JOHN DEERE

WORLDWIDE COMMERCIAL & CONSUMER EQUIPMENT DIVISION

Gator Utility Vehicles
4X2 and 4X6

TM1518 MAY 2005

TECHNICAL MANUAL

JOHN DEERE

North American Version
Litho in U.S.A.

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.

Recognize Safety Information

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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.

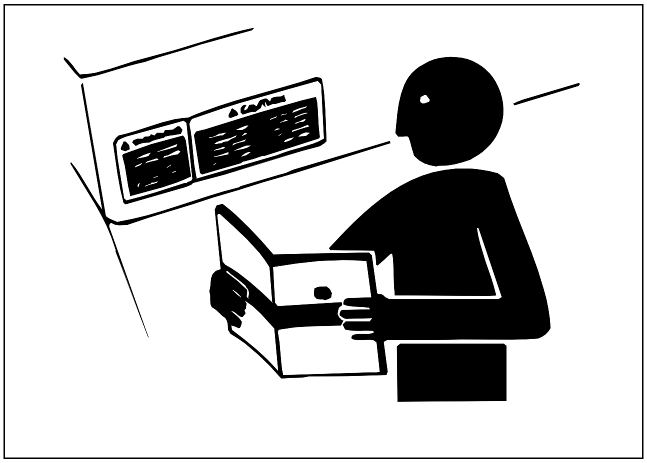
Follow recommended precautions and safe servicing practices.

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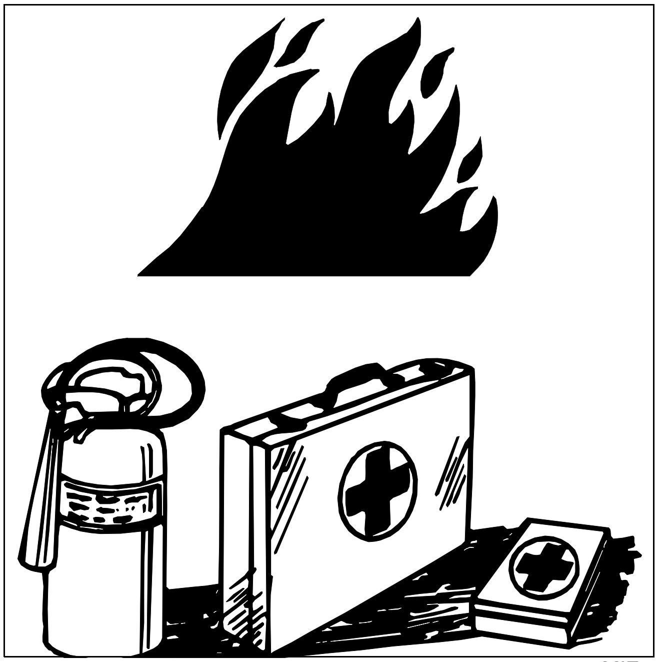
Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

Handle Fluids Safely - Avoid Fires

Be Prepared For Emergencies



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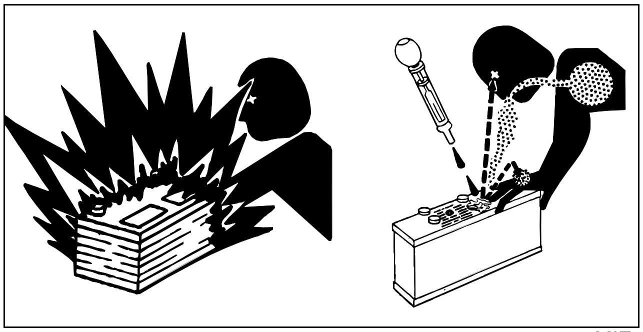
- When you work around fuel, do not smoke or work near heaters or other fire hazards.
- Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.
- Make sure machine is clean of trash, grease, and debris.
- Do not store oily rags; they can ignite and burn spontaneously.
- 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.

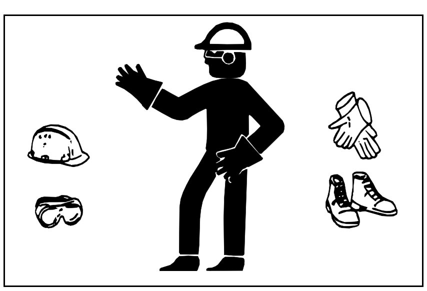
If you spill acid on yourself:

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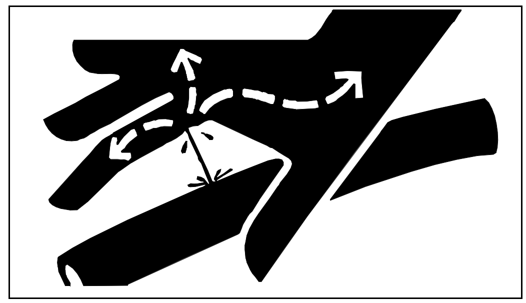
Wear close fitting clothing and safety equipment appropriate to the job.

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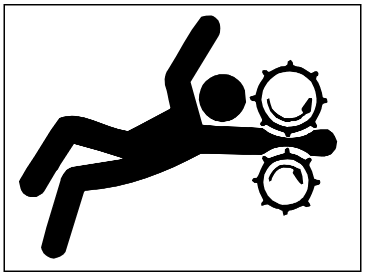
Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can be accidentally cut when heat goes beyond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

Service Machines Safely



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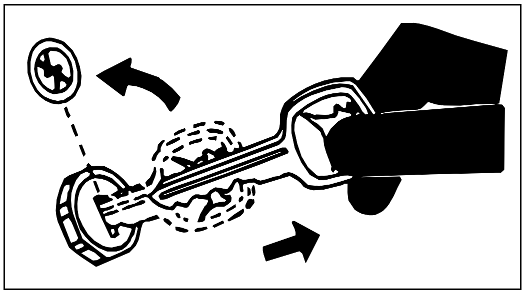
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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.

Park Machine Safely



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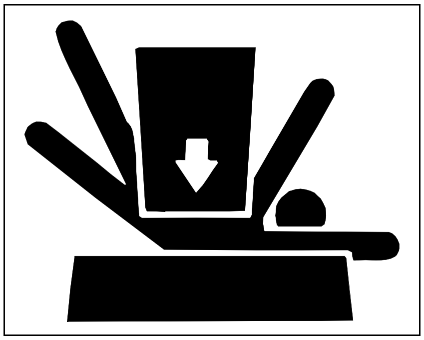
Before working on the machine:

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

Support Machine Properly and Use Proper Lifting Equipment



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

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

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

Work In Clean Area

Before starting a job:

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

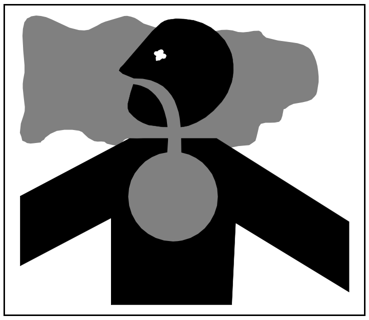
Using High Pressure Washers

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

Illuminate Work Area Safely

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

Work In Ventilated Area



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

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

Warning: California Proposition 65 Warning

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.

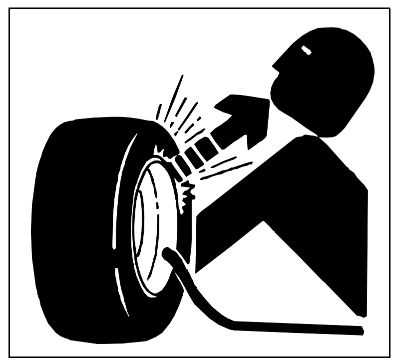
Avoid Harmful Asbestos Dust

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.

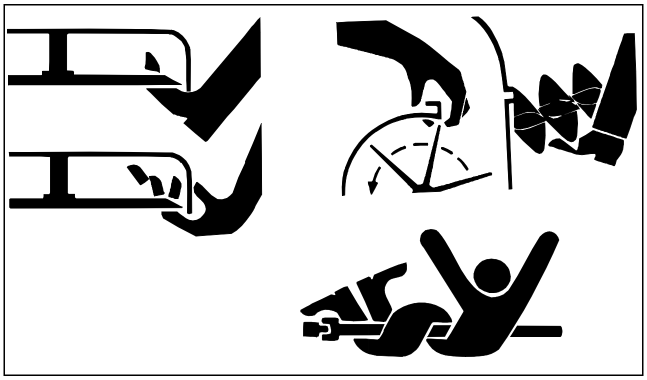
Do not attempt to mount a tire unless you have the proper equipment and experience to perform the job.

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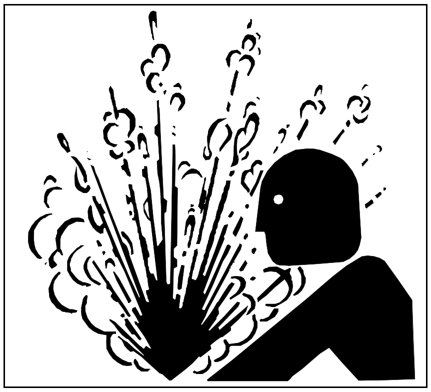
Keep hands and feet away while machine is running. Shut off power to service, lubricate or remove mower blades, augers or PTO shafts.

Service Cooling System Safely



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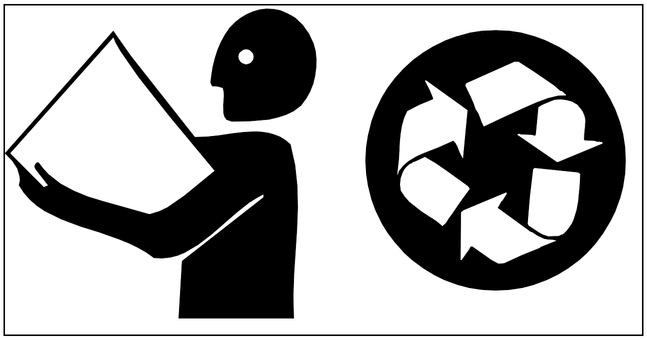
Explosive release of fluids from pressurized cooling system can cause serious burns.

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.

Live With Safety

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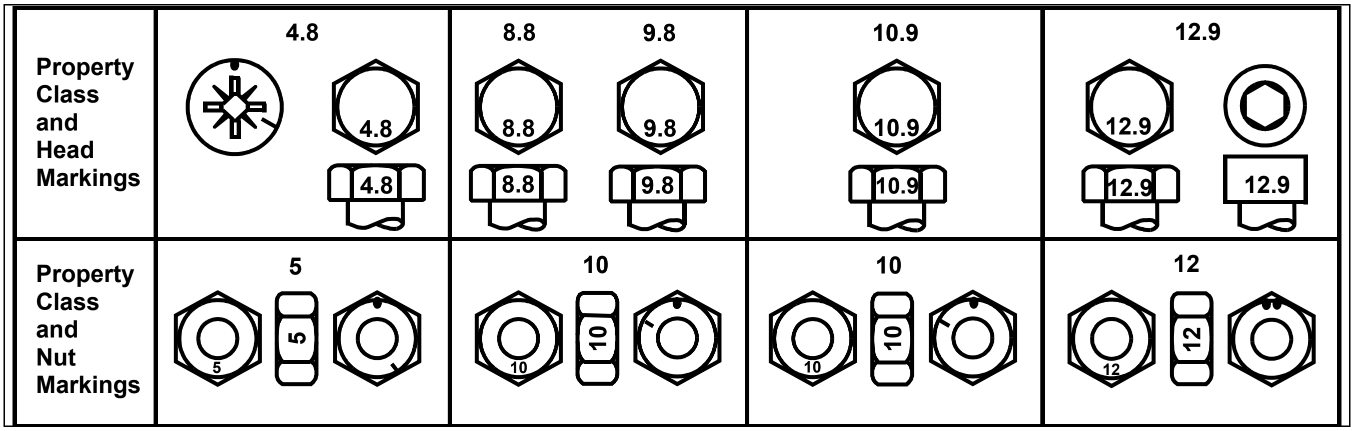
Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

Table of Contents

Fastener Torques

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.

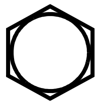
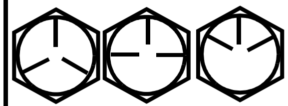
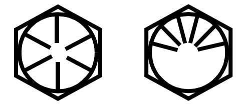
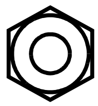
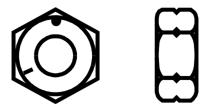
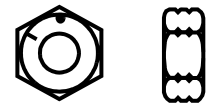
When bolt and nut combination fasteners are used, torque values should be applied to the NUT instead of the bolt head.

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

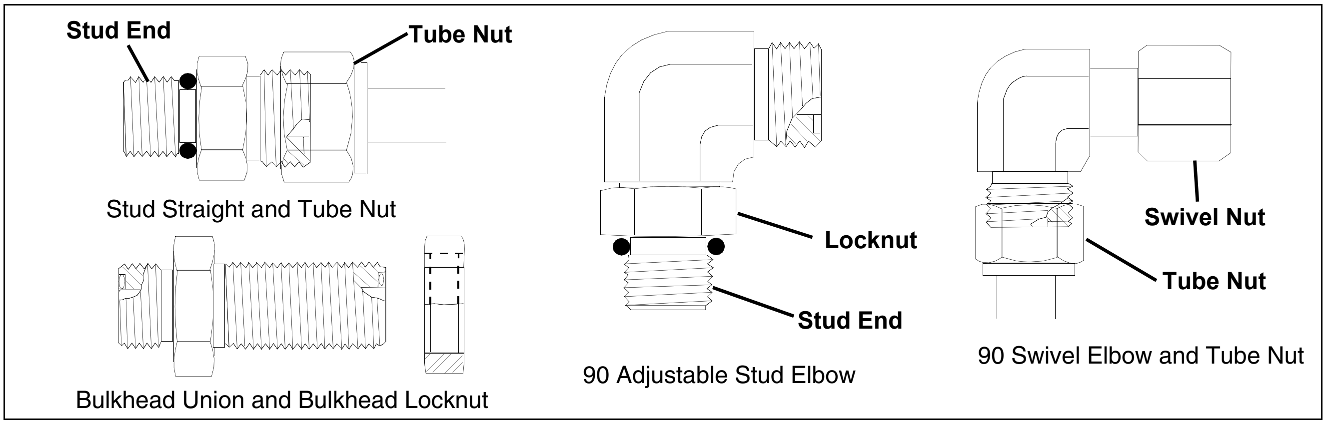
a *“Lubricated” means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. “Dry” means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication*.

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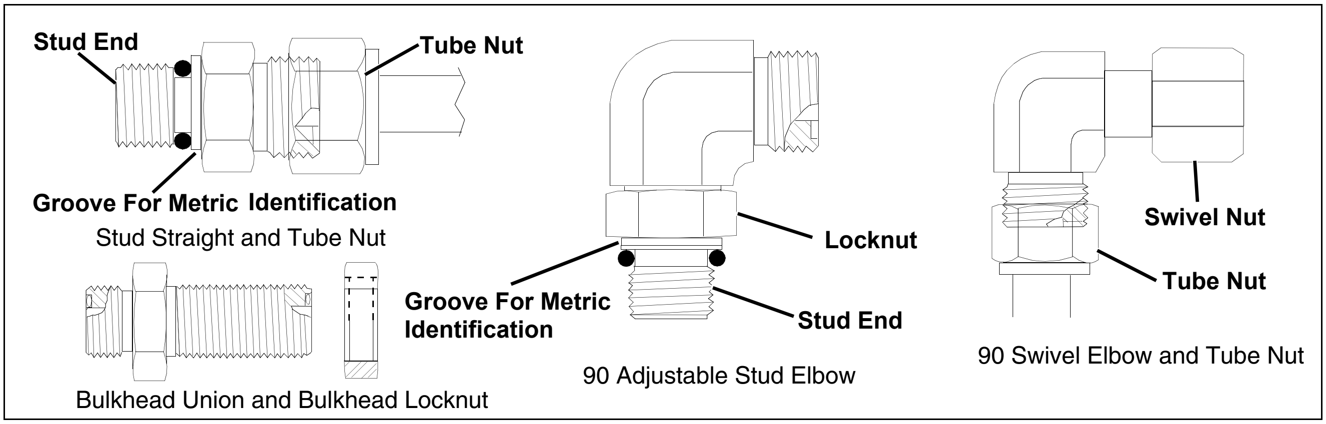
Nominal Tube OD/Hose ID				Face Seal Tube/Hose End					O-Ring Stud Ends		
Metric Tube OD	Inch Tube OD			Thread Size	Tube Nut/ Swivel Nut Torque		Bulkhead Lock Nut Torque		Thread Size	Straight Fitting or Lock Nut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
5	-3	0.188	4.76						3/8-24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

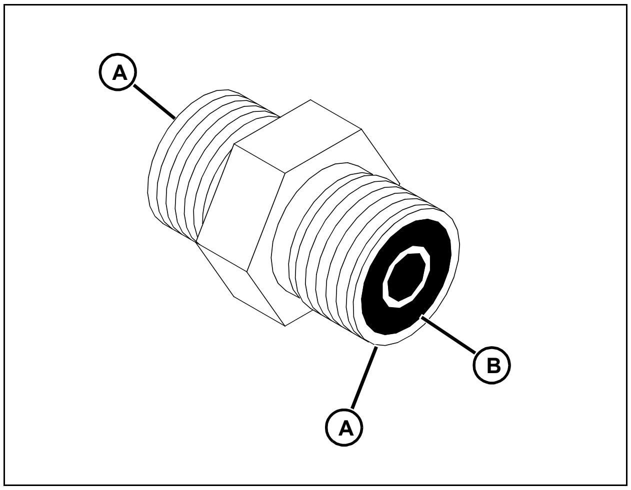


MIF

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



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

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

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

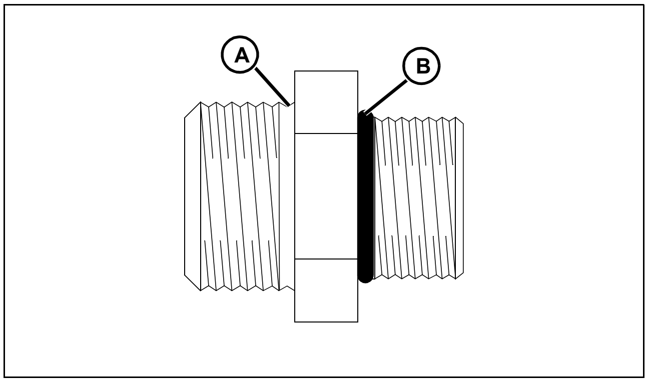
4. Index angle fittings and tighten by hand pressing joint together to insure O-ring remains in place.

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.



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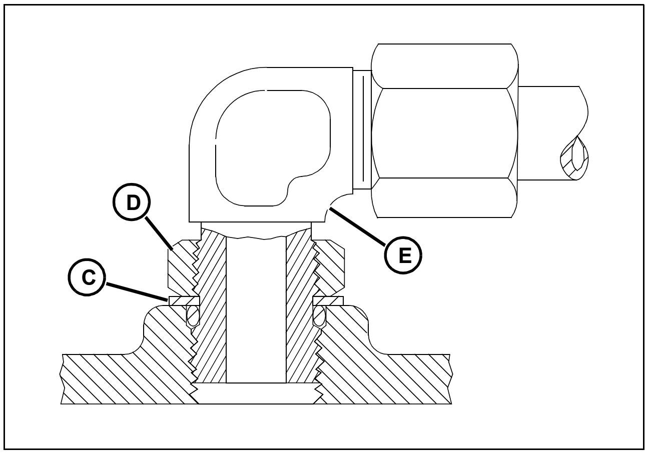
2. Put hydraulic oil or petroleum jelly on the O-ring (B). Place electrical tape over the threads to protect O-ring from nicks. Slide O-ring over the tape and into the groove (A) of fitting. Remove tape.



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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.

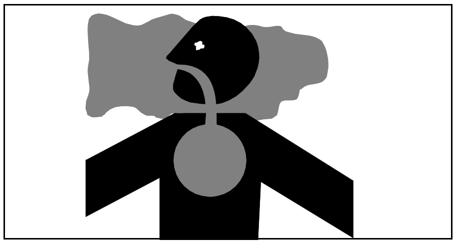
To avoid engine damage:

- 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.

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:

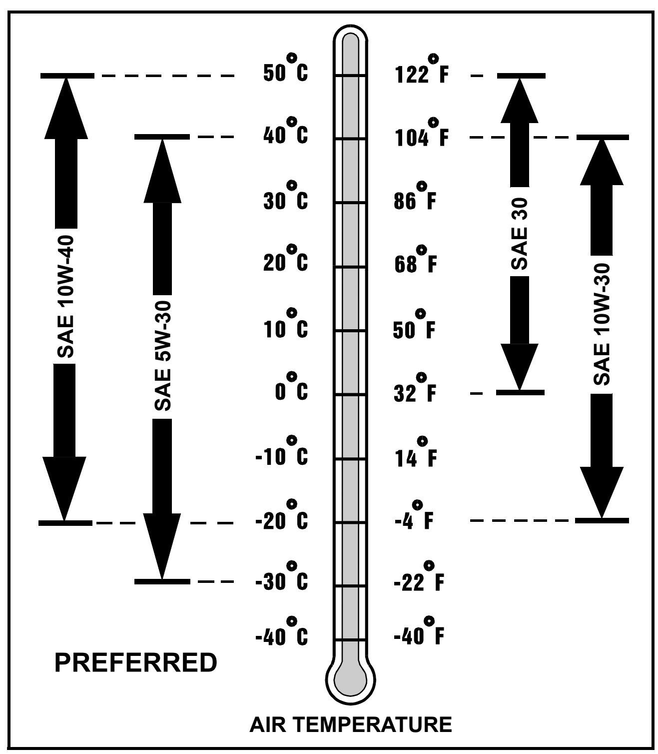
- **PLUS - 4® - SAE 10W-40**;
- **TORQ - GARD SUPREME® - SAE 5W-30**.

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.



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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.

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.

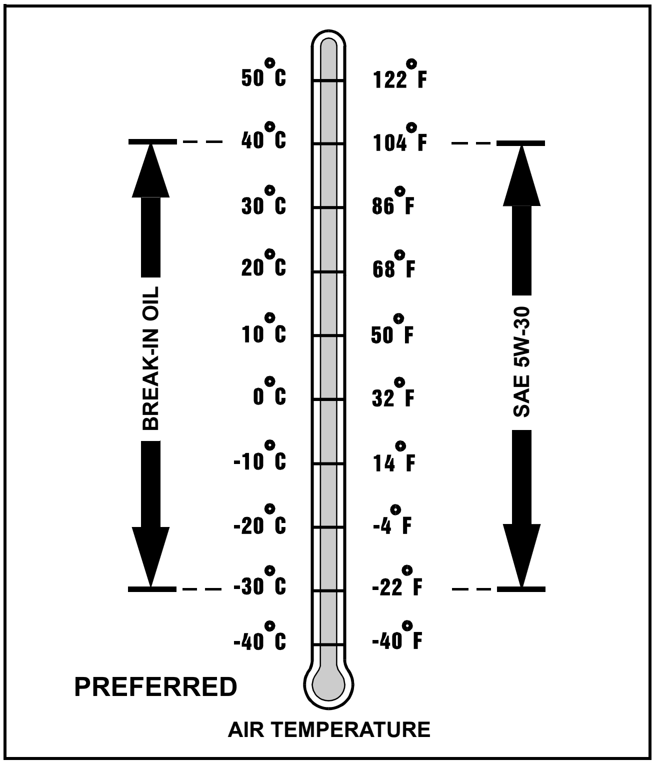
The following John Deere oil is **also recommended**:

- **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.



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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**.

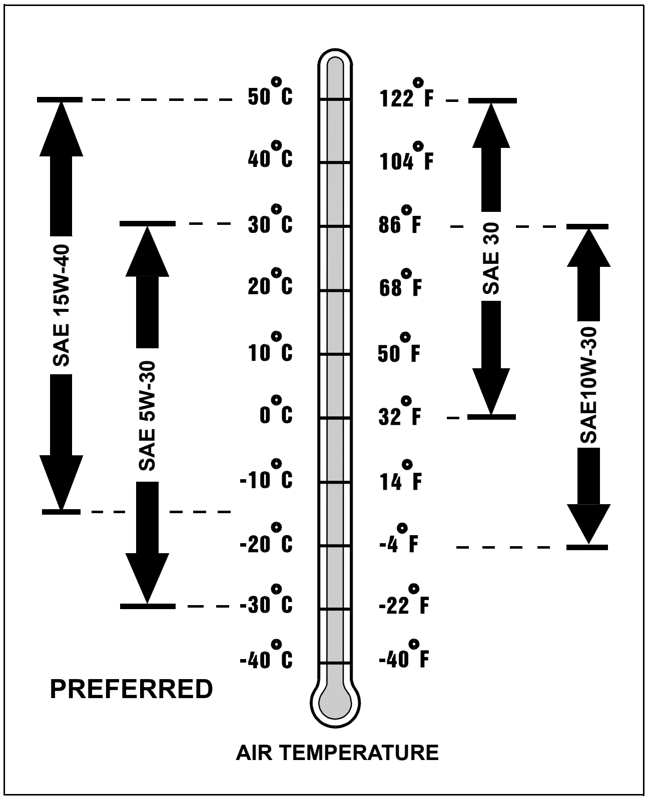
The following John Deere oils are **also** recommended, based on their specified temperature range:

- **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%.



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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**.

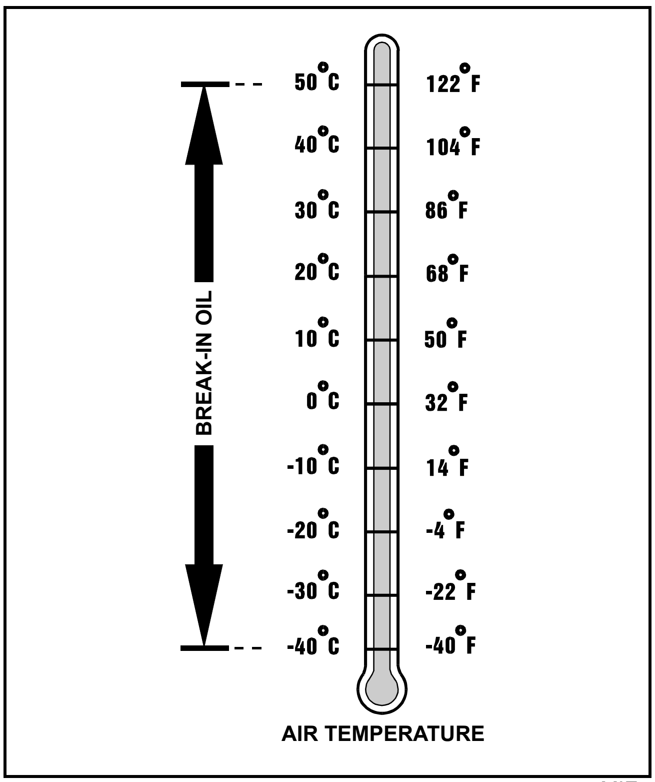
John Deere BREAK - IN ENGINE OIL is formulated with special additives for aluminum and cast iron type engines to allow the power cylinder components (pistons, rings, and liners as well) to "wear-in" while protecting other engine components, valve train and gears, from abnormal wear. Engine rebuild instructions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



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Hydrostatic Transmission and Hydraulic 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. DO NOT use BIO-HY-GARD® in this transmission.

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

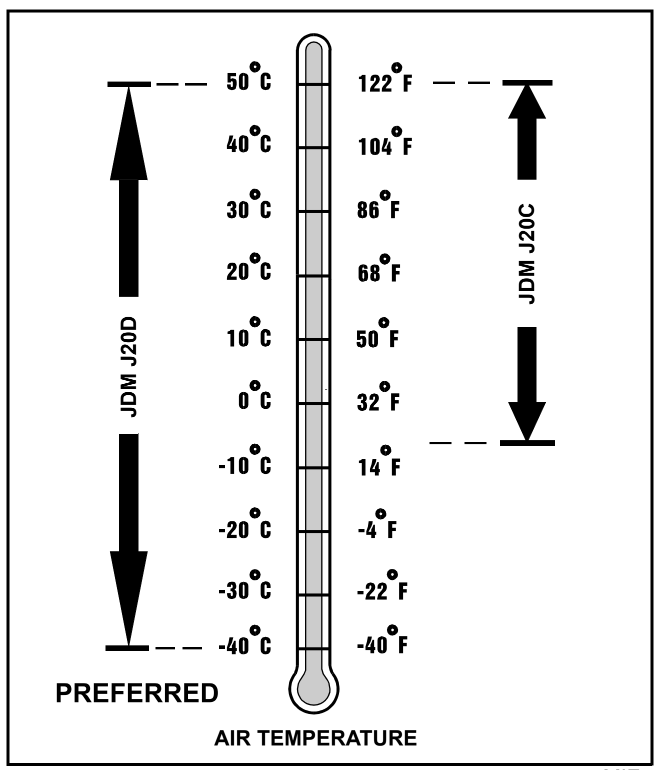
- **LOW VISCOSITY HY-GARD® - JDM J20D**.

The following John Deere oil is also recommended if above preferred oil is not available:

- **HY-GARD® - JDM J20C.**

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 J20D;
- John Deere Standard JDM J20C.



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Gear Case Oil

Use the appropriate oil viscosity based on the air temperature ranges. Operating outside of these recommended oil air temperature ranges may cause premature gear case failure.

IMPORTANT: Avoid damage! ONLY use a quality oil in this gear case. DO NOT mix any other oils in this gear case. DO NOT use BIO-HY-GARD® in this gear case.

The following John Deere gear case oil is PREFERRED:

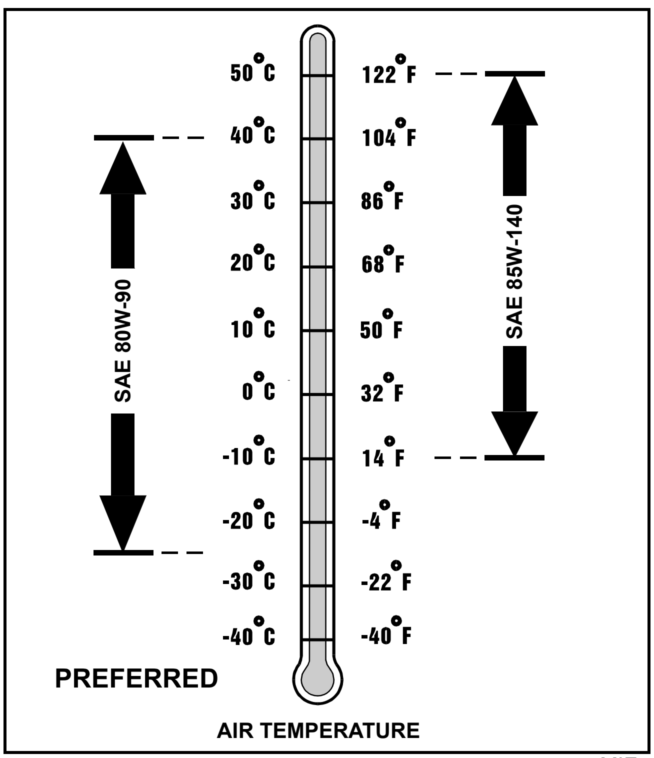
- **GL-5 GEAR LUBRICANT® - SAE 80W-90.**

The following John Deere gear case oil is also recommended if above preferred oil is not available:

- **GL-5 GEAR LUBRICANT® - SAE 85W-140.**

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

- API Service Classification GL - 5.



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Gear Transmission Grease

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

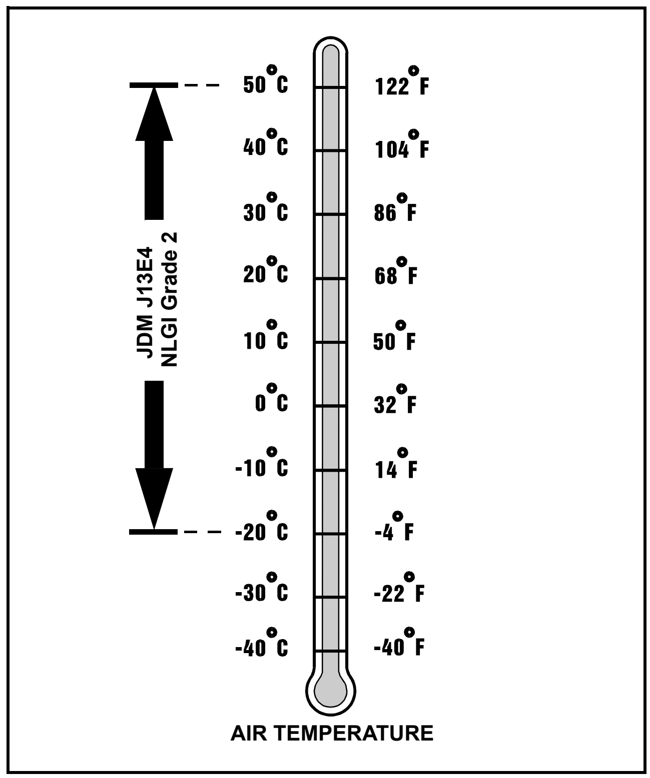
IMPORTANT: Avoid damage! ONLY use a quality gear grease in this transmission. DO NOT mix any other greases in this transmission. DO NOT use any BIO - GREASE in this transmission.

The following John Deere gear grease is PREFERRED:

- **NON-CLAY HIGH-TEMPERATURE EP GREASE® -** JDM J13E4, NLGI Grade 2.

Other greases may be used if above preferred John Deere grease is not available, provided they meet the following specification:

- John Deere Standard JDM J13E4, NLGI Grade 2.



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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.

Coolant Specifications

Gasoline 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 CONCENTRATE™ (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).

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.

Gasoline 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.

Diesel Engine Coolant

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

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

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

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

The above preferred pre-diluted anti-freeze provides:

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

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

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

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

- ASTM D3306 (JDM H24C1).

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

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

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.

Diesel Engine Coolant Drain Interval

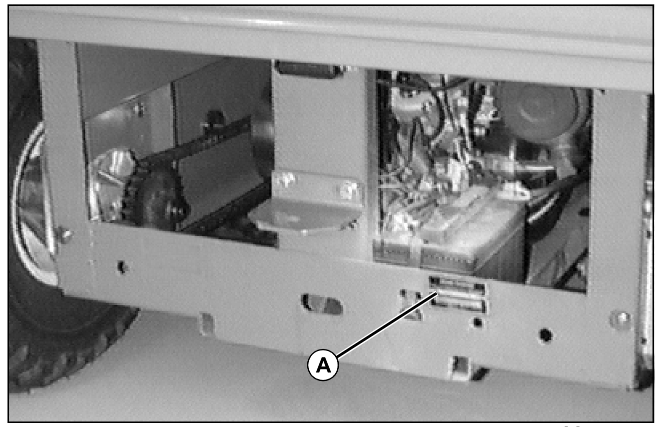
When using John Deere Pre-Diluted (TY16036) Automobile and Light Duty Engine Service coolants, drain and flush the cooling system and refill with fresh coolant mixture every 36 months or 3,000 hours of operation, whichever comes first.

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



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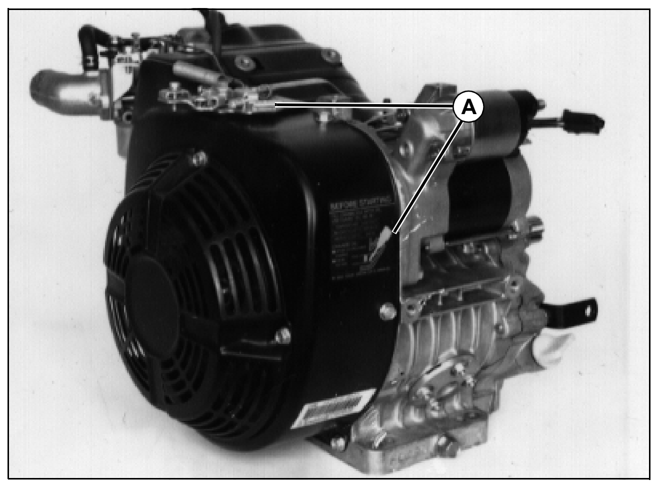
The product identification number (A) is located on the rear of the frame.

Engine (FE290D) Serial Number Location



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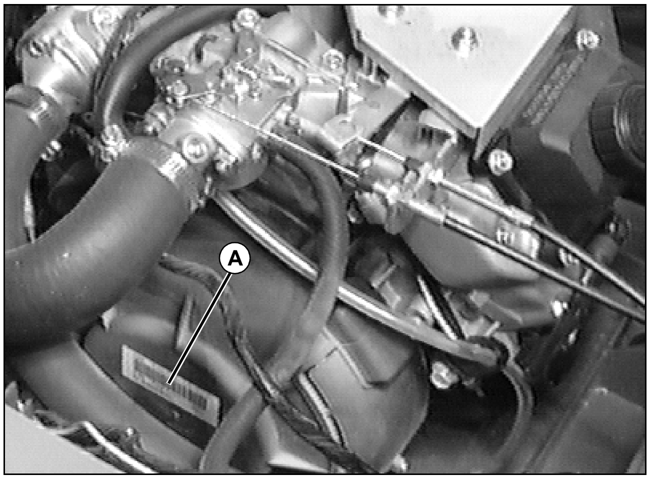
Engine serial number (A) can be located on either the top or side of blower housing.

Engine (FE620D) Serial Number Location



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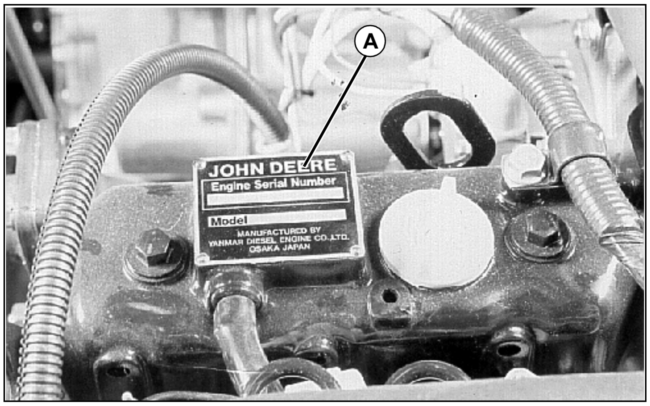
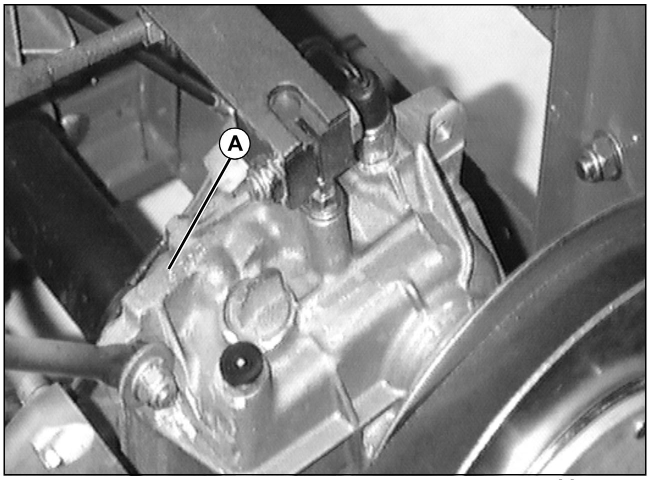
Engine (3TN66C) Serial Number Location



M76678

Transaxle Serial Number Location



M55707

Table of Contents

ENGINE - GAS (AIR-COOLED) SPECIFICATIONS

Specifications

General Specifications

Make . . . . **Kawasaki**
Model **FE290D-BS08**
Type . . . . **4-cycle gas/Air cooled**
Power . . . . **7.46 kW (10 hp)**
Cylinders **1**
Cycles **4**
Bore . . . . **78 mm (3.070 in.)**
Stroke . . . . **60 mm (2.360 in.)**
Displacement . . . . **286 cm3 (17.5 cu-in.)**

Test and Adjustment Specifications

Engine:

Oil pressure (minimum) . . . . **314 kPa (46 psi)**
Oil filter bypass valve opening pressure . . . . **78 - 118 kPa (11.3 - 17.0 psi)**
Compression pressure at operating temperature (minimum) . . . . **393 kPa (57 psi)**
Compression pressure at operating temperature (maximum) . . . . **965 kPa (140 psi)**
Crankcase vacuum (minimum) . . . . **25 mm (1 in.) water movement**
Intake and exhaust valve clearance (cold) . . . . **0.125 ± 0.025 mm (0.005 ± 0.001 in.)**
Intake and exhaust valve adjustment interval . . . . **300 hrs**
Valve clearance adjusting nut torque . . . . **20 N•m (180 lb-in.)**
Auto Compression Release minimum lift . . . . **0.6 mm (0.023 in.)**
Auto Compression Release standard lift . . . . **1.2 mm (0.047 in.)**
Auto Compression Release release rpm . . . . **600 ± 100 rpm**
Breather reed valve tip air gap . . . . **0.2 mm (0.008 in.)**
Valve cover cap screw torque . . . . **6 N•m (53 lb-in.)**

Fuel/Air System:

Fuel Pump
Minimum Pressure . . . . **6.12 kPa (0.9 psi)**
Minimum Flow . . . . **80 ml (2.7 oz) in 15 seconds**
Carburetor SLOW idle mixture screw initial setting
(PIN -12700) with no limiter cap . . . . **1-3/8 Turns**
Throttle control arm SLOW idle stop screw setting . . . . **1125 ± 75 rpm**
Carburetor SLOW idle stop screw setting . . . . **50 rpm less than throttle control arm SLOW idle stop screw setting**
Throttle control arm FAST idle stop screw setting (S.N. - 345211) . . . . **3750 ± 100 rpm**
Throttle control arm FAST idle stop screw setting (S.N. 345212-) . . . . **3850 ± 75 rpm**
Fuel tank check valve (PIN -14950) maximum opening pressure . . . . **3 kPa (0.4 psi)**

ENGINE - GAS (AIR-COOLED) SPECIFICATIONS

Repair Specifications

Miscellaneous Repair Specifications

Breather Maximum Air Gap . . . . . 0.20 mm (0.008 in.)

Flywheel Nut Torque . . . . . 85 N•m (63 lb-ft)

Cylinder Head Assembly

Cylinder Head Flatness . . . . . 0.05 mm (0.002 in.)

Cap Screw Torque
First . . . . . 18 N•m (159 lb-in.)

Second. . . . . 21 N•m (186 lb-in.)

Final . . . . . 24 N•m (212 lb-in.)

Spark Plug Torque . . . . . 25 N•m (221 lb-in.)

Rocker Arm:

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

Maximum Bearing ID . . . . . 12.07 mm (0.475 in.)

Push Rod:

Maximum Bend . . . . . 0.30 mm (0.012 in.)

Valves and Springs:

Valve Clearance . . . . . 0.127 mm (0.005 in.)

Valve Seat Width. . . . . 0.50 - 1.10 mm (0.020 - 0.043 in.)

Intake and Exhaust Valves
Maximum Bend . . . . . 0.03 mm (0.0012 in.)

Minimum Valve Face Margin . . . . . 0.060 mm (0.024 in.)

Valve Stem OD (Wear Limit)
Intake Valve . . . . . 6.930 mm (0.2728 in.)

Exhaust Valve . . . . . 6.915 mm (0.2722 in.)

Valve Guides
Maximum Guide ID . . . . . 7.065 mm (0.2781 in.)

Finished (Reamed) ID. . . . . 7.00 - 7.015 mm (0.2756 - 0.2762 in.)

Valve Springs Minimum Free Length . . . . . 32.75 mm (1.289 in.)

Valve Seat - Recondition
Valve Face Angle . . . . . 45°

Valve Margin . . . . . 0.60 mm (0.020 in.)

Valve Narrowing Angle. . . . . 30°

Valve Seat Angle. . . . . 45°

Valve Seating Surface Width . . . . . 0.50 - 1.10 mm (0.020 - 0.043 in.)

ENGINE - GAS (AIR-COOLED) SPECIFICATIONS

Crankcase:

Cover Mounting Cap Screw Torque . . . . 26 N•m (230 lb-in.)

Oil Drain Plug Torque . . . . 21 N•m (186 lb-in.)

Maximum Crankcase Main Bearing ID . . . . 30.08 mm (1.184 in.)

End Play . . . . 0.09 - 0.22 mm (0.004 - 0.009 in.)

Crankshaft Oil Seal Depth (PTO End) . . . . 4 mm (0.158 in.)

Governor Mounting Shaft Height (Top of Shaft-to-Cover) . . . . 32.2 - 32.8 mm (1.267 - 1.291 in.)

Governor Shaft Oil Seal Depth . . . . 1.42 mm (0.056 in.)

Camshaft:

Minimum Cam Lobe Height . . . . 32.70 mm (1.287 in.)

Minimum PTO and Flywheel Side Journal OD . . . . 22.93 mm (0.903 in.)

Maximum Cylinder Block and Cover Bearing ID . . . . 23.06 mm (0.908 in.)

Crankshaft:

Maximum Total Indicated Runout . . . . 0.05 mm (0.002 in.)

Minimum Main Bearing Journal OD . . . . 29.92 mm (1.178 in.)

Minimum Connecting Rod Journal OD
Standard . . . . 35.43 mm (1.395 in.)

Undersized . . . . 34.93 mm (1.375 in.)

Crankshaft Bearing
Standard . . . . 35.57 mm (1.400 in.)

Undersized . . . . 35.07 mm (1.380 in.)

Reciprocating Balancer:

Link Rod

Minimum Journal OD . . . . 46.86 mm (1.845 in.)

Maximum Small End ID . . . . 12.06 mm (0.475 in.)

Maximum Large End ID . . . . 47.12 mm (1.855 in.)

Bushing Depth . . . . 1.00 mm (0.040 in.)

Support Shaft

Maximum Bearing ID . . . . 26.10 mm (1.027 in.)

Minimum Shaft OD . . . . 25.93 mm (1.021 in.)

Piston and Rings:

Maximum Ring Groove Clearance
First Compression Ring . . . . 0.16 mm (0.006 in.)

Second Compression Ring . . . . 14 mm (0.005 in.)

Oil Ring Assembly . . . . Not Measured

Maximum Ring End Gap
Compression Rings . . . . 120 mm (0.047 in.)

Oil Ring Assembly . . . . Not Measured

Maximum Piston Pin Bore ID . . . . 19.03 mm (0.749 in.)

Minimum Piston Pin OD . . . . 18.98 mm (0.747 in.)

Piston OD, Standard. . . . . 77.85 - 77.87 mm (3.0649 - 3.0657 in.)

Piston OD, Oversized (0.50 mm (0.020 in.). . . . . 78.35 - 78.37 mm (3.0849 - 3.0857 in.)

Connecting Rod:

Maximum Crankshaft Bearing ID
Standard . . . . . 35.57 mm (1.400 in.)

Undersized . . . . . 35.07 mm (1.380 in.)

Maximum Piston Pin Bearing ID . . . . . 19.06 mm (0.750 in.)

End-Cap Screw Torque . . . . . 20 N•m (177 lb-in.)

Cylinder Bore ID:

Standard Size Bore
Standard . . . . . 77.98 - 78.00 mm (3.070 - 3.071 in.)

Wear Limit . . . . . 78.07 mm (3.074 in.)

Out-of-Round (Maximum) . . . . . 0.056 mm (0.0022 in.)

0.50 mm (0.020 in.) Oversize Bore
Standard . . . . . 78.46 - 78.48 mm (3.089 - 3.090 in.)

Wear Limit . . . . . 78.55 mm (3.093 in.)

Oil Pump

Maximum Outer Rotor Bearing Depth . . . . . 10.17 mm (0.400 in.)

Maximum Outer Rotor Shaft Bearing ID . . . . . 40.77 mm (1.605 in.)

Minimum Outer Rotor Shaft OD . . . . . 40.47 mm (1.596 in.)

Minimum Outer Rotor Thickness . . . . . 9.92 mm (0.391 in.)

Minimum Relief Valve Spring Free Length . . . . . 19 mm (0.748 in.)

Maximum Rotor Shaft Bearing ID . . . . . 12.77 mm (0.503 in.)

Minimum Rotor Shaft OD . . . . . 12.63 mm (0.497 in.)

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).

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.
Carburetor Test Kit	JDZ25-2	Fuel tank check valve test.
Compression Gauge Spark Plug Test Tool	JDM59 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.

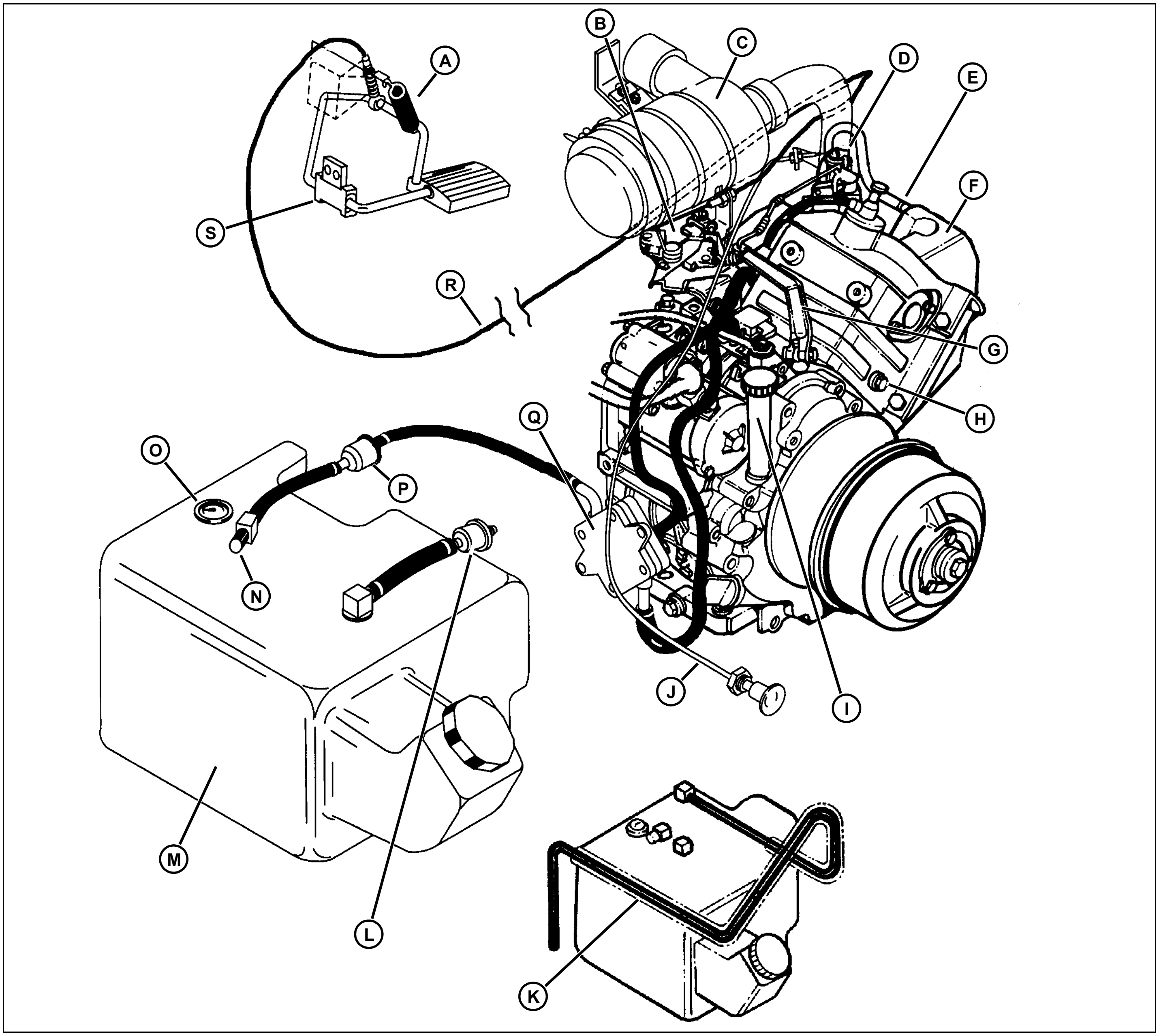
Other Materials

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.

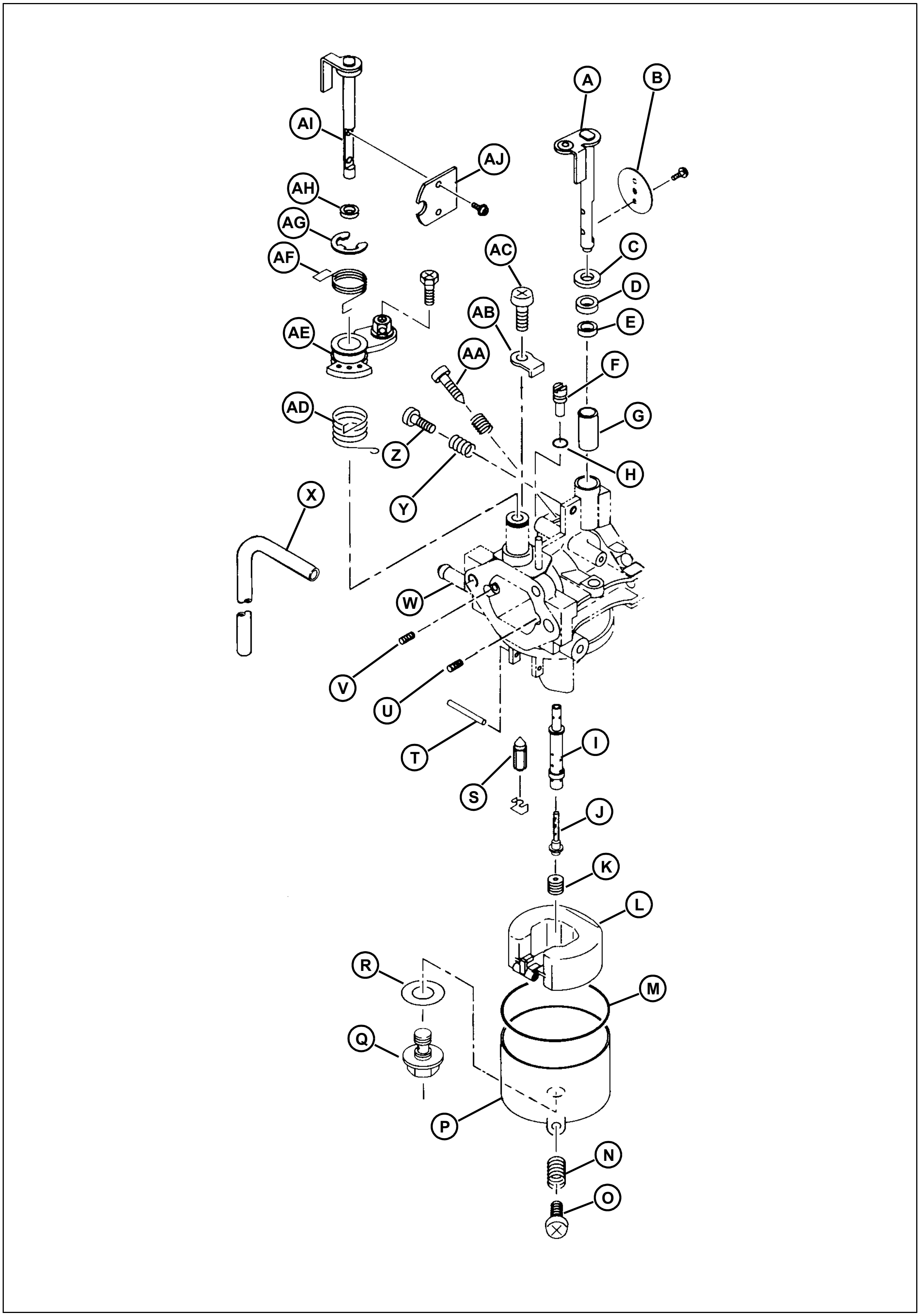
Component Location

FE290D Engine



- A - Throttle Pedal Return Spring
- B - Throttle Control Arm Assembly
- C - Air Filter Assembly
- D - Carburetor Assembly
- E - Breather Reed Valve Assembly
- F - Intake and Exhaust Valves, 0.25 mm (0.01 in.)
- G - Governor Arm Assembly, Fully Counter-Clockwise
- H - Oil Pressure Test Port, Pressure (Minimum) 314 kPa (46 psi)
- I - Crankcase Vacuum Test Port (Engine Dipstick)
- J - Choke Cable Assembly (Slight Freeplay)
- K - Fuel Tank Vent Hose Assembly (PIN 009369-)
- L - Fuel Tank Check Valve Assembly (PIN -009368)
- M - Fuel Tank Assembly, 20 L (5.3 U.S. gal)
- N - Shutoff Valve
- O - Fuel Tank Gauge
- P - In-line Fuel Filter
- Q - Fuel Pump Assembly
- R - Throttle Cable Assembly
- S - Throttle Pedal Assembly

Carburetor Components



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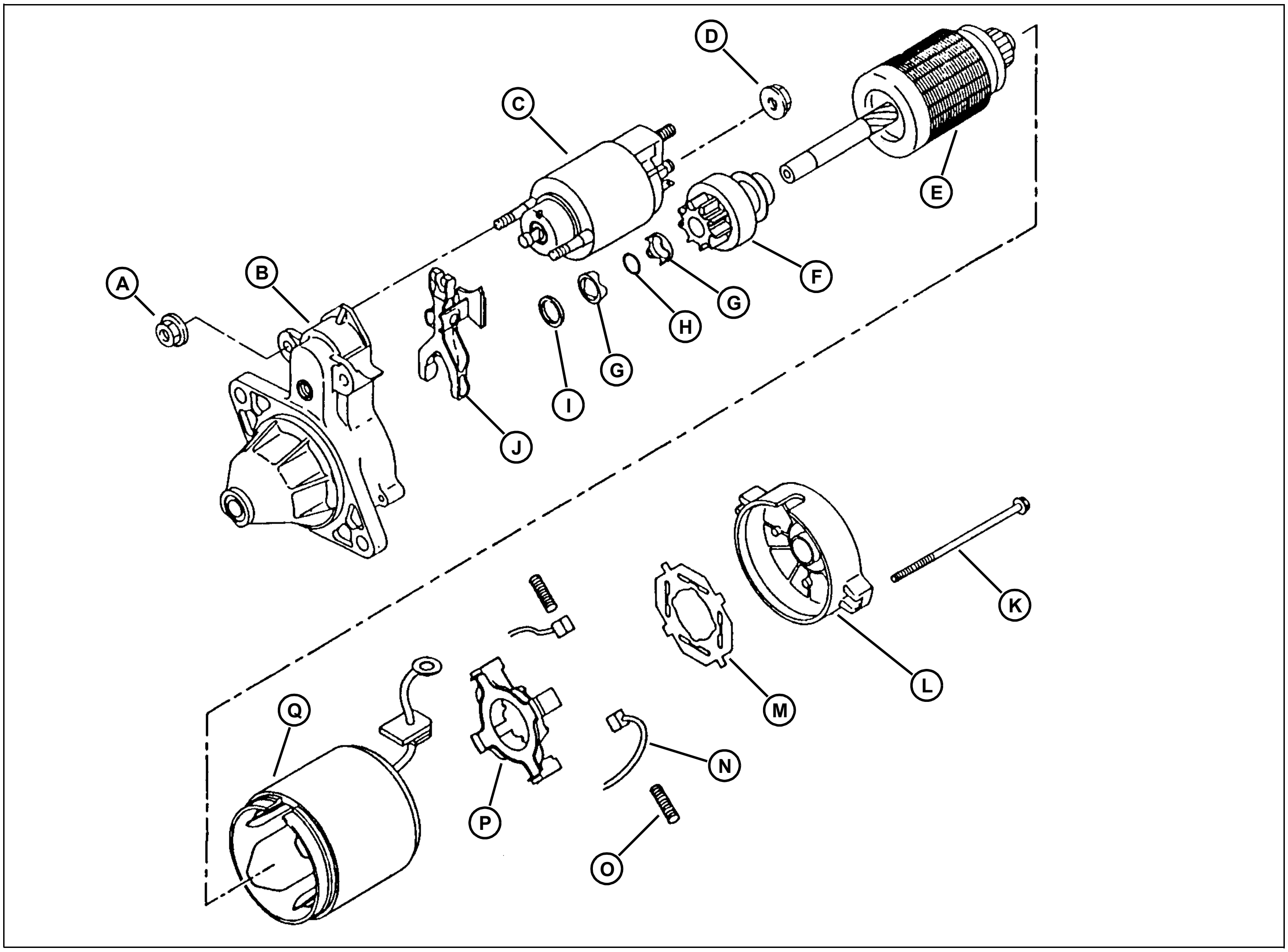
A - Throttle Shaft
B - Throttle Valve
C - Washer
D - Seal
E - Bushing
F - Pilot Jet
G - Bushing
H - O-Ring
I - Main Nozzle
J - Bleed Pipe (older models only)
K - Main Jet
L - Float
M - Gasket
N - Spring
O - Drain Screw
P - Float Chamber
Q - Plug
R - Washer
S - Needle Valve
T - Float Pin
U - Main Air Jet
V - Pilot Air Jet
W - Carburetor Body
X - Vent Tube
Y - Spring (2)
Z - Idle Screw
AA- Pilot Screw
AB- Lock Plate
AC- Screw
AD- Spring
AE- Lever
AF- Spring
AG- E-Clip
AH- Seal
AI - Choke Shaft
AJ- Choke Valve

NOTE: Main jet high altitude kits for standard or heavy duty air cleaners are available.

Starter Motor Components



M82414A

A - Solenoid Mount Nuts (2)
B - Front Cover
C - Solenoid
D - Flange Nut
E - Armature
F - Pinion
G - Stopper Half
H - Retaining Clip
I - Washer
J - Shift Lever
K - Long Cap Screw (2)
L - End Cover
M - Insulator
N - Brush (4)
O - Spring (4)
P - Brush Holder
Q - Field Coil

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
- PTO Switch In Off Position
- 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 "Automatic Compression Release (A.C.R.) Test" on page 46. 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, float bowl level too high.

No - Check fuel tank and lines.

(5) Compression is low?

Yes - Check piston rings and cylinder for wear. See "Piston and Connecting Rod" on page 60. Inspect cylinder head. See "Cylinder Head Inspection and Replacement" on page 55.

Symptom: Engine Runs Erratically

(1) Is fuel delivery correct? See "Fuel Pump Flow Test" on page 43.

Yes - Check for plugged air/fuel passages in carburetor. See "Carburetor Disassembly and Assembly" on page 52.

No - Check for contamination, or an air or vapor lock in the fuel tank and lines. Check tank check valve (PIN -14950), shut off valve, 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 38.

No - Go to next step.

Symptom: Engine Malfunctions At Low Speed

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

Yes - Plug in carburetor interior, clean carburetor. See “Carburetor Disassembly and Assembly” on page 52.

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 45.

No - Adjust valves.

Symptom: Oil Consumption Is Excessive

(1) Check compression. See “Automatic Compression Release (A.C.R.) Test” on page 46. 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” on page 71.

Symptom: Starter Does Not Rotate

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

(2) Are battery cables loose or dirty?

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

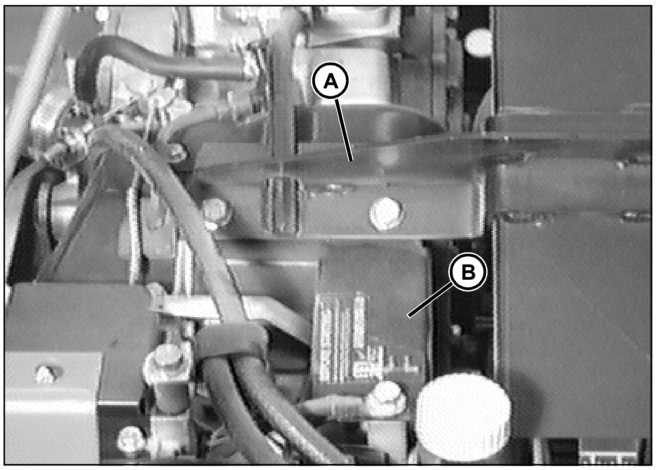
Governor Adjustment

Reason:

To get proper governor response.

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



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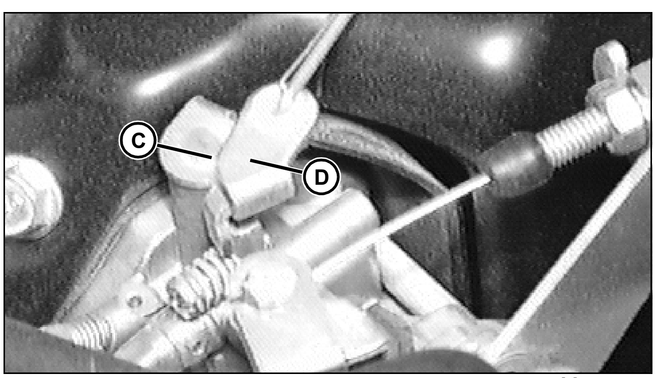
2. Remove engine-to-transaxle support (A) and governor shaft cover (B).

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



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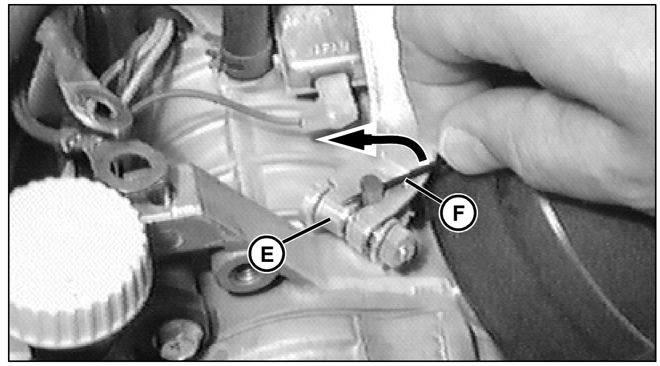
3. Depress throttle pedal to FAST idle. Make sure tab (C) contacts stop (D).



M56370

4. Loosen and spread clamp (E) of governor arm.

5. Insert pin (F) in governor shaft hole, turn shaft counterclockwise to stop.

6. Tighten clamp.

7. Move throttle pedal to determine full linkage travel and no binding.

8. Install governor shaft cover and engine-to-transaxle support.

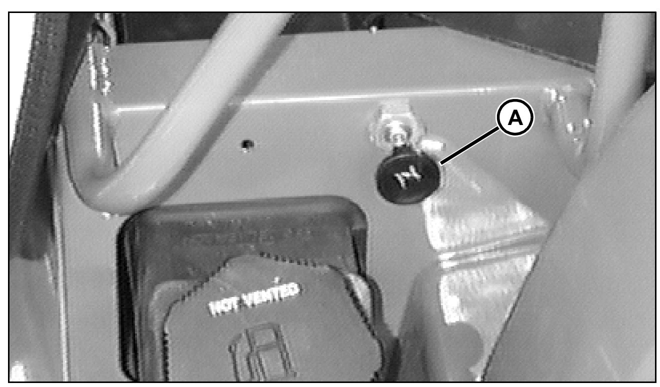
Choke Cable Adjustment

Reason:

To get full choke operation.

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



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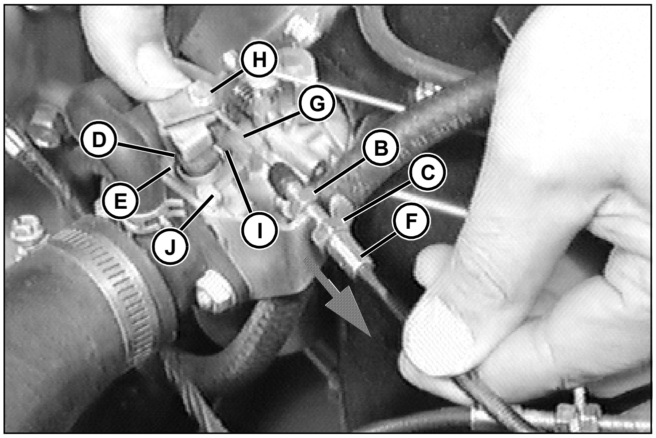
2. Be sure choke knob (A) is in OFF (released) position.



M56377

3. Loosen jam nuts (B and C).

4. Hold tab (D) against stop (E).

5. Pull choke cable conduit (F) away to remove all slack in cable (G).

6. Snug jam nuts.

7. Turn jam nut (C) 1 to 2 additional turns counterclockwise (to add a slight amount of cable slack).

8. Tighten jam nut (B).

9. Pull choke knob slightly as your watch choke arm of the carburetor. Choke arm should respond as soon as the slight freeplay of cable and anchor barrel is removed.

10.Move choke linkage through full range of motion to be sure choke opens and closes fully and linkage moves smoothly from stop-to-stop.

Slow Idle Mixture Screw and Speed Adjustments

NOTE: Slow idle mixture screw on models after PIN (012700-) have plastic limiter cap installed and may not be adjusted more than ¼ turn.

Reason:

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

Equipment:

- JDM-71 Vibration Tachometer

  -or-

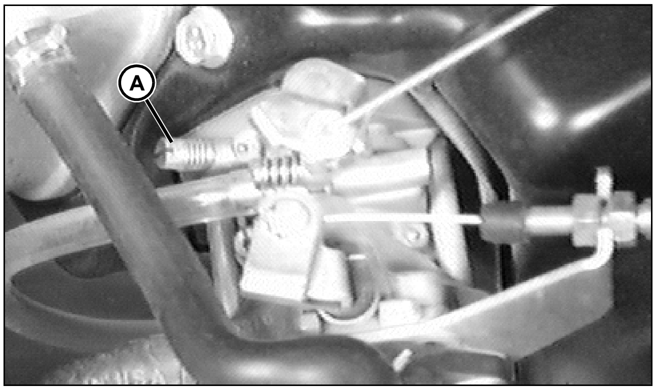
- JT05719 Digital Tachometer

NOTE: It may be difficult to get a good reading with a vibration tachometer on this engine, especially at slow idle. Therefore, you may want to use the digital tachometer.

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.

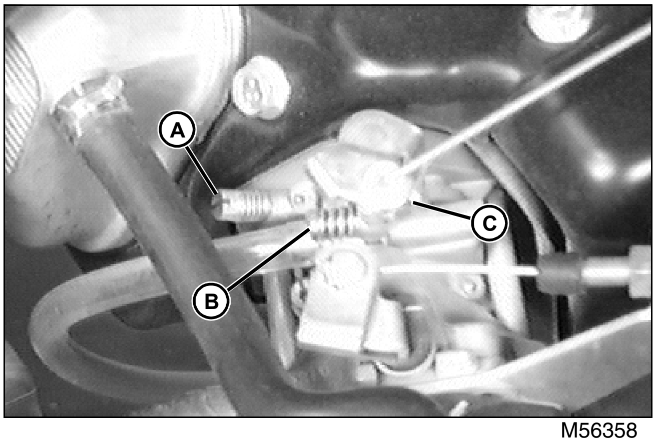
IMPORTANT: Avoid damage! It may be difficult to get a good reading with a vibration tachometer on this engine, especially at slow idle. Therefore, you may want to use the digital tachometer.



M56358

2. On models with no limiter cap (PIN -012700), Turn SLOW idle mixture screw (A) clockwise until lightly seated. Turn screw counterclockwise 1-3/8” turns. On models with limiter cap (PIN 012700-), move screw to centered position.

IMPORTANT: Avoid damage! DO NOT overtighten idle mixture screw, the needle and seat will be damaged.



M56358

3. Run engine at MEDIUM idle for five minutes to reach operating temperature.

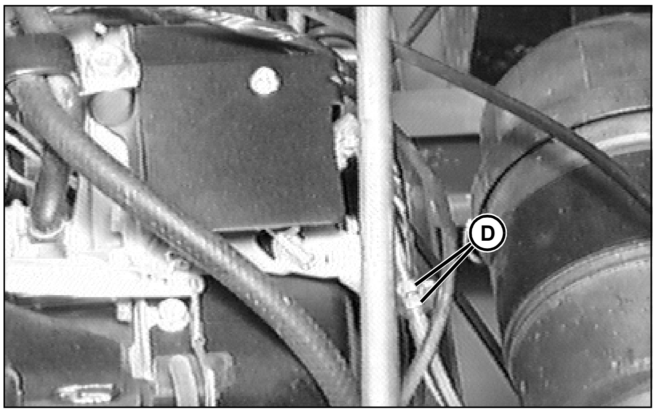
NOTE: When throttle pedal is released, it takes approximately 30 seconds for engine idle speed to stabilize.

4. Release throttle pedal.

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.

5. Turn SLOW idle stop screw (B) counterclockwise until screw is NOT touching throttle arm stop tab (C).

NOTE: It may be necessary to loosen throttle cable jam nuts (D) and move cable conduit slightly to get proper SLOW idle speed setting.



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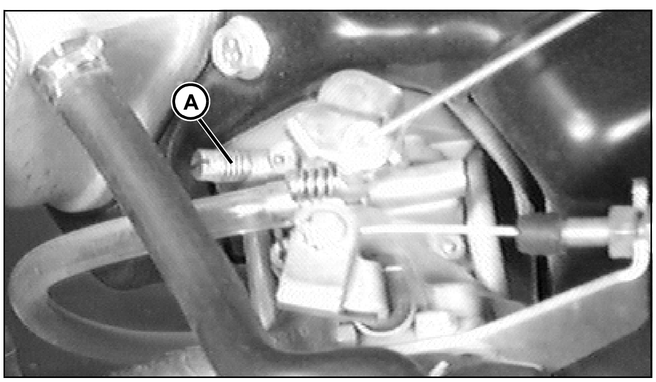
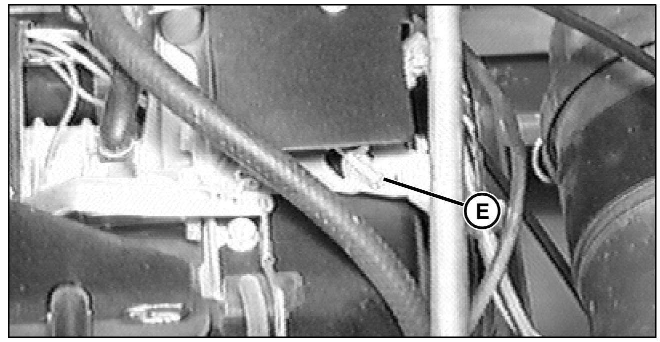


M56358

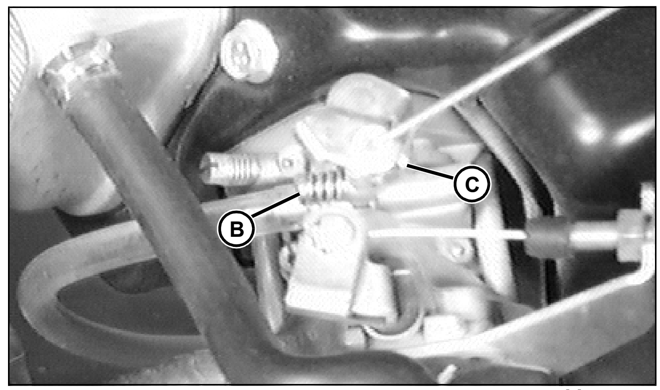
6. Turn SLOW idle mixture screw (A) clockwise until engine speed begins to drop-off, note position. Turn it counterclockwise until engine speed increases and begins to drop-off, note position.

7. Adjust screw halfway between positions. Turn it counterclockwise additional ¼ turn. On models with limiter caps installed, adjust for highest idle.



M56357

8. Adjust throttle control arm SLOW idle stop screw (E) to 1125 ± 75 rpm.



M56358

9. Turn SLOW idle stop screw (B) clockwise until it touches tab (C).

10.Hold tab (C) against stop screw (B), adjust screw until engine speed is 50 rpm's less than throttle control arm SLOW idle.

11.Depress and slowly release throttle pedal. Allow idle speed to stabilize. Recheck throttle SLOW idle speed

12.Hold throttle arm against carburetor SLOW idle stop screw, engine speed, should be 50 rpm less than throttle control arm SLOW idle. Readjust if necessary.

13.It may be necessary to readjust throttle cable. (See "Throttle Cable Adjustment" on page 41.)

Fast Idle Speed Adjustment

Reason:

To ensure that engine is running at proper FAST idle speed.

Equipment:

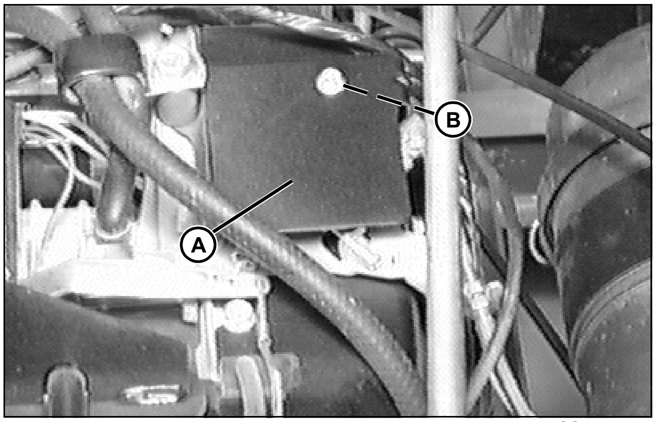
- JDM-71 Vibration Tachometer

-or-

- JT05719 Digital Tachometer

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



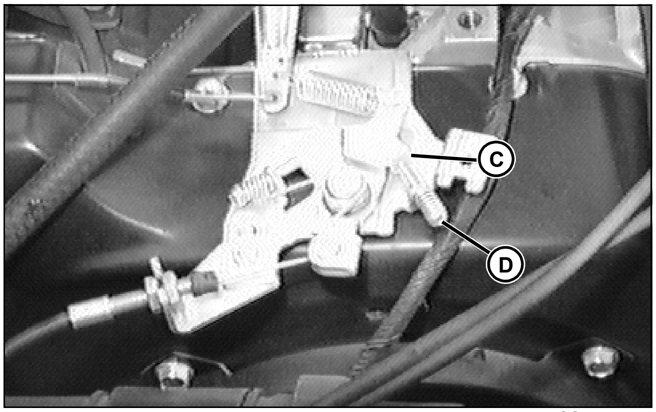
M56357

2. Remove cover (A). Be sure you don't lose spacer (B), under cover.

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

3. Run engine at MEDIUM idle speed for five minutes to reach operating temperature

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.



M56378

4. Hold throttle pedal in FAST idle position so tab (C) contacts screw (D).

5. Adjust screw (D) until proper rpm is reached. (See "Fuel/Air System:" on page 27.)

6. Install throttle control arm cover. DO NOT forget to install small spacer under cover.

Throttle Cable Adjustment

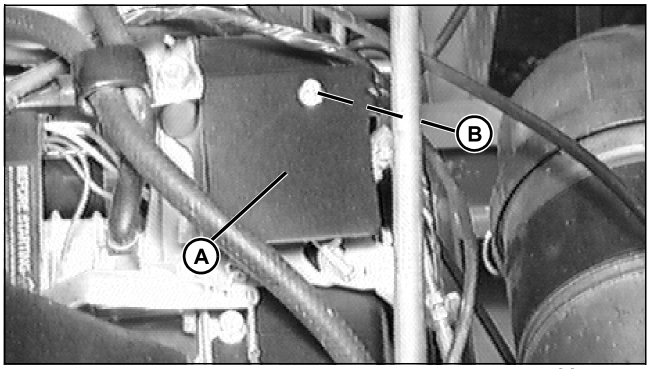
NOTE: Adjust and FAST idle speed settings are also going to be adjusted, perform them BEFORE adjusting throttle cable. (See SLOW Idle Mixture and Speed Adjustment or FAST Idle speed Adjustment.)

Reason:

To ensure throttle cable is adjusted correctly, and that throttle pedal movement provides full travel of carburetor linkage.

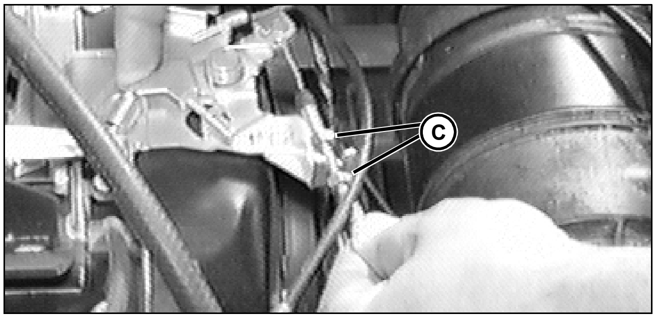
Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



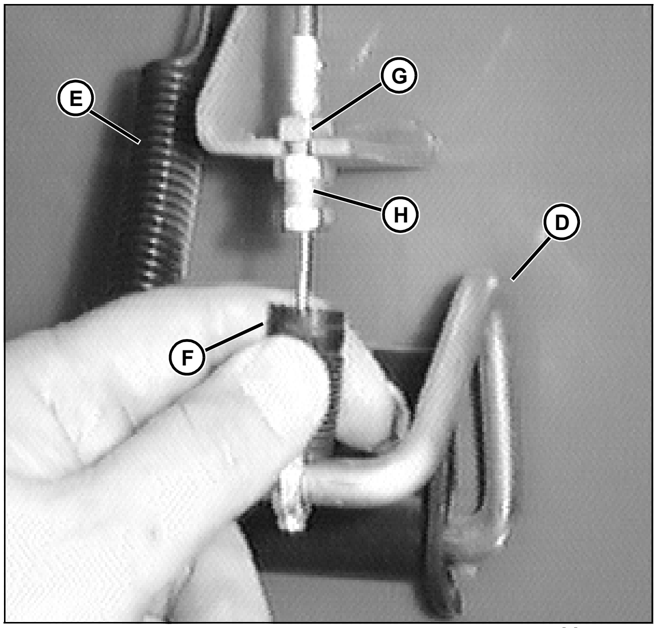
M56357

2. Remove throttle control arm cover (A). DO NOT lose small spacer (B) under the cover.



M56360

3. Loosen cable jam nuts (C), and adjust nuts so an equal amount of threads are showing on each side of mounting bracket (with rubber boot removed). Tighten jam nuts and replace rubber boot.



M56359

4. Check that throttle pedal rod is resting against front panel at (D), and return spring (E) is in place.

5. Pull down rubber boot (F).

6. Loosen jam nut (G).

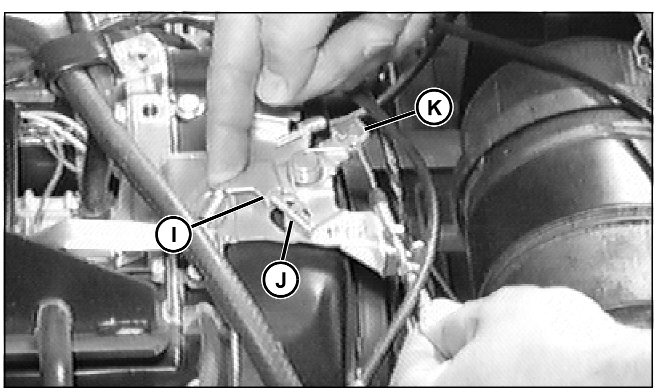
7. Turn adjusting nut (H) until there is a 2 mm gap between pedal rod and front panel at point (D) when pedal is pushed downward but before cable begins to pull carburetor linkage open.

8. Tighten jam nut (G), and recheck gap at (D). Readjust if necessary.

9. Install rubber boot (F) over adjusting nut (H).

10.Adjust pedal stop. (See “Pedal Stop Adjustment” on page 42.)

Results:



M56360

- at SLOW idle throttle pedal rod should be against front panel with a slight slack in inner cable.
- at SLOW idle throttle control arm slow idle stop tab (I) should be against slow idle stop screw (J).
- at FAST idle throttle control arm fast idle stop tab should contact fast idle stop screw.

11.Install throttle control arm cover.

Pedal Stop Adjustment

NOTE: Pedal stop adjustment is done after throttle cable adjustment is complete. (See “Throttle Cable Adjustment” on page 41.)

Reason:

To adjust throttle pedal stop, and limit pedal travel, preventing throttle cable from being over stretched and wearing prematurely.

Procedure:

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

NOTE: Do not force pedal assembly to deflect.

2. Loosen jam nuts on pedal stop and turn stop bolt until just touching back of pedal.

3. Back stop bolt off ONE TURN until there is a 1 - 1-1/2 mm gap between pedal and stop bolt.

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

4. Tighten pedal stop jam nut. Recheck adjustment.

Fuel Pump Pressure Test

Reason:

To check output pressure of fuel pump.

Equipment:

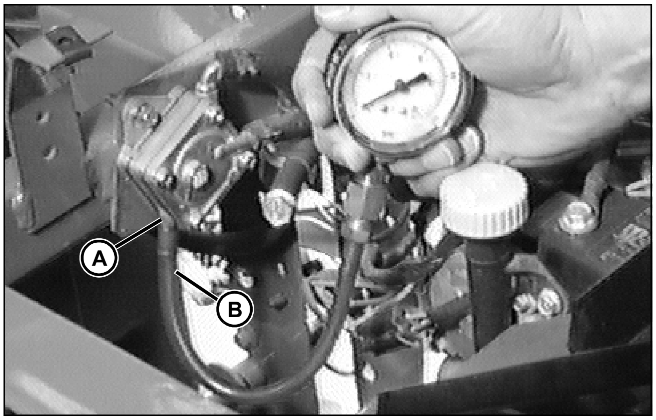
- JDG356 Pressure Gauge

Procedure:

1. Shift lever in NEUTRAL, and park brake LOCKED.

2. Run engine at SLOW idle for 1 minute to fill carburetor with fuel.

3. Turn engine OFF.



M56379

4. Disconnect hose from fuel pump outlet (A). Plug hose.

5. Connect JDG356 Pressure Gauge hose (B) to fuel pump outlet.

6. Run engine at FAST idle for 15 seconds, record pressure reading. Minimum pressure 6.12 kPa (0.9 psi).

7. Turn engine OFF.

8. Remove pressure gauge, connect pump outlet hose and clamp.

Results:

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

Fuel Pump Flow Test

Reason:

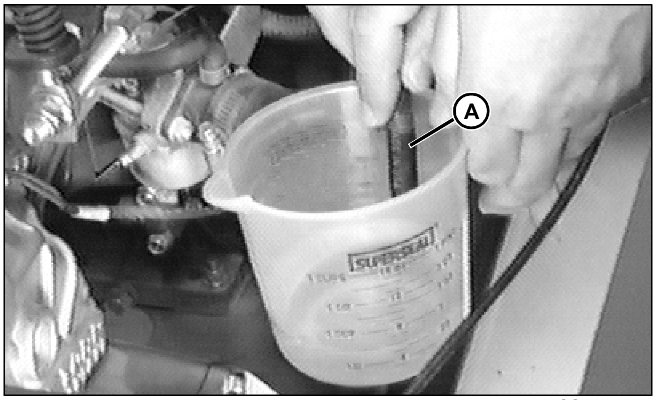
To check output volume of fuel pump.

Equipment:

- Graduated container

Procedure:

1. Shift lever in NEUTRAL, and park brake LOCKED.



M56380

2. Run engine at SLOW idle for 1 minute to fill carburetor. Turn engine OFF.

3. Disconnect carburetor inlet hose (A) from carburetor, put end in graduated container.

4. Run engine at FAST idle for 15 seconds, stop engine. Check fuel. Minimum flow 80 ml (2.7 oz) in 15 seconds.

Results:

- If fuel flow BELOW minimum specification, check fuel pump filter, in-line filter, hoses, and fuel shutoff valve for debris or restrictions. Repeat test.
- If fuel flow is still BELOW minimum specification, replace fuel pump.

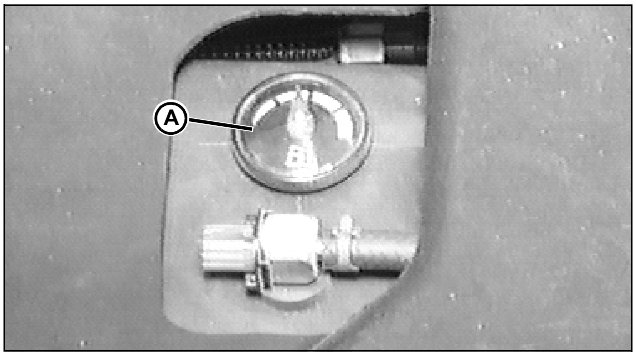
Fuel Tank Gauge Test

Reason:

To ensure gauge is indicating actual fuel level in tank.

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



M55773

2. Check fuel level (A).

3. Add fuel, check fuel level (A).

4. If indicator does not move, replace gauge.

Fuel Tank Check Valve Test

Reason:

To ensure check valve is functioning properly.

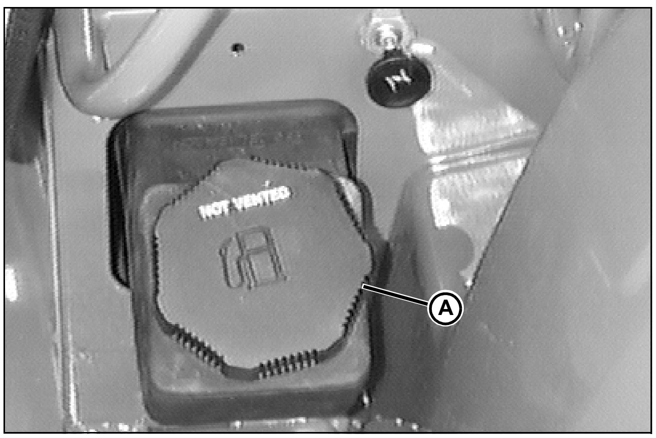
NOTE: This test is performed for early models only (PIN -009368). Later models do not have a check valve installed. The fuel tank is modified with a breather tube through the left armrest.

Equipment:

- JDZ25-2 Carburetor Tester Kit or Equivalent

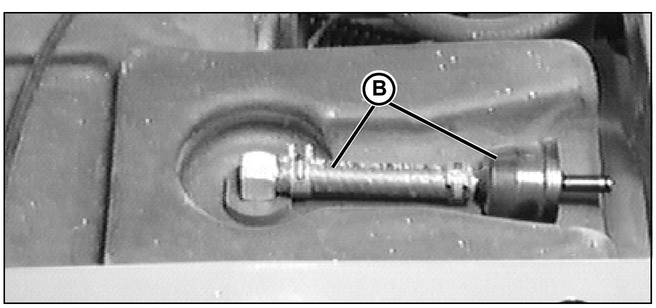
Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.
2. Remove seats and shrouding.



M55733

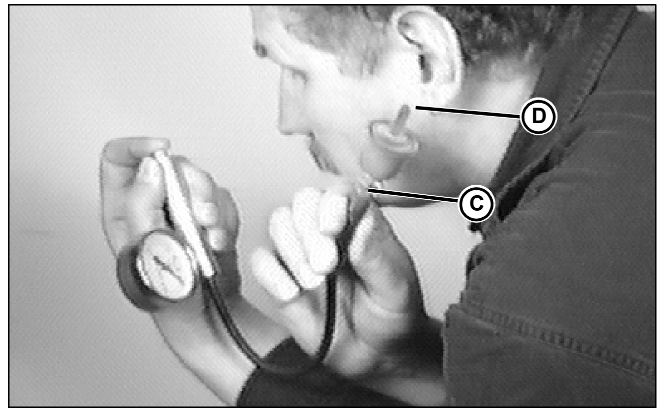
3. Loosen fill cap (A) to relieve any air pressure in tank.



M55770

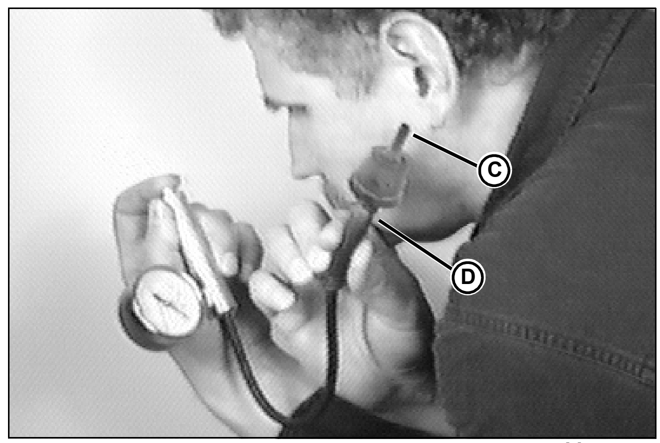
4. Disconnect check valve and hose assembly (B) from elbow fitting.

IMPORTANT: Avoid damage! Use hand pump/ pressure gauge to test valve. DO NOT use compressed air, check valve will be damaged.



M55771

5. Connect pump/pressure gauge to check valve tapered-side port (C).
6. Hold flanged-side port (D) along side ear and pump air valve. Air should be heard and gauge should show slight pressure.



M55772

7. Reverse ports and test again. Air should be heard and no pressure should be seen on gauge.
8. Replace valve if it does not pass either test.

Cylinder Compression Test

Reason:

To determine condition of piston, piston rings, cylinder wall, valves, valve guides, gaskets, and seals.

Equipment:

- JDM-59 Compression Gauge
- JDM-74A-5 Spark Plug Wire Test Tool or equivalent

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.

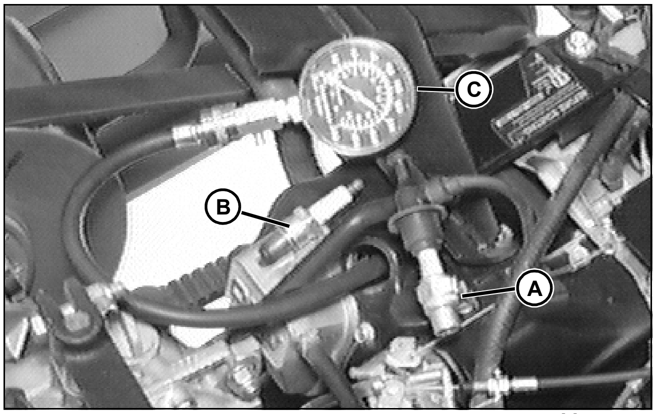
NOTE: The starter will crank the engine at 650 ± 50

rpm. This may not be fast enough to disengage the automatic compression release mechanism, and compression test will not show actual compression.

2. Run engine at MEDIUM idle for five minutes to reach operating temperature.

3. Turn engine OFF.

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.



M56361

4. Disconnect spark plug wire, and ground spark plug (A) to prevent accidental starting.

IMPORTANT: Avoid damage! Spark plug wire MUST BE GROUNDED or ignition could be damaged.

5. Remove spark plug (B), install JDM-59 Compression Gauge (C).

6. Hold throttle pedal in FAST idle position, make sure choke is OFF.

7. Crank engine.

NOTE: Starter must crank engine at approximately 700 rpm for accurate test results, make sure battery is fully charged.

8. If compression is LOW, remove compression gauge. Squirt clean engine oil onto cylinder.

9. Repeat cylinder compression test procedure.

Results:

- Minimum compression should be 393 kPa (57 psi).
- If compression pressure INCREASES after oil is put into cylinder, check rings, piston and cylinder bore for wear or damage.
- If compression pressure is STILL LOW check valves, valve seats, valve seals, and cylinder head gasket.

Valve Clearance Adjustment

Reason:

To check and adjust valve clearance.

Equipment:

- JDM-74A-5 Spark Plug Wire Test Tool or equivalent
- Flat bladed feeler gauge

Procedure:

IMPORTANT: Avoid damage! Make this adjustment when engine is COLD.

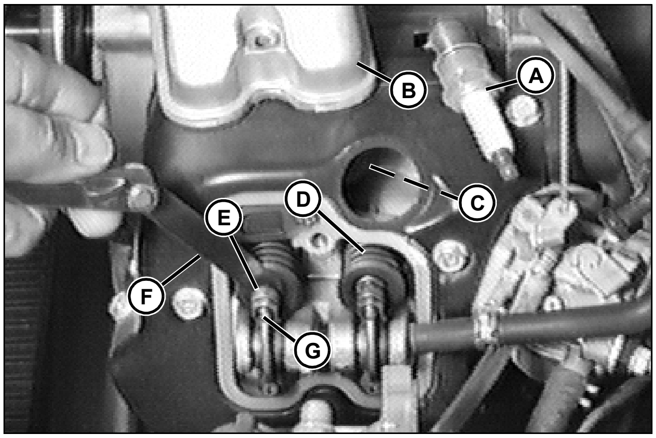
1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.

2. Remove engine-to-transaxle support. Remove valve cover (B).

IMPORTANT: Avoid damage! Spark plug wire MUST BE GROUNDED or electronic ignition could be damaged.

3. Disconnect spark plug wire, and ground spark plug to prevent accidental starting (A).

NOTE: Proper valve clearance is critical to the correct operation of the compression release system.



M56363

4. Find piston TDC (Top Dead Center) of compression stroke as follows:

    - Turn crankshaft counterclockwise until intake valve (D) opens.
    - Put a long, small diameter, wooden dowel into spark plug hole (C), 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 (F) to check that valve clearance is 0.125 mm (0.005 in.).

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

7. Hold adjusting screw stationary with pliers while you tighten lock nut to 20 N•m (180 lb-in.).

8. Recheck valve clearance, readjust if necessary.

9. Repeat procedure for other valve.

10.Install spark plug and spark plug lead.

NOTE: While valve cover is removed, perform Automatic Compression Release Test.

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

Automatic Compression Release (A.C.R.) Test

Reason:

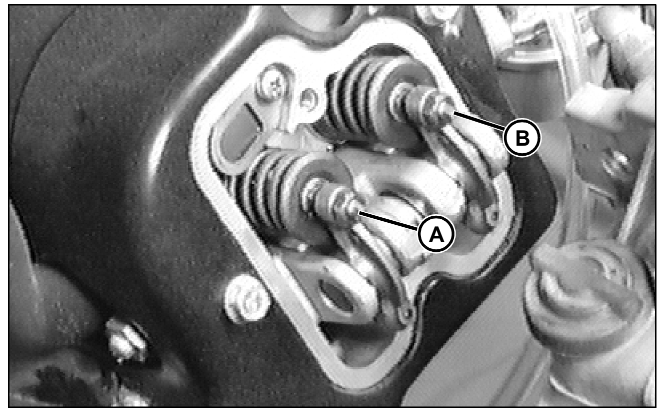
To verify automatic compression release (A.C.R.) mechanism operation.

Procedure:

IMPORTANT: Avoid damage! Spark plug wire MUST BE GROUNDED or electronic ignition could be damaged.

IMPORTANT: Avoid damage! Exhaust valve clearance MUST BE set properly BEFORE this test is performed. (See "Valve Clearance Adjustment" on page 45.)

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



M56364

2. Rotate crankshaft counterclockwise slowly, watch exhaust valve.

Results:

- Exhaust valve (A) must lift briefly, after intake valve (B) closes.
- If A.C.R. lift movement not within specifications, "Automatic Compression Release" on page 60.

Specifications:

A.C.R. lift

Minimum . . . . 0.6 mm (0.024 in.)

Maximum. . . . . 1.65 mm (0.065 in.)

Crankcase Vacuum Test

Reason:

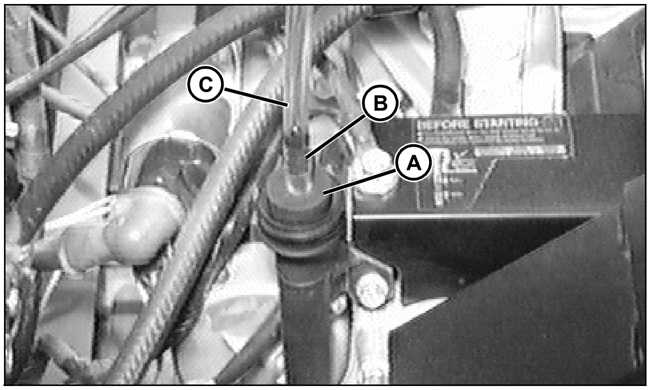
To determine operation of breather, condition of seals, gaskets, rings, piston, and cylinder wall.

Equipment:

- JT05703 Barb Fitting
- JT05699 Line
- JT05698 U-Tube Manometer

Procedure:

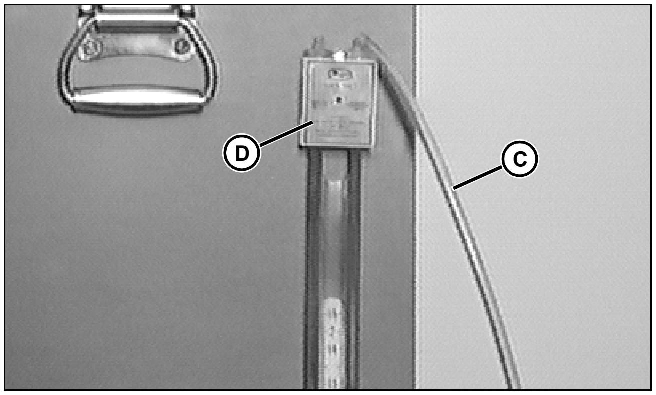
1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



M56367

2. Remove dipstick.
3. Put barbed fitting (B) and clear tube (C) into plug (A).
4. Push plug (A) in dipstick hole until tight.

IMPORTANT: Avoid damage! DO NOT make connection between manometer (D), and engine line (B), BEFORE the engine is running! Fluid in manometer could be drawn into crankcase. DO NOT turn engine OFF until line (B) has been disconnected from manometer (D).



M56365

5. Attach U-tube/scale assembly (D) to side of tool box.
6. Run engine at SLOW idle.
7. Connect clear tube (C) to either barbed fitting on manometer.
8. Run engine at FAST idle.
9. Manometer minimum vacuum 25 mm (1.0 in.) water.
10. Run engine at SLOW idle. DO NOT TURN ENGINE OFF!
11. Disconnect clear tube (C) from manometer.
12. Turn engine OFF.
13. Remove plug and install dipstick.

Results:

If crankcase vacuum LESS than specification, check:

- 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 warp.

Oil Pressure Test

Reason:

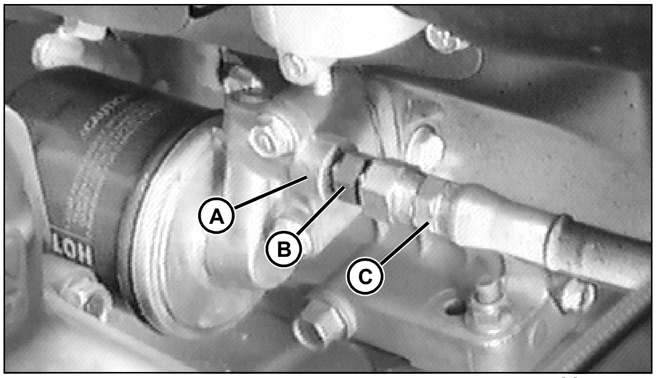
To determine condition of lubrication system.

Equipment:

- JT05577 Pressure Gauge Assembly
- JT03017 Hose Assembly
- JT03349 Connector - 1/8” BSP Thread

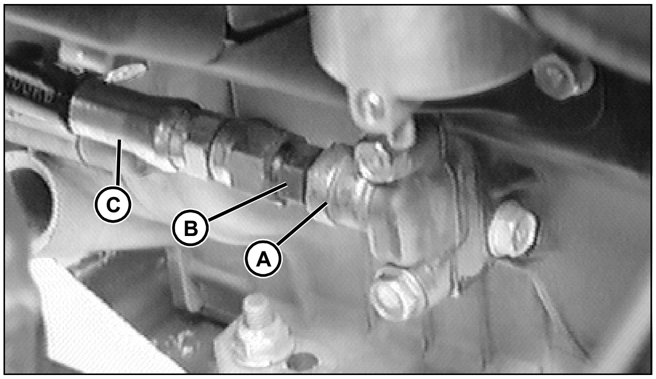
Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.
2. Check engine oil level, fill to full mark, if necessary.



M56381

3. For engines with oil filter kit installed, remove plug from filter housing (A).
4. Install straight fitting (B) and hose plus gauge (C).



M56382

5. For engines without oil filter kit installed, remove plug from housing (A).

6. Install straight fitting (B) and hose plus gauge (C).

7. Run engine at MEDIUM idle for five minutes to reach operating temperature.

8. Run at FAST idle. Oil pressure minimum 314 kPa (46 psi).

Results:

If oil pressure is BELOW specification, inspect following:

- If equipped with oil filter kit, check if plugged and replace
- Oil pressure relief valve for broken or weak spring, stuck or damaged valve
- Oil pump suction screen or oil passages plugged
- Oil pump worn or damaged
- Excessive wear of connecting rod and main bearings

9. Remove hose, gauge, and straight fitting. Install plug using John Deere Pipe Sealant with TEFLON (medium strength), or equivalent, on plug threads.

Alternator Drive Belt Adjustment

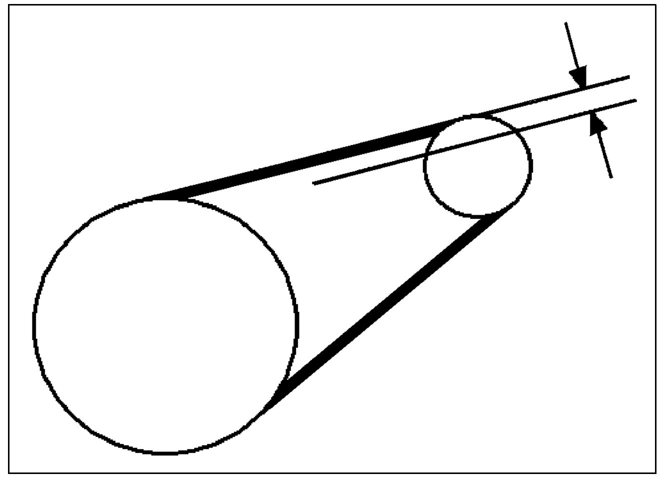
Reason:

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

Equipment:

- JDST28 Belt Tension Gauge
- Straight Edge

Procedure:



MX1346

1. Check belt tension between flywheel sheave 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 and nuts.
- Apply force only to right side of alternator housing (near the belt) until tension is correct.
- Tighten alternator mounting hardware.

Air Intake System Check

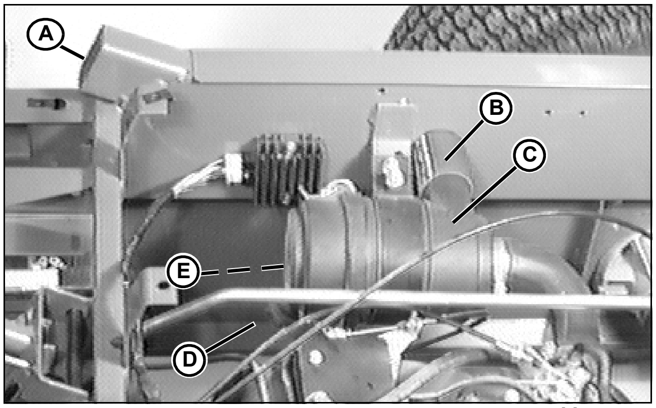
Reason:

Check air intake system for leaks or restrictions.

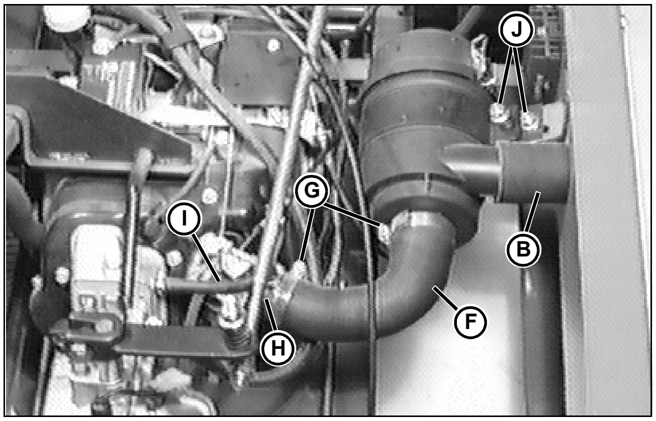
Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.

2. Remove seats and shrouding.



M55776

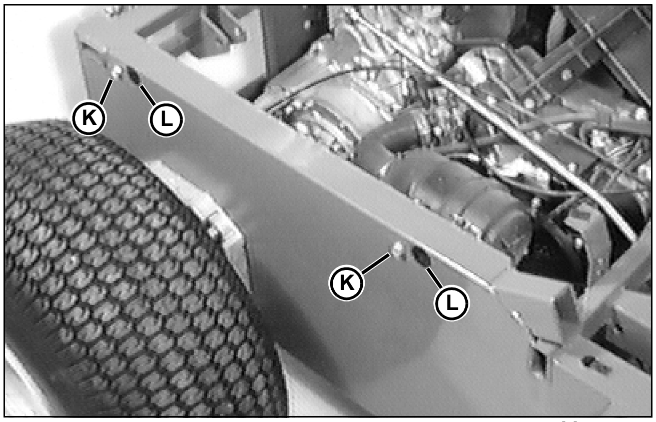


M55777

3. Check for:

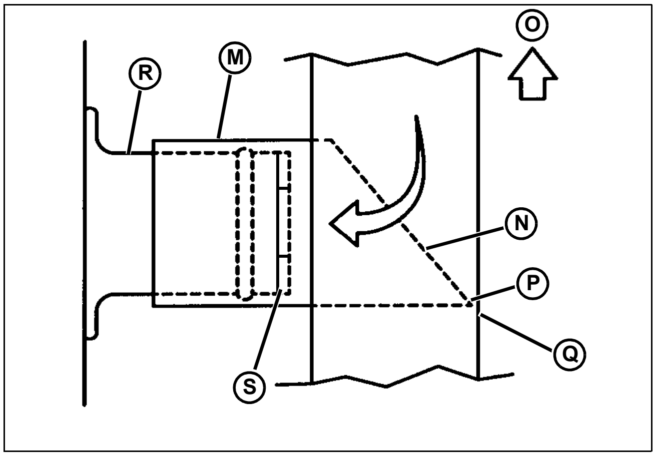
- air intake channel (A) clear of dust or restrictions
- frame hose (B) not cracked, damaged or leaking
- restrictor (B) in canister intake above s/n 19972
- air filter canister (C) not cracked or leaking
- rubber debris boot (D) not cracked or leaking
- air filter element(s) (E) not missing, plugged, torn, distorted, or damaged
- air intake hose (F) not cracked, cut, or leaking
- hose clamps (G) in good shape and tight
- adapter (H) not cracked, or loose
- breather hose (I) not cracked, cut, or leaking

NOTE: Use compressed air and/or a long hooked rod when trying to remove dust or debris from inside channel.



M55778

4. Be sure cap screws (K) and plugs (L) are installed.



M55741

Top View Shown

5. Install frame hose (M) so angled edge (N) faces to front (O) of machine and tip (P) just touches inside edge of frame (Q) without being bent.

6. Install canister mounting strap on top side of mounting bracket. Remember that spring goes on-top-of mounting strap. Tighten spring lock nut until two threads of long cap screw are exposed. DO NOT collapse spring completely.

NOTE: Check placement of restrictor (S) in inlet tube (R) on later model machines (19972-). The restrictor should be seated in the inlet tub of the air filter housing.

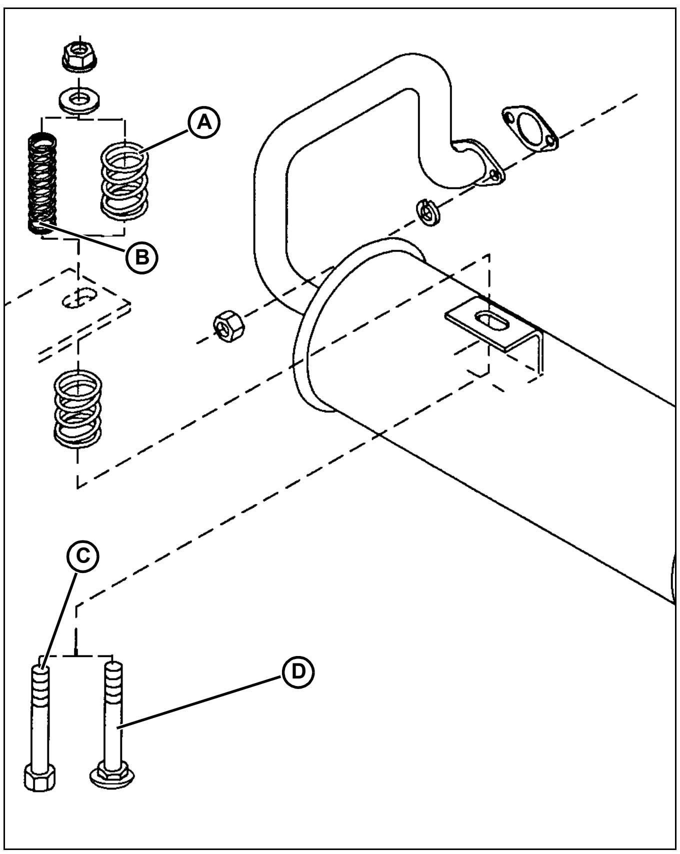
7. Insert canister inlet tube (R) inside frame hose (M).

Repair

Muffler Removal and Installation

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

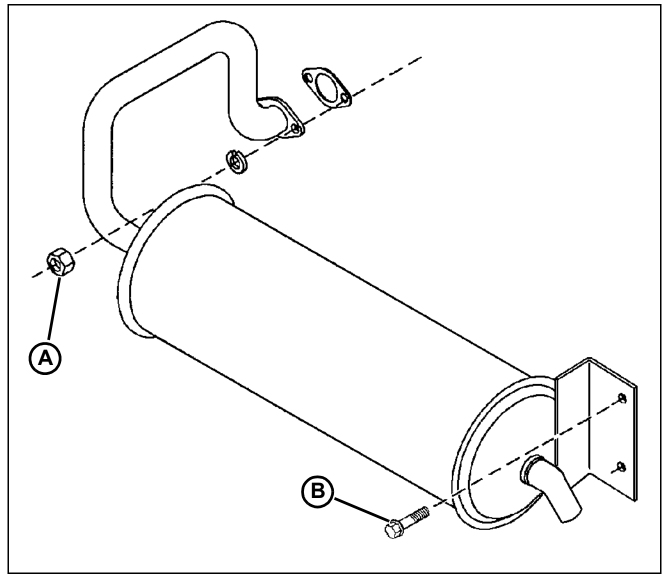
1. Remove mount bolt and flange nuts. Remove muffler
   - Replace gasket.
2. Loosely install muffler to engine, and muffler to frame bracket with springs and hardware shown.
3. Tighten muffler engine flange lock nuts.
4. Tighten muffler bracket.
   - Units (PIN -1850) tighten muffler mount lock nut until at least two threads are showing.
   - Units (PIN 1851-) tighten muffler mount lock nut until 5 mm (0.20 in.) of threads showing.



M82410AE

A - Large Spring (PIN 1851-)
B - Small Spring (PIN -1850)
C - Muffler Mount Cap Screw, M8 x 65 (PIN -1850)
D - Muffler Mount Carriage Bolt, M8 x 50 (PIN 1851-)

Machines (PIN -30551):



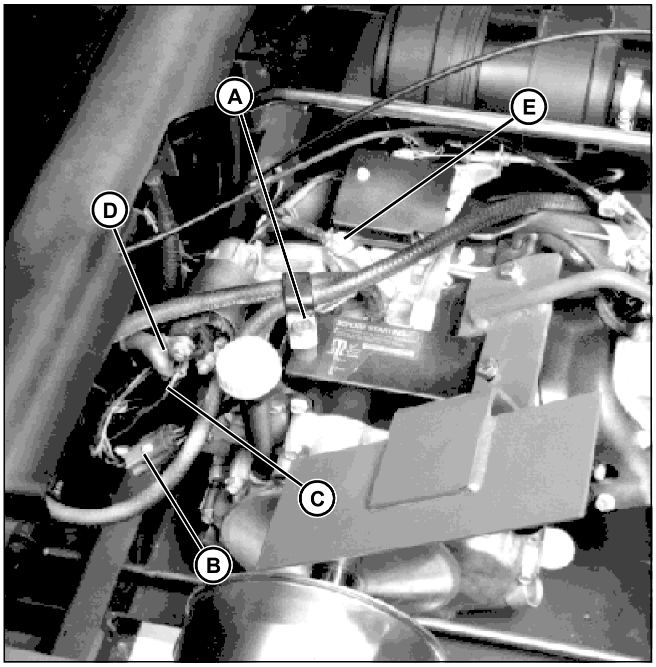
MX1410

1. Remove mount bolts and flange nuts. Remove muffler
   - Replace gasket.
2. Loosely install muffler to engine.
3. Tighten muffler engine flange lock nuts (A).
4. Tighten muffler bracket cap screws (B) and nuts.

Engine Removal and Installation

Removal:

1. Disconnect battery negative (-) cable.
2. Remove muffler and drive belt.
3. Remove hose clamp cap screw (A) and spacer.
4. Disconnect engine wiring harness connector (B).



M82407

5. Disconnect single (purple) wire connector (C) from starter solenoid. Disconnect battery positive (+) cable (D) and wire lead from starter solenoid.

6. Remove ground wiring lead cap screw (E), move battery negative cable and ground wiring lead.

7. Disconnect choke control and accelerator cables.

8. Remove air cleaner-to-engine hose.

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

9. Disconnect vacuum and fuel supply hoses.

10.Remove support cap screw and lock nut.

NOTE: Remove engine from left-hand side of machine.

11.Remove mounting cap screws, lock nuts and engine.

NOTE: Removal of drive clutch is necessary only if engine repair is needed.

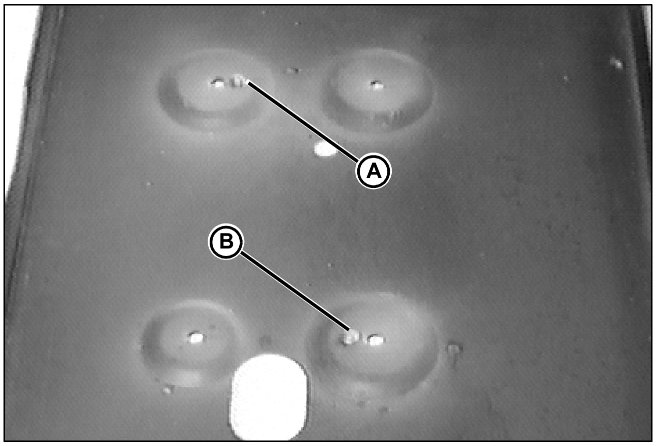
12.Remove drive clutch.

Installation:

Installation is done in the reverse order of removal.

1. Set engine in frame so that indents (A) at left front and (B) at right rear fit into pockets in engine base.

2. Install and tighten mounting bolts.



M55790

3. Fill engine with proper oil. (See Specifications and Information section.)

4. Adjust choke and throttle cables.

Engine oil capacity:

Without filter . . . . 1.1 L (2.33 pt)

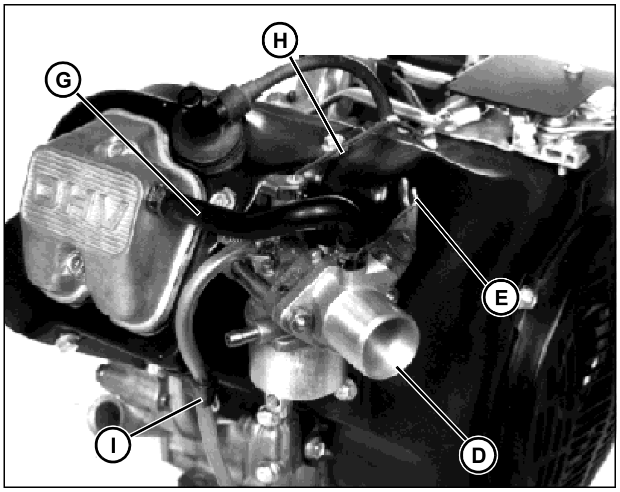
With filter. . . . . 1.4 L (3.0 pt)

Carburetor Removal and Installation

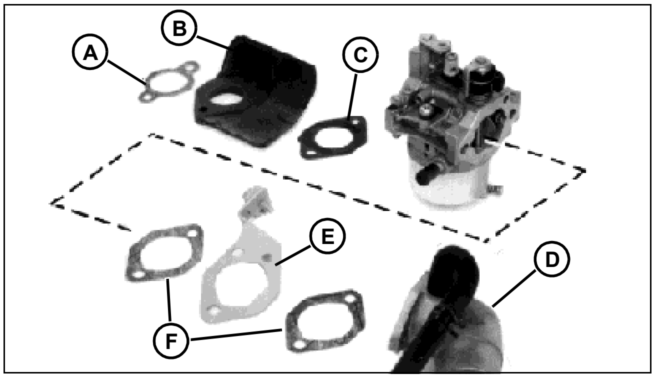
Removal:

1. Drain float bowl.

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



M82400



M80400

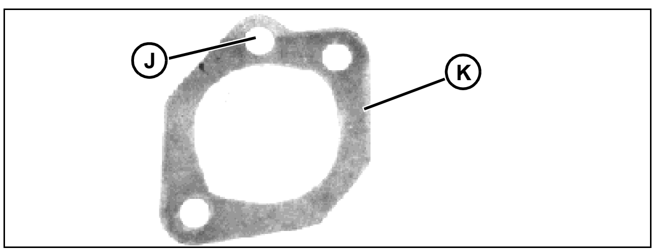
A - Gasket
B - Heat Shield
C - Gasket, w/ tab
D - Air Intake Duct
E - Bracket
F - Bracket Gaskets

2. Remove breather hose (G), air intake duct (D), bracket (E), bracket gaskets, hose from clamp (I), carburetor, heat shield and gaskets.

3. Disconnect throttle control linkage (H).

Installation:

Installation is done in the reverse order of removal.



M80401

- Install heat shield gasket with tab pointing up on fuel inlet side of carburetor.
- Install bracket gaskets (K) with alignment hole (J) pointing up and away from fuel inlet side of carburetor.

Carburetor Disassembly and Assembly

IMPORTANT: Avoid damage! To remove float, use a long nosed pliers on end of pin. Do not strike opposite end of pin. Damage to pin holder may result.

Do not clean holes or passages with drill bits or wire.

- Soak body and all parts, except gaskets, float and plastic rings, in carburetor cleaning solvent for 1/2 hour maximum.
- Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

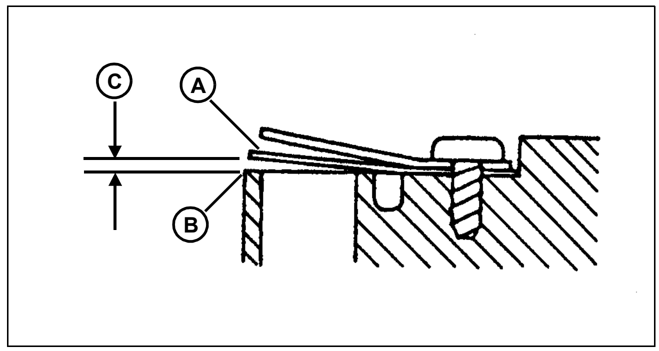
IMPORTANT: Avoid damage! Rinse carburetor body in warm water to neutralize corrosive action of cleaner.

- Rinse carburetor with warm water and dry with compressed air. Do not use rags or paper to dry parts. Lint may plug holes or passages.

NOTE: Float is plastic. The float cannot be adjusted. Replace if necessary.

Crankcase Breather Inspection

1. Remove rocker arm cover and gasket.



M51757

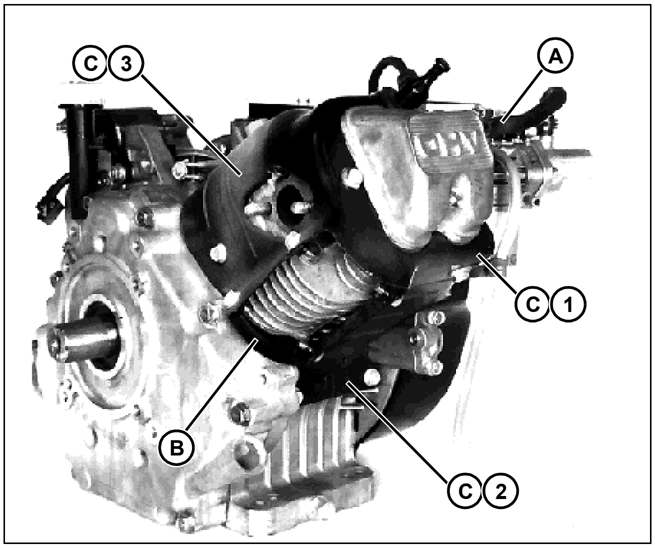
2. Measure air gap between reed valve (A) and valve seat (B) at valve tip. Replace reed valve if gap is greater than 0.20 mm (0.008 in.) (C).

M80403

3. Remove breather valve assembly (D).
4. Inspect all parts for wear or damage. Replace as necessary.
5. Inspect valve seating surface. Surface must be free of nicks or burrs.
6. Install breather assembly.
7. Install rocker arm cover and gasket.

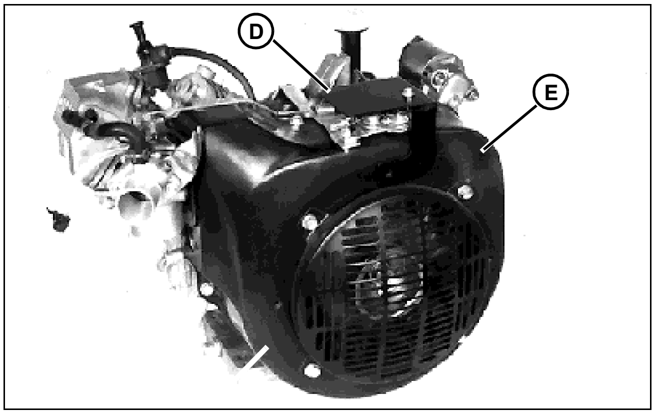
Blower Housing Removal and Installation

NOTE: It is not necessary to remove recoil starter, if equipped.



M82401

1. Disconnect spark plug lead and breather hose (A).
2. Remove support (B) and three covers (C). Remove covers in order shown.



M82402

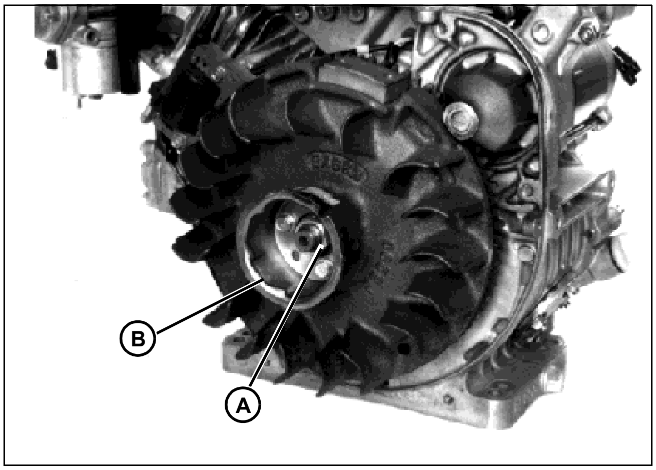
3. Remove bracket cover (D) and blower housing (E).

Installation:

Installation is done in reverse order of removal.

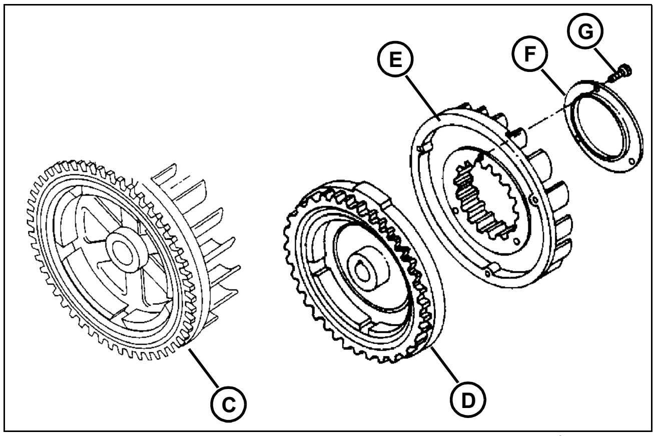
Flywheel Removal and Installation

1. Remove armature with coil, cap screws and recoil starter cup.



M82403

2. Hold flywheel and remove nut (A), washer and recoil starter cup (B).



M76809/M76810

Picture Note: FE290D-AS08 engines have one piece cast flywheel (C).

FE290D-BS08 engines have assembled flywheel (D), including cast flywheel, attached fan (E), plate (F), and capscrews (M6 x 10) (G).

3. Remove flywheel using a puller set.
4. Remove shaft key.

Installation:

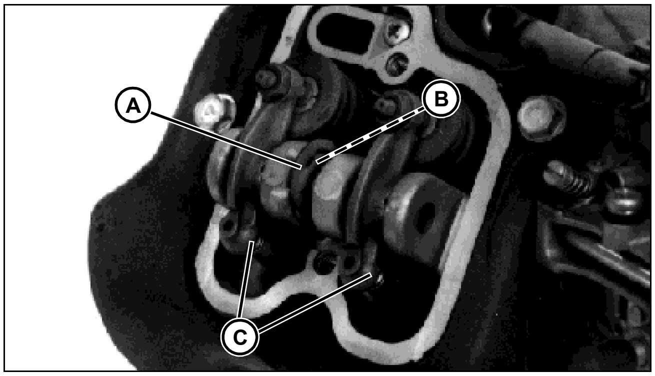
Installation is done in reverse order of removal.

- Install washer with concave side toward flywheel.
- Tighten flywheel nut to 85 N•m (63 lb-ft).

Rocker Arm Removal and Installation

1. Remove rocker arm cover and gasket.

2. Turn crankshaft until piston is at its highest position in compression stroke until both valves are closed and all valve spring pressure is off of valve train.



M80405

3. Remove E-clip (A) from rocker shaft.

4. Remove rocker shaft, washer (B) and rocker arms (C).

IMPORTANT: Avoid damage! Push rods must be installed in the same locations from which they were removed.

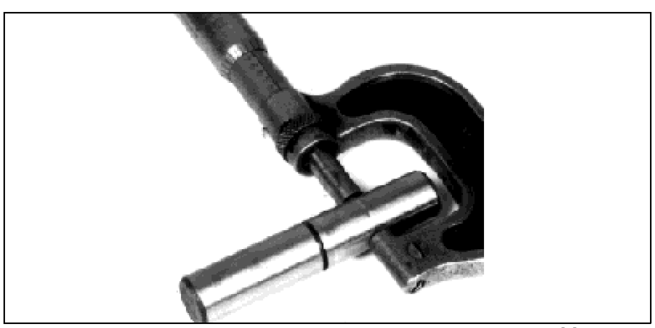
5. Put a mark on each push rod and cylinder head bore to aid in installation.

6. Remove push rods.

Installation is done in reverse order of removal.

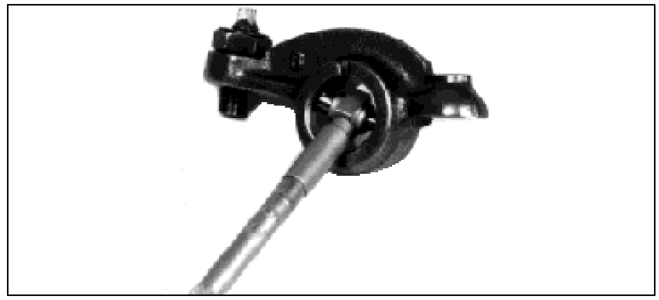
- Check valve clearance when complete and adjust as needed. (See “Valve Clearance Adjustment” on page 45.)

Rocker Arm Inspection



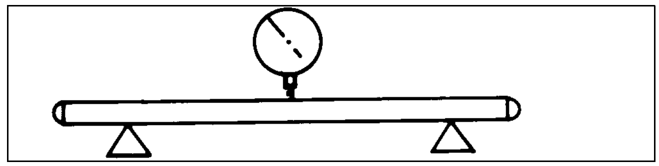
M80406

1. Measure outside diameter of rocker shaft. Replace shaft if OD is less than specification.



M80407

2. Measure inside diameter of rocker arms. Replace arms if ID is greater than specification.



M50044

3. Inspect push rods for bend using V-blocks and a dial indicator. Replace push rod if bend is greater than specification.

Specifications:

Rocker Shaft OD (minimum)	**11.95 mm (0.470 in.)**
Rocker Arm ID (maximum)	**12.07 mm (0.475 in.)**
Push Rod Bend (maximum)	**0.30 mm (0.012 in.)**

Cylinder Head Removal and Installation

Removal:

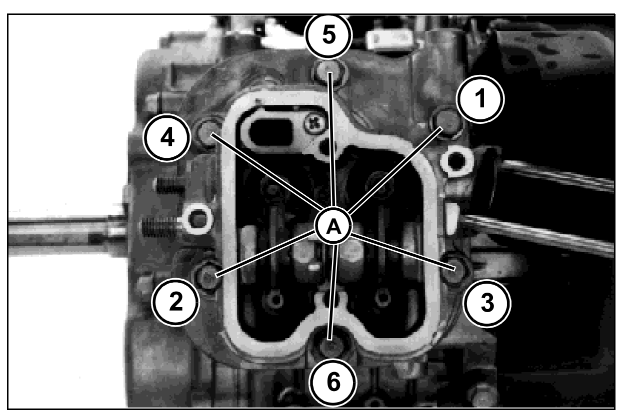
1. Remove blower housing, carburetor, rocker arm assembly, and spark plug.

2. Remove cap screws, cylinder head assembly and gasket.

3. Disassemble and inspect cylinder head and valves.

Installation:

1. Install a new gasket and cylinder head assembly.



M53065

2. Install cap screws (M8 x 45) (A), and tighten finger tight.

3. Tighten cap screws, in the sequence shown, in three stages of gradually-increasing torque.

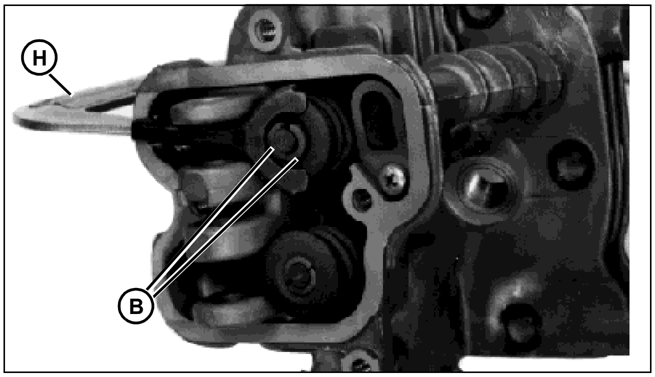
4. Install spark plug and tighten to 20 N•m (177 lb-in.).

5. Install rocker arm assembly, carburetor and blower housing.

Torque Specifications:

First	**18 N•m (159 lb-in.)**
Second	**21 N•m (186 lb-in.)**
Final	**24 N•m (212 lb-in.)**

Cylinder Head Disassembly and Assembly

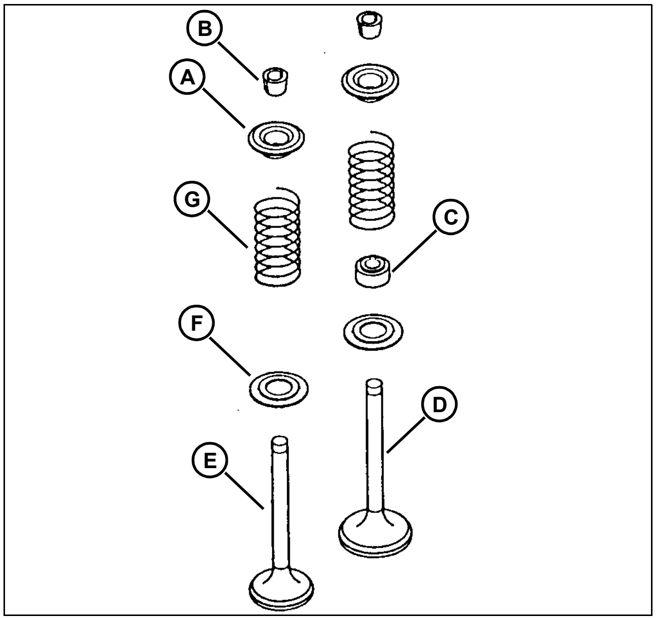


M53066

1. Compress valve springs using JDM70 Valve Spring Compressor (H) and remove collet halves (B).

IMPORTANT: Avoid damage! Spring seat for intake valve can only be removed with valve stem seal. Removal of seat or seal damages stem seal. If seal is not damaged, do not remove it.

2. Inspect intake valve stem seal for wear or damage.



M82404A

A - Retainer
B - Collet Halves
C - Stem Seal
D - Intake Valve
E - Exhaust Valve
F - Seat
G - Spring

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

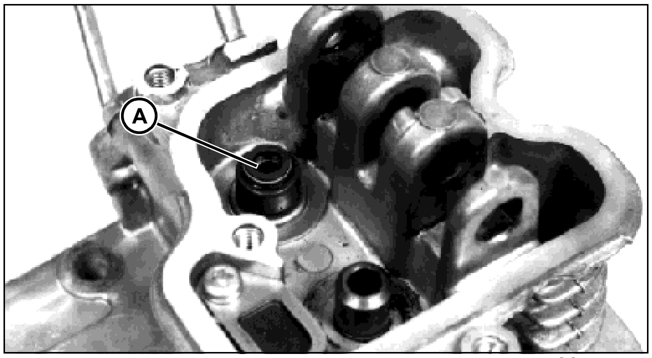
4. Install springs with smaller pitch end toward cylinder head.

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

Cylinder Head Inspection and Replacement

Before inspection, thoroughly clean all components of carbon or dirt using solvent and SCOTCH-BRITE abrasive pads or an equivalent.

Intake Valve Stem Seal:

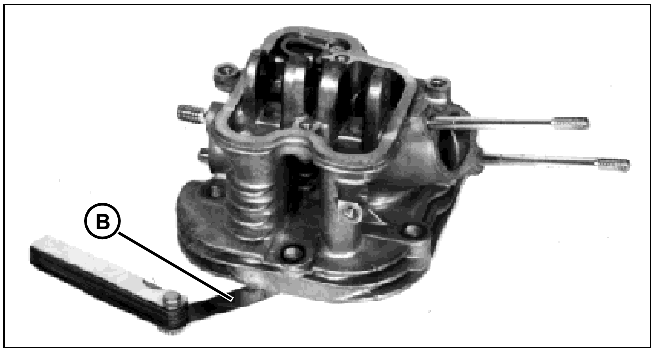


M80408

1. Inspect stem seal (A) for wear or damage. Remove stem seal using a screwdriver.

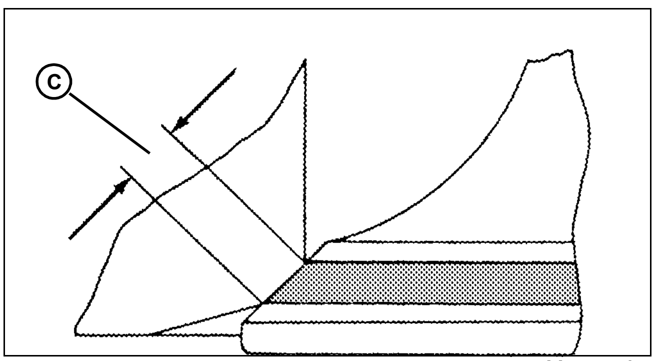
Cylinder Head:

1. Inspect for cracks or broken cooling fins.
2. Check that oil drain back passages are not plugged.



M80409

3. Put head on a surface plate. Check for distortion at several points around head with feeler gauge (B). If distortion greater than 0.05 mm (0.002 in.), replace.

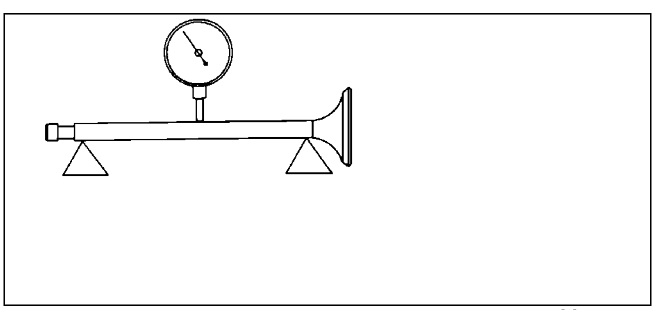


M82405A

4. Measure valve seat width. Inspect valve seat for wear or damage. If valve seat width is not within 0.50 - 1.10 mm (0.020 - 0.043 in.) (C), recondition valve seats.

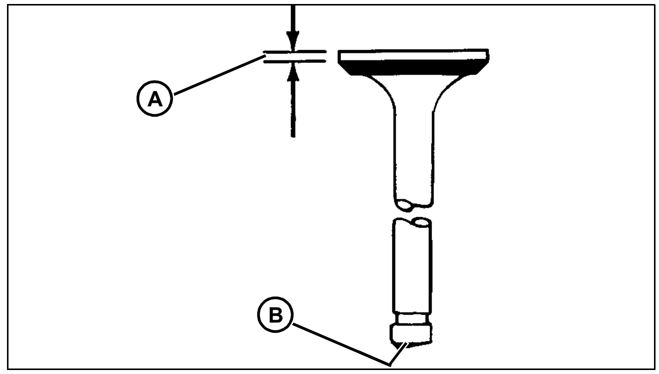
Intake and Exhaust Valves:

1. Analyze valves.



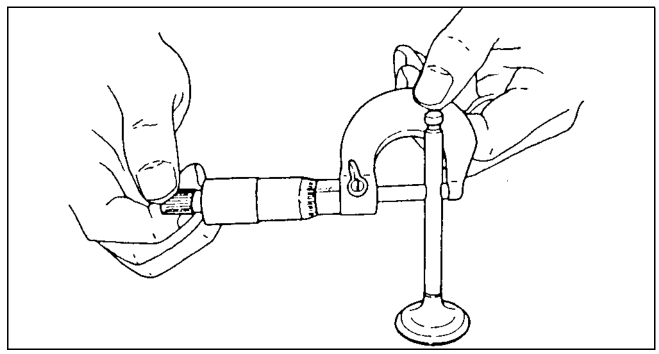
M51753

2. Inspect valve stem for bend using v-blocks and dial indicator. Turn valve slowly and read variation on indicator. If variation is greater than 0.03 mm (0.0012 in.) replace valve.



M38087

3. Remove carbon from valve head, face and stem. Check for defects. Measure face margin. If margin less than 0.60 mm (0.024 in.) (A), replace.
4. Check valve stem end (B) for uneven wear. If stem ends are uneven, grind ends square.



M82406A

5. Measure valve stem diameter in two directions at right angles, at four different positions. Replace if measurement is less than specifications.

Specification:

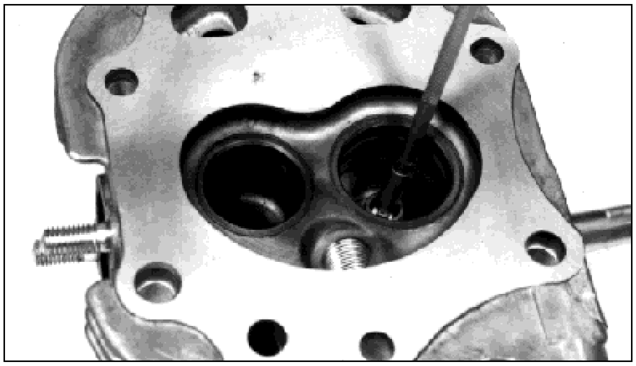
Valve Stem OD (Wear Limit):

Intake Valve. . . . . 6.930 mm (0.2728 in.)

Exhaust Valve . . . . 6.915 mm (0.2722 in.)

Valve Guides:

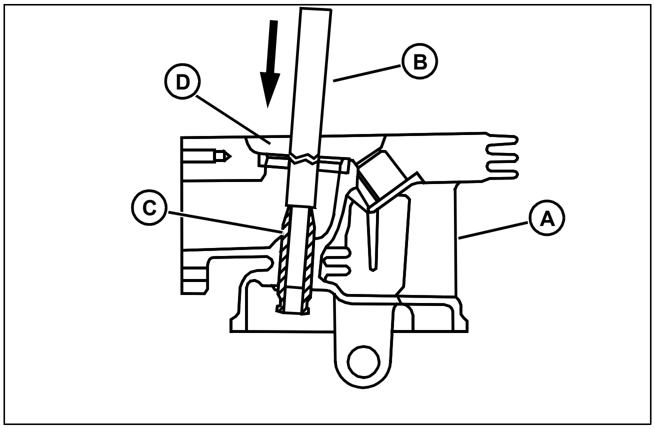
1. Clean valve guides using a valve guide brush and cleaner.



M80410

2. Measure inside diameter of valve guide bushings. If ID is greater than 7.065 mm (0.2781 in.), replace bushings.

To Replace Bushings:



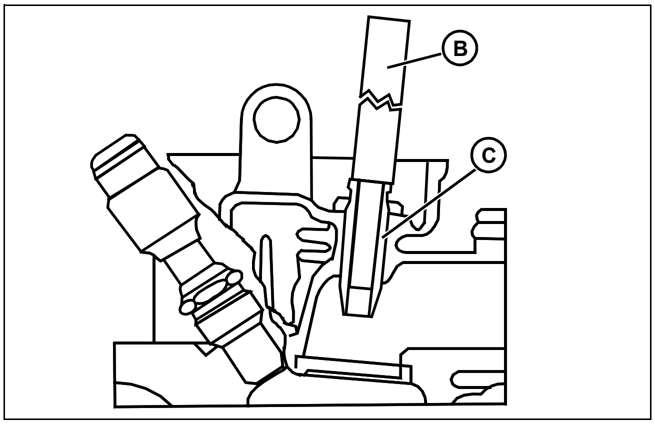
M50038

1. Invert cylinder head (A) and insert JDG504 Valve Guide Driver (B) into valve guide (C).

2. Drive valve guide out through top of cylinder head.

3. Clean carbon deposits from valve guide port (D).

NOTE: Place valve guide in dry ice before installation.



MIF

4. Install new bushing with JDG504 Valve Guide Driver. Drive in from top of cylinder head until bottom of groove on outside of guide is even with top of cylinder head.

5. Ream inside diameter of valve guide bushings with Stanisol or kerosene lubricant and 7 mm valve guide reamer. Ream bushings to finished ID of 7.00 - 7.015 mm (0.2756 - 0.2762 in.).

Valve Springs:

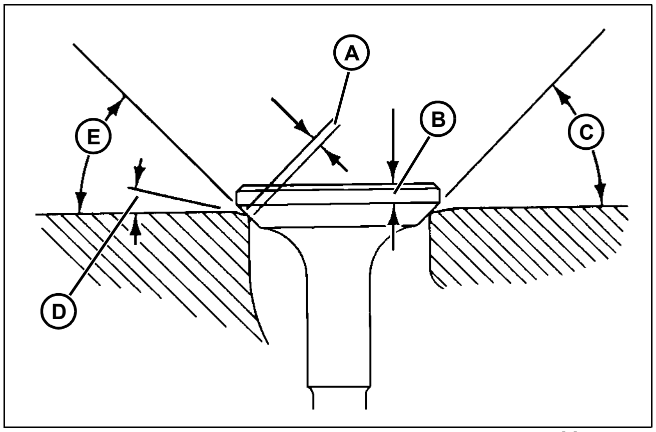
1. Measure spring free length. Replace spring if measurement is less than 32.75 mm (1.289 in.).

Recondition Valve Seats

1. Inspect valve seats for damage. If seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be refaced using a seat cutter.

2. To recondition valve seat, cut at 45° angle to clean up seat. Cut narrowing angle at 30°. Finish cut at 45° to establish seating surface width.

3. Cut valve seating surface as close as possible to specifications.



M87766

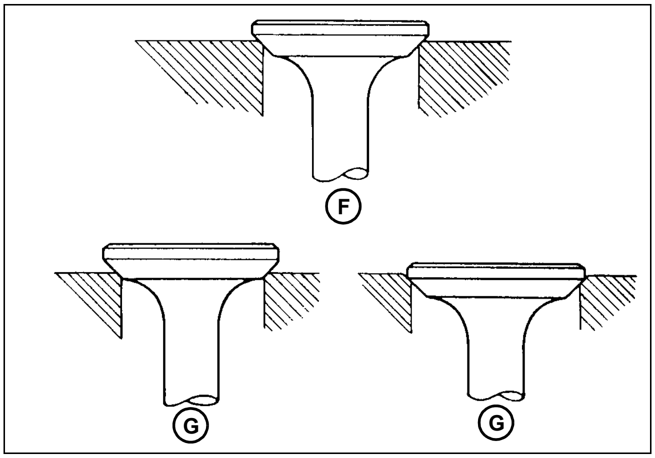
A - Valve Seating Surface Width
B - Valve Margin
C - Valve Face Angle
D - Valve Narrowing Angle
E - Valve Seat Angle

4. Lap valves to seats after refacing.

5. Center valve seat on valve face, note correct and incorrect positions.

6. Check seat for good contact:

- Apply a coat of Prussian Blue Compound to the valve face.
- Insert the valve and “snap” it closed against the seat several times.



M18615

- The valve seating surface should show good contact all the way around (F). If seat does not make proper contact (G), lap valves to seats.

Specifications:

Valve Seating Surface Width . . . . 0.50 - 1.10 mm (0.020 - 0.043 in.)

Valve Seat Angle. . . . . .45°

Valve Face Angle . . . . .45°

Valve Margin . . . . 0.60 mm (0.020 in.)

Valve Narrowing Angle. . . . . .30°

Lap Valves

1. If seat does not make proper contact, lap valve in seat.
2. Apply small amount of fine lapping compound to face of valve.
3. Grip top of valve with a vacuum cup tool. Turn valve to lap valve to seat.
4. Lift valve from seat every eight to ten strokes. Lap until uniform ring appears around surface of valve face.

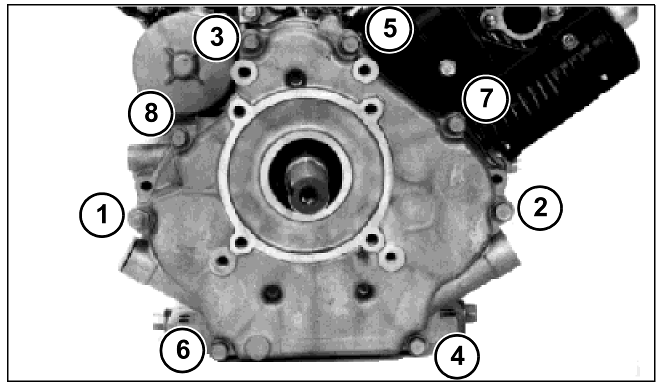
M50041

5. Wash all parts in solvent to remove lapping compound. Dry parts.
6. Check position of lap mark on valve face. Lap mark must be on or near center of valve face.

Crankcase Cover Removal and Installation

1. Remove drain plug and drain crankcase.
2. Remove crankcase cover and gasket.

NOTE: Do not force cover. Gears must mesh for proper positioning.



M53069

3. Install short end of mounting stud into block.
4. Tighten cap screws to specification using sequence shown.

Specifications:

Crankcase capacity (approximate):
Without filter. . . . . 1.1 L (2.3 pt)

With filter. . . . . 1.4 L (3.0 pt)

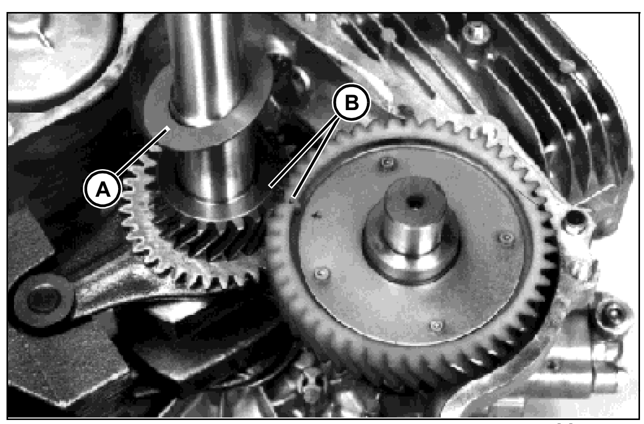
Torque Specifications:

Mounting Stud . . . . 26 N•m (230 lb-in.)

Mounting Cap Screws . . . . 26 N•m (230 lb-in.)

Oil Drain Plug . . . . 21 N•m (186 lb-in.)

Camshaft Removal and Installation



M80412

1. Remove crankcase cover and crankshaft shim(s) (A).

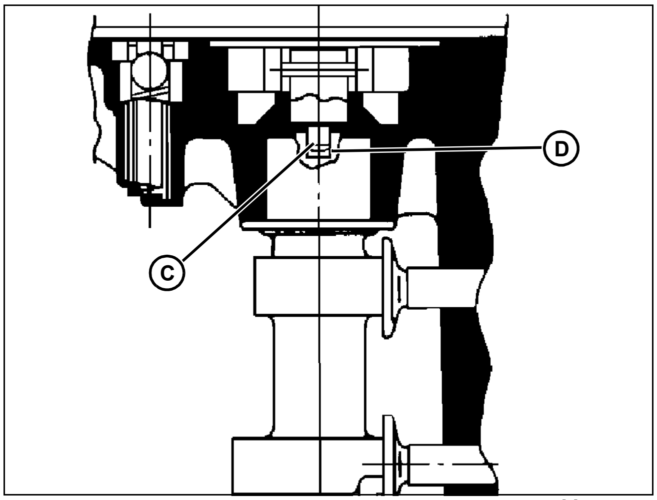
IMPORTANT: Avoid damage! Turn engine upside down and align timing marks to prevent damage to tappets when removing camshaft.

2. Rotate crankshaft until timing marks (B) align.

3. Remove camshaft.

Installation is done in reverse order of removal.

CAUTION: Avoid Injury! Be sure and remove the oil pump before camshaft installation. If the oil pump tang (C) does not fit into the slot (D) in the end of the camshaft, serious engine damage will result



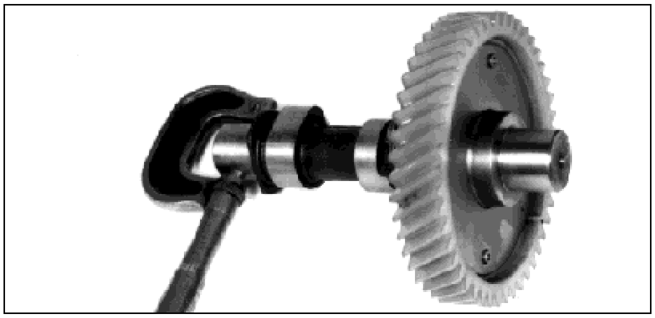
M76915

4. Apply clean engine oil to camshaft lobes, journals, and tappet guides before installation.

Camshaft Inspection

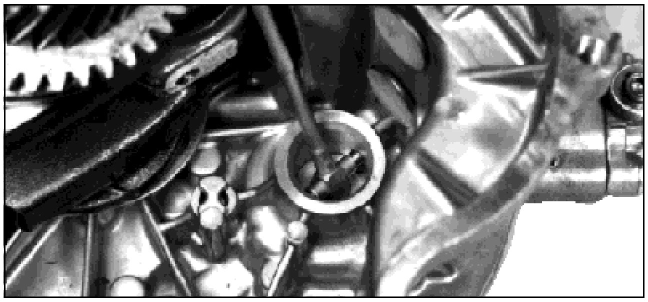
1. Inspect camshaft for worn or broken teeth.

NOTE: Camshaft and tappets are a matched set. Replace both, if necessary.



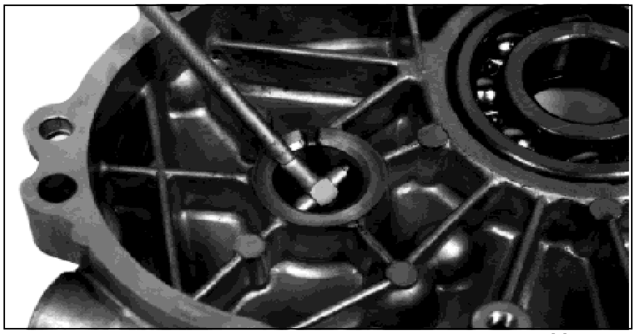
M80413

2. Measure side journal diameters and lobe height. If measurements are less than specifications, replace.



M80414

3. Measure camshaft bearing diameter in cylinder block. If bearing ID is greater than 23.06 mm (0.908 in.), replace block.



M80415

4. Measure camshaft bearing diameter in crankcase cover. If bearing ID is greater than 23.06 mm (0.908 in.), replace cover.

Camshaft Specifications (Wear Limit):

PTO and Flywheel Side

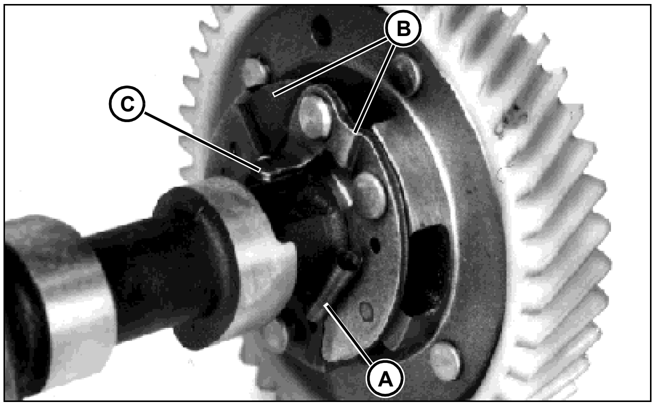
Journal OD . . . . 22.93 mm (0.903 in.)

Cam Lobe Height . . . . 32.70 mm (1.287 in.)

Automatic Compression Release

Inspection/Replacement:

1. Remove camshaft. (See "Camshaft Removal and Installation" on page 58.)
2. Inspect A.C.R. mechanism for wear or damage.



M80416

3. Inspect spring (A) for wear or damage. Replace if necessary.
4. Move weights (B) by hand to check for proper operation. Check that top of tab (C) is slightly above cam lobe when weights are pulled fully outward. Tab should drop below cam lobe when weights are fully retracted.

CAUTION: Avoid Injury! Be sure to remove the oil pump before camshaft installation. If the oil pump tang does not fit into the slot in the end of the camshaft, serious engine damage will result. (See "Camshaft Removal and Installation" on page 58.)

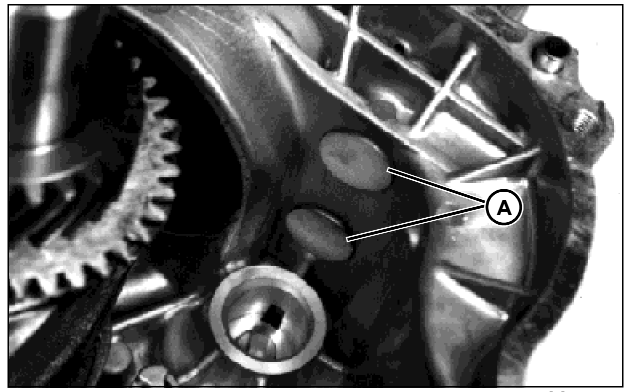
5. Replace camshaft assembly if A.C.R. does not operate properly.

Tappets Inspection and Replacement

1. Remove camshaft. (See "Camshaft Removal and Installation" on page 58.)

IMPORTANT: Avoid damage! Tappets must be installed in the same bores from which they were removed.

2. Put a mark on each tappet and cylinder block bore to aid in installation.



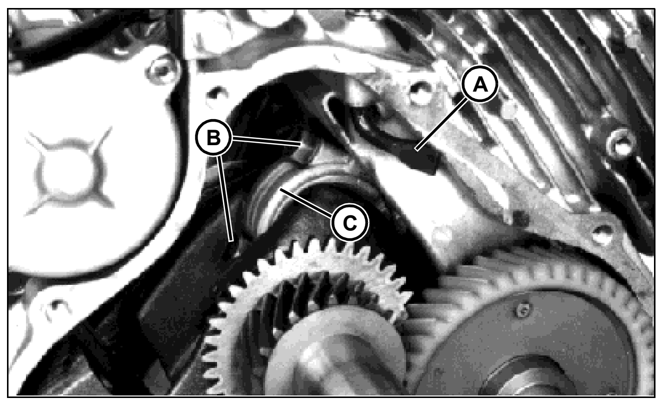
M80417

3. Remove tappets (A). Inspect tappets for wear or damage.
4. Apply clean engine oil to tappets and bores.

Piston and Connecting Rod

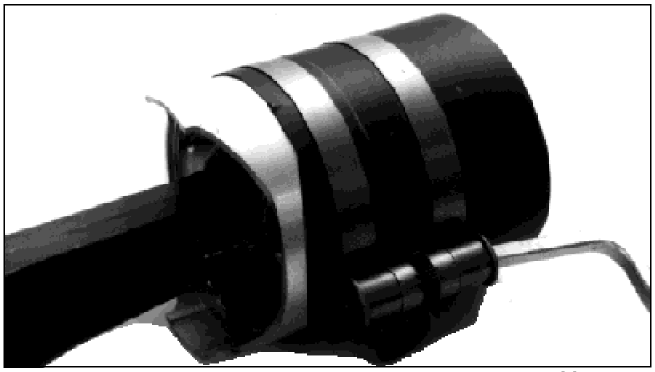
Removal and Installation:

1. Remove cylinder head.
2. Remove crankcase cover.



M80425

3. Loosen governor arm nut and rotate governor shaft (A) 180°.
4. Remove carbon and varnish from top of cylinder bore with a ridge reamer, if necessary.
5. Remove cap screws (B) and connecting rod cap (C).
6. Push piston and connecting rod from cylinder bore.
7. Disassemble and inspect all parts for wear or damage.
    - Apply clean engine oil on all parts during installation.
8. If new piston rings installed, deglaze cylinder.
9. Stagger piston rings 180° apart, but do not align with oil ring side rail end gaps.
10. Compress piston rings with a ring compressor.



M50074

11.Install piston and connecting rod assembly in cylinder bore with engraved match mark/arrow on piston head facing flywheel side of engine.

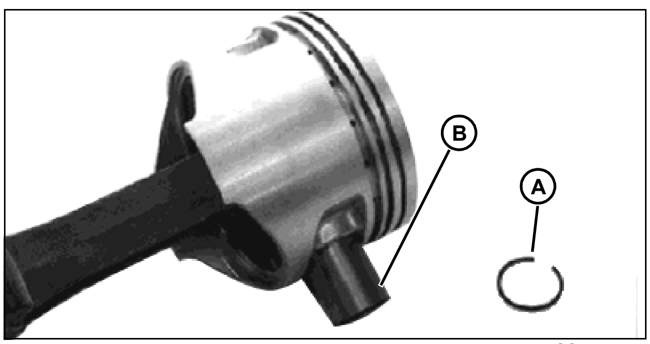
12.Install connecting rod cap and cap screws. Tighten cap screws to 20 N•m (177 lb-in.).

13.Rotate governor shaft 180° and tighten nut.

14.Install crankcase cover and cylinder head.

Disassembly:

1. Analyze piston and piston ring wear.
2. Remove piston rings using a piston ring expander.

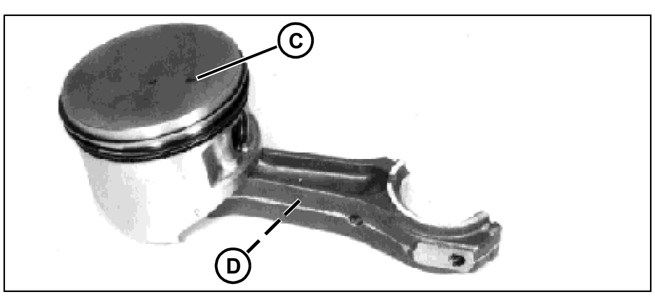


M50063

3. Remove circlip (A), piston pin (B) and connecting rod.
4. Inspect all parts for wear or damage.

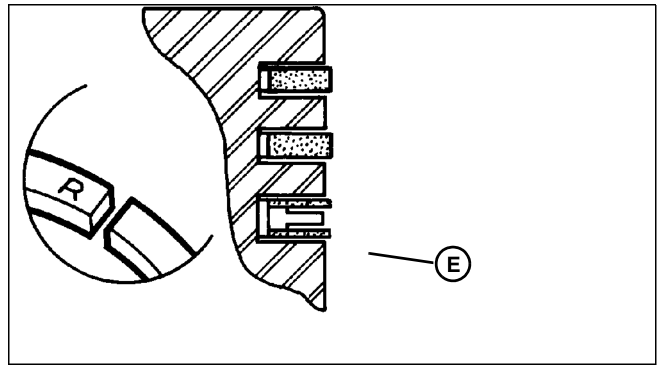
Assembly:

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



M80426

2. Assemble piston to rod with arrow mark (C) on piston opposite “MADE IN JAPAN” (D) on rod.
3. Install piston pin and circlip.



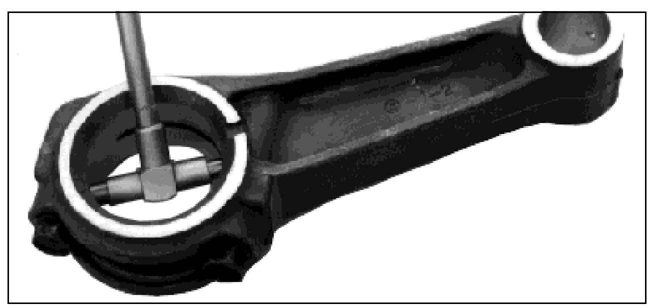
M80429

4. Oil ring is an assembly. Install spacer (E), then side rails in bottom ring groove of piston. Put side rail end gaps 180° apart.
5. Install compression rings with R or NPR mark facing up.
6. Stagger piston rings 180° apart, but do not align with oil ring side rail end gaps.

Inspection:

1. Inspect all parts for wear or damage.
2. Measure crankshaft connecting rod journal diameter.
3. Analyze connecting rod and crankshaft wear.
4. Install connecting rod cap. Tighten cap screws to 20 N•m (177 lb-in.).

NOTE: If engine has had a previous overhaul, undersized rod may have been installed, 0.50 mm (0.020 in.) undersize rod is available.



M50066

5. Measure connecting rod crankshaft bearing and piston pin bearing diameters.

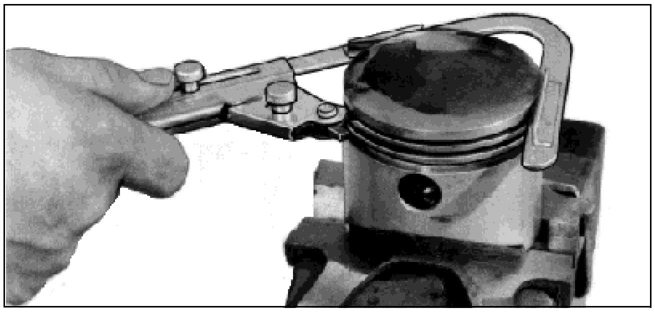
Connecting Rod Bearing ID (Wear Limit):

Crankshaft Bearing Standard	**35.57 mm (1.400 in.)**
Undersized	**35.07 mm (1.380 in.)**
Piston Pin Bearing	**19.06 mm (0.750 in.)**

NOTE: Replace connecting rod if either measurement is greater than specifications.

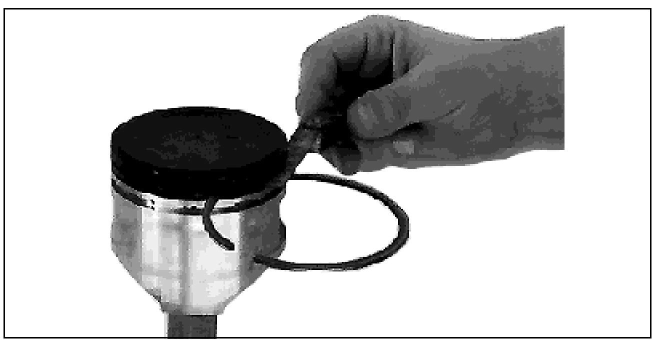
IMPORTANT: Avoid damage! Do not use a caustic cleaning solution or a wire brush to clean piston.

6. Remove all deposits from the piston.



M29946

7. Clean carbon from piston ring grooves with a ring groove cleaner. If a cleaning tool is not available, break an old ring and use it carefully to clean groove.
8. Check that oil return passages in the grooves are open.



M38102

9. Measure piston ring groove clearance. Measure several places around piston.

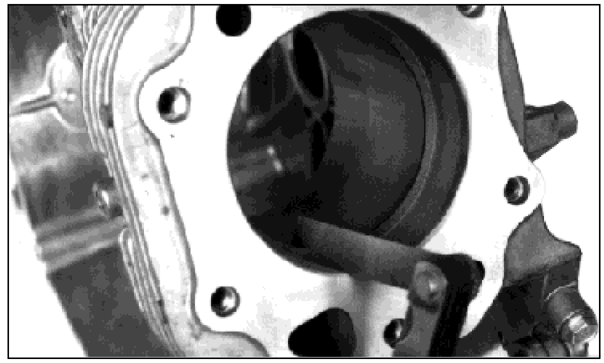
Piston Ring Groove Clearance (Wear Limit):

First Compression Ring. . . . . 0.16 mm (0.006 in.)

Second Compression Ring . . . . 0.14 mm (0.005 in.)

Oil Ring Assembly . . . . .Not Measured

NOTE: Replace piston if clearance is greater than specification.



M80430

10.Measure piston ring end gap. Push ring into cylinder bore, using a piston, until ring is approximately 25.4 mm (1 in.) down from top of cylinder bore.

Piston Ring End Gap (Wear Limit):

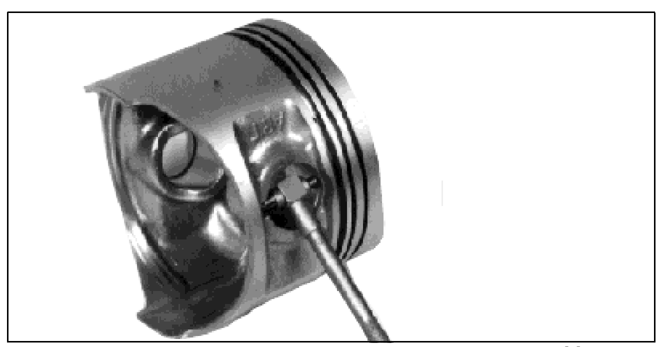
Compression Rings . . . . 1.20 mm (0.047 in.)

Oil Ring Assembly . . . . .Not Measured

NOTE: Replace ring if end gap is greater than specifications.

M50064

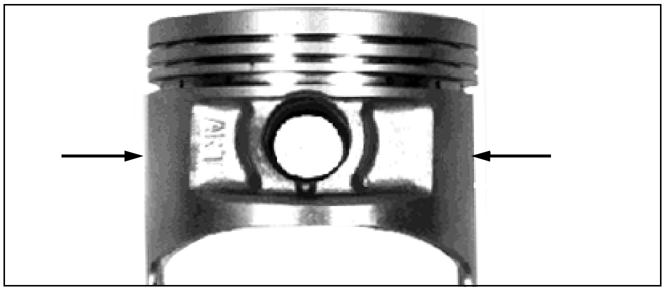
11.Measure piston pin diameter. Replace pin if diameter is less than 18.98 mm (0.747 in.).



M80427

12.Measure piston pin bore diameter. Replace piston if diameter is greater than 19.03 mm (0. 749 in.).

NOTE: If engine has had a previous overhaul, oversize pistons and rings may have been installed. Pistons and rings are available in 0.50 (0.020 in.) oversize.



M80428

13.Measure piston diameter perpendicular to piston pin bore.

Piston OD:

Standard . . . . 77.85 - 77.87 mm (3.0649 - 3.0657 in.)

Oversize 0.50 mm (0.020 in.). . . . . . . 78.35 - 78.37 mm (3.0849 - 3.0857 in.)

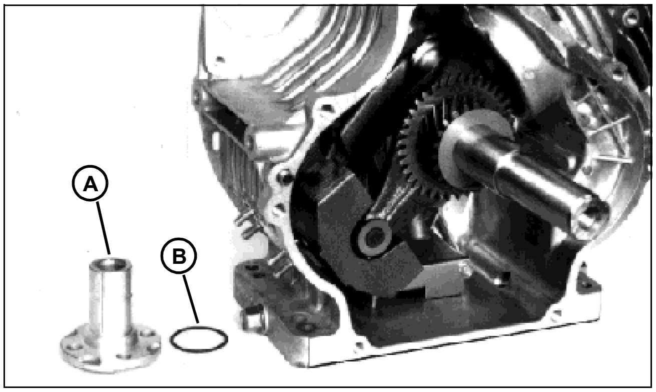
NOTE: Replace piston if diameter not within specifications.

14.Measure cylinder bore diameter. (See “Cylinder Bore ID:” on page 67.)

Reciprocating Balancer

Removal and Installation:

1. Remove flywheel, camshaft, and piston.
2. Remove four nuts, support shaft (A) and O-ring (B).
3. Remove crankshaft with balancer assembly.



M80418

4. Disassemble and inspect balancer assembly.
5. Inspect oil seals.

Installation is done in reverse order of removal.

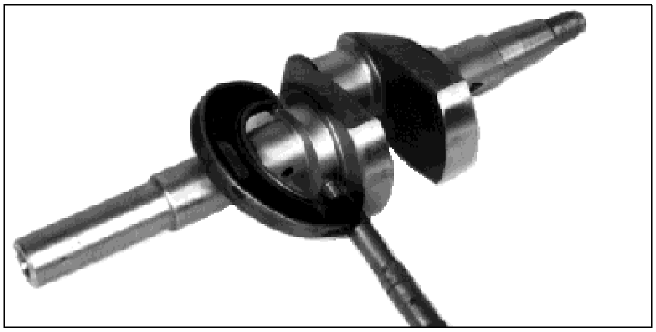
1. Cover keyway on flywheel end of crankshaft with tape to prevent damage to oil seal when installing assembly.
2. Apply clean engine oil to crankshaft bearing surfaces and all components during assembly.
3. Check and adjust crankshaft end play.

Disassembly/Assembly:

1. Inspect crankshaft for wear or damage.
2. Inspect balancer assembly for wear or damage.
3. Apply clean engine oil on all components during assembly.
4. Install collar with flat face toward link rod.
5. Install governor drive gear with chamfered face toward link rod.
6. Install crank gear with flat face toward governor drive gear.

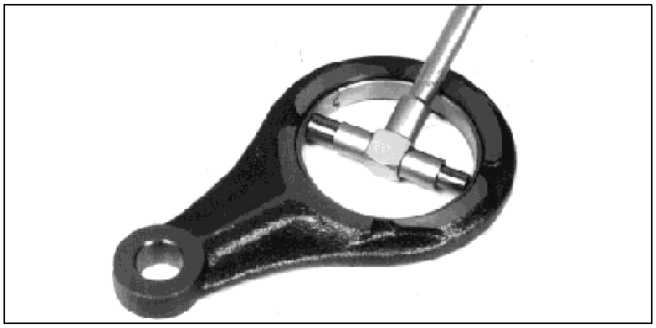
Inspection/Replacement:

1. Clean and inspect all parts for wear or damage. Replace as necessary.



M80420

2. Measure link rod journal diameters on crankshaft. If journal OD is less than 46.86 mm (1.845 in.), replace crankshaft.

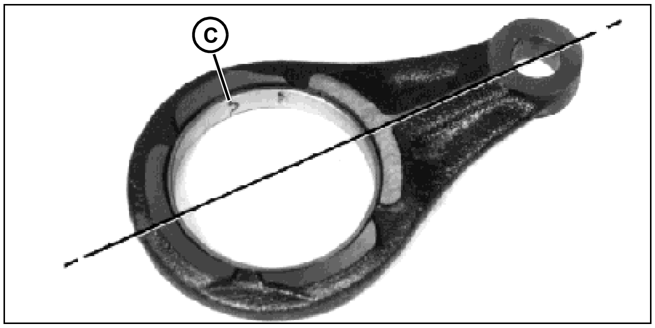


M80421

3. Measure inside diameter of link rod bearings. If link rod small end ID is more than 12.06 mm (0.475 in.), replace link rod. If link rod large end ID is more than 47.12 mm (1.855 in.), replace link rod bushing.

To replace link rod bushing:

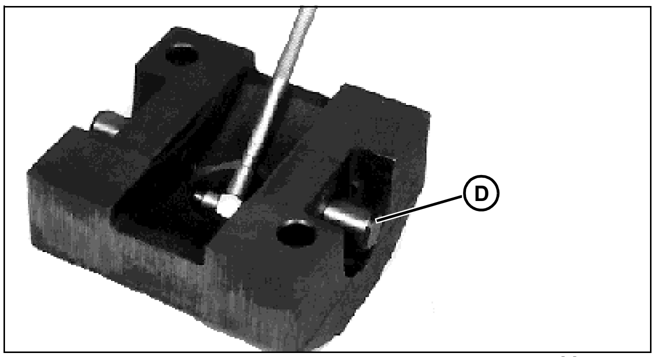
1. Replace bushing using a driver set and a press.



M80424

2. Install bushing with seam (C) at a 90° angle to rod centerline.

3. Install bushing 1.00 mm (0.040 in.) below link rod surface.



M80422

4. Measure support shaft bearing diameter in balancer weight. If bearing ID is more than 26.10 mm (1.027 in.), replace balancer weight.

5. Inspect wrist pins (D) for wear or damage.

M80423

6. Measure support shaft diameter. If shaft OD is less than 25.93 mm (1.021 in.), replace shaft.

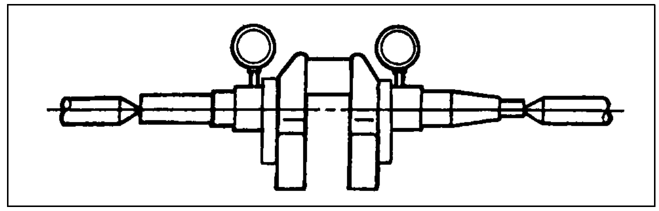
Crankshaft Removal and Installation

1. Check crankshaft end play.
2. Remove balancer.
3. Remove balancer assembly from crankshaft.
4. Inspect crankshaft for wear or damage.

Installation is done in reverse order of removal.

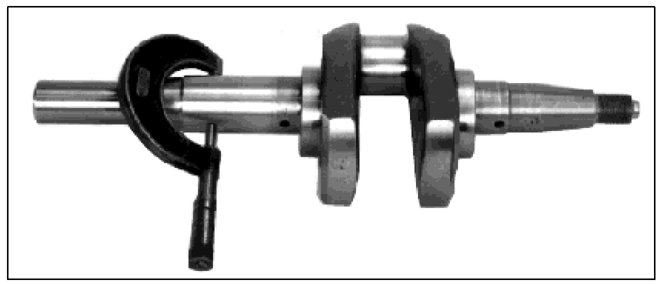
Crankshaft Inspection

1. Analyze crankshaft and connecting rod wear.



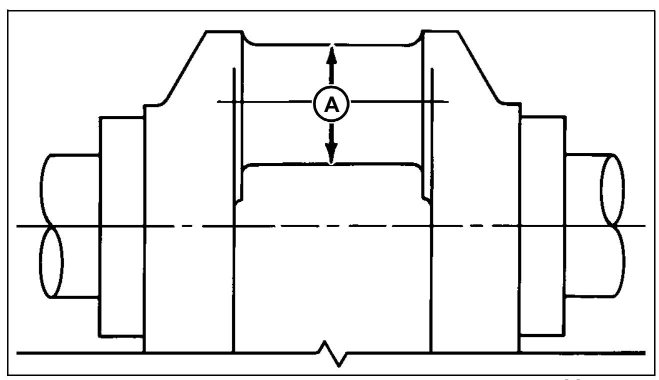
M80432

2. Inspect crankshaft for bend. Place crankshaft into an alignment jig and rotate crankshaft slowly. Use dial indicators to measure maximum total indicated runout (TIR). If TIR is greater than 0.05 mm (0.002 in.), replace crankshaft.



M54495

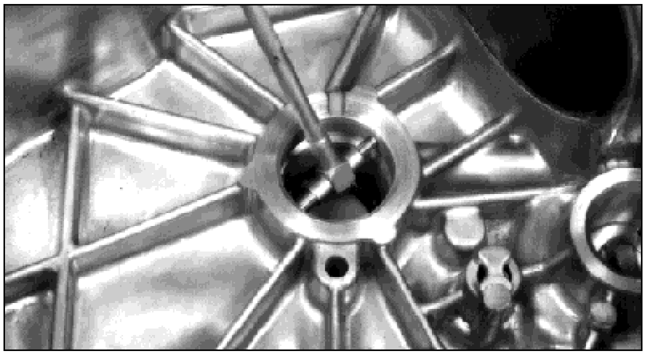
3. Measure crankshaft main bearing journal diameters. If either journal OD is less than 29.92 mm (1.178 in.), replace crankshaft.



M38036

4. Measure connecting rod journal diameter (A). (See “Specifications:” on page 65.)

NOTE: If engine has had a previous overhaul, connecting rod journal may have been resized for undersized rod. 0.50 mm (0.020 in.) undersize rod available.



M80431

5. Measure crankshaft main bearing diameter in crankcase. Replace crankcase if diameter is greater than 30.08 mm (1.184 in.).

6. Inspect crankshaft main ball bearing in crankcase cover for wear or damage:

- Remove crankcase cover oil seal.
- Remove bearing using a driver set.
- Thoroughly clean bearing in solvent. Dip bearing in light weight oil.
- Spin bearing check for axil and radial free play.
- Replace bearing if it is noisy or has too much play.
- Install bearing flush to inside of crankcase cover using a driver set.

Results:

- If standard journal diameter is less than specifications, have journal ground undersized by a qualified machine shop. Before sending for grinding, inspect journal radii for cracks.
- If undersized journal diameter is less than specifications, replace crankshaft.

Specifications:

Connecting Rod Journal OD (Wear Limit):

Standard . . . . 35.43 mm (1.395 in.)

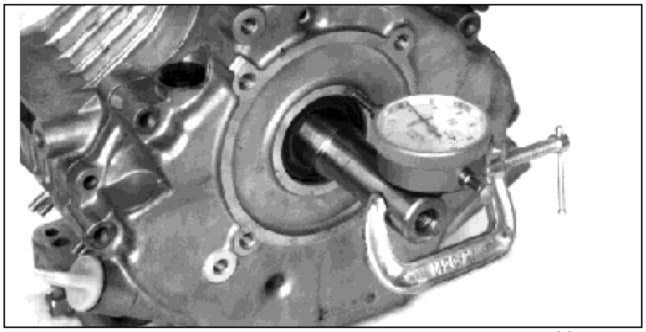
Undersized . . . . 34.93 mm (1.375 in.)

Crankshaft End Play Check

1. Fasten dial indicator to crankshaft and position indicator tip on crankcase cover.

2. Move crankshaft in and out, then pull crankshaft as far as it can go.

3. Zero the dial indicator.



M80433

4. Push crankshaft in as far as possible. If end play is not within 0.09 - 0.22 mm (0.004 - 0.009 in.), adjust end play.

Analyze Crankshaft and Connecting Rod Wear

Check connecting rod and cap for damage or unusual wear patterns.

Lack of lubrication or improper lubrication can cause the connecting rod and cap to seize the crankshaft.

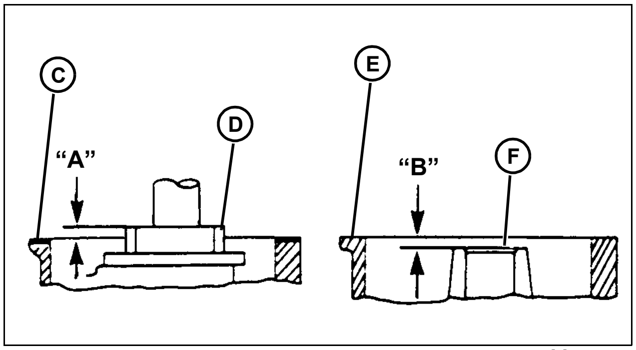
When the rod and cap seize to the crankshaft, the connecting rod and piston may both break causing other internal damage. Inspect block carefully before rebuilding engine.

Crankshaft and connecting rod damage can result from:

1. Engine run low on oil or without oil.
2. Oil not changed regularly.
3. Bearing cap installed incorrectly.

Crankshaft End Play Adjustment

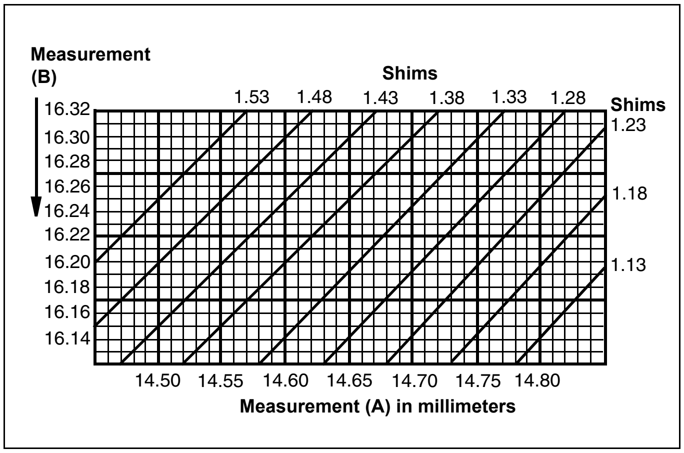
1. Remove crankcase cover.



M51545

2. With gasket (C) installed on crankcase, measure from gasket surface to crankshaft gear surface (D). Record this measurement as "A".

3. Measure from crankcase cover mounting face (E) to PTO bearing end (F). Record this measurement as "B".



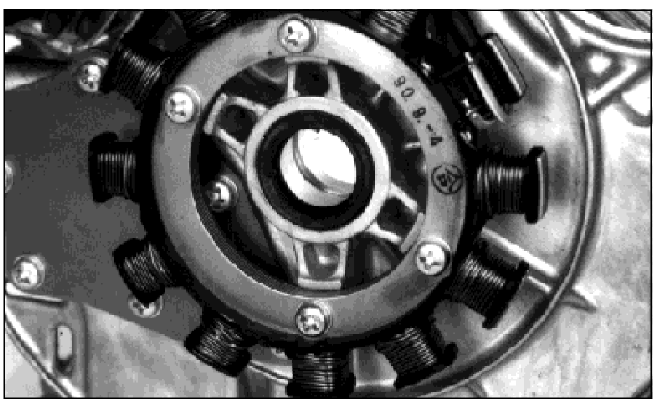
MIF

4. Locate measurements on appropriate table. Follow lines to where recorded measurements intersect. Choose the next smaller shim from the table.

5. Install shim(s) on end of crankshaft.

Crankshaft Oil Seal - Flywheel End Replacement

1. Remove crankshaft.



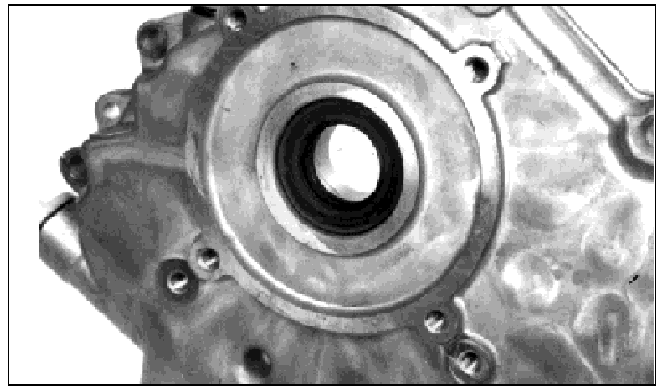
M80435

2. Remove worn or damaged seal using a screwdriver. Install seal with lip toward inside of engine using a driver set. Press in seal until flush with hub.

3. Pack lithium base grease inside lips of seal.

Crankshaft Oil Seal - PTO End Replacement

1. Remove crankcase cover.



M80436

2. Remove worn or damaged seal using a screwdriver. Install seal with lip toward inside of cover using a driver set. Press in seal 4 mm (0.158 in.) below cover flange surface.

3. Pack lithium base grease inside lips of seal.

Governor Shaft Oil Seal Replacement

1. Remove governor shaft.

M80437

2. Remove worn or damaged seal using a screwdriver. Install seal with lip toward inside of engine using a driver set. Press in seal 1.42 mm (0.056 in.) below flange surface.

3. Pack lithium base grease inside lips of seal.

Cylinder Block Inspection

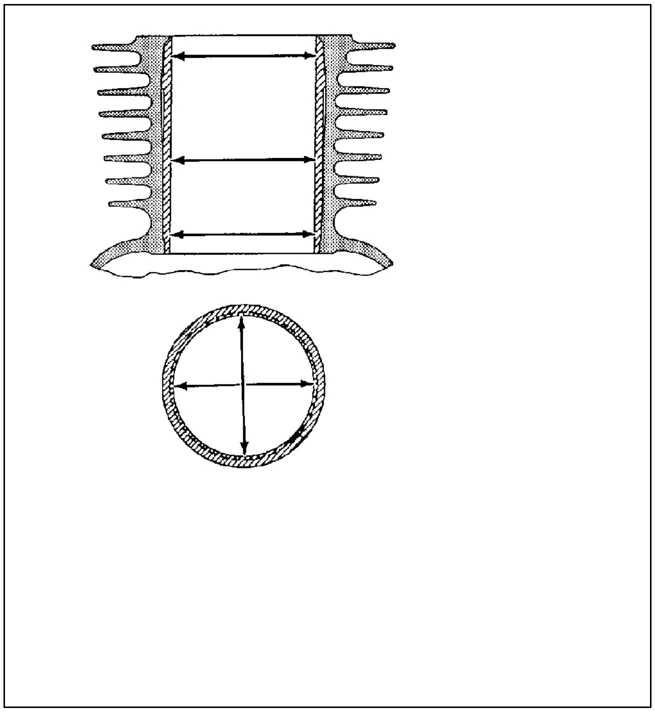
1. Remove crankshaft.

2. Clean and check block for cracks.

3. Cracks not visible to the eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil.

4. Wipe areas dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area. Replace block if cracks found.

NOTE: A bare block is available for service.



M82411A

5. Measure cylinder bore diameter at three positions; top, middle and bottom. At these three positions, measure in both directions; along crankshaft center line and direction of crankshaft rotation.

NOTE: If engine has had a previous overhaul, oversize piston/ rings may have been installed.

Results:

- If cylinder bore exceeds wear limit, replace cylinder block or have cylinder rebored.
- If cylinder is rebored, oversize pistons and rings must be installed. Pistons and rings are available in 0.25, 0.50 and 0.75 mm (0.010, 0.020 and 0.030 in.) oversize.

Cylinder Bore ID:

Standard Size Bore:
Standard . . . . 77.98 - 78.00 mm (3.070 - 3.071 in.)

Wear Limit . . . . 78.07 mm (3.074 in.)

Out-of-Round (Maximum) . . . . . . 0.056 mm (0.0022 in.)

0.50 mm (0.020 in.) Oversize Bore:
Standard . . . . 78.46 - 78.48 mm (3.089 - 3.090 in.)

Wear Limit . . . . 78.55 mm (3.093 in.)

Cylinder 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 rigid hone with 220 to 300 grit stone.

2. Use hone as instructed by manufacturer to obtain a 45° crosshatch pattern.

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

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

Cylinder Reboring

NOTE: Cylinder block can be rebored to use 0.50 mm (0.020 in.) oversize pistons and rings.

1. Align center of bore to drill press center.

IMPORTANT: Avoid damage! Check stone for wear or damage. Use correct hone for the job.

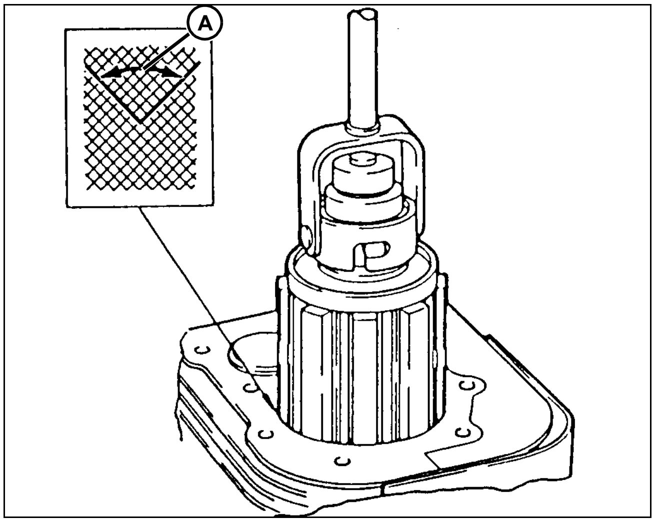
2. Adjust hone so lower end is even with lower end of cylinder bore.

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.

5. Run drill press at about 250 RPM. Move hone up and down in cylinder approximately 20 times per minute.

NOTE: Measure bore when cylinder is cool.



M82412A

6. Stop press and check cylinder diameter.

NOTE: Finish should not be smooth. It should have a 40 - 60° crosshatch pattern (A).

7. Check bore for size, taper and out-of-round.

8. Hone the cylinder an additional 0.028 - 0.030 mm (0.0011 - 0.0012 in.) for final bore specifications. This allows for 0.020 mm (0.0008 in.) shrinkage when cylinder cools.

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

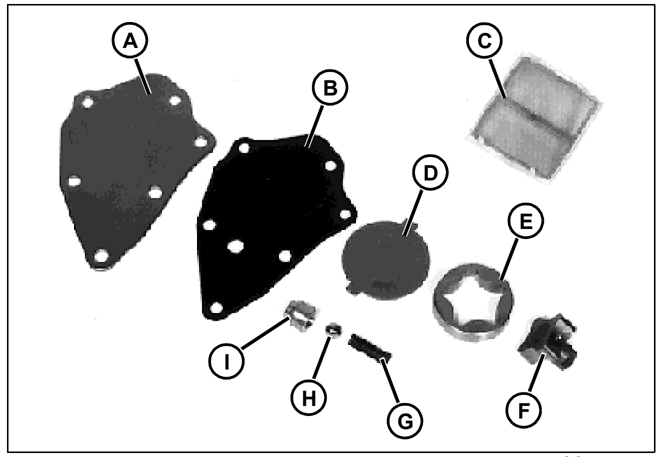
9. Clean cylinder thoroughly using warm soapy water until clean white rags show no discoloration.

10.Dry cylinder and apply engine oil.

Oil Pump Disassembly and Assembly

1. Remove stator, pump cover, gasket, rotor, outer rotor, rotor shaft, relief valve, check ball and spring.

NOTE: To inspect or clean oil screen, remove crankcase cover. (See "Crankcase Cover Removal and Installation" on page 58.)



M80438

A - Pump Cover
B - Gasket
C - Oil Screen
D - Rotor Cover
E - Outer Rotor
F - Rotor Shaft
G - Spring
H - Check Ball
I - Relief Valve

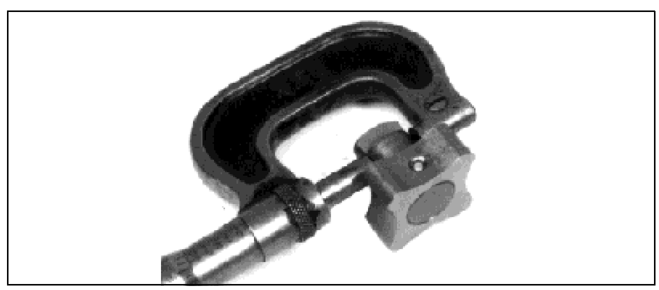
2. Inspect all parts for wear or damage.

Assembly is done in reverse order of disassembly.

- Apply clean engine oil on all internal parts during assembly.

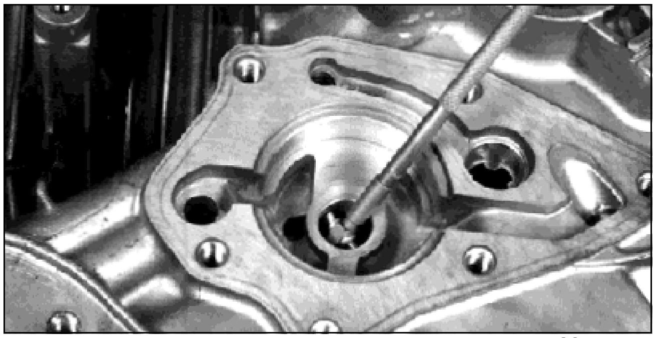
Oil Pump Inspection

Clean and inspect all parts for wear or damage.



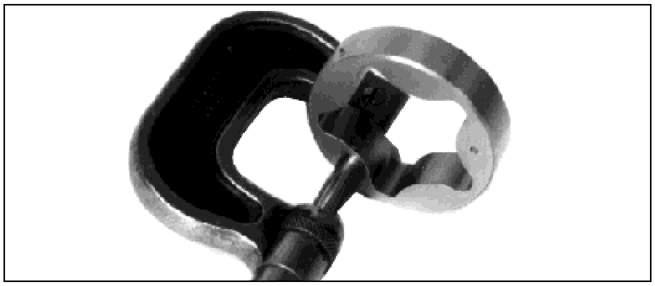
m80439

- Measure rotor shaft diameter. If shaft OD is less than 12.63 mm (0.497 in.), replace both shaft and outer rotor.



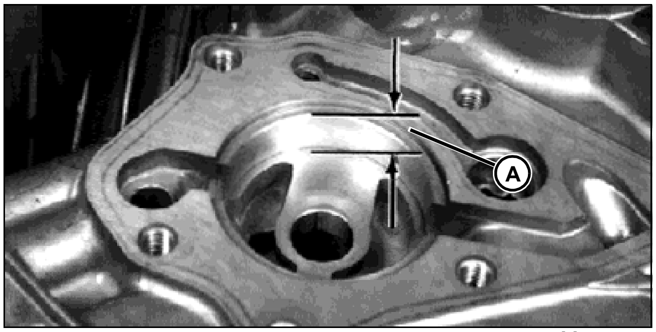
M80440

- Measure rotor shaft bearing. If bearing ID is greater than 12.77 mm (0.503 in.), replace cylinder block.



M80015

- Measure thickness of outer rotor. If thickness is less than 9.92 mm (0.391 in.), replace both outer rotor and rotor shaft.

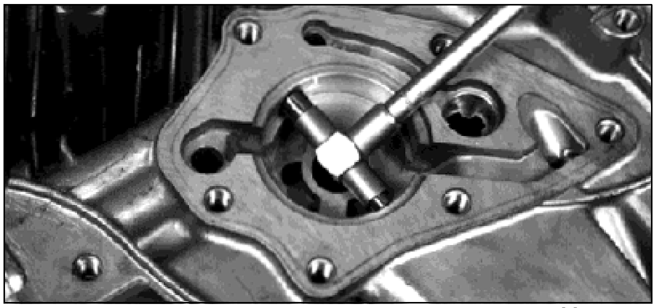


M80441

- Measure outer rotor bearing depth. If depth is greater than 10.17 mm (0.400 in.) (A), replace cylinder block.

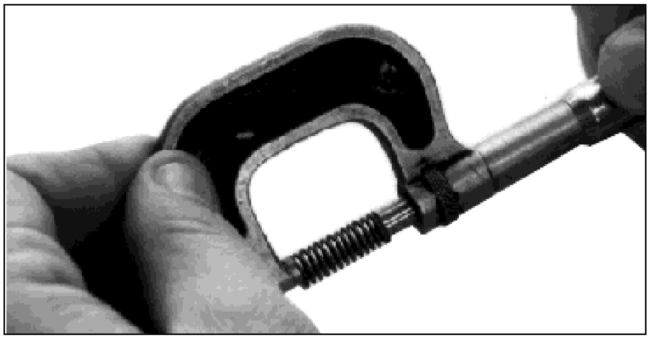
M80017

- Measure outer rotor diameter. If shaft OD is less than 40.47 mm (1.596 in.), replace both rotor and rotor shaft.



M80442

- Measure outer rotor bearing. If bearing ID is greater than 40.77 mm (1.605 in.), replace cylinder block.

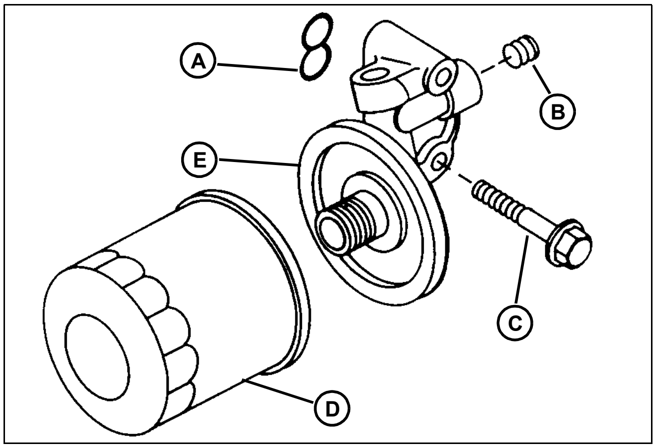


M50083

- Measure relief valve spring free length. Replace spring if measurement is less than 19 mm (0.748 in.).

Oil Filter Manifold Removal and Installation

NOTE: Not all engines are equipped with oil filter manifold



M80443

A - Gasket
B - Plug
C - Mounting Cap Screw (2) M6 X 40
D - Oil Filter
E - Oil Filter Manifold

Governor Inspection and Replacement

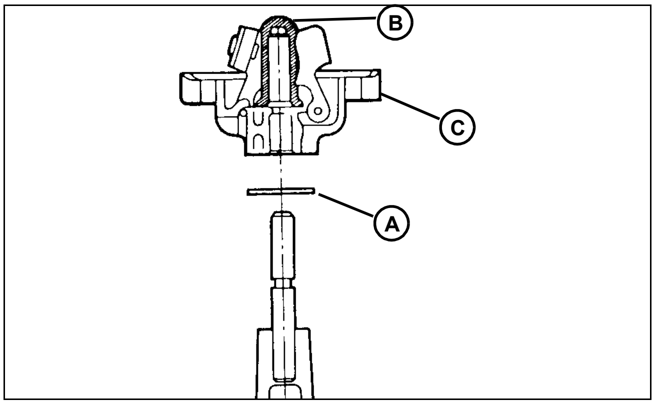
1. Remove crankcase cover.

IMPORTANT: Avoid damage! Removal damages governor. If not damaged, do not remove.

2. Inspect governor for wear or damage.

To replace governor:

- Remove governor with a screwdriver.
- If shaft is removed, press back into cover until it protrudes 32.2 - 32.8 mm (1.267 - 1.291 in.).



M51762

- Install washer (A) and sleeve (B) onto governor gear.
- Install governor gear (C) onto shaft. Push down on governor assembly until it snaps into place.

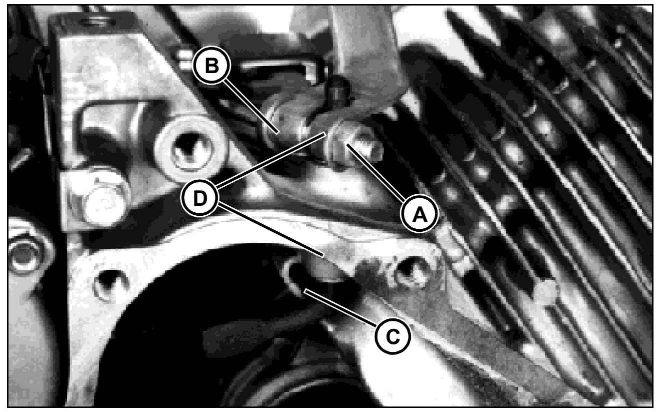
Governor Shaft Inspection and Replacement

NOTE: It is not necessary to remove governor shaft unless seal is leaking or shaft is damaged.

1. Remove crankcase cover.
2. Inspect governor shaft for wear or damage. Replace if necessary.

To replace governor shaft:

- Scribe a mark across shaft and lever to aid installation.

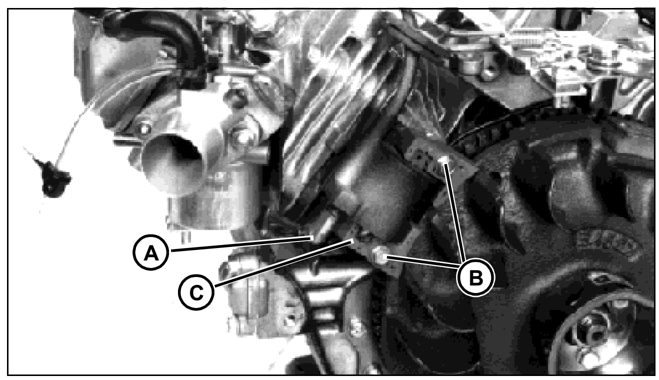


M80444

- Loosen nut (A) on governor lever.
- Remove retaining pin (B), governor shaft (C) and washers (D).
- Install washers, shaft and pin.
- Align marks made during removal and tighten nut.

Armature With Coil Removal and Installation

1. Remove blower housing.

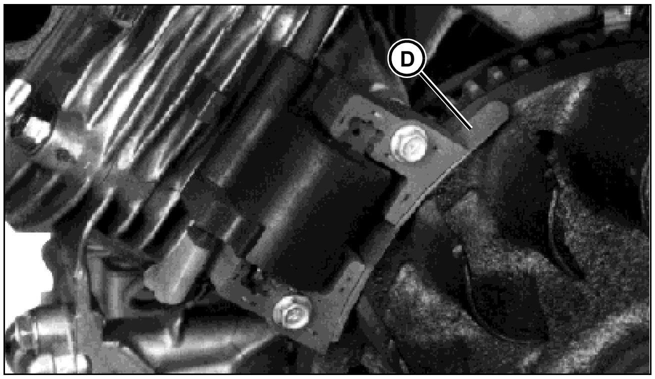


M82413

2. Disconnect wiring lead (A).
3. Remove cap screws (B) and armature with coil (C).
4. Install armature with coil. Leave mounting cap screws loose.
5. Connect wiring lead.
6. Adjust armature air gap. Tighten cap screws.
7. Install blower housing.

Coil Air Gap Adjustment:

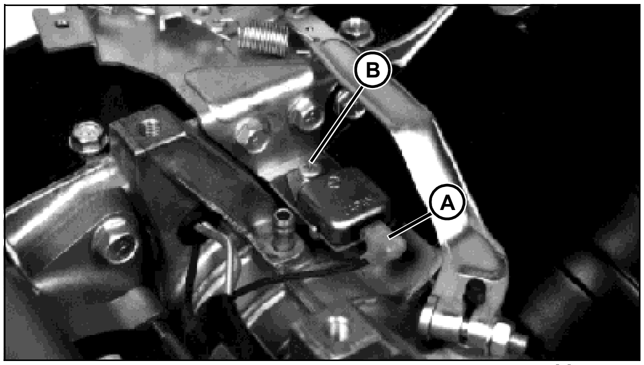
1. Turn flywheel magnet away from armature.



M80447

2. Insert a 0.30 mm (0.012 in.) feeler gauge blade (D) between flywheel and armature.
3. Push armature against flywheel and tighten mounting cap screws.
4. Turn flywheel to remove feeler gauge blade.

Ignitor Replacement

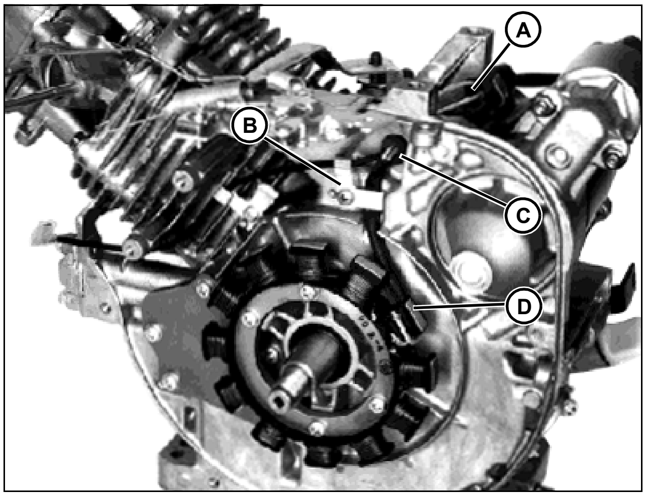


M80448

1. Disconnect wiring lead (A).
2. Remove mounting screw (B) and replace ignitor.

Stator Removal and Installation

1. Remove flywheel.



M80445

2. Disconnect wiring leads (A).
3. Remove clamp (B), rubber grommet (C), screws and stator (D).

Installation:

Installation is done in reverse order of removal.

Starting Motor

Disassembly/Assembly:

1. Mark body and covers for correct alignment during reassembly.
2. Remove two long cap screws and end cover.
3. Remove insulator, springs and holder.
4. Remove flange nut.
5. Remove field coil from armature assembly.
6. Remove two solenoid mount nuts.
7. Remove solenoid, shift lever and armature assembly.
8. Test solenoid.
9. Remove washer and separate stopper halves to remove retaining clip.
10. Remove pinion from armature.
11. Inspect and test brushes, field coil and armature.

Assembly:

Assembly is done in the reverse order of assembly.

Apply multipurpose grease to:

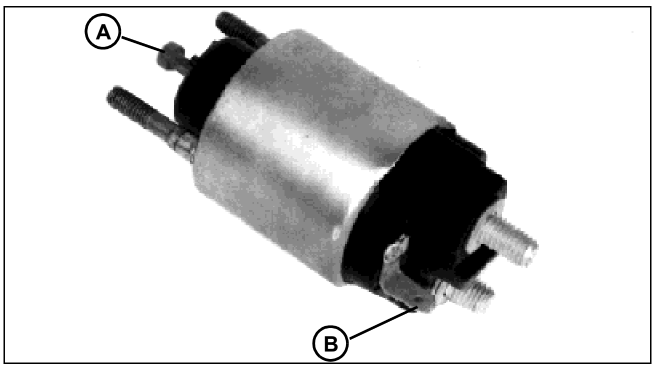
- Sliding surfaces of armature and shift lever.
- Armature shaft spline.
- Front and rear cover bearings.

Inspection/Test:

1. Measure brush lengths. If any one brush length is less than 6 mm (0.240 in.), replace all four brushes.

NOTE: Test all components using an ohmmeter or test light.

2. Test solenoid:



M51705

- Test solenoid terminals A and B for continuity. There should be no continuity.
- Depress switch arm (A). There should be continuity when arm is fully depressed.
- Test for open circuits between terminal B and tang (B). There should be continuity.
- Test for open circuits between tang and body. There should be continuity.

If solenoid fails any test, it is defective and must be replaced.

3. Test for grounded field winding:

M50115

- Touch one probe of tester to field coil brush and other probe to field coil housing. 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.

4. Test for open field coil:

M50116

- 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.

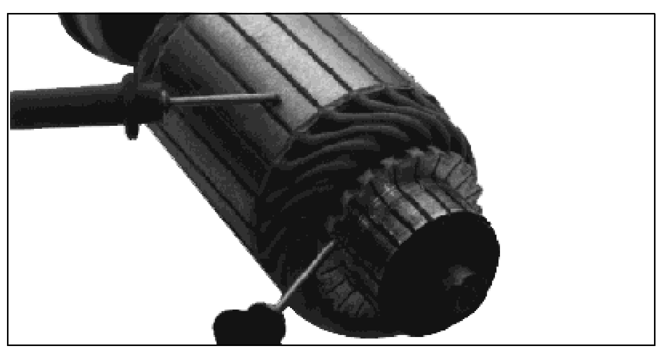
IMPORTANT: Avoid damage! Do not clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.

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

6. 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.

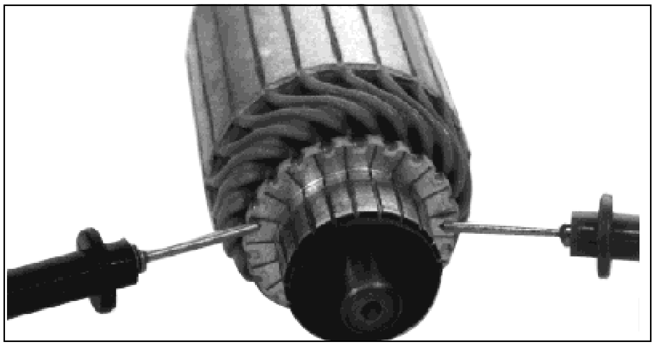
7. Test for grounded windings:



M50112

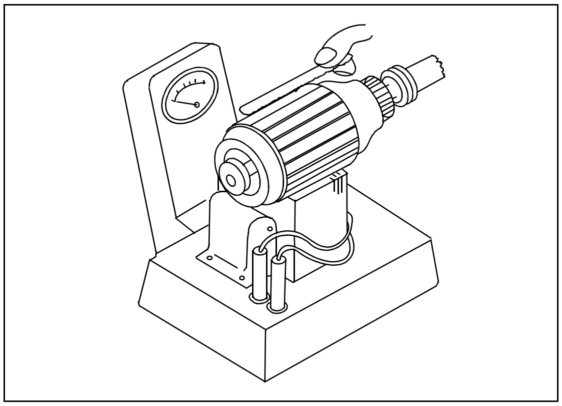
- Touch probes on each commutator bar. Armature windings are connected in parallel, so each commutator bar needs to be checked.
- If test shows continuity, a winding is grounded and the armature must be replaced.

8. Test for open circuit windings:



M50113

- Touch probes on two different commutator bars. If test shows no continuity, there is an open circuit and the armature must be replaced.



MIF

9. Test for short circuit windings using a growler. Put armature in a growler and hold a hacksaw blade or steel strip 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.

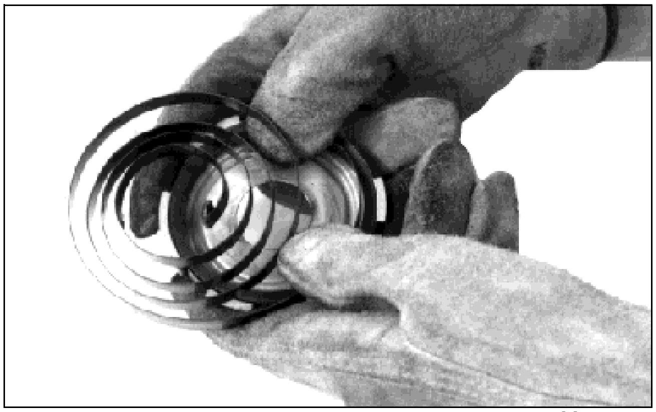
10.If test indicates short circuit windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.

Recoil Starter Disassembly and Assembly

- Inspect spring and case as an assembly.

Recoil Starter Spring Replacement

CAUTION: Avoid Injury! Spring is wound under great tension in spring case. Do not let spring fly loose. Hold spring firmly in place while replacing.



M54497

1. Working from the center out, carefully unwind spring from spring case.

2. Hook outside spring tang in case. Wind spring into spring case, working toward center.

Table of Contents

ENGINE - GAS (LIQUID-COOLED) SPECIFICATIONS

Specifications

General Specifications

Make. . . . . . **Kawasaki**

Model . . . . . **FD620D (AS11-JS11)**

Type . . . . . **4-cycle gas/Liquid Cooled**

Power. . . . . . **13.4 kW (18 hp)**

Cylinders **2**

Cycles **4**

Bore . . . . . **74 mm (2.900 in.)**

Stroke . . . . . **68 mm (2.660 in.)**

Displacement . . . . . **617 cm^3 (37.7 cu-in.)**

Spark Plugs

Engine Models through FS11 . . . . . **NGK BMR2A-10 (AM122402) or Champion RH18Y (TY6082)**

Engine Models GS11 and later . . . . . **NGK BPR2ES (M138938)**

Test and Adjustment Specifications

Engine:

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 mixture screw initial setting (FD620D-AS11 - CS11) . . . . . **1.5 Turns**

Carburetor SLOW idle stop screw setting . . . . **50 rpm less than throttle control arm SLOW idle stop screw setting**

Throttle Cable Throttle control arm SLOW idle stop screw setting . . . . . **1125 ± 75 rpm**

Throttle control arm FAST idle stop screw setting
FD620D-AS11 - BS11 . . . . . **3650 ± 50 rpm**

FD620D-CS11 - JS11 . . . . . **3850 ± 75 rpm**

Air Restriction Indicator
Normal restriction vacuum . . . . . **102 - 178 mm (4 - 7 in.)**

Maximum restriction vacuum . . . . . **381 mm (15 in.)**

Fuel Tank
Check valve opening pressure (maximum) . . . . . **3 kPa (0.4 psi)**

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.)**

Runout . . . . **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:

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.
Carburetor Test Kit	JDZ25-2	Fuel tank check valve 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.

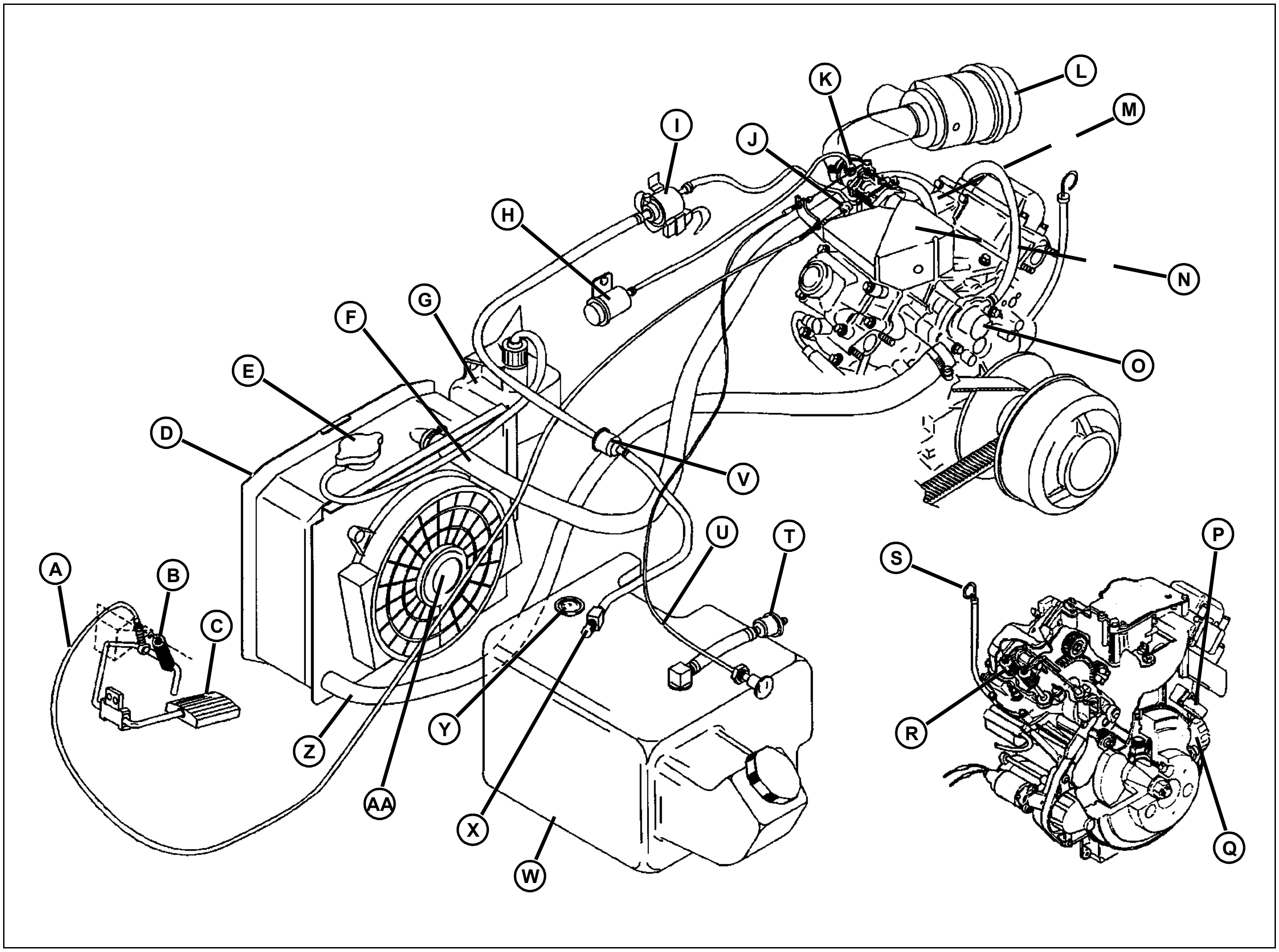
Other Materials

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

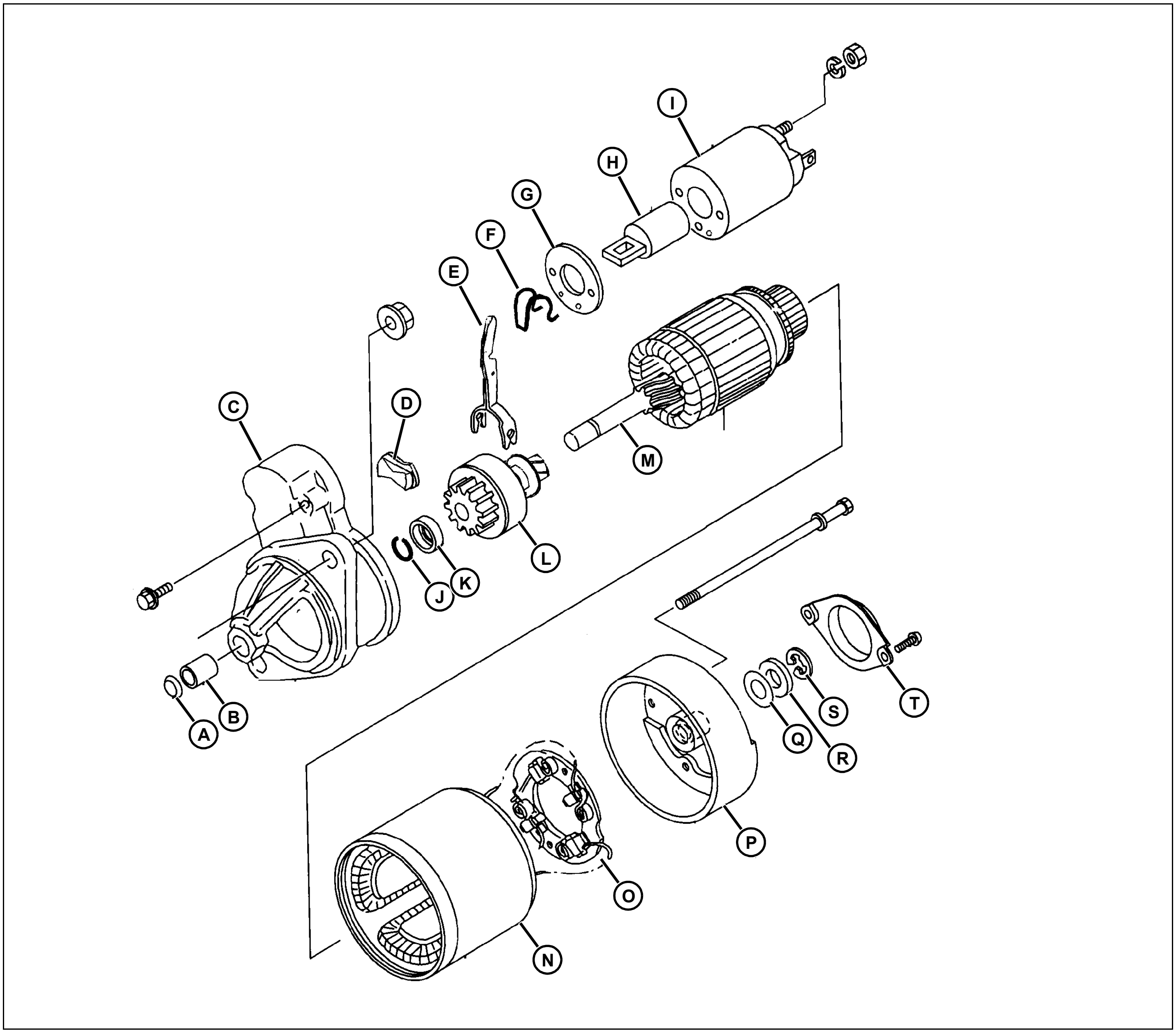
Engine Component Location



M55735A

- **A - Throttle Cable**
- **B - Throttle Return Spring**
- **C - Throttle Pedal**
- **D - Radiator**
- **E - Radiator Cap**
- **F - Upper Radiator Hose**
- **G - Coolant Recovery Tank**
- **H - Air Restriction Indicator**
- **I - Fuel Pump**
- **J - Throttle Control Arm**
- **K - Carburetor Assembly**
- **L - Air Filter Assembly**
- **M - Thermostat**
- **N - Governor Control**
- **O - Water Pump**
- **P - Oil Pressure Switch**
- **Q - Oil Filter**
- **R - Rocker Arms & Valves**
- **S - Dipstick**
- **T - Check Valve (-011285)**
- **U - Choke Cable**
- **V - Fuel Filter**
- **W - Fuel Tank Assembly**
- **X - Fuel Shut Off Valve**
- **Y - Fuel Level Indicator**
- **Z - Lower Radiator Hose**
- **AA- Cooling Fan**

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

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
- PTO Switch In Off Position
- 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 96. 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, float bowl 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 and Cleaning" on page 114.

Symptom: Engine Runs Erratically

(1) Is fuel delivery correct? See "Fuel Pump Flow Test" on page 96.

Yes - Check for plugged air/fuel passages in carburetor. See "Carburetor Repair" on page 106.

No - Check for contamination, or an air or vapor lock in the fuel tank and lines. Check tank check valve, shut off valve, 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 92.

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 - Plug in carburetor interior, clean carburetor. (See “Carburetor Repair” on page 106.)

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 97.)

No - Adjust valves.

Symptom: Oil Consumption Is Excessive

(1) Check compression. (See “Cylinder Compression Test” on page 96.) 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 124.)

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 Adjustment (FD620D-AS11)

Model: FD620D-AS11

(Chassis S/N 001001 - 014949)

NOTE: FD620D-BS11 - HS11 engines have governor controlled high and low idles; BS11 and CS11 engines have crankcase vented to the atmosphere; CS11 - HS11 engines have a recalibrated carburetor with a limiter cap on the idle mixture adjustment screw; engines marked GS11 and above have long reach automotive style spark plugs and 2 piece governor. Check engine model number and use appropriate adjustment procedure.

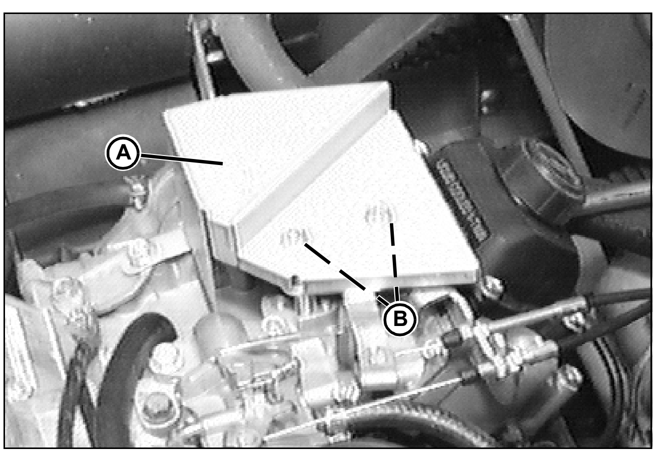
IMPORTANT: Avoid damage! Adjustments are printed in the order in which they should be performed. Always make adjustments as follows:
1. Governor
2. Fast Idle Speed
3. Slow Idle Speed and Slow Idle Mixture
4. Choke Cable
5. Throttle Cable
6. Pedal Stop

Reason:

To position governor arm and shaft for proper governor response.

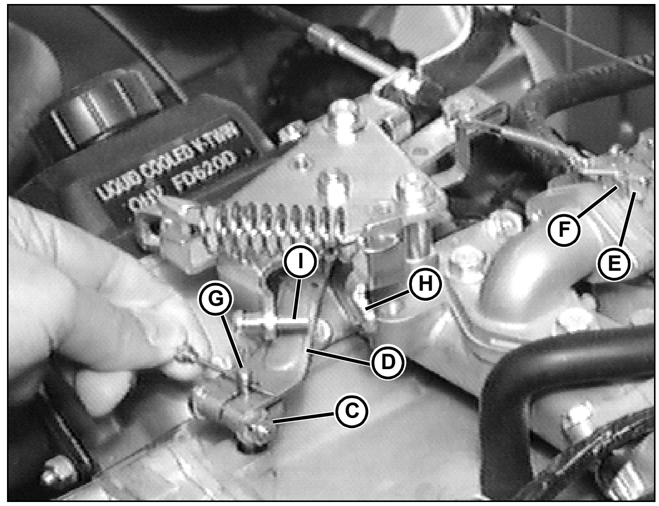
Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



M56391

2. Remove throttle control arm cover (A). DO NOT lose two small spacers (B) underneath cover.



M56392

3. Loosen nut (C) and spread jaws of governor arm (D) slightly until shaft (G) can turn.

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

4. Depress and hold throttle pedal to fast idle position. Check that carburetor fast idle stop tab (E) is against carburetor fast idle stop (F).

5. Turn and hold governor shaft (G) counterclockwise all-the-way using small pin through hole in shaft.

6. Tighten nut (C).

7. Release throttle pedal and check that throttle control arm stop tab (H) rests against throttle control arm slow idle stop screw (I).

Governor Adjustment (FD620D-BS11 - FS11)

Model: FD620D-BS11 - FS11

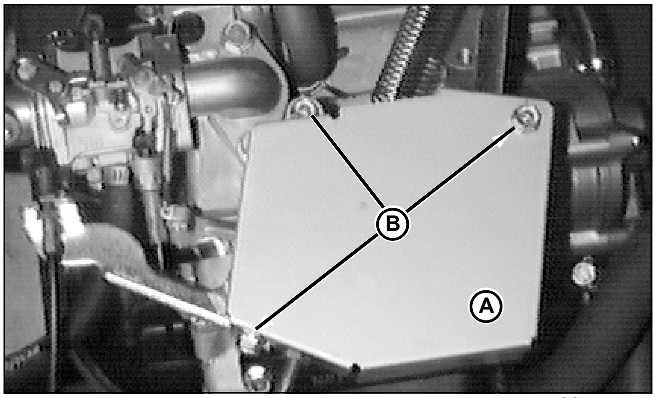
(Chassis S/N 014950 - 043829)

Reason:

To position governor arm and shaft for proper governor response.

