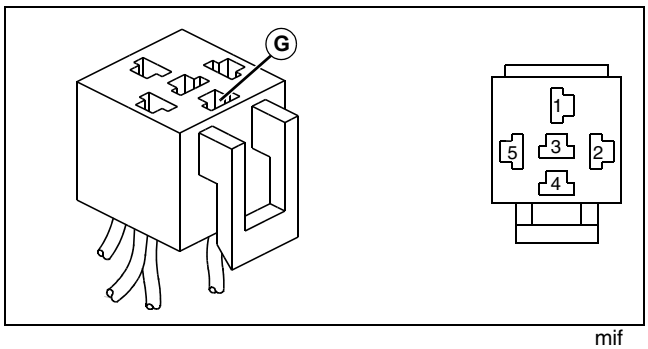


mif

(4) Is battery voltage present at X13 accessory power port, 207 Red wire (F)?

Yes - Go to next step.

No - Check 207 Red wire.



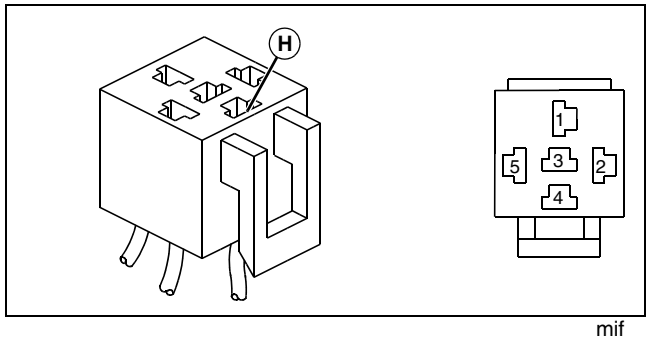
mif

(5) Remove K1 start relay. Is battery voltage present at terminal 4 (87) of relay connector, 216 Red wire (G)?

Yes - Install relay Go to next step.

No - Check 216 Red wire.

System: Unswitched Circuit Wiring

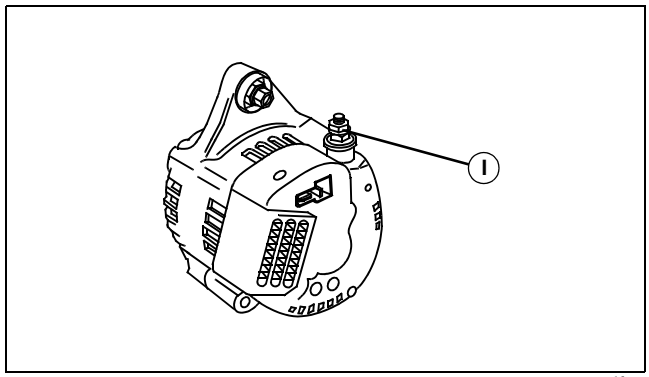


mif

(6) Remove K2 fan relay. Is battery voltage present at terminal 4 (87) of relay connector, 217 Red wire (H)?

Yes - Install relay. Go to next step.

No - Check 217 Red wire.

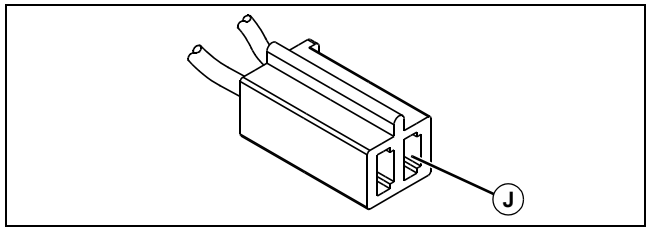


mif

(7) Is battery voltage present at battery terminal of alternator, 200 Red wire (I)?

Yes - Go to next step.

No - Check 200 Red wire.



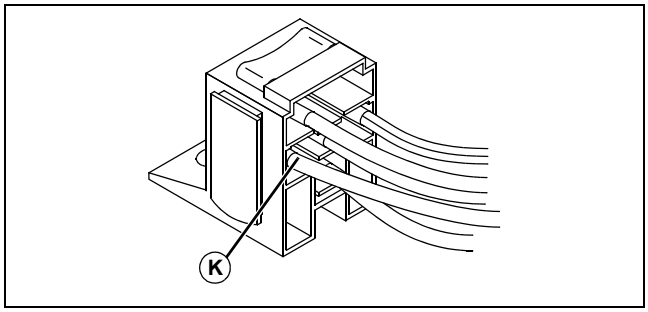
mif

(8) Is battery voltage present at pin A of X17 rear optional attachments connector, 204 Red wire (J)?

Yes - Go to next step.

No - Check 204 Red wire.

System: Unswitched Circuit Wiring



(9) Is battery voltage present at 205 Red wire of A1 glow plug module?

Yes - Test complete or go to switched power circuit tests.

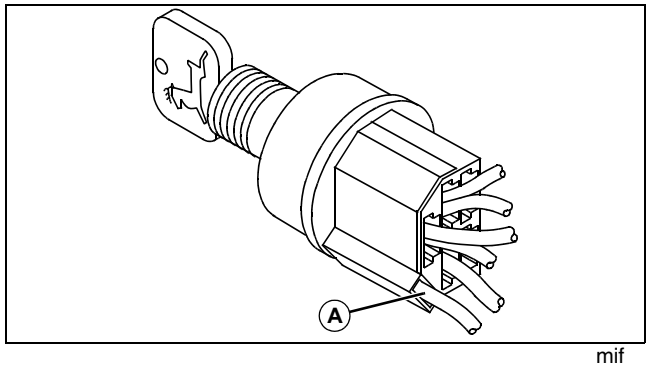
No - Check 205 Red wire and connections.

Test Procedure B

Test Conditions:

- Unswitched power circuits OK.
- Machine parked safely. See “Parking Safely” in the Safety section.
- Park brake locked.
- Key switch in run position with engine not running.
- Negative (Blk) lead of voltmeter placed on battery negative (-) terminal or suitable frame ground.
- Voltmeter positive (Red) placed on designated test point.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.

System: Switched Circuit Wiring

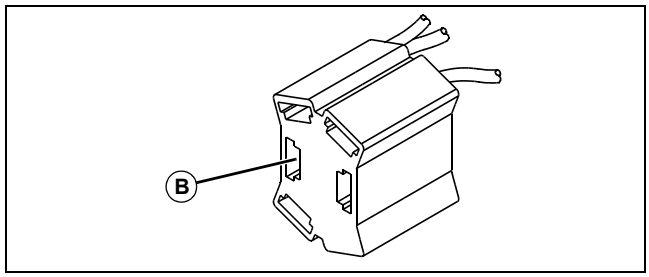


mif

(1) Is battery voltage present at pin A of S1 key switch, 420J Yel wire (A)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341.

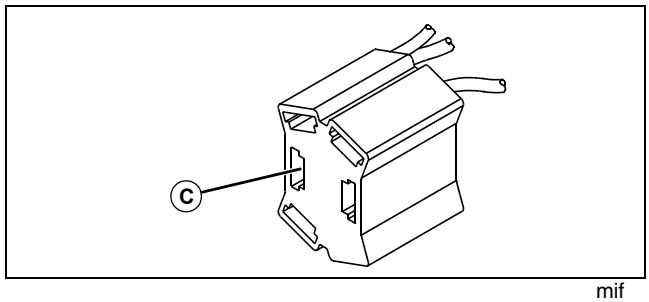


mif

(2) Disconnect S4 light switch. Is battery voltage present at pin 2 of switch connector, 420G Yel wire (B)?

Yes - Connect switch. Go to next step.

No - Check 420J and 420G Yel wires, and connections.



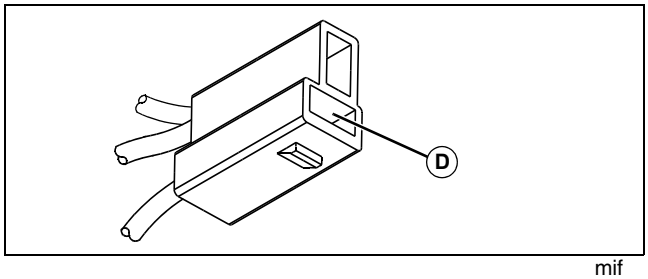
mif

(3) Disconnect S5 cargo box lift switch. Is battery voltage present at pin 2 of switch connector, 420H Yel wire (C)?

Yes - Connect switch. Go to next step.

No - Check 420J and 420H Yel wires, and connections.

System: Switched Circuit Wiring

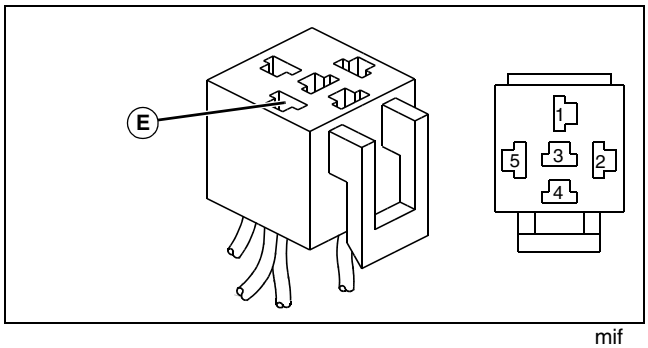


mif

(4) Is battery voltage present at pin A of X7 front optional attachments connector, 420L Yel wire (D)?

Yes - Go to next step.

No - Check 420J and 420L Yel wires, and connections.

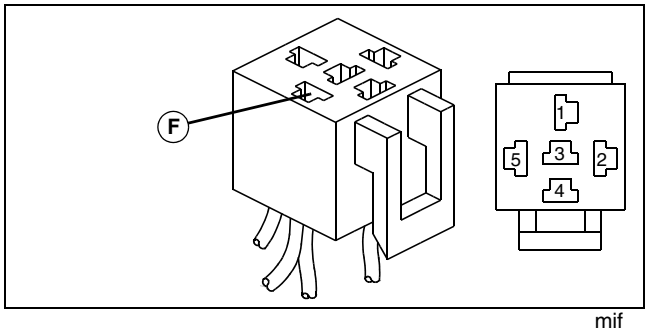


mif

(5) Remove K1 start relay. Is battery voltage present at terminal 5 (86) of K1 start relay connector, 420E Yel wire (E)?

Yes - Install relay. Go to next step.

No - Check 420E Yel wire.



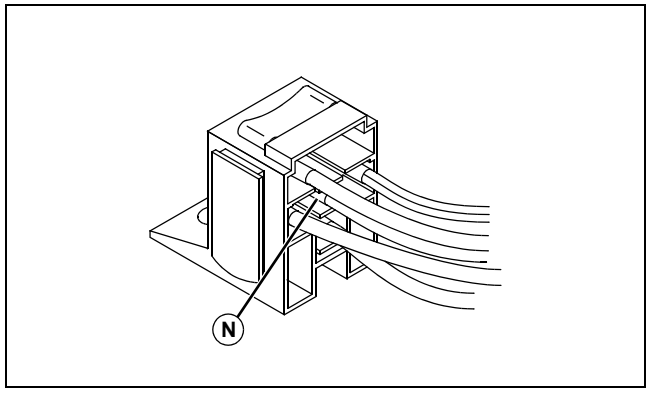
mif

(6) Remove K2 fan relay. Is battery voltage present at terminal 5 (86) of K2 fan relay connector, 420E Yel wire (F)?

Yes - Install relay. Go to next step.

No - Check 420E Yel wire.

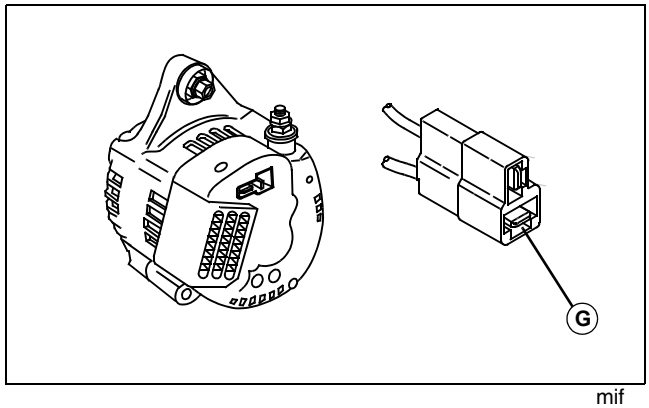
System: Switched Circuit Wiring



(7) Is battery voltage present at 420N Yel wire (N) of A1 glow plug module?

Yes - Go to next procedure.

No - Check 420N Yel wire and connections.



mif

(8) Disconnect alternator connector. Is battery voltage present at 420B Yel wire (G)?

Yes - Connect alternator connector. Go to next step.

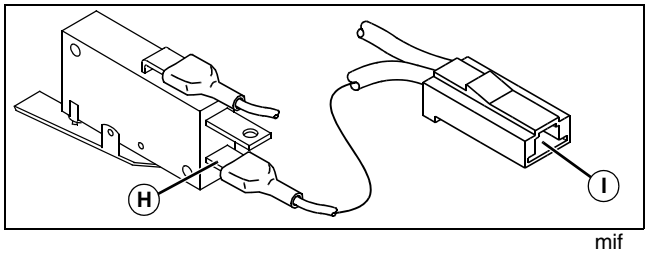
No - Check 420B Yel wire.

(9) Is park brake light illuminated?

Yes - See “Park Brake Circuit Diagnosis (Gas and Diesel Engines - All)” on page 331.

No - Go to next step.

System: Switched Circuit Wiring

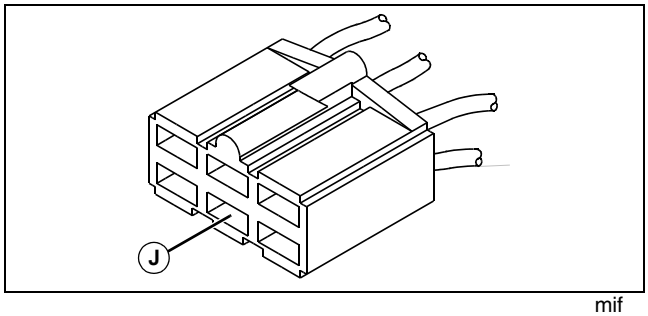


mif

(10) Is battery voltage present at S3 park brake switch, 420P Yel wire (H)?

Yes - Go to next step. Test park brake switch.

No - Check 420P and 420F Yel (I) wires.

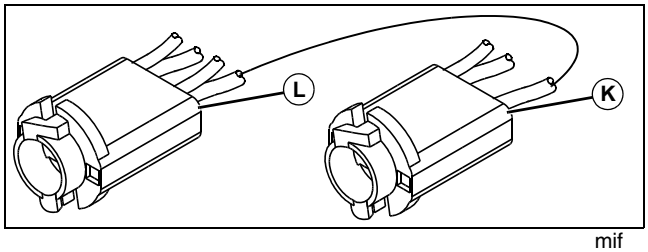


mif

(11) Is battery voltage present at pin E of X15 front lights connector, 420K Yel wire (J)?

Yes - Go to next step.

No - Check 420K Yel wire.



mif

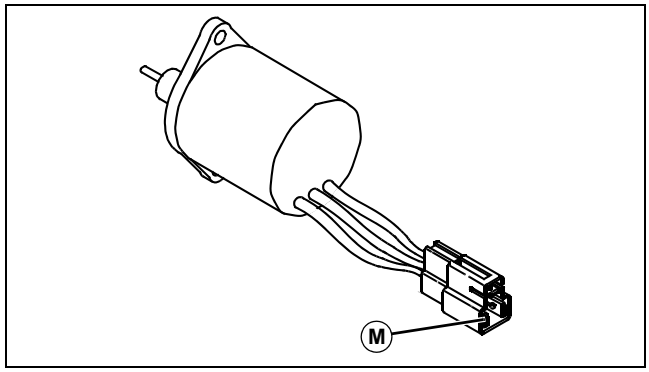
(12) Is battery voltage present at H2 engine coolant temperature light socket, 419 Yel wire (K)? Is H3 engine oil pressure light illuminated?

Yes - Go to next step.

No - Check 419 (K) and 420M (L) Yel wires.

No - Check 419 (K) and 420M (L) Yel wires. Test H3 engine oil pressure bulb.

System: Switched Circuit Wiring



(13) Is battery voltage present at X3 connector, 420A Yel wire (M) of Y3 fuel shutoff solenoid?

Yes - Test complete or go to static switched power tests.

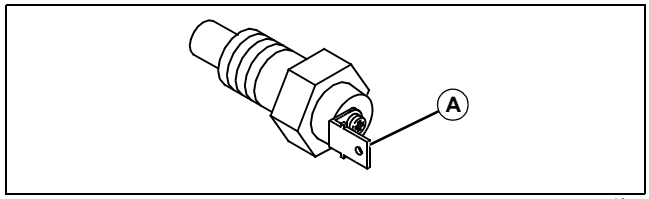
No - Check 420A Yel wire and connections.

Test Procedure C

Test Conditions:

- Unswitched power circuits OK.
- Machine parked safely. See “Parking Safely” in the Safety section.
- Park brake locked.
- Key switch in run position with engine not running.
- Negative (Blk) lead of voltmeter placed on battery negative (-) terminal or suitable frame ground.
- Voltmeter positive (Red) placed on designated test point.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.

System: Static Switched Circuit Wiring



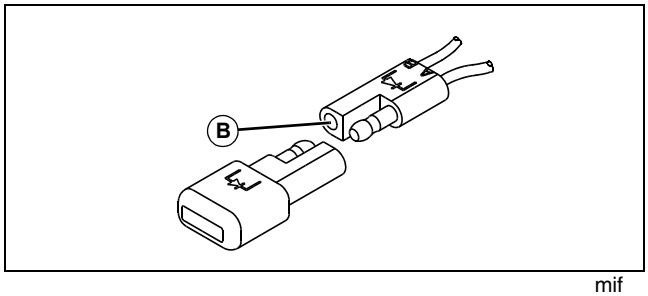
mif

(1) Is battery voltage present at B3 engine coolant temperature switch, Yel wire (A)?

Yes - Go to next step.

System: Static Switched Circuit Wiring

No - Test H2 engine coolant temperature bulb. Check 300 org wire and Yel engine wire and connections.

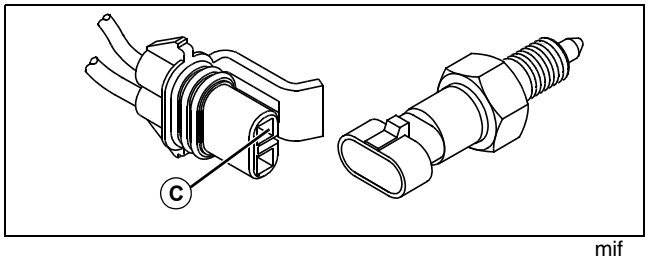


mif

(2) Disconnect V1 diode. Is battery voltage present at V1 diode 301 Org wire (B)?

Yes - Install diode. Go to next step.

No - Test H2 engine coolant temperature bulb. Check 301 org wire and connections.

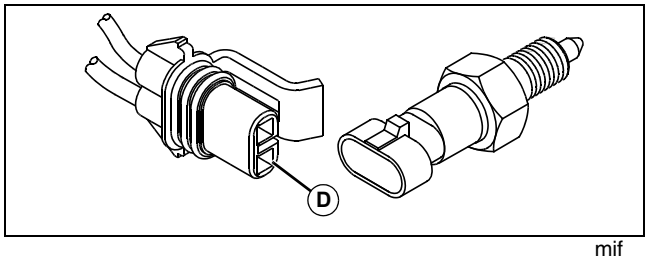


mif

(3) Disconnect S2 neutral start switch connector. Is battery voltage present at pin A of S2 neutral start switch, 705 Pur wire (C)?

Yes - Go to next step.

No - Test V1 diode. Check 302 Org and 705 Pur wires and connections.



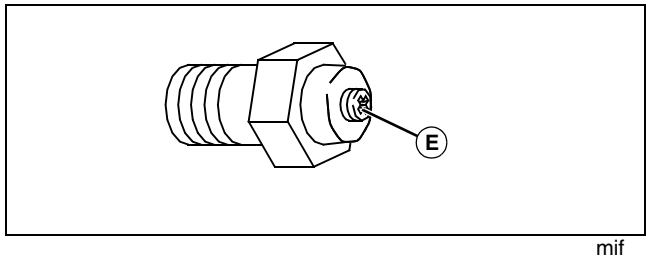
mif

(4) Disconnect S2 neutral start switch connector. Is battery voltage present at pin B of S2 neutral start switch, 710 Pur wire (D)?

Yes - Connect switch. Go to next step.

No - Test K1 start relay. Check 710 Pur wire and connections.

System: Static Switched Circuit Wiring

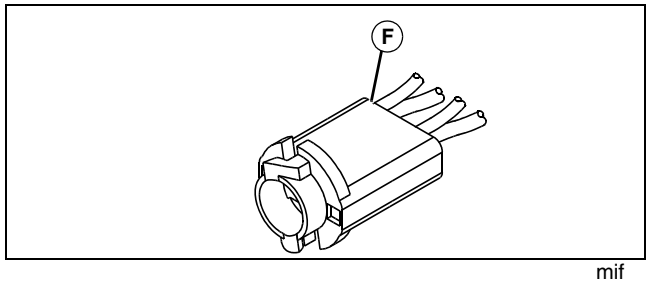


mif

(5) Is continuity to ground present at B4 engine oil pressure switch, Blu/Red wire (E)?

Yes - Go to next step.

No - Test B4 engine oil pressure switch. Check engine ground wire and connections.



mif

(6) Is continuity to ground present at B3 engine oil pressure light, 601 Tan wire (F)?

Yes - Test complete.

No - Check 601 Tan wire and engine Blu/Red wires and connections. Test complete.

Power Circuit Operation (Diesel Engine) (SN 40001 -)

Function:

Provides unswitched and switched power to the primary components whenever the battery is connected and the key switch is in the run position.

Operating Conditions Unswitched Circuits:

- Battery fully charged and properly connected to the wiring harness.
- Ground circuit properly connected to the wiring harness.

Battery voltage must be present at the following components with the key switch “OFF”:

- Battery Positive Terminal
- Y1 Starting Motor Solenoid “B” Terminal 209 Red wire
- G2 Alternator positive 200 Red wire
- K1 Start Relay 216 Red wire
- K2 Fan Relay 217 Red wire
- A1 Glow Plug Module 205 Red wire
- X17 Rear Optional Attachments Connector “A” terminal 204 Red wire
- X13 Accessory Power Port Connector “A” terminal 207 Red wire
- S1 Key Switch “B” terminal 208 Red wire
- X14 Front Optional Attachments Connector “A” terminal 203 Red wire

Unswitched Circuit Operation:

The positive battery cable connects the battery to the Y1 starting motor solenoid. Power is also directly run from the battery positive terminal to two fuse blocks. These fuse blocks distribute power to all unswitched circuits, with the exception of the Y1 starting motor solenoid. The individual fuses in the blocks protect the components and wiring from damage by preventing a high current circuit overload.

The battery cable and fuse block connections must be in good condition for the machine’s electrical system to work properly.

The ground cable and connections are equally important. Proper operation depends on these cables and connections to carry the power necessary for operation.

Operating Conditions Switched Circuits:

- Unswitched circuits functioning properly.
- Key switch in the RUN position.

Battery voltage must be present at the following locations:

- Y3 Fuel Shutoff Solenoid 420A Yel wire
- G2 Alternator 420B Yel wire
- K1 Start Relay 420D Yel wire
- K2 Fan Relay 420E Yel wire
- X8 Mid Optional Attachments Connector 420F Yel wire
- S4 Light Switch 420G Yel wire
- S5 Cargo Box Control Switch (option) 420H Yel wire
- X15 Front Lights Connector “E” terminal 420K Yel wire
- X7 Front Optional Attachments Connector “A” terminal 420L Yel wire
- H3 Engine Oil Pressure Light 420M Yel wire
- A1 Glow Plug Module 420N Yel wire
- S3 Park Brake Switch 420P Yel wire
- K3 4WD Interlock Relay 420Q Yel wire
- H4 Discharge Light 420R Yel wire
- K3 4WD Interlock Relay 420X Yel wire
- H2 Engine Coolant Temperature Light 419 Yel wire

Switched Circuit Operation:

Power supplied by the battery, through a fuse block is supplied to the S1 key switch. When the key switch is in the ON position, power is routed to a central splice. This splice distributes power to the switched components through individual circuits and grounds.

Static Switched Circuits:

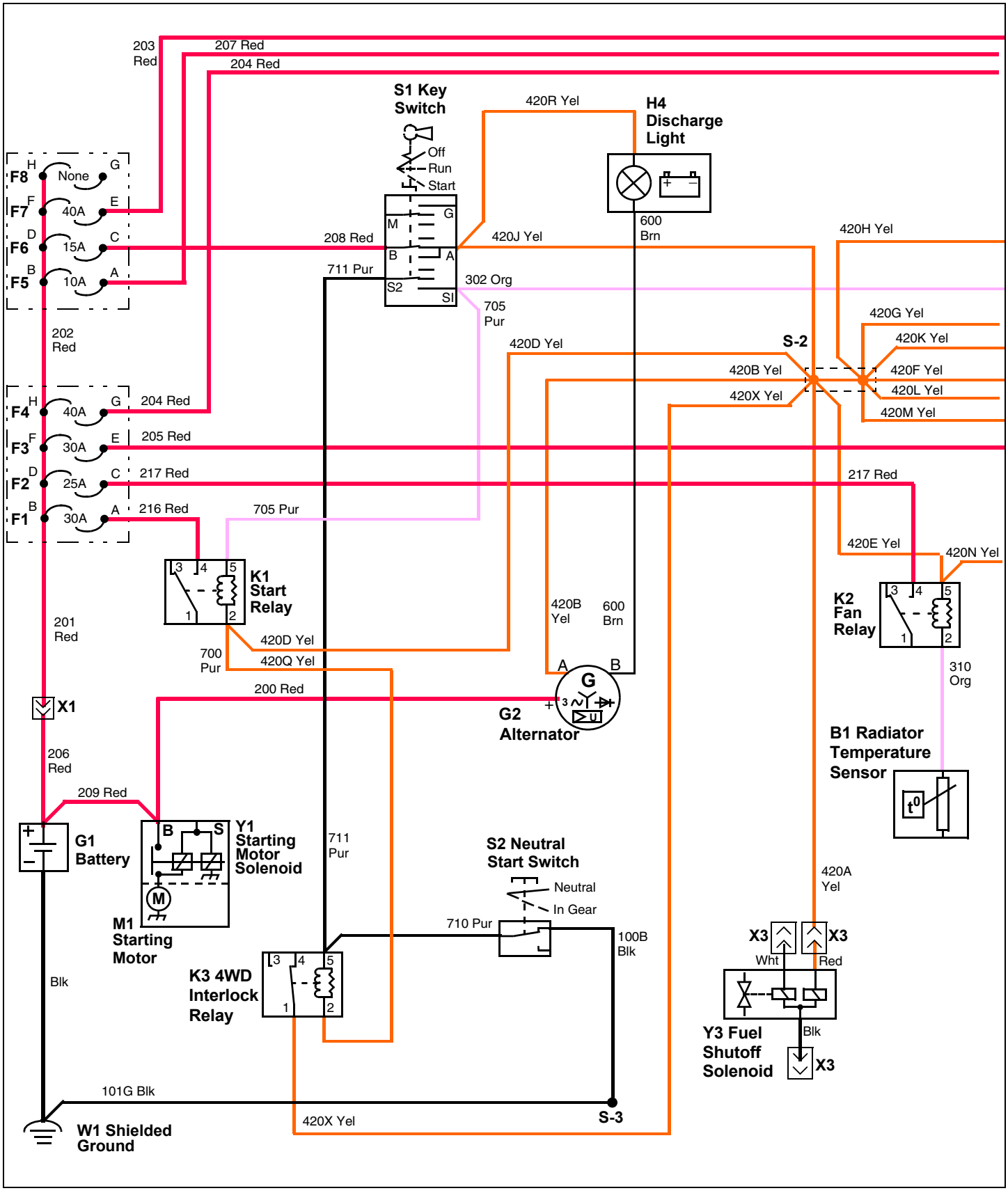
- Switched circuits functioning properly.

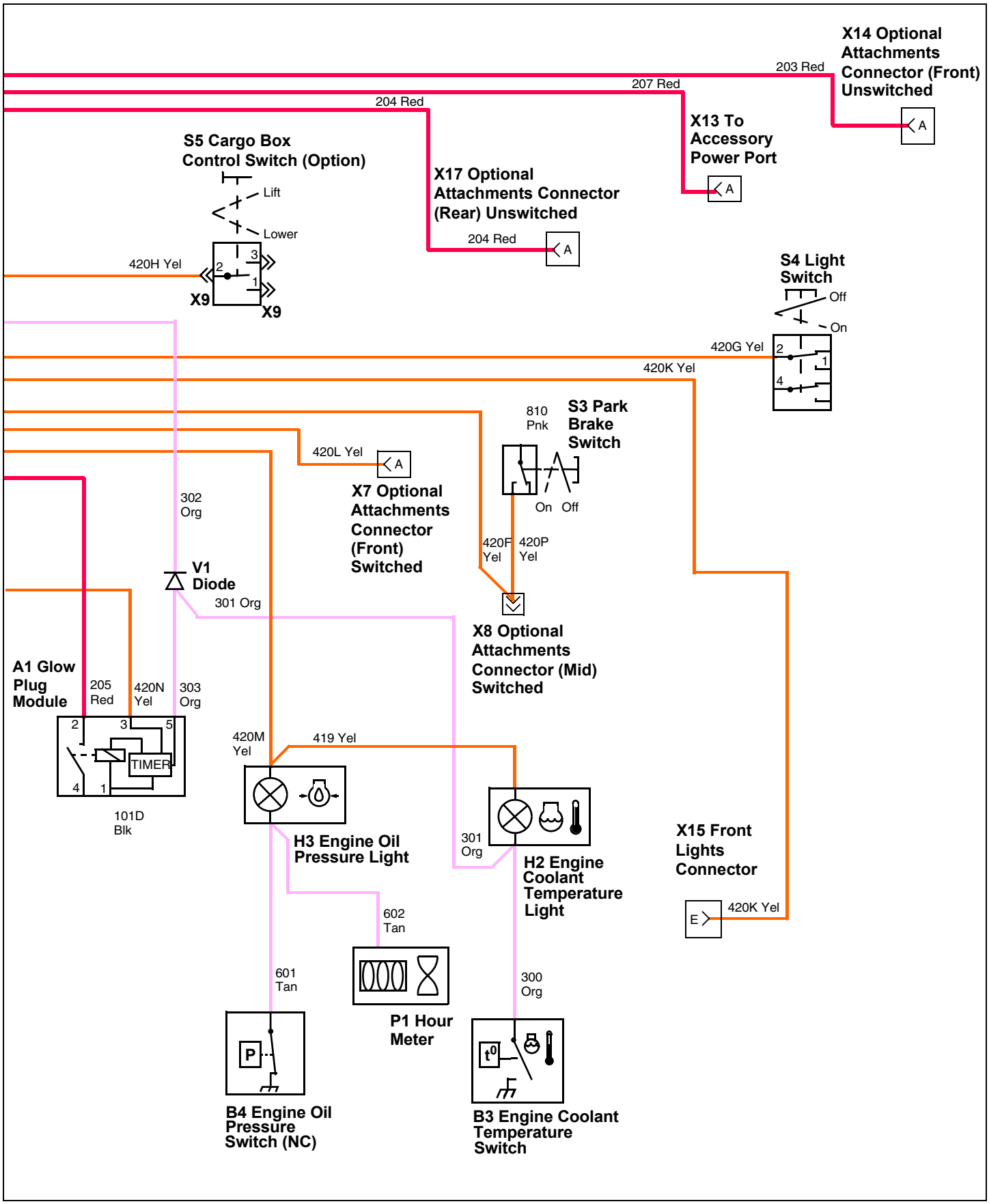
As a result of the key switch being placed in the run position, battery voltage passes through several components and is switched on the ground side to activate the component. These wires will have battery voltage present when not being used and will become a ground circuit when the function is activated.

Battery voltage must be present at the following locations:

- B1 Radiator Temperature Switch 310 Org wire
- B3 Engine Coolant Temperature Switch 300 Org wire
- V1 Light Check Diode 301 and 302 Org wires
- S1 Key Switch “S1” terminal 302 Org and 705 Pur wires
- K1 Start Relay 705 Pur wire
- A1 Glow Plug Module 303 Org wire
- B4 Engine Oil Pressure Switch 601 Tan wire when engine oil pressure is within operating range.
- P1 Hour Meter 602 Tan wire when engine oil pressure is within operating range.

Power Circuit Schematic (Diesel Engine) (SN 40001 -)




X14 Optional Attachments Connector (Front) Unswitched
203 Red
207 Red
204 Red
X13 To Accessory Power Port
A
S5 Cargo Box Control Switch (Option)
Lift
Lower
X17 Optional Attachments Connector (Rear) Unswitched
204 Red
420H Yel
X9
S4 Light Switch
Off
On
420G Yel
420K Yel
810 Pnk
S3 Park Brake Switch
On Off
420L Yel
X7 Optional Attachments Connector (Front) Switched
302 Org
V1 Diode
301 Org
420F Yel
420P Yel
X8 Optional Attachments Connector (Mid) Switched
A1 Glow Plug Module
205 Red
420N Yel
303 Org
TIMER
101D Blk
420M Yel
419 Yel
H3 Engine Oil Pressure Light
301 Org
H2 Engine Coolant Temperature Light
X15 Front Lights Connector
E
602 Tan
601 Tan
300 Org
P1 Hour Meter
B4 Engine Oil Pressure Switch (NC)
B3 Engine Coolant Temperature Switch

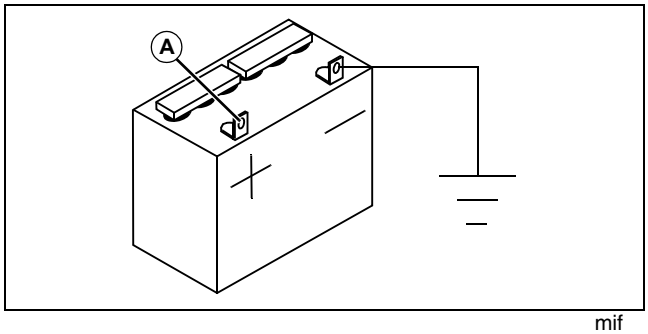
Power Circuit Diagnosis (Diesel Engine) (SN 40001 -)

Test Procedure A

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Key switch in the off position.
- Cargo box raised and locked.
- Battery fully charged.
- Negative (Blk) lead of voltmeter placed on battery negative (-) terminal or suitable frame ground.
- Voltmeter positive (Red) placed on designated test point.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.

System: Battery Circuit

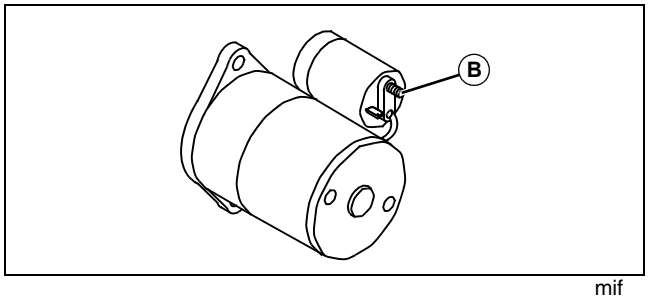


mif

(1) Is 12.4 volts or above present at battery positive terminal (A)?

Yes - Go to next step.

No - Test battery. See “Battery Load Test” on page 336.



mif

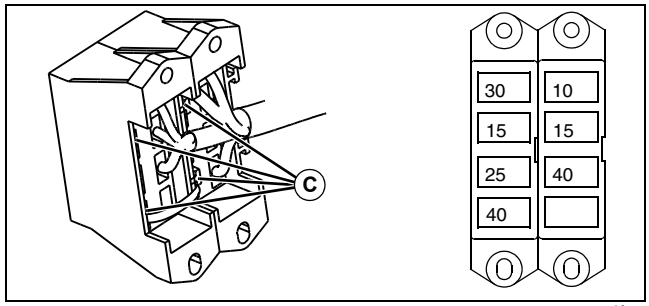
(2) Is battery voltage present at battery terminal of starter solenoid (B)?

System: Battery Circuit

Yes - Go to next step.

No - Check 209 Red cable and connections.

System: Unswitched Circuit Wiring

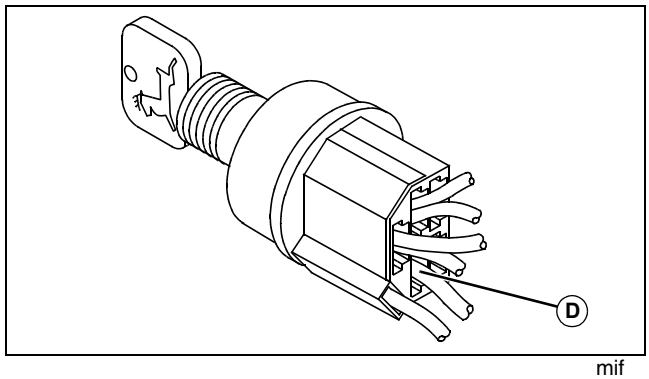


mif

(1) Is battery voltage present at both sides of all fuses (F1 - F7) (C)?

Yes - Go to next step.

No - Check 206 Red wire, X1 connector, 201 Red wire, 202 Red wire (behind fuse blocks), and all fuses.

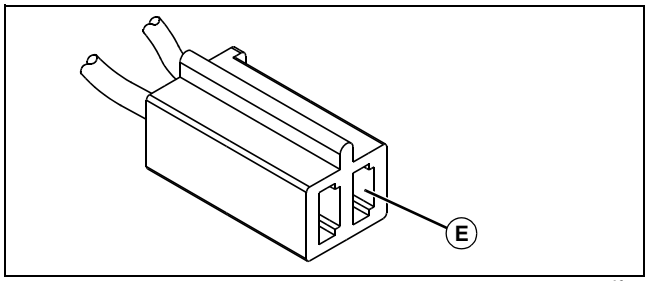


mif

(2) Is battery voltage present at the B terminal of S1 key switch connector, 208 Red wire (D)?

Yes - Connect switch. Go to next step.

No - Test F6 fuse. Test battery and positive (+) battery cable. Check 201 and 202 Red wires and connections. Check 208 Red wire and connections.

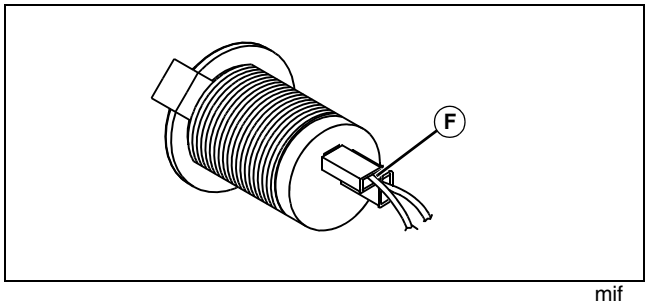


mif

(3) Is battery voltage present at pin A of X14 front optional attachments connector, 203 Red wire (E)?

Yes - Go to next step.

No - Check 203 Red wire.

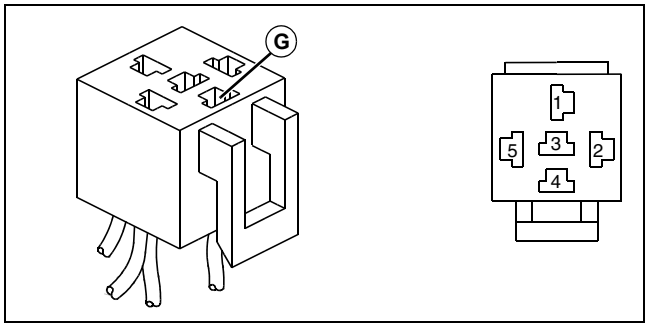


mif

(4) Is battery voltage present at X13 accessory power port, 207 Red wire (F)?

Yes - Go to next step.

No - Check 207 Red wire.

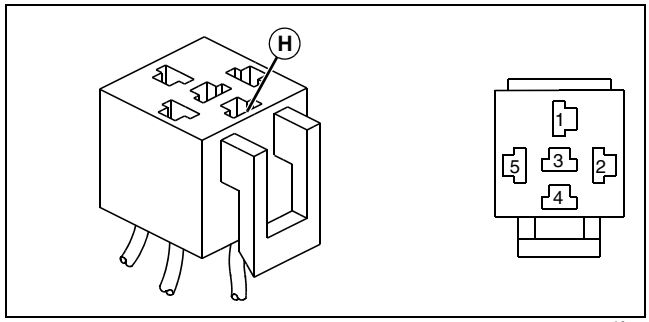


mif

(5) Remove K1 start relay. Is battery voltage present at terminal 4 (87) of relay connector, 216 Red wire (G)?

Yes - Install relay Go to next step.

No - Check 216 Red wire.

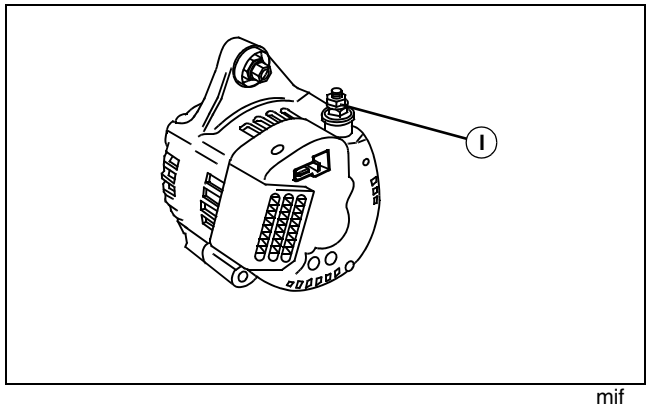


mif

(6) Remove K2 fan relay. Is battery voltage present at terminal 4 (87) of relay connector, 217 Red wire (H)?

Yes - Install relay. Go to next step.

No - Check 217 Red wire.

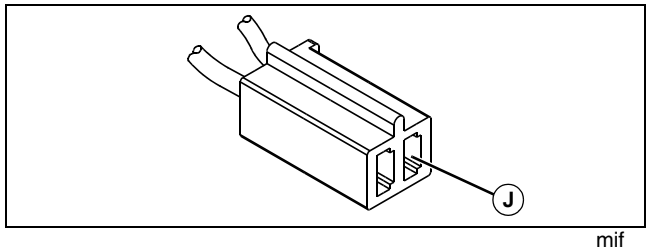


mif

(7) Is battery voltage present at battery terminal of alternator, 200 Red wire (I)?

Yes - Go to next step.

No - Check 200 Red wire.



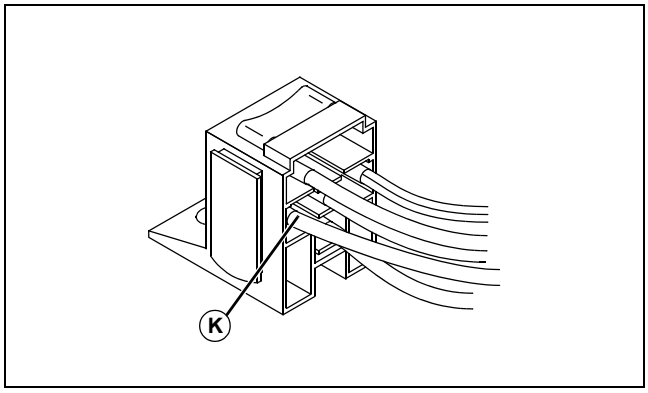
mif

(8) Is battery voltage present at pin A of X17 rear optional attachments connector, 204 Red wire (J)?

Yes - Go to next step.

No - Check 204 Red wire.

System: Unswitched Circuit Wiring



(9) Is battery voltage present at 205 Red wire of A1 glow plug module?

Yes - Test complete or go to switched power circuit tests.

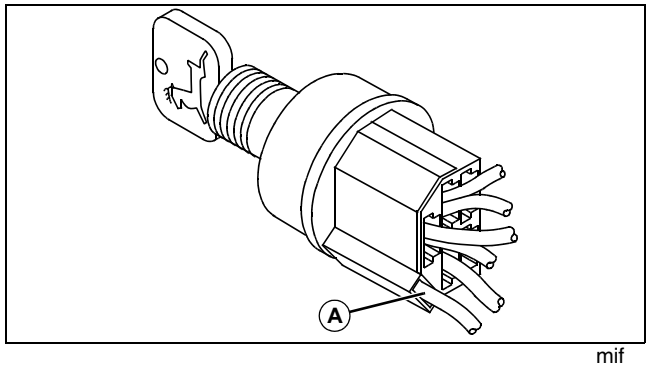
No - Check 205 Red wire and connections.

Test Procedure B

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Unswitched power circuits OK.
- Key switch in run position with engine not running.
- Negative (Blk) lead of voltmeter placed on battery negative (-) terminal or suitable frame ground.
- Voltmeter positive (Red) placed on designated test point.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.

System: Switched Circuit Wiring

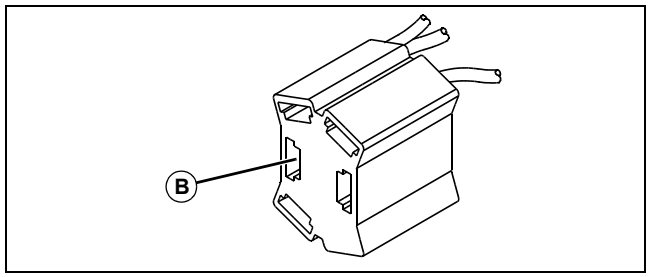


mif

(1) Is battery voltage present at pin A of S1 key switch, 420J Yel wire (A)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341.

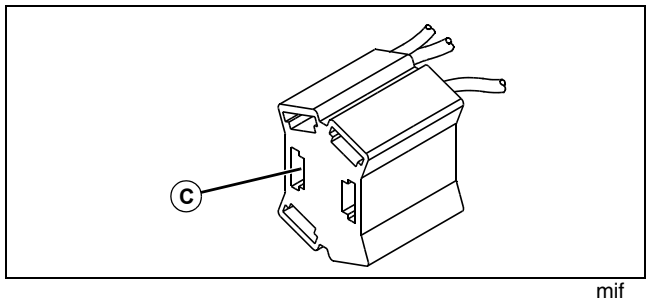


mif

(2) Disconnect S4 light switch. Is battery voltage present at pin 2 of switch connector, 420G Yel wire (B)?

Yes - Connect switch. Go to next step.

No - Check 420J and 420G Yel wires, and connections.



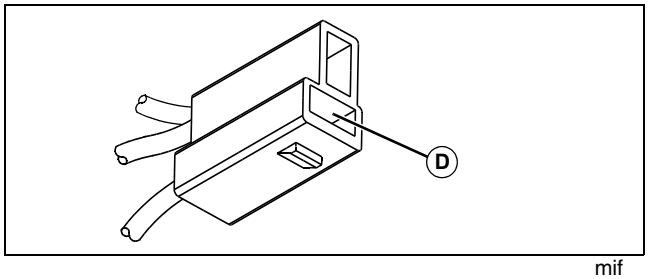
mif

(3) Disconnect S5 cargo box lift switch. Is battery voltage present at pin 2 of switch connector, 420H Yel wire (C)?

Yes - Connect switch. Go to next step.

No - Check 420J and 420H Yel wires, and connections.

System: Switched Circuit Wiring

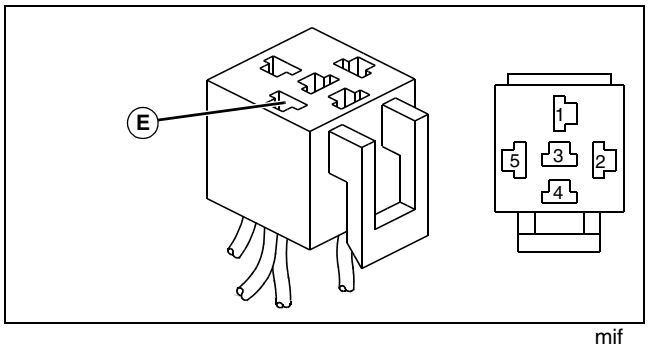


mif

(4) Is battery voltage present at pin A of X7 front optional attachments connector, 420L Yel wire (D)?

Yes - Go to next step.

No - Check 420J and 420L Yel wires, and connections.

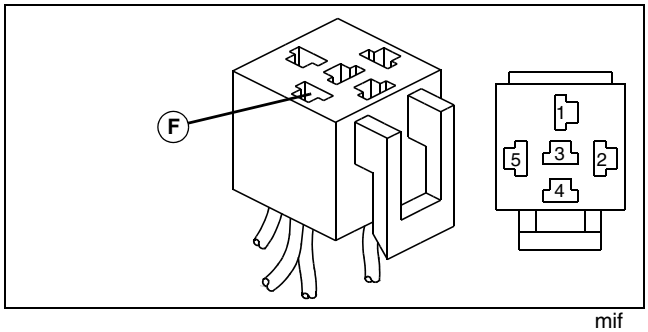


mif

(5) Remove K1 start relay. Is battery voltage present at terminal 5 (86) of K1 start relay connector, 420E Yel wire (E)?

Yes - Install relay. Go to next step.

No - Check 420E Yel wire.



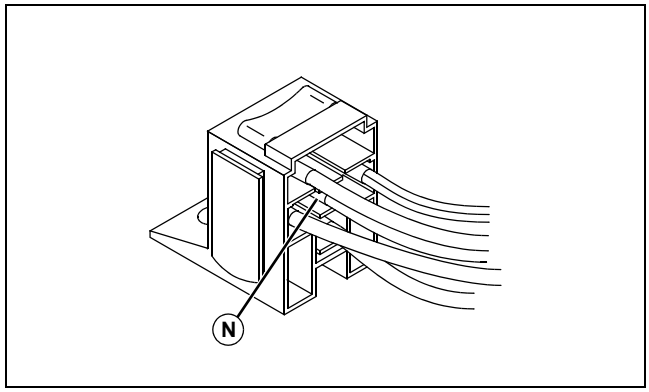
mif

(6) Remove K2 fan relay. Is battery voltage present at terminal 5 (86) of K2 fan relay connector, 420E Yel wire (F)?

Yes - Install relay. Go to next step.

No - Check 420E Yel wire.

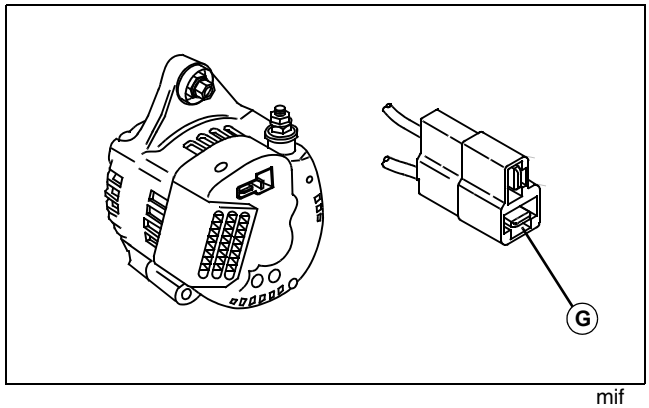
System: Switched Circuit Wiring



(7) Is battery voltage present at 420N Yel wire (N) of A1 glow plug module?

Yes - Go to next procedure.

No - Check 420N Yel wire and connections.



mif

(8) Disconnect alternator connector. Is battery voltage present at 420B Yel wire (G)?

Yes - Connect alternator connector. Go to next step.

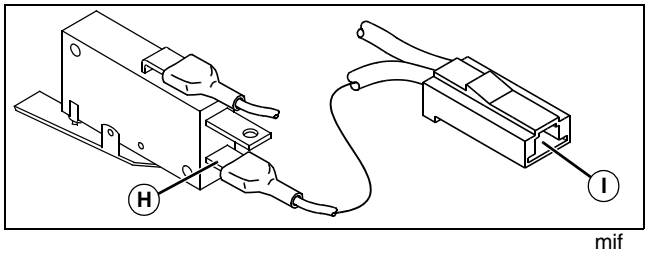
No - Check 420B Yel wire.

(9) Is park brake light illuminated?

Yes - See “Park Brake Circuit Diagnosis (Gas and Diesel Engines - All)” on page 331.

No - Go to next step.

System: Switched Circuit Wiring

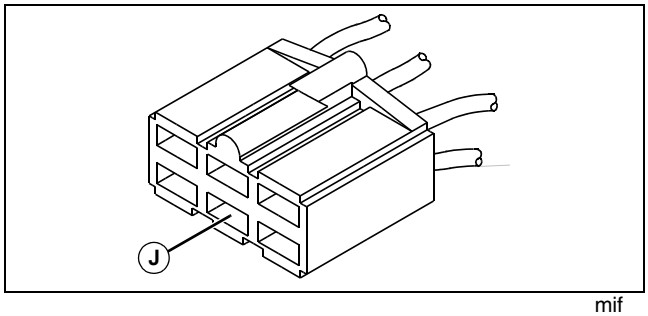


mif

(10) Is battery voltage present at S3 park brake switch, 420P Yel wire (H)?

Yes - Go to next step. Test park brake switch.

No - Check 420P and 420F Yel (I) wires.

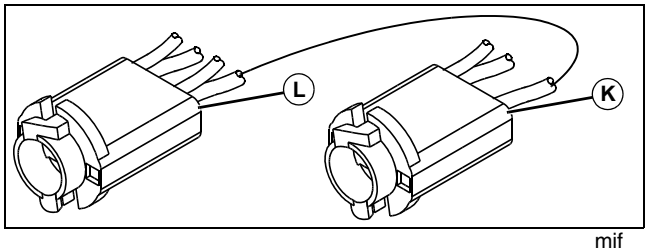


mif

(11) Is battery voltage present at pin E of X15 front lights connector, 420K Yel wire (J)?

Yes - Go to next step.

No - Check 420K Yel wire.



mif

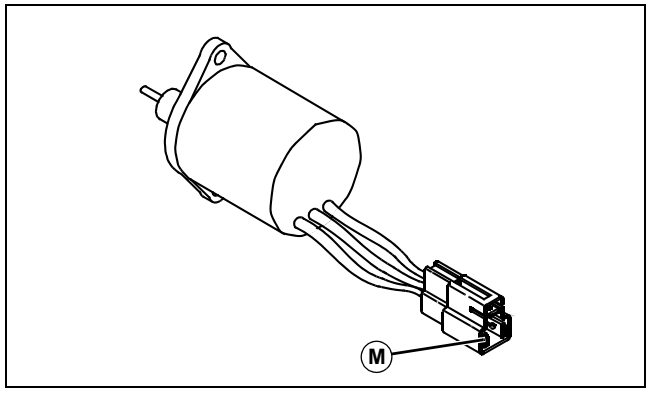
(12) Is battery voltage present at H2 engine coolant temperature light socket, 419 Yel wire (K)? Is H3 engine oil pressure light illuminated?

Yes - Go to next step.

No - Check 419 (K) and 420M (L) Yel wires.

No - Check 419 (K) and 420M (L) Yel wires. Test H3 engine oil pressure bulb.

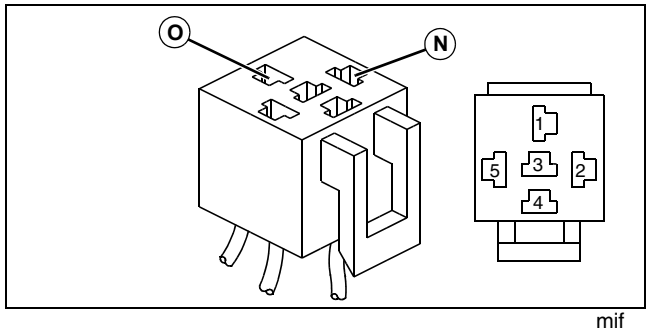
System: Switched Circuit Wiring



(13) Is battery voltage present at X3 connector, 420A Yel wire (M) of Y3 fuel shutoff solenoid?

Yes - Go to next step.

No - Check 420A Yel wire and connections.



mif

(14) Remove relay. Is battery voltage present at terminal 2 (85) of K3 4WD interlock relay connector, 420Q Yel wire (N)?

Yes - Go to next step.

No - Check 420Q and 420D Yel wires.

(15) Is battery voltage present at terminal 1 (30) of K3 4WD interlock relay connector, 420X Yel wire (O)?

Yes - Install relay. Test complete or go to static switched power tests.

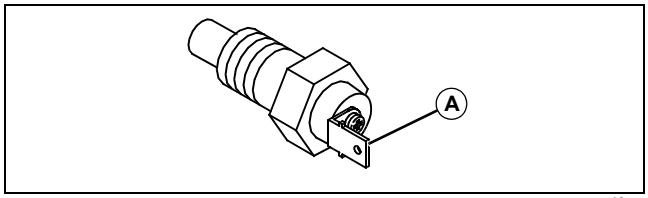
No - Check 420X Yel wire.

Test Procedure C

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Unswitched power circuits OK.
- Switched power circuits OK.
- Key switch in run position with engine not running.
- Negative (Blk) lead of voltmeter placed on battery negative (-) terminal or suitable frame ground.
- Voltmeter positive (Red) placed on designated test point.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.

System: Static Switched Circuit Wiring

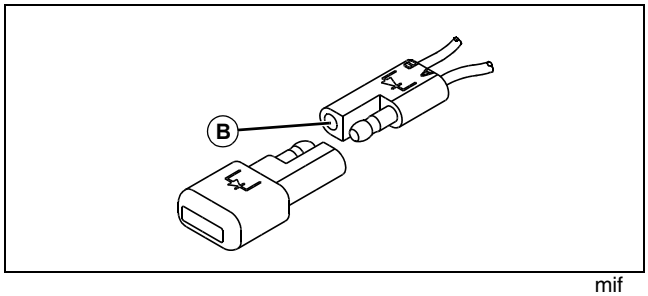


mif

(1) Is battery voltage present at B3 engine coolant temperature switch, Yel wire (A)?

Yes - Go to next step.

No - Test H2 engine coolant temperature bulb. Check 300 org wire and Yel engine wire and connections.



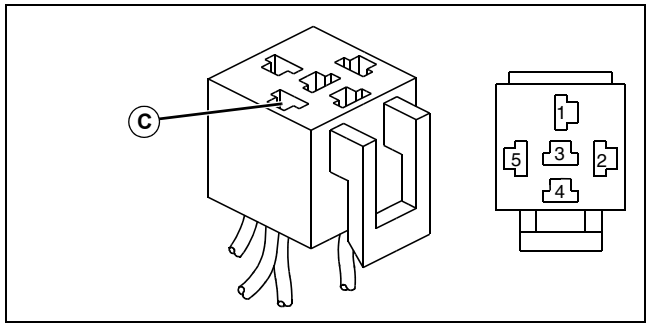
mif

(2) Disconnect V1 diode. Is battery voltage present at V1 diode 301 Org wire (B)?

Yes - Install diode. Go to next step.

No - Test H2 engine coolant temperature bulb. Check 301 org wire and connections.

System: Static Switched Circuit Wiring

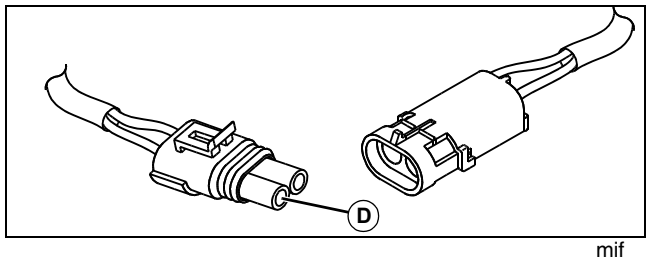


mif

(3) Remove relay. Is battery voltage present at terminal 5 (86) of K1 start relay connector, 705 Pur wire (C)?

Yes - Install relay. Go to next step.

No - Test V1 diode. Check 302 Org and 705 Pur wires.

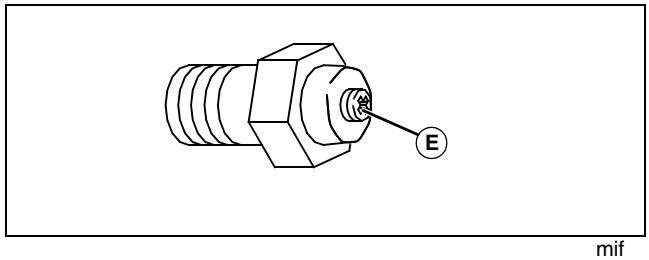


mif

(4) Disconnect B1 radiator temperature switch connector. Is battery voltage present at pin B of main wire harness, 310 Org wire (D)?

Yes - Connect switch. Go to next step.

No - Test K2 fan relay. Check 310 Org wire and connections.



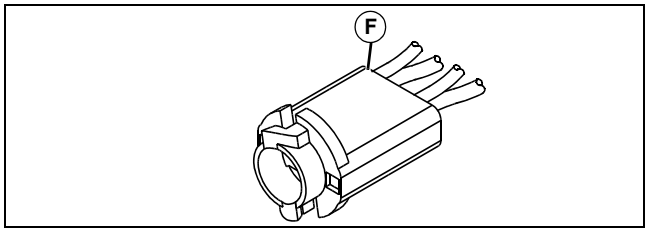
mif

(5) Is continuity to ground present at B4 engine oil pressure switch, Blu/Red wire (E)?

Yes - Go to next step.

No - Test B4 engine oil pressure switch. Check engine ground wire and connections.

System: Static Switched Circuit Wiring



mif

(6) Is continuity to ground present at B3 engine oil pressure light, 601 Tan wire (F)?

Yes - Test complete.

No - Check 601 Tan and engine Blu/Red wires and connections. Test complete.

Cranking Circuit Operation (Gas and Diesel Engines) (SN -40000)

Function:

To energize the starter motor solenoid and engage the starting motor.

Additionally, this circuit will test the engine coolant temperature bulb.

Operating Conditions:

- Transmission must be in NEUTRAL.
- Key switch must be in the START position.

Theory of Operation:

Unswitched power is supplied from the G1 battery through the 201 Red wire, F1 fuse, and the 216 Red wire to the K1 start relay normally open contact (terminal 4). When this relay is energized, contact internally is completed allowing power to flow to the 700 Pur and engine harness Blk/Wht (Gas) or 701 Pur (Diesel) wires to the Y1 starting motor solenoid. When the solenoid is energized, contact internally is completed to allow power to flow to the M1 starting motor, running the starting motor.

The K1 start relay is energized by the following circuit:

Unswitched power is supplied from the G1 battery through the 201 and 202 Red wires, F6 fuse, and the 208 Red wire to the S1 key switch. When the S1 key switch is in the START position, power is supplied through the switch to the 420J Yel wire to the S-2 power splice (switched power). From the S-2 power splice, power is supplied to the 420D Yel wire and the K1 start relay coil (terminal 5).

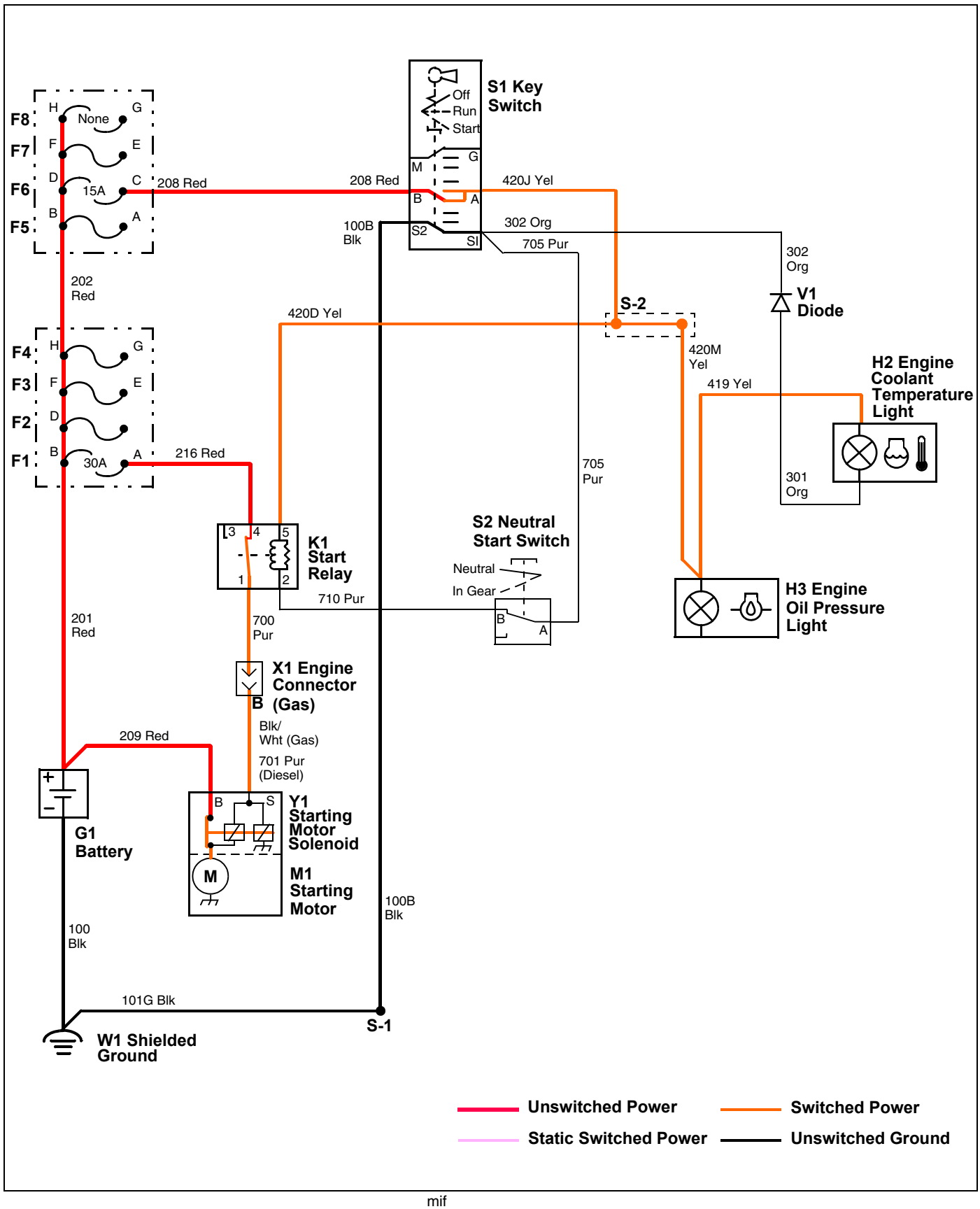
When the K1 start relay receives a ground through the S2 neutral start switch (transmission in neutral) and S1 key switch (in start position) the circuit is complete and the relay will be energized. The ground path is provided from the relay through the 710 Pur wire, S2 neutral start switch (contacts closed), 705 Pur wire, S1 key switch, and 100B, 100J and 101G Blk wires to the W1 ground.

As long as the S1 key switch is in the START position and the transaxle is in NEUTRAL (S2 neutral start switch closed) the circuit to ground for the relay coil is established and the relay coil is energized.

When the S1 key switch is in the start position, in addition to energizing the starting circuit, the H2 engine coolant temperature light is provided a ground path to test the bulb.

The H2 engine coolant temperature light is supplied switched power from the S-2 power splice through the 420M and 419 Yel wires. Static power across the bulb is changed to ground continuity when the S1 key switch is in the START position. This ground path is provided from the H2 engine coolant light through the 301 Org wire, V1 diode, 302 Org wire, S1 key switch, and 100B, 100J and 101G Blk wires to the W1 ground.

Cranking Circuit Schematic (Gas and Diesel Engines) (SN -40000)



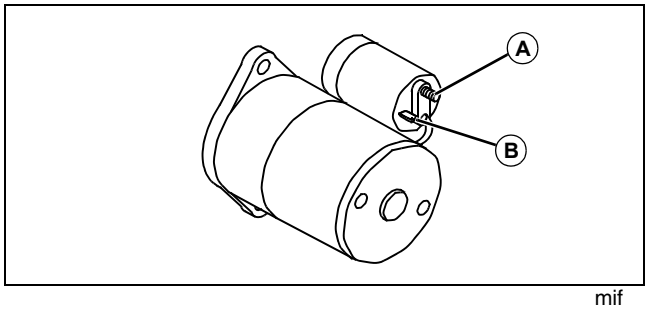
mif

Cranking Circuit Diagnosis (Gas and Diesel Engines) (SN -40000)

Test Conditions:

- Park brake locked.
- Cargo Box raised and locked.
- Hood open and storage tray removed.
- Transmission in neutral.
- Battery fully charged.
- Spark plug wires disconnected and grounded to frame.
- Key switch in the start position during each test step.

System: Cranking Circuit



mif

(1) Is battery voltage present at B terminal of Y1 starting motor solenoid (A)?

Yes - Go to next step.

No - Check battery cables and connections. Test battery. See “Battery Load Test” on page 336.

(2) Is battery voltage present at S terminal of starting motor solenoid (B)?

Yes - Cranking circuit is operating properly. Go to next step.

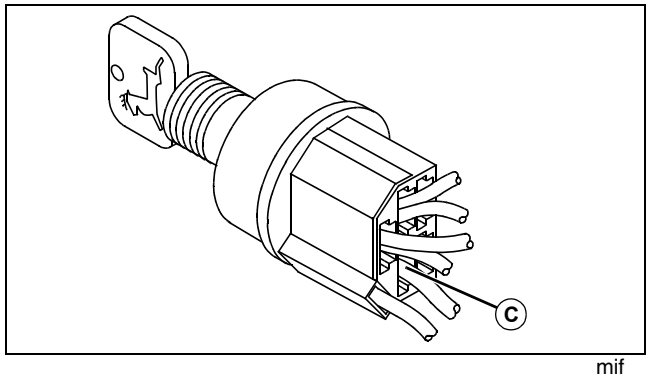
No - Go to step (4) to continue test.

(3) Is starting motor cranking engine?

Yes - Starting motor solenoid and motor are operating properly. To test H2 engine coolant light circuit, go to step 1 of engine coolant light circuit test, if OK, cranking circuit test complete.

No - Test starting motor solenoid. See “Starting Motor Solenoid Test” on page 339.

System: Cranking Circuit

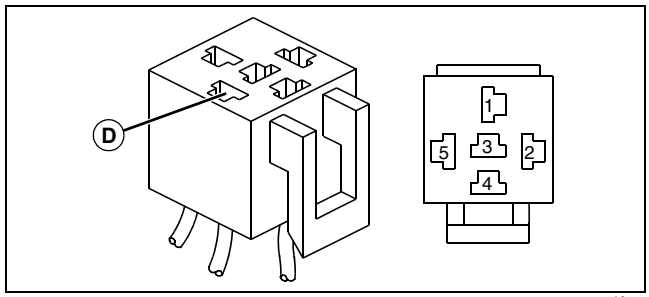


mif

(4) Is battery voltage present at B terminal of S1 key switch, 208 Red wire (C)?

Yes - Go to next step.

No - See “Power Circuit Diagnosis (Gas Engine) (SN -40000)” on page 246.

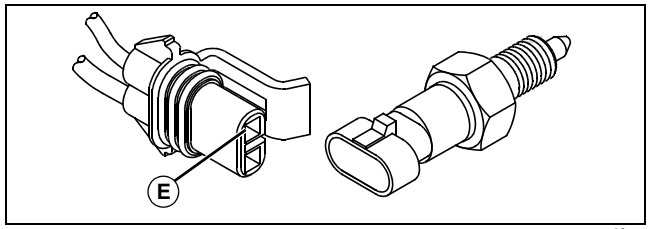


mif

(5) Remove K1 start relay. With key switch in start position, is battery voltage present at terminal 5 (86) of K1 start relay connector, 420D Yel wire (D)?

Yes - Install relay. Go to next step.

No - Test key switch. See “Key Switch Test” on page 341. Check 420J and 420D Yel wires.



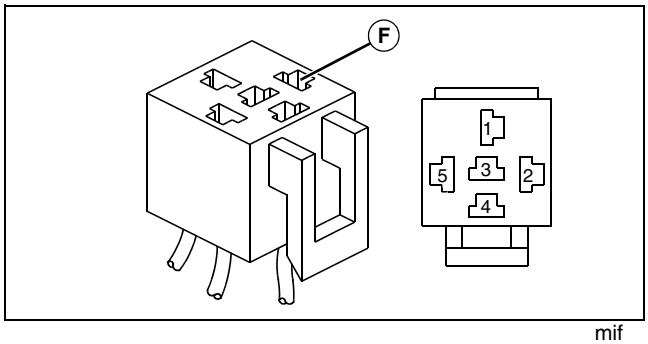
mif

(6) Disconnect S2 neutral start switch. With key switch in start position, is continuity to ground present at A terminal S2 neutral start switch connector, 705 Pr wire (E)?

Yes - Connect neutral start switch. Go to next step.

System: Cranking Circuit

No - Test key switch. See “Key Switch Test” on page 341. Check 705 Pur, 100B and 101G Blk wires and connections.



mif

(7) Remove K1 start relay. With key switch in start position, is continuity to ground present at terminal 2 (85) of K1 start relay, 710 Pur wire (F)?

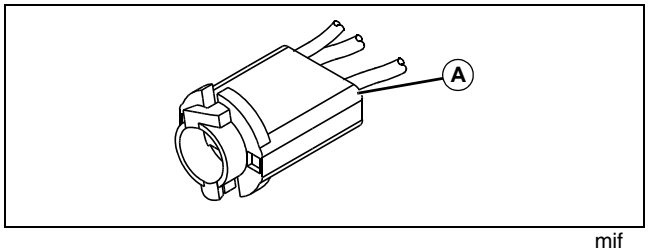
Yes - Install relay. Test neutral start switch. See “Neutral Start Switch Test” on page 343. If neutral start switch is OK, test start relay. See “Relay Test” on page 345.

No - Cranking circuit test complete. To test H2 engine coolant light circuit, go to step 1 of engine coolant light circuit test, if ok, cranking circuit test complete.

Test Conditions:

- Park brake locked.
- Hood open and storage tray removed.
- Transmission in neutral.
- Battery fully charged.
- X1 engine connector disconnected.
- Key switch in the start position during each test step.

System: Engine Coolant Light Check Circuit



mif

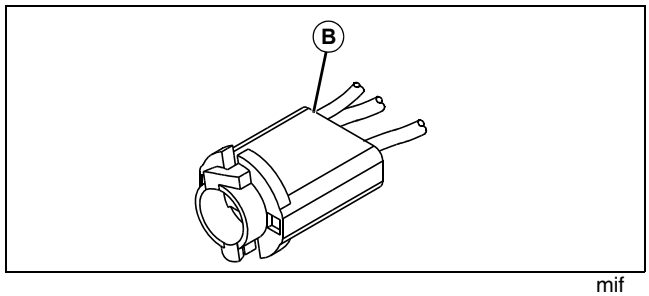
(1) Is battery voltage present at H2 engine coolant temperature light socket, 419 Yel wire (A)? Is H2 engine coolant temperature light illuminated?

Yes - Both conditions are yes. Circuit is operating properly. Test complete.

System: Engine Coolant Light Check Circuit

No - No voltage. Test key switch. See “Key Switch Test” on page 341. Check 420J, 420M, and 419 Yel wires and connections. Repair as needed and retest.

No - Light not illuminated. Test H2 engine coolant temperature bulb. See “Bulb Test” on page 347. If bulb is OK, go to next step.



mif

(2) Is continuity to ground present at H2 engine coolant temperature light socket, 301 Org wire (B)?

Yes - Test complete.

No - Test V1 diode. See “Diode Test” on page 344. Test key switch. See “Key Switch Test” on page 341. Check 302 Org, 100B and 101G Blk wires and connections.

Cranking Circuit Operation (Gas and Diesel Engines) (SN 40001 -)

Function:

To energize the starter motor solenoid and engage the starting motor.

Additionally, this circuit will test the engine coolant temperature bulb.

Operating Conditions:

- Transmission must be in NEUTRAL.
- Key switch must be in the START position.

Theory of Operation:

Unswitched power is supplied from the G1 battery through the 201 Red wire, F1 fuse, and the 216 Red wire to the K1 start relay normally open contact (terminal 4). When this relay is energized, contact internally is completed allowing power to flow to the 700 Pur and engine harness Blk/Wht (Gas) or 701 Pur (Diesel) wires to the Y1 starting motor solenoid. When the solenoid is energized, contact internally is completed to allow power to flow to the M1 starting motor, running the starting motor.

The K1 start relay is energized by the following circuit:

Unswitched power is supplied from the G1 battery through the 201 and 202 Red wires, F6 fuse, and the 208 Red wire to the S1 key switch. When the S1 key switch is in the START position, power is supplied through the switch to the 420J Yel wire to the S-2 power splice (switched power). From the S-2 power splice, power is supplied to the 420D Yel wire and the K1 start relay coil (terminal 5).

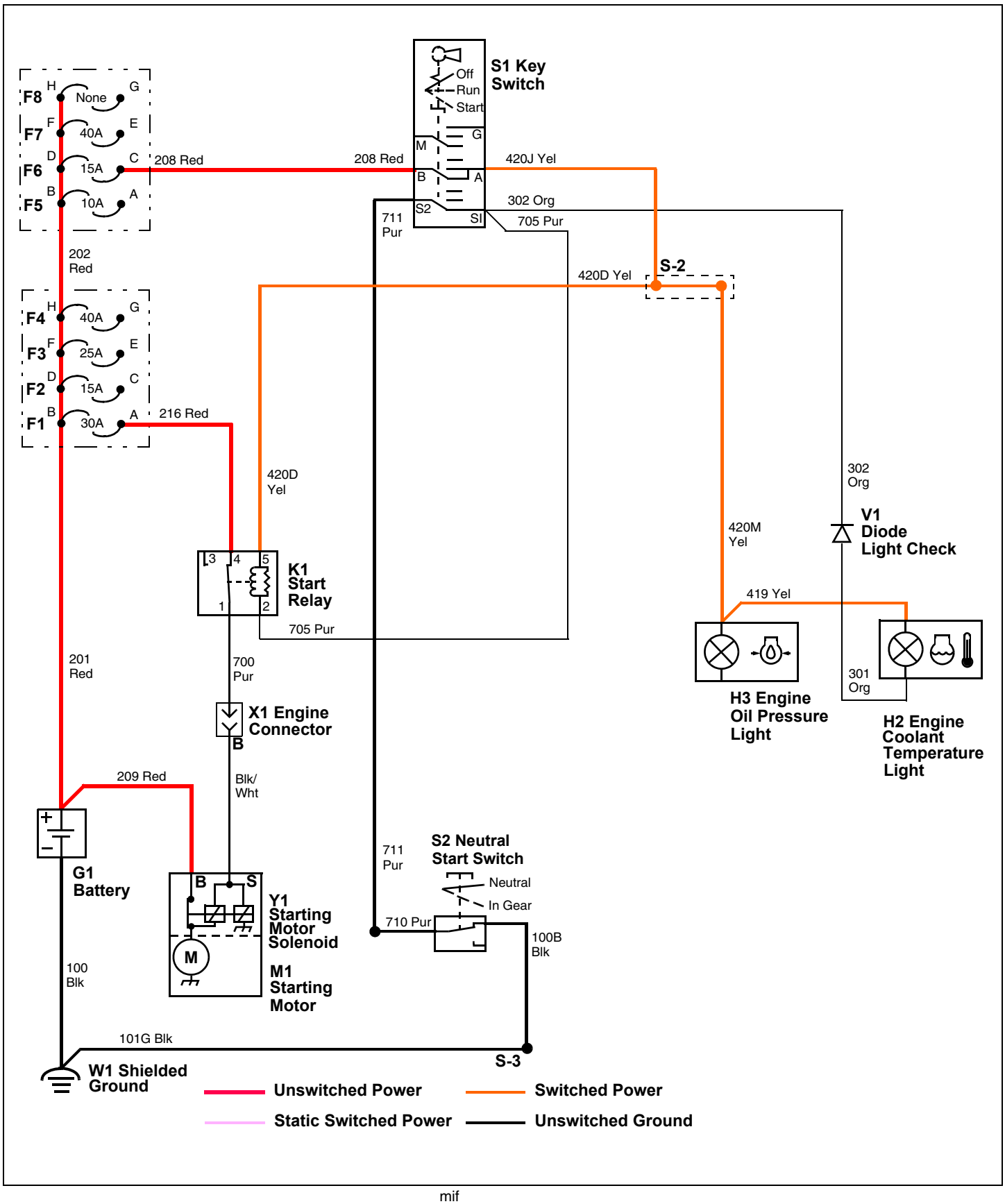
When the K1 start relay receives a ground through the S1 key switch (in start position) and S2 neutral start switch (transmission in neutral) the circuit is complete and the relay will be energized. The ground path is provided from the relay through the 705 Pur wire, S1 key switch (in start position), 711 and 710 Pur wires, S2 neutral start switch (contacts closed), and 100B and 101G Blk wires to the W1 ground.

As long as the S1 key switch is in the START position and the transaxle is in NEUTRAL (S2 neutral start switch closed) the circuit to ground for the relay coil is established and the relay coil is energized.

When the S2 neutral start switch is neutral (transmission in neutral) and the S1 key switch is in the start position, in addition to energizing the starting circuit, the H2 engine coolant temperature light is provided a ground path to test the bulb.

The H2 engine coolant temperature light is supplied switched power from the S-2 power splice through the 420M and 419 Yel wires. Static power across the bulb is changed to ground continuity when the S1 key switch is in the START position and the S2 neutral start switch is in neutral (transmission in neutral). This ground path is provided from the H2 engine coolant light through the 301 Org wire, V1 diode, 302 Org wire, S1 key switch (in start position), 711 and 710 Pur wires, S2 neutral start switch (contacts closed), and 100B and 101G Blk wires to the W1 ground.

Cranking Circuit Schematic (Gas and Diesel Engines) (SN 40001 -)



mif

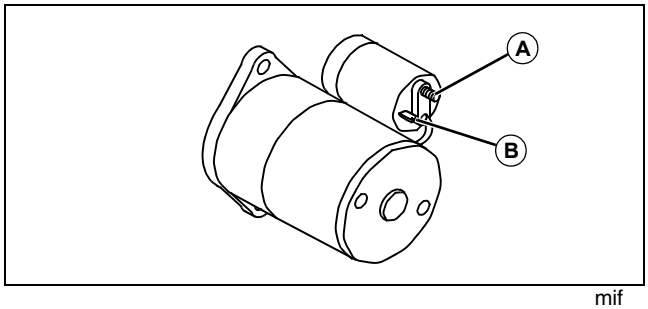
Cranking Circuit Diagnosis (Gas and Diesel Engines) (SN 40001 -)

Test Procedure A

Test Conditions:

- Cargo Box raised and locked.
- Hood open and storage tray removed.
- Transmission in neutral.
- Battery fully charged.
- Spark plug wires disconnected and grounded to frame.
- Key switch in the start position during each test step.

System: Cranking Circuit



mif

(1) Is battery voltage present at B terminal of Y1 starting motor solenoid (A)?

Yes - Go to next step.

No - Check battery cables and connections. Test battery. See “Battery Load Test” on page 336.

(2) Is battery voltage present at S terminal of starting motor solenoid (B)?

Yes - Cranking circuit is operating properly. Go to next step.

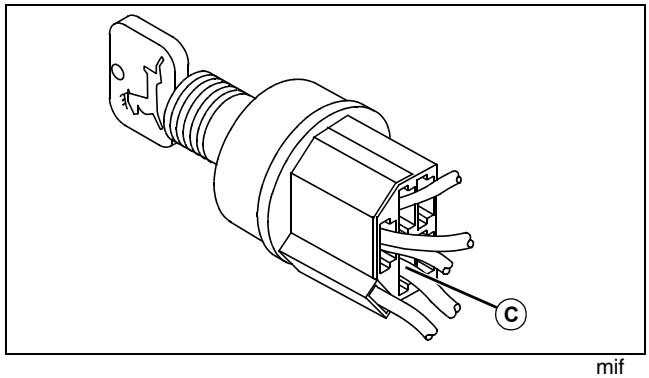
No - Go to step (4) to continue test.

(3) Is starting motor cranking engine?

Yes - Starting motor solenoid and motor are operating properly. To test H2 engine coolant light circuit, go to step 1 of engine coolant light circuit test, if OK, cranking circuit test complete.

No - Test starting motor solenoid. See “Starting Motor Solenoid Test” on page 339.

System: Cranking Circuit

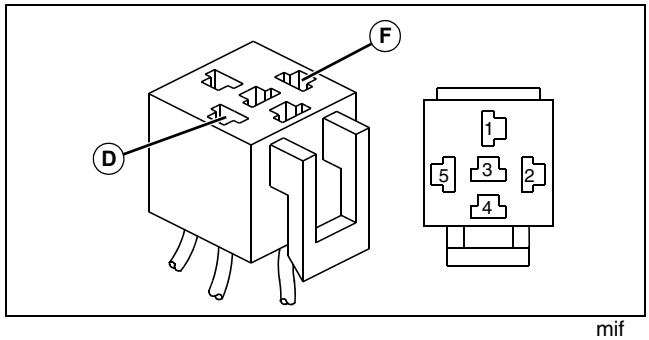


mif

(4) Is battery voltage present at B terminal of S1 key switch, 208 Red wire (C)?

Yes - Go to next step.

No - See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252 or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.



mif

(5) Remove K1 start relay. With key switch in start position, is battery voltage present at terminal 5 (86) of K1 start relay connector, 420D Yel wire (D)?

Yes - Go to next step.

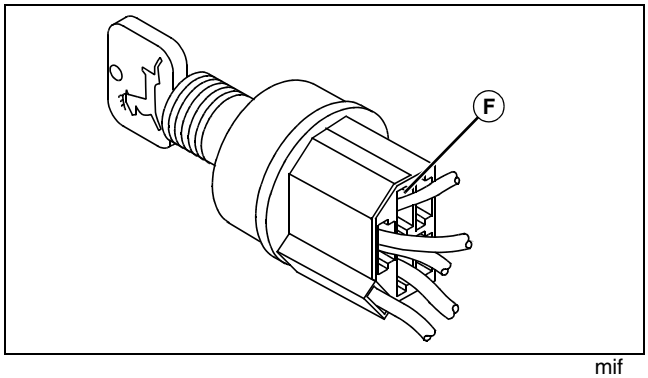
No - Test key switch. See “Key Switch Test” on page 341. Check 420J and 420D Yel wires.

(6) With key switch in start position and transmission in neutral, is continuity to ground present at terminal 2 (85) of K1 start relay, 705 Pur wire (E)?

Yes - Install relay. Test neutral start switch. See “Neutral Start Switch Test” on page 343. If neutral start switch is OK, test start relay. See “Relay Test” on page 345.

No - Go to next step.

System: Cranking Circuit

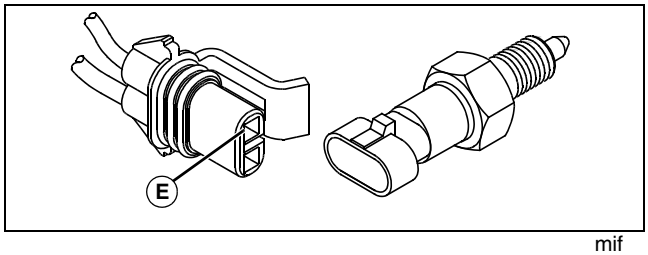


mif

(7) With transmission in neutral, is continuity to ground present at terminal S2 of S1 key switch, 711 Pur wire (F)?

Yes - Test key switch. See “Key Switch Test” on page 341. Check 705 Pur wire and connections.

No - Go to next step.



mif

(8) Disconnect S2 neutral start switch. is continuity to ground present at A terminal S2 neutral start switch connector, 705 Pur wire (G)?

Yes - Test neutral start switch. See “Neutral Start Switch Test” on page 343. Cranking circuit test complete. To test H2 engine coolant light circuit, go to step 1 of engine coolant light circuit test, if ok, cranking circuit test complete.

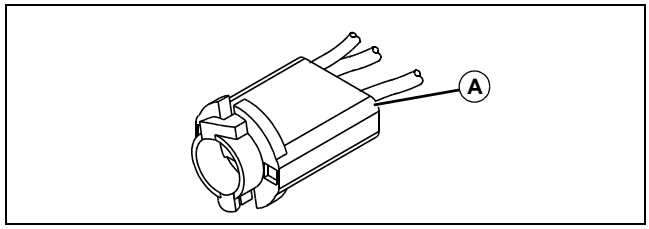
No - Check 100B and 101G wires and connections.

Test Procedure B

Test Conditions:

- Park brake locked.
- Hood open and storage tray removed.
- Transmission in neutral.
- Battery fully charged.
- X1 engine connector disconnected.
- Key switch in the start position during each test step.

System: Engine Coolant Light Check Circuit



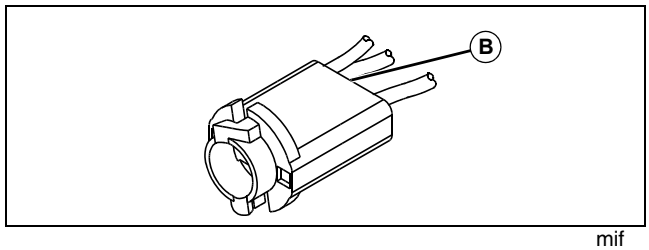
mif

(1) Is battery voltage present at H2 engine coolant temperature light socket, 419 Yel wire (A)? Is H2 engine coolant temperature light illuminated?

Yes - Both conditions are yes. Circuit is operating properly. Test complete.

No - No voltage. Test key switch. See “Key Switch Test” on page 341. Check 420J, 420M, and 419 Yel wires and connections. Repair as needed and retest.

No - Light not illuminated. Test H2 engine coolant temperature bulb. See “Bulb Test” on page 347. If bulb is OK, go to next step.



mif

(2) With key switch in start position and transmission in neutral, Is continuity to ground present at H2 engine coolant temperature light socket, 301 Org wire (B)?

Yes - Ground circuit is functional. Check the bulb and bulb socket.

No - Test V1 diode. See “Diode Test” on page 344. Test key switch. See “Key Switch Test” on page 341. Check 302 Org, 100B and 101G Blk wires and connections.

Ignition Circuit Operation (Gas Engine - All)

Function:

- To create a spark at the correct time that ignites the fuel/air mixture in the cylinder, thereby keeping the engine running.
- To ground the ignition system in order to shut off the engine.

Operating Conditions:

- Key switch must be in the RUN or START position.
- Flywheel on engine must be rotating the reference point past the pulser coil.
- Pulser coil must be the proper distance from the reference point as it rotates past.

Theory of Operation:

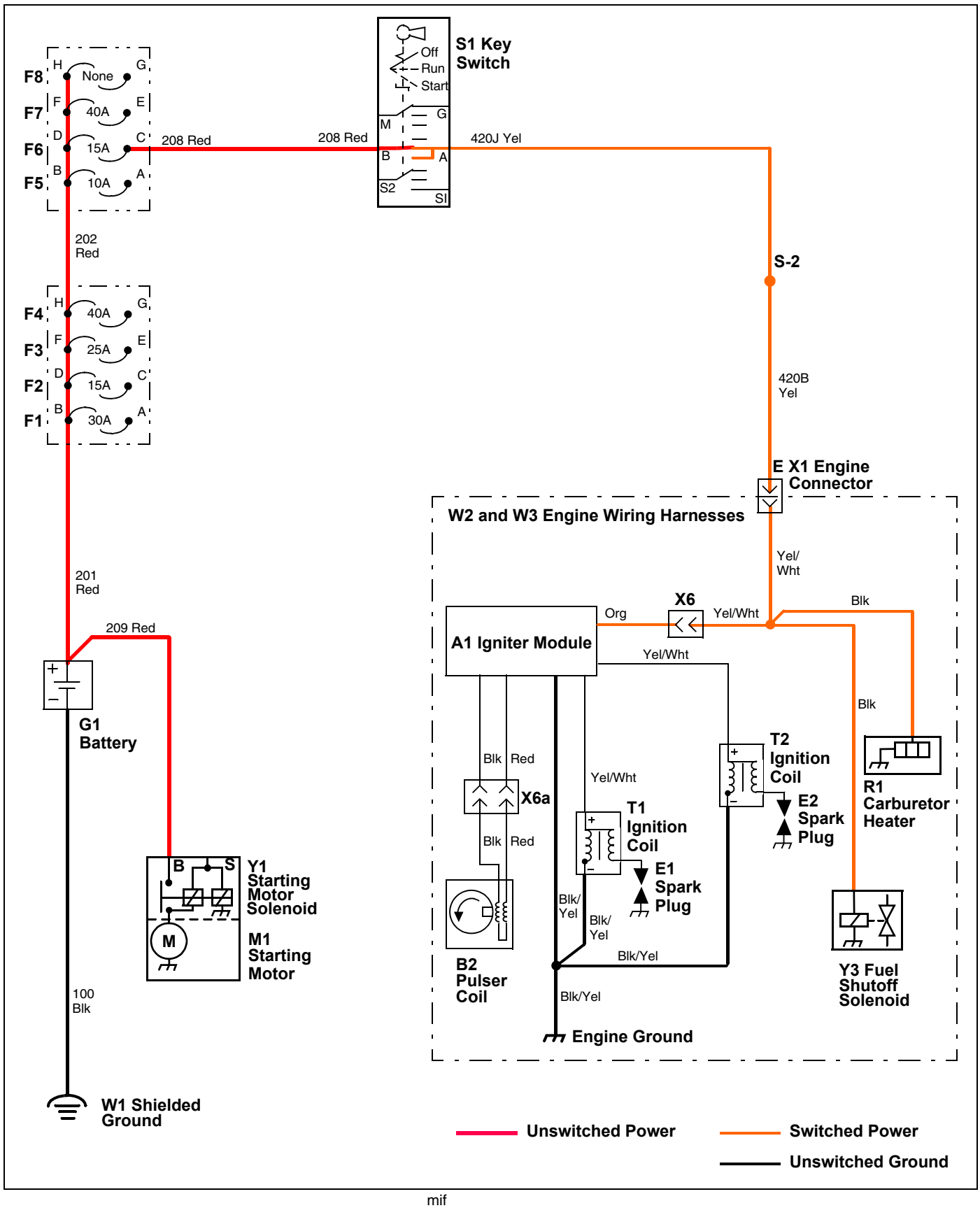
The ignition system is a digitally controlled capacitive discharge design. Ignition timing is controlled by the A1 ignitor module and is not adjustable. The engine is shut off by grounding both sides of the ignition coils through the A1 ignitor module.

When the key switch is in the START or RUN position, power is supplied from the G1 battery through 201 and 202 Red wires, F6 fuse, S1 key switch, 420J Yel wire S-2 power splice, 420B Yel wire to the X1 engine connector and on to the A1 ignitor module.

The A1 ignitor module controls spark timing by detecting raised reference points on the flywheel with a single pulser coil. Each cylinder is fired independently as controlled by the A1 ignitor module.

The engine is shut off by turning the key switch to the OFF position which, in turn, shuts power off to the A1 ignitor module. This will cause both sides of the T1 and T2 ignition coils to be grounded and spark will no longer be produced.

Ignition Circuit Schematic (Gas Engine - All)



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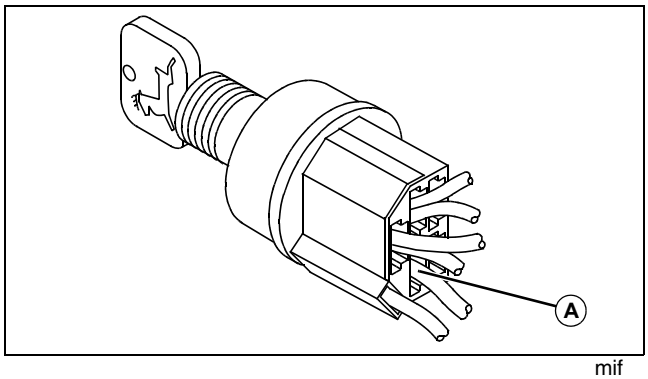
Ignition Circuit Diagnosis (Gas Engine - All)

Test Procedure A

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Park brake locked.
- Cargo box raised and locked.
- Key switch in the off position, engine not running.
- Check wires and connections for looseness and corrosion.

System: Ignition Circuit - Off

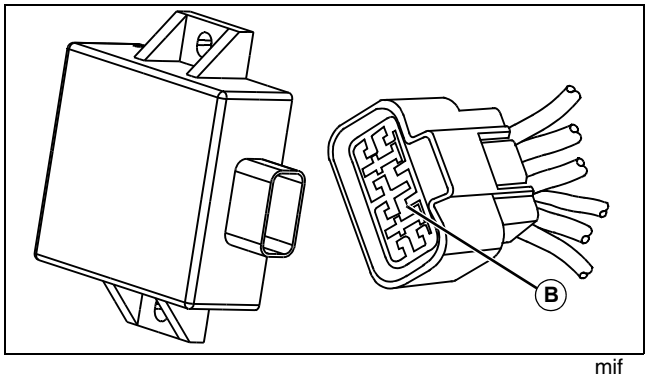


mif

(1) Is battery voltage present at the B terminal of the S1 key switch, 208 Red wire (A)?

Yes - Go to next step.

No - Test the unswitched power circuit. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243.



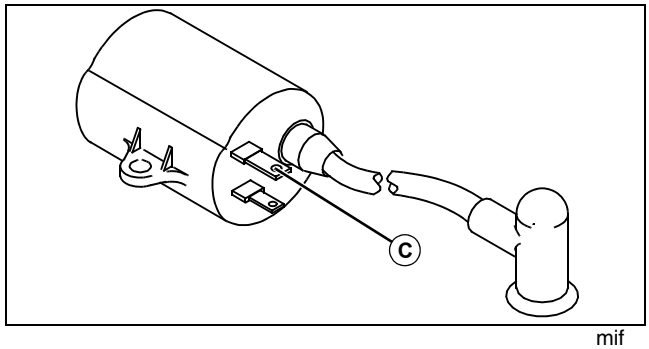
mif

(2) A1 Ignitor module disconnected. Is continuity to ground present at the X6 ignitor connector, Blk/Yel wire (B)?

Yes - Connect ignitor module connector. Go to next step.

System: Ignition Circuit - Off

No - Check engine ground and Blk/Yel wire and connections.

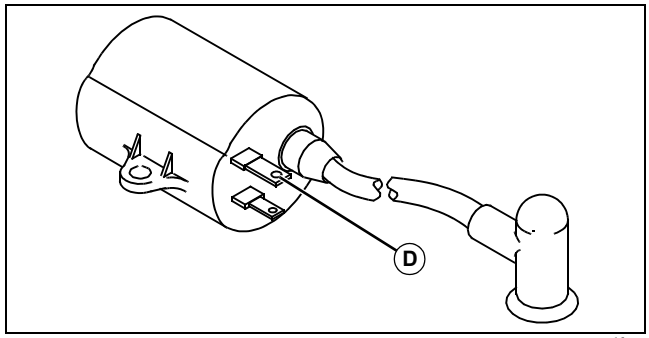


mif

(3) Is continuity to ground present at the T1 ignition coil, Yel/Wht wire (C)?

Yes - Go to next step.

No - Check Yel/Wht wire and connections. If ok, replace A1 ignitor module.

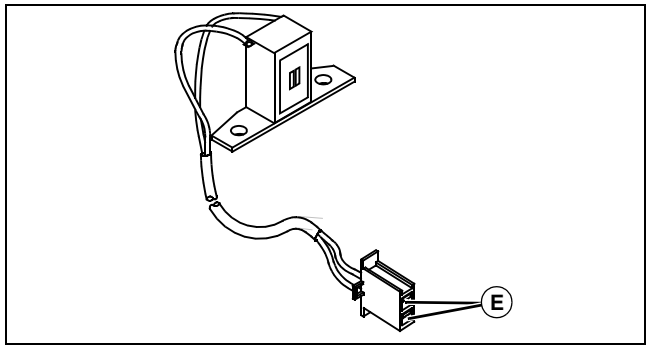


mif

(4) Is continuity to ground present at the T2 ignition coil, Yel/Wht wire (D)?

Yes - Go to next step.

No - Check Yel/Wht wire and connections. If ok, replace A1 ignitor module.



(5) Measure resistance across pulser coil (E). Is resistance 188 ohms ± 5 ohms?

System: Ignition Circuit - Off

Yes - Pulser coil is ok. Go to next step.

No - Replace pulser coil.

(6) Perform spark test on each ignition coil. See "Spark Test (Gas Engine)" on page 347. Is a strong blue spark present on each ignition coil?

Yes - Ignition coils are ok. Go to next step.

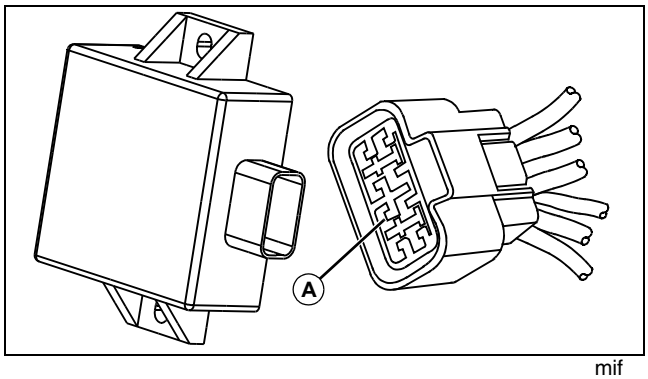
No - Replace components as indicated by spark test.

Test Procedure B

Test Conditions:

- Machine parked safely. See "Parking Safely" in the Safety section.
- Park brake locked.
- Cargo box raised and locked.
- Key switch in the run position, engine not running.
- Check wires and connections for looseness and corrosion.

System: Ignition Circuit - On



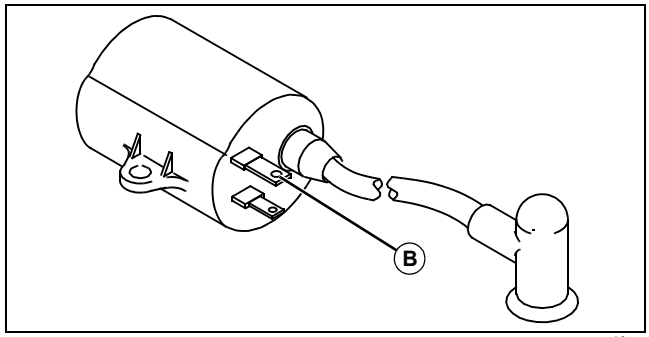
mif

(1) A1 Ignitor module disconnected. Is battery voltage present at the X6 ignitor connector, Org wire (A)?

Yes - Go to next step.

No - Test the key switch. See "Key Switch Test" on page 341. Check 420B and 420J Yel wires and connections.

System: Ignition Circuit - On

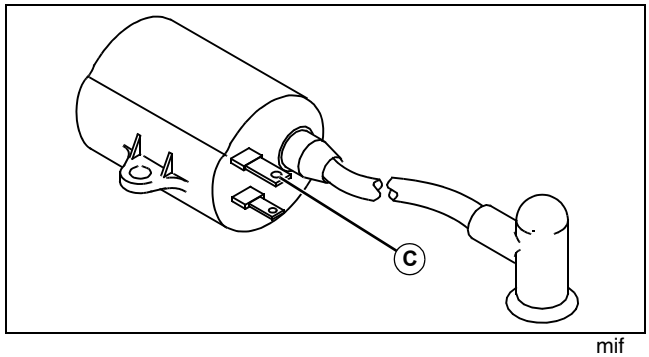


mif

(2) Is battery voltage present at the T1 ignition coil, Yel/Wht wire (B)?

Yes - Go to next step.

No - Check Yel/Wht wire and connections. If ok, replace A1 ignitor module.



mif

(3) Is battery voltage present at the T2 ignition coil, Yel/Wht wire (C)?

Yes - Test complete.

No - Check Yel/Wht wire and connections. If ok, replace A1 ignitor module. Test complete.

Charging Circuit Operation (Gas Engine - All)

Function:

To maintain battery voltage between 12.4 and 13.2 volts.

Operating Conditions:

- Key switch must be in the RUN position.
- Engine must be RUNNING for the charging system to operate.

Theory of Operation:

The charging system is a permanent magnet and stator design. Charging output is controlled by the N1 voltage regulator/rectifier.

With the S1 key switch in the run position, battery sensing circuit current flows from battery positive terminal through 201 and 202 Red wires, F6 fuse, 208 Red wire, S1 key switch, 420J Yel wire, S-2 power splice, 420C Yel wire and Brn wire to the N1 voltage regulator/rectifier.

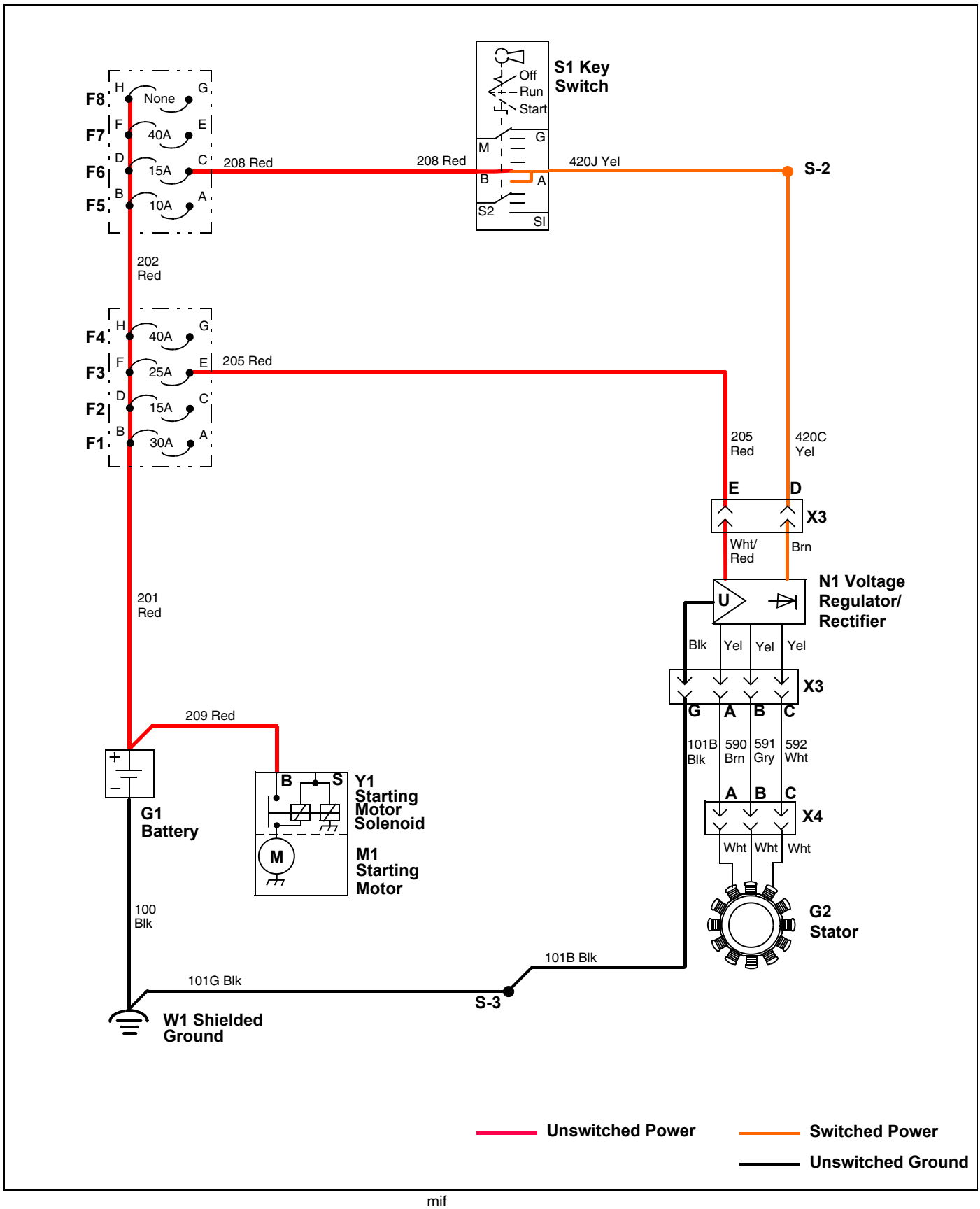
The battery sensing circuit allows the voltage regulator/rectifier to monitor battery voltage.

As the flywheel turns, permanent magnets located in the flywheel induces AC current in the stator. The AC current flows to the voltage N1 regulator/rectifier. The voltage regulator/rectifier converts AC current to DC current needed to charge the battery.

If G1 battery voltage is low, the voltage regulator/rectifier allows DC current to flow to the battery, through the Wht/Red wire, 205 Red wire, F3 fuse, and 201 Red wire. When the battery is fully charged, the regulator stops current flow to the battery.

The ground circuit provides a path to ground for the voltage regulator/rectifier through the Blk, 101B Blk, and 101G Blk wires.

Charging Circuit Schematic (Gas Engine - All)



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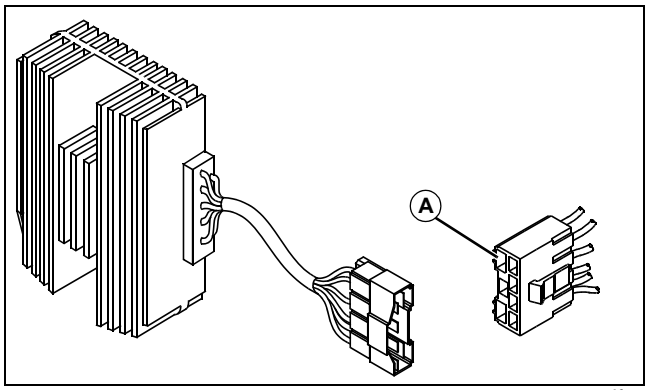
Charging Circuit Diagnosis (Gas Engine - All)

Test Procedure A

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Cargo box raised and locked.
- Key switch in the run position, engine not running.
- Check wires and connections for looseness and corrosion.

System: Charging Circuit

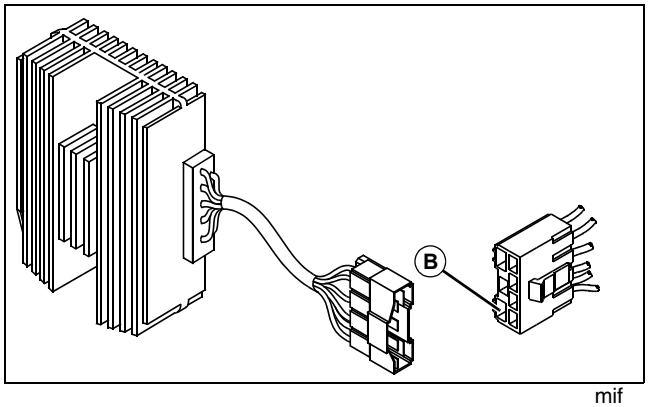


mif

(1) Disconnect N1 voltage regulator/rectifier. Is continuity to ground present at pin G of X3 connector, 101B Blk wire (A)?

Yes - Go to next step.

No - Check 101B Blk and 101G Blk wires and connections.



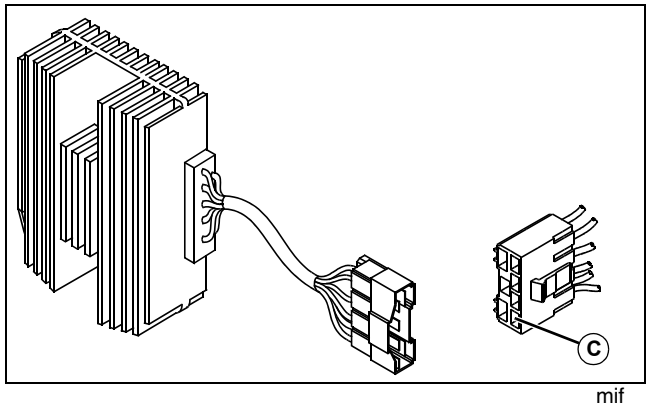
mif

(2) Disconnect N1 voltage regulator/rectifier. Is battery voltage present at pin E of X3 connector, 205 Red Yel wire (B)?

Yes - Go to next step.

System: Charging Circuit

No - Test the unswitched power circuit. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243.



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(3) Disconnect N1 voltage regulator/rectifier. Is battery voltage present at pin D of X3 connector, 420C Yel wire (C)?

Yes - Go to next step.

No - Test the switched power circuit. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243.

Test Procedure B

Test Conditions:

- Park brake locked.
- Transmission in neutral.
- Cargo box raised and locked.
- Key switch in run position, engine running at slow idle.
- Engine speed increased from slow idle to fast idle during test.

System: Charging Circuit

(1) Start measuring voltage at battery terminals with engine running at slow idle. Record voltage as engine speed is increased to fast idle. Does voltage increase from approximately 12.0 volts to approximately 15.0 volts?

Yes - Test complete.

No - Test voltage rectifier/regulator. See “Unregulated Voltage Test (Gas Engine)” on page 337. Test stator. See “Stator Resistance Test (Gas Engine)” on page 337.

Charging Circuit Operation (Diesel Engine - All)

Function:

To maintain battery voltage between 12.4 and 13.2 volts.

Operating Conditions:

- Key switch must be in the RUN position.
- Engine must be RUNNING for the charging system to operate.

Theory of Operation:

The charging system consists of an alternator with an internal voltage regulator/rectifier. Charging output is controlled by the internal voltage regulator/rectifier. A discharge indicator light is mounted on the dash to alert the operator of charging system problems.

With the S1 key switch in the run position, battery sensing circuit current flows from battery positive terminal through the 206, 201 and 202 Red wires, F6 fuse, 208 Red wire, S1 key switch, 420J Yel wire, S-2 power splice, 420B Yel wire to the G2 Alternator.

The battery sensing circuit allows the internal voltage regulator/rectifier to monitor battery voltage.

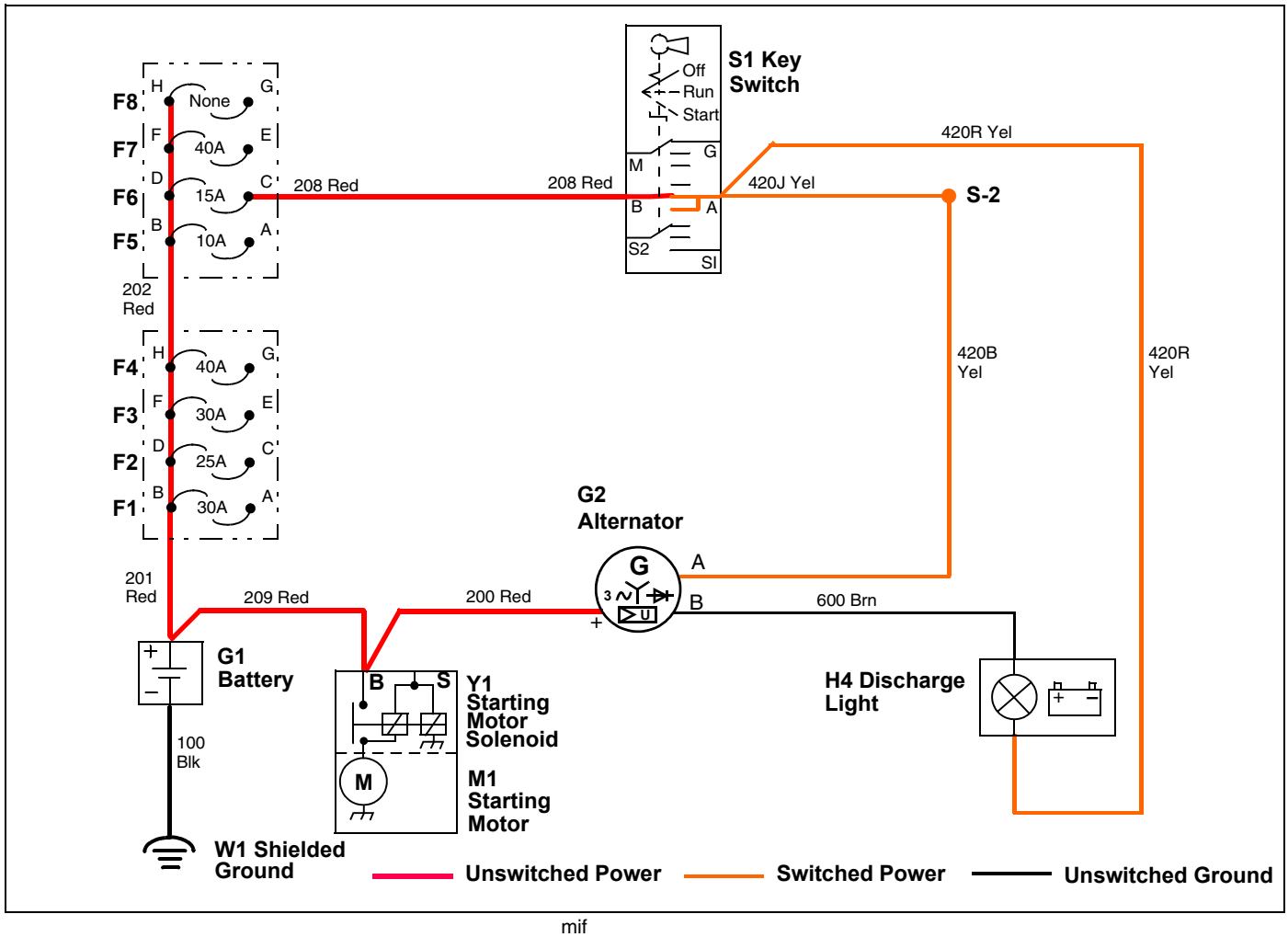
A rotating permanent magnet in the alternator induces AC current in the alternator stator coils. The AC current flows to the internal voltage regulator/rectifier. The voltage regulator/rectifier converts AC current to DC current needed to charge the battery.

If G1 battery voltage is low, the voltage regulator/rectifier allows DC current to flow to the battery through the 200 and 209 Red wires. When the battery is fully charged, the regulator stops current flow to the battery.

When the alternator output is incapable of meeting the electrical charging demands, the internal voltage regulator will complete a path to ground for the H4 discharge light and cause it to illuminate.

The G1 alternator is grounded through the engine ground.

Charging Circuit Schematic (Diesel Engine - All)



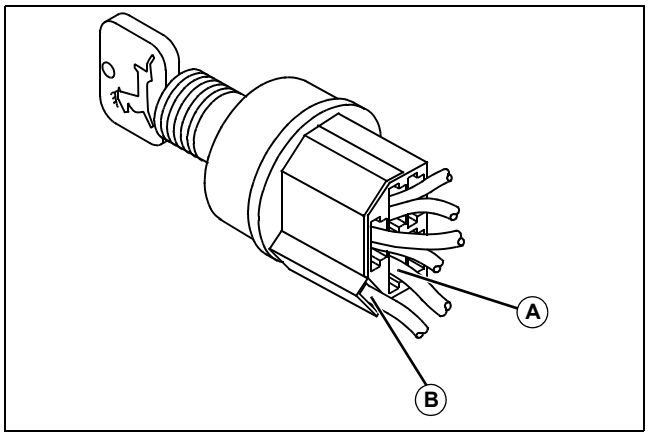
mif

Charging Circuit Diagnosis (Diesel Engine - All)

Test Conditions:

- Test output of alternator. See “Alternator Unregulated Amperage Test” on page 338 and “Alternator Regulated Output Test” on page 338.
- Machine parked safely. See “Parking Safely” in the Safety section.
- Cargo box raised and locked.
- Open hood and remove storage tray.
- Key switch in run position, engine not running.
- Disconnect any other attachment option(s) from the main wiring harness.
- Battery fully charged.

System: Alternator Circuit



(1) Is battery voltage present at the “B” terminal of the S1 key switch (A)?

Yes - Go to next step.

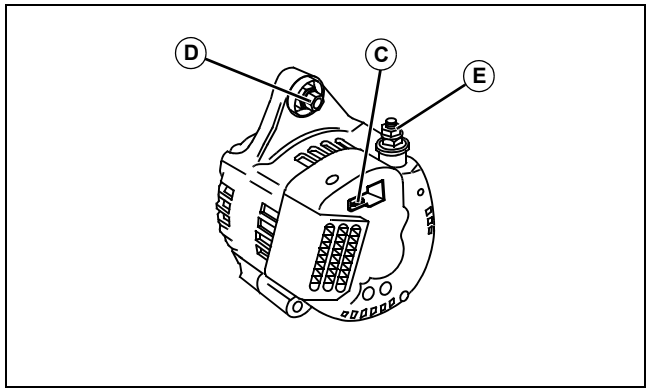
No - Check F6 fuse, 206, 201, 202, and 208 Red wires, and connections.

(2) Is battery voltage present at the “A” terminal of the S1 key switch (B)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341.

System: Alternator Circuit



(3) Is battery voltage present at the G2 alternator, 420B Yel wire (C)?

Yes - Go to next step.

No - Check 420J and 420B Yel wires, S-2 splice and connections.

(4) Is continuity to ground present at adjustment bolt (D) of G2 alternator?

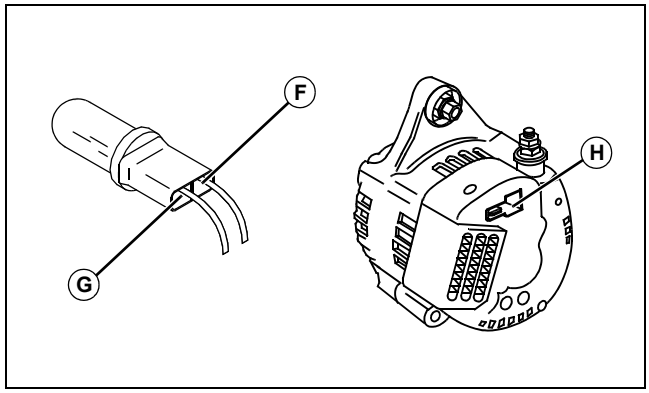
Yes - Go to next step.

No - Check engine ground and connections.

(5) Is battery voltage present at G2 alternator 200 Red wire (E)?

Yes - Go to next step.

No - Check 209 and 200 Red wires and connections.



(6) Is battery voltage present at 420R Yel wire (F) of H4 discharge light?

Yes - Go to next step.

No - Check 420R Yel wire and connections. Test key switch. See “Key Switch Test” on page 341.

System: Alternator Circuit

(7) Is continuity present between H4 discharge light 600 Brn wire termination (G) and G2 alternator 600 Brn wire termination (H).

Yes - Test H4 discharge light bulb. If OK, go to next step.

No - Check 600 Brn wire and connections.

(8) Is continuity between 600 Brn wire at G2 alternator and ground?

Yes - End of test.

No - Check engine ground. If OK, disassemble and check alternator internal components. See “High Capacity Alternator Removal and Installation” on page 353. If OK, replace voltage regulator.

Fuel Pump Circuit Operation (Gas Engine - All)

Function:

To provide a constant flow of fuel to the engine.

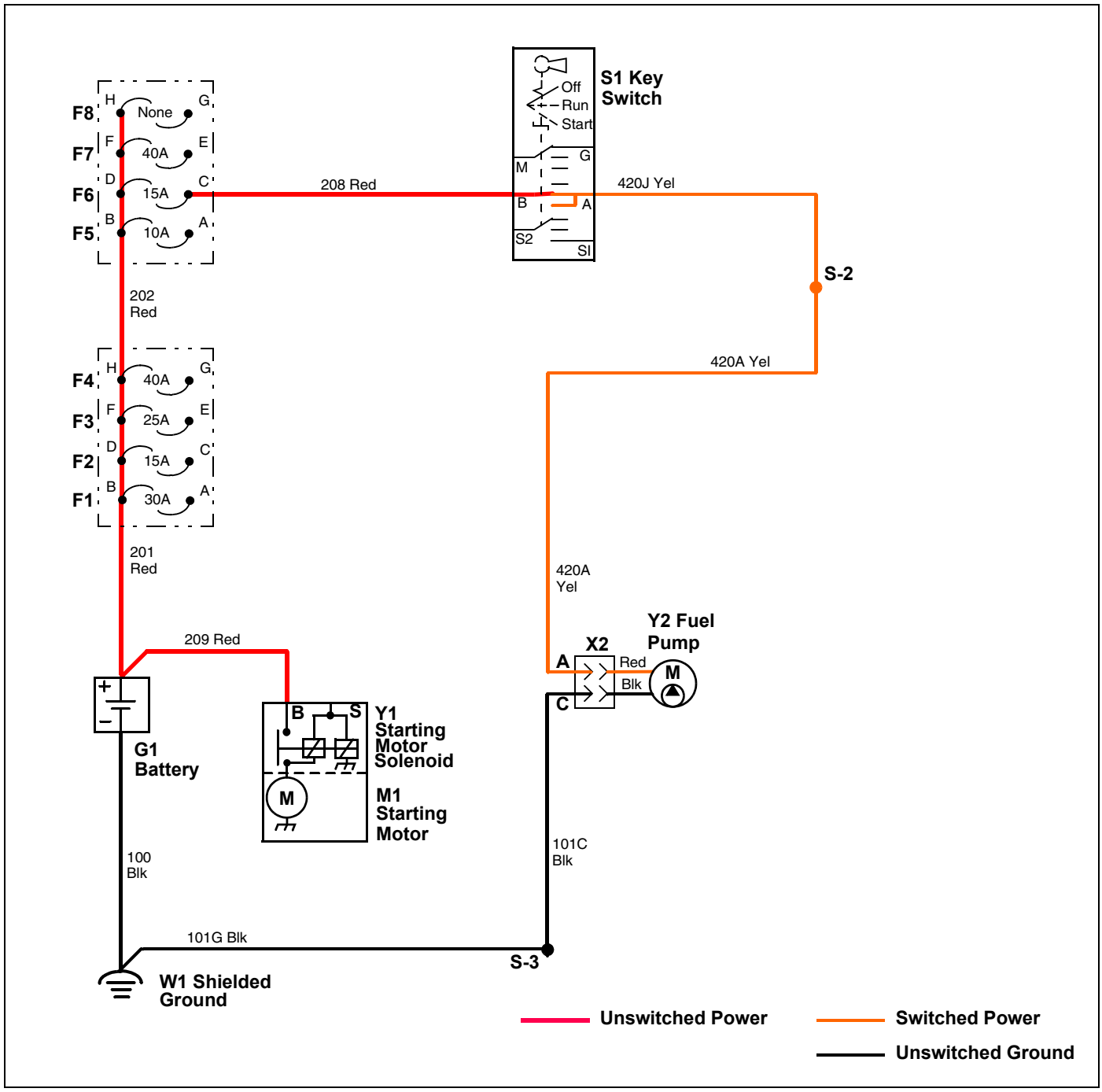
Operating Conditions:

- Key switch in the START or RUN position.

Theory of Operation:

The G1 battery supplies current through the F6 fuse and S1 key switch to the S-2 power splice. Voltage then flows, over the 420A Yel wire to the Y2 fuel pump. The fuel pump is a constant flow 10.8 kPa (1.6 psi) DC sealed unit. The circuit is completed by the 101C Blk, S3 splice, and 101G Blk wire to ground.

Fuel Pump Circuit Schematic (Gas Engine - All)



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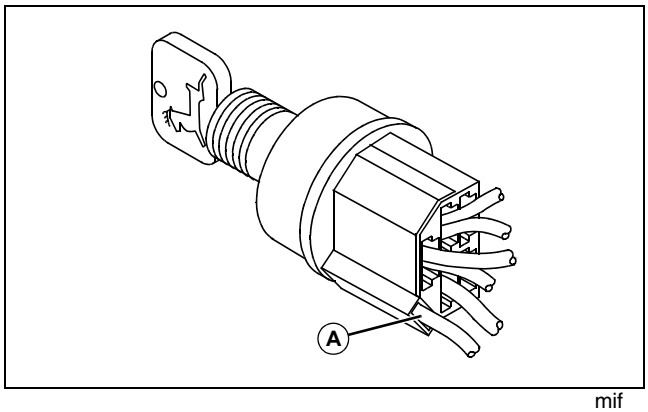
Fuel Pump Circuit Diagnosis (Gas Engine - All)

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Cargo box raised and locked.
- Battery fully charged.
- Key switch in run position, engine off.
- Check wire connections for looseness and corrosion.

System: Fuel Pump Circuit



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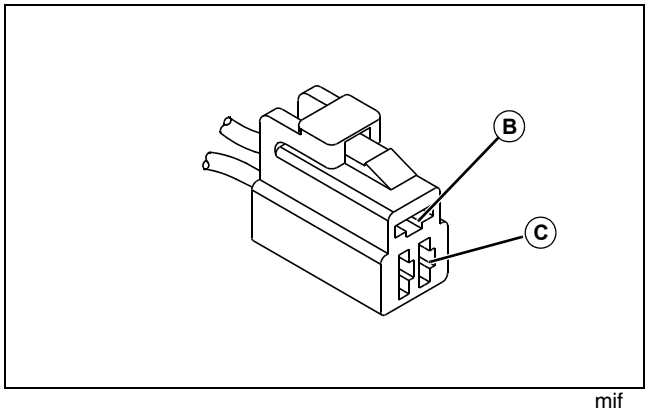
(1) Is battery voltage present at pin A of S1 key switch (A)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341. See “Power Circuit Diagnosis (Gas Engine) (SN -40000)” on page 246 or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252.



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(2) Disconnect Y2 fuel pump from harness. Is battery voltage present at A terminal of Y2 fuel pump connector, 420A Yel wire (B)?

System: Fuel Pump Circuit

Yes - Go to next step.

No - Check 420J and 420A Yel wires and connections.

(3) Is continuity to ground present at C terminal of Y2 fuel pump connector, 101C Blk wire (C)?

Yes - Test fuel pump. See “Fuel Pump Flow Test” on page 38 of Kawasaki Engine section.

No - Check 101C and 101G Blk wires and connections.

Fuel Shutoff Circuit Operation (Gas Engine - All)

Function:

To shut off the supply of fuel to the carburetor with the key switch in the OFF position.

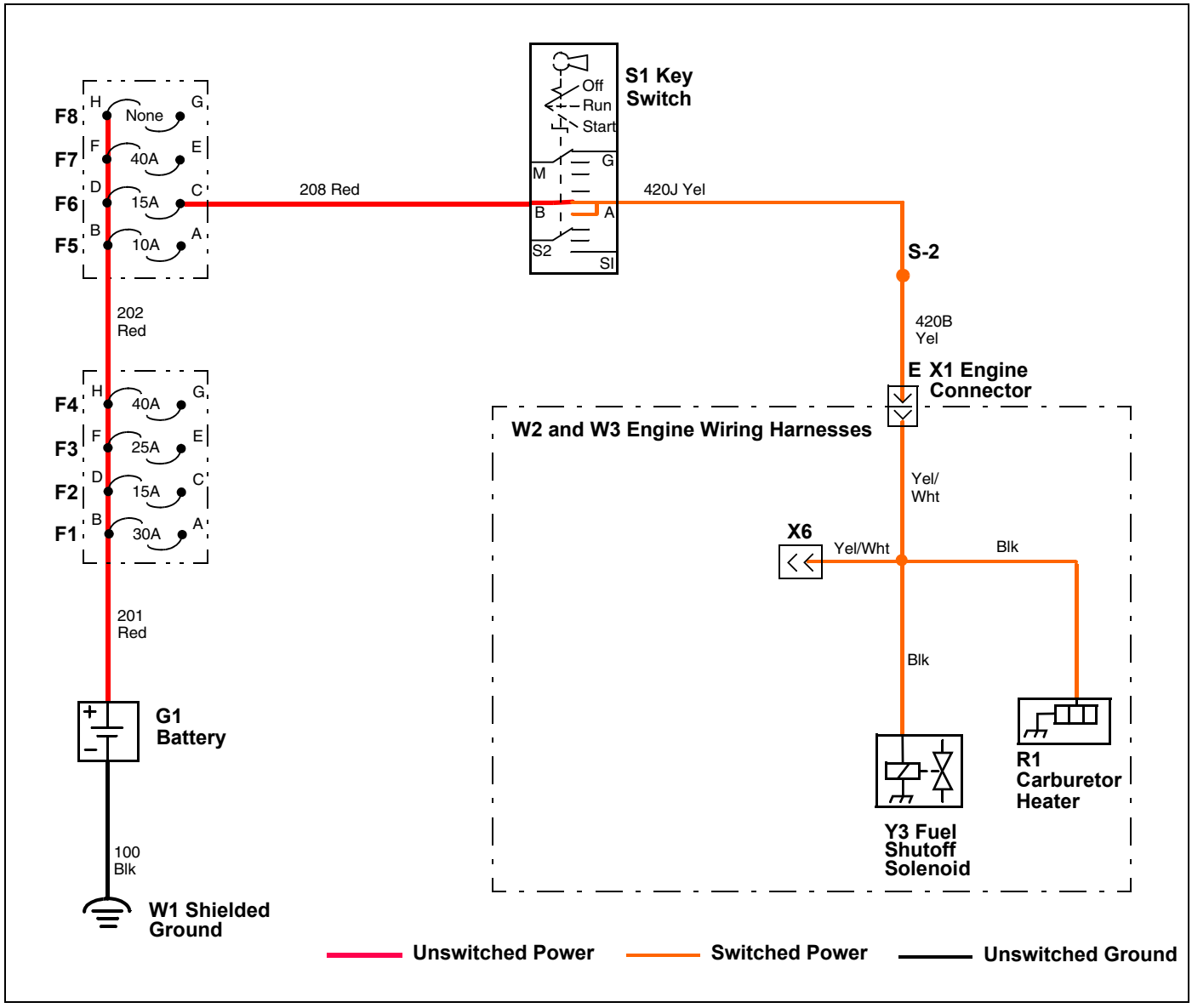
Operating Conditions:

- Key switch in the ON position to allow fuel to the carburetor.

Theory of Operation:

The G1 battery supplies current through the F6 fuse and S1 key switch over the 420J Yel wire to the S2 splice. Battery voltage then flows over the 420B yel wire to the X1 engine connector. A Yel/Wht wire, splice, and a Blk wire carry power to the Y3 fuel shutoff solenoid. The path to ground is completed the body of the solenoid to the engine. This will cause the solenoid to energize and allow fuel to the carburetor.

Fuel Shutoff Solenoid Circuit Schematic (Gas Engine - All)



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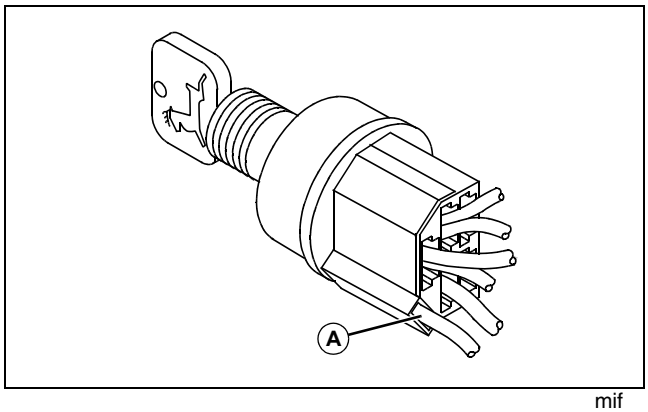
Fuel Shutoff Circuit Diagnosis (Gas Engine - All)

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Cargo box raised and locked.
- Battery fully charged.
- Key switch in run position, engine off.
- Check wire connections for looseness and corrosion.

System: Fuel Shutoff Solenoid Circuit



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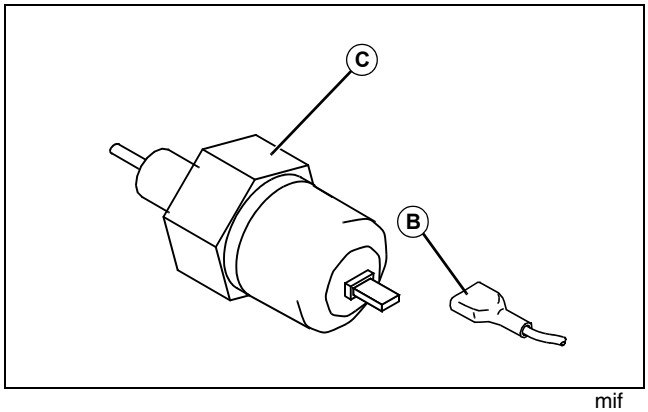
(1) Is battery voltage present at pin A of S1 key switch (A)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341. See “Power Circuit Diagnosis (Gas Engine) (SN -40000)” on page 246 or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252.



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(2) Disconnect Y3 fuel shutoff solenoid from harness. Is battery voltage present at Y3 fuel shutoff solenoid, Blk wire (B)?

System: Fuel Shutoff Solenoid Circuit

Yes - Go to next step.

No - Check Blk, Yel/Wht, 420B, and 420J Yel wires and connections.

(3) Is continuity to ground present at body of Y3 fuel shutoff solenoid (C)?

Yes - Test fuel shutoff solenoid. See “Fuel Shutoff Solenoid Test (Gas Engine)” on page 350. Connect fuel shutoff solenoid.

No - Check engine ground to frame and battery.

Fuel Shutoff Circuit Operation (Diesel Engine) (SN -40000)

Function:

To shut off the supply of fuel to the engine with the key switch in the OFF position.

Operating Conditions:

- Key switch in the ON position to allow fuel to the engine.

Theory of Operation:

Pull-In Coil - Unswitched power is supplied from the G1 battery through the 201 and 202 Red wires, F6 fuse, and the 208 Red wire to the S1 key switch. When the S1 key switch is in the START position, power is supplied through the switch to the 420J Yel wire to the S-2 power splice (switched power). From the S-2 power splice, power is supplied to the 420D Yel wire and the K1 start relay coil (terminal 5).

When the K1 start relay receives a ground through the S2 neutral start switch (transmission in neutral) and S1 key switch (in start position) the circuit is complete and the relay will be energized. The ground path is provided from the relay through the 710 Pur wire, S2 neutral start switch (contacts closed), 705 Pur wire, S1 key switch, and 100B, 100J and 101G Blk wires to the W1 ground.

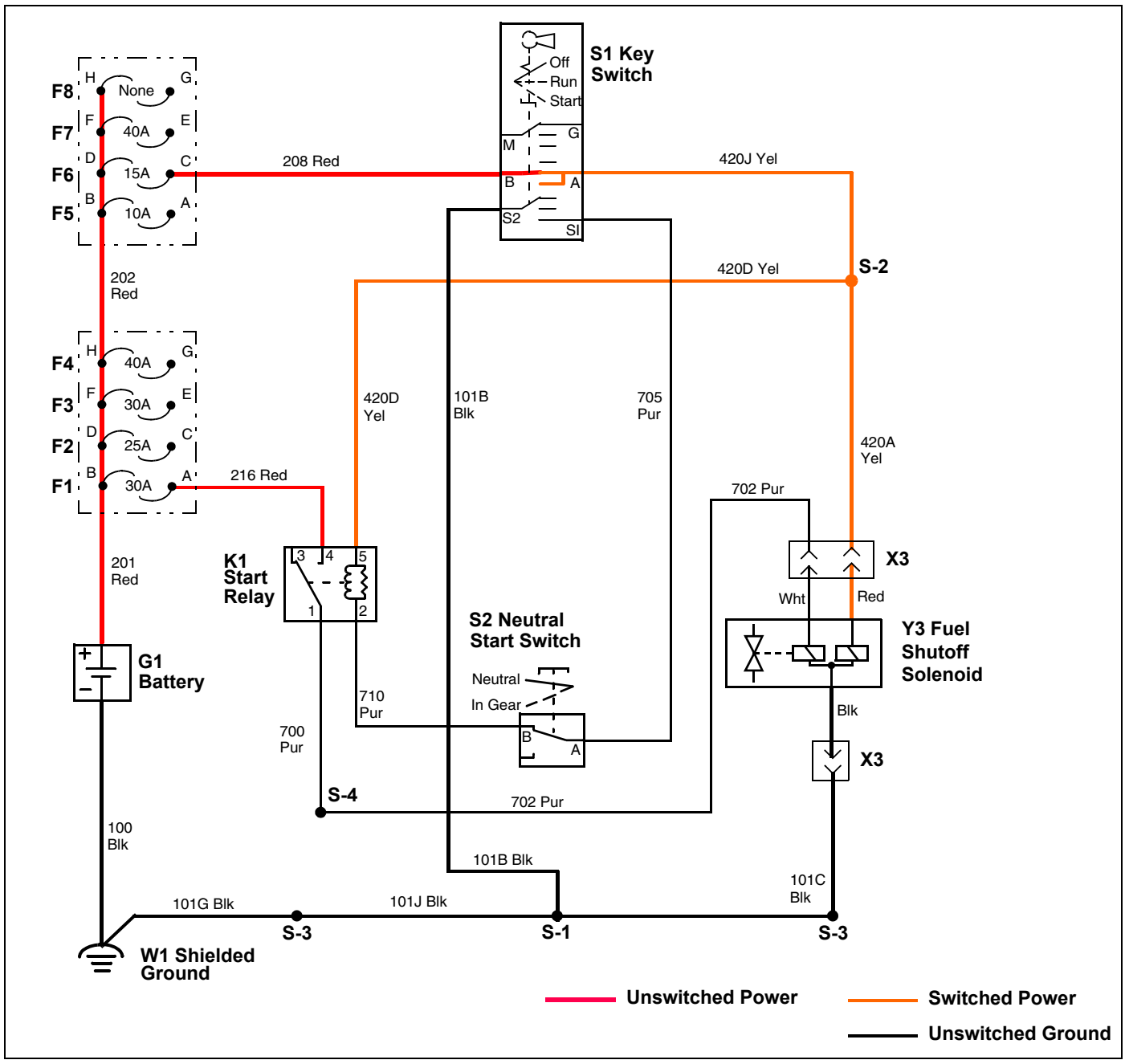
As long as the S1 key switch is in the START position and the transaxle is in NEUTRAL (S2 neutral start switch closed) the circuit to ground for the relay coil is established and the relay coil is energized.

With the K1 start relay energized, the 700 Pur wire, S-4 splice, and 702 Pur wire carry power to the Y3 fuel shutoff solenoid pull-in coil.

The path to ground for the Y3 fuel shutoff solenoid is completed through a Blk wire, X3 connector, 101C Blk wire, S-3 splice, and 100G Blk wire.

Hold-In Coil - The G1 battery supplies current through the F6 fuse and S1 key switch to the S2 splice. Battery voltage then flows over the 420A Yel wire to the X3 connector. A Red wire carries power to the Y3 fuel shutoff solenoid.

Fuel Shutoff Circuit Schematic (Diesel Engine) (SN -40000)



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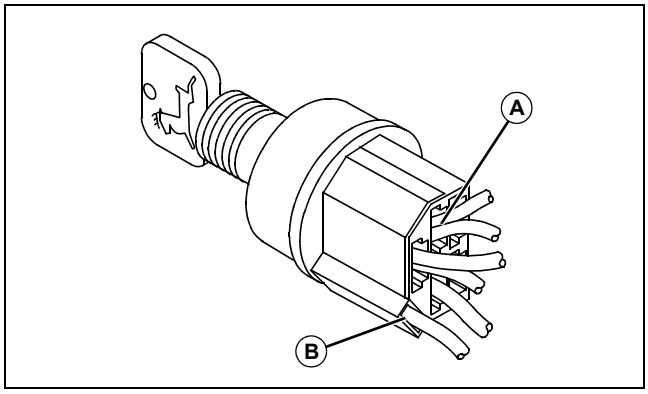
Fuel Shutoff Circuit Diagnosis (Diesel Engine) (SN -40000)

Test Procedure A

Test Conditions:

- Park brake locked.
- Cargo box raised and locked.
- Battery fully charged.
- Transmission in neutral.
- Key switch in start position.
- Check wire connections for looseness and corrosion.

System: Fuel Shutoff Solenoid Pull-In Circuit



(1) Is continuity to ground present at 705 Pur wire (pin S1) (A) of S1 key switch?

Yes - Go to next step.

No - Test S1 key switch. See “Key Switch Test” on page 341.

No - Check 101B, 101J, and 101G Blk wires to ground.

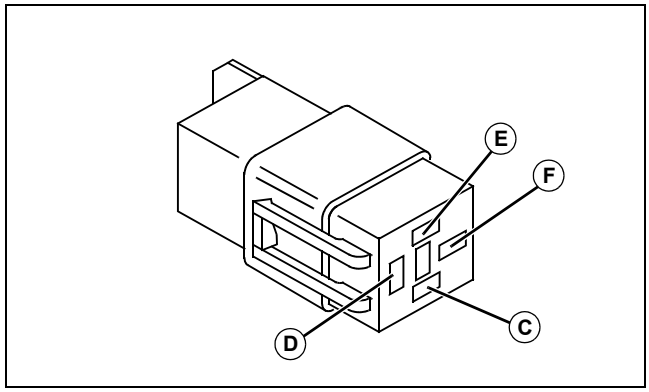
(2) Is battery voltage present at 420J Yel wire (pin A) (B) of S1 key switch?

Yes - Go to next step.

No - Test power circuit to key switch. See “Power Circuit Diagnosis (Diesel Engine) (SN -40000)” on page 264.

No - Test key switch. See “Key Switch Test” on page 341.

System: Fuel Shutoff Solenoid Pull-In Circuit



(3) Is battery voltage present at 420D Yel wire (pin 5) (C) of K1 start relay?

Yes - Go to next step.

No - Check 420J and 420D Yel wires and connections.

(4) Is battery voltage present at 216 Red wire (pin 4) (D) of K1 start relay.

Yes - Go to next step.

No - Check 201 Red wire, F1 fuse and 216 Red wire and connections.

(5) Is continuity to ground present at 710 Pur wire (pin 2) (E) of K1 start relay?

Yes - Test K1 start relay. See “Relay Test” on page 345. If OK, go to next step.

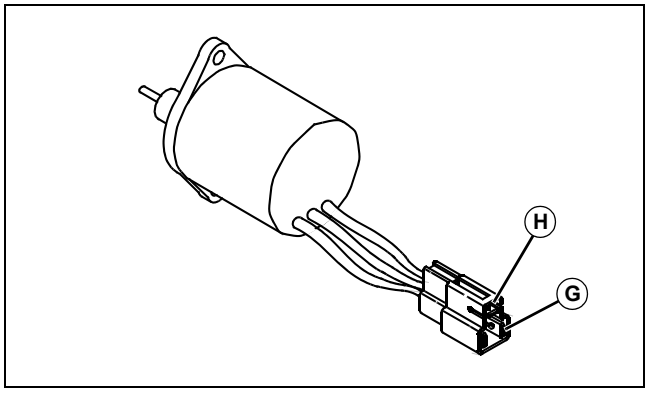
No - Test S2 neutral start switch. See “Neutral Start Switch Test” on page 343. If OK, check 710 and 705 Pur wires and connections.

(6) Is battery voltage present at 700 Pur wire (pin 1) (F) of K1 start relay?

Yes - Go to next step.

No - Test K1 start relay. See “Relay Test” on page 345.

System: Fuel Shutoff Solenoid Pull-In Circuit



(7) Is battery voltage present at X3 connector, 702 Pur wire (G) of Y3 fuel shutoff solenoid?

Yes - Go to next step.

No - Check 700 and 702 Pur wires and connections.

(8) Is there continuity between X3 connector, 101C Blk wire (H) at Y3 fuel shutoff solenoid and ground?

Yes - Test fuel shutoff solenoid. See “Fuel Shutoff Solenoid Test (Diesel Engine)” on page 350.

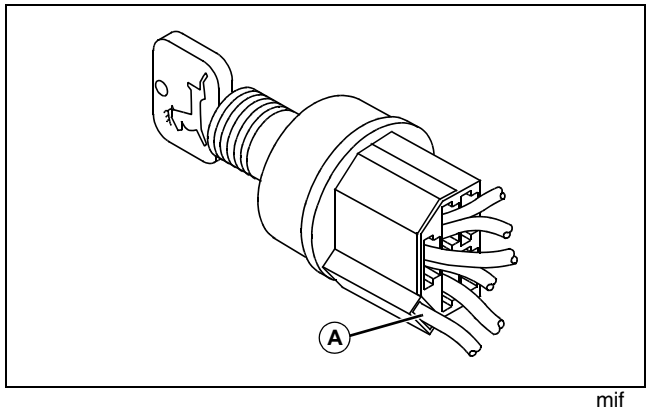
No - Check 101C, 100J, and 100G Blk wires, connections and splices.

Test Procedure B

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Park brake locked.
- Cargo box raised and locked.
- Battery fully charged.
- Key switch in run position, engine off.
- Check wire connections for looseness and corrosion.

System: Fuel Shutoff Solenoid Hold-In Circuit



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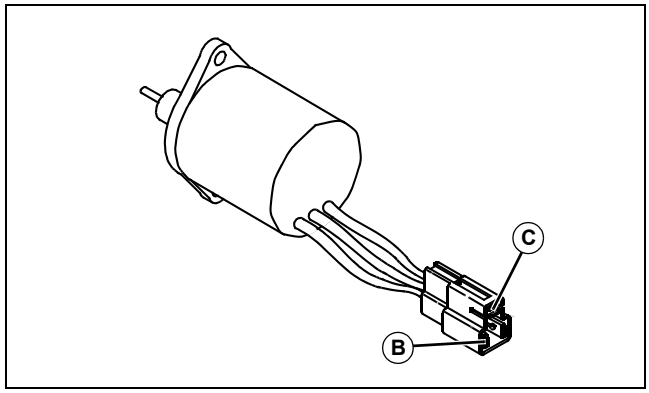
(1) Is battery voltage present at 420J Yel wire (pin A) (A) of S1 key switch?

Yes - Go to next step.

No - Test power circuit to key switch. See “Power Circuit Diagnosis (Diesel Engine) (SN -40000)” on page 264.

No - Test key switch. See “Key Switch Test” on page 341.



(2) Is battery voltage present at X3 connector, 420A Yel wire (B) of Y3 fuel shutoff solenoid?

Yes - Go to next step.

No - Check 420J and 420A Yel wires, splice and connections.

(3) Is there continuity between X3 connector, 101C Blk wire (C) at Y3 fuel shutoff solenoid and ground?

Yes - Test fuel shutoff solenoid. See “Fuel Shutoff Solenoid Test (Diesel Engine)” on page 350.

No - Check 101C, 100J, and 100G Blk wires, connections and splices.

Fuel Shutoff Circuit Operation (Diesel Engine) (SN 40001 -)

Function:

To shut off the supply of fuel to the engine with the key switch in the OFF position.

Operating Conditions:

- Key switch in the ON position to allow fuel to the engine.

Theory of Operation:

Pull-In Coil - Unswitched power is supplied from the G1 battery through the 201 and 202 Red wires, F6 fuse, and the 208 Red wire to the S1 key switch. When the S1 key switch is in the START position, power is supplied through the switch to the 420J Yel wire to the S-2 power splice (switched power). From the S-2 power splice, power is supplied to the 420D Yel wire and the K1 start relay coil (terminal 2).

When the K1 start relay receives a ground through the S1 key switch (in start position) and S2 neutral start switch (transmission in neutral) and the circuit is complete and the relay will be energized. The ground path is provided from the relay through the 705 Pur wire, S1 key switch (in start position), 711 and 710 Pur wires, S2 neutral start switch (contacts closed), and 100B and 101G Blk wires to the W1 ground.

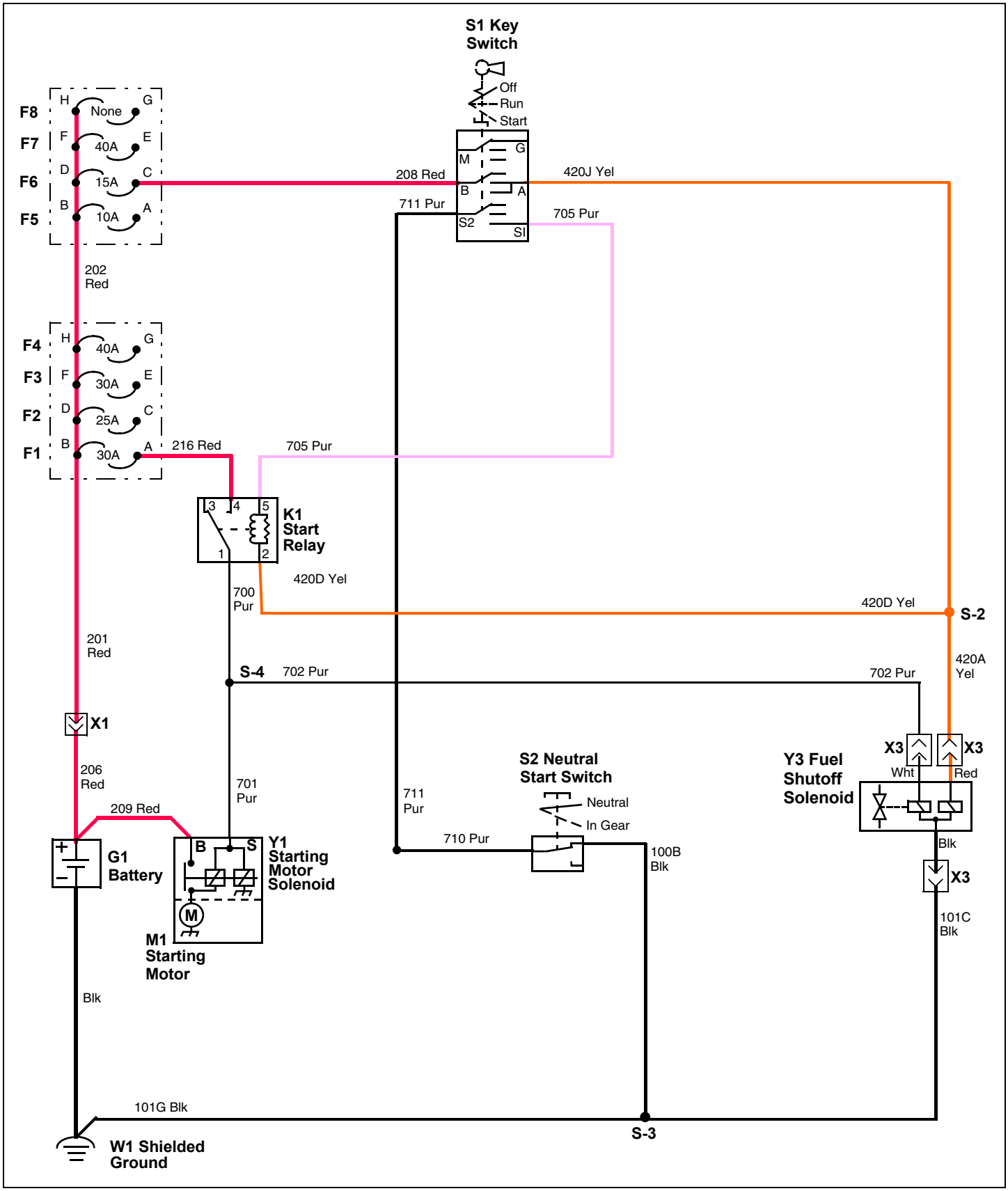
As long as the S1 key switch is in the START position and the transaxle is in NEUTRAL (S2 neutral start switch closed) the circuit to ground for the relay coil is established and the relay coil is energized.

With the K1 start relay energized, power is supplied from the 201 Red wire, F1 fuse, 216 Red wire across the K1 start relay to the 700 Pur wire, S-4 splice, and 702 Pur wire to the Y3 fuel shutoff solenoid pull-in coil.

The path to ground for the Y3 fuel shutoff solenoid is completed through a Blk wire, X3 connector, 101C Blk wire, S-3 splice, and 101G Blk wire.

Hold-In Coil - The G1 battery supplies current through the F6 fuse and S1 key switch to the S2 splice. Battery voltage then flows over the 420A Yel wire to the X3 connector. A Red wire carries power to the Y3 fuel shutoff solenoid.

Fuel Shutoff Circuit Schematic (Diesel Engine) (SN 40001 -)



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Fuel Shutoff Circuit Diagnosis (Diesel Engine) (SN 40001 -)

Test Procedure A

Test Conditions:

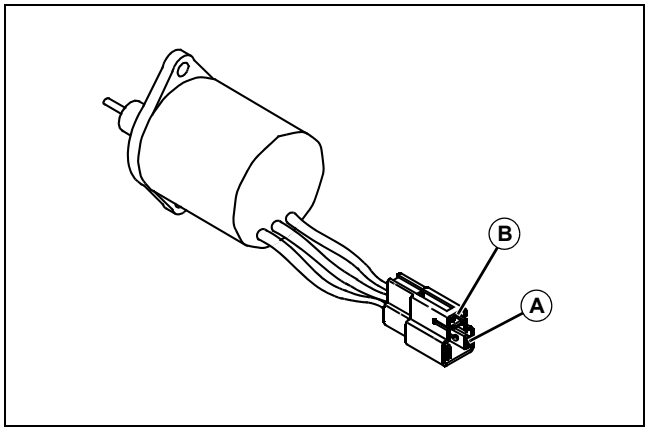
- Park brake locked.
- Transmission in neutral.
- Cargo box raised and locked.
- Battery fully charged.
- Key switch in start position.
- Check wire connections for looseness and corrosion.

System: Fuel Shutoff Solenoid Pull-In Circuit

(1) When test conditions are set, does the engine crank?

Yes - Go to next step.

No - See “Cranking Circuit Operation (Gas and Diesel Engines) (SN 40001 -)” on page 284 and make repairs as needed. When complete, go to next step.



(2) Is battery voltage present at X3 connector, 702 Pur wire (A) of Y3 fuel shutoff solenoid?

Yes - Go to next step.

No - Check 700 and 702 Pur wires and connections.

(3) Is there continuity between X3 connector, 101C Blk wire (B) at Y3 fuel shutoff solenoid and ground?

Yes - Test fuel shutoff solenoid. See “Fuel Shutoff Solenoid Test (Diesel Engine)” on page 350.

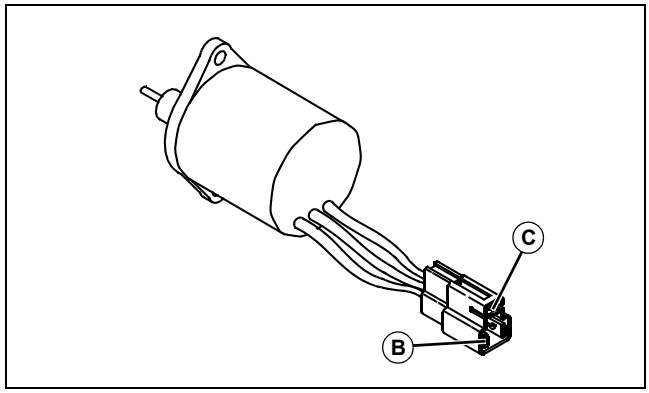
No - Check 101C and 100G Blk wires, connections and splices.

Test Procedure B

Test Conditions:

- Transmission in neutral.
- Park brake locked.
- Cargo box raised and locked.
- Battery fully charged.
- Key switch in run position, engine off.
- Check wire connections for looseness and corrosion.

System: Fuel Shutoff Solenoid Hold-In Circuit



(1) Is battery voltage present at X3 connector, 420A Yel wire (B) of Y3 fuel shutoff solenoid?

Yes - Go to next step.

No - Check 420J and 420A Yel wires, splice and connections. Test key switch. See “Key Switch Test” on page 341.

No - Test power circuit. See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.

(2) Is there continuity between X3 connector, 101C Blk wire (C) at Y3 fuel shutoff solenoid and ground?

Yes - Test fuel shutoff solenoid. See “Fuel Shutoff Solenoid Test (Diesel Engine)” on page 350.

No - Check 101C and 100G Blk wires, connections and splices.

Carburetor Heater Circuit Operation (All)

Function:

To preheat the air/fuel mixture entering the engine in order to prevent spark plug fouling and poor engine performance.

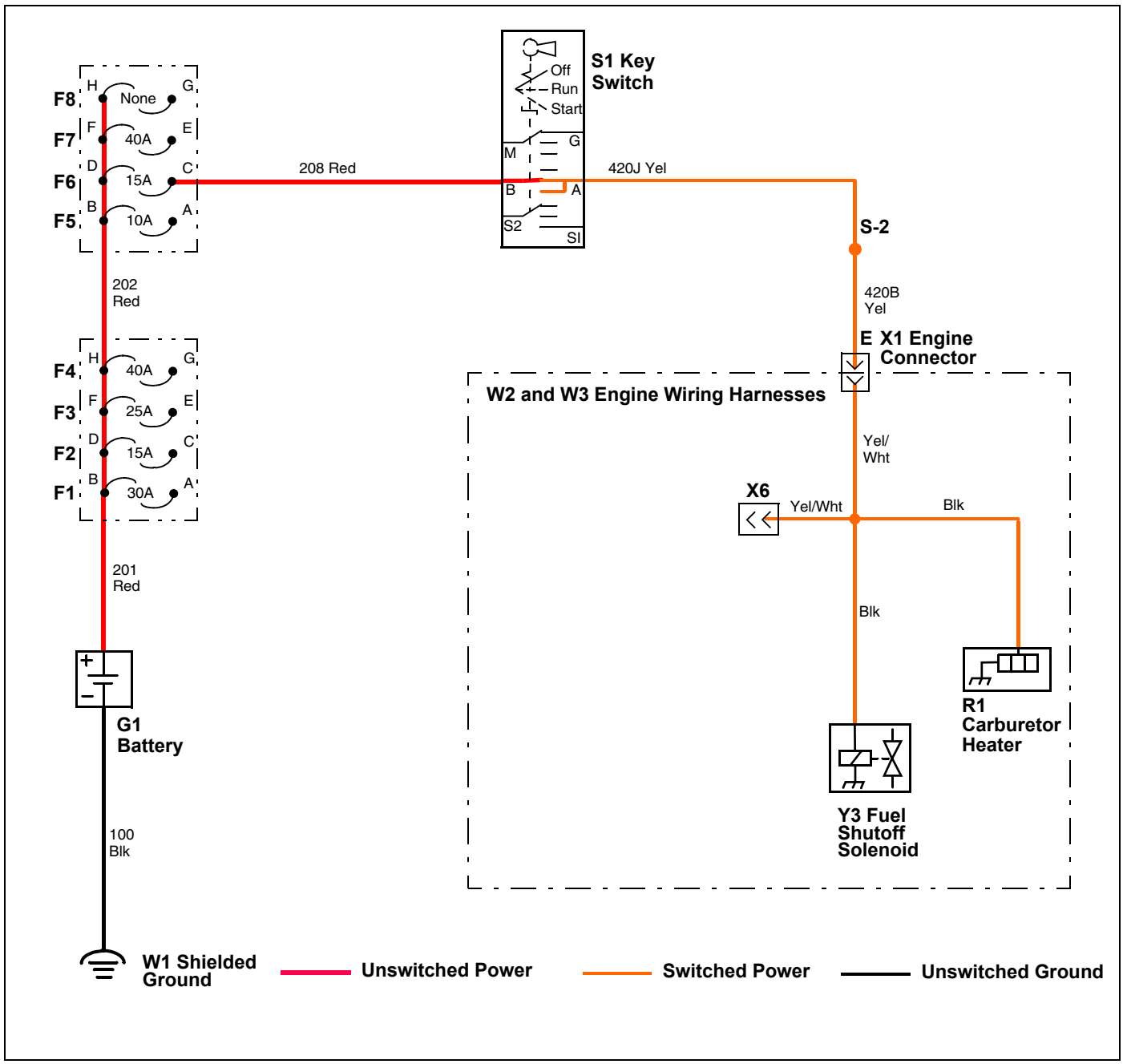
Operating Conditions:

- Key switch in RUN or START position.

Theory of Operation:

The G1 battery supplies current through the F6 fuse and S1 key switch to the S2 splice. Battery voltage then flows over the 420B Yel wire to the X1 engine connector. A Yel/Wht wire, splice, and a Blk wire carrie power to the R1 carburetor heater. The heater is grounded to the engine through it's body with current controlled by an internal resistance of approximately 8.0 ohms (cold).