Procedure:

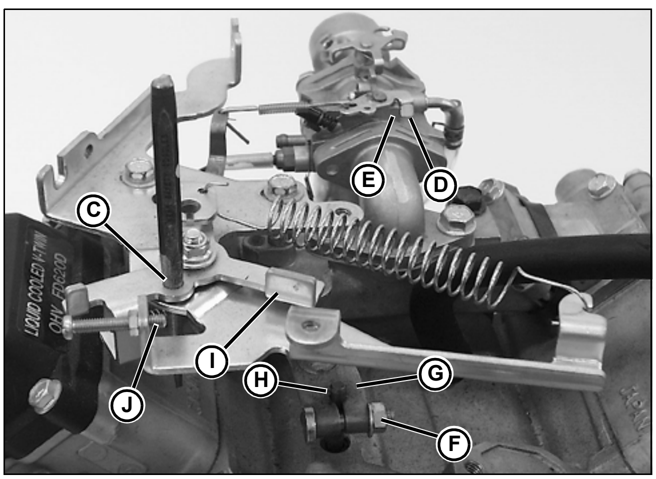
1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



M85286

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

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



MX1437

3. Depress throttle pedal until a 1/4” or 6 mm punch or pin can be inserted through hole in throttle lever and into throttle plate (C).

4. Check that carburetor fast idle stop tab (D) is against carburetor fast idle stop (E).

5. Loosen clamp nut (F) until governor arm (G) can turn.

6. Insert small drill bit through hole in governor shaft (H)

7. While holding the fast idle stop tab (D) against the carburetor fast idle stop (E), turn governor shaft (H) counterclockwise until it stops.

8. Tighten clamp nut (F) to 7.8 N•m (69 lb-in.).

9. Remove drill bit from governor shaft.

10.Remove pin or punch from throttle plate.

11.Check that throttle control arm stop tab (I) rests against throttle control arm slow idle stop screw (J). Adjust stop screw to make contact if does not.

Governor Adjustment (FD620D-GS11 - HS11)

Model: FD620D-GS11 - HS11

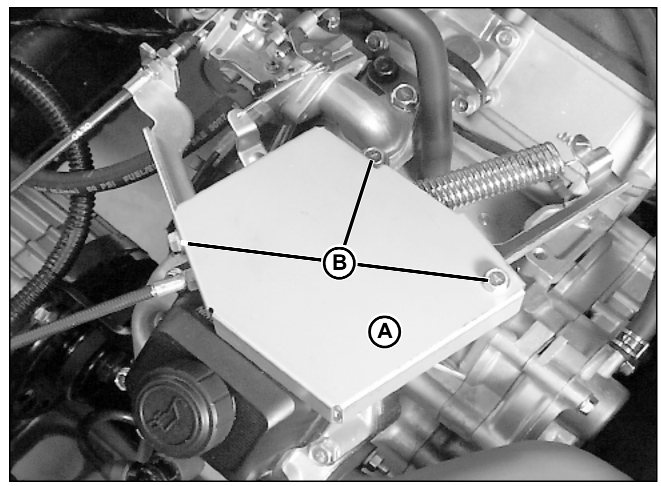
(Chassis S/N 043830-)

Reason:

To position governor arm and shaft for proper governor response.

Procedure:

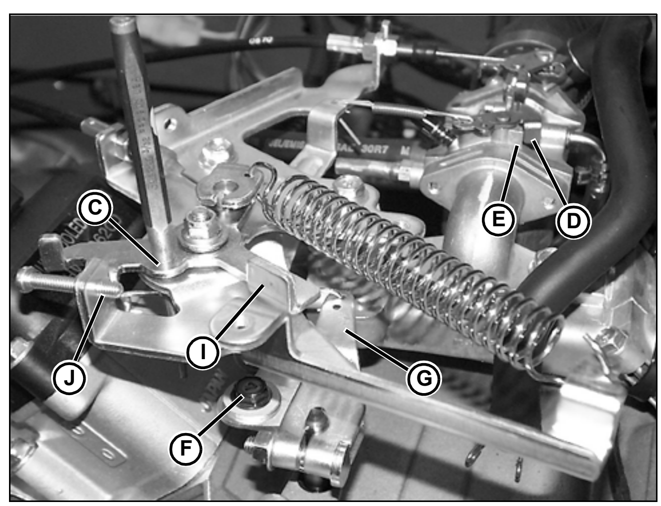
1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



MX1435

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

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



MX1436

3. Depress throttle pedal until a 1/4” or 6 mm punch or pin can be inserted through hole in throttle lever and into throttle plate (C).

4. Check that carburetor fast idle stop tab (D) is against carburetor fast idle stop (E).

5. Loosen cap screw (F) until governor shaft arm (G) can turn.

6. While holding the fast idle stop tab (D) against the carburetor fast idle stop (E), turn governor shaft arm (G) counterclockwise until it stops.

7. Tighten cap screw (F) to 6.8 N•m (60 lb-in.).

8. Remove pin or punch from throttle plate.

9. Check that throttle control arm stop tab (I) rests against throttle control arm slow idle stop screw (J). Adjust stop screw to make contact if does not.

Fast Idle Speed Adjustment (FD620D-AS11)

Model: FD620D-AS11

(Chassis S/N 001001 - 014949)

Reason:

To ensure that engine is running at correct fast idle speed.

Equipment:

- JT05801 Induction Tachometer

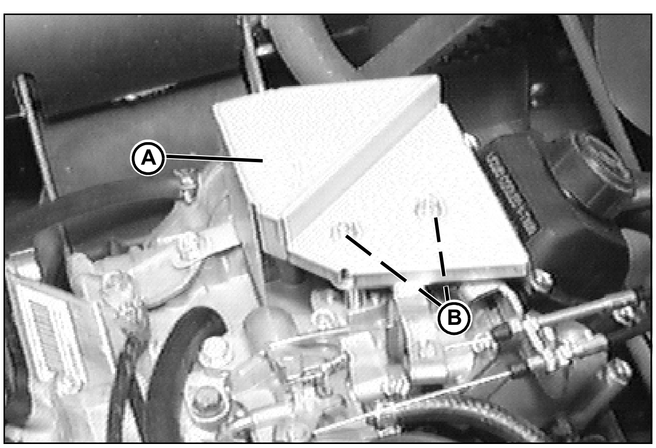
-or-

- JT05719 Digital Tachometer

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.

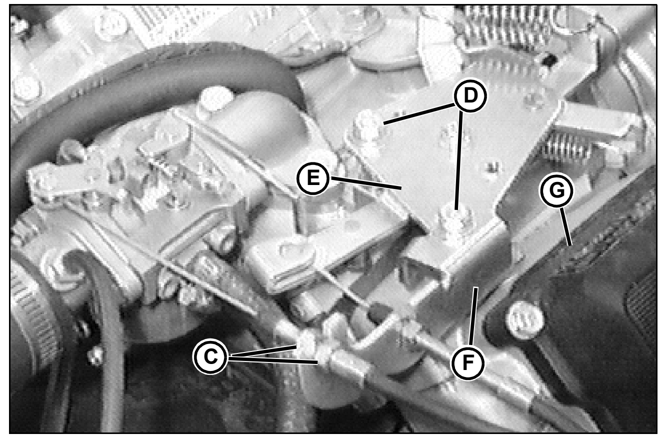
IMPORTANT: Avoid damage! DO NOT move throttle control arm by hand, this will kink the wire cable and damage it. Use throttle pedal.



M56391

2. Remove throttle control arm cover (A). DO NOT lose two small spacers (B), underneath cover.

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



M56388

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

4. Loosen jam nuts (C) and remove choke cable from mounting bracket.

NOTE: Throttle control arm plate (E) should be moved forward or rearward only, DO NOT twist plate side-to-side. The slightest movement, even when tightening the cap screws, will cause the rpm’s to fluctuate considerably.

5. Loosen cap screws (D) and move plate (E) forward or rearward until a fast idle setting of 3650 ± 50 rpm is obtained. Keep front face of plate (F) parallel with valve cover (G) during adjustment.

6. Tighten cap screws and recheck rpm’s - readjust if necessary.

7. Install and adjust choke cable. (See “Choke Cable Adjustment” on page 92.)

8. Readjust the throttle slow idle speed and the carburetor slow idle speed settings. DO NOT readjust the carburetor slow idle mixture screw. (See “Slow Idle Mixture and Speed Adjustments (FD620D-AS11)” on page 90.)

Fast Idle Speed Adjustment (FD620D-BS11 -)

Model: FD620D-BS11 -

(Chassis S/N 014950-)

Reason:

To ensure that engine is running at correct fast idle speed.

Equipment:

- JT05801 Induction Tachometer

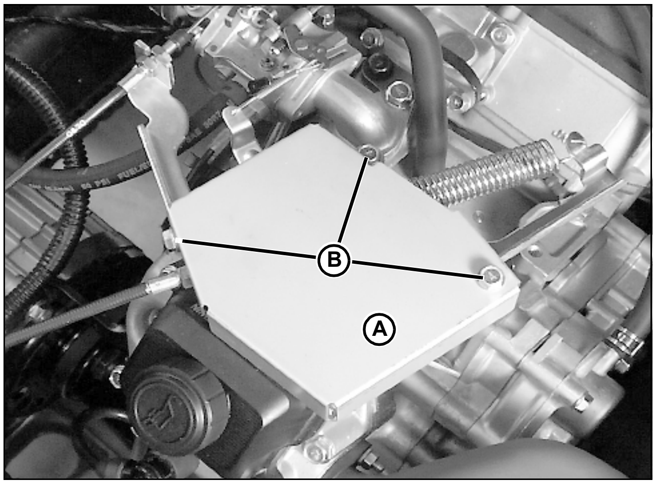
-or-

- JT05719 Digital Tachometer

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.

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

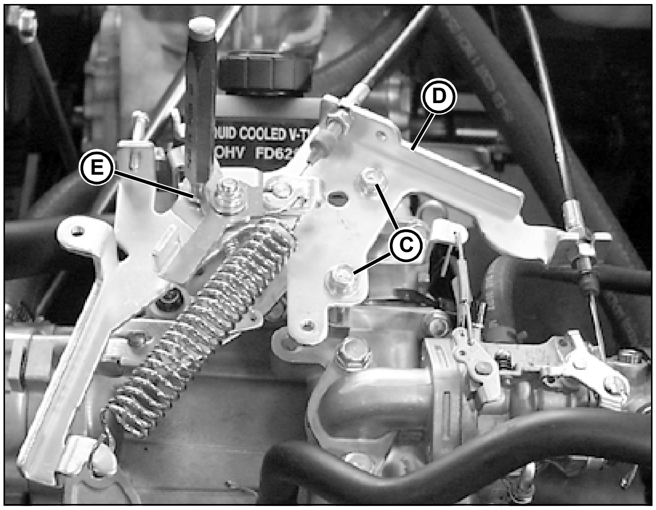


MX1435

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

3. Run engine at fast idle until cooling fan starts.

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

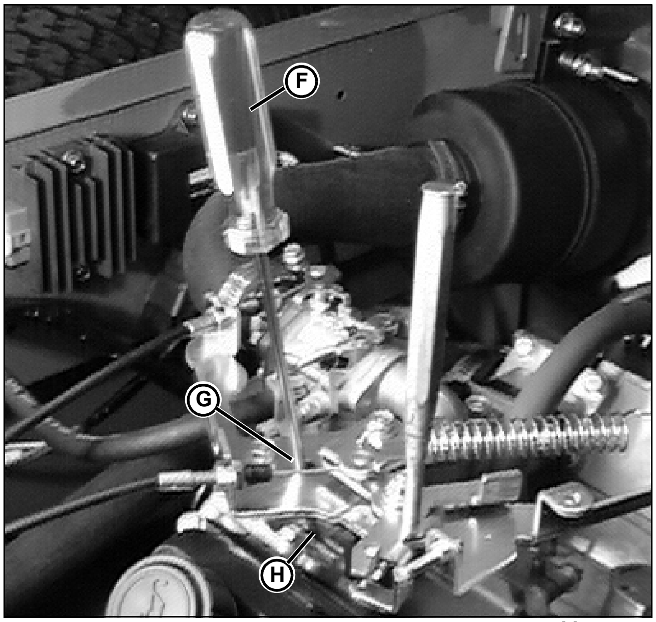


MX1381

4. Depress throttle pedal until a 1/4” or 6 mm punch or pin can be inserted through hole in throttle lever and into throttle plate (E).

NOTE: Throttle control arm plate (D) should be moved forward or rearward only, DO NOT twist plate side-to-side. The slightest movement, even when tightening the cap screws, will cause the rpm’s to fluctuate considerably.

To ease adjustment, insert a flat blade screw driver (F) through hole (G) so it engages groove (H) in raised boss on intake manifold. The screw driver will serve as a lever to slide the throttle plate fore and aft to achieve the desired 3850 ± 75 rpm high idle speed.



M85288

5. Loosen cap screws (C) and move plate (D) forward or rearward until a fast idle is as follows:

6. Tighten cap screws to 4.5 N•m (3.3 lb-ft) and recheck rpm's - readjust if necessary.

7. Remove screw driver and punch.

8. Adjust choke cable. (See "Choke Cable Adjustment" on page 92.)

9. Readjust the throttle slow idle speed and the carburetor slow idle speed settings. DO NOT readjust the carburetor slow idle mixture screw. (See "Slow Idle Mixture and Speed Adjustments (FD620D-BS11 -)" on page 91.)

Specifications:

Fast Idle

S/N FD620DAS11 - BS11 . . . . 3650 ± 50 RPM

S/N FD620DCS11 - . . . . 3850 ± 75 RPM

Slow Idle Mixture and Speed Adjustments (FD620D-AS11)

Model: FD620D-AS11

(Chassis S/N 001001 - 014949)

Reason:

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

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

Equipment:

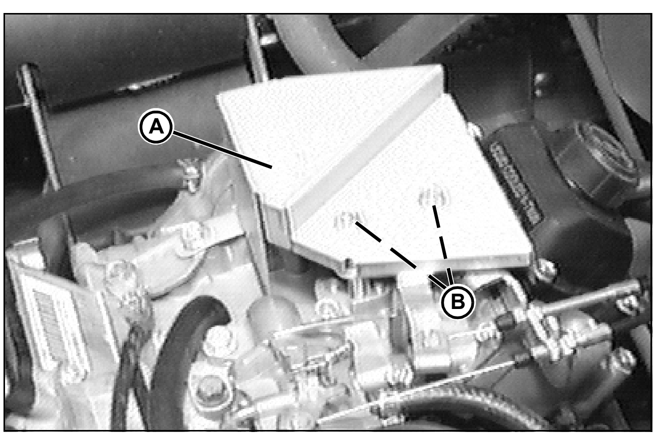
- JT05801 Induction Tachometer

-or-

- JT05719 Digital Tachometer

Procedure:

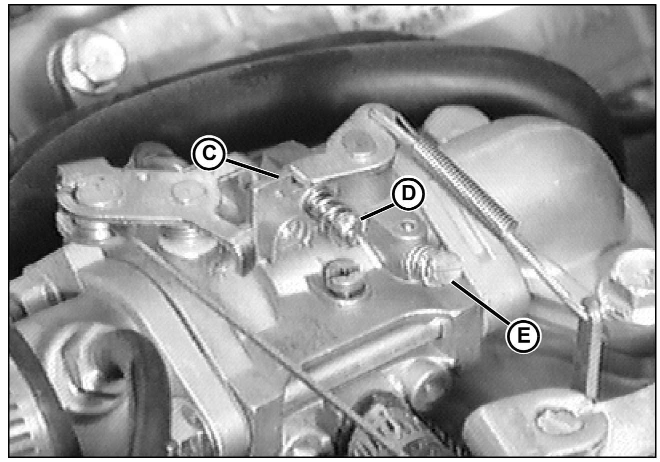
1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



M56391

2. Remove throttle control arm cover (A). DO NOT lose two small spacers (B), underneath cover.

IMPORTANT: Avoid damage! DO NOT overtighten idle mixture screw, the needle and seat will be damaged.



M56390

3. Turn slow idle mixture screw (E) clockwise until lightly seated, then turn screw counterclockwise 3/4 turn.

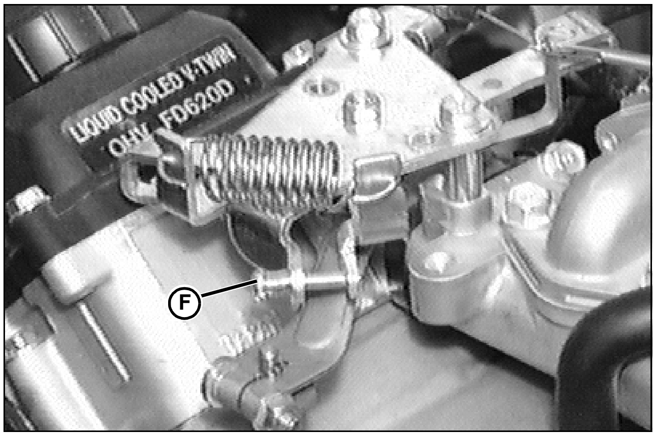
IMPORTANT: Avoid damage! DO NOT move throttle control arm by hand, this will kink the wire cable and damage it. Use throttle pedal only.

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

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

5. Turn slow idle stop screw (D) counterclockwise until it no longer touches stop tab (C).

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.



M56389

6. Adjust throttle control arm slow idle stop screw (F) until engine is idling at 1125 ± 75 rpm.

7. Turn mixture screw (E) clockwise until engine speed begins to drop-off, note position. Turn mixture screw counterclockwise until engine speed increases and begins to drop-off, note position.

8. Adjust mixture screw to highest speed between to positions above. Turn screw an additional 1/4 turn counterclockwise to ensure it is slightly on the rich side of the mixture.

9. Reset slow idle stop screw (F) to 1125 ± 75 rpm, if necessary.

10.Turn slow idle stop screw (D) clockwise until it lightly touches throttle arm stop tab (C).

11.Push and hold tab (C) against slow idle stop screw (D). Turn screw counterclockwise until engine speed is 100 rpm less than throttle control arm stop screw setting.

12.Depress and release throttle pedal.

13.Check that throttle control arm slow idle speed is 1125 ± 75 rpm.

14.Push and hold tab (C) against screw (D). Engine speed should drop to 100 rpm less than throttle SLOW idle stop screw setting.

15.Adjust carburetor screw (D), if necessary.

Slow Idle Mixture and Speed Adjustments (FD620D-BS11 -)

Model: FD620D-BS11 -

(Chassis S/N 014950-)

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

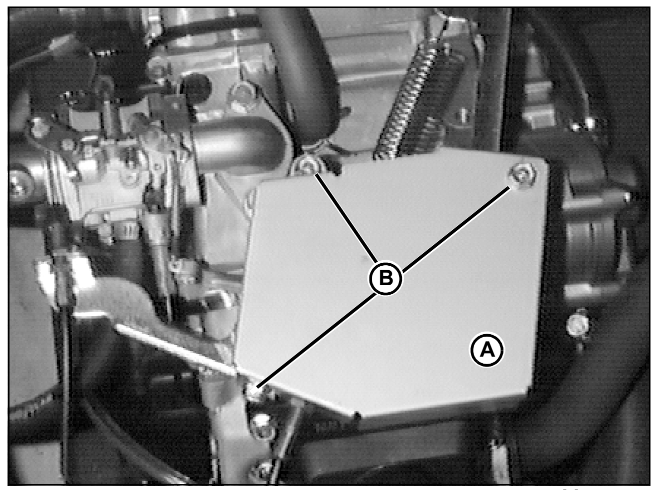
-or-

- JT05719 Digital Tachometer

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.

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.



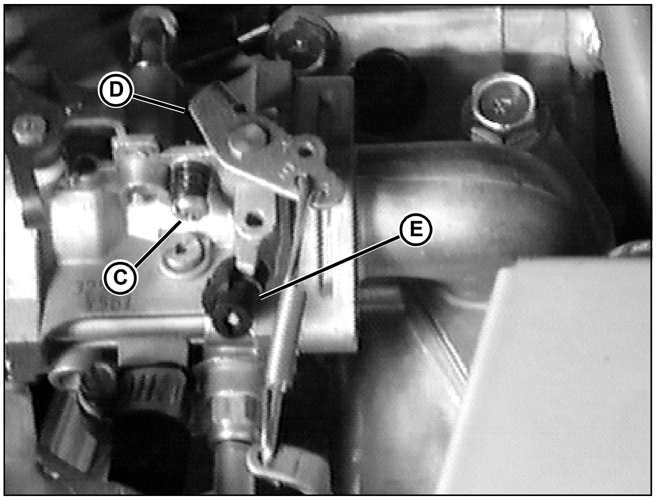
M85286

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.

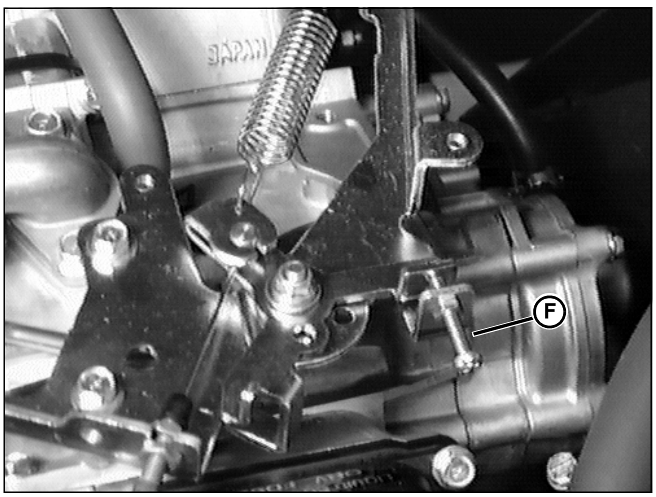
3. Run engine at fast idle until cooling fan starts. Release throttle pedal.

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



M85280

4. Turn slow idle stop screw (C) counterclockwise until it no longer touches stop tab (D).



M85289

5. Adjust throttle control arm slow idle stop screw (F) until engine is idling at 1175 +25/-50 rpm.

6. Turn slow idle mixture screw (E), until highest idle speed is obtained.

NOTE: Do not remove limiter cap or force beyond stops.

7. Reset throttle control arm slow idle stop screw (F) to 1175 +25/-50 rpm, if necessary.

8. Turn carburetor slow idle stop screw (C) clockwise until it lightly touches throttle arm stop tab (D).

9. Push and hold tab (D) against slow idle stop screw (C). Turn screw counterclockwise until engine speed is 50 rpm less than throttle control arm stop screw setting.

10.Depress and release throttle pedal.

11.Check that throttle control arm slow idle speed is 1175 +25/-50 rpm.

12.Push and hold tab (D) against screw (C). Engine speed should drop to 50 rpm less than throttle slow idle stop screw setting.

13.Adjust carburetor screw (C), if necessary.

Choke Cable Adjustment

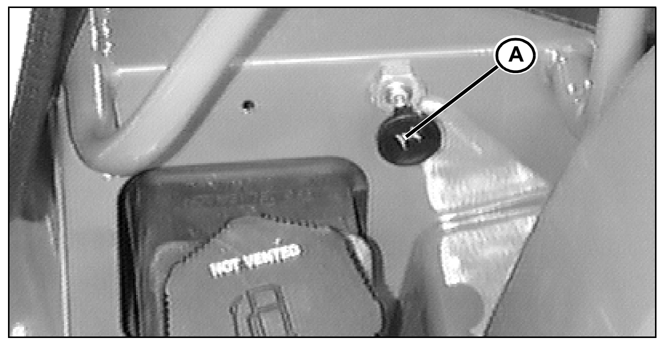
Reason:

To get full choke operation and prolong choke cable life

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

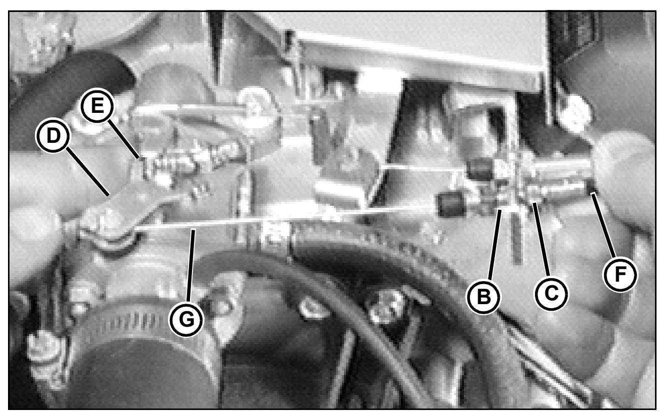
Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



M55733

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



M56394

3. Loosen jam nuts (B and C).

4. Hold choke arm tab (D) against stop (E).

5. Pull choke cable conduit (F) away from carburetor until all slack in cable (G) is removed.

6. Snug jam nuts without releasing tension on conduit or choke arm.

7. Turn jam nut (C) one to two additional turns counterclockwise to add cable slack.

8. Tighten jam nut (B) to mounting bracket.

9. Pull choke knob slightly as you watch choke arm of the carburetor. Choke arm should respond as-soon-as the slight freeplay of cable and anchor barrel is removed.

10.Move choke linkage through full range of motion to be sure choke opens and closes fully and linkage moves smoothly from stop-to-stop.

Throttle Cable Adjustment (FD620D-AS11)

Model: FD620D-AS11

(Chassis S/N 001001 - 014949)

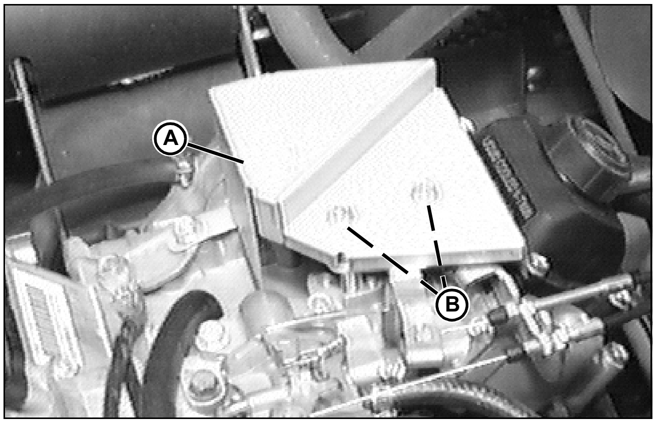
NOTE: Adjust fast idle, slow idle and mixture, and choke cable before adjusting throttle cable.

Reason:

To ensure throttle cable is adjusted correctly, and that throttle pedal movement provides full travel of carburetor linkage.

Procedure:

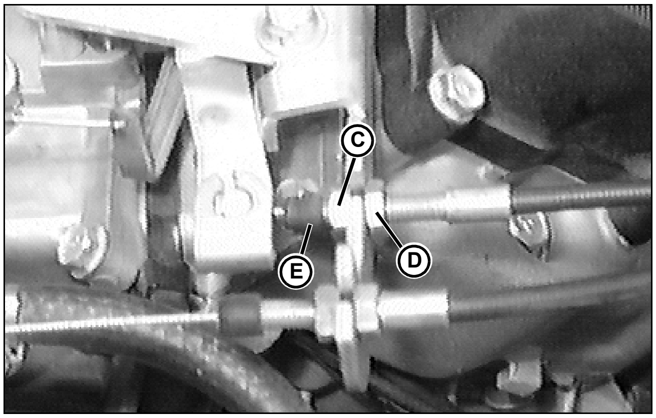
1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



M56391

2. Remove throttle control arm cover (A). Be sure NOT to lose small spacers (B), underneath cover.

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

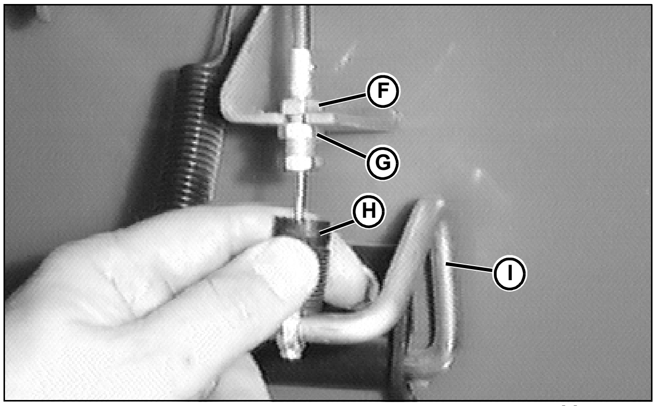


M56395

3. Loosen jam nut (D).

4. Adjust jam nut (C) until there is a maximum of 2 threads between edge of jam nut (C) and edge of rubber wiper boot (E).

5. Tighten jam nut (D).



M56359

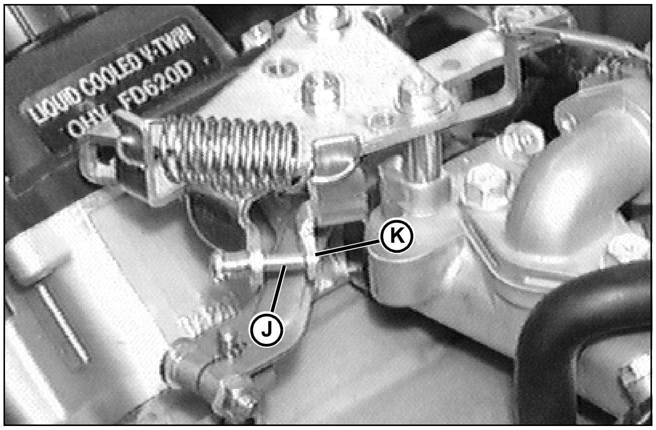
6. Check that throttle pedal rod is resting against front panel at (I).

7. Pull rubber boot (H) down.

8. Loosen jam nut (F).

9. Turn adjusting nut (G) until there is enough slack in cable so that when throttle pedal is depressed there is a 2 mm gap between pedal rod and front panel at (I) before carburetor throttle arm begins to move.

10.Tighten jam nut (F). Recheck gap at (I).



M56389

11.With throttle pedal released, stop tab (K) should be resting against screw (J).

12.With throttle pedal fully depressed, and throttle control arm on engine touching metal stop tab, throttle control arm should not touch rubber boot on end of throttle cable.

Throttle Cable Adjustment (FD620D-BS11 -)

Model: FD620D-BS11 -

(Chassis S/N 014950-)

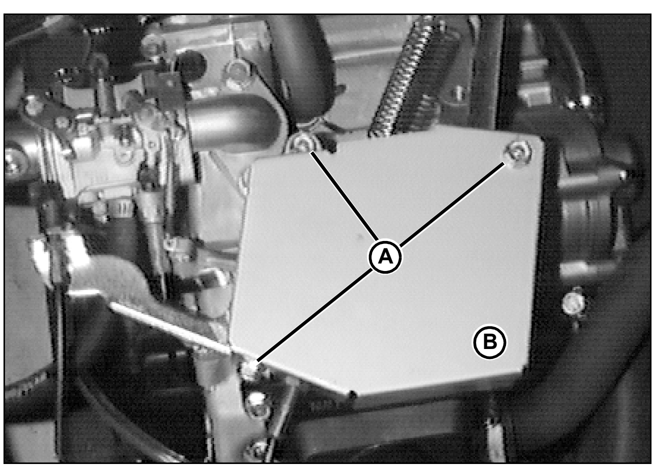
NOTE: Adjust fast idle, slow idle and mixture, and choke cable before adjusting throttle cable.

Reason:

To ensure throttle cable is adjusted correctly, and that throttle pedal movement provides full travel of carburetor linkage.

Procedure:

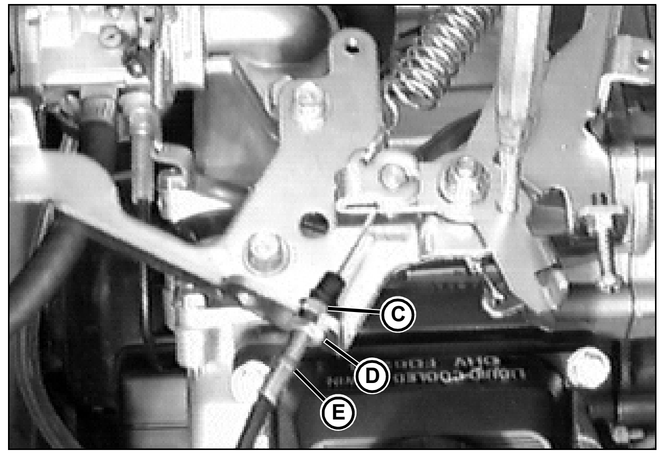
1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



M85286

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

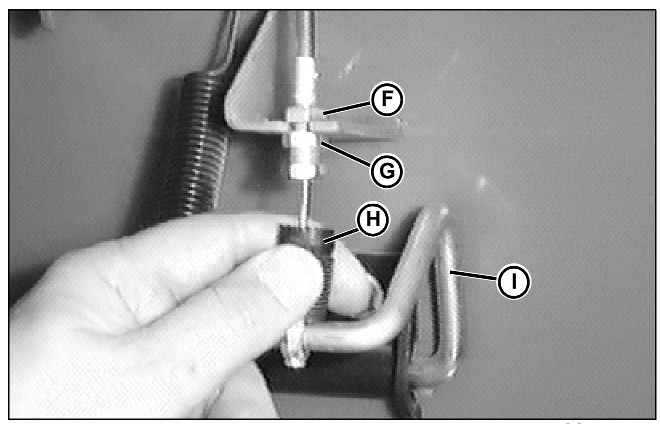
IMPORTANT: Avoid damage! DO NOT move throttle control arm by hand, this will kink the wire cable and damage it. Use throttle pedal only.



M85287

3. Loosen jam nut (D) and unscrew cable ferrule (E) until equal amounts of threads are exposed on both sides of cable support bracket.

4. Tighten jam nut (C).



M56359

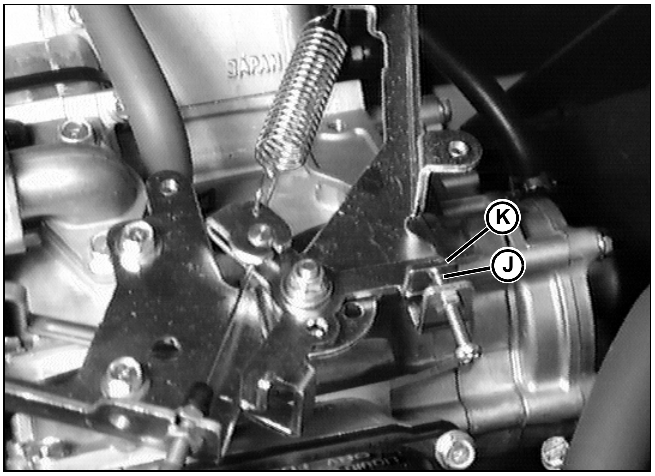
5. Check that throttle pedal rod is resting against front panel at (I).

6. Pull rubber boot (H) down.

7. Loosen jam nut (F).

8. Turn adjusting nut (G) until there is enough slack in cable so that when throttle pedal is depressed there is a 2 mm gap between pedal rod and front panel at (I) before carburetor throttle arm begins to move.

9. Tighten jam nut (F).



M85289

10.With throttle pedal released, stop tab (K) should be resting against screw (J).

11.Adjust pedal stop. (See “Pedal Stop Adjustment (FD620D-BS11 -)” on page 95.)

Pedal Stop Adjustment (FD620D-AS11)

Model: FD620D-AS11

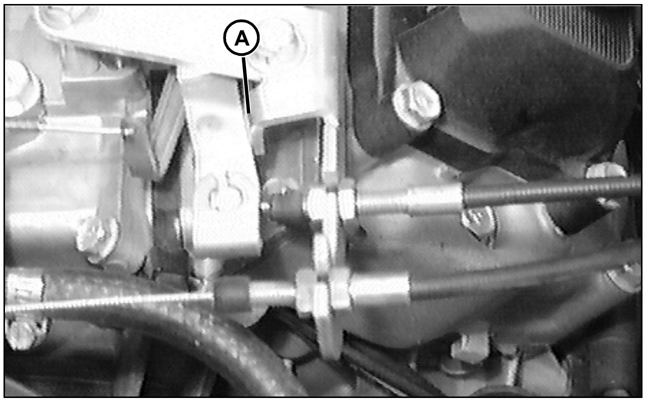
(Chassis S/N 001001 - 014949)

NOTE: Pedal stop adjustment is only done after fast idle, slow idle and mixture, choke cable, and throttle cable adjustment are complete.

Reason:

To adjust throttle pedal stop, and limit pedal travel, preventing throttle cable from being over stretched and wearing prematurely.

Procedure:



M56395

1. Place a 2 mm (0.079 in.) spacer (A) between the engine throttle arm and stop tab.

2. Depress throttle pedal to full FAST idle position (engine throttle control arm touching 2 mm spacer).

NOTE: Do not force pedal assembly to deflect.

3. Loosen jam nuts on pedal stop and turn stop bolt until just touching back of pedal.

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

4. Tighten pedal stop jam nut. Recheck adjustment.

Pedal Stop Adjustment (FD620D-BS11 -)

Model: FD620D-BS11 -

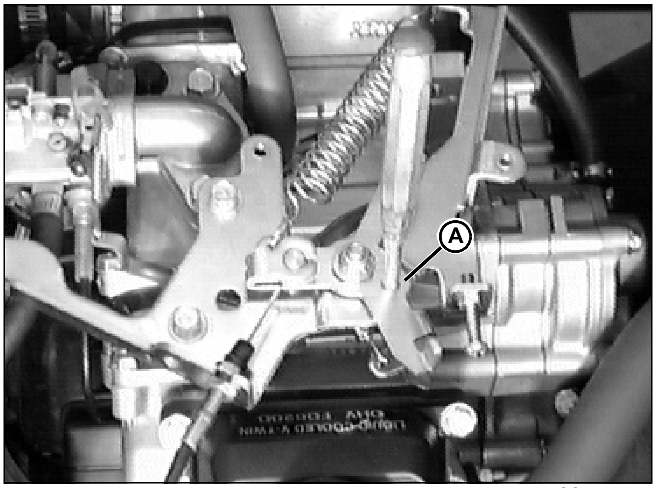
(Chassis S/N 014950-)

NOTE: Pedal stop adjustment is only done after fast idle, slow idle and mixture, choke cable, and throttle cable adjustments are complete.

Reason:

To adjust throttle pedal stop, and limit pedal travel, preventing throttle cable from being over stretched and wearing prematurely.

Procedure:



M85287

1. Depress throttle pedal until a 1/4” or 6 mm punch or pin can be inserted through hole in throttle lever and into throttle plate (A).

2. Loosen jam nuts on pedal stop and turn stop bolt until just touching back of pedal.

3. Back stop bolt off ONE TURN until there is a 1.0 - 1.5 mm (0.04 - 0.06 in.) gap between pedal and stop bolt.

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

4. Tighten pedal stop jam nut.

5. Remove pin. Check for full movement of throttle shaft on carburetor.

Fuel Pump Pressure Test

Reason:

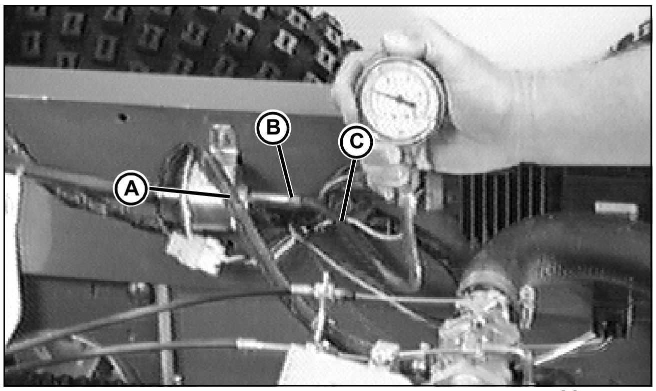
To determine condition of fuel pump.

Equipment:

- JDG356 Fuel Pump Pressure Test Kit

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



M47625

2. Disconnect and plug fuel supply hose (A) from fuel pump outlet (B).
3. Connect hose (C) of Test Kit to fuel pump outlet (B).

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

Fuel Pump Flow Test

Reason:

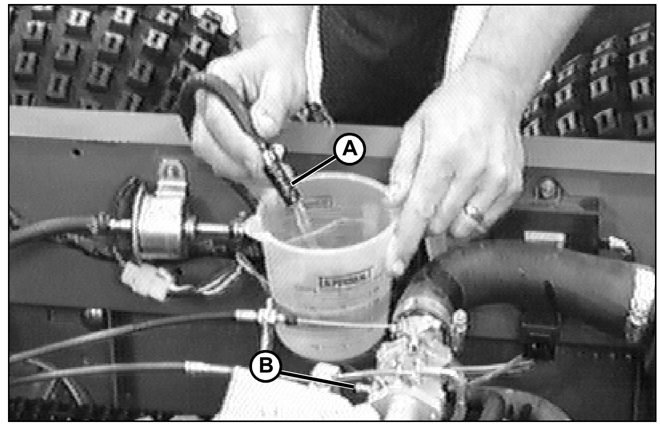
To determine condition of fuel pump.

Equipment:

- Graduated container.

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



M47624

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

NOTE: DO NOT start engine.

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 and readjusting the idle speed and idle mixture screws to specified rpm.

Cylinder Compression Test

Reason:

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

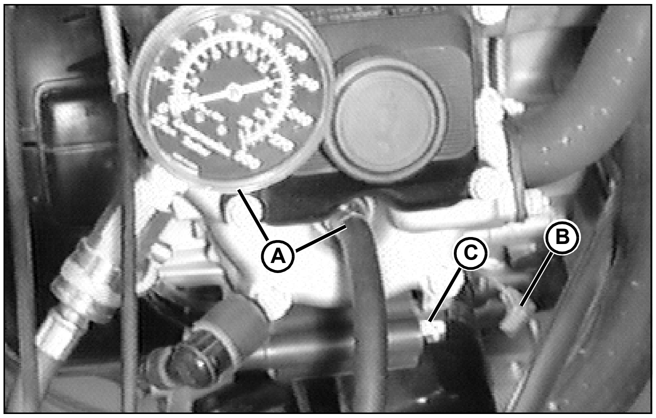
Equipment:

- JDM59 Compression Gauge

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.
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.

NOTE: The automatic compression release mechanism is thermally activated and will not show actual compression unless engine is up to operating temperature.



M56385

4. Remove spark plug and install JDM59 Compression Gauge (A) in one cylinder.

5. Disconnect wiring connector (B) from positive terminal (C) of both ignition coils.

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

7. 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.

8. Crank engine for five to ten compression strokes.

9. 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.

10.Install spark plug.

11.Repeat procedure for second cylinder.

12.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:

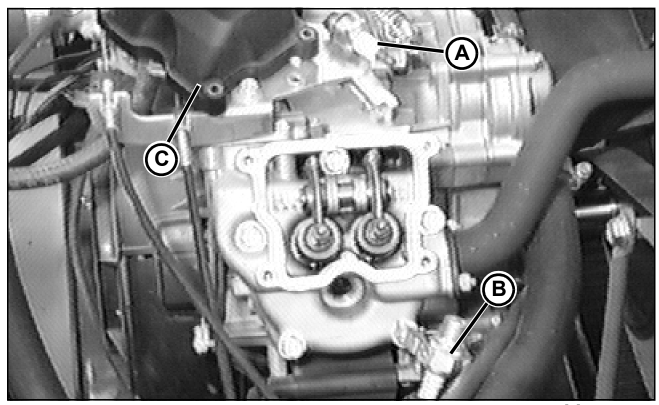
To check and adjust valve clearances for proper engine operation.

Equipment:

- JDM74A-5 Spark Plug Wire Tester
- Flat feeler gauge.

Procedure:

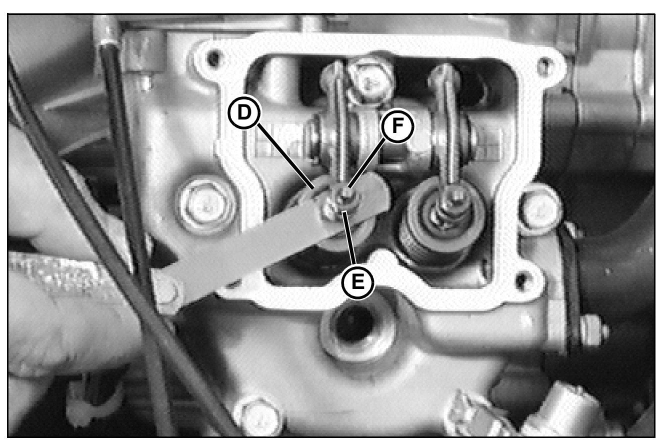
1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



M56397

2. Remove spark plug (A) and ground lead with JDM74A-5 Spark Plug Tester (B).

3. Remove valve cover (C).



M56398

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

- Turn crankshaft counterclockwise until intake valve (D) 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 (E) and turn adjusting screw (F) to correct clearance.

7. Hold adjusting screw stationary with pliers while you tighten 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.

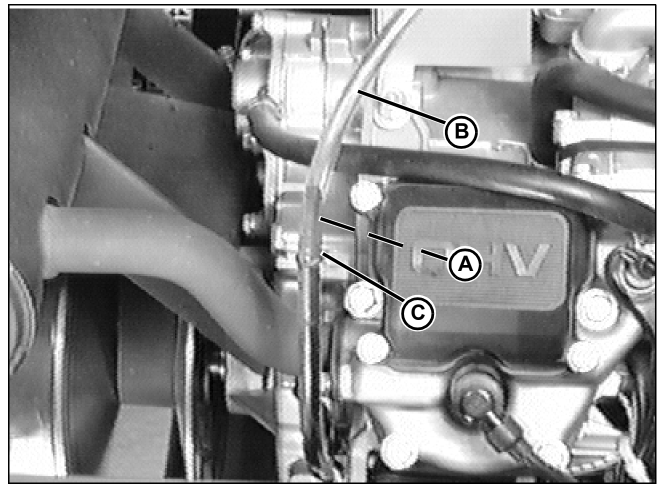
Equipment:

- JT05701 Hose Clamp
- JT05703 Barb Fitting
- JT05699 Line
- JT05698 U-Tube Manometer

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.

2. Remove dipstick.

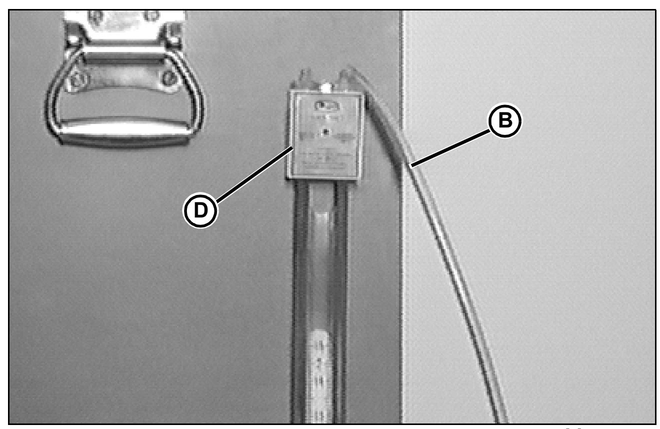


M56366

3. Put small end of barb fitting (A) into line (B) and fasten with hose clamp (C).

4. Install large end of barbed fitting into dipstick tube.

IMPORTANT: Avoid damage! DO NOT make connection between manometer (D) and engine line (B) BEFORE engine is running or fluid in manometer could be drawn into crankcase. DO NOT turn engine OFF until line (B) has been disconnected from manometer (D).



M56365

5. START and run engine at SLOW idle.

6. Connect line (B) to U-Tube Manometer Kit (D).

7. Run engine at FAST idle.

8. Record crankcase vacuum reading. Manometer should show a minimum vacuum of 25 mm (1.0 in.) of H_2O.

9. Run engine at SLOW idle. DO NOT TURN ENGINE OFF!

10.Disconnect clear tube (B) from manometer.

11.Turn engine OFF.

12.Remove barbed fitting 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.

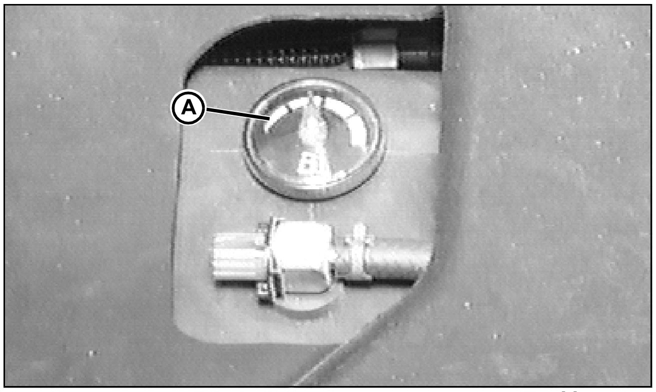
Fuel Tank Gauge Test

Reason:

To ensure gauge is functioning properly.

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



M55773

2. Check gauge indicator (A).
3. Add a substantial amount of unleaded fuel and watch indicator.
4. If indicator does not move, gauge is defective and must be replaced.

Fuel Tank Check Valve Test

Reason:

NOTE: This test is performed for early models only (S/N -011285). Later models do not have a check valve installed. The fuel tank is modified with a breather tube through the left hand armrest.

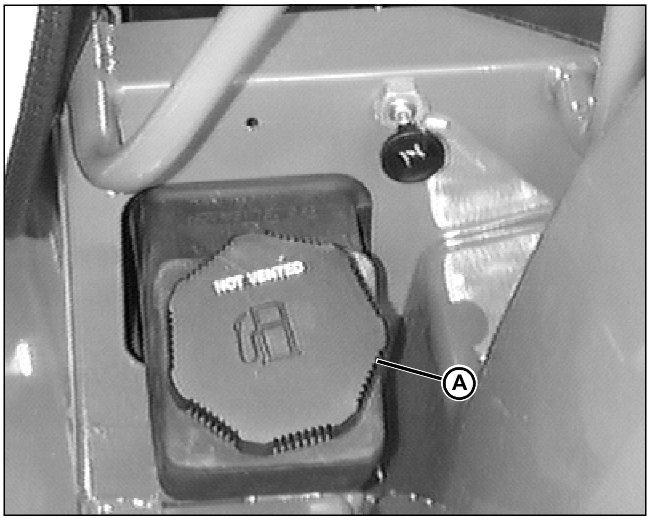
To ensure check valve is functioning properly.

Equipment:

- JDZ25-2 Carburetor Tester Kit

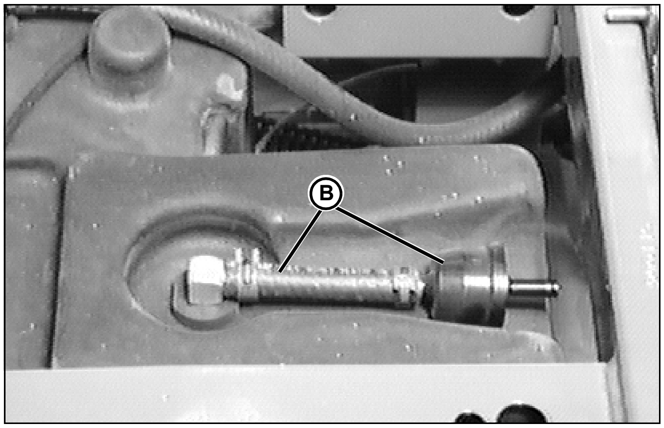
Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Remove seats and shrouding.



M55733

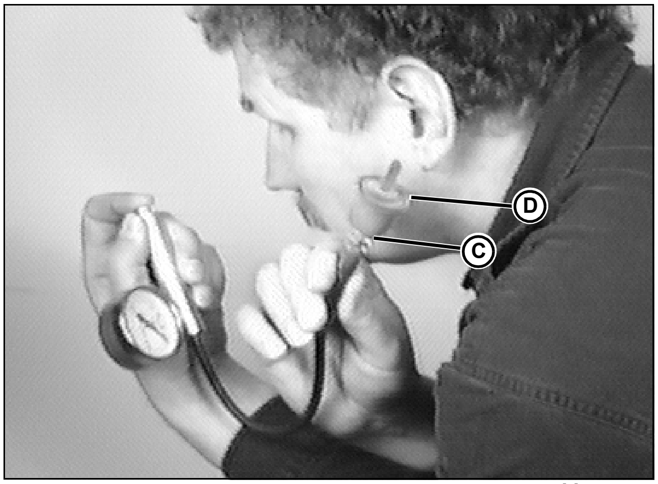
4. Loosen fill cap (A) to relieve any air pressure in tank.



M55770

5. Disconnect check valve and hose assembly (B) from elbow fitting.

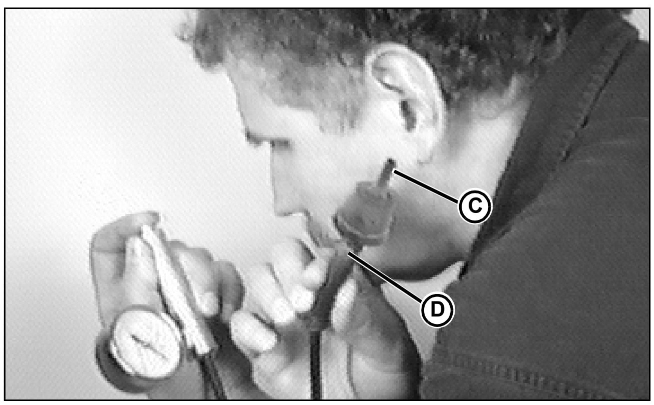
IMPORTANT: Avoid damage! Use hand pump/ pressure gauge to test valve. DO NOT use compressed air, check valve will be damaged.



M55771

6. Connect pump/pressure gauge to check valve tapered-side port (C).

7. Hold flanged-side port (D) along side ear and pump air valve. Air should be heard and gauge should show slight pressure.



M55772

8. Reverse ports and test again. Air should be heard and no pressure should be seen on gauge.

Results:

- Replace valve if it does not pass both tests.

Oil Pressure Test

Reason:

To determine condition of lubrication system.

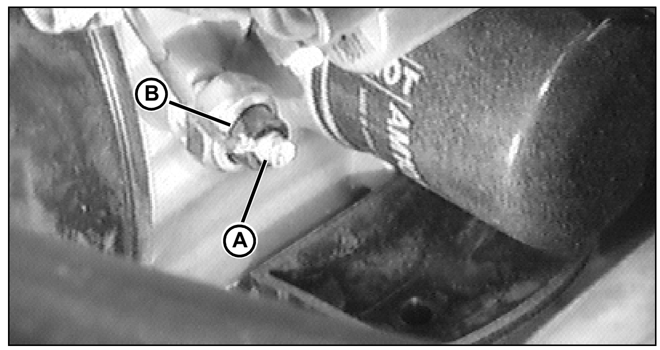
Equipment:

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

Procedure:

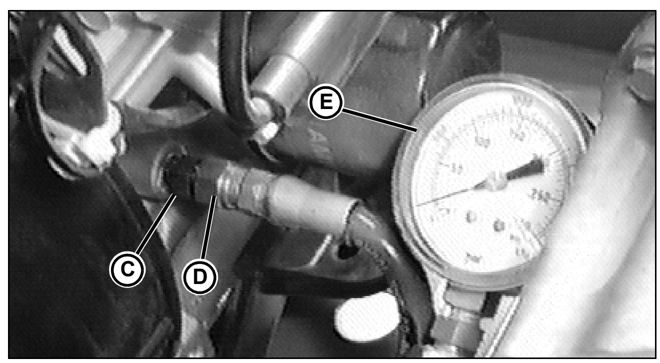
1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.
2. Check engine oil level, bring level to full mark.
3. Run engine at FAST idle until cooling fan starts.
4. STOP engine

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 Bubble Test

Reason:

To determine if compression pressure is leaking into cooling system.

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.
2. With coolant at proper level and radiator cap tight, start and run engine at FAST idle until cooling fan starts.

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.

3. Remove overflow hose from coolant recovery tank.

M47621

4. Put end of overflow hose in a container of water.
5. Check for bubbles coming from hose.
6. Install overflow hose in recovery tank. Be sure end of hose is slightly above bottom of tank to ensure it does not create a vacuum and that it uses all available coolant in the tank.

Results:

- If bubbles are present, replace head gaskets.

Cooling System Test

Reason:

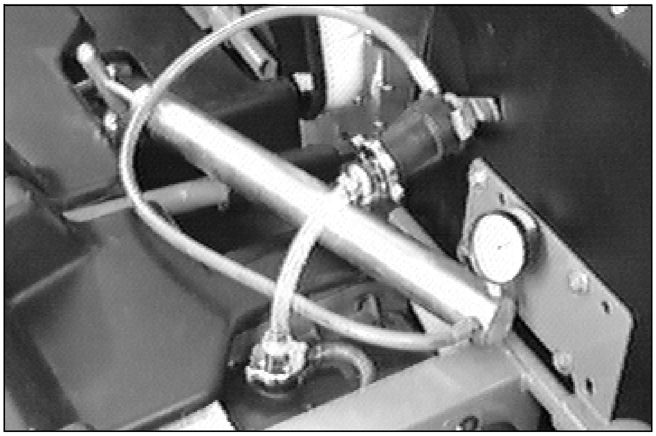
Inspect cooling system for leaks.

Equipment:

- D05104ST Cooling System Pressure Pump
- JDG692 Adaptor

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



M47622

2. Remove cap and attach Pressure Pump to radiator.
3. Apply 117 kPa (17 psi) pressure.
4. Check for pressure drop, minimum pressure minimum pressure 90 kPa (13 psi) after 15 seconds.

Results:

- If pressure decreases BELOW specification, check for leaks. Repair leaks or replace parts as necessary.
- If pressure test still indicates leakage and all external leaks have been stopped, a defective head gasket or cracked block may be the cause.

Radiator Cap Pressure Test

Reason:

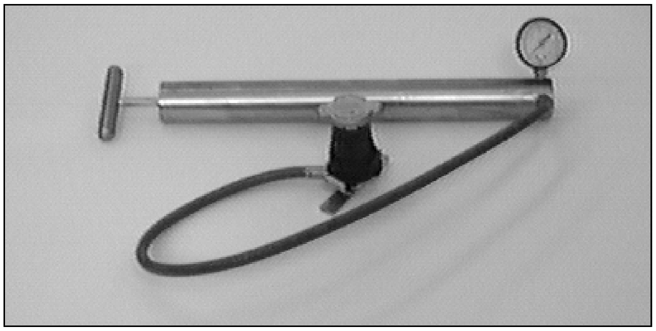
To be sure cap is operating at correct pressures.

Equipment:

- D05104ST Cooling System Pressure Pump
- JDG692 Adaptor

Procedure:

1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.



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.

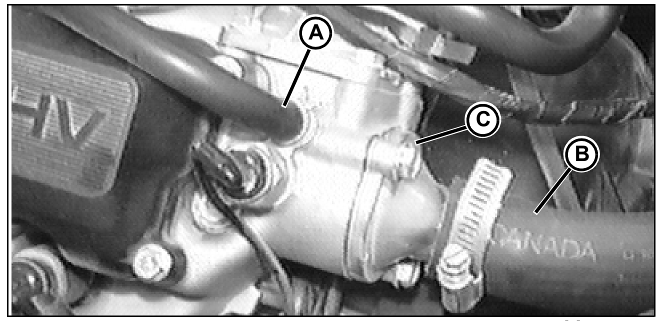
Equipment:

- D-05103ST Thermostat Tester

Procedure:

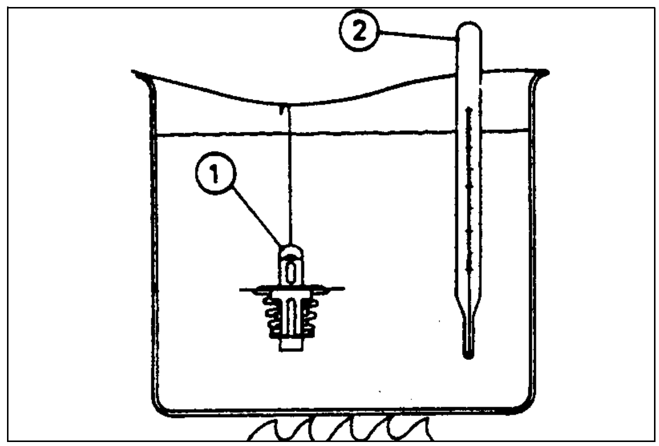
1. Park machine on level surface, turn key switch OFF, shift transmission to NEUTRAL, and LOCK park brake.
2. Cooling system to completely BEFORE testing.

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)

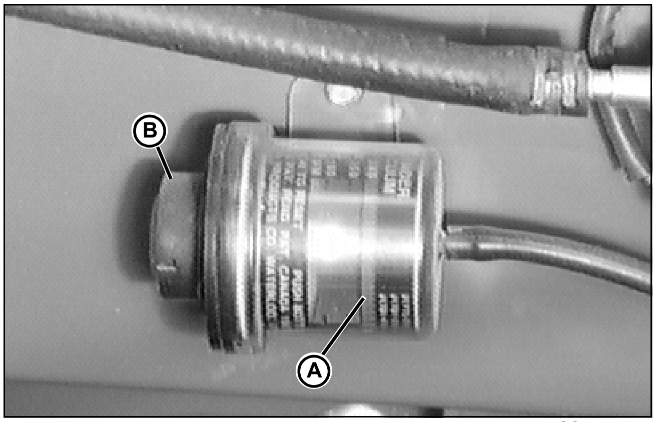
Air Filter and Air Restriction Indicator Tests (If Equipped)

Reason:

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

Procedure (Normal Operation):

1. Park machine on level surface, shift transmission to NEUTRAL, and LOCK park brake.
2. Run engine at FAST idle.



M56400

3. Check air restriction indicator yellow marker (A). Normal operating range 102 - 178 mm (4 - 7 in.) vacuum.

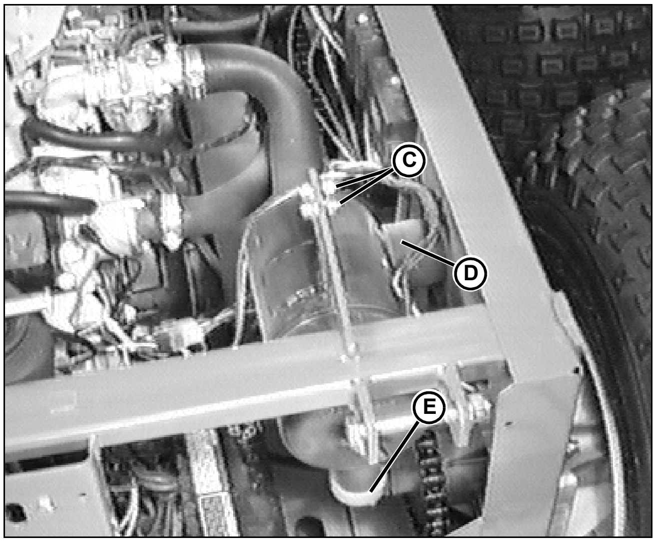
Results:

If vacuum less than normal, check for:

- missing or damaged air filter
- loose or damaged hoses
- damaged filter canister
- loose hardware on canister

Procedure (Simulated Excess Restriction)

1. Remove cap screws (C) and separate filter canister and inlet hose (D) from frame.:

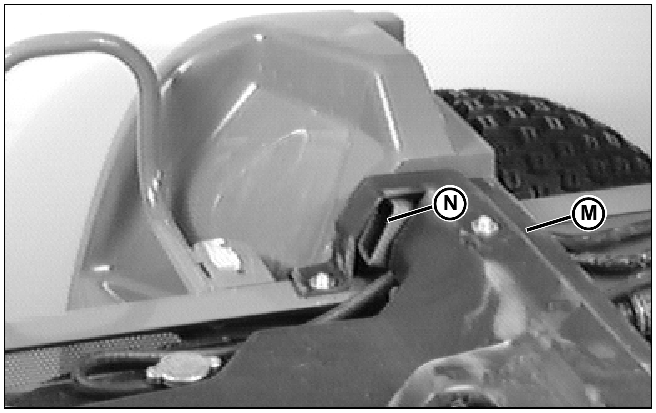


M56401

2. Start and run engine at FAST idle.
3. Pinch debris boot (E) shut with one hand. Gradually close-off canister inlet (D) with other hand to simulate plugged filter.
4. Watch air restriction indicator yellow marker (A). It should move into the red area - 381 mm (15 in.) vacuum.
5. Release throttle pedal and STOP engine.
6. Push indicator reset button (B), indicator should drop to bottom of scale. If not, replace indicator.

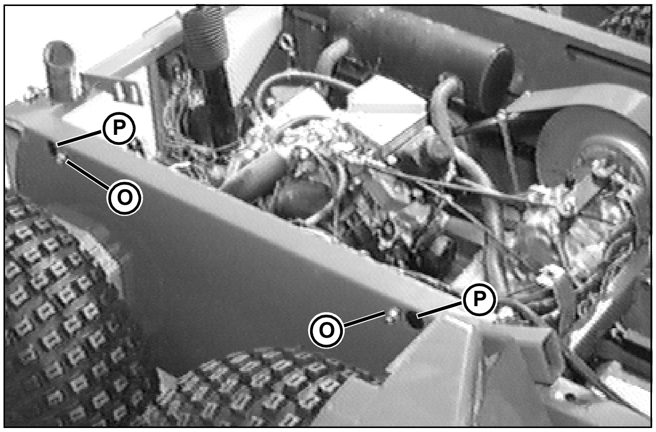
Results:
If yellow marker DID NOT move or moved very little, check for:

- air leaks in air filter canister
- air leaks at canister hardware
- air leak at debris boot
- air leaks or cuts in air intake and indicator hoses
- loose or damaged hose clamps
- cracked or broken indicator.



M55742

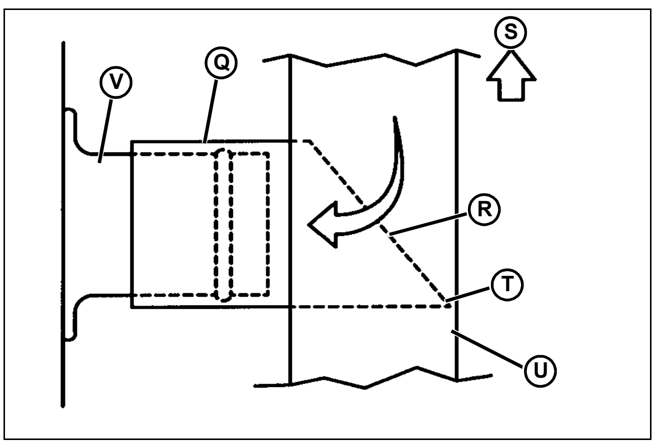
7. While air filter assembly is disconnected, remove seats and plastic shroud (M) to check frame air intake channel (N) for debris or obstructions.



M55748

8. Be sure shipping cap screws (O) and black plugs (P) are installed in frame.

NOTE: Use compressed air ONLY when trying to remove dust and debris from inside channel.



M55741

Picture Note: Top View Shown

9. Install frame hose (Q) so angled edge (R) faces to front (S) of machine and tip (T) just touches inside edge of frame (U) without being bent.

NOTE: Check placement of restrictor (Q) in inlet tube (N) on later model machines (19972-). The restrictor should be seated in the inlet tub of the air filter housing.

10.Install canister and insert canister inlet tube (V) inside frame hose.

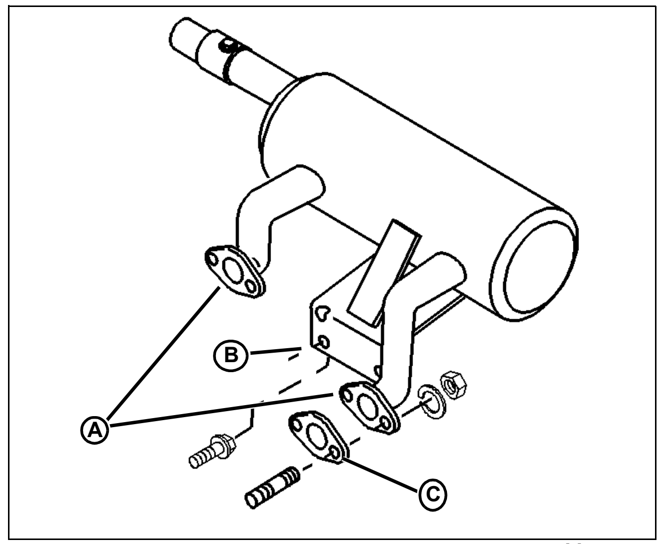
Repair

Muffler Removal and Installation

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

Removal:

1. Remove muffler mount hardware.
2. Remove muffler flanges to engine hardware.
3. Remove muffler.



M46434

Installation:

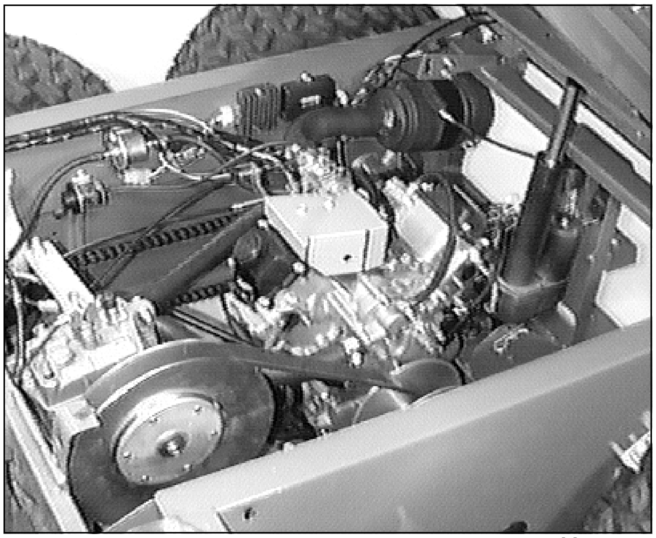
- Replace flange gaskets (C).

1. Loosely install muffler to engine and brackets to muffler.
2. Tighten muffler engine flanges (A) hardware.
3. Tighten muffler mount (B) hardware.

Engine Removal and Installation

Removal:

1. Disconnect battery negative (-) cable.
2. Remove muffler and drive belt.
3. Remove coolant hose clamps cap screw and spacer.



M46433

4. Disconnect W8/W12 engine wiring harness connector.
5. Disconnect single (purple) wire connector from starting motor solenoid.
6. Disconnect battery positive (+) cable and wire lead from starting motor solenoid.
7. Remove ground wiring lead cap screw, move battery negative cable and ground wiring lead.
8. Disconnect choke control and accelerator cables.
9. Remove air cleaner-to-engine hose.

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

10. Disconnect vacuum and fuel supply hoses.
11. Drain cooling system and remove hoses.

NOTE: Remove engine from left-hand side of machine.

12. Remove mounting cap screws, lock nuts and engine.

NOTE: Removal of drive clutch is only necessary, if engine repair is needed.

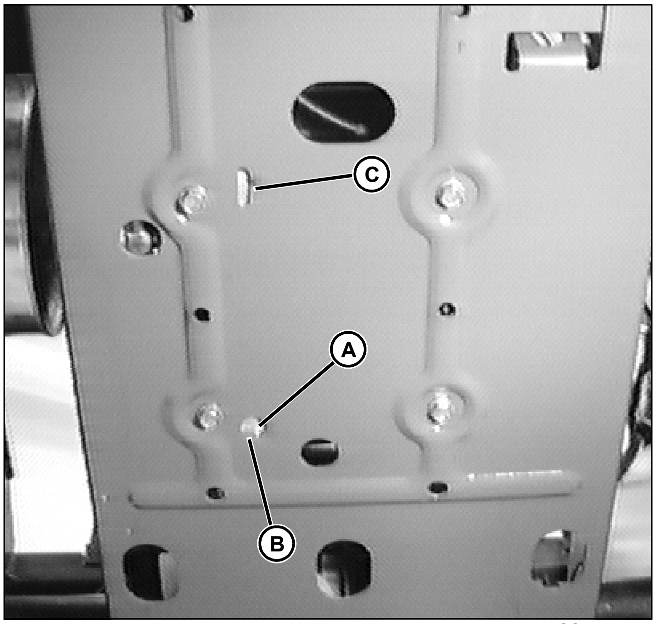
13. Remove drive clutch.

Installation:

Installation is done in the reverse order of removal.

1. Place engine in frame, loosely install mounting bolts.

NOTE: Engine location is critical for proper clutch operation. Engine is located with three tabs; two at front left corner of engine (A) and (B), the other at rear left corner of engine (C).



M56828

2. Slide engine forward to contact tab (A), and right to contact tabs (B) and (C).

IMPORTANT: Avoid damage! Do not force engine when locating to tabs. Engine could be forced out of position.

3. Tighten mounting bolts.
4. Install components and hardware removed.

IMPORTANT: Avoid damage! Proper filling of the cooling system is critical. (See "Radiator Drain and Flush Procedure" on page 121.)

5. Fill cooling system.
6. Fill engine with proper oil. (See Specifications and Information section.)
7. Adjust choke and accelerator cables.

Specifications:

Engine oil capacity

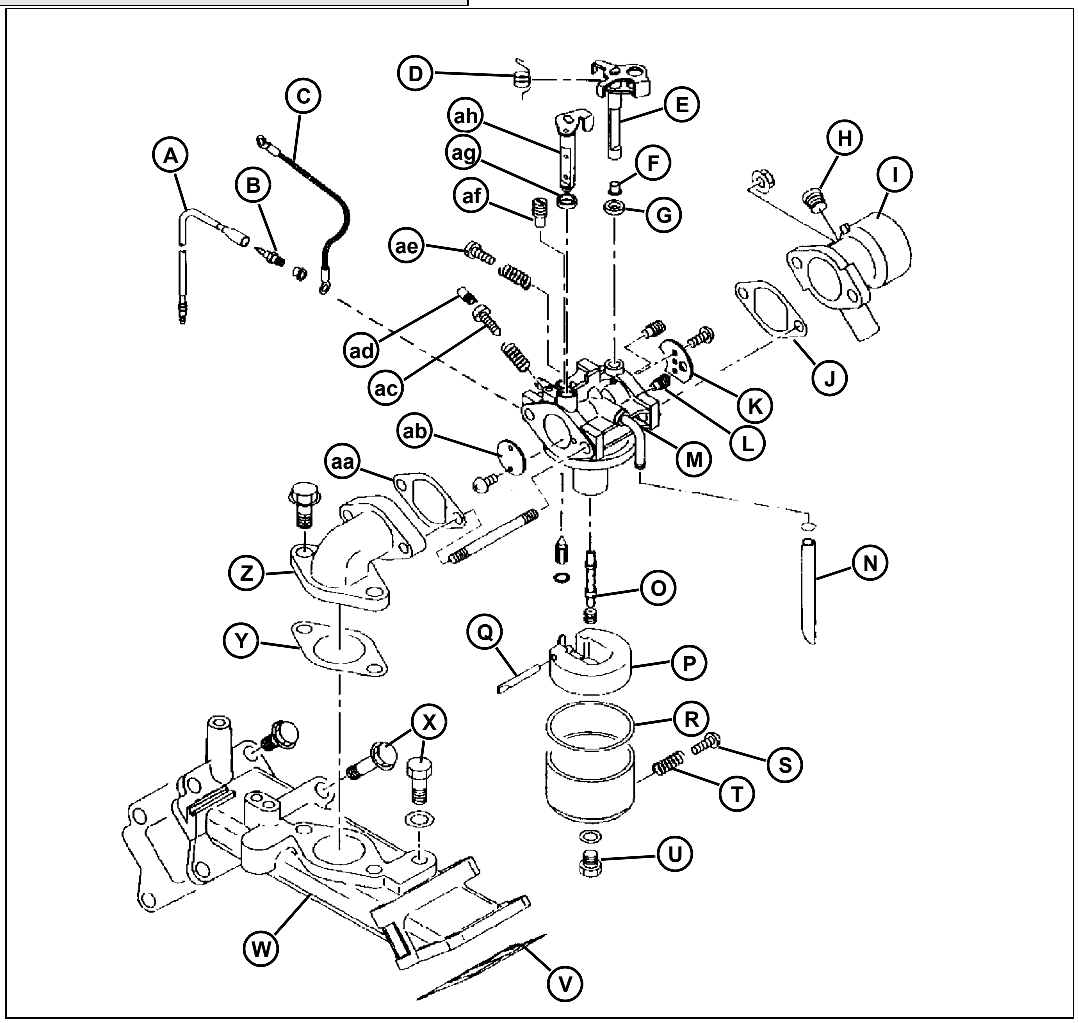
Without filter. . . . . 1.3 L (2.8 pt)

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.

Refer to the illustration and the following notes for disassembly and assembly:



MX1173

A - Power Lead
B - Heater Element
C - Ground Lead
D - Spring
E - Choke Shaft
F - Seal
G - Washer
H - Fitting
I - Adaptor
J - Gasket
K - Choke Plate
L - Main Air Jet
M - Body
N - Vent Hose
O - Emulsion Tube
P - Float
Q - Float Pin
R - Gasket
S - Drain Screw
T - Spring
U - Bowl Screw
V - Gasket
W - Manifold

X - Bolts
Y - Gasket
Z - Intake Elbow
AA- Gasket
AB- Throttle Plate
AC- Mixture Screw
AD- Limiter Cap
AE- Stop Screw
AF- Pilot Jet
AG- Seal
AH- Throttle Shaft

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.

2. Remove slow idle mixture limiter cap, turn mixture screw in counting number of turns required to lightly seat screw. Remove screw.

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.

3. Remove rubber or plastic parts. Immerse all the metal parts in a carburetor cleaning solution.

4. 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.

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

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

7. Install choke valve with metering hole towards fuel inlet joint of carburetor.

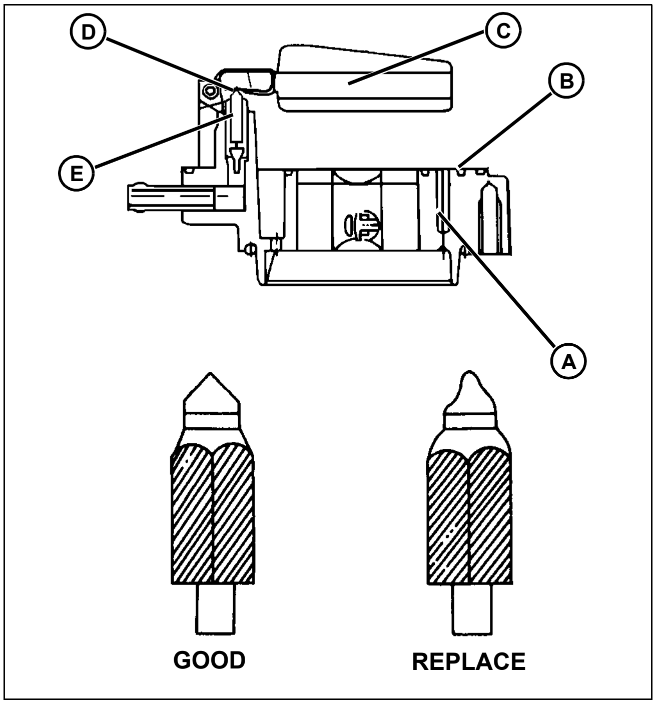
8. Ensure float pin extends same distance on both sides of float hinge bracket when reassembling.

9. 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.

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.

11.Inspect slow idle mixture screw for wear or damage, replace it if necessary.

Float Level Adjustment



M46436

1. Hold body (A) upside down at eye level with float assembly (C) installed.

2. Gently support float with a finger and lower it slowly until the float arm tab (D) just touches the float valve needle (E).

3. The float lower surface should be parallel with the body mating surface (B).

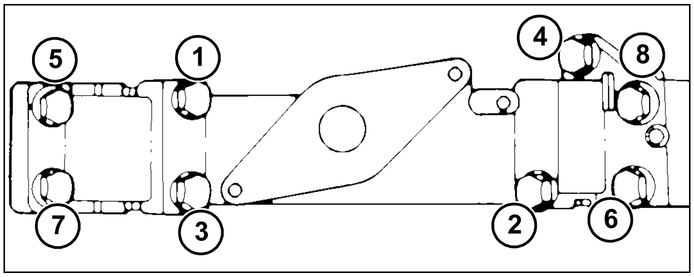
4. Float is plastic and not adjustable, replace if level not correct.

Intake Manifold Removal and Installation

Removal:

1. Remove carburetor and governor control panel.

2. Drain coolant.



M48862

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

4. Visually inspect manifold passages for corrosion or deposits and clean as necessary.

5. Inspect manifold for cracks or a porous casting.

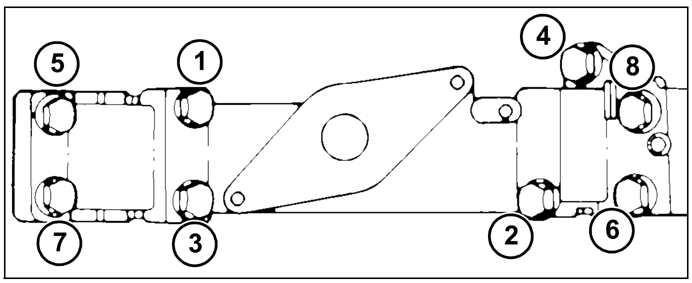
NOTE: Cracks not visible to the eye may be detected by coating suspected area with a mixture of 25% kerosene and 75% light engine oil. Wipe area dry and immediately apply a coat of zinc oxide dissolved in wood alcohol. If cracks are present, the coating will become discolored at the crack location.

6. 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.



M46862

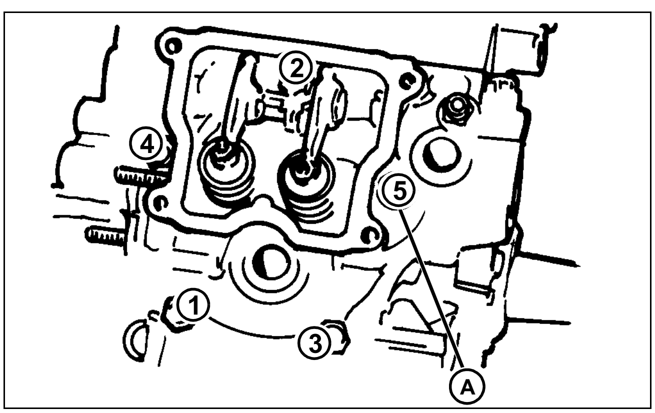
1. Install intake manifold and tighten bolts in two steps to a final torque of 6 N•m (52 lb-in.).

2. 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.

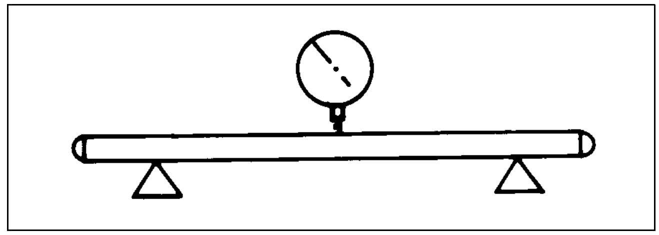


M46437

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 109 for disassembly and inspection procedures.)

Push Rod Inspection:

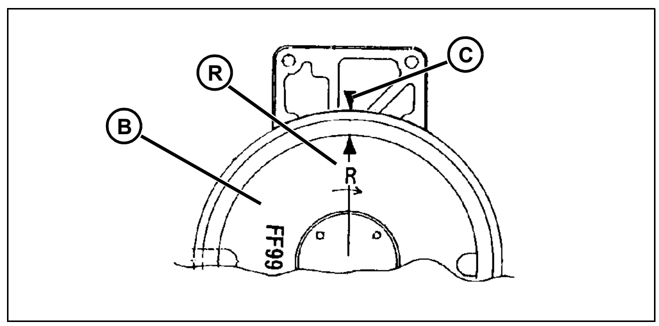


M50044

- 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.



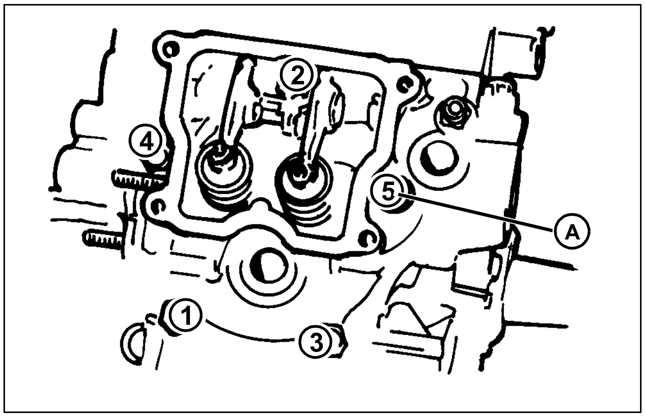
M46438

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.

IMPORTANT: Avoid damage! Engines before model GS11 used a short reach spark plug, part number AM122402 or TY6082. Models GS11 and newer use a long reach spark plug, part number M138938. The spark plugs ARE NOT interchangeable. Be certain to install the correct plug for the engine being worked on.

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.

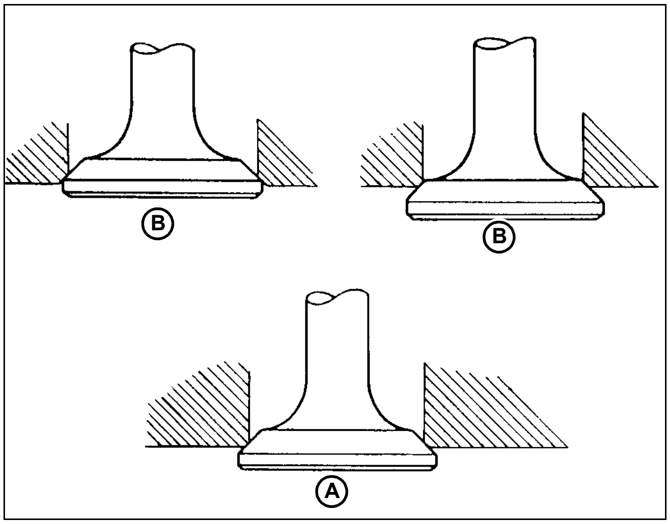
5. Clean and inspect rocker arm where it contacts push rod and valve stem. If the contact points are worn or damaged, replace rocker arm.

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.

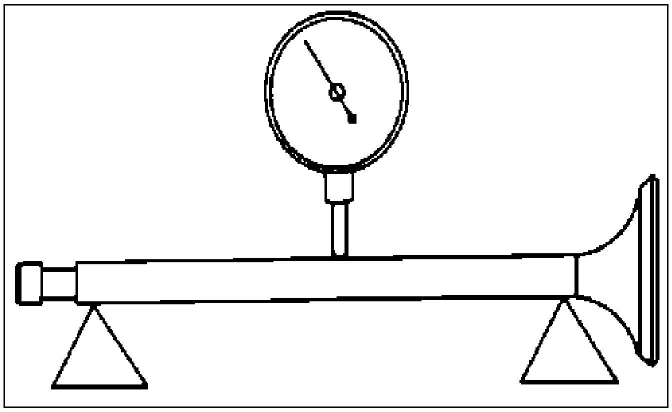
8. Inspect valve seats for damage. If seats are warped or distorted beyond reconditioning, replace cylinder head.



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.

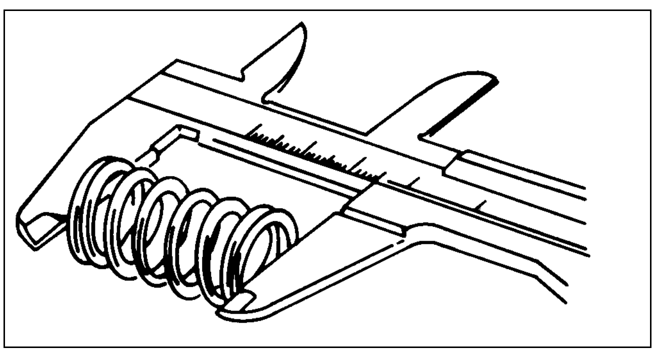


M51753

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.)

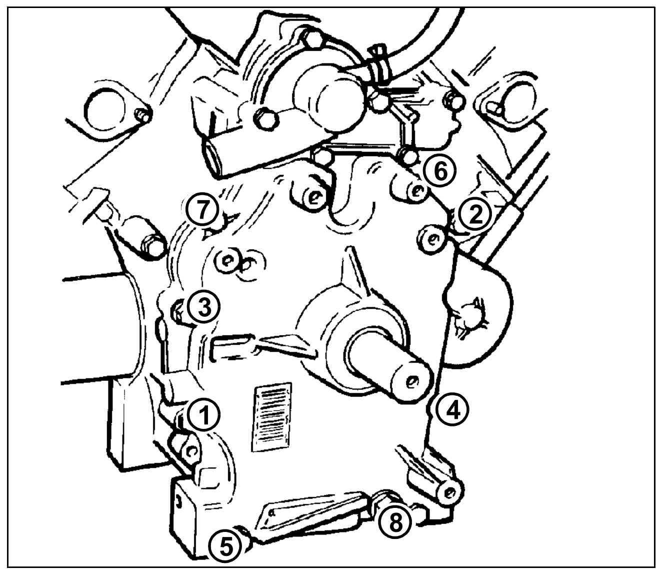
Minimum Valve Spring Free Length 29.70 mm (1.17 in.)

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).

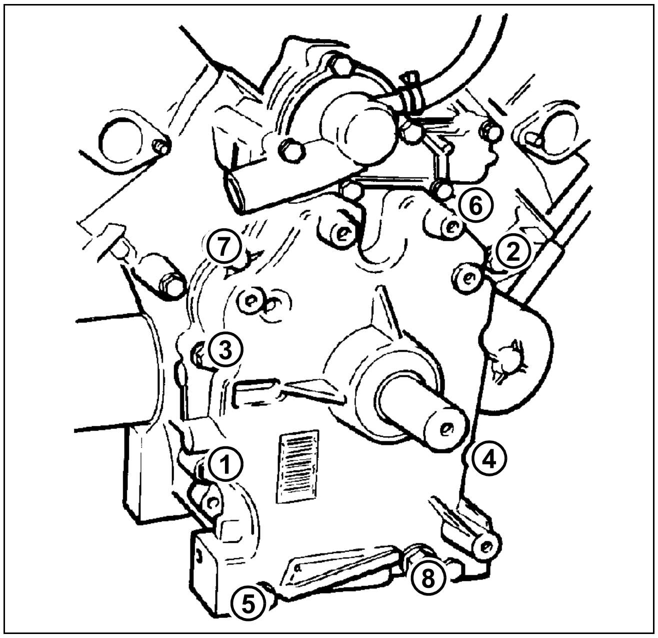
Specifications:

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:

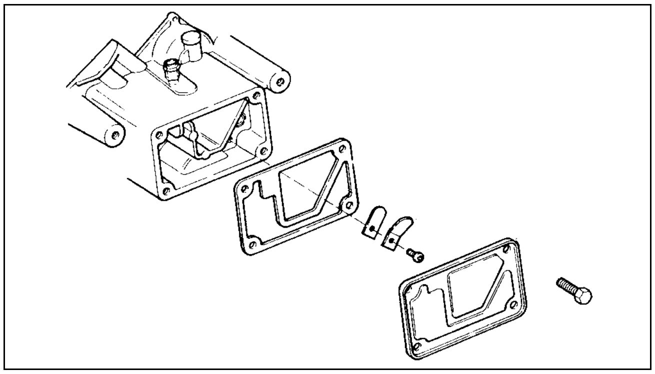
IMPORTANT: Avoid damage! Do Not force cover into position.



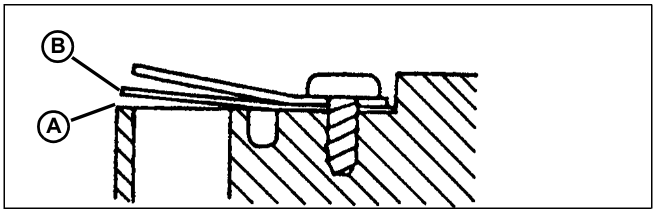
M46439

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

Crankcase Breather Inspection



M54277

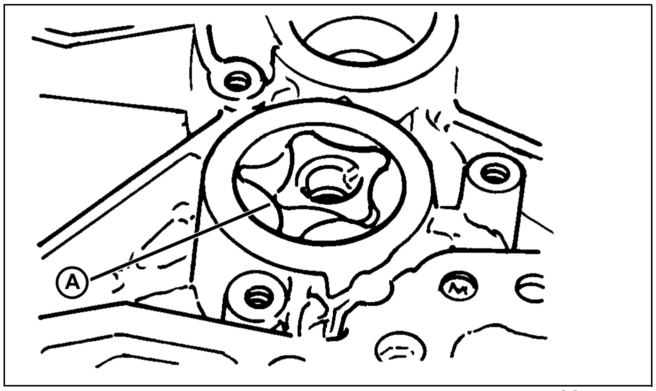


M51757

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.

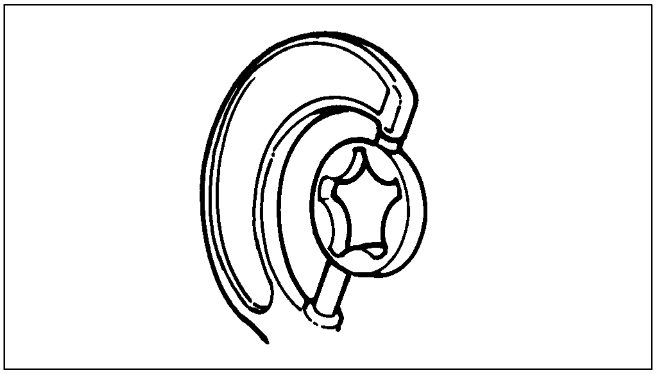
Oil Pump Inspection

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



M46440

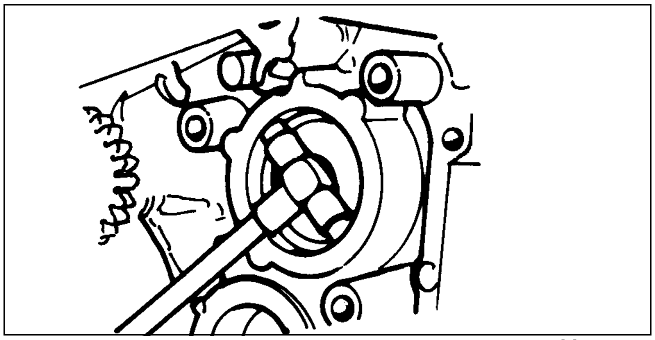
2. Check clearance between inner and outer rotor (A) with a feeler gauge. Measure clearance between high point of the inner rotor and the high point of outer rotor. If measurement exceeds 0.3 mm (0.012 in.), replace both rotors as a set.



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

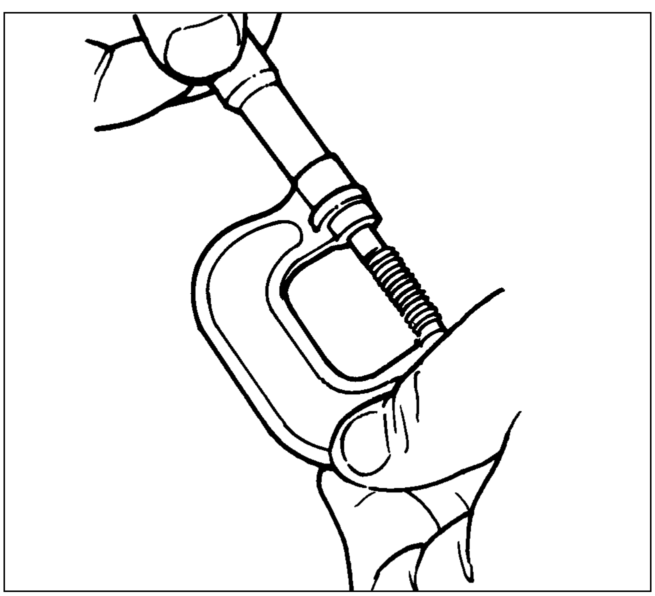
5. Measure inside diameter of the pump housing at several points. If inside diameter is more than 40.80 mm (1.606 in.), replace cover.

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.)

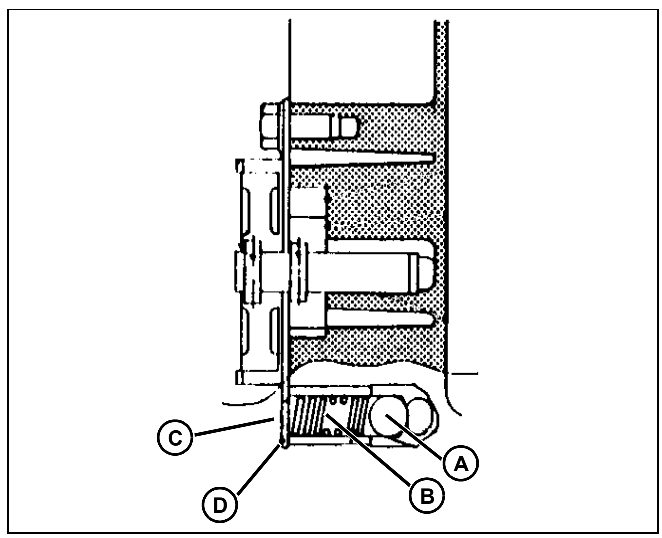
Inside Diameter of Pump Shaft Bearing
Service Limit. . . . . 11.07 mm (0.436 in.)

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

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

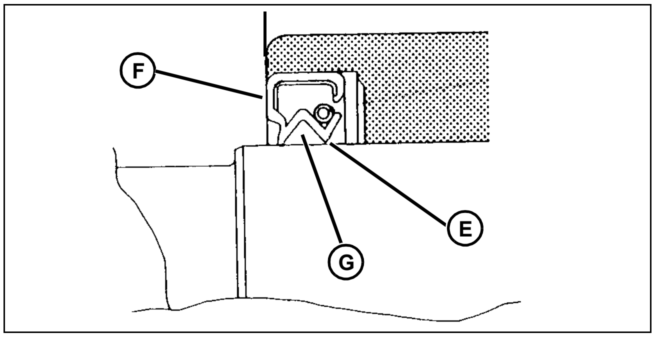
Oil Pump Installation

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 110 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.)

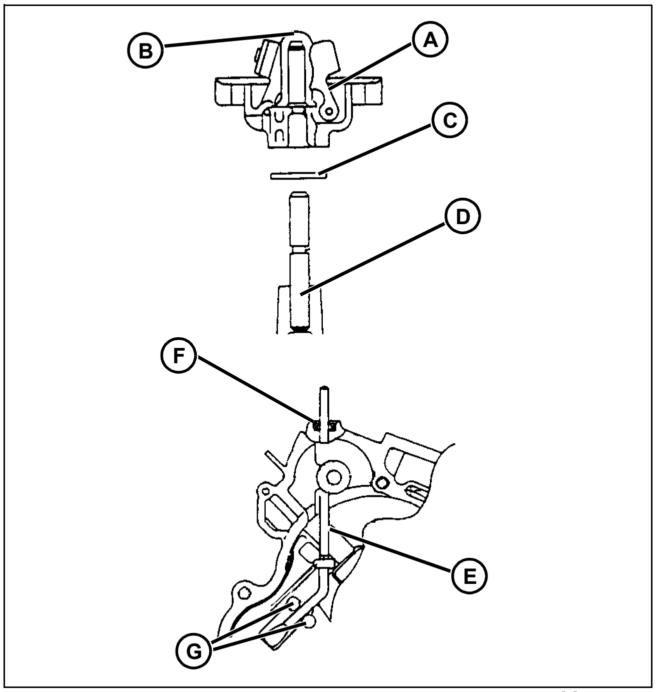
Flywheel Side . . . . 15.92 mm (0.627 in.)

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).

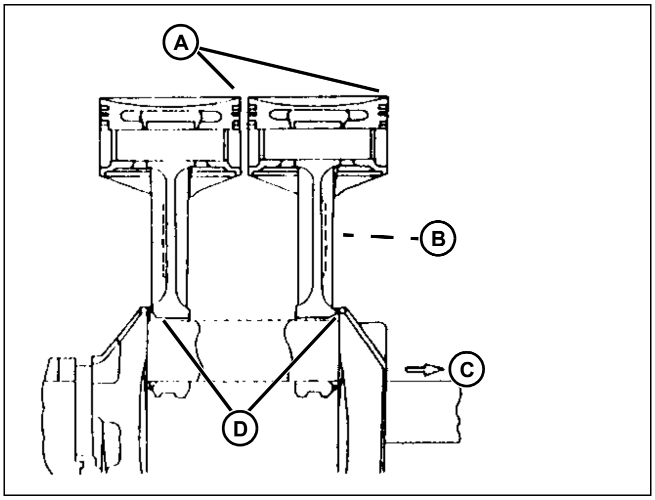
5. Press seal in (lip towards inside of engine) and 1.0 mm (0.04 in.) below crankcase surface.

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 and Cleaning



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.

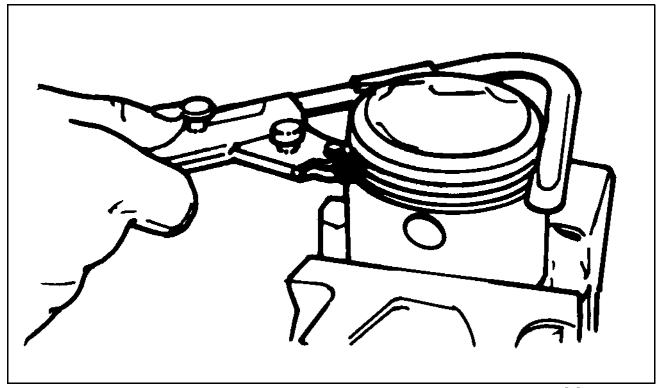
2. Remove carbon and/or ridge from the top of the cylinder bore with a suitable ridge remover, then remove piston and connecting rod through top of cylinder bore.

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.



M46488

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:

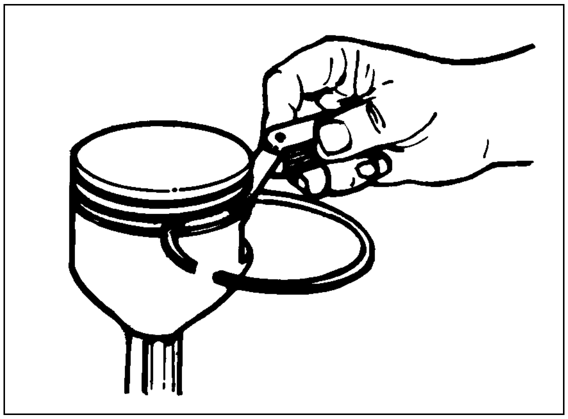
- Lean fuel mixture
- Low octane fuel
- Advanced ignition timing
- Incorrect spark plug (wrong heat range)
- Broken spark plug
- Sharp edges on valves or in combustion chamber
- Overloading
- Higher than normal compression (a result of excessive deposits in the combustion chamber
- Incorrect cylinder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

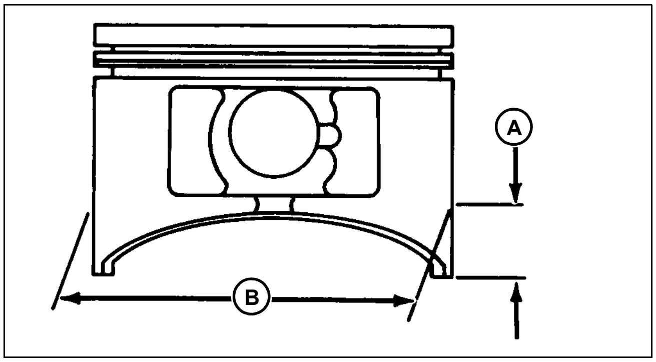
- Misaligned or bent connecting rod
- Excessive crankshaft end-play
- Crankshaft journal taper
- Weak retaining rings
- Incorrectly installed retaining rings.



M46449

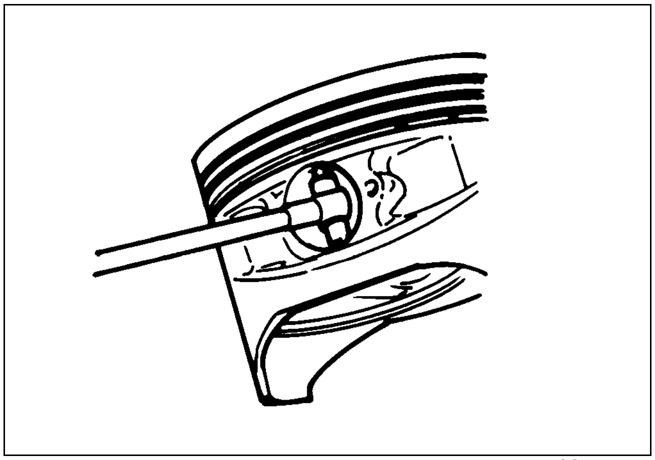
1. Measure the top and second ring groove clearance by inserting a new piston ring in the groove at several locations and measuring the gap between the ring and the ring land with a thickness gauge. Replace piston if the gap exceeds 0.15 mm (0.006 in.) for the top groove and 0.12 mm (0.005 in.) for the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

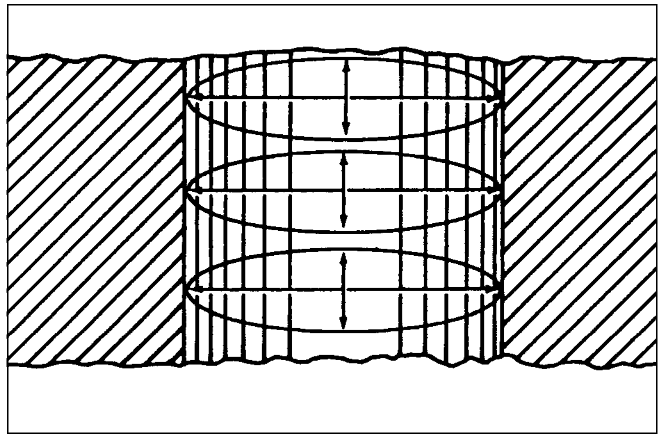
IMPORTANT: Avoid damage! Do Not use solvents to remove abrasives from cylinder wall.

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.)

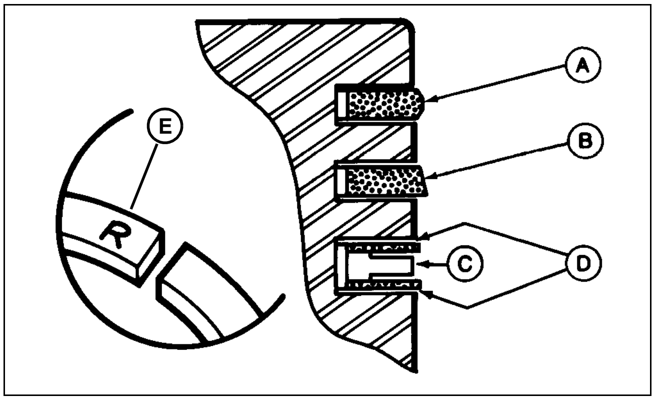
Wear Limit. 76.07 mm (2.995 in.)

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

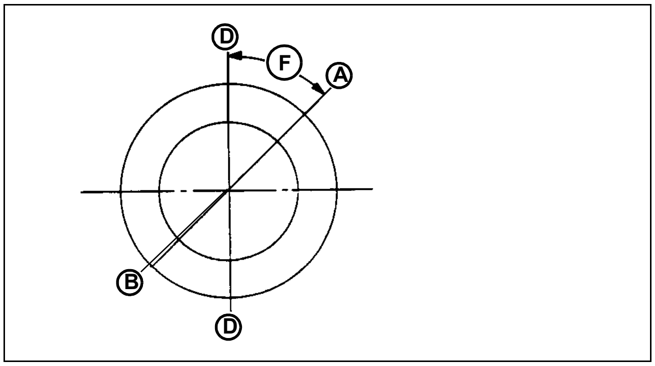
Wear Limit. 76.57 mm (3.014 in.)

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 “N” mark (E) facing up. Align the piston and ring end gaps 45° apart (F).

Cylinder Boring

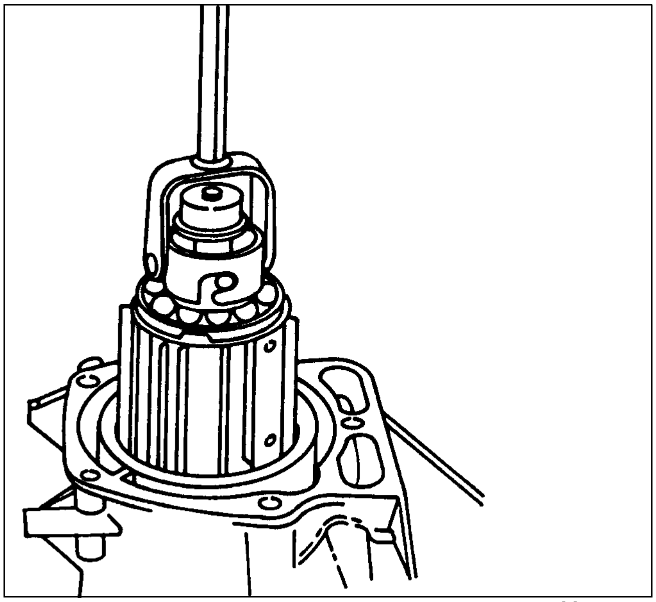
Tips:

- 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.

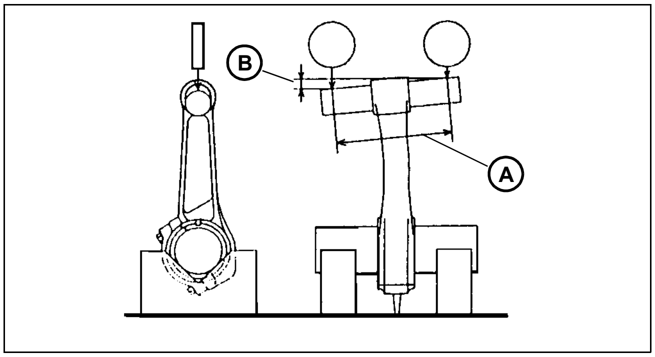
9. Use hot soapy water to wash the cylinder and rinse with clean water. Wipe dry with a clean, lint free white cloth until the cloth shows no sign of discoloration. Apply clean engine oil to the cylinder after cleaning.

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

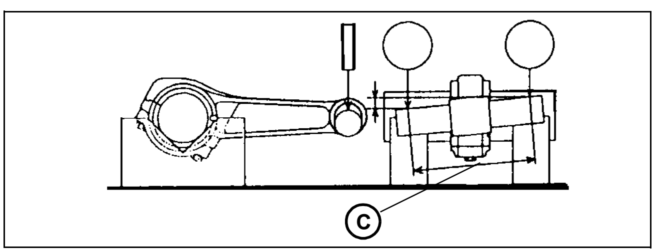


M46452

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.)

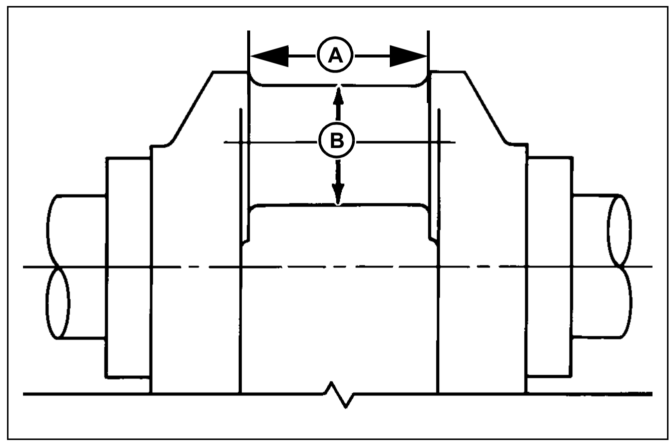
Connecting Rod Big End:

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.)

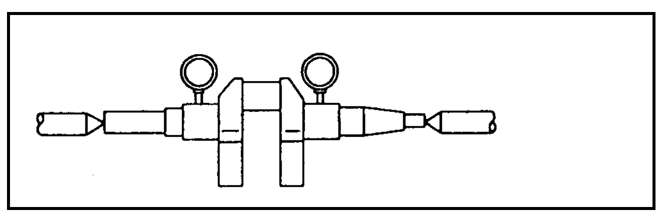
Crankshaft Inspection



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.



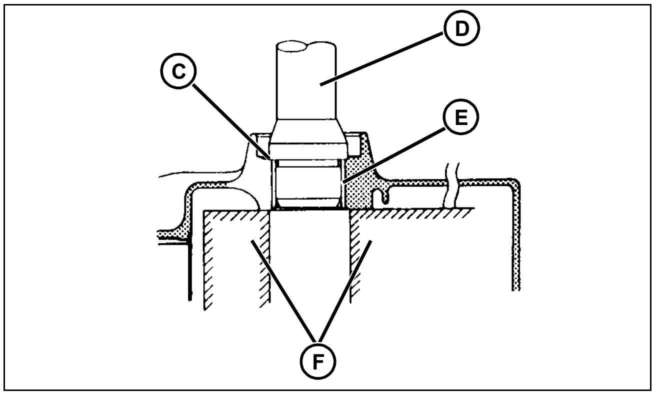
M46454

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.

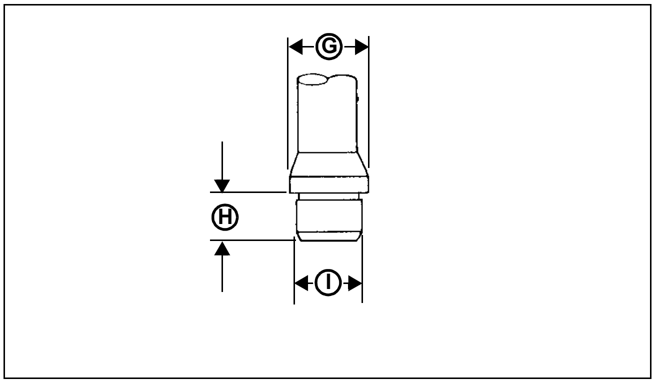
Journal Bushing Replacement:



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.

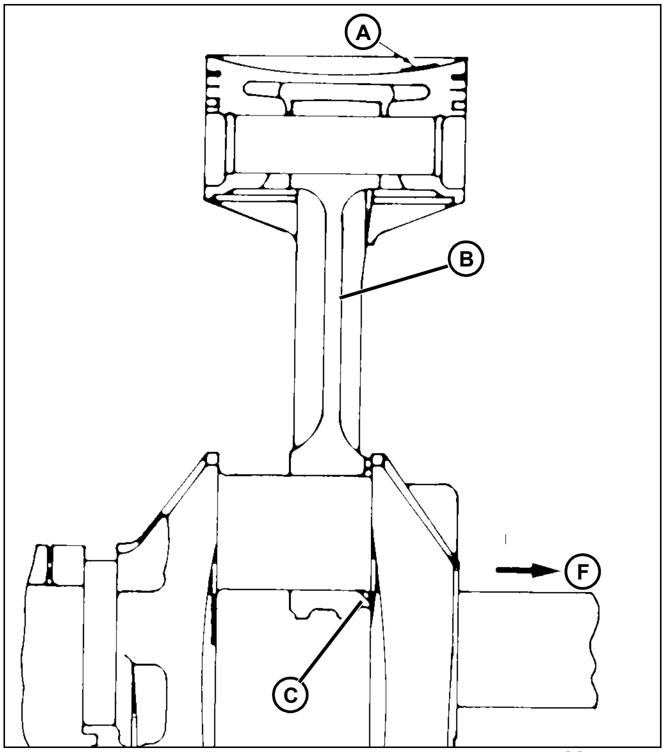
1. Pack high temperature grease into oil seal of crankcase.
2. Apply engine oil to journal and bearing.
3. Carefully insert crankshaft flywheel end into main bearing and oil seal, being careful not to damage oil seal.
4. Install crankshaft woodruff key into crankshaft taper.

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.

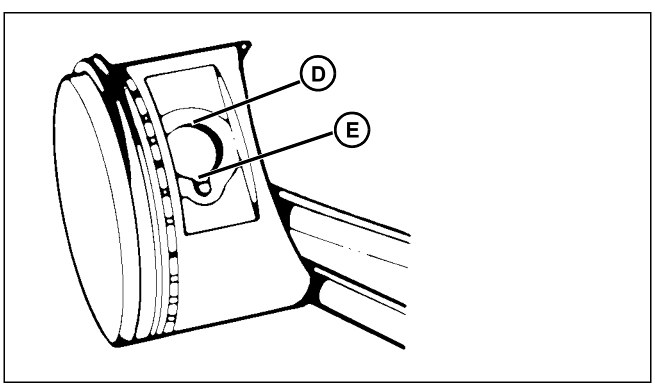
1. Apply engine oil to piston pins and assemble pistons to connecting rods as follows.



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.).

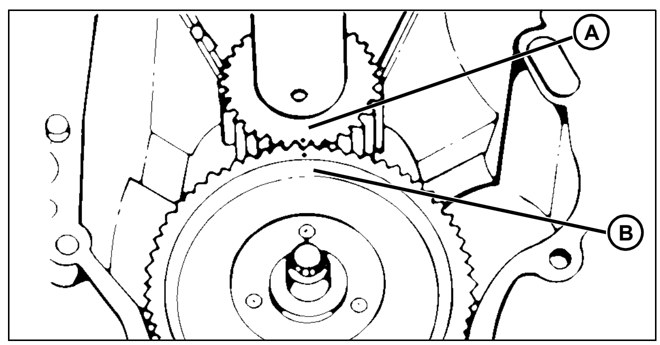
Tappet and Camshaft Installation

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).

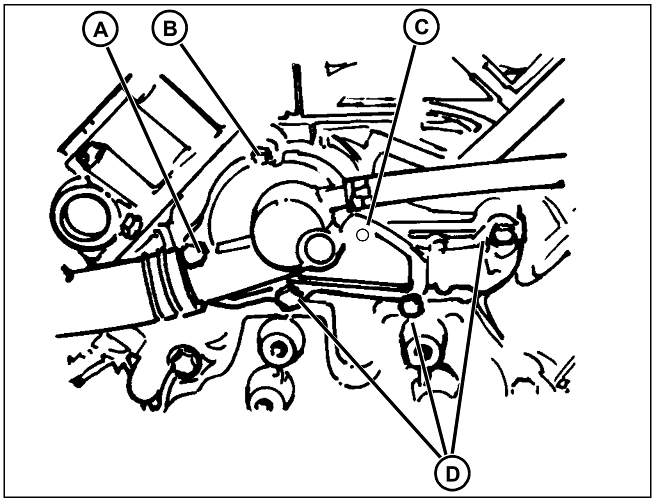
Water Pump Removal and Installation

1. Drain coolant from radiator just below level of water pump assembly. (See “Radiator Drain and Flush Procedure” on page 121 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 121.)

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.)

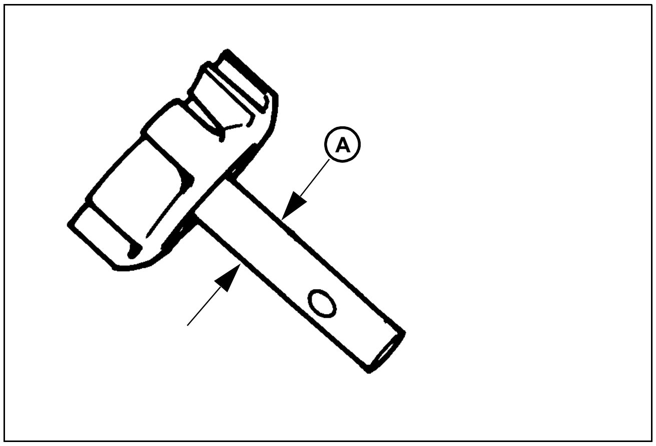
B. Bolt M6 . . . . 9.5 N•m (84 lb-in.)

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.

Radiator Drain and Flush Procedure

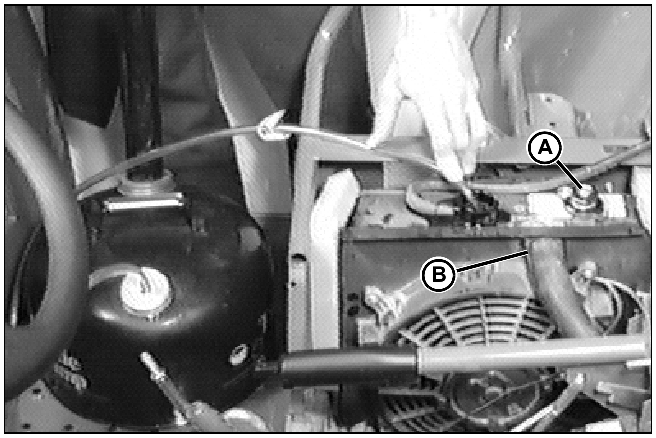
Drain:

IMPORTANT: Avoid damage! Allow engine and cooling system to cool completely.

1. Remove seats, shrouding and drive belt.

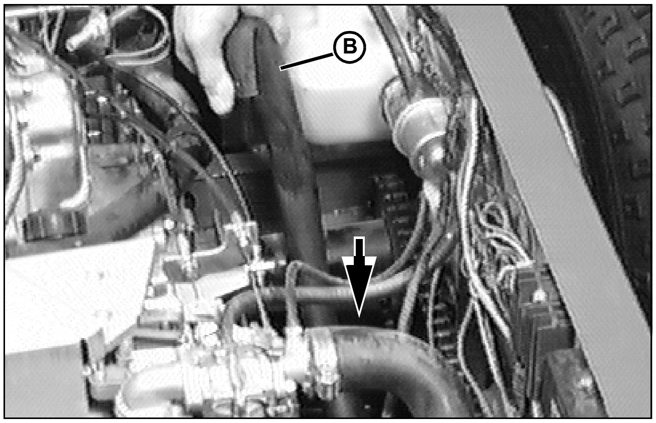
2. Put container (minimum 7.6 L (2 gal)) under right side frame opening behind radiator and second container under left side frame opening behind drive clutch.

IMPORTANT: Avoid damage! BE SURE to wipe-up and wash-off any spilled coolant IMMEDIATELY.



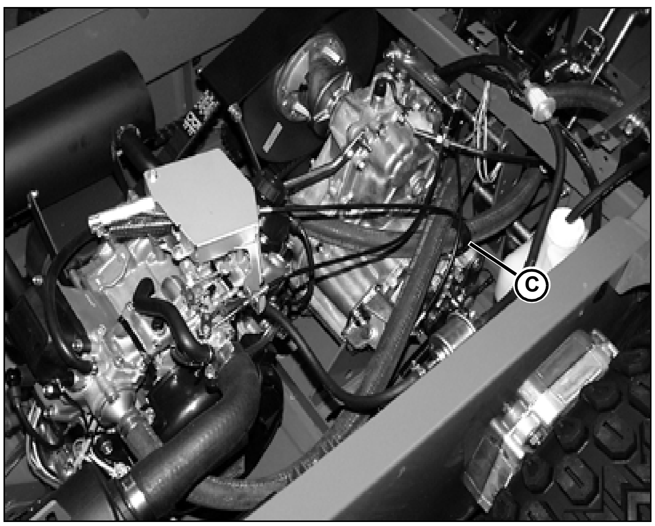
M55760

3. Slowly remove radiator cap (A). Suction off coolant to lower coolant level below upper radiator hose (B).



M55761

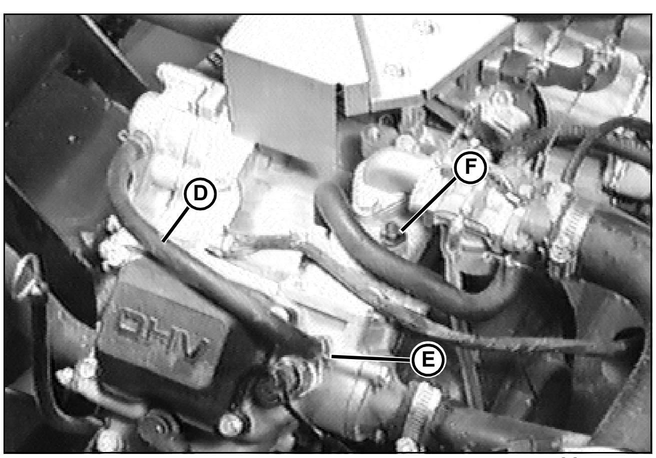
4. Disconnect upper radiator hose (B) and drain remaining coolant into container.



M55762

5. Disconnect hose clamp (C) from transaxle.

6. Position a flex-neck funnel between engine and left side container.

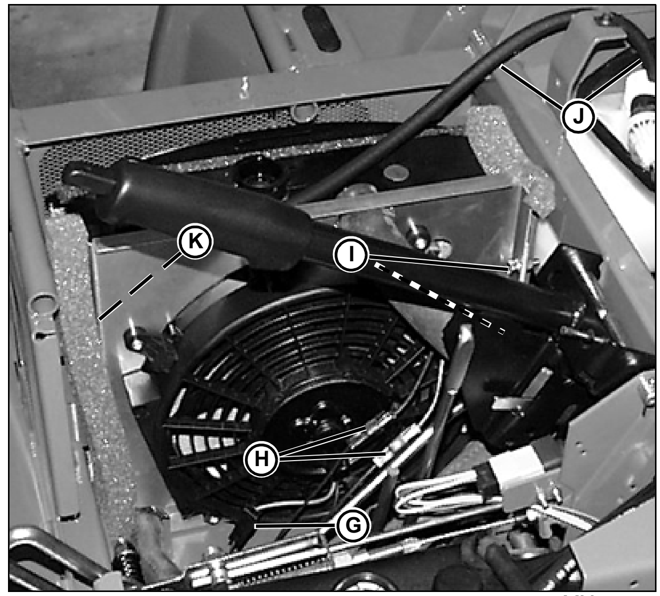


M55764

7. Pinch and disconnect bypass hose (D) at fitting (E) and drain remaining coolant into funnel.

IMPORTANT: Avoid damage! Bleed cap screw (F) uses special aluminum washer. DO NOT lose or substitute washer with another type.

8. Remove bleed screw (F).

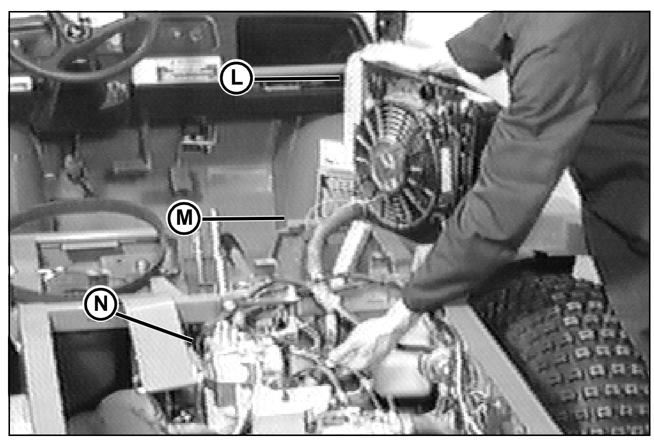


MX1200

9. Disconnect fan wiring connections (G and H). Remove two radiator mounting cap screws (I).

10.Remove hose (J) from expansion bottle.

11. Lift radiator/fan assembly out of front slot (K).

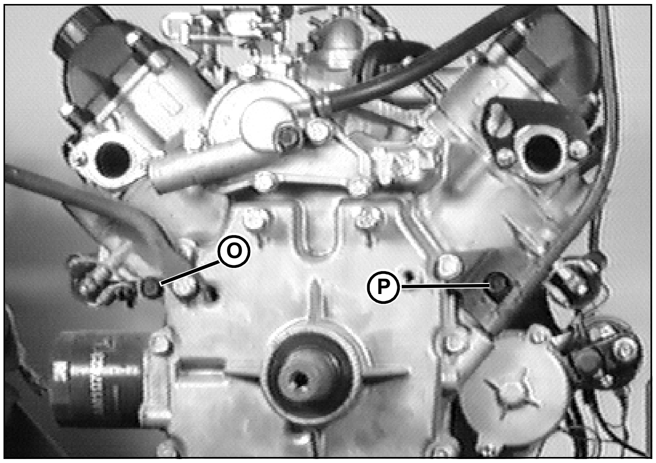


M55766

12.Raise radiator/fan assembly (L) to drain remaining coolant from radiator. Flex lower hose several times to help drain radiator and hose (M).

13.Remove lower radiator hose from water pump (N) to drain coolant.

IMPORTANT: Avoid damage! Engine block drain plugs (O and P) use special aluminum washer seals. DO NOT lose or substitute with other types.



M55767

Picture Note: Drive clutch and muffler assemblies removed for clarity purposes only.

14.Remove plugs (O) and (P) to drain engine block.

Flush:

1. Install drain plugs, lower radiator hose to water pump inlet, bypass hose, bleed cap screw, radiator/fan assembly into front slot (do not install mounting cap screws), expansion bottle hose and cap, and upper radiator hose (tighten all hose clamps securely).

2. Flush cooling system using brand name flushing agent suitable for aluminum engines and radiators.

3. Follow Cooling System Fill/Bleed Procedure in this section.

4. Circulate flushing solution with engine running at MEDIUM idle for ten minutes or until fan starts, whichever comes first.

5. Cool engine and cooling system completely.

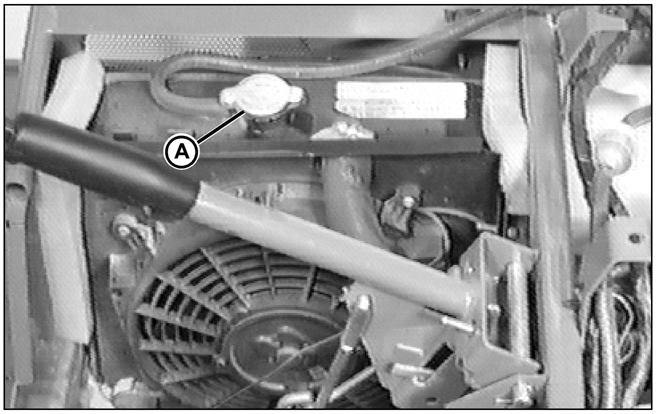
6. Repeat Cooling System Drain Procedure.

7. Repeat Cooling System Fill/Bleed Procedure.

Radiator Fill and Bleed Procedure

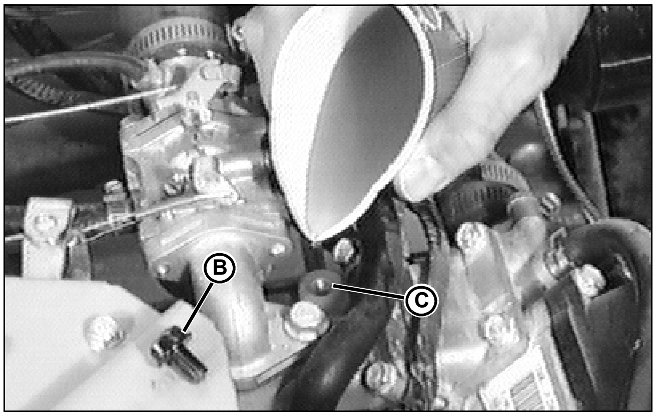
IMPORTANT: Avoid damage! Allow engine and cooling system to cool completely.

1. Remove seats and shrouding.



M55756

2. Remove radiator cap (A).
3. Check all hose clamps for tightness.



M55759

4. Fill cooling system as follows:

- Remove the black bleed screw (B) from bleed screw hole (C).

IMPORTANT: Avoid damage! Use ONLY 50/50 mixture of name brand ethylene glycol antifreeze (specified suitable for aluminum engines) and deionized soft or distilled water.

- Add coolant to radiator until it comes out of radiator cap hole. Install radiator cap.

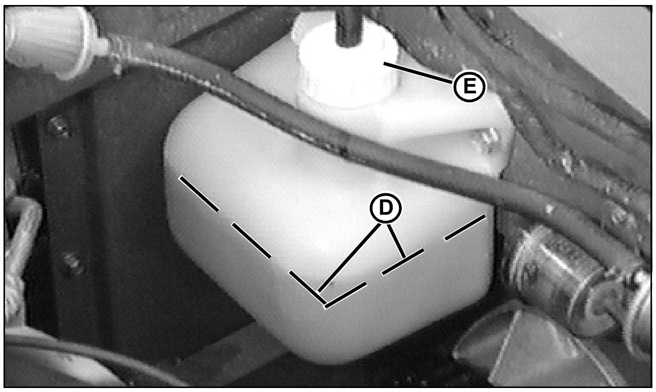
- Add coolant at bleed screw hole (C) until coolant runs out.

IMPORTANT: Avoid damage! Cooling system black bleed cap screw (B) uses special aluminum washer seal. DO NOT lose or substitute with another type.

- Install bleed screw (B) halfway.

- Run engine at MEDIUM speed for approximately five minutes. Check that upper radiator hose is warm indicating thermostat has opened and coolant is circulating.

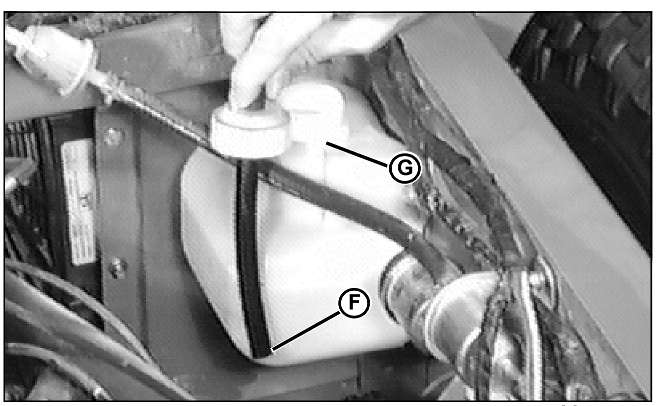
- Add coolant to radiator until only coolant is coming out of bleed screw hole (air bubbles no longer visible). Tighten bleed screw.
- Run engine for approximately five more minutes Check that lower radiator hose is warm indicating coolant is circulating through entire system.
- Run until cooling fan starts, approximately five more minutes (15 minutes total), indicating coolant and engine have reached operating temperature and system is functioning properly.



M55758

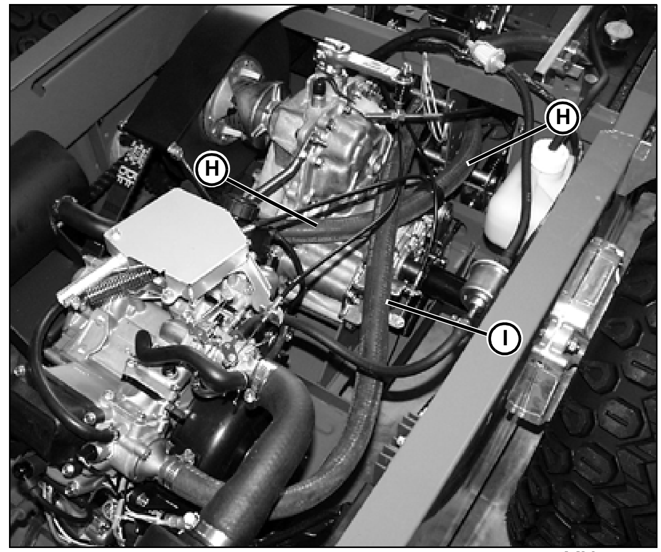
5. Remove cap (E) and fill expansion bottle with coolant to approximate level shown (D).

IMPORTANT: Avoid damage! Be sure expansion bottle hose (F) is positioned SLIGHTLY above bottom of bottle. DO NOT allow hose to touch bottom of bottle or force hose to bend back towards top of bottle.



M55768

6. If hose (F) was removed from bottle cap, remove cap and insert hose into cap. Hold bottom edge of cap on bottle lip (G), just below neck threads. Push hose down through cap until it is slightly above bottom of bottle. Install and tighten hose and cap.



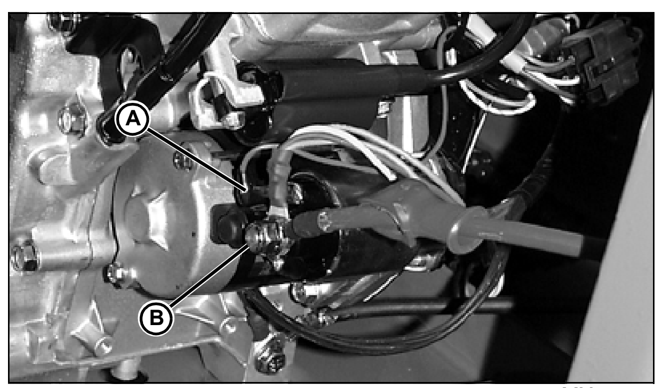
MX1199

NOTE: Radiator hose routing was changed on machines with PIN W006X4X001450 and above. Lower radiator hose (H) is now routed through the hose clamp on the transaxle and under upper radiator hose (I) as it passes over the transaxle to the water pump fitting. Upper radiator hose (I) is routed on top. It is not necessary to reroute these hoses at this time. However, it is advisable to reroute them the first time they are disconnected from the engine or the radiator.

Starting Motor Removal and Installation

Removal:

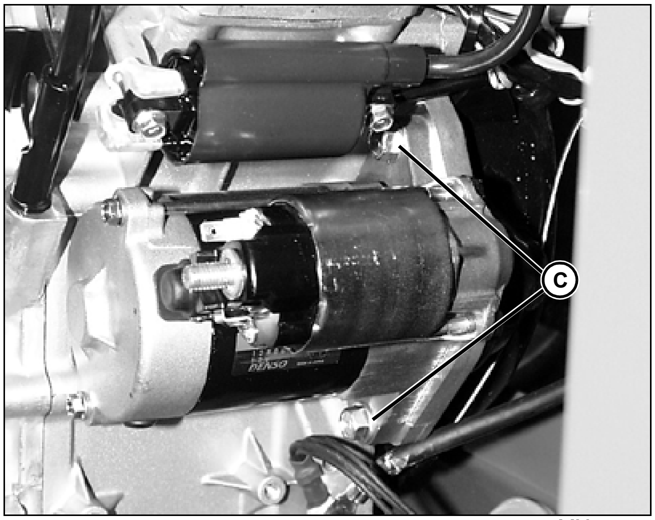
1. Disconnect both the battery negative (-) and positive (+) cables from the battery and remove the battery.



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.

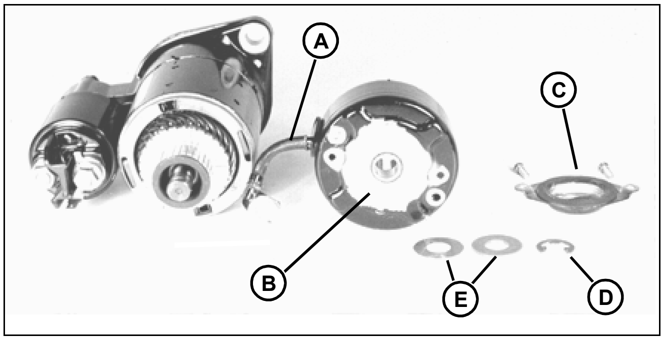
1. Place starting motor in engine frame, install mounting bolts and tighten evenly.

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).

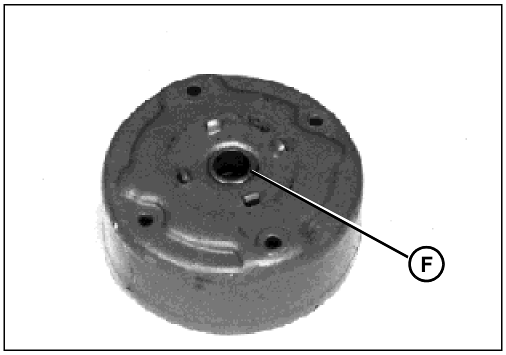
3. Pry off cap (C).

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 83.)

To Replace Bushing:

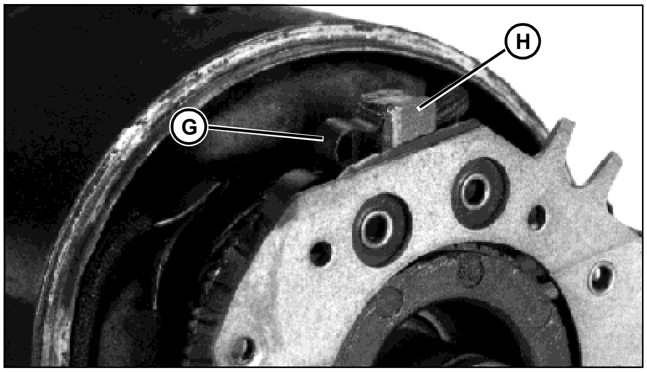
Remove bushing using a blind-hole puller set. Install new bushing until it bottoms in cover bore using a driver set.



M37874

1. Ream out bushing (F) to 12.50 - 12.53 mm (0.492 - 0.493 in.).

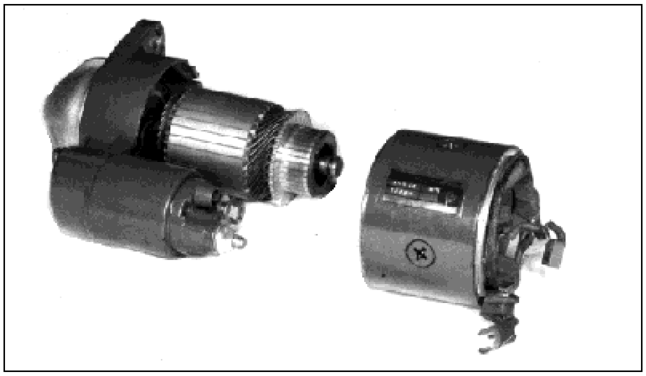
2. Remove field coil brushes from brush holder.



M37875

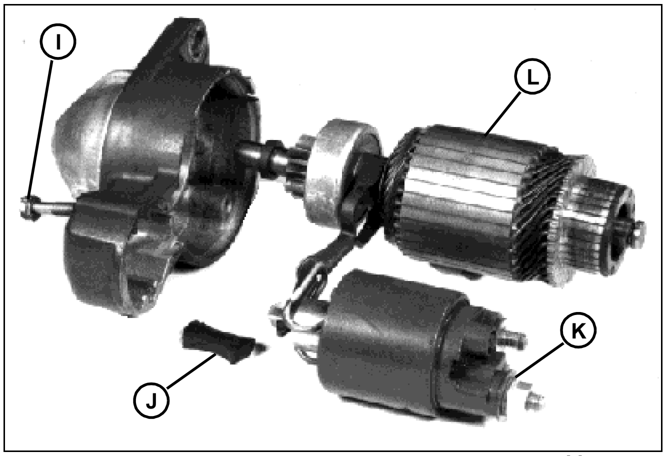
3. Pry brush springs (G) away and pull negative brushes (H) up enough to allow spring to hold brush in place.

4. Remove brush holder.



M37876

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



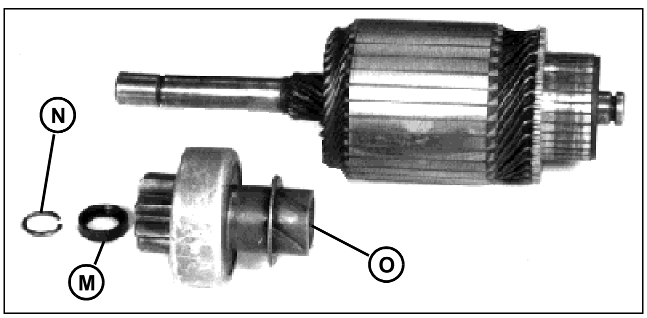
M37877

6. Remove two cap screws (I).

7. Remove dust cover (J).

8. Remove solenoid (K) and armature (L) assemblies from end frame.

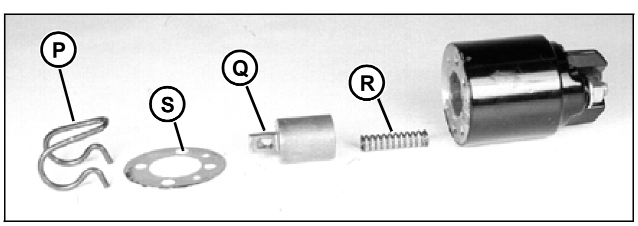
9. Inspect end frame bushing for wear or damage. Replace if necessary.



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

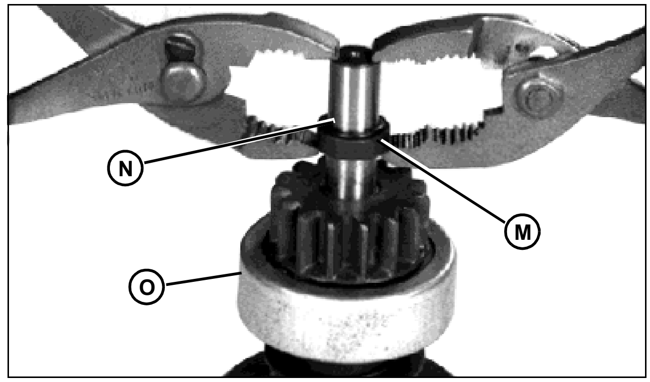
12.Remove clutch fork pivot (P), plunger (Q), spring (R) and shim plate (S) from solenoid.

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 126.)

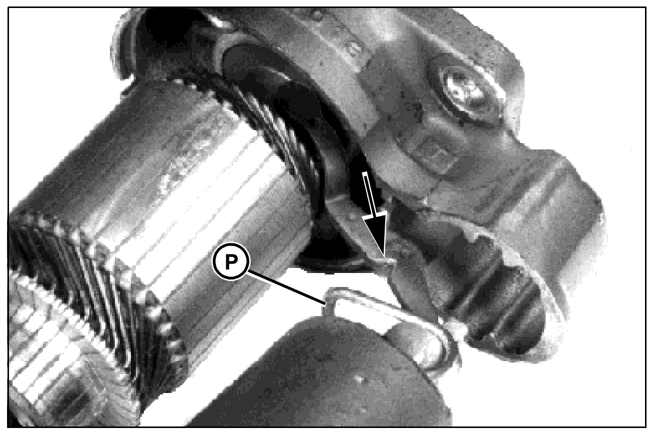
Assembly:

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

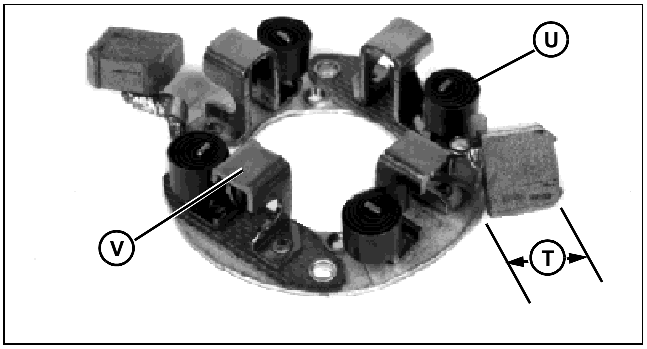
- When installing solenoid and armature assemblies into end frame, make sure fork pivot seats in notch on clutch fork.

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.



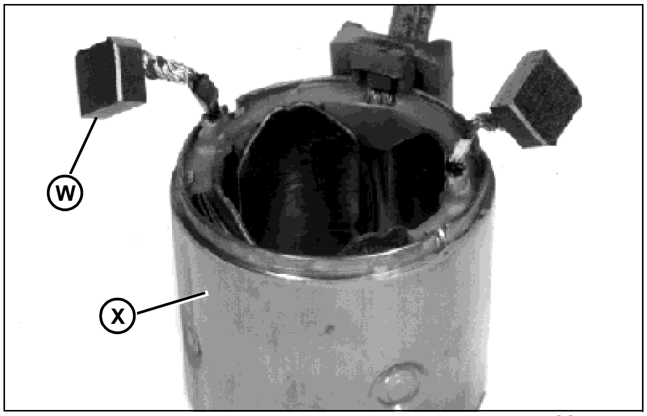
M82234

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.

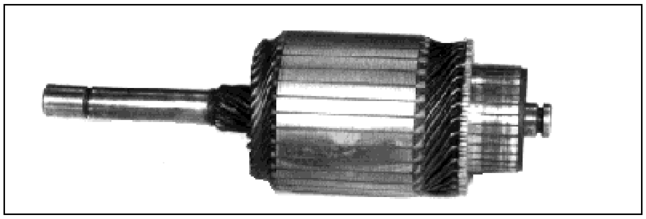


M82235

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.

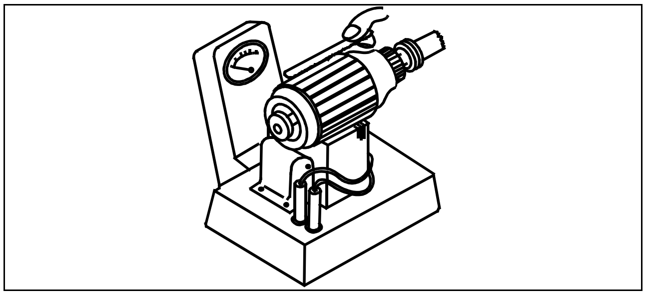


M82246

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

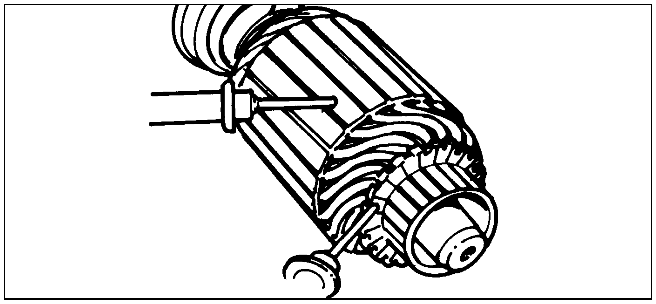
8. Test for short circuited windings using a growler. Put armature in a growler and hold a hacksaw blade above each slot while slowly rotating armature.

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.

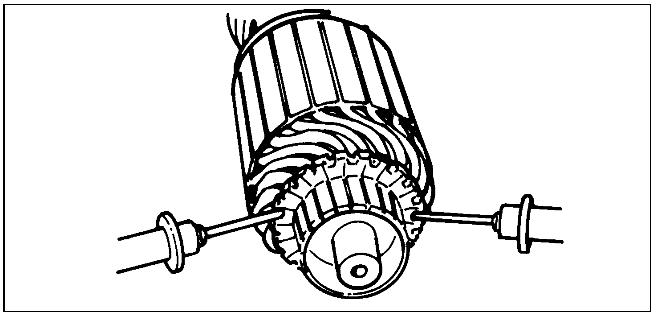
NOTE: Test for grounded windings using an ohmmeter or test light.



M46890

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

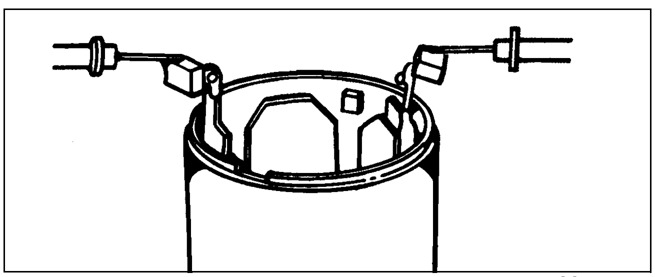
11.If the test shows continuity, a winding is grounded and the armature must be replaced.



M46891

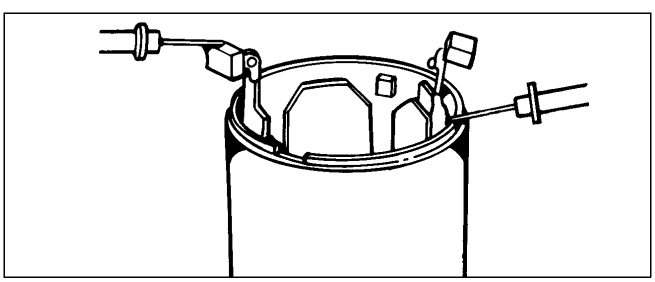
12.Test for open circuits in the windings. If the test shows no continuity, the armature has an open circuit and must be replaced.

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

Table of Contents

ENGINE - DIESEL SPECIFICATIONS

Specifications

General Specifications

Make	Yanmar
Model (S/N -013716)	3TN66C-JUV
Model (S/N 013717-)	3TN66C-EJUV
Type	Vertical, 4-cycle Diesel
Output Power	13.4 kW (18 HP)
Cylinders	3
Bore	66 mm (2.6 in.)
Stroke	64.2 mm (2.53 in.)
Displacement	0.658 L (40.2 cu-in.)
Firing Order	1 - 3 - 2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Combustion System	Indirect Injection Type
Compression Ratio	22.4 to 1
Oil Capacity without filter (approximately)	2.0 L (2.1 qt)
Oil Capacity with filter	2.2 L (2.3 qt)
Cooling	Liquid
Capacity	4.5 L (4.8 qt)
Governor	Centrifugal
Slow Idle (no-load)	1000 ± 25 rpm
High Idle (no-load)	3550 ± 25 rpm
Rated RPM	3150 rpm

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.)
Rocker Arm Shaft OD Wear Limit	9.95 mm (0.3920 in.)
Rocker Arm and Shaft Support ID's Clearance	0.14 mm (0.005 in.)
Rocker Arm and Shaft Support ID's Standard	10.00 - 10.02 mm (0.3937 - 0.3945 in.)
Rocker Arm and Shaft Support ID's Wear Limit	10.09 mm (0.3972 in.)
Push Rod Length (Standard)	114 - 115 mm (4.488 - 4.528 in.)
Push Rod Bend Wear Limit	0.08 mm (0.003 in.)

ENGINE - DIESEL SPECIFICATIONS

Cylinder Head:

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

Mounting Cap Screw Torque Second . . . . . 22 N•m (195 lb-in.)

Mounting Cap Screw Torque Final . . . . . 34 N•m (25 lb-ft)

Piston-to-Cylinder Head Clearance . . . . . 0.59 - 0.74 mm (0.023 - 0.029 in.)

Cylinder Head Distortion Standard . . . . . 0.05 mm (0.002 in.) or less

Cylinder Head Distortion Wear Limit . . . . . 0.15 mm (0.006 in.)

Cylinder Head Distortion Maximum Amount of Metal to be Removed . . . . . 0.20 mm (0.008 in.)

Intake and Exhaust Valves:

Intake Valve Seat Width Standard . . . . . 1.15 mm (0.045 in.)

Intake Valve Seat Width Wear Limit . . . . . 1.65 mm (0.065 in.)

Exhaust Valve Seat Width Standard . . . . . 1.41 mm (0.056 in.)

Exhaust Valve Seat Width Standard . . . . . 1.41 mm (0.056 in.)

Valve Seat Surface Angles Exhaust Valve . . . . . 45°

Valve Seat Surface Angles Intake Valve . . . . . 30°

Valve Seat Surface Angles Lower Seat Surface . . . . . 70°

Valve Seat Surface Angles Upper Seat Surface . . . . . 15°

Valve Faces Minimum Margin . . . . . 0.51 mm (0.020 in.)

Valve Faces Exhaust Angle . . . . . 45°

Valve Faces Intake Angle . . . . . 30°

Valve Stem OD Distance A . . . . . 20 mm (0.787 in.)

Valve Stem OD Distance B . . . . . 40 mm (1.575 in.)

Intake Valve Standard . . . . . 5.46 - 5.48 mm (0.215 - 0.216 in.)

Intake Valve Wear Limit . . . . . 5.40 mm (0.213 in.)

Exhaust Valve Standard . . . . . 5.44 - 5.46 mm (0.214 - 0.215 in.)

Exhaust Valve Wear Limit . . . . . 5.40 mm (0.2126 in.)

Exhaust Valve Standard . . . . . 5.44 - 5.46 mm (0.214 - 0.215 in.)

Exhaust Valve Wear Limit . . . . . 5.40 mm (0.213 in.)

Valve Recession Intake Valve . . . . . 0.40 mm (0.016 in.)

Valve Recession Exhaust Valve . . . . . 0.85 mm (0.033 in.)

Valve Lift . . . . . 7.5 mm (0.30 in.)

Valve Guides:

Valve Guide ID Maximum Clearance . . . . . 0.20 mm (0.008 in.)

Valve Guide ID Standard . . . . . 5.50 - 5.52 mm (0.216 - 0.217 in.)

Valve Guide ID 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.)

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

ENGINE - DIESEL SPECIFICATIONS

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:

Clearance . . . . . 0.16 mm (0.006 in.)
Standard . . . . . 36 - 36.042 mm (1.417 - 1.419 in.)
Wear Limit . . . . . 37.07 mm (1.459 in.)
Connecting Rod Cap Screw Torque . . . . . 23 N•m (203 lb-in.)

Piston Ring Groove Clearance:

First Compression Ring Standard . . . . . 0.065 - 0.100 mm (0.0026 - 0.0039 in.)
First Compression Ring Wear Limit . . . . . 0.20 mm (0.0079 in.)
Second Compression Ring Standard . . . . . 0.030 - 0.065 mm (0.0012 - 0.0026 in.)
Second Compression Ring Wear Limit . . . . . 0.20 mm (0.0079 in.)
Oil Ring Standard . . . . . 0.020 - 0.055 mm (0.0008 - 0.0022 in.)
Oil Ring Wear Limit . . . . . 0.20 mm (0.0079 in.)

Piston End Ring Gap:

First Compression Ring and Oil Ring . . . . . 0.15 - 0.35 mm (0.006 - 0.014 in.)
Second Compression Ring . . . . . 0.25 - 0.40 mm (0.010 - 0.016 in.)
Wear Limit . . . . . 1.50 mm (0.059 in.)

Piston Pin:

Pin OD Standard . . . . . 19.991 - 20.00 mm (0.7870 - 0.7874 in.)
Pin OD Wear Limit . . . . . 19.975 mm (0.786 in.)
Bore ID Clearance . . . . . 0.045 mm (0.0018 in.)
Bore ID Standard . . . . . 20.00 - 20.008 mm (0.787 - 0.788 in.)
Bore ID Wear Limit . . . . . 20.02 mm (0.788 in.)
Bushing ID Clearance . . . . . 0.110 mm (0.0043 in.)
Bushing ID Standard . . . . . 20.025 - 20.038 mm (0.788 - 0.789 in.)
Bushing ID Wear Limit . . . . . 20.10 mm (0.781 in.)

Piston OD:

Distance A . . . . . 5 mm (0.197 in.)
Standard Size Piston Standard . . . . . 65.927 - 65.957 mm (2.596 - 2.597 in.)
Standard Size Piston Wear Limit . . . . . 65.85 mm (2.593 in.)
0.25 mm (0.010 in.) Oversize Piston Standard . . . . . 66.18 - 66.21 mm (2.606 - 2.607 in.)
0.25 mm (0.010 in.) Oversize Piston Wear Limit . . . . . 66.10 mm (2.602 in.)
0.50 mm (0.020 in.) Oversize Piston Standard . . . . . 66.43 - 66.46 mm (2.615 - 2.616 in.)
0.50 mm (0.020 in.) Oversize Piston Wear Limit . . . . . 66.35 mm (2.612 in.)

ENGINE - DIESEL SPECIFICATIONS

Cylinder Bore ID:

Standard Size Bore Clearance. . . . . 0.25 mm (0.010 in.)
Standard Size Bore Standard . . . . . 66.00 - 66.03 mm (2.599 - 2.600 in.)
Standard Size Bore Wear Limit . . . . . 66.20 mm (2.606 in.)
0.25 mm (0.010 in.) Oversize Bore Standard . . . . . 66.25 - 66.28 mm (2.609 - 2.610 in.)
0.25 mm (0.010 in.) Oversize Bore Wear Limit . . . . . 66.45 mm (2.616 in.)
0.50 mm (0.020 in.) Oversize Bore Standard . . . . . 66.50 - 66.53 mm (2.619 - 2.620 in.)
0.50 mm (0.020 in.) Oversize Bore Wear Limit . . . . . 66.70 mm (2.626 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:

Main Bearing Cap Screw Torque. . . . . 54 N•m (40 lb-ft)
Connecting Rod Journal OD Standard . . . . . 35.97 - 35.98 mm (1.4161 - 1.4165 in.)
Connecting Rod Journal OD Wear Limit . . . . . 35.92 mm (1.414 in.)
Crankshaft Maximum Bend . . . . . 0.02 mm (0.0007 in.)
Connecting Rod Journal OD Standard . . . . . 35.97 - 35.98 mm (1.4161 - 1.4165 in.)
Connecting Rod Journal OD Wear Limit . . . . . 35.92 mm (1.414 in.)
Main Bearing Journal OD Standard . . . . . 39.97 - 39.98 mm (1.5736 - 1.5740 in.)
Main Bearing Journal OD Wear Limit . . . . . 39.92 mm (1.572 in.)
Main Bearing ID Clearance . . . . . 0.15 mm (0.0059 in.)
Main Bearing ID Standard . . . . . 40.00 - 40.042 mm (1.575 - 1.577 in.)
Main Bearing ID Wear Limit . . . . . 40.07 mm (1.578 in.)

Stub Shaft:

Stub Shaft-to-Flywheel Cap Screw Torque . . . . . 59 N•m (44 lb-ft)

Flywheel:

Maximum Distortion . . . . . 0.02 mm (0.0008 in.)
Flywheel Mounting Cap Screw Torque. . . . . 83 N•m (61 lb-ft)
Engine Back Plate Mounting Cap Screw Torque. . . . . 49 N•m (36 lb-ft)

Camshaft:

Mounting Cap Screw Torque . . . . . 11 N•m (96 lb-in.)
Camshaft Side Gap Standard . . . . . 0.05 - 0.15 mm (0.0020 - 0.0060 in.)
Camshaft Side Gap Wear Limit . . . . . 0.40 mm (0.016 in.)
Maximum Camshaft Bend . . . . . 0.02 mm (0.001 in.)
Lobe Height Standard . . . . . 29.97 - 30.03 mm (1.180 - 1.182 in.)
Lobe Height Wear Limit . . . . . 29.75 mm (1.171 in.)

Camshaft Journal OD:

Gear Housing and Flywheel Ends Standard	35.94 - 35.96 mm (1.4150 - 1.4157 in.)
Gear Housing and Flywheel Ends Wear Limit	35.85 mm (1.4114 in.)
Intermediate Standard	35.91 - 35.94 mm (1.4138 - 1.4150 in.)
Intermediate Wear Limit	35.85 mm (1.4114 in.)
Bushing ID Clearance	0.18 mm (0.007 in.)
Bushing ID Standard	36.00 - 36.065 mm (1.417 - 1.420 in.)
Bushing ID Wear Limit	36.10 mm (1.421 in.)
Bore ID Clearance	0.18 mm (0.007 in.)
Bore ID Standard	36.00 - 36.025 mm (1.417 - 1.418 in.)
Bore ID Wear Limit	36.10 mm (1.421 in.)

Cam Followers:

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

Timing Gear Cover:

Fan Mounting Cap Screw Torque	11 N•m (96 lb-in.)
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.)
Shaft OD Wear Limit	19.93 mm (0.785 in.)
Bushing ID Clearance	0.15 mm (0.0059 in.)
Bushing ID Standard	20.00 - 20.021 mm (0.787 - 0.788 in.)
Bushing ID Wear Limit	20.08 mm (0.791 in.)

Timing Gear Housing Cap Screw Torque:

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

ENGINE - DIESEL SPECIFICATIONS

Oil Pump:

Mounting Cap Screw Torque . . . . . 25 N•m (18 lb-ft)
Rotor Shaft OD-to-Backing Plate ID Clearance Standard . . . . . 0.015 - 0.048 mm (0.0006 - 0.0035 in.)
Rotor Shaft OD-to-Backing Plate ID Clearance Wear Limit . . . . . 0.20 mm (0.0078 in.)
Rotor Recess Wear Limit . . . . . 0.25 mm (0.010 in.)
Outer Rotor-to-Pump Body Clearance Standard . . . . . 0.03 - 0.09 mm (0.0012 - 0.0035 in.)
Outer Rotor-to-Pump Body Clearance Wear Limit . . . . . 0.13 mm (0.0051 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)
Spring 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.)
Governor Shaft Bore ID 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.)
Injection Pump Camshaft OD Wear Limit . . . . . 7.90 mm (0.311 in.)

Fuel Injection Nozzles:

Mounting Nut Torque . . . . . 40 N•m (30 lb-ft)
Nozzle Fitting Torque . . . . . 40 N•m (30 lb-ft)
Nozzle Torque . . . . . 50 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)

ENGINE - DIESEL SPECIFICATIONS

Checks, Tests and Adjustments:

Valve Clearance	20 mm (0.008 in.)
Connecting Rod Side Play Standard Clearance	0.20 - 0.40 mm (0.0079 - 0.0157 in.)
Connecting Rod Side Play Wear Limit	0.55 mm (0.0217 in.)
Connecting Rod Bearing Clearance Standard Clearance	0.020 - 0.072 mm (0.0008 - 0.0028 in.)
Connecting Rod Bearing Clearance Wear Limit	0.15 mm (0.0059 in.)
Crankshaft End Play Standard Clearance	0.090 - 0.271 mm (0.004 - 0.011 in.)
Crankshaft End Play Wear Limit	0.33 mm (0.0129 in.)
Crankshaft Main Bearing Standard Clearance	0.020 - 0.072 mm (0.0008 - 0.0028 in.)
Crankshaft Main Bearing Wear Limit	0.15 mm (0.0059 in.)
Crankshaft Main Bearing Cap Screw Torque	54 N•m (40 lb-ft)
Valve Lift (Intake and Exhaust)	7.5 mm (0.300 in.)
Camshaft End Play Standard Clearance	0.05 - 0.20 mm (0.0020 - 0.0079 in.)
Camshaft End Play Wear Limit	0.40 mm (0.016 in.)

Timing Gear Backlash:

Standard Backlash (All except crankshaft gear-to-oil pump gear)	0.04 - 0.12 mm (0.0016 - 0.0047 in.)
Standard Backlash Crankshaft Gear-to-Oil Pump Gear	0.11 - 0.19 mm (0.0043 - 0.0075 in.)
Wear Limit	0.20 mm (0.0079 in.)

Fuel Injection Nozzle:

Opening Pressure	11722 ± 480 kPa (1700 ± 70 psi)
Leakage at 11032 kPa (1600 psi)	Minimum of 10 Seconds
Chatter at 11722 ± 480 kPa (1700 ± 70 psi) Slow Hand Lever Movement	Chatter Sound
Spray Pattern at 11722 ± 480 kPa (1700 ± 70 psi) Slow Hand Lever Movement	Fine Stream Spray Pattern
Spray Pattern at 11722 ± 480 kPa (1700 ± 70 psi) 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)

Radiator Core Temperature Switch (Operates Fan Motor):

Continuity (Closes)	70° ± 14° C (160° ± 7° F)
No Continuity (Opens)	60° ± 14° C (140° ± 7° F)

Starter No-Load Amp Draw/RPM:

Maximum Starter Amperage	60 Amps at 7000 rpm
Minimum Starter RPM	7000 rpm

ENGINE - DIESEL SPECIFICATIONS

Fuel Injection Pump Static Timing:

Injection Pump Timing . . . . 14° BTDC (Before Top Dead Center)
Distance Outer Surface Of Flywheel Travels Per 1° Of Rotation . . . . 2.62 mm (0.100 in.)
Timing Change per 0.1 mm Shim Thickness (approximately) . . . . 2°
Engine Crankshaft Position. . . . . No. 1 Cylinder on TDC Compression Stroke
Total Shim Pack Thickness (New Shims) . . . . 0.5 mm (0.020 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 (17 psi)
Cooling System Minimum Pressure after 15 Seconds . . . . 90 kPa (13 psi)
Radiator Cap Valve Opening Pressure . . . . 83 - 96 kPa (12 - 14 psi)
Cylinder Compression Pressure. . . . . 2448 kPa (355 psi)
Cylinder Compression Maximum Difference Between Cylinders . . . . 490 kPa (71 psi)
Engine Speed @ Fast Idle . . . . .3550 ± 25 rpm
Engine Speed @ Slow Idle. . . . . 1000 ± 25 rpm
Engine Oil Pressure . . . . 294 - 392 kPa (43 - 57 psi)
Air Intake System Holding Pressure. . . . . 34 - 69 kPa (5 - 10 psi)

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).

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Tachometer	JT05719	Used to set slow idle engine rpm and check fast idle rpm.
Fuel Pump Pressure Test Kit	JDG356	Fuel transfer pump pressure test.
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.
Compression Gauge	JT01682	Cylinder compression test.
Pressure Gauge Assembly Hose Assembly Connector 1/8” BSP Thread	JT05577 JT03017 JT03349	Oil pressure test.
Tension Gauge or, Belt Tension Gauge	JDG529 JDST28	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
Clutch Removal Tool	JDG813-1	Used to remove clutch from flywheel
Center Distance Gauge	JDG1175-2	Used to determine isolator spacers for engine mount
Dial Indicator	Dial Indicator	Used for valve lift check

Other Materials

Other Material

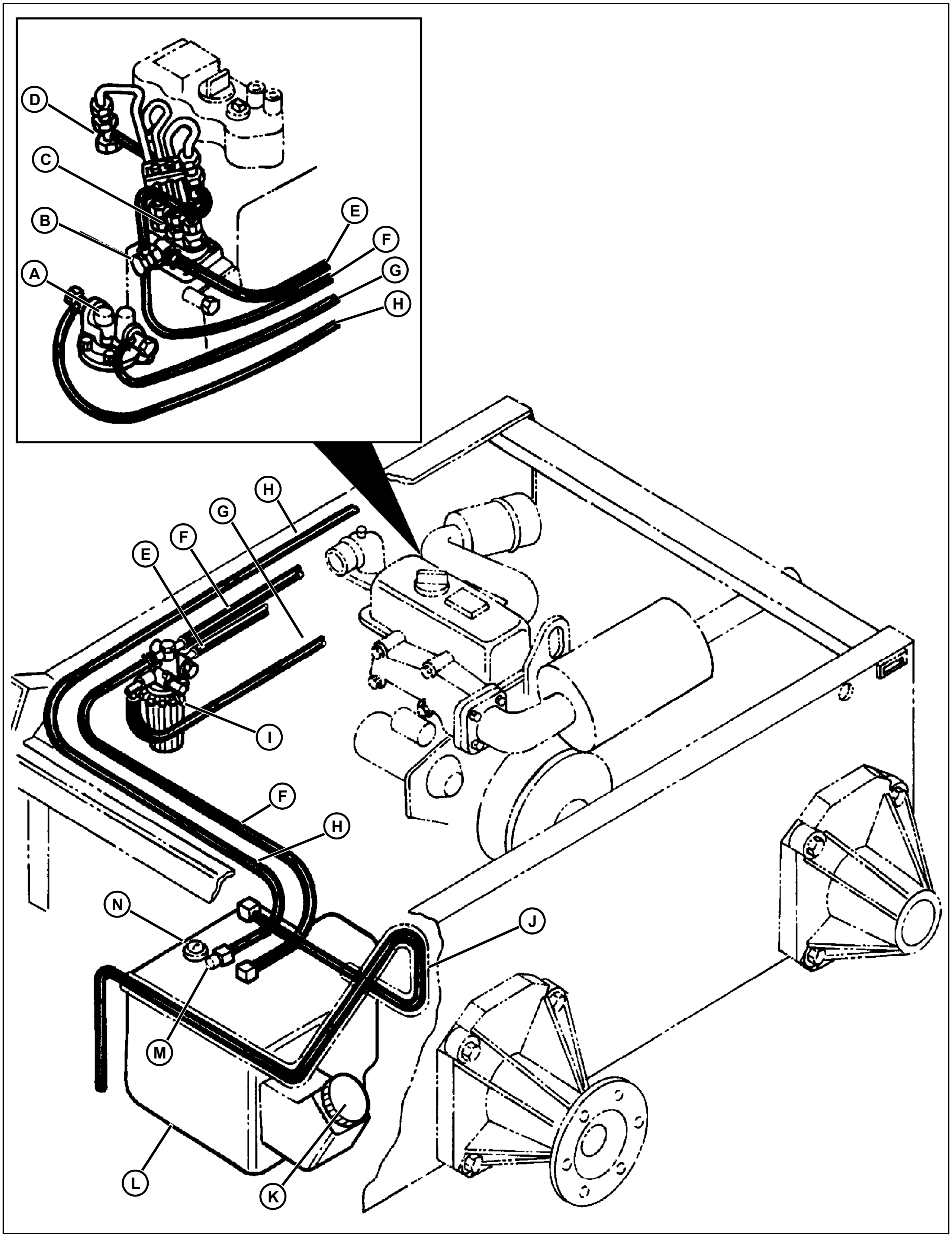
Part No.	Part Name	Part Use
	SCOTCH-BRIGHT®	Clean cylinder head.
	Valve Guide Cleaner	Clean valve guides.
	Stanisol or Kerosene	Finish ream valve guide.
	Prussion Blue Compound	Check valve seat contact.
	Lithium Base Grease	Pack oil seals.
	Zinc Oxide/Wood Alcohol	Check block for cracks.
	PLASTIGAGE®	Used for clearance measurements
TY15130 LOCTITE® No. 395	John Deere Form-In-Place Gasket	Seal engine block seams

PLASTIGAGE® is a registered trademark of the DANA Corp.

LOCTITE® is a registered trademark of the Loctite Corp.

Component Location

Fuel System Component Location



MX0550

A - Fuel Transfer Pump
B - Fuel Shutoff Solenoid
C - Injection Pump and Governor
D - Injection Nozzles
E - Fuel Line (to fuel injection pump)
F - Fuel Return Line
G - Fuel Line (transfer pump to fuel filter)
H - Fuel Supply Line
I - Fuel Filter and Shutoff Valve
J - Fuel Tank Vent Hose (inside frame)
K - Tank Filler Cap
L - Fuel Tank
M - Tank Shutoff Valve
N - Fuel Gauge

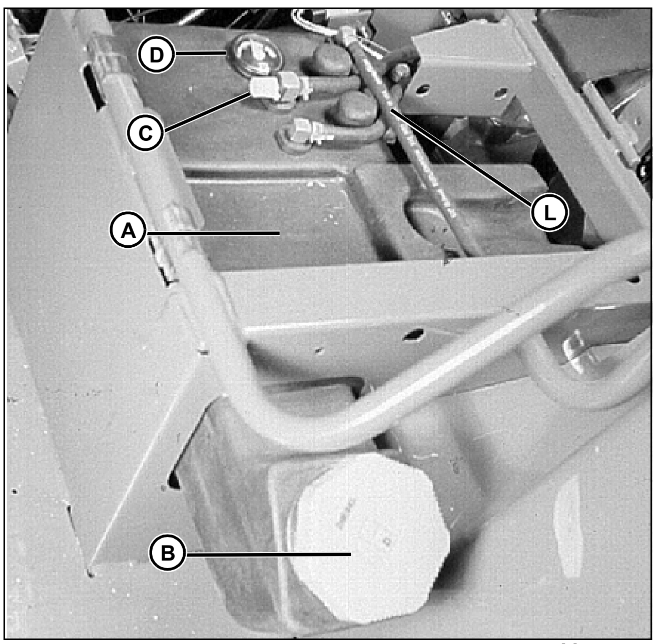
Theory of Operation

Fuel System Operation

Function:

Fuel system supplies fuel to injection nozzles.

Theory of Operation:



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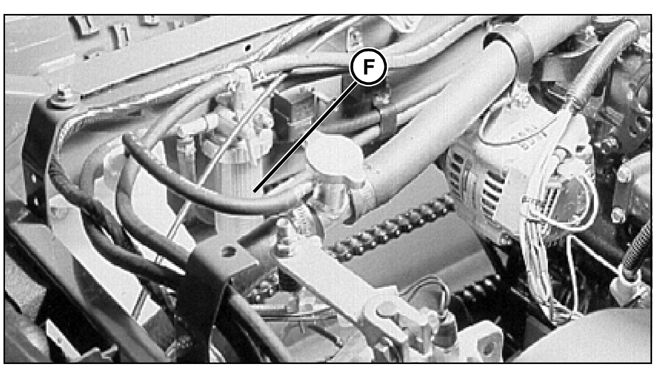


M76680

NOTE: See component location view above for additional component information.

The engine driven mechanical fuel transfer pump draws fuel from the fuel tank (L). Fuel cap (K) is not vented. Tank is vented through hose (J), which goes into left armrest pipe. Fuel is drawn through the fuel tank shutoff valve (M), through fuel supply line (H), to the transfer pump (A) (on the back of the engine). Pressurized fuel is then sent through a fuel line (G) from the fuel transfer pump to the fuel filter/ water separator (I) mounted on the right side of the frame, then through a fuel line (E) on to the fuel injection pump (C). After the injection pump galley is full, excess fuel is returned, along with excess leak-off fuel from the injectors, through the return line (F) to the fuel tank.

If the machine is run out of fuel, air may enter the fuel system. There is a priming lever on the side of the mechanical fuel transfer pump (A), which allows fuel to be manually pumped from the tank to the injector pump/ governor assembly and help bleed the fuel system. See “Checks, Tests and Adjustments:” on page 137.

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

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

The injection nozzle prevents flow until high pressure is reached, opening the valve and spraying atomized fuel into the combustion chamber. Injection lines have trapped fuel 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 (N), mounted on the top of the tank informs the operator of the fuel level.

The fuel shutoff solenoid stops the flow of fuel inside the fuel injector pump by forcing the governor rack linkage to a no fuel position, causing the fuel injector pump to stop suppling fuel to the injectors.

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 oil pressure switch closed.

Cooling System

Function:

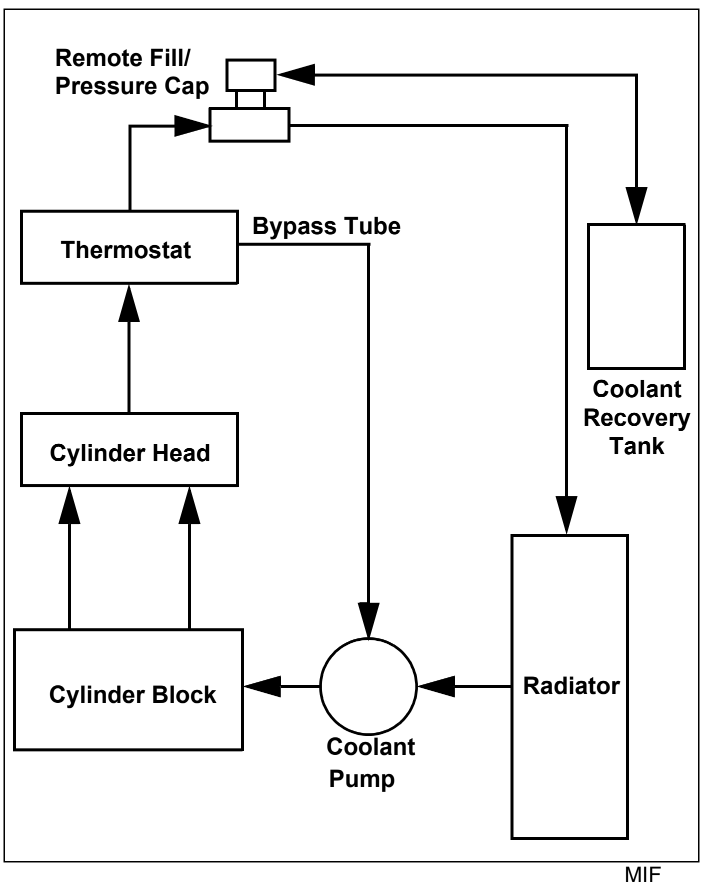
The cooling system allows the engine to rise to full operating temperature when engine is started cold. Once engine reaches operating temperature, coolant is circulated from the hot engine to the radiator to prevent engine overheating. The cooling system is pressurized, which raises the boiling point of the coolant and allows coolant to carry away more heat from the engine.

Theory of Operation:

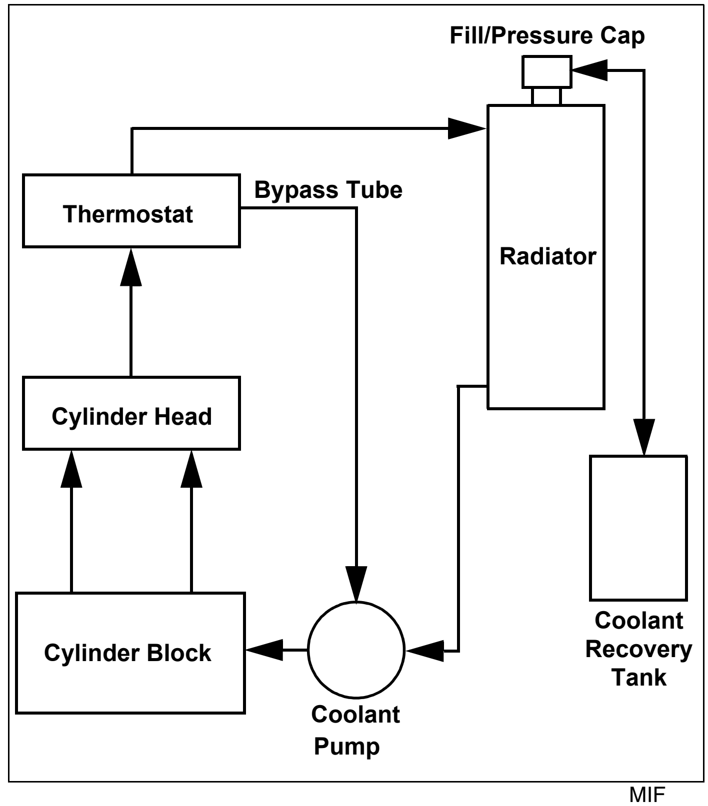
The pressurized cooling system includes the radiator, water pump, fan and thermostat.

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

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



Picture Note: S/N -033432



Picture Note: S/N 033433-

From the block, coolant is then directed through the cylinder head, and into thermostat housing. With the thermostat open, 85° C (184° F), warm engine coolant passes through the housing into the top of the radiator where it is circulated to dissipate heat.

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

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

A coolant temperature switch informs the operator of the engine coolant temperature and warns of a high temperature condition by lighting a lamp when the coolant temperature reaches approximately 109° ± 1°C (228° ± 2°F).

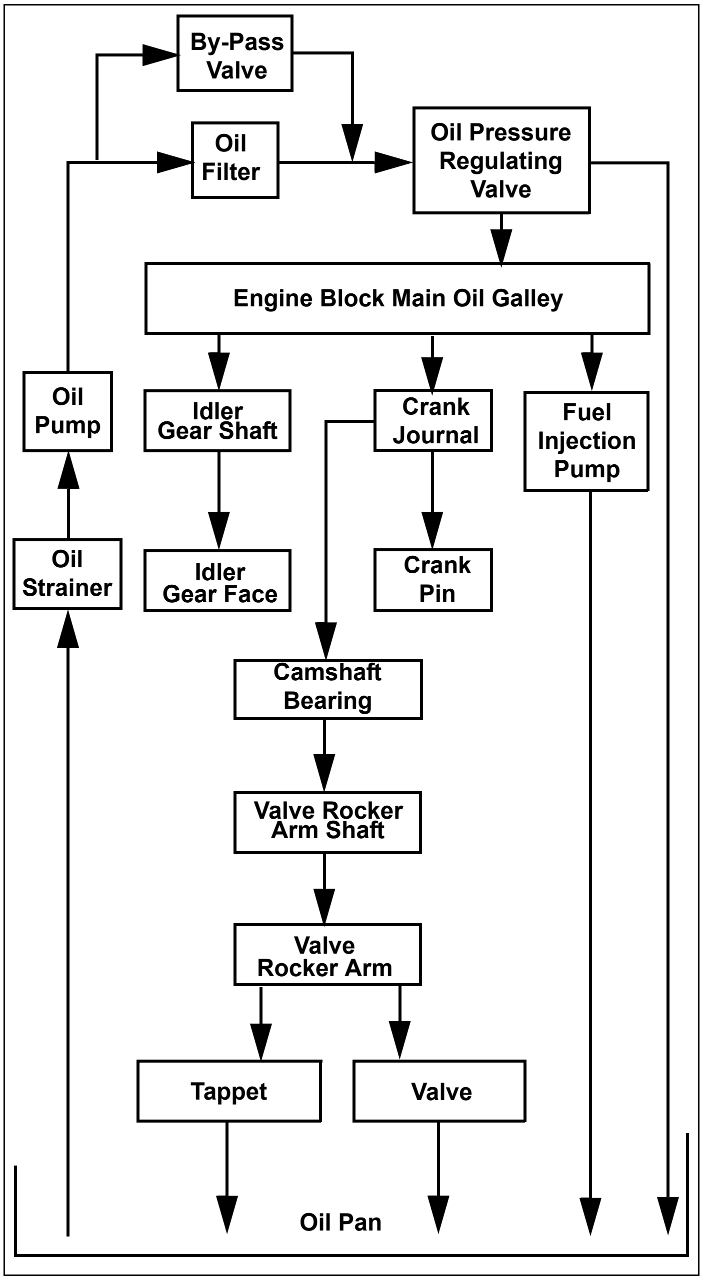
The radiator is equipped with a core temperature sensor which will activate an electric cooling fan mounted on the inside of the radiator. Air is pulled by the fan through a grate under the right passenger seat, through a removable debris guard, through the radiator and fan, and out to the engine compartment.

Lubrication System Operation

Function:

A full pressure system lubricates engine parts with clean oil.

Theory of Operation:



MIF

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

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

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

Lube oil holes in main bearing oil grooves are provided to direct oil to the camshaft bearings.

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

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

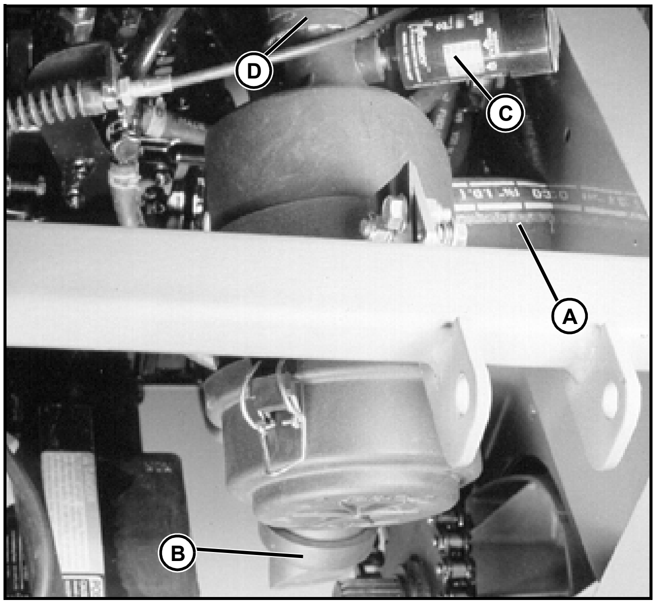
An oil pressure switch activates an indicator light to alert the operator to shut down the engine if oil pressure drops below a specification.

Air System Operation

Function:

The air intake system filters air needed for combustion.

Theory of Operation:



M76783

Air enters the air cleaner inlet (A) 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 (B).

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 remaining air enters the filter element. The filter element filters the air before entering the intake manifold hose (D).

The dirt that is deposited in the unloader valve is removed by the rubber diaphragm at the base of the valve. 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 (C). As the air cleaner becomes clogged, and intake manifold vacuum increases, the restriction indicator piston is pulled down against spring tension, and is calibrated to show when it’s time to change air filter.

Diagnostics

Engine Troubleshooting Guide

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

Coolant in the radiator is extremely hot during operation.

Engine

Symptom: Engine Will Not Start

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

Yes - Go to step (2).

No - Use correct procedure for conditions See the Operator's Manual. Go to step (2) if problem continues.

(2) Battery 12.7 VDC or higher?

Yes - Go to step (3).

No - Charge and check battery. (See Battery tests in the "Electrical" section.) Go to step (3) if problem continues.

(3) No open circuits in wiring?

Yes - Go to step (4).

No - Repair or replace as needed. (See "Common Circuit Tests" in the "Electrical" section.) Go to step (4) if problem continues.

(4) Starting motor functioning properly?

Yes - Go to step (5).

No - Repair or replace starting motor. Go to step (5) if problem continues.

(5) Alternator output correct?

Yes - Go to step (6).

No - Repair or replace alternator. Go to step (6) if problem continues.

(6) Engine oil of correct viscosity and type?

Yes - Go to step (7).

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

(7) No water in fuel?

Yes - Go to step (8).

Symptom: Engine Will Not Start

No - Drain and replace fuel. Go to step (8) if problem continues.

(8) Fuel filter not clogged?

Yes - Go to step (9).

No - Replace fuel filter. See "Fuel Filter" on page 207. Go to step (9) if problem continues.

(9) No air leak in fuel system?

Yes - Go to step (10).

No - Repair fuel system. Go to step (10) if problem continues.

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

Yes - Go to step (11).

No - Repair or replace fuel lines as needed. Go to step (11) if problem continues.

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

Yes - Go to step (12).

No - Replace fuel transfer pump. See "Fuel Transfer Pump" on page 206. Go to step (12) if problem continues.

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

Yes - Go to step (13).

No - Adjust valve clearance. Go to step (13) if problem continues.

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

Yes - Go to step (14).

No - Adjust valve clearance. Check valve timing. Go to step (14) if problem continues.

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

Yes - Go to step (15).

No - Replace valve and check valve guide. Go to step (15) if problem continues.

(15) Piston rings not broken or seized?

Yes - Go to step (16).

No - Replace rings. Check piston and cylinder. Go to step (16) if problem continues.

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

Symptom: Engine Will Not Start

Yes - Go to step (17).

No - Replace piston and/or rings, bore or hone cylinder. Go to step (17) if problem continues.

(17) Crankshaft pin or bearing not seized?

Yes - Go to step (1).

No - Regrind crankshaft and replace bearings. Go to step (1) if problem continues.

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

(1) Engine oil of proper viscosity and type.

Yes - Go to step (2).

No - Replace engine oil filter and oil of proper viscosity and type. Go to step (2) if problem continues.

(2) Fuel filter not clogged?

Yes - Go to step (3).

No - Replace fuel filter. See “Fuel Filter” on page 207. Go to step (3) if problem continues.

(3) No air leak in fuel system?

Yes - Go to step (4).

No - Repair fuel system. Go to step (4) if problem continues.

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

Yes - Go to step (5).

No - Repair or replace fuel lines as needed. Go to step (5) if problem continues.

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

Yes - Go to step (6).

No - Replace fuel transfer pump. See “Fuel Transfer Pump” on page 206. Go to step (6) if problem continues.

(6) Valve clearance proper?

Yes - Go to step (7).

No - Adjust valve clearance. Go to step (7) if problem continues.

(7) Crankshaft pin or bearing not seized?

Yes - Go to step (1).

No - Regrind crankshaft and replace bearings. Go to step (1) if problem continues.

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

(1) No water in fuel?

Yes - Go to step (2).

No - Drain and replace fuel. Go to step (2) if problem continues.

(2) Fuel filter not clogged?

Yes - Go to step (3).

No - Replace fuel filter. See “Fuel Filter” on page 207. Go to step (3) if problem continues.

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

Yes - Go to step (4).

No - Replace valve and check valve guide. Go to step (4) if problem continues.

(4) Piston rings not broken or seized?

Yes - Go to step (5).

No - Replace rings. Check piston and cylinder. Go to step (5) if problem continues.

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

Yes - Go to step (1).

No - Replace piston and/or rings, bore or hone cylinder. Go to step (1) if problem continues.

Symptom: Low Engine Output - Exhaust color NORMAL

(1) Correct type of fuel being used?

Yes - Go to step (2).

No - Drain and replace fuel. Go to step (2) if problem continues.

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

Yes - Go to step (3).

No - Replace engine oil and filter. Go to step (3) if problem continues.

(3) Fuel filter not clogged?

Yes - Go to step (4).

No - Replace fuel filter. Go to step (4) if problem continues.

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

Yes - Go to step (5).

No - Clean or replace fuel lines. Go to step (5) if problem continues.

Symptom: Low Engine Output - Exhaust color NORMAL

(5) No air leakage into fuel system?

Yes - Go to step (6).

No - Repair fuel supply system. Go to step (6) if problem continues.

(6) Proper volume of fuel to injection pump?

Yes - Go to step (7).

No - Check or replace fuel transfer pump. Go to step (7) if problem continues.

(7) Intake and exhaust valve clearance correct?

Yes - Go to step (8).

No - Adjust valve clearance. Go to step (8) if problem continues.

(8) Intake or exhaust valves not leaking compression?

Yes - Go to step (9).

No - Grind valves and seats. Go to step (9) if problem continues.

(9) Intake or exhaust valves not seized?

Yes - Go to step (10).

No - Replace valve and check valve guide. Go to step (10) if problem continues.

(10) Cylinder head gasket not leaking compression?

Yes - Go to step (11).

No - Replace head gasket, Resurface head and block if necessary. Go to step (11) if problem continues.

(11) Crankshaft pin or bearing not worn?

Yes - Go to step (1).

No - Grind crankshaft and replace bearings. Go to step (1) if problem continues.

Symptom: Low Engine Output - Exhaust color WHITE

(1) Correct type of fuel?

Yes - Go to step (2).

No - Drain and replace fuel. Go to step (2) if problem continues.

(2) No water in fuel?

Yes - Go to step (3).

Symptom: Low Engine Output - Exhaust color WHITE

No - Drain and replace fuel. Go to step (3) if problem continues.

(3) Even volume of fuel being injected?

Yes - Go to step (4).

No - Repair or replace fuel injector pump or fuel injectors. Go to step (4) if problem continues.

(4) Proper spray pattern from injectors?

Yes - Go to step (5).

No - Clean or replace fuel injector nozzles. Go to step (5) if problem continues.

(5) Intake or exhaust valve stems not worn?

Yes - Go to step (6).

No - Replace valve guides and valves. Go to step (6) if problem continues.

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

Yes - Go to step (7).

No - Adjust valve clearance. Go to step (7) if problem continues.

(7) Piston rings installed correctly?

Yes - Go to step (8).

No - Install piston rings correctly. Go to step (8) if problem continues.

(8) Piston ring ends staggered?

Yes - Go to step (9).

No - Stagger piston ring ends. Go to step (9) if problem continues.

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

Yes - Go to step (10).

No - Replace pistons and rings, bore or hone cylinders. Go to step (10) if problem continues.

(10) Piston rings not broken or seized?

Yes - Go to step (1).

No - Replace rings. Replace pistons if damaged. Bore cylinder if damaged. Go to step (1) if problem continues.

Symptom: Low Engine Output - Exhaust color BLACK

(1) Correct type of fuel?

Symptom: Low Engine Output - Exhaust color BLACK

Yes - Go to step (2).

No - Drain and replace fuel. Go to step (2) if problem continues.

(2) Air filter elements not clogged?

Yes - Go to step (3).

No - Clean or replace air filter elements. Go to step (3) if problem continues.

(3) Exhaust pipe not clogged?

Yes - Go to step (4).

No - Clean exhaust pipe. Go to step (4) if problem continues.

(4) Engine running cool enough?

Yes - Go to step (5).

No - Check thermostat, replace if faulty. Adjust fan belt tension. Go to step (5) if problem continues.

(5) Cooling system filled to correct level?

Yes - Go to step (6).

No - Check for leaks and fill system to correct level. Go to step (6) if problem continues.

(6) Correct volume of fuel being injected?

Yes - Go to step (7).

No - Replace faulty fuel injector pump or fuel injectors. Go to step (7) if problem continues.

(7) Correct pattern from fuel injectors?

Yes - Go to step (8).

No - Clean or replace fuel injector nozzles. Go to step (8) if problem continues.

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

Yes - Go to step (9).

No - Adjust valve clearance. Go to step (9) if problem continues.

(9) Intake or exhaust valves not leaking compression?

Yes - Go to step (10).

No - Grind valves and seats. Go to step (10) if problem continues.

(10) Intake or exhaust valve not seized?

Yes - Go to step (11).

Symptom: Low Engine Output - Exhaust color BLACK

No - Replace valve and check valve guide. Go to step (11) if problem continues.

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

Symptom: Exhaust color WHITE under load

(1) Correct type of fuel?

Yes - Go to step (2).

No - Drain and replace fuel. Go to step (2) if problem continues.

(2) No water in fuel?

Yes - Go to step (3).

No - Drain and replace fuel. Go to step (3) if problem continues.

(3) Engine not running too cool?

Yes - Go to step (4).

No - Check thermostat, replace if faulty. Go to step (4) if problem continues.

(4) Correct volume of fuel being injected?

Yes - Go to step (5).

No - Replace faulty fuel injector pump or fuel injectors. Go to step (5) if problem continues.

(5) Correct pattern from fuel injectors?

Yes - Go to step (6).

No - Clean or replace fuel injector nozzles. Go to step (6) if problem continues.

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

Yes - Go to step (7).

No - Adjust valve clearance. Go to step (7) if problem continues.

(7) Piston rings installed correctly?

Yes - Go to step (8).

No - Install piston rings correctly. Go to step (8) if problem continues.

(8) Piston, rings or cylinder not worn?

Yes - Go to step (9).

No - Replace pistons and rings, bore or hone cylinders. Go to step (9) if problem continues.

Symptom: Exhaust color WHITE under load

(9) Piston rings not broken or seized?

Yes - Go to step (1).

No - Replace rings. Check pistons and cylinders. Go to step (1) if problem continues.

Symptom: Exhaust color BLACK under load

(1) Correct type of fuel?

Yes - Go to step (2).

No - Drain and replace fuel. Go to step (2) if problem continues.

(2) Air filter elements not clogged?

Yes - Go to step (3).

No - Clean or replace air filter elements. Go to step (3) if problem continues.

(3) Exhaust pipe not clogged?

Yes - Go to step (4).

No - Clean exhaust pipe. Go to step (4) if problem continues.

(4) Even volume of fuel being injected?

Yes - Go to step (5).

No - Repair or replace fuel injector pump or fuel injectors. Go to step (5) if problem continues.

(5) Correct volume of fuel being injected?

Yes - Go to step (6).

No - Replace faulty fuel injector pump or fuel injectors. Go to step (6) if problem continues.

(6) Proper spray pattern from injectors?

Yes - Go to step (7).

No - Clean or replace fuel injector nozzles. Go to step (7) if problem continues.

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

Yes - Go to step (8).

No - Adjust valve clearance. Go to step (8) if problem continues.

(8) Intake or exhaust valves not leaking compression?

Yes - Go to step (9).

No - Grind valves and seats. Go to step (9) if problem continues.

Symptom: Exhaust color BLACK under load

(9) Intake or exhaust valves not seized?

Yes - Go to step (10).

No - Replace valve and check valve guide. Go to step (10) if problem continues.

(10) Engine being run under high altitude or high temperature conditions?

Symptom: Exhaust temperature too high

(1) Cooling system filled to correct level?

Yes - Go to step (2).

No - Check for leaks and fill system to correct level. Go to step (2) if problem continues.

(2) Engine running cool enough?

Yes - Go to step (3).

No - Check thermostat, replace if faulty. Adjust fan belt tension. Go to step (3) if problem continues.

(3) Exhaust pipe not clogged?

Yes - Go to step (4).

No - Clean exhaust pipe. Go to step (4) if problem continues.

(4) Even volume of fuel being injected?

Yes - Go to step (5).

No - Repair or replace fuel injector pump or fuel injectors. Go to step (5) if problem continues.

(5) Correct volume of fuel being injected?

Yes - Go to step (6).

No - Replace faulty fuel injector pump or fuel injectors. Go to step (6) if problem continues.

(6) Intake or exhaust valve clearance correct?

Yes - Go to step (7).

No - Adjust valve clearance. Go to step (7) if problem continues.

(7) Intake or exhaust valves not leaking compression?

Yes - Go to step (8).

No - Grind valves and seats. Go to step (8) if problem continues.

(8) Piston rings not broken or seized?

Yes - Go to step (1).

Symptom: Exhaust temperature too high

No - Replace rings. Replace pistons if damaged. Bole cylinder if damaged. Go to step (1) if problem continues.

Symptom: Engine Runs Rough - Misfiring

(1) Intake or exhaust valve clearance correct?

Yes - Go to step (2).

No - Adjust valve clearance. Go to step (2) if problem continues.

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

Yes - Go to step (3).

No - Adjust valve clearance. Check valve timing. Go to step (3) if problem continues.

(3) Backlash of timing gear not excessive?

Yes - Go to step (4).

No - Repair gears as needed. Go to step (4) if problem continues.

(4) Combustion chambers clean of foreign matter?

Yes - Go to step (5).

No - Clean combustion chambers. Go to step (5) if problem continues.

(5) Intake or exhaust valves not leaking compression?

Yes - Go to step (6).

No - Grind valves and seats. Go to step (6) if problem continues.

(6) Intake or exhaust valves not seized?

Yes - Go to step (7).

No - Replace valves and check valve guide. Go to step (7) if problem continues.

(7) Piston rings not broken or seized?

Yes - Go to step (8).

No - Replace rings, Check pistons and cylinders. Go to step (8) if problem continues.

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

Yes - Go to step (9).

No - Grind crankshaft and replace bearings. Go to step (9) if problem continues.

(9) Connecting rod bolts torqued properly?

Yes - Go to step (1).

Symptom: Engine Runs Rough - Misfiring

No - Replace damaged components. Torque to correct specification. Go to step (1) if problem continues.

Symptom: Engine Runs Rough - Uneven combustion sound

(1) Correct type of fuel being used?

Yes - Go to step (2).

No - Drain and replace fuel. Go to step (2) if problem continues.

(2) No water in fuel?

Yes - Go to step (3).

No - Drain and replace fuel. Go to step (3) if problem continues.

(3) Even volume of fuel being injected?

Yes - Go to step (4).

No - Repair or replace fuel injector pump and fuel injectors. Go to step (4) if problem continues.

(4) Proper spray pattern from injectors?

Yes - Go to step (5).

No - Clean or replace fuel injector nozzles. Go to step (5) if problem continues.

(5) Air filter elements not clogged?

Yes - Go to step (6).

No - Clean or replace air filter elements. Go to step (6) if problem continues.

(6) Exhaust pipe not clogged?

Yes - Go to step (1).

No - Clean exhaust pipe. Go to step (1) if problem continues.

Symptom: Engine Runs Rough - Engine surges DURING IDLING

(1) No water in fuel?

Yes - Go to step (2).

No - Drain and replace fuel. Go to step (2) if problem continues.

(2) Even volume of fuel injected?

Yes - Go to step (3).

No - Repair or replace fuel injector pump and fuel injectors. Go to step (3) if problem continues.

Symptom: Engine Runs Rough - Engine surges DURING IDLING

(3) Proper spray pattern from injectors?

Yes - Go to step (4).

No - Clean or replace fuel injector nozzles. Go to step (4) if problem continues.

(4) Piston rings not broken or seized?

Yes - Go to step (5).

No - Replace rings, Check pistons and cylinders. Go to step (5) if problem continues.

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

Yes - Go to step (1).

No - Grind crankshaft and replace bearings. Go to step (1) if problem continues.

Symptom: Engine Runs Rough - Engine surges UNDER LOAD

(1) No water in fuel?

Yes - Go to step (2).

No - Drain and replace fuel. Go to step (2) if problem continues.

(2) Even volume of fuel injected?

Yes - Go to step (3).

No - Repair or replace fuel injector pump and fuel injectors. Go to step (3) if problem continues.

(3) Proper spray pattern from injectors?

Yes - Go to step (4).

No - Clean or replace fuel injector nozzles. Go to step (4) if problem continues.

(4) Piston rings not broken or seized?

Yes - Go to step (5).

No - Replace rings, Check pistons and cylinders. Go to step (5) if problem continues.

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

Yes - Go to step (1).

No - Grind crankshaft and replace bearings. Go to step (1) if problem continues.

Symptom: Engine Runs Rough - Excessive Engine Vibration

(1) Even volume of fuel injected?

Yes - Go to step (2).

Symptom: Engine Runs Rough - Excessive Engine Vibration

No - Repair or replace fuel injector pump and fuel injectors. Go to step (2) if problem continues.

(2) Proper spray pattern from injectors?

Yes - Go to step (3).

No - Clean or replace fuel injector nozzles. Go to step (3) if problem continues.

(3) Piston rings not broken or seized?

Yes - Go to step (4).

No - Replace rings, Check pistons and cylinders. Go to step (4) if problem continues.

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

Yes - Go to step (5).

No - Grind crankshaft and replace bearings. Go to step (5) if problem continues.

(5) Connecting rod bolts torqued properly?

Yes - Go to step (1).

No - Replace damaged components. Torque to correct specification. Go to step (1) if problem continues.

Symptom: Engine Runs Rough - Poor return to low speed

(1) Go to steps procedures for “Engine Runs Rough”.

Fuel Consumption

Symptom: Excessive Fuel Consumption

(1) Engine not running too cool?

Yes - Go to step (2).

No - Check thermostat, replace if faulty. Go to step (2) if problem continues.

(2) Correct volume of fuel being injected?

Yes - Go to step (3).

No - Replace faulty fuel injector pump or fuel injectors. Go to step (3) if problem continues.

(3) Correct pattern from fuel injectors?

Yes - Go to step (4).

No - Clean or replace fuel injector nozzles. Go to step (4) if problem continues.

Symptom: Excessive Fuel Consumption

(4) Intake or exhaust valves not leaking compression?

Yes - Go to step (1).

No - Grind valves and seats. Go to step (1) if problem continues.

Lubrication

Symptom: Excessive oil consumption

(1) Engine oil of correct viscosity and type?

Yes - Go to step (2).

No - Replace engine oil with oil of prover viscosity and type. Replace oil filter. Go to step (2) if problem continues.

(2) No external or internal oil leak?

Yes - Go to step (3).

No - Repair as needed. Go to step (3) if problem continues.

(3) Intake or exhaust valve stems not worn?

Yes - Go to step (4).

No - Replace valve guides and valves. Go to step (4) if problem continues.

(4) Piston rings installed correctly?

Yes - Go to step (5).

No - Install piston rings correctly. Go to step (5) if problem continues.

(5) Piston ring ends staggered?

Yes - Go to step (6).

No - Stagger piston ring ends. Go to step (6) if problem continues.

(6) Piston, rings or cylinder not worn?

Yes - Go to step (7).

No - Replace pistons and rings, bore or hone cylinders. Go to step (7) if problem continues.

(7) Piston rings not broken or seized?

Yes - Go to step (8).

No - Replace rings. Check pistons and cylinders. Go to step (8) if problem continues.

(8) No foreign matter in combustion chamber?

Yes - Go to step (1).

Symptom: Excessive oil consumption

No - Clean head and top of piston. Check for damage. Go to step (1) if problem continues.

Symptom: Fuel oil in crankcase

(1) Correct volume of fuel being injected"

Yes - Go to step (2).

No - Replace faulty fuel injector pump or fuel injectors. Go to step (2) if problem continues.

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

Yes - Go to step (3).

No - Replace valve and check valve guide. Go to step (3) if problem continues.

(3) Piston rings not broken or seized?

Yes - Go to step (4).

No - Replace rings and check pistons and cylinders. Go to step (4) if problem continues.

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

Yes - Go to step (1).

No - Replace piston and or rings. Bore or hone cylinder. Go to step (1) if problem continues.

Symptom: Water in crankcase

(1) Cylinder head gasket not leaking?

Yes - Go to step (2).

No - Replace head gasket, Resurface head and block if necessary. Go to step (2) if problem continues.

(2) Water jacket not cracked?

Yes - Go to step (1).

No - Repair or replace water jacket. Go to step (1) if problem continues.

Symptom: Low oil pressure

(1) Oil at correct level?

Yes - Go to step (2).

No - Add oil. Go to step (2) if problem continues.

(2) Engine oil of correct viscosity and type?

Yes - Go to step (3).

No - Replace engine oil with oil of proper viscosity and type. Replace oil filter. Go to step (3) if problem continues.

(3) No external or internal oil leak?

Symptom: Low oil pressure

Yes - Go to step (4).

No - Repair as needed. Go to step (4) if problem continues.

(4) Oil filter not clogged.

Yes - Go to step (5).

No - Replace oil filter and oil. Go to step (5) if problem continues.

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

Yes - Go to step (6).

No - Clean, adjust or replace relief valve. Go to step (6) if problem continues.

(6) Crankshaft pin or bearing not worn?

Yes - Go to step (7).

No - Grind crankshaft and replace bearings. Go to step (7) if problem continues.

(7) Connecting rod bolts torqued properly?

Yes - Go to step (8).

No - Replace damaged components. Torque to correct specification. Go to step (8) if problem continues.

(8) Water jacket not cracked?

Yes - Go to step (1).

No - Repair or replace water jacket. Go to step (1) if problem continues.

Coolant

Symptom: Overheating

(1) Cooling system filled to correct level?

Yes - Go to next step.

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

(2) Cooling system operating correctly?

Yes - Go to next step.

No - Check thermostat, water pump belt tension, inspect tee fitting for roundness, test radiator core temperature switch.

(3) Correct volume of fuel being injected?

Yes - Go to step (4).

No - Replace faulty fuel injector pump or fuel injectors. Go to step (4) if problem continues.

Symptom: Overheating

(4) Cylinder head gasket not leaking?

Yes - Go to step (5).

No - Replace head gasket, Resurface head and block if necessary. Go to step (5) if problem continues.

(5) Piston rings not broken or seized?

Yes - Go to step (6).

No - Replace rings. Check pistons and cylinders. Go to step (6) if problem continues.

(6) Water jacket not cracked?

Yes - Go to step (7).

No - Repair or replace water jacket. Go to step (7) if problem continues.

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

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 step (2).

No - Replace engine oil of correct viscosity and type. Replace oil filter. Go to step (2) if problem continues.

(2) Oil filter not clogged?

Yes - Go to step (3).

No - Replace oil filter. Go to step (3) if problem continues.

(3) Correct volume of fuel being injected?

Yes - Go to step (4).

No - Replace faulty fuel injector pump or fuel injectors. Go to step (4) if problem continues.

(4) Intake or exhaust valves not leaking compression?

Yes - Go to step (5).

No - Grind valves and seats. Go to step (5) if problem continues.

(5) Intake or exhaust valve stems not worn?

Yes - Go to step (6).

Symptom: Low compression

No - Replace valve guides and valves. Go to step (6) if problem continues.

(6) No foreign matter in combustion chamber?

Yes - Go to step (7).

No - Clean head and top of piston. Check for damage. Go to step (7) if problem continues.

(7) Intake or exhaust valve not seized?

Yes - Go to step (8).

No - Replace valve and check valve guide. Go to step (8) if problem continues.

(8) Piston rings not broken or seized?

Yes - Go to step (9).

No - Replace rings. Check pistons and cylinders. Go to step (9) if problem continues.

(9) Piston, rings or cylinder not worn?

Yes - Go to step (10).

No - Replace pistons and rings, bore or hone cylinders. Go to step (10) if problem continues.

(10) Crankshaft pin or bearing not worn?

Yes - Go to step (11).

No - Grind crankshaft and replace bearings. Go to step (11) if problem continues.

(11) Piston rings installed correctly?

Yes - Go to step (12).

No - Install piston rings correctly. Go to step (12) if problem continues.

(12) Piston ring ends staggered?

Yes - Go to step (1).

No - Stagger piston ring ends. Go to step (1) if problem continues.

Symptom: Intake Manifold Pressure Low

(1) Air filter elements not clogged?

Yes - Go to step (2).

No - Clean or replace air filter elements. Go to step (2) if problem continues.

(2) Intake or exhaust valve clearance correct?

Yes - Go to step (3).

No - Adjust valve clearance. Go to step (3) if problem continues.

Symptom: Intake Manifold Pressure Low

(3) Intake or exhaust valve not seized?

Yes - Go to step (4).

No - Replace valve and check valve guide. Go to step (4) if problem continues.

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

Symptom: Intake Manifold Pressure High pressure

(1) Correct volume of fuel being injected?

No - Replace faulty fuel injector pump or fuel injectors.

Troubleshooting Test Points

Test Conditions:

- Machine parked on level surface.
- Park brake engaged.
- 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. Coolant not contaminated with oil, fuel or discolored brown. Radiator screen free of debris. Hoses not cracked or leaking, clamps and radiator cap tight. Water pump/alternator belt tight, not glazed or cracked. Fan blades not damaged or warped.	Add proper coolant mix. Drain and flush system. Check for source of contamination. Clean or replace. Pressure test radiator and cap. Replace and adjust belt tension. Replace 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. Fuel tank and filter shutoff valves both in on position. Fuel hoses not cracked or leaking. Fuel hose clamps tight. Fuel tank does not have vacuum.	Drain and clean fuel tank. Replace filters. Add fresh fuel. Move fuel tank and filter shutoff valves to on position. Replace hoses. Replace or tighten clamps. Replace fuel tank vent hose.
Air filter and air intake - Air Intake System Check	Air filter hose not cracked, clamps tight. Element not plugged. Air filter housing sealed, no dirt tracking inside filter element. Air filter restriction indicator not leaking	Replace and tighten clamps. Replace element or housing. Replace indicator
Fuel shutoff solenoid. (Key in run position.)	Fuel shutoff solenoid must pull in and stay in. Listen for clicking as key is cycled	Test fuel shutoff solenoid circuit. See Fuel Shutoff Solenoid Test in Electrical section.
Engine Coolant Temperature Light (Key in run position.)	Indicator light should come on up to 30 seconds depending on air temperature.	See Indicator Light Diagnosis in 6x4 Diesel Electrical section.

Test/Check Point	Normal	If Not Normal
Fuel filter/water separator.	Fuel level visible in filter bowl. Fuel bowl not full of water. Fuel present at injector pump inlet hose	Pump lever on side of fuel transfer pump to prime pump and fuel bowl. Drain water from bowl. Replace fuel filter. Recheck. Test fuel pump.
Throttle cable and pedal stop.	Cable not binding and pedal stop adjusted correctly.	Repair, replace or adjust cable.
Intake and exhaust valves	Valve clearance within specification (engine cold). Valves not sticking.	Adjust valves. See Tests and Adjustments in this section. 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 Tests and Adjustments in this section. Replace injectors.
Engine compression tested at fuel injector ports.	Cylinder compression within specification. Pressure difference between cylinders within specification.	Perform cylinder compression test. See Tests and Adjustments in this section.
Flywheel and starting motor	Minimum cranking rpm within specification.	See Starter Amp Draw Test in Electrical section.
Injection pump timing inspection (key on, 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 1000 ± 25 rpm.	See Slow Idle Adjustment in this section.
Injection pump fast idle speed (Engine running)	Engine runs at 3550 ± 25 rpm.	See Fast Idle Speed Adjustment in this section.
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 Tests and Adjustments in this section.
Thermostat	Opening temperature within specification.	Perform thermostat opening test. See Tests and Adjustments in this section.
Muffler	Not restricted.	Replace muffler.

Tests and Adjustments

Cylinder Compression Test

Reason:

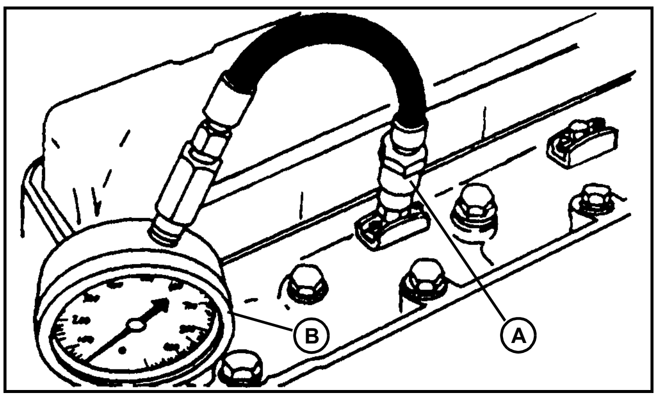
To determine the condition of the pistons, rings, cylinder walls and valves.

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.

Specifications:

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.

Compression Pressure . . . . 2448 kPa (355 psi)

Maximum difference between cylinders . . . . 490 kPa (71 psi)

Minimum cranking speed . . . . .250 rpm

Results:

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

Throttle Cable Adjustment

Reason:

To ensure that throttle pedal and cable adjustment is allowing throttle lever on governor to reach full high idle and slow idle positions, and that enough slack is in throttle cable to prevent unnecessary wear.

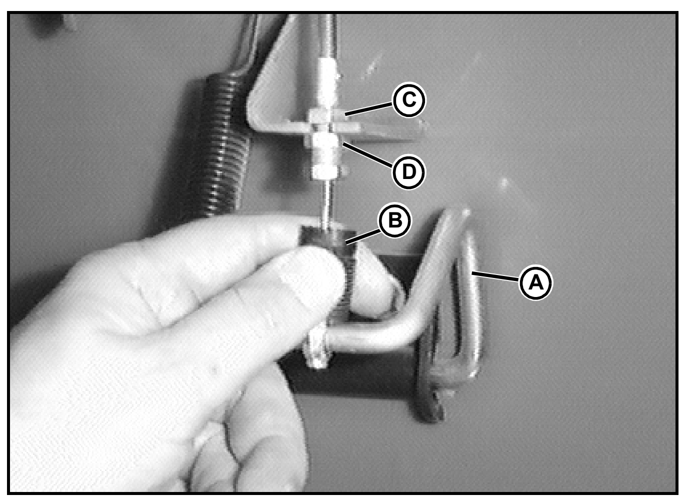
Equipment:

- Two 1/2” Open End Wrenches

Procedure:

1. Park machine safely with park brake locked.
2. Loosen jam nut on cable end at engine and turn adjuster until an equal amount of threads are showing on front and rear of cable ferrule. Tighten jam nut.

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



M56359

3. Check that throttle pedal rod is resting against front panel at (A).
4. Pull rubber boot (B) down.
5. Loosen jam nut (C).

6. Turn adjusting nut (D) until there is enough slack in cable so that when throttle pedal is depressed there is a 2 mm gap between pedal rod and front panel before throttle lever arm on governor begins to move.

7. Tighten jam nut (C). Reset rubber boot over adjusting nut.

8. With throttle pedal released, throttle lever arm on governor should be resting against slow idle stop screw. Make sure high idle is achieved with pedal fully depressed (injection pump lever against high idle stop).

Slow Idle Adjustment

Reason:

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

Equipment:

- JT05719 Hand Held Digital Tachometer or JT07270 Digital Pulse Tachometer.

Procedure:

1. Start engine and run for 5 minutes.

2. Visually check that injection pump throttle lever is against slow idle stop screw. If not against slow idle stop screw, adjust throttle cable. See "Throttle Cable Adjustment" on page 157.

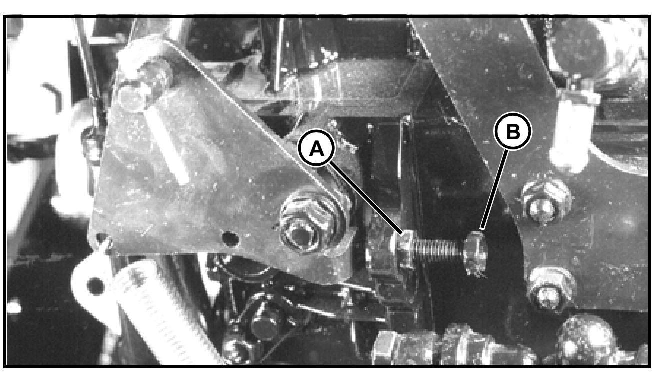
3. Use JT05719 Hand Held Digital Tachometer or JT07270 Digital Pulse Tachometer to check engine speed at flywheel.

Specifications:

Slow Idle Speed . . . . .1000 ± 25 rpm

Results:

NOTE: If surging occurs at low idle speed, correction possible by increasing low idle to 1075 ± 50 rpm. DO not exceed 1125 rpm. If surging still occurs on machines (S/N -008806; engine S/N -CH3007D056152) see DTAC Solution M012218 (old) or M34017 (new).



M76724

1. If slow idle rpm is not according to specifications, loosen nut (A) and turn slow idle stop screw (B).

2. After adjustment, tighten nut.

Fast Idle Speed Adjustment (Engines -013716)

CAUTION: Avoid injury! Do not attempt to adjust fast idle stop screw unless you are a factory trained technician with authorization to service CARB/EPA Certified engines.

Reason:

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

Equipment:

- JT05719 Digital Tachometer or JT07270 Digital Pulse Tachometer
- JDG991 Fast Idle Adjustment Tool
- Flat Blade Screwdriver
- Open End Wrench

Procedure:

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

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

2. Start engine and run for 5 minutes to obtain normal operating temperature.

3. Move throttle lever to fast idle position.

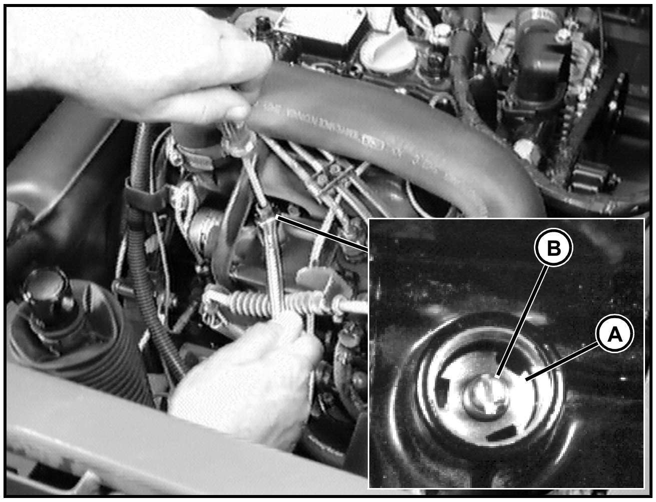
4. Use JT05719 Digital Tachometer or JT07270 Digital Pulse Tachometer to check engine speed at crankshaft pulley.

Specification:

Fast Idle Speed. . . . . .3350 ± 25 rpm

Results:

1. If fast idle speed does not meet specifications, remove the plug from the fast idle stop screw hole.



M76882, MX1441

2. Loosen special nut (A) using JDG991 Fast Idle Adjustment Tool.
3. Turn fast idle stop screw (B) with screwdriver until fast idle speed is 3350 ± 25 rpm.
4. While holding screw from turning, tighten special nut to 4 N•m (35 lb-in.).
5. Recheck fast idle speed.
6. If engine still does not meet fast idle speed specification, have injection pump inspected by an authorized diesel service (ADS) center.
7. Install a new plug into the fast idle stop screw hole.

Fast Idle Speed Adjustment (Engines 013717-)

CAUTION: Avoid injury! 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 or JT07270 Digital Pulse Tachometer

Procedure:

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

1. Place a small piece of reflective tape on crankshaft pulley.
2. Start engine and run for 5 minutes to obtain normal operating temperature.
3. Move throttle pedal to fast idle position.
4. Use JT05719 Digital Tachometer or JT07270 Digital Pulse Tachometer to check engine speed at crankshaft pulley.

Specifications:

Fast Idle Speed. . . . . 3550 ± 25 rpm

Results:

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

Valve Clearance, Check and Adjustment

Reason:

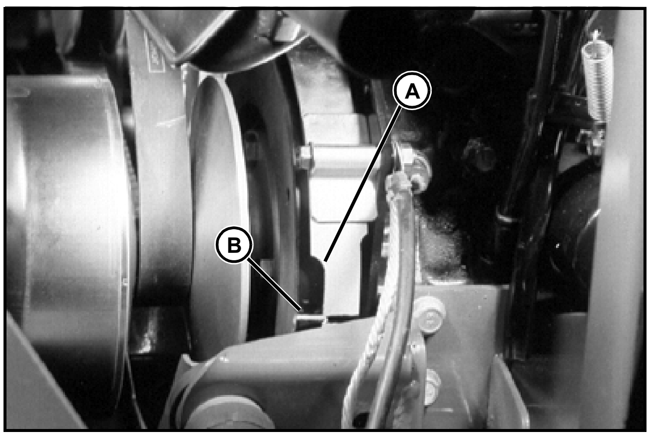
To be sure valves are fully opening at the correct time, but not remaining open too long or wearing valve train unnecessarily.

Equipment:

- Feeler Gauge
- Open End Wrench
- Flat Blade Screwdriver

Procedure:

1. Remove rocker arm cover.

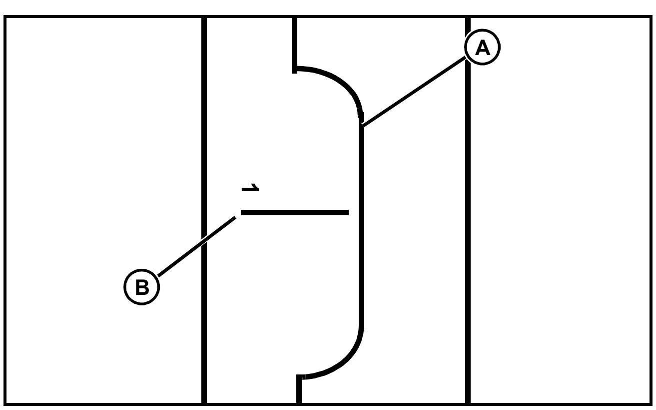


MX0552

2. Locate the notched out area (A) on the flywheel guard near left rear engine mount isolator bracket.

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.

There are two marks on flywheel for each cylinder, approximately 30 mm (1.2 in.) apart. The mark with the cylinder number stamped next to it is the mark for finding TDC for that cylinder.

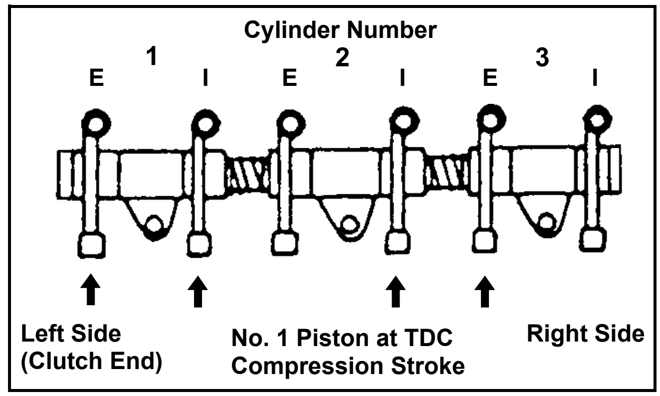


MIF

3. Rotate flywheel counterclockwise (turn top towards front of machine) until No. 1 cylinder TDC mark (B) on flywheel is visible in notch of flywheel guard.

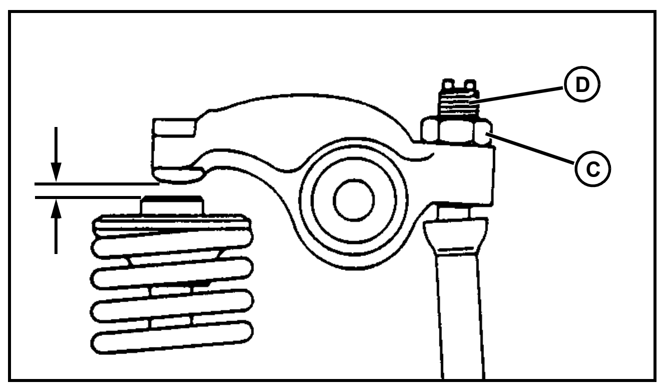
4. Try to move intake and exhaust rocker arms and/or push rods for No. 1 cylinder:

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



M82327A

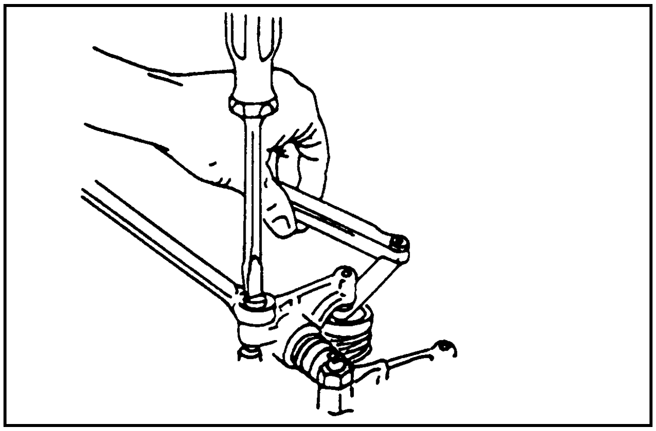
5. Measure and adjust valve clearance only on the four valves indicated above with black arrows while No. 1 piston is at TDC on compression stroke.



MX0553

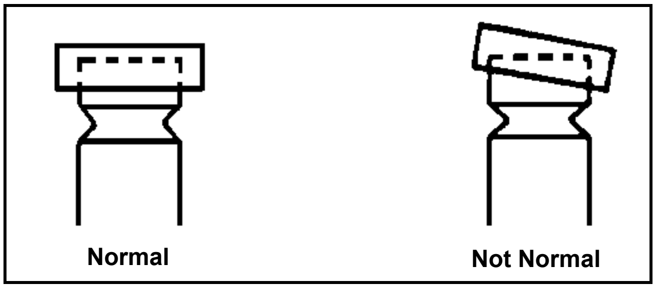
6. To adjust valves, loosen lock nut (C) and turn adjusting screw (D) until 0.20 mm (0.008 in.) feeler gauge can be inserted between rocker arm and valve cap.

7. Hold adjusting screw while tightening lock nut.



T6105BF

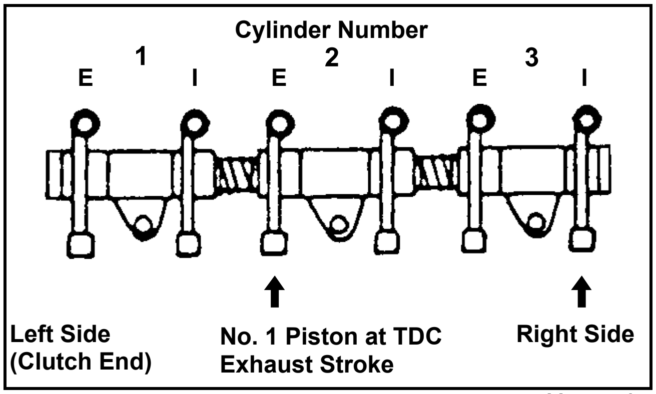
8. Recheck valve clearance after tightening lock nut.