Carburetor Heater Circuit Schematic (All)



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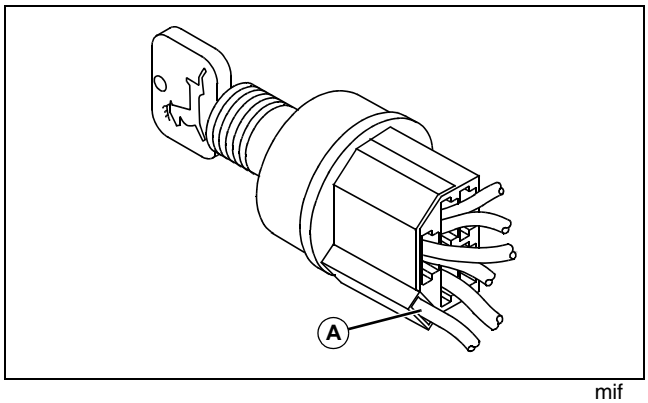
Carburetor Heater Circuit Diagnosis (All)

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Cargo box raised and locked.
- Battery fully charged.
- Key switch in run position, engine off.
- Check wire connections for looseness and corrosion.

System: Carburetor Heater Circuit



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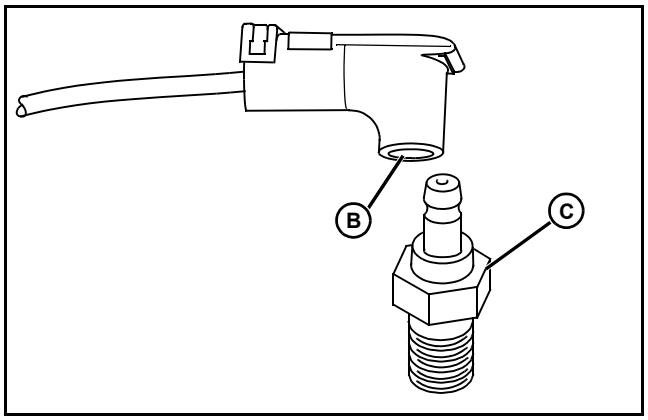
(1) Is battery voltage present at420J Yel wire (pin A) (A) of S1 key switch?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341. See “Power Circuit Diagnosis (Gas Engine) (SN -40000)” on page 246 or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252.



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(2) Disconnect R1 carburetor heater from harness. Is battery voltage present at R1 carburetor heater, Blk wire (B)?

System: Carburetor Heater Circuit

Yes - Go to next step.

No - Check Blk, Yel/Wht, 420B, and 420J Yel wires and connections.

(3) Is continuity to ground present at body of R1 carburetor heater (C)?

Yes - Test carburetor heater.

No - Check engine ground to frame and battery.

Glow Plug Circuit Operation (SN -40000)

Function:

To provide an added source of heat for combustion during cold starts, especially below **5°C (40°F)**.

Operating Conditions:

- Key switch must be in the start or run position.

Theory of Operation:

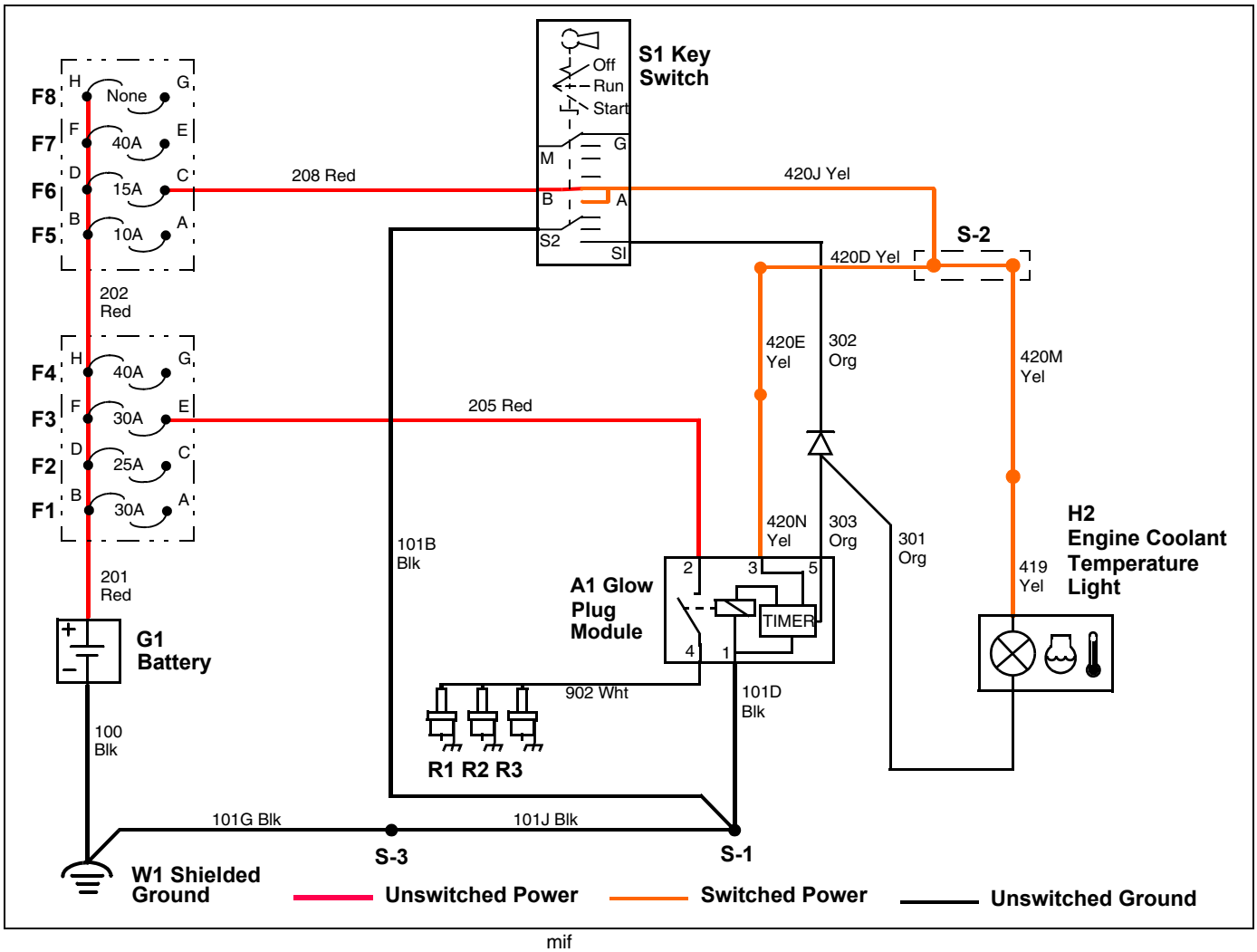
The ignition system is designed to inject diesel fuel into the precombustion chamber and piston cylinder where heat from compression ignites the fuel and air mixture. When starting a cold engine, compression pressure may not provide enough heat to ignite the fuel when injected into a cold precombustion chamber. An electronically operated glow plug is installed into the precombustion chamber to provide added heat to ignite the fuel as it is injected. The glow plugs are energized during starting, and also may be preheated by turning the key switch to the run position for up to 30 seconds before turning the key to the start position.

The glow plugs heat when current is provided through the glow plug module. The glow plug module provides current to the glow plugs through relay contacts controlled by a timer.

The timer is started by turning the key switch to either the run or start position. The length of time the timer stays on is a function of the glow plug temperature and ranges from approximately 0 to 30 seconds. The colder the temperature, the longer the timer stays on.

When the key switch is in the start position, the ground circuit is allowed to pass through the glow plug module ground. This will turn on the coolant temperature light for a few seconds. When the glow plug control times out the light will go out.

Glow Plug Circuit Schematic (SN -40000)



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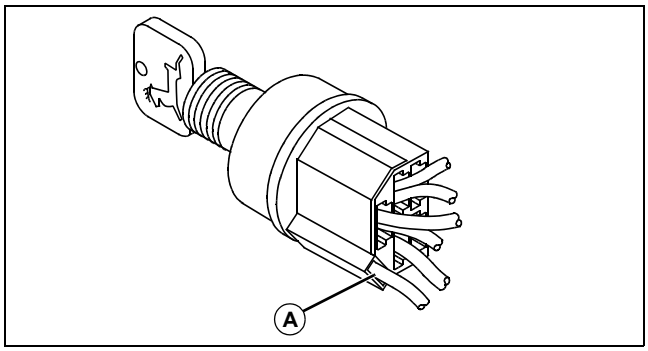
Glow Plug Circuit Diagnosis (SN -40000)

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Park brake locked.
- Cargo box raised and locked.
- Battery fully charged.
- Key switch in run position, engine off.
- Check wire connections for looseness and corrosion.

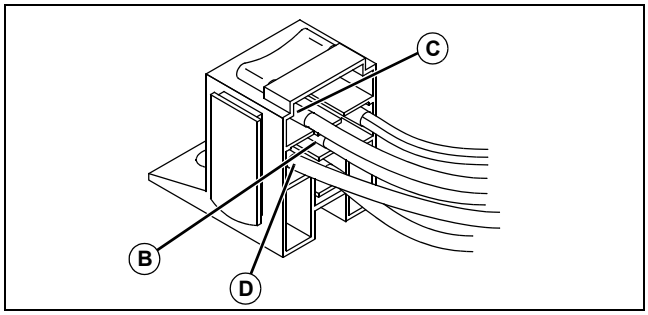
System: Glow Plug Circuit



(1) Is battery voltage present at 420J Yel wire (pin A) (A) of S1 key switch?

Yes - Go to next step.

No - Check power circuit to key switch. See “Power Circuit Diagnosis (Diesel Engine) (SN -40000)” on page 264. If OK, test key switch. See “Key Switch Test” on page 341.



(2) Is battery voltage present at 420N Yel wire (pin 3) (B) of A1 glow plug module?

Yes - Go to next step.

No - Check 420J, 420E and 420N Yel wires, splices and connections.

System: Glow Plug Circuit

(3) Is there continuity between 101D Blk wire (pin 1) (C) of A1 glow plug module and ground?

Yes - Go to next step.

No - Check 101D, 101J, and 101G Blk wires, splices, and connections.

(4) Is battery voltage present at 205 Red wire (pin 2) (D) of A1 glow plug module?

Yes - Go to next procedure.

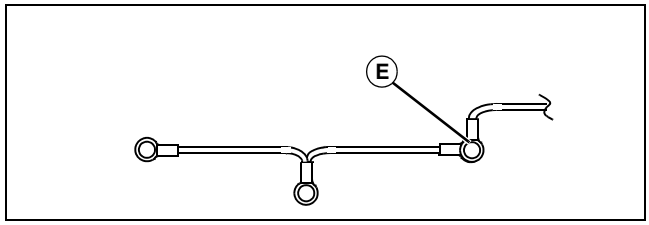
No - Check 206 and 201 Red wires, F3 fuse, and 205 Red wire and connections.

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Cargo box raised and locked.
- Battery fully charged.
- Key switch must be cycled from off to run for each test step - engine off.
- Check wire connections for looseness and corrosion.
- Engine glow plug 902 Wht wire terminal disconnected.

NOTE: There is approximately a 30 second window during key switch OFF-ON cycles in which the tests will be valid (power to the glow plugs).

System: Glow Plug Module



(1) Is battery voltage present at 902 Wht glow plug wire (E)?

Yes - Go to next step.

No - Replace A1 glow plug module.

(2) After approximately 30 seconds, does battery voltage turn off at 902 Wht glow plug wire?

Yes - Test glow plugs and connections. See “Glow Plug Test (Diesel Engine)” on page 351.

No - Replace A1 glow plug module.

Glow Plug Circuit Operation (SN 40001 -)

Function:

To provide an added source of heat for combustion during cold starts, especially below **5°C (40°F)**.

Operating Conditions:

- Key switch must be in the start or run position.

Theory of Operation:

The ignition system is designed to inject diesel fuel into the precombustion chamber and piston cylinder where heat from compression ignites the fuel and air mixture. When starting a cold engine, compression pressure may not provide enough heat to ignite the fuel when injected into a cold precombustion chamber.

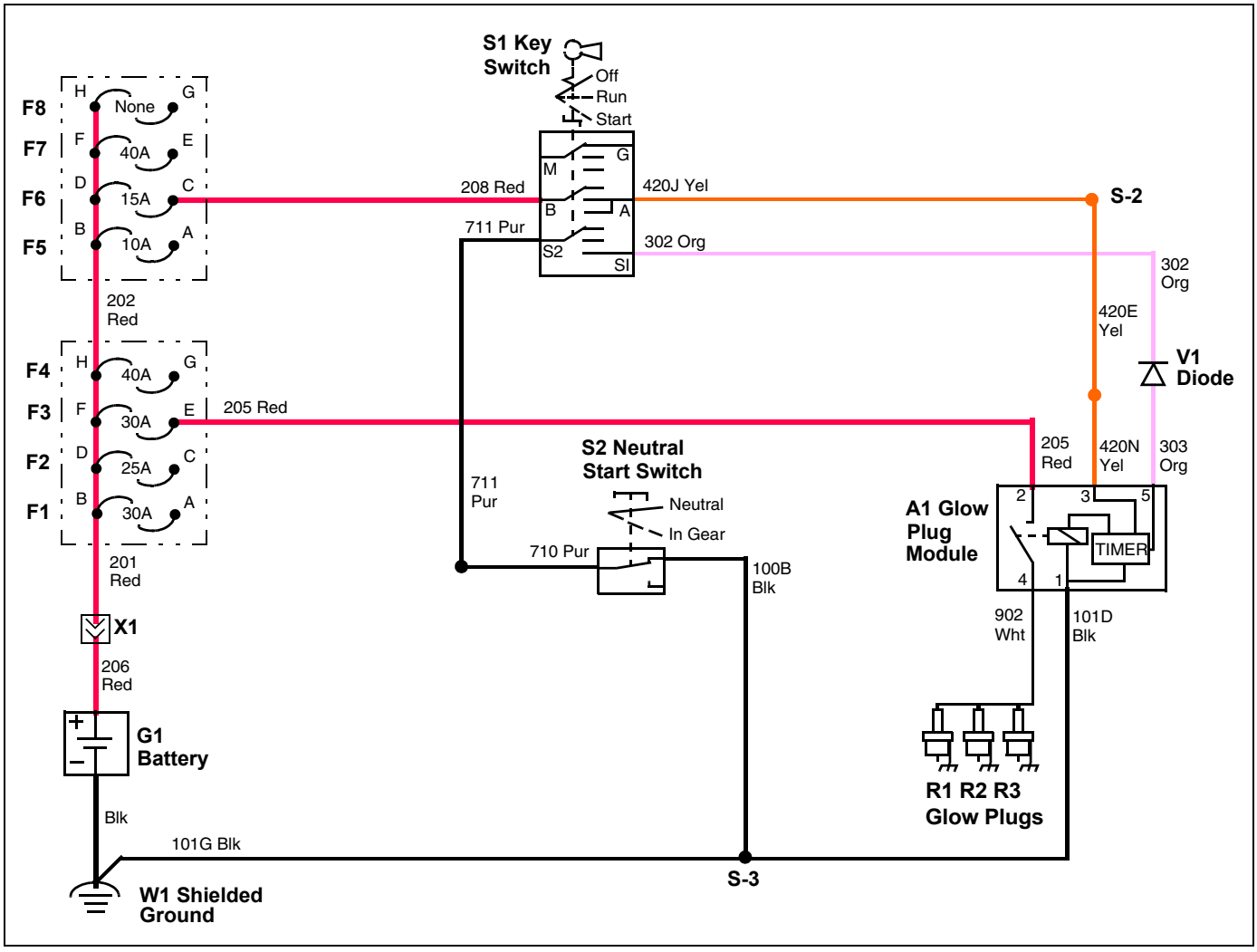
An electronically operated glow plug is installed into the precombustion chamber to provide added heat to ignite the fuel as it is injected. The glow plugs are energized during starting, and also may be preheated by turning the key switch to the run position for up to 30 seconds before turning the key to the start position.

The glow plugs heat when current is provided through the glow plug module. The glow plug module provides current to the glow plugs through relay contacts controlled by a timer.

The timer is started by turning the key switch to either the run or start position. The length of time the timer stays on is a function of the glow plug temperature and ranges from approximately 0 to 30 seconds. The colder the temperature, the longer the timer stays on.

When the key switch is in the start position, the ground circuit is allowed to pass through the glow plug module ground. This will turn on the coolant temperature light for a few seconds. When the glow plug control times out the light will go out.

Glow Plug Circuit Schematic (SN 40001 -)



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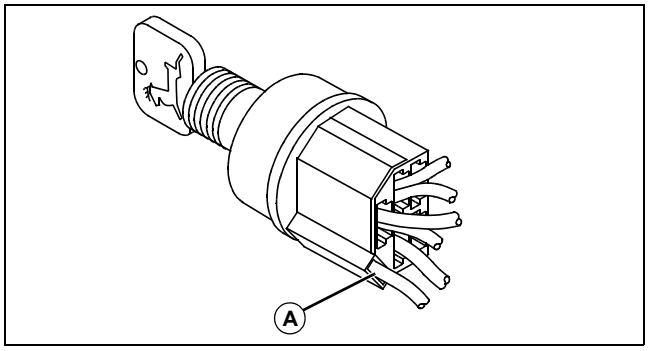
Glow Plug Circuit Diagnosis (SN 40001 -)

Test Conditions:

- Transmission in neutral.
- Park brake locked.
- Cargo box raised and locked.
- Battery fully charged.
- Key switch in run position, engine off.
- Check wire connections for looseness and corrosion.

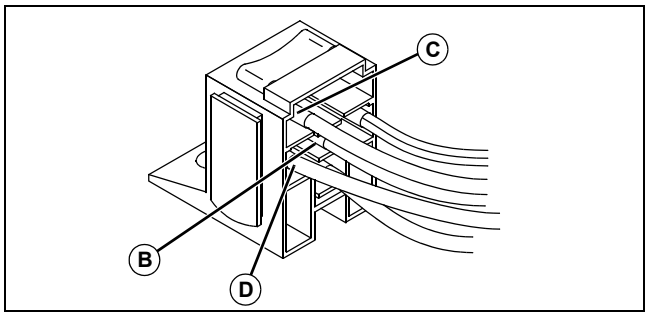
System: Glow Plug Circuit



(1) Is battery voltage present at 420J Yel wire (pin A) (A) of S1 key switch?

Yes - Go to next step.

No - Check power circuit to key switch. See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270. If OK, test key switch. See “Key Switch Test” on page 341.



(2) Is battery voltage present at 420N Yel wire (pin 3) (B) of A1 glow plug module?

Yes - Go to next step.

No - Check 420J, 420E and 420N Yel wires, splices and connections.

(3) Is there continuity between 101D Blk wire (pin 1) (C) of A1 glow plug module and ground?

System: Glow Plug Circuit

Yes - Go to next step.

No - Check 101D and 101G Blk wires, splices, and connections.

(4) Is battery voltage present at 205 Red wire (pin 2) (D) of A1 glow plug module?

Yes - Go to next procedure.

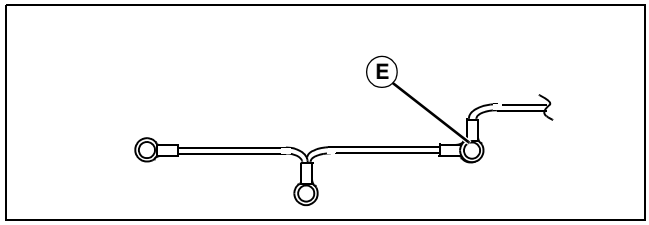
No - Check 206 and 201 Red wires, F3 fuse, and 205 Red wire and connections.

Test Conditions:

- Transmission in neutral.
- Park brake locked.
- Cargo box raised and locked.
- Battery fully charged.
- Key switch must be cycled from off to run for each test step - engine off.
- Check wire connections for looseness and corrosion.
- Engine glow plug 902 Wht wire terminal disconnected.

NOTE: There is approximately a 30 second window during key switch OFF-ON cycles in which the tests will be valid (power to the glow plugs).

System: Glow Plug Module



(1) Is battery voltage present at 902 Wht glow plug wire (E)?

Yes - Go to next step.

No - Replace A1 glow plug module.

(2) After approximately 30 seconds, does battery voltage turn off at 902 Wht glow plug wire?

Yes - Test glow plugs and connections. See “Glow Plug Test (Diesel Engine)” on page 351.

No - Replace A1 glow plug module.

4WD Clutch Circuit Operation (Gas and Diesel Engines) (SN 40001 -)

Function:

To provide power to energize the 4WD clutch.

Operating Conditions:

- Key switch must be in the run position.
- Transmission must be in gear.
- 4WD switch must be on.

Theory of Operation:

The 4WD system is designed to allow the operator to engage the 4WD system on-demand. The system uses the neutral start switch and a relay to interlock the operation with the transmission. When the transmission is in neutral, no power will be provided to the 4WD switch. When the transmission is in gear, power will be provided to the 4WD switch and if the switch is on the power will continue on to the 4WD clutch. When the 4WD clutch is engaged, the power train will supply power through the front differential to drive the front wheels.

The 4WD circuit receives power from the switched power circuit.

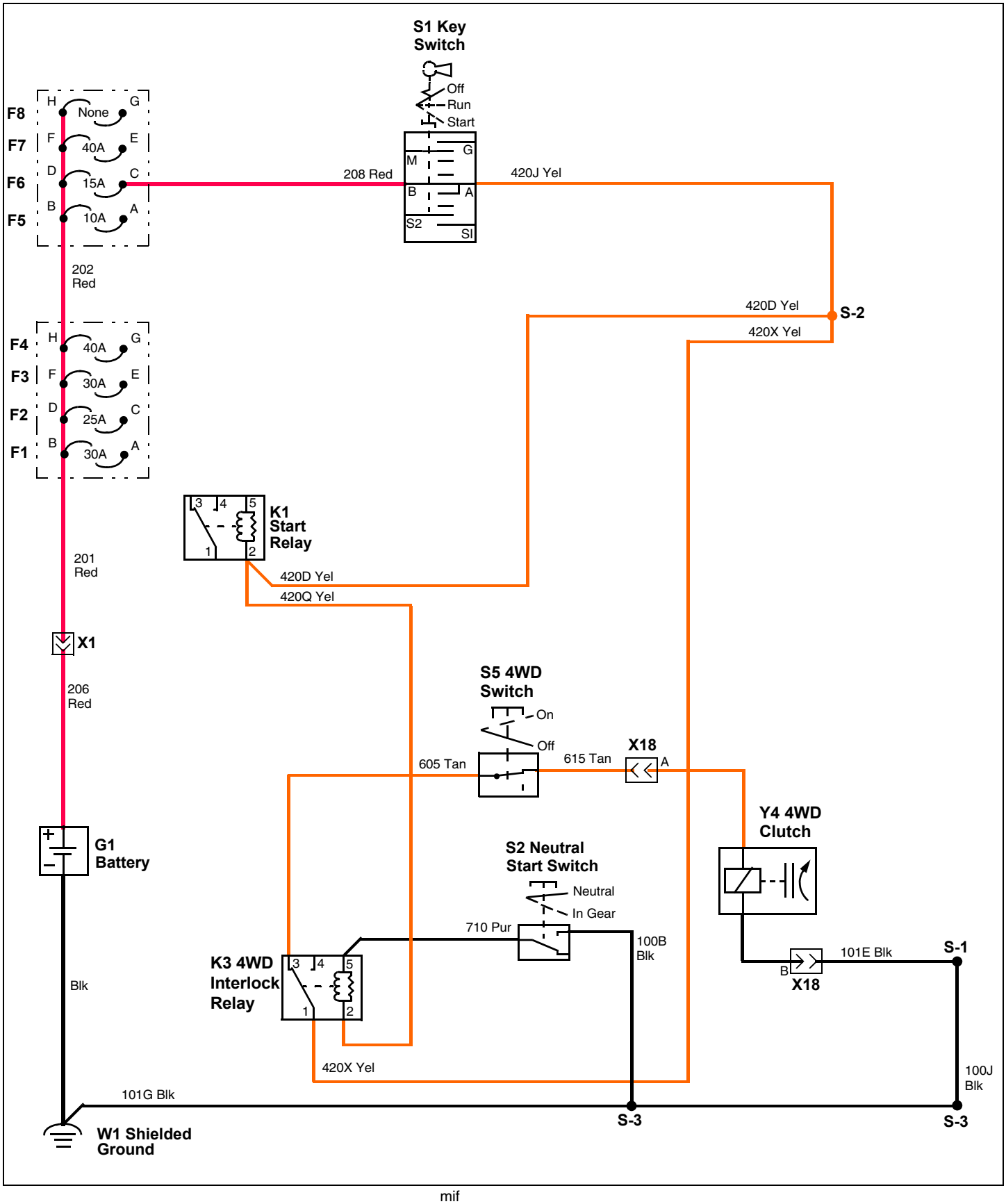
Switched power is supplied to the K3 4WD interlock relay from the 420Q and 420D Yel wires to the relay coil. Switched power is also provided to the common terminal (1) of the relay from the 420X Yel wire.

When the transmission is in neutral, (S2 neutral start switch contacts closed) the 4WD interlock relay is energized and the relay pulls in and opens the normally closed contact. This prevents power from flowing across the relay. This circuit is used during the starting process. See “Cranking Circuit Operation (Gas and Diesel Engines) (SN 40001 -)” on page 284.

When the transmission is in gear, the S2 neutral start switch opens its contacts and removes the ground path for the K3 4WD interlock relay. This de-energizes the relay allowing the contact to return to the normally closed position. With the contacts in the normally closed position power from the 420X Yel wire flows across the K3 4WD interlock relay to the 605 Tan wire to the S5 4WD switch. When the 4WD switch is placed in the on position, power flows across the switch to the 615 Tan wire and on to the Y4 4WD clutch.

The ground for the clutch is provided on the 101E and 101G Blk wires.

4WD Clutch Circuit Schematic (Gas and Diesel Engines) (SN 40001 -)



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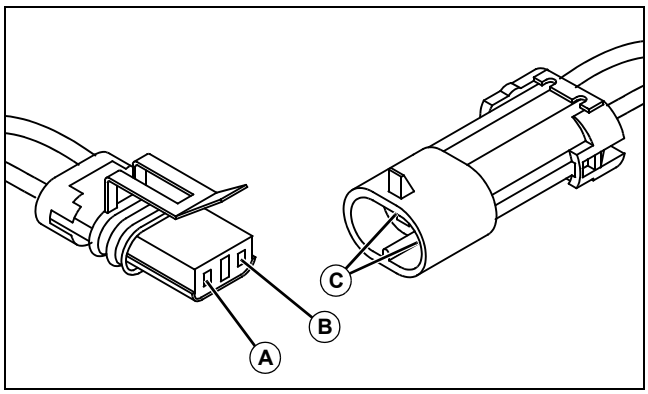
4WD Clutch Circuit Diagnosis (Gas and Diesel Engines) (SN 40001 -)

Test Conditions:

- Park brake locked.
- Transmission in gear.
- Cargo box raised and locked.
- Open hood and remove storage tray.
- Battery fully charged.
- Key switch in run position, engine off.
- 4WD switch on.
- Check wire connections for looseness and corrosion.

System: 4WD Clutch Circuit



(1) Disconnect the X18 connector to the 4WD clutch. Is battery voltage present at 615 Tan wire (A) of main wire harness?

Yes - Go to next step.

No - Go to step (4) to continue test.

(2) Is continuity to ground present at the 101E Blk wire (B) of X18 connector?

Yes - Go to next step.

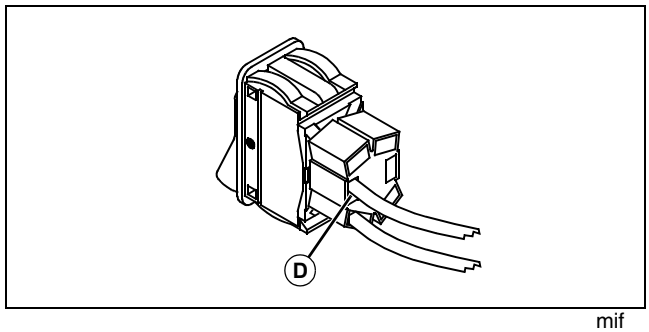
No - Check 101E and 101G Blk wires, splices and connections.

(3) Measure the resistance across the terminals of the clutch connector (C). Is the resistance reading between 22 and 28 ohms?

Yes - Clutch electrical circuit is functional. Go Power Train Section to check mechanical functions. See “Front Differential Removal and Installation (SN 40001-)” on page 505.

System: 4WD Clutch Circuit

No - Replace the 4WD clutch. See “Front Differential Removal and Installation (SN 40001-)” on page 505 and See “Front Differential Disassembly (SN 40001-)” on page 506.



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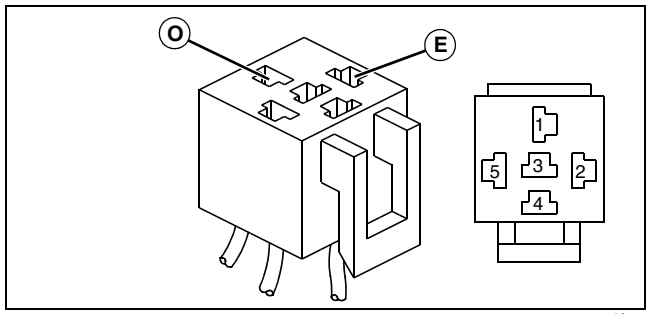
(4) Is battery voltage present at terminal 2 of S5 4WD switch, 605 Tan wire (D)?

Yes - Check 615 Tan wire and connections. If ok, replace 4WD switch.

No - Go to next step.



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(5) Remove relay. Is battery voltage present at terminal 2 (85) of K3 4WD interlock relay connector, 420Q Yel wire (E)?

Yes - Test relay. See “Relay Test” on page 345.

No - Check 420Q, 420D Yel wires, and switched power circuit. See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252 or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.

(6) Is battery voltage present at terminal 1 (30) of K3 4WD interlock relay connector, 420X Yel wire (O)?

Yes - Check 605 Tan wire and connections. If ok, replace 4WD interlock relay. Test complete.

System: 4WD Clutch Circuit

No - Install relay. Check 420X Yel wire, and switched power circuit. See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252 or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.

Engine Oil Pressure Light Circuit Operation (Gas and Diesel Engines - All)

Function:

To provide a visual warning if the engine oil pressure drops below a preset level.

Operating Conditions:

- Key switch in the ON position with engine running.

Theory of Operation:

With the engine OFF and key switch in the RUN position, oil pressure will be below 28 kPa (4 psi). The oil pressure switch will be closed, completing the circuit path to ground and illuminating the light. This will inform the operator that the light is functioning.

When the engine is started and running, the light should go out when the oil pressure is adequate to open the pressure switch, turning out the light.

The G1 battery supplies power through the 201 Red wire to the F6 fuse and the on to the S1 key switch. With the key switch in the ON position, power is supplied to the 420J Yel wire, S-2 power splice, and 420M Yel wire to the H3 engine oil pressure light. The 601 Tan and Blu/Red (Gas Engine) wire(s) complete the circuit to the B4 engine oil pressure switch. When the B4 engine oil pressure switch is closed, oil pressure is below 28 kPa (4 psi), the ground path is completed thought the engine ground.

Hour Meter Circuit Operation (Gas and Diesel Engines - All)

Function:

To record the number of hours the key switch is in the RUN position with the engine running.

Operating Conditions:

- Key switch in the RUN position.
- Engine running

Theory of Operation:

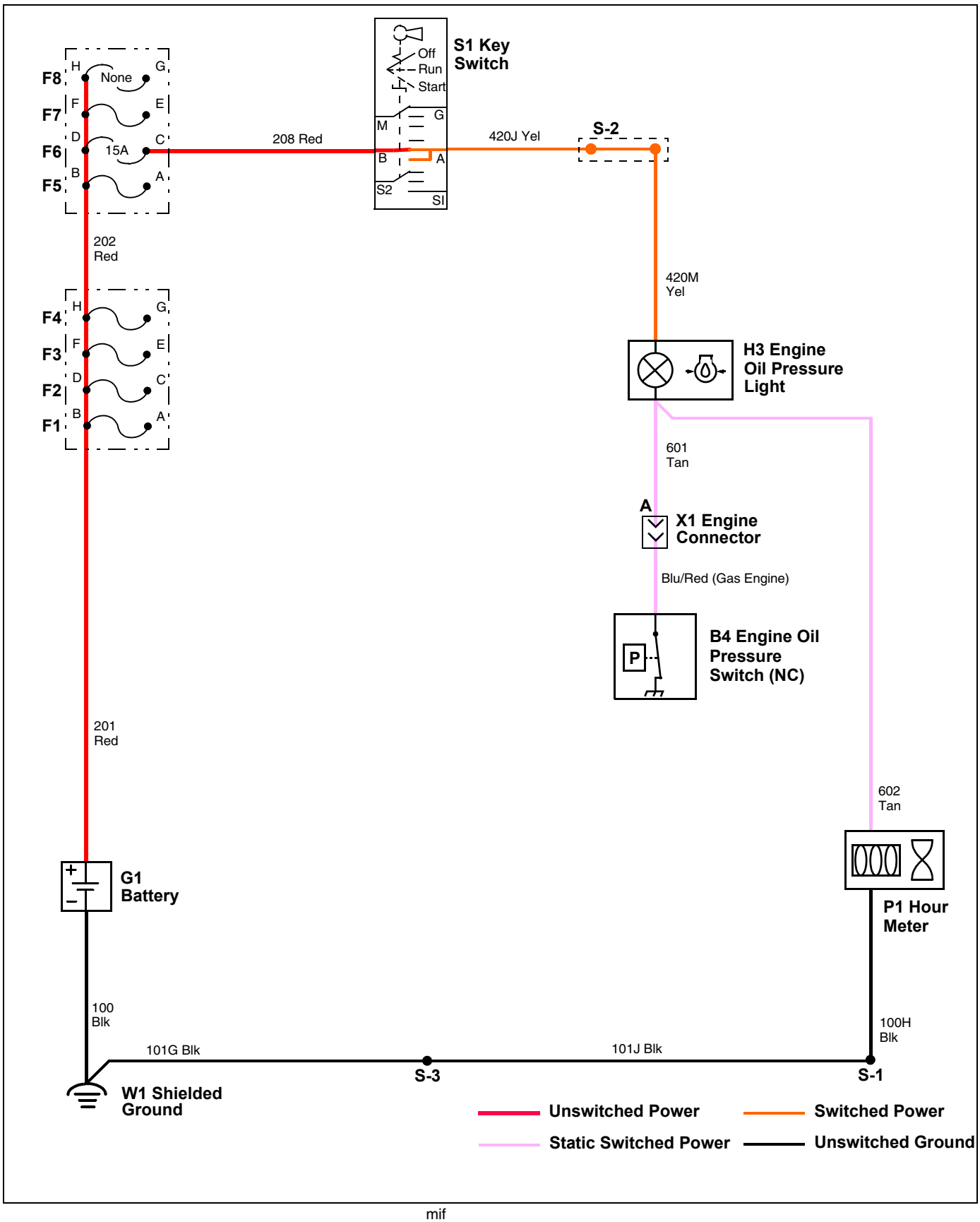
Power flows from the G1 battery through the F6 fuse and the S1 key switch to the S2 splice. The 420M Yel wire carries the current to the H3 engine oil pressure light. The light is grounded by the engine (normally closed) oil pressure switch when the engine off or oil pressure is low. With engine oil pressure switch closed, a ground is at both sides of the hour meter and the meter does not run.

When the engine oil pressure switch opens, the current passes through the oil pressure light and the 602 Tan wire continues the circuit to the P1 hour meter.

The H3 engine oil pressure light does not illuminate because the P1 hour meter provides a sufficient voltage drop of 1.6M ohms in the series circuit.

The circuit is completed by the 100H Blk wire, splice 1, 100J Blk wire, splice 3 and 100G Blk wire to ground.

Engine Oil Pressure Light/Hour Meter Circuit Schematic (Gas and Diesel Engines - All)



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Engine Oil Pressure Light Diagnosis (Gas and Diesel Engines - All)

Test Conditions:

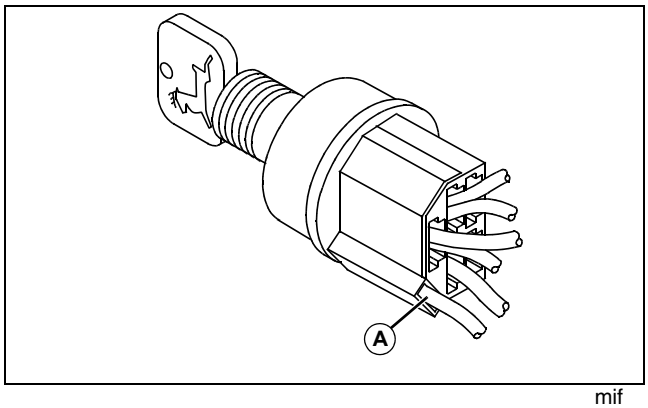
- Machine parked safely. See “Parking Safely” in the Safety section.
- Park brake locked.
- Cargo box raised and locked.
- Open hood and remove storage tray.
- Battery fully charged.
- Key switch in run position, engine off.
- Check wire connections for looseness and corrosion.

System: Engine Oil Pressure Circuit

(1) Is H3 engine oil pressure light illuminated?

Yes - Circuit is operational. Test oil pressure switch. See “Engine Oil Pressure Switch Test” on page 351.

No - Test bulb. Replace as needed. If OK, go to next step.



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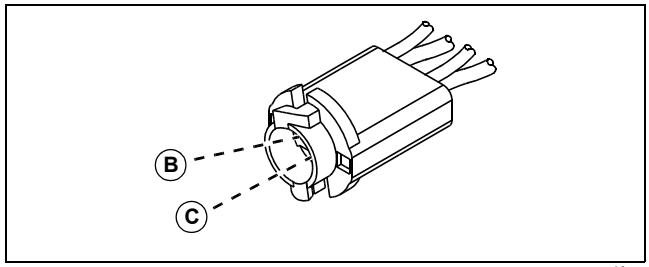
(2) Is battery voltage present at A terminal of S1 key switch, 420J Yel wire (A)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341. See “Power Circuit Diagnosis (Gas Engine) (SN -40000)” on page 246, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.

System: Engine Oil Pressure Circuit



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(3) Remove H3 engine oil pressure light socket from instrument panel. Remove bulb. Is battery voltage present at H3 engine oil pressure light socket, 420M Yel wire (B)?

Yes - Go to next step.

No - Check 420J and 420M Yel wires and connections.

(4) Is continuity to ground present at H3 engine oil pressure light socket, 601 Tan wire (C)?

Yes - Test complete.

No - Disconnect hour meter and go to next step.

(5) Is continuity to ground present at H3 engine oil pressure light socket, 601 Tan wire (C)?

Yes - Test hour meter. Engine oil pressure circuit is operational.

No - Test engine oil pressure switch. See “Engine Oil Pressure Switch Test” on page 351.

Hour Meter Circuit Diagnosis (Gas and Diesel Engines - All)

Test Conditions:

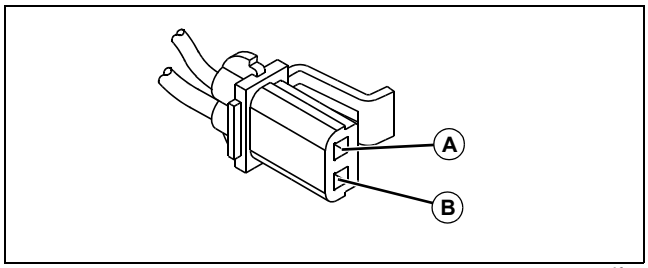
- Machine parked safely. See “Parking Safely” in the Safety section.
- Park brake locked.
- Engine oil pressure circuit operating properly.
- Cargo box raised and locked.
- Open hood and remove storage tray.
- Battery fully charged.
- Key switch in run position, engine off.
- Check wire connections for looseness and corrosion.

System: Hour Meter Circuit

(1) Is H3 engine oil pressure light illuminated?

Yes - Go to next step.

No - Go To Engine Oil Pressure Light Diagnosis (Gas and Diesel Engines - All) on page 321.



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(2) Disconnect X1 engine connector. Disconnect P1 hour meter from harness. Is battery voltage present at A terminal of the P1 hour meter connector, 602 Tan wire (A)?

Yes - Go to next step.

No - Check 602 Tan wire and connections.

(3) Is continuity to ground present at B terminal of the P1 hour meter connector, 100H Blk wire (B)?

Yes - Replace hour meter.

No - Check 100H, 101J, and 101G Blk wires and connections.

Cooling Fan and Temperature Light Circuit Operation (Gas and Diesel Engines - All)

Function:

To provide engine cooling when coolant reaches a predetermined temperature. Also provides an indicator light when the coolant temperature exceeds a predetermined level.

Operating Conditions:

- Key switch in the RUN position.
- Engine at operating temperature.

Theory of Operation - Cooling Fan:

The G1 battery supplies unswitched power through the F2 fuse (15 amp - gasoline engines; 25 amp - diesel engines) to the K2 fan relay. The relay is activated as follows:

The G1 battery supplies power through the F6 fuse and S1 key switch to the S2 splice. The 420D Yel wire carries this power to the K1 start relay where it splices to the 420E Yel wire which leads to the K2 fan relay. Current exits the relay over the 310 Org wire to the B1 radiator temperature switch. If the coolant temperature is 93° ± 3° C (199° ± 5° F), the switch will close the circuit to ground through the 105 Blk wire, S1 splice, 100J Blk wire, S3 splice, and 101G Blk wire to ground. This will cause the K2 fan relay to energize.

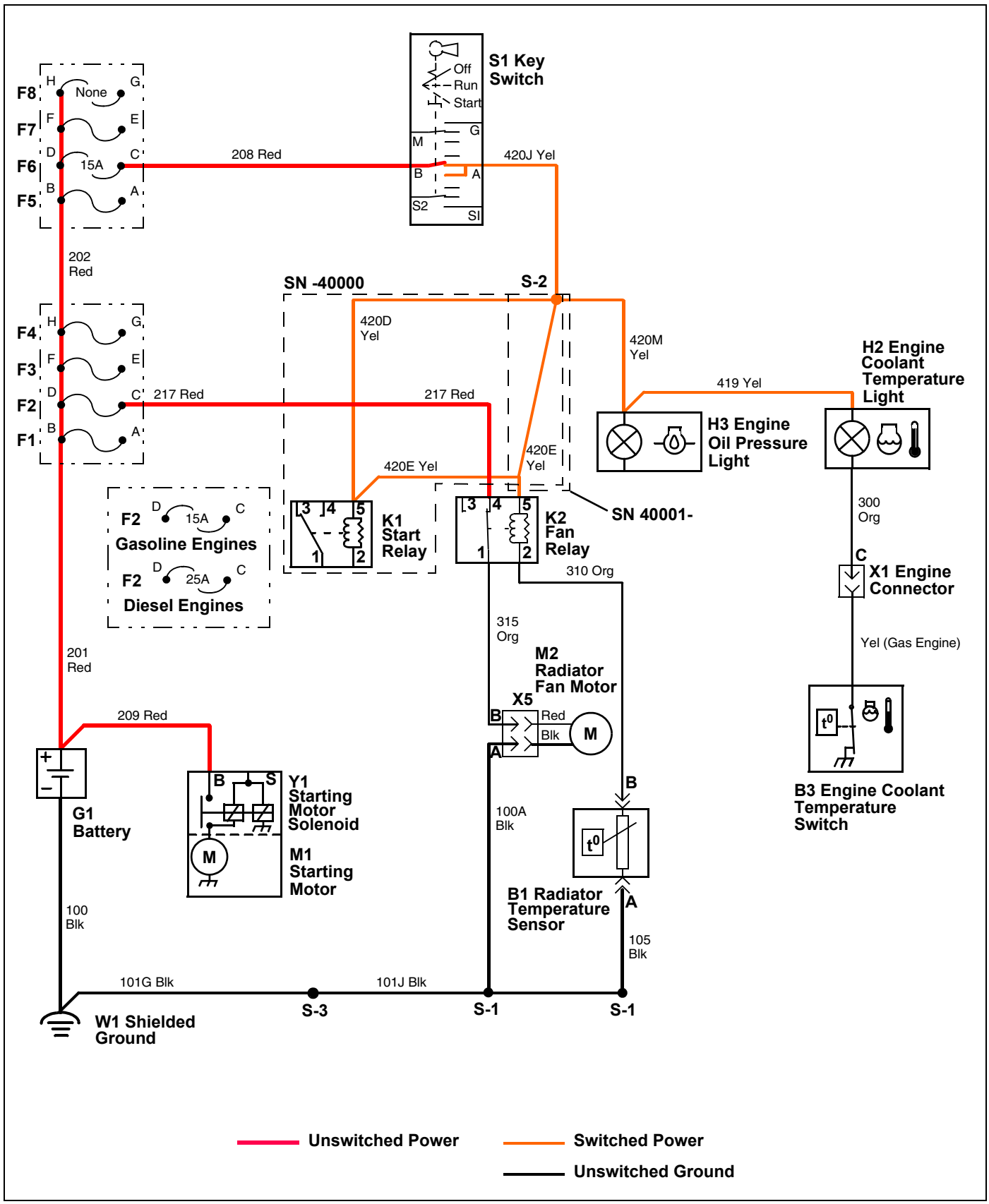
With the relay energized, it allows power to flow from the F2 fuse, 217 Red wire across the K2 fan relay, 315 Org wire to the M2 radiator fan motor. The circuit is completed by the 100A Blk wire, S1 splice, 101J Blk wire, S3 splice, and 101G Blk wire to ground.

As the temperature drops below the preset level, the B1 radiator temperature switch will open and the K2 fan relay will unlatch, causing the cooling fan to shut off.

Theory of Operation - Engine Temperature Light:

The G1 battery supplies switched power through the F6 fuse and S1 key switch to the S2 splice. Current then flows through the 420M Yel wire over the to the H3 engine oil pressure light, where a splice to the 419 Yel wire carries power to the H2 engine coolant temperature light. This light is controlled by the B3 engine coolant temperature switch which will close the circuit and complete a path to ground at 111° ± 3° C (232° ± 5° F).

Cooling Fan and Temperature Light Circuit Schematic (Gas and Diesel Engines - All



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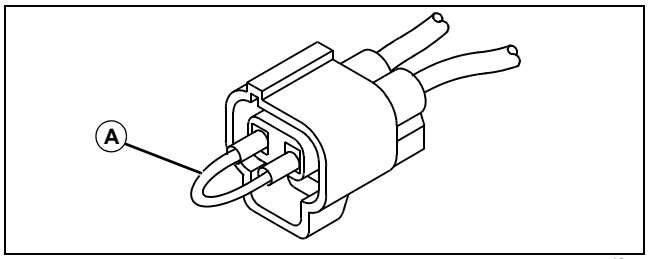
Cooling Fan and Temperature Light Circuit Diagnosis (Gas and Diesel Engines - All)

Test Procedure A

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Park brake locked.



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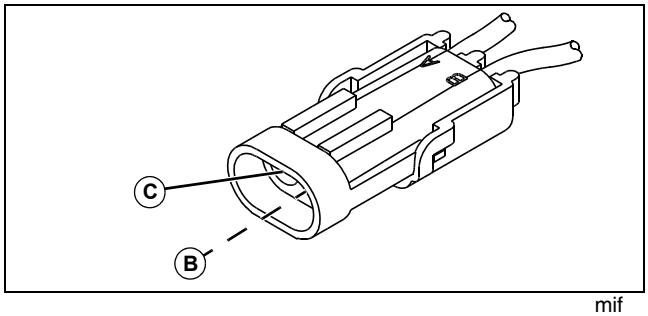
4. Install jumper wire (A) across B1 radiator temperature sensor connector terminals A and B.

- Disconnect X5 connector to M2 radiator fan motor.
- Key switch in run position, engine not running.

System: Cooling Fan Circuit



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(1) Is battery voltage present at B terminal of X5 radiator fan motor connector, 315 Org wire (B)?

Yes - Go to next step.

No - Test fan relay. See “Relay Test” on page 345. Check 315 Org wire and connections.

(2) Is continuity to ground present at A terminal of X5 radiator fan motor connector, 100A Blk wire (C)?

Yes - Go to next step.

No - Check 100A, 101J, and 101G Blk wires and connections.

(3) Connect X5 fan motor connector to fan. Does fan run?

Yes - Remove jumper and go to next procedure.

System: Cooling Fan Circuit

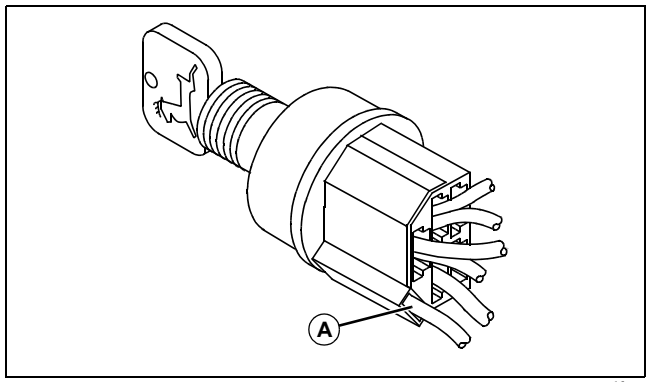
No - Replace M2 radiator fan.

Test Procedure B

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Park brake locked.
- Battery fully charged.
- Jumper removed from B1 radiator temperature sensor connector (installed in previous procedure).
- Key switch in run position, engine not running.
- Check wire connections for looseness and corrosion.

System: Cooling Fan Circuit



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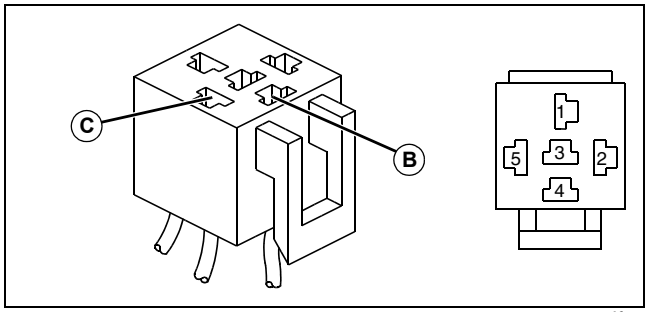
(1) Is battery voltage present at A terminal, 420J Yel wire of S1 key switch (A)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341. See “Power Circuit Diagnosis (Gas Engine) (SN -40000)” on page 246, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.

System: Cooling Fan Circuit



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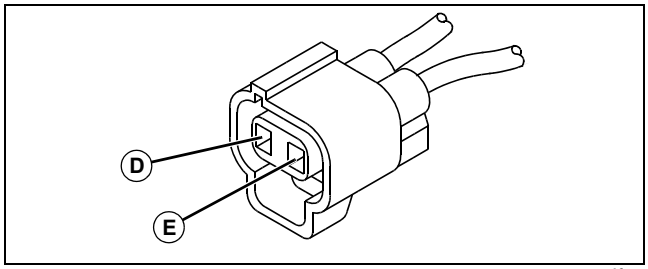
(2) Remove K2 fan relay. Is battery voltage present at terminal 4 (87) 217 Red wire (B) and terminal 5 (86) 420E Yel wire (C) of K2 fan relay connector?

Yes - Install relay. Go to next step.

No - See “Power Circuit Diagnosis (Gas Engine) (SN -40000)” on page 246, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.



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(3) Disconnect B1 radiator temperature sensor connector. Is battery voltage present at 310 Org wire of B1 radiator temperature sensor connector (D)?

Yes - Go to next step.

No - Test fan relay. See “Relay Test” on page 345. Check 310 Org wire and connections.

(4) Is continuity to ground present at 105 Blk wire of B1 radiator temperature sensor connector (E)?

Yes - Test radiator temperature sensor. See “Radiator Coolant Temperature Switch Test” on page 345. Connect B1 radiator temperature switch connector. Go to next step.

No - Check 105, 101J, and 101G Blk wires and connections.

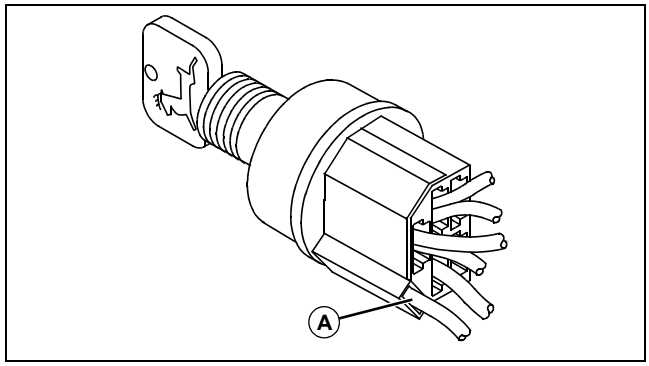
Test Procedure C

CAUTION: Avoid injury! Test procedure may cause radiator cooling fan to start. Disconnect X5 connector to M2 radiator fan motor before turning key switch to run position.

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Park brake locked.
- Battery fully charged.
- Key switch in run position, engine not running.
- Check wire connections for looseness and corrosion.

System: Temperature Light Circuit



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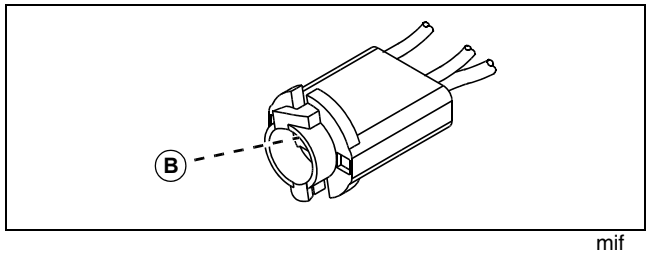
(1) Is battery voltage present at A terminal, 420J Yel wire of S1 key switch (A)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341.



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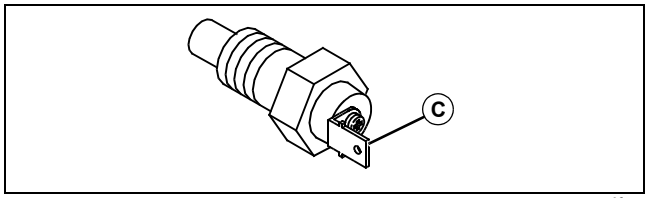
(2) Remove H2 engine coolant temperature light socket from instrument panel. Remove bulb. Is battery voltage present at H2 engine coolant temperature light socket, 419 Yel wire (B)?

Yes - Test bulb. See “Bulb Test” on page 347. Install bulb. Install H2 engine coolant temperature light socket into instrument panel. Go to next step.

System: Temperature Light Circuit

No - Check 420J, 420M, and 419 Yel wires.



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(3) Is battery voltage present at B3 engine coolant temperature switch, Yel (Gas Engine) or 300 Org (Diesel Engine) wire (C)?

Yes - Test B3 engine coolant temperature switch. See “Engine Coolant Temperature Switch Test” on page 346.

No - Check Yel (Gas Engine) wire of engine harness and 300 Org wire and connections.

Headlight Circuit Operation (Gas and Diesel Engines - All)

Function:

Provides power to the headlights.

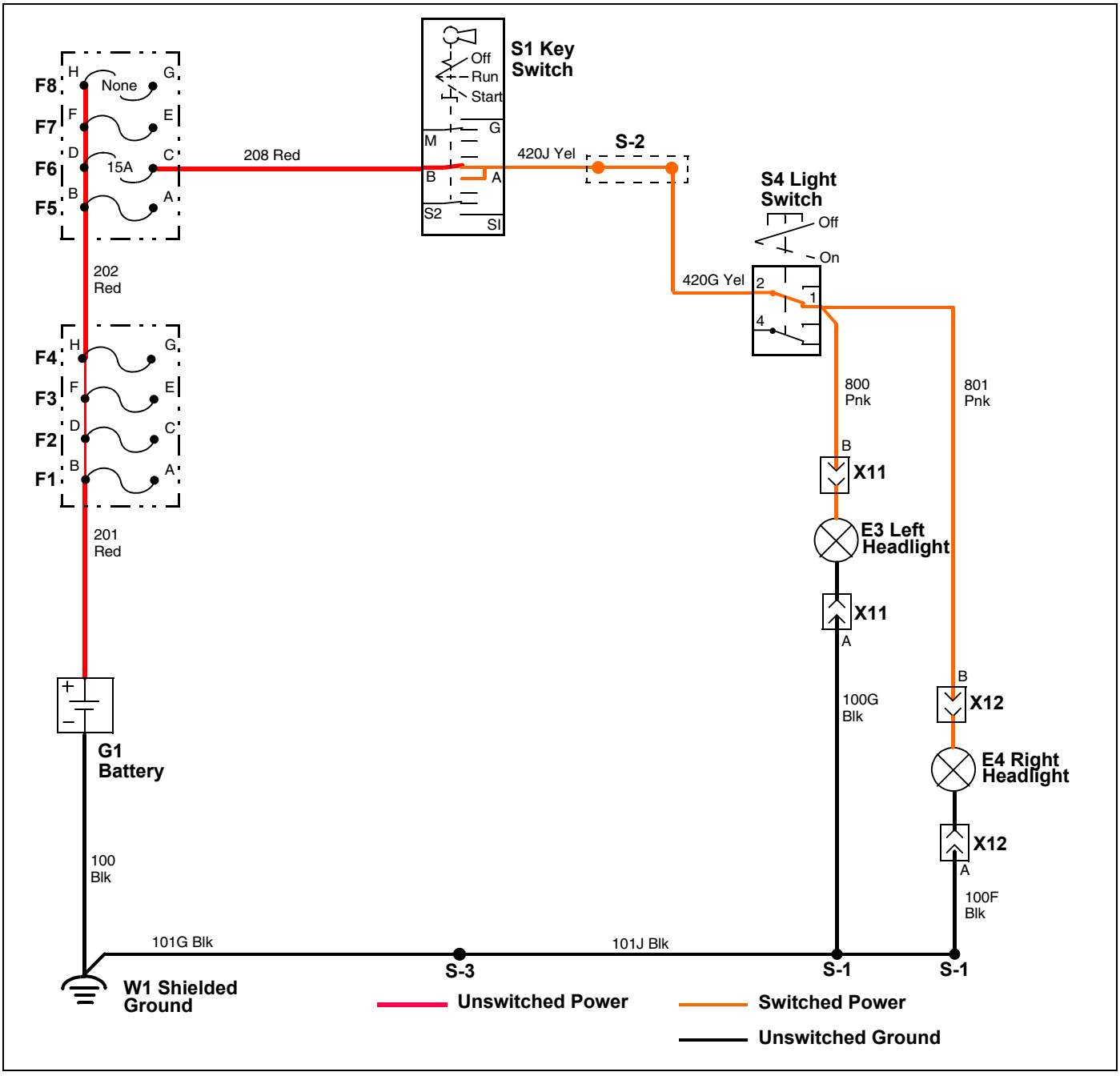
Operating Conditions:

- Key switch in the RUN position.
- Headlight switch in the ON position.

Theory of Operation:

Power flows from the G1 battery through the F6 fuse, S1 key switch, and on to the S-2 power splice. The 420G Yel wire carries power to the S4 light switch. With the switch in the ON position, current then continues to the E3 Left headlight and the E4 Right headlight. The 100G (Left) and 100F (Right) Blk wires provide ground through the S1 and S3 splices.

Headlight Circuit Schematic (Gas and Diesel Engines - All)



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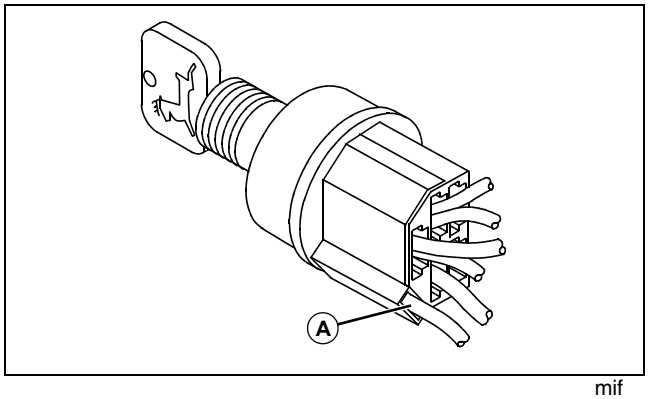
Headlight Circuit Diagnosis (Gas and Diesel Engines - All)

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Park brake locked.
- Open hood and remove storage tray.
- Key switch in run position, engine not running.
- Light switch in on position.
- Check wire connections for looseness and corrosion.

System: Headlight Circuit



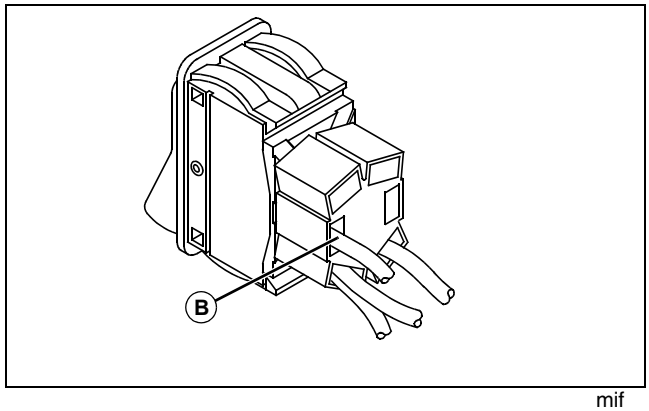
mif

(1) Is battery voltage present at A terminal, 420J Yel wire of S1 key switch (A)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341. See “Power Circuit Diagnosis (Gas Engine) (SN -40000)” on page 246, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.

System: Headlight Circuit

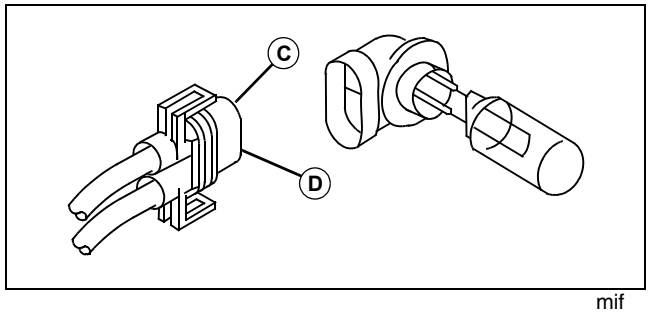


mif

(2) Is battery voltage present at 420G Yel wire of S4 light switch (B)?

Yes - Go to next step.

No - Check 420J and 420G Yel wires and connections.



mif

(3) Disconnect headlight connectors. Is battery voltage present at B terminal of X11 (Left), 800 Pnk wire and X12 (Right), 801 Pnk wire (C) connectors?

Yes - Go to next step.

No - Test light switch. See “Headlight Switch Test (Standard)” on page 341. Check 800 and 801 Pnk wires and connections.

(4) Is continuity to ground present at A terminal of X11 (Left), 100G Blk wire and X12 (Right) 100F Blk wire (D) connectors?

Yes - Replace headlight(s). Connect headlight connector(s) to headlight.

No - Check 100G (Left), 100F (Right), 101, and 101G Blk wires and connections.

Park Brake Circuit Operation (Gas and Diesel Engines - All)

Function:

To illuminate a light on the instrument panel and provide a visual indication to the operator that the park brake is locked.

Operating Conditions:

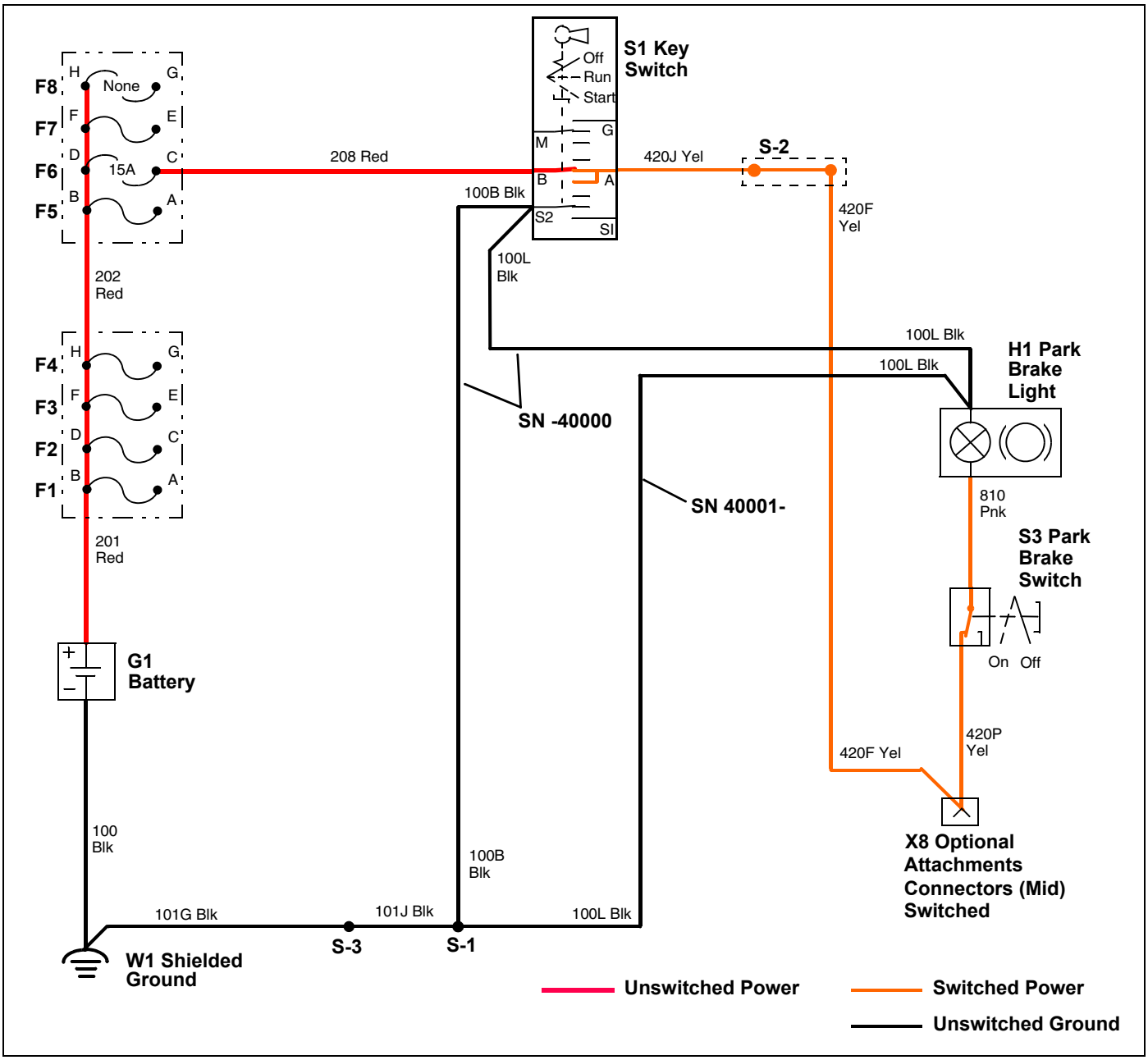
- Key switch in the RUN position.
- Park brake locked.

Theory of Operation:

Power flows from the G1 battery through the F6 fuse, S1 key switch, and on to the S-2 power splice. The 420F and 420P Yel wire carries power to the S3 park brake switch. With the switch in the closed (park brake locked) position, current then flows across the 810 Pnk wire to the H1 park brake light, illuminating the park brake light.

The 100L, 100B, 101J and 101G Blk wires provide ground through the S1 and S3 splices.

Park Brake Schematic (Gas and Diesel Engines - All)



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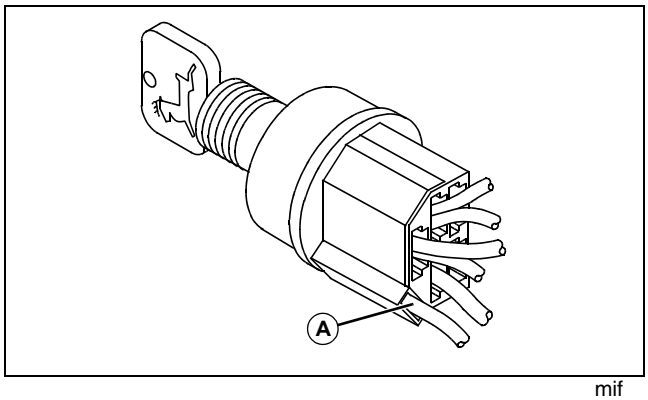
Park Brake Circuit Diagnosis (Gas and Diesel Engines - All)

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Park brake locked.
- Hood open.
- Key switch in run position, engine not running.
- Check wire connections for looseness and corrosion.

System: Headlight Circuit

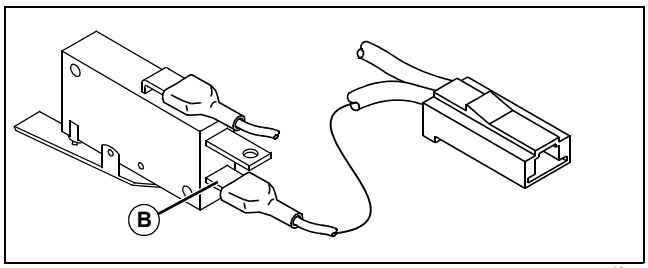


mif

(1) Is battery voltage present at A terminal, 420J Yel wire of S1 key switch (A)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341. See “Power Circuit Diagnosis (Gas Engine) (SN -40000)” on page 246, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.



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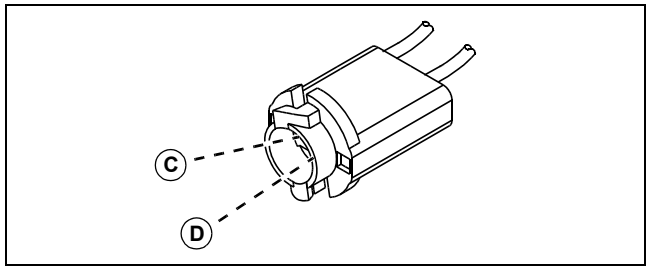
(2) Is battery voltage present at S3 park brake switch, 420P Yel wire (B)?

Yes - Go to next step.

No - Check 420P and 420F Yel wires.

System: Headlight Circuit



mif

(3) Remove H1 park brake light socket from instrument panel. Remove bulb. Is battery voltage present at H1 park brake light socket, 810 Pnk wire (C)?

Yes - Go to next step.

No - Test park brake switch. See “Park Brake Switch Test” on page 344. Check 810 Pnk wire.

(4) Is continuity to ground present at H1 park brake light socket, 100L Blk wire (D)?

Yes - Test bulb. See “Bulb Test” on page 347. Install bulb. Install H1 park brake light socket into instrument panel.

No - Check 100L, 100B, 101J and 101G Blk wires.

Accessory Power Port Circuit Operation (Gas and Diesel Engines - All)

Function:

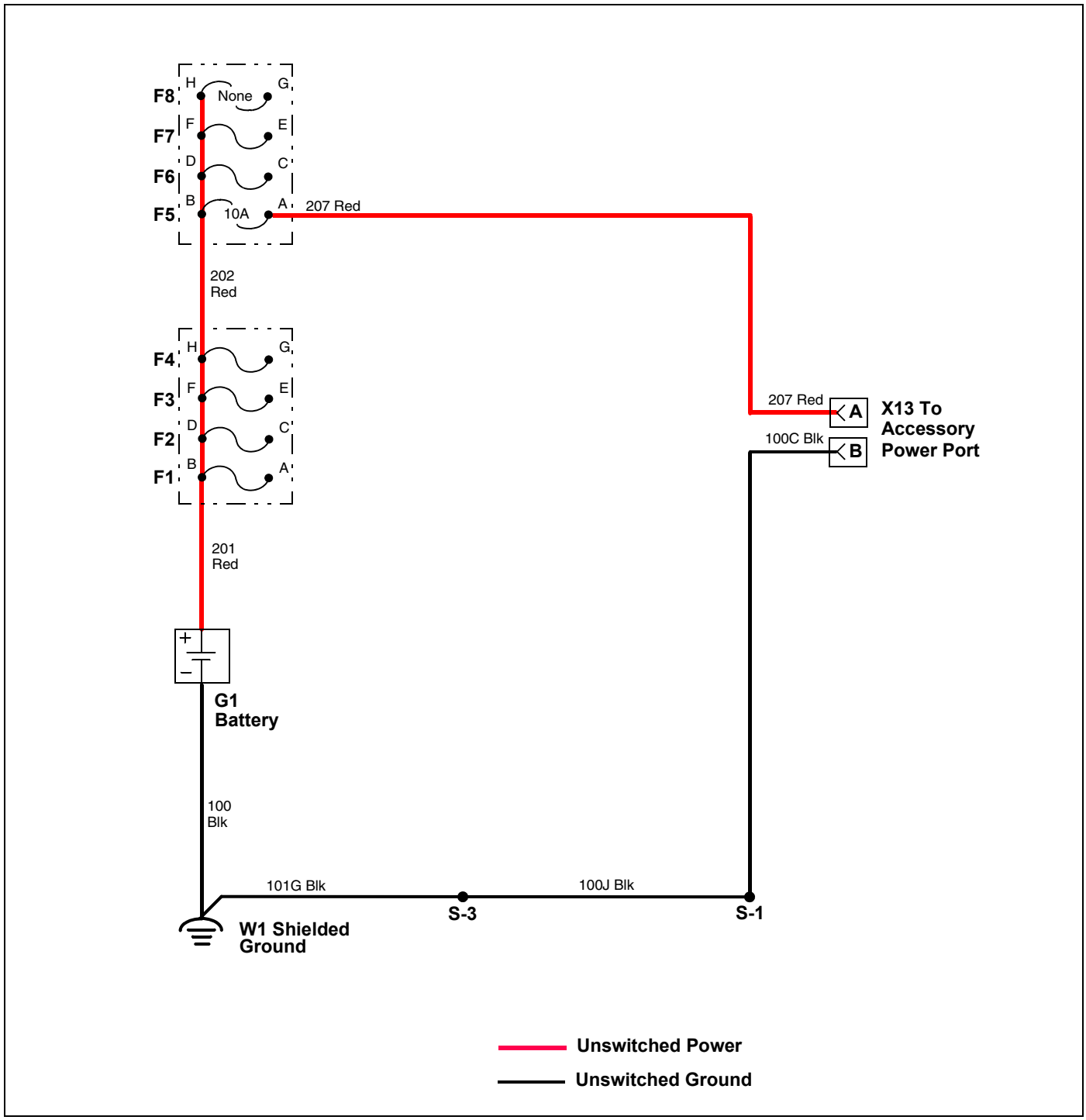
To provide unswitched 12VDC to power optional accessories.

Theory of Operation:

The G1 battery supplies unswitched current through the (206 Red - Diesel Engine) 201 and 202 Red wires, F5 fuse, and 207 Red wire directly to the X13 power port.

The ground path for the power port is completed using the 100C, 100J, and 101G Blk wires.

Accessory Power Port Schematic (Gas and Diesel Engine - All)



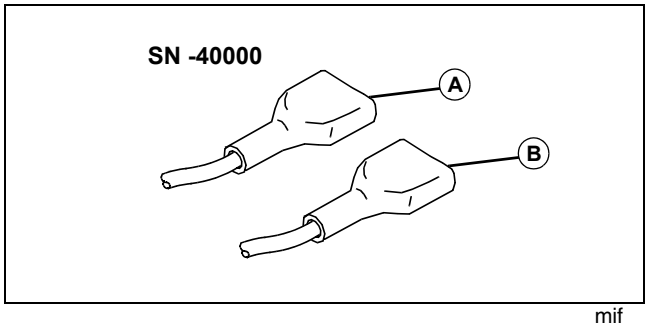
mif

Accessory Power Port Circuit Diagnosis (Gas and Diesel Engines - All)

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Park brake locked.
- Cargo box raised and locked.
- Battery fully charged.
- Key switch in off position.
- Check wire connections for looseness and corrosion.

System: Accessory Power Port Circuit



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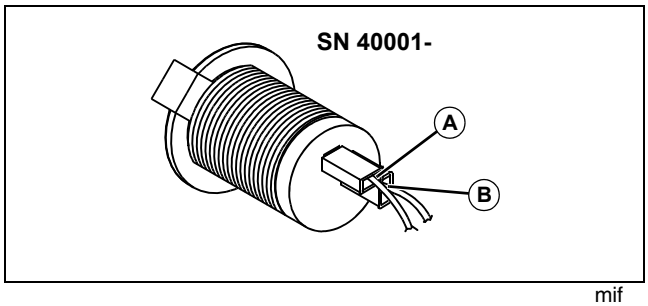


mif

(1) Is battery voltage present at 207 Red wire (A) of X13 power port?

Yes - Go to next step.

No - Check 201 and 202 Red wires, F5 fuse, and 207 Red wire.

(2) Is there continuity to ground between 100C Blk wire (B) of X13 accessory power port and ground?

Yes - Replace power port.

No - Check 100C, 101J, and 101G Blk wires and connections.

Tests and Adjustments

Common Circuit Tests

Shorted/Grounded Circuit:

A shorted circuit on the ground side of a component (i.e. improper wire-to-wire or wire to ground contact) may result in improper component operation.

A shorted circuit on the power side of a component or contact of two power circuits (i.e. improper wire-to-wire or wire to ground contact) may result in blown fusible link and fuses.

To test for a shorted or improperly wired circuit:

1. Turn component switch on.

2. Start at the controlling switch of the component that is not be operating.

3. Follow the circuit and disconnect wires at connectors until components stop operating.

4. Shorted or improper connections will be the last two wires disconnected.

High Resistance or Open Circuit:

High resistance or open circuits usually result in slow, dim, or no component operation (i.e. poor, corroded, or severed 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 ground connections of the circuit for corrosion.

2. If terminals are not loose or corroded, the problem is in the component or wiring.

Ground Circuit Tests

Reason:

To check for open circuits, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

Equipment:

- Ohmmeter or Voltmeter

NOTE: The voltmeter method checks ground connections under load.

Procedure - Ohmmeter Method:

1. Park machine safely. See “Parking Safely” in the Safety section.

2. Raise and lock cargo box.

3. Connect ohmmeter red lead to ground terminal of circuit or component to be tested that is closest to the battery negative terminal. Work backward from the battery on the ground side of the problem circuit until the resistance reading increases above 0.1 ohms. If the reading is above 0.1 ohms, 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 ohms. Check both sides of the connectors closely, as disconnecting and connection may temporarily solve problem.

Procedure - Voltmeter Method:

1. Park machine safely. See “Parking Safely” in the Safety section.

2. Turn key switch to on position.

3. Raise and lock cargo box.

4. Connect voltmeter negative (black) lead to negative (-) terminal of battery.

5. Connect voltmeter positive (Red) lead to ground terminal of circuit or component to be tested. Be sure that the component circuit is activated (key on, switch(es) closed) so that 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 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.

Charge Battery

Reason:

To increase battery charge after the battery has been discharged.

Equipment:

- Battery charger (variable rate)

Procedure:

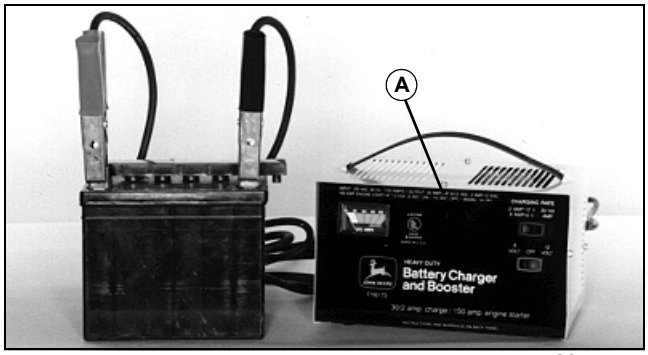
NOTE: See “Battery Test” on page 335 before charging battery.

1. Park machine safely. See “Parking Safely” in the Safety section.

2. Raise and lock cargo box.

3. Clean cable ends, battery terminals and top of battery.

4. Remove battery to workbench.



M49598

5. Connect variable rate charger (A) to battery.

6. 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.

7. Check if battery is accepting 10 amp charge rate after 10 minutes at boost setting.

Results:

- If battery will not accept 10 amp charge after 10 minutes at boost setting, replace battery;
- If battery is accepting 10 amp charge after 10 minutes at boost setting, and battery did not need water, go to Steps 7 and 8.
- If battery is accepting 10 amp charge after 10 minutes at boost setting, but battery did need water or all cells were below 1.175, go to Steps 7 and 8.

8. Set charger at 15 - 25 amps.

IMPORTANT: Avoid damage! Decrease charge rate if battery gases or bubbles excessively or becomes too warm to touch.

9. Check specific gravity after 30 minutes (60 minutes for maintenance-free battery).

Results:

- If more than 50 point variation between cells, replace battery;
- If less than 50 point variation between cells, go to Step 8 and 9.

NOTE: If battery was discharged at slow or unknown rate, charge battery 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.)

10.Continue to charge battery until specific gravity is 1.230 - 1.265 points.

11.Load test battery. See “Battery Load Test” on page 336.

12.Install battery.

Battery Test

CAUTION: Avoid injury! Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into the eyes.

Avoid the hazard by:

- **Filling batteries in a well-ventilated area.**
- **Wearing eye protection and rubber gloves.**
- **Avoiding breathing fumes when electrolyte is added.**
- **Avoid spilling or dripping electrolyte.**
- **Use proper jump-start procedure.**

If you spill acid on yourself:

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

If acid is swallowed:

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

Reason:

To check condition of battery and determine battery voltage.

Equipment:

- Hydrometer
- Voltmeter or JT05685 Battery Tester

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.

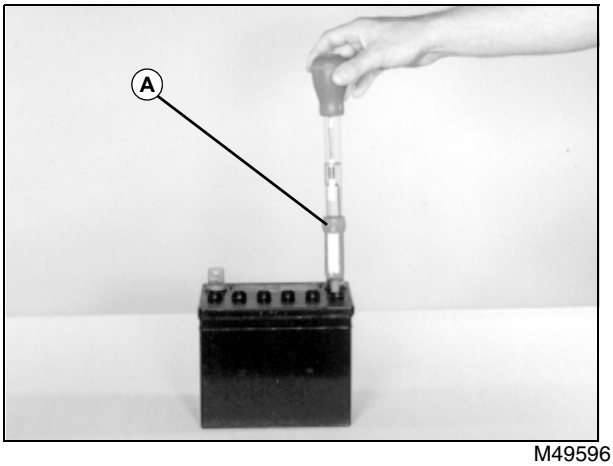
2. Clean cable ends, battery terminals and top of battery.

3. Remove battery to workbench.

4. Inspect battery terminals and case for breakage or cracks.

5. Check electrolyte level in each battery cell. Add clean, soft water as needed. If water is added, charge battery for 20 minutes at 10 amps.

6. Remove surface charge by placing a small load on the battery for 15 seconds.



M49596

7. Use a hydrometer (A) to check for a minimum specific gravity of 1.225 with less than 50 point variation in each cell.

Results:

- If all cells are less than 1.175, charge battery at 10 amp rate.
- If all cells are less than 1.225 with less than 50 point variation, charge battery at 10 amp.
- If all cells are more than 1.225 with less than 50 point variation, load test battery. See “Battery Load Test” on page 336.
- If more than 50 point variation, replace battery.

Use a voltmeter or JT05685 Battery Tester to check for a minimum battery voltage of 12.4 volts.

Results:

- If battery voltage is less than 12.4 VDC, charge battery See “Charge Battery” on page 334.
- If battery voltage is more than 12.4 VDC, test specific gravity. See **Step 7.**

Install battery.

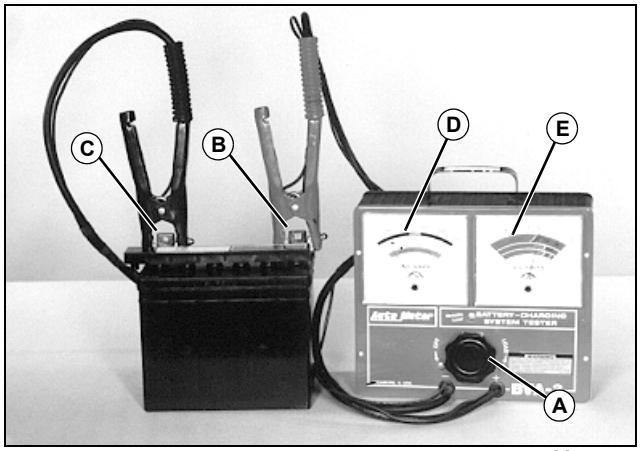
Battery Load Test

Equipment:

- JT05685 Battery Tester

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Cargo box raised and locked.
3. Clean cable ends, battery terminals and top of battery.
4. Remove battery.



M49597

5. Turn load knob (A) counterclockwise to off position.
6. Connect tester positive (Red) cable to battery positive (+) terminal (B).
7. Connect tester negative (black) cable to battery negative (-) terminal (C).
8. Turn load knob (A) of tester clockwise (in) until amperage reading (D) is equal to:
   - Cold cranking amperage rating of battery (use blue scale), or:
   - Three times ampere hour rating (use black scale).
9. Hold for 15 seconds and turn load knob (A) of tester counterclockwise to off position.
10. Repeat Steps 7 and 8 above and read condition of battery at DC Volts scale (E).

Results:

- If battery does not pass test and has not been charged, charge battery and retest.
- If battery does not pass test and has been charged, replace battery.

Unregulated Voltage Test (Gas Engine)

Reason:

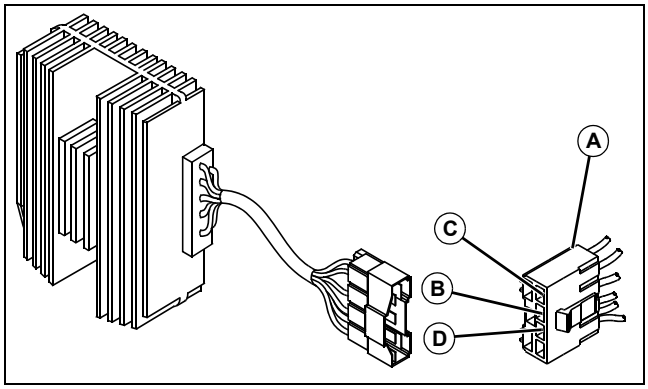
To determine charging output of the alternator stator.

Test Equipment:

- Voltmeter

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Cargo box raised and locked.



MIF

3. Disconnect connector (A) from voltage rectifier/ regulator.
4. Set voltmeter to AC volts.
5. Connect voltmeter to each set of stator terminals (B, C, and D).
6. Start and run engine at low idle.
7. Record stator voltage while increasing engine speed to high idle.

Specifications:

Unregulated voltage (minimum at low idle) . . . . 21 VAC
Unregulated voltage (minimum at high idle) . . . 50 VAC

Results:

- If voltage is less than specification, replace stator.

Stator Resistance Test (Gas Engine)

Reason:

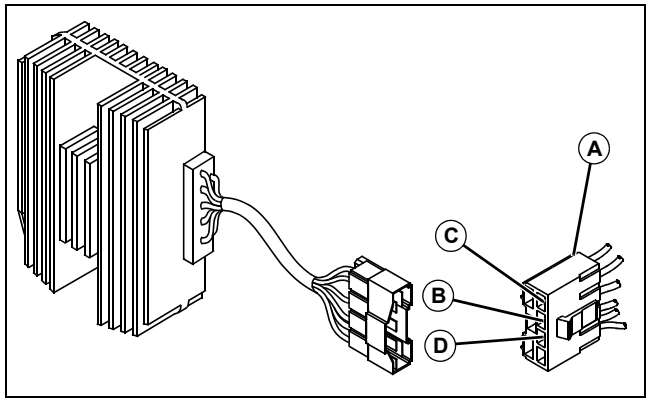
To determine if stator windings are open or grounded.

Equipment:

- Voltmeter

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Cargo box raised and locked.



MIF

3. Disconnect connector (A) from voltage rectifier/ regulator.
4. Set voltmeter to ohms.
5. Connect meter across terminals (B, C, and D) of alternator.
6. If reading is not within specification, replace stator.
7. Connect meter to each terminal of alternator connector and to frame ground.
8. If continuity is measured, replace stator.

Specifications:

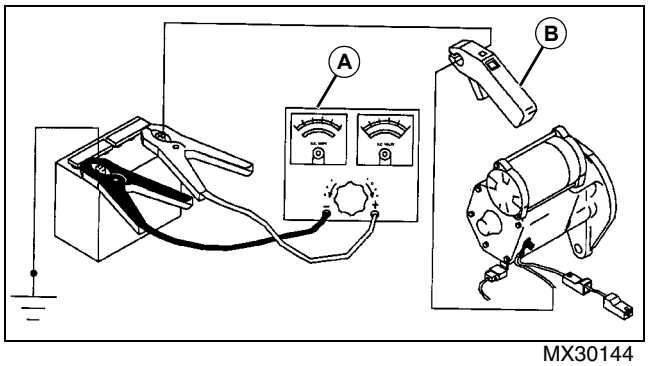
Stator Resistance . . . . . 0.5 ohms

Alternator Regulated Output Test

Prepare Unit for Testing

NOTE: The alternator in this kit is rated at 60 amps. The engine stator output is rated at 20 amps. To test the output of the 60 amp alternator, the stator must be disconnected from the voltage regulator.

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Turn off all electrical attachments that would create an additional current draw during the test procedure.
3. Disconnect stator plug connector from the machine voltage regulator, located on the right side frame.



MX30144

1. Attach battery tester JT05685 (A):
   a. Connect red cable on tester to positive (+) terminal on battery.
   b. Connect black cable to negative (-) terminal on battery.
   c. Turn LOAD knob on tester fully out (counterclockwise).
2. Attach current gun JT05712 (B):
   a. Clamp current gun over red positive (+) cable at alternator.
   b. Set current gun for DC current.

IMPORTANT: Avoid damage! Perform the test quickly to prevent damage to battery tester. DO NOT apply full load to battery for more that 5-10 seconds.

3. Run engine at full throttle.
4. Read battery voltage on battery tester, should be over 12.4 volts.
5. Turn LOAD knob on tester in (clockwise) until voltage is reduced to 12.4 volts.
6. Read amperage output on current gun, should be 55 amps minimum.
7. Disconnect and remove test equipment.
8. Connect stator plug to machine voltage regulator.

Specifications

Battery Voltage . . . . . 12.4 Volts
Regulated Amperage/Voltage
. . . . . 55 Amps (min.) at 12.2-13.8 Volts

Alternator Unregulated Amperage Test

Reason:

To determine charging output of the alternator stator.

Equipment:

- JTO5712 Current Gun

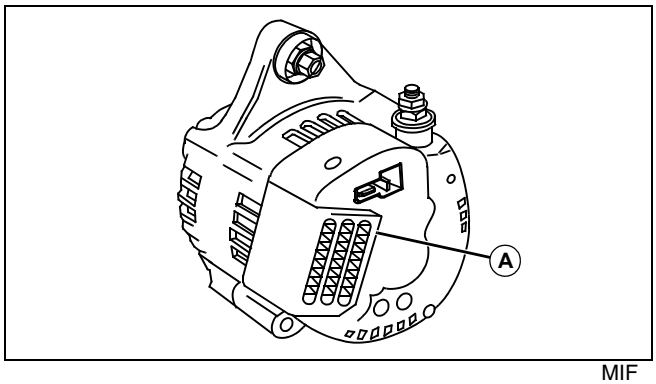
Conditions:

1. Put JTO5712 Current Gun over alternator Red wire.
2. Set current gun for DC current.

Procedure:

IMPORTANT: Avoid damage! Perform this test quickly to prevent damage to the battery. Do not apply full load to battery for more than 10 seconds.

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Raise and lock cargo box.
3. Start and run engine at high idle.



MIF

4. Insert a small Phillips screwdriver through the hole (A) in rear cover of alternator to ground the regulator to the rear cover. Read amperage on current gun.

Specification:

Minimum unregulated amperage . . . . . 40 amps

Results:

If reading does not meet specifications, verify voltage at the alternator regulated terminal and good alternator ground. If voltage and ground are ok, repair or replace the alternator.

Starting Motor Solenoid Test

Reason:

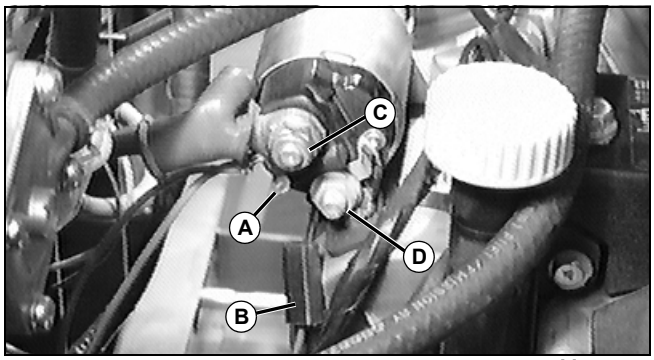
To determine if starting motor solenoid or starting motor is defective.

Equipment:

- Jumper wire.

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Disconnect and ground spark plug lead.
3. Cargo box raised and locked.



M56822

Gas Engine Shown

4. Disconnect wire (B) from starting motor solenoid terminal (A).
5. Connect jumper wire to positive battery terminal (+) and briefly jump to starting motor solenoid terminal (A).
   - Starting motor runs - solenoid is good, check circuit wiring.
   - Starting motor does not run - go to Step 6.
6. Remove rubber boot(s) from terminals (C and D).
7. Connect a heavy gauge, insulated jumper wire between starting motor solenoid large terminals (C and D).

Results:

- Starting motor runs - replace solenoid.
- Starting motor does not run - check battery and ground cables, then replace starting motor.

Starting Motor Loaded Amperage Draw Test

Reason:

To determine the amperage required to crank the engine and check starting motor operation under load.

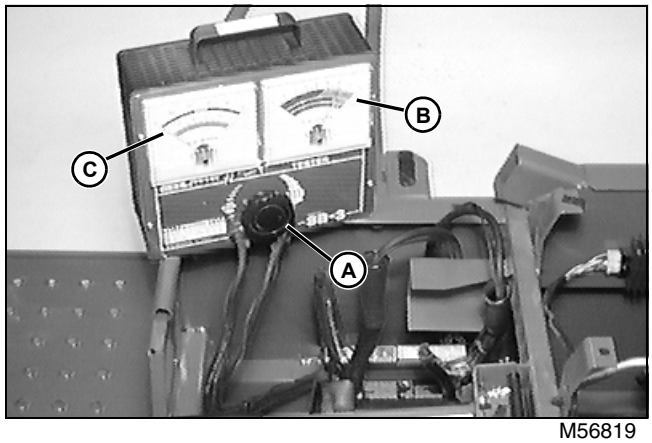
Equipment:

- JT05685 Battery Tester

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Cargo box RAISED and LOCKED.
3. Gas Engine - Disconnect and ground spark plug leads.
4. Diesel Engine - Disconnect fuel shutoff solenoid.

IMPORTANT: Avoid damage! Turn load knob (A) fully counterclockwise (out) into OFF position before making any test connections.



M56819

5. Connect JT05685 Battery Tester to battery.
6. Crank engine - read and record voltage on DC voltage scale (B) of battery tester.
7. Turn key switch to OFF position.

IMPORTANT: Avoid damage! Perform following procedure within 15 seconds to prevent damage to tester and/or machine components.

8. Turn load knob (A) clockwise (in) until DC voltage (B) reads the same as when cranking.
9. Read and record DC amperage (C).
10. Turn load knob (A) completely counterclockwise (out) into OFF position.

Results:

- Maximum starting motor draw should be 51 amps at 750 rpm.

• If amperage is above specification, perform Starting Motor No-Load Amperage and RPM Test to determine if starting motor is binding or damaged.

• If starting motor is good, check internal engine components for binding, wear, or damage.

Starting Motor No-load Amperage and rpm Tests

Reason:

To determine if starting motor is binding or has excessive amperage draw under no-load.

Equipment:

• JT05712 Current Gun

• JDM71 Vibration Tachometer or JT07270 Digital Pulse Tachometer

Procedure:

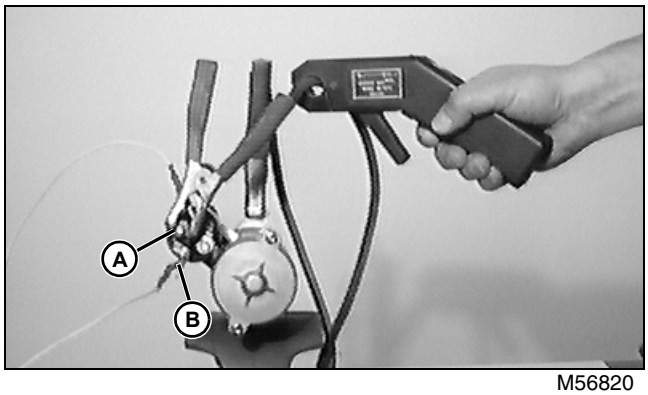
NOTE: Check that battery is fully charged and of proper size to ensure accuracy of test.

1. Park machine safely. See “Parking Safely” in the Safety section.

2. Cargo box RAISED and LOCKED.

3. Remove starting motor assembly to workbench.

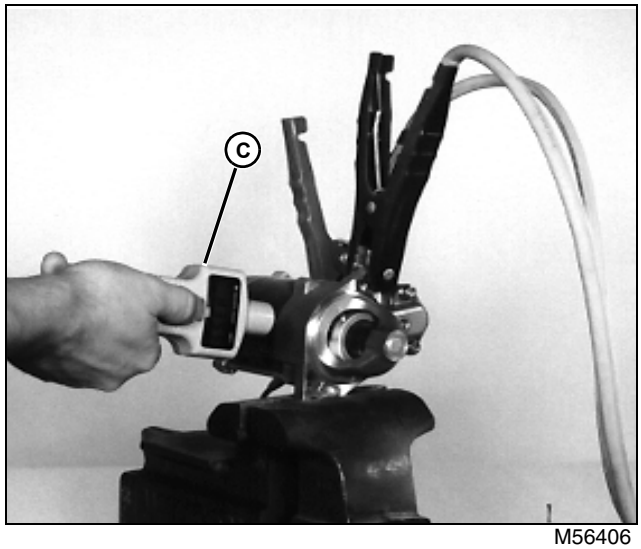
4. Connect jumper cables to battery.



M56820

5. Connect negative jumper cable to starting motor body and positive cable (red) to solenoid battery terminal (A).

6. Use reflective tape on starting motor worm gear and JT05719 Photo Tachometer to measure starting motor rpm.



M56406

7. Put JT05712 current gun around positive jumper cable (red).

IMPORTANT: Avoid damage! Complete this test in 20 seconds or less to prevent starting motor damage.

8. Use jumper wire to briefly connect terminal (A) and solenoid engagement terminal (B).

9. Measure and record starting motor amperage with current gun and rpm with tachometer (C).

Results:

• A good starting motor should have a maximum amperage reading of 50 amps and a minimum rotational reading 6000 rpm.

• If amperage reading is above 50 amps or starting motor rpm is less than 6000, check for binding or seized bearings, sticky brushes, and dirty or worn commutator.

• Repair or replace starting motor.

Key Switch Test

Reason:

To verify key switch functions are operating properly.

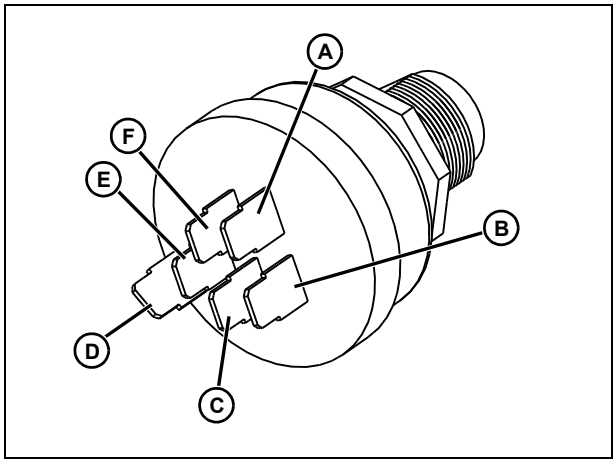
Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Open hood and remove storage tray.
3. Disconnect key switch connector.

NOTE: DO NOT refer to markings stamped on terminals. Identify terminals by art keys ONLY. Terminal combinations other than those listed in chart should NOT have continuity.



mif

4. Use an ohmmeter to test switch continuity in OFF, RUN, and START positions.

Switch Position Terminal Continuity

- OFF: A and B
- RUN: C and D
- START: C and D
- E and F

Results:

- If any continuity is NOT correct, replace switch.

Headlight Switch Test (Standard)

Reason:

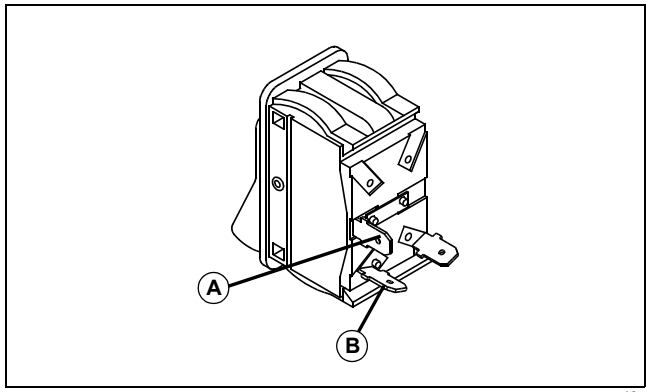
To make sure the headlight switch terminals have continuity when the headlight switch is in the on position.

Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Open hood and remove storage tray.
3. Disconnect headlight switch connector.



mif

4. Move headlight switch to the on and then the off position. Check continuity between terminals (A and B).

Results:

- Terminals should have continuity with switch on.
- Terminals should not have continuity with switch off.
- If continuity is not correct, replace headlight switch.

Light Switch Test (Optional Marker or Signal Lights)

Reason:

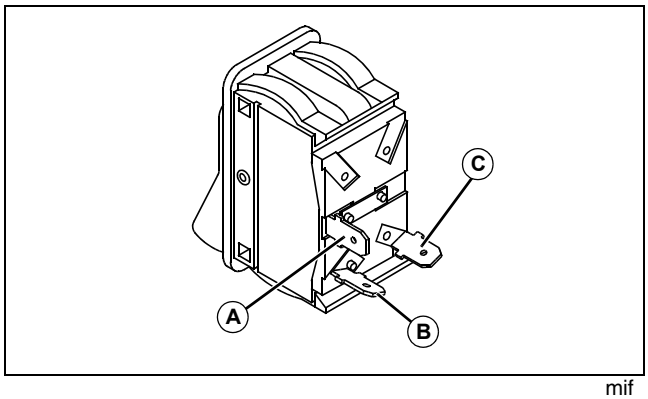
To make sure the light switch terminals have continuity when the light switch is in the various positions.

Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Open hood and remove storage tray.
3. Disconnect light switch connector.



mif

4. With the light switch in the off position, check continuity between all terminals (A and B), (B and C), and (A and C).
5. Move light switch to the marker lights (middle) position. Check continuity between all terminals (A and B), (B and C), and (A and C).
6. Move light switch headlights position. Check continuity between all terminals (A and B), (B and C), and (A and C).

Results:

Switch in Off position:

Continuity . . . . . .No Continuity

Switch in Marker (middle) position:

Continuity . . . . . .A and C

Switch in Headlights position:

Continuity . . . . . A and C, A and B, B and C

There should not be continuity between any other terminals. If continuity is not correct, replace light switch.

Turn Signal Lights Switch Test

Reason:

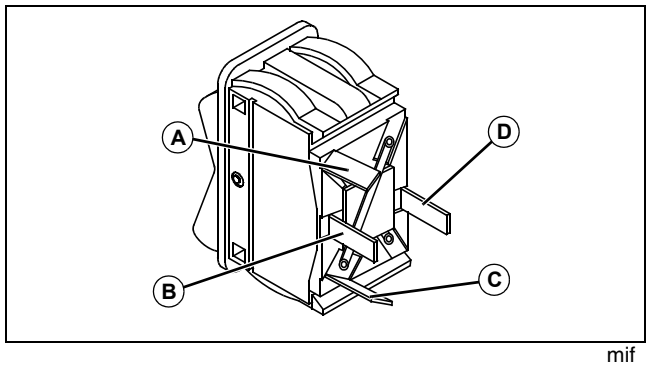
To verify turn signal lights switch is operating properly.

Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Open hood and remove storage tray.
3. Disconnect turn signal lights switch connector from harness.
4. Use an ohmmeter or continuity tester to test the switch in the off, left turn, and right turn positions.



mif

Specifications:

Off Position. . . . . A and D, C and D
Left Turn Position. . . . . B and C
Right Turn Position . . . . . A and B

Results:

- If continuity is not correct, replace turn signal light switch.

Hazard Lights Switch Test

Reason:

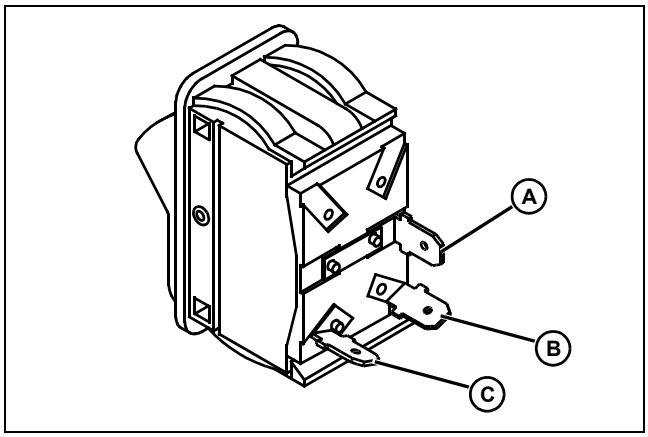
To verify hazard switch functions are operating properly.

Equipment:

- Ohmmeter

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Remove the hood.
3. Disconnect hazard lights switch connector from harness.
4. Use an ohmmeter to test switch continuity in the OFF and ON positions.



MIF

5. Set the multimeter to measure ohms to sequentially test continuity across each terminal combination (A), (B), and (C).

OFF Position Continuity:

No continuity between any terminals.

ON Position Continuity:

Continuity between all terminals.

Results:

- If any continuity is NOT correct, replace the hazard lights switch.

Neutral Start Switch Test

Reason:

To verify neutral start switch functions are operating properly.

Equipment:

- Ohmmeter or Continuity Tester

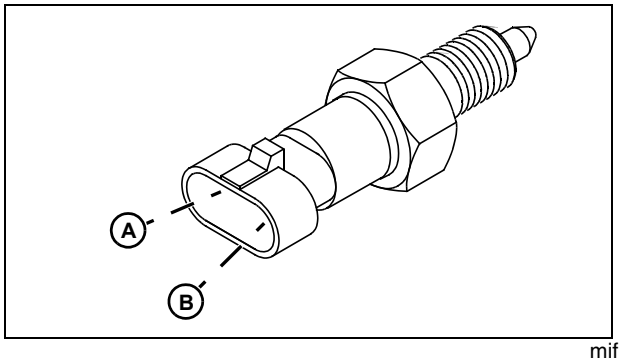
Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Raise cargo box.
3. Disconnect neutral start switch connector.
4. Use an ohmmeter to test switch continuity with transaxle in gear and in neutral.

Switch Position Terminal Continuity

- Forward and reverse gear position (plunger released): A to B no continuity
- Neutral (plunger pressed in): A to B continuity

5. If continuity is not correct, remove switch from transaxle.



mif

6. Use an ohmmeter to test switch continuity in OPEN and CLOSED positions.

Switch Position Terminal Continuity

- OPEN (plunger released): A to B no continuity
- CLOSED (plunger pressed in): A to B continuity

Results:

- If any continuity is NOT correct, replace switch.
- If continuity is correct with sw.tch removed but not with switch installed in transaxle see “Transaxle Repair” in Power Train section.

Park Brake Switch Test

Reason:

To make sure the brake pedal switch has continuity when plunger is released.

This switch is optional with light kits or back up alarm kit.

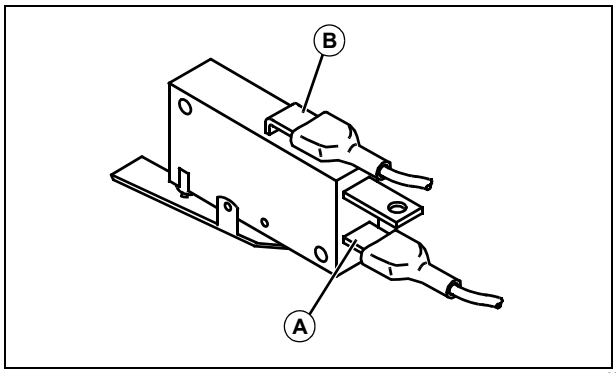
Equipment:

- Ohmmeter

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Remove center console. See “Center Console Removal and Installation” on page 580 of Miscellaneous section.
3. Check continuity.

Results:



mif

- There should be continuity between terminals (A and B) when lever is released.
- There should not be continuity between terminals (A and B) when plunger is depressed.
- If continuity is not correct, replace switch.

Fuse Test

Reason:

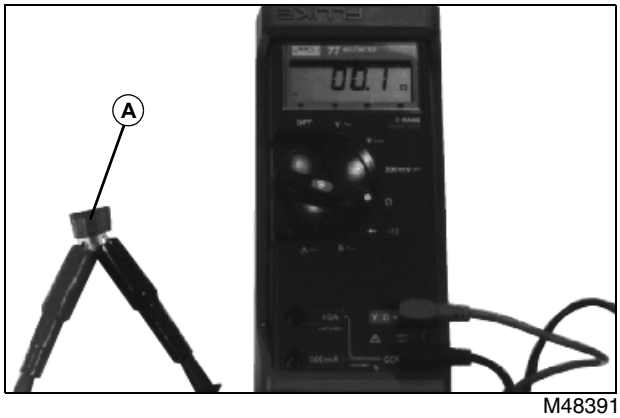
To verify that the fuse has continuity.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Remove fuse from connector.



M48391

3. Check visually for broken filament (A).
4. Connect ohmmeter or continuity tester to each end of fuse.
5. Check for continuity.

Results:

- If continuity is not indicated, replace fuse.

Diode Test

Reason:

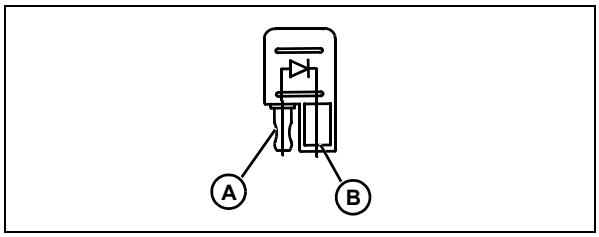
To verify that diode has proper continuity.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Raise hood.
3. Remove diode from connector.



mif

4. Connect ohmmeter red (+) lead to pin (A) of diode.
5. Connect ohmmeter black (-) lead to pin (B) of diode. Check for continuity.
6. Reverse test leads. Check for continuity.

Results:

Diode must have continuity in one direction only. Replace defective diode.

Relay Test

Reason:

To check relay terminal continuity in the energized and de-energized condition.

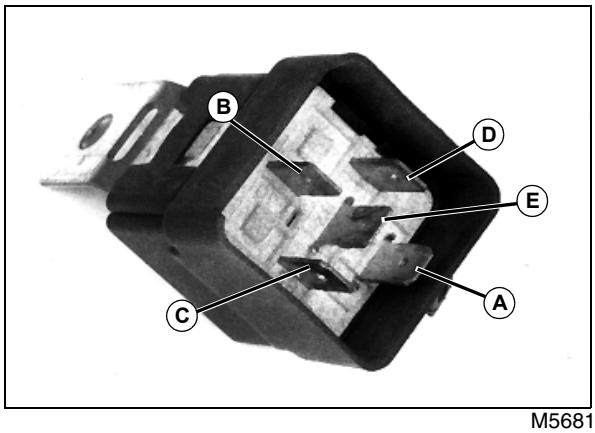
Equipment:

- Ohmmeter

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Cargo box raised and locked.
3. Disconnect relay connector from harness.
4. Check continuity.

Results:



M56817

- There should be continuity between terminals (E) and (B), and between terminals (C) and (D).
- There should not be continuity between terminals (A) and (B).
- Connect a jumper wire from battery positive (+) terminal to relay terminal (C). Connect a jumper wire from relay terminal (D) to ground (-).
- There should be continuity between terminals (A) and (B).
- If continuity is not correct, replace relay.

Radiator Coolant Temperature Switch Test

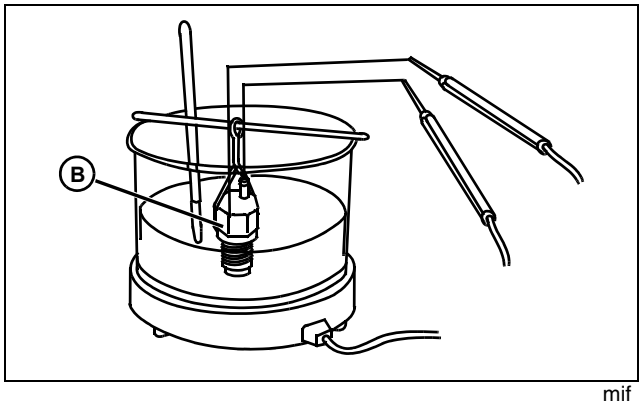
Reason:

To verify radiator coolant temperature switch is functioning properly to control radiator fan.

NOTE: Perform the test with the engine at room temperature.

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Disconnect radiator coolant temperature switch. Check for continuity between the terminal and the switch body. If there is continuity, replace switch.
3. Remove coolant temperature switch.



mif

4. Place switch (B) in antifreeze solution heated to 93° ± 3° C (199° ± 5° F). Measure continuity while switch is heated.

Results:

- Replace switch if continuity does not occur at specified temperature.

Switch Specifications:

Open/Close Temperature. . . . . 93° ± 3° C (199° ± 5° F)
Torque Specification . . . . . 24 ± 3 N•m (212 ± 27 lb-in.)

Engine Coolant Temperature Switch Test

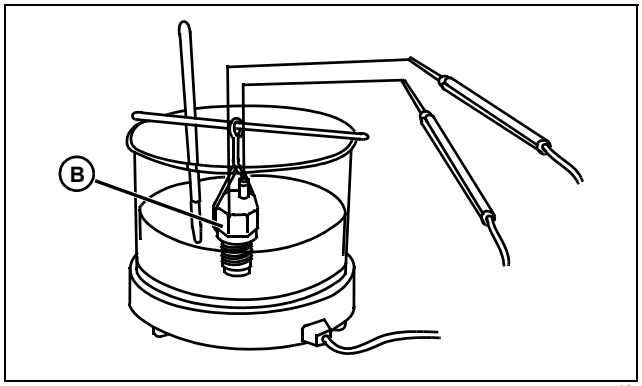
Reason:

To verify engine coolant temperature switch is functioning properly to control temperature light.

NOTE: Perform the test with the engine at room temperature.

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Disconnect engine coolant temperature switch. Check for continuity between the terminal and the switch body. If there is continuity, replace switch.
3. Remove coolant temperature switch.



mif

4. Place switch (B) in antifreeze solution heated to 111° ± 3° C (232° ± 5° F). Measure continuity while switch is heated.

Results:

- Replace switch if continuity does not occur at specified temperature.

Switch Specifications:

Open/Close Temperature . . . . . 111° ± 3° C (232° ± 5° F)
Torque Specification . . . . . 24 ± 3 N•m (212 ± 27 lb-in.)

Flywheel Magnet(s) Test (Gas Engine)

Reason:

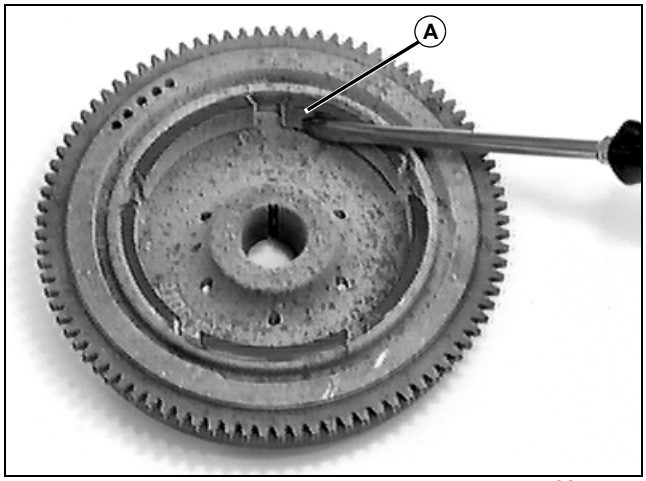
To make sure flywheel magnet(s) have enough force to induce current into ignition coil.

Equipment:

- Screwdriver

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Cargo box raised and locked.
3. Remove flywheel from engine.



M55789

4. Loosely hold screwdriver blade about 25 mm (1.0 in.) away from magnet(s) (A).

Results:

- Each magnet should attract blade to it.
- If blade is not attracted to magnet(s), flywheel must be replaced.

Bulb Test

Reason:

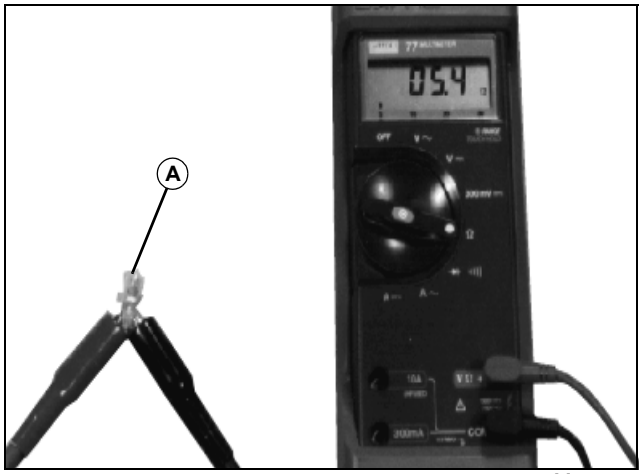
To verify that the bulb has continuity.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Remove bulb from socket.



M48392

3. Check visually for broken filament (A).
4. Connect ohmmeter or continuity tester to each terminal of bulb.
5. Check for continuity.

Results:

- If continuity is not indicated, replace bulb.

Cargo Box Raise/Lower Switch Test

Reason:

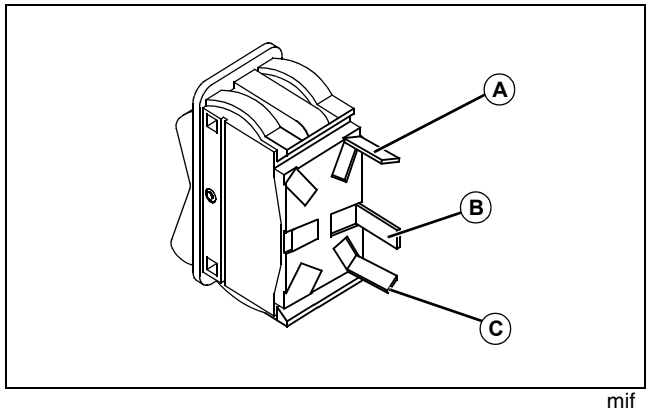
To verify cargo box raise/lower switch functions properly.

Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Raise hood.
3. Disconnect cargo box raise/lower switch connector.
4. Check continuity.



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Specifications:

Off Position. . . . . No continuity between any terminals
Raise Position . . . . . A and B
Lower Position . . . . . B and C

Spark Test (Gas Engine)

Reason:

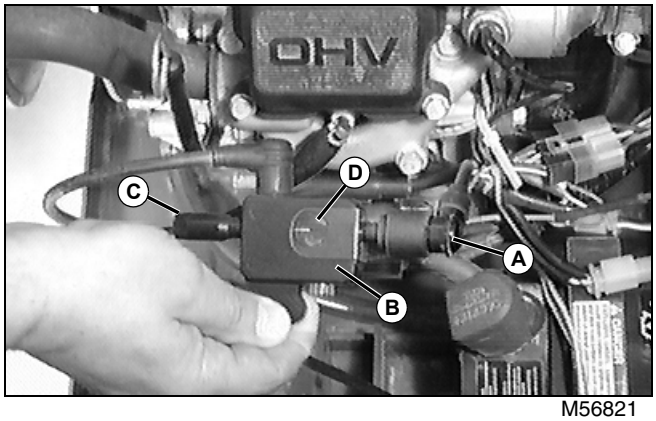
To check overall condition of ignition system.

Equipment:

- D-05351ST - Spark Tester

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Cargo box raised and locked.



M56821

3. Remove high tension lead (A) from spark plug and connect to spark tester (B).
4. Connect spark tester lead to spark plug.

IMPORTANT: Avoid damage! Do not adjust spark tester gap beyond 5.0 mm (0.20 in.) as damage to ignition system components could occur.

5. Adjust spark tester gap to 4.2 mm (0.166 in.) with screw (C).

6. Turn key switch to start position and watch spark (D) at spark tester.

Results:

- If engine will start, watch spark with engine running. There should be a strong, steady, blue spark.
- If spark is weak, or if no spark, install a new spark plug and test again.
- If spark is still weak, or still no spark, run tests on individual components to find cause of malfunction.

Pulser Coil Test (Gas Engine)

Reason:

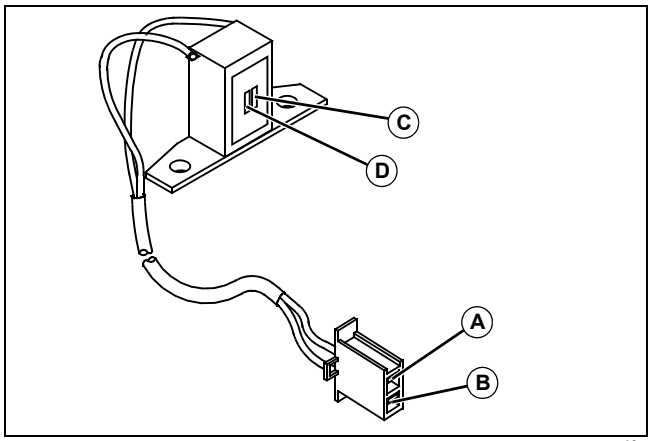
To determine condition of pulser coil windings and verify pulser12VDCcoil wire continuity.

Equipment:

- Ohmmeter

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Cargo box raised and locked.
3. Disconnect 2 - pin pulser connector.



mif

4. Measure resistance between Red wire (A) and Blk wire (B).
5. Measure resistance between pickups (C and D).

Results:

- If resistance does not read approximately 196 ohms between A and B and approximately 2 ohms between C and D, replace pulser coil.

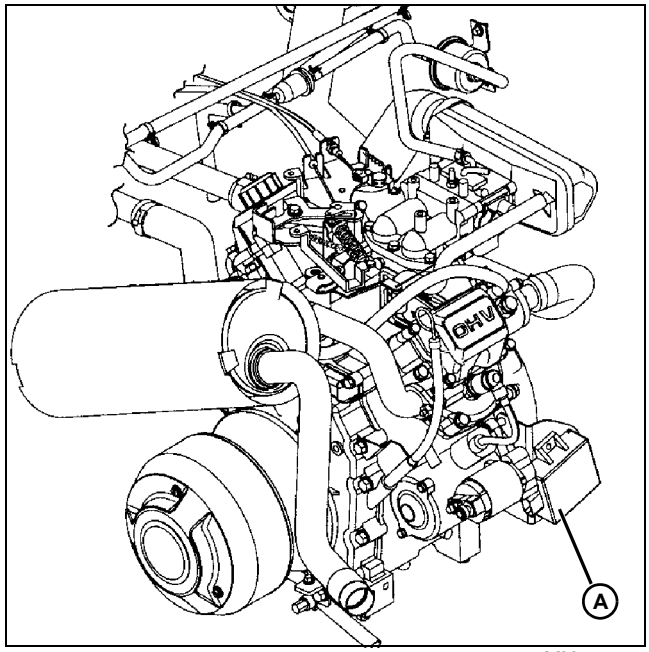
Ignition Module Test (Gas Engine)

Reason:

To determine if the ignition module is defective.

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Cargo box RAISED and LOCKED.



MX31987

3. Locate the ignition module (A) mounted on the back of the engine.
4. The ignition module (A) is very sensitive to the type of ohmmeter used to check resistance. Due to variations in ohmmeters, the best way to determine if the ignition module is good is to replace the questionable ignition module with a known good module.

Results:

- If the new ignition module does not solve the problem, check other ignition components.

Ignition Coil Test (Gas Engine)

Reason:

Check the windings of the ignition coil.

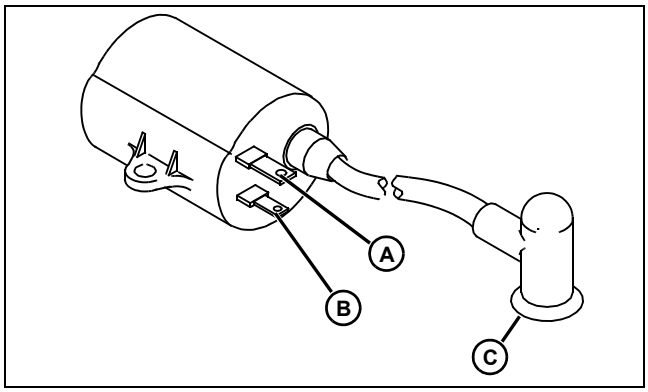
Test Equipment:

- Ohmmeter

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Cargo box RAISED and LOCKED.
3. Disconnect wires from ignition coil terminals.

Primary windings:



MIF

1. Connect one ohmmeter lead to coil positive (+) (wide) terminal (A).
2. Connect other ohmmeter lead to coil negative (-) terminal (B).
3. Measure resistance across primary windings. Resistance should measure approximately 0.2 ohms.
4. Repeat test procedures on other ignition coils.

Secondary windings:

1. Connect one ohmmeter lead to coil positive (+) terminal (A).
2. Connect other ohmmeter lead to high tension lead (C).
3. Measure resistance across secondary windings. Resistance should measure approximately 12,000 ohms.
4. Repeat test procedures on other ignition coils.

Results:

- If the ohmmeter readings are not within specifications, replace coil.
- If ohmmeter readings are within specifications, the coils are probably good. If system still does not perform properly after all tests/checks, replace coil with a good coil.

Spark Plug Cap Test (Gas Engine)

Reason:

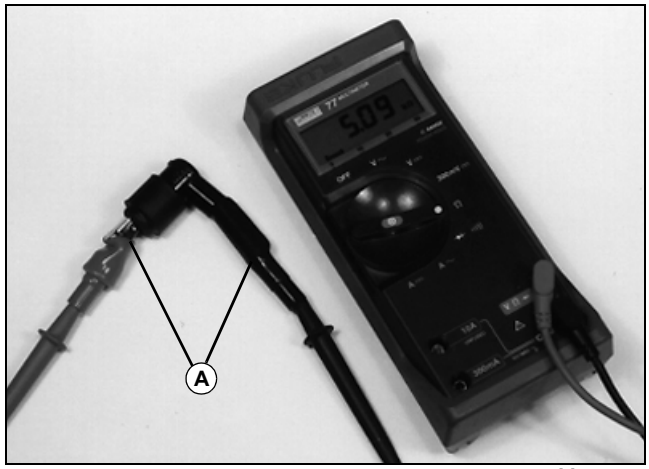
To determine if spark plug cap is defective.

Equipment:

- Ohmmeter

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Cargo box RAISED and LOCKED.
3. Disconnect spark plug cap.



M56818

4. Measure resistance across spark plug cap terminals (A).

Results:

- Resistance should be approximately 5000 ohms, the same as marked on the spark plug cap.
- If resistance DOES NOT meet specification, replace spark plug cap.

Fuel Pump Test (Gas Engine)

See “Fuel Pump Circuit Diagnosis (Gas Engine - All)” on page 299.

Fuel Shutoff Solenoid Test (Gas Engine)

Reason:

To determine if the fuel shutoff plunger retracts when the solenoid is energized.

Equipment:

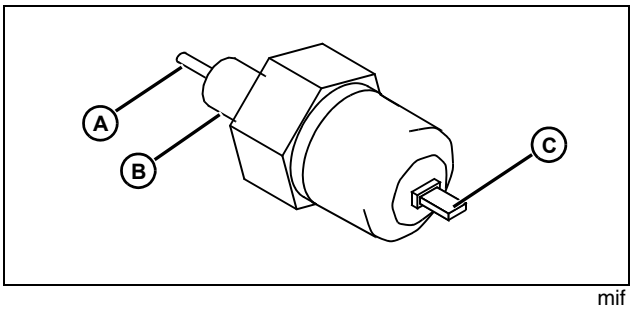
- 2 jumper wires

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Cargo box raised and locked.

CAUTION: Avoid Injury! Keep gasoline away from sparks, flame, or hot engine parts or personal injury can result.

3. Remove drain screw and spring to drain gasoline from float bowl.
4. Disconnect fuel shutoff solenoid connector.
5. Remove fuel shutoff solenoid, washer and float bowl.



mif

6. Connect a jumper wire from the battery positive (+) terminal to solenoid terminal (C). It may be necessary to push plunger (A) inward slightly for plunger to retract.

NOTE: It may be necessary to push plunger (A) inward slightly for plunger to retract.

7. Connect a jumper wire from the battery negative (-) terminal to solenoid threads (B). Plunger should now retract with the solenoid energized.
8. Remove jumper wire from the battery negative (-) terminal. Plunger should extend.

Results:

If plunger does not move, replace solenoid.

Fuel Shutoff Solenoid Test (Diesel Engine)

Reason:

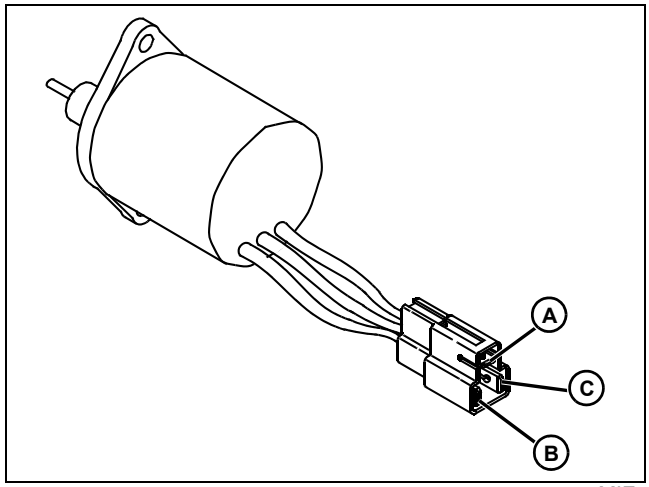
To verify fuel shutoff solenoid is functioning properly.

Equipment:

- Ohmmeter

Procedure:

1. Park machine on level surface and turn start switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Disconnect fuel shutoff solenoid connector.



MIF

5. Measure and record the resistance across each combination of terminals as listed below.

	Blk Wire (A)	Red Wire (B)	Wht Wire (C)
Blk Wire (A)		12	0.4
Red Wire (B)	12		12.4
Wht Wire (C)	0.4	12.4	

The red lead (+) position of the meter is listed down the side and the black lead (-) position of the meter is listed across the top of the chart.

Results:

If continuity is not correct, replace fuel shutoff solenoid.

Glow Plug Test (Diesel Engine)

Reason:

To test operation of glow plugs.

Equipment:

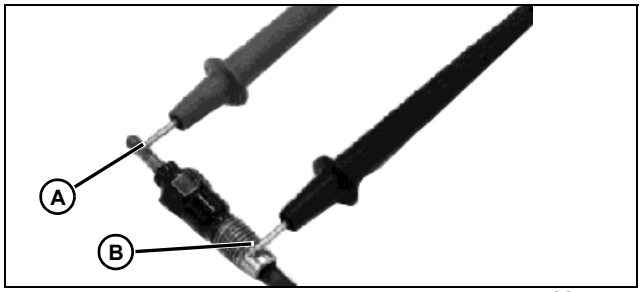
- Ohmmeter

Procedure:

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. ENGAGE park brake, place gear shift in NEUTRAL position.
4. Cargo box RAISED and LOCKED.

NOTE: Cover glow plug hole to prevent debris from entering cylinder when glow plug is removed.

5. Remove glow plug lead. Remove glow plug.



M46296

6. Check continuity across terminal (A) and glow plug body (B). The reading should be between 0.3 - 0.5 ohms.

Results:

- If glow plug does not have proper resistance, replace glow plug.

Engine Oil Pressure Switch Test

Reason:

To determine if the oil pressure switch is functioning properly.

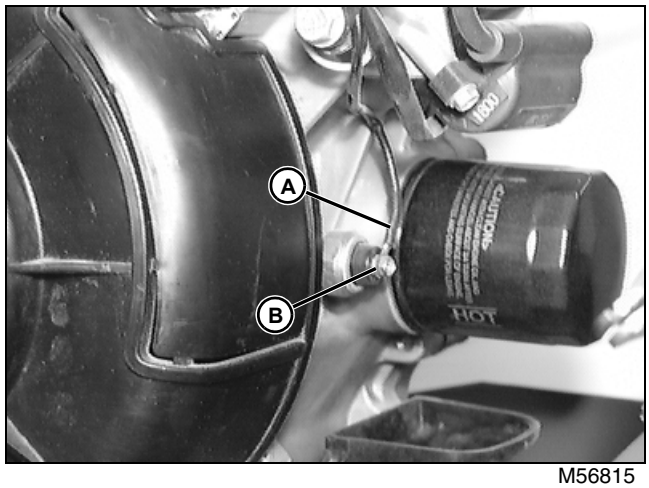
Equipment:

- Ohmmeter

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Cargo box RAISED and LOCKED.

IMPORTANT: Avoid damage! Do not allow wire connector to contact engine or frame because there will be voltage at that point during the test.



M56815

Gas Engine Shown

3. Disconnect wiring lead (A) from switch.
4. Connect black lead of meter to engine block and red lead of meter to terminal (B) of switch.
5. Set ohmmeter for 1X ohms scale.
6. Read meter.

Results:

- There should be continuity to ground.
- If the switch does NOT have continuity to ground, replace the switch.
- Start and run engine.
- Read meter.

NOTE: BE SURE to apply John Deere Pipe Thread Sealant with TEFLON®, or an equivalent to threads of switch anytime it is installed.

Results:

- The switch should NOT have continuity to ground.
- If the switch DOES have continuity to ground with the engine running, check engine oil pressure. (See Oil Pressure Test in Engine Tests and Adjustments Section.)
- If the oil pressure is to specification, replace the switch.

Carburetor Heater Test (Gas Engine)

Reason:

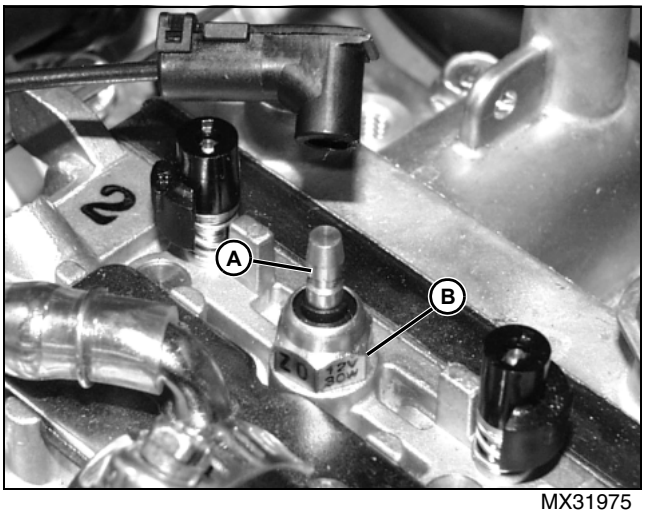
To test operation of carburetor heater.

Equipment:

- Ohmmeter

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Cargo box RAISED and LOCKED.
3. Remove carburetor heater lead. Remove carburetor heater.



MX31975

4. Check continuity across terminal (A) and carburetor heater body (B). The reading should be 8.0 ohms ± 0.5 ohms.

Results:

- If carburetor heater does not have proper resistance, replace carburetor heater.

Brake Lights Switch Test

Reason:

To make sure the brake lights switch has continuity when plunger is released.

This switch is optional with light kits or back up alarm kit.

Equipment:

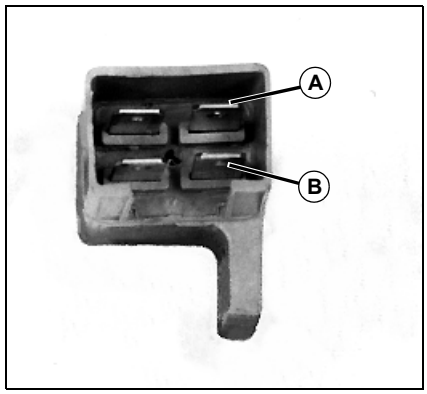
- Ohmmeter

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Open hood and remove storage tray.
3. Disconnect harness connector from brake pedal switch.
4. Check continuity.

Results:

NOTE: Two of the four terminals are not used in this application.



M56409

- There should be continuity between terminals (A and B) when plunger is released.
- There should not be continuity between terminals (A and B) when plunger is depressed.
- If continuity is not correct, replace switch.

Horn Switch Test

Reason:

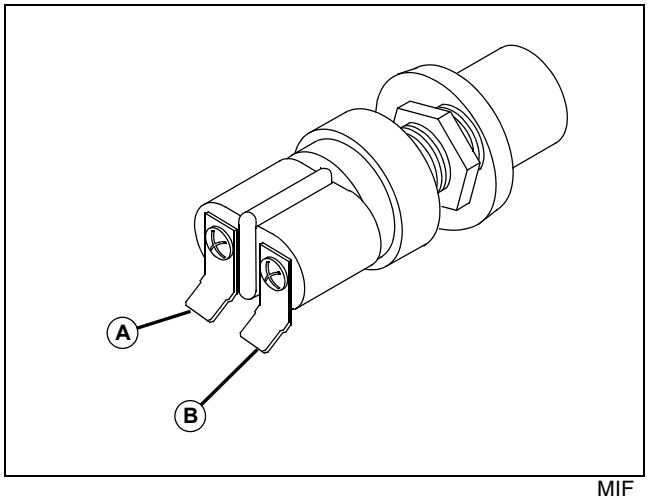
To verify the horn switch is operating properly.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Open hood and remove storage tray.
3. Disconnect the horn switch connectors from the switch.



MIF

4. With the button released, check continuity across both switch terminals (A) and (B). There should be no continuity.
5. Depress the horn switch button. Continuity should exist between both terminals (A) and (B).

Results:

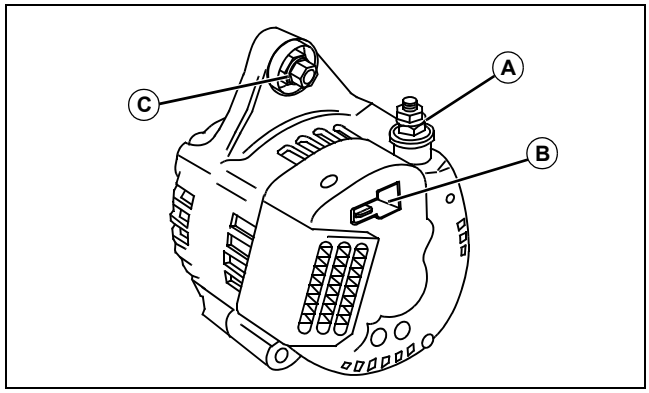
- If continuity is not correct, replace horn switch.

Repair

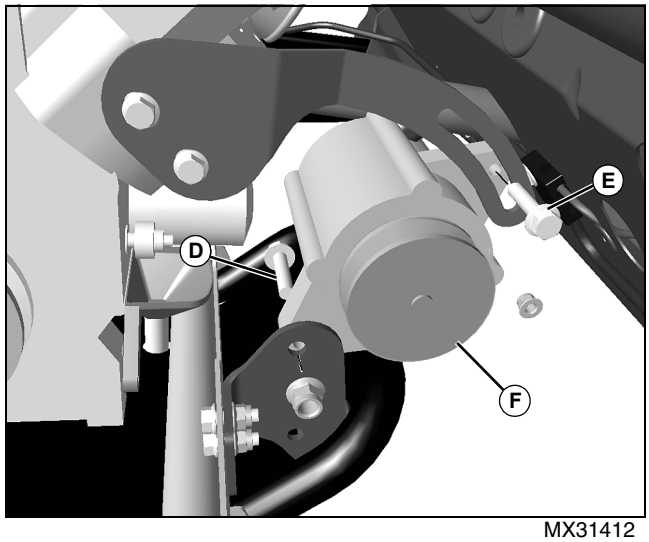
High Capacity Alternator Removal and Installation

Removal:

1. Park machine safely. See “Parking Safely” in the Safety section.
2. Disconnect negative (-) battery cable from battery.



3. Lift red plastic protective cover, and remove the nut, washer, and positive (+) wire (A) from the battery.
4. Disconnect the voltage sensing wire (B).
5. Remove the nut (C) and ground wire.



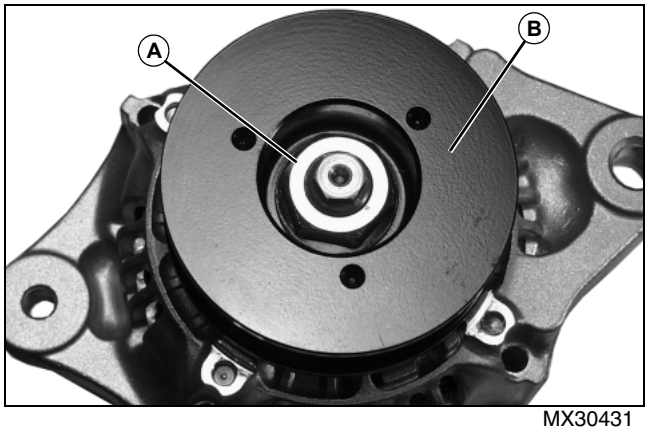
MX31412

6. Loosen the lower (D) and upper (E) alternator mounting bolts.
7. Pivot the alternator towards the engine and remove belt from drive pulley (F).
8. Remove the mounting bolts and alternator.

Equipment:

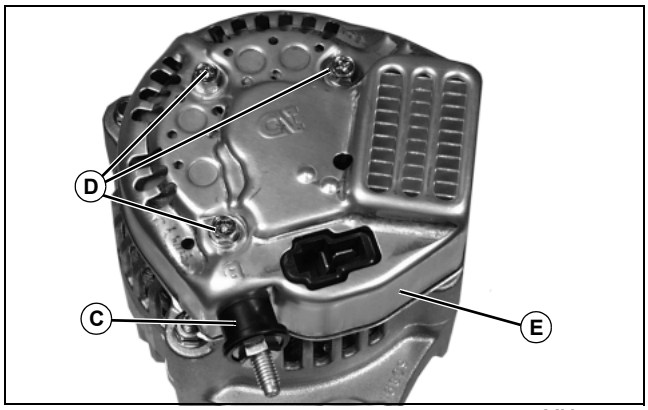
- Volt-Ohm-Amp Meter
- 13 Ton Bearing Puller Set

Disassembly:



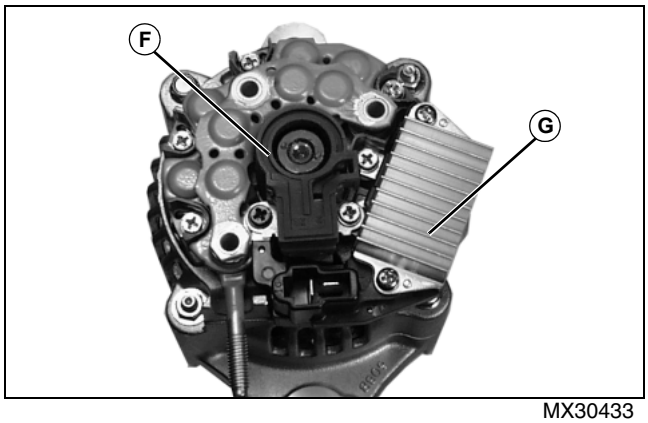
MX30431

1. Clamp sheave in a soft jaw vise and remove sheave nut (A).
2. Use puller to remove sheave (B).



MX30425

3. Remove nut and insulator (C).
4. Remove screws (D) and cover (E).

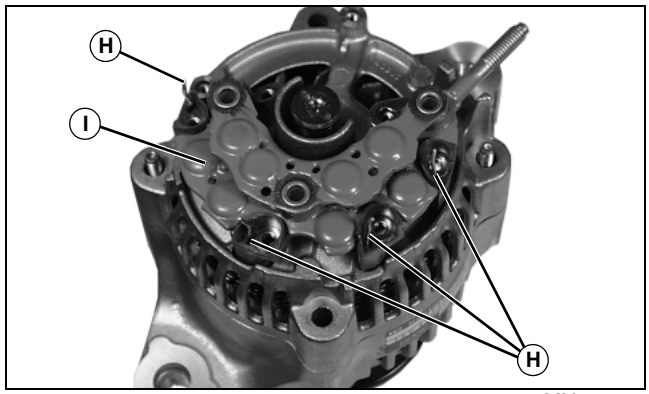


MX30433

5. Remove brush holder and cover (F).

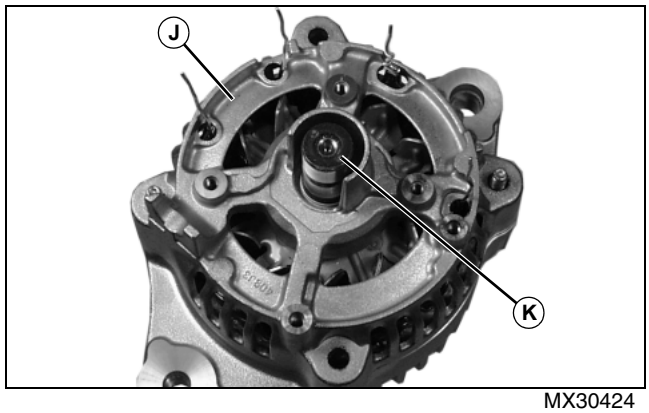
NOTE: Remember location of short screw on regulator tab.

6. Remove regulator (G).



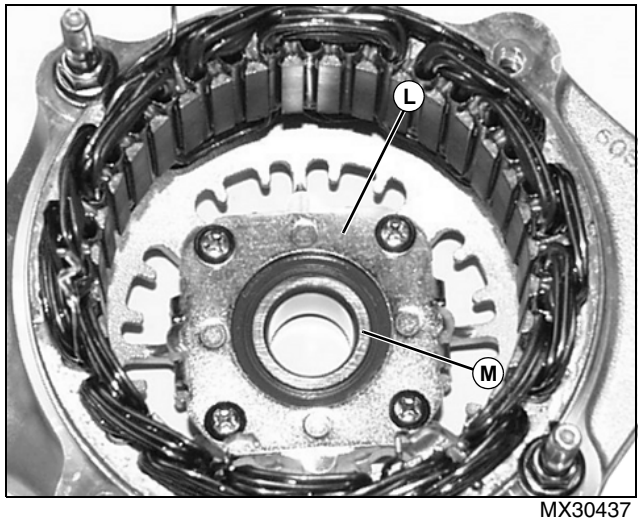
MX30429

7. Remove screw and straighten wire leads (H).
8. Remove rectifier (I).



MX30424

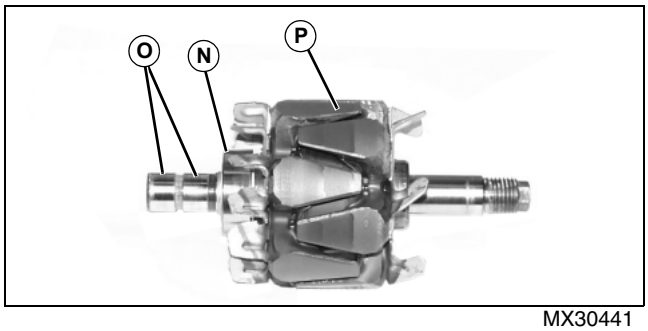
9. Remove rear case assembly (J).
10. Press rotor shaft (K) from rear case.



MX30437

11. Remove retainer plate (L).
12. Press bearing (M) from case.

Inspection:



MX30441

1. Inspect bearing (N) for smooth rotation. Replace if necessary.

2. Inspect slip rings (O) for dirt or rough spots. If necessary, use No. 00 sandpaper or 400-grit silicon carbide paper to polish rings.

3. Measure outer diameter of slip rings (O). Replace rotor if less than specification (see Specification below).

NOTE: Use an ohmmeter that is sensitive to 0 - 1 ohm.

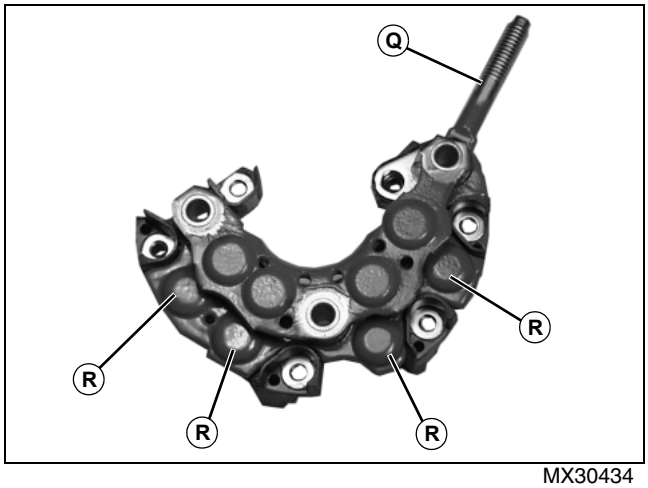
4. Check continuity between slip rings (O) using ohmmeter or continuity tester. Replace rotor assembly if there is no continuity.

5. Check continuity between slip rings and rotor core (P). Replace rotor assembly if there is continuity.

6. Inspect stator for defective insulation, discoloration, or burned odor.

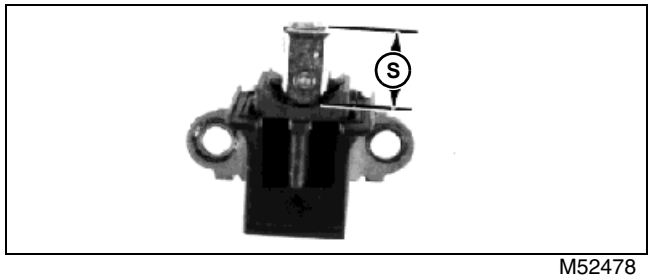
NOTE: Set ohmmeter to the K ohm range.

7. Check for continuity between each stator lead and body. Replace stator if there is continuity.



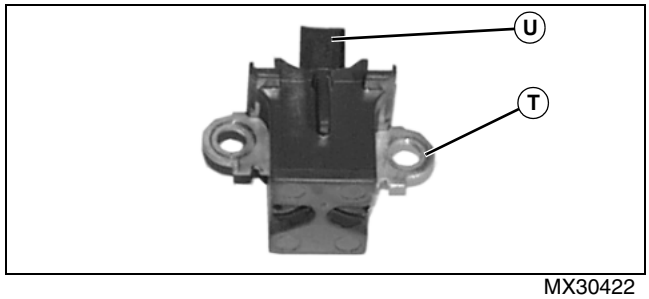
MX30434

8. Check continuity between lead (Q) and each diode lead (R). Reverse ohmmeter leads and recheck. There should be continuity in one direction, but not the other. Replace diodes or rectifier plate if bad.



M52478

9. Measure length of brush (S) protruding from holder. Dimension should be within specification (see Specifications below). Replace brushes if worn below minimum.



MX30422

10.Check continuity between brush (U) and terminal (T). There should be continuity only at these points. Repeat procedure for other brush and terminal.

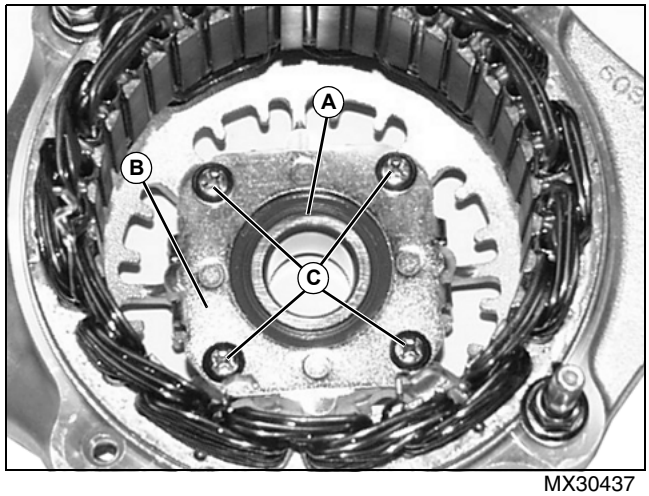
Specification:

Slip Ring Diameter (Minimum) . . . . . 14.0 mm (0.55 in.)

Brush Length Specifications:

Exposed Brush Length:
Minimum . . . . . 4.5 mm (0.17 in.)
Maximum. . . . . 10.5 mm (0.41 in.)

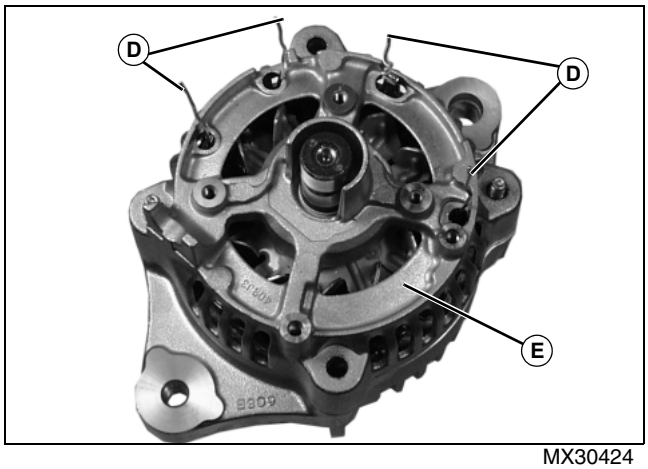
Assembly:



MX30437

1. Press new bearing (A) into case and install retainer plate (B).

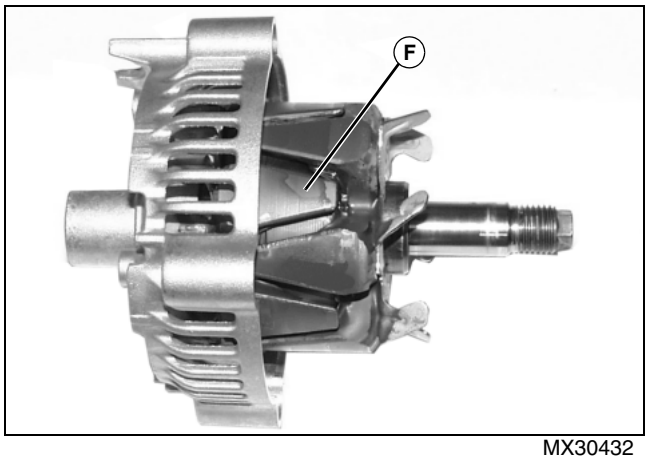
2. Install four screws (C).



MX30424

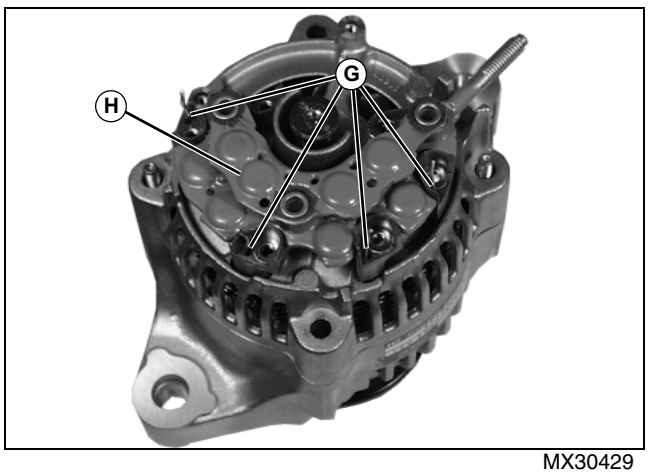
3. Route stator leads (D) through holes in rear case (E).

NOTE: Check that rotor fan does not contact case and that rotor assembly turns smoothly in bearing.



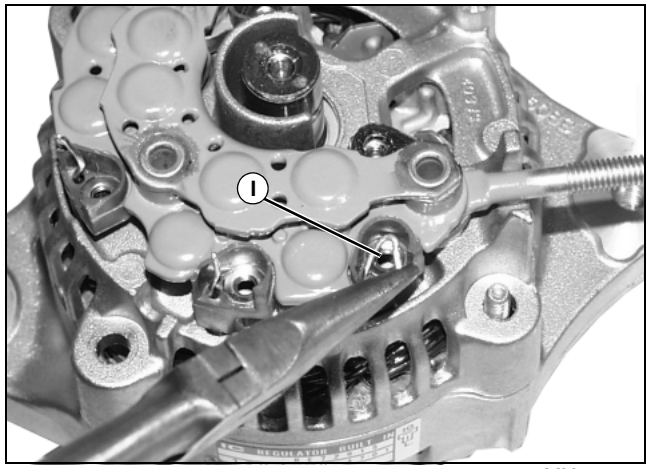
MX30432

4. Press rotor shaft (F) into rear case.



MX30429

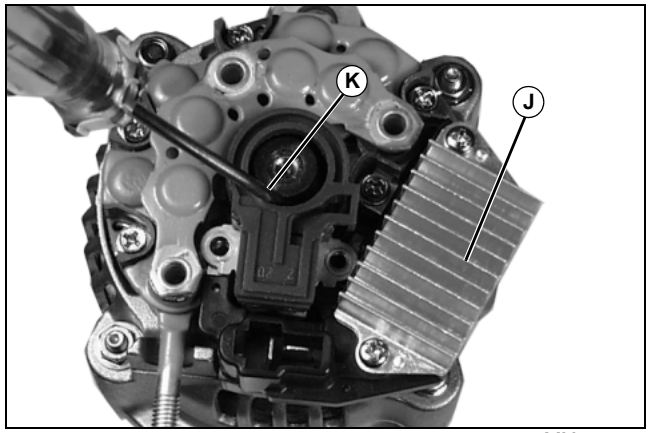
5. Route stator leads (G) through holes in rectifier (H) and install rectifier.



MX30436

6. Using a needle nose pliers, form a loop (I) in each stator wire lead and install screws through the loops.

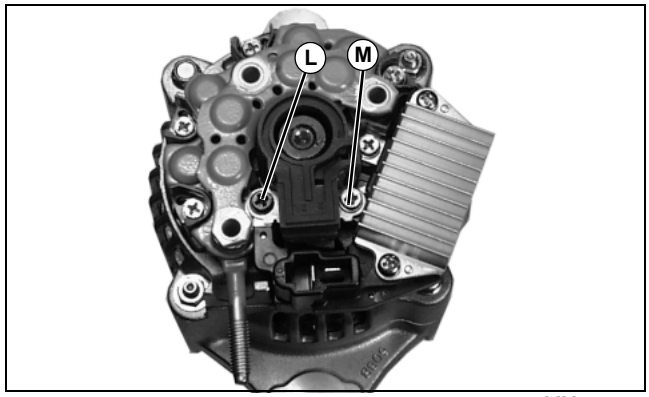
IMPORTANT: Avoid damage! Check that short screw is installed in regulator tab. Longer screw will contact frame and will cause damage to the charging system.



MX30427

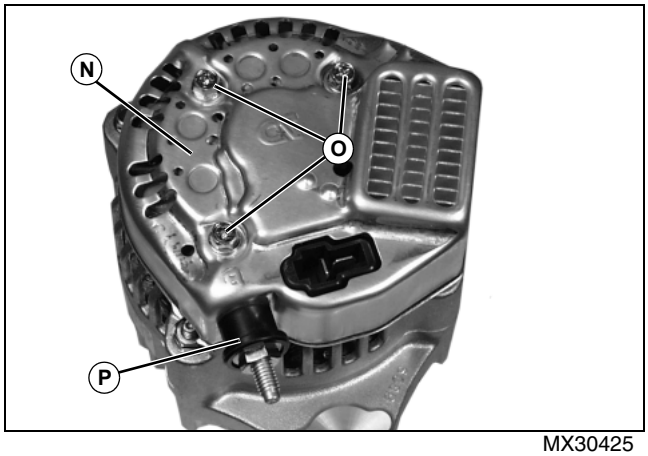
7. Install regulator (J).

8. Using a small screwdriver to hold brushes, install brush holder (K).



MX30433

9. Install brush holder screws as shown; black screw (L) and light screw (M).

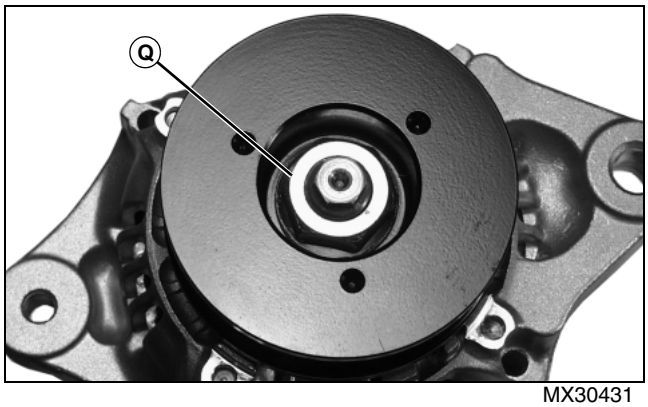


MX30425

10.Install regulator cover (N) and screws (O).

11.Install insulator (P) and nut.

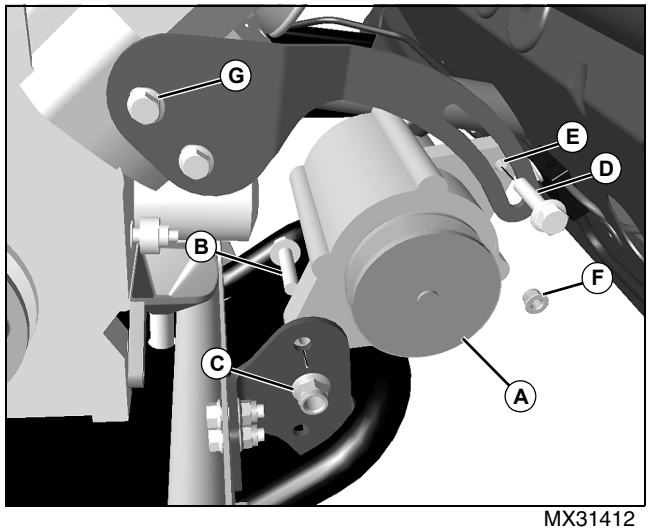
12.Install sheave.



MX30431

13.Clamp sheave in soft jaw vise. Install sheave nut (Q) and tighten to 69 N•m (51 lb-ft).

Installation:



MX31412

1. Position alternator (A) behind the upper and lower brackets, as shown.

2. Install the M10x45 pivot bolt (B) through the alternator and the lower bracket and secure with the M10 locknut (C). Do not tighten.

3. Pivot the alternator in and install the drive belt.

4. Install the M8x35 capscrew (D) through the adjustment slot in the upper bracket and into the threaded alternator hole (E). Do not tighten. Note that the nut (F) that will be installed on the M8x35 capscrew in a later step is used only to secure the ground strap to the alternator, not to secure the alternator itself.

5. Position the upper bracket as necessary so that the M8x35 capscrew in the upper bracket sweeps properly through the slot and tighten the M8x16 (G) capscrews.

6. Apply tension on belt and tighten M8x35 bolt (D) in adjustment slot of upper bracket.

7. Tighten alternator pivot hardware.

Attachments Theory of Operation

Attachments Circuit Operation

Theory:

Optional attachments circuits are installed using five different methods, depending on their power and control requirements. They are as follows:

1. Low current control for the circuit is contained in the main wiring harness. High current for the circuit is provided by the main wiring harness and is carried by the optional attachment's wiring harness.

- Cargo Box Lift Kit.

2. Low current control for the circuit is contained within the optional attachment's wiring harness. High current for the circuit is provided by the main wiring harness and is carried by the optional attachment's wiring harness.

- Hydraulic Front Implement Lift Kit.
- Signal Lights Kit.

3. High current is provided by the main wiring harness and is carried by the optional attachment's wiring harness. Component operation and control is contained in this circuit. There are no low current connections.

- Back Up Alarm Kit.
- Accessory Power Port Kit.

4. Low current is provided by the main wiring harness and control is provided by the optional attachment's wiring harness. There are no high current connections.

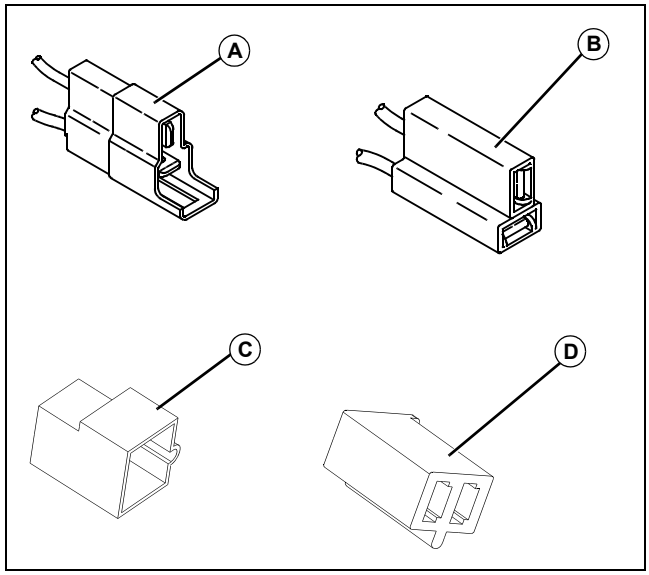
- Rear Marker/Brake Lights Kit.

5. High current for the optional attachment is provided by connecting directly to the battery and frame ground. Low current control is provided by connecting the optional attachment's wiring harness to the main wiring harness.

- Auxiliary Alternator Kit.

These configurations are achieved by the main wiring harness having high current and low current attachment connectors at both the front and the rear of the machine. Multiple attachments are connected in a "piggyback" fashion and are in no particular order. Their connections are determined by their physical location on the machine and proximity to other installed options. Refer to individual attachment circuit descriptions for more information.

Many of these optional attachment wiring harnesses are individually fused in addition to being fused in series with the main wiring harness. When diagnosing a problem, it is very important to have the option under test as the only circuit connected to the main wiring harness.



A - Female Low Current Connector (Rear of Machine - Main Wiring Harness to Lift Harness OUT)

B - Male Low Current Connector (Front of Machine - Main Wiring Harness or Attachment power OUT)

C - Female High Current Connector (All Attachments - Power IN)

D - Male High Current Connector (Front and Rear of Machine - Main Wiring Harness or All Attachment Power OUT)

Each optional attachment has either a high current, a low current, or both type connectors on it's respective harness to pass power along to the next installed attachment.

Auxiliary Alternator Kit (Gas Engine)

Charging Circuit Operation - Auxiliary Alternator (Gas Engine)

Function:

To maintain battery voltage between 12.4 and 13.2 volts.

Operating Conditions:

- The key switch in the RUN position.
- The must engine running for the charging system to operate.

Theory of Operation:

The charging system consists of the G3 auxiliary alternator with an integrated voltage regulator/rectifier. Charging output is controlled by an internal regulator/rectifier.

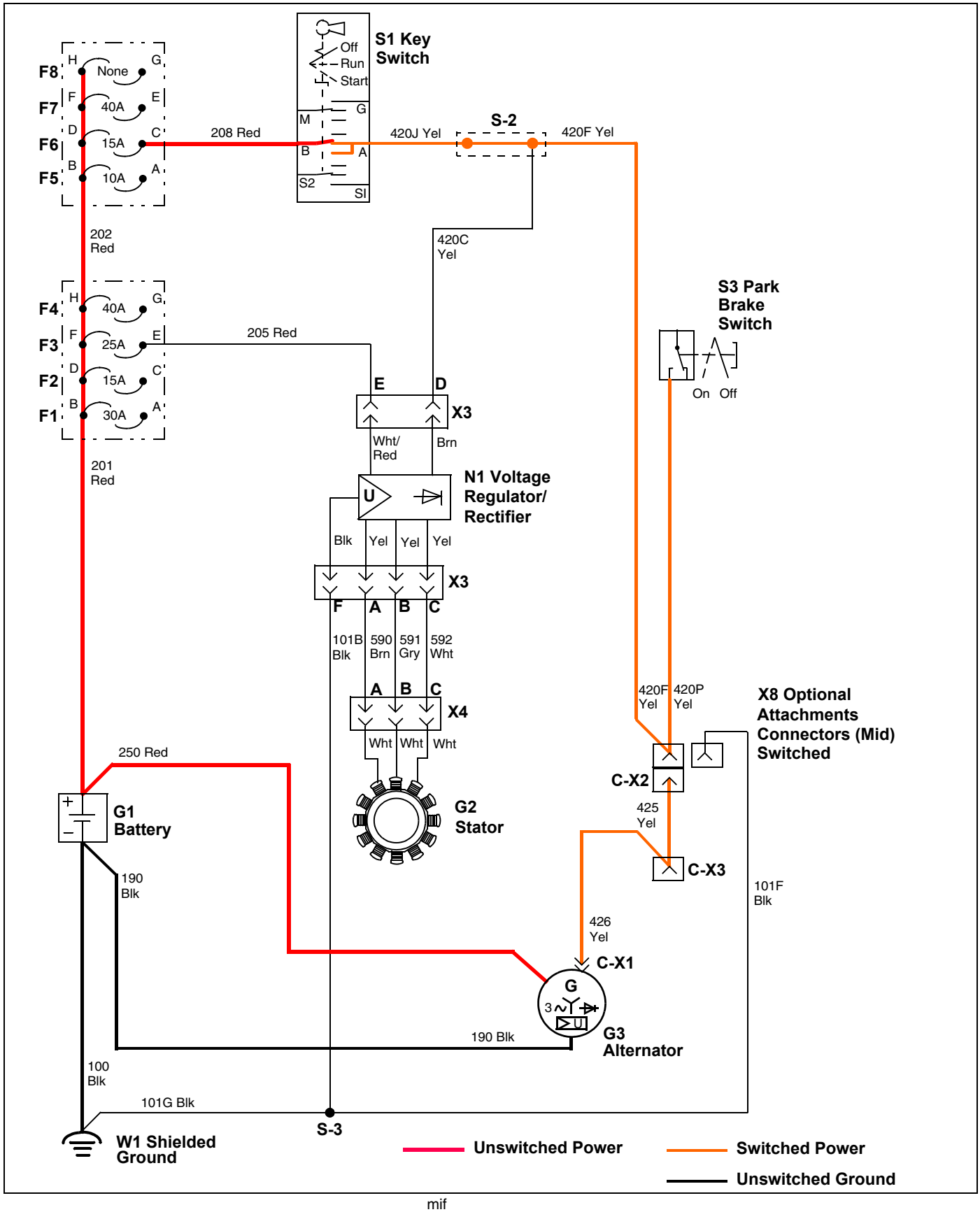
With the key switch in the RUN position, battery sensing circuit current flows from battery positive terminal through the 201 and 202 Red wires, F6 fuse, 208 Red wire, S1 key switch, 420J, 420F, 425, 426 Yel wires, and connections to the auxiliary alternator internal voltage regulator/rectifier. This battery sensing circuit allows the voltage regulator/rectifier to monitor battery voltage.

A rotating permanent magnet in the alternator induces AC current in the alternator stator coils. The AC current flows to the internal voltage regulator/rectifier. The voltage regulator/rectifier converts AC current to DC current needed to charge the battery.

If battery voltage is low, the regulator/rectifier allows DC current to flow to the battery to charge it through the battery charging circuit, 250 Red wire. When the battery is fully charged, the voltage regulator/rectifier stops current flow to the battery.

The ground circuit 190 Blk wire provides a path to ground for the internal voltage regulator/rectifier and G3 alternator.

Auxiliary Alternator Circuit Schematic (Gas Engine)



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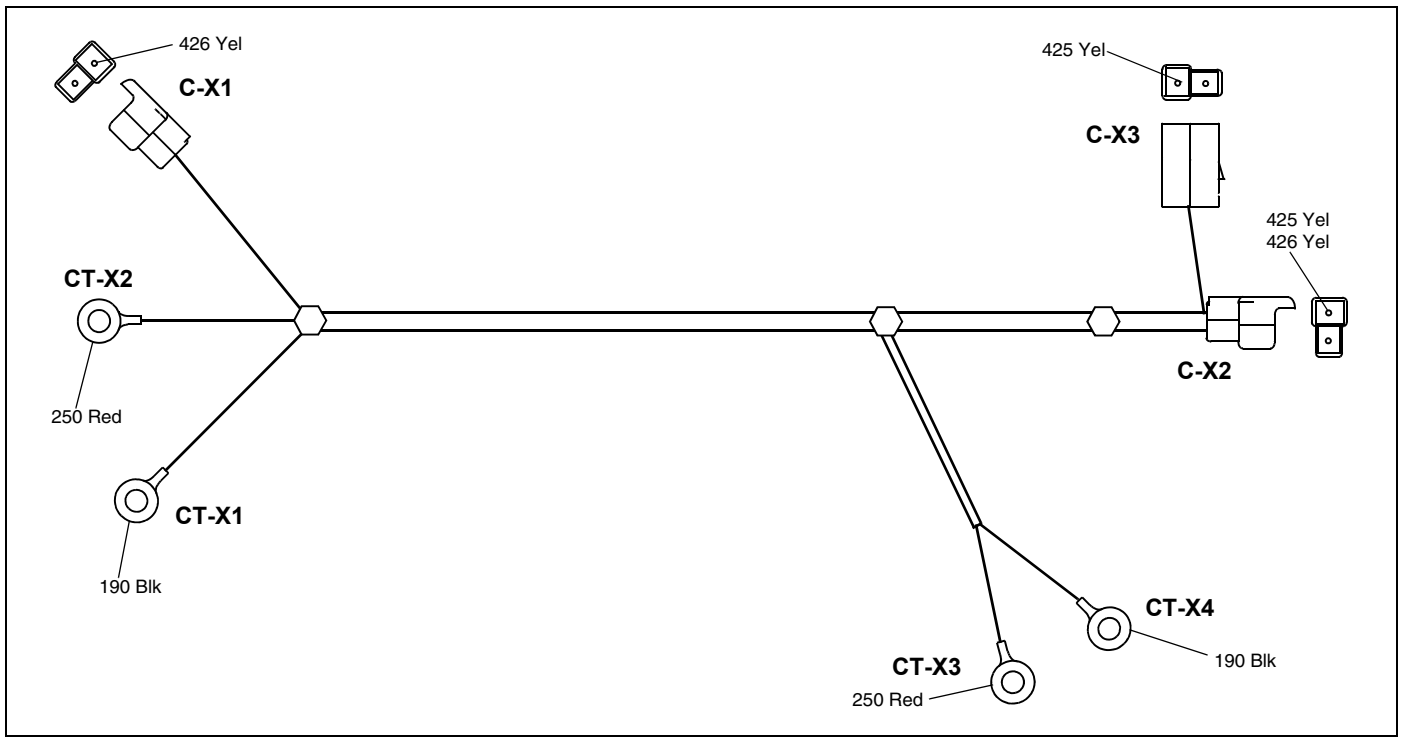
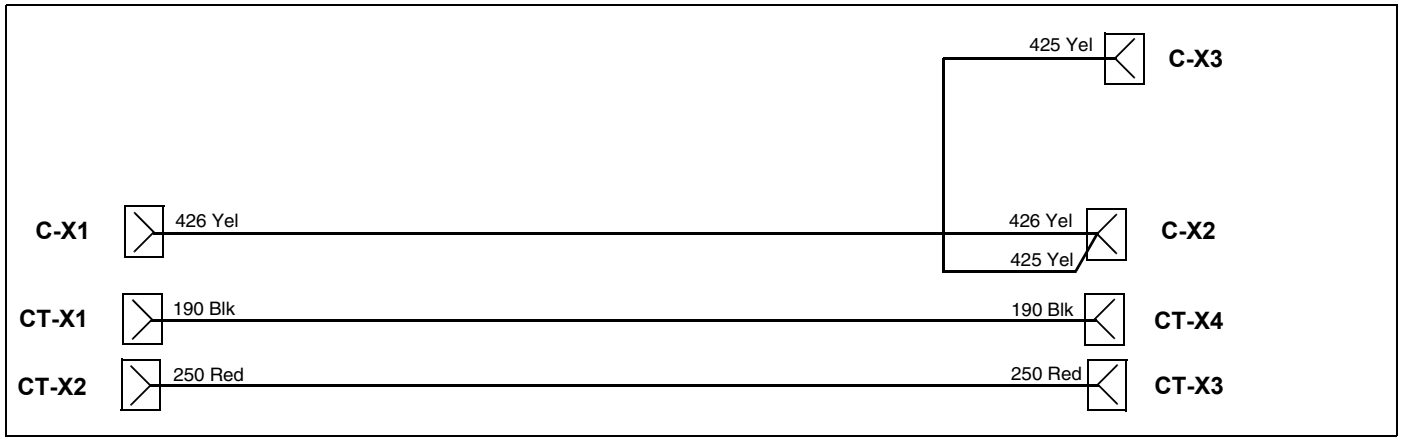
Auxiliary Alternator Wiring Harness (Gas Engine)



mif

Auxiliary Alternator Kit Schematic (Gas Engine)



Auxiliary Alternator Kit Wiring Harness Color Codes (Gas Engine)

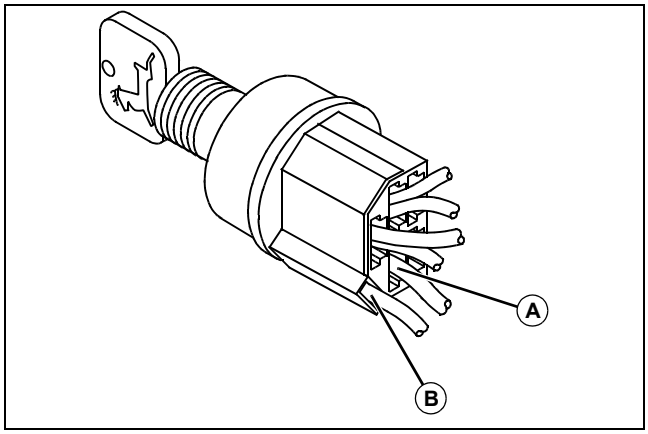
Size/No./Color	Wire Connection Points
8.0 190 Blk	CT-X1, CT-X4
8.0 250 Red	CT-X2, CT-X3
1.0 425 Yel	C-X3, C-X2
1.0 426 Yel	C-X1, C-X2

Auxiliary Alternator Circuit Diagnosis (Gas Engine)

Test Conditions:

- Machine parked safely. See “Parking Safely” in the Safety section.
- Park brake LOCKED.
- Cargo box RAISED and LOCKED.
- Open hood and remove storage tray.
- Key switch in RUN position, engine NOT RUNNING.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Disconnect X3 connector at N1 voltage regulator.
- Battery fully charged.

System: Auxiliary Alternator Circuit



(1) Is battery voltage present at the “B” terminal of the S1 key switch (A)?

Yes - Go to next step.

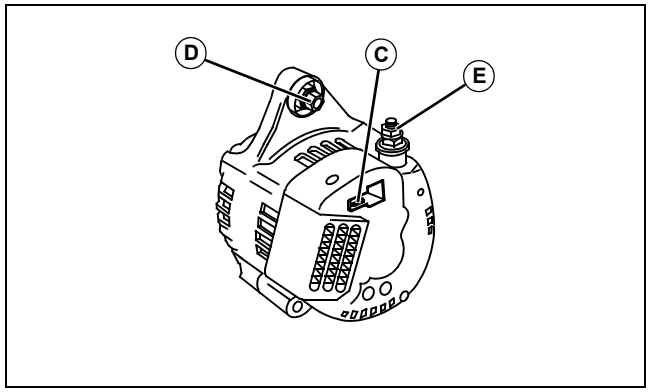
No - Check F6 fuse, 201, 202, and 208 Red wires, and connections.

(2) Is battery voltage present at the “A” terminal of the S1 key switch (B)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341.

System: Auxiliary Alternator Circuit



(3) Is battery voltage present at the G3 alternator, 426 Yel wire (C)?

Yes - Go to next step.

No - Check 420J, 420F, 425, and 426 Yel wires, and connections.

(4) Is continuity to ground present at 190 Blk wire (D) of G3 alternator?

Yes - Go to next step.

No - Check 190 Blk wire and connections.

(5) Is battery voltage present at G3 alternator 250 Red wire (E)?

Yes - Test auxiliary alternator. See “Alternator Regulated Output Test” on page 338.

No - Check 250 Red wire and connections.

Backup Alarm Kit

Backup Alarm Kit Circuit Operation

Function:

To provide power and control for the backup warning alarm.

Operating Conditions:

- The backup alarm uses unswitched power. The key switch and other switches may be in any safe operating position.
- Machine transmission in REVERSE position (backup alarm switch in CLOSED position).

Theory of Operation:

Current flows from the G1 positive (+) battery terminal to the F4 fuse. The 204 red wire carries the unswitched power to the X17 optional attachments rear connector.

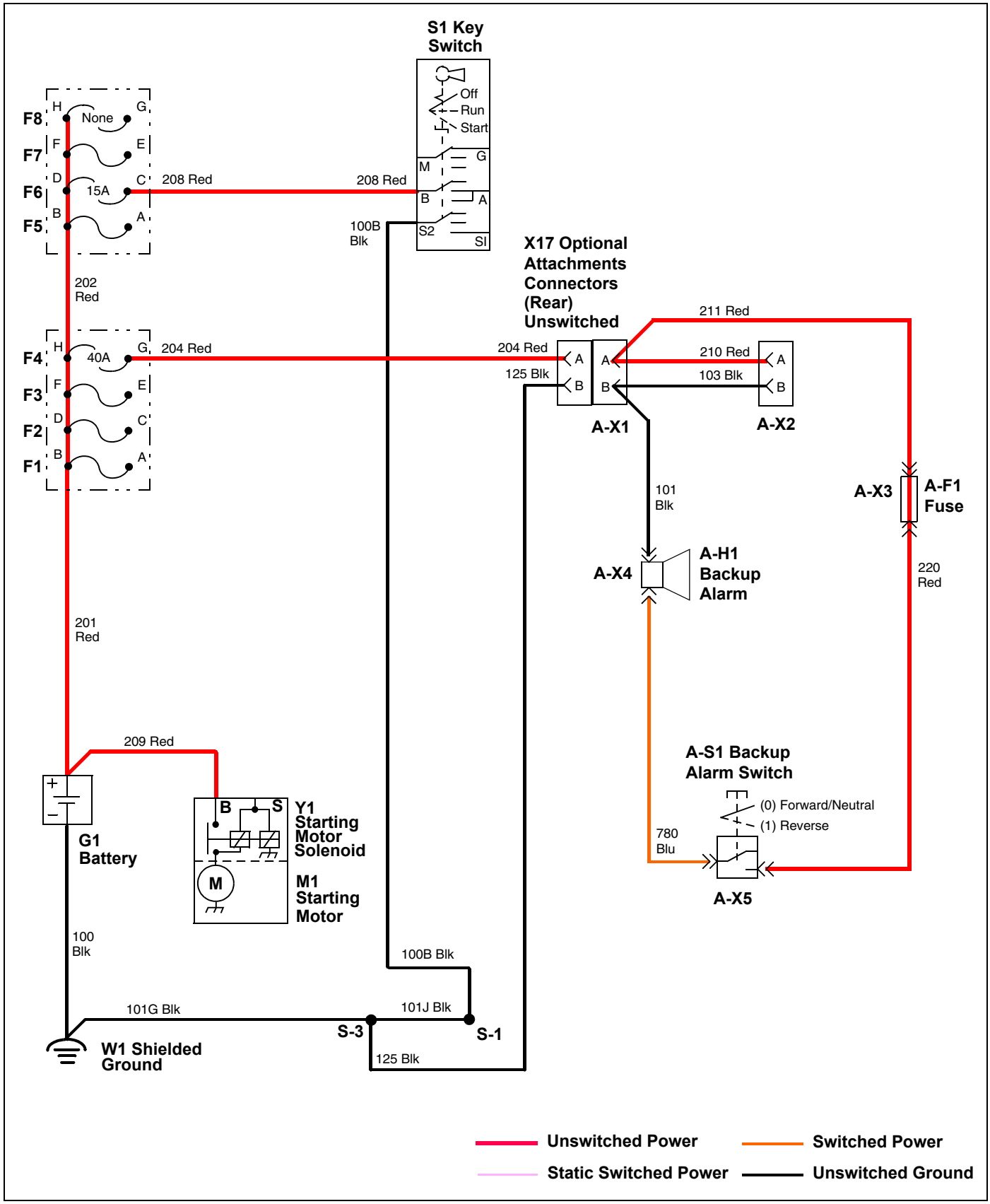
The 211 Red wire carries power through the A-F1 fuse and to the A-S1 backup alarm switch, through connector A-X3. Power to the A-H1 backup alarm module is supplied from the switch (closed for circuit operation) through the 780 Blu wire, through connector A-X4.

A path to ground is provided by 101 Blk wire to connector A-X1 which plugs into the W1 main wiring harness optional attachments connector X17. The path to ground is then completed through 125 and 101G Blk wires, and finally to the W1 ground.

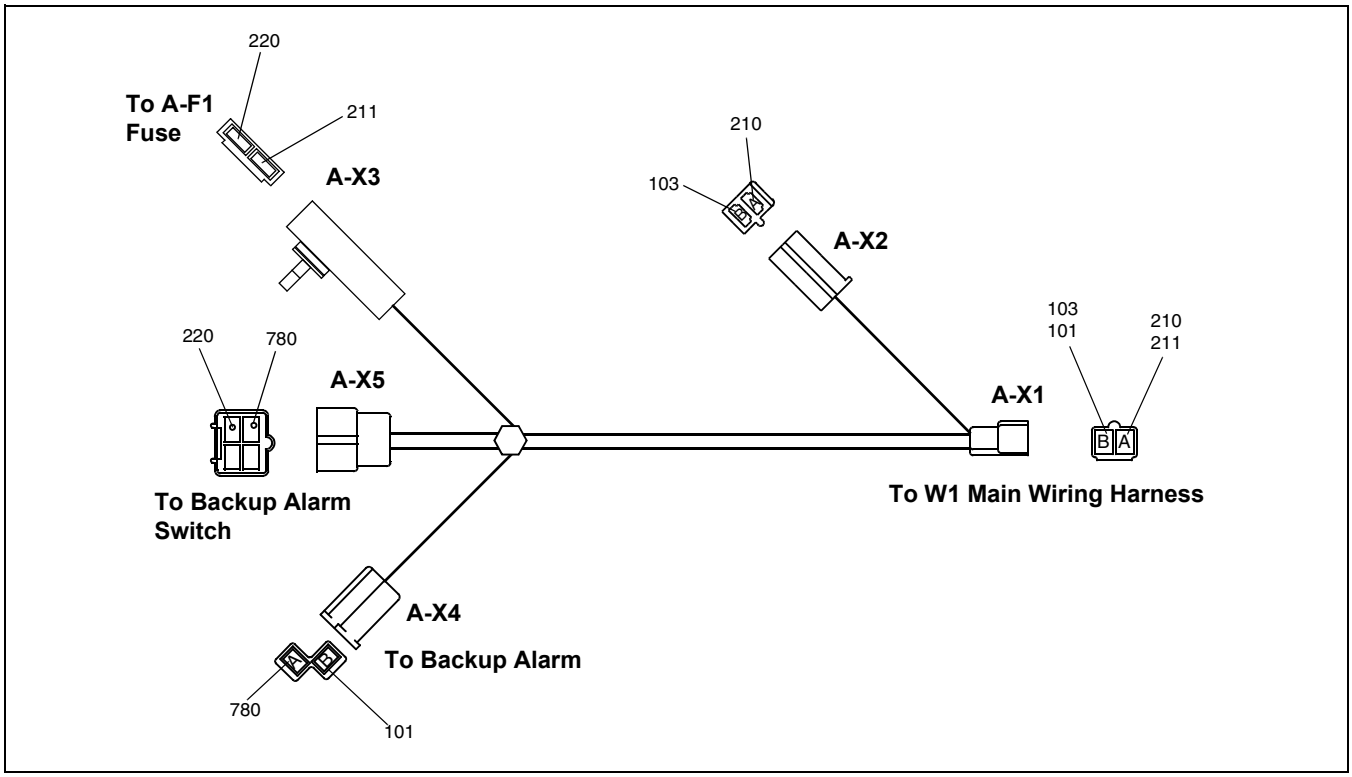
The 210 Red and 103 Blk wires, which are spliced into the A-X1 connector and terminate at the A-X2 connector, provide a circuit for a power supply for other optional attachments.

The machine does not need to be running for the backup alarm to sound.

Backup Alarm Kit Circuit Schematic



Backup Alarm Kit Wiring Harness



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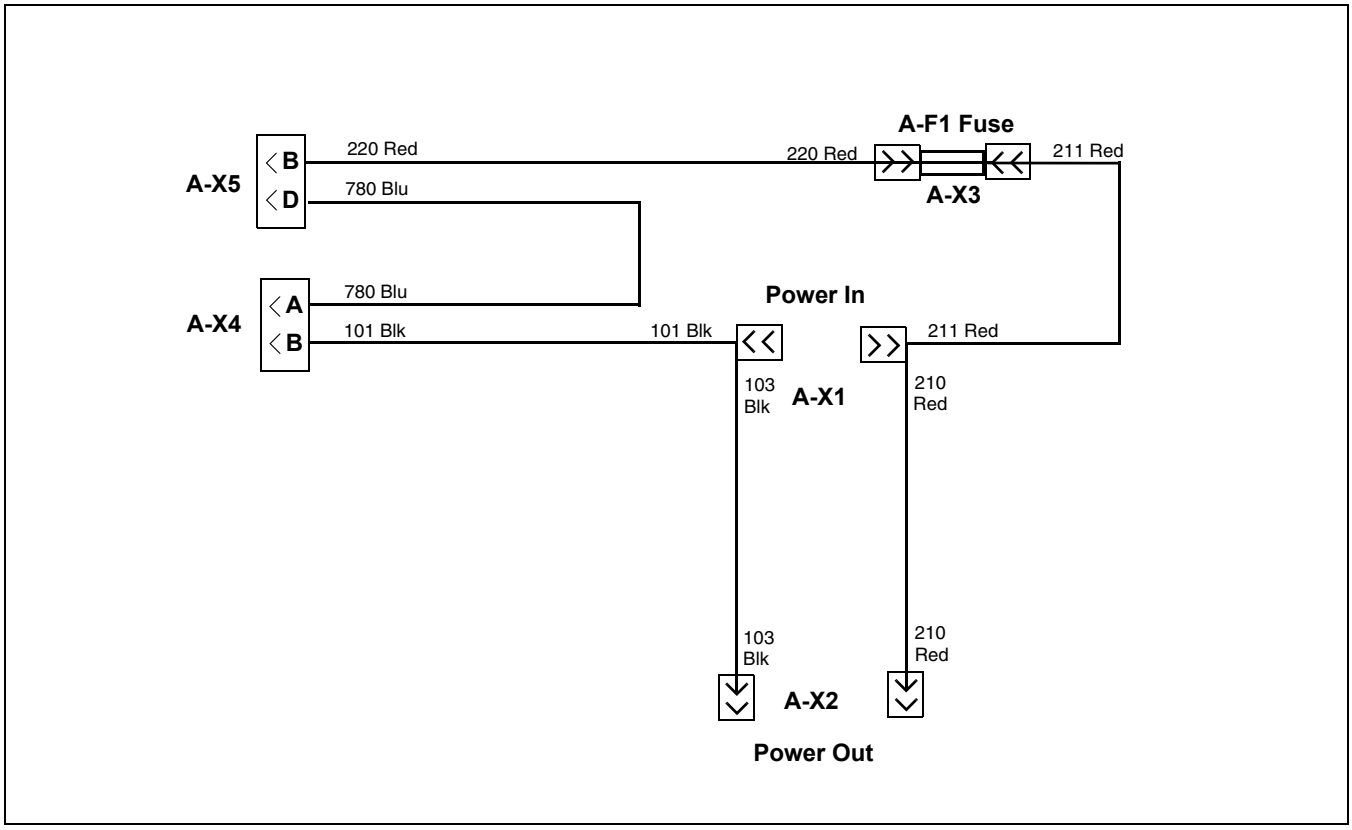
Backup Alarm Kit Schematic



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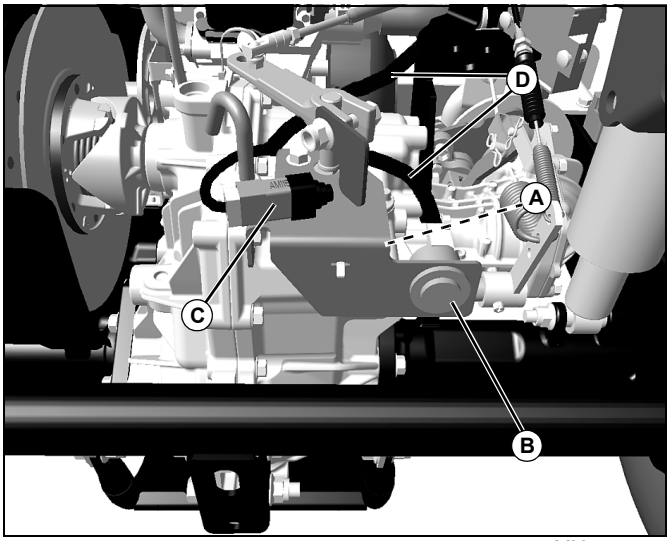
Backup Alarm Kit Circuit Component Location



MX31347

A - A-F1 Backup Alarm Fuse
B - A-H1 Backup Alarm
C - A-S1 Backup Alarm Switch
D - A-X1 AH Backup Alarm Wiring Harness Connector

Backup Alarm Kit Wiring Color Codes

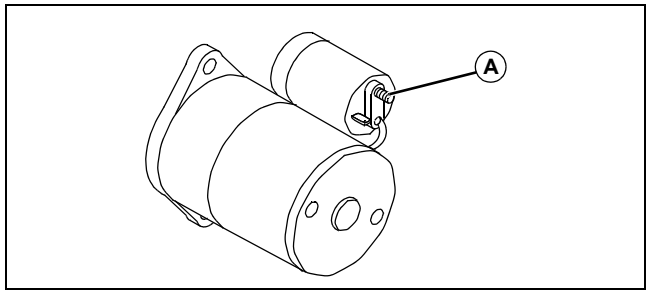
Size/No./Color	Wire Connection Points
1.0 101 Blk	A-X1, A-X4
3.0 103 Blk	A-X1, A-X2
3.0 210 Red	A-X1, A-X2
1.0 211 Red	A-X1, A-X3
1.0 220 Red	A-X3, A-X5
1.0 780 Blu	A-X5, A-X4

Backup Alarm Kit Circuit Diagnosis

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Park brake LOCKED.
- Cargo box RAISED and LOCKED.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in OFF position.
- Park brake locked.
- Transmission in reverse.
- Battery fully charged.
- Check wires for looseness and corrosion.

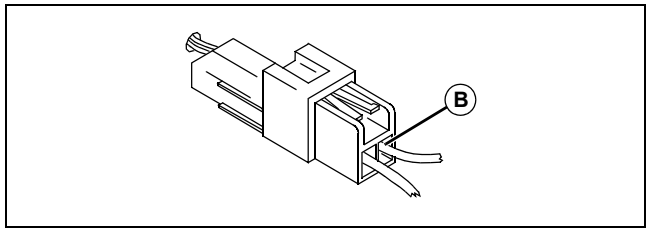
System: Backup Alarm Circuit



(1) Is battery voltage present at the positive (+) battery terminal of the Y1 starting motor solenoid (A)?

Yes - Go to next step.

No - Check battery positive (+) cable and connections.

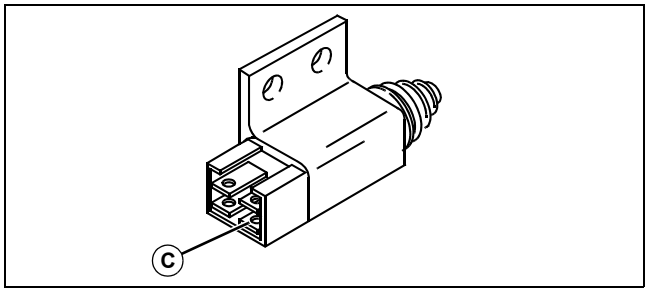


(2) Is battery voltage present at 204 Red wire of X17 optional attachments connector (B)?

Yes - Go to next step.

No - Check 201 Red wire, F4 fuse, 204 Red wire, and connections.

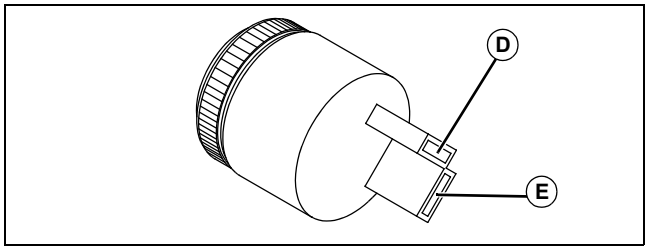
System: Backup Alarm Circuit



(3) Is battery voltage present at A-X5 backup alarm switch connector, 220 Red wire (C)?

Yes - Go to next step.

No - Check 211 Red wire, A-F1 fuse, 220 Red wire, and connections.



(4) Is battery voltage present at A-X4 connector, 780 Blu wire of H4 backup alarm module connector (D)?

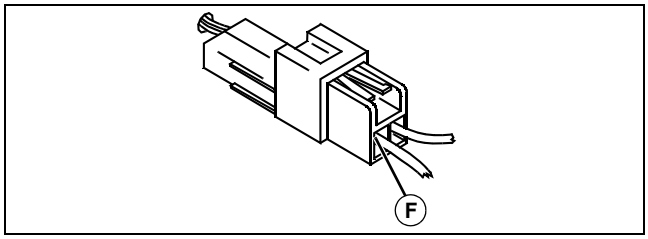
Yes - Go to next step.

No - Check 780 Blu wire. If OK, replace AS-1 backup alarm switch.

(5) Is continuity to ground present at A-X4 connector, 101 Blk wire (E)?

Yes - Replace A-H1 backup alarm.

No - Go to next step.



(6) Is continuity to ground present at optional attachments connector X17, 125 Blk wire of the W1 main wiring harness (F)?

No - Check 125, and 101G Blk wires and connections.

Hydraulic Front Implement Lift Kit

Hydraulic Front Implement Lift Operation

Function:

To activate and control the direction of current through the hydraulic motor and pump to lift and lower optional attachments mounted to the front of the machine.

Operating Conditions:

- Key switch in the RUN position.
- Lift/lower switch in either the LIFT or LOWER position.

Theory of Operation:

The hydraulic implement lift/lower circuit consists of a low current switched power control circuit and a high current unswitched power circuit. When the lift/lower control switch is held to the lift or lower position, it energizes the appropriate directional relay.

The motor ground circuit grounds through the other non-operating relay to battery negative.

Switched Power Circuit:

Current flows from the G1 battery to the positive (+) terminal through the 201 and 202 Red wires, F6 fuse, and 208 Red wire to the “B” terminal of the S1 key switch. Current leaves the key switch at the “A” terminal and flows over the 420J and 420L Yel wires, X7 attachment connector, to the B-S1 lift/lower switch.

If an implement is being raised, battery current flows over the 680 Grn wire to the B-K2 lift relay. This activates the relay which is grounded by the 193, 195, 198, 100D, 101J, and 101G Blk wires.

If an implement is being lowered, battery current flows over the 685 Org wire to the B-K1 lower relay. This activates the relay which is grounded by the 194, 196, 198, 100D, 101J, and 101G Blk wires.

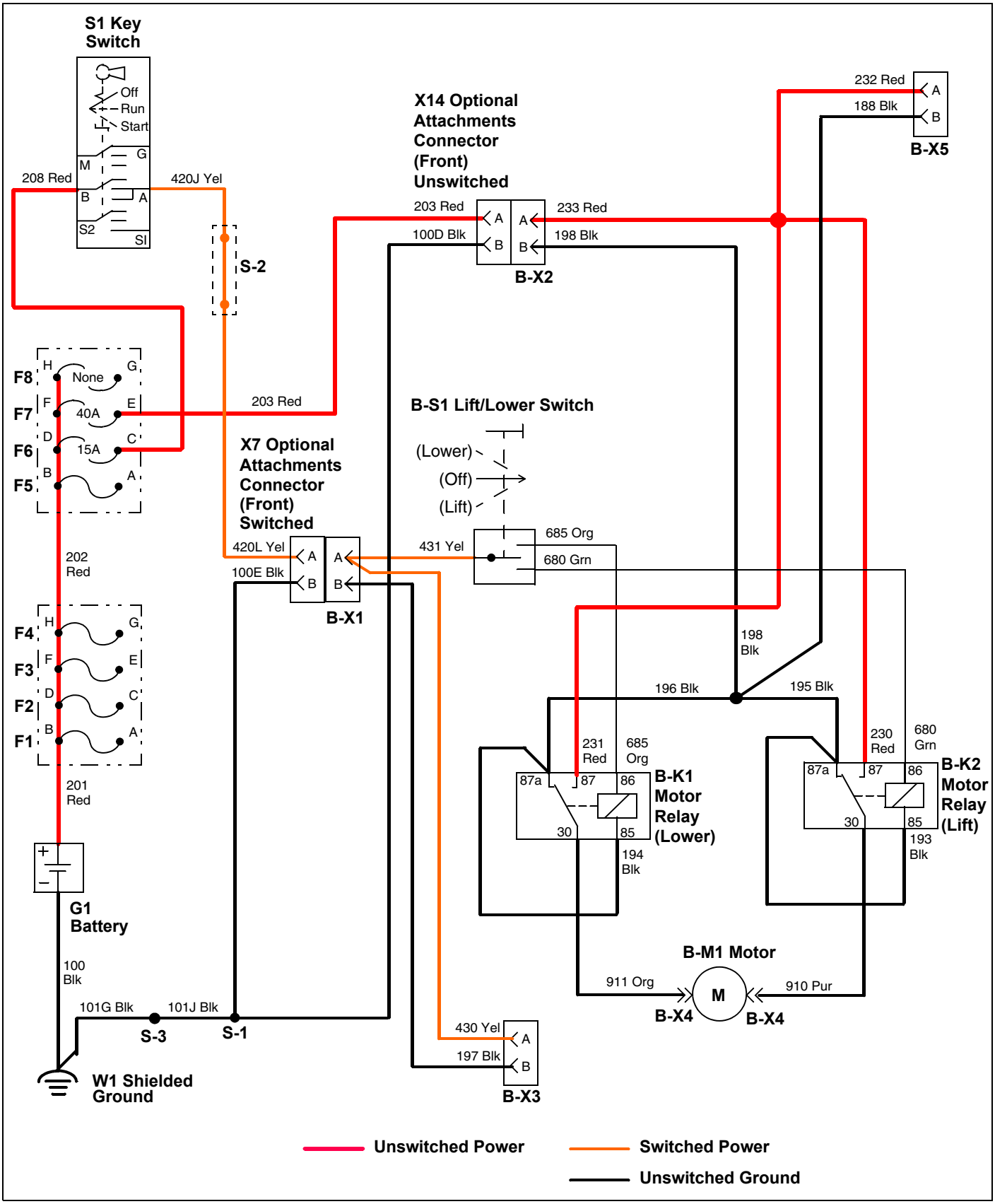
Unswitched Power Circuit:

Current flows from the G1 battery to the positive (+) terminal through the 201 and 202 Red wires, F7 fuse, X14 attachment connector, to the 233, 232, 231, and 230 Red wires.

If an implement is being raised, current flows to the B-K2 lift relay from the 230 Red wire. The relay is activated by the switched circuit allowing the motor to be powered in the raise direction. The 910 Pur wire provides the high current necessary to activate the motor. A ground path to complete the circuit is provided through the 911 Org wire leading to the B-K1 lower relay and out to the 196, 198, 100D, 101J, and 101G Blk wires.

If an implement is being lowered, current flows to the B-K1 lower relay over the 231 Red wire. The relay is activated by the switched circuit allowing the motor to be powered in the lower direction. The 911 Org wire provides the high current necessary to activate the motor. A ground path to complete the circuit is provided through the 910 Pur wire leading to the B-K2 lift relay and out to the 195, 198, 100D, 101J, and 101G Blk wires.

Hydraulic Front Implement Lift Circuit Schematic



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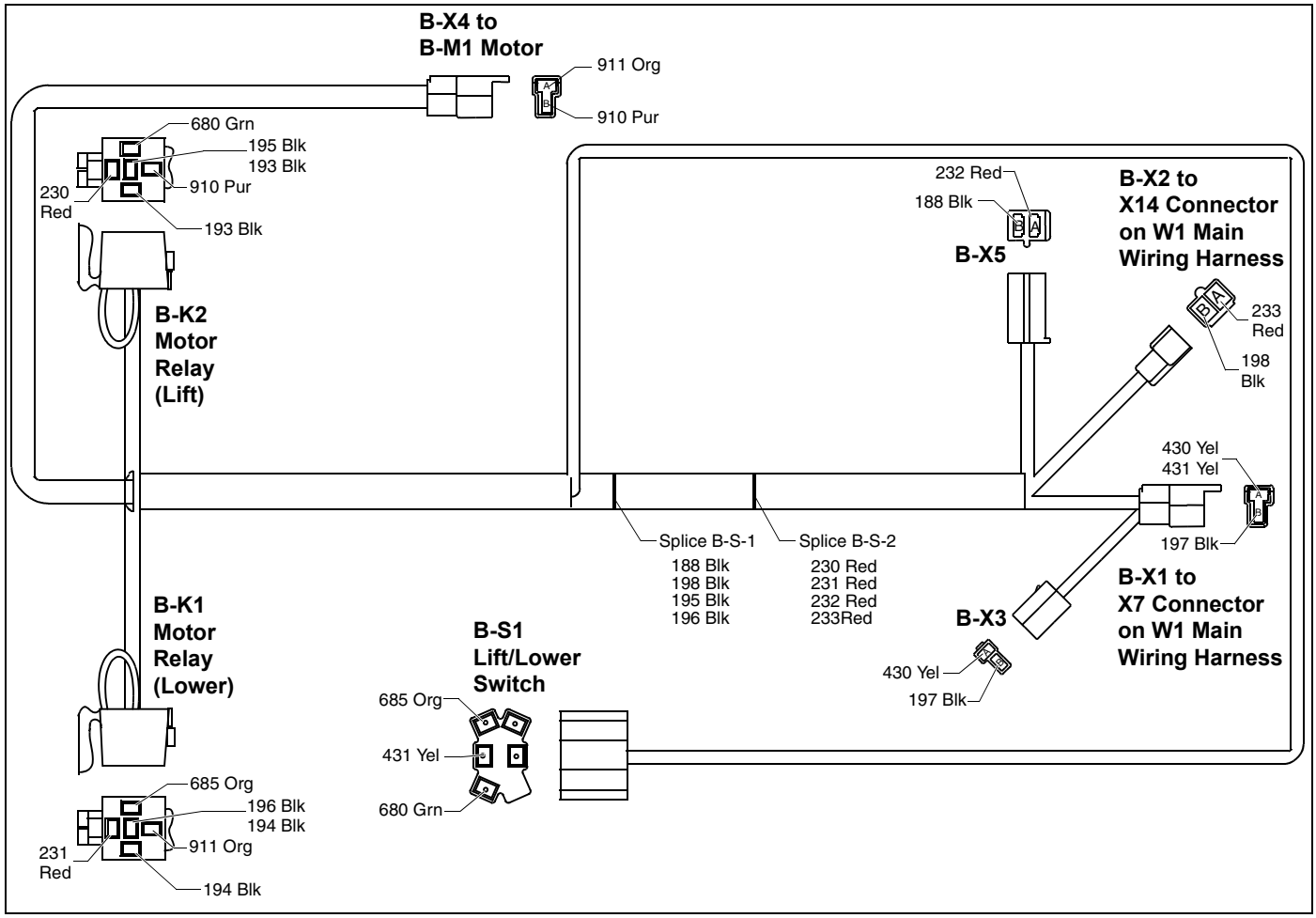
Hydraulic Front Implement Lift Wiring Harness



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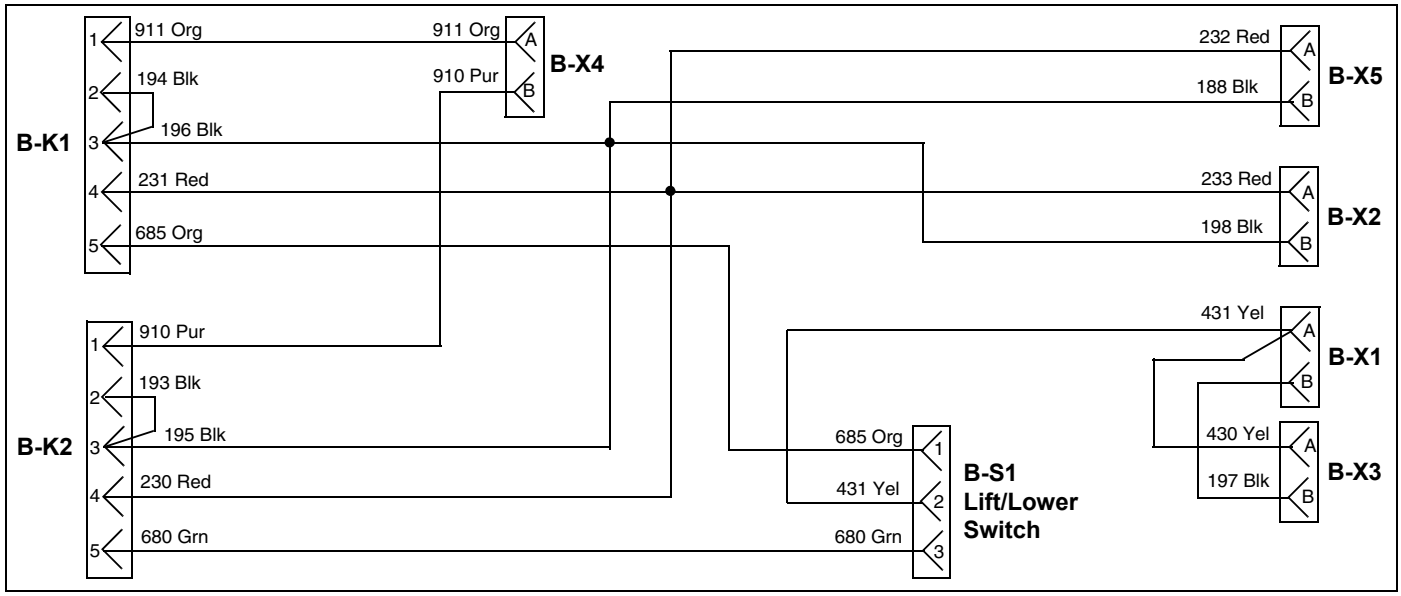
Hydraulic Front Implement Lift Schematic



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Hydraulic Front Implement Lift Wiring Color Codes

Size/No./Color	Wire Connection Points
3.0 188 Blk	Splice, B-X5
0.8 193 Blk	B-K2, B-K2
0.8 194 Blk	B-K1, B-K1
2.0 195 Blk	Splice, B-K2
2.0 196 Blk	Splice, B-K1
1.0 197 Blk	B-X1, B-X3
3.0 198 Blk	B-X2, Splice
2.0 230 Red	Splice, B-K2
2.0 231 Red	Splice, B-K1
3.0 232 Red	Splice, B-X5
3.0 233 Red	B-X2, Splice
1.0 430 Yel	B-X1, B-X3
1.0 431 Yel	B-X1, B-S1
1.0 680 Grn	B-S1, B-K2
1.0 685 Org	B-S1, B-K1
2.0 910 Pur	B-K2, B-X4
2.0 911 Org	B-K1, B-X4

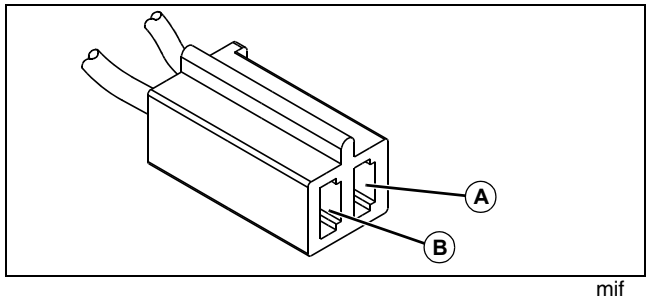
Hydraulic Front Implement Lift Circuit Diagnosis

Test Procedure A

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Park brake LOCKED.
- Hood open and storage tray removed.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in OFF position.
- Battery fully charged.
- Check wires for looseness and corrosion.

System: Hydraulic Front Implement Lift Circuit - Unswitched



mif

(1) Disconnect X14 connector from hydraulic front implement lift wiring harness. Is battery voltage present at pin A of X14 front optional attachments connector, 203 Red wire (A)?

Yes - Go to next step.

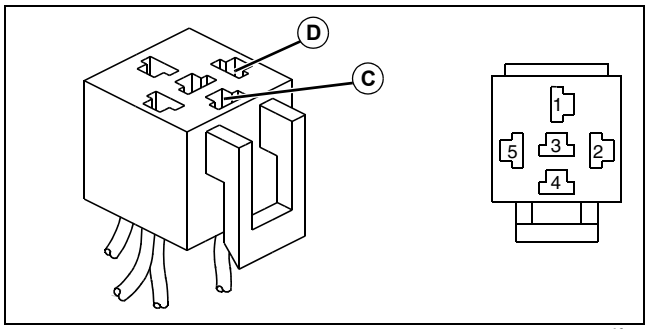
No - Test F7 fuse. Check 203 Red wire. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.

(2) Is continuity to ground present at pin B of X14 front optional attachments connector, 100D Blk wire (B)?

Yes - Connect X14 connector to hydraulic front implement lift wiring harness. Go to next step.

No - 100D, 101J, and 101G Blk wires and connections.

System: Hydraulic Front Implement Lift Circuit - Unswitched



mif

(3) Remove B-K1 lower relay. Is battery voltage present at terminal 4 (87) of relay connector, 231 Red wire (C)?

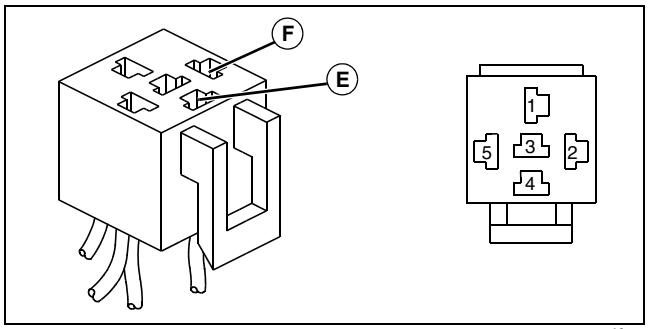
Yes - Go to next step.

No - Check 231 and 233 Red wires.

(4) Is continuity to ground present at terminal 2 (85) of relay connector, 194 Blk wire (D)?

Yes - Install relay. Go to next step.

No - Check 194, 196, and 198 Blk wires.



mif

(5) Remove B-K2 lift relay. Is battery voltage present at terminal 4 (87) of relay connector, 230 Red wire (E)?

Yes - Go to next step.

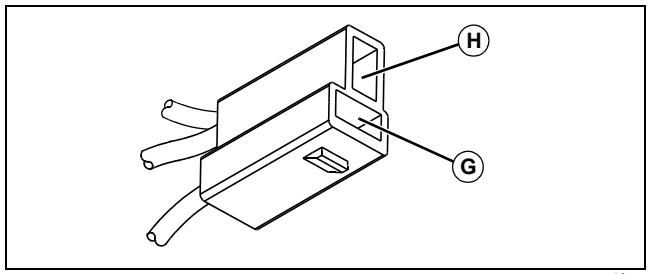
No - Check 230 and 233 Red wires.

(6) Is continuity to ground present at terminal 2 (85) of relay connector, 193 Blk wire (F)?

Yes - Install relay. Go to next step.

No - Check 193, 195, and 198 Blk wires.

System: Hydraulic Front Implement Lift Circuit - Unswitched



mif

(7) Disconnect B-X4 connector from B-M1 motor. Is continuity to ground present at terminal A of B-X4 connector, 911 Org wire (G)?

Yes - Go to next step.

No - Test B-K1 lower relay. See “Relay Test” on page 345. Check 911 Org wire.

(8) Is continuity to ground present at terminal B of B-X4 connector, 910 Pur wire (H)?

Yes - Connect B-X4 connector to B-M1 motor. Go to next step.

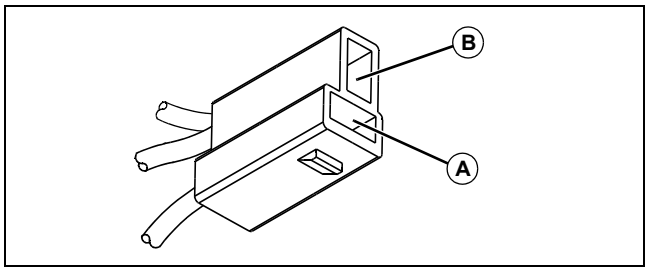
No - Test B-K2 lift relay. See “Relay Test” on page 345. Check 910 Pur wire.

Test Procedure B

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Hood open and storage tray removed.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in RUN position, engine NOT running.
- Battery fully charged.
- Check wires for looseness and corrosion.

System: Hydraulic Front Implement Lift Circuit - Switched



mif

(1) Disconnect X7 connector from hydraulic front implement lift wiring harness. Is battery voltage present at pin A of X7 front optional attachments connector, 420L Yel wire (A)?

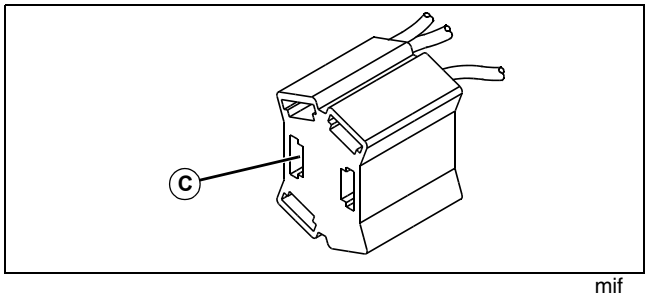
Yes - Go to next step.

No - Check 420J and 420L Yel wires, and connections.

(2) Is continuity to ground present at pin B of X7 front optional attachments connector, 100E Blk wire (B)?

Yes - Connect X7 connector to hydraulic front implement lift wiring harness. Go to next step.

No - 100E, 101J, and 101G Blk wires and connections.



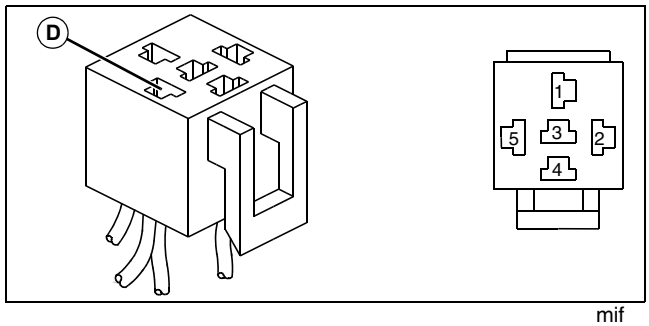
mif

(3) Disconnect B-S1 lift/lower switch. Is battery voltage present at pin 2 of switch connector, 431 Yel wire (C)?

Yes - Connect switch. Go to next step.

No - Check 431 Yel wire and connections.

System: Hydraulic Front Implement Lift Circuit - Switched

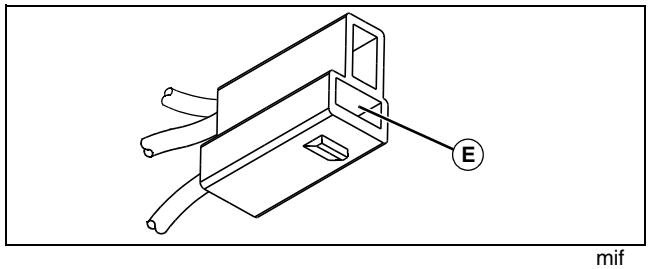


mif

(4) Remove B-K1 lower relay. Toggle B-S1 lift/lower switch to the lower position. Is battery voltage present at terminal 5 (86) of relay connector, 685 Org wire (D)?

Yes - Install relay. Go to next step.

No - Check 685 Org wire and connections. If ok, replace lift/lower switch.



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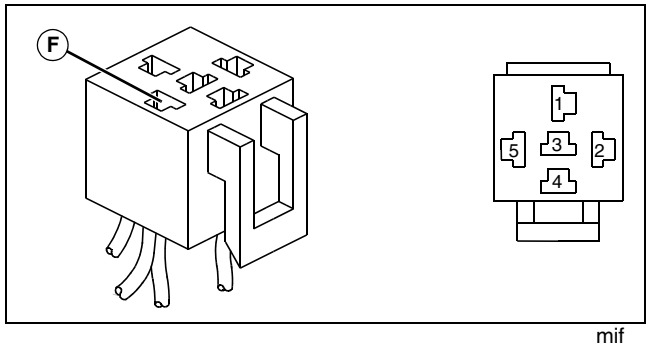
(5) Disconnect B-X4 connector from B-M1 motor. Toggle B-S1 lift/lower switch to the lower position. Is battery voltage present at terminal A of B-X4 connector, 911 Org wire (E)?

Yes - Replace hydraulic pump motor. Go to next step.

No - Test B-K1 lower relay. See “Relay Test” on page 345. Check 911 Org wire.



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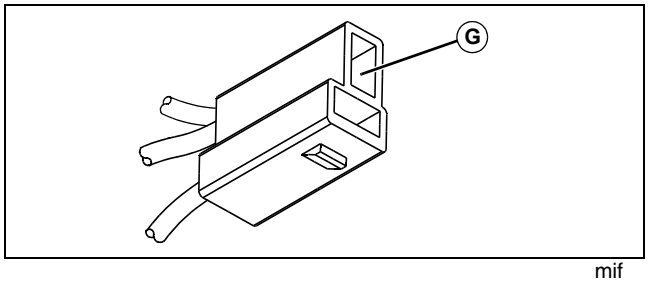
(6) Remove B-K2 lift relay. Toggle B-S1 lift/lower switch to the lift position. Is battery voltage present at terminal 5 (86) of relay connector, 680 Grn wire (F)?

System: Hydraulic Front Implement Lift Circuit - Switched

Yes - Install relay. Go to next step.

No - Check 680 Grn wire and connections. If ok, replace lift/lower switch.



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(7) Disconnect B-X4 connector from B-M1 motor. Toggle B-S1 lift/lower switch to the lower position. Is battery voltage present at terminal B of B-X4 connector, 910 Pur wire (G)?

Yes - Replace hydraulic pump motor. Go to next step.

No - Test B-K2 lift relay. See “Relay Test” on page 345. Check 910 Pur wire.

Cargo Box Lift Kit

Cargo Box Lift Circuit Operation

Function:

To activate and control the direction of current through the hydraulic motor and pump to lift and lower the cargo box.

Operating Conditions:

- Key switch in the RUN position.
- Lift/lower switch in either the LIFT or LOWER position.

Theory of Operation:

The cargo box lift/lower circuit consists of a low current switched power control circuit and a high current unswitched power circuit. When the lift/lower control switch is held to the lift or lower position, it energizes the appropriate directional relay.

The motor ground circuit grounds through the other non-operating relay to battery negative.

Switched Power Circuit:

Current flows from the G1 battery to the positive (+) terminal through the 201 and 202 Red wires, F6 fuse, and 208 Red wire to the “B” terminal of the S1 key switch. Current leaves the key switch at the “A” terminal and flows over the 420J and 420H Yel wires, X9 connector, to the S5 cargo box control switch.

If the cargo box is being raised, battery current flows over the 670 Org wire, X10 connector, and 671 Org wire to the L-K1 lift relay. This activates the relay which is grounded by the 180, 161, 163, 125, and 101G Blk wires.

If the cargo box is being lowered, battery current flows over the 675 Grn wire, X10 connector, and 676 Grn wire to the L-K2 lower relay. This activates the relay which is grounded by the 185, 160, 163, 125, and 101G Blk wires.

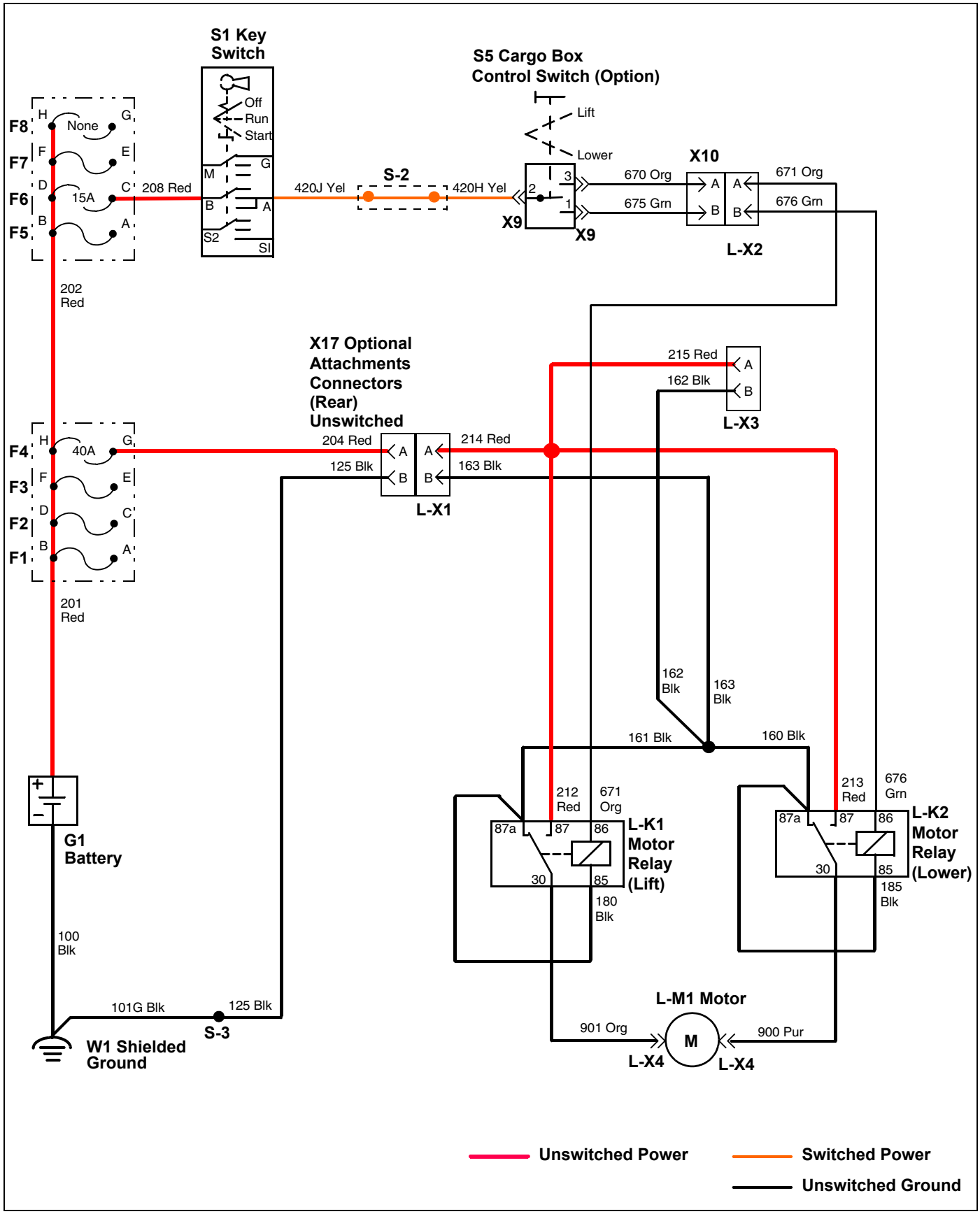
Unswitched Power Circuit:

Current flows from the G1 battery to the positive (+) terminal through the 201 Red wire, F4 fuse, X17 attachment connector, to the 214, 213, 212, and 215 Red wires.

If the cargo box is being raised, current flows to the L-K1 lift relay from the 212 Red wire. The relay is activated by the switched circuit allowing the motor to be powered in the raise direction. The 901 Org wire provides the high current necessary to activate the motor. A ground path to complete the circuit is provided through the 900 Pur wire leading to the L-K2 lower relay and out to the 160, 163, 125, and 101G Blk wires.

If an implement is being lowered, current flows to the L-K2 lower relay from the 213 Red wire. The relay is activated by the switched circuit allowing the motor to be powered in the raise direction. The 900 Pur wire provides the high current necessary to activate the motor. A ground path to complete the circuit is provided through the 901 Org wire leading to the L-K1 lift relay and out to the 161, 163, 125, and 101G Blk wires.

Cargo Box Lift Circuit Schematic



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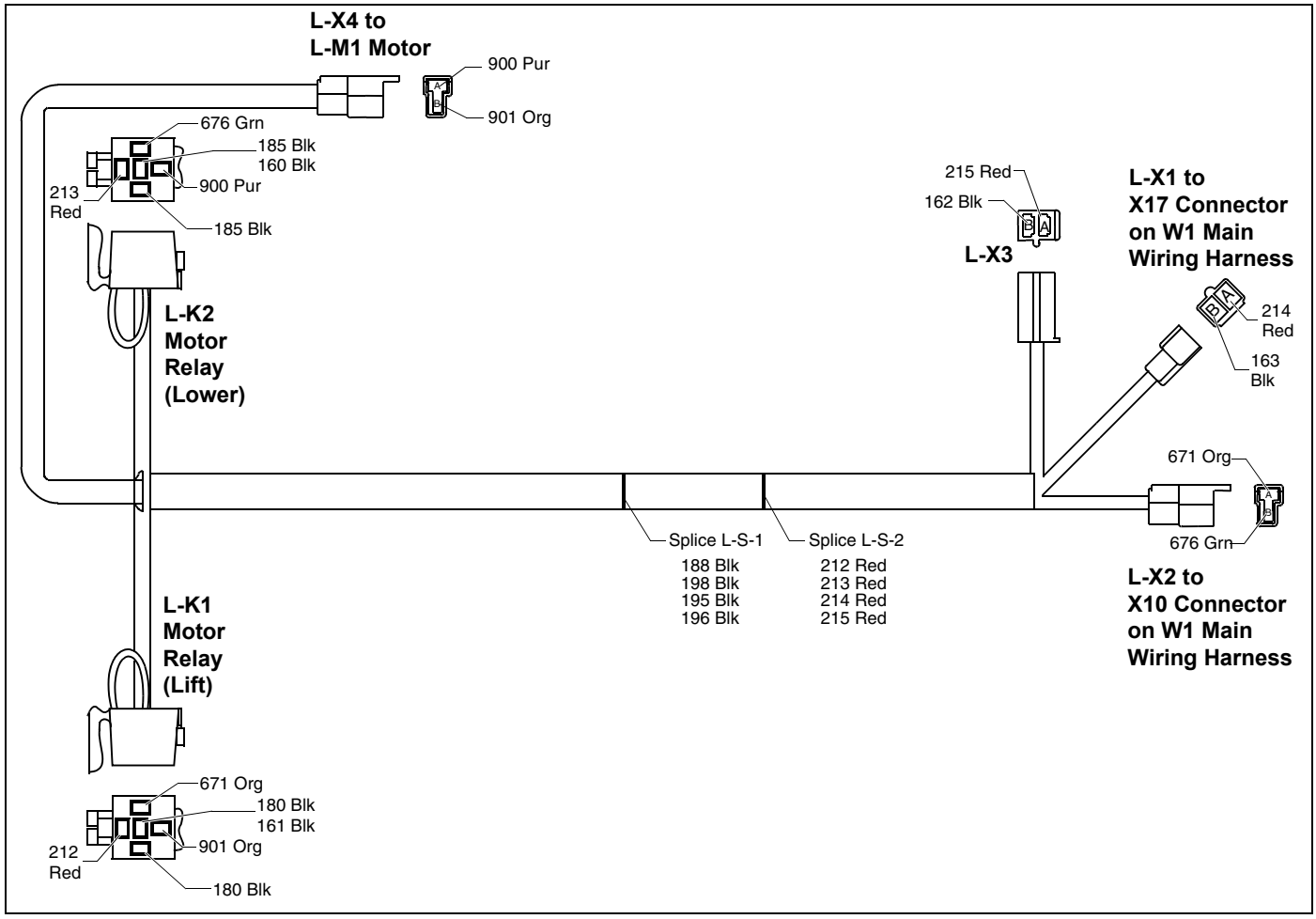
Cargo Box Lift Wiring Harness



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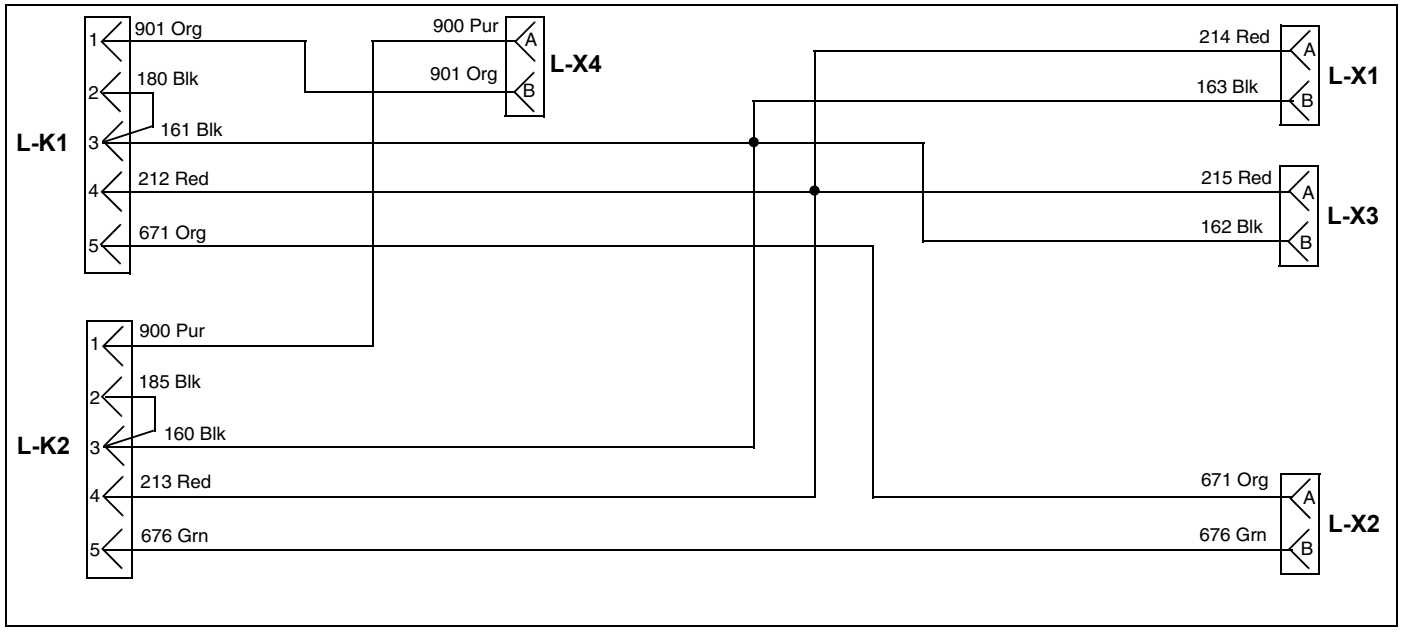
Cargo Box Lift Schematic



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Cargo Box Lift Kit Wire Color Codes

Size/No./Color	Wire Connection Points
2.0 160 Blk	Splice, L-K2
2.0 161 Blk	Splice, L-K1
3.0 162 Blk	Splice, L-X6
3.0 163 Blk	L-X1, Splice
0.8 180 Blk	L-K1, L-K1
0.8 185 Blk	L-K2, L-K2
2.0 212 Red	Splice, L-K1
2.0 213 Red	Splice, L-K2
3.0 214 Red	L-X1, Splice
3.0 215 Red	Splice, L-X3
1.0 671 Org	L-X2, L-K1
1.0 676 Grn	L-X2, L-K2
2.0 900 Pur	L-X4, L-K2
2.0 901 Org	L-X4, L-K1

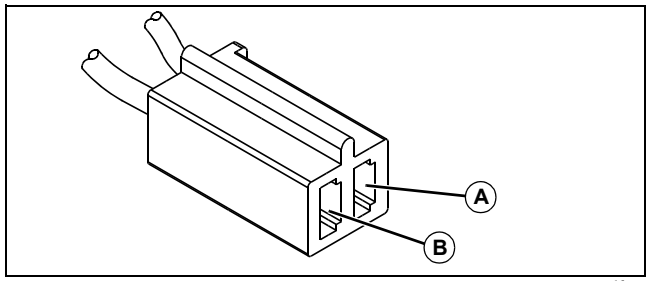
Cargo Box Lift Circuit Diagnosis

Test Procedure A

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Cargo box raised and locked.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in OFF position.
- Battery fully charged.
- Check wires for looseness and corrosion.

System: Cargo Box Lift Circuit - Unswitched



mif

(1) Disconnect X17 connector from cargo box lift wiring harness. Is battery voltage present at pin A of X17 rear optional attachments connector, 204 Red wire (A)?

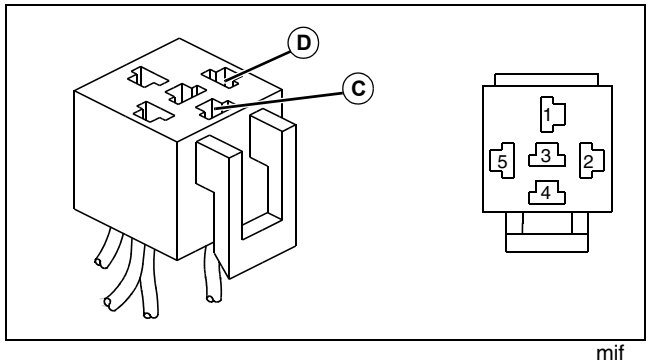
Yes - Go to next step.

No - Test F4 fuse. Check 204 Red wire. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.

(2) Is continuity to ground present at pin B of X17 rear optional attachments connector, 125 Blk wire (B)?

Yes - Connect X17 connector to cargo box lift wiring harness. Go to next step.

No - 125 and 101G Blk wires and connections.



mif

(3) Remove L-K1 lift relay. Is battery voltage present at terminal 4 (87) of relay connector, 212 Red wire (C)?

Yes - Go to next step.

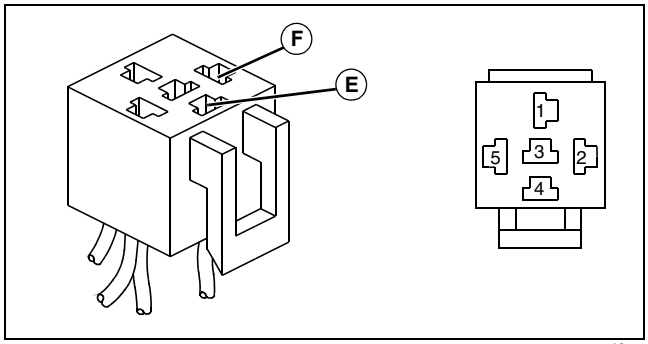
No - Check 212 and 214 Red wires.

(4) Is continuity to ground present at terminal 2 (85) of relay connector, 180 Blk wire (D)?

Yes - Install relay. Go to next step.

System: Cargo Box Lift Circuit - Unswitched

No - Check 180, 161, and 163 Blk wires.



mif

(5) Remove L-K2 lower relay. Is battery voltage present at terminal 4 (87) of relay connector, 213 Red wire (E)?

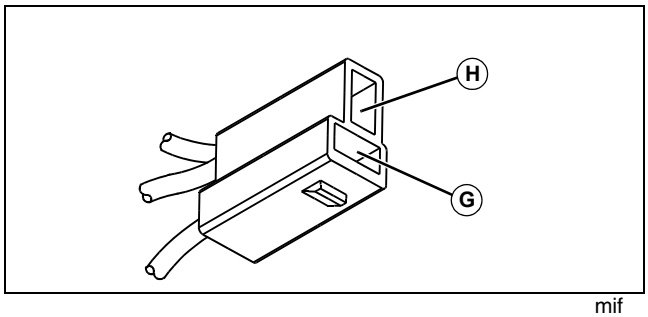
Yes - Go to next step.

No - Check 213 and 214 Red wires.

(6) Is continuity to ground present at terminal 2 (85) of relay connector, 185 Blk wire (F)?

Yes - Install relay. Go to next step.

No - Check 185, 160, and 163 Blk wires.



mif

(7) Disconnect L-X4 connector from L-M1 motor. Is continuity to ground present at terminal A of L-X4 connector, 900 Pur wire (G)?

Yes - Go to next step.

No - Test L-K1 lower relay. See “Relay Test” on page 345. Check 900 Pur wire.

(8) Is continuity to ground present at terminal B of L-X4 connector, 901 Org wire (H)?

Yes - Connect L-X4 connector to L-M1 motor. Go to next step.

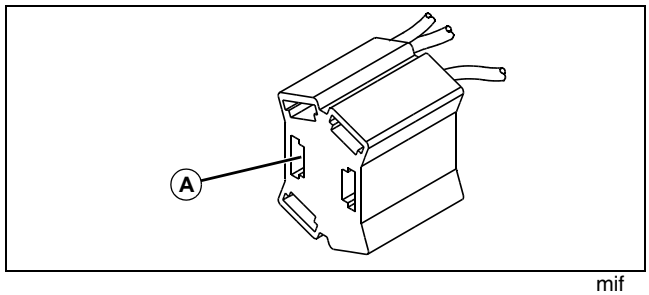
No - Test L-K2 lift relay. See “Relay Test” on page 345. Check 901 Org wire.

Test Procedure B

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Cargo box raised and locked.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in RUN position, engine NOT running.
- Battery fully charged.
- Check wires for looseness and corrosion.

System: Cargo Box Lift Circuit - Switched

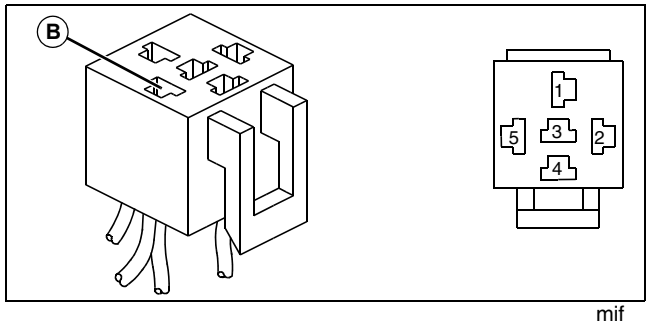


mif

(1) Disconnect S5 cargo box control switch. Is battery voltage present at pin 2 of switch connector, 420H Yel wire (A)?

Yes - Connect switch. Go to next step.

No - Check 420H Yel wire and connections. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.



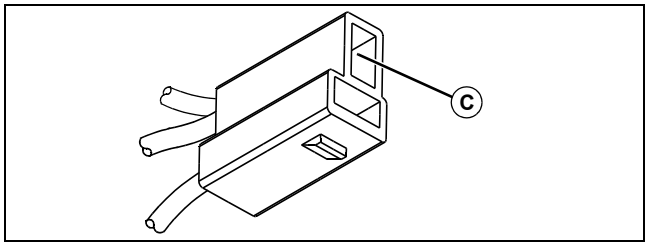
mif

(2) Remove L-K1 lift relay. Toggle S5 cargo box switch to the lift position. Is battery voltage present at terminal 5 (86) of relay connector, 671 Org wire (B)?

Yes - Install relay. Go to next step.

System: Cargo Box Lift Circuit - Switched

No - Check 671 Org wire and connections. If ok, replace cargo box switch.

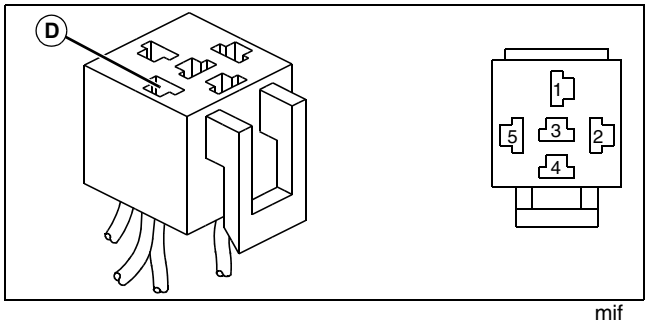


mif

(3) Disconnect L-X4 connector from L-M1 motor. Toggle S5 cargo box switch to the lift position. Is battery voltage present at terminal B of L-X4 connector, 901 Org wire (C)?

Yes - Replace hydraulic pump motor. Go to next step.

No - Test L-K1 lower relay. See “Relay Test” on page 345. Check 901 Org wire.

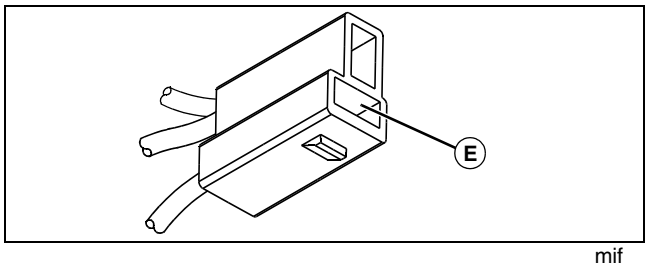


mif

(4) Remove L-K2 lower relay. Toggle S5 cargo box switch to the lower position. Is battery voltage present at terminal 5 (86) of relay connector, 676 Grn wire (D)?

Yes - Install relay. Go to next step.

No - Check 676 Grn wire and connections. If ok, replace cargo box switch.



mif

(5) Disconnect L-X4 connector from L-M1 motor. Toggle S5 cargo box switch to the lower position. Is battery voltage present at terminal A of L-X4 connector, 900 Pur wire (E)?

Yes - Replace hydraulic pump motor. Go to next step.

System: Cargo Box Lift Circuit - Switched

No - Test L-K2 lower relay. See “Relay Test” on page 345. Check 900 Pur wire.

Horn Kit

Horn Kit Circuit Operation

Function:

To provide power and control for the horn.

Operating Conditions:

- Operating machine safely.
- The horn circuit uses unswitched power. The key switch and other switches may be in any safe operating position.

Theory of Operation:

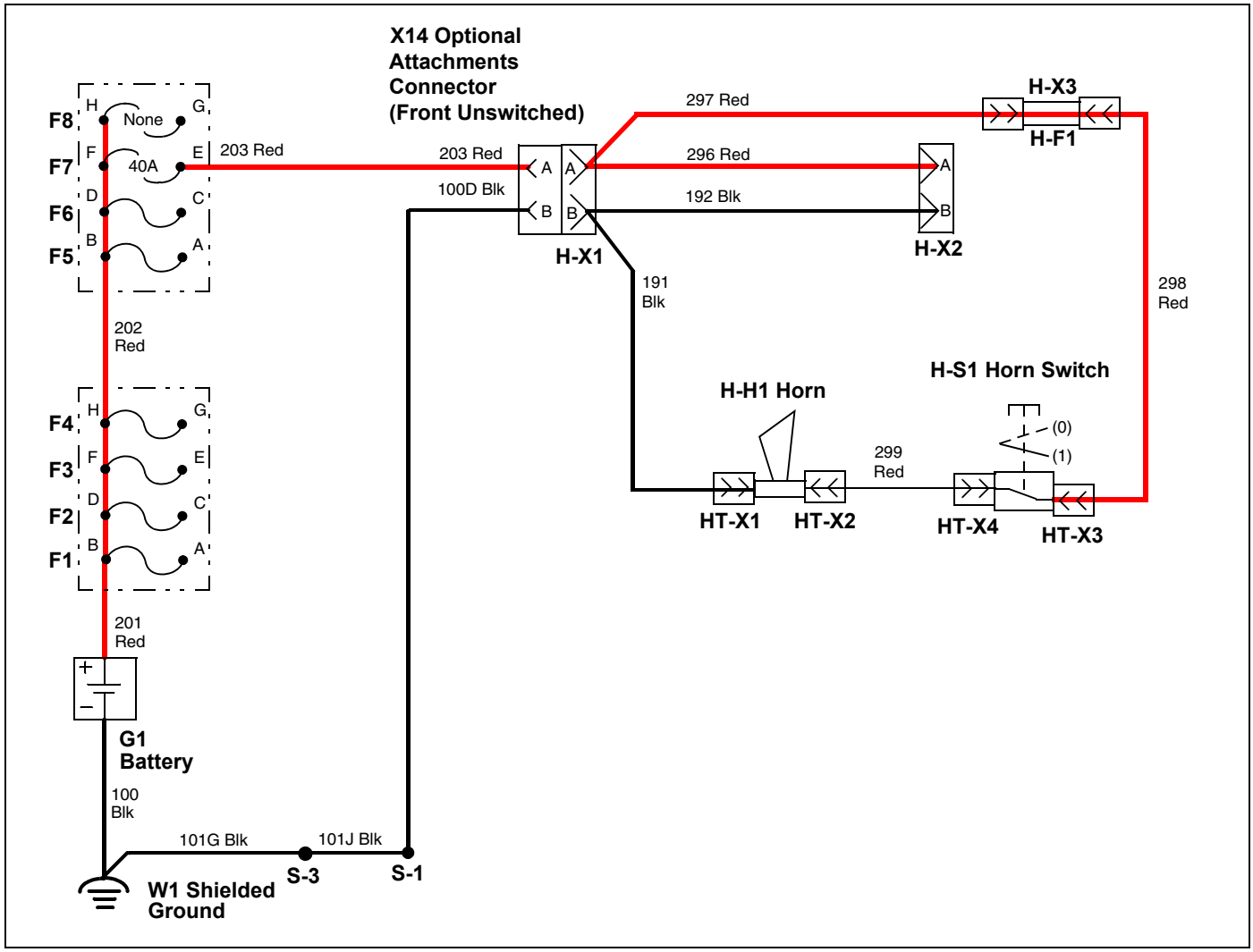
Current flows from the G1 battery positive (+) terminal to the 201 and 202 Red wires, F7 fuse, 203 Red wire, and to X14 optional attachments connector. This plugs into the (depending on installed options) H-X1 connector of the horn wiring harness. The 297 Red wire carries power to the H-F1 horn fuse to the 298 Red wire and to the H-S1 horn switch. Power for the H-H1 horn is supplied out of the switch (closed for horn operation) via the 299 Red wire. A path to ground is provided by 191 Blk wire to connector H-X1 which plugs into the W1 main wiring harness optional attachments connector X14.

The path to ground is then completed through 100D Blk wire which splices into 101J and 101G Blk wires, and finally to the W1 ground.

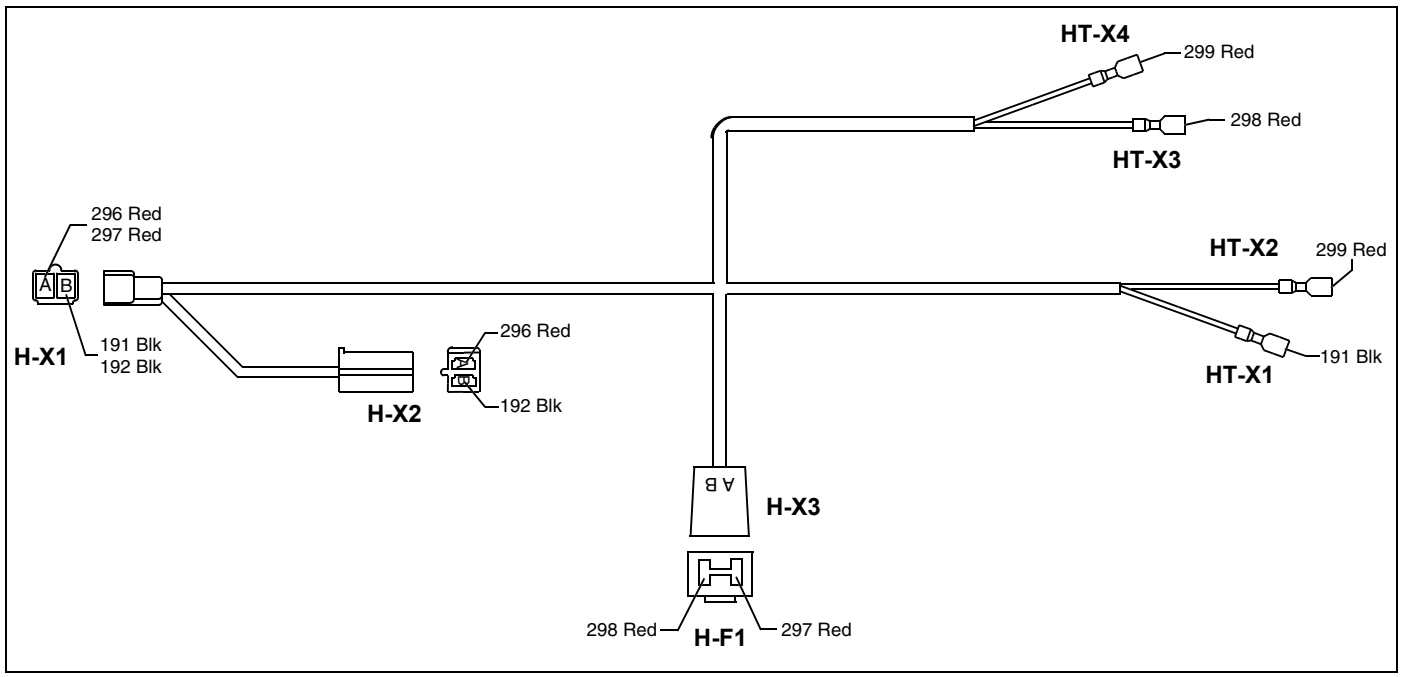
The circuit for the power tap for other optional attachments is continued by the 296 Red and 192 Blk wires, which are spliced into the H-X1 connector and terminate at the H-X2 power tap out connector.

The machine does not need to be running for the horn to sound.

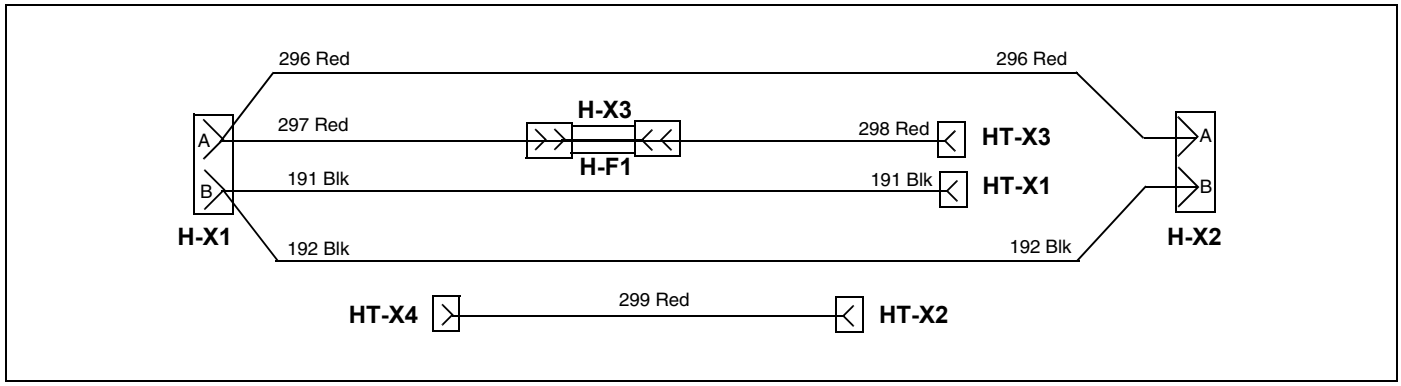
Horn Kit Circuit Wiring Schematic



Horn Kit Wiring Harness



Horn Kit Schematic



Horn Kit Circuit Wiring Harness Color Codes

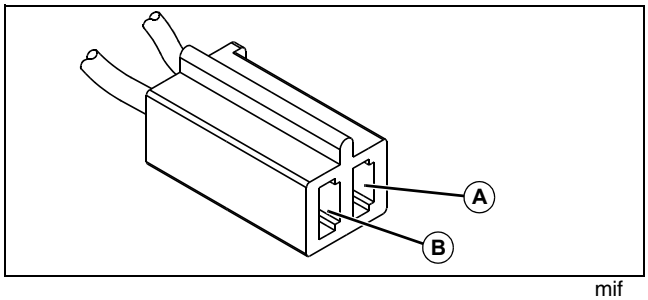
Size/No./Color	Wire Connection Points
0.8 191 Blk	HT-X1, H-X1
3.0 192 Blk	H-X2, H-X1
3.0 296 Red	H-X2, H-X1
0.8 297 Red	H-F1, H-X1
0.8 298 Red	H-F1, HT-X3
0.8 299 Red	HT-X2, HT-X4

Horn Kit Circuit Diagnosis

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Open hood and remove storage tray.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in OFF position.
- Battery fully charged.
- Check wires for looseness and corrosion.

System: Horn Circuit



mif

(1) Disconnect X14 connector from horn wiring harness. Is battery voltage present at pin A of X14 front optional attachments connector, 203 Red wire (A)?

Yes - Go to next step.

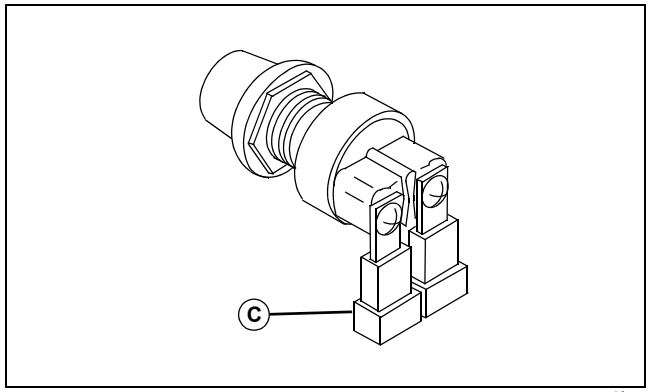
No - Test F7 fuse. Check 203 Red wire. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.

(2) Is continuity to ground present at pin B of X14 front optional attachments connector, 100D Blk wire (B)?

Yes - Connect X14 connector to horn wiring harness. Go to next step.

No - 100D, 101J, and 101G Blk wires and connections.

System: Horn Circuit

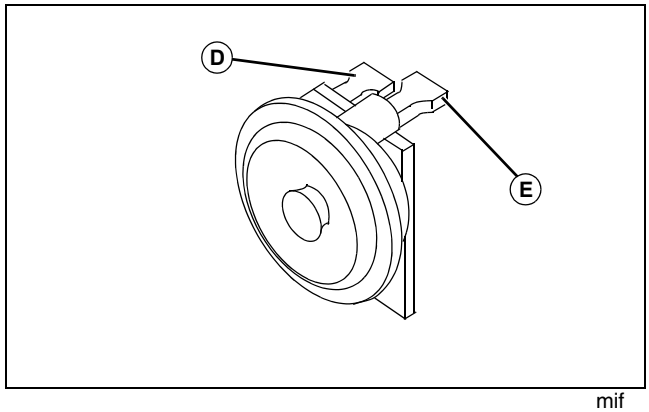


mif

(3) Is battery voltage present at 298 Red wire of H-S1 horn switch (C)?

Yes - Go to next step.

No - Check 298 Red wire, H-F1 fuse, 297 Red wire, and connections.



mif

(4) Is continuity to ground present at 191 Blk wire of H-H1 horn (D)?

Yes - Go to next step.

No - Check 191 Blk wire and connections.

(5) Depress and hold horn switch for test. Is battery voltage present at 299 Red wire of H-H1 horn (E)?

Yes - Replace horn.

No - Check 299 Red wire. If OK, replace H-S1 horn switch.

Optional Light Kits

Rear Marker/Brake Lights Kit Operation

Function:

To provide rear marker and brake lights.

Operating Conditions - Brake Lights:

- Key switch in the RUN position.
- Brake pedal depressed (Brake switch CLOSED).

Theory of Operation - Brake Lights:

Current for the brake lights flows from the G1 battery through the 201 and 202 Red wires, F6 fuse, and 208 Red wire to the “B” terminal of the S1 key switch. Current leaves the key switch at the “A” terminal, over the 420J and 420K Yel wires to the “E” pin on the X15 connector of the W1 main wiring harness. The X15 connector is plugged into the T-X2 connector and current leaves over 421 Yel wire and into the T-F1 brake switch fuse. The 422 Yel wire carries power to the T-S3 brake lights switch and is routed out of the closed switch contacts over the 823 Pur wire to the T-X2/X15 connectors. The W1 main wiring harness carries this power over the 820 Pur wire to the rear marker/brake lights wiring harness X16/T-X5 connectors. The current is then divided over 822 Pur wire for the T-E1 right rear brake light and 821 Pur wire for the T-E2 left rear brake light.

A path to ground is provided by the 116 Blk wire for the T-E1 right rear brake light and 115 Blk wire for the T-E2 left rear brake light. These wires are spliced into a common path at the T-X5 connector and to the X16 connector of the W1 main wiring harness. The 101A and 101G Blk wires complete the path to the W1 shielded ground.

Operating Conditions - Rear Marker Lights:

- Key switch in RUN position.
- Light switch in either the CENTER ON or FULL ON positions.

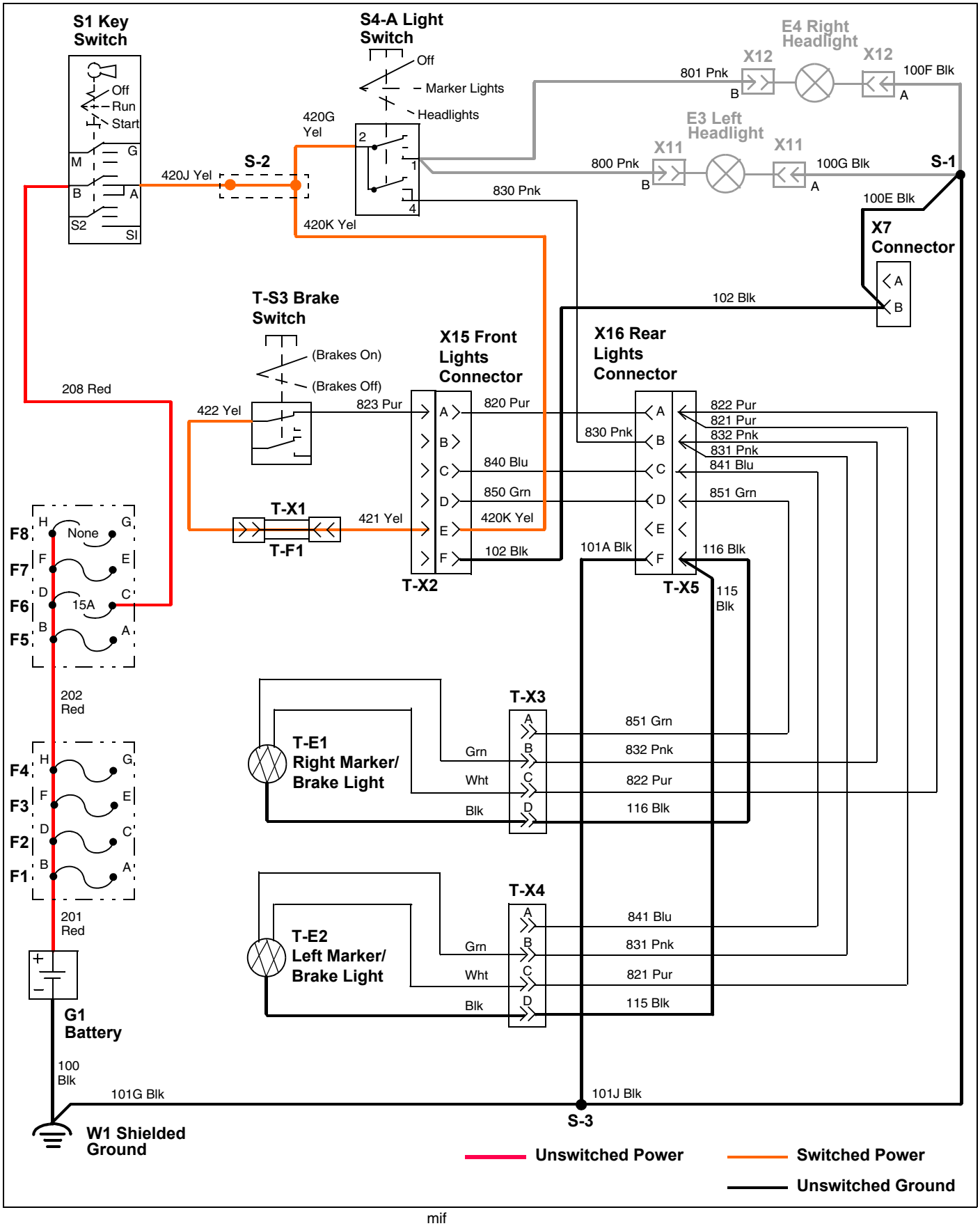
Theory of Operation - Rear Marker Lights:

Current for the marker lights flows from the G1 battery through the 201 and 202 Red wires, F6 fuse, and 208 Red wire to the “B” terminal of the S1 key switch. Current leaves the key switch at the “A” terminal over 420J and 420G Yel wires to the S4-A light switch.

With the S4-A light switch in either the center on or full on position, current is supplied to the 830 Pnk wire to the marker/brake lights wiring harness across the B terminal of the X16/T-X5 connectors. At the T-X5 connector, current is then divided over 832 Pnk wire for the T-E1 right rear marker light and 831 Pnk wire for the T-E2 left rear marker light.

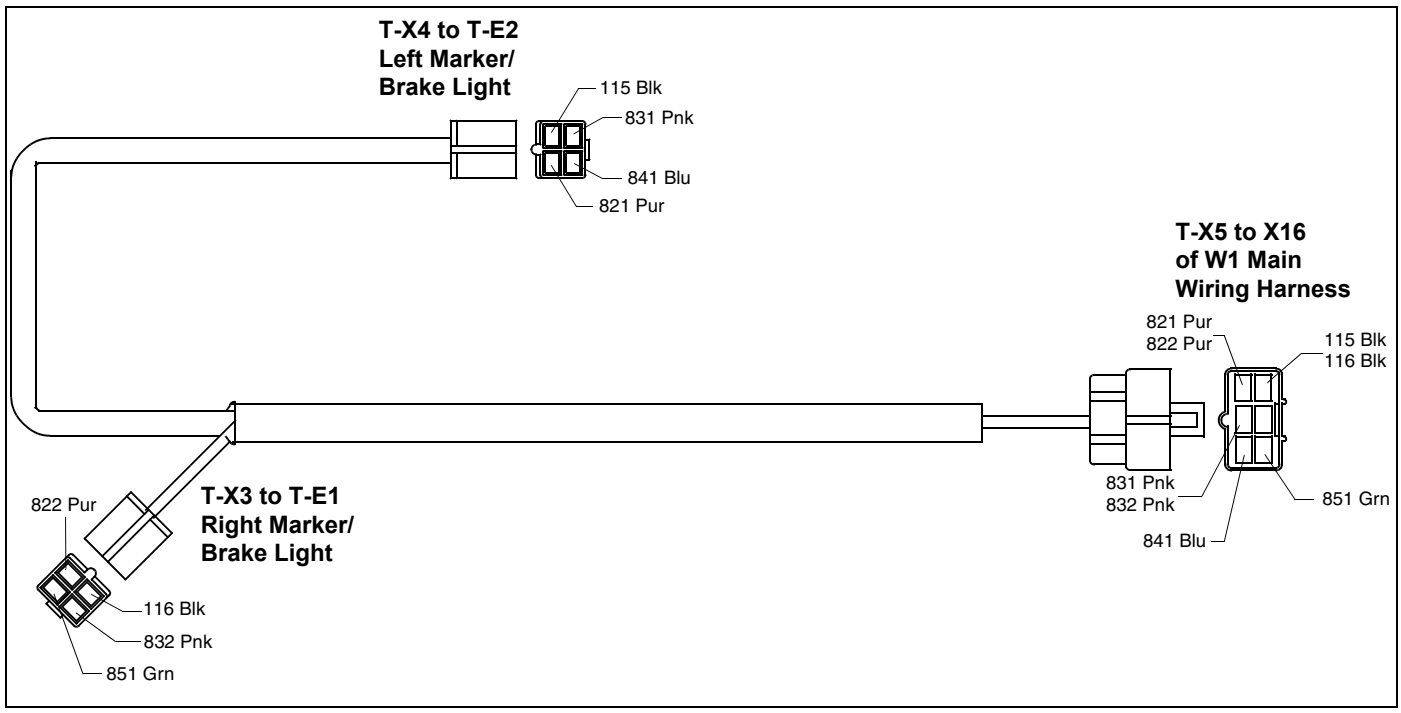
A path to ground is provided by the 116 Blk wire for the T-E1 right rear marker light and 115 Blk wire for the T-E2 left rear marker light. These wires are spliced into a common path at the T-X5 connector and to the X16 connector of the W1 main wiring harness. The 101A and 101G Blk wires complete the path to the W1 shielded ground.

Rear Marker/Brake Lights Kit Schematic



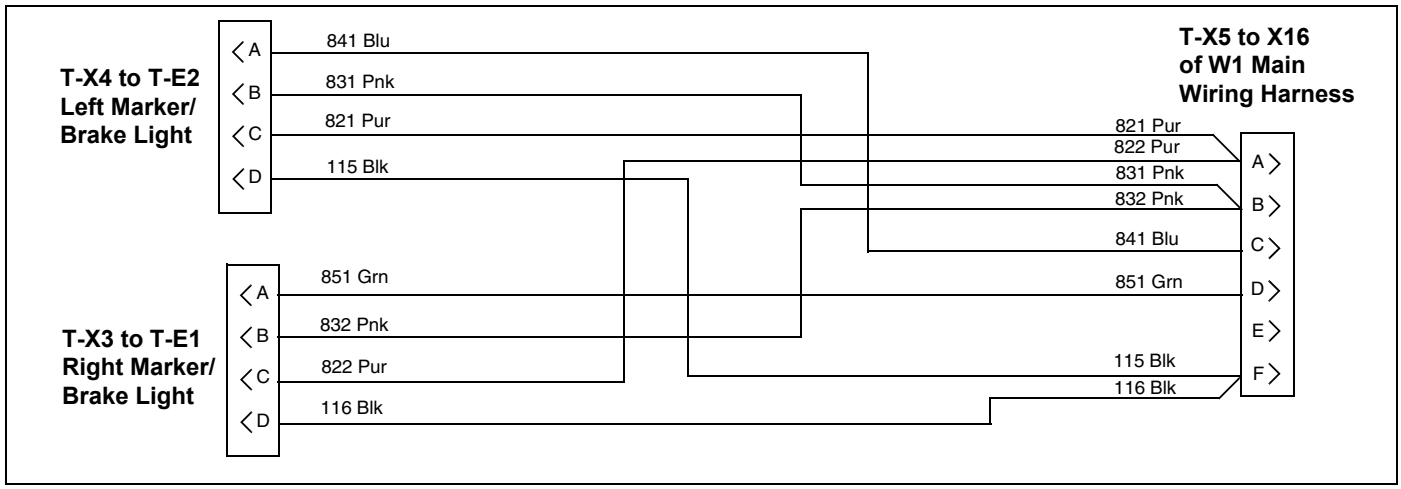
mif

Rear Marker/Brake Lights Circuit Wiring Harness



mif

Rear Marker/Brake Lights Kit Circuit Schematic

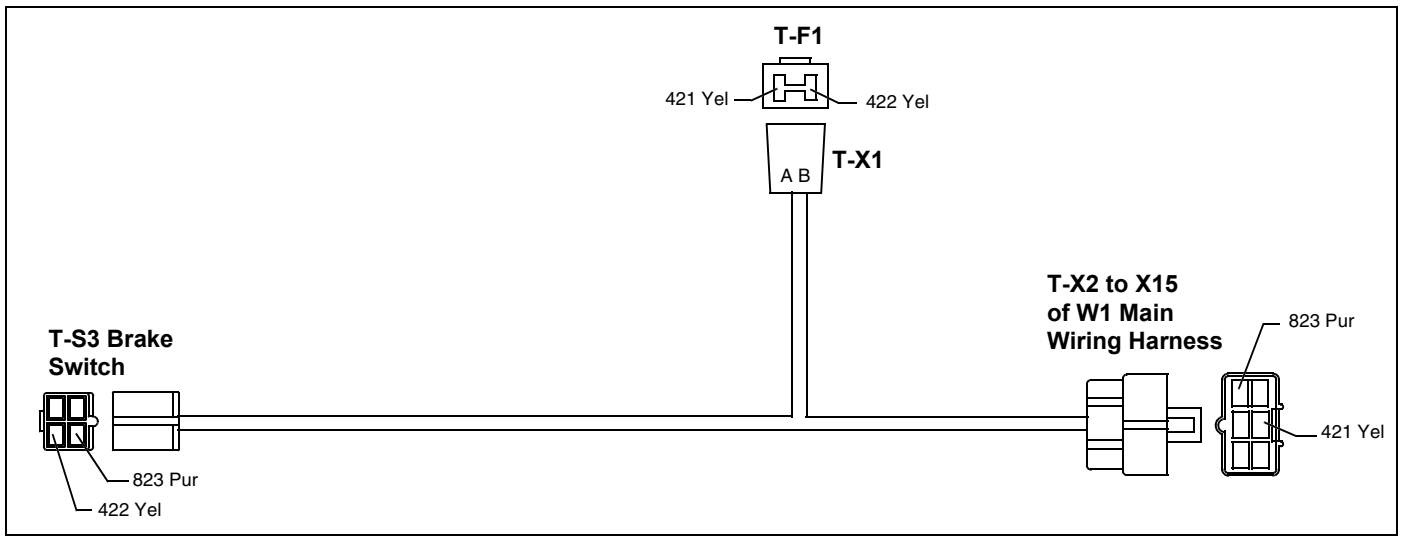


mif

Rear Marker/Brake Lights Kit Circuit Wiring Harness Color Codes

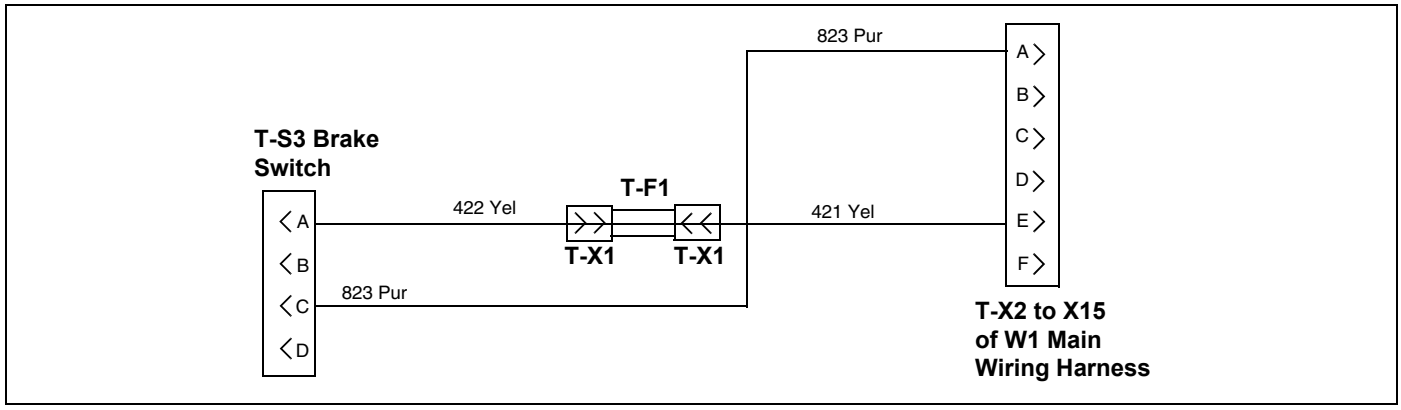
Size/No./Color	Wire Connection Points
1.0 115 Blk	T-X5, T-X4
1.0 116 Blk	T-X5, T-X3
0.8 821 Pur	T-X5, T-X4
0.8 822 Pur	T-X5, T-X3
0.8 831 Pnk	T-X5, T-X4
0.8 832 Pnk	T-X5, T-X3
0.8 841 Blu	T-X5, T-X4
0.8 851 Grn	T-X5, T-X3

Brake Switch Circuit Wiring Harness



mif

Brake Switch Circuit Schematic



mif

Brake Switch Circuit Wiring Harness Color Codes

Size/No./Color	Wire Connection Points
0.8 421 Yel	T-X2, T-X1
0.8 422 Yel	T-X1, T-S3
0.8 823 Pur	T-X2, T-S3

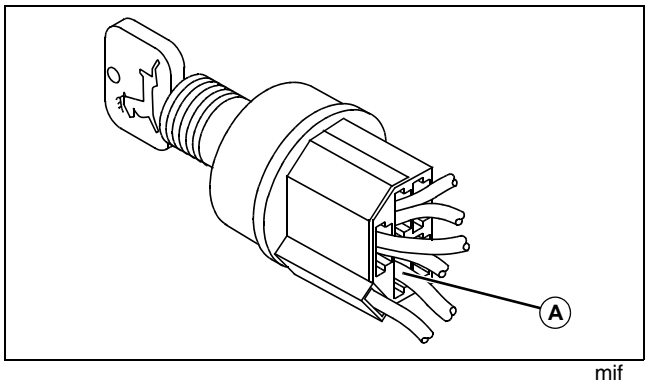
Rear Marker/Brake Lights Kit Diagnosis

Brake Lights Circuit

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Cargo box RAISED and LOCKED.
- Open hood and remove storage tray.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in RUN position - engine OFF.
- Brake pedal depressed (Switch CLOSED).
- Battery fully charged.
- Check connections for looseness and corrosion.

System: Brake Lights Circuit

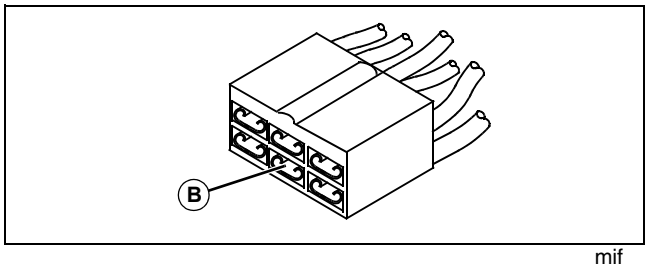


mif

(1) Is battery voltage present at the B terminal of switch connector, 208 Red wire (A)?

Yes - Go to next step.

No - Test F6 fuse. Test battery and positive (+) battery cable. Check 201 and 202 Red wires and connections. Check 208 Red wire and connections.



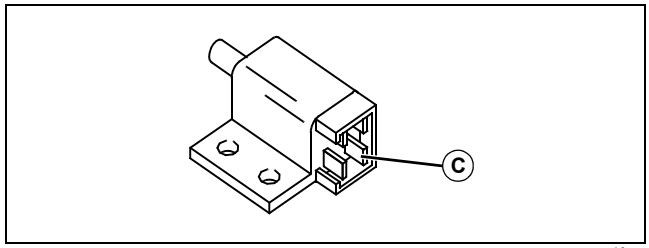
mif

(2) Is battery voltage present at 420K Yel wire at the X15 front lights connector (B)?

Yes - Go to next step.

System: Brake Lights Circuit

No - Test the S1 key switch. See “Key Switch Test” on page 341. Check 420K and 420J Yel wires and connections.

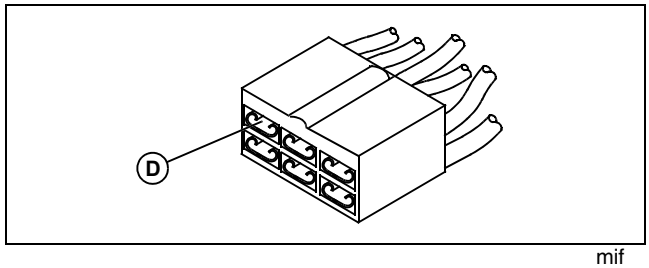


mif

(3) Is battery voltage present at 421 Yel wire of the T-S3 brake lights switch (C)?

Yes - Go to next step.

No - Test T-F1 fuse. Check 421 and 422 Yel wire and connections.

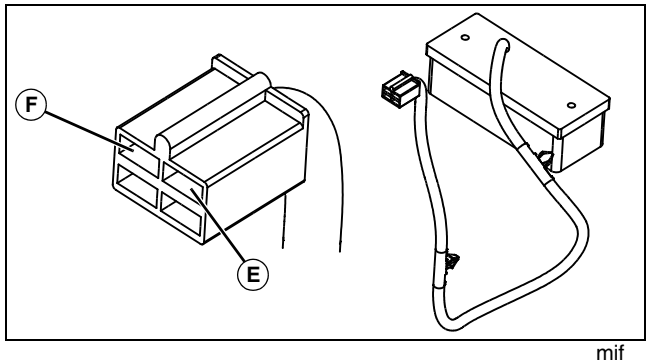


mif

(4) Is battery voltage present at 820 Pur wire of pin “A” on the X16 rear lights connector (D)?

Yes - Go to next step.

No - Test brake light switch. See “Park Brake Switch Test” on page 344. Check 823 and 820 Pur wires and connections.



mif

(5) Disconnect right marker light connector. Is battery voltage present at C terminal of right marker light connector T-X3, 822 Pur wire (E)?

Yes - Go to next step.

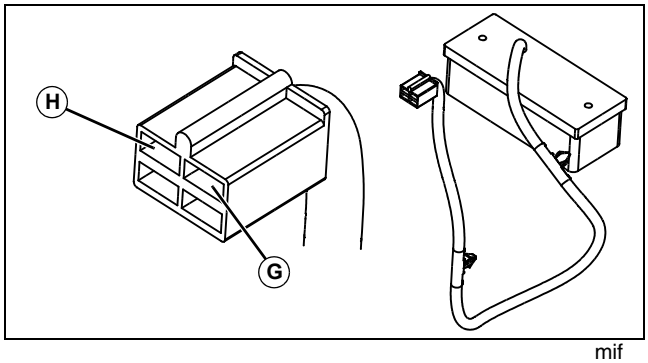
No - Check 822 Pur wire and connections.

System: Brake Lights Circuit

(6) Is continuity to ground present at D terminal of right marker light connector T-X3, 116 Blk wire (F)?

Yes - Connect right marker connector. Test bulb. See “Bulb Test” on page 347.

No - Check 116, 101A, and 101G Blk wires and connections.



mif

(7) Disconnect left marker light connector. Is battery voltage present at C terminal of left marker light connector T-X4, 821 Pur wire (G)?

Yes - Go to next step.

No - Check 821 Pur wire and connections.

(8) Is continuity to ground present at D terminal of left marker light connector T-X4, 115 Blk wire (H)?

Yes - Connect left marker connector. Test bulb. See “Bulb Test” on page 347.

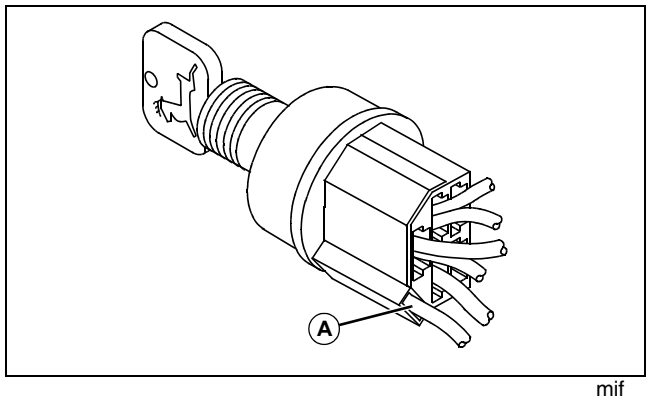
No - Check 115, 101A, and 101G Blk wires and connections.

Marker Lights Circuit

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Cargo box RAISED and LOCKED.
- Open hood and remove storage tray.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in RUN position - engine OFF.
- Light switch in CENTER ON position.
- Battery fully charged.
- Check wire connections for looseness and corrosion.

System: Marker Lights Circuit



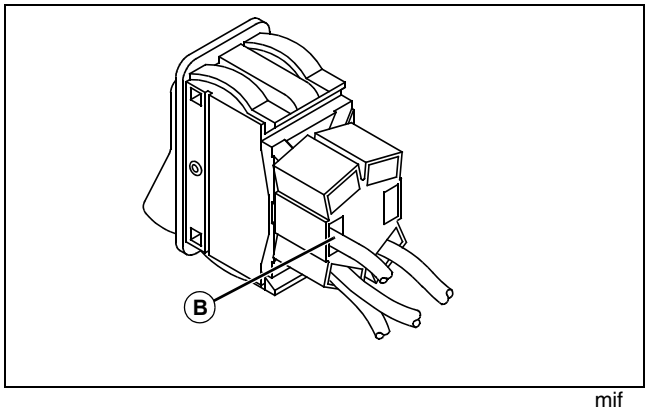
mif

(1) Is battery voltage present at A terminal of S1 key switch (A)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.

System: Marker Lights Circuit

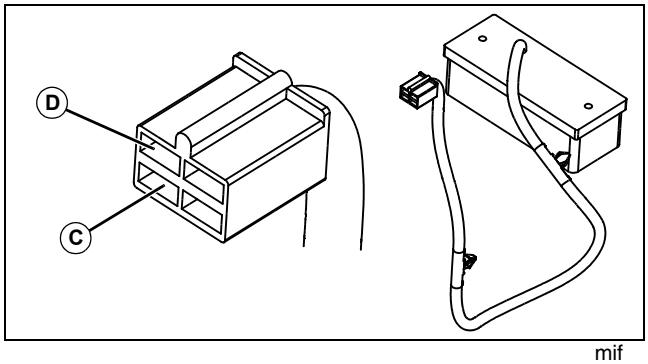


mif

(2) Is battery voltage present at 420G Yel wire of S4-A light switch (B)?

Yes - Go to next step.

No - Check 420J and 420G Yel wires and connections.



mif

(3) Disconnect right marker light connector. Is battery voltage present at B terminal of right marker light connector T-X3, 832 Pnk wire (C)?

Yes - Go to next step.

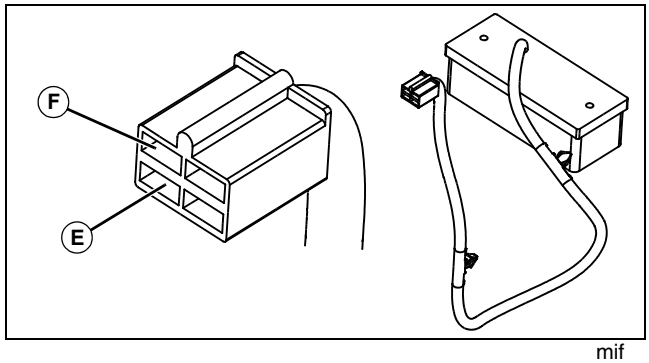
No - Test light switch. See “Light Switch Test (Optional Marker or Signal Lights)” on page 342. Check 830 and 831 Pnk wires and connections.

(4) Is continuity to ground present at D terminal of right marker light connector T-X3, 116 Blk wire (D)?

Yes - Connect right marker connector. Test bulb. See “Bulb Test” on page 347.

No - Check 116, 101A, and 101G Blk wires and connections.

System: Marker Lights Circuit



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(5) Disconnect left marker light connector. Is battery voltage present at B terminal of left marker light connector T-X4, 831 Pnk wire (E)?

Yes - Go to next step.

No - Test light switch. See “Light Switch Test (Optional Marker or Signal Lights)” on page 342. Check 830 and 831 Pnk wires and connections.

(6) Is continuity to ground present at D terminal of left marker light connector T-X4, 115 Blk wire (F)?

Yes - Connect left marker connector. Test bulb. See “Bulb Test” on page 347.

No - Check 115, 101A, and 101G Blk wires and connections.

Optional Deluxe Light Kit

Turn Signal/Hazard/Marker/Brake Lights Operation

Function:

To provide control and power to the turn signal, hazard, rear marker, and brake lights.

Operating Conditions - Turn Signal Lights:

- The signal lights circuit uses unswitched power. The key switch and other switches may be in any safe operating position.
- Turn signal lights switch in either LEFT or RIGHT position.

Theory of Operation - Turn Signal Lights:

Power for the turn signal lights flows from the G1 battery through the 201 and 202 Red wires, F7 fuse, and 203 Red wire to the X14 front optional attachments connector. This plugs into the T-X9 signal lights wiring harness connector and power flows through the 255 Red wire, T-F2 fuse, 256 Red wire, and into the T-K1 flasher. The 470 Yel wire leaves the flasher to the T-S2 turn signal lights switch and the signal is divided to the 471 Yel wire to the T-S1 hazard lights switch.

If the turn signal switch is in the left turn position, current flows through the T-S2 turn signal lights switch, forward biasing an internal indicator LED causing it to illuminate. The signal exits the switch at the number “3” pin and is routed over the 840C Blu wire to the 840 splice. The 840D Blu wire carries power to the T-X6 connector of the T-E5 left front signal light. A path to ground is provided through the 118 Blk wire to the T-X1/X15 connectors, 102, 100E, 101J, and 101G Blk wires to the W1 shielded ground.

At the same time, the 840A Blu wire carries power to the T-X1/X15 connector, 840 Blu wire, X16/T-X2 connector, 841 Blu wire to the T-X4 connector of the T-E4 left rear signal light. A path to ground is provided through the 115 Blk wire to the T-X2/X16 connectors, 101A, 101J, and 101G Blk wires to the W1 shielded ground.

If the turn signal switch is in the right turn position, current flows through the T-S2 turn signal lights switch, forward biasing an internal indicator LED causing it to illuminate. The signal exits the switch at the number “1” pin and is routed over the 850C Grn wire to the 850 splice. The 850D Grn wire carries power to the T-X7 connector of the T-E6 right front signal light. A path to ground is provided through the 119 and 117 Blk wires to the T-X1/X15 connectors, 102, 100E, 101J, and 101G Blk wires to the W1 shielded ground.

At the same time, The 850A Grn wire carries power to the T-X1/X15 connector, 850 Grn wire, X16/T-X2 connector, 851 Grn wire to the T-X3 connector of the T-E3 right rear signal light. A path to ground is provided through the 116 Blk wire to the T-X2/X16 connectors, 101A, 101J, and 101G Blk wires to the W1 shielded ground.

Operating Conditions - Hazard Lights:

- The hazard lights circuit uses unswitched power. The key switch and other switches may be in any safe operating position.
- Hazard switch in the ON position.

Theory of Operation - Hazard Lights:

Power for the hazard lights flows from the G1 battery through the 201 and 202 Red wires, F7 fuse, and 203 Red wire to the X14 front optional attachments connector. This plugs into the T-X9 signal lights wiring harness connector and power flows through the 255 Red wire, T-F2 fuse, 256 Red wire, and into the T-K1 flasher. The 470 Yel wire leaves the flasher to the T-S2 turn signal lights switch and the signal is divided to the 471 Yel wire to the T-S1 hazard lights switch.

When the hazard light switch is in the on position, power is supplied to the 840 Blu wire splice from the number “1” pin of the hazard lights switch using the 840B Blu wire. At the same time, power is supplied to the 850 Grn wire splice from the number “4” pin of the hazard lights switch using the 850B Grn wire.

From these splices, power is supplied to all four signal lights using the left and right turn signal lights circuit. Power is also feed back to the turn signal light switch to illuminate the LEDs within the turn signal switch. This is a visual indicator to the operator that the hazard lights circuit is operational.

Operating Conditions - Rear Marker Lights:

- Key switch in RUN position.
- Light switch in either the CENTER ON or FULL ON positions.

Theory of Operation - Rear Marker Lights:

Current for the marker lights flows from the G1 battery through the 201 and 202 Red wires, F6 fuse, and 208 Red wire to the “B” terminal of the S1 key switch. Current leaves the key switch at the “A” terminal over 420J and 420G Yel wires to the S4-A light switch.

With the S4-A light switch in either the center on or full on position, current is supplied to the 830 Pnk wire to the marker/brake lights wiring harness across the B terminal of the X16/T-X2 connectors. At the T-X2 connector, current is then divided over 832 Pnk wire for the T-E1 right rear marker light and 831 Pnk wire for the T-E2 left rear marker light.

A path to ground is provided by the 116 Blk wire for the T-E1 right rear marker light and 115 Blk wire for the T-E2 left rear marker light. These wires are spliced into a common path at the T-X2 connector and to the X16 connector of the W1 main wiring harness. The 101A and 101G Blk wires complete the path to the W1 shielded ground.

Operating Conditions - Brake Lights:

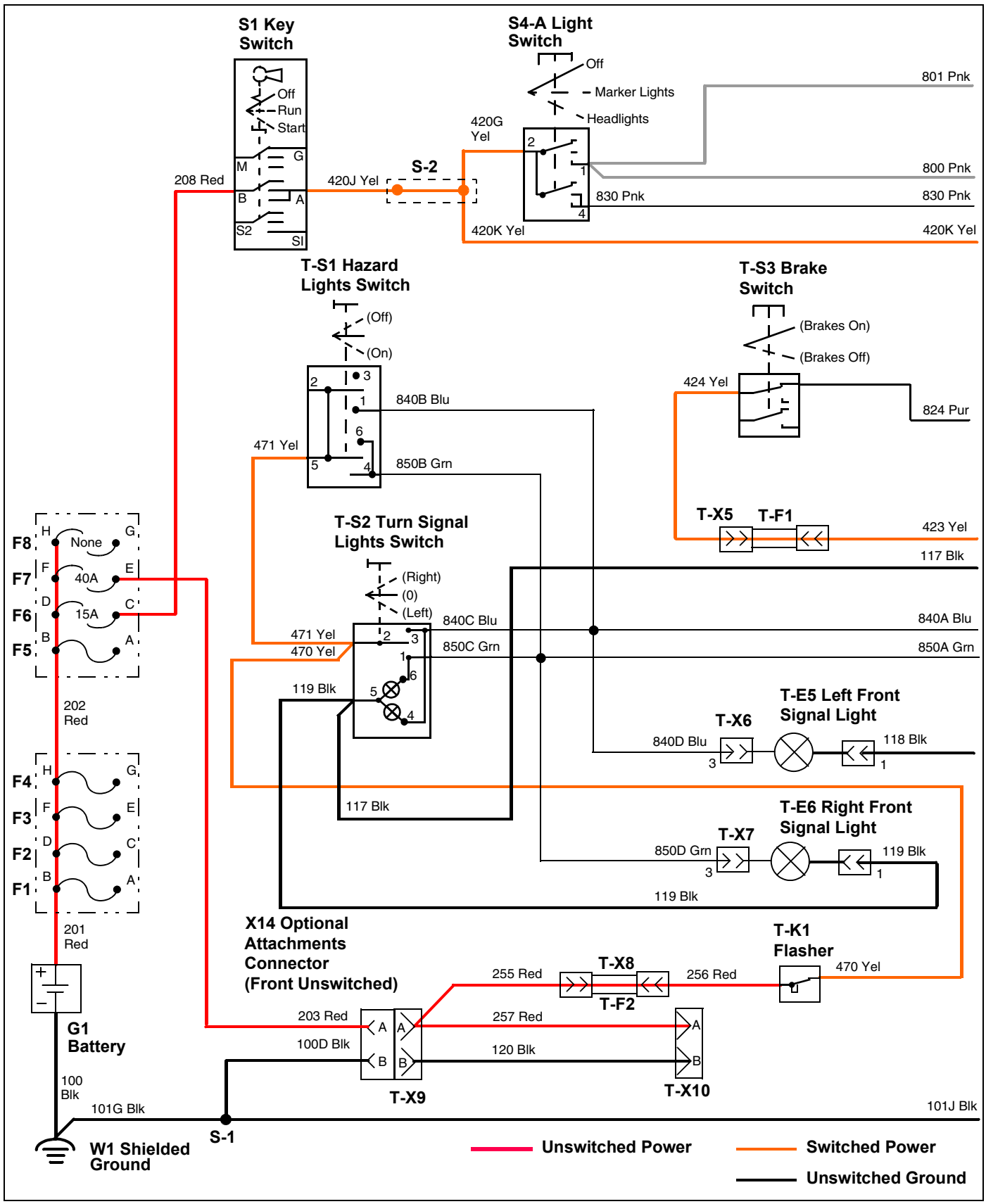
- Key switch in the RUN position.
- Brake pedal depressed (Brake switch CLOSED).

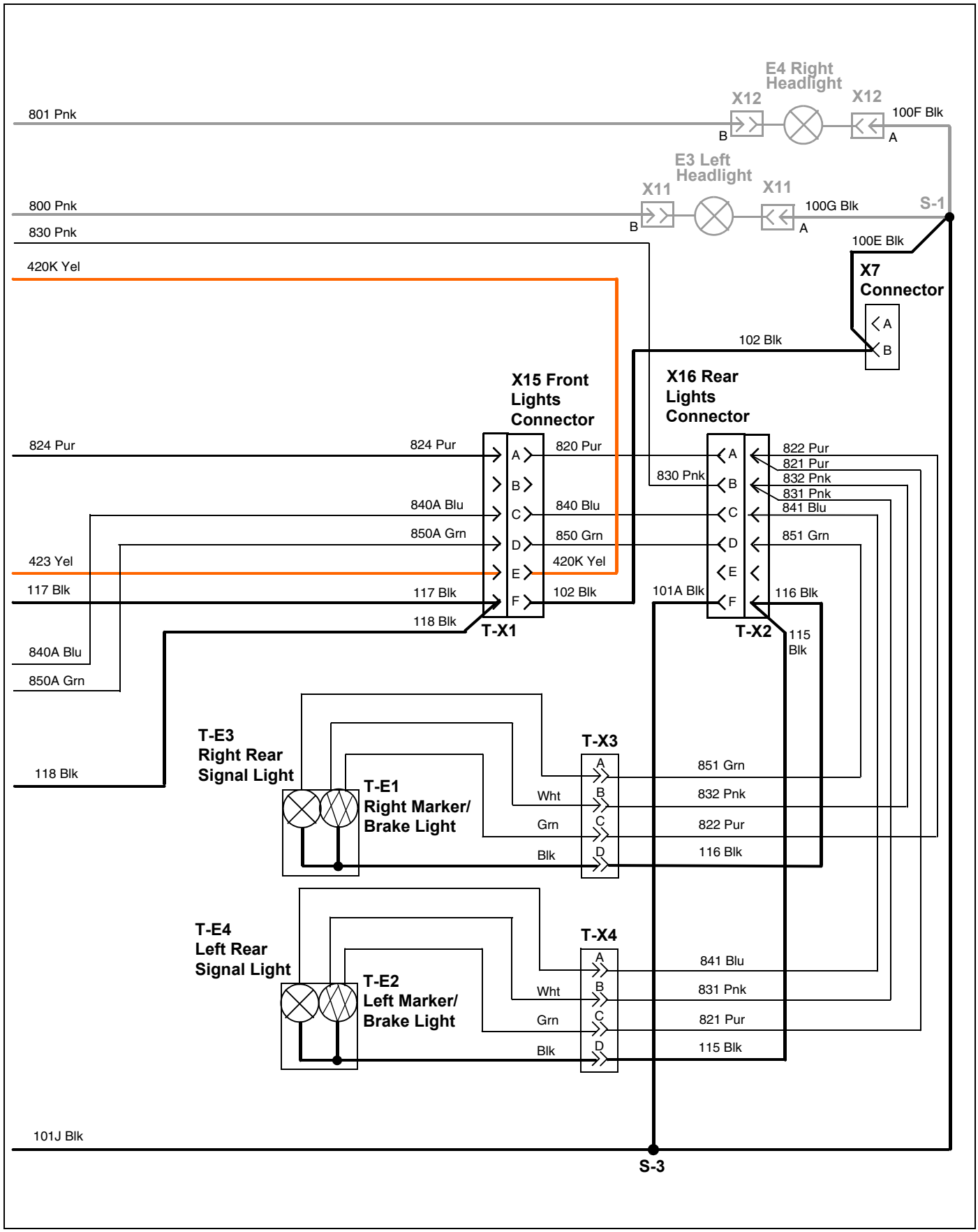
Theory of Operation - Brake Lights:

Current for the brake lights flows from the G1 battery through the 201 and 202 Red wires, F6 fuse, and 208 Red wire to the “B” terminal of the S1 key switch. Current leaves the key switch at the “A” terminal, over the 420J and 420K Yel wires to the “E” pin on the X15 connector of the W1 main wiring harness. The X15 connector is plugged into the T-X1 connector and current leaves over 423 Yel wire and into the T-F1 brake switch fuse. The 424 Yel wire carries power to the T-S3 brake lights switch and is routed out of the closed switch contacts over the 824 Pur wire to the T-X1/X15 connectors. The W1 main wiring harness carries this power over the 820 Pur wire to the rear marker/brake lights wiring harness X16/T-X2 connectors. The current is then divided over 822 Pur wire for the T-E1 right rear brake light and 821 Pur wire for the T-E2 left rear brake light.

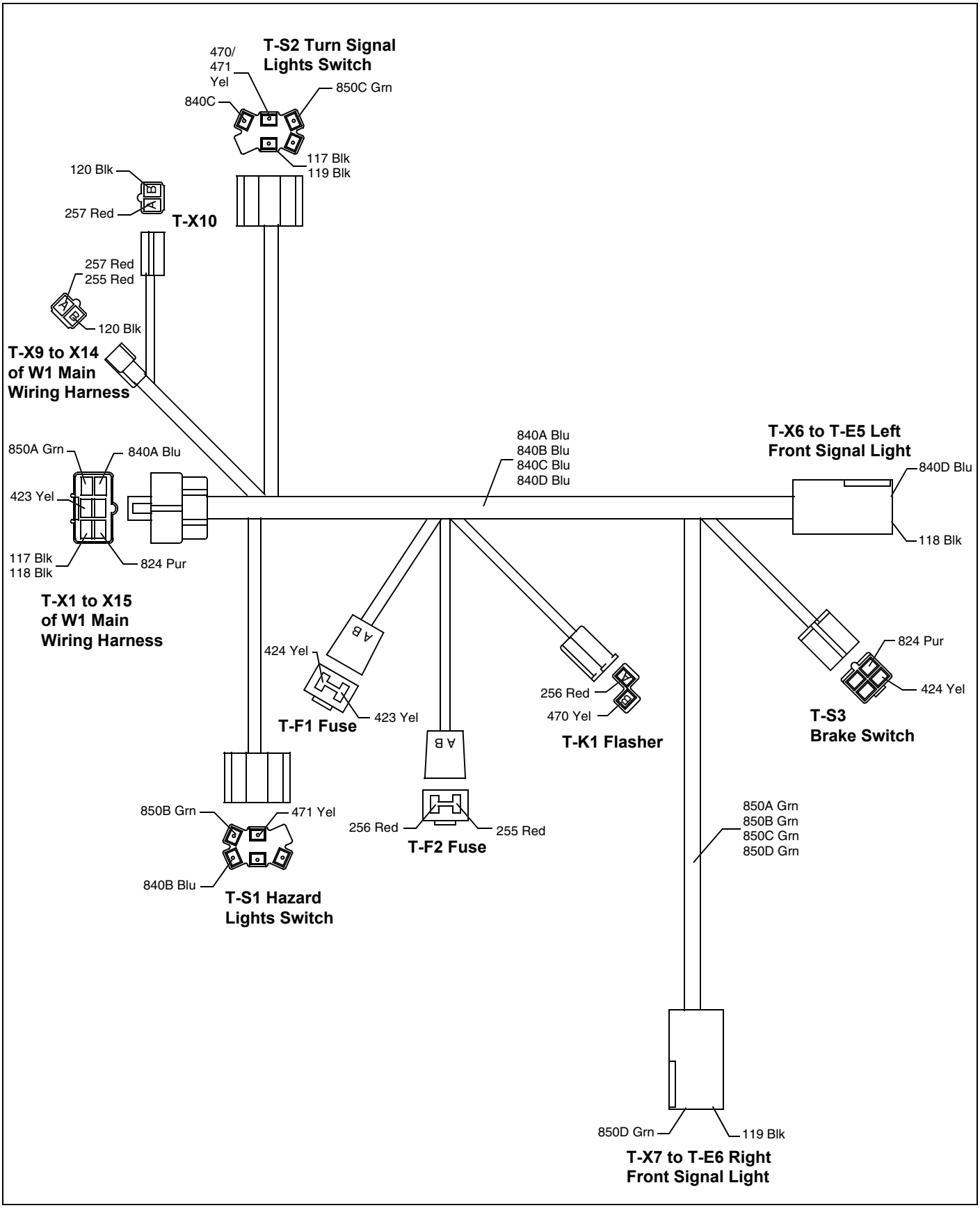
A path to ground is provided by the 116 Blk wire for the T-E1 right rear brake light and 115 Blk wire for the T-E2 left rear brake light. These wires are spliced into a common path at the T-X2 connector and to the X16 connector of the W1 main wiring harness. The 101A and 101G Blk wires complete the path to the W1 shielded ground.

Turn Signal/Hazard/Marker/Brake Lights Kit Circuit Schematic




E4 Right Headlight
X12
X12
801 Pnk
100F Blk
B
A
E3 Left Headlight
X11
X11
800 Pnk
100G Blk
S-1
B
A
830 Pnk
100E Blk
420K Yel
X7 Connector
A
B
102 Blk
X15 Front Lights Connector
X16 Rear Lights Connector
824 Pur
824 Pur
820 Pur
822 Pur
821 Pur
830 Pnk
832 Pnk
831 Pnk
840A Blu
840 Blu
841 Blu
850A Grn
850 Grn
851 Grn
423 Yel
420K Yel
117 Blk
117 Blk
102 Blk
101A Blk
116 Blk
118 Blk
T-X1
T-X2
115 Blk
840A Blu
850A Grn
118 Blk
T-E3 Right Rear Signal Light
T-E1 Right Marker/ Brake Light
T-X3
Wht
Grn
Blk
851 Grn
832 Pnk
822 Pur
116 Blk
T-E4 Left Rear Signal Light
T-E2 Left Marker/ Brake Light
T-X4
Wht
Grn
Blk
841 Blu
831 Pnk
821 Pur
115 Blk
101J Blk
S-3

Signal Lights Wiring Harness



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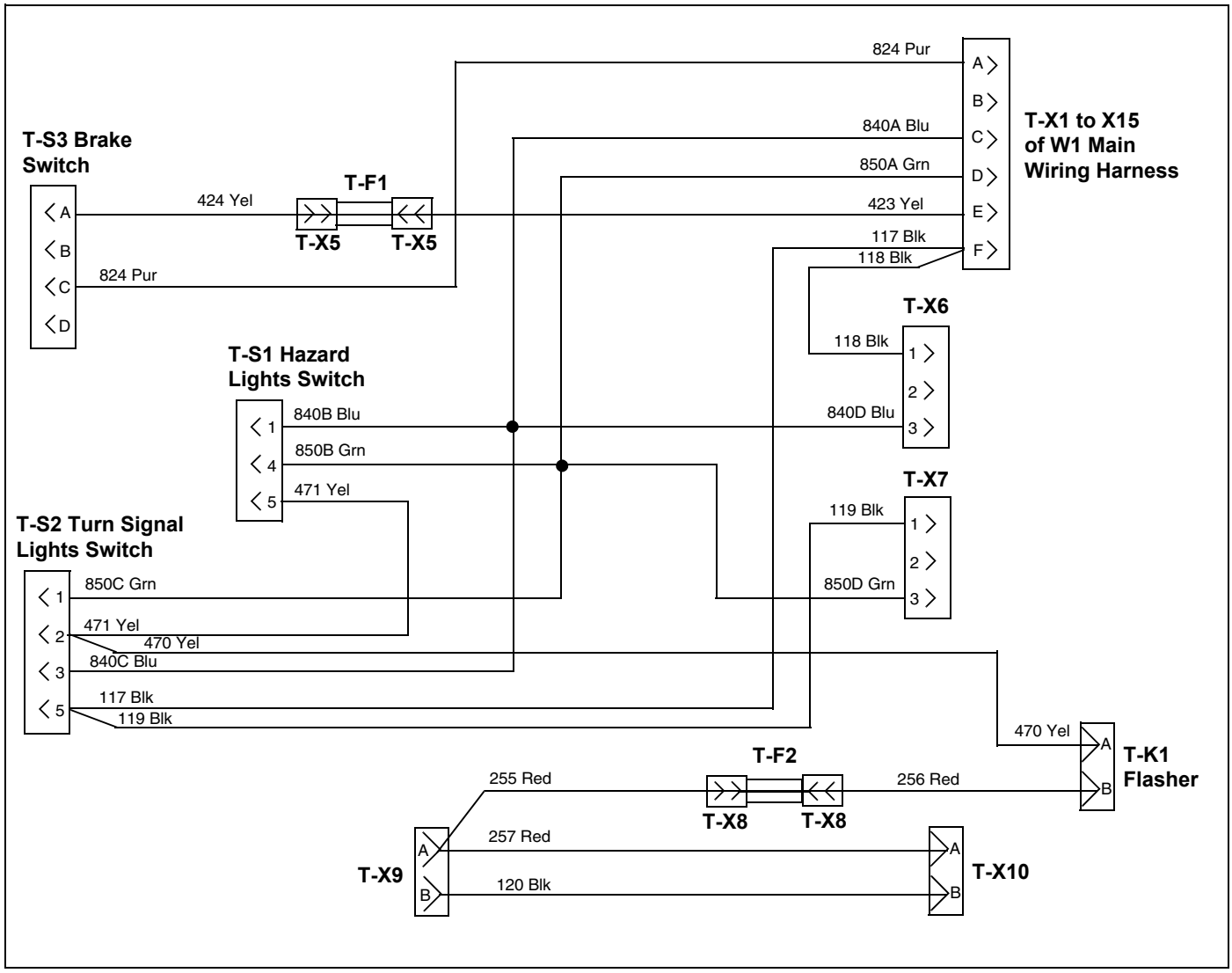
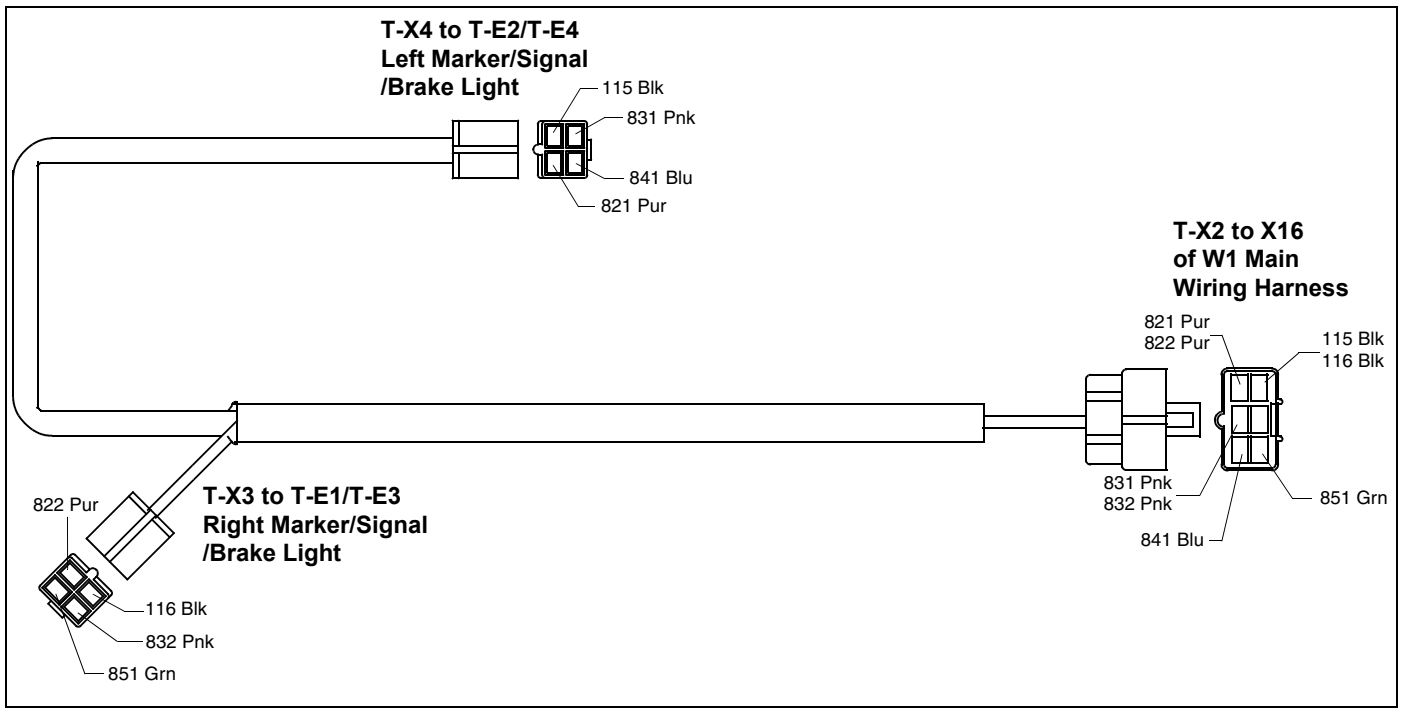
Signal Lights Schematic



Signal Lights Wiring Color Codes

Size/No./Color	Wire Connection Points
0.8 117 Blk	S-X1, S-X9
0.8 118 Blk	S-X1, S-X4
0.8 119 Blk	S-X4, S-X10
3.0 120 Blk	S-X6, S-X7
0.8 255 Red	S-X6, S-F1
0.8 256 Red	S-F1, S-K1
3.0 257 Red	S-X6, S-X7
0.8 423 Yel	S-X1, S-F2
0.8 424 Yel	S-F2, S-S3
0.8 470 Yel	S-K1, S-X4
0.8 471 Yel	S-X4, S-X5
0.8 824 Pur	S-X1, S-S3
0.8 840A Blue	S-X1, SS-1
0.8 840B Blue	SS-1, S-X5
0.8 840C Blue	SS-1, S-X4
0.8 840D Blue	SS-3, S-X10
0.8 850A Grn	S-X1, SS-2
0.8 850B Grn	S-X5, SS-2
0.8 850C Grn	SS-2, S-X4
0.8 850D Grn	S-X10, SS-2

Rear Marker/Brake Lights Circuit Wiring Harness



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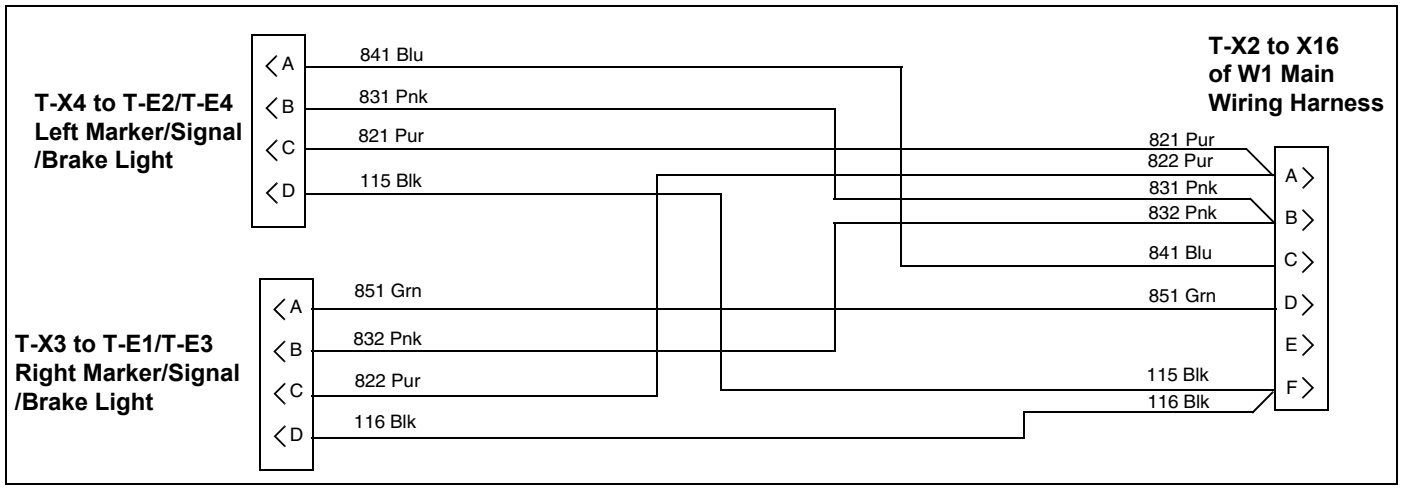
Rear Marker/Brake Lights Kit Circuit Schematic



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Rear Marker/Brake Lights Kit Circuit Wiring Harness Color Codes

Size/No./Color	Wire Connection Points
1.0 115 Blk	T-X2, T-X4
1.0 116 Blk	T-X2, T-X3
0.8 821 Pur	T-X2, T-X4
0.8 822 Pur	T-X2, T-X3
0.8 831 Pnk	T-X2, T-X4
0.8 832 Pnk	T-X2, T-X3
0.8 841 Blu	T-X2, T-X4
0.8 851 Grn	T-X2, T-X3

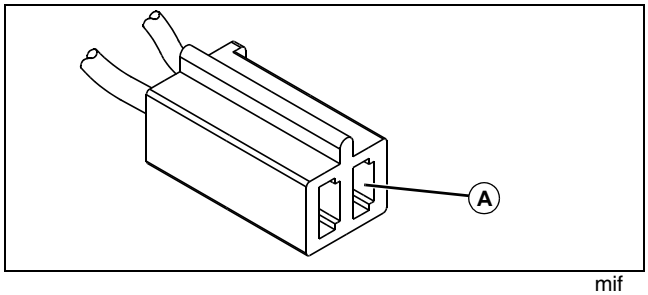
Turn Signal Lights Circuit Diagnosis

Turn Signal Lights - Power Circuit

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Park brake LOCKED.
- Cargo box RAISED and LOCKED.
- Open hood and remove storage tray.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in OFF position.
- Turn signal lights switch in OFF position.
- Battery fully charged.
- Check wire connections for looseness and corrosion.

System: Turn Signal Lights Power Circuit



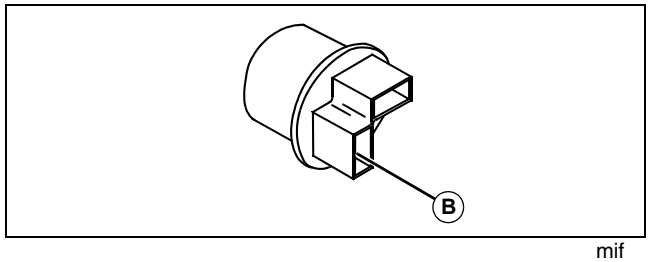
mif

(1) Disconnect X14 connector from turn signal/ hazard lights wiring harness. Is battery voltage present at pin A of X14 front optional attachments connector, 203 Red wire (A)?

Yes - Connect X14 connector to turn signal/hazard lights wiring harness. Go to next step.

No - Test F7 fuse. Check 203 Red wire. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.

System: Turn Signal Lights Power Circuit

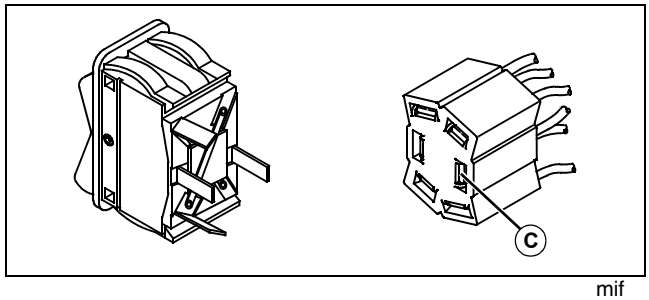


mif

(2) Is battery voltage present at 256 Red wire of T-K1 flasher (B)?

Yes - Go to next step.

No - Check 255 Red wire, T-F2 fuse, 256 Red wire, and connections.



mif

(3) Disconnect connector from turn signal/hazard lights switch. Is battery voltage present at T-S2 turn signal lights switch connector, 470 Yel wire (C)?

Yes - Connect the connector to the turn signal lights switch. Go to next step.

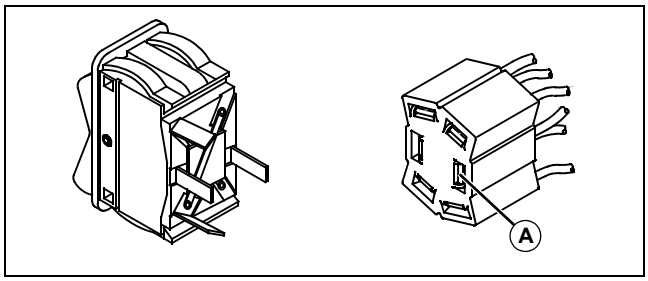
No - Check 470 Yel wire and connections. If OK, replace T-K1 flasher.

Turn Signal Lights - Right Turn Circuit

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Park brake LOCKED.
- Cargo box RAISED and LOCKED.
- Open hood and remove storage tray.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in OFF position.
- Turn signal lights switch in RIGHT turn position.
- Battery fully charged.
- Check wire connections for looseness and corrosion.

System: Turn Signal Lights Circuit - Right Turn

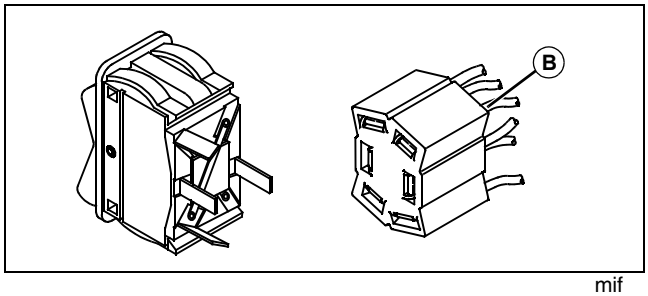


mif

(1) Disconnect connector from turn signal lights switch. Is pulsing battery voltage present at T-S2 turn signal lights switch connector, 470 Yel wire (A)?

Yes - Connect turn signal switch connector. Go to next step.

No - Check 470 Yel wire and connections. If ok, replace T-K1 flasher.



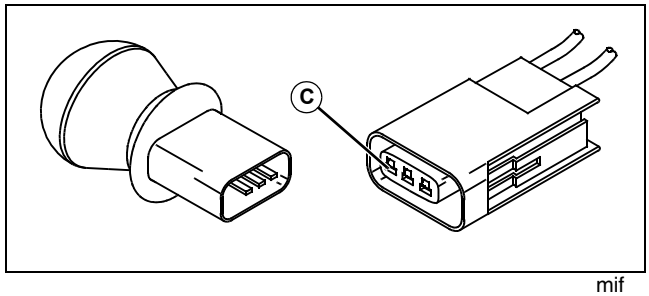
mif

(2) Is pulsing battery voltage present at T-S2 turn signal lights switch connector, 850C Grn wire (B)?

Yes - Go to next step.

No - Replace T-S2 turn signal lights switch.

System: Turn Signal Lights Circuit - Right Turn

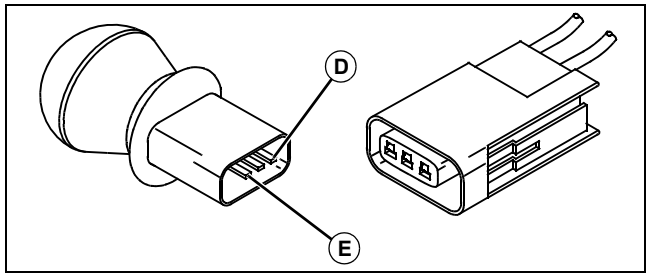


mif

(3) Disconnect right front turn signal light connector. Is pulsing battery voltage present at terminal 3 of T-X7 connector, 850D Grn wire of T-E6 right front turn signal light (C)?

Yes - Go to next step.

No - Check 850C Grn wire, splice, 850D Grn wire, and connections.

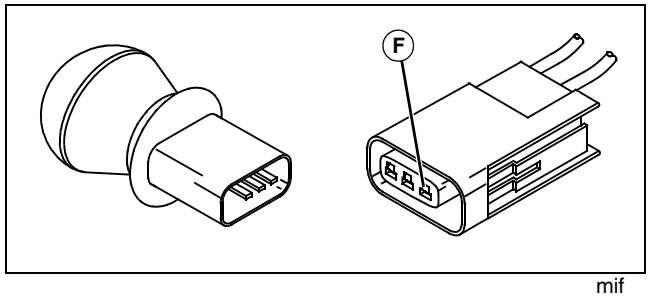


mif

(4) Check for continuity between terminals 1 (D) and 3 (E) of T-E6 right front turn signal lamp. Is continuity present?

Yes - Go to next step.

No - Replace lamp.



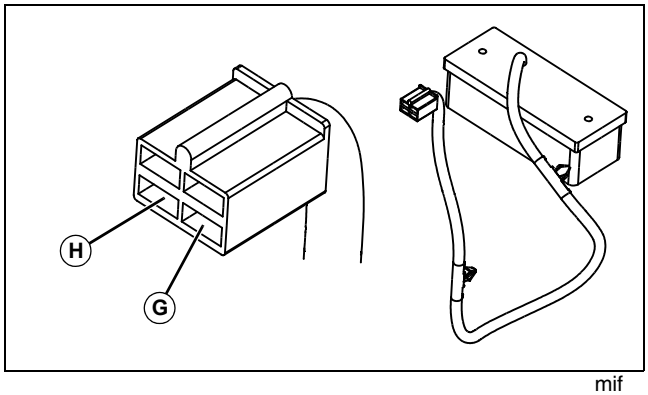
mif

(5) Is continuity to ground present at terminal 1 of T-X7 connector, 119 Blk wire of T-E6 right front turn signal light (F)?

Yes - Connect right front signal connector. Go to next step.

No - Check 119 and 117 Blk wire, T-X1 and X15 connectors, 102 and 100A Blk wires, and connections.

System: Turn Signal Lights Circuit - Right Turn



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(6) Disconnect right rear signal light connector. Is pulsing battery voltage present at A terminal of right rear signal light connector T-X3, 851 Grn wire (G)?

Yes - Go to next step.

No - Check 850C, 850A, 850, and 851 Grn wires and connections.

(7) Is continuity to ground present at D terminal of right rear signal light connector T-X3, 116 Blk wire (H)?

Yes - Connect right marker connector. Test bulb. See “Bulb Test” on page 347.

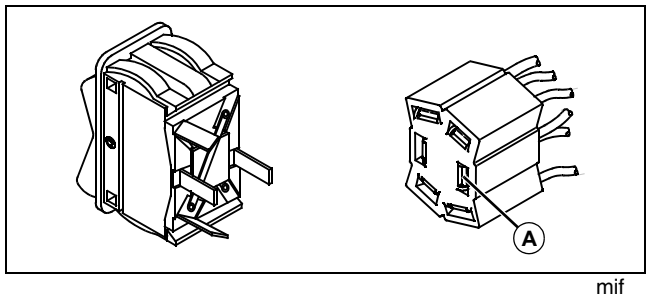
No - Check 116, 101A, and 101G Blk wires and connections.