MX0554

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

10.Turn crankshaft pulley one revolution (360°). This puts the piston in No. 1 cylinder at TDC on the exhaust stroke.



M82327A

11.Measure and adjust valve clearance on the last two valves (black arrows) with No. 1 piston at TDC of exhaust stroke.

Valve Lift Check

Reason:

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

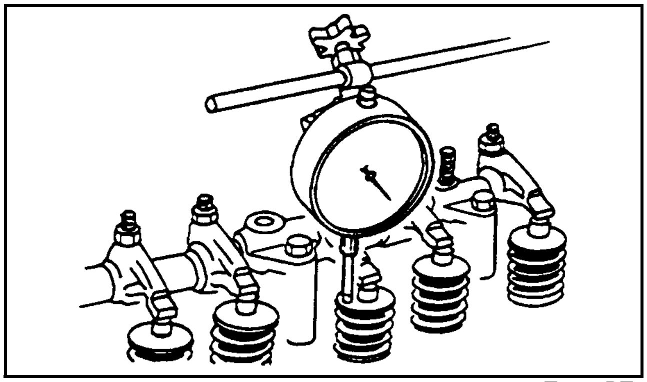
Equipment:

- Dial Indicator

Procedure:

1. Adjust valve clearance. See “Valve Clearance, Check and Adjustment” on page 160.

2. Remove rocker arm cover. See “Rocker Arm Cover Removal and Installation” on page 174.



T6333DT

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

4. Zero the dial indicator.

5. Rotate crankshaft towards front of machine while observing dial indicator as valve is moved to the full open (down) position.

6. Repeat for each valve.

Specification:

Valve lift (intake and exhaust) . . . . . . 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.

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:

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

M35913

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

Procedure 1:

Test fuel injection nozzle opening pressure following the Nozzle Tester manufacturer's instructions.

Specifications:

Fuel Injection Nozzle Opening Pressure
. 11722 ± 480 kPa (1700 ± 70 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.

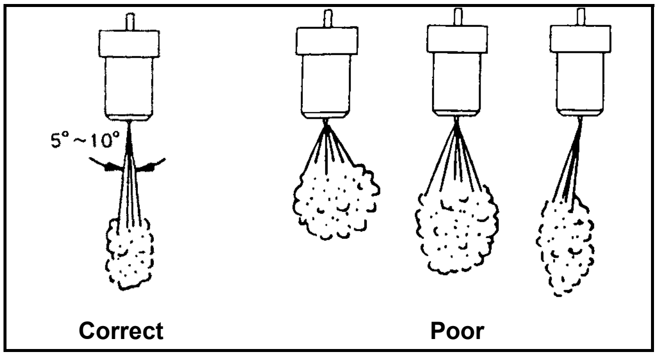
Results:

- 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. Pressurize nozzle to 11722 ± 480 kPa (1700 ± 70 psi).



M76981, M76985

2. 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 208. 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” on page 208. Replace nozzle assembly if necessary.

Fuel Injection Pump Timing Adjustment (Engines -013716)

Reason:

To make sure that injection pump timing is set so fuel is delivered to the injector nozzles at the correct time for combustion.

Equipment:

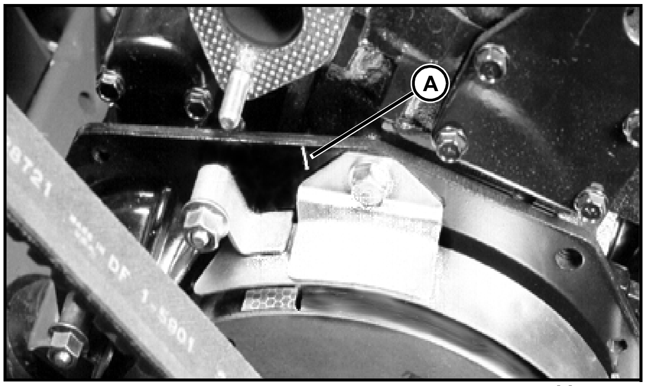
- End Wrenches
- Timing Tool (Made from high pressure pipe, nut and a clear plastic straw**)
** straw from carb cleaner, brake parts cleaner, etc.

Procedure:

CAUTION: Avoid injury! Do not attempt to adjust the fuel injection timing unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions engines.

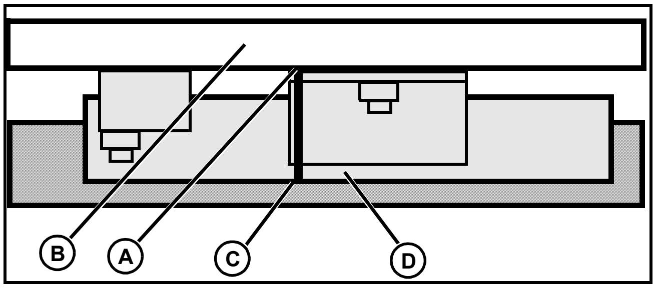
IMPORTANT: Avoid damage! Injection pump timing will remain correct unless a major engine failure occurs. Once timing is set, it will normally not change during the life of the engine, unless it was tampered with. Check and adjust timing only as the last option. Check fuel, fuel supply system, injectors, air intake system and cylinder compression before continuing.

1. Park machine safely with park brake locked.
2. Remove cargo box to allow access to fuel injection pump.
3. Remove muffler from exhaust manifold. See “Muffler Removal and Installation” on page 173.
4. Remove air cleaner assembly.



M76727

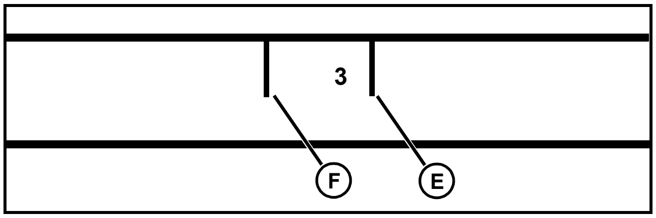
5. Locate the index mark (A) stamped into the engine back plate.



MIF

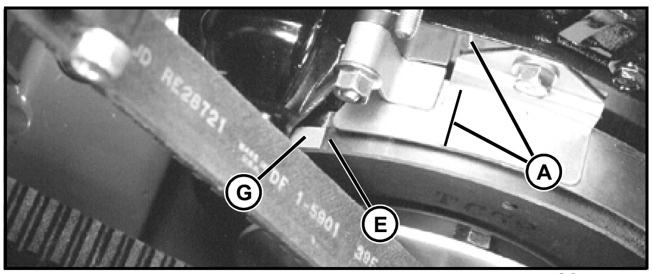
Picture Note: Top view of flywheel

6. Extend the index mark (A) from it’s location on the engine back plate (B) to the outside edge (C) of the flywheel guard (D) using a square or similar tool.



MIF

7. Rotate flywheel until the No. 3 timing mark is located. (The marks are only visible where flywheel guard is notched on rear of engine, and between starting motor and guard.) There are two marks side-by-side. One is stamped with the number 3 (E) and is top-dead-center (TDC) for cylinder No.3. The other mark (F) is 14° before top-dead-center (BTDC) and is the mark to be used to set the timing of the injection pump.



M76789

8. Use the No. 3 timing mark (E) to set timing of No. 1 cylinder.

9. Attach tape (G) to flywheel or extend 14° before top dead center (BTDC) timing mark so it can be seen with flywheel guard in place as it aligns with index mark (A).

Timing Fuel Injection Pump:

NOTE: The crankshaft turns counterclockwise (as viewed from the flywheel/clutch end). The number one cylinder is closest to the flywheel.

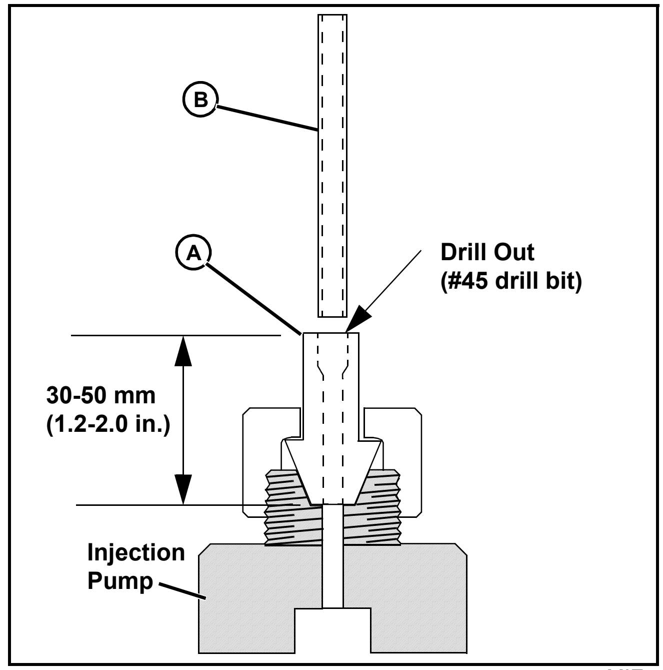
1. The timing procedure must be performed with the fuel shutoff solenoid pulled in and holding open so a steady supply of fuel may be available to the injection pump. The key switch must be left on during test to hold-in fuel solenoid.

2. To pull solenoid in, the key switch must be momentary turned to the start position and an audible click heard from governor housing. Do not start engine during test.

3. Turn crankshaft (by hand) until the No. 3 cylinder 14° BTDC timing mark is about 1 inch to the right of the index mark on the flywheel guard.

4. Remove the number one fuel injection line from the injector pump and injector.

5. Use manual pump lever located on fuel transfer pump to keep a continuous supply of fuel to injection pump while performing timing procedure.



MIF

6. Install the timing tool (A) and clear straw (B) on the number 1 delivery valve on the injector pump.

NOTE: If the fuel level does not change, the number one piston may be on TDC of the exhaust stroke instead of compression stroke. Turn flywheel one revolution and repeat test.

Check that fuel shutoff solenoid is pulled in and battery is up to full charge.

7. While fuel transfer pump lever is being pumped, slowly turn flywheel counterclockwise until timing mark on flywheel approaches index mark on flywheel guard. Watch fuel level in the straw in the timing tool. At exact moment when fuel level begins to rise in straw, stop turning flywheel and check where timing mark is. 14° timing mark should be lined up with index mark on flywheel guard.

8. Turn key switch off.

Specifications:

Injection Pump Timing. . . . . 14° BTDC

Engine Crankshaft Position . . . . No.1 Cylinder

Distance Outer Surface of Flywheel Travels Per 1° Of Rotation . . . . 2.62 mm (0.103 in.)

Timing Change per 0.1 mm Shim Thickness Approximately . . . . 2°

Results:

If Timing Is Not According To Specifications:

- Remove injection pump and shims.
- Increase shim pack thickness to retard injector timing, decrease thickness to advance timing.
- Install injection pump, and tighten nuts to 20 N•m (180 lb-in.).
- Recheck timing.

If Engine Performance Is Poor:

- Check air filters, fuel filter, fuel supply, injectors and cylinder compression before removing pump for service. Check all timing gears for wear. Retest performance.

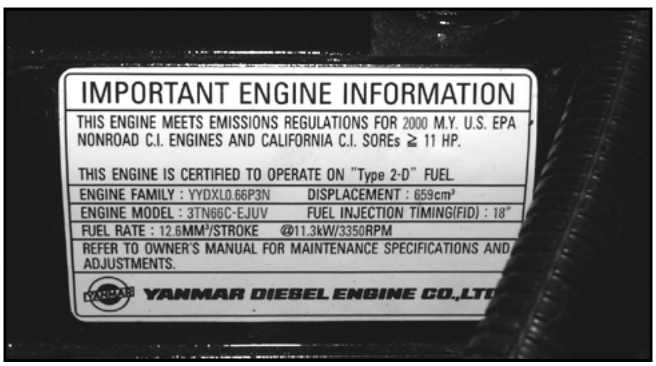
If Performance Did Not Change:

- Have pump tested by an Authorized Diesel Service (ADS) Center. When reinstalling injection pump, use same thickness of shim pack removed. If shim pack thickness is unknown or new pump is installed, replace with 0.8 mm (0.031 in.) shim pack thickness.

If Timing Is OK:

- Install number one injection line.
- Install muffler, air cleaner assembly, and cargo box.

Injection Pump Static Timing (Engines 013717-)



MX1339

EJUV engine emission compliance sticker located 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.

NOTE: Injection pump timing should be correct and should not have to be checked. Once timing is set, it will not normally change during the life of the engine. If engine performed well at one time, and then performance changed, timing is not the problem.

Check these items first as possible cause of engine problem:

- Fuel quality. Go to a higher cetane rated fuel.
- Check compression. A new engine with low compression and non-seated rings will not fire as cleanly as an older engine with seated rings. Engine must be broken-in.
- Check for dirty injector. Crack individual injector fuel lines and note performance change. Test suspect injectors.
- Verify glow plug circuit is working correctly.
- Check throttle cable adjustment. Reference proper procedure.
- Check for plugged fuel filter.
- Check fuel transfer pump pressure.

Water Pump/Alternator Drive Belt Adjustment

Reason:

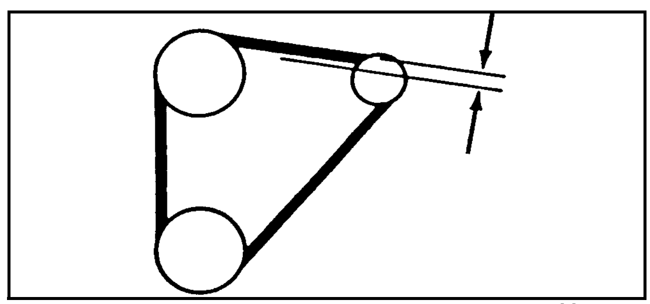
To keep proper tension on belt to drive water pump and alternator. To prevent shortened belt and bearing life.

Equipment:

- JDG529 or JDST28 Belt Tension Gauge
- Straight Edge

Procedure:

1. Remove belt cover.



M54014

2. Check belt tension between water pump and alternator using Belt Tension Gauge and a straight edge.

Specifications:

Applied Force . . . . 98 N (22 lb)

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 only to right side of alternator housing (near the belt) until tension is correct.
- Tighten alternator mounting hardware.
- Replace belt cover.

Thermostat Test

Reason:

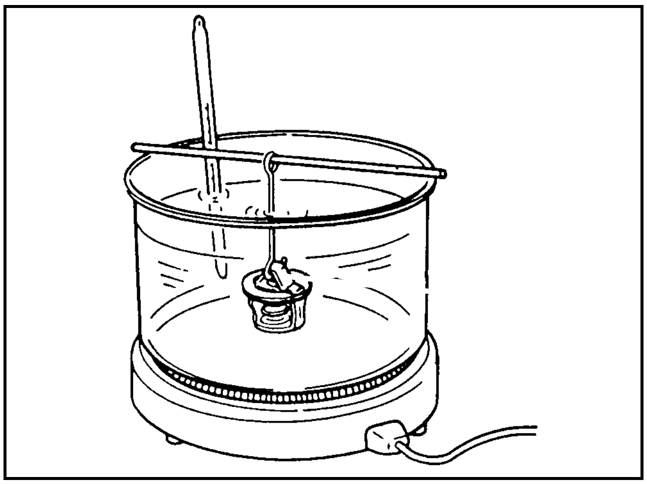
To determine opening temperature of thermostat.

Equipment:

- Thermometer
- Glass Container
- Heating Unit

Procedure:

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



M82122A

1. Suspend thermostat and a thermometer in a container of water.
2. Heat and stir the water. Observe opening action of thermometer and compare temperatures with specifications.
3. 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.
- Install thermostat in block with air bleed screw at 12 o'clock (top) position.

Radiator Bubble Test

Reason:

To determine if compression pressure is leaking from combustion cylinder into water jacket of cylinder block.

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.
4. If bubbles are present, isolate source of compression leak.
5. Remove injection nozzles.
6. Install JDG472 Adapter in injection port of cylinder to be tested.
7. Move piston to bottom of stroke with intake and exhaust valves closed.

> **IMPORTANT: Avoid damage! Do not exceed rated pressure of hoses and tools being used. Do not exceed 355 psi pressure cylinder pressure.**

8. Connect hose from compressed air source to adapter.
9. Check for bubbles in coolant recovery tank, or air escaping from muffler, air cleaner or oil fill opening.
10. 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.

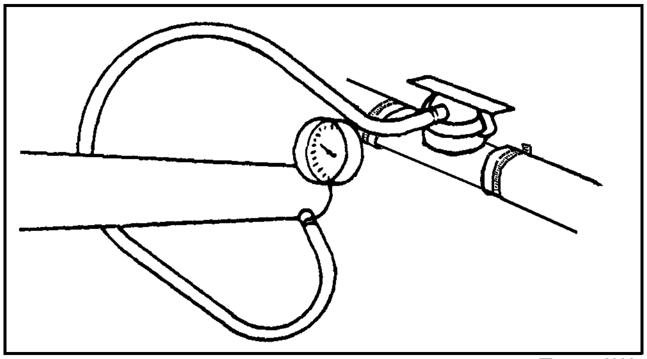
Equipment:

- 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.

1. Check cooling system is cool and squeeze top radiator hose to check system pressure has dropped.



T6333AW

2. Remove cap. Top off coolant if low. Attach cooling system pressure pump to hose.
3. Pressurize system with tester to 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:

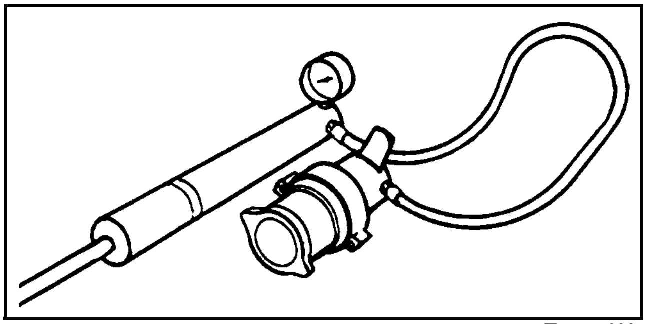
To test radiator cap spring and seal for correct opening pressure range.

Equipment:

- D05104ST Cooling System Pressure Pump
- JDG692 Radiator Pressure Test Kit (Adapters)

Procedure:

1. Install radiator cap on appropriate adapter.



T6333AX

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)

- If cap leaks, relieve pressure and re-tighten cap. Test again. Replace cap if pressure is not within specification.

Engine Oil Pressure Test

Reason:

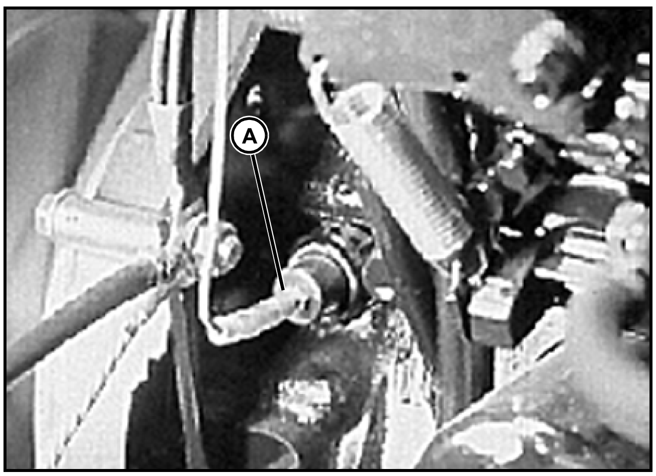
To determine if engine bearings or lubrication system components are worn.

Equipment:

- JT03017 Hose Assembly
- JT05577 Pressure Gauge (100 psi)
- JT03349 Connector

Procedure:

1. Park machine safely with park brake locked.
2. Remove wire to oil pressure switch.



M76710

3. Unscrew oil pressure switch (A) from block.
4. Install JT03349 Connector into block.
5. Connect Hose Assembly and Pressure Gauge.

IMPORTANT: Avoid damage! Stop running engine if no oil pressure present.

6. Start engine. If pressure reading is below 69 kPa (10 psi), stop engine.
7. Run engine approximately five minutes to heat oil, then check oil pressure at fast idle.

Specifications:

Fast Idle Speed . . . . .3550 ± 25 rpm

Engine Oil Pressure . . . . 343 ± 49 kPa (50 ± 7 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 “Oil Pressure Regulating Valve” on page 203.

Fuel Transfer Pump Pressure Test

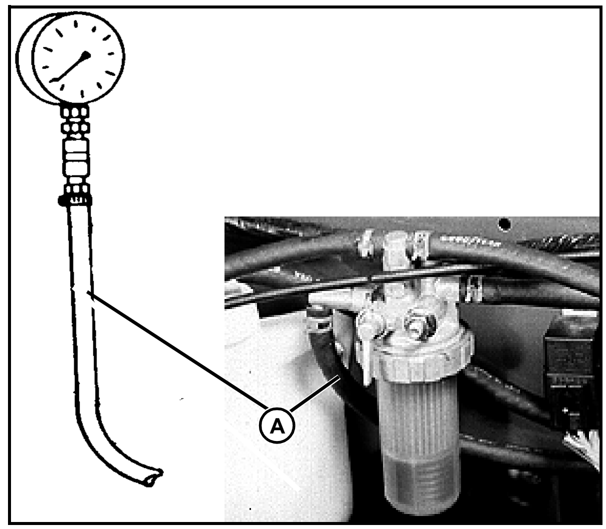
Reason:

To determine transfer pump operating pressure.

Equipment:

- JDG356 Fuel Pump Pressure Test Kit, includes:
  - JDZ27 Pressure Gauge (0-15 psi)
  - JT03247 Reducer
  - JT01609 Hose Coupler

Procedure:



M82145B, M76723

1. Disconnect transfer pump-to-filter hose (A).
2. Install hose coupler on gauge to transfer pump hose.
3. Use manual pump lever located on fuel transfer pump to pressurize test gauge.

Specifications:

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

Results:

- If pressure is below specification, replace fuel transfer pump.

Fuel Drain Back Test

Reason:

Determines if air is entering the fuel system at connections, allowing fuel to siphon back to tank.

Procedure:

1. Disconnect fuel supply line and return line at fuel tank.
2. Drain all fuel from the system, including fuel transfer pump, injection pump and filters.
3. Plug end of fuel return hose.
4. Pressurize fuel system at fuel supply line, to a maximum pressure of 103 kPa (15 psi).
5. Apply liquid soap and water solution to all joints and connections in the fuel system and inspect for leaks.

Results:

- Find leaks and repair or replace parts as necessary.

Fuel System Bleeding

The diesel engine incorporates a self bleeding fuel system. Manually bleeding the fuel system is usually not necessary after opening the fuel system. A primer lever is provided on the fuel transfer pump to fill the fuel bowl should the system be completely drained and will not self-prime.

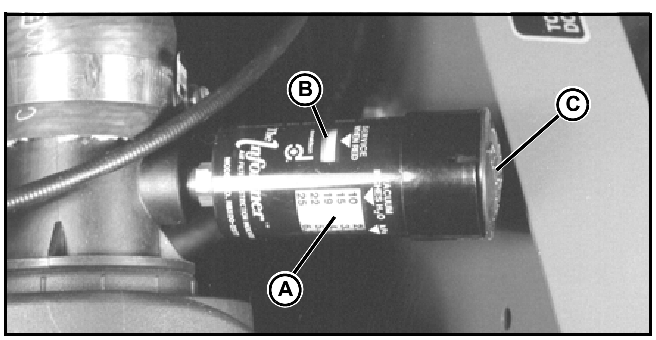
Air Filter/Air Restriction Indicator Tests

Reason:

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

Procedure (Normal Operation):

1. Park machine safely with park brake locked.
2. Run engine at fast idle.



M76782

3. Check air restriction indicator yellow marker (A).
4. Press reset button (C) and recheck.
5. Stop engine.

Specifications:

NOTE: Normal vacuum is between 2.5 - 6.25 kPa (10 - 25 in. H2O), and indicates a partially dirty air filter. Do not change air filter under this condition.

Normal Vacuum
(with clean filters). . . . . 2.5 kPa (10 in. H2O)

Results:

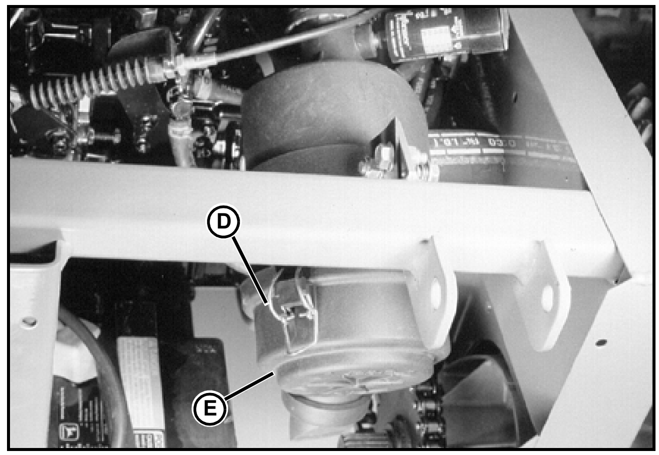
If vacuum is 6.25 kPa (25 in. H2O) or higher:

- replace primary filter
- reset air restrictor (C)

If vacuum is still greater than 2.5 kPa (10 in. H2O):

- replace secondary filter

Procedure (Simulated Excess Restriction)



M76783

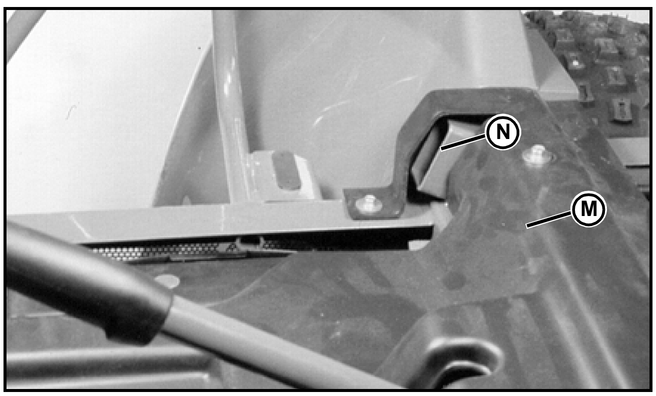
1. Unsnap spring clips (D) and remove filter cover (E) from filter housing.
2. Remove large primary filter and set aside.
3. Remove smaller secondary filter and keep nearby the air filter housing.
4. Lock park brake and start and run engine at slow idle.
5. Turn secondary filter so closed rubber end is inserted first into the air filter housing (opposite normal installation).
6. Watch air restriction indicator yellow marker (A) and (B). It should move into the red area - 4.75 kPa (19 in. H2O) vacuum.
7. Remove secondary filter and stop engine.
8. Push indicator reset button (C), indicator should drop to bottom of scale.

Results:

If yellow marker did not move or moved very little, check for:

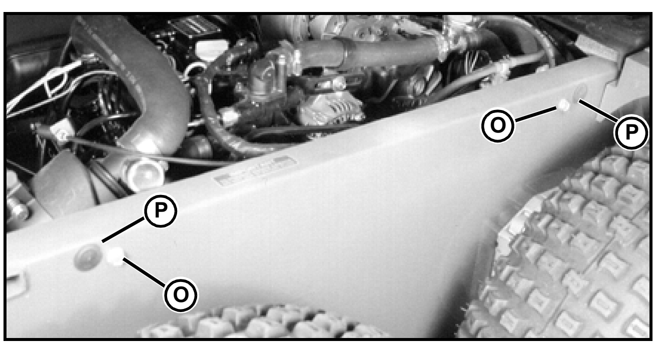
- loose or damaged hose clamps
- air leaks in air filter to intake manifold hose
- air leaks where air filter seals primary filter
- air leaks in intake manifold
- air leaks at indicator mounting threads
- cracked indicator housing or diaphragm.

NOTE: Use compressed air to remove dust and debris from inside channel. Always remove air cleaner-to-frame hose and cover air inlet to air cleaner before using compressed air to blow channel clear.



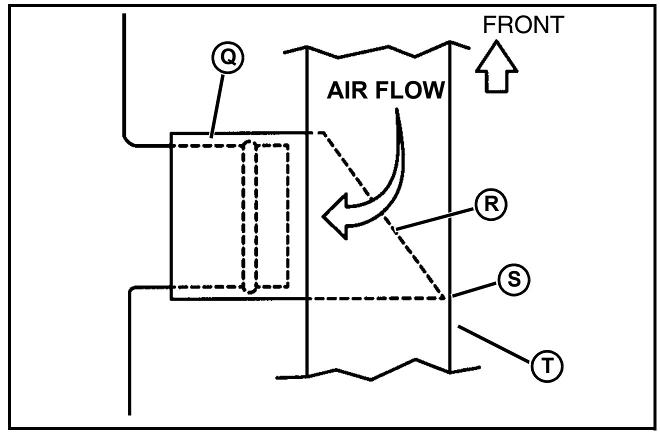
M76784

- While air filter assembly is disconnected, remove seats and plastic shroud (M) to check frame air intake channel (N) for debris or obstructions.



M76785

- Be sure shipping cap screws (O) and black plugs (P) are installed in frame.



M55741A

Picture Note: Top view

- Install frame hose (Q) so angled edge (R) faces to front of machine and tip (S) just touches inside edge of frame (T) without being bent.

Repair

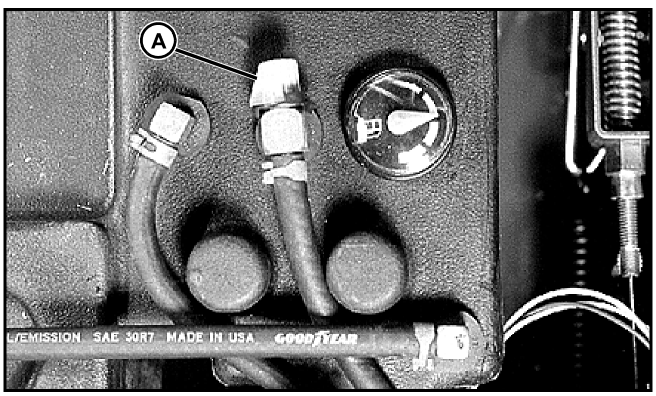
Engine Removal and Installation

Special or Required Tools

- JD1175-2-1 Center Distance Gauge

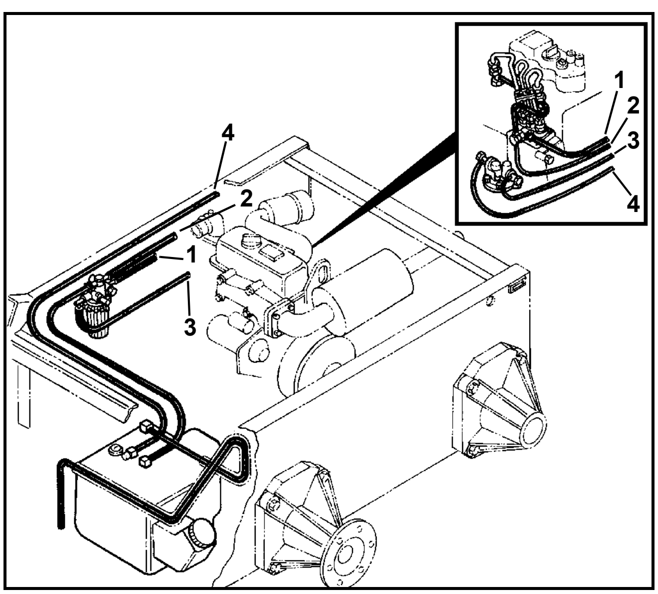
Removal:

1. Disconnect battery negative (-) cable.
2. Disconnect battery positive (+) cable.
3. Remove cargo box.
4. Remove air cleaner assembly.
5. Remove drive belt.
6. Drain cooling system, lower block, and hose.
7. Remove coolant hose clamps and remove radiator hoses.



M76722

8. Shut off fuel valve at tank (A) if so equipped.



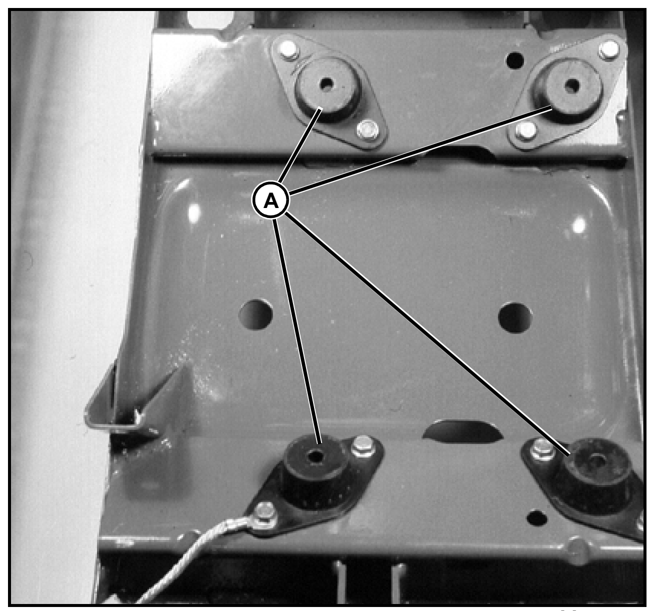
M76682

9. Mark and remove fuel lines.
10. Mark and remove wiring harness connections.
11. Remove grounding wire lead cap screw, remove battery negative cable and ground wire lead.
12. Remove throttle cable.
13. Remove mounting cap screws and lock nuts from motor mounts.
14. Remove engine with safe lifting device and lifting straps.
15. Remove drive clutch.

Installation:

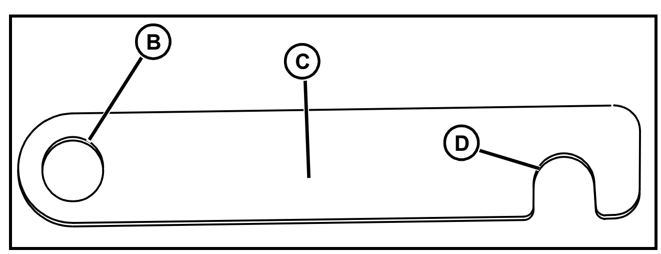
Installation is done in reverse order of removal.

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.



M76746

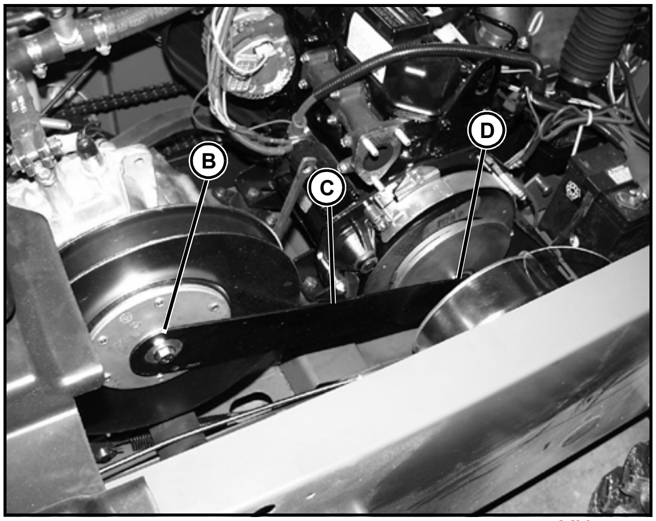
3. Lower engine fully onto isolators (A). Tighten four main mounting cap screws to 50 N•m (37 lb-ft).



MIF

4. Place the closed end (B) of clutch center distance gauge (C) (JD1175-2-1) over the end of the secondary clutch. Position the open end (D) over the center shaft of the primary clutch.

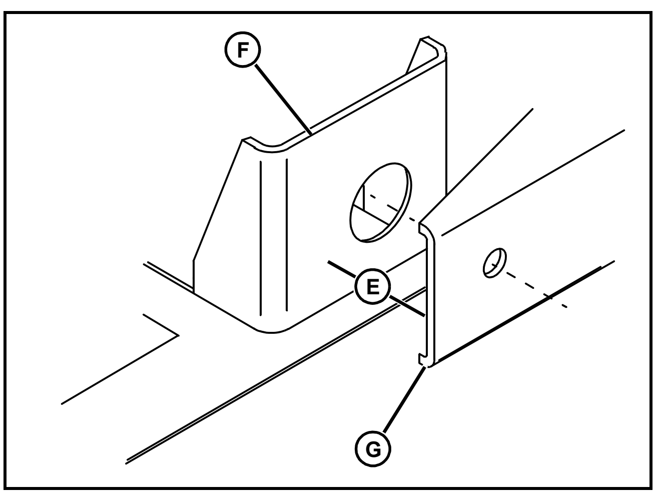
NOTE: The engine may need to be pushed toward the driven clutch to allow the gauge to drop onto the drive clutch shaft.



MX0768

5. Make sure closed end (B) is seated completely over bushing end at secondary clutch.

NOTE: The gap is defined as the distance between the frame and engine snubber brackets when the center distance tool (JD1175-2-1) is in place and properly positioning the engine relative to the driven clutch. Isolator parts are not installed during this measurement.



MIF

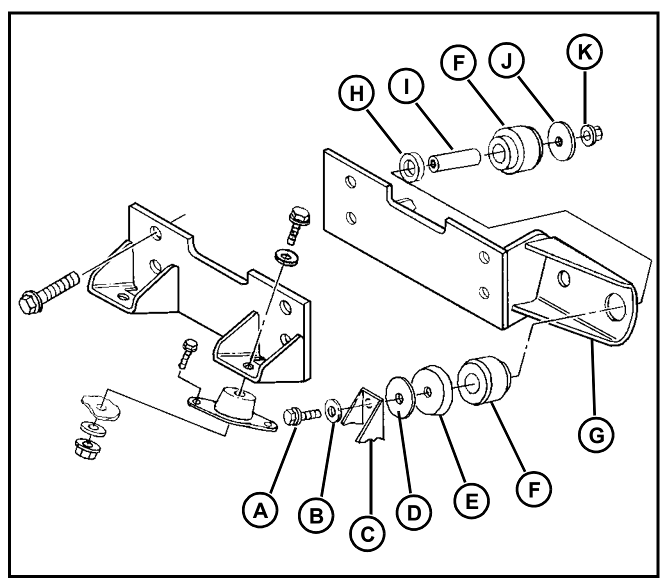
6. Measure the distance (E) between front surface of engine isolator bracket (F) and the rear surface of the frame bracket (G). Gap may be measured with an inside caliper.

7. Compare the measurement with the GAP column of the Shim Thickness Chart. This will determine the approximate thickness of shim(s) to be installed with the isolator mounting hardware.

Diesel Engine Shim Thickness			
Gap (mm)	**Total shim thickness required (mm)**	**# of 24H1313 Shims**	**# of 24H1291 Shims**
20	0	0	0
20.5	0.3	0	0
21	0.8	0	0
21.5	1.3	1	0
22	1.8	1	0
22.5	2.3	1	0
23	2.8	0	1
23.5	3.3	2	0
24	3.8	2	0
24.5	4.3	1	1
25	4.8	3	0
25.5	5.3	3	0
26	5.8	2	1

8. Shim washers used are 24H1291 and 24H1313. The 24H1291 washer is 2.8 mm thick and the 24H1313 washer is 1.5 mm thick.

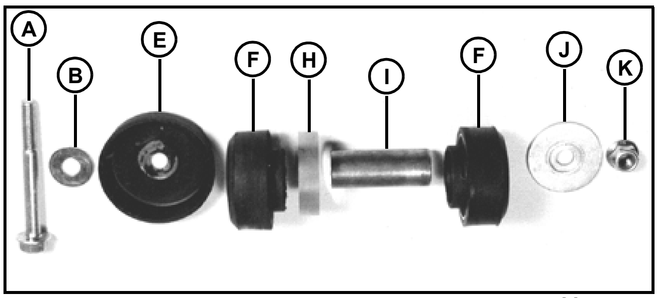
9. Remove center distance gauge.



M76770

A - Capscrew
B - Washer
C - Frame Mount
D - Shim Washer(s)
E - Metal Cup
F - Rubber Mount
G - Engine Mount
H - Bushing
I - Bushing
J - Washer
K - Nut

10.Install fifth isolator parts in order shown.



M76748

11.Assemble bushings (H and I) and rubber mounts (F) onto engine mount (G).

12.The shim(s) (D), metal cup (E) and one rubber mounting (F) are installed between the frame mounting bracket (C) and engine mounting bracket (G).

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.

13.Install correct number shim(s) (D) as determined using shim thickness chart.

14.Install fifth isolation mounting cap screw (A) and nut (K).

15.Tighten fifth isolation mounting cap screw (A) to 37 ± 7 N•m (27 ± 5 lb-ft).

16.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.

17.Connect all electrical wires.

IMPORTANT: Avoid damage! Proper filling of the cooling system is critical

18.Connect coolant hoses and fill cooling system. See “Filling Coolant System (S/N -033432)” on page 205.

19.If drained, fill engine with proper oil. Refer to Specifications section.

20.Install air cleaner assembly.

21.Install drive belt onto primary clutch. Install belt to secondary clutch by rotating belt and clutch slowly until belt slides onto clutch.

22.Prime fuel system by pumping lever on fuel transfer pump until fuel filter bowl is full.

23.Adjust throttle cable. See “Throttle Cable Adjustment” on page 157.

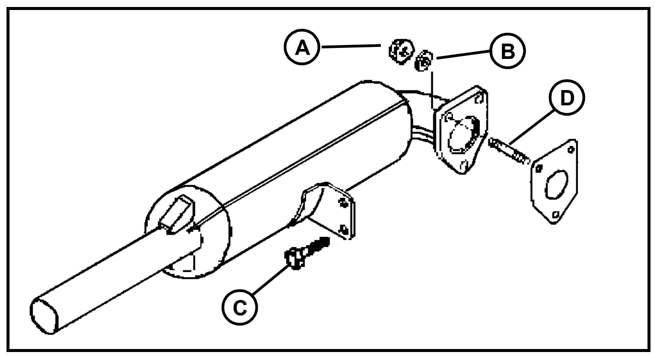
24.Connect battery positive (+) cable and then negative (-) cable.

25.Install cargo box.

Muffler Removal and Installation

Removal:

1. Allow muffler to cool, or wear protective gloves before working on muffler.



MX0555

2. Remove three nuts (A) and lock washers (B) holding muffler flange to exhaust manifold.

3. Remove cap screw (C) holding muffler to cylinder block and remove muffler.

4. Inspect studs (D) on exhaust manifold. Replace if worn.

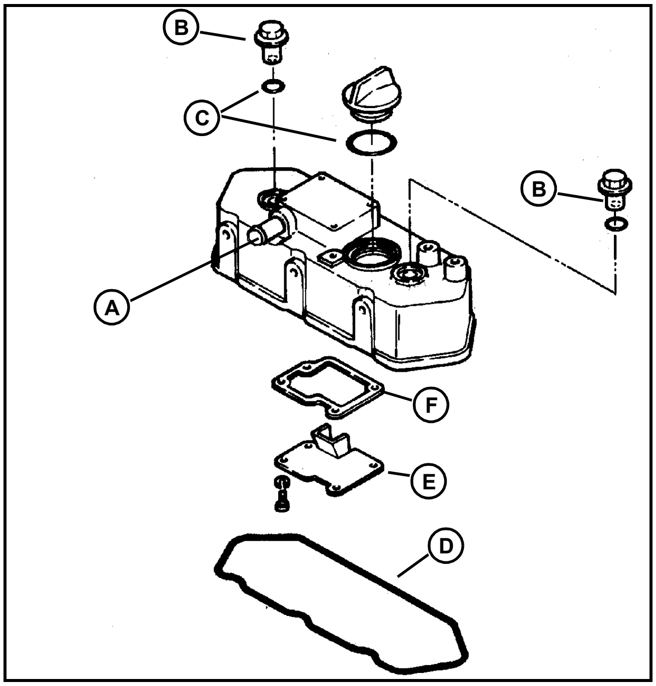
Installation:

Installation is done in the reverse order of removal.

- Clean sealing surfaces of muffler flange and exhaust manifold and replace gasket before installation.
- Tighten mounting nuts to 28 N•m (240 lb-in.).

Rocker Arm Cover Removal and Installation

Removal:



M82004A

1. Remove crankcase breather tube from breather fitting (A) on rocker cover.

2. Remove two special nuts (B) securing cover to cylinder head.

NOTE: If cover has not been removed recently, it may be necessary to lightly tap side of cover with soft faced hammer.

3. Remove rocker cover.

4. Inspect O-ring seals (C) for wear or damage. Replace if necessary.

5. Inspect O-ring type rocker cover seal (D) for damage. Replace if necessary.

6. Disassemble breather baffle (E) and clean all parts thoroughly. Replace gasket (F).

Installation:

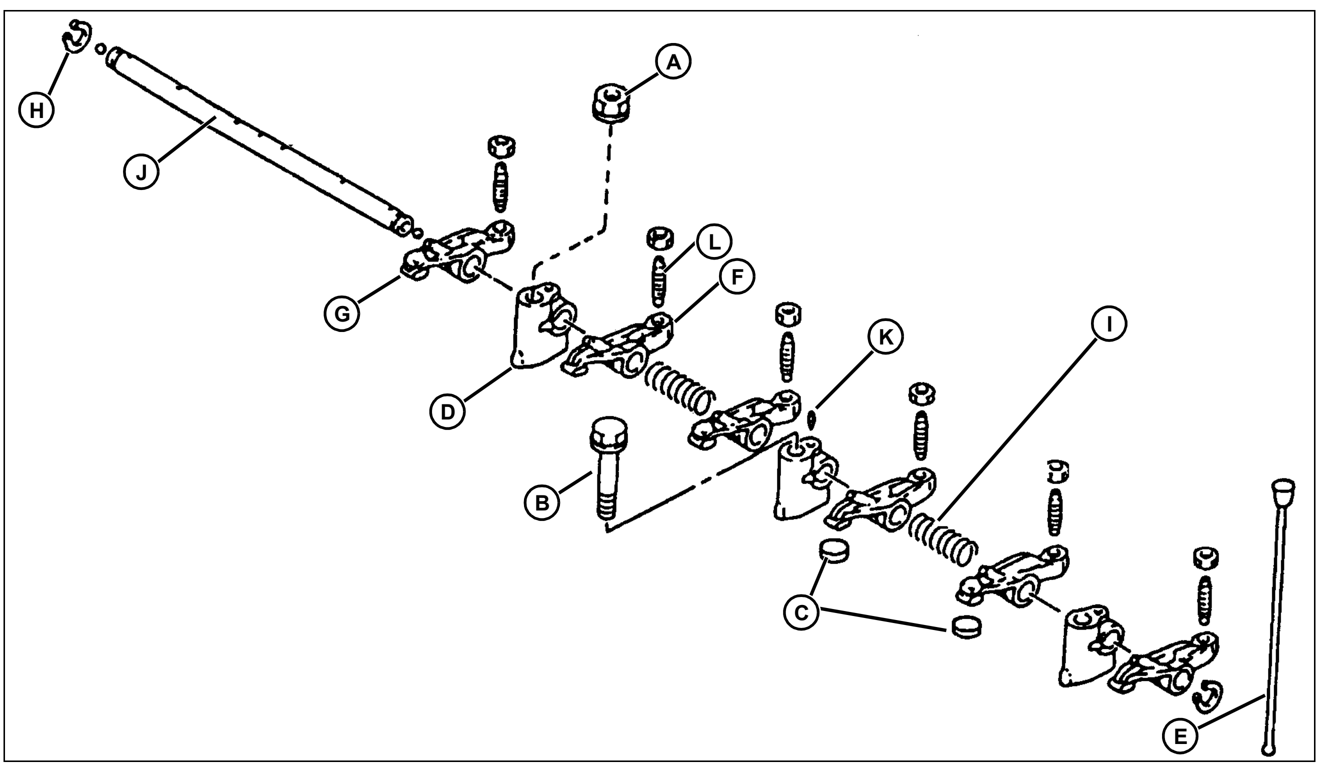
Installation is done in the reverse order of removal.

- Tighten nuts (B) to 18 N•m (160 lb-in.).

Rocker Arm

Removal:

1. Remove rocker arm cover. See “Rocker Arm Cover Removal and Installation” on page 174.



M82257A

2. Remove two M8 rocker arm mounting nuts (A) from end arm supports and one M8 cap screw (B) from center support.

3. Pull rocker arm assembly straight up off of mounting studs on cylinder head.

4. 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, Check and Adjustment" on page 160.

7. Install rocker arm cover. See "Rocker Arm Cover Removal and Installation" on page 174.

Inspection:

1. Remove rocker arm cover and rocker arm assembly.

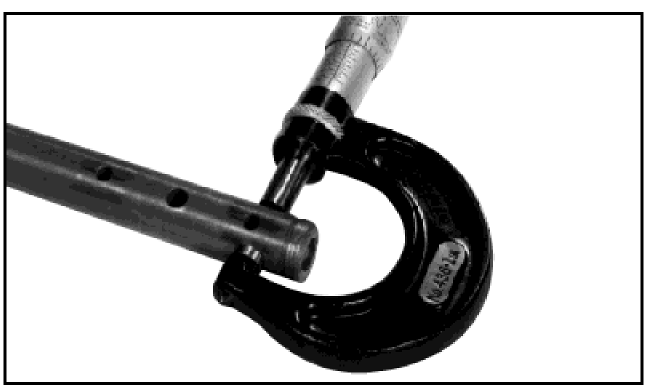
2. Mark all parts before tear-down to aid assembly. Intake (F), and exhaust (G), rocker arms are different.

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

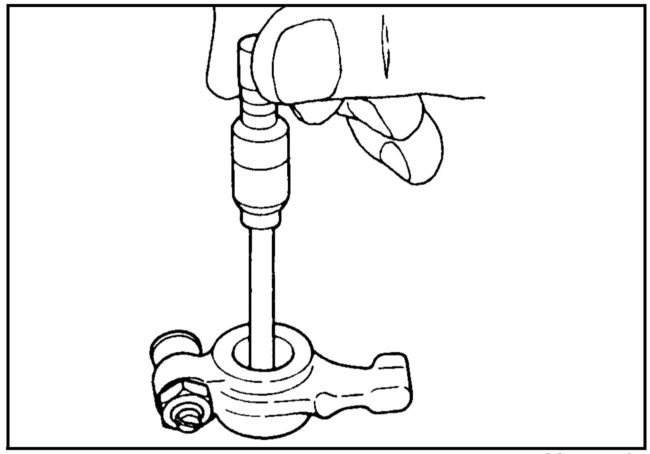
Replace rocker arm shaft if diameter is less than wear limit.

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:

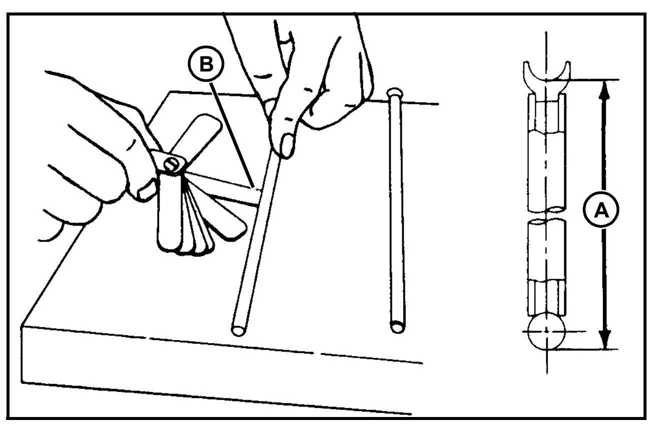
Standard . . . . 10.00 - 10.02 mm (0.394 - 0.395 in.)

Wear Limit. 10.09 mm (0.397 in.)

Clearance . . . . 0.14 mm (0.005 in.)

Measure Push Rod Length & 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.



M82023A

Replace push rod if not within specifications.

Push Rod:

Length (A) Standard . . . 114 - 115 mm (4.488 - 4.528 in.)

Bend (Maximum). . . . . 0.08 mm (0.003 in.)

Rocker Arm Assembly:

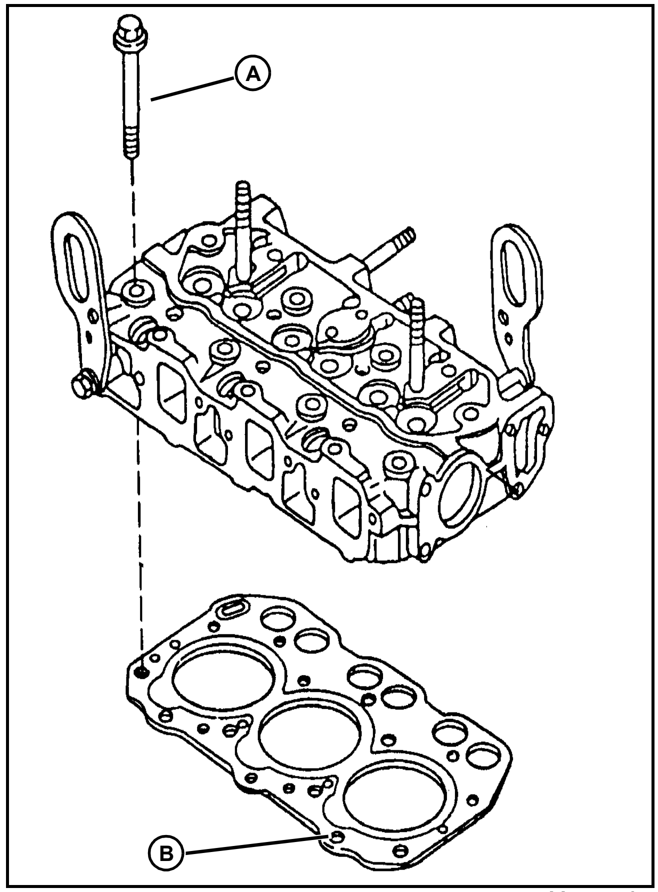
1. Clean all parts of varnish and oil.
2. Assemble rocker shaft into center support, aligning set screw hole in support with hole in rocker shaft.
3. Be sure rocker arms are installed in same order as removed.

Cylinder Head Removal and Installation

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 with park brake locked.
2. Disconnect negative battery cable from battery.
3. Remove cargo box from chassis.
4. Remove air cleaner.
5. Remove engine if needed (see note above). See “Engine Removal and Installation” on page 171.
6. Remove muffler, rocker arm cover, rocker arm assembly, push rods and valve caps.
7. Drain cooling system, cylinder block, and hoses.
8. Remove water pump.
9. Shut off fuel valve at tank and fuel filter.
10. Remove fuel injector lines from injection pump to nozzles.
11. Remove fuel injection nozzles from cylinder head.
12. Remove glow plug wires and glow plugs from cylinder head.
13. Remove electrical leads to coolant temperature switch, fuel shutoff solenoid, engine ground, oil pressure switch, battery positive cable, and any alternator leads across top of cylinder head.



M82259A

14. Loosen and remove cylinder head bolts (A).
15. Using lift brackets and hoist, pull head straight up from block.
16. Remove exhaust and intake manifolds. See “Intake Manifold Removal and Installation” on page 177.
17. Disassemble and inspect cylinder head and valves. See “Cylinder Head Recondition” on page 178.

Installation:

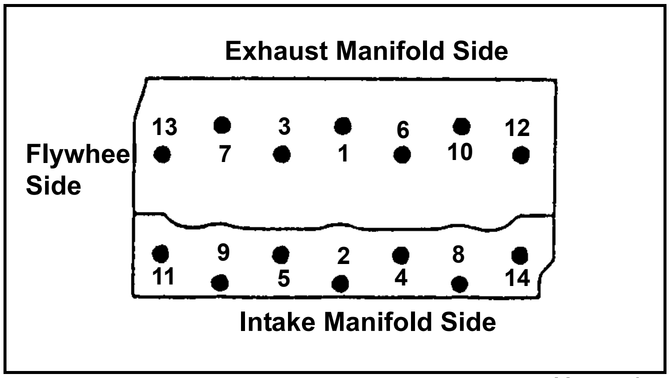
1. Clean top of cylinder block and check for flatness.

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

2. Place new cylinder head gasket on block with oil passage (B) lined up with oil port in block.
3. Set cylinder head on gasket.

NOTE: Dip cylinder head bolt 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:

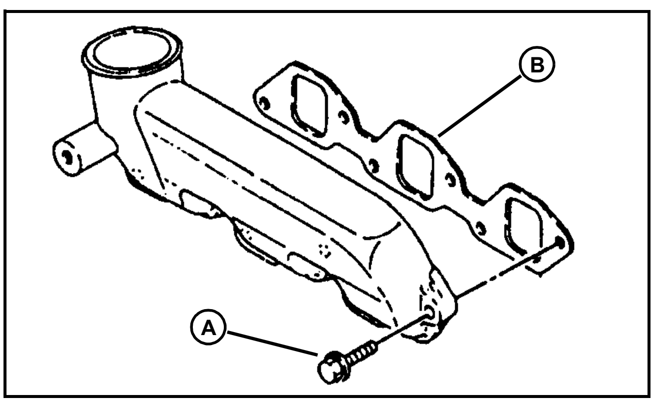
IMPORTANT: Avoid damage! Cylinder head mounting bolts must be checked for proper torque after 50 hours of engine operation.

First	**11 N•m (97 lb-in.)**
Second	**22 N•m (195 lb-in.)**
Final	**34 N•m (25 lb-ft)**

Intake Manifold Removal and Installation

Removal:

1. Remove cylinder head. See “Cylinder Head Removal and Installation” on page 176.



M82269A

2. Remove four intake manifold mounting cap screws (A).

3. Remove gasket (B) and clean mating surfaces. Check flange for flatness with straight edge.

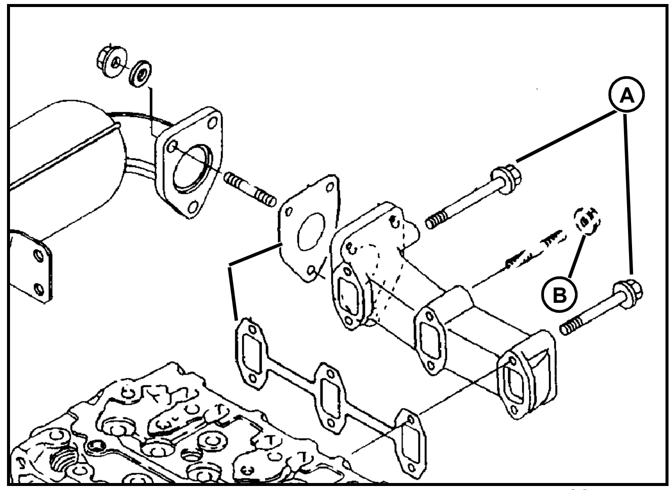
Installation:

- Install new gasket.
- Tighten mounting cap screws to 11 N•m (97 lb-in.).
- Tighten muffler mounting nuts to 28 N•m (240 lb-in.).

Exhaust Manifold Removal and Installation

Removal:

1. Remove muffler and gasket. See “Muffler Removal and Installation” on page 173.



M76798

2. Remove four cap screws (A) and two flange nuts (B) holding manifold to cylinder head.

Installation:

- Tighten all cap screws to 11 N•m (97 lb-in.).
- Tighten muffler mounting nuts to 28 N•m (240 lb-in.).

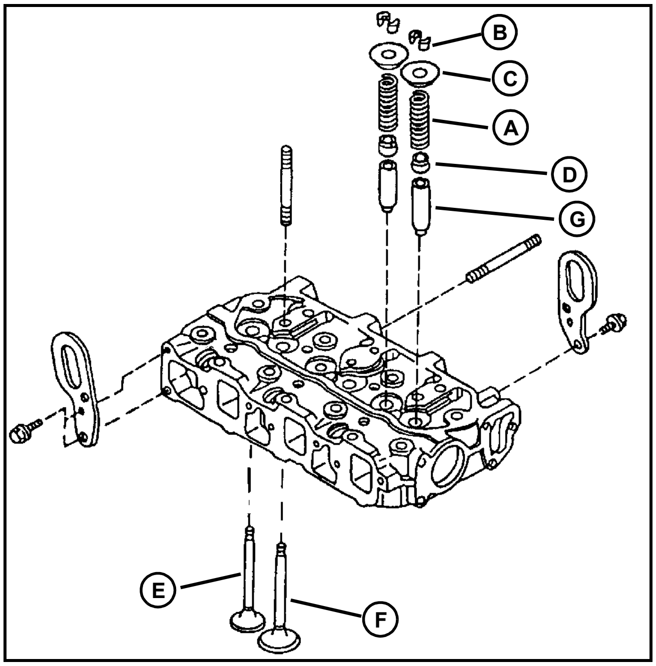
Cylinder Head Recondition

Equipment:

- JDE138 Valve Spring Compressor
- JDE504 Valve Guide Driver

Disassembly:

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



M82261A

1. Compress valve springs (A) using JDE138 valve spring compressor
2. Remove collet halves (B) from retainer (C).
3. Slowly release compressor and valve spring.
4. Remove valve spring (A), stem seal (D), and valve (E or F) from head.
5. Valve guides (G) do not need to be removed unless they are worn out.
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.

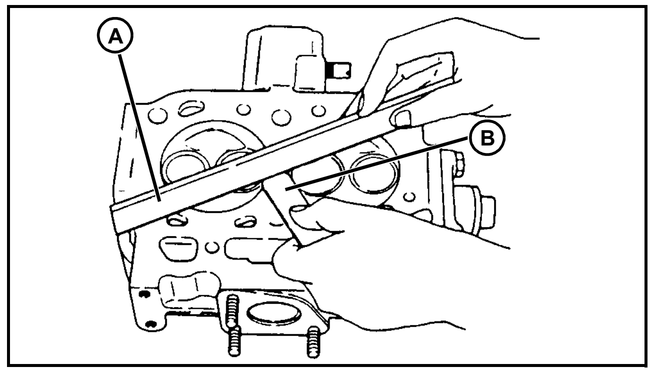
NOTE: If new valves are installed, measure valve recession.

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

1. Measure cylinder head flatness.
2. Place a straight-edge (A) along each of the four sides and each diagonal.
3. Measure clearance between straight edge and combustion surface with a feeler gauge (B).
4. If distortion exceeds the wear limit, resurface or replace cylinder head. Remove only enough metal to make cylinder head flat; but do not remove more than 0.20 mm (0.008 in.).

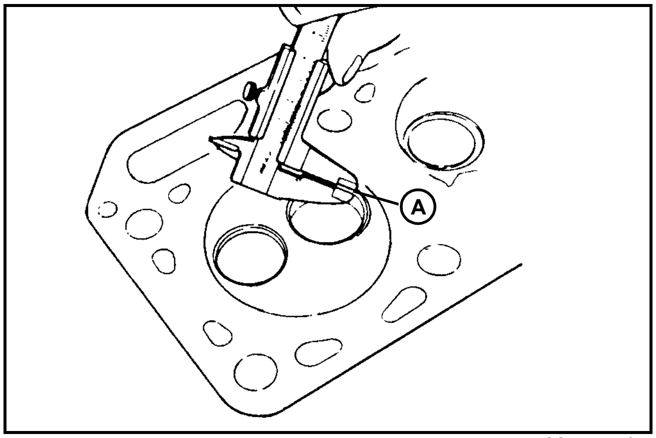
Cylinder Head Distortion:

Standard . . . . 0.05 mm (0.002 in.) or less

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

If Cylinder Head Was Resurfaced:

1. Measure piston-to-cylinder head clearance.
2. Measure valve recession.



M82029A

3. Measure valve seat width (A).

If necessary, grind valve seats to meet specifications.

Valve Seat Width Specifications:

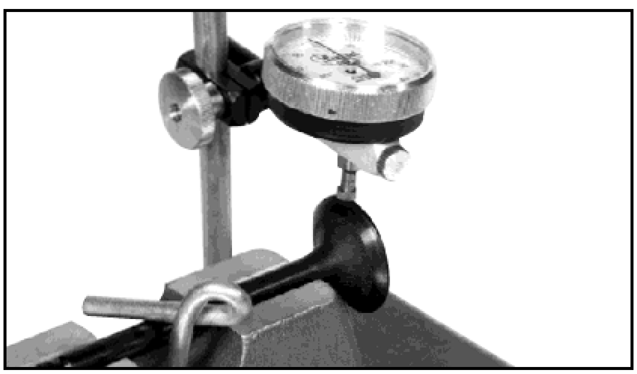
Intake Valve Standard. . . . . 1.15 mm (0.045 in.)

Wear Limit . . . . 1.65 mm (0.065 in.)

Exhaust Valve Standard . . . . 1.41 mm (0.056 in.)

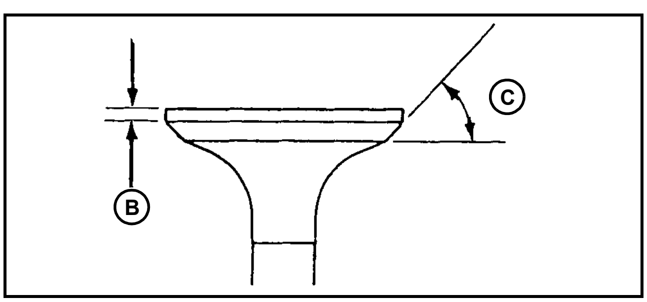
Wear Limit . . . . 1.91 mm (0.075 in.)

Intake and Exhaust Valves:



M35307

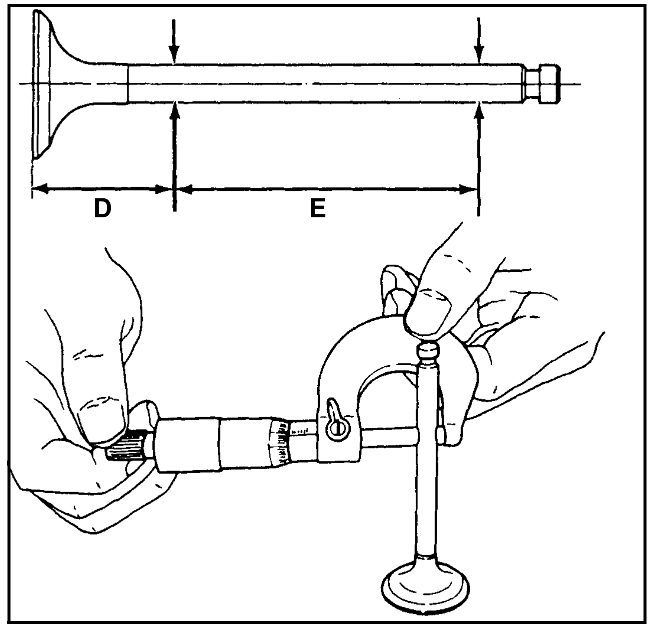
1. Check valve for out-of-round, bent or warped condition using a valve inspection center. Replace valve if necessary.



M82030A

2. 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.

3. Valve face angle (C) is 30° on intake valves, and 45° on exhaust valves.



M82031A

4. Measure valve stem diameter at two locations shown. Replace valve if measurement is less than wear limit.

Valve Stem Specifications:

Valve Stem OD Measurement Location Distance D. . . . . 20 mm (0.787 in.)

Valve Stem OD Measurement Location Distance E. . . . . 40 mm (1.575 in.)

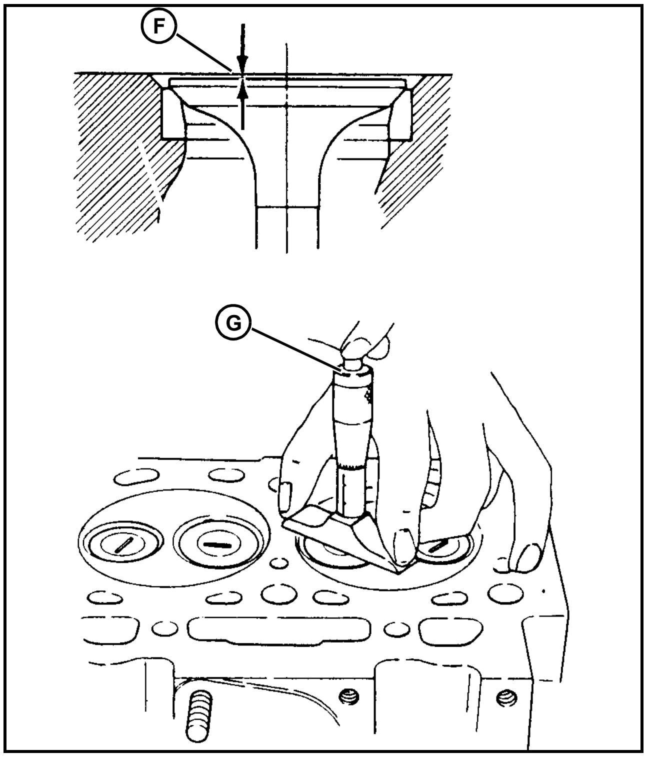
Intake Valve Stem OD Standard . . . . . . 5.46 - 5.48 mm (0.2149 - 0.2157 in.)

Intake Valve Stem OD Wear Limit . . . . 5.40 mm (0.2126 in.)

Exhaust Valve Stem OD Standard . . . . . . 5.44 - 5.46 mm (0.2142 - 0.2149 in.)

Exhaust Valve Stem OD Wear Limit. 5.40 mm (0.2126 in.)

Valve Recession:



M82032A

1. Measure valve recession (F) using a depth gauge (G). Replace valve or cylinder head if measurement exceeds specifications.

Valve Recession Specifications:

Intake Valve . . . . 0.40 mm (0.016 in.)

Exhaust Valve . . . . 0.85 mm (0.033 in.)

Valve Guides:

1. Clean valve guides using a valve guide brush.
2. Measure valve guide inside diameter.

Valve Guide ID:

Standard . . . . 5.50 - 5.52 mm (0.216 - 0.217 in.)

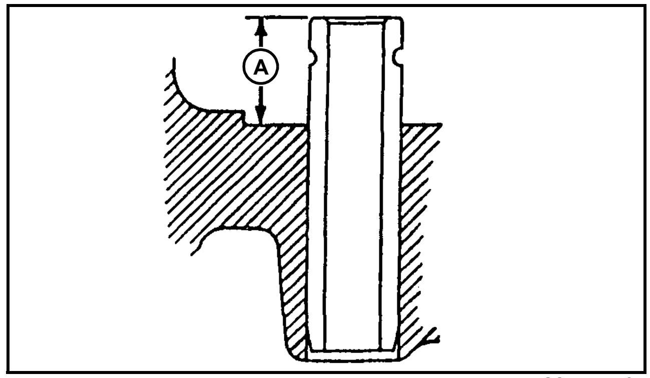
Wear Limit . . . . 5.58 mm (0.220 in.)

- 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 0.20 mm (0.008 in.), knurl valve guides using a 5.50 mm Valve Guide Knurler.
- If clearance exceeds 0.20 mm (0.008 in.), replace valve guide.

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.



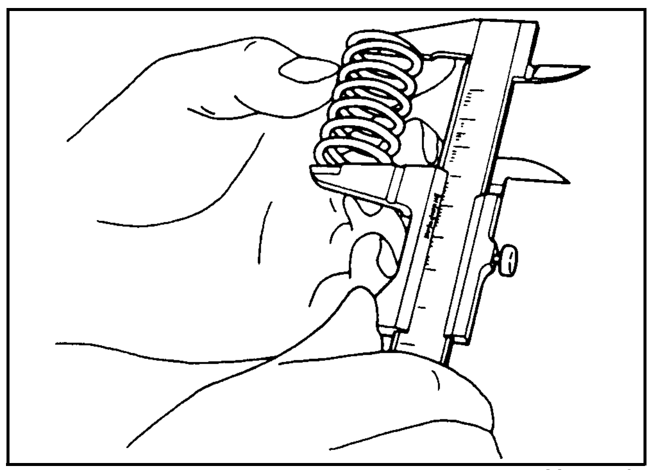
M82193A

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.

2. Ream inside diameter of valve guides using 5.50 mm Valve Guide Reamer

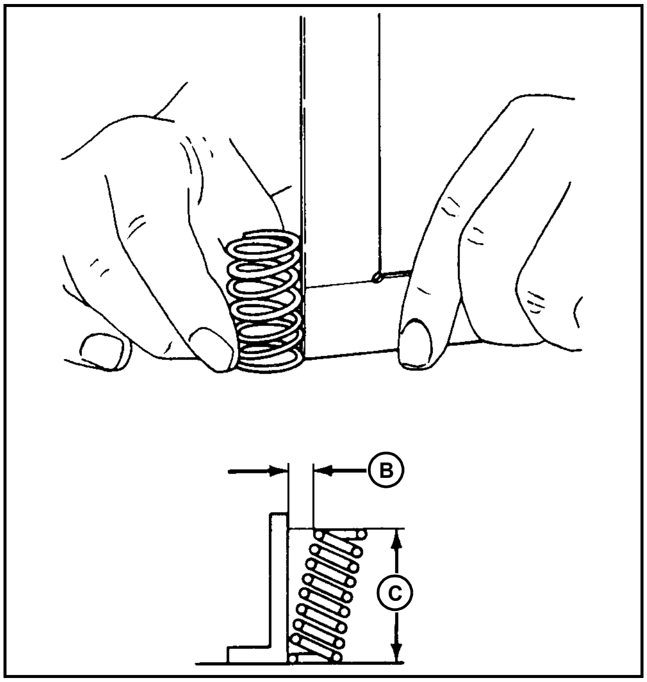
Valve Guide Height (A). . . . . 7 mm (0.276 in.)

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:

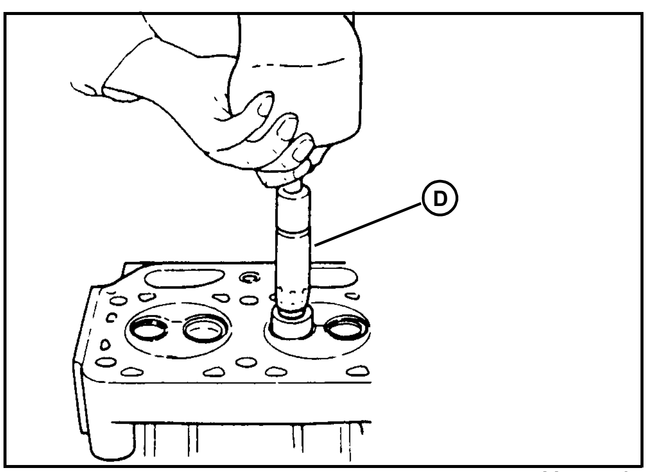
Spring Free Length (C). . . . . 28 mm (1.102 in.)

Maximum Inclination (B) . . . . 0.80 mm (0.032 in.)

Valve Seat Grinding:

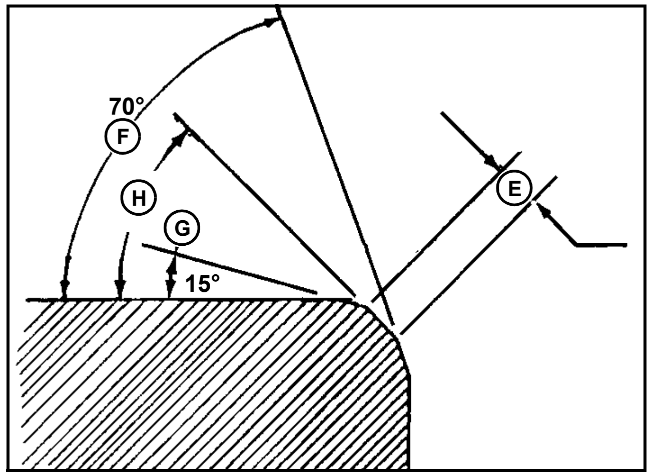
IMPORTANT: Avoid damage! Valve seats should never be cut. Cutting a valve seat can damage its sealing surface, which may result in leaks or valve/seat failure. Valve seats should be ground and lapped.

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



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.

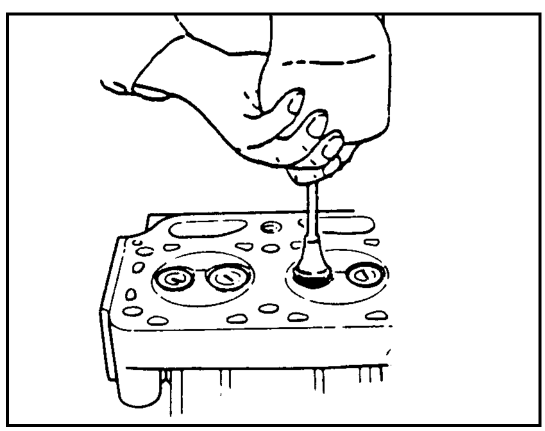
4. Grind upper seat surface (G) using a 15° seat grinder until seat width is narrowed to specifications.

5. If valve seats (H) are ground, measure valve recession and check contact pattern between the seat and valve with bluing dye.

NOTE: If valve recession exceeds maximum specifications or seats cannot be reconditioned, replace valves and/or cylinder head.

6. Lap valves.

Valve Lapping:

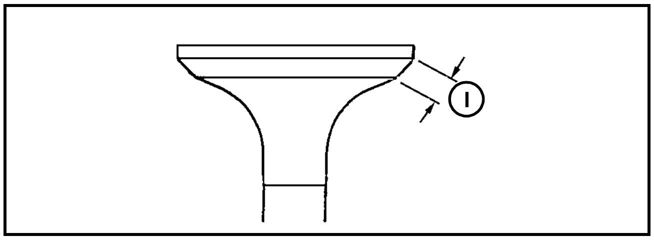


M82041A

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

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

2. Turn valve to lap valve to seat.



M82030B

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

Engine In Chassis:

NOTE: The crankshaft rear oil seal (on left side of machine) may be replaced with engine in chassis.

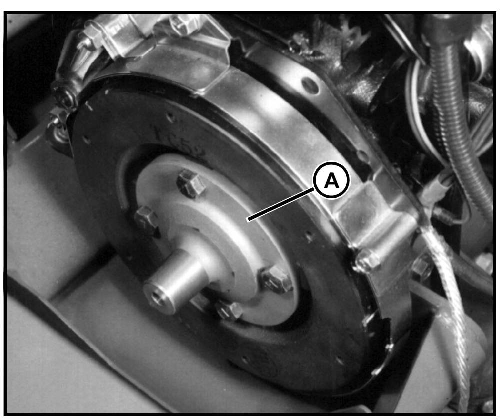
1. Remove muffler from exhaust manifold.

2. Remove drive belt from front transaxle pulley and engine clutch.

3. Remove left rear axle chain master link and pull chain from axle sprocket. Set chain out of way of engine clutch.

4. Remove plastic plug from left side of engine drive clutch.

5. Remove clutch retaining cap screw and remove clutch with JDG813-1 clutch removal tool.



M76891

6. Remove four cap screws holding clutch stub shaft (A) to flywheel. Remove stub shaft.

7. Remove five cap screws holding flywheel to crankshaft.

8. Remove flywheel from alignment pin on crankshaft.

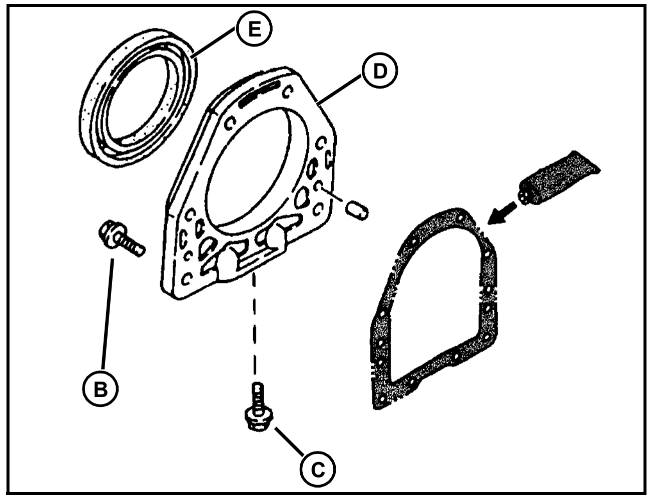
9. Carefully pry oil seal from oil seal case.

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.

10.Replace oil seal using a driver set. Install seal with lip toward cylinder block. Install seal flush with surface of oil seal case.

Rear Oil Seal Case:

NOTE: It is not necessary to remove oil seal case to remove oil seal.



M82279A

1. Remove six oil seal case-to-block cap screws (B), and two oil pan-to-seal case cap screws (C).

2. Pry oil seal case (D) from block and oil pan.

3. Clean all old gasket material from seal case and oil pan.

4. Install seal case with form-in-place gasket sealer on mating surfaces to block and to oil pan. Tighten cap screws to specification.

5. Install new oil seal (E) after oil seal case is installed.

6. Install flywheel and tighten five cap screws to specification.

7. Install clutch stub shaft to flywheel and tighten four cap screws to specification.

8. Install clutch on stub shaft and tighten clutch mounting bolt to specification.

9. Replace clutch dust cap and drive chain master link.

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)

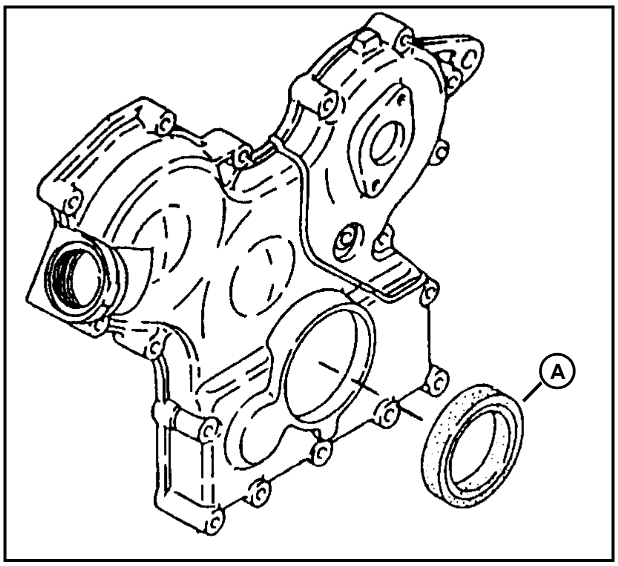
Clutch Mounting Bolts . . . . 55 N•m (40 lb-ft)

Crankshaft Front Oil Seal

Engine In Chassis:

NOTE: The crankshaft front oil seal (on right side) may be replaced with engine in chassis.

1. Remove alternator/water pump belt guard from front of engine.
2. Loosen alternator mounts and remove belt.
3. Remove right rear axle chain master link and remove chain from axle shaft sprocket. Set chain out of the way of crankshaft pulley.
4. Remove crankshaft pulley mounting bolt and washer.
5. Using a puller and two 7 x 40 mm cap screws installed into tapped holes on crankshaft pulley, remove crankshaft pulley from crankshaft.



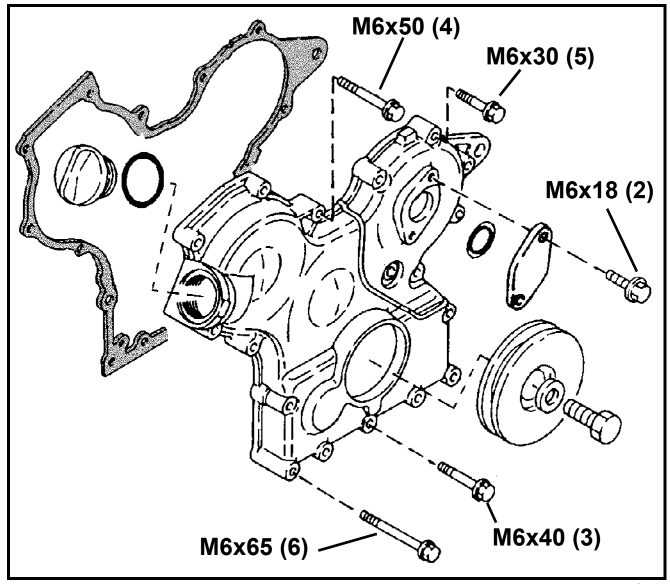
M82281A

6. Carefully pry oil seal (A) 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 pulley on crankshaft, lining up pin on crankshaft timing gear with hole in crankshaft pulley. Tighten cap screw to 115 N•m (85 lb-ft).
10. Install alternator/water pump belt, belt cover, and drive chain as removed.

Timing Gear Cover

Removal/Installation

1. Remove battery negative (-) cable.
2. Remove alternator/water pump belt cover.
3. Loosen alternator mounting screws and remove alternator/water pump belt.



M82295C

4. Remove crankshaft pulley mounting bolt and washer.

NOTE: It is not necessary to remove end cover or end cover o-ring to remove timing gear cover.

5. Using a puller and two 7 x 40 mm cap screws installed into tapped holes on crankshaft pulley, remove crankshaft pulley from crankshaft.
6. Remove mounting cap screws and timing gear cover.
7. Clean all old gasket material from timing cover and timing cover housing on block.
8. Apply John Deere Form-In-Place Gasket Sealer to timing cover prior to installation
9. Tighten all cover mounting cap screws to 9 N•m (78 lb-in.).
10. Install crankshaft pulley and tighten cap screw to 115 N•m (85 lb-ft).
11. Adjust alternator drive belt tension. See “Water Pump/ Alternator Drive Belt Adjustment” on page 165.

Camshaft End Play Check

Reason:

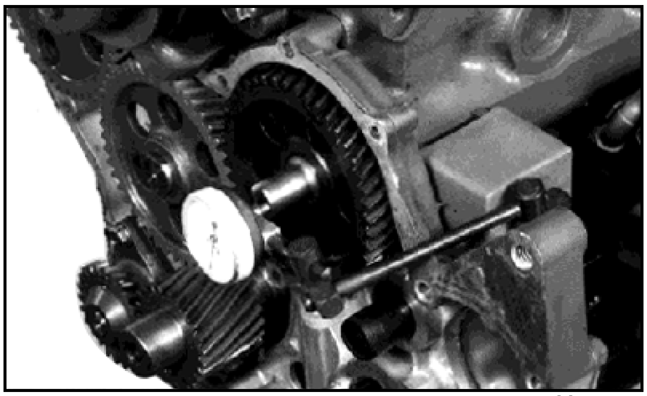
To determine proper side clearance between camshaft gear end journal and thrust plate.

Equipment:

- Dial Indicator

Procedure:

1. Remove timing gear cover. See "Timing Gear Cover" on page 183.



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.

Clearance Specifications:

Standard . . . . 0.05 - 0.20 mm (0.002 - 0.008 in.)

Wear Limit . . . . 0.40 mm (0.016 in.)

Results:

- If end play exceeds specification, remove camshaft and replace thrust plate. See "Camshaft" on page 186.

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. Place dial indicator magnetic base on cylinder block with tip of indicator on tooth of gear being measured.
2. 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:

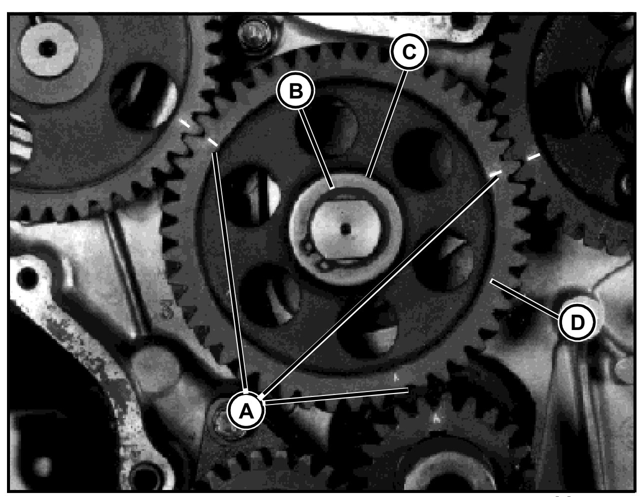
Idler Gear, Camshaft Gear, Crankshaft Gear, Oil Pump Gear and/or Idler Gear, Fuel Injection Pump Gear.

Idler Gear

Removal:

1. Remove timing gear cover. See "Timing Gear Cover" on page 183.
2. Check backlash of timing gears. See "Timing Gear Backlash Check" on page 184.

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.)

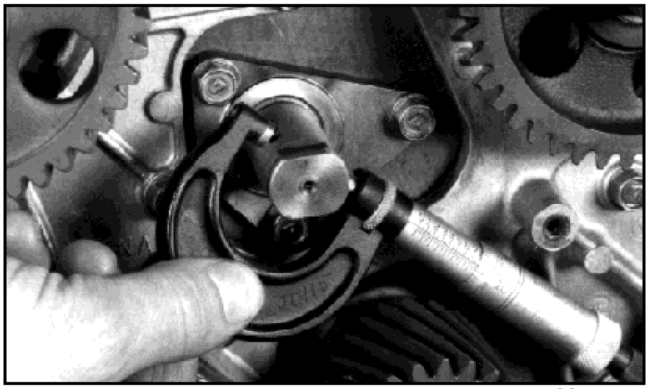


M37516

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 below.)

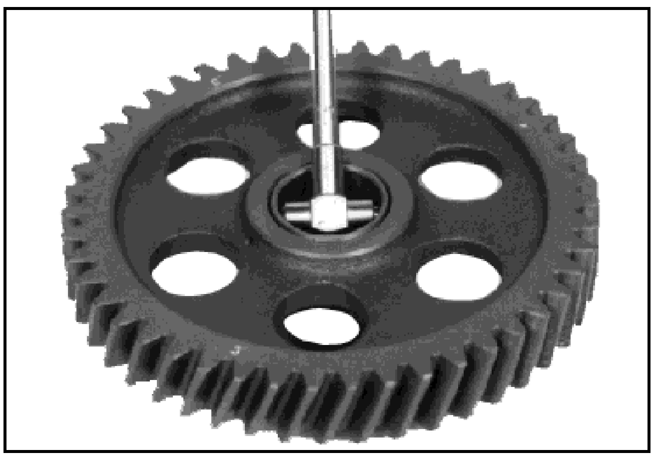
Inspection/Replacement:

1. Inspect gear for chipped or broken teeth. Replace if necessary.



M37834

2. Measure idler gear shaft diameter.
   - If shaft diameter is less than wear limit (see Specifications below), replace idler gear shaft.



M35492

3. Measure idler gear bushing diameter.
   - If bushing diameter exceeds wear limit (see Specifications below), replace bushing.

Specifications:

Idler Gear Shaft OD:

Standard . . . . 19.96 - 19.98 mm (0.786 - 0.787 in.)

Wear Limit . . . . 19.93 mm (0.785 in.)

Idler Gear Bushing ID:

Standard . . . . 20.00 - 20.021 mm (0.787 - 0.788 in.)

Wear Limit . . . . 20.08 mm (0.791 in.)

Clearance . . . . 0.15 mm (0.0059 in.)

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.

Cam Followers

Removal:

1. Remove cylinder head. See “Cylinder Head Removal and Installation” on page 176.

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.

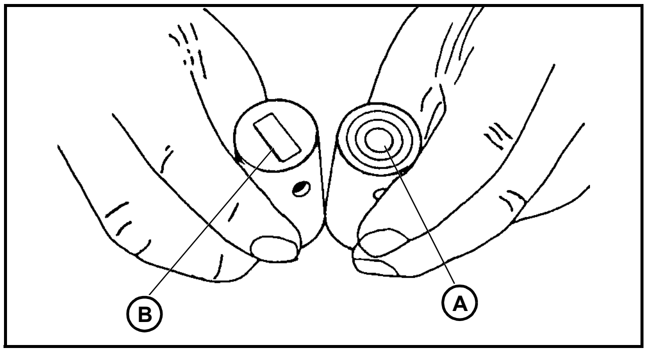
Installation:

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:

NOTE: Camshaft and lifters should be replaced as a set.



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.


M35268

2. Measure cam follower diameter.
   - If stem diameter is less than wear limit (see Specifications below), replace cam follower.
3. Measure cam follower bore diameter in cylinder block.
   - If cam follower bore diameter exceeds wear limit, replace cylinder block.
   - If bore clearance (bore ID minus follower stem OD) exceeds specification (see Specifications below), replace cam follower, cylinder block or both.

Specifications:

Cam Follower OD Specifications:

Standard . . . . 17.95 - 17.97 mm (0.707 - 0.708 in.)

Wear Limit . . . . 17.93 mm (0.706 in.)

Cam Follower Bore ID Specifications:

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.)

Camshaft

Removal:

1. Remove rocker arm assembly and push rods. See “Rocker Arm” on page 174.

2. Remove timing gear cover. See “Timing Gear Cover” on page 183.

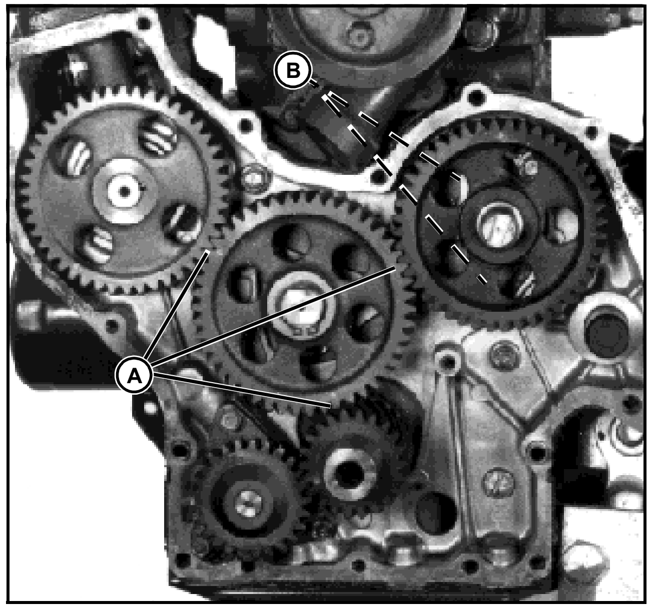
3. Check camshaft end play. See “Camshaft End Play Check” on page 184.

4. Check backlash of timing gears. See “Timing Gear Backlash Check” on page 184.

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.



M37832

6. Rotate crankshaft and align timing marks (A).

7. Remove two cap screws (B) holding camshaft mounting flange to block (through holes in camshaft gear).

IMPORTANT: Avoid damage! Do not allow camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces can be damaged.

8. Inspect all parts for wear or damage. (See Inspection/ Replacement procedure below.)

Installation:

1. 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.

2. Rotate crankshaft to align timing marks.

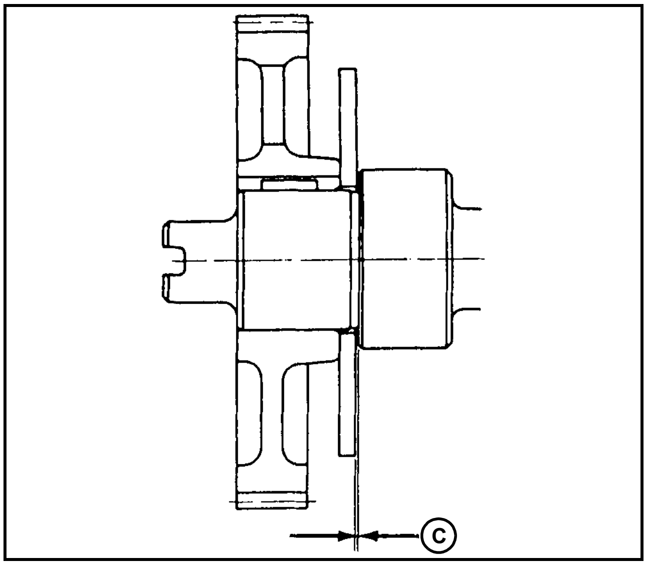
3. Install camshaft.

4. Install and tighten mounting cap screws to 11 N•m (96 lb-in.).

5. Install timing gear cover. See “Timing Gear Cover” on page 183.

6. Install push rods and rocker arm assembly. See “Rocker Arm” on page 174.

Inspection/Replacement:



M82067A

1. Check camshaft side gap (C) between thrust plate and camshaft using a feeler gauge.

Camshaft Side Gap:

Standard . . . . 0.05 - 0.15 mm (0.002 - 0.006 in.)

Wear Limit . . . . 0.40 mm (0.016 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.

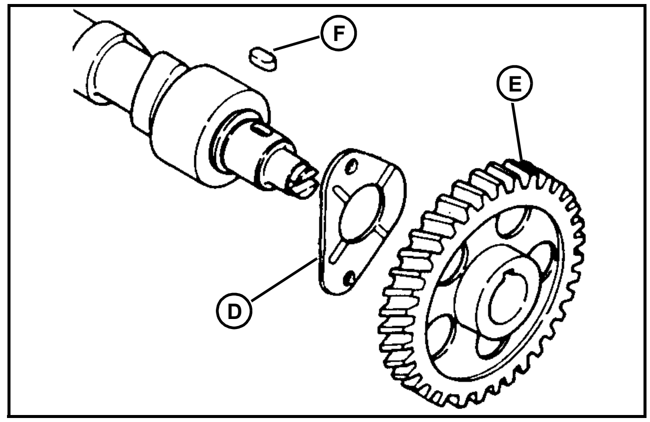
To Remove/Replace Gear:

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.

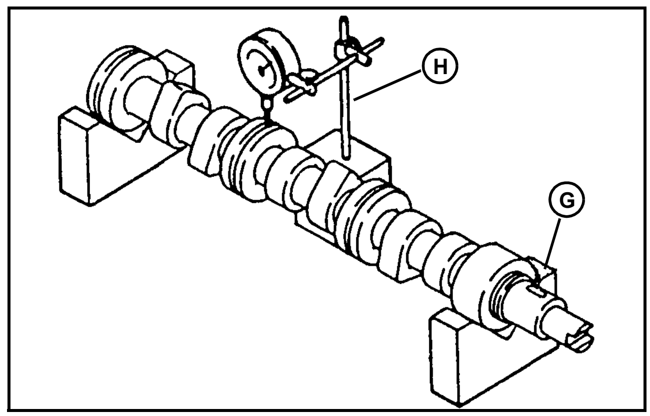


M82068A

3. Install thrust plate (D) if removed. Install gear (E) with timing mark “C” side toward press table.

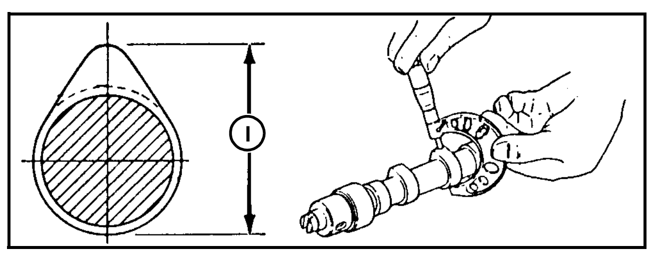
NOTE: Thrust plate must spin freely on camshaft.

4. Align slot in gear with key (F) in shaft. Press camshaft into gear until gear is tight against camshaft shoulder.



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

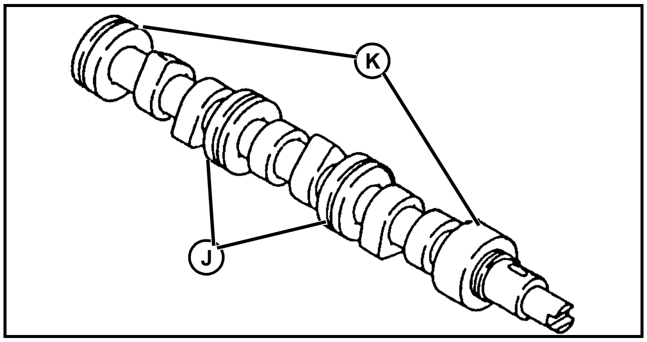
6. Measure camshaft lobe height (I).

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 (K) and intermediate journal (J) diameters.

Camshaft Journal OD Specifications:

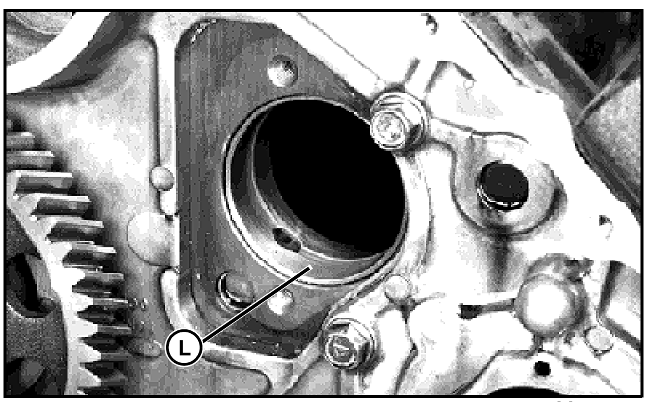
Gear Housing and Flywheel Ends
Standard . . . . 35.94 - 35.96 mm (1.415 - 1.416 in.)

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.

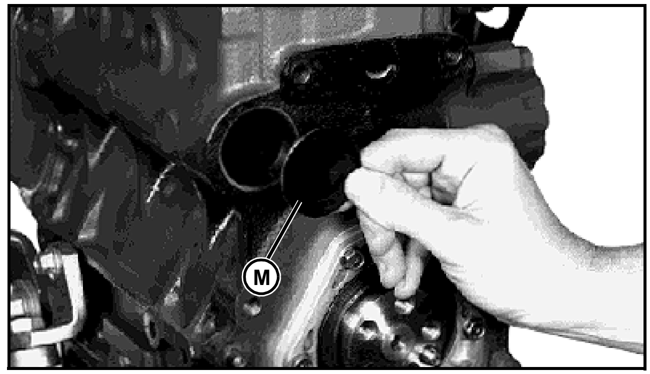
To Replace Bushing:

NOTE: Engine back plate must be removed to measure camshaft intermediate and flywheel end bearing diameters.

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.

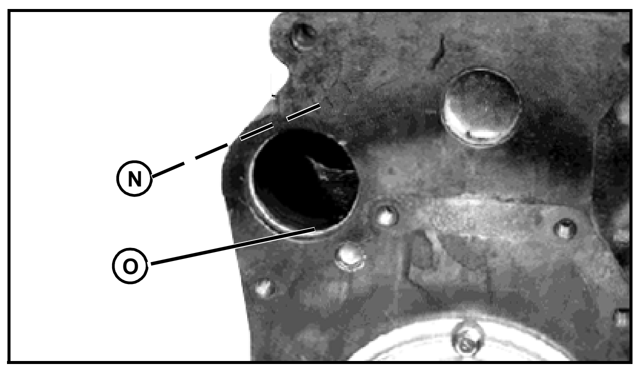
2. Measure intermediate and flywheel end camshaft bore diameters using the following procedures:

3. Remove engine back plate.



M35287

4. Remove plug (M) using a long wooden dowel. Insert wooden dowel through gear housing side.



M82073

5. 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.
- 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.

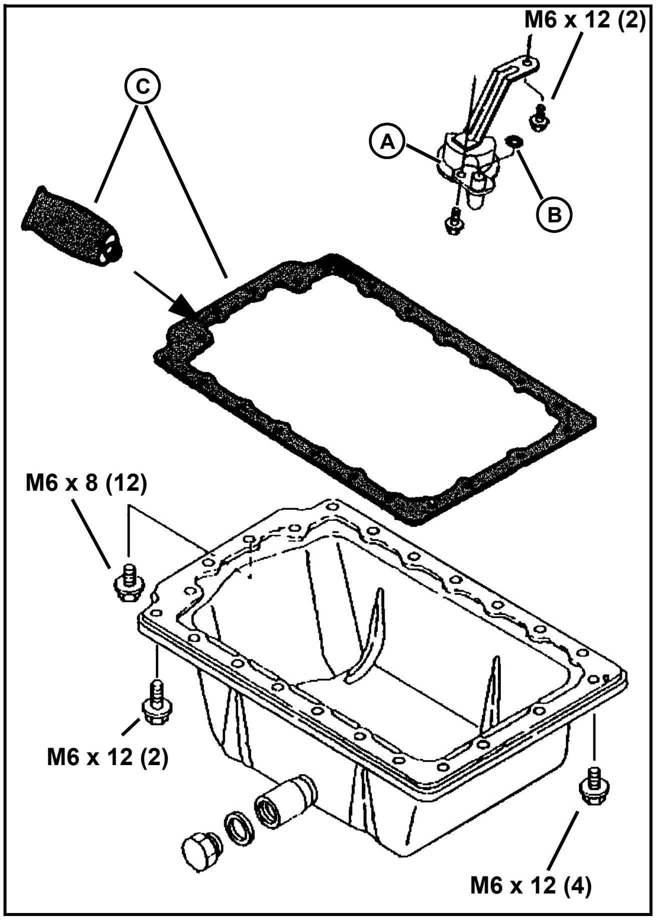
Oil Pan and Strainer

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.



M82302B

Installation:

1. Install oil strainer (A) with new O-ring (B).

2. Tighten cap screws to 11 N•m (96 lb-in.).

3. Cover oil pan mounting flange with a thin layer of sealant (C).

4. Install oil pan and tighten cap screws to specification.

5. Install drain plug with new washer.

6. Fill crankcase with oil.

7. Crankcase oil capacity is 2.0 L (2.1 qt).

8. Fill engine with proper engine oil. (See Specifications and Information section.)

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.)

Connecting Rod Side Play Check

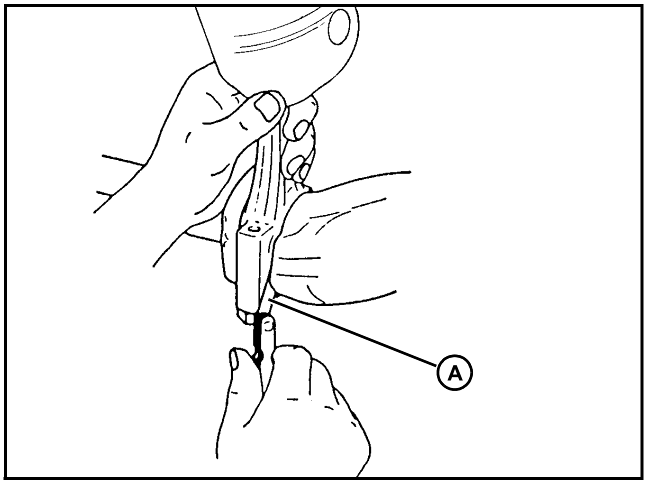
Reason:

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.)

Wear Limit. . . . . 0.55 mm (0.022 in.)

Results:

- If side play exceeds wear limit, replace connecting rod and connecting rod cap.

Crankshaft End Play Check

Reason:

To determine proper side clearance between crankshaft and engine block.

Equipment:

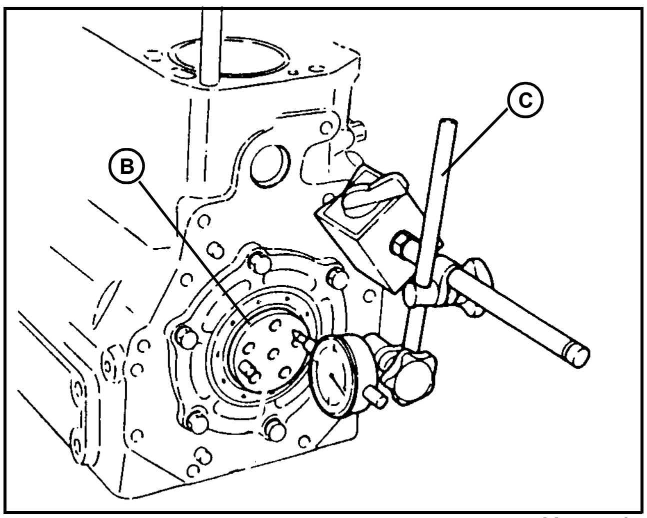
- Dial Indicator

Procedure:

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

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

1. Fasten dial indicator to engine and position indicator tip on end of crankshaft.



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.

Clearance Specifications:

Standard . . . . 0.090 - 0.271 mm (0.004 - 0.011 in.)

Wear Limit . . . . 0.33 mm (0.0129 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.

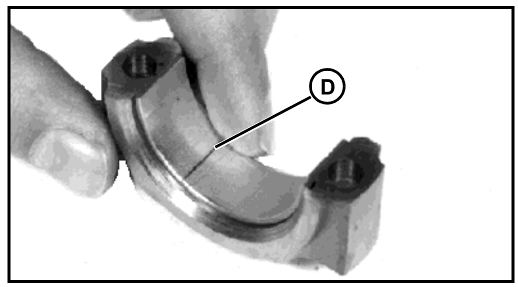
Equipment:

- 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.

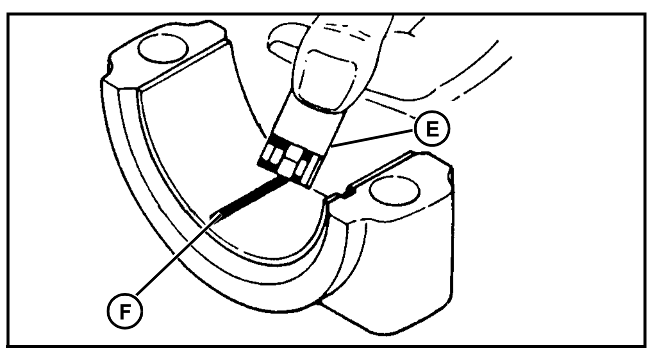
1. Remove connecting rod cap.
2. Wipe oil from bearing insert and crankshaft journal.



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 23 N•m (203 lb-in.).
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®.

Clearance Specifications:

Standard . . . . 0.020 - 0.072 mm (0.0008 - 0.0028 in.)

Wear Limit . . . . 0.15 mm (0.0059 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.

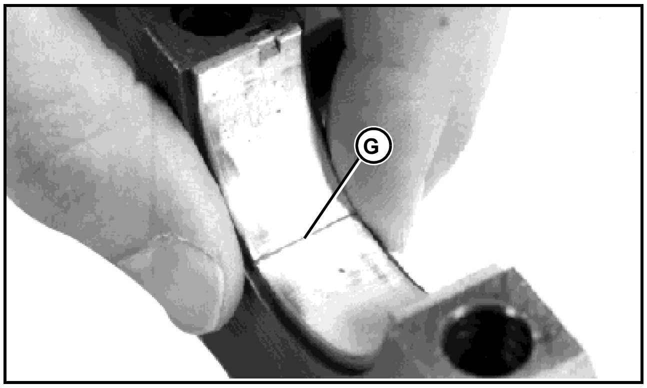
Equipment:

- PLASTIGAGE®

Procedure:

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

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



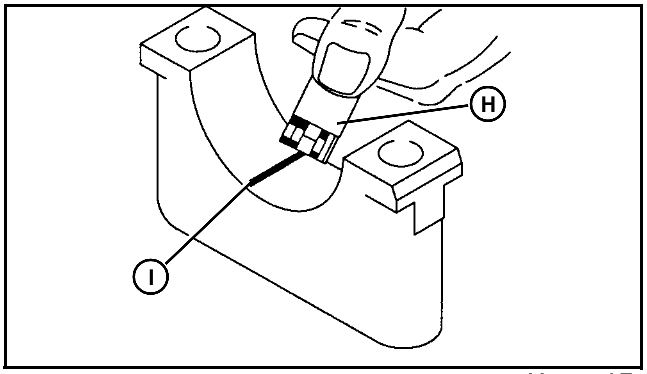
M35382

3. Place a piece of PLASTIGAGE®, (G) or an equivalent, along the full length of the bearing insert approximately 6 mm (0.25 in.) off center.

4. Install main bearing cap and cap screws. Tighten cap screws to 54 N•m (40 lb-ft).

5. Remove cap screws and main bearing cap.

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



M82119AE

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:

Standard
Clearance . . . . . . 0.020 - 0.072 mm (0.0008 - 0.0028 in.)

Wear Limit. 0.15 mm (0.0059 in.)

Results:

- If clearance exceeds specification, replace bearing inserts.

Piston-to-Cylinder Head Clearance

1. Place small pieces of solder 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" on page 176.

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:

Clearance . . . . 0.59 - 0.74 mm (0.023 - 0.029 in.)

- 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 189.

2. Remove cylinder head. See “Cylinder Head Removal and Installation” on page 176.

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

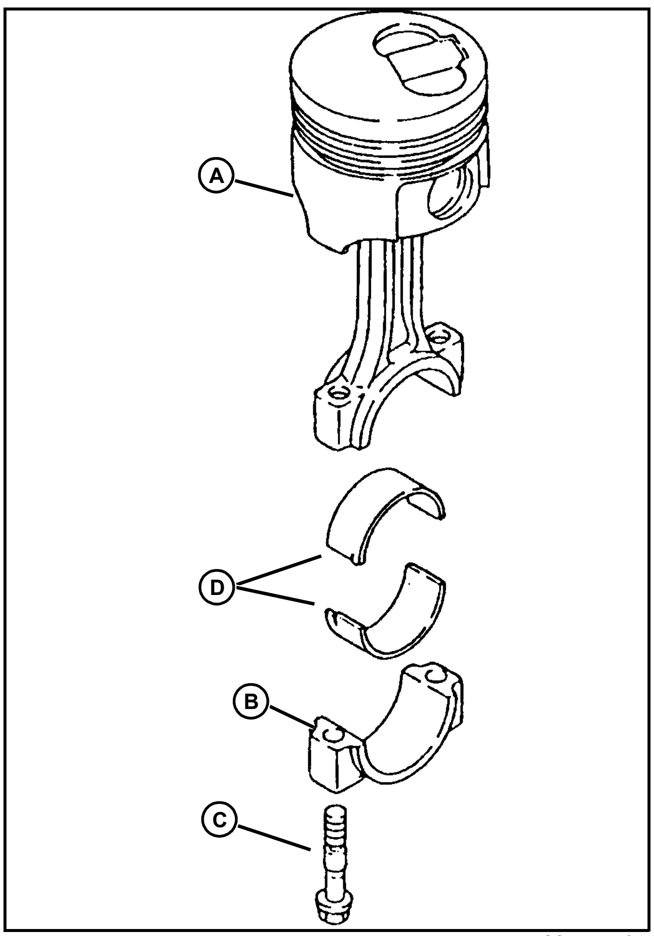
4. If necessary, remove ridge from top of cylinder bore using a ridge reamer.

5. Measure connecting rod side play. See “Connecting Rod Side Play Check” on page 189.

6. Measure connecting rod bearing clearance. See “Connecting Rod Bearing Clearance Check” on page 190.

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

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)

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).

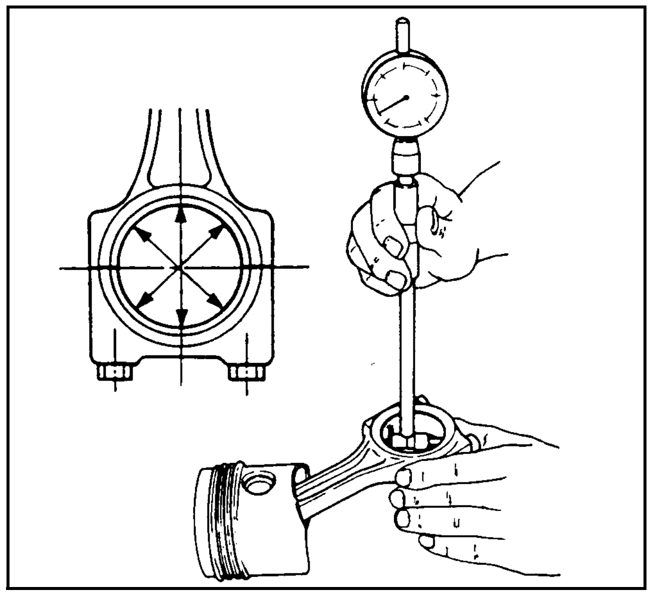
11.Disassemble and inspect all parts for wear or damage.

Inspection/Replacement:

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

2. Measure crankshaft connecting rod journal diameter. See “Crankshaft and Main Bearings” on page 199.

3. Install connecting rod cap and bearing inserts on connecting rod. Install old connecting rod cap screws and tighten to 23 N•m (203 lb-in.).



M82048A

4. Measure connecting rod bearing inside diameter (see Specifications below).

- 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.

Specifications:

Torque Specification:

Connecting Rod Cap Screw . . . . . . 23 N•m (203 lb-in.)

Connecting Rod Bearing ID:

Standard . . . . 36 - 36.042 mm (1.417 - 1.419 in.)

Wear Limit . . . . 37.07 mm (1.459 in.)

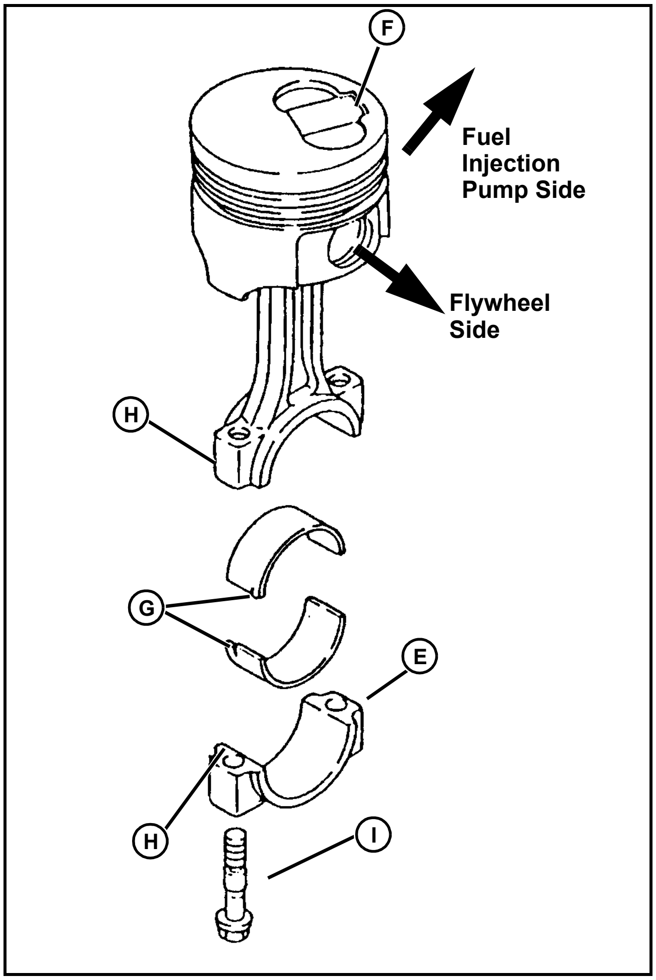
Clearance . . . . 0.16 mm (0.006 in.)

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.



M82273A

1. If new piston rings are being installed, deglaze cylinder bore. See “Deglazing:” on page 198.

2. Install bearing inserts on connecting rod and rod cap, aligning tangs (G) with grooves.

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

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.

4. Match the connecting rods to caps using alignment marks. Install caps.

5. Dip entire connecting rod cap screw (I) in clean engine oil. Install new cap screws and tighten to 23 N•m (203 lb-in.).

   - 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.

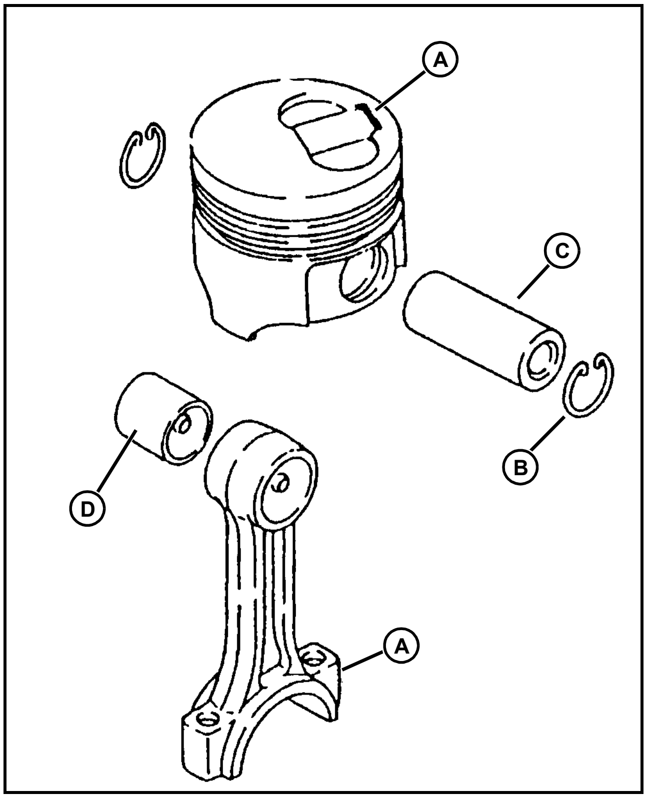
6. Install cylinder head. See “Cylinder Head Removal and Installation” on page 176.

7. 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

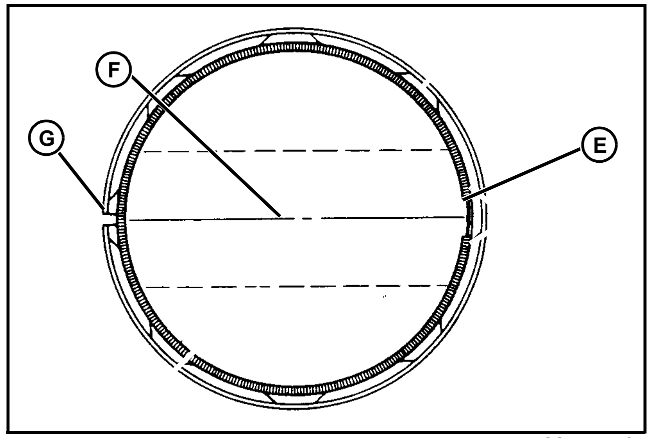
1. Note mark on each piston and connecting rod (A) to aid in assembly.
2. Remove piston pin retainer (B) and piston pin (C).
3. Piston pin bushing (D) is press fit in connecting rod. Remove bushing only if replacement is necessary. (See Inspection/Replacement procedures.)
4. Inspect all parts for wear or damage. Replace as necessary.

Assembly:

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

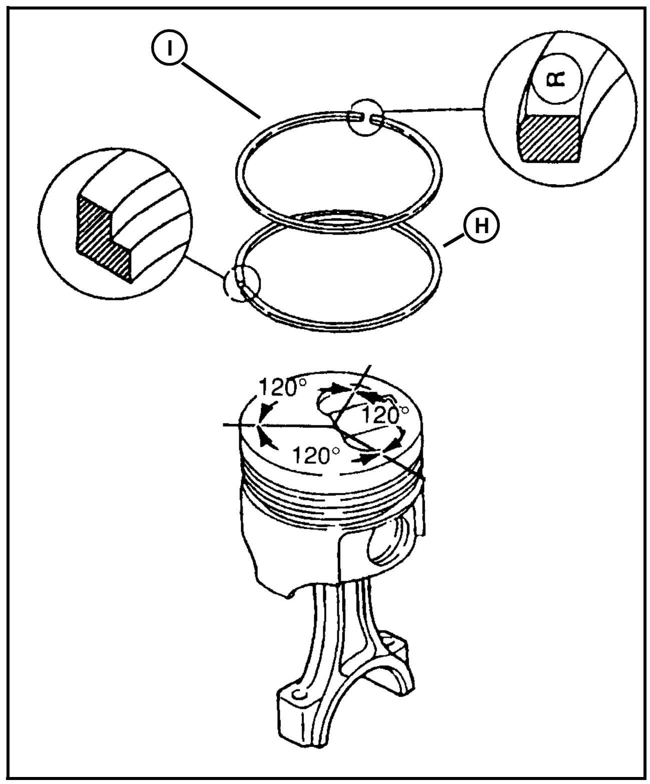
IMPORTANT: Avoid damage! Pistons must be installed on the same connecting rod they were removed from.

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.



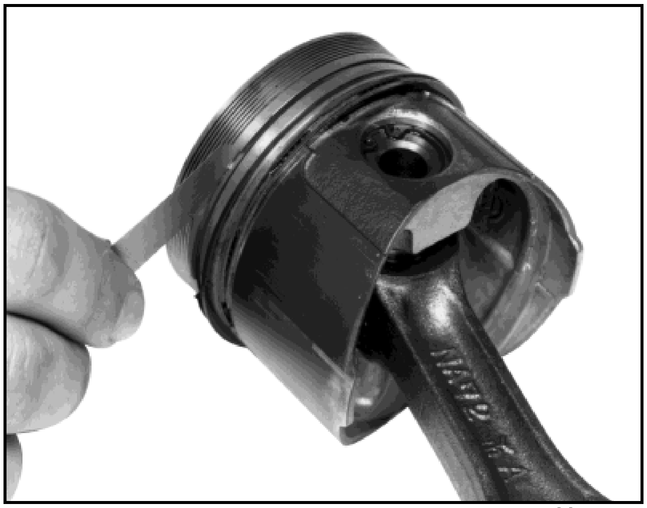
M82046A

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) (180°) 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.



M35360

7. 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.

Piston Ring Groove Clearance:

First Compression Ring
Standard . . . . 0.065 - 0.100 mm (0.0026 - 0.0039 in.)

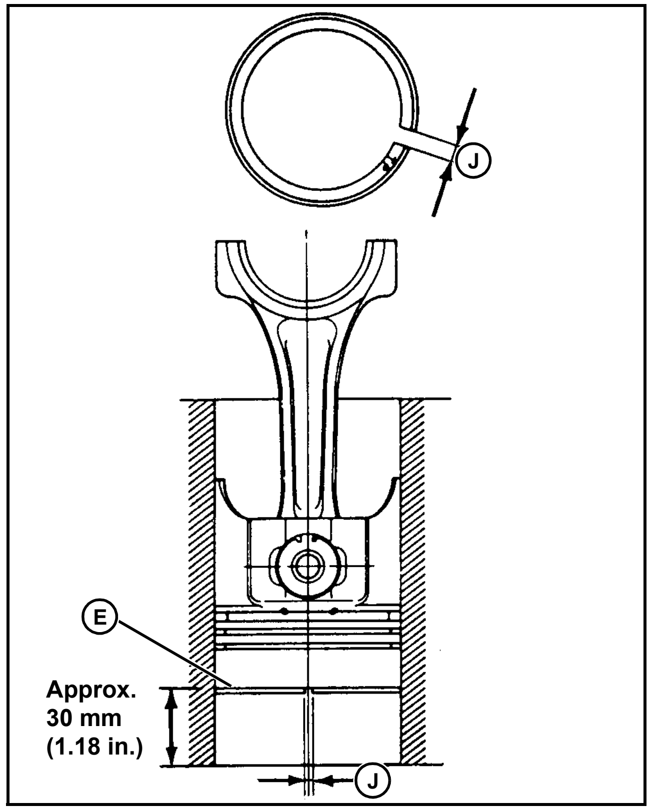
Wear Limit . . . . 0.20 mm (0.0079 in.)

Second Compression Ring
Standard . . . . 0.030 - 0.065 mm (0.0012 - 0.0026 in.)

Wear Limit . . . . 0.20 mm (0.0079 in.)

Oil Ring
Standard . . . . 0.020 - 0.055 mm (0.0008 - 0.0022 in.)

- If clearance exceeds maximum limit, replace rings or piston.



M82049A

8. 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.

9. Measure end gap with a feeler gauge.

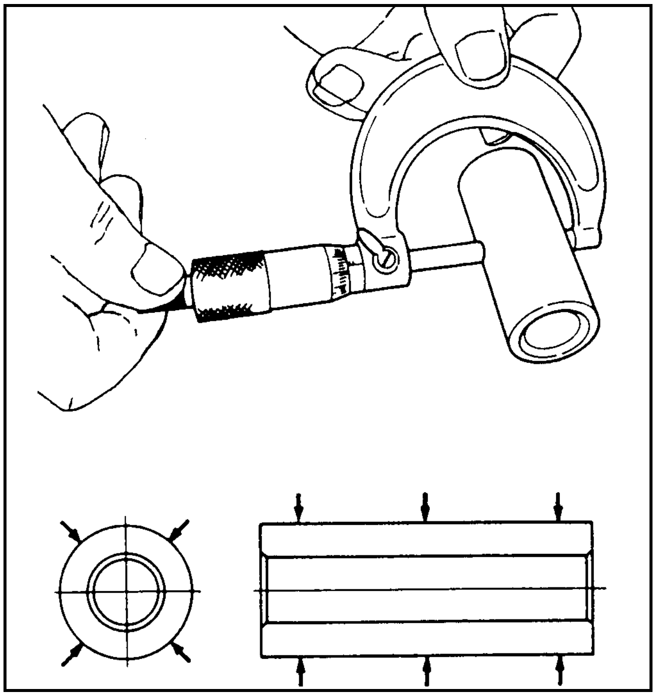
Standard Piston Ring End Gap:

First Compression Ring
and Oil Ring . . . . 0.15 - 0.35 mm (0.006 - 0.014 in.)

Second
Compression Ring . . . 0.25 - 0.40 mm (0.010 - 0.016 in.)

Wear Limit. 1.50 mm (0.0591 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

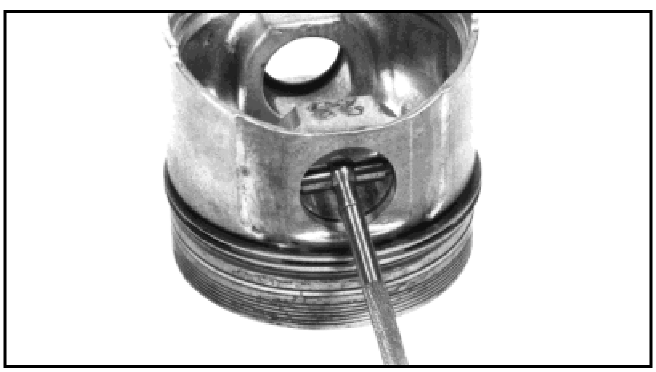
10.Measure piston pin diameter. Measure diameter at six places.

Piston Pin OD Diameter Specifications:

Standard . . . . 19.991 - 20.00 mm (0.787 - 0.788 in.)

Wear Limit . . . . 19.975 mm (0.786 in.)

- If pin diameter is less than wear limit, replace pin.



M37683

11.Measure piston pin bore diameter in piston.

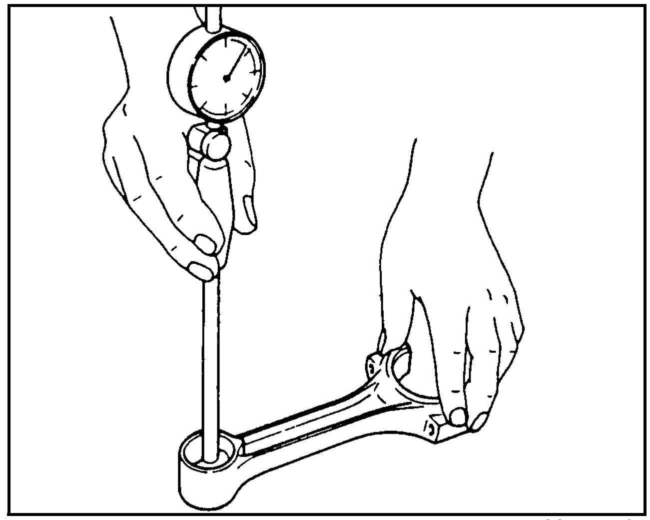
Piston Pin Bore ID Specifications:

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.)

- 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

12.Measure piston pin bushing diameter in connecting rod.

Piston Pin Bushing ID Specifications:

Standard . . . . 20.025 - 20.038 mm (0.788 - 0.789 in.)

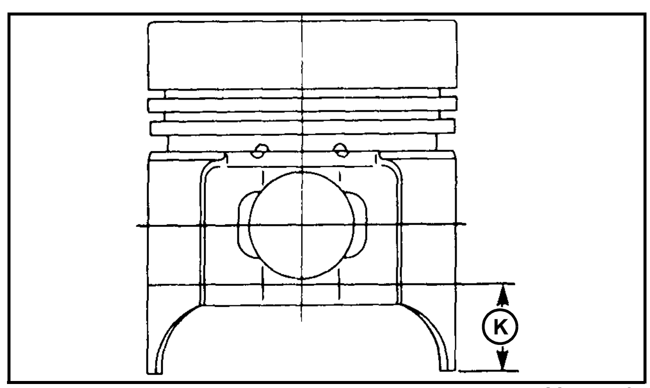
Wear Limit. 20.10 mm (0.781 in.)

Clearance . . . . 0.11 mm (0.0043 in.)

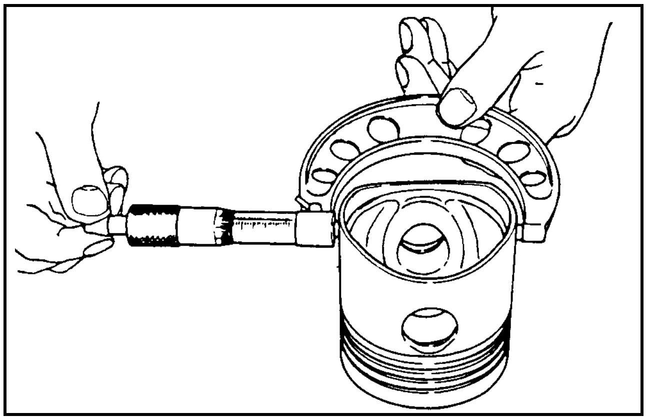
NOTE: Piston pin bushing is press fit. Replace bushing using a driver set. When installing bushing, make sure to align oil hole in bushing with hole in connecting rod.

- If bushing diameter exceeds wear limit, replace bushing.
- 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.) and 0.50 mm (0.020 in.) oversize.



M82200A



M82052A

13.Measure piston diameter perpendicular to piston pin bore at distance (K).

Specifications:

Piston OD Distance (K) . . . . 5 mm (0.197 in.)

Standard Size Piston
Standard . . . . 65.927 - 65.957 mm (2.596 - 2.597 in.)

Wear Limit . . . . 65.85 mm (2.593 in.)

Oversize Piston - 0.25 mm (0.010 in.)
Standard . . . . 66.18 - 66.21 mm (2.606 - 2.607 in.)

Wear Limit . . . . 66.10 mm (2.602 in.)

Oversize Piston - 0.50 mm (0.020 in.)
Standard . . . . 66.43 - 66.46 mm (2.615 - 2.616 in.)

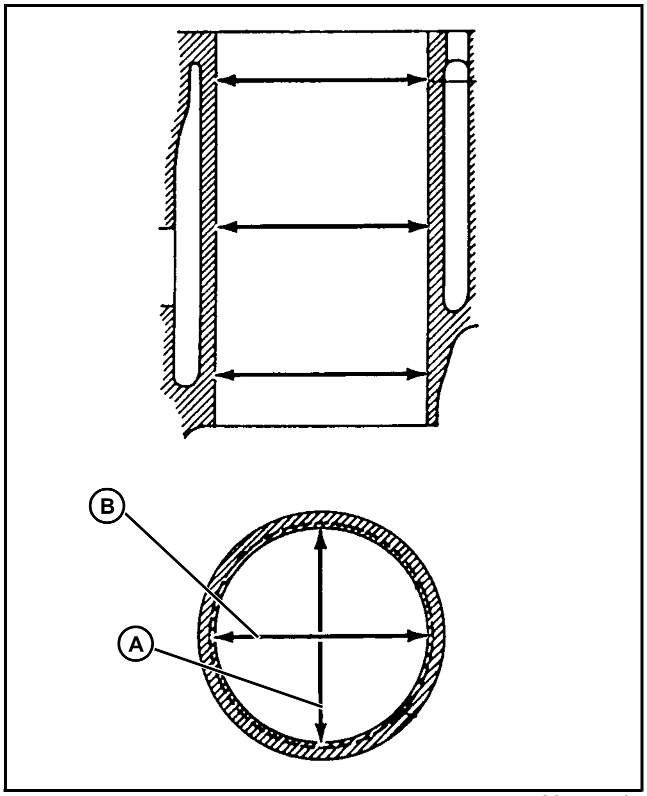
Wear Limit . . . . 66.35 mm (2.612 in.)

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

14.Measure cylinder bore diameter. See “Cylinder Bore” on page 197.

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). (See Specifications below.)

NOTE: If engine has had a previous major overhaul, oversize pistons and rings may have been installed.

- If cylinder bore exceeds wear limit, replace cylinder block or have cylinder rebored. See “Reboring:” on page 198.
- If cylinder is rebored, oversize pistons and rings must be installed. Pistons and rings are available in 0.25 mm (0.010 in.) and 0.50 mm (0.020 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.

Specifications:

Cylinder Bore ID Specifications:

Standard Size Bore
Standard . . . . 66.00 - 66.03 mm (2.599 - 2.600 in.)

Wear Limit . . . . 66.20 mm (2.606 in.)

Piston to Cylinder Clearance. . . . . . 0.25 mm (0.010 in.)

Cylinder Roundness. . . . . 0.25 mm (0.010 in.)

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

First Oversize Bore
Standard . . . . 66.25 - 66.28 mm (2.609 - 2.610 in.)

Wear Limit . . . . 66.45 mm (2.616 in.)

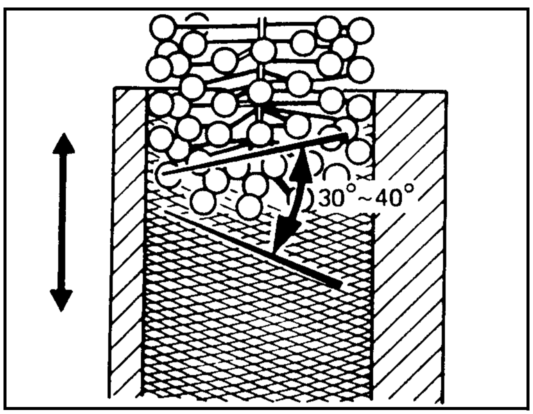
Second Oversize Bore
Standard . . . . 66.50 - 66.53 mm (2.619 - 2.620 in.)

Wear Limit . . . . 66.70 mm (2.626 in.)

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.



M82054A

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

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.

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

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.) and 0.50 mm (0.020 in.) oversize. (See this group for cylinder bore ID specifications.)

1. Align center of bore to drill press center.

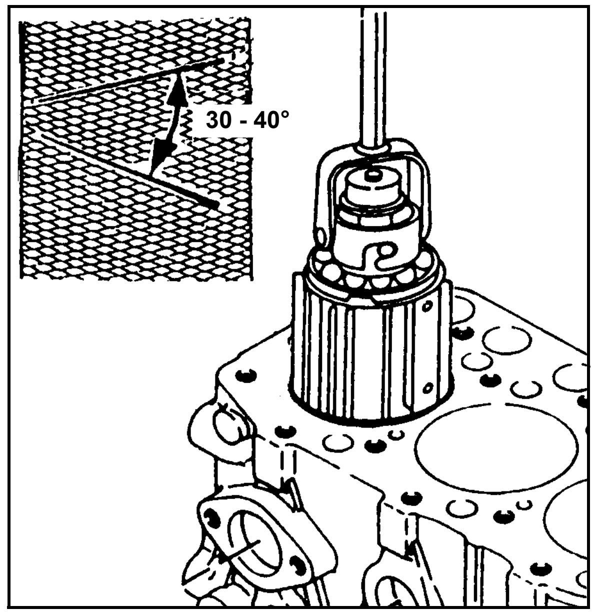
IMPORTANT: Avoid damage! Check stone for wear or damage. Use a rigid hone with 300 grit stones.

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.

NOTE: Measure bore when cylinder is cool.



M52959

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

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

6. Stop press and check cylinder diameter.

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.

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

9. Check bore for size, taper and out-of-round. (See Inspection procedures above.)

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 190.
2. Remove flywheel. See “Flywheel” on page 201.
3. Remove rear oil seal case. See “Crankshaft Rear Oil Seal” on page 182.
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 191.

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.

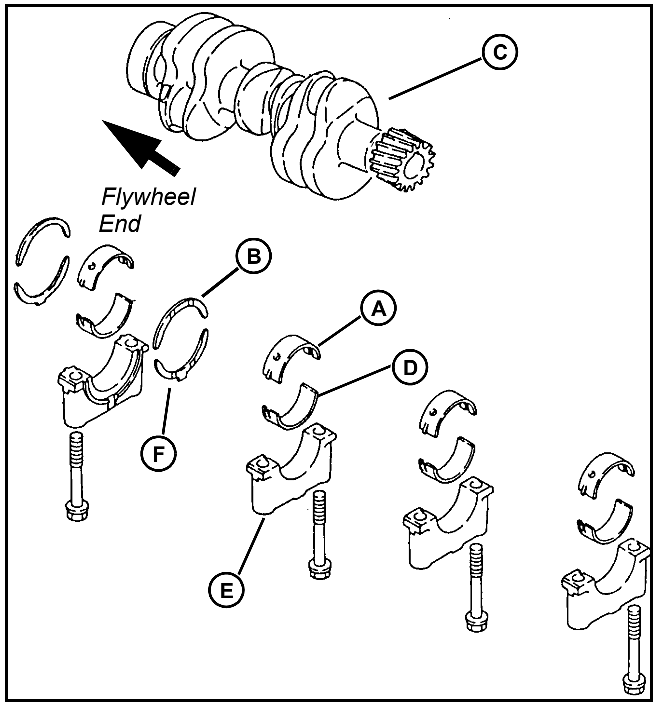
6. Remove connecting rod cap screws and end caps.

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

7. Push pistons and connecting rods away from crankshaft.
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:” on page 200.

Installation:

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



M82283A

2. Install bearing inserts drilled with oil passage (A) in cylinder block bearing bores, aligning tangs with slots in bores.

NOTE: Main bearing caps have “raised arrows” that are stamped with numbers. Both correspond to their location on the engine block. The number “1” main bearing bore is at flywheel end. Install bearing caps beginning with number 1, then 2, etc. The main bearing cap at gear train end does not have a number. Also install bearing caps with the “arrow” toward the flywheel end.

3. Install block thrust bearings (B) with oil grooves facing away from engine block.
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.

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

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

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:

Main Bearing Cap Screws . . . . 54 N•m (40 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.

- 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.

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 (0.0008 in.), replace crankshaft.

NOTE: If engine has had a previous major overhaul, journals may have been ground and undersized bearing inserts installed.

3. Measure crankshaft connecting rod journal and main bearing journal diameters. Measure several places around each journal.

Connecting Rod Journal OD Specifications:

Standard . . . . 35.97 - 35.98 mm (1.4161 - 1.4165 in.)

Wear Limit. 35.92 mm (1.414 in.)

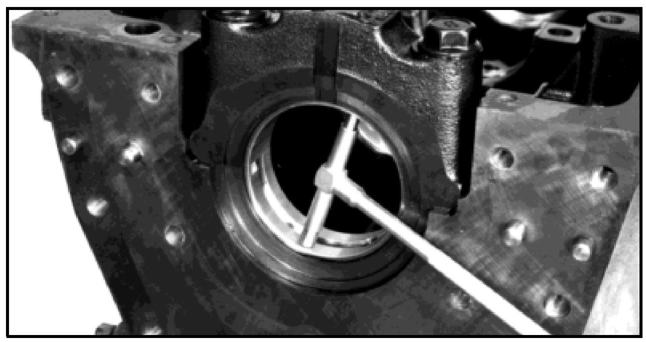
Main Bearing Journal OD Specifications:

Standard . . . . 39.97 - 39.98 mm (1.5736 - 1.5740 in.)

Wear Limit. 39.92 mm (1.572 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:

Standard . . . . 40.000 - 40.042 mm (1.575 - 1.576 in.)

Wear Limit. 40.07 mm (1.578 in.)

Clearance . . . . 0.15 mm (0.006 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.

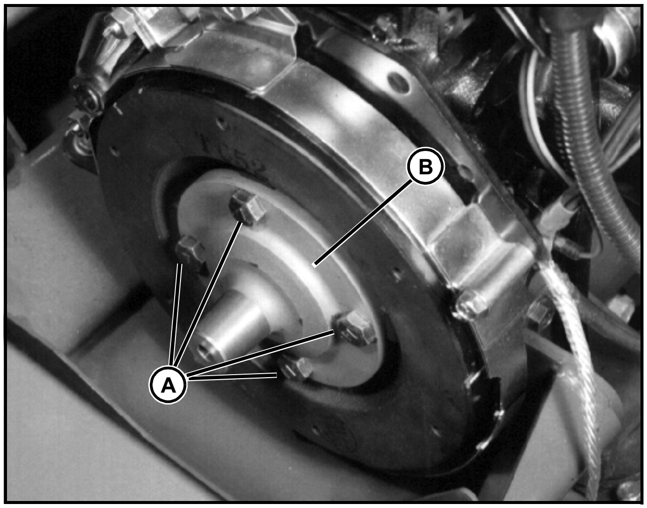
6. Clean and inspect oil passages in main bearing journals, connecting rod journals and main bearing bores in cylinder block.

7. Inspect crankshaft for cracks or damage. Replace if necessary.

Flywheel

Removal:

1. Remove engine drive clutch. (See Gear Power Train section.



M76891

1. Remove flywheel guard.
2. Remove four cap screws (A) securing engine drive clutch stub shaft (B) to flywheel hub.
3. Remove five flywheel mounting cap screws 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 flywheel if worn.

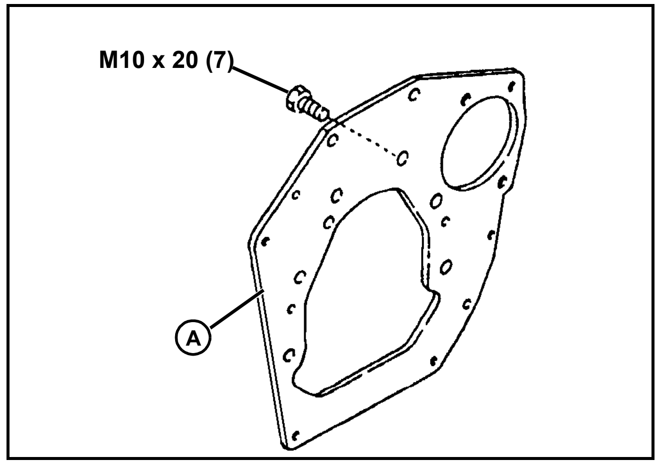
Installation:

1. Align flywheel on spring pin and install five new flywheel mounting cap screws (see note above). Tighten cap screws to 83 N•m (61 lb-ft).
2. Install stub shaft to flywheel hub and tighten four mounting cap screws to 59 N•m (44 lb-ft).
3. Install flywheel guard.

Flywheel Plate

Removal:

1. Remove clutch from crankshaft.
2. Remove flywheel guard.
3. Remove flywheel. See “Flywheel” on page 201.
4. Remove starting motor.



M82290B

5. Remove seven mounting cap screws and flywheel plate (A).

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 171.

2. Remove timing gear cover. See “Timing Gear Cover” on page 183.

3. Remove fuel injector lines from engine. See “Fuel Injection Nozzle” on page 208.

4. Remove engine camshaft. See “Camshaft” on page 186.

5. Remove water pump. See “Water Pump” on page 204.

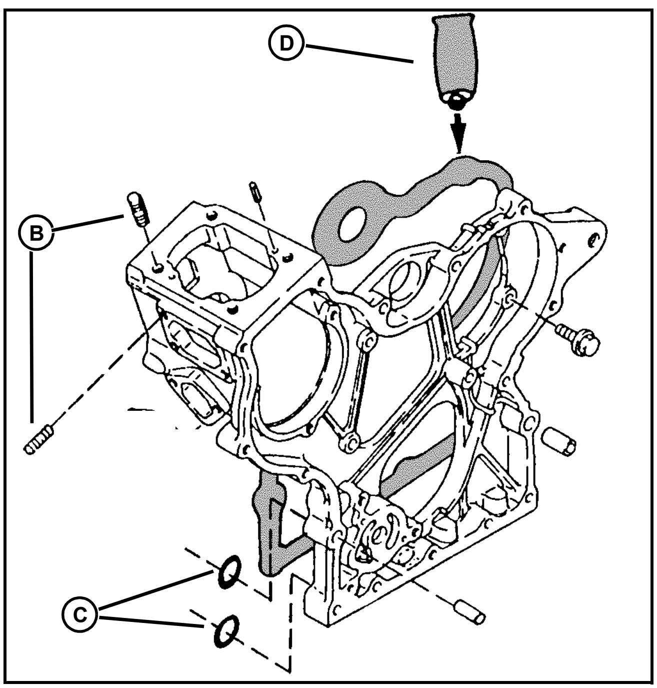
6. Remove oil dipstick tube.

7. Remove oil pan. See “Oil Pan and Strainer” on page 189.

8. Remove timing gear housing mounting cap screws and remove housing from cylinder block.

Installation:

Installation is done in the reverse order of removal.



M82299A

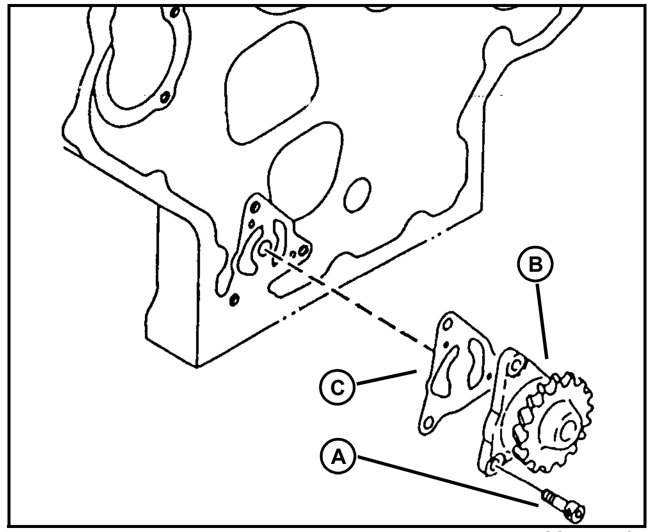
- Apply low strength thread lock to studs (B) before installing into timing gear housing.
- Replace O-rings (C).
- Apply John Deere form in place gasket (D) on cover
- Tighten timing gear housing mounting cap screws to 11 N•m (96 lb-in.).

Oil Pump

Removal/Installation

1. Remove timing gear cover. See “Timing Gear Cover” on page 183.

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 (18 lb-ft).

Disassembly/Assembly:

1. Remove gear using a knife edge puller and a press. Gear is press fit on rotor shaft.

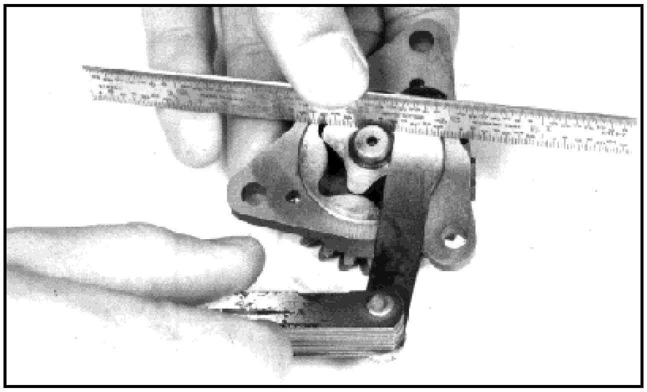
2. Inspect parts for wear or damage. (See Inspection procedure below.)

3. Coat all parts with clean engine oil.

4. Install outer rotor with identification mark facing toward rotor shaft assembly.

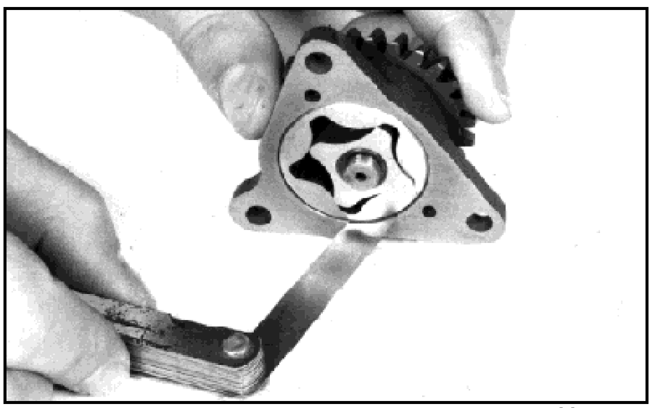
Inspection:

1. Check rotor shaft outer diameter and the shaft hole diameter in backing plate. If clearance is more than wear limit, replace entire assembly. (See Specifications below.)



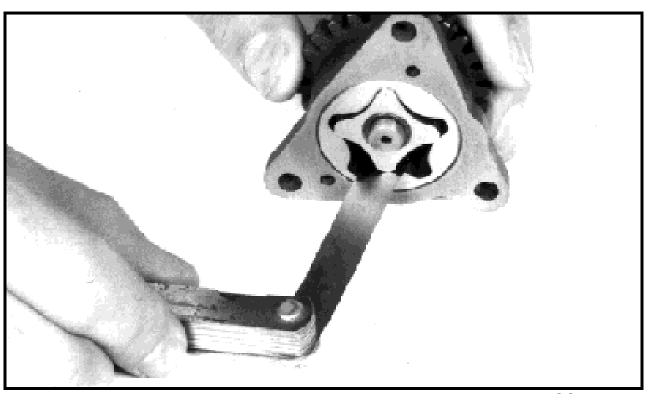
M37775

2. Check rotor recess. If rotors are below face of pump housing more than 0.25 mm (0.01 in.), replace rotor assembly.



M37776

3. Check outer rotor-to-pump body clearance. If clearance is more than wear limit, replace entire assembly. (See Specifications below.)



M37777

4. Check inner-to-outer rotor clearance. If clearance is more than 0.15 mm (0.0059 in.), replace rotor assembly.

Specifications:

Rotor Shaft and Plate Clearance:

Standard . . . . 0.015 - 0.048 mm (0.001 - 0.004 in.)

Wear Limit. . . . . 0.20 mm (0.008 in.)

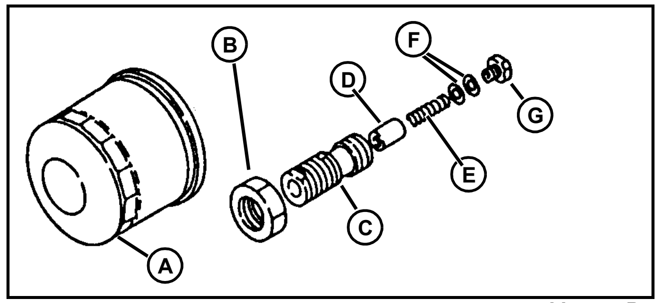
Outer Rotor-to-Pump Body Clearance:

Standard . . . . 0.03 - 0.09 mm (0.0011 - 0.0035 in.)

Wear Limit. 0.13 mm (0.0051 in.)

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. . . . . 21.9 - 24.5 mm (0.86 - 0.96 in.)

Compressed Length . . . . 14.7 mm (0.58 in.)
. . . . . @ 12 N (2.7 lb-force)

Installation:

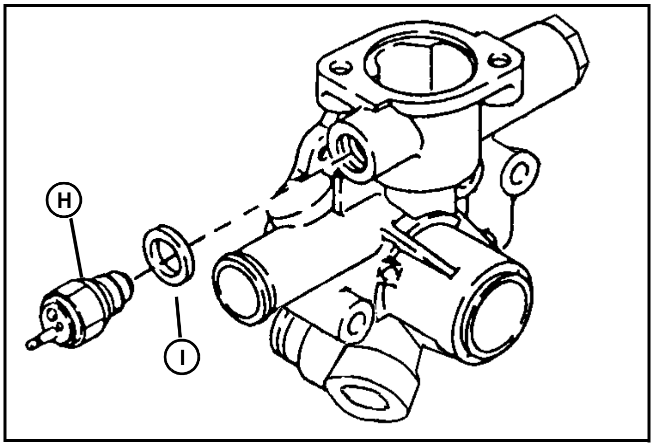
Installation is done in the reverse order of removal.

- Tighten retaining nut to 30 N•m (22 lb-ft).

Coolant Temperature Switch

Replacement:

1. Open engine drain valve to drain coolant level to below coolant sensor level.
2. Disconnect wiring lead.



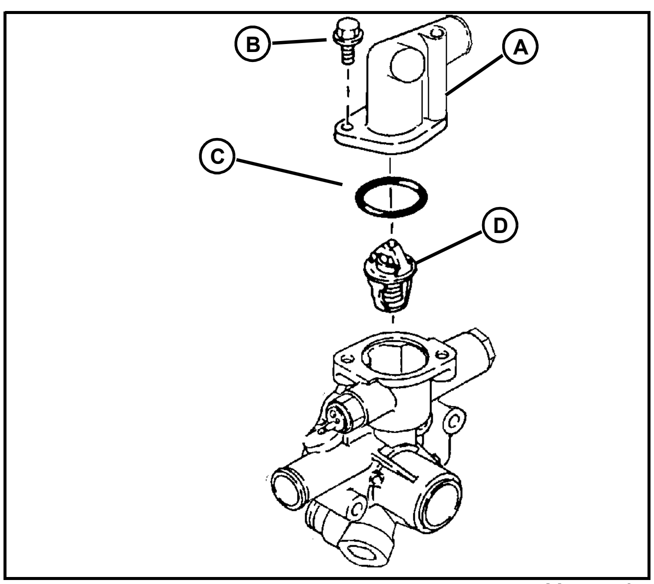
M82313A

3. Remove sensor (H) and washer (I).
4. Test sensor. (See Electrical Section.)
5. Installation is done in reverse order of removal.
6. Replace copper washer.

Thermostat

Removal:

1. Open engine drain valve to drain coolant level to below thermostat level.



M82314A

2. Disconnect upper radiator hose from thermostat housing (A).
3. Remove two cap screws (B) holding thermostat housing to water pump.
4. Test thermostat (D). See “Thermostat Test” on page 166.

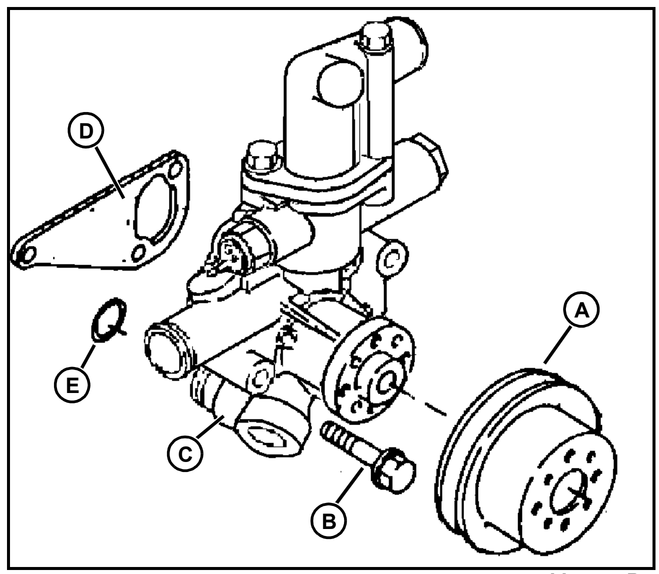
Installation:

- Replace O-ring (C) when installing thermostat.
- Tighten cap screws to 19 N•m (230 lb-in.).

Water Pump

Removal:

1. Remove engine belt guard.
2. Open engine drain valve to drain coolant from cylinder block.
3. Disconnect coolant temperature switch lead.
4. Disconnect upper and lower radiator hoses.
5. Remove water pump/alternator drive belt.



M82316B

6. Remove four pulley cap screws and pulley (A).
7. Remove three pump mounting cap screws (B), pump (C), and gasket (D).
8. Inspect all parts for wear or damage.
9. Clean cylinder block mating surfaces of all old gasket material.

Installation:

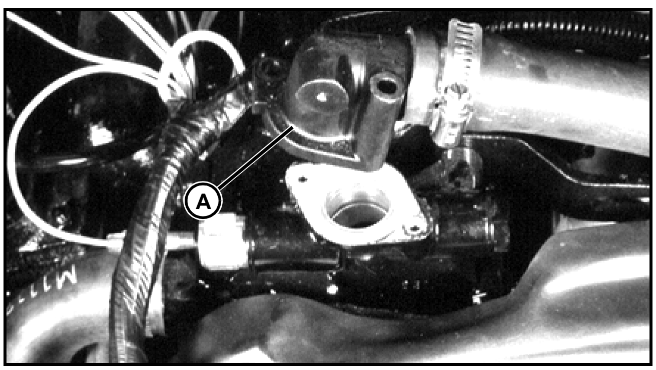
Installation is done in the reverse order of removal.

1. Install new gasket and O-ring (E).
2. Tighten mounting cap screws to 26 N•m (230 lb-in.).
3. Install coolant temperature switch. See “Coolant Temperature Switch” on page 204.
4. Install thermostat. See “Thermostat” on page 204.
5. Adjust water pump/alternator drive belt tension. See “Water Pump/Alternator Drive Belt Adjustment” on page 165.
6. Install engine belt cover.

Filling Coolant System (S/N -033432)

Fill and Bleed Procedure:

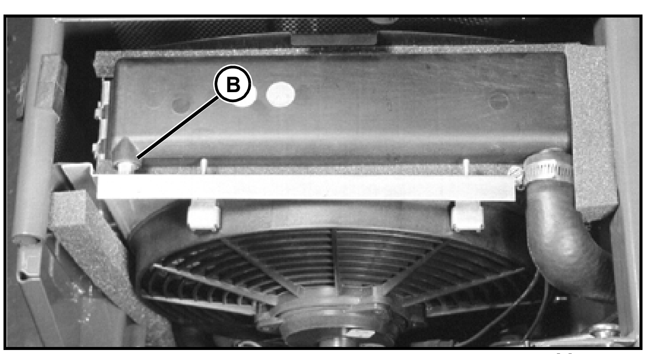
1. Allow radiator to cool completely.



M76753

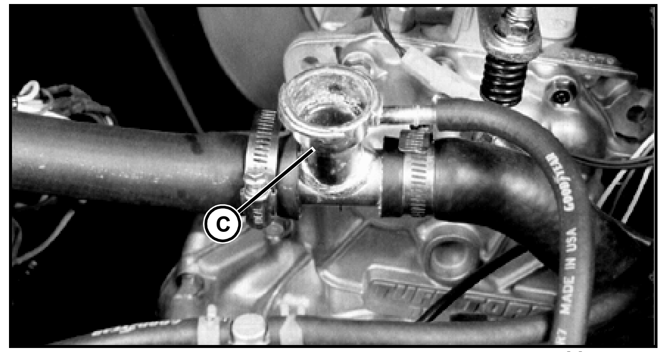
2. Remove thermostat housing (A), O-ring and thermostat.
3. Fill engine block with coolant through thermostat port.
4. Install new O-ring, thermostat and thermostat housing. Tighten thermostat housing screws to 26 N•m (230 lb-in.).
5. Remove upper radiator hose bracket between thermostat housing and filler neck.

NOTE: Capacity of cooling system is approximately 4.5 L (4.8 qt).



M76754

6. Remove the bleed screw (B) at the top of the radiator.
7. Remove radiator cap from filler neck.
8. Fill cooling system until coolant comes out bleed screw hole of the radiator.
9. Install and tighten radiator bleed screw.



M76771

10. Continue filling until coolant level is at the bottom of the filler neck (C).
11. Lift the filler neck until it is higher than the thermostat housing to allow air to escape from the upper radiator hose.
12. Continue lifting the filler neck. Add coolant through the filler neck until full. Gently squeeze the upper radiator hose on both sides of the filler neck to force air out through the filler neck opening.

NOTE: Repeat step 12 until no air escapes from the upper hose and the coolant level remains constant.

13. Install the radiator cap, then lower the upper radiator hose.
14. Run the machine at half throttle until the fan turns on.
15. Stop the engine, Allow the engine to cool.
16. After engine is cool, remove radiator cap.
17. Remove radiator bleed screw to allow air to escape from the radiator.
18. Add coolant to the filler neck until coolant flows out the radiator bleed screw hole.
19. Install and tighten the bleed screw to the radiator.
20. Lift the filler neck until it is higher than the thermostat housing.
21. Add coolant to the filler neck until full. Gently squeeze the upper radiator hose on both sides of the filler neck to force air out through the filler neck opening.

NOTE: Repeat step 21 until no air escapes from the upper hose and the coolant level remains constant.

22. Install the radiator cap, then lower the upper radiator hose.
23. Install the upper radiator hose bracket located between the thermostat housing and the filler neck.

24.Verify that 51 - 76 mm (2 - 3 in.) of coolant is in the reservoir. Add coolant if required.

25.Check the condition of the hoses and all hose clamps. Replace any damaged or worn hoses. Tighten clamps as necessary.

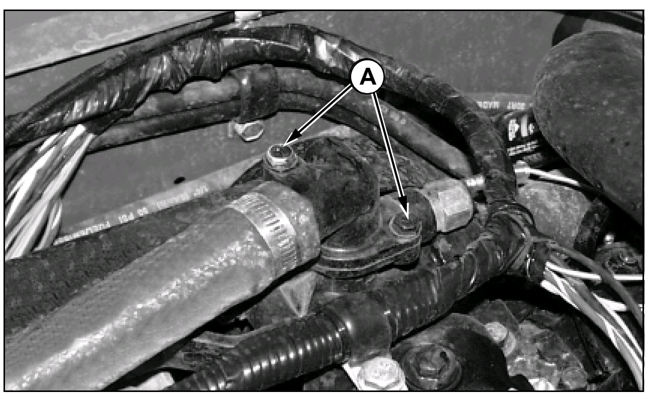
Filling Cooling System (S/N 033433-)

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 4.3L (4.5 qt.) including reservoir.



MX4648

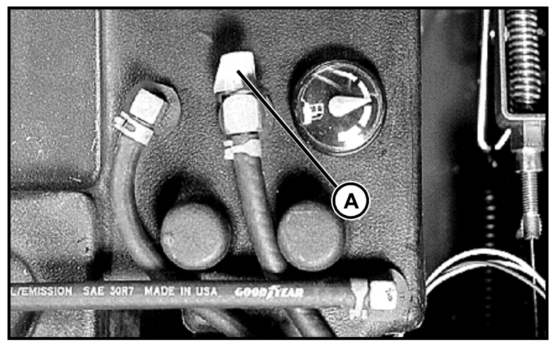
1. Remove screws (A) to remove thermostat housing, O-ring, and thermostat. Inspect and replace O-ring if necessary.
2. Fill engine block with coolant through thermostat port.
3. Install O-ring, thermostat, and thermostat housing. Tighten thermostat screws to 26 N•m (230 lb-in.).
4. Fill cooling system through radiator cap opening until coolant level is at bottom of filler neck. Install and tighten radiator cap.

IMPORTANT: Avoid damage! If coolant temperature indicator comes on while engine is running, stop engine and add more coolant mixture to radiator.

5. Run engine until cooling fan starts turning. Stop engine.
6. Check coolant level in overflow reservoir:
   - If engine is warm, reservoir tank should contain 75 - 100mm (3 - 4 in.) of coolant.
   - If engine is cold, reservoir tank should contain approximately 25 - 50mm (1 - 2 in.) of coolant.
7. Add coolant as necessary.
8. Check condition of hoses.
9. Check all hose clamps and tighten if necessary.

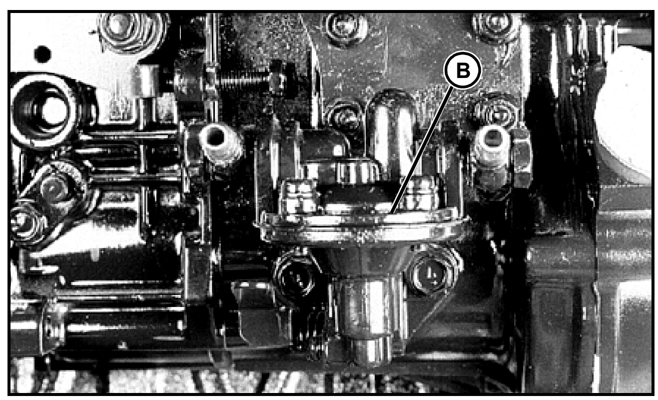
Fuel Transfer Pump

CAUTION: Avoid Injury! Fuel tank shutoff valve must be closed before disconnecting fuel lines.



M76722

1. Close fuel shutoff valve (A) at tank and at filter.

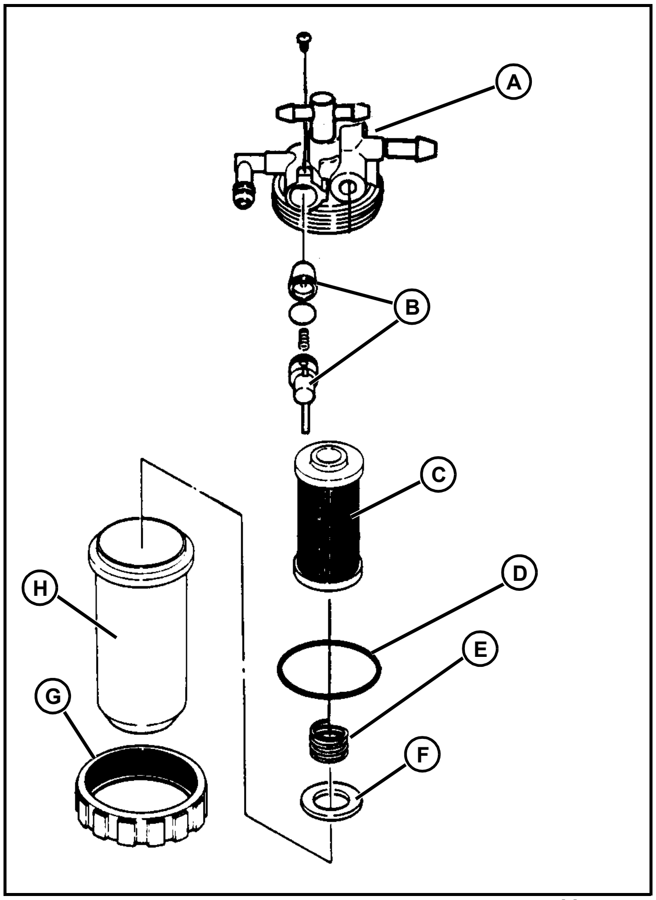


M76729

2. Remove inlet and outlet hose clamps at fuel transfer pump (B) and disconnect hoses.
3. Disconnect two cap screws securing fuel pump assembly to frame.
4. Remove all old gasket material from mating surfaces before installation.
5. Installation is done in the reverse order of removal.

Fuel Filter

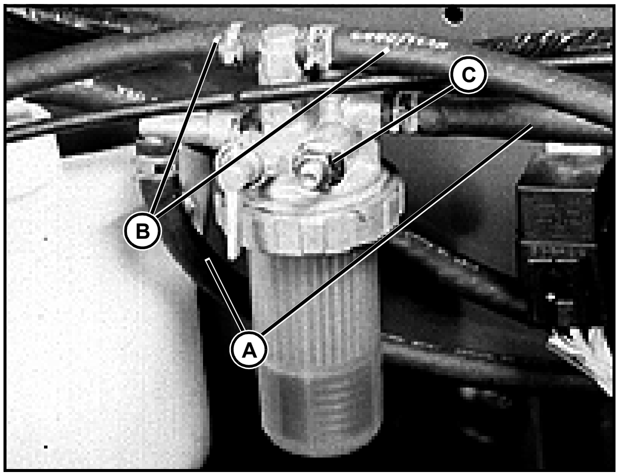
Components:



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

Removal:



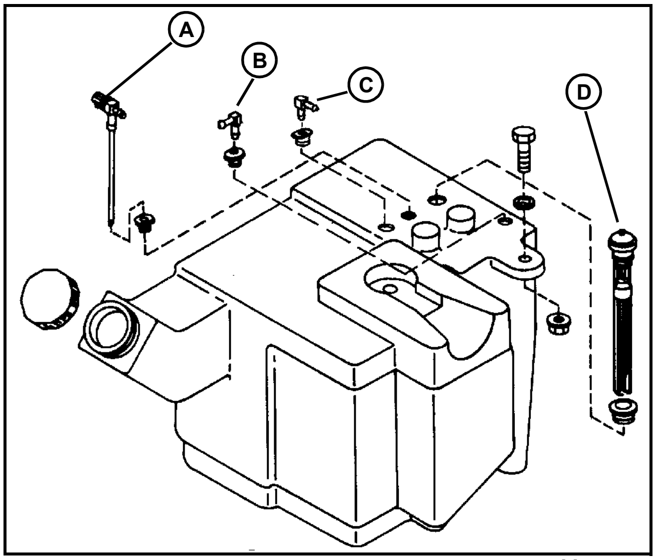
M76723

1. Remove two fuel lines (A) from fuel filter assembly.
2. Remove two fuel return lines (B) from fuel filter assembly.
3. Remove nut (C) securing filter assembly to mounting stud.
4. Slide fuel filter assembly off of mounting stud.

Installation:

Installation is done in the reverse order of removal.

Fuel Tank Components



M76800

A - Pickup Tube/Shutoff (Fuel shutoff valve on early models only)
B - Vent
C - Return Fuel Fitting
D - Fuel Level Indicator

Fuel Injection Nozzle

Removal:

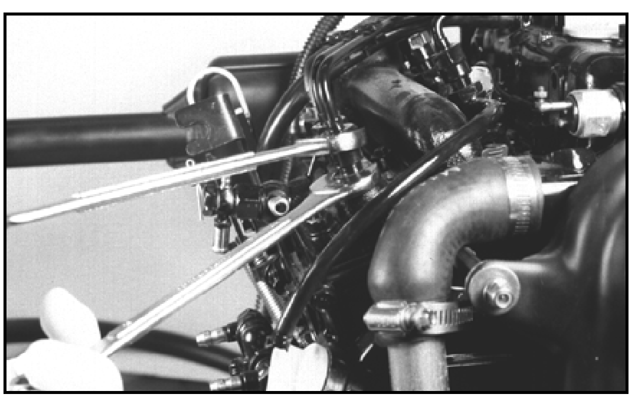
> **CAUTION: Avoid Injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and 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 warm. Doing so can damage the pump.**

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

> **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.**

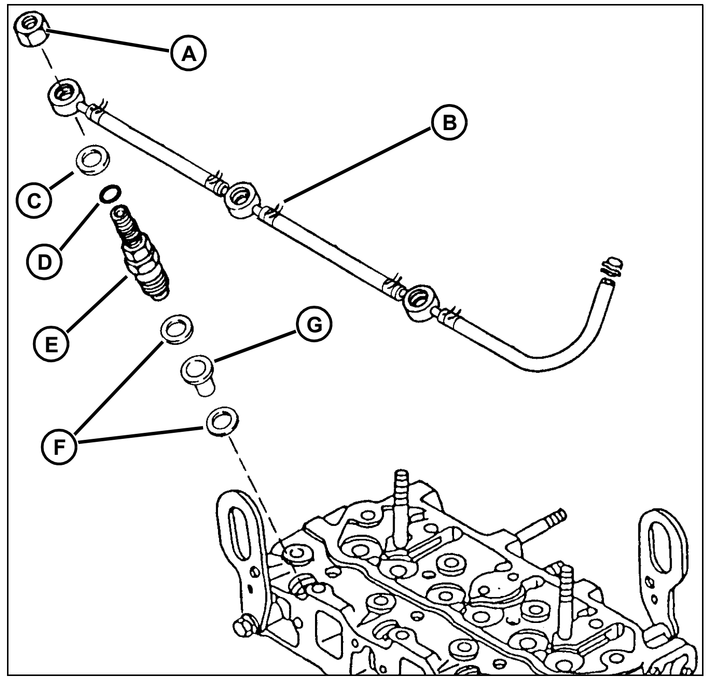
NOTE: Nozzles are matched to the cylinders. If removing more than one nozzle, tag nozzles, according to the cylinder from which it was removed.



M76730

2. 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.

3. Loosen fuel line clamp, and remove fuel lines.



M82323A

4. Remove nuts (A) and leak-off hose assembly (B).

5. Remove bronze washers (C) and O-rings (D).

6. Remove injection nozzle (E), washers (F), and heat protector (G).

7. Test injection nozzles. See “Fuel Injection Nozzle Test” on page 162.

Installation:

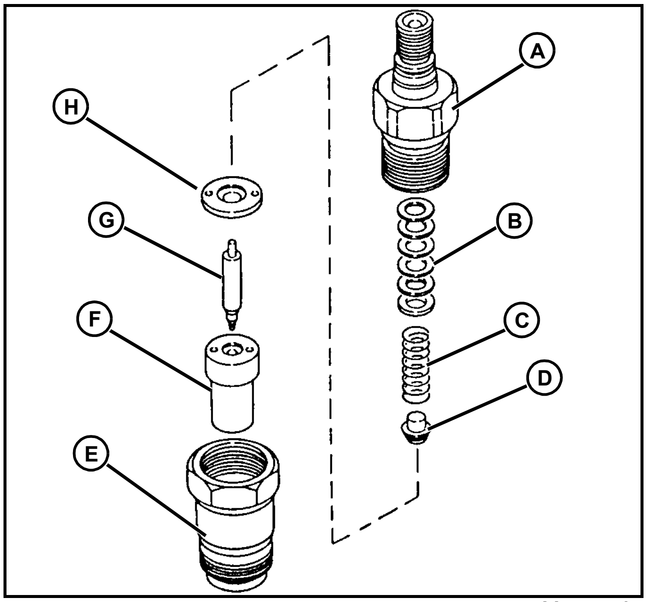
Installation is done in reverse order of removal.

- Tighten injection nozzle to 50 N•m (37 lb-ft).
- Tighten leak-off hose nuts to 40 N•m (30 lb-ft).

Repair:

> **IMPORTANT: Avoid damage! If injection nozzles are disassembled to be cleaned, the same number and thickness of shims must be installed.**

NOTE: If servicing more than one nozzle, keep parts for each nozzle separate from one another.



M82324A

A - Injector Body
B - Shims
C - Spring
D - Spring Seat
E - Nozzle Fitting
F - Nozzle Body
G - Nozzle Valve
H - Separator Plate

- Clean and inspect nozzle assembly. See “Cleaning and Inspection:” on page 209.
- After assembly is complete, test injection nozzle. See “Fuel Injection Nozzle Test” on page 162.

Cleaning and Inspection:

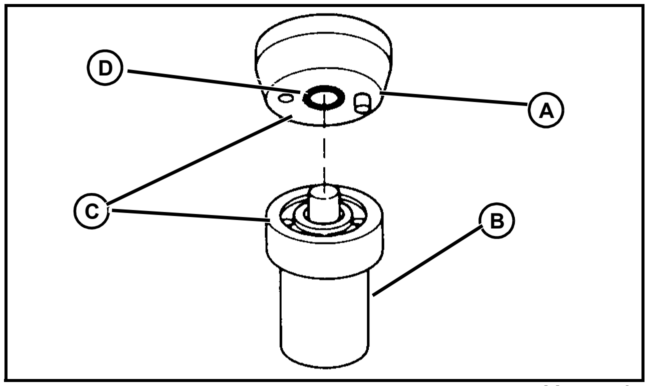
NOTE: To clean nozzles properly, JDF13 Nozzle Cleaning Kit is recommended. The Cleaning Kit is available through the John Deere SERVICEGARD™ Catalog.

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

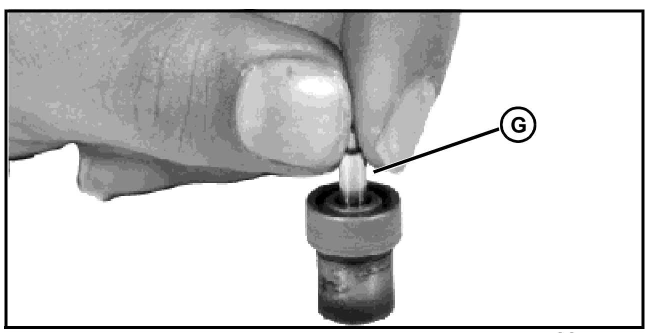
4. Inspect condition of separator plate (A) and nozzle body (B). Contact area of separator plate (both parts) must not be scored or pitted. Use an inspection magnifier (No. 16487 or equivalent) to aid in making the inspection.

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:

8. Dip the nozzle valve in clean diesel fuel. Insert valve in nozzle body.



M35919

9. Hold nozzle vertical, and pull valve (G) out about 1/3 of its engaged length.

10.Release valve. Valve should slide down to its seat by its own weight.

11.Replace nozzle assembly if the valve does not slide freely to its seat.

Fuel Injection Pump (Engines -013716)

Removal:

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.

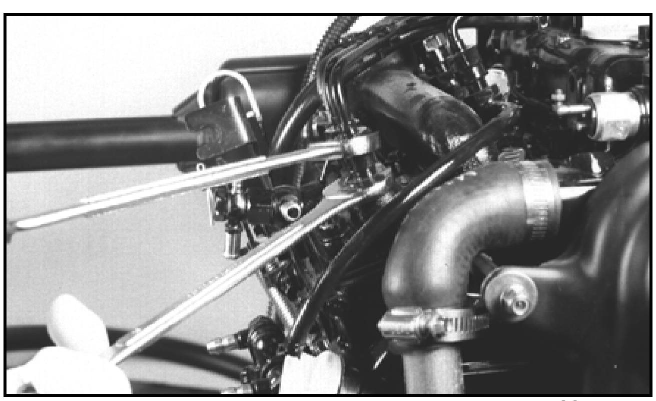
Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

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 warm. Doing so can damage the pump.

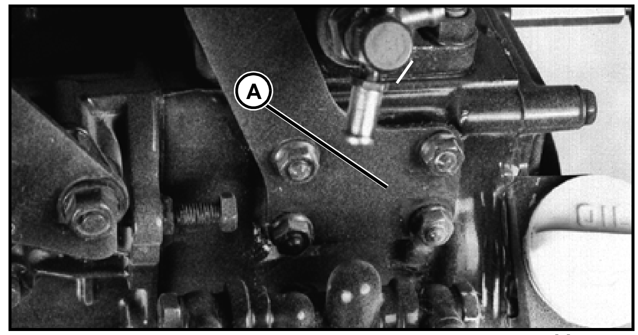
1. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner.

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.



M76730

2. Disconnect injector/bypass fuel line.
3. Remove hose from air cleaner to intake manifold.
4. Loosen fuel line connectors at fuel injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench to keep delivery valves from loosening.
5. Loosen line clamp and remove fuel injection lines.
6. Disconnect hoses from fuel injection pump.
7. Disconnect leak-off hoses from injectors.

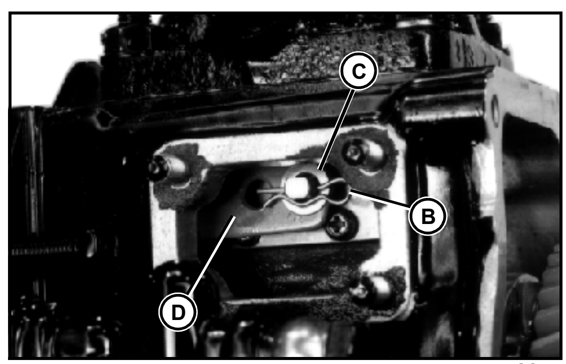


M76731

8. Remove four nuts, governor linkage cover (A) and gasket.

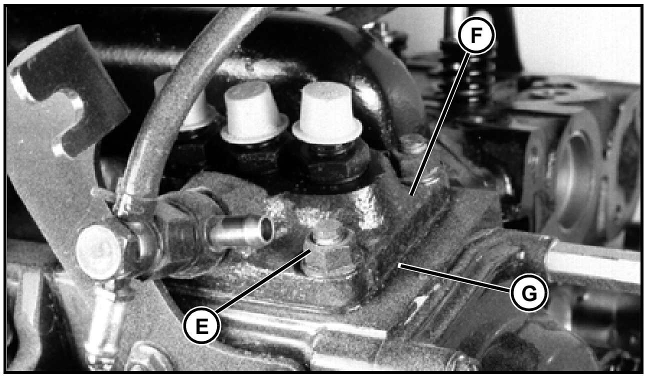
IMPORTANT: Avoid damage! If injection pump is being removed to be serviced or replaced, the same thickness of new shims must be installed when pump is assembled. New shims must be used with protective seal coating.

NOTE: Washer may be fixed to linkage. Do not drop pin during removal.



M82685

9. Remove pin (B) and washer (C) if equipped. Disconnect governor linkage (D).



M76732

10.Remove four nuts (E) to remove fuel injection pump (F) and shims (G).

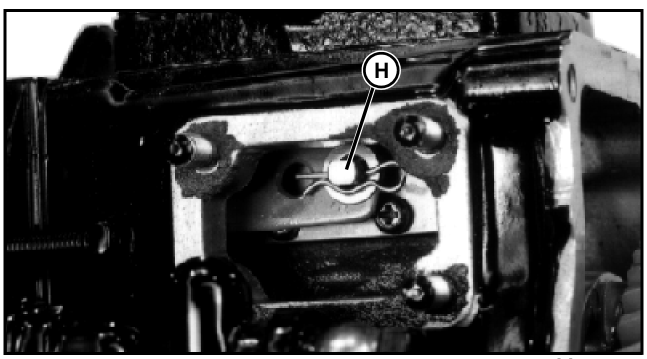
Installation:

Installation is done in the reverse order of removal.

IMPORTANT: Avoid damage! If a serviced or replacement fuel injection pump is installed, measure old shim thickness and install new shims of the same thickness.

NOTE: Governor linkage has two holes. Connect governor linkage to injection pump rack using hole closest to injection pump gear.

Do not drop pin or washer during installation.



M82685

- When connecting governor linkage to injection pump rack (H), attach link to rack at hole closest to injection pump gear.
- Bleed the fuel system.
- If new injection pump is being installed, check and adjust injection pump timing. See "Fuel Injection Pump Timing Adjustment (Engines -013716)" on page 163.
- 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 (Engines 013717-)

Removal:.

MX1339

Picture Note: EJUV engine emission compliance sticker located on rocker arm cover

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.

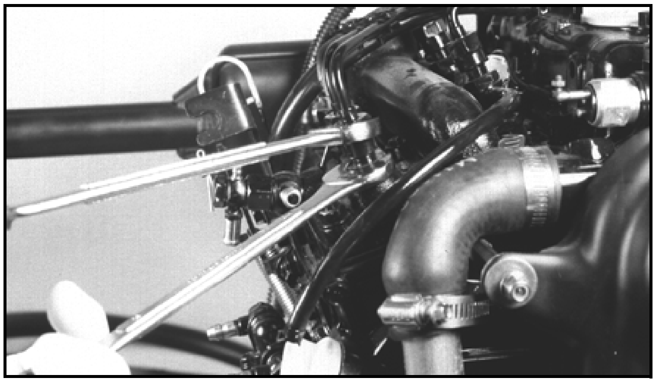
Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

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 warm. Doing so can damage the pump.

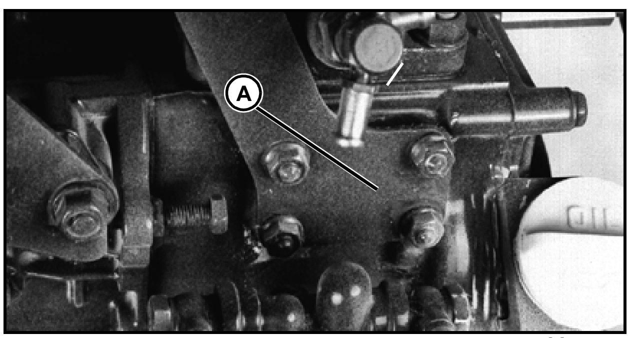
1. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner.

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.



M76730

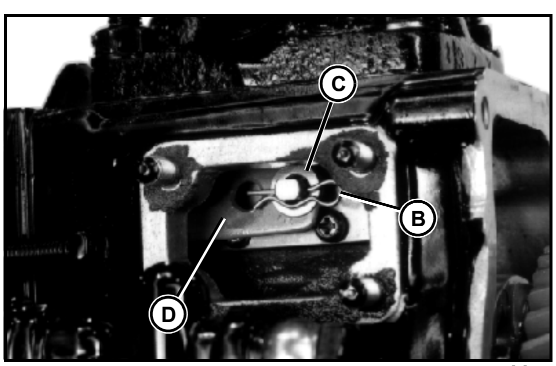
2. Disconnect injector/bypass fuel line.
3. Remove hose from air cleaner to intake manifold.
4. Loosen fuel line connectors at fuel injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench to keep delivery valves from loosening.
5. Loosen line clamp and remove fuel injection lines.
6. Disconnect hoses from fuel injection pump.
7. Disconnect leak-off hoses from injectors.



M76731

8. Remove four nuts, governor linkage cover (A) and gasket.

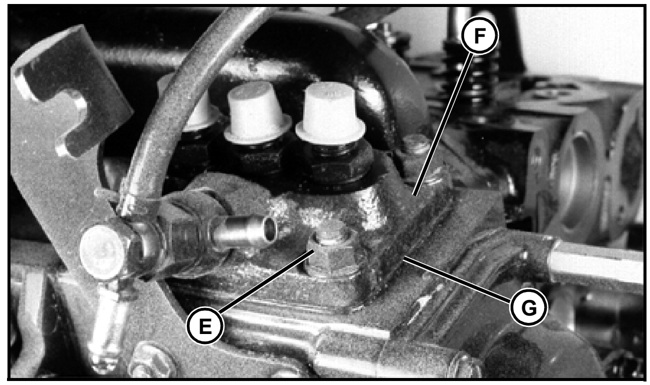
NOTE: Washer may be fixed to linkage. Do not drop pin during removal.



M82685

9. Remove pin (B) and washer (C) if equipped. Disconnect governor linkage (D).

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.



M76732

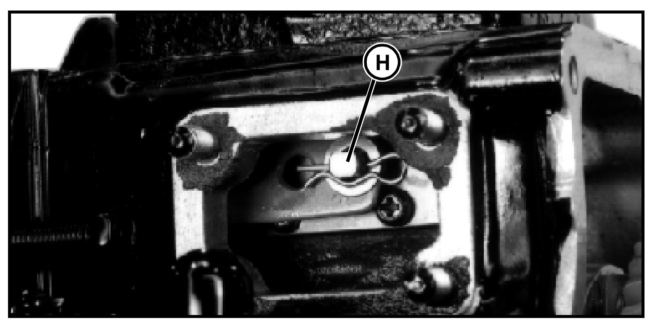
10. Remove four nuts (E) to remove fuel injection pump (F) and shim (G).

Installation:

Installation is done in the reverse order of removal.

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 (H), 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 Camshaft

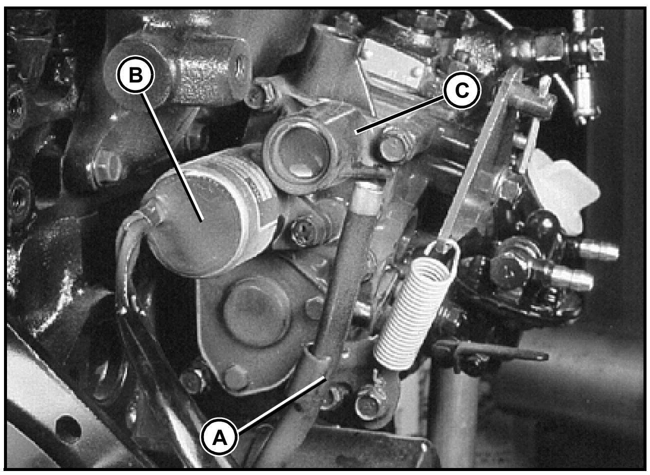
Removal:

IMPORTANT: Avoid damage! Do not loosen four bolts on injector pump camshaft gear on EJUV engines!

1. Remove timing gear cover. See "Timing Gear Cover" on page 183.

2. Remove fuel injection pump. See "Fuel Injection Pump (Engines -013716)" on page 210, or "Fuel Injection Pump (Engines 013717-)" on page 211.

3. Remove fuel transfer pump. See "Fuel Transfer Pump" on page 206.



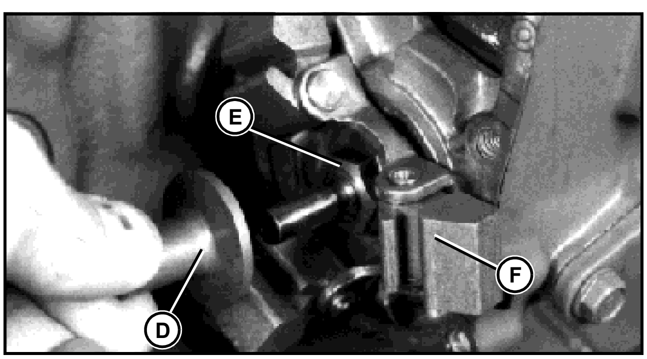
M76734

4. Remove throttle return spring and oil dipstick tube (A).

5. Disconnect and remove fuel shutoff solenoid (B).

6. Remove five cap screws attaching governor assembly (C) to timing gear housing.

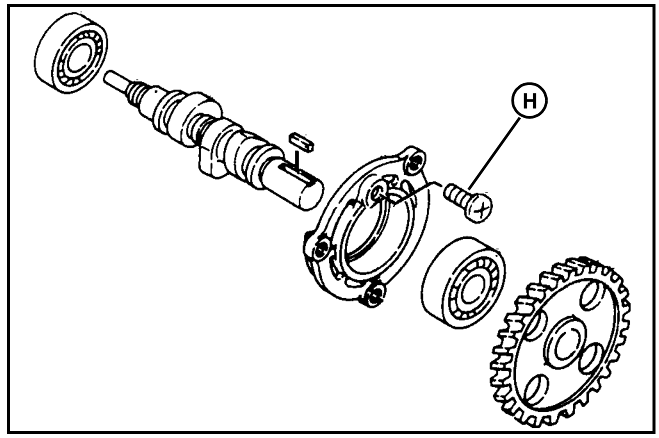
7. Remove governor assembly.



M37755

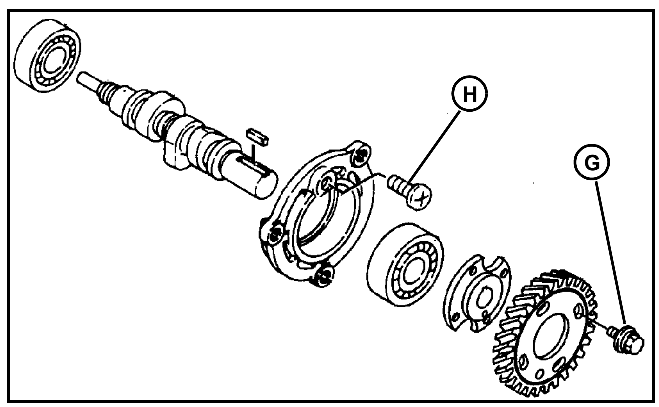
8. Remove sleeve (D), nut (E) and governor weights (F) from end of injection pump camshaft.

IMPORTANT: Avoid damage! There are two types of fuel injection pump camshaft gears shown below. The 3TN66C-JUV is a solid gear. The 3TN66C-EJUV has a gear with four slots bolted to a hub on the camshaft. Do not loosen the bolts (G) on the 3TN66C-EJUV securing the gear or camshaft timing will be altered. If the bolts have been loosened the camshaft and gear must be replaced with AM880627 Fuel injection pump camshaft kit.



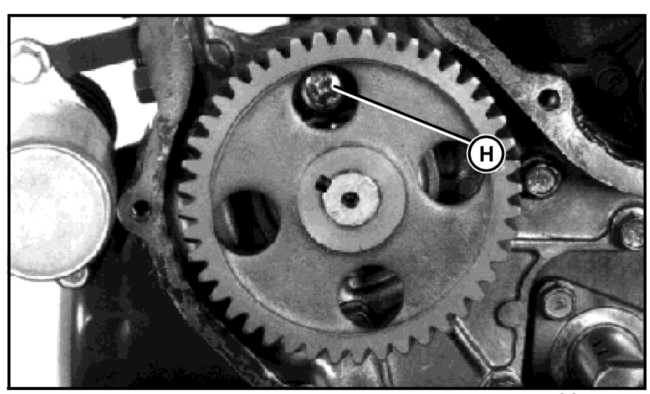
MX1340

Picture Note: 3TN66C-JUV



MX1341

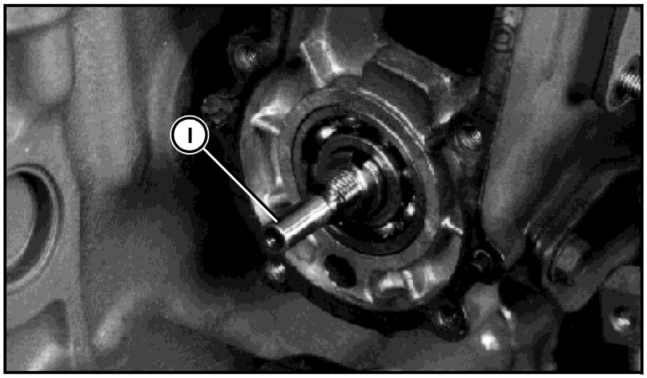
Picture Note: 3TN66C-EJUV



M37804

9. Remove bearing retaining screw (H).

IMPORTANT: Avoid damage! Do not allow fuel injection pump camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces may be damaged.



M37796

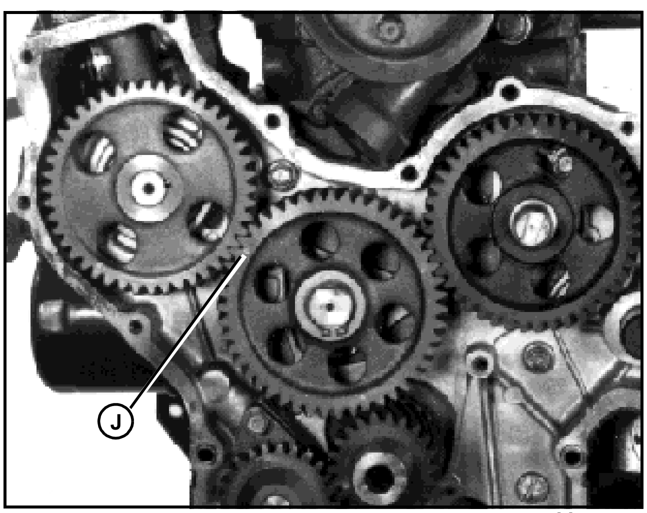
10.Carefully tap the rear of camshaft (I) with plastic hammer to remove from housing.

11.Disassemble and inspect all parts for wear or damage. See “Fuel Injection Pump Camshaft” on page 213.

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 (H) to 20 N•m (180 lb-in.).



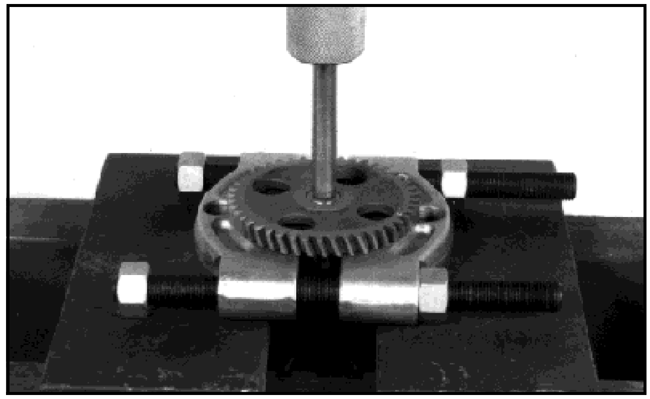
M37832

- Align timing marks (J) on injection pump gear and idler gear when installing camshaft.

Disassembly:

IMPORTANT: Avoid damage! Hold camshaft while removing gear and bearings. Shaft can be damaged if dropped.

NOTE: Gear and bearings are press fit on shaft.



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” on page 213.

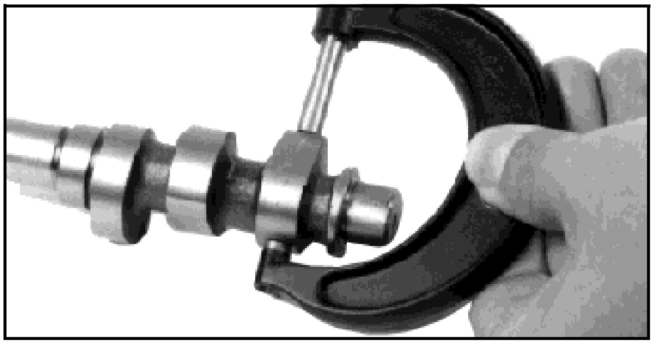
Assembly:

IMPORTANT: Avoid damage! When pressing bearings apply pressure on the inner bearing race only.

NOTE: Install large bearing on gear end.

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:

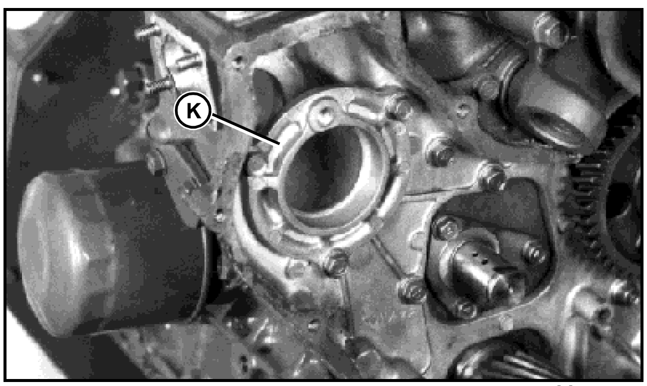


M35905

1. Measure height of each camshaft lobe. Replace camshaft if lobe height is less than 30.90 mm (1.217 in.).

2. Inspect camshaft bearing supports in timing gear housing. Check for cracks, damage or indications that bearings have spun in support.

3. If rear bearing bore is damaged, replace timing gear housing.



M37803

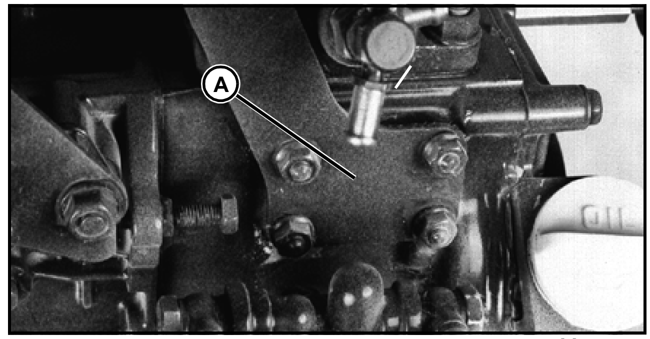
4. If front bearing bore (K) is damaged, remove three cap screws and replace support.

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

Governor

Removal:

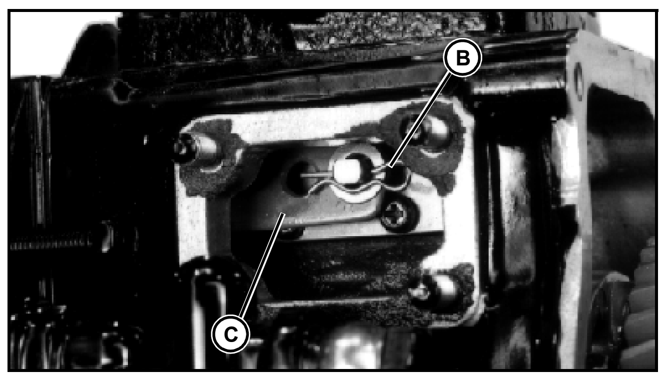
1. Disconnect and remove fuel shutoff solenoid.
2. Remove muffler.
3. Remove valve cover breather hose.



M76731

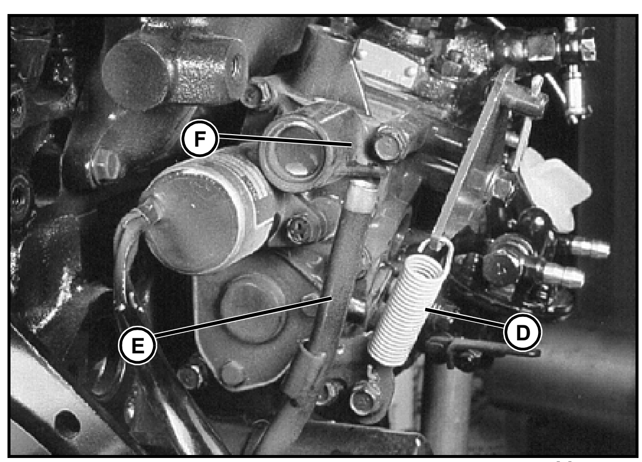
4. Remove four nuts, governor linkage cover (A) and gasket. Discard old gasket.

NOTE: Washer may be fixed to linkage. Do not drop pin during removal.



M82685

5. Remove pin (B) and washer to disconnect governor linkage (C).

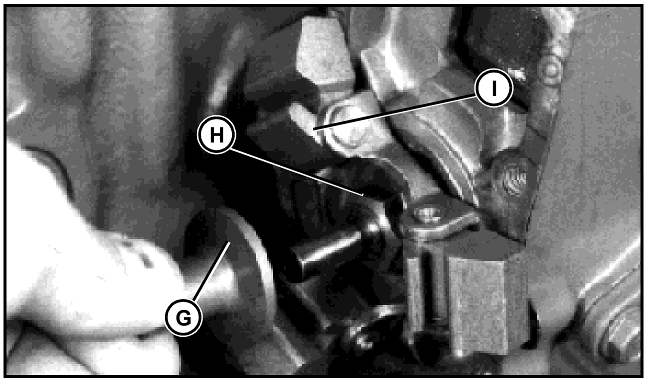


M76734

6. Remove throttle return spring (D) and dipstick tube (E).

7. Remove five cap screws attaching fuel linkage housing (F).

8. Remove linkage housing and gasket.



M37755

9. Remove sleeve (G).

10.Remove nut (H) and governor weights (I).

11.Disassemble and inspect all parts for wear or damage. See "Fuel Control and Governor Linkage:" on page 136.

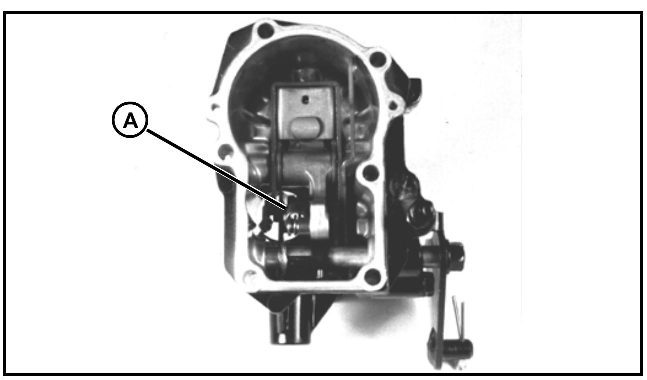
Installation:

Installation is done in the reverse order of removal.

- Governor linkage has two holes. Connect governor linkage to injection pump rack using hole closest to injection pump gear.
- Check and adjust slow idle settings. See "Slow Idle Adjustment" on page 158.

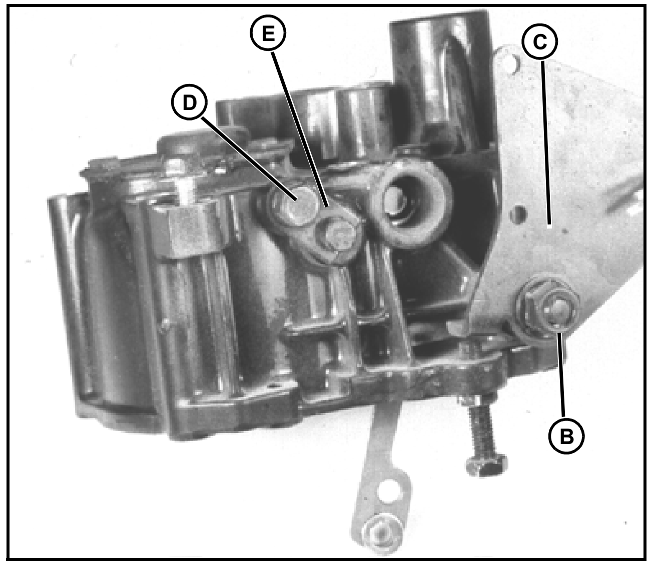
Disassembly:

IMPORTANT: Avoid damage! This section covers only 3TN66C-JUV engines. Governor assembly cannot be serviced on 3TN66C-EJUV. If trouble with governor occurs, entire governor must be replaced.



M76735

1. Remove spring (A).

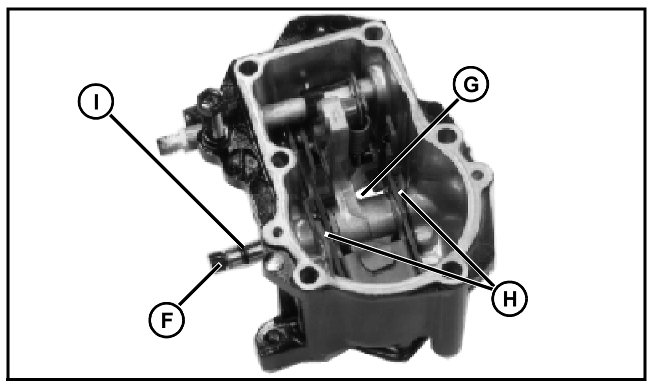


M76736

2. Remove nut (B) and throttle lever plate (C).

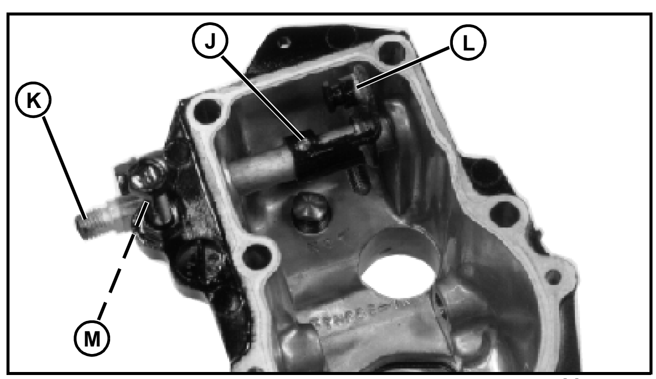
3. Remove cap screw and throttle shaft retaining plate.

4. Remove cap screw (D) and governor shaft retaining plate (E).



M82689

5. Remove governor shaft (F), governor linkage assembly (G), shims (H) and O-ring (I).

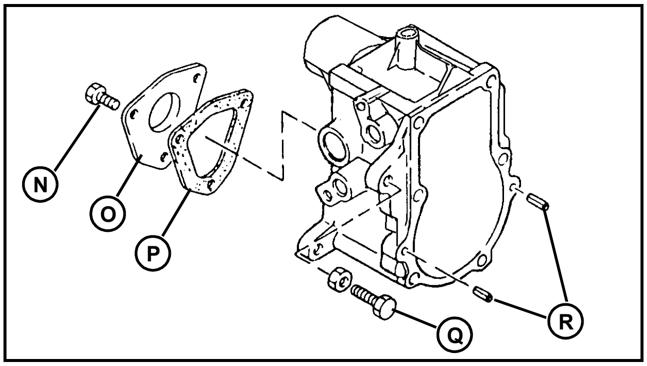


M82690

6. Rotate throttle shaft assembly as shown.

7. Remove tapered pin (J) from tapered hole using a punch.

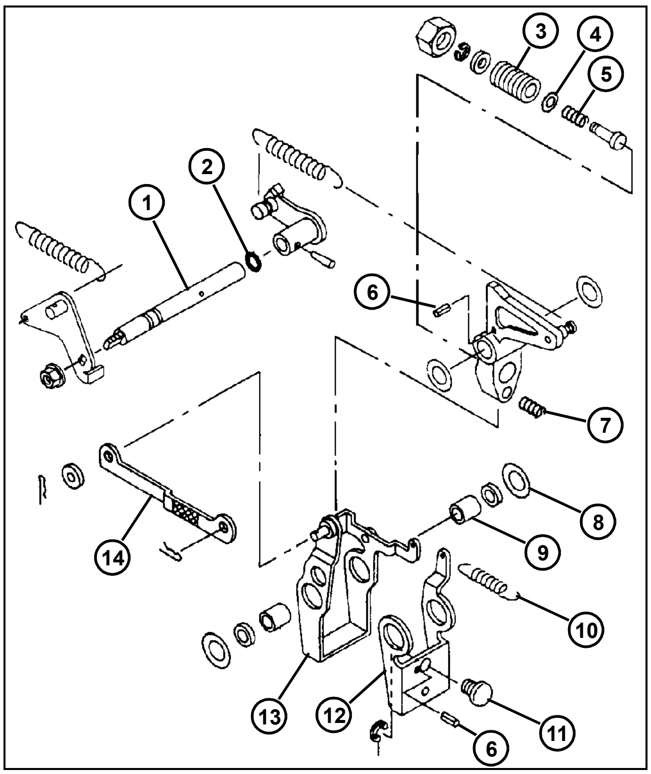
8. Remove throttle shaft (K), shaft lever (L) and O-ring (M).



M82676B

9. Remove three cap screws (N), cover (O), and gasket (P). Replace gasket.

10.Check slow idle stop screw (Q) and two spring pins (Q) for wear or damage, and replace as necessary.



MX0762

1. Throttle Shaft	8. Shim
2. O-ring	9. Bushing
3. Adjuster Stud	10. Spring
4. Shim(s) (as required)	11. Pin
5. Spring	12. Governor Lever
6. Spring Pin	13. Bracket
7. Spring	14. Governor Link

11.Disassemble governor linkage assembly.

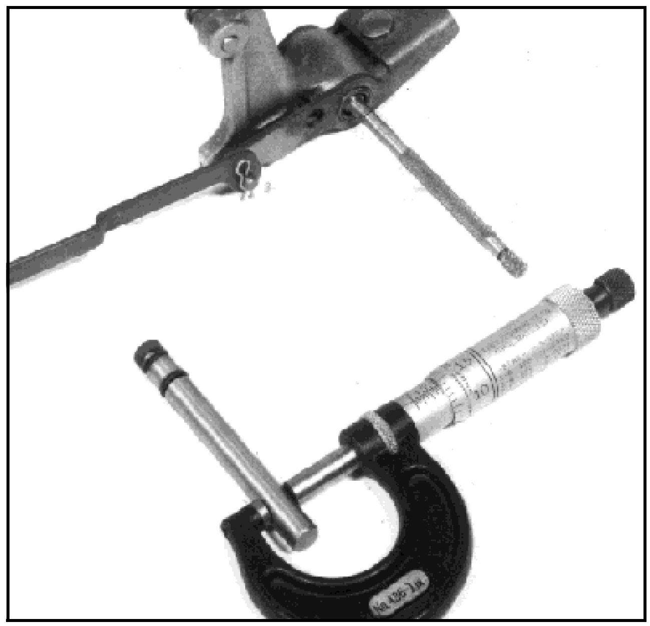
12.Inspect all parts for wear or damage. Replace as necessary.

Assembly:

Assembly is done in the reverse order of disassembly.

- Apply clean engine oil on all internal parts.
- When installing throttle shaft:
    - Install new O-ring, throttle shaft and shaft lever.
    - Install tapered pin in tapered hole.
- Slow idle adjustments are made after engine has been installed in the machine. See “Slow Idle Adjustment” on page 158.

Inspection:

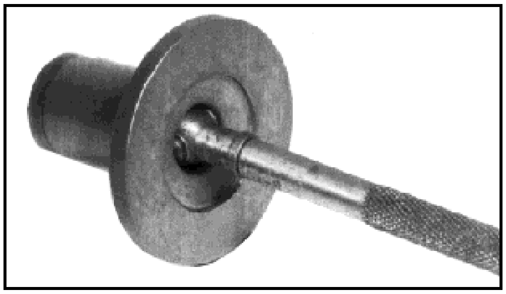


M37763

1. Measure governor shaft diameter. If OD is less than specification, replace governor shaft.

2. Measure governor shaft bore diameter in governor linkage.

    - If shaft bore exceeds wear limit, replace governor linkage.
    - If bore clearance (bore ID minus shaft OD) exceeds specification, replace governor shaft, governor linkage or both.



M37756

3. Measure inside diameter of sleeve. If ID is more than specification (see Specification below), replace sleeve.

M37757

4. Measure injection pump camshaft diameter (see Specifications below).

- If camshaft diameter is less than wear limit, replace injection pump camshaft.
- If clearance (sleeve ID minus camshaft OD) exceeds specification, replace sleeve, injection pump camshaft or both.

Specifications:

Governor Shaft Specifications:

Shaft OD (Wear Limit)	**8.01 mm (0.315 in.)**
Bore ID (Wear Limit)	**8.50 mm (0.335 in.)**
Clearance	**0.09 mm (0.004 in.)**
Sleeve ID (Maximum)	**9.00 mm (0.354 in.)**

Injection Pump Camshaft OD:

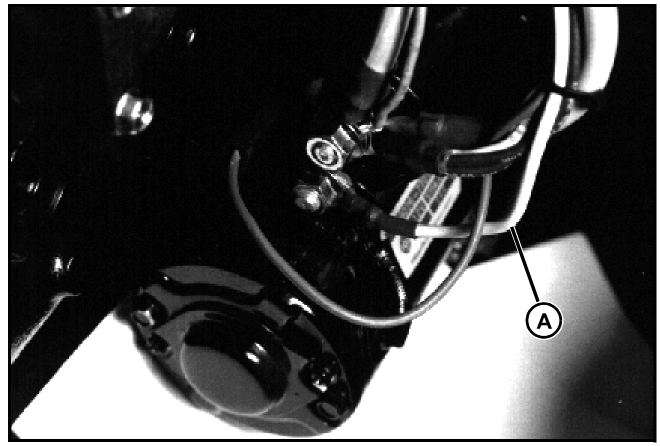
Wear Limit	**7.90 mm (0.311 in.)**
Clearance	**0.15 mm (0.006 in.)**

Starting Motor

Removal:

1. Park machine on level surface, engine OFF, park brake ON, cargo box UP.

2. Disconnect negative battery cable.



M76900

3. Mark and remove all wires to starting motor. Note that white wire (A) is connected to lower starting motor stud.

4. Remove two mounting nuts holding starting motor to frame, and pull starting motor off of studs and out of engine compartment.

Installation:

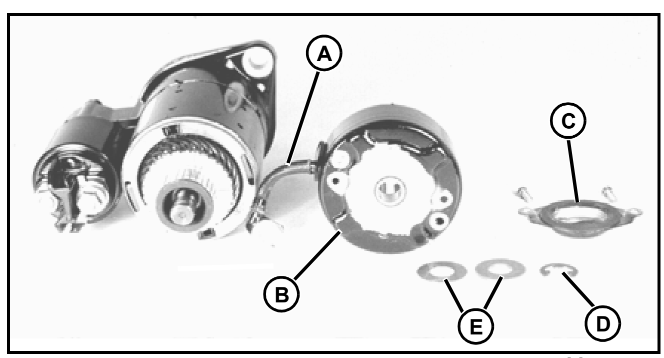
1. Install starting motor on studs as removed and tighten mounting bolts to 28 N•m (20 lb-ft).

2. Install all wires as removed, note that white wire is connected to lower starting motor stud.

3. Reconnect negative battery lead to battery.

Starting Motor Repair

Disassembly and Inspection:

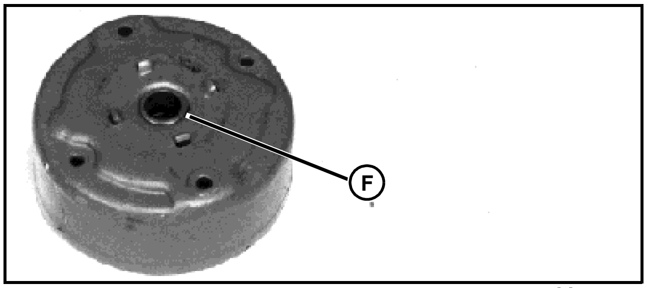


M76738

1. Disconnect field lead (A).

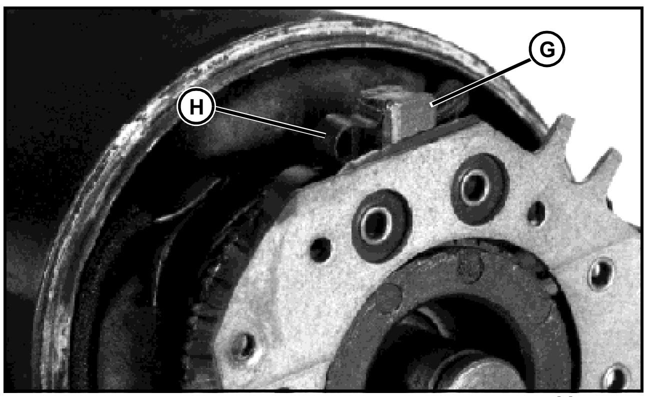
2. Remove two cap screws and two screws from rear cover (B).

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.



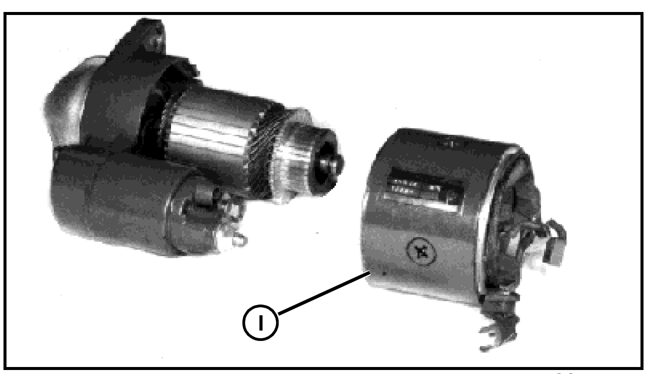
M37874

6. Ream bushing (F) to 12.50 - 12.53 mm (0.492 - 0.493 in.).



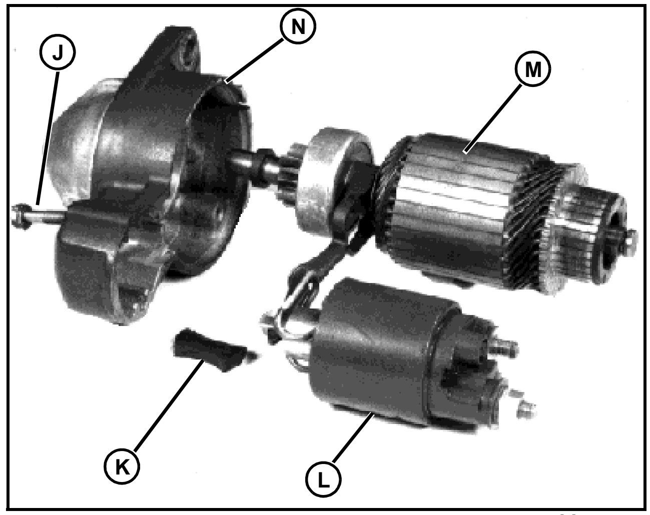
M37875

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.
9. Remove brush holder.



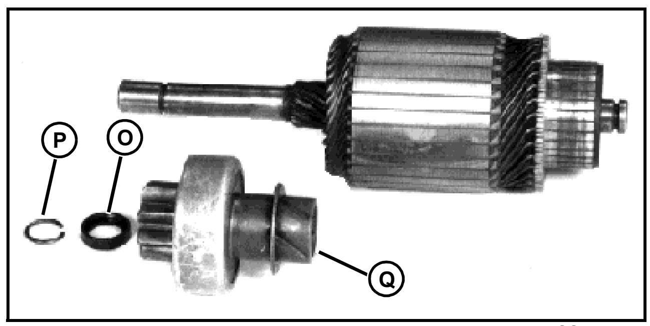
M37876

10. Remove field coil housing (I) from armature/solenoid assembly.



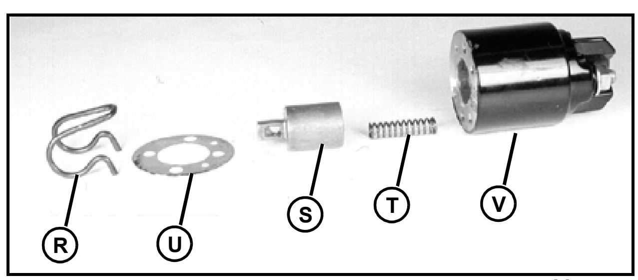
M37877

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

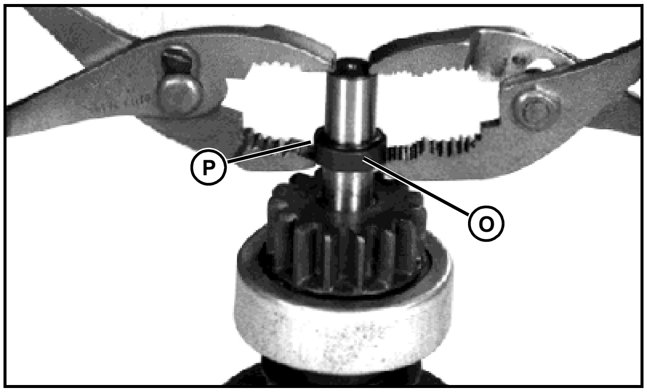
17. Remove clutch fork pivot (R), plunger (S), spring (T) and shim(s) (U) from solenoid (V).

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 below.)

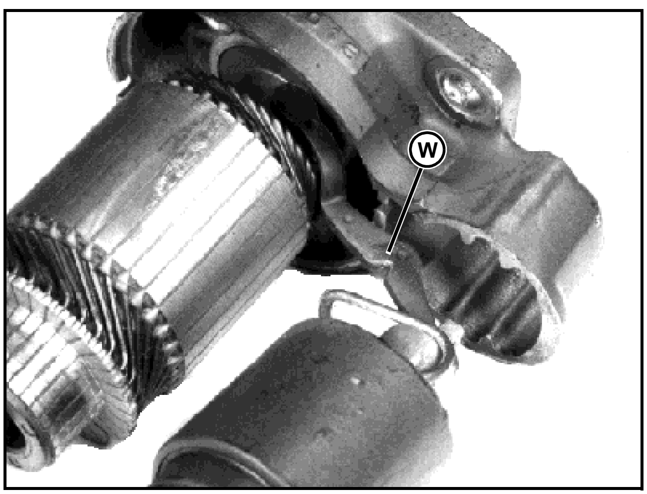
Assembly:

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.



M37881

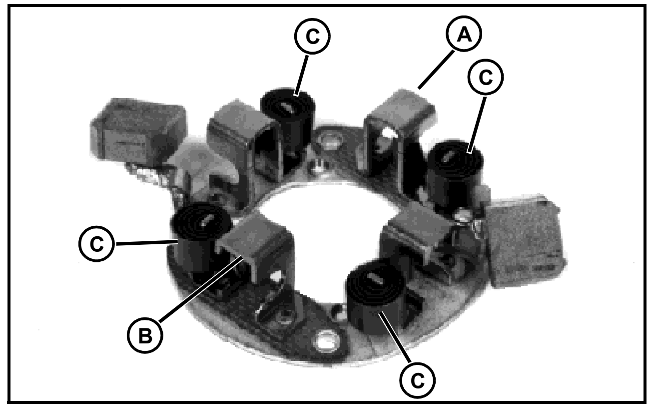
- When installing solenoid and armature assemblies into end frame, make sure fork pivot seats in notch (W) on clutch fork.

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.

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.

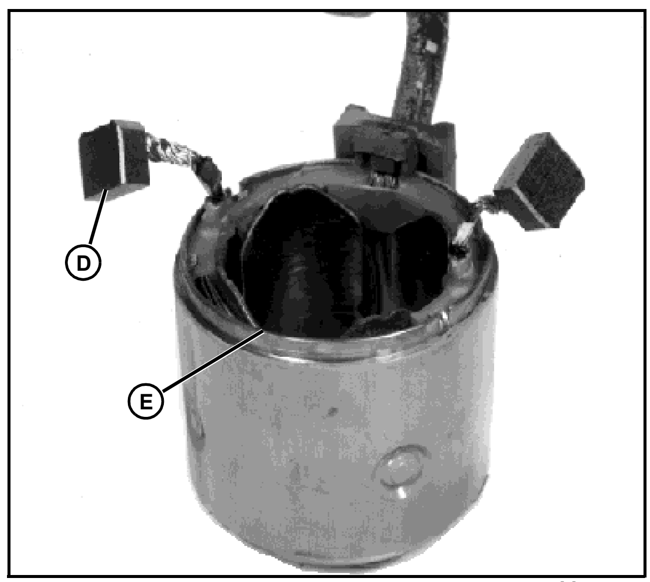
NOTE: Test brush holder using an ohmmeter or test light.



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.

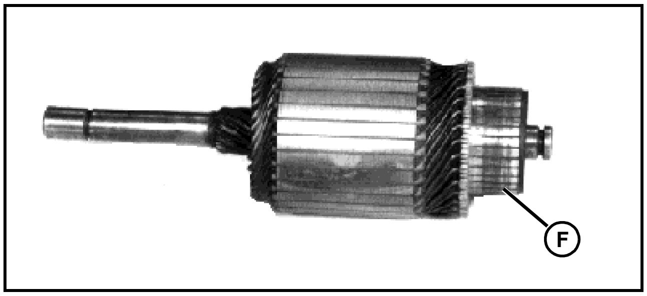


M82235

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.

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

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



M82246

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.

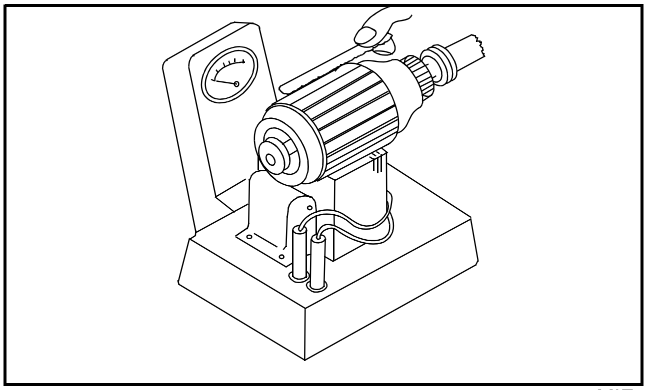
NOTE: Test armature windings using an ohmmeter or test light.

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.

Alternator

Equipment:

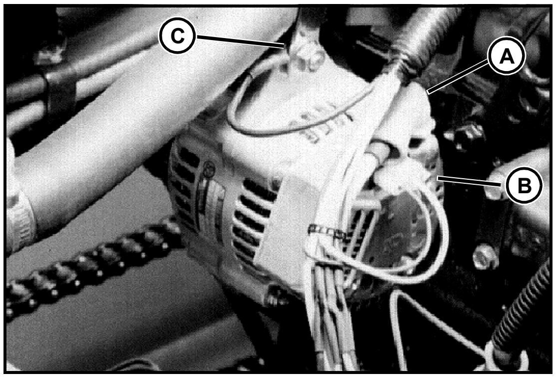
- Volt-Ohm-Amp Meter
- 13 Ton Bearing Puller Set

Removal:

1. Park machine on level surface, park brake ON, engine OFF, cargo box RAISED.

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

3. Remove alternator/water pump belt cover from front of engine by removing three nuts and washers from front of cover.



M76901

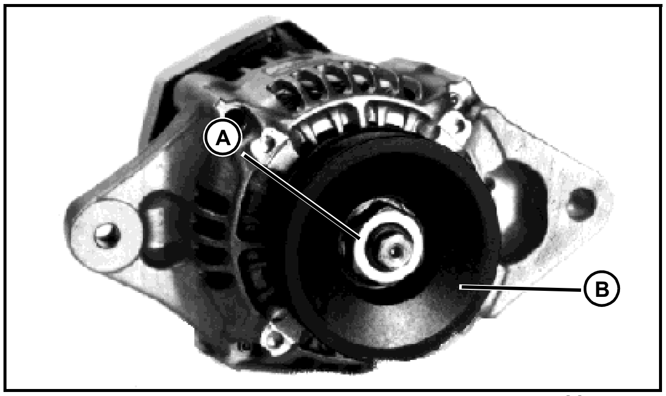
4. Lift red plastic protective cover from positive (red) lead (A) from battery. Remove nut and washer and remove lead from alternator stud.

5. Remove indicator lamp connector (B) and ground wire (C) from alternator and move wiring harness to the side

6. Loosen alternator mounting bolts and remove belt from drive pulley.

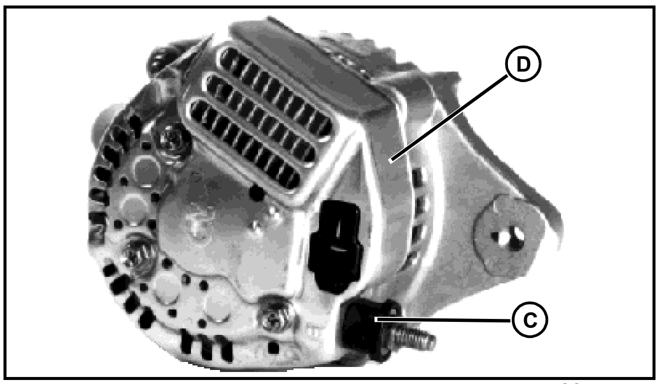
7. Remove mounting bolts. Pull alternator from frame.

Disassembly:



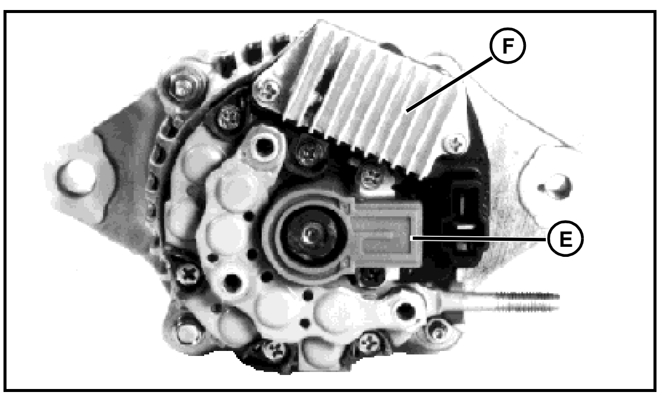
M52469

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).

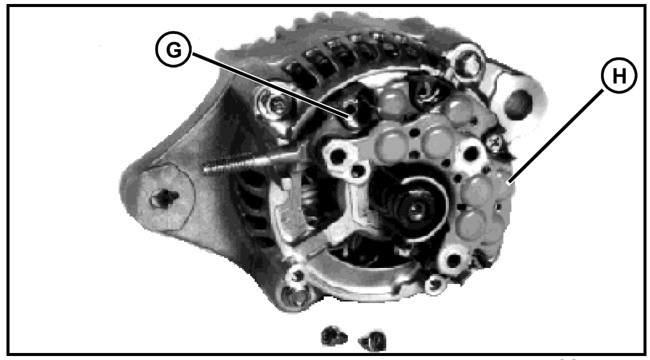


M52472

5. Remove brush holder and cover (E).

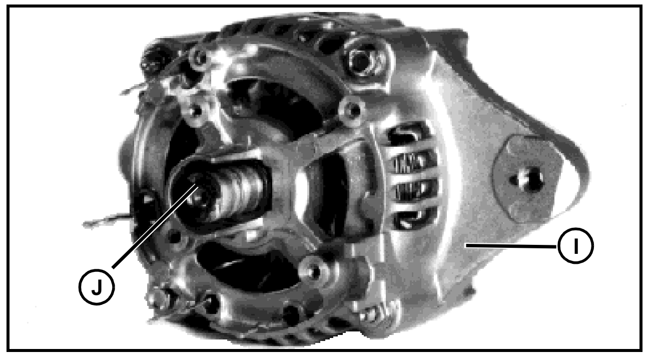
NOTE: Remember location of short screw on regulator tab.

6. Remove regulator (F).



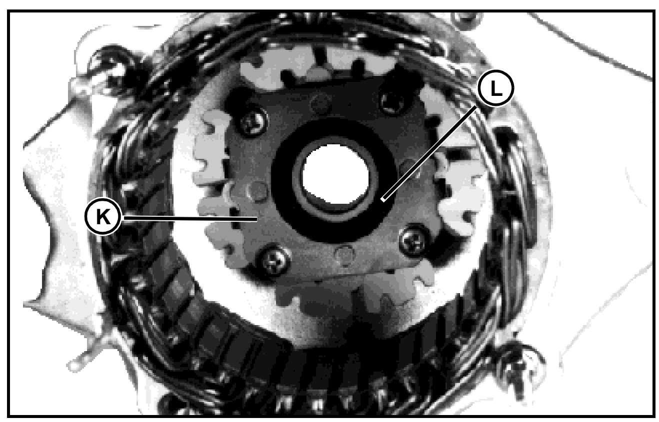
M52471

7. Remove screw and straighten wire leads (G).
8. Remove rectifier (H).



M52473

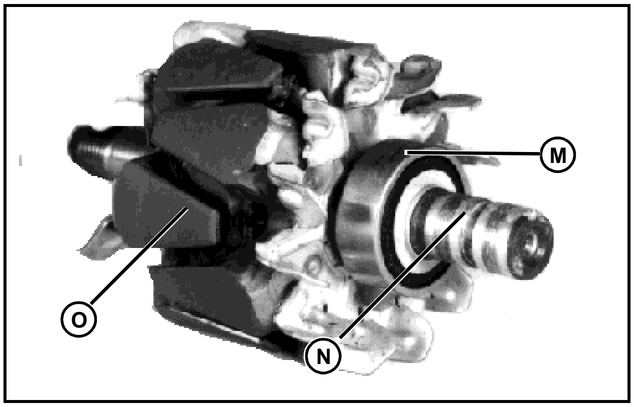
9. Remove rear case assembly (I).
10. Press rotor shaft (J) from rear case.



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 (see Specification below).

4. Check continuity between slip rings (N) using ohmmeter or continuity tester. Replace rotor assembly if there is no continuity.

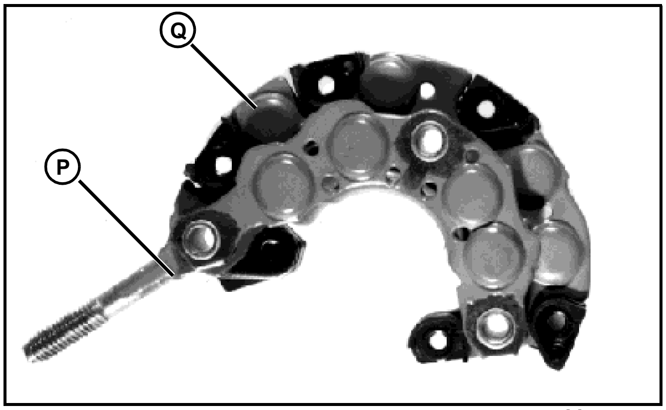
NOTE: Use an ohmmeter that is sensitive to 0 - 1 ohm.

5. Check continuity between slip rings and rotor core (O). Replace rotor assembly if there is continuity.

6. Inspect stator for defective insulation, discoloration, or burned odor.

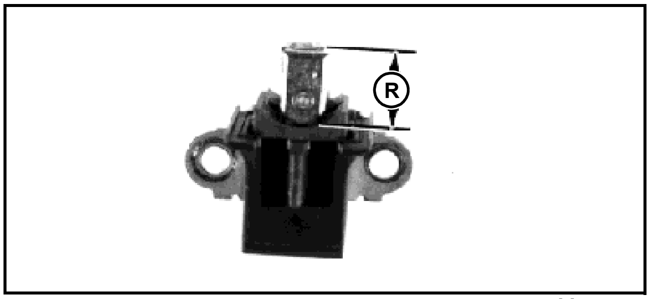
NOTE: Set ohmmeter to the K ohm range.

7. Check for continuity between each stator lead and body. Replace stator if there is continuity.



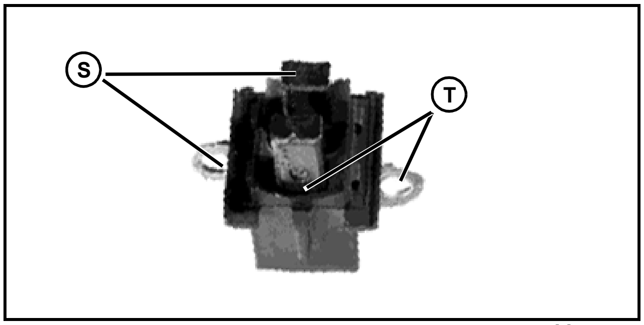
M52477

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 (see Specifications below). 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) . . . . . 14.0 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:

1. Press new bearing (L) into case.

NOTE: Check that rotor fan does not contact case and that rotor assembly turns smoothly in bearing.

2. Install retainer plate (K).
3. Press rotor shaft (J) into rear case.
4. Install rear case assembly (I).
5. Install rectifier (H).

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.

6. Install screws through loop formed in wire leads (G).
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).

Installation:

Installation in reverse of removal.

- Tension drive belt. See “Water Pump/Alternator Drive Belt Adjustment” on page 165.

Table of Contents

Operation and Diagnostics

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 schematics are drawn with the components in the operating position, with the power, or battery positive, into them across the top and the ground, or battery negative, across the bottom.

Diagnostic Information

The diagnostic procedures 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:

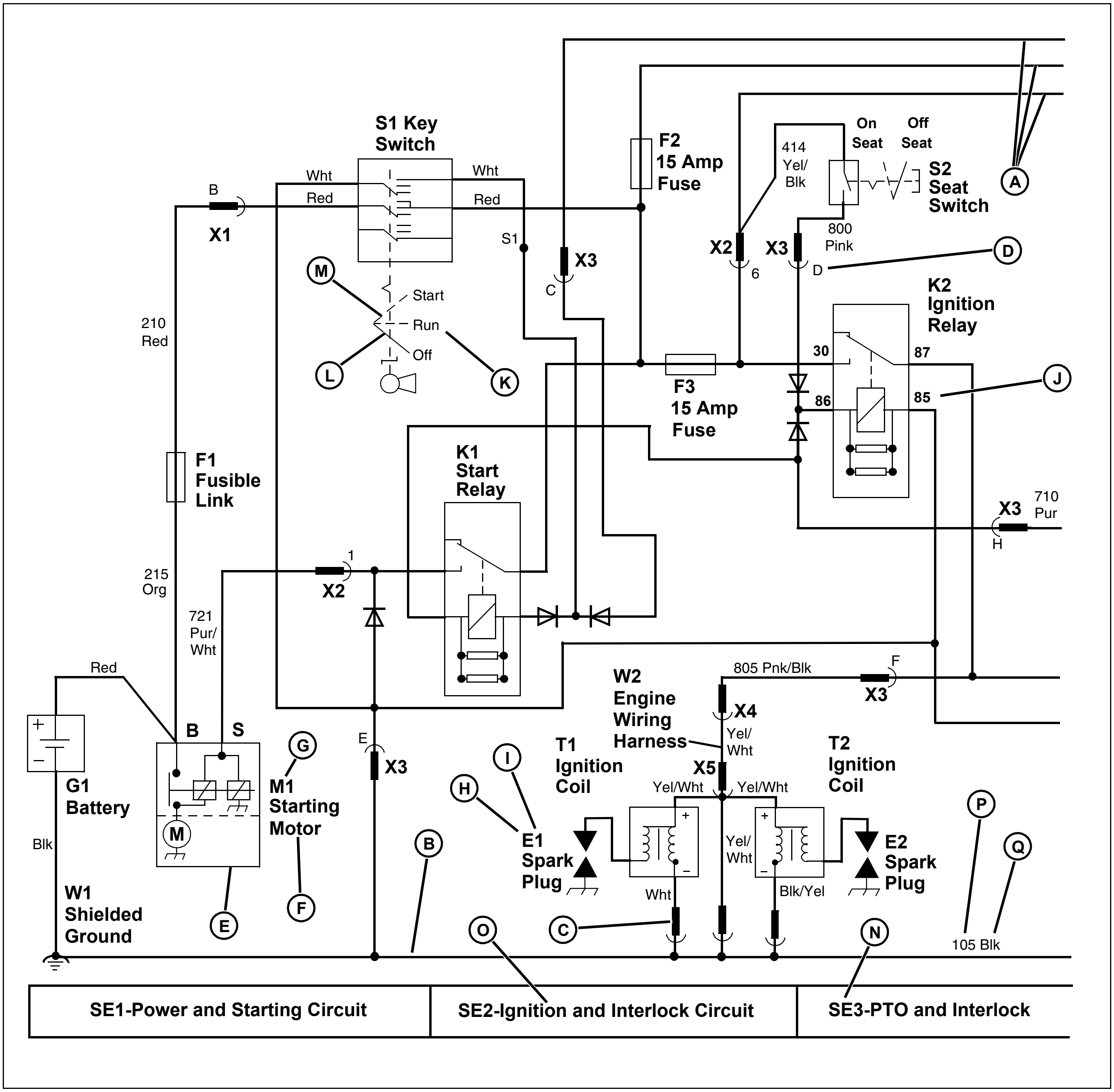
- Test conditions
- Test sequence
- Test location
- Normal reading
- Check or test to perform if reading is not normal

When performing the test or check, be sure to set your machine up to the test conditions listed and follow the sequence carefully. The middle “NORMAL” column gives the reading or condition that should be obtained when performing the test or check. If the results of the test or check are not normal, perform the test, check, or adjustment listed in the third “IF NOT NORMAL” column to repair the malfunction. The detailed tests or adjustments referred to in the “IF NOT NORMAL” column are located at the end of that group. The system diagram that accompanies each test procedure is drawn to resemble machine components. The key number on the art matches the number in the “TEST LOCATION” column 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**
Blk/Wht	**Black/White**
Blu/Wht	**Blue/White**
Brn/Wht	**Brown/White**
Brn/Yel	**Brown/Yellow**
Dk Blu	**Dark Blue**
Dk Brn/Lt Grn	**Dark Brown/Light Green**
Dk Brn/Red	**Dark Brown/Red**
Dk Brn/Yel	**Dark Brown/Yellow**
Dk Grn	**Dark Green**
Lt Blue	**Light Blue**
Lt Grn	**Light Green**
Org/Wht	**Orange/White**
Pnk/Blk	**Pink/Black**
Pur/Wht	**Purple/White**
Red/Blk	**Red/Black**
Red/Wht	**Red/White**
Wht/Blk	**White/Black**
Wht/Red	**White/Red**
Yel/Blk	**Yellow/Black**
Yel/Red	**Yellow/Red**
Yel/Wht	**Yellow/White**

Reading Electrical Schematics



The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all ground wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in the off position. The diagram does not list connector (C) information unless needed to avoid confusion. If the connector is shown, the number next to it is the terminal pin location (D) in the connector.

Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

The identifying letter is always the same for a specific component, but the identifying numbers are numbered consecutively from upper left to lower right. The terminal designation (J) is placed directly outside the symbol next to the connecting wire path. Switch positions (K) are also placed directly outside the symbol. The solid line (L) shows the position the switch is currently in and dash lines (M) represent other switch positions.

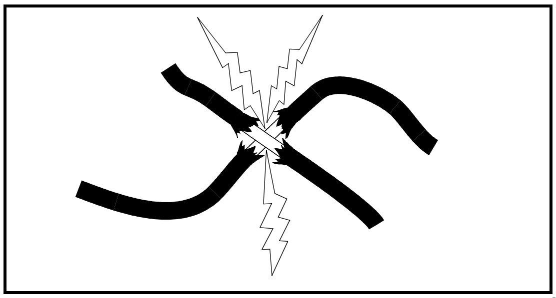
Each circuit is identified at the bottom of the drawing by a section number (N) and section name (O).

The circuit number (P) and wire color (Q) 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:

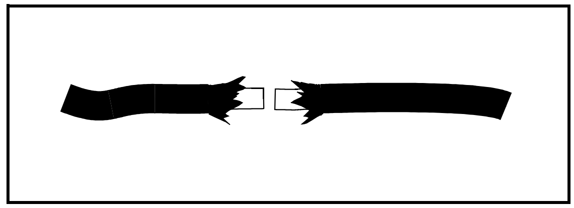


MIF

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.

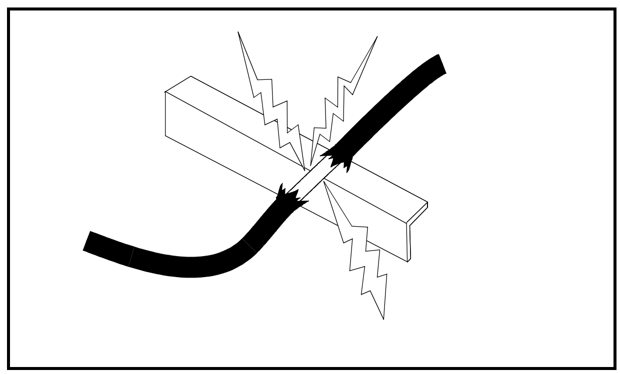
High Resistance or Open Circuit:



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:



MIF

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

Electrical Section Wiring Harness Legend

W1 - Main Wiring Harness - 4X2

W2 - Main Wiring Harness - 6X4 Gas

W3 - Main Wiring Harness - 6X4 Diesel

W4 - Standard Headlight Wiring Harness

W5 - FE290D - BS08 Engine Wiring Harness

W6 - FE290D - BS08 Engine Wiring Harness

W7 - FE290D - BS08 Engine Wiring Harness

W8 - FD620D - Engine Wiring Harness (Main)

W9 - FD620D - Engine Wiring Harness (Ignition Coils)

W10 - FD620D - Engine Wiring Harness (Ignition Module)

W11 - FD620D - Engine Wiring Harness (Pulser Coils)

W12 - FD620D - Engine Wiring Harness (Stator)

W13 - FD620D - Engine Wiring Harness (Carburetor Heater)

W14 - 3TN66C - JUV Engine Wiring Harness (Starting Motor Solenoid)

W15 - 3TN66C - JUV Engine Wiring Harness (Glow Plugs)

W16 - 3TN66C - JUV Engine Wiring Harness (Fuel Shut-off Solenoid)

W17 - Cargo Box Lift Wiring Harness

W18 - Light and Horn Wiring Harness
(North American/European) - Earlier Models

W19 - Light and Horn Wiring Harness
(Road Homologated)

W20 - Rear Position/Brake/Turn Wiring Harness (Left)

W21 - Rear Position/Brake/Turn Wiring Harness (Right)

W22 - Front Position/Turn Wiring Harness (Left and Right)

W23 - Trailer Connector Wiring Harness

W24 - License Plate Light Wiring Harness

W25 - Headlight Adaptor Wiring Harness (Domestic Use)

W26 - Hour Meter Wiring Harness

W27 - Front Blade Wiring Harness (Relays)

W28 - Front Blade Wiring Harness (Switch)

W29 - Auxiliary Alternator Wiring Harness (Option)

W30 - Light and Horn Wiring Harness
(North American/European) - Later Models

W31 - Backup Alarm Wiring Harness

ELECTRICAL SPECIFICATIONS - 4X2 GAS

Specifications - 4X2 Gas

Battery:

Voltage	12
BCI group	U-1
CCA rating (Amps at 0° F)	325
Reserve capacity (minutes)	38
Specific gravity	1.225 or above
Electrolyte required fill (approximately)	1.9 L (2.0 qt)
Load test (minimum)	325 amps for 15 seconds

Ignition:

Primary coil resistance	0.67 - 1.10 ohms
Secondary (Plug wire and core)	6 - 10 ohms
Air gap	0.3 mm (0.012 in.)

Spark Plug:

Type	NGK BPR5ES
Gap	0.64 mm (0.025 in.)
Torque	25 N•m (221 lb-in.)

Starting Motor:

Type	Solenoid Shift
Amp draw (on machine)	51 amps at 750 rpm
No-load amp draw (free running)	50 amps (maximum) at 6000 rpm

Stator:

Stator size	13 amps
Regulated amperage/voltage	13 amps (minimum) at 12.2 - 13.8 volts
Unregulated voltage	34 VAC

Alternator: (FE290D)

High Capacity Alternator (Option)	45 amps
Regulated amperage/voltage	45 amp at 12.2 - 13.8 volts

Lighting:

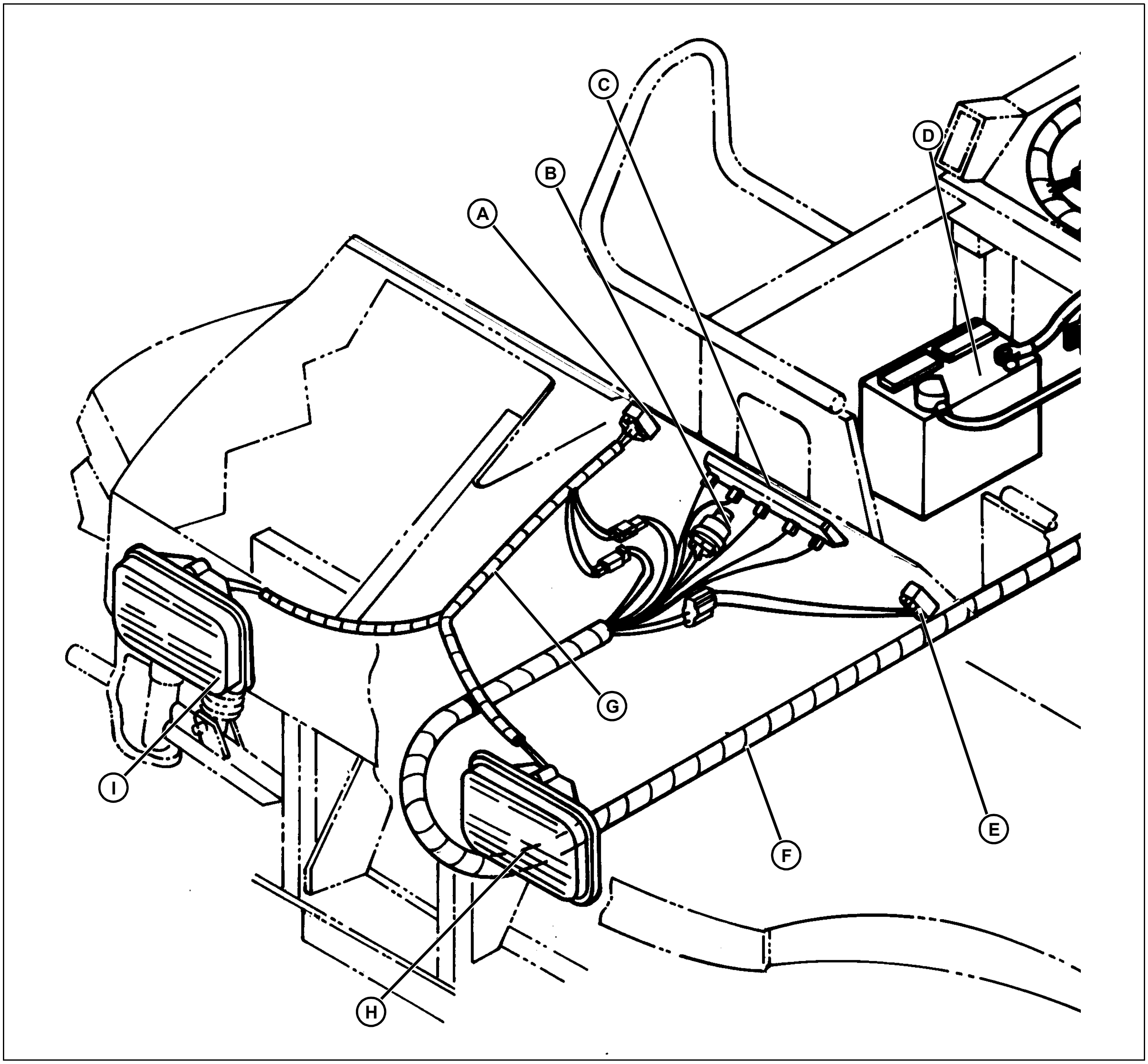
Headlights (halogen)	37.5 watts
Tail/Brake Lights	21 watts
Position Lights	10 watts
Front /Rear Turn Lights	21 watts

Neutral Start Switch:

Neutral (depressed)	Continuity
In Gear (released)	No Continuity

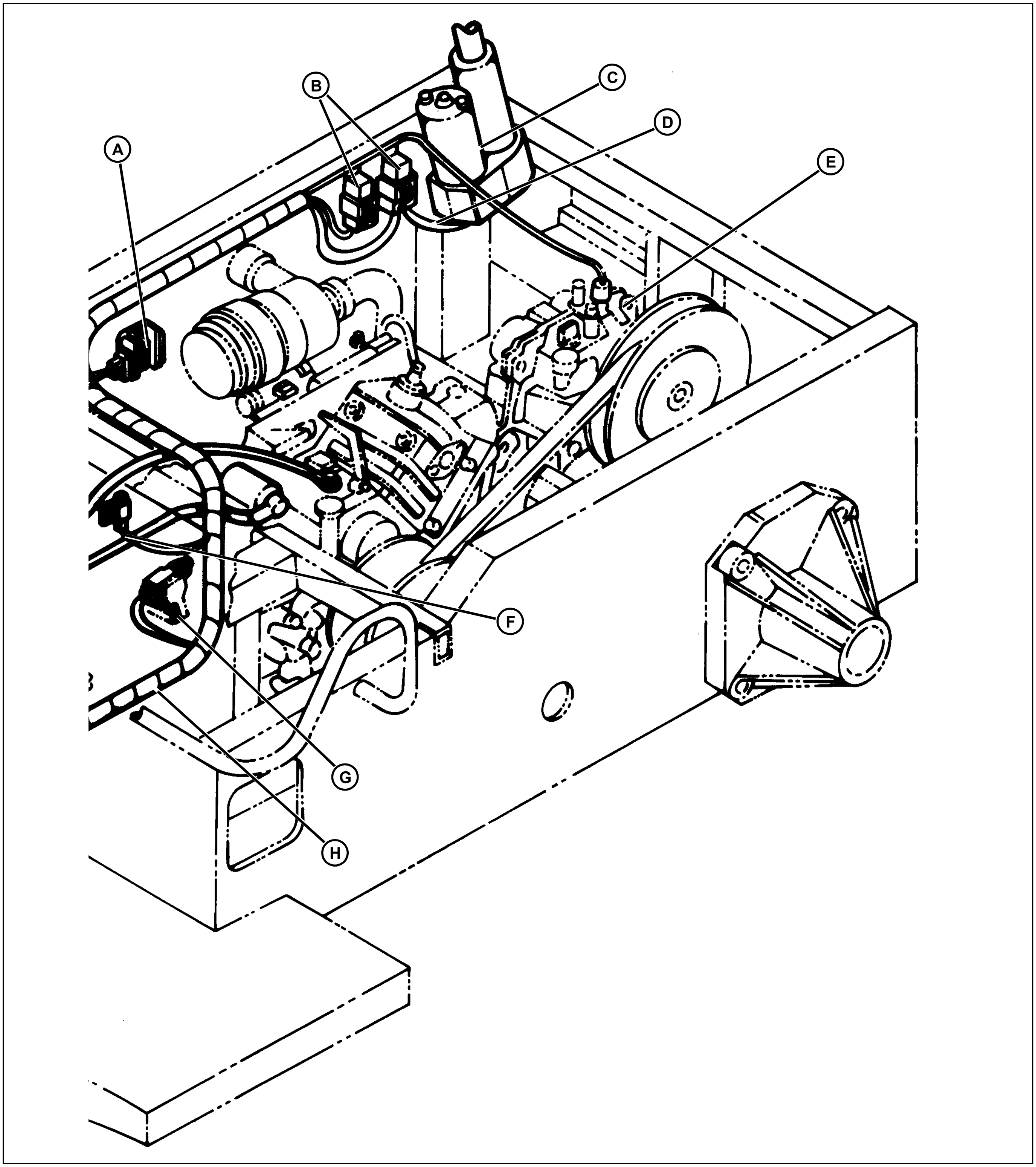
Component Locations

Component Location - 4X2 Gas



M56331I

A - S5 Light Switch
B - S2 Key Switch
C - Instrument Lights
D - G1 Battery
E - Cargo Box Lift Switch (optional)
F - W1 Main Wiring Harness
G - W4 Standard Headlight Wiring Harness
H - E3 Headlight
I - E2 Headlight



M56331R

A - H1 High Voltage Regulator/Rectifier

B - K1 and K2 Cargo Box Lift Directional Relays

C - M2 Cargo Box Lift Motor

D - W17 Cargo Box Lift Wiring Harness

E - S1 Neutral Start Switch

F - S3 Park Brake Switch

G - S4 Differential Lock Switch

H - W1 Main Wiring Harness

Schematics and Harnesses - 4X2 Gas

Electrical Schematic and Wiring Harness Legend - 4X2 Gas

A1 - Ignition Module (SE3, W1)

E1 - Spark Plug (SE3, W1)

E2 - Right Headlight (SE5, W1; SE5, W4)

E3 - Left Headlight (SE5, W1; SE5, W4)

F1 - Fusible Link (SE1, W1)

G1 - Battery (SE1, W1)

G2 - Stator (SE2, W1)

G3 - Auxiliary Alternator (SE2, W1)

H1 - Park Brake Light (SE4, W1)

H2 - Differential Lock Light (SE4, W1)

K1 - Cargo Box Lift Kit Directional Relay (Optional)

K2 - Cargo Box Lift Kit Directional Relay (Optional)

M1 - Starting Motor (SE1, W1)

M2 - Cargo Box Lift Kit Motor (Optional)

N1 - Voltage Regulator/Rectifier (SE2, W1)

S1 - Neutral Start Switch (SE1, W1)

S2 - Key Switch (SE1, W1)

S3 - Park Brake Switch (SE4, W1)

S4 - Differential Lock Switch (SE4, W1)

S5 - Light Switch (SE5, W1)

S6 - Cargo Box Lift Switch (Optional) (SE6, W1)

T1 - Magneto Ignition Coil (SE3, W1)

W1 - Shielded Ground (SE1, W1)

Connectors:

X1 - W1 Main Wiring Harness to W5 Engine Wiring Harness (SE2, W1)

X2 - W5 Engine Wiring Harness to W7 Engine Wiring Harness (SE2, W1)

X3 - W5 Engine Wiring Harness to W6 Engine Wiring Harness (SE3, W1; SE3, W5; SE3, W7)

X4 - W1 Main Wiring Harness to W4 Standard Headlight Wiring Harness (SE5, W1; SE5, W4)

X5 - W1 Main Wiring Harness to W4 Standard Headlight Wiring Harness (SE5, W1; SE5, W4)

X6 - W1 Main Wiring Harness to S6 Cargo Box Lift Kit Switch (SE6, W1)

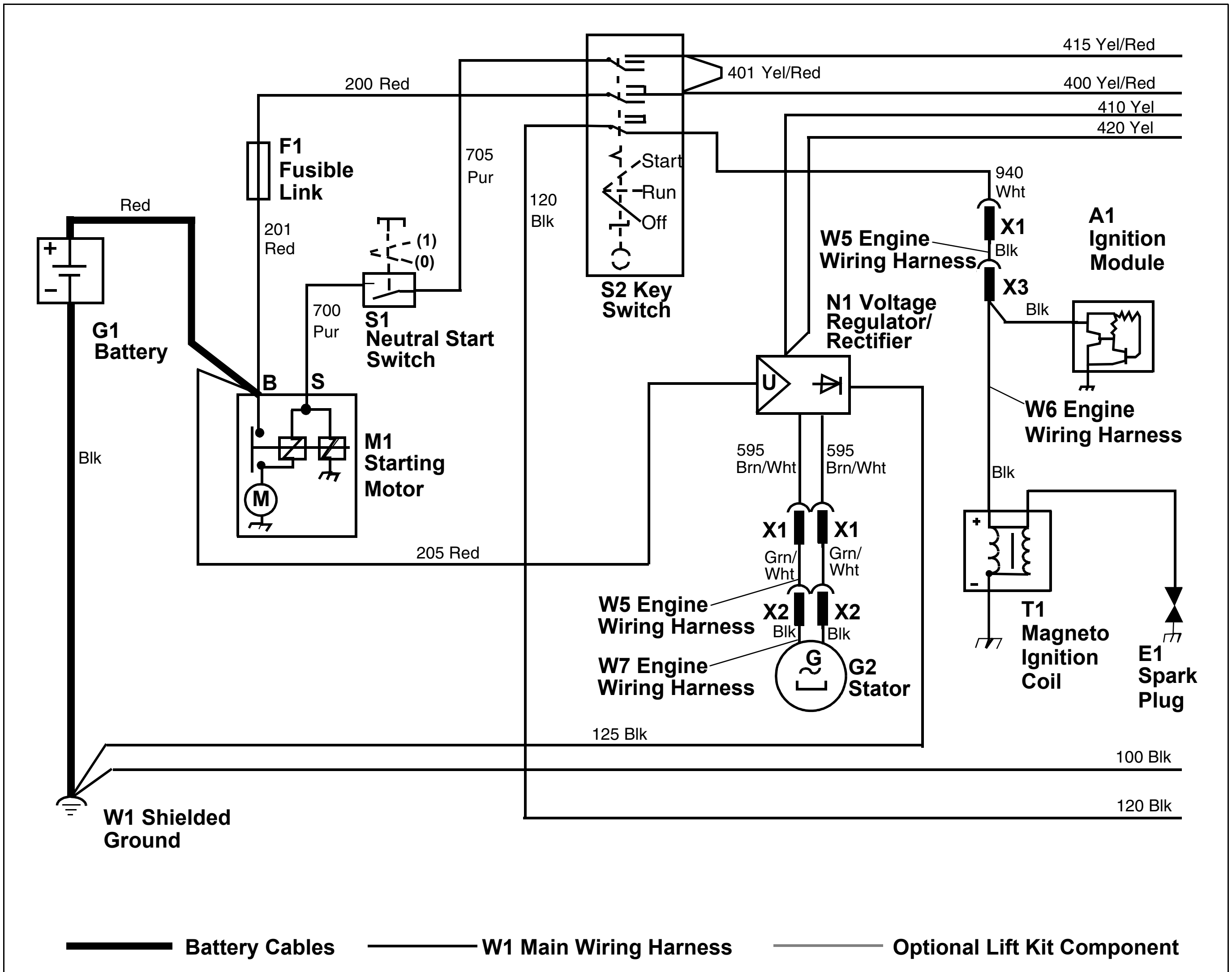
X7 - W1 Main Wiring Harness to W17 Cargo Box Lift Kit Wiring Harness (SE6, W1)

X8 - W29 Auxiliary Alternator Wiring Harness to W1 Main Wiring Harness (SE2, W1)

X9 - W29 Auxiliary Alternator Wiring Harness to N1 Voltage Regulator (SE2, W1)

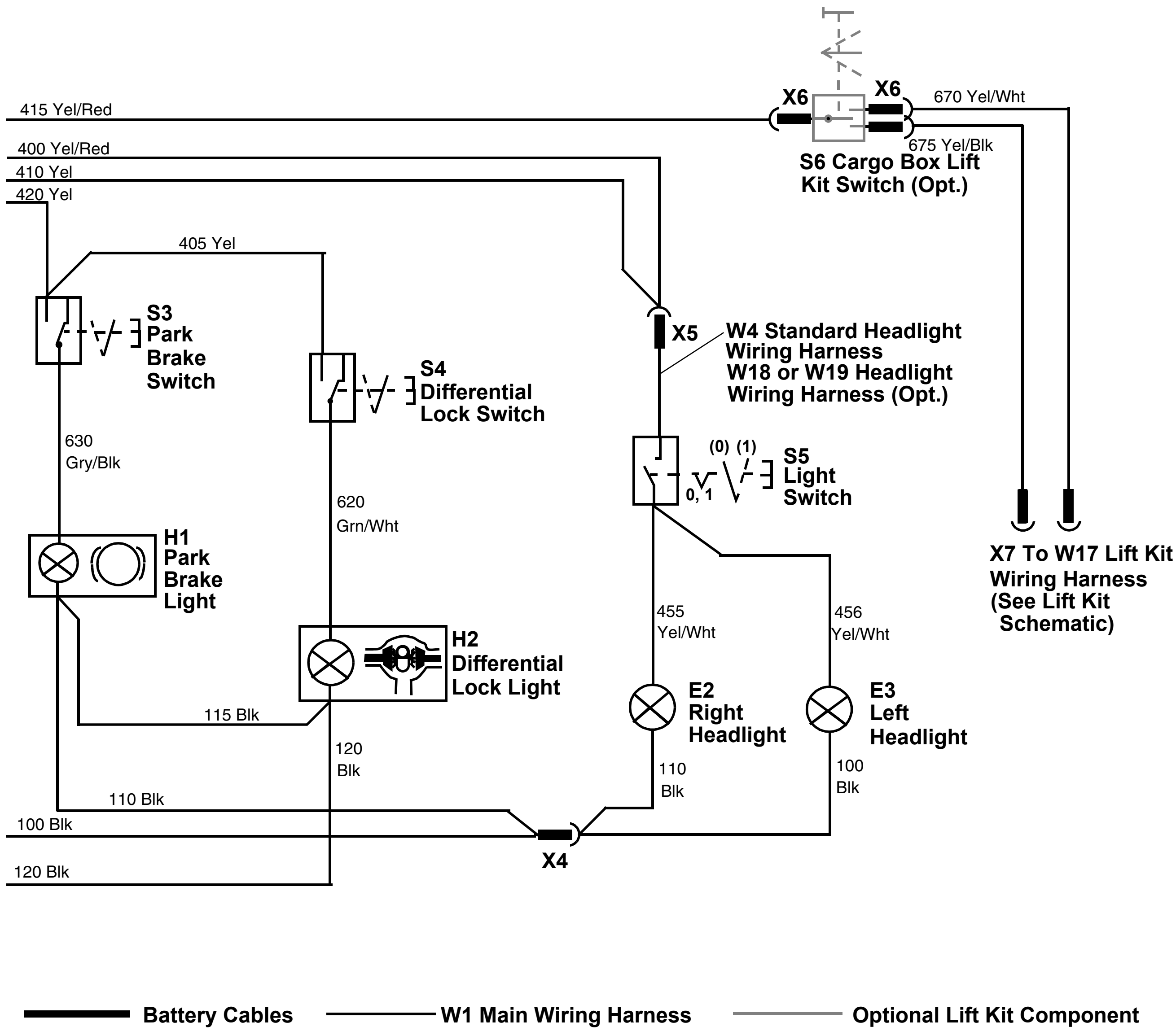
W1 Standard Electrical Schematic - 4X2 Gas

W1 Standard Electrical Schematic - 4X2 Gas (1 of 2)



SE1 - Starting	SE2 - Charging	SE3 - Ignition

W1 Standard Electrical Schematic - 4X2 Gas (2 of 2)



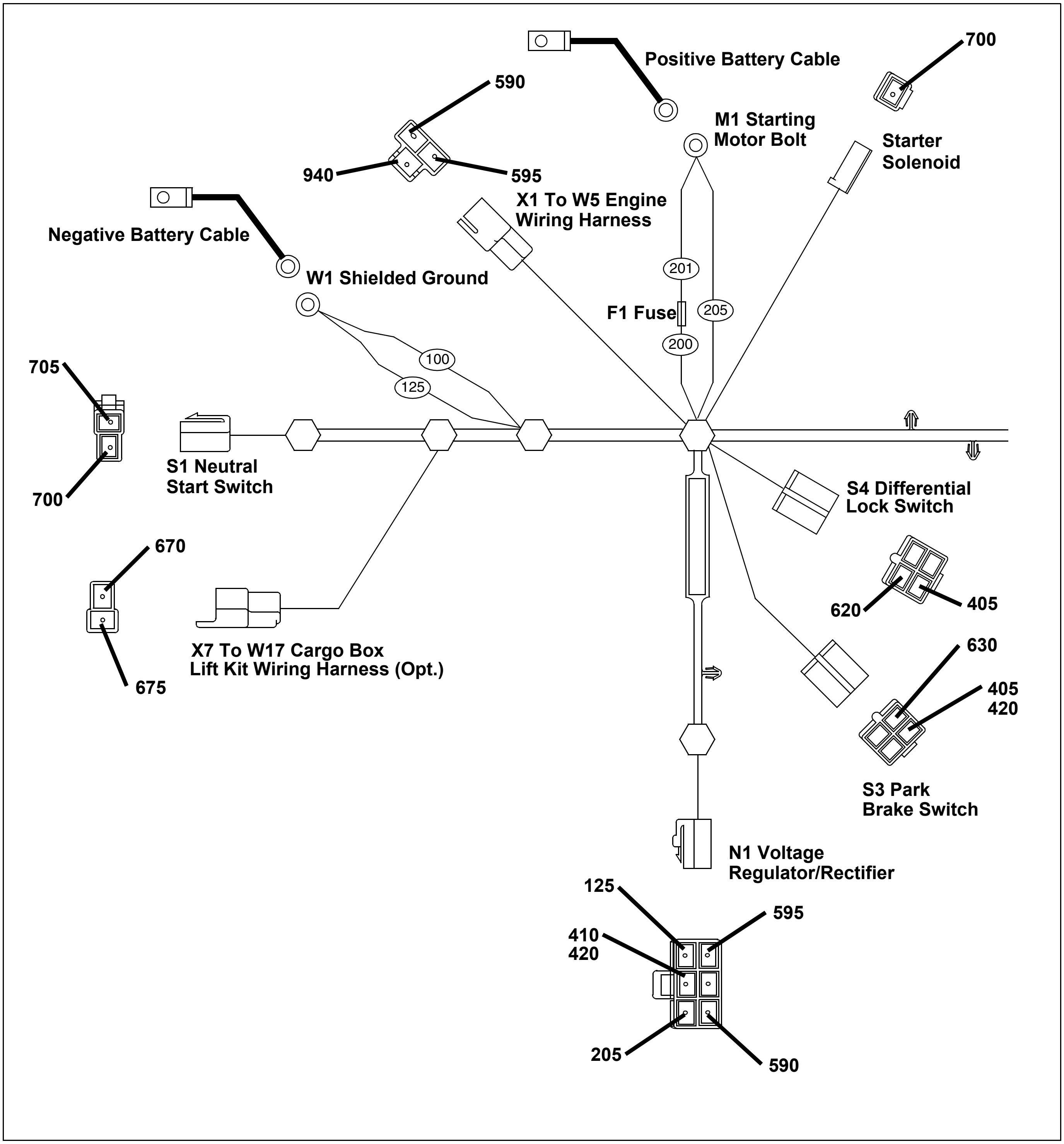
SE4 - Instrumentation	SE5 - Domestic Headlights	SE6 - Optional Lift Harness

Wire Color Code Table - 4X2 Gas

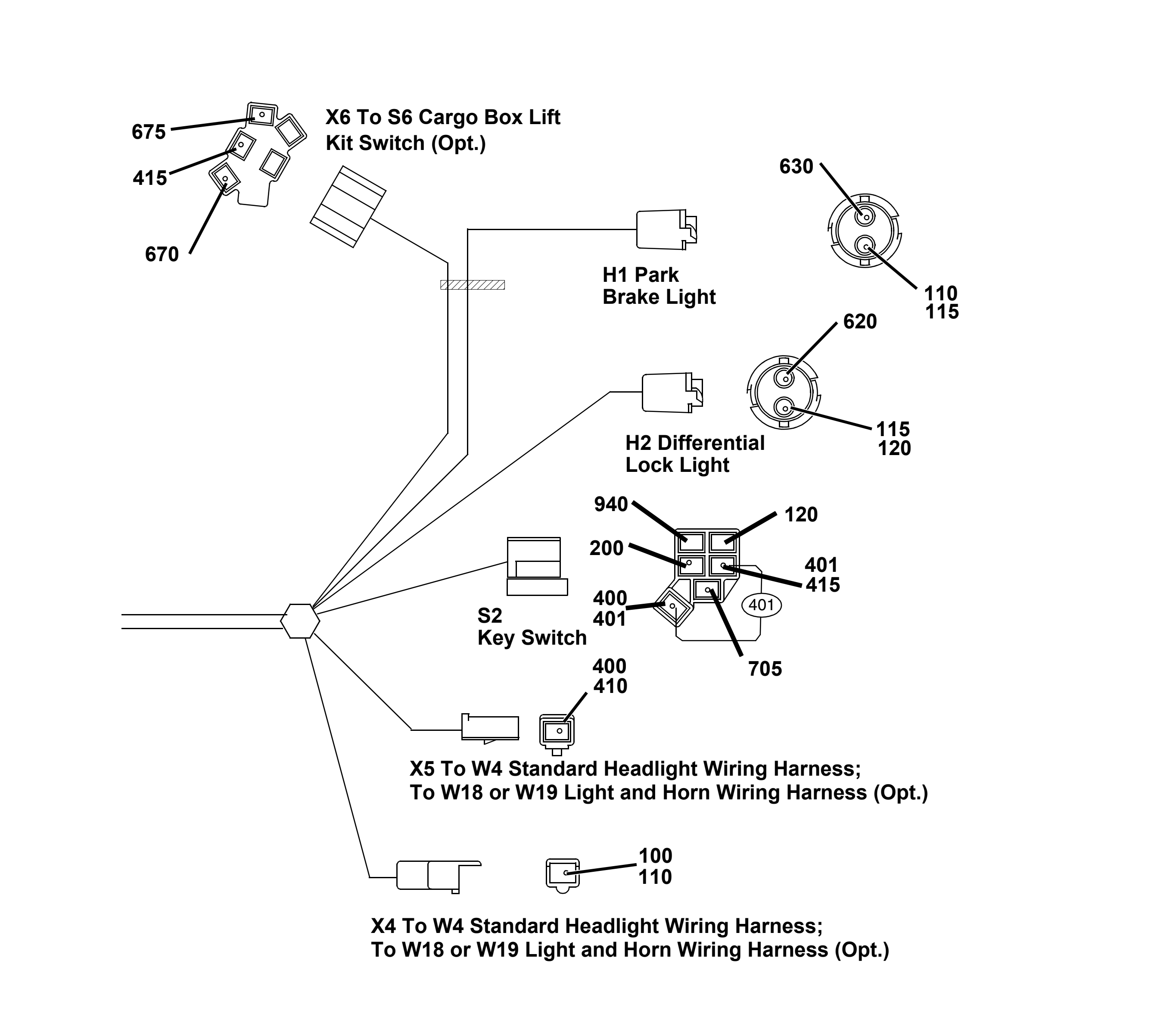
Circuit Number	Wire Size	Color	Termination Points
100	1.0	Blk	X4, W1 Gnd
110	0.5	Blk	H1, X4
115	0.5	Blk	H2,H1
120	0.5	Blk	S2, H2
125	1.0	Blk	N1, W1 Gnd
200	1.0	Red	F1, S2
F1 Fuse	0.5	Red	201 Red, 200 Red
201	1.0	Red	M1, F1
205	1.0	Red	M1, N1
400	1.0	Yel/Red	S2, X5
401	1.0	Yel/Red	S2, S2
405	0.8	Yel	S3, S4
410	1.0	Yel	X5, N1
415	1.0	Yel/Red	S2, X6
420	0.8	Yel	N1, S3
590	2.0	Brn/Yel	N1, X1
595	2.0	Brn/Wht	N1, X1
620	0.5	Grn/Wht	S4, H2
630	0.5	Gry/Blk	S3, H1
670	1.0	Yel/Wht	X6, X7
675	1.0	Yel/Blk	X6, X7
700	1.0	Pur	M1, S1
705	1.0	Pur	S1, S2
940	0.5	Wht	S2, X1

W1 Main Wiring Harness - 4X2 Gas

W1 Main Wiring Harness - 4X2 Gas (1 of 2)

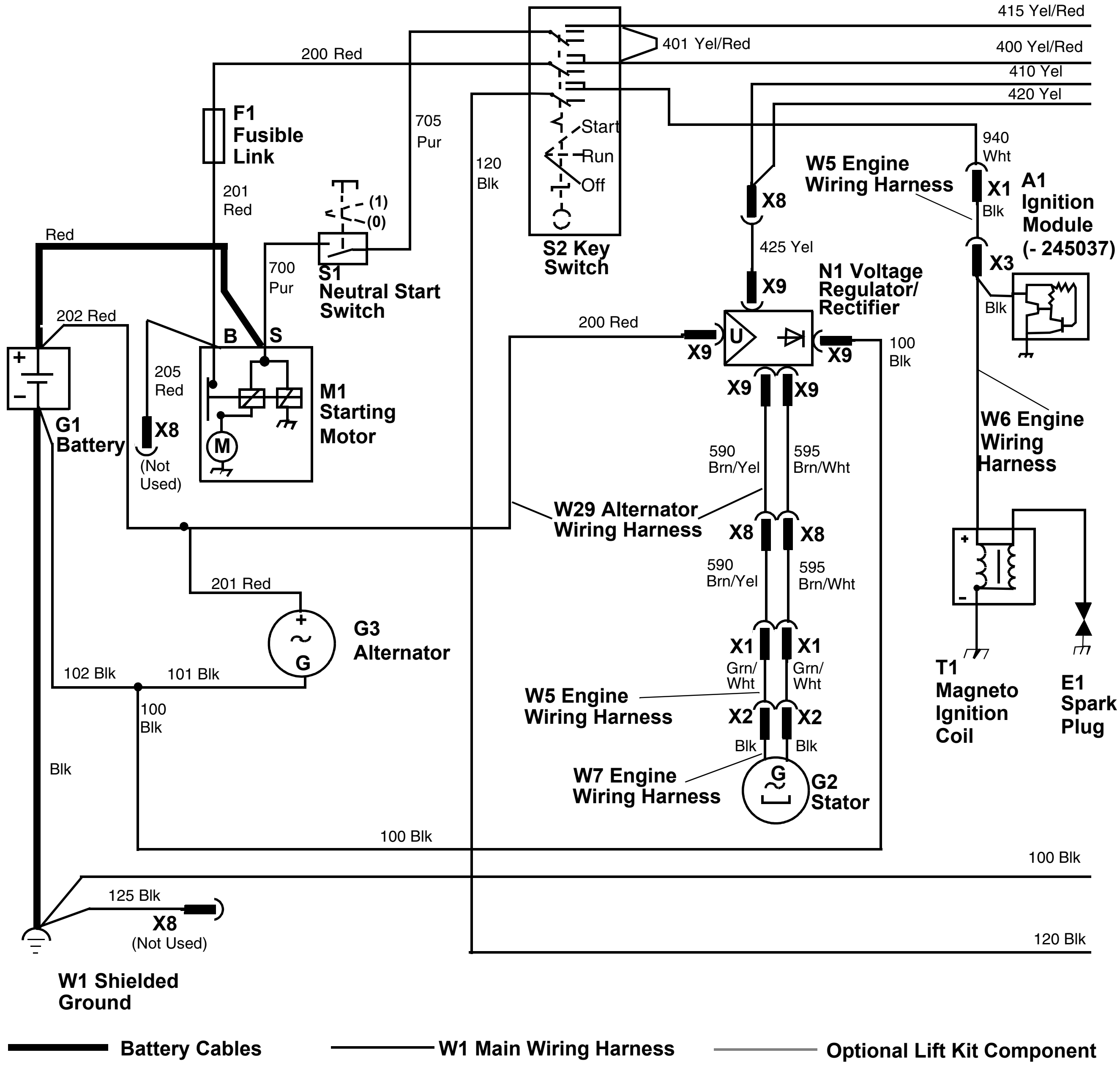


W1 Main Wiring Harness - 4X2 Gas (2 of 2)



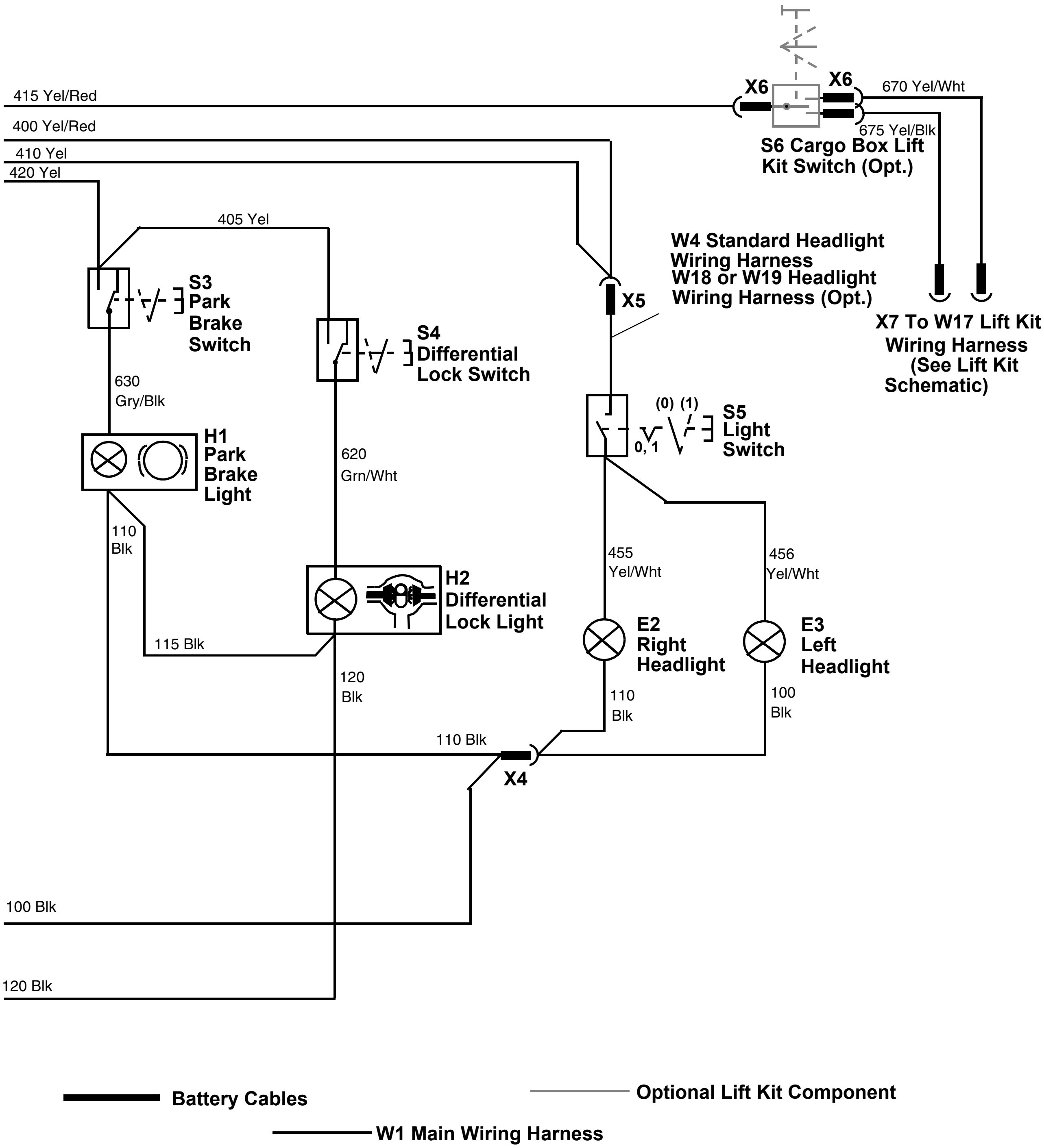
W1 Electrical Schematic with Auxiliary Alternator - 4X2 Gas

W1 Electrical Schematic with Auxiliary Alternator - 4X2 Gas (1 of 2)



SE1 - Starting	SE2 - Charging	SE3 - Ignition

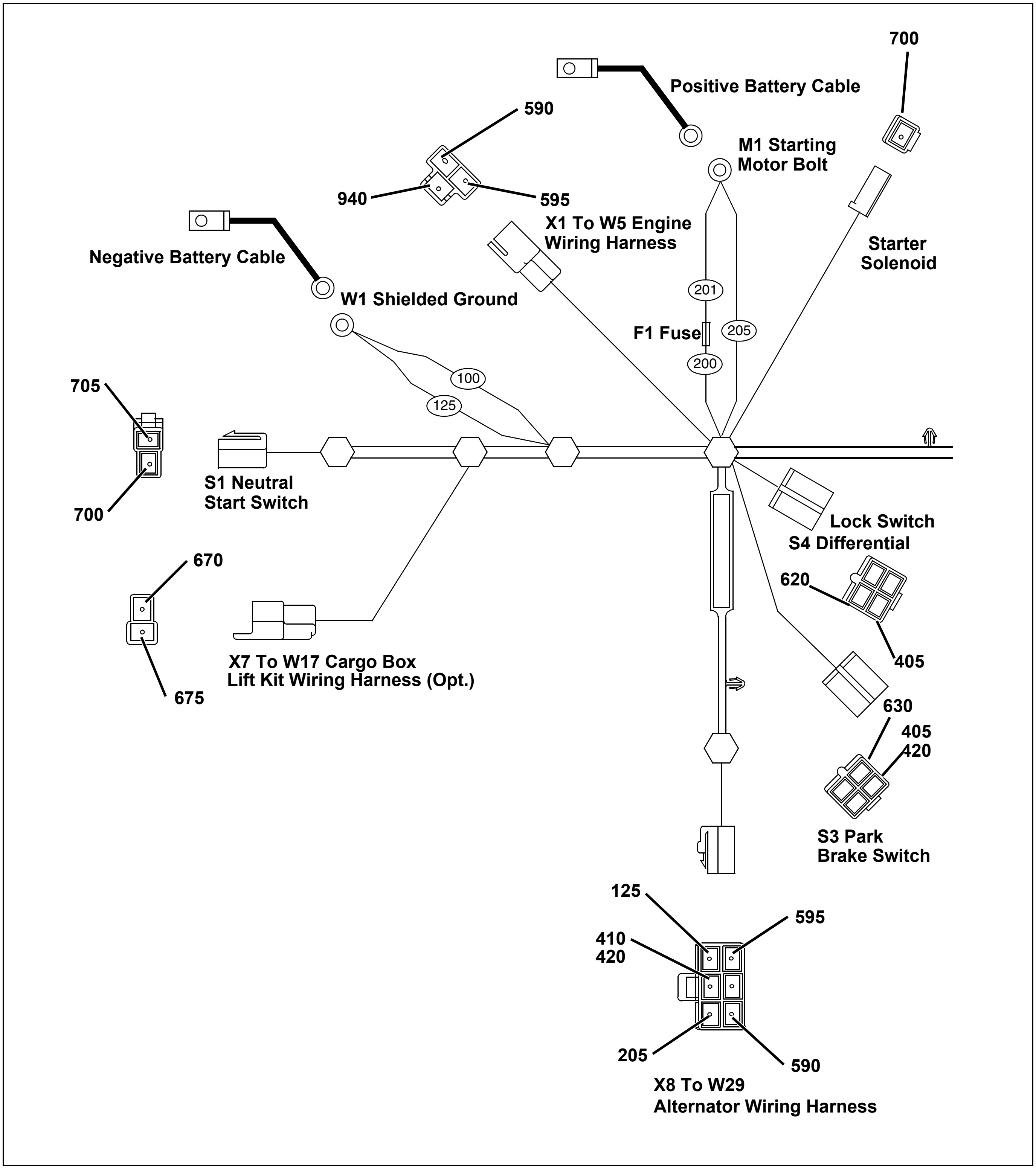
W1 Electrical Schematic with Auxiliary Alternator - 4X2 Gas (2 of 2)



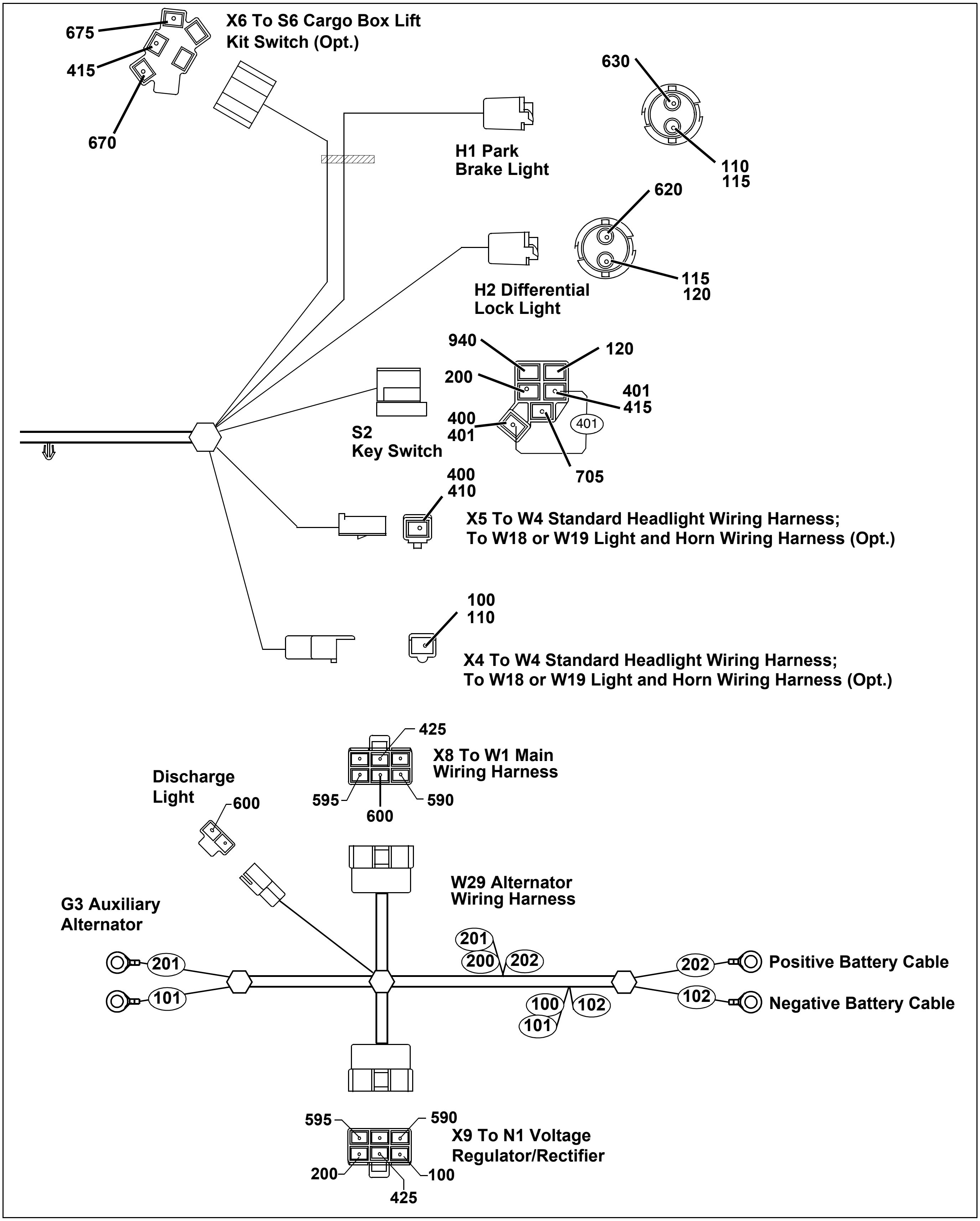
SE4 - Instrumentation	SE5 - Domestic Headlights	SE6 - Optional Lift Harness

W29 Auxiliary Alternator Wiring Harness - 4X2 Gas

W29 Auxiliary Alternator Wiring Harness - 4X2 Gas (1 of 2)



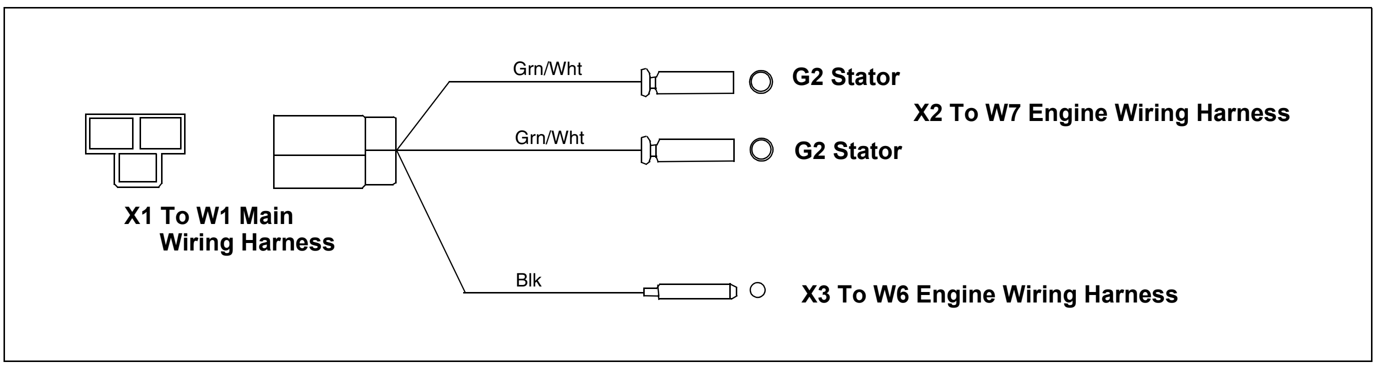
W29 Auxiliary Alternator Wiring Harness - 4X2 Gas (2 of 2)



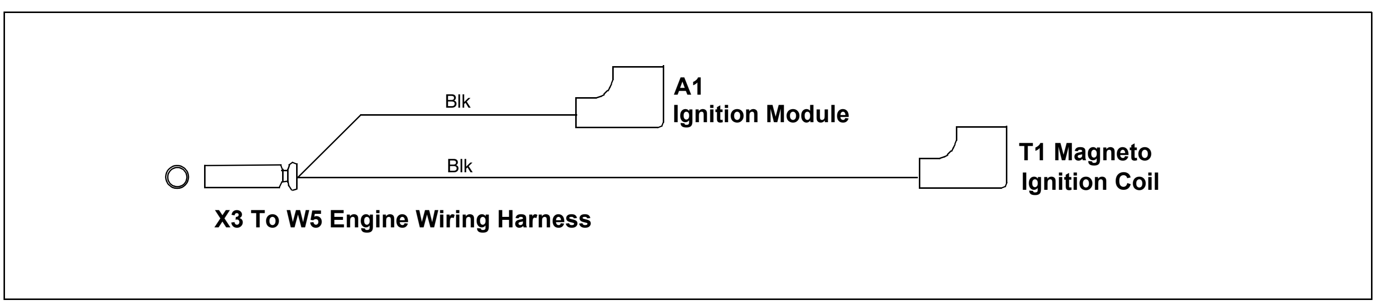
W29 Wiring Harness Wire Color Code Table - 4X2 Gas

Circuit Number	Wire Size	Color	Termination Points
100	3.0	Blk	W29, X8
101	3.0	Blk	Solder Splice 100/102, G3 Gnd
102	5.0	Blk	Solder Splice 100/102 Blk, Battery Negative
200	3.0	Red	W29, X8
201	3.0	Red	Solder Splice 200/202, G3 Output
202	5.0	Red	Solder Splice 200/201 Red, Battery Positive
425	1.0	Yel	W1, X8, X9
590	3.0	Brn/Wht	W1, X8, X9
595	3.0	Brn/Yel	W1, X8, X9
600	1.0	Blu	W1, X9

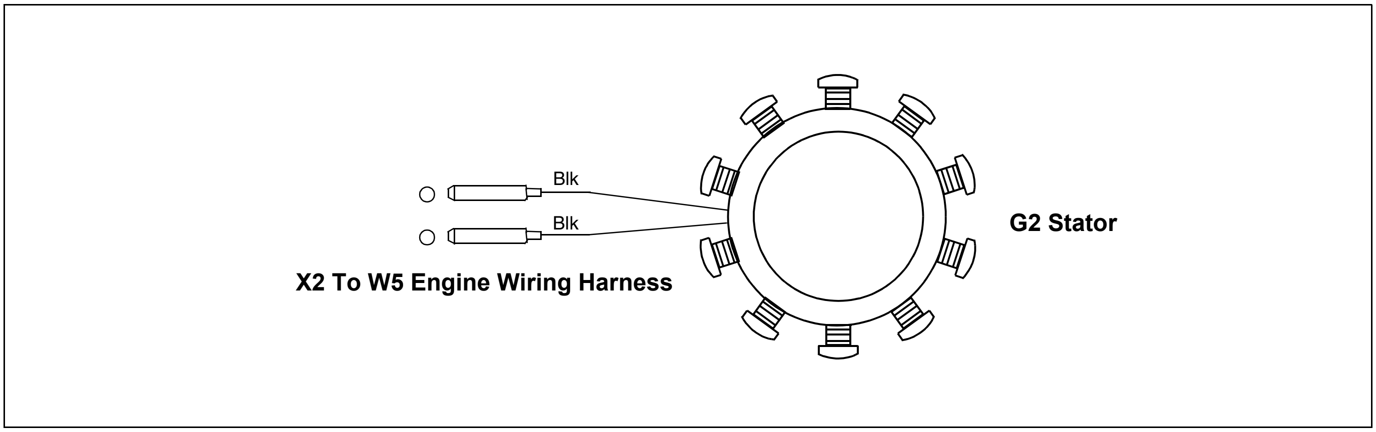
W5 Engine Wiring Harness



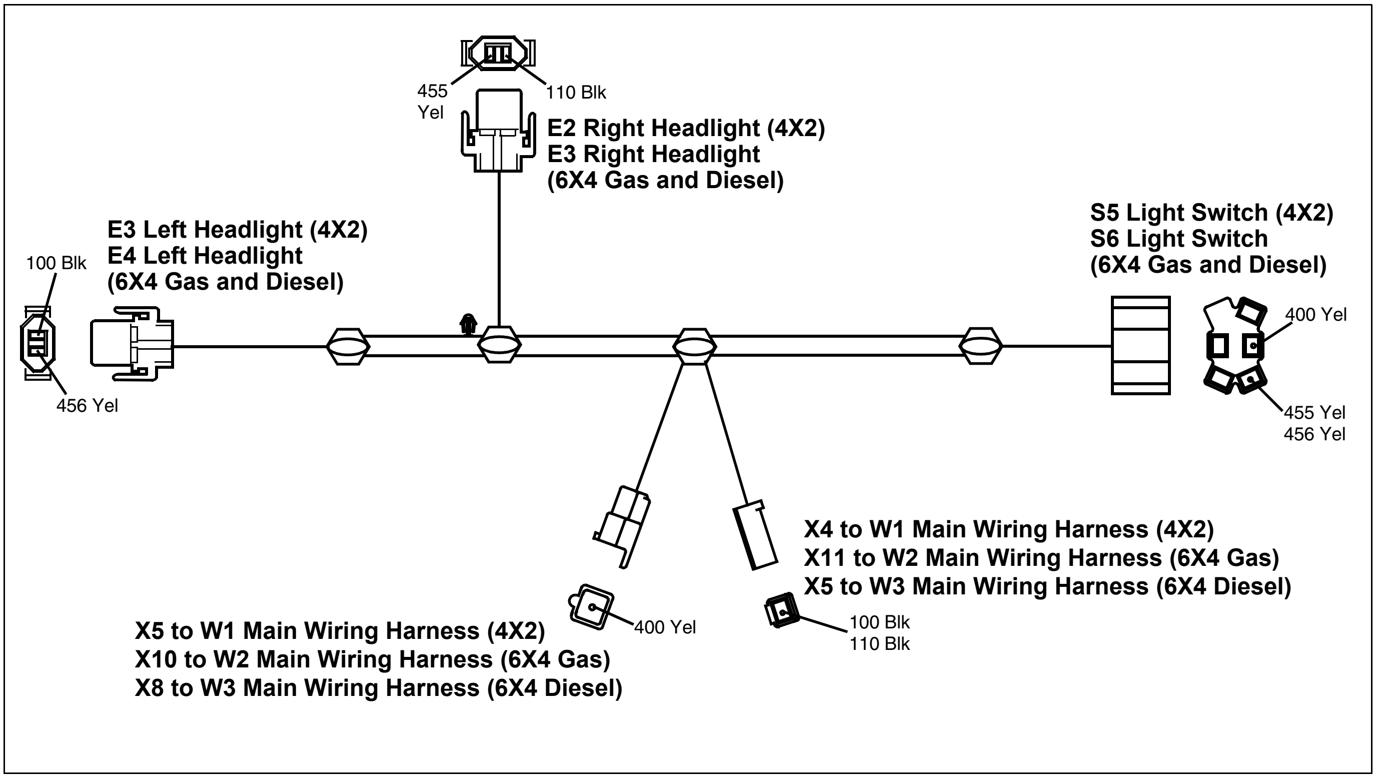
W6 Engine Wiring Harness



W7 Engine Wiring Harness



W4 Standard Headlight Wiring Harness



Operation and Diagnostics - 4X2 Gas

Troubleshooting - 4X2 Gas

System: Electrical

(1) Does starter have cranking problems?

Yes - See “Power Circuit Diagnosis - 4X2 Gas” on page 253

Yes - See “Cranking Circuit Diagnosis - 4X2 Gas” on page 256

Yes - See “Ground Circuit Tests” on page 396

Yes - See “Battery Test” on page 372

Yes - See “Starting Motor Solenoid Test” on page 377

Yes - See “Neutral Start Switch Test” on page 381

(2) Does engine crank but not start?

Yes - See “Ground Circuit Test” on page 371

Yes - See “Ignition Circuit Diagnosis - 4X2 Gas” on page 260

(3) Is there spark from the ignition?

Yes - See “Ignition Circuit Diagnosis - 4X2 Gas” on page 260

(4) Is the fuel pump operating?

Yes - See “Ignition Circuit Diagnosis - 4X2 Gas” on page 260.

(5) Does the engine not shut off?

Yes - Check for a shorted circuit.

(6) Is an improper component working with a switch?

Yes - Check for a shorted circuit.

(7) Does the battery go dead, discharge, or over charge?

Yes - See “Charging Circuit Diagnosis - 4X2 Gas” on page 264.

(8) Are there instrumentation light problems?

Yes - See “Park Brake Light Diagnosis - 4X2 Gas” on page 267 and “Differential Lock Light Diagnosis - 4X2 Gas” on page 268.

(9) Are there light and horn problems?

System: Electrical

Yes - See “Road Homologated Light and Horn Circuit Diagnosis” on page 493 or “Light and Horn Circuit Diagnosis (Earlier Model)” on page 447 or “Light and Horn Circuit Diagnosis (Later Model)” on page 468.

(10) Are there domestic headlight problems?

Yes - See “W4 Standard Headlight Wiring Harness” on page 249.

(11) Are there cargo box lift problems?

Yes - See “Cargo Box Lift System Troubleshooting Chart” on page 405. Also see “Cargo Box Lift Circuit Diagnosis” on page 406.

Power Circuit Operation - 4X2 Gas

Function:

Provides unswitched power to the primary components whenever the battery is connected.

Operating Conditions, Unswitched Circuits:

Voltage must be present at the following components with the key switch “OFF”:

- Battery Positive Terminal
- “B” Terminal of Starter Bolt
- “B” Terminal of Key Switch
- “B” Terminal of Voltage Regulator/Rectifier
- Auxiliary Alternator Positive Terminal (if equipped)

The positive battery cable connects the battery to the starting motor. The starting motor bolt is used as a tie point for the rest of the electrical system. In systems with an auxiliary alternator, an additional positive battery cable connects to the alternator bolt.

The battery cables, starting motor tie point, and alternator connections must be in good condition for the machine’s electrical system to work properly.

The ground cable connections are equally important. Proper starter operation depends on these cables and connections to carry the high current for its operation.

The connection between the starter and key switch is fused by a fusible link. This is a short piece of wire that is designed to fail if current load is too high or a short occurs. It protects the wiring harness from damage.

The charging wires running between the voltage regulator/ rectifier and starting motor and between the alternator and the battery positive terminal are unprotected.

Switched Power:

Voltage must be present at the following components with the key switch in “RUN” position:

- “A” and “S1” Terminals of key switch
- Voltage Regulator/Rectifier
- Park Brake Switch
- Differential Switch
- Light Switch (Standard or Homologated)
- Lift Switch Connector

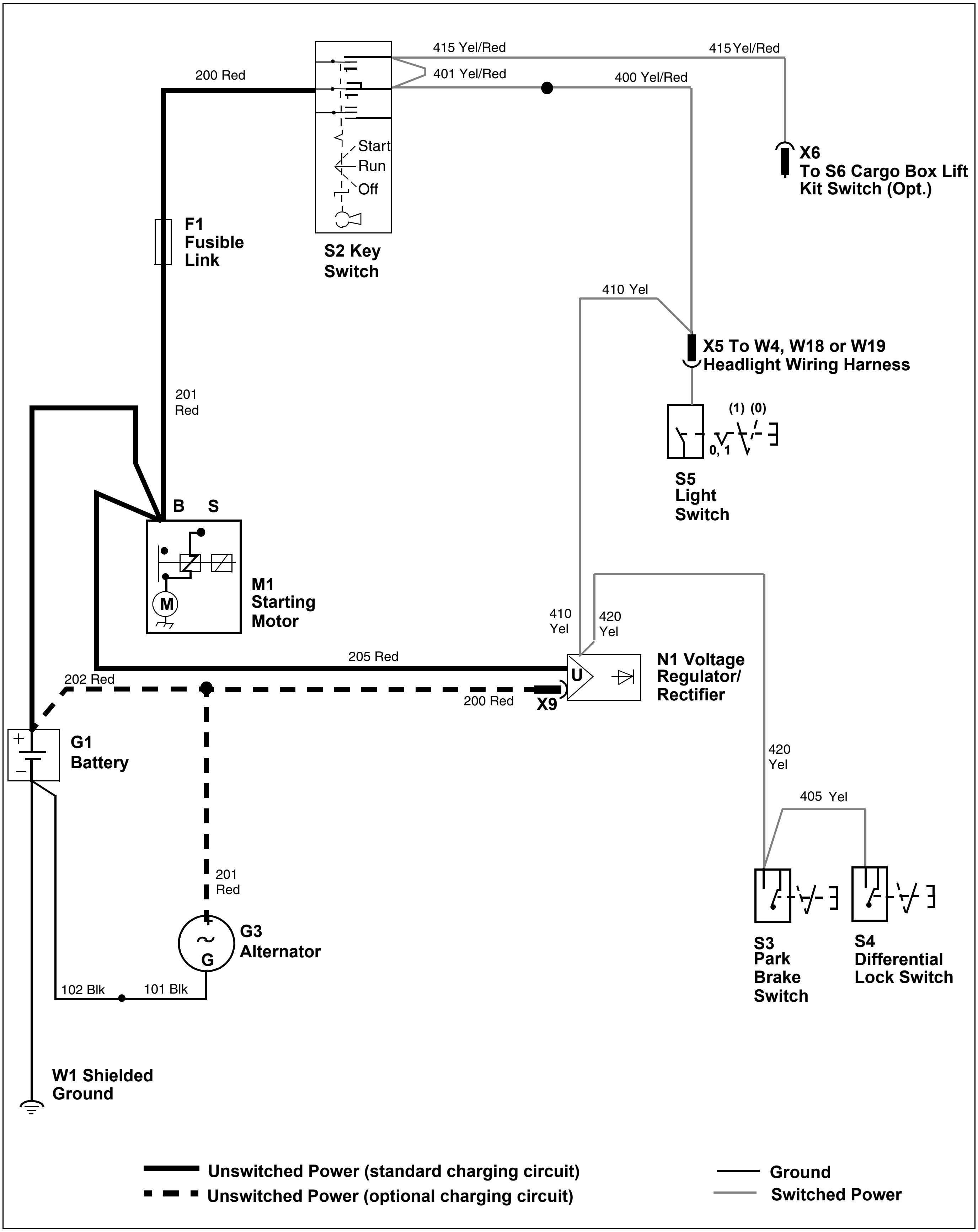
These circuits are controlled by the key switch and are protected by the fusible link.

Optional Lighting Kit and Lift Kit Power Circuits:

See the appropriate schematics and diagnostic procedures for these kits.

When optional kits are installed, the positive wires for these kits are also connected to the starting motor bolt. These leads also contain fusible links to protect the wiring harnesses.

Power Circuit Schematic - 4X2 Gas



MIF

Power Circuit Diagnosis - 4X2 Gas

Test Conditions:

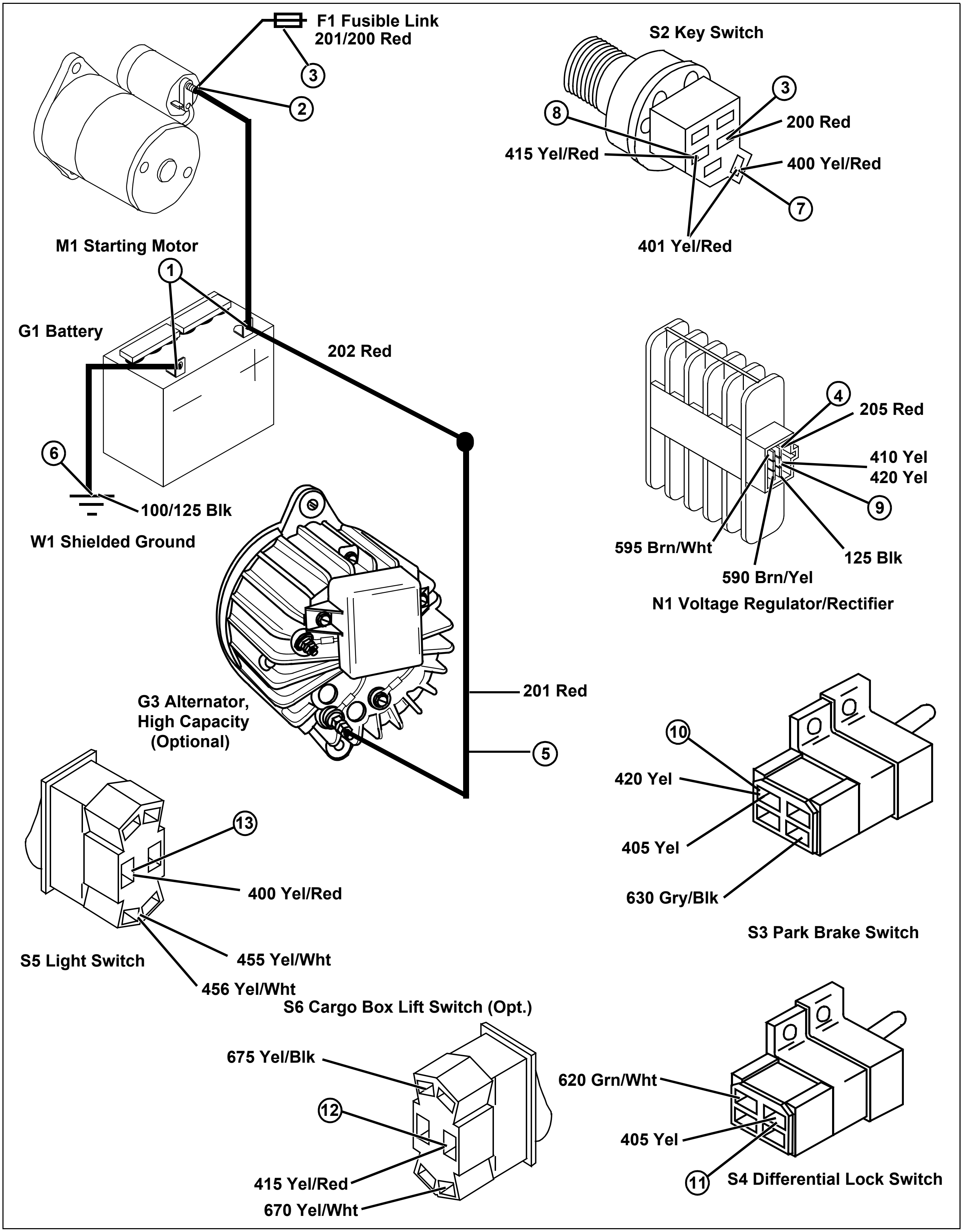
- Key switch in OFF position

Test/Check Point	Normal	If Not Normal
1. Positive and negative battery post	12.4 volts or above	Clean battery terminals and test battery.
2. Starting motor solenoid terminal “B”	Battery voltage	Clean and check battery cable and tighten connections.
3. Key switch	Battery voltage	Check 200 Red wire connections, F1 fusible link. Replace fusible link.
4. Voltage regulator/rectifier	Battery voltage	Check 205 Red wire and connections.
5. Alternator, high capacity (optional)	Battery voltage	Check wires 201 and 202 Red in W29 Harness.
6. Ground cable frame connection to negative battery terminal	Less than 0.1 ohm resistance	Check negative harness wires and negative cable connections to frame, removing any paint, rust or corrosion. Clean negative battery connection to battery post.

Test Conditions:

- Key switch in RUN position

Test/Check Point	Normal	If Not Normal
7. Key switch	Battery voltage	Replace key switch.
8. Key switch	Battery voltage	Check 401 Yel/Red jumper wire.
9. Voltage rectifier/regulator	Battery voltage	Check 410 Yel wire connection at X5 light harness connector and 400 Yel/Red to key switch.
10. Park brake switch connector	Battery voltage	Check 420 Yel wire and connections.
11. Differential switch connector	Battery voltage	Check 405 Yel wire and connections.
12. Cargo box lift kit switch	Battery voltage	Check 415 Yel wire and connections at key switch.
13. Light switch	Battery voltage	Check 400 Yel/Red wire and connections.


F1 Fusible Link
201/200 Red
S2 Key Switch
3
2
8
200 Red
415 Yel/Red
400 Yel/Red
7
401 Yel/Red
M1 Starting Motor
1
G1 Battery
202 Red
4
205 Red
410 Yel
420 Yel
6
9
100/125 Blk
W1 Shielded Ground
595 Brn/Wht
125 Blk
590 Brn/Yel
N1 Voltage Regulator/Rectifier
201 Red
G3 Alternator,
High Capacity
(Optional)
5
10
420 Yel
13
405 Yel
400 Yel/Red
630 Gry/Blk
S3 Park Brake Switch
S5 Light Switch
455 Yel/Wht
456 Yel/Wht
S6 Cargo Box Lift Switch (Opt.)
675 Yel/Blk
620 Grn/Wht
12
405 Yel
415 Yel/Red
11
S4 Differential Lock Switch
670 Yel/Wht

MIF

Cranking Circuit Operation - 4X2 Gas

Function:

To energize the starter motor solenoid and engage the starting motor.

Operating Conditions:

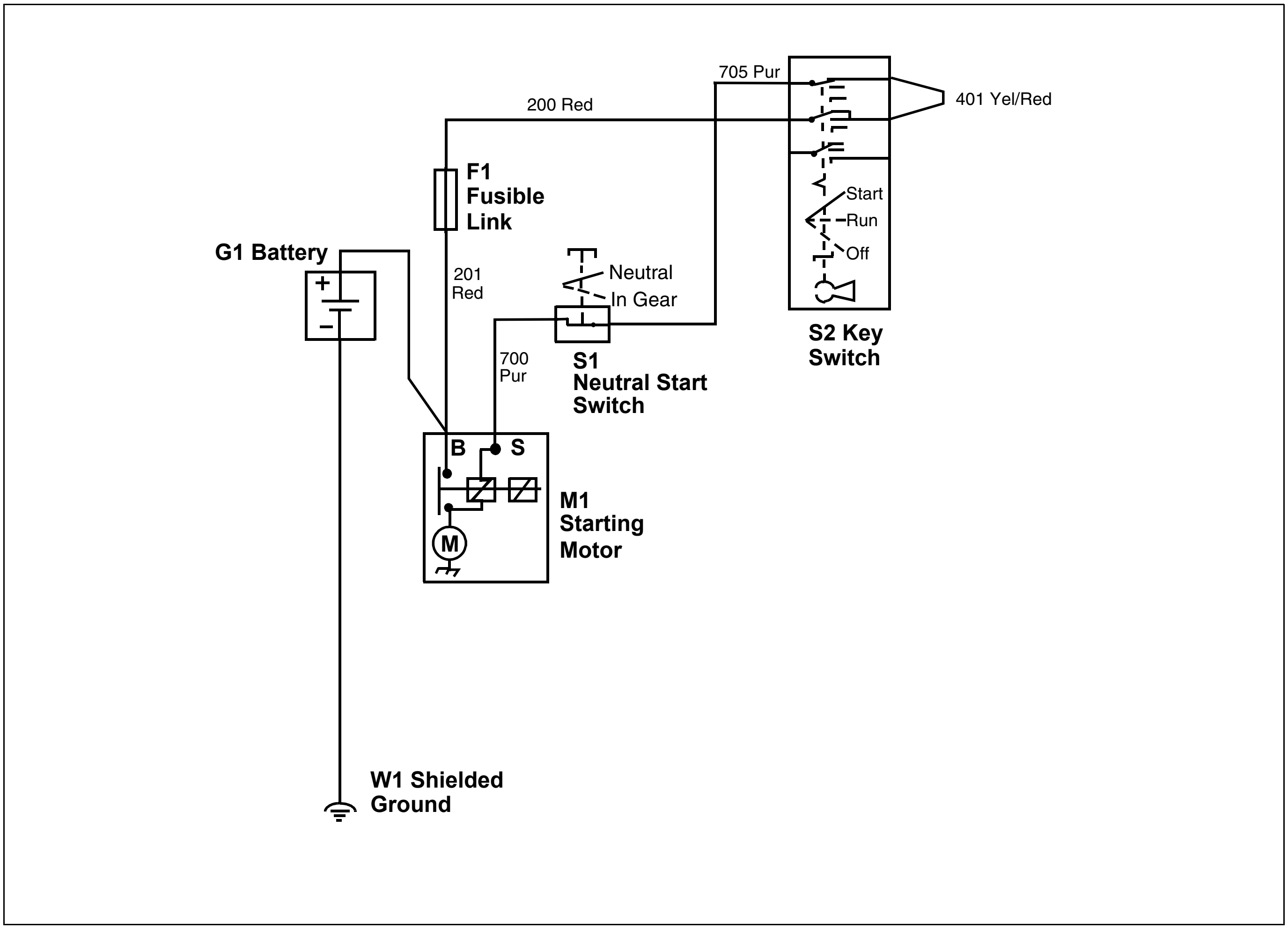
To crank the engine, the transmission must be in neutral and key switch must be in the start position.

Theory of Operation:

Current flows from the battery through F1 fusible link to the key switch. With key switch in the start position current flows through the key switch, through jumper 401 Yel/Red, then back through the key switch to the neutral start switch. With transmission in neutral, current activates the starting motor solenoid.

High current from the battery flows across the solenoid contacts to operate the starting motor.

Cranking Circuit Schematic - 4X2 Gas



Cranking Circuit Diagnosis - 4X2 Gas

Test Conditions:

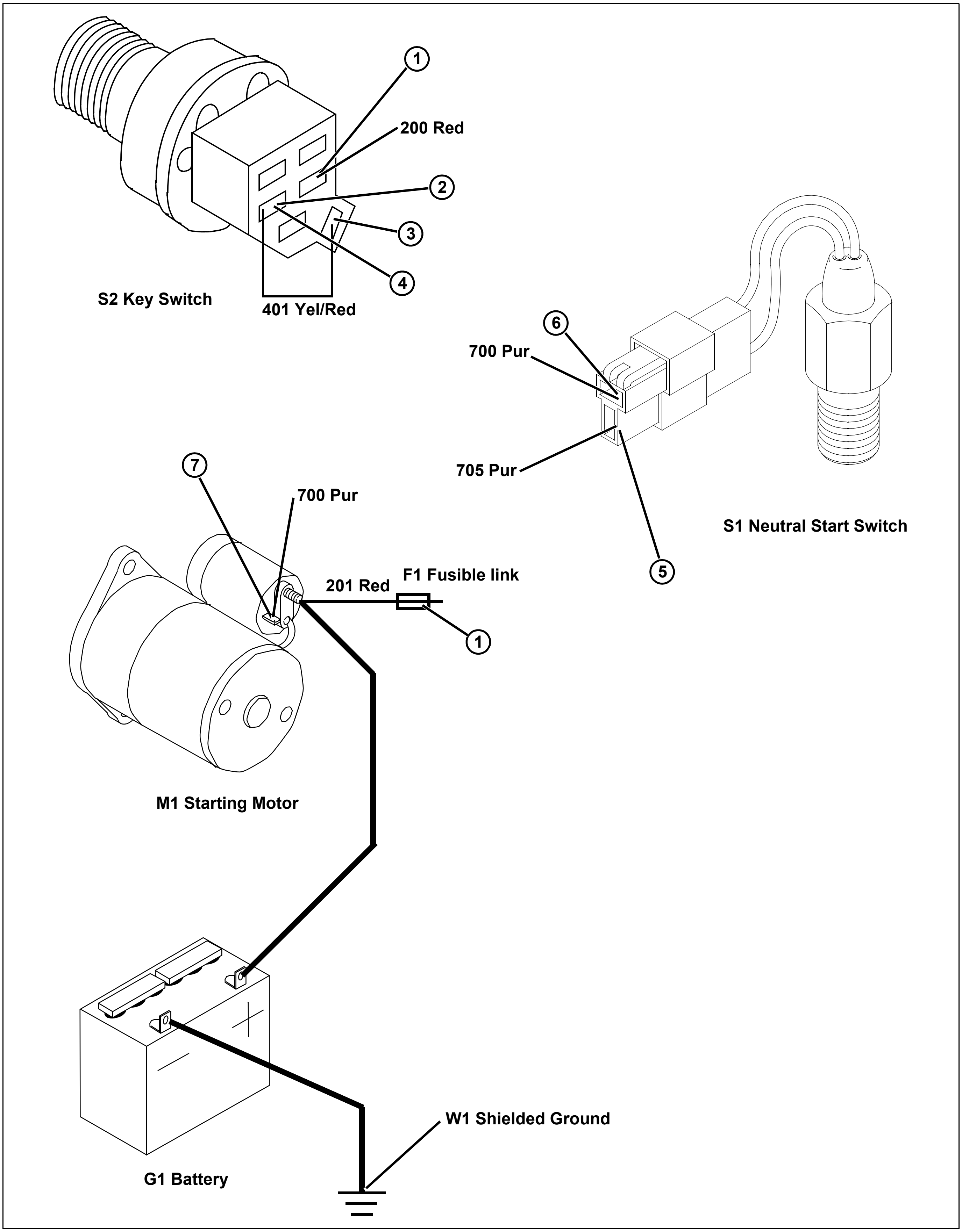
- Transmission in NEUTRAL

Test/Check Point	Normal	If Not Normal
1. Key switch	Battery voltage	Check 200 Red wire and F1 fusible link.

Test Conditions:

- Key switch in START position

Test/Check Point	Normal	If Not Normal
2. Key switch	Battery voltage	Replace key switch.
3. Key switch	Battery voltage	Test 401 Yel/Red wire and connections.
4. Key switch	Battery voltage	Replace key switch.
5. Neutral start switch	Battery voltage	Test 705 Pur wire and connections.
6. Neutral start switch	Battery voltage	Check transmission linkage neutral adjustment. Replace neutral start switch.
7. Starting motor solenoid “S” terminal	Battery voltage	No Voltage: Test 700 Pur wire and connections. Voltage: Check battery ground cable and connections. Test or replace starting motor solenoid.


1
200 Red
2
3
4
S2 Key Switch
401 Yel/Red
6
700 Pur
705 Pur
5
S1 Neutral Start Switch
7
700 Pur
201 Red
F1 Fusible link
1
M1 Starting Motor
W1 Shielded Ground
G1 Battery

Ignition Circuit Operation - 4X2 Gas

Function:

To create a spark at the correct time that ignites the fuel/air mixture in the cylinder. To ground the system to shut off the engine.

Operating Conditions:

To produce a spark, the key switch must be in the RUN or START position.

System Operation:

The ignition system is a transistor-controlled magneto design. Ignition timing is controlled by the transistor and is not adjustable. The engine is shut off by grounding the ignition coil.

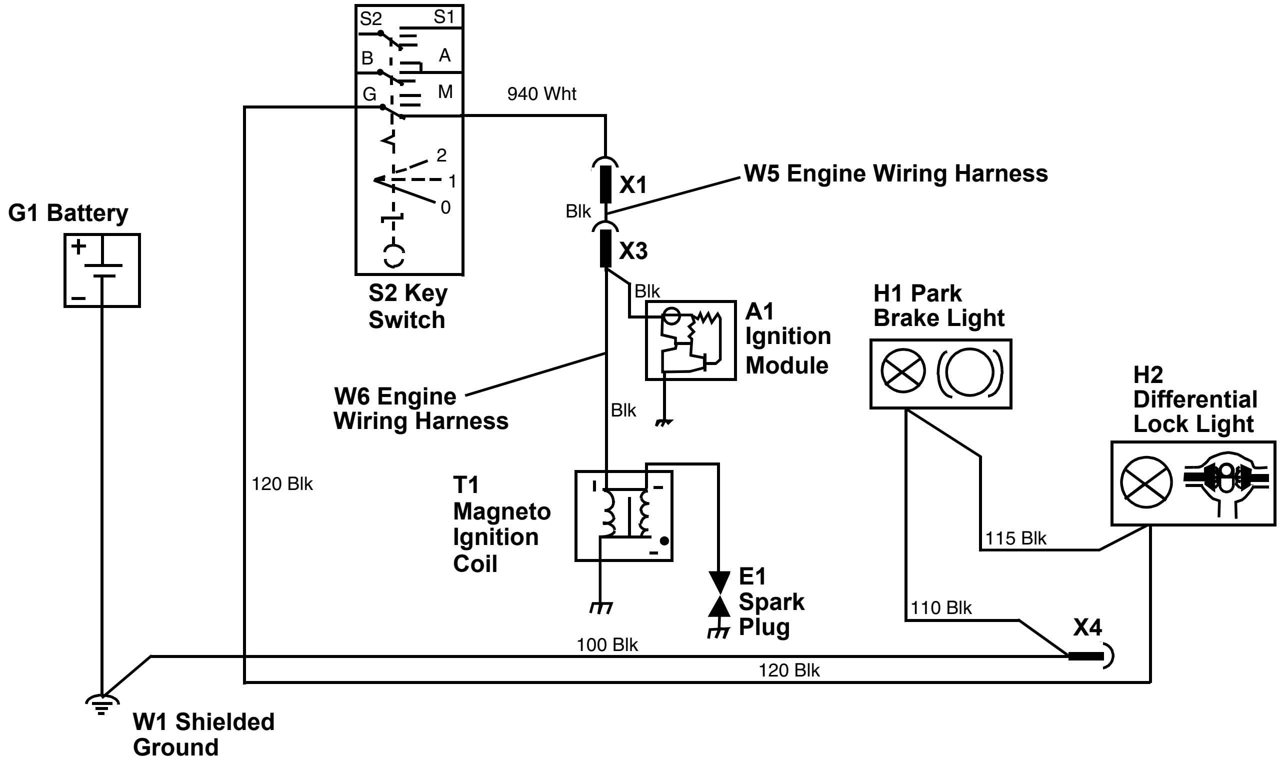
With the key switch in the start or run position, the key switch eliminates the path to ground for ignition current, so a spark can be produced.

As the flywheel turns, a magnet in the flywheel starts to align with the ignition coil and produces current in the primary windings by electromagnetic induction. The low voltage current flows to the ignition module. The ignition module controls the current flow in the primary windings of the ignition coil.

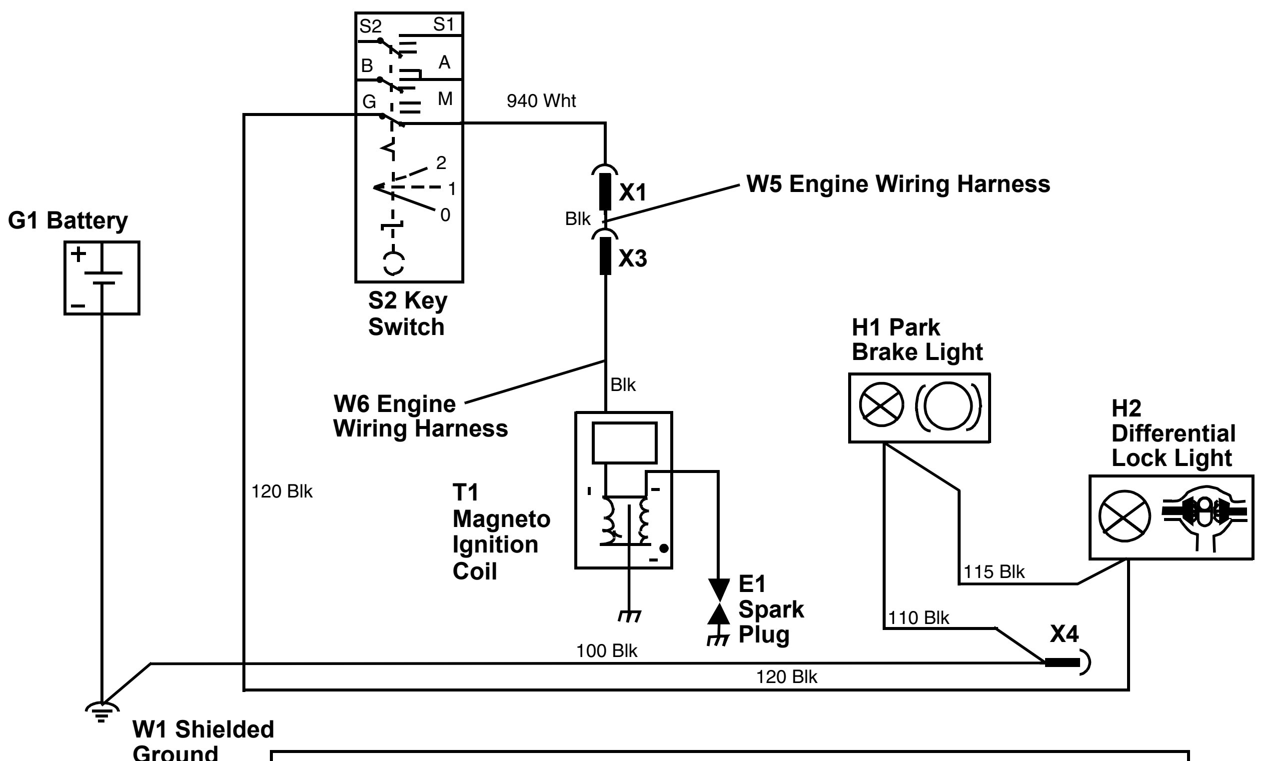
NOTE: Earlier models (S/N - 245037) have a separate ignition module. Later models (S/N 245038 -) have the ignition module built into the ignition coil.

In the spark stage (spark produced), the flywheel magnet is fully aligned with the ignition coil and high voltage (maximum current) is induced in the primary coil. This high voltage current causes the ignition module to ground the primary coil windings. The sudden reduction of current flow induces high voltage current in the secondary coil. The high voltage current flows through the ignition coil wire to the spark plug. The voltage is now high enough to jump the spark plug gap and a spark is produced.

Ignition Circuit Schematic - 4X2 Gas



SE3 - Ignition (S/N - 245037)



SE3 - Ignition (Solid State) (S/N 245038 -)

Ignition Circuit Diagnosis - 4X2 Gas

Test Conditions:

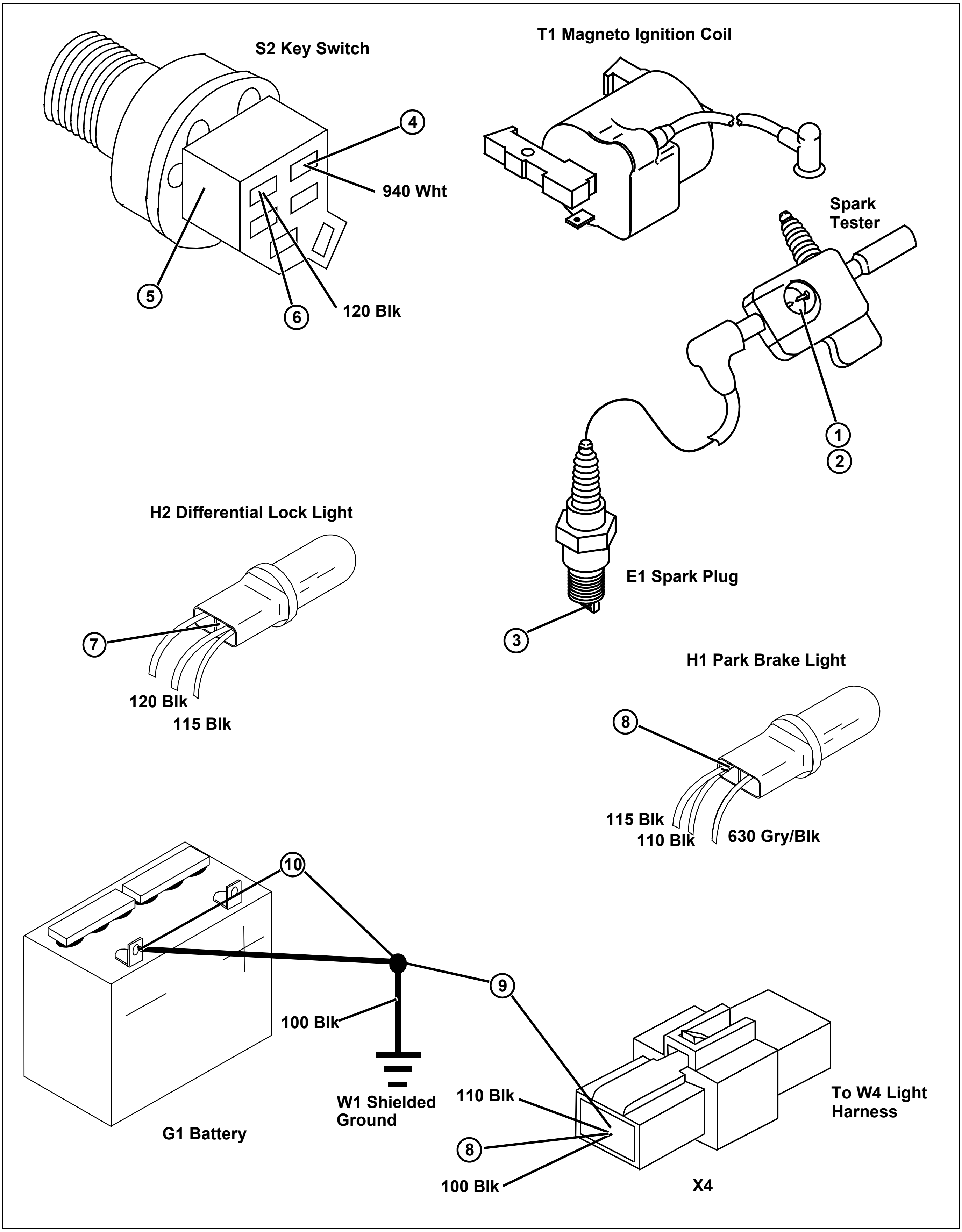
- Transmission in NEUTRAL
- Key switch in START position

Test/Check Point	Normal	If Not Normal
1. Spark plug tester	Spark test indicates hot blue spark.	No spark: Test ignition coil. Check armature air gap. Check for grounded primary lead. Check for leaking or grounded secondary plug wire. Spark: Check spark plug.
2. Engine connector disconnected	Spark present at tester.	Continue testing ignition circuit through key switch.
3. Spark plug	Spark plug not fouled. Correct air gap.	Adjust air gap. Replace spark plug.

Test Conditions:

- Key switch in RUN position

Test/Check Point	Normal	If Not Normal
4. Key switch to engine connector	Continuity between key switch connector and engine connector. No continuity to ground.	Repair 940 Wht wire.
5. Key switch (in RUN position)	No continuity between 940 Wht wire and 120 Blk wire.	Replace key switch.
6. Key switch connector to differential lock light socket	Continuity between connectors. No continuity to ground.	Repair 120 Blk wire or connections.
7. Differential lock socket to park brake light socket	Continuity. No continuity to ground.	Repair 115 Blk wire or connections.
8. Park brake light to X4	Continuity. No continuity to ground.	Repair 110 Blk wire or connections.
9. X4 to W1 shielded ground	Continuity to ground at engine	Check 100 Blk wire or connections at engine ground connection.
10. Battery ground cable to battery	Continuity	Replace negative battery cable or clean connections.


S2 Key Switch
T1 Magneto Ignition Coil
4
940 Wht
5
6
120 Blk
Spark
Tester
1
2
H2 Differential Lock Light
E1 Spark Plug
7
3
120 Blk
115 Blk
H1 Park Brake Light
8
115 Blk
110 Blk
630 Gry/Blk
10
9
100 Blk
W1 Shielded
Ground
G1 Battery
110 Blk
8
100 Blk
X4
To W4 Light
Harness

Charging Circuit Operation - Stator

Function:

To maintain battery voltage between 12.4 and 13.2 volts.

Operating Conditions:

The key switch must be in the run position with the engine running for the charging system to operate.

System Operation:

The charging system is a permanent magnet and stator design. Charging output is controlled by a voltage regulator/rectifier.

With the key switch in the run position, battery sensing circuit current flows from battery positive terminal to starting motor terminal, fusible link, key switch, and voltage regulator/rectifier.

The battery sensing circuit allows the voltage regulator/rectifier to monitor battery voltage.

As the flywheel turns, a permanent magnet located in the flywheel induces AC current in the stator. The AC current flows to the voltage regulator/rectifier. The voltage regulator/rectifier converts AC current to DC current needed to charge the battery.

If battery voltage is low, the voltage regulator/rectifier allows DC current to flow to the battery to charge it through the battery charging circuit. 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.

Charging Circuit Operation - Auxiliary Alternator (Option)

Function:

To maintain battery voltage between 12.4 and 13.2 volts.

Operating Conditions:

The key switch must be in the RUN position with the engine running for the charging system to operate.

System Operation:

The charging system consists of the G3 alternator with an integrated voltage regulator/rectifier. Charging output is controlled by a regulator/rectifier.

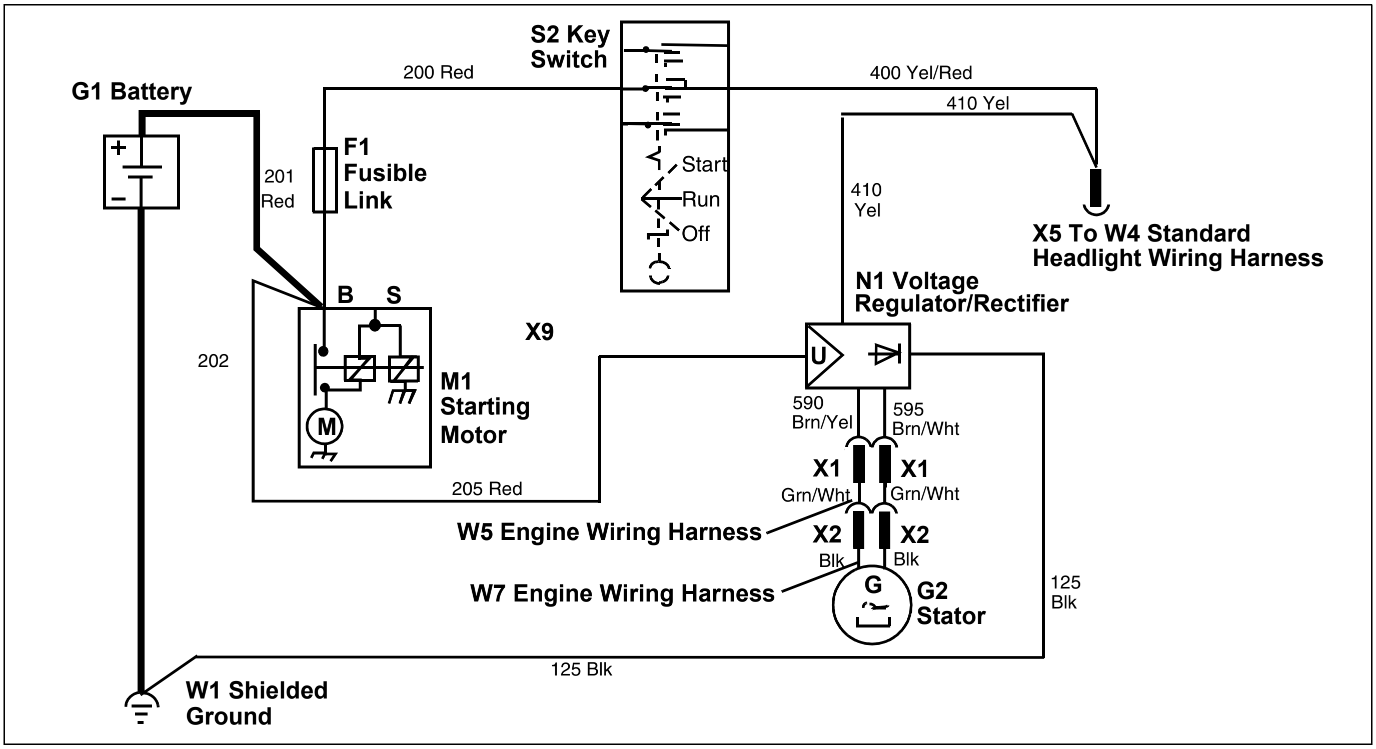
With the key switch in the RUN position, battery sensing circuit current flows from battery positive terminal 202 and 201 Red wires to the auxiliary alternator internal voltage regulator/rectifier. The battery sensing circuit allows the voltage regulator/rectifier to monitor battery voltage.

A rotating permanent magnet in the alternator induces AC current in the alternator stator coils. The AC current flows to the 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 (201 and 202 Red). When the battery is fully charged, the voltage regulator/rectifier stops current flow to the battery.

The ground circuit (101 and 102 Blk) provides a path to ground for the voltage regulator/rectifier.

Charging Circuit Schematic - Stator



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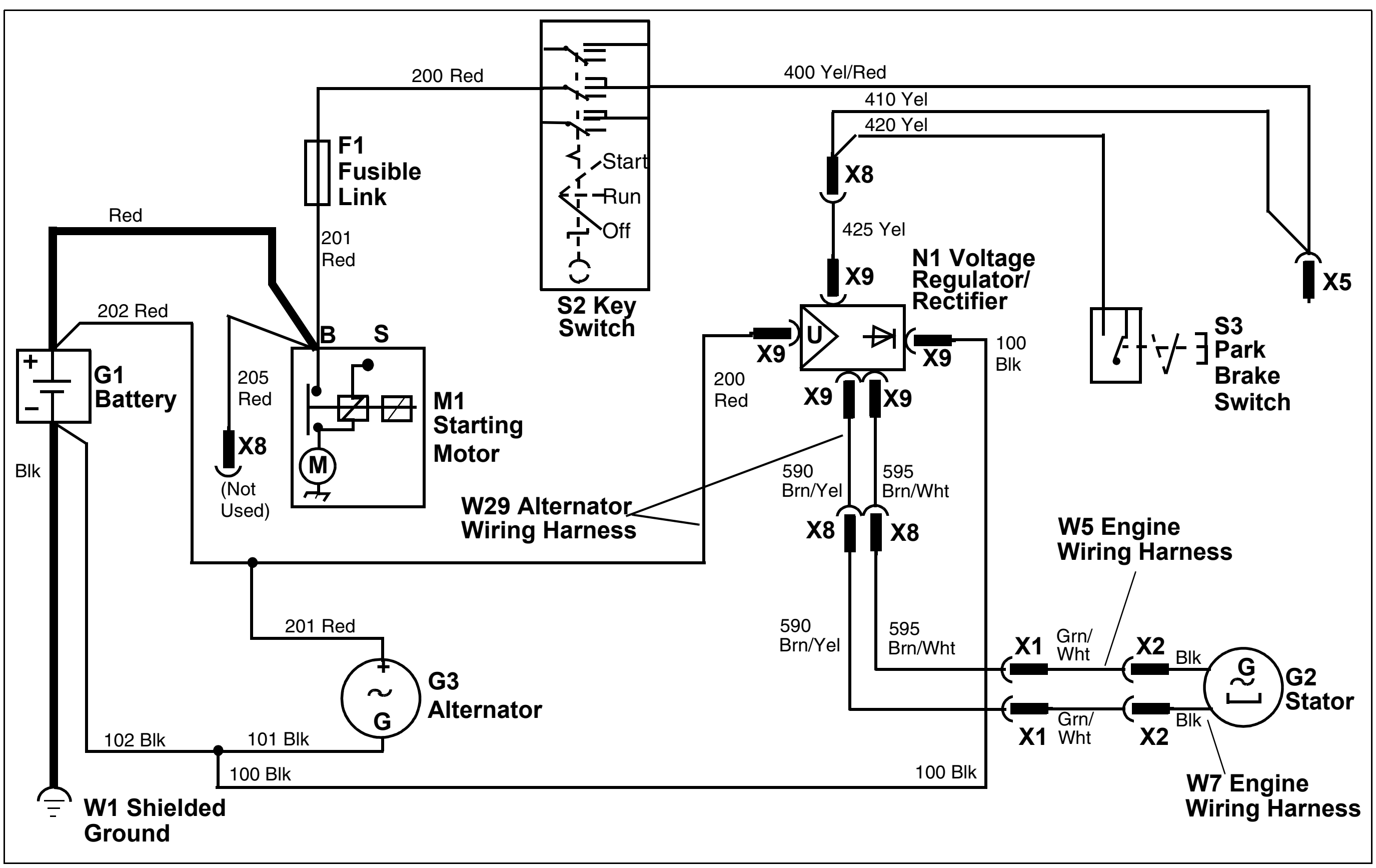
Charging Circuit Schematic - Auxiliary Alternator (Option)



MIF

Charging Circuit Diagnosis - 4X2 Gas

Test Conditions:

- Park brake set
- Transmission in NEUTRAL
- Key switch in RUN position/engine OFF

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal	11.8 - 13.2 volts	Test battery. See “Battery Test” on page 372.
2. Voltage regulator/rectifier	Battery voltage	Check 590 Brn/Wht, 595 Brn/Wht wire and connections
3. Alternator, high capacity (optional)	Battery voltage	Check 202 and 201 Red wires and connections

Test Conditions:

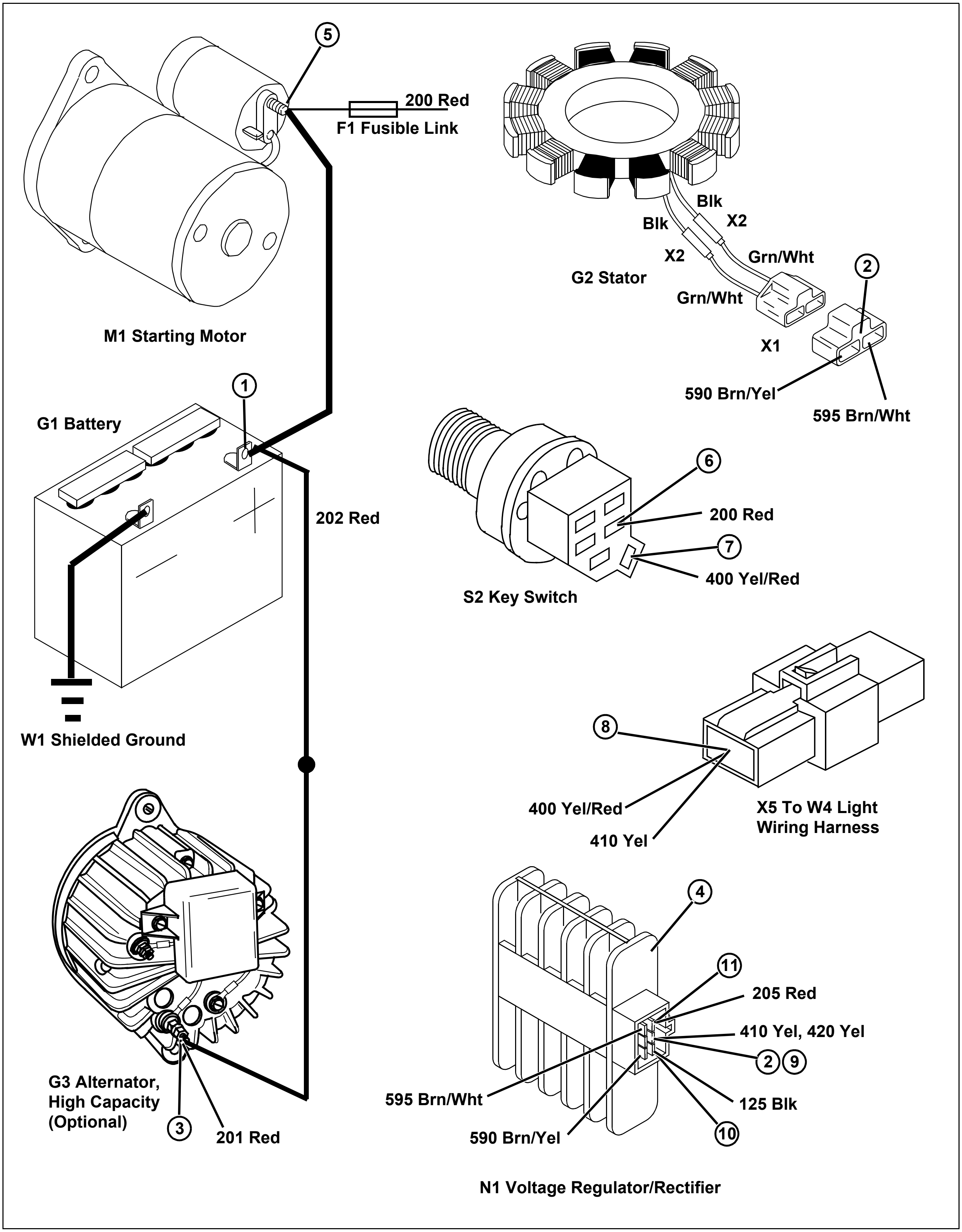
- Engine connector disconnected
- Engine running at high idle

Test/Check Point	Normal	If Not Normal
4. Voltage regulator/rectifier	Minimum unregulated voltage - 34 VAC	Test stator, check flywheel magnets.

Test Conditions:

- Engine connector connected

Test/Check Point	Normal	If Not Normal
5. Starting motor battery terminal	Battery voltage	Test battery and starting motor cable connections.
6. Key switch	Battery voltage	Test 200 Red wire or replace fusible link.
7. Key switch	Battery voltage	Replace key switch.
8. X5 Light wiring harness connector	Battery voltage	Check 400 Yel/Red wire and connections.
9. Voltage regulator/rectifier	Battery voltage	Check 410 Yel wire and connections.
10. Voltage regulator/rectifier (at 125 Blk wire)	Greater than 0 volts less than 0.2 volts	Greater the 0.2 volts: Test voltage. regulator/rectifier ground circuit. 0 volts: Test voltage regulator/rectifier.
11.Voltage regulator/rectifier (at 205 Red wire)	13 amps (minimum) at 12.2 to 13.8 volts	Replace voltage regulator/rectifier.


5
200 Red
F1 Fusible Link
M1 Starting Motor
Blk
X2
Blk
X2
Grn/Wht
G2 Stator
Grn/Wht
2
X1
590 Brn/Yel
595 Brn/Wht
1
G1 Battery
202 Red
6
200 Red
7
400 Yel/Red
S2 Key Switch
W1 Shielded Ground
8
400 Yel/Red
410 Yel
X5 To W4 Light Wiring Harness
4
11
205 Red
410 Yel, 420 Yel
2 9
125 Blk
595 Brn/Wht
10
590 Brn/Yel
G3 Alternator, High Capacity (Optional)
3
201 Red
N1 Voltage Regulator/Rectifier

Park Brake and Differential Lock Lights Operation - 4X2 Gas

Park Brake Light Circuit Operation:

Function:

The circuit turns on the dash warning light when the park brake is set.

Operating Conditions:

- Key switch must be in the RUN position.

Theory of Operation:

Current flows through the key switch and two tie points at the headlight harness connector (X5) and the voltage regulator/rectifier. Current then flows to the park brake switch.

When the park brake lever is moved to the brake set position, the park brake switch is released (closing), allowing current to flow to the park brake light.

Differential Lock Warning Light Circuit Operation:

Function:

The circuit turns on the warning light when the differential lock is engaged.

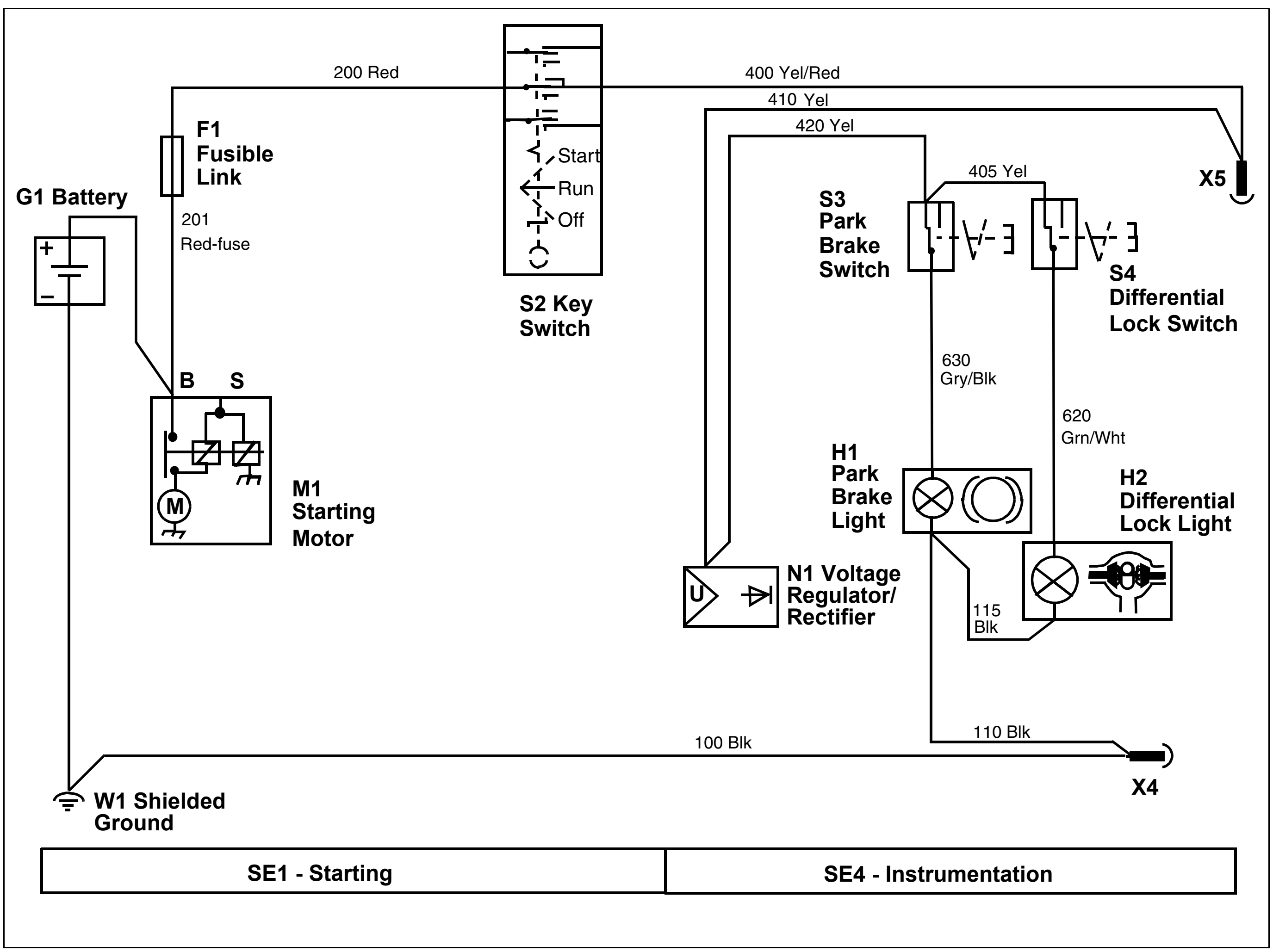
Operation Conditions:

- Key switch must be in the RUN position.

Theory of Operation:

Current flows through the key switch and three tie points at the light harness connector (X5), the voltage regulator/ rectifier and at the park brake switch. Current then flows to the differential lock switch. When the differential lock is engaged, the switch is depressed allowing current to flow to the differential lock light.

Park Brake and Differential Lock Lights Schematic - 4X2 Gas

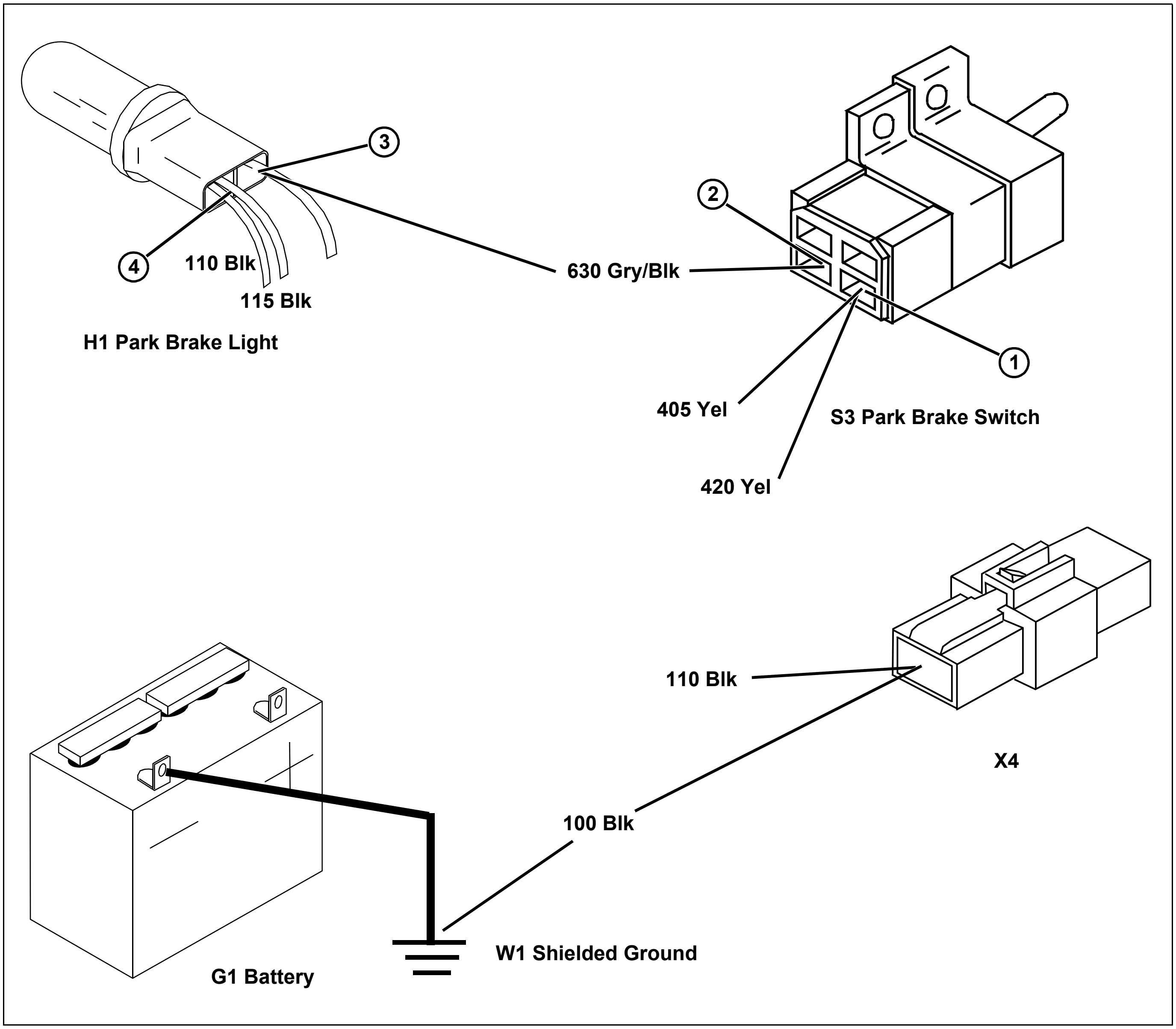


Park Brake Light Diagnosis - 4X2 Gas

Test Conditions:

- Key switch in RUN position
- Park brake set

Test/Check Point	Normal	If Not Normal
1. Park brake switch	Battery voltage	See “Power Circuit Diagnosis - 4X2 Gas” on page 253.
2. Park brake switch	Battery voltage	Check switch adjustment. Replace park brake switch.
3. Park brake light	Battery voltage	Check 630 Gry/Blk wire and connections.
4. Park brake light	Greater than 0 volts - less than 0.2 volts	0 Volts: Replace light bulb. Greater than 0.2 volt: Check 110 Blk wire and connections at X4. Check 100 Blk wire to engine ground connection.

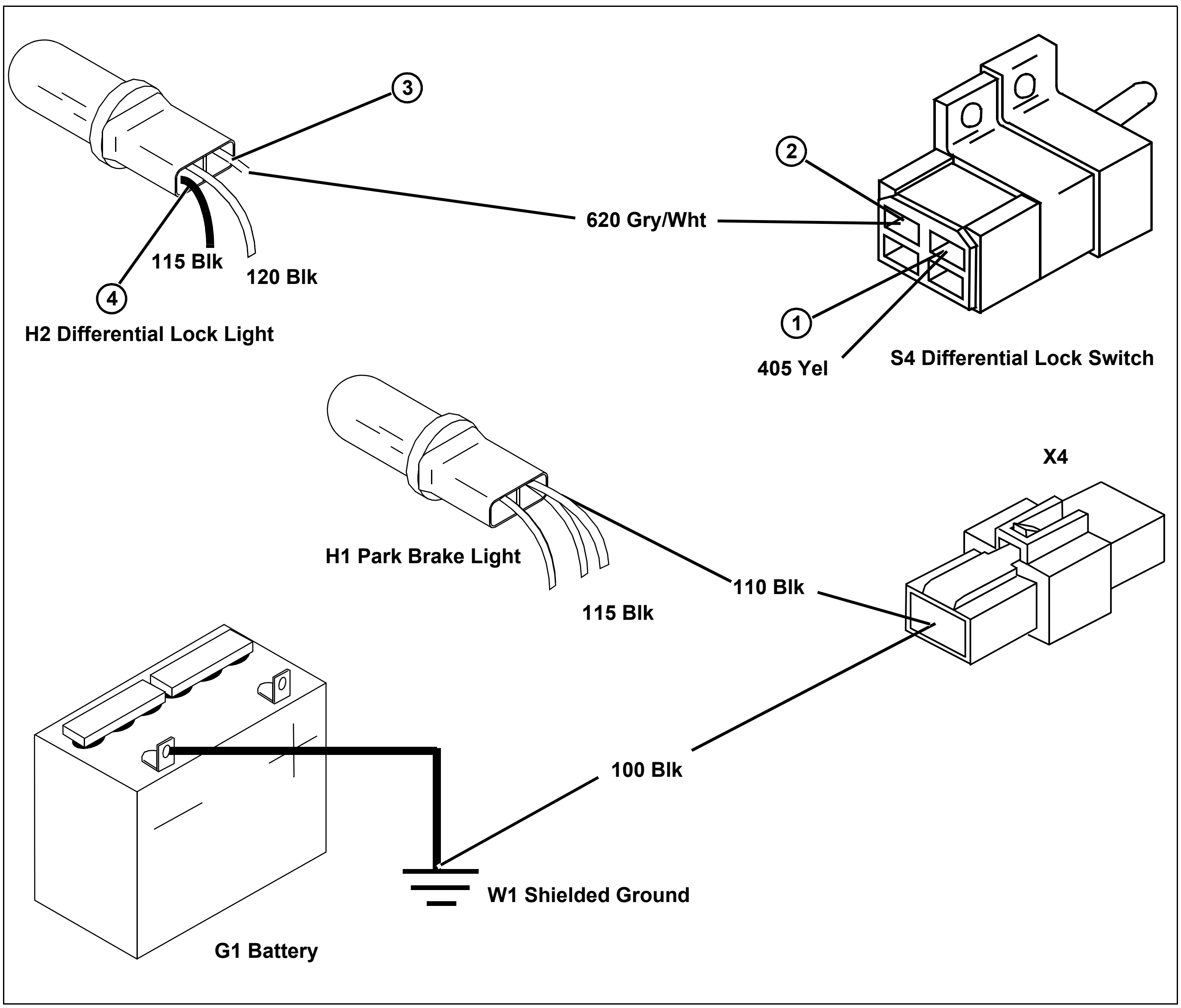


Differential Lock Light Diagnosis - 4X2 Gas

Test Conditions:

- Key switch in RUN position
- Differential lock set

Test/Check Point	Normal	If Not Normal
1. Differential lock switch	Battery voltage	See “Power Circuit Diagnosis - 4X2 Gas” on page 253.
2. Differential lock switch	Battery voltage	Adjust switch rod. Replace switch.
3. Differential lock light	Battery voltage	Check 620 Grn/Wht wire and connections.
4. Differential lock light	Greater than 0 volts - less than 0.2 volts.	0 volts: Replace bulb. Greater than 0.2 volts: Check ground circuit 115 Blk wire to park brake light, and 110 Blk wire to X4. Check 100 Blk wire and connections to engine ground.



Standard Headlight Circuit Operation - 4X2 Gas

NOTE: If the Light and Horn kit option is added, the new wiring harness plugs into the W1 main wiring harness connectors (X5 and X4). The original domestic light wiring harness is removed.

Function:

Provides power to the headlights.

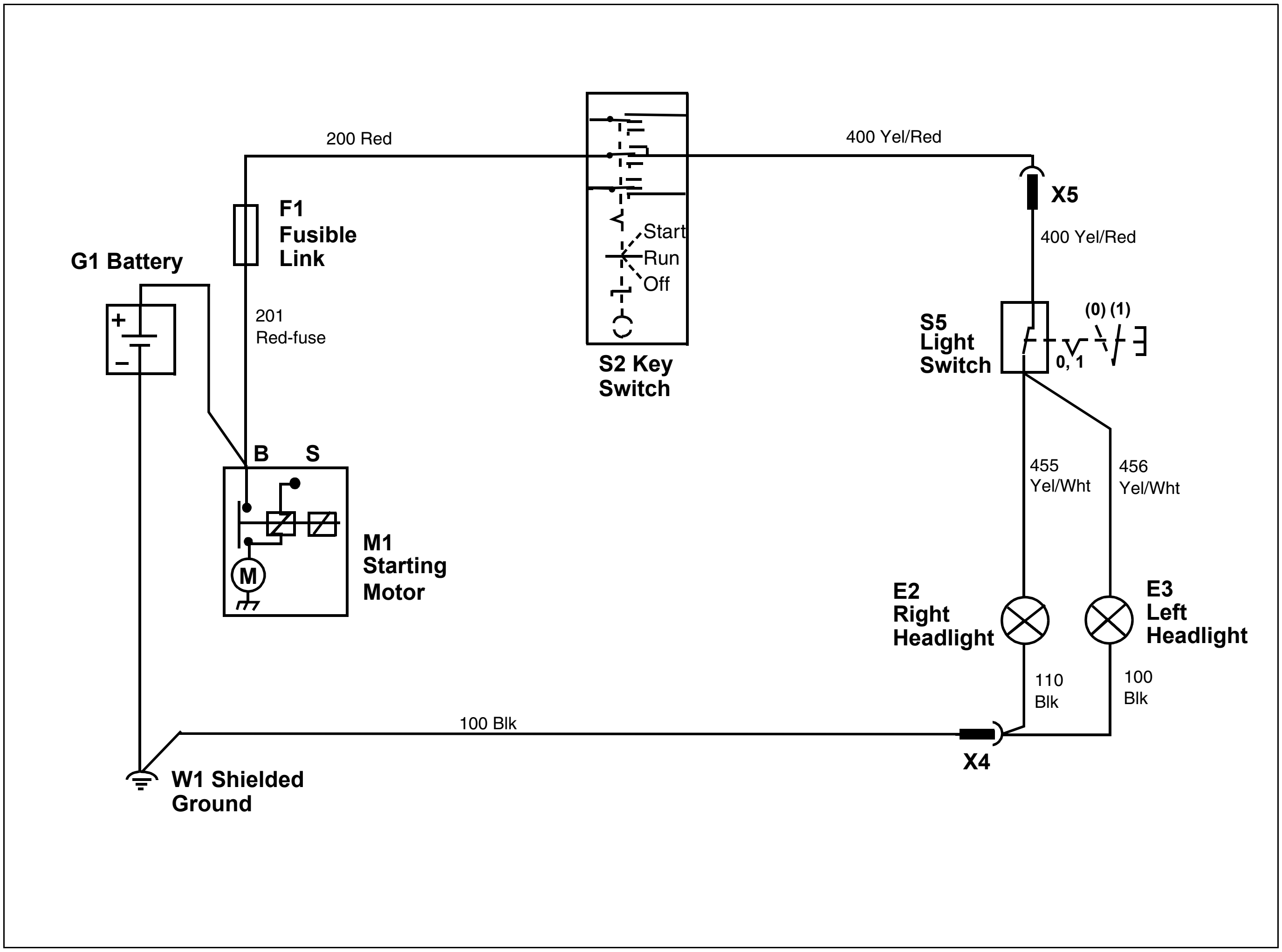
Operating Conditions:

The key switch must be in the RUN position.

Theory of Operation:

The W4 standard headlight wiring harness is attached to the W1 main wiring harness. Power from the headlight harness connector (X5) is connected to the light switch. Current then flows from the light switch to the headlights. Ground circuit is obtained through the headlight harness connector (X4) and 100 Blk wire to engine ground.

Standard Headlight Circuit Schematic - 4X2 Gas

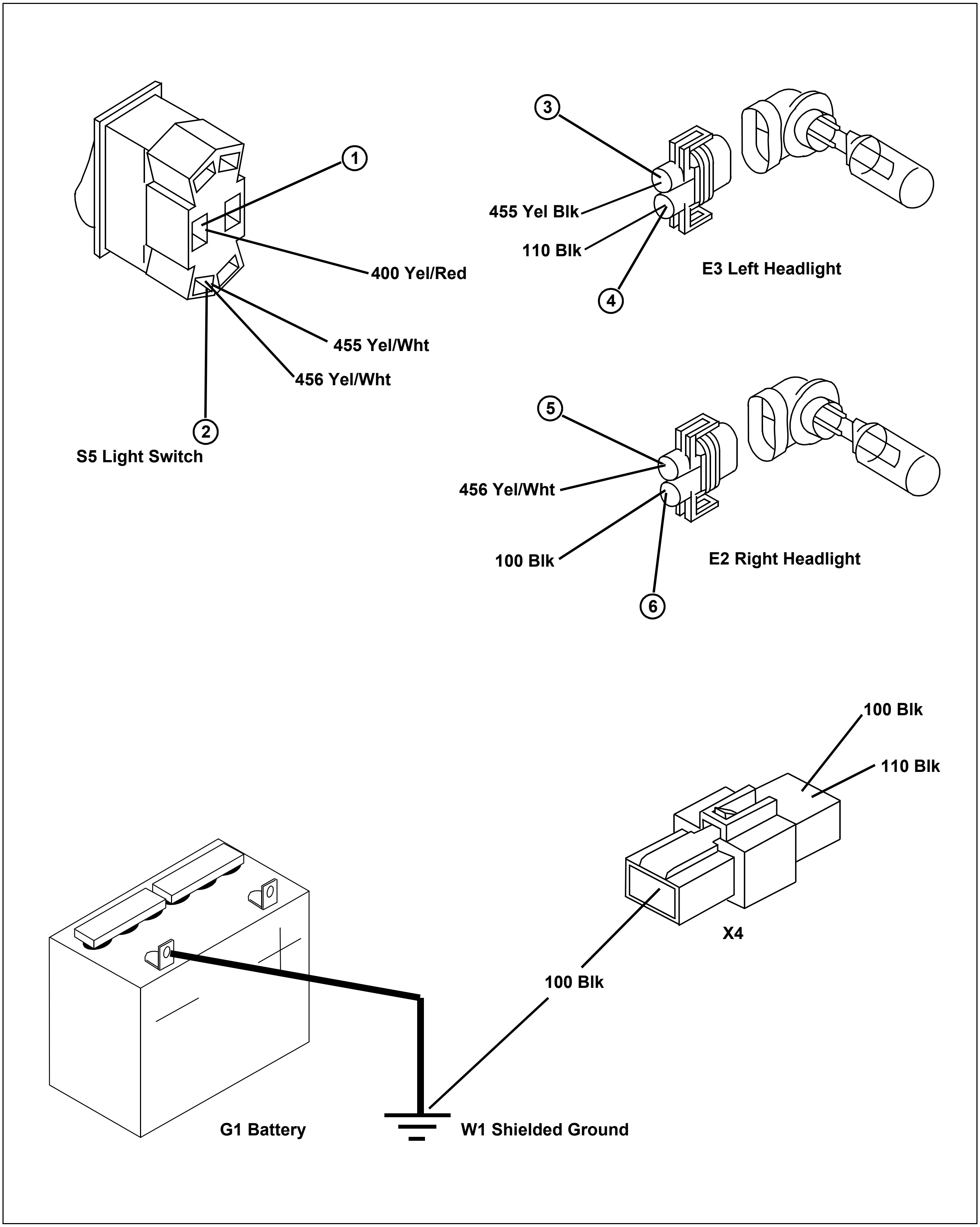


Standard Headlight Circuit Diagnosis - 4X2 Gas

Test Conditions:

- Key switch must be in the RUN position
- Light switch ON

Test/Check Point	Normal	If Not Normal
1. Light switch	Battery voltage	Check connection at S5. See “Power Circuit Diagnosis - 4X2 Gas” on page 253.
2. Light switch	Battery voltage	Replace light switch.
3. Left headlight	Battery voltage	Check 455 Yel/Wht wire and connections.
4. Left headlight	Greater than 0 volts - less than 0.2 volts.	0 volts: Replace headlight. Greater than 0.2 volts: Check harness connector (X4) and 100 Blk wire to engine ground.
5. Right headlight	Battery voltage	Check 456 Yel/Wht wire and connections.
6. Right headlight	Greater than 0 volts - less than 0.2 volts.	0 volts: Replace headlight. Greater than 0.2 volts: Check harness connector (X4) and 100 Blk wire to engine ground.



1
400 Yel/Red
455 Yel/Wht
456 Yel/Wht
2
S5 Light Switch
3
455 Yel Blk
110 Blk
4
E3 Left Headlight
5
456 Yel/Wht
100 Blk
6
E2 Right Headlight
100 Blk
110 Blk
X4
100 Blk
G1 Battery
W1 Shielded Ground

Specifications - 6X4 Gas

Battery:

Voltage . . . 12 VDC
BCI group . . . U-1
CCA rating (Amps at 0° F) . . . 325 amps
Reserve capacity (minutes) . . . 38
Specific gravity . . . 1.225 or above
Electrolyte required fill (approximately) . . . 1.9 L (2.0 qt)
Load test (minimum) . . . 325 amps for 15 seconds

Ignition:

Pulser Coil (Resistance) . . . 85 - 270 ohms

Ignition Coil
Primary resistance . . . 3.4 - 4.5 ohms
Secondary winding resistance . . . 10.4 - 15.6 k ohms

Spark Plug:

Engine AS11 - FS11 (Engine S/N: - 199856)
Type . . . NGK BMR2A-10
Gap . . . 1.0 mm (0.040 in.)
Torque . . . 25 N•m (221 lb-in.)
or
Type . . . Champ Right18Y
Gap . . . 0.71 mm (0.028 in.)
Torque . . . 27 N•m (240 lb-in.)

Engine GS11 - HS11 (Engine S/N: 204959 -)
Type . . . NGK BPR2ES
Gap . . . 0.63 mm (0.025 in.)
Torque . . . 25 N•m (221 lb-in.)

Starting Motor:

Type . . . Solenoid Shift
Amp draw (on machine) . . . 72 amps (maximum) at 500 rpm
No-load amp draw (free running) . . . 50 amps (maximum) at 6000 rpm

Alternator: (FD620D)

High Capacity Alternator . . . 45 amp
Regulated amperage/voltage . . . 45 amp at 12.2 - 13.8 volts

Stator: (PIN FD620D038267-)

Stator size . . . . 16 amps

Regulated amperage/voltage. . . . . 14 amp at 12.2 - 13.8 volts

Unregulated voltage . . . . 26 VAC

Stator: (PIN FD620D009262 - FD620D038266)

Stator size . . . . 20 amps

Regulated amperage/voltage. . . . . 16 amp at 12.2 - 13.8 volts

Unregulated voltage . . . . 26 VAC

Engine: Temperature:

Engine Coolant Temperature Light Switch . . . . From OFF (open) to ON (closed) at 109° ± 1° C (228° ± 2° F)

Radiator Core Temperature Switch:

Early Models (To Model Year 2002)

Closes (Continuity - Radiator Fan ON) . . . . 71 ± 4° C (160° ± 7° F)

Opens (Infinity - Radiator Fan OFF) . . . . 60 ± 4° C (140° ± 7° F)

NOTE: The radiator core temperature switch closes when the coolant heats to 89° C (192° ± 7° F) raising the outer radiator core temperature to 71° C (160° ± 7° F). The outer radiator core temperature is approximately 20° C (36° F) lower than engine coolant temperature.

Later Models (From Model Year 2002)

Closes (Continuity - Radiator Fan ON) . . . . 93 ± 3° C (200° ± 5° F)

Lighting:

Headlights (halogen) . . . . 37.5 watts

Tail/Brake Lights . . . . 21 watts

Position Lights . . . . 10 watts

Front /Rear Turn Lights . . . . 21 watts

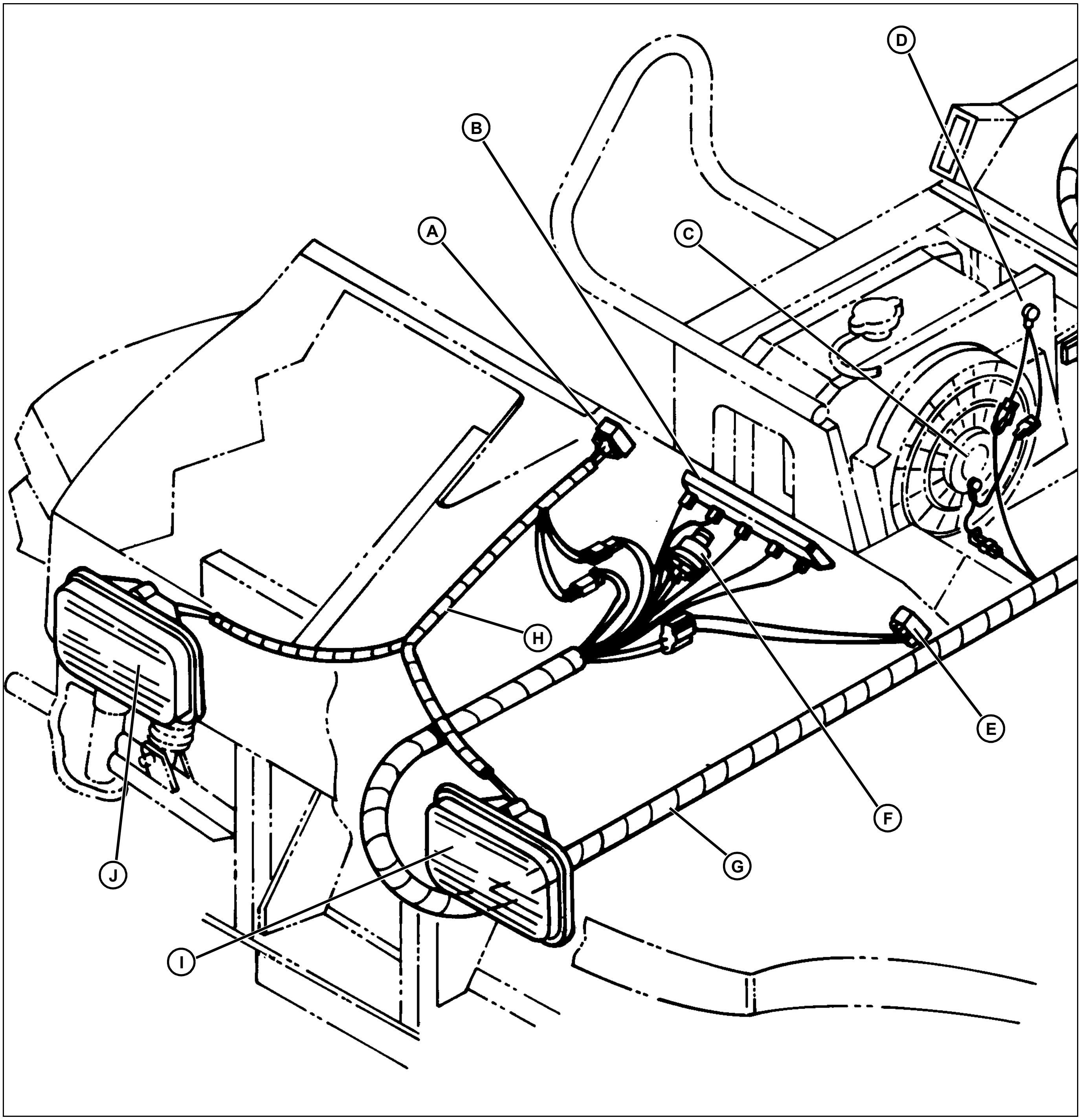
Neutral Start Switch:

Neutral (Depressed) . . . . Continuity

In Gear (Released) . . . . No Continuity

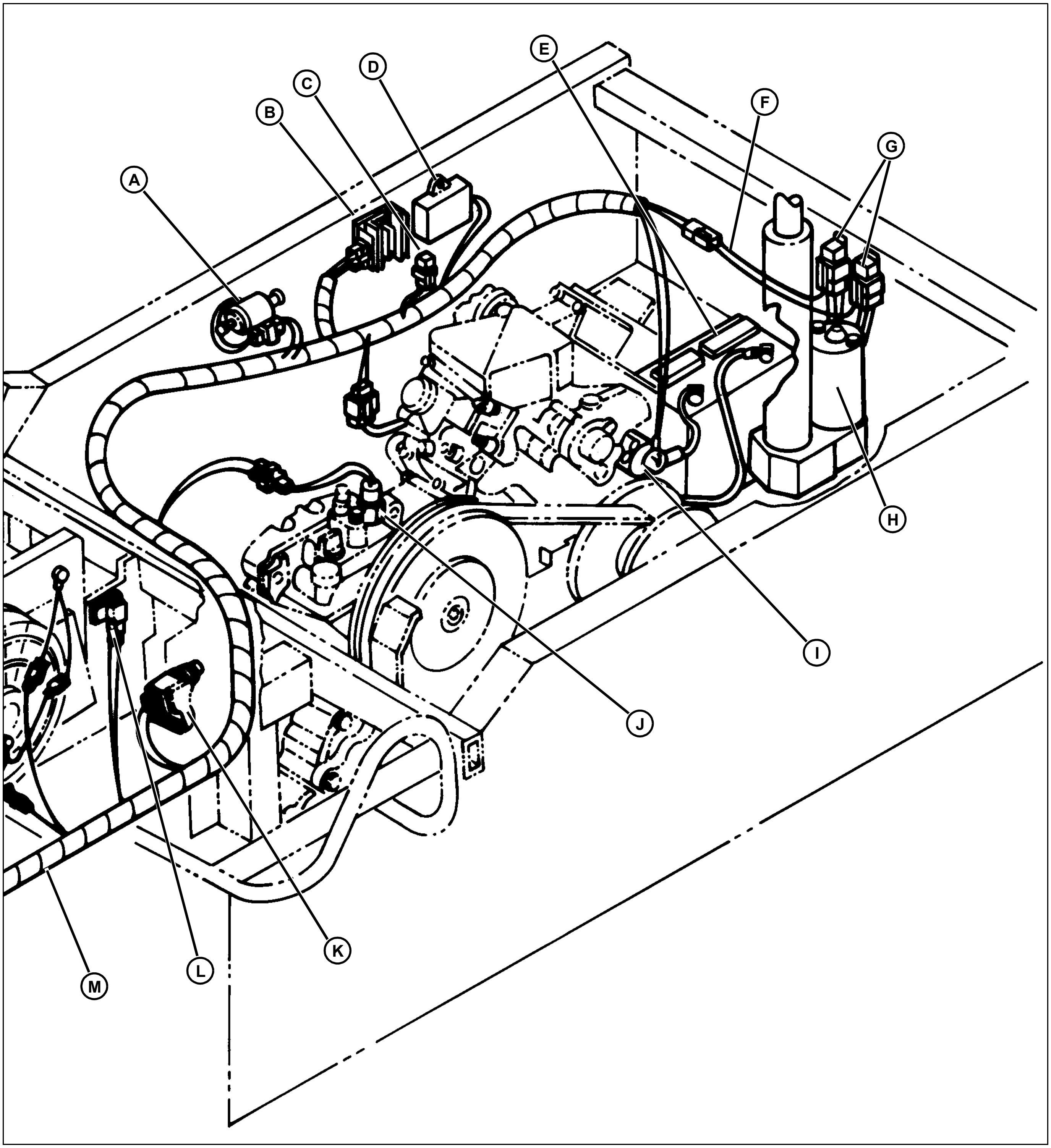
Component Location

Component Location - 6X4 Gas



A - S5 Light Switch
B - Instrument Panel Lights
C - M3 Radiator Fan Motor
D - B3 Radiator Core Temperature Switch
E - Cargo Box Lift Switch (optional)
F - S2 Key Switch
G - W2 Main Wiring Harness
H - W4 Standard Headlight Wiring Harness
I - E4 Headlight
J - E3 Headlight

ELECTRICAL COMPONENT LOCATION



M56334R

A - M2 Fuel Pump
B - N1 Voltage Regulator/Rectifier
C - K1 Start Relay
D - A1 Ignition Module
E - G1 Battery
F - W17 Cargo Box Lift Wiring Harness
G - K1 and K2 Cargo Box Lift Directional Relays
H - M2 Cargo Box Lift Motor
I - M1 Starting Motor
J - S1 Neutral Start Switch
K - S4 Differential Lock Switch
L - S3 Park Brake Switch
M - W2 Main Wiring Harness

Schematics and Harnesses - 6X4 Gas

Electrical Schematic and Wiring Harness Legend - 6X4 Gas

A1 - Ignition Module (SE3, W2)

B1 - Left Pulser Coil (SE3, W2)

B2 - Right Pulser Coil (SE3, W2)

B3 - Radiator Core Temperature Switch (SE4, W2)

B4 - Engine Temperature Switch (SE5, W2)

B5 - Engine Oil Pressure Switch (SE5, W2)

E1 - Spark Plug (SE3, W2)

E2 - Spark Plug (SE3, W2)

E3 - Right Headlight (SE6, W2)

E4 - Left Headlight (SE6, W2)

F1 - Fusible Link (SE1, W2)

F2 - Fusible Link (SE1, W2)

F3 - Fusible Link (SE1, W2)

G1 - Battery (SE1, W2)

G2 - Stator (SE2, W2)

G3 - High Capacity Alternator (Optional) (SE2, W2)

H1 - Discharge Light (SE5, W2)

H2 - Park Brake Light (SE5, W2)

H3 - Differential Lock Light (SE5, W2)

H4 - Engine Coolant Temperature Light (SE5, W2)

H5 - Engine Oil Pressure Light (SE5, W2)

K1 - Start Relay (SE1, W2)

M1 - Starting Motor (SE1, W2)

M2 - Fuel Pump (SE4, W2)

M3 - Radiator Fan Motor (SE4, W2)

M4 - Cargo Box Lift Kit Motor (Optional) (SE5, W2)

N1 - Voltage Regulator/Rectifier (SE2, W2)

R1 - Carburetor Heater (SE4, W2)

S1 - Neutral Start Switch (SE1, W2)

S2 - Key Switch (SE1, W2)

S3 - Park Brake Switch (SE5, W2)

S4 - Differential Lock Switch (SE5, W2)

S5 - Cargo Box Lift Kit Switch (Opt.) (SE5, W2)

S6 - Light Switch (SE6, W2)

T1 - Ignition Coil (SE3, W2)

T2 - Ignition Coil (SE3, W2)

V1 - Diode (SE1, W2)

V2 - Diode (SE5, W2)

W1 - Shielded Ground (SE1, W2)

Connectors:

X1 - W2 Main Wiring Harness to W8 Engine Wiring Harness (SE1, W2; SE2, W2; SE3, W2; SE5, W2)

X2 - W8 Engine Wiring Harness to W9 Engine Wiring Harness and W13 Engine Wiring Harness (SE3, W2)

X3 - W9 Engine Wiring Harness to W10 Engine Wiring Harness (SE3, W2)

X4 - W10 Engine Wiring Harness to W11 Engine Wiring Harness (SE3, W2)

X5 - W2 Main Wiring Harness to M3 Radiator Fan Motor (SE4, W2)

X6 - M3 Radiator Fan Motor to B3 Radiator Core Temperature Switch (SE4, W2)

X7 - B3 Radiator Core Temperature Switch to W1 Shielded Ground (SE3, W2)

X8 - W2 Main Wiring Harness to S5 Cargo Box Lift Kit Switch (Opt.) (SE5, W2)

X9 - W2 Main Wiring Harness to W17 Cargo Box Lift Kit Wiring Harness (SE5, W2)

X10 - W2 Main Wiring Harness to W4 Standard Headlight Wiring Harness (SE6, W2; SE2, W18)

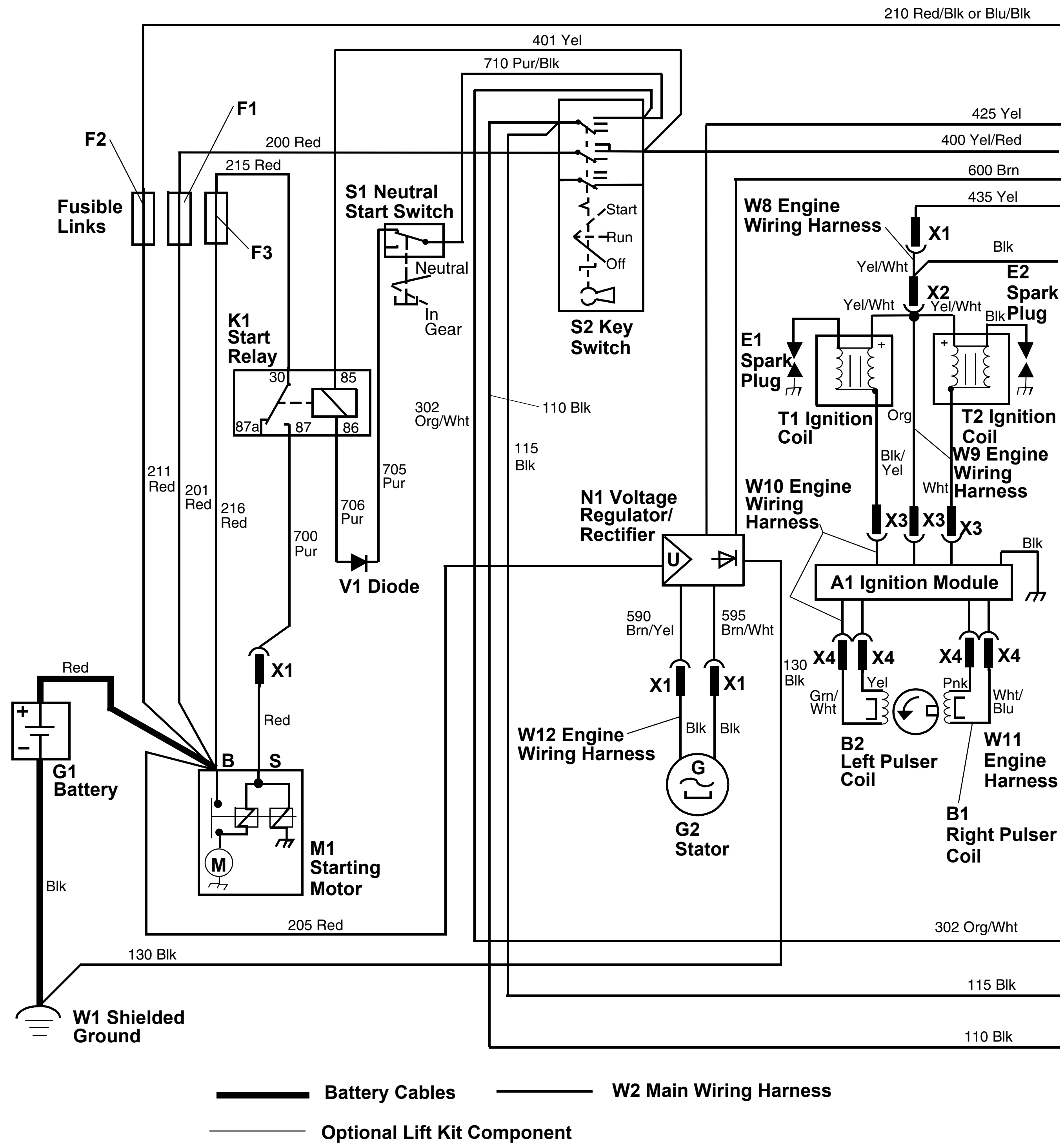
X11 - W4 Standard Headlight Wiring Harness to W2 Main Wiring Harness (SE6, W2; SE1, W18)

X12 - W29 Auxiliary Alternator Wiring Harness to W2 Main Wiring Harness (SE2, W2)

X13 - W29 Auxiliary Alternator Wiring Harness to N1 Voltage Regulator(SE2, W2)

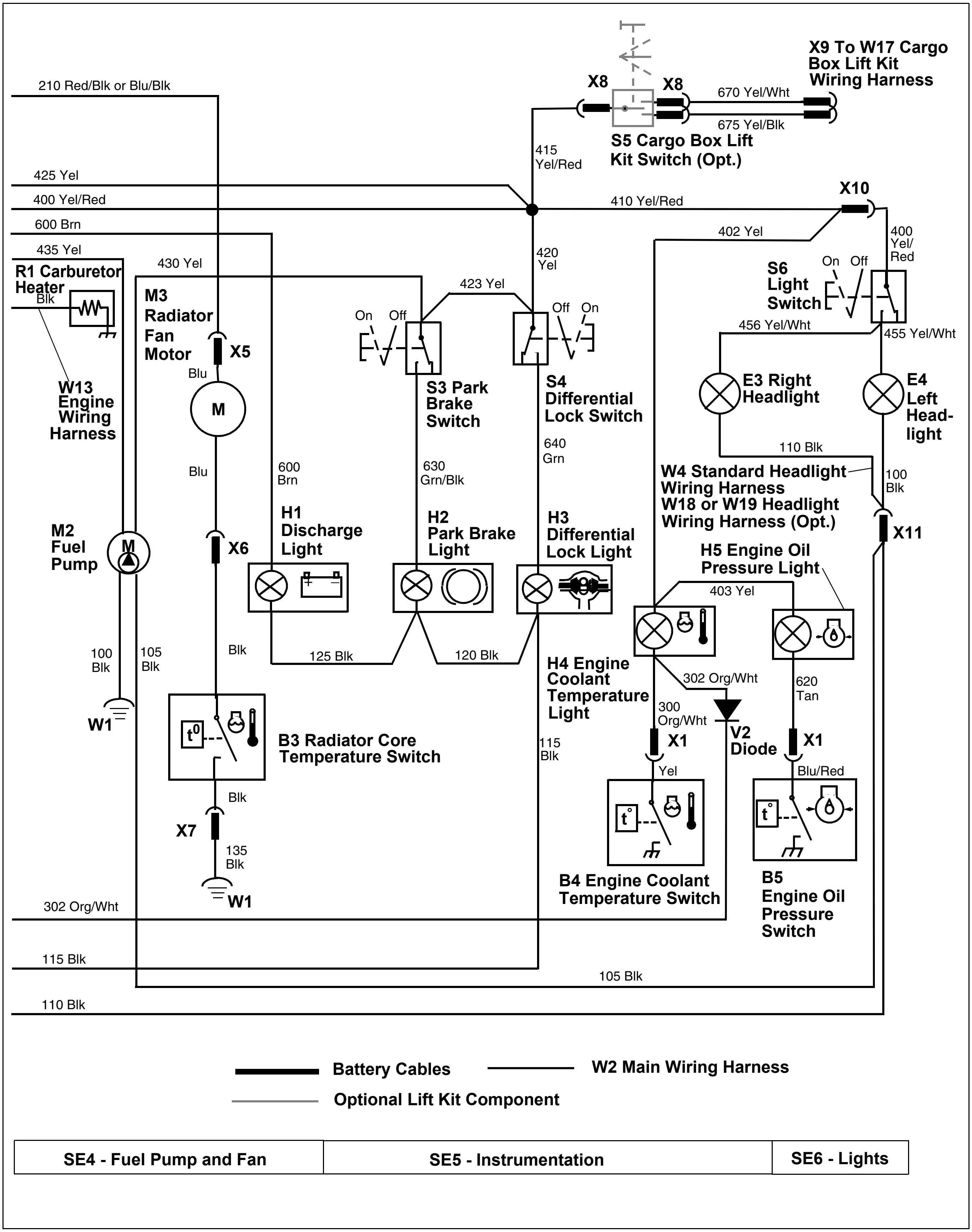
W2 Standard Electrical Schematic - 6X4 Gas

W2 Standard Electrical Schematic - 6X4 Gas (1 of 2)



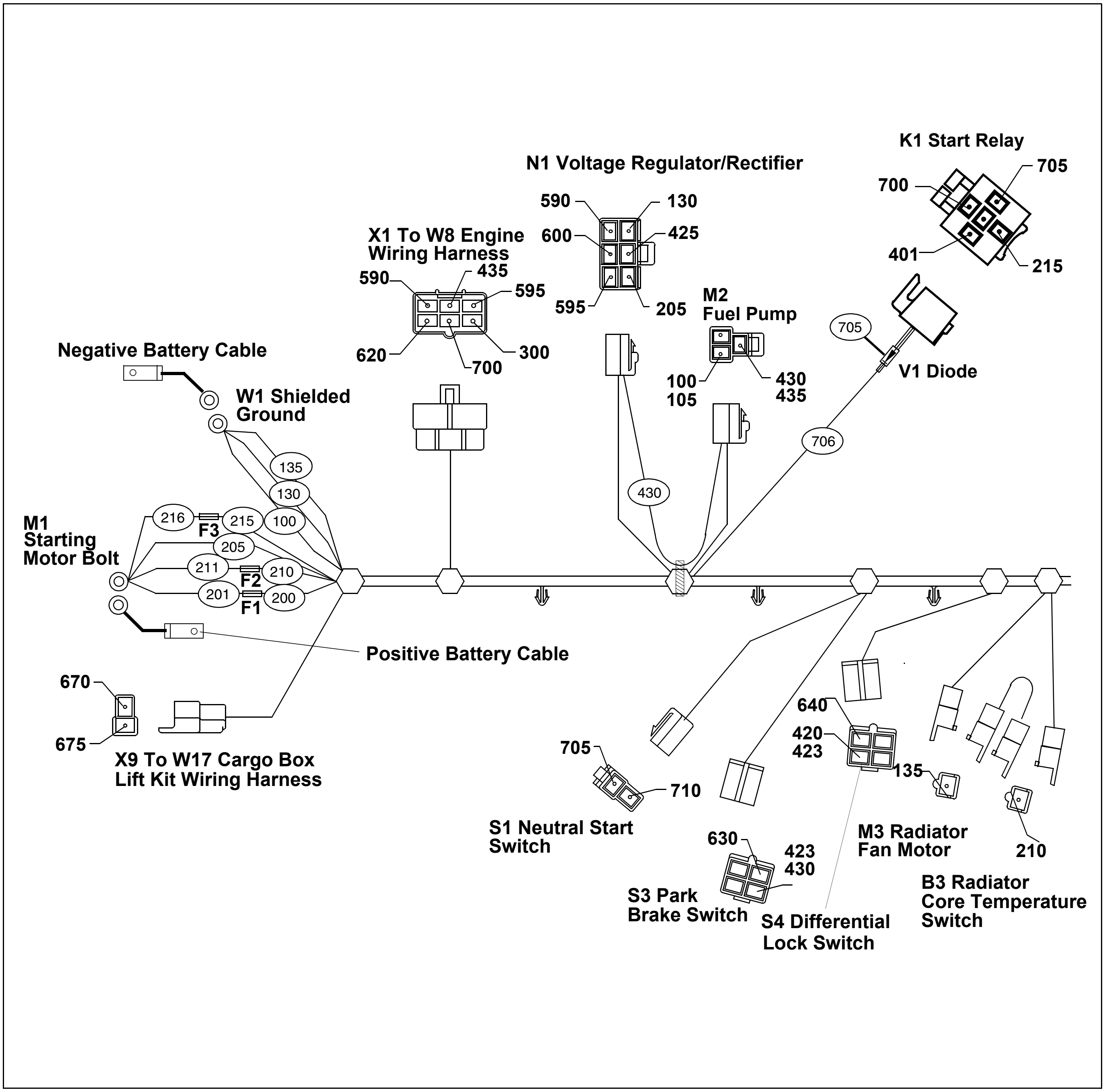
SE1 - Starting	SE2 - Charging	SE3 - Ignition

W2 Standard Electrical Schematic - 6X4 Gas (2 of 2)

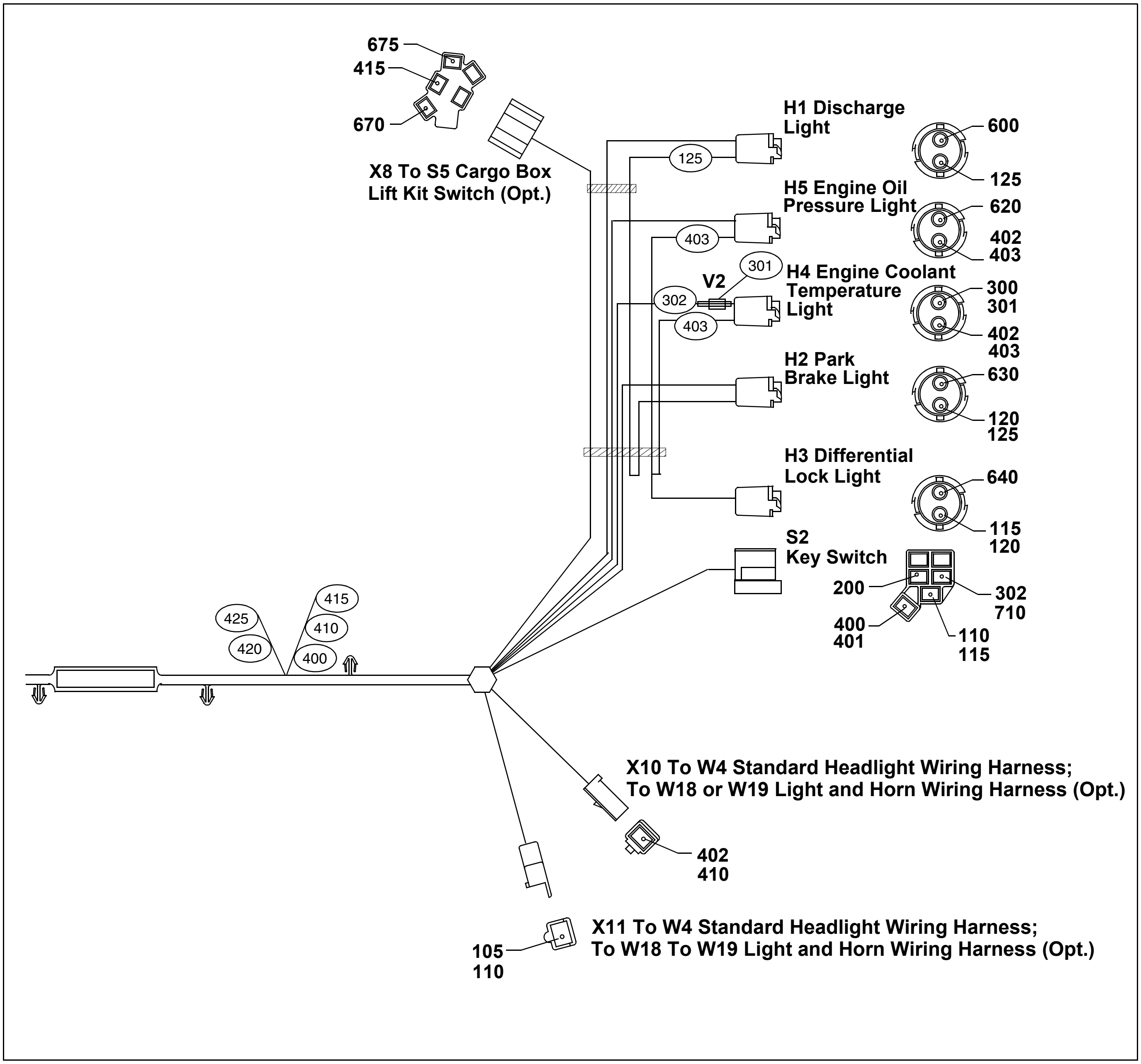


W2 Main Wiring Harness - 6X4 Gas

W2 Main Wiring Harness - 6X4 Gas (1 of 2)



W2 Main Wiring Harness - 6X4 Gas (2 of 2)

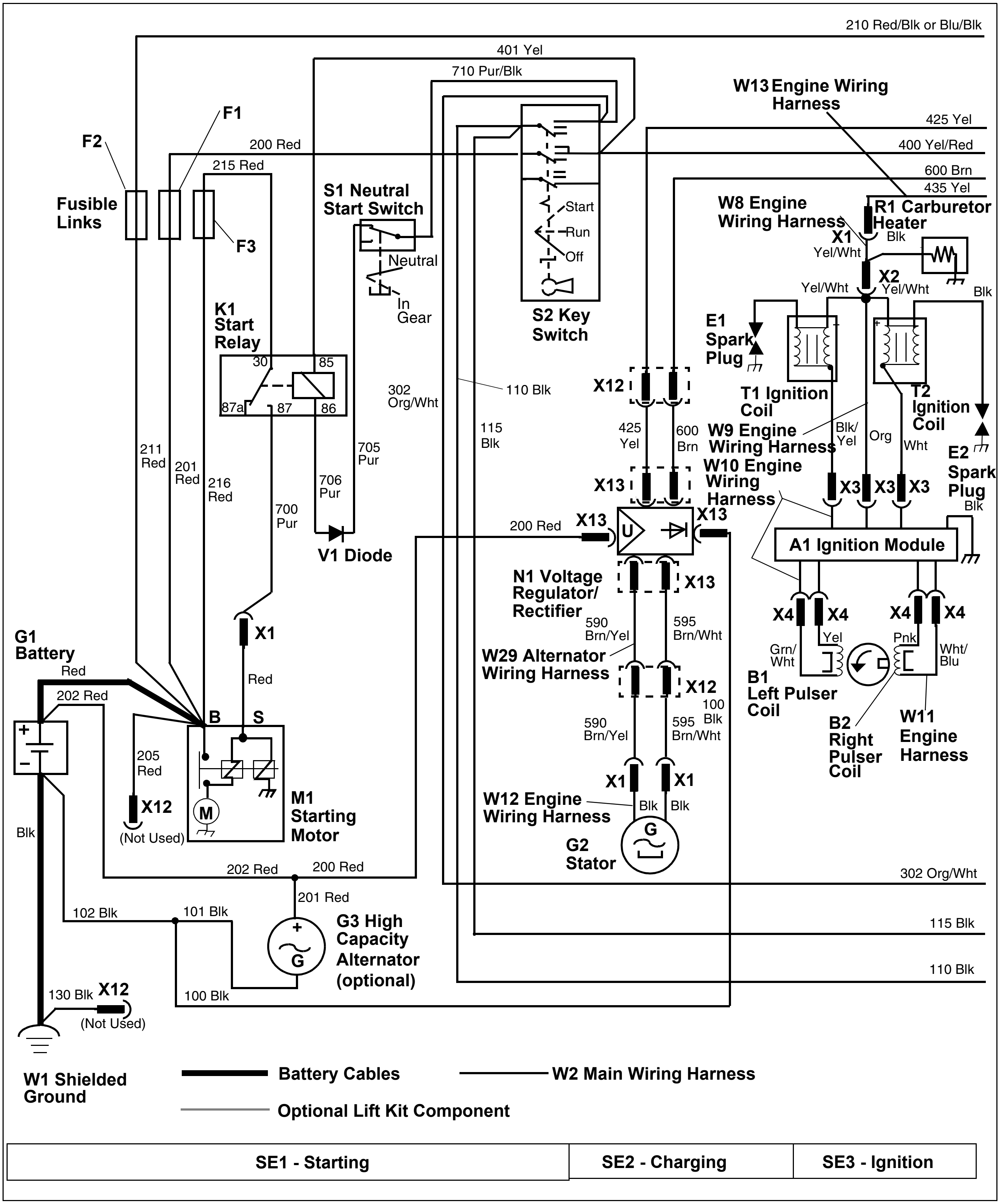


W2 Main Wiring Harness Color Code Table - 6X4 Gas

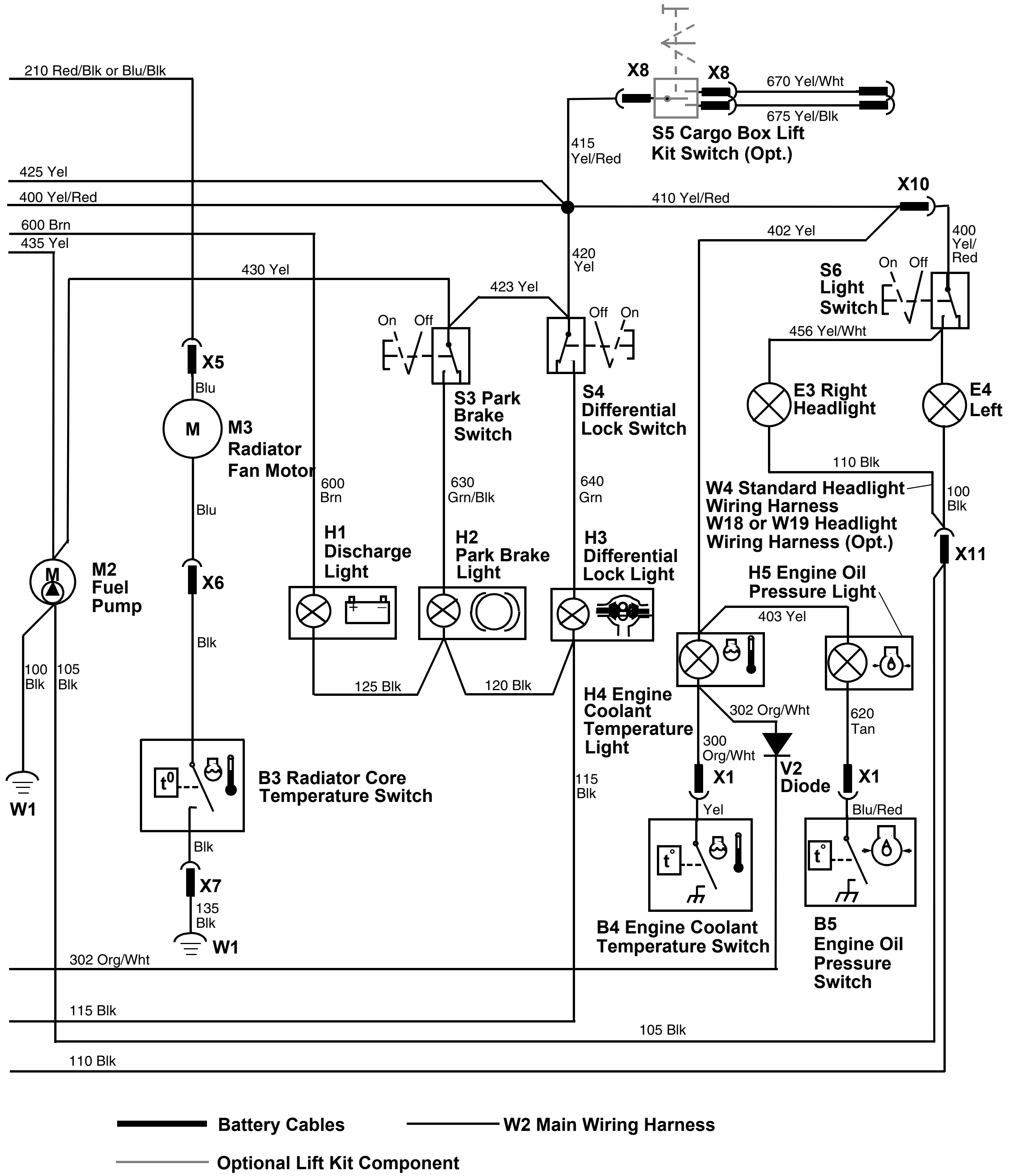
Circuit Number	Wire Size	Color	Termination Points
100	1.0	Blk	M2, W1 Gnd
105	1.0	Blk	X11, M2
110	0.5	Blk	S2, X11
115	0.5	Blk	H3, S2
120	0.5	Blk	H2, H3
125	0.5	Blk	H1, H2
130	2.0	Blk	N1, W1 Gnd
135	1.0	Blk	X7, W1 Gnd
200	1.0	Red	F1, S2
201	0.5	Red-Fuse	F1 Fuse soldered inline; M1, 200 Red
205	2.0	Red	M1, N1
210	1.0	Red/Blk, or Blu/Blk	F2, M3
211	0.5	Red-Fuse	F2 Fuse soldered inline; M1, 210 Red
215	2.0	Red	F3, K1
216	0.8	Red-Fuse	F3 Fuse soldered inline; M1, 215 Red
300	0.5	Org/Wht	H4, X1
301	0.5	Diode	Soldered inline; 302 Org/Wht
302	0.5	Org/Wht	H4, S2
400	1.0	Yel/Red	S2, solder connection (410 Yel/Red, 415 Yel/Red, 420 Yel)
401	0.8	Yel	S2, K1
402	0.8	Yel	X10, H4
403	0.8	Yel	H4, H5
410	1.0	Yel/Red	Solder connection (400 Yel/Red), X10
415	1.0	Yel/Red	Solder connection (400 Yel/Red), X8
420	0.8	Yel	Solder connection (400 Yel/Red), S4
423	0.8	Yel	S4, S3
425	1.0	Yel	Solder connection (400 Yel/Red), N1
430	0.8	Yel	S3, M2
435	0.8	Yel	M2, X1
590, 595	2.0	Brn/Yel	N1, X1
600	0.5	Brn	N1, H1
620	0.5	Tan	H5, X1
630	0.8	Gry/Blk	S3, H2
640	0.5	Grn	S4, H3
670, 675	1.0	Yel/Wht	X8, X9
700	2.0	Pur	K1, X1
705	0.8	Pur	V1 Diode, S1
706	0.8	Pur	K1, V1 Diode
710	0.8	Pur/Blk	S1, S2

W2 Electrical Schematic with Auxiliary Alternator - 6X4 Gas

W2 Electrical Schematic with Auxiliary Alternator - 6X4 Gas (1 of 2)



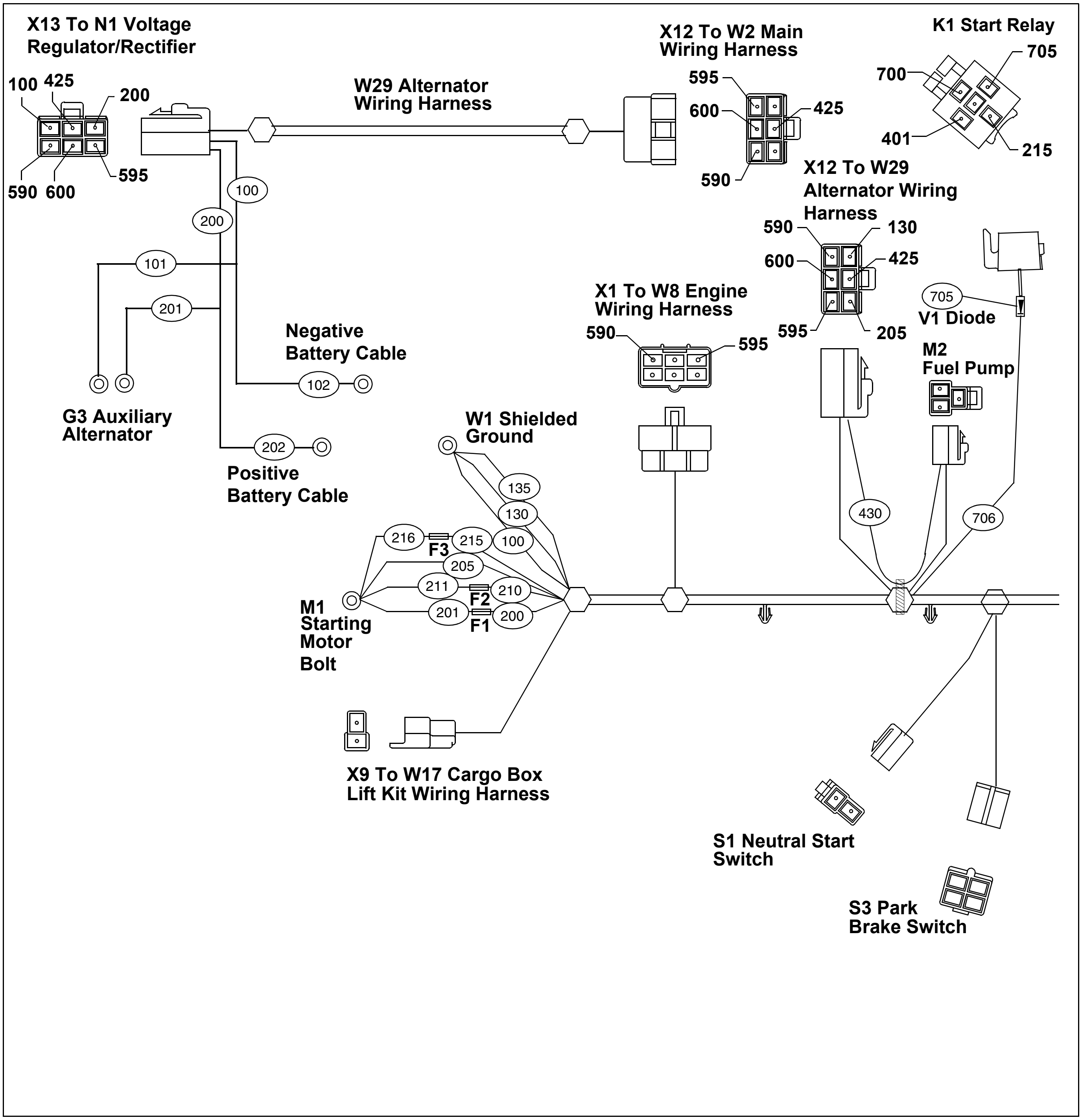
W2 Electrical Schematic with Auxiliary Alternator - 6X4 Gas (2 of 2)



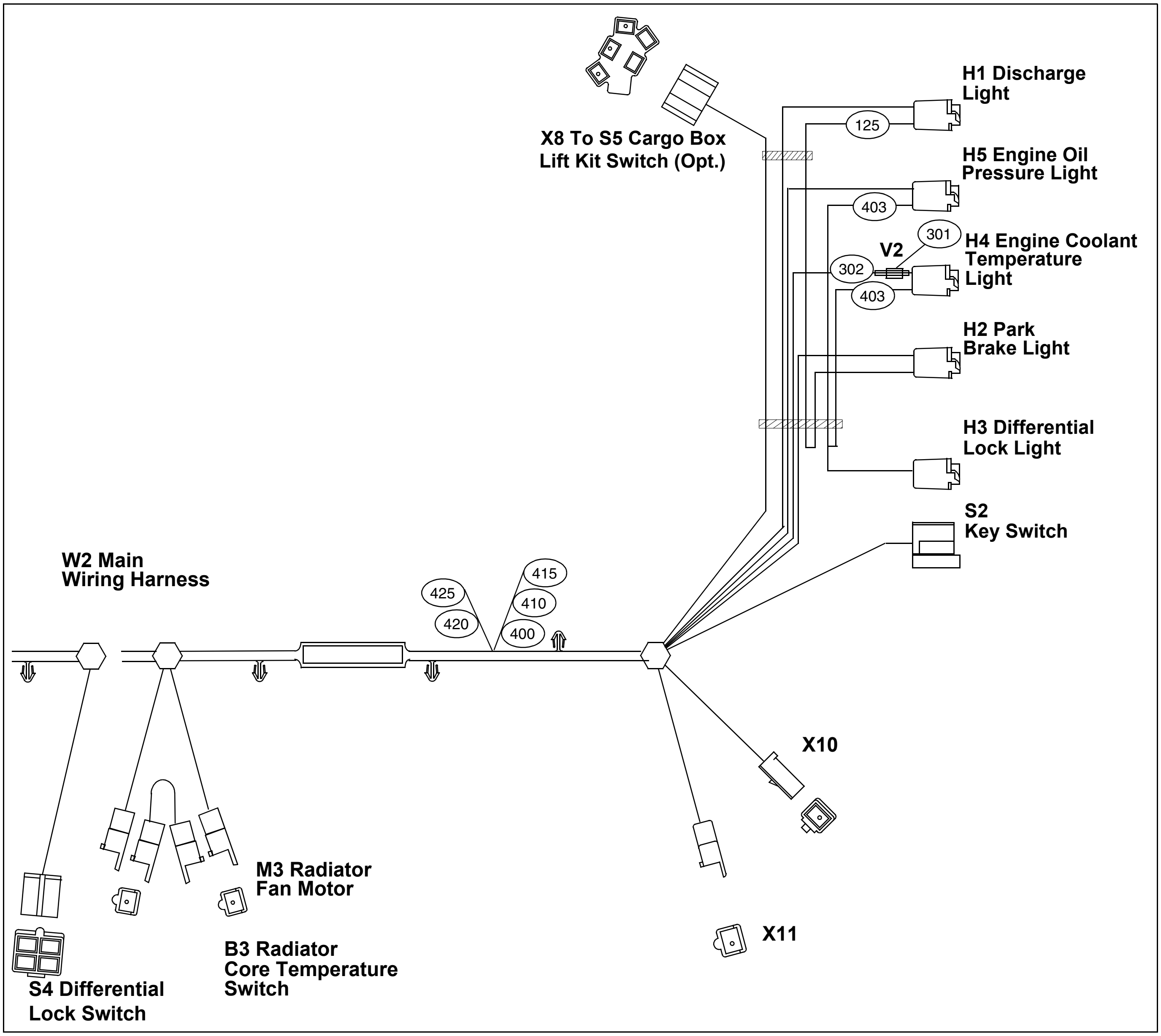
SE4 - Fuel Pump and Fan	SE5 - Instrumentation	SE6 - Lights

W29 Auxiliary Alternator Wiring Harness - 6X4 Gas

W29 Auxiliary Alternator Wiring Harness - 6X4 Gas (1 of 2)



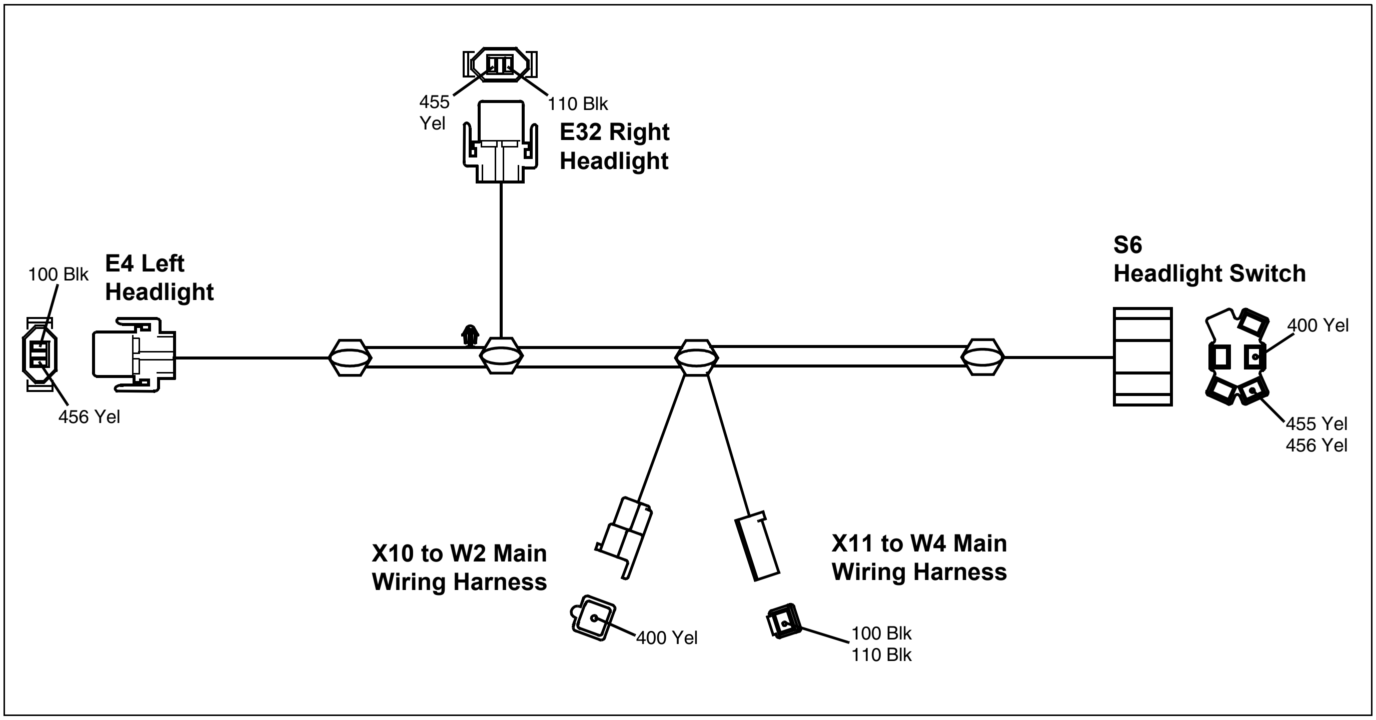
W29 Auxiliary Alternator Wiring Harness - 6X4 Gas (2 of 2)



W29 Wiring Harness Wire Color Code Table - 6X4 Gas

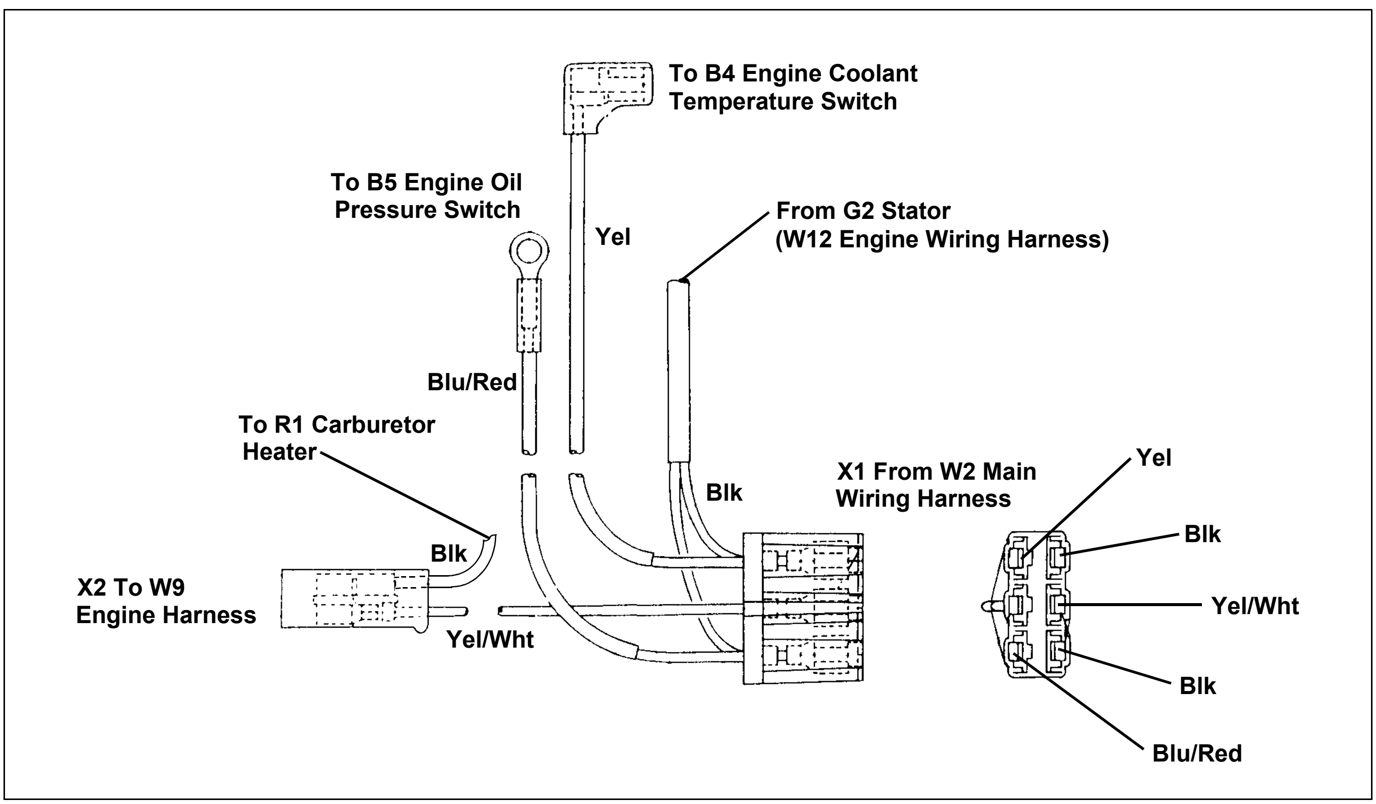
Circuit Number	Wire Size	Color	Termination Points
100	3.0	Blk	X13, N1
101	3.0	Blk	G3 Gnd
102	5.0	Blk	Solder Splice to 100/ 101 Blk, Battery Neg
200	3.0	Red	Solder Splice, X13
201	3.0	Red	Solder Splice, G3
202	5.0	Red	Solder Splice to 200/ 201 Blk, Battery Pos
425	1.0	Yel	W2, X12, X 13
590	3.0	Brn/Wht	W2, X12, X13
595	3.0	Brn/Yel	W2, X12, X13
600	1.0	Blu	W2, X12, X13

W4 Standard Headlight Wiring Harness - 6X4 Gas



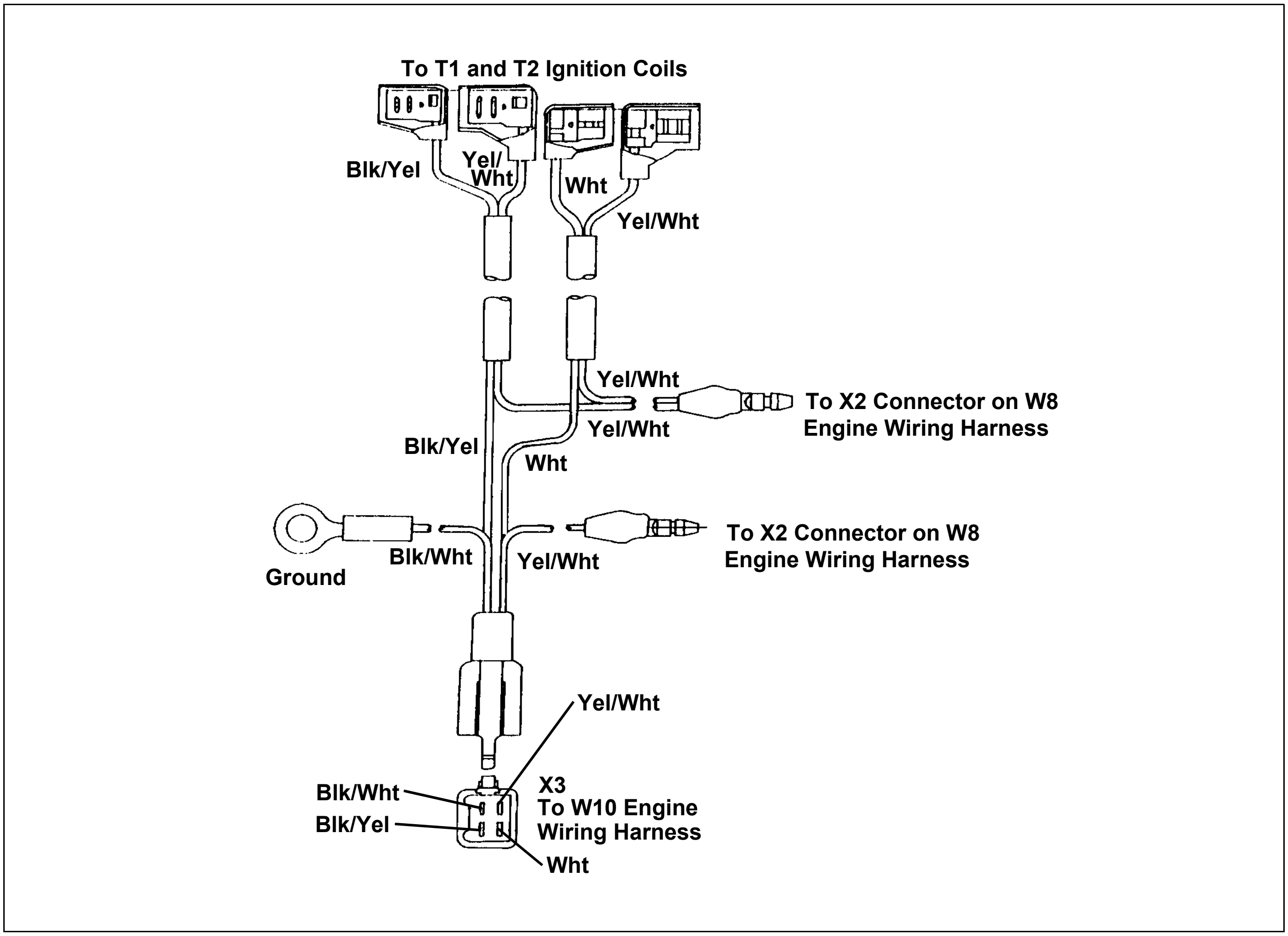
MIF

W8 Engine Wiring Harness



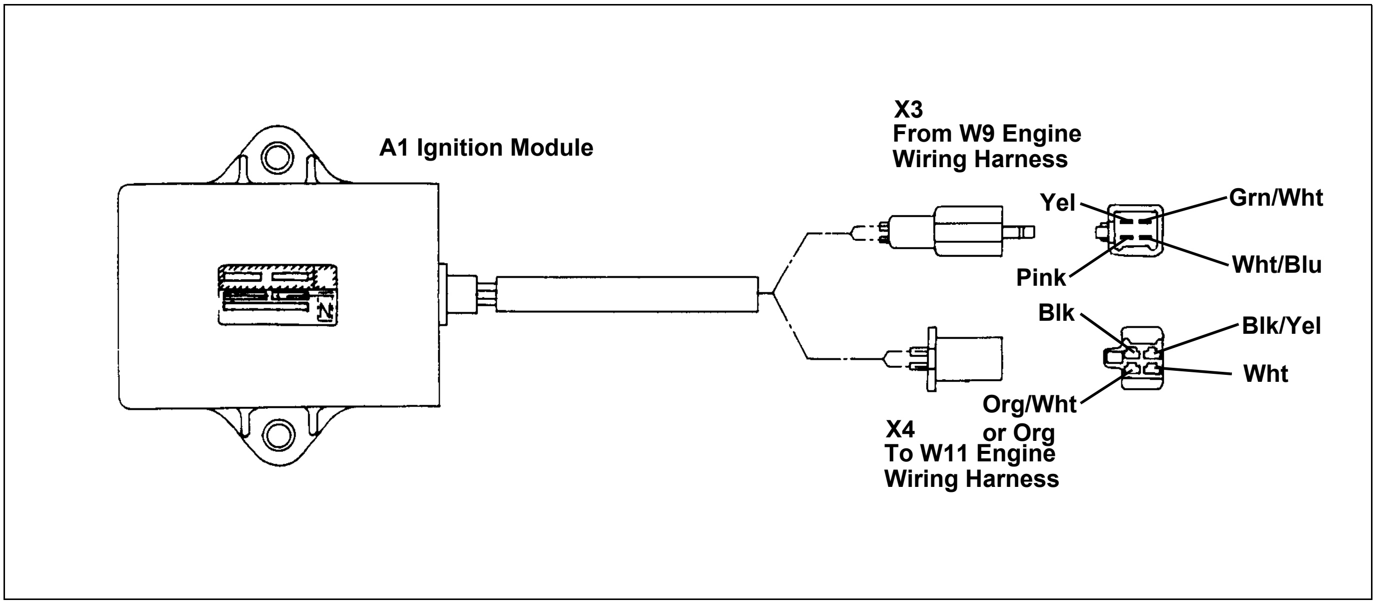
M72546

W9 Engine Wiring Harness



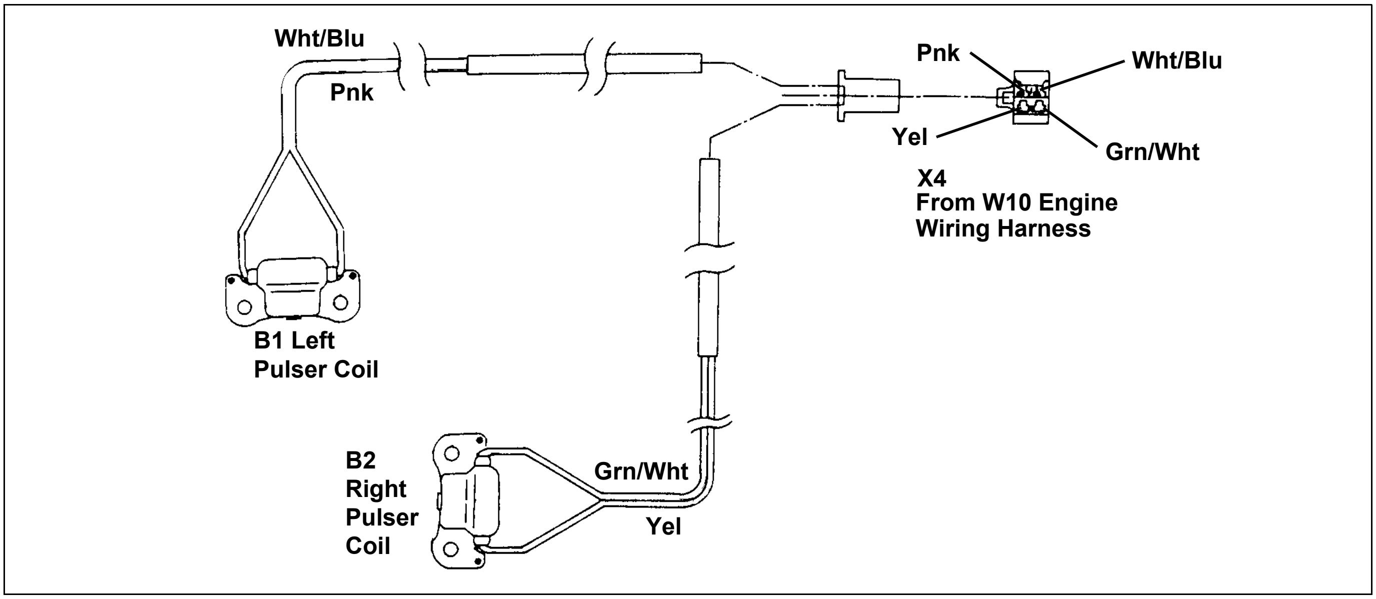
M72547

W10 Engine Wiring Harness



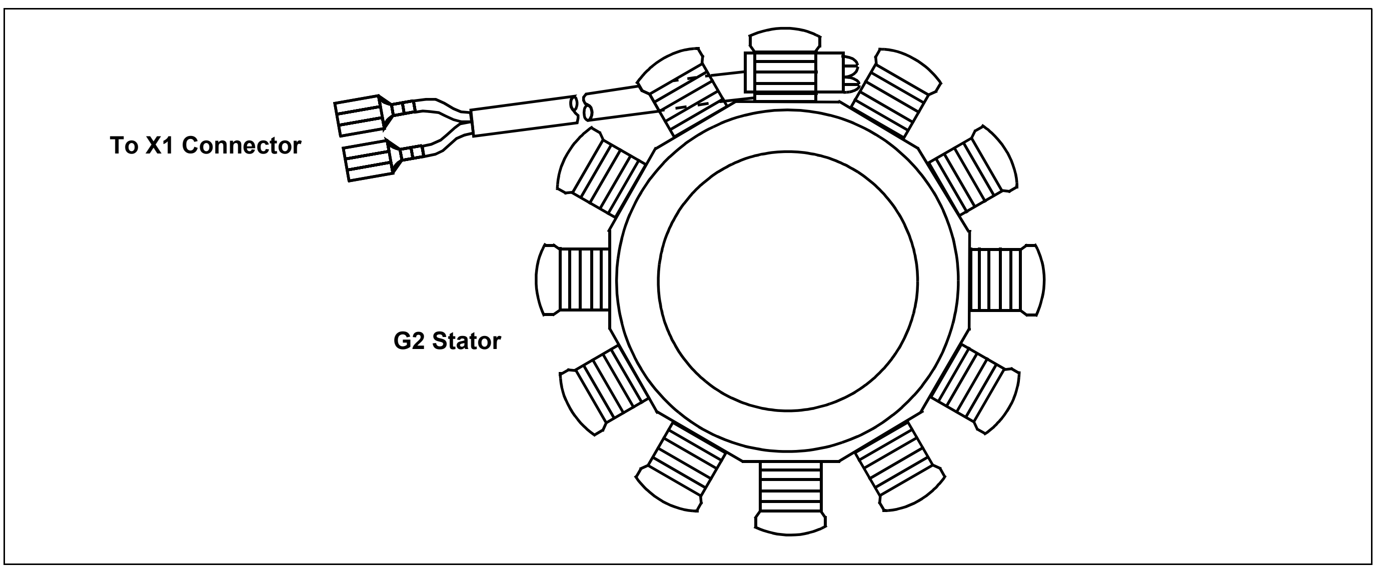
M72548

W11 Engine Wiring Harness



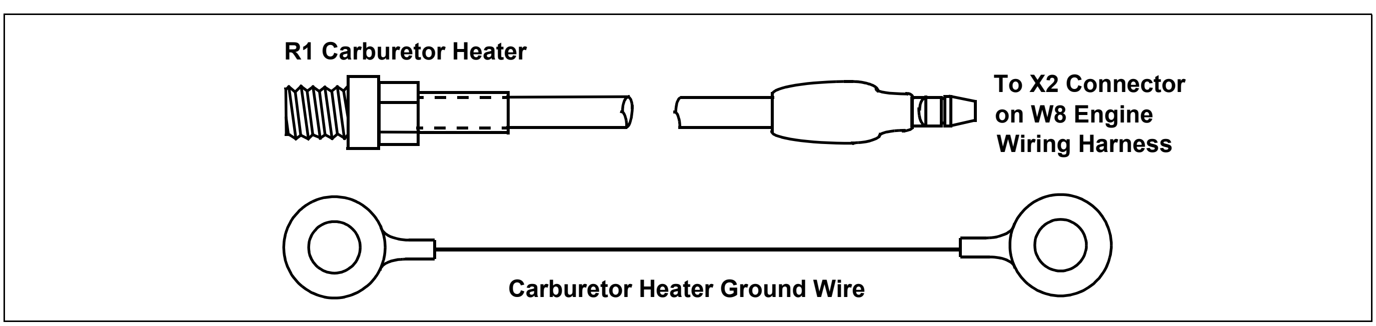
M72549

W12 Engine Wiring Harness



MIF

W13 Engine Wiring Harness



MIF

Operation and Diagnostics - 6X4 Gas

Troubleshooting - 6X4 Gas

System: Electrical

(1) Does starter have cranking problems?

Yes - See “Power Circuit Diagnosis - 6X4 Gas” on page 292.

Yes - See “Cranking Circuit Diagnosis - 6X4 Gas” on page 296.

Yes - See “Ground Circuit Tests” on page 396.

Yes - See “Battery Test” on page 372.

(2) Does engine crank but not start?

Yes - See “Ground Circuit Tests” on page 396.

Yes - See “Ignition Circuit Diagnosis - 6X4 Gas” on page 299.

(3) Is there spark from the ignition?

Yes - See “Ignition Circuit Diagnosis - 6X4 Gas” on page 299.

(4) Is the fuel pump operating?

Yes - See “Ignition Circuit Diagnosis - 6X4 Gas” on page 299.

(5) Does the engine not shut off?

Yes - Check for a shorted circuit.

(6) Is an improper component working with a switch?

Yes - Check for a shorted circuit.

(7) Is there a problem with the engine oil light?

Yes - See “Indicator Lights Circuit Diagnosis - 6X4 Gas” on page 307.

(8) Does the battery go dead, discharge, or over charge?

Yes - See “Charging Circuit Diagnosis - 6X4 Gas” on page 303.

(9) Is there a discharge light problem?

Yes - See “Charging Circuit Diagnosis - 6X4 Gas” on page 303.

(10) Are there cooling fan problems?

Yes - See “Indicator Lights Circuit Diagnosis - 6X4 Gas” on page 307.

(11) Are there instrumentation light problems?

System: Electrical

Yes - See “Indicator Lights Circuit Diagnosis - 6X4 Gas” on page 307.

(12) Are there light and horn problems?

Yes - See “Road Homologated Light and Horn Circuit Diagnosis” on page 493 or “Light and Horn Circuit Diagnosis (Earlier Model)” on page 447 or “Light and Horn Circuit Diagnosis (Later Model)” on page 468.

(13) Are there domestic headlight problems?

Yes - See “Standard Headlight Circuit Diagnosis - 6X4 Gas” on page 312.

(14) Are there cargo box lift problems?

Yes - See “Cargo Box Lift System Troubleshooting Chart” on page 405 and “Cargo Box Lift Circuit Diagnosis” on page 406.

Power Circuit Operation - 6X4 Gas

Function:

Provides unswitched power to the primary components whenever the battery is connected.

Operating Conditions, Unswitched Circuits:

Voltage must be present at the following components with the key switch “OFF”:

- Battery Positive Terminal
- “B” Terminal of Starting Motor
- “B” Terminal of Key Switch
- Voltage Regulator/Rectifier
- Alternator Positive Terminal (if equipped)
- Radiator Fan Motor

The positive battery cable connects the battery to the starting motor. The starting motor bolt is used as a tie point for the rest of the electrical system. In systems with an alternator an additional positive battery cable connects to the alternator bolt.

The battery cables, starting motor tie point and alternator connections must be good for the machine’s electrical system to work properly.

The ground cable connections are equally important. Proper starting motor and alternator operation depends on these cables and connections to carry the high current for its operation.

The connection between the starting motor and key switch is fused by a fusible link. This is a short piece of wire that is designed to fail if current load is too high or a short occurs. It protects the wiring harness from damage.

The charge wires running between the voltage regulator/ rectifier and starting motor and between the alternator and the battery positive terminal are unprotected.

Switched Power:

Voltage must be present at the following components with the key switch “ON or RUN” position:

- “A “and “S1” Terminals of key switch
- Start Relay
- Voltage Regulator/Rectifier
- Ignition Module
- Fuel Pump
- Park Brake Switch
- Differential Lock Switch
- Light Switch (Standard or Homologated)
- Lift Switch Connector
- Engine Coolant Temperature Light
- Engine Oil Pressure Light

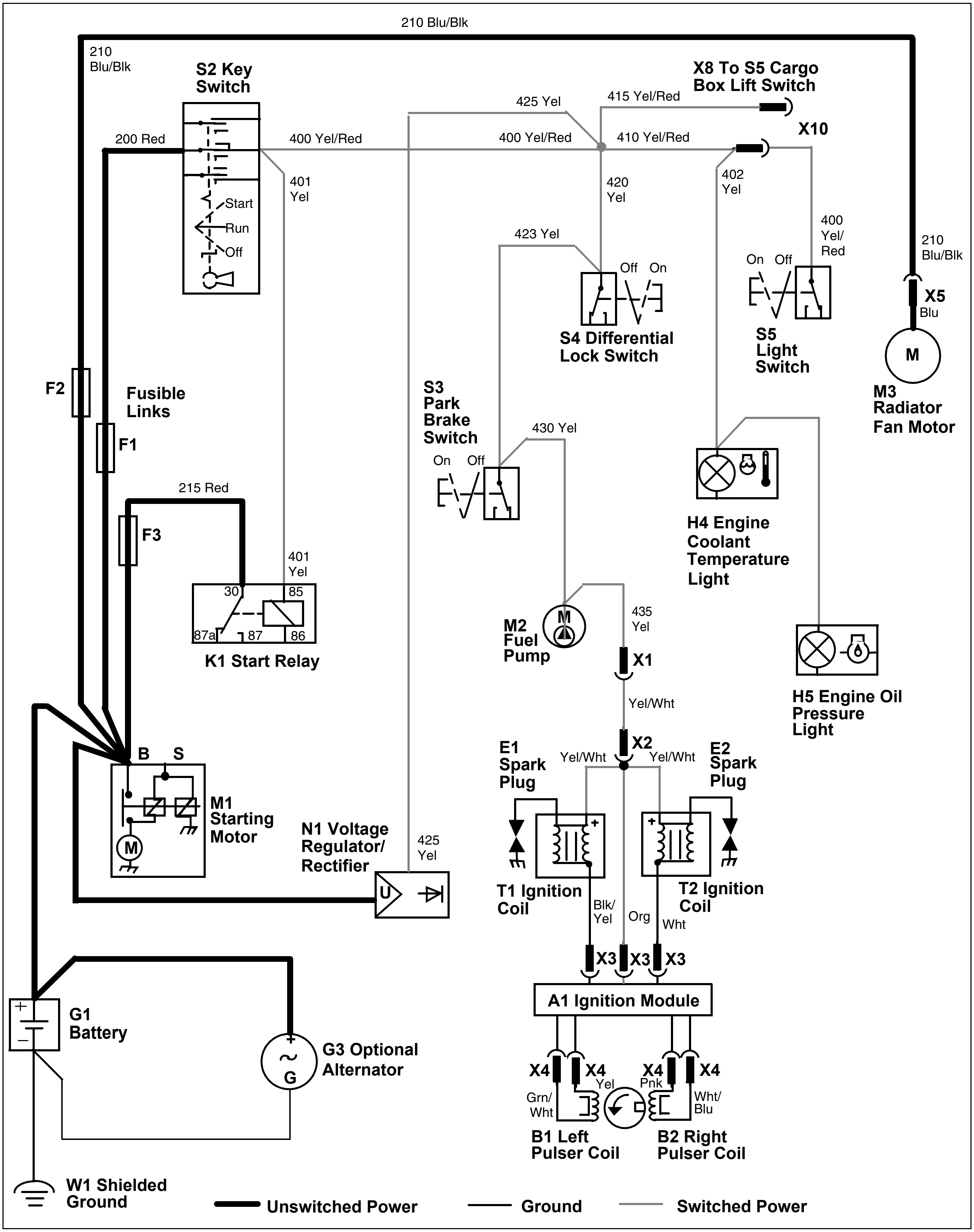
These circuits are controlled by the key switch and are protected by the fusible link.

Optional Lighting Kit and Lift Kit Power Circuits:

See the appropriate schematics and diagnostic procedure for these kits.

When optional kits are installed, the positive wires for these kits are also connected to the starting motor. These leads also contain fusible links to protect the wiring harnesses.

Power Circuit Schematic - 6X4 Gas



Power Circuit Diagnosis - 6X4 Gas

Test Conditions:

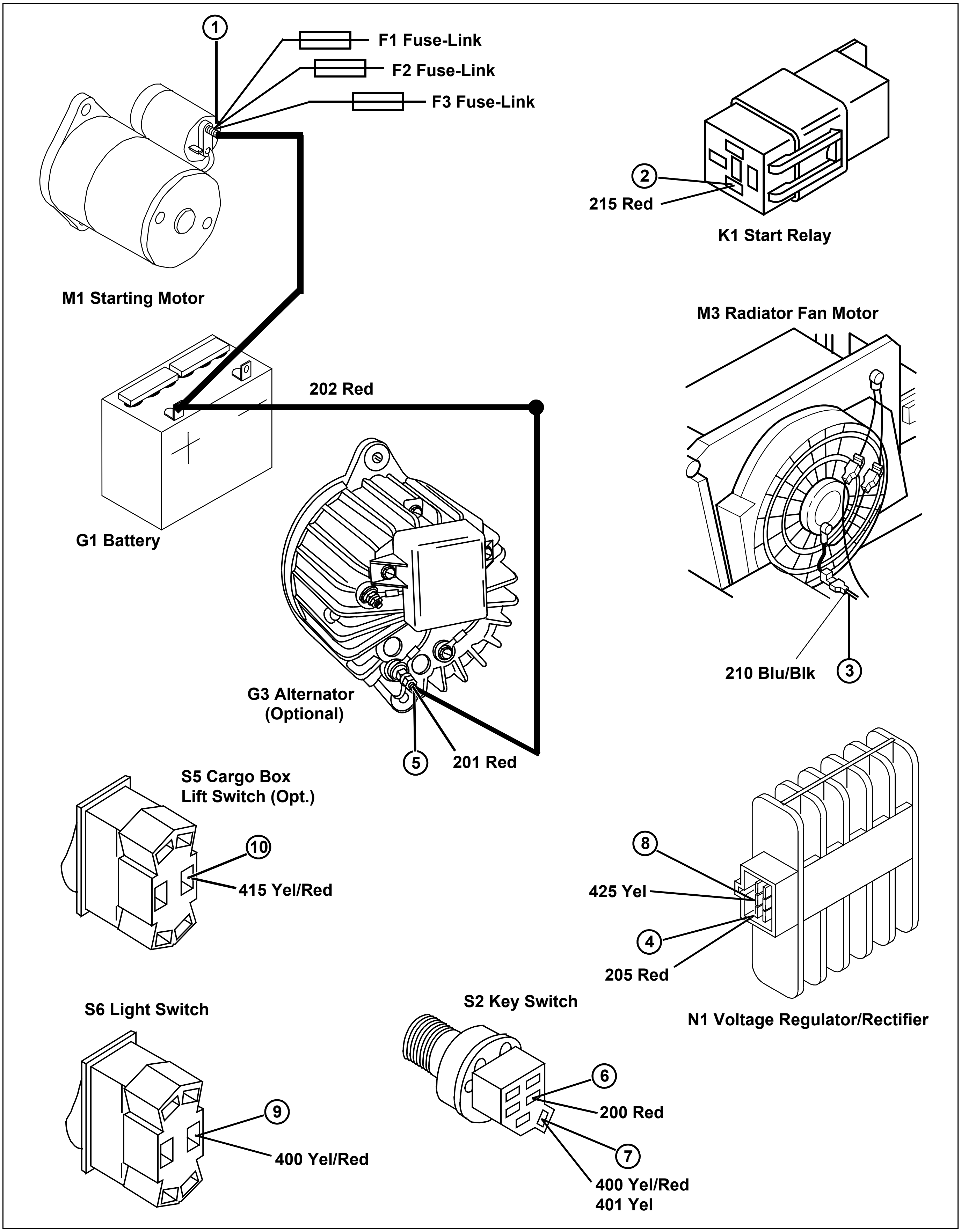
- Key switch in OFF position

Test/Check Point	Normal	If Not Normal
1. Starting motor battery terminal	Battery voltage	Check battery cables and test battery. See “Battery Test” on page 372.
2. Start relay	Battery voltage	Check 215 Red wire. Replace F3 fusible link.
3. Radiator fan motor	Battery voltage	Check 210 Blu/Blk wire and connections. Replace F2 fusible link.
4. Voltage regulator/rectifier	Battery voltage	Check 205 Red wire and connections.
5. Alternator, high capacity (optional)	Battery voltage	Check 202 and 201 Red in W29 Harness
6. Key switch	Battery voltage	Check 200 Red wire and connections. Replace F1 fusible link.

Test Conditions:

- Key switch in RUN position

Test/Check Point	Normal	If Not Normal
7. Key switch	Battery voltage	Replace S2 key switch.
8. Voltage regulator/rectifier	Battery voltage	Check 425 Yel wire and connections.
9. Light switch	Battery voltage	Check 400 Yel/Red wire and connections.
10. Lift switch connector	Battery voltage	Check 415 Yel/ Red wire connection.