Turn Signal Lights - Left Turn Circuit

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Park brake LOCKED.
- Cargo box RAISED and LOCKED.
- Open hood and remove storage tray.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in OFF position.
- Turn signal lights switch in LEFT turn position.
- Battery fully charged.
- Check wire connections for looseness and corrosion.

System: Turn Signal Lights Circuit - Left Turn

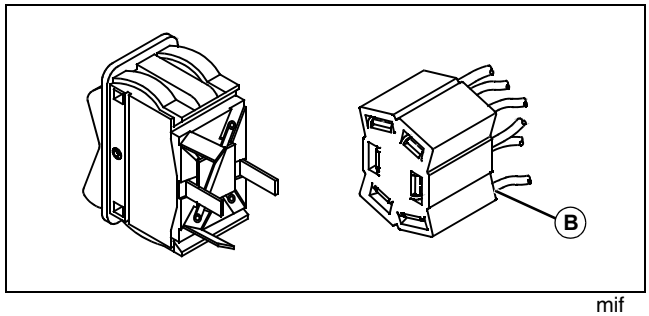


mif

(1) Disconnect connector from turn signal lights switch. Is pulsing battery voltage present at T-S2 turn signal lights switch connector, 470 Yel wire (A)?

Yes - Connect turn signal switch connector. Go to next step.

No - Check 470 Yel wire and connections. If OK, replace T-K1 flasher.



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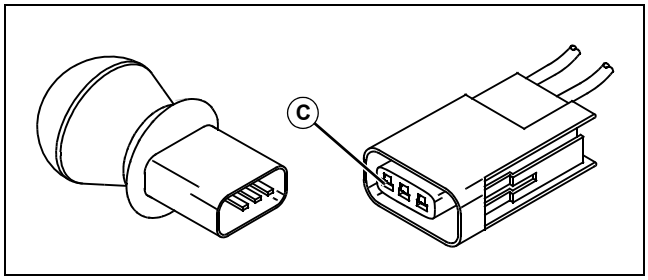
(2) Is pulsing battery voltage present at T-S2 turn signal lights switch connector, 840C Blu wire (B)?

Yes - Go to next step.

No - Replace T-S2 turn signal lights switch.

System: Turn Signal Lights Circuit - Left Turn



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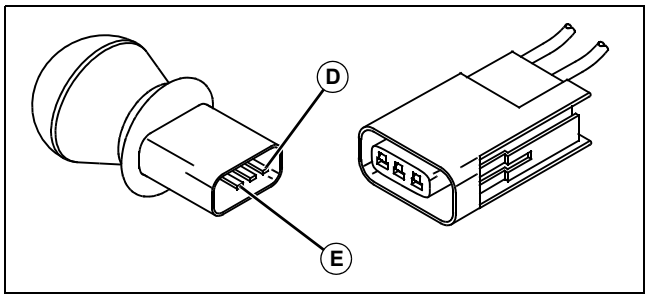
(3) Disconnect left front turn signal light connector. Is pulsing battery voltage present at terminal 3 of T-X6 connector, 840D Blu wire of T-E5 left front turn signal light (C)?

Yes - Go to next step.

No - Check 840C Blu wire, splice, 840D Blu wire, and connections.

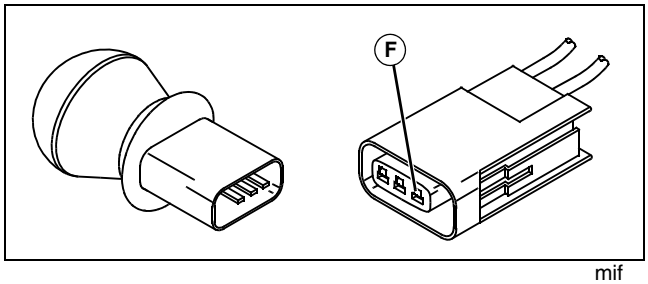


mif

(4) Check for continuity between terminals 1 (D) and 3 (E) of T-E5 left front turn signal lamp. Is continuity present?

Yes - Go to next step.

No - Replace lamp.



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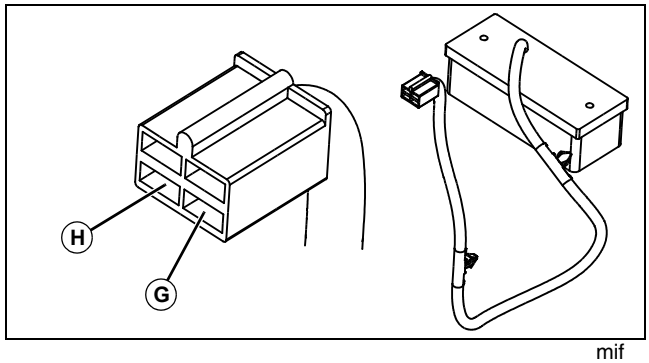
(5) Is continuity to ground present at terminal 1 of T-X6 connector, 118 Blk wire of T-E5 left front turn signal light (F)?

Yes - Connect left front signal connector. Go to next step.

No - Check 118 Blk wire, T-X1 and X15 connectors, 102 and 100A Blk wires, and connections.

System: Turn Signal Lights Circuit - Left Turn



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(6) Disconnect left rear signal light connector. Is pulsing battery voltage present at A terminal of left rear signal light connector T-X4, 841 Blu wire (G)?

Yes - Go to next step.

No - Check 840C, 840A, 840, and 841 Blu wires and connections.

(7) Is continuity to ground present at D terminal of left rear signal light connector T-X4, 115 Blk wire (H)?

Yes - Connect right marker connector. Test bulb. See “Bulb Test” on page 347.

No - Check 115, 101A, and 101G Blk wires and connections.

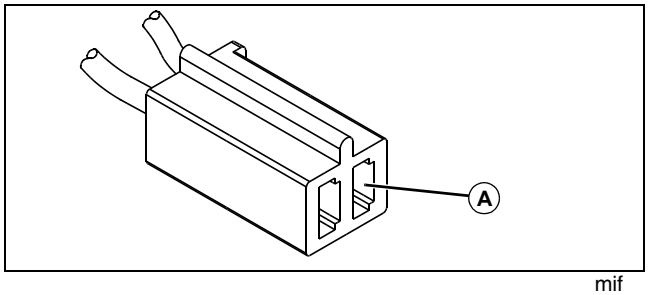
Hazard Lights Circuit Diagnosis

Hazard Lights Power Circuit

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Park brake LOCKED.
- Cargo box RAISED and LOCKED.
- Open hood and remove storage tray.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in OFF position.
- Hazard lights switch in OFF position.
- Battery fully charged.
- Check wire connections for looseness and corrosion.

System: Hazard Lights Power Circuit



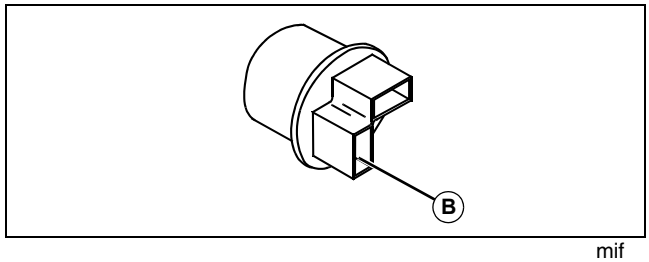
mif

(1) Disconnect X14 connector from turn signal/ hazard lights wiring harness. Is battery voltage present at pin A of X14 front optional attachments connector, 203 Red wire (A)?

Yes - Connect X14 connector to turn signal/hazard lights wiring harness. Go to next step.

No - Test F7 fuse. Check 203 Red wire. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.

System: Hazard Lights Power Circuit

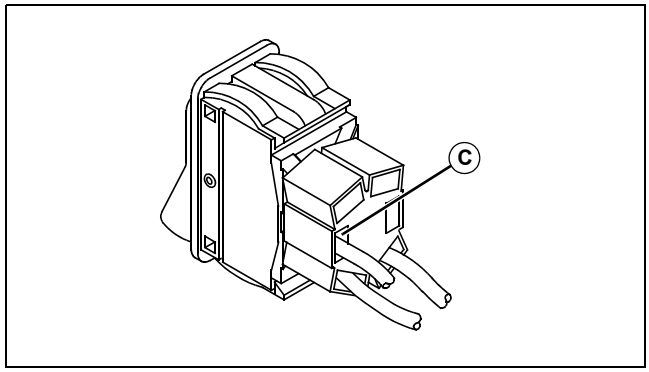


mif

(2) Is battery voltage present at 256 Red wire of T-K1 flasher (B)?

Yes - Go to next step.

No - Check 255 Red wire, T-F2 fuse, 256 Red wire, and connections.



mif

(3) Is battery voltage present at T-S1 hazard lights switch connector, 471 Yel wire (C)?

Yes - Go to next step.

No - Check 471 and 470 Yel wires and connections. If ok, replace T-K1 flasher.

Hazard Lights Operation Circuit

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Park brake LOCKED.
- Cargo box RAISED and LOCKED.
- Open hood and remove storage tray.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in OFF position.
- Hazard lights switch in ON position.
- Battery fully charged.
- Check wire connections for looseness and corrosion.

System: Hazard Lights Operation Circuit

(1) Is the right turn signal operational?

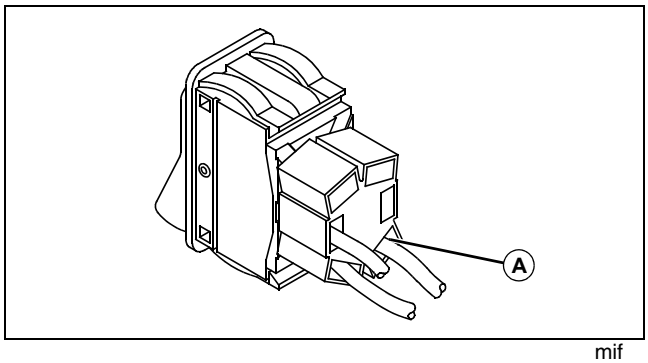
Yes - Go to next step.

No - See “Turn Signal Lights - Right Turn Circuit” on page 399

(2) Is the left turn signal operational?

Yes - Go to next step.

No - See “Turn Signal Lights - Left Turn Circuit” on page 400



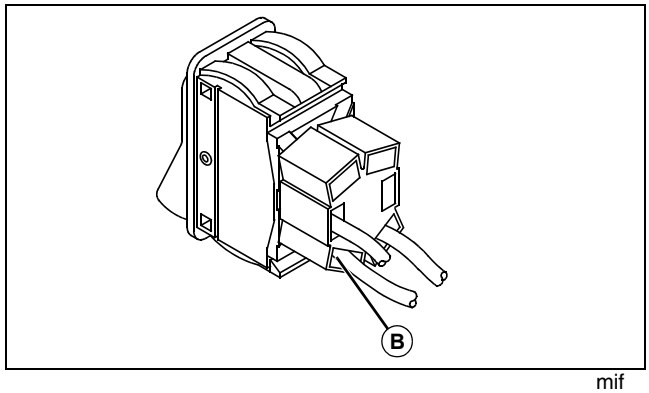
mif

(3) Is pulsing battery voltage present at T-S1 hazard lights switch connector, 840B Blu wire (A)?

Yes - Go to next step.

No - Replace hazard switch.

System: Hazard Lights Operation Circuit



mif

(4) Is pulsing battery voltage present at T-S1 hazard lights switch connector, 850B Grn wire (B)?

Yes - Test complete.

No - Replace hazard switch.

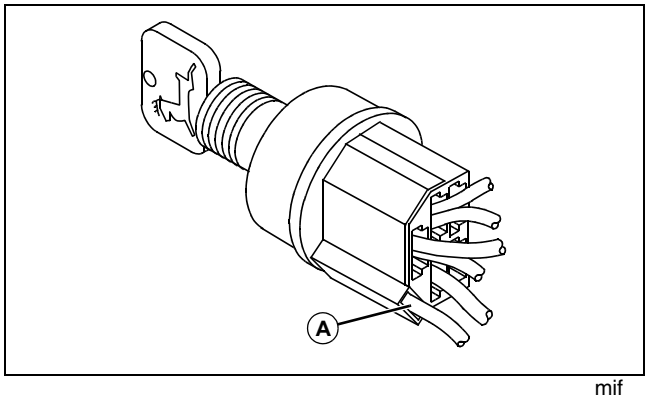
Rear Marker Lights Diagnosis

Marker Lights Circuit

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Park brake LOCKED.
- Cargo box RAISED and LOCKED.
- Open hood and remove storage tray.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in RUN position - engine OFF.
- Light switch in CENTER ON position.
- Battery fully charged.
- Check wire connections for looseness and corrosion.

System: Marker Lights Circuit



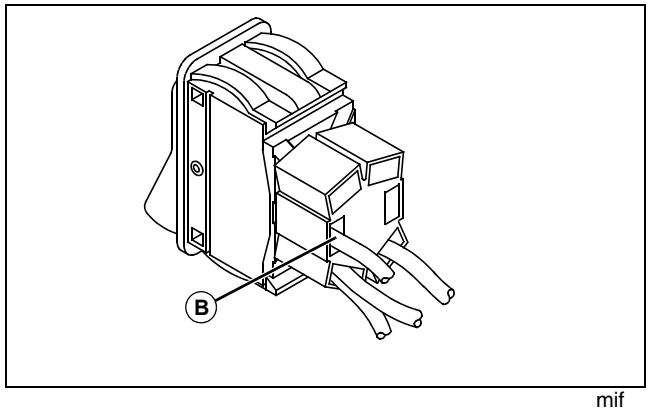
mif

(1) Is battery voltage present at A terminal of S1 key switch (A)?

Yes - Go to next step.

No - Test key switch. See “Key Switch Test” on page 341. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.

System: Marker Lights Circuit

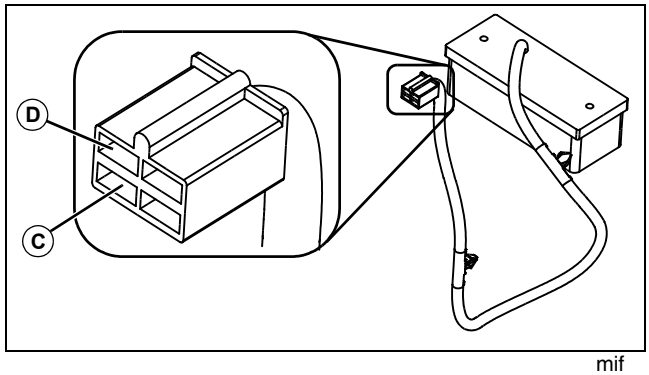


mif

(2) Is battery voltage present at 420G Yel wire of S4-A light switch (B)?

Yes - Go to next step.

No - Check 420J and 420G Yel wires and connections.



mif

(3) Disconnect right marker light connector. Is battery voltage present at B terminal of right marker light connector T-X3, 832 Pnk wire (C)?

Yes - Go to next step.

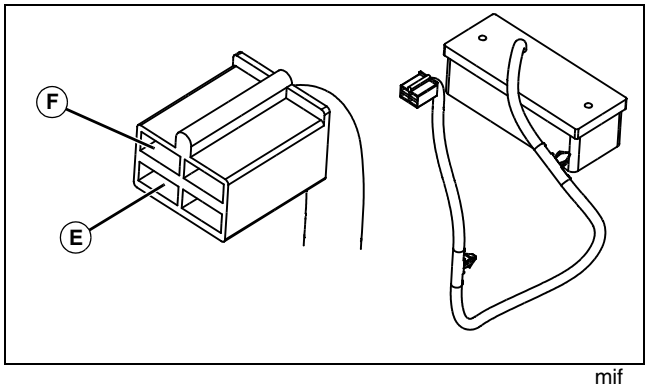
No - Test light switch. See “Light Switch Test (Optional Marker or Signal Lights)” on page 342. Check 830 and 831 Pnk wires and connections.

(4) Is continuity to ground present at D terminal of right marker light connector T-X3, 116 Blk wire (D)?

Yes - Connect right marker connector. Test bulb. See “Bulb Test” on page 347.

No - Check 116, 101A, and 101G Blk wires and connections.

System: Marker Lights Circuit



mif

(5) Disconnect left marker light connector. Is battery voltage present at B terminal of left marker light connector T-X4, 831 Pnk wire (E)?

Yes - Go to next step.

No - Test light switch. See “Light Switch Test (Optional Marker or Signal Lights)” on page 342. Check 830 and 831 Pnk wires and connections.

(6) Is continuity to ground present at D terminal of left marker light connector T-X4, 115 Blk wire (F)?

Yes - Connect left marker connector. Test bulb. See “Bulb Test” on page 347.

No - Check 115, 101A, and 101G Blk wires and connections.

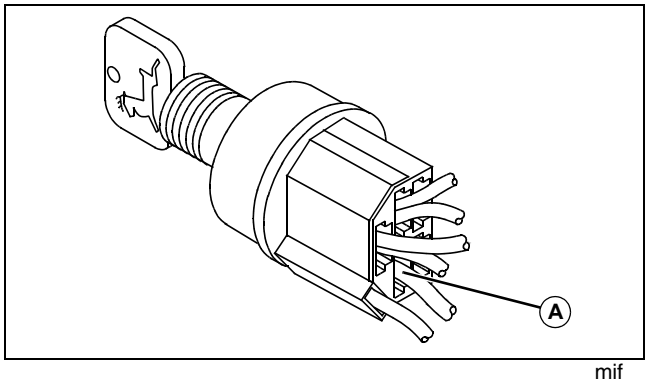
Brake Lights Diagnosis

Brake Lights Circuit

Test Conditions:

- Park machine safely. See “Parking Safely” in the Safety section.
- Park brake LOCKED.
- Cargo box RAISED and LOCKED.
- Open hood and remove storage tray.
- DISCONNECT any other attachment option(s) from the main wiring harness.
- Key switch in RUN position - engine OFF.
- Brake pedal depressed (Switch CLOSED).
- Battery fully charged.
- Check connections for looseness and corrosion.

System: Brake Lights Circuit

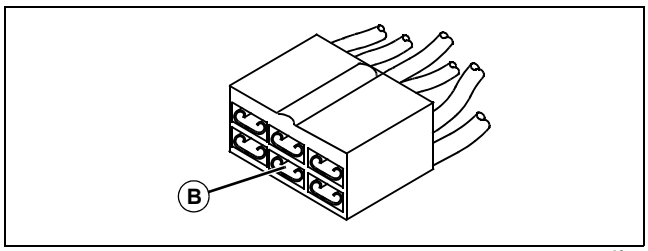


mif

(1) Is battery voltage present at the B terminal of switch connector, 208 Red wire (A)?

Yes - Go to next step.

No - Test F6 fuse. Test battery and positive (+) battery cable. Check 201 and 202 Red wires and connections. Check 208 Red wire and connections.



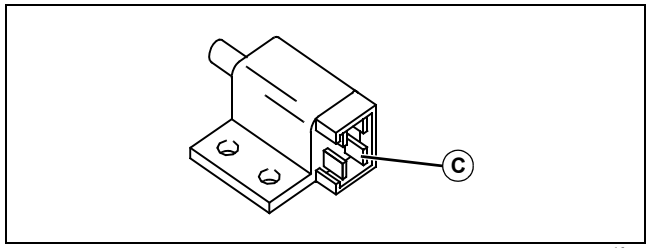
mif

(2) Is battery voltage present at 420K Yel wire at the X15 front lights connector (B)?

Yes - Go to next step.

System: Brake Lights Circuit

No - Test the S1 key switch. See “Key Switch Test” on page 341. Check 420K and 420J Yel wires and connections.

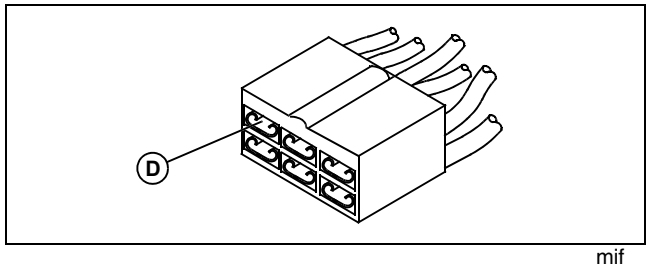


mif

(3) Is battery voltage present at 421 Yel wire of the T-S3 brake lights switch (C)?

Yes - Go to next step.

No - Test T-F1 fuse. Check 421 and 422 Yel wire and connections.

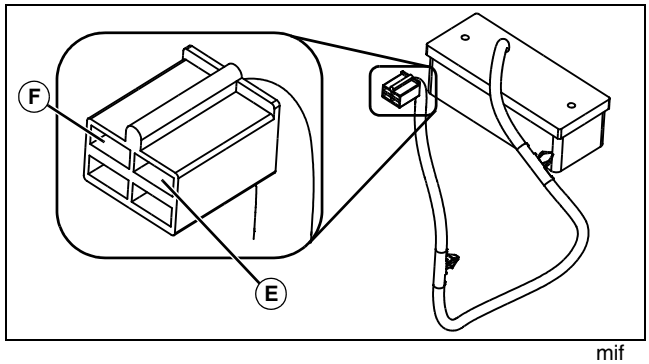


mif

(4) Is battery voltage present at 820 Pur wire of pin “A” on the X16 rear lights connector (D)?

Yes - Go to next step.

No - Test brake light switch. See “Park Brake Switch Test” on page 344. Check 823 and 820 Pur wires and connections.



mif

(5) Disconnect right marker light connector. Is battery voltage present at C terminal of right marker light connector T-X3, 822 Pur wire (E)?

Yes - Go to next step.

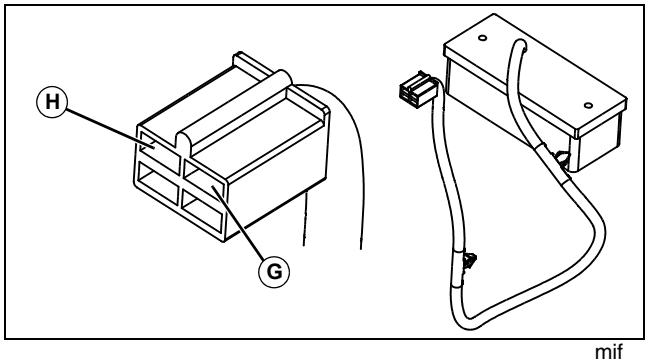
No - Check 822 Pur wire and connections.

System: Brake Lights Circuit

(6) Is continuity to ground present at D terminal of right marker light connector T-X3, 116 Blk wire (F)?

Yes - Connect right marker connector. Test bulb. See “Bulb Test” on page 347.

No - Check 116, 101A, and 101G Blk wires and connections.



mif

(7) Disconnect left marker light connector. Is battery voltage present at C terminal of left marker light connector T-X4, 821 Pur wire (G)?

Yes - Go to next step.

No - Check 821 Pur wire and connections.

(8) Is continuity to ground present at D terminal of left marker light connector T-X4, 115 Blk wire (H)?

Yes - Connect left marker connector. Test bulb. See “Bulb Test” on page 347.

No - Check 115, 101A, and 101G Blk wires and connections.

Homologated Light and Horn Kit

Homologated Light and Horn Kit Wiring Harness Legend

Electrical Components:

HM-E1 - Left Rear Brake Light

HM-E2 - Left Rear Turn Signal Light

HM-E3 - Left Rear Position Light

HM-E4 - License Plate Light

HM-E5 - Right Rear Brake Light

HM-E6 - Right Rear Turn Signal Light

HM-E7 - Right Rear Position Light

HM-E8 - Vehicle Bulb Integrity Light

HM-E9 - Trailer Bulb Integrity Light

HM-E10 - Left Front Position Light

HM-E11 - Left Front Turn Light

HM-E12 - Left Headlight

HM-E13 - Right Headlight

HM-E14 - Right Front Turn Light

HM-E15 - Right Front Position Light

HM-F1 - Flasher Fuse (15A)

HM-F2 - Brake Lights Fuse (10A)

HM-F3 - Horn Fuse (10A)

HM-F4 - Not Used (15A)

HM-F5 - Left Position Lights Fuse (10A)

HM-F6 - Right Position Lights Fuse (10A)

HM-F7 - Right headlight Fuse (10A)

HM-F8 - Left headlight Fuse (10A)

HM-H1 - Horn

HM-K1 - Brake Switch

HM-R1 - 91 Ohm 2 Watt resistor

HM-S1 - Flasher

HM-S2 - Light Switch

HM-S3 - Turn Switch

HM-S4 - Flasher Switch

HM-S5 - Horn Switch

HM-V1 - Diode

HM-V2 - Diode

HMS-1 - Switched Power Splice

HMS-2 - Flasher Circuit Ground Splice

HMS-3 - Rear Lights Ground Splice

HMS-4 - Front Lights Ground Splice

Connectors:

HM-X1 - Trailer Connector

HM-X2 - Optional Front Attachment Connector

HM-X3 - Wiring Harness to Left Rear Lights Wiring Harness

HM-X4 - Wiring Harness to License Plate Light Wiring Harness

HM-X5 - Wiring Harness to Optional Attachments

HM-X6 - Wiring Harness to Right Rear Lights Wiring Harness

HM-X7 - Wiring Harness to Trailer Wiring Harness

HM-X8 - Wiring Harness to W? Trailer Wiring Harness

HM-X9 - Wiring Harness to Trailer Wiring Harness

HM-X10 - Wiring Harness to Left Front Position Light

HM-X11 - Wiring Harness to Left Front Turn Light

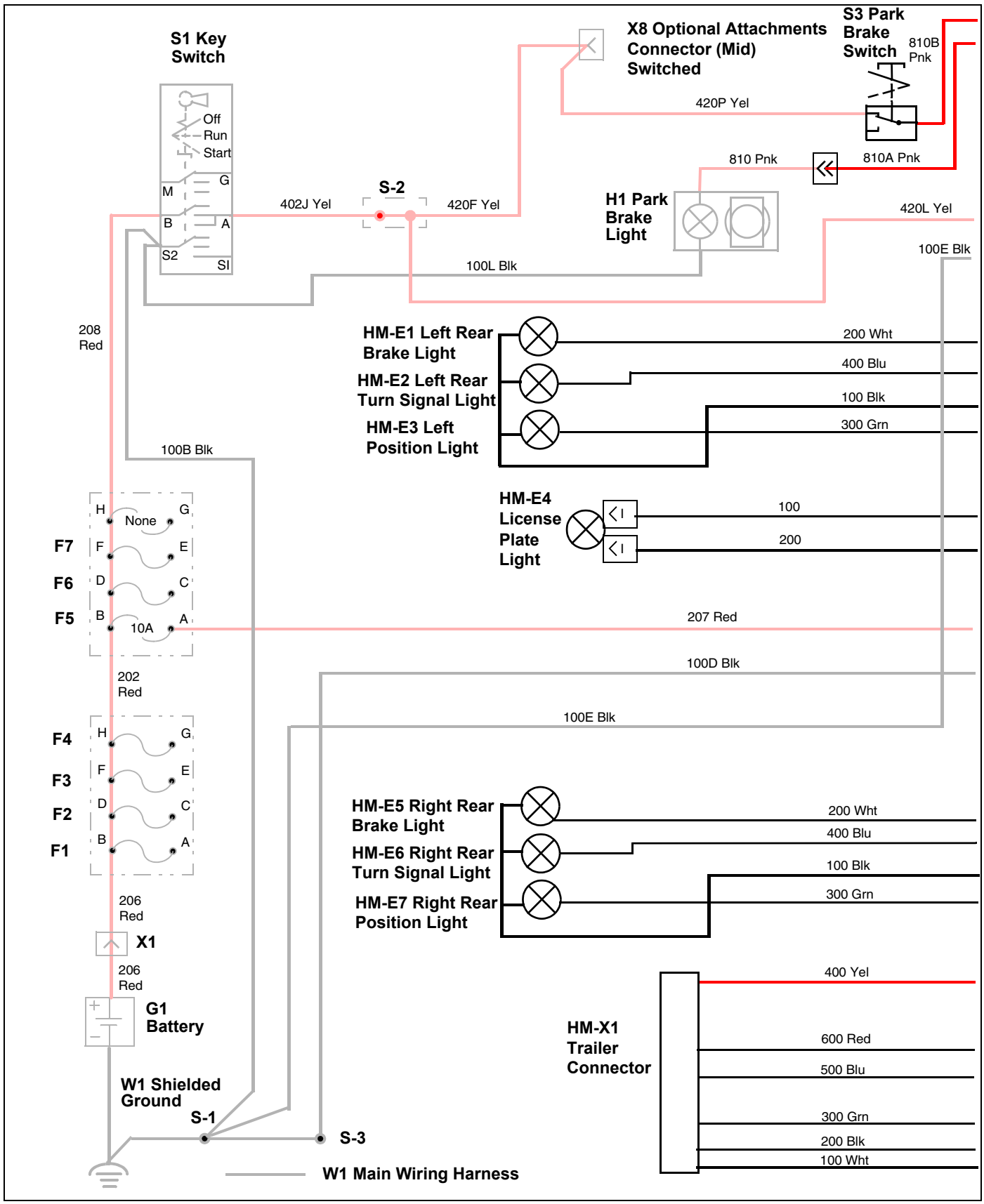
HM-X12 - Wiring Harness to Left Headlight

HM-X13 - Wiring Harness to Right Headlight

HM-X14 - Wiring Harness to Right Front Turn Light

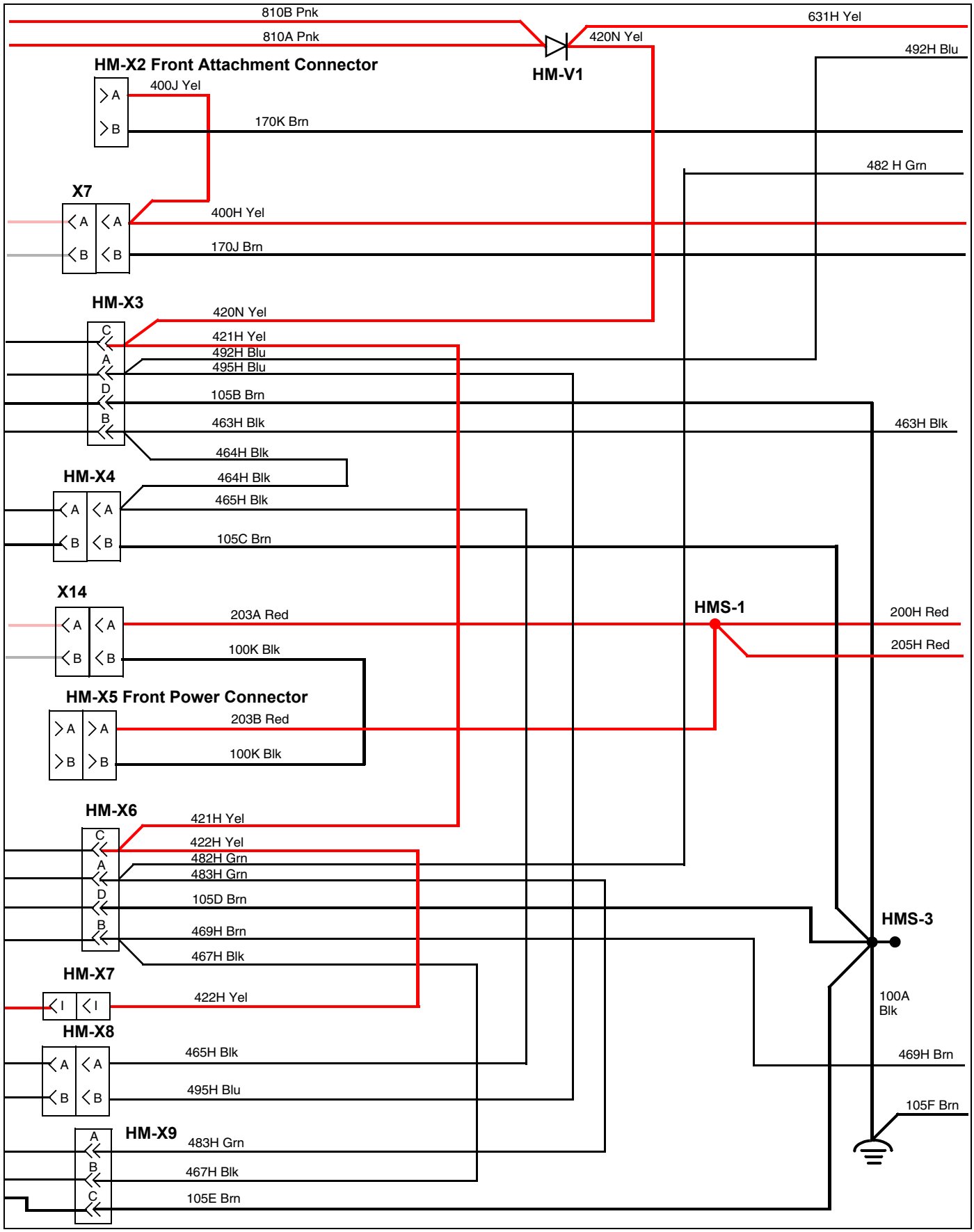
HM-X15 - Wiring Harness to Right Front Position Light

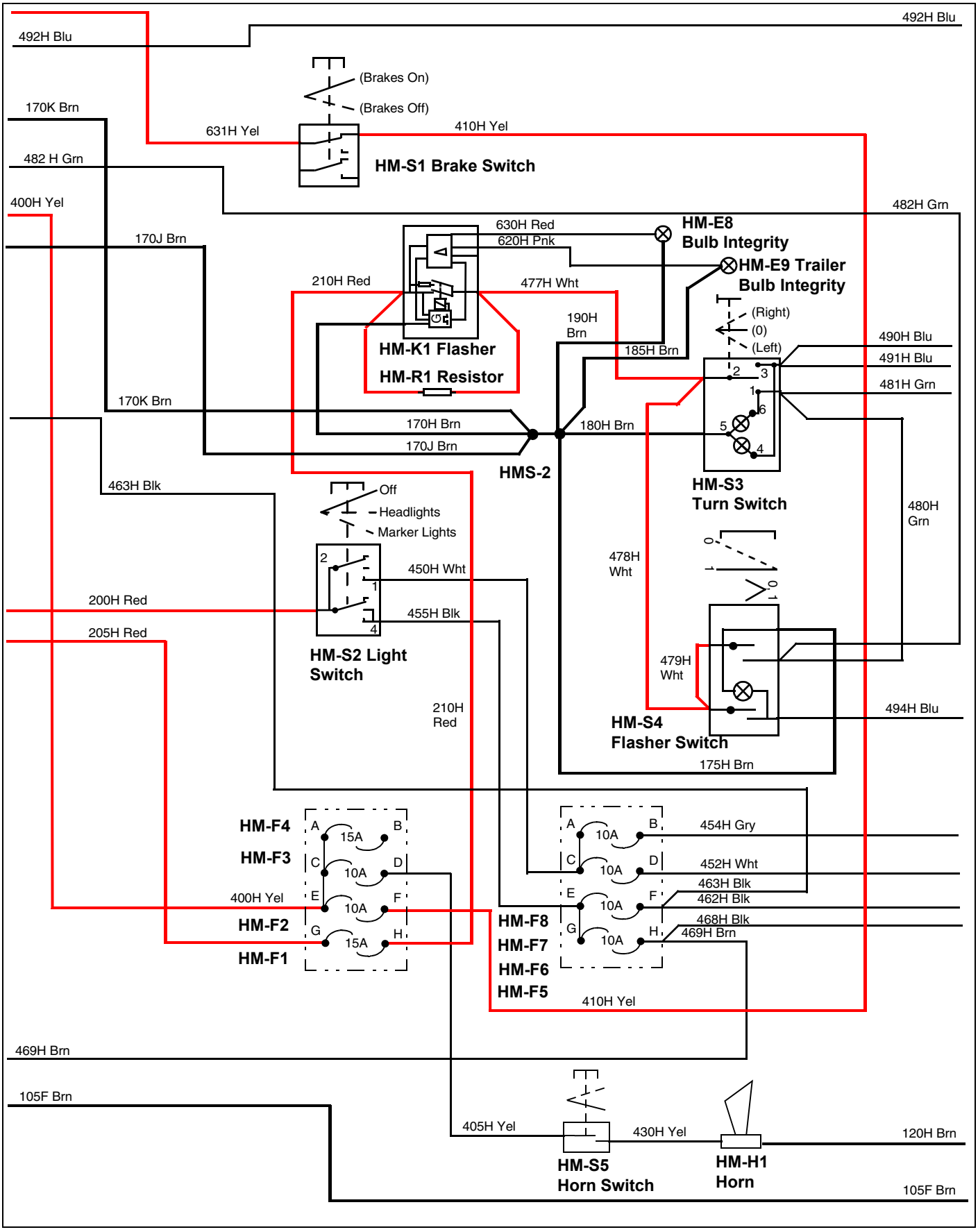
Homologated Light and Horn Circuit Schematic

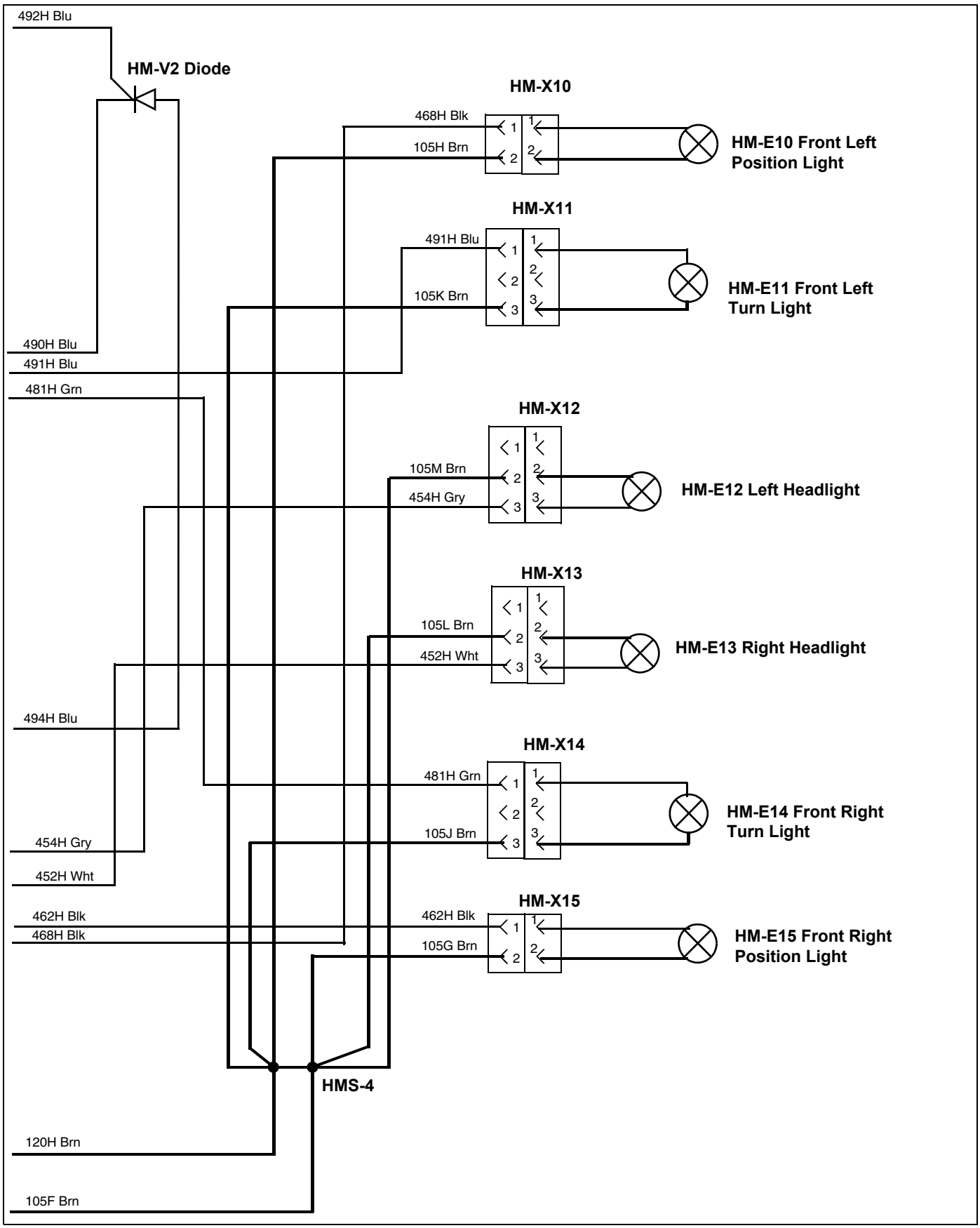


mif

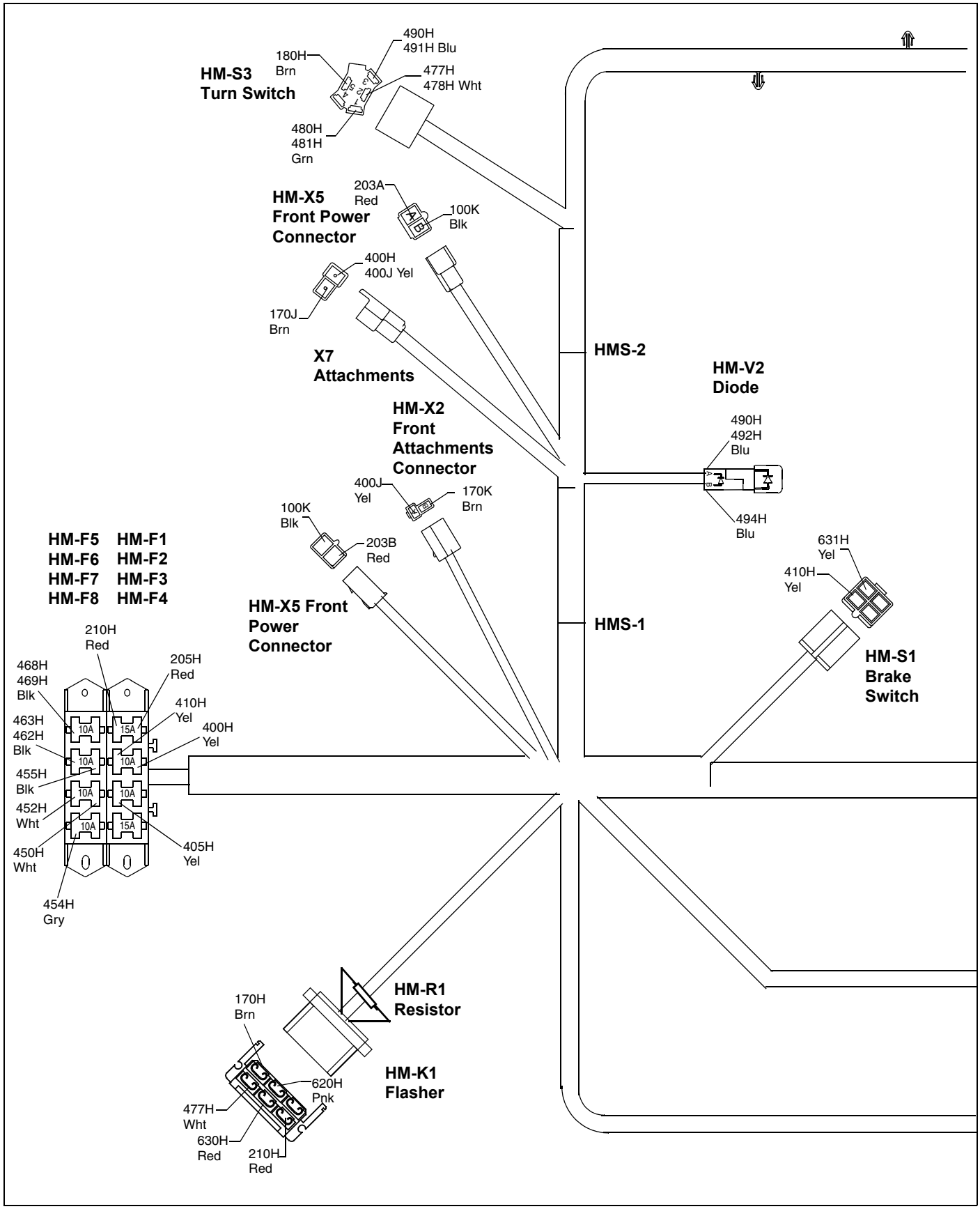
ELECTRICAL HOMOLOGATED LIGHT AND HORN KIT



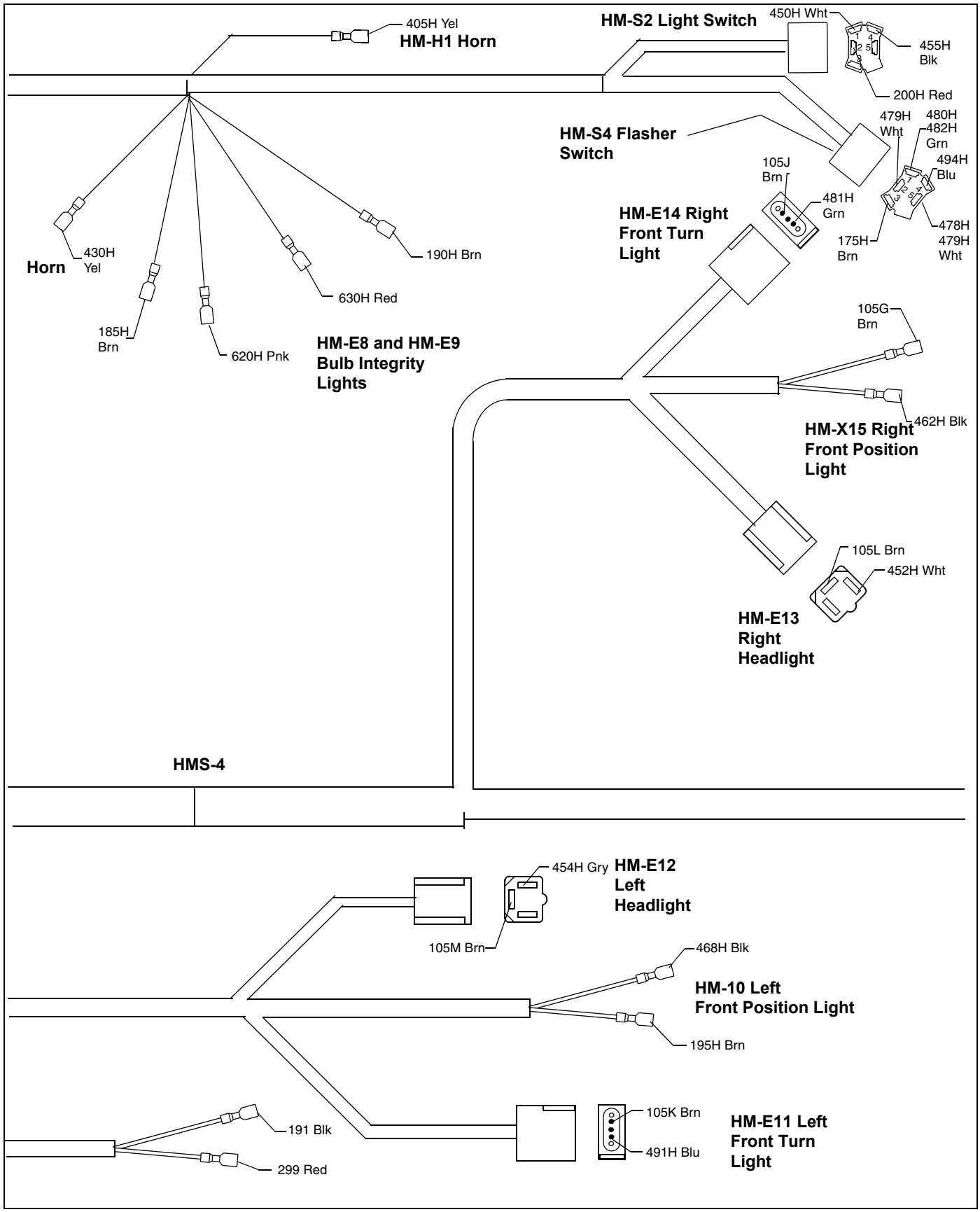

492H Blu
492H Blu
(Brakes On)
(Brakes Off)
170K Brn
631H Yel
410H Yel
HM-S1 Brake Switch
482 H Grn
400H Yel
482H Grn
630H Red
620H Pnk
HM-E8
Bulb Integrity
HM-E9 Trailer
Bulb Integrity
170J Brn
210H Red
477H Wht
190H
Brn
(Right)
(0)
(Left)
490H Blu
491H Blu
481H Grn
185H Brn
HM-K1 Flasher
HM-R1 Resistor
170K Brn
170H Brn
170J Brn
180H Brn
HMS-2
HM-S3
Turn Switch
463H Blk
Off
Headlights
Marker Lights
480H
Grn
478H
Wht
450H Wht
200H Red
455H Blk
205H Red
HM-S2 Light
Switch
479H
Wht
210H
Red
494H Blu
HM-S4
Flasher Switch
175H Brn
HM-F4
HM-F3
HM-F2
HM-F1
15A
10A
10A
15A
400H Yel
454H Gry
452H Wht
463H Blk
462H Blk
468H Blk
469H Brn
HM-F8
HM-F7
HM-F6
HM-F5
10A
10A
10A
10A
410H Yel
469H Brn
105F Brn
405H Yel
430H Yel
120H Brn
HM-S5
Horn Switch
HM-H1
Horn
105F Brn

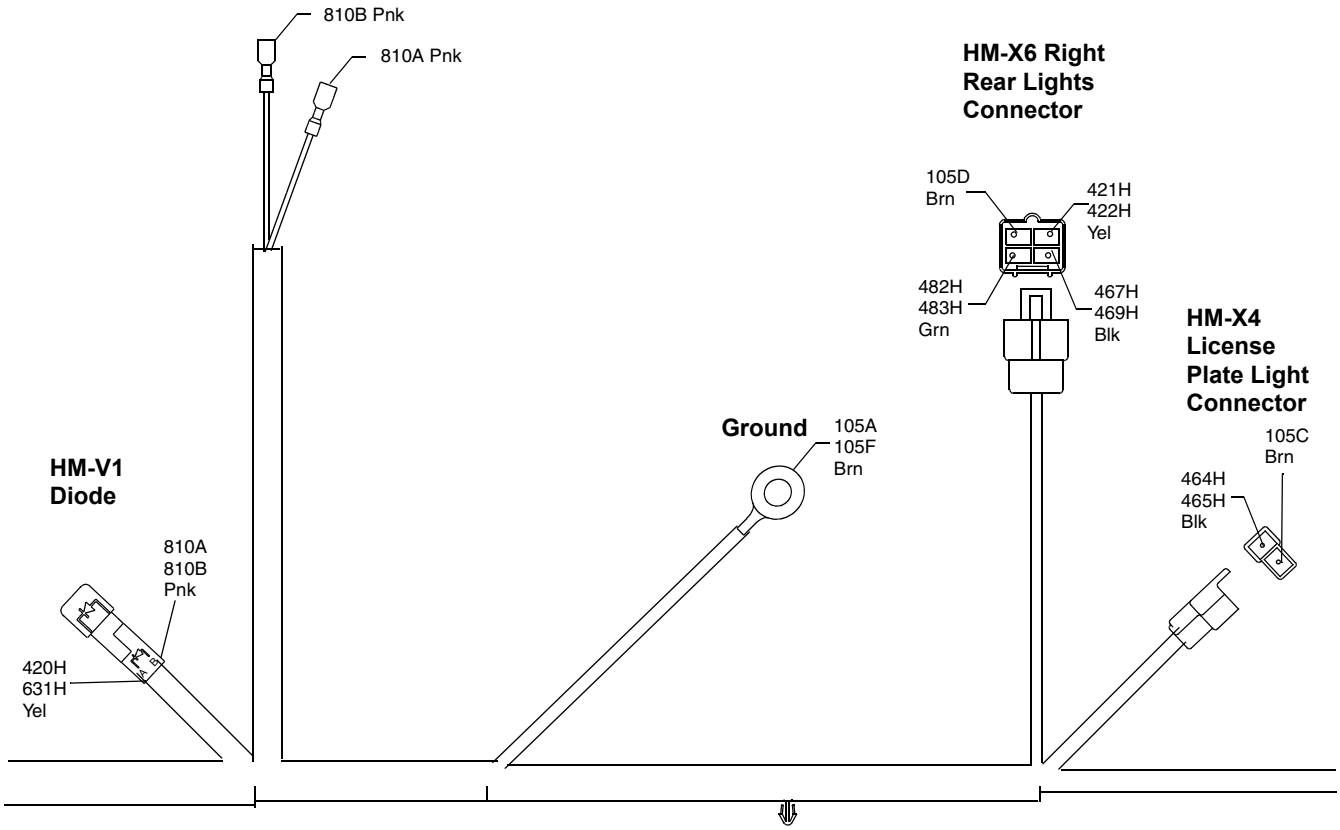

492H Blu
HM-V2 Diode
HM-X10
468H Blk
105H Brn
HM-E10 Front Left Position Light
HM-X11
491H Blu
105K Brn
HM-E11 Front Left Turn Light
490H Blu
491H Blu
481H Grn
HM-X12
105M Brn
454H Gry
HM-E12 Left Headlight
HM-X13
105L Brn
452H Wht
HM-E13 Right Headlight
494H Blu
HM-X14
481H Grn
105J Brn
HM-E14 Front Right Turn Light
454H Gry
452H Wht
462H Blk
468H Blk
HM-X15
462H Blk
105G Brn
HM-E15 Front Right Position Light
HMS-4
120H Brn
105F Brn

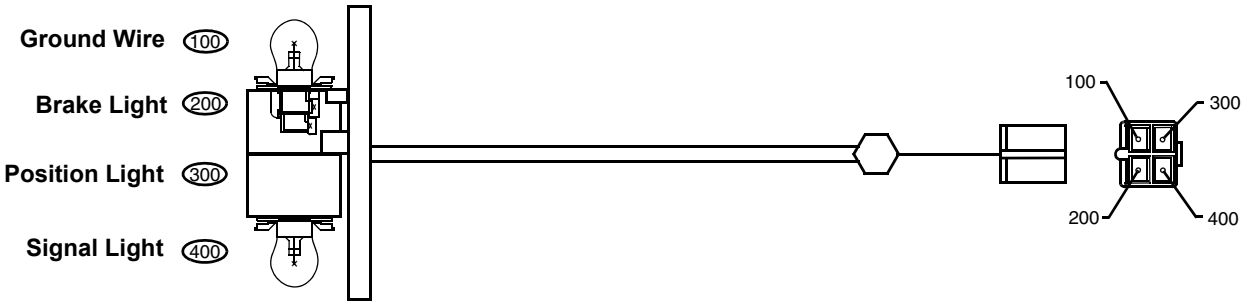
Homologated Light and Horn Wiring Harness

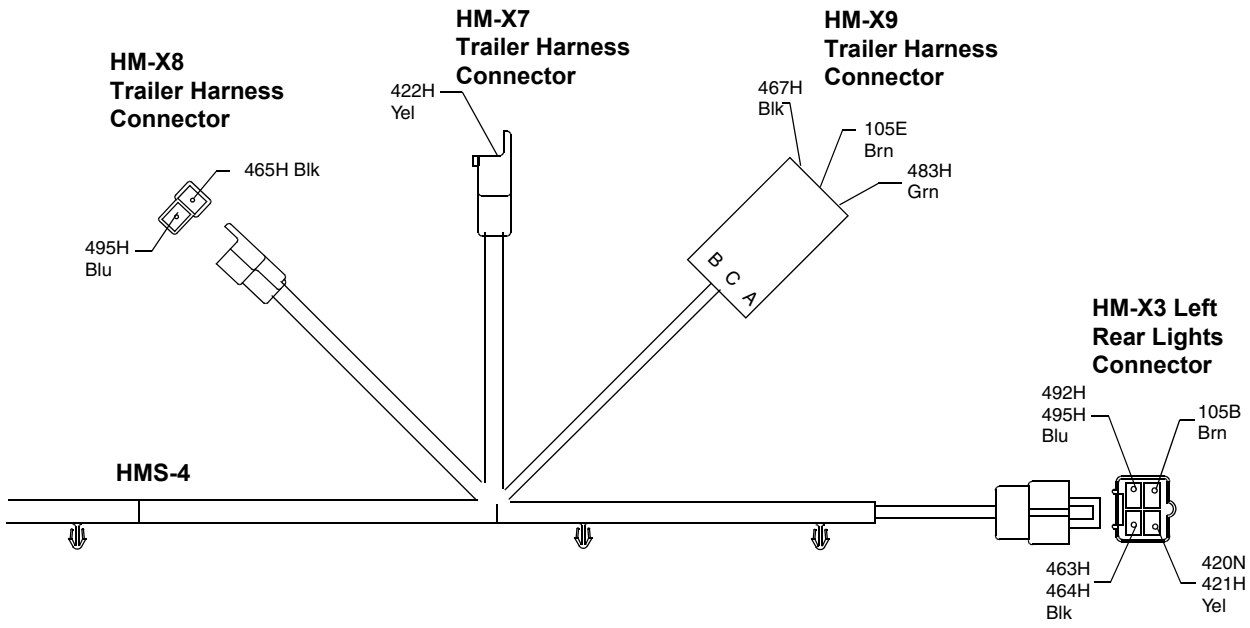


ELECTRICAL HOMOLOGATED LIGHT AND HORN KIT




810B Pnk
810A Pnk
HM-X6 Right Rear Lights Connector
105D Brn
421H 422H Yel
482H 483H Grn
467H 469H Blk
HM-X4 License Plate Light Connector
105C Brn
464H 465H Blk
Ground
105A 105F Brn
HM-V1 Diode
810A 810B Pnk
420H 631H Yel


Ground Wire 100
Brake Light 200
Position Light 300
Signal Light 400
100
300
200
400


HM-X8
Trailer Harness
Connector
465H Blk
495H
Blu
HM-X7
Trailer Harness
Connector
422H
Yel
HM-X9
Trailer Harness
Connector
467H
Blk
105E
Brn
483H
Grn
B C A
HM-X3 Left
Rear Lights
Connector
492H
495H
Blu
105B
Brn
HMS-4
463H
464H
Blk
420N
421H
Yel

Homologated Light and Horn Kit Harness Wire Color Codes

Size/No./Color	Wire Connection Points
3.0 100K Blk	X14, HM-X5
1.0 105A Brn	Splice, HMS-3
0.8 105B Brn	HMS-3, HM-X3
0.8 105C Brn	HMS-3, HM-X4
0.8 105D Brn	HMS-3, HM-X6
1.0 105E Brn	HMS-3, HM-X9
3.0 105F Brn	Splice, HMS-4
0.8 105G Brn	HMS-4, HM-X15
0.8 105H Brn	HMS-4, HM-X10
0.8 105J Brn	HMS-4, HM-X14
0.8 105K Brn	HMS-4, HM-X11
0.8 105L Brn	HMS-4, HM-X13
0.8 105M Brn	HMS-4, HM-X12
0.8 120H Brn	HM-H1, HMS-4
0.8 170H Brn	HMS-2, HM-K1
1.0 170J Brn	HMS-2, HM-X2
1.0 170K Brn	HMS-2, HM-X2
0.8 175H Brn	HMS-2, HM-S4
0.8 180H Brn	HMS-2, HM-S3
0.5 185H Brn	HMS-2, HM-E9
0.5 190H Brn	HMS-2, HM-E8
2.0 200H Red	HMS-1, HM-S2
3.0 203A Red	HMS-1, X14
3.0 203B Red	HMS-1, HM-X5
2.0 205H Red	HM-F1, HMS-1
1.0 210H Red	HM-F1, HM-K1
1.0 400H Yel	HM-F2, X7
1.0 400J Yel	HM-X2, X7
0.8 405H Yel	X7, HM-F2
1.0 410H Yel	HM-S1, HM-F2
1.0 420N Yel	HM-X3, HM-V1
1.0 421H Yel	HM-X3, HM-X6
1.0 422H Yel	HM-X6, HM-X7
0.8 430H Yel	HM-S5, HM-H1
2.0 450H Wht	HM-S2, HM-F7
0.8 452H Wht	HM-X13, HM-F7
0.8 454H Gry	HM-X12, HM-F8
2.0 455H Blk	HM-S2, HM-F6
0.8 462H Blk	HM-F6, HM-X15
1.0 463H Blk	HM-X3, HM-F6
1.0 464H Blk	HM-X3, HM-X4
1.0 465H Blk	HM-X4, HM-X8
1.0 467H Blk	HM-X6, HM-X9
0.8 468H Blk	HM-X10, HM-F5
0.8 469H Blk	HM-X6, HM-F5
1.0 477H Wht	HM-K1, HM-S3
1.0 478H Wht	HM-S4, HM-S3
1.0 479H Wht	HM-S4, HM-S4
1.0 480H Grn	HM-S3, HM-S4
0.8 481H Grn	HM-X14, HM-S3
1.0 482H Grn	HM-X6, HM-S4
1.0 483H Grn	HM-X6, HM-X9
1.0 490H Blu	HM-S3, HM-V2
0.8 491H Lt. Blu	HM-X11, HM-S3
1.0 492H Blu	HM-X3, HM-V2
1.0 494H Blu	HM-S4, HM-V2
1.0 495H Blu	HM-X3, HM-X8
0.5 620H Pnk	HM-E8, HM-K1
0.5 630H Red	HM-E9, HM-K1
0.8 631 Yel	HM-V1, HM-S1
1.0 810A Pnk	H1, HM-V1
1.0 810B Pnk	S3, HM-V1

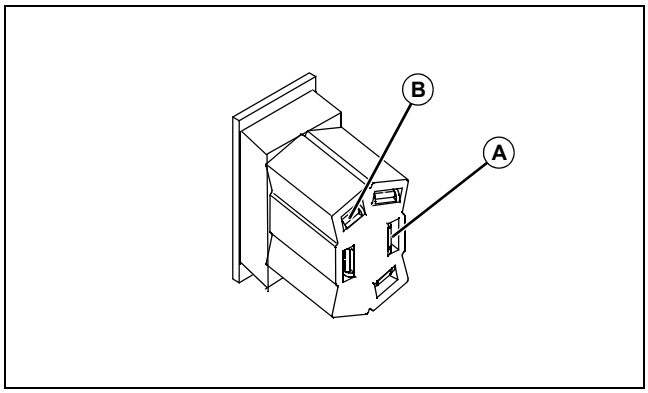
Homologated Lights Circuit Diagnosis

Headlights and Position Lights:

Test Conditions:

- Machine parked safely on a level surface.
- Park braked locked.
- Key switch in run position, engine off.
- Battery fully charged.
- Power circuits working properly. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.
- Light switch in the on position.

System: Left Headlight Circuit



(1) Is battery voltage present at 200H Red wire of HM-S2 light switch?

Yes - Go to next step.

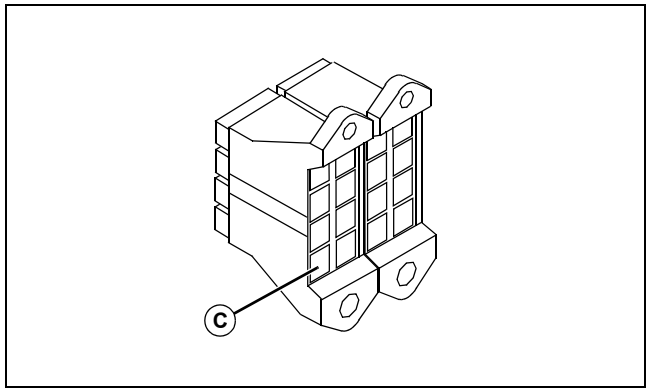
No - Check X14 connector, 203H and 200H Red wires, splice, and connections.

(2) Is battery voltage present at 450H Wht wire of HM-S2 light switch?

Yes - Go to next step.

No - Test light switch. See “Light Switch Test (Optional Marker or Signal Lights)” on page 342.

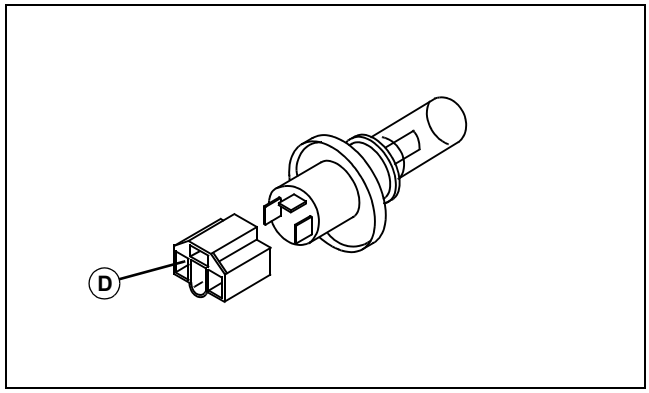
System: Left Headlight Circuit



(3) Is battery voltage present at 454H Gry wire of fuse block?

Yes - Go to next step

No - Check 450H Wht wire and connections. Test HM-F8 fuse.

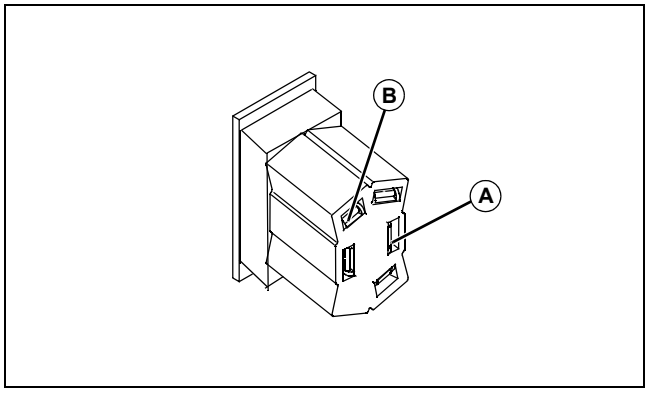


(4) Is battery voltage present at 454HGgry wire of HM-E12 Left headlight?

Yes - Test headlight bulb. If OK, test 105M and 105F Brn ground circuit wires, splices, and connections.

No - Check 454H Gry wire and connections.

System: Right Headlight Circuit



(1) Is battery voltage present at 200H Red wire (B) of HM-S2 light switch?

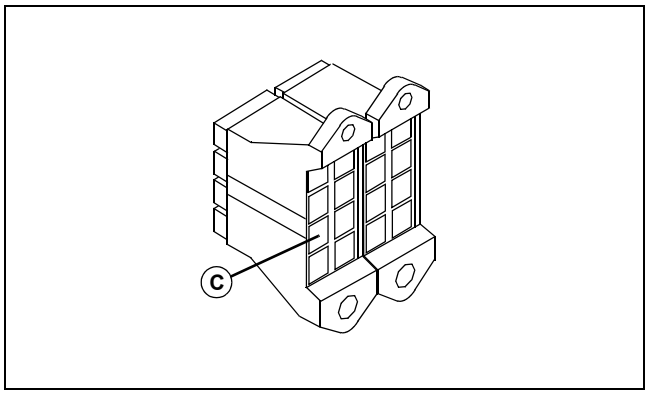
Yes - Go to next step.

No - Check X14 connector, 203H and 200H Red wires, splice, and connections.

(2) Is battery voltage present at 455H Blk wire (B) of HM-S2 light switch?

Yes - Go to next step.

No - Test light switch. See “Light Switch Test (Optional Marker or Signal Lights)” on page 342.

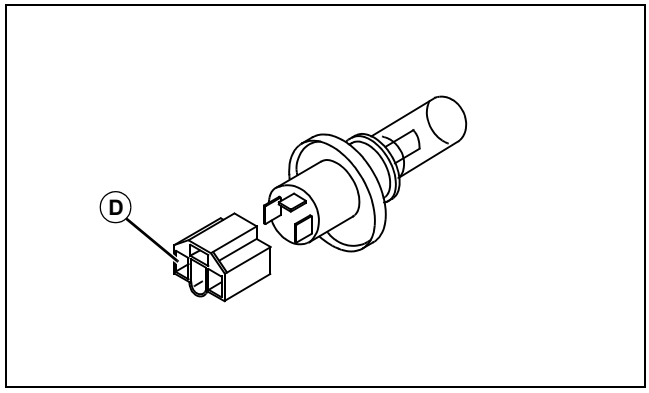


(3) Is battery voltage present at 452H Wht wire (C) of fuse block?

Yes - Go to next step.

No - Check 450H Wht wire and connections. Test HM-F7 fuse.

System: Right Headlight Circuit

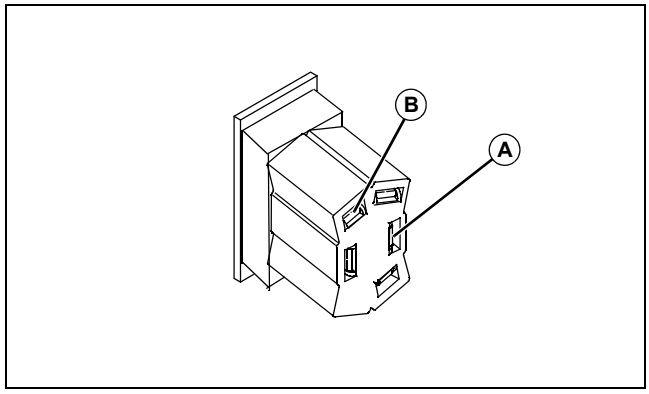


(4) Is battery voltage present at 452H Wht wire (D) of HM-E13 Right headlight?

Yes - Test headlight bulb. If OK, test 105M and 105F Brn ground circuit wires, splices, and connections.

No - Check 452H Wht wire and connections.

System: Left Front Position Light Circuit



(1) Is battery voltage present at 200H Red wire (A) of HM-S2 light switch?

Yes - Go to next step.

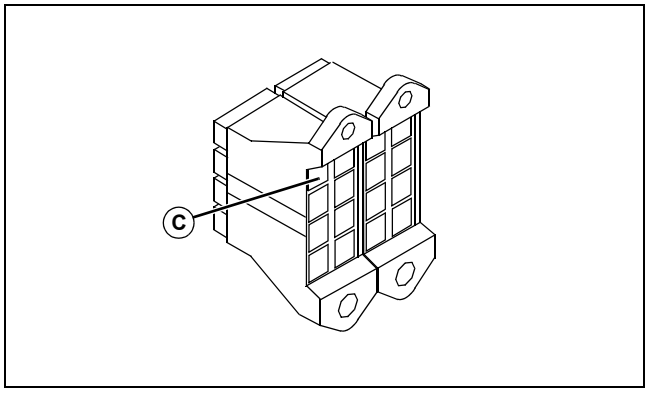
No - Check X14 connector, 203H and 200H Red wires, splices, and connections.

(2) Is battery voltage present at 455H Blk wire (B) of HM-S2 light switch?

Yes - Go to next step.

No - Test light switch. See “Light Switch Test (Optional Marker or Signal Lights)” on page 342.

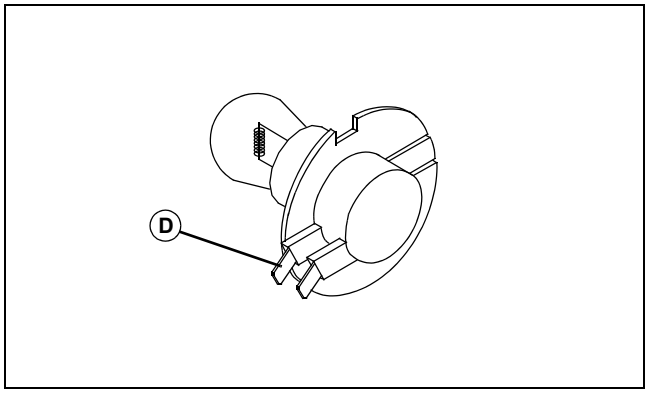
System: Left Front Position Light Circuit



(3) Is battery voltage present at 468H Blk wire (C) of fuse block?

Yes - Go to next step.

No - Check 455H Blk wire and connections. If OK, check HM-F5 fuse.

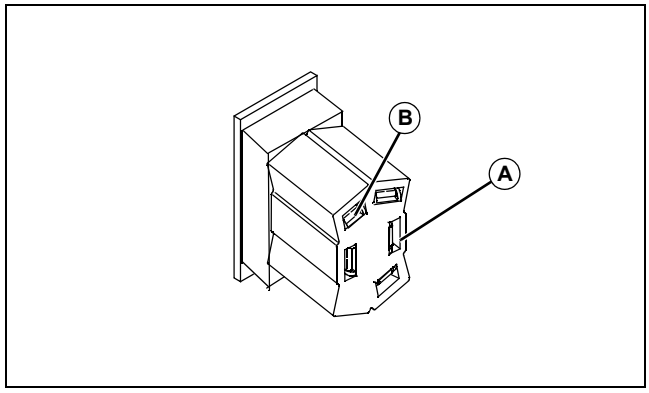


(4) Is battery voltage present at 468H Blk wire (D) of HM-E10 Left front position light?

Yes - Test light bulb. If OK, check 105H and 105F Brn ground wires, splices, and connections.

No - Check 468H Blk wire and connections.

System: Right Front Position Light Circuit



(1) Is battery voltage present at 200H Red wire (A) of HM-S2 light switch?

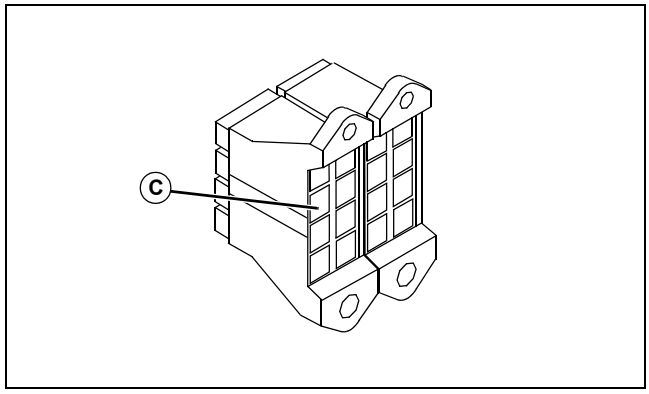
Yes - Go to next step.

No - Check X14 connector, 203H and 200H Red wires, splice, and connections.

(2) Is battery voltage present at 455H Blk wire (B) of HM-S2 light switch?

Yes - Go to next step.

No - Test light switch. See “Light Switch Test (Optional Marker or Signal Lights)” on page 342.

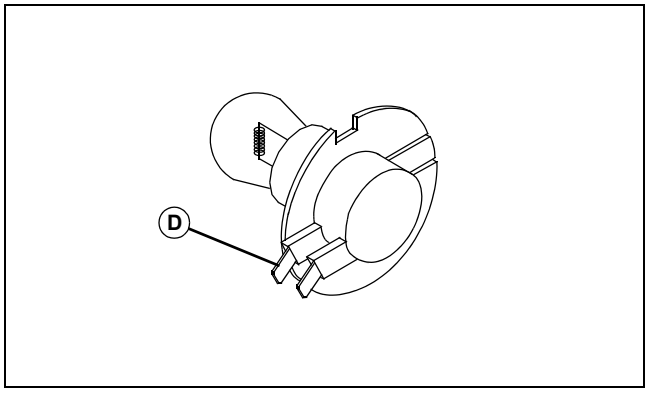


(3) Is battery voltage present at 462H Blk wire (C) of fuse block?

Yes - Go to next step.

No - Check 455H Blk wire and connections. Test HM-F6 fuse.

System: Right Front Position Light Circuit

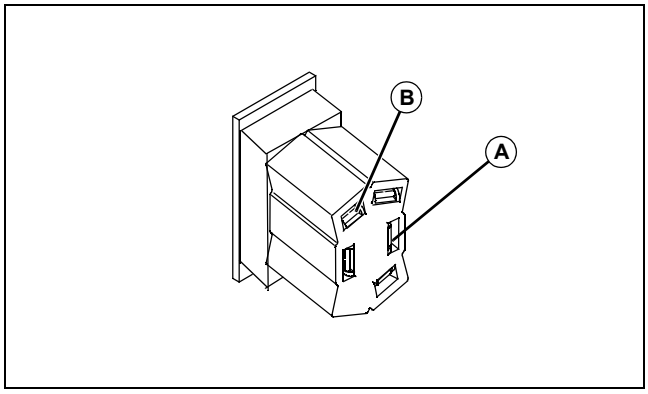


(4) is battery voltage present at 462H Blk wire (D) of HM-E15 Right front position light?

Yes - Test light bulb. If OK, check 105G and 105F Brn ground wires, splices, and connections.

No - Check 462H Blk wire and connections.

System: Left Rear Position Light Circuit



(1) Is battery voltage present at 200H Red wire (A) of HM-S2 light switch?

Yes - Go to next step.

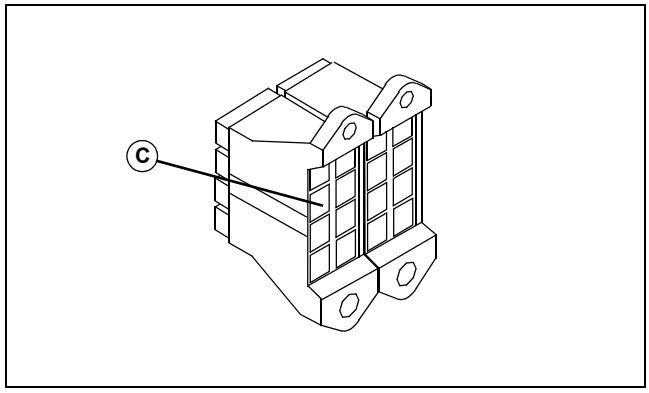
No - Check X14 connector, 203H and 200H Red wires, splice, and connections.

(2) Is battery voltage present at 455H Blk wire (B) of HM-S2 light switch?

Yes - Go to next step.

No - Test light switch. See “Light Switch Test (Optional Marker or Signal Lights)” on page 342.

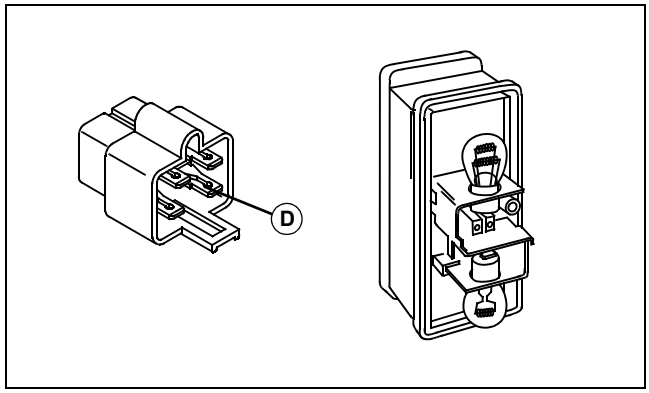
System: Left Rear Position Light Circuit



(3) Is battery voltage present at 463H Wht wire (C) of fuse block?

Yes - Go to next step.

No - Check 455H Blk wire and connections. Test HM-F6 fuse.

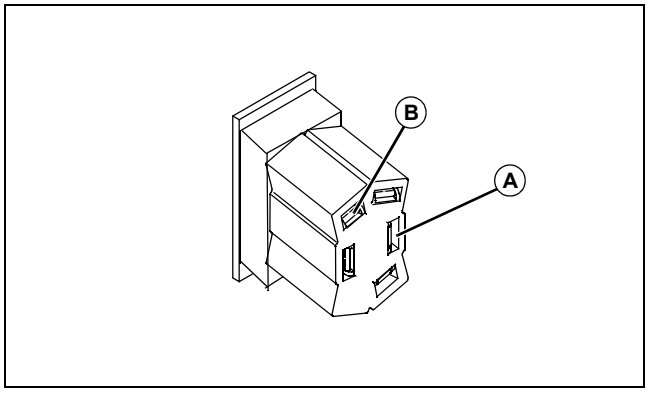


(4) Is battery voltage present at HM-E3 Left rear position light 300 Blk wire (D)?

Yes - Test light bulb. If OK, check 100 Wht, 105B and 105A Brn ground wires, splices and HM-X3 connector.

No - Check 463H and 300 Blk wires and HM-X3 connector.

System: Right Rear Position Light Circuit



(1) Is battery voltage present at 200H Red wire (A) of HM-S2 light switch?

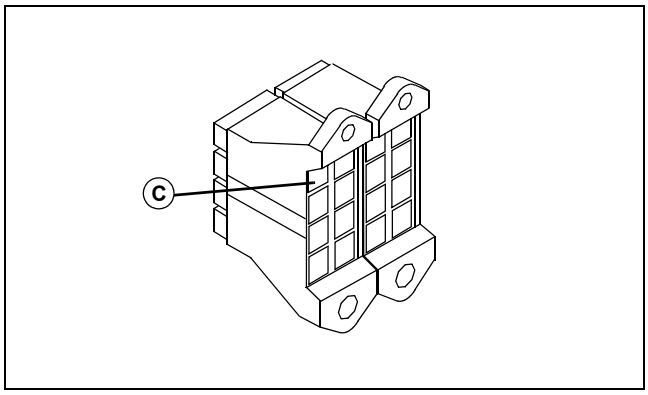
Yes - Go to next step.

No - Check X14 connector, 203H and 200H Red wires, splice, and connections.

(2) Is battery voltage present at 455H Blk wire (B) of HM-S2 light switch?

Yes - Go to next step.

No - Test light switch. See “Light Switch Test (Optional Marker or Signal Lights)” on page 342.

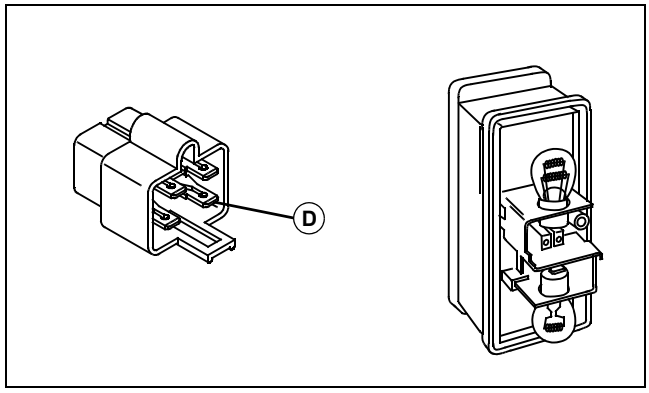


(3) Is battery voltage present at 469H Brn wire (C) of fuse block?

Yes - Go to next step.

No - Check 455H Blk wire and connections. Test HM-F5 fuse.

System: Right Rear Position Light Circuit



(4) Is battery voltage present at 300 Blk wire (D) of HM-E7 Right rear position light?

Yes - Test light bulb. If OK, check 100 Wht, 105D and 105A Brn ground wires, splices and HM-X6 connector.

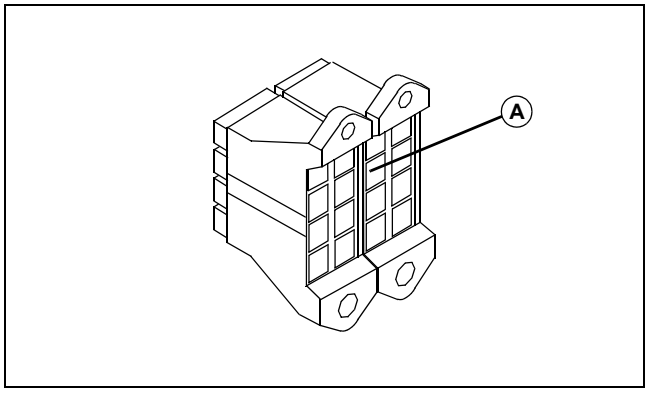
No - Check 469H Brn and 300 Blk wires and HM-X6 connector.

Brake Lights:

Test Conditions:

- Machine parked safely on a level surface.
- Park braked locked.
- Key switch in run position, engine off.
- Battery fully charged.
- Power circuits working properly. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.
- Brake switch in the closed (depressed) position.

System: Left Brake Light Circuit

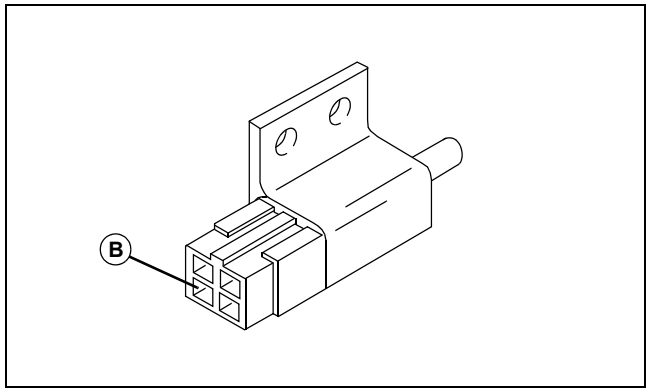


(1) Is battery voltage present at 410H Yel wire (A) at fuse block?

Yes - Go to next step.

No - Check 400H Yel wire and connections. If OK, test HM-F2 fuse.

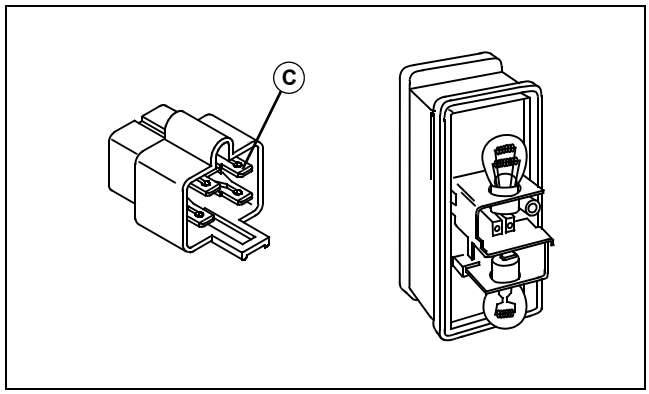
System: Left Brake Light Circuit



(2) Is battery voltage present at 631H Yel wire (B) of HM-S1 brake switch?

Yes - Go to next step.

No - Check 410H Yel wire and connections. If OK, test brake switch. See “Brake Lights Switch Test” on page 352.

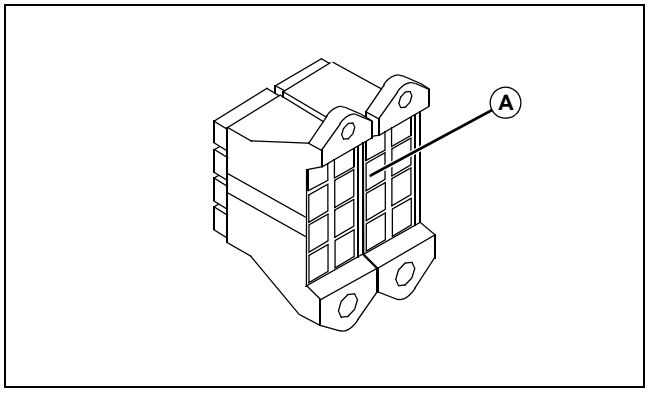


(3) Is battery voltage present at HM-E1 Left brake light 200 Blu wire (C)?

Yes - Test light bulb. If OK, check 100 Wht, 105B and 105A Brn ground wires, splices, and HM-X3 connector.

No - Check 631H and 420N Yel wires, HM-X3 connector, 200 Blu wire and connections.

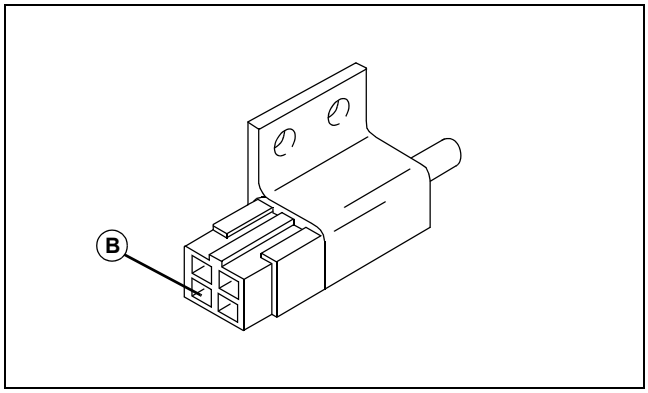
System: Right Brake Light Circuit



(1) Is battery voltage present at 410H Yel wire (A) at fuse block?

Yes - Go to next step.

No - Check 400H Yel wire and connections. If OK, test HM-F2 fuse.

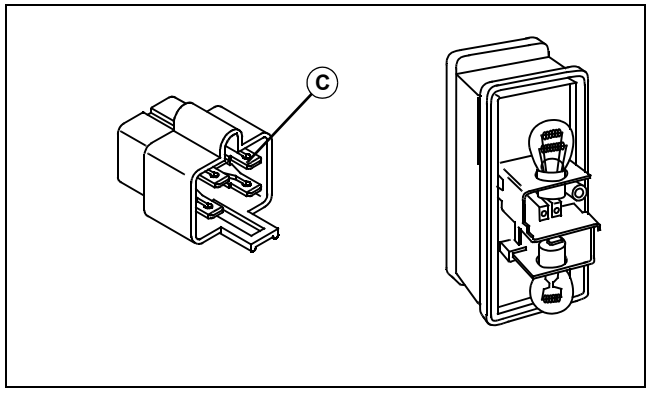


(2) Is battery voltage present at 631H Yel wire (B) of HM-S1 brake switch?

Yes - Go to next step.

No - Check 410H Yel wire and connections. If OK, test brake switch. See “Brake Lights Switch Test” on page 352.

System: Right Brake Light Circuit



(3) Is battery voltage present at HM-E5 Right brake light 200 Blu wire (C)?

Yes - Test light bulb. If OK, check 100 Wht, 105D and 105A Brn ground wires, splices, and HM-X6 connector.

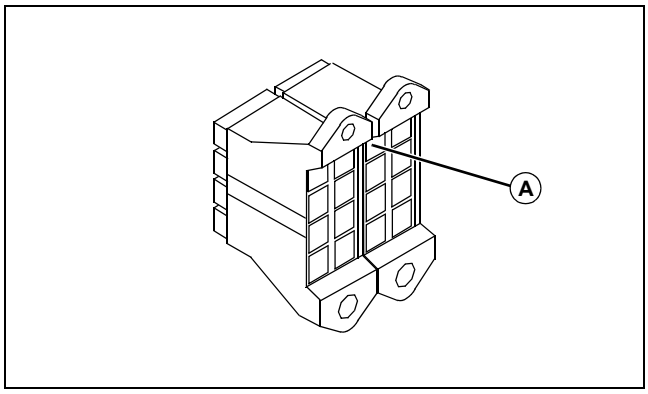
No - Check 631H , 420N, and 421H Yel wires, HM-X6 connector, 200 Blu wire and connections.

Turn Signal Lights:

Test Conditions:

- Machine parked safely on a level surface.
- Park braked locked.
- Key switch in run position, engine off.
- Battery fully charged.
- Power circuits working properly. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.
- Turn switch in either the Left or Right position, depending on the test being performed.

System: Left Rear Turn Light Circuit

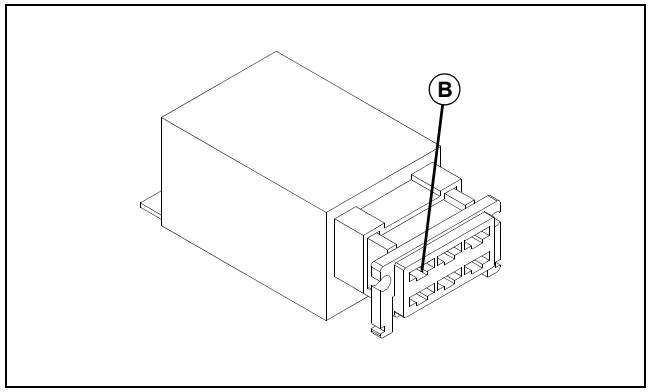


(1) Is battery voltage present at 210H Red wire (A) of fuse block?

Yes - Go to next step.

No - Check 203A and 205H Red wires, splices, and X14 connector. If OK, test HM-F1 fuse.

System: Left Rear Turn Light Circuit

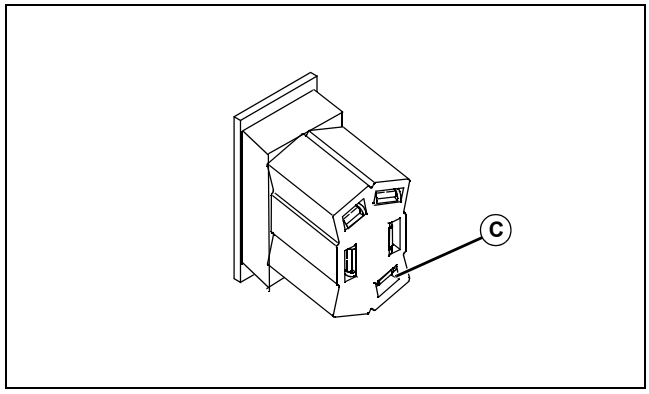


(2) Is intermittent battery voltage present at 477H Wht wire of HM-K1 flasher?

Yes - Check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, go to next step.

No - Check 210H Red wire and connections. If OK, check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, replace flasher.

No - Check HM-R1 resistor for 91 ohms of resistance. If not OK, replace resistor.

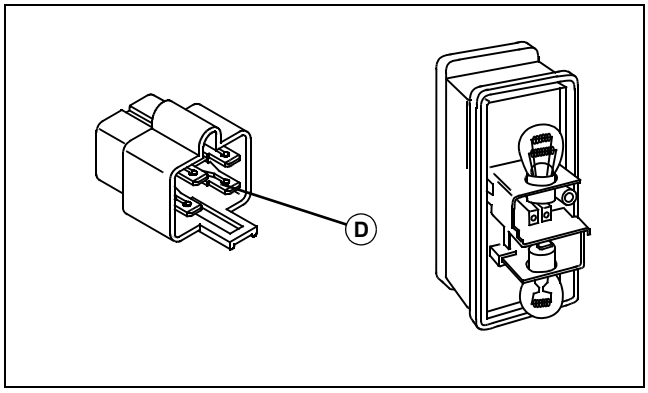


(3) Is intermittent battery voltage present at 490H Blu wire of HM-S3 turn switch?

Yes - Go to next step.

No - Check 477H Wht wire and connections. If OK, test turn switch. See “Turn Signal Lights Switch Test” on page 342.

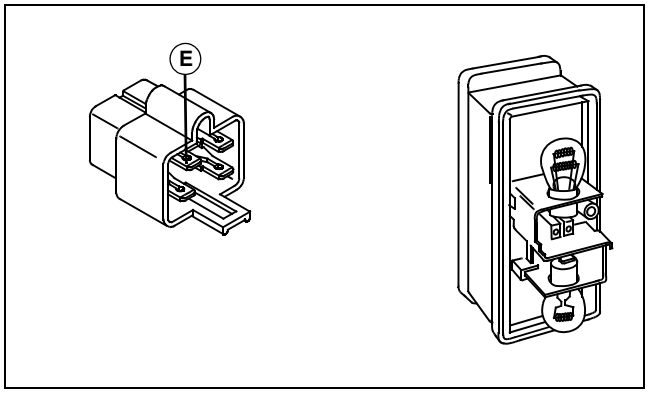
System: Left Rear Turn Light Circuit



(4) Is intermittent battery voltage present at 400 Grn wires of HM-E2 Left rear turn light?

Yes - Go to next step.

No - Check 490H and 492H Blu wires, HM-X3 connector, and 400 Grn wire.

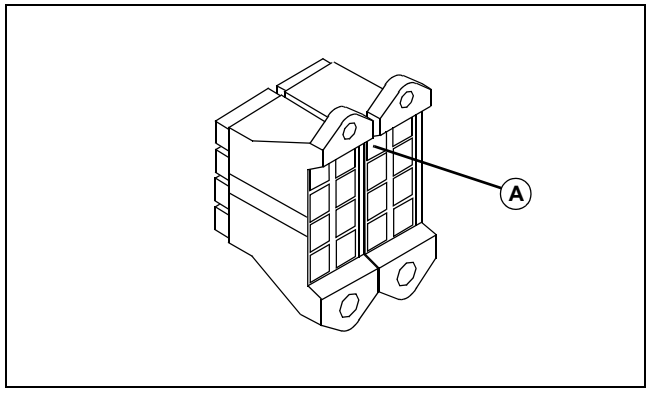


(5) Is continuity present between 100 Wht wire of HM-E2 Left rear turn light and ground?

Yes - Test bulb.

No - Check 100 Wht wire, HM-X3 connector, 105B and 105A Brn wires, and splices.

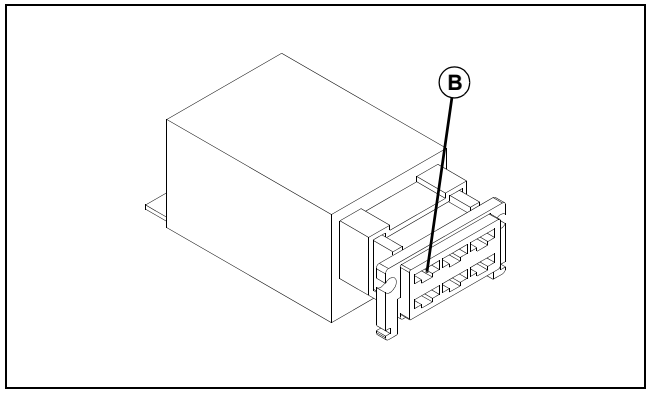
System: Right Rear Turn Light Circuit



(1) Is battery voltage present at 210H Red wire of fuse block?

Yes - Go to next step.

No - Check 203A and 205H Red wires, splices, and X14 connector. If OK, test HM-F1 fuse.



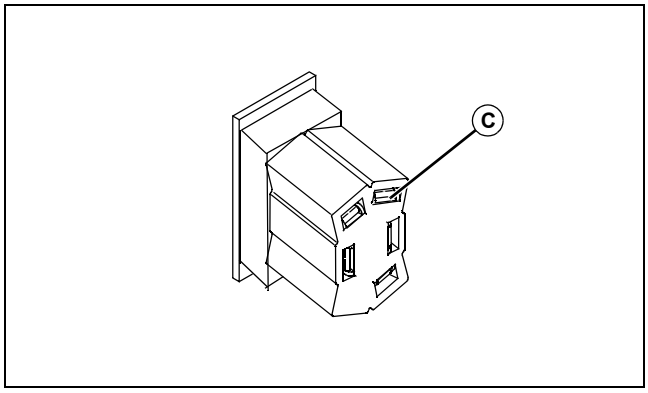
(2) Is intermittent battery voltage present at 477H Wht wire of HM-K1 flasher?

Yes - Check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, go to next step.

No - Check 210H Red wire and connections. If OK, check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, replace flasher.

No - Check HM-R1 resistor for 91 ohms of resistance. If not OK, replace resistor.

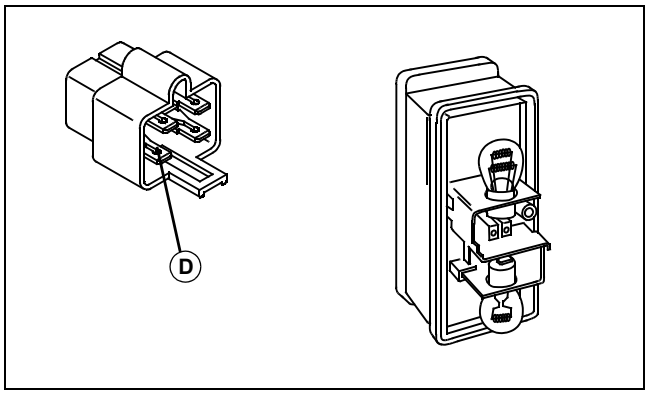
System: Right Rear Turn Light Circuit



(3) Is intermittent battery voltage present at 480H Grn wire of HM-S3 turn switch?

Yes - Go to next step.

No - Check 477H Wht wire and connections. If OK, test turn switch. See “Turn Signal Lights Switch Test” on page 342.

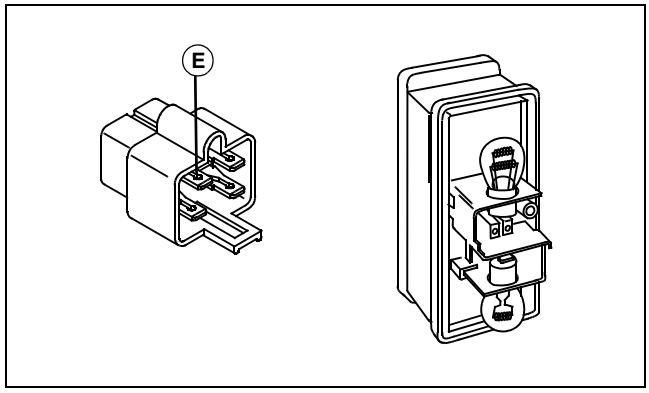


(4) Is intermittent battery voltage present at 400 Grn wire of HM-E6 Right rear turn light?

Yes - Go to next step.

No - Check 480H and 482H Grn wires, HM-X6 connector, and 400 Grn wire.

System: Right Rear Turn Light Circuit

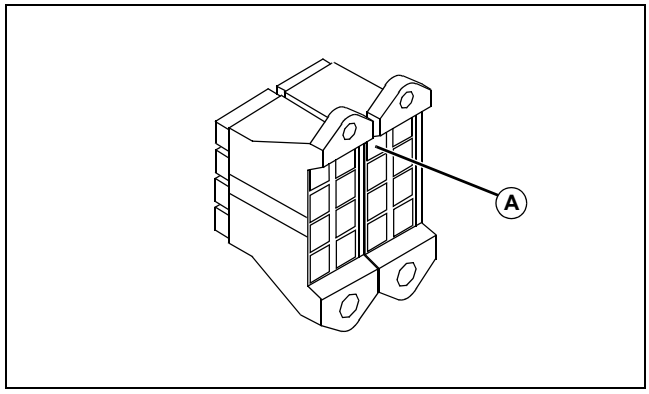


(5) Is continuity present between 100 Wht wire of HM-E6 Right rear turn signal light and ground?

Yes - Test bulb.

No - Check 100Wht wire, HM-X6 connector, 105D and 105A Brn wires, and splices.

System: Left Front Turn Light Circuit

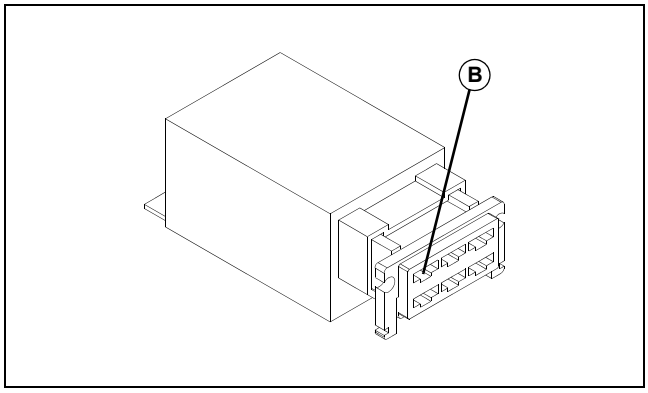


(1) Is battery voltage present at 210H Red wire of fuse block?

Yes - Go to next step.

No - Check 203A and 205H Red wires, splices, and X14 connector. If OK, test HM-F1 fuse.

System: Left Front Turn Light Circuit

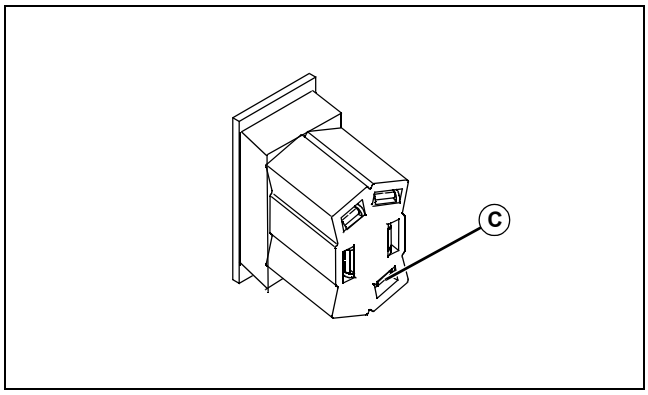


(2) Is intermittent battery voltage present at 477H Wht wire of HM-K1 flasher?

Yes - Check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, go to next step.

No - Check 210H Red wire and connections. If OK, check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, replace flasher.

No - Check HM-R1 resistor for 91 ohms of resistance. If not OK, replace resistor.

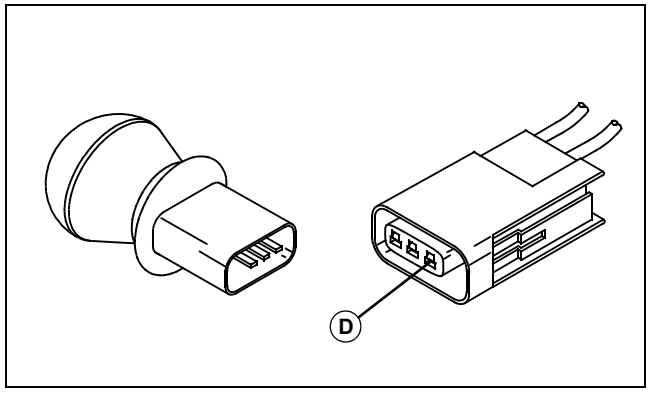


(3) Is intermittent battery voltage present at 491H Blu wire of HM-S3 turn switch?

Yes - Go to next step.

No - Check 477H Wht wire and connections. If OK, test turn switch. See “Turn Signal Lights Switch Test” on page 342.

System: Left Front Turn Light Circuit

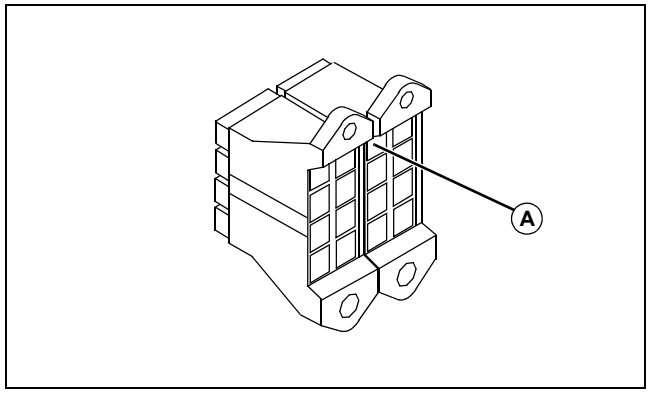


(4) Is intermittent battery voltage present at 491H Blu wire of HM-X11 Left front turn light connector?

Yes - Check for continuity between 105K and 105F Brn wires and ground. If OK, test bulb.

No - Check 491H wire and connections.

System: Right Front Turn Light Circuit

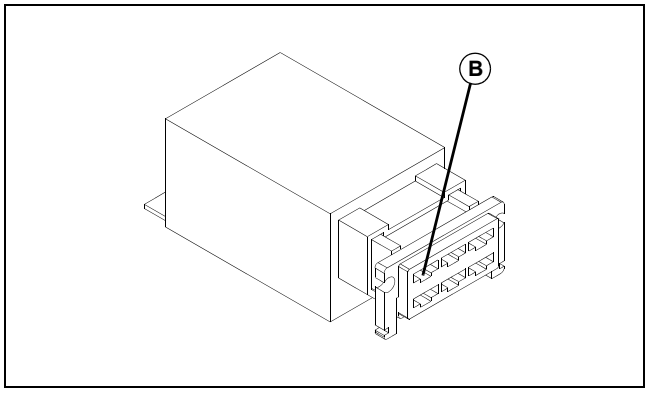


(1) Is battery voltage present at 210H Red wire of fuse block?

Yes - Go to next step.

No - Check 203A and 205H Red wires, splices, and X14 connector. If OK, test HM-F1 fuse.

System: Right Front Turn Light Circuit

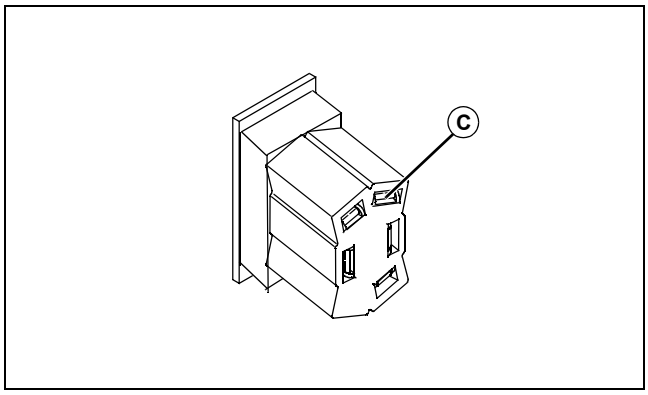


(2) Is intermittent battery voltage present at 477H Wht wire of HM-K1 flasher?

Yes - Check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, go to next step.

No - Check 210H Red wire and connections. If OK, check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, replace flasher.

No - Check HM-R1 resistor for 91 ohms of resistance. If not OK, replace resistor.

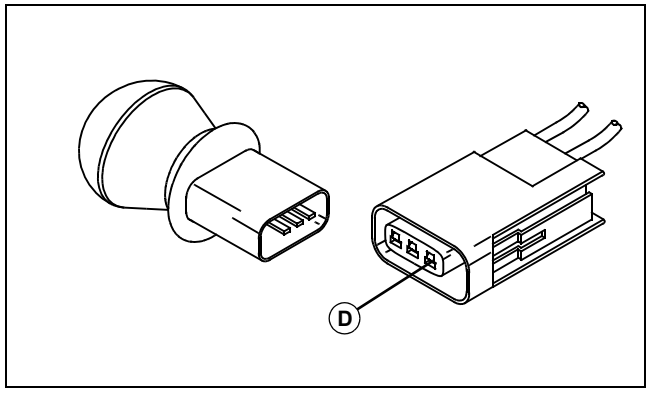


(3) Is intermittent battery voltage present at 481H Grn wire of HM-S3 turn switch?

Yes - Go to next step.

No - Check 477H Wht wire and connections. If OK, test turn switch. See “Turn Signal Lights Switch Test” on page 342.

System: Right Front Turn Light Circuit



(4) Is intermittent battery voltage present at 481H Grn wire of HM-X14 Right front turn light connector?

Yes - Check for continuity between 105J and 105F Brn wires and ground. If OK, test bulb.

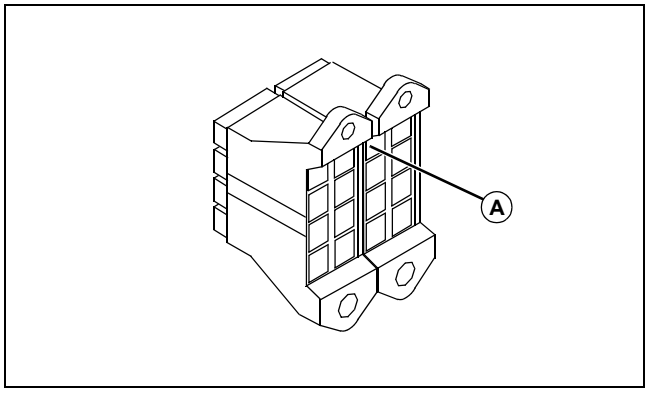
No - Check 481H Grn wire and connections.

Hazard Lights:

Test Conditions:

- Machine parked safely on a level surface.
- Park braked locked.
- Key switch in run position, engine off.
- Battery fully charged.
- Power circuits working properly. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.
- Hazard switch in the on position.

System: Left Rear Hazard Light Circuit

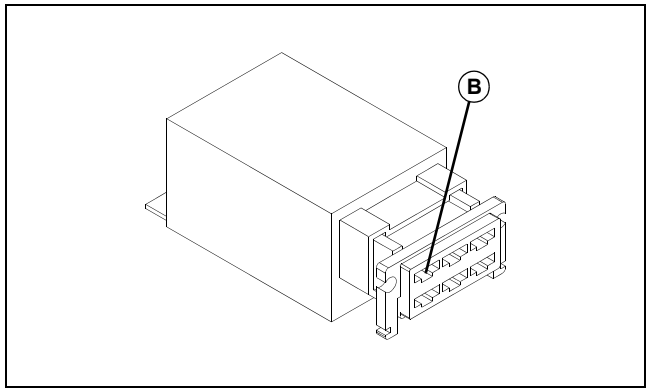


(1) Is battery voltage present at 210H Red wire of fuse block?

Yes - Go to next step.

No - Check 203A and 205H Red wires, splices, and X14 connector. If OK, test HM-F1 fuse.

System: Left Rear Hazard Light Circuit

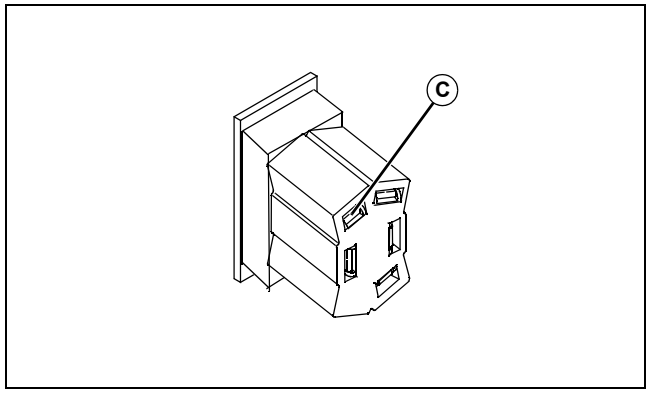


(2) Is intermittent battery voltage present at 477H Wht wire of HM-K1 flasher?

Yes - Check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, go to next step.

No - Check 210H Red wire and connections. If OK, check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, replace flasher.

No - Check HM-R1 resistor for 91 ohms of resistance. If not OK, replace resistor.

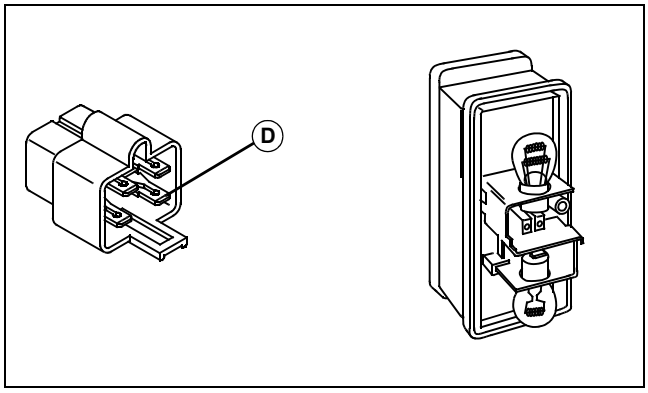


(3) Is intermittent battery voltage present at 494H Blu wire of HM-S4 flasher switch?

Yes - Go to next step.

No - Check 477H, 478H and 479H Wht wires and connections. If OK, replace flasher switch.

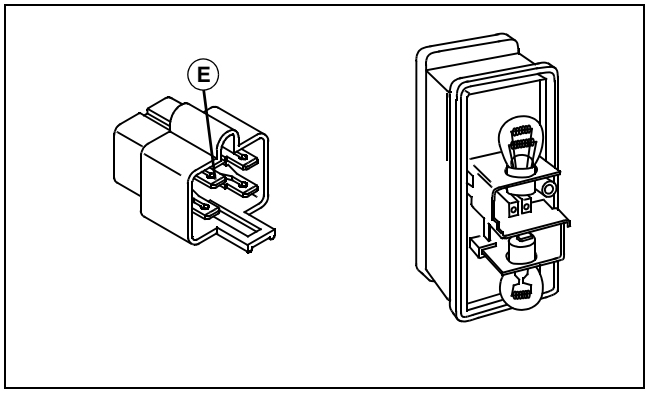
System: Left Rear Hazard Light Circuit



(4) Is intermittent battery voltage present at 400 Grn wire of HM-E2 Left rear flasher light?

Yes - Go to next step.

No - Check 494H and 492H Blu wires, HM-V2 diode, HM-X3 connector, and 400 Grn wire.

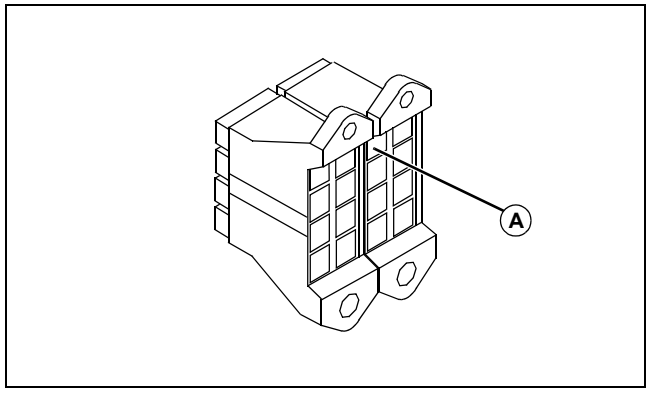


(5) Is continuity present between 100 Wht wire of HM-E2 Left rear turn light and ground?

Yes - Test bulb.

No - Check 100 Wht wire, HM-X3 connector, 105B and 105A Brn wires, and splices.

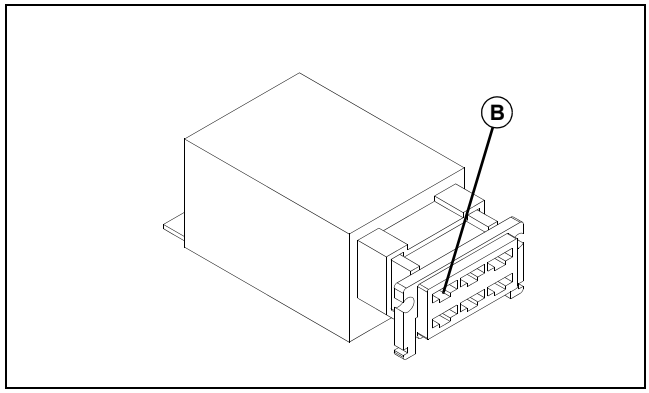
System: Right Rear Hazard Light Circuit



(1) Is battery voltage present at 210H Red wire of fuse block?

Yes - Go to next step.

No - Check 203A and 205H Red wires, splices, and X14 connector. If OK, test HM-F1 fuse.



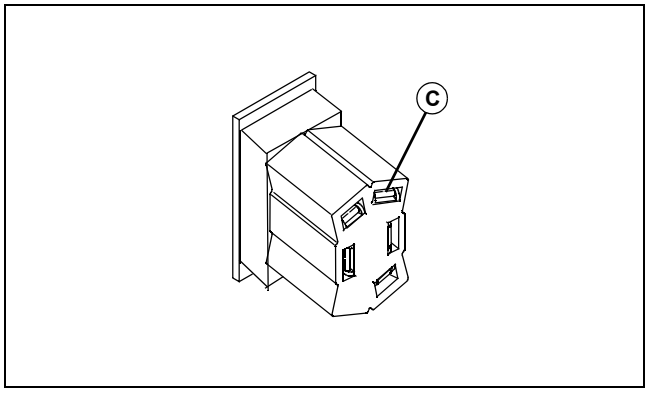
(2) Is intermittent battery voltage present at 477H Wht wire of HM-K1 flasher?

Yes - Check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, go to next step.

No - Check 210H Red wire and connections. If OK, check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, replace flasher.

No - Check HM-R1 resistor for 91 ohms of resistance. If not OK, replace resistor.

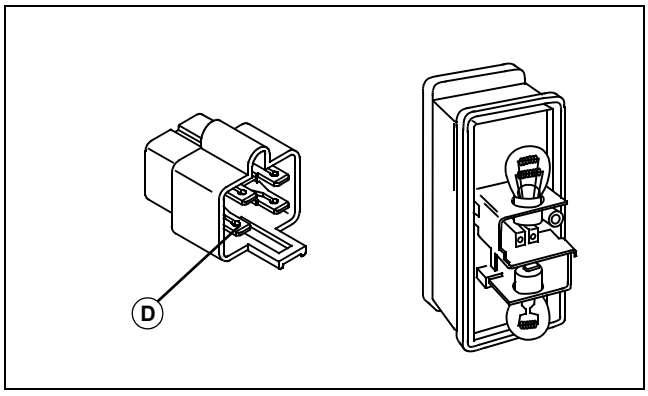
System: Right Rear Hazard Light Circuit



(3) Is intermittent battery voltage present at 482H Grn wire of HM-S4 flasher switch?

Yes - Go to next step.

No - Check 477H and 478H Wht wires and connections. If OK, test flasher switch. See “Hazard Lights Switch Test” on page 343.

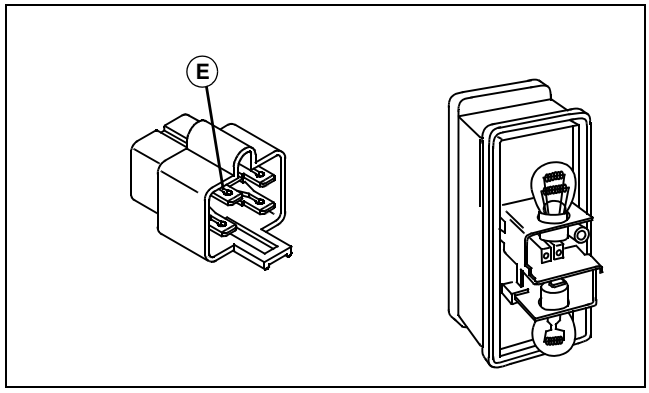


(4) Is intermittent battery voltage present at 400 Grn wire of HM-E6 Right rear flasher light?

Yes - Go to next step.

No - Check 482H Grn wire, HM-X6 connector, and 400 Grn wire.

System: Right Rear Hazard Light Circuit

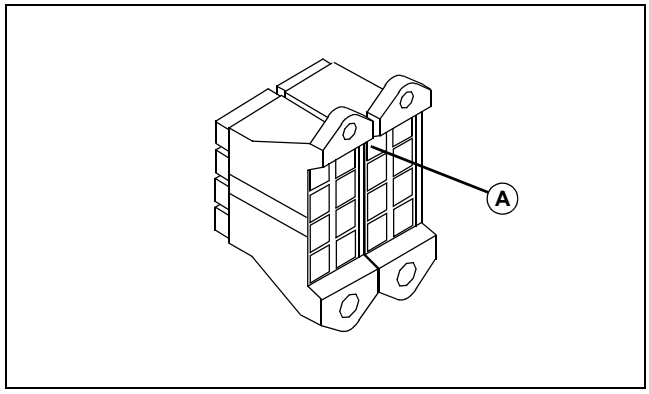


(5) Is continuity present between 100 Wht wire of HM-E6 Right rear flasher light and ground?

Yes - Test bulb.

No - Check 100 Wht wire, HM-X6 connector, 105D and 105A Brn wires, and splices.

System: Left Front Hazard Light Circuit

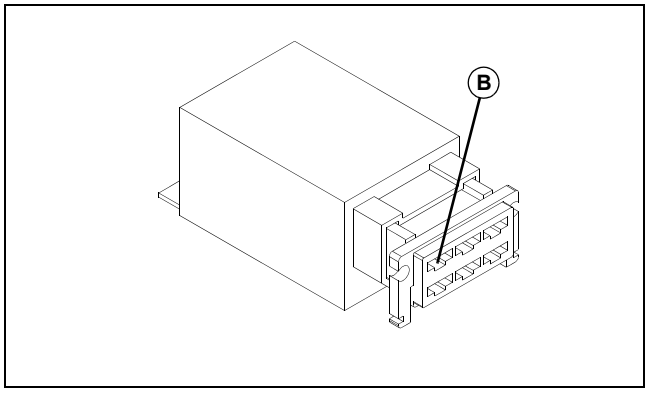


(1) Is battery voltage present at 210H Red wire of fuse block?

Yes - Go to next step.

No - Check 203A and 205H Red wires, splices, and X14 connector. If OK, test HM-F1 fuse.

System: Left Front Hazard Light Circuit

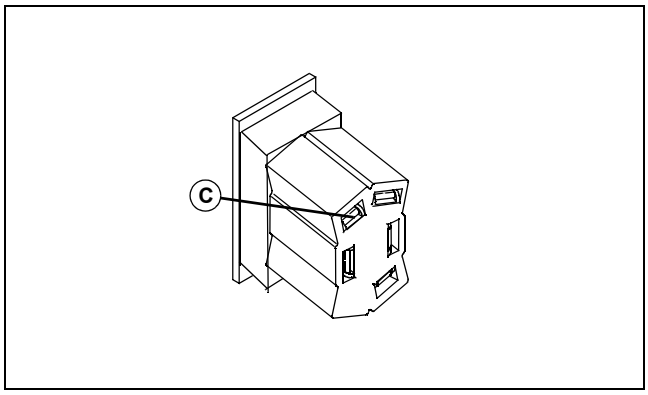


(2) Is intermittent battery voltage present at 477H Wht wire of HM-K1 flasher?

Yes - Check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, go to next step.

No - Check 210H Red wire and connections. If OK, check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, replace flasher.

No - Check HM-R1 resistor for 91 ohms of resistance. If not OK, replace resistor.

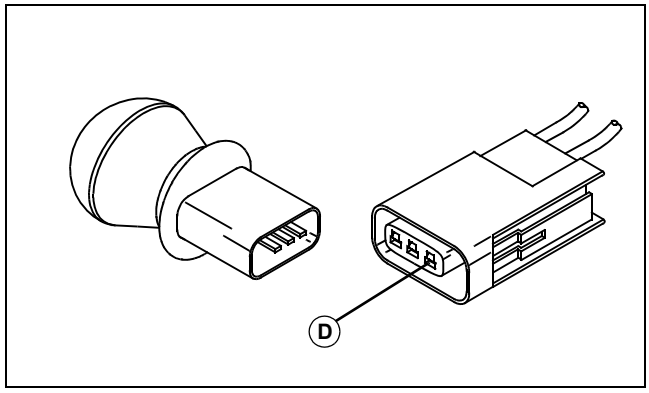


(3) Is intermittent battery voltage present at 494H Blu wire of HM-S4 flasher switch?

Yes - Go to next step.

No - Check 477H, 478H and 479H Wht wires and connections. If OK, test flasher switch. See “Hazard Lights Switch Test” on page 343.

System: Left Front Hazard Light Circuit

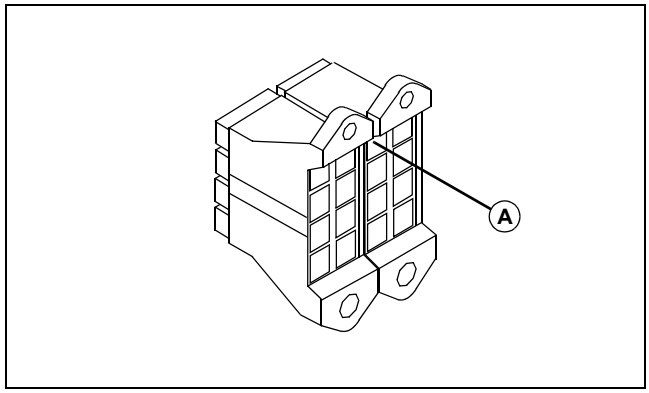


(4) Is intermittent battery voltage present at 491H Blu wire of HM-X11 Left front flasher light?

Yes - Check for continuity between 105K and 105F Brn wires and ground. If OK, test bulb.

No - Check 491 and 490H Blu wires, HM-V2 diode, 494H Blu wire and connections.

System: Right Front Hazard Light Circuit

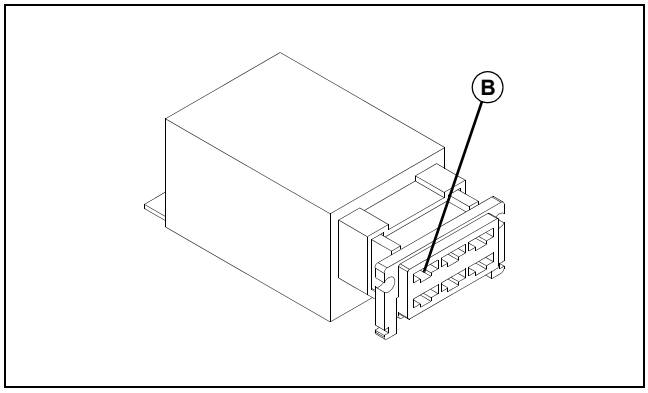


(1) Is battery voltage present at 210H Red wire of fuse block?

Yes - Go to next step.

No - Check 203A and 205H Red wires, splices, and X14 connector. If OK, test HM-F1 fuse.

System: Right Front Hazard Light Circuit

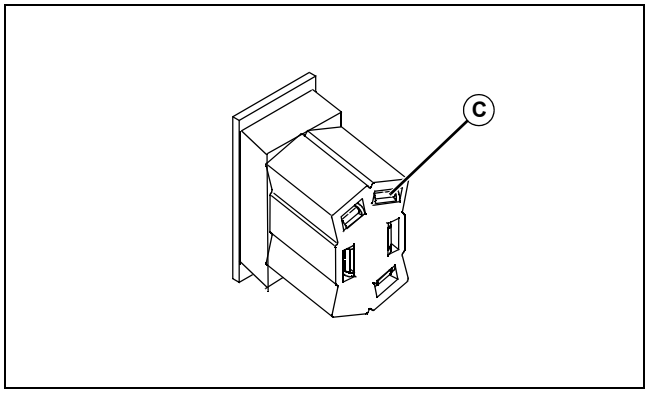


(2) Is intermittent battery voltage present at 477H Wht wire of HM-K1 flasher?

Yes - Check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, go to next step.

No - Check 210H Red wire and connections. If OK, check for flasher continuity to ground through 170H and 170J Brn wires, 100E Blk wire, splices, and X7 connector. If OK, replace flasher.

No - Check HM-R1 resistor for 91 ohms of resistance. If not OK, replace resistor.

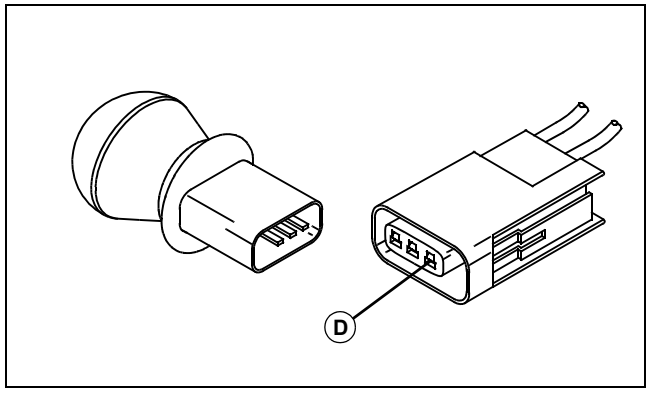


(3) Is battery voltage present at 480H grn wire of HM-S4 flasher switch?

Yes - Go to next step.

No - Check 477H, 478H and 479H Wht wires and connections. If OK, test flasher switch. See “Hazard Lights Switch Test” on page 343.

System: Right Front Hazard Light Circuit



(4) Is battery voltage present at 481H Grn wire of HM-X14 Right front flasher light?

Yes - Check for continuity between 105J and 105F Brn wires and ground. If OK, test bulb.

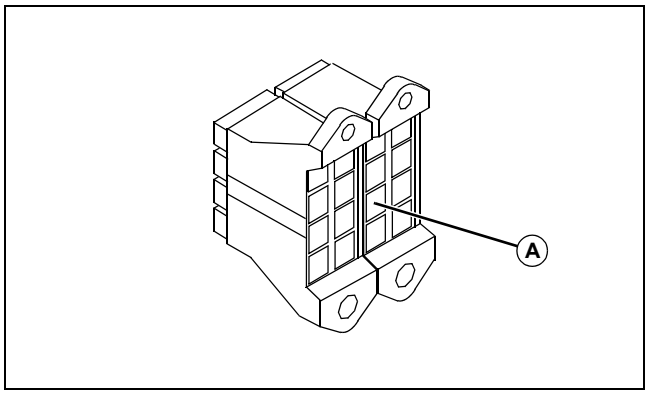
No - Check 481H and 480H wires and connections.

Homologated Horn Circuit Diagnosis

Test Conditions:

- Machine parked safely on a level surface.
- Park braked locked.
- Key switch in run position, engine off.
- Battery fully charged.
- Power circuits working properly. See “Power Circuit Operation (Gas Engine) (SN -40000)” on page 243, or See “Power Circuit Operation (Gas Engine) (SN 40001 -)” on page 252, or See “Power Circuit Operation (Diesel Engine) (SN -40000)” on page 261, or See “Power Circuit Operation (Diesel Engine) (SN 40001 -)” on page 270.
- Ensure that frame, harness, and engine grounds are clean and secure with good continuity.
- Check wires and connections for looseness and corrosion.

System: Horn Circuit

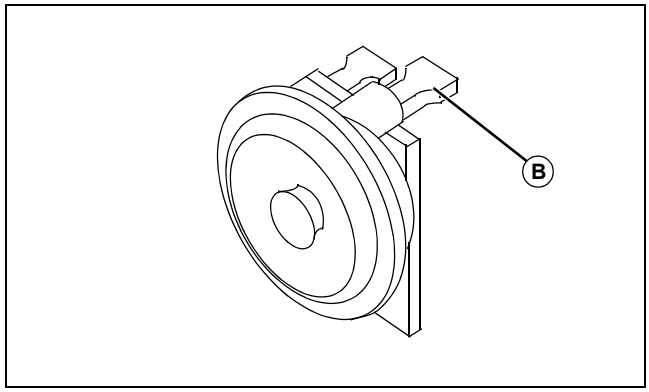


(1) Is battery voltage present at HM-F3 fuse, 405H Yel wire?

Yes - Go to next step.

No - Check HM-F3 fuse, 400H Yel wire, X7 connector, and connections.

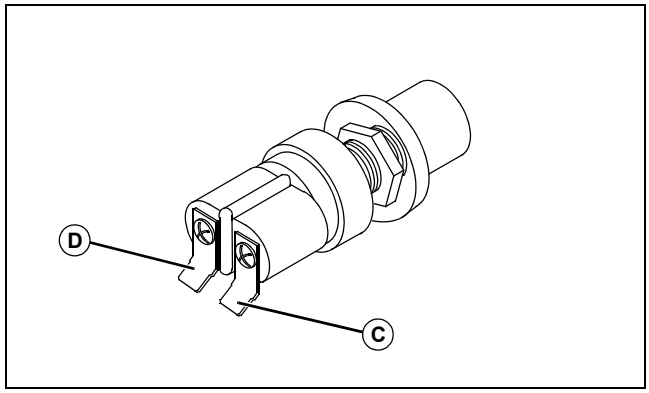
System: Horn Circuit



(2) With horn switch depressed, is battery voltage present at 430H Yel wire?

Yes - Go to next step.

No - Test horn switch. See “Horn Switch Test” on page 353.



(3) Is battery voltage present at HM-H1 horn, 430H Yel wire?

Yes - Go to next step.

No - Check 430H Yel wire and connections.

(4) Is continuity present between 120H Brn wire and ground?

Yes - Replace horn.

No - Check 120H and 105F Brn wires, HMS-4 splice, and connections.

POWER TRAIN - GEAR TABLE OF CONTENTS

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POWER TRAIN - GEAR TABLE OF CONTENTS

Specifications

General Specifications

Drive Train

Type	**Continuous Variable Transmission (CVT) with Gear-Driven Transaxle**
Gear Ranges	**Forward HI and LO - Neutral - Reverse**
Travel Speed Maximum (Forward HI)	**40 km/h (25 mph)**
Transaxle Oil and MFWD	**Low Viscosity HY-GARD™ - JDM J20C**
EMFWD (Electric Engagement)	**Low Viscosity HY-GARD™ - JDM J20D**
Clutch Engagement	**1350 rpm**
Clutch Disengagement	**1250 rpm**

Fluid Capacities

Transaxle (4X2)	**4.0 L (4.25 qt) J20C**
Transaxle (4X4)	**4.5 L (4.8 qt) J20C**
MFWD Differential (SN -40000)	**0.9 L (0.95 qt) J20C**
EMFWD Differential (SN 40001-)	**150 mL (5.1 oz) J20D**
Cooling system (Including Reservoir)	**5.0 L (5.3 qt)**

Torque Specifications

Drive Clutch Cover Screws	**8.5 - 11.3 N•m (75 - 100 lb-in.)**
Drive Clutch to Crankshaft Cap Screw	**37 N•m (26 lb-ft)**
Drive Clutch Spider Assembly to Drive Clutch[1]	**135 N•m (100 lb-ft)**
Driven Clutch to Transaxle Cap Screw	**73 N•m (52 lb-ft)**
Ring Gear Cap Screws (Front and Rear Differentials)	**70 - 80 N•m (52 - 59 lb-ft)**
Lower Swing Arm Frame Pivot Bolts[2]	**167 N•m (125 lb-ft)**
Cover to EMFWD Housing	**23 N•m (17 lb-ft)**

Special Or Required Tools

Special or Required Tools

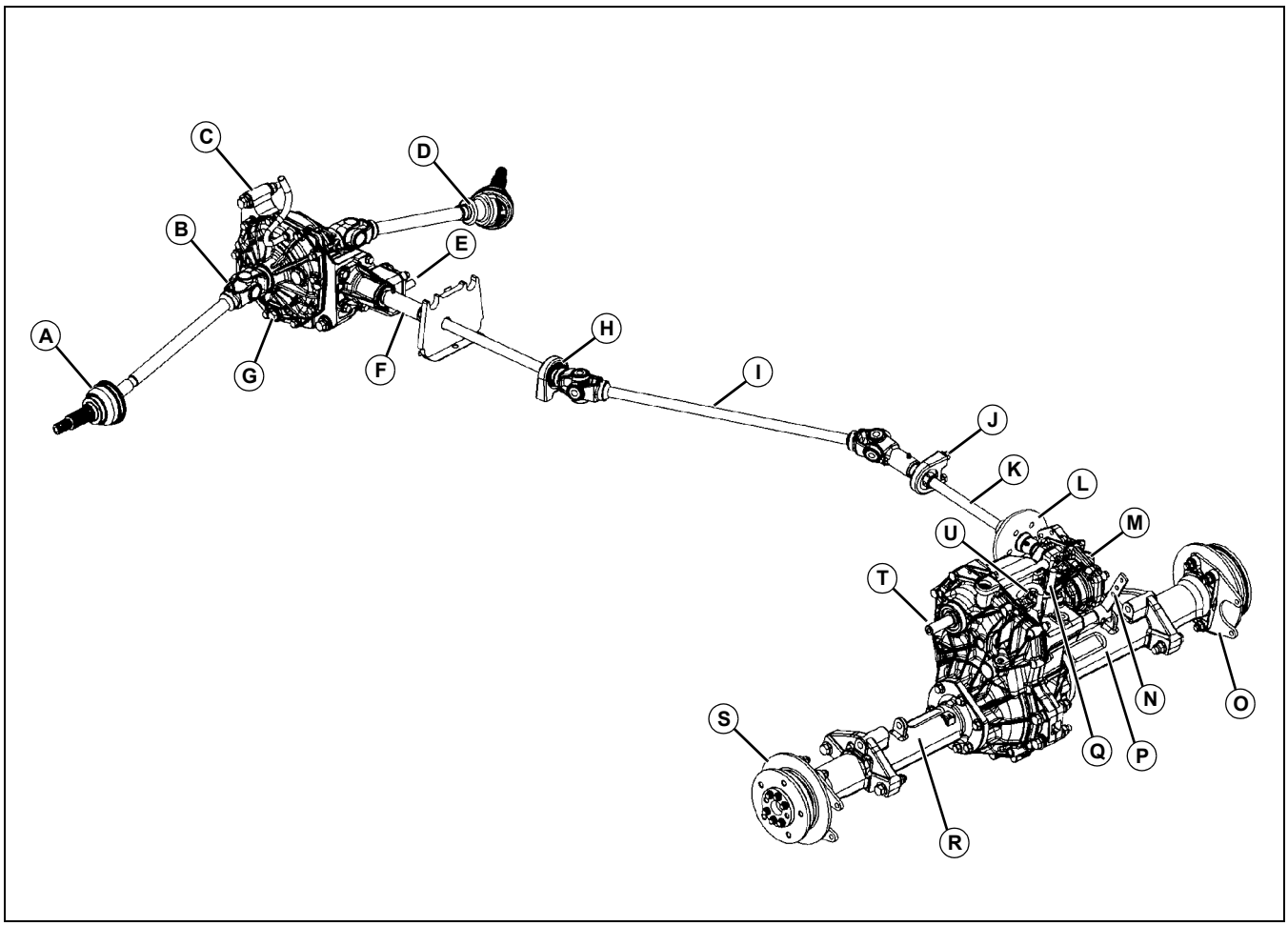
Tool Name	Tool No.	Tool Use
Clutch Removal Tool	JDG1641	To remove primary drive clutch from tapered fit on engine crankshaft.
Clutch Servicing Kit	JDG831	To disassemble and assemble primary drive clutch.