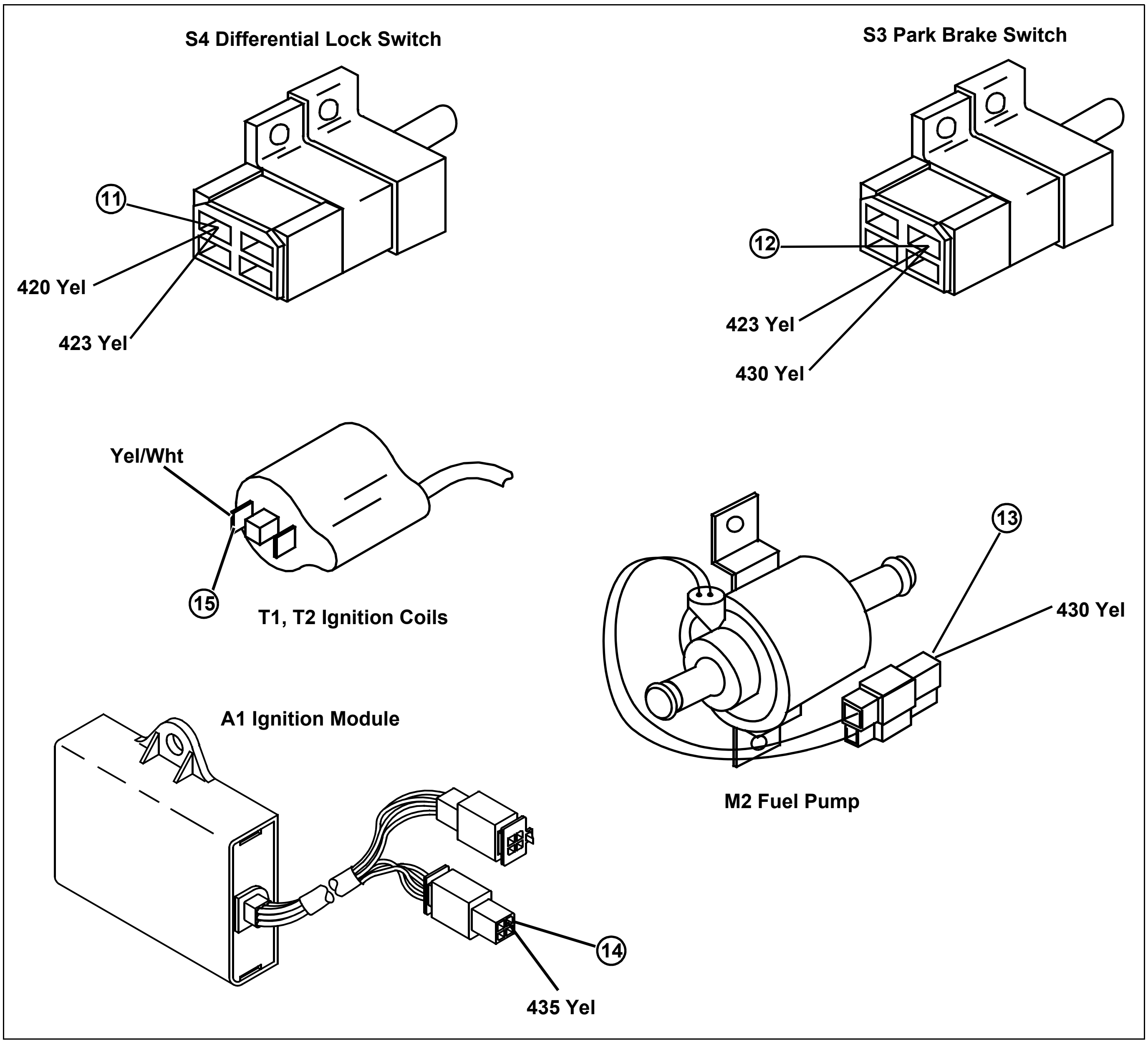

1
F1 Fuse-Link
F2 Fuse-Link
F3 Fuse-Link
2
215 Red
K1 Start Relay
M1 Starting Motor
M3 Radiator Fan Motor
202 Red
G1 Battery
210 Blu/Blk
3
G3 Alternator
(Optional)
5
201 Red
S5 Cargo Box
Lift Switch (Opt.)
10
415 Yel/Red
8
425 Yel
4
205 Red
S6 Light Switch
S2 Key Switch
N1 Voltage Regulator/Rectifier
6
200 Red
9
400 Yel/Red
7
400 Yel/Red
401 Yel

Power Circuit Diagnosis - 6X4 Gas (continued)

Test Conditions:

- Key switch in ON position

Test/Check Point	Normal	If Not Normal
11. Differential lock switch	Battery voltage	Check connection of 420 Yel wire.
12. Park brake switch	Battery voltage	Check 423 Yel wire and connections.
13. Fuel pump motor	Battery voltage	Check 430 Yel wire and connections.
14. Ignition module	Battery voltage	Check 435 Yel wire and connections.
15. Ignition coils	Battery voltage	Check X3 engine harness connector and Yel/Wht wire at ignition module.



Cranking Circuit Operation - 6X4 Gas

Function:

To energize the starting motor solenoid and engage the starter motor to crank the engine.

Operating Conditions:

- Key switch in START position
- Transmission in NEUTRAL

Theory of Operation:

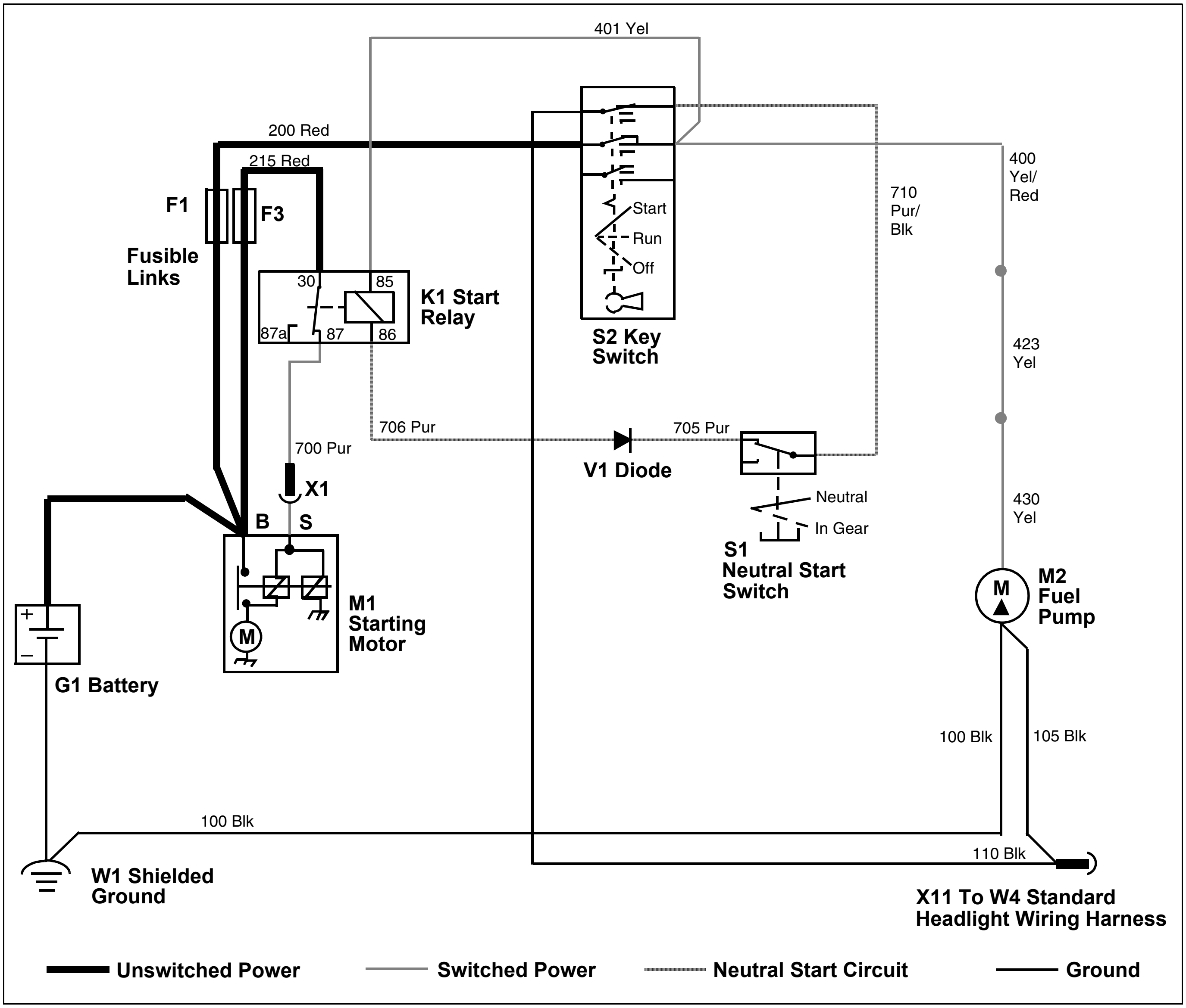
Current from the power circuit (200 Red) flow through a fusible link to the key switch.

The S2 key switch allows current to flow to the start relay when in the run or start position (401 Yel). With the transmission in neutral the S2 key switch connects the neutral start circuit (706 Pur, V1 Diode, 705 Pur and 710 Pur) to ground, allowing the start relay to activate.

The start relay then allows a higher current to pass from the battery, through the F2 fusible link and start relay to energize the starter solenoid (215 Red, 700 Pur).

With the starting motor solenoid activated, high current from the battery passes through the battery cable, across the solenoid and energizes the starting motor.

Cranking Circuit Schematic - 6X4 Gas



Cranking Circuit Diagnosis - 6X4 Gas

Test Conditions:

- Transmission in NEUTRAL and brake set
- Key switch in OFF position

Test/Check Point	Normal	If Not Normal
1. Key switch	Battery voltage	Check 200 Red wire and F3 fusible link. See “Power Circuit Diagnosis - 6X4 Gas” on page 292.
2. Start relay	Battery voltage	Check 215 red wire and connections. Replace F2 fusible link.

Test Conditions:

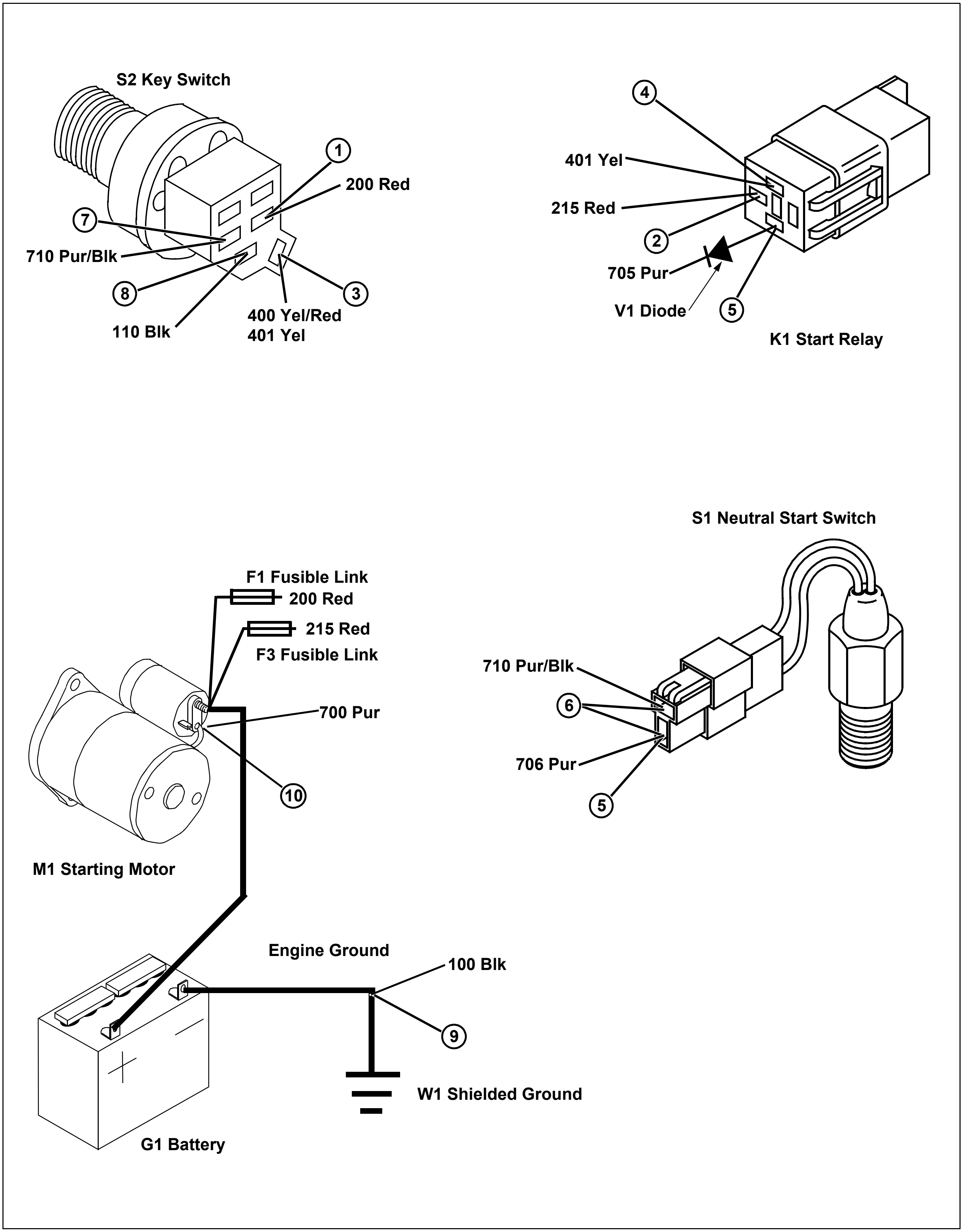
- Key switch in START position

Test/Check Point	Normal	If Not Normal
3. Key switch	Battery voltage	Replace S2 key switch.
4. Start relay	Battery voltage	Test 401 Yel wire and connections.

Test Conditions:

- Remove connector from start relay
- Change meter to ohm scale
- Test for continuity to ground with transmission in neutral and key switch in START position

Test/Check Point	Normal	If Not Normal
5. Relay connector to neutral start switch	Continuity in one direction only	Continuity in both directions replace V1 diode or wiring harness. No continuity in either direction, repair wire.
6. Neutral start switch (Switch disconnected)	Continuity across neutral start switch	Check transmission linkage neutral adjustment. Replace neutral start switch.
7. Neutral start switch to key switch	Continuity	Repair 710 Pur/Blk wire.
8. Key switch	Continuity across switch in START position	Replace S2 key switch.
8. Key switch to engine ground	Continuity	Check Blk wires and connection at fuel pump, light harness connector, and engine and battery ground location. Repair wires and/or connections.
10. Starting motor solenoid “S” terminal	Battery voltage	No voltage: Test 700 Pur wire and connections. Replace K1 start relay. Voltage: Check battery ground cable and connections. Test or replace starting motor solenoid.


S2 Key Switch
1
200 Red
7
710 Pur/Blk
8
110 Blk
400 Yel/Red
401 Yel
3
4
401 Yel
215 Red
2
705 Pur
V1 Diode
5
K1 Start Relay
S1 Neutral Start Switch
F1 Fusible Link
200 Red
215 Red
F3 Fusible Link
700 Pur
10
M1 Starting Motor
710 Pur/Blk
6
706 Pur
5
Engine Ground
100 Blk
9
W1 Shielded Ground
G1 Battery

Ignition Circuit Operation - 6X4 Gas

Function:

To create a spark at the correct time, that ignites the fuel and air mixture.

Operating Conditions:

- Key switch must be in the START or RUN position.

Theory of Operation:

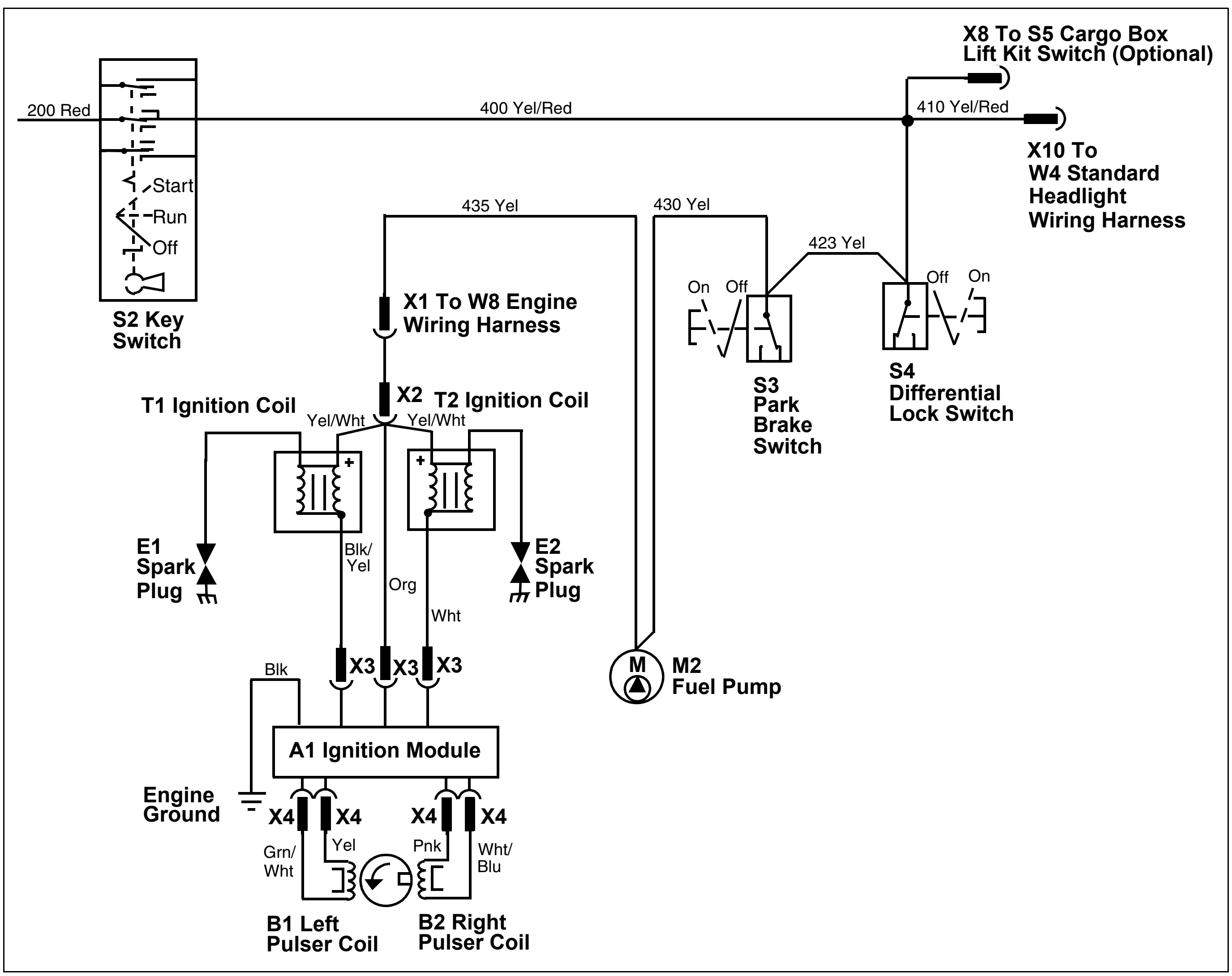
The ignition system is a transistor controlled, battery ignition design. The battery supplies current to the ignition coils. The timing is controlled by the ignition module and is not adjustable. The engine is shutoff by de-energizing the ignition coils.

Current flows from the key switch to the left and right ignition coils. The differential lock, park brake and fuel pump are all powered by this circuit.

Two pulser coils, one for each cylinder, are mounted in a fixed position next to the flywheel. As the flywheel turns, a tab on the flywheel travels past the pulser coils and produces current in the pulser coils by electromagnetic induction. Pulser coil current flows to the ignition module as a signal for the module to ground the coil primary windings. When the current flow stops in the primary windings, the magnetic field collapses and induces high voltage in the secondary coil windings. The high voltage current travels through the plug wire and jumps the gap at the spark plug, igniting the fuel/air mixture.

Each spark plug fires on both the compression and exhaust stroke. The spark produced during the exhaust stroke does not affect engine operation because there is no compression or combustible mixture in the cylinder.

Ignition Circuit Schematic - 6X4 Gas



Ignition Circuit Diagnosis - 6X4 Gas

Test Conditions:

- Key switch in RUN position

Test/Check Point	Normal	If Not Normal
1. Main wiring harness to engine wiring harness connector	Battery voltage	Check connections at differential lock and park brake switches and at the fuel pump. See "Power Circuit Diagnosis - 6X4 Gas" on page 292.
2. Positive terminals of right and left ignition coils	Battery voltage	Check Yel/Wht wire of coil harnesses and X2 connections at engine harness connector.
3. Ignition module connector module side. (Org or Org/Wht wire lead)	Battery voltage	Check Org wire and connections through module and engine harness power connector.
4. Right and left negative terminal of ignition coils. (Wht and Blk/Yel leads)	Battery voltage minus voltage drop across coils	No voltage: Replace ignition coil.

Test Conditions:

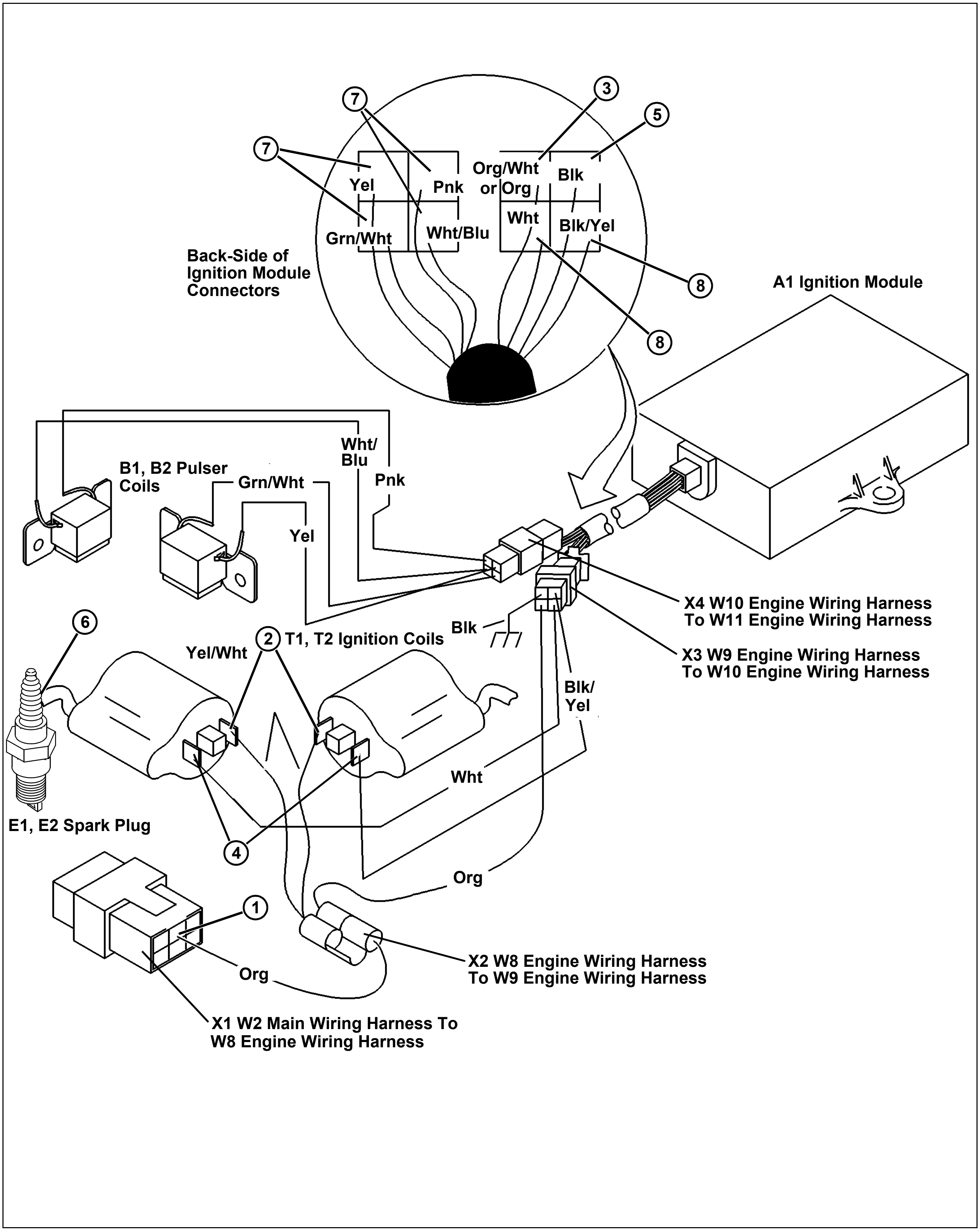
- Key switch to OFF position

Test/Check Point	Normal	If Not Normal
5. Ignition module connector (Blk ground wire)	Maximum 0.1 ohms resistance	Check ignition module ground connection.

Test Conditions:

- Meter set to AC voltage
- Plug wires grounded
- Key switch to START position
- Engine cranking

Test/Check Point	Normal	If Not Normal
6. Spark plugs	Spark plug tester: Hot blue spark	Inspect or replace spark plug(s).
7. Pulser coil connection (Wht/Blu and Pnk, then Grn/Wht and Yel)	0.1 - 1.0 VAC Coil resistance 85 - 270 ohms	Check pulser coil connections. Test pulser coil resistance. Replace pulser coil.
8. Ignition module connector (Wht then Blk/Yel wire leads)	Using test light: Rapid flashing light, not steady glow. Coil resistance: Primary windings 3.4 - 4.6 ohms. Secondary windings 10.4 - 15.5 ohms	Flashing light: Check coil resistance. No Light: Check connections. Replace ignition module.



Back-Side of Ignition Module Connectors
Yel
Pnk
Grn/Wht
Wht/Blu
Org/Wht or Org
Blk
Wht
Blk/Yel
A1 Ignition Module
B1, B2 Pulser Coils
Wht/ Blu
Grn/Wht
Pnk
Yel
X4 W10 Engine Wiring Harness To W11 Engine Wiring Harness
X3 W9 Engine Wiring Harness To W10 Engine Wiring Harness
Blk
T1, T2 Ignition Coils
Yel/Wht
Blk/ Yel
Wht
E1, E2 Spark Plug
Org
Org
X2 W8 Engine Wiring Harness To W9 Engine Wiring Harness
X1 W2 Main Wiring Harness To W8 Engine Wiring Harness
1
2
3
4
5
6
7
8

M56701

Charging Circuit Operation - Stator

Function:

To maintain battery voltage between 12.4 and 13.2 volts.

Operating Conditions:

The key switch must be in the RUN position with the engine running for the charging system to operate.

System Operation (Stator equipped):

The charging system is a permanent magnet and stator design. Charging output is controlled by a voltage regulator/rectifier.

With the key switch in the run position, battery sensing circuit current flows from battery positive terminal to starting motor terminal, fusible link, key switch, and regulator-rectifier. The battery sensing circuit allows the voltage regulator/rectifier to monitor battery voltage.

As the flywheel turns, a permanent magnet located in the flywheel induces AC current in the stator. The AC current flows to the voltage regulator/rectifier. The voltage regulator/rectifier converts AC current to DC current needed to charge the battery.

If battery voltage is low, the voltage regulator/rectifier allows DC current to flow to the battery to charge it through the battery charging circuit (205 Red). When the battery is fully charged, the voltage regulator stops current flow to the battery.

If the stator output current falls below the system usage or is insufficient to maintain a preset voltage, the voltage regulator provides current to turn on the discharge indicator light.

The ground circuit provides a path to ground for the voltage regulator/rectifier

Charging Circuit Operation - Auxiliary Alternator (Optional)

Function:

To maintain battery voltage between 12.4 and 13.2 volts.

Operating Conditions:

The key switch must be in the RUN position with the engine running for the charging system to operate.

System Operation:

The charging system consists of the G3 alternator with an integrated voltage regulator/rectifier. Charging output is controlled by a regulator/rectifier.

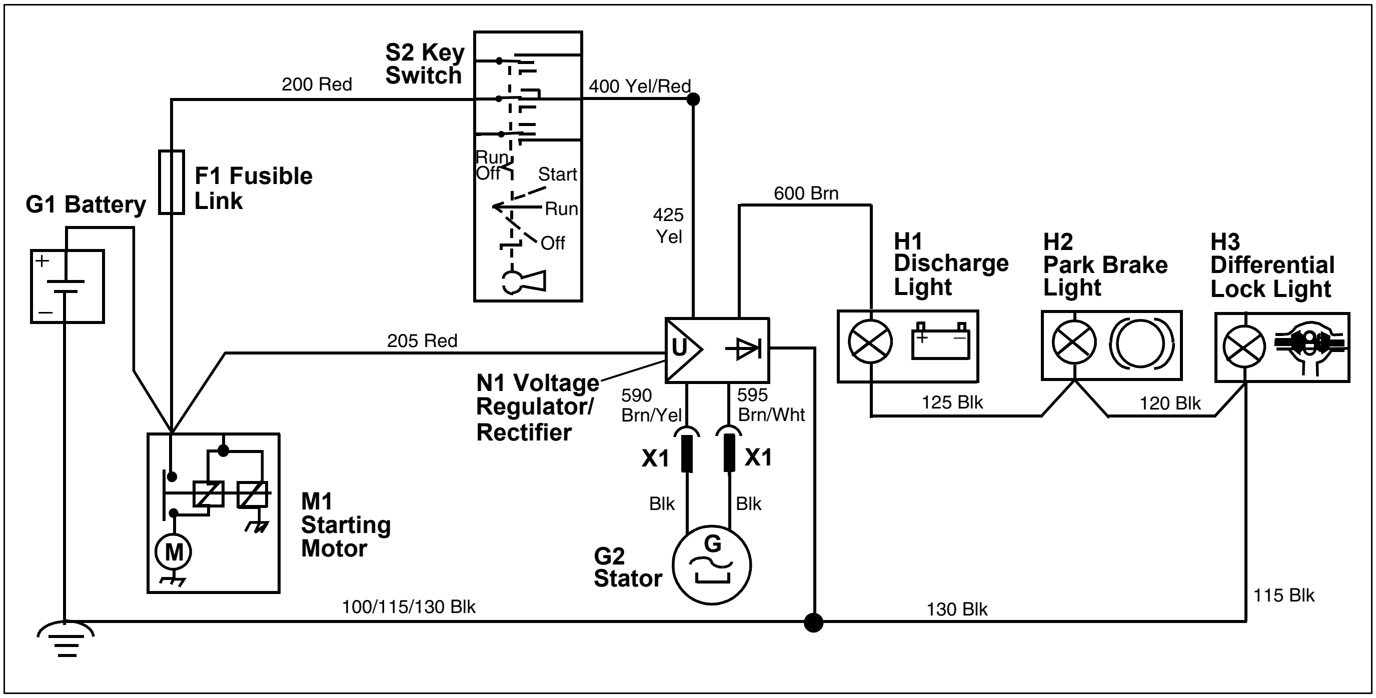
With the key switch in the RUN position, battery sensing circuit current flows from battery positive terminal 202 and 201 Red wires to the auxiliary alternator internal voltage regulator/rectifier. The battery sensing circuit allows the voltage regulator/rectifier to monitor battery voltage.

A rotating permanent magnet in the alternator induces AC current in the alternator stator coils. The AC current flows to the voltage regulator/rectifier. The voltage regulator/rectifier converts AC current to DC current needed to charge the battery.

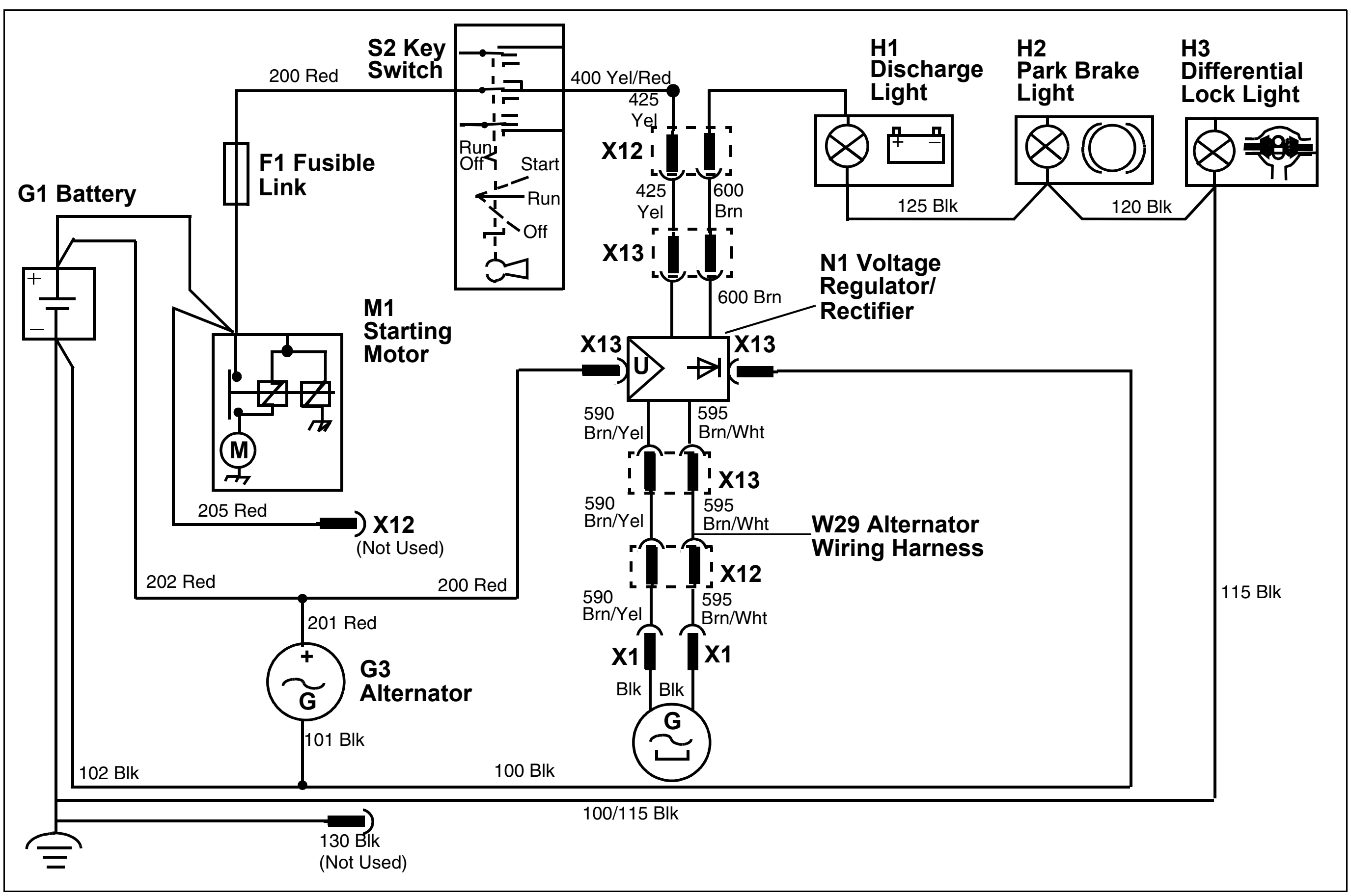
If battery voltage is low, the regulator/rectifier allows DC current to flow to the battery to charge it through the battery charging circuit (201 and 202 Red). When the battery is fully charged, the voltage regulator/rectifier stops current flow to the battery.

The ground circuit (101 and 102 Blk) provides a path to ground for the voltage regulator/rectifier.

Charging Circuit Schematic - Stator



Charging Circuit Schematic - Auxiliary Alternator



Charging Circuit Diagnosis - 6X4 Gas

Test Conditions:

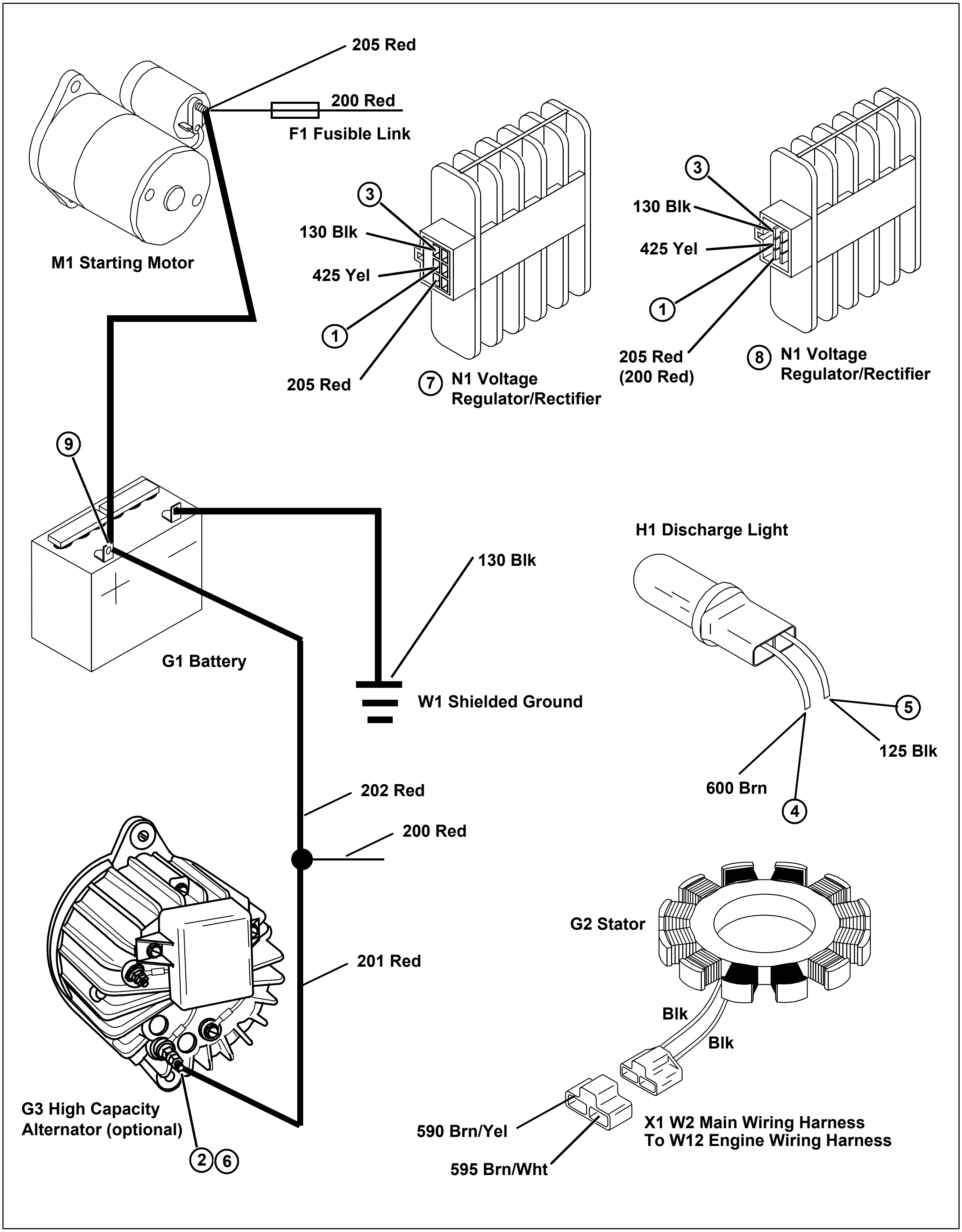
- Transmission in NEUTRAL
- Engine OFF

Test/Check Point	Normal	If Not Normal
1. Voltage regulator/rectifier	Battery voltage	Check 425 Yel wire and connections. Check F1 fusible link and S2 key switch. See “Power Circuit Diagnosis - 6X4 Gas” on page 292.
2. High Capacity Alternator (If equipped)	Battery voltage	Check 202 and 201 Red wires and connections.
3. Voltage regulator/rectifier	Greater than 0 volts - less than 0.2 volts	Greater than 0.2 volts: Test voltage regulator/rectifier ground circuit.
4. Charge indicator light (600 Brn Wire)	Battery voltage	Check 600 Brn wire and connections X12, X13.
5. Charge indicator light	Greater than 0 volts - less than 0.2 volts	0 volts: Replace bulb. Greater than 0.2 volts: Check all connections and ground wires for open or poor connections.

Test Conditions:

- Stator disconnected
- Engine running at high idle

Test/Check Point	Normal	If Not Normal
6. High capacity alternator	Minimum unregulated voltage output - 45 amps at 12.2-13.8 V	Check stator leads and connector. Check flywheel magnets. Replace stator.
7. Voltage regulator/rectifier (Machine SN -007496) (Engine SN -038265)	Minimum 20 Amps at 12.2 -13.8 V	Replace voltage regulator/rectifier. See “Alternator Output - 4X2” on page 392.
8. Voltage regulator/rectifier (Machine SN 007497-) (Engine SN 038266 -)	Minimum 16 Amps at 12.2 -13.8 V	See “Stator - Regulated Amperage and Voltage Tests” on page 375. Replace voltage regulator/rectifier.
9. Battery	Voltage above normal battery voltage	Check for excessive load on electrical system.


205 Red
200 Red
F1 Fusible Link
M1 Starting Motor
3
130 Blk
425 Yel
1
205 Red
7 N1 Voltage Regulator/Rectifier
3
130 Blk
425 Yel
1
205 Red (200 Red)
8 N1 Voltage Regulator/Rectifier
9
G1 Battery
130 Blk
W1 Shielded Ground
H1 Discharge Light
5
125 Blk
600 Brn
4
202 Red
200 Red
201 Red
G2 Stator
Blk
Blk
G3 High Capacity Alternator (optional)
2 6
590 Brn/Yel
595 Brn/Wht
X1 W2 Main Wiring Harness To W12 Engine Wiring Harness

Indicator Lights Circuit Operation - 6X4 Gas

Function:

Engine Oil Pressure Light:

To alert operator of low engine oil pressure by illuminating a warning light.

Engine Coolant Temperature Light:

Inform operator of critical engine and coolant operating temperature by illuminating a warning light.

Park Brake Light:

Informs the operator that the park brake is ON by illuminating a warning light.

Differential Lock Light:

Inform the operator that the differential Lock is ON by illuminating a warning light.

Operating Condition:

The key switch must be in RUN position.

Theory of Operation:

Oil Pressure Light:

With the engine OFF and key in 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.

Engine Coolant Temperature Light:

When the key switch is in the START position, the ground circuit is allowed to pass through the V2 diode and the key switch starting circuit to ground. This will momentarily turn on the light as a bulb check, When the engine starts and the key switch is returned to the RUN position, the light will go out. If the engine temperature reaches 109° C ± 1° C (228° F ± 2° F), the sensor will close, providing a path to ground through the engine block.

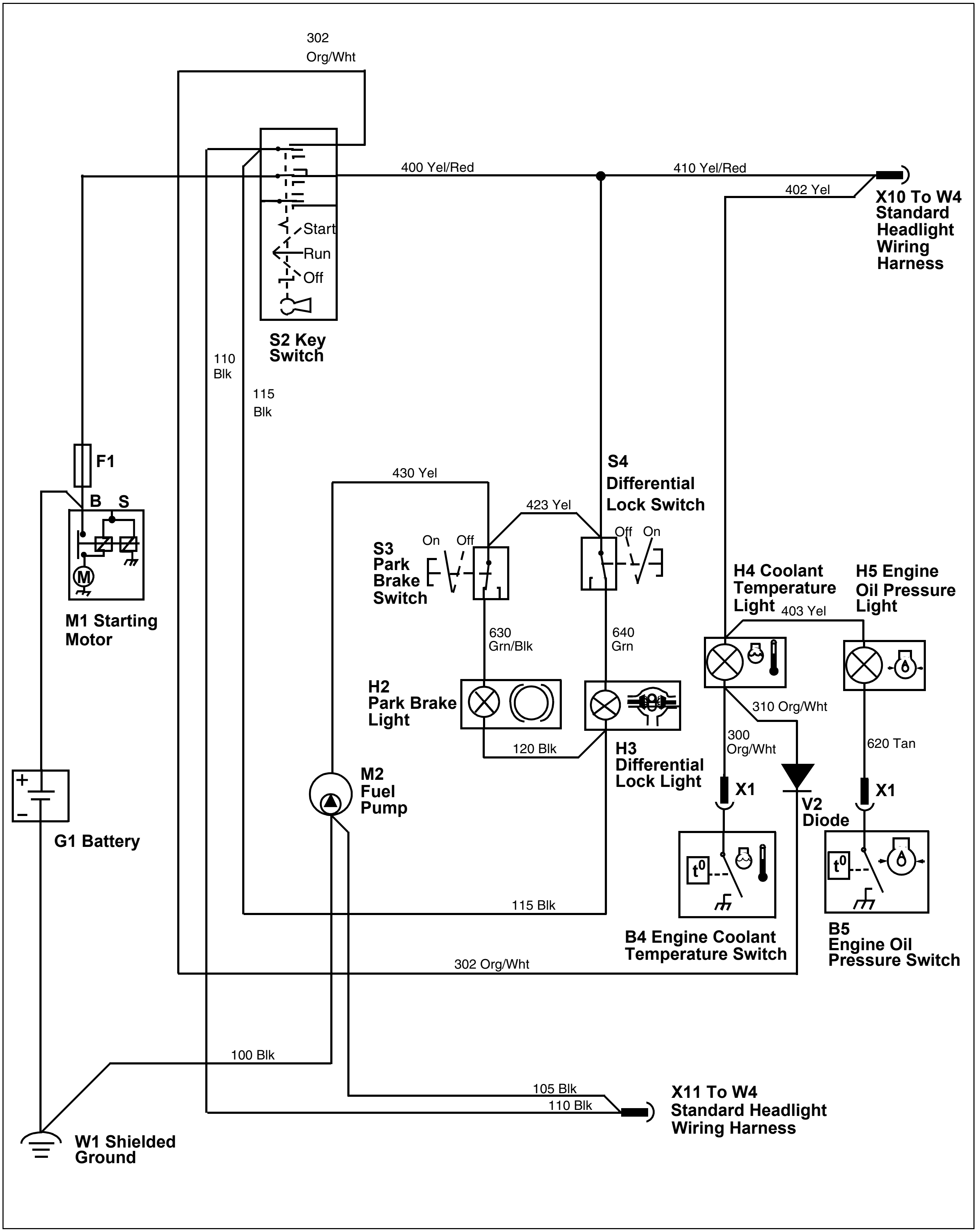
Park Brake Light:

When the park brake is set the switch is released (closes), allowing current to flow to the warning light. When the brake is released the switch is opened and the light goes out.

Differential Lock Light:

When the differential lock lever is moved to engage the differential lock, the switch is depressed (closed), allowing current flow to the light. When the differential is released, the switch is released (open), and the light goes out.

Indicator Lights Circuit Schematic - 6X4 Gas



Indicator Lights Circuit Diagnosis - 6X4 Gas

Test Conditions:

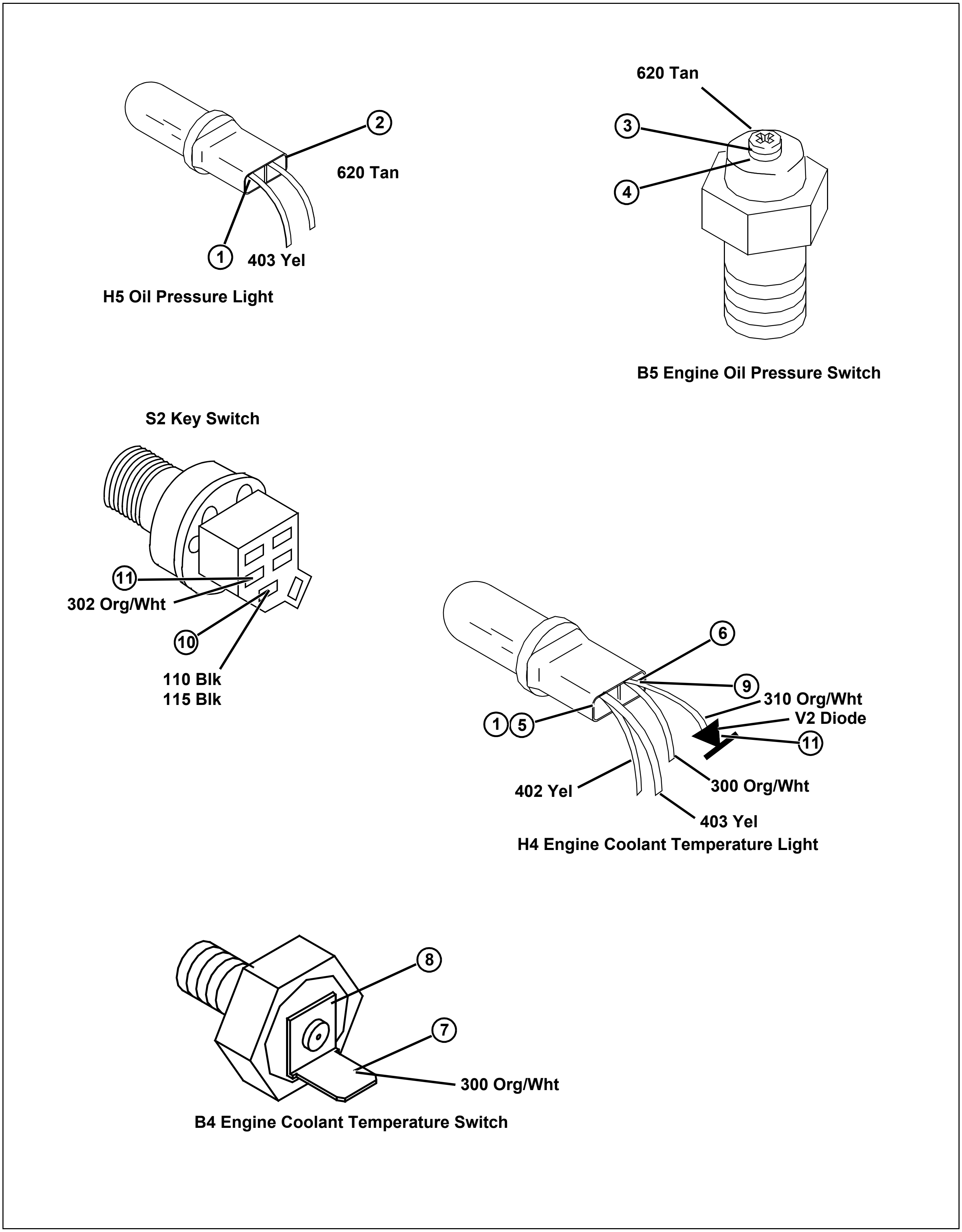
- Key switch in RUN position
- Engine OFF
- Differential lock engaged
- Park brake set

Test/Check Point	Normal	If Not Normal
1. Engine oil pressure light	Battery voltage	Check 402 and 403 Yel Wires and connections. See “Power Circuit Diagnosis - 6X4 Gas” on page 292.
2. Engine oil pressure light	Battery voltage	Replace light bulb.
3. Engine oil pressure switch	Battery voltage	Check 620 Tan wire and connections.
4. Engine oil pressure switch (Wire lead disconnected)	Continuity to ground	Check engine ground. If OK replace engine oil pressure switch.
5. Engine coolant temperature light	Battery voltage	Check 402 Yel wire. See “Power Circuit Diagnosis - 6X4 Gas” on page 292.
6. Engine coolant temperature light	Battery voltage	Replace light bulb.
7. Engine coolant temperature switch	Battery voltage	Check 300 Org/Wht wire and connections.
8. Engine coolant temperature switch	Switch closes at 108° - 110° C (226° - 230° F). Switch opens at 101° - 107° C (214° - 225° F).	Replace Switch. See “Engine Coolant Temperature Switch Test - 6X4’s” on page 390.

Test Conditions:

- Meter positive lead to voltage source
- Negative lead to ground side of coolant light

Test/Check Point	Normal	If Not Normal
9. Engine coolant temperature light (Momentarily turn key switch to start. This tests ground circuit and diode for bulb test circuit)	Battery voltage	Test V2 diode and check 302 Org/Wht wire lead and connections to S2 key switch.
10. Key switch	Continuity to ground. Maximum 0.1 ohm resistance,	Check ground wire 110, 105, 100 Blk wires and connections.
11. Key switch	Battery voltage	Test or replace key switch. Test V2 diode.


620 Tan
2
620 Tan
1
403 Yel
H5 Oil Pressure Light
620 Tan
3
4
B5 Engine Oil Pressure Switch
S2 Key Switch
11
302 Org/Wht
10
110 Blk
115 Blk
6
9
310 Org/Wht
V2 Diode
1 5
11
402 Yel
300 Org/Wht
403 Yel
H4 Engine Coolant Temperature Light
8
7
300 Org/Wht
B4 Engine Coolant Temperature Switch

Fuel Pump and Fan Motor Operation - 6X4 Gas

Radiator Fan Motor:

Operates whenever the coolant switch is closed.

The radiator core temperature switch closes when the coolant heats to 89° C (192° ± 7° F) raising the outer radiator core temperature to 71° C (160° ± 7° F).

NOTE: The outer radiator core temperature is approximately 20° C (36° F) lower than engine coolant temperature.

The fan motor will stop when the coolant temperature drops to 80° C (177° ± 7° F), the outer radiator core temperature cools to 60° ± 4° C (140° ± 7° F), and the radiator core temperature switch opens. The radiator fan motor circuit is connected directly to the battery and does not depend upon the start switch position.

Theory of Operation:

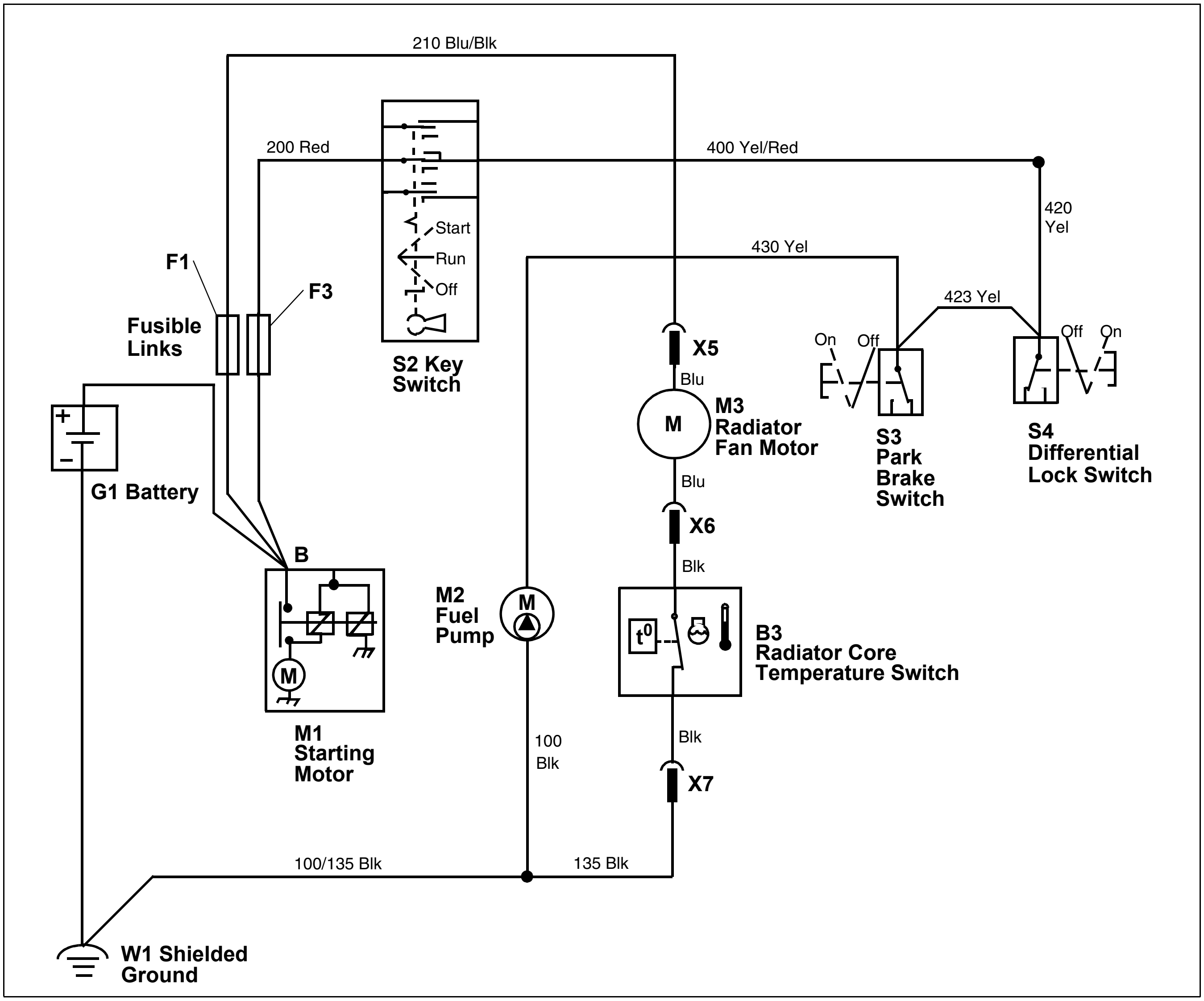
Operates when the radiator core temperature switch closes when coolant heats the outer radiator core to 71° ± 4° C (160° ± 7° F). The radiator core temperature switch monitors outer radiator core temperature, not engine coolant temperature.

Fan motor may run after engine is shutoff. Fan motor will stop when outer radiator core temperature cools to 60° ± 4° C (140° ± 7° F) and radiator core temperature switch opens.

Fuel Pump:

Operates whenever the key is in the run or start position.

Fuel Pump and Fan Motor Schematic - 6X4 Gas



Fuel Pump and Fan Motor Diagnosis - 6X4 Gas

Test Conditions:

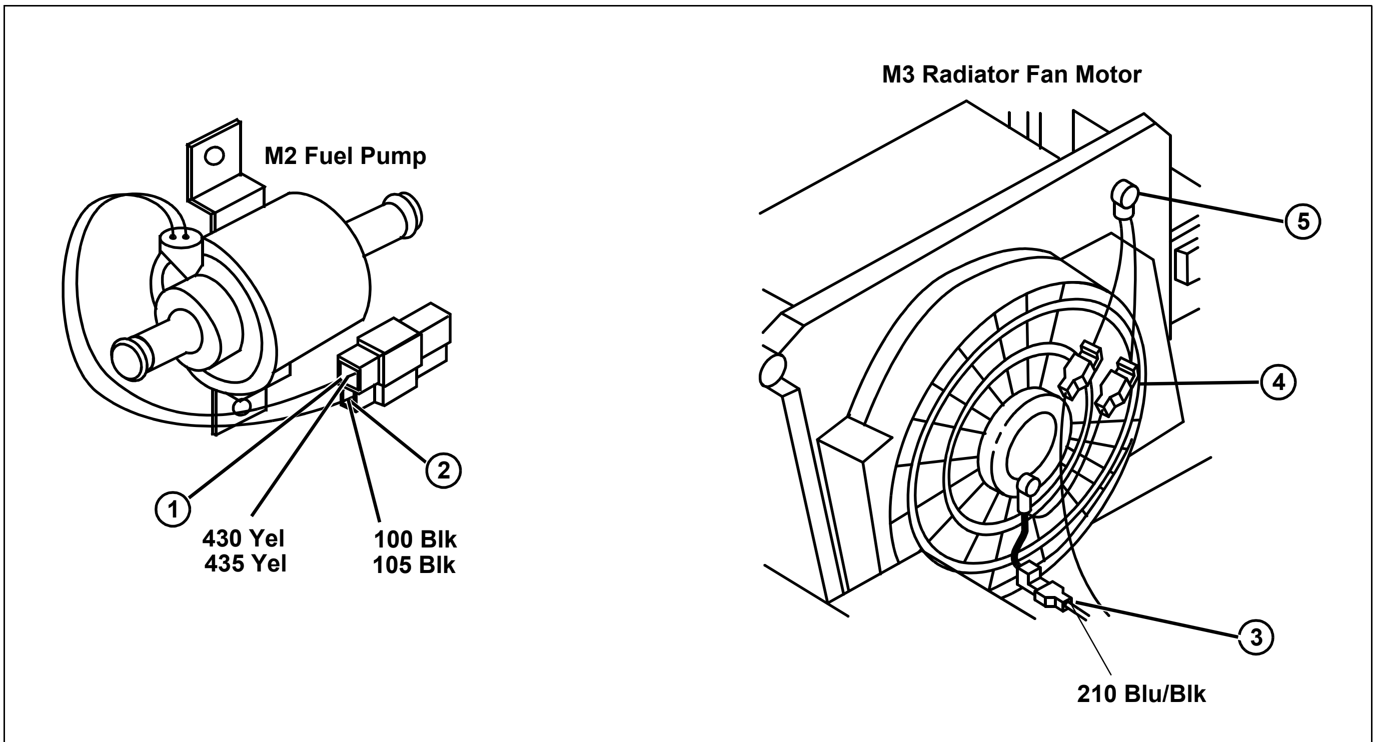
- Key switch in RUN position

Test/Check Point	Normal	If Not Normal
1. Fuel pump	Battery voltage	Check connector. See “Power Circuit Diagnosis - 6X4 Gas” on page 292.
2. Fuel pump.	Greater than 0 - less than 0.2 volts	No voltage: Replace pump. Greater than 0.2 volts: Check ground wire (100 Blk) and connections.

Test Conditions:

- Key switch in OFF position

Test/Check Point	Normal	If Not Normal
3. Radiator fan	Battery voltage	Check 210 Blu/Blk wire and connections. Replace F1 fusible link.
4. Fan to B3 radiator core temperature switch connector. Disconnect and jump fan lead to good ground.	Fan should run. Fan amperage draw - 7 amps	Replace fan.
5. Radiator core temperature switch	Coolant switch closes (fan starts) at 67° - 75° C (153° - 167° F). Coolant switch opens at 56° - 64° C (133° - 147° F).	Check Blk wire, X7, and 135 Blk wire. Replace switch.



Standard Headlight Circuit Operation - 6X4 Gas

NOTE: If the Light and Horn kit option is added, the new harness plugs into the light harness connector (X10) and connector (X11). The light switch and the original light harness are removed.

Function:

Provides power to the headlights.

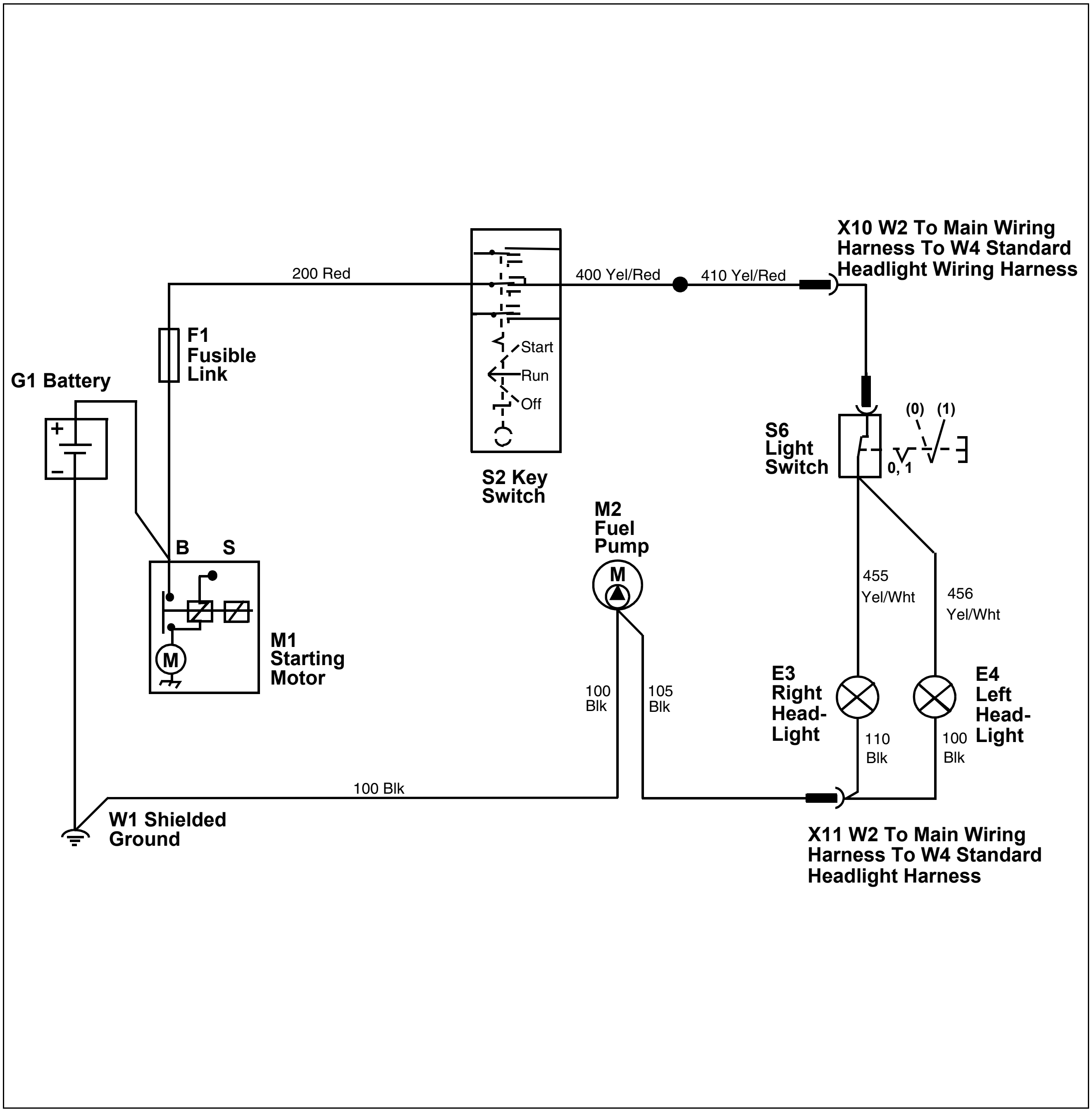
Operating Conditions:

The key switch must be in the RUN position.

Theory of Operation:

The headlight harness is attached to the W2 main wiring harness. Power from the headlight harness connector X10 is connected to the S6 light switch. Current then flows from the switch to the headlights.

Standard Headlight Circuit Schematic - 6X4 Gas

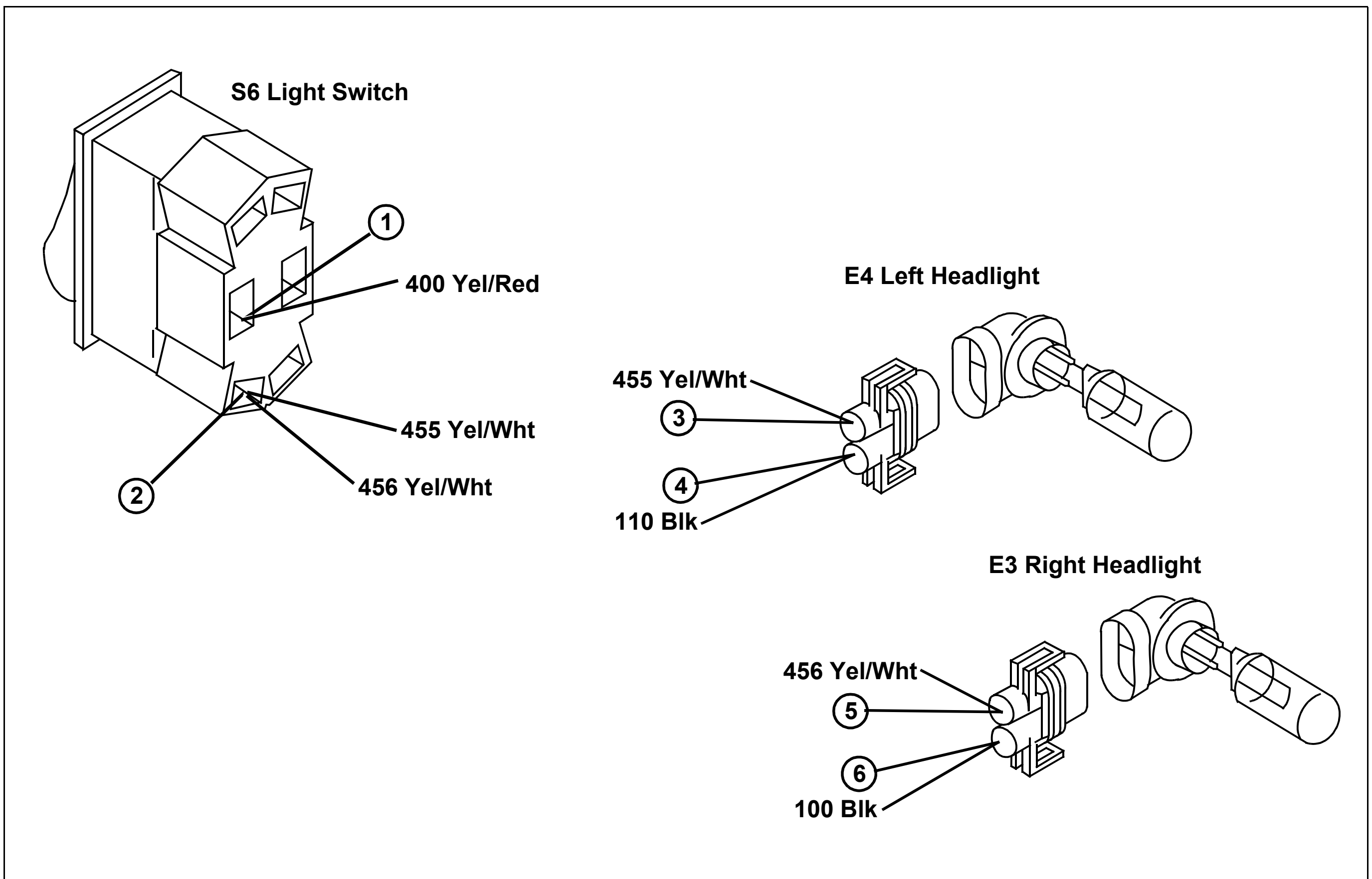


Standard Headlight Circuit Diagnosis - 6X4 Gas

Test Conditions:

- Key switch must be in the RUN position
- Light switch ON

Test/Check Point	Normal	If Not Normal
1. Light switch	Battery voltage	Check connection at X10 connector. See “Power Circuit Diagnosis - 6X4 Gas” on page 292.
2. Light switch	Battery voltage	Replace light switch.
3. Left headlight	Battery Voltage	Check 455 Yel/Wht wire and connections.
4. Left headlight	Greater than 0 volts - less than 0.2 volts	0 volts: Replace headlight. Greater than 0.2 volts: Check ground circuit connection at light harness ground connector X11 and 105 and 100 Blk wires and connections.
5. Right headlight	Battery voltage	Check 456 Yel/Wht wire and connections.
6. Right headlight	Greater than 0 volts - less than 0.2 volts	0 volts: Replace headlight. Greater than 0.2 volts: Check ground circuit connection at light harness ground connector X11and 105 and 100 Blk wires and connections.



ELECTRICAL SPECIFICATIONS - 6X4 DIESEL

Specifications - 6X4 Diesel

Battery:

Voltage	12
BCI group	U-1
CCA rating (Amps at 0° F)	340 amps
Reserve capacity (minutes)	41
Specific gravity	1.225 or above
Electrolyte required fill (approximately)	1.9 L (2.0 qt)
Load test (minimum)	340 amps for 15 seconds

Starting Motor:

Type	Solenoid Shift
Amp draw (on machine)	60 amps (maximum)
No-load amp draw (free running)	50 amps (maximum) at 6000 rpm

Alternator:

Rating	40 amps
Unregulated amperage	40 amps (minimum)
Regulated voltage	12.2 - 14.8 volts

Regulated Amperage

1000 rpm (Engine Cold)	23 amps
1000 rpm (Engine Hot)	16 amps
3300 rpm (Engine Cold)	51 amps
3300 rpm (Engine Hot)	42 amps

Fuel Shutoff Solenoid:

Hold voltage	3.0 volts

Glow Plug:

Resistance	0.3 - 0.5 ohms

Radiator Core Temperature Switch:

Early Models (To Model Year 2002)

Closes (Continuity - Radiator Fan ON)	71 ± 4° C (160° ± 7° F)
Opens (Infinity - Radiator Fan OFF)	60 ± 4° C (140° ± 7° F)

NOTE: The radiator core temperature switch closes when the coolant heats to 89° C (192° ± 7° F) raising the outer radiator core temperature to 71° C (160° ± 7° F). The outer radiator core temperature is approximately 20° C (36° F) lower than engine coolant temperature.

Later Models (From Model Year 2002)

Closes (Continuity - Radiator Fan ON)	86 ± 3° C (187° ± 5° F)

ELECTRICAL SPECIFICATIONS - 6X4 DIESEL

Engine Temperature:

Engine Coolant Temperature Light Switch . . . . From OFF (Open) to ON (Closed) at 109° ± 1° C (228° ± 2° F)

Lighting:

Headlights (halogen) . . . . 37.5 watts

Tail/Brake Lights . . . . 21 watts

Position Lights . . . . 10 watts

Front/Rear Turn Lights . . . . 21 watts

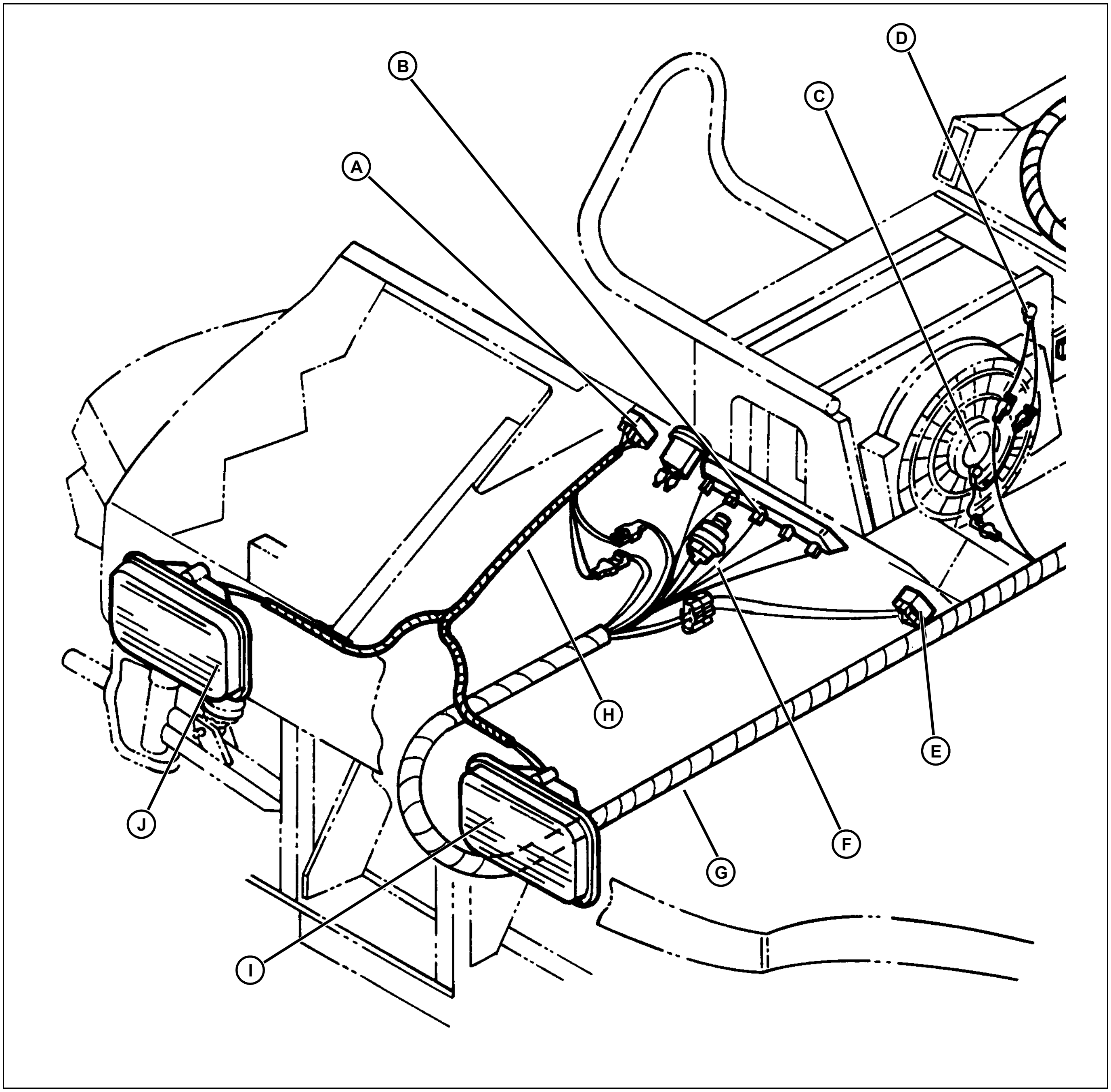
Neutral Start Switch:

Neutral (depressed) . . . . Continuity

In Gear (released) . . . . No Continuity

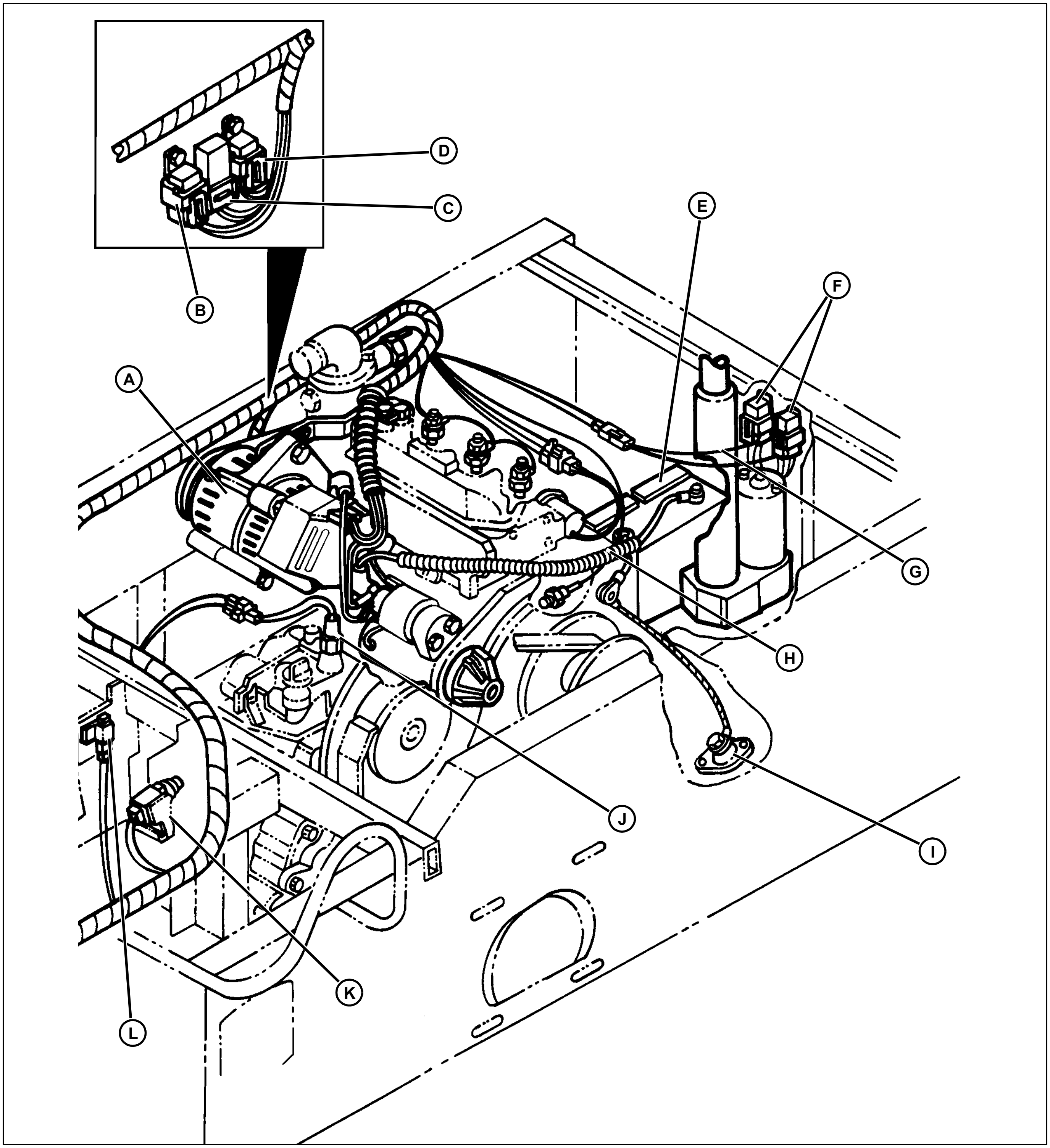
Component Location

Component Location - 6X4 Diesel



M76676L

A - S6 Light Switch
B - Instrument Panel Lights
C - M2 Radiator Fan Motor
D - B3 Radiator Core Temperature Switch
E - Cargo Box Lift Switch (optional)
F - S2 Key Switch
G - W3 Main Wiring Harness
H - W4 Standard Headlight Wiring Harness
I - E4 Headlight
J - E3 Headlight



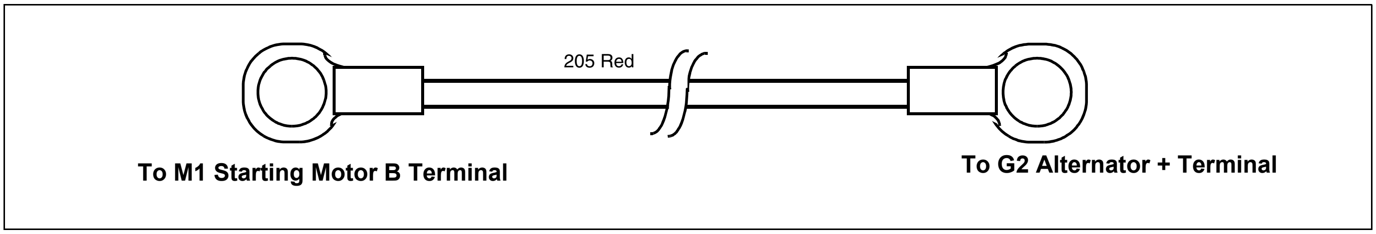
M76676R

- A - G2 Alternator
- B - K2 Pull-in Coil Cut Out Relay (SN -033000)
- C - K3 Fan Relay (SN 039741-)
- D - A1 Glow Plug Module
- E - K1 Start Relay
- F - G1 Battery
- G - Cargo Box Lift Directional Relays
- H - W17 Cargo Box Lift Wiring Harness
- I - W16 Engine Wiring Harness
- J - W1 Shielded Ground
- K - S1 Neutral Start Switch
- L - S4 Differential Lock Switch
- M - S3 Park Brake Switch

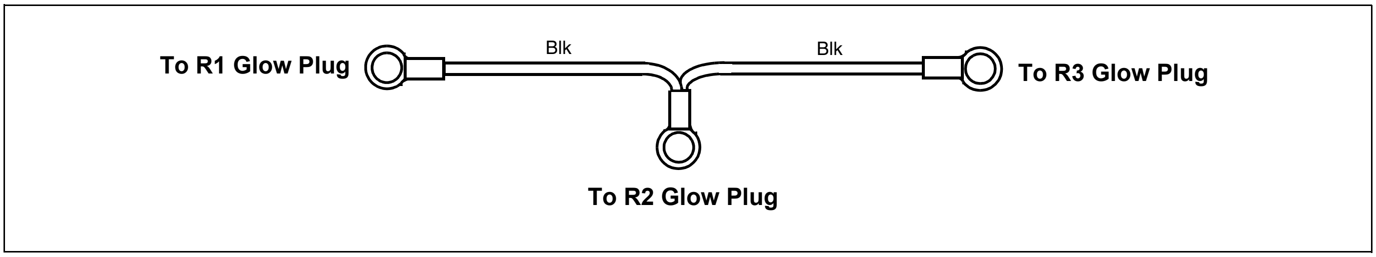
Schematics and Harnesses - 6X4 Diesel

3TN66C - JUV Engine Wiring Harnesses

W14 Engine Wiring Harness

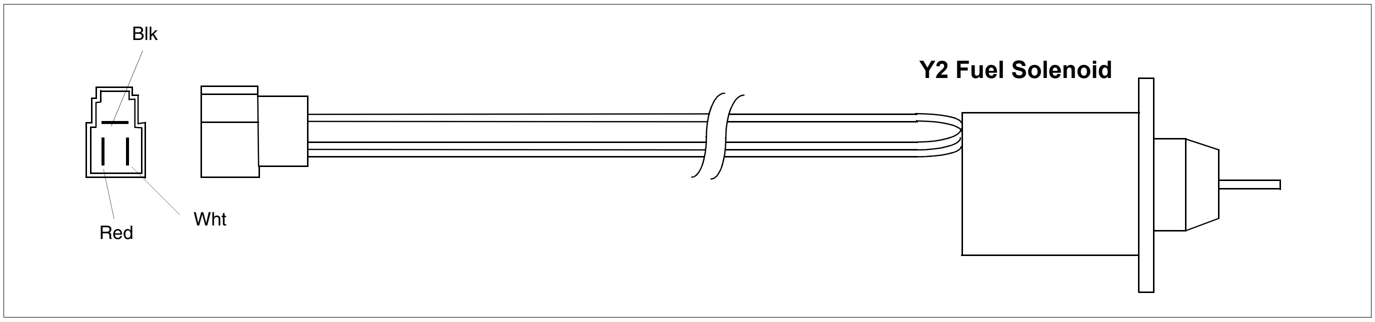


W15 Engine Wiring Harness

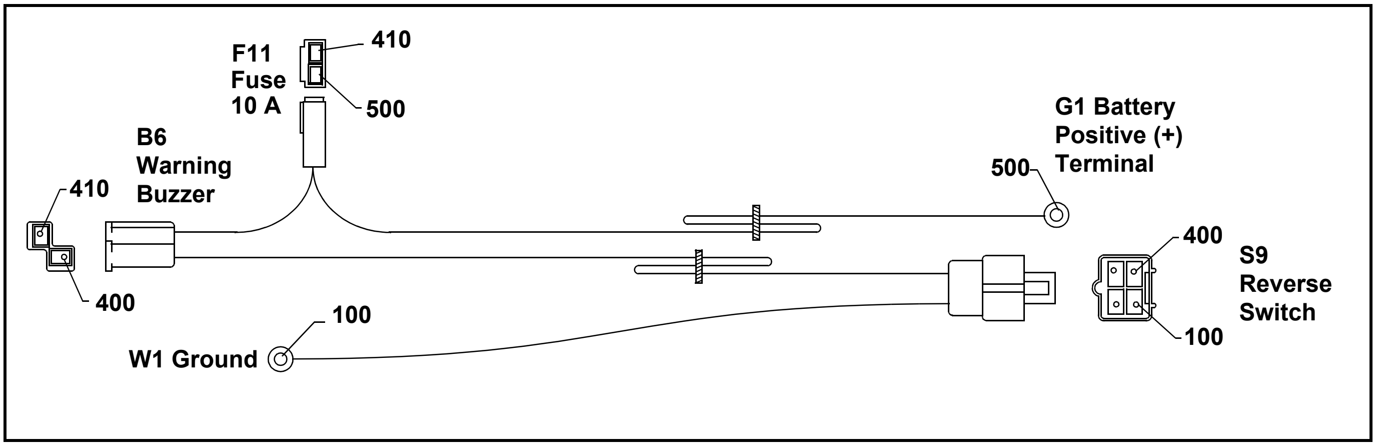


M76874

W16 Engine Wiring Harness



W31 Backup Alarm Wiring Harness



W31 Backup Alarm Wiring Harness Wire Color Codes

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Blk	W1, S9
400	1.0	Blk	S9, B6
410	1.0	Red	B6, F11
500	1.0	Red	F11, G1 (+) Terminal

Electrical Schematic and Wiring Harness Legend - 6X4 Diesel

A1 - Glow Plug Module (SE3, W3)

B1 - Radiator Core Temperature Switch (SE5, W3)

B2 - Engine Coolant Temperature Switch (SE6, W3)

B3 - Engine Oil Pressure Switch (SE6, W3)

E1 - Right Headlight (SE7, W3)

E2 - Left Headlight (SE7, W3)

F1 - Fusible Link (SE1, W3)

F2 - Fusible Link (SE1, W3)

F3 - Fusible Link (SE1, W3)

F4 - Fusible Link (SE1, W3)

F5 - Fusible Link (SE1, W3,) (S/N 003925 - 033000)

F1 - Fuse 10A (Back-Up Alarm Option) (SE6, W3)

G1 - Battery (SE1, W3)

G2 - Alternator (SE2, W3)

H1 - Discharge Light (SE6, W3)

H2 - Park Brake Light (SE6, W3)

H3 - Differential Lock Light (SE6, W3)

H4 - Engine Coolant Temperature Light (SE6, W3)

H5 - Engine Oil Pressure Light (SE6, W3)

H6 - Back-Up Alarm (option) (SE6, W3)

K1 - Start Relay (SE1, W3)

K2 - Pull-in Coil Cut Out Relay (SE4, W3) (S/N - 033000)

K3 - Fan Relay (SE4, W3) (S/N 039741-)

M1 - Starting Motor (SE1, W3)

M2 - Radiator Fan Motor (SE5, W3)

P1 - Hourmeter (SE6, W3) (S/N 033001 -)

R1 - Glow Plug (SE3, W3)

R2 - Glow Plug (SE3, W3)

R3 - Glow Plug (SE3, W3)

S1 - Neutral Start Switch (SE1, W3)

S2 - Key Switch (SE3, W3)

S3 - Park Brake Switch (SE6, W3)

S4 - Differential Lock Switch (SE6, W3)

S5 - Cargo Box Lift Switch (SE7, W3) (optional)

S6 - Light Switch (SE7, W3)

S9 - Reverse Switch (Back-up Alarm Option)(SE6, W3)

V1 - Diode (SE4, W3) (S/N - 033000)

W1 - Shielded Ground (SE1, W3)

Y1 - Starting Motor Solenoid (SE1, W3)

Y2 - Fuel Shutoff Solenoid (SE4, W3)

Connectors:

X1 - W3 Main Wiring Harness to W16 Engine Wiring Harness (SE4, W3)

X2 - W3 Main Wiring Harness to M2 Radiator Fan Motor (SE5, W3)

X3 - M2 Radiator Fan Motor to B1 Radiator Core Temperature Switch (SE5, W3)

X4 - B1 Radiator Core Temperature Switch to W3 Main Wiring Harness (SE5, W3)

X5 - W4 Standard Headlight Wiring Harness to W3 Main Wiring Harness (SE6, W3; SE7, W4)

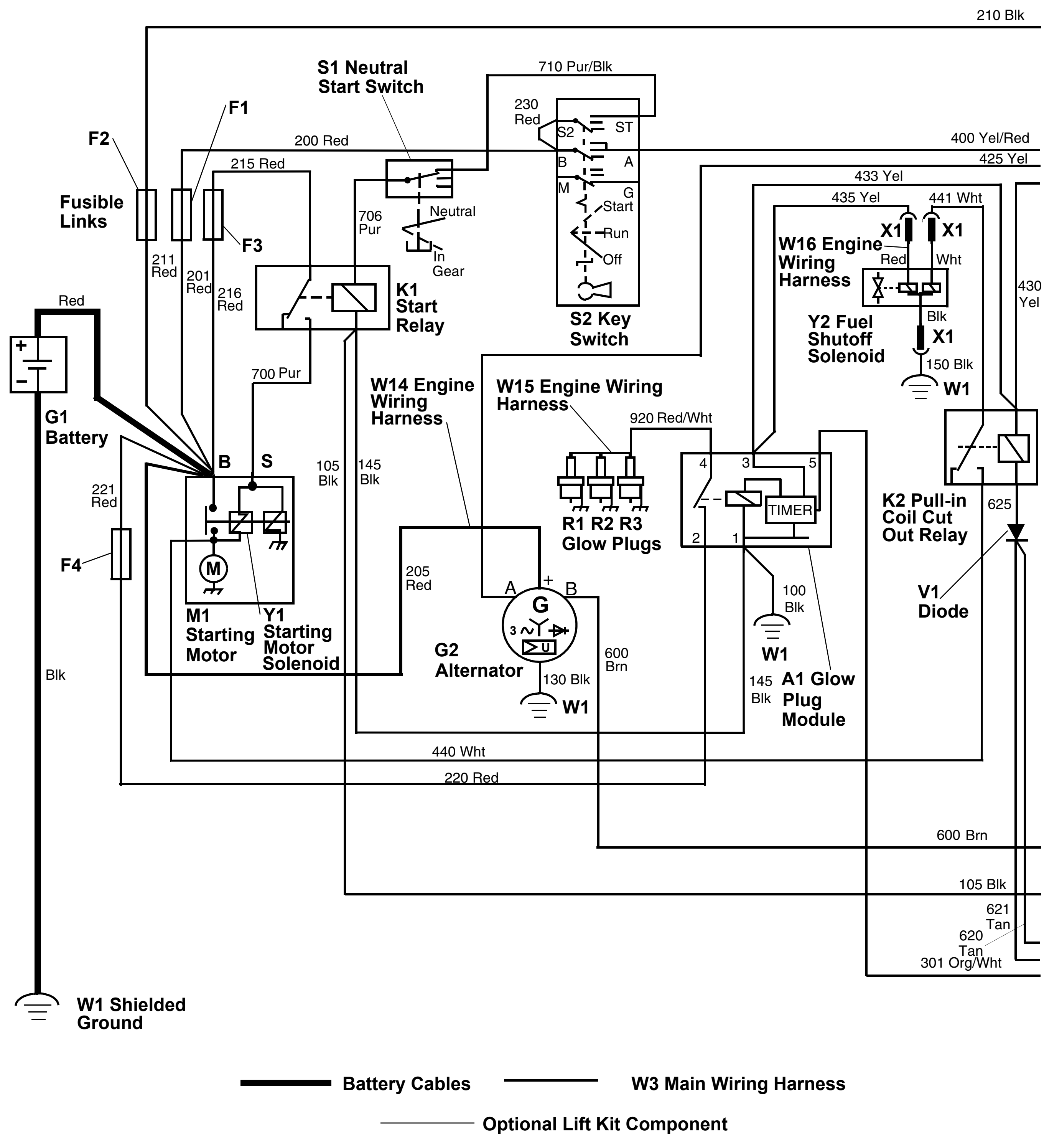
X6 - W3 Main Wiring Harness to S5 Cargo Box Lift Kit Switch (SE6, W3; SE1, W17)

X7 - W3 Main Wiring Harness to W17 Cargo Box Lift Kit Wiring Harness (SE6, W3)

X8 - W3 Main Wiring Harness to W4 Standard Headlight Wiring Harness (SE7, W3; SE7, W4)

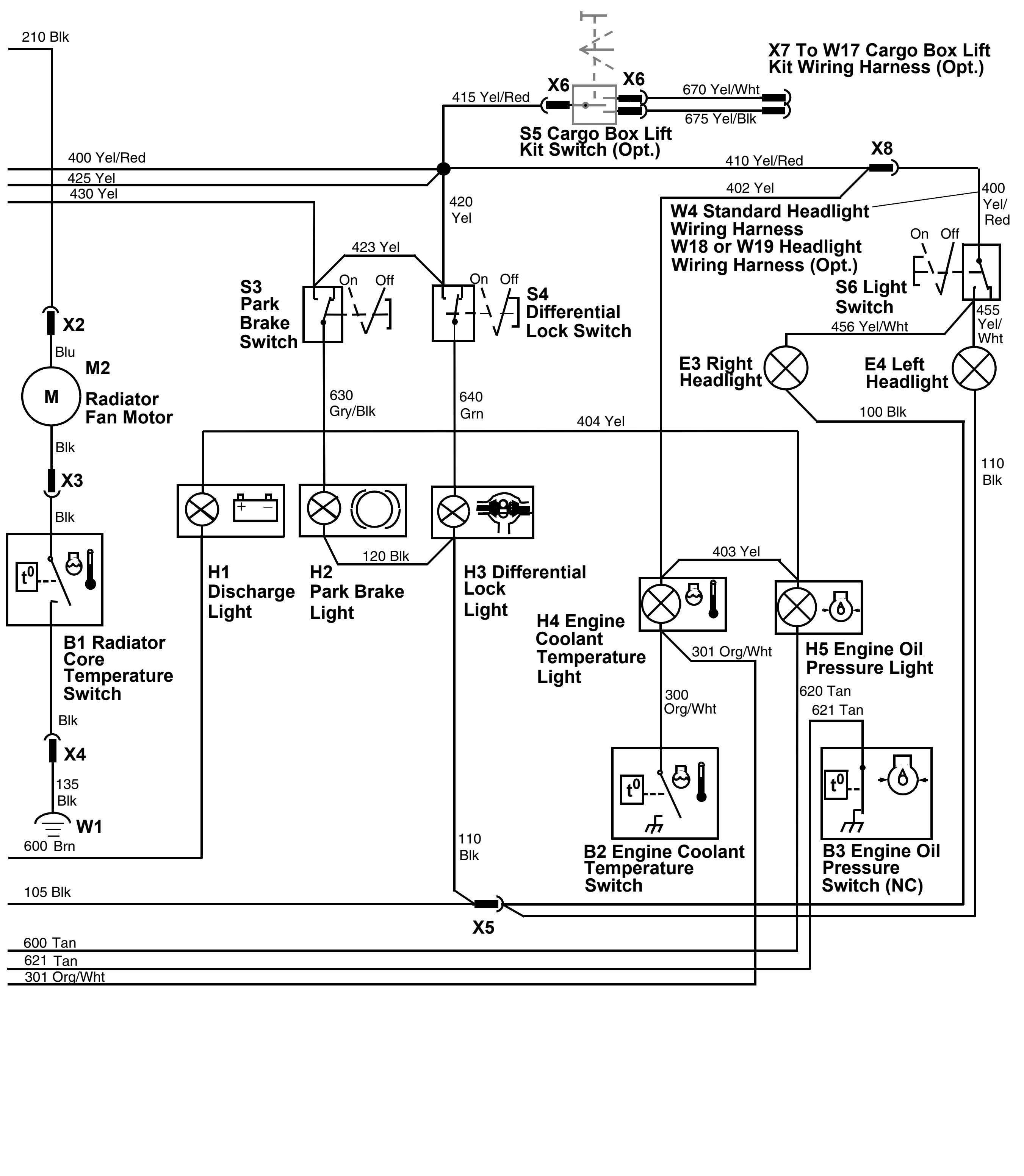
W3 Standard Electrical Schematic - 6X4 Diesel (S/N - 003924)

W3 Standard Electrical Schematic - 6X4 Diesel (S/N - 003924) (1 of 2)



SE1 - Starting	SE2 - Charging	SE3 - Ignition	SE4 - Engine

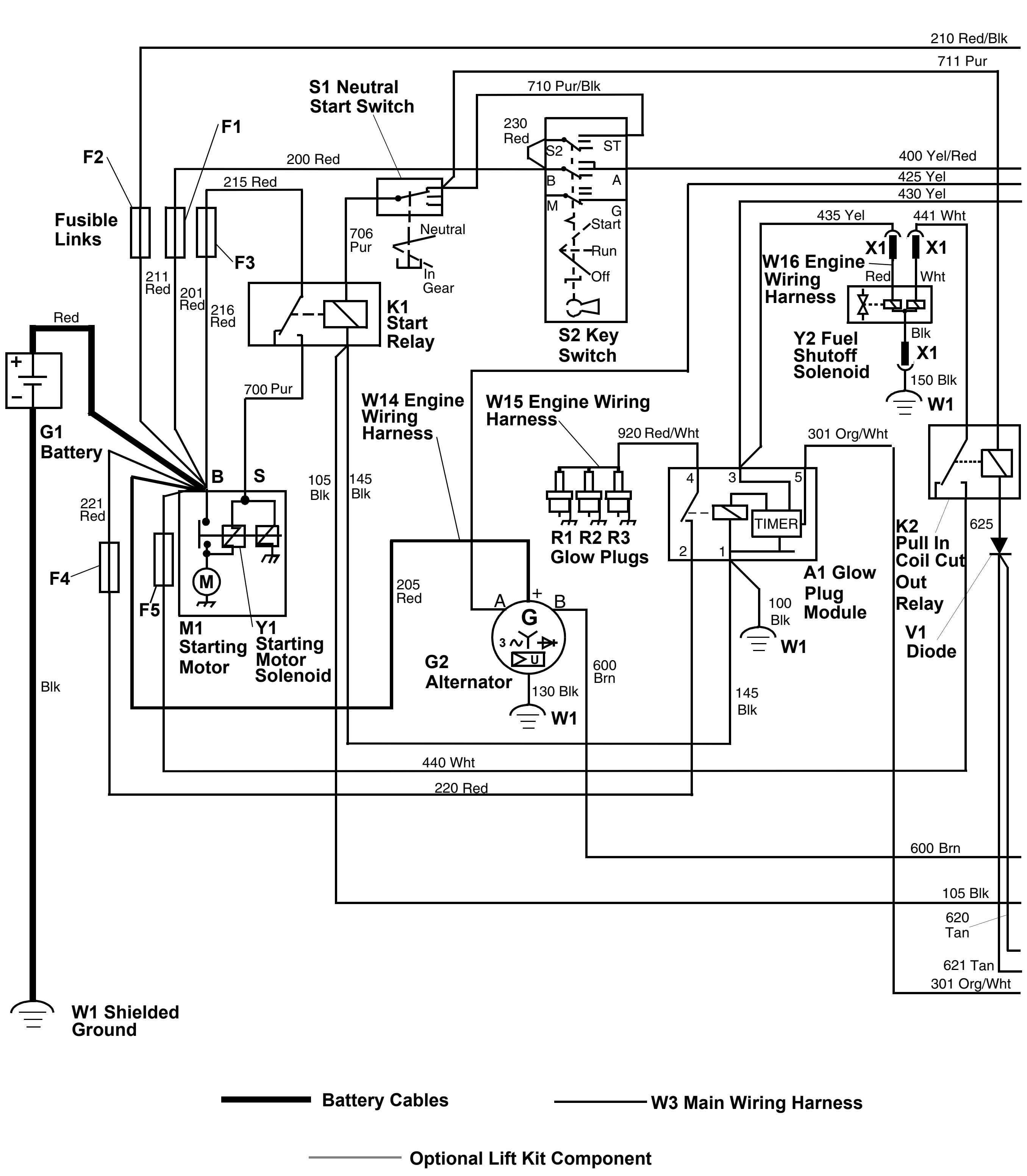
W3 Standard Electrical Schematic - 6X4 Diesel (S/N - 003924) (2 of 2)



SE5 - Cooling	SE6 - Instrumentation	SE7 - Lights

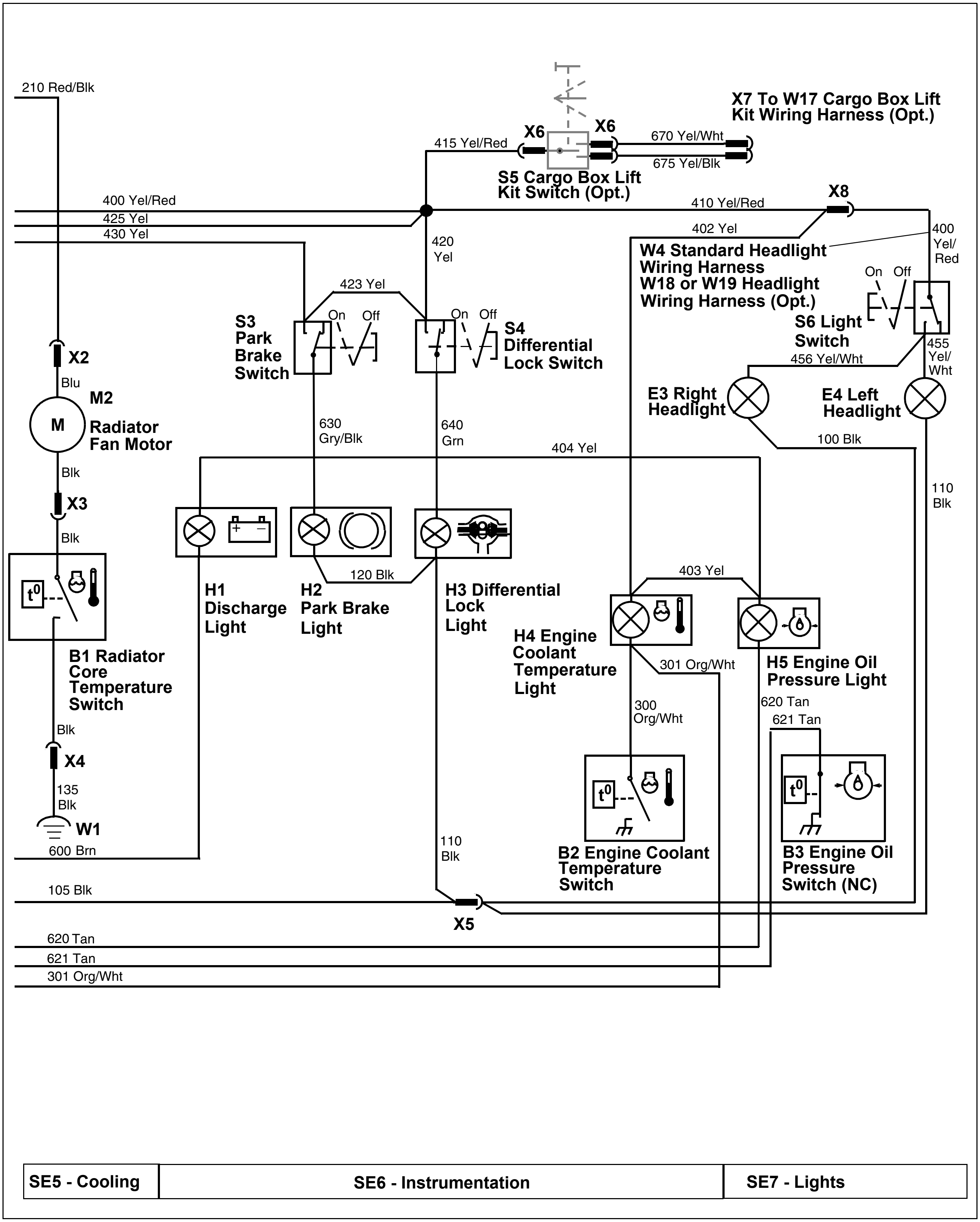
W3 Standard Electrical Schematic - 6X4 Diesel (S/N 003925 - 033000)

W3 Standard Electrical Schematic - 6X4 Diesel (S/N 003925 - 033000) (1 of 2)



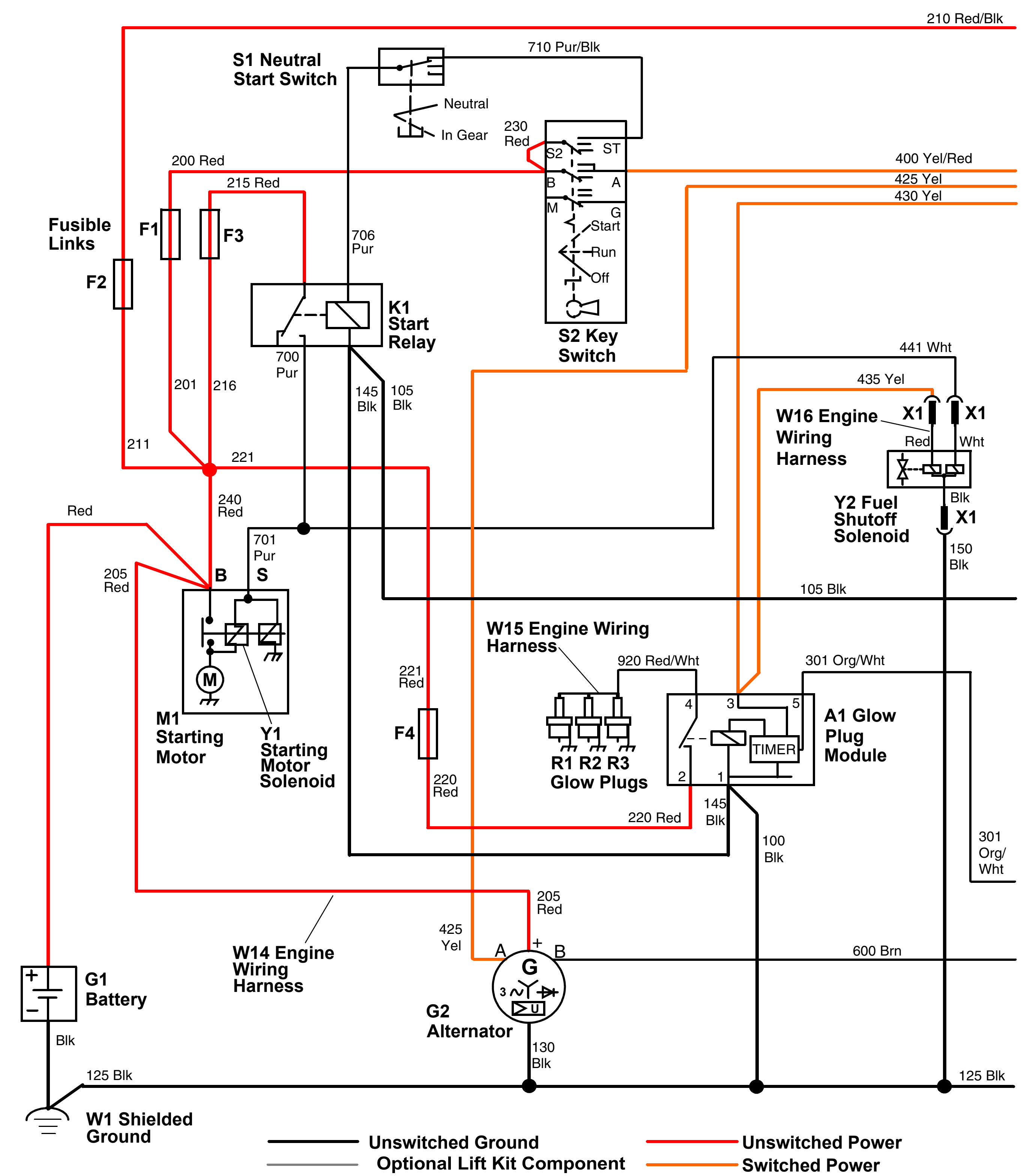
SE1 - Starting	SE2 - Charging	SE3 - Ignition	SE4 - Engine

W3 Standard Electrical Schematic - 6X4 Diesel (S/N 003925 - 033000) (2 of 2)



W3 Standard Electrical Schematic - 6X4 Diesel (S/N 033001 - 039740)

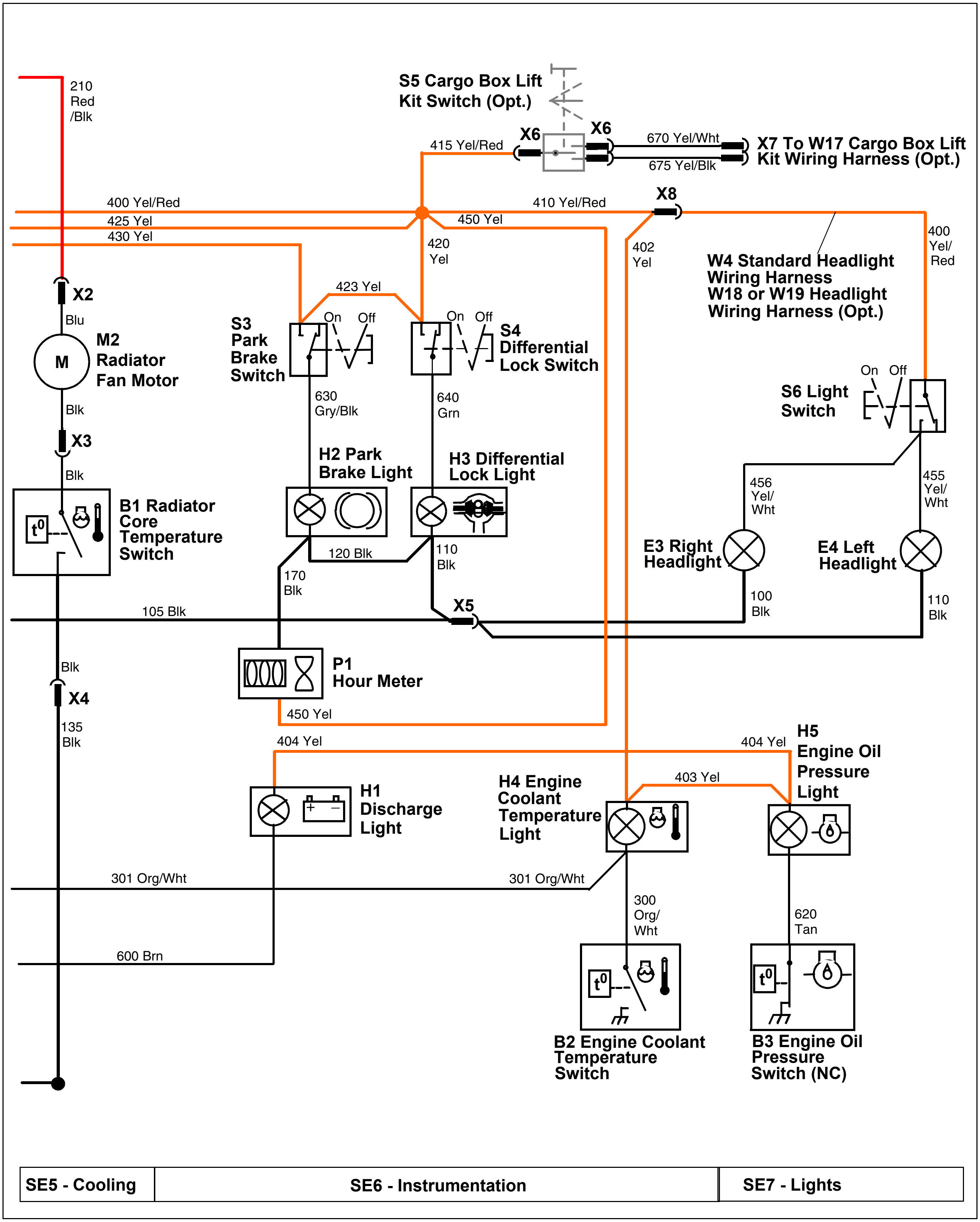
W3 Standard Electrical Schematic - 6X4 Diesel (S/N 033001 - 039740) (1 of 2)



SE1 - Starting	SE2 - Charging	SE3 - Ignition	SE4 - Engine

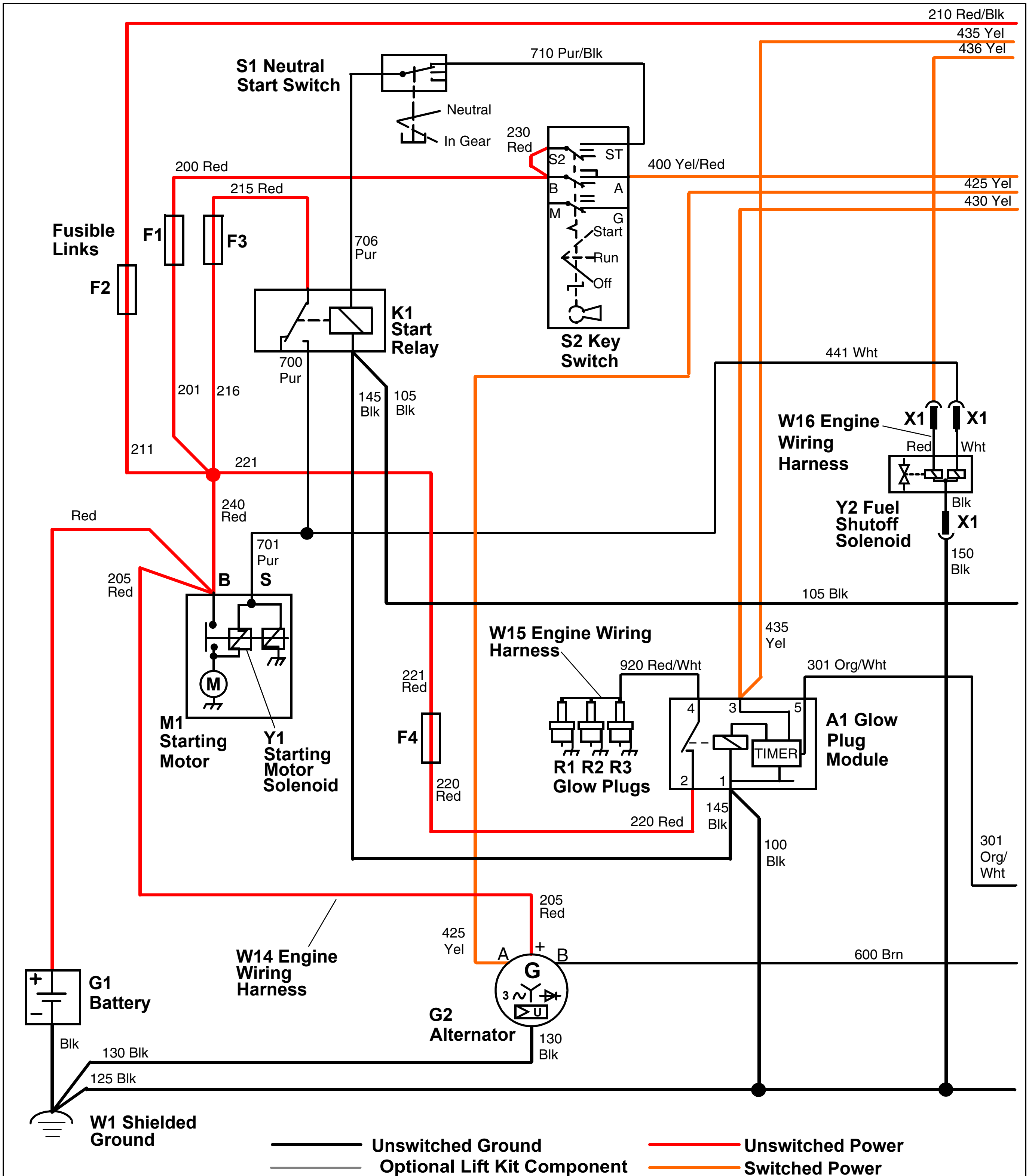
MIF

W3 Standard Electrical Schematic - 6X4 Diesel (S/N 033001 - 039740) (2 of 2)



W3 Standard Electrical Schematic - 6X4 Diesel (S/N 039741-)

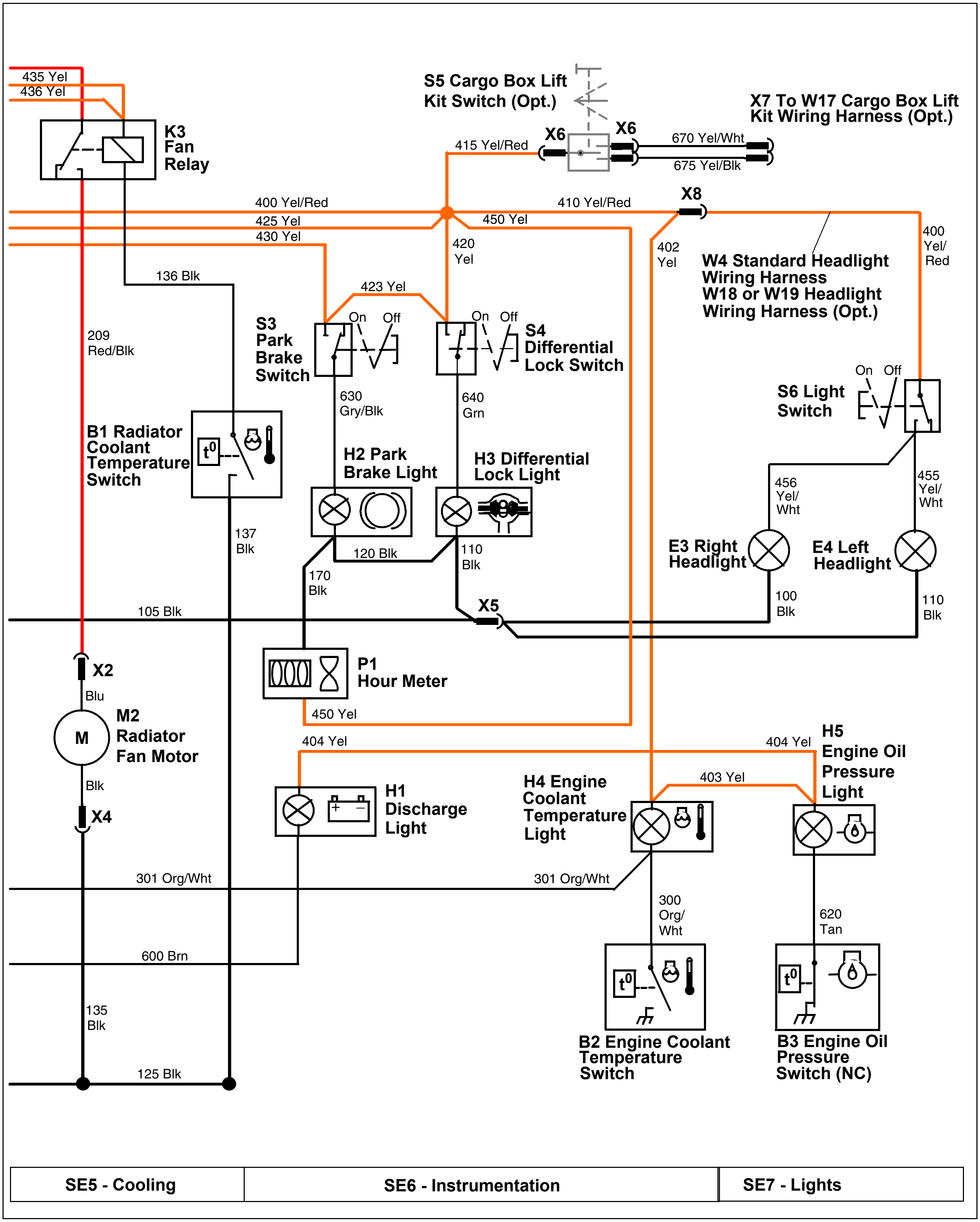
W3 Standard Electrical Schematic - 6X4 Diesel (S/N 039741-) (1 of 2)



SE1 - Starting	SE2 - Charging	SE3 - Ignition	SE4 - Engine

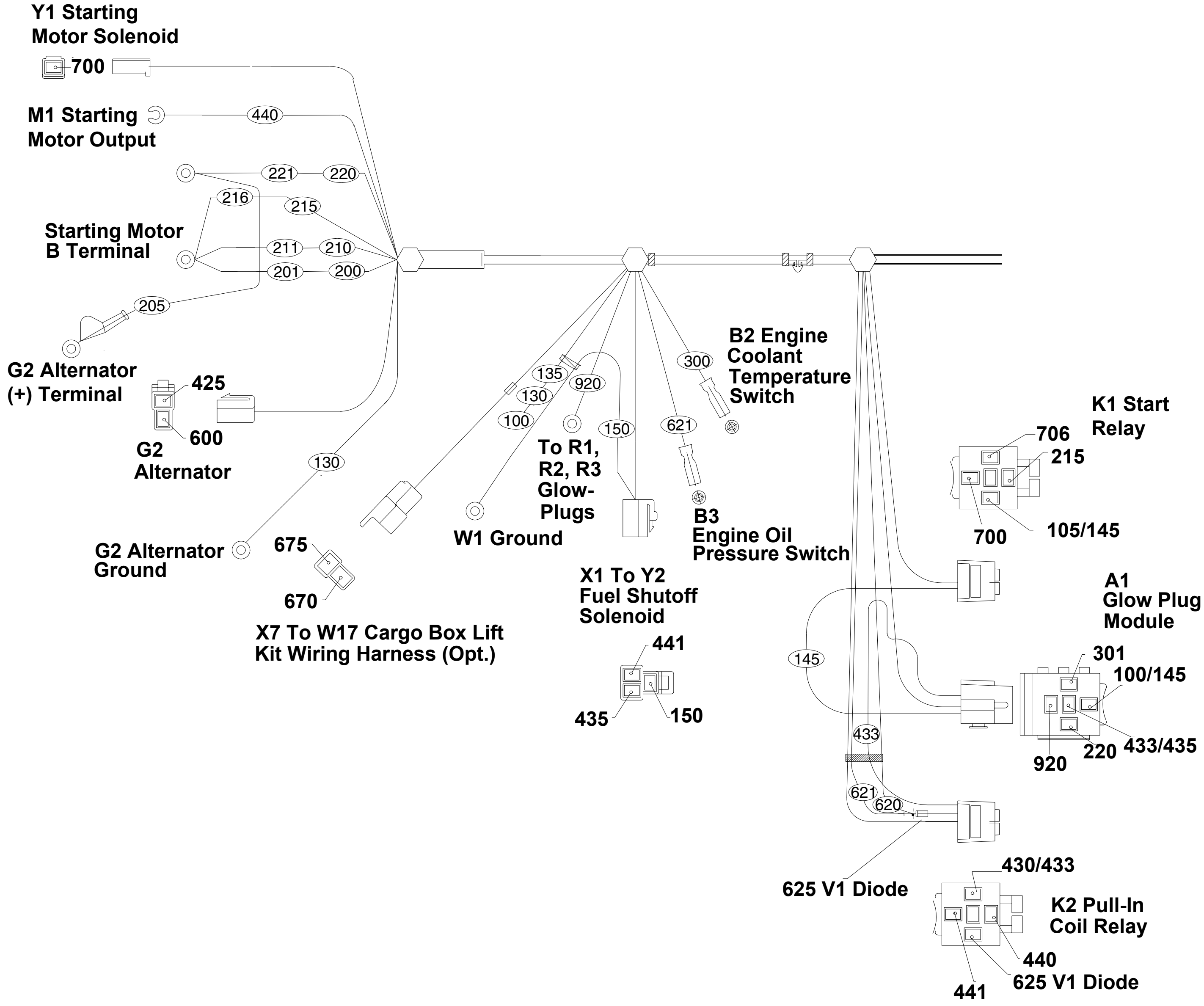
MIF

W3 Standard Electrical Schematic - 6X4 Diesel (S/N 039741-) (2 of 2)

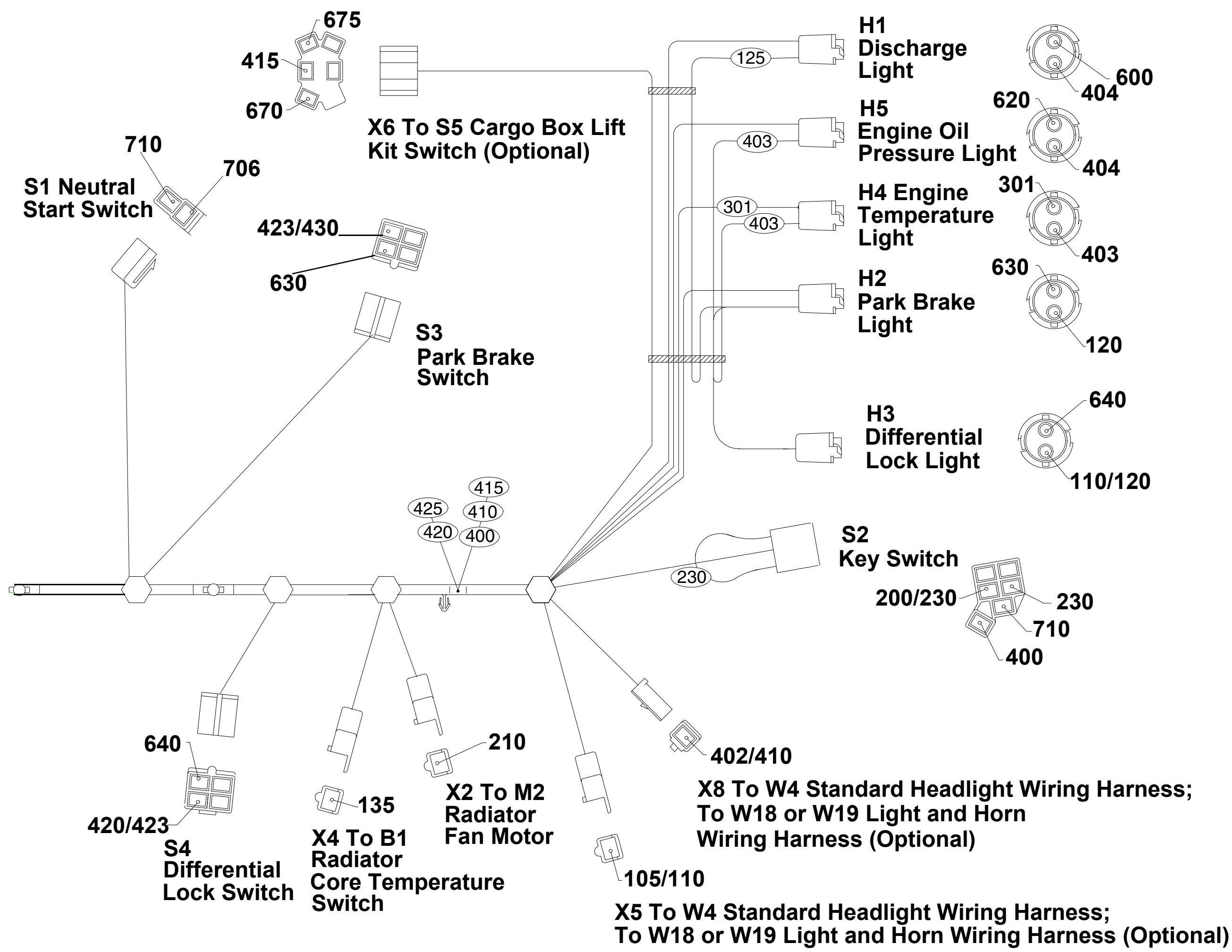


W3 Main Wiring Harness - 6X4 Diesel (S/N -003924)

W3 Main Wiring Harness - 6X4 Diesel (S/N -003924) (1 of 2)

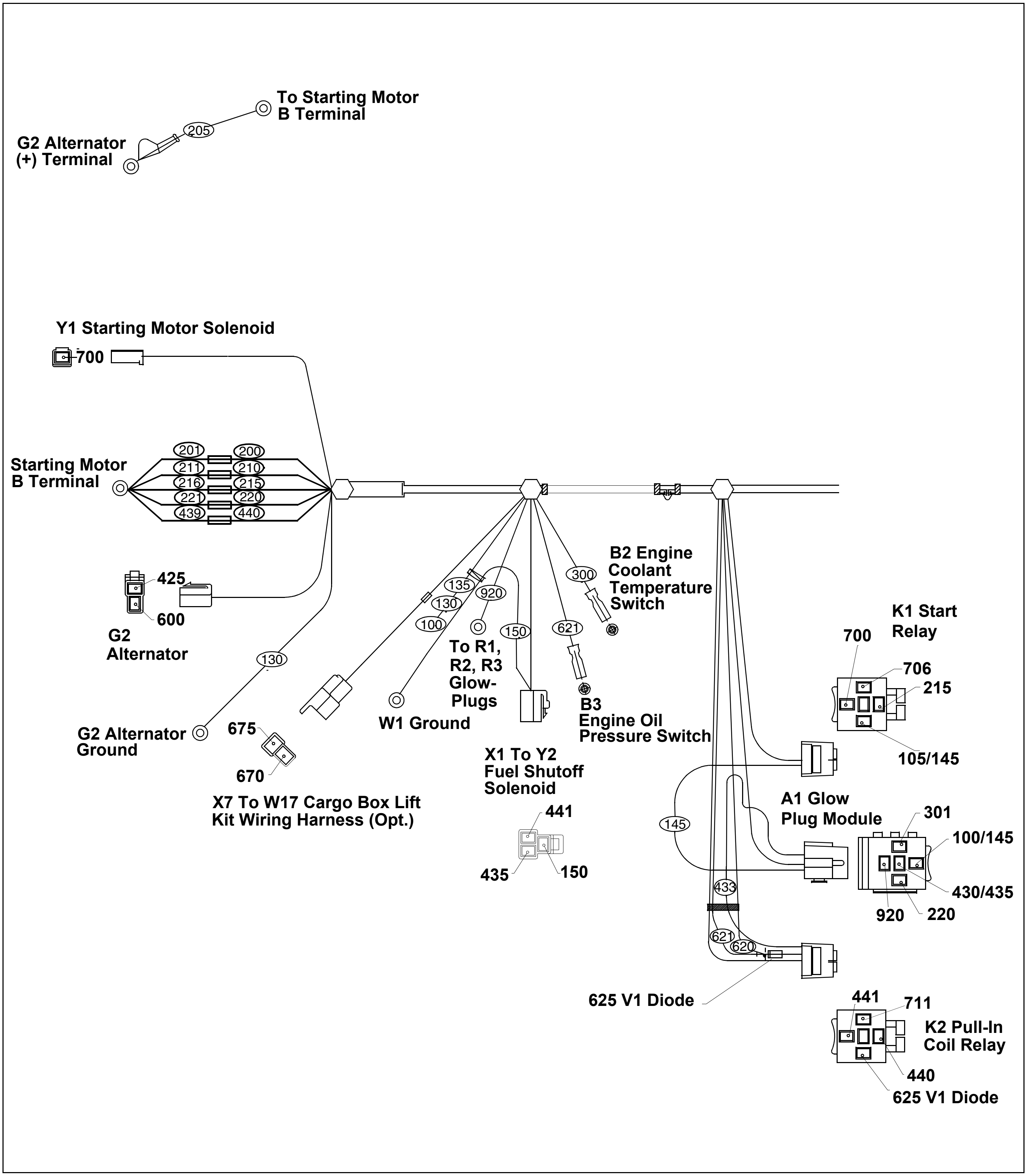


W3 Main Wiring Harness - 6X4 Diesel (S/N -003924) (2 of 2)

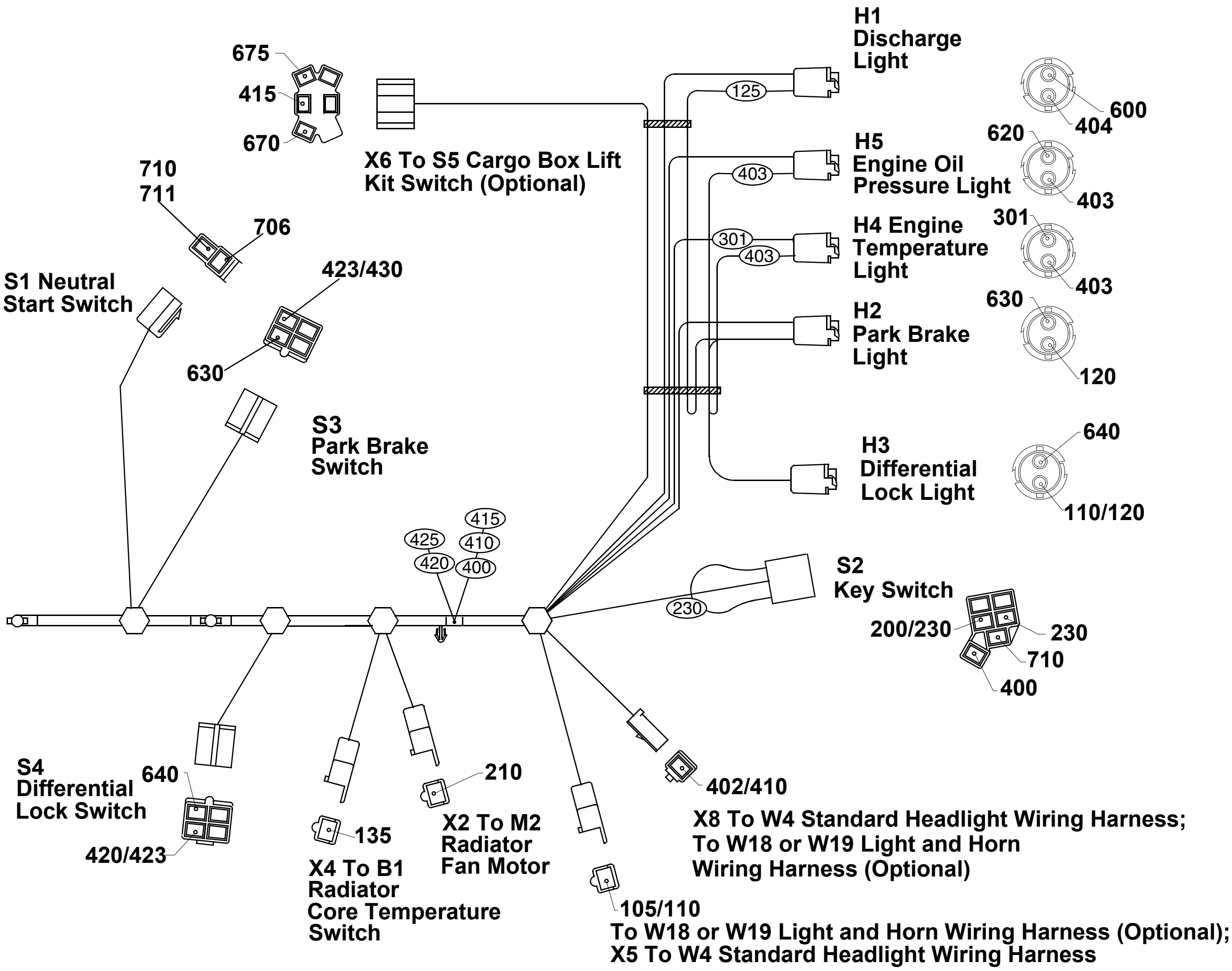


W3 Main Wiring Harness - 6X4 Diesel (S/N 003925 - 033000)

W3 Main Wiring Harness - 6X4 Diesel (S/N 003925 - 033000) (1 of 2)

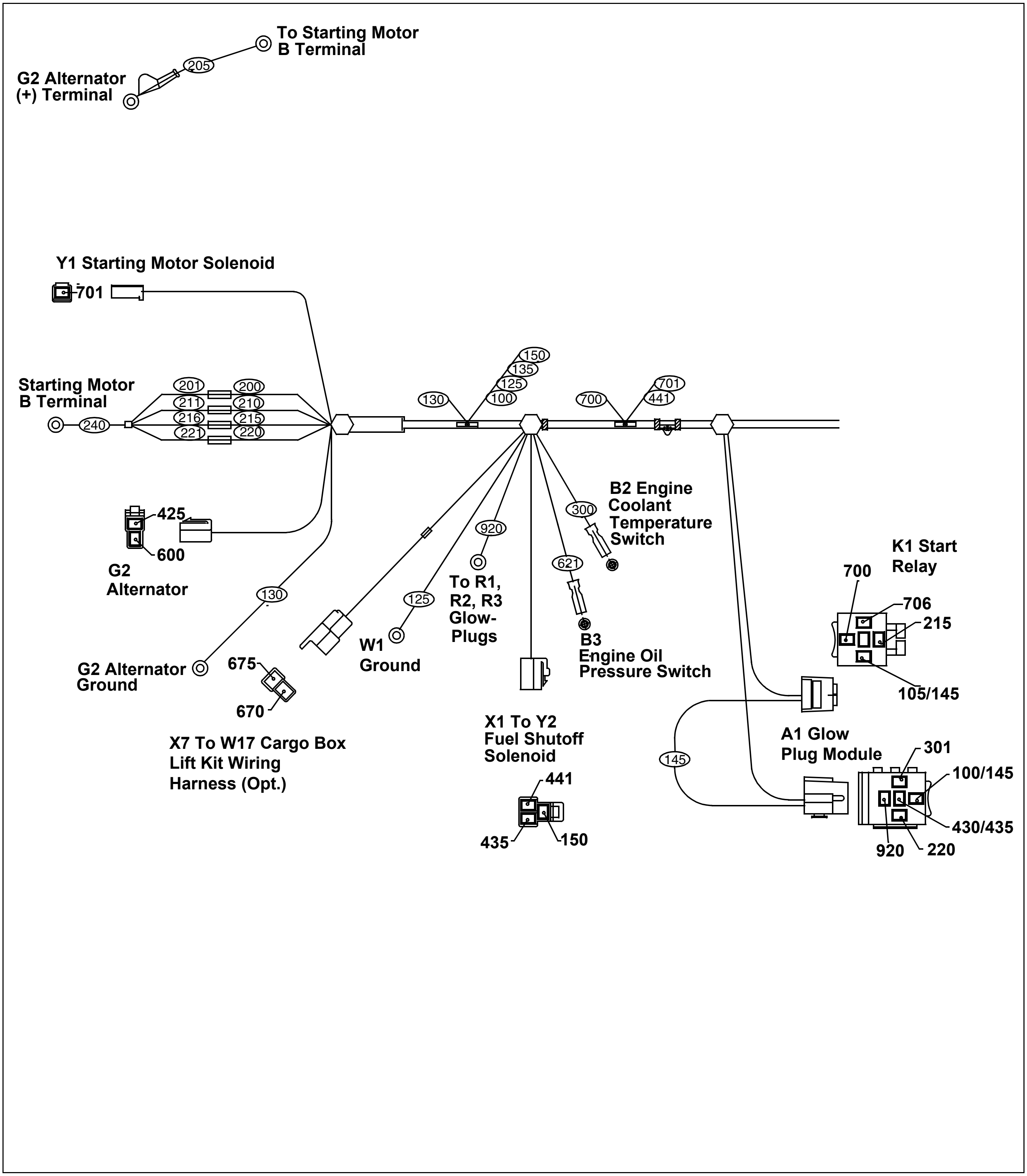


W3 Standard Wiring Harness - 6X4 Diesel (S/N 003925 - 033000) (2 of 2)

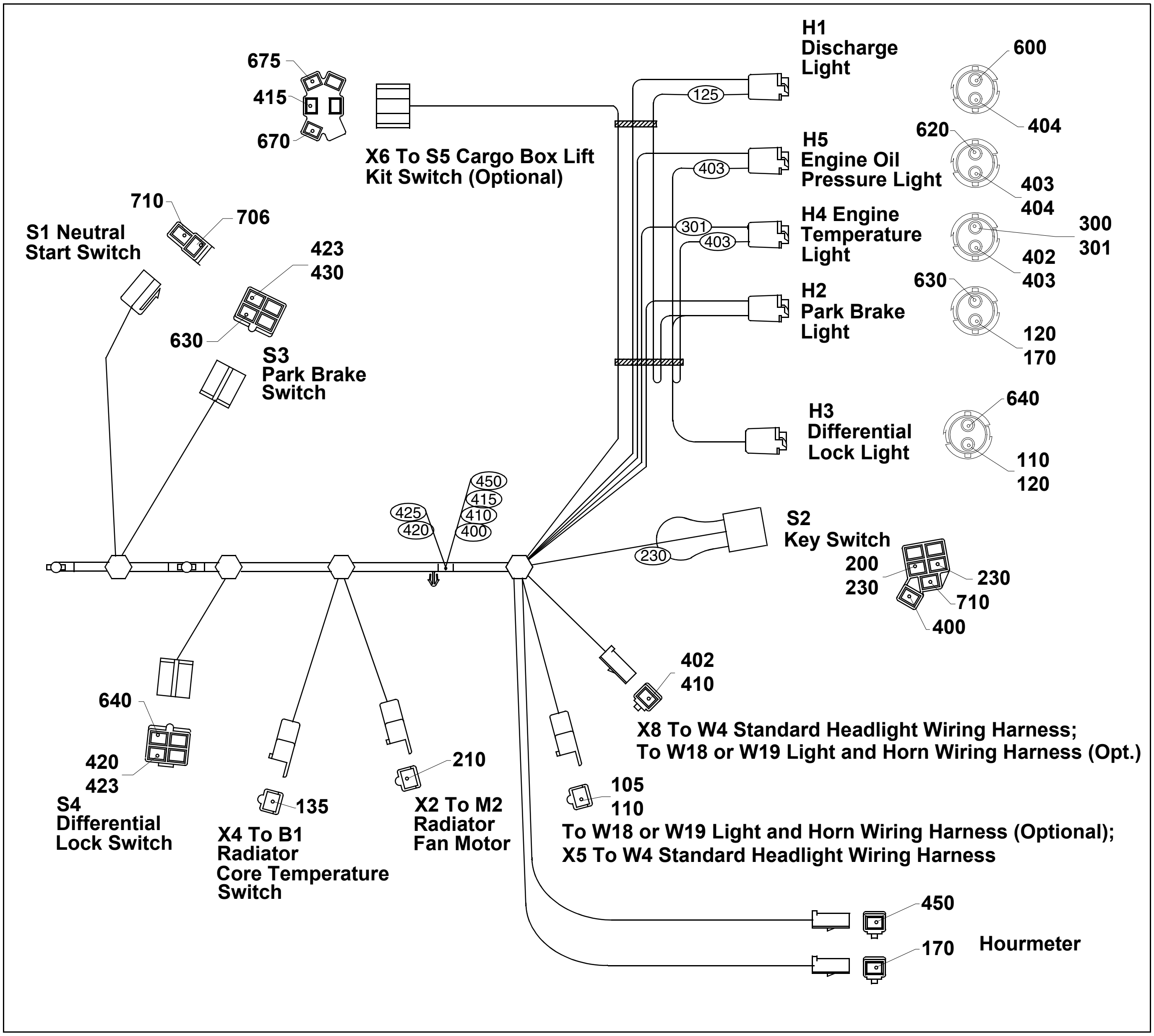


W3 Main Wiring Harness - 6X4 Diesel (S/N 033001 - 039740)

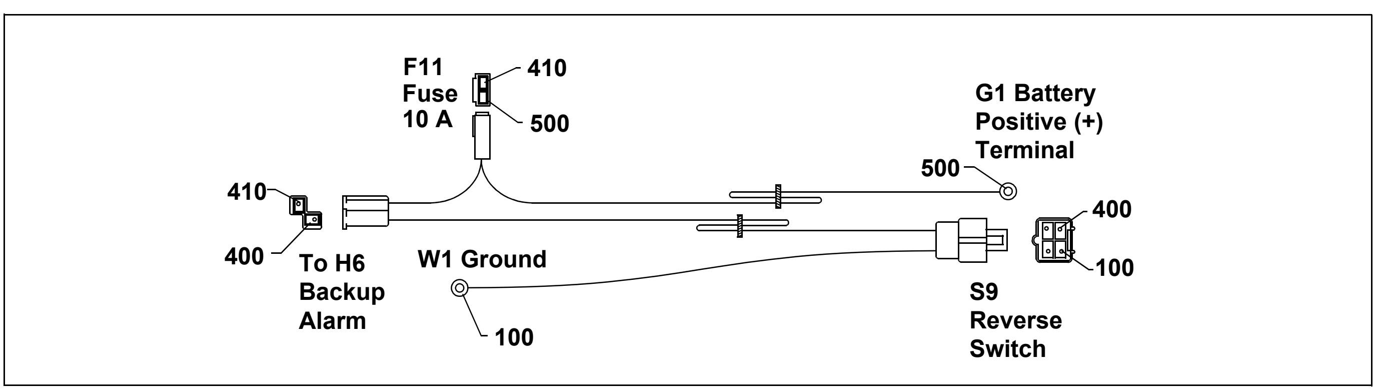
W3 Main Wiring Harness - 6X4 Diesel (S/N 033001 - 039740) (1 of 2)



W3 Standard Wiring Harness - 6X4 Diesel (S/N 033001 - 039740) (2 of 2)

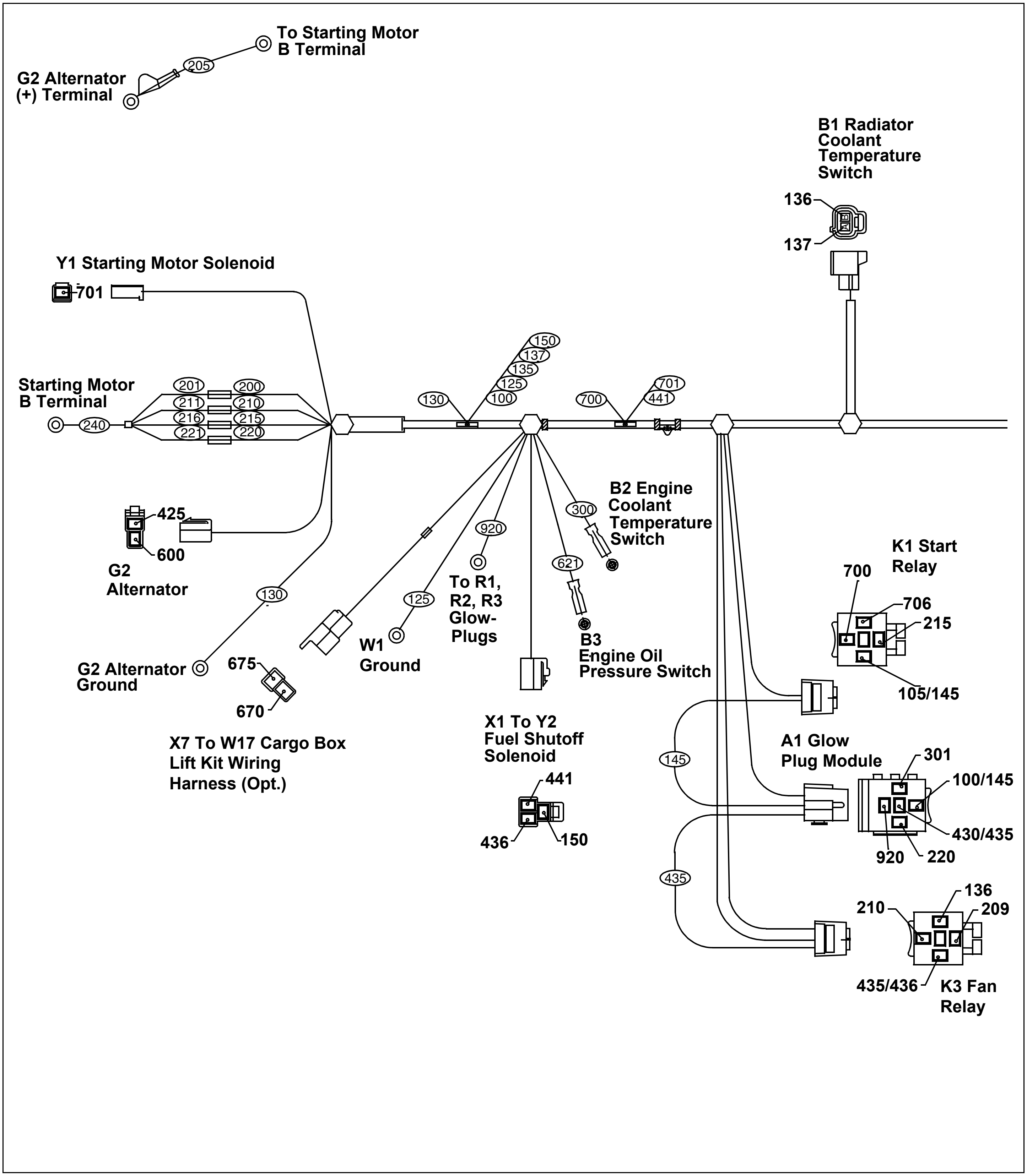


W31 Backup Alarm Wiring Harness - 6X4 Diesel

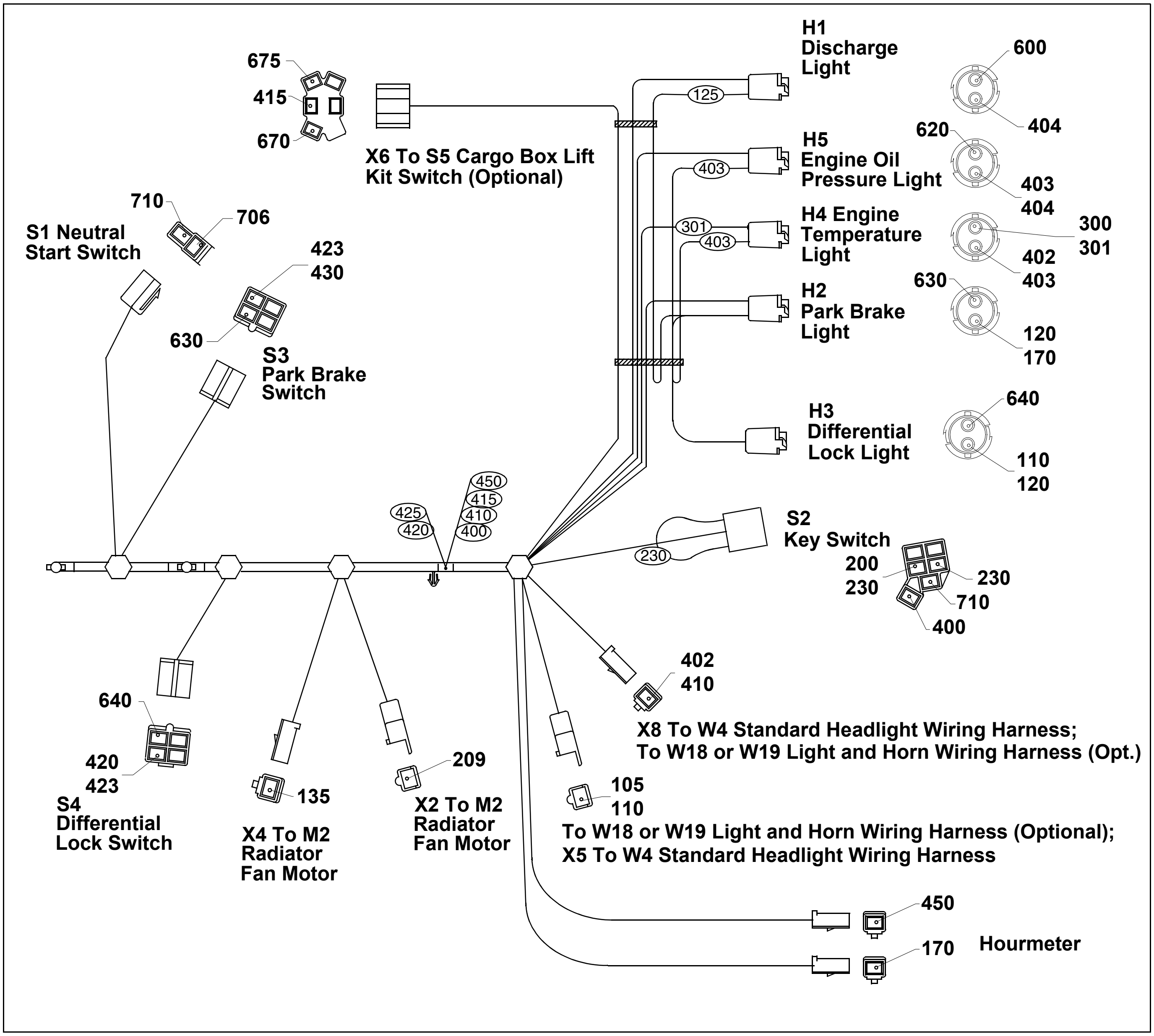


W3 Main Wiring Harness - 6X4 Diesel (S/N 039471-)

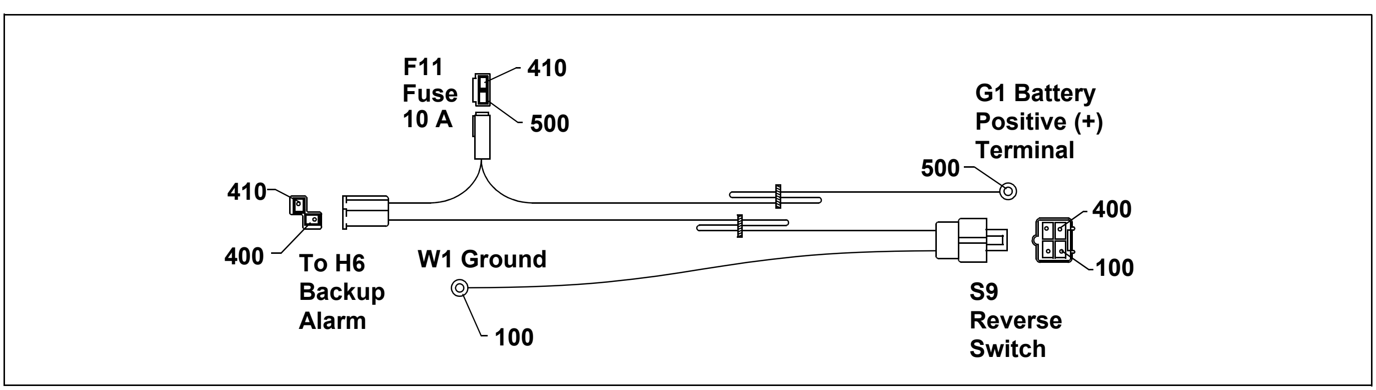
W3 Main Wiring Harness - 6X4 Diesel (S/N 039741-) (1 of 2)



W3 Standard Wiring Harness - 6X4 Diesel (S/N 039741-) (2 of 2)



W31 Backup Alarm Wiring Harness - 6X4 Diesel



W3 Main Wiring Harness Wire Color Code Chart (S/N -033000)

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Blk	A1, W1 Gnd
105	1.0	Blk	X5, K1
110	0.5	Blk	H3, X5
120	0.5	Blk	H2, H3
130	3.0	Blk	G2, W1 Gnd
135	3.0	Blk	X4, W1 Gnd
145	1.0	Blk	K1, A1
150	3.0	Blk	X1, W1 Gnd
200	2.0	Red	F1, S2
201	0.8	Fuselink	F1 Fuse soldered in-line; M1, 200
205	5.0	Red	M1, G2
210 (S/N - 003924)	3.0	Blk	F2, X2
210 (S/N 003925 - 033000)	3.0	Red/Blk	F2, X2
211	1.0	Fuselink	F2 Fuse soldered in-line; M1, 210
215	2.0	Red	F3, K1
216	0.8	Fuselink	F3 Fuse soldered in-line; M1, 215
220	3.0	Red	F4, A1
221	1.0	Fuselink	F4 Fuse soldered in-line; M1, A1
230	2.0	Red	S2, S2
300	0.8	Org/Wht	H4, B2
301	0.5	Org/Wht	H4, A1
400	2.0	Yel/Red	S2, Splice (410, 415, 420, and 425)
402	0.8	Yel	X8, H4
403	0.8	Yel	H4, H5
404	0.5	Yel	H5, H1
410	1.0	Yel/Red	Splice (400), X8
415	1.0	Yel/Red	Splice (400), X8
420	0.8	Yel	Splice (400), S4
423	0.8	Yel	S4, S3
425	1.0	Yel	Splice (400), A1
430 (S/N - 003924)	0.8	Yel	S3, K2
430 (S/N 003925 - 033000)	0.8	Yel	S3, A1
433 (S/N - 003924)	0.8	Yel	K2, A1
435	0.8	Yel	A1, Y2
440 (S/N - 003924)	3.0	Wht	M1, K2
440 (S/N 003925 - 033000)	3.0	Wht	F5, K2
441	3.0	Wht	X1, K2
600	0.5	Brn	H1, G2
620	0.5	Tan	H5, V1
621	0.8	Tan	V1, B3
625	0.5	Diode	K2, 620 and 621
630	0.8	Gry/Blk	S3, H2
640	0.5	Grn	S4, H3
670	1.0	Yel/Wht	X6, X7
675	1.0	Yel/Blk	X6, X7
700	2.0	Pur	K1, Y1
706	0.8	Pur	S1, K1
710	0.8	Pur/Blk	S2, S1
711 (S/N 003925 - 033000)	0.8	Pur	S1, K2
920	3.0	Red/ Wht	A1, R3

W3 Main Wiring Harness Wire Color Code Chart (S/N 033001 - 039740)

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Blk	A1, Splice
105	1.0	Blk	X5, K1
110	0.5	Blk	H3, X5
120	0.5	Blk	H2, H3
125	5.0	Blk	W1, Splice
130	3.0	Blk	G2, Splice
135	3.0	Blk	B1, Splice
145	1.0	Blk	K1, A1
150	3.0	Blk	Y2, Splice
170	0.8	Blk	H2, P1
200	2.0	Red	F1, S2
201	0.8	Fuselink	F1 Fusible link soldered in-line.
205	13.0	Red	M1, G2
210	3.0	Red/Blk	F2, M2
211	1.0	Fuselink	F2 Fusible link soldered in-line.
215	5.0	Red	F3, K1
216	2.0	Fuselink	F3 Fusible link soldered in-line.
220	3.0	Red	F4, A1
221	1.0	Fuselink	F4 Fusible link soldered in-line.
230	2.0	Red	S2, S2
240	5.0	Red	M1, Fusible link splice
300	0.8	Org/Wht	H4, B2
301	0.5	Org/Wht	H4, A1
400	2.0	Yel/Red	S2, Splice
402	0.8	Yel	X8, H4
403	0.8	Yel	H4, H5
404	0.5	Yel	H5, H1
410	1.0	Yel/Red	Splice, X8
415	1.0	Yel/Red	Splice, S5 (optional)
420	0.8	Yel	Splice, S4
423	0.8	Yel	S4, S3
425	1.0	Yel	Splice, G2
430	0.8	Yel	S3, A1
435	0.8	Yel	A1, Y2
441	3.0	Wht	Y2, Splice
450	0.8	Yel	P1, Splice
600	0.8	Brn	H1, G2
620	0.5	Tan	H5, B3
630	0.8	Gry/Blk	S3, H2
640	0.5	Grn	S4, H3
670	1.0	Yel/Wht	S5 (optional), X7
675	1.0	Yel/Blk	S5 (optional), X7
700	5.0	Pur	K1, Splice
701	2.0	Pur	Y1, Splice
706	0.8	Pur	S1, K1
710	0.8	Pur/Blk	S2, S1
920	3.0	Red/Wht	A1, R3

W3 Main Wiring Harness Wire Color Code Chart (S/N 039741-)

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Blk	A1, Splice
105	1.0	Blk	X5, K1
110	0.5	Blk	H3, X5
120	0.5	Blk	H2, H3
125	5.0	Blk	W1, Splice
130	3.0	Blk	G2, W1
135	3.0	Blk	M2, Splice
136	1.0	Blk	K3, B1
137	1.0	Blk	B1, Splice
145	1.0	Blk	K1, A1
150	3.0	Blk	Y2, Splice
170	0.8	Blk	H2, P1
200	2.0	Red	F1, S2
201	0.8	Fuselink	F1 Fusible link soldered in-line.
205	13.0	Red	M1, G2
209	3.0	Red/Blk	K3, M2
210	3.0	Red/Blk	F2, K3
211	1.0	Fuselink	F2 Fusible link soldered in-line.
215	5.0	Red	F3, K1
216	2.0	Fuselink	F3 Fusible link soldered in-line.
220	3.0	Red	F4, A1
221	1.0	Fuselink	F4 Fusible link soldered in-line.
230	2.0	Red	S2, S2
240	5.0	Red	M1, Fusible link splice
300	0.8	Org/Wht	H4, B2
301	0.5	Org/Wht	H4, A1
400	2.0	Yel/Red	S2, Splice
402	0.8	Yel	X8, H4
403	0.8	Yel	H4, H5
404	0.5	Yel	H5, H1
410	1.0	Yel/Red	Splice, X8
415	1.0	Yel/Red	Splice, S5 (optional)
420	0.8	Yel	Splice, S4
423	0.8	Yel	S4, S3
425	1.0	Yel	Splice, G2
430	0.8	Yel	S3, A1
435	0.8	Yel	A1, K3
436	0.8	Yel	K3, Y2
441	3.0	Wht	Y2, Splice
450	0.8	Yel	P1, Splice
600	0.8	Brn	H1, G2
620	0.5	Tan	H5, B3
630	0.8	Gry/Blk	S3, H2
640	0.5	Grn	S4, H3
670	1.0	Yel/Wht	S5 (optional), X7
675	1.0	Yel/Blk	S5 (optional), X7
700	5.0	Pur	K1, Splice
701	2.0	Pur	Y1, Splice
706	0.8	Pur	S1, K1
710	0.8	Pur/Blk	S2, S1
920	3.0	Red/Wht	A1, R3

Operation and Diagnostics

Troubleshooting - 6X4 Diesel

System: Electrical

(1) Does starter have cranking problems?

Yes - See “Power Circuit Diagnosis - 6X4 Diesel” on page 341.

Yes - See “Cranking Circuit Diagnosis - 6X4 Diesel” on page 346.

Yes - See “Ground Circuit Tests” on page 396.

Yes - See “Battery Test” on page 372.

(2) Does engine crank but not start?

Yes - See “Ground Circuit Tests” on page 396.

Yes - See “Glow Plug and Fuel Supply Diagnosis - 6X4 Diesel” on page 353.

(3) Does the engine not shut off?

Yes - See “Glow Plug and Fuel Supply Diagnosis - 6X4 Diesel” on page 353.

Yes - Check for a shorted circuit.

(4) Is an improper component working with a switch?

Yes - Check for a shorted circuit.

(5) Is there a problem with the engine oil light?

Yes - See “Indicator Lights Diagnosis - 6X4 Diesel” on page 360.

(6) Does the battery go dead, discharge, or over charge?

Yes - See “Charging Circuit Diagnosis - 6X4 Diesel” on page 356.

(7) Is there a discharge light problem?

Yes - See “Charging Circuit Diagnosis - 6X4 Diesel” on page 356.

(8) Are there cooling fan problems?

Yes - See “Indicator Lights Diagnosis - 6X4 Diesel” on page 360.

Yes - See “Radiator Fan Motor and Headlights Diagnosis - 6X4 Diesel (SN -039740)” on page 363.

(9) Are there instrumentation light problems?

Yes - See “Indicator Lights Diagnosis - 6X4 Diesel” on page 360.

(10) Are there light and horn problems?

System: Electrical

Yes - See “Road Homologated Light and Horn Circuit Diagnosis” on page 493 or “Light and Horn Circuit Diagnosis (Earlier Model)” on page 447 or See “Light and Horn Circuit Diagnosis (Later Model)” on page 468.

(11) Are there domestic headlight problems?

Yes - See “Radiator Fan Motor and Headlights Diagnosis - 6X4 Diesel (SN -039740)” on page 363.

(12) Are there cargo box lift problems?

Yes - See “Cargo Box Lift System Troubleshooting Chart” on page 405 and “Cargo Box Lift Circuit Diagnosis” on page 406.

Power Circuit Operation - 6X4 Diesel

Function:

Provides unswitched power to the primary components whenever the battery is connected.

Operating Conditions, Unswitched Circuits:

Voltage must be present at the following components with the key switch “OFF”:

- Battery Positive Terminal
- “B” Terminal of Starting Motor
- “B” Terminal of Key Switch
- Start Relay
- Alternator
- Glow Plug Module
- Radiator Fan Motor

The positive battery cable connects the battery to the starting motor. The starting motor bolt is used as a tie point for the rest of the electrical system.

The battery cables and the starting motor tie point connections must be good for the machine’s electrical system to work properly.

The ground cable connections is equally important as the positive cable. Proper starter operation depends on these cables and connections to carry the high current for its operation.

The connection between the starting motor and key switch is fused by a fusible link. This is a short piece of wire that is designed to fail if current load is too high or a short occurs. It protects the wiring harness from damage.

The charge wire running between the alternator and starting motor is unprotected.

Switched Power:

Voltage must be present at the following components with the key switch “ON or RUN” position:

- “A “and “S1” Terminals of key switch
- Start Relay
- Alternator
- Glow Plug Module
- Fuel Shutoff Solenoid
- Pull-In Coil Cut Out Relay
- Park Brake Switch
- Differential Lock Switch
- Light Switch (Standard or Homologated)
- Lift Switch Connector
- Engine Coolant Temperature Light
- Engine Oil Pressure Light
- Discharge Light

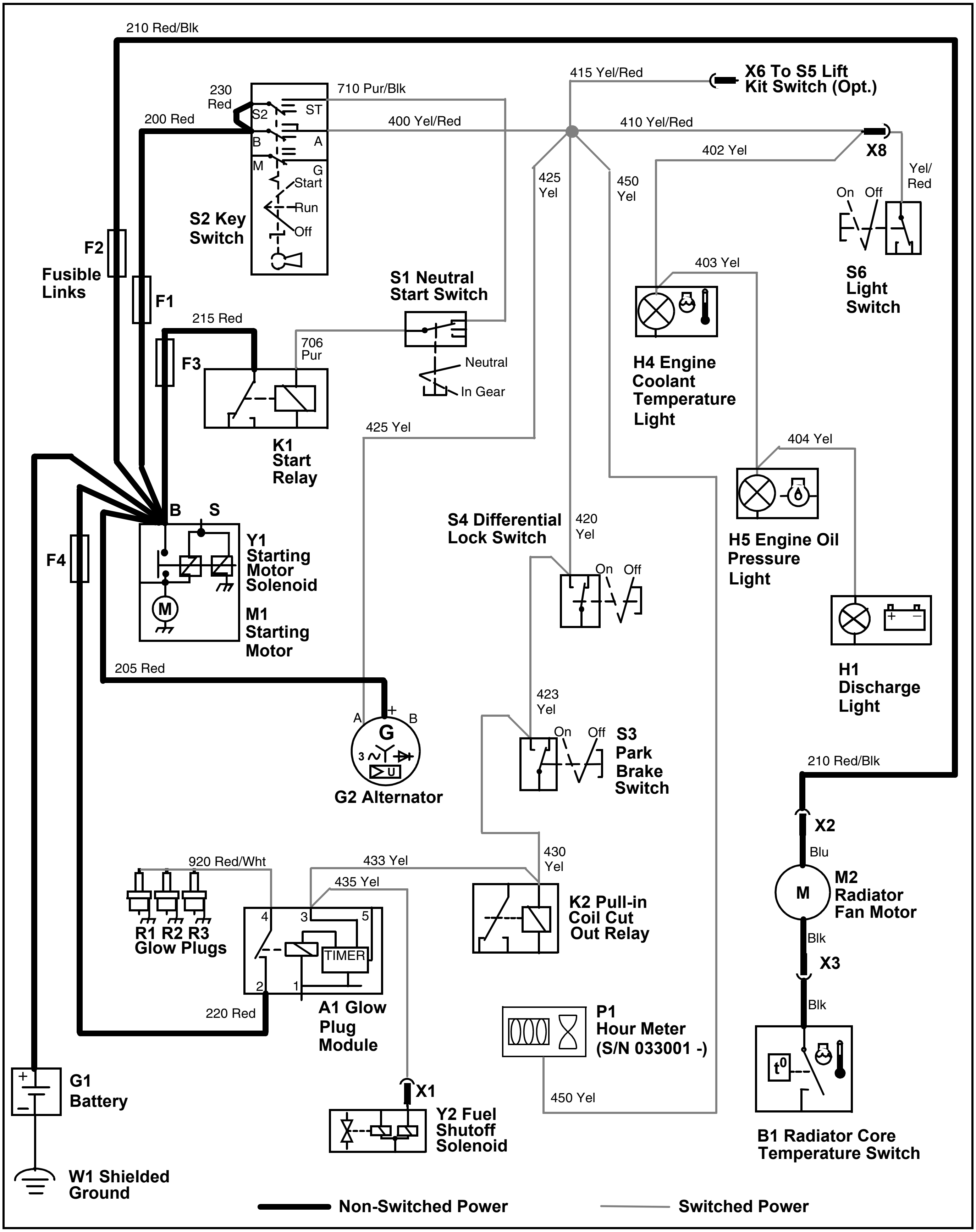
These circuits are controlled by the key switch and are protected by the fusible link.

Optional Lighting Kit and Lift Kit Power Circuits:

See the appropriate schematics and diagnostic procedures for these kits.

When optional kits are installed, the positive wires for these kits are also connected to the starter bolt. These leads also contain fusible links to protect the wiring harnesses

Power Circuit Schematic - 6X4 Diesel



Power Circuit Diagnosis - 6X4 Diesel

Test Conditions:

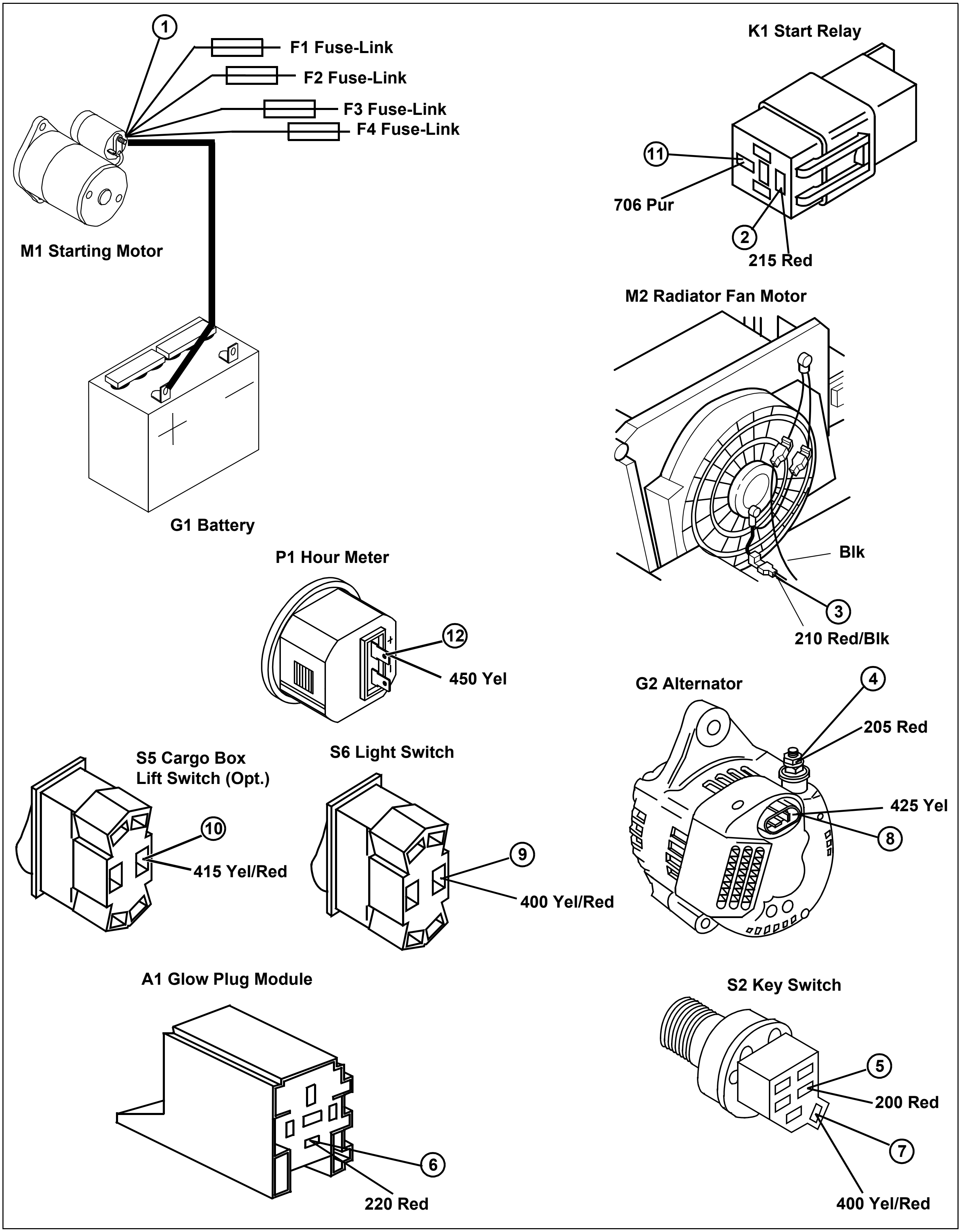
- Key switch in OFF position

Test/Check Point	Normal	If Not Normal
1. Starting motor battery (B) terminal	Battery voltage	Check battery cables and test battery. See “Battery Test” on page 372.
2. Start relay	Battery voltage	Check 215 Red wire. Replace F3 fusible link.
3. Radiator fan motor	Battery voltage	Check 210 Red/Blk wire and connections. Replace F2 fusible link.
4. Alternator	Battery voltage	Check 205 Red wire and connections.
5. Key switch	Battery voltage	Check 200 Red wire and connections. Replace F1 fusible link.
6. Glow plug module	Battery voltage	Check 220 Red wire and connections.

Test Conditions:

- Key switch in RUN position

Test/Check Point	Normal	If Not Normal
7. Key switch	Battery voltage	Replace key switch.
8. Alternator	Battery voltage	Check 425 Yel wire and connections.
9. Light switch	Battery voltage	Check 400 Yel/Red wire and connections.
10. Lift switch	Battery voltage	Check 415 Yel/Red wire connection.
11. Start relay	Battery voltage	Check 706 Pur wire and connections. See “Neutral Start Switch Test” on page 381.
12. Hourmeter (S/N 033001 -)	Battery voltage	Check 450 Yel wire and connections.

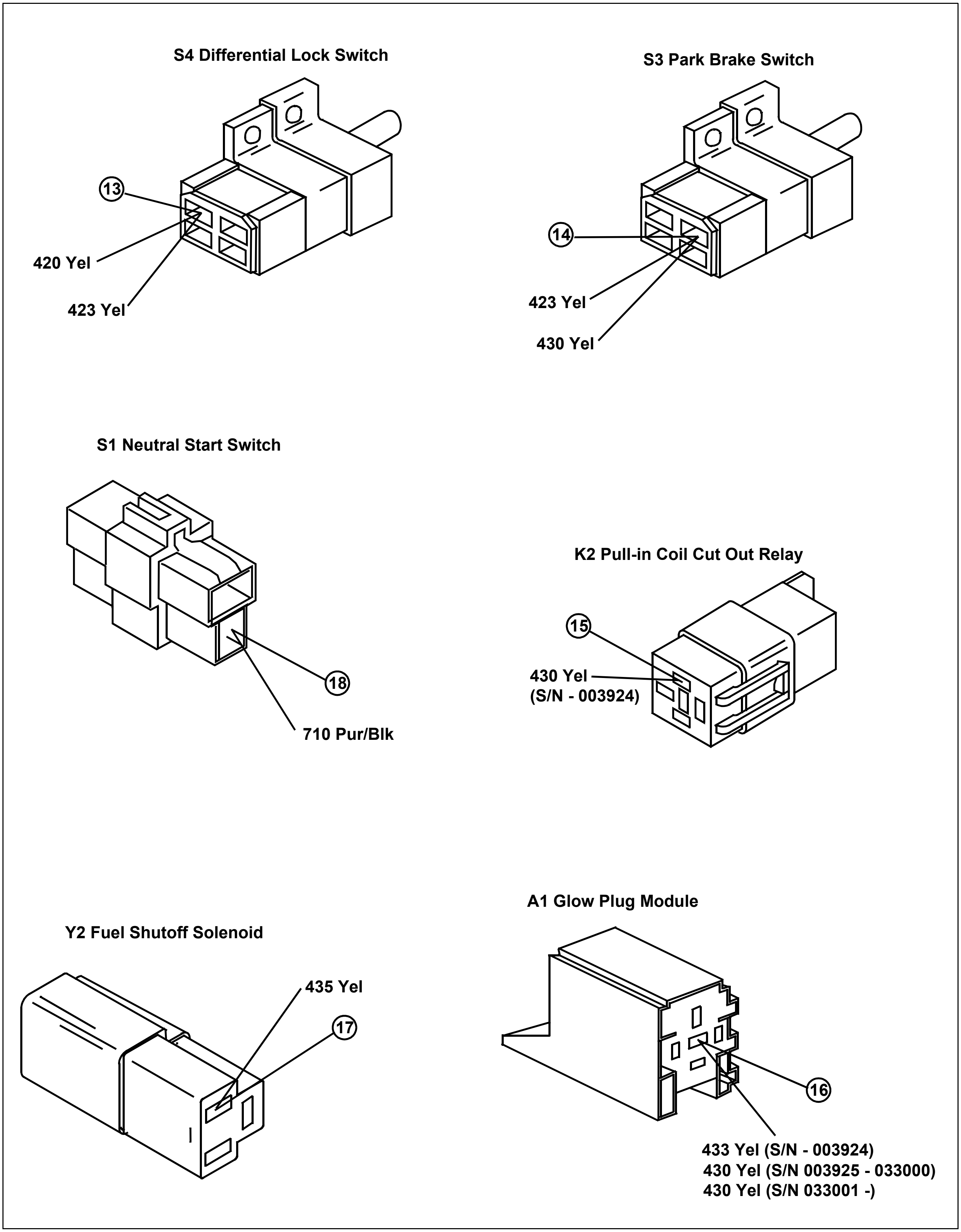

1
F1 Fuse-Link
F2 Fuse-Link
F3 Fuse-Link
F4 Fuse-Link
M1 Starting Motor
G1 Battery
K1 Start Relay
11
706 Pur
2
215 Red
M2 Radiator Fan Motor
Blk
3
210 Red/Blk
P1 Hour Meter
12
450 Yel
G2 Alternator
4
205 Red
425 Yel
8
S5 Cargo Box
Lift Switch (Opt.)
10
415 Yel/Red
S6 Light Switch
9
400 Yel/Red
A1 Glow Plug Module
6
220 Red
S2 Key Switch
5
200 Red
7
400 Yel/Red

Power Circuit Diagnosis - 6X4 Diesel (Continued)

Test Conditions:

- Key switch in RUN position.

Test/Check Point	Normal	If Not Normal
13. Differential lock switch	Battery voltage	Check connection of 420 Yel wire.
14. Park brake switch	Battery voltage	Check 423 Yel wire and connections.
15. Pull-in coil cut out relay (S/N - 003924)	Battery voltage	Check 430 Yel wire and connections.
16. Glow plug module	Battery voltage	Check 433 Yel wire and connections (S/N - 003924). Check 430 Yel wire and connections (S/N 003925 - 033000). Check 430 Yel wire and connections (S/N 033001-).
17. Fuel shutoff solenoid	Battery voltage	Check 435 Yel wire and connections.
18. Neutral start switch	Battery voltage	Check 710 Pur/Blk wire and connections.


S4 Differential Lock Switch
13
420 Yel
423 Yel
S3 Park Brake Switch
14
423 Yel
430 Yel
S1 Neutral Start Switch
18
710 Pur/Blk
K2 Pull-in Coil Cut Out Relay
15
430 Yel
(S/N - 003924)
Y2 Fuel Shutoff Solenoid
435 Yel
17
A1 Glow Plug Module
16
433 Yel (S/N - 003924)
430 Yel (S/N 003925 - 033000)
430 Yel (S/N 033001 -)

Cranking Circuit Operation - 6X4 Diesel

Function:

To energize the starting motor solenoid and engage the starting motor to crank the engine.

Operating Conditions:

- Key switch in START position
- Transmission in NEUTRAL

Theory of Operation:

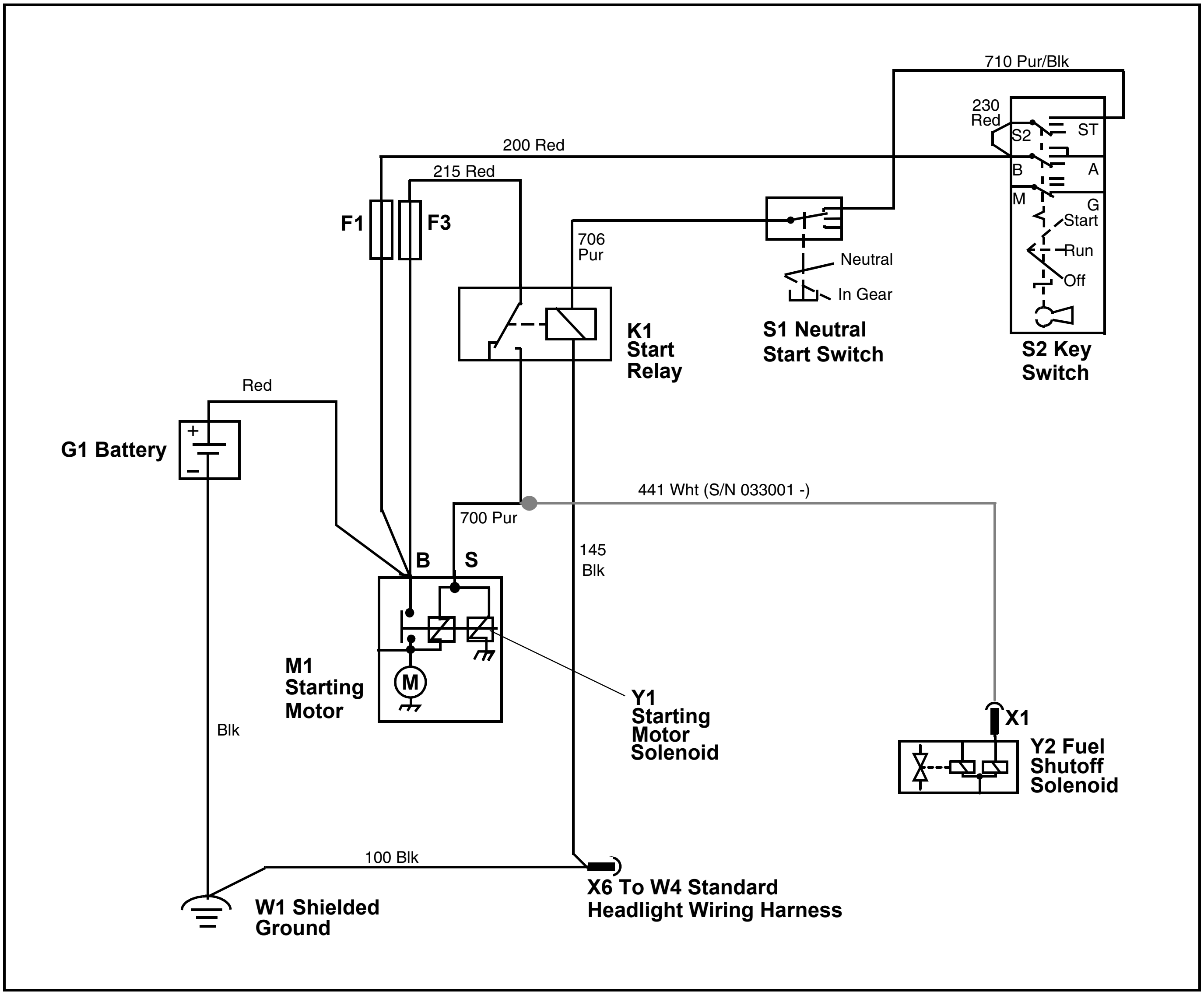
Current from the power circuit (200 Red) flows through a fusible link to the key switch, and is connected from the B terminal of the key switch to the S2 terminal of the key switch through circuit 230 Red.

When in the start position the key switch allows current to flow to the neutral start switch (710 Pur/Blk). With the transmission in neutral, current flows to the K1 start relay coil allowing the start relay to activate.

When activated, the start relay contacts pass current from the battery, and the F3 fusible link to energize the starting motor solenoid (215 Red, 700 Pur).

With the starting motor solenoid activated, high current from the battery passes through the battery cable and solenoid contacts, and energizes the starting motor.

Cranking Schematic - 6X4 Diesel



Cranking Circuit Diagnosis - 6X4 Diesel

Test Conditions:

- Transmission in NEUTRAL and brake set
- Key switch in OFF position

Test/Check Point	Normal	If Not Normal
1. Key switch	Battery voltage	Check 200 Red wire and F1 fusible link. See “Power Circuit Diagnosis - 6X4 Diesel” on page 341.
2. Start relay	Battery voltage	Check 215 Red wire and connections. Replace F3 fusible link.

Test Conditions:

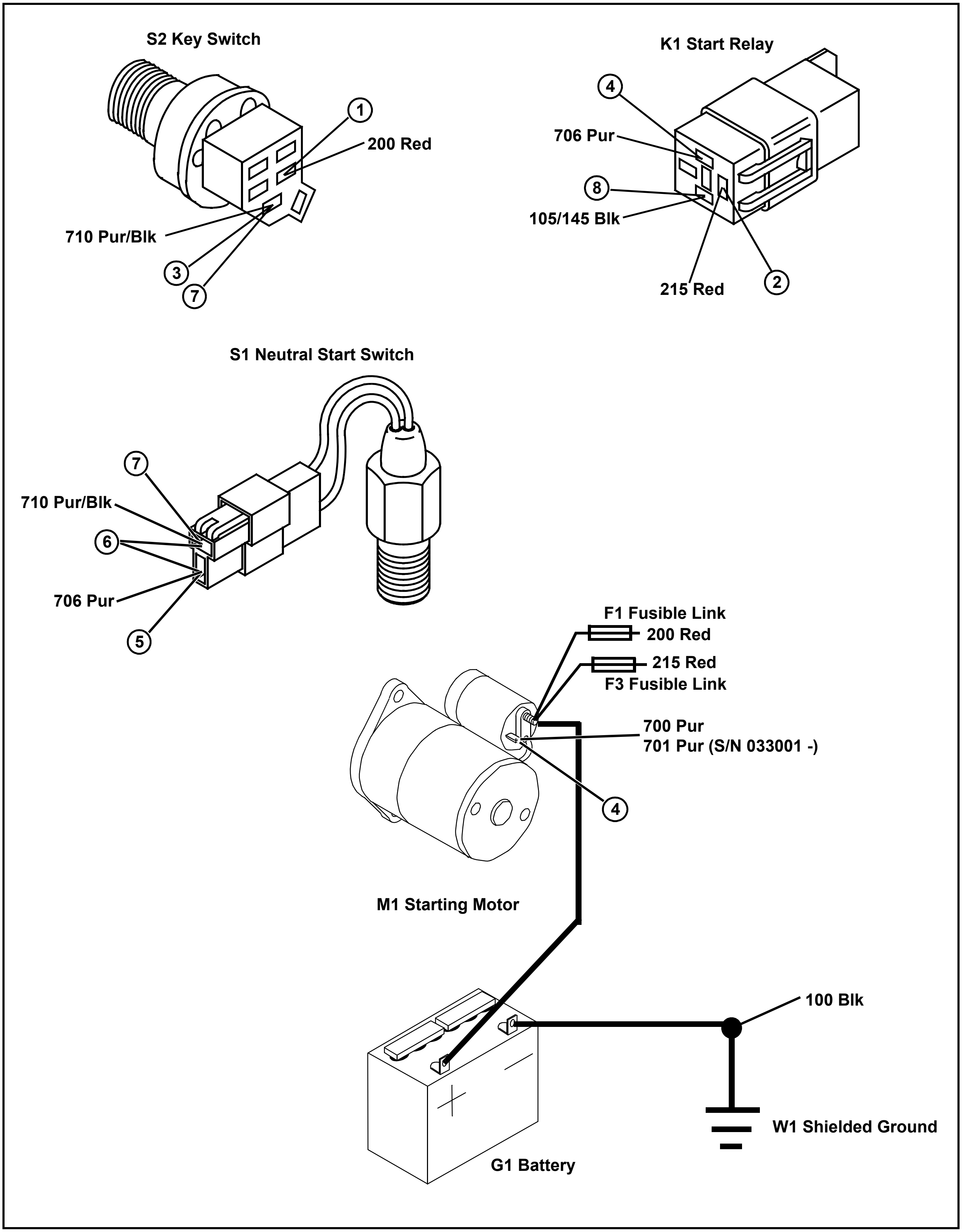
- Key switch in START position

Test/Check Point	Normal	If Not Normal
3. Key switch	Battery voltage	Replace key switch.
4. Start relay	Battery voltage	Ensure that machine is in neutral gear. Test 706 Pur wire and connections. See “Power Circuit Diagnosis - 6X4 Diesel” on page 341.

Test Conditions:

- Key switch in OFF position
- Remove connector from start relay. See “Component Location” on page 315.
- Change meter to ohm scale

Test/Check Point	Normal	If Not Normal
5. Start relay connector to neutral start switch	Continuity	Repair 706 Pur wire.
6. Transmission neutral switch (Switch disconnected)	Continuity across transmission switch	Check transmission linkage neutral adjustment. Replace neutral start switch.
7. Transmission switch to key switch	Continuity	Repair 710 Pur/Blk wire.
Key switch	Continuity across switch in START position.	Replace key switch.
8.Start relay to engine ground	Continuity	Check 145 Blk wire, 100 Blk wire and connections. Repair wires or connections.


S2 Key Switch
1
200 Red
710 Pur/Blk
3
7
K1 Start Relay
4
706 Pur
8
105/145 Blk
215 Red
2
S1 Neutral Start Switch
7
710 Pur/Blk
6
706 Pur
5
F1 Fusible Link
200 Red
215 Red
F3 Fusible Link
700 Pur
701 Pur (S/N 033001 -)
4
M1 Starting Motor
100 Blk
W1 Shielded Ground
G1 Battery

Glow Plug and Fuel Supply Operation - 6X4 Diesel

Function:

To control the injection of diesel fuel and provide and an added source of heat for combustion.

Operating Conditions:

- Key switch must be in the start or run position.

Theory of Operation (S/N - 003924):

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.

In the start position current flows from the key switch to the start relay which in turn energizes the starting motor. The differential lock, park brake, pull-in coil cut out relay, fuel shutoff solenoid and glow plug module are all provided current by the key switch in either the run or start position.

When the key switch is turned to the start position the starting motor turns the engine over. Before oil pressure opens the engine oil pressure switch (normally closed), the closed engine oil pressure switch provides a ground path for the pull-in coil cut out relay. While this ground is provided, the pull-in coil energizes, closing the cut out relay contacts which allow current flow from the starting motor to energize the fuel shutoff solenoid.

Diesel fuel is provided to the engine when the fuel shutoff solenoid is energized. The fuel shutoff solenoid is initially pulled in when current from the starting motor energizes it. After oil pressure opens the oil pressure switch and de-energizes the pull-in coil, the fuel shutoff solenoid is held in the energized state by current provided through the key switch in the run 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 ambient air temperature and ranges from approximately 10 to 30 seconds. The colder the temperature, the longer the timer stays on.

Theory of Operation (S/N 003925 - 033000):

The differential lock, park brake, fuel shutoff solenoid and glow plug module are all provided current by the key switch in either the run or start position.

The pull-in coil cut out relay is provided current by the key switch only in the start position.

When the key switch is turned to the start position the starting motor turns the engine over. Before oil pressure opens the engine oil pressure switch (normally closed), the closed engine oil pressure switch provides a ground path for the pull-in coil cut out relay. While this ground is provided, the pull-in coil energizes, closing the cut out relay contacts which allow current flow from the starting motor through the F5 fusible link, to energize the fuel shutoff solenoid.

Diesel fuel is provided to the engine when the fuel shutoff solenoid is energized. The fuel shutoff solenoid is initially pulled in when current from the starting motor energizes it. After oil pressure opens the oil pressure switch and de-energizes the pull-in coil, the fuel shutoff solenoid is held in the energized state by current provided through the key switch in the run 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 ambient air temperature and ranges from approximately 10 to 30 seconds. The colder the temperature, the longer the timer stays on.

Theory of Operation (033001-):

When the key switch is placed in the run position, current is provided to the A1 glow plug module timer and the Y2 fuel shutoff solenoid hold-in coil. The glow plug timer is activated to energize the glow plug module contacts and provide current to the glow plugs. At the same time, the timer provides a ground path for the H4 engine coolant temperature/glow plug light to illuminate the light providing a visual indicator to the operator that the glow plug circuit is energized.

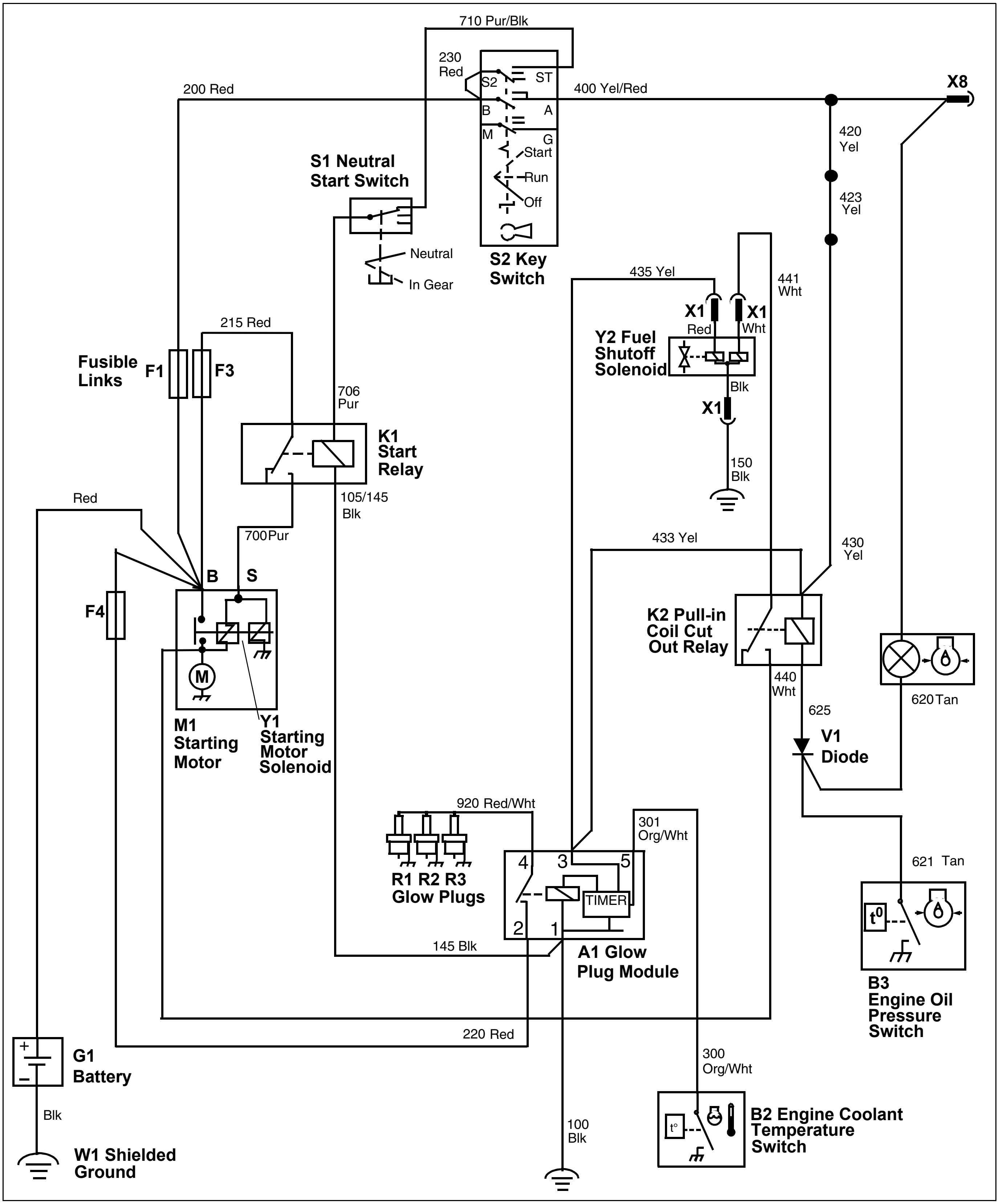
The timer is started by turning the key switch to either the run or start position. The length of time the timer stays on is a function of ambient air temperature and ranges from approximately 10 to 30 seconds. The colder the temperature, the longer the timer stays on. Stopping the electronic timer de-energizes the glow plugs.

The fuel shutoff solenoid pull-in coil is provided current by the K1 start relay with the S1 transmission in neutral and the S2 key switch in the start position.

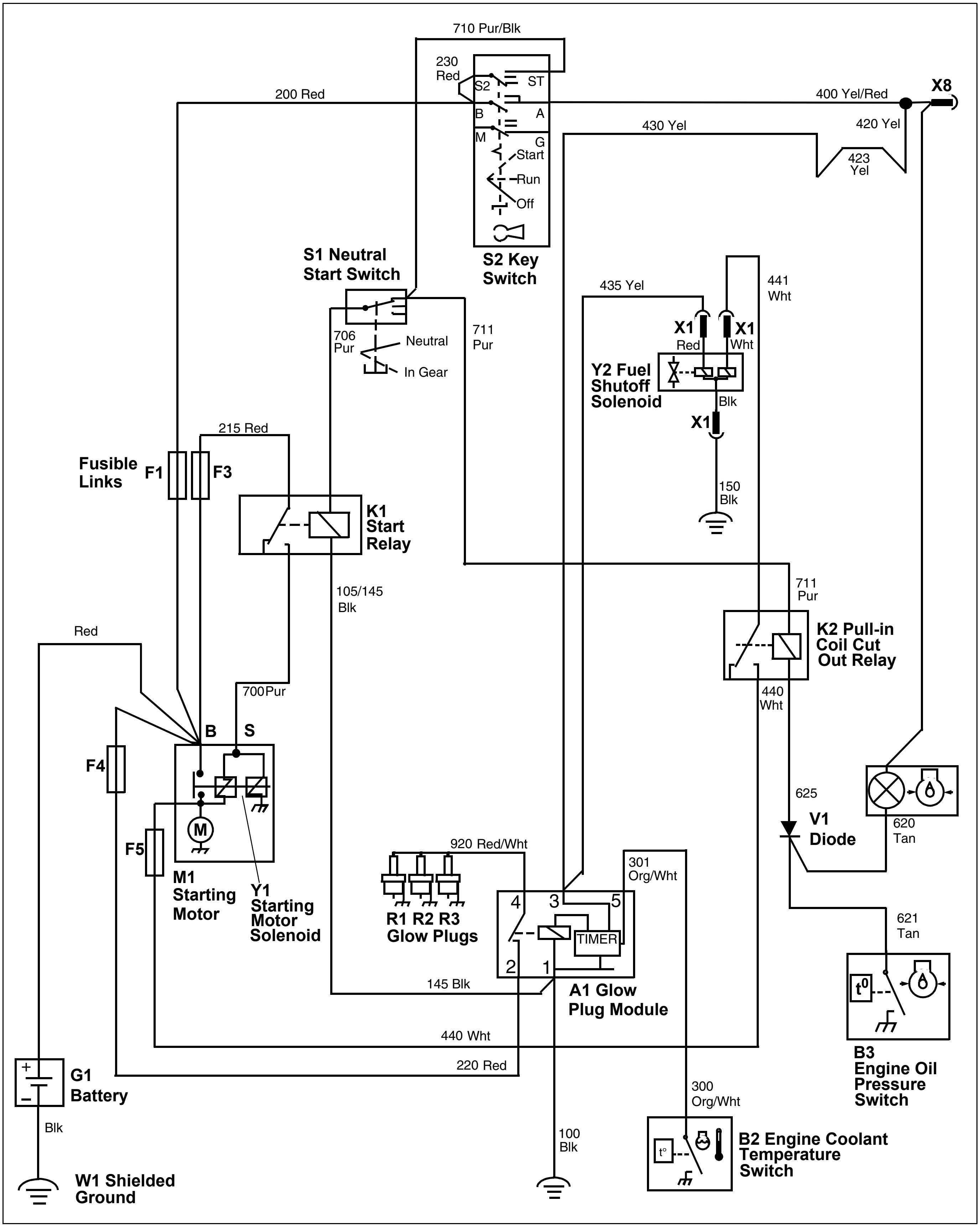
Diesel fuel is provided to the engine when the fuel shutoff solenoid is energized. The fuel shutoff solenoid is initially pulled in when current from the start relay energizes it during the engine cranking function. After the engine is running, the key switch is released which in turn de-energizes the start relay and the fuel shutoff solenoid pull-in coil. The fuel shutoff solenoid is held in the energized state by current provided through the key switch in the run position to the fuel shutoff solenoid hold-in coil.

Glow Plug and Fuel Supply Schematic - 6X4 Diesel

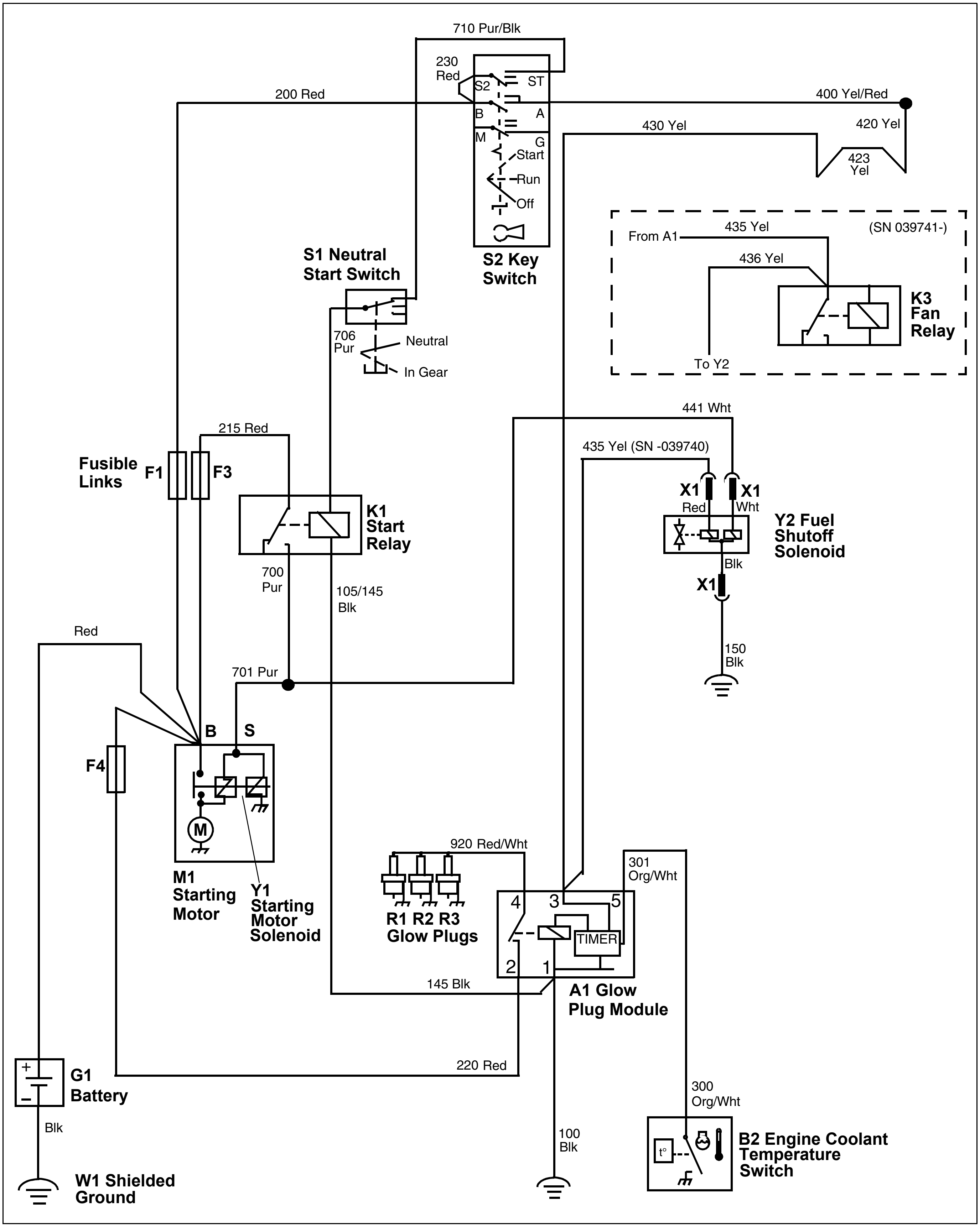
Glow Plug and Fuel Supply Schematic - 6X4 Diesel (S/N - 003924)



Glow Plug and Fuel Supply Schematic - 6X4 Diesel (S/N 003925 - 033000)



Glow Plug and Fuel Supply Schematic - 6X4 Diesel (S/N 033001 -)



Glow Plug and Fuel Supply Diagnosis - 6X4 Diesel

Test Conditions:

- Key switch in RUN position

Test/Check Point	Normal	If Not Normal
1. Differential lock switch	Battery voltage	Test 420 Yel/Red wire and connections.
2. Park brake switch	Battery voltage	Ensure park brake is on. Test 423 Yel wire and connections.
3. Pull-in coil cut out relay	Battery voltage	Test 430 Yel wire and connections (S/N - 003924). Test 711 Pur and 710 Pur/Blk wires and connections (S/N 003925 - 033000) - Key in START position only.
4. Glow plug module	Battery voltage	Test 433 Yel wire and connections (S/N - 003924). Test 430 Yel wire and connections (S/N 003925 - 033000). Test 430 Yel wire and connections (S/N 033001 -).
5. Glow plugs	Battery voltage within 10 to 30 seconds of key in RUN position	Test 920 Red/Wht wire and connections. Replace glow plug module.
6. Temperature/Wait light	Battery voltage	Test 402 Yel wire and connections.
7. Fuel shutoff solenoid	Battery voltage	Test 435 Yel wire and connections.

Test Conditions:

- Key switch to OFF position

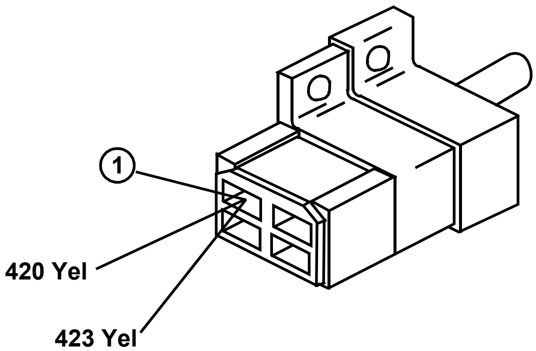
Test/Check Point	Normal	If Not Normal
8. Fuel shutoff solenoid (Blk ground wire)	Maximum 0.1 ohm resistance	Check fuel shutoff solenoid 150 Blk wire and ground connection.
9. Glow plug module (Blk ground wire)	Maximum 0.1 ohm resistance	Check glow plug module, 100 Blk wire and ground connection.
10. Glow plug module (Org/Wht 301 wire)	Maximum 0.1 ohm resistance	Test 300 Org/Wht and 301 Org/Wht wires and connections. Replace engine coolant temperature switch.
11. Temperature/Wait light (Disconnect glow plug module)	Maximum 0.1 ohm resistance	Test 300 Org/Wht wire and connections. Replace engine coolant temperature switch.

Test Conditions:

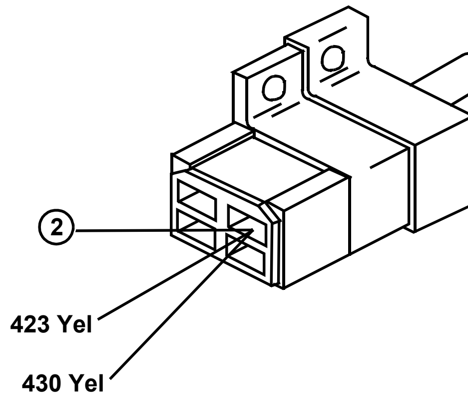
- Disconnect engine coolant temperature switch
- Key switch in RUN position

Test/Check Point	Normal	If Not Normal
12. Temperature/Wait light	Maximum 1 ohm resistance within 3 to 10 seconds of key in RUN position. High or infinite resistance after 3 to 10 seconds.	Test 301 Org/Wht wire and connections. Replace glow plug module.

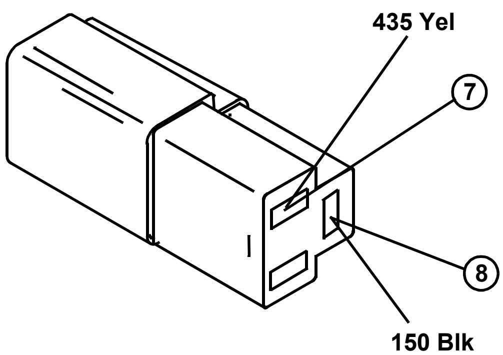
S4 Differential Lock Switch



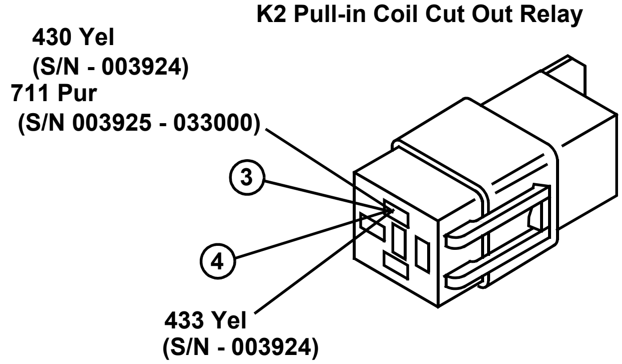
S3 Park Brake Switch



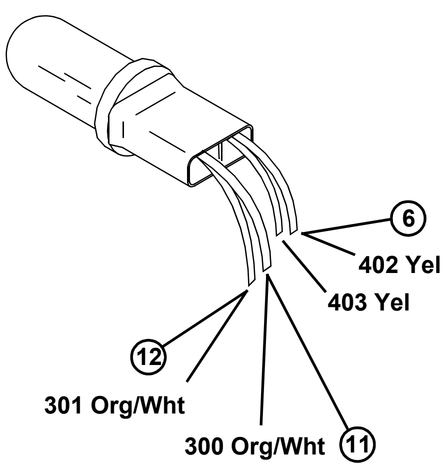
Y2 Fuel Shutoff Solenoid



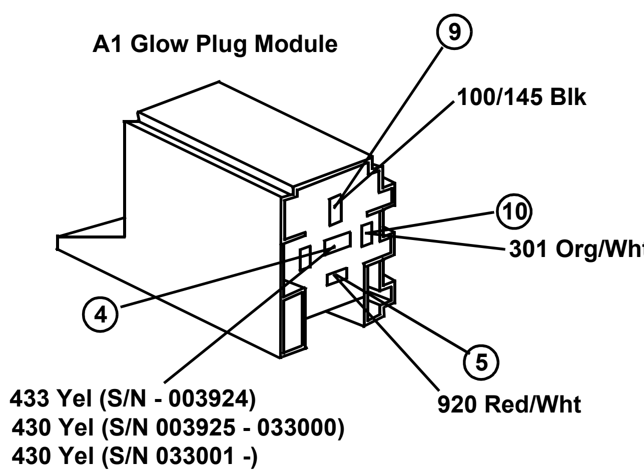
K2 Pull-in Coil Cut Out Relay



H4 Engine Coolant Temperature Light



A1 Glow Plug Module



Charging Circuit Operation - 6X4 Diesel

Function:

To maintain battery voltage between 12.4 and 13.2 volts.

Operating Conditions:

The key switch must be in the RUN position with the engine running for the charging system to operate.

System Operation:

The charging system is a permanent magnet and stator design. Charging output is controlled by a regulator/rectifier built into the alternator.

With the key switch in the RUN position, battery sensing circuit current flows from battery positive terminal to starter terminal, fusible link F1 (200 Red), key switch, and to regulator/rectifier (425 Yel). The battery sensing circuit allows the voltage regulator/rectifier to monitor battery voltage.

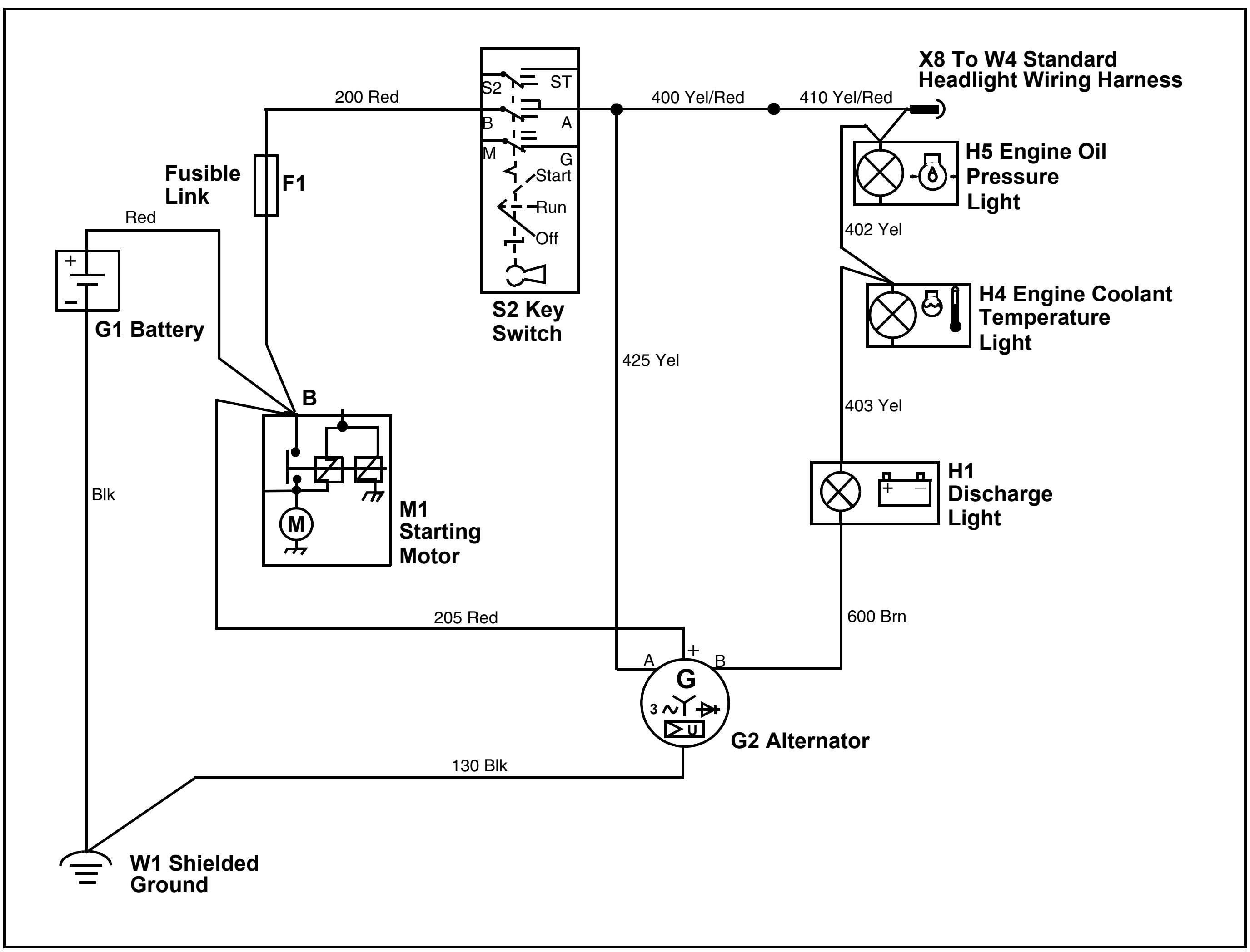
As the flywheel turns, a permanent magnet located in the flywheel induces AC current in the stator. The AC current flows to the voltage regulator/rectifier. The voltage regulator/rectifier converts AC current to DC current needed to charge the battery.

If battery voltage is low, the regulator/rectifier allows DC current to flow to the battery to charge it through the battery charging circuit (205 Red). When the battery is fully charged, the voltage regulator/rectifier stops current flow to the battery.

If the stator output current falls below the system usage or is insufficient to maintain a preset voltage, the voltage regulator/rectifier provides a current path to turn on the discharge light (600 Brn).

The ground circuit (130 Blk) provides a path to ground for the voltage regulator/rectifier.

Charging Circuit Schematic - 6X4 Diesel



Charging Circuit Diagnosis - 6X4 Diesel

Test Conditions:

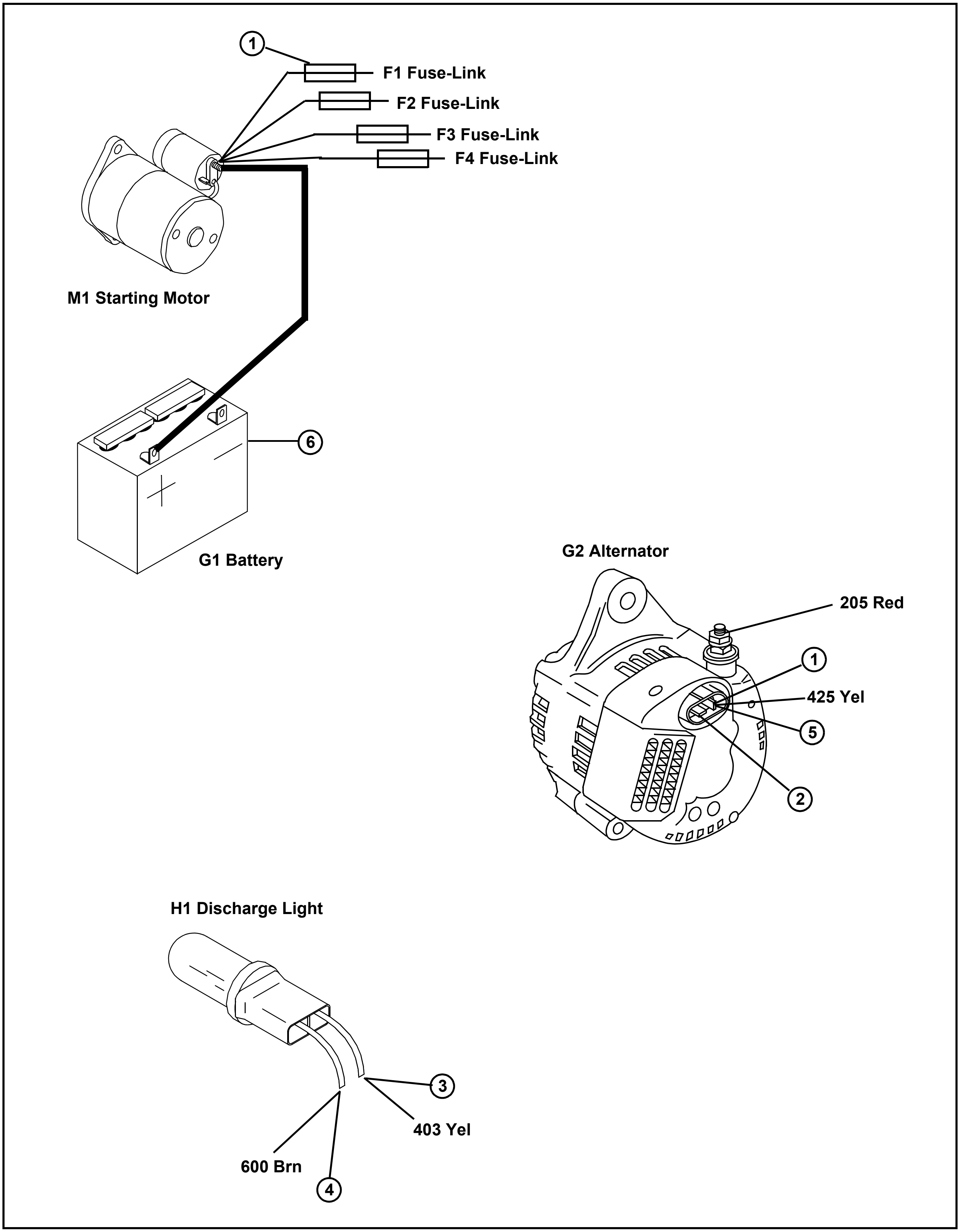
- Park brake set
- Transmission in neutral
- Engine OFF
- Key Switch in RUN position

Test/Check Point	**Normal**	**If Not Normal**
1. Alternator (A terminal)	Battery voltage	Check 425 Yel wire and connections. Check F1 fusible link and key switch. See “Power Circuit Diagnosis - 6X4 Diesel” on page 341.
2. Alternator (B terminal)	Greater than 0 volts - less than 0.2 volts	Greater than 0.2 volts: Test voltage regulator/rectifier ground circuit.
3. Discharge light (404 Yel wire)	Battery voltage	Check 402, 403 and 404 Yel wires and connections.
4. Charge indicator light (600 Brn wire)	Greater than 0 volts - less than 0.2 volts	0 volts: Replace bulb. Greater than 0.2 volts: Check all connection and ground wires for open or poor connection.

Test Conditions:

- Engine running

Test/Check Point	**Normal**	**If Not Normal**
5. Alternator	Minimum 40 Amps at 12.2 to 13.8 volts	See “Auxiliary Alternator - Regulated Amperage and Voltage Tests” on page 376. Replace voltage regulator/rectifier.
6. Battery	Voltage above normal battery voltage.	Check for excessive load on electrical system.


1
F1 Fuse-Link
F2 Fuse-Link
F3 Fuse-Link
F4 Fuse-Link
M1 Starting Motor
6
G1 Battery
G2 Alternator
205 Red
1
425 Yel
5
2
H1 Discharge Light
3
403 Yel
600 Brn
4

Indicator Lights Operation - 6X4 Diesel

Function:

Engine Discharge Light:

Inform the operator of a low charge rate by illuminating a warning light.

Engine Oil Pressure Light:

To alert operator of low engine oil pressure by illuminating a warning light.

Engine Coolant Temperature Light:

Dual function to inform operator of critical engine and coolant operating temperature by illuminating a warning light, and inform operator of glow plug operation.

Park Brake Light:

Informs the operator that the park brake is ON by illuminating a warning light.

Differential Lock Light:

Inform the operator that the differential Lock is ON by illuminating a warning light.

Operating Condition:

The key switch must be in RUN position.

Theory of Operation:

Engine Discharge Light:

With the engine off and key in RUN position, the voltage regulator built into the alternator provides a voltage difference across the discharge light allowing the light to go on.

When the engine is started and running the light should go out when the voltage regulator allows no or too small of a current.

Oil Pressure Light:

With the engine off and key in 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 B3 engine oil pressure switch.

Engine Coolant Temperature Light:

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 light for a few seconds depending on air temperature. When the glow plug control times out the light will go out. If the engine temperature reaches 109° C ± 1° C (228° F ± 2° F) the switch contacts will close, providing a path to ground through the engine block which turns on the engine coolant temperature light.

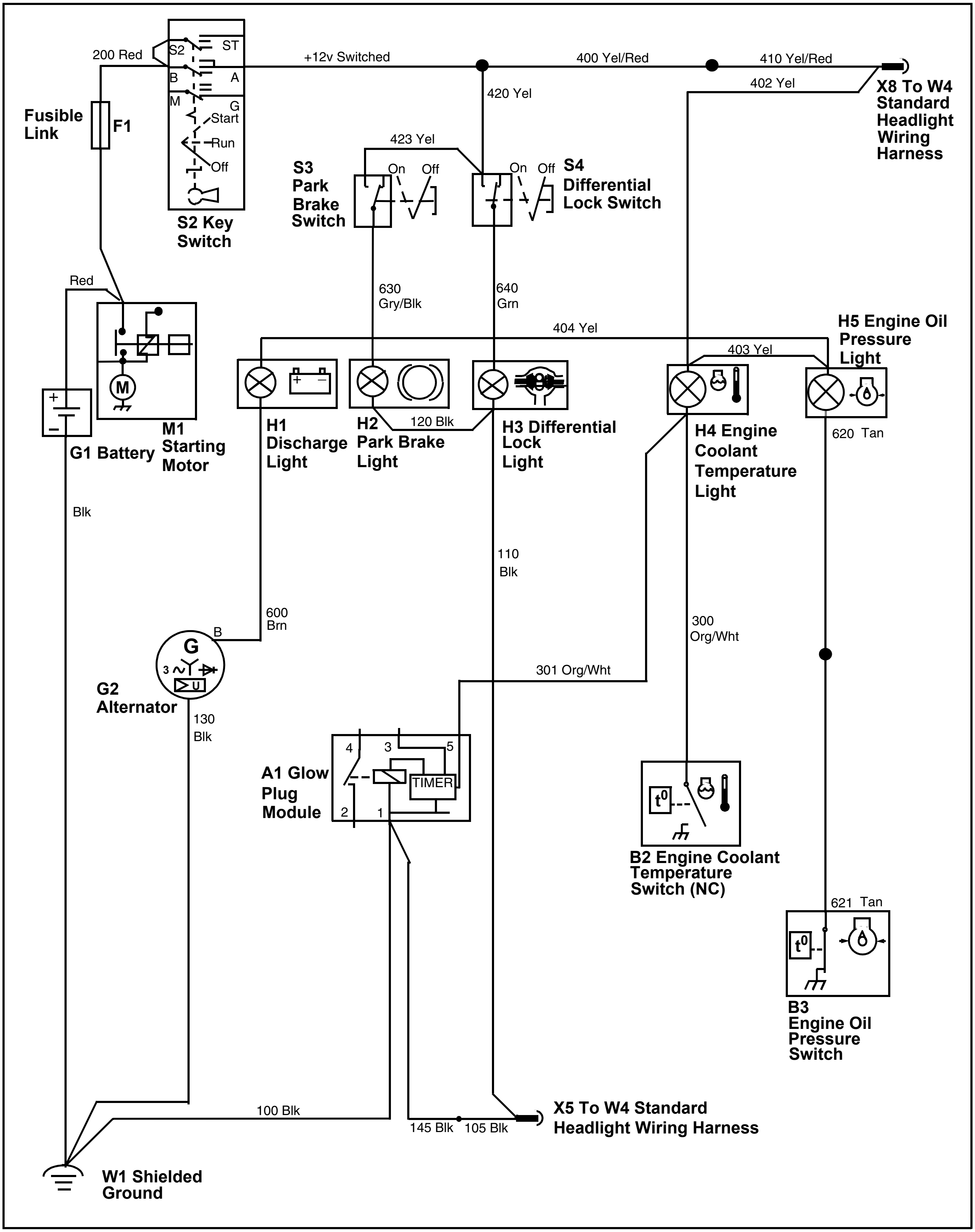
Park Brake Light:

When the park brake is set the switch is released (closes), allowing current to flow to the warning light. When the park brake is released the park brake switch is opened and the light goes out.

Differential Lock Light:

When the differential lock lever is moved to engage the differential lock, the differential lock switch is depressed (closed), allowing current flow to the differential lock light. When the differential is released, the switch is released (open), and the light goes out.