1. Use Loctite 271

2. Overtorque can damage bushing and create loss of flexibility in swing arm.

Component Location

Power Train Components (SN -40000)



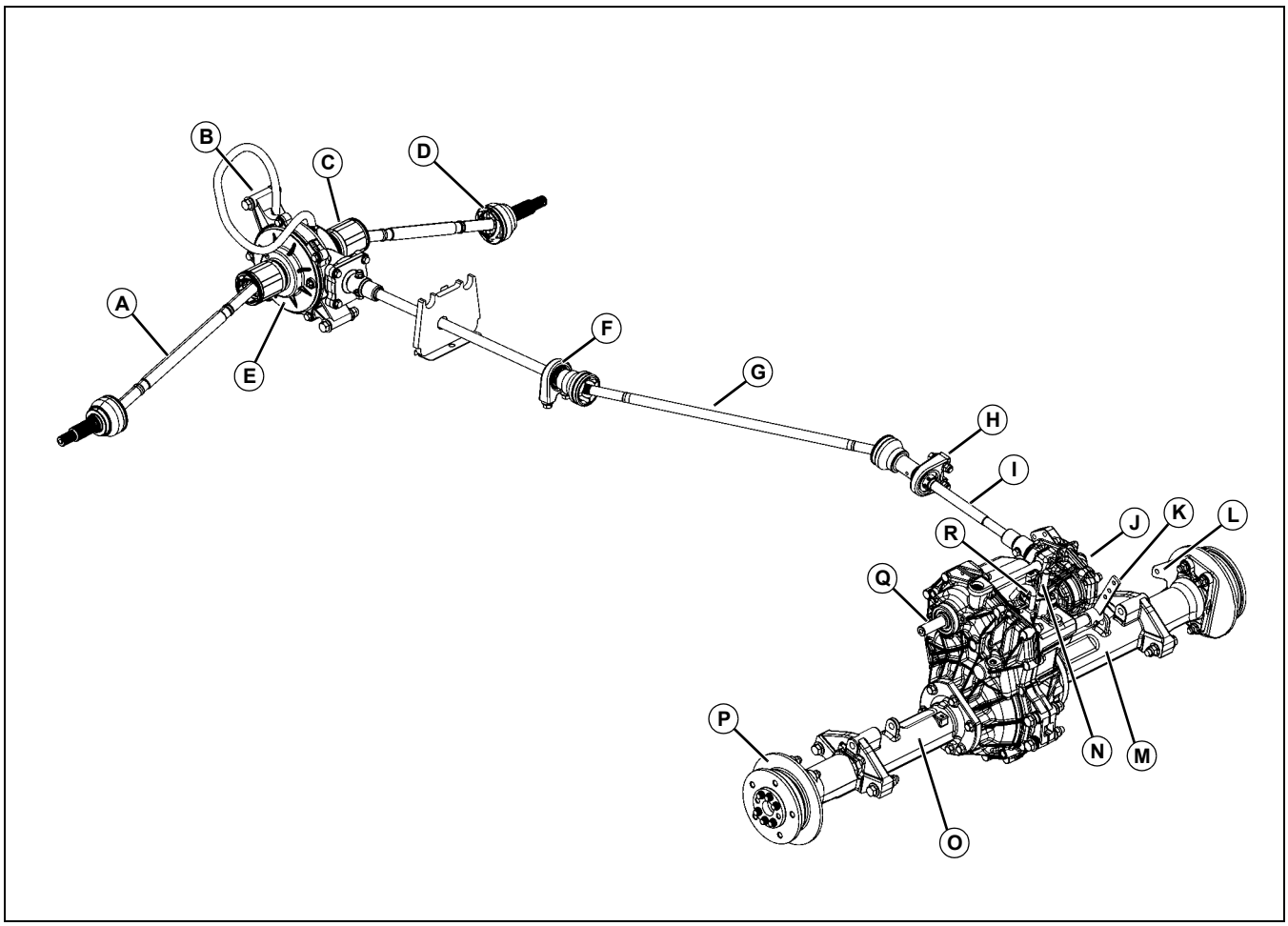
MX31463

Picture Note: MFWD System Shown

A - Left Front Hub[3]
B - U-Joint
C - Housing
D - CV
E - MFWD Shift Shaft
F - Coupler
G - Drain Plug
H - Cast Bearing Housing
I - MFWD Drive Shaft
J - Cast Bearing Housing
K - Stub Shaft
L - Park Brake Disk
M - MFWD Drive Gear Housing
N - Differential Lock Lever
O - Brake Caliper Mounting Bracket
P - Right Axle Housing
Q - Shift Shaft
R - Left Axle Housing
S - Brake Disk
T - Input Shaft
U - Neutral Switch

3. Components A through M are for MFWD machines only.

Power Train Components (SN 40001-)



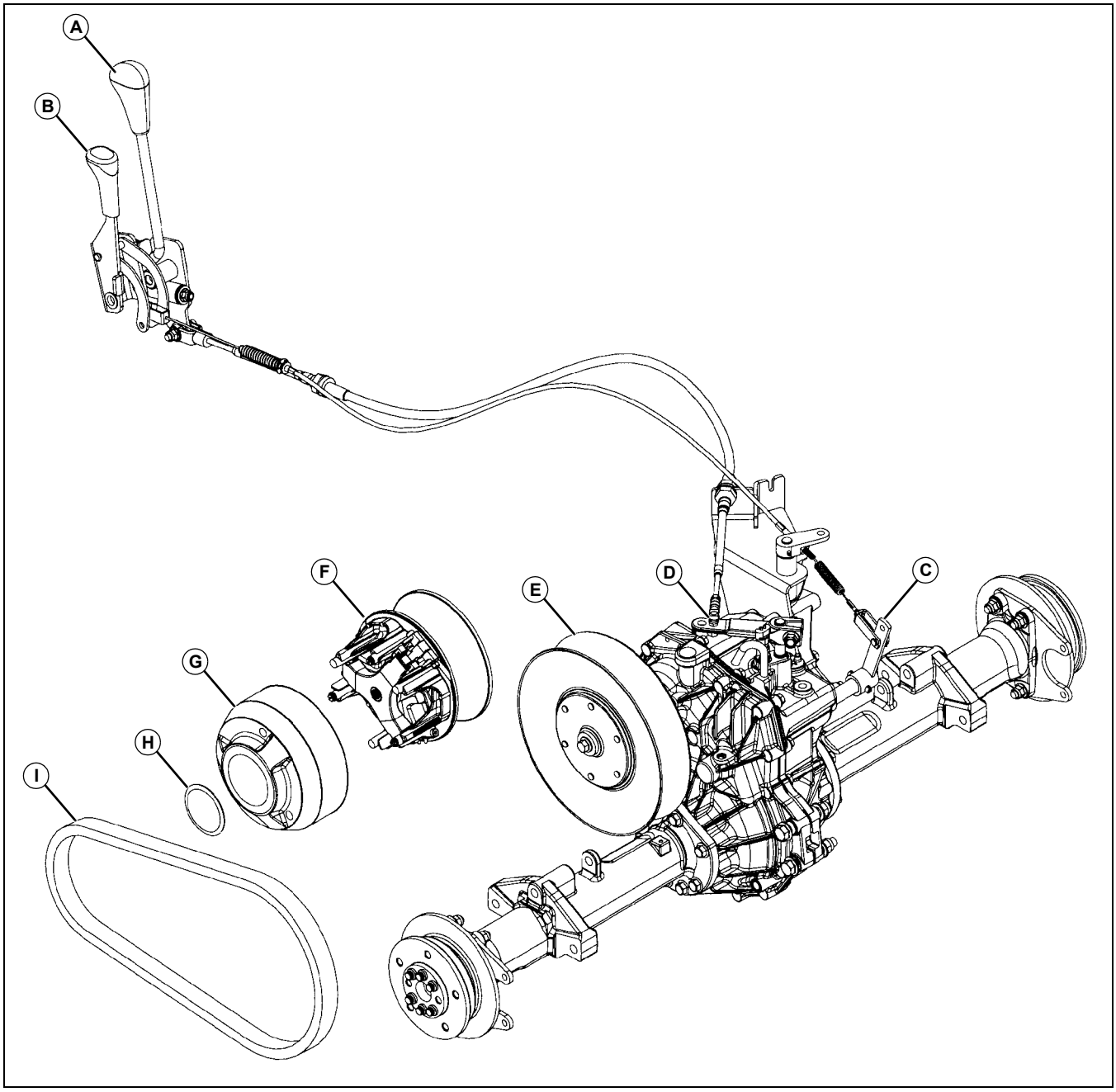
MX36442

Picture Note: EMFWD System Shown

A - Left Halfshaft[4]
B - Housing
C - Inner CV-Joint
D - Outer CV Joint
E - Cover W/Coil
F - Pillow Block Bearing
G - EMFWD Drive Shaft
H - Pillow Block Bearing
I - Stub Shaft
J - MFWD Drive Gear Housing
K - Differential Lock Lever
L - Brake Caliper Mounting Bracket
M - Right Axle Housing
N - Shift Shaft
O - Left Axle Housing
P - Brake Disk
Q - Input Shaft
R - Neutral Switch

4. Components A through J are for MFWD machines only.

Transaxle Control Components

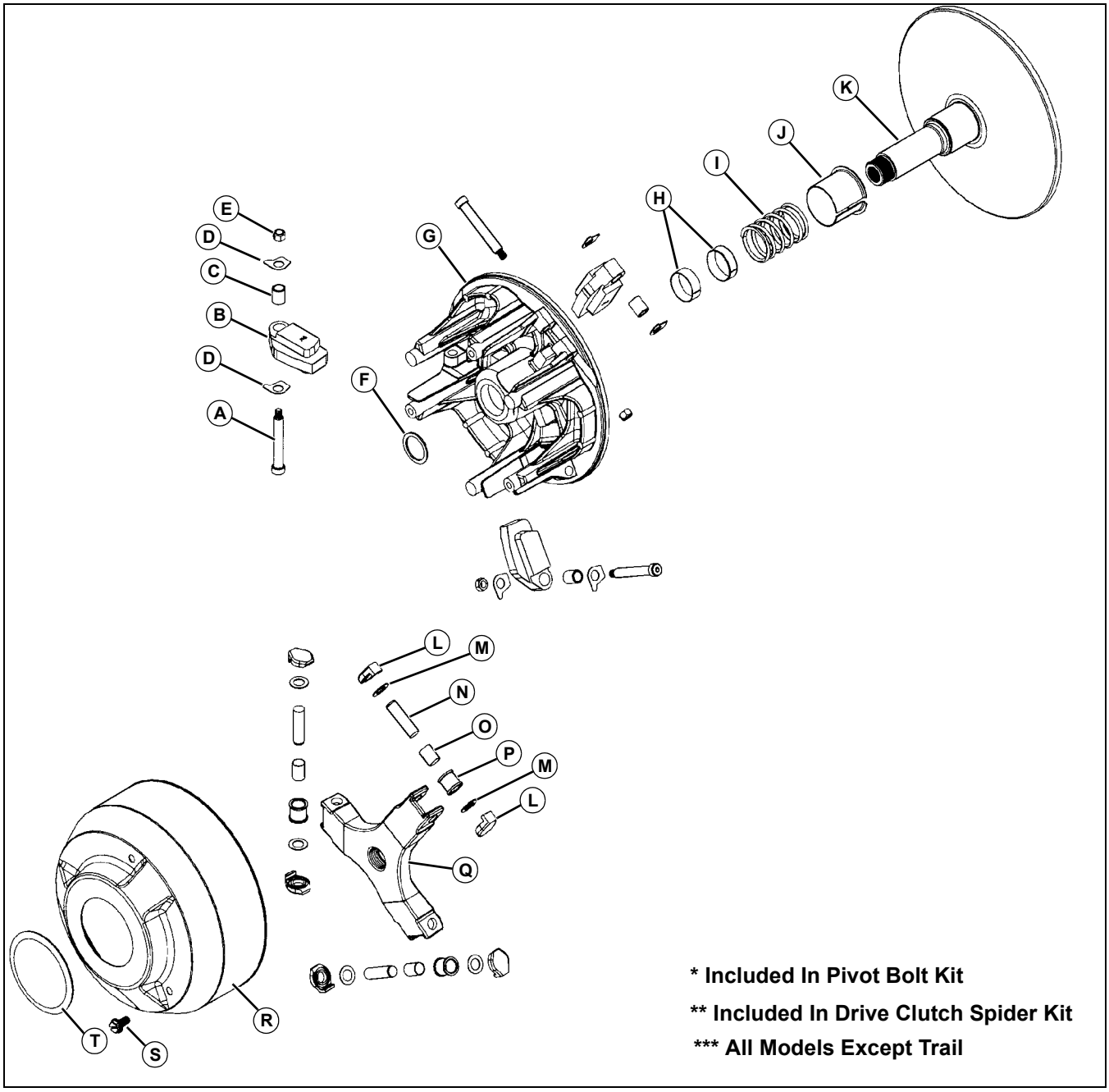


MX3509

Picture Note: 2WD Transaxle Shown

A - Gear Shift Handle
B - Differential Lock Handle
C - Differential Lock Arm
D - Gear Shift Arm
E - Driven Clutch
F - Drive Clutch
G - Drive Clutch Cover
H - Clutch Cover Plug
I - Drive Belt

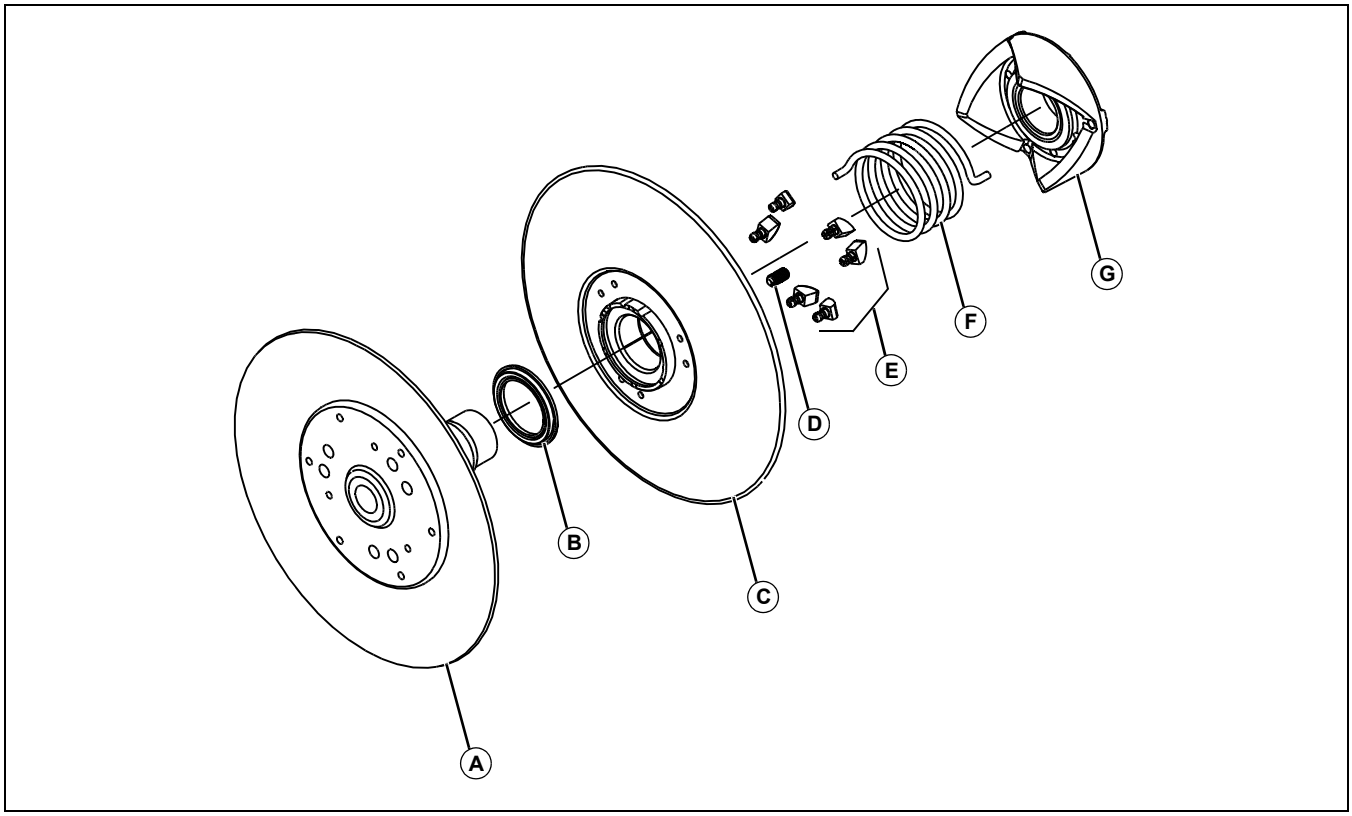
Drive Clutch Components



MX3509

A - Pivot Bolt*
B - Cam Arm
C - Bushing*
D - Special Washer*
E - Lock Nut*
F - Washer
G - Half Sheave
H - Bushings
I - Spring
J - Bushing
K - Half Sheave (Fixed)
L - Button**
M - Thrust Washer**
N - Pin**
O - Bushing**
P - Roller**
Q - Spider***
R - Cover***
S - Screw***
T - Plug***

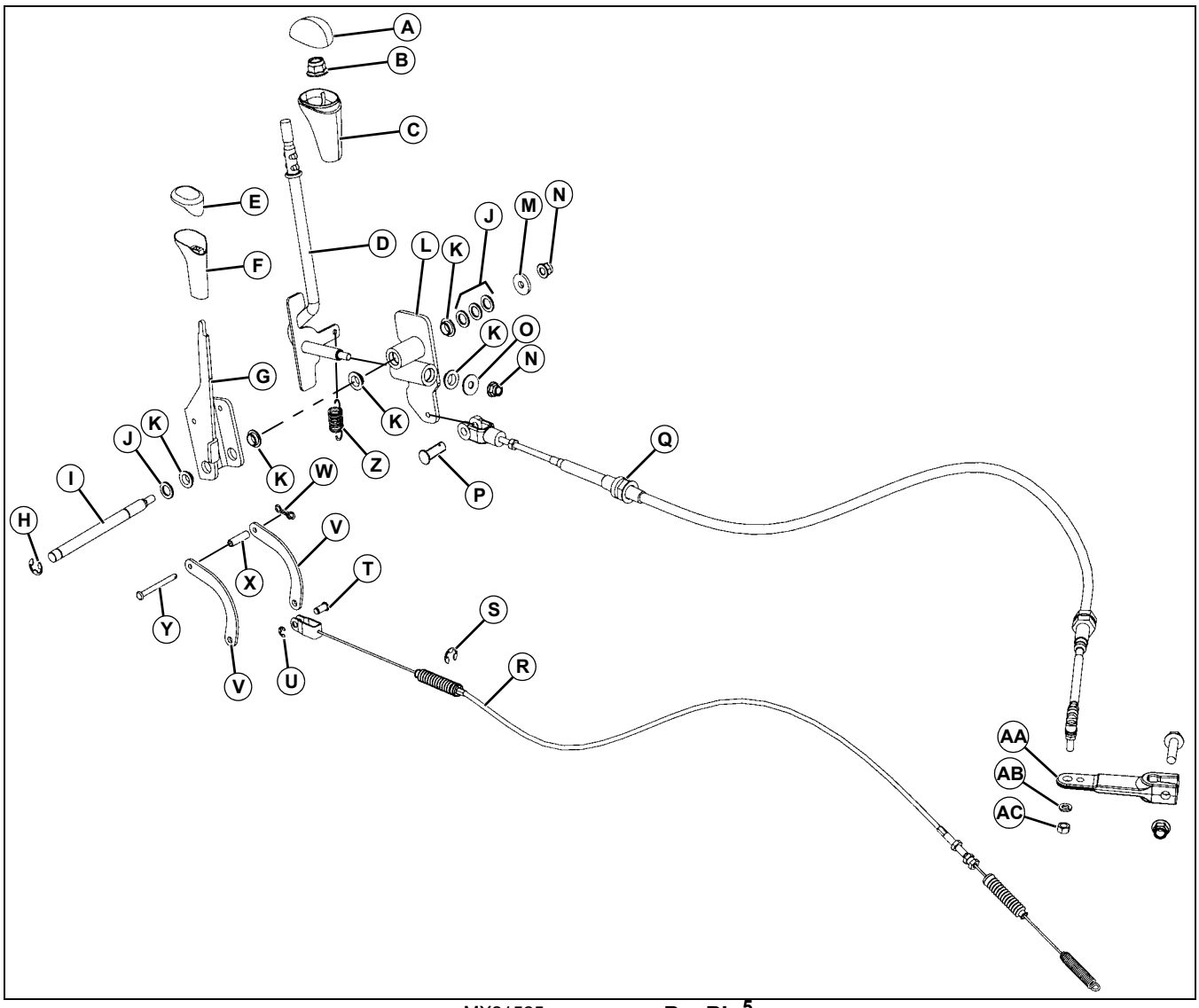
Driven Clutch



mif

A - Clutch Plate, Stationary
B - Wiper Seal
C - Clutch Plate, Moveable
D - Set Screw
E - Wear Buttons (6 used)
F - Spring
G - Clutch Ramp

Shift Linkage Components

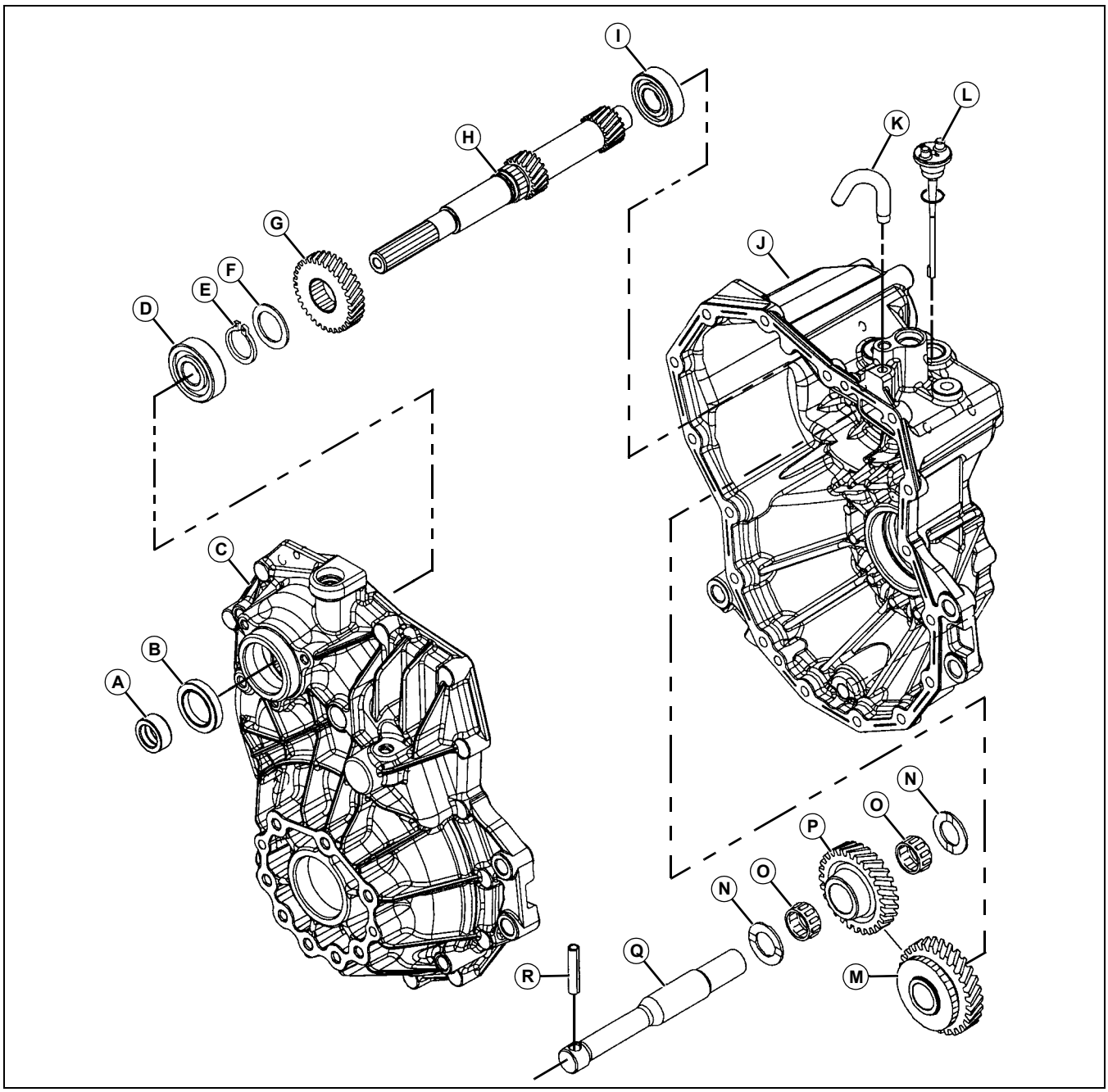


MX31525

A - Cap
B - Nut
C - Gear Shift Handle
D - Gear Shift Arm
E - Cap
F - Differential Lock Handle
G - Differential Shift Arm
H - E-Clip
I - Shaft
J - Spacer
K - Bushing
L - Shift Bracket
M - Washer
N - Nut
O - Washer
P - Pin[5]
Q - Gear Shift Cable assembly
R - Differential Lock Cable Assembly
S - E-Clip
T - Pin
U - E-Clip
V - Differential Lock Linkage Arm
W - Clip
X - Spacer
Y - Drilled Pin
Z - Spring
AA- Transaxle Shift Arm
AB- Lock Washer
AC- Nut

5. Pin secured by spring end (Z).

Transaxle Input Components

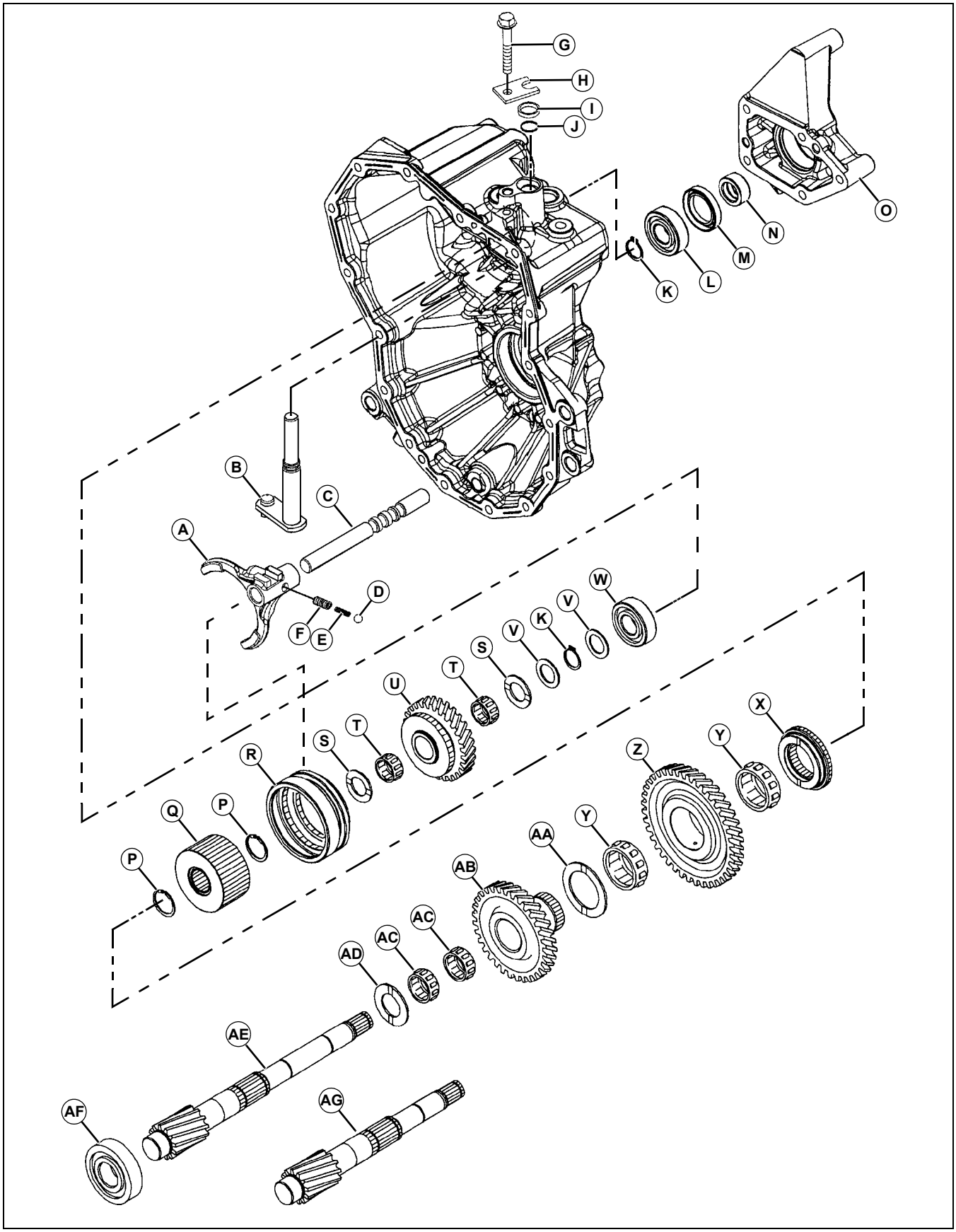


MX31488

A - Sleeve
B - Seal
C - Transaxle Housing Cover
D - Bearing
E - Snap Ring
F - Washer
G - Input Gear
H - Input Shaft
I - Bearing
J - Transaxle Housing
K - Breather
L - Dipstick
M - Reverse Reduction Gear[6]
N - Washer
O - Needle Bearing
P - Reverse Idler Gear
Q - Reverse Idler Shaft
R - Spring Pin

6. Part U on next page.

Transaxle Gear Components

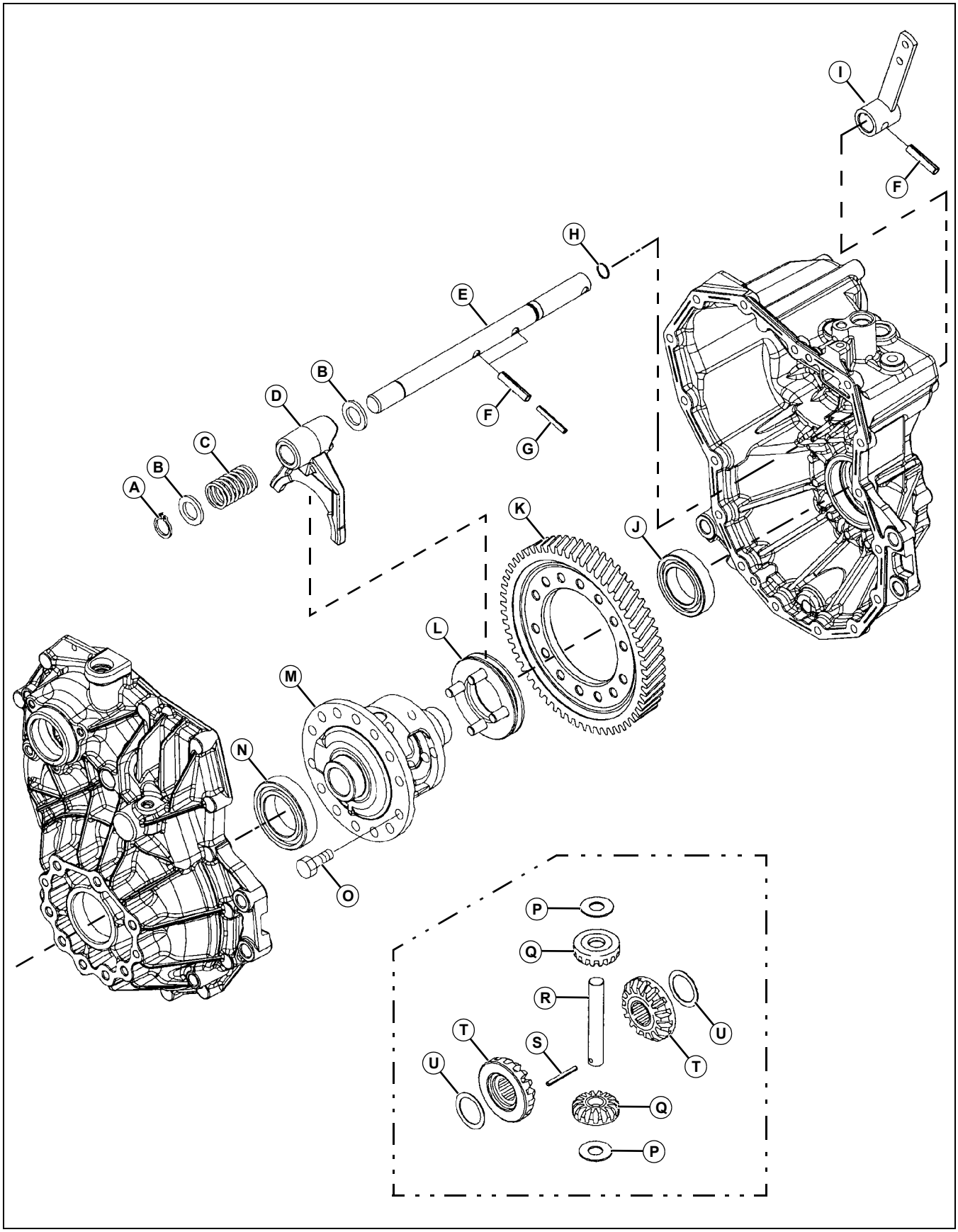


MX31489

A - Shift Fork
B - Shift Arm
C - Shift Shaft
D - Ball
E - Spring, Inner
F - Spring
G - Bolt
H - Keeper Plate
I - Collar
J - Packing
K - Snap Ring
L - Bearing
M - Seal
N - Sleeve
O - Front Drive Cover (2WD Machines)[7]
P - Snap Ring
Q - Spline Collar
R - Shifter
S - Washer
T - Needle Bearing
U - Reverse Reduction Gear
V - Washer
W - Bearing
X - Reduction Collar (High)
Y - Needle Bearing
Z - Reduction Gear (Low)
AA- Washer
AB- Reduction Gear (High)
AC- Needle Bearing
AD- Washer
AE- Reduction Shaft (2 Wheel Drive)
AF- Bearing
AG- Reduction Shaft (MFWD)

7. See "MFWD Rear Gear Case Components" for MFWD machines.

Differential Components

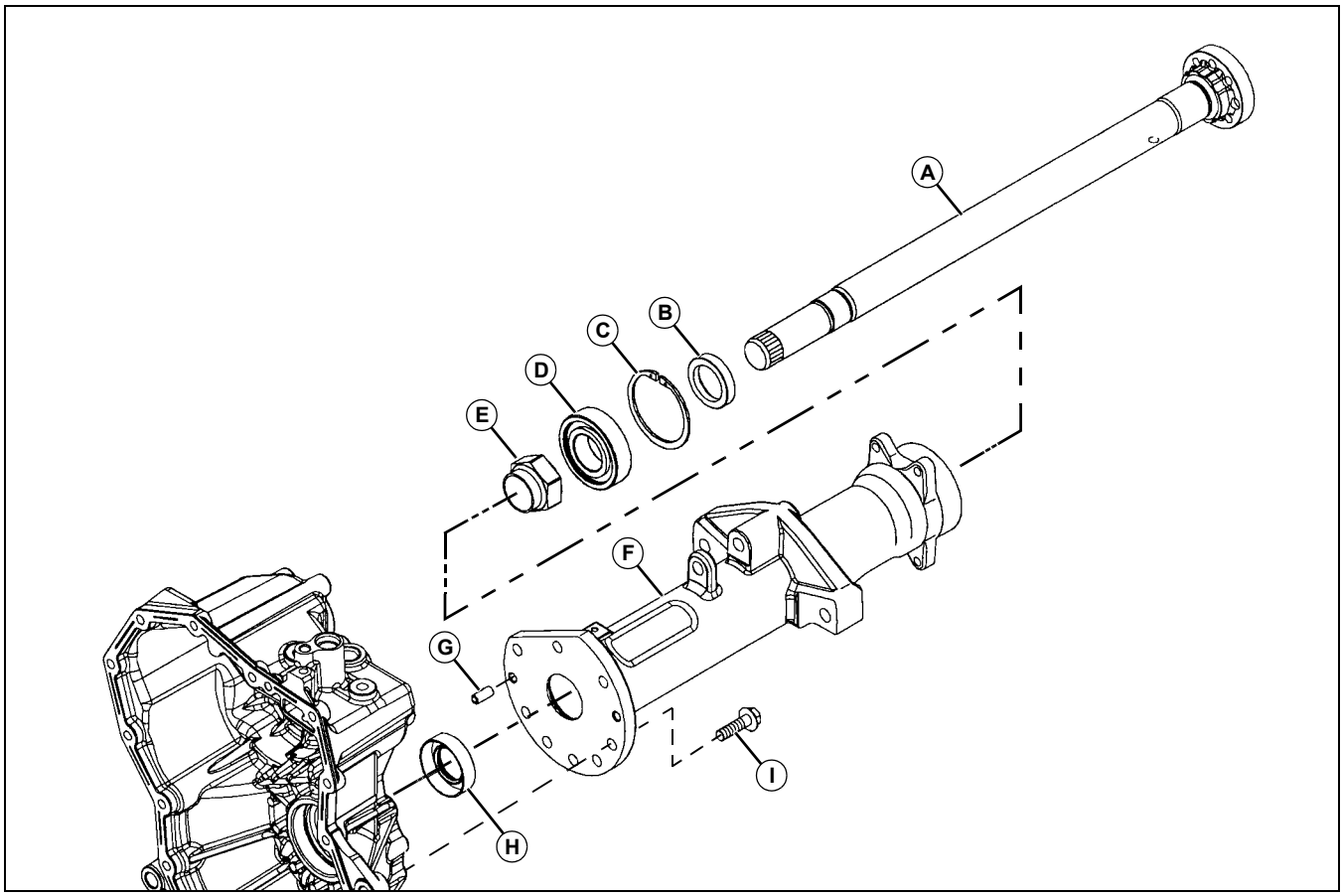


MX31490

A - Snap Ring
B - Spacer
C - Spring
D - Differential Lock Shift Fork
E - Differential Lock Shaft
F - Spring Pin (Outer)
G - Spring Pin (inner)
H - Packing
I - Differential Lock Arm
J - Bearing
K - Ring Gear
L - Differential Lock Slider
M - Differential Case
N - Bearing
O - Bolt (14 used)
P - Washer, Differential Pinion[8]
Q - Differential Pinion Gear
R - Differential Pinion
S - Spring Pin
T - Differential Side Gear
U - Washer

8. Components P through U are inside the differential case.

Rear Axle Components

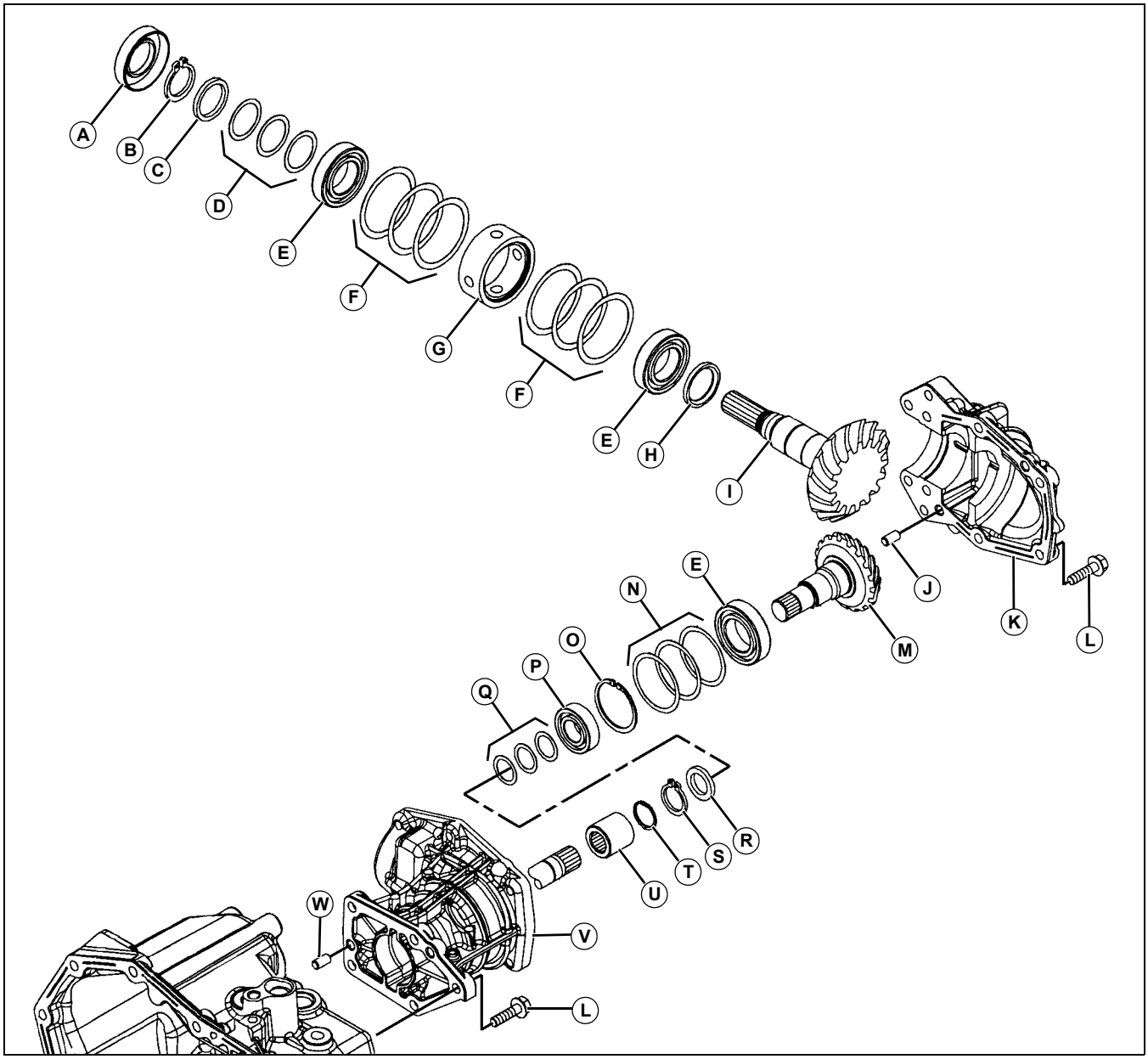


MX31491

A - Axle Shaft[9]
B - Collar
C - Internal Snap Ring
D - Bearing
E - Lock Nut
F - Axle Housing
G - Pin (2 used on each axle housing)
H - Oil Seal
I - Bolt (8 used on each axle housing)

9. Axle component, including axle housing, are identical on each side of machine.

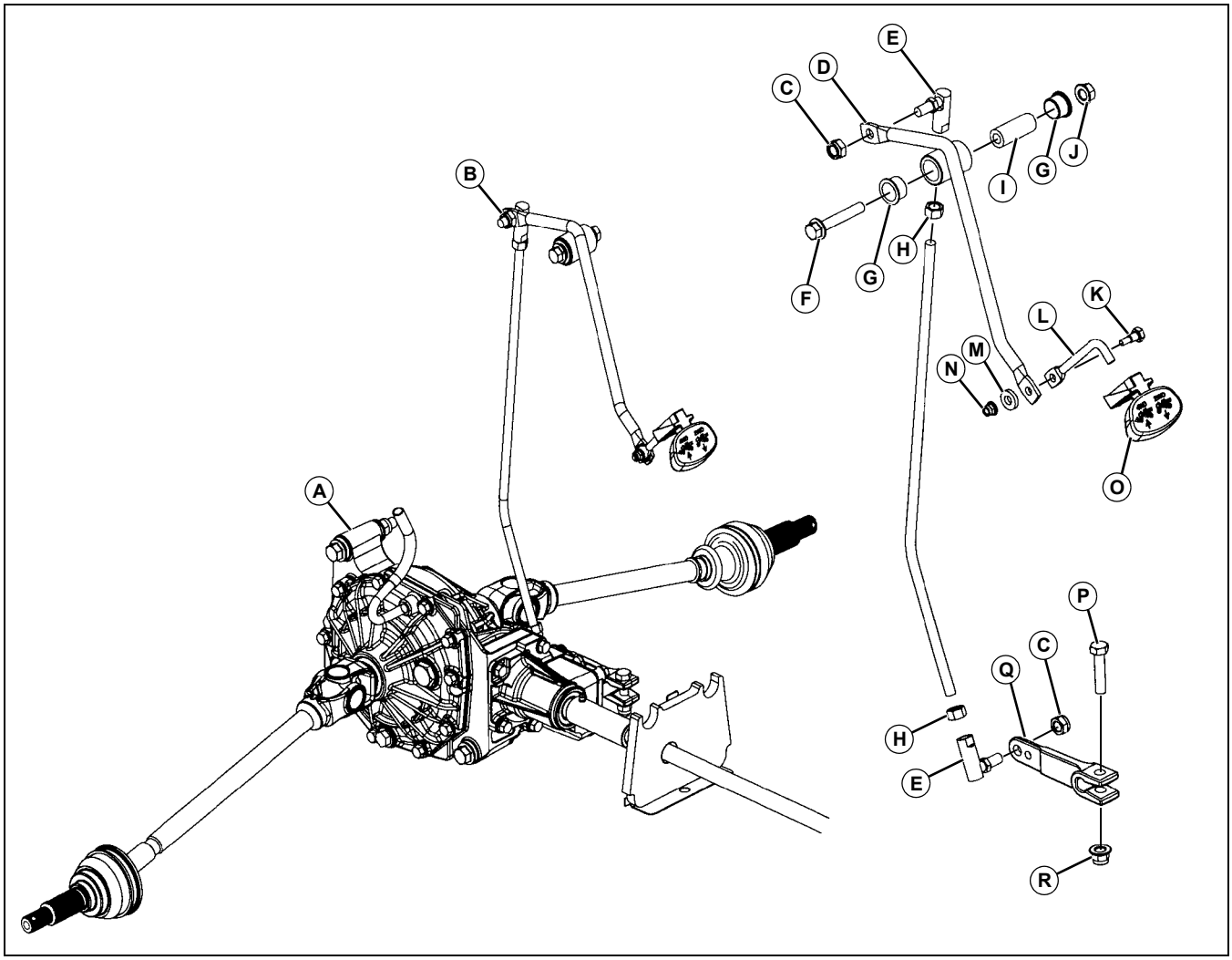
Front Drive Gear Box Components



MX31480

- A - Seal
- B - Snap Ring
- C - Collar
- D - Shims, Assorted (Use as needed)
- E - Bearing
- F - Shims, Assorted (Use as needed)
- G - Collar
- H - Collar
- I - MFWD Front Drive Shaft
- J - Pin (2 used)
- K - Drive Case Cover
- L - Bolt (11 used)
- M - Front Drive Shaft
- N - Shims, Assorted (Use as needed)
- O - Snap ring
- P - Bearing
- Q - Shims, Assorted (Use as needed)
- R - Collar
- S - Snap Ring
- T - Ring
- U - Coupler
- V - MFWD Front Drive Case
- W - Pin (2 used)

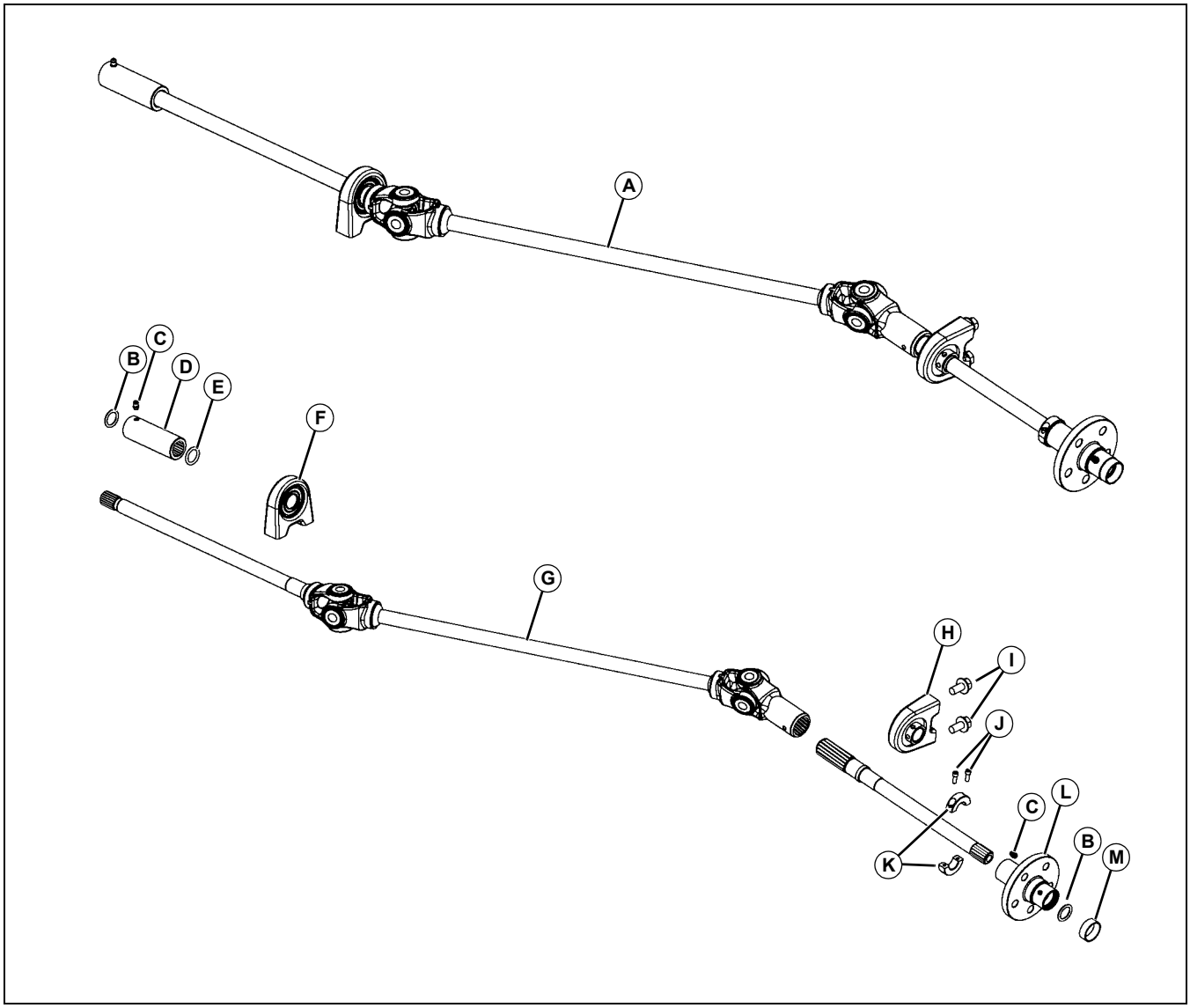
MFWD Shift Linkage Components



MX31535

A - MFWD Front Axle Assembly
B - MFWD Shift Assembly
C - Nut
D - Shift Linkage Weldment
E - Ball Joint
F - Bolt
G - Bushing
H - Nut
I - Spacer
J - Flange Nut
K - Shoulder Bolt
L - Bracket
M - Spacer
N - Nut
O - Handle
P - Bolt
Q - MFWD Shift Arm
R - Flange Nut

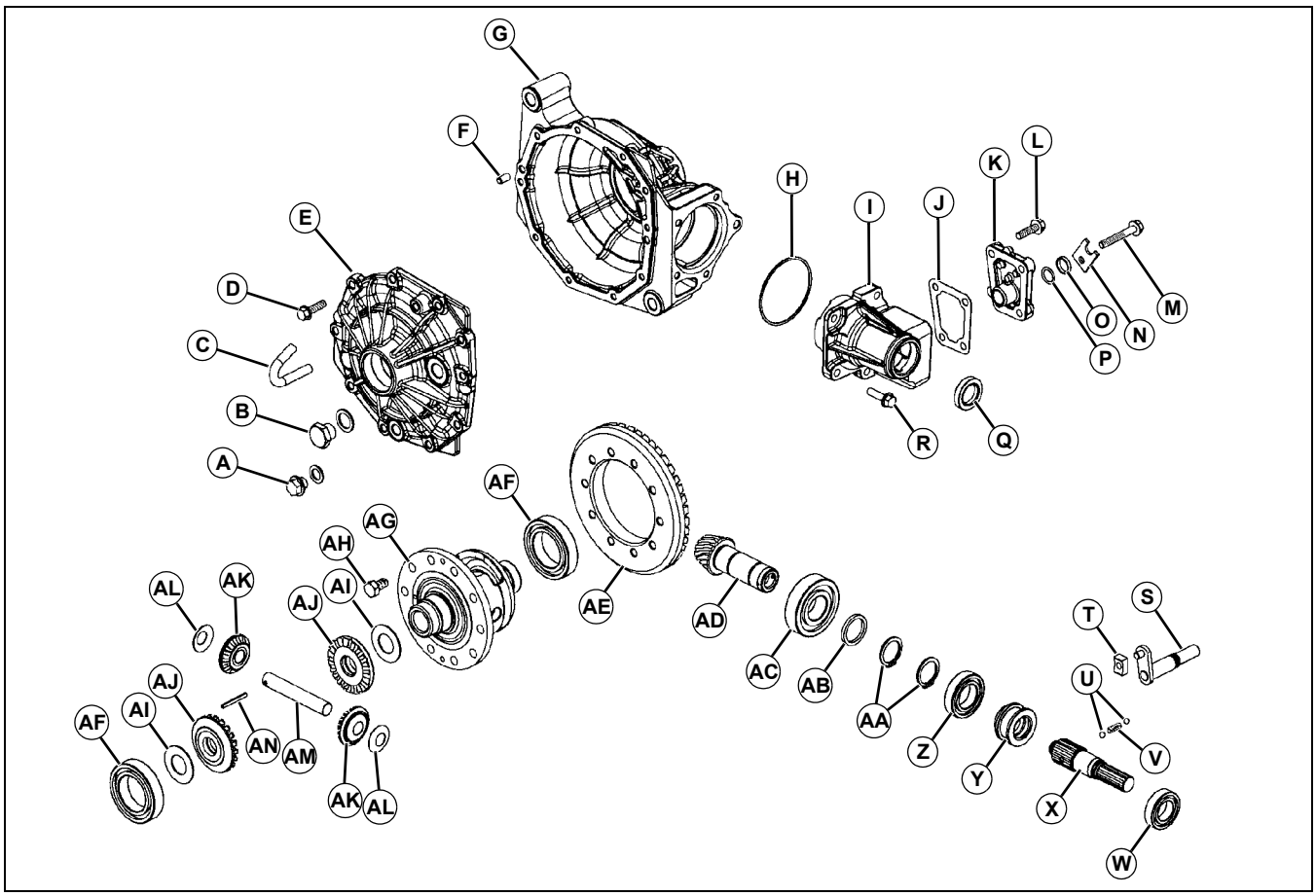
MFWD Driveline Components



MX31537

A - Drive Line Assembly
B - O-Ring
C - Zerk
D - Splined Coupler (to front gear case input shaft)
E - O-Ring
F - Cast Bearing
G - Drive Shaft
H - Cast Bearing
I - Bolts
J - Cap Screws
K - Clamp
L - Brake Disc
M - Spacer

MFWD Front Differential Components

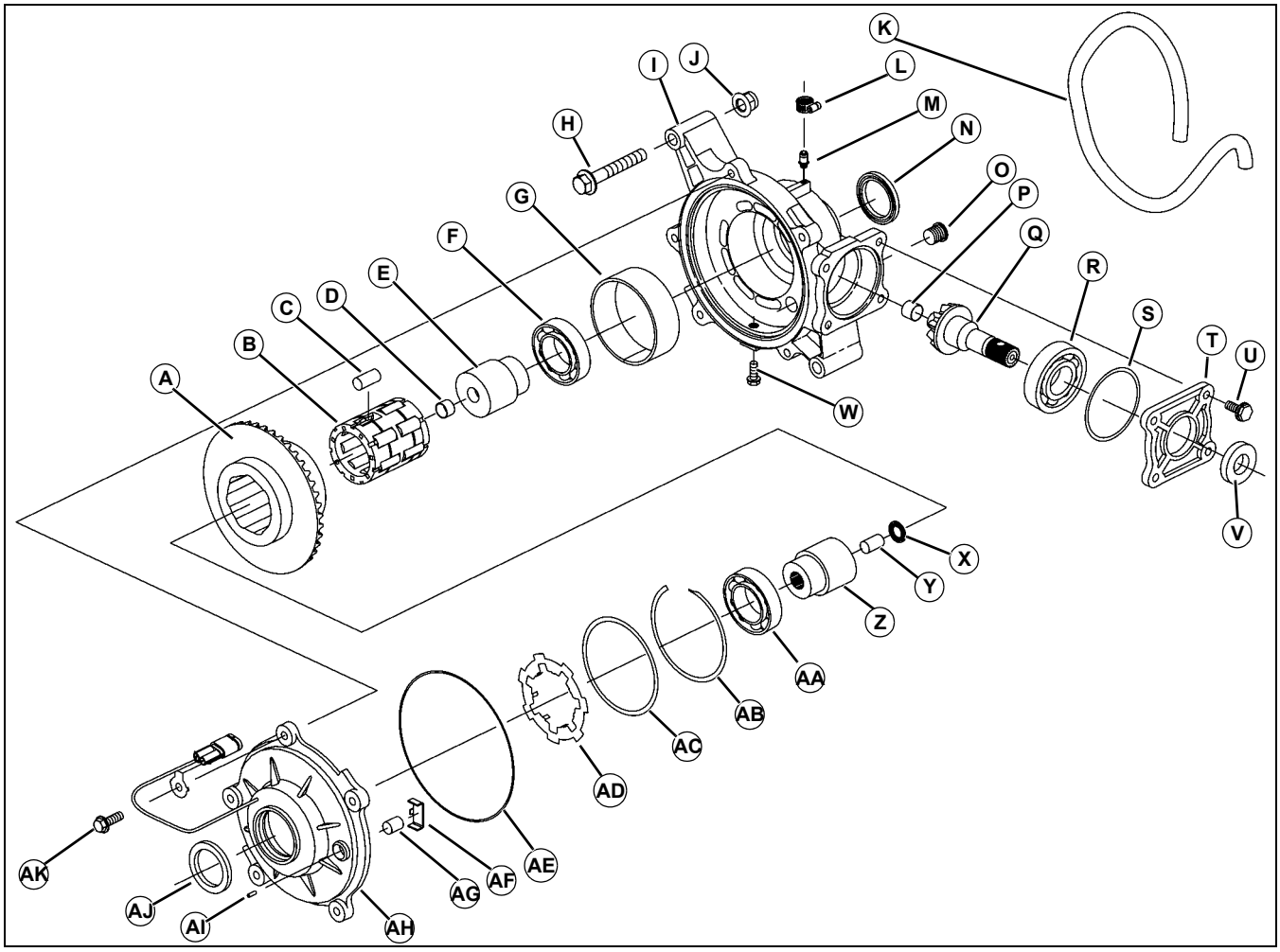


MX31462

A - Bolt and Washer
B - Plug and Packing
C - Breather
D - Bolt (15 used)
E - Housing Cover
F - Pin (2 used)
G - Housing
H - Packing
I - Input Housing
J - Shift Cover Gasket
K - Shift cover
L - Bolt (3 used)
M - Bolt (1 used)
N - Keeper Plate
O - Collar
P - Packing
Q - Seal
R - Bolt (5 used)
S - Shift Shaft
T - Shift Block
U - Ball (2 used)
V - Spring
W - Bearing
X - Input Shaft
Y - Shift Collar
Z - Bearing
AA- Snap ring (2 used)
AB- Collar
AC- Bearing
AD- Pinion Shaft
AE- Ring Gear
AF- Bearing (2 used)
AG- Differential Case
AH- Bolt (10 used)
AI - Liner (side Gear) (2 used)[10]
AJ- Differential Side Gear (2 used)
AK- Differential Pinion Gear (2 used)
AL- Washer (2 used)
AM- Differential Pinion Shaft
AN- Spring Pin

10. Components AI through AN are inside the differential case.

EMFWD Front Differential Components



MX36455

A - Ring Gear
B - Roll Cage
C - Roller
D - Bushing
E - Race - Output Hub Female
F - Bearing
G - Bushing
H - Bolt
I - Gear Case
J - Nut
K - Vent Hose
L - Clamp
M - Hose Fitting
N - Seal
O - Fill Plug
P - Bushing
Q - Pinion Gear
R - Bearing
S - O-ring
T - Pinion Cover
U - Bolt
V - Oil Seal
W - Drain Plug
X - Thrust Bearing
Y - Dowel Pin
Z - Race - Output Hub Male
AA- Bearing
AB- Retaining Ring
AC- Shim
AD- Armature Plate
AE- O-ring
AF- Thrust Bearing
AG- Thrust Button
AH- Cover W/Coil
AI - Set Screw
AJ- Oil Seal
AK- Bolt

Theory of Operation

Power Transfer Operation

Drive Clutch:

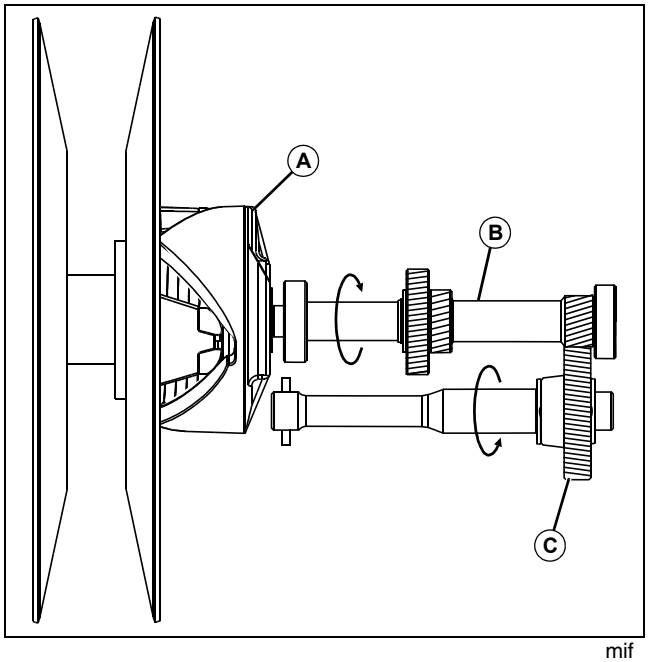
The primary clutch is mounted on the engine crankshaft and is engine speed sensitive. It operates on the principle of centrifugal force. See “Drive Clutch Operation” below.

Driven Clutch:

The secondary clutch, mounted on the transaxle input shaft, is load sensitive to the rear drive wheels. It is driven by a drive belt connected to the drive clutch.

Transaxle:

The transaxle is a gear drive, fork shift, 2-speed forward and single speed reverse transmission.



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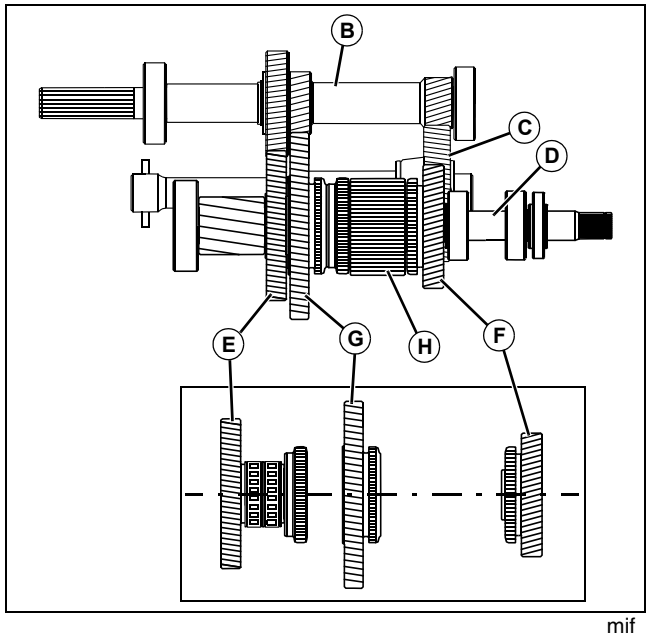
The driven clutch (A) is splined to the input shaft (B). The reverse idler shaft gear C) is in constant engagement to the input shaft.

The input shaft is also in constant engagement to the low speed and high speed gears on the reduction shaft (D).



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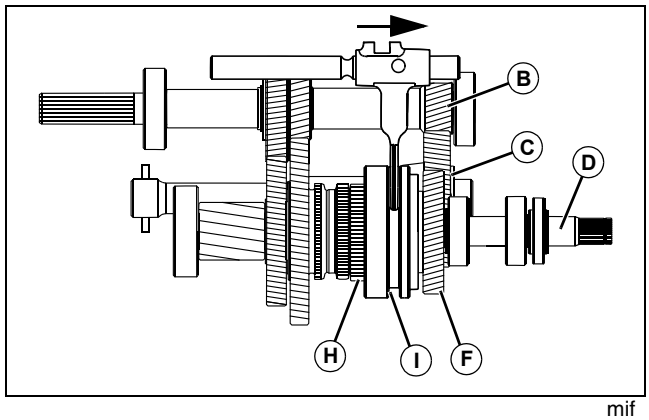
The high speed gears (E) and reverse gear (F) spin freely on the reduction shaft. The low speed gear (G) spins freely on the high speed gear (E) hub and bearings.

The reverse gear (F) is in constant engagement to the reverse idler shaft gear (C). The low speed and high speed gears are in constant engagement with the input shaft (B) gears.

A collar gear (H) is splined to the reduction shaft. Input shaft rotation is transferred to the reduction shaft through the splined gear (H) when forward or reverse is selected.



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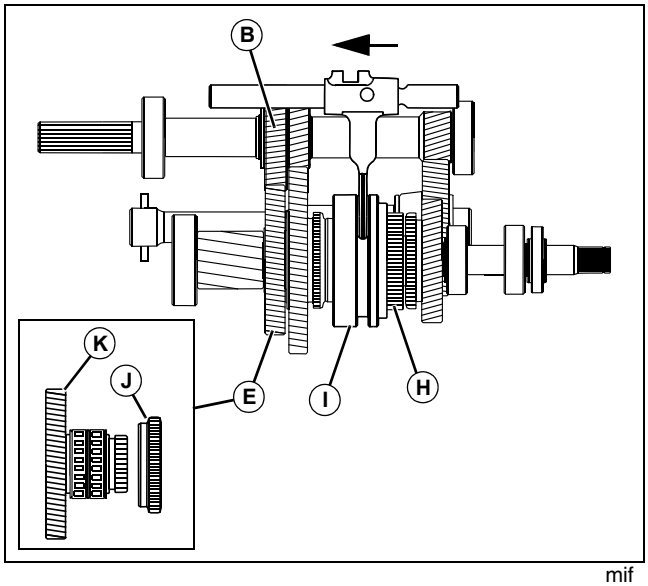
Picture Note: Shown in Reverse

A shift collar (I) is shifted from side to side to select gears. In the neutral position the shift collar (I) is centered on the collar gear (H).

Reverse: In reverse the inside set of splines of the shift collar (I) engage the collar gear (H) to the reverse gear (F). Power is transferred from the input shaft (B) through the reverse idler gear (C), reverse gear (F), shift collar (I) and collar gear (H) to the reduction shaft (D).



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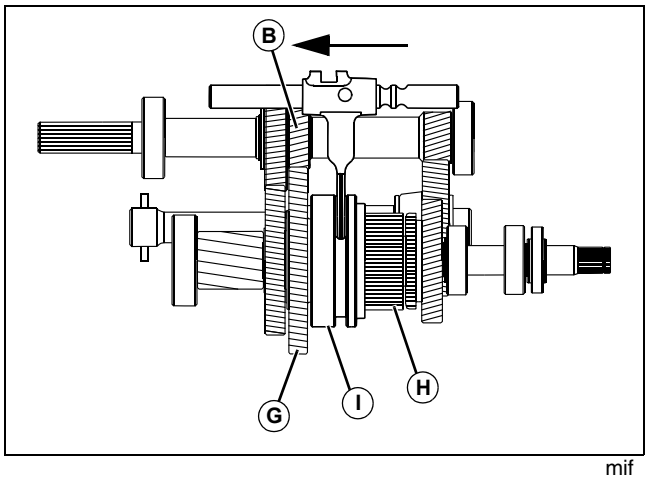
Picture Note: Shown in High Forward

High Forward: In high forward the inside set of splines of the shift collar (I) engage the collar gear (H) to the forward high gear assembly (E). The shift collar engages the gear collar (J) which is splined to the gear (K). This is a set of gears to allow the removal and installation of the low speed gear and bearings to the hub of gear (K). Power is transferred from the input shaft (B) through the high speed gear set (E), shift collar (I) and collar gear (H) to the reduction shaft.



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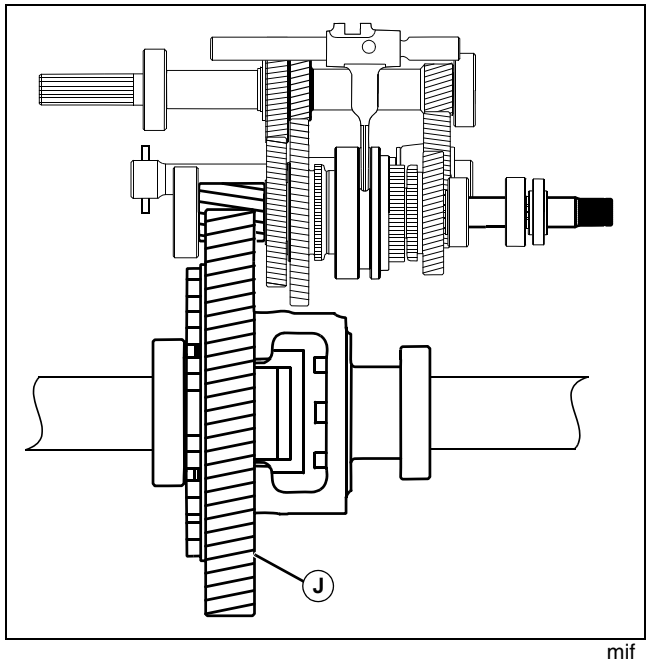
Picture Note: Shown in Low Forward

Low Forward: In low forward the inside set of splines of the shift collar (I) engage the collar gear (H) to the forward low gear (G). Power is transferred from the input shaft (B) through the low speed gear (G), shift collar (I) and collar gear (H) to the reduction shaft.

The higher gear ratio produces a lower speed rotation of the reduction shaft.

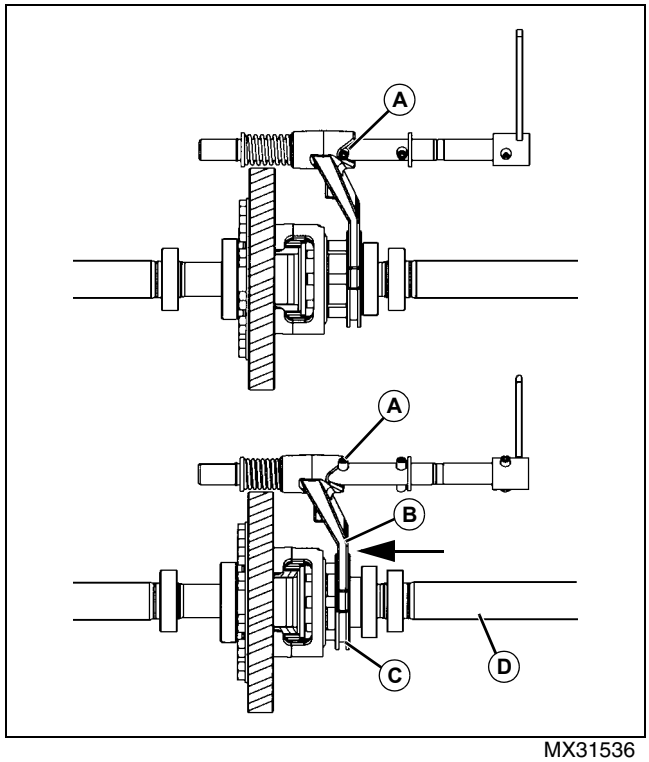


mif

The reduction shaft gears transfer power to the differential ring gear (J) and then to the axles.

Differential Lock:

The rear wheels can be locked together by a fork shift differential. The differential is engaged by the operator station shift lever, or when the park brake lever is set. The differential is locked in the first 12 degrees of park brake lever movement, before the park brake is set.



MX31536

As the differential shaft is rotated forward a spring pin (A) moves the shift fork (B) to the left engaging the differential lock slider (C) to the differential. This locks the right axle (D) to the differential gears and left axle.

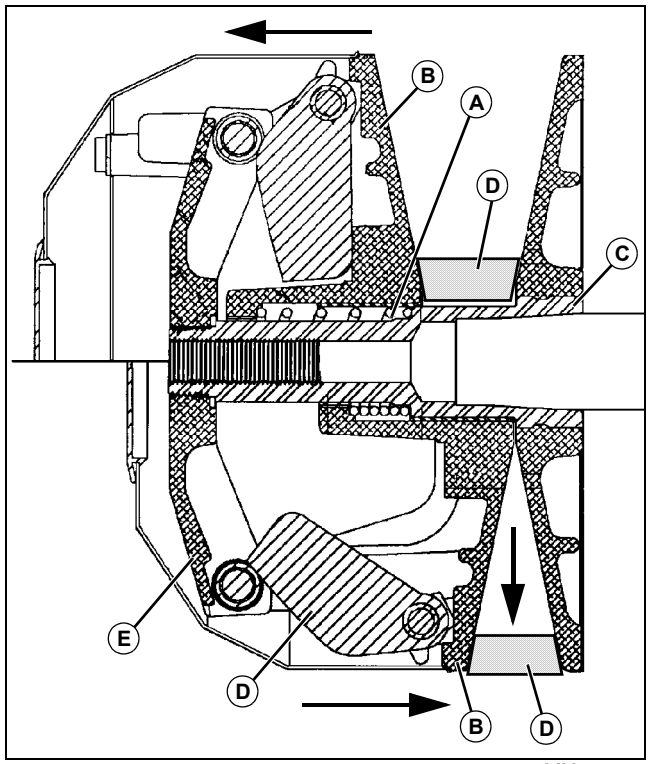
Mechanical Four Wheel Drive (MFWD):

On MFWD machines the reduction shaft is coupled to a direct drive right angle gear case bolted to the side of the transaxle.

A drive shaft couples the gear case output shaft to an input shaft of the front axle MFWD gear case. The drive shaft rotates any time the forward or reverse gears are selected.

A shift fork in the front gear case engages the input shaft to a pinion shaft and ring gear of the front axle differential. The differential transfers power to the front wheels. There is not a differential lock for the front axle.

Drive Clutch Operation



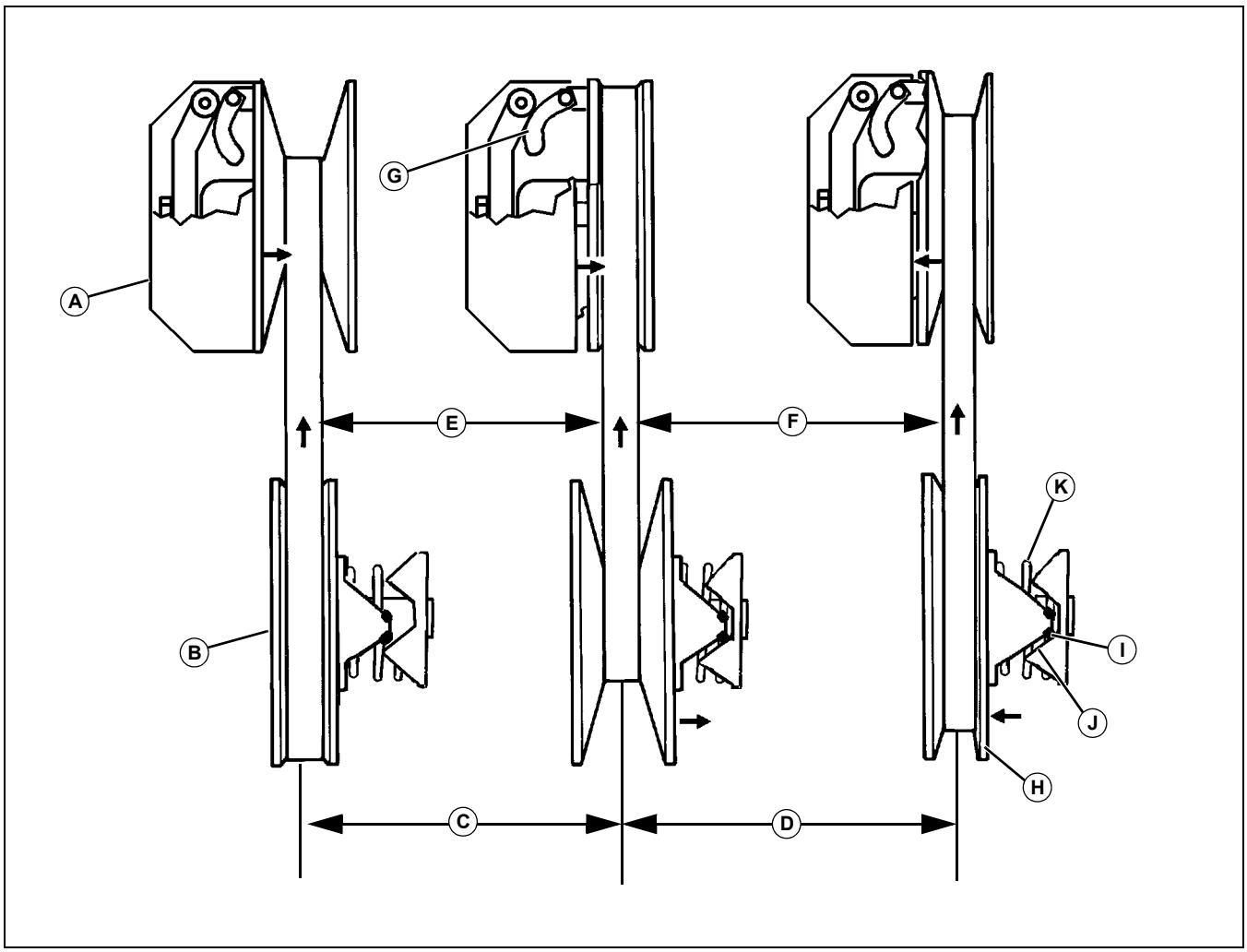
MX31492

Picture Note: Top - Low Engine RPM, Bottom - High Engine RPM

The drive clutch sheave opens and closes based on the actions of two opposing forces. At rest (with no rotation) the compression spring (A) pushes the movable half of the sheave (B) away from the hub (C) on the crankshaft of the engine. The drive belt (D) rides low in the separated sheave halves.

As the engine rpms increase centrifugal force rotates the weights (D) out. The weights ride on rollers attached to the spider (E) which is fixed to the hub (C). This action forces the movable half of the sheave (B) toward the fixed half. This movement compresses the spring (A) and forces the drive belt (D) toward the outside of the sheave.

Clutch Operation



MX30398

Theory of Operation:

The variable clutch system is speed and load sensitive. The primary (A) and secondary (B) clutches work together, automatically up-shifting (C) and back-shifting (D). This shifting changes the ratio between the clutches, allowing the engine to operate at optimum efficiency, at the peak of its power curve.

The primary clutch is engine speed sensitive, and is mounted on the engine crankshaft. It operates on the principle of centrifugal force. The secondary clutch, mounted on the transaxle input shaft, is load sensitive to the rear drive wheels.

Engagement RPM, Minimum Load, Low Output Speed (E):

Primary clutch sheaves are moving closer together, just starting to move drive belt. Drive belt is running at the top of secondary clutch. A high ratio between the clutches exist, similar to a low gear, as long as there is a minimum load.

High Engine RPM, Light Load, High Output Speed (F):

As engine speed increases, centrifugal forces of the flyweights (G) force the primary clutch to up-shift, moving the drive belt to outer pulley diameter, overcoming secondary clutch spring. Drive belt then is pulled deep in secondary clutch giving a low ratio, similar to a high gear.

High Engine RPM, Increasing Load, Lower Output Speed:

Back-shifting occurs as a load is encountered, such as a hill or soft terrain. The stationary side of the secondary clutch resists forward movement of the wheels, at the same time, torque from the drive belt moves the moveable sheave (H) up the ramp. The ramp buttons (I), ramp (J), and spring (K) force the belt to the outside diameter of the secondary clutch, and overcomes centrifugal forces of the primary clutch causing the back-shifting.

Diagnostics

Diagnostic Check Points

Test Conditions:

- Engine off
- Rear wheels supported off floor
- Air pressure equal in driving tires. Driving tires close to same radius.

System: Drive Train

(1) Drive belt is in good condition?

Yes - Go to next step.

No - Replace drive belt.

(2) Shift linkage shifts in to forward high and low, neutral and reverse and stays in gear during operation?

Yes - Go to next step.

No - Adjust shift linkage. See “Transaxle Shift Adjustment” on page 461.

(3) Axles rotate smoothly and quietly; no free play in axles, bearings or housings?

Yes - Go to next step.

No - Check axles and housings.

(4) Brakes not dragging?

Yes - Go to next step.

No - Adjust or repair brakes. See Brakes section.

(5) Differential lock engages and disengages

Yes - Go to next step.

No - Adjust differential lock. See “Differential Lock Adjustment” on page 462.

(6) Differential lock produces no ratcheting sound in transaxle?

Yes - Go to next step.

No - Check internal components.

Test Conditions:

- Engine running at operating temperature and brakes set
- Transmission in neutral position
- Ensure engine is at correct slow idle speed. See appropriate engine specifications.

System: Engine Primary Clutch

(1) Primary clutch disengaged (drive belt not moving)?

Yes - Go to next check.

No - Repair or replace primary clutch.

Test Conditions:

- Engine running at operating temperature and brakes set
- Transmission in neutral position
- Accelerate engine

System: Engine Primary Clutch

(1) Primary clutch engages drive belt at 1350 - 1600 rpm?

Yes - Go to next check.

No - Replace drive belt. Repair or replace primary clutch.

Test Conditions:

- Engine running at operating temperature and brakes set
- Transmission in neutral position
- Ensure engine is at correct fast idle speed. See appropriate engine specifications.

System: Primary and Secondary Clutch

(1) Primary clutch sheave (movable clutch sheave) moves toward stationary sheave?

Yes - Go to next step.

No - Repair or replace primary clutch.

(2) Secondary clutch sheaves separate?

Yes - Go to next step.

No - Repair or replace secondary clutch.

(3) Secondary clutch fully up-shifted, primary clutch sheaves completely close?

Yes - Go to next check.

No - Repair or replace drive and/or secondary clutches.

Tests and Adjustments

Transaxle Shift Adjustment

Purpose:

To adjust gear shift lever to center of shift quadrant.

To insure both forward and reverse gears will be completely engaged.

To help prevent shifter from disengaging from gear during operation.

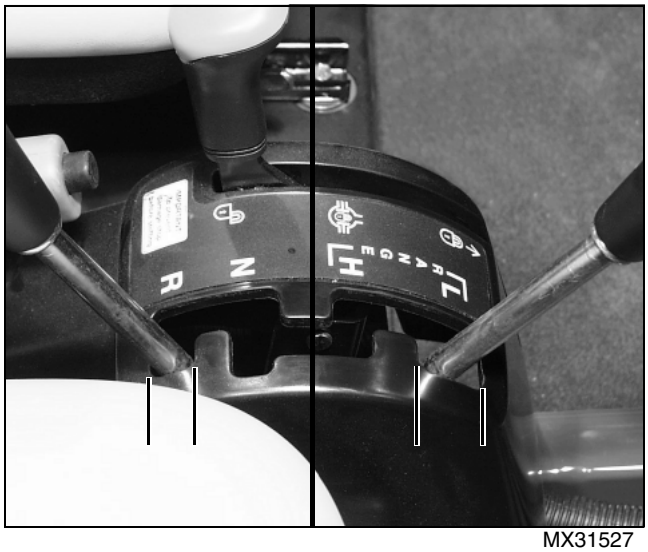
Procedure:

1. Park machine safely. See Parking Safely in the Safety Section.

2. Lock park brake.

3. Raise and lock cargo box.

NOTE: It may be necessary to rock the machine to fully shift into Forward and/or Reverse.



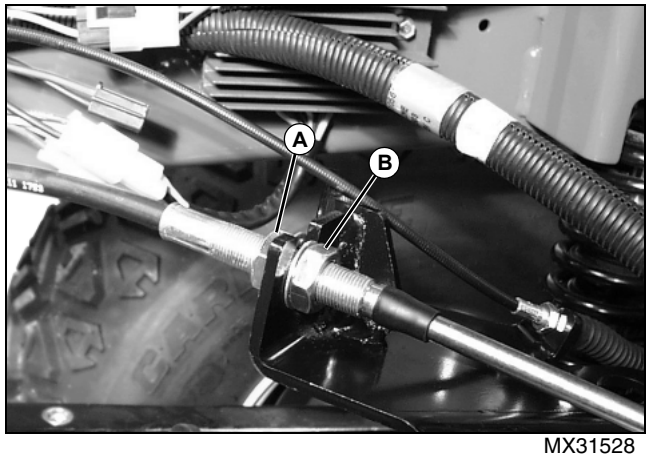
MX31527

Picture Note: Split picture used to show shift lever centered in both Forward and Reverse positions.

4. Shift into forward and reverse. There should be an even gap between the lever and quadrant in both forward and reverse positions. The shift lever should NOT contact the shift quadrant in either forward or reverse.

5. If necessary adjust cable to position shift lever in quandrant.

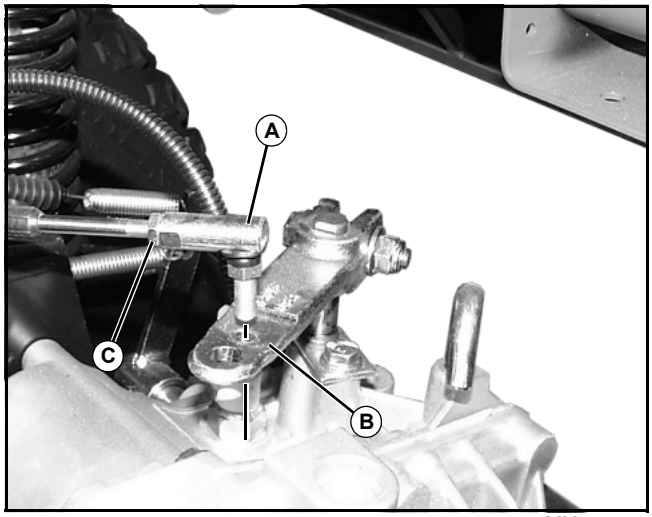
- Place shift lever in the Neutral “N” position.
- Verify that the transaxle clicks firmly into the center neutral position.



MX31528

- Loosen nuts (A) and (B) on transaxle shift cable.
- To move shift lever forward in shift quadrant: Loosen nut (B) and tighten nut (A).
- To move shift lever toward the rear in shift quadrant: Loosen nut (A) and tighten nut (B).
- Adjust nuts until the shift lever is centered in the Neutral position of the shift quadrant opening and does not touch the quadrant when placed fully in Reverse or Range L.

6. Move shift lever until detent inside transaxle clicks firmly into the center neutral position.



MX31526

7. Remove nut and lock washer securing shift cable end (A) to transaxle shift arm (B).

8. Place transaxle shift arm in NEUTRAL position.

9. Place shift lever in NEUTRAL position in shifter quadrant.

10.Check that shift cable end can be inserted and removed from transaxle shift arm easily. Adjust cable end if necessary.

- Loosen jam nut (D).

- While holding shift cable screw or unscrew shift cable end (A) until it can inserted and removed from transaxle shift arm easily.
- Tighten jam nut (D).

11.Install lock washer and nut securing shift cable end (A) to transaxle shift arm (B).

12.Shift into forward and reverse. There should be an even gap between the lever and quadrant in both forward and reverse positions. The shift lever should NOT contact the shift quadrant in either forward or reverse.

13.Shift into neutral and check neutral start.

14.Drive machine over rough ground to check adjustments.

Differential Lock Adjustment

Purpose:

To insure differential shift lever fully engages and disengages differential lock.

To insure differential lock works with park brake.

Procedure:

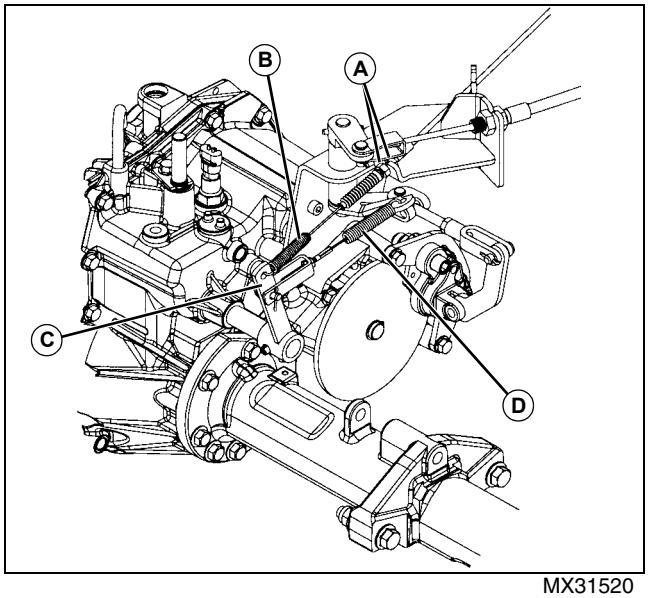
1. Park machine safely. See Parking Safely in the Safety Section.

2. Raise and lock cargo box.

3. Block wheels to prevent machine from rolling.

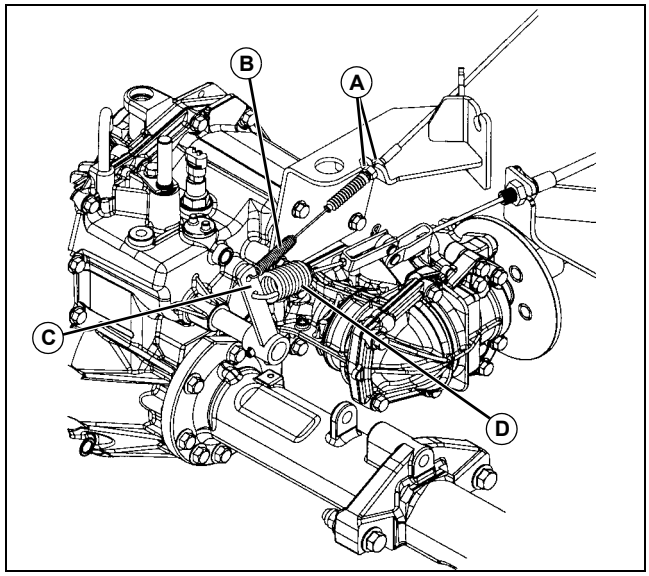
4. Unlock park brake.

NOTE: Setting the park brake engages the differential lock and locks the rear wheels together before the park brake is engaged.



MX31520

Picture Note: 2-Wheel Drive Machine



MX31521

Picture Note: MFWD Machine

5. Loosen jam nuts (A). Adjust nuts until differential cable places tension on spring (B) but does not move differential lock arm (C).

6. Check park brake-to-differential lock arm spring (D) for tension.

- If slight tension is there without the differential lock arm moving, no adjustment is needed.
- If there is no tension but the cable through the spring is taut, no adjustment is needed.
- If there is no tension and the cable through the spring is loose, adjust park brake-to-differential arm cable. See “2-Wheel Drive Park Brake Adjustment” on page 549, or “MFWD Drive Park Brake Adjustment” on page 549.

Results:

1. Engage and disengage differential lock several times.
   - Check that the differential cable places slight tension on spring (B) but does not move differential lock arm (C) with the differential lock released.
   - Check that the differential lock arm moves to engaged position with either the differential lock lever or the park brake engaged. You may have to push the machine a short distance with the wheels turned until the differential lock engages.

MFWD Linkage Adjustment

Purpose:

To set MFWD engagement and disengagement properly and to avoid preload being applied to front differential shift fork. Preload being applied to the shift fork can cause damage if left uncorrected.

MFWD linkage needs adjustment if the following complaints or symptoms are noted:

- Four wheel drive does not stay engaged under load
- Noise from front axle transfer case

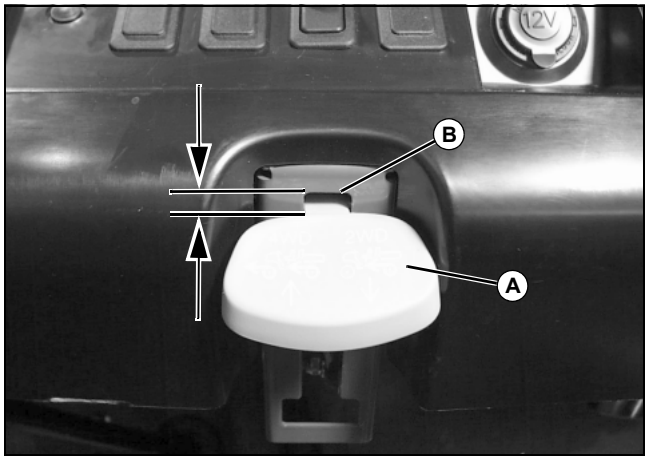
Check Adjustment:

1. Engage the MFWD.

2. Park machine safely. See Parking Safely in the Safety Section.

3. Lock park brake.

NOTE: It may be necessary to wiggle the MFWD linkage to set it in a "free-float" position.



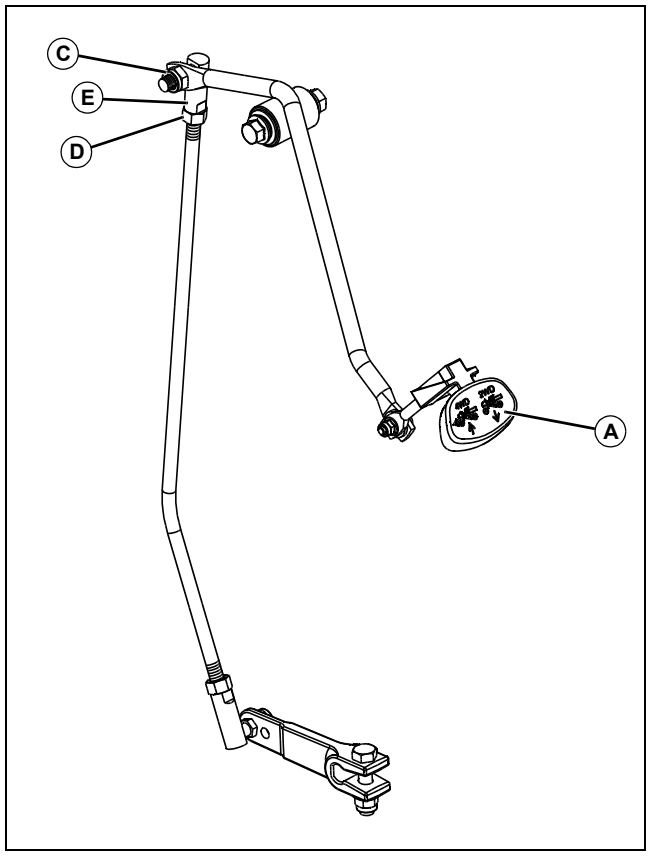
MX32610

4. Check that the top of the MFWD lever (A), when allowed to "free-float", is 1 - 6 mm (0.4 - 0.24 in.) from the top of the lever slot (B).

Results:

- It the MFWD lever is positioned correctly no adjustment is needed.
- If the MFWD lever is too close or too far from the top of the lever follow the Adjustment Procedure.

Adjustment Procedure:



1. Remove lock nut (C) and disconnect adjustment rod from MFWD shift lever rod.

2. Loosen jam nut (D).

NOTE: It may be necessary to adjust both the top and bottom ball joints to ensure proper thread engagement at both ends.

3. Unscrew ball joint (E) to increase gap or screw ball joint onto rod to decrease gap. Adjust as necessary.

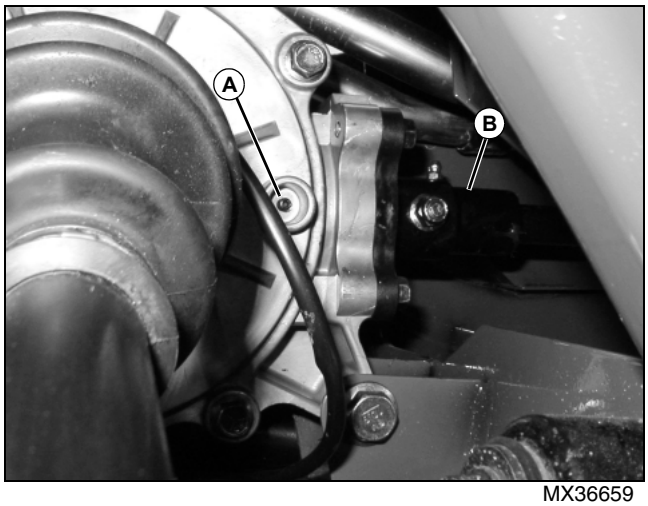
4. Tighten jam nut (D).

5. Connect ball joint to shift lever and install lock nut (C).

EMFWD Ring and Pinion Backlash Adjustment

Procedure:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Lock park brake.
3. Jack up front of machine and place on jack stands.
4. Turn steering wheel to full left turn position.



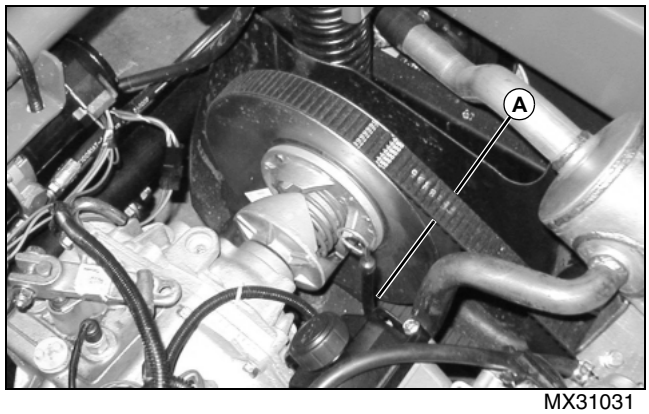
MX36659

5. Using a 3/32 in. allen wrench, turn set screw (A) clockwise until tight. (Do not apply a lot of torque). At this point you should not be able to turn the pinion shaft (B).
6. While trying to turn the pinion shaft, slowly loosen the set screw (counter clockwise) until the pinion shaft starts to turn. Keep loosening the set screw in small increments until the pinion shaft can be rotated four times freely (one revolution of the ring gear) without any tight spots. You should only have to loosen the setscrew between 3/8 and 3/4 of a turn to obtain proper backlash setting.

Checking Drive Belt

CAUTION: Avoid injury! Rotating parts can catch fingers or loose clothing. Stop engine and wait for all moving parts to stop before servicing.

1. Park machine safely. See Parking Safely in the Safety Section.
2. Lock park brake.
3. Raise and lock cargo box.
4. HPX Trail Gator 4x4: Remove clutch enclosure.
5. Rotate and inspect belt for wear or damage.



MX31031

6. Measure the top surface of the belt width at (A). Dimension should be a minimum of 27 mm (1.1 in.).
7. Replace belt if worn beyond limit.
8. HPX Trail Gator 4x4: Install clutch enclosure.
9. Lower the cargo box.

Repair

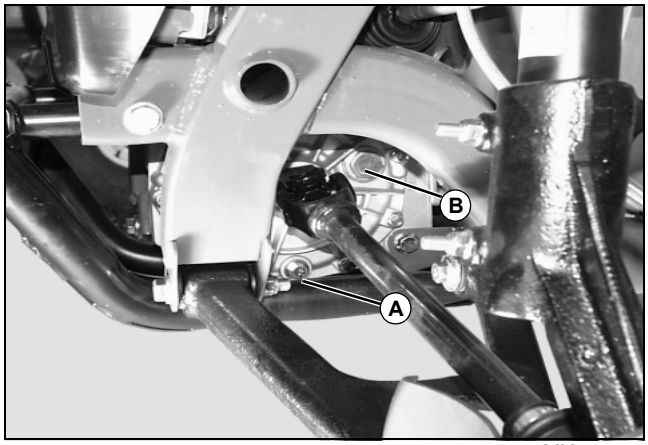
Changing MFWD Differential Oil (SN -40000)

1. Operate machine to warm MFWD differential oil.

2. Park machine safely. See Parking Safely in the Safety Section.

3. Lock park brake.

IMPORTANT: Avoid damage! Dirt and debris in oil may cause damage to the MFWD differential. Clean area around opening before removing plug.



MX31027

4. Position drain pan under MFWD differential drain plug (A).

5. Remove fill plug (B) located on left side of MFWD differential.

6. Remove MFWD differential drain plug (A) and allow oil to drain.

7. Install and tighten drain plug after all oil has drained.

8. Add approximately 0.9 L (0.95 qt) of J20C low viscosity HY-GARD oil until the level is even with the bottom of the fill port.

9. Install and tighten fill plug.

10.Check MFWD differential oil level again after the first several hours of operation.

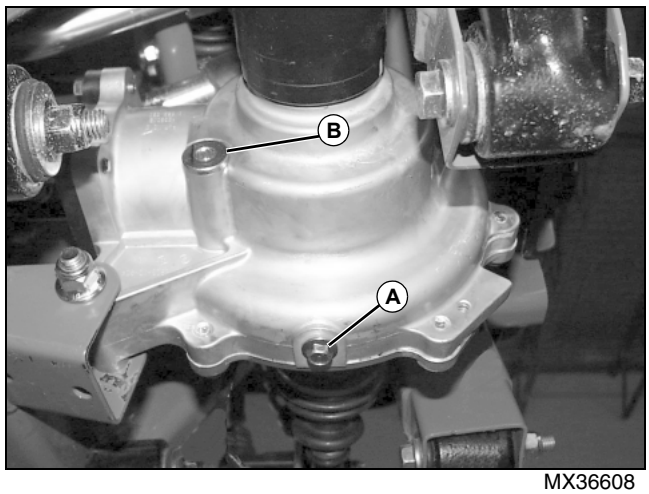
Changing EMFWD Differential Oil (SN 40001-)

1. Operate machine to warm EMFWD differential oil.

2. Park machine safely. See Parking Safely in the Safety Section.

3. Lock park brake.

IMPORTANT: Avoid damage! Dirt and debris in oil may cause damage to the MFWD differential. Clean area around opening before removing plug.



MX36608

4. Place a drain pan under front differential and remove drain plug (A) and allow oil to drain.

5. Clean drain plug and install with new nylon sealing washer. Tighten to 12 N•m (110 lb in.).

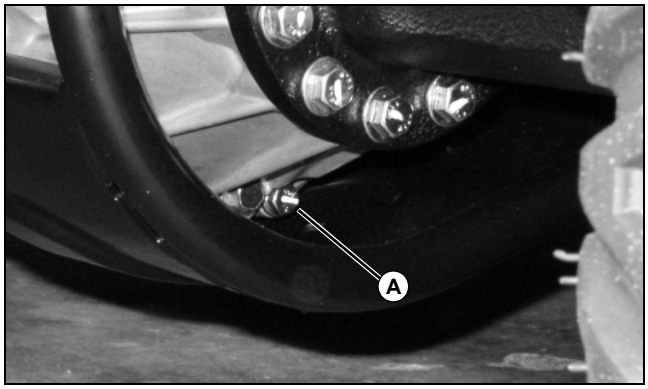
6. Remove fill plug (T) and fill gearcase with 150 ml (5 oz) of J20D low viscosity HY-GARD oil.

7. Install fill plug and tighten to 13.5 N•m (120 lb in.).

Changing Transaxle Oil

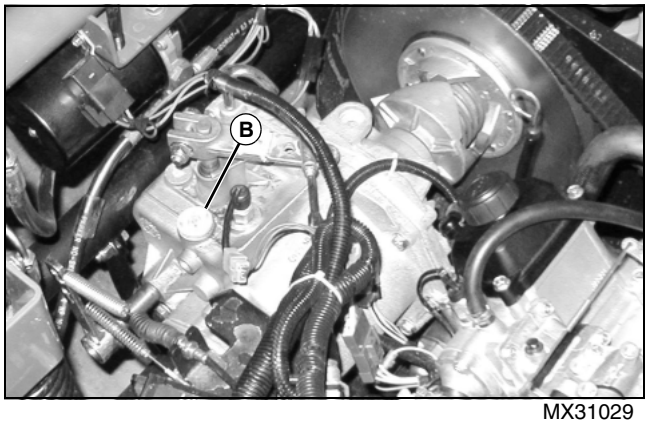
1. Operate machine to warm transaxle oil.
2. Park machine safely. See Parking Safely in the Safety Section.
3. Lock park brake.
4. Raise and lock cargo box.

IMPORTANT: Avoid damage! Dirt and debris in oil may cause damage to the transaxle. Clean area around opening before removing plug or dipstick.



MX31028

5. Position drain pan under transaxle drain plug (A).
6. Remove plug and drain oil.
7. Check O-ring on drain plug. Replace if missing or in poor condition.
8. Install and tighten drain plug.



MX31029

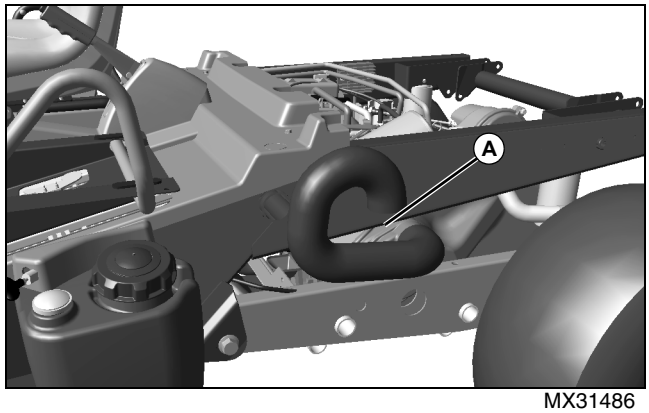
9. Remove dipstick (B) located on top of transaxle housing. Wipe dipstick clean.
10. 4X4 Machines: Add approximately 4.5 L (4.8 qt) of oil 4X2 Machines: Add approximately 4.0 L (4.2 qt) of oil.
11. Check oil level by setting dipstick on threads in transaxle case, then removing and checking oil level.
12. Wait for two minutes then check oil level. Add oil if necessary.
13. Install dipstick and tighten.
14. Lower the cargo box.

Removing and Installing Clutch Enclosure Cover - Trail HPX 4x4

Removing

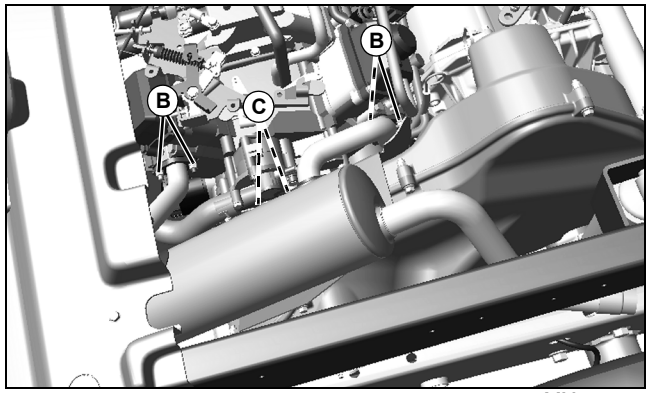
CAUTION: Avoid injury! Rotating parts can catch fingers or loose clothing. Stop engine and wait for all moving parts to stop before servicing.

1. Park the vehicle safely.
2. Raise and secure cargo box.



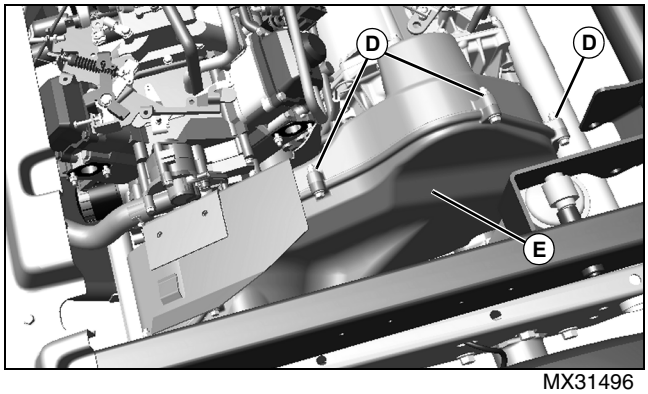
MX31486

3. Remove breather intake hose (A).



MX31495

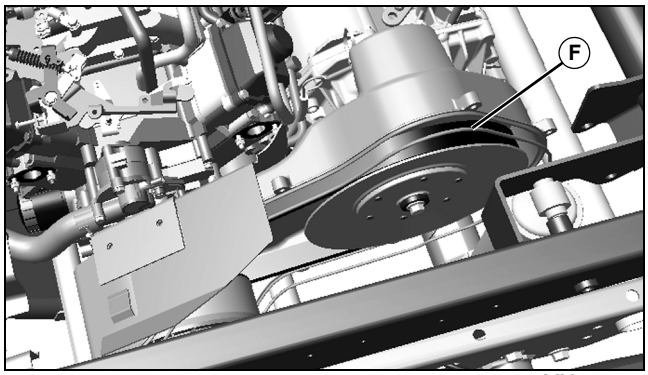
4. Remove the nuts (B) securing the muffler to engine block and cap screws (C) securing the muffler to the mounting bracket.
5. Remove muffler.



MX31496

6. Remove the ten cap screws and nuts (D) (three shown), securing the enclosure cover (E) to the enclosure.

7. Remove the enclosure cover (E).



MX31497

8. Remove and inspect the seal gasket (F) for cracks or damage.

Installing

1. Install seal gasket (F) onto enclosure.

2. Install the enclosure cover (E) and secure with ten cap screws and nuts (D) (three shown).

3. Install muffler and secure with nuts (B) to engine block and cap screws (C) to the mounting bracket.

4. Install breather intake hose (A).

5. Lower the cargo box.

Primary Drive Clutch Removal

1. Park machine safely. See Parking Safely in the Safety Section.

2. Lock park brake.

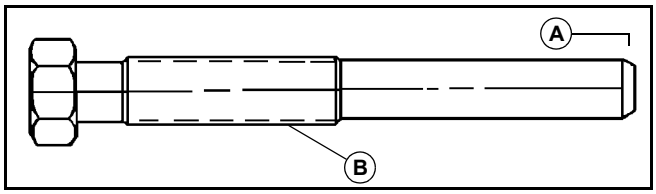
3. Raise and lock cargo box.

4. Raise and safely support the rear axle.

5. Remove left rear wheel.

6. Remove drive belt.

IMPORTANT: Avoid damage! Lightly grease end of puller (A) to help prevent puller wear. To prevent clutch thread damage, DO NOT thread bolt in any farther than necessary to remove clutch.



M58704

7. Remove plastic plug from clutch cover.

8. Remove clutch mounting bolt and washers.

9. Use JDG1641 Clutch Removal Tool (B). Thread puller into clutch and against crankshaft. Tighten until clutch pops free from crankshaft taper.

NOTE: An air impact wrench works well to remove the primary clutch.

10.Install clutch in reverse order of removal. Tighten clutch bolt to specification.

Torque Specification:

Clutch Bolt . . . . . 37 N•m (26 lb-ft)

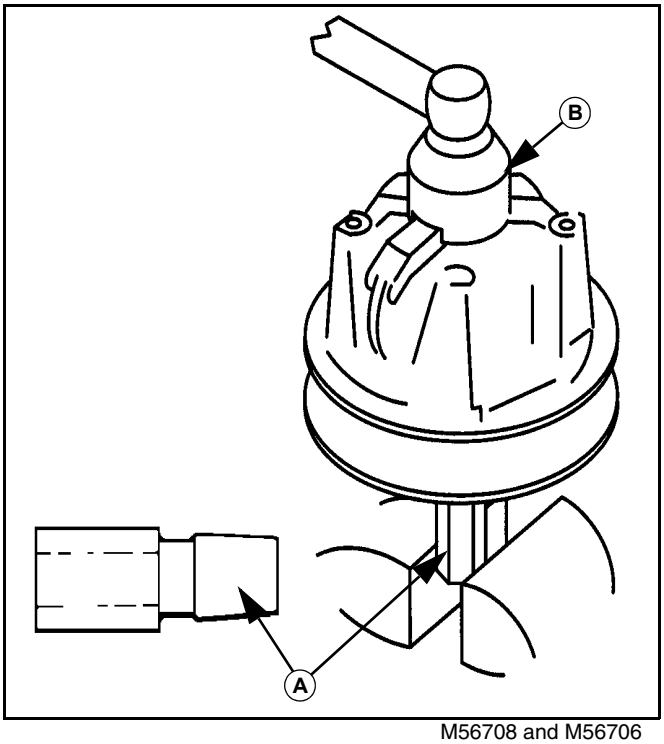
Primary Drive Clutch Repair

Special or Required Tools:

- JDG813 Clutch Servicing Kit

Procedure:

1. Remove clutch cover bolts. Remove cover. (Cover should pop off; do not pry on cover).



M56708 and M56706

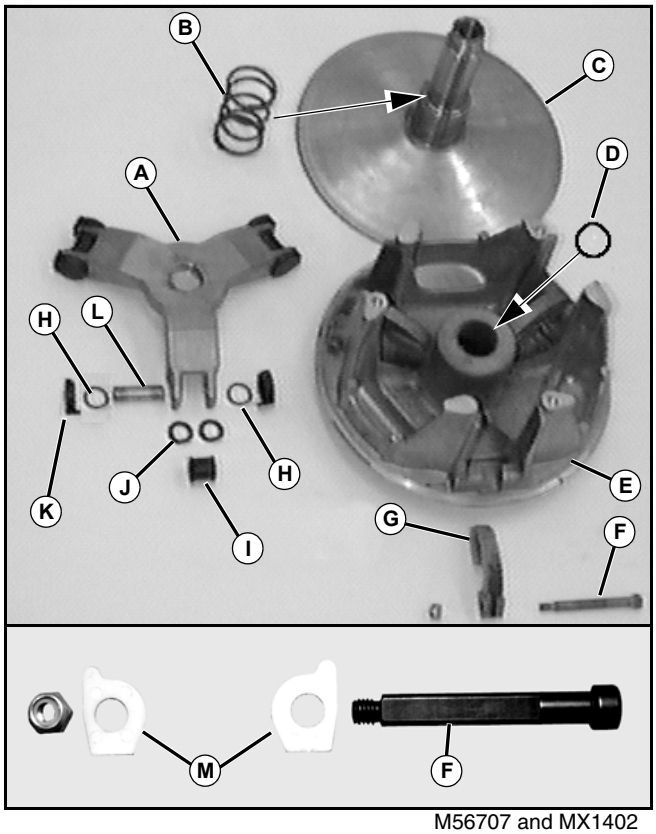
2. Install JDG813-3 Tapered Holding Tool (A) and retain it with a M10 X 1.5 X 150 mm hex-head bolt.

IMPORTANT: Avoid damage! Always use spider wrench to remove spider. Unequal pressure on clutch towers could cause stress fractures or break them off. A medium strength thread lock is used on spider threads.

3. Use JDG813-2 Spanner Wrench (B) to remove spider.

Inspection:

NOTE: The cam weights (G) have plastic thrust washers (M) inserted on each side of the cam weight.



M56707 and MX1402

A - Spider
B - Spring
C - Stationary Sheave
D - Washer
E - Clutch Sheave
F - Pivot Ball
G - Cam Weight
H - O-Ring
I - Roller
J - Thrust Washers
K - Button
L - Pin
M - Plastic Thrust Washers

1. Check spider rollers for flat spots or binding.

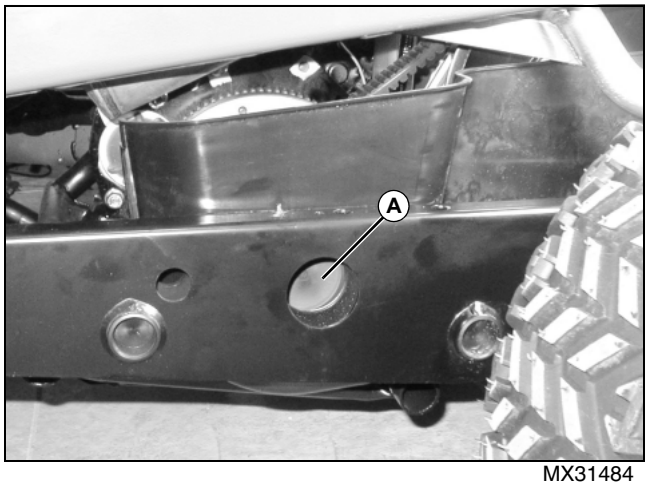
2. Reassemble components. Tighten spider to **135 N•m (100 lb-ft)**.

- Use medium strength thread lock on threads.

Cleaning Primary Drive Clutch

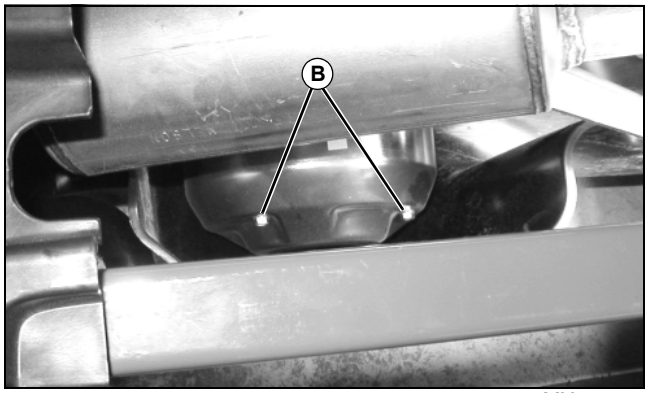
IMPORTANT: Avoid damage! Never lubricate any part of the primary drive clutch.

1. Park machine safely. See Parking Safely in the Safety Section.
2. Lock park brake.



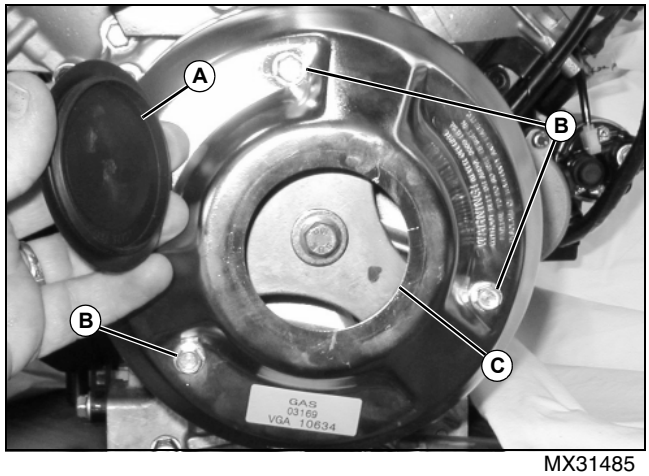
MX31484

3. Remove clutch cover plug (A).



MX31483

4. Remove three screws (B) securing clutch cover. Pull cover away from clutch.



MX31485

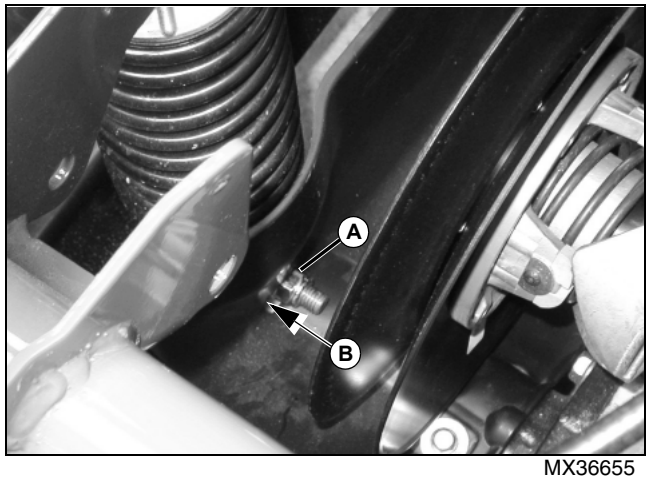
Picture Note: Engine and clutch assembly removed for clarity only.

5. Through clutch access hole (C), use compressed air to blow dust and debris out of clutch.
6. Install clutch cover and tighten screws (B).
7. Install clutch cover plug (A).

Driven Clutch Removal and Installation

Removal:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Lock park brake.
3. Raise and lock cargo box.
4. Remove drive belt.



MX36655

5. Remove nut (A) from lower shock mounting cap screw.
6. Slide the cap screw toward the outside (B) until the end of the cap screw is even with the axle mounting tab. Do not remove the cap screw.

MX36656

7. Remove cap screw and washer (C) and remove driven clutch.

8. Disassemble and repair the clutch as needed. See “Driven Clutch Disassembly and Assembly” on page 470.

Installation:

1. Install clutch in reverse order of removal.

2. Tighten clutch and lower shock bolts to specification.

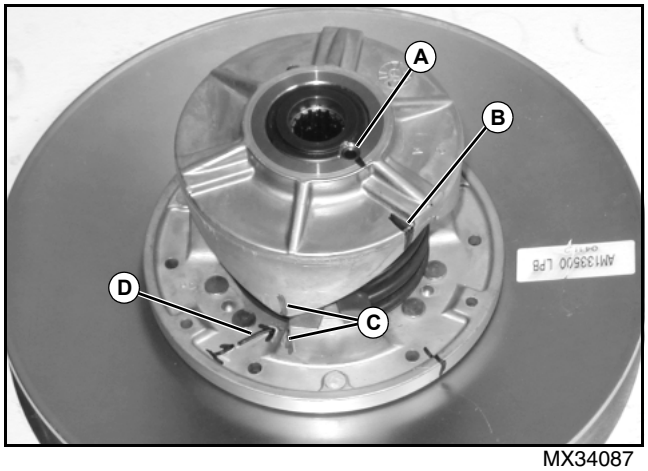
Specifications

Driven Clutch to Transaxle Cap Screw . . . . . 73 N•m (52 lb-ft)

Rear Shock to Frame . . . . . 126 ± 24 N•m (93 ± 18 lb-ft)

Driven Clutch Disassembly and Assembly

Disassembly:



MX34087

1. Mark location of set screw (A) on the outer edge of the cam (B).

2. Place alignment marks (C) on cam and movable sheave to aid in assembly.

3. Mark the location of the spring tab in the movable sheave (D).

4. Remove set screw (A).

CAUTION: Avoid Injury! Hold cam securely to prevent sudden spring release

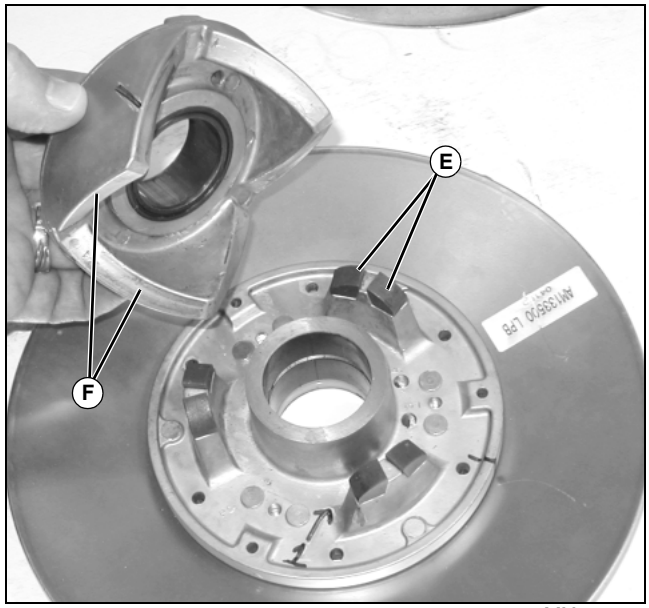
NOTE: Cam is press fit on shaft. Use a three-jaw puller and an impact wrench, at low speed, to remove cam from shaft.

5. Use a three-jaw puller to pull the cam off of the shaft.

6. Remove cam, spring, and movable sheave from shaft.

Inspection:

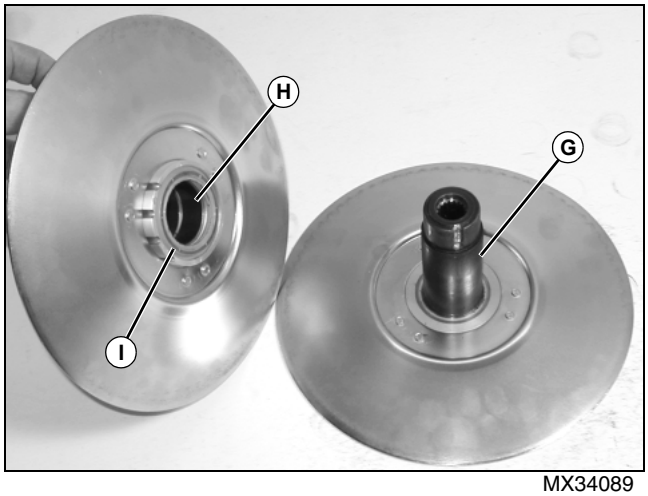
NOTE: Ramp buttons are mounted with tabs on backside. Tabs are interference fit into holes on face of ramps. Remove buttons only if replacement is necessary.



MX34088

1. Inspect ramp buttons (E) for wear or cracks.

2. Inspect the ramps (F) for nicks or scratches.



MX34089

3. Inspect sheave shaft (G) and bore (H) for wear, nicks, or scratches.

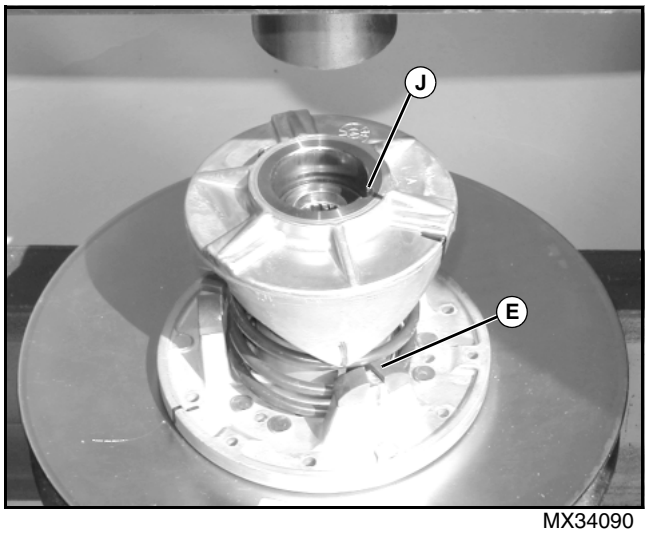
4. Inspect movable sheave seal (I) for wear or damage.

5. Replace any damaged components as needed.

Assembly:

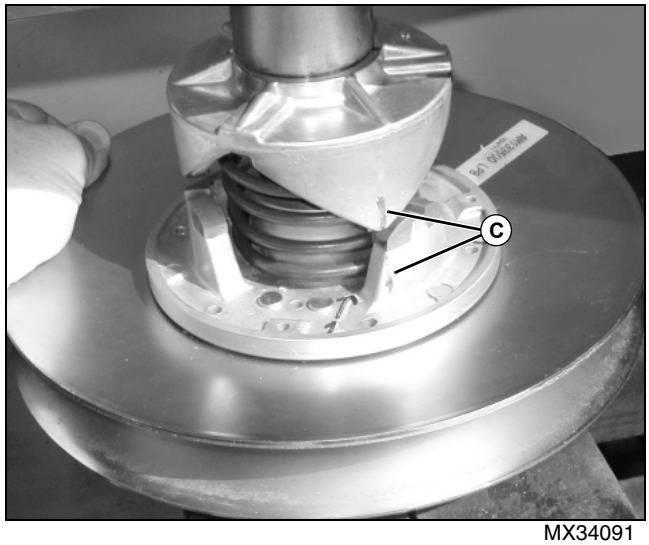
1. Install movable sheave on fixed sheave.

2. Install spring. Insert spring tab into previously marked hole in movable sheave and hole in cam.



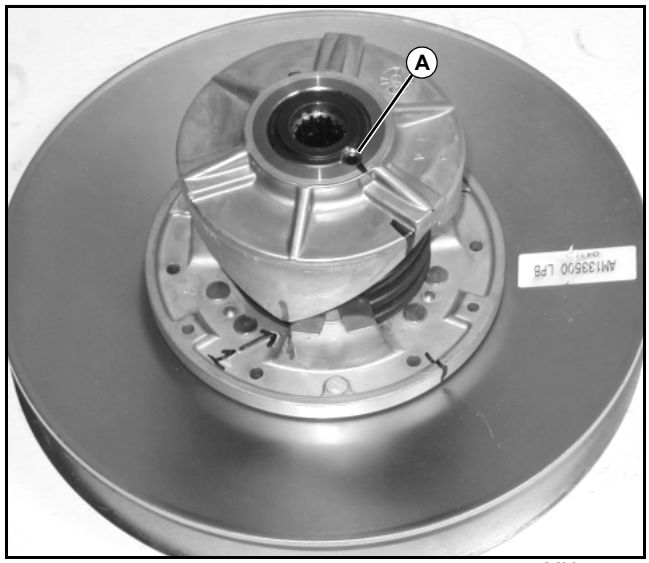
MX34090

3. Align set screw bores (J) and press cam on shaft until cam lobe almost touch ramp buttons (E).



MX34091

4. Rotate the movable sheave until the marks (C) are aligned and continue to press the cam onto the shaft until fully seated.



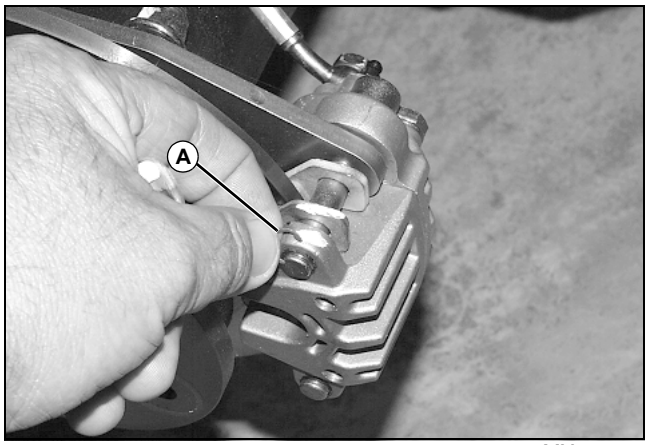
MX34087

5. Apply thread lock and sealer (medium strength) to threads of set screw (A) and install.

6. After clutch in installed, check clutch operation.

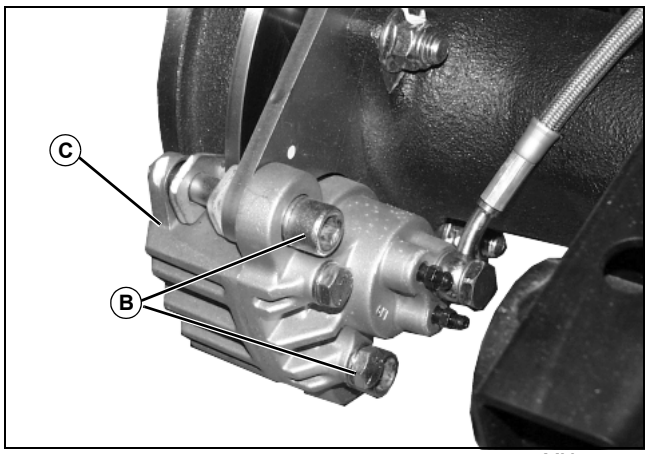
Transaxle Removal and Installation

1. Park machine safely. See Parking Safely in the Safety Section.
2. Lock park brake.
3. Block wheels to prevent machine from rolling.
4. Remove cargo box from machine.
5. Jack up rear of machine and place on stands.
6. Remove rear wheels.



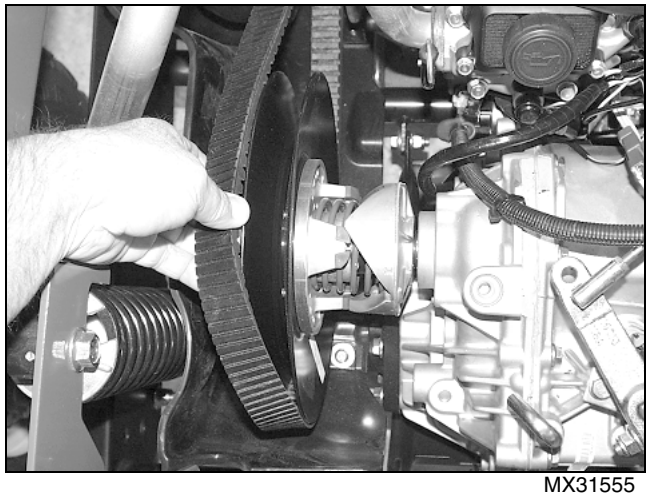
MX31556

7. Remove circlips (A) from brake caliper bolts.

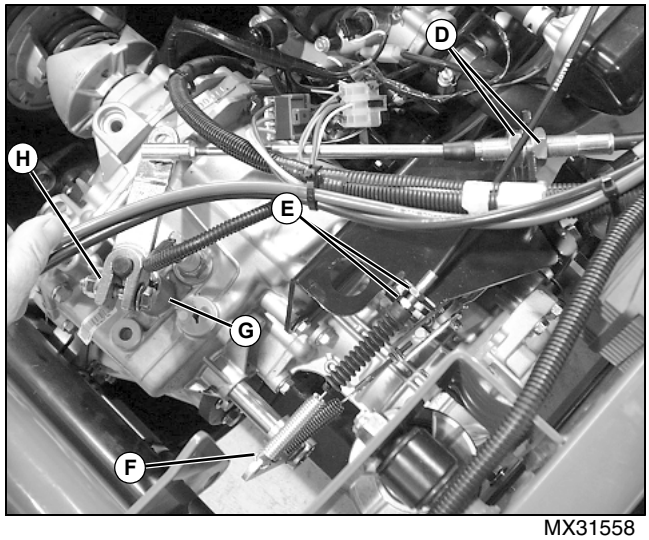


MX31557

8. Remove brake caliper bolts (B) and caliper (C) from each side of machine.

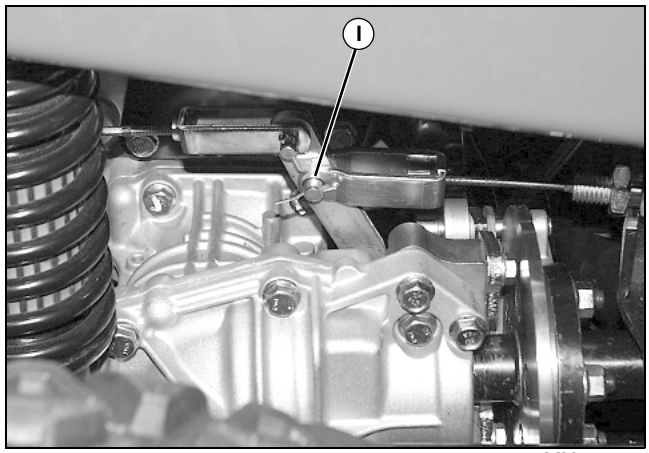

MX31555

9. Remove drive belt.



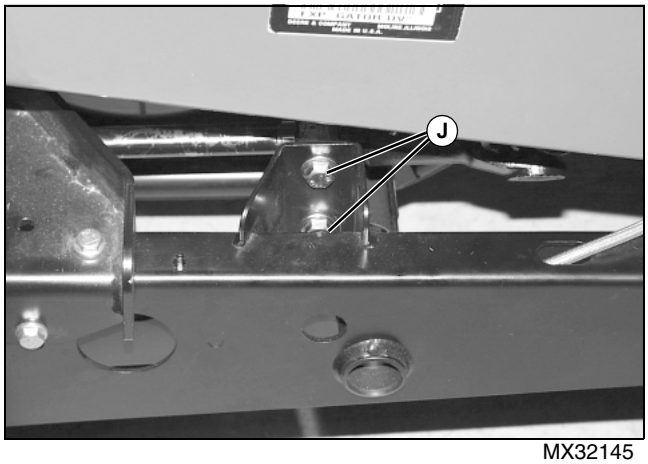
MX31558

10. Loosen cable adjusting nuts (D and E) and lift cables out of brackets.
11. Disconnect spring (F) from lever.
12. Loosen pinch bolt (H) and slide lever off of shaft.



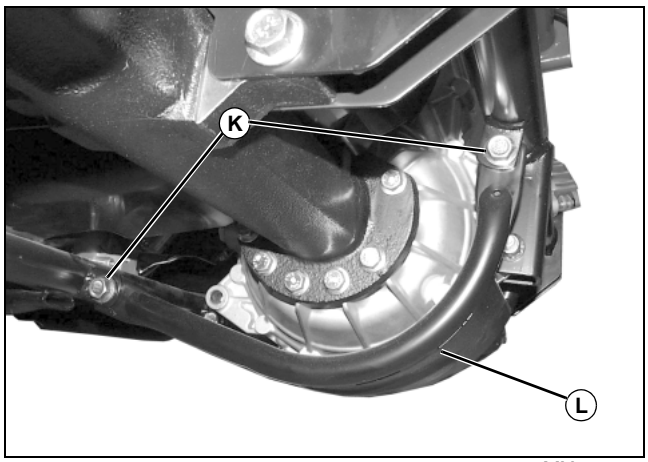
MX31559

13.Remove cotter pin and pin (I) from park brake cable.



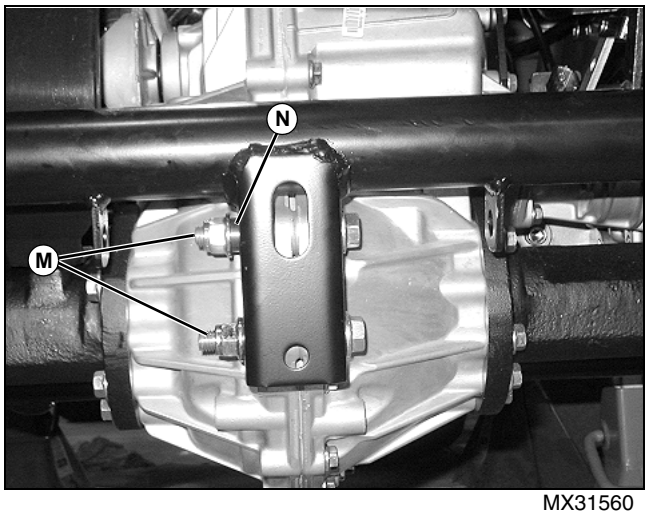
MX32145

14.If unit is equipped with MFWD remove the two bolts (J) from the MFWD drive shaft support. bearing.



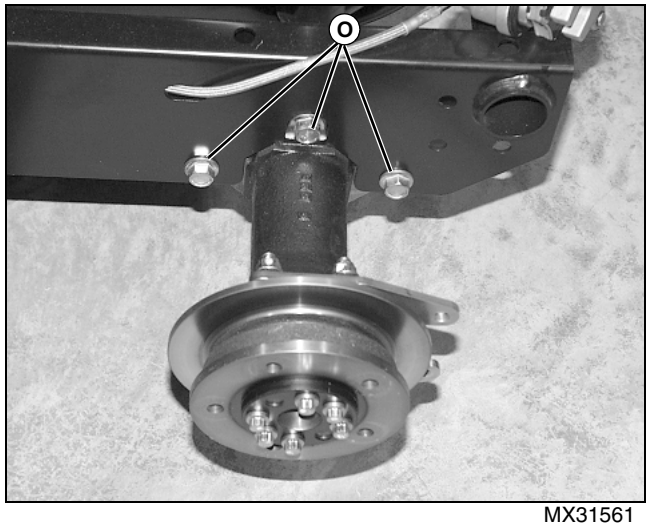
MX31564

15.Remove four cap screws and nuts (K) from skid plate (L) and remove skid plate.



MX31560

16.Remove the two rear transaxle mounting cap screws and nuts (M). Note location of spacer (N).



MX31561

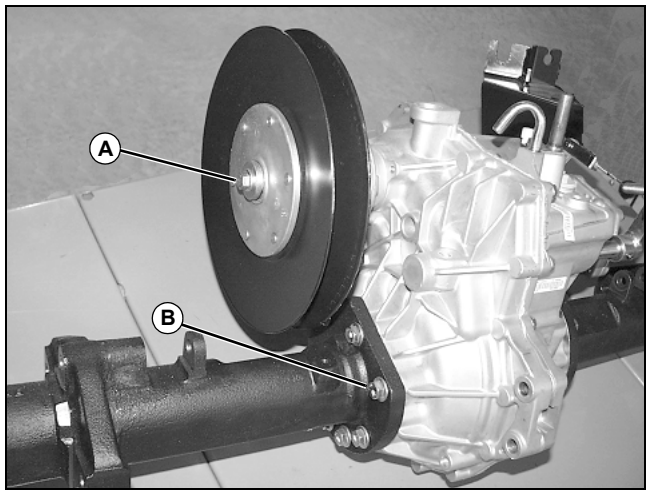
17.Support transaxle assembly with a floor jack and remove three axle mounting bolts (O) from each side.

18.Secure the lower swinging frame to the upper frame to keep it from coming down with the transaxle.

19.Start to lower transaxle until axle housing mounting holes are just below the swinging frame. Move axle to right until driven clutch clears guard, then lower transaxle completely.

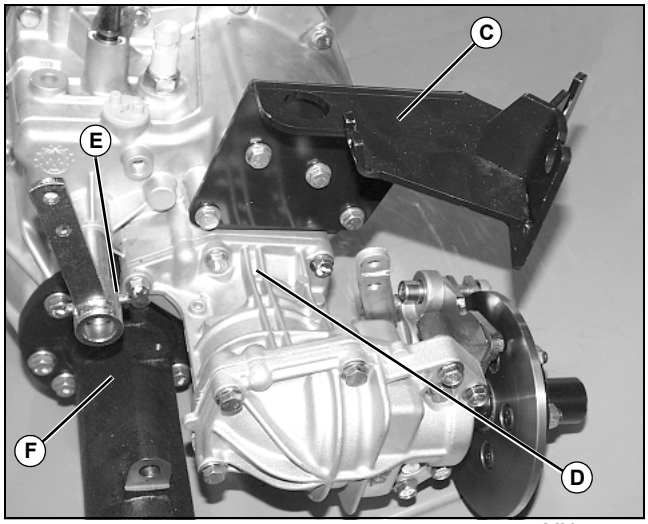
Transaxle Disassembly

Disassembly:



MX31563

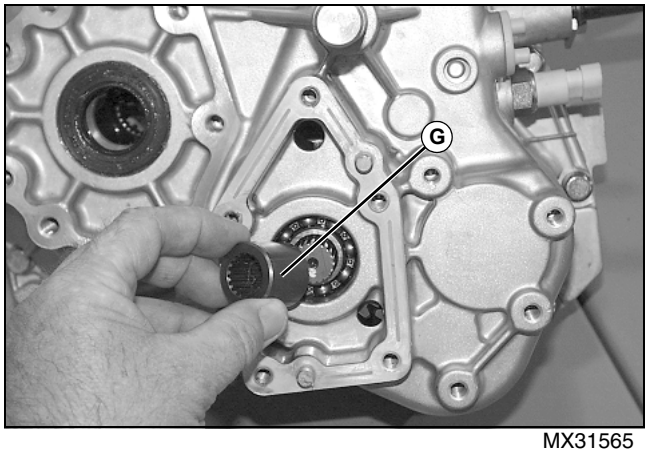
1. Remove cap screw and washer (A) and remove driven clutch. Remove cap screws (B) and remove axle housing from left side of transaxle.



MX31562

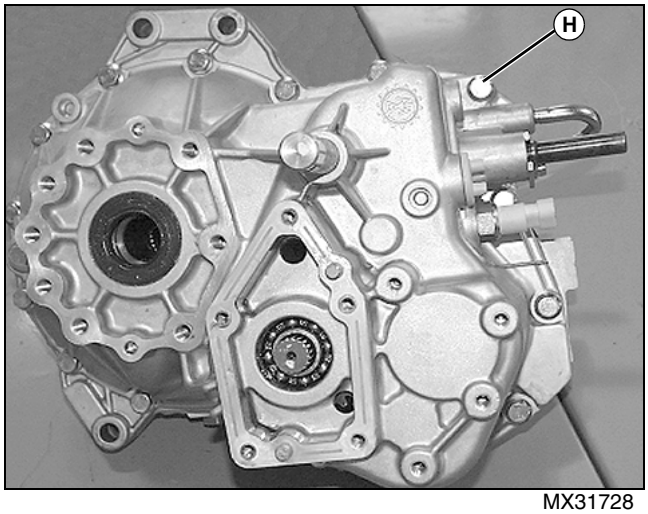
Picture Note: Cable support bracket (C) from (SN -40000) shown, (SN 40001-) similar.

2. Remove cable support bracket (C), front drive bevel gear box (D) MFWD only, differential lock lever (E), and right axle housing (F).



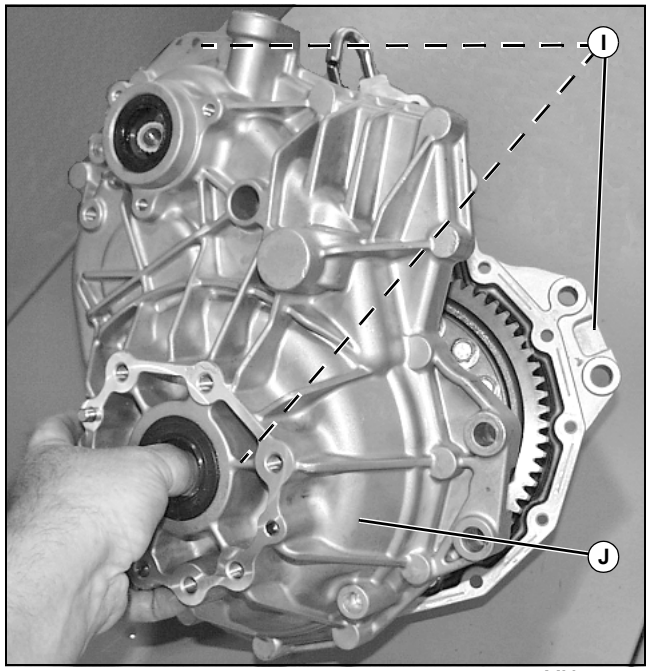
MX31565

3. Remove splined collar (G) MFWD only.



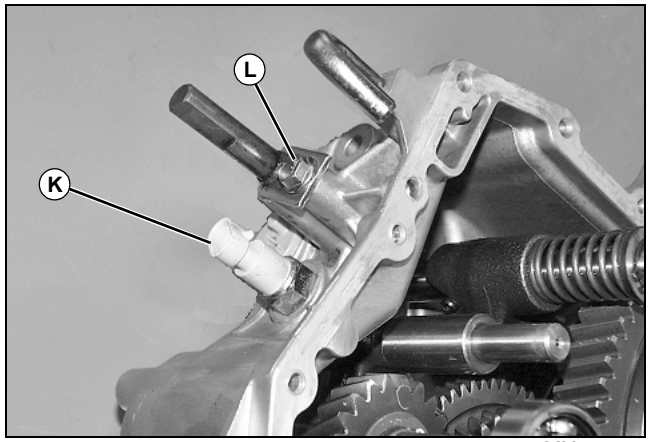
MX31728

4. Remove 16 cap screws (H) from transaxle case.



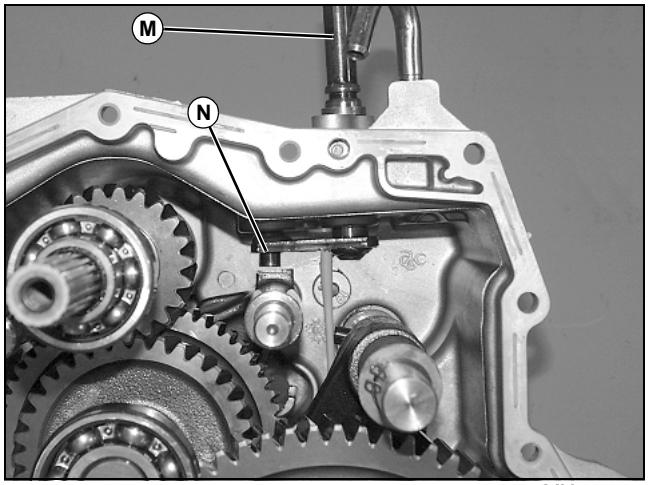
MX31729

5. Use pry areas provided (I) and gently pry apart case halves. Remove left case half (J).



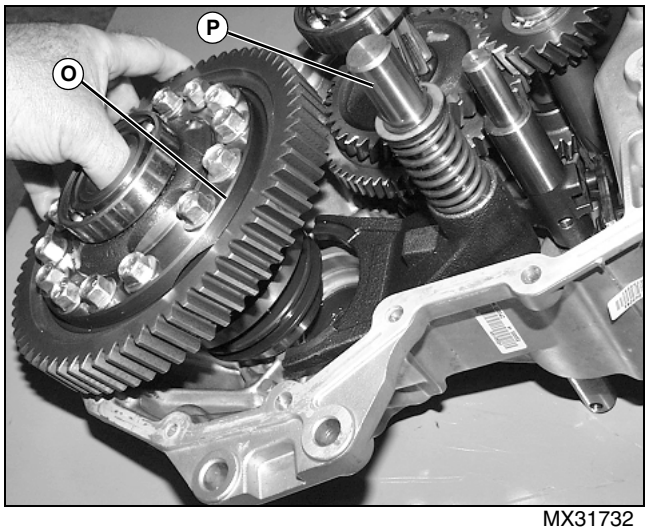
MX31730

6. Remove neutral switch (K) and cap screw and keeper plate (L).



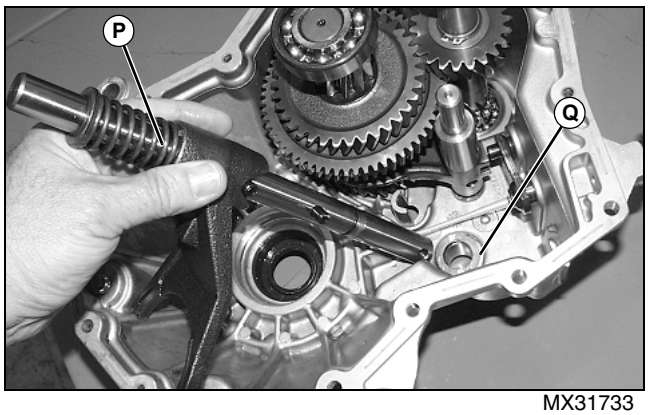
MX31731

7. Pull shaft (M) up until pin (N) is out of slot in shift fork.



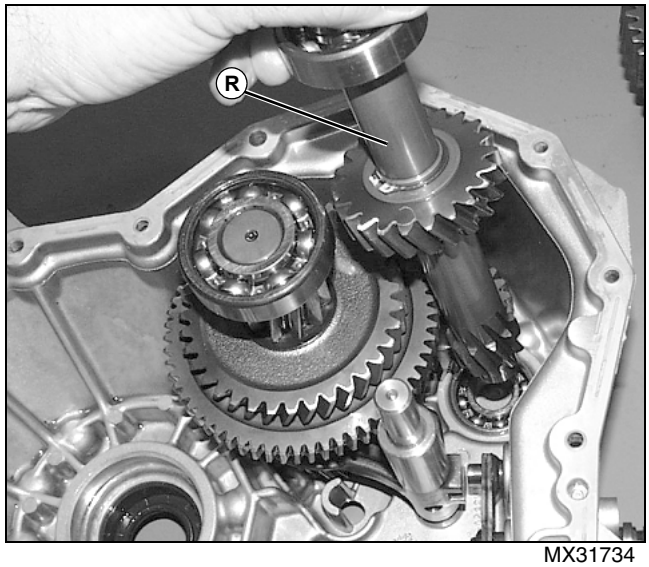
MX31732

8. Simultaneously lift differential assembly (O) and differential lock shaft (P) until bearing on differential clears bore in case. Differential can then be lowered out of fork and removed.



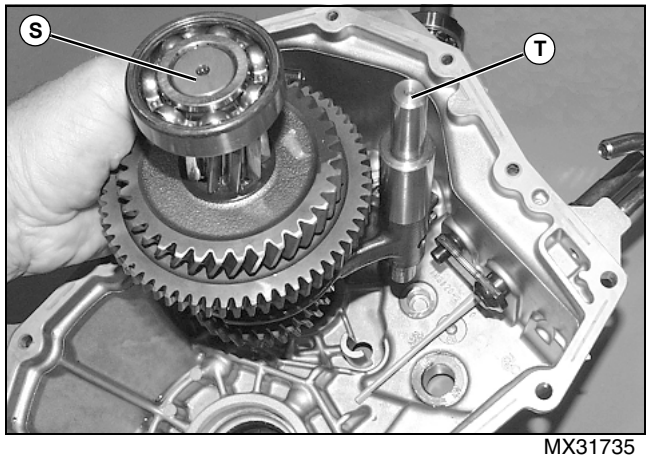
MX31733

9. Pull differential lock shaft (P) and washer (Q) out of case.



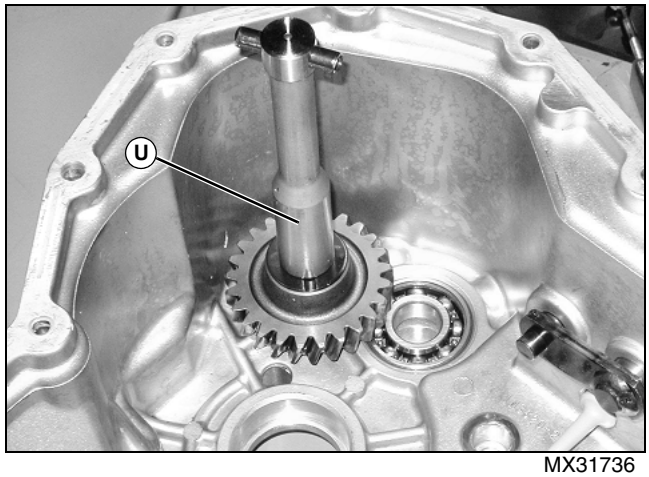
MX31734

10. Remove input shaft (R).



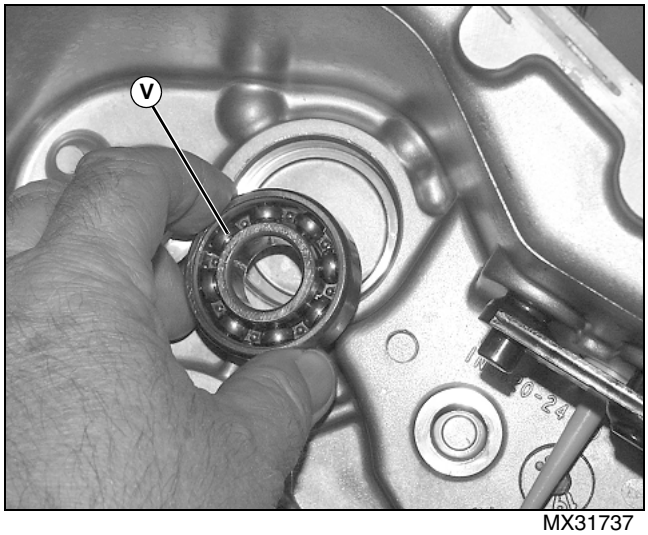
MX31735

11. Remove reduction shaft (S) and shift fork and shaft assembly (T).



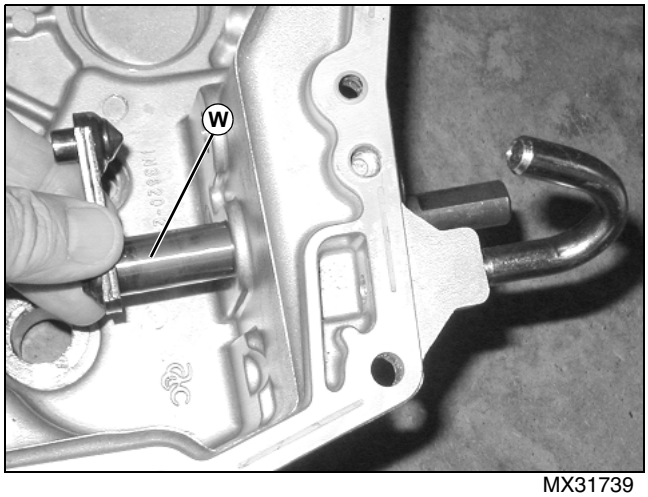
MX31736

12. Remove reverse idler shaft and gear (U).



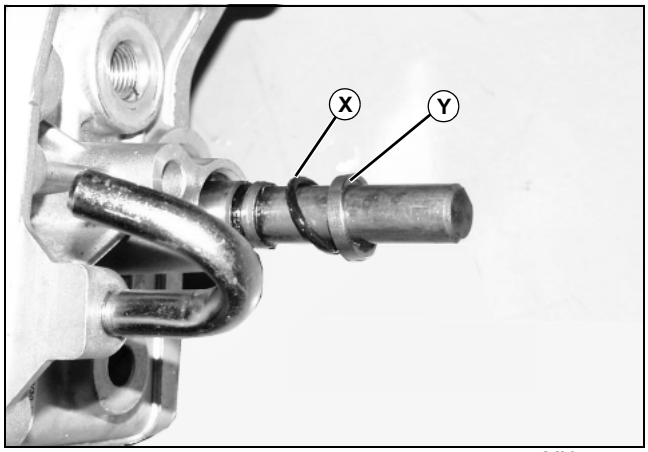
MX31737

13.Remove input shaft bearing (V) from case.



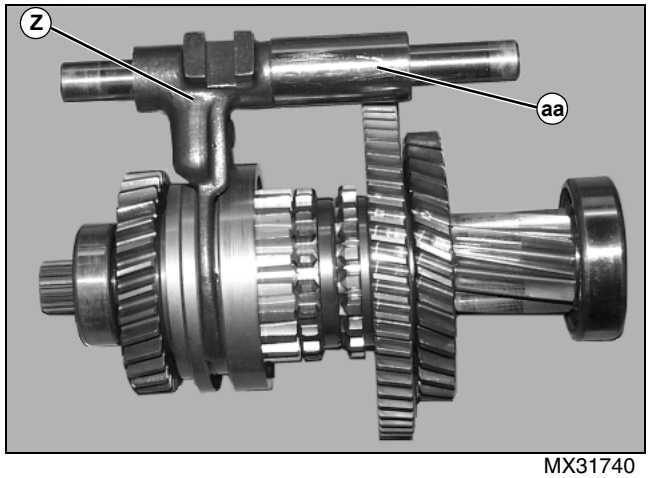
MX31739

14.Pull shift shaft (W) into case and then push back in.



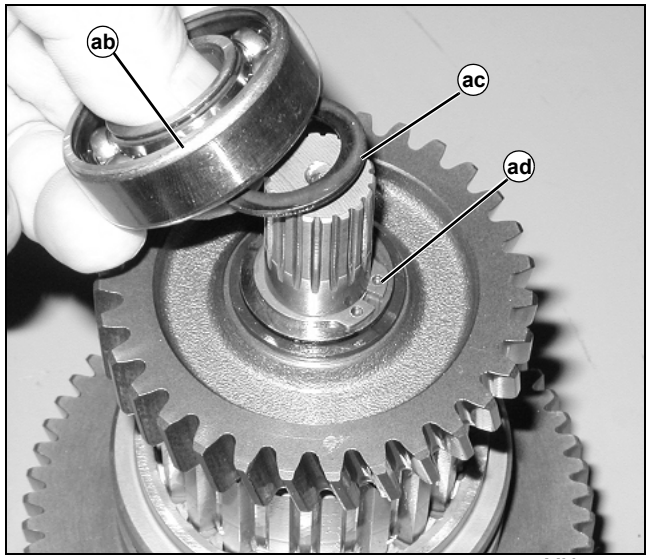
MX31738

15.O-ring (X) and spacer (Y) should come out on shaft, if not, remove shaft and pull them out with a small hook tool.



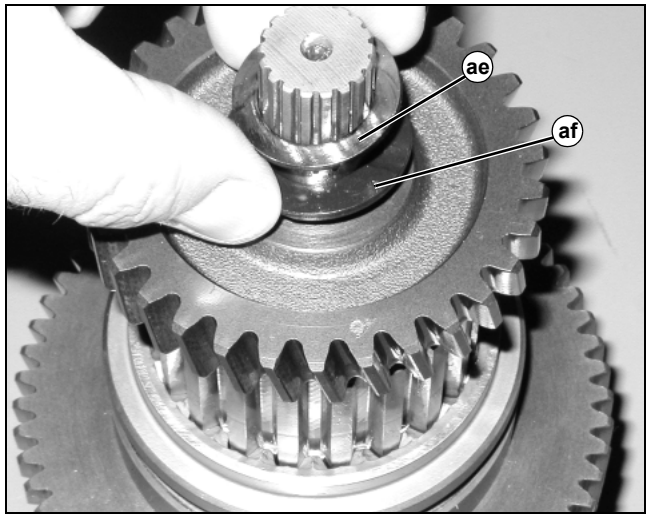
MX31740

16.Remove shift fork (Z) and spacer (aa).



MX31741

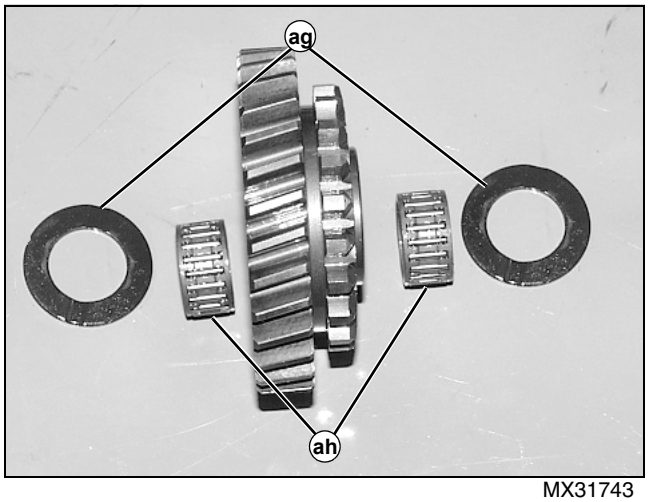
17.Remove bearing (ab), washer (ac), and snap ring (ad).



MX31742

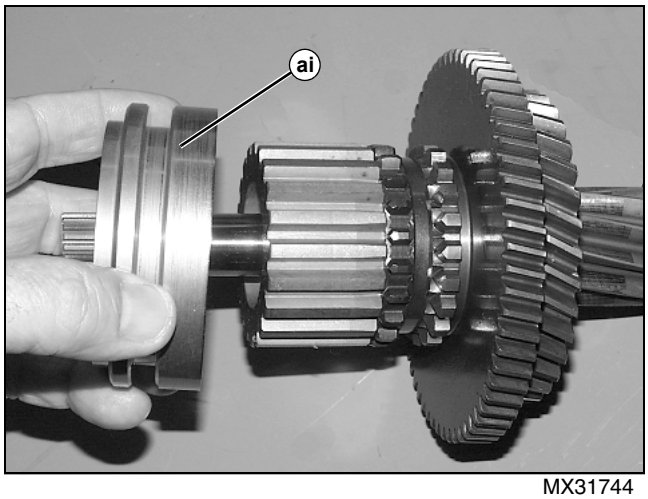
18.Remove washer (ae) and thrust washer (af).

19.Remove reverse gear (af).



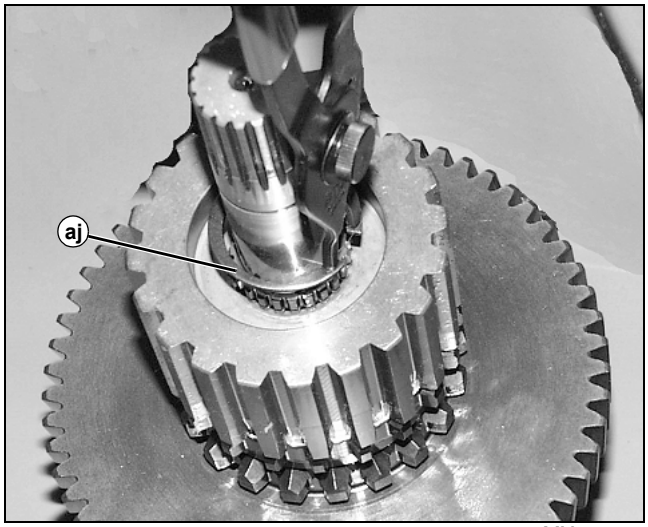
MX31743

20.Inspect thrust washers (ag) and bearings (ah).



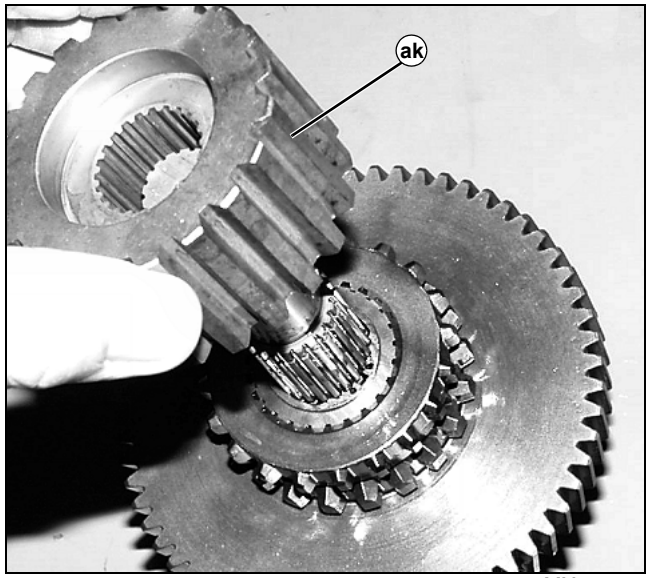
MX31744

21.Remove shift collar (ai).



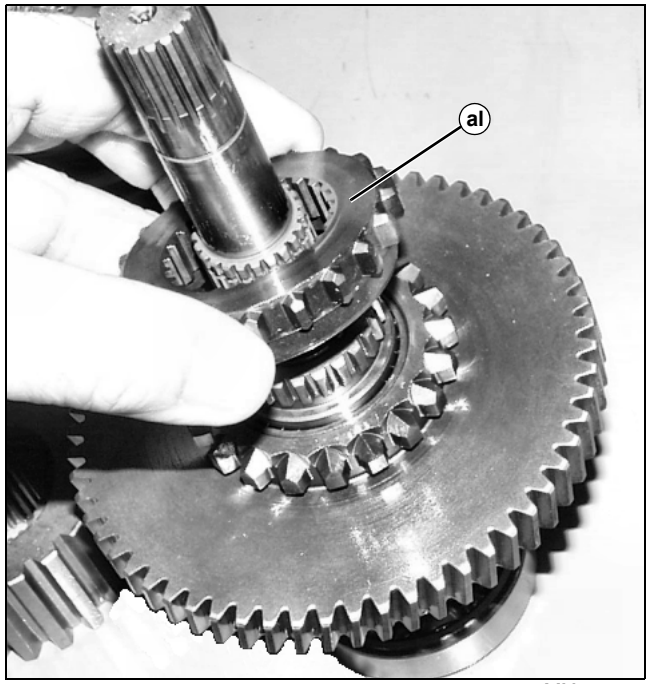
MX31745

22.Remove snap ring (aj).



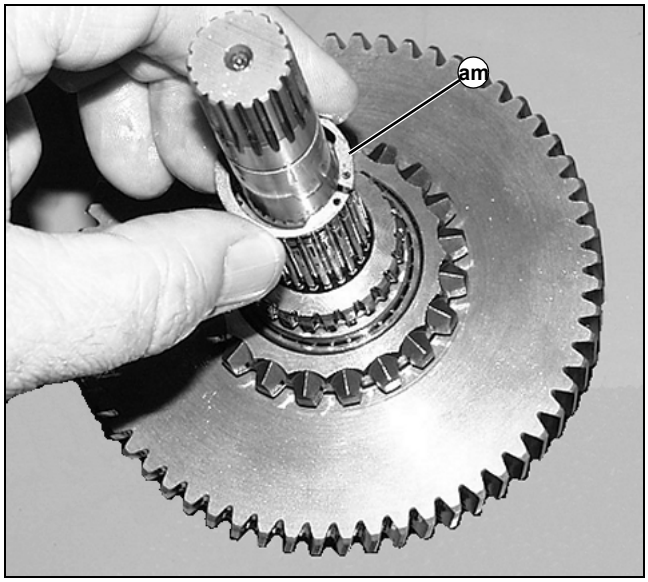
MX31746

23.Remove splined collar (ak).



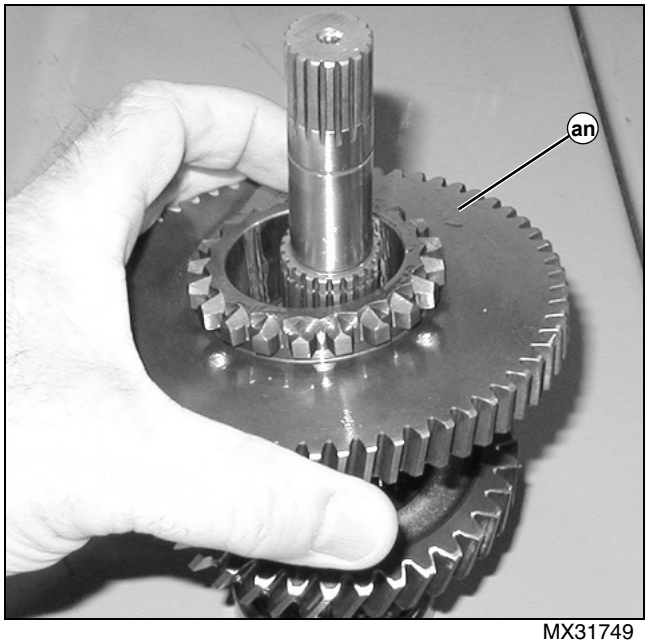
MX31747

24.Remove high gear collar (al).



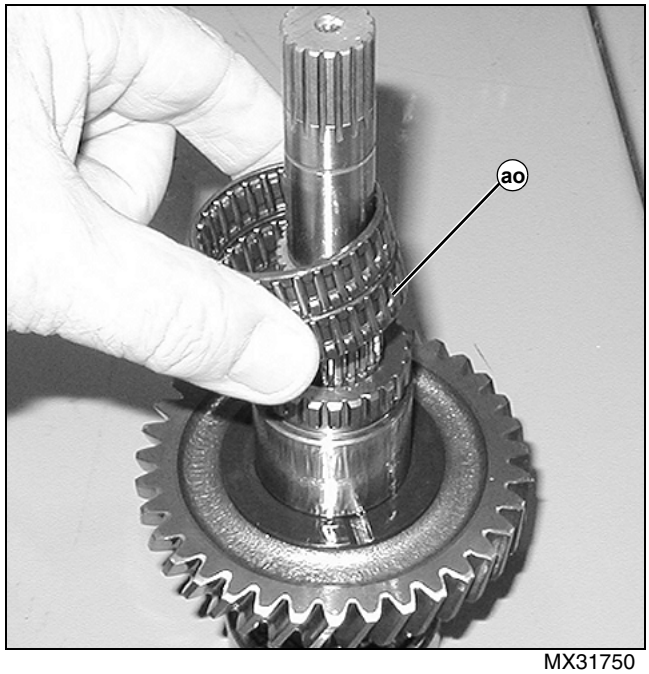
MX31748

25.Remove snap ring (am).



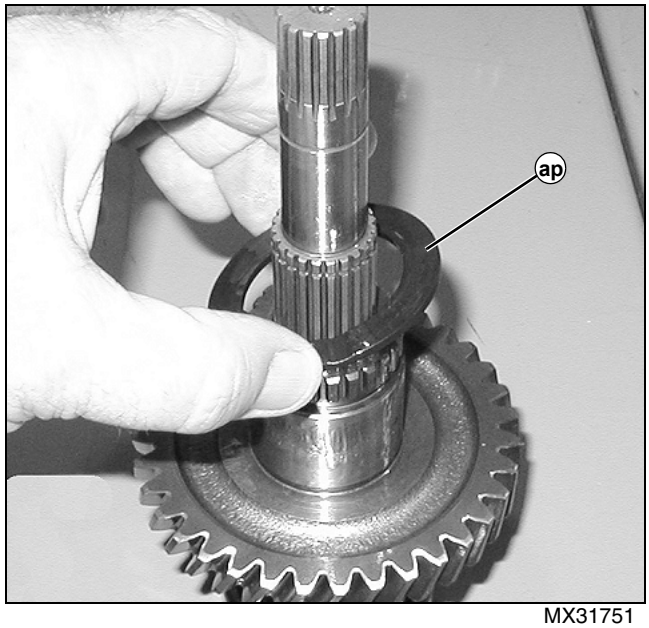
MX31749

26.Remove low gear (an).



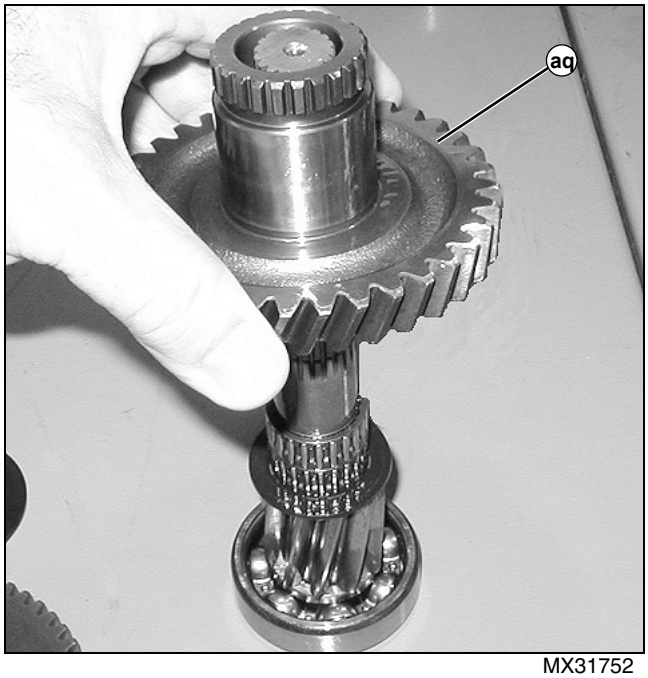
MX31750

27.Remove bearings (ao).



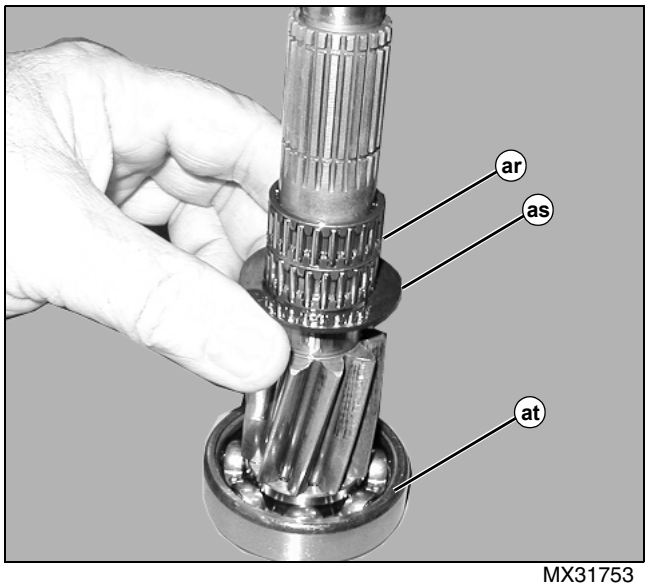
MX31751

28.Remove thrust washer (ap).



MX31752

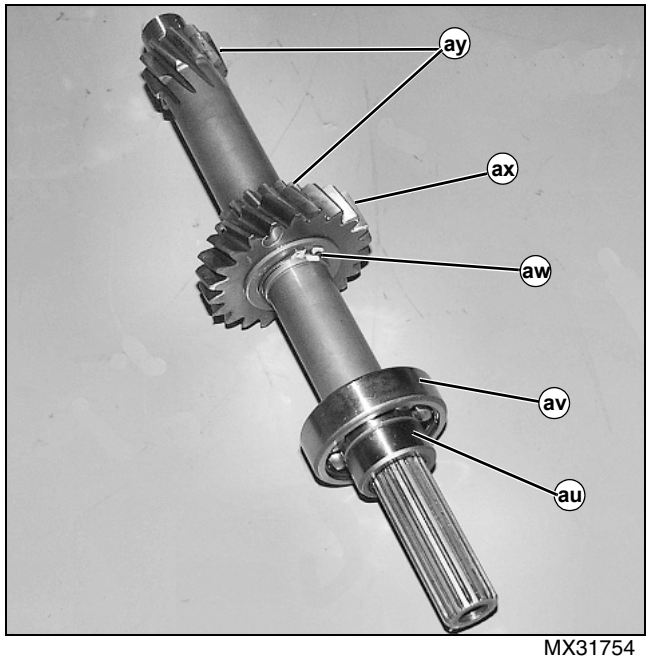
29.Remove high gear (aq).



MX31753

30.Remove bearings (ar) and thrust washer (as).

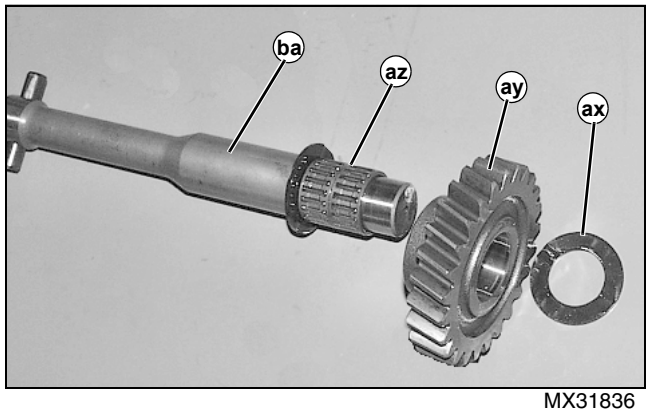
31.Inspect bearing (at). If bearing needs replacement, press bearing off of shaft.



MX31754

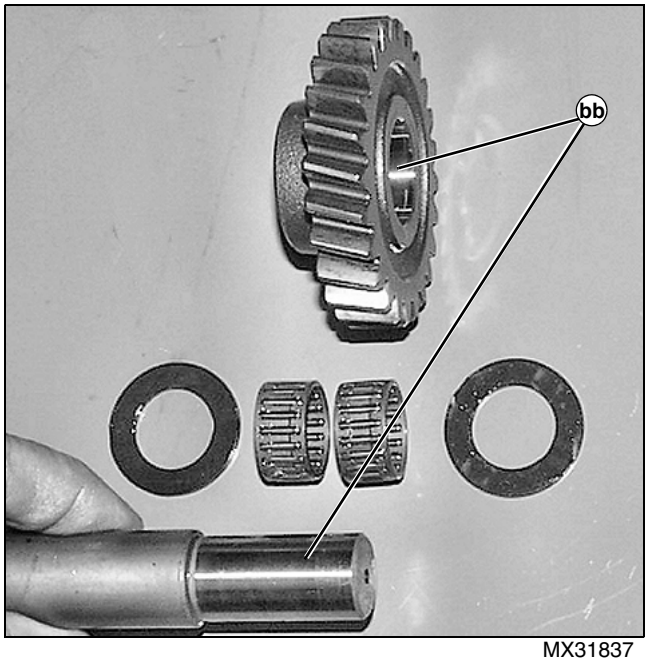
32.Inspect seal sleeve (au) and bearing (av) for wear or damage. Replace if necessary. Inspect gears (ax) and (ay) for missing or damaged teeth. Gears (ay) are part of shaft, if damaged replace shaft. Gear (ax) can be replaced by removing bearing, seal sleeve, snap ring and washer (aw). Bearing and seal sleeve can be pressed off together in a press. Do not re use seal sleeve, rubber seal on inside diameter is damaged whenever sleeve is removed.

Reverse Idler Shaft Disassembly:



MX31836

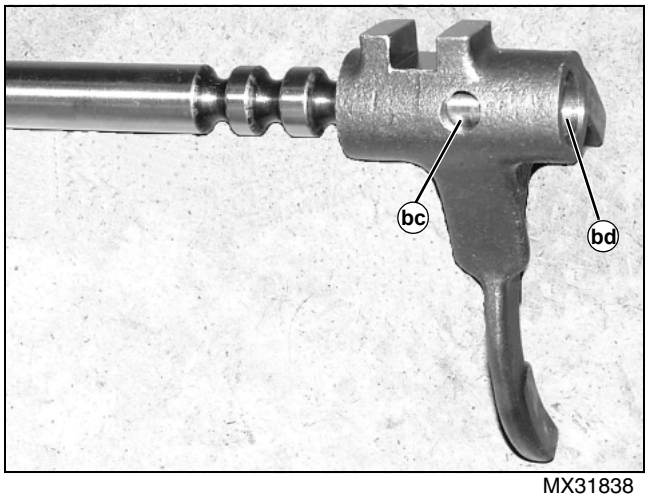
1. Remove thrust washer (ax), reverse idler gear (ay), bearings (az), and second thrust washer from reverse idler shaft (ba).



MX31837

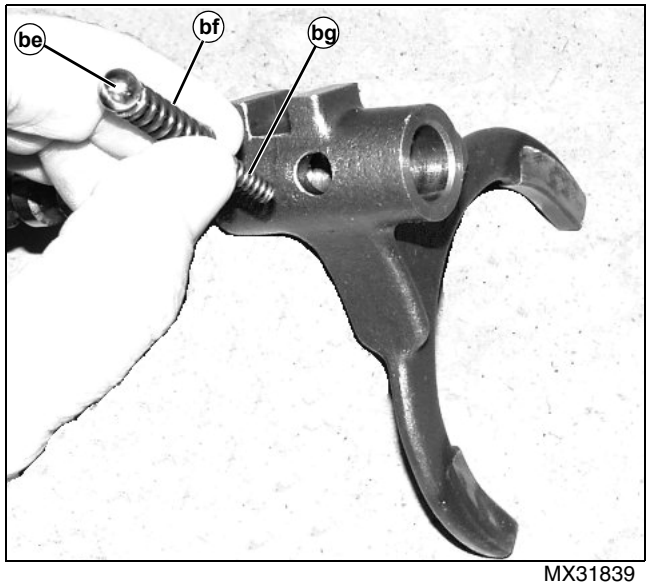
2. Inspect parts for wear or damage. Bearing race areas on OD of shaft and ID of gear (bb) should be smooth with no nicks or scratches. Bearing rollers should be smooth with no discoloration. Replace any worn/damaged parts as needed.

Shift Shaft Disassembly:



MX31838

1. Slide shift fork near end of shaft, but not beyond detent ball hole (bc). Cover holes (bc and bd) with your fingers before shaft is pulled beyond detent ball to avoid loosing ball.



MX31839

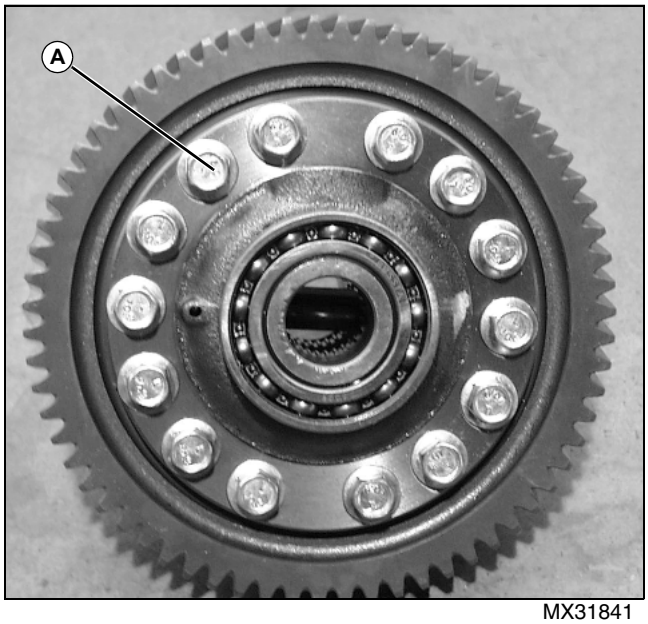
2. Remove ball (be), outer spring (bf), and inner spring (bg).

3. Inspect parts for wear or damage. Replace worn or damaged parts.


MX31840

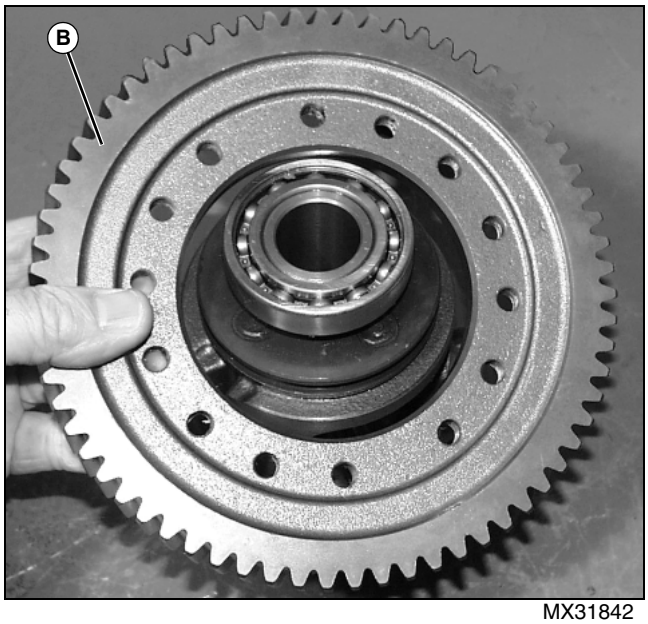
4. When assembling shift fork to shaft, press ball against spring tension with a punch as shown, until shaft is in far enough to hold the detent ball. Then remove the punch and push the shaft in to a detent notch.

Differential Disassembly:



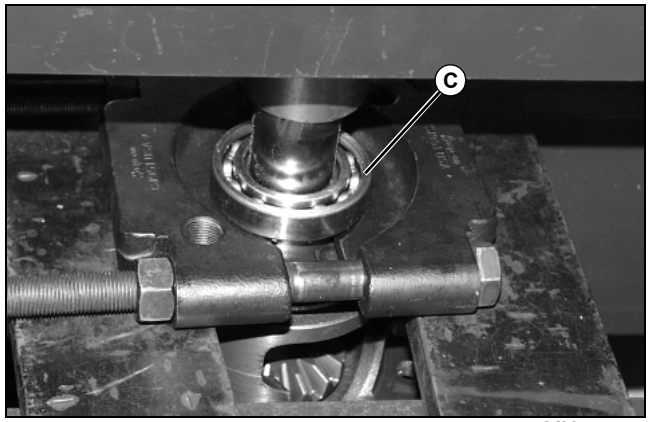
MX31841

1. Remove 14 cap screws (A).



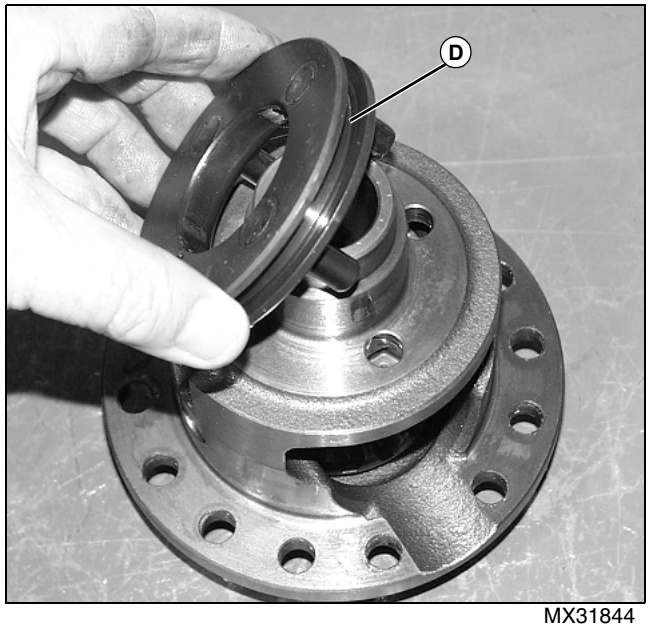
MX31842

2. Remove ring gear (B) from differential case.



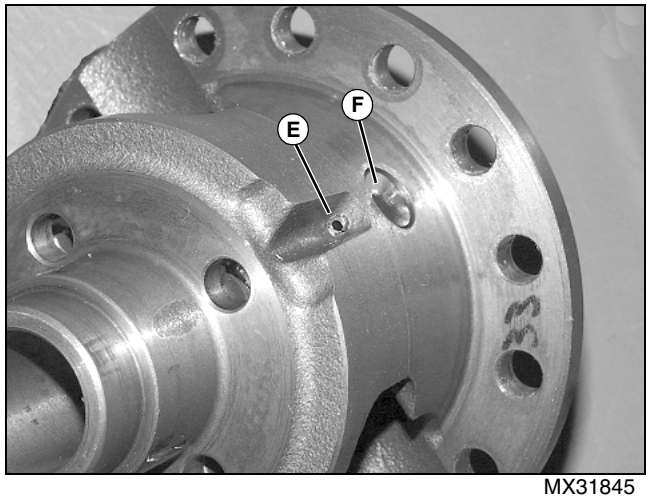
MX31843

3. Press bearing (C) off each side of differential case.



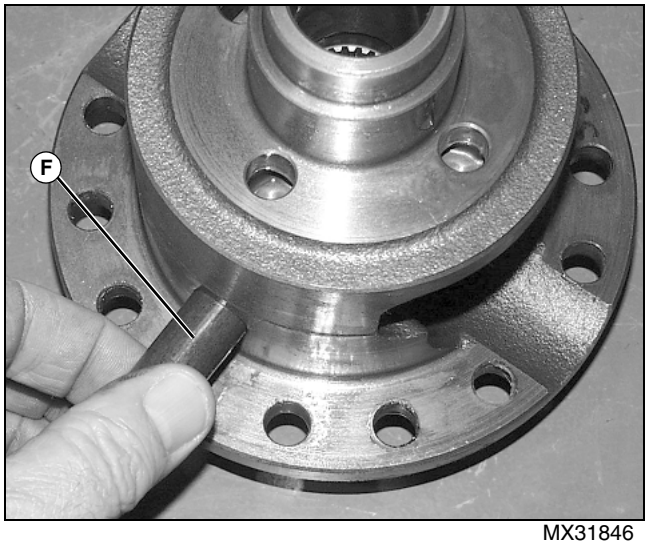
MX31844

4. Remove differential lock slider (D).



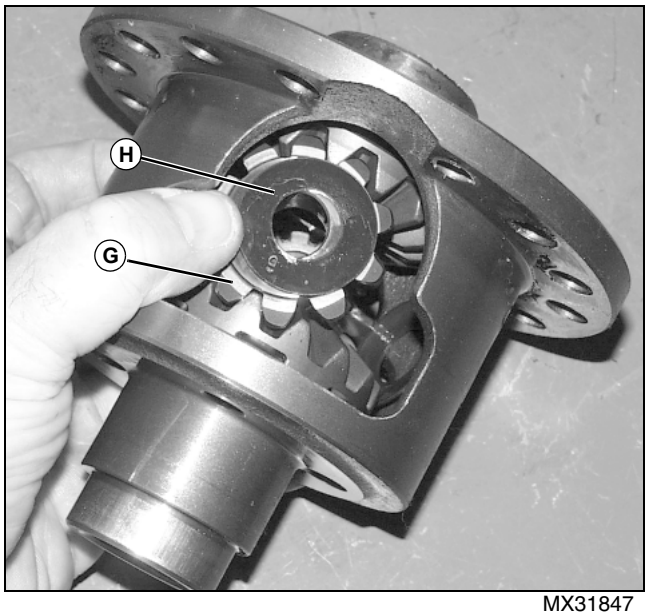
MX31845

5. Drive roll pin (E) into differential case until it is through pinion shaft (F).



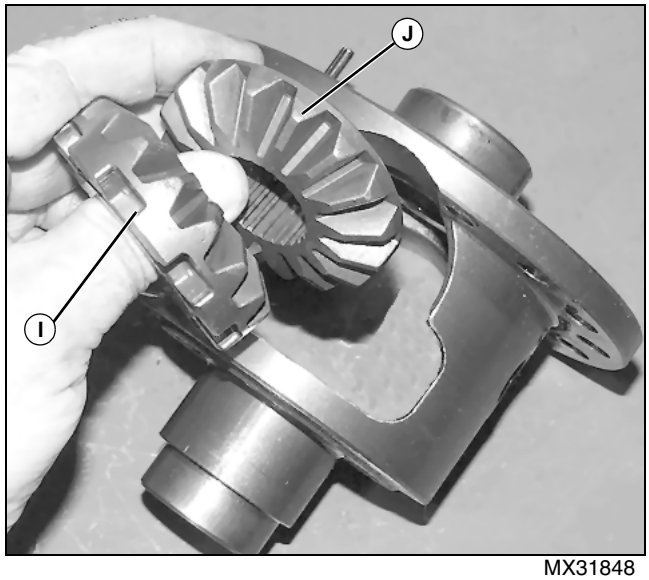
MX31846

6. Remove pinion shaft (F) from case.



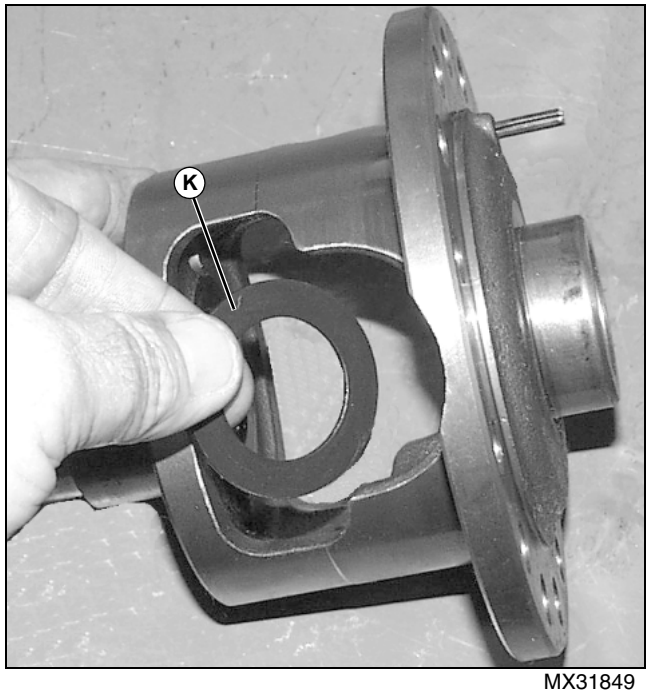
MX31847

7. Turn differential gears to line up with openings in case. Remove pinion gears (G) and washers (H)



MX31848

8. Remove differential side gears (I and J).



MX31849

9. Remove two side gear thrust washers (K) from case.

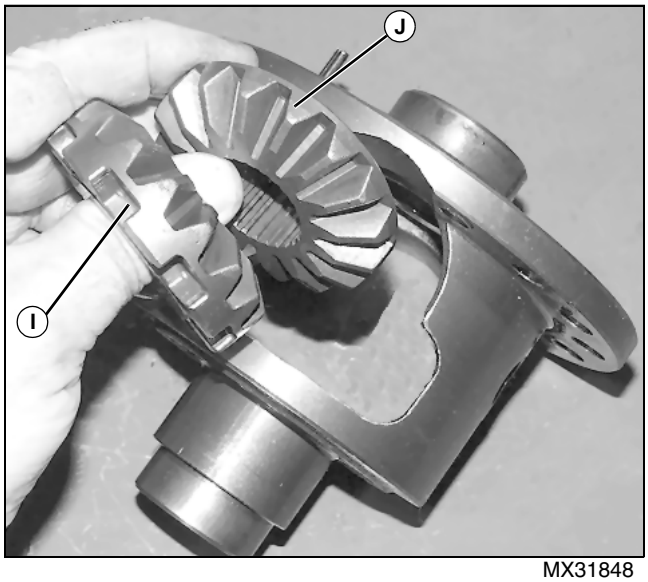
Transaxle Assembly

Differential Assembly

1. Clean and inspect all parts. Replace any worn or damaged parts.

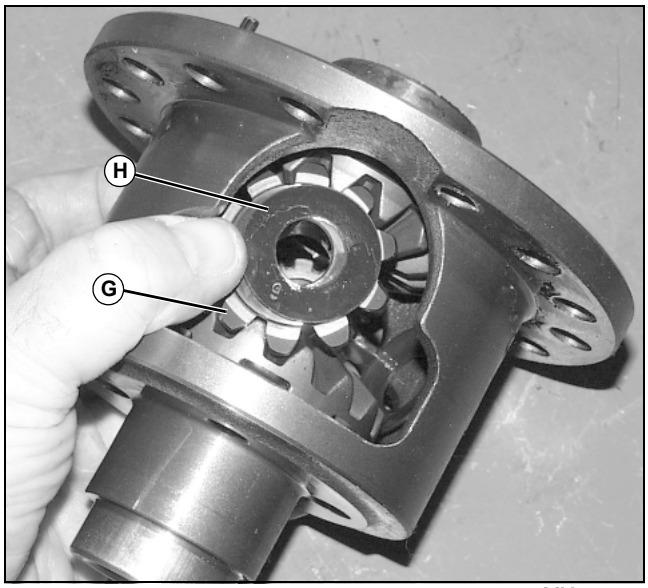
2. Apply grease to thrust washers to hold them in place during assembly.

3. Install side gear thrust washers into differential case.



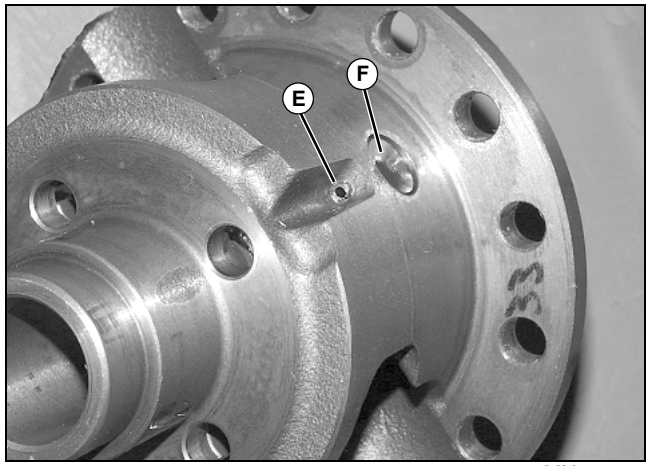
MX31848

4. Install differential side gear (J) first, then side gear (I). Note notches in side gear (I) for differential lock.



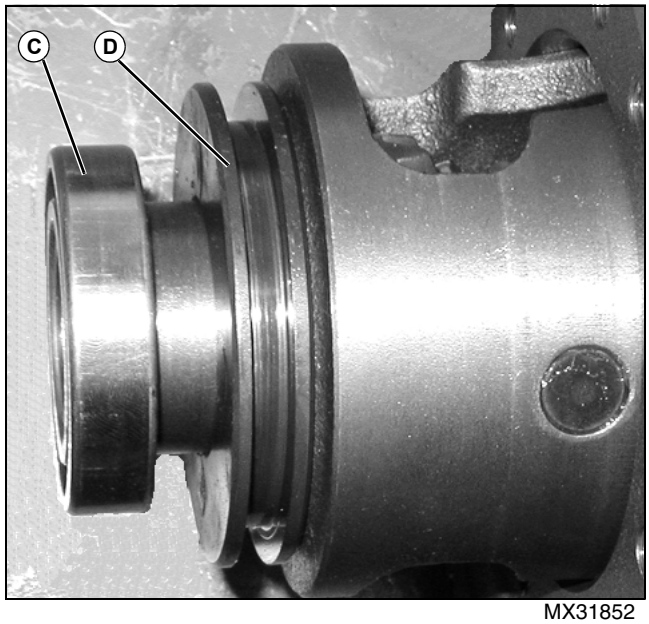
MX31847

5. Install the differential pinion gears (G) and washers (H) straight across from each other. Turn gears to align with pinion shaft holes.



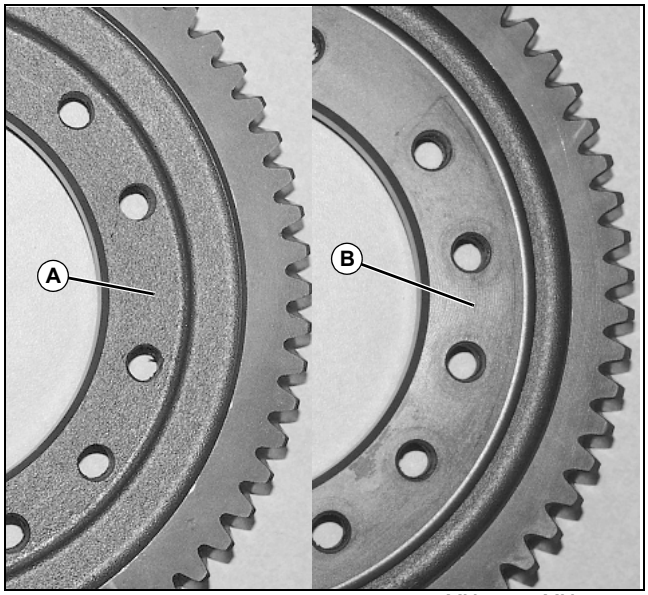
MX31845

6. Check that thrust washers have not moved out of place and install pinion shaft (F), carefully aligning hole in pinion shaft with hole in differential case. Install roll pin (E).



MX31852

7. Install differential lock slider (D) and bearing (C).



MX31850 MX31851

Picture Note: Note difference in surface on different sides of ring gear. Side (A) is rough, side (B) is machined smooth and has a larger diameter flat area.

MX31842

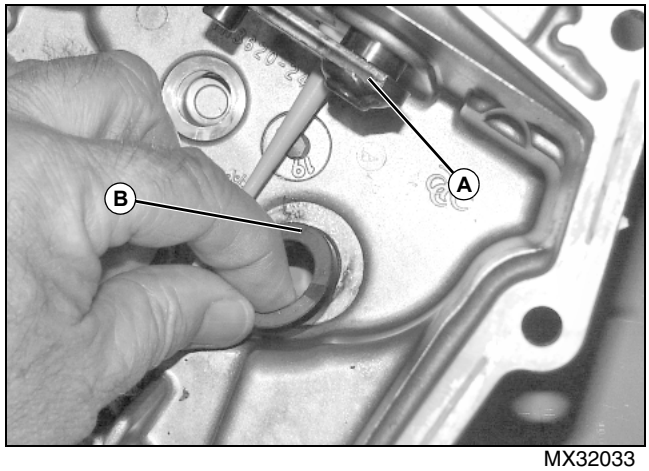
8. Install ring gear with smooth side against differential housing.

MX31841

9. Apply high strength thread locking compound to threads of bolts. Install bolts and tighten in a cross pattern to 70 - 80 N•m (52 - 59 lb ft).

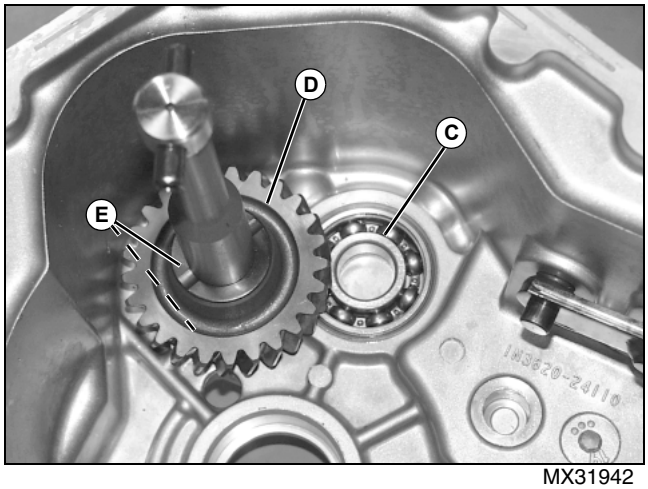
Assembly:

1. Clean and inspect all parts. Replace any worn or damaged parts.



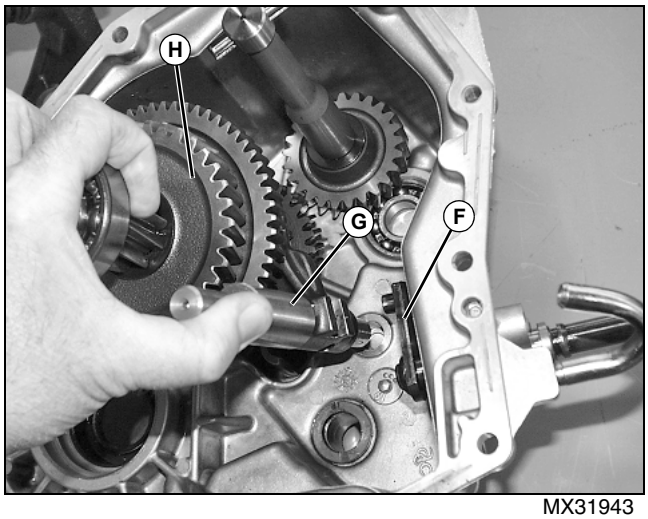
MX32033

2. Lubricate and install shift arm (A) into transaxle case. Apply some grease to differential lock shaft washer (B) and position over hole.



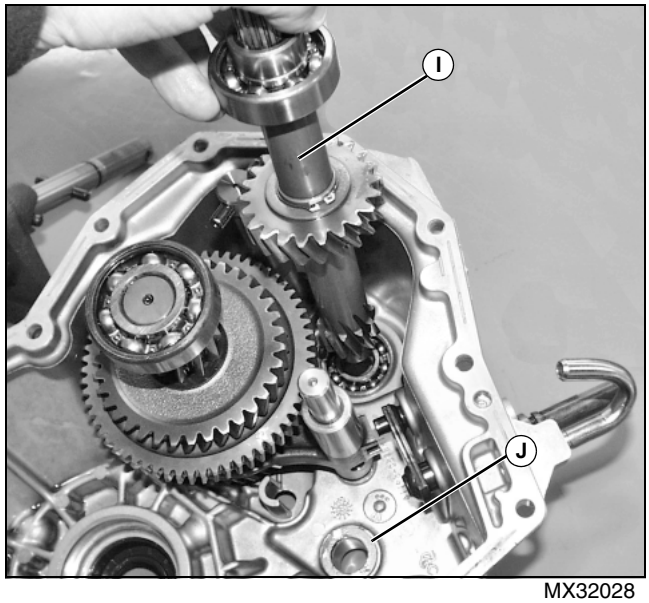
MX31942

3. Install bearing (C) and reverse idler shaft assembly. Reverse idler gear (D) is installed with raised side of hub toward you and thrust washers (E) on each side.



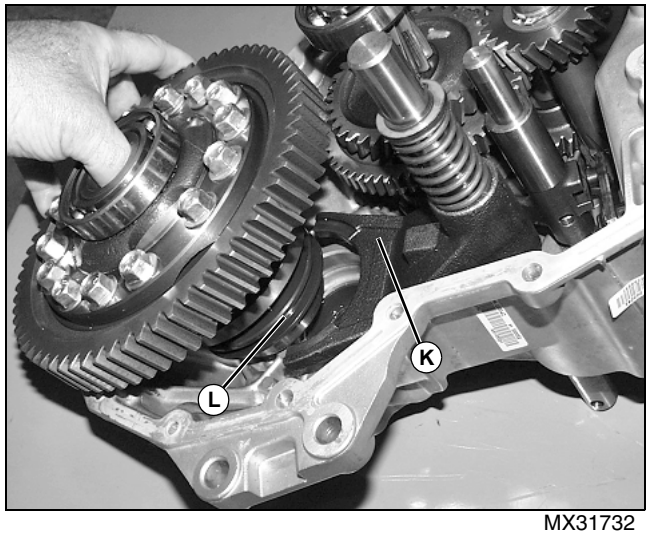
MX31943

4. Make sure shift arm (F) is up against case. Engage the fork on shift shaft (G) into the shift collar on reduction shaft (H). Hold (G and H) together and slide them into position together.



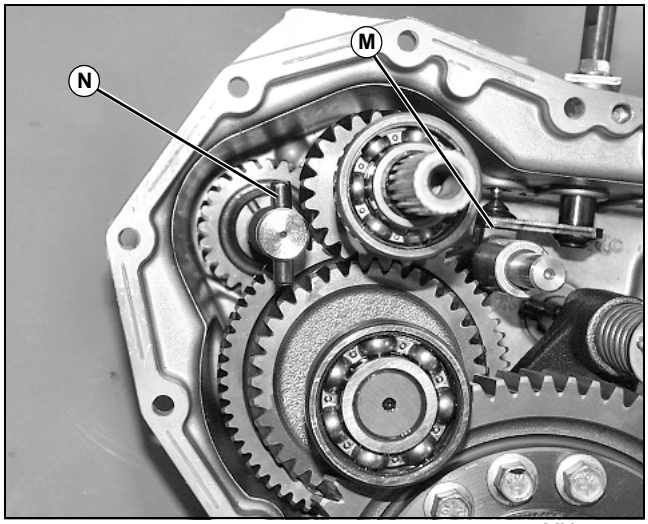
MX32028

5. Install input shaft (I). Install washer (J) if not already in place.



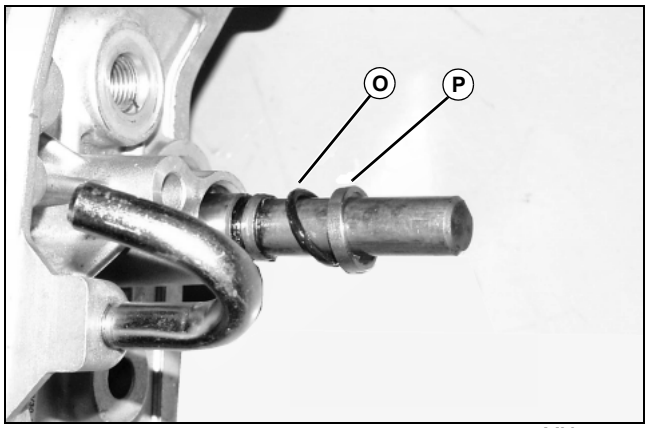
MX31732

6. Install differential lock fork and shaft (K) into case. Leave fork up far enough to engage fork into groove of differential lock collar (L). Slide fork shaft and differential down together until differential bearing is seated in bearing bore.



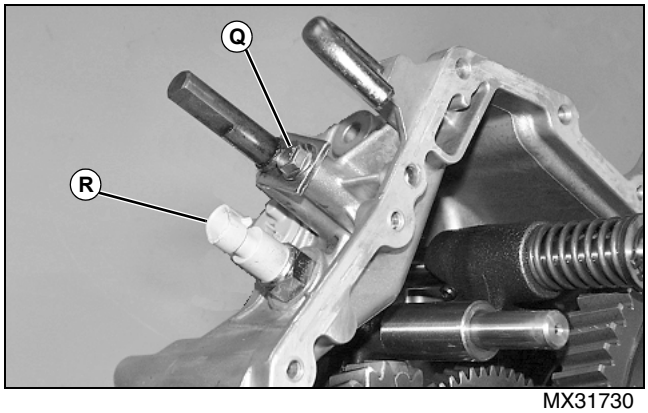
MX32031

7. Engage the shift arm into the slot in the shift fork (M). Position roll pin (N) in reverse idler shaft as shown so it will align with slot in other half of transmission case.



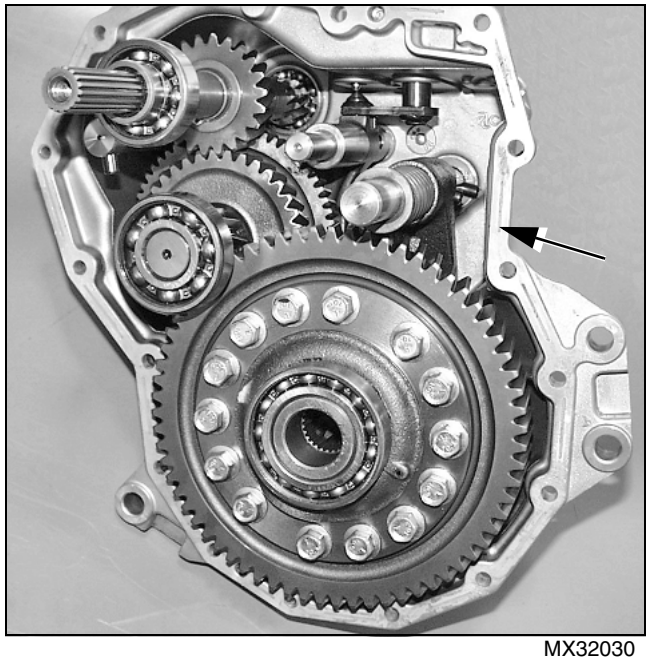
MX31738

8. Lubricate and install the O-ring (O) and spacer (P) into the recess in the transaxle case.



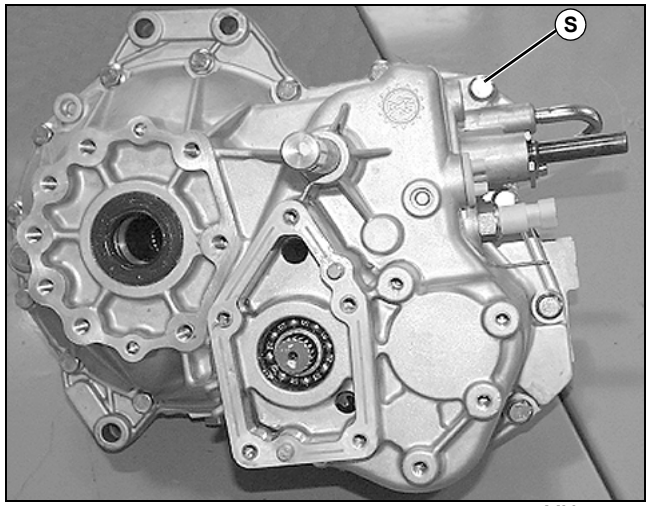
MX31730

9. Install the keeper plate and cap screw (Q), and neutral switch (R).



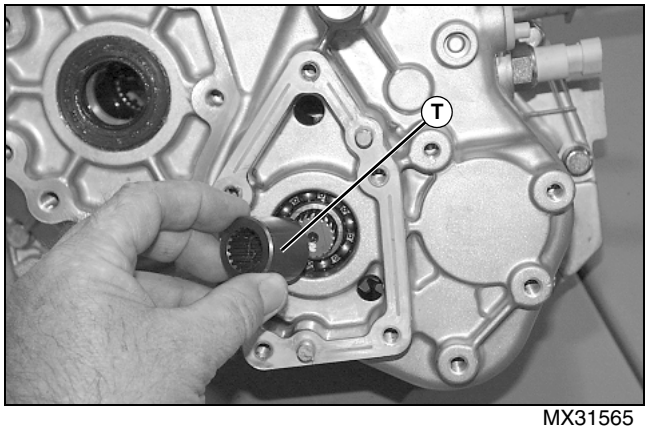
MX32030

10.Make sure gasket surfaces are clean. Install new input shaft and axle shaft seals. Apply a thin bead of John DeereTY16021 form in place gasket around mating surfaces of transmission case. Assemble case halves.



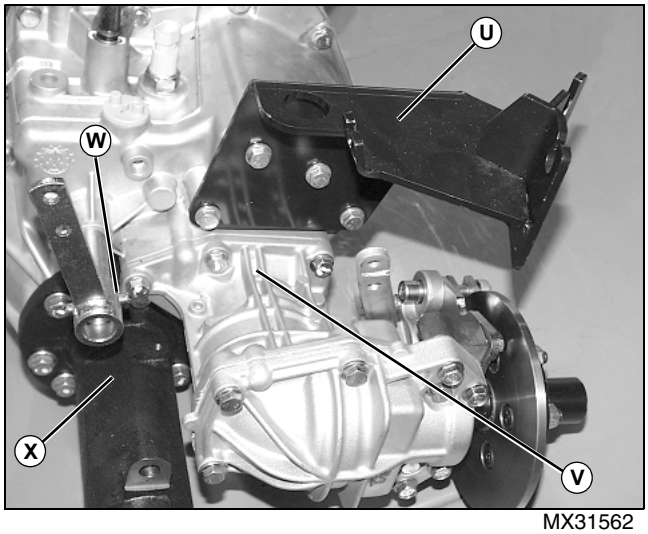
MX31728

11.Install 16 cap screws (S) to transaxle case.



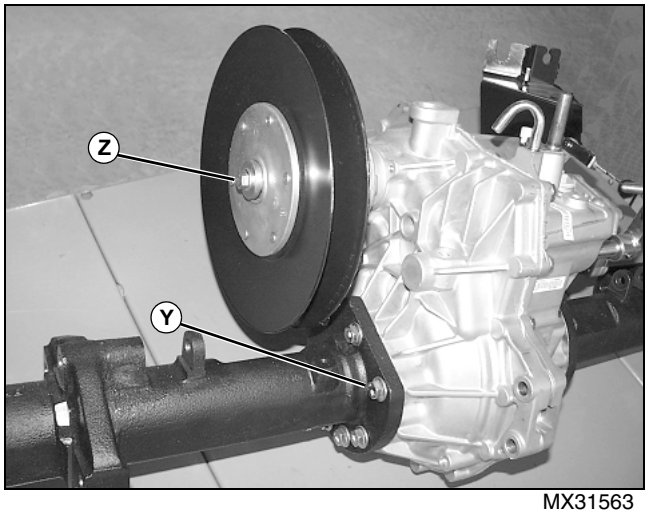
MX31565

12.Install splined collar (T) MFWD machines only.



MX31562

13.Install cable support bracket (U), front drive bevel gear box (V) MFWD only, differential lock lever (W), and right axle housing (X).



MX31563

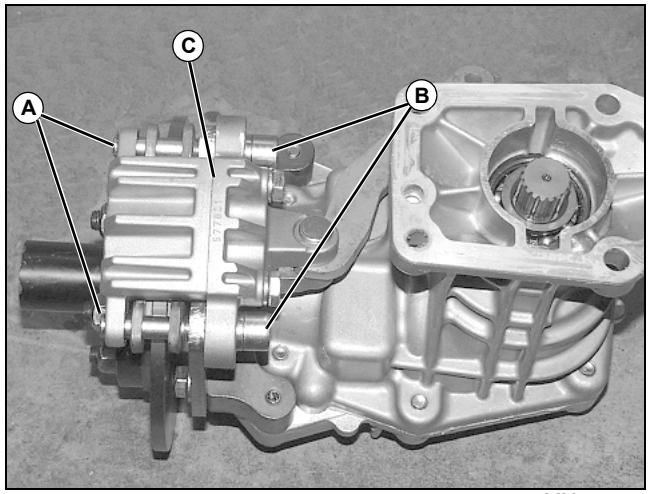
14.Install axle (Y) housing to left side of transaxle. Install driven clutch and secure with cap screw and washer (Z). Tighten cap screw to specification.

Specifications

Driven Clutch to Transaxle Cap Screw 73 N•m (52 lb-ft)

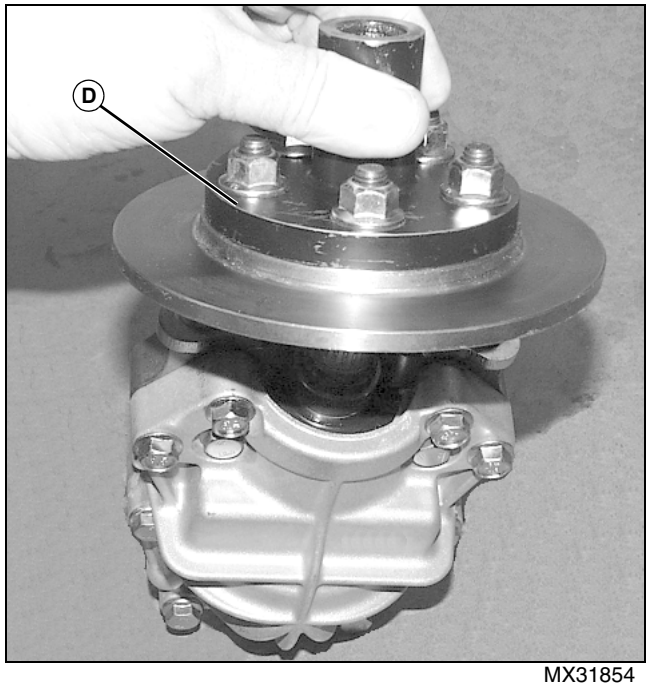
Front Drive Gearbox Disassembly and Assembly

Disassembly:



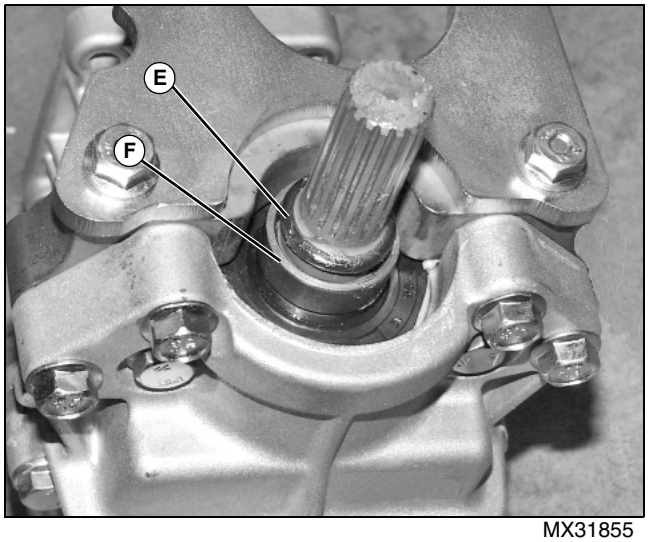
MX31853

1. Remove C clips (A) and then anchor bolts (B) to remove park brake caliper (C).



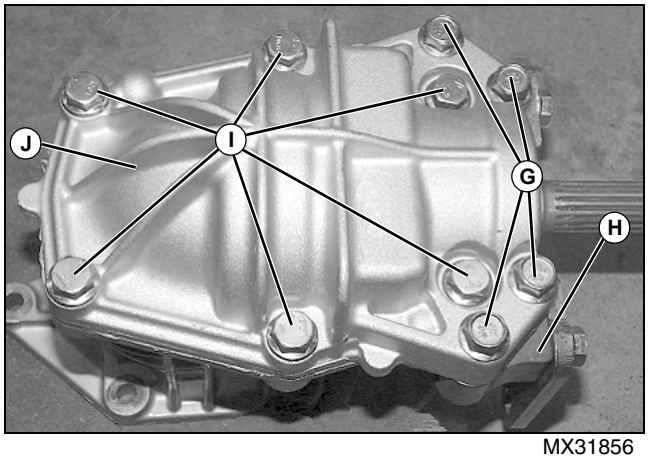
MX31854

2. Remove brake rotor and drive hub assembly (D).



MX31855

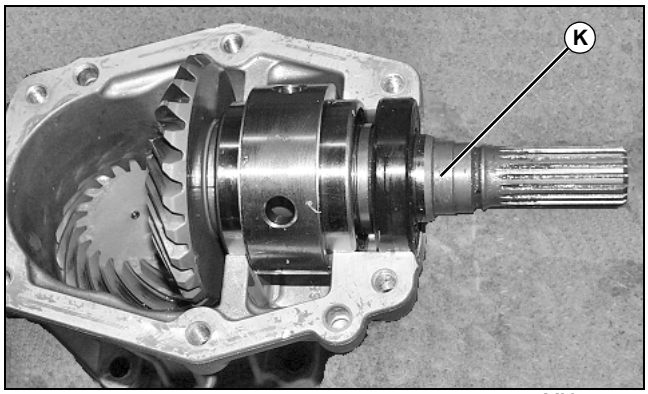
3. Remove O-ring (E) and spacer (F).



MX31856

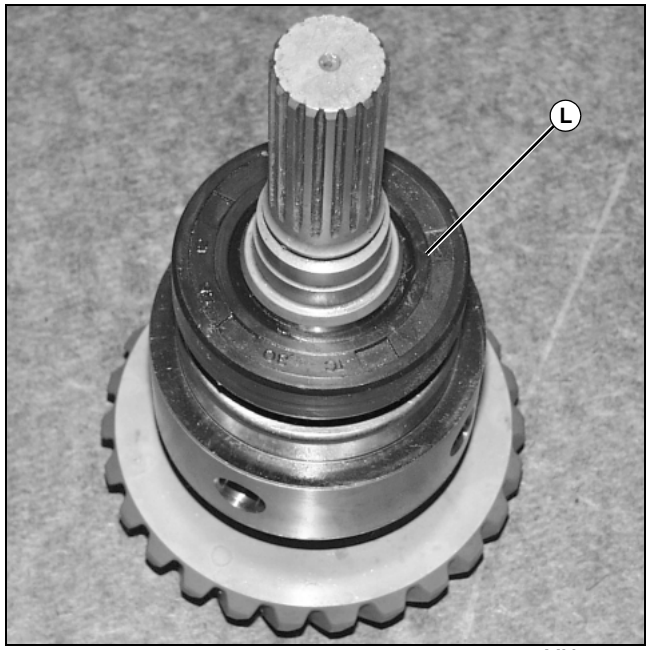
4. Remove four cap screws (G) securing park brake anchor assembly (H) and remove assembly (H).

5. Remove six cap screws (I) and cover (J).



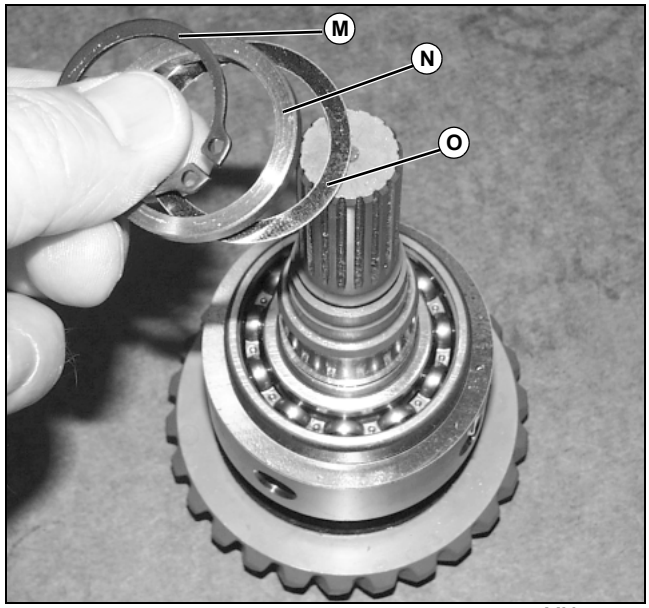
MX31857

6. Remove output shaft assembly (K).



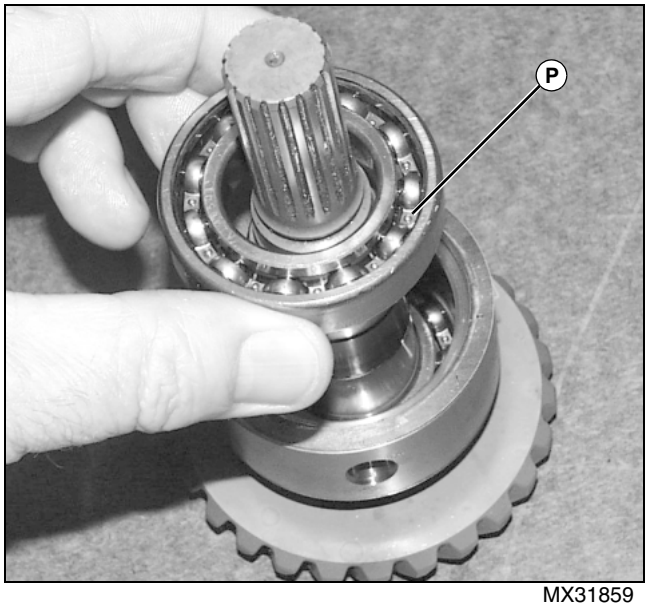
MX31858

7. Remove oil seal (L).



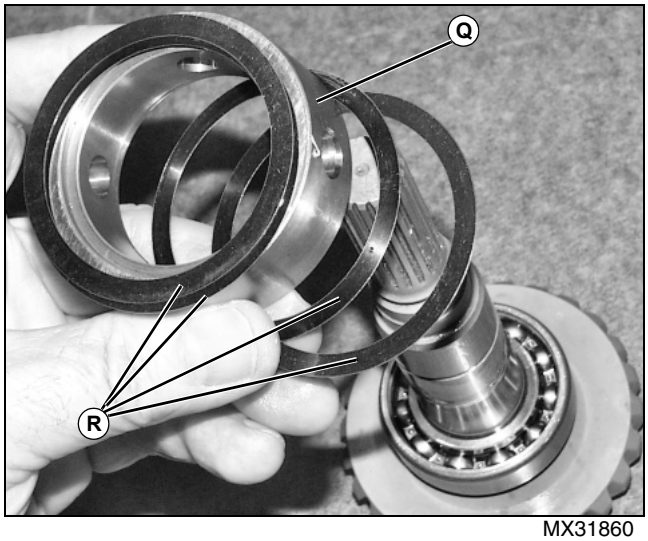
MX31862

8. Remove snap ring (M), spacer (N) and shim(s) (O).



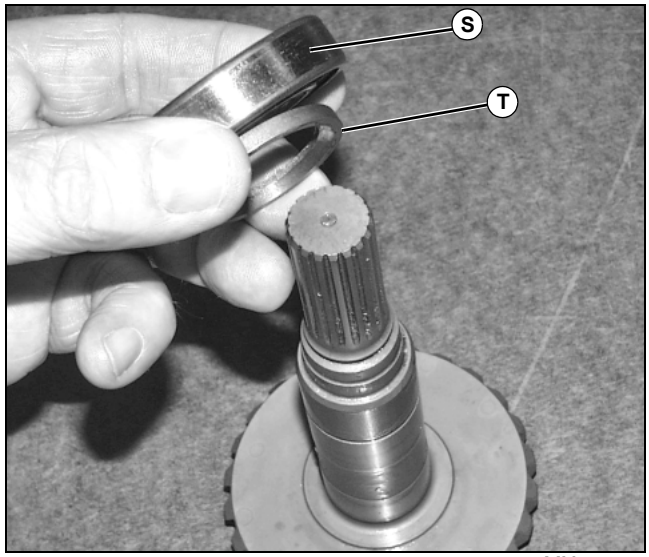
MX31859

9. Remove bearing (P).



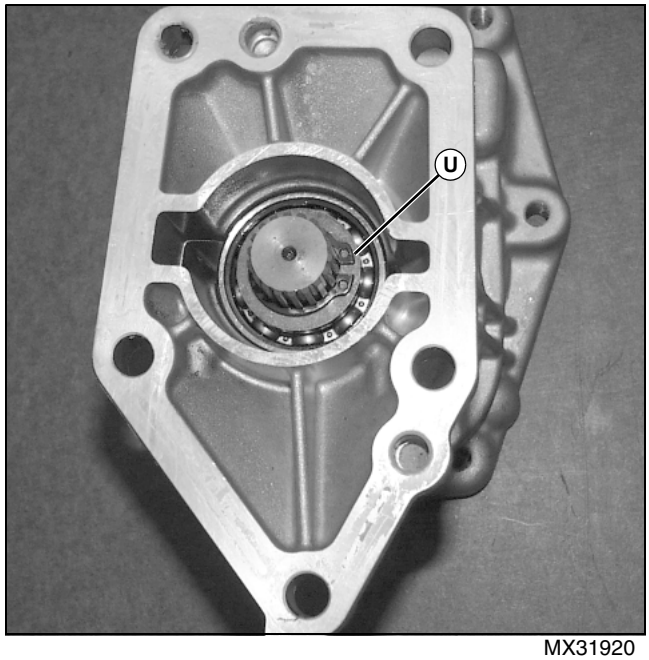
MX31860

10.Remove collar (Q) and shims (R). Note position and number of shims. Shims must be installed their original positions.



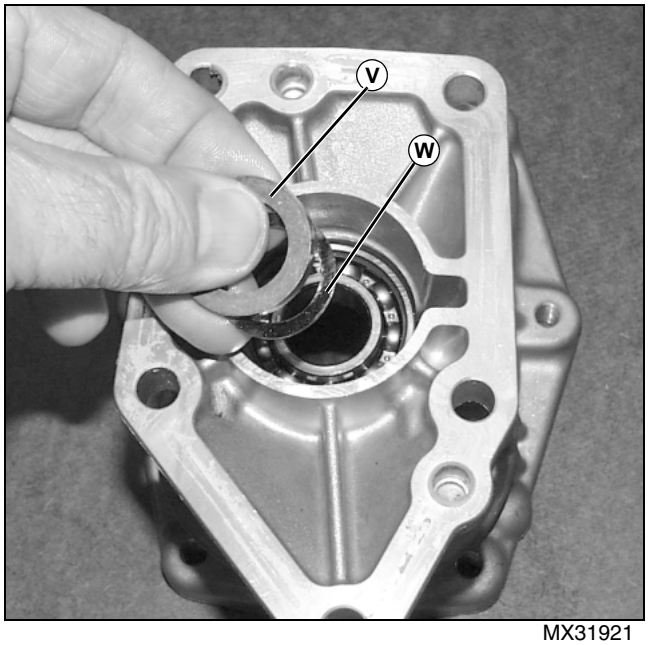
MX31861

11.Remove bearing (S) and washer (T). Note that washer (T) has bevel that goes toward gear.



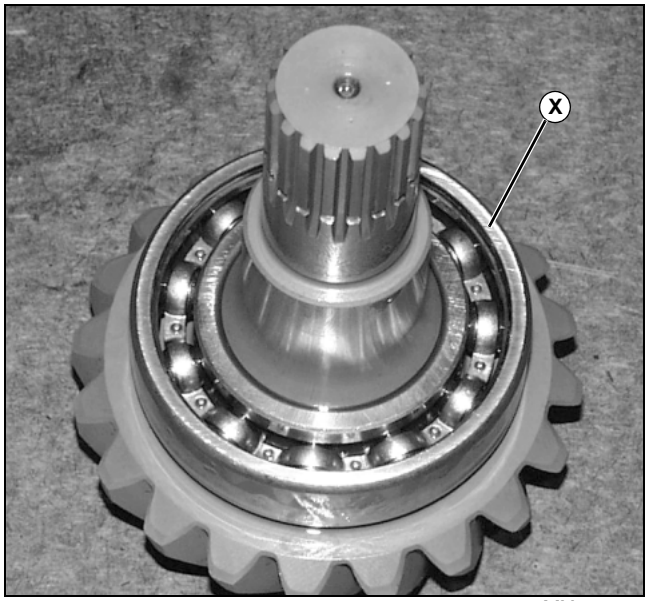
MX31920

12.Remove snap ring (U).



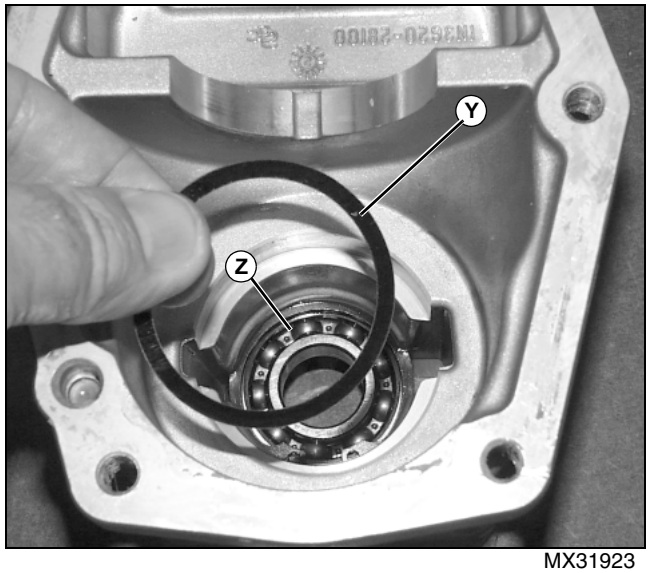
MX31921

13.Remove spacer (V) and shim(s) (W).



MX31922

14.Inspect bearing (X). If bearing needs replacement, remove with a bearing puller or press.



MX31923

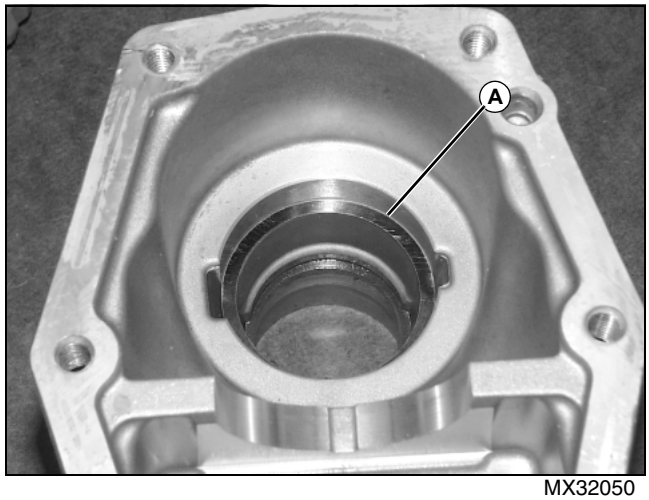
15.Remove shim(s) (Y) and retain for possible re use during assembly.

16.Inspect bearing (Z). Replace bearing if necessary.

Assembly:

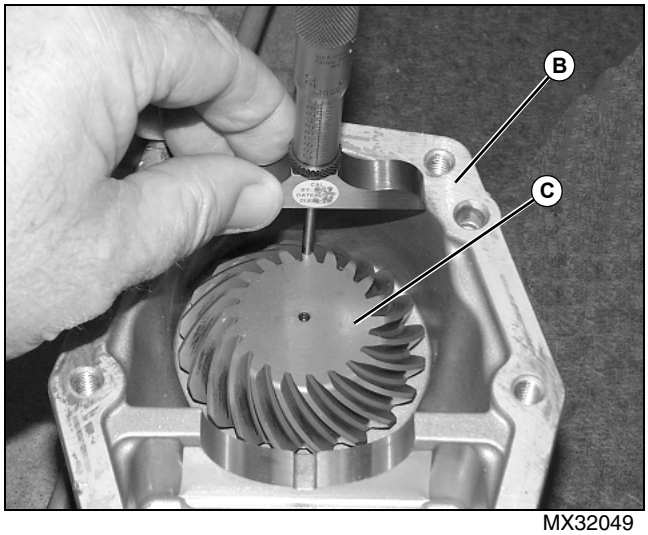
NOTE: If reusing original gears and housings, install shims in original locations and check backlash. If housings or gear set have been changed, assemble gearbox using following procedure.

1. Clean and inspect all parts. Replace any worn or damaged parts. Clean all old gasket material from mating surfaces.



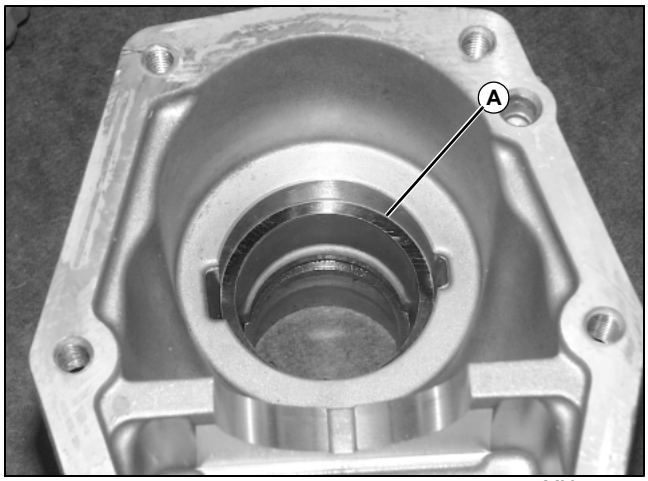
MX32050

2. Install original shim (A) into bearing bore.



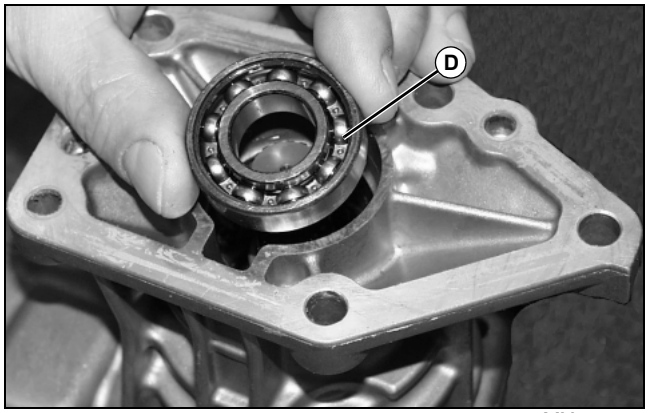
MX32049

3. Install gear and bearing into housing. Use a depth micrometer and check distance between top of housing (B) and flat face of gear (C) as shown. Dimension should be 29 ± 0.05 mm (1.142 ± 0.002 in.)



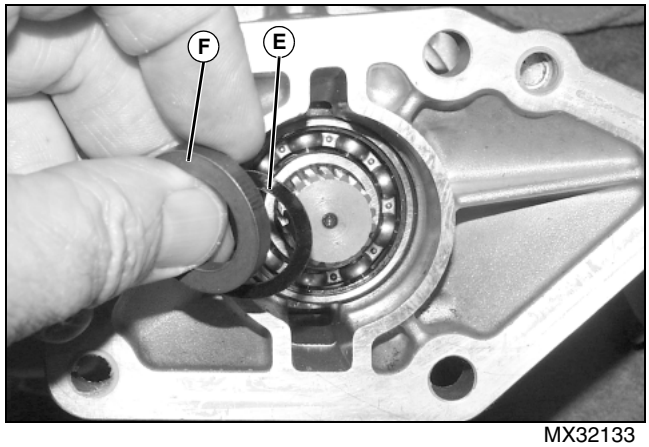
MX32050

4. If dimension is not correct, add or remove shim(s) (A) until correct dimension is obtained.



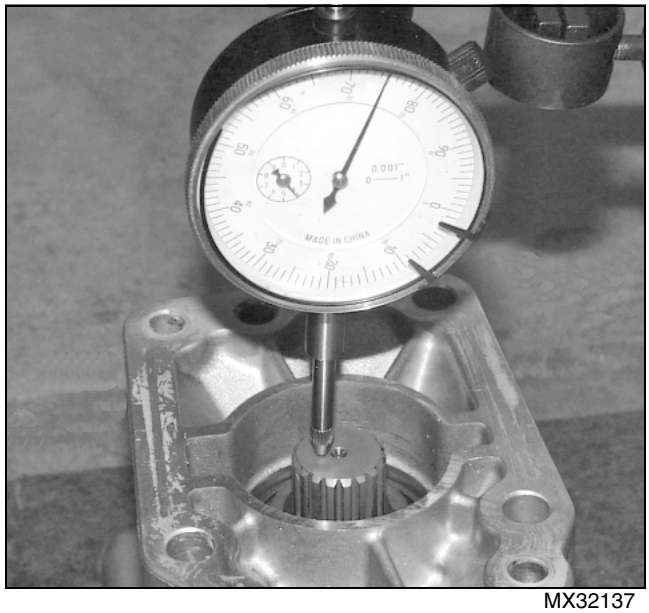
MX32051

5. Install bearing (D).

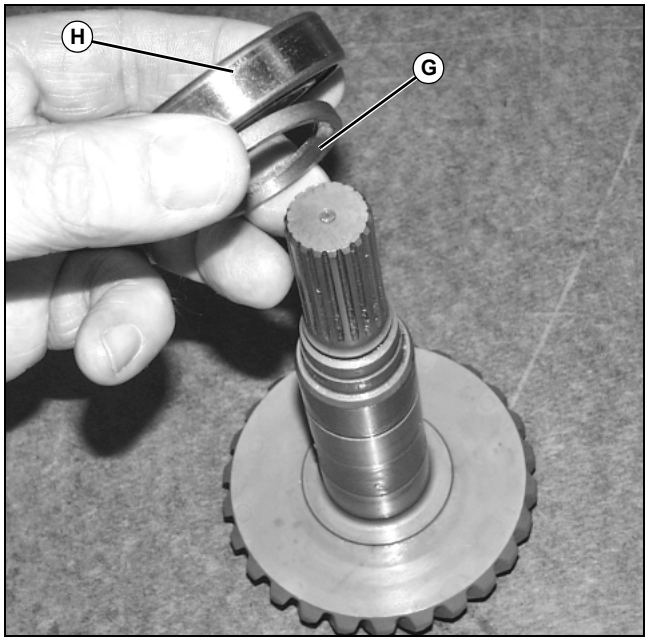


MX32133

6. Install shim(s) (E), spacer (F), and the snap ring.

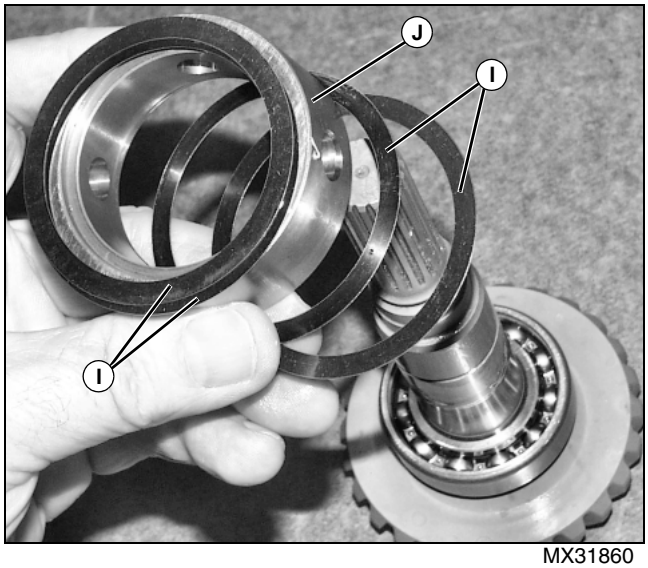

MX32137

7. Measure shaft end play. End play should be less than 0.05 mm (0.002 in.) To adjust end play remove snap ring and washer and add or remove shims as required until proper end play is obtained.



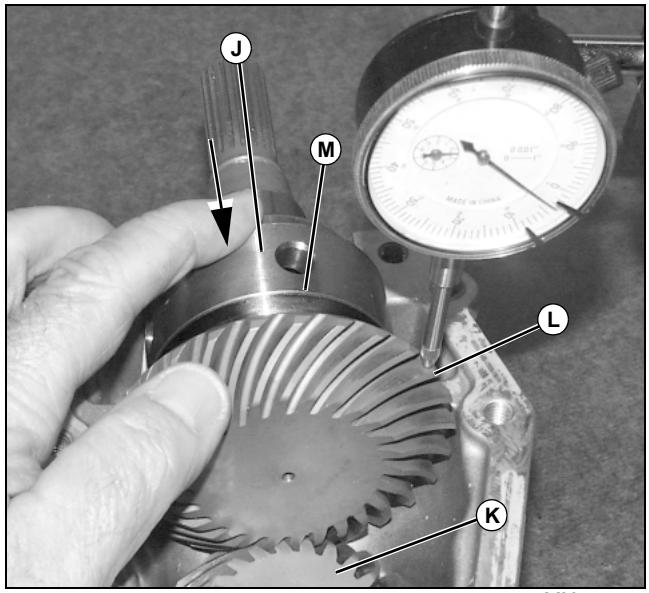
MX31861

8. Install spacer with chamfer (G) toward gear. Install bearing (H).



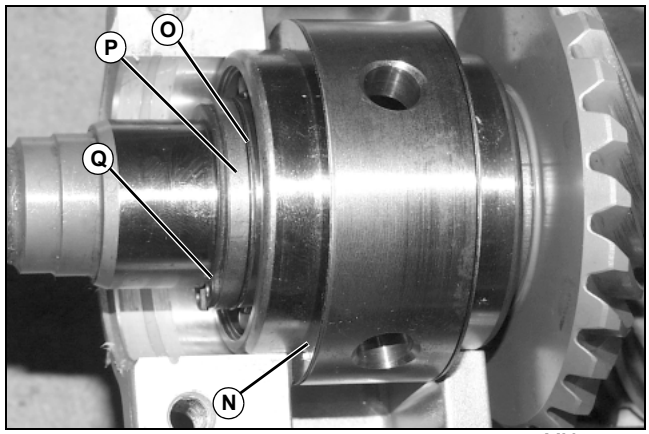
MX31860

9. Install original shims (I) and spacer (J) onto shaft and bearing. If original shim thickness is unknown or you are using new gears or case, start with 0.5 mm (0.020 in.) shim.



MX32138

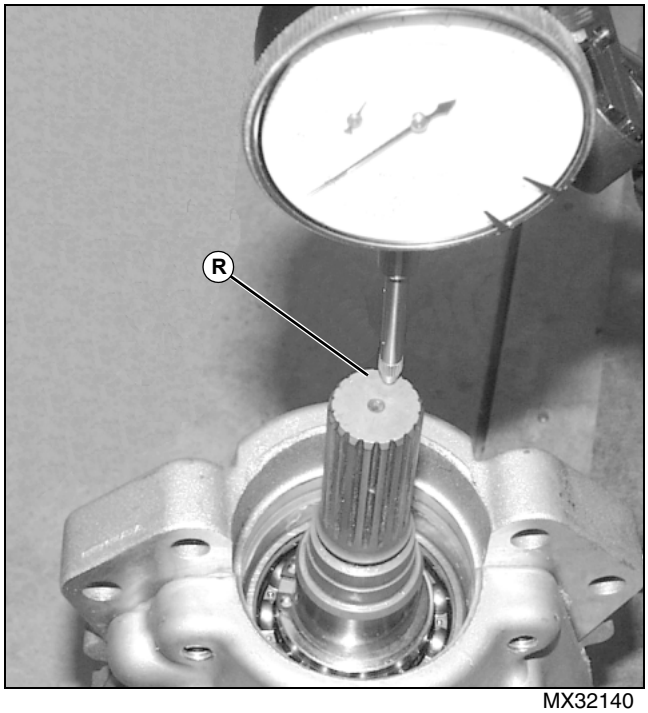
10.Push collar (J) in direction of arrow. Hold gear and shaft (K) from moving. Turn gear (L) back and forth and measure backlash on dial indicator. Backlash should be 0.2 - 0.3 mm (0.008 - 0.012 in.) If backlash is not within specification, adjust thickness of shim(s) (M). Adding shims decreases backlash, removing shims increases backlash.



MX32139

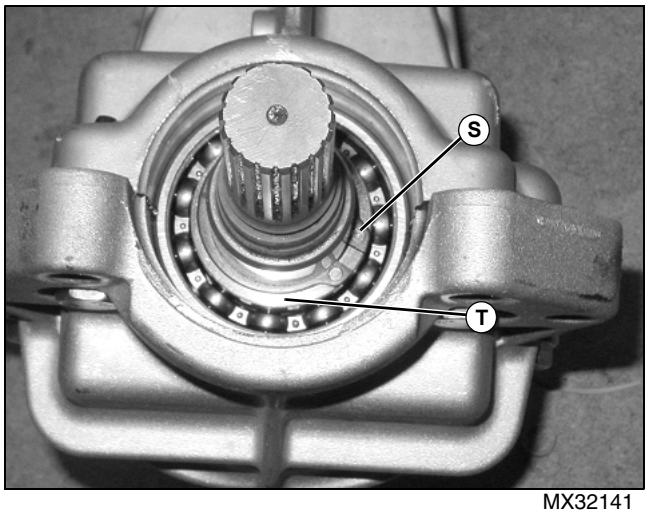
11.Place shim(s) (N) on other side of collar until the collar has no end play.

12.Install shim(s) (O), spacer (P), and snap ring (Q).



MX32140

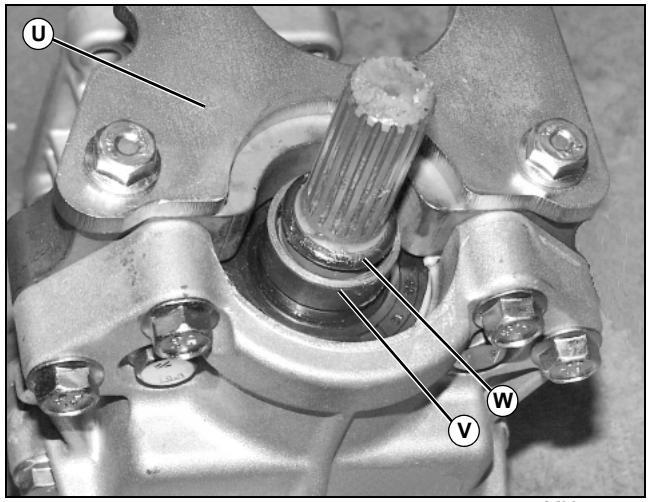
13.Apply a thin bead of John DeereTY16021 form in place gasket around mating surfaces of case halves. Assemble case and check end play of shaft (R) with dial indicator. End play should be 0.05 mm (0.002 in.) or less.



MX32141

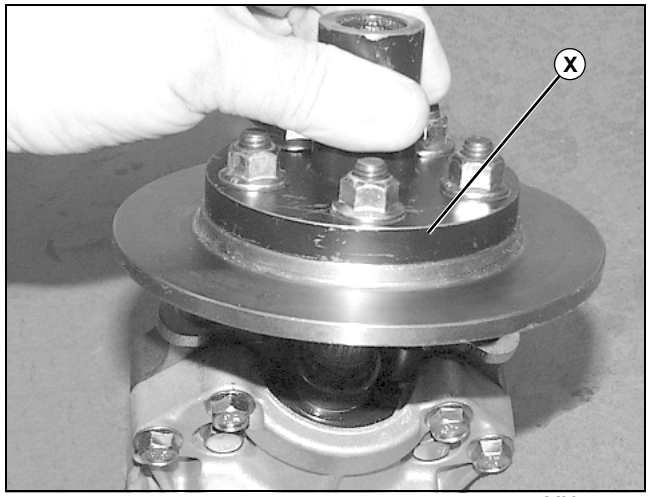
14.If shaft end play is not 0.05 mm (0.002 in.) or less, remove snap ring (S) and spacer (T). Add or remove shims under spacer until end play is correct.

15.Install the seal with an appropriate seal driver.



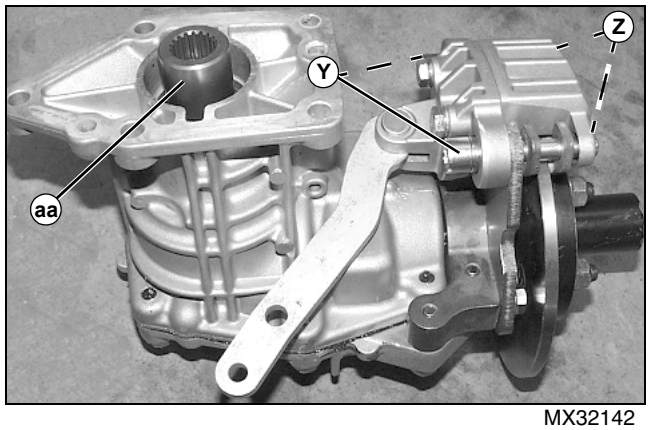
MX31855

16.Install the parking brake bracket (U), spacer (V), and O-ring (W).



MX31854

17.Install park brake rotor and hub assembly (X).



MX32142

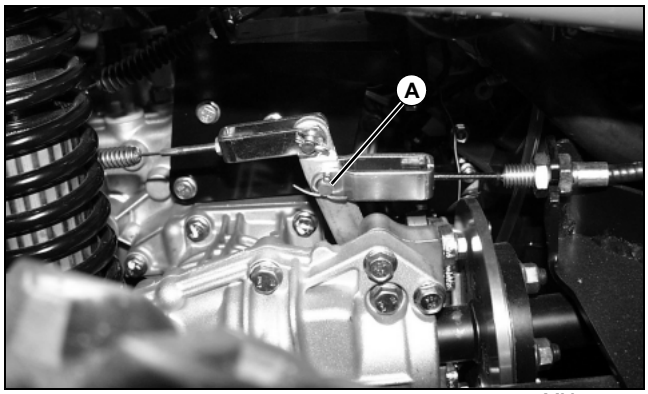
18.Install park brake caliper with socket head bolts (Y). Install C clips (Z) on end of bolts. Make sure splined coupling (aa) is either on gearbox or transaxle before installing gearbox.

MFWD Driveshaft Removal and Installation (SN -40000)

NOTE: Engine removed for clarity in photos.

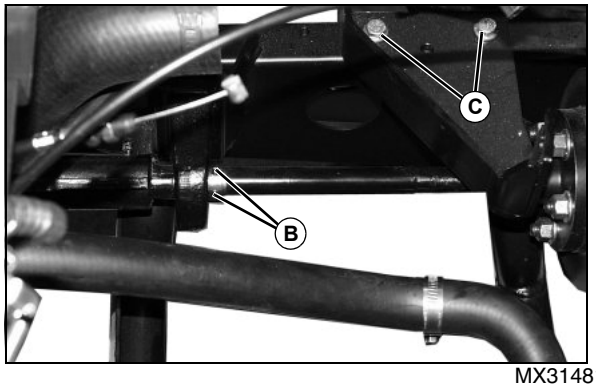
Removal:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Raise and lock cargo box.
3. Block wheels to prevent movement.
4. Unlock park brake.



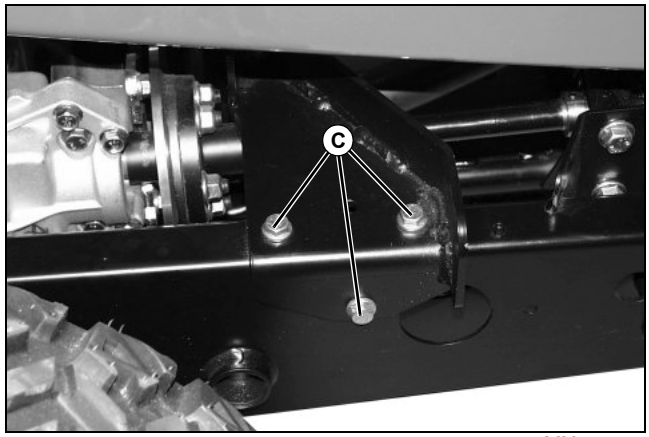
MX31451

5. Remove cotter pin from park brake actuator pivot pin (A).



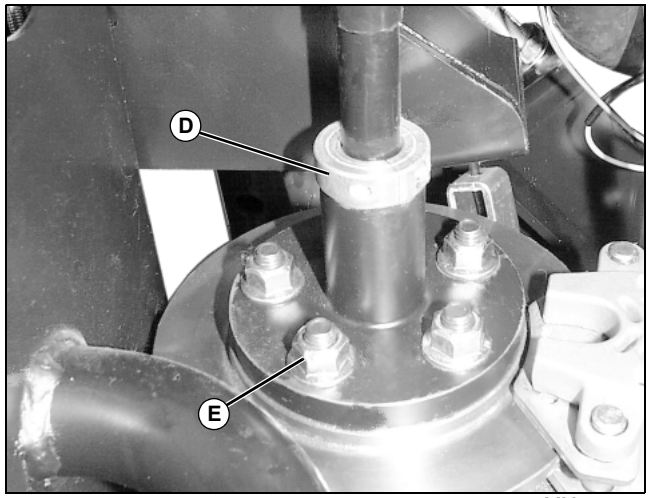
MX31481

6. Loosen two set screws (B) on drive shaft near yolk.



MX31476

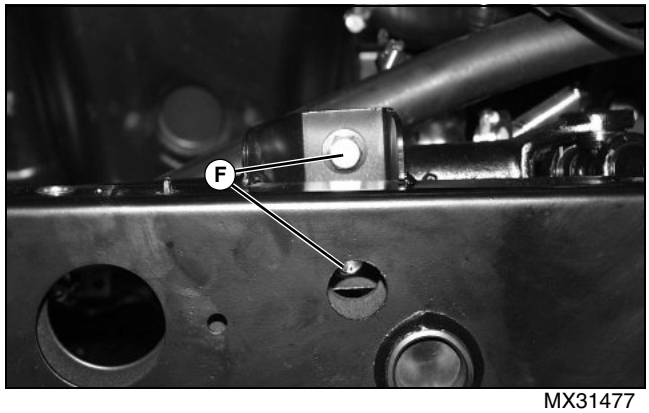
7. Remove three bolts (C) securing park brake cable bracket.



MX32143

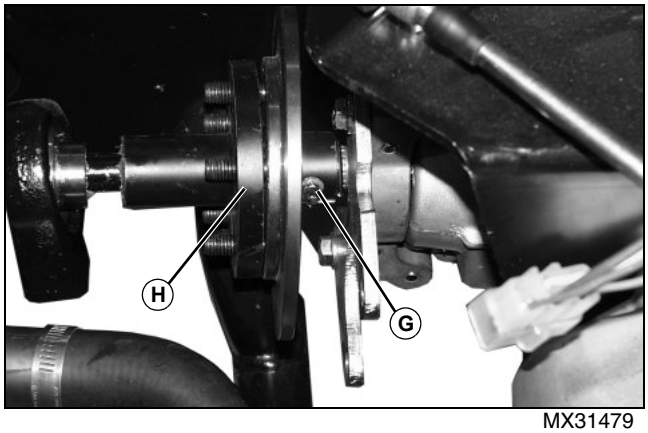
Picture Note: Shown from bottom

8. Loosen screws in collar (D) and slide collar forward on drive shaft.
9. Remove five nuts (E) securing drive shaft collar plate to park brake disc.



MX31477

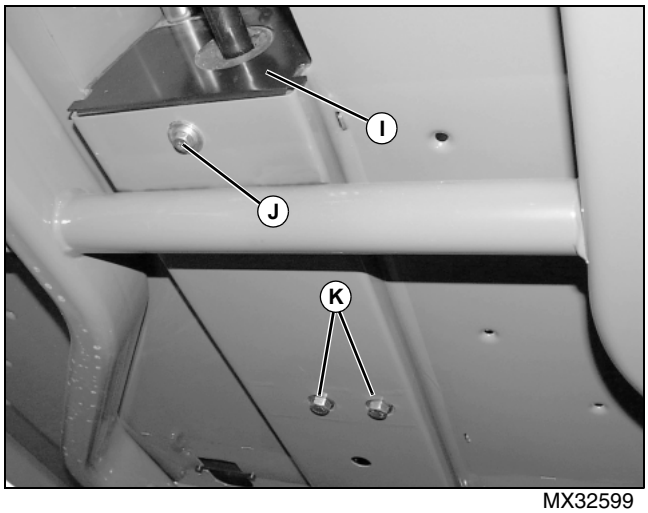
10. Remove two bolts (F) securing rear drive shaft cast support bearing to frame.



MX31479

11.Remove zerk fitting (G) from drive shaft collar.

12.Using a prybar, carefully separate drive shaft collar (H) from brake disc.



MX32599

13.Locate tunnel cover (I) under chassis. Remove cap screw (J) securing cover. Slide cover forward.

14.Remove two cap screw (K) securing front drive shaft cast support bearing.

15.Pull drive shaft out of splined coupling on MFWD differential.

16.Remove drive shaft assembly from machine.

Installation:

- Installation is in the reverse of removal.
- Ensure that spacer and O-ring behind brake disc (on transaxle output shaft) are in place.
- Ensure disc and drive shaft collar assembly are fully seated over O-ring on transaxle output shaft.
- Slide locking collar against disc and drive shaft collar assembly and tighten collar screws.
- Apply one or two pumps of grease to zerk fitting on drive shaft collar.
- Apply one or two pumps of grease to zerk fitting on splined coupling on front differential.

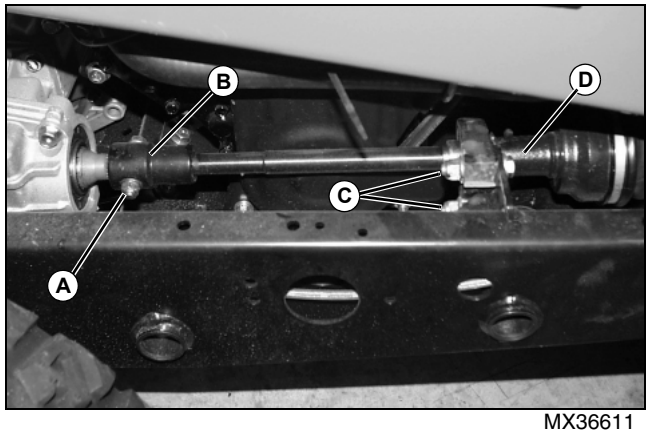
Specifications:

Brake Disc to Drive Shaft Collar Nuts
. . . . . 73 ± 15 N•m (54 ± 11 lb-ft)

EMFWD Driveshaft Removal and Installation (SN 40001-)

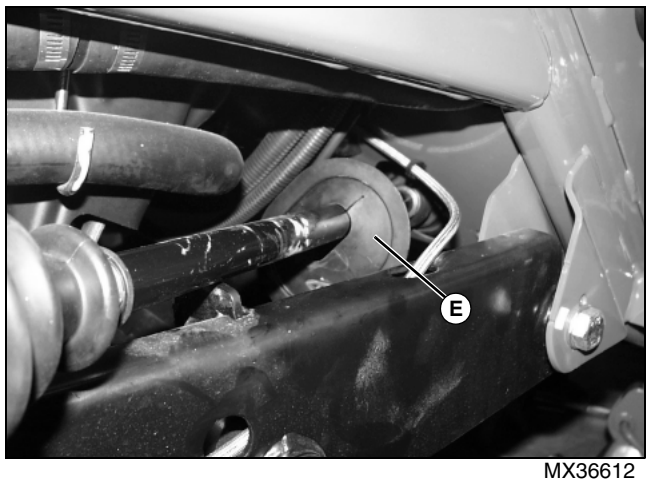
Removal:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Lock park brake.
3. Raise and lock cargo box.
4. Remove battery. See “Battery Removal and Installation” on page 588



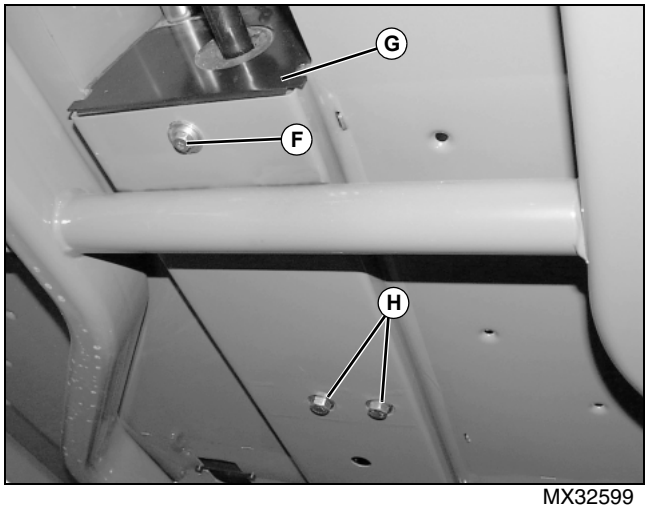
MX36611

5. Remove bolt (A) from splined collar (B). Remove bolts (C) from support bearing. Slide splined collar forward on stub shaft until it disconnects from transmission. Pull stub shaft and support bearing out of CV joint (D).



MX36612

6. Remove cover (E) from opening and slide cover back on driveshaft.



MX32599

7. Remove tunnel cover retaining bolt (F) and slide cover (G) away from tunnel. Remove center bearing bolts (H).

8. Slide the driveshaft back until the splines of the shaft are out of the splined coupling on the EMFWD unit.

9. Pull the driveshaft out from the rear of the machine.

Installation:

- Install driveshaft in the reverse order of removal.

Front Differential Removal and Installation (SN -40000)

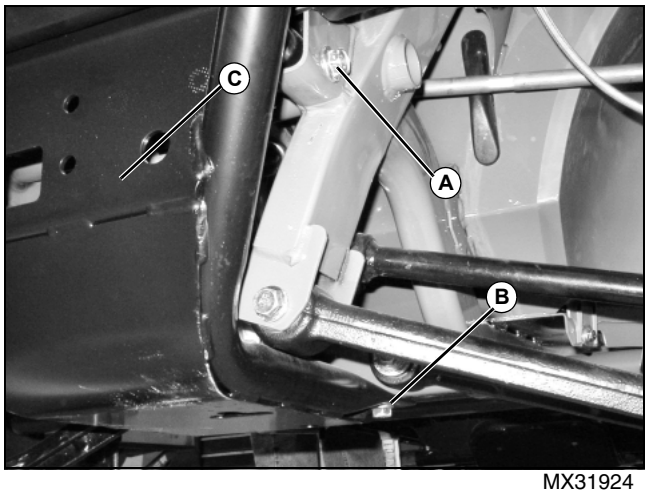
Removal:

1. Park machine safely. See Parking Safely in the Safety Section.

2. Lock park brake.

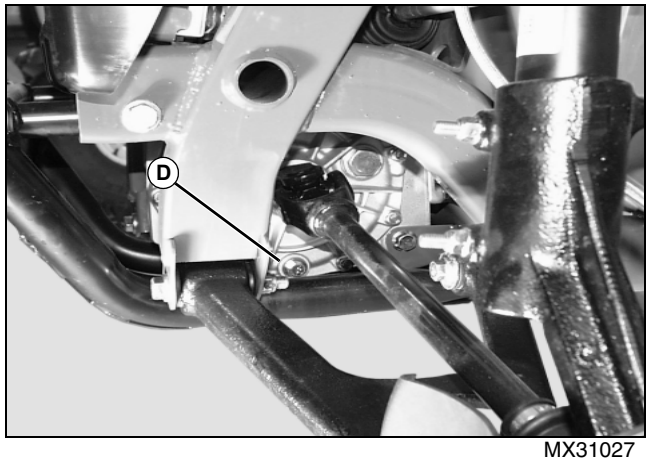
3. Jack up front of machine and place on jack stands.

4. Remove front tires.



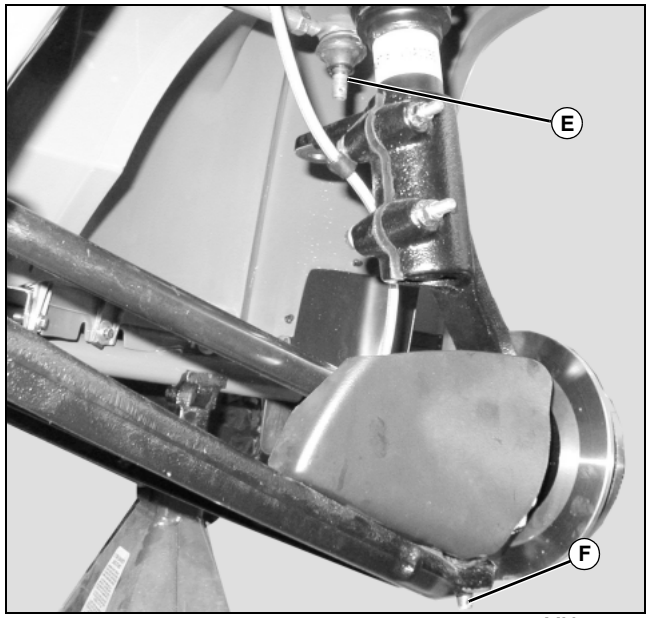
MX31924

5. Remove cap screws and nuts (A) and cap screws (B) on each side of machine. Remove front guard (C).



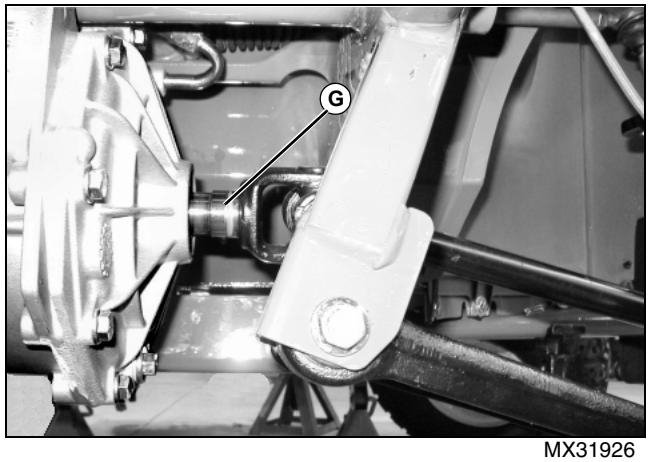
MX31027

6. Place a drain pan under differential. Remove drain plug (D) and drain oil from differential case.



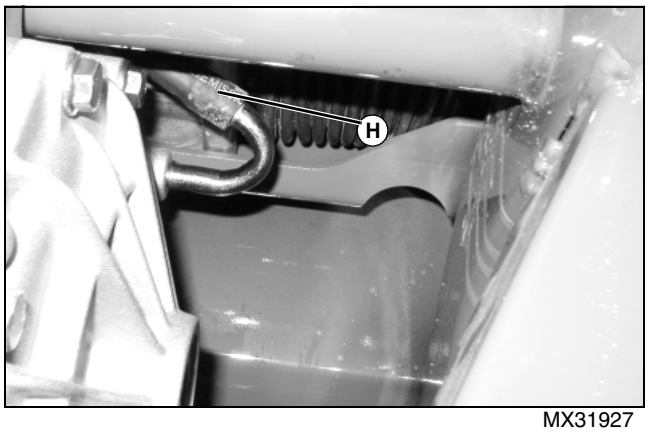
MX31925

7. On both sides of machine, disconnect tie rod end (E) from steering knuckle. Disconnect ball joint (F) from A arm.



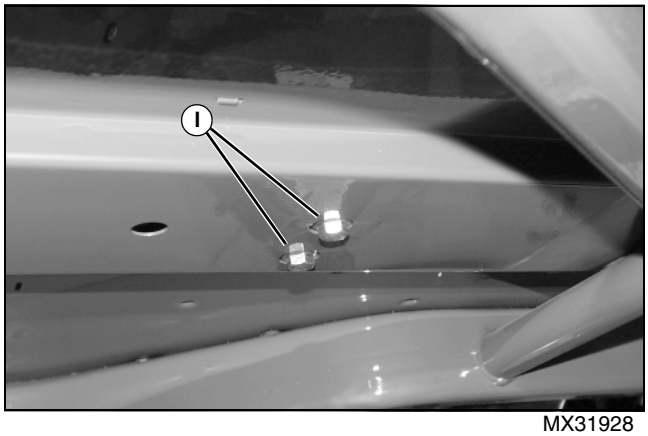
MX31926

8. Apply outward pressure on steering strut and pull half shaft (G) out of differential. Repeat on other side.



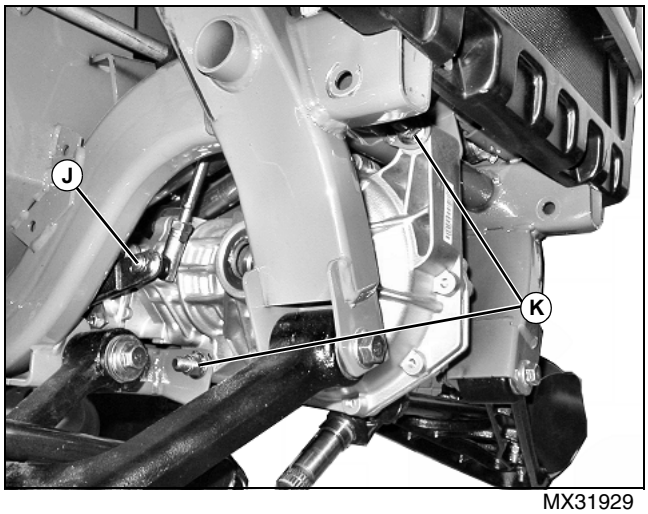
MX31927

9. Disconnect vent hose (H).



MX31928

10.On bottom front of tunnel, remove two cap screws (I) from front drive shaft support bearing.



MX31929

11.Remove nut (J) and disconnect shift linkage from lever.

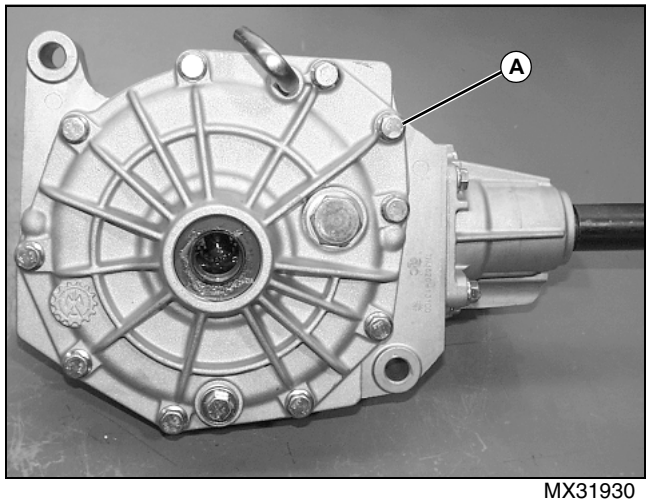
12.Support differential and remove cap screws and nuts (K). Pull differential forward and out of machine.

Installation:

- Install unit in the reverse order of removal.
- Tighten differential to frame bolts to 43 N•m (32 lb ft).
- Tighten ball joint nuts to 54 N•m (40 lb ft).

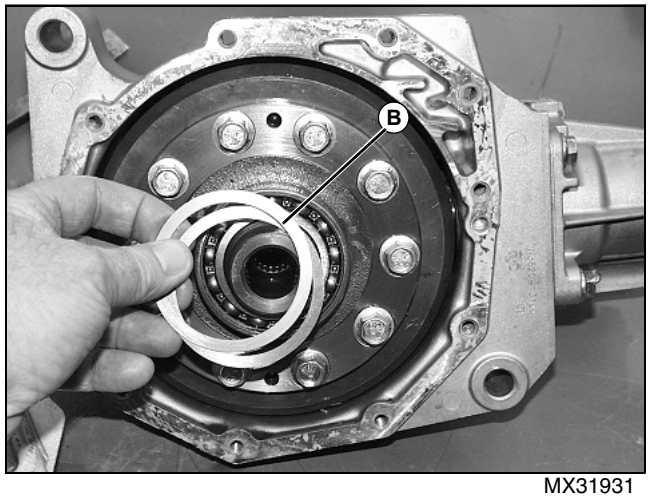
Front Differential Disassembly (SN -40000)

Disassembly:



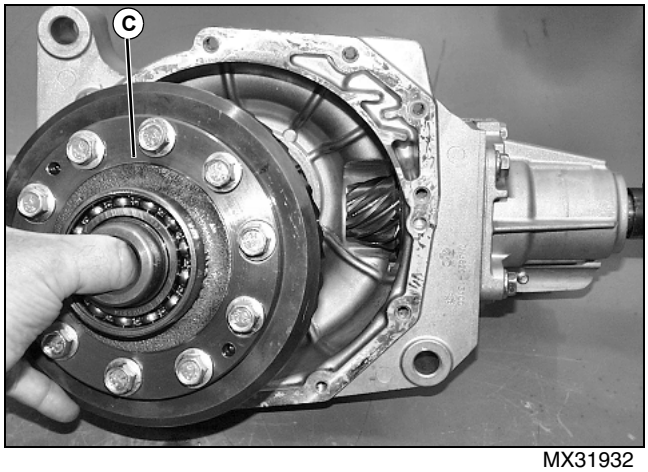
MX31930

1. Remove ten cap screws (A) holding side cover to differential case and remove side cover.



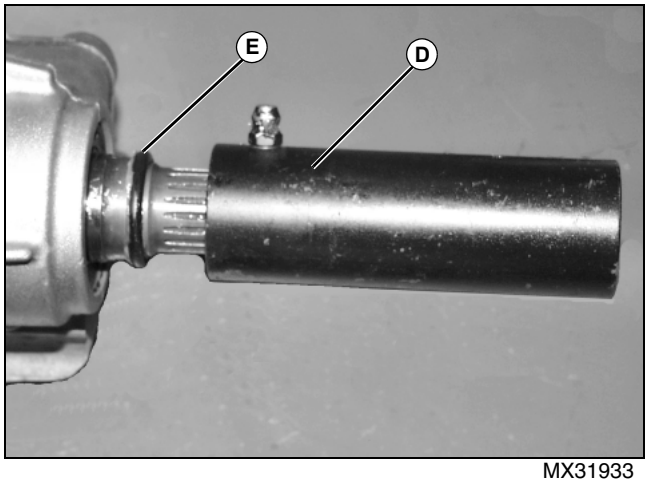
MX31931

2. Remove and retain shims (B). Shims may be on the bearing or in the bearing bore in the cover.



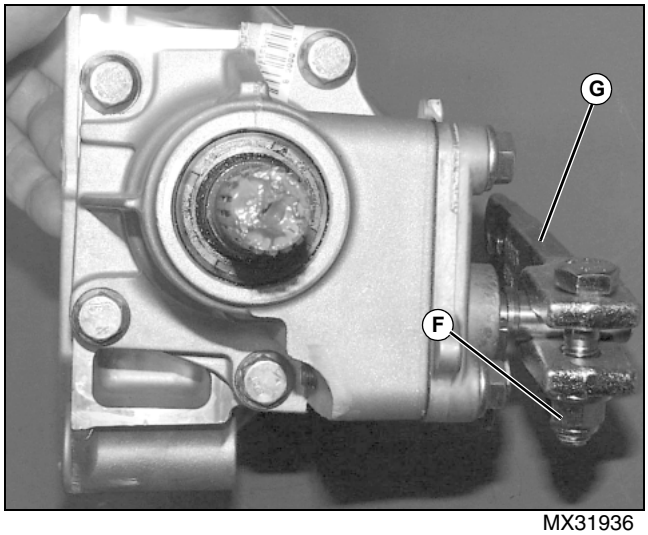
MX31932

3. Remove differential carrier assembly (C).



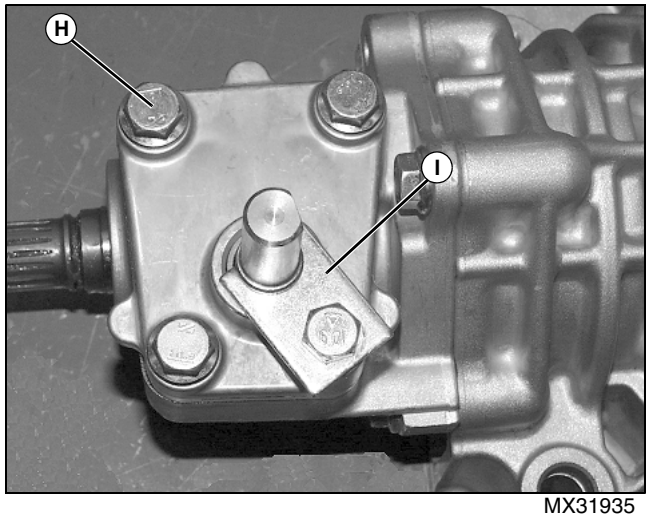
MX31933

4. Remove splined coupling (D) and O-ring (E).



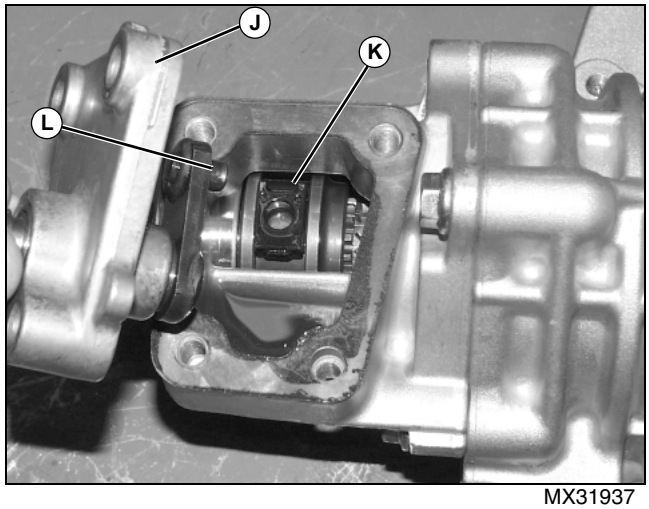
MX31936

5. Remove cap screw and nut (F). Remove FWD engagement lever (G).



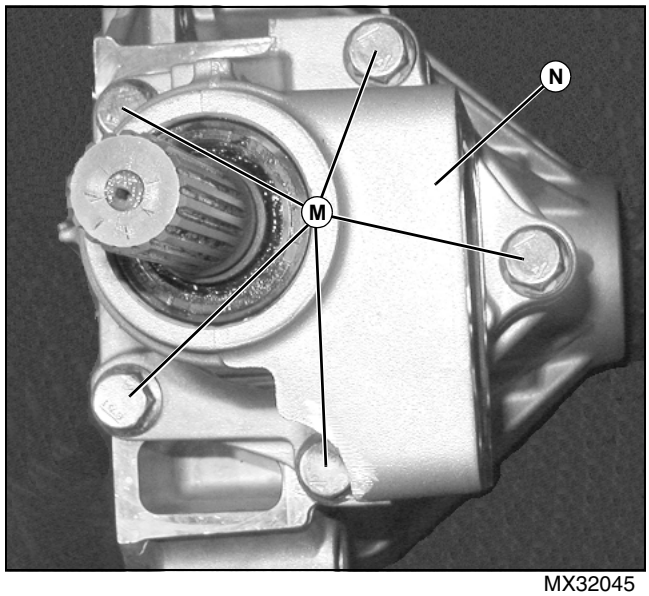
MX31935

6. Remove four cap screws (H) and shift shaft retainer (I).



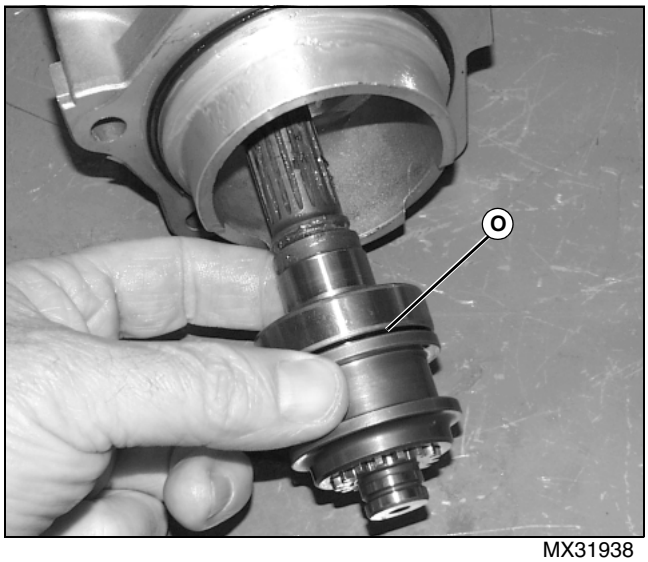
MX31937

7. Remove cover (J). Shift block (K) may be on shift collar as shown, or it may remain on shift arm (L).



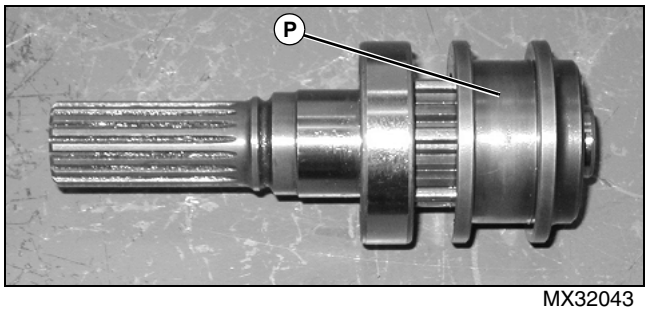
MX32045

8. Remove five cap screws (M) and input shaft housing (N).



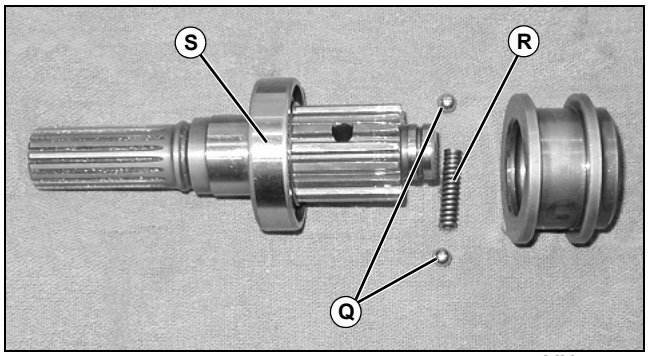
MX31938

9. Remove input shaft (O) from housing.



MX32043

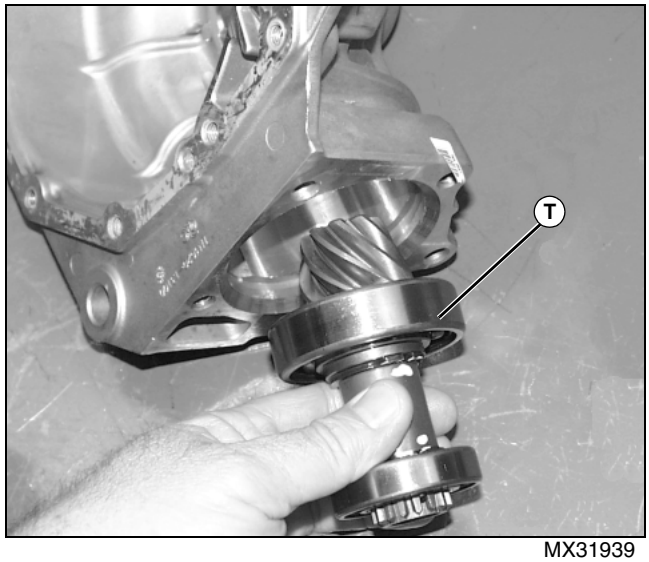
10.Position shift collar (P) as shown. Wrap a shop cloth around the shaft assembly to capture spring loaded detent balls when they are released from under the collar. Remove shift collar.



MX32044

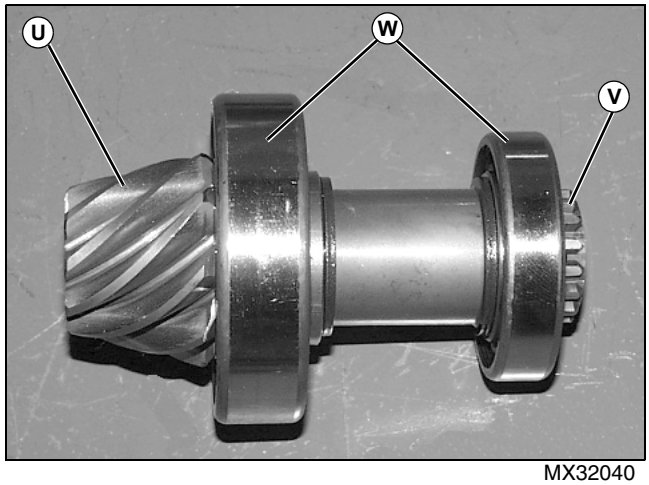
11.Inspect splines on shaft and inside collar. Inspect detent balls (Q), spring (R), and bearing (S). Replace any worn or damaged parts.

- Assemble in the reverse order of disassembly.



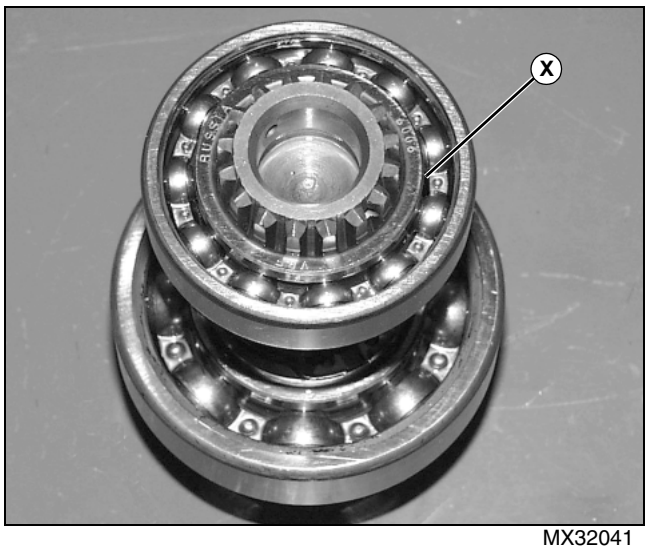
MX31939

12.Remove pinion shaft assembly (T) from differential housing



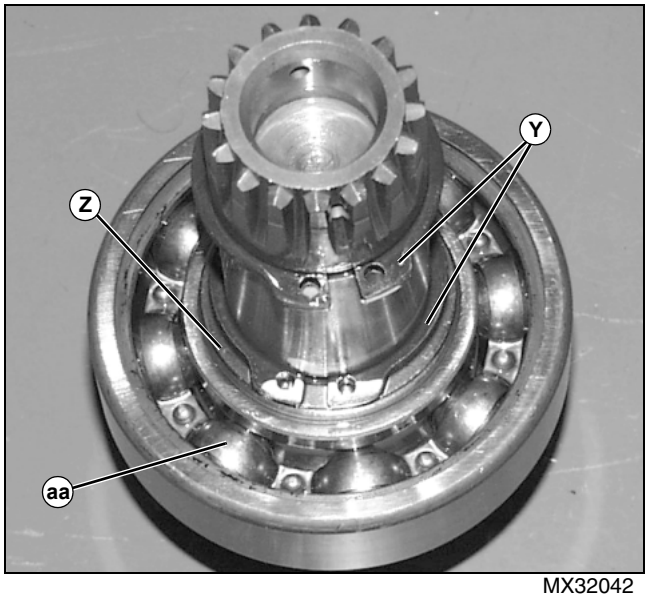
MX32040

13.Inspect all gear teeth (U), splines (V), and bearings (W) on pinion shaft for wear or damage. Replace all worn or damaged parts.



MX32041

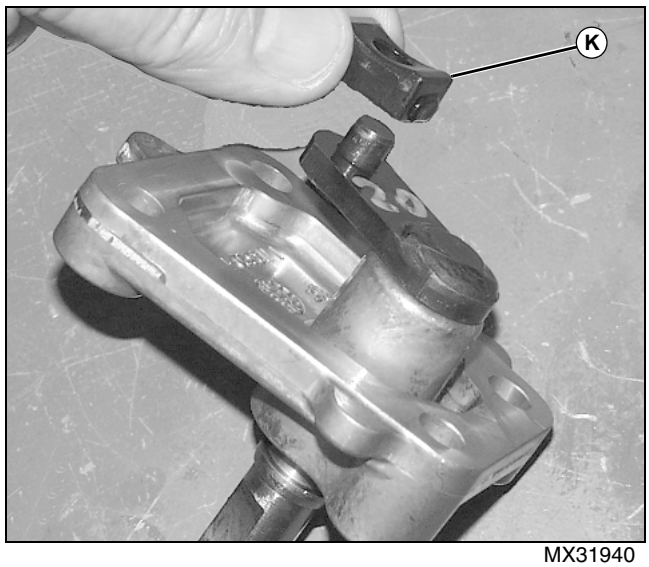
14.If bearings or shaft need replacement, remove outer bearing (X).



MX32042

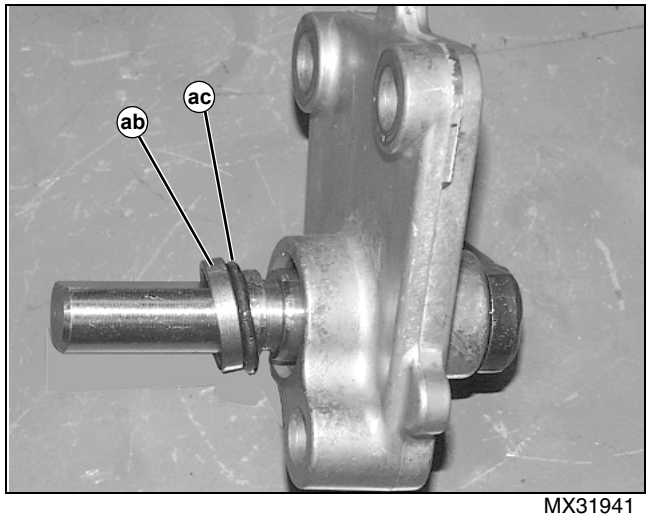
15.Remove snap rings (Y), spacer (Z), and bearing (aa).

- Replace any worn or damaged parts and assemble in the reverse order of disassembly.



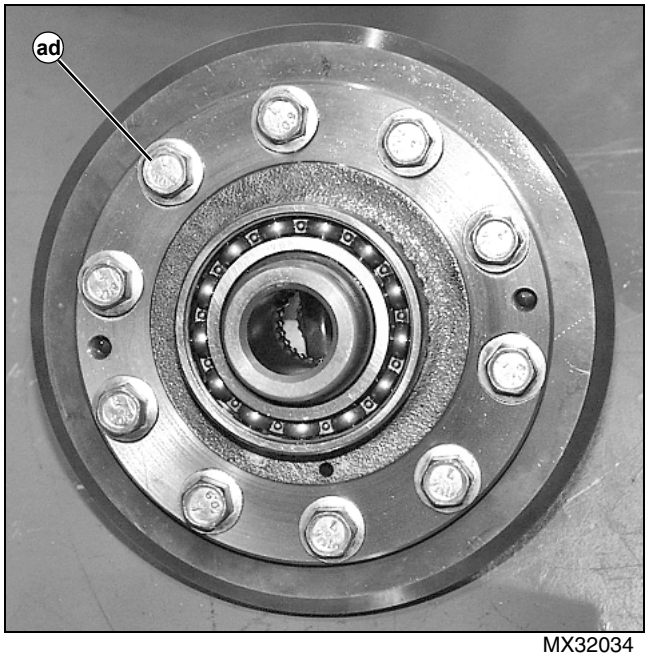
MX31940

16.If shift block (K) remained on shift arm, remove shift block.



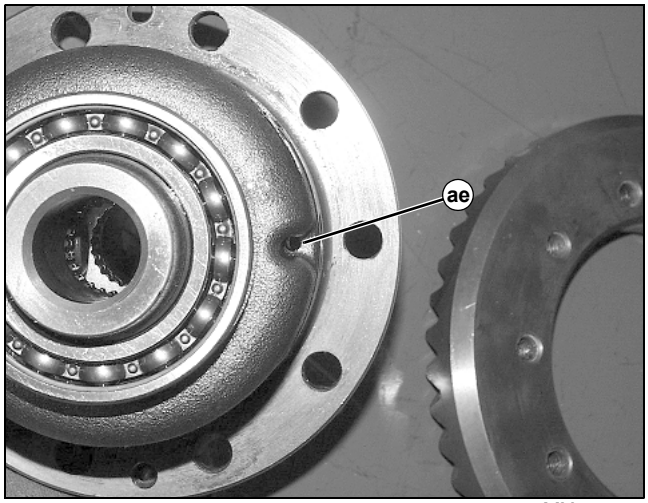
MX31941

17.Remove spacer (ab) and O-ring (ac) from shaft.



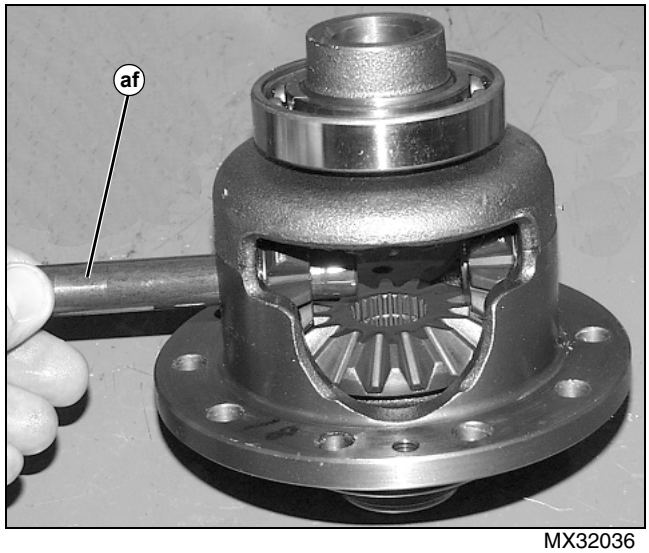
MX32034

18.Remove cap screws (ad) from ring gear.



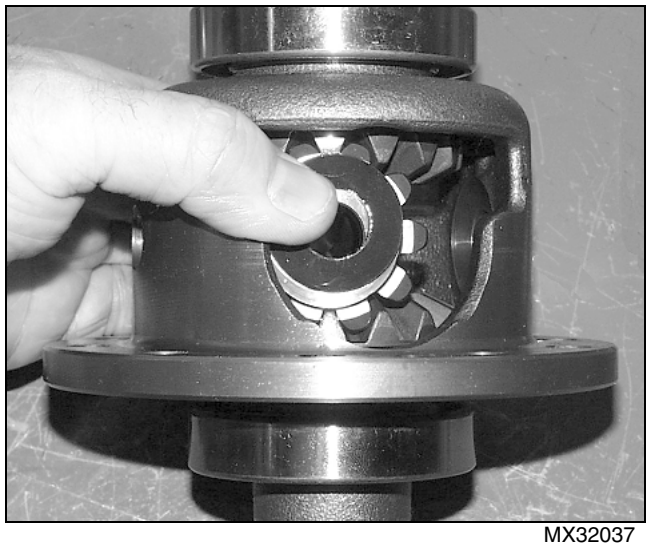
MX32035

19.From either side of differential carrier, use a long pin punch in hole (ae) and drive out roll pin from pinion shaft.



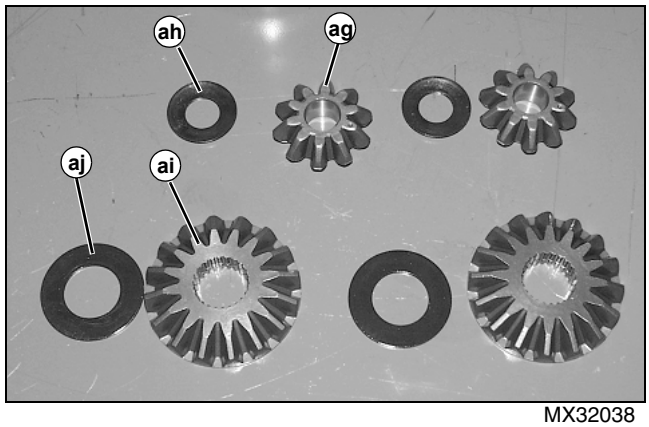
MX32036

20.Remove pinion shaft (af).



MX32037

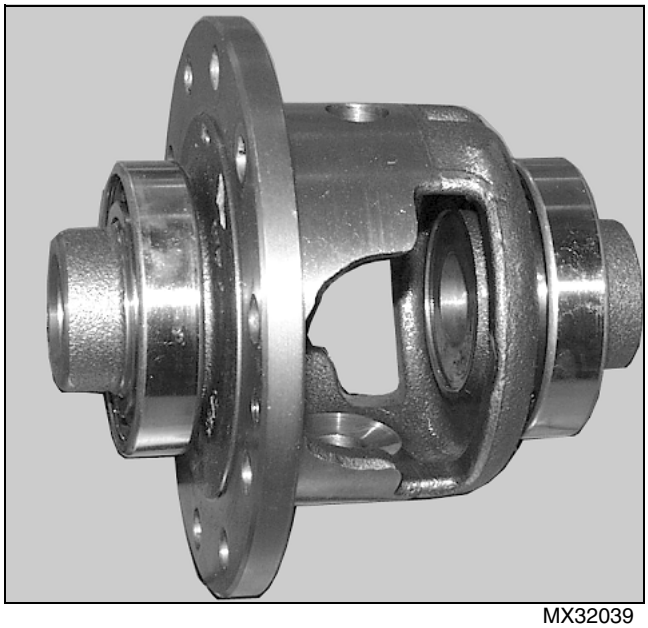
21.Turn the gears to the opening in the differential carrier and remove all gears and thrust washers.



MX32038

22.Inspect pinion gears (ag) and thrust washers (ah). Inspect differential side gears (ai) and thrust washers (aj).

Replace any worn or damaged parts.



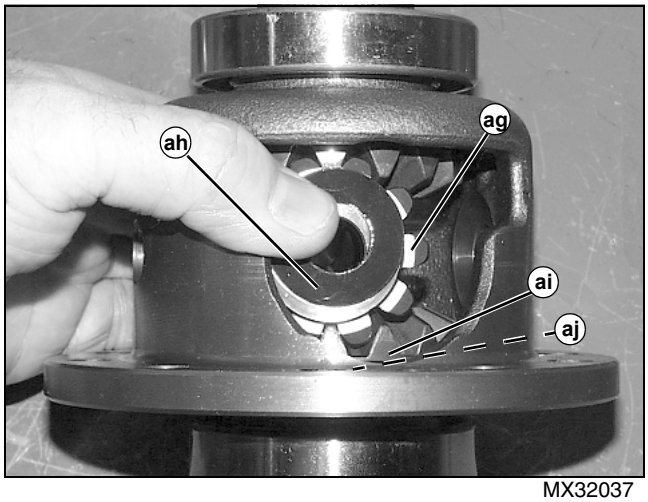
MX32039

23.Inspect differential carrier and bearings for wear or damage. Replace any worn or damaged parts.

Front Differential Assembly (SN -40000)

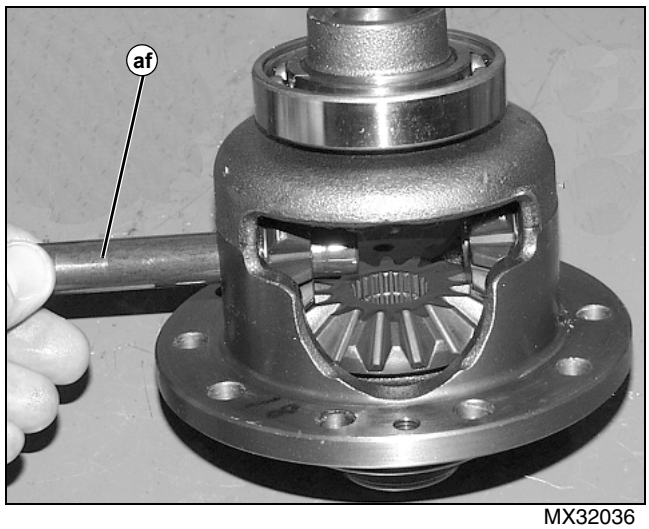
Assembly:

1. Apply grease to thrust washers to help keep them in place during assembly.



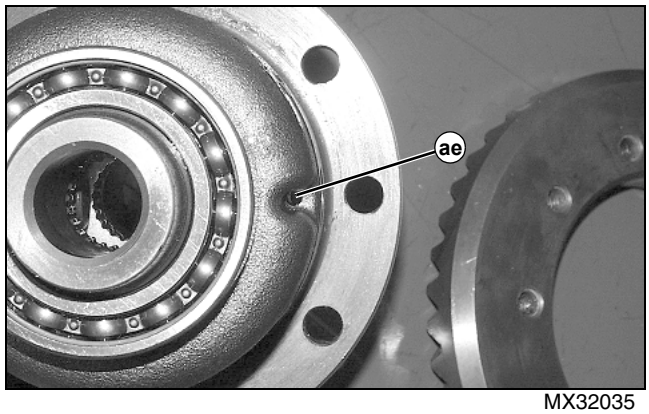
MX32037

2. Install thrust washers (aj) and side gears (ai), then pinion gears (ag) and thrust washers (ah).



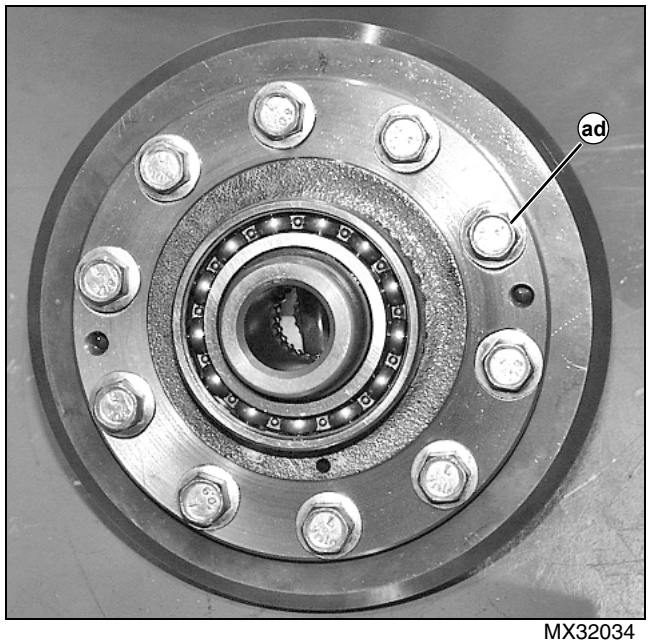
MX32036

3. Align pinion gears and thrust washers with pinion shaft hole. Install pinion shaft (af) and align hole for roll pin with hole in differential carrier.



MX32035

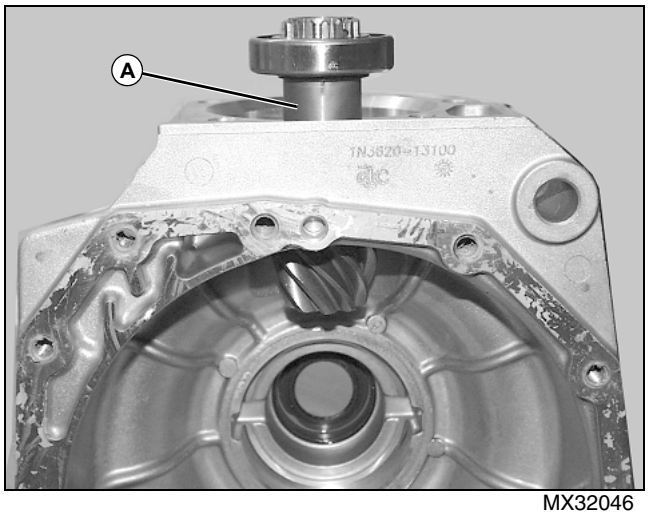
4. Install roll pin into hole (ae) and through pinion shaft.



MX32034

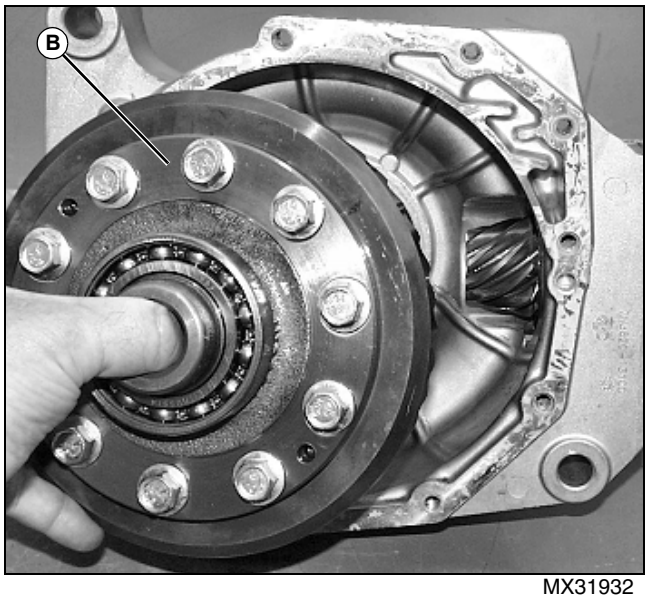
5. Install ring gear on differential carrier. Apply high strength thread locking compound to threads of bolts. Install bolts (ad) and tighten in a cross pattern to 70 - 80 N•m (52 - 59 lb ft).

6. Clean all gasket material from mating surfaces.



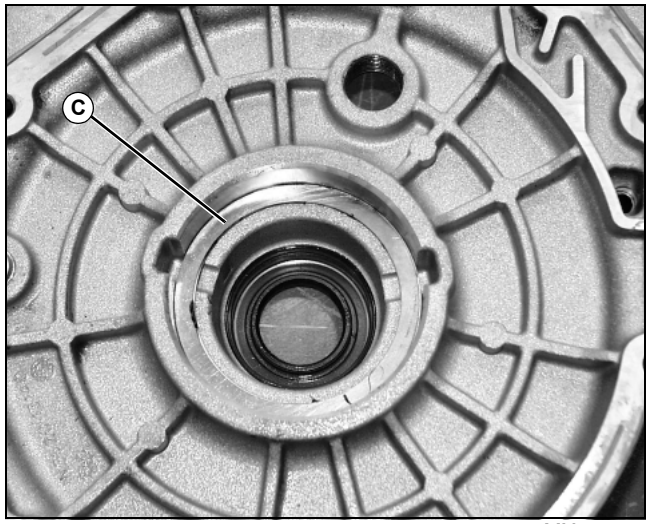
MX32046

7. Install the pinion shaft assembly (A) into the differential housing.



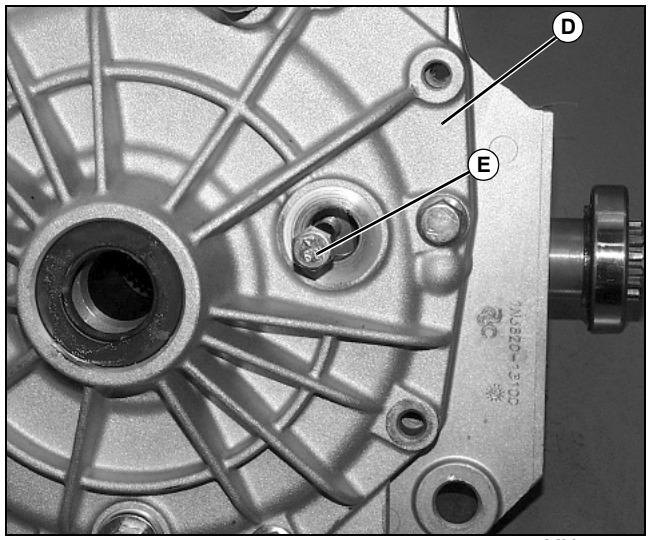
MX31932

8. Install the differential carrier assembly (B) onto the differential housing.



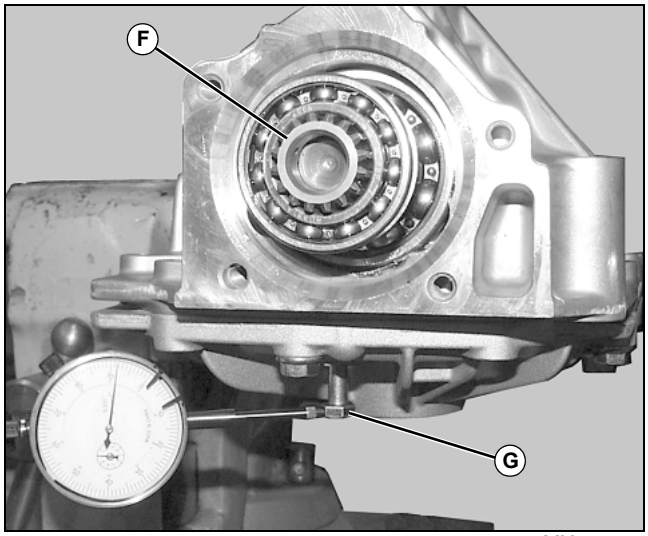
MX32047

9. Apply a light film of grease to original shims (C) to hold them in place in differential cover.



MX32048

10.Install differential side cover (D) with four cap screws tightened to specification. Turn gears and locate threaded hole in differential carrier. Install M8 bolt (E) into differential carrier through oil fill hole as shown. Tighten bolt enough to keep it from wiggling in the threads and causing a false reading on the dial indicator.

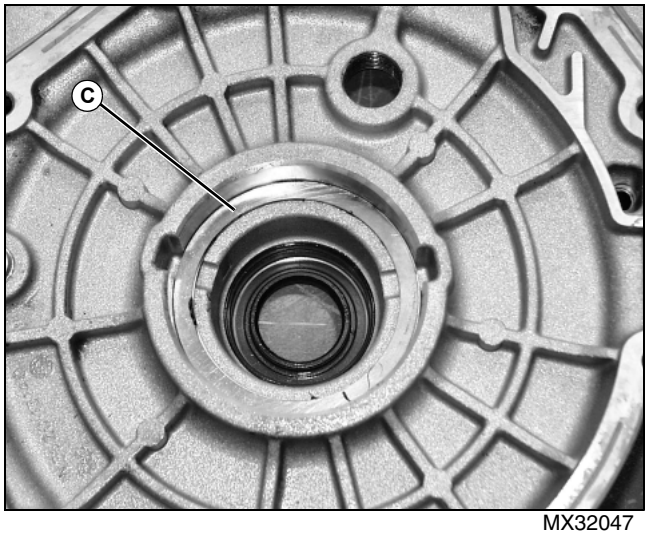


MX32144

11.Place differential assembly in a fixture or vice with the cover facing down. This keeps the weight of the differential carrier against the shims. Tap on the case to make sure the differential has seated on the shims. Set up dial indicator as shown to read movement of bolt (G). Hold pinion shaft (F) in toward case and continue to hold to keep shaft from turning during measurement.

12.While holding shaft (F) move bolt (G) back and forth and record reading on dial indicator.

13.Backlash should be 0.12 - 0.19 mm (0.004 - 0.007 in.).

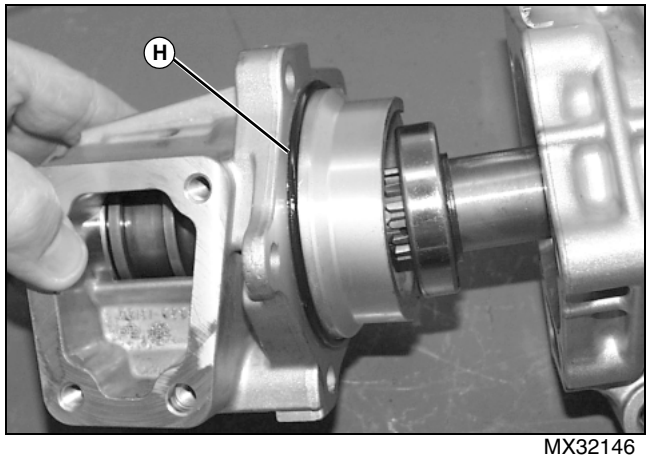


MX32047

14.If backlash is not 0.12 - 0.19 mm (0.004 - 0.007 in.) remove differential side cover and adjust the shim pack thickness until backlash is correct. Adding shims decreases backlash, removing shims increases backlash.

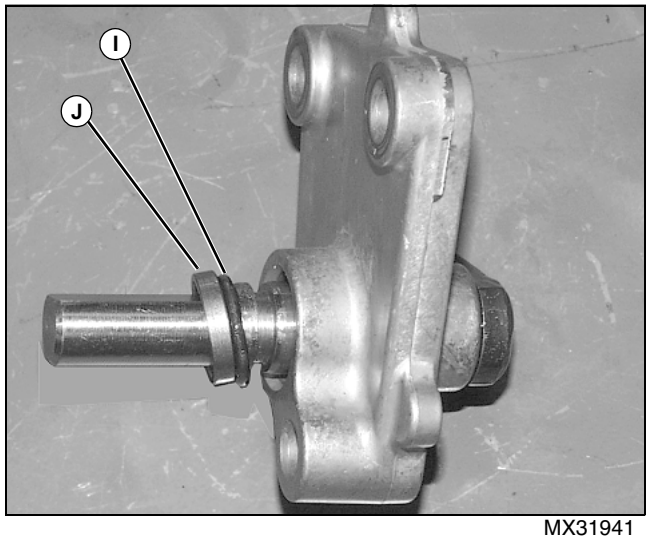
15.When backlash meets specification, apply a thin bead of John Deere Form In Place Gasket on mating surface and install cover.

16.Replace the oil seals.



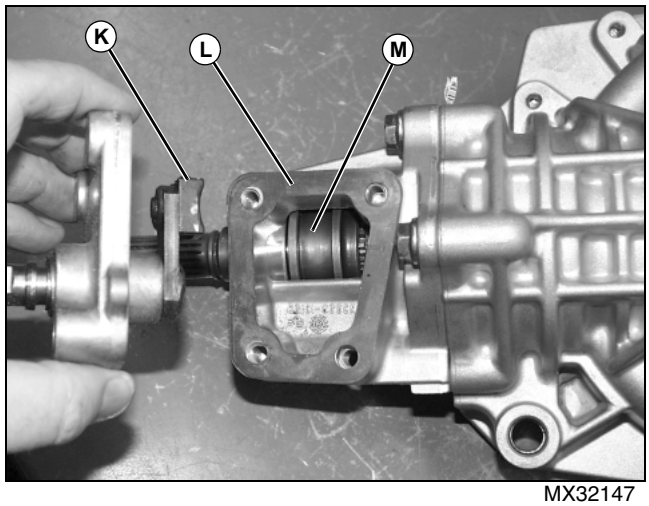
MX32146

17.Install new O-ring (H) on nose cone and install nose cone.



MX31941

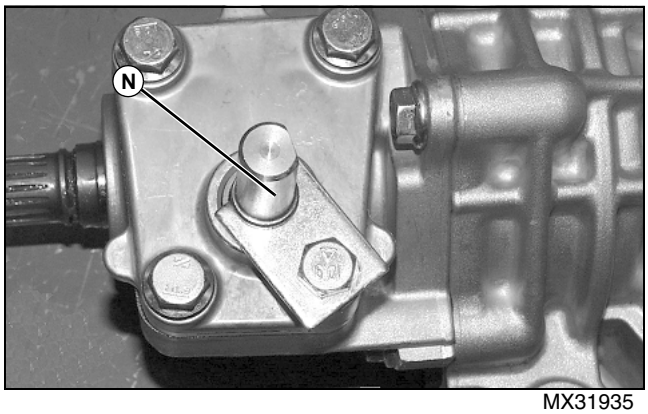
18.Install new O-ring (I) and the spacer (J) onto the shift shaft.



MX32147

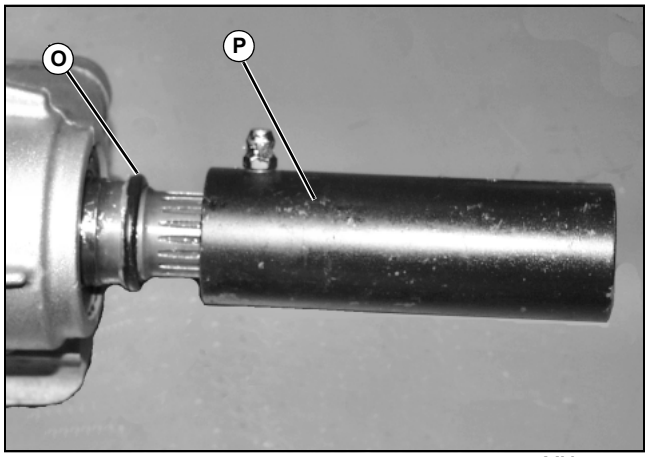
19.Place a dab of grease on the back of the shift block (K) to keep it from falling off of the lever.

20.Install new gasket (L). Make sure shift block engages properly in shift collar slot (M) when installing cover.



MX31935

21.Install keeper tab (N) into slot in shaft as shown.



MX31933

22.Install O-ring (O) and splined collar (P).

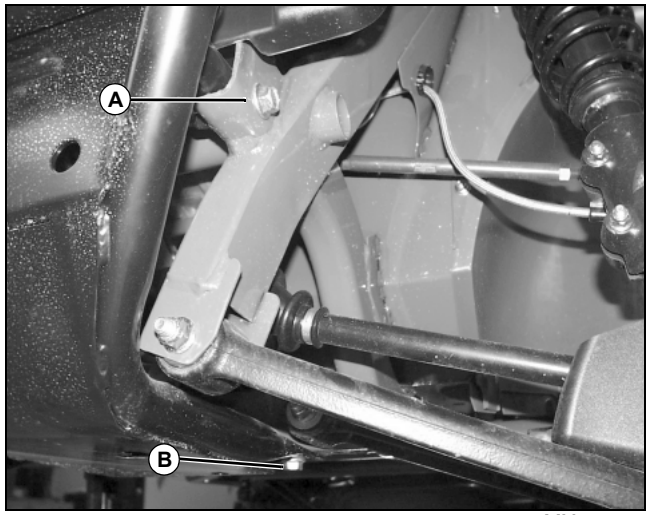
Front Differential Removal and Installation (SN 40001-)

1. Park machine safely. See Parking Safely in the Safety Section.

2. Lock park brake.

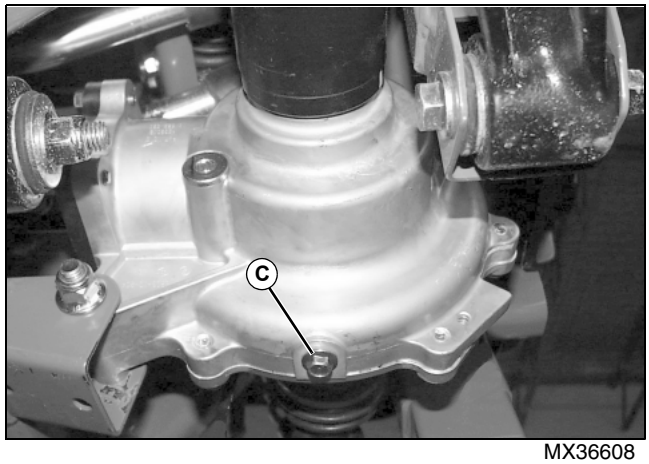
3. Jack up front of machine and place jackstands under frame.

4. Remove front wheels.



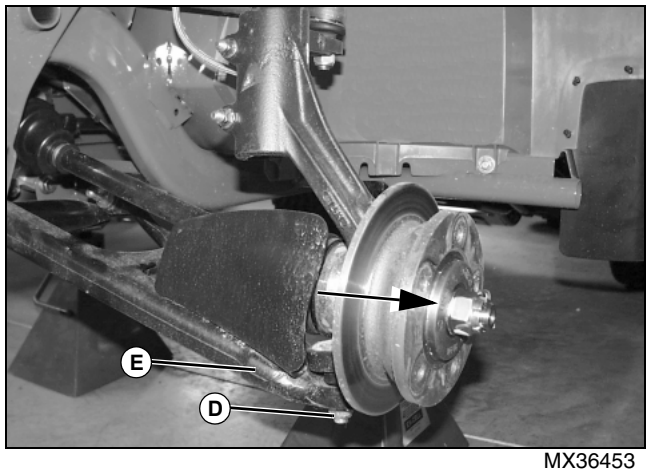
MX36182

5. Remove upper bolts (A) and lower bolts (B) from each side of front guard and remove guard.



MX36608

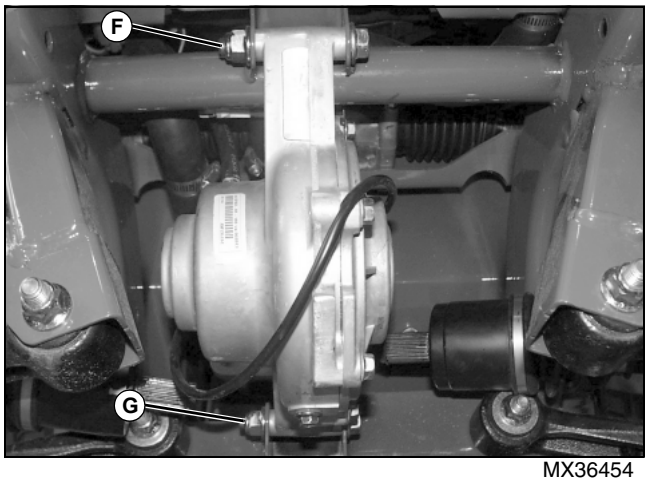
6. Place a drain pan under the EMFWD. Remove drain bolt (C) and drain oil from unit.



MX36453

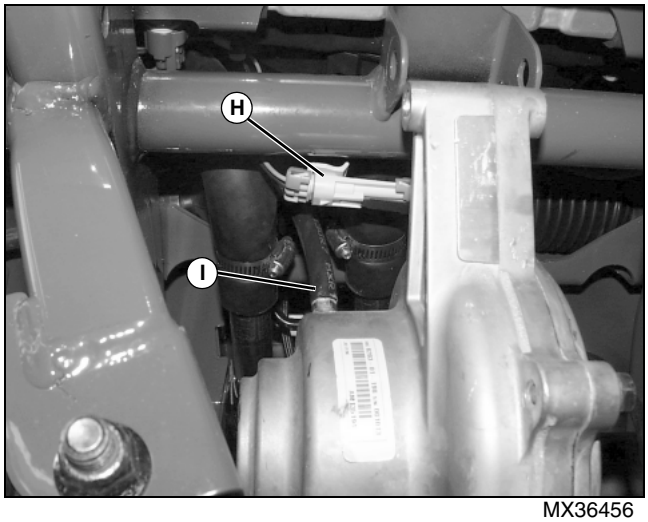
7. Remove nut (D) from ball joint on each side of machine. Use a ball joint separator and disconnect ball joint from A arm (E).

8. Pull suspension and halfshafts away from machine until halfshafts come out of differential case.



MX36454

9. Remove upper and lower mounting bolts (F) and (G).



MX36456

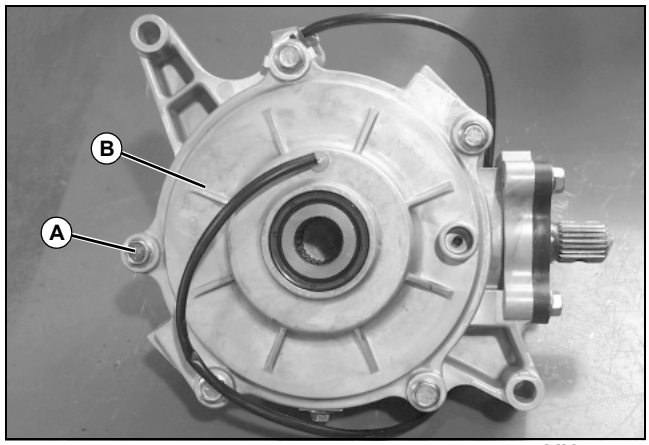
10. Disconnect wire connector (H) and vent hose (I).

11. Remove differential from machine.

Installation:

- Install unit in the reverse order of removal.
- Tighten differential to frame bolts to 43 N•m (32 lb ft).
- Tighten ball joint nuts to 54 N•m (40 lb ft).

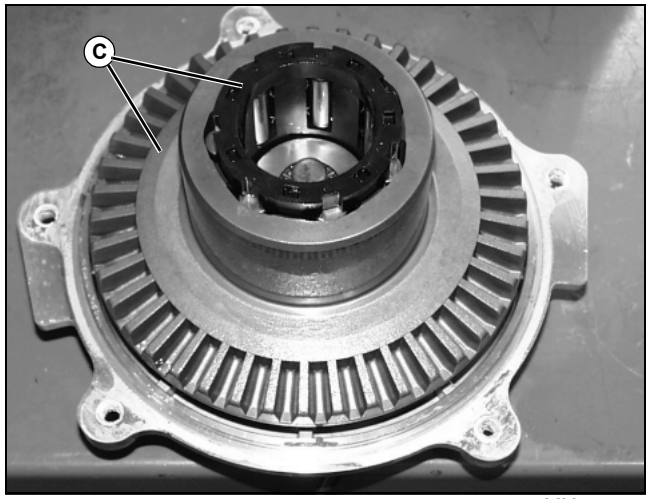
Front Differential Disassembly (SN 40001-)



MX36458

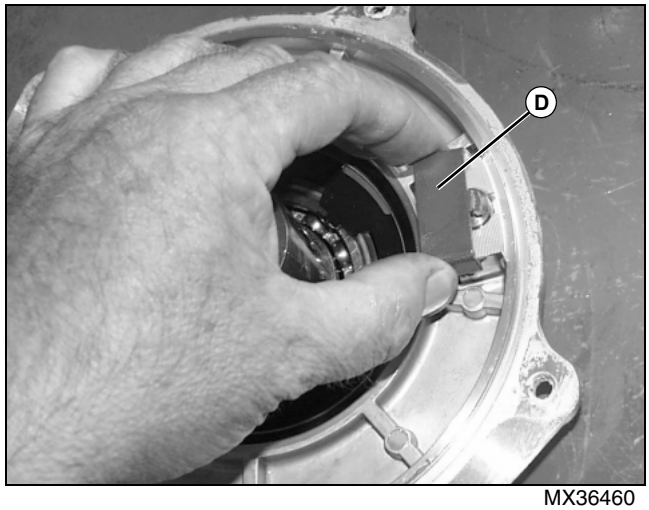
Picture Note: Driveshaft coupler previously removed from pinion shaft.

1. Remove five cover bolts (A) and remove cover (B).



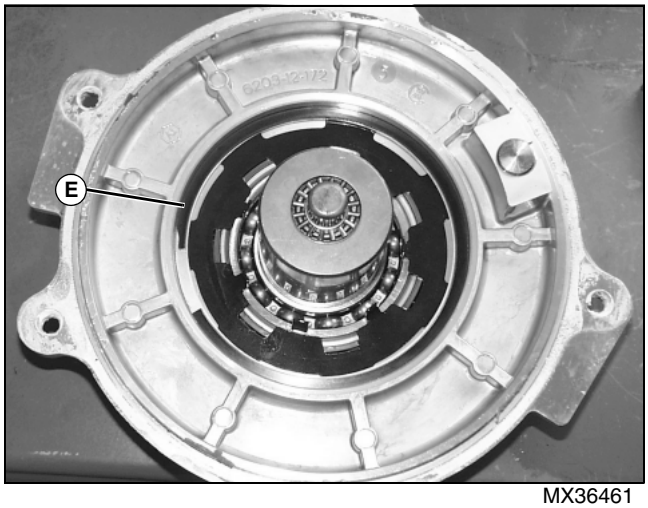
MX36459

2. Lift ring gear and rollcage assembly (C) out of cover.



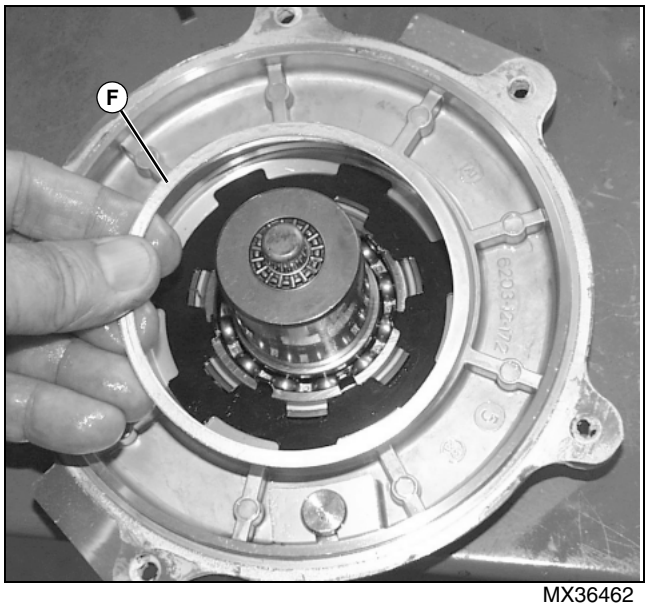
MX36460

3. Remove thrust plate (D).



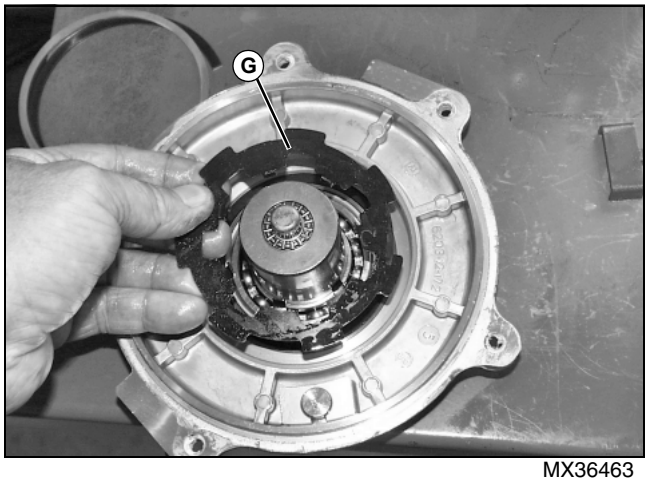
MX36461

4. Remove retaining ring (E).



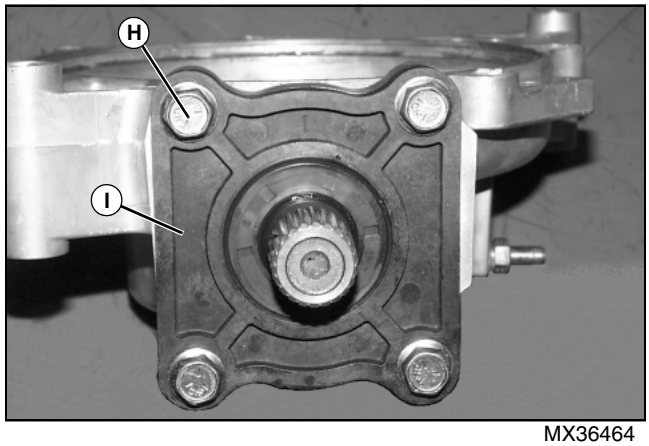
MX36462

5. Remove shim (F).



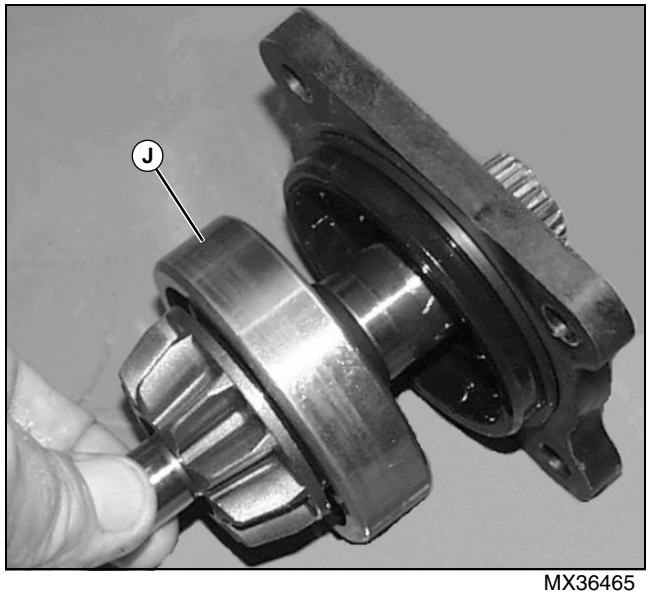
MX36463

6. Remove armature plate (G).



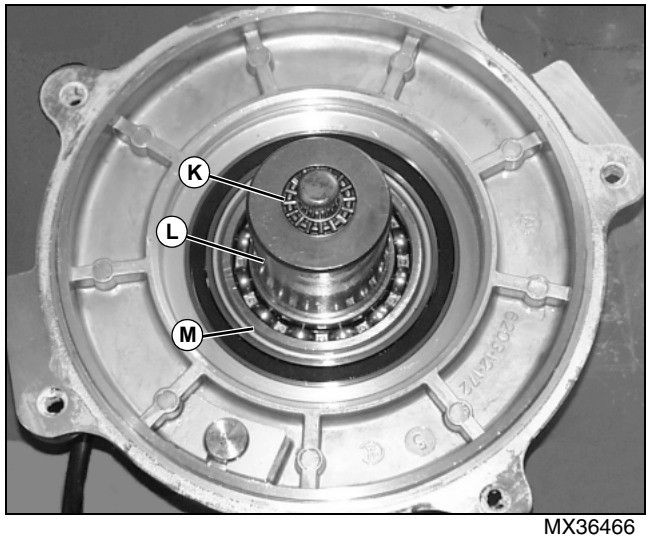
MX36464

7. Remove four bolts (H) and pinion cover (I).



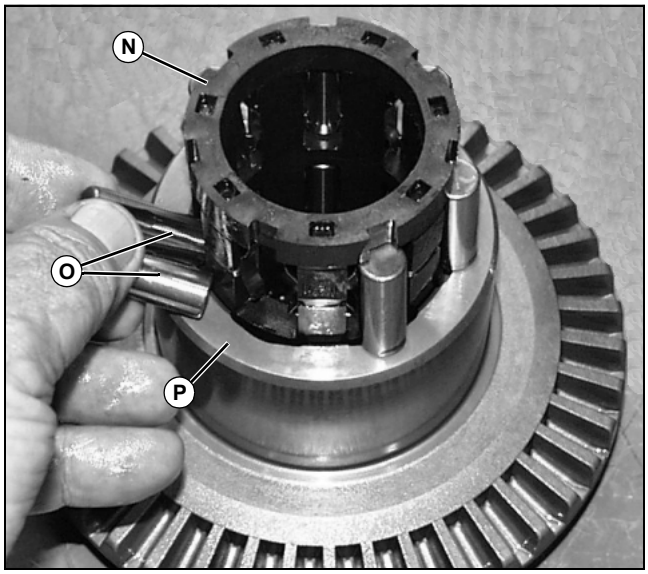
MX36465

8. Remove pinion shaft (J) from cover, or if pinion shaft remained in housing, remove it from housing.



MX36466

9. Remove thrust bearing (K), and output hub (L) from the EMFWD cover. Bearing (M) will usually stay on the output hub. Remove the opposite output hub and bearing from the EMFWD case.



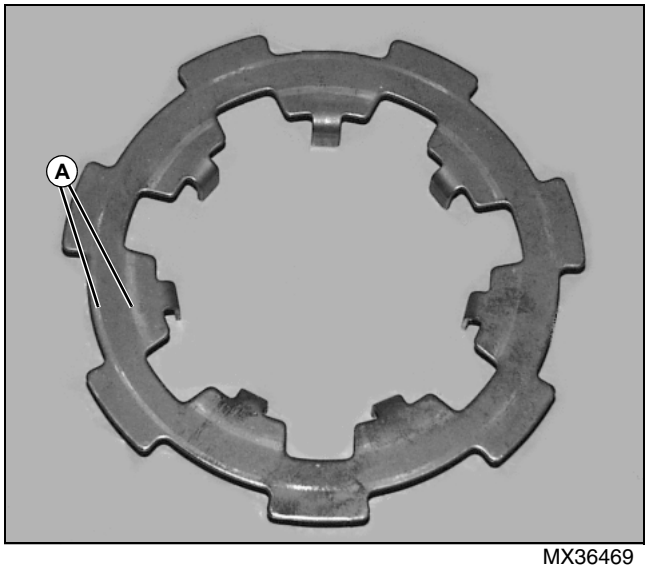
MX36467

10.Slide roll cage (N) up out of the ring gear until about one half of the first set of rollers is exposed. Prepare to catch the rollers (O) as cage is lifted, as they are spring loaded. There are two rows of seven rollers.

Inspection:

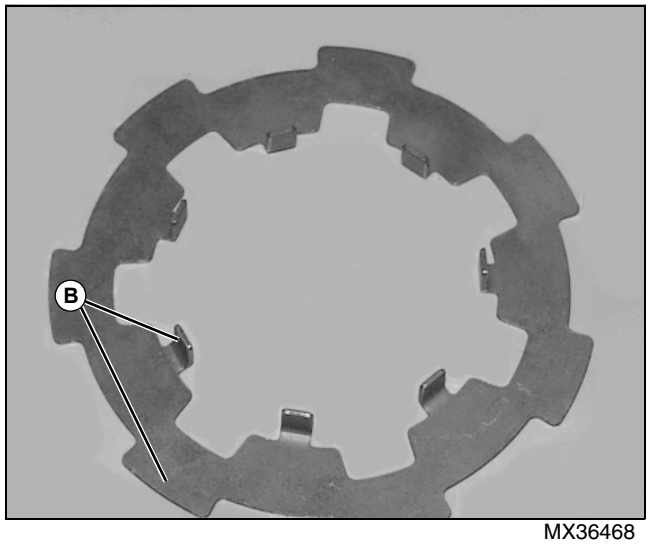
CAUTION: Avoid injury! Use safety glasses and protective clothing when using compressed air

1. Clean all parts in an approved solvent and dry with compressed air.



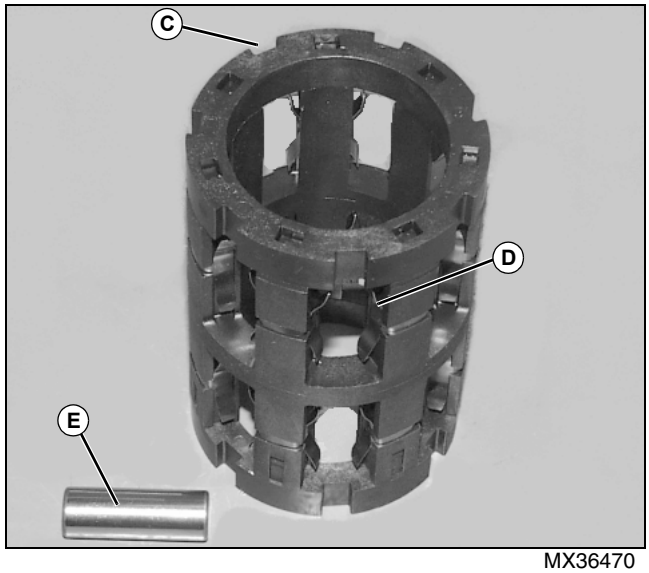
MX36469

2. Inspect the wear marks (A) on the flat side of the armature for a consistent wear pattern. If wear pattern is uneven check for warpage by laying flat side of armature on a piece of glass or other flat surface and try to rock it. If armature is warped, replace it.



MX36468

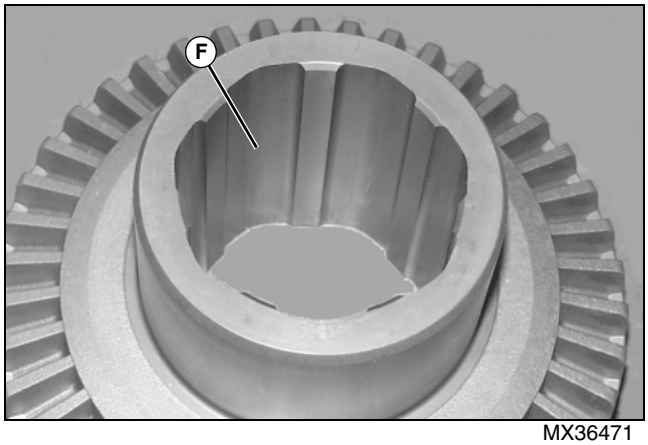
3. Check for worn/broken tangs (B). If tangs are bent or worn replace armature.



MX36470

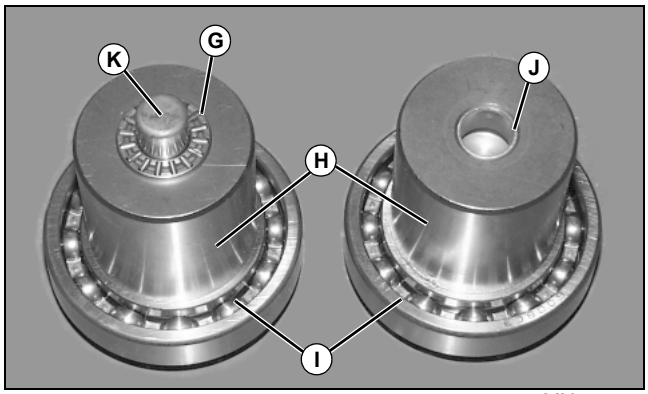
4. Inspect the slots (C) in the end of roll cage for wear or damage. Check springs (D) in each roller slot. If any springs are bent or missing and/or any slots are damaged, replace cage.

5. Inspect all rollers (E). If there are excessive scratches, nicks, or any flat spots replace rollers.



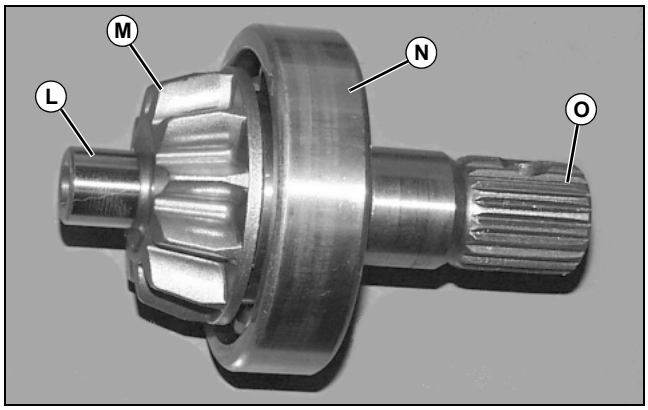
MX36471

6. Inspect inside of ring gear (F). If there are excessive scratches, nicks, or any flat spots replace ring gear.



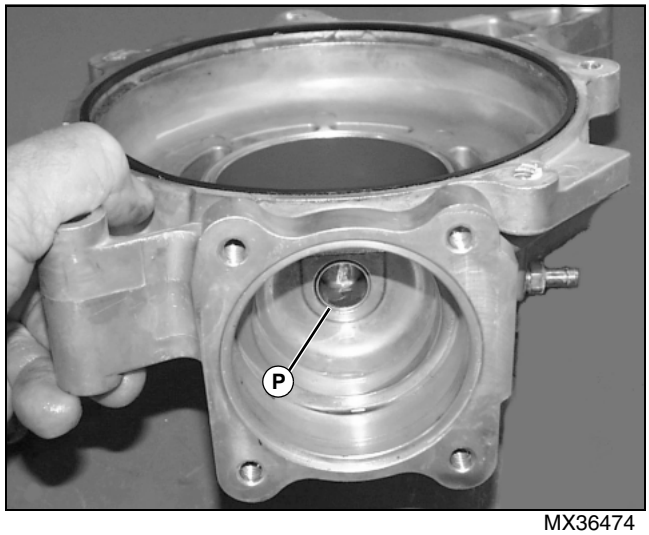
MX36472

7. Inspect thrust bearing (G) and the ends of both drive hubs where the thrust bearing runs for any scratches or damage. Inspect clutch roller races (H) for any scratches, nicks, or flat spots. Inspect bearings (I) for smooth operation and no excessive play. Inspect bushing (J) and dowel pin (K) for wear or damage. Replace worn/ damaged parts as needed.