Indicator Lights Schematic - 6X4 Diesel

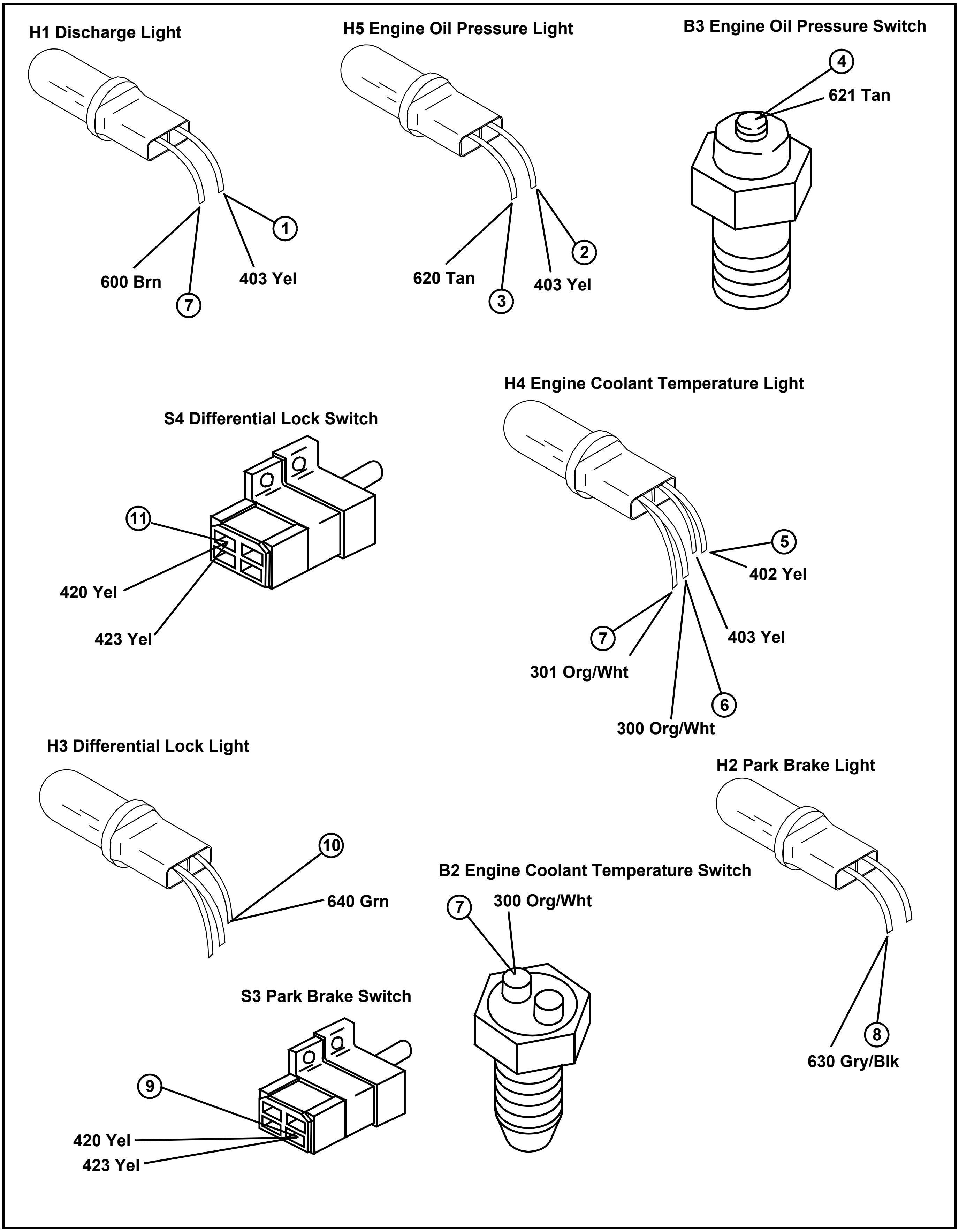


Indicator Lights Diagnosis - 6X4 Diesel

Test Conditions:

- Key switch in RUN position, engine OFF
- Differential lock engaged
- Park brake set

Test/Check Point	Normal	If Not Normal
1. Discharge light	Battery voltage (light should be ON)	Check 402, 403 and 404 Yel wires and connections. Replace light bulb. See “Power Circuit Diagnosis - 6X4 Diesel” on page 341.
2. Engine oil pressure light	Battery voltage (light should be ON)	Check 402 and 403 Yel wires and connections. Replace light bulb. See “Power Circuit Diagnosis - 6X4 Diesel” on page 341.
3. Engine oil pressure switch	Battery voltage	Check 620 and 621 Tan wires and connections. See “Power Circuit Diagnosis - 6X4 Diesel” on page 341.
4. Oil pressure switch (621 Tan wire lead disconnected)	Continuity to ground	Check engine ground. If engine ground OK: Replace switch.
5. Engine coolant temperature light	Battery voltage (light should be on for 3 to 30 seconds after turning key to RUN position)	Check 402 Yel wire. Replace engine coolant temperature light. See “Power Circuit Diagnosis - 6X4 Diesel” on page 341.
6. Engine coolant temperature switch	Battery voltage after 10 seconds. Sensor open lower than 109° C ± 1° C (228° F ± 2° F)	Check 300 Org/Wht wire and connections. Replace engine coolant temperature switch. See “Power Circuit Diagnosis - 6X4 Diesel” on page 341.
7. Engine coolant temperature switch	Battery voltage after 10 seconds. Switch open lower than 109° C ± 1° C (228° F ± 2° F)	Disconnect 300 Org/Wht wire at engine coolant temperature switch. Check 301 Org/Wht wire and connections. Replace glow plug module.
8. Park brake light	Battery voltage (light should be ON)	Check 630 Gry/Blk wire and connections. See “Brake Pedal Switch and Park Brake Switch Tests” on page 380 and “Power Circuit Diagnosis - 6X4 Diesel” on page 341.
9. Park brake switch	Battery voltage	Check 420 and 423 Yel wires. Adjust or replace park brake switch.
10. Differential lock light	Battery voltage	Check 640 Grn wire and connections. Check differential lock switch. See “Power Circuit Diagnosis - 6X4 Diesel” on page 341.
11. Differential lock switch	Battery voltage	Check 420 Yel wires. Adjust or replace differential lock switch.


H1 Discharge Light
1
600 Brn
403 Yel
7
H5 Engine Oil Pressure Light
2
620 Tan
3
403 Yel
B3 Engine Oil Pressure Switch
4
621 Tan
H4 Engine Coolant Temperature Light
S4 Differential Lock Switch
11
420 Yel
423 Yel
5
402 Yel
7
403 Yel
301 Org/Wht
6
300 Org/Wht
H3 Differential Lock Light
10
640 Grn
H2 Park Brake Light
B2 Engine Coolant Temperature Switch
7
300 Org/Wht
S3 Park Brake Switch
9
420 Yel
423 Yel
8
630 Gry/Blk

Radiator Fan Motor Operation - 6X4 Diesel (SN -039740)

Theory of Operation:

The fan operates when the radiator core temperature switch closes. The radiator core temperature switch closes when the coolant heats to 89° ± 4°C (192° ± 7°F), a radiator core temperature of 71° ± 4°C (160° ± 7°F).

The radiator core temperature switch monitors outer radiator core temperature, not engine coolant temperature.

NOTE: The outer radiator core temperature is approximately 20° C (36° F) lower than engine coolant temperature.

The fan motor stops when the coolant temperature drops to 80° C (177° ± 7° F), a radiator core temperature of 60° ± 4° C (140° ± 7° F) and the radiator core temperature switch opens. The radiator fan motor circuit is connected directly to the battery and is independent of the start switch position. Fan motor may run after engine is shut off.

Radiator Fan Motor Operation - 6X4 Diesel (SN 039741-)

Theory of Operation:

The fan operates when the key switch is in the RUN position and the radiator core temperature switch closes. The radiator coolant temperature switch closes when the coolant heats to 86° ± 3°C (187° ± 5°F).

The coolant temperature switch monitors engine coolant temperature and provides a ground control of the fan relay coil.

The fan motor stops when the coolant temperature drops to 86° ± 3°C (187° ± 5°F) and the coolant temperature switch opens, or when the key switch is placed in the OFF position. The radiator fan motor is powered through the fan relay. The fan relay contact is connected directly to the battery through the F2 fusible link. The fan relay coil is powered through the key switch.

Headlights Operation - 6X4 Diesel

Function:

Provides power to the headlights.

Operating Conditions:

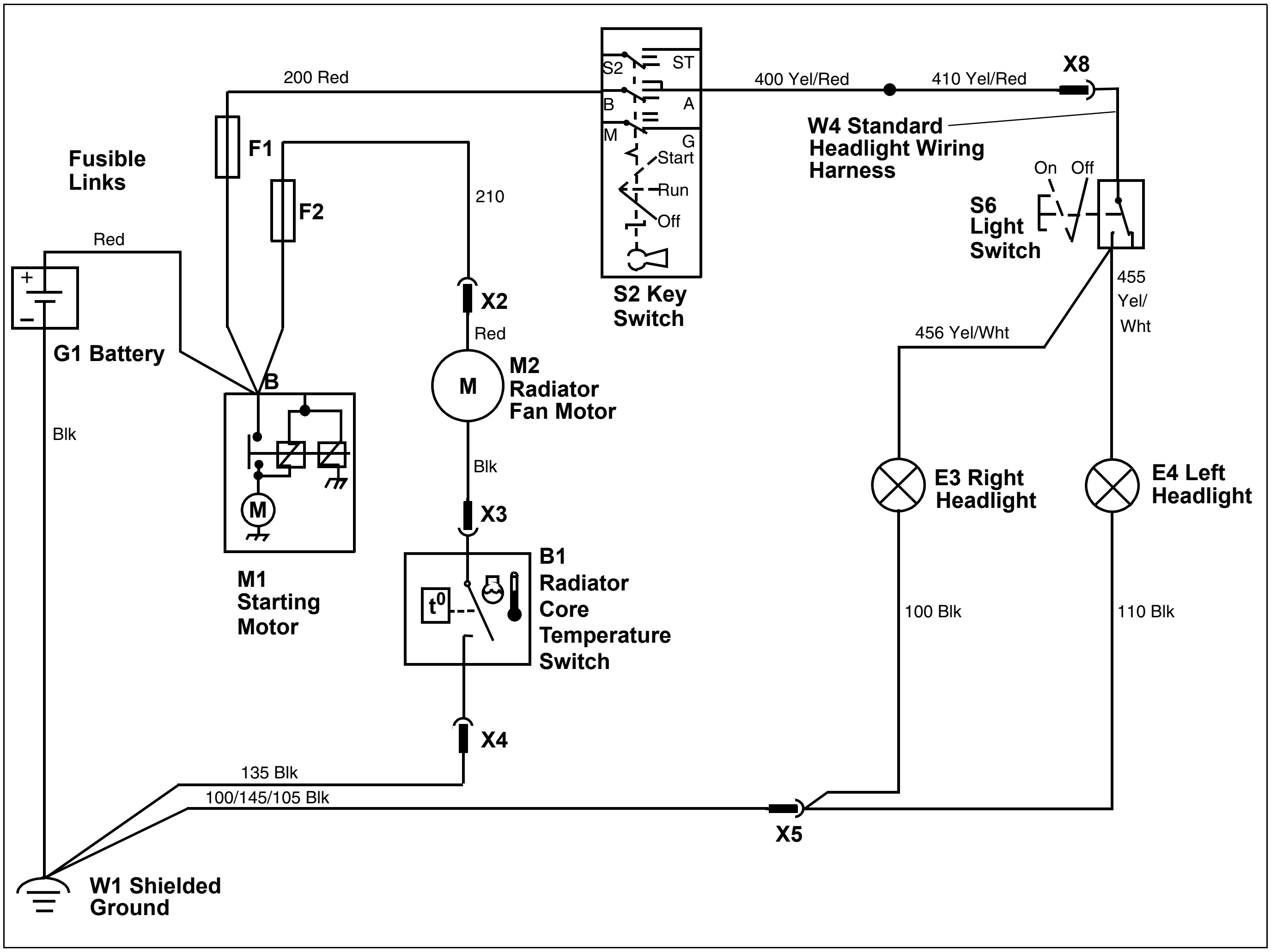
The key switch must be in the RUN position.

Theory of Operation:

The W4 headlight wiring harness is attached to the W3 main wiring harness. Power from the headlight wiring harness connector (X8) is connected to the light switch. Current then flows from the light switch to the headlights.

NOTE: If one of the Light and Horn kit options is added, the new wiring harness plugs into wiring harness power connector (X8) and connector (X5). The light switch and the original headlight wiring harness are removed.

Radiator Fan Motor and Headlights Schematic - 6X4 Diesel (SN -039740)



Radiator Fan Motor and Headlights Diagnosis - 6X4 Diesel (SN -039740)

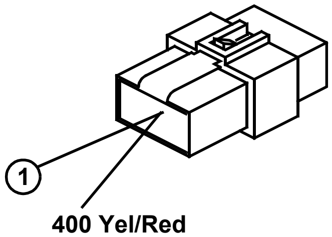
Test Conditions:

- Key switch must be in the RUN position
- Light switch ON

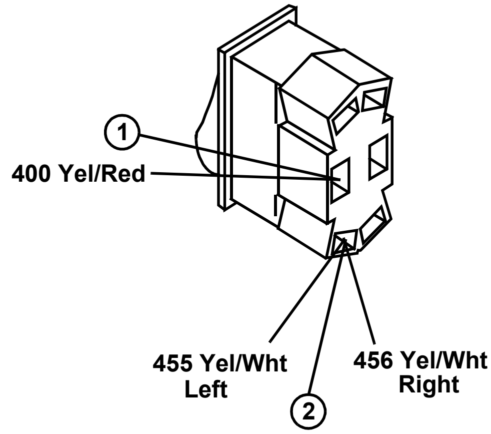
Test/Check Point	Normal	If Not Normal
1. Light switch	Battery voltage	Check connection at X8 headlight wiring harness power connector. See “Power Circuit Diagnosis - 6X4 Diesel” on page 341.
2. Light switch	Battery voltage	Replace light switch.
3. Left headlight	Battery voltage	Check 455 Yel/Wht wire and connections.

Test/Check Point	Normal	If Not Normal
4. Left headlight	Greater than 0 volts - less than 0.2 volts	0 volts: Replace headlight. Greater than 0.2 volts: Check ground circuit connection at (X5), 105/145/100 Blk wires and connections to engine ground.
5. Right headlight	Battery voltage	Check 456 Yel/Wht wire and connections.
6. Right headlight	Greater than 0 volts - less than 0.2 volts	0 volts: Replace headlight. Greater than 0.2 volts: Check ground circuit connection at (X5) and 105/145/100 Blk wires and connections to W1 shielded ground.
7. Radiator fan motor	Battery voltage	Check 210 Red/Blk wire, F2 fuse link and connections. See “Power Circuit Diagnosis - 6X4 Diesel” on page 341.
8. Radiator core temperature switch	Battery voltage	Check Blk wire and connections.

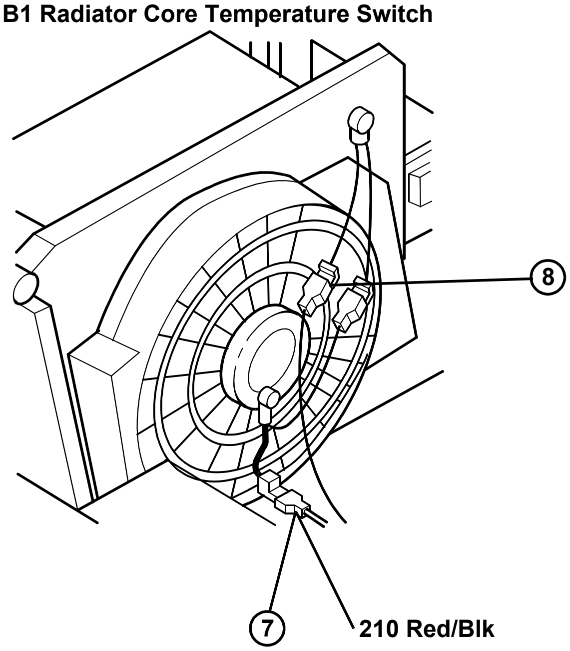
X8



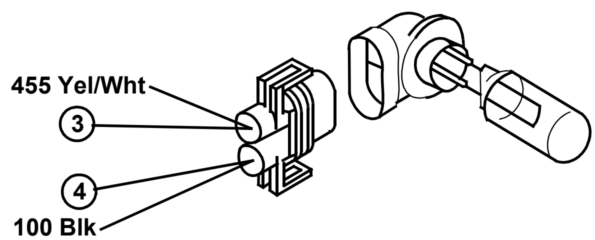
S5 Light Switch



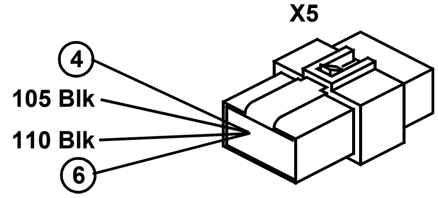
M2 Radiator Fan Motor
B1 Radiator Core Temperature Switch



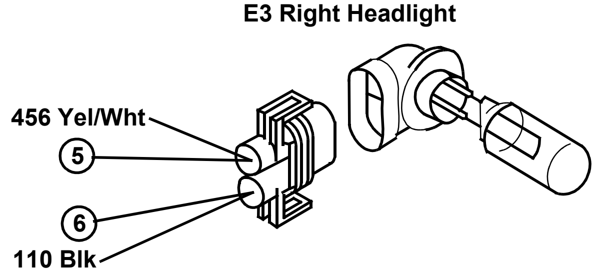
E4 Left Headlight



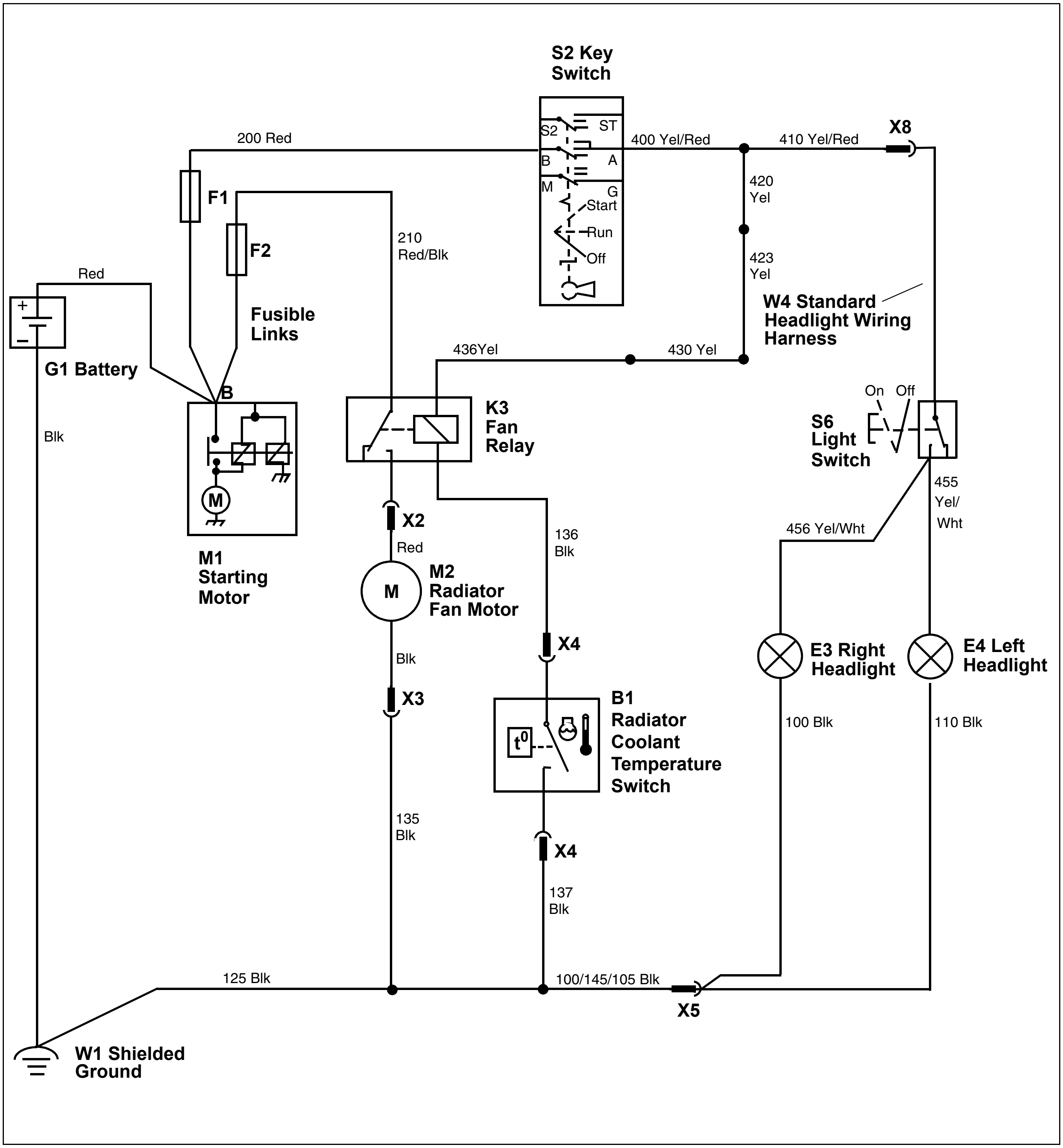
X5



E3 Right Headlight



Radiator Fan Motor and Headlights Schematic - 6X4 Diesel (SN 039741-)



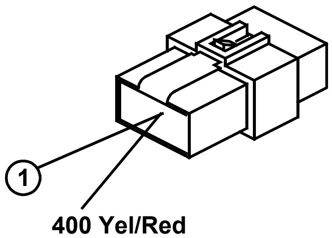
Radiator Fan Motor and Headlights Diagnosis - 6X4 Diesel (SN 039741-)

Test Conditions:

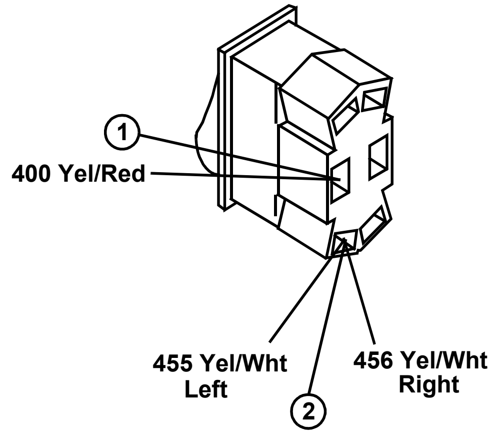
- Key switch must be in the RUN position
- Light switch ON
- Disconnect radiator coolant sensor

Test/Check Point	Normal	If Not Normal
1. Light switch	Battery voltage	Check connection at X8 headlight wiring harness power connector. See “Power Circuit Diagnosis - 6X4 Diesel” on page 341.
2. Light switch	Battery voltage	Replace light switch.
3. Left headlight	Battery voltage	Check 455 Yel/Wht wire and connections.
4. Left headlight	Greater than 0 volts - less than 0.2 volts	0 volts: Replace headlight. Greater than 0.2 volts: Check ground circuit connection at (X5), 105/145/100 Blk wires and connections to engine ground.
5. Right headlight	Battery voltage	Check 456 Yel/Wht wire and connections.
6. Right headlight	Greater than 0 volts - less than 0.2 volts	0 volts: Replace headlight. Greater than 0.2 volts: Check ground circuit connection at (X5) and 105/145/100 Blk wires and connections to W1 shielded ground.
7. Radiator fan relay	Battery voltage	Check 210 Red/Blk wire, F2 fuse link and connections. See “Power Circuit Diagnosis - 6X4 Diesel” on page 341.
8. Radiator fan relay	Battery voltage	Check 436, 430, 423, 420, and 400 Yel wires and connections.
9. Radiator coolant temperature sensor	Battery voltage and continuity to ground	Check 136 Blk wire and connections to fan relay. Check 137 and 125 Blk wires and connections to ground.
10. Radiator coolant temperature sensor	Battery voltage	Check 209 Red/Blk wire and connections. Test relay.

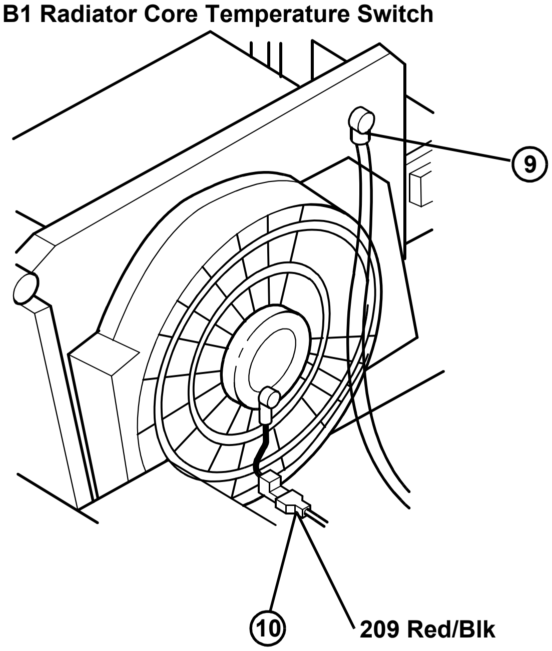
X8



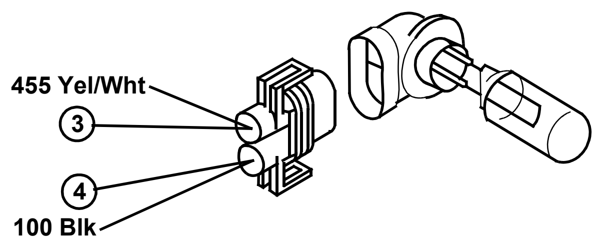
S5 Light Switch



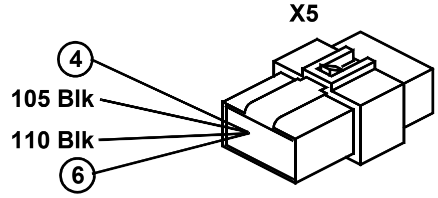
M2 Radiator Fan Motor
B1 Radiator Core Temperature Switch



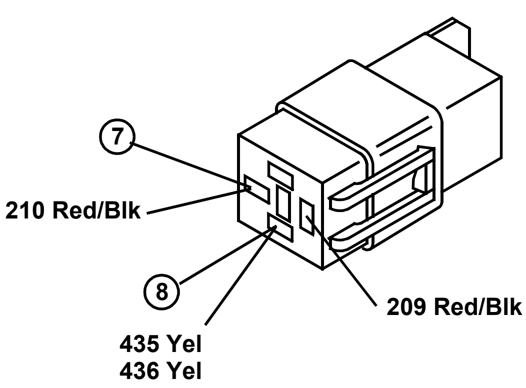
E4 Left Headlight



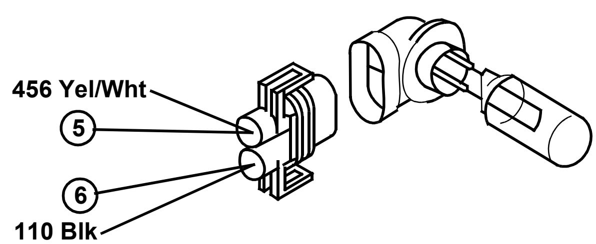
X5



K3 Radiator Fan Relay



E3 Right Headlight



Back-up Alarm Operation - 6X4 Diesel

Function:

To sound a warning buzzer when the operator places the shift lever into the reverse position.

Operating Conditions:

- Shift lever in reverse.

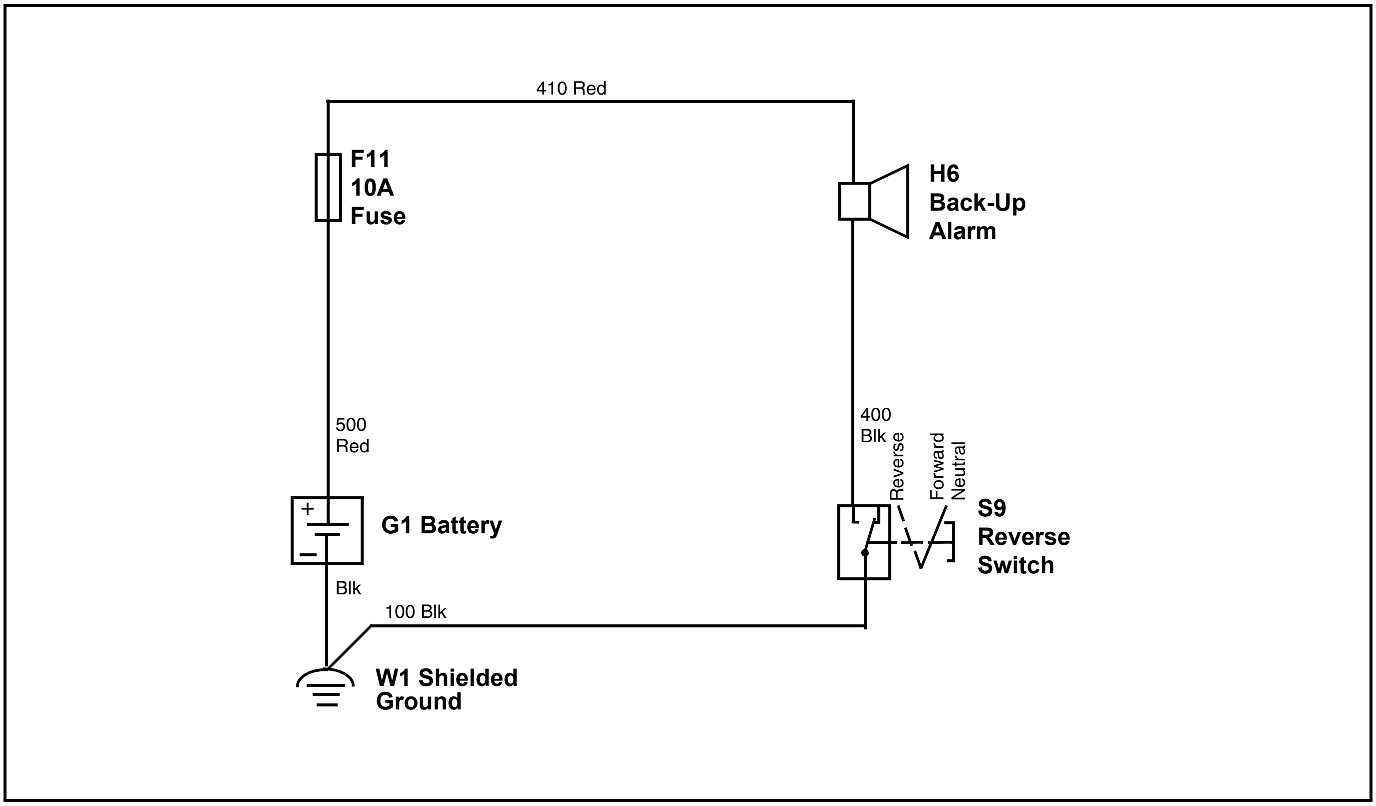
Theory of Operation:

When the machine is shifted into reverse, the S9 reverse switch closes allowing current to flow through the H6 warning buzzer. The buzzer will beep intermittently as long as the shift lever is in reverse whether the machine is stationary or in motion.

The 500 Red wire is connected to the G1 battery positive terminal and supplies power to the F11 10A fuse, 410 Red wire, H6 warning buzzer, 400 Blk wire, and the S9 reverse switch. When the shift lever is placed in reverse the S9 reverse switch plunger is depressed closing the contacts connecting the 400 Blk wire to the 100 Blk wire and completing the circuit.

The machine does not need to be running for the back-up alarm to sound.

Back-up Alarm Schematic - 6X4 Diesel



Back-up Alarm Diagnosis - 6X4 Diesel

Test Conditions:

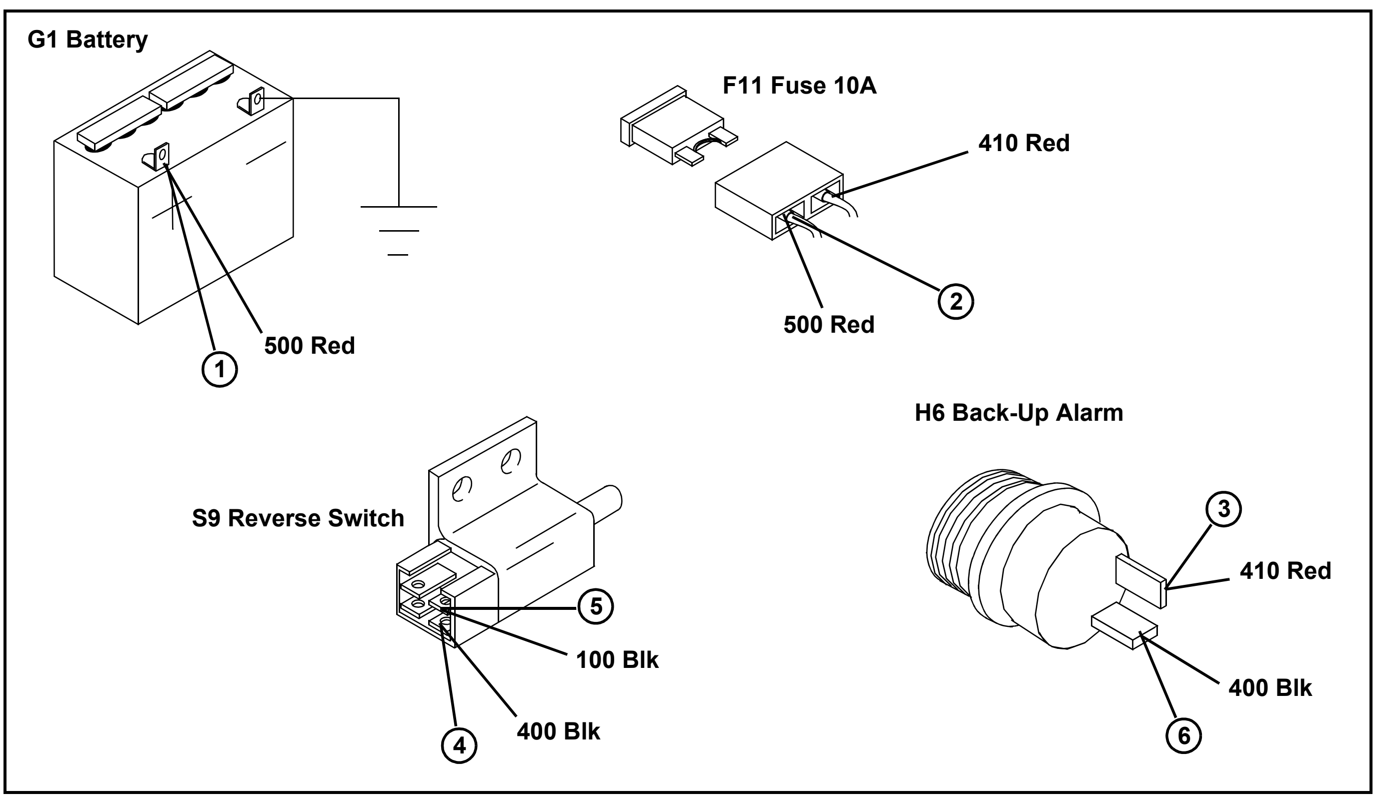
- Key switch in the OFF position
- Shift lever in NEUTRAL

Test/Check Point	Normal	If Not Normal
1. Battery	12.5 volts or higher	Test Battery.
2. 10A Fuse	Battery voltage	Check 500 Red wire and connections. If OK, replace 10A fuse.
3. Back-Up Alarm	Battery voltage	Check 410 Red wire and connections. If OK, replace back-up alarm.
4. Reverse Switch	Battery voltage	Check 400 Blk wire and connections.
5. Reverse Switch	Continuity to ground	Check 100 Blk wire and connections.

Test Conditions:

- Key switch in the OFF position
- Shift lever in reverse

Test/Check Point	Normal	If Not Normal
6. Back-Up Alarm	Greater than 0 volts - less than 0.2 volts	0 volts: Replace back-up alarm. Greater than 0.2 volts: Check ground circuit connection; 400 Blk wire, reverse switch, 100 Blk wire, and connections from W1 ground to battery.



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 should 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 Test

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 on level surface.
2. Turn key switch off.
3. Move forward/reverse pedals to neutral position.
4. Lock park brake.
5. Raise hood.
6. 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 on level surface.
2. Move forward/reverse pedals to NEUTRAL position.
3. LOCK park brake.
4. Turn key switch to ON position.
5. Raise hood.
6. Connect voltmeter negative (black) lead to negative (-) terminal of battery.
7. 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.

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 jumpstart 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:

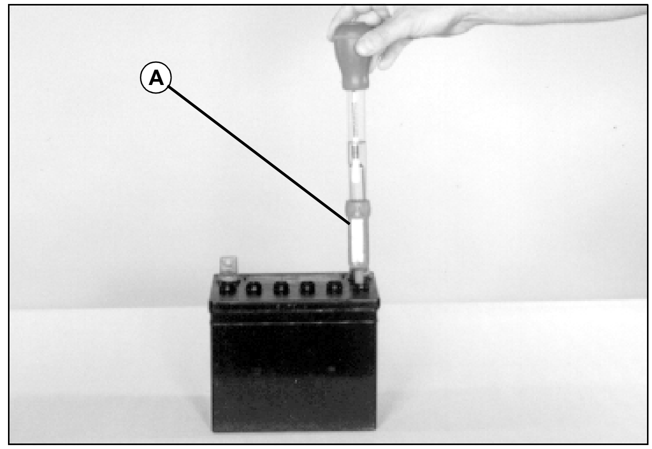
To check condition of battery and determine battery voltage.

Equipment:

- Hydrometer
- Voltmeter or JT05685 Battery Tester

Procedure:

1. Park machine on level surface.
2. Turn key switch off.
3. Lock park brake.
4. Clean cable ends, battery terminals and top of battery.
5. Remove battery to workbench.
6. Inspect battery terminals and case for breakage or cracks.
7. 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.
8. Remove surface charge by placing a small load on the battery for 15 seconds.



M49596

9. 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.
- 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 373.
- If battery voltage is more than 12.4 VDC, test specific gravity (see Step 9).

Install battery.

Charge Battery

Reason:

To increase battery charge after the battery has been discharged.

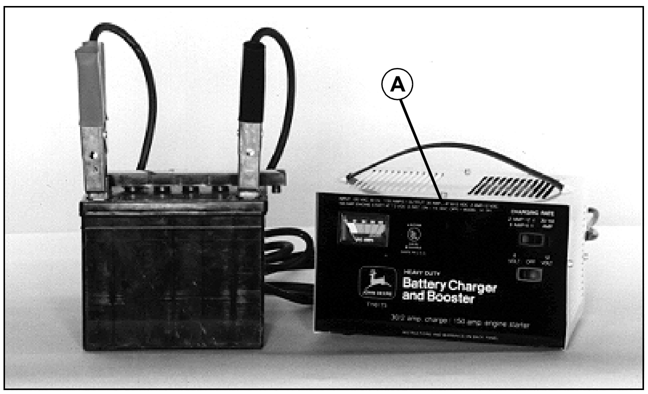
Equipment:

- Battery charger (variable rate)

Procedure:

NOTE: See "Battery Test" on page 372, before charging battery.

1. Park machine on level surface.
2. Turn key switch off.
3. Lock park brake.
4. Clean cable ends, battery terminals and top of battery.
5. Remove battery to workbench.



M49598

6. Connect variable rate charger (A) to battery.
7. 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.
8. 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 9 and 10.
- 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 9 and 10.

9. Set charger at 15 - 25 amps.

IMPORTANT: Avoid damage! Decrease charge rate if battery gases or bubbles excessively or becomes too warm to touch.

10. 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 10 and 11.

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.)

11. Continue to charge battery until specific gravity is 1.230 - 1.265 points.
12. Load test battery. See "Battery Load Test" on page 373
13. Install battery.

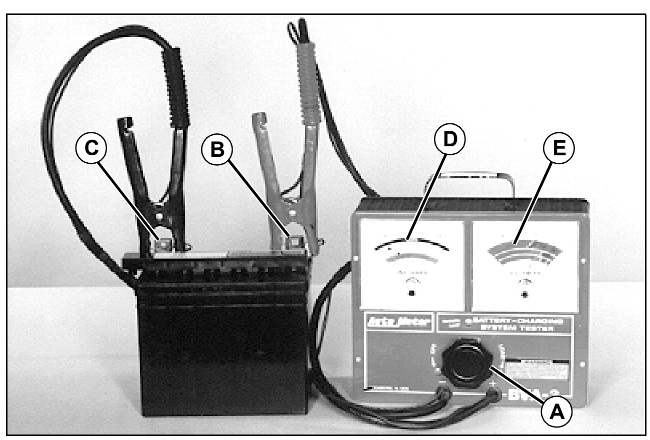
Battery Load Test

Equipment:

- JT05685 Battery Tester

Procedure:

1. Park machine on level surface.
2. Turn key switch off.
3. Move forward/reverse pedals to neutral position.
4. Lock park brake.
5. Clean cable ends, battery terminals and top of battery.
6. Remove battery.



M49597

7. Turn load knob (A) counterclockwise to off position.

8. Connect tester positive (red) cable to battery positive (+) terminal (B).

9. Connect tester negative (black) cable to battery negative (-) terminal (C).

10. 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).

11. Hold for 15 seconds and turn load knob (A) of tester counterclockwise to off position.

12. Repeat Steps 10 and 11 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.

Stator - Unregulated Voltage Output Test - Gas Engines

Reason:

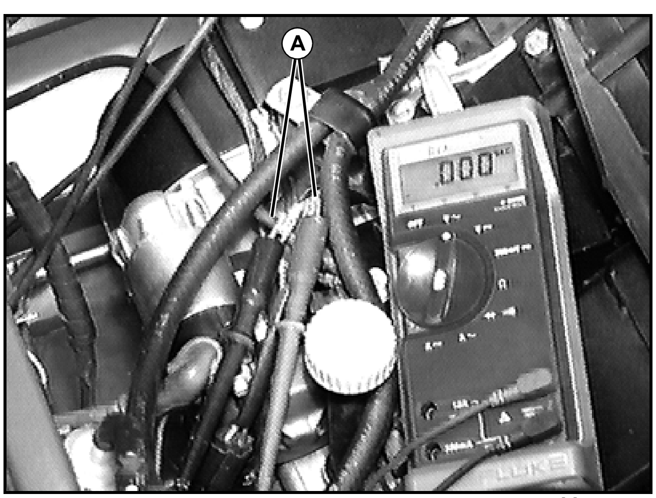
To measure stator voltage output to determine condition of stator and flywheel magnets.

Equipment:

- Voltmeter

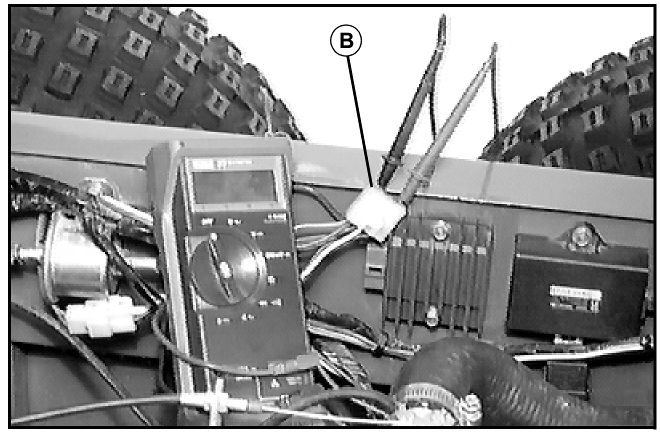
Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.



M56823

4. Disconnect two pin connectors (A) on wires routed from stator.
5. Connect voltmeter to pin connectors on wires routed from stator.



M56824

6. Disconnect wiring harness connector (B) from voltage regulator.
7. Connect voltmeter to brown/white and brown/yellow wires in connector.
8. Set voltmeter on AC volt scale.
9. Start and run engine at FAST idle and read meter:

- **4X2 should have a minimum of 34 volts AC at FAST idle (3750 ± 100 rpm).**
- **6X4 should have a minimum of 26 volts AC at FAST idle (3650 ± 50 rpm; - FD620D075777) (3850 ± 75 rpm; FD620D075778 -)**
- If reading is BELOW specification, check stator and flywheel magnets.

See “Flywheel Magnet(s) Test - Gas Engines” on page 385.

Stator - Regulated Amperage and Voltage Tests

Reason:

To determine regulated voltage (charging) output of voltage regulator/rectifier.

Equipment:

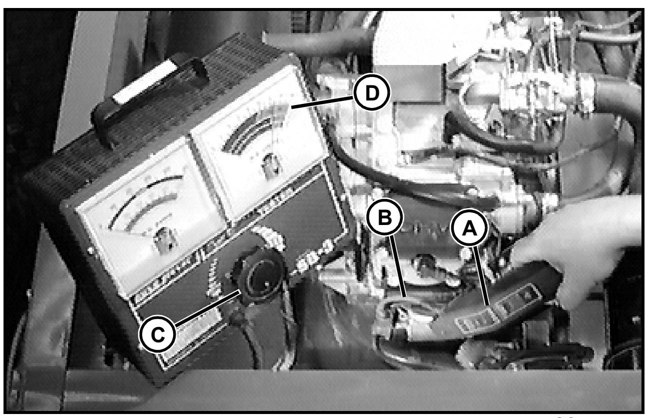
- JT05712 Current Gun
- JT05685 Battery Tester

Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Remove seats and operator's station black plastic shroud on 4X2.
4. Cargo box RAISED and LOCKED.

NOTE: Battery must be in good state of charge.

See "Battery Test" on page 372.



M56407

5. Put JT05712 Current Gun (A) around positive (red) battery cable (B) going to starting motor so current-flow arrow points towards battery. Set current gun for DC current.

IMPORTANT: Avoid damage! Turn load knob (C) fully counterclockwise (out) into OFF position BEFORE making any test connections.

6. Connect battery tester to battery.

IMPORTANT: Avoid damage! Perform this test quickly to prevent damage to battery tester. DO NOT apply full load to battery for more than 5 - 10 seconds.

7. Turn load knob (C) clockwise (in) until voltage on tester voltage scale (D) reads **11 volts for 5 seconds only** to partially drain battery.

8. Quickly turn load knob (C) completely counterclockwise (out) into OFF position.

9. Start and run engine at FAST idle. Battery voltage should read between **12.2 - 14.7 volts DC.**

10. Turn load knob (C) clockwise (in) until voltage on tester voltage scale (D) reads **11 volts** and look at current gun (A) for a "minimum" amperage reading:

- 13 amps 4X2 Gas (All)
- 16 amps 6X4 Gas (- FD620D038265)
- 14 amps 6X4 Gas (FD620D038266 -)
- 40 amps 6X4 Diesel (All)
- Quickly turn load knob (C) completely counterclockwise (out) into OFF position.
- **After load test, voltmeter should return to a maximum of 14.7 volts DC.**
- If current gun amp reading is BELOW specification, test for unregulated voltage output. If unregulated voltage output test meets specifications and you have verified voltage and ground to voltage regulator/rectifier, replace voltage regulator/rectifier.

See "Stator - Unregulated Voltage Output Test - Gas Engines" on page 374.

- If at anytime voltage increase exceeds 14.7 volts DC, replace voltage regulator/rectifier.

Alternator - Unregulated Amperage Test - Diesel Engines

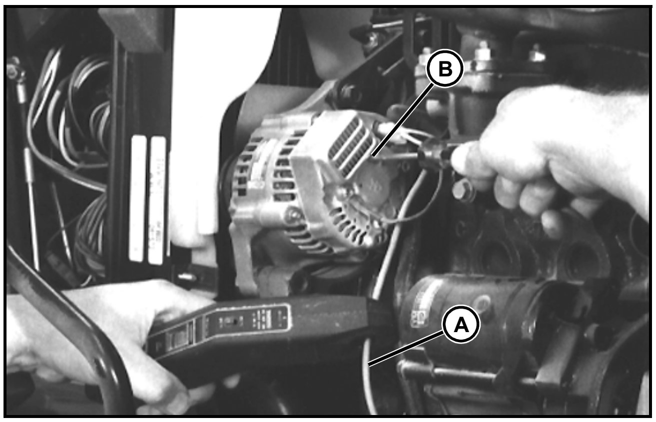
Reason:

To determine charging output of the alternator stator.

Equipment:

- JT05712 Current Gun

Connections:



M46290

1. Put JT05712 Current Gun over alternator red wire (A). Set Current Gun for DC current.

Procedure:

> **IMPORTANT: Avoid damage! Perform this test quickly to prevent damage to battery. DO NOT apply full load to battery for more than 10 seconds.**

1. Start and run engine at 3550 rpm.

2. Insert a Phillips screwdriver through hole (B) in rear cover of alternator to ground the regulator to the rear cover. Read amperage on current gun.

Specifications:

Minimum unregulated amperage . . . . 45 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, replace the alternator.

- If reading meets the specification, replace the regulator. See “Alternator” in Diesel Engine Section.

Auxiliary Alternator - Regulated Amperage and Voltage Tests

Reason:

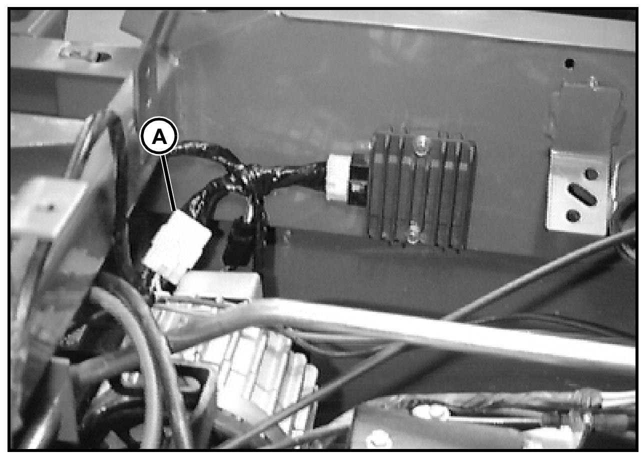
To determine regulated voltage (charging) output of auxiliary alternator.

Equipment:

- JT05712 Current Gun
- JT05685 Battery Tester

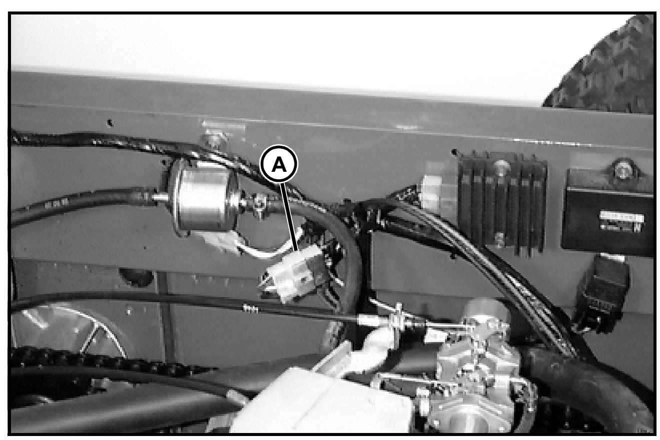
Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.



M86501

4X2 Gas

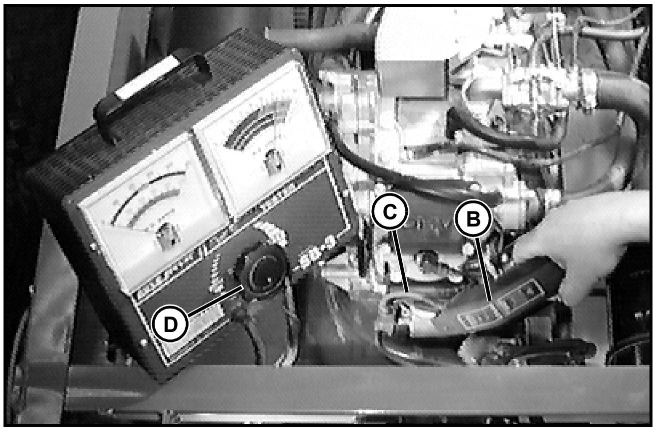


M86523

6X4 Diesel

4. Disconnect the auxiliary wiring harness connector (A) from the main wiring harness.

NOTE: Battery must be in good state of charge. See “Battery Test” on page 372.



M56407

5. Put JT05712 Current Gun (B) around positive (red) battery cable (C) going to starting motor so current-flow arrow points towards battery. Set current gun for DC current.

IMPORTANT: Avoid damage! Turn load knob (D) fully counterclockwise (out) into OFF position BEFORE making any test connections.

6. Connect battery tester to battery.
   - Connect RED cable on tester to positive (+) terminal on battery.
   - Connect BLACK cable on tester to negative (-) terminal on battery.

IMPORTANT: Avoid damage! Perform this test quickly to prevent damage to battery tester. DO NOT apply full load to battery for more than five to ten seconds.

7. Start and run engine at FAST idle.
8. Read battery voltage.
9. Turn LOAD knob in until maximum amperage output is obtained.
10. Connect the auxiliary wiring harness connector to the main wiring harness.

Specifications:

Battery Voltage . . . . 12.4 Volts

Regulated Amperage/ Voltage . . . . 45 amps (minimum) at 12.2 - 13.8 volts

Starting Motor Solenoid Test

Reason:

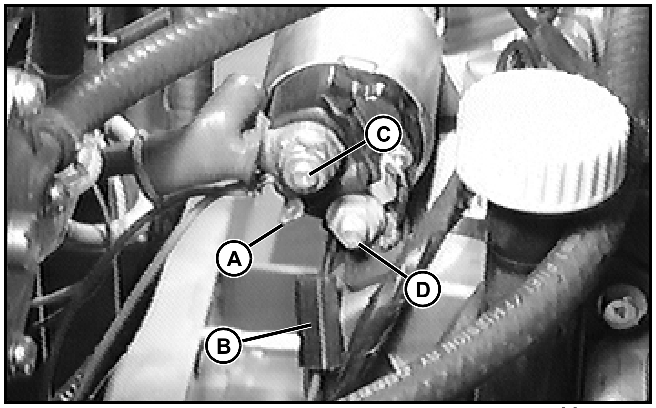
To determine if starting motor solenoid or starting motor is defective.

Equipment:

- Jumper wire.

Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Disconnect and ground spark plug lead(s).
4. Cargo box RAISED and LOCKED.



M56822

5. Disconnect wire (B) from starting motor solenoid terminal (A).
6. 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 7.**
7. Remove rubber boot(s) from terminals (C and D).
8. Connect jumper wire between starting motor solenoid large terminals (C and D).

Results

- **Starting motor runs - replace solenoid.**
- **Starting motor DOES NOT run - check battery 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.

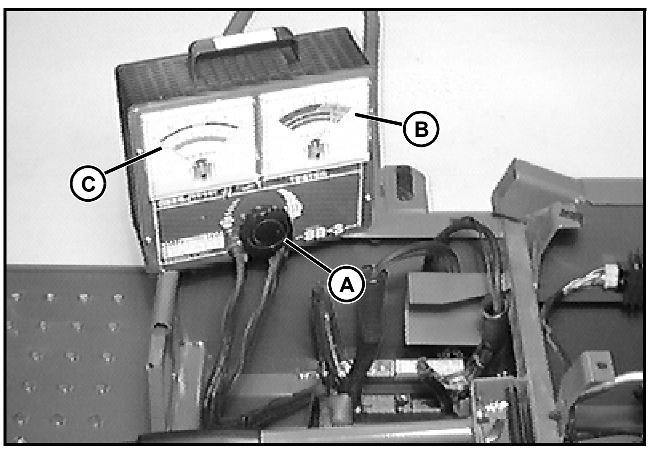
Equipment:

- JT05685 Battery Tester

Procedure:

1. Park machine on flat surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Remove seats and operator's station black plastic shroud on 4X2.
4. Cargo box RAISED and LOCKED.
5. Disconnect and ground spark plug lead(s).

IMPORTANT: Avoid damage! Turn load knob (A) fully counterclockwise (out) into OFF position before making any test connections.



M56819

6. Connect JT05685 Battery Tester to battery.
7. Crank engine - read and record voltage on DC voltage scale (B) of battery tester.
8. Turn key switch to OFF position.

IMPORTANT: Avoid damage! Perform following procedure within 15 seconds to prevent damage to tester and/or machine components.

9. Turn load knob (A) clockwise (in) until DC voltage (B) reads the same as when cranking.
10. Read and record DC amperage (C).
11. Turn load knob (A) completely counterclockwise (out) into OFF position.

Results:

- **Maximum starting motor draw on 4X2 should be 51 amps at 750 rpm.**
- **Maximum starting motor draw on 6X4 gas should be 72 amps at 500 rpm.**
- Maximum starting motor draw on 6X4 diesel should be 60 amps.
- 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.

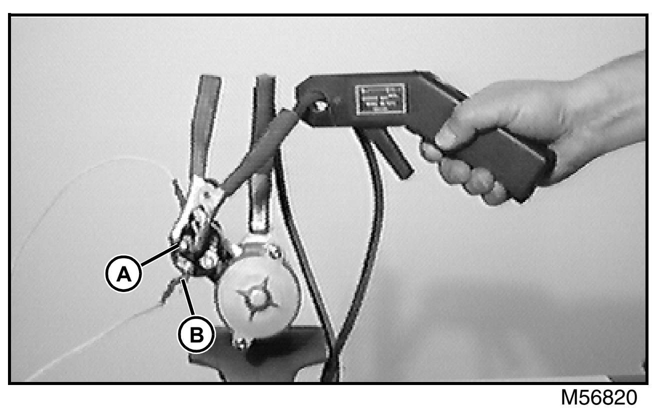
Equipment:

- 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.

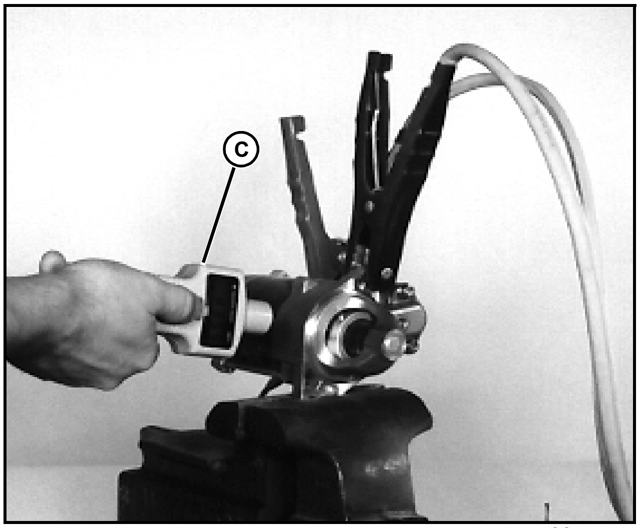
1. Park machine on flat surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Remove starting motor assembly to workbench.
5. Connect jumper cables to battery.



M56820

6. Connect negative jumper cable to starting motor body and positive cable (red) to solenoid battery terminal (A).

7. Use reflective tape on starting motor worm gear and JT05719 Photo Tachometer to measure starting motor rpm'.



M56406

8. 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.

9. Use jumper wire to briefly connect terminal (A) and solenoid engagement terminal (B).

10.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.

Spark Test - Gas Engines

Reason:

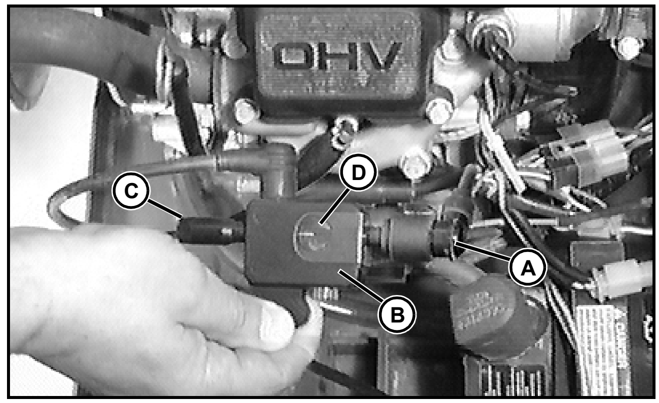
To check overall condition of ignition system.

Equipment:

- D-05351ST - Spark Tester

Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.



M56821

4. Remove high tension lead (A) from spark plug and connect to spark tester (B).
5. 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.

6. Adjust spark tester gap to **4.2 mm (0.166 in.)** with screw (C).
7. 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.

Spark Plug Cap Test - Gas Engines

Reason:

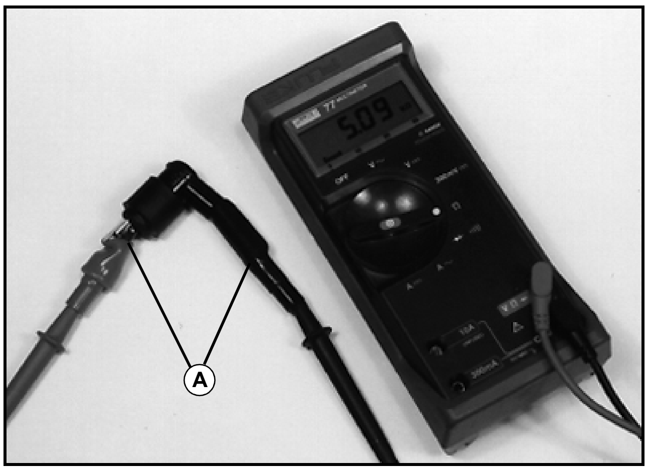
To determine if spark plug cap is defective.

Equipment:

- Ohmmeter

Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Disconnect spark plug cap.



M56818

5. 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.

Brake Pedal Switch and Park Brake Switch Tests

Reason:

To make sure the brake pedal switch and park brake switch have continuity when plunger is RELEASED.

Equipment:

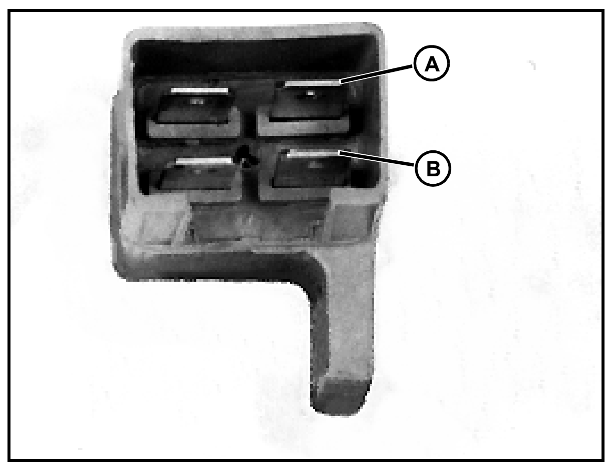
- Ohmmeter

Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Remove front hood, seats, and operator's station black plastic shroud.
4. Disconnect harness connector from brake pedal and park brake switch.
5. Check continuity.

Results:

NOTE: Two of the four terminals ARE NOT used in each of these applications.



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.

Neutral Start Switch Test

Reason:

To make sure the neutral start switch terminals have continuity when the gear shift is in neutral position.

Equipment:

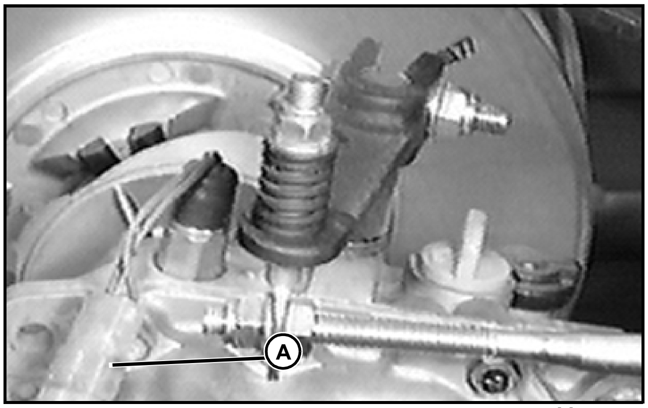
- Ohmmeter

Procedure:

1. Park machine on level surface and turn key switch OFF.

NOTE: When transaxle shift lever is in NEUTRAL the neutral start switch plunger is DEPRESSED.

2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.



M56088

4. Disconnect neutral start switch from harness and check continuity across neutral start switch terminals (A).

Results:

- There should BE continuity when shift lever is in NEUTRAL position**.**
- If the neutral start switch DOES NOT have continuity with the plunger DEPRESSED (while the gear shift is in NEUTRAL position), replace the switch.
- Move transaxle shift lever into FORWARD and then REVERSE (this should RELEASE switch plunger) and check continuity across neutral start switch terminals (A).
- **There should NOT BE continuity when shift lever is in FORWARD and REVERSE.**
- If the neutral start switch DOES have continuity with the plunger RELEASED (while the gear shift is in either FORWARD or REVERSE position), replace the switch.

Relay Test

Reason:

To check relay terminal continuity in the energized and de-energized condition.

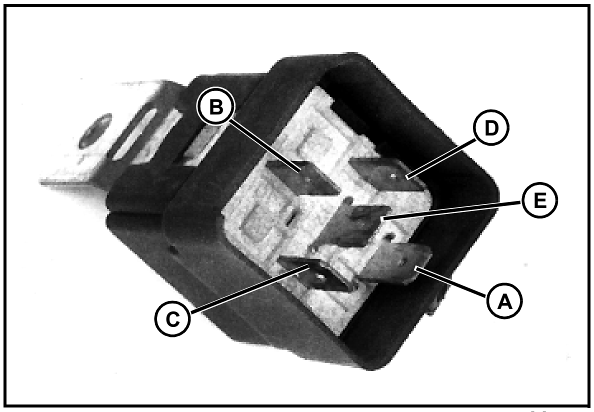
Equipment:

- Ohmmeter

Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Disconnect relay connector from harness.
5. Check continuity.

Results:



M56817

- **There should be continuity between terminals (A) and (E), and between terminals (C) and (D);**
- **There should NOT be continuity between terminals (E) 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.

Engine Oil Pressure Switch Test - 6X4's

Reason:

To determine if the oil pressure switch is functioning properly.

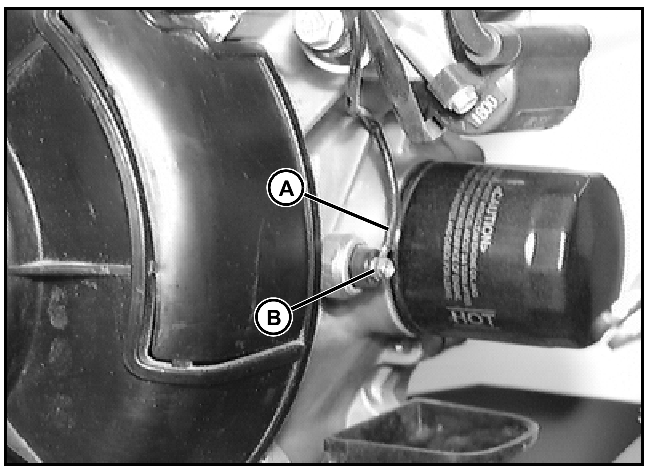
Equipment:

- Ohmmeter

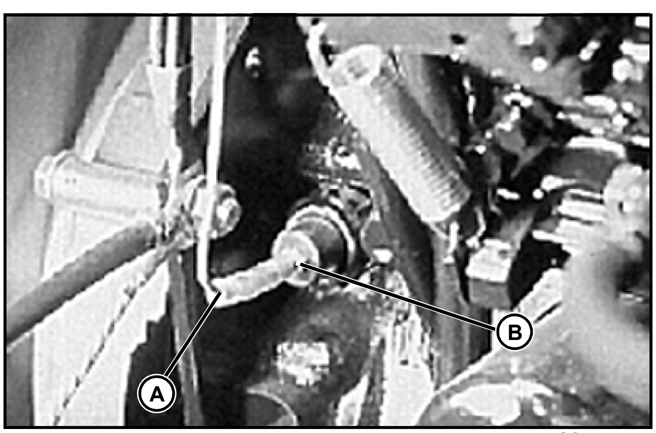
Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. 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.



6X4 Gas



6X4 Diesel

4. Disconnect wiring lead (A) from switch.
5. **Connect black lead of meter to engine block and red lead of meter to terminal (B) of switch.**
6. **Set ohmmeter for 1X ohms scale**.
7. **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.

Fuse Test

Reason:

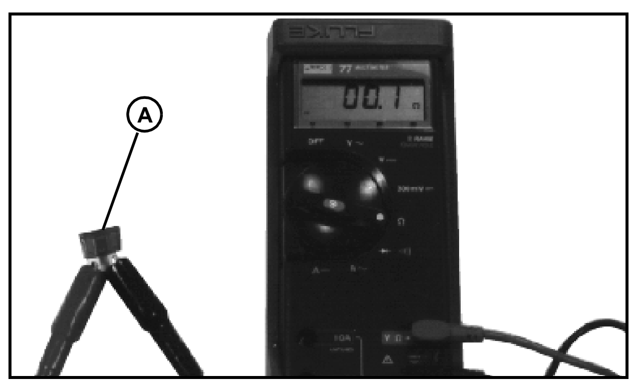
To verify that the fuse has continuity.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Remove fuse from connector.



2. Check visually for broken filament (A).
3. Connect ohmmeter or continuity tester to each end of fuse.
4. Check for continuity.

Results:

- If continuity is not indicated, replace fuse.

Light Switch Test

Reason:

To make sure the light switch terminals have continuity when the light switch is **ON**.

Equipment:

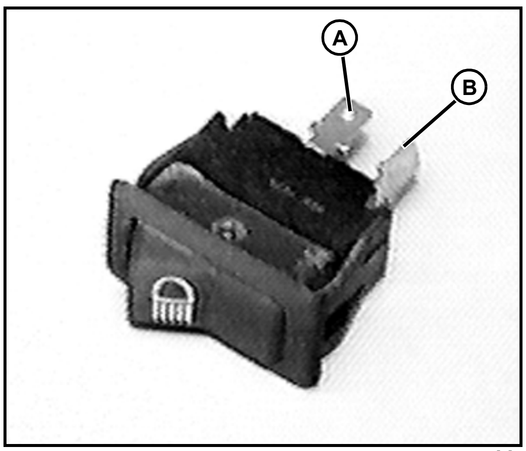
- Ohmmeter or Continuity Tester

Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.

NOTE: You may want to remove front hood for easy access to dash panel electrical components.

3. Disconnect light switch connector.



M56813

4. Move light 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 light switch.

Differential Lock Switch Test

Reason:

To make sure differential lock switch terminals have continuity when the plunger is DEPRESSED.

Equipment:

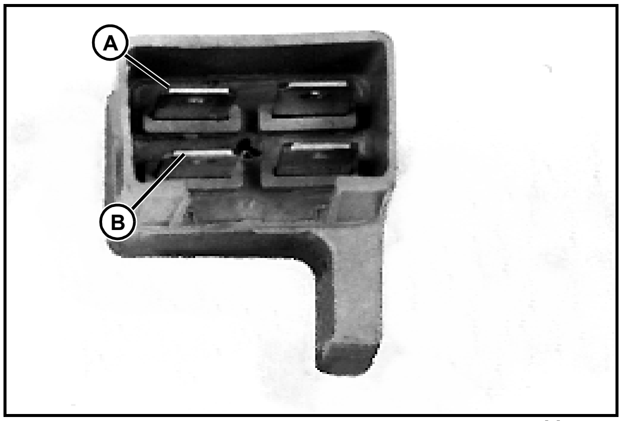
- Ohmmeter

Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Remove seats and operator's station black plastic shroud.
4. Disconnect differential lock switch connector.
5. Check continuity.

Results:

NOTE: Two of these terminals ARE NOT used in this application.



M56409

- there should NOT BE continuity between terminals (A and B) when plunger is RELEASED,
- there should BE continuity between terminals (A and B) when plunger is DEPRESSED.
- If continuity is NOT correct, replace switch.

Key Switch Test

Reason:

To verify key switch functions are operating properly.

Equipment:

- Ohmmeter or Continuity Tester

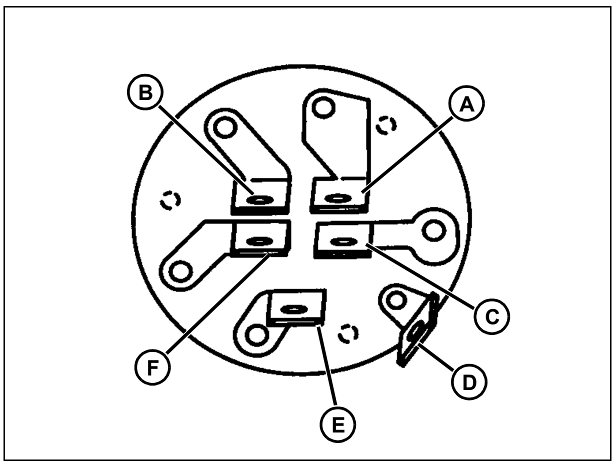
Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.

NOTE: You may want to remove front hood for easy access to dash panel electrical components.

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.



M56827

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.

Fuel Shutoff Solenoid Test - Gas Engine

Reason:

To determine if the fuel shutoff plunger retracts when the solenoid is energized.

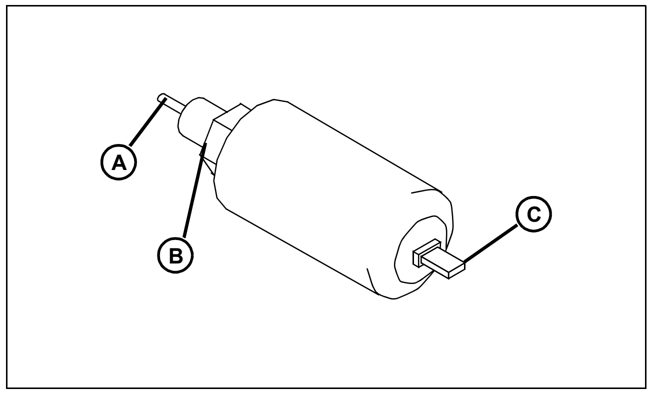
Equipment:

- 2 jumper wires

Procedure:

CAUTION: Avoid Injury! Keep gasoline away from sparks, flame, or hot engine parts or personal injury can result.

1. Disconnect fuel shutoff solenoid connector.
2. Remove fuel shutoff solenoid, washer.



NOTE: It may be necessary to push plunger (A) inward slightly for plunger to retract.

3. Connect a jumper wire from the battery positive (+) terminal to solenoid terminal (C).
4. Connect a jumper wire from the battery negative (-) terminal to solenoid threads (B). Plunger should now retract with the solenoid energized.
5. Remove jumper wire from the battery negative (-) terminal. Plunger should extend.

Results:

- If plunger does not move, replace solenoid.

Flywheel Magnet(s) Test - Gas Engines

Reason:

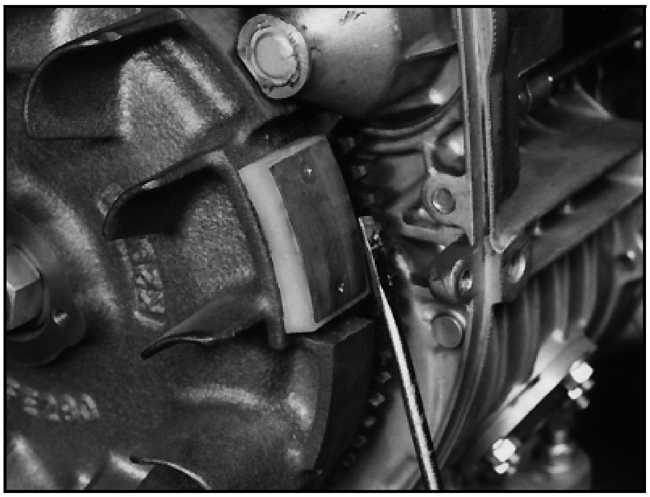
To make sure flywheel magnet(s) have enough force to induce current into ignition coil.

Equipment:

- Screwdriver.

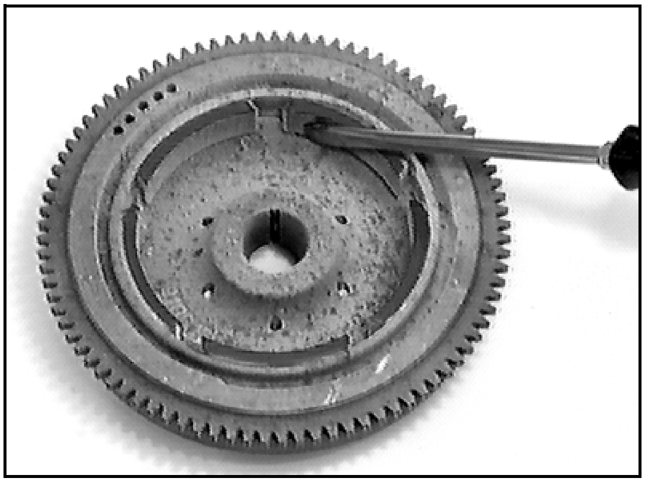
Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Remove flywheel housing from 4X2 or 6X4 engine and flywheel from 6X4 engine.



M56825

4X2 Gas



M55789

6X4 Gas

5. Loosely hold screwdriver blade about 25 mm (1.0 in.) away from magnet(s).

Results:

- Each magnet should attract blade to it.
- If blade is NOT attracted to magnet(s), flywheel must be replaced.

Bulb Test

Reason:

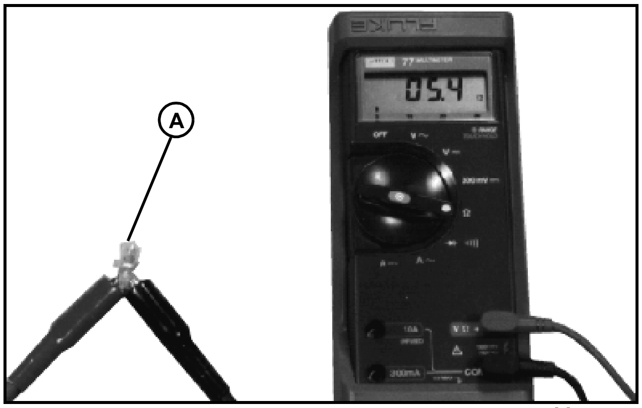
To verify that the bulb has continuity.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Remove bulb from socket.



M48392

2. Check visually for broken filament (A).
3. Connect ohmmeter or continuity tester to each terminal of bulb.
4. Check for continuity.

Results:

- If continuity is not indicated, replace bulb.

Ignition Coil Air Gap Adjustment - 4X2

Reason:

To adjust air gap between ignition coil and flywheel magnets to a specified dimension needed for proper ignition timing.

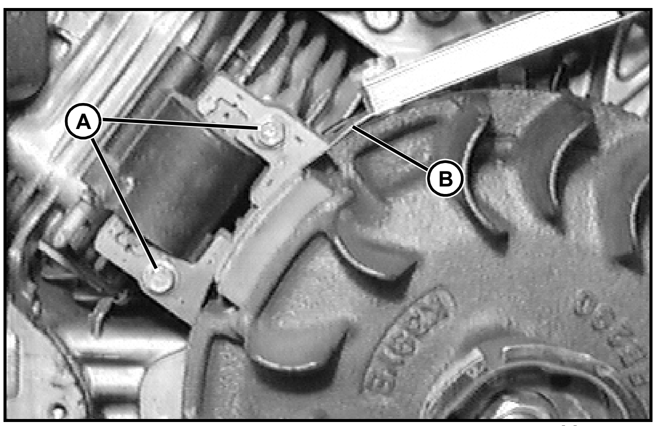
Equipment:

- Flat bladed feeler gauge.

Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.
4. Remove flywheel housing.
5. Turn flywheel magnet away from coil.

IMPORTANT: Avoid damage! The engine is very sensitive to this adjustment so both legs of coil must have the same air gap.



M56814

6. Loosen ignition coil cap screws (A).
7. **Select the 0.3 mm (0.12 in.) feeler gauge blade (B) and insert it between flywheel and coil legs.**

NOTE: If a misfire condition exists, adjust air gap to a minimum of 0.25 mm (0.10 in.) to increase magnetic force.

8. Turn flywheel until magnet aligns with legs of ignition coil and feeler gauge spans both legs of coil and the flywheel magnet at the same time.
9. Hold coil in position and tighten cap screws (A). Turn flywheel to remove feeler gauge.

Pulser Coil Test - 6X4 Gas

Reason:

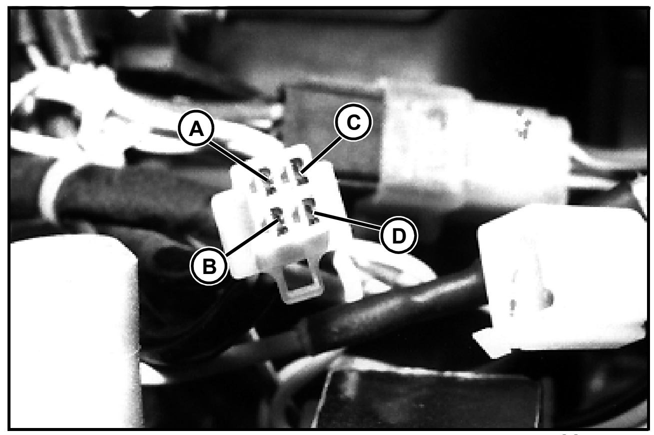
To determine condition of pulser coil windings and verify pulser coil wire continuity.

Equipment:

- Ohmmeter

Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Disconnect 4 - pin pulser connector.



M56816

4. **Measure resistance between Wht/Blu wire (A) and Pnk wire (B), then Grn/Wht wire (C) and Yel wire (D) at pulser side of connector.**

Results:

- **If resistance does not read between 85 - 270 ohms, replace pulser coil.**

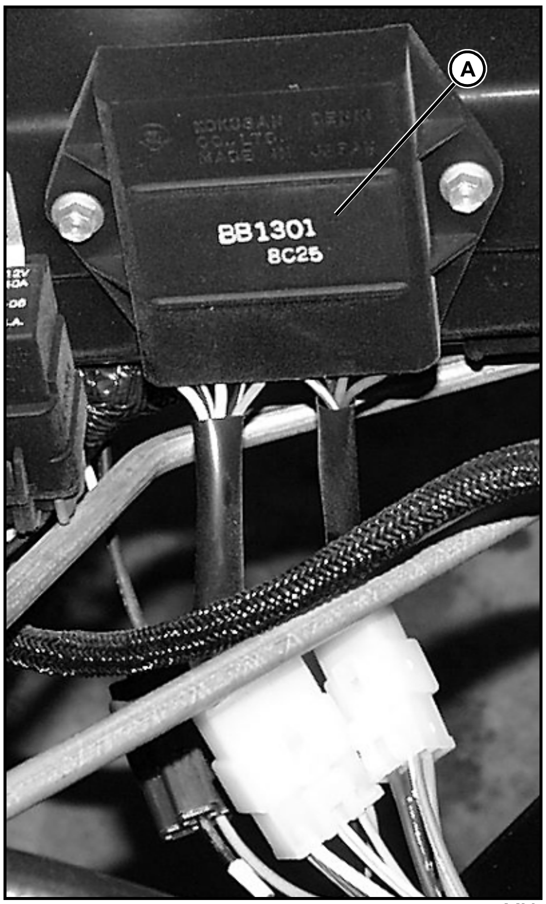
Ignition Module Test

Reason:

To determine if the ignition module is defective.

Procedure:

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Shift lever in NEUTRAL and park brake LOCKED.
4. Cargo box RAISED and LOCKED.
5. Locate the ignition module mounted on the inside right frame rail.



MX0700

6. 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

Reason:

Check the windings of the ignition coil.

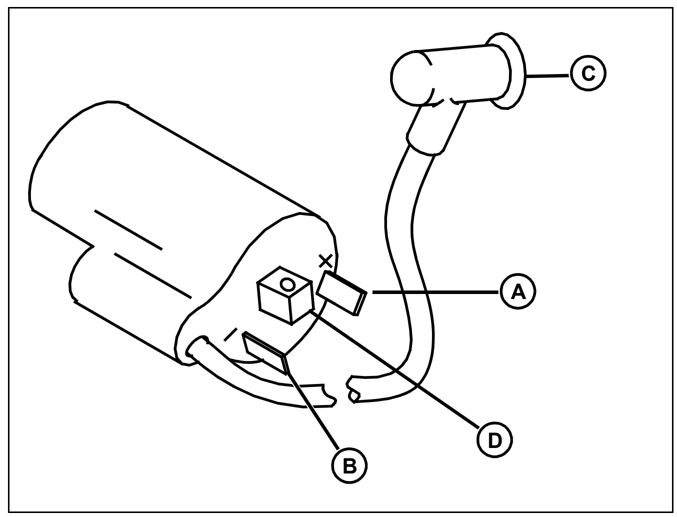
Test Equipment:

- Ohmmeter

Procedure:

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Shift lever in NEUTRAL and park brake LOCKED.
4. Cargo box RAISED and LOCKED.
5. 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 4.6 ohms.

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 16,500 ohms.

Open Circuit Check:

1. Connect one ohmmeter lead to coil positive (+) terminal (A) or negative (-) terminal (B).

NOTE: Do not connect ohmmeter lead to ignition coil mounting screws, as this will result in an inaccurate reading.

2. Connect other ohmmeter lead to coil core (D).

3. Measure resistance from primary leads to coil core. There should be no continuity (open circuit) between coil primary terminals and coil core.

4. Connect one ohmmeter lead to high tension lead (C).

NOTE: Do not connect ohmmeter lead to ignition coil mounting screws, as this will result in an inaccurate reading.

5. Connect other ohmmeter lead to coil core (D).

6. Measure resistance from high tension lead to coil core. There should be no continuity (open circuit) between high tension lead and coil core.

7. 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.

Radiator Core Temperature Switch Test - Removed

Reason:

To verify radiator core temperature/fan motor switch is functioning properly at specified temperatures to turn cooling fan ON and OFF to protect engine from over heating.

Equipment:

- Thermometer
- Glass Container
- Heating Unit
- Ohmmeter

Procedure (Early Models):

1. Park machine on level surface and turn key switch OFF.

2. Shift lever in NEUTRAL and park brake LOCKED.

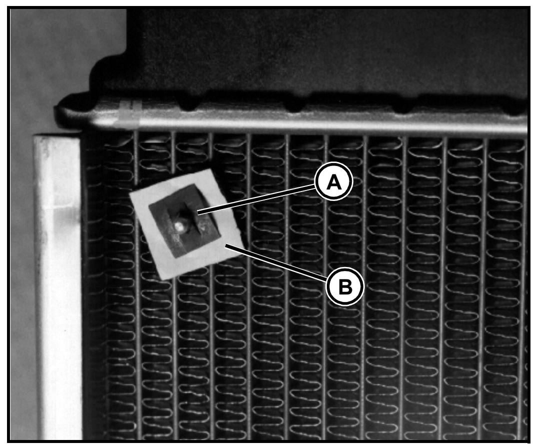
CAUTION: Avoid Injury! Radiator fan can start at any time, even with ignition key is OFF position. Always disconnect the negative battery cable before doing any electrical repair.

3. Remove seats and operator's station black plastic shroud.

4. Disconnect electrical leads to radiator core temperature/fan motor switch sending unit on top rear inside edge of radiator.

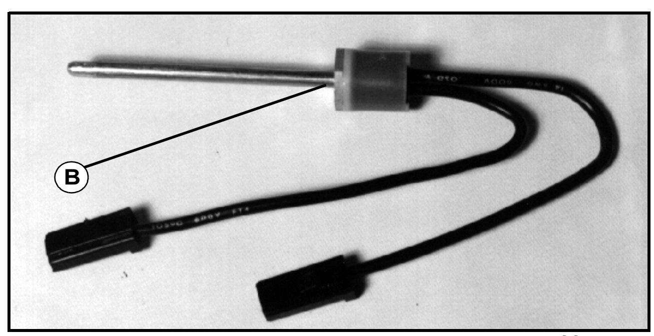
5. Remove screen bolted to frame under passenger's right side grab handle.

6. Remove slide-in screen on right side of radiator.



M76888

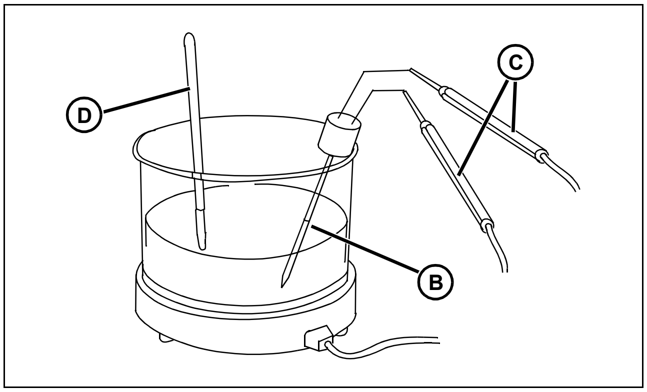
7. Reaching up into frame where screens were removed, bend tabs of push-on nut (A) and remove nut and protective pad (B) from end of radiator core temperature/fan motor switch.



M76877

8. Pull radiator core temperature/fan motor switch (B) from left side of radiator.

CAUTION: Avoid Injury! DO NOT allow switch or thermometer to rest against the side or bottom of glass container when heating water. Either may rupture if over heated.



MIF

9. Connect lead wires from ohmmeter probes (C), to switch terminals.

10.Suspend switch (B) and a thermometer (D) in a container of water.

11.Heat and stir the water. Observe water temperature when continuity occurs. Water temperature should be 71° ± 4° C (160° ± 7° F).

Results:

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

Specifications:

- Switch closes (fan should turn **ON**) when temperature reaches **71° ± 14° C (160° ± 7° F).**
- Switch opens (fan should turn **OFF**) when temperature reaches **60° ± 14° C (140° ± 7° F).**
- If switch fails to meet either of these specifications, replace it.

Procedure (Later Models):

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.

CAUTION: Avoid Injury! Radiator fan can start at any time, even with ignition key is OFF position. Always disconnect the negative battery cable before doing any electrical repair.

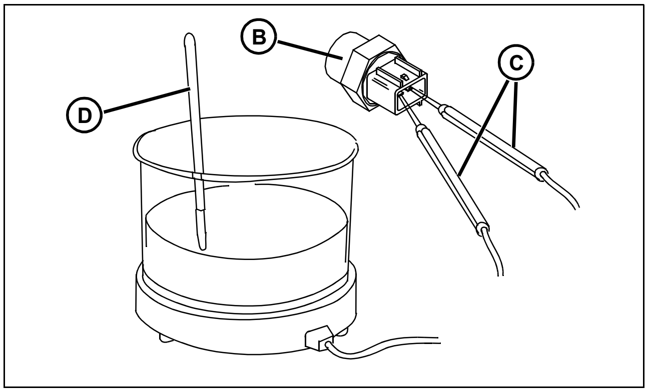
3. Remove seats and operator's station black plastic shroud.

4. Disconnect electrical leads to radiator core temperature/ fan motor switch sending unit on bottom rear edge of radiator.

MX19752

5. Remove radiator core temperature/fan motor switch (B) from radiator.

CAUTION: Avoid Injury! DO NOT allow switch or thermometer to rest against the side or bottom of glass container when heating water. Either may rupture if over heated.



MIF

6. Connect lead wires from ohmmeter probes (C), to switch terminals.

7. Suspend switch (B) and a thermometer (D) in a container of water.

8. Heat and stir the water. Observe water temperature when continuity occurs. Water temperature should be to specification.

Results:

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

Specifications:

NOTE: Plastic housing of switch for gas engines is green. Plastic housing of switch for diesel engines is yellow.

Closes - Gas Engines
Continuity - Radiator Fan ON . . 93 ± 3° C (200° ± 5° F)

Closes - Diesel Engines
Continuity - Radiator Fan ON . . 86 ± 3° C (187° ± 5° F)

Engine Coolant Temperature Switch Test - 6X4's

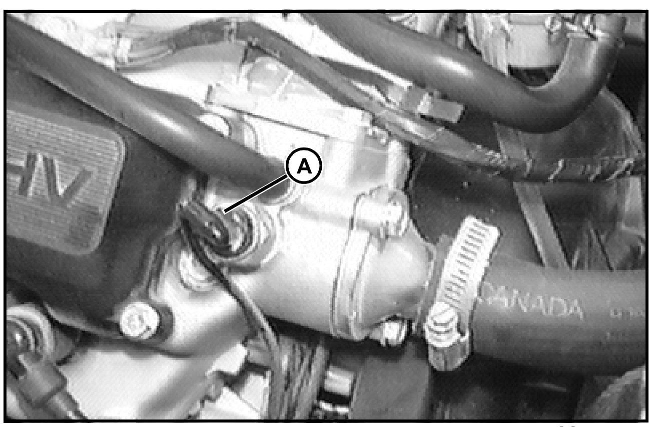
Reason:

To verify coolant temperature switch is functioning properly.

NOTE: Perform the test with the engine at room temperature.

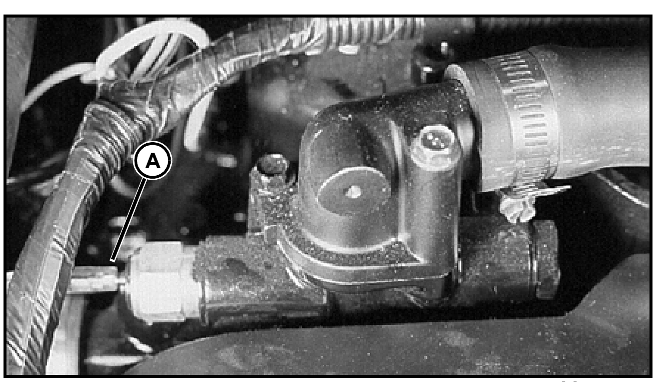
Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.



M56403

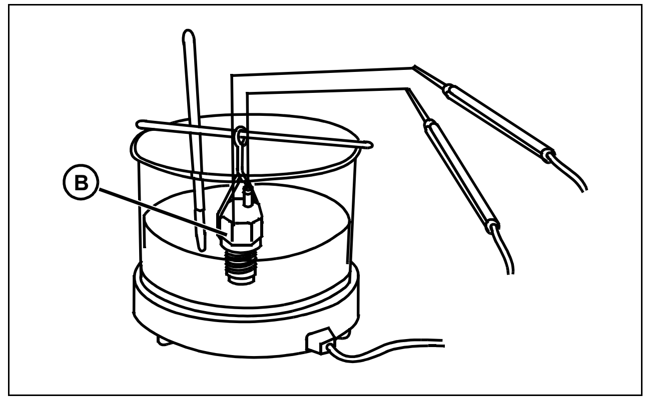
6X4 Gas



M76708

6X4 Diesel

4. Check for continuity between the terminal (A) and the sensor body. If there is continuity, replace engine coolant temperature switch.
5. Remove coolant temperature sensor.



MIF

6. Place sensor (B) in antifreeze solution heated to **109° ± 1° C (228° ± 2° F)**. Measure continuity while sensor is heated.

Results:

- Replace sensor if continuity does not occur at temperature listed above.

Unregulated Voltage Output Test - 6X4 Diesel

Reason:

To measure alternator output.

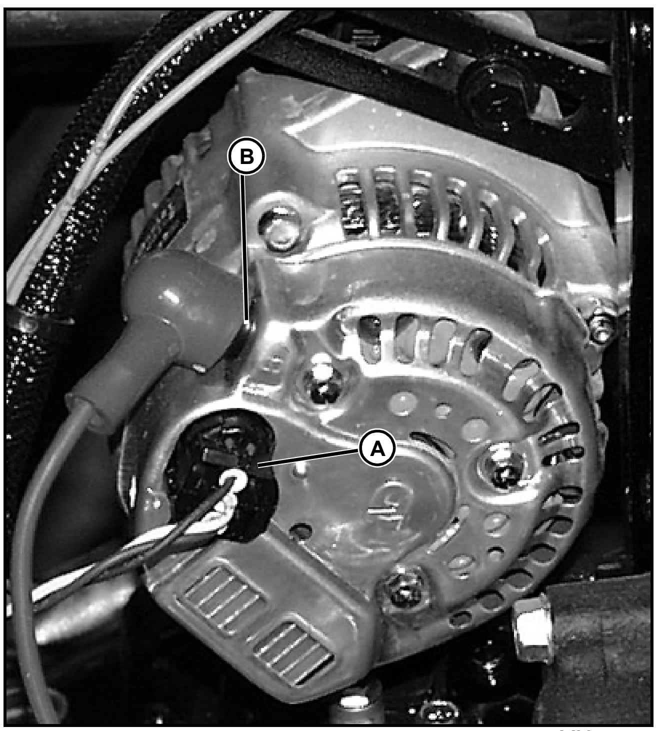
Equipment:

- Voltmeter

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 and DISENGAGE differential lock.
4. Raise cargo box, or remove the optional component installed on the machine as needed to provide clearance.

CAUTION: Avoid Injury! Engine parts may be hot. Allow engine to cool before servicing.



MX0703

5. Disconnect three pin connector (A) from alternator.
6. Connect voltmeter, set to read AC voltage, to alternator outputs (B).
7. Start and run engine at fast idle. The meter should read a minimum of 50 volts AC at FAST idle (3530 rpm).

Results:

- If reading is BELOW specification, test alternator.

Specifications:

Slow Idle . . . . 32 VAC

Fast Idle. . . . . 50 VAC

Unregulated Amperage Test - 6X4 Diesel

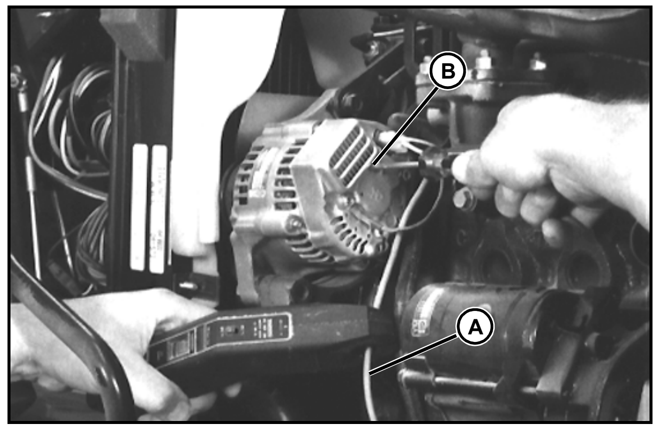
Reason:

To determine charging output of the alternator stator.

Equipment:

- JT05712 Current Gun

Connections:



M46290

1. Put JT05712 Current Gun over alternator red wire (A). Set Current Gun for DC current.

Procedure:

IMPORTANT: Avoid damage! Perform this test quickly to prevent damage to battery. DO NOT apply full load to battery for more than 10 seconds.

1. Start and run engine at 3550 rpm.
2. Insert a Phillips screwdriver through hole (B) in rear cover of alternator to ground the regulator to the rear cover. Read amperage on current gun.

Specifications:

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, replace the alternator.
- If reading meets the specification, replace the regulator. See Alternator Repair in Diesel Engine Section.

Electrical System Amperage Draw Tests

Reason:

To measure amperage draw of electrical components when battery has a discharge problem.

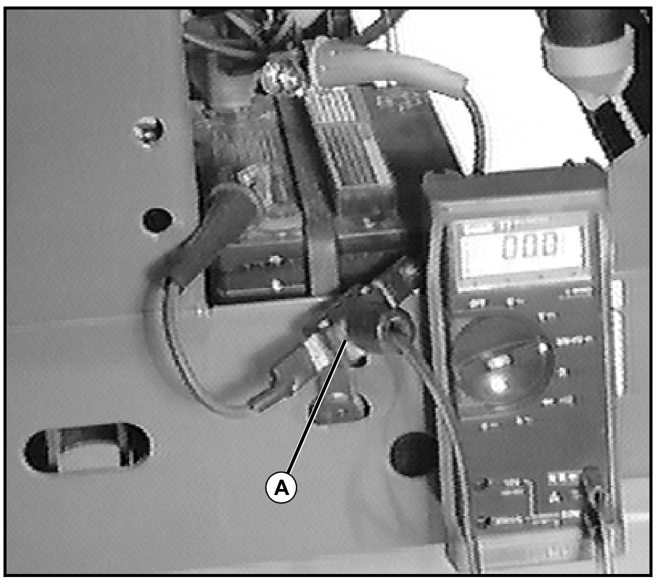
NOTE: The battery will discharge if operating several electrical components at the same time with the engine at low idle.

Equipment:

- Ammeter
- JT05792 Ammeter Shunt Assembly

Procedure:

1. Turn key switch to OFF position.



M56831

2. Disconnect battery positive cable. Connect ammeter shunt (A) to battery positive cable and battery positive terminal.
3. Turn key switch to ON position.
4. Turn one component ON at a time and measure amperage draw. Several components can be ON to measure total amperage draw to match a specific operating condition that a battery discharge occurs.

Component Amperage Draw

The following tables show approximate component amperage draw and charging output.

NOTE: Fluke Multi-Meter set at 300 mV scale for following tests.

Some of the following tests apply only to Optional Kits or Road Homologated Machines.

Component Amperage Draw* Tests conducted with key switch ON. Fuel pump and ignition amperage draw included for gas engines.

Item	4X2	6X4 Gas	6X4 Diesel
Fuel pump and ignition	N/A	0.9 - 1	N/A
Radiator fan motor	N/A	6	10
Brake light*	3.6	4.7	4.7
Differential lock light*	1.4	1.4	1.4
Headlights, position light and license plate light.*	6.9	6.9	6.9
Road homologated headlights*	9.1	9.1	9.1
Position and license plate lights*	3.95	3.9	3.9
Turn signal lights*	1.9 - 4.9	1.9 - 4.9	1.9 - 4.9
Hazard lights*	2.1 - 8.8	2.1 - 8.8	2.1 - 8.8
Lift motor (Maximum load)*	25	25	25
Lift motor (No load)*	7.9	7.9	7.9
Horn*	6.1	6.1	6.1
Hour meter*	1.1	1.1	1.1

Alternator Output - 4X2

RPM	FE290D Amperage Output
1200	3.6
3850	13.7

Alternator Output - 6X4 Gas

RPM	FD620D-AS11 (FD620D038266 -) Amperage Output	FD620D-AS11 (- FD620D038265) Amperage Output
1200	7.5	3.1
3600	15.8	21.3
3850	16	N/A

Alternator Output - 6X4 Diesel

RPM	3TN66C - JUV with cold engine Amperage Output	3TN66C - JUV with hot engine Amperage Output
1000	23	16
3550	51	42

Stator Output Results:

- If component amperage draw exceeds stator output at that engine speed, the battery will discharge. Either reduce amperage draw or do not let engine idle for extended periods of time.

Glow Plug Relay Test

Reason:

To check relay terminal continuity in the energized and de-energized condition.

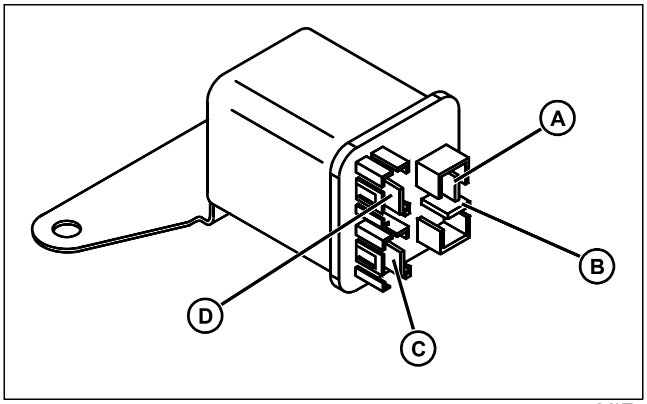
Equipment:

- Ohmmeter or continuity tester
- 12 volt battery and jumper wires

Energized 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.
5. Locate the relays mounted on the inside right frame rail.
6. Disconnect glow plug relay connector from harness.
7. Check terminal continuity using an ohmmeter or continuity tester.

Results:



MIF

- There should be continuity between terminals (A) and (B).
- There should NOT be continuity between any other terminals.

De-energized Procedure

1. Connect a jumper wire from battery positive (+) terminal to relay terminal (A). Connect a jumper wire from relay terminal (B) and ground (-).

Results:

- There should be continuity between terminals (C) and (D).
- If continuity is NOT correct, replace relay.

Glow Plug Test

Reason:

To test operation of glow plugs.

Equipment:

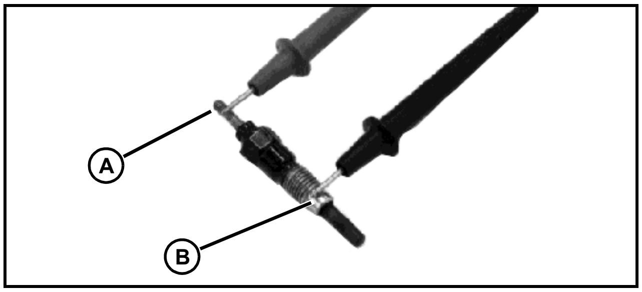
- Ohmmeter

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.

Fuel Shutoff Solenoid Test - Diesel Engine

Reason:

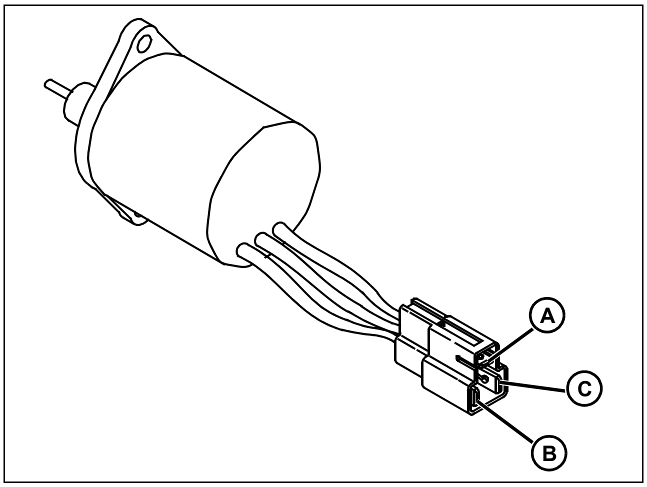
To verify fuel shutoff solenoid is functioning properly.

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.

Hazard Lights Switch Test

Reason:

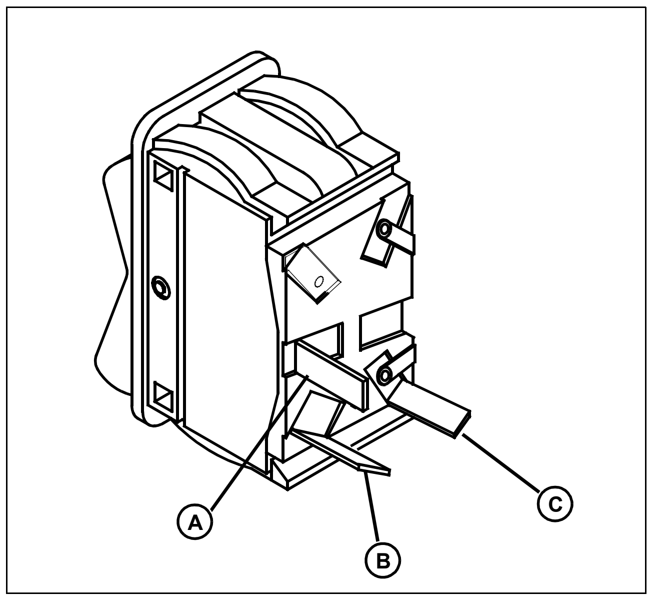
To verify hazard switch functions are operating properly.

Equipment:

- Ohmmeter

Procedure:

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Ensure park brake is LOCKED, place gear shift in NEUTRAL position.
4. Remove the hood.
5. Disconnect hazard lights switch connector from harness.
6. Use an ohmmeter to test switch continuity in the OFF and ON positions.



MIF

7. 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.

Turn Signal Switch Test

Reason:

To verify turn signal switch functions are operating properly.

Equipment:

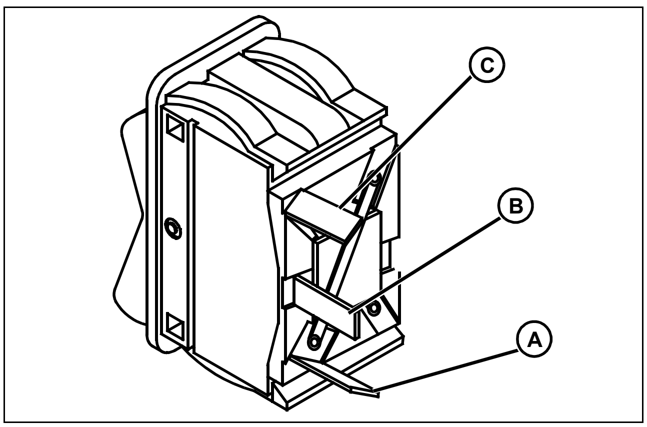
- Ohmmeter

Procedure:

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Ensure park brake is LOCKED, place gear shift in NEUTRAL position.
4. Remove the hood.
5. Disconnect turn signal switch connector from harness.
6. Use an ohmmeter to test switch continuity in OFF, RIGHT, and LEFT positions.
7. Set the multimeter to measure ohms to sequentially test continuity across each terminal combination.

OFF Position Continuity:

No continuity between any terminals.



MIF

Right Turn Position Continuity

B to A . . . . .Continuity

B to C . . . . .No Continuity

A to C . . . . .No Continuity

Left Turn Position Continuity:

B to C . . . . Continuity

B to A . . . . .No Continuity

A to C . . . . .No Continuity

Results:

- If any continuity is NOT correct, replace the turn signal switch.

Horn Switch Test

Reason:

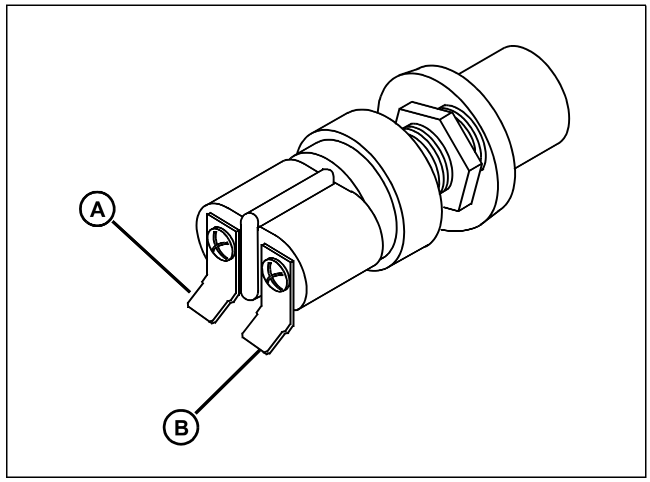
To verify the horn switch is operating properly.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Park machine on level surface.
2. Turn all switches to the OFF position.
3. Ensure park brake is LOCKED, place gear shift in NEUTRAL position and DISENGAGE differential lock.
4. Remove the grill from the front of the machine. Remove the entire hood if necessary. See Miscellaneous Section.
5. Disconnect the horn switch connectors from the switch



MIF

6. With the button released, check continuity across both switch terminals (A) and (B). There should be no continuity.
7. Depress the horn switch button. Continuity should exist between both terminals (A) and (B).

Results:

- If continuity is not correct, replace horn switch.

Ground Circuit Tests

Reason:

To check for opens, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

Equipment:

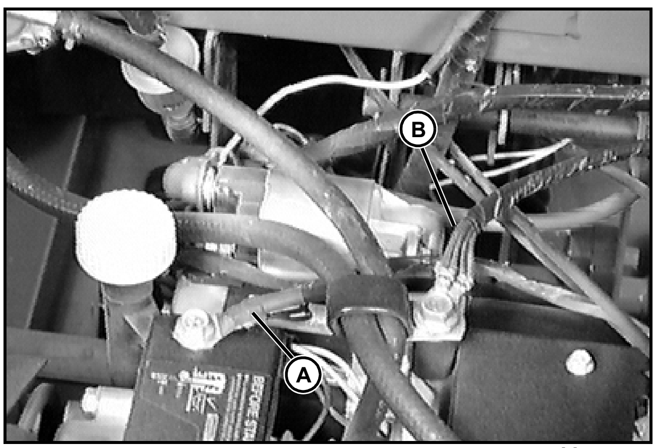
- Ohmmeter or Voltmeter.

The voltmeter method checks ground connections under load.

Procedure:

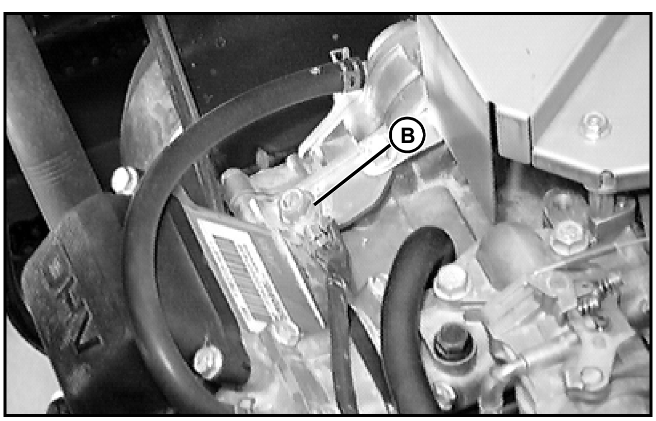
Ohmmeter Method:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Cargo box RAISED and LOCKED.



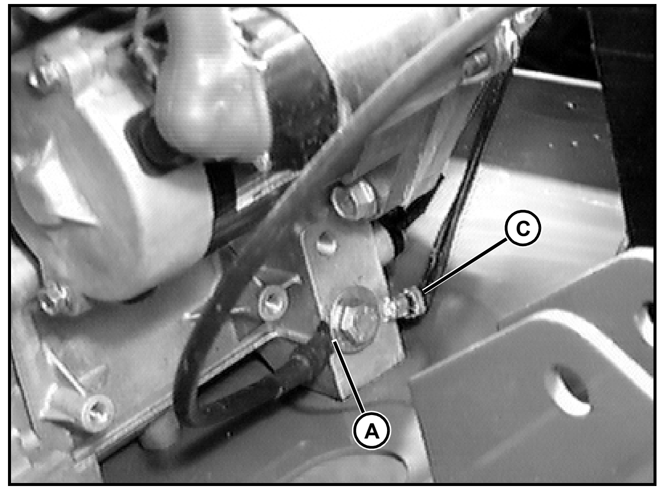
M56410

4X2 Engine and frame ground



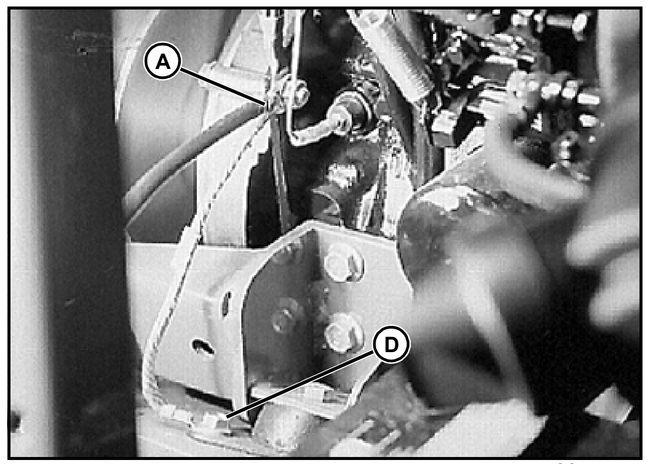
M56811

6X4 Gas Engine ground



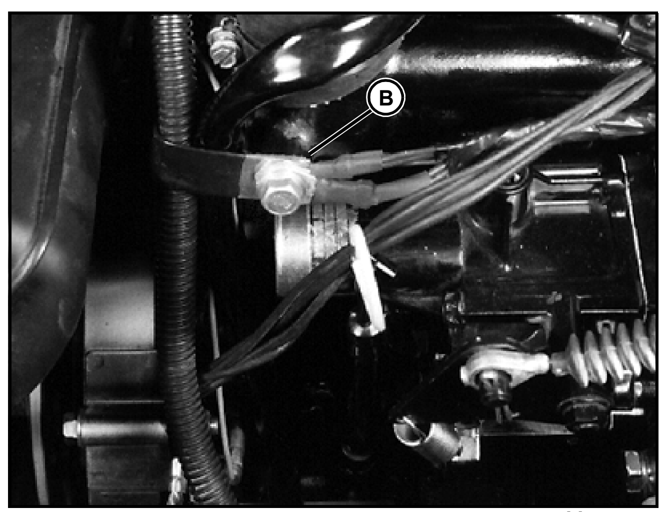
M56812

6X4 Gas frame ground



M76709

6X4 Diesel frame ground



M76833

6X4 Diesel engine ground

4. Put meter red lead on ground terminal of circuit or component:

- Harness ground (A),
- Light Kit ground (B),
- Voltage Regulator/Rectifier ground (C), and/or
- Frame ground (D) to be tested that is closest to the battery negative terminal.

5. Resistance reading must be very close to or the same as the battery negative terminal reading.

6. Work backwards from the battery on the ground side of the problem circuit until the resistance reading increases above 0.1 ohms.

7. The problem is between the last two test points.

8. If a problem is indicated, disconnect the wiring harness connector to isolate the wire or component and check resistance again.

9. Maximum allowable resistance in the circuit is 0.1 ohms.

10.Check both sides of connectors closely as disconnecting and connecting may temporarily solve problem.

Voltmeter Method:

1. Park machine on level surface and turn key switch ON.

2. Shift lever in NEUTRAL and park brake LOCKED.

3. Cargo box RAISED and LOCKED.

4. Connect voltmeter negative (black) lead to negative terminal of battery.

5. Put meter positive (red) lead on ground terminal of circuit or component (A, B, and/or C) to be tested.

6. Be sure the component circuit is activated (key ON, switches CLOSED) so voltage will be present at the component.

7. Record voltage. Voltage must be greater than 0 but less than 1 volt.

8. 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.

Cargo Box Lift Kit

Cargo Box Lift Specifications

Electrical Input12 VDC

Lift Capacity 4X2 250 Kg minimum (550 lbs) minimum

Lift Capacity 6X4 400 Kg minimum (880 lbs) minimum

Lift Rate 1.27 cm/sec (0.5 in./sec)

Stroke Length 130 mm (5.12 in.)

Current Draw28 amps @ 12 VDC - Full Load

Duty Cycle25% on time at rated load per cycle

Motor ProtectionAutomatic reset thermal overload in windings

Overload ProtectionBall Detent Overload Clutch

Temperature Range -40° to 66° C (-40° to 150° F)

DriveBall Bearing Screw

ConnectorPackard Series 56

Lead Wires14 gauge

MountingClevis mounting only

Restraining Torque 17 N•m (150 lb-in.)

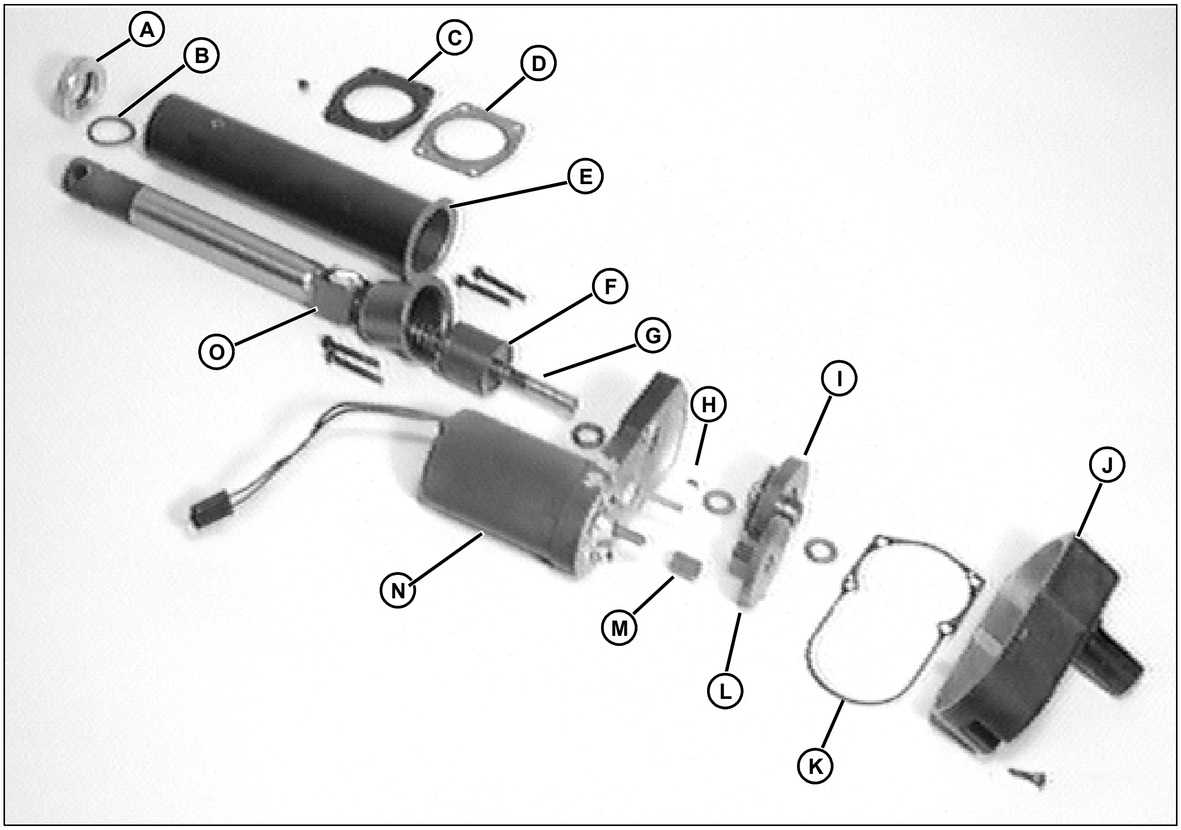
End Play 1.14 mm maximum (0.045 in.) maximum

Static Load 1818 Kg (4000 lbs)

Duty cycle means that for an actuator operating continuously for 10 seconds, it must cool for 30 seconds.

Component Location

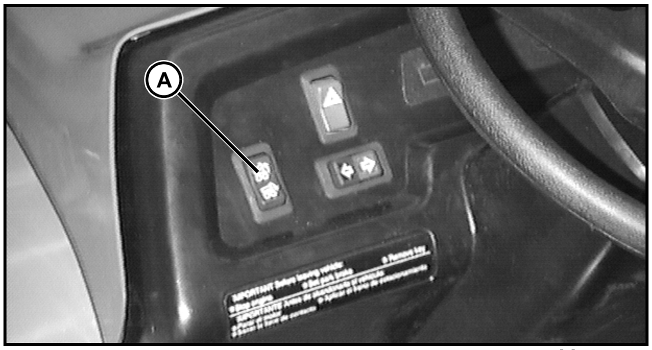
Actuator Components



M56349

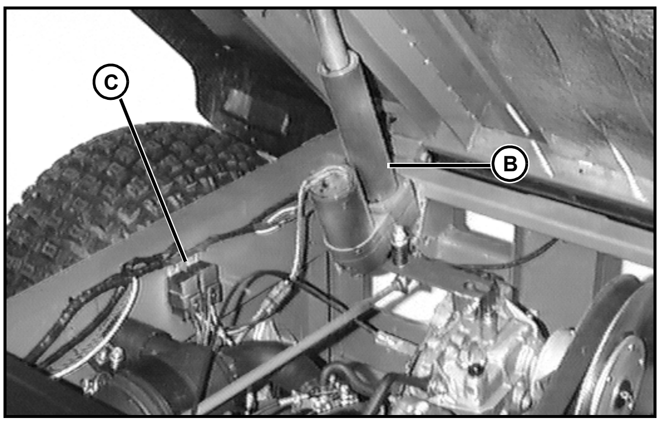
A - Seal
B - O-Ring
C - Retaining Plate
D - Tube Seal
E - Cover Tube
F - Brake
G - Screw
H - Key
I - Clutch
J - Lower Gear Housing
K - Gasket
L - Reduction Gear
M - Motor Gear
N - Motor
O - Ball Bearing Nut

Cargo Box Lift System Components



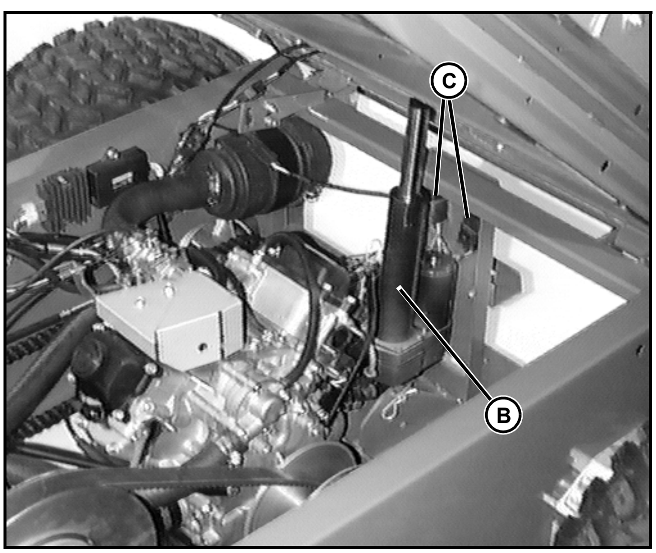
M56079

The lift control switch (A) is a three position self-centering switch.



M560807

4X2 Component Location



M55731

6X4 Gas (shown) or 6X4 Diesel

The switch (A), actuator (B), directional control relays (C), and relay harness are the same. Only the locations are different.

Schematics and Harnesses

Wiring Harness Legend - Cargo Box Lift Kit

F1 - Fusible Link (SE1, W17; SE1, W1; SE1, W2; SE1, W3)

G1 - Battery (SE1, W17; SE1, W1; SE1, W2; SE1, W3)

K1 - Raise Relay (SE2, W17)

K2 - Lower Relay (SE2, W17)

M1 - Starting Motor (SE1, W17; SE1, W1; SE1, W2; SE1, W3)

M2 - Cargo Box Lift Motor (SE2, W17)

S2 - Key Switch (SE1, W17; SE1, W1; SE1, W2; SE1, W3)

S5/S6 - Lift Switch (SE2, W17; SE6, W1; SE5, W2; SE6, W3)

W1 - Shielded Ground (SE1, W17; SE1, W1; SE1, W2; SE1, W3)

Connectors:

X1 - W17 Cargo Box Lift Kit Wiring Harness to Cargo Box Lift Motor (SE2, W17)

To S5/S6 Lift Switch:

X6 - S5/S6 Lift Switch to W1 4X2 Main Wiring Harness and W3 6X4 Diesel Main Wiring Harness (SE2, W17; SE6, W1; SE6, W3)

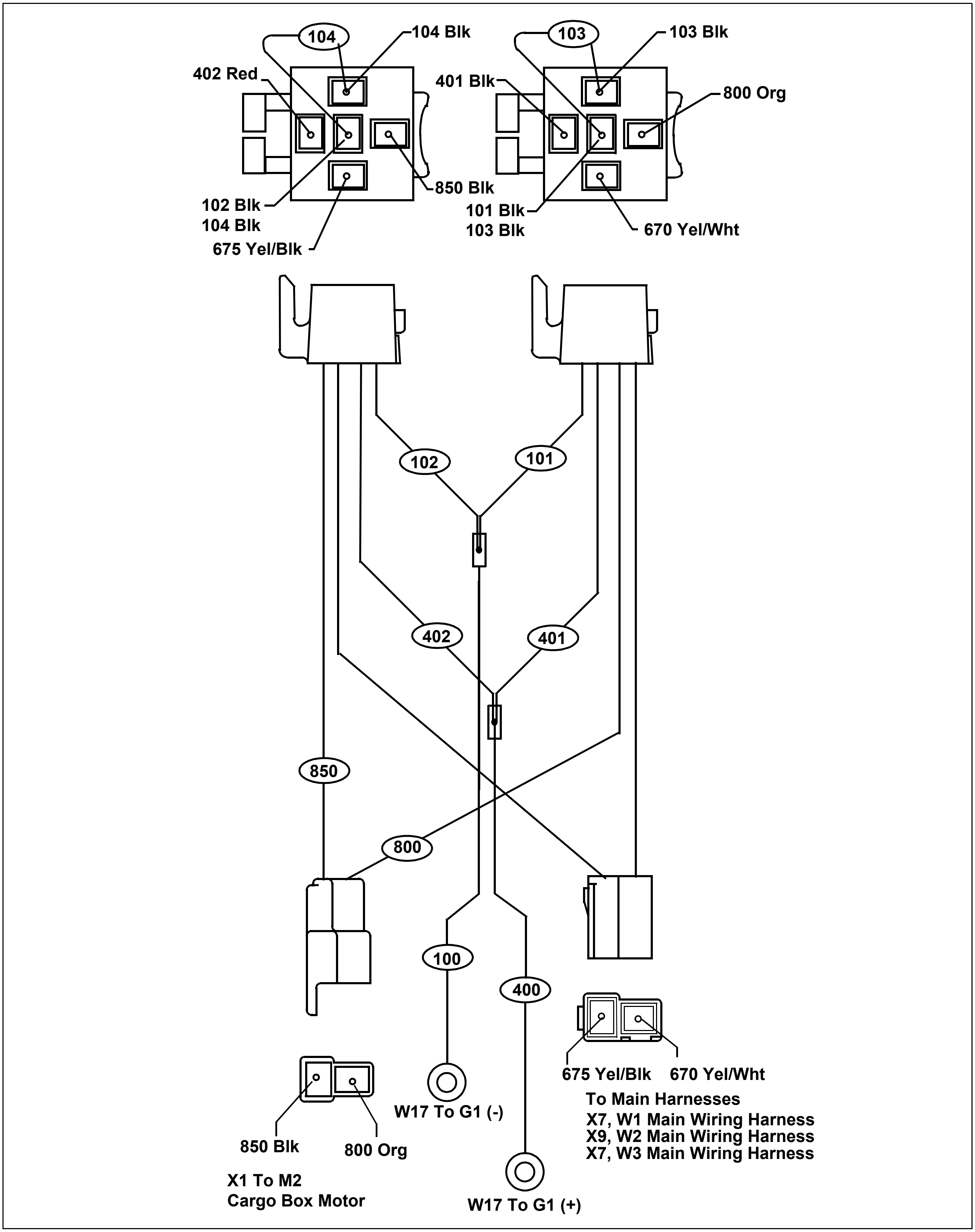
X8 - S5/S6 Lift Switch to 6X4 Gas Main Wiring Harness (SE2, W17; SE5, W2)

To W17 Cargo Box Lift Kit Main Wiring Harness:

X6 - W17 Cargo Box Lift Kit Wiring Harness to W1 4X2 Main Wiring Harness and W3 6X4 Diesel Main Wiring Harness (SE2, W17; SE6, W1; SE6, W3)

X8 - W17 Cargo Box Lift Kit Wiring Harness to 6X4 Gas Main Wiring Harness (SE2, W17; SE6, W2)

W17 Cargo Box Lift Wiring Harness



W17 Cargo Box Lift Wire Color Codes

Circuit Number	Wire Size	Color	Termination Points
100	3.0	Blk	G1 (-), 101 and 102 splice
101	2.0	Blk	K1, 102 and 100 splice
102	2.0	Blk	K2, 101 and 100 splice
103	0.8	Blk	K1, K1
104	0.8	Blk	K2, K2
400	3.0	Red	G1 (+), 401 and 402 splice, K1
401	2.0	Blk	400 and 402 splice, K1
402	2.0	Red	400 and 401 splice, K2
670	0.8	Yel/Wht	X7 (4X2 or 6X4 diesel) or X9 (6X4 gas), K1
675	0.8	Yel/Blk	X7 (4X2 or 6X4 diesel) or X9 (6X4 gas), K2
800	2.0	Org	K1, X1
850	2.0	Blk	K2, X1

Cargo Box Lift Circuit Operation

Function:

Controls the direction of current through the actuator motor, raising and lowering the cargo box.

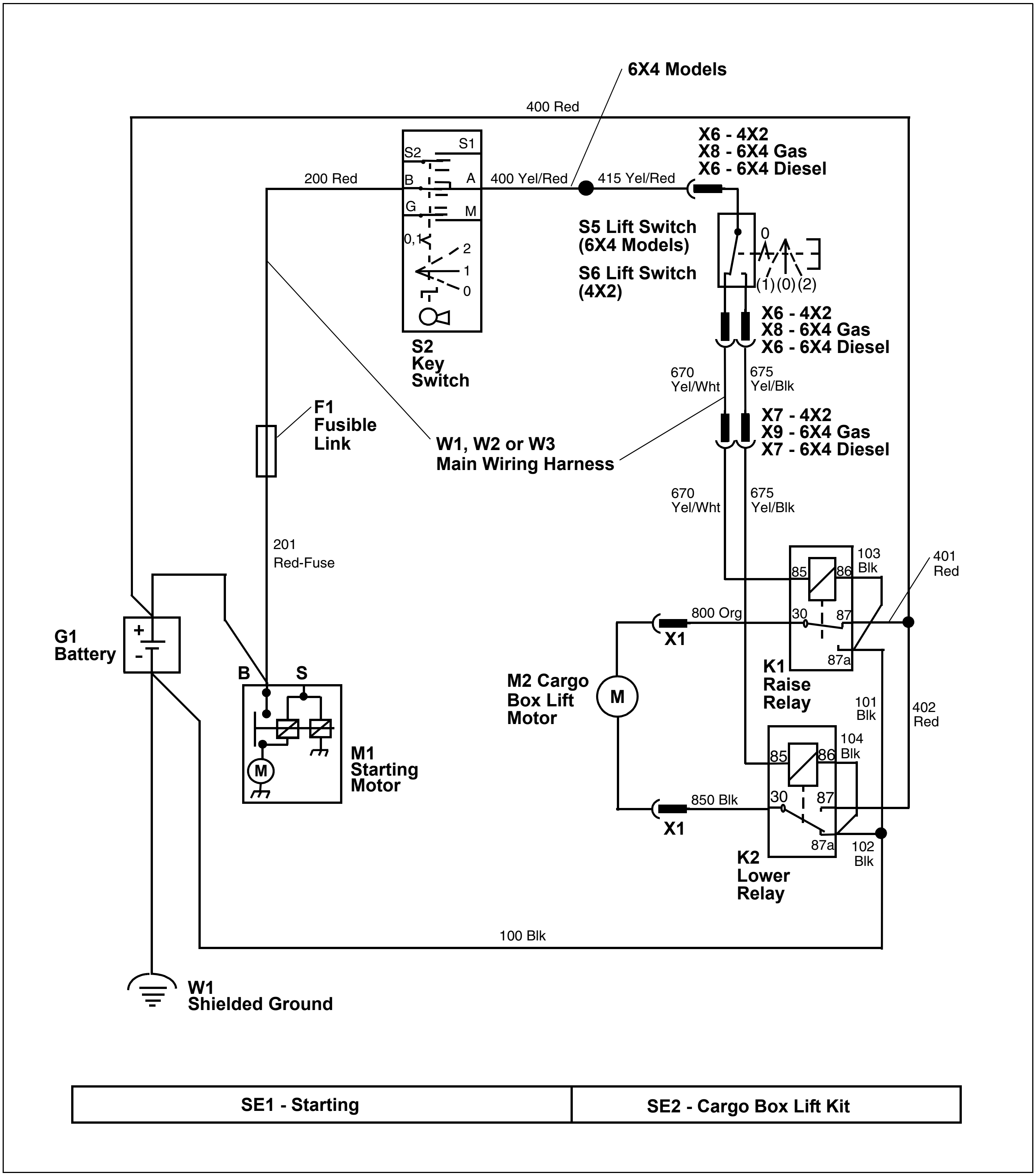
Theory of Operation:

The primary controlling circuit passes through the key switch and lift control switch. Therefore, the key must be in the RUN position for the system to operate. When the lift control switch is held to the raise or lower position, it energizes the appropriate directional relay.

The secondary circuit is connected directly to the battery positive bolt. It is protected by a fusible link. When the control circuit energizes a directional relay, the relay allows the secondary high current from the battery to flow to the motor.

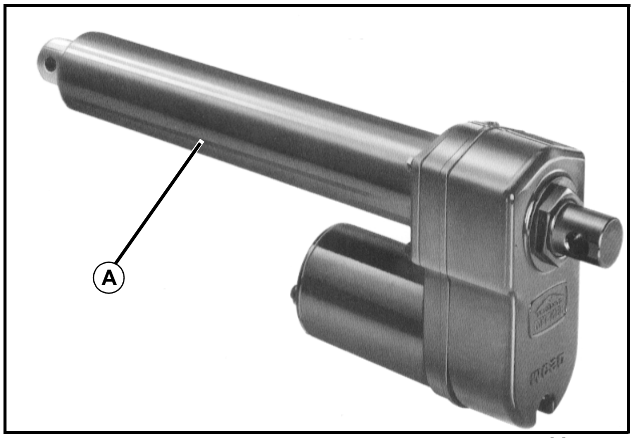
The motor ground circuit grounds through the other non-operating relay to the battery negative bolt.

Cargo Box Lift Circuit Schematic



Operation and Diagnostics

Cargo Box Lift Theory of Operation



M56081

The heart of the cargo box lift system is a linear actuator (A). It is an electromechanical, ball-bearing screw type actuator. It consist of a electric motor, gear train, drive screw and ram.

The electric motor turns the drive screw that extends and retracts the stainless steel ram from the ram tube. The direction in which the motor turns is determined by which way current flows through it. Current flow is controlled by the lift control switch and directional control relays.

Cargo Box Lift System Troubleshooting Chart

System: Electrical

(1) Does the lift operate?

No - Lift not receiving power; check connection and fusible links at starter. See “Cargo Box Lift Circuit Diagnosis” on page 406.

No - Excessive load; reduce load.

No - Fusible link burnt; replace.

No - Faulty switch. See “Cargo Box Lift Circuit Diagnosis” on page 406.

(2) Will the lift extend or raise cargo box?

No - Lift not receiving power; check connection and fusible links at starter. See “Cargo Box Lift Circuit Diagnosis” on page 406.

No - Thermal overload cut-out; let cool.

No - Stripped nut or gears; check for excessive shock loads.

No - Excessive load; reduce load.

No - Clutch worn; replace clutch.

System: Electrical

No - Brake worn, seized, or broken; replace brake.

No - Actuator binding; check distribution of load, cargo box, and lift pivot points for binding or wear.

(3) Will lift retract to lower cargo box?

No - Lift not receiving power; check connection and fusible links at starter. See “Cargo Box Lift Circuit Diagnosis” on page 406.

No - Brake worn, seized, or broken; replace brake.

No - Actuator binding; check distribution of load, cargo box, and lift pivot points for binding or wear.

(4) Does the lift stop in mid-stroke?

Yes - Thermal overload cut-out; let cool.

Yes - Brake worn, seized, or broken; replace brake.

Yes - Low voltage.

Yes - Actuator binding; check distribution of load, cargo box, and lift pivot points for binding or wear.

(5) Will the lift hold its position?

No - Brake worn, seized, or broken; replace brake.

(6) Is the lift slow?

Yes - Excessively loaded; reduce load.

Yes - Low voltage.

(7) Is there a fast thumping noise?

Yes - Excessively loaded; reduce load.

Yes - Clutch worn; replace clutch.

(8) Does the switch operate in the wrong direction?

Yes - Wire locations switched at lift control switch outlet terminals or in lift motor connector.

Cargo Box Lift Circuit Diagnosis

Test Conditions:

- Key switch in OFF position

Test/Check Point	Normal	If Not Normal
1. Battery positive post	Battery voltage (11.8 - 13.3 volts)	Check and clean battery cable connections. Test battery.
2. Terminal 87 of both control relays	Battery voltage	Check for failed fusible link. Test continuity of 400 Red wire between battery positive post and relays. Also check for short to ground. Perform Raise Motor Amperage Draw Test.
3. Key switch “B” terminal	Battery voltage	Check for failed fusible link. Check connections and continuity of 200 Red wire.

Test Conditions:

- Turn key switch to RUN position

4. Key switch “A” terminal	Battery voltage	Replace key switch.
5. Cargo box motor control switch	Battery voltage	Check connections and continuity of 415 Yel/Red wire.

Test Conditions:

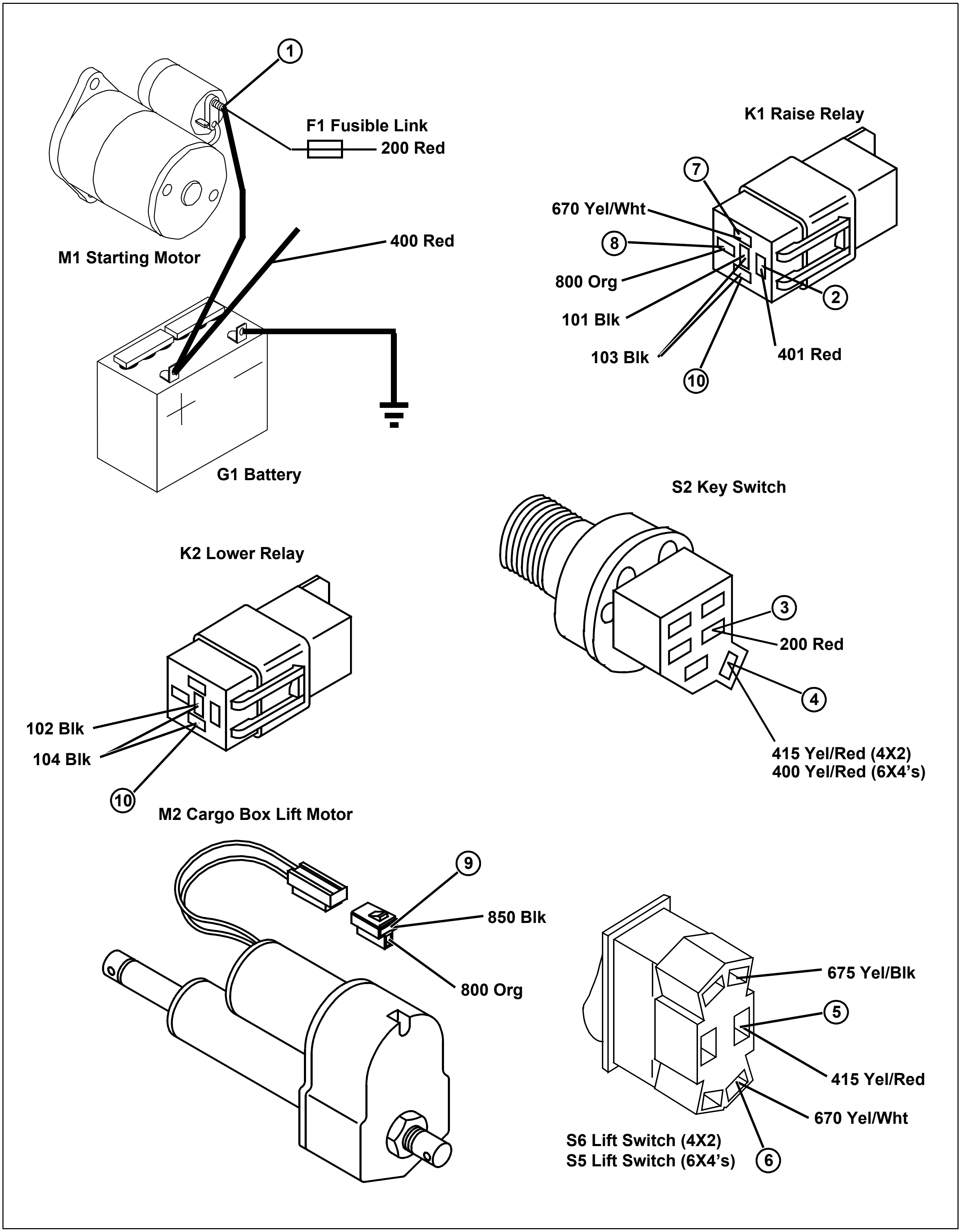
- Turn key switch to RUN position
- Depress cargo box motor control switch to raise position. Hold in position for the following test.

6. Cargo box motor control switch Yel/Wht wire	Battery voltage	Replace cargo box control switch

Test Conditions:

- Turn key switch to RUN position
- If no voltage, test with switch in lower position. Position of raise wire and lower wire may be switched. Switch position of Yel/Blk wire and Yel/Wht wire if switch direction does not match box direction.

7. Raise relay terminal 85	Battery voltage	Check connections and continuity of 670 Yel/Wht wire.
8. Raise relay terminal 30	Battery voltage	Replace relay.
9. Motor connector	Battery voltage	Check connections and continuity of 800 Org wire between connector and relay.
10. Motor connector (ground side)	Greater than 0 volts - less than 0.2 volts OR: Disconnect motor connector and measure resistance of ground circuit for less than 1 ohm resistance	Check connections at lower relay and continuity through 30 and 87a. Replace relay. Check ground wires 100, 101, 102, 103 and 104 Blk connections and continuity. Check battery ground cable connections.


1
F1 Fusible Link
200 Red
400 Red
M1 Starting Motor
G1 Battery
K1 Raise Relay
7
670 Yel/Wht
8
800 Org
101 Blk
103 Blk
10
2
401 Red
S2 Key Switch
3
200 Red
4
415 Yel/Red (4X2)
400 Yel/Red (6X4's)
K2 Lower Relay
102 Blk
104 Blk
10
M2 Cargo Box Lift Motor
9
850 Blk
800 Org
675 Yel/Blk
5
415 Yel/Red
670 Yel/Wht
S6 Lift Switch (4X2)
S5 Lift Switch (6X4's)
6

Cargo Box Lift Circuit Diagnosis (Continued)

Test Conditions:

- Turn key switch to RUN position
- If no voltage, test with switch in lower position. Position of raise wire and lower wire may be switched. Switch position of Yel/Blk wire and Yel/Wht wire if switch direction does not match box direction.

Test/Check Point	Normal	If Not Normal
11. Actuator motor	Operates and raises maximum load and holds set position	Motor operates slow. Will not hold position. See "Cargo Box Motor Amperage Draw Test" on page 410.

Test Conditions:

- Turn key switch to RUN position
- Depress and hold cargo box control switch to lower position.

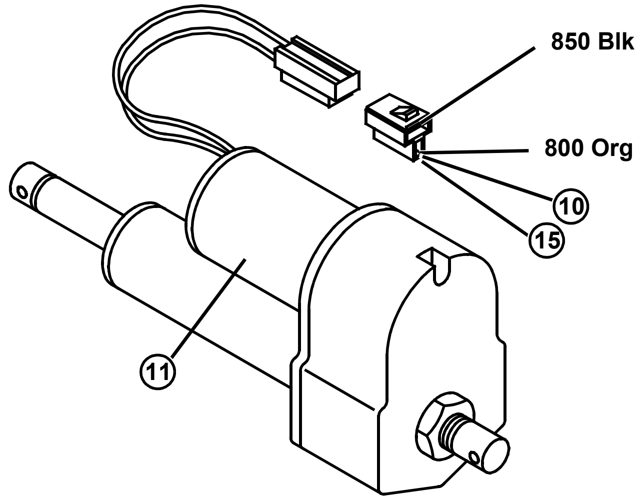
12. Cargo box control switch Yel/Blk wire	Battery voltage	Replace cargo box control switch.

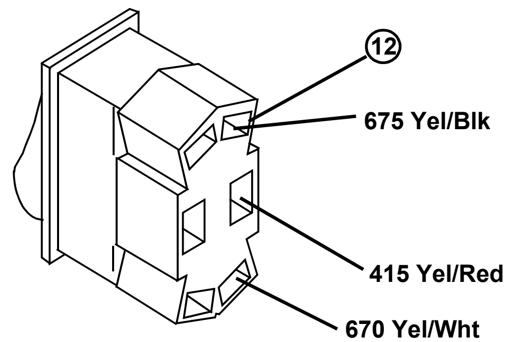
Test Conditions:

- Turn key switch to RUN position
- If no voltage, test with switch in raised position. Position of raise wire and lower wire may be switched.

13. Lower relay terminal 85	Battery voltage	Check connections and continuity of 675 Yel/Blk wire.
14. Lower relay terminal 30	Battery voltage	Replace relay.
15. Cargo box motor connector	Battery voltage	Check connections and continuity of 800 Org wire between motor and relay.
16. Cargo box motor connector (ground side).	Greater than 0 volts - less than 0.2 volts	Check connections at raise relay and continuity through 30 and 87a. Replace relay. Check 100, 101, 102, 103 and 104 Blk ground wire connections and continuity.

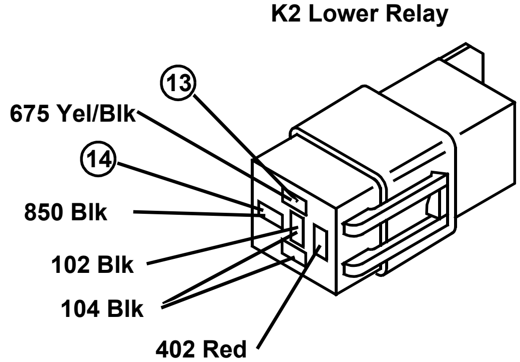
M2 Cargo Box Lift Motor

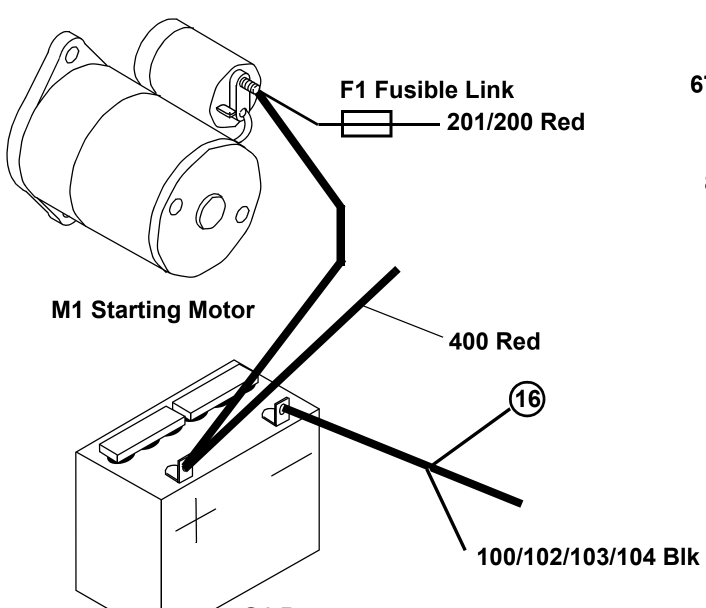




S6 Lift Switch (4X2)
S5 Lift Switch (6X4's)

K2 Lower Relay





M1 Starting Motor

G1 Battery

Cargo Box Tests and Adjustments

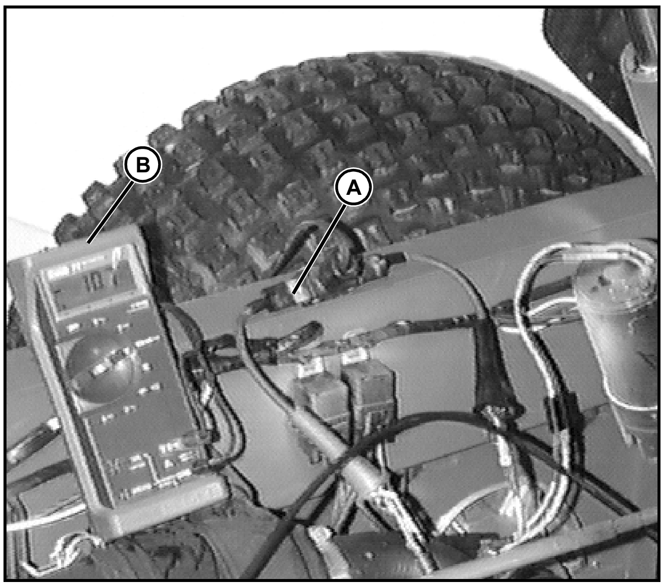
Cargo Box Motor Amperage Draw Test

Reason:

To determine the condition of cargo box motor and actuator assembly.

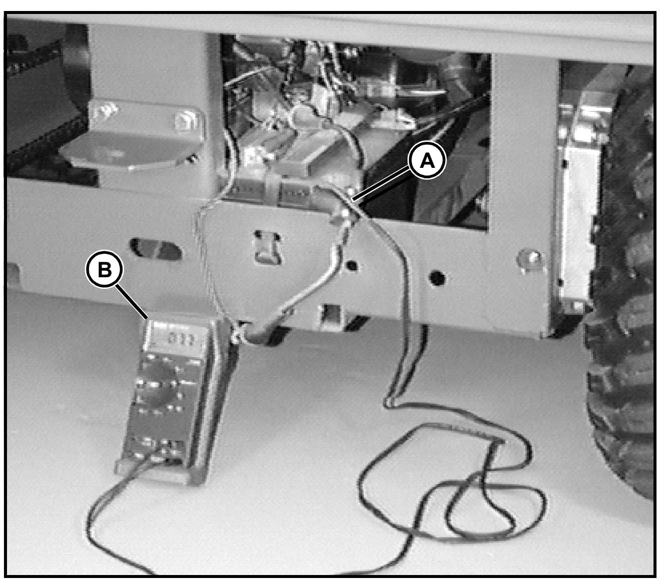
Equipment:

- JT05792 Shunt
- JT05791 Multimeter
- Jumper Wire



M56082

4X2



M56083

6X4 Gas

Procedure:

1. Battery fully charged and key in RUN position.
2. Connect JT05792 shunt (A) in series between battery connection and cargo box motor. (Some jumper wire required).
3. Connect shunt leads to JT05791 Multimeter (B).
4. Set meter to the milli-amp scale.
5. Raise box and observe amperage reading
6. Lower box and observe amperage reading.

Specifications:

Maximum Amperage Draw

No Load Up. . . . . 3 - 6 amps

No Load Down . . . . 3 - 4 amps

With Clutch Operating . . . . 4 - 28 amps

4X2 - 550 lb Load . . . . .28 amps

6X4 - 880 lb Load . . . . 28 Amps

Results:

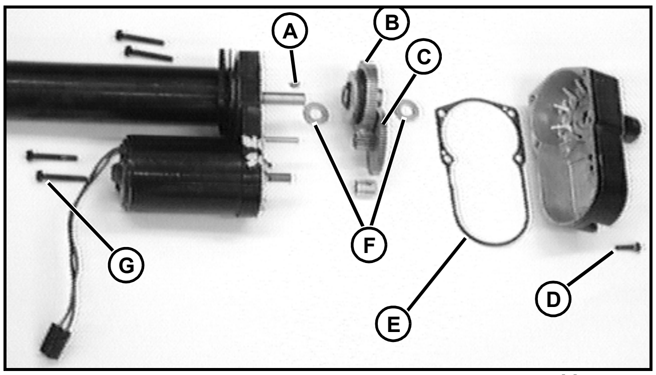
- If amperage is below specification, cargo box motor is OK, or if unit does not raise, check for stripped gears or worn clutch.
- If amperage is zero, check control circuit or fusible link.
- If control circuit and fusible link are OK, and motor will not run, thermal protector or motor maybe defective. Replace motor.
- If amperage is above specification, check cargo box for binding or gears, worm gear, or bearings causing an excessive load.
- Repair or replace cargo box actuator.

Cargo Box Repair

Actuator Repair Kits

- Clutch Kit
- Seal Kit
- Motor

Replace Actuator Clutch



M56967

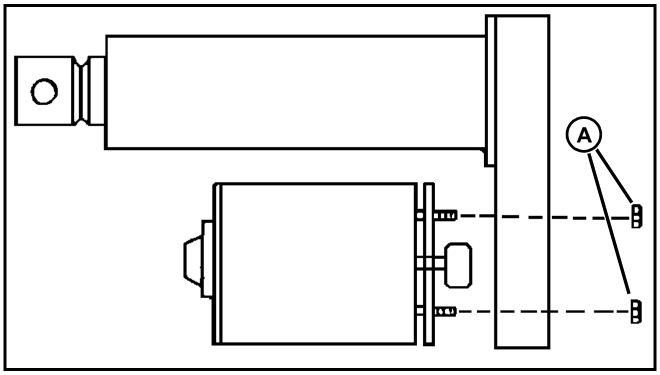
A - Key
B - Clutch
C - Intermediate Gear
D - Screw, 2.3 N•m (20 lb-in.)
E - Gasket
F - Thrust Washers
G - Screws, 8 N•m (70 lb-in.)

1. Remove gear case housing, intermediate gear (C), clutch (B), and thrust washers (F).
2. Install new clutch.
3. Install new gear case housing gasket (E).
4. Tighten hardware evenly.

Replace Motor

IMPORTANT: Avoid damage! When replacing motor, note direction that motor gear is installed. Intermediate gear teeth should ride close to the center of motor gear.

1. Remove gear case housing.
2. Remove nuts from motor.
3. Replace motor and seal.



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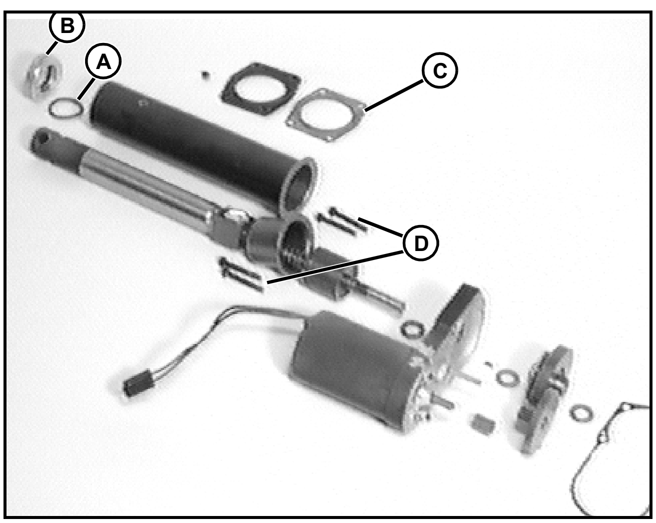
4. Tighten nuts (A) evenly to 8 N•m (70 lb-in.).

Cover Tube Seal



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If tube is removed or leaking, replace the upper o-ring (A) and lip seal (B). Drive seal and o-ring from end of tube use a disk and driver.

1. Install new seal and o-ring flush with end of tube.
2. Install new tube retaining gasket (C).
3. Install thrust tabbed thrust washer and thicker thrust washer.
4. Tighten bolts (D) evenly.

ELECTRICAL   FRONT BLADE KIT

Front Blade Kit

Front Blade Lift Specifications

Electrical Input 12 VDC

Lift Capacity 227 Kg (500 lbs)

Stroke Length 130 mm (5.12 in.)

Lift Rate 1.27 cm/sec (1 in/sec)

Current Draw 13 amps @ 12 VDC - Full Load

Duty Cycle 25% on time at rated load per cycle

Motor ProtectionAutomatic Reset Thermal Overload in Windings

Overload ProtectionBall Detent Overload Clutch

Temperature Range -40° to 66° C (-40° F to 150° F)

DriveBall Bearing Screw

ConnectorPackard Series 56

Lead Wires14 gauge

MountingClevis mounting only

Restraining Torque 10 N•m (90 lb-in.)

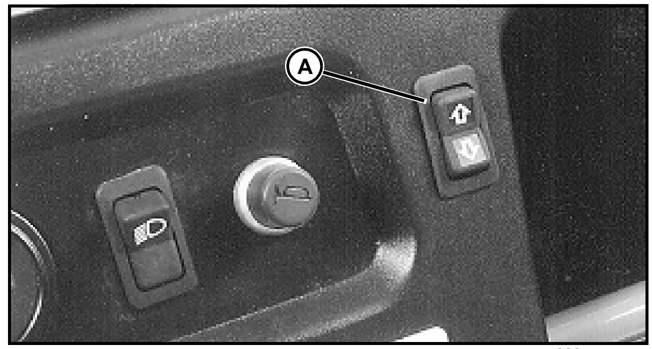
End Play (maximum) 1.14 mm (0.045 in.)

Static Load 1364 Kg (3000 lbs)

Duty cycle means that for an actuator operating continuously for 10 seconds, it must cool for 30 seconds.

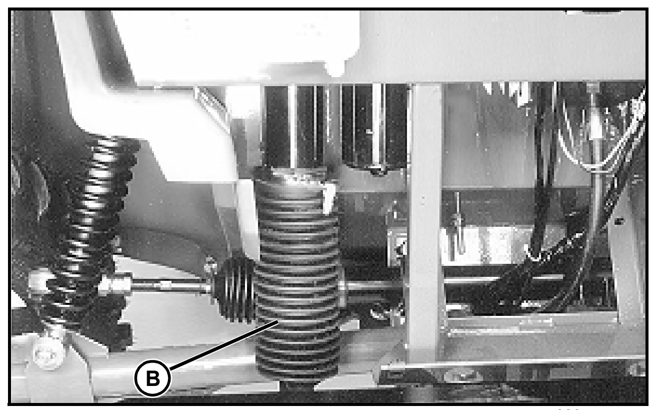
Component Location

Front Blade Lift System Components



W01846

The front blade lift switch (A) is a three position self-centering switch.



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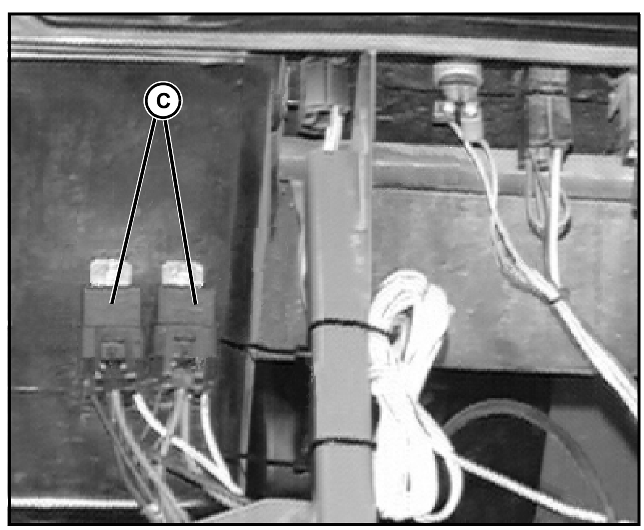
Motor Actuator Location



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Directional Relay Locations

The switch (A), actuator (B), directional control relays (C), and relay harness are the same. Only the locations are different.

Schematics and Harnesses

Wiring Harness Legend - Front Blade

F1 - Fusible Link (SE1, W17; SE1, W1; SE1, W2; SE1, W3)

F2 - Fusible Link (SE1, W27)

G1 - Battery (SE1, W17; SE1, W1; SE1, W2; SE1, W3)

K1 - Raise Relay (SE2, W27)

K2 - Lower Relay (SE2, W27)

M1 - Starting Motor (SE1, W27; SE1, W1; SE1, W2; SE1, W3)

M2 - Front Blade Motor (SE2, W27)

S1 - Front Blade Lift Switch (SE2, W27)

S2 - Key Switch (SE1, W27; SE1, W1; SE1, W2; SE1, W3)

W1 - Shielded Ground (SE1, W27; SE1, W1; SE1, W2; SE1, W3)

Connectors:

X1 - W27 Front Blade Kit Wiring Harness to Front Blade Motor (SE2, W27)

X2 - Front blade lift switch to W27 Front Blade Kit Wiring Harness (SE2, W27)

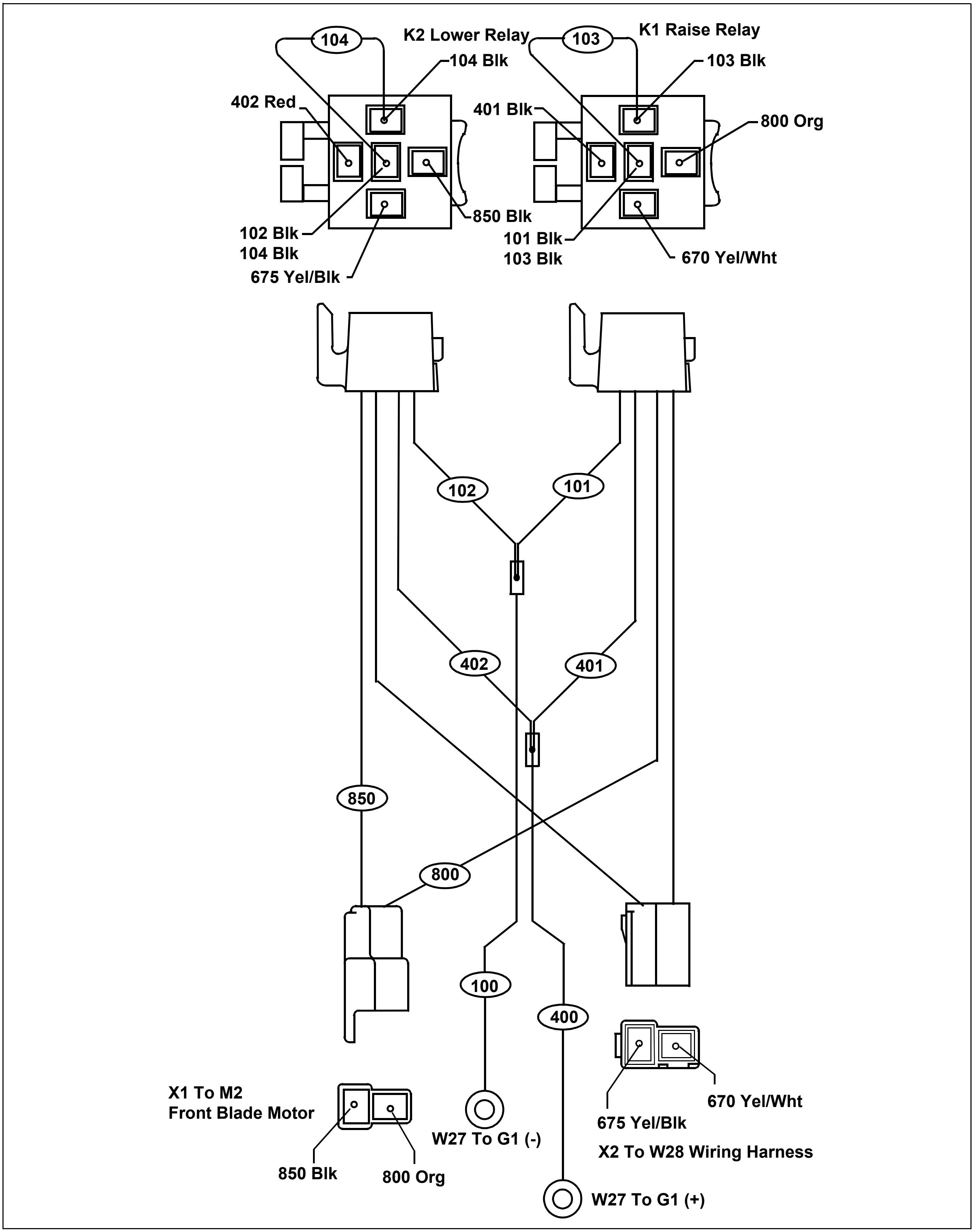
To/From W27 Front Blade Wiring Harness:

X5 - W27 Front Blade Wiring Harness to 4X2 Main Wiring Harness (SE2, W27; SE5, W1)

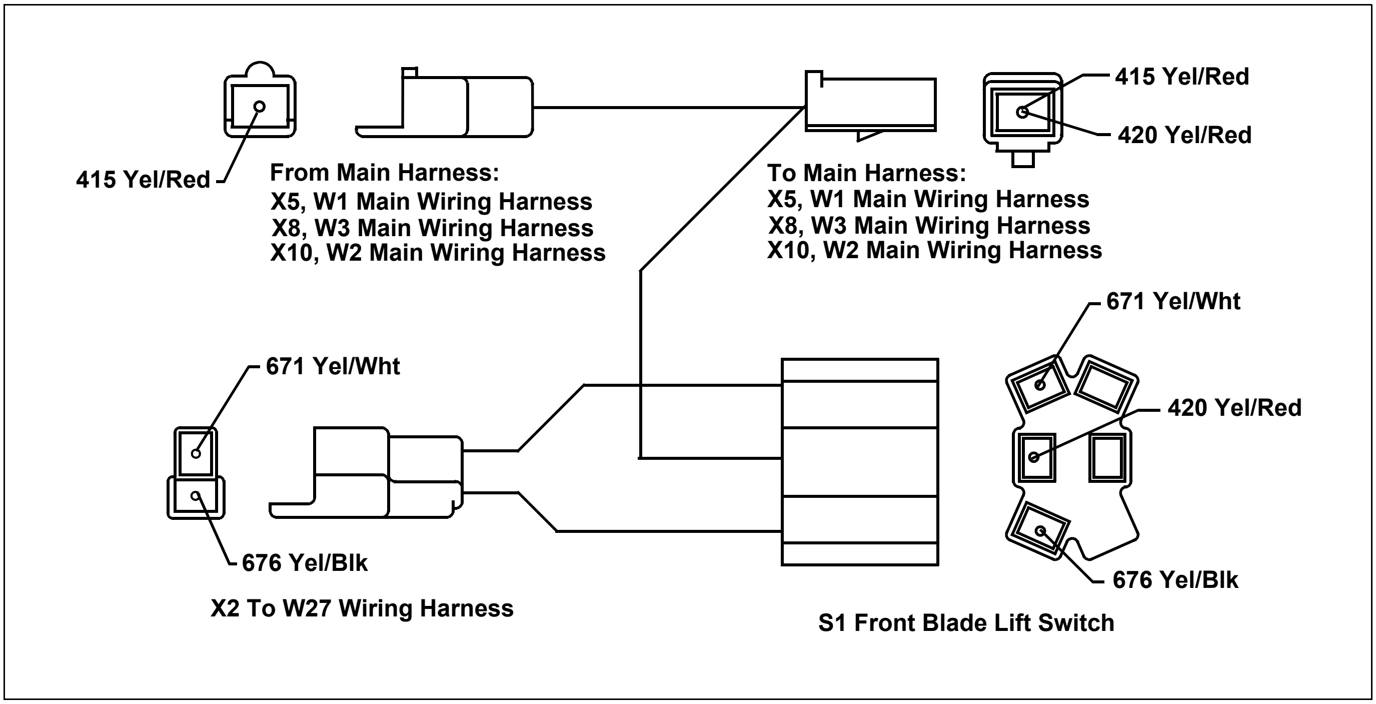
X8 - W27 Front Blade Wiring Harness to 4X6 Diesel Main Wiring Harness (SE2, W27; SE7, W3)

X10 - W27 Front Blade Wiring Harness to 6X4 Gas Main Wiring Harness (SE2, W27; SE6, W2)

W27 Front Blade Relay Wiring Harness



W28 Front Blade Switch Wiring Harness



W27 Front Blade Relay Wiring Harness Color Codes

Circuit Number	Wire Size	Color	Termination Points
100	3.0	Blk	101 and 102 splice, G1
101	2.0	Blk	K1, 102 and 100 splice
102	2.0	Blk	K2, 101 and 100 splice
103	0.8	Blk	K1, K1
104	0.8	Blk	K2, K2
400	3.0	Red	G1 (+), 401 and 402 splice
401	2.0	Blk	400 and 402 splice, K1
402	2.0	Red	400 and 401 splice, K2
415	2.0	Yel/Red	X5/X8/X10 to W1, W3, W2 Main Harness
420	0.8	Yel/Red	X5/X8/X10 to W1, W3, W2 Main Harness, S1
670	0.8	Yel/Wht	X2, K1
671	0.8	Yel/Wht	S1, X2
675	0.8	Yel/Blk	X2, K2
676	0.8	Yel/Blk	S1, X2
800	2.0	Org	K1, X1
850	2.0	Blk	K2, X1

Operation and Diagnostics

Front Blade System Troubleshooting Chart

System: Electrical

(1) Does the actuator operate?

No - Lift not receiving power; check connection and fusible links at battery. See “Front Blade Circuit Diagnosis” on page 419.

No - Fusible link burnt; replace.

No - Faulty switch. See “Front Blade Circuit Diagnosis” on page 419.

(2) Will the actuator raise the front blade?

No - Lift not receiving power; check connection and fusible links at battery. See “Front Blade Circuit Diagnosis” on page 419.

No - Thermal overload cut-out; let cool.

No - Stripped nut or gears; check for excessive shock loads.

No - Clutch worn; replace clutch.

No - Brake worn, seized, or broken; replace brake.

No - Actuator binding; check front blade lift pivot points for binding and wear.

(3) Will the actuator retract to lower the front blade?

No - Lift not receiving power; check connection and fusible links at battery. See “Front Blade Circuit Diagnosis” on page 419.

No - Brake worn, seized, or broken; replace brake.

No - Actuator binding; check front blade lift pivot points for binding and wear.

(4) Does the actuator stop in mid-stroke?

Yes - Thermal overload cut-out; let cool.

Yes - Brake worn, seized, or broken; replace brake.

Yes - Low voltage.

Yes - Actuator binding; check front blade lift pivot points for binding and wear.

(5) Will the actuator hold its position?

No - Brake worn, seized, or broken; replace brake.

(6) Is the actuator slow?

Yes - Low voltage.

(7) Is it making a fast thumping noise?

System: Electrical

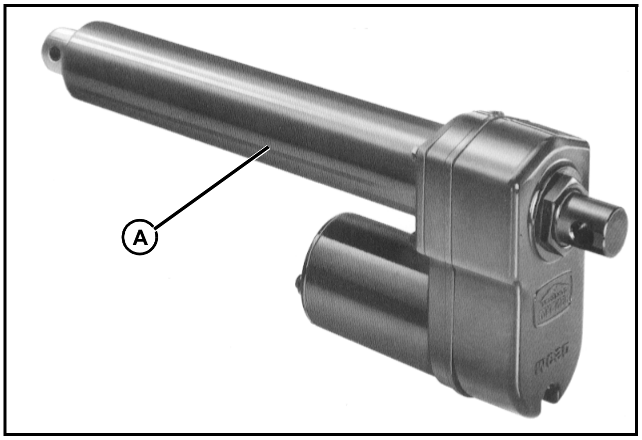
Yes - Clutch worn; replace clutch.

Yes - The cylinder is at the end of stroke or the clutch is slipping.

(8) Does the switch operate in the wrong direction?

Yes - Wire location switched at blade lift control switch outlet terminals or in blade lift motor connector.

Front Blade Theory of Operation



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The heart of the front blade system is a linear actuator (A). It is a electromechanical, ball-bearing screw type actuator. It consists of a electric motor, gear train, drive screw and ram.

The electric motor turns the drive screw that extends and retracts the stainless steel ram from the ram tube. The direction in which the motor turns is determined by which way current flows through it. Current flow is controlled by the front blade control switch and directional control relays.

Front Blade Circuit Operation

Function:

Controls the direction of current through the actuator motor, raising and lowering the front blade.

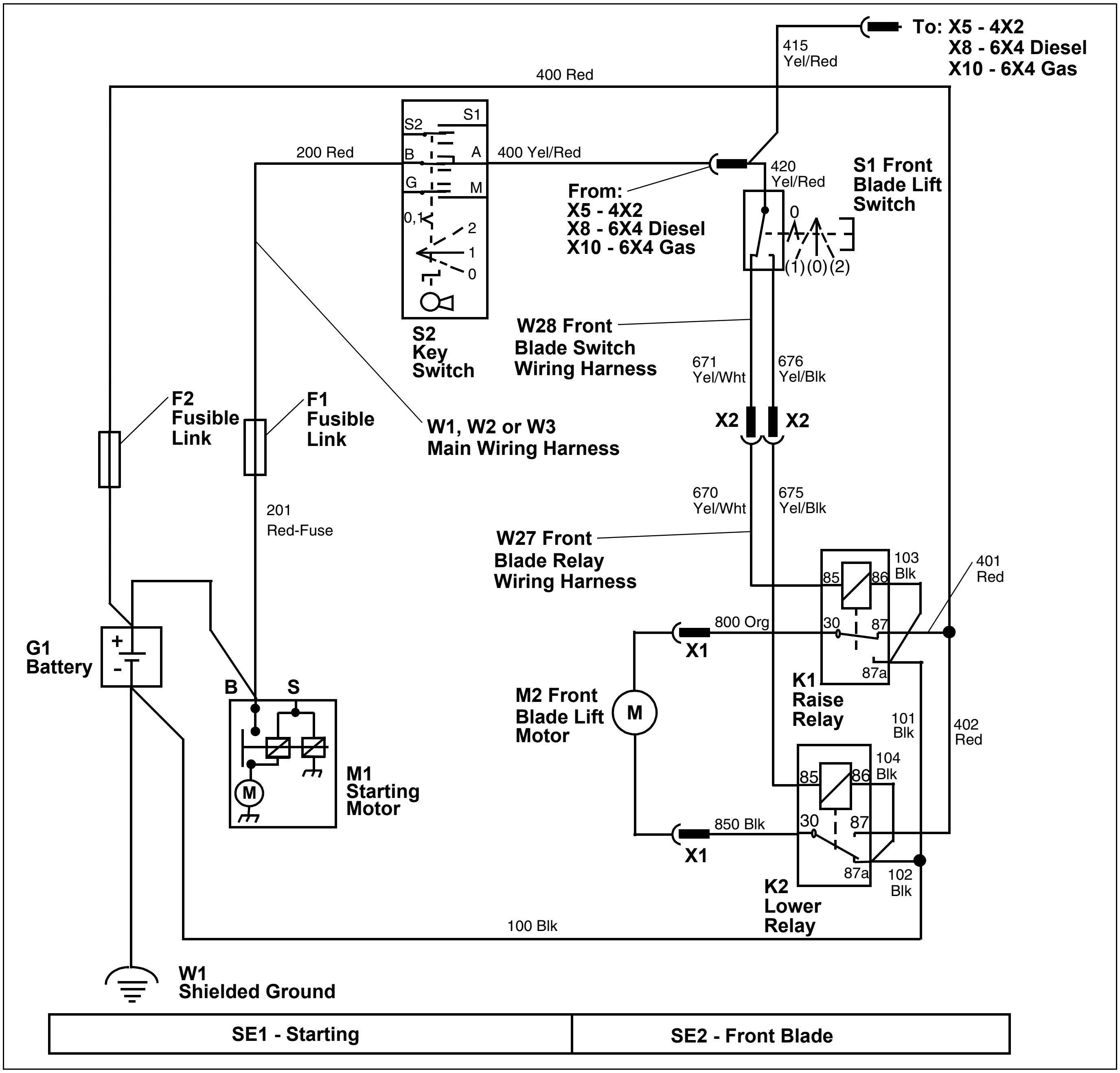
Theory of Operation:

The primary controlling circuit passes through the key switch and lift control switch. Therefore, the key must be in the RUN position for the system to operate. When the lift control switch is held to the raised or lower position, it energizes the appropriate directional relay.

The secondary circuit is connected directly to the battery positive bolt. It is protected by a fusible link. When the control circuit energizes a directional relay, the relay allows the secondary high current from the battery to flow to the motor.

The motor ground circuit grounds through the other non-operating relay to the battery negative bolt.

Front Blade Circuit Schematic



Front Blade Circuit Diagnosis

Test Conditions:

- Key switch in OFF position

Test/Check Point	Normal	If Not Normal
1. Battery positive post	Battery voltage (11.8 - 13.3 volts)	Check and clean battery cable connections. Test battery.
2. Terminal 87 of both control relays	Battery voltage	Check for failed fusible link. Test continuity of 400 Red wire between battery positive post and relays. Also check for short to ground. See “Front Blade Motor Amperage Draw Test” on page 423.
3. Key switch “B” terminal	Battery voltage	Check for failed fusible link. Check connections and continuity of 200 Red wire.

Test Conditions:

- Turn key switch to RUN position

4. Key switch “A” terminal	Battery voltage	Replace key switch.
5. Front blade lift switch	Battery voltage	Check connections and continuity of 400 Yel/Red wire, connections, and 420 Yel/Red wire.

Test Conditions:

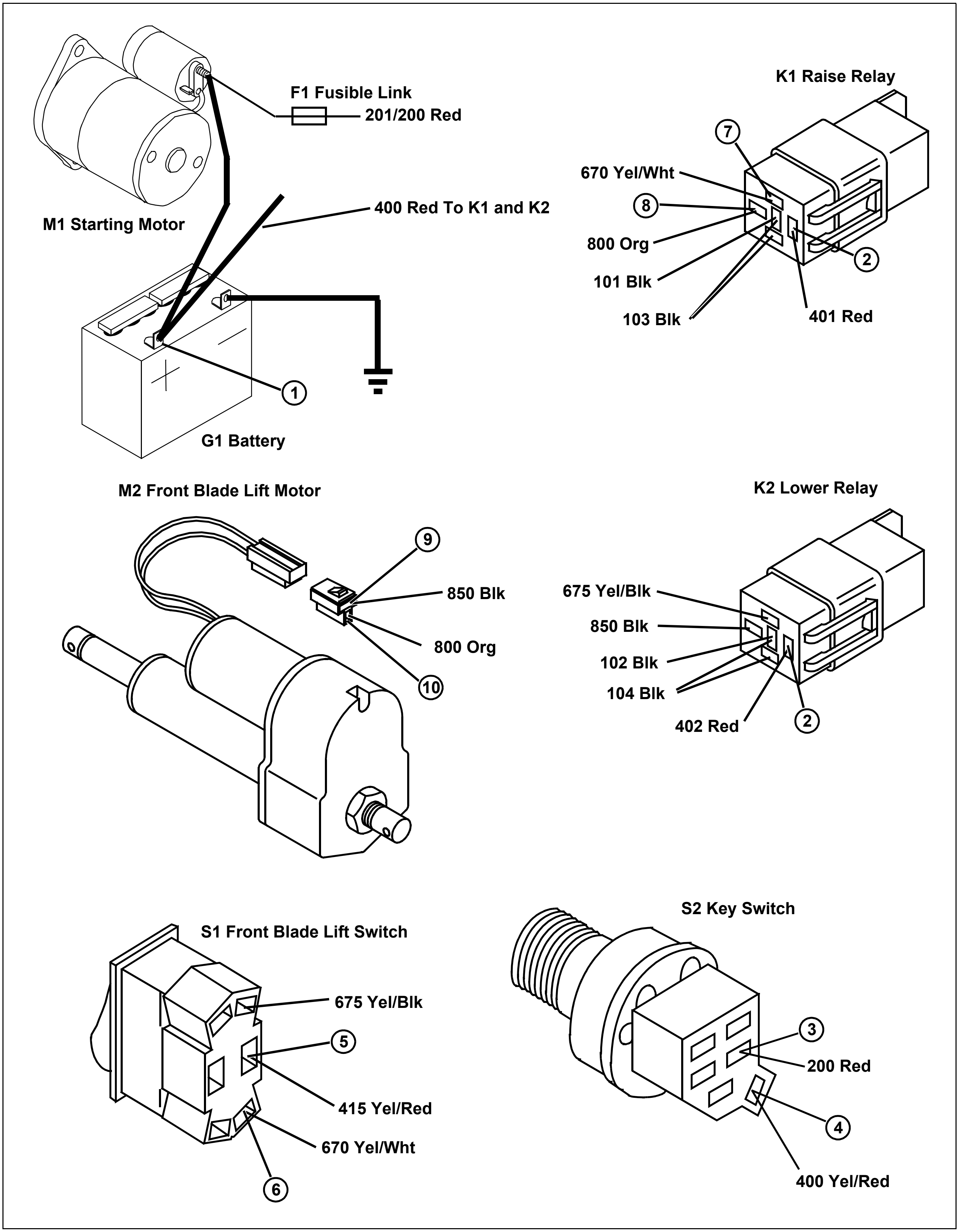
- Turn key switch to RUN position
- Depress cargo box motor control switch to raise position. Hold in position for the following test.

6. Front blade lift switch Yel/Wht wire	Battery voltage	Replace front blade control switch.

Test Conditions:

- Turn key switch to RUN position
- If no voltage, test with switch in lower position. Position of raise wire and lower wire may be switched. Switch position of Yel/Blk wire and Yel/Wht wire if switch direction does not match box direction.

7. Raise relay terminal 85	Battery voltage	Check connections and continuity of 670 Yel/Wht wire.
8. Raise relay terminal 30	Battery voltage	Replace relay.
9. Motor connector	Battery voltage	Check connections and continuity of 800 Org wire between connector and relay.
10. Motor connector (ground side)	Greater than 0 volts - less than 0.2 volts OR: Disconnect motor connector and measure resistance of ground circuit for less than 1 ohm resistance	Check connections at lower relay and continuity through 30 and 87a. Replace relay. Check ground wires 100, 101, 102, 103 and 104 Blk connections and continuity. Check battery ground cable connections.



F1 Fusible Link
201/200 Red
K1 Raise Relay
7
670 Yel/Wht
8
800 Org
101 Blk
103 Blk
2
401 Red
400 Red To K1 and K2
M1 Starting Motor
1
G1 Battery
M2 Front Blade Lift Motor
K2 Lower Relay
9
850 Blk
800 Org
10
675 Yel/Blk
850 Blk
102 Blk
104 Blk
402 Red
2
S1 Front Blade Lift Switch
675 Yel/Blk
5
415 Yel/Red
670 Yel/Wht
6
S2 Key Switch
3
200 Red
4
400 Yel/Red

Front Blade Circuit Diagnosis (Continued)

Test Conditions:

- Turn key switch to RUN position
- If no voltage, test with switch in lower position. Position of raise wire and lower wire may be switched. Switch position of Yel/Blk wire and Yel/Wht wire if switch direction does not match box direction.

Test/Check Point	Normal	If Not Normal
11. Actuator motor	Operates and raises maximum load and holds set position	Motor operates slow. Will not hold position. See “Front Blade Motor Amperage Draw Test” on page 423. Repair or replace motor. See “Replace Actuator Clutch” on page 423. See “Replace Actuator Clutch” on page 411.

Test Conditions:

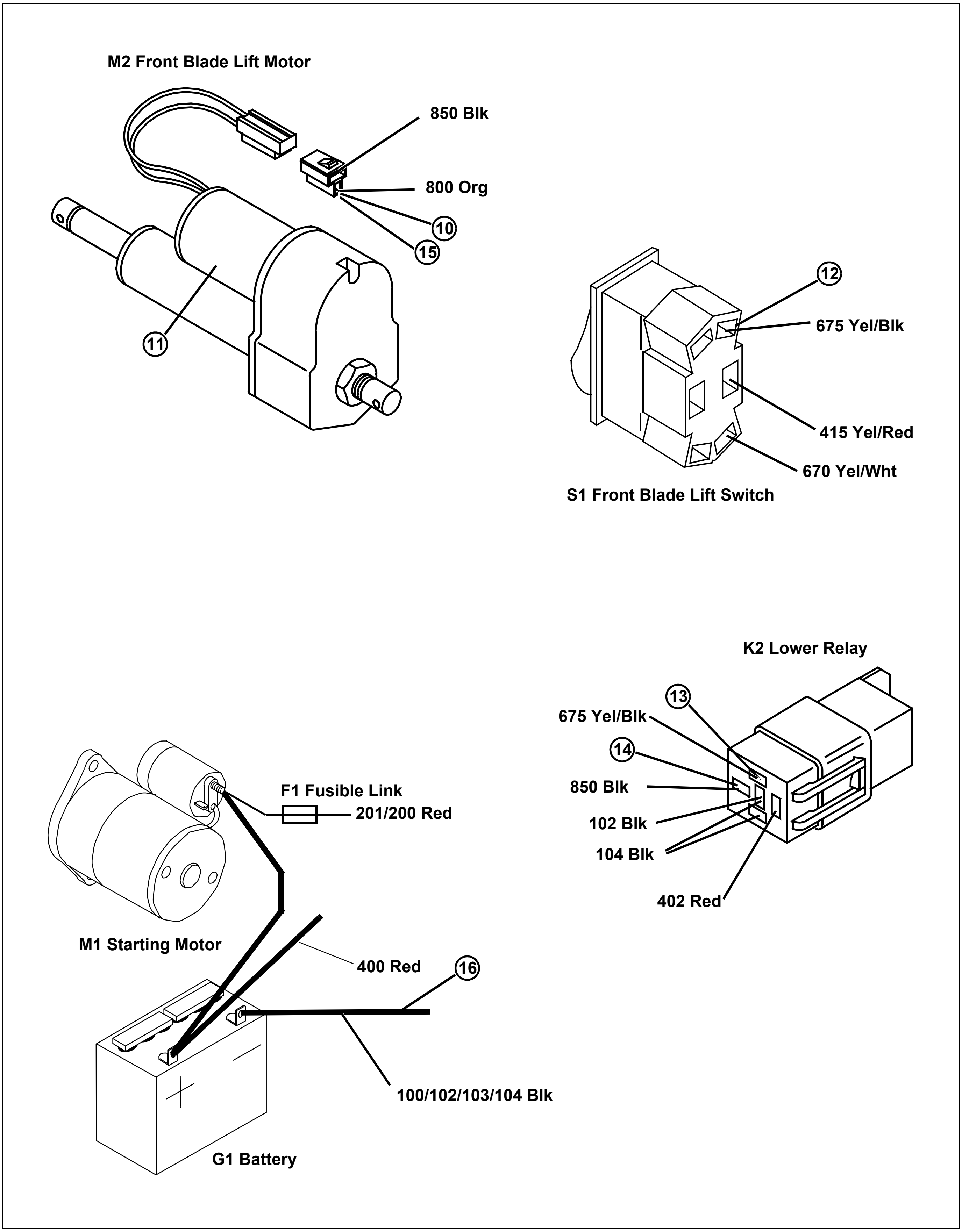
- Turn key switch to RUN position
- Depress and hold front blade control switch to lower position.

12. Front blade lift switch Yel/Blk wire	Battery voltage	Replace front blade control switch.

Test Conditions:

- Turn key switch to RUN position
- If no voltage, test with switch in raised position. Position of raise wire and lower wire may be switched.

13. Lower relay terminal 85	Battery voltage	Check connections and continuity of 675 Yel/Blk wire.
14. Lower relay terminal 30	Battery voltage	Replace relay.
15. Front blade motor connector	Battery voltage	Check connections and continuity of 800 Org wire between motor and relay.
16. Front blade motor connector (ground side).	Greater than 0 volts - less than 0.2 volts	Check connections at raise relay and continuity through 30 and 87a. Replace relay. Check 100, 101, 102, 103 and 104 Blk ground wire connections and continuity.


M2 Front Blade Lift Motor
850 Blk
800 Org
10
15
11
12
675 Yel/Blk
415 Yel/Red
670 Yel/Wht
S1 Front Blade Lift Switch
K2 Lower Relay
13
675 Yel/Blk
14
850 Blk
102 Blk
104 Blk
402 Red
F1 Fusible Link
201/200 Red
M1 Starting Motor
400 Red
16
100/102/103/104 Blk
G1 Battery

Front Blade Tests and Adjustments

Front Blade Motor Amperage Draw Test

Reason:

To determine the condition of front blade motor and actuator assembly.

Procedure:

1. Battery fully charged and key in RUN position.
2. Connect shunt in series between battery connection and front blade motor. (Some jumper wire required).
3. Connect shunt leads to voltmeter.
4. Set meter to the milli-amp scale.
5. Raise blade and observe amperage reading
6. Lower blade and observe amperage reading.

Specifications:

Maximum Amperage Draw

No Load Up . . . . 3 - 6 Amps

No Load Down . . . . 3 - 4 Amps

With Clutch Operating . . . . 4 - 13 Amps

Results:

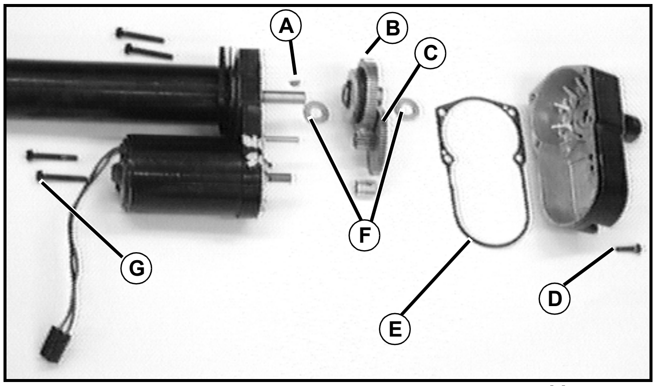
- If amperage is below specification, front blade motor is OK, or if blade does not raise, check for stripped gears or worn clutch.
- If amperage is zero, check control circuit or fusible link.
- If control circuit and fusible link are OK, and motor will not run, thermal protector or motor maybe defective. Replace motor.
- If amperage is above specification, check front blade for binding or gears, worm gear or bearings causing an excessive load.
- Repair or replace front blade actuator.

Front Blade Repair

Actuator Repair Kits

- Clutch Kit
- Seal Kit
- Motor

Replace Actuator Clutch



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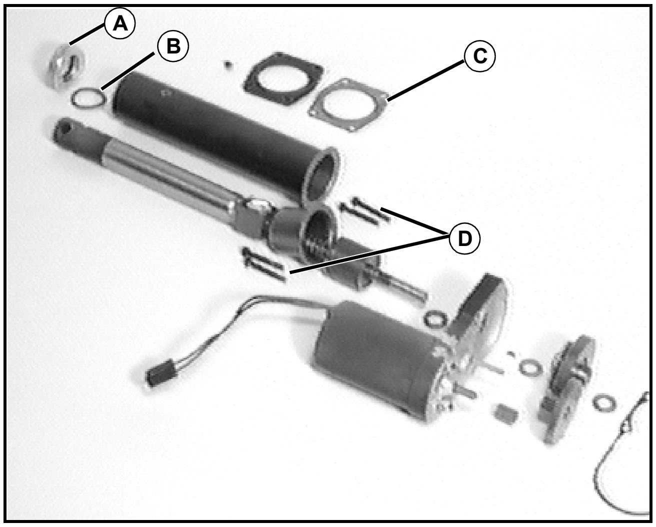
A - Key
B - Clutch
C - Intermediate Gear
D - Screw, 23 N•m (20 lb-in.)
E - Gasket
F - Thrust washers
G - Bolts, 8 N•m (70 lb-in.)

1. Remove gear case housing, intermediate gear, clutch and thrust washers.
2. Install new clutch.
3. Install new gear case housing gasket.
4. Tighten hardware evenly.

Cover Tube Seal



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A - Seal
B - O-Ring
C - Gasket
D - Bolts (4)

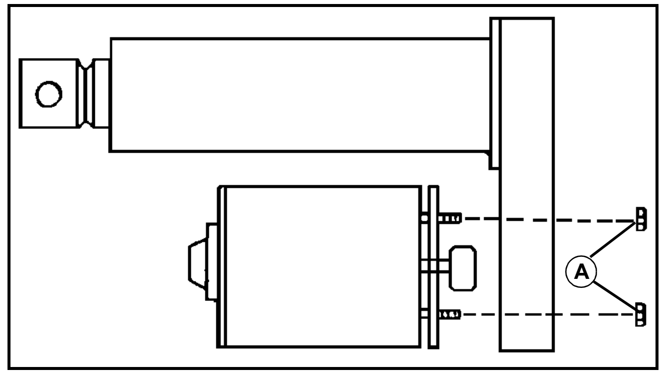
If tube is removed or leaking, replace the upper o-ring and lip seal. Drive seal and o-ring from end of tube using a disk and driver.

1. Install new seal and o-ring flush with end of tube.
2. Install new tube retaining gasket.
3. Install thrust tabbed thrust washer and thicker thrust washer.
4. Tighten hardware evenly.

Replace Motor

IMPORTANT: Avoid damage! When replacing motor, note direction that motor gear is installed. Intermediate gear teeth should ride close to the center of motor gear.

1. Remove gear case housing.



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2. Remove nuts (A) from motor.
3. Replace motor and seal.
4. Tighten nuts evenly.

Hour Meter

Wiring Harness Legend - Hour Meter

F1 - Fusible Link (SE1, W26; SE1, W1; SE1, W2; SE1, W3)

G1 - Battery (SE1, W26; SE1, W1; SE1, W2; SE1, W3)

M1 - Starting Motor (SE1, W26; SE1, W1; SE1, W2; SE1, W3)

P1 - Hour Meter (SE2, W26)

S2 - Key Switch (SE1, W26; SE1, W1; SE1, W2; SE1, W3)

W1 - Shielded Ground (SE1, W26; SE1, W1; SE1, W2; SE1, W3)

Connectors:

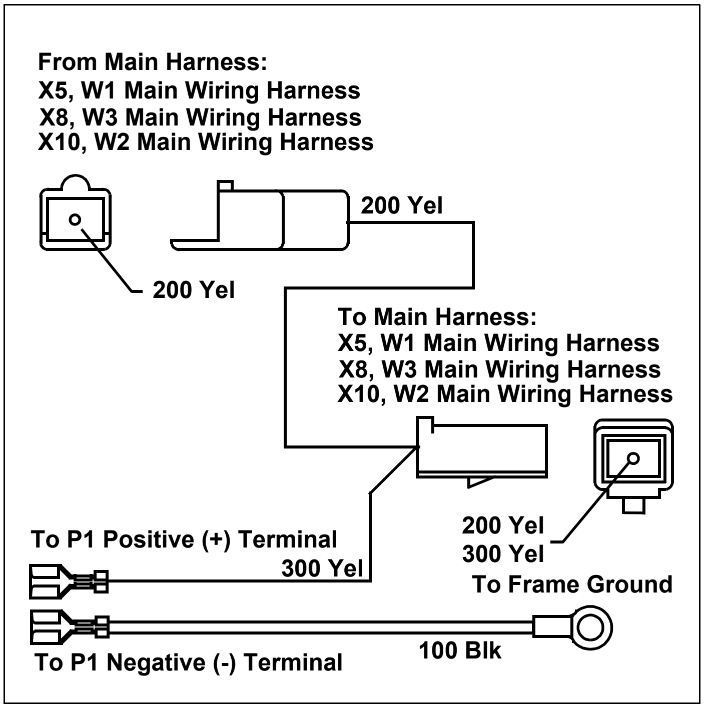
To/From W26 Front Blade Wiring Harness:

X5 - W26 Hour Meter Wiring Harness to 4X2 Main Wiring Harness (SE2, W27; SE5, W1)

X8 - W26 Hour Meter Wiring Harness to 4X6 Diesel Main Wiring Harness (SE2, W27; SE7, W3)

X10 - W26 Hour Meter Wiring Harness to 6X4 Gas Main Wiring Harness (SE2, W27; SE6, W2)

W26 Hour Meter Wiring Harness



W26 Hour Meter Wiring Harness Color Code Chart

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Blk	P1, Frame Ground
200	2.0	Yel	X5/X8/X10, X5/X8/X10
300	1.0	Yel	X5/X8/X10, P1

Hour Meter Circuit Operation

Function:

To record the number of hours the key switch is in the RUN position.

Operating Conditions:

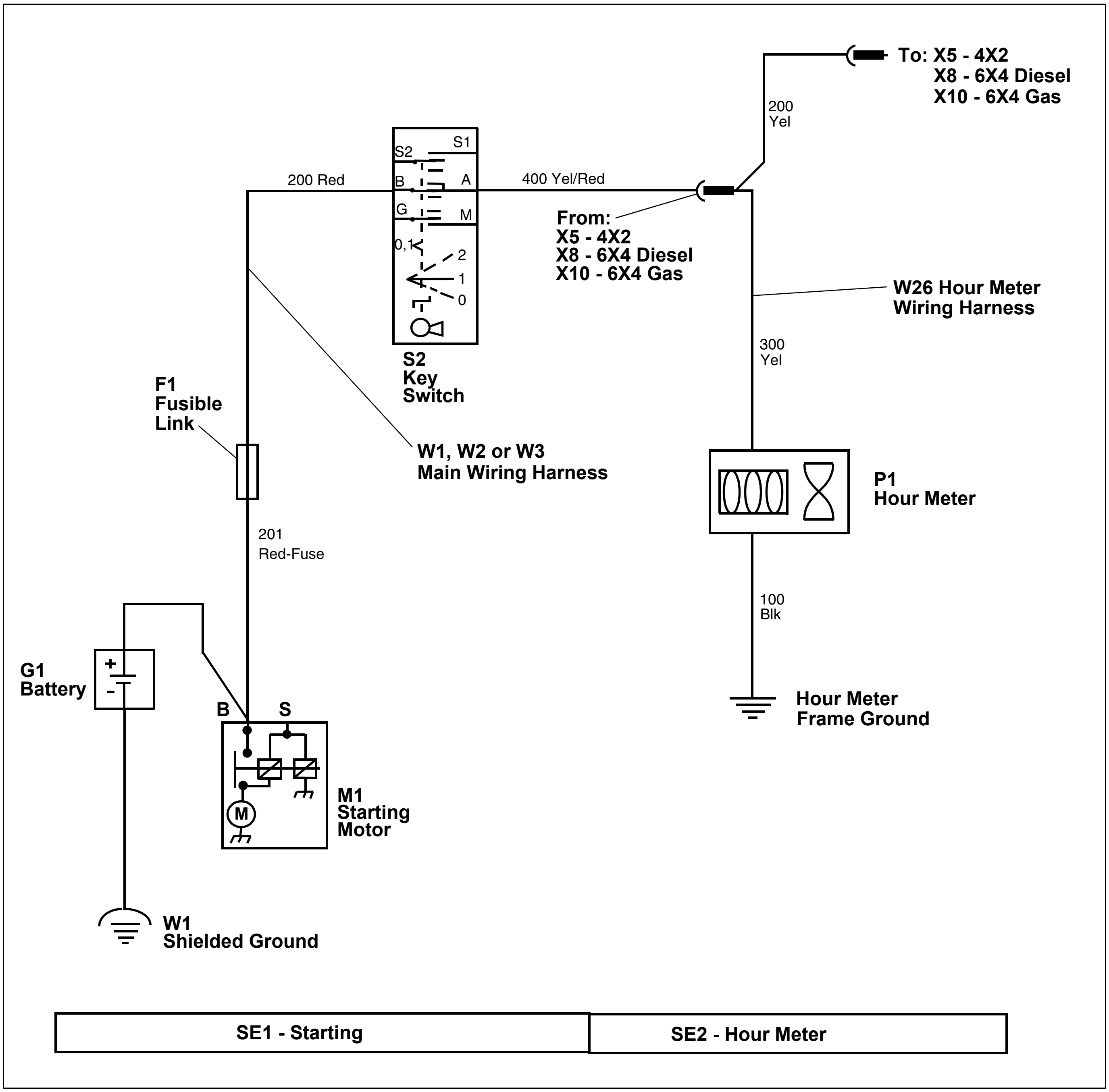
- Key switch in RUN position.

Theory of Operation:

The power circuit provides current to the key switch (S2) and protects the hour meter circuit with a fusible link (F1). Current flows from the battery (G1) positive (+) terminal to the fusible link and key switch. With the key switch in the RUN position, current flows to the wire harness connection and hour meter (P1).

The ground circuit provides a path to frame ground for the hour meter.

Hour Meter Circuit Schematic



Hour Meter Circuit Diagnosis

Test Conditions:

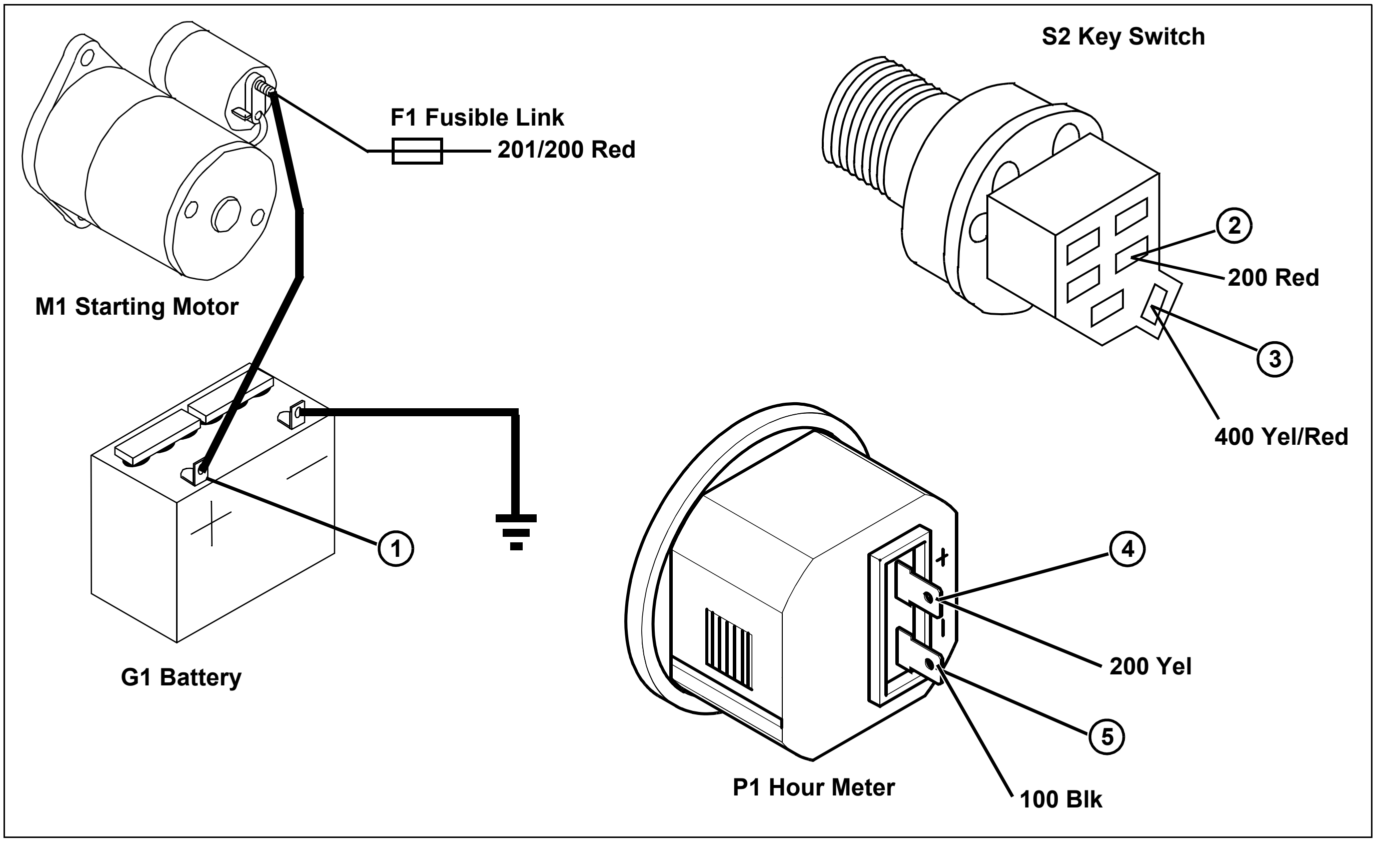
- Key switch in OFF position.
- Park brake set.

Test/Check Point	Normal	If Not Normal
1. Battery positive post	Battery voltage (11.8 - 13.3 volts)	Check and clean battery cable connections. Test battery.
2. Key switch "B" terminal	Battery voltage	Check for failed fusible link. Check connections and continuity of 200 Red wire.

Test Conditions:

- Turn key switch in RUN position

Test/Check Point	Normal	If Not Normal
3. Key switch "A" terminal	Battery voltage	Replace key switch.
4. Hour meter	Battery voltage	Check connections and continuity of 400 Yel/Red wire, connections, and 200 Yel wire.
5. Hour meter connector (ground side)	Disconnect hour meter connector. Measure resistance of ground circuit for less than 0.1 ohm resistance.	Check ground 100 Blk wire and connections. Replace hour meter.



W18 North American/European Light and Horn Kit (Earlier Model)

W18 Light and Horn Schematic and Wiring Harness Legend (Earlier Model)

B1 - Horn (SE5, W18)

E1 - Left Rear Turn Signal Light (SE2, W18)

E2 - Left Front Turn Signal Light (SE2, W18)

E3 - Right Front Turn Signal Light (SE2, W18)

E4 - Right Rear Turn Signal Light (SE2, W18)

E5 - Right Rear Position Light (SE3, W18)

E6 - Left Front Position Light (SE3, W18)

E7 - Right Front Position Light (SE3, W18)

E8 - Left Rear Position Light (SE3, W18)

E9 - Left Headlight (SE3, W18)

E10 - Right Headlight (SE3, W18)

E11 - Left Brake Light (SE4, W18)

E12 - Right Brake Light (SE4, W18)

F1 - Fusible Link (SE1, W18; SE1, W1; SE1, W2; SE1, W3)

F2 - Fusible Link (SE1, W18)

F3 - 15 Amp Fuse (SE2, W18)

F4 - 10 Amp Fuse (SE3, W18)

F5 - 10 Amp Fuse (SE3, W18)

F6 - 10 Amp Fuse (SE3, W18)

F7 - 10 Amp Fuse (SE3, W18)

F8 - 15 Amp Fuse, Spare (SE4, W18)

F9 - 10 Amp Fuse (SE4, W18)

F10 - 10 Amp Fuse (SE4, W18)

G1 - Battery (SE1, W18; instead of SE1, W1; SE1, W2; SE1, W3)

K1 - Flasher (SE2, W18)

M1 - Starting Motor (SE1, W18; instead of SE1, W1; SE1, W2; SE1, W3)

S1 - Hazard Switch (SE2, W18)

S2 - Key Switch (SE1, W18; instead of SE1, W1; SE1, W2; SE1, W3)

S3 - Park Brake Switch - (SE4, W18; SE4, W1; SE5, W2; SE6, W3)

S4 - Turn Signal Switch (SE2, W18)

S5 - Light Switch (SE3, W18; SE5, W1)

S6 - Light Switch (SE3, W18; SE6, W2; SE7, W3)

S7 - Brake Pedal Switch (SE4, W18)

S8 - Horn Switch (SE5, W18)

V1 - Diode (SE2, W18)

V2 - Diode (SE4, W18)

W1 - Shielded Ground (SE1, W18; SE1, W1; SE1, W2; SE1, W3)

Connectors:

X1 - W18 Light and Horn Wiring Harness to W20 Rear Position/Brake/Turn Wiring Harness (SE2, W18; SE3, W18; SE4, W18)

X2 - W18 Light and Horn Wiring Harness to W22 Left Front Position/Turn Wiring Harness (SE2, W18; SE3, W18)

X3 - W18 Light and Horn Wiring Harness to W22 Right Front Position/Turn Wiring Harness (SE2, W18; SE3, W18)

X4 - W18 Light and Horn Wiring Harness Ground Connection to W1 Main Wiring Harness (4X2) (SE1, W18; SE5, W1)

X5 - W18 Light and Horn Wiring Harness Ground Connection to W3 Main Wiring Harness (6X4 Diesel) (SE1, W18; SE6, W3)

X5 - W18 Light and Horn Wiring Harness Power Connection to W1 Main Wiring Harness (4X2) (SE2, W18; SE5, W1)

X6 - W18 Light and Horn Wiring Harness to W21 Rear Position/Brake/Turn Wiring Harness (SE2, W18; SE3, W18; SE4, W18)

X7 - W18 Light and Horn Wiring Harness to W25 Headlight Adaptor Wiring Harness (when used) (SE3, W18)

X8 - W18 Light and Horn Wiring Harness Power Connection to W3 Main Wiring Harness (6X4 Diesel) (SE2, W18; SE7, W3)

X9 - W18 Light and Horn Wiring Harness to W25 Headlight Adaptor Wiring Harness (when used) (SE3, W18)

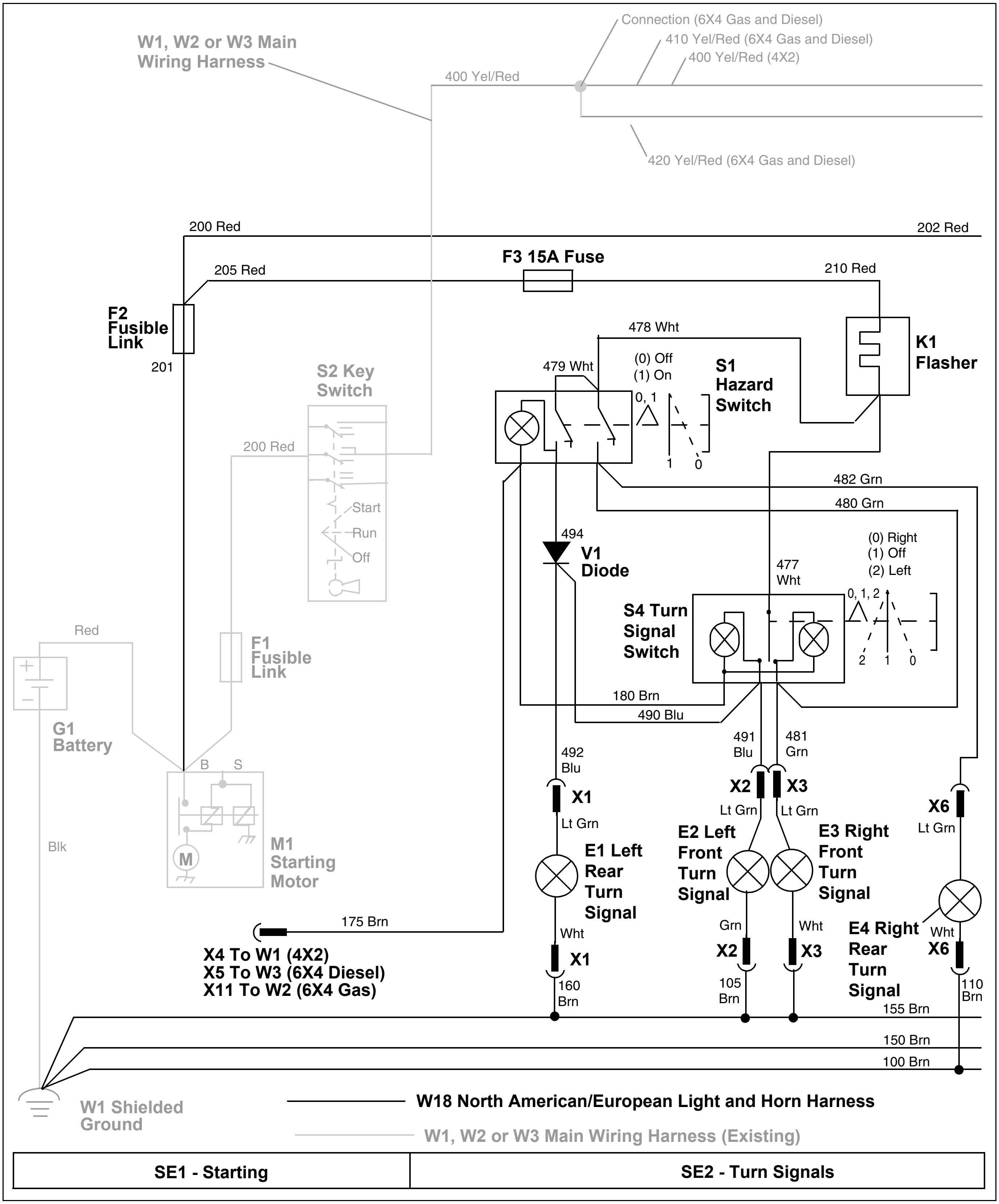
X10 - W18 Light and Horn Wiring Harness Power Connection to W2 Main Wiring Harness (6X4 Gas) (SE2, W18; SE6, W2)

X11 - W18 Light and Horn Wiring Harness Ground Connection to W2 Main Wiring Harness (6X4 Gas) (SE1, W18; SE6, W2)

X12 - W18 Light and Horn Wiring Harness to W1, W2 or W3 Main Wiring Harness (SE4, W18)

W18 Light and Horn Wiring Schematic (Earlier Model)

W18 Light and Horn Wiring Schematic (Earlier Model) (1 of 2)



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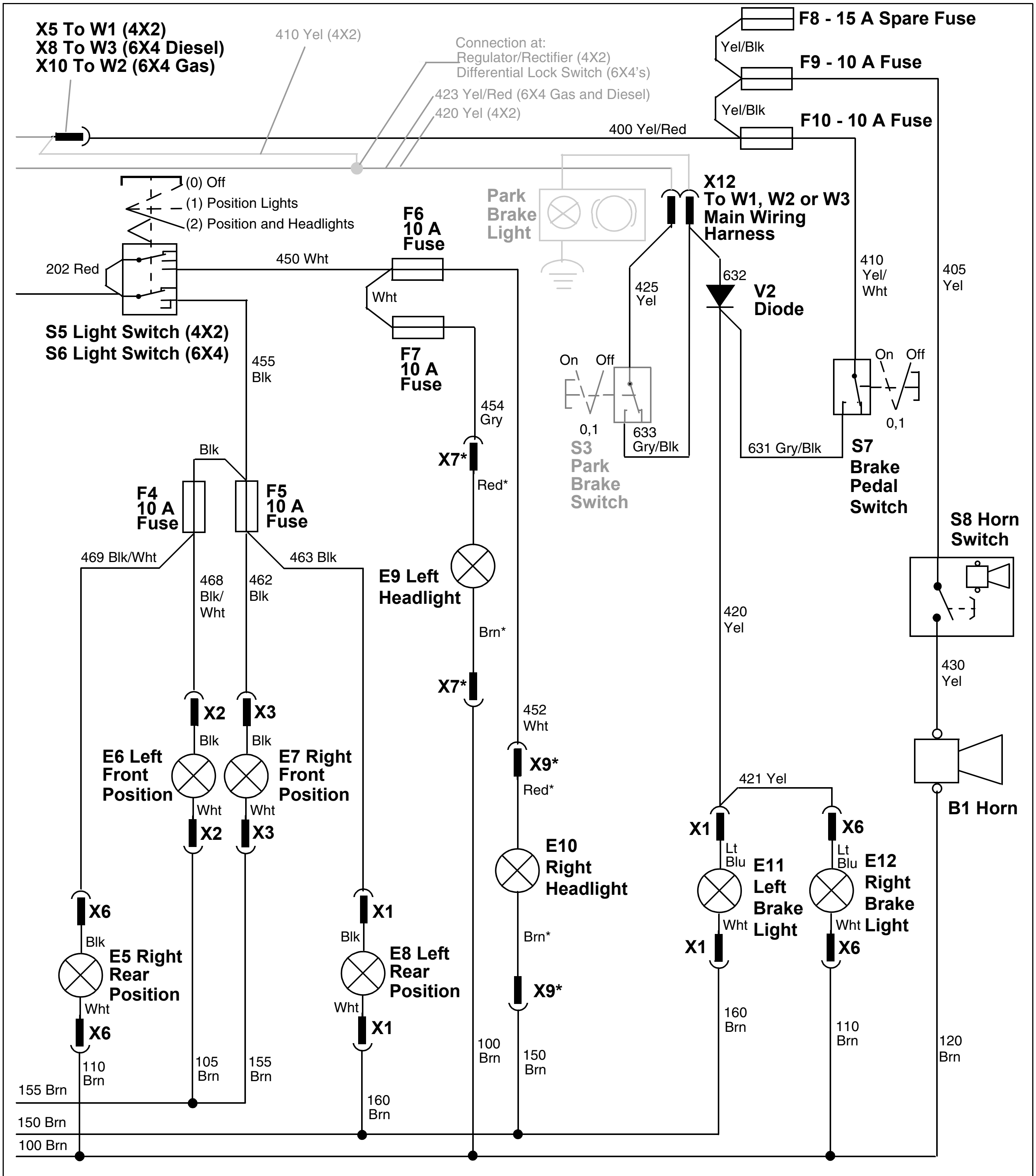
W18 Light and Horn Wiring Schematic (Earlier Model) (2 of 2)



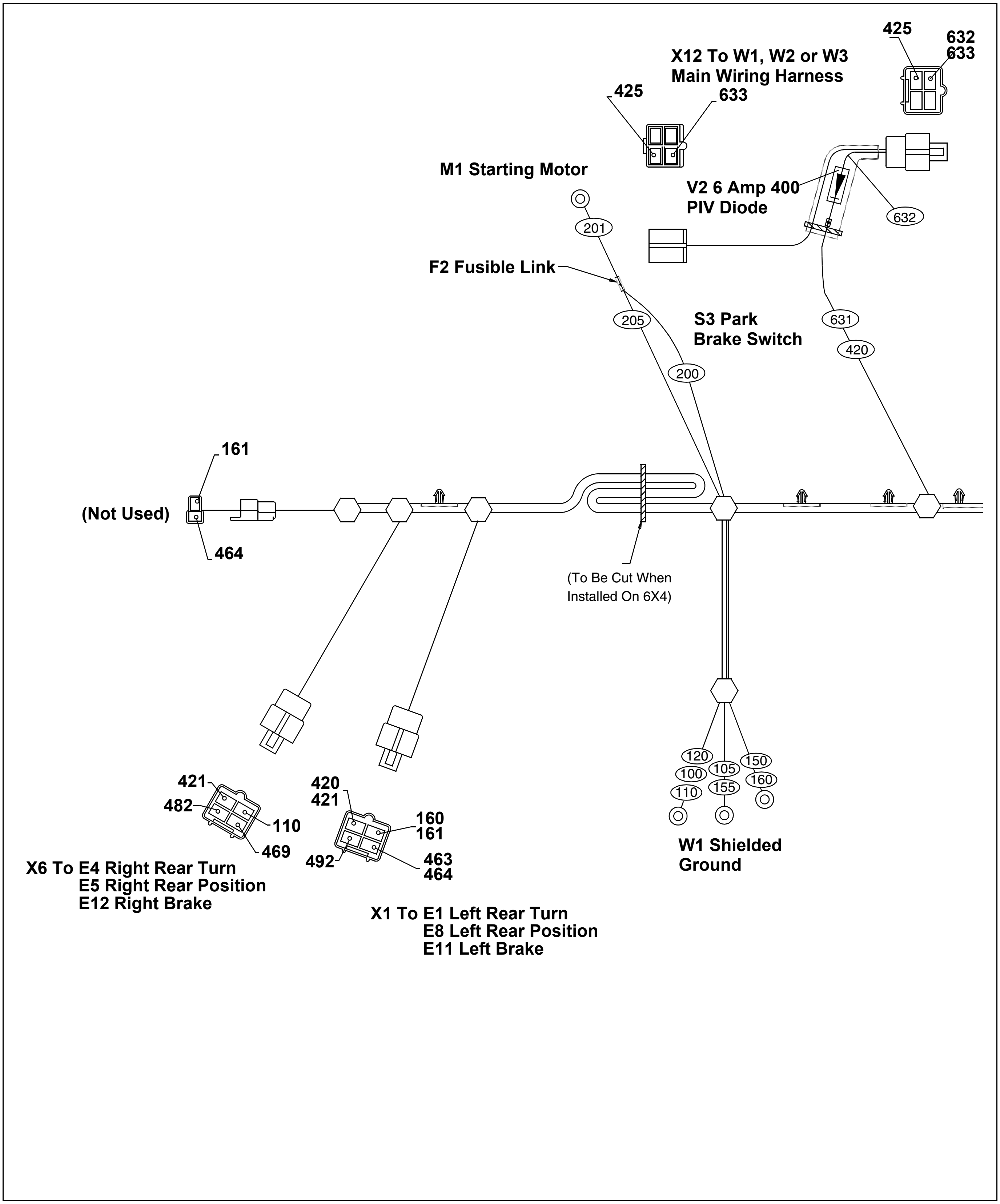
*** Note: X7 and X9 Connectors are only used when W25 Headlight Adaptor Wiring Harness (For North American/European Headlights) Is used with W18 North American/European Light and Horn Harness**

SE3 - Lights	SE4 - Brake Lights	SE5 - Horn

MIF

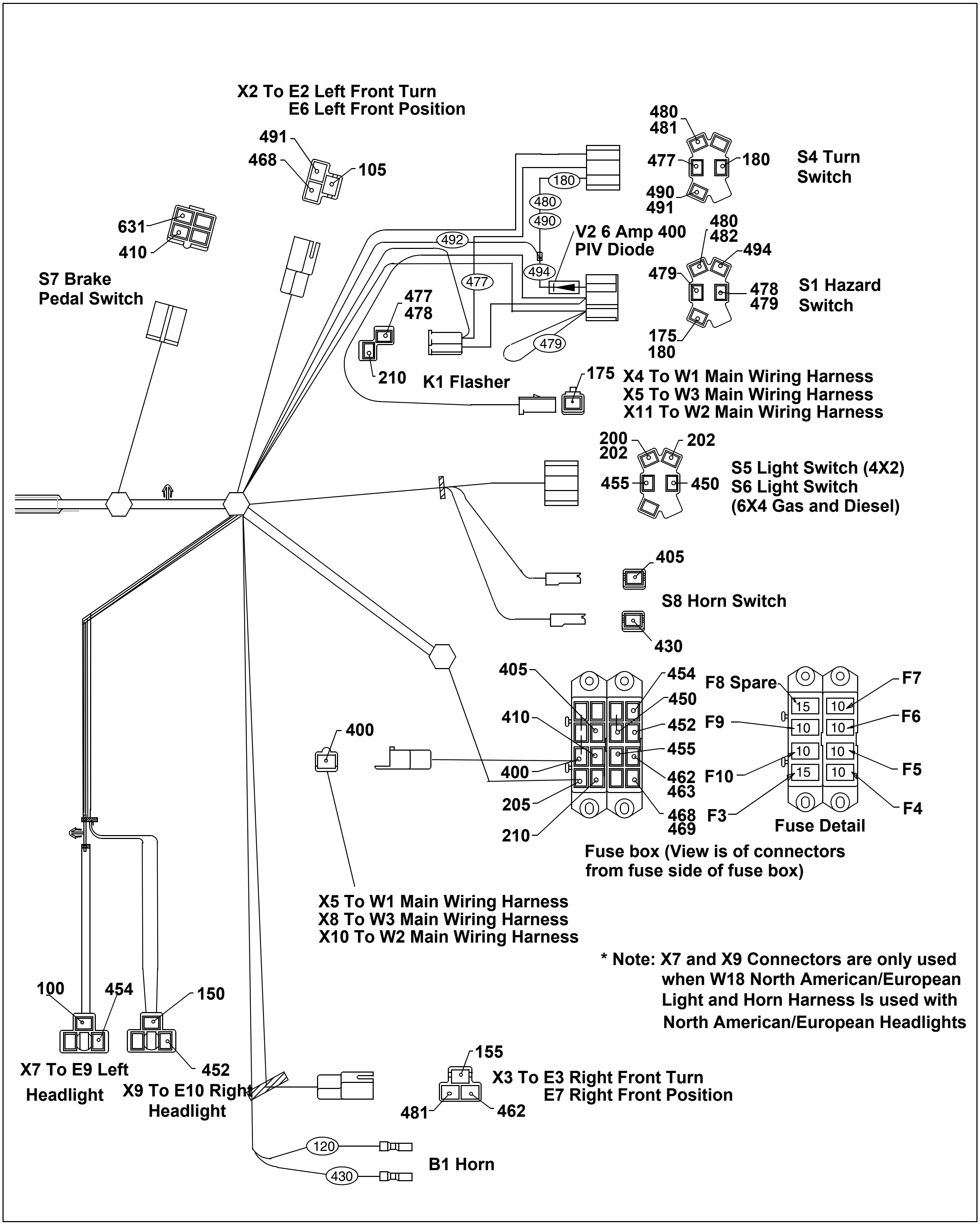
W18 Light and Horn Wiring Harness (Earlier Model)

W18 Light and Horn Wiring Harness (Earlier Model) (1 of 2)



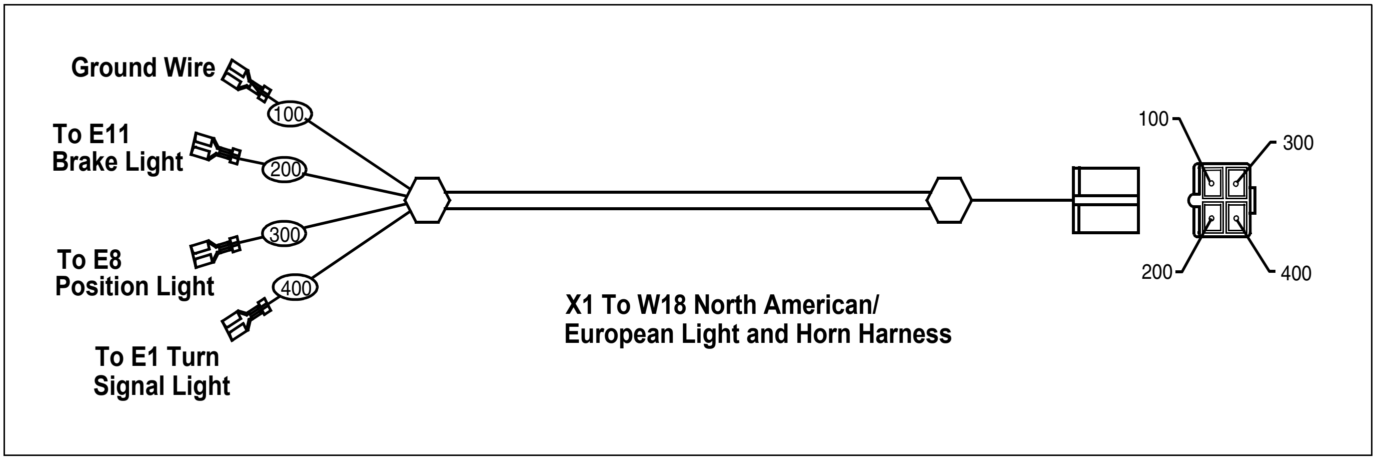
ELECTRICAL W18 NORTH AMERICAN/EUROPEAN LIGHT AND HORN

W18 Light and Horn Wiring Harness (Earlier Model) (2 of 2)

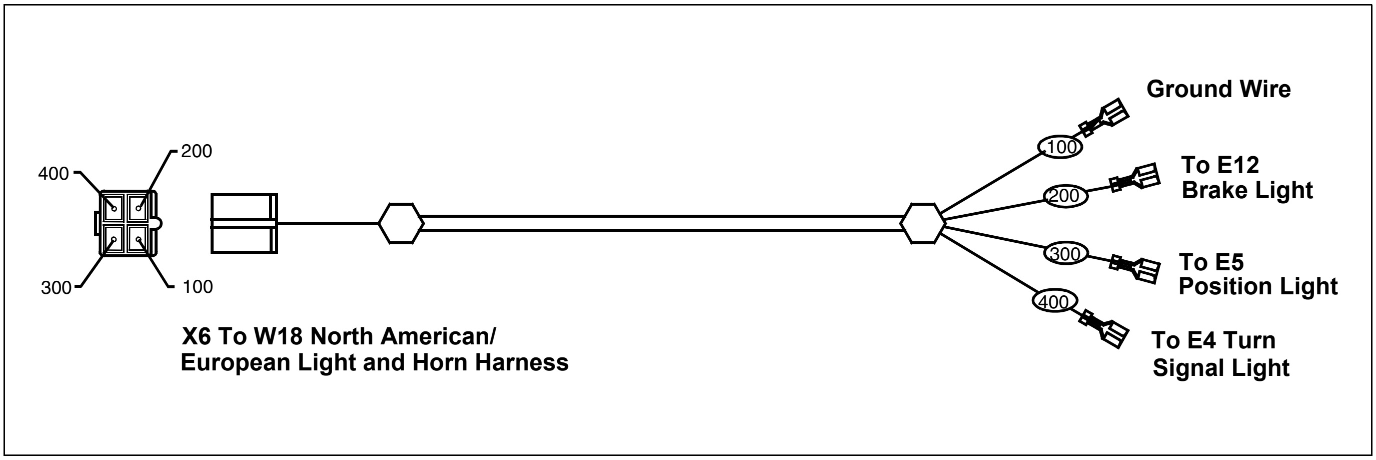


ELECTRICAL W18 NORTH AMERICAN/EUROPEAN LIGHT AND HORN

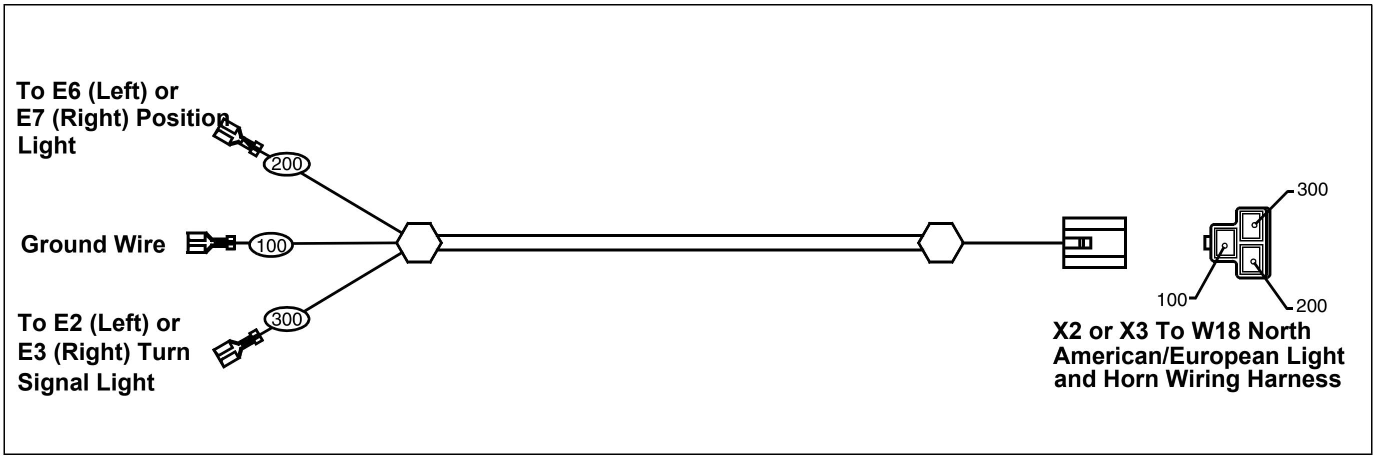
W20 Rear Lights Wiring Harness (Earlier Model, Left)



W21 Rear Lights Wiring Harness (Earlier Model, Right)

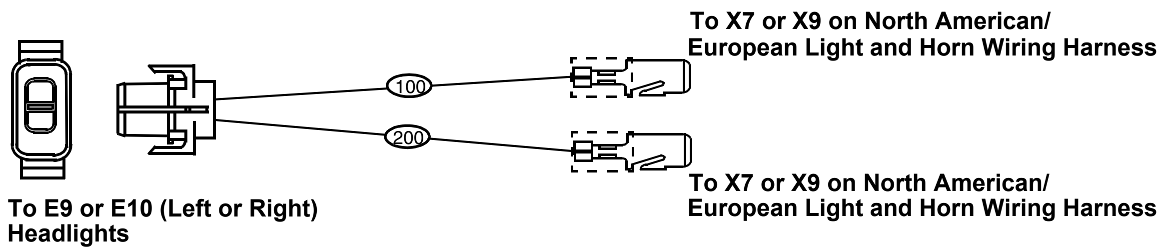


W22 Front Position/Turn Wiring Harness (Earlier Model)



W25 Headlight Adaptor Wiring Harness (Earlier Model)

NOTE: The W25 Headlight Adaptor Wiring Harness is used when the W18 North American/European Light and Horn Wiring Harness is installed and North American/European headlights are used. If Road Homologated lights are used or installed with the North American/European Light and Horn kit, the Headlight Adaptor Wiring Harness is not used.