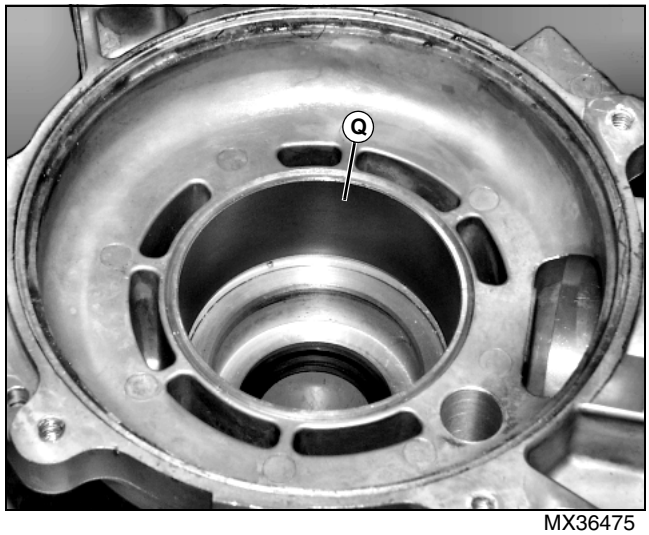
MX36473

8. Inspect pinion shaft wear and damage. Inspect bearing area (L) for wear. Inspect gear teeth for wear and damaged or broken teeth. Inspect bearing (N) for smooth operation and wear. Inspect splines (O) for wear or broken splines. Replace any worn or damaged parts.



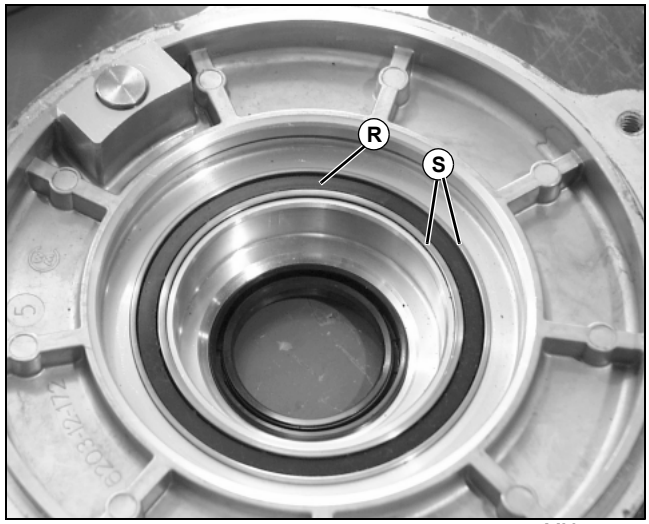
MX36474

9. Inspect pinion bushing (P). Replace if worn or damaged.



MX36475

10. Inspect bushing (Q). Replace if worn or damaged.



MX36476

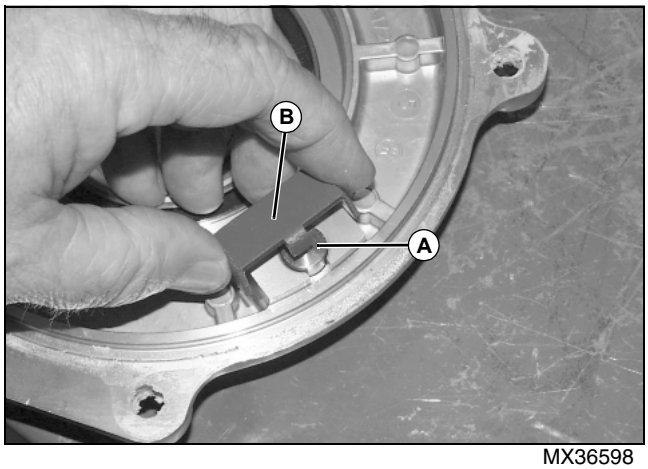
11.Check the coil depth. The black colored coil (R) should be below the pole faces (S) of the coil pocket insert in the cover. Go around the coil with your finger and if the coil is above the pole faces in any area, replace the entire cover.

12.Check the resistance of the coil with an ohm meter. Attach the leads of the meter to the two connections in the coil plug. The resistance should be 24.7 to 27.3 ohms at 20°C (68°F). Replace cover if not within specification.

Front Differential Assembly (SN 40001-)

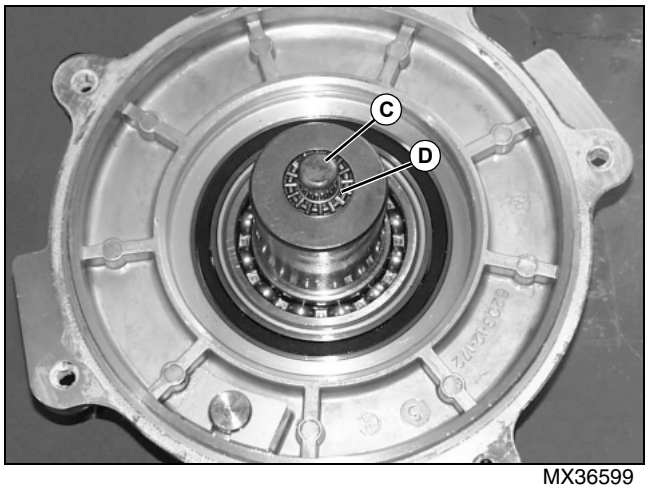
NOTE: Always use new seals and O-ring when assembling unit.

1. Make sure all parts are clean and dry.



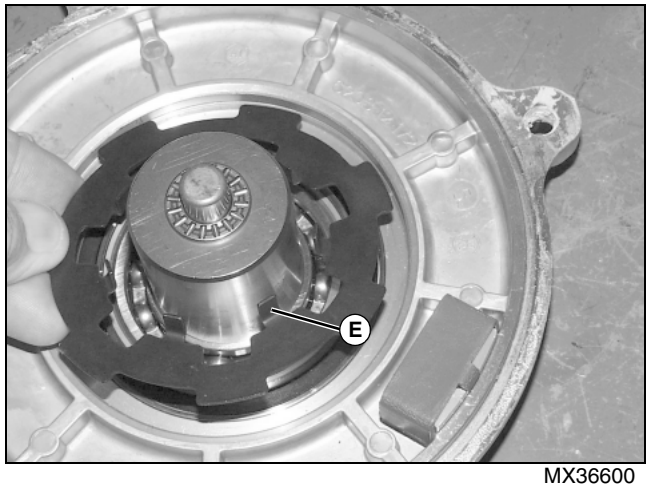
MX36598

2. Install the thrust button (A) and thrust plate (B).



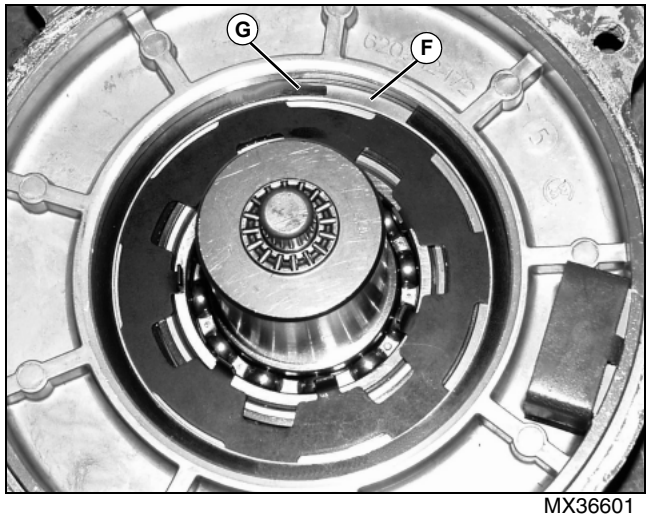
MX36599

3. Install the output hub and bearing assembly with the dowel pin (C) into the cover assembly. Install thrust bearing (D).



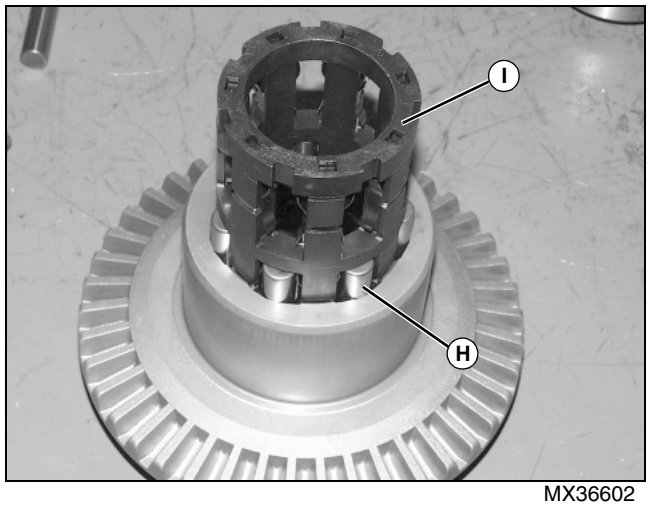
MX36600

4. Install the armature plate (E) with tangs facing up.



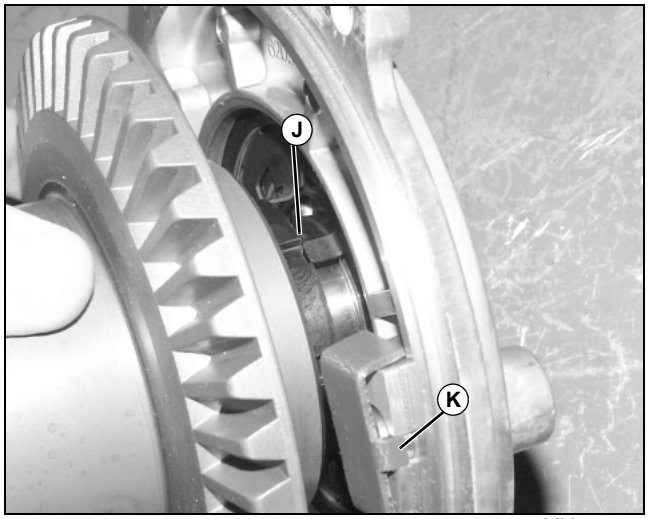
MX36601

5. Install the brass shim (F) and retaining ring (G).



MX36602

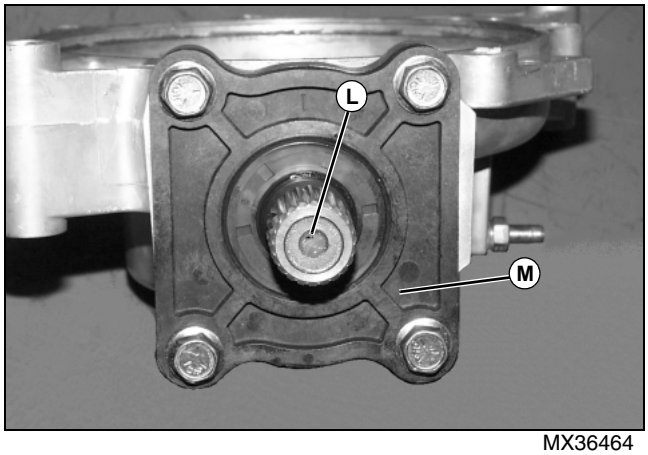
6. Install seven rollers (H) into first row of slots in roll cage (I) and slide cage and rollers half way into clutch housing of ring gear. Install next seven rollers and slide cage the rest of the way into clutch housing.



MX36603

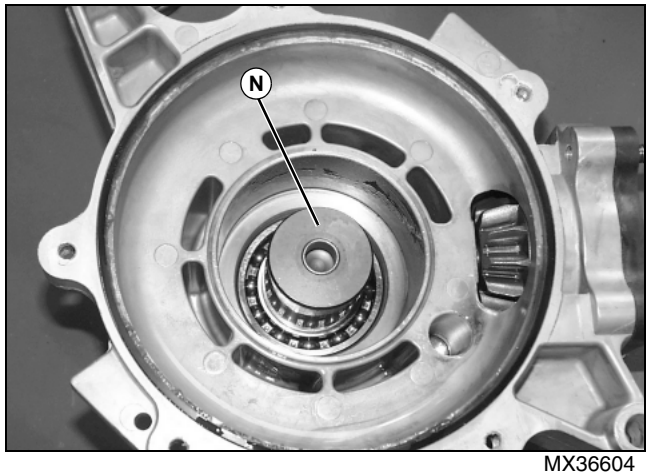
7. Install the ring gear/clutch assembly onto the output hub of the cover assembly. Make sure the slots in the roll cage (J) are lined up with the tangs on the armature. Make sure tang (K) on thrust plate stays in place during assembly.

IMPORTANT: Avoid damage! Make sure the tangs on the armature are properly aligned into the slots on the roll cage. Improper alignment will damage the armature plate and the 4WD will not work!



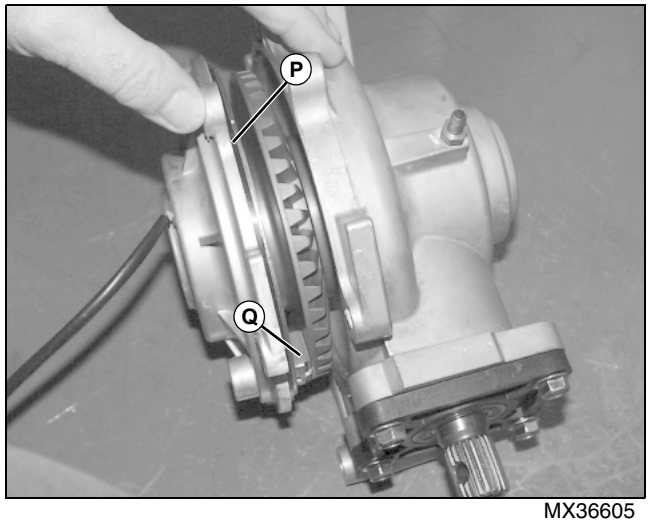
MX36464

8. Install pinion shaft (L) with bearing into gearcase. Install pinion cover (M) and tighten bolts to 23 N•m (17 lb ft).



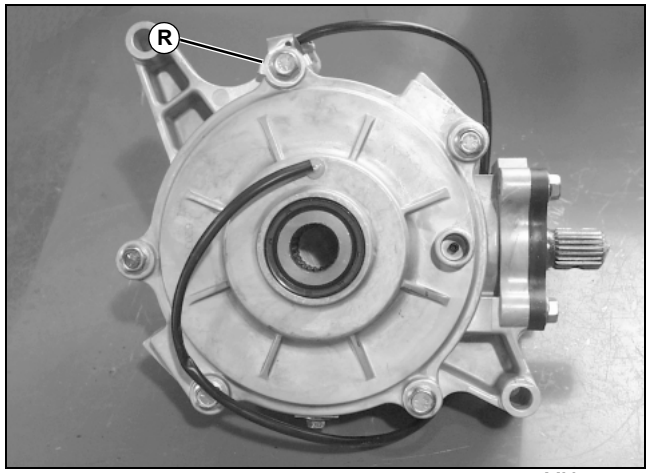
MX36604

9. Install female output hub assembly (N) into the gearcase.



MX36605

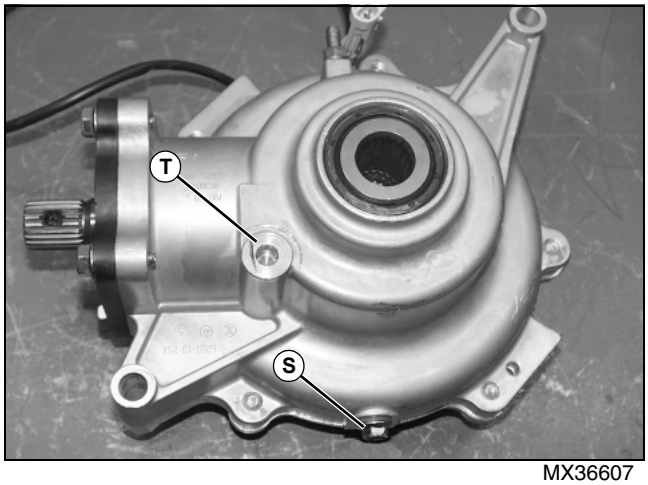
10.Lubricate and install new square O-ring (P) on cover. Make sure thrust plate (Q) stays in position ring and pinion gears mesh properly as cover is installed.



MX36606

11.Install cover bolts with wire clamp (R) in position shown.

Tighten bolts in a star pattern to 23 N•m (17 lb ft).



MX36607

12.Install drain bolt (S) with new nylon sealing washer. Tighten to 12 N•m (110 lb in.).

13.Remove fill plug (T) and fill gearcase with 150 ml (5 oz) of J20C low viscosity HY-GARD oil.

14.Install fill plug and tighten to 13.5 N•m (120 lb in.).

15.Adjust gear backlash. See “EMFWD Ring and Pinion Backlash Adjustment” on page 464.

16.Install driveshaft coupler.

Table of Contents

STEERING TABLE OF CONTENTS

STEERING SPECIFICATIONS

Specifications

General Specifications

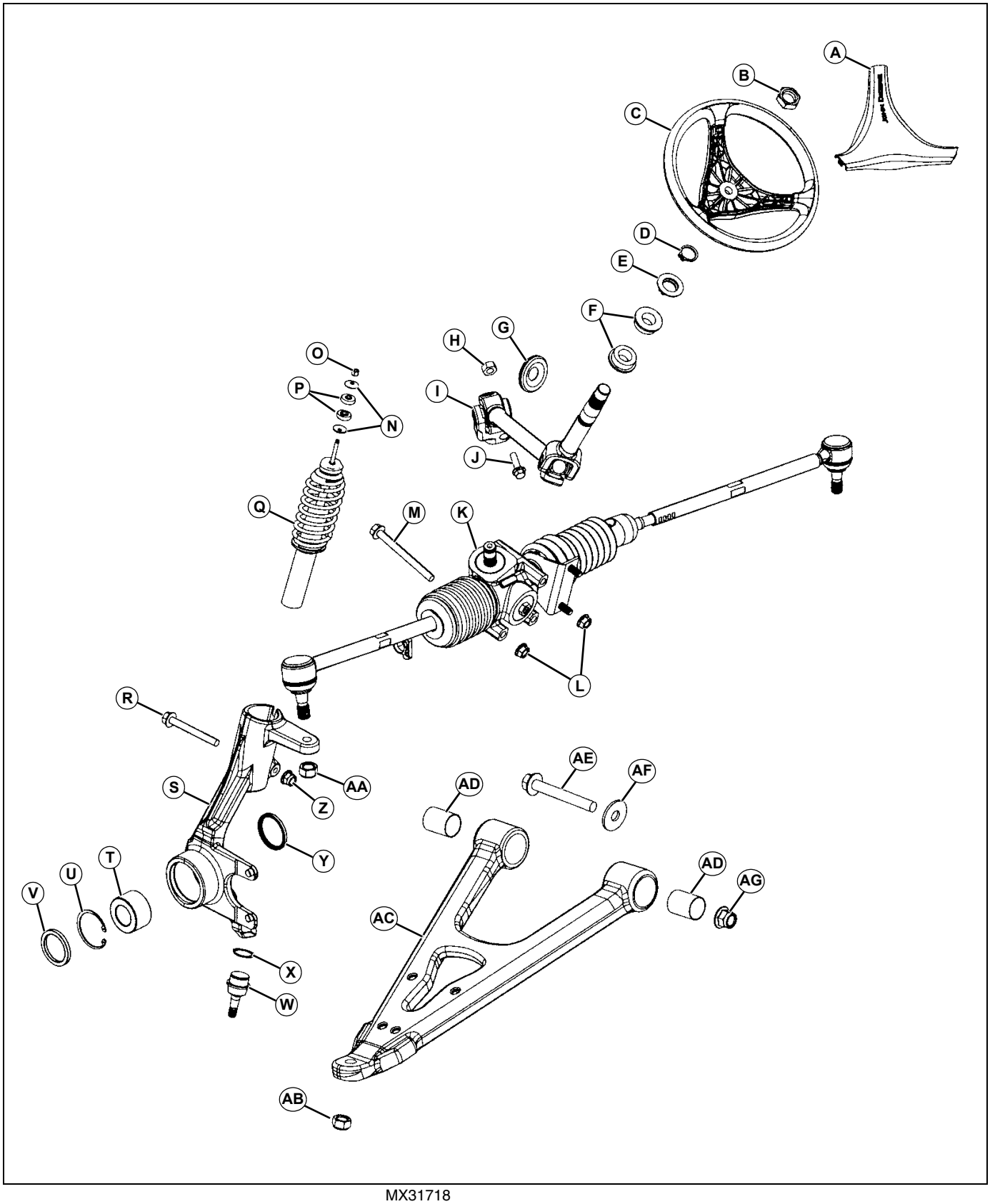
Toe-Out	**30 ± 5 mm (1.18 ± 0.2 in.)**
Caster	**Not Adjustable**
Camber	**Not Adjustable**

Torque Specifications

Steering Shaft to Pinion (Torque Prevailing Lock Nut to Bolt)	**68 N•m (50 lb-ft)**
Steering Wheel Nut to Shaft Nut	**38 ± 7 N•m (28 ± 5 lb-ft)**
Steering Rack Body to Frame Nuts	**28.5 ± 5.5 N•m (21 ± 4 lb-ft)**
Ball Joint to A-Arm Lock Nut	**54 N•m (40 lb-ft)**
Tie Rod End to Steering Arm Lock Nut	**54 N•m (40 lb-ft)**
Shock Absorber Mounting Nut to Bolt	**126 ± 24 N•m (93 ± 18 lb-ft)**
A-Arm to Frame Mounting Nut to Bolt	**84 ± 16 N•m (62 ± 12 lb-ft)**
Wheel Hub to Halfshaft	**102 N•m (75 lb-ft)**
Caliper Sliding Pins to Steering Knuckle	**41 - 52 N•m (30 - 38 lb-ft)**
Wheel Bolt Torque	**81 N•m (60 lb-ft)**

Component Location

Steering System



MX31718

A - Cover
B - Nut M16
C - Steering Wheel
D - Snap Ring
E - Washer
F - Bearing
G - Grommet
H - Lock Nut
I - Steering Shaft
J - Screw M10 x 35
K - Steering Rack
L - Nut
M - ScrewM8 x 90
N - Washer
O - Lock Nut
P - Cushion
Q - Shock Absorber
R - Screw M8 x 70
S - Knuckle (LH Shown)
T - Bearing
U - Snap Ring
V - Seal
W - Ball Joint
X - Snap Ring
Y - Seal
Z - Lock Nut
AA- Lock Nut
AB- Lock Nut
AC- Arm
AD- Bushing
AE- Screw, M12 x 90
AF- Washer 13 x 37 x 3 mm
AG- Lock Nut M12

Theory of Operation

Steering System Operation

Function:

The steering system provides a means of turning the machine when in motion.

Theory of Operation:

The machine uses a manual rack and pinion type steering system. The steering rack is a sealed unit with no serviceable parts. Input for the steering rack is provided by the steering wheel connected via a shaft and two U-joints. The rack has an adjustable tie rod end for each of the front wheels. These tie rod ends are sealed units which allow the toe-in geometry of the front wheels to be adjusted for proper machine tracking.

The front wheels are attached to struts which rotate on strut mounting washers. Caster and camber are fixed and not adjustable.

Diagnostics

System Diagnosis

Symptom: Steering System

(1) Does machine pull to the left or to the right?

Yes - Ensure that tire pressure is correct on all wheels.

Yes - Check tie rod ends for wear or looseness.

Yes - Check toe-in adjustment. See “Toe-Out Adjustment” on page 519.

Yes - Check upper strut mounting washer for wear.

Yes - Check ball joints for wear or looseness.

Yes - Check front springs for sagging.

Yes - Check the A-arm bushings for wear or looseness.

No - Go to next step.

(2) Does machine wander or not track properly.

Yes - Ensure that tire pressure is correct on all wheels.

Yes - Check tie rod ends for wear.

Yes - Check toe-in adjustment. See “Toe-Out Adjustment” on page 519.

Yes - Check upper strut mounting washer for wear.

Yes - Check ball joints for wear or looseness.

Yes - Check front springs for sagging.

Yes - Check the A-arm bushings for wear or looseness.

No - Go to next step.

(3) Does steering feel loose or unresponsive?

Yes - Ensure that tire pressure is correct on all wheels.

Yes - Check tie rod ends for wear.

Yes - Check ball joints for wear or looseness.

Yes - Check the steering rack for play in tie rods and steering input shaft.

Yes - Check upper strut mounting washers and hardware for wear or looseness.

Yes - Check the A-arm bushings for wear or looseness.

No - Go to next step.

Symptom: Steering System

(4) Is steering effort excessive?

Yes - Ensure that tire pressure is correct on all wheels.

Yes - Check components for wear or damage.

Yes - Steering rack may be binding. Check for smooth operation. If not OK, replace steering rack.

(5) Does the steering wheel pull upward?

Yes - Check steering wheel nut for looseness.

Yes - Check for missing or bent steering shaft snap rings.

No - Go to next step.

(6) Does the steering wheel spin freely?

Yes - Check the steering wheel splines for damage.

Yes - Check the steering rack splines for damage.

Yes - Check steering shaft for damage.

Yes - Steering rack may be broken. Replace steering rack.

No - Go to next step.

(7) Does the steering system make noise during turns or over rough terrain?

Yes - Check wheel bearings for wear or damage.

Yes - Check shock absorbers for leaks or wear.

Yes - Check upper strut mounts for worn, loose, broken, or missing hardware.

Yes - Check springs for damage.

Yes - Check A-arm bushings for wear or damage.

Yes - Check ball joints for damage or wear.

Yes - Check tie rods for wear or damage.

Yes - Check steering rack for wear or damage.

Tests and Adjustments

Toe-Out Adjustment

Toe-Out Check Procedure:

1. Park machine safely on a level surface.

2. Lock park brake.

3. Ensure that all suspension components are in good condition.

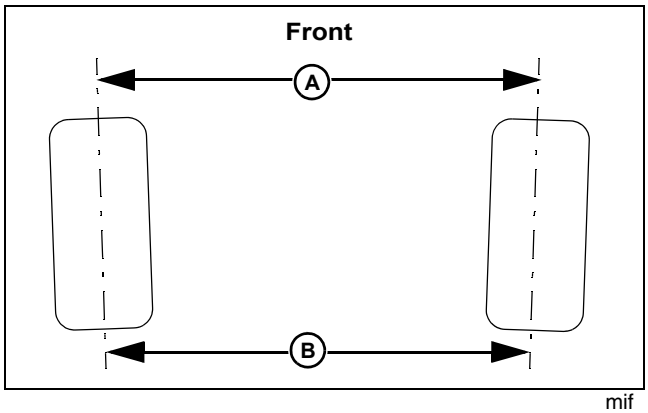
4. Ensure that tire pressure is correct on all wheels.

5. Remove any cargo or passengers from machine.

NOTE: Toe-out must be checked and adjusted with the front tires elevated off the ground and front suspension fully extended.

6. Turn steering wheel until the rack is centered on the vehicle. Centering of the rack can be checked by measuring the distance from the outer tie rod tube end to the outer surface of the main frame tube on each side of the machine. The distances must be equal before checking or adjusting the toe out. Secure the steering wheel when rack has been centered.

7. After rack is centered, make sure there are an equal number of threads showing between the tie rod jam nut and the outer tie rod ball joint on both sides.



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Picture Note: Viewed from top down.

8. At hub height and center of tire tread, measure front distance (A) and rear distance (B) at center of tire. Subtract measurement (B) from measurement (A). The difference is the toe out.

9. Compare toe out measurement to specification and adjust if not within specification.

Adjustment Procedure:

MX31398

1. Loosen jam nut (C).

NOTE: The rubber boot on steering rack may turn with the tie rod if boot tie strap is too tight. If this happens, unlatch tie strap and hold with hand enough to allow the rubber boot to remain stationary.

2. Turn tie rod until front to rear measurement is within specification. Make sure the rack has stayed centered during adjustment, and that an equal number of threads are showing between the tie rod jam nut and the outer tie rod ball joint on both sides after adjusting.

3. Tighten jam nut.

Toe-Out Specification:

Toe-Out . . . . . 30 ± 5 mm (1.18 ± 0.2 in.)

Repair

Steering Wheel Removal and Installation

Removal:

1. Park machine safely on a level surface.
2. Lock park brake.

MX31360

3. Remove cover from steering wheel by gently prying up on center cover at three points (C).

MX31353

4. Remove nut (D) securing steering wheel to shaft.
5. Note position of steering wheel by marking spline and wheel for proper positioning during assembly.
6. Gently tap bottom of steering wheel up and off of shaft splines.

Installation:

- Installation is in the reverse of removal.
- Ensure that wheel is installed in the same position as it was removed.
- Tighten nut to specification.

Specifications:

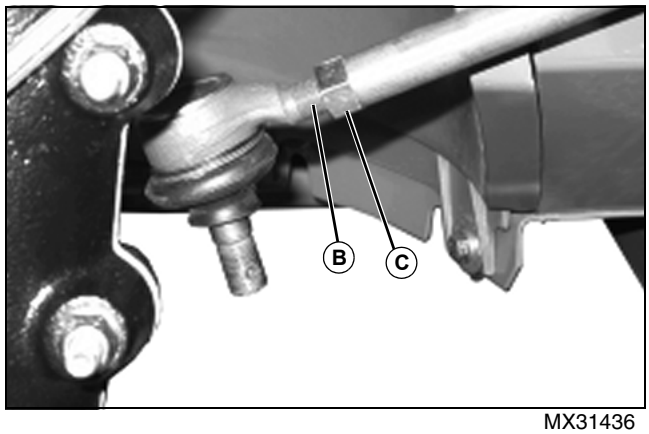
Steering Wheel Nut . . . . . 38 ± 7 N•m (28 ± 5 lb-ft)

Tie Rod End Removal and Replacement

1. Park machine safely on a level surface.
2. Lock park brake.
3. Block wheels and raise front of machine. Support with jack stands.
4. Remove front wheel(s).

MX31398

5. Remove nut (A) securing tie rod end to steering knuckle.
6. Separate tie rod end from steering knuckle.



MX31436

7. Mark or count exposed threads (B) on tie rod end to provide a rough alignment guide when installing new tie rod end.
8. Repeat for other tie rod end if necessary.
9. Loosen jam nut (C) and unscrew tie rod end.

Installation:

1. Install new tie rod end and screw into tie rod, exposing the same number of threads as the one removed. Repeat for other side of machine if necessary.
2. Install tie rod end onto steering knuckle.

3. Install tie rod end to steering knuckle nut and tighten to specification.

4. Install wheel(s).

5. Lower machine.

6. Perform toe-in adjustment. See “Toe-Out Adjustment” on page 519.

Specification:

Tie Rod End to Steering Arm Lock Nut
. . . . . 54 N•m (40 lb-ft)

Steering Rack Removal and Installation

Removal:

1. Park machine safely on a level surface.

2. Lock park brake.

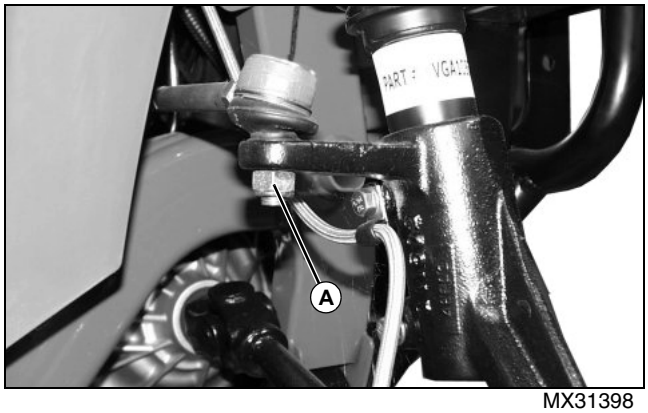
3. Block rear wheels and raise front of machine. Support with jack stands.

4. Remove front wheel(s).

5. Remove hood. See “Hood Removal and Installation” on page 576 in the Miscellaneous section.

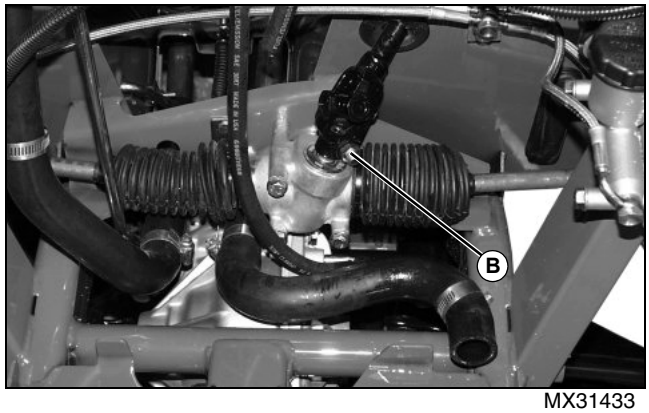
6. Remove front grille. See “Front Grille Removal and Installation” on page 576 in the Miscellaneous section.

7. Remove Radiator. See “Radiator Removal and Installation” in the appropriate engine section.



MX31398

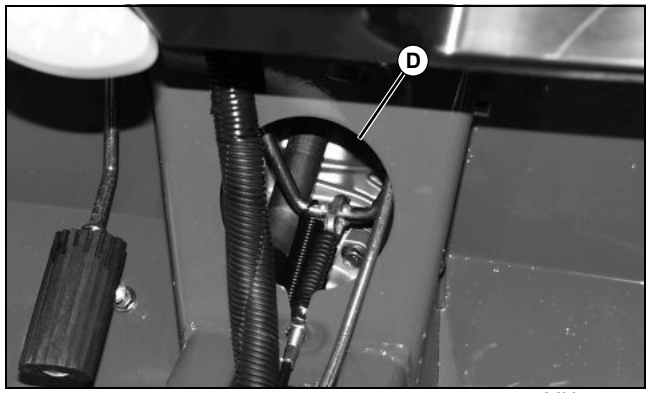
8. Remove nuts (A) and separate both tie rod ends from steering knuckles.



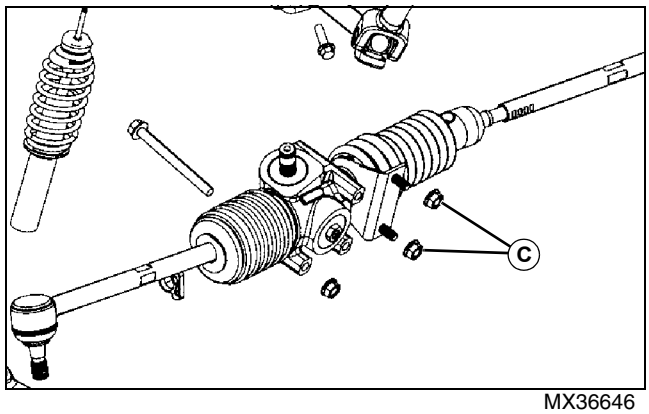
MX31433

9. Remove bolt and nut (B) on steering shaft U-joint.

10. Remove center console. See “Center Console Removal and Installation” on page 580 in the Miscellaneous section.

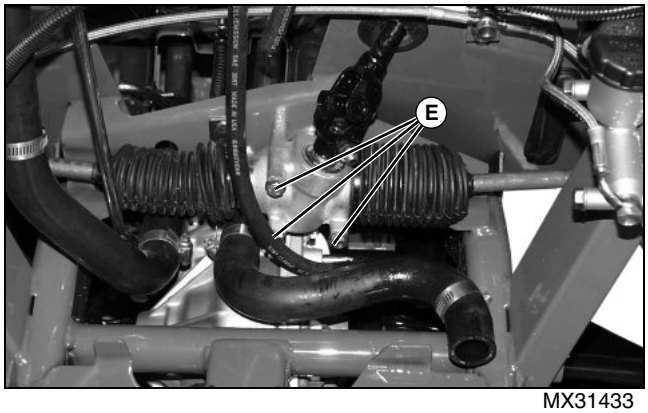


MX31432



MX36646

11. Remove steering rack alignment stud nuts (C) through access hole (D) behind firewall.



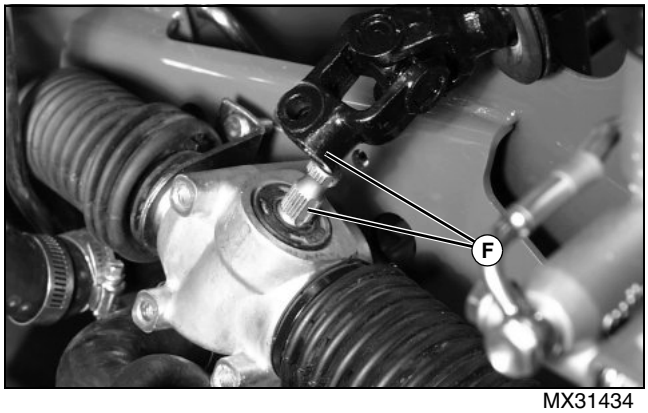
MX31433

12.Remove three nuts and bolts (E) securing steering rack to firewall.

13.Disconnect steering shaft U-joint from rack input splines.

14.Remove steering rack from machine.

Installation:



MX31434

1. Align flats (F) on splines of steering rack and steering shaft U-joint.

2. Install retaining bolt and nut. Tighten to specification.

3. Insert steering rack alignment studs into holes in firewall.

4. Install nuts and tighten to specification.

5. Install bolts and nuts securing steering rack to firewall. Tighten to specification.

6. Attach tie rod ends to steering knuckles. Tighten nuts to specification.

7. Install radiator. See “Radiator Removal and Installation” in the appropriate engine section.

8. Install front grille. See “Front Grille Removal and Installation” on page 576 in the Miscellaneous section.

9. Install hood. See “Hood Removal and Installation” on page 576 in the Miscellaneous section.

10.Install wheels.

11.Lower machine.

12.Check toe-in adjustment. See “Toe-Out Adjustment” on page 519.

Torque Specifications:

Steering Shaft to Pinion
(Torque Prevailing Lock Nut to Bolt) . . 68 N•m (50 lb-ft)
Steering Wheel Nut . . . . . 38 ± 7 N•m (28 ± 5 lb-ft)
Steering Rack to Frame Nuts
. . . . . 28.5 ± 5.5 N•m (21 ± 4 lb-ft)
Tie Rod End to Steering Arm Lock Nut
. . . . . 54 N•m (40 lb-ft)
Wheel Bolt Torque . . . . . 81 N•m (60 lb-ft)

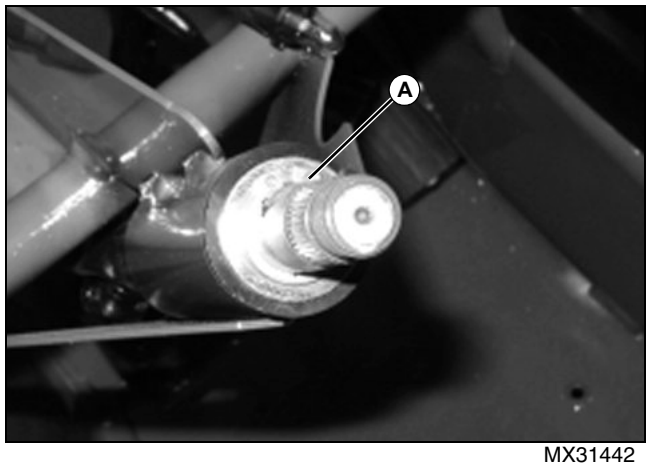
Steering Shaft Removal

Removal:

1. Park machine safely on a level surface.

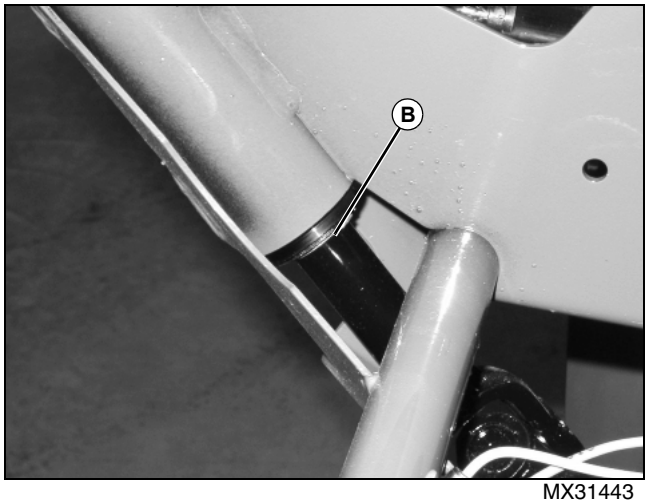
2. Lock park brake.

3. Remove dash panel. See “Dash Panel Removal and Installation” on page 578 in the Miscellaneous section.



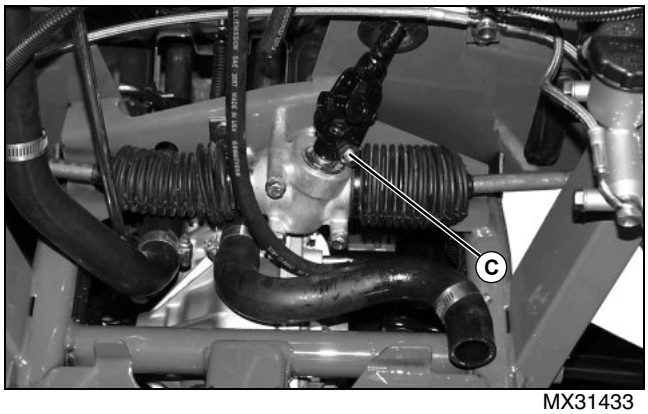
MX31442

4. Remove upper steering shaft outside snap ring (A) and washer.



MX31443

5. Remove lower steering shaft snap ring (B) and let ring and washer slide down steering shaft.



MX31433

6. Remove bolt and nut (C) on steering shaft U-joint.

7. Slide shaft up and toward steering column to remove from steering rack splines.

8. Pull shaft down toward steering rack and slide out of steering column.

Installation:

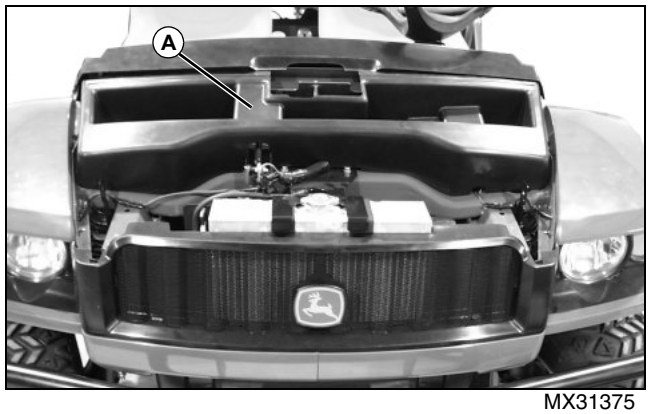
- Installation is in the reverse of removal.

Torque Specifications:

Steering Shaft to Pinion
(Torque Prevailing Lock Nut to Bolt) . 68 N•m (50 lb-ft)

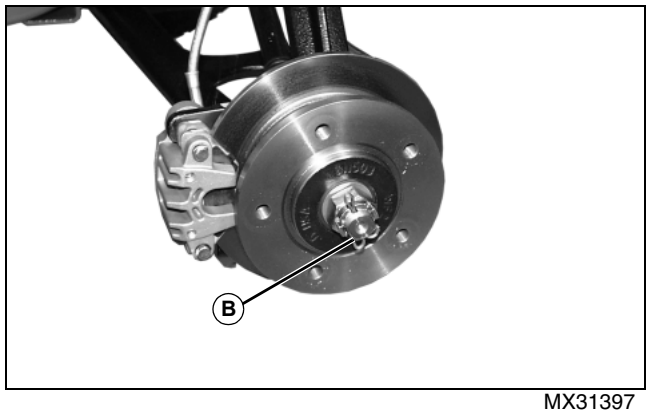
Front Strut/Shock Removal and Replacement

1. Park machine safely on a level surface.
2. Lock park brake.



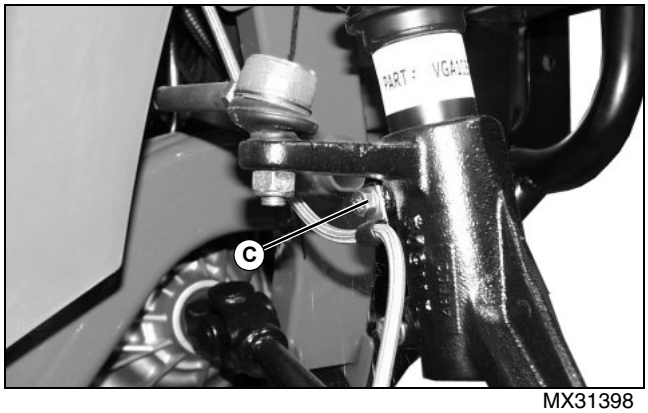
MX31375

3. Raise hood and remove utility box (A).
4. Block rear wheels on both sides.
5. Raise front of vehicle and support with jack stands.
6. Remove front wheels. See “Wheel Removal and Installation” on page 575.



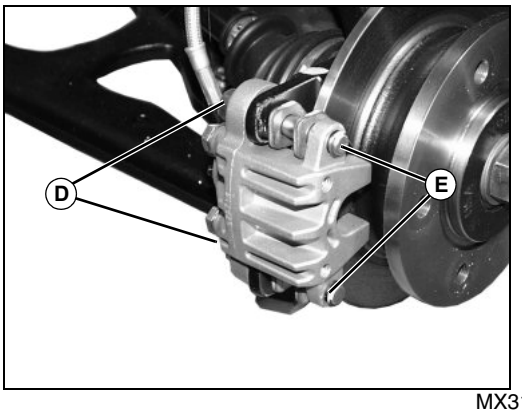
MX31397

7. Remove cotter pin (B) from castle nut at wheel hub. Discard cotter pin.
8. Remove castle nut and washer. It may be necessary for an assistant to apply pressure to the brake pedal in order to keep the brake disc assembly from turning.



MX31398

9. Remove nut and bolt (C) on steering knuckle holding brake line support.

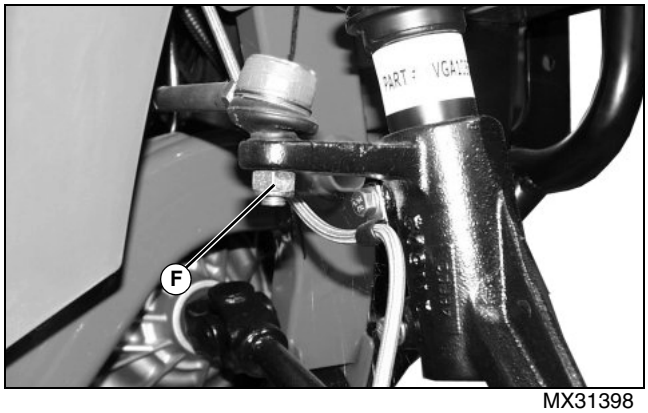


MX31399

10.Remove two C-clips (E) and two sliding pins (D) securing brake caliper.

11.Remove caliper and secure out of the way ensuring the stress is taken off of the brake line.

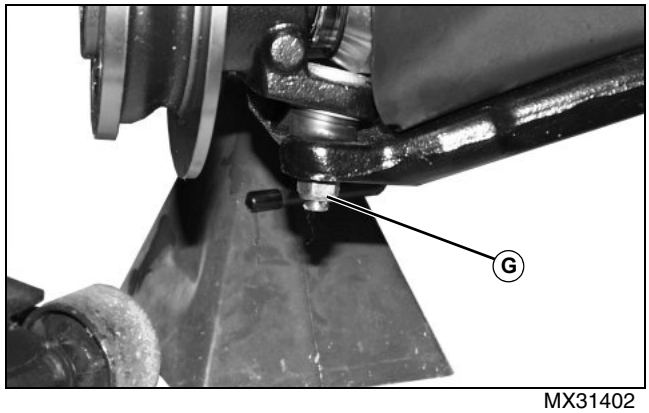
12.Remove brake disc.



MX31398

13.Remove nut (F) securing tie rod end to steering knuckle.

14.Separate tie rod end from steering knuckle.

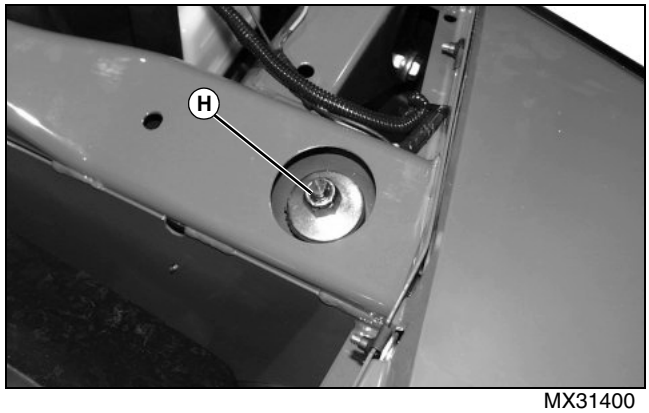


MX31402

15.Remove nut (G) securing ball joint to A-arm.

16.Separate ball joint from A-arm.

17.Hold or support strut to prevent it from falling.

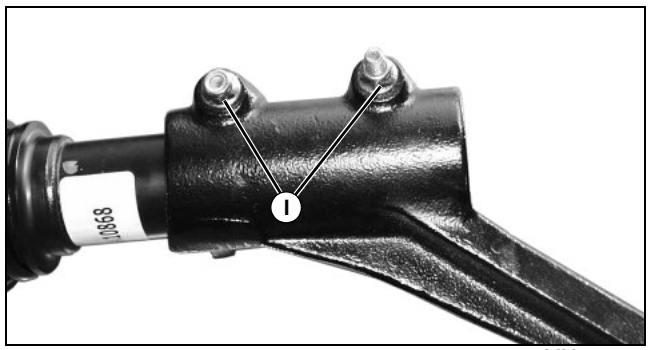


MX31400

18.Remove strut retaining nut (H) from top of machine.

19.Lower strut and remove from machine.

Shock Removal:



MX31403

1. Remove two bolts and nuts (I) securing shock to steering knuckle.

2. Remove shock from steering knuckle.

Installation:

1. If shock was removed, install into steering knuckle until it fully seats. Tighten steering knuckle bolts to specification.

2. Insert strut, bushings, and washers into strut mounting hole.

3. Install strut retaining nut.

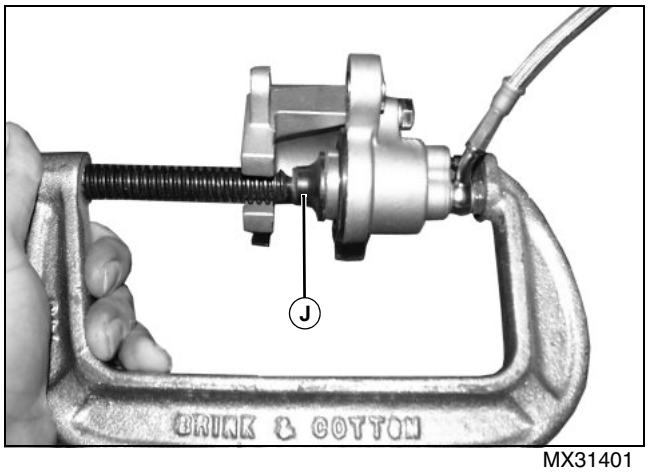
4. Insert drive shaft into steering knuckle.

5. Install ball joint and nut onto steering knuckle.

6. Install tie rod end and nut onto steering knuckle.

7. Install brake disc onto drive shaft splines.

8. Install washer and castle nut finger tight.



MX31401

9. Install brake caliper. It may be necessary to press caliper cylinder into it's bore with a C-clamp (J) to allow clearance for brake pads.

10. Install brake pads, two caliper sliding pins, and two C-clips. Tighten to specification.

11. Tighten castle nut and install a new cotter pin. Bend ends of cotter pin in opposite directions.

12. Check for free rotation of wheel with no binding.

13. Ensure that brake pedal is firm when pressed.

14. Test brake pedal for proper operation.

15. Install wheel. See "Wheel Removal and Installation" on page 575.

16. Lower machine.

Torque Specifications:

A-Arm to Frame . . . . . 84 ± 16 N•m (62 ± 12 lb-ft)
Wheel Hub to Halfshaft . . . . . 102 N•m (75 lb-ft)
Ball Joint to A-Arm Lock Nut. . . . . 54 N•m (40 lb-ft)
Tie Rod End to Steering Arm Lock Nut . . . . . 54 N•m (40 lb-ft)
Caliper Sliding Pins to Steering Knuckle . . . . . 41 - 52 N•m (30 - 38 lb-ft)

Front Wheel Bearing Removal and Replacement

Removal:

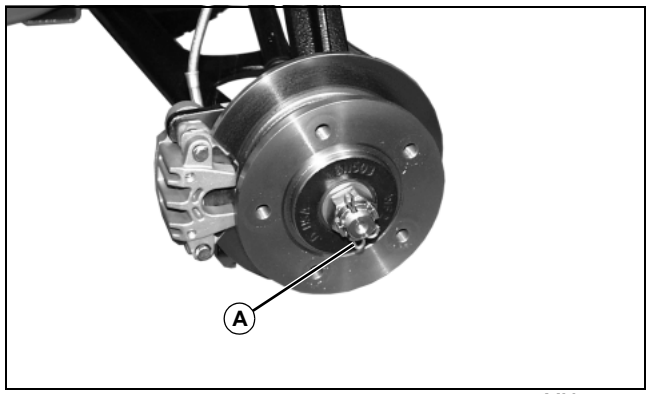
1. Park machine safely on a level surface.

2. Lock park brake.

3. Block rear wheels on both sides.

4. Raise front of vehicle and support with jack stands.

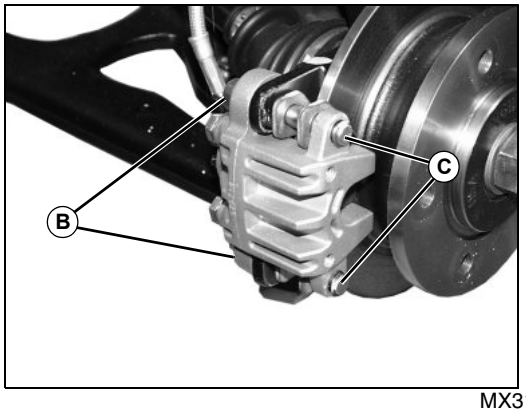
5. Remove front wheels. See "Wheel Removal and Installation" on page 575.



MX31397

6. Remove cotter pin (A) from castle nut at wheel hub. Discard cotter pin.

7. Remove castle nut and washer. It may be necessary for an assistant to apply pressure to the brake pedal in order to keep the brake disc assembly from turning.

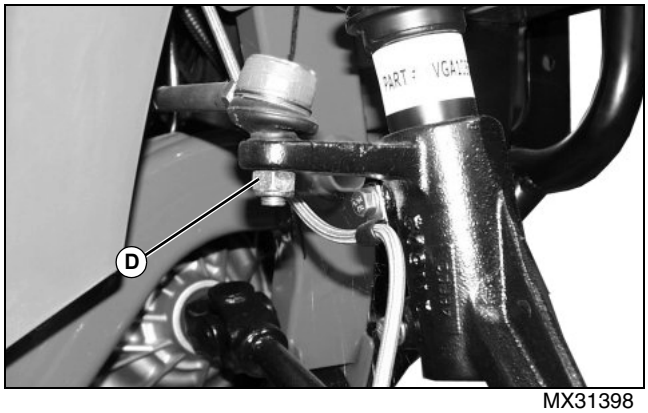


MX31399

8. Remove two C-clips (C) and two sliding pins (B) securing brake caliper.

9. Remove caliper and secure out of the way ensuring the stress is taken off of the brake line.

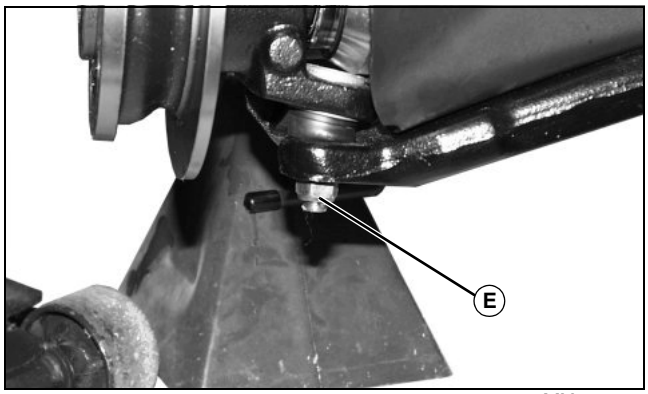
10. Remove brake disc.



MX31398

11.Remove nut (D) securing tie rod end to steering knuckle.

12.Separate tie rod end from steering knuckle.

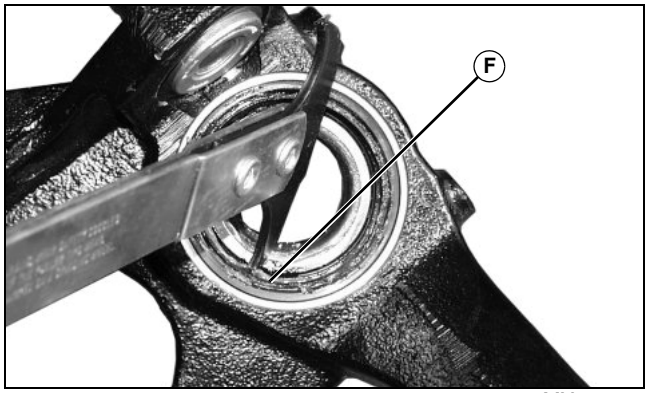


MX31402

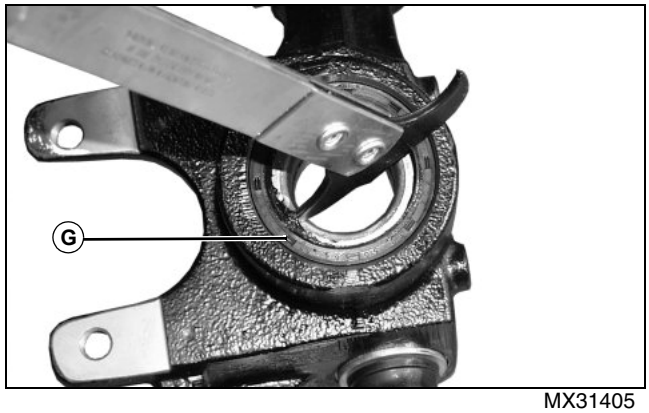
13.Remove nut (E) securing ball joint to A-arm.

14.Separate ball joint from A-arm.

15.Pull strut assembly away from drive shaft.

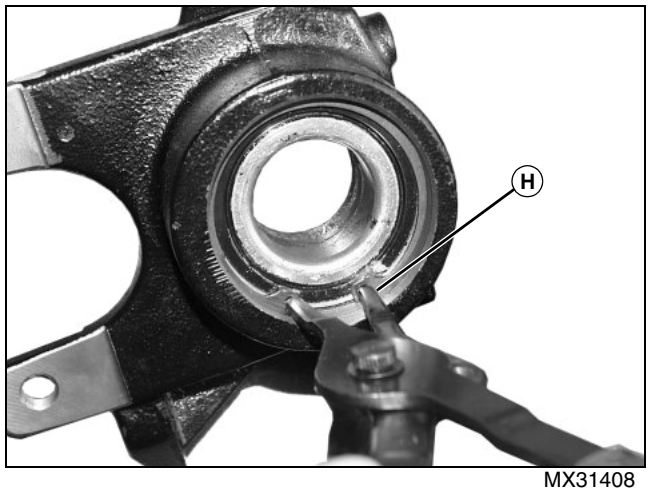


MX31406



MX31405

16.Using a suitable puller, remove inner (F) and outer (G) bearing seals.



MX31408

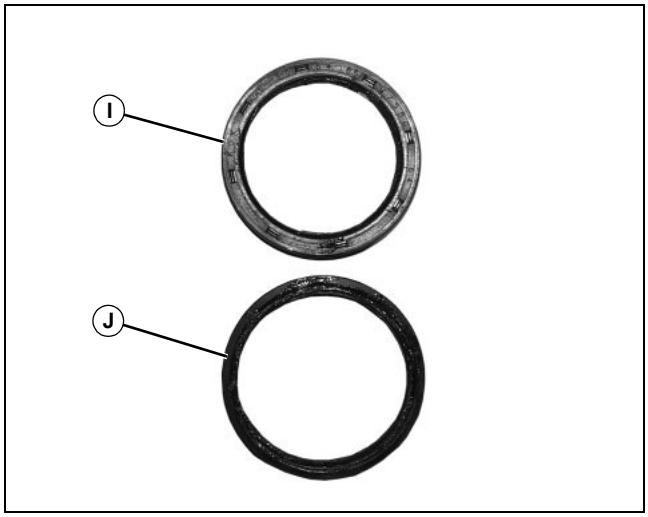
17.Remove inside snap ring (H) from steering knuckle.

18.Using a suitable press, remove wheel bearing from front of steering knuckle.

Installation:

1. Clean steering knuckle bearing surface, ensuring that it is free of grease and debris.

2. Press new bearing into steering knuckle from the front until it seats.



MX31407

3. Install new inner (J) and outer (I) seals, ensuring they seat properly.

4. Coat inner bearing race and seals with grease.

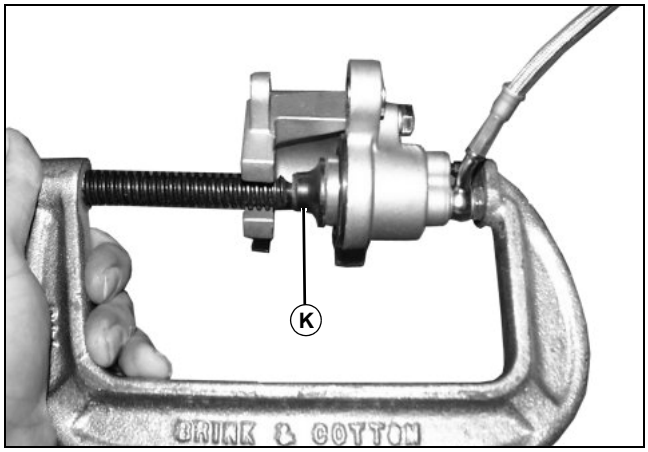
5. Insert drive shaft into steering knuckle.

6. Install ball joint and nut onto steering knuckle.

7. Install tie rod end and nut onto steering knuckle.

8. Install brake disc on drive shaft splines.

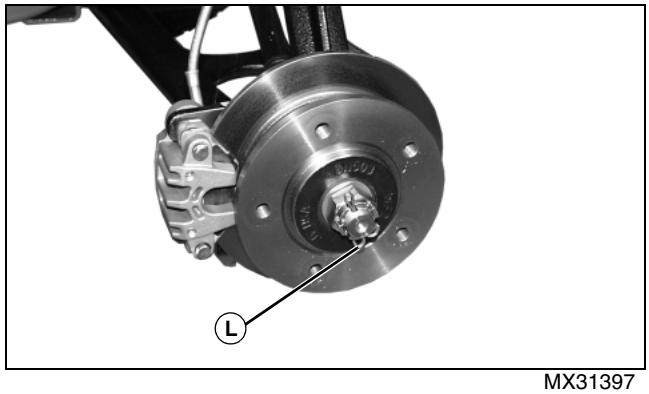
9. Install washer and castle nut finger tight.



MX31401

10.Install brake caliper. It may be necessary to press caliper cylinder into it's bore with a C-clamp (K) to allow clearance for brake pads.

11.Install brake pads, two caliper sliding pins, and C-clips. Tighten to specification.



MX31397

12.Tighten castle nut and install a new cotter pin (L). Bend ends of cotter pin in opposite directions.

13.Check for free rotation of wheel with no binding.

14.Ensure that brake pedal is firm when pressed.

15.Install wheel. See "Wheel Removal and Installation" on page 575.

16.Lower machine.

Specifications:

Wheel Hub to Halfshaft . . . . . 102 N•m (75 lb-ft)
Ball Joint to A-Arm Lock Nut . . . . . 54 N•m (40 lb-ft)
Tie Rod End to Steering Arm Lock Nut . . . . . 54 N•m (40 lb-ft)
Caliper Sliding Pins to Steering Knuckle . . . . . 41 - 52 N•m (30 - 38 lb-ft)

Ball Joint Removal and Installation

Removal:

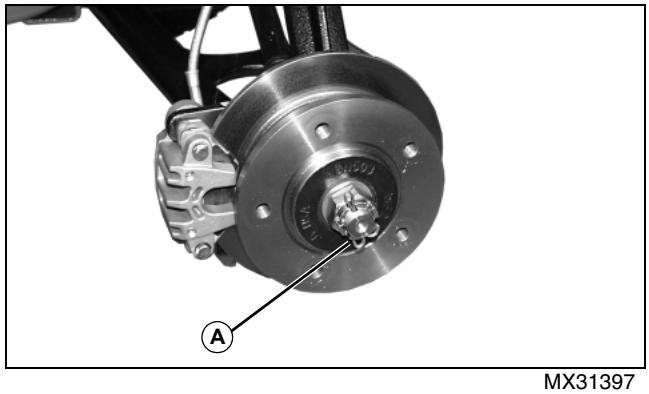
1. Park machine safely on a level surface.

2. Lock park brake.

3. Block rear wheels on both sides.

4. Raise front of vehicle and support with jack stands.

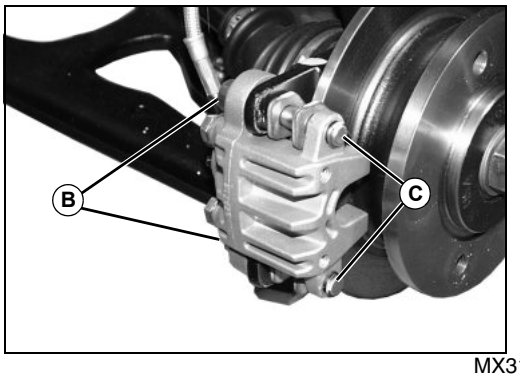
5. Remove front wheels. See "Wheel Removal and Installation" on page 575.



MX31397

6. Remove cotter pin (A) from castle nut at wheel hub. Discard cotter pin.

7. Remove castle nut and washer. It may be necessary for an assistant to apply pressure to the brake pedal in order to keep the brake disc assembly from turning.

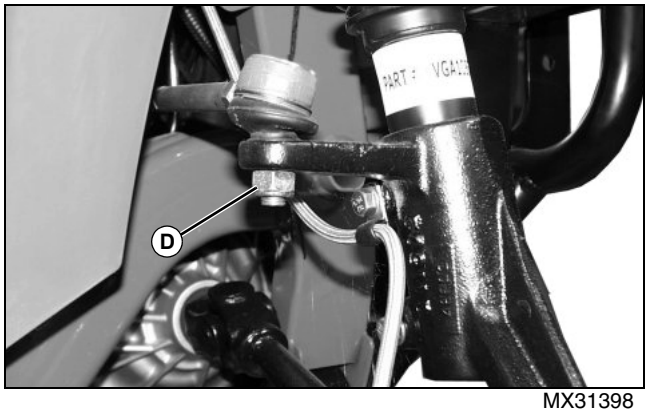


MX31399

8. Remove two C-clips (C) and two sliding pins (B) securing brake caliper.

9. Remove caliper and secure out of the way ensuring the stress is taken off of the brake line.

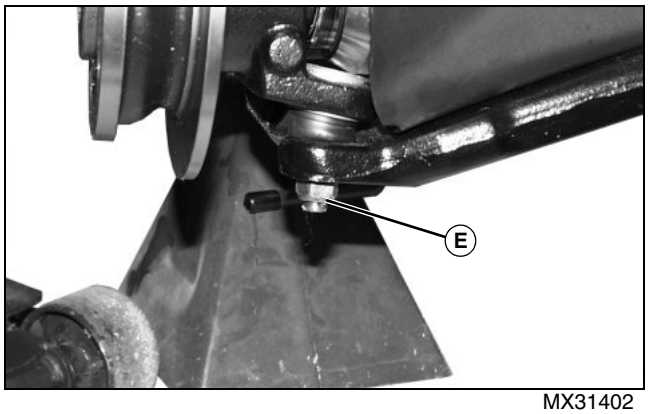
10. Remove brake disc.



MX31398

11. Remove nut (D) securing tie rod end to steering knuckle.

12. Separate tie rod end from steering knuckle.

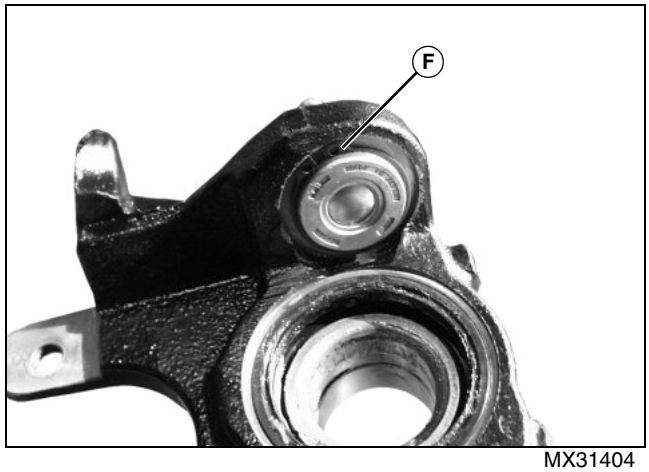


MX31402

13. Remove nut (E) securing ball joint to A-arm.

14. Separate ball joint from A-arm.

15. Pull strut assembly away from drive shaft.



MX31404

16. Remove outside snap ring (F) from ball joint.

17. Using a suitable press, press ball joint out of steering knuckle.

Installation:

1. Ensure that steering knuckle ball joint receptacle is clean and free of grease and debris.

2. Using a suitable press, press new ball joint into steering knuckle until it seats.

3. Install outside snap ring onto ball joint.

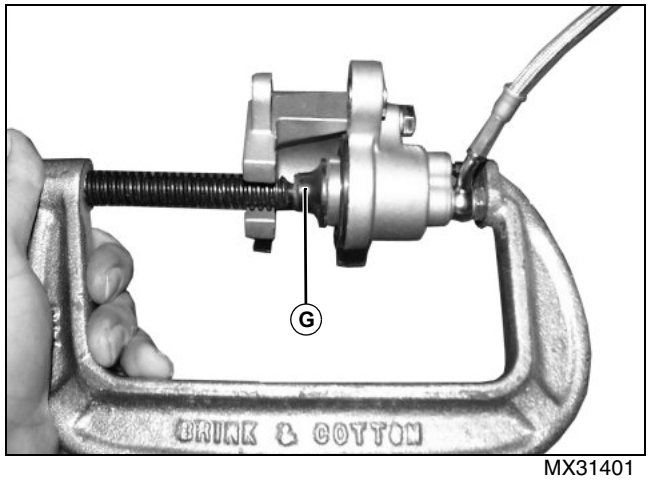
4. Insert drive shaft into steering knuckle.

5. Install ball joint and nut onto steering knuckle.

6. Install tie rod end and nut onto steering knuckle.

7. Install brake disc onto drive shaft splines.

8. Install washer and castle nut finger tight.



MX31401

9. Install brake caliper. It may be necessary to press caliper cylinder into it's bore with a C-clamp (G) to allow clearance for brake pads.

10.Install brake pads, two caliper sliding pins, and two C-clips. Tighten to specifications.

11.Tighten castle nut and install a new cotter pin. Bend ends of cotter pin in opposite directions.

12.Check for free rotation of wheel with no binding.

13.Ensure that brake pedal is firm when pressed.

14.Install wheel. See “Wheel Removal and Installation” on page 575.

15.Lower machine.

Specifications:

Wheel Hub to Halfshaft . . . . . 102 N•m (75 lb-ft)
Ball Joint to A-Arm Lock Nut. . . . . 54 N•m (40 lb-ft)
Caliper Sliding Pins to Steering Knuckle
. . . . . 41 - 52 N•m (30 - 38 lb-ft)

Front A-Arm Removal and Installation

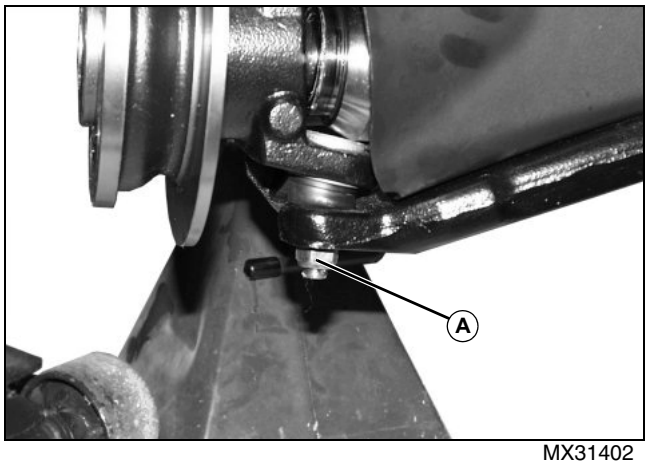
Removal:

1. Park machine safely on a level surface.

2. Lock park brake.

3. Block rear wheels, raise front of machine, and support with jack stands.

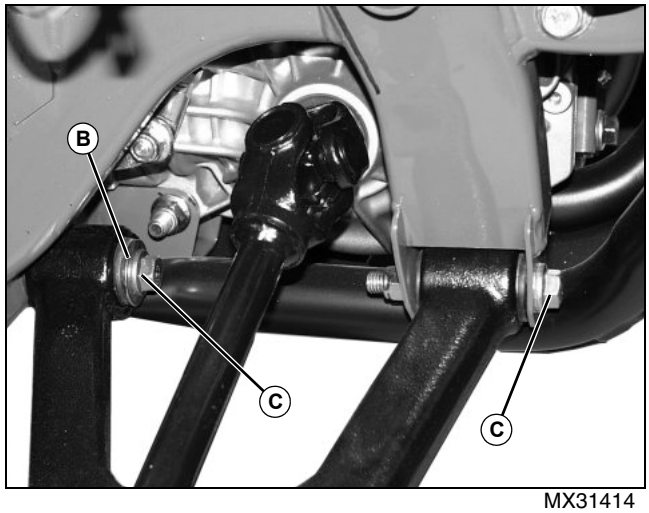
4. Remove front wheels. See “Wheel Removal and Installation” on page 575.



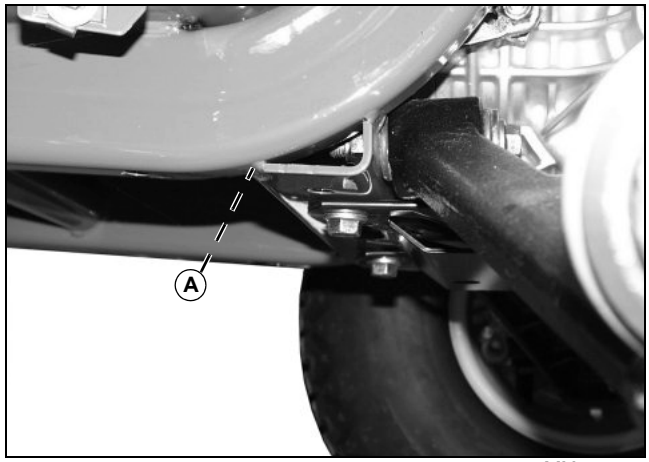
MX31402

5. Remove nut (A) securing ball joint.

6. Separate ball joint from steering assembly.



MX31414



MX31421

7. Remove two bolts and nuts (C) securing A-arm to machine frame. Remove washer (B) from rear A-arm bushing. An access hole (D) for the rear A-arm nut is located in the frame.

8. Remove A-arm.

Installation:

- Installation is in the reverse of removal.
- Tighten all hardware to specifications.

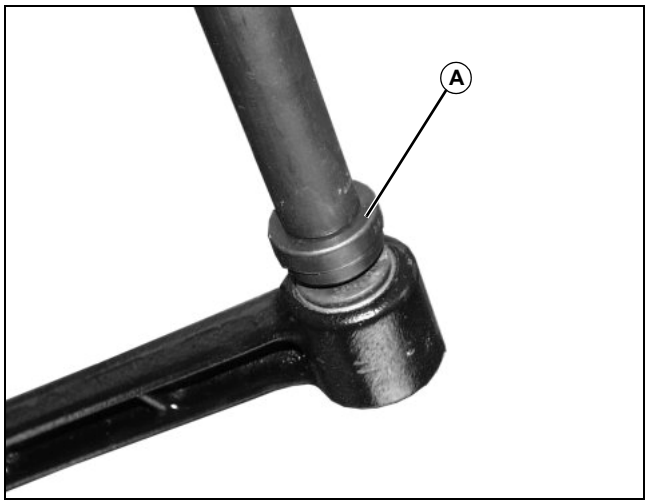
Torque Specifications:

A-Arm to Frame . . . . . 84 ± 16 N•m (62 ± 12 lb-ft)
Wheel Hub to Halfshaft . . . . . 102 N•m (75 lb-ft)
Ball Joint to A-Arm Lock Nut . . . . . 54 N•m (40 lb-ft)

A-Arm Bushing Removal and Installation

Removal:

1. Remove A-arm. See “A-Arm Bushing Removal and Installation” on page 530.



MX31418

2. Using a proper size bushing driver (A), remove A-arm bushings.

Installation:

- Using a proper size bushing driver, install A-arm bushings.
- Install A-arm.

BRAKES TABLE OF CONTENTS

Table of Contents

BRAKES TABLE OF CONTENTS

BRAKES SPECIFICATIONS

Specifications

General Specifications

Type	**Four Wheel Hydraulic Disc**
Park Brake	**Mechanical Disc**
Brake Fluid	**DOT3**

Torque Specifications

Hydraulic Brakes:

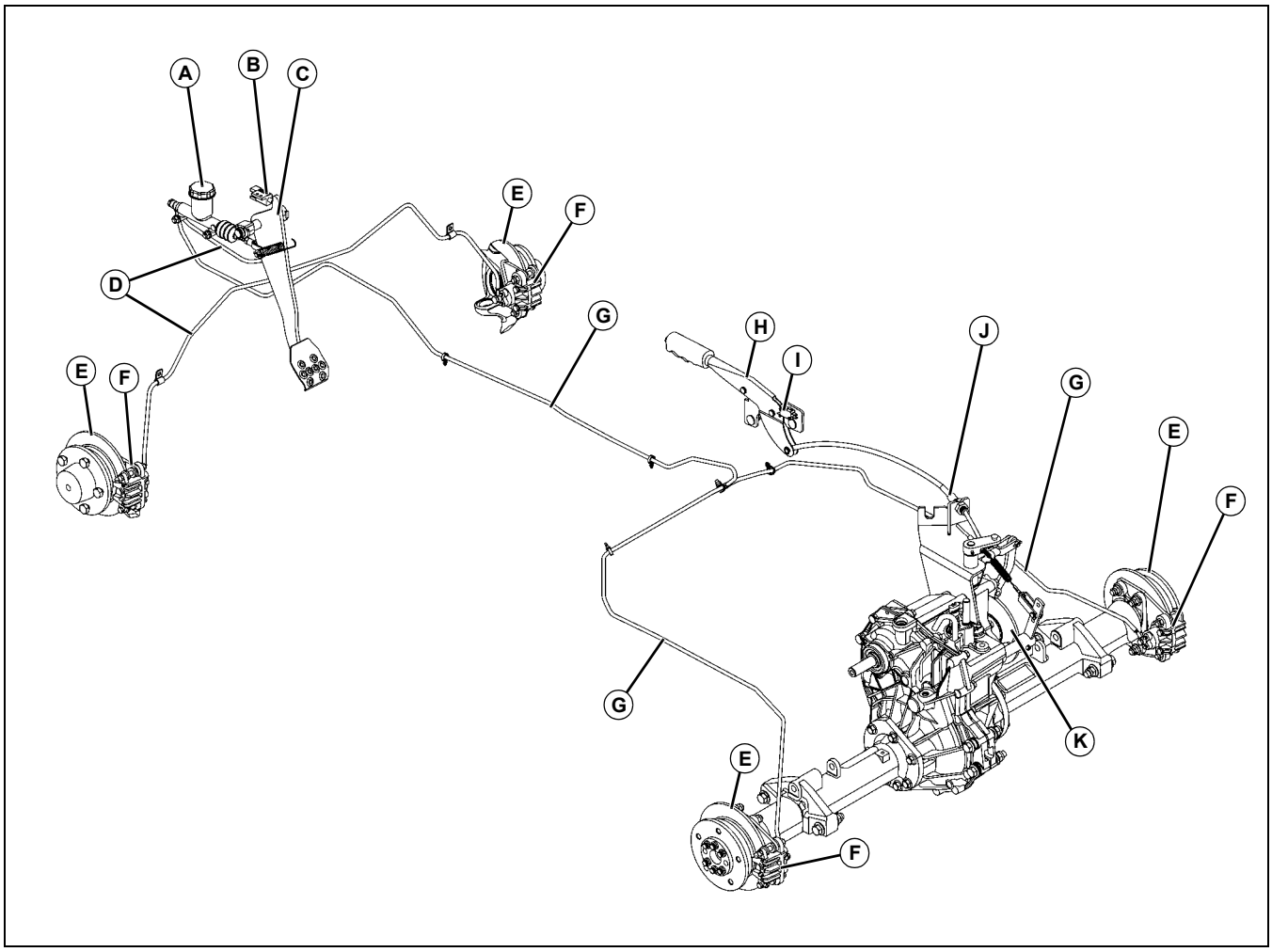
Master Cylinder Banjo Bolts	**15 - 24 N•m (10 - 18 lb-ft)**
Caliper Banjo Bolts	**15 - 24 N•m (10 - 18 lb-ft)**
Caliper Sliding Pins	**41 - 52 N•m (30 - 38 lb- ft)**
Master Cylinder Rod Jam Nut	**20 N•m (15 lb-ft)**
Brake Line 3-Way Valve to Firewall	**10.4 N•m (92 lb-in.)**

Park Brake:

Caliper Sliding Pins	**41 - 52 N•m (30 - 38 lb-ft)**
Brake Disc to Drive Shaft Collar Nuts	**73 ± 15 N•m (54 ± 11 lb-ft)**
Park Brake Handle Bolts	**37 ± 7 N•m (27 ± 5 lb-ft)**
Cable Adjust Jam Nut	**54 - 61 N•m (40 - 45 lb-ft)**

Component Location (SN -40000)

Brake System



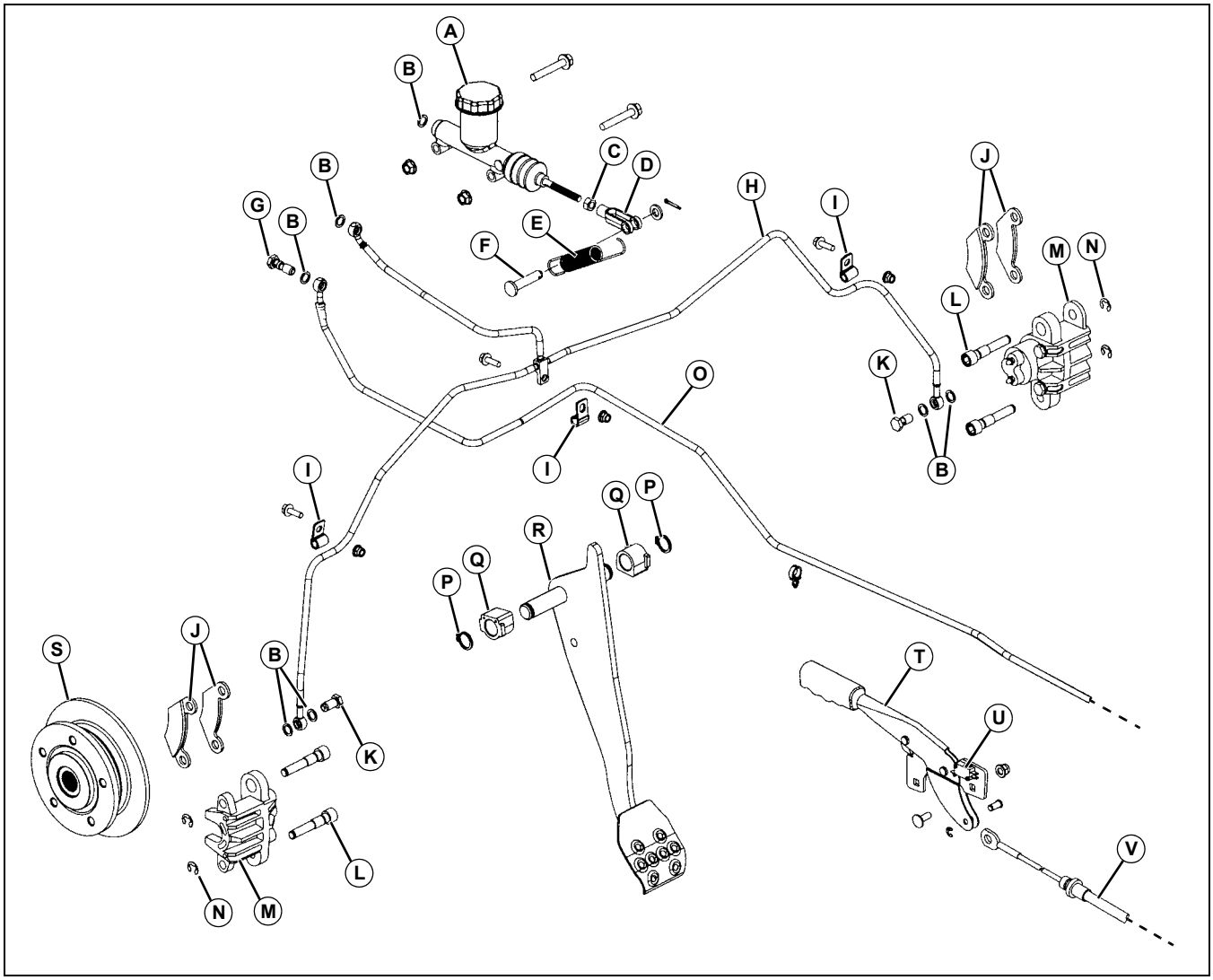
MX36443

Picture Note: 2-Wheel Drive Machine Shown

A - Master Cylinder
B - Brake Switch
C - Brake Pedal Assembly
D - Front Brakes Hydraulic Line
E - Brake Disc
F - Brake Caliper
G - Rear Brakes Hydraulic Line
H - Park Brake Handle Assembly
I - Park Brake Switch
J - Park Brake Cable
K - Park Brake Disc (2WD Shown)[1]

1. See "Park Brake System" on next page for park brake components.

Brake System Components - Front

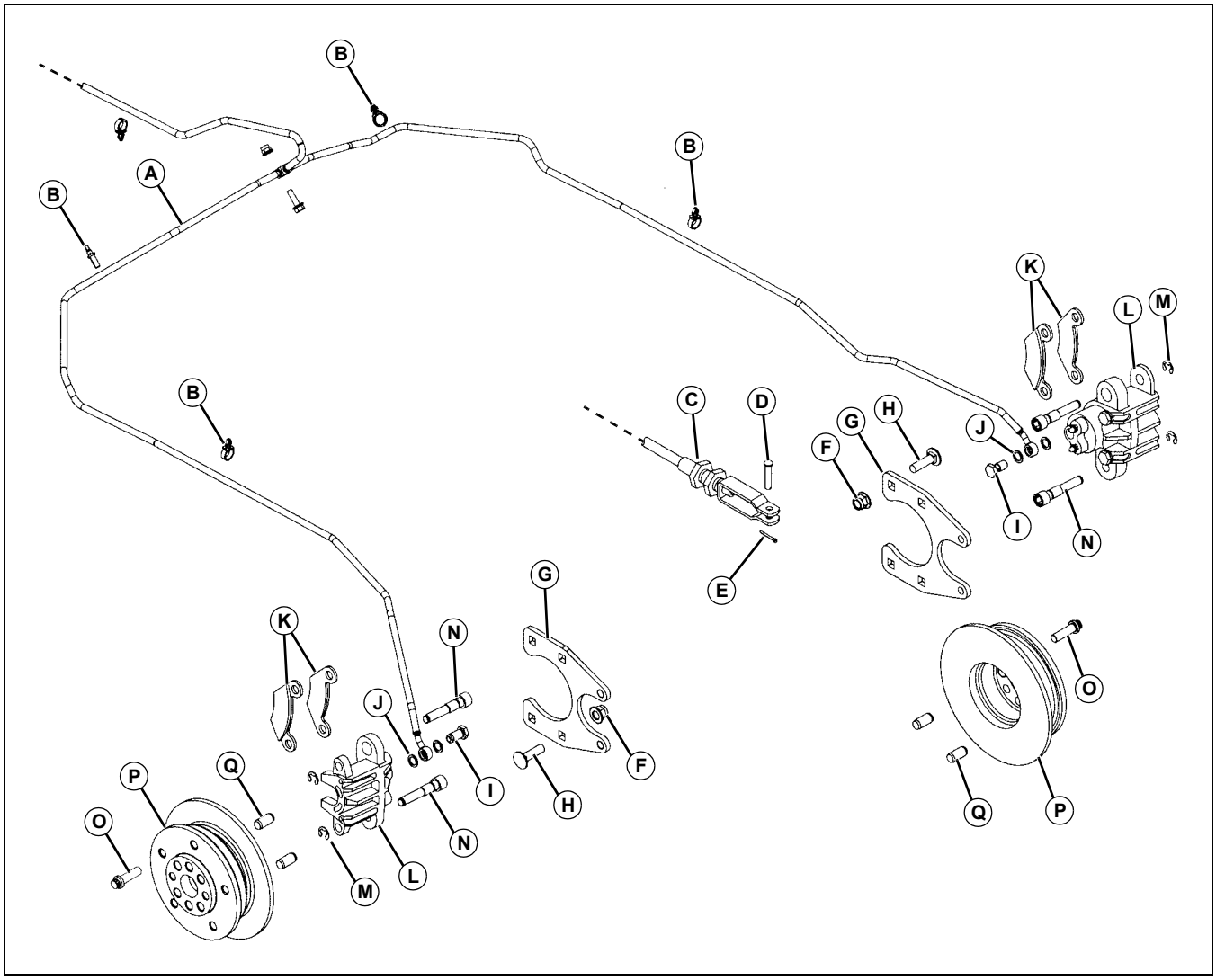


MX31878

Picture Note: 2-Wheel Drive Machine Shown

A - Master Cylinder
B - Seal
C - Jam Nut
D - Yoke
E - Spring
F - Drilled Pin
G - Hydraulic Brake Line Bolt
H - Front Brake Line
I - Retainer Clip
J - Brake Pad
K - Hydraulic Caliper Bolt
L - Brake Sliding Pins
M - Brake Caliper Assembly
N - Snap Ring
O - Rear Brake Line
P - Snap Ring
Q - Bearing
R - Brake Pedal
S - Front Rotor
T - Park Brake Handle Assembly
U - Park Brake Switch
V - Park Brake Cable (Front Shown)

Brake System Components - Rear



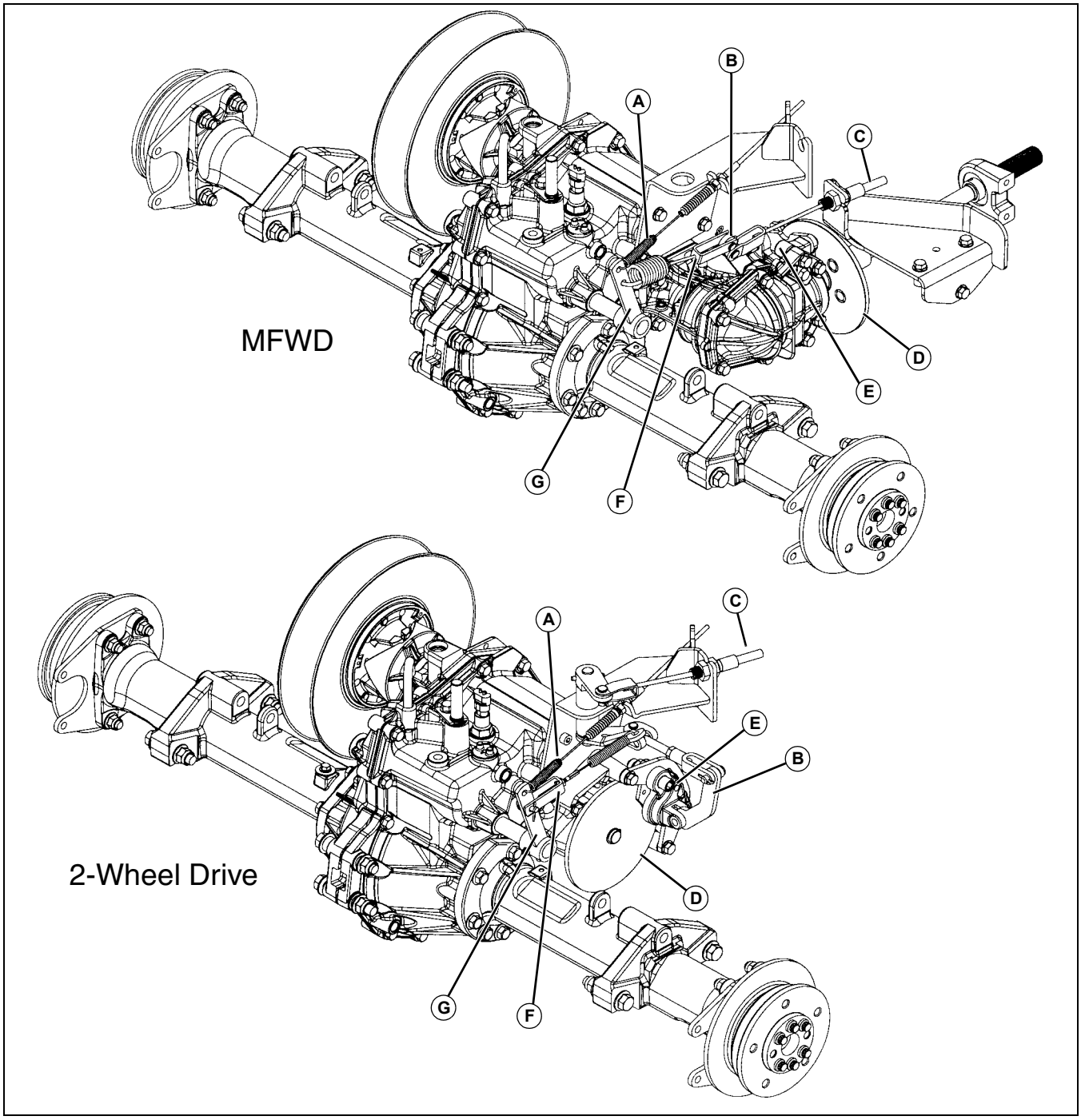
MX31879

Q - Alignment Pins

Picture Note: 2-Wheel Drive Machine Shown

A - Rear Brake Line
B - Retainer Clip
C - Park Brake Cable (Rear Shown)
D - Drilled Pin
E - Cotter Pin
F - Flange Nut (4 used on each side)
G - Caliper Mounting Bracket (1 used on each side)
H - Carriage Bolt (4 used on each side)
I - Hydraulic Caliper Bolt
J - Seal
K - Brake Pad
L - Brake Caliper Assembly
M - Snap Ring
N - Brake Sliding Pins
O - Wheel Mounting Bolts
P - Rear Rotor

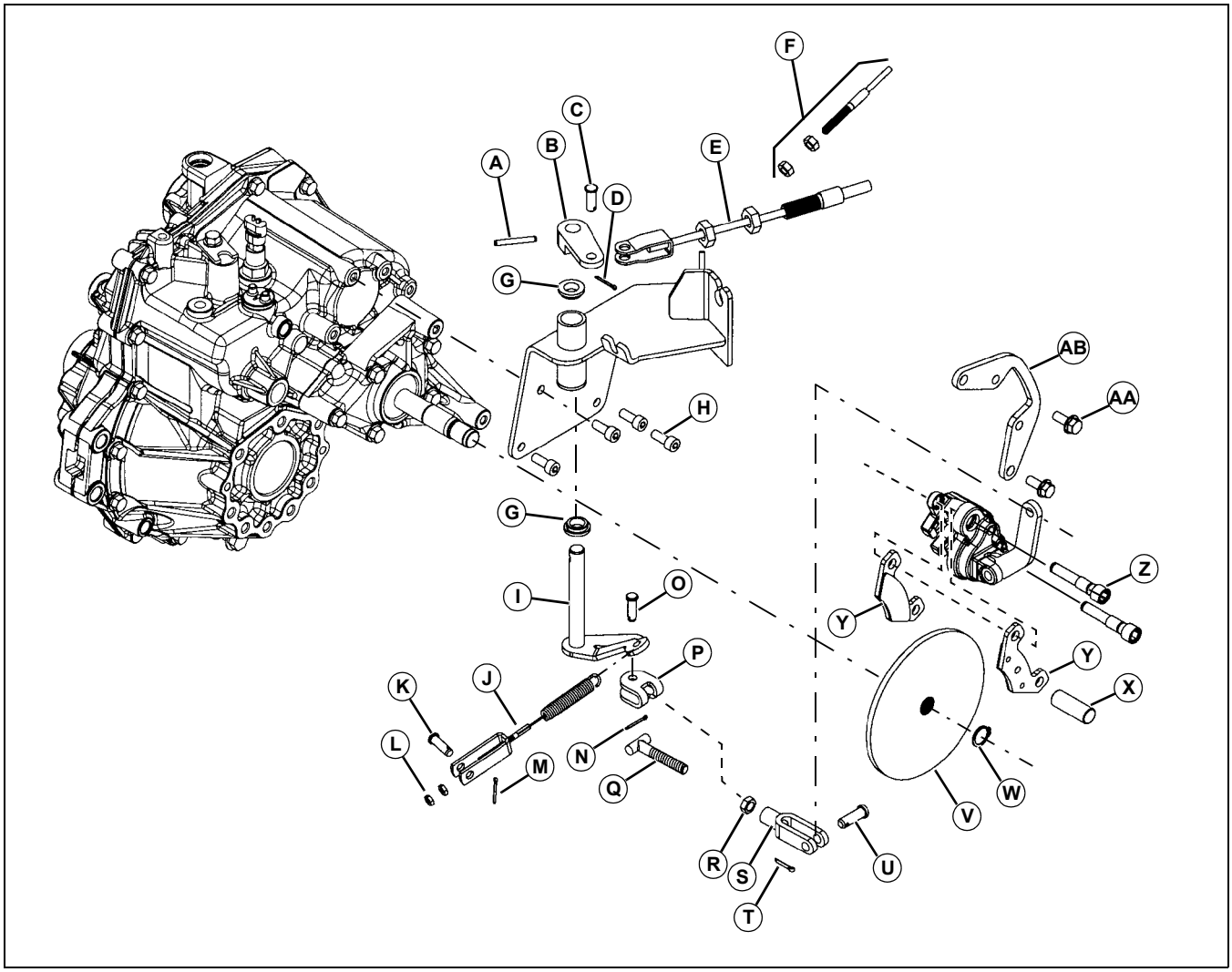
Park Brake System



MX31518

A - Differential Lock Cable
B - Park Brake Actuator Arm
C - Park Brake Cable
D - Park Brake Disc
E - Brake Caliper
F - Park Brake Arm to Differential Lock Arm Linkage
G - Differential Lock Arm

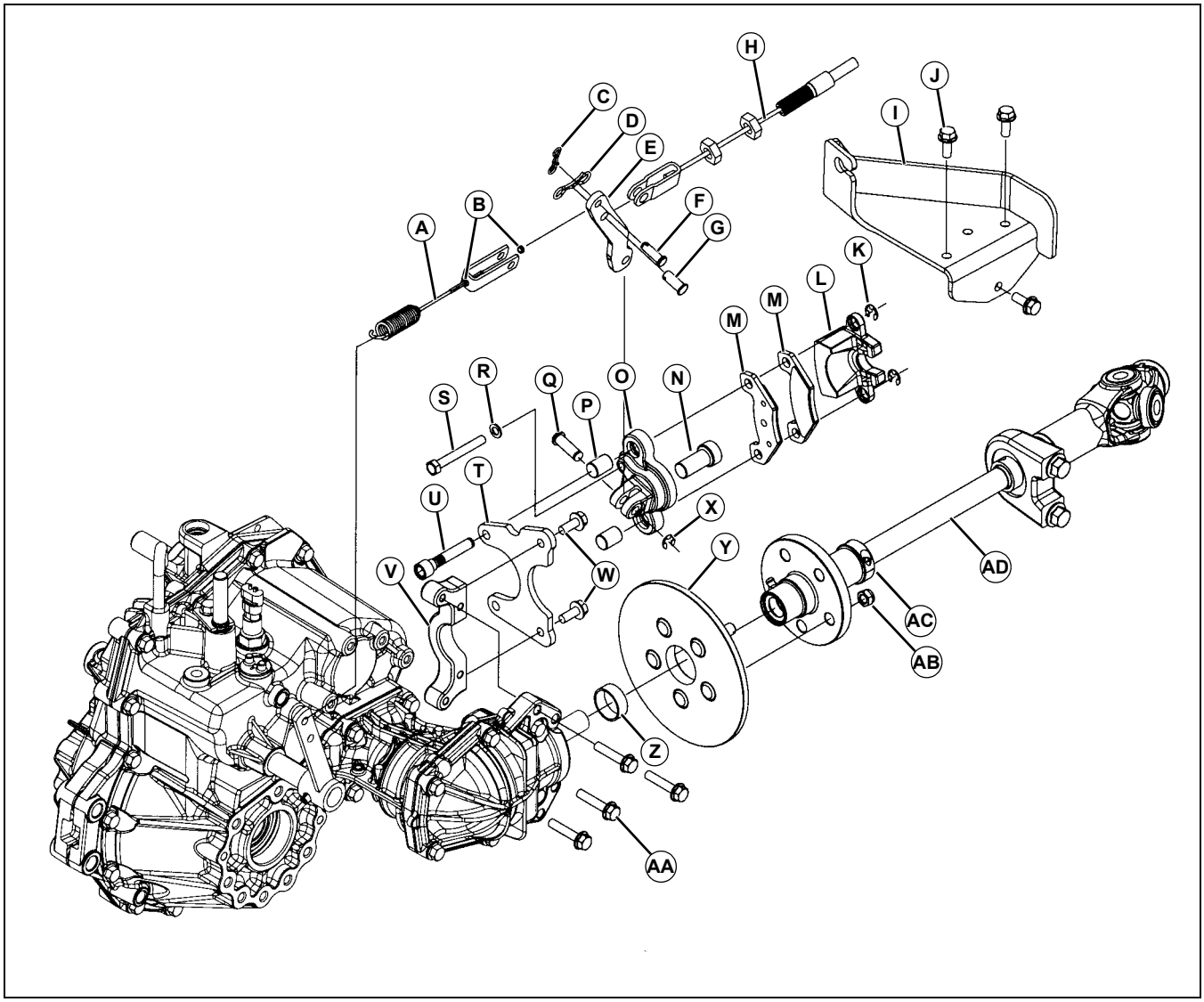
2-Wheel Drive Park Brake Components



MX31620

A - Roll Pin
B - Park Brake Arm
C - Pin
D - Cotter Pin
E - Park Brake Cable
F - Differential Lock Cable
G - Bushing
H - Bolt (4 used)
I - Park Brake Arm Shaft
J - Park Brake Arm to Differential Arm Spring Assembly
K - Pin
L - Nut (2 used)
M - Cotter Pin
N - Cotter Pin
O - Pin
P - Bracket
Q - T-Bolt
R - Jam Nut
S - Clevis
T - Cotter Pin
U - Pin
V - Park Brake Disc
W - Snap Ring
X - Brake Actuator Pin
Y - Brake Pad (2 used)
Z - Caliper Sliding Pin Screw (2 used)
AA- Bolt (2 used)
AB- Caliper Mounting Bracket

MFWD Park Brake Components

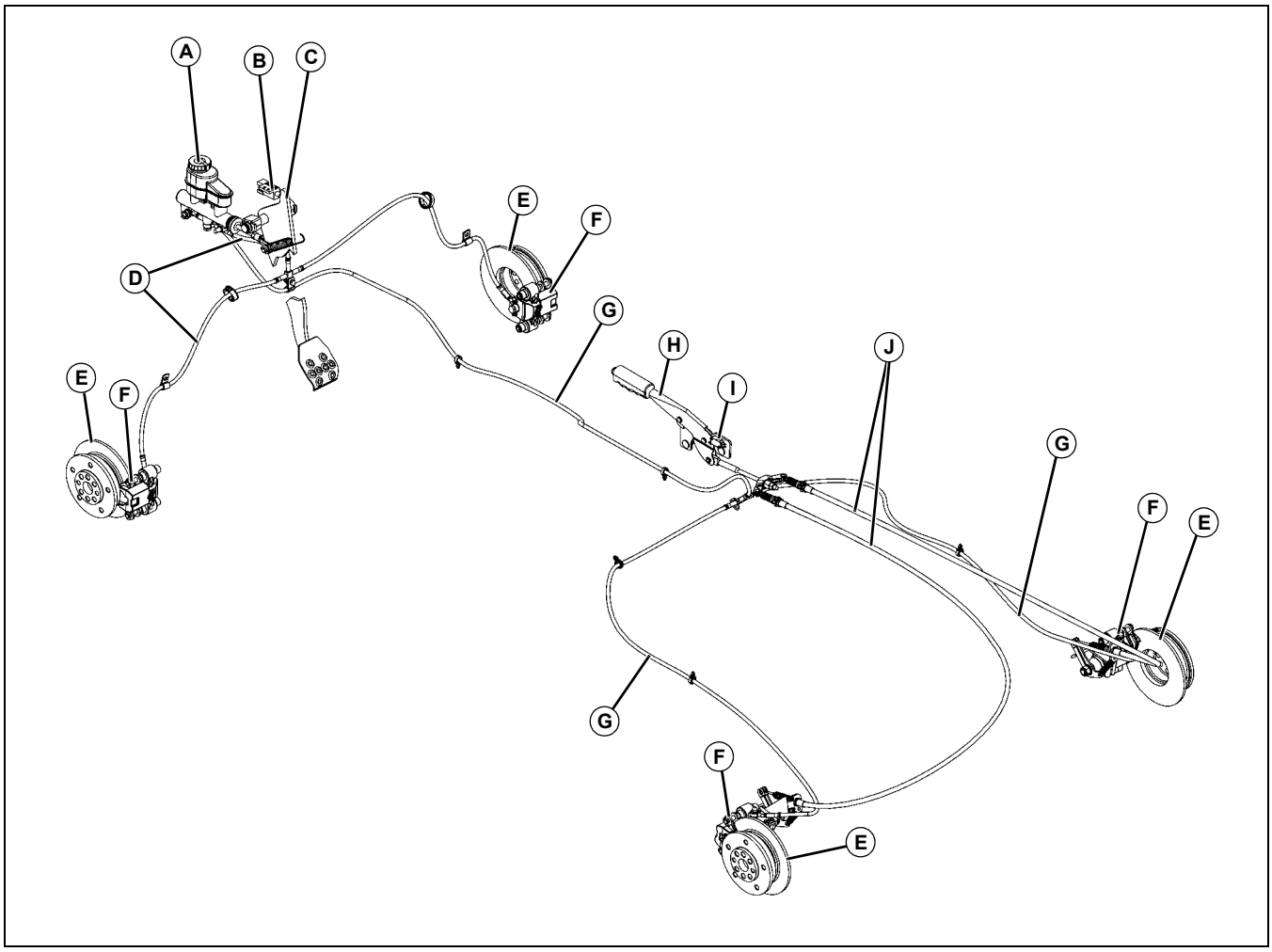


MX31621

A - Park Brake Arm to Differential Arm Spring Assembly
B - Nut (2 used)
C - Spring Locking Pin
D - Spring Locking Pin
E - Park Brake Arm
F - Pin
G - Pin
H - Park Brake Cable
I - Bracket
J - Bolt (3 used)
K - E-Clip (2 used)
L - Brake Caliper Housing (half)
M - Brake Pad (2 used)
N - Brake Actuator Pin
O - Brake Caliper Housing (half)
P - Bushing (2 used)
Q - Pin
R - Washer (2 used)
S - Bolt (2 used)
T - Caliper Mounting Bracket
U - Caliper Sliding Pin Screw (2 used)
V - Bracket
W - Bolt (2 used)
X - E-Clip
Y - Park Brake Disc
Z - Spacer
AA- Bolt (4 used)
AB- Nut (5 used)
AC- Locking Collar
AD- Driveline Assembly

Component Location (SN 40001-)

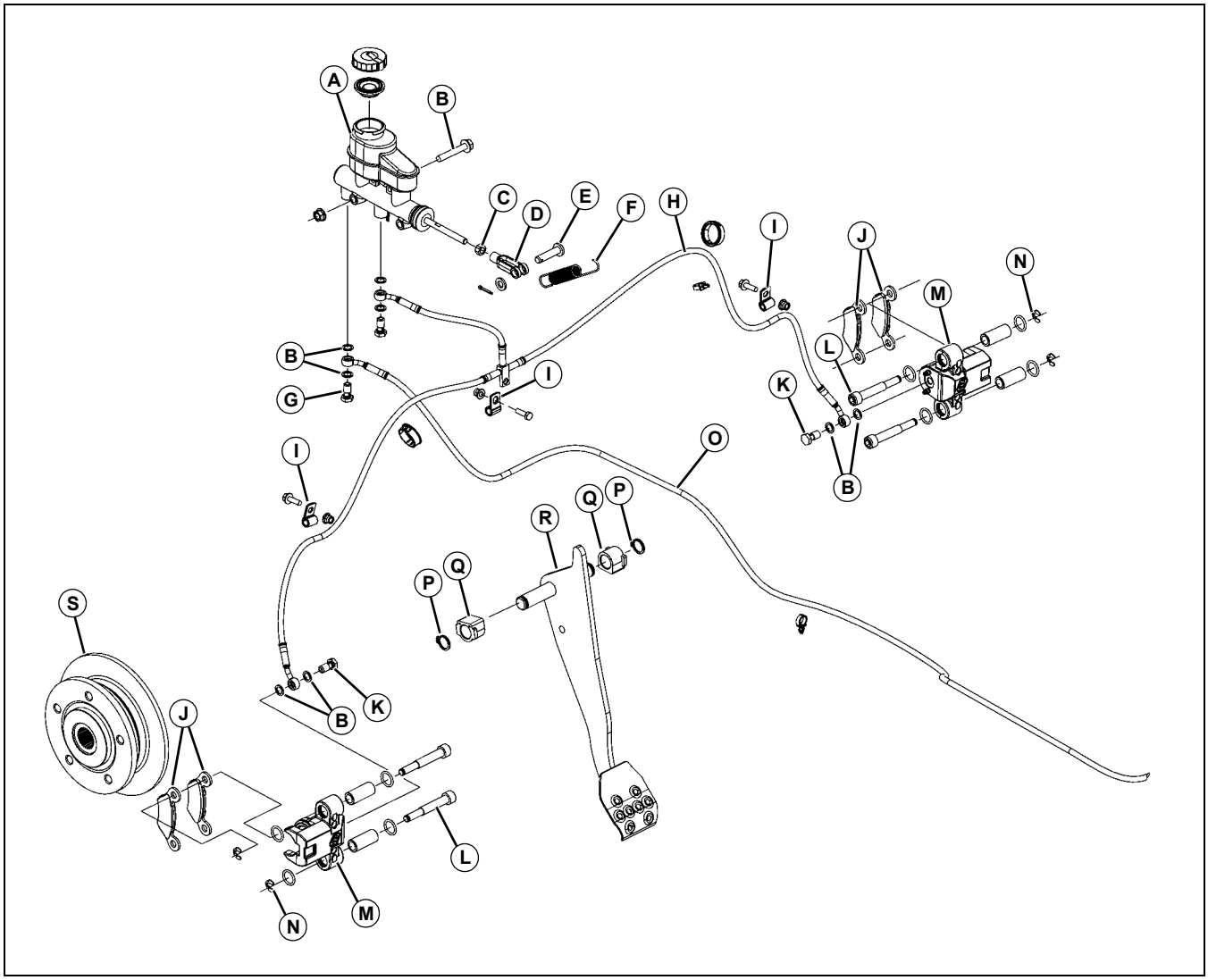
Brake System



MX36444

A - Master Cylinder
B - Brake Switch
C - Brake Pedal Assembly
D - Front Brakes Hydraulic Line
E - Brake Disc
F - Brake Caliper
G - Rear Brakes Hydraulic Line
H - Park Brake Handle Assembly
I - Park Brake Switch
J - Park Brake Cable

Brake System Components - Front

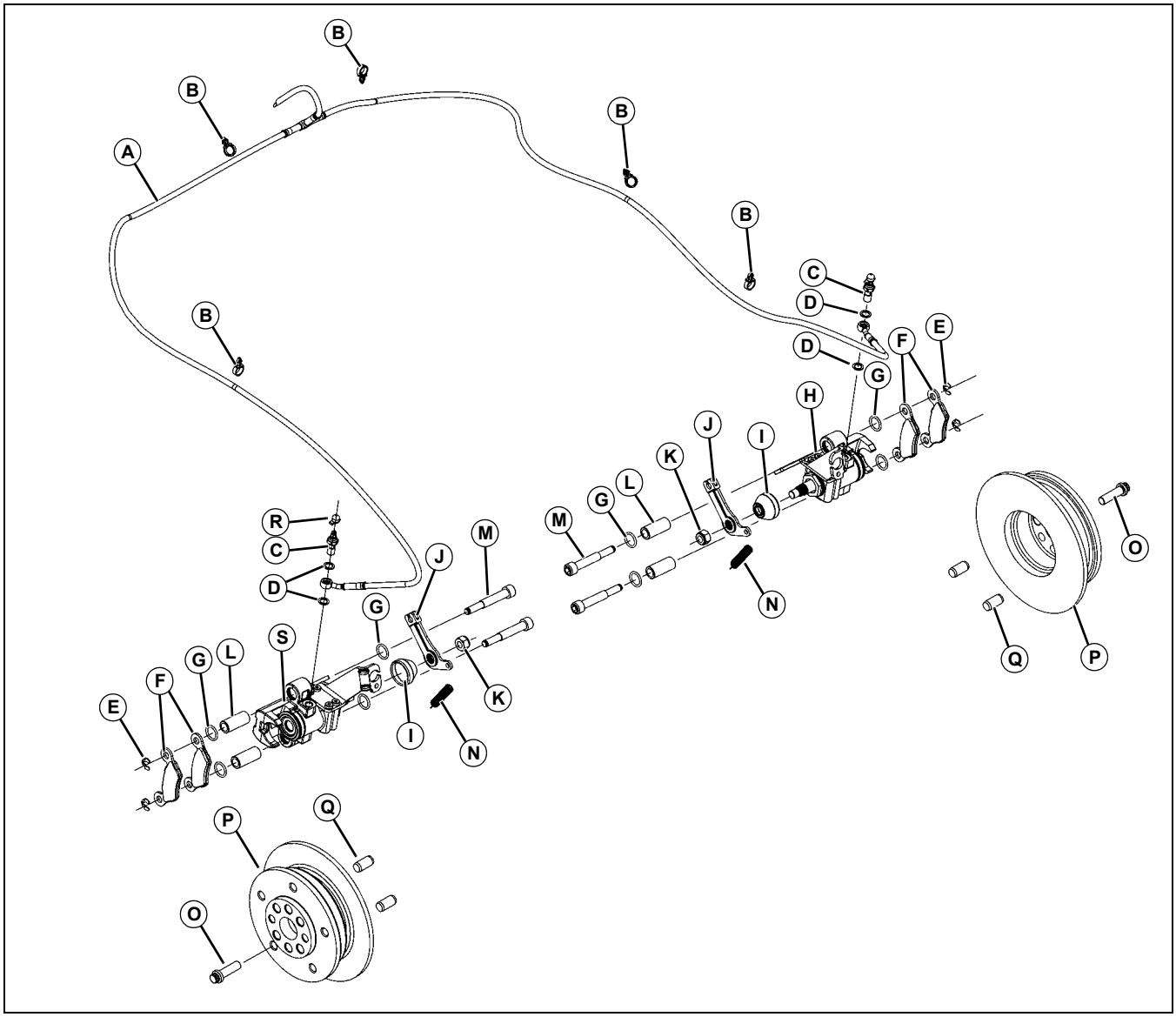


MX36447

Picture Note: 2-Wheel Drive Machine Shown

A - Master Cylinder
B - Seal
C - Jam Nut
D - Yoke
E - Drilled Pin
F - Spring
G - Hydraulic Brake Line Bolt
H - Front Brake Line
I - Retainer Clip
J - Brake Pad
K - Hydraulic Caliper Bolt
L - Brake Sliding Pins
M - Brake Caliper Assembly
N - Snap Ring
O - Rear Brake Line
P - Snap Ring
Q - Bearing
R - Brake Pedal
S - Front Rotor

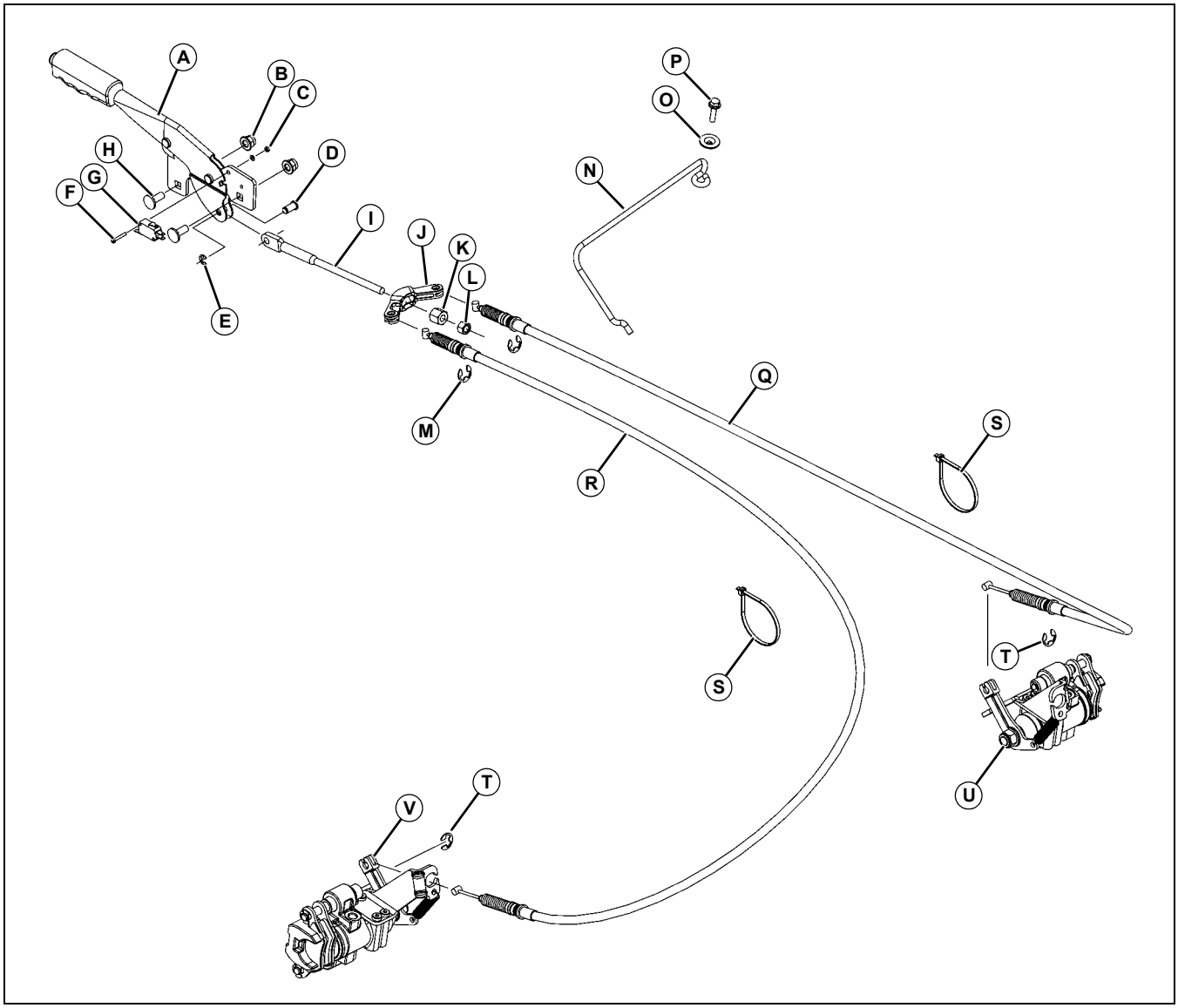
Brake System Components - Rear



MX36448

A - Rear Brake Line
B - Retainer Clip
C - Bleed Valve
D - Seal
E - Snap Ring
F - Brake Pad
G - Seal
H - RH Brake Caliper Assembly
I - Boot
J - Park Brake Arm
K - Flange Nut
L - Sleeve
M - Brake Sliding Pin
N - Spring
O - Wheel Mounting Bolts
P - Rear Rotor
Q - Alignment Pins
R - Bleed Valve Cover
S - LH Brake Caliper Assembly

Park Brake Components



MX36445

A - Park Brake Arm Assembly
B - Nut (2 used)
C - Nut and Washer (2 used)
D - Pin
E - E-Clip
F - Screw (2 used)
G - Switch
H - Bolt (2 used)
I - E-Clip (2 used)
J - Park Brake Cable Balancer
K - Nut
L - Jam Nut
M - E-Clip (2 used)
N - Brake Caliper Housing (half)
O - Bracket
P - Washer
Q - RH Park Brake Cable
R - LH Park Brake Cable
S - Tie Wrap
T - E-Clip (2 used)
U - RH Brake Assembly
V - LH Brake Assembly

Theory of Operation

Brake System

Function:

The brakes provide a means of stopping or slowing the unit when in motion. The park brakes prevent movement when the unit is not in use.

Theory of Operation:

The machine uses an automotive style, self adjusting, hydraulic, four wheel disc brake system. The piston of the master cylinder supplies brake fluid to the front and rear brakes.

When the brake pedal is depressed, the top of the pedal pulls a pivot plate through a clevis, which pivots on a bolt pushing the rod into the brake master cylinder. As the rod is pushed into the master cylinder it pressurizes the brake fluid inside the master cylinder. The pressure is transferred through the brake lines and hoses to the brake caliper, where it presses outward on the pistons. The caliper pistons press outward on the brake shoes causing them to contact the brake discs.

The friction between the brake shoes and brake discs slows or stops wheel rotation.

SN -40000 Machines:

On 2-wheel drive machines the park brake disc is splined to the transaxle reduction shaft.

On MFWD machines the transaxle has a right angle direct drive output shaft connected to the transaxle reduction shaft. A brake disc is mounted to the output shaft.

The park brake system is cable operated. When the park brake lever is raised into its locked position, the park brake cable pulls a transaxle mounted lever. The lever mechanically pushes a brake caliper piston. The piston presses on a caliper mounted brake shoe, clamping the output shaft brake disc, locking the transaxle output shaft.

SN 40001- Machines:

The park brake system is cable operated. When the park brake lever is raised into its locked position, the park brake cable pulls a brake caliper assembly mounted lever. The lever mechanically pushes the brake caliper piston. The piston presses on the brake shoes causing them to contact the brake discs.

The friction between the brake shoes and brake discs slows or stops wheel rotation.

Diagnostics

System Diagnosis

System: Hydraulic Brakes

(1) Brakes working properly? Is the brake fluid level correct?

Yes - Go to next step.

No - Add brake fluid. Check system for leaks.

(2) Is there air in the brake system?

Yes - Bleed the brake system. See “Bleeding Brakes” on page 548 and “Bleeding Master Cylinder” on page 548.

No - Go to next step.

(3) Do brake system components leak?

Yes - Repair or replace components as necessary. Bleed brake system.See “Bleeding Brakes” on page 548 and “Bleeding Master Cylinder” on page 548.

Symptom: Brakes Will Not Engage or Show Poor Response

(1) Is the brake fluid low?

Yes - Add fluid. See “Check Brake Fluid Level” on page 547.

No - Go to next step.

(2) Do the master cylinder seal, brake lines or brake calipers leak?

Yes - Repair or replace components.

No - Go to next step.

(3) Is there air in the brake system?

Yes - Bleed brake lines. See “Bleeding Brakes” on page 548 and “Bleeding Master Cylinder” on page 548.

No - Go to next step.

(4) Is the master cylinder push rod adjusted correctly? (SN -40001) only

Yes - Go to next step.

No - Adjust brake rod. See “Master Cylinder Rod Adjustment” on page 547.

(5) Is the brake pedal or pivot bent, broken or worn?

Yes - Repair or replace components as needed.

Symptom: Brakes Will Not Engage or Show Poor Response

No - Go to next step.

Symptom: Brake Effort Excessive

(1) Is the brake fluid low?

Yes - Add fluid. See “Check Brake Fluid Level” on page 547.

No - Go to next step.

(2) Does the master cylinder seal leak?

Yes - Repair or replace components.

No - Go to next step.

(3) Is the master cylinder push rod adjusted correctly? (SN -40001) only

Yes - Go to next step.

No - Adjust brake rod. See “Master Cylinder Rod Adjustment” on page 547.

(4) Is the brake pedal or pivot bent, broken or worn?

Yes - Repair or replace components as needed.

No - Go to next step.

(5) Are the brake pads excessively worn?

Yes - Replace brake pads. See “Brake Pad Replacement” on page 555.

Symptom: Wheel Brakes Will Not Release

(1) Is the master cylinder push rod adjusted correctly? (SN -40001) only

Yes - Go to next step.

No - Adjust brake rod. See “Master Cylinder Rod Adjustment” on page 547.

(2) Is the brake pedal or pivot bent, broken or worn?

Yes - Repair or replace components as needed.

No - Go to next step.

Symptom: Brake Noisy or Chattering

(1) Do brake calipers leak?

Yes - Repair or replace components.

No - Go to next step.

(2) Do the brake calipers have loose or missing hardware?

Symptom: Brake Noisy or Chattering

Yes - Repair or replace hardware.

Symptom: Excessive Brake Pad Wear

(1) Is the brake return spring stretched, broken or missing?

Yes - Replace spring.

No - Go to next step.

(2) Is the master cylinder push rod adjusted correctly? (SN -40001) only

Yes - Go to next step.

No - Adjust brake rod. See “Master Cylinder Rod Adjustment” on page 547.

(3) Is the brake pedal or pivot bent, broken or worn?

Yes - Repair or replace components as needed.

No - Go to next step.

Symptom: Brake Pedal Travel Excessive

(1) Is the brake fluid low?

Yes - Add fluid. See “Check Brake Fluid Level” on page 547.

No - Go to next step.

(2) Do the master cylinder seal, brake lines or brake calipers leak?

Yes - Repair or replace components.

No - Go to next step.

(3) Is there air in the brake system?

Yes - Bleed brake lines. See “Bleeding Brakes” on page 548 and “Bleeding Master Cylinder” on page 548.

No - Go to next step.

Symptom: Brakes Pull Left or Right

(1) Is the brake fluid low?

Yes - Add fluid. See “Check Brake Fluid Level” on page 547.

No - Go to next step.

(2) Do the brake lines or brake calipers leak?

Yes - Repair or replace components.

No - Go to next step.

(3) Is there air in the brake system?

Symptom: Brakes Pull Left or Right

Yes - Bleed brake lines. See “Bleeding Brakes” on page 548.

No - Go to next step.

Symptom: Pedal Feels Hard With Little Travel

(1) Is the master cylinder push rod adjusted correctly? (SN -40001) only

Yes - Go to next step.

No - Adjust brake rod. See “Master Cylinder Rod Adjustment” on page 547.

(2) Is the brake pedal or pivot bent, broken or worn?

Yes - Repair or replace components as needed.

No - Go to next step.

Symptom: Park Brake Will Not Engage or Hold

(1) Is the park brake cable incorrectly adjusted, stretched, worn or binding?

Yes - Adjust or replace brake cable. See “MFWD Park Brake Cable Removal and Installation (SN -40000)” on page 564.

No - Go to next step.

(2) Is the park brake lever or locking pawl bent, broken, binding or worn?

Yes - Repair or replace components as needed.

No - Go to next step.

(3) Does the park brake mechanism have missing or worn components?

Yes - Replace components.

Symptom: Park Brake Will Not Release (SN -40000)

(1) Is the park brake cable incorrectly adjusted, stretched, worn or binding?

Yes - Adjust or replace brake cable. See “MFWD Drive Park Brake Adjustment” on page 549 and “MFWD Park Brake Cable Removal and Installation (SN -40000)” on page 564.

No - Go to next step.

(2) Is the park brake lever or locking pawl bent, broken, binding or worn?

Yes - Repair or replace components as needed.

No - Go to next step.

Symptom: Park Brake Will Not Release (SN -40000)

(3) Is the transaxle park brake spring broken, out of adjustment, or missing?

Yes - Adjust spring. See “MFWD Park Brake Return Spring Adjustment” on page 550.

Yes - Replace spring.

Symptom: Park Brake Will Not Release (SN 40001-)

(1) Are the park brake cables incorrectly adjusted, stretched, worn or binding?

Yes - Adjust or replace brake cables.

No - Go to next step.

(2) Is the park brake lever or locking pawl bent, broken, binding or worn?

Yes - Repair or replace components as needed.

No - Go to next step.

(3) Are the caliper park brake springs broken or missing?

Yes - Replace spring(s).

Tests and Adjustments (SN -40000)

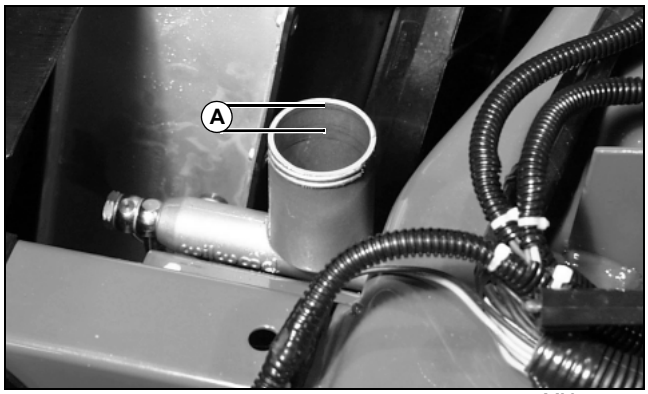
Check Brake Fluid Level

IMPORTANT: Avoid damage! Avoid contamination of the brake fluid. Thoroughly clean area around the filler cap before removing. Do not open the brake fluid reservoir cap unless absolutely necessary.

Use extreme care when filling the reservoir. Fluid spilled on painted surfaces can cause damage.

Use only DOT3 brake fluid from a sealed container.

1. Park machine safely. See Parking Safely in the Safety Section.
2. Open hood.
3. Carefully clean area around reservoir cap.

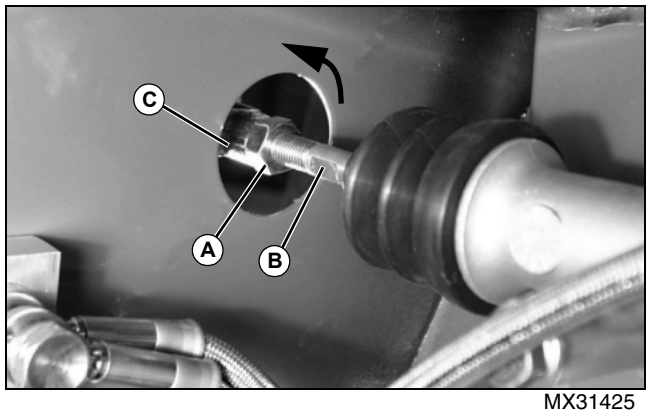


MX31032

4. Remove reservoir cap and visually check fluid level.
   - Fluid levels must be maintained to 12 - 13 mm (0.47 - 0.51 in.) below top of filler (A).
5. If fluid is low:
   - Add fluid to maintain level within specification.
6. Install reservoir cap.
7. Close hood.

Master Cylinder Rod Adjustment

1. Park machine safely. See Parking Safely in the Safety Section.
2. Raise hood.



MX31425

3. Loosen jam nut (A), in direction shown by arrow.
4. Slide rubber boot forward to expose flats (B) on master cylinder rod.
5. Turn the master cylinder rod in the clevis (C) attached to the brake pedal to adjust brake pedal.
   - Adjustment is correct when the return spring has pulled the back of the brake arm 1 - 2 mm (0.039 - 0.079 in.) from the stop bar, and the master cylinder primary piston is fully destroked and resting against the retaining washer.
6. Tighten the jam nut, and verify brake pedal operation.

Specifications:

Brake Arm to Stop Bar. . . . . 1 - 2 mm (0.39 - 0.079 in.)
Brake Rod Jam Nut . . . . . 20 N•m (15 lb-ft)

Bleeding Brakes

IMPORTANT: Avoid damage! Avoid contamination of the brake fluid. Thoroughly clean area around the filler cap before removing.

Use extreme care when filling the reservoir. Fluid spilled on painted surfaces can cause damage.

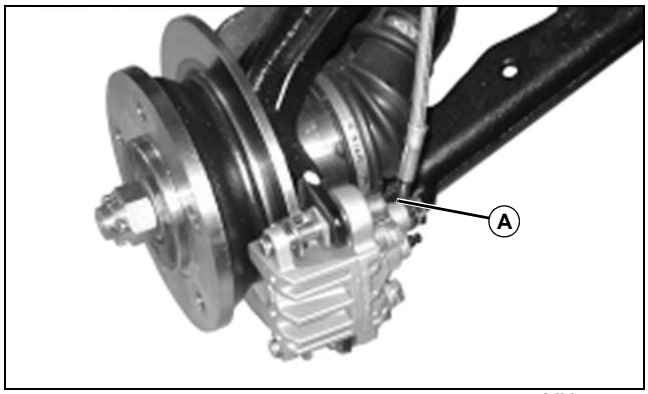
Use only DOT3 brake fluid from a sealed container.

NOTE: The brake hydraulic system must be bled any time a new component is installed, or any time the system has been breached. If only one component has been repaired or replaced it may only be necessary to bleed that component. If bleeding all four wheels, start at the wheel furthest away from the master cylinder and finish at the wheel closest to the master cylinder (right rear, left rear, right front, left front).

1. Park machine safely. See Parking Safely in the Safety Section.

2. Lock park brake.

NOTE: Each caliper has two bleeder screws. Use only top screw.



MX31448

3. Remove the wheel to access the bleeder screw (A).

4. Attach one end of a clear piece of tubing to the bleeder screw. Put the other end into a clear container with approximately 13 mm (1/2 in.) of fresh brake fluid.

5. With the bleeder screw closed, have an assistant slowly pump the brake pedal to build pressure in the system.

6. After several pumps have the assistant stop pumping, but keep pressure on the brake pedal.

7. Open the brake bleeder screw, allowing brake fluid and air to escape.

- Watch the fluid entering the container through the tube. The fluid should be clear, without any air bubbles.

8. Close the bleeder screw. The assistant can now release the pedal.

9. Check the fluid level in the master cylinder, topping off as required.

10. Repeat as required until the fluid running into the container is clear, and there is no evidence of air or bubbles. The pedal should have a firm feel and should not “sink” toward the floor with constant pressure.

11. Make sure all bleeder screws are closed securely and the master cylinder has the correct amount of brake fluid.

12. Install the wheel(s).

Bleeding Master Cylinder

IMPORTANT: Avoid damage! Avoid contamination of the brake fluid. Thoroughly clean area around the filler cap before removing.

Use extreme care when filling the reservoir. Fluid spilled on painted surfaces can cause damage.

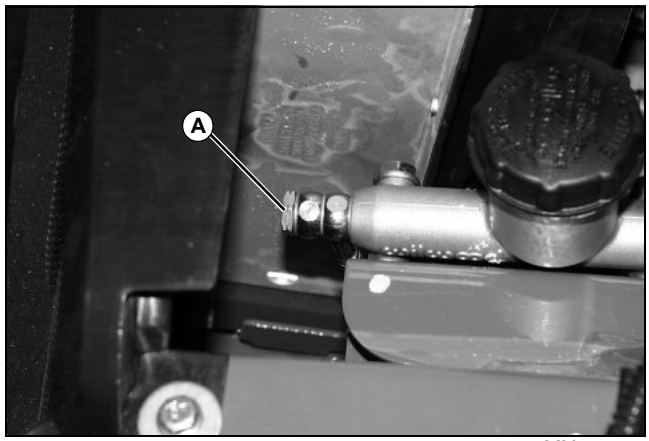
Use only DOT3 brake fluid from a sealed container.

NOTE: The master cylinder must be bled anytime it is replaced or allowed to run completely out of fluid.

1. Park machine safely. See Parking Safely in the Safety Section.

2. Lock park brake.

3. Remove cap and check the level in the master cylinder. Top off if necessary.



MX31505

4. Disconnect brake line (A) from master cylinder.

5. Connect master cylinder bleeding adaptor and clear tubing to master cylinder.

6. Insert tubing in master cylinder reservoir so that end is completely submerged in brake fluid.

7. Slowly depress brake pedal completely and release while observing for bubbles in reservoir.

8. Repeat procedure until bubbles no longer appear. Top off reservoir as needed.

9. Remove bleeding adaptor and connect brake line. Tighten to specification.

10.Bleed brake system. See “Bleeding Brakes” on page 548.

Specifications:

Brake Line to Master Cylinder
. . . . . 15 - 24 N•m (10 - 18 lb-ft)

2-Wheel Drive Park Brake Adjustment

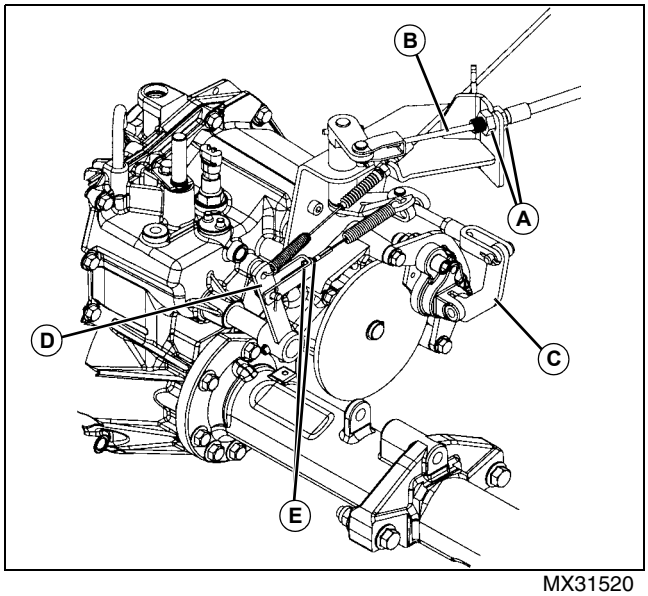
NOTE: Park brake lever should be able to be raised two to three “clicks” with reasonable effort.

1. Park machine safely. See Parking Safely in the Safety Section.

2. Block wheels to prevent machine from rolling.

3. Park brake released.

NOTE: Setting the park brake engages the differential lock to lock the rear wheels together before the park brake is engaged.



MX31520

4. Loosen jam nuts (A). Adjust nuts until park brake cable (B) slack is removed but before park brake arm (C) or differential lock arm (D) move.

5. Tighten jam nuts.

NOTE: If cable slack can not be removed without differential arm movement the differential cable will need to be adjusted to lengthen the cable between the park brake arm and differential arm.

6. Adjust differential cable if necessary:

- Loosen nuts (E).
- Adjust nuts to remove slack and until there is no movement in the differential arm with the park brake handle released and immediate movement when the park brake handle is pulled up.
- Tighten nuts.

7. Recheck park brake operation.

8. Check park brake return spring adjustment. See “MFWD Park Brake Return Spring Adjustment” on page 550.

Specifications:

Cable Adjust Jam Nut . . . . . 54 - 61 N•m (40 - 45 lb-ft)
Park Brake Lever Movement for Differential Lock
. . . . . 0 - 12°
Minimum Lever Angle for Full Differential Lock . . . . 16°
Park Brake Lever Travel Angle . . . . . 0 - 36°
Detent Increment Angle (12 total) . . . . . 2°

MFWD Drive Park Brake Adjustment

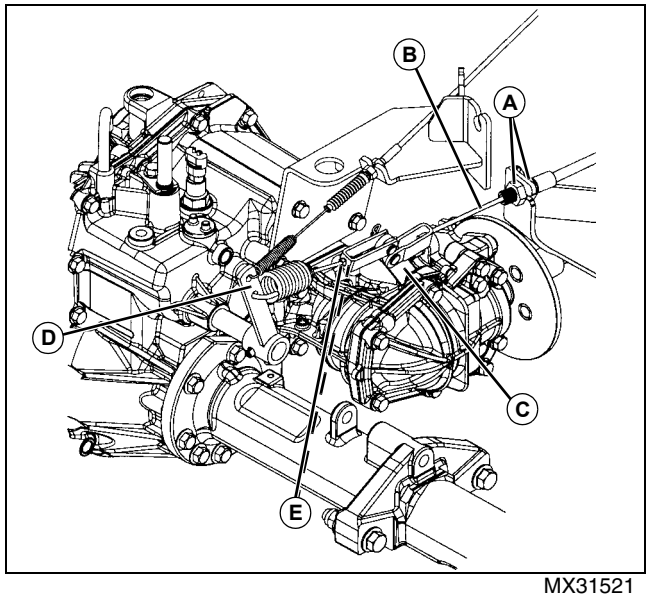
NOTE: Park brake lever should be able to be raised two to three “clicks” with reasonable effort.

1. Park machine safely. See Parking Safely in the Safety Section.

2. Block wheels to prevent machine from rolling.

3. Park brake released.

NOTE: Setting the park brake engages the differential lock to lock the rear wheels together before the park brake is engaged.



MX31521

4. Loosen jam nuts (A). Adjust nuts until park brake cable (B) slack is removed but before park brake arm (C) or differential lock arm (D) move.

5. Tighten jam nuts.

NOTE: If cable slack can not be removed without differential arm movement the differential cable will need to be adjusted to lengthen the cable between the park brake arm and differential arm.

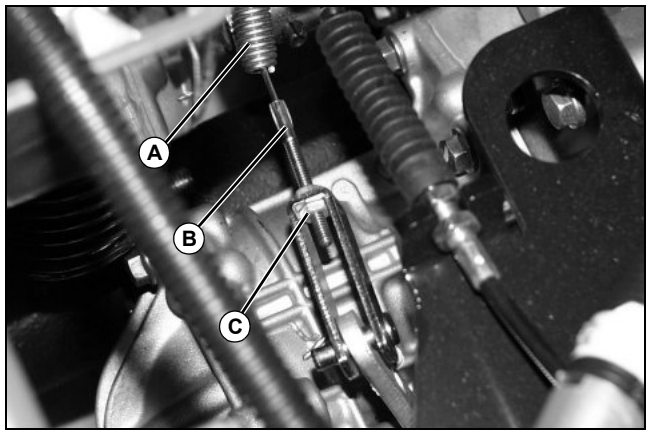
6. Adjust differential cable if necessary:
   - Loosen nuts (E).
   - Adjust nuts to remove slack and until there is no movement in the differential arm with the park brake handle released and immediate movement when the park brake handle is pulled up.
   - Tighten nuts.
7. Recheck park brake operation.
8. Check park brake return spring adjustment. See “MFWD Park Brake Return Spring Adjustment” on page 550.

Specifications:

Cable Adjust Jam Nut . . . . . 54 - 61 N•m (40 - 45 lb-ft)
Park Brake Lever Movement for Differential Lock . . . . . 0 - 12°
Minimum Lever Angle for Full Differential Lock . . . . 16°
Park Brake Lever Travel Angle . . . . . 0 - 36°
Detent Increment Angle (12 total) . . . . . 2°

MFWD Park Brake Return Spring Adjustment

1. Park machine safely. See Parking Safely in the Safety Section.
2. Block wheels and park brake must be off.



3. Park bake return spring (A) and cable (B) should be taut but with no stretching of spring with park brake off.
4. Loosen jam nut (C) and adjust spring and cable tension if necessary.
5. Tighten jam nut and test park brake.

Tests and Adjustments (SN 40001-)

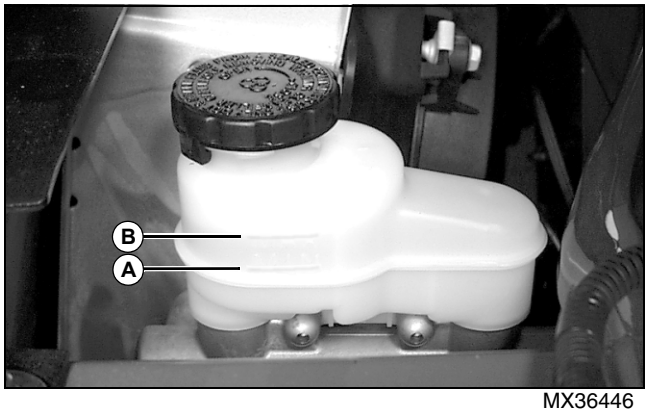
Check Brake Fluid Level

IMPORTANT: Avoid damage! Avoid contamination of the brake fluid. Thoroughly clean area around the filler cap before removing. Do not open the brake fluid reservoir cap unless absolutely necessary.

Use extreme care when filling the reservoir. Fluid spilled on painted surfaces can cause damage.

Use only DOT3 brake fluid from a sealed container.

1. Park machine safely. See Parking Safely in the Safety Section.
2. Open hood.

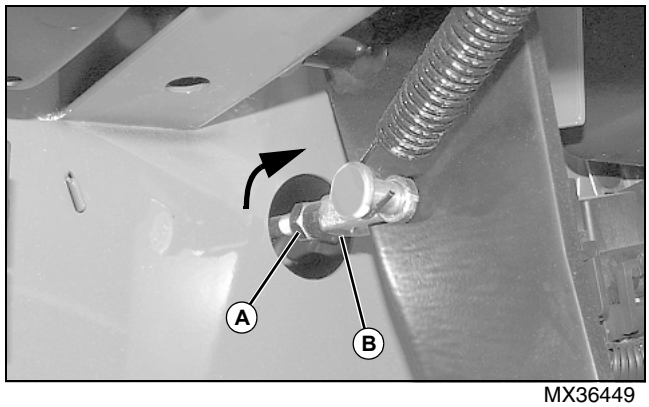


MX36446

3. Visually check fluid level.
   - Fluid levels must be maintained between low (A) and high (B) level marks.
4. If fluid is low, carefully clean area around reservoir cap and remove cap:
   - Add fluid to maintain level within specification.
5. Install reservoir cap.
6. Close hood.

Master Cylinder Rod Adjustment

1. Park machine safely. See Parking Safely in the Safety Section.
2. Raise hood.



MX36449

3. Loosen jam nut (A), in direction shown by arrow.
4. Turn the master cylinder rod in the clevis (B) attached to the brake pedal to adjust brake pedal.
   - Adjustment is correct when the return spring has pulled the back of the brake arm 1 - 2 mm (0.039 - 0.079 in.) from the stop bar, and the master cylinder primary piston is fully destroked and resting against the retaining washer.
5. Tighten the jam nut, and verify brake pedal operation.

Specifications:

Brake Arm to Stop Bar. . . . . 1 - 2 mm (0.39 - 0.079 in.)
Brake Rod Jam Nut . . . . . 20 N•m (15 lb-ft)

Bleeding Brakes

IMPORTANT: Avoid damage! Avoid contamination of the brake fluid. Thoroughly clean area around the filler cap before removing.

Use extreme care when filling the reservoir. Fluid spilled on painted surfaces can cause damage.

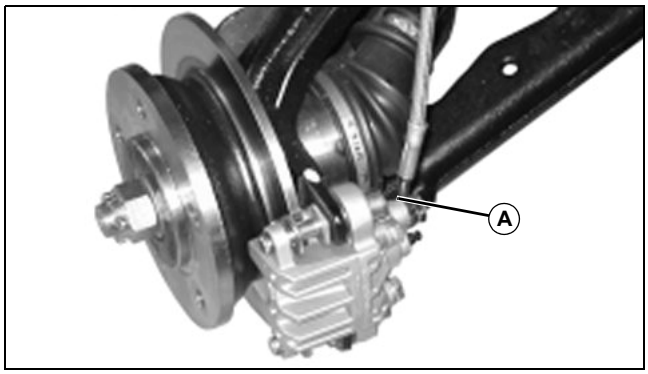
Use only DOT3 brake fluid from a sealed container.

NOTE: The brake hydraulic system must be bled any time a new component is installed, or any time the system has been breached. If only one component has been repaired or replaced it may only be necessary to bleed that component. If bleeding all four wheels, start at the wheel furthest away from the master cylinder and finish at the wheel closest to the master cylinder (right rear, left rear, right front, left front).

1. Park machine safely. See Parking Safely in the Safety Section.

2. Lock park brake.

NOTE: Each caliper has two bleeder screws. Use only top screw.



MX31448

Picture Note: Right front brake shown.

3. Remove the wheel to access the bleeder screw (A).

4. Attach one end of a clear piece of tubing to the bleeder screw. Put the other end into a clear container with approximately 13 mm (1/2 in.) of fresh brake fluid.

5. With the bleeder screw closed, have an assistant slowly pump the brake pedal to build pressure in the system.

6. After several pumps have the assistant stop pumping, but keep pressure on the brake pedal.

7. Open the brake bleeder screw, allowing brake fluid and air to escape.

   - Watch the fluid entering the container through the tube. The fluid should be clear, without any air bubbles.

8. Close the bleeder screw. The assistant can now release the pedal.

9. Check the fluid level in the master cylinder, topping off as required.

10. Repeat as required until the fluid running into the container is clear, and there is no evidence of air or bubbles. The pedal should have a firm feel and should not “sink” toward the floor with constant pressure.

11. Make sure all bleeder screws are closed securely and the master cylinder has the correct amount of brake fluid.

12. Install the wheel(s).

Bleeding Master Cylinder

IMPORTANT: Avoid damage! Avoid contamination of the brake fluid. Thoroughly clean area around the filler cap before removing.

Use extreme care when filling the reservoir. Fluid spilled on painted surfaces can cause damage.

Use only DOT3 brake fluid from a sealed container.

NOTE: The master cylinder must be bled anytime it is replaced or allowed to run completely out of fluid.

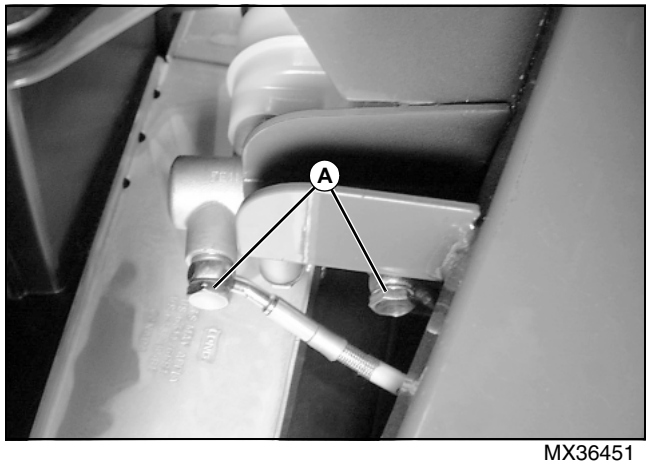
1. Park machine safely. See Parking Safely in the Safety Section.

2. Lock park brake.

3. Remove cap and check the level in the master cylinder. Top off if necessary.

CAUTION: Avoid injury! Wear eye protection when bleeding brakes to avoid eye injury from escaping fluid.

IMPORTANT: Avoid damage! Keep brake fluid from contacting painted surfaces. Clean all brake fluid immediately.



MX36451

Picture Note: View from left front wheel well.

4. Have an assistant depress and keep pressure on brake pedal while loosening brake lines (A). Observe fluid for air bubbles at line connections. Hold brake pedal down and tighten brake lines.

5. Repeat procedure until air or bubbles no longer appear. Tighten to bolts to specification.

6. Top off reservoir as needed during and after procedure.

7. Bleed brake system. See “Bleeding Brakes” on page 552.

Specifications:

Brake Line to Master Cylinder
. . . . . 15 - 24 N•m (10 - 18 lb-ft)

Park Brake Adjustment

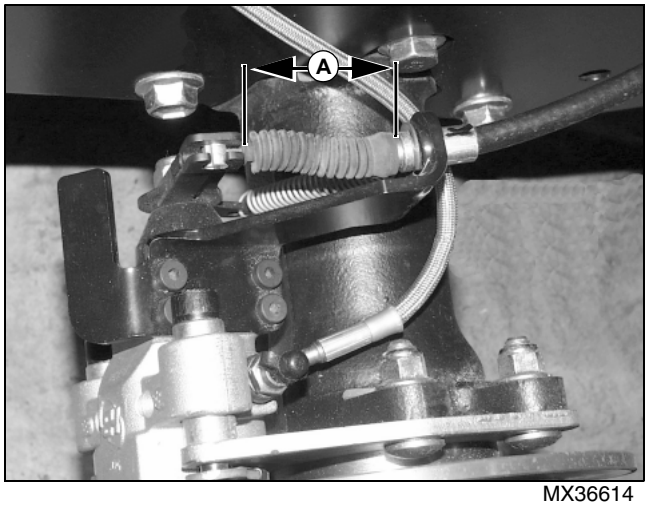
NOTE: The park brake should be adjusted when the hand lever reaches the top of its travel (12 clicks) and will not hold the vehicle in place.

1. Park machine safely. See Parking Safely in the Safety Section.

2. Raise or remove cargo box.

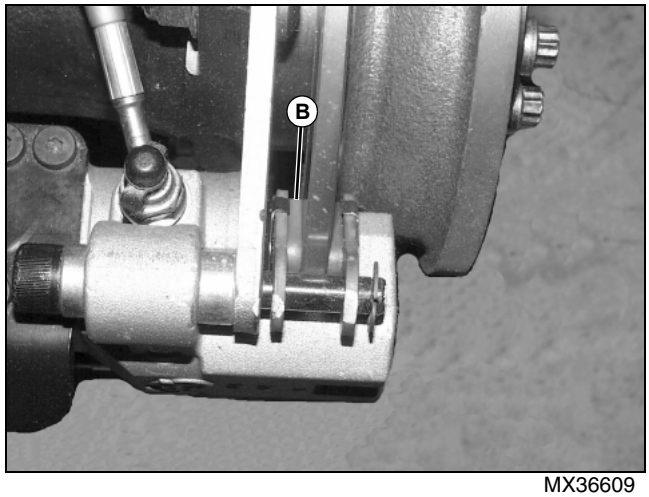
3. Block front wheels to prevent machine from rolling and safely raise rear wheels off surface. Remove wheels.

4. If cables were replaced, cycle the park brake handle from fully locked to fully unlocked several times to stretch and seat cables.



MX36614

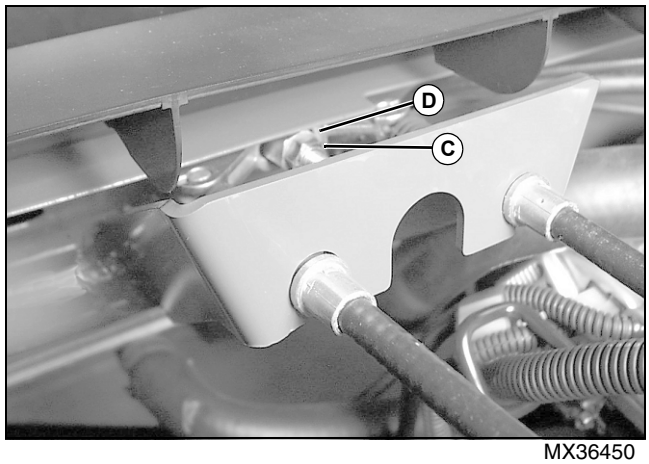
5. Pull the park brake lever all the way up and measure the length of the rubber bellows (A) on the end of each brake cable. If the measurement exceeds 63 mm (2.5 in.) proceed to step 15.



MX36609

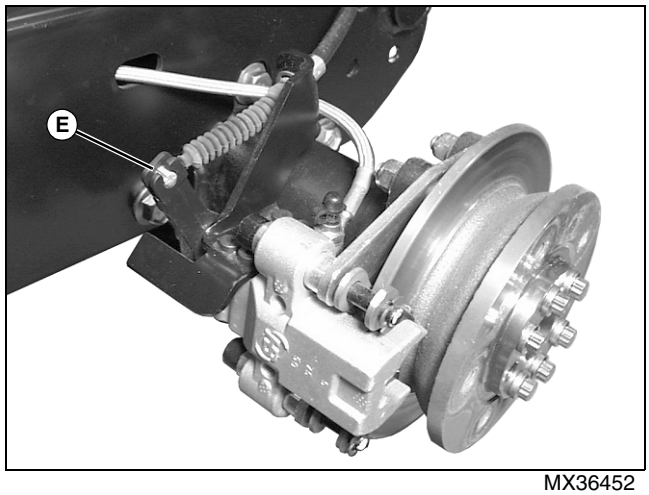
6. If the measurement is less than 63 mm (2.5 in.) check if brake pads are worn out. If friction material (B) on any brake pad is less than 1 mm (0.040 in) thick, replace brake pads. See “Brake Pad Replacement” on page 555 and then check park brake adjustment.

7. Place the park brake lever in the off position.



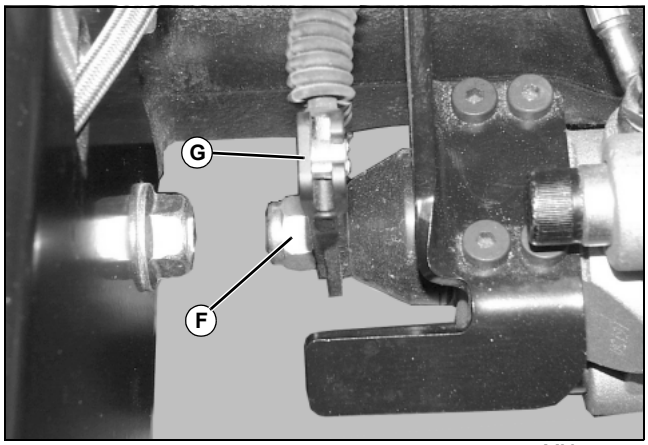
MX36450

8. Loosen jam nut (C). Back off jam nut and adjusting nut (D) 30 mm (1.25 in.).



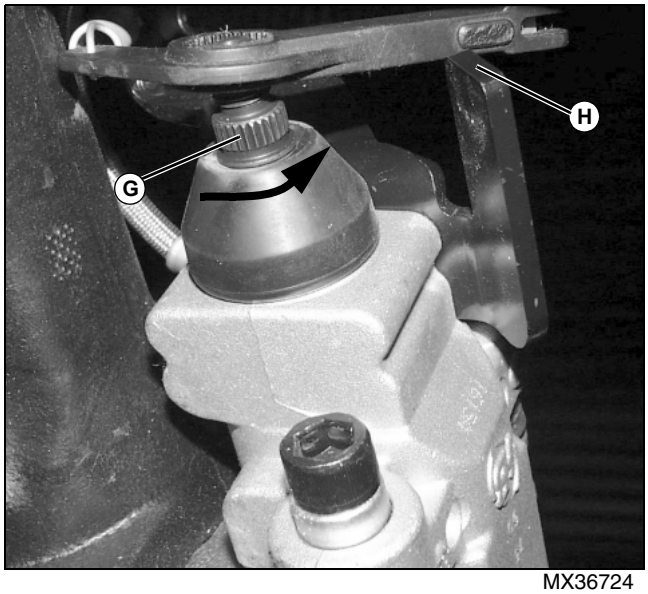
MX36452

9. Pull forward on brake lever (E) to ensure the park brake is fully released.



MX36723

10.Remove the actuator nut (F) and actuator lever (G) from the actuator screw.



MX36724

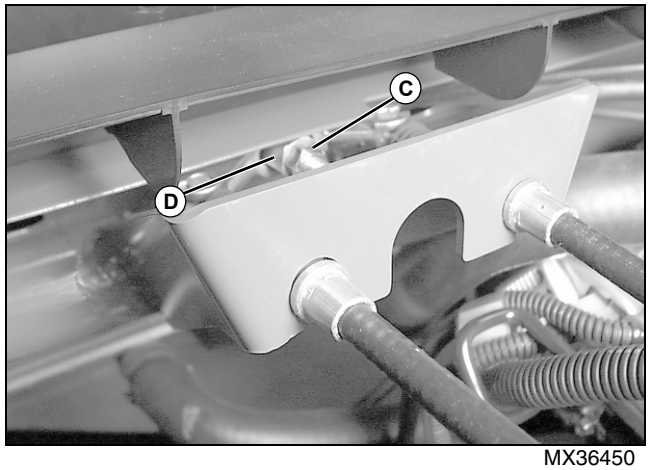
Picture Note: Left side caliper shown

11.On the left side caliper, turn the actuator screw (G) counter clockwise until it is hand tight.

12.Rotate the actuator lever as close to the leverstop (H) as possible and engage it back on the actuator screw splines.

13.Install actuator nut and tighten to specification.

14. Repeat steps 9-13 on right side of machine. On the right side caliper, turn the actuator screw clockwise until it is hand tight.



MX36450

15.Adjust nut (D) until cables are tight; about 5 N•m (4 lb ft).

16.Check the park brake lever movement. It should move 2-4 clicks with a medium pull (about 50 lbs) force on the handle. Move the adjuster nut accordingly.

17. Hold adjuster nut and tighten jam nut (C) to specification.

Specification:

Actuator Lever Nuts . . . . . 46 N•m (34 lb ft)
Jam Nut . . . . . 30 N•m (22 lb-ft)

Repair

Brake Pad Replacement

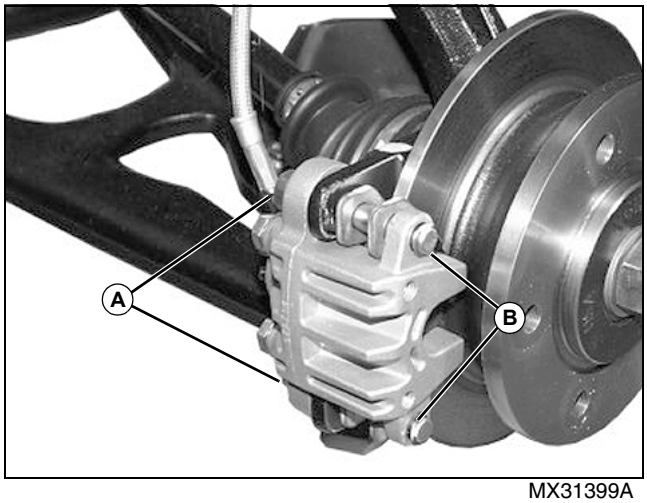
NOTE: Brake pads must be replaced when the brake material thickness is 1mm (0.040 in.) or less.

1. Park machine safely. See Parking Safely in the Safety Section.

2. Lock park brake.

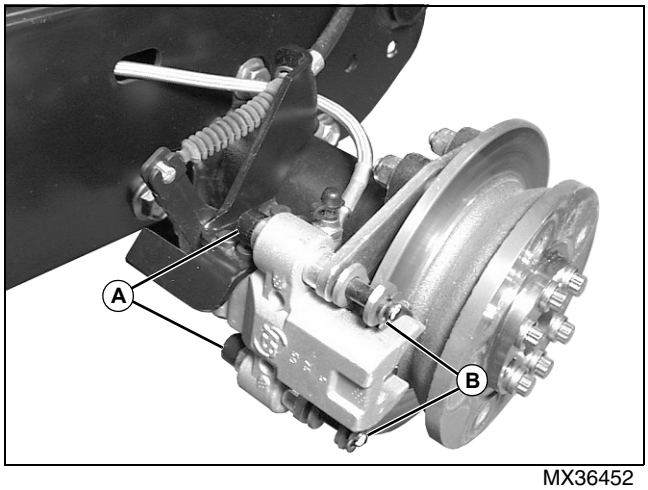
3. Raise machine and support with jack stands.