W18 Light and Horn Wiring Harness Color Codes (Earlier Model)

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Brn	E9, W1 Ground
105	0.8	Brn	X2, W1 Ground
110	0.8	Brn	X6, W1 Ground
120	0.8	Brn	B1, W1 Ground
150	1.0	Brn	E10, W1 Ground
155	0.8	Brn	X3, W1 Ground
160	0.8	Brn	X1, W1 Ground
161	0.8	Brn	Not used
175	0.5	Brn	S1, X4/X5/X11 Ground Connection to W1, W3 or W2 Main Wiring Harness
180	0.5	Brn	S1, S4
200	2.0	Red	201 Fusible Link (F2), S5/ S6
201	0.8	Red-Fuse	F2 Fuse soldered in-line; M1, 200 Red
202	2.0	Red	S5/S6, S5/S6
205	2.0	Yel/Red	201 Fusible Link, F3
210	1.0	Red	F3, K1
400	1.0	Yel/Red	X5/X8/X10 Power Connection to W1, W3 or W2 Main Wiring Harness, F10
405	0.8	Yel	F9, S8
410	0.8	Yel/Wht	F10, S7
420	0.8	Yel	V2 Diode, X1
421	0.8	Yel	X1, X6
425	0.8	Yel	X12, S3
430	0.8	Yel	S8, B1
450	2.0	Wht	S5/S6, F6
452	1.0	Wht	F6, E10
454	1.0	Gry	F7, E9
455	2.0	Blk	S5/S6, F5
462	0.8	Blk	F5, X3
463	0.8	Blk	F5, X1
464	0.8	Blk	Not used
468	0.8	Blk/Wht	F4, X2
469	0.8	Blk/Wht	F4, X6
477	1.0	Wht	K1, S4
478	1.0	Wht	K1, S1
479	1.0	Wht	S1, S1
480	1.0	Grn	S1, S4

Circuit Number	Wire Size	Color	Termination Points
481	0.8	Grn	S4, X3
482	0.8	Grn	S1, X6
490	1.0	Blu	V1 Diode, S4
491	0.8	Blu	S4, X2
492	0.8	Blu	V1 Diode, X1
494	0.8	Diode	V1 Soldered in-line; S1, 490 Blu and 492 Blu
631	0.8	Gry/Blk	V2 Diode, S7
632	0.8	Diode	V2 Soldered in-line; X12, 420 Yel and 631 Gry/Blk
633	0.8	Gry/Blk	X12, S3

W20 Rear Lights Wiring Harness Color Codes (Earlier Model, Left)

Circuit Number	Wire Size	Color	Termination Points
100	0.8	Wht	X2, Ground Wire
200	0.8	Blu	X2, E11
300	0.8	Blk	X2, E6
400	0.8	Grn	X2, E1

W21 Rear Lights Wiring Harness Color Codes (Earlier Model, Right)

Circuit Number	Wire Size	Color	Termination Points
100	0.8	Wht	X6, Ground Wire
200	0.8	Blu	X6, E12
300	0.8	Blk	X6, E5
400	0.8	Grn	X6, E4

W22 Front Position/Turn Wiring Harness Color Codes (Earlier Model)

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Wht	X2 or X3, Ground Wire
200	1.0	Blk	X2 or X3, E6 or E7
300	1.0	Lt Grn	X2 or X3, E2 or E3

W25 Headlight Adaptor Wiring Harness Color Codes (Earlier Model)

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Brn	E9 or E10, Ground Wire
200	1.0	Red	X2 or X3, E9 or E10

Operation and Diagnostics

Light and Horn Kit (Earlier Model)

Earlier Model with Square Tail Lights

Function:

Provides wiring harness and lights for braking lights, position lights and turn signal lights. It also provides a horn.

Theory of Operation:

The North American/European light and horn kit replaces the standard headlight wiring harness and the standard headlight harness is discarded.

When the North American/European wiring harness is installed, the existing main wiring harness connector to the park brake switch is unplugged and the X12 connector of the North American/European wiring harness is plugged into the molded connector disconnected from the park brake switch. A separate connector on the North American/ European wiring harness is then plugged into the park brake switch. Connections are also made at the “B” terminal of the M1 starting motor and the X5/X8/X10 connector and X4/X5/X11 connector that were previously connected to the standard headlight harness

There are four powered circuits in the light and horn wiring harness. Power for the first two of the circuits is provided from the “B” terminal of the starting motor and the F2 fusible link provided with the wiring harness. The first leaves the F2 fusible link through the 200 Red wire to the S5/S6 light switch. The second leaves the F2 fusible link through the 205 Red wire, F3 fuse and 210 Red, K1 flasher, 478 Wht wire and 479 Wht jumper wire to the S1 hazard switch. Current also flows from the K1 flasher and 477 Wht wire to the S4 turn signal switch.

The third circuit is also powered from the “B” terminal of the starting motor. Current flows through the existing F1 fusible link, 200 Red wire, S2 key switch, 400 Yel/Red wire, 410 Yel/Red wire (6X4 machines), and the X5/X8/X10 12 volt powered connector that was disconnected from the standard headlight wiring harness and connected to the North American/European wiring harness. Current enters the North American/European wiring harness, and flows through the 400 Yel/Red wire, F9 fuse and 405 Yel wire to the S8 horn switch; and from the 400 Yel/Red wire, Yel/Blk jumper wire, F10 fuse and 410 Yel/Wht wire to the S7 brake pedal switch.

The fourth circuit is also powered from the “B” terminal of the starting motor, through the existing F1 fusible link, 200 Red wire, S2 key switch and 400 Yel/Red wire. In the 4X2 machine, current flows from the S2 key switch through the 400 Yel/Red wire, 410 Yel wire, 420 Yel wire and X12 connector. Current enters the North American/European wiring harness at that point and flows through the 425 Yel wire to the S3 park brake switch. In the 6X4 machines, current flows from the key switch through the 400 Yel/Red wire, 420 Yel/Red wire, 423 Yel/Red wire and X12 connector. Current enters the North American/European wiring harness at that point and flows through the 425 Yel wire to the S3 park brake switch.

The switches then provide power to the appropriate lights or horn.

Light and Horn Kit Power Circuit Operation (Earlier Model)

Function:

Provides power to the primary components.

Operating Conditions, Unswitched Circuits:

Voltage must be present at the following components with the key switch “OFF”:

- “B” Terminal of Starting Motor
- “B” Terminal of Key Switch
- Light Switch
- F3 Fuse
- Flasher
- Hazard Switch
- Turn Signal Switch

The positive battery cable connects battery to a starting motor bolt. This bolt is used as a power tie point for the light and horn kit harness.

The connection between the starting motor and the key switch or light switch is protected by fusible links. The fusible links protect the wiring harness from high current load and shorts.

Switched Circuits:

Voltage must be present at following components with key switch in the “RUN” position:

- “A” Terminal of Key Switch
- Park Brake Switch
- Brake Pedal Switch
- Horn Switch

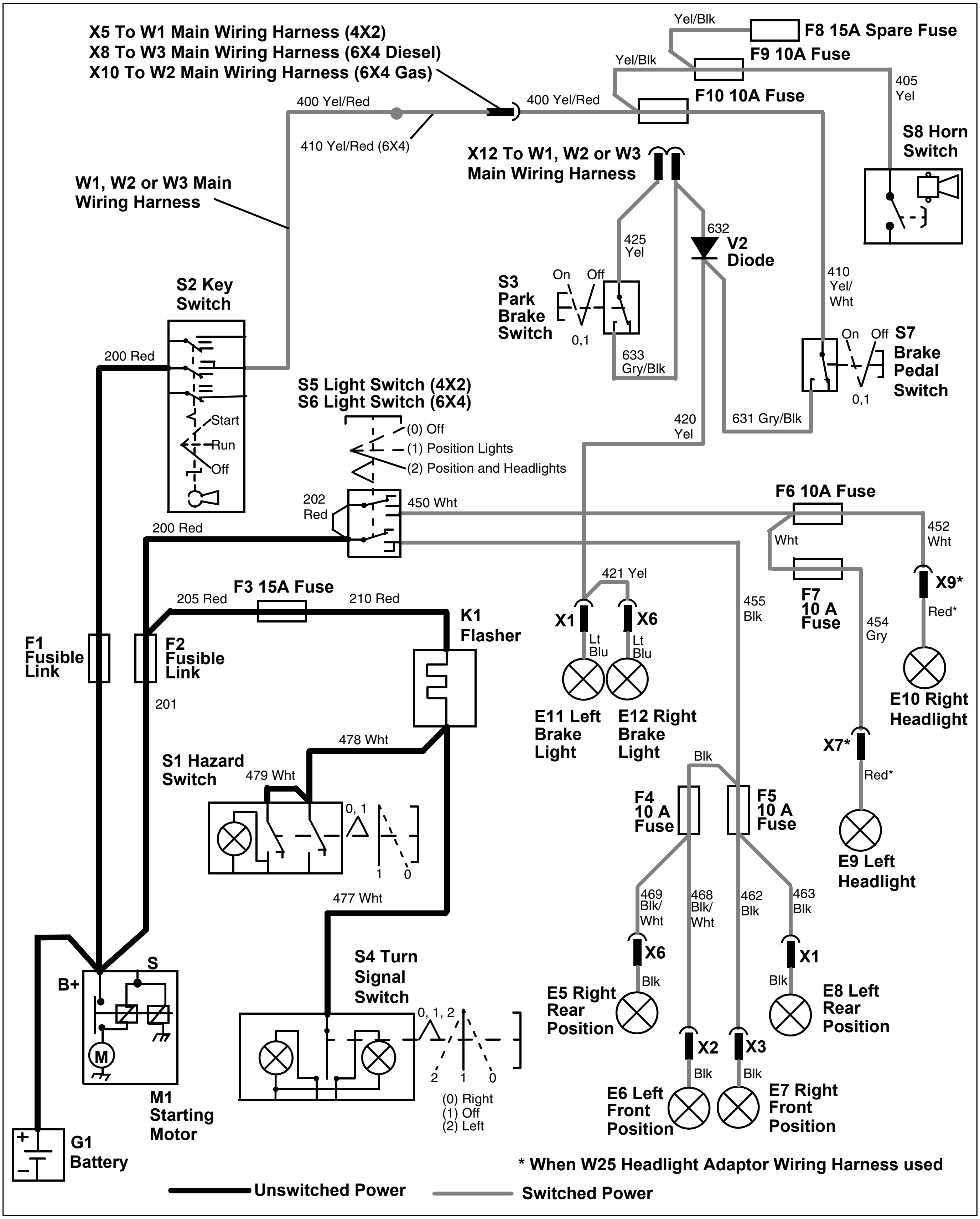
These components are controlled by the key switch and protected by the F1, F9 and F10 fuses.

Voltage must be present at the following lights with the key switch in the “RUN” position and the light switch in Position Lights and Headlights position:

- Left Front Position
- Left Rear Position
- Right Front Position
- Right Rear Position
- Left Headlight
- Right Headlight

These components are controlled by the light switch and protected by the F2, F4, F5, F6 and F7 fuses.

Light and Horn Kit Power Circuit Electrical Schematic



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Light and Horn Kit Power Circuit Diagnosis (Earlier Model)

Test Conditions:

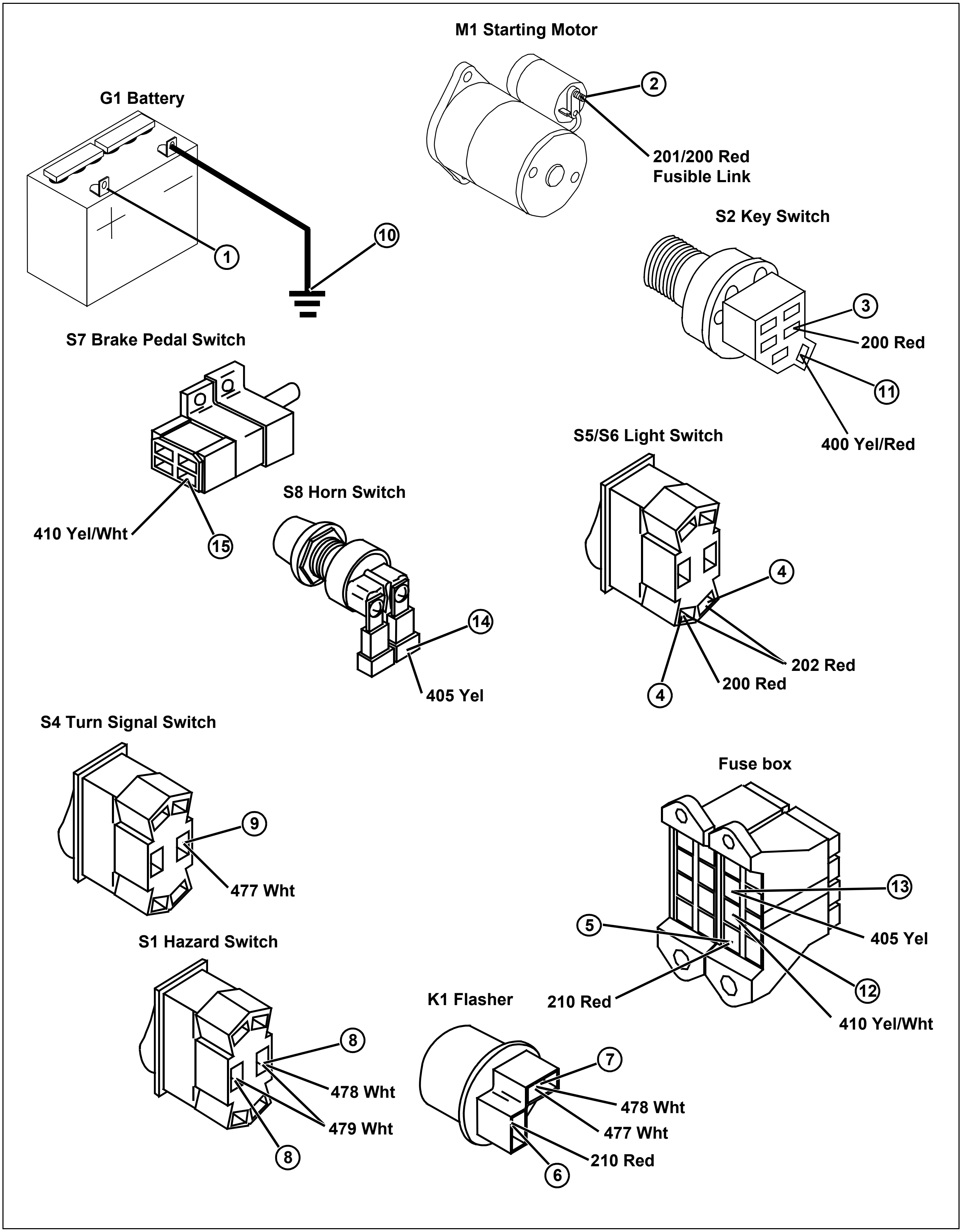
- Park brake engaged
- Key Switch in the OFF position.
- Meter negative (-) lead on battery negative (-) terminal.
- Meter positive (+) lead on numbered test point.
- Check connections for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal	Battery voltage (11.8 - 13.2 volts)	Test battery.
2. Starting motor solenoid terminal B	Battery voltage	Check battery cable and connection.
3. Key switch terminal B	Battery voltage	Check F1 fusible link.
4. Light switch	Battery voltage	Check F2 fusible link, 200 Red, and 202 Red wires.
5. Fusebox	Battery voltage	Check fuse and 205 Red wire.
6. Flasher	Battery voltage	Check 210 Red wire.
7. Flasher	Battery voltage	Replace flasher.
8. Hazard switch	Battery voltage	Check 478 Wht, and 479 Wht wires.
9. Turn signal switch	Battery voltage	Check 477 Wht wire.
10. Ground cable	Maximum 0.1 ohm resistance	Check battery negative cable and connection.

Test Conditions:

- Key switch in run position

Test/Check Point	Normal	If Not Normal
11. Key switch terminal A	Battery voltage	Replace key switch.
12. Fusebox	Battery voltage	Check 400 Yel/Red wire, light and horn harness connection and fuse.
13. Fusebox	Battery voltage	Check Yel/Blk wire and fuse.
14. Horn switch	Battery voltage	Check 405 Yel wire.
15. Brake pedal switch	Battery voltage	Check 410 Yel/Wht wire.


M1 Starting Motor
2
201/200 Red
Fusible Link
G1 Battery
1
10
S2 Key Switch
3
200 Red
11
400 Yel/Red
S7 Brake Pedal Switch
410 Yel/Wht
15
S8 Horn Switch
14
405 Yel
S5/S6 Light Switch
4
202 Red
200 Red
4
S4 Turn Signal Switch
9
477 Wht
Fuse box
13
405 Yel
5
12
210 Red
410 Yel/Wht
S1 Hazard Switch
8
478 Wht
479 Wht
8
K1 Flasher
7
478 Wht
477 Wht
210 Red
6

Turn Signal and Hazard Light Operation (Earlier Model)

Function:

Turn Signal Lights:

To provide power to illuminate the right or left front and rear turn signal lights depending on turn signal switch position.

Hazard Lights:

To provide power to illuminate the front and rear turn signal lights when the hazard switch is ON.

Operating Conditions:

The hazard switch must be closed or the turn signal switch must be in the right or left position.

Theory of Operation:

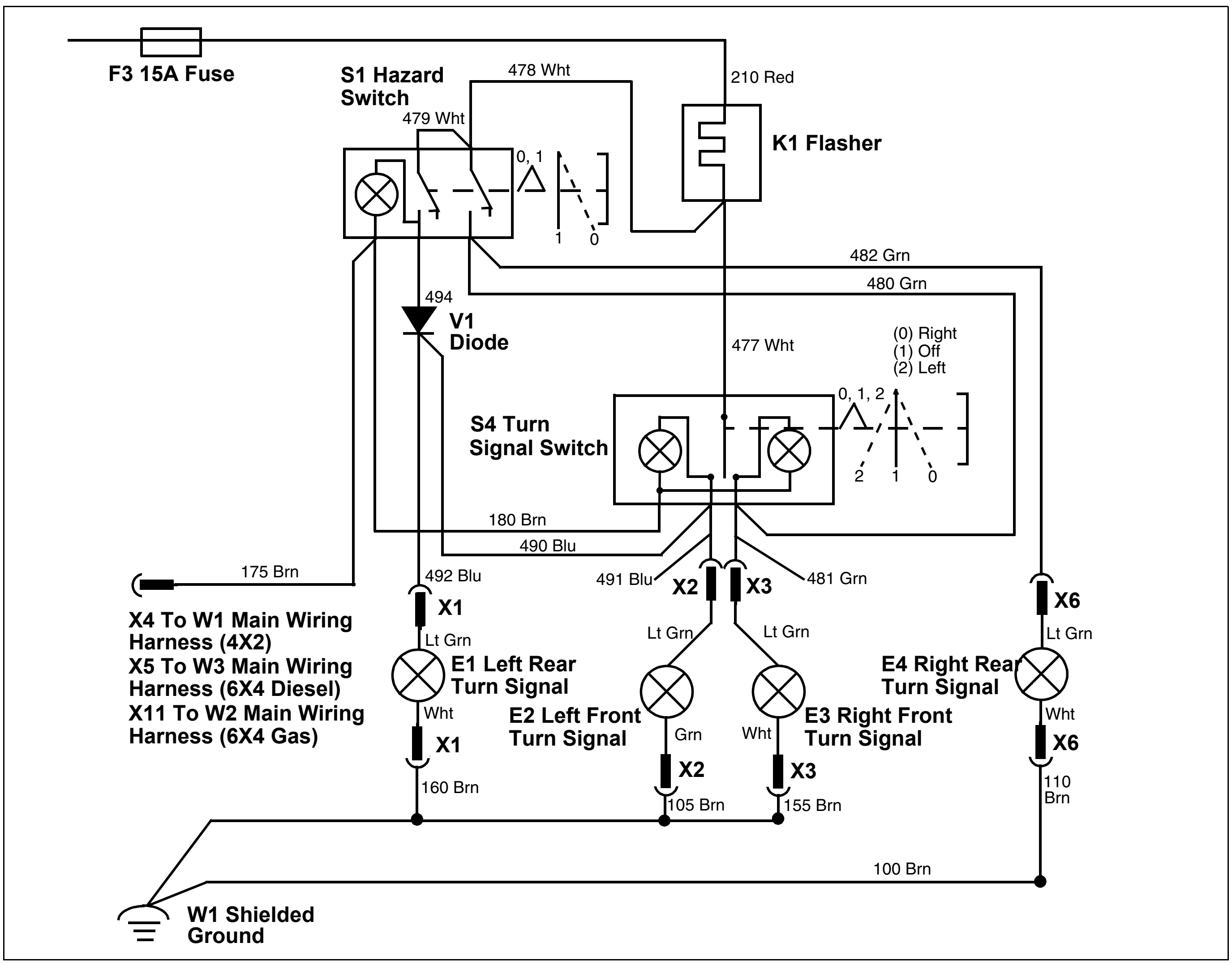
Turn Signal Lights:

With the turn signal switch (S4) in the right position, current from the flasher (K1) flows through the turn signal switch and illuminates the right turn signal switch light, front turn signal light (E3), and rear turn signal light (E4). When the turn signal switch is closed, current flowing through the flasher causes the flasher switch to open and close intermittently to produce the flashing signal.

Hazard Lights:

With the hazard switch (S1) on (switch closed), current from the flasher flows through the hazard switch and illuminates the hazard switch light, and both front and rear turn signal lights (E1, E2, E3 and E4). The diode (V1) at the hazard switch prevents the hazard switch light from illuminating when the left turn signal is energized. The circuit is protected by fusible link (F2) and fuse (F3).

Turn Signal and Hazard Light Electrical Schematic (Earlier Model)



MIF

Turn Signal and Hazard Light Diagnosis (Earlier Model)

Test Conditions:

- Light bulb continuity OK or bulb replaced
- Park brake engaged
- Key switch in OFF position
- Hazard switch in OFF position
- Turn signal in RIGHT position
- Meter positive (+) lead on numbered test point
- Meter negative (-) lead on battery negative (-) terminal
- Check connections for corrosion and loose terminals when testing

Test/Check Point	Normal	If Not Normal
Battery positive terminal	Battery voltage (11.8 - 13.2 volts)	Test battery.
1. Flasher	Battery voltage	Check turn signal power circuit.
2. Turn signal switch	Battery voltage	Check 477 Wht wire.
3. Turn signal switch	Battery voltage	Replace turn signal switch.
4. Turn signal switch	Right lamps illuminated	Check ground connection, 175 and 180 Brn wires, replace switch.
5. Right front turn signal	Battery voltage	Check 481 Grn and Lt Grn wires.
6. Right rear turn signal	Battery voltage	Check 480 Grn, 482 Grn, and Lt Grn wires.

Test Conditions:

- Turn signal switch in LEFT position

Test/Check Point	Normal	If Not Normal
7. Turn signal switch	Intermittent battery voltage	Replace turn signal switch.
8. Turn signal switch	Left lamps illuminated	Replace turn signal switch.
9. Left front turn signal	Intermittent battery voltage	Check 491 Blu and Lt Grn wires.
10. Left rear turn signal	Intermittent battery voltage	Check 490 Blu, 492 Blu, and Lt Grn wires.

Test Conditions:

- Turn signal switch in OFF position

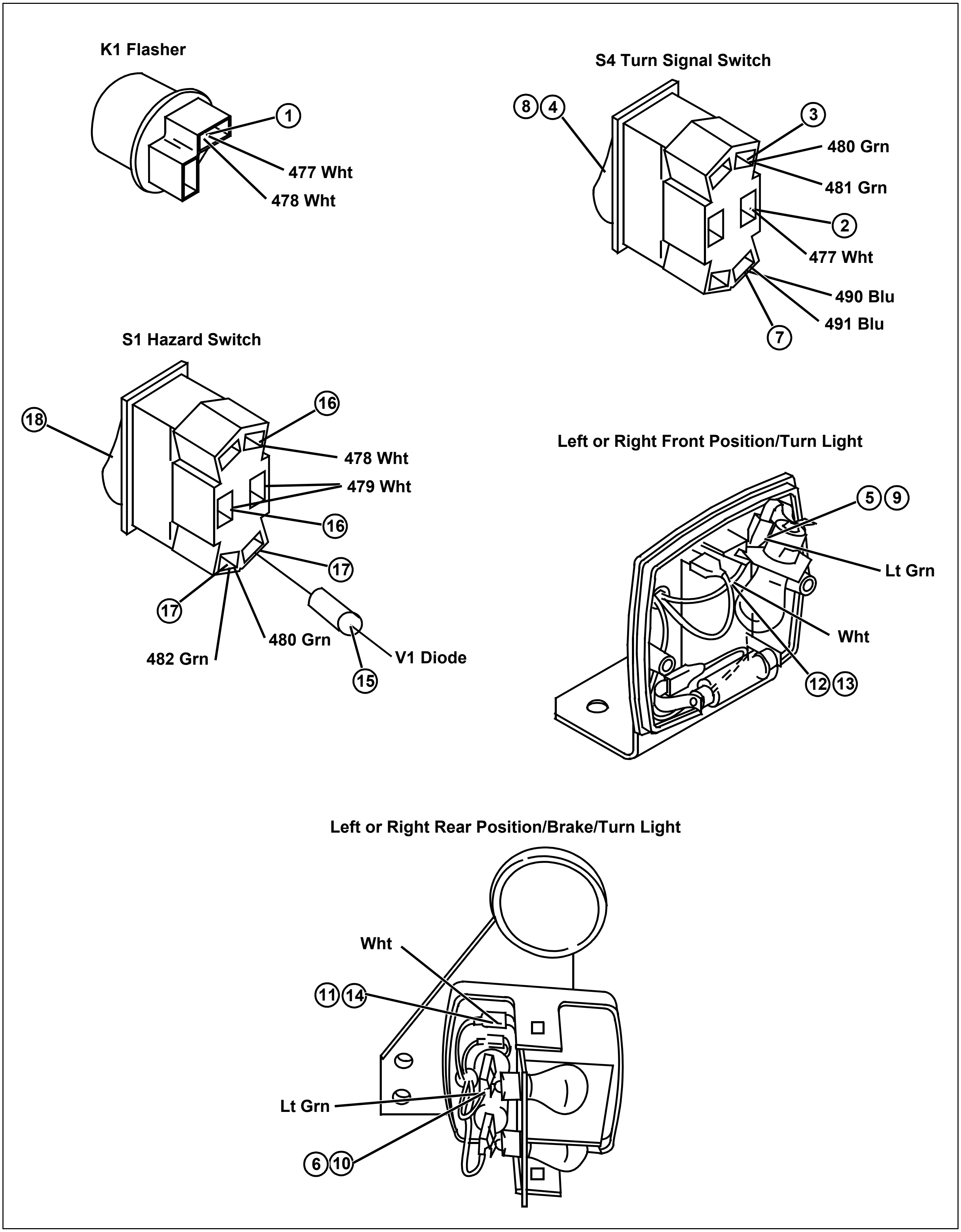
Test/Check Point	Normal	If Not Normal
11. Right rear turn signal	Maximum 0.1 ohm resistance	Check battery negative cable, engine ground connections, Wht and 110 Brn wires.

Test/Check Point	Normal	If Not Normal
12. Right front turn signal	Maximum 0.1 ohm resistance	Check Wht and 155 Brn wires.
13. Left front turn signal	Maximum 0.1 ohm resistance	Check Wht and 105 Brn wire.
14. Left rear turn signal	Maximum 0.1 ohm resistance	Check Wht and 160 Brn wire.
15. V1 Diode	Continuity one direction only	Replace diode.

Test Conditions:

- Hazard switch in ON position

Test/Check Point	Normal	If Not Normal
16. Hazard switch	Battery voltage	Check 478 Wht and 479 Wht wires.
17. Hazard switch	Battery voltage	Replace hazard switch.
18. Hazard switch	Lamp illuminated	Replace hazard switch.


K1 Flasher
1
477 Wht
478 Wht
S4 Turn Signal Switch
8 4
3
480 Grn
481 Grn
2
477 Wht
490 Blu
491 Blu
7
S1 Hazard Switch
18
16
478 Wht
479 Wht
16
17
17
480 Grn
482 Grn
V1 Diode
15
Left or Right Front Position/Turn Light
5 9
Lt Grn
Wht
12 13
Left or Right Rear Position/Brake/Turn Light
Wht
11 14
Lt Grn
6 10

Light and Horn Circuit Operation (Earlier Model)

Function:

Position Lights and Headlights Circuit:
To provide power to illuminate the front and rear position lights, and/or headlights depending on light switch position.

Brake Lights Circuit:
To provide power to illuminate the rear brake lights when the brake pedal is depressed or the park brake is engaged.

Horn Circuit:
To energize the horn when desired by the operator.

Operating Conditions:

Position Lights:
The light switch must be in the position lights position.

Position Lights and Headlights:
The light switch must be in the position lights and headlights position.

Brake Lights:

The key switch must be in the RUN position and the brake pedal depressed or the park brake engaged.

Horn:

The key switch must be in the RUN position and the horn switch depressed.

Theory of Operation:

Position Lights and Headlights:

With the light switch (S5/S6) in the position light position (closed), current flows to the fuses (F4 and F5), and illuminates the Left and Right front position lights (E6 and E7), and Left and Right rear position lights (E5 and E8).

With the light switch (S5/S6) in the position lights and headlights position (closed), current flows to the fuses (F4, F5, F6 and F7) and illuminates all position lights, and the headlights (E9 and E10).

Brake Lights:

With the brake pedal switch (S7) closed (brake pedal depressed), current from fuse (F10) and brake pedal switch illuminates the Left and Right brake lights (E5, E4).

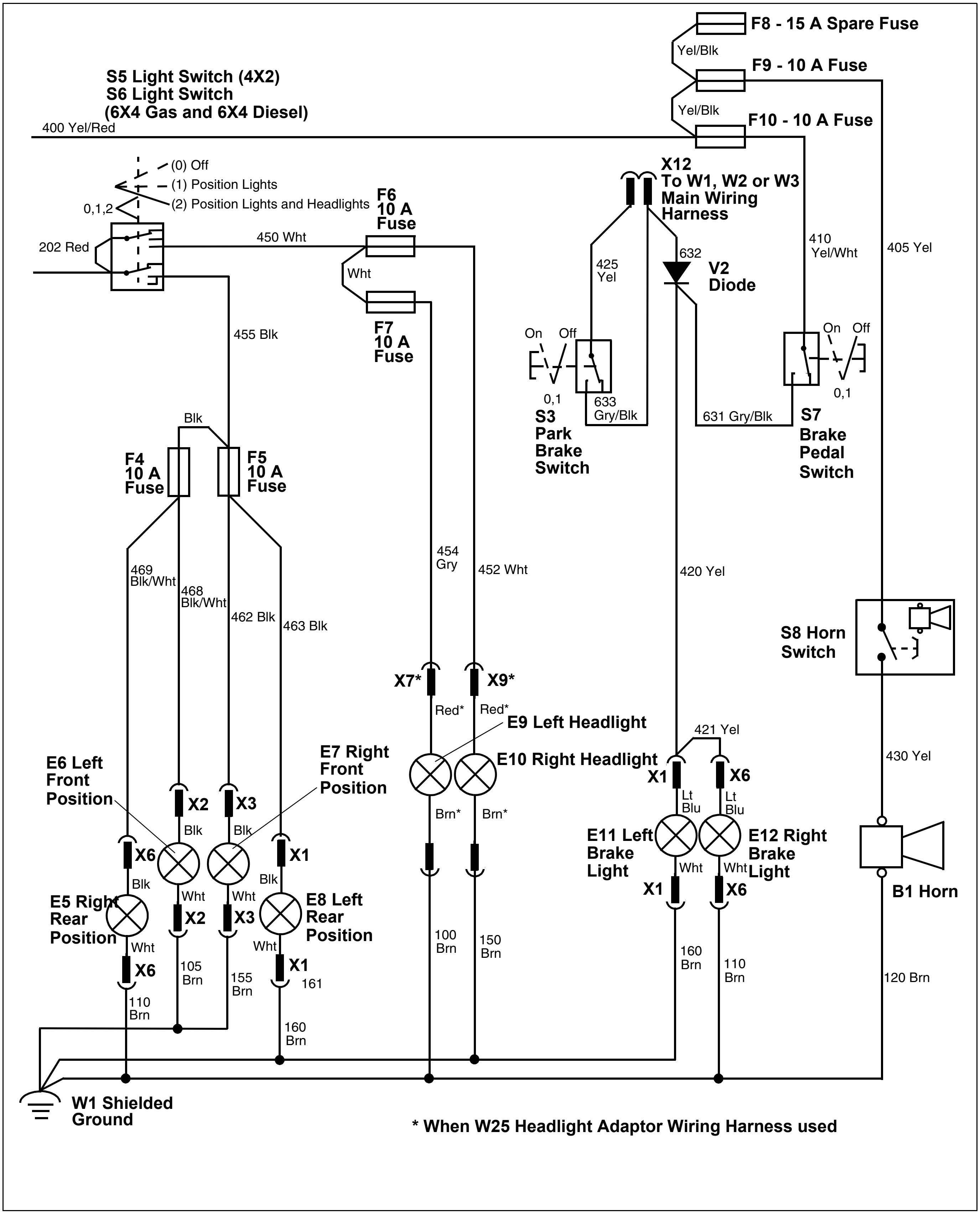
With the park brake switch (S3) closed (park brake engaged), current from fuse (F1), key switch (S2), park brake switch, and diode (V2) illuminates the Left and Right brake lights (E5, E4).

The diode (V2) at the park brake switch connector prevents the park brake light from illuminating when the brake pedal switch is closed.

Horn:

With the horn switch (S8) closed (switch depressed), current from fuse (F9) and horn switch energizes the horn (B1).

Light and Horn Circuit Electrical Schematic (Earlier Model)



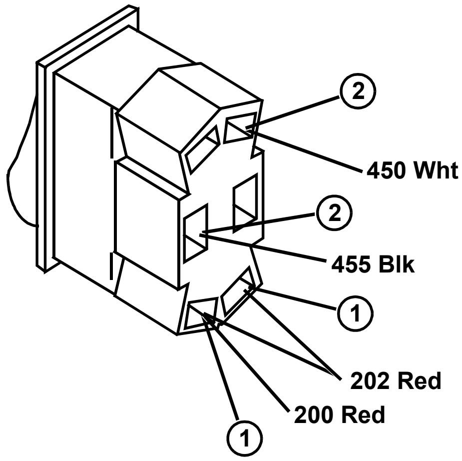
Light and Horn Circuit Diagnosis (Earlier Model)

Test Conditions:

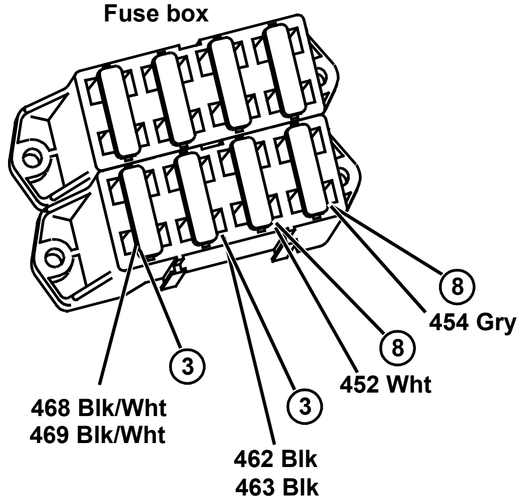
- Light bulb continuity OK or bulb replaced.
- Park brake engaged.
- Key switch in RUN position.
- Headlight switch in POSITION LIGHTS AND HEADLIGHTS position.
- Meter positive (+) on numbered test point.
- Meter negative (-) on battery negative (-) terminal.
- Check connections for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Light switch	Battery voltage	Check light switch power circuit.
2. Light switch	Battery voltage	Replace light switch.
3. F4 and F5 fuses	Battery voltage	Check fuses and 455 Blk and Blk jumper wire.
4. Left and Right front position lights	Battery voltage	Check 468 Blk/Wht, 462 Blk, and Blk wires.
5. Left and Right front position lights	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check battery negative cable, engine ground connections, Wht, 105 Brn, and 155 Brn wires. 0 volts: Replace bulb.
6. Left and Right rear position lights	Battery voltage	Check 469 Blk/Wht, 463 Blk, and Blk wires.
7. Left and Right rear position lights	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check ground connections, Wht, 110 Brn, and 160 Brn wires. 0 volts: Replace bulb.
8. Fusebox	Battery voltage	Check fuses and 450 Wht and Wht jumper wire.
9. Left and Right headlights	Battery voltage	Check 454 Gry and 452 Wht wires; Also check X7, X9 and Red wires if headlight adaptor wiring harness is used.
10. Left and Right headlights	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check ground connections, 100 and 150 brn wires. 0 volts: Replace bulb.

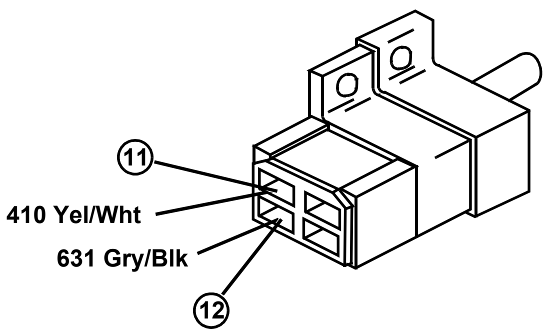
S5/S6 Light Switch



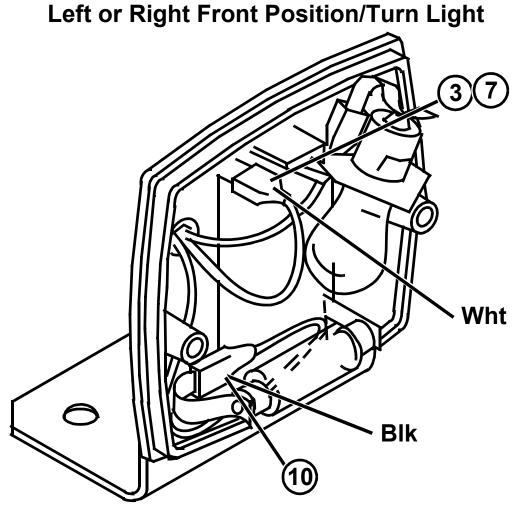
Fuse box



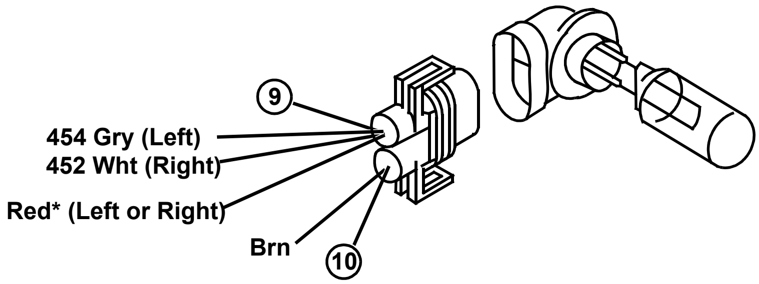
S7 Brake Pedal Switch



Left or Right Front Position/Turn Light

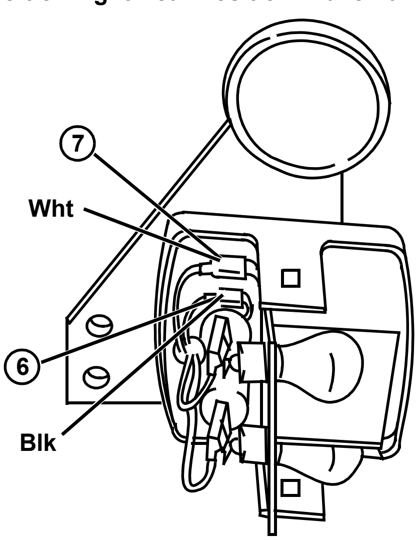


E9 or E10 Headlight



* Red when W25 Headlight Adaptor Wiring Harness is installed

Left or Right Rear Position/Brake/Turn Light



Test Conditions:

- Brake pedal depressed
- Park brake engaged

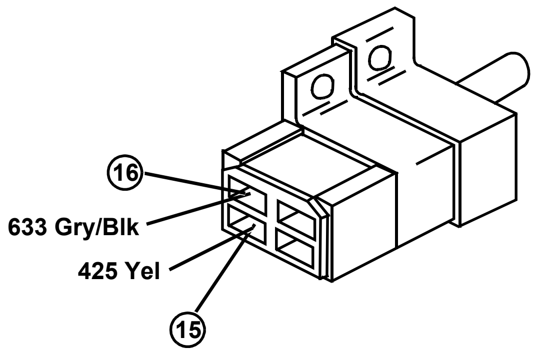
Test/Check Point	Normal	If Not Normal
11. Brake pedal switch	Battery voltage	Check brake light power circuit.
12. Brake pedal switch	Battery voltage	Replace brake pedal switch.
13. Left and Right brake lights	Battery voltage	Check 631 Gry/Blk, 420 Yel, 421 Yel, and Lt Blu wires.
14. Left and Right brake lights	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check ground connections, Wht, 110 Brn, and 160 Brn wires. 0 volts: Replace bulb.
15. Park brake switch	Battery voltage	Check 425 Yel wire and connections.
16. Park brake switch	Battery voltage	Replace park brake switch.
17. Park brake switch connector	Battery voltage	Check 633 Gry/Blk wire.
18. V2 Diode	Continuity one direction only	Replace diode.

Test Conditions:

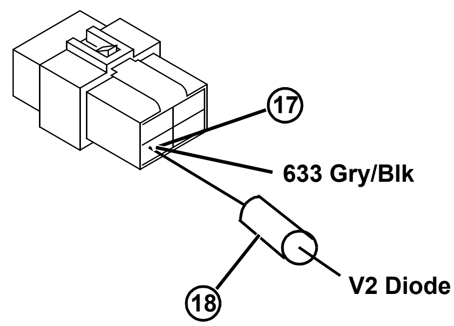
- Horn switch depressed

Test/Check Point	Normal	If Not Normal
19. Horn switch	Battery voltage	Check horn switch power circuit.
20. Horn switch	Battery voltage	Replace horn switch.
21. Horn	Battery voltage	Check 430 Yel wire and connections.
22. Horn	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check ground connections and 120 Brn wire. 0 volts: Replace horn.

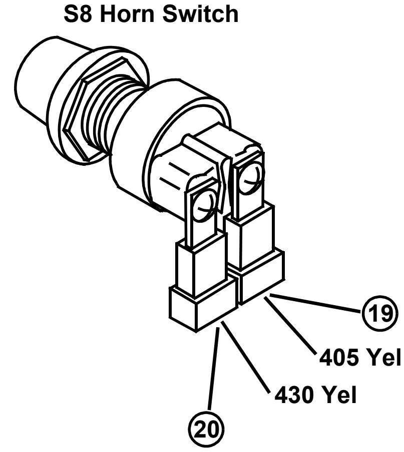
S3 Park Brake Switch



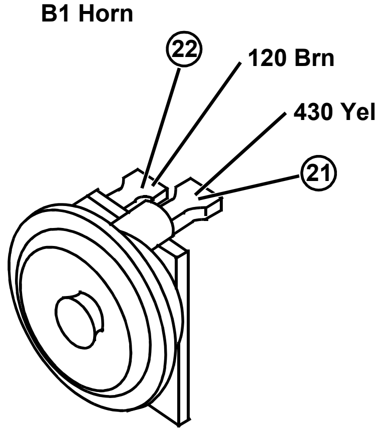
X12



S8 Horn Switch



B1 Horn



W30 North American/European Light and Horn Kit (Later Model)

W30 Schematic and Wiring Harness Legend (Later Model)

B1 - Horn (SE5, W30)

E1 - Left Rear Turn Signal Light (SE2, W30)

E2 - Left Front Turn Signal Light (SE2, W30)

E3 - Right Front Turn Signal Light (SE2, W30)

E4 - Right Rear Turn Signal Light (SE2, W30)

E5 - Right Rear Position Light (SE3, W30)

E6 - Left Rear Position Light (SE3, W30)

E7 - Left Front Position Light (SE3, W30)

E8 - Right Front Position Light (SE3, W30)

E9 - Left Headlight (SE3, W4)

E10 - Right Headlight (SE3, W4)

E11 - Left Brake Light (SE4, W30)

E12 - Right Brake Light (SE4, W30)

F1 - Fusible Link (SE1, W1; SE1, W2; SE1, W3)

F2 - Fusible Link (SE1, W30)

F6 - 20 Amp Fuse (SE2, W30)

F7 - 15 Amp Fuse (SE2, W30)

F9 - 10 Amp Fuse (SE4, W30)

F10 - 10 Amp Fuse (SE4, W30)

G1 - Battery (SE1, W30; instead of SE1, W1; SE1, W2; SE1, W3)

K1 - Flasher (SE2, W30)

M1 - Starting Motor (SE1, W30; instead of SE1, W1; SE1, W2; SE1, W3)

S1 - Hazard Switch (SE2, W30)

S2 - Key Switch (SE1, W30; instead of SE1, W1; SE1, W2; SE1, W3)

S4 - Turn Signal Switch (SE2, W30)

S5 - Light Switch (4X2 gas) (SE3, W30; SE5, W1)

S6 - Light Switch (6X4 gas and diesel) (SE3, W30; SE6, W2; SE7, W3)

S7 - Brake Pedal Switch (SE4, W30)

S8 - Horn Switch (SE5, W30)

W1 - Shielded Ground (SE1, W30; SE1, W1; SE1, W2; SE1, W3)

Connectors:

X1 - W30 Light and Horn Wiring Harness to W20 Rear Position/Brake/Turn Wiring Harness (SE2, W30; SE3, W30; SE4, W30)

X2 - W30 Light and Horn Wiring Harness to W22 Left Front Position/Turn Wiring Harness (SE2, W30; SE3, W30)

X3 - W30 Light and Horn Wiring Harness to W22 Right Front Position/Turn Wiring Harness (SE2, W30; SE3, W30)

X4 - W4 Standard Headlight Wiring Harness Ground Connection to W1 Main Wiring Harness (4X2) (SE3, W30; SE5, W1)

X5 - W4 Standard Headlight Wiring Harness Ground Connection to W3 Main Wiring Harness (6X4 Diesel) (SE3, W3; SE6, W3)

X5 - W30 Light and Horn Wiring Harness Power Connection to W1 Main Wiring Harness (4X2) (SE2, W30; SE5, W1)

X6 - W30 Light and Horn Wiring Harness to W21 Rear Position/Brake/Turn Wiring Harness (SE2, W30; SE3, W30; SE4, W30)

X8 - W30 Light and Horn Wiring Harness Power Connection to W3 Main Wiring Harness (6X4 Diesel) (SE2, W30; SE7, W3)

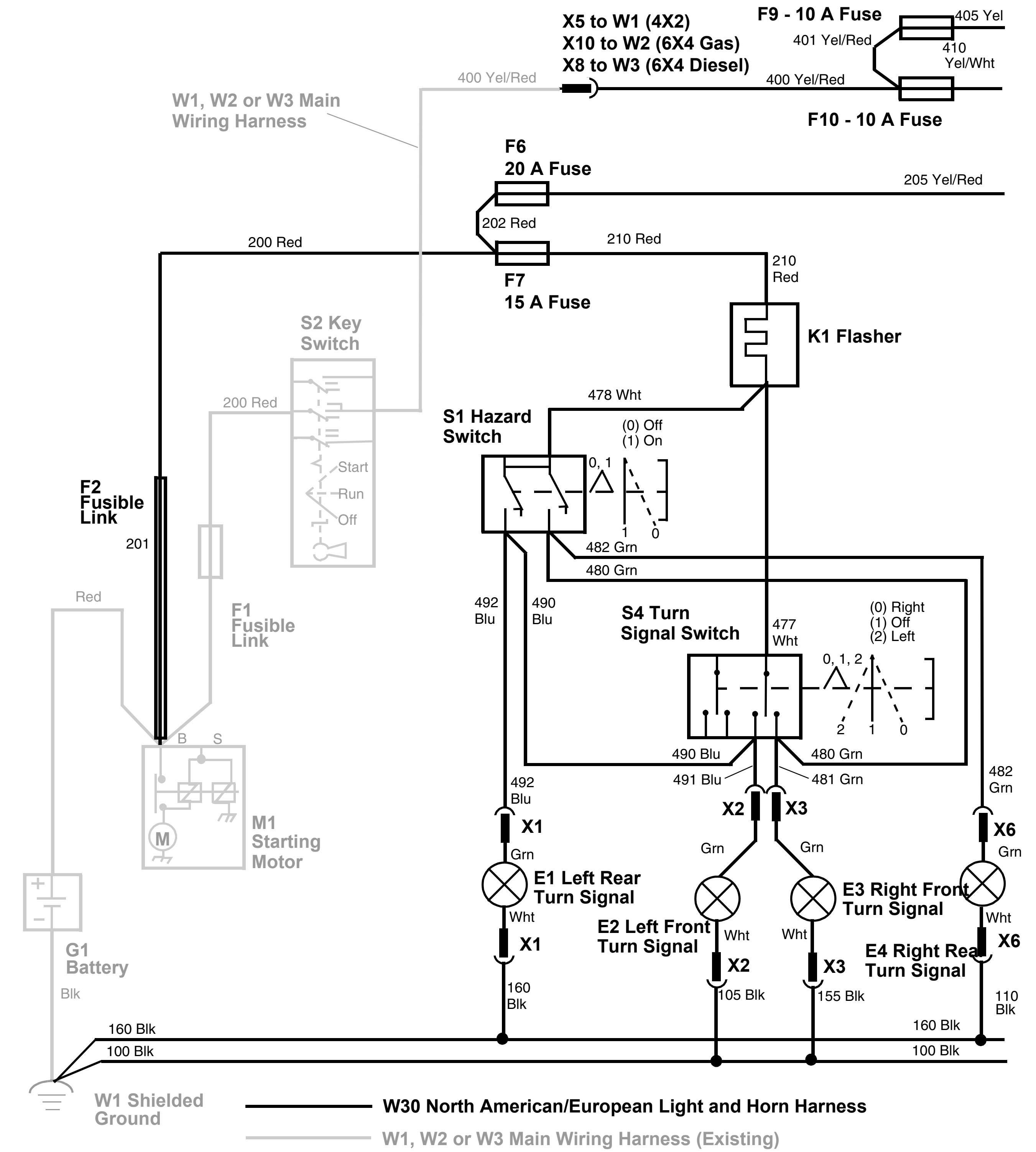
X10 - W30 Light and Horn Wiring Harness Power Connection to W2 Main Wiring Harness (6X4 Gas) (SE2, W30; SE6, W2)

X11 - W4 Standard Headlight Wiring Harness Ground Connection to W2 Main Wiring Harness (6X4 Gas) (SE3, W30; SE6, W2)

X12 - W30 Light and Horn Wiring Harness to W4 Standard Headlight Wiring Harness (SE3, W30)

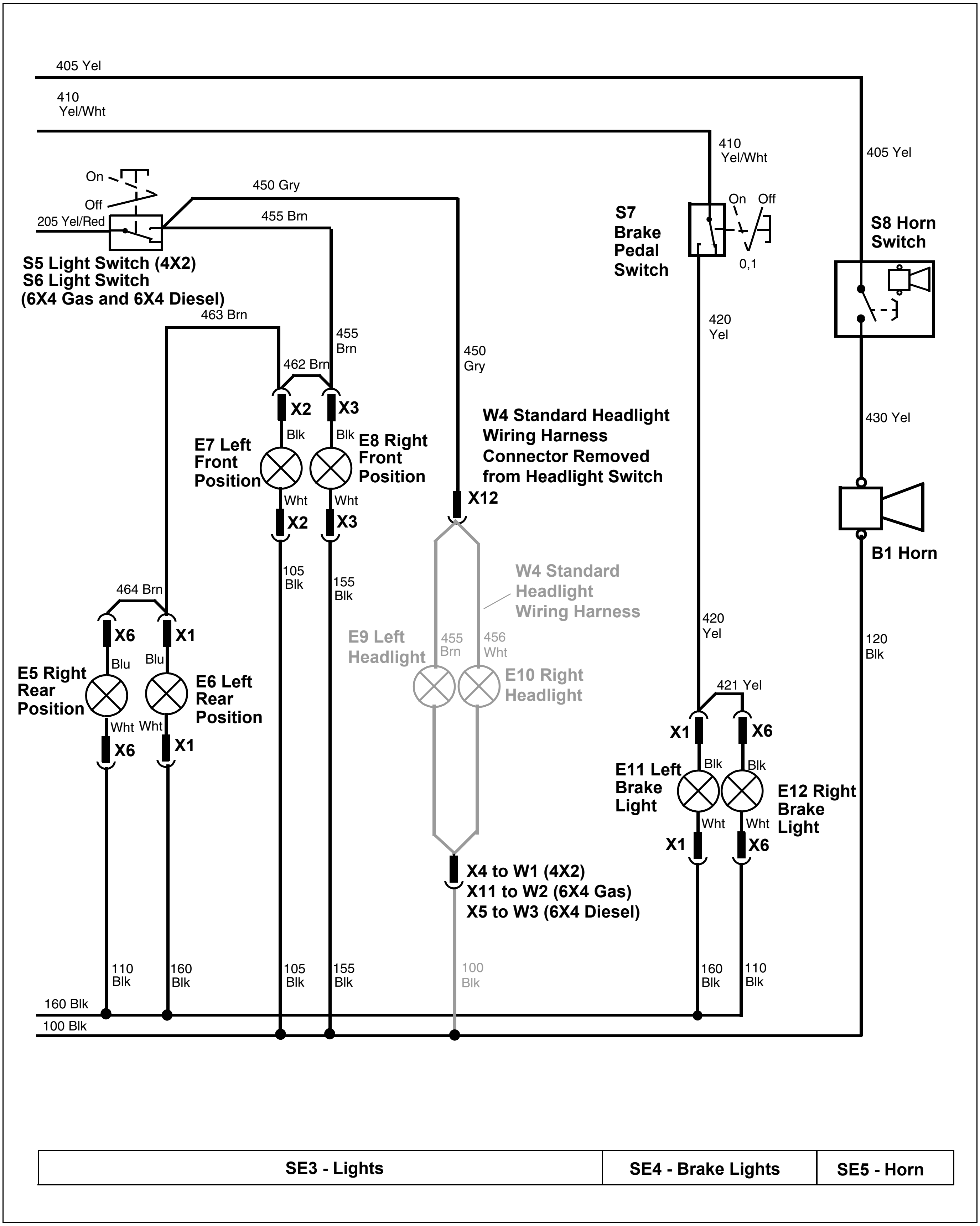
W30 Light and Horn Electrical Schematic (Later Model)

Light and Horn Electrical Schematic (Later Model) (1 of 2)



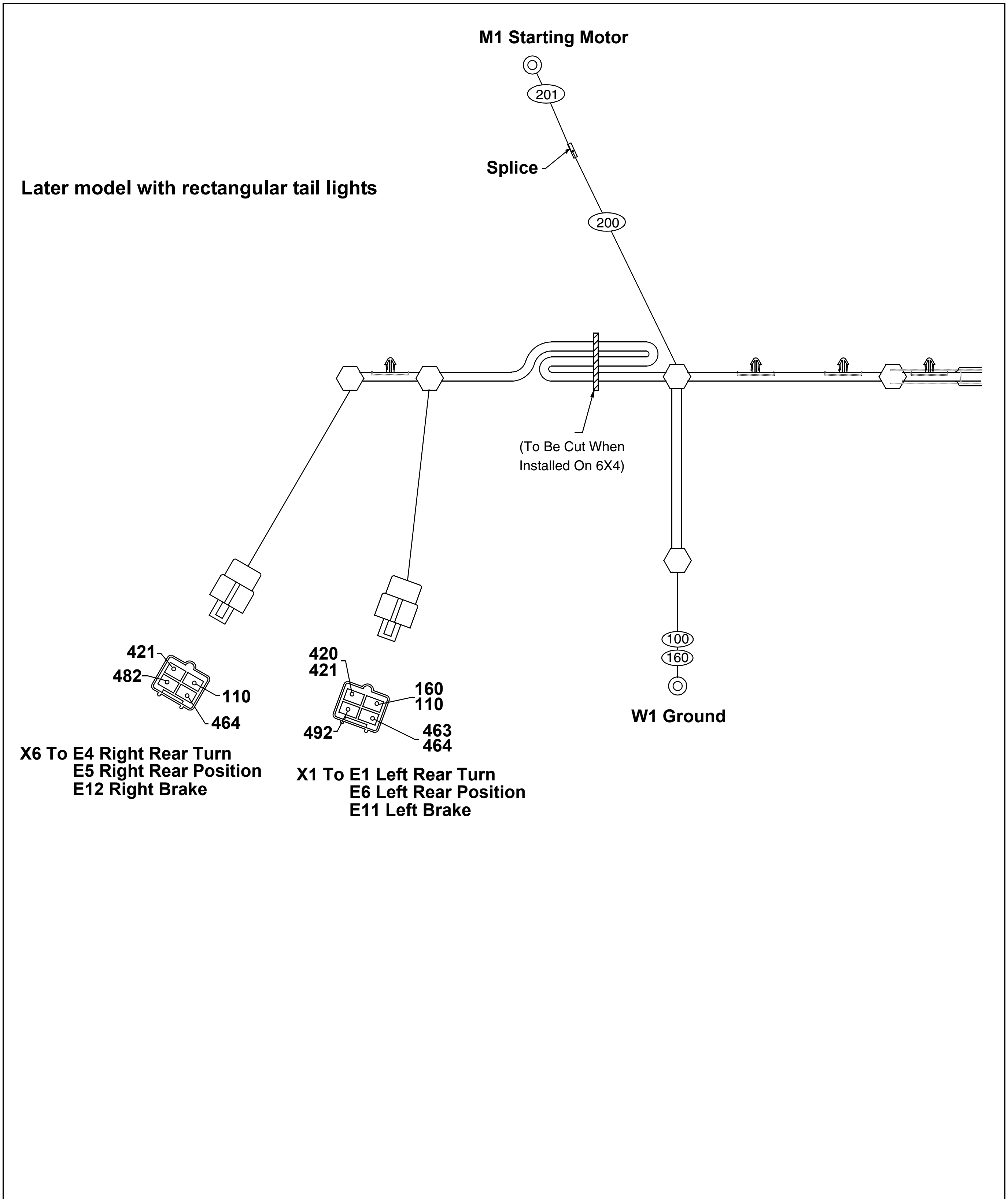
SE1 - Starting	SE2 - Turn Signals

Light and Horn Electrical Schematic (Later Model) (2 of 2)

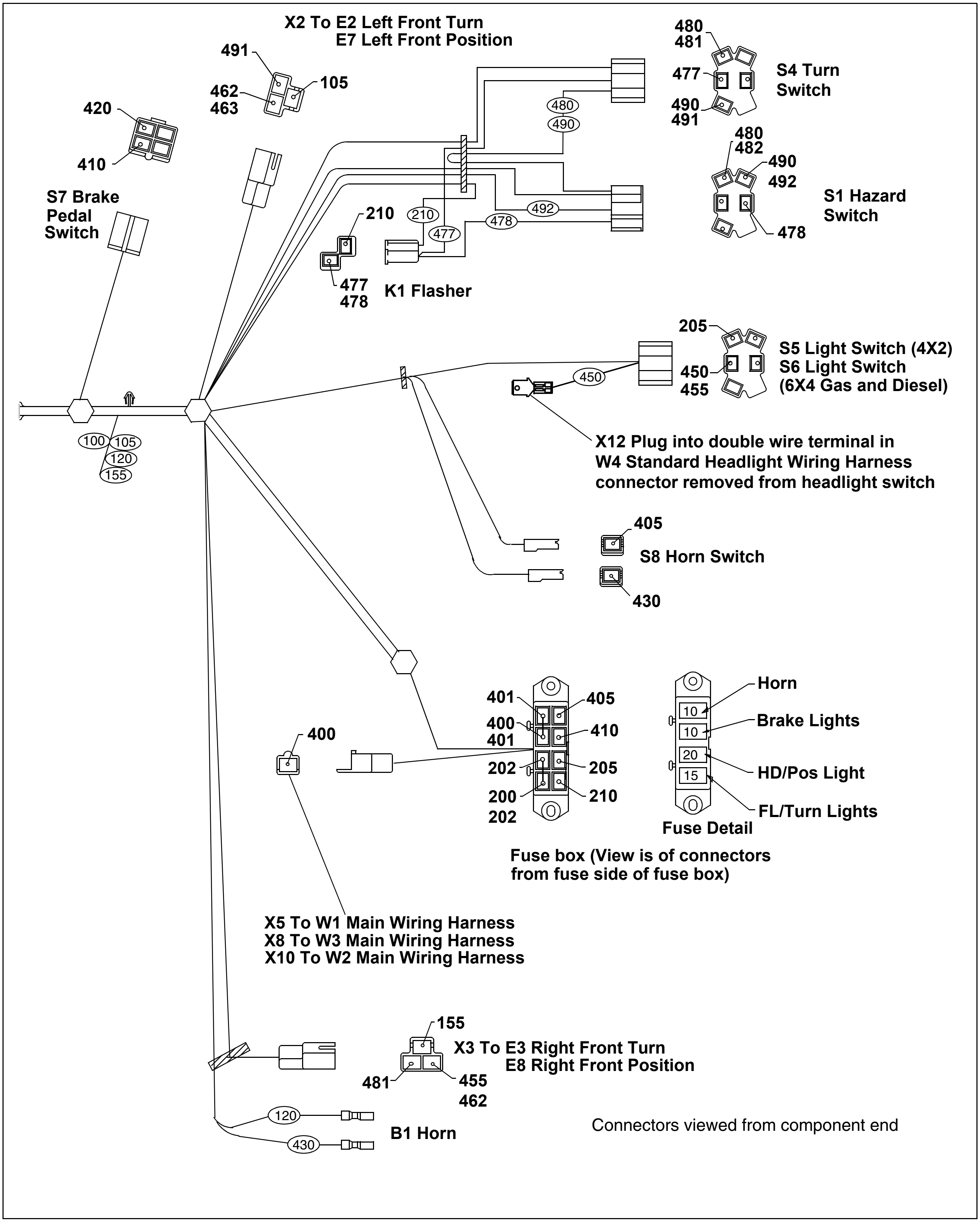


W30 Light and Horn Wiring Harness (Later Model)

W30 Light and Horn Wiring Harness (Later Model) (1 of 2)

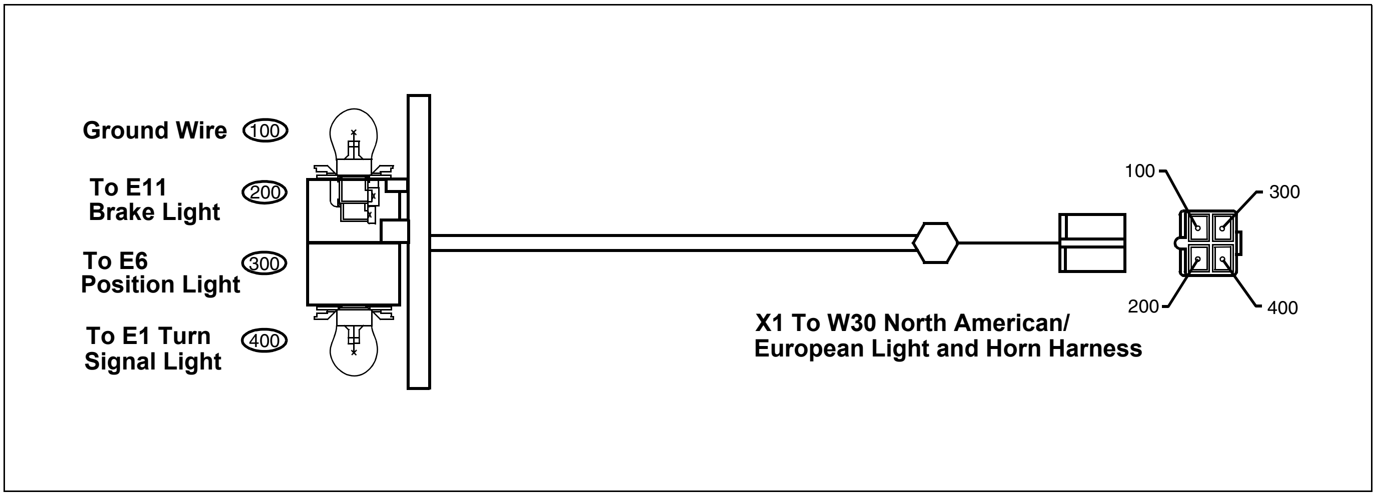


W30 Light and Horn Wiring Harness (Later Model) (2 of 2)

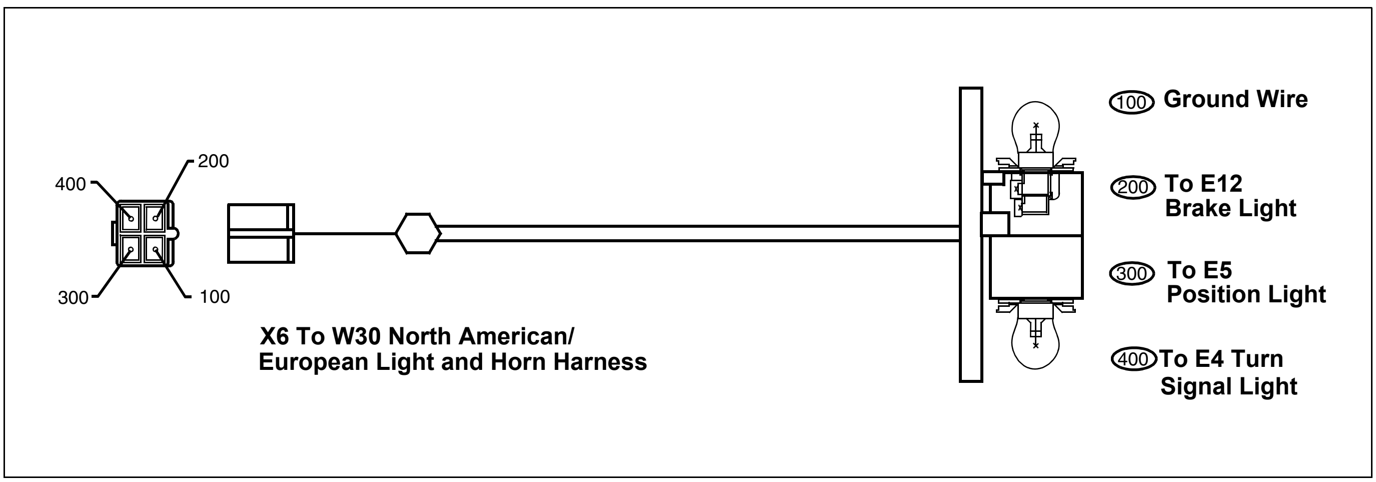


ELECTRICAL W30 NORTH AMERICAN/EUROPEAN LIGHT AND HORN

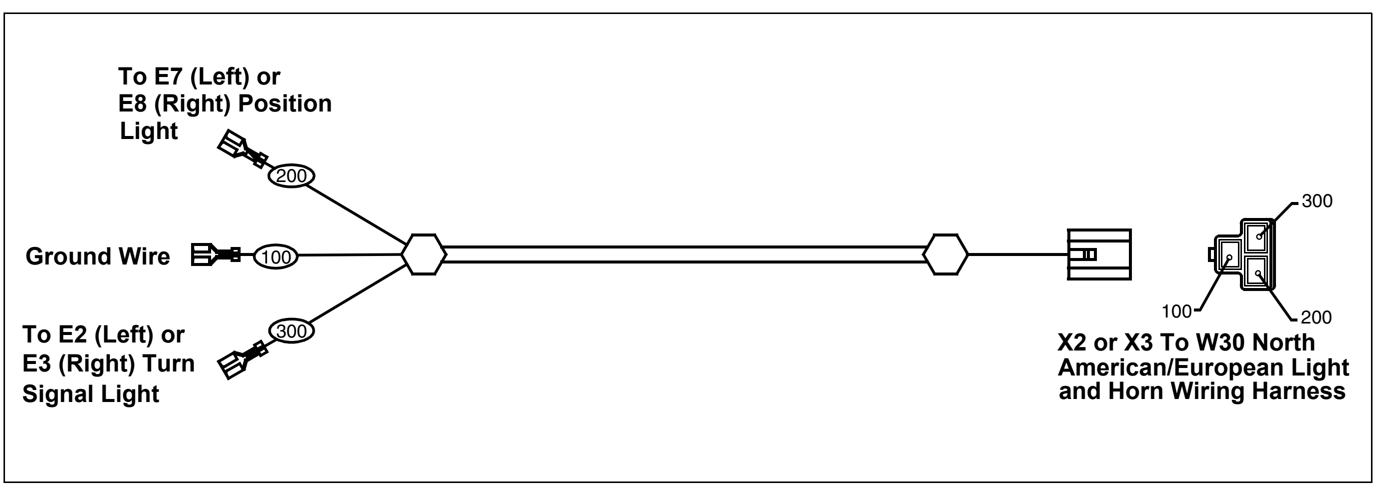
W20 Rear Position/Turn/Brake Wiring Harness (Later Model, Left)



W21 Rear Position Turn/Brake Wiring Harness (Later Model, Right)



W22 Front Position/Turn Wiring Harness (Later Model)



W30 Light/Horn Wiring Harness Color Codes (Later Model)

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Blk	W1, Splice 105, 155, and 120 Blk
105	0.8	Blk	100 Blk Splice, X2
110	1.0	Blk	160 Blk Splice, X6
120	0.8	Blk	100 Blk Splice, B1
155	0.8	Blk	100 Blk Splice, X3
160	1.0	Blk	W1, 110 Blk Splice, X1
200	2.0	Red	F2, F7
201	0.8	Fusible Link	M1, 200 Red
202	2.0	Red	F7, F6
205	2.0	Yel/Red	F6, S5 (4X2) or S6 (6X4)
210	1.0	Red	F7, K1
400	1.0	Yel/Red	X5 (4X2), F10 X10 (6X4 gas), F10 X8 (6X4 diesel), F10
401	0.8	Yel/Red	F10, F9
405	0.8	Yel	F9, S8
410	0.8	Yel/Wht	F10, S7
420	0.8	Yel	S7, X1
421	0.8	Yel	X1, X6
430	0.8	Yel	S8, B1
450	1.0	Gry	S5 (4X2), X12 S6 (6X4), X12
455	1.0	Brn	S5 (4X2), X3 S6 (6X4), X3
462	1.0	Brn	X3, X2
463	0.8	Brn	X2, X1
464	0.8	Brn	X1, X6
477	1.0	Wht	K1, S4
478	1.0	Wht	K1, S1
480	1.0	Grn	S1, S4
481	0.8	Grn	S4, X3
482	0.8	Grn	S1, X6
490	1.0	Blu	S1, S4
491	0.8	Blu	S4, X2
492	0.8	Blu	S1, X1

W20 Rear Position/Turn/Brake Wiring Harness Color Codes (Later Model, Left)

Circuit Number	Wire Size	Color	Termination Points
100	0.8	Blk	X1, Ground Wire
200	0.8	Wht	X1, E11
300	0.8	Blu	X1, E6
400	0.8	Grn	X1, E1

W21 Rear Position Turn/Brake Wiring Harness Color Codes (Later Model, Right)

Circuit Number	Wire Size	Color	Termination Points
100	0.8	Blk	X6, Ground Wire
200	0.8	Wht	X6, E12
300	0.8	Blu	X6, E5
400	0.8	Grn	X6, E4

W22 Front Position/Turn Wiring Harness Color Codes (Later Model)

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Wht	X2 or X3, Ground Wire
200	1.0	Blk	X2 or X3, E7 or E8
300	1.0	Grn	X2 or X3, E2 or E3

Operation and Diagnostics

W30 North American/European Light and Horn Kit Operation (Later Model)

Later Models with Rectangular Tail Lights

Function:

Provides wiring harness and lights for braking lights, position lights and turn signal lights. It also provides a horn.

Theory of Operation:

When the North American/European wiring harness is installed, the existing main wiring harness connector to the W4 standard headlights wiring harness is unplugged and the X12 connector of the North American/European wiring harness is plugged into the molded connector disconnected from the headlight switch. A separate connector on the North American/European wiring harness is then plugged into the X5 (4X2 gas), X10 (6X4 gas), or X8 (6X4 diesel) connectors from the main wiring harnesses. Connections are also made at the “B” terminal of the M1 starting motor and the W1 ground.

Two power circuits provide power to the four functional circuits of the light and horn kit. One power supply circuit is the F2 fusible link connected to the “B” terminal of the starting motor which provides power to the 200 and 202 Red wires and the F6 and F7 fuses of the fuse block.

From the F6 20 amp fuse power is supplied to the 205 Yel/Red wire and the S5/S6 light switch. When the light switch is in the ON position power is supplied to the 450 Gry wire to the W4 standard headlight wiring harness and the headlights as well as the 455, 462, 463, and 464 Brn wires. The 455, 462, 463, and 464 Brn wires provide power the position lights located at each corner of the machine.

From the F7 15 amp fuse power is supplied to the 210 Red wire, K1 flasher, and 478 Wht wire to the S1 hazard switch. Current also flows from the K1 flasher and 477 Wht wire to the S4 turn signal switch.

With the S4 turn signal switch in either the left or right turn position, power is supplied to the two signal lights on the left side of the machine or the two signal lights on the right side of the machine. When the S1 hazard switch is in the ON position, power is supplied to all four signal lights.

The ground path for the positioning and signal lights is provided in the front of the machine by the 105 and 155 Blk wires spliced into the 100 Blk wire which connects to the W1 ground and in the rear of the machine by the 110 and 160 Blk wires spliced into the 160 Blk wire which connects to the W1 ground.

The second power supply circuit is also powered from the “B” terminal of the starting motor. Current flows through the existing F1 fusible link, 200 Red wire, S2 key switch, 400 Yel/Red wire, 410 Yel/Red wire (6X4 machines), and the X5/X8/X10 12 volt powered connector that was disconnected from the standard headlight wiring harness and connected to the North American/European wiring harness. Current enters the North American/European wiring harness, and flows through the 400 Yel/Red wire, 401 Yel/Red jumper wire to the F9 and F10 fuses.

From the F9 fuse current flows to the 405 Yel wire and the S8 horn switch. Current also flows from the F10 fuse and 410 Yel/Wht wire to the S7 brake pedal switch.

When the S8 horn switch is depressed current will flow across the switch to the 430 Yel wire and the horn, allowing the horn to sound. The ground path for the horn is provided by the 120 and 100 Blk wires.

When the brake pedal is depressed, current flows across the S7 brake pedal switch to the 420 and 421 Yel wires to the brake lights at the rear of the machine. The ground path for the brake lights is provided by the 110 and 160 Blk wires.

Light and Horn Kit Power Circuit Operation (Later Model)

Function:

Provides power to the primary components of the light and horn kit.

Operating Conditions, Unswitched Circuits:

Voltage must be present at the following components with the key switch “OFF”:

- “B” Terminal of Starting Motor
- “B” Terminal of Key Switch
- F6 and F7 Fuses
- Light Switch
- K1 Flasher
- S1 Hazard Switch
- S4 Turn Signal Switch

The positive battery cable connects battery to a starting motor bolt. This bolt is used as a power tie point for the light and horn kit harness.

The connection between the starting motor and the key switch or light switch is protected by fusible links. The fusible links protect the wiring harness from high current load and shorts.

Switched Circuits:

In addition to those locations that must have voltage present with the key switch in the “OFF” position, voltage must be present at following components with key switch in the “RUN” position:

- “A” Terminal of Key Switch
- S3 Park Brake Switch
- S7 Brake Pedal Switch
- S8 Horn Switch

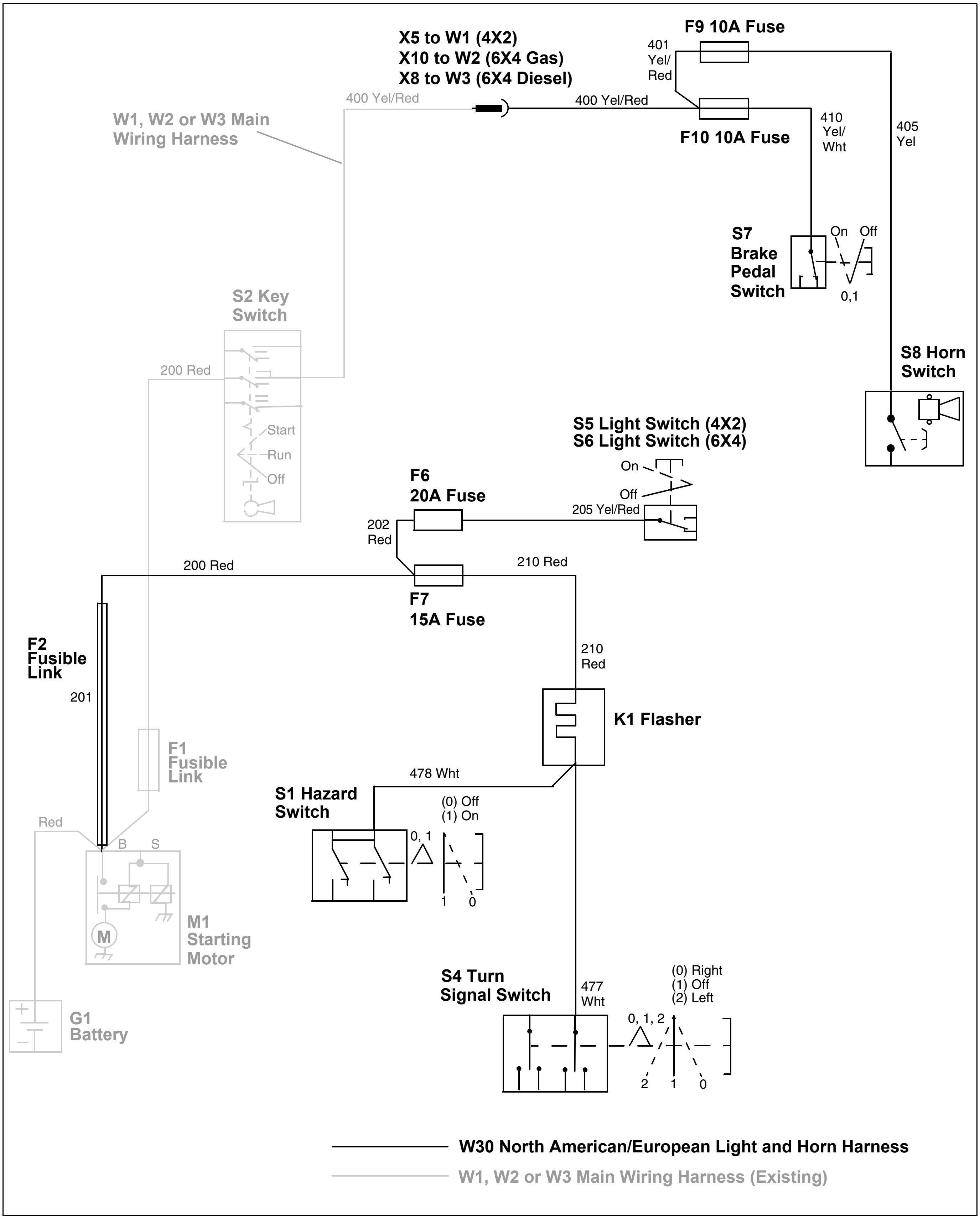
These components are controlled by the key switch and protected by the F1 fusible link, F9 and F10 fuses.

Additional voltage must be present at the following lights with the key switch in the “RUN” position and the light switch in the ON position:

- E7 Left Front Position
- E6 Left Rear Position
- E8 Right Front Position
- E5 Right Rear Position
- E9 Left Headlight
- E10 Right Headlight

These components are controlled by the light switch and protected by the F2 fusible link, F6 and F7 fuses.

Light and Horn Kit Power Circuit Electrical Schematic (Later Model)



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Light and Horn Kit Power Circuit Diagnosis (Later Model)

Test Conditions:

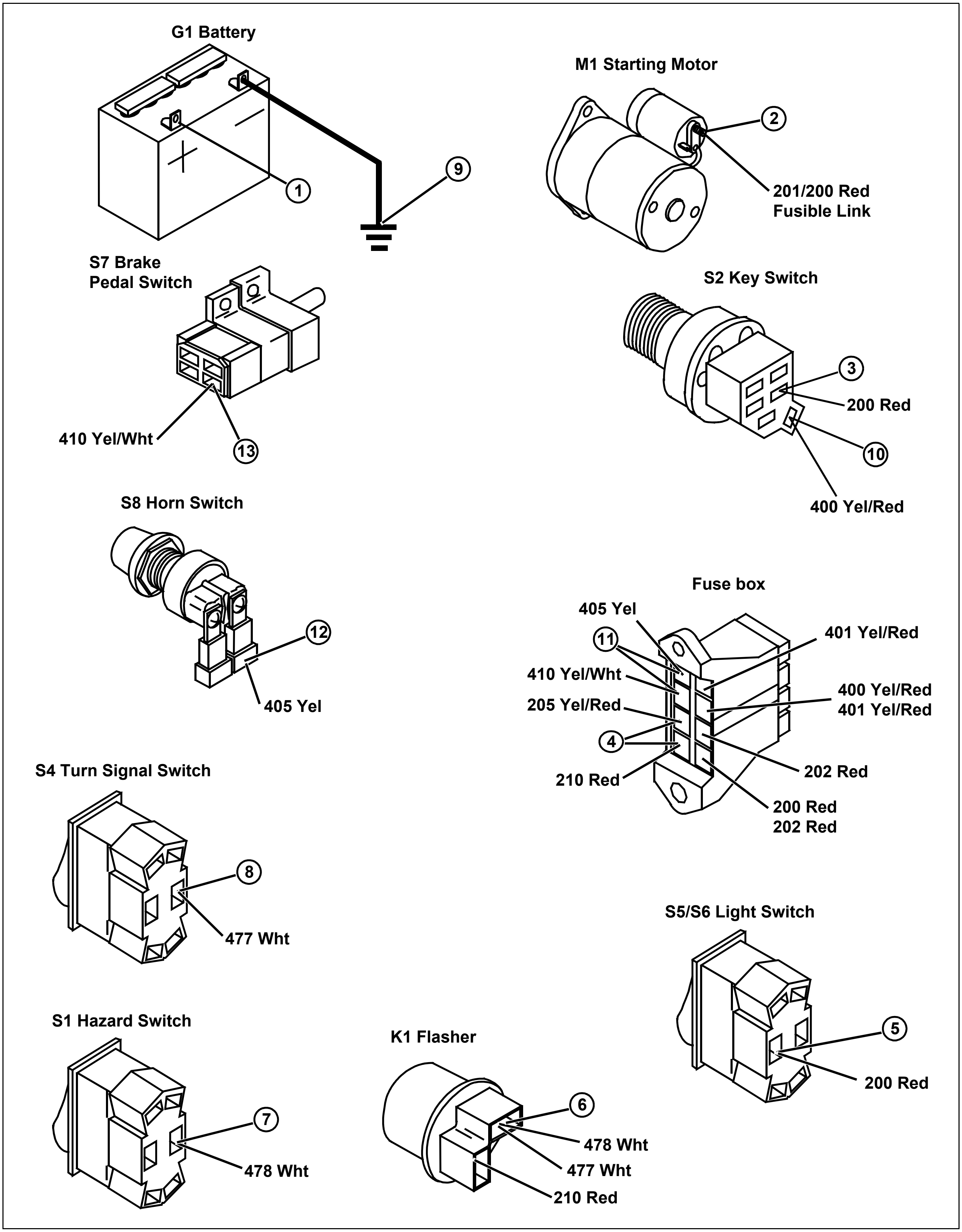
- Park Brake engaged.
- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal.
- Meter positive (+) lead on numbered test point.
- Check connections for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal	Battery voltage (11.8 - 13.2 volts)	Test battery.
2. Starting motor solenoid terminal B	Battery voltage	Check battery cable and connection.
3. Key switch terminal B	Battery voltage	Check F1 fusible link and 200 Red wire and connections.
4. Fuse Box	Battery voltage	Check F2 fusible link, 200 Red and 202 Red wires. Test Fuses
5. Light switch	Battery voltage	Check F2 fusible link, 200 Red and 202 Red wires, F6 fuse and 205 Yel/Red wire and connections.
6. Flasher	Battery voltage	Check 210 Red wire and connections. If OK, replace flasher.
7. Hazard switch	Battery voltage	Check 478 Wht wire and connections.
8. Turn signal switch	Battery voltage	Check 477 Wht wire and connections.
9. Ground cable	Maximum 0.1 ohm resistance	Check battery negative cable and connection.

Test Conditions:

- Key switch in RUN position

Test/Check Point	Normal	If Not Normal
10. Key switch terminal A	Battery voltage	Replace key switch.
11. Fusebox	Battery voltage	Check 400 and 401 Yel/Red wires, light and horn harness connection. Test Fuses
12. Horn switch	Battery voltage	Check 405 Yel wire and connections.
13. Brake pedal switch	Battery voltage	Check 410 Yel/Wht wire and connections.



G1 Battery
1
9
M1 Starting Motor
2
201/200 Red
Fusible Link
S7 Brake
Pedal Switch
410 Yel/Wht
13
S2 Key Switch
3
200 Red
10
400 Yel/Red
S8 Horn Switch
12
405 Yel
Fuse box
405 Yel
11
401 Yel/Red
410 Yel/Wht
400 Yel/Red
401 Yel/Red
205 Yel/Red
4
210 Red
202 Red
200 Red
202 Red
S4 Turn Signal Switch
8
477 Wht
S5/S6 Light Switch
5
200 Red
S1 Hazard Switch
7
478 Wht
K1 Flasher
6
478 Wht
477 Wht
210 Red

Turn Signal and Hazard Light Circuit Operation (Later Model)

Function:

Turn Signal Lights:

To provide power to illuminate the right or left front and rear turn signal lights depending on turn signal switch position.

Hazard Lights:

To provide power to illuminate the front and rear turn signal lights when the hazard switch is ON.

Operating Conditions:

The hazard switch must be closed or the turn signal switch must be in the right or left position.

Theory of Operation:

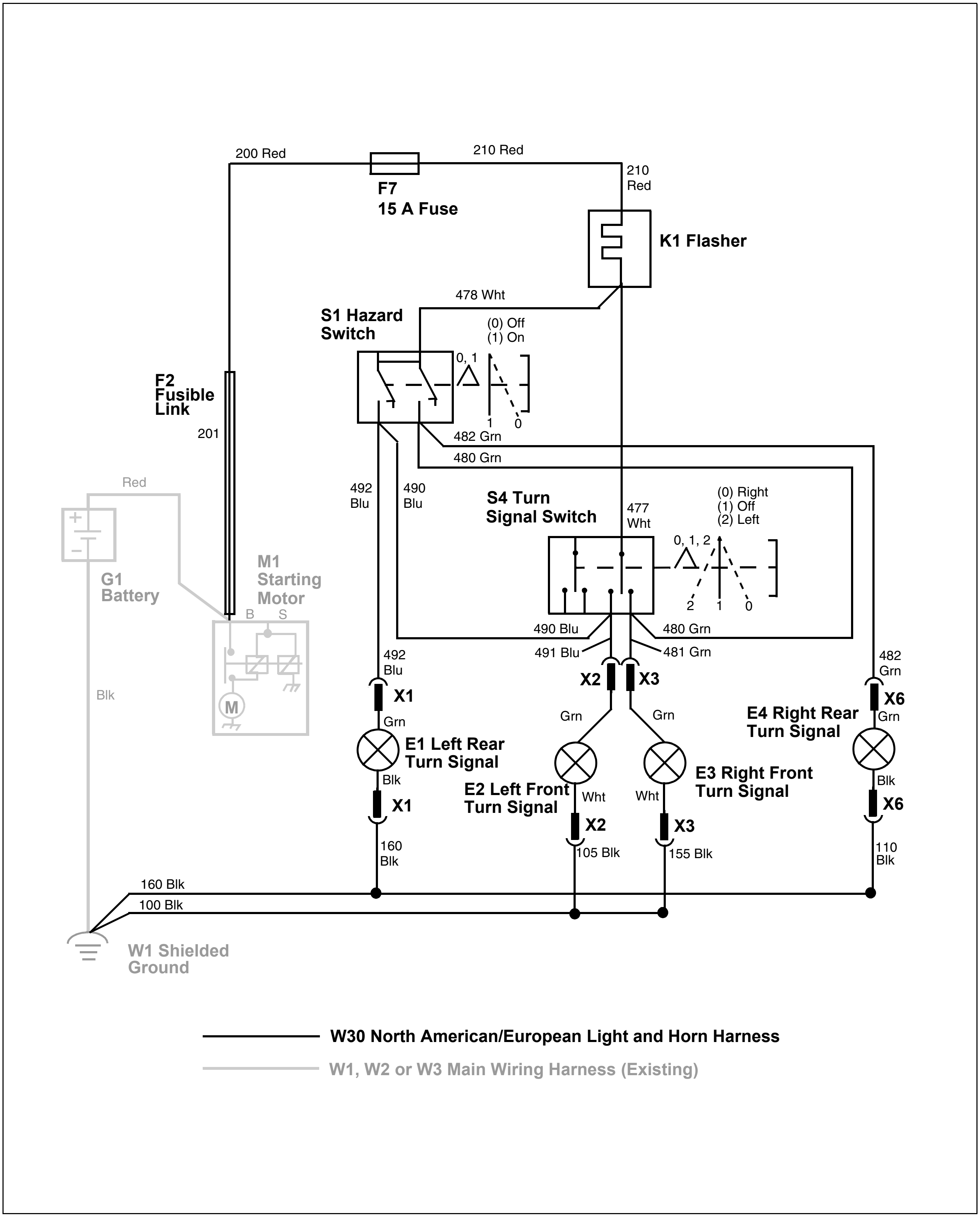
Turn Signal Lights:

With the turn signal switch (S4) in the right position, current from the flasher (K1) flows through the turn signal switch and illuminates the right front turn signal light (E3), and right rear turn signal light (E4). When the turn signal switch is closed, current flowing through the flasher causes the flasher switch to open and close intermittently to produce the flashing signal.

Hazard Lights:

With the hazard switch (S1) ON (switch closed), current from the flasher (K1) flows through the hazard switch and illuminates both front and rear turn signal lights (E1, E2, E3 and E4). The circuit is protected by fusible link (F2) and fuse (F7).

Turn Signal and Hazard Light Circuit Electrical Schematic (Later Model)



Turn Signal and Hazard Light Circuit Diagnosis (Later Model)

Test Conditions:

- Light bulb continuity OK or bulb replaced.
- Park brake engaged.
- Key switch in OFF position.
- Hazard switch in OFF position.
- Turn signal in RIGHT position.
- Meter positive (+) lead on numbered test point.
- Meter negative (-) lead on battery negative (-) terminal.
- Check connection for corrosion and loose terminals when testing.

Test/Check Point	Normal	If Not Normal
1. Flasher	Intermittent battery voltage	Check 200, 201 and 210 Red wires and connections and F7 fuse. If OK, replace flasher.
2. Turn signal switch	Intermittent battery voltage	Check 477 Wht wire and connections. If OK, replace turn signal switch.
3. Right front turn signal	Intermittent battery voltage	Check 481 Grn and Grn wires.
4. Right rear turn signal	Intermittent battery voltage	Check 480 Grn, 482 Grn, and Grn wires.

Test Conditions:

- Turn signal in LEFT position

Test/Check Point	Normal	If Not Normal
5. Flasher	Intermittent battery voltage	Check 200, 201 and 210 Red wires and connections and F7 fuse. If OK, replace flasher.
6. Turn signal switch	Intermittent battery voltage	Check 477 Wht wire and connections. If Ok, replace turn signal switch.
7. Left front turn signal	Intermittent battery voltage	Check 491 Blu and Grn wires.
8. Left rear turn signal	Intermittent battery voltage	Check 490 Blu, 492 Blu, and Grn wires.

Test Conditions:

- Turn signal in OFF position

Test/Check Point	Normal	If Not Normal
9. Right rear turn signal	Maximum 0.1 ohm resistance	Check battery negative cable, engine ground connections, Blk and 110 Blk wires.

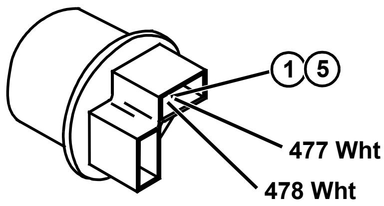
Test/Check Point	Normal	If Not Normal
10. Right front turn signal	Maximum 0.1 ohm resistance	Check Wht and 155 Blk wires.
11. Left front turn signal	Maximum 0.1 ohm resistance	Check Wht and 105 Blk wire.
12. Left rear turn signal	Maximum 0.1 ohm resistance	Check Blk and 160 Blk wire.

Test Conditions:

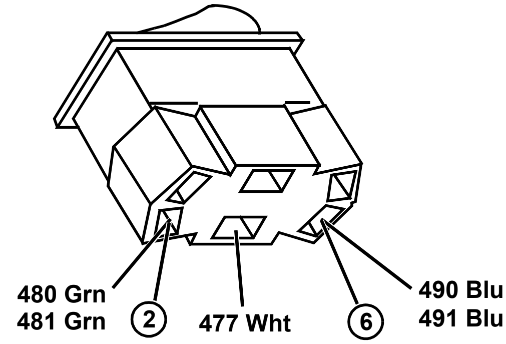
- Hazard switch in ON position

Test/Check Point	Normal	If Not Normal
13. Hazard switch	Intermittent battery voltage	Check 478 Wht wire and connections.
14. Hazard switch	Intermittent battery voltage. All four lamps flashing.	Replace hazard switch.

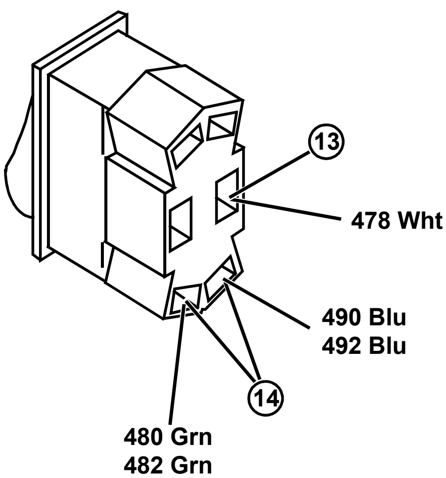
K1 Flasher



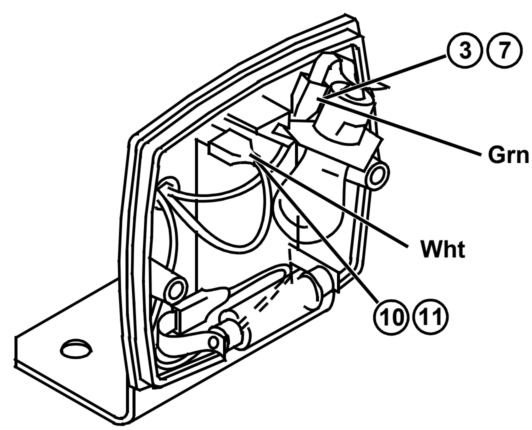
S4 Turn Signal Switch



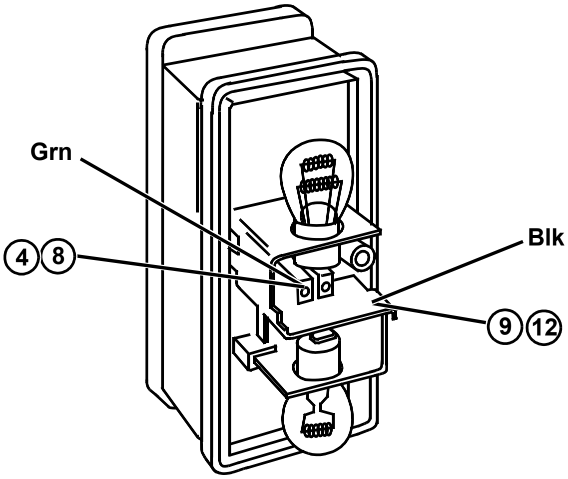
S1 Hazard Switch



Left or Right Front Position/Turn Light



Left or Right Rear Position/Brake/Turn Light



Light and Horn Circuit Operation (Later Model)

Function:

Position Lights and Headlights Circuit:
To provide power to illuminate the front and rear position lights, and/or headlights depending on light switch position.

Brake Lights Circuit:
To provide power to illuminate the rear brake lights when the brake pedal is depressed.

Horn Circuit:
To energize the horn when desired by the operator.

Operating Conditions:

Position Lights and Headlights:
The light switch must be in the ON position.

Brake Lights:
The key switch must be in the RUN position and the brake pedal depressed.

Horn:
The key switch must be in the RUN position and the horn switch depressed.

Theory of Operation:

Position Lights and Headlights:
With the light switch (S5/S6) in the ON position (closed), current flows to the 450 Gry and illuminates the headlights (E9 and E10) and 455, 462, 463, and 464 Brn wires and illuminates all position lights (E5, E6, E7, E8).

Brake Lights:
With the brake pedal switch (S7) closed (brake pedal depressed), current from fuse (F10) and brake pedal switch illuminates the Left and Right brake lights (E11, E12).

Horn:

With the horn switch (S8) closed (switch depressed), current from fuse (F9) and horn switch energizes the horn (B1).

Light and Horn Circuit Diagnosis (Later Model)

Test Conditions:

- Light bulb continuity OK or bulb replaced.
- Headlight switch in ON position.
- Meter positive (+) lead on numbered test point.
- Meter negative (-) lead on negative (-) terminal.
- Check terminals for corrosion and loose connections.

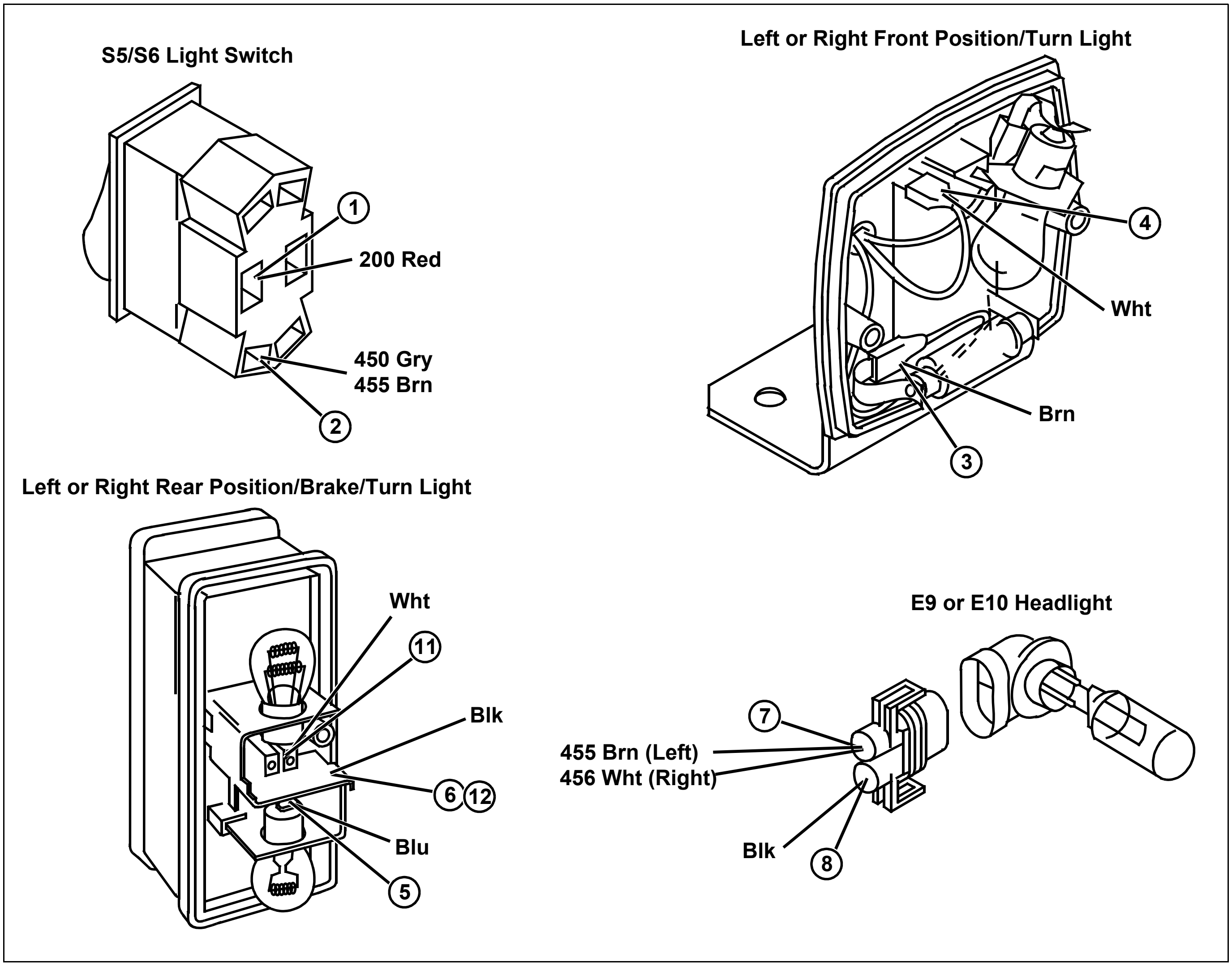
Test/Check Point	Normal	If Not Normal
1. Light switch	Battery voltage	Check light switch power circuit.
2. Light switch	Battery voltage	Replace light switch.
3. Left and Right front position lights	Battery voltage	Check 455 and 462 Brn wires and connections.
4. Left and Right front position lights	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check battery negative cable, engine ground connections, Wht, 105 Blk, and 155 Blk wires. 0 volts: Replace bulb.
5. Left and Right rear position lights	Battery voltage	Check 455, 462, 463 and 464 Brn wires and Blu wire and connections.
6. Left and Right rear position lights	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check ground connections, Blk, 110 Blk, and 160 Blk wires. 0 volts: Replace bulb.
7. Left and Right headlights	Battery voltage	Check 450 Gry, 455 Brn and 456 Wht wires and connections.

Test/Check Point	Normal	If Not Normal
8. Left and Right headlights	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check ground connections, 100 blk wire. 0 volts: Replace bulb

Test Conditions:

- Key switch in RUN position
- Brake pedal depressed

Test/Check Point	Normal	If Not Normal
9. Brake pedal switch	Battery voltage	Check brake light power circuit.
10. Brake pedal switch	Battery voltage	Replace brake pedal switch.
11. Left and Right brake lights	Battery voltage	Check 420 and 421 Yel wires and Wht wires and connections.
12. Left and Right brake lights	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check ground connections, Blk, 110 Blk, and 160 Blk wires. 0 volts: Replace bulb.



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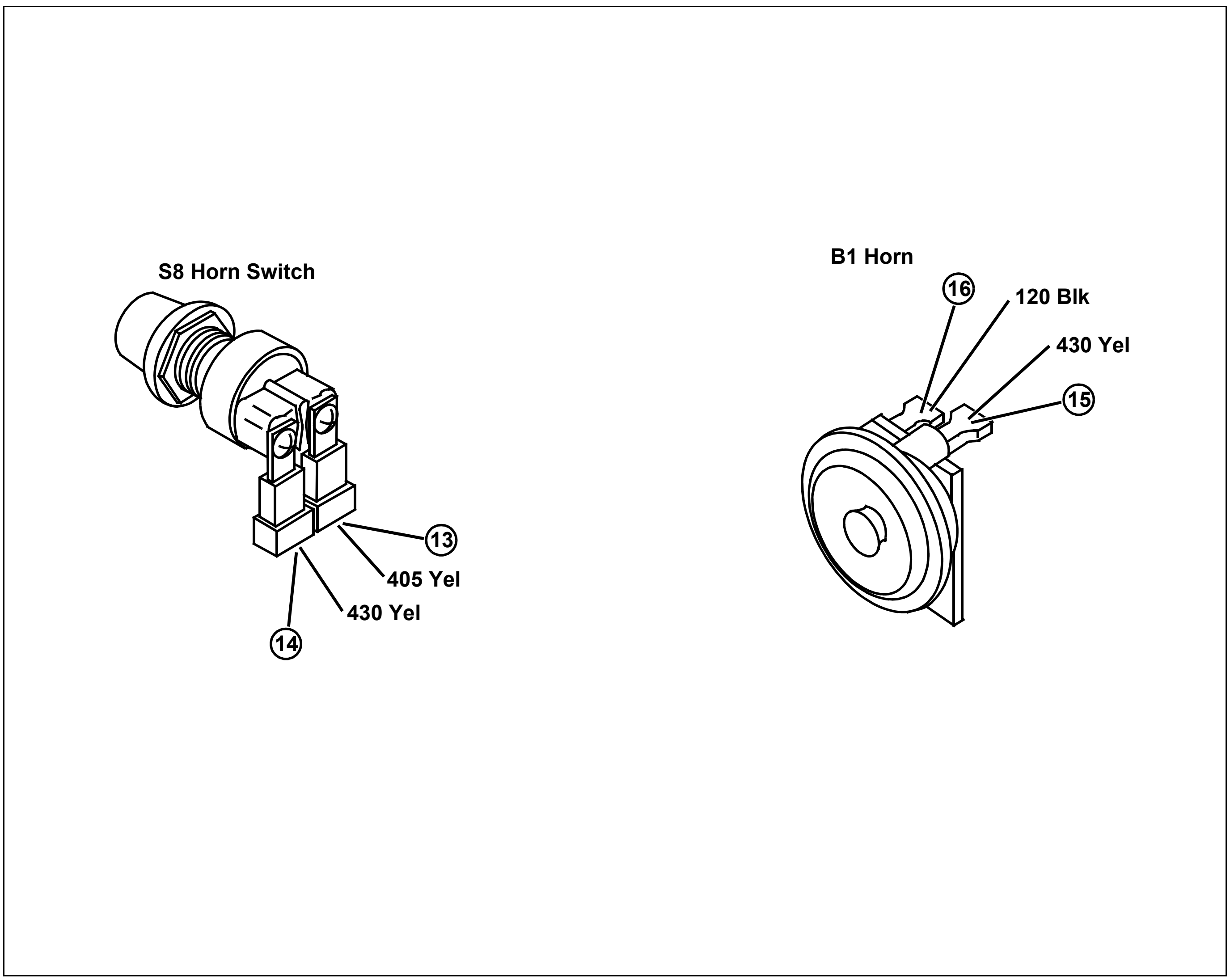
Test Conditions:

- Light bulb continuity OK or bulb replaced.
- Horn switch depressed.
- Meter positive (+) lead on numbered test point.
- Meter negative (-) lead on negative (-) terminal.
- Check terminals for corrosion and loose connections.

Test/Check Point	Normal	If Not Normal
13. Horn switch	Battery voltage	Check horn switch power circuit.
14. Horn switch	Battery voltage	Replace horn switch.
15. Horn	Battery voltage	Check 430 Yel wire and connections.
16. Horn	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check ground connections and 120 Blk wire. 0 volts: Replace horn.



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W19 Road Homologated Light and Horn Kit

W19 Road Homologated Light and Horn Kit Schematic and Wiring Harness Legend

Road Homologated Light and Horn Kit

B1 - Horn (SE5, W19)

E1 - Left Rear Turn Signal Light (SE2, W19)

E2 - Left Front Turn Signal Light (SE2, W19)

E3 - Right Front Turn Signal Light (SE2, W19)

E4 - Right Rear Turn Signal Light (SE2, W19)

E5 - Right Rear Position Light (SE3, W19)

E6 - Left Front Position Light (SE3, W19)

E7 - Right Front Position Light (SE3, W19)

E8 - Left Rear Position Light (SE3, W19)

E9 - License Plate Light (SE3, W19)

E10 - Left Headlight (SE3, W19)

E11 - Right Headlight (SE3, W19)

E12 - Left Brake Light (SE4, W19)

E13 - Right Brake Light (SE4, W19)

E14 - Bulb Integrity Light (SE2, W19)

E15 - Bulb Integrity Light (SE2, W19)

F1 - Fusible Link (SE1, W19; SE1, W1; SE1, W2; SE1, W3)

F2 - Fusible Link (SE1, W19)

F3 - 15 Amp Fuse (SE2, W19)

F4 - 10 Amp Fuse (SE3, W19)

F5 - 10 Amp Fuse (SE3, W19)

F6 - 10 Amp Fuse (SE3, W19)

F7 - 10 Amp Fuse (SE3, W19)

F8 - 15 Amp Fuse, Spare (SE4, W19)

F9 - 10 Amp Fuse (SE4, W19)

F10 - 10 Amp Fuse (SE4, W19)

G1 - Battery (SE1, W19, SE1, W1; SE1, W2; SE1, W3)

K1 - Flasher (SE2, W19)

M1 - Starting Motor (SE1, W19 / W1 / W2 / W3)

R1 - 91 Ohm, 2 Watt Resistor (SE2, W19)

S1 - Hazard Switch (SE2, W19)

S2 - Key Switch (SE1, W19, SE1, W1; SE1, W2; SE1, W3)

S3 - Park Brake Switch (SE4, W19; SE4, W1; SE5, W2; SE6, W3)

S4 - Turn Signal Switch (SE2, W19)

S5 - Light Switch (4X2) (SE3, W19; SE5, W1)

S6 - Light Switch (6X4's) (SE3, W19; SE6, W2; SE7, W3)

S7 - Brake Pedal Switch (SE4, W19)

S8 - Horn Switch (SE5, W19)

V1 - Diode (SE2, W19)

V2 - Diode (SE4, W19)

W1 - Shielded Ground (SE1, W19 / W1 / W2 / W3)

Connectors:

X1 - W19 Light and Horn Wiring Harness to W20 Rear Position/Brake/Turn Wiring Harness (SE2, W19; SE3, W19; SE4, W19)

X2 - W19 Light and Horn Wiring Harness to W22 Left Front Position/Turn Wiring Harness (SE2, W19; SE3, W19)

X3 - W19 Light and Horn Wiring Harness to W22 Right Front Position/Turn Wiring Harness (SE2, W19; SE3, W19)

X4 - W19 Light and Horn Wiring Harness Ground Connection to W1 Main Wiring Harness (4X2) (SE1, W19; SE5, W1)

X5 - W19 Light and Horn Wiring Harness Ground Connection to W3 Main Wiring Harness (6X4 Diesel) (SE1, W19; SE6, W3)

X5 - W19 Light and Horn Wiring Harness Power Connection to W1 Main Wiring Harness (4X2) (SE2, W19; SE5, W1)

X6 - W19 Light and Horn Wiring Harness to W21 Rear Position/Brake/Turn Wiring Harness (SE2, W19; SE3, W19; SE4, W19)

X7 - W19 Light and Horn Wiring Harness to W24 License Plate Wiring Harness (SE3, W19)

X8 - W19 Light and Horn Wiring Harness Power Connection to W3 Main Wiring Harness (6X4 Diesel) (SE2, W19; SE7, W3)

X9 - W19 Light and Horn Wiring Harness to W1, W2 or W3 Main Wiring Harness (SE4, W19)

X10 - W19 Light and Horn Wiring Harness Power Connection to W2 Main Wiring Harness (6X4 Gas) (SE2, W19; SE6, W2)

X11 - W19 Light and Horn Wiring Harness Ground Connection to W2 Main Wiring Harness (6X4 Gas) (SE1, W19; SE6, W2)

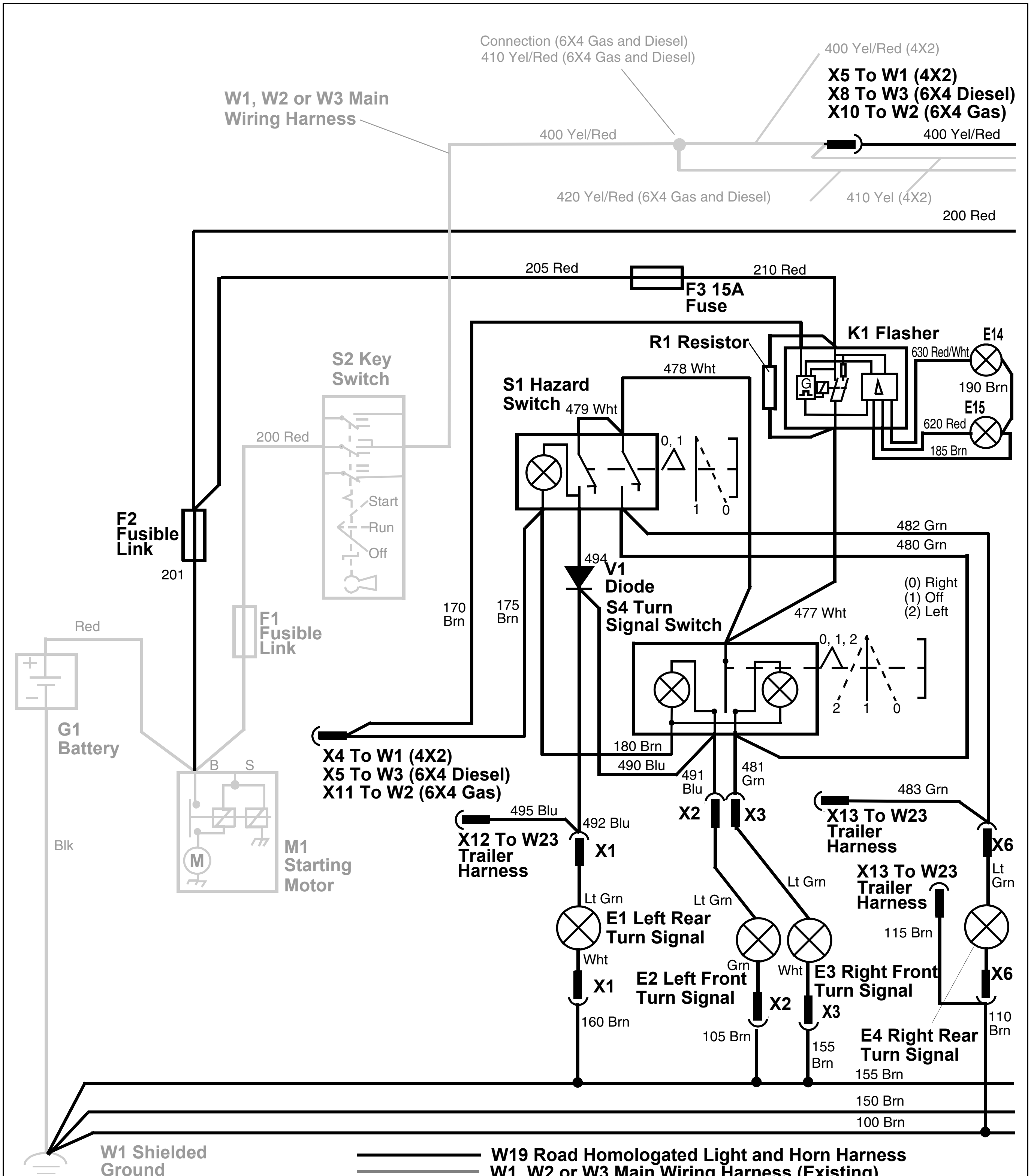
X12 - W19 Light and Horn Wiring Harness to W23 Trailer Connector Wiring Harness (SE2, W19; SE3, W19)

X13 - W19 Light and Horn Wiring Harness to W23 Trailer Connector Wiring Harness (SE2, W19)

X14 - W19 Light and Horn Wiring Harness to W23 Trailer Connector Wiring Harness (SE4, W19)

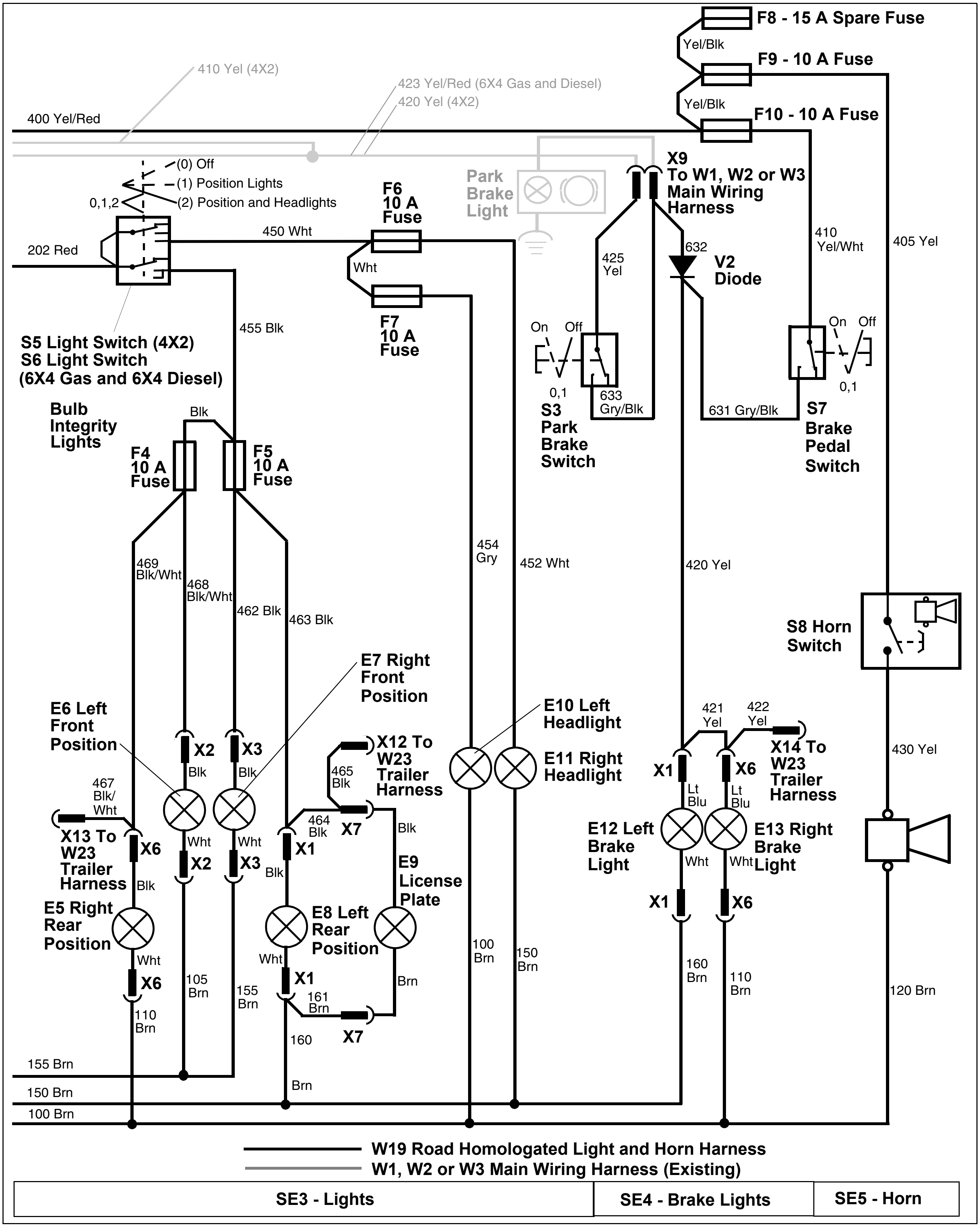
W19 Road Homologated Light and Horn Schematic

W19 Road Homologated Light and Horn Schematic (1 of 2)



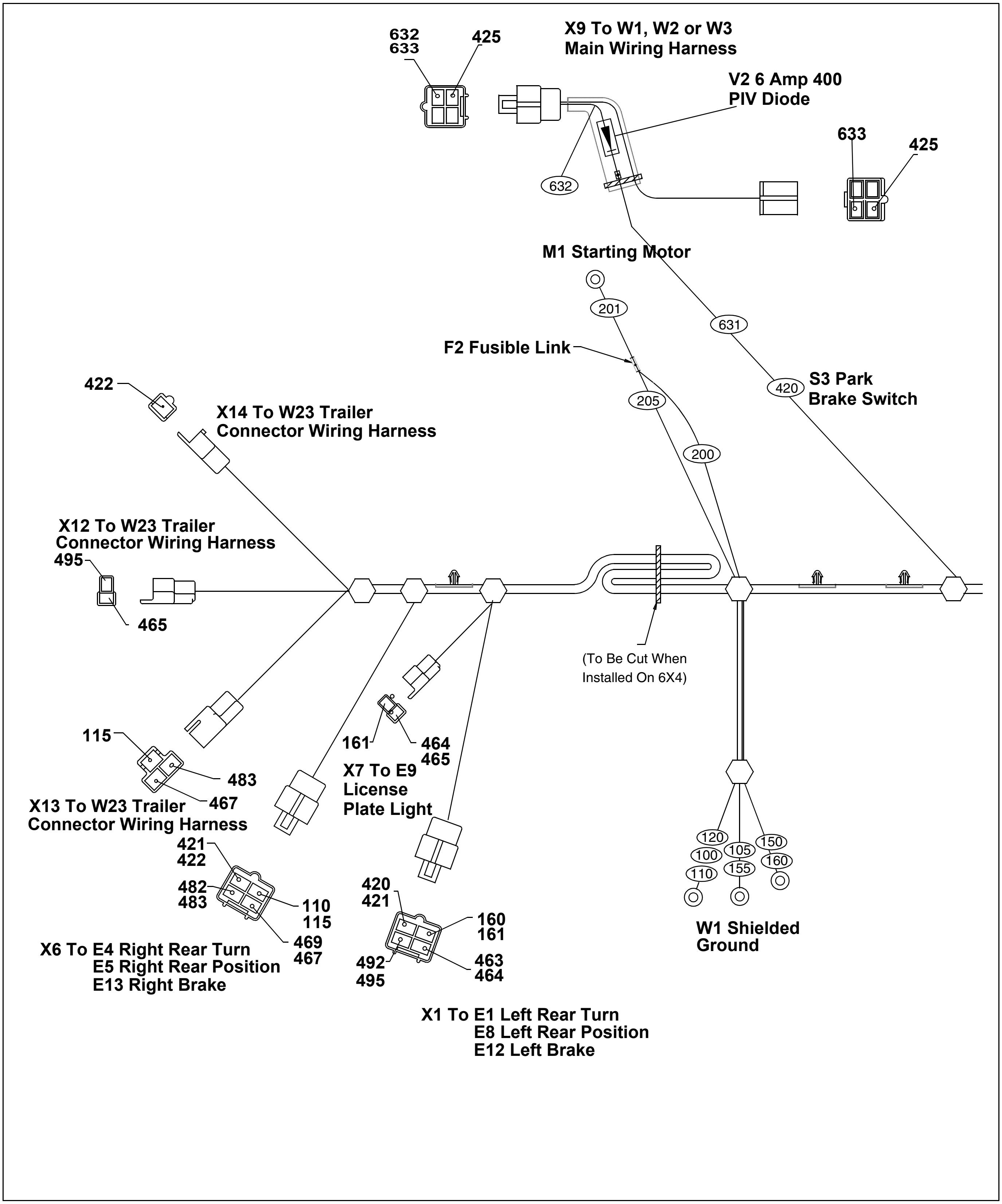
SE1 - Starting	SE2 - Turn Signals

W19 Road Homologated Light and Horn Schematic (2 of 2)

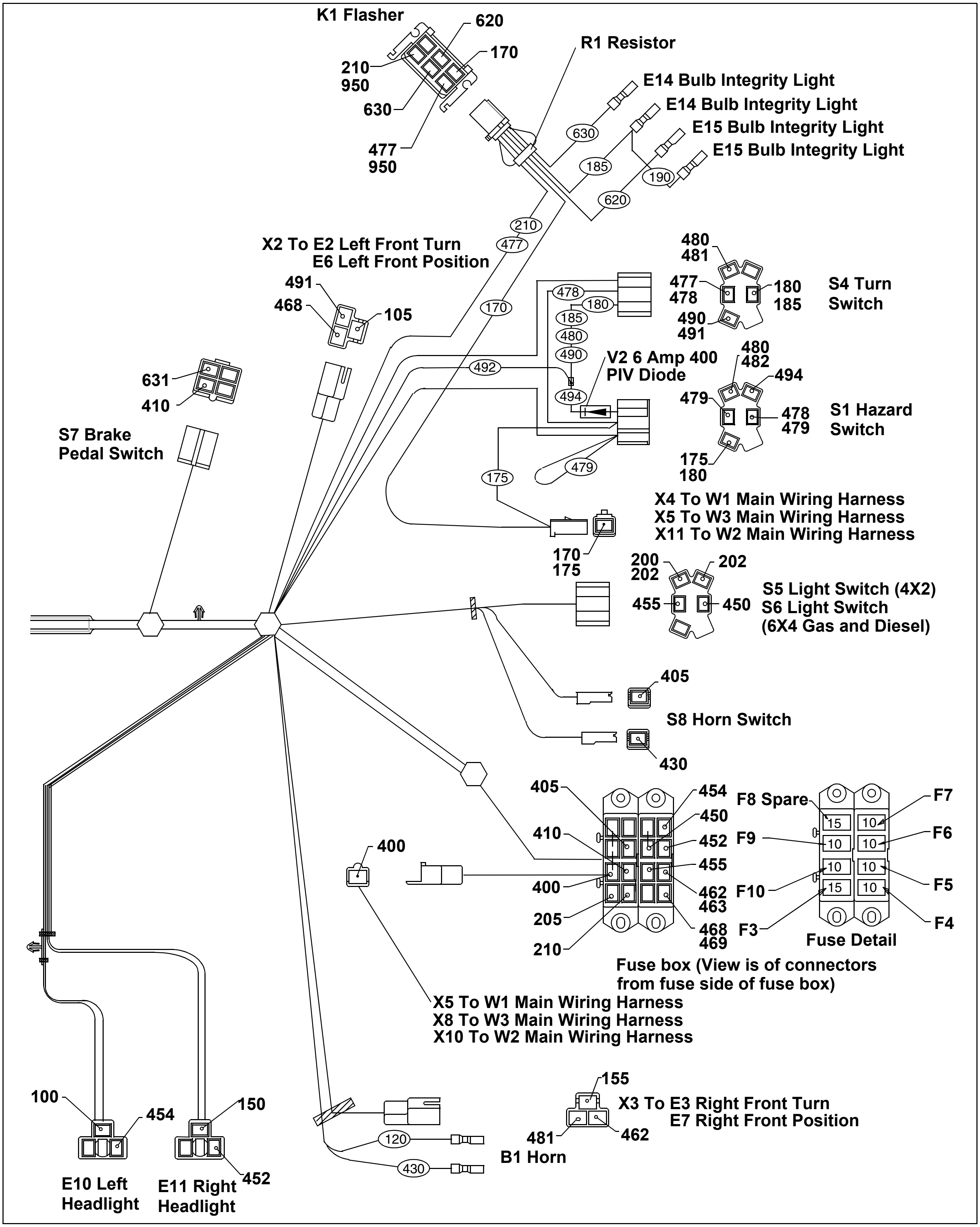


W19 Homologated Light and Horn Wiring Harness

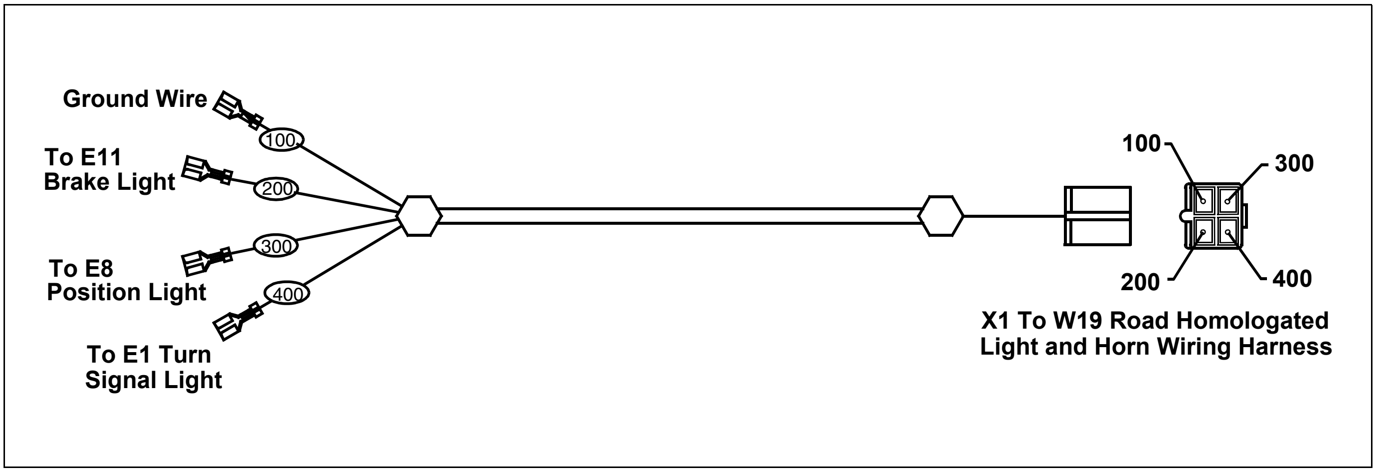
W19 Homologated Light and Horn Wiring Harness (1 of 2)



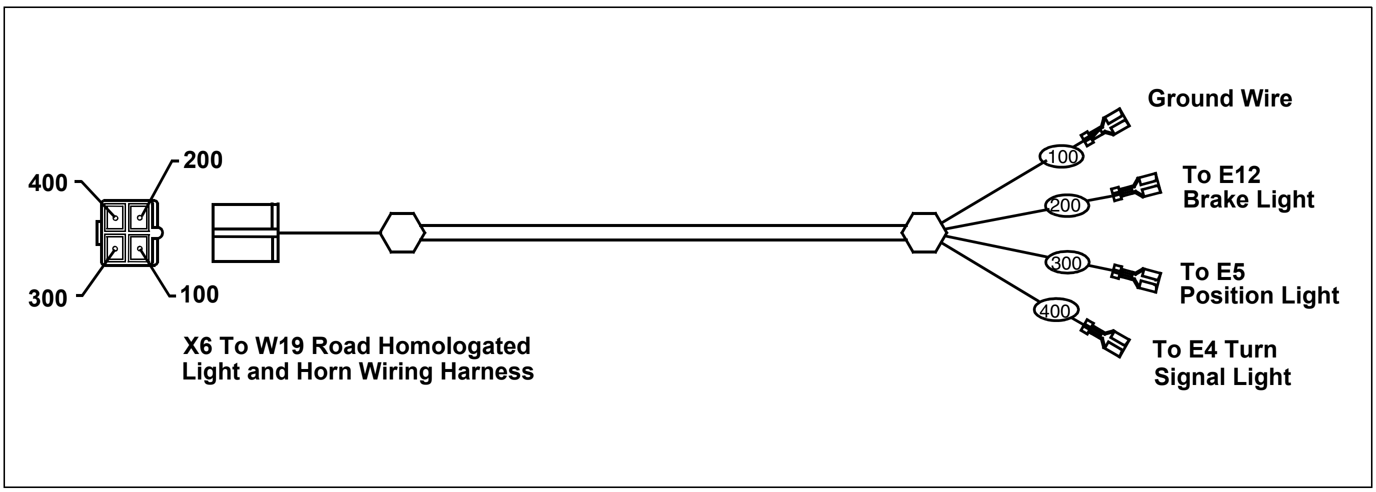
W19 Road Homologated Light and Horn Wiring Harness (2 of 2)



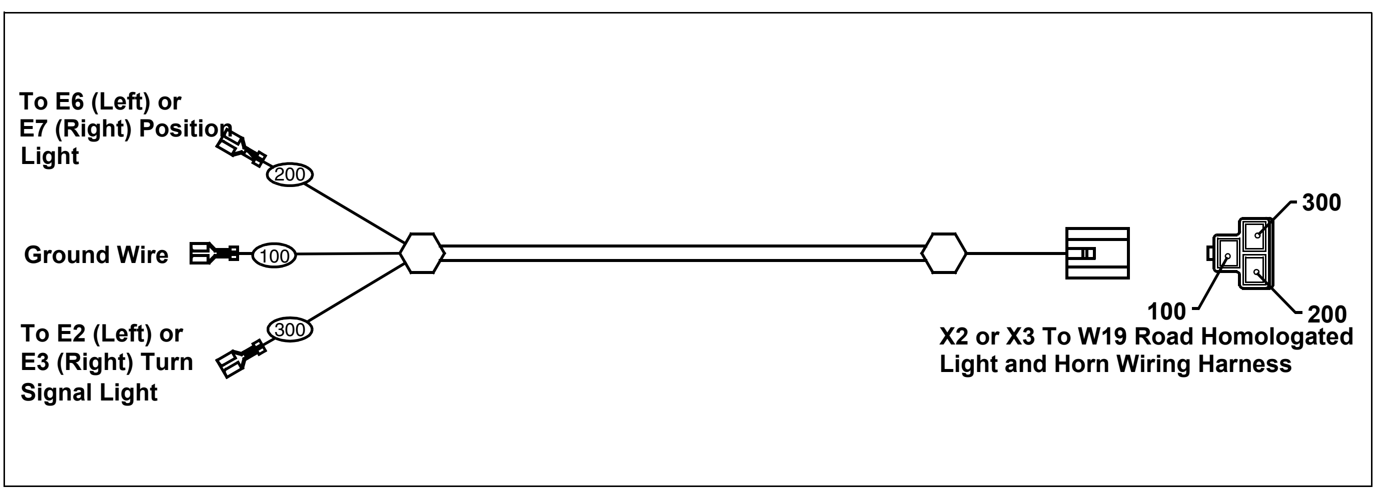
W20 Rear Position/Turn/Brake Wiring Harness, (Left)



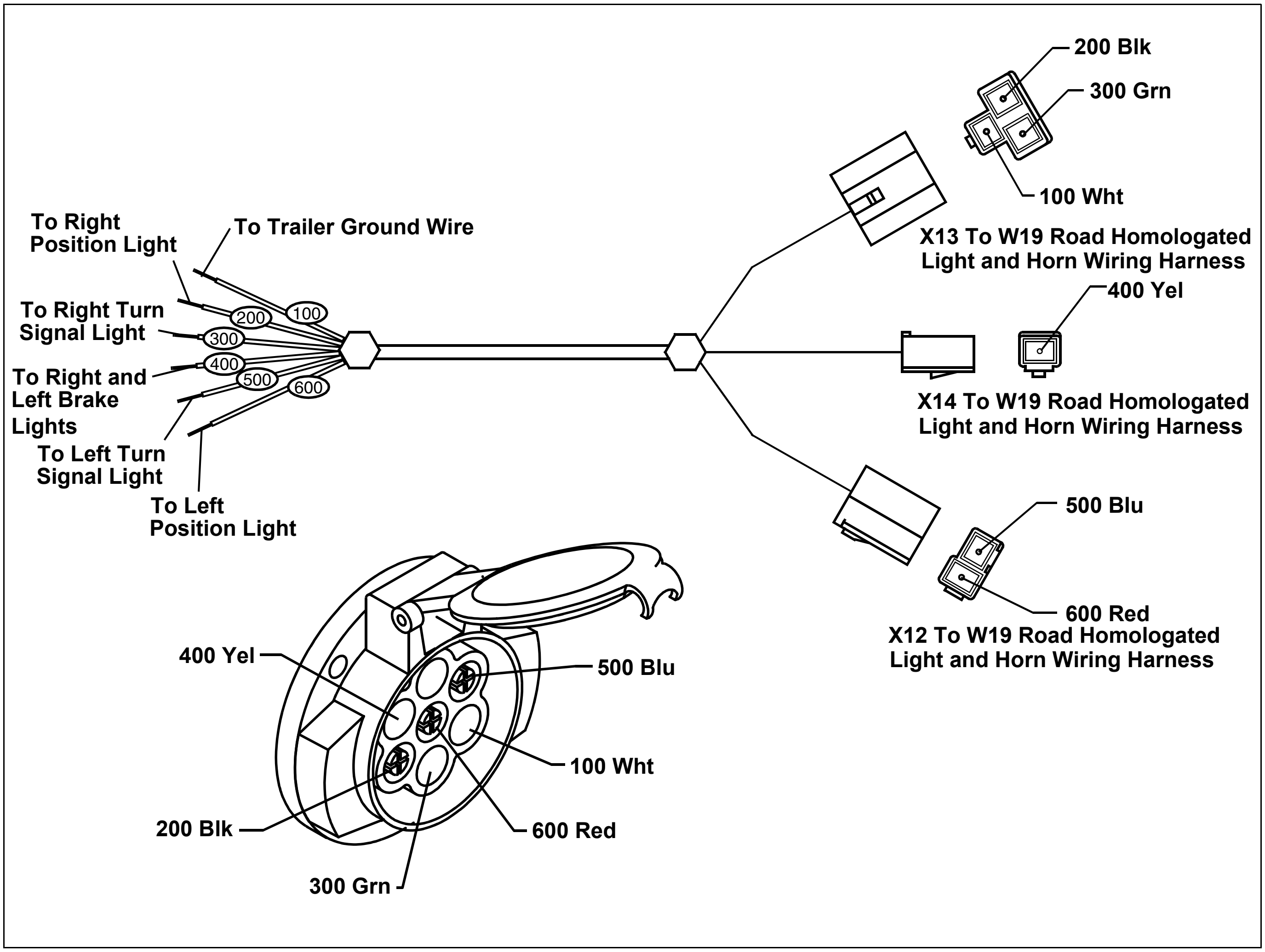
W21 Rear Position/Turn/Brake Wiring Harness, (Right)



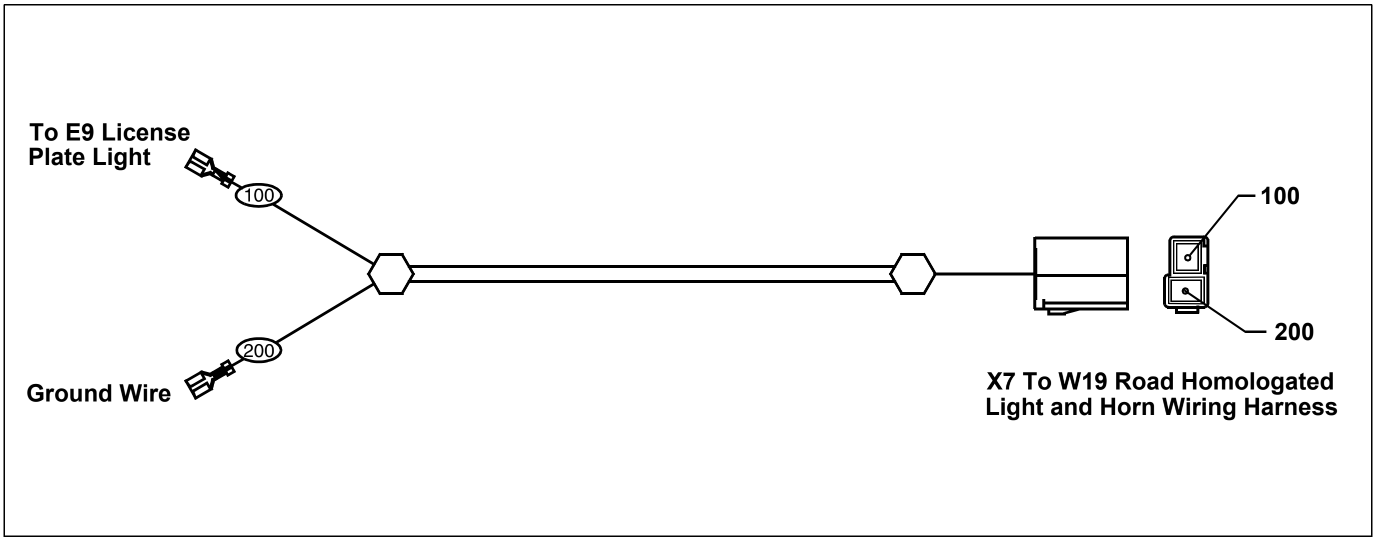
W22 Front Position/Turn Wiring Harness



W23 Trailer Connector Wiring Harness



W24 License Plate Light Wiring Harness



W19 Road Homologated Light and Horn Wiring Harness Color Codes

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Brn	E10, W1 Ground
105	0.8	Brn	X2, W1 Ground
110	1.0	Brn	X6, W1 Ground
115	1.0	Brn	X6, X13
120	0.8	Brn	B1, W1 Ground
150	1.0	Brn	E11, W1 Ground
155	0.8	Brn	X3, W1 Ground
160	0.8	Brn	X1, W1 Ground
161	0.8	Brn	X1, X7
170	0.5	Brn	X4/X5/X11 Ground Connection to W1, W3, or W2 Main Wiring Harness, K1
175	0.5	Brn	S1, X4/X5/X11 Ground Connection to W1, W3, or W2 Main Wiring Harness
180	0.5	Brn	S1, S4
185	0.5	Brn	K1, E15
190	0.5	Brn	E14, E15
200	2.0	Red	201 Fusible Link (F2), S5/S6
201	0.8	Red-Fuse	F2 Fuse soldered in-line; M1, 200 Red
202	2.0	Red	S5/S6, S5/S6
205	2.0	Yel/Red	201 Fusible Link, F3
210	1.0	Red	F3, K1
400	1.0	Yel/Red	X5/X8/X10 Power Connection to W1, W3 or W2 Main Wiring Harness, F10
405	0.8	Yel	F9, S8
410	1.0	Yel/Wht	F10, S7
420	1.0	Yel	V2 Diode, X1
421	1.0	Yel	X1, X6
422	1.0	Yel	X6, X14
425	0.8	Yel	X9, S3

Circuit Number	Wire Size	Color	Termination Points
430	0.8	Yel	S8, B1
450	2.0	Wht	S5/S6, F6
452	1.0	Wht	F6, E11
454	1.0	Gry	F7, E10
455	2.0	Blk	S5/S6, F5
462	0.8	Blk	F5, X3
463	1.0	Blk	F5, X1
464	1.0	Blk	X1, X7
465	1.0	Blk	X7, X12
467	1.0	Blk/Wht	X6, X13
468	0.8	Blk/Wht	F4, X2
469	0.8	Blk/Wht	F4, X6
477	1.0	Wht	K1, S4
478	1.0	Wht	S1, S4
479	1.0	Wht	S1, S1
480	1.0	Grn	S1, S4
481	1.0	Grn	S4, X3
482	1.0	Grn	S1, X6
483	1.0	Grn	X6, X13
490	1.0	Blu	V1 Diode, S4
491	1.0	Blu	S4, X2
492	1.0	Blu	V1 Diode, X1
494	0.8	Diode	V1 Soldered in-line; S1, 490 Blu and 492 Blu
495	1.0	Blu	X1, X12
620	0.5	Red	K1, E15
630	0.5	Red/Wht	K1, E14
631	0.8	Gry/Blk	V2 Diode, S7
632	0.8	Diode	V2 Soldered in-line; X9, 420 Yel and 631 Gry/Blk
633	0.8	Gry/Blk	X9, S3
950	0.5	Tubing	

W20 Rear Position/Turn/Brake Wiring Harness Color Codes (Left)

Circuit Number	Wire Size	Color	Termination Points
100	0.8	Wht	X2, Ground Wire
200	0.8	Blu	X2, E11
300	0.8	Blk	X2, E6
400	0.8	Grn	X2, E1

W21 Rear Position/Turn/Brake Wiring Harness Color Codes (Right)

Circuit Number	Wire Size	Color	Termination Points
100	0.8	Wht	X6, Ground Wire
200	0.8	Blu	X6, E12
300	0.8	Blk	X6, E5
400	0.8	Grn	X6, E4

W22 Front Position/Turn Wiring Harness Color Codes

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Wht	X2 or X3, Ground Wire
200	1.0	Blk	X2 or X3, E6 or E7
300	1.0	Lt Grn	X2 or X3, E2 or E3

W23 Trailer Connector Wiring Harness Color Codes

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Wht	X13, Ground Wire Socket
200	1.0	Blk	X13, Right Position Light Pin
300	1.0	Grn	X13, Right Turn Signal Light Socket
400	1.0	Yel	X14, Left and Right Brake Lights Socket
500	1.0	Blu	X12, Left Turn Signal Light Socket
600	1.0	Red	X12, Left Position Light Pin

W24 License Plate Light Wiring Harness Color Codes

Circuit Number	Wire Size	Color	Termination Points
100	1.0	Brn	X7, Ground Wire
200	1.0	Blk	X7, E9

Operation and Diagnostics

Road Homologated Light and Horn Kit Operation

Function:

Provides wiring harness and lights for braking lights, position lights, turn signal lights, license plate light, and dashboard bulb integrity lights. It also provides a horn, and a wiring harness connection for a trailer wiring harness.

Theory of Operation:

The road homologated light and horn kit replaces the standard headlight wiring harness, and the standard headlight wiring harness is discarded.

When the road homologated wiring harness is installed, the existing main wiring harness connector to the park brake switch is unplugged and the X9 connector of the road homologated wiring harness is plugged into the molded connector disconnected from the park brake switch. A separate connector on the road homologated wiring harness is then plugged into the park brake switch. Connections are also made at the “B” terminal of the M1 starting motor and the X5/X8/X10 connector and X4/X5/X11 connector that were previously connected to the standard headlight wiring harness

There are four powered circuits in the light and horn wiring harness. Power for the first two of the circuits is provided from the “B” terminal of the starting motor and the F2 fusible link provided with the wiring harness.

The first power circuit leaves the F2 fusible link through the 200 Red wire to the S5/S6 light switch. The second leaves the F2 fusible link through the 205 Red wire, F3 fuse and 210 Red to the K1 flasher. Current bypasses the flasher through the R1 resistor to the 477 Wht wire and S4 turn signal switch. Current continues through the 478 Wht wire and 479 Wht wire to the S1 hazard switch.

The internal logic circuit in the flasher determines whether E14 bulb integrity light or both E14 and E15 bulb integrity lights are illuminated. The current flow through the logic circuit and parallel R1 resistor is measured and current flows either through the 630 Red/Wht wire to the E14 bulb integrity light, or, through both the 630 Red/Wht wire to the E14 bulb integrity light and the 620 Red wire to the E15 bulb integrity light.

The third circuit is powered from the “B” terminal of the starting motor. Current flows through the existing F1 fusible link, 200 Red wire, S2 key switch, 400 Yel/Red wire, 410 Yel/Red wire (6X4 machines), and the 12 volt powered connector that was disconnected from the standard headlight wiring harness and connected to the road homologated wiring harness. Current enters the road homologated wiring harness at that point and flows through the 400 Yel/Red wire, F9 fuse and 405 Yel wire to the S8 horn switch; and from the 400 Ye/Red wire, through the Yel/Blk jumper wire, F10 fuse and 410 Yel/Wht wire to the S7 brake pedal switch.

The fourth circuit is also powered from the “B” terminal of the starting motor, through the existing F1 fusible link, 200 Red wire, S2 key switch and 400 Yel/Red wire. In the 4X2 machine, current flows from the S2 key switch through the 400 Yel/Red wire, 410 Yel wire, 420 Yel wire and X9 connector. Current enters the road homologated wiring harness at that point and flows through the 425 Yel wire to the S3 park brake switch. In the 6X4 machines, current flows from the key switch through the 400 Yel/Red wire, 420 Yel/Red wire, 423 Yel/Red wire and X9 connector. Current enters the road homologated wiring harness at that point and flows through the 425 Yel wire to the S3 park brake switch.

The switches then provide power to the appropriate lights and trailer connection or horn.

Road Homologated Light and Horn Kit Power Circuit Operation

Function:

Provides power to the primary components.

Operating Conditions, Unswitched Circuits:

Voltage must be present at the following components with the key switch “OFF”:

- “B” Terminal of Starting Motor
- “B” Terminal of Key Switch
- Light Switch
- F3 Fuse
- Flasher
- Hazard Switch
- Turn Signal Switch

The positive battery cable connects battery to a starting motor bolt. This bolt is used as a power tie point for the light and horn kit wiring harness.

The connection between the starting motor and the key switch or light switch is protected by fusible links. The fusible links protect the wiring harness from high current load and shorts.

Switched Circuits:

Voltage must be present at following components with key switch in the “RUN” position:

- “A” Terminal of Key Switch
- Brake Pedal Switch
- Horn Switch
- Park Brake Switch

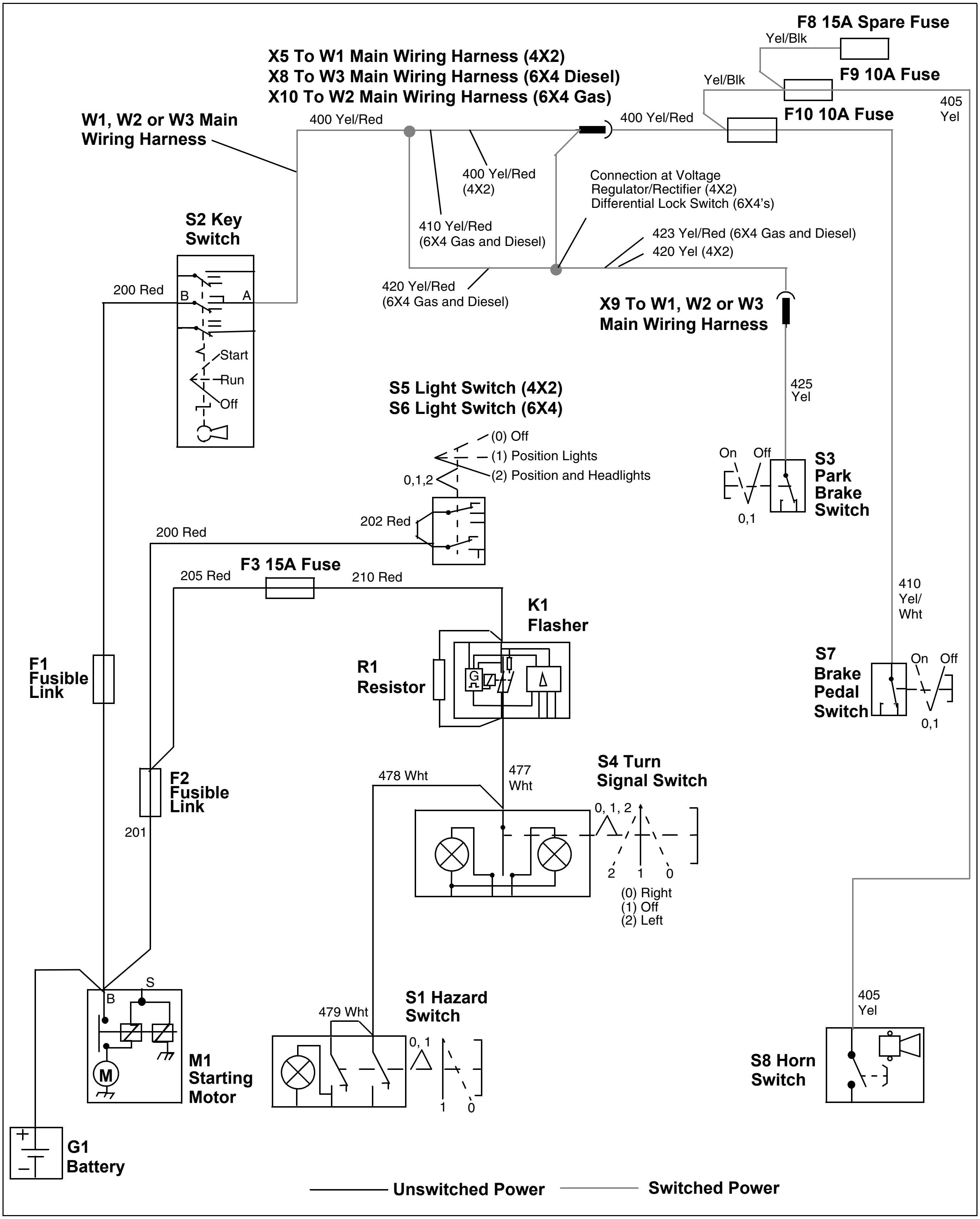
These components are controlled by the key switch and protected by the F1, F9 and F10 fuses.

Voltage must be present at the following lights with the key switch in the “RUN” position and the light switch in Position Lights and Headlights position:

- Left Front Position
- Left Rear Position
- Right Front Position
- Right Rear Position
- License Plate Light
- Left Headlight
- Right Headlight

These components are controlled by the light switch and protected by the F2, F4, F5, F6 and F7 fuses.

Road Homologated Light and Horn Kit Power Circuit Electrical Schematic



Road Homologated Light and Horn Kit Power Circuit Diagnosis

Test Conditions:

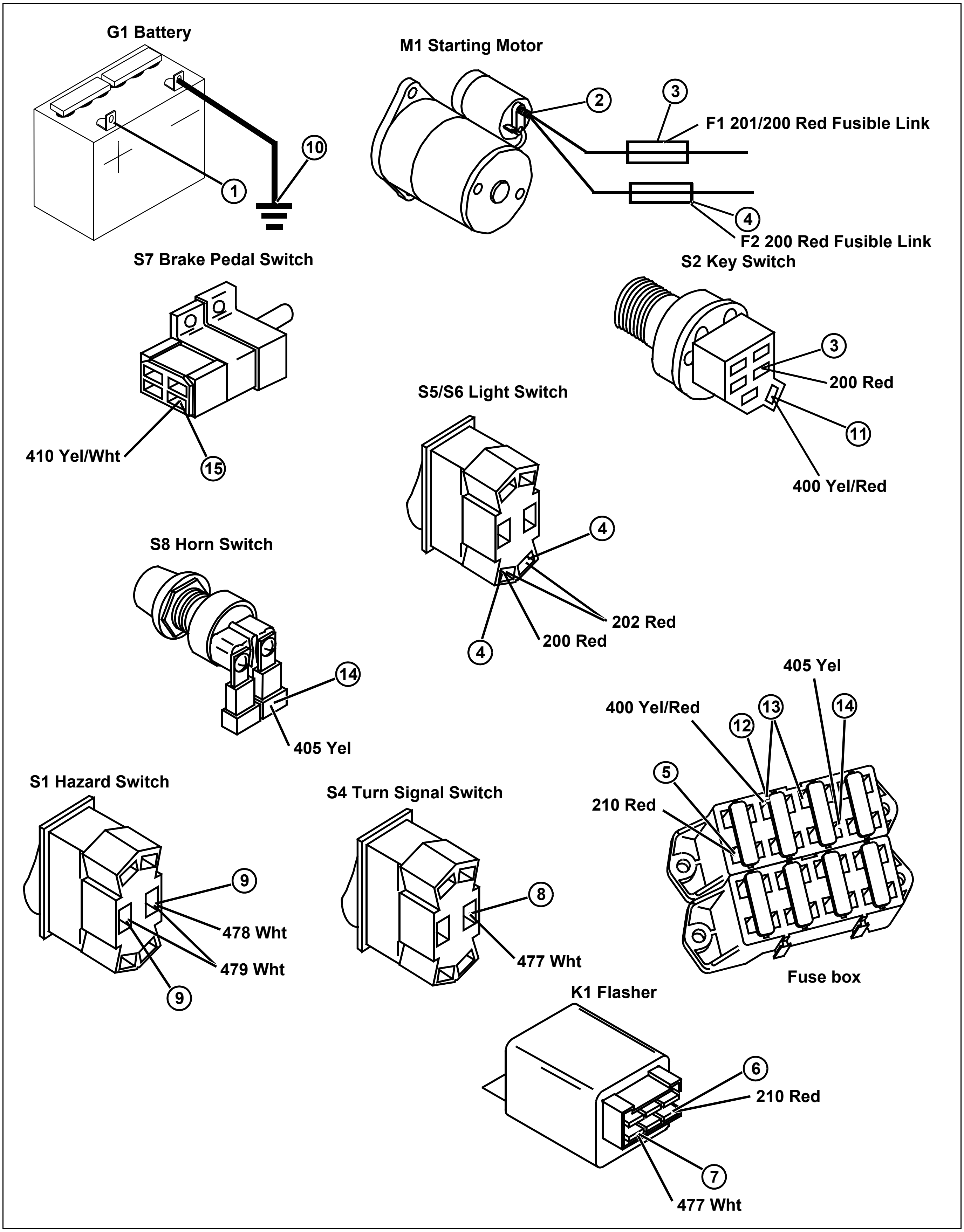
- Park brake engaged.
- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal.
- Meter positive (+) lead on numbered test point.
- Check connections for corrosion and loose terminals.

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal	11.8 - 13.2 volts	Test battery.
2. Starting motor solenoid terminal B	Battery voltage	Check battery cable and connection.
3. Key switch terminal B	Battery voltage	Check F1 fusible link and 200 Red wire.
4. Light switch	Battery voltage	Check F2 fusible link, 200 Red and 202 Red wires.
5. Fusebox	Battery voltage	Check fuse and 205 Red wire.
6. Flasher	Battery voltage	Check F3 fuse and 210 Red wire.
7. Flasher	Battery voltage	Replace flasher.
8. Turn signal switch	Battery voltage	Check R1 resistor and 477 Wht wire.
9. Hazard switch	Battery voltage	Check 478 Wht and 479 Wht wires.
10. Ground cable	Maximum 0.1 ohm resistance	Check battery negative cable and connection.

Test Conditions:

- Key switch in RUN position

Test/Check Point	Normal	If Not Normal
11. Key switch terminal A	Battery voltage	Replace key switch.
12. Fusebox	Battery voltage	Check 400 Yel/Red wire, light and horn harness connection and fuse.
13. Fusebox	Battery voltage	Check Yel/Blk jumper wire and fuse.
14. Horn switch	Battery voltage	Check 405 Yel wire.
15. Brake pedal switch	Battery voltage	Check 410 Yel/Wht wire.


G1 Battery
M1 Starting Motor
F1 201/200 Red Fusible Link
F2 200 Red Fusible Link
S7 Brake Pedal Switch
S2 Key Switch
200 Red
400 Yel/Red
410 Yel/Wht
S5/S6 Light Switch
S8 Horn Switch
202 Red
200 Red
405 Yel
400 Yel/Red
210 Red
405 Yel
S1 Hazard Switch
S4 Turn Signal Switch
478 Wht
479 Wht
477 Wht
Fuse box
K1 Flasher
210 Red
477 Wht
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

Road Homologated Turn Signal and Hazard Circuit Operation

Function:

Turn Signal Lights:

To provide power to illuminate the right or left front and rear turn signal lights depending on turn signal switch position.

Hazard Lights:

To provide power to illuminate the front and rear turn signal lights when the hazard switch is ON.

Bulb Integrity Lights:

To provide a visible indicator that the hazard lights are on or the turn signals are functioning properly.

Operating Conditions:

The hazard switch must be closed or the turn signal switch must be in the right or left position.

Theory of Operation:

Turn Signal Lights:

With the turn signal switch (S4) in the right position (closed), low current flows through the flasher (K1) internal logic unit which in turn sends an intermittent current flow to the flasher internal relay. The intermittent current flow to the flasher relay opens and closes the relay contacts allowing a higher current flow through the flasher, 477 Wht wire and turn signal switch which illuminates the right turn signal switch light, Right front turn signal light (E3), and Right rear turn signal light (E4).

With the turn signal switch in the left position (closed), the same function is provided for the left turn signal switch light, Left front turn signal light (E2), and Left rear turn signal light (E1).

Hazard Lights:

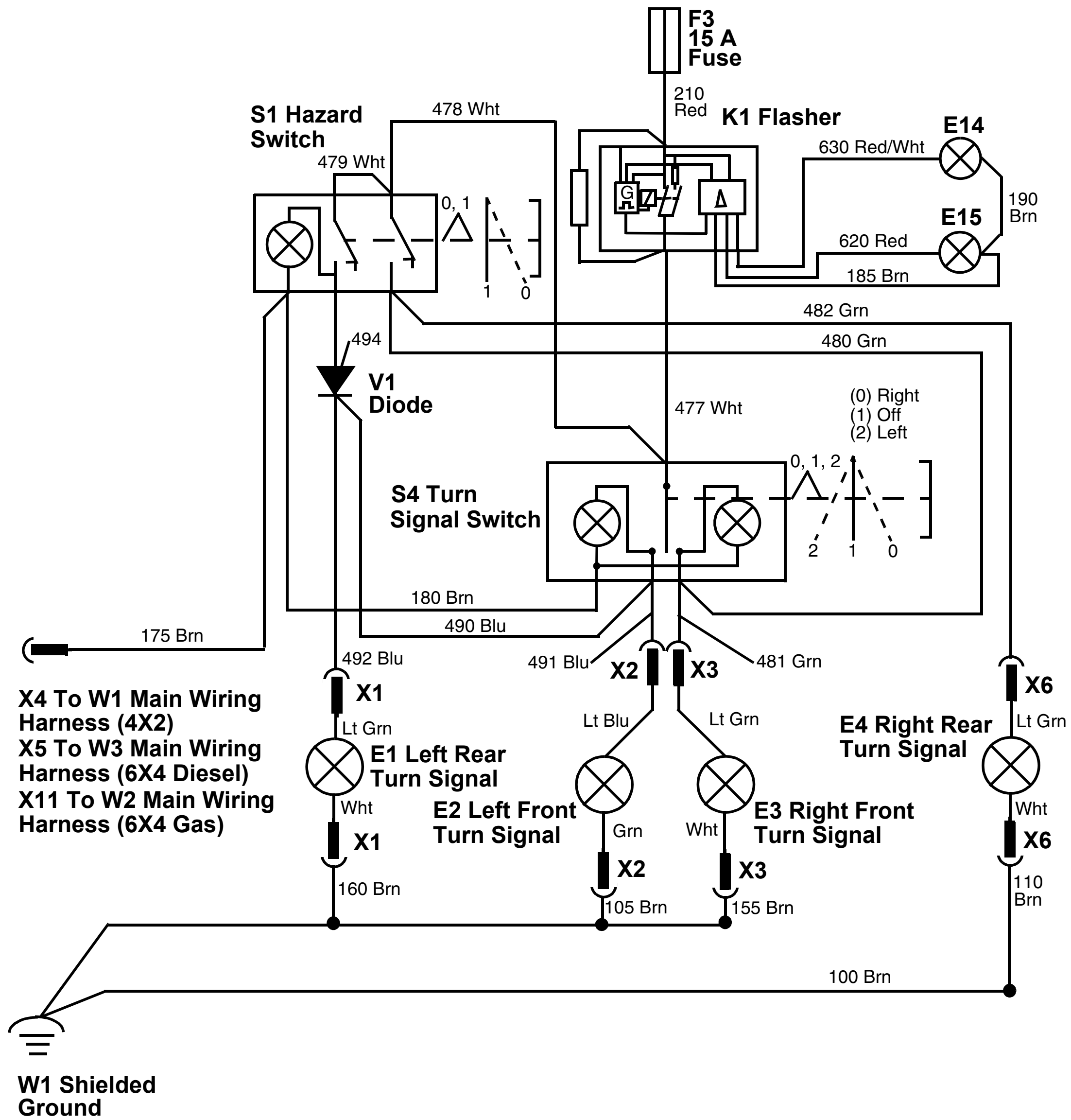
With the hazard switch (S1) ON (switch closed), low current flows through the flasher (K1) internal logic unit which in turn sends an intermittent current flow to the flasher internal relay. The intermittent current flow to the flasher relay opens and closes the relay contacts allowing a higher current flow through the flasher, 477 Wht wire, 478 Wht wire and hazard switch, which illuminates the hazard switch light, both turn signal switch lights, and the Left and Right front and rear turn signal lights (E1, E2, E3 and E4). The diode (V1) at the hazard switch prevents the hazard switch light from illuminating when the left turn signal is energized. The circuit is protected by fusible link (F2) and fuse (F3).

Bulb Integrity Lights:

With the turn signal switch in the right or left position, current from the flasher (K1) internal logic unit flows through the 630 Red/Wht wire and illuminates the E14 bulb integrity light. Current flow through the turn signal lights (E1, E2, E3 and E4) is monitored by the flasher logic unit. When any of the turn signal lights are open, causing a rise in current flow, current is not passed from the flasher to the E14 bulb integrity light, keeping it from illuminating and providing a visual warning to the operator that one of the turn signal lights should be replaced.

With the hazard switch in the ON (closed) position, current from the flasher internal logic unit flows through the 630 Red/Wht wire and the 620 Red wire and illuminates both of the bulb integrity lights (E14 and E15).

Road Homologated Turn Signal and Hazard Circuit Electrical Schematic



Road Homologated Turn Signal and Hazard Circuit Diagnosis

Test Conditions:

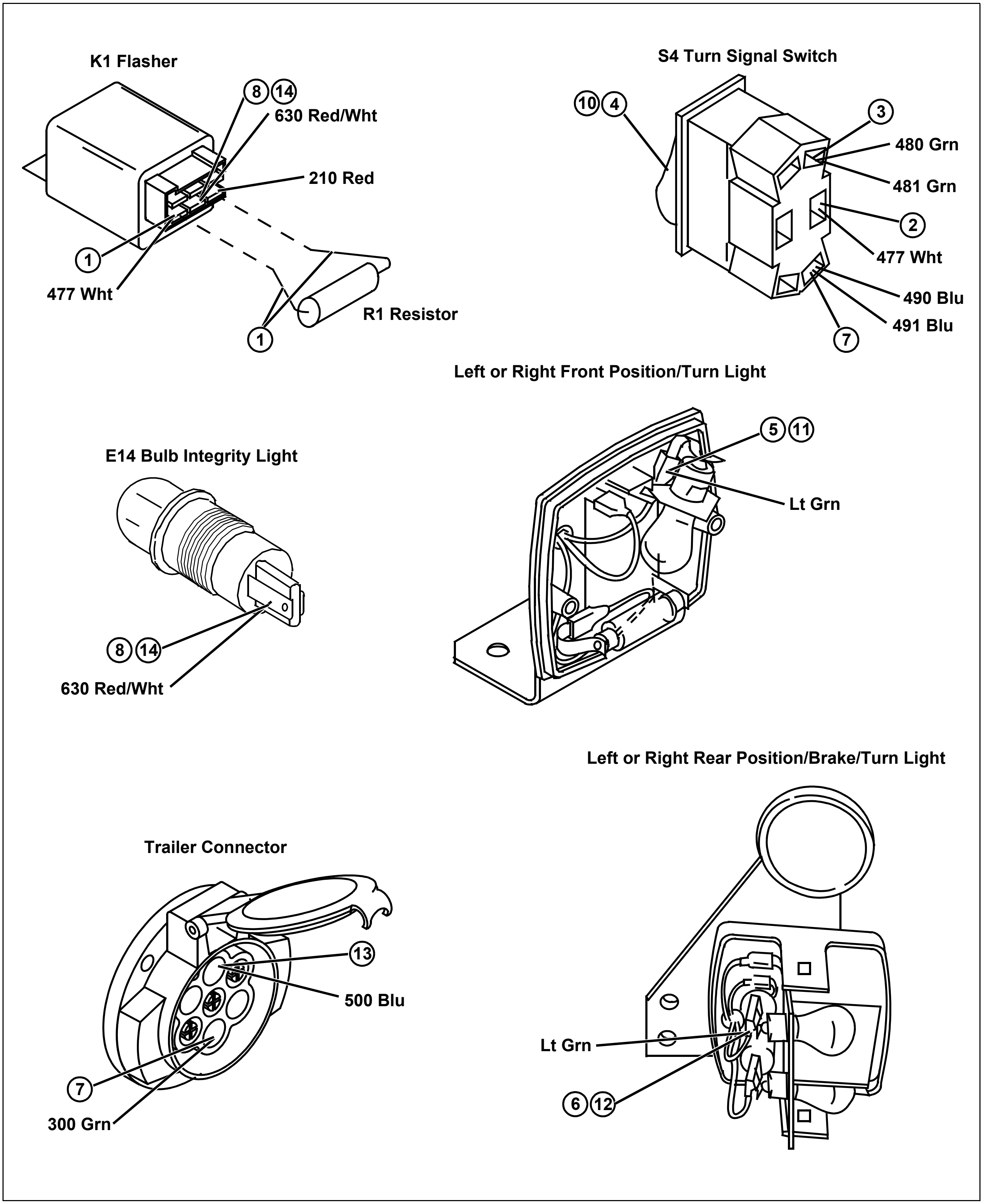
- Light bulb continuity OK or bulb replaced
- Park brake engaged
- Key switch in OFF position
- Hazard switch in OFF position
- Turn signal switch in RIGHT position
- Meter positive (+) lead on numbered test point
- Meter negative (-) lead on battery negative (-) terminal
- Check connection for corrosion and loose terminals when testing

Test/Check Point	Normal	If Not Normal
1. Flasher	Intermittent battery voltage	Check turn signal power circuit. Remove flasher from connector, change meter to ohms scale and measure resistance across R1. 91 ± 5 ohms: Reconnect flasher, change meter to DC volts. Less than 86 or greater than 96 ohms: Replace resistor.
2. Turn signal switch	Intermittent battery voltage	Check 477 Wht wire.
3. Turn signal switch	Intermittent battery voltage	Replace turn signal switch.
4. Turn signal switch	Right switch light illuminated	Check ground connection, 175 Brn wire and 180 Brn wire. Replace turn signal switch.
5. Right front turn signal	Intermittent battery voltage	Check 481 Grn wire, connections and Lt Grn wire.
6. Right rear turn signal	Intermittent battery voltage	Check 480 and 482 Grn wires, connections and Lt Grn wire.
7. Right trailer connector turn signal socket	Intermittent battery voltage	Check 300 Grn wire, X13, 483 Grn wire and connections.
8. E14 bulb integrity light	Intermittent battery voltage	Check 630 Red/Wht wire. Replace K1 flasher.

Test Conditions:

- Turn signal switch in LEFT position

Test/Check Point	Normal	If Not Normal
9. Turn signal switch	Intermittent battery voltage	Replace turn signal switch.
10. Turn signal switch	Left switch light illuminated	Replace turn signal switch.
11. Left front turn signal	Intermittent battery voltage	Check 491 Blu wire, connections and Lt Grn wire.
12. Left rear turn signal	Intermittent battery voltage	Check 490 wire, 492 Blu wire, connections and Lt Grn wire.
13. Left trailer connector turn signal	Intermittent battery voltage	Check 500 Blu wire, X12, 495 Blu wire, and connections.
14. E14 bulb integrity light	Intermittent battery voltage	Check 630 Red/Wht wire. Replace K1 flasher.


K1 Flasher
8 14
630 Red/Wht
210 Red
1
477 Wht
1
R1 Resistor
S4 Turn Signal Switch
10 4
3
480 Grn
481 Grn
2
477 Wht
490 Blu
491 Blu
7
Left or Right Front Position/Turn Light
5 11
Lt Grn
E14 Bulb Integrity Light
8 14
630 Red/Wht
Left or Right Rear Position/Brake/Turn Light
Trailer Connector
13
500 Blu
7
300 Grn
Lt Grn
6 12

MIF

Test Conditions:

- Turn signal in OFF position

Test/Check Point	Normal	If Not Normal
15.Right rear turn signal	Maximum 0.1 ohm resistance	Check battery negative cable, engine ground connections, Wht wire, and 110 Brn wires.
16. Right front turn signal	Maximum 0.1 ohm resistance	Check Wht wire and 155 Brn wires.
17. Left front turn signal	Maximum 0.1 ohm resistance	Check Wht wire and 105 Brn wire.
18. Left rear turn signal	Maximum 0.1 ohm resistance	Check Wht wire and 160 Brn wire.
19. Trailer connector ground connector	Maximum 0.1 ohm resistance	Check 100 Wht wire, X13, 115 Brn wire, and connections.
20. E14 bulb integrity light	Maximum 1.0 ohm resistance	Check 190 Brn wire and 185 Brn wire.
21. V1 Diode	Continuity one direction only	Replace diode.

Test Conditions:

- Hazard switch in ON position

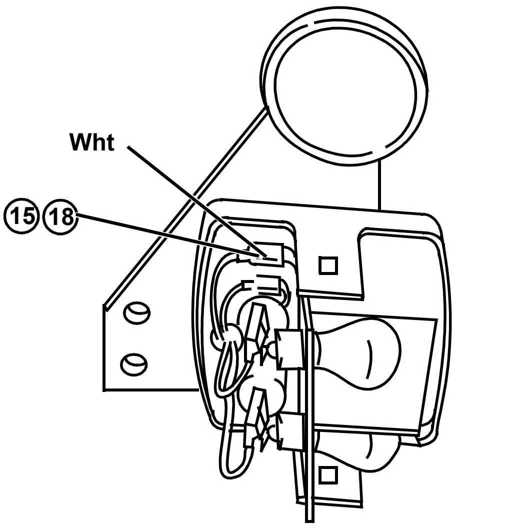
Test/Check Point	Normal	If Not Normal
22. Hazard switch	Intermittent battery voltage	Check 478 and 479 Wht wires.
23. Hazard switch	Intermittent battery voltage	Replace hazard switch
24. Hazard witch	Switch light illuminated	Replace hazard switch
25. Bulb integrity lights	Intermittent battery voltage	Check 630 Red/Wht wire and 620 Red wire. Replace flasher.

Test Conditions:

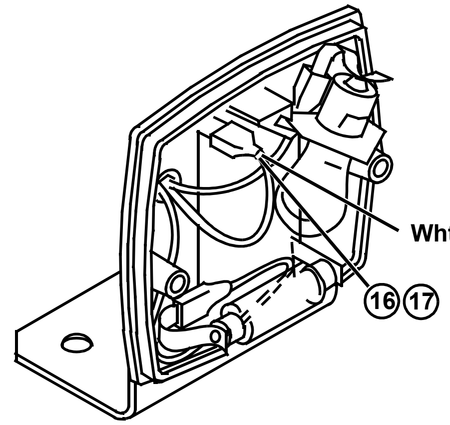
- Hazard switch in OFF position

Test/Check Point	Normal	If Not Normal
26. E14 bulb integrity light	Maximum 1.0 ohm resistance	Check Brn wire and 185 Brn wire
27. E15 bulb integrity light	Maximum 1.0 ohm resistance	Check 185 Brn wire

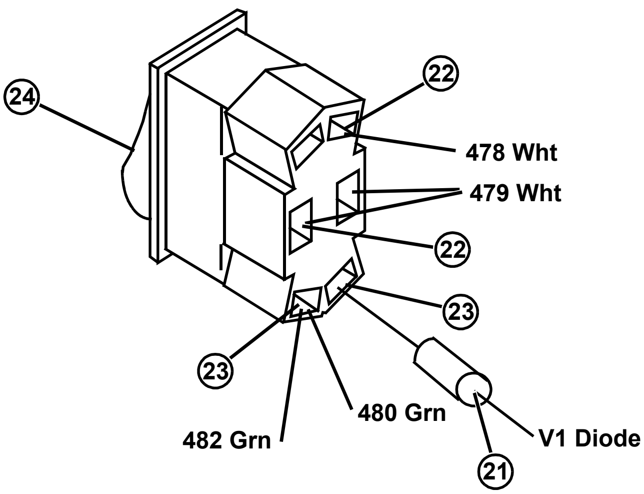
Left or Right Rear Position/Brake/Turn Light



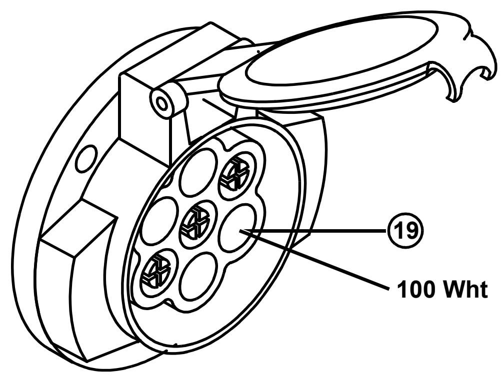
Left or Right Front Position/Turn Light



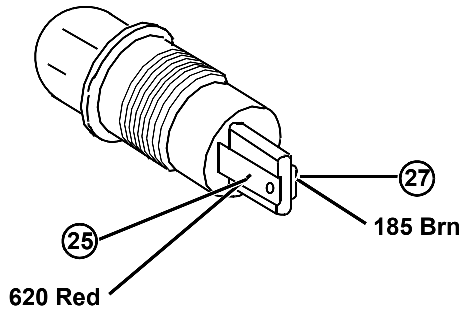
S1 Hazard Switch



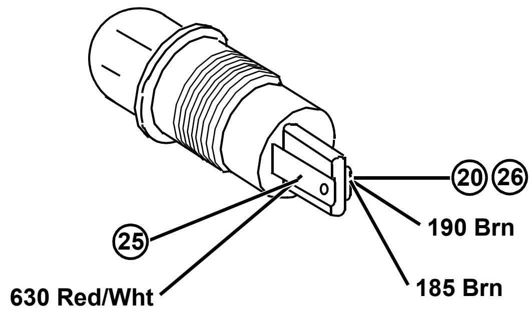
Trailer Connector



E15 Bulb Integrity Light



E14 Bulb Integrity Light



MIF

Road Homologated Light and Horn Circuit Operation

Function:

Position Lights and Headlights Circuit:
To provide power to illuminate the front and rear position lights, license plate light, and/or headlights depending on light switch position.

Brake Lights Circuit:
To provide power to illuminate the rear brake lights when the brake pedal is depressed or the park brake is engaged.

Horn Circuit:
To energize the horn when desired by the operator.

Operating Conditions:

Position Lights and Headlights:
The light switch must be in the position lights or position lights and headlights position.

Brake Lights:
The key switch must be in the RUN position and the brake pedal depressed or the park brake engaged.

Horn:
The key switch must be in the RUN position and the horn switch depressed.

Theory of Operation:

Position Lights and Headlights:
With the light switch (S5/S6) in the position light position, current flows to the fuses (F4 and F5), and illuminates the Left and Right front position lights (E6 and E7), Left and Right rear position lights (E5 and E8), and license plate light (E9).

With the light switch (S5/S6) in the position lights and headlights position, current flows to the fuses (F4, F5, F6 and F7) and illuminates all position lights and the headlights (E10 and E11).

Brake Lights:
With the brake pedal switch (S7) closed (brake pedal depressed), current from fuse (F10) and brake pedal switch illuminates the Left and Right brake lights (E5, E4).

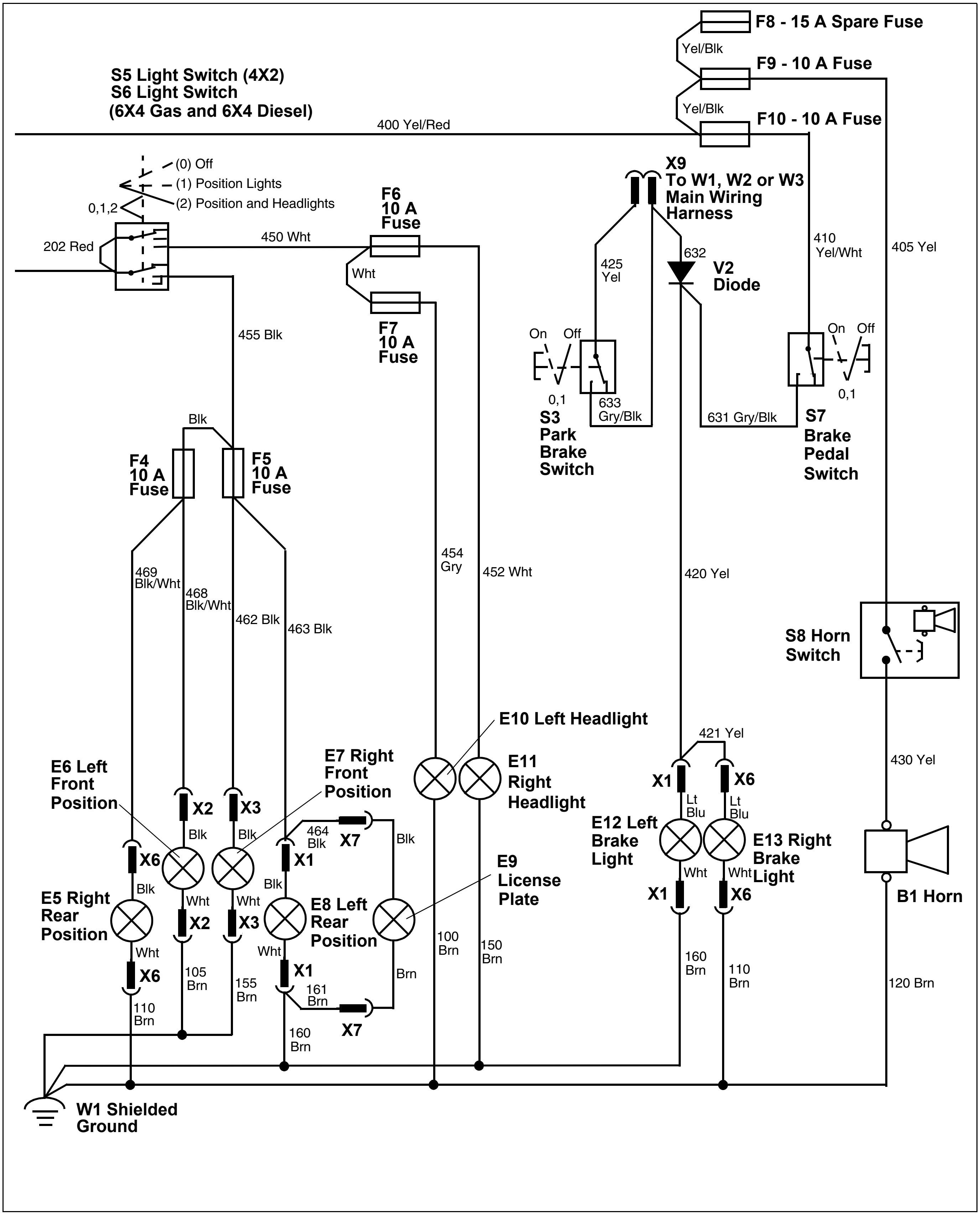
With the park brake switch (S3) closed (park brake engaged), current from fuse (F1), key switch (S2), park brake switch, and diode (V2), illuminates the Left and Right brake lights (E5, E4).

The diode (V2) at the park brake switch connector prevents the park brake light from illuminating when the brake pedal switch is closed.

Horn:

With the horn switch (S8) closed (switch depressed), current from fuse (F9) and horn switch energizes the horn (B1).

Road Homologated Light and Horn Circuit Electrical Schematic

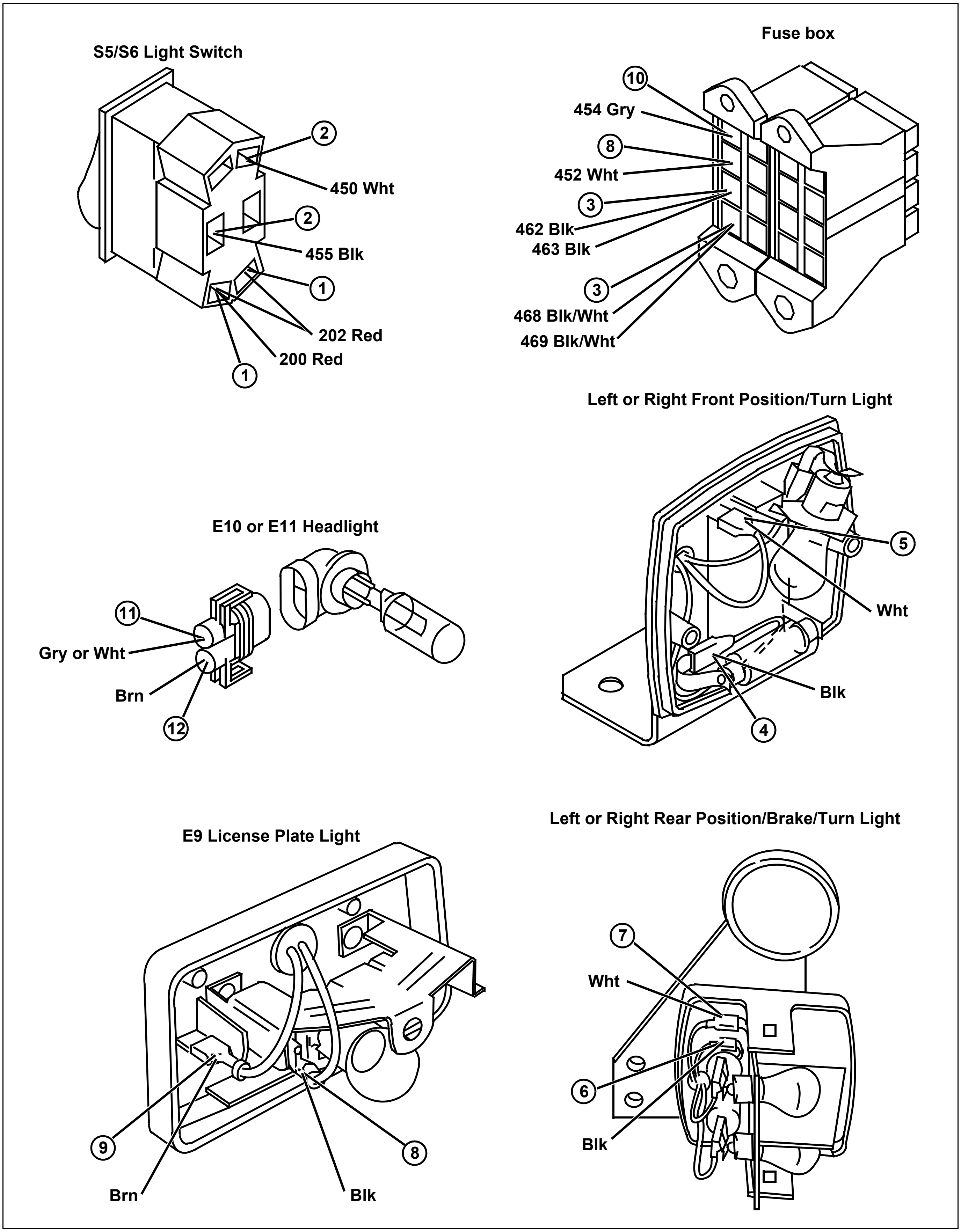


Road Homologated Light and Horn Circuit Diagnosis

Test Conditions:

- Light bulb continuity OK or bulb replaced.
- Park brake engaged.
- Key switch in RUN position.
- Light switch in POSITION LIGHTS AND HEADLIGHTS position.
- Meter positive (+) lead on numbered test point.
- Meter negative (-) lead on battery negative (-) terminal.
- Check connections for corrosion and loose connections when testing.

Test/Check Point	Normal	If Not Normal
1. Light switch	Battery voltage	Check light switch power circuit.
2. Light switch	Battery voltage	Replace light switch.
3. F4 and F5 fuses	Battery voltage	Check fuses and 455 Blk wire and Blk jumper wire.
4. Left and Right front position lights	Battery voltage	Check 468 Blk/Wht wire, 462 Blk wire, connections, and Blk wires.
5. Left and Right front position lights	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check battery negative cable, engine ground connections, Wht wires, and 105 Brn wire, and 155 Brn wire. 0 volts: Replace bulb.
6. Left and Right rear position lights	Battery voltage	Check 469 Blk/Wht, 463 Blk wires, connections, and Blk wires.
7. Left and Right rear position lights	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check ground connections, Wht wires, 110 Brn wire. and 160 Brn wires. 0 volts: Replace bulb.
8. License plate light	Battery voltage	Check Blk wire, X7, 464 Blk wire, and connections.
9. License plate light	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check ground connections, 160 Brn wire, 161 Brn wire, X7, and Brn wire. 0 volts: Replace bulb.
10. Fusebox	Battery voltage	Check fuses, 450 Wht wire, and Wht jumper wire.
11. Left and Right headlights	Battery voltage	Left headlight: Check 454 Gry, F7 fuse, Wht jumper wire, and 100 Brn wires. Right headlight: Check 452 Wht wire, F6 fuse, and 150 Brn wire.
12. Left and Right headlights	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check ground connections, 100 Brn wire, and 150 brn wire. 0 volts: Replace bulb.


S5/S6 Light Switch
2
450 Wht
2
455 Blk
1
202 Red
200 Red
1
Fuse box
10
454 Gry
8
452 Wht
3
462 Blk
463 Blk
3
468 Blk/Wht
469 Blk/Wht
Left or Right Front Position/Turn Light
5
Wht
Blk
4
E10 or E11 Headlight
11
Gry or Wht
Brn
12
E9 License Plate Light
9
Brn
Blk
8
Left or Right Rear Position/Brake/Turn Light
7
Wht
6
Blk

MIF

Road Homologated Light and Horn Circuit Diagnosis (continued)

Test Conditions:

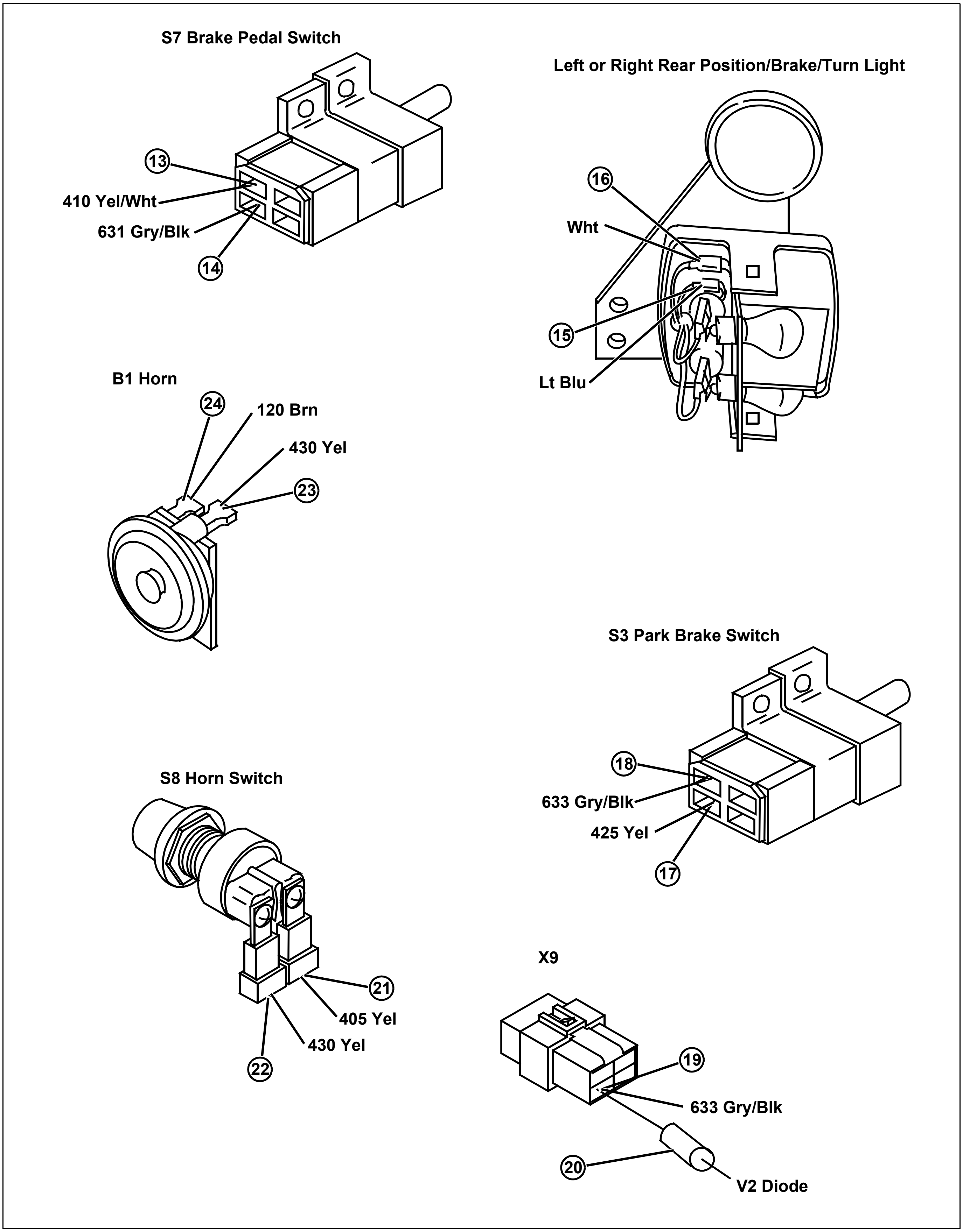
- Brake pedal depressed.
- Park brake engaged.

Test/Check Point	Normal	If Not Normal
13. Brake pedal switch	Battery voltage	Check brake light power circuit.
14. Brake pedal switch	Battery voltage	Replace brake pedal switch.
15. Left and Right brake lights	Battery voltage	Left brake light: Check 631 Gry/Blk wire, V2 diode, 420 Yel, 421 Yel, and Lt Blu wires. Right brake light: Check 631 Gry/Blk wire, V2 diode, 420 Yel, and Lt Blu wires.
16. Left and Right brake lights	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check ground connections, Wht and 110 and 160 Brn wires. 0 volts: Replace bulb.
17. Park brake switch	Battery voltage	Check 425 Yel wire and connections.
18. Park brake switch	Battery voltage	Replace park brake switch.
19. Park brake switch connector	Battery voltage	Check 633 Gry/Blk wire.
20. V2 diode	Continuity one direction only	Replace diode.

Test Conditions:

- Horn switch depressed

Test/Check Point	Normal	If Not Normal
21. Horn switch	Battery voltage	Check horn switch power circuit.
22. Horn switch	Battery voltage	Replace horn switch.
23. Horn	Battery voltage	Check 430 Yel wire and connections.
24. Horn	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check ground connections and 120 Brn wire. 0 volts: Replace horn.


S7 Brake Pedal Switch
13
410 Yel/Wht
631 Gry/Blk
14
Left or Right Rear Position/Brake/Turn Light
16
Wht
15
Lt Blu
B1 Horn
24
120 Brn
430 Yel
23
S3 Park Brake Switch
18
633 Gry/Blk
425 Yel
17
S8 Horn Switch
21
405 Yel
430 Yel
22
X9
19
633 Gry/Blk
20
V2 Diode

MIF

Table of Contents

POWER TRAIN - GEAR SPECIFICATIONS

Specifications

General Specifications

Drive Belt Width (New) . . . . . 30.2 mm (1.19 in.)

Drive Belt Width (Minimum) . . . . . 27 mm (1.063 in.)

Clutch Engagement Speed . . . . . 1350 - 1600 rpm

Clutch Disengage Speed . . . . . 1300 rpm

Secondary Clutch Spring Torsion
1 Wrap (for 4x2 models) . . . . . 40 - 58 N (9 - 13 lbs)
2 Wraps (for 6x4 models) . . . . . 71 - 89 N (16 - 20 lbs)

Secondary Clutch Spring Torsion
120 Degree Wrap (4X2 #W004X2X039280 and up) . . . . . 40 - 58 N (9 - 13 lbs)
240 Degree Wrap (6x4 #W006X4X039286 or W006X4D009699 and up) . . . . . 71 - 89 N (16 - 20 lbs)

Chain Tension (6X4) . . . . . 12 - 38 mm (0.5 - 1.5 in.)

Chain Size (6X4) . . . . . Number 50

Chain Length (6X4) . . . . . 112 Links

Secondary Clutch Mounting Cap Screw Torque
M8 with Left Hand Threads . . . . . 38 N•m (28 lb-ft)
M10 with Right Hand Threads . . . . . 70 N•m (52 lb-ft)

Repair Specifications

Torques:

Rear Rim-to-Axle Bolts . . . . . 88 N•m (65 lb-ft)

Transaxle-to-Frame . . . . . 200 N•m (148 lb-ft)

Engine-to-Frame . . . . . 28 - 42 N•m (20 - 30 lb-ft)

Engine-to-Transaxle Strut (Transaxle Bolt and Lock Nut) . . . . . 37 N•m (27 lb-ft)

Engine-to-Transaxle Strut (Engine Bolt and Lock Washer) . . . . . 25 N•m (18 lb-ft)

Primary Clutch Mounting Cap Screw Torque . . . . . 50 ± 10 N•m (37 lb-ft)

Transaxle:

Input Shaft Washer Thickness (Reverse Drive Gear End)
Standard . . . . . 1.45 - 1.55 mm (0.057 - 0.061 in.)
Wear Limit . . . . . 1.20 mm (0.047 in.)

Input Shaft Washer Thickness (Forward Drive Sprocket End)
Standard . . . . . 1.52 - 1.68 mm (0.060 - 0.066 in.)
Wear Limit . . . . . 1.30 mm (0.051 in.)

Shift Collar Shift Groove Width . . . . . 16.10 - 16.30 mm (0.634 - 0.642 in.)

Shift Groove-to-Block Clearance (Maximum) . . . . . 2 mm (0.08 in.)

Spring Free Length . . . . . 29.50 mm (1.161 in.)

Shifter Arm
Shifter Block Width . . . . . 15.7 - 15.9 mm (0.618 - 0.626 in.)
Block-to-Collar Groove Clearance (Maximum) . . . . . 2 mm (0.080 in.)

Transaxle Case Thrust Washer Thickness . . . . . 1.12 - 1.28 mm (0.044 - 0.050 in.)

Drain Plug Torque . . . . . 39 N•m (29 lb-ft)

Shifter Arm Retaining Plate Cap Screw Torque . . . . . 25 N•m (221 lb-in.)

Differential Housing Half Cap Screw and Nut Torque . . . . 27 N•m (20 lb-ft)

Transaxle Case Half Cap Screw Torque PIN (-4150) . . . . 26 N•m (230 lb-in.)

Transaxle Case Half Cap Screw Torque PIN (4151-) . . . . 35 N•m (310 lb-in.)

Neutral Start Switch Torque . . . . 39 N•m (29 lb-ft)

Transaxle Mounting Bolts . . . . 200 N•m (148 lb-ft)

Differential:

Bevel Gear Washer Thickness (Standard) . . . . 1.50 - 1.70 mm (0.059 - 0.067 in.)

Bevel Gear Washer Thickness (Wear Limit) . . . . 1.30 mm (0.051 in.)

Pinion Gear Washer Thickness (Standard) . . . . 0.96 - 1.04 mm (0.038 - 0.041 in.)

Pinion Gear Washer Thickness (Wear Limit) . . . . 0.70 mm (0.028 in.)

Differential Lock Collar
Groove Width . . . . 7.10 - 7.30 mm (0.280 - 0.287 in.)

Collar Groove-to-Lock Fork Finger Clearance (Maximum) . . . . 2 mm (0.080 in.)

Differential Lock Shaft
Differential Lock Fork Finger Thickness . . . . 6.70 - 6.90 mm (0.264 - 0.272 in.)

Finger-to-Collar Groove Clearance (Maximum) . . . . 2 mm (0.080 in.)

Spring Free Length . . . . 93.2 mm (3.669 in.)

Spring Working Load . . . . 74 mm at 150 N (2.913 in. at 33.72 lb force)

Differential Lock Lever Bracket Cap Screw Torque . . . . 26 N•m (230 lb-in.)

Secondary Clutch Mounting Cap Screw Torque . . . . 38 N•m (28 lb-ft)

Axles:

Drive Axle Mounting Nut Torque . . . . 90 N•m (67 lb-ft)

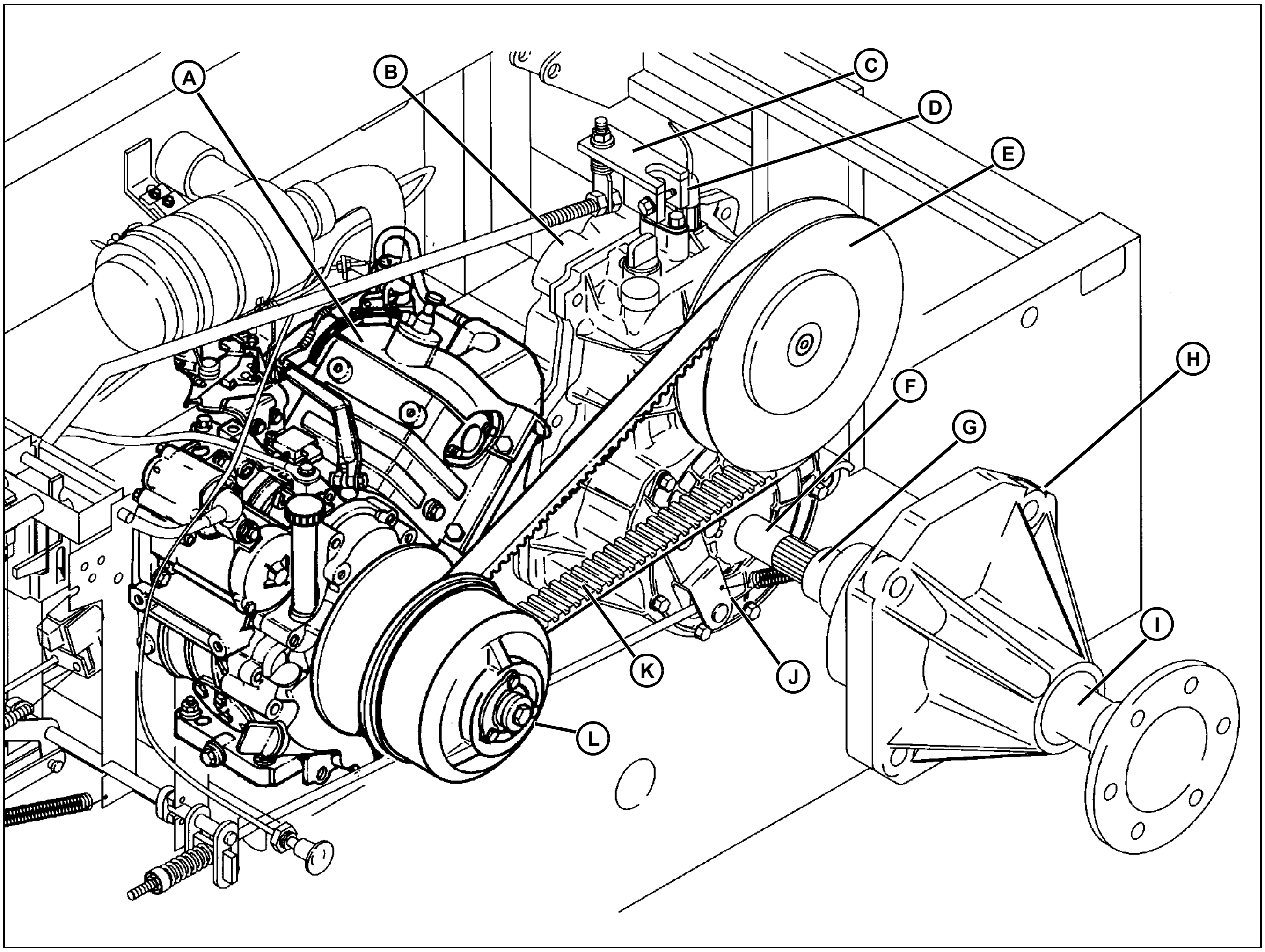
Rear Wheel Mounting Cap Screw Torque . . . . 88 N•m (65 lb-ft)

Other Materials

Number	Name	Use
TY6305	John Deere Clean and Cure Primer	Cleans parts and speeds cure of sealant.
TY15139/ TY15443	John Deere Sealant	Seals transaxle case halves.
TY6333	Moly High Temperature EP Grease	Apply to splines of transaxle input shaft.
TY22034	John Deere SuperLube ®	Apply to rollers and cam weigh pivots of primary clutch.
TY9370/TY9477 #242	Thread Lock and Sealer (Medium Strength)	Apply to threads of secondary clutch set screw and ramp tabs. Threads of retaining screw.

Component Location

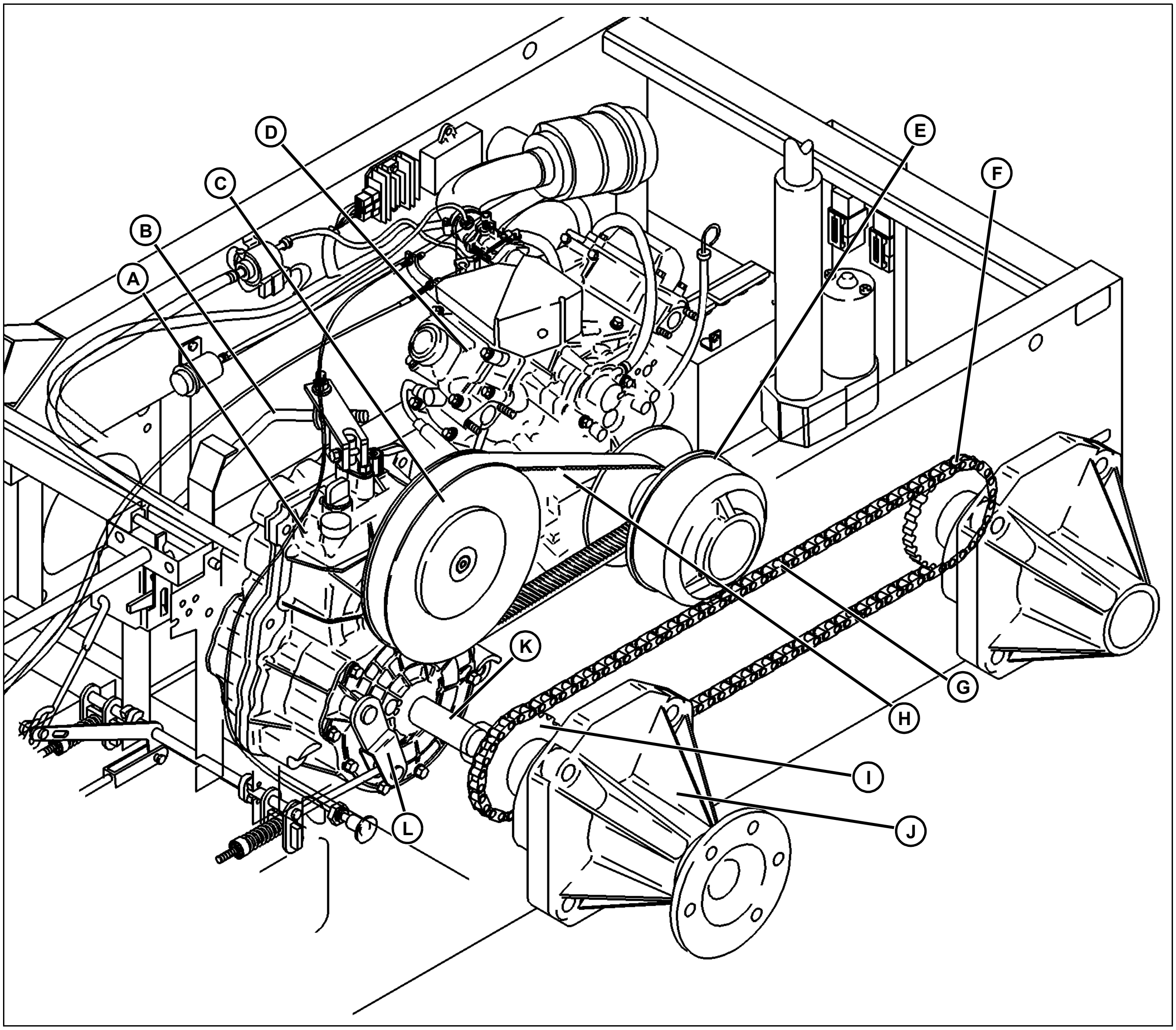
Component Location - 4X2



M55708

- **A - Engine**
- **B - Transaxle**
- **C - Shift Linkage**
- **D - Neutral Start Switch**
- **E - Secondary Clutch**
- **F - Transmission Output Shaft**
- **G - Coupler**
- **H - Axle Housing**
- **I - Axle**
- **J - Internal Wet Brake**
- **K - Drive Belt**
- **L - Primary Clutch**

Component Location - 6X4



M55709

A - Transaxle
B - Shift Linkage
C - Secondary Clutch
D - Engine
E - Primary Clutch
F - Rear Sprocket and Axle
G - Drive Chain
H - Drive Belt
I - Front Axle and Sprocket
J - Axle Housing
K - Coupler
L - Internal Wet Brake

NOTE: Gas Engine Shown above.

Theory of Operation

Clutch Operation

Theory of Operation:

The variable clutch system is speed and load sensitive. The primary and secondary clutches work together, automatically up-shifting (A) and down-shifting (B). This shifting changes the ratio between the clutches, allowing the engine to operate at optimum efficiently, at the peak of its power curve.

The primary clutch (C) is engine speed sensitive, and is mounted on the engine crankshaft. It operates on the principle of centrifugal force. The secondary clutch (D), mounted on the transaxle input shaft, is load sensitive to the rear drive wheels.

Idle Speed:

Primary clutch is spinning with engine crankshaft, but centrifugal force on the weights is not enough to overcome primary spring tension. The primary clutch sheave remains opened wide and does not engage drive belt.

Engagement RPM, Minimum Load, Low Output Speed (E):

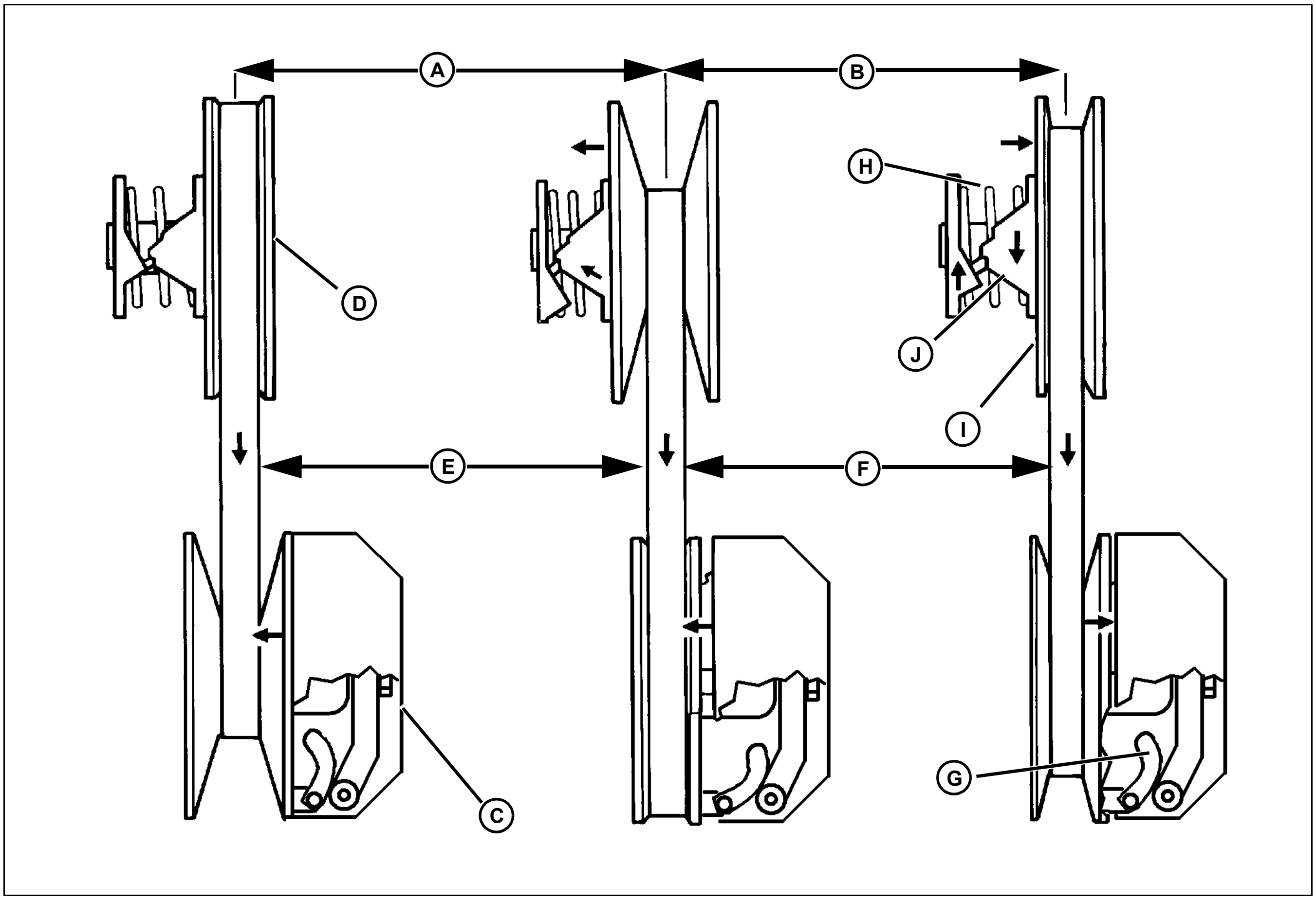
Primary clutch sheaves are moving closer together, just starting to move drive belt. Drive belt is running at the top of secondary clutch. A high ratio between the clutches exist, similar to a low gear, as long as there is minimal load.

High Engine RPM, Light Load, High Output Speed (F):

As engine speed increases, centrifugal forces of the cam weights (G) force the primary clutch to up-shift, moving the drive belt to outer pulley diameter, overcoming secondary clutch spring (H). 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

Down-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 (I) up the ramp (J). The ramp and spring forces the belt to the outside diameter of the secondary clutch, and overcomes centrifugal forces of the primary clutch causing the down-shifting.



M56089

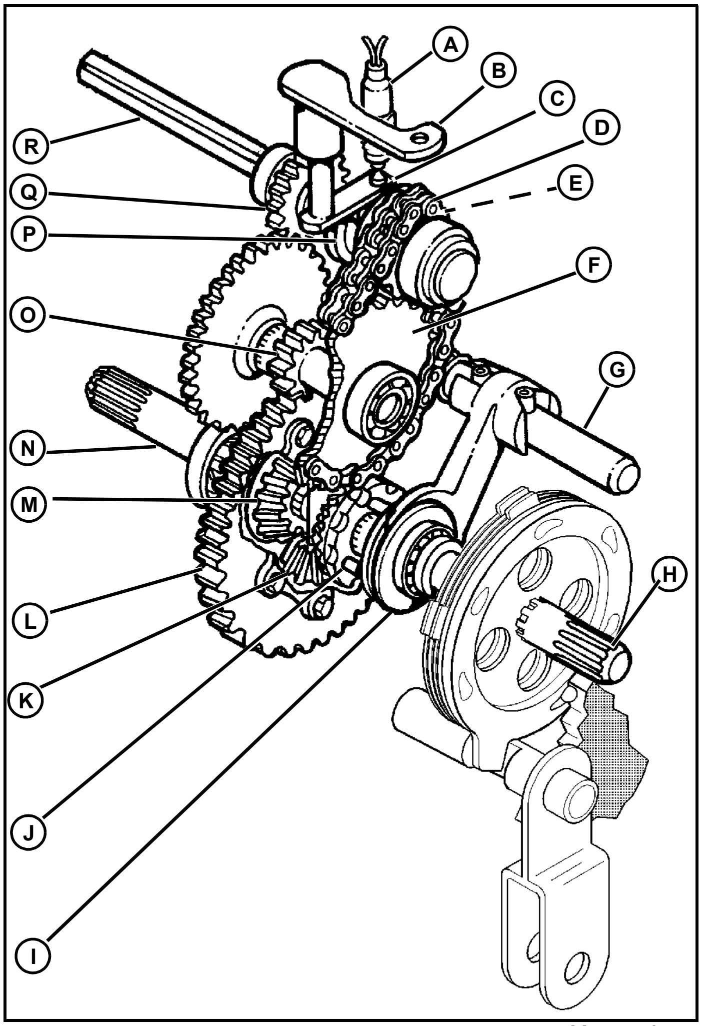
Transaxle Component Location and Operation

Function:

The transaxle provides:

- shifting into forward, neutral and reverse.
- differential action between axles for turning
- differential lock, locking axles together for better traction.

Neutral:



M56345A

In neutral the shift arm (B) centers the shift collar (P) between the forward drive gear (Q), and reverse drive sprocket (E), so they are not engaged. The input shaft (R) rotates freely, not transferring power to the gear on the reduction shaft (O). The shift fork (C) also depresses the neutral start switch (A) only allowing the engine to be started when the transaxle is in neutral.

Forward Power Flow:

When shifted into the forward position, the shift collar (P) engages the forward drive gear (Q). Power is transmitted through the reduction shaft (O) that is in constant mesh with the differential gear (L). The differential gear (L) and assembly rotate, transferring power through the pinion (K) and side gears (M) to the output shafts (H and N).

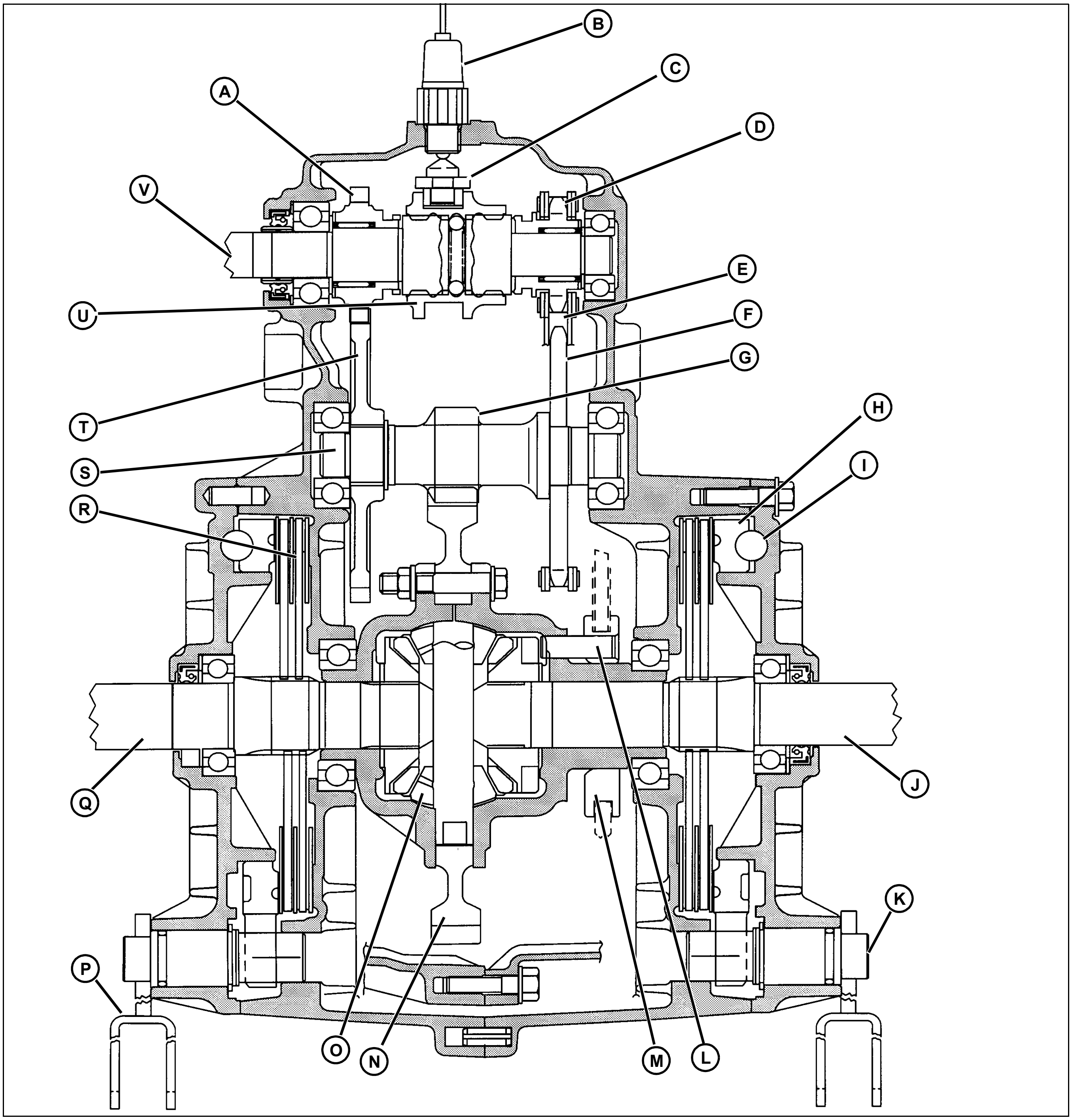
Reverse Power Flow:

When shifted into reverse, the shift collar (P) engages the reverse drive sprocket (E), that transmits power through the reverse drive chain (D) to the reduction shaft (O). The chain drives the reduction shaft in the opposite direction of the forward gear (Q), rotating the differential gear (L) in the reverse direction. Power is then transferred through the pinion (K) and side gears (M) to the output shafts (H and N).

Differential Lock:

When the differential lock (G) is engaged, the differential lock collar (I) and pins (J) are pushed in, locking the side gears (M) to the differential housing. Power then flows equally out of both output shafts (H and N).

Transaxle Component Location

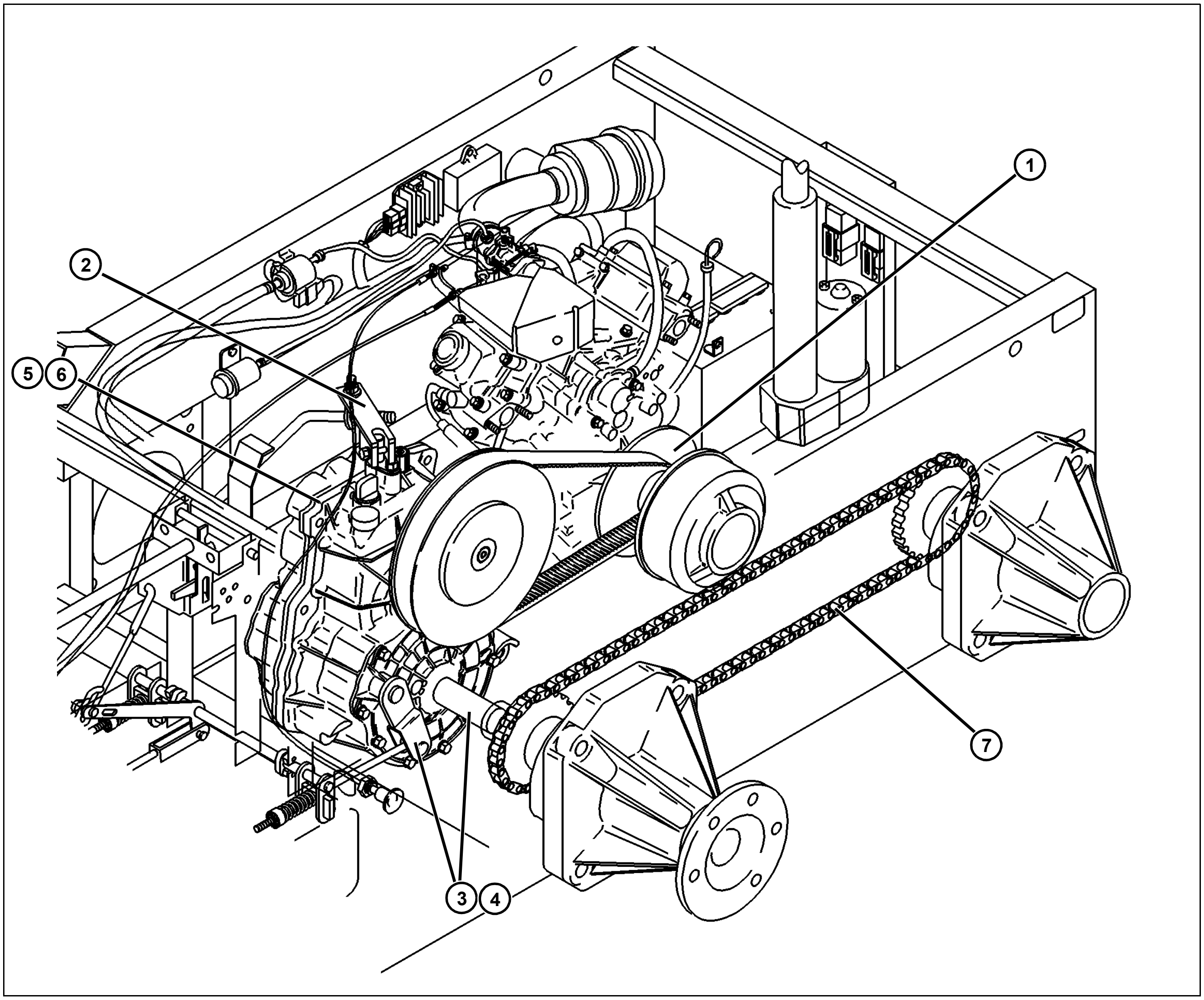


M56084

A - Forward Drive Gear
B - Neutral Switch
C - Shift Fork
D - Reverse Drive Sprocket
E - Reverse Drive Chain
F - Reverse Driven Sprocket
G - Reduction Drive Shaft
H - Brake Actuator Plate
I - Ball and Ramp
J - Right Output Shaft
K - Brake Shaft
L - Differential Pin
M - Differential Lock Collar
N - Differential Gear
O - Differential Pinion Gears
P - Brake Lever
Q - Left Output Shaft
R - Brake Disks and Plates
S - Reduction Gear Shaft
T - Forward Driven Gear
U - Shift Collar
V - Input Shaft

Diagnostics

Diagnostic Check Points



M55709

Test Conditions:

- Engine off
- Rear wheels supported off floor
- Air pressure equal in all driving tires. All driving tires close to same radius.

System: Drive Train

(1) Drive belt is in good condition; minimum belt width 27 mm (1-1/16 in.)?

Yes - Go to next step.

No - Replace drive belt.

System: Drive Train

(2) Shift linkage shifts in to forward, neutral and reverse and stays in gear during operation?

Yes - Go to next step.

No - Adjust shift linkage.

(3) Axles rotate smoothly and quietly; no free play in axles, bearings or housings?

Yes - Go to next step.

No - Check axles and housings. Check axle couplers.

(4) Brakes not dragging?

Yes - Go to next step.

No - Adjust brakes.

System: Drive Train

(5) Differential lock engages when in a turn or when wheels slip on one side; disengages when lever is released and torque is equalized on axles?

Yes - Go to next step.

No - Adjust differential lock.

(6) Differential lock produces no ratcheting sound in transaxle?

Yes - Go to next step.

No - Check internal components.

(7) Drive chain (6X4's) has slack between 8 mm (0.3 in.) and 25 mm (1.0 in.)?

Yes - Go to next check.

No - Adjust drive chain tension.

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 to 1600 rpm

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.

Test Conditions:

- Engine running at operating temperature
- Machine on level surface.

System: Machine Performance

(1) Top speed 4.5 seconds minimum per 30 m (100 ft)? Acceleration to 21 m (70 ft) in maximum of 5.5 seconds.

Yes - End of checks.