4. Remove wheels. See “Wheel Removal and Installation” on page 575 in the Miscellaneous section.



MX31399A

Picture Note: Front calipers.



MX36452

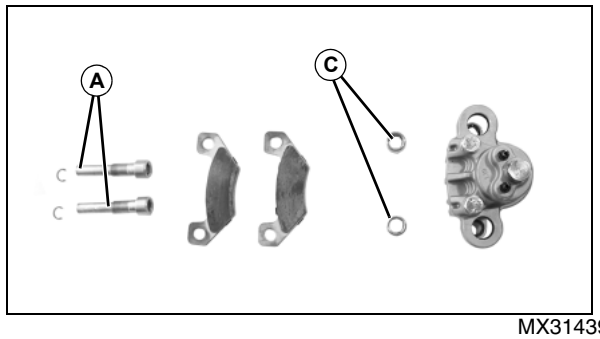
Picture Note: SN 40001- machines rear calipers shown, SN -40000 similar.

5. Remove two C-clips (B) and two sliding pins (A) securing brake caliper.

6. Remove caliper and secure out of the way ensuring the stress is taken off of the brake line.

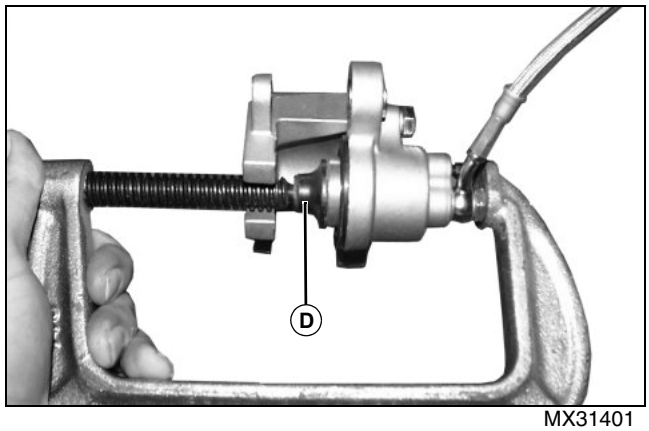
7. Clean all dirt and corrosion off of brake hardware components.

8. Measure the thickness or the brake rotors at the wear area. Minimum thickness is 4.76 mm (0.187 in.). Replace rotors if worn below minimum specification.



MX31439

9. Lubricate brake sliding pins (A) and sleeves (C) with ANTI-SEIZE compound.



MX31401

10.Install brake calipers onto disc. It may be necessary to press caliper piston into it’s bore with a C-clamp (D) to allow clearance for brake pads.

11.Insert new brake pads, friction material sides toward disc.

12.Install sleeves, sliding pins, and C-clips. Tighten sliding pins to specification.

13.Bleed brake lines if necessary. See “Bleeding Brakes” on page 548 for SN -40000 machines and See “Bleeding Brakes” on page 552 for SN 40001- machines.

14.Install wheels.

Specifications:

Caliper Sliding Pins . . . . . 41 - 52 N•m (30 - 38 lb-ft)

Master Cylinder Removal and Installation

IMPORTANT: Avoid damage! Avoid contamination of the brake fluid. Thoroughly clean area around the filler cap before removing. Do not open the brake fluid reservoir cap unless absolutely necessary.

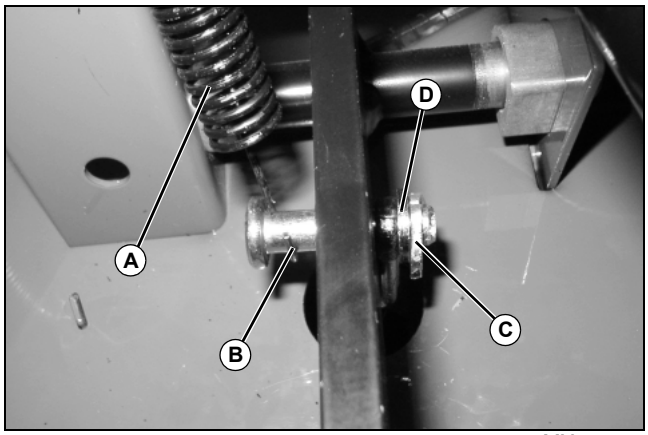
Use extreme care when filling the reservoir. Fluid spilled on painted surfaces can cause damage.

Use only DOT3 brake fluid from a sealed container.

Removal:

1. Park machine safely. See Parking Safely in the Safety Section.

2. Raise hood.

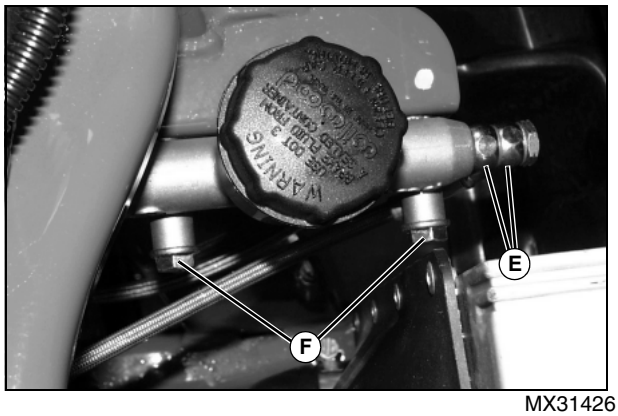


MX31460

Picture Note: Under dash

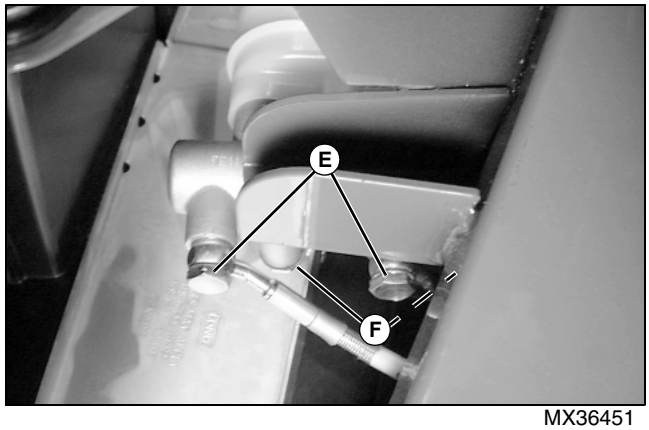
3. Disconnect brake pedal return spring (A) from pivot pin (B).

4. Remove cotter pin (C), clevis pin, and washer (D) from master cylinder rod clevis.



MX31426

Picture Note: SN -40000 view from top.



MX36451

Picture Note: SN 40001- view from bottom.

5. Disconnect brake lines (E) from the master cylinder.

6. Turn the master cylinder rod counter-clockwise to remove it from the brake pedal clevis.

7. Remove cap screws (F) and remove the master cylinder.

Installation:

1. Connect the master cylinder rod clevis to the brake pedal using the clevic pin and washer.

2. Install a new cotter pin in the master cylinder rod clevis pin.

3. Connect the brake pedal return spring to the clevis pin.

NOTE: If installing a new or completely dry master cylinder, perform master cylinder bleeding procedure. See “Bleeding Master Cylinder” on page 548.

4. Install the master cylinder and secure with cap screws (F).

5. Connect brake lines (E) to the master cylinder. Tighten to specification.

6. Adjust the master cylinder rod length. See “Master Cylinder Rod Adjustment” on page 547.

7. Bleed brake system. See “Bleeding Brakes” on page 548 for SN -40000 machines and See “Bleeding Brakes” on page 552 for SN 40001- machines.

Specifications:

Brake Line to Master Cylinder . . . . . 15 - 24 N•m (10 - 18 lb-ft)

Brake Rod Jam Nut . . . . . 20 N•m (15 lb-ft)

Brake Line Removal and Replacement

IMPORTANT: Avoid damage! Avoid contamination of the brake fluid. Thoroughly clean area around the filler cap and brake lines before removing. Do not open the brake fluid reservoir cap unless absolutely necessary.

Use extreme care when filling the reservoir. Fluid spilled on painted surfaces can cause damage.

Use only DOT3 brake fluid from a sealed container.

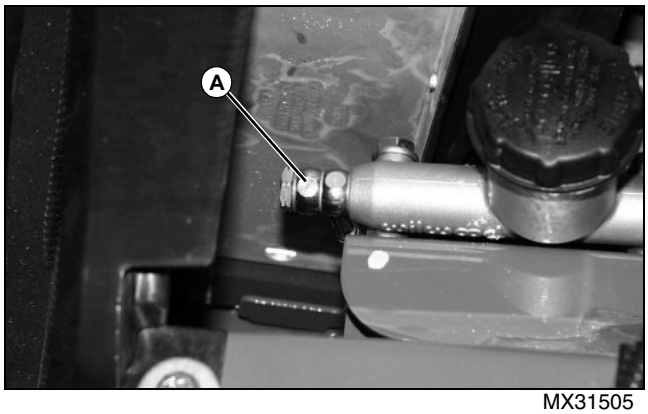
NOTE: Engine removed for clarity in photos.

1. Park machine safely. See Parking Safely in the Safety Section.

2. Lock park brake.

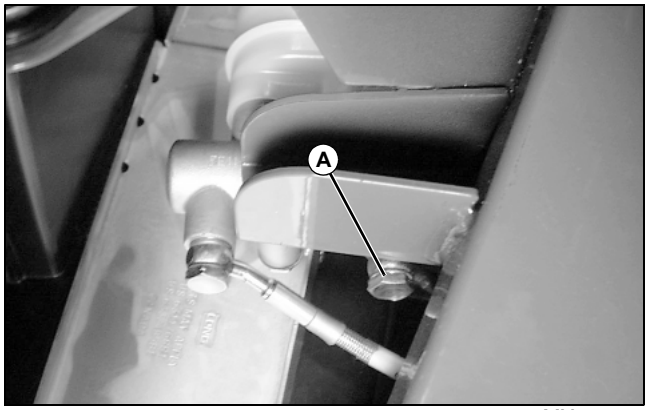
3. Machine may be raised and wheels removed. (Brake line removal and installation procedure shown with wheels removed for clarity.)

Front Brake Line Removal:



MX31505

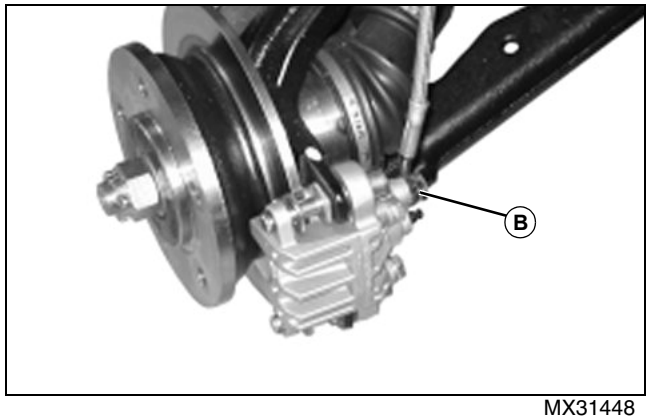
Picture Note: SN -40000 view from top.



MX36451

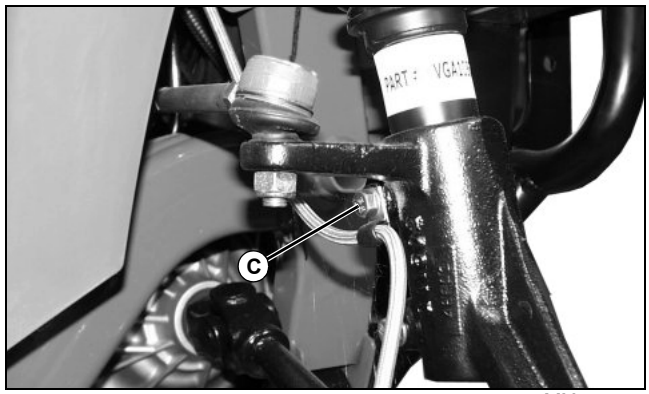
Picture Note: SN 40001- view from bottom.

1. Disconnect front brake line (A) from master cylinder.



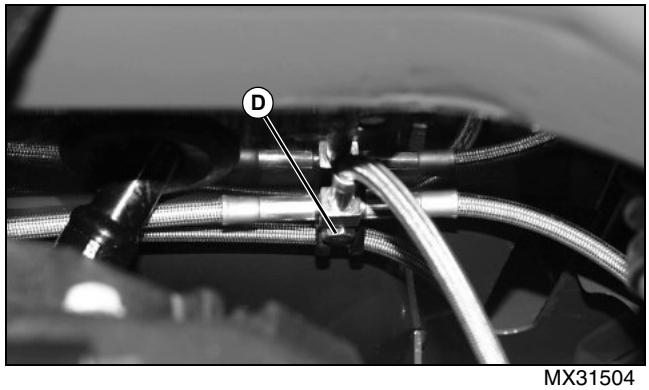
MX31448

2. Disconnect brake line (B) from each front brake caliper.



MX31398

3. Remove bolt (C) securing brake line and retainer to each strut. (One on each side.)

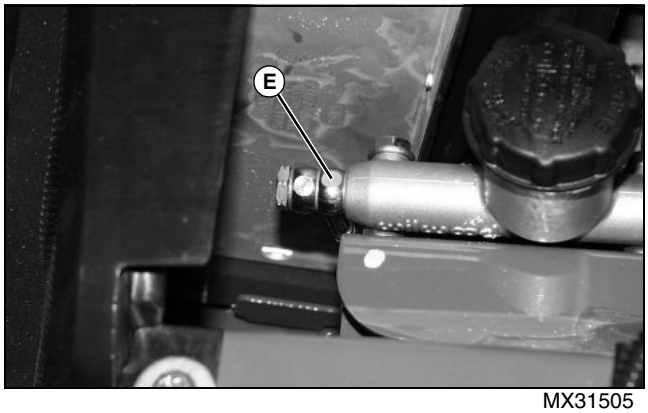


MX31504

4. Remove bolt and nut (D) securing brake line assembly to front firewall.

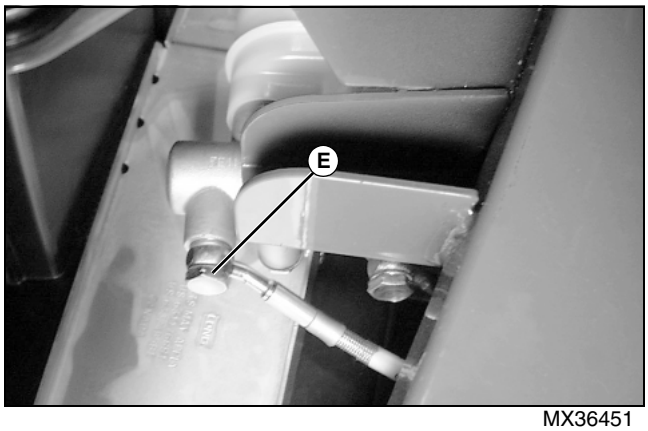
5. Noting routing, remove front brake line assembly from machine.

Rear Brake Line Removal:



MX31505

Picture Note: SN -40000 view from top.



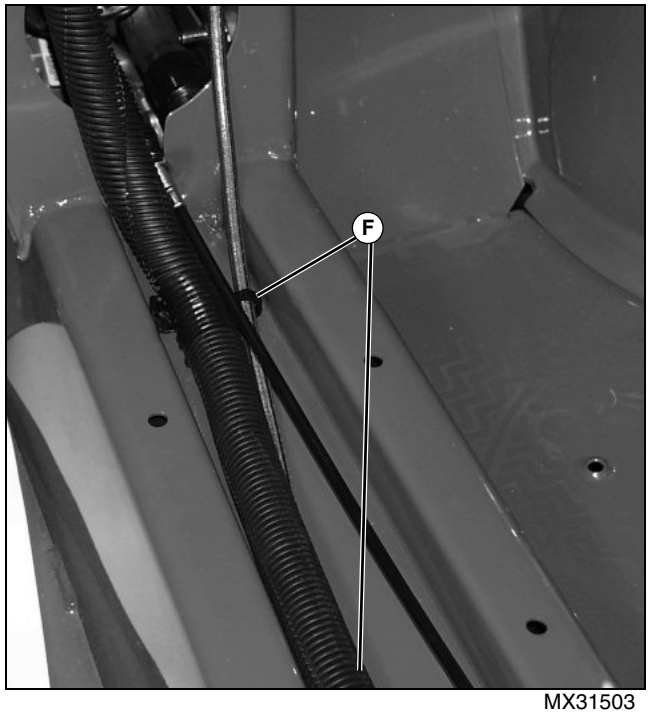
MX36451

Picture Note: SN 40001- view from bottom.

1. Disconnect rear brake line (E) from master cylinder.

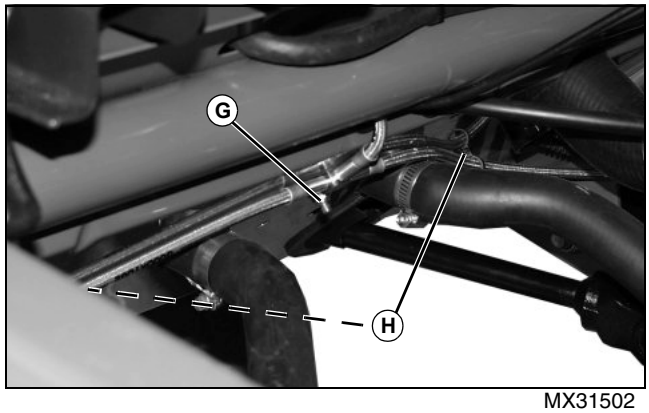
2. Remove center console. See “Center Console Removal and Installation” on page 580 in the Miscellaneous section.

3. Remove transaxle control lever housing. See “Transaxle Control Lever Housing Removal and Installation” on page 581 in the Miscellaneous section.



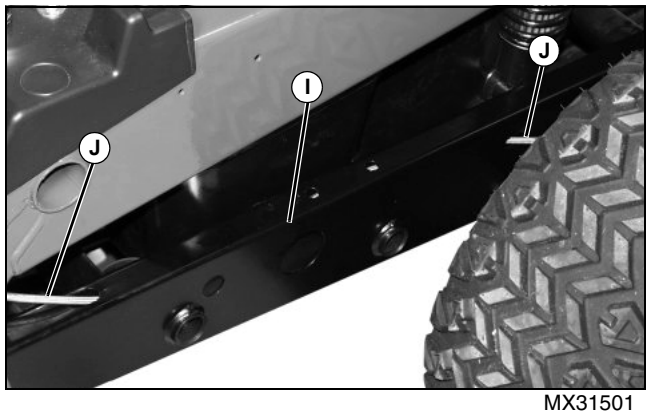
MX31503

4. Remove plastic straps (F) securing brake line to frame tunnel.



MX31502

5. Remove bolt and nut (G) securing rear brake line to rear firewall. Remove plastic straps (H) securing brake lines to frame.



MX31501

6. Remove plastic straps (I) securing brake lines to subframe. (One an each side.)

7. Disconnect brake lines from each rear brake caliper.

8. Remove rear brake line assembly, noting routing through frame and subframe (J).

Front and Rear Brake Line Installation:

- Installation is in the reverse of removal.
- Ensure that brake lines are routed correctly. Rear brake line must be routed through the rear firewall towards the front of machine first.
- Ensure that plastic straps are installed in correct locations.
- Insure that all crush washers are installed onto brake line banjo bolts.
- Bleed master cylinder if necessary. See “Bleeding Master Cylinder” on page 548.
- Bleed brake system. See “Bleeding Brakes” on page 548 for SN -40000 machines and See “Bleeding Brakes” on page 552 for SN 40001- machines.

Specifications:

Brake Line to Master Cylinder . . . . . 15 - 24 N•m (10 - 18 ft-lb)
Brake Line to Caliper . . . . . 15 - 24 N•m (10 - 18 ft-lb)
Brake Line 3-Way Valve to Firewall . . . . . 10.4 N•m (92 lb-in.)

Brake Caliper Removal and Installation

IMPORTANT: Avoid damage! Avoid contamination of the brake fluid. Thoroughly clean area around the filler cap and brake lines before removing. Do not open the brake fluid reservoir cap unless absolutely necessary.

Use extreme care when filling the reservoir. Fluid spilled on painted surfaces can cause damage.

Use only DOT3 brake fluid from a sealed container.

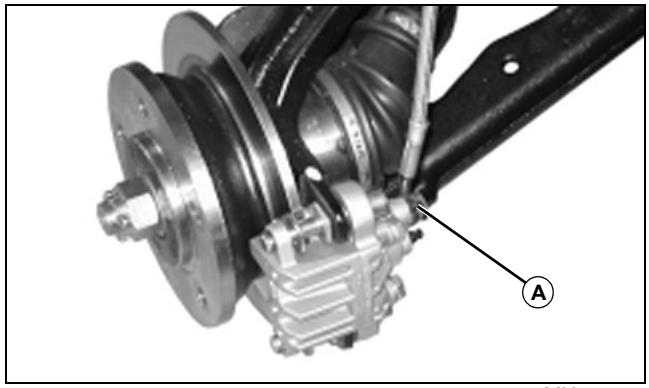
Removal:

NOTE: Front and rear calipers removal and installation is the same. Front caliper removal shown.

1. Park machine safely. See Parking Safely in the Safety Section.

2. Lock park brake.

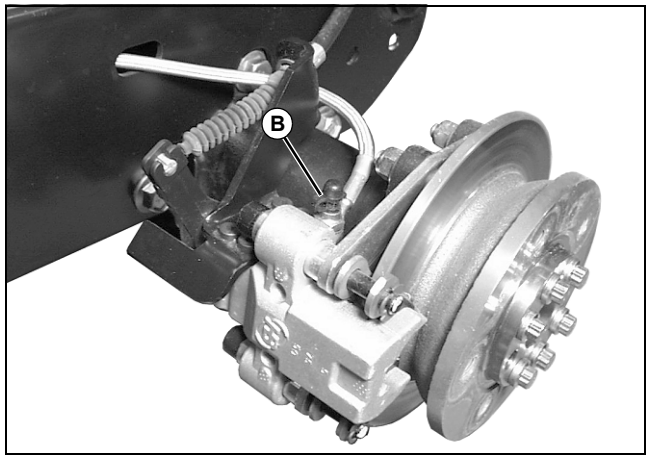
3. Remove wheels. See “Wheel Removal and Installation” on page 575 in the Miscellaneous section.



MX31448

Picture Note: Front caliper.

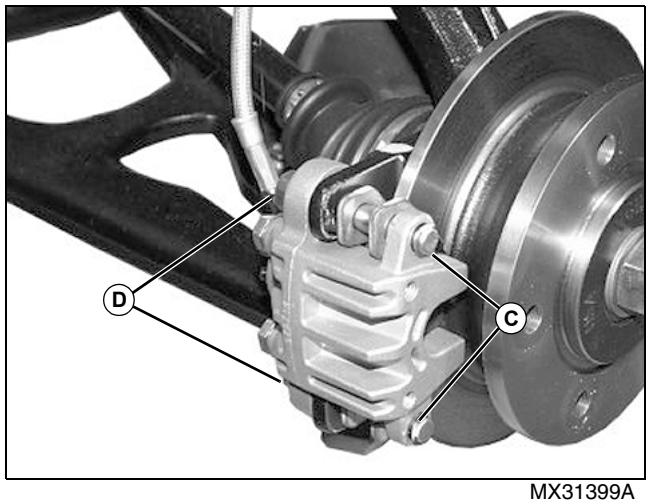
4. Remove banjo bolt (A), and crush washers securing brake line to front caliper.



MX36452

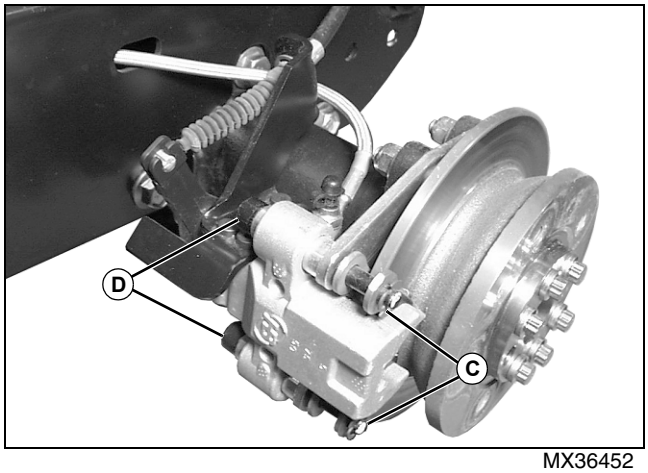
Picture Note: SN 40001- machines rear calipers shown, SN -40000 similar.

5. Remove bleed valve/brake line (B) from rear caliper.



MX31399A

Picture Note: Front calipers.



MX36452

Picture Note: SN 40001- machines rear calipers shown, SN -40000 similar.

6. Remove two C-clips (C) and two sliding pins (D) securing brake caliper.

7. Remove caliper and secure out of the way ensuring the stress is taken off of the brake line.

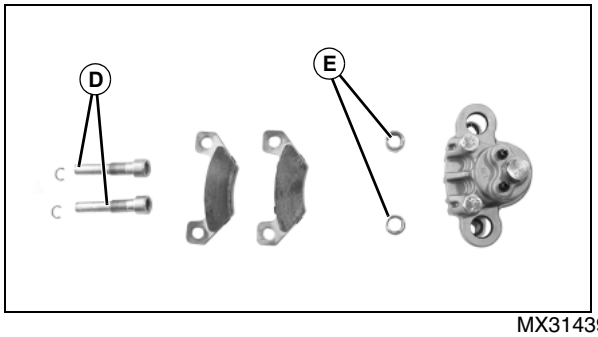
8. Remove brake pads from calipers.

9. Clean all dirt and corrosion off of brake hardware components.

10. Remove caliper from machine.

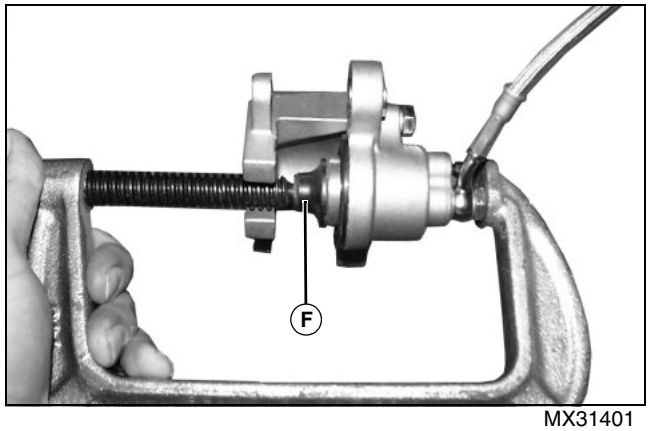
Installation:

1. Installation is in the reverse of removal.



MX31439

2. Lubricate brake sliding pins (D) and sleeves (E) with ANTI-SEIZE compound.



MX31401

3. Install brake calipers onto disc. It may be necessary to press caliper piston into it's bore with a C-clamp (F) to allow clearance for brake pads.

4. Insert new brake pads, friction material sides toward disc.

5. Install sleeves, sliding pins, and C-clips. Tighten sliding pins to specification.

6. Ensure that all crush washers are installed in their correct locations. Tighten banjo bolt to specification.

7. Bleed brake system. See "Bleeding Brakes" on page 548 for SN -40000 machines and See "Bleeding Brakes" on page 552 for SN 40001- machines.

8. Install wheels.

Specifications:

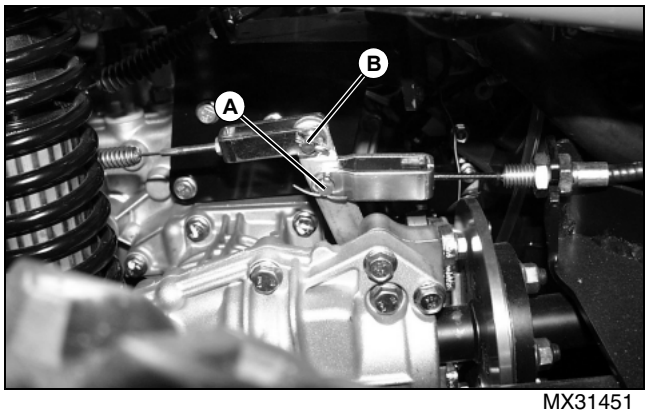
Caliper Banjo Bolt . . . . . 15 - 24 N•m (10 - 18 lb-ft)
Caliper Sliding Pins . . . . . 41 - 52 N•m (30 - 38 lb-ft)

MFWD Park Brake Pad Replacement (SN -40000)

NOTE: Engine removed for clarity in photos.

1. Park machine safely. See Parking Safely in the Safety Section.

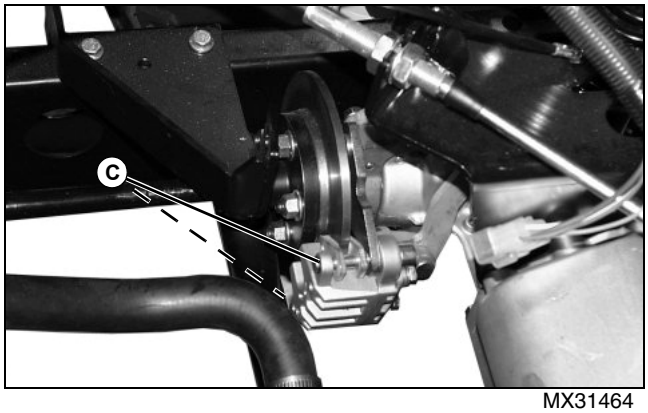
2. Block wheels and leave park brake off.



MX31451

3. Remove cotter pin from park brake actuator clevis pin (B). Remove pin.

4. Remove cotter pin from park brake adjuster clevis pin (A). Remove pin.



MX31464

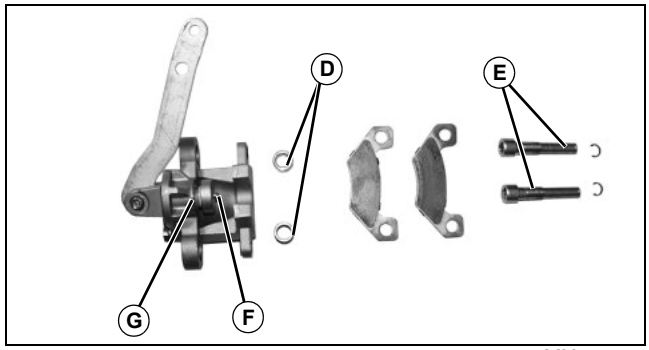
Picture Note: Engine removed for clarity

5. Remove C-clips (C) from park brake caliper sliding pins.

6. Remove sliding pins.

7. Remove caliper from machine.

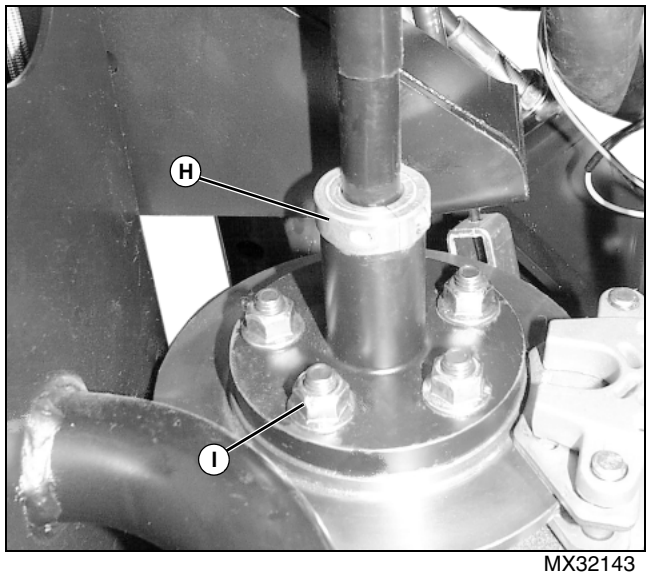
8. Clean all dirt and corrosion off of brake hardware components.



MX31468

9. Lubricate brake sliding pins (E) and sleeves (D) with ANTI-SEIZE compound.

10. Lubricate caliper piston shaft (G) with lithium grease.



MX32143

Picture Note: Shown from bottom

11. Loosen collar (H) screws and slide collar forward on drive shaft.

12. Loosen five retaining nuts (I) on disc to allow disc to slide back and forth on drive shaft collar.

13. Install caliper onto disc.

14. Insert new brake pads, friction material sides toward disc. Ensure that nipple (F) on caliper fits into hole on back of brake pad.

15. Install sleeves, sliding pins, and C-clips. Tighten sliding pins to specification.

16. Tighten five disc retaining nuts to specification.

IMPORTANT: Avoid damage! If using a soft mallet to seat disc and drive shaft collar assembly, only strike drive shaft collar. Do not strike brake disc.

17. Ensure disc and drive shaft collar assembly are fully seated over O-ring on transaxle output shaft.

18.Slide collar (H) against disc and drive shaft collar assembly and tighten collar screws.

19.Install clevis pin and new cotter pin into park brake adjuster clevis.

20.Install clevis pin and new cotter pin into park brake actuator clevis.

21.Adjust park brake. See “2-Wheel Drive Park Brake Adjustment” on page 549.

Specifications:

Caliper Sliding Pins . . . . . 41 - 52 N•m (30 - 38 lb-ft)
Brake Disc to Drive Shaft Collar Nuts
. . . . . 73 ± 15 N•m (54 ± 11 lb-ft)

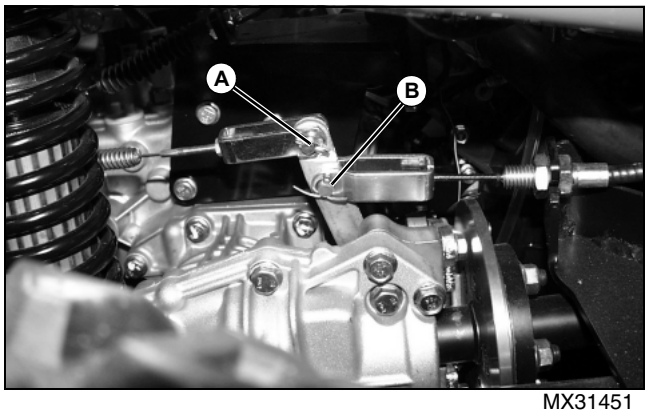
MFWD Park Brake Disc Removal and Installation (SN -40000)

NOTE: Engine removed for clarity in photos.

Removal:

1. Park machine safely. See Parking Safely in the Safety Section.

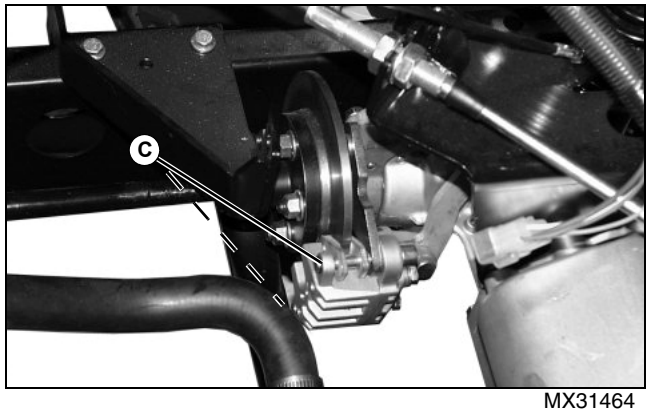
2. Block wheels and unlock park brake.



MX31451

3. Remove cotter pin from park brake actuator pivot pin (B).

4. Remove cotter pin from park brake adjuster pivot pin (A).

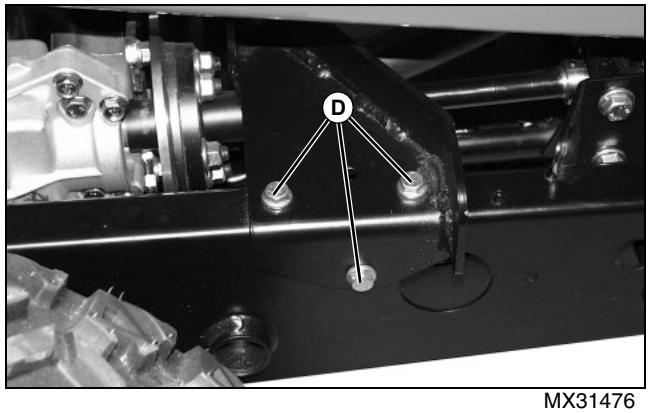


MX31464

5. Remove C-clips (C) from park brake caliper sliding pins.

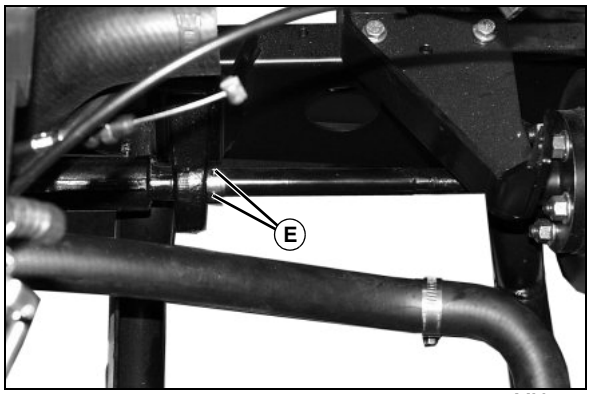
6. Remove sliding pins.

7. Remove caliper from machine.



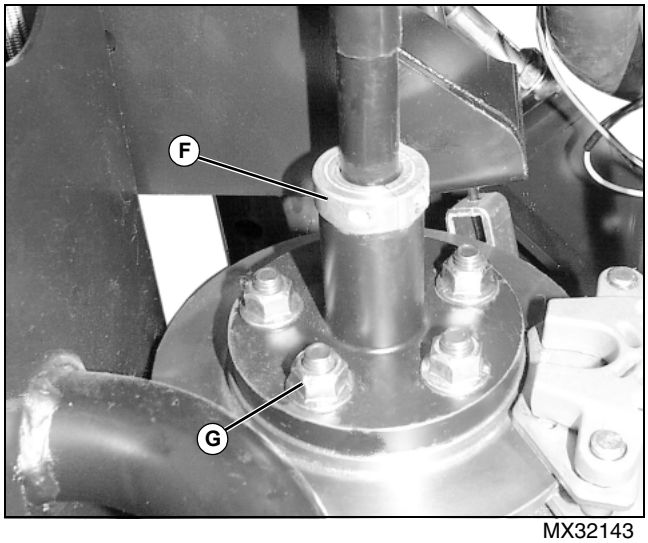
MX31476

8. Remove three bolts (D) securing park brake cable bracket.



MX31481

9. Loosen two set screws (E) on drive shaft near yolk.

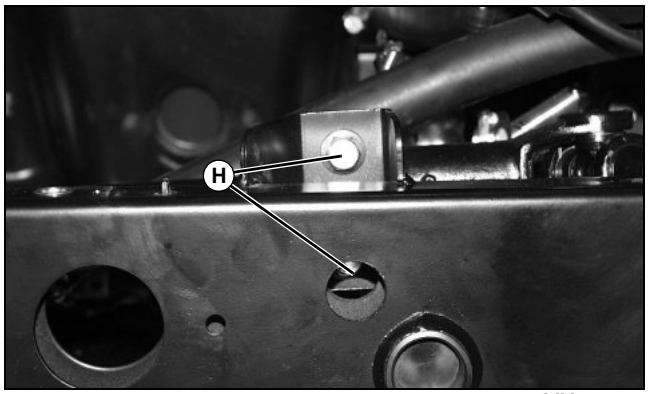


MX32143

Picture Note: Shown from bottom

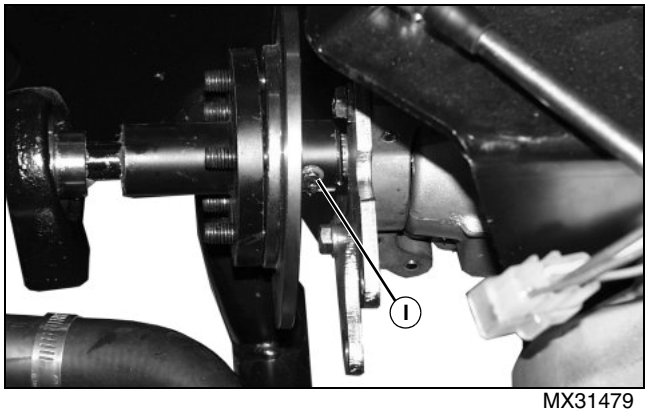
10.Loosen set screws and slide collar (F) forward on drive shaft.

11.Remove five nuts (G) securing drive shaft collar to park brake disc.



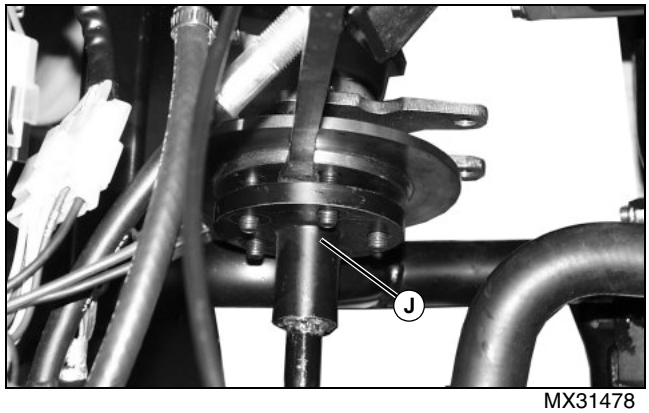
MX31477

12.Remove two bolts (H) securing drive shaft cast bearing to frame.



MX31479

13.Remove zerk fitting (I) from drive shaft collar.



MX31478

14.Using a prybar, carefully separate drive shaft collar (J) from brake disc.

15.Remove brake disc from machine by sliding drive shaft forward.

Installation:

- Installation is in the reverse of removal. See “MFWD Park Brake Pad Replacement (SN -40000)” on page 561.
- Ensure that spacer and O-ring behind disc (on transaxle output shaft) are in place.
- Ensure disc and drive shaft collar assembly are fully seated over O-ring on transaxle output shaft.
- Slide locking collar against disc and drive shaft collar assembly and tighten collar screws.
- Apply one or two pumps of grease to zerk fitting on drive shaft collar.

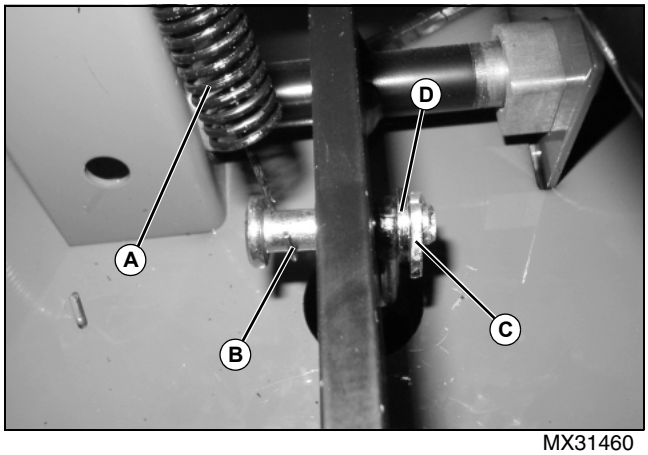
Specifications:

Caliper Sliding Pins . . . . . 41 - 52 N•m (30 - 38 lb-ft)

Brake Disc to Drive Shaft Collar Nuts . . . . . 73 ± 15 N•m (54 ± 11 lb-ft)

Brake Pedal Removal and Installation

1. Park machine safely. See Parking Safely in the Safety Section.

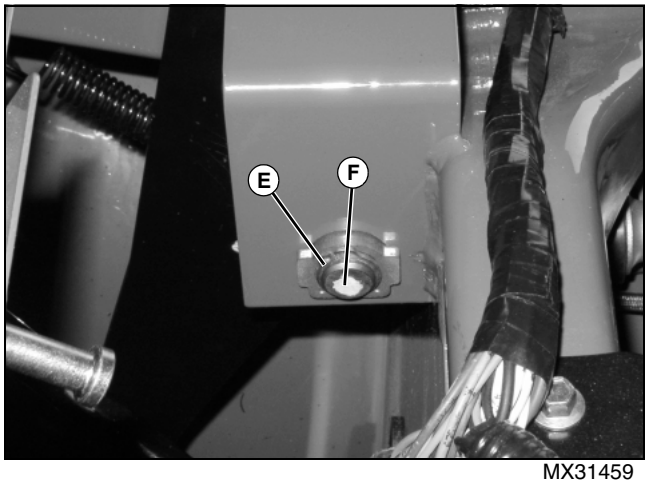


MX31460

Picture Note: Under dash

2. Disconnect brake pedal return spring (A) from pivot pin (B).

3. Remove cotter pin (C), clevis pin, and washer (D) from master cylinder rod clevis.



MX31459

4. Remove outside snap rings (E) on brake pedal pivot shaft (one on each side).

5. Remove bushings (F) from brake pedal pivot shaft (one on each side).

6. Remove brake pedal from machine.

Installation:

- Installation is in the reverse of removal.
- Install a new cotter pin in the master cylinder rod clevis pin.
- Adjust master cylinder rod. See “Master Cylinder Rod Adjustment” on page 547.

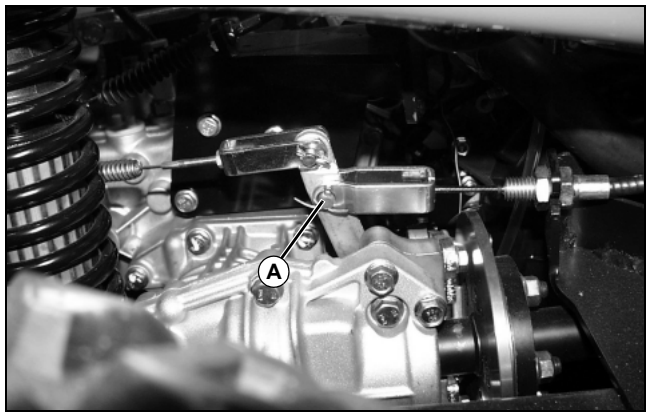
MFWD Park Brake Cable Removal and Installation (SN -40000)

1. Park machine safely. See Parking Safely in the Safety Section.

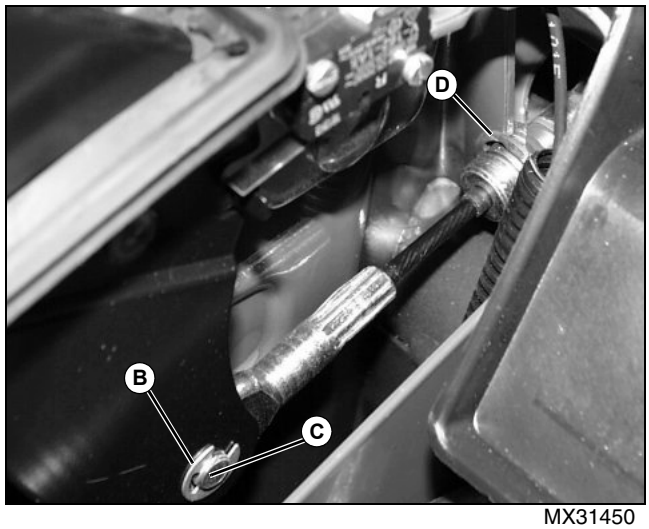
2. Block wheels to prevent machine from rolling.

3. Unlock park brake.

4. Remove transaxle control lever housing. See “Transaxle Control Lever Housing Removal and Installation” on page 581 in the Miscellaneous section.



5. Remove cotter pin and clevis pin (A) at park brake caliper lever clevis.

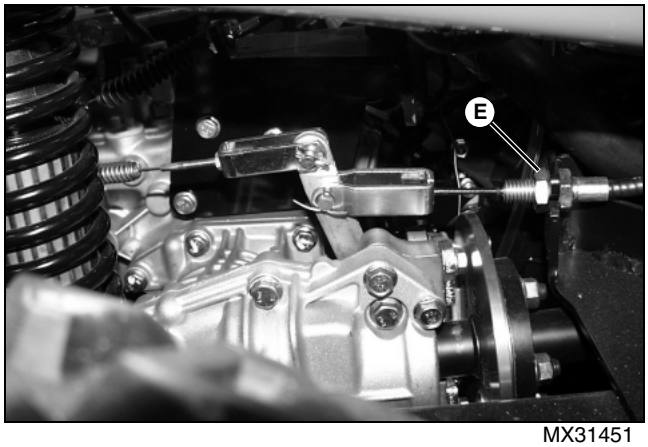


MX31450

6. Remove C-clip (B) at park brake lever.

7. Lift park brake lever up and remove pivot pin (B).

8. Remove C-clip (D) at front cable bracket.



MX31451

9. Completely unscrew park brake jam nut (E).

10. Slide park brake cable out of front and rear brackets.

11. Remove cable from machine.

Installation:

1. Route cable through front and rear brackets.

2. Install C-clip at front frame bracket.

3. Install cable, pivot pin, and C-clip at park brake lever.

4. Fully lower park brake lever.

5. Install clevis pin and new cotter pin at park brake caliper lever clevis.

6. Install jam nut finger tight.

7. Adjust park brake. See “2-Wheel Drive Park Brake Adjustment” on page 549.

8. Install transaxle control lever cover. See “Transaxle Control Lever Housing Removal and Installation” on page 581 in the Miscellaneous section.

Specifications:

Cable Adjust Jam Nut . . . . . 54 - 61 N•m (40 - 45 lb-ft)

Park Brake Cable Removal and Installation (SN 40001-)

Removal:

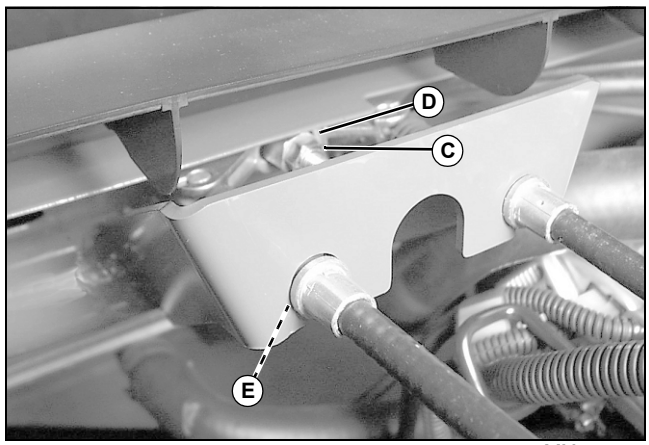
1. Park machine safely. See Parking Safely in the Safety Section.

2. Raise and lock or remove cargo box.

3. Block wheels to prevent machine from rolling.

4. Block front wheels to prevent machine from rolling and safely raise rear wheels off surface. Remove wheels.

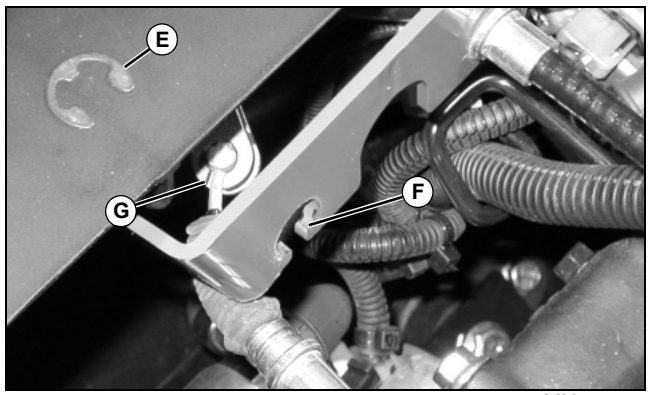
5. Unlock park brake.



MX36450

6. Loosen jam nut (C). Back off jam nut and adjusting nut (D) 30 mm (1.25 in.).

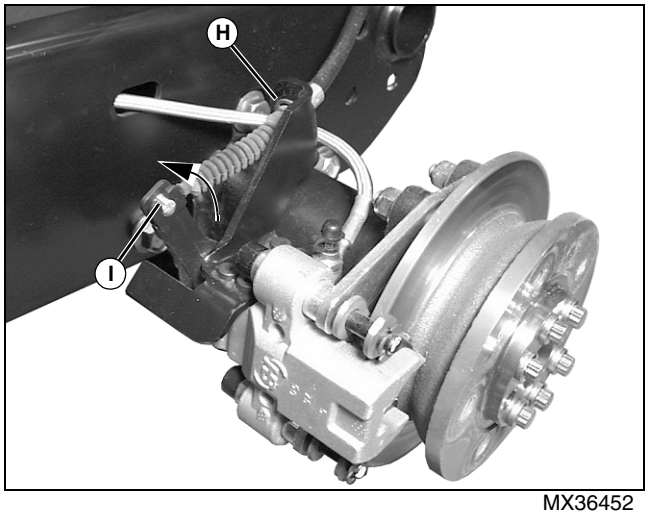
7. Remove C-clip (E) at the back side of the mounting bracket.



MX36658

8. Pull the cable sheath rearward to remove from mounting bracket slot (F).

9. Pivot the cable outward to disconnect the cable from the equalizer slot (G).



MX36452

10.Remove C-clip (H) at axle mounting bracket.

11.Pull the cable sheath rearward to remove from mounting bracket.

12.Pivot the cable outward to disconnect the cable from the actuator lever slot (I).

13.Route the cable through the cable ties used at the rear frame cross member, or cut the cable ties and replace with new during installation. Remove the cables from machine.

Installation:

1. Installation is in the reverse of removal.

2. Adjust park brake. See “Park Brake Adjustment” on page 553.

Specifications:

Cable Adjust Jam Nut . . . . . 54 - 61 N•m (40 - 45 lb-ft)

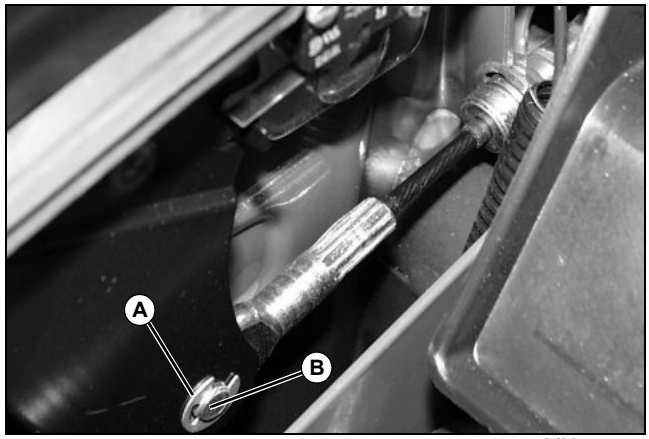
Park Brake Lever Removal and Installation

1. Park machine safely. See Parking Safely in the Safety Section.

2. Block wheels to prevent machine from rolling.

3. Unlock park brake.

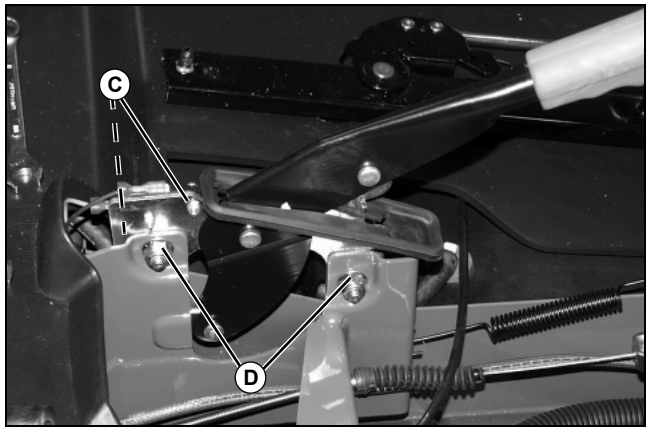
4. Remove transaxle control lever housing. See “Transaxle Control Lever Housing Removal and Installation” on page 581 in the Miscellaneous section.



MX31450

5. Remove C-clip (A) at park brake lever.

6. Lift park brake lever up and remove pivot pin (B).



MX31453

7. Remove park brake switch screws (C). Remove switch.

8. Remove two bolts and nuts (D) securing park brake lever to frame.

9. Remove park brake lever from machine.

Installation:

- Installation is in the reverse of removal.
- Park brake may have to be adjusted. See “2-Wheel Drive Park Brake Adjustment” on page 549.

Specifications:

Park Brake Handle Bolts . . . . . 37 ± 7 N•m (27 ± 5 lb-ft)

Table of Contents

MISCELLANEOUS TABLE OF CONTENTS

MISCELLANEOUS SPECIFICATIONS

Specifications

General Specifications

Fluid Capacities

Fuel Tank	20.0 L (5.3 gal)
Crankcase (with filter)	1.3 L (1.37 qt)
Transaxle (4X2)	4.0 L (4.25 qt)
Transaxle (4X4)	4.5 L (4.8 qt)
MFWD Transaxle (4X4 Only)	0.9 L (0.95 qt)
Cooling system (Including Reservoir)	5.0 L (5.3 qt)

Dimensions

Width (overall)	1.52 m (59.8 in.)
Length (without bumper)	2.67 m (105.0 in.)
Length (with bumper)	2.69 m (106.0 in.)
Height (overall)	1.11 m (43.6 in.)
Weight HPX (includes fuel/fluids)	476 kg (1050 lb)
Weight HPX 4x4 (includes fuel/fluids)	476 kg (1050 lb)
Weight Trail HPX 4x4 (includes fuel/fluids)	476 kg (1050 lb)
Ground Clearance (under transaxle)	17.0 cm (6.7 in.)
Cargo Box Capacity	409 kg (900 lb)
Towing Capacity	590 kg (1300 lb)

Tires

Knobby, Bar-Type, and Turf

Front	22.5 x 10.00-8
Rear	25 x 12.00-9

Heavy Duty All Purpose

Front	22.5 x 10.00-8
Rear	25 x 13.00-9

Inflation Pressure

Front	41 - 47 kPa (6 - 7 psi)
Rear	90 - 97 kPa (13 - 14 psi)

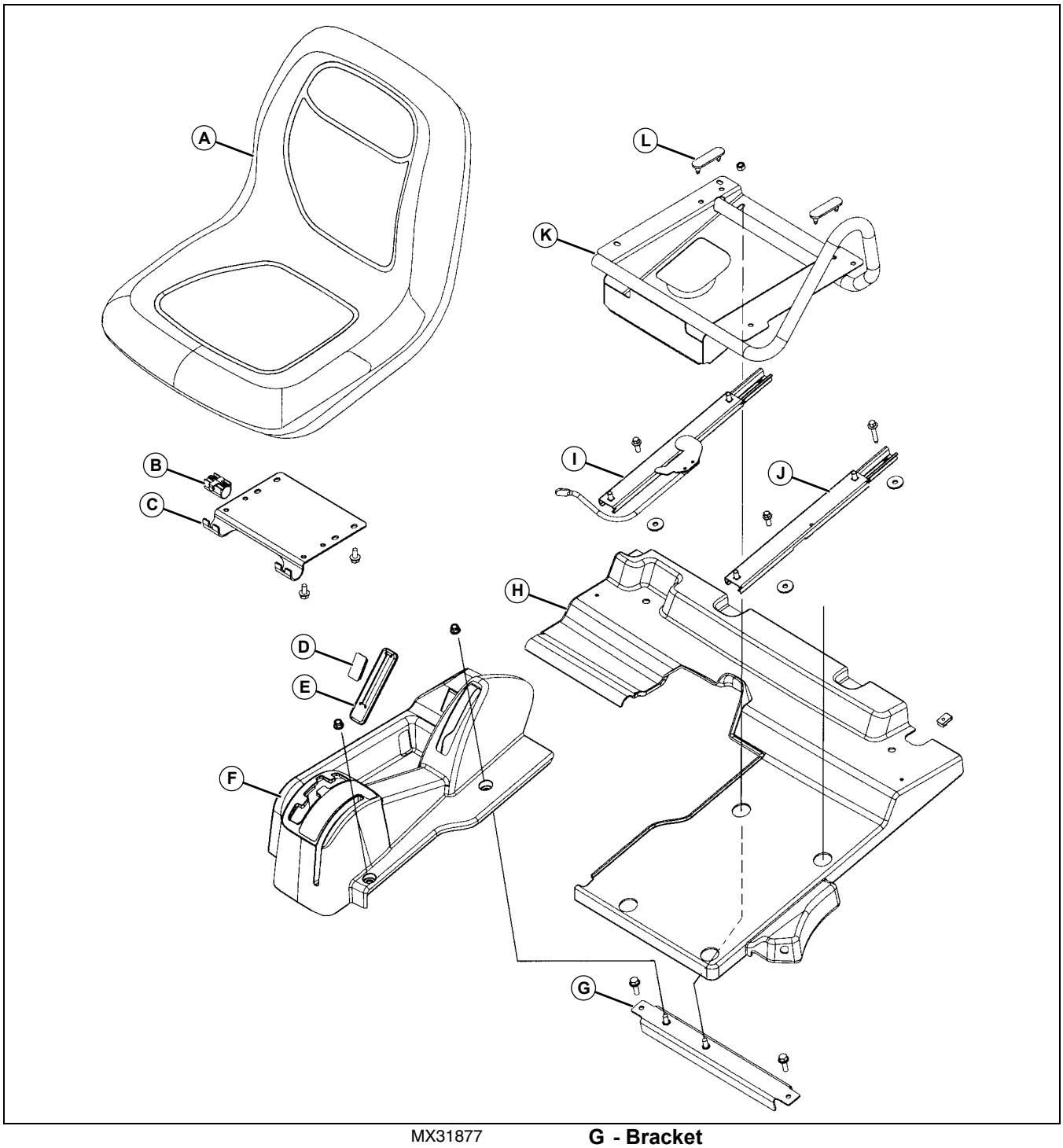
Torque Specifications

Wheel Hub to Halfshaft	102 N•m (75 lb-ft)
Front and Rear Wheels	81 N•m (60 lb-ft)
Lower Swing Arm Frame Pivot Bolts[1]	167 N•m (125 lb-ft)
Seat Bracket to Seat	10 N•m (88 lb-in.)
Wheel Bolt Torque	81 N•m (60 lb-ft)

1. Overtorque can damage bushing and create loss of flexibility in swing arm.

Component Location

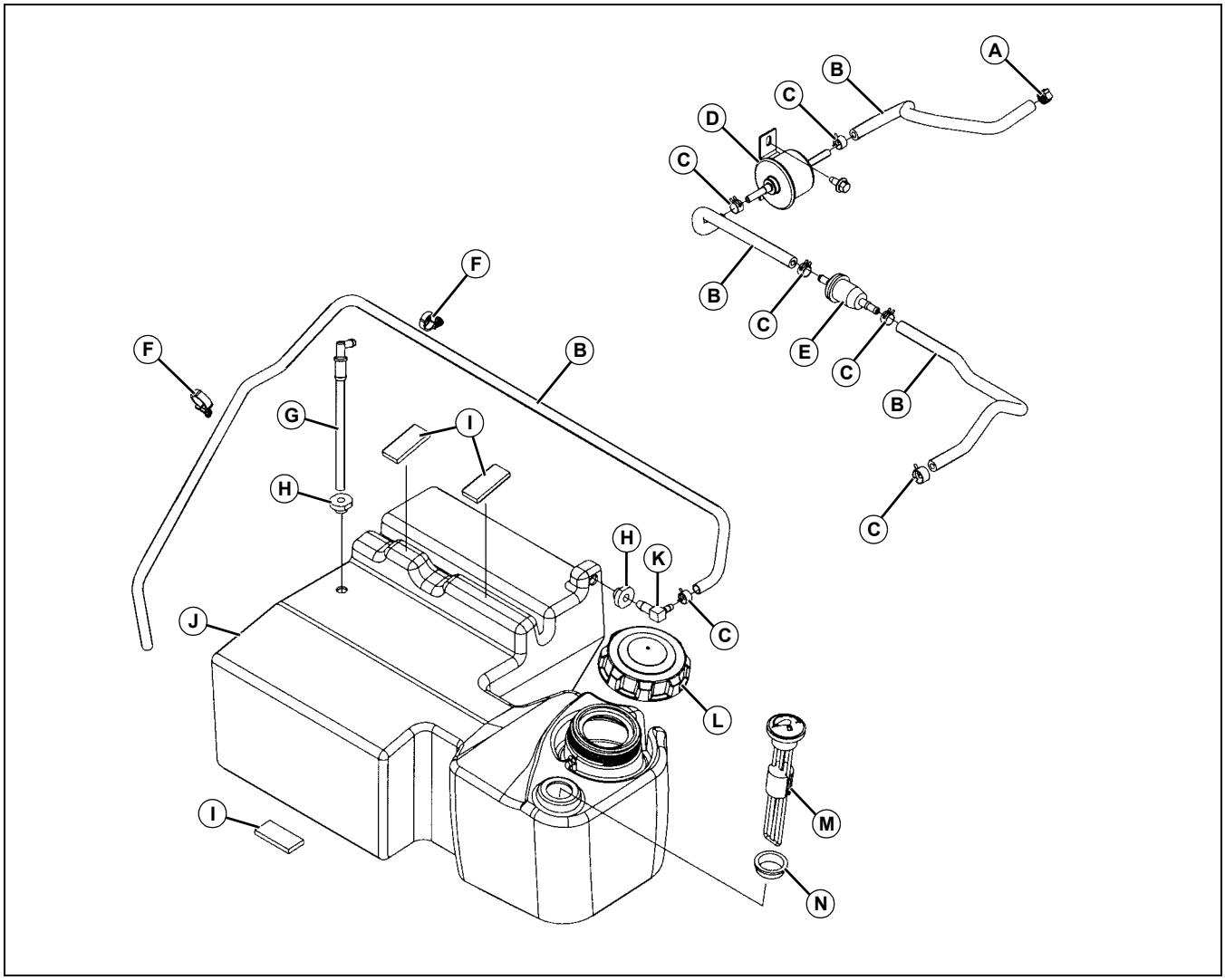
Seat and Seat Support Components



MX31877

A - Seat (2 used)
B - Bushing (4 used)
C - Bracket (2 used)
D - Plug
E - Boot
F - Console
G - Bracket
H - Cover
I - Seat Adjuster with Latch
J - Seat Rail
K - Seat Base
L - Bumper (4 used)

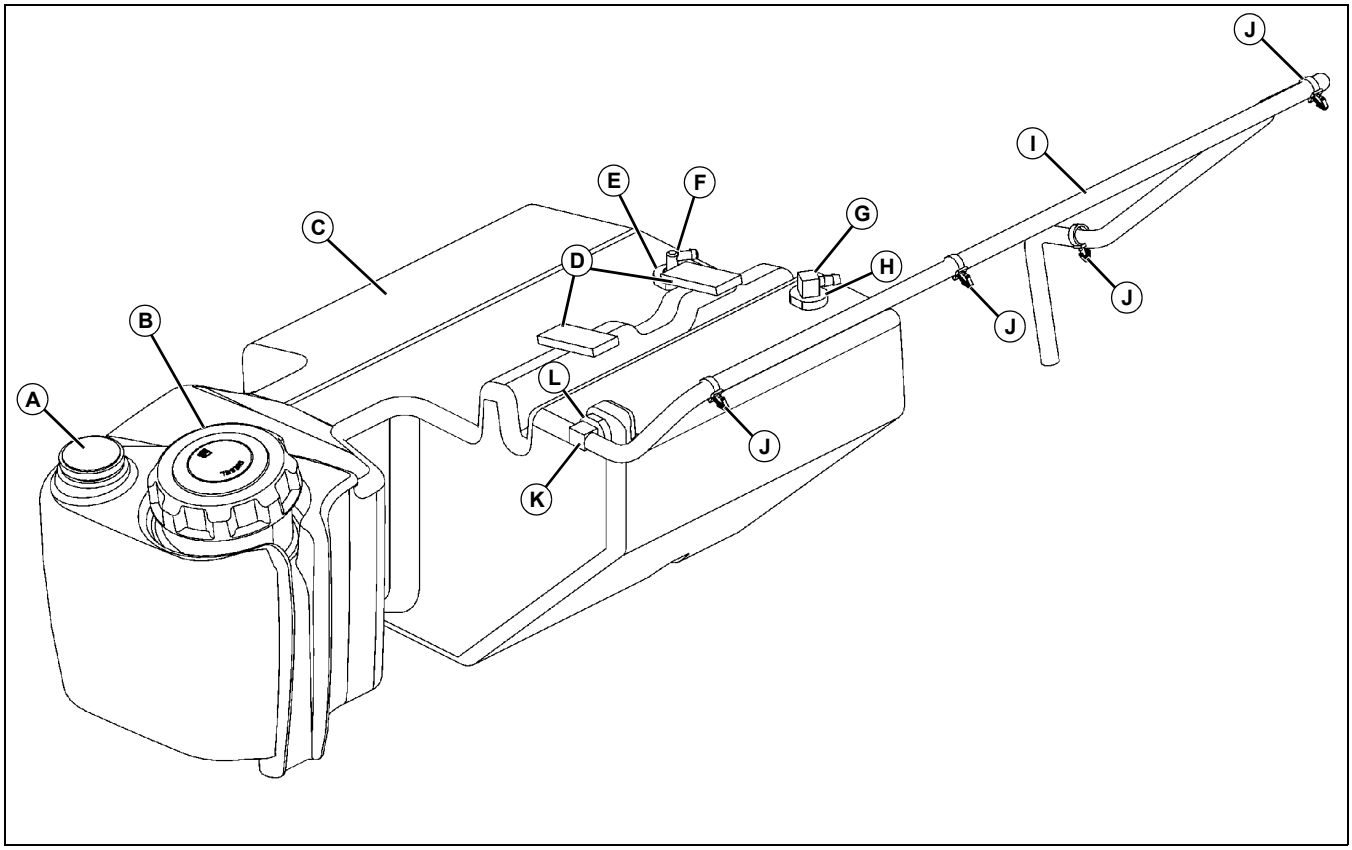
Fuel System Components - Gas



MX31875

A - Clamp
B - Hose (TY22551)
C - Clip
D - Fuel Pump
E - Fuel Filter
F - Retainer
G - Pick Up Tube
H - Bushing
I - Pad
J - Fuel Tank
K - Elbow Fitting
L - Filler Cap
M - Fuel Gauge
N - Bushing

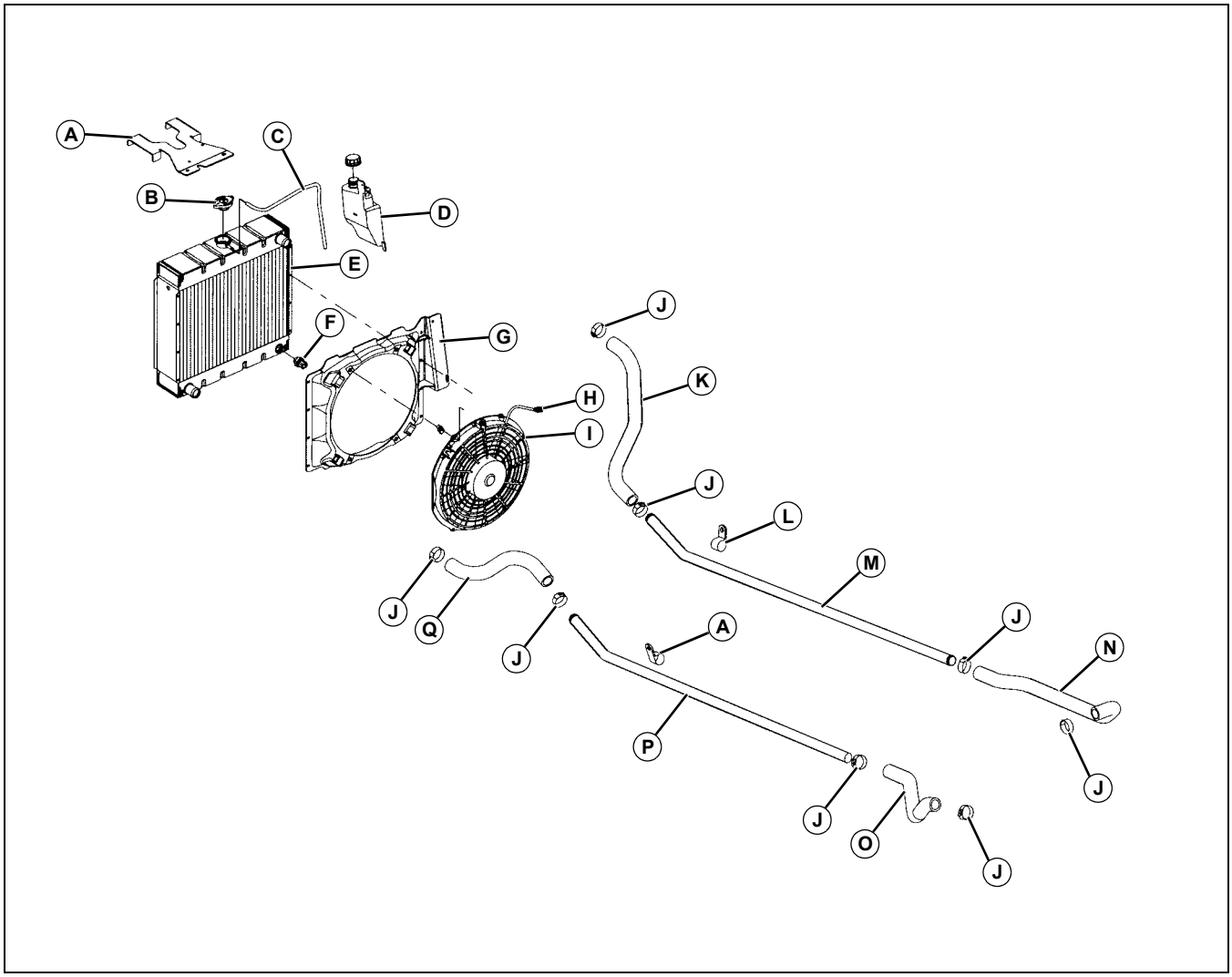
Fuel System Components - Diesel



MX32948

A - Fuel Gauge
B - Filler Cap
C - Fuel Tank
D - Pad
E - Bushing
F - Pick Up Tube
G - Elbow Fitting
H - Bushing
I - Vent Hose
J - Retainer
K - Elbow Fitting
L - Bushing

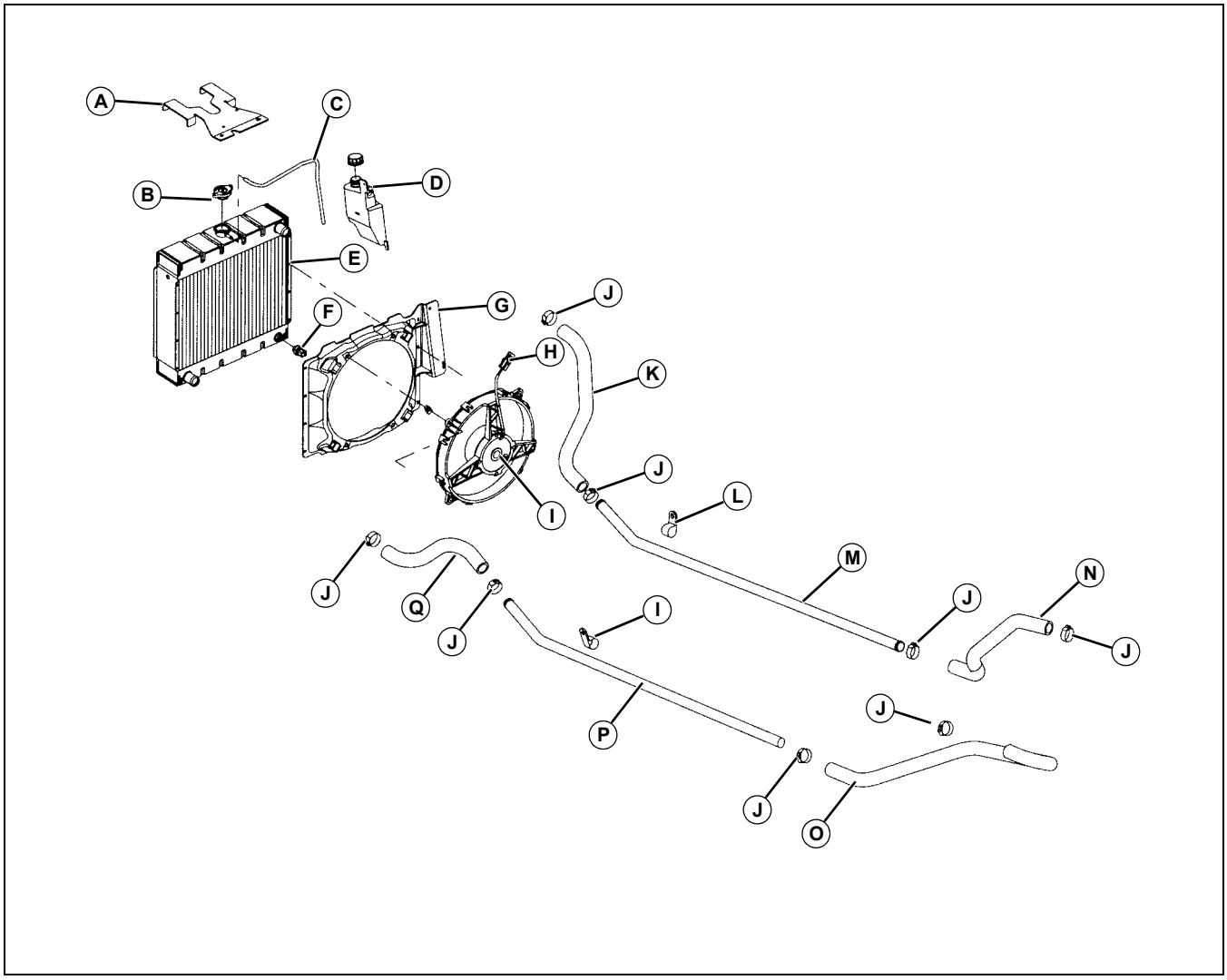
Coolant System Components - Gas



MX31876

A - Support Bracket
B - Radiator Cap
C - Vent Tube
D - Overflow Reservoir
E - Radiator
F - Temperature Sensor
G - Shroud
H - Cooling Fan Electrical Connector
I - Cooling Fan
J - Clamp
K - Upper Radiator Hose
L - Retainer
M - Coolant Supply Tube
N - Coolant Supply Hose
O - Coolant Return Hose
P - Coolant Return Tube
Q - Lower Radiator Hose

Coolant System Components - Diesel



MX32913

A - Support Bracket
B - Radiator Cap
C - Vent Tube
D - Overflow Reservoir
E - Radiator
F - Temperature Sensor
G - Shroud
H - Cooling Fan Electrical Connector
I - Cooling Fan
J - Clamp
K - Upper Radiator Hose
L - Retainer
M - Coolant Supply Tube
N - Coolant Supply Hose
O - Coolant Return Hose
P - Coolant Return Tube
Q - Lower Radiator Hose

Repair

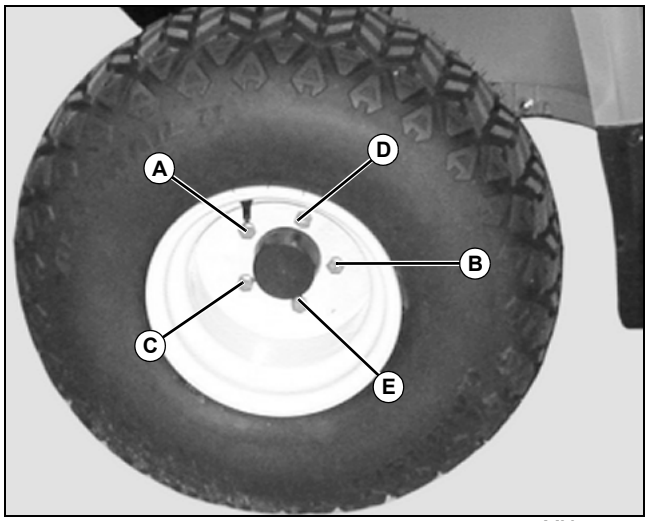
Wheel Removal and Installation

Removal:

1. Park machine safely. (See Parking Safely in the SAFETY section.)
2. Raise and support machine.
3. Remove wheel bolts.
4. Remove wheel from hub.

Installation:

Installation is done in the reverse order of removal.



MX31037

- Tighten wheel bolts evenly in proper sequence (A), (B), (C), (D), and (E) until snug.
- Finish tightening to specification using a torque wrench.

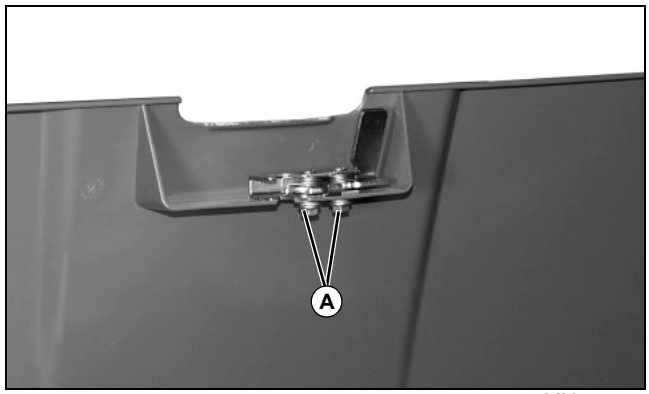
Specifications:

Wheel Bolt Torque . . . . . 81 N•m (60 lb-ft)

Hood Latch Removal and Installation

Removal:

1. Park machine safely on a level surface.
2. Raise hood.

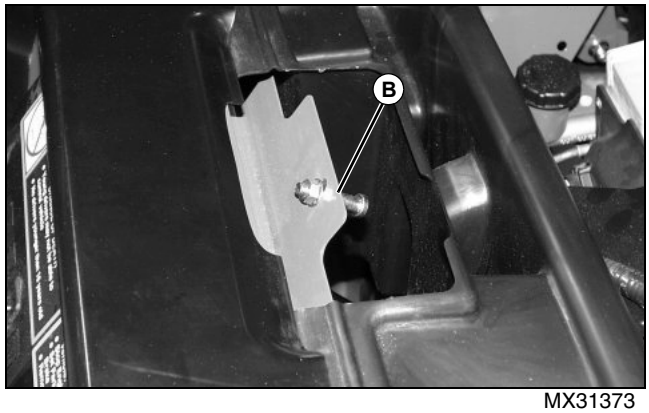


MX31350

3. Remove two bolts (A) securing hood latch.
4. Remove hood latch.

Installation:

- Installation is in the reverse of removal.
- Check for proper latch operation.



MX31373

- If hood does not fit properly when closed, adjust latch post (B).

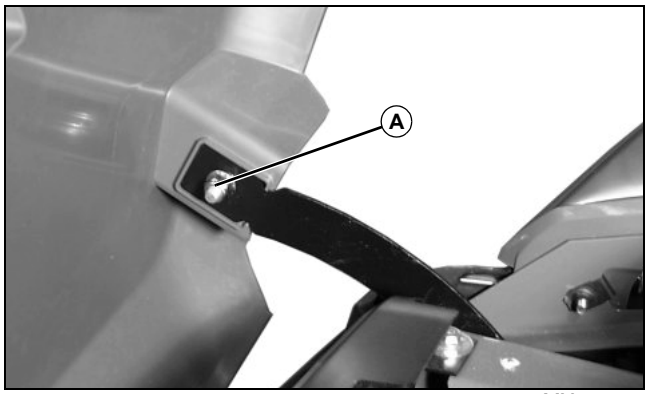
Specifications:

Seat Bracket Nuts . . . . . 10 N•m (88 lb-in.)

Hood Removal and Installation

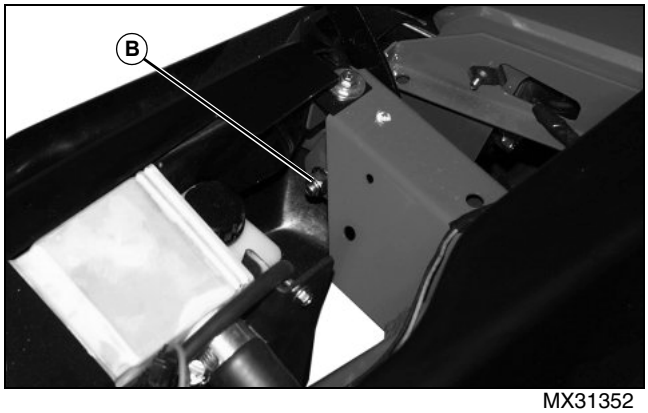
Removal:

1. Park machine safely on a level surface.
2. Raise hood.



MX31351

3. Remove bolt and nut (A) attaching one side of hood and repeat for the other side.
4. Remove hood.
5. If hood hinges are to be removed:

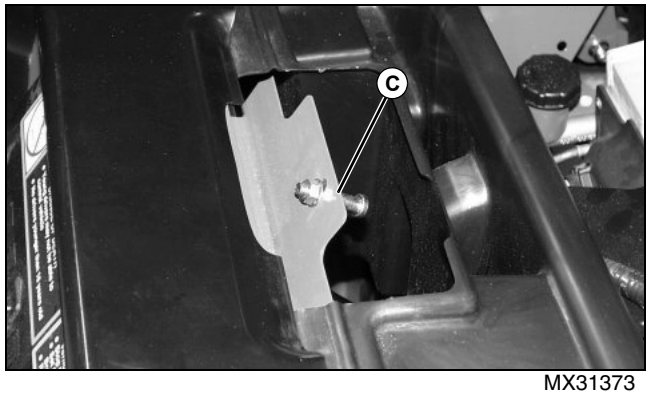


MX31352

- Remove bolt and nut (B) securing hinge on one side. Remove hinge.
- Repeat for second side.

Installation:

- Installation is in the reverse of removal.
- Check for proper hood operation.



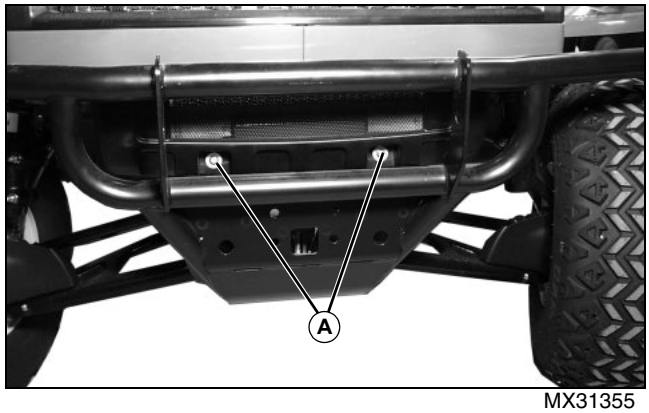
MX31373

- If hood does not fit properly when closed, adjust latch post (C).

Front Grille Removal and Installation

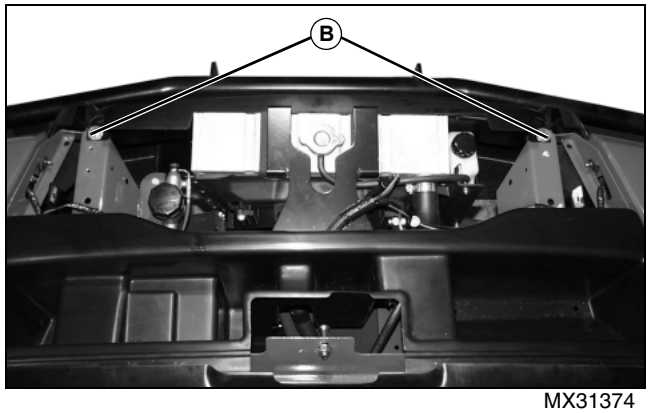
Removal:

1. Park machine safely on a level surface.
2. Raise and remove hood.



MX31355

3. Remove two bolts (A) securing lower section of front grille.



MX31374

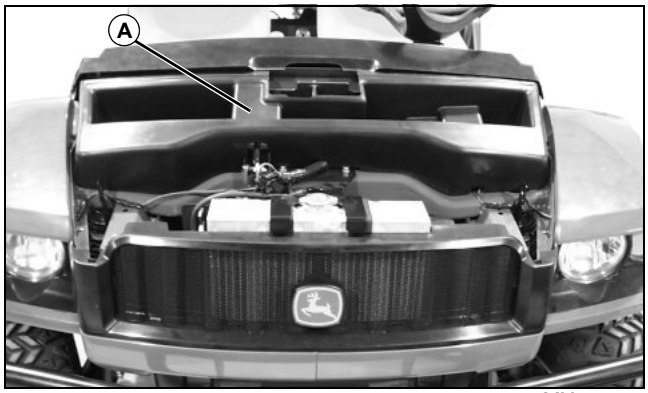
4. Remove two upper bolts (B) securing upper section of front grille.
5. Remove grille.

Installation:

- Installation is in the reverse of removal.

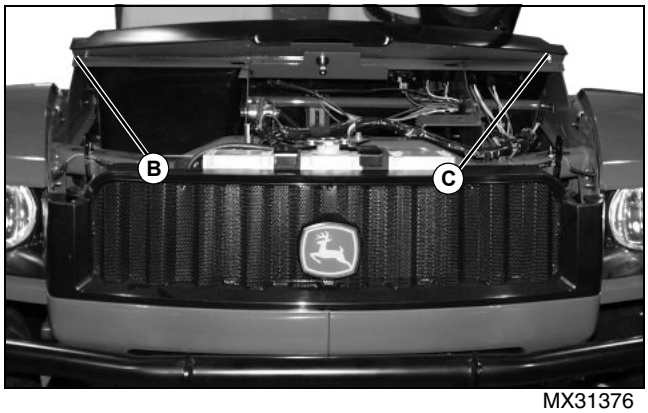
Front Fender Removal and Installation

1. Park machine safely on a level surface.
2. Raise hood.
3. Turn steering wheel in opposite direction of fender being removed. This will allow easier access to fasteners securing fender.



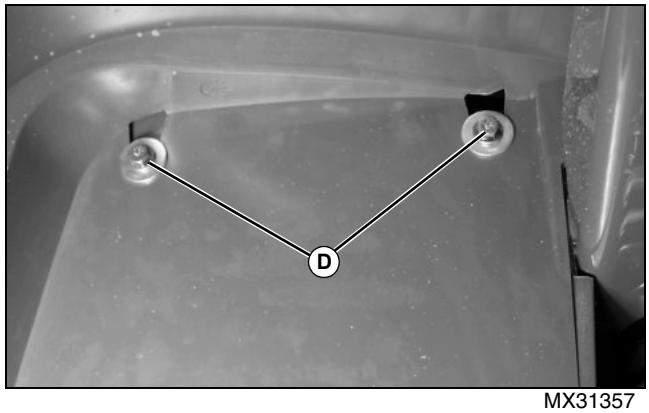
MX31375

4. Remove utility box (A) by lifting up and out towards front of machine.



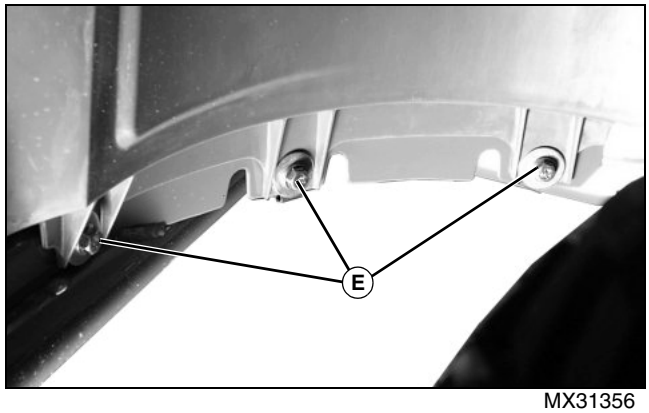
MX31376

5. Remove bolt securing dash on side of machine [(B) for right side and (C) for left side] on which fender is being removed.



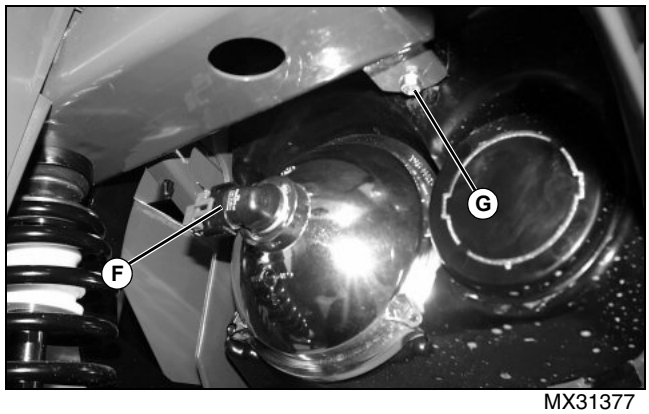
MX31357

6. Remove two upper bolts (D) securing fender to frame.



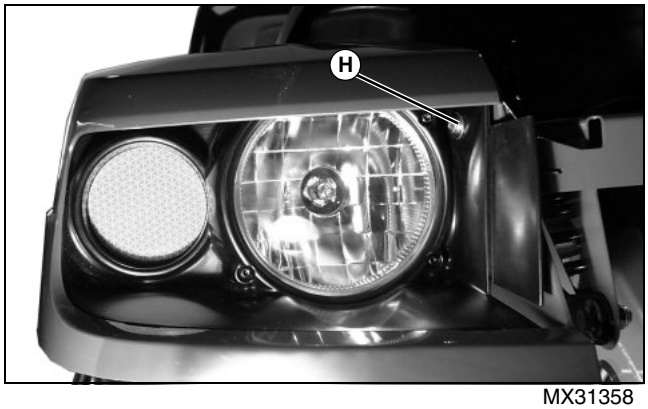
MX31356

7. Remove three lower bolts (E) securing fender to frame.



MX31377

8. Disconnect headlight connector (F).
9. Remove inner bolt (G) securing fender to frame near headlight.



MX31358

10.Remove outer bolt (H) securing fender to frame near headlight.

11.Remove fender.

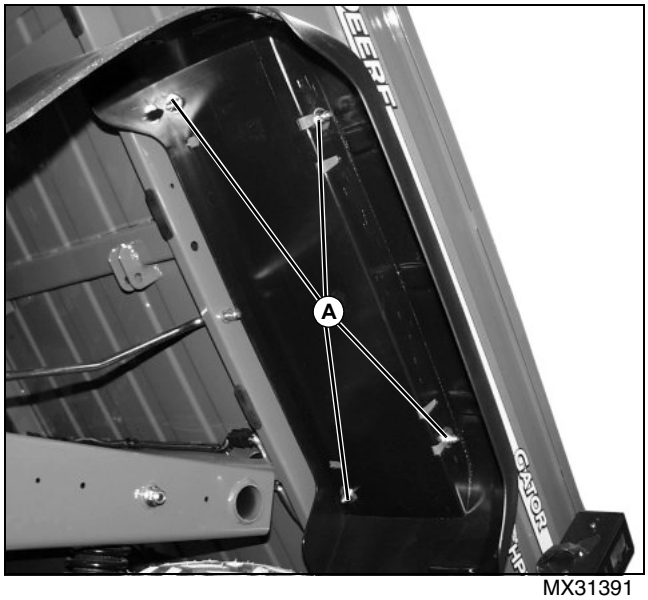
Installation:

- Installation is in the reverse of removal.
- Install fender bolts loosely.
- Check alignment of fender.
- Tighten mounting bolts.

Rear Fender Removal and Installation

Removal:

1. Park machine safely.
2. Lock park brake.
3. Raise and lock cargo box.



MX31391

4. Remove four nut (A) s securing rear fender.

5. On left-hand fender, it will be necessary to remove inner bolts in order for fender to clear prop rod.

6. Remove fender.

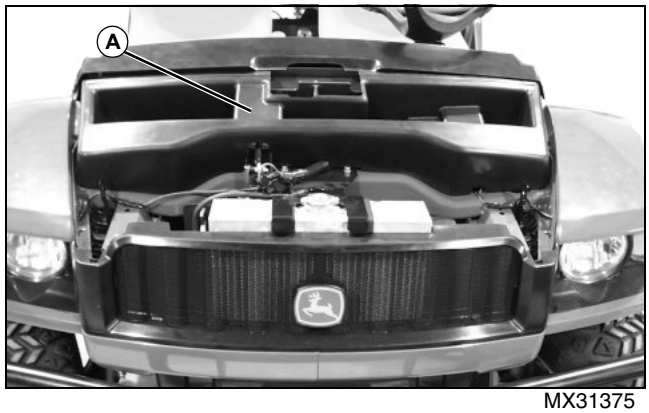
Installation:

- Installation is in the reverse of removal.

Dash Panel Removal and Installation

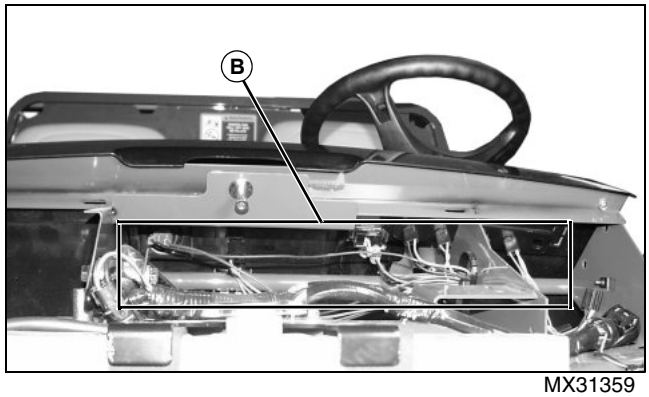
Removal:

1. Park machine safely on a level surface.
2. Disconnect battery negative (-) cable.
3. Raise hood.



MX31375

4. Remove utility box (A) by lifting up and out toward front of machine.

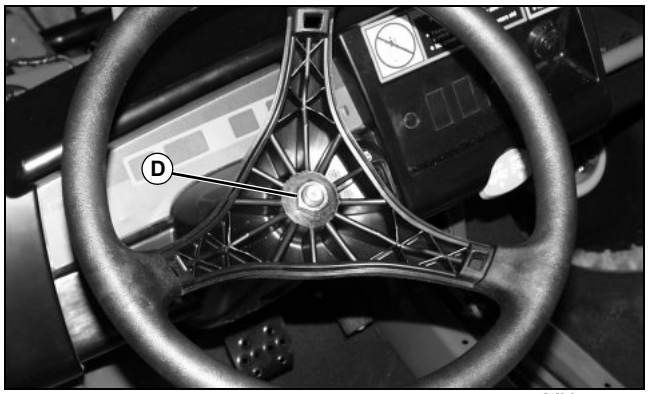


MX31359

5. Disconnect all electrical connectors (B) from rear of dash panel. (Connectors and locations will vary depending on installed options.) See Electrical section for more information.

MX31360

6. Remove cover from steering wheel by gently prying up on center cover at three points (C).

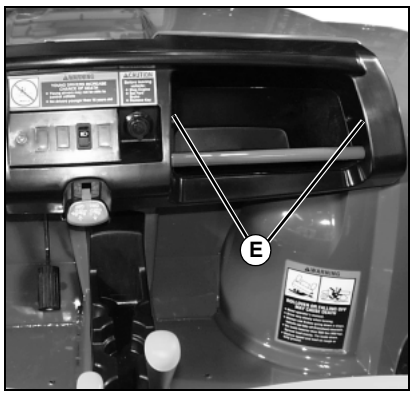


MX31353

7. Remove nut (D) securing steering wheel to shaft.

8. Note position of steering wheel by marking spline and wheel for proper positioning during assembly.

9. Gently tap bottom of steering wheel up and off of shaft splines.

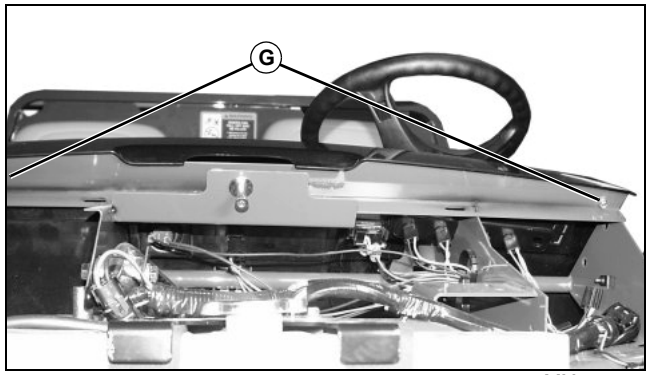


MX30995

10.Remove passenger hand hold recess from dash by removing two screws (E).

MX31354

11.Remove one screw (F) securing dash to steering column.



MX31359

12.Remove two bolts (G) securing dash at front of machine.

13.Lift dash up and over steering column towards rear of machine.

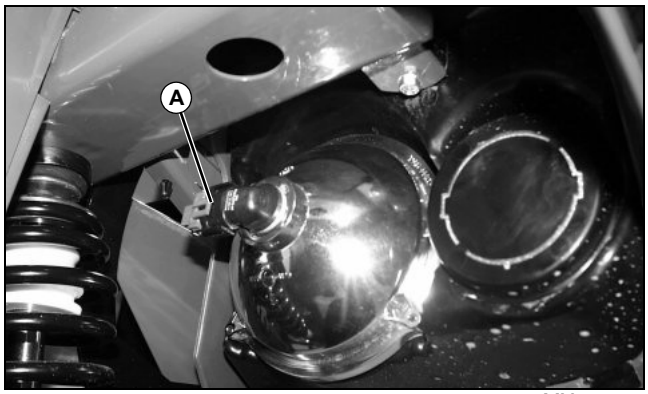
Installation:

- Installation is in the reverse of removal.
- Install steering wheel as marked during removal.
- Ensure that all electrical lights and components work correctly.

Headlight Removal and Installation

Removal:

1. Park machine safely on a level surface.
2. Ensure that key is in the OFF position.



MX31377

3. Disconnect headlight connector (A) from underneath fender.

IMPORTANT: Avoid damage! If headlight is not held when removing screws, the headlight may fall and shatter.

MX31358

4. While holding headlight from underneath fender, remove three screws (B) securing headlight to bezel.
5. Remove headlight from rear of fender.

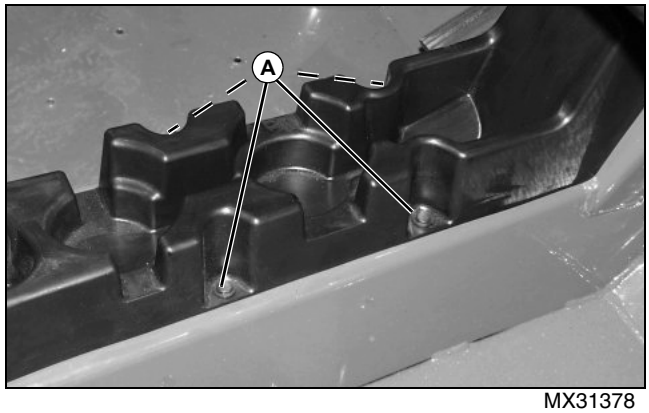
Installation:

- Installation is in the reverse of removal.

Center Console Removal and Installation

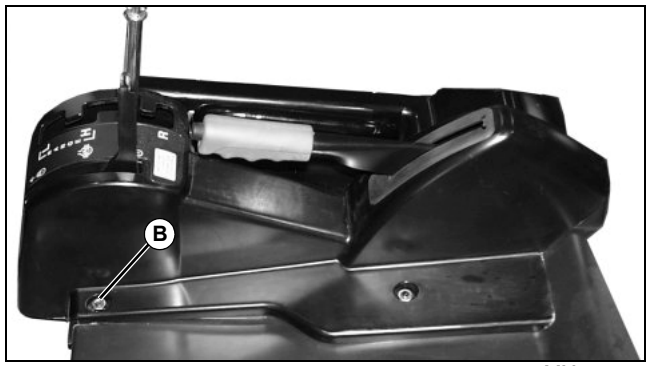
Removal:

1. Park machine safely on a level surface.



MX31378

2. Using a small screwdriver, pry up the four expansion rivets (A) from center console.



MX31379

3. Remove nut (B) from control lever housing.
4. Remove center console.

Installation:

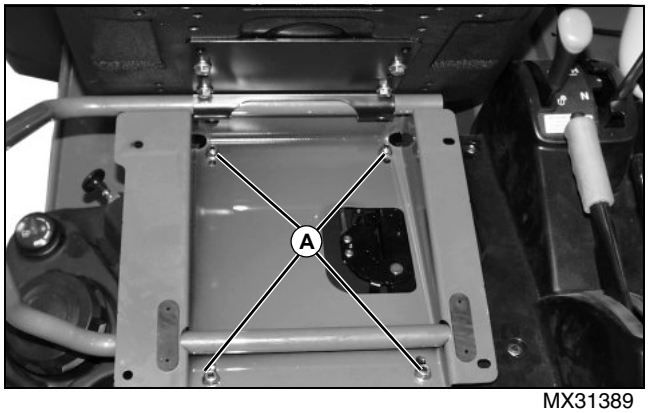
- Installation is in the reverse of removal.

Transaxle Control Lever Housing Removal and Installation

Removal:

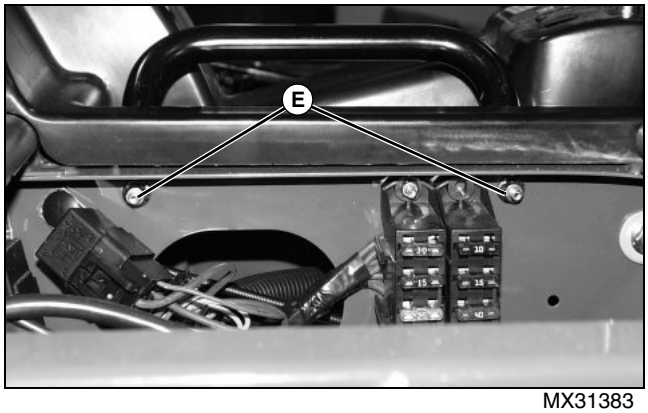
1. Park machine safely on a level surface.
2. Tip seats forward.

NOTE: The driver's seat and base may be removed as an assembly.



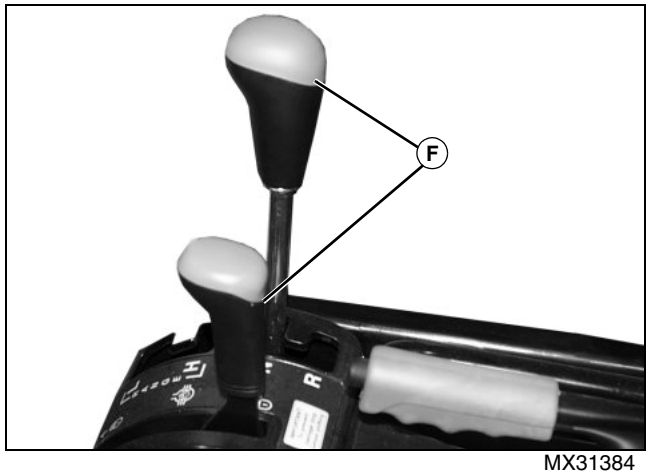
MX31389

3. Remove the four nuts (A) securing the seat base to the machine and remove seat and base.
4. Remove the seat adjustment rails.



MX31383

5. Remove two nut (E) s securing passenger seat handle and remove handle.



MX31384

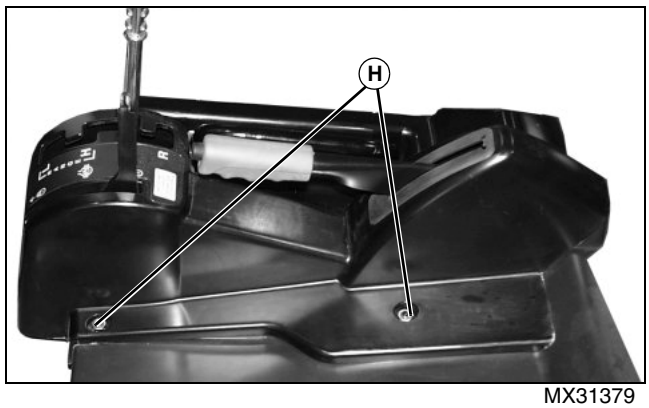
6. Using a small screwdriver, gently pry the caps (F) off of the traction lock and shift levers.

MX31385

7. Remove the retaining nuts (G) securing the traction lock and shift lever handles.

CAUTION: Avoid injury! Exposed threads are sharp. Cover the treads of the traction control and shift levers with tape or other protective material.

8. Remove handles. It may be necessary to gently tap the handles up and off of the levers with a soft faced hammer.



MX31379

9. Remove the two nuts (H) securing shifter housing.

10.Lift shifter housing up and off of levers and park brake handle. Note that the rear of the housing is attached by tangs.

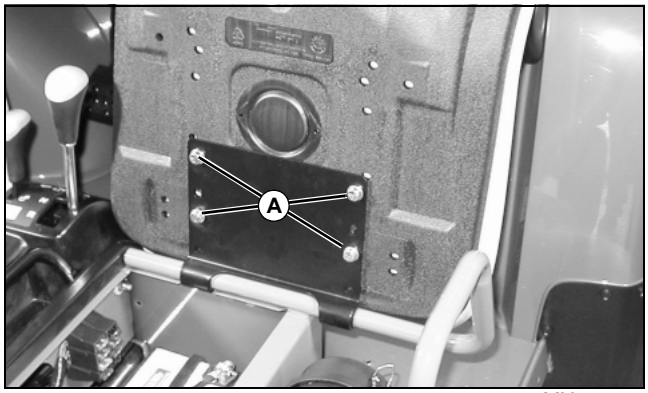
Installation:

- Installation is in the reverse of removal.
- Remove tape or protective material from control levers before installing handles and retaining nuts.

Seat Removal and Installation

Removal:

1. Tip seat forward.

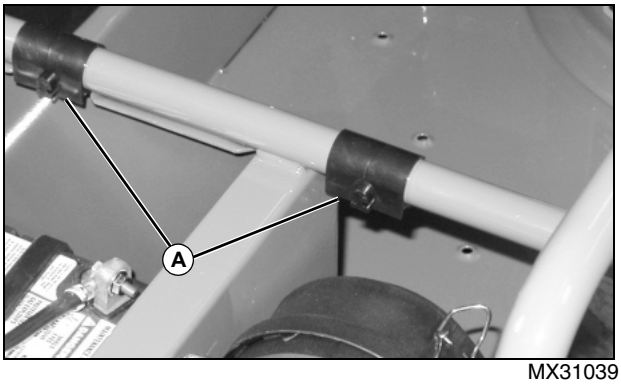


MX31038

2. Hold onto seat and remove all screws (A).
3. Remove seat and seat bracket from support rail.

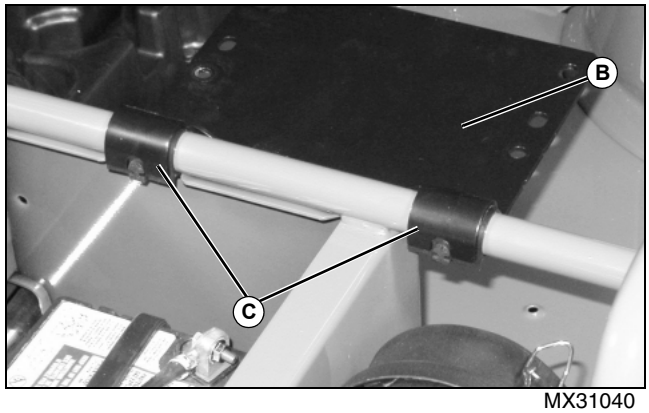
Installation:

NOTE: Apply silicone lubricant to inner surface of seat bushings to improve ease of seat rotation if desired.



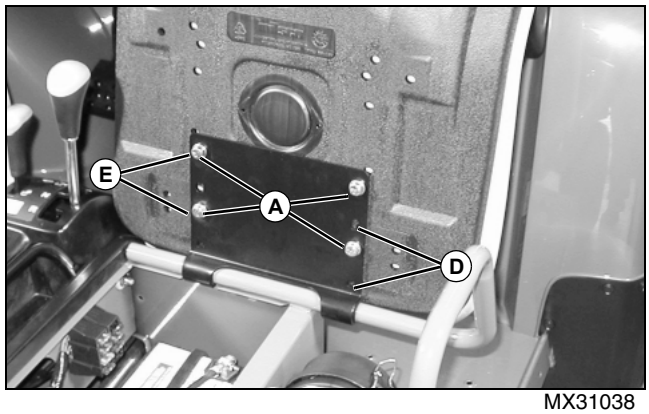
MX31039

1. Position seat bushings (A) on support rail so tabs face toward rear of vehicle.



MX31040

2. Position seat bracket (B) onto support rail so hinges (C) fit around rubber bushing tabs.



MX31038

Picture Note: Rear position shown.

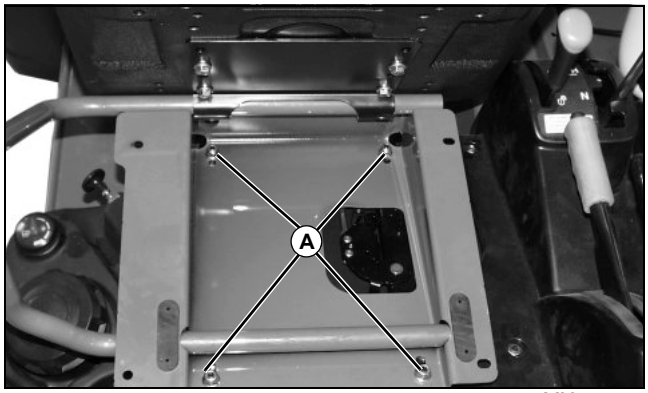
3. Rotate seat bracket upward. Position bottom of seat against bracket and align correct holes with holes in seat.
4. Slide seat to the forward (D) or rearward (E) position.
5. Install original hardware to secure seat.
6. Tighten seat bracket hardware to specification.

Seat Base Cover Removal and Installation

Removal:

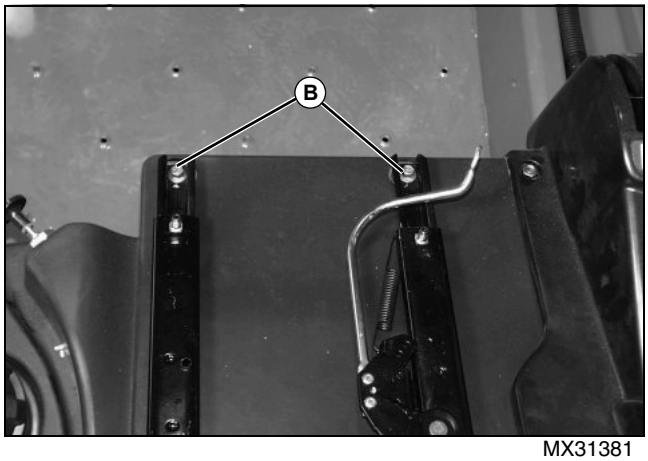
1. Park machine safely on a level surface.
2. Tip seats forward.
3. Remove passenger seat. See “Seat Removal and Installation” on page 582.

NOTE: The driver’s seat and base may be removed as an assembly.



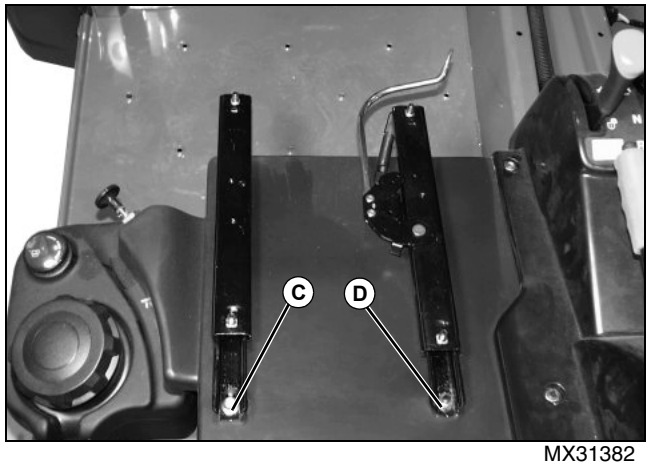
MX31389

4. Remove the four nuts (A) securing the seat base to the machine and remove seat and base.



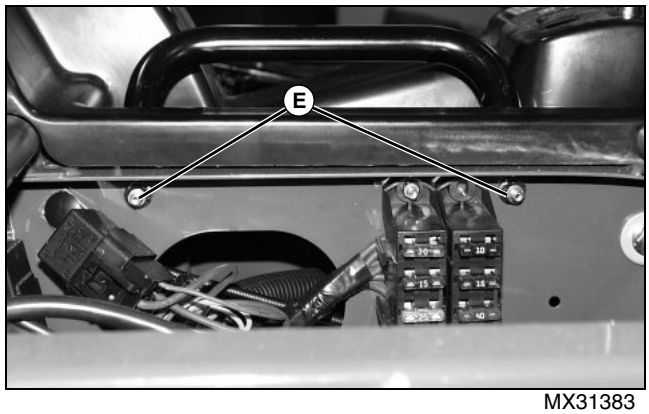
MX31381

5. Push seat adjustment rails fully to the rear of machine to expose front mounting bolts (B). Remove bolts.



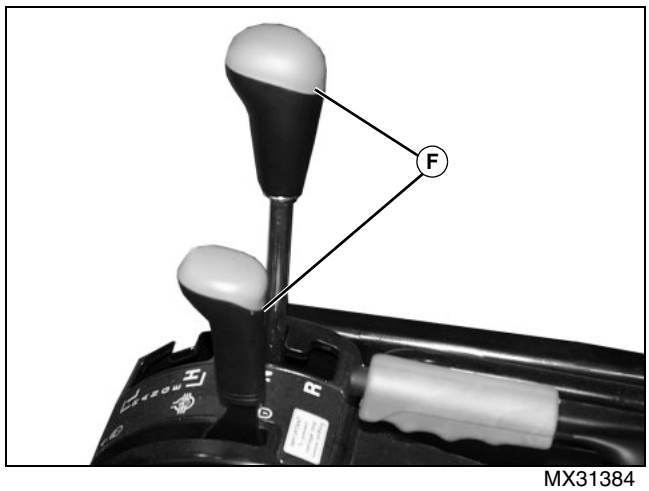
MX31382

6. Push seat adjustment rails fully to the front of machine to expose seat adjustment rail bolt (C) and nut (D). Remove bolt, nut, seat rails, and washers.
7. Remove the seat adjustment rails.



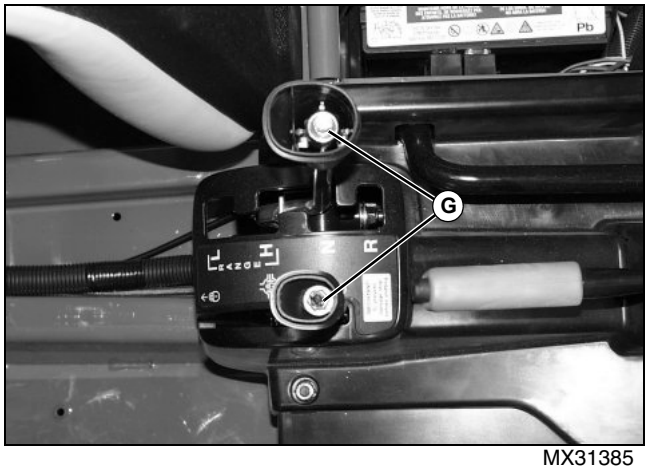
MX31383

8. Remove two nuts (E) securing passenger seat handle and remove handle.



MX31384

9. Using a small screwdriver, gently pry the caps (F) off of the traction assist and shift levers.

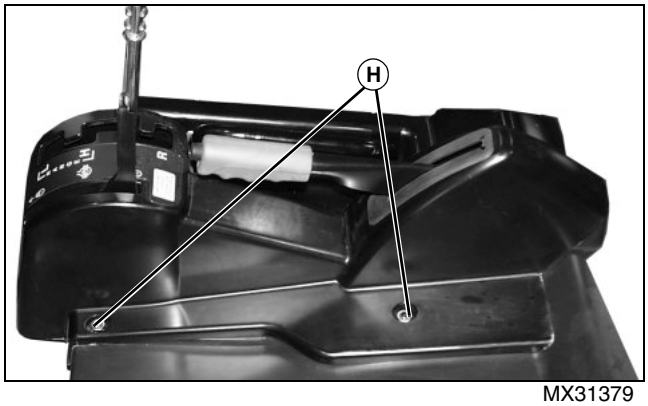


MX31385

10.Remove the retaining nuts (G) securing the traction assist and shift lever handles.

CAUTION: Avoid injury! Exposed threads are sharp. Cover the treads of the traction control and shift levers with tape or other protective material.

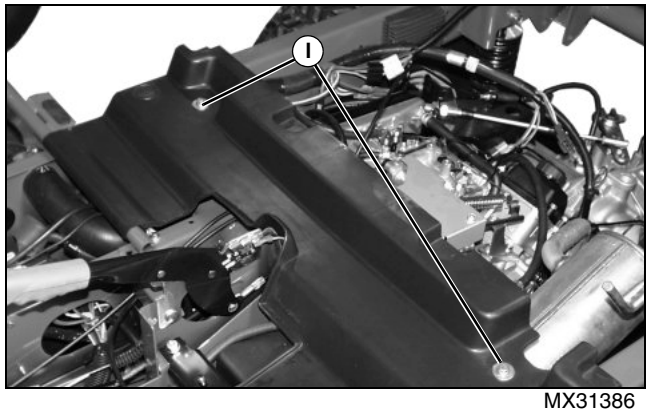
11.Remove handles. It may be necessary to gently tap the handles up and off the levers with a soft faced hammer.



MX31379

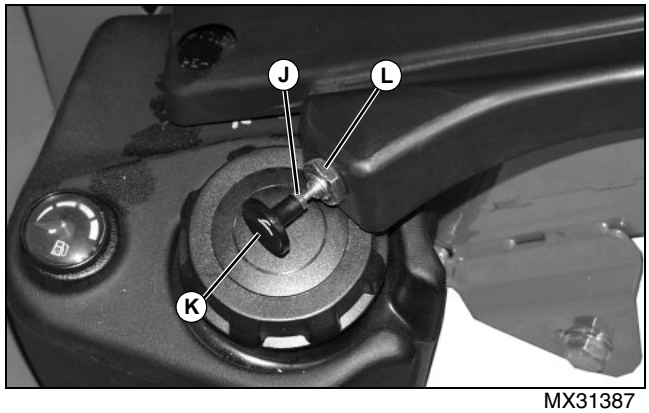
12.Remove the two nuts (H) securing shifter housing.

13.Lift shifter housing up and off of levers and park brake handle. Note that the rear of the housing is attached by tabs.



MX31386

14.Remove two nuts (I) securing seat base cover to frame.



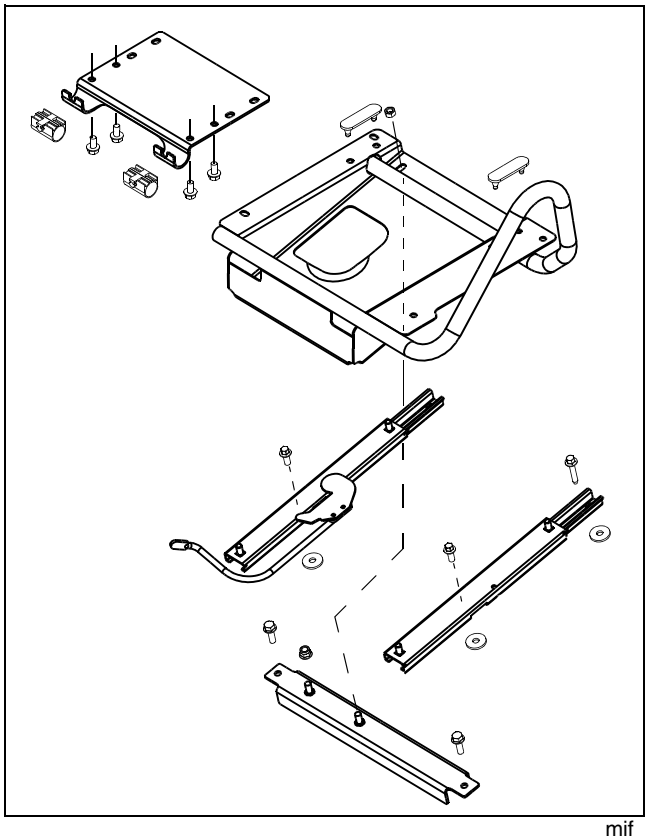
MX31387

15.Using an open end wrench, hold nut (J) on choke cable while unscrewing choke control knob (K).

16.Remove nut (L) securing choke cable assembly.

17.Remove seat base cover from machine.

Installation:



mif

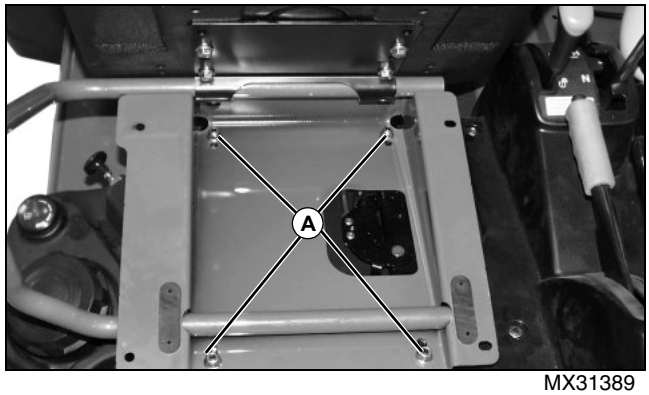
- Installation is in the reverse of removal.
- Remove tape or protective material from control levers before installing handles and retaining nuts.
- When installing seat, rails must be in the same position. Push rails to either furthest forward or furthest back positions before installing driver seat.

Seat Adjuster Removal and Installation

Removal:

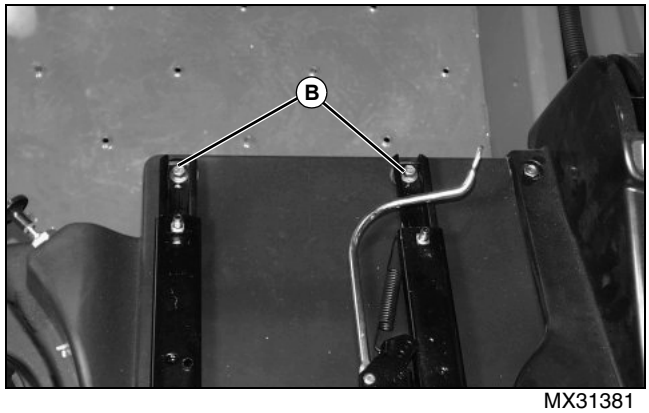
1. Park machine safely on a level surface.
2. Tip seats forward.
3. Remove passenger seat. See “Seat Removal and Installation” on page 582.

NOTE: The driver’s seat and base may be removed as an assembly.



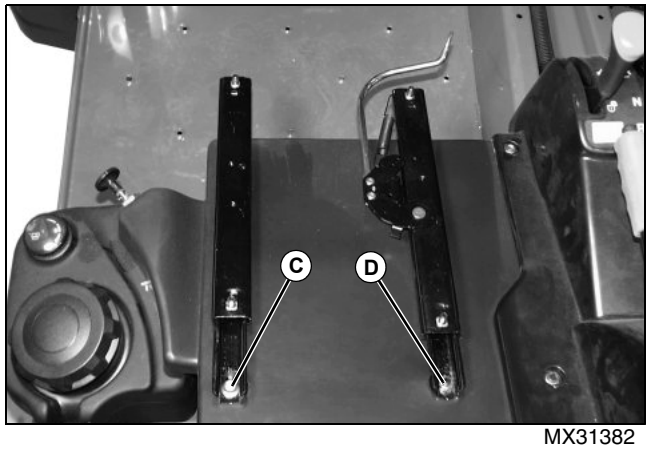
MX31389

4. Remove the four nuts (A) securing the seat base to the machine and remove seat and base.



MX31381

5. Push seat adjustment rails fully to the rear of machine to expose front mounting bolts (B). Remove bolts.



MX31382

6. Push seat adjustment rails fully to the front of machine to expose seat adjustment rail bolt (C) and nut (D). Remove bolt, nut, seat rails, and washers.

Installation:

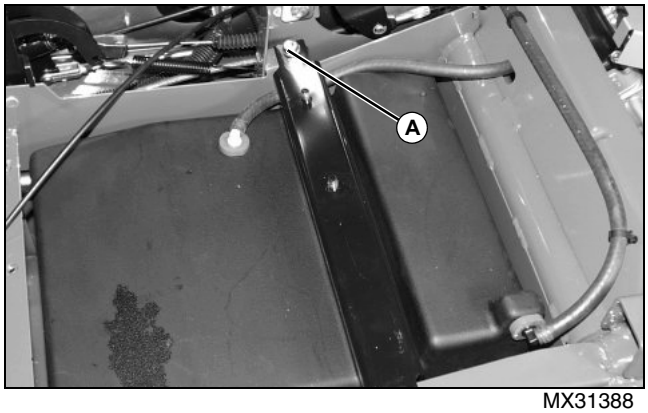
- Installation is in the reverse of removal.
- When installing seat, rails must be in the same position. Push rails to either furthest forward or furthest back positions before installing seat.

Fuel Tank Removal and Installation

1. Park machine safely on a level surface.

2. Remove seat base cover. See “Seat Base Cover Removal and Installation” on page 583.

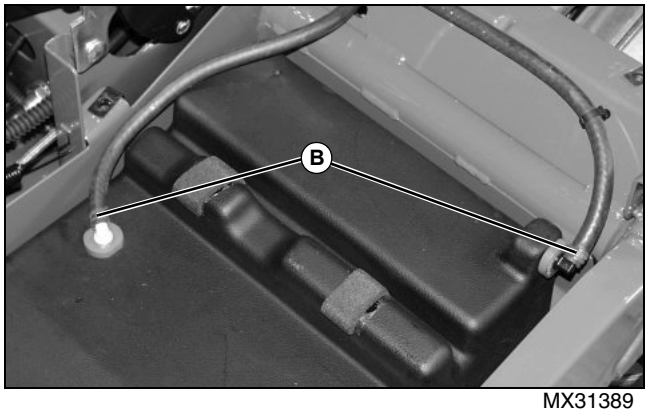
NOTE: Observe routing of fuel lines for reassembly.



MX31388

3. Remove bolt (A) from fuel tank retaining bracket. Remove bracket.

CAUTION: Avoid injury! Gasoline is explosive. Do not expose to open flame or spark. Serious injury can result. Store in a proper container. Wipe up any spills immediately.



MX31389

4. Disconnect fuel lines to tank by compressing spring clamps (B). Plug fuel lines to prevent spills.

5. Remove fuel tank by lifting from machine.

Installation:

- Installation is in the reverse of removal.

Cargo Box Removal and Installation

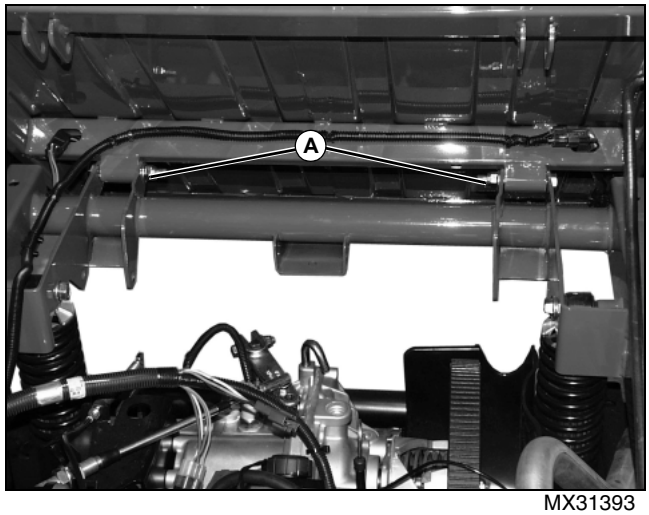
Removal:

1. Park machine safely on a level surface.

2. Lock park brake.

3. Raise and lock cargo box.

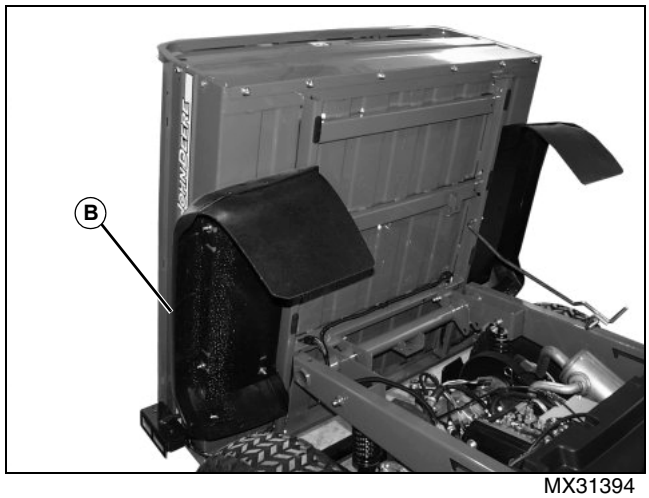
4. Disconnect any optional accessory wiring that is installed.



MX31393

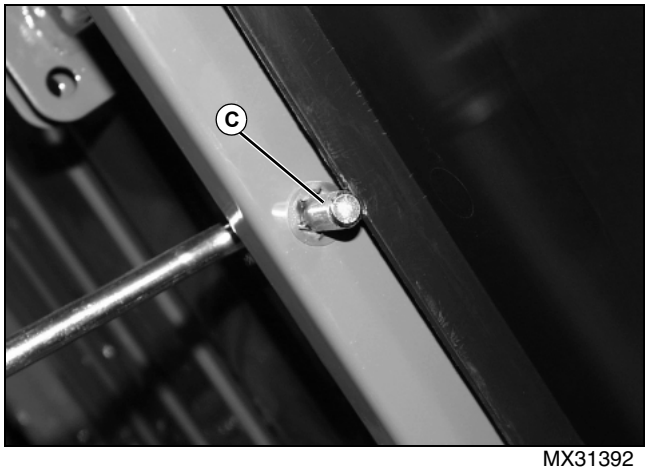
5. Loosen two nuts (A) at cargo box pivot points.

6. Remove prop rod from left frame rail track by pulling out and up.



MX31394

7. Raise cargo box (B) until the bottom rests on rear wheels.



MX31392

8. Tap outside of prop rod (C) attached at cargo box with a punch to remove prop rod and push-on nut. Remove prop rod from cargo box and left frame rail.

9. Lower cargo box to normal (horizontal) position.

10.Remove two nuts and bolts at cargo box pivot points.

11.Along with an assistant, remove cargo box from machine.

Installation:

- Installation is in the reverse of removal.

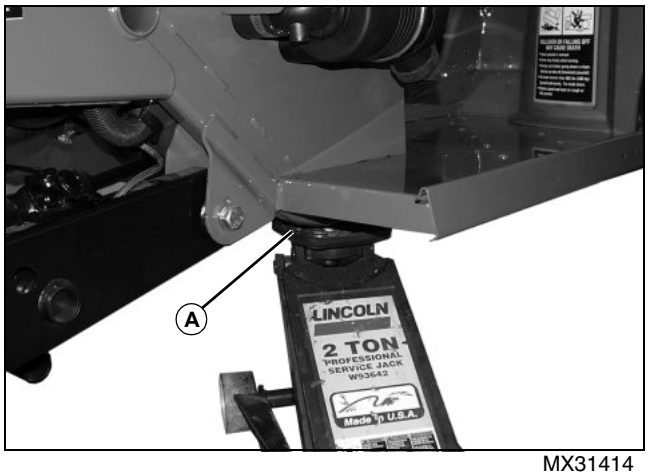
Rear Shock Absorber Removal and Installation

Removal:

NOTE: Only remove and replace one shock absorber at a time.

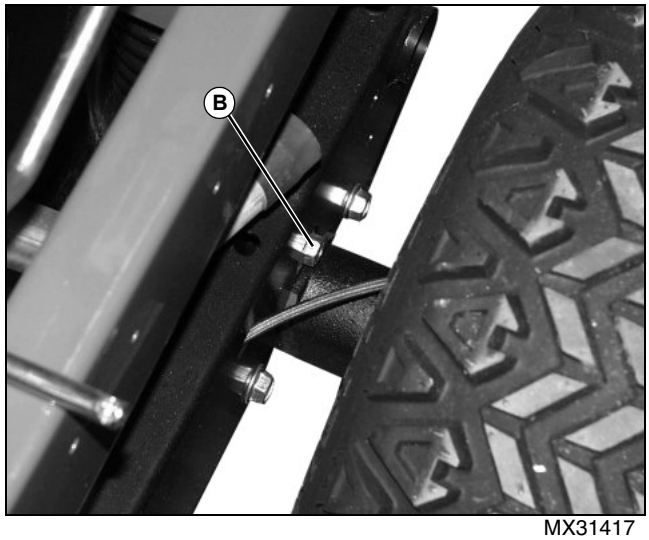
1. Park machine safely on a level surface.

2. Lock park brake.



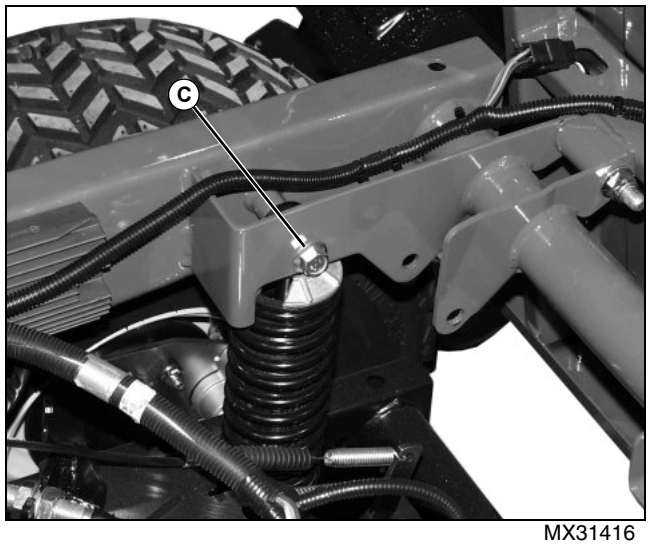
MX31414

3. Install a jack (A) under main frame as shown (do not raise machine).



MX31417

4. Remove lower nut and bolt (B) securing shock.



MX31416

5. Remove upper nut and bolt (C) securing shock. It may be necessary to use jack to raise or lower machine in order to level the frame and swing arm frame to ease bolt removal.

6. Remove shock from frame.

Installation:

- Installation is in the reverse of removal.
- It may be necessary to use jack to raise or lower machine in order to level the frame and swing arm frame to ease bolt installation.
- Tighten bolts to specification.

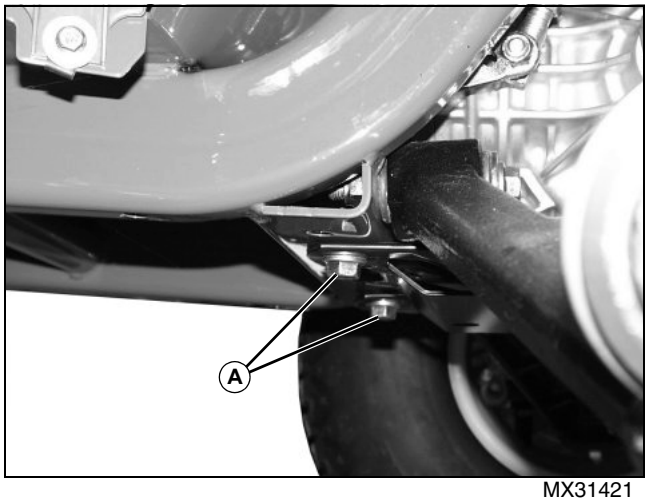
Specifications:

Rear Shock to Axle . . . . . 126 ± 24 N•m (93 ± 18 lb-ft)
Rear Shock to Frame . . . . . 126 ± 24 N•m (93 ± 18 lb-ft)

Front Bumper/Skid Plate Removal and Installation

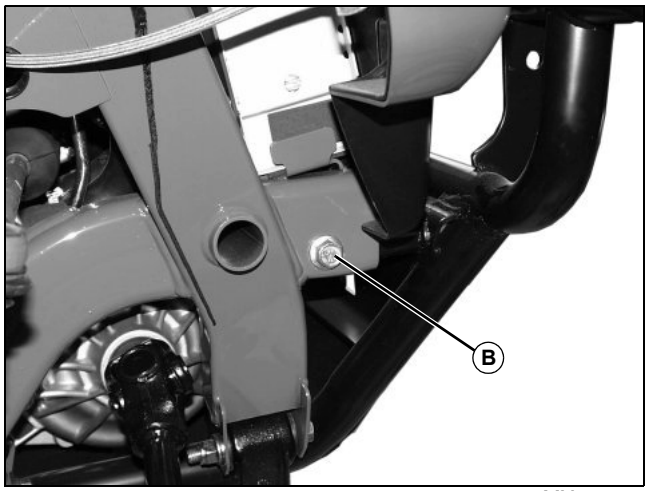
Removal:

1. Park machine safely on a level surface.
2. Lock park brake.



MX31421

3. Remove two lower bolts (A) securing skid plate.



MX31421

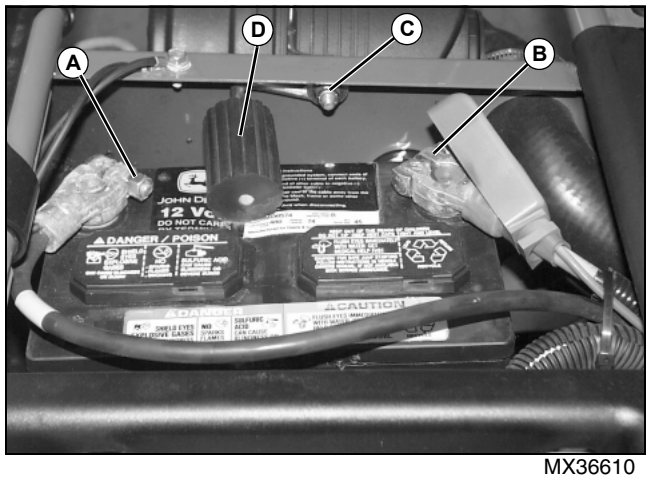
4. Remove two upper bolts and nuts (B) securing front bumper (located on both sides of machine).

Installation:

- Installation is in the reverse of removal.

Battery Removal and Installation

Removal:



MX36610

1. Park machine safely and raise passenger seat.
2. Disconnect negative – battery terminal (A) first, then positive + terminal (B).
3. Remove nut and washer (C) from battery hold down (D) and remove battery hold down.
4. Remove battery.

Installation:

1. Install battery with negative – terminal toward front of machine.
2. Install battery hold down. Keep downward pressure on hold down while tightening hold down bolt.
3. Connect and tighten positive + cable first, then negative – cable.

Radiator Drain Procedure - Gas

Draining Cooling System

1. Park the vehicle safely. (See Parking Safely in the SAFETY section.)
2. Raise cargo box.
3. Open hood.
4. Remove storage tray.

IMPORTANT: Avoid damage! Allow engine and cooling system to cool completely.

5. Make sure engine has cooled completely.

IMPORTANT: Avoid damage! BE SURE to wipe-up and wash-off any spilled coolant IMMEDIATELY.

6. Place a large drain pan under left side of engine to catch coolant.

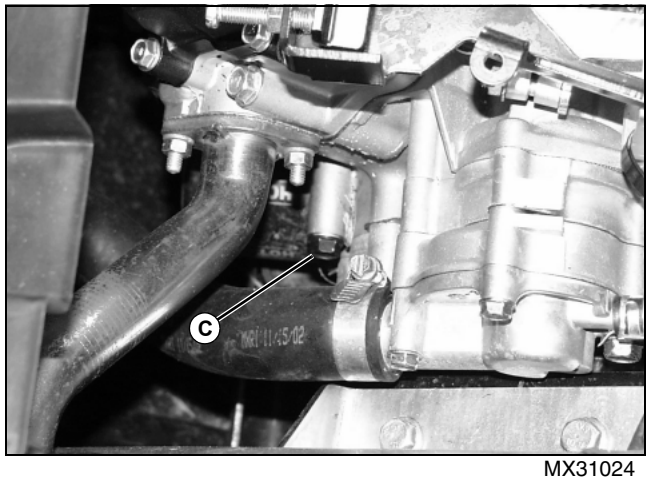
MX31021

7. Slowly open radiator cap (A) to the first stop to release all pressure.
8. Remove cap after all pressure is released.

MX31015

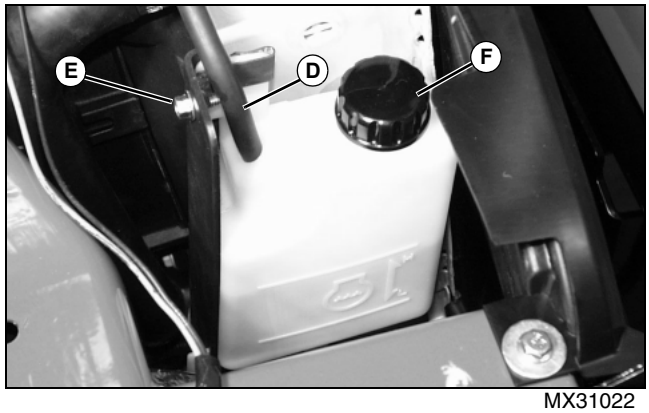
9. Disconnect radiator hoses (B) from intermediate tubes.
10. Route radiator hoses over the drain pan and allow coolant to drain into drain pan.

NOTE: Engine block drain screws may be black in color.



MX31024

11. Loosen engine block drain screw (C) on left side of engine. Allow coolant to drain into a drain pan.
12. After all coolant has drained, connect radiator hoses and tighten the engine block drain screw.



MX31022

13. Remove overflow hose (D) from recovery tank.
14. Remove the screw (E) and lift recovery tank out of machine.
15. Remove cap and empty recovery tank into drain pan.
16. Check condition of all hoses. Replace as needed. Check all hose clamps and tighten as needed.
17. Install recovery tank in machine and secure with screw (E).

IMPORTANT: Avoid damage! Install overflow hose properly to ensure proper function of the cooling system. Position hose slightly above bottom of reservoir. Do not allow hose to contact bottom of reservoir or bend upwards out of the coolant.

18.Install overflow hose (D) and cap (F).

19.Fill and bleed cooling system.

Flushing Cooling System

1. Drain cooling system.

2. Prepare a cooling system flushing solution using clean water and John Deere Cooling System Cleaner, John Deere Cooling System Quick Flush, or an equivalent.

3. Fill radiator completely with flushing solution. Install and tighten radiator cap.

4. Start and run engine until it reaches operating temperature.

5. Stop engine.

CAUTION: Avoid injury! Engine and coolant will be hot. Use a thick rag or gloves to protect your skin.

6. Turn radiator cap slowly to the stop to release system pressure. Remove radiator cap.

7. Drain cooling system immediately into a container before rust and dirt settle:

- Disconnect radiator hoses from engine.
- Loosen engine block drain screws.

8. After all solution has drained, connect radiator hoses and tighten engine block drain screws.

9. Remove and clean recovery tank.

10.Install the recovery tank.

11.Fill cooling system with recommended coolant mixture.

Radiator Drain Procedure - Diesel

Draining Cooling System

1. Park the vehicle safely. (See Parking Safely in the SAFETY section.)

2. Raise cargo box.

3. Open hood.

4. Remove storage tray.

IMPORTANT: Avoid damage! Allow engine and cooling system to cool completely.

5. Make sure engine has cooled completely.

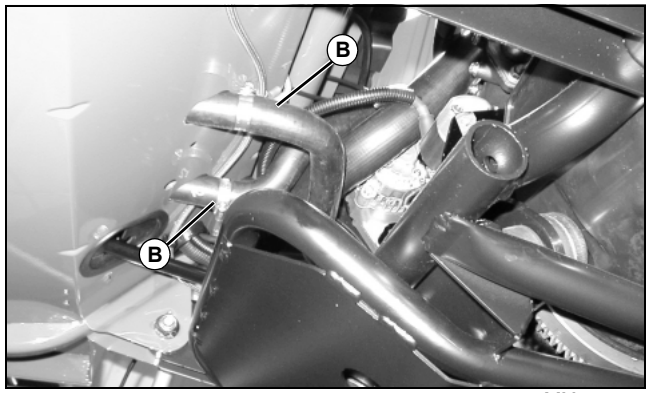
IMPORTANT: Avoid damage! BE SURE to wipe-up and wash-off any spilled coolant IMMEDIATELY.

6. Place drain pan under engine.

MX35816

7. Slowly open radiator cap (A) to the first stop to release all pressure.

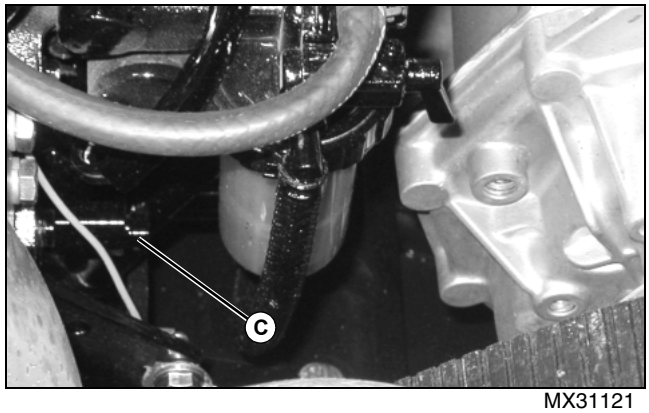
8. Remove cap after all pressure is released.



MX31120

9. Disconnect radiator hoses (B).

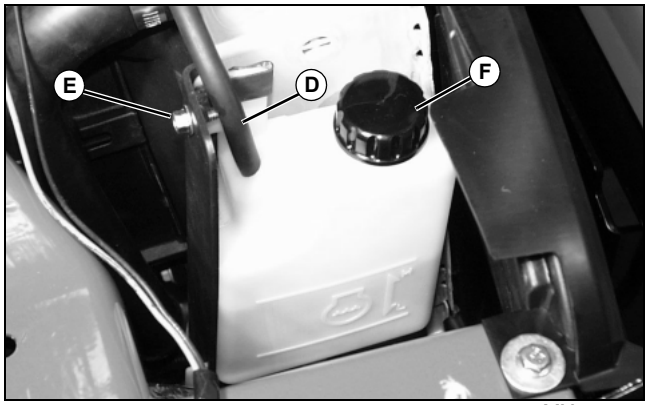
10.Route radiator hoses over the drain pan and allow coolant to drain into drain pan.



MX31121

11.Loosen engine block drain (C) near engine oil filter. Allow coolant to drain into a container.

12.After all coolant has drained, connect radiator hoses and tighten the engine block drain screw.



MX31022

13.Remove overflow hose (D) from recovery tank.

14.Remove the screw (E) and lift recovery tank out of machine.

15.Remove cap and empty recovery tank into drain pan.

16.Check condition of all hoses. Replace as needed. Check all hose clamps and tighten as needed.

17.Install recovery tank in machine and secure with screw (E).

IMPORTANT: Avoid damage! Install overflow hose properly to ensure proper function of the cooling system. Position hose (C) slightly above bottom of reservoir. Do not allow hose to contact bottom of reservoir or bend upwards out of the coolant.

18.Install overflow hose (D) and cap (F).

19.Fill and bleed cooling system.

Flushing Cooling System

1. Drain cooling system.

2. Prepare a cooling system flushing solution using clean water and John Deere Cooling System Cleaner, John Deere Cooling System Quick Flush, or an equivalent.

3. Fill radiator completely with flushing solution. Install and tighten radiator cap.

4. Start and run engine until it reaches operating temperature.

5. Stop engine.

CAUTION: Avoid injury! The radiator will be hot and can burn skin. Built-up pressure may cause explosive release of coolant when the radiator cap is removed:

- **Slowly loosen the cap to the first stop to release all pressure. Then remove the drain plug.**

6. Turn radiator cap slowly to the stop to release system pressure. Remove radiator cap.

7. Drain cooling system immediately into a container before rust and dirt settle:

- Disconnect radiator hoses from engine.
- Loosen engine block drain screws.

8. After all solution has drained, connect radiator hoses and tighten engine block drain screws.

9. Remove and clean recovery tank.

10.Install the recovery tank.

11.Fill cooling system with recommended coolant mixture.

Radiator Removal and Installation

CAUTION: Avoid Injury! Coolant may be above boiling temperature and under pressure in cooling system. DO NOT remove pressure cap when system is hot. Escaping steam will burn unprotected skin. Always wear protective clothing and goggles when servicing cooling system

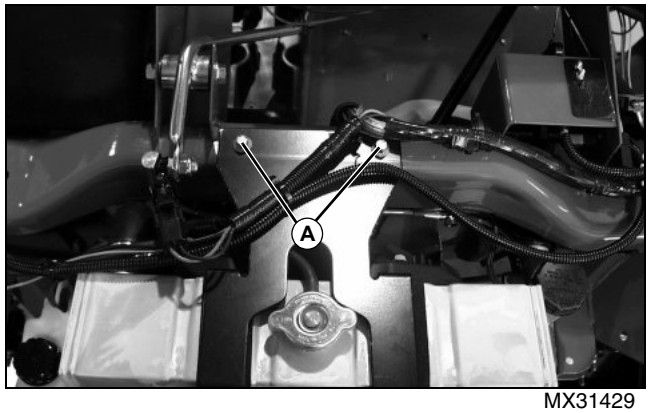
Removal:

1. Park machine safely on a level surface.

2. Lock park brake.

3. Remove hood. See “Hood Removal and Installation” on page 576 in the Miscellaneous section.

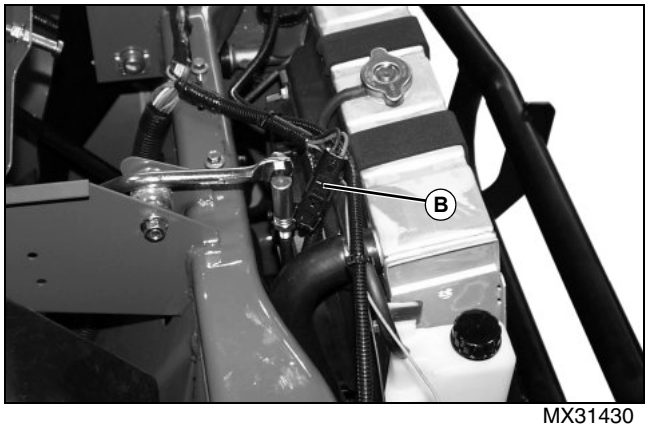
4. Remove front grille. See “Front Grille Removal and Installation” on page 576 in the Miscellaneous section.



MX31429

5. Remove two bolts (A) securing radiator bracket to frame.

6. Remove electrical harness tie down point on bracket by compressing nipple with a long-nosed pliers.



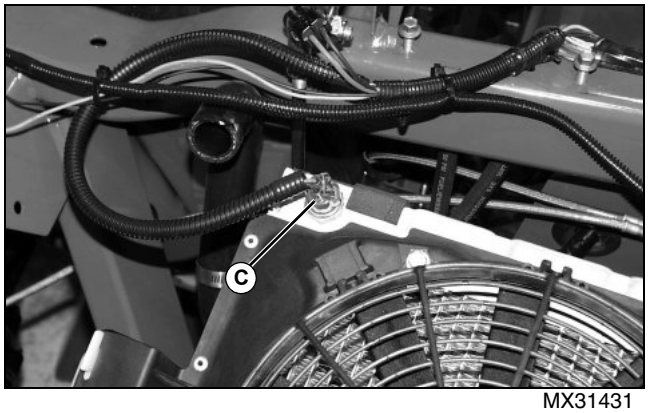
MX31430

7. Disconnect cooling fan motor connector (B).

8. Place a suitable container under machine for coolant recovery.

9. Loosen clamp on lower radiator hose and carefully separate hose from radiator. Allow coolant to drain.

10.Loosen clamp on upper radiator hose and separate from radiator.



MX31431

11.Disconnect temperature sensor connector (C).

12.Remove radiator from machine.

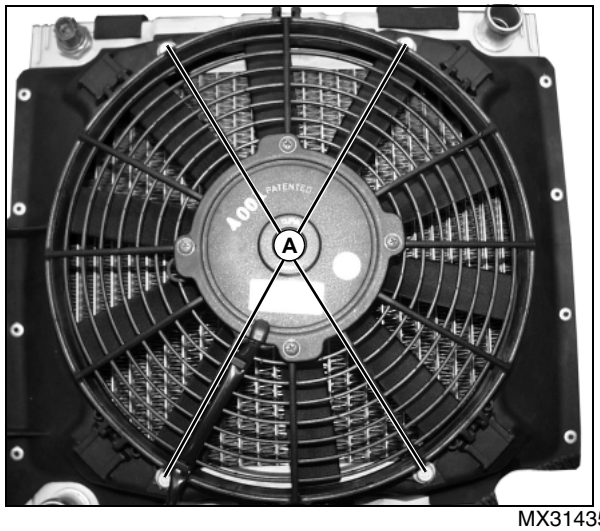
Installation:

- Installation is in the reverse of removal.
- Replace coolant.
- Bleed air from cooling system. See “Radiator Fill and Bleed Procedure - Gas” on page 592.

Cooling Fan Removal and Installation

Removal:

1. Park machine safely on a level surface.
2. Lock park brake.
3. Remove radiator. See “Radiator Removal and Installation” on page 591.



MX31435

4. Remove four screws (A) securing cooling fan to radiator.

Installation:

- Installation is in the reverse of removal.

Radiator Fill and Bleed Procedure - Gas

Filling and Bleeding Cooling System

IMPORTANT: Avoid damage! Using incorrect coolant mixture can damage the radiator:

- **Do not operate engine with plain water.**
- **Use antifreeze approved for use in aluminum engines.**
- **Do not exceed a 50% antifreeze mixture for the coolant.**
- **Do not pour coolant or water into the radiator when the engine is hot.**

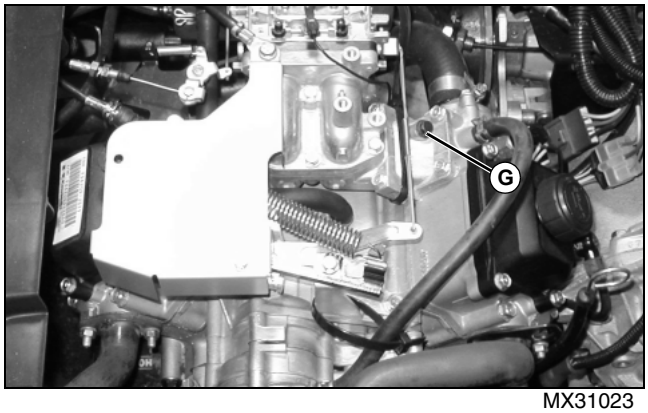
NOTE: John Deere COOL-GARD coolant is recommended when adding coolant to the cooling system. Follow the directions on the container for correct mixture ratio.

Cooling system capacity is approximately 5.0 L (5.2 qt.) including recovery tank.

1. Check that all hose clamps are secured and tight.

IMPORTANT: Avoid damage! Bleed screw uses a special aluminum seal washer. Do not lose or substitute with any other type of washer.

NOTE: Engine block bleed screw may be black in color.



MX31023

2. Remove bleed screw and seal washer (G) located by carburetor.

3. Remove radiator cap and add recommended coolant mixture to radiator until coolant flows out of bleed port.

4. Install and tighten bleed screw with seal washer.

5. Add additional coolant mixture to radiator until coolant flows out of overflow port and into the recovery tank.

6. Install radiator cap.

IMPORTANT: Avoid damage! Position hose slightly above bottom of recovery tank. Do not allow hose to contact bottom of recovery tank or bend upwards out of the coolant.

7. Remove recovery tank cap and add coolant mixture to recovery tank until it is approximately half full.

8. Install recovery tank cap.

IMPORTANT: Avoid damage! If coolant temperature indicator comes on while engine is running, stop engine and add more coolant mixture to radiator.

9. Start and run engine at medium speed until upper and lower radiator hoses have become warm (10 - 15 minutes), indicating thermostat has opened and coolant is circulating.

10.Allow engine to cool.

11.Loosen bleed screw and allow air to bubble out until air bubbles are no longer visible at bleed port. Tighten bleed screw completely.

12.Remove radiator cap and add recommended coolant mixture to radiator until coolant runs out of overflow port and into the recovery tank.

13.Install radiator cap.

14.Run engine until cooling fan starts, indicating the engine and coolant has reached operating temperature.

15.Stop engine and remove key.

16.Allow engine to cool and suction back any needed coolant from overflow recovery tank. Fill recovery tank as needed to lower line.

Radiator Fill and Bleed Procedure - Diesel

Filling and Bleeding Cooling System

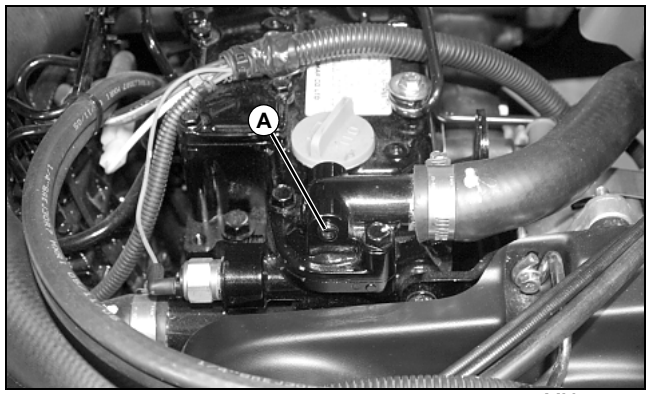
IMPORTANT: Avoid damage! Using incorrect coolant mixture can damage the radiator:

- **DO not operate engine with plain water.**
- **Use antifreeze approved for use in aluminum engines.**
- **DO not exceed a 50% antifreeze mixture for the coolant.**
- **DO not pour coolant or water into the radiator when the engine is hot.**

NOTE: John Deere COOL-GARD coolant is recommended when adding coolant to the cooling system. Follow the directions on the container for correct mixture ratio.

Cooling system capacity is approximately 5.0 L (5.2 qt) including recovery tank.

1. Check that all hose clamps are secured and tight.



MX35817

2. Remove bleed screw (A) located on the thermostat housing.

3. Remove radiator cap and add recommended coolant mixture to radiator until coolant runs out of bleed port.

4. Install and tighten bleed screw.

5. Add additional coolant mixture to radiator until coolant runs out of overflow port and into the recovery tank.

6. Install radiator cap.

IMPORTANT: Avoid damage! Position hose slightly above bottom of recovery tank. Do not allow hose to contact bottom of recovery tank or bend upwards out of the coolant.

7. Remove recovery tank cap and add coolant mixture to recovery tank until it is approximately half full.

8. Install recovery tank cap.

IMPORTANT: Avoid damage! If coolant temperature indicator comes on while engine is running, stop engine and add more coolant mixture to radiator.

9. Start and run engine at medium speed until upper and lower radiator hoses have become warm (10 - 15 minutes), indicating thermostat has opened and coolant is circulating.

10. Allow engine to cool.

11. Loosen bleed screw and allow air to bubble out until air bubbles are no longer visible at bleed port. Tighten bleed screw completely.

12. Remove radiator cap and add recommended coolant mixture to radiator until coolant runs out of overflow port and into the recovery tank.

13. Install radiator cap.

14. Run engine until cooling fan starts, indicating the engine and coolant has reached operating temperature.

15. Stop engine and remove key.

16. Allow engine to cool and suction back any needed coolant from overflow recovery tank. Fill recovery tank as needed to lower line.

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