No - Check drive train components and engine performance. Check for correct engine mounting location.

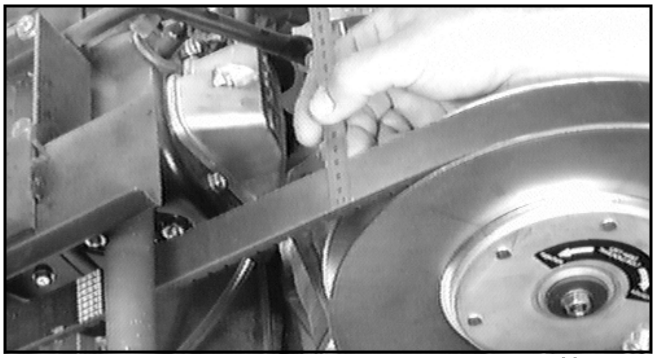
Tests and Adjustments

Drive Belt Check

Reason:

To check drive belt wear and condition of drive belt.

Procedure:



M56085

1. Measure drive belt width. Drive belt must not be less than 27 mm (1-1/16 in.).

2. Check drive belt condition. Drive belt must not be cracked. Some amount of glazing is normal.

Results:

- If drive belt width is less than specification, replace.
- If drive belt is within specification, and there is a performance complaint, check primary clutch and secondary clutch, and run Drive Train Performance Test on next page.

Transaxle Shift Linkage Adjustment

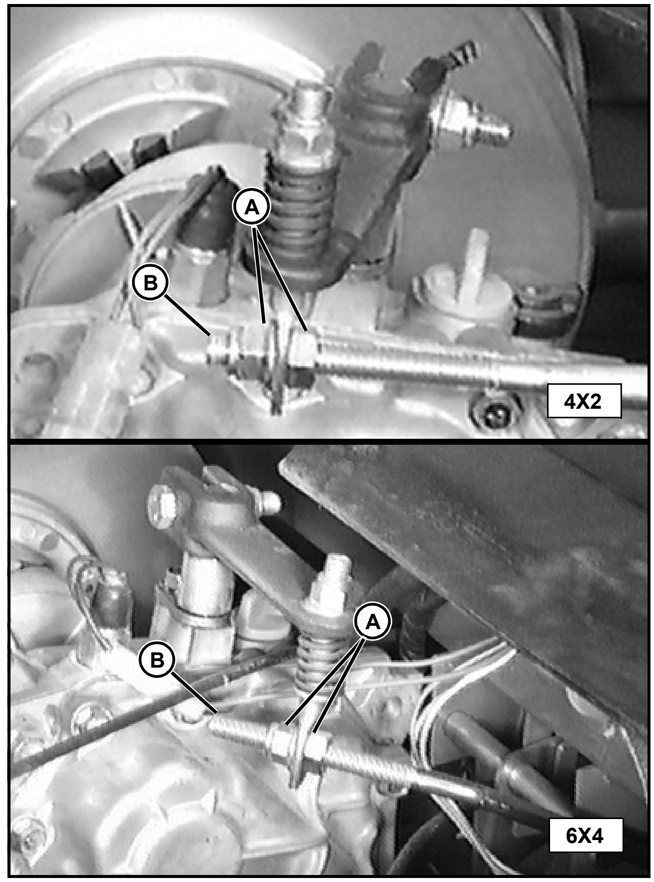
Reason:

- To insure gear shift lever is centered in neutral when transaxle is in neutral.
- To insure both forward and reverse gears will be completely engaged.
- To help prevent shifter from disengaging from gear during operation.

Procedure:

1. Park on level surface and LOCK park brake. Cargo box RAISED, engine OFF, key REMOVED. Plastic shroud under operator's seats must be bolted securely into place.

2. Move shift lever until detent inside transaxle clicks firmly into the center neutral position.



M56088 and M56344

3. Move shift lever until transaxle is in neutral detent position.

NOTE: With transmission in neutral position the shift lever rod will be perpendicular to the transmission.

4. Loosen shift rod nuts on transaxle as necessary. Adjust the shift rod nuts so the shift lever is contacting the shifter quadrant in the neutral slot

5. 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. Adjust the shift linkage if the gaps are uneven.Tighten the shift rod nuts.

6. Shift into neutral and check neutral start.

7. Drive machine over rough ground to check adjustments.

Drive Train Performance Tests

Engagement and Full Up-Shift Check

CAUTION: Avoid Injury! When operating machine to observe drive train performance, always operate in an area flat and free of obstacles. Use a passenger to observe power train so you can concentrate on driving safely. Never back machine with cargo box raised.

Reason:

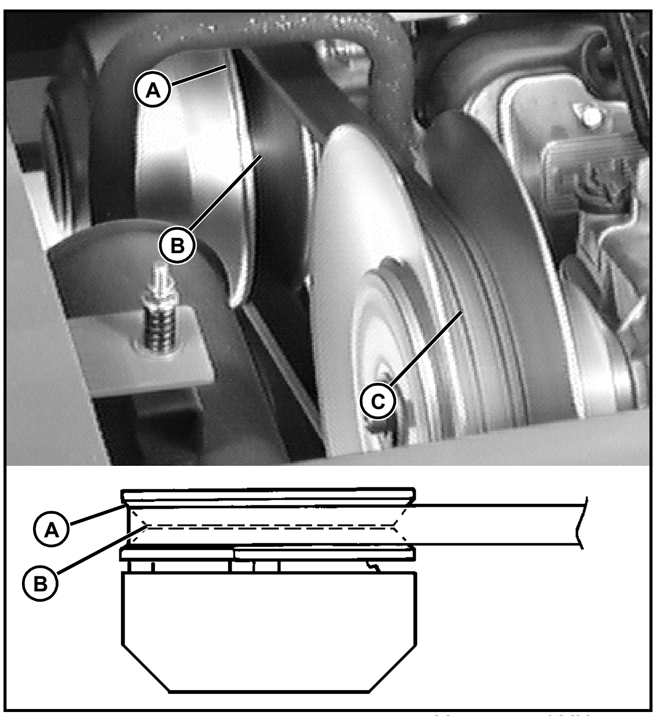
To determine if the engine and drive train are operating at peak performance.

Conditions:

- Engine slow idle and fast idle speed set correctly
- Drive belt width at or above minimum specification
- Engine warmed up

Procedure:

1. Transaxle in neutral and park brake set. Start engine.
2. Slowly increase engine rpm. Observe engine rpm when clutch starts to engage and move drive belt.



M56086 and MX0763

4X2 Model Shown

3. Accelerate from idle to wide-open-throttle and back to idle several times. Watch drive belt for a smooth transition from bottom to top of primary clutch (A). Watch closely for any hesitation or engine surging. Observe gap between primary clutch movable sheave and stationary sheave. Gap should completely close (B).
4. When approaching idle, watch for a positive disengagement from drive belt.

NOTE: On clutches with some hours of use, system may not disengage as smoothly due to primary clutch spring taking a set and other wear in the drive components.

5. Shut off engine.

Result:

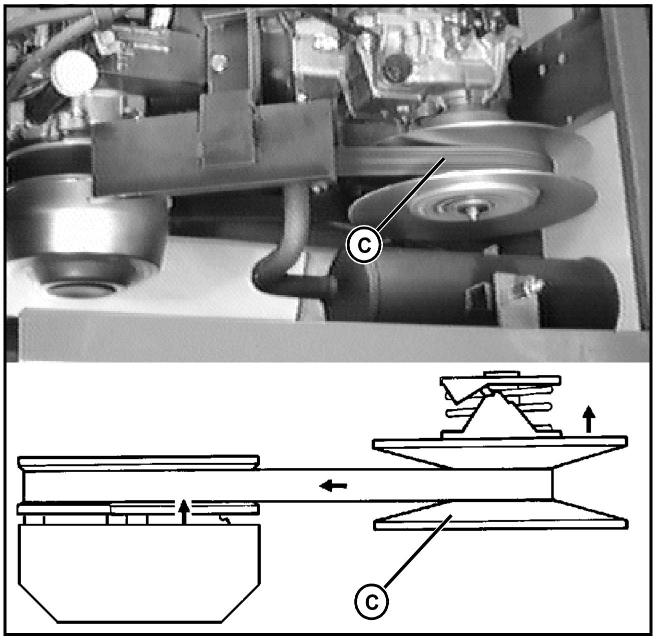
- Clutch should slowly start to engage and move drive belt between 1350 - 1600 rpm. Drive belt should be riding high in primary clutch and low in secondary clutch (C).
- If clutch has harsh engagement, erratic transition, hesitation, or clutch noise (chirping); perform primary clutch lubrication. Check primary clutch for cam weights binding, pivot pins worn, flat spots on rollers or rollers sticking, and no groove in sheave. Repair or replace primary clutch.
- If engine is surging; check engine and governor performance.
- Smooth engagement and transition (up-shift), primary clutch is good. Go to Drive Train Performance Tests; secondary clutch down-shifting check.

Secondary Clutch Back-Shifting Check

Reason:

To determine condition of secondary clutch and back-shifting performance.

Conditions:



M56090 and MX0764

4X2 Model Shown

- Cargo box raised
- Indoor testing - all rear wheels off ground and machine supported safely on jack-stands.
- Front wheels chocked
- Differential lock engaged
- Tachometer displaying engine speed

Procedure:

> **CAUTION: Avoid Injury! Rear wheels will rotate during test. Keep clear!**

1. Start engine.
2. Put transaxle in gear.
3. Operate engine at wide open throttle.

Results:

- Engine and wheel speed should remain at constant speed. Drive belt should be riding high in primary clutch and low in secondary clutch.

Procedure:

1. Momentarily load power train by slowly applying brake or park brake until back-shift is made.
2. Quickly observe engine speed, then release brake.

Results:

- Clutches should back-shift as load is increased.
- Drive belt should not squeal or slip.
- If engine speed drops below 2400 rpm or clutches are not back-shifting, see “Secondary Clutch Spring Torsion Check” on page 511.
- Check secondary clutch for complete up-shift. Check for load on drive train, such as an engaged brake or failed axle bearings. (See Brake Adjustment procedure.)

Secondary Clutch Spring Torsion Check

Reason:

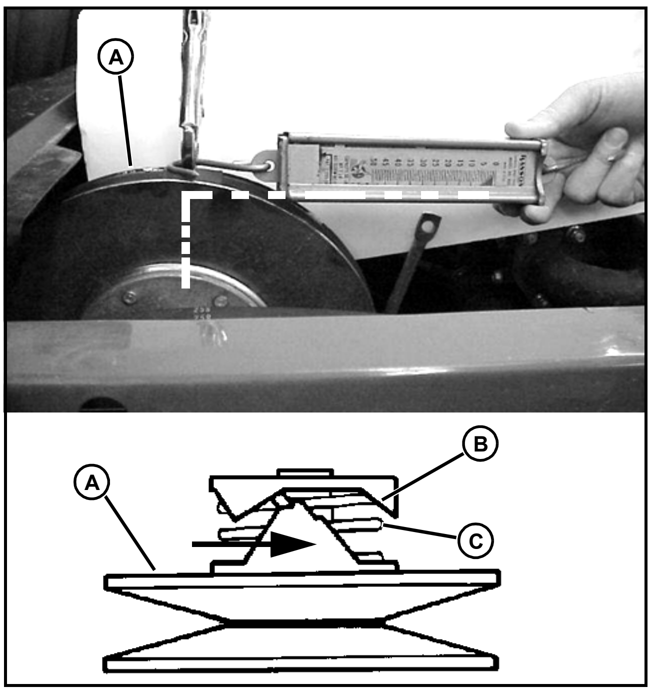
Verify condition and spring adjustment of secondary clutch.

Conditions:

- Transmission in gear.
- Park brake set.
- Drive belt removed.

Procedure:

IMPORTANT: Avoid damage! Do not damage sheave when clamping Vise-Grip®. Use protective strips of brass or aluminum.



MX1196 and MX0828

1. Clamp vise grip to movable sheave (A).

2. Hook the spring scale into the Vise-Grip® at the outer diameter of the clutch. Pull against Vise-Grip® keeping the spring scale at a right angle to the sheave.

3. Pull sheave/buttons away from ramp approximately 13 mm (1/2 in.).

4. Take the measurement as the sheave is slowly RETURNED toward the ramp, just BEFORE the button contacts the ramp.

NOTE: Setting the spring in a HIGHER # hole INCREASES tension.
Setting the spring in a LOWER # hole DECREASES the tension.

Torque Specification for Movement:

1 Wrap (4x2 models) . . . . 40 - 58 N (9 - 13 lbs)

2 Wraps (6x4 models) . . . . 71 - 89 N (16 - 20 lbs)

120 Degree Wrap
(4X2 #W004X2X039280 and up) . . . 40 - 58 N (9 - 13 lbs)
240 Degree Wrap (6x4 #W006X4X039286 or
W006X4D009699 and up). . . . . . . 71 - 89 N (16 - 20 lbs)

Results:

- Spring force within specification, secondary clutch is OK. Check engine rpm and performance. If a machine has had drive or driven clutch components replaced, the engine rpm must be set to the latest specifications. Be sure the carburetor is clean and the brakes are not dragging.
- Spring force less than specification, up-shift will be faster and slower backshift, reducing engine rpm and response time. Check spring position, set spring tab in next higher number hole (i.e. move from hole “2” to hole”3”). See “Secondary Clutch” on page 518. Re-check spring force. Replace spring if still not within specifications.
- Spring force higher than specification, up-shift or acceleration will be slower, reducing engine load, increasing engine rpm and response time. Check spring position, set spring tab in next lower number hole (i.e. move from hole “2” to hole”1”). Recheck spring force. Replace spring (C) if still not within specifications.

Clutch Center Distance (6X4 Diesel Only)

Reason:

To set optimal distance between clutches. May eliminate creep, grinding noise when shifting, or poor climbing.

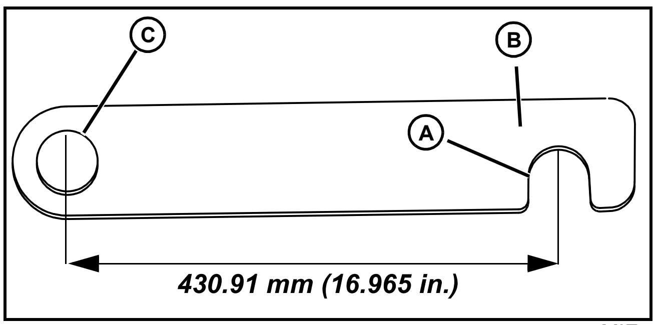
Tools:

- JD1175-2-1 Center Gauge

Check Procedure:

1. Remove drive belt.

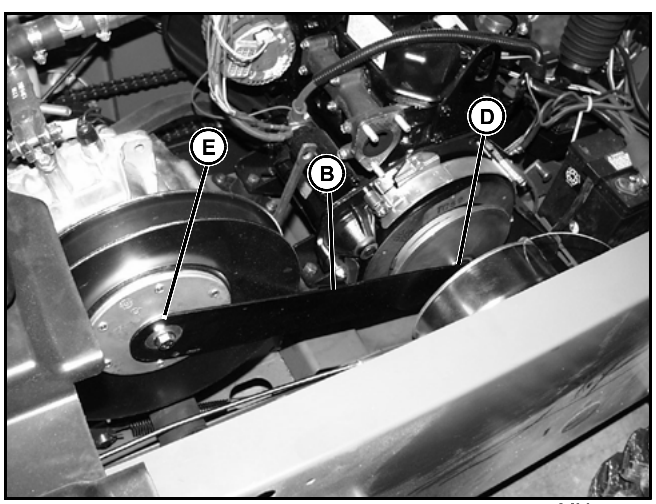
NOTE: Remove and discard step gauge JDG1175-2-2 from main gauge. Verify the distance between the centers of the tool openings (C, A). The correct distance is 430.91 mm (16.965 in.)



MIF

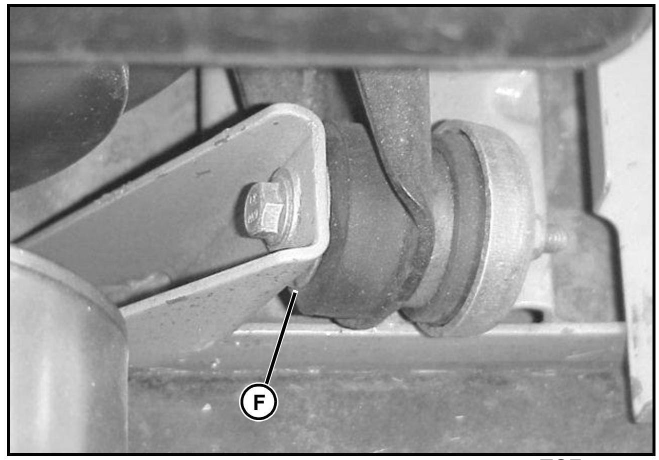
2. Place the open end (A) of the center gauge (B) on the primary clutch shaft (D).

NOTE: When verifying center distance, an incorrect reading will occur if the gauge is installed on the secondary clutch and then forced over the primary clutch.



MX0768

3. Verify the closed end (C) of the gauge easily slips onto the secondary clutch hub (E).



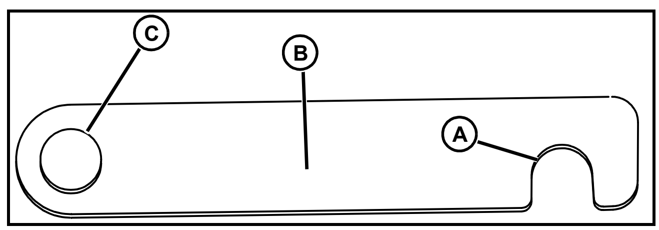
TCF01411

4. Remove or add shims (F) as necessary.

   - If the center distance is too long (gauge does not quite get to the secondary clutch hub) fewer shims are required.
   - If the center distance is too short (gauge goes past the secondary clutch hub) more shims are required.

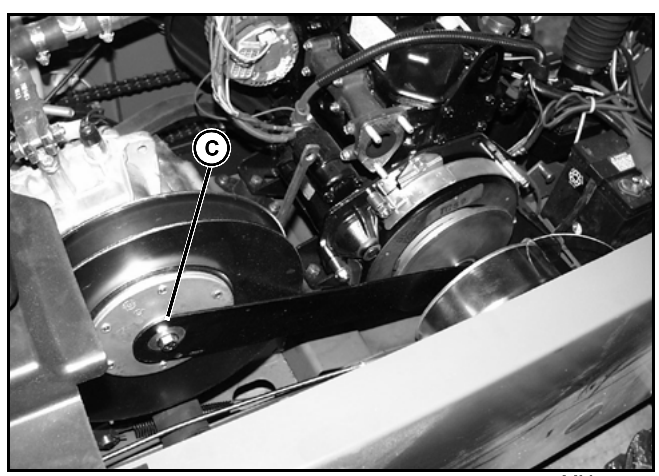
If Engine Has Been Removed:

1. If engine has been removed or motor mounts replaced, install and tighten the four isolators/mounts. Check center distance before the fifth isolator (G) is installed.



MIF

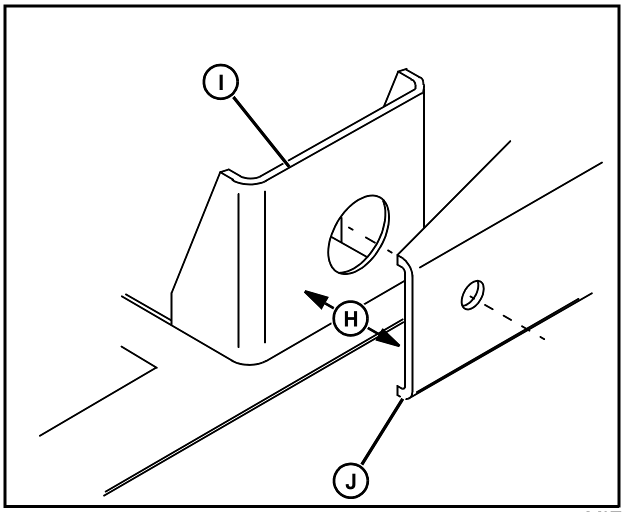
2. Place the closed end (C) of clutch center distance gauge (B) over the end of the secondary clutch. Position the open end (A) over the center shaft of the primary clutch.



MX0768

3. Make sure closed end (C) is seated completely over bushing end at secondary clutch.

NOTE: The engine may need to be pushed toward the driven clutch to allow the gauge to drop onto the drive clutch shaft.



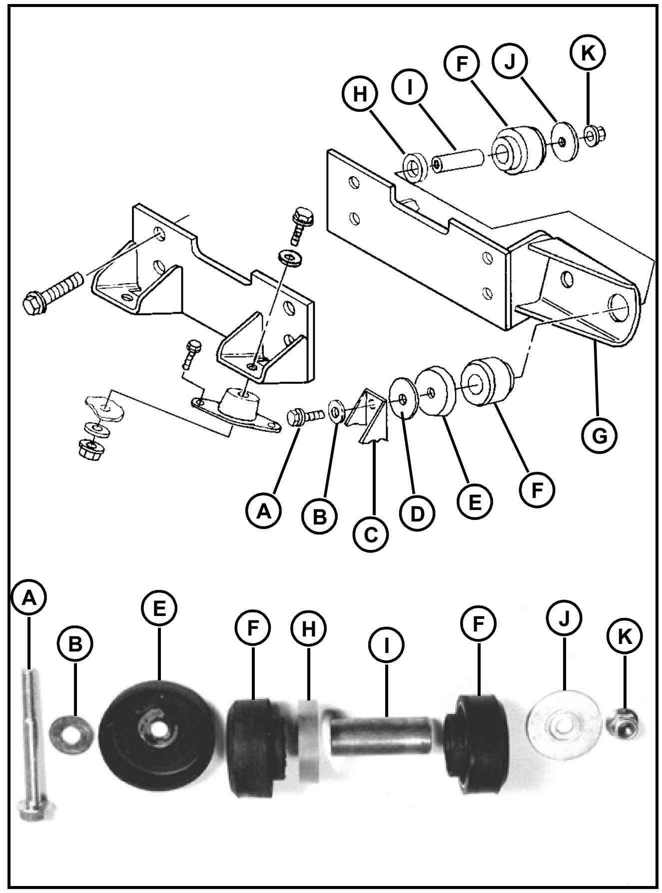
MIF

4. Measure the distance (H) between front surface of engine isolator bracket (I) and the rear surface of the frame bracket (J).

5. Compare the measurement with the GAP column of the Shim Thickness Chart. This will determine the thickness of shim(s) to be installed with the other isolator mounting hardware.

6. 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.

- Shim washers used are 24H1291 and 24H1313. the 24H1291 washer is approximately 2.8 mm thick and the 24H1313 is approximately 1.5 mm thick. Tolerance on shims is approximately 0.3 mm.



M76770 and M76748

A - Cap Screw
B - Washer
C - Frame Mount
D - Shim Washer(s)
E - Metal Cup
F - Rubber Mount
G - Engine Mount
H - Bushing
I - Bushing
J - Washer
K - Nut

7. Install fifth isolator parts in order shown.

- Assemble bushings and rubber mounts onto frame bracket. The shim(s), metal cup and one rubber mounting are installed between the frame mounting bracket and engine mounting bracket. Install correct number shim(s) as determined using shim thickness chart.

- Loosely install fifth isolation mounting cap screw and nut.

- Tighten fifth isolation mounting cap screw (G) to 37 ± 7 N•m (27 ± 5 lb-ft).

6X4 Diesel Engine Shim Thickness			
Gap (mm)	Total shim thickness required (mm)	Approx # of 24H1313 Shims	Approx # of 24H1291 Shims
20	0	0	0
20.5	0.3	0	0
21	0.8	0	0
21.5	1.3	1	0
22	1.8	1	0
22.5	2.3	1	0
23	2.8	0	1
23.5	3.3	2	0
24	3.8	2	0
24.5	4.3	1	1
25	4.8	3	0
25.5	5.3	3	0
26	5.8	2	1

Differential Lock Linkage Adjustment

Reason:

To insure complete disengagement and engagement of differential lock, and that indicator lamp switch is adjusted properly.

Conditions:

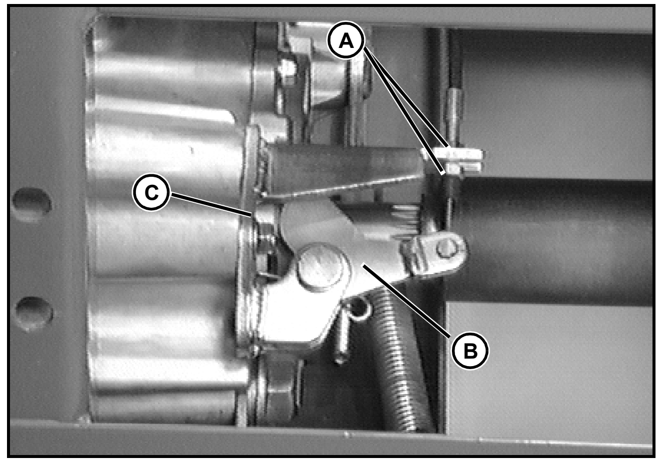
- Engine OFF
- Park brake OFF
- Cargo box raised
- Differential lock lever in disengaged (UP) position
- Right side wheels jacked up and free to rotate
- Left side of machine wheels on ground and chocked

Disengagement Check:

1. By hand, rotate right side drive wheels.

Results:

- Wheels should rotate freely with no clicking sound in transaxle.
- Differential should be disengaged and cable loose.
- Differential lock arm on transaxle should be just touching differential lock shaft.



M56342

- If there is noise or wheel will not rotate, loosen differential lock cable at rear adjusting nuts (A), and slacken cable:
  - If differential releases, check cable adjustment.
  - If differential will not release, move differential lock arm on transaxle by hand while trying to rotate tires and check if differential lock shaft is moving freely into and out of transaxle case. If not, repair transaxle.
- If cable is adjusted correctly and lock lever movement will still not disengage transaxle, check that differential lock switch rod linkage is not preventing the cable from going slack when lock lever is raised to disengaged (UP) position.

Conditions:

- Engine OFF
- Park brake OFF
- Cargo box raised
- Differential lock lever in engaged (DOWN) position

Engagement Check:

1. Engage differential lock lever at operator's station.
2. Move differential lock arm (B) at transaxle forward by hand and check for free play. Arm should be depressing differential lock shaft completely.

NOTE: If internal differential lock collar pins do not align, differential may not be engaged. Engagement spring should be compressed. Rotate tires until engagement spring pulls differential lock into position.

Results:

- Differential lock should engage, or engage as tires are rotated. When locked, tires should not rotate. If differential will not lock, adjust cable.
- Differential lock shaft (C) should be bottomed out within transaxle after rotating tires. If not, adjust cable.

- If lock lever will not move to full engaged (DOWN) position, check lock switch actuating rod is not contacting switch before lock lever is going over center, or that secondary brake linkage (Road Homologated only) is not binding.

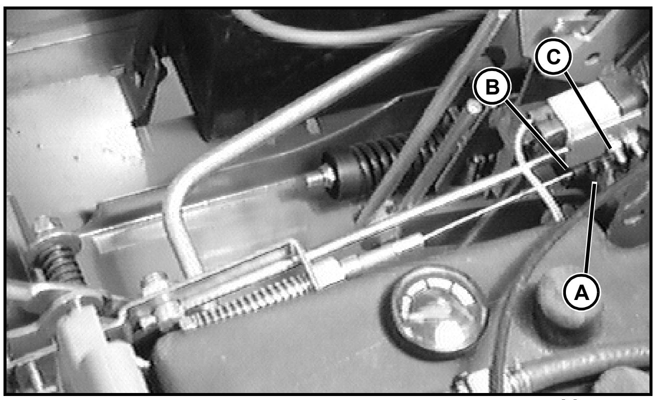
Cable Adjustment:

To adjust the cable so there is no play in the system and maximum cable travel is utilized to assure that the transaxle internal differential lock pins are completely engaged.

Conditions:

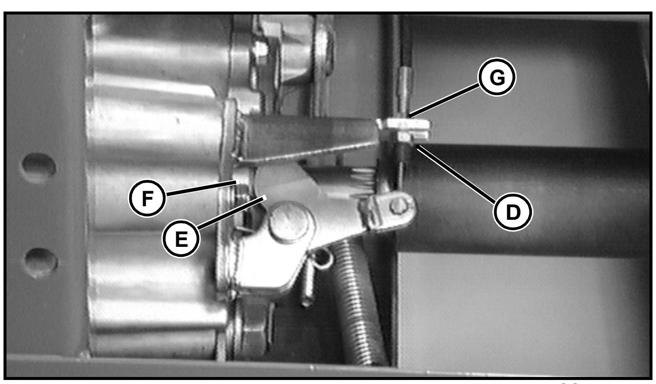
- Park brake must be OFF
- Differential lock lever must be disengaged (UP)
- Transaxle in NEUTRAL

Procedure:



M56343

1. Loosen differential lock cable front adjusting nut (A) so there is 3 - 5 mm (0.1 - 0.2 in.) of threads showing between the nut and the front cable wiper seal (B). Hold nut (A) and tighten the rear nut (C).



M56342

2. Keep the differential lock lever up in the “off or unlock” position. Loosen nut (D) to end of threads.

3. Pull cable housing up and forward until lever on transaxle (E) contacts end of differential lock shaft (F). Hold cable in position and turn nut (D) up against the bottom of the forked bracket.

4. Hold nut (D) and tighten nut (G).

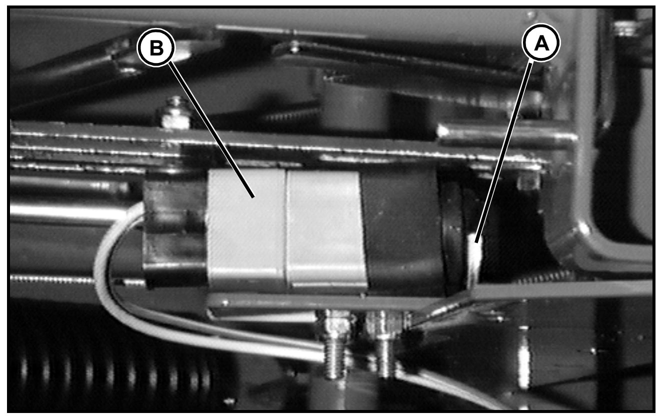
Conditions:

- Engine OFF
- Park brake OFF
- Key switch in ON position

Differential Lock Switch Actuating Rod Adjustment:

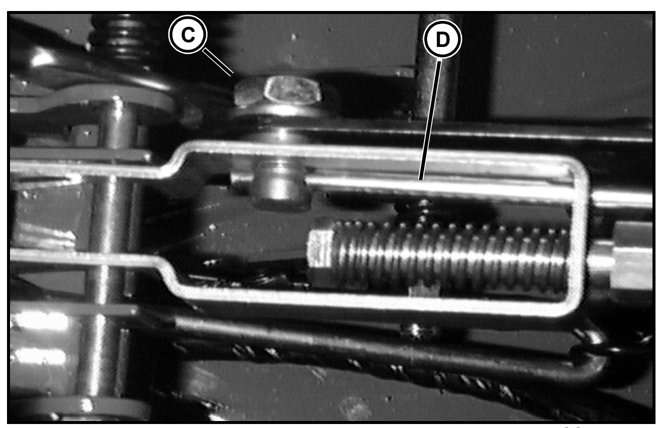
1. Engage differential lock lever (DOWN position). The tab on the end of the differential lock switch actuating rod (A) should move forward, depressing the switch (B) , and lighting indicator lamp on the dashboard.

NOTE: If park brake is ON, differential lock is automatically ENGAGED, and both park brake and differential lock indicator lamps will be ON.



M58859

2. Disengage differential lock. Indicator light should go out.

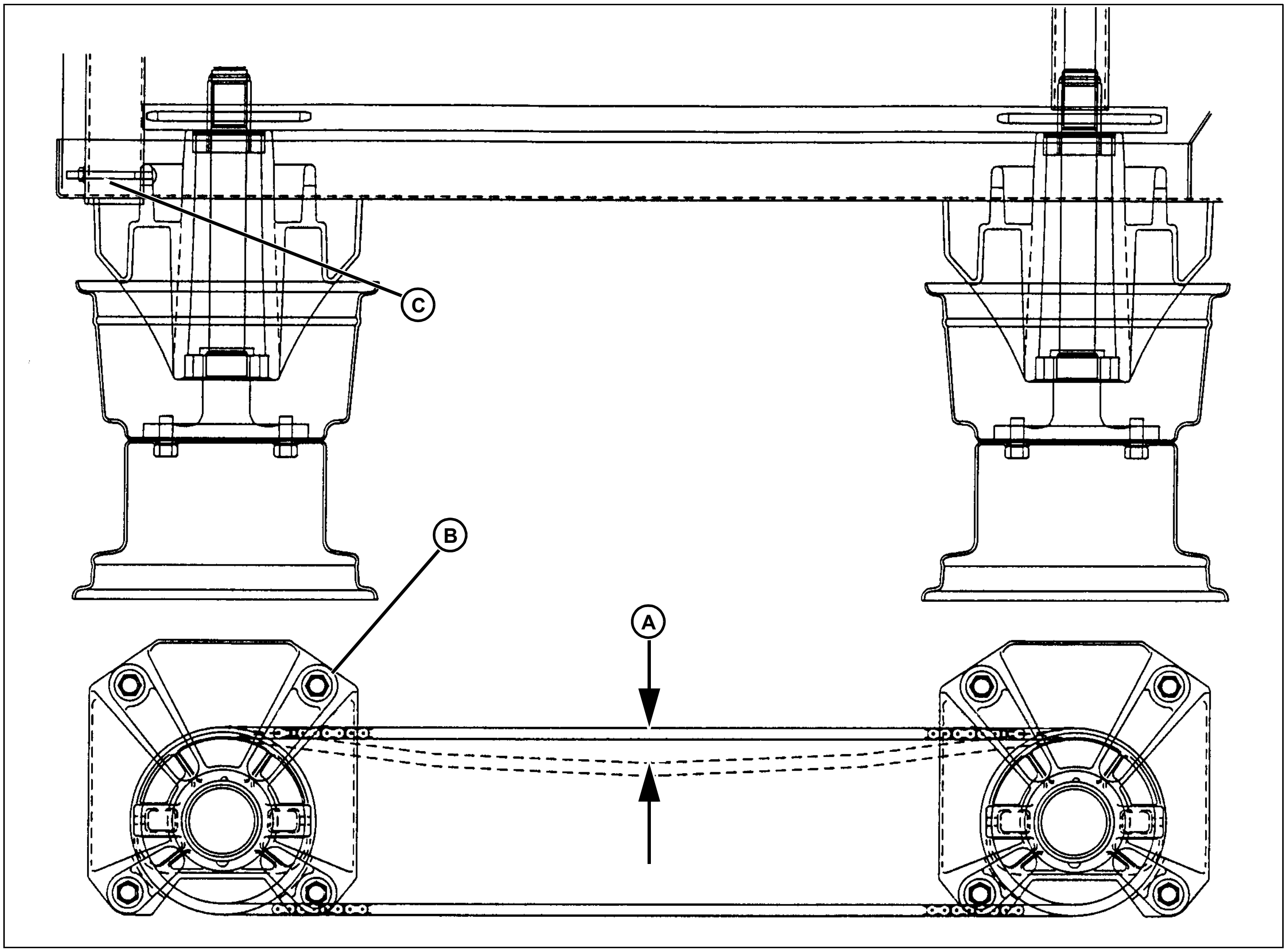


M58858

3. To adjust switch rod (D), engage differential lock (DOWN position). Loosen rod nut (C). Position switch rod so it is centered on switch plunger and plunger is depressed, but not bottomed out.

4. Tighten rod nut.

Drive Chain Adjustment - 6X4'S



M56087

Reason:

Proper chain slack prevents excessive wear and backlash problems that could cause chain damage.

Conditions:

- Engine off
- Park brake set
- Box raised
- Jack-up side of machine to be adjusted so wheels are off ground and properly supported with jackstands.

Check Chain Slack:

1. Jack up one side so tires are free to rotate. Properly support machine with jackstands.

2. With brakes set, attempt to rotate rear wheel forward against resistance of transaxle.

3. Measure chain slack on top run of chain at center point between axles (A).

Adjust Chain Slack:

IMPORTANT: Avoid damage! Do NOT use adjusting bolt to move axle housings. Damage to axle housing could result.

1. Loosen rear axle housing bolts (4 each side).

2. Move axle housings to obtain chain slack. Slack should be 8 - 25 mm (0.3 - 1.0 in.).

3. Use adjusting bolt to hold axle in place while tightening axle-to-frame bolts.

4. Tighten rear axle bolts and recheck chain slack. Readjust if necessary.

Torque Specifications:

Rear Axle Bolts. . . . . 90 - 108 N•m (66 - 90 lb-ft)

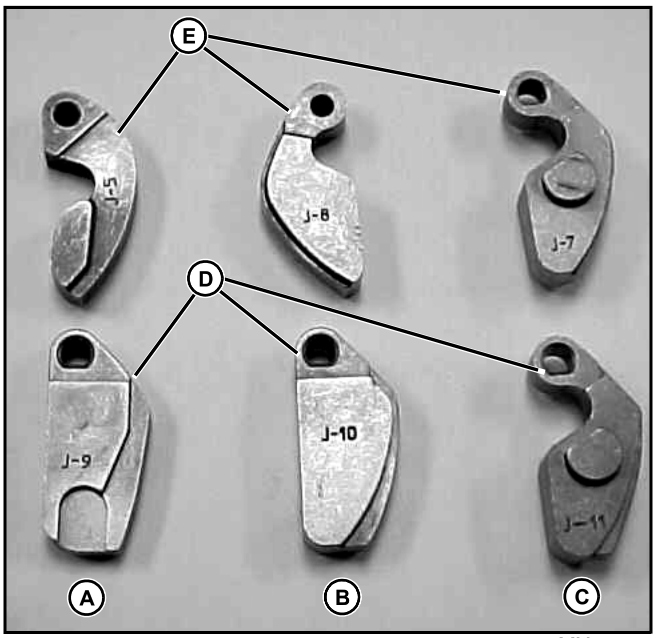
NOTE: If chain is too long, remove one link and replace with half-link.

Repair

Serial Number Breaks

NOTE: There have been improvements to the drive and driven clutches to improve top speed and climbing grades. Serial number breaks are as follows:
4X2 - W004X2X037280
6X4 - W006X4X039286
Diesel - W006X4D009699
Serial numbers above these numbers have new style drive and driven clutch, below these numbers are the old style.

Primary Clutch Cam Weights



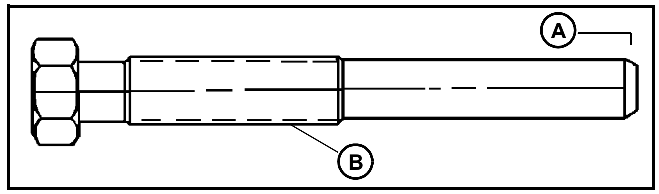
MX1195

The 4X2 (A) and 6X4 Gas (B) and 6X4 Diesel (C) use different primary cam weights. They can be identified by a model number which is stamped on the face of the cam weights. Note the new style (D) weights for the gas engine machines have a D shaped hole and can not be used in old (E) style clutches. Diesel engines have always had the D shaped hole.

Primary Clutch Removal

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.

1. Remove left rear wheel.
2. Remove black plug between tires on left side of frame.
3. Remove drive belt guard and drive belt.



M58704

4. Remove plastic plug from left side of clutch cover.
5. Remove clutch mounting bolt and washers.
6. Use JDG813-1 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.

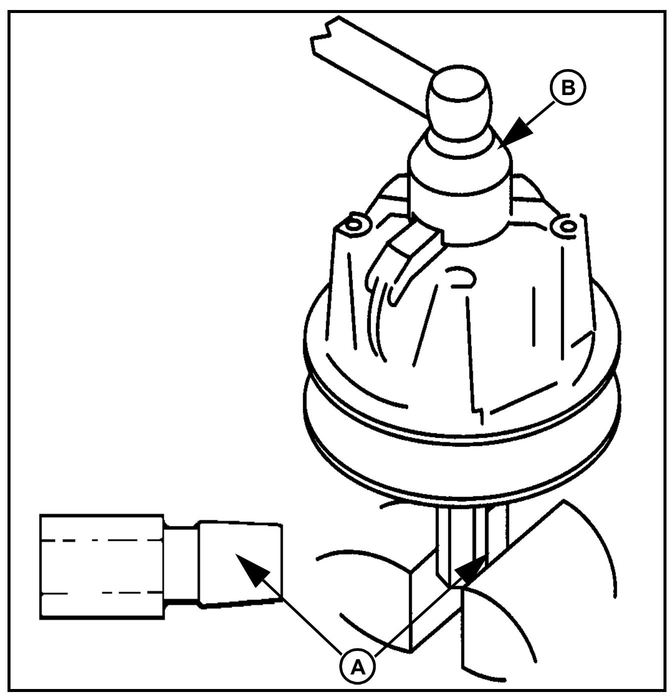
7. Install clutch in reverse order of removal. Tighten clutch bolt to specification.

Torque Specification:

Clutch Bolt . . . . 50±10 N•m (37±7 lb-ft)

Primary Clutch Repair

1. Remove clutch cover bolts. Remove cover. (Cover should pop off; do not pry on cover).



M56708 and M56706

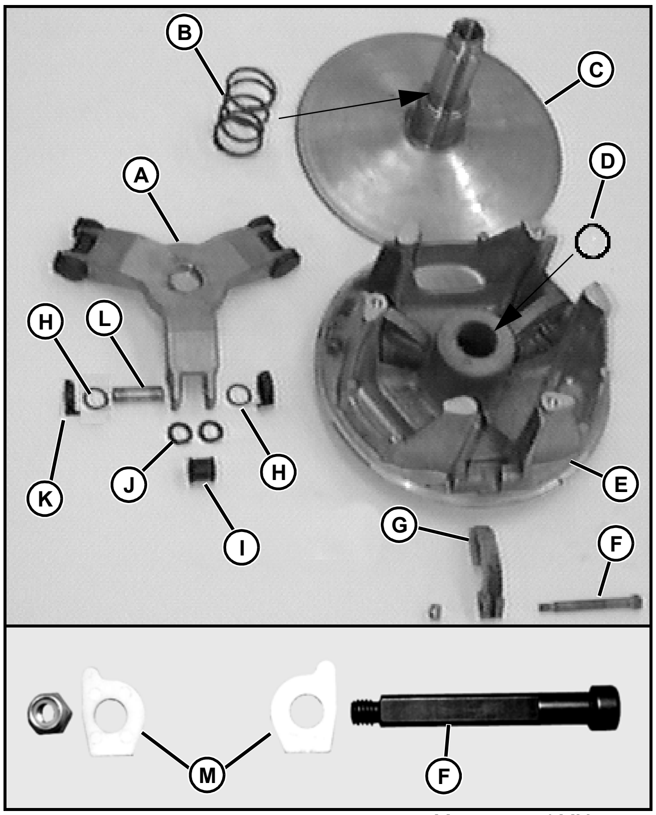
2. Install JDG813-3 Tapered Holding Tool (A) and retain it with a M10 X 1.5 X 150 mm hex-head bolt.

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 14.2 mm (0.56 in.) wide 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.

NOTE: When replacing new design drive and driven clutches on early model machines, refer to DTAC Solution 00-11-50-8.

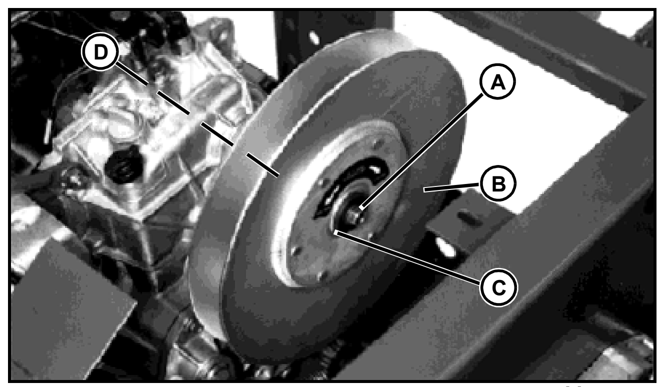
2. Reassemble components. Tighten spider to 135 N•m (100 lb-ft).

Secondary Clutch

Removal:

1. Remove drive belt and muffler.

IMPORTANT: Avoid damage! Early model transaxles with serial numbers through 28314 have 8mm left hand thread mounting cap screw. Late model transaxles with serial numbers 28315 and higher have 10 mm right hand thread mounting cap screw.



M82417

2. Hold clutch with a strap wrench and remove cap screw (A) and bushing (C).

3. Tap on inside of clutch with a rubber mallet.

4. Remove secondary clutch (B) and thrust washer.

NOTE: Early model transaxles have 25mm diameter input shaft and seal sleeve R92288. The small diameter sleeve allowed the driven clutch to wear into the sleeve. The hardened washer prevents this wear. Late model transaxles have larger 30mm diameter input shaft and seal sleeve M806721 on the input shaft and the thrust washer is not used

Transaxle (PIN -KANZAKA04800):

Short clutch splines (Input shaft M806312). Install thrust washer part number C12180.

Transaxle (PIN KANZAKA004801-):

Long clutch splines (Input shaft M80641). NO Thrust washer installed.

Installation:

Installation is done in the reverse order of removal.

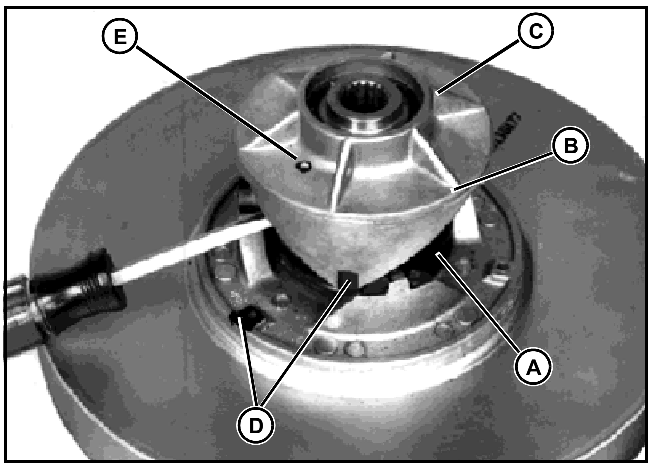
- Apply Moly High Temperature EP Grease, or equivalent, to splines of transaxle input shaft.
- Install new cap screw (A) or apply Thread Lock and Sealer to original cap screw. New cap screw will have thread lock applied. Tighten to specification.

Cap Screw Torque Specification:

8 mm Left-hand thread. . . . . 38 N•m (28 lb-ft)

10 mm Right-hand thread . . . . 70 N•m (52 lb-ft)

Disassembly:



M82418

1. Release tension on spring (A) by prying spring out of hole in cam (B).
2. Remove set screw (C).

NOTE: Cam is press fit on shaft. Use a three-jaw puller and an impact wrench, at low speed, to remove cam from shaft.

3. Place alignment marks (D) on cam and movable sheave to aid in assembly.
4. Before removing spring, mark the hole (E) on the sheave that the spring tab is installed in.

CAUTION: Avoid Injury! Hold cam securely to prevent sudden spring release

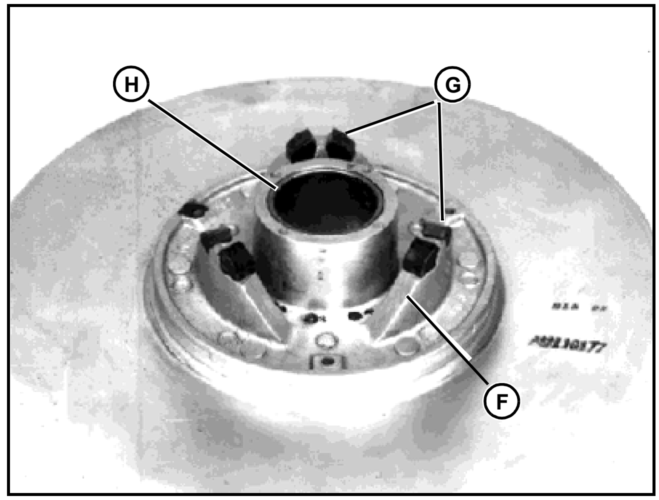
5. Remove spring, movable sheave and spacer from shaft.

Inspection:

NOTE: Ramp shoes are mounted with tabs on backside. Tabs are interference fit into holes on face of ramps. Remove shoes only if replacement is necessary.

1. Inspect ramp shoes for wear or cracks.

To replace shoes:

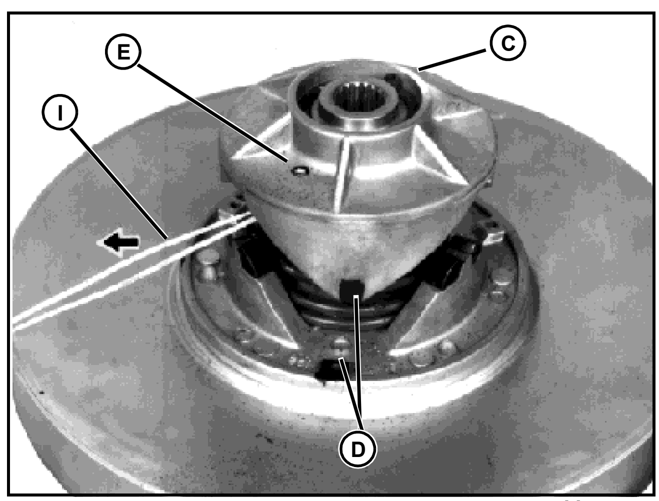


M82422

- Apply heat to movable sheave ramp (F) until shoe mounting tabs release from holes in ramp. Pull off shoes (G).
- If shoe mounting tabs break off inside holes in ramp, remove tabs using a drill bit.
- Install ramp shoe tabs into ramp holes. If shoes are too difficult to install, sand tab as necessary. If tabs are loose, apply thread lock and sealer (medium strength) on tabs.
- Inspect bushing (H) for wear or damage. Replace movable sheave if necessary.

Assembly:

1. Install spacer and movable sheave on fixed sheave.
2. Install spring. Insert spring tab into previously marked hole in movable sheave. Place cam on spring.



M82421

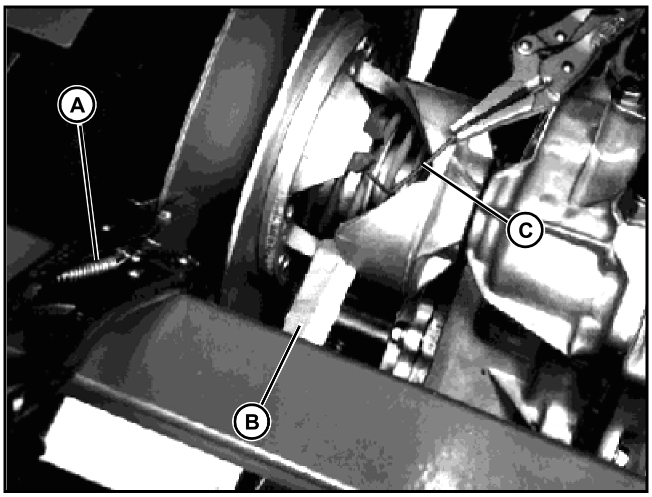
3. Align set screw bores and alignment marks (D). Press cam on shaft until it stops.

4. Apply thread lock and sealer (medium strength) to threads of set screw (C) and install.

5. Pry spring away from cam and loop a piece of string (I) around top spring tab. Pull on string until tab seats in hole in cam.

IMPORTANT: Avoid damage! After clutch in reinstalled, check spring tension. See "Secondary Clutch Spring Torsion Check" on page 511.

Replace Ramp Shoes (Clutch Mounted On Machine):



M82423

1. Remove drive belt.

2. Install locking pliers (A) on outer edge of fixed sheave half. Rotate sheave until pliers contact frame and prevent sheave from turning.

3. Turn moveable sheave until shoes are away from ramps. Install small block of wood (B) between other ramps and shoes to hold sheave half in position.

4. Clamp long end of 2 mm (0.078 in.) allen wrench (C) into locking pliers. Heat short end of allen wrench until red. Insert wrench into center of ramp shoe as plastic melts.

5. Hold wrench in place until plastic hardens.

6. Twist and pull on allen wrench to remove ramp shoe.

7. Install new ramp shoes. Push ramp shoe straight in with a screwdriver by prying against cam.

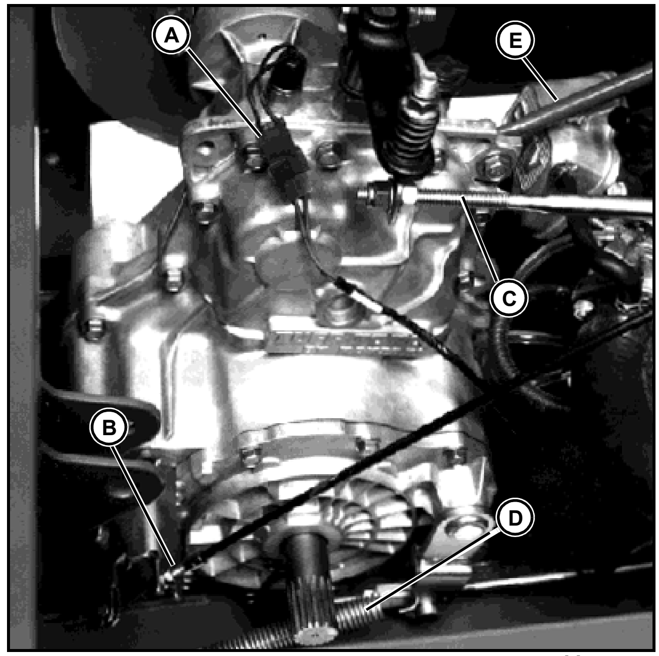
- If shoe is difficult to install, sand mounting tab as necessary.
- If shoe is loose, apply thread lock and sealer (medium strength) on mounting tabs.

Transaxle Removal and Installation

Removal:

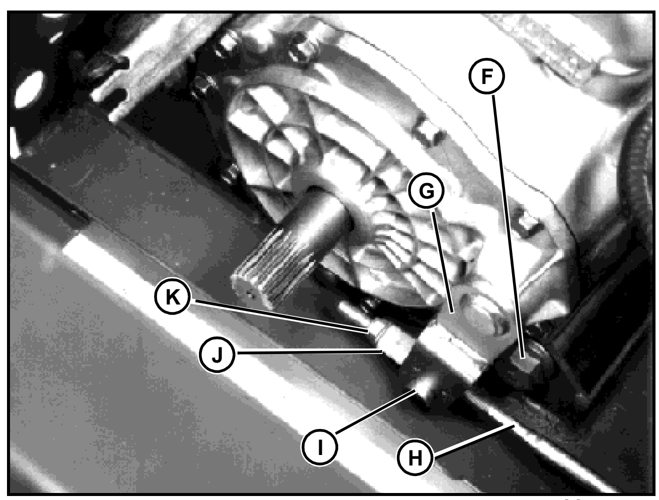
1. Remove cargo box, drive belt and drive axles.

2. Drain transaxle.



M82426

3. Disconnect neutral start switch (A), differential lock cable (B), shift rod (C), and brake return springs (D).



M82427

4. Remove lock nut (K) and adjustment nut (J) from brake rods (H) on each side of transaxle. Remove brake rods and cross pins (I) from cam levers (G).

5. Remove support bracket (E), mounting cap screws (F) and washers. Remove transaxle.

Installation of 4X2 (PIN: -KANZAKA001620) and 6X4 Gas (PIN: -KANZAKA001945):

1. Place transaxle in frame.

2. Install and tighten both left side mounting cap screws and right side rear mounting bolt.

3. Measure gap between right side front mounting tab and case.

4. Install shims between tab and case equal to gap plus 0.5 mm (0.020 in.). Pry tab out slightly to fit tabs.

5. Install mounting cap screws and tighten to 175 N•m (130 lb-ft).

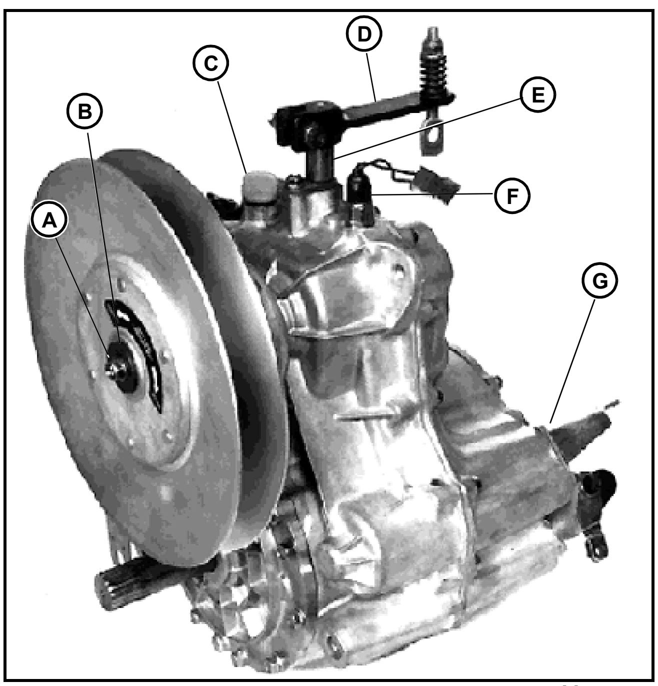
Installation for all other machines:

- Installation is in the reverse order of removal.
- Adjust brake linkage.
- Adjust shift rod and differential lock cable.
- Fill transaxle with John Deere J20C Hy-Gard.

Transaxle Capacity:

4x2 S/N 0000 - 6845	**5.9 L (6.1 qt)**
6x4 S/N 0000 - 7280	**5.9 L (6.1 qt)**
All Others	**4.5 L (4.75 qt)**

Disassembly and Inspection:

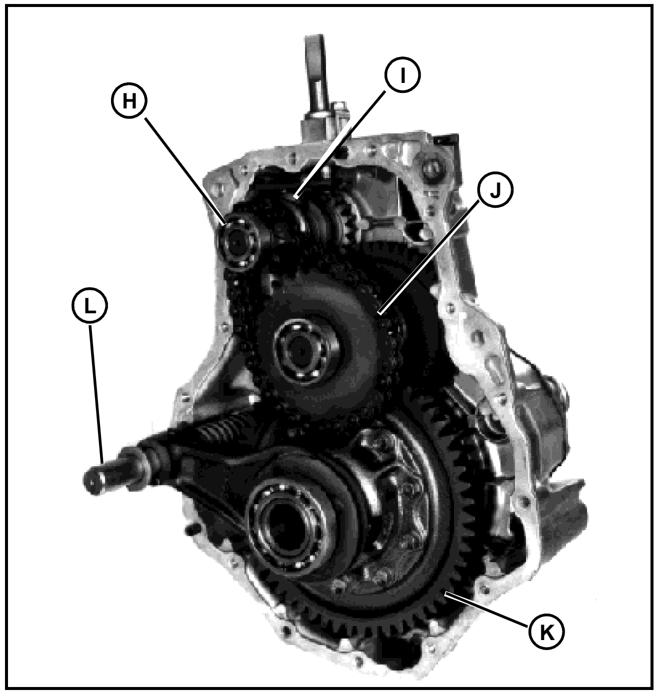


M82428

1. Remove secondary clutch (A), thrust washer (if used), neutral start switch (F), O-ring, shift lever (D), spacer (E), and differential lock bracket (G).

2. Remove dipstick (C) and O-ring.

3. Remove sixteen cap screws. Tap seam of case with a plastic hammer or pry apart at pry points and separate case halves.

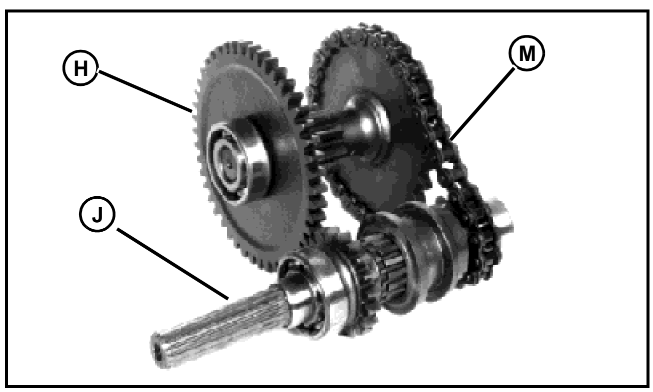


M82429

4. Lift input shaft (J) and secondary shaft (H) just enough to unseat from bearing bores.

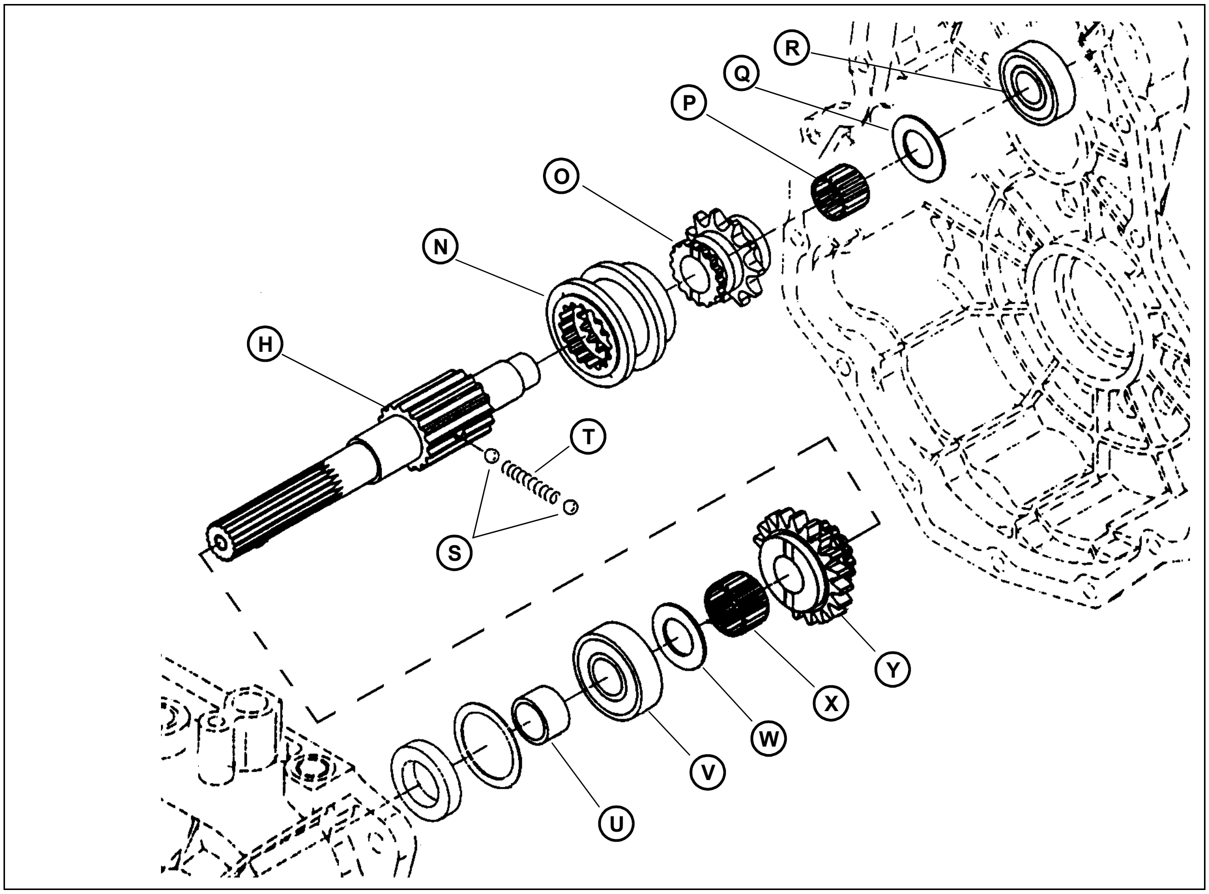
NOTE: Do not lose shift block (I) when removing input and secondary shaft assembly.

5. Remove differential unit (K) and differential lock shaft (L) together as an assembly.



M82430

6. Remove input shaft (J) and secondary shaft (H) together as an assembly.



M82431B

7. Remove reverse drive chain (M) from input (H) and secondary shaft assembly (H).

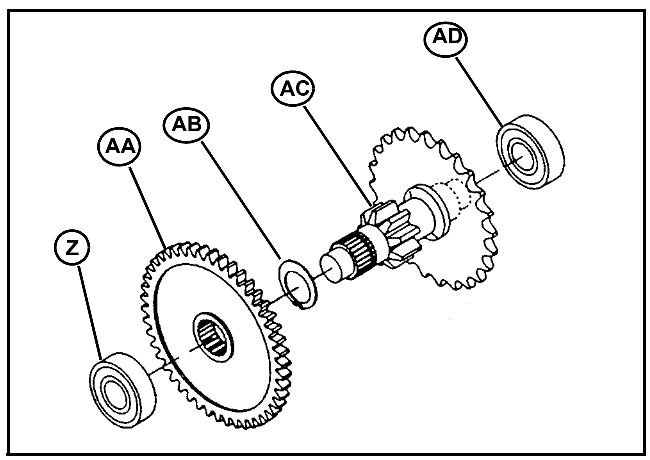
8. Remove sleeve (U), bearing (V), washer (W), needle bearing (X), and forward drive sprocket (Y) from the input shaft (H).

> **CAUTION: Avoid Injury! Balls (S) and spring (T) will shoot from hole in shaft when shift collar is removed.**

9. Remove shift collar (N), balls (S) and spring (T), reverse drive gear (O), needle bearing (P), washer (Q), and ball bearing (R) from input shaft (H).

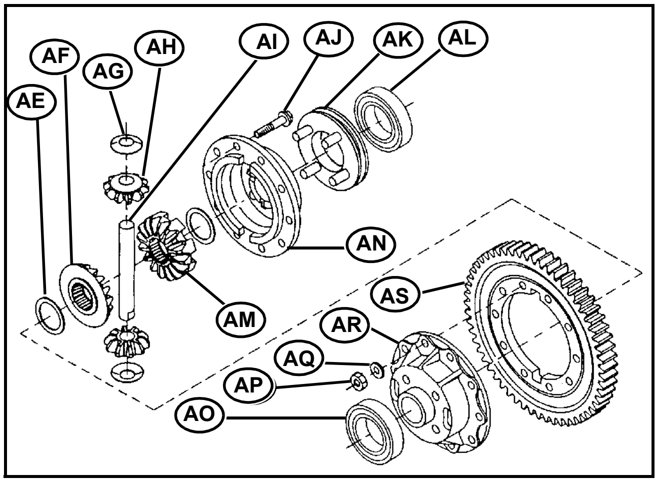
10.Measure thickness of washers (Q and Y), and width of shift groove in shift collar (N). See specifications below.

NOTE: Bearings (Z and AD) on the secondary shaft are press fit.



M82432A

11.Remove the ball bearing (Z), forward driven gear (AA), snap ring (AB), and ball bearing (AD), from secondary shaft (AC). Inspect all parts for wear and damage.



M82433B

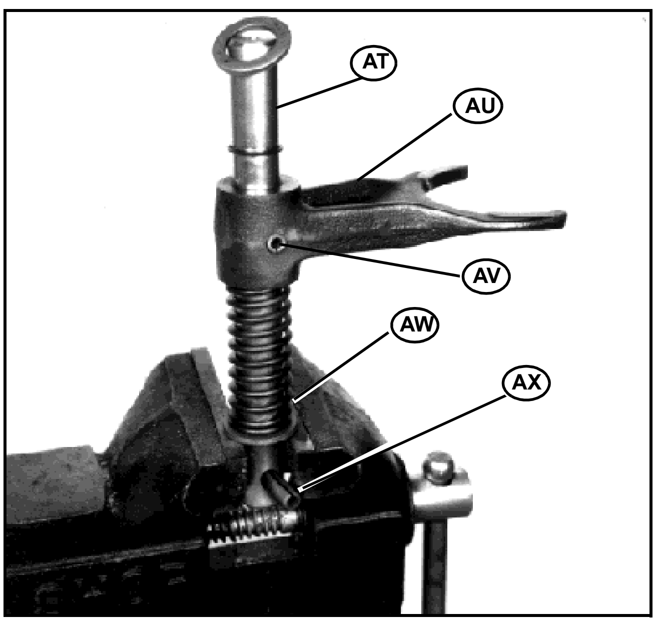
12.Disassemble differential. Remove bevel gear washers (AE), bevel side gear (AF), bevel pinion washers (AG), bevel pinion gears (AH), bevel pinion shaft (AI), and notched bevel gear (AM).

13.Remove bearing (AL) and differential lock collar (AK).

14.Remove nuts (AP), and lock washers (AQ) from 10 cap screws (AJ), and separate the differential housing halves (AN, AR) from final drive gear (AS).

15.Measure thickness of washers and groove width of differential lock collar.

16.Disassemble differential lock shaft. Remove washer.



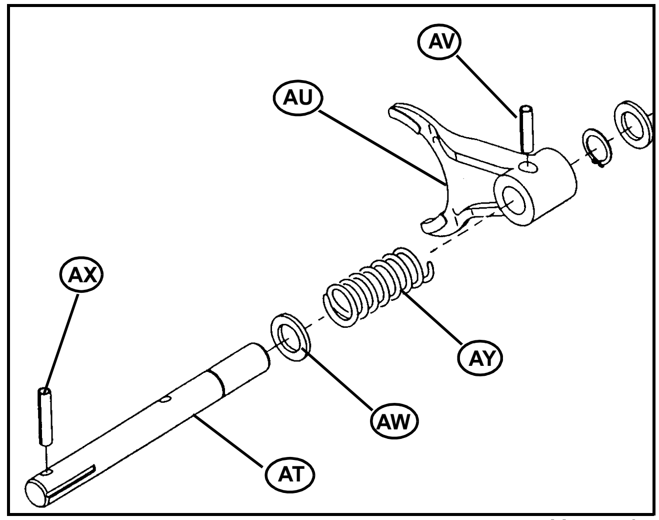
M82434

17.Put end of differential lock shaft (AT) in a soft jawed vise as shown. Push down on lock shaft until washer (AW) is away from short spring pin (AX). Tighten vise around shaft.

18.Drive out short spring pin.

19.Hold differential lock fork (AU) and slowly loosen vise.

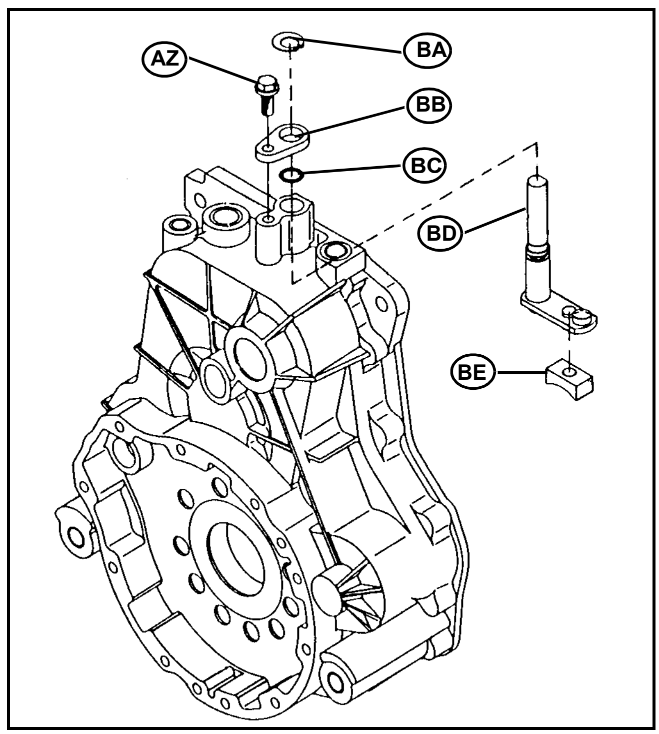
Remove washer and spring.



M82435A

20.Drive out long spring pin (AV). Remove differential lock fork.

21.Inspect all parts. Measure thickness of lock fork fingers and spring free length and working load.



M82436A

22.Remove cap screw (AZ), snap ring (BA) and retaining plate (BB).

23.Remove the shifter arm (BD) and block (BE).

24.Inspect all parts of shifter arm for wear or damage. Replace as necessary.

25.Measure width of shifter block. Replace block if not within specifications.

26.Inspect case halves for cracks or damage.

27.Measure thickness of thrust washer. If thickness is not within 1.12 - 1.28 mm (0.044 - 0.050 in.), replace washer.

Specifications:

Input Shaft Specifications:

Washer (Q) Thickness
Standard . . . . 1.45 - 1.55 mm (0.057 - 0.061 in.)
Wear Limit . . . . 1.20 mm (0.047 in.)

Washer (Y) Thickness
Standard . . . . 1.52 - 1.68 mm (0.060 - 0.066 in.)
Wear Limit . . . . 1.30 mm (0.051 in.)

Shift Collar (N) Specifications:

Shift Groove Width . . . 6.10 - 16.30 mm (0.24 - 0.642 in.)

Shift Groove-to-Block Clearance
Maximum . . . . 2 mm (0.080 in.)

Spring Free Length. . . . . 29.50 mm (1.161 in.)

Differential Specifications:

Bevel Side Washer (AE) Thickness
Standard . . . . 1.50 - 1.70 mm (0.059 - 0.067 in.)
Wear Limit . . . . 1.30 mm (0.051 in.)

Pinion Gear Washer (AG) Thickness
Standard . . . . 0.96 - 1.04 mm (0.038 - 0.041 in.)
Wear Limit . . . . 0.70 mm (0.028 in.)

Differential Lock Collar (AK)
Groove Width . . . . 7.10 - 7.30 mm (0.280 - 0.287 in.)

Collar Groove-to-Lock Fork
Finger Clearance . . . . 2 mm (0.080 in.)

Differential Lock Fork (AU)
Finger Thickness . . . . 6.70 - 6.90 mm (0.264 - 0.272 in.)

Finger-to-Groove Clearance
(maximum) . . . . 2 mm (0.08 in.)

Spring (AY) Free Length. . . . . 93.2 mm (3.669 in.)

Working
Load . . . . . . 74 mm @ 150 N (2.913 in. @ 33.72 lb force)

Shifter Arm (BD) Specifications:

Shifter Block (BE)
Width . . . . 15.7 - 15.9 mm (0.618 - 0.626 in.)

Block-to-Collar Groove Clearance
(maximum) . . . . 2 mm (0.08 in.)

Assembly:

NOTE: Lubricate all internal parts with clean oil during assembly.

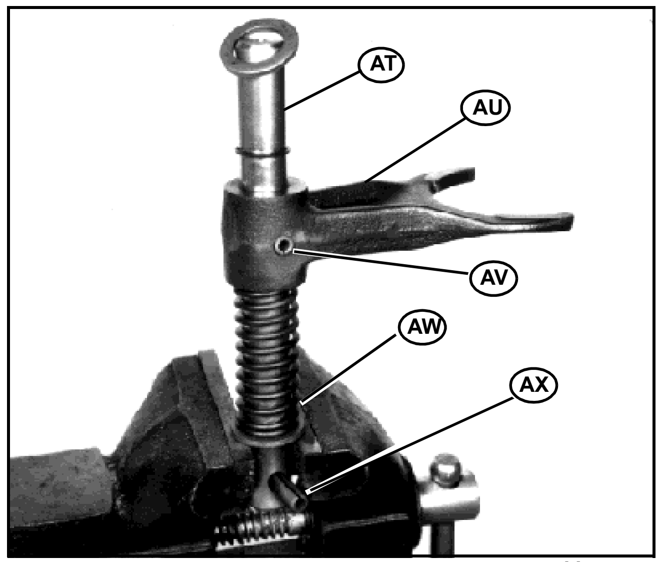
1. Apply multipurpose grease to new O-ring and inside lips of seals.

2. Install input shaft seal into case bore until it stops with seal lips facing away from case half.

3. Install differential lock shaft seal until flush with case bore and with seal lips facing toward case half.

4. Apply multipurpose grease on thrust washer to hold in place.

5. Apply multipurpose grease to shifter arm shaft, new O-ring and shifter block to hold in place.



M82434

6. Install differential lock fork (AU) on shaft (AT).

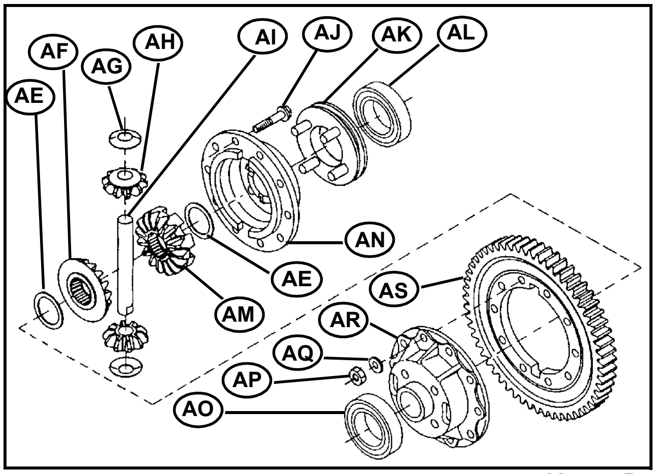
7. Drive in long spring pin (AV) with split facing toward long end of shaft.

8. Install spring (AW) and washer.

9. Put end of differential lock shaft in a soft jawed vise as shown. Push down on lock shaft until washer is away from hole in shaft. Tighten vise around shaft.

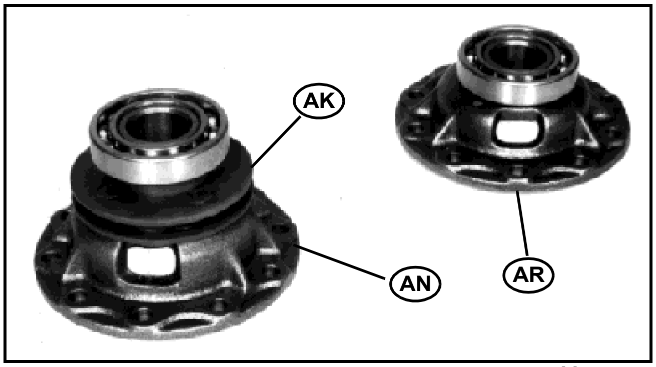
10.Drive in short spring pin (AX) with split facing washer.

11.Install snap ring and washer.



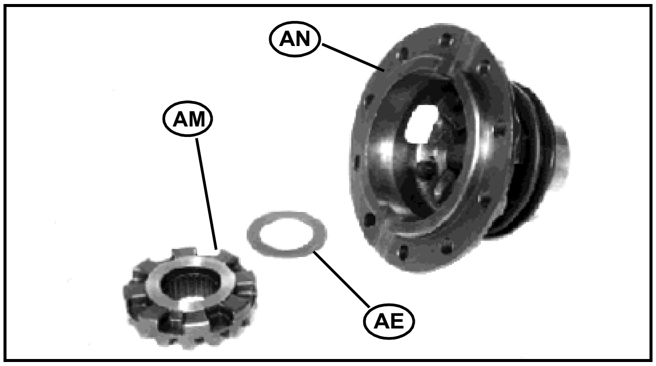
M82433B

12.Install differential lock collar (AK).



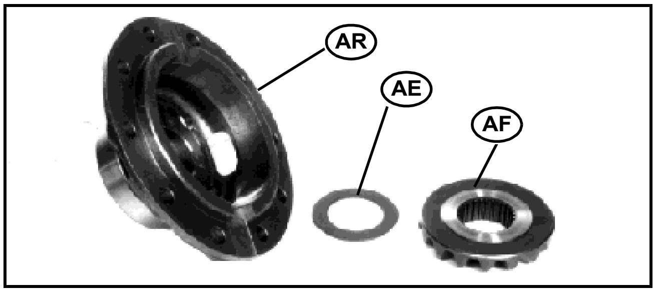
M82438

13.Press bearings tight against housing half shoulders (AN, AR).



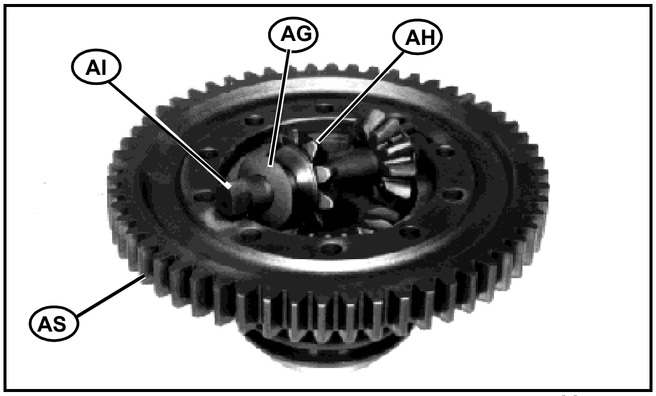
M82439

14.Install washer (AE) and notched bevel side gear (AM) into housing half with lock collar (AN).



M82440

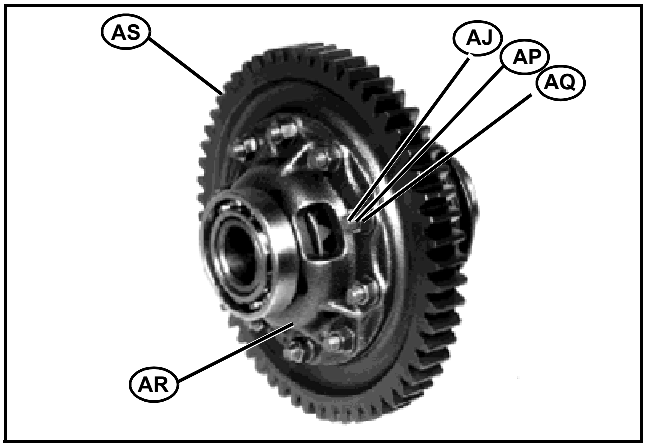
15.Install washer (AE) and bevel side gear (AF) into other housing half (AR).



M82441

16.Place final drive gear (AS) on differential housing half (AN).

17.Install bevel pinion shaft (AI) with pinion gears (AH) and washers (AG).

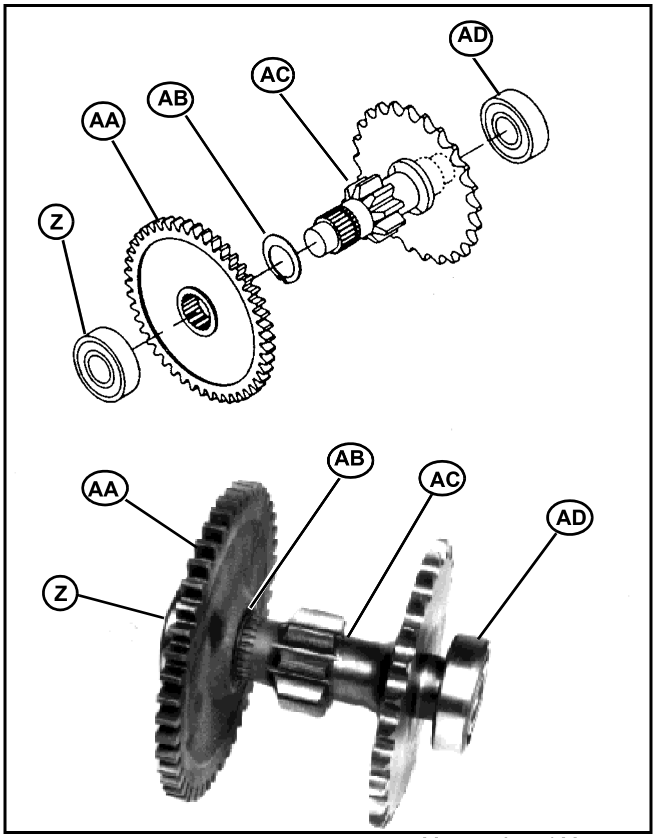


M82442

18.Place other differential housing half (AR) on final drive gear (AS).

IMPORTANT: Avoid damage! Use new cap screws (AJ), lock washers (AQ), and nuts (AP) to secure differential halves. Locking strength of existing hardware is lost when removed. Reuse of existing hardware will result in damage to differential assembly.

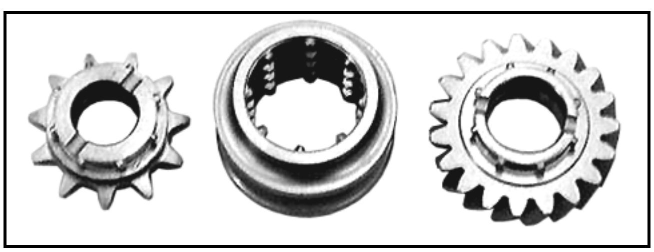
19.Install ten new cap screws, washers and nuts. Tighten nuts to 27 N•m (20 lb-ft).



M82432A and M82443

20.Install snap ring (AB) and forward secondary gear (AA) with shoulder facing snap ring.

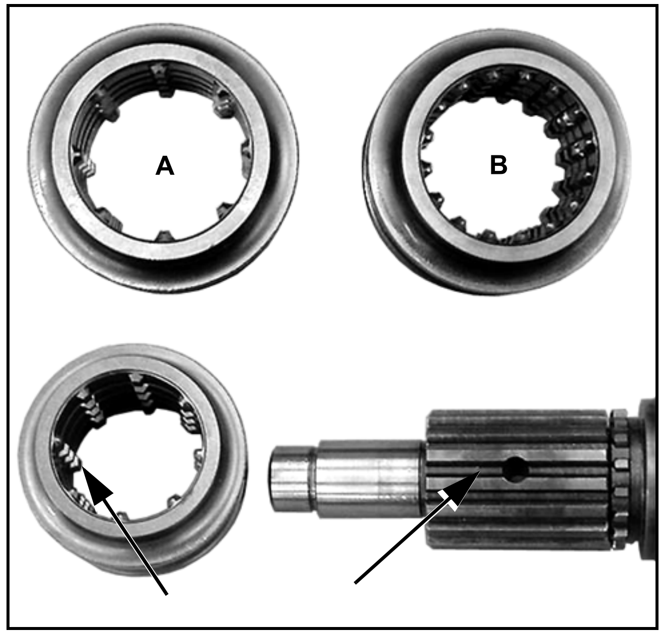
21.Press bearings (Z, AD) tight against shoulders of secondary shaft (AC).



MX1384

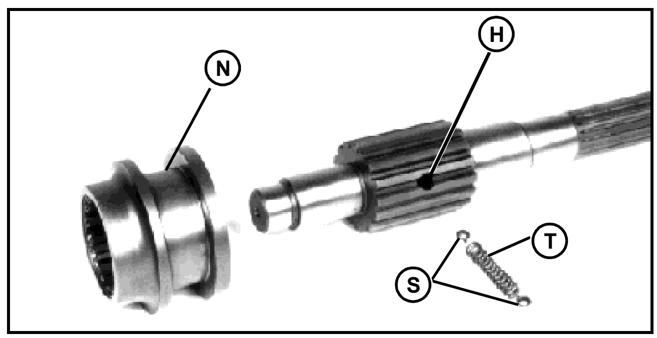
22.Reverse drive sprocket, 8-tooth shift collar, and forward drive gear.

IMPORTANT: Avoid damage! Later production transaxles changed from a sixteen tooth splined shift collar to an eight tooth splined shift collar, forward gear and reverse gear. One of the splines in the eight tooth collar must engage the groove in the input shaft that has the detent spring and balls. If not, unintended disengagement of the transaxle may occur.



MX1382 and MX1383

23.8-Tooth Collar (Shown on left): Ensure one of the splines in the shift collar engages the input shaft spline groove with the detent spring hole.



MX1383 and M82444

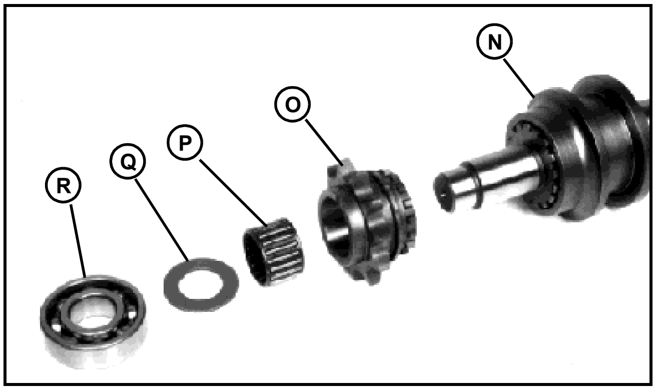
24.Apply multipurpose grease to balls (S) and spring (T).

25.Insert spring and balls into hole in input shaft (H).

26.Install shift collar (N) with shoulder toward short end of input shaft (H).

NOTE: Spline tooth on 8-tooth collar should push detent ball into shaft hole to create detent action.

27.Move shift collar to “neutral” position.



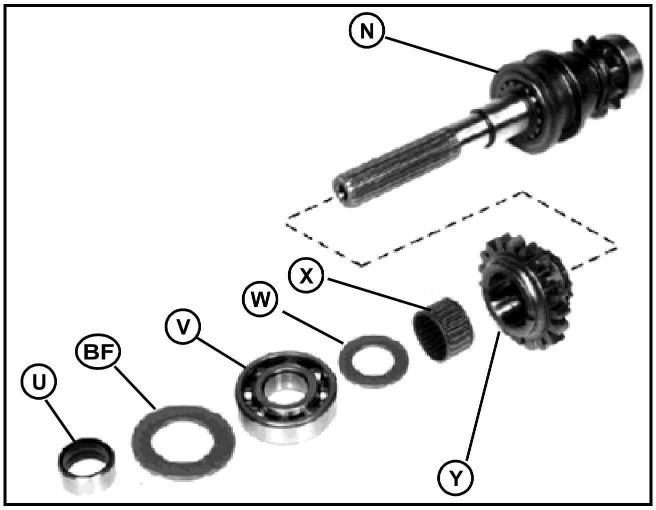
M82445

28.Install reverse drive sprocket (O) onto short end of input shaft with shift splines facing shift collar (N).

29.Install needle bearing (P) inside gear.

30.Install washer (Q) tight against shoulder of shaft.

31.Press bearing (R) tight against washer.



M82446

32.Install forward drive gear (Y) onto long end of input shaft with shift splines facing shift collar (N).

33.Install needle bearing (X) inside gear.

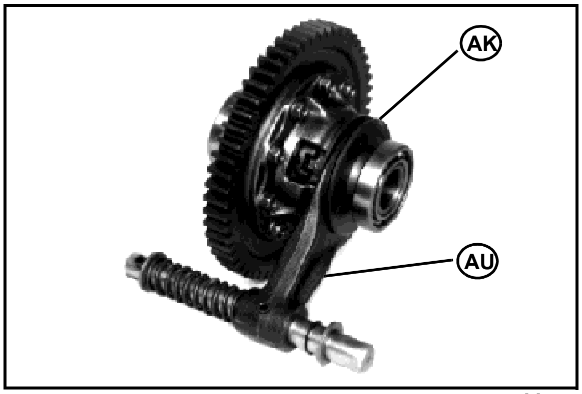
34.Install ID washer (W) tight against shoulder of shaft.

35.Press bearing (V) tight against washer using a piece of pipe and a press.

36.Install OD washer (BF) tight against bearing.

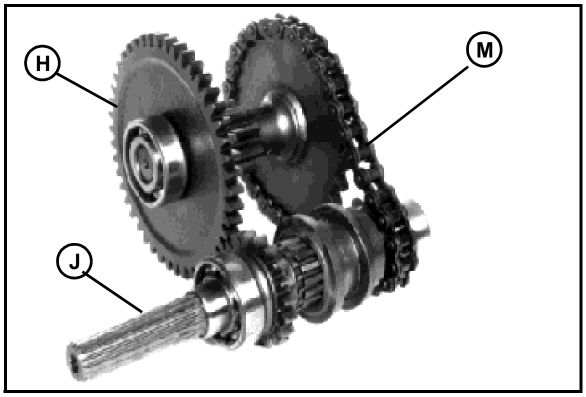
37.Apply multipurpose grease to inside diameter of sleeve and on input shaft.

38.Press sleeve (U) tight against bearing using a piece of pipe and a press.



M82447

39.Assemble differential lock shaft fork (AU) into differential lock collar (AK).



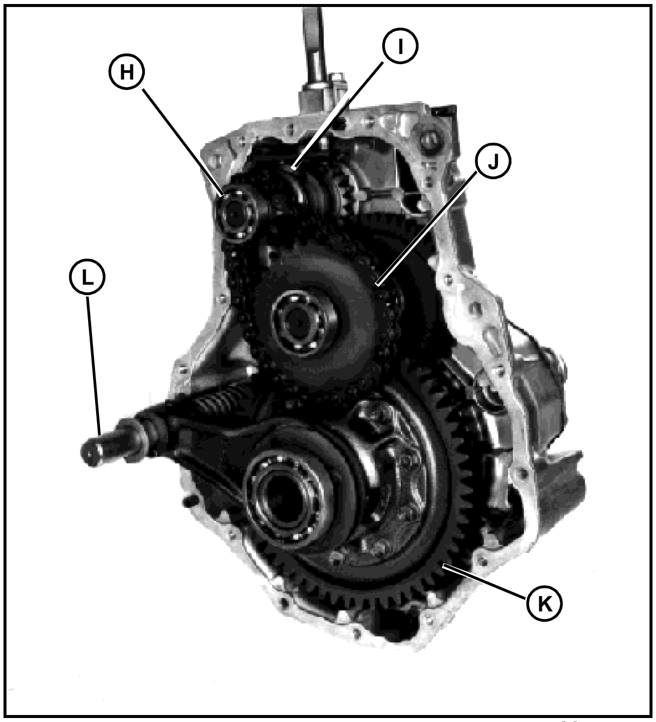
M82430

40.Assemble input shaft (J) and secondary shaft (H) with reverse drive chain (M).

NOTE: Apply multipurpose grease to input and differential lock shafts to avoid damaging seal lips.

41.Apply multipurpose grease to splined end of input shaft.

42.Align shifter block with groove in shift collar and install input shaft and secondary shaft together as an assembly.



M82429

43.Lift input shaft (H) and secondary shaft (J) to seat into bearing bores, and then install differential (K) and differential lock shaft (L) together as an assembly.

44.Tap on end of shafts and differential with a rubber mallet to seat bearings.

45.Clean mating surfaces of transaxle case halves using Clean and Cure Primer. Apply a coat of John Deere Plastic Gasket, or an equivalent, to case halves.

46.Apply multipurpose grease to end of differential lock shaft.

IMPORTANT: Avoid damage! Allow sealant to cure at least 30 minutes before filling transaxle with oil.

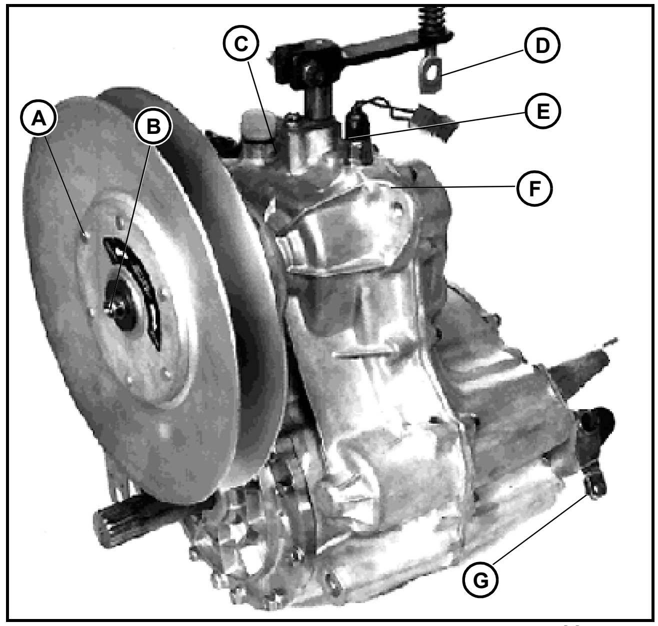
47.Assemble case halves. Install sixteen cap screws and tighten to specification.

48.Install:

- Dipstick and O-ring (C).
- Spacer (E) and gear shift lever (D). Tighten nut.
- Neutral start switch (F) and new O-ring. Tighten to 39 N•m (29 lb-ft).
- Differential lock lever bracket (G) and cap screws.

49.Apply Moly High Temperature EP Grease, or an equivalent, to splines of transaxle input shaft, before installing secondary clutch.

NOTE: Secondary clutch mounting cap screw (B) has left-hand threads. Install new bolt or apply medium strength Thread Lock and Sealer.



M82428

50.Install secondary clutch (A).

NOTE: *Secondary clutch mounting cap screw (B) has left-hand threads. Install new bolt or apply medium strength Thread Lock and Sealer.*

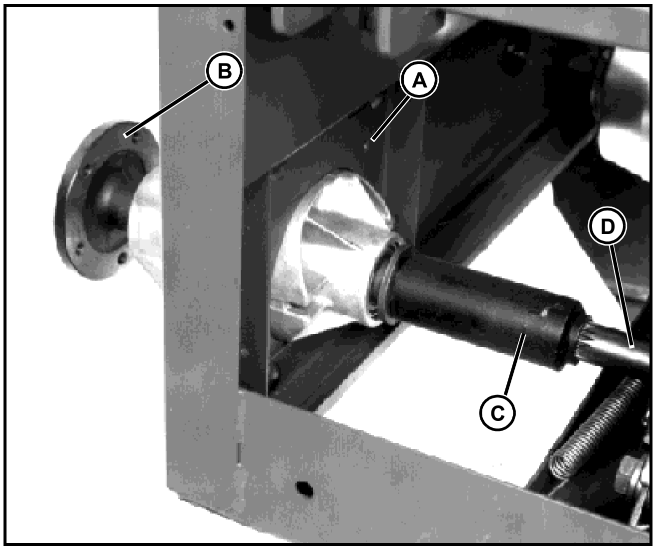
51.Install bushing and cap screw (B). Hold clutch with a strap wrench and tighten cap screw to specification.

Cap Screw Torque Specification:

8 mm Left-hand thread . . . . 38 N•m (28 lb-ft)

10 mm Right-hand thread . . . . 70 N•m (52 lb-ft)

Drive Axle Removal and Installation - 4X2



M82415

1. Jack frame and remove rear wheel and tire.

NOTE: See "Drive Axle Assembly - 4X2" on page 530 for removal and disassembly parts assemblies.

2. Remove four lock nuts and carriage bolts (A).

3. Pull drive axle assembly (B) and drive coupler (C) from transaxle shaft (D).

4. Installation is done in the reverse order of removal.

- Apply Moly High Temperature EP Grease, or an equivalent, to splines of transaxle output shaft.
- Install four carriage bolts and lock nuts, and tighten to specification.
- Install rear wheels with tire stem toward outside of machine. Tighten rear wheel mounting cap screws to specification.

Specifications:

Axle Housing Carriage Bolts	**90 N•m (67 lb-ft)**
Rear Wheel Mounting Cap Screws . . .	**88 N•m (65 lb-ft)**

Drive Axle Disassembly - 4X2

1. Remove splined coupler from end of axle shaft if coupler remained with shaft when removed.

2. Remove snap ring, washer or spacer, and hub (early models only), from end of axle shaft.

NOTE: Bearings are press fit on shaft and in housing. Remove bearings only if replacement is necessary. Do not reuse bearings.

3. Remove axle from axle housing using a soft-faced mallet.

4. Inspect bearings for wear or damage. Replace if necessary.

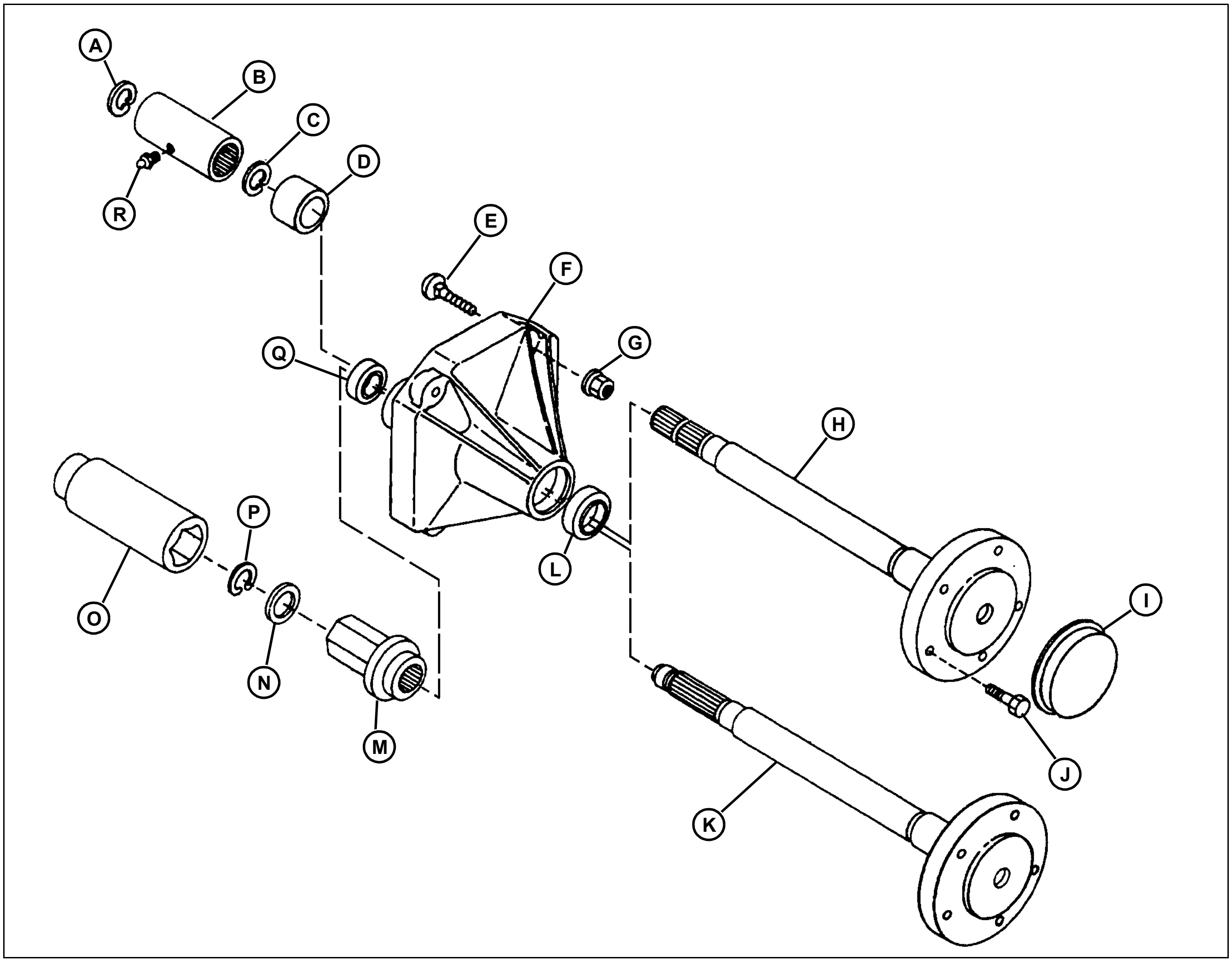
5. To replace large outside bearing:
   - Remove bearing from axle shaft using a knife-edge puller and a press.
   - Install bearing in axle housing using a driver set, only pressing on inside race of bearing.

6. To replace small bearing:
   - Replace bearing using a driver set.

Assembly is done in reverse order of disassembly.

- The small bearing may unseat from housing bore during axle installation. Install small bearing into housing bore using a piece of pipe and a hammer. Apply force on inner race of bearing only.
- Apply Moly High Temperature EP Grease, or an equivalent, to splines of axle shaft before installing secondary coupler.

Drive Axle Assembly - 4X2



M76918

A - Washer
B - Splined Coupler, S/N KANZAKA005149-
C - Snap Ring
D - Spacer
E - Carriage Bolt
F - Axle Housing
G - Flanged Lock Nut, M12 (90 N•m [67 lb-ft])
H - Axle Shaft, S/N KANZAKA005149-
I - Cap
J - Wheel Mounting Bolt (88 N•m [65 lb-ft])
K - Axle Shaft, S/N -KANZAKA005148
L - Outer Bearing (Large)
M - Hub, S/N -KANZAKA005148
N - Washer
O - Coupler, S/N -KANZAKA005148
P - Snap Ring
Q - Inner Bearing (Small)
R - Grease Fitting

Drive Axle Removal and Installation - 6X4

NOTE: See "Drive Axle Assembly - 6X4" on page 532 for removal and disassembly parts assemblies.

1. Lift cargo box and remove master link from drive chain on the axle being serviced. Remove drive chain from axle sprockets.

2. Jack frame and remove tire and wheel from axle being serviced.

3. Remove four carriage head bolts and flange nuts holding axle housing to frame. Remove axle and sprocket assembly from machine.

Installation:

Installation is in reverse of removal.

- Apply Moly High Temperature EP Grease, or an equivalent, to splines of transaxle output shaft.
- Align splines of coupler on front axle with splines of transaxle output shaft.
- Tighten axle housing mounting bolts to 90 N•m (67 lb-ft.).
- Install drive chain around axle sprockets and install master link.
- Install wheels and tires. Tighten wheel mounting cap screws to 88 N•m (65 lb-ft).
- Adjust drive chain tension. See "Drive Chain Adjustment - 6X4'S" on page 516.

Drive Axle Disassembly - 6X4

1. Remove splined coupler from end of axle shaft if coupler remained with shaft when removed.

2. Remove snap ring, washer or spacer, and hub (early models only), from end of axle shaft.

NOTE: Bearings are press fit on shaft and in housing. Remove bearings only if replacement is necessary. Do not reuse bearings.

3. Remove axle from axle housing using a soft-faced mallet.

4. Inspect bearings for wear or damage. Replace if necessary.

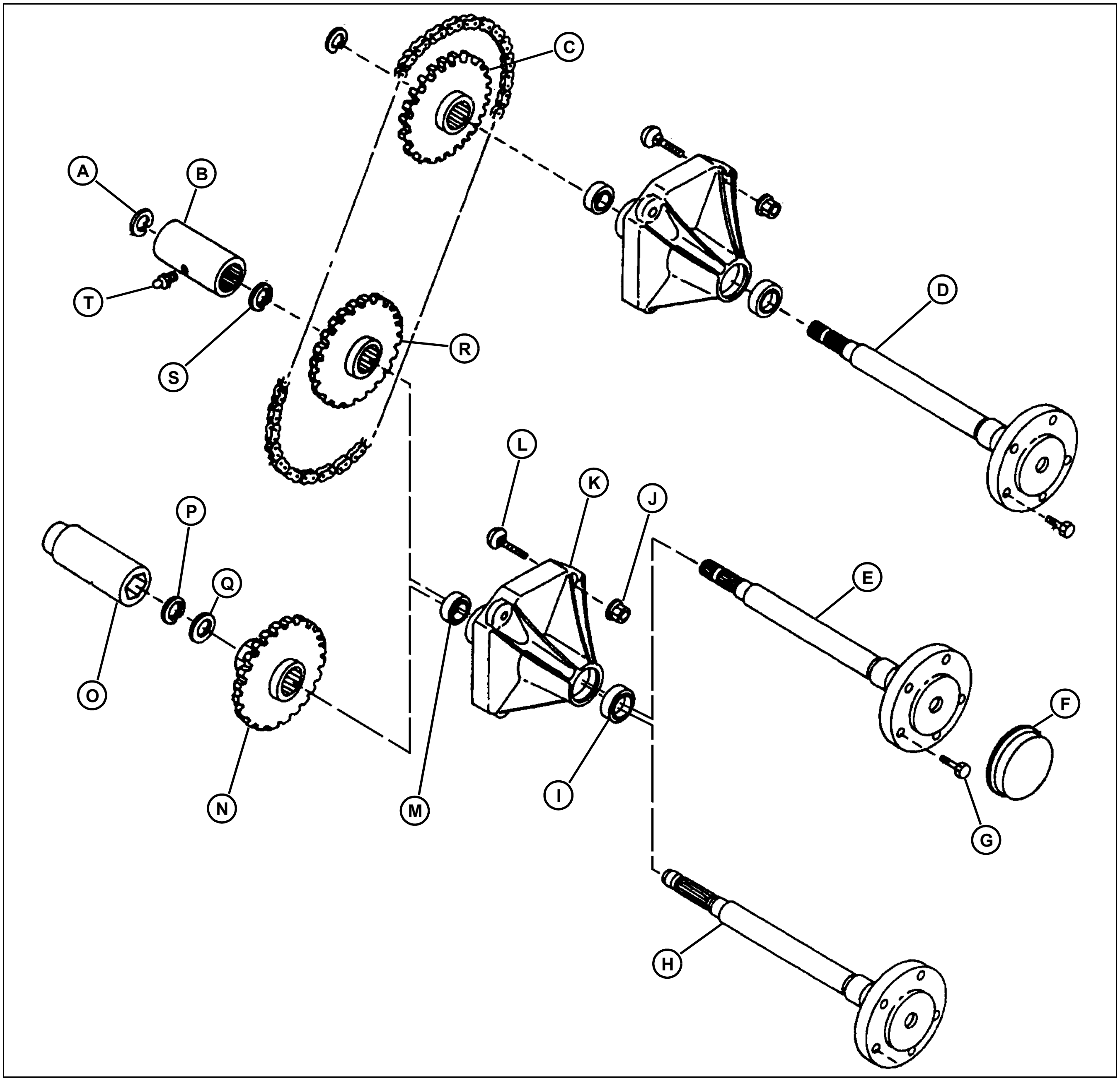
5. To replace large outside bearing:
    - Remove bearing from axle shaft using a knife-edge puller and a press.
    - Install bearing in axle housing using a driver set, only pressing on inside race of bearing.

6. To replace small bearing:
    - Replace bearing using a driver set.

Assembly is done in reverse order of disassembly.

- The small bearing may unseat from housing bore during axle installation. Install small bearing into housing bore using a piece of pipe and a hammer. Apply force on inner race of bearing only.
- Apply Moly High Temperature EP Grease, or an equivalent, to splines of axle shaft before installing secondary coupler.
- Tighten M12 flanged nuts (10) securing axle housing to frame to 90 N•m (67 lb-ft).

Drive Axle Assembly - 6X4



M76919

A - Snap Ring
B - Splined Coupler, S/N KANZAK005788-
C - Chain Sprocket, S/N KANZAK005788-
D - Axle Shaft, S/N KANZAK005788-
E - Axle Shaft, S/N KANZAK005788-
F - Cap
G - Wheel Mounting Bolt
H - Axle Shaft, S/N -KANZAK005787
I - Outer Bearing (Large)
J - Flanged Lock Nut, M12
K - Axle Housing
L - Carriage Bolt
M - Inner Bearing (Small)
N - Chain Sprocket, S/N -KANZAK005787
O - Coupler, S/N -KANZAK005787
P - Snap Ring, S/N -KANZAK005787
Q - Washer, S/N KANZAK005788-
R - Chain Sprocket, S/N KANZAK005788-
S - Snap Ring, S/N KANZAK005788-
T - Grease Fitting

Table of Contents

STEERING SPECIFICATIONS

Specifications

Service and Adjustment Specifications

Lubrication Interval:

Spindle Grease Fitting and Kingpin . . . . Every 25 hours (severe conditions)
. . . . . Every 50 hours (normal conditions)

Toe-In Adjustment

Front-to-Rear Difference . . . . Front is 4 ± 3 mm (0.16 ± 0.12 in.) less than rear at axle height

Torque Specifications

Shock Absorber Lock Nuts . . . . 80 N•m (60 lb-ft)

King Pin Bolts - M10 . . . . 73 N•m (54 lb-ft)

King Pin Bolts - M12 . . . . 130 N•m (96 lb-ft)

A-Arm Assembly Lock Nuts . . . . 90 N•m (105 lb-ft)

A-Arm Spindle Cap Screws and Lock Nuts - 10 mm x 170mm Cap Screw . . . . 60 N•m (46 lb-ft)

A-Arm Spindle Cap Screws and Lock Nuts - 12 mm x 173mm Cap Screw . . . . 130 N•m (95 lb-ft)

Rack and Pinion Assembly Lock Nuts . . . . 70 N•m (40 lb-ft)

Rubber Boot Assembly Tie Straps . . . . Snug Only - boot must not turn with tie rod when tie rod is adjusted

Front Wheel Bolts. . . . . 88 ± 10 N•m (65 ± 7 lb-ft)

Tie Rod Lock Nuts . . . . 50 N•m (37 lb-ft)

Tie Rod Jam Nuts . . . . 70 N•m (52 lb-ft)

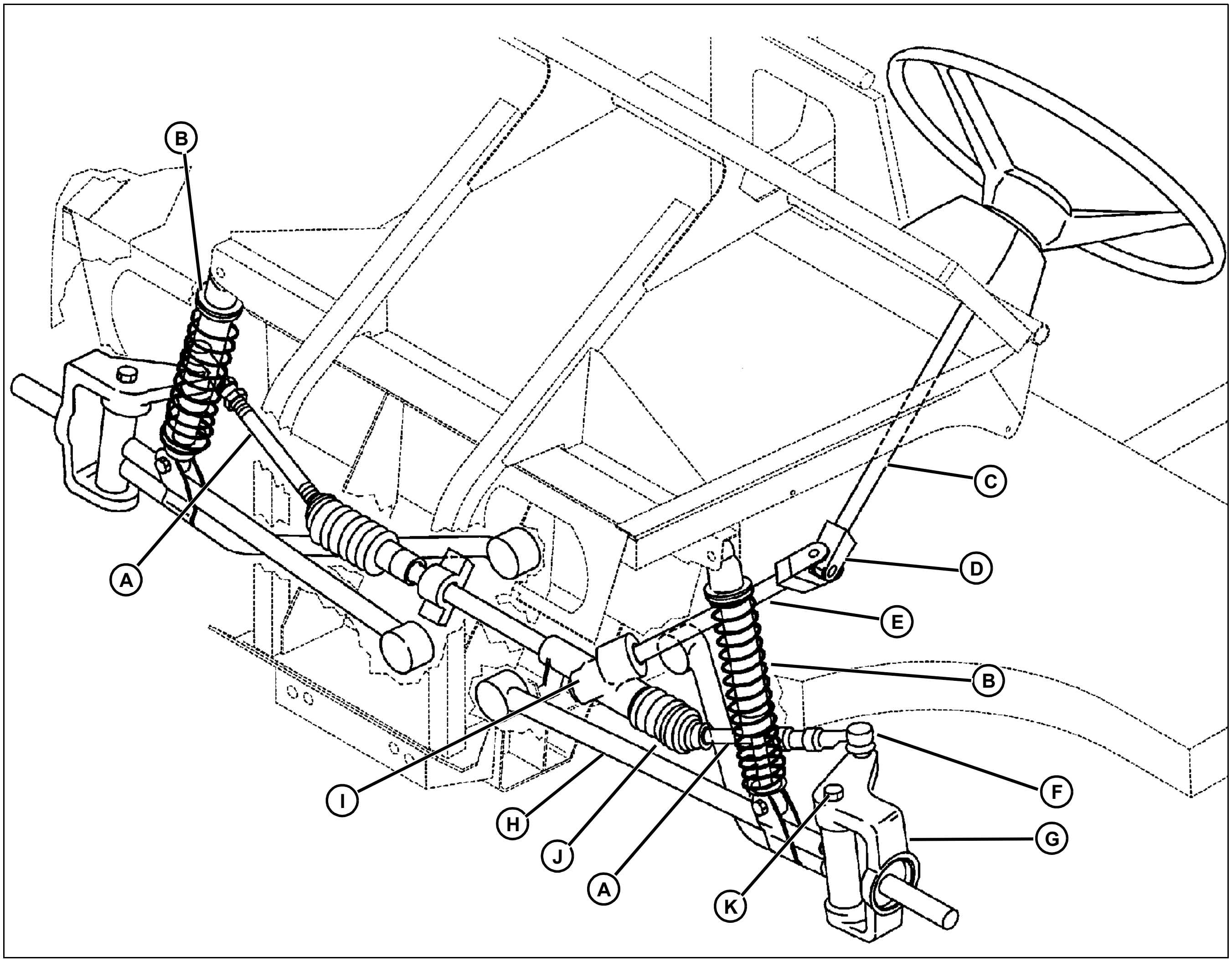
Steering Wheel Nut. . . . . 38 N•m (28 lb-ft)

Steering Shaft U-Joint Assembly Cap Screw - 8mm Cap Screw
PIN - W006X4D008595
PIN - W006X4X034505
PIN - W004X2X033953 . . . . 38 N•m (28 lb-ft)

Steering Shaft U-Joint Assembly Cap Screw - 10mm Cap Screw
PIN W006X4D008596 -
PIN W006X4X034506 -
PIN W004X2X033954 - . . . . 70 N•m (52 lb-ft)

Component Location

Steering Component Location



MX0597

A - Tie Rod
B - Shock Absorber
C - Upper Steering Shaft
D - Steering Shaft U-Joint
E - Lower Steering Shaft
F - Tie Rod End
G - Spindle Assembly
H - A-Arm
I - Rack and Pinion
J - Rubber Boot
K - King Pin Bolt

Diagnostics

Troubleshooting

Symptom: Steering pulls in one direction.

(1) Are the spindles, king pins, or king pin A-frame bearings worn?

Yes - Repair or replace as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(2) Do spindles, king pins, or king pin A-frame bearings require lubrication?

Yes - Lubricated as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(3) Is the rack and pinion assembly worn or broken?

Yes - Repair or replace as needed. See “Steering Assembly Removal and Installation” on page 546.

No - Go to next step.

(4) Are the tie rods bent or loose?

Yes - Repair or replace as needed. See “Tie Rod End Replacement” on page 545.

No - Go to next step.

(5) Is toe-in out of specification?

Yes - Adjust toe-in as needed. See “Toe-In Adjustment” on page 544.

No - Go to next step.

(6) Are wheel bearing worn or lost lubrication?

Yes - Repair or replace as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(7) Have the wrong size tire(s) been installed?

Yes - Replace with correct size tires.

No - Go to next step.

(8) Are the tires out of round or have improper air pressure?

Yes - Inflate to proper air pressure. Replace tire(s) as needed.

No - Go to next step.

Symptom: Steering pulls in one direction.

(9) Is the steering shaft to rack and pinion assembly snap ring dislodged or missing?

Yes - Install or replace as needed. See “Steering Assembly Removal and Installation” on page 546.

No - Go to next step.

(10) Are the A-arm bushings worn, or is A-arm bent?

Yes - Repair or replace as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(11) Are the shock absorber mounts bent, or have worn, loose, broken, or missing hardware?

Yes - Repair or replace as needed. See Miscellaneous Section.

No - Go to next step.

Symptom: Steering wanders.

(1) Are the spindles, king pins, or king pin A-frame bearings worn?

Yes - Repair or replace as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(2) Do spindles, king pins, or king pin A-frame bearings require lubrication?

Yes - Lubricated as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(3) Is the rack and pinion assembly worn or broken?

Yes - Repair or replace as needed. See “Steering Assembly Removal and Installation” on page 546.

No - Go to next step.

(4) Are the tie rods bent or loose?

Yes - Repair or replace as needed. See “Tie Rod End Replacement” on page 545.

No - Go to next step.

(5) Is toe-in out of specification?

Yes - Adjust toe-in as needed. See “Toe-In Adjustment” on page 544.

No - Go to next step.

Symptom: Steering wanders.

(6) Is the steering shaft u-joint worn or cap screw loose?

Yes - Repair or replace as needed. See "Steering Wheel and Shaft Removal and Installation" on page 545.

No - Go to next step.

(7) Are wheel bearing worn or lost lubrication?

Yes - Repair or replace as needed. See "Spindle Shaft and Bushing Removal and Installation" on page 546.

No - Go to next step.

(8) Have the wrong size tire(s) been installed?

Yes - Replace with correct size tires.

No - Go to next step.

(9) Are the tires out of round or have improper air pressure?

Yes - Inflate to proper air pressure. Replace tire(s) as needed.

No - Go to next step.

(10) Are the steering wheel or shaft splines worn or stripped?

Yes - Repair or replace as needed. See "Steering Wheel and Shaft Removal and Installation" on page 545.

No - Go to next step.

(11) Is the steering wheel nut loose, stripped, or missing?

Yes - Tighten or replace as needed. See "Steering Wheel and Shaft Removal and Installation" on page 545.

No - Go to next step.

(12) Is the steering shaft to rack and pinion assembly snap ring dislodged or missing?

Yes - Install or replace as needed. See "Steering Assembly Removal and Installation" on page 546.

No - Go to next step.

(13) Are the A-arm bushings worn, or is A-arm bent?

Yes - Repair or replace as needed. See "Spindle Shaft and Bushing Removal and Installation" on page 546.

No - Go to next step.

Symptom: Steering wanders.

(14) Are the shock absorber mounts bent, or have worn, loose, broken, or missing hardware?

Yes - Repair or replace as needed. See Miscellaneous Section.

No - Go to next step.

Symptom: Steering shimmies or vibrates.

(1) Are the spindles, king pins, or king pin A-frame bearings worn?

Yes - Repair or replace as needed. See "Spindle Shaft and Bushing Removal and Installation" on page 546.

No - Go to next step.

(2) Do spindles, king pins, or king pin A-frame bearings require lubrication?

Yes - Lubricated as needed. See "Spindle Shaft and Bushing Removal and Installation" on page 546.

No - Go to next step.

(3) Is the rack and pinion assembly worn or broken?

Yes - Repair or replace as needed. See "Steering Assembly Removal and Installation" on page 546.

No - Go to next step.

(4) Are the tie rods bent or loose?

Yes - Repair or replace as needed. See "Tie Rod End Replacement" on page 545.

No - Go to next step.

(5) Is toe-in out of specification?

Yes - Adjust toe-in as needed. See "Toe-In Adjustment" on page 544.

No - Go to next step.

(6) Are wheel bearing worn or lost lubrication?

Yes - Repair or replace as needed. See "Spindle Shaft and Bushing Removal and Installation" on page 546.

No - Go to next step.

(7) Have the wrong size tire(s) been installed?

Yes - Replace with correct size tires.

No - Go to next step.

(8) Are the tires out of round or have improper air pressure?

Symptom: Steering shimmies or vibrates.

Yes - Inflate to proper air pressure. Replace tire(s) as needed.

No - Go to next step.

(9) Is the steering shaft to rack and pinion assembly snap ring dislodged or missing?

Yes - Install or replace as needed. See “Steering Assembly Removal and Installation” on page 546.

No - Go to next step.

(10) Are the A-arm bushings worn, or is A-arm bent?

Yes - Repair or replace as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(11) Do shock absorbers have leaks or broken springs?

Yes - Repair or replace as needed. See Miscellaneous Section.

No - Go to next step.

(12) Are the shock absorber mounts bent, or have worn, loose, broken, or missing hardware?

Yes - Repair or replace as needed. See Miscellaneous Section.

No - Go to next step.

Symptom: Wheel bearing noise.

(1) Are wheel bearing worn or lost lubrication?

Yes - Repair or replace as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

Symptom: Steering hard left or right or both.

(1) Are the spindles, king pins, or king pin A-frame bearings worn?

Yes - Repair or replace as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(2) Do spindles, king pins, or king pin A-frame bearings require lubrication?

Yes - Lubricated as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

Symptom: Steering hard left or right or both.

No - Go to next step.

(3) Is the rack and pinion assembly worn or broken?

Yes - Repair or replace as needed. See “Steering Assembly Removal and Installation” on page 546.

No - Go to next step.

(4) Are the tie rods bent or loose?

Yes - Repair or replace as needed. See “Tie Rod End Replacement” on page 545.

No - Go to next step.

(5) Is toe-in out of specification?

Yes - Adjust toe-in as needed. See “Toe-In Adjustment” on page 544.

No - Go to next step.

(6) Are wheel bearing worn or lost lubrication?

Yes - Repair or replace as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(7) Have the wrong size tire(s) been installed?

Yes - Replace with correct size tires.

No - Go to next step.

(8) Are the tires out of round or have improper air pressure?

Yes - Inflate to proper air pressure. Replace tire(s) as needed.

No - Go to next step.

(9) Are the steering wheel or shaft splines worn or stripped?

Yes - Repair or replace as needed. See “Steering Wheel and Shaft Removal and Installation” on page 545.

No - Go to next step.

(10) Is the steering shaft to rack and pinion assembly snap ring dislodged or missing?

Yes - Install or replace as needed. See “Steering Assembly Removal and Installation” on page 546.

No - Go to next step.

(11) Is the rubber boot cracked or torn?

Yes - Replace as needed. See “Steering Assembly Removal and Installation” on page 546.

Symptom: Steering hard left or right or both.

No - Go to next step.

Symptom: Steering locks in hard left or right turn.

(1) Are the spindles, king pins, or king pin A-frame bearings worn?

Yes - Repair or replace as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(2) Do spindles, king pins, or king pin A-frame bearings require lubrication?

Yes - Lubricated as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(3) Is the rack and pinion assembly worn or broken?

Yes - Repair or replace as needed. See “Steering Assembly Removal and Installation” on page 546.

No - Go to next step.

(4) Are the tie rods bent or loose?

Yes - Repair or replace as needed. See “Tie Rod End Replacement” on page 545.

No - Go to next step.

(5) Is toe-in out of specification?

Yes - Adjust toe-in as needed. See “Toe-In Adjustment” on page 544.

No - Go to next step.

(6) Is the steering shaft to rack and pinion assembly snap ring dislodged or missing?

Yes - Install or replace as needed. See “Steering Assembly Removal and Installation” on page 546.

No - Go to next step.

(7) Is the rubber boot cracked or torn?

Yes - Replace as needed. See “Steering Assembly Removal and Installation” on page 546.

No - Go to next step.

Symptom: Steering wheel pulls upward.

(1) Is the steering shaft u-joint worn or cap screw loose?

Symptom: Steering wheel pulls upward.

Yes - Repair or replace as needed. See “Steering Wheel and Shaft Removal and Installation” on page 545.

No - Go to next step.

(2) Is the steering wheel nut loose, stripped, or missing?

Yes - Tighten or replace as needed. See “Steering Wheel and Shaft Removal and Installation” on page 545.

No - Go to next step.

(3) Is the steering shaft to rack and pinion assembly snap ring dislodged or missing?

Yes - Install or replace as needed. See “Steering Assembly Removal and Installation” on page 546.

No - Go to next step.

Symptom: Steering wheel spins freely.

(1) Is the rack and pinion assembly worn or broken?

Yes - Repair or replace as needed. See “Steering Assembly Removal and Installation” on page 546.

No - Go to next step.

(2) Is the steering shaft u-joint worn or cap screw loose?

Yes - Repair or replace as needed. See “Steering Wheel and Shaft Removal and Installation” on page 545.

No - Go to next step.

(3) Are the steering wheel or shaft splines worn or stripped?

Yes - Repair or replace as needed. See “Steering Wheel and Shaft Removal and Installation” on page 545.

No - Go to next step.

(4) Is the steering wheel nut loose, stripped, or missing?

Yes - Tighten or replace as needed. See “Steering Wheel and Shaft Removal and Installation” on page 545.

No - Go to next step.

(5) Is the steering shaft to rack and pinion assembly snap ring dislodged or missing?

Symptom: Steering wheel spins freely.

Yes - Install or replace as needed. See “Steering Assembly Removal and Installation” on page 546.

No - Go to next step.

Symptom: Noise during turns or over rough terrain.

(1) Are the spindles, king pins, or king pin A-frame bearings worn?

Yes - Repair or replace as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(2) Do spindles, king pins, or king pin A-frame bearings require lubrication?

Yes - Lubricated as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(3) Is the rack and pinion assembly worn or broken?

Yes - Repair or replace as needed. See “Steering Assembly Removal and Installation” on page 546.

No - Go to next step.

(4) Are the tie rods bent or loose?

Yes - Repair or replace as needed. See “Tie Rod End Replacement” on page 545.

No - Go to next step.

(5) Is toe-in out of specification?

Yes - Adjust toe-in as needed. See “Toe-In Adjustment” on page 544.

No - Go to next step.

(6) Is the steering shaft u-joint worn or cap screw loose?

Yes - Repair or replace as needed. See “Steering Wheel and Shaft Removal and Installation” on page 545.

No - Go to next step.

(7) Are wheel bearing worn or lost lubrication?

Yes - Repair or replace as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(8) Is the rubber boot cracked or torn?

Symptom: Noise during turns or over rough terrain.

Yes - Replace as needed. See “Steering Assembly Removal and Installation” on page 546.

No - Go to next step.

(9) Are the A-arm bushings worn, or is A-arm bent?

Yes - Repair or replace as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(10) Do shock absorbers have leaks or broken springs?

Yes - Repair or replace as needed. See Miscellaneous Section.

No - Go to next step.

(11) Are the shock absorber mounts bent, or have worn, loose, broken, or missing hardware?

Yes - Repair or replace as needed. See Miscellaneous Section.

No - Go to next step.

(12) Are the shock absorber installed upside down?

Yes - Install in proper direction. See Miscellaneous Section.

No - Go to next step.

Symptom: Front steering suspension weak or unstable.

(1) Are the A-arm bushings worn, or is A-arm bent?

Yes - Repair or replace as needed. See “Spindle Shaft and Bushing Removal and Installation” on page 546.

No - Go to next step.

(2) Do shock absorbers have leaks or broken springs?

Yes - Repair or replace as needed. See Miscellaneous Section.

No - Go to next step.

(3) Are the shock absorber mounts bent, or have worn, loose, broken, or missing hardware?

Yes - Repair or replace as needed. See Miscellaneous Section.

Symptom: Front steering suspension weak or unstable.

No - Go to next step.

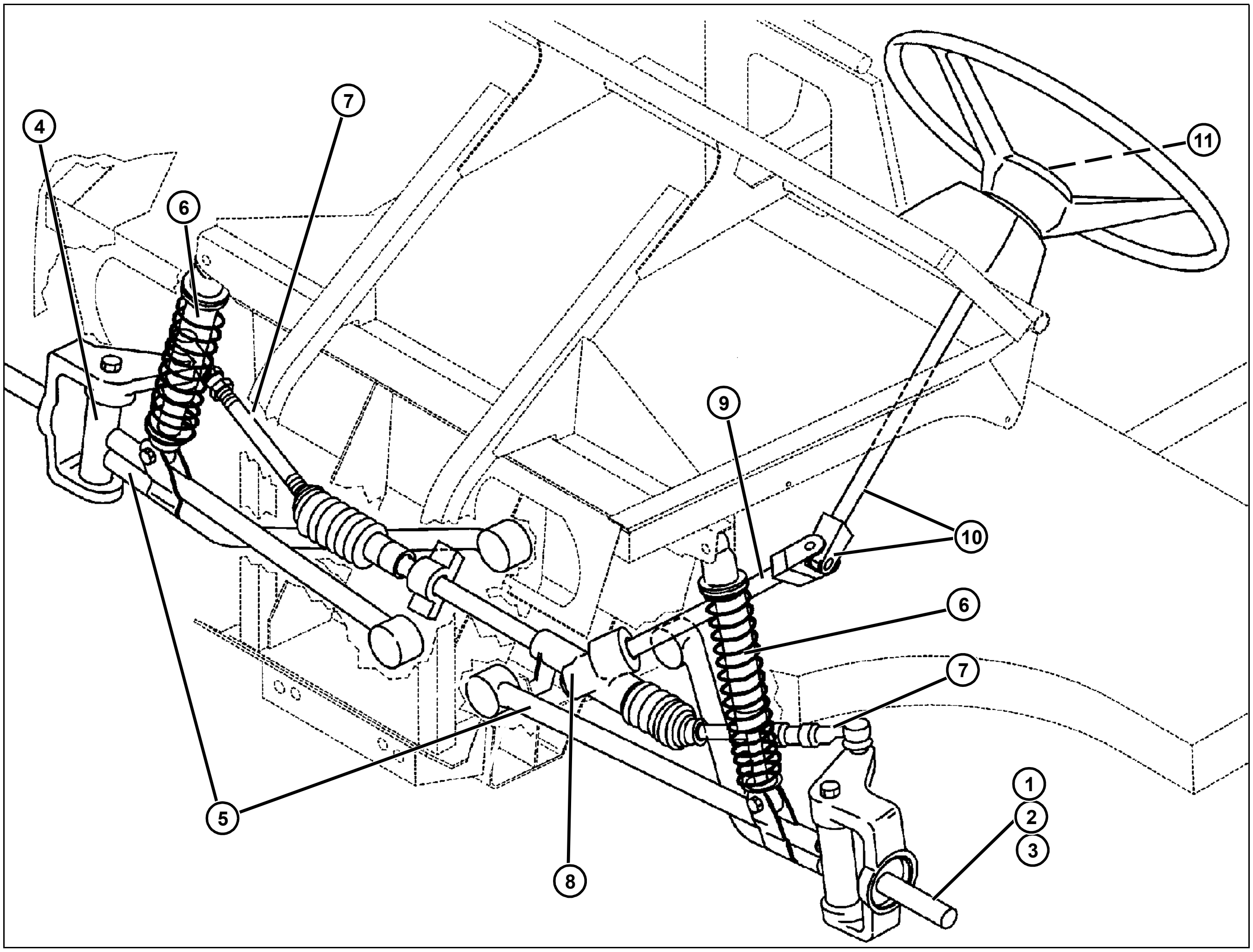
(4) Are the shock absorber installed upside down?

Yes - Install in proper direction. See Miscellaneous Section.

No - Go to next step.

Steering Troubleshooting Test Points

Test/Check Point	Normal	If Not Normal
1. Rims	Runout less than 3 mm (0.12 in.)	Replace rims.
	Wheel bolts tight	Tighten to specification.
2. Tires	Runout less than 10 mm (0.4 in.)	Remount or replace tires.
	Tires properly inflated	Inflate tires to proper pressure.
3. Wheel bearings and bushings	Wheels rotate freely without rough spots	Replace rims.
4. Spindle and kingpin assemblies	Assemblies tight and turn smoothly	Tighten assemblies.
	King pins properly greased	Replace assemblies.
		Grease.
5. A-arm assemblies	Fastened securely	Tighten lock nuts to 90 N•m (66 lb-ft).
	Assemblies not bent	Replace A-arm assemblies.
	Pivot bushing not worn or binding	Replace bushings.
6. Shock absorbers	Installed and tightened properly	Tighten lock nuts to specification.
	Operate smoothly and not leaking	Replace shock absorbers.
7. Tie rods and tie rod ends	Jam nuts tight, tie rod ends tight, and toe-in adjusted properly	Adjust toe-in and tighten jam nuts to 70 N•m (52 lb-ft) and lock nuts to 50 N•m (37 lb-ft).
	Tie rods straight, not worn	Replace components as necessary.
8. Rack 'n' pinion assembly	Assembly fastened securely	Tighten assembly to 70 N•m (52 lb-ft).
	Operates from stop-to-stop smoothly with little effort	Replace assembly.
9. Lower steering shaft	Fastened securely to rack 'n' pinion assembly	Fasten securely.
	Straight	Replace shaft.
10. Upper steering shaft and U-joint	U-joint fastened securely	Tighten U-joint cap screw to specification.
	Operates smoothly. Shaft splines good	Replace upper steering shaft and U-joint.
11. Steering wheel and leaping deer emblem	Installed properly, nut snug	Install and tighten properly.
	No cracks or breaks, splines good	Replace components as necessary.



MX0597

Tests and Adjustments

Toe-In Adjustment

Reason:

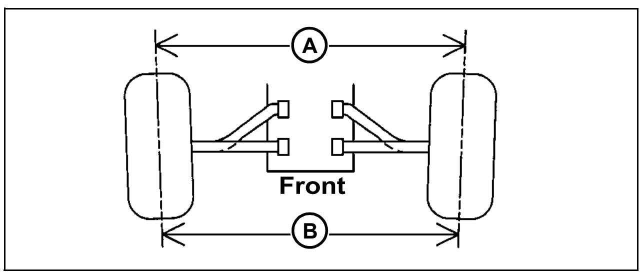
To prevent tire wear and steering wander.

Test Procedure:

1. Park machine safely with park brake locked.

NOTE: Toe-in cannot be correctly adjusted with the front wheels off the surface, an uneven surface, or any weight or load on machine.

2. Turn steering wheel until front drivers-side tire aligns with drivers-side rear tire(s). Use straight 2 x 4 or piece of angle iron for guide.



M55739

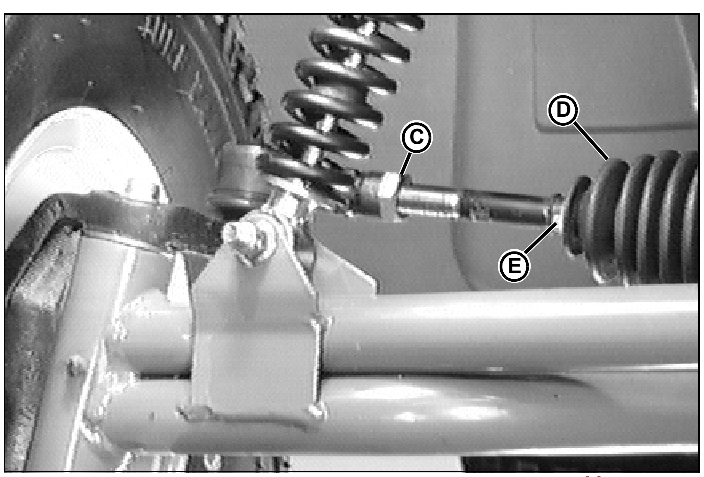
Picture Note: Viewed from top down.

3. At hub height and center of tire tread, measure rear distance (A) and front distance (B).

4. Compare measurement to specification.

Front-to-Rear
Difference . . . . Front is 4 ± 3 mm
. . . . . (0.16 ± 0.12 in.) less than rear.

Adjustment Procedure:



M56351

Picture Note: Right side shown.

1. Loosen jam nut (C).

NOTE: The rubber boot (D) may turn with the tie rod if boot clamp (E) is too tight. If this happens, loosen clamp enough to allow the rubber boot to remain stationary.

2. Turn tie rod until front to rear measurement is within specification.

3. Tighten jam nut.

Front-to-Rear
Difference . . . . Front is 4 ± 3 mm
. . . . . (0.16 ± 0.12 in.) less than rear

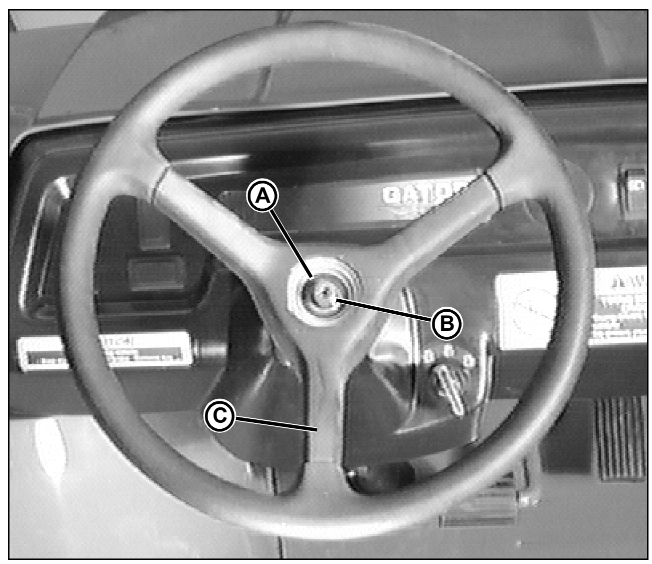
Steering Wheel Adjustment

Reason:

To position steering wheel properly.

Procedure:

1. Park machine safely with park brake locked.
2. Turn steering wheel to right or left steering stop.
3. Turn wheel to other stop while counting number of turns.
4. Turn wheel back 1/2 of total turns counted.



M56396

5. Proper position of steering wheel is as shown with spokes at approximately 2, 6, and 10 o'clock.

6. If wheel is not correct, remove leaping deer emblem, nut (A), and washer.

7. Without moving steering shaft, remove steering wheel.

8. Align steering wheel on splines (B) so bottom spoke (C) points to 6 o'clock.

9. Install washer and nut, tighten until snug only.

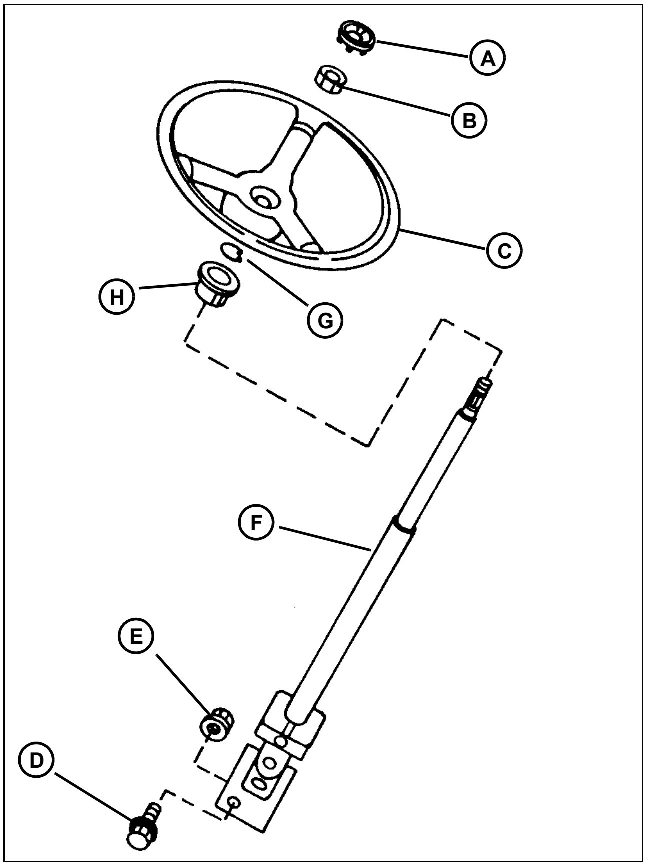
10. Install leaping deer emblem.

Repair

Steering Wheel and Shaft Removal and Installation

Removal:

1. Park machine safely with park brake locked.



M82448A

2. Remove cap (A), lock nut (B), and steering wheel (C).
3. Remove U-joint cap screw (D) and nut (E).
4. Pull up on steering shaft (F). Remove snap ring (G).
5. Remove shaft (F) and bushing (H).
6. Inspect all parts for wear or damage. Replace as necessary.

Installation:

1. Installation is done in the reverse order of removal.
2. Tighten U-joint cap screw to torque specification.

U-Joint Cap Screw Torque Specifications:

8mm Cap Screw
PIN - W006X4D008595
PIN - W006X4X034505
PIN - W004X2X033953 . . . . 40 N•m (30 lb-ft)

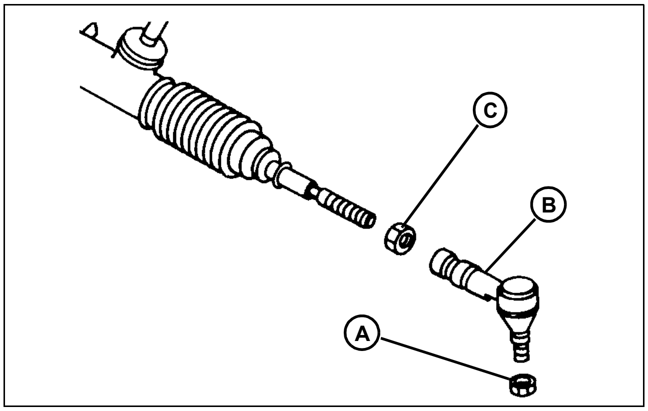
10mm Cap Screw
PIN W006X4D008596 -
PIN W006X4X034506 -
PIN W004X2X033954 - . . . . 73 N•m (54 lb-ft)

Tie Rod End Replacement

Removal:

1. Park machine safely with park brake locked.
2. Remove front wheel.

NOTE: Tie rod end is a tapered bore fit into spindle. Use a ball joint fork or puller to ease removal.



M82450A

3. Remove tie rod end lock nuts (A) and disconnect tie rod ends from spindles.
4. Remove tie rod end (B).

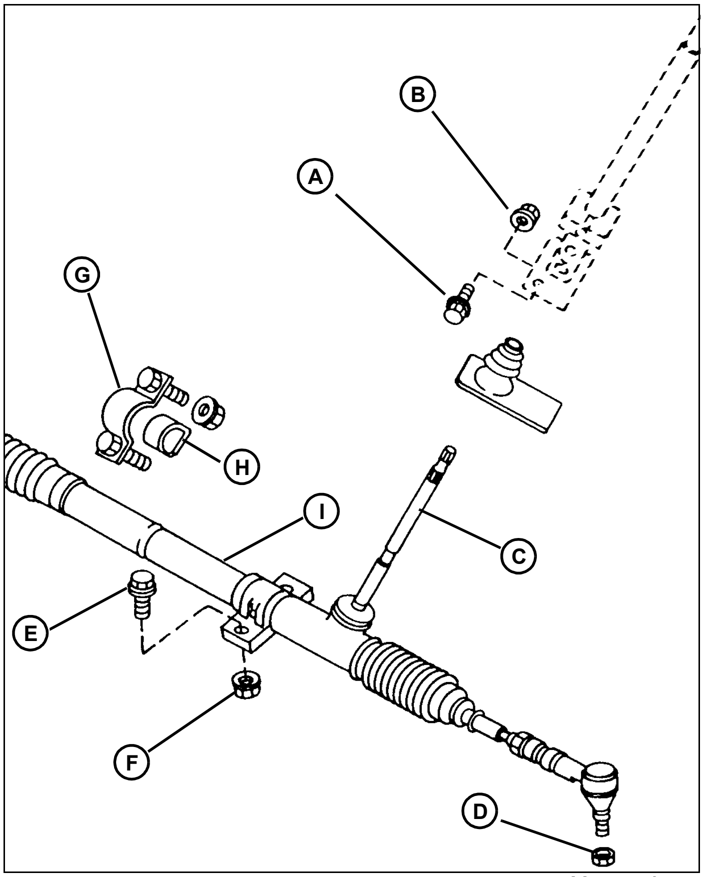
Installation:

1. Install new tie rod end. Position spindle shaft 90° to machine and turn wheel on other side to straight position.
2. Turn tie rod end until tapered end fits into arm of spindle.
3. Tighten lock nut (B) to 50 N•m (37 lb-ft).
4. Adjust toe-in.
5. Tighten jam nut (C) to 70 N•m (52 lb-ft).

Steering Assembly Removal and Installation

Removal:

1. Park machine safely with park brake locked.



M82449A

2. Remove front wheels.
3. Remove U-joint cap screw (A) and lock nut (B).
4. Pull up on steering wheel to disconnect U-joint from lower steering shaft (C).
5. Remove tie rod end lock nuts (D) and disconnect tie rod ends from spindles.
6. Remove mounting cap screws (E) and lock nuts (F).
7. Loosen the mounting bracket (G) and isolator (H).
8. Remove nine mounting screws and washers from left-hand fender.
9. Remove steering assembly (I) from left-hand side of machine.
10. Inspect all parts for wear or damage. Replace as necessary.

Installation:

1. Installation is done in the reverse order of removal.
2. Adjust toe-in.
3. Tighten cap screws to specification.

Torque Specifications:

Tie Rod End Lock Nut . . . . 50 N•m (37 lb-ft)

U-Joint Cap Screw - 8 mm . . . . 38 N•m (28 lb-ft)

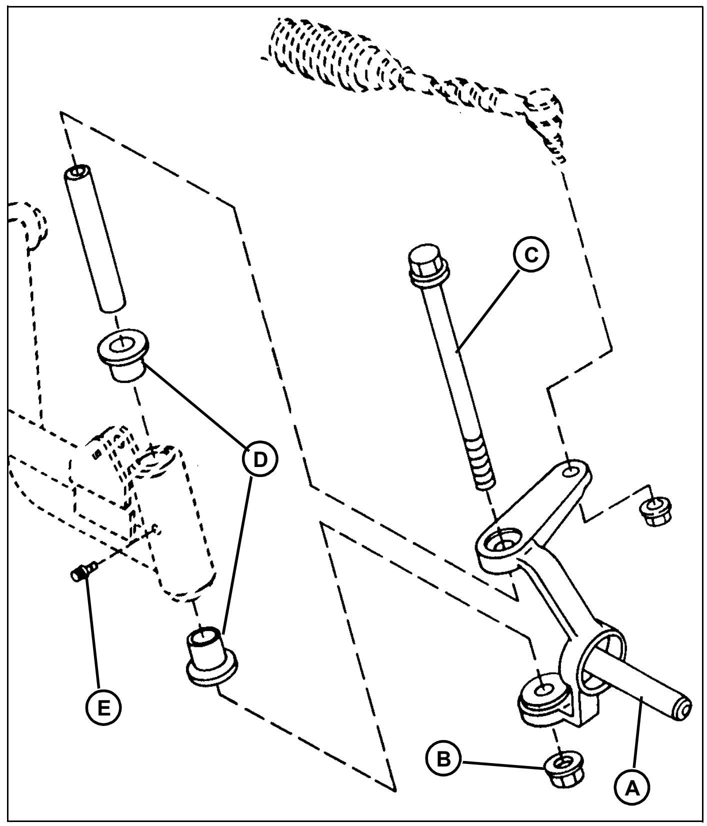
U-Joint Cap Screw - 10 mm . . . . 70 N•m (52 lb-ft)

Mounting Lock Nuts . . . . 70 N•m (52 lb-ft)

Spindle Shaft and Bushing Removal and Installation

Removal:

1. Park machine safely with park brake locked.
2. Remove tire.



M82451A

3. Disconnect tie rod end from spindle shaft (A).
4. Remove lock nut (B) and cap screw (C).
5. Remove spindle shaft.
6. Replace bushings (D).
7. Bushings are press fit into the a-arm. Use an inside puller set to remove bushings, and a driver set to install bushings.

Installation:

1. Installation is done in the reverse order of removal.
2. Apply multipurpose grease to lubrication fitting (E).
3. Tighten lock nut (B) to specification.

Torque Specifications:

10 mm x 170 mm cap screw . . . . 73 N•m (54 lb-ft)

12 mm x 173 mm cap screw . . . . 130 N•m (95 lb-ft)

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BRAKES TABLE OF CONTENTS

Specifications

Brake Specifications

Brake Plate Thickness . . . . **1.44 - 1.60 mm (0.057 - 0.063 in.)**

Friction Disk Thickness . . . . **4.60 - 4.80 mm (0.181 - 0.189 in.)**

Thrust Washer Thickness . . . . **0.92 - 1.08 mm (0.036 - 0.043 in.)**

Brake Pedal Freeplay Adjustment (maximum) . . . . **4 mm (0.16 in.)**

Driven Clutch Mounting Cap Screw Torque . . . . **38 N•m (28 lb-ft)**

Brake Cover-to-Transaxle Case Cap Screw Torque . . . . **26 N•m (19 lb-ft)**

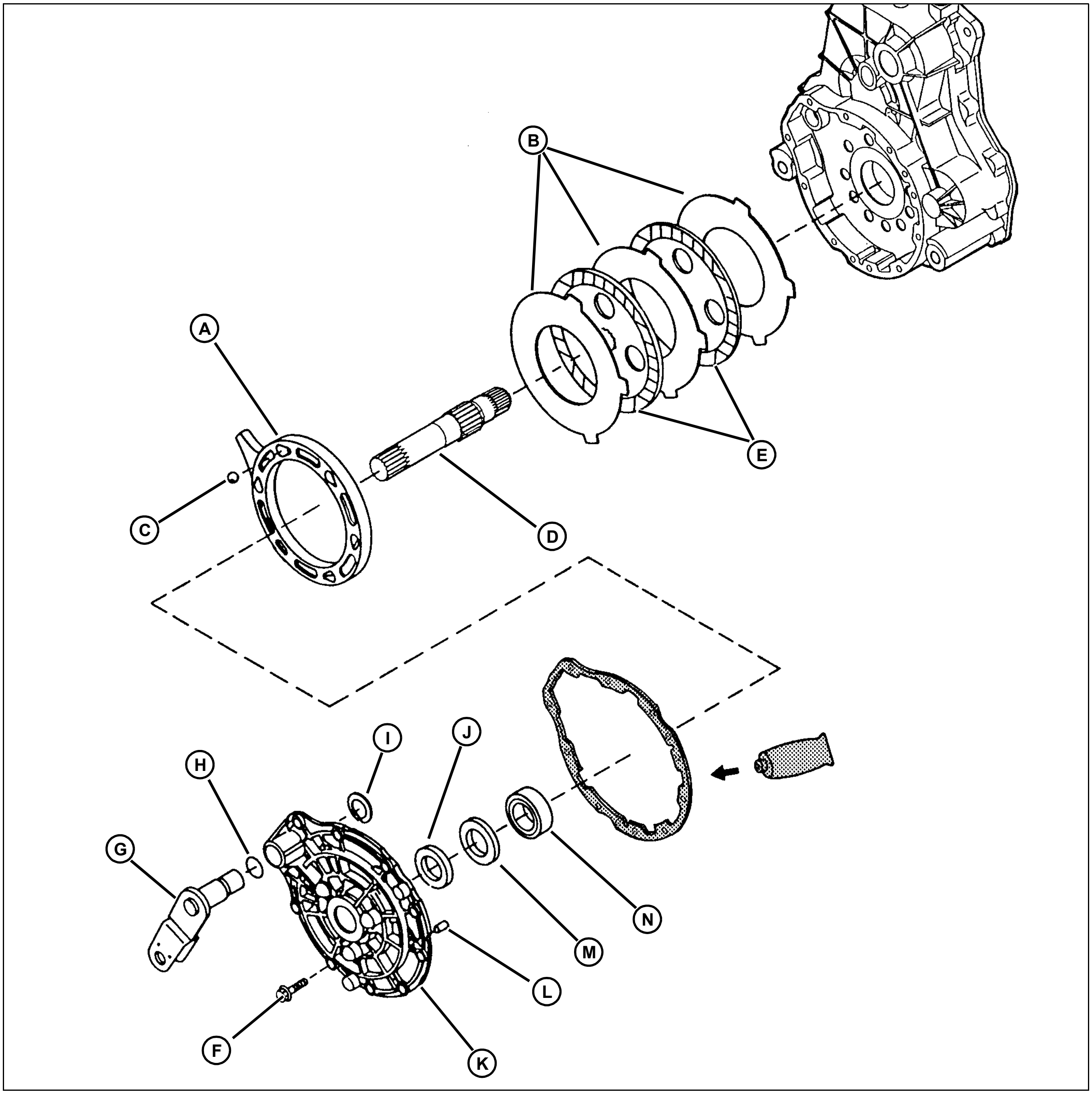
Other Materials

Other Material

Part No.	Part Name	Part Use
TY6305	John Deere Clean and Cure Primer	Cleans parts and speeds cure of sealant.
TY15130 or TY15443	John Deere Sealant	Seals brake cover to transaxle case.
TY6333	Moly High Temperature EP Grease	Apply to splines of transaxle input shaft.

Component Location

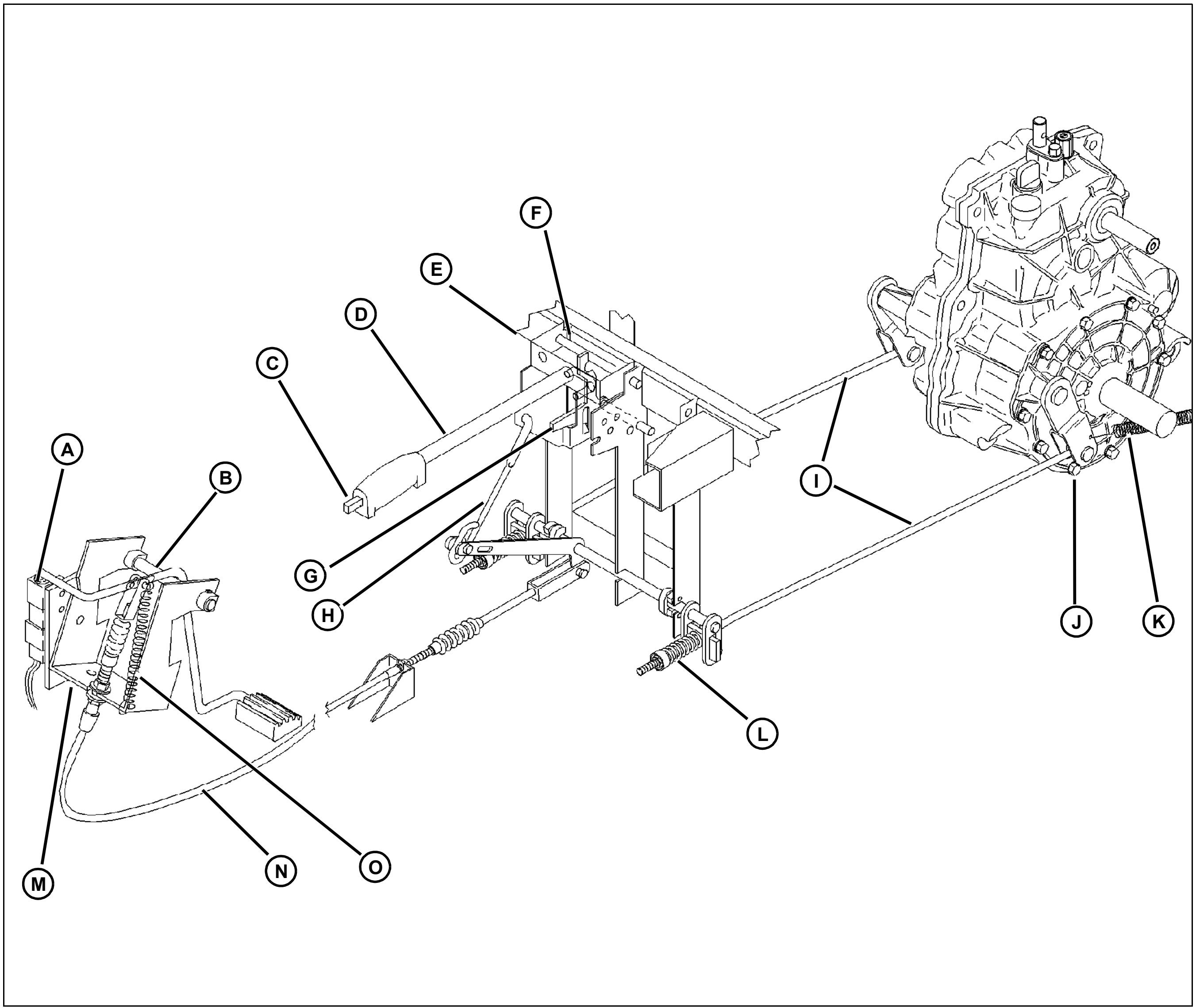
Transaxle Brake Components



M82425

- **A - Actuator Ring**
- **B - Brake Plates (3 used)**
- **C - Ball (6 used)**
- **D - Output Shaft (left side)**
- **E - Brake Disks (2 used)**
- **F - Cap Screw (10 used)**
- **G - Brake Arm**
- **H - O-Ring**
- **I - Snap Ring**
- **J - Seal**
- **K - Transaxle Housing Cover**
- **L - Alignment Pin (2 used)**
- **M - Thrust Washer**
- **N - Ball Bearing**

System Brake Components



MX0956

A - Brake Pedal Switch
B - Brake Rod Assembly
C - Park Brake Release Button
D - Park Brake Lever
E - Park Brake Switch
F - Park Brake Release Pawl
G - Park Brake Locking Pawl
H - Park Brake Rod
I - Brake Rods
J - Transaxle Assembly
K - Brake Return Spring
L - Load Spring (1 per side)
M - Brake Pedal Bracket
N - Brake Cable
O - Brake Pedal Return Spring

Diagnostics

Troubleshooting Guide

Symptom: Brake effort excessive, binding, does not engage or has poor response.

(1) Is brake cable mis-adjusted, stretched, worn or binding?

Yes - Adjust cable or replace cable as necessary. See “Brake Cable Adjustment:” on page 561.

No - Go to next step.

(2) Is brake pedal freeplay adjustment incorrect?

Yes - Adjust freeplay.

No - Go to next step.

(3) Is brake pedal bent, binding or worn?

Yes - Replace brake pedal.

No - Go to next step.

(4) Is brake pedal stop plate worn or mis-adjusted?

Yes - Adjust or replace as necessary.

No - Go to next step.

(5) Are mid-frame brake springs mis-adjusted, collapsed or broken?

Yes - Adjust or replace spring(s) as necessary.

No - Go to next step.

(6) Is mid-frame brake linkage loose, mis-adjusted, binding, worn or broken?

Yes - Repair or replace as necessary.

No - Go to next step.

(7) Are mid-frame to transaxle brake rods mis-adjusted, loose or bent?

Yes - Adjust brake rods. Replace as necessary.

No - Go to next step.

(8) Are transaxle brake arm return springs stretched or broken?

Yes - Replace as necessary.

No - Go to next step.

(9) Are internal brake plates and disks warped, grooved or worn?

Yes - Replace as necessary.

No - Go to next step.

Symptom: Brake effort excessive, binding, does not engage or has poor response.

(10) Is internal actuator ring warped, grooved, missing balls or worn?

Yes - Repair or replace as necessary.

No - Go to next step.

Symptom: Brake engagement too aggressive.

(1) Is brake cable mis-adjusted, stretched, worn or binding?

Yes - Adjust cable or replace cable as necessary. See “Brake Cable Adjustment:” on page 561.

No - Go to next step.

(2) Is brake pedal freeplay adjustment incorrect?

Yes - Adjust freeplay.

No - Go to next step.

(3) Is brake pedal stop plate worn or mis-adjusted?

Yes - Adjust or replace as necessary.

No - Go to next step.

(4) Are mid-frame brake springs mis-adjusted, collapsed or broken?

Yes - Adjust or replace spring(s) as necessary.

No - Go to next step.

(5) Is mid-frame brake linkage loose, mis-adjusted, binding, worn or broken?

Yes - Repair or replace as necessary.

No - Go to next step.

(6) Are mid-frame to transaxle brake rods mis-adjusted, loose or bent?

Yes - Adjust brake rods. Replace as necessary.

No - Go to next step.

(7) Are transaxle brake arm return springs stretched or broken?

Yes - Replace as necessary.

No - Go to next step.

(8) Are transaxle brake arm and shaft bent, binding or worn?

Yes - Replace as necessary.

No - Go to next step.

Symptom: Brake will not release.

(1) Is brake cable mis-adjusted, stretched, worn or binding?

Yes - Adjust cable or replace cable as necessary. See “Brake Cable Adjustment:” on page 561.

No - Go to next step.

(2) Is brake pedal freeplay adjustment incorrect?

Yes - Adjust freeplay.

No - Go to next step.

(3) Is brake pedal bent, binding or worn?

Yes - Replace brake pedal.

No - Go to next step.

(4) Is brake pedal return spring stretched or broken.

Yes - Replace spring.

No - Go to next step.

(5) Is brake pedal stop plate worn or mis-adjusted?

Yes - Adjust or replace as necessary.

No - Go to next step.

(6) Are mid-frame brake springs mis-adjusted, collapsed or broken?

Yes - Adjust or replace spring(s) as necessary.

No - Go to next step.

(7) Is mid-frame brake linkage loose, mis-adjusted, binding, worn or broken?

Yes - Repair or replace as necessary.

No - Go to next step.

(8) Are mid-frame to transaxle brake rods mis-adjusted, loose or bent?

Yes - Adjust brake rods. Replace as necessary.

No - Go to next step.

(9) Are transaxle brake arm return springs stretched or broken?

Yes - Replace as necessary.

No - Go to next step.

(10) Are transaxle brake arm and shaft bent, binding or worn?

Yes - Replace as necessary.

No - Go to next step.

Symptom: Brake will not release.

(11) Are internal brake plates and disks warped, grooved or worn?

Yes - Replace as necessary.

No - Go to next step.

(12) Is internal actuator ring warped, grooved, missing balls or worn?

Yes - Repair or replace as necessary.

No - Go to next step.

Symptom: Park brake will not engage.

(1) Is park brake lever, locking pawl, slotted rod or park brake arm bent, binding, worn or broken?

Yes - Repair or replace as necessary.

No - Go to next step.

(2) Is brake pedal freeplay adjustment incorrect?

Yes - Adjust freeplay.

No - Go to next step.

(3) Are mid-frame brake springs mis-adjusted, collapsed or broken?

Yes - Adjust or replace spring(s) as necessary.

No - Go to next step.

(4) Is mid-frame brake linkage loose, mis-adjusted, binding, worn or broken?

Yes - Repair or replace as necessary.

No - Go to next step.

(5) Are mid-frame to transaxle brake rods mis-adjusted, loose or bent?

Yes - Adjust brake rods. Replace as necessary.

No - Go to next step.

(6) Are transaxle brake arm and shaft bent, binding or worn?

Yes - Replace as necessary.

No - Go to next step.

(7) Are internal brake plates and disks warped, grooved or worn?

Yes - Replace as necessary.

No - Go to next step.

(8) Is internal actuator ring warped, grooved, missing balls or worn?

Yes - Repair or replace as necessary.

Symptom: Park brake will not engage.

No - Go to next step.

Symptom: Park brake will not release.

(1) Is park brake lever, locking pawl, slotted rod or park brake arm bent, binding, worn or broken?

Yes - Repair or replace as necessary.

No - Go to next step.

(2) Is brake pedal freeplay adjustment incorrect?

Yes - Adjust freeplay.

No - Go to next step.

(3) Is mid-frame brake linkage loose, mis-adjusted, binding, worn or broken?

Yes - Repair or replace as necessary.

No - Go to next step.

(4) Are mid-frame to transaxle brake rods mis-adjusted, loose or bent?

Yes - Adjust brake rods. Replace as necessary.

No - Go to next step.

(5) Are transaxle brake arm return springs stretched or broken?

Yes - Replace as necessary.

No - Go to next step.

(6) Are transaxle brake arm and shaft bent, binding or worn?

Yes - Replace as necessary.

No - Go to next step.

(7) Are internal brake plates and disks warped, grooved or worn?

Yes - Replace as necessary.

No - Go to next step.

(8) Is internal actuator ring warped, grooved, missing balls or worn?

Yes - Repair or replace as necessary.

No - Go to next step.

Symptom: Park brake will not hold.

(1) Is park brake lever, locking pawl, slotted rod or park brake arm bent, binding, worn or broken?

Yes - Repair or replace as necessary.

No - Go to next step.

Symptom: Park brake will not hold.

(2) Is brake pedal freeplay adjustment incorrect?

Yes - Adjust freeplay.

No - Go to next step.

(3) Are mid-frame brake springs mis-adjusted, collapsed or broken?

Yes - Adjust or replace spring(s) as necessary.

No - Go to next step.

(4) Is mid-frame brake linkage loose, mis-adjusted, binding, worn or broken?

Yes - Repair or replace as necessary.

No - Go to next step.

(5) Are transaxle brake arm and shaft bent, binding or worn?

Yes - Replace as necessary.

No - Go to next step.

(6) Are internal brake plates and disks warped, grooved or worn?

Yes - Replace as necessary.

No - Go to next step.

(7) Is internal actuator ring warped, grooved, missing balls or worn?

Yes - Repair or replace as necessary.

No - Go to next step.

Symptom: Brake noisy or chattering.

(1) Change transaxle oil - use only Hy-Gard J20C. Does noise stop

No - Go to next step.

(2) Is brake pedal bent, binding or worn?

Yes - Replace brake pedal.

No - Go to next step.

(3) Is brake pedal return spring stretched or broken.

Yes - Replace spring.

No - Go to next step.

(4) Is brake pedal stop plate worn or mis-adjusted?

Yes - Adjust or replace as necessary.

No - Go to next step.

Symptom: Brake noisy or chattering.

(5) Are mid-frame brake springs mis-adjusted, collapsed or broken?

Yes - Adjust or replace spring(s) as necessary.

No - Go to next step.

(6) Is mid-frame brake linkage loose, mis-adjusted, binding, worn or broken?

Yes - Repair or replace as necessary.

No - Go to next step.

(7) Are mid-frame to transaxle brake rods mis-adjusted, loose or bent?

Yes - Adjust brake rods. Replace as necessary.

No - Go to next step.

(8) Are transaxle brake arm return springs stretched or broken?

Yes - Replace as necessary.

No - Go to next step.

(9) Are transaxle brake arm and shaft bent, binding or worn?

Yes - Replace as necessary.

No - Go to next step.

(10) Are internal brake plates and disks warped, grooved or worn?

Yes - Replace as necessary.

No - Go to next step.

(11) Is internal actuator ring warped, grooved, missing balls or worn?

Yes - Repair or replace as necessary.

No - Go to next step.

Symptom: Excessive brake wear.

(1) Is brake pedal freeplay adjustment incorrect?

Yes - Adjust freeplay.

No - Go to next step.

(2) Is brake pedal bent, binding or worn?

Yes - Replace brake pedal.

No - Go to next step.

(3) Is brake pedal return spring stretched or broken.

Yes - Replace spring.

Symptom: Excessive brake wear.

No - Go to next step.

(4) Is brake pedal stop plate worn or mis-adjusted?

Yes - Adjust or replace as necessary.

No - Go to next step.

(5) Is mid-frame brake linkage loose, mis-adjusted, binding, worn or broken?

Yes - Repair or replace as necessary.

No - Go to next step.

(6) Are mid-frame to transaxle brake rods mis-adjusted, loose or bent?

Yes - Adjust brake rods. Replace as necessary.

No - Go to next step.

(7) Are transaxle brake arm return springs stretched or broken?

Yes - Replace as necessary.

No - Go to next step.

(8) Are transaxle brake arm and shaft bent, binding or worn?

Yes - Replace as necessary.

No - Go to next step.

(9) Are internal brake plates and disks warped, grooved or worn?

Yes - Replace as necessary.

No - Go to next step.

(10) Is internal actuator ring warped, grooved, missing balls or worn?

Yes - Repair or replace as necessary.

No - Go to next step.

Symptom: Brake pedal travel excessive.

(1) Is brake pedal stop plate worn or mis-adjusted?

Yes - Adjust or replace as necessary.

No - Go to next step.

(2) Is mid-frame brake linkage loose, mis-adjusted, binding, worn or broken?

Yes - Repair or replace as necessary.

No - Go to next step.

(3) Are mid-frame to transaxle brake rods mis-adjusted, loose or bent?

Symptom: Brake pedal travel excessive.

Yes - Adjust brake rods. Replace as necessary.

No - Go to next step.

(4) Are transaxle brake arm and shaft bent, binding or worn?

Yes - Replace as necessary.

No - Go to next step.

(5) Are internal brake plates and disks warped, grooved or worn?

Yes - Replace as necessary.

No - Go to next step.

(6) Is internal actuator ring warped, grooved, missing balls or worn?

Yes - Repair or replace as necessary.

No - Go to next step.

Diagnosis Test/Check Points

Test Conditions:

- Operator in seat
- Engine running at operating temperature
- Minimum of 50 feet of open and flat pavement away from any people
- Shift lever in forward or reverse

System: Brake Operation

(1) When brakes are applied, machine stops aggressively with rear wheels locking?

Yes - Go to next step.

No - Check linkage and brake components for adjustment, binding, wear or damage.

(2) Brake pedal operates smoothly and with little effort?

Yes - Brakes functioning normally.

No - Check linkage and brake components for adjustment, binding, wear or damage.

Test Conditions:

- Machine parked safely.
- Engine off and cool.

System: Brake Pedal

(1) Springs not broken or stretched

Yes - Go to next step.

No - Replace springs.

(2) Hardware and components not worn, damaged or missing?

Yes - Go to next step.

No - Repair or replace as necessary.

System: Mid-Frame Brake System

(1) Cable not binding, mount and jam nut in good condition?

Yes - Go to next step.

No - Repair or replace as necessary.

(2) Rubber boot and clamps in good condition?

Yes - Go to next step.

No - Repair or replace as necessary.

(3) Load springs not broken or compressed?

Yes - Go to next step.

No - Repair or replace as necessary.

System: Transaxle Brake Components

(1) Linkage adjusted properly and not damaged or worn?

Yes - Go to next step.

No - Repair or replace as necessary.

(2) Internal components not damaged or worn?

Yes - Go to next step.

No - Repair or replace as necessary.

System: Park Brake

(1) Park brake properly adjusted?

Yes - Go to next step.

No - Adjust park brake.

(2) Park brake linkage worn or damaged?

No - Repair or replace as necessary.

Theory of Operation

Brake Operation

Function:

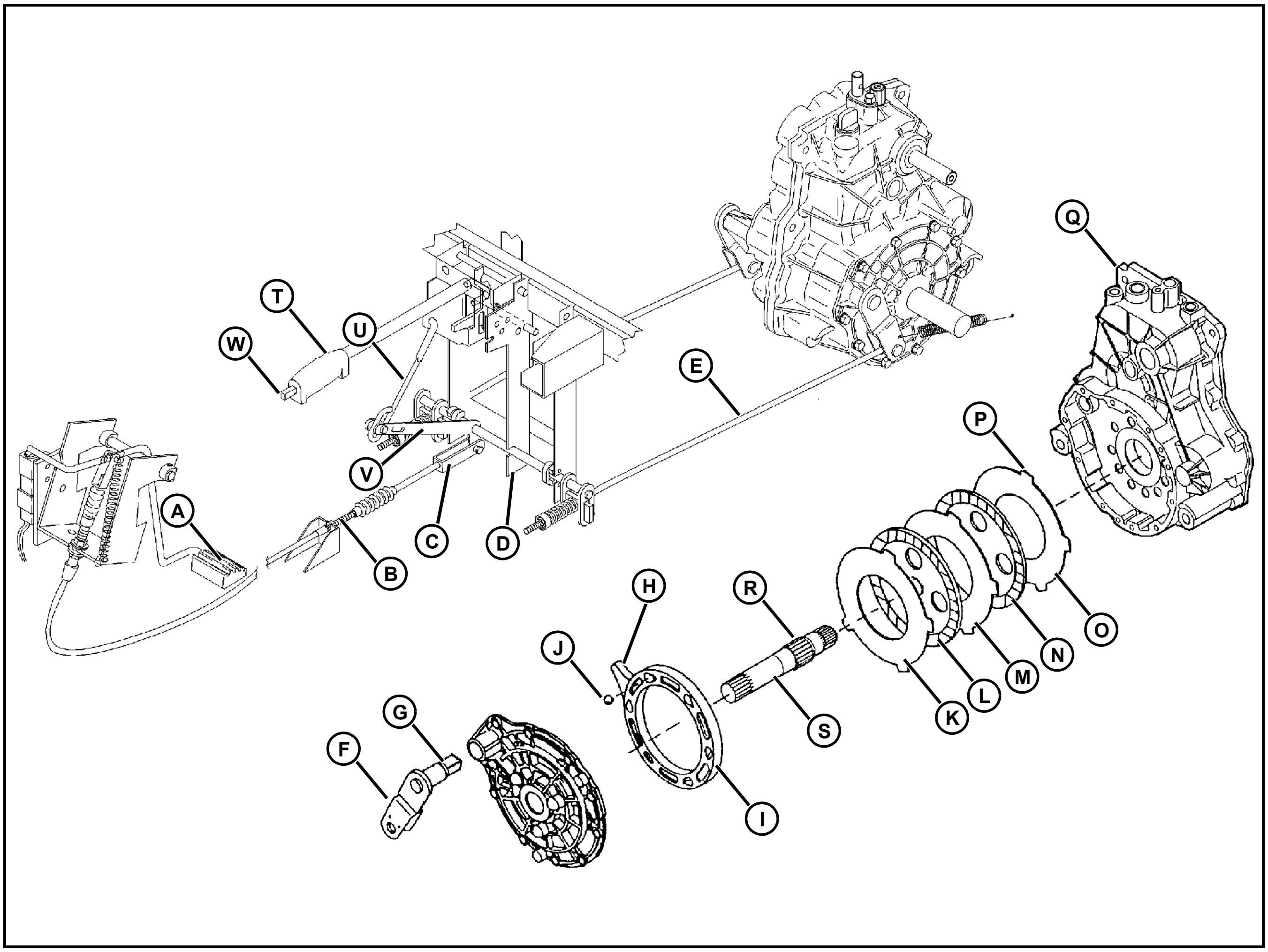
To provide a means of stopping the machine and also prevent movement when not in use.

Theory of Operation:

When the brake pedal (A) is depressed, the brake cable anchor (B) pulls U-bracket (C) and mid-frame brake arms (D) forward. Mid-frame brake arms pull left and right side brake rods (E) which pull transaxle brake arms (F) forward. When transaxle brake arms are pulled forward the flat edge at the internal end of the brake arm shaft (G) pushes against the actuator ring tab (H). This rotates the right-side actuator ring clockwise and the left-side actuator ring counter-clockwise causing the six angled ramps (I) to move against the six captured balls (J). This action forces the actuator ring against the outer brake plate (K), outer brake disc (L), middle brake plate (M), inner brake disc (N), and finally the inner brake plate (O).

The friction between the brake plates and brake discs slows or stops output shaft (S) rotation, which slows or stops the drive wheels. The brake plates are held stationary by four tabs (P) on each of three brake plates which are seated in four transaxle housing grooves (Q). The brake discs are spline engaged to the output shaft's center splines (R).

When the park brake lever (T) is raised into its locked position, the slotted rod (U) pulls the park brake arm (V) up and the mid-frame brake arms (D) forward. From hereon, everything works the same. To release the park brake lever, first raise the lever slightly, then depress the release button (W) and lower lever all-the-way.



M55755A

Tests and Adjustments

Brake Adjustments

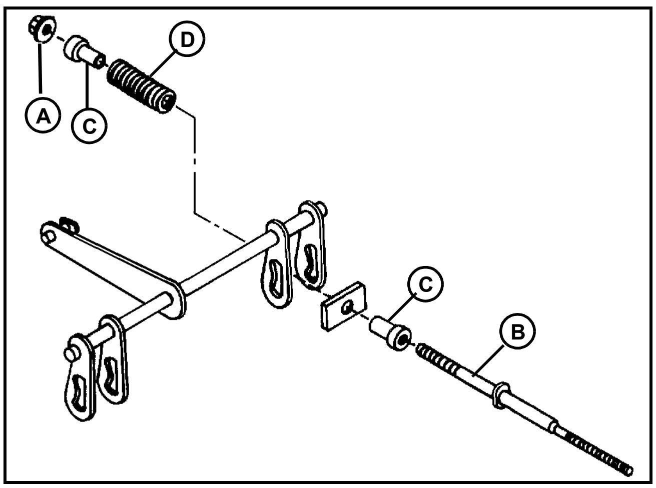
Reason:

To ensure service brake linkage and park brake linkage are adjusted properly.

NOTE: The front end of the brake rod needs to be adjusted before the rear end of the brake rod.

Brake Rod Front End Adjustment:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake lever in released position, and front wheels BLOCKED.
3. Raise cargo box.



MX1185

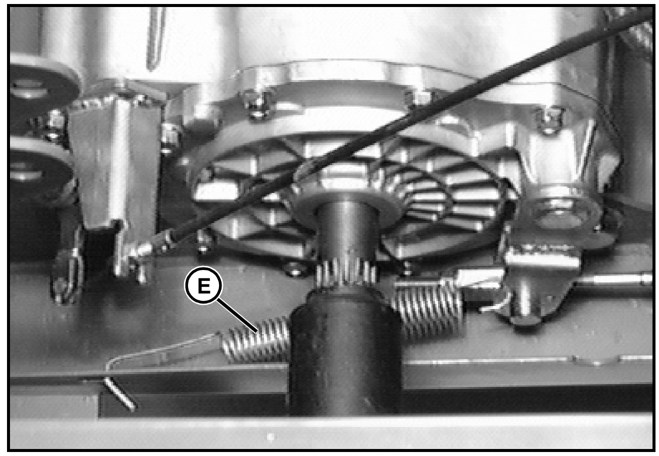
4. Tighten nut (A) onto linkage (B) completely until the ends of sleeves (C) make contact inside spring (D). This sets a predetermined preload on the spring.

Brake Rod Rear End Adjustment:

NOTE: If this is a NEW transaxle or you have replaced the brake pack assembly, ONLY perform steps 1-5, and 7-9. New brake parts require a tighter linkage adjustment to account for initial break-in wear.

1. Use jack stands or hoist to raise rear wheels at least 25 mm (1.0 in.) off ground.

NOTE: If brake cable is being replaced, DO NOT attach cable to brake pedal at this time. Attach cable only at mid-frame mounting and brake arm assembly.



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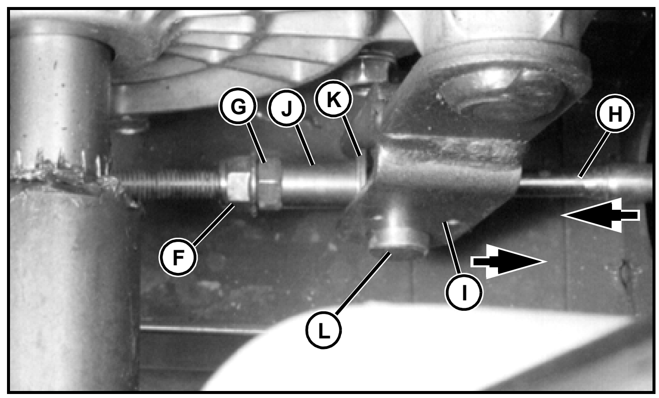
2. Disconnect brake arm return spring (E).



M76917

3. Loosen jam nut (F) and coupler nut (G).
4. Hold brake rod (H) to rear and brake arm (I) forward to remove all play.
5. Turn coupler nut (G) forward until it pushes spacer (J) and washer (K) forward until washer just contacts coupler pin (L).
6. Turn coupler nut (G) 3 turns (eighteen flats of nut) away from pin (L).
7. Tighten jam nut (F).
8. Install brake arm return spring (E).
9. Turn rear wheel, it should rotate with a slight drag and provide even braking on both sides.

NOTE: If no new parts have been installed, proceed to "Alternate Rear End Adjustment Procedure" below. (DO NOT proceed if NEW parts have been installed).

Alternate Rear End Adjustment Procedure:

(DO NOT use this step for NEW parts):

NOTE: When using torque wrench, the torque wrench centerline should intersect the axle flange centerline!

For 4X2: Using torque wrench, turn any lug of rear tire. Tire should rotate at less then 11 N•m (8 lb-ft), ideally 7 N•m (62 lb-in.).

For 6X4's: Turn any lug of rear tire. Tire should rotate at less then 20 N•m (15 lb-ft), ideally.

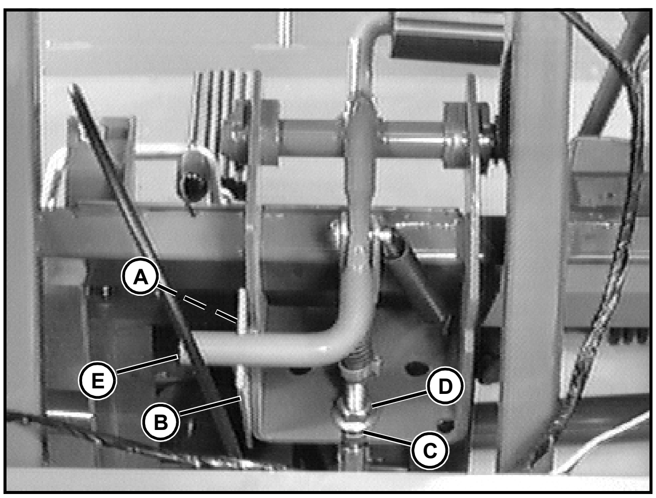
After repeating procedure for both sides, check both sides (left and right) for EVEN braking. If NOT EVEN, repeat entire procedure.

NOTE: This completes the routine portion of brake adjustment procedure. If brake cable has been replaced or foot pedal linkage needs adjustment, complete "Brake Cable Adjustment" below.

Brake Cable Adjustment:

1. Ensure park brake is in released position.

IMPORTANT: Avoid damage! DO NOT allow brake cable to slip out of slot or cable may become kinked. Hold cable in slot by holding cable below lower nut (C) when loosening top nut (D).



M56376

2. Loosen cap screw(s) (A) of stop plate (B) and lower plate.

3. Loosen jam nuts (C) and (D).

4. Pull down on cable housing to take out all play in cable. Hold cable housing in place and tighten jam nuts (C) and (D).

NOTE: Brake pedal freeplay is necessary to prevent any preload of brake linkage. If stop plate (B) is adjusted too high, brakes will be preloaded. If stop plate is adjusted too low, return spring pressure, will kink brake cable.

5. Adjust stop plate (B) up to reduce amount of freeplay in brake pedal. *Apply only enough up force to stop plate to take up freeplay. Do not start actuating brake.*

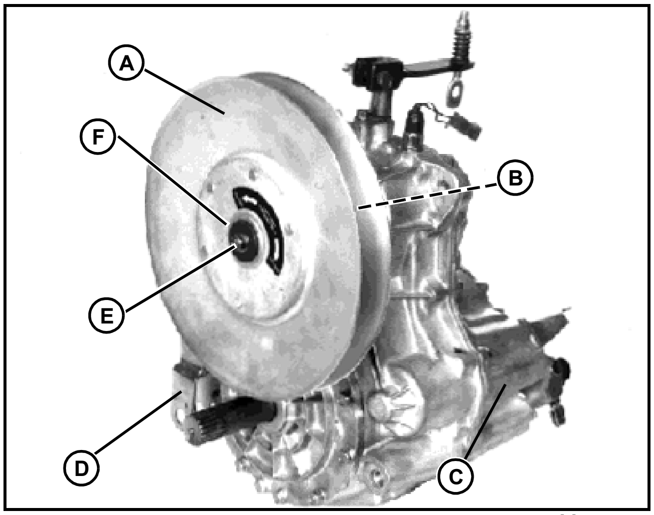
6. Hold stop plate (B) while you tighten cap screw (A).

- If light and horn kit is installed, stop plate will have a switch fastened to it. Stop plate must be positioned so switch is aligned with bottom of brake pedal rod (E). Be sure brake pedal rod contacts switch plunger (plunger depressed) but does not contact the switch body.

Repair

Brake Removal and Installation

Removal:



M82424

1. Remove transaxle assembly (C).

NOTE: Driven clutch must be removed to service left hand brake assembly (D). Mounting cap screw (E) has left-hand threads.

2. Remove driven clutch (A). Hold clutch with a strap wrench and remove left hand thread cap screw (E) and bushing (F).

3. Tap on inside of clutch with a rubber mallet.

NOTE: Balls may fall out when cover is removed. Bearing is slip fit on output shaft and in cover.

4. Remove brake cover and brake parts.

IMPORTANT: Avoid damage! Replace all seals and O-rings.

5. Pry out seal using a screwdriver.

6. Inspect all parts for wear or damage. Installation is done in the reverse order of removal.

- Apply multipurpose grease to lips of new seal. Install seal flush to inside of cover using a driver set.
- Apply petroleum jelly on thrust washer and balls to hold in place during installation.
- Clean mating surfaces of transaxle case and brake cover using Clean and Cure Primer. Apply a coat of John Deere Sealant, or an equivalent, to mating surfaces.
- Apply Moly High Temperature EP Grease, or an equivalent, to splines of transaxle input shaft before installing driven clutch.

Inspection:

Inspect all parts for wear or damage. Measure thickness of brake plates, friction discs and thrust washer. If not within specifications, replace.

Thickness Specifications:

Brake Plate . . . . 1.44 - 1.60 mm (0.057 - 0.063 in.)

Friction Disk . . . . 4.60 - 4.80 mm (0.181 - 0.189 in.)

Thrust Washer . . . . . . 0.92 - 1.08 mm (0.036 - 0.043 in.)

Installation:

Installation is done in the reverse order of removal.

Table of Contents

Specifications, Rotary Broom

Rotary Broom Specifications

Capacities

Crankcase . . . . . 1.0 L (1.1 qt)

Fuel . . . . . 6.9 L (1.8 gal)

Hydraulic Reservoir . . . . . 0.47 L (16 oz)

Dimensions

Overall Broom Height. . . . . 939.8 mm (37 in.)

Overall Broom Width . . . . . 1943.1 mm (76.5 in.)

Sweeping width when angled 0° . . . . . 1828.8 mm (72 in.)

Sweeping width when angled 25° left or right . . . . . 1645.9 mm (64.8 in.)

Brush Diameter. . . . . 609.6 mm (24 in.)

Tires

Caster Wheels Size. . . . . 280 x 102 mm (11 x 4 in.)

Tire Pressure . . . . . 317 kPa (46 psi)

Miscellaneous

Hood and Frame Material. . . . . Steel

Brush Material. . . . . Polypropylene and/or Steel

Sections. 34

Angling . . . . . 0 - 25° each side

Angling Method . . . . . Hydraulic

Speed. . . . . 200 rpm

Brush Drive . . . . . Independent engine with PTO

Recommended Lubricants

Engine Oil . . . . . API Service Classification SG or SF

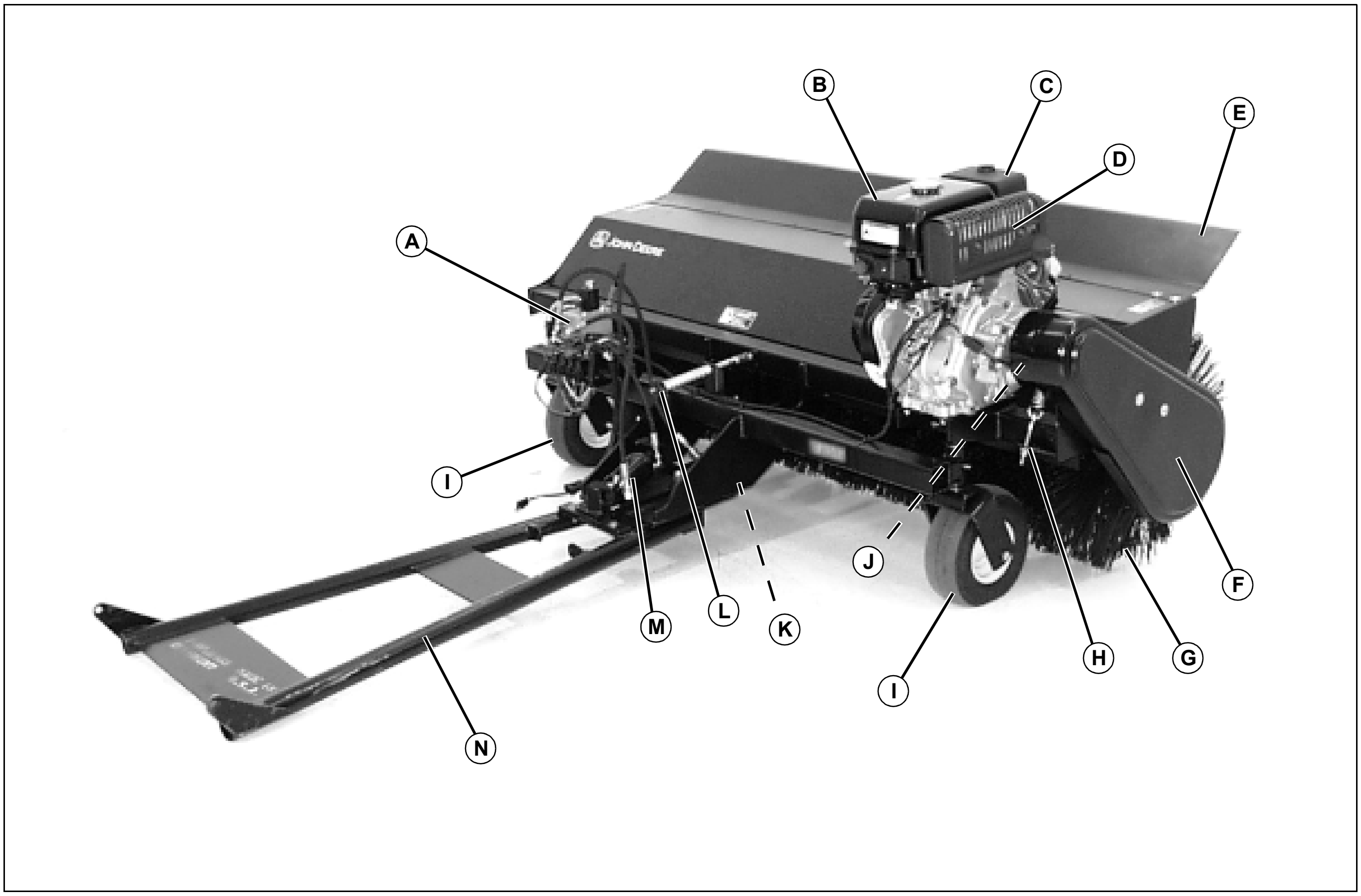
Hydraulic Oil . . . . . Hy-Gard - JDM J20C

Grease . . . . . SAE Multi-Purpose EP Grease

(Specifications and design subject to change without notice.)

Component Location, Rotary Broom

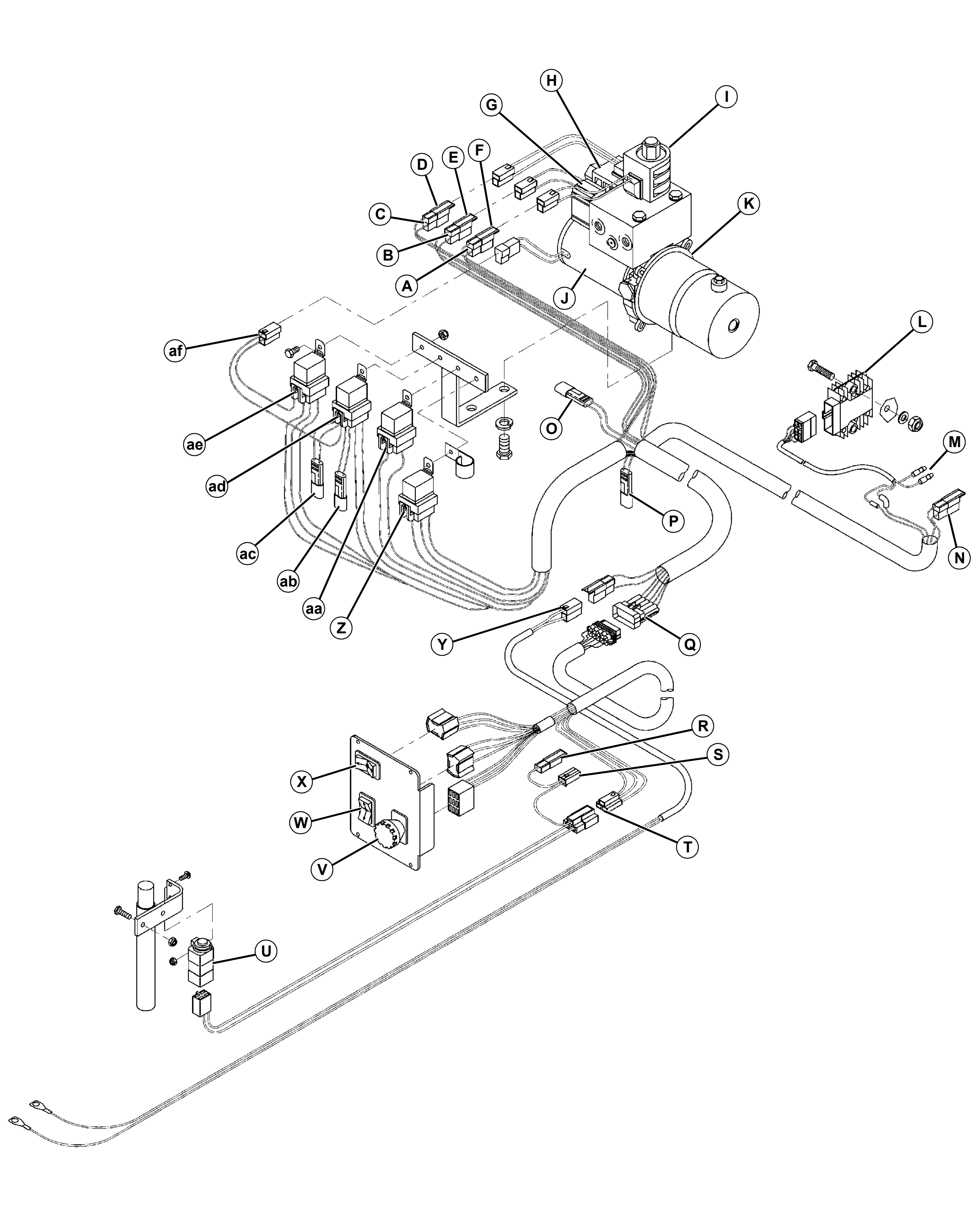
Rotary Broom



MX17059

A - Hydraulic Pump and Valve Manifold Assembly
B - Fuel Tank
C - Air Cleaner
D - Heat Shield
E - Deflector
F - Belt Guard
G - Brush
H - Belt Tension Adjuster
I - Caster Wheel
J - PTO Clutch
K - Lift Cylinder
L - Broom Contact Adjustment Knob
M - Angle Cylinder
N - Frame

Hydraulic and Electrical Components



MX19759

A - V2 Diode
B - V1 Diode
C - V5 Diode
D - X7 Connector
E - X9 Connector
F - X5 Connector
G - Lowering Solenoid
H - Lift Solenoid
I - Angle Solenoid
J - M1 Motor
K - Hydraulic Pump and Reservoir Assembly
L - Voltage Regulator/Rectifier
M - X14 Connector
N - X18 Connector
O - V1 Diode
P - V3 Diode
Q - X11 Connector
R - X15 Connector
S - X16 Connector
T - X13 Connector
U - S5 Seat Switch
V - S6 PTO Switch
W - S2 Lift/Lower Switch
X - S1 Angle Switch
Y - X1 Connector
Z - K 4 PTO Relay
AA- K3 Power Relay
AB- V6 Diode
AC- V4 Diode
AD- K2 Motor Relay
AE- K1 Motor Relay
AF- X3 Connector

Electrical, Rotary Broom

Schematic And Wiring Harness Legend

Components

A1 - Oil Warning Module (SE2, W6)

E1 - Spark Plug (SE2, W6)

F1 - Fusible Link (SE1, W4)

F2 - Fusible Link (SE1, W1)

G2 - Stator (SE2, W5)

H1 - Oil Warning Light (SE2, W6)

K1 - Motor Relay (SE1, W1)

K2 - Motor Relay (SE1, W1)

K3 - Power Relay (SE1, W1)

K4 - PTO Relay (SE1, W1)

M1 - Motor (SE1, W1)

N1 - Voltage Regulator/Rectifier (SE2, W5)

S1 - Angle Switch (SE2, W2)

S2 - Lift/Lower Switch (SE2, W2)

S3 - Oil Switch (SE2, W6)

S4 - Ignition Switch (SE2, W6)

S5 - Seat Switch (SE2, W3)

S6 - PTO Switch (SE2, W2)

T1 - Ignition Module (SE2, W6)

V1 - Diode (SE1, W1)

V2 - Diode (SE1, W1)

V3 - Diode (SE1, W1)

V4 - Diode (SE1, W1)

V5 - Diode (SE1, W1)

V6 - Diode (SE1, W1)

V7 - Diode (SE1, W1)

Y1 - Angle Solenoid (SE1, W1)

Y2 - Lift Solenoid (SE1, W1)

Y3 - Lower Solenoid (SE1, W1)

Y4 - PTO Clutch (SE2, W1)

Connectors

X1 - W4 Power Supply Wiring Harness to W1 Main Wiring Harness (SE1, W4)

X2 - W1 Main Wiring Harness to V1 Diode (SE1, W1)

X3 - W1 Main Wiring Harness to M1 Motor (SE1, W1)

X4 - W1 Main Wiring Harness to V3 Diode (SE1, W1)

X5 - W1 Main Wiring Harness to Y1 Angle Solenoid (SE1, W1)

X6 - W1 Main Wiring Harness to V4 Diode (SE1, W1)

X7 - W1 Main Wiring Harness to Y2 Lift Solenoid (SE1, W1)

X8 - W1 Main Wiring Harness to V6 Diode (SE1, W1)

X9 - W1 Main Wiring Harness to Y3 Lower Solenoid (SE1, W1)

X10 - W6 Engine Wiring Harness to A1 Oil Warning Module (SE2, W6)

X11 - W1 Main Wiring Harness to W2 Control Panel Wiring Harness (SE2, W1)

X12 - W1 Main Wiring Harness to W5 Engine Wiring Harness (SE2, W1)

X13 - W2 Control Panel Wiring Harness to W3 Jumper Wiring Harness (SE2, W2)

X14 - W5 Engine Wiring Harness to G2 Stator (SE2, W5)

X15 - W3 Jumper Wiring Harness to Machine Headlight Wiring Harness (SE2, W3)

X16 - W3 Jumper Wiring Harness to Machine Main Wiring Harness (SE2, W3)

X17 - W1 Main Wiring Harness to W5 Engine Wiring Harness (SE2, W1)

X18 - W1 Main Wiring Harness to Y4 PTO Clutch (SE2, W1)

Wiring Harnesses

W1 - Main Wiring Harness (SE1)

W2 - Control Panel Wiring Harness (SE2)

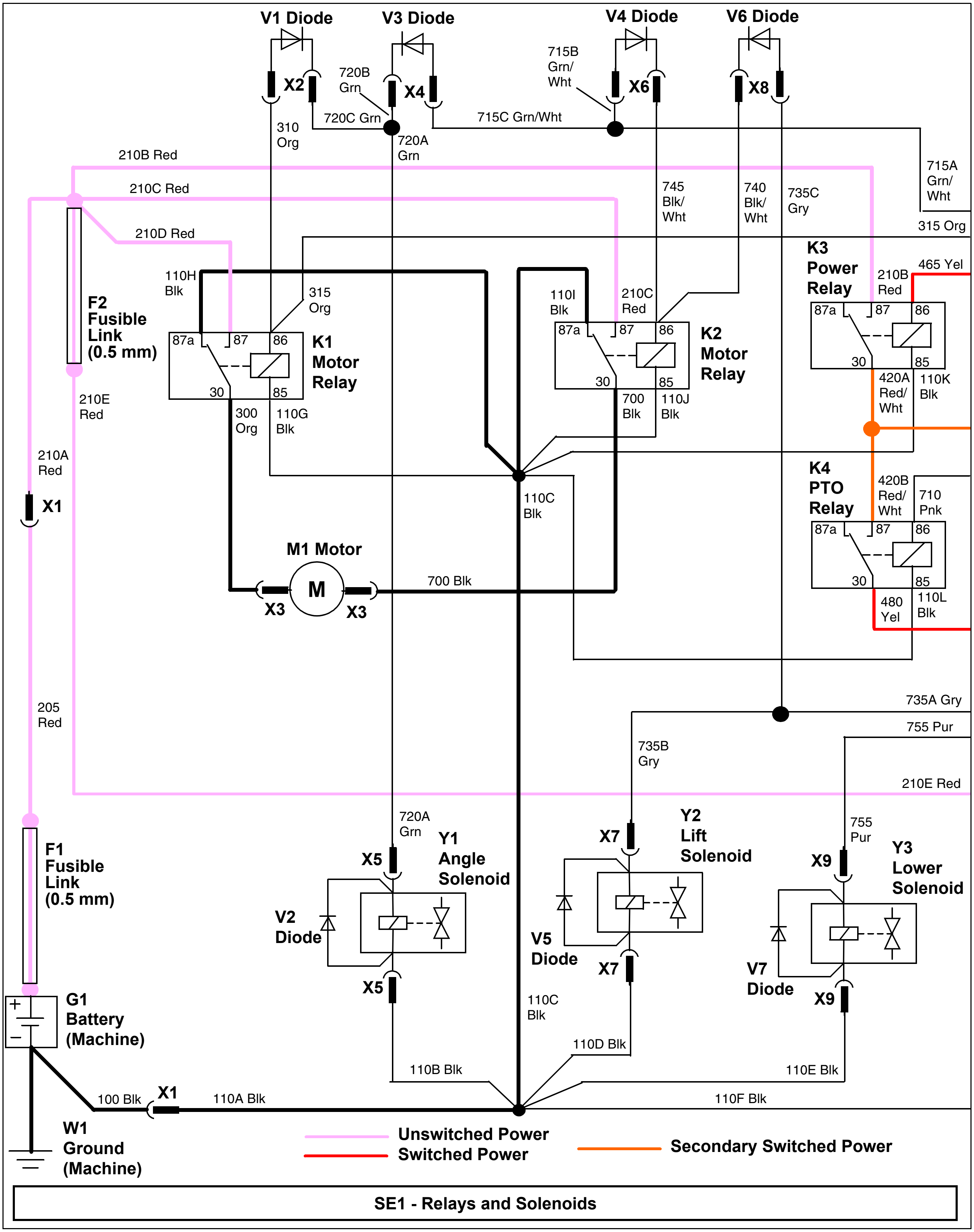
W3 - Jumper Wiring Harness (SE2)

W4 - Power Supply Wiring Harness (SE1)

W5 - Engine Wiring Harness (SE2)

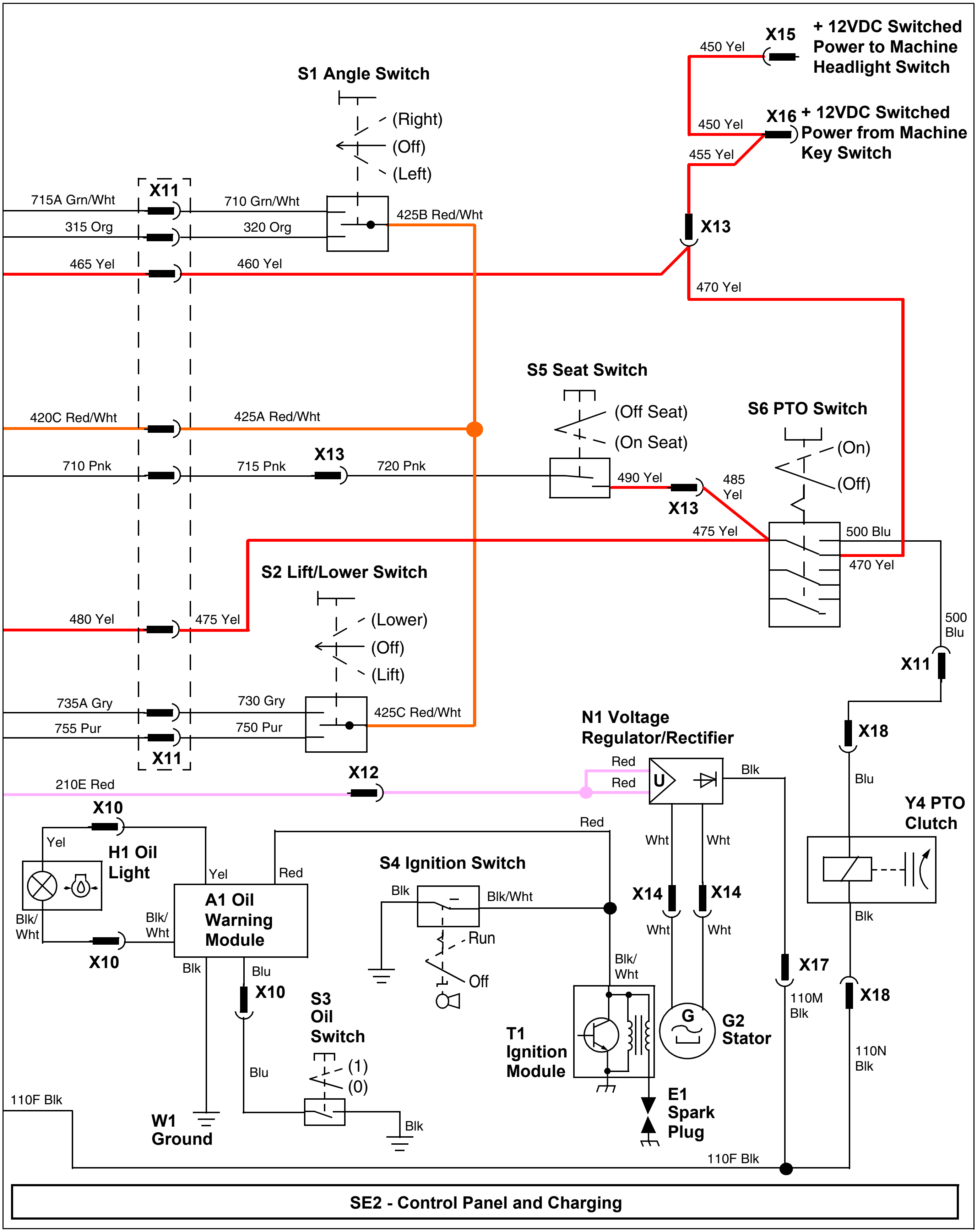
W6 - Engine Wiring Harness (SE2)

Rotary Broom Electrical Schematic (1 of 2)



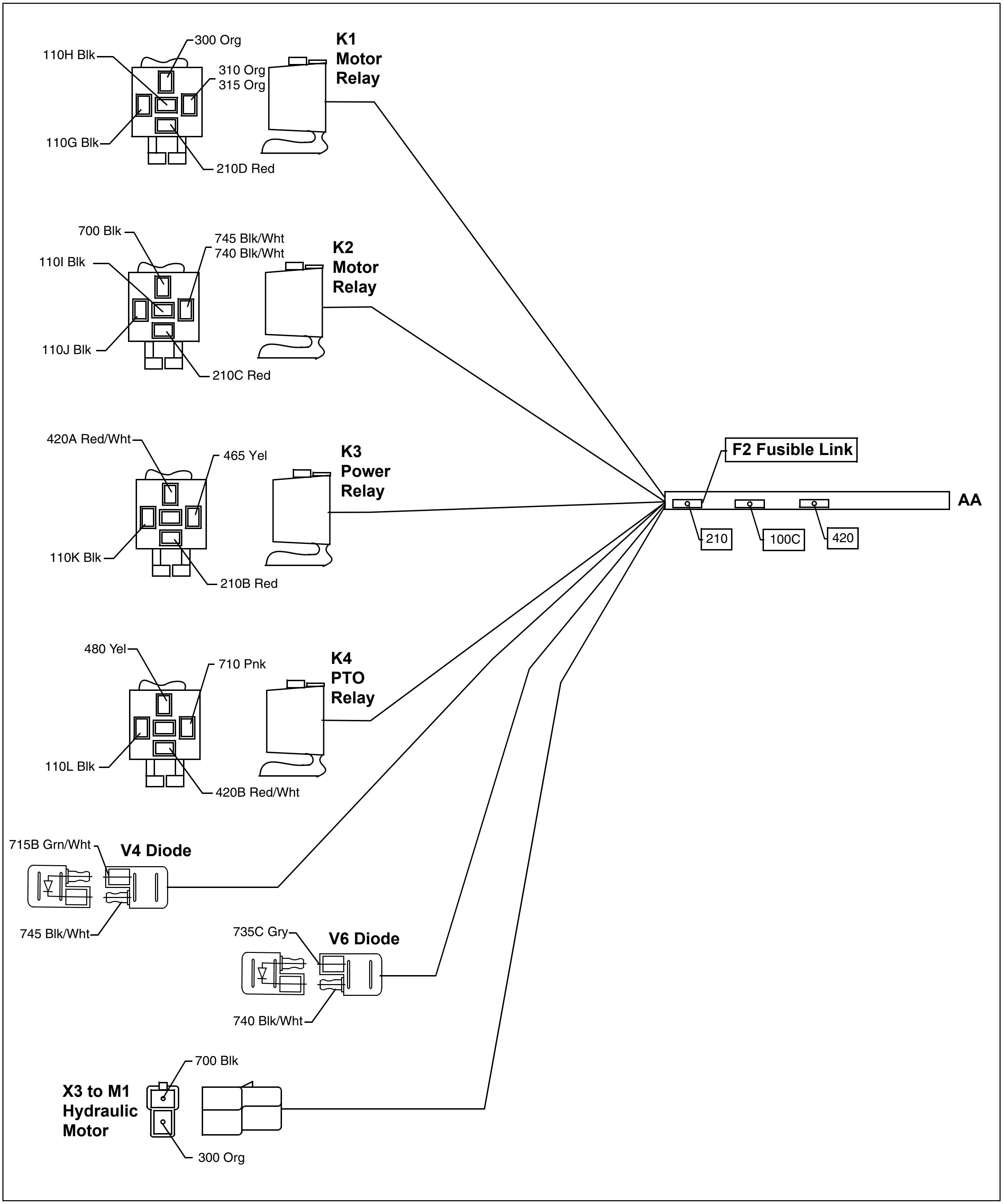
MIF

Rotary Broom Electrical Schematic (2 of 2)



MIF

W1 Main Wiring Harness (1 of 2)



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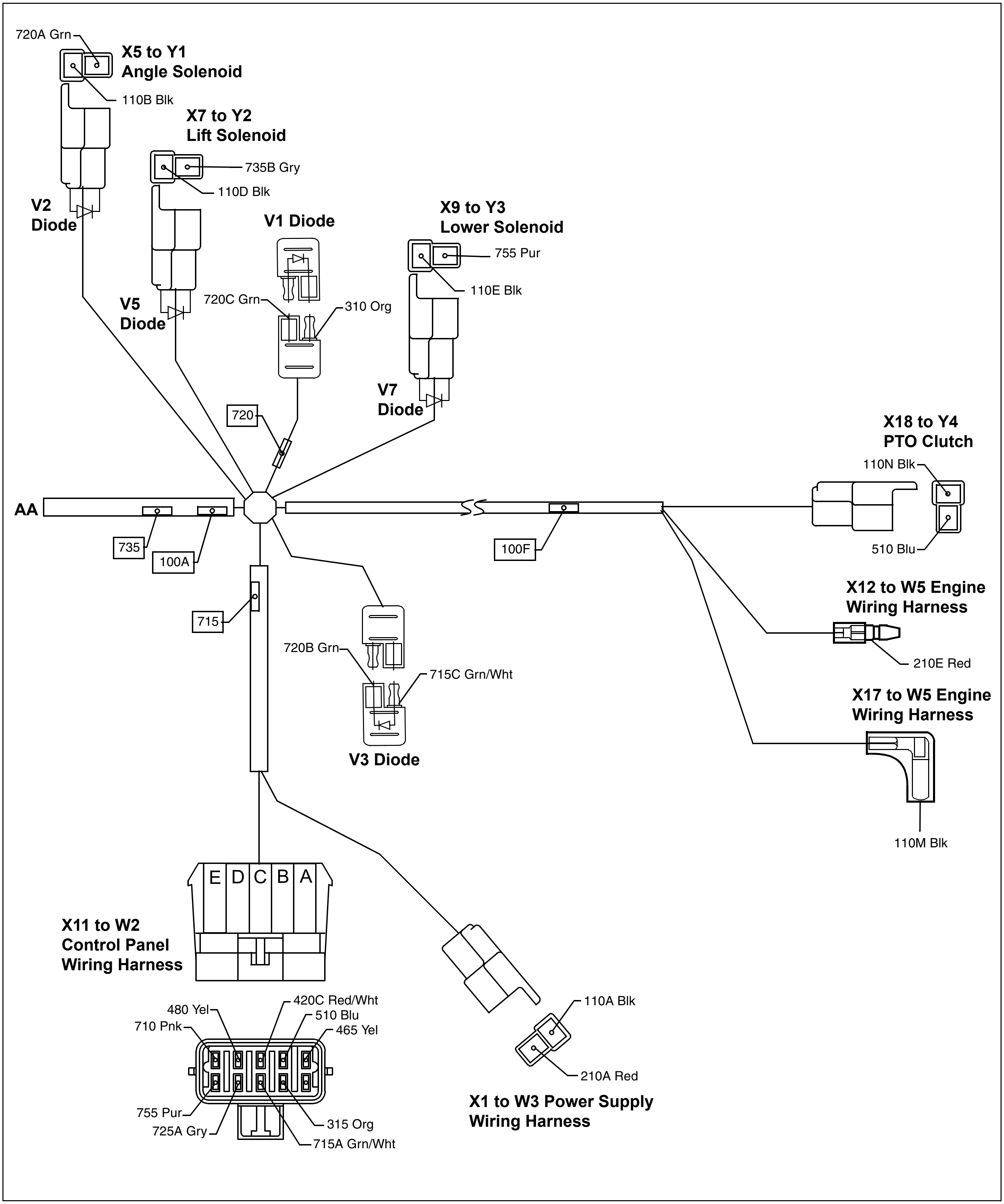
W1 Main Wiring Harness (2 of 2)



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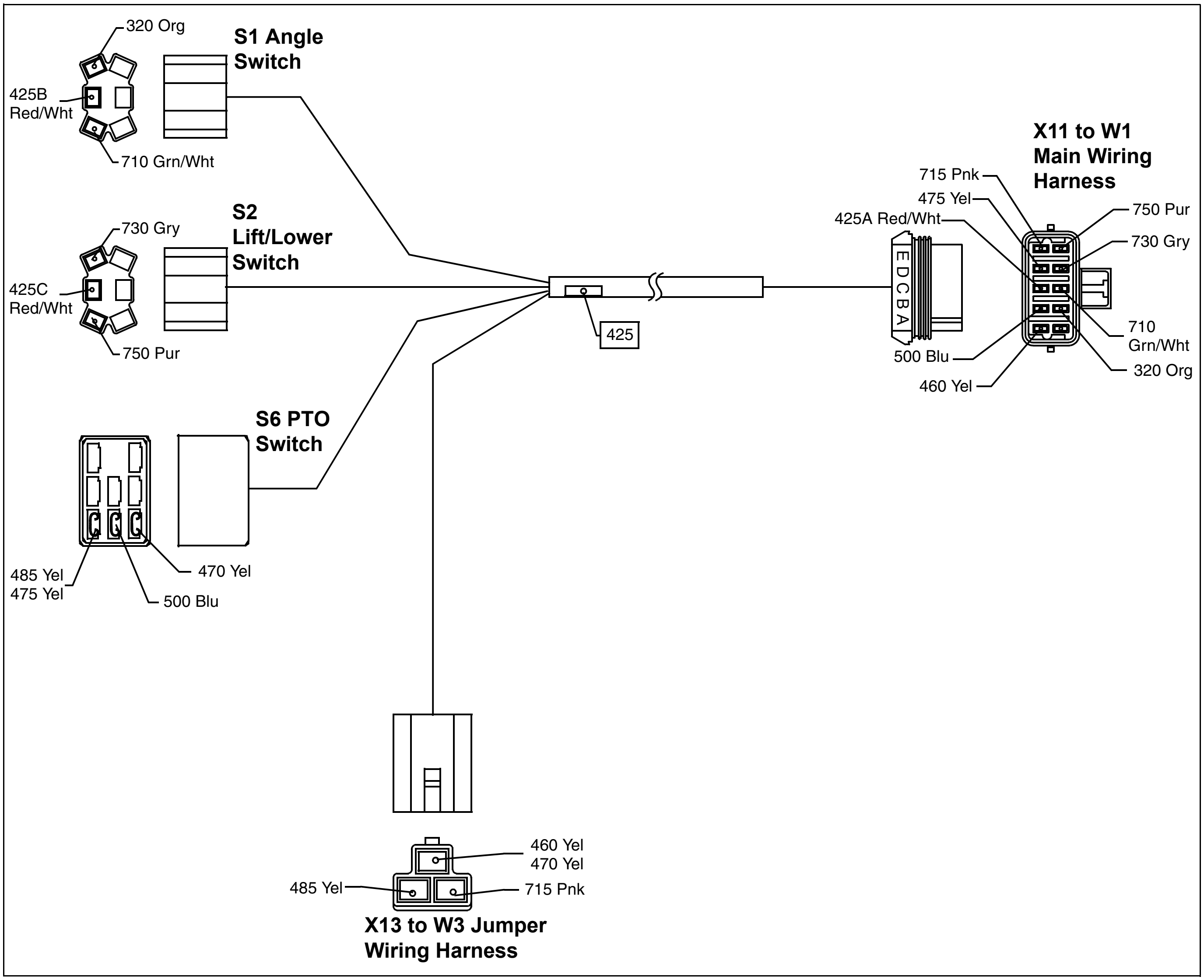
W2 Control Panel Wiring Harness



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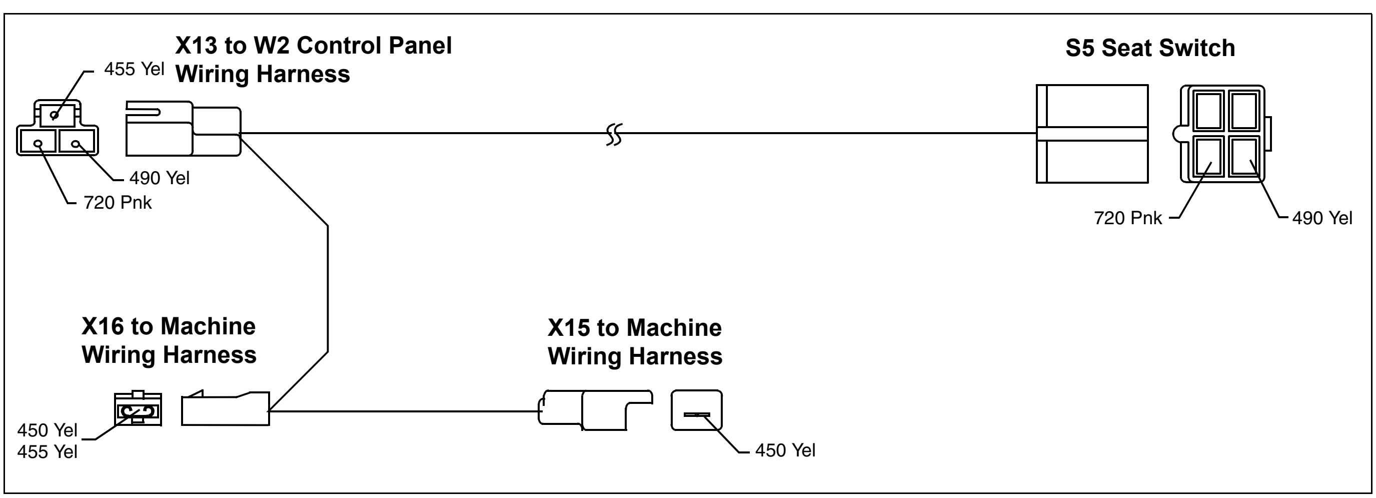
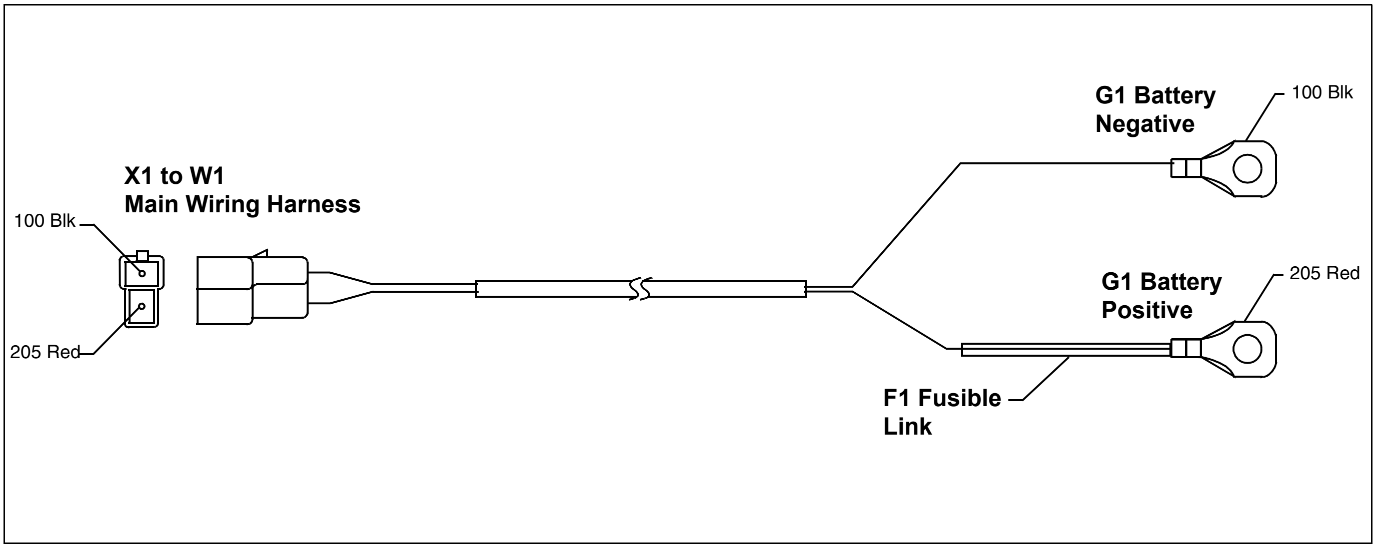
W3 Jumper Wiring Harness



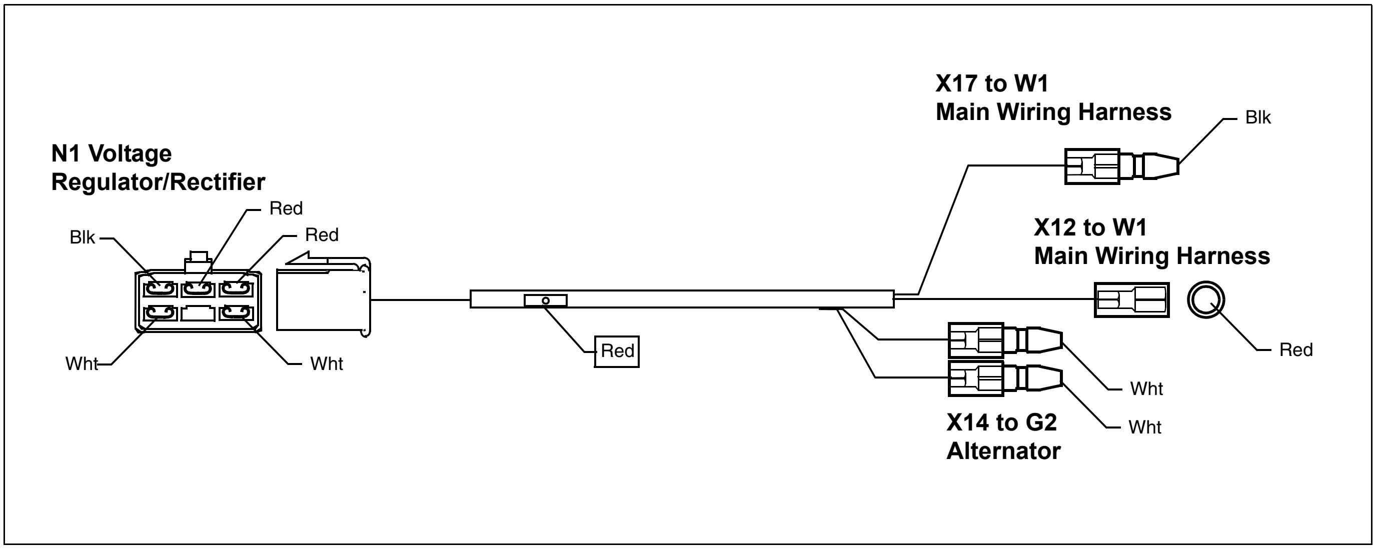
MIF

W4 Power Supply Wiring Harness



MIF

W5 Engine Wiring Harness



MIF

W1 Main Wiring Harness Color Codes

Size/No./Color	Wire Connection Points
2.0 110A Blk	X1, Splice
0.8 110B Blk	Splice, Y1
2.0 110C Blk	Splice, Splice
0.8 110D Blk	Splice, Y2
0.8 110E Blk	Splice, Y3
0.8 110F Blk	Splice, Splice
0.8 110G Blk	Splice, K1
2.0 110H Blk	Splice, K1
2.0 110I Blk	Splice, K2
0.8 110J Blk	Splice, K2
0.8 110K Blk	Splice, K3
0.8 110L Blk	Splice, K4
0.8 110M Blk	Splice, X17
0.8 110N Blk	Splice, X18
2.0 210A Red	X1, Splice
2.0 210B Red	Splice, K3
2.0 210C Red	Splice, K2
2.0 210D Red	Splice, K1
0.8 210E Red	Splice, X12
2.0 300 Org	K1, M1
0.8 310 Org	V1, K1
0.8 315 Org	K1, X10
0.8 420A Red/Wht	Splice, K3
0.8 420B Red/Wht	Splice, K4
0.8 420C Red/Wht	X11, Splice
0.8 465 Yel	K3, X11
0.8 480 Yel	K4, X11
0.8 510 Blu	X11, X18
2.0 700 Blk	K2, M1
0.8 710 Pnk	K4, X11
0.8 715A Grn/Wht	Splice, X11
0.8 715B Grn/Wht	Splice, V4
0.8 715C Grn/Wht	V3, Splice
0.8 720A Grn	Splice, Y1
0.8 720B Grn	V3, Splice
0.8 720C Grn	V1, Splice
0.8 735A Gry	X11, Splice
0.8 735B Gry	Y2, Splice
0.8 735C Gry	V6, Splice
0.8 740 Blk/Wht	K2, V6
0.8 745 Blk/Wht	V4, K2
0.8 755 Pur	Y3, X11

W2 Control Panel Wiring Harness Color Codes

Size/No./Color	Wire Connection Points
0.8 320 Org	S1, X11
0.8 425A Red/Wht	X11, Splice
0.8 425B Red/Wht	S1, Splice
0.8 425C Red/Wht	S2, Splice
0.8 460 Yel	X13, X11
0.8 470 Yel	S6, X13
0.8 475 Yel	S6, X11
0.8 485 Yel	S6, X13
0.8 500 Blu	S6, X11
0.8 710 Grn/Wht	S1, X11
0.8 715 Pnk	X13, X11
0.8 730 Gry	S2, X11
0.8 750 Pur	S2, X11

W3 Jumper Wiring Harness Color Codes

Size/No./Color	Wire Connection Points
0.8 450 Yel	X15, X16
0.8 455 Yel	X16, X13
0.8 490 Yel	X13, S5
0.8 720 Pnk	X13, S5

W4 Power Supply Wiring Harness Color Codes

Size/No./Color	Wire Connection Points
1.5 100 Blk	G1, X1
1.5 205 Red	G1, X1

W5 Engine Wiring Harness Color Codes

Size/Color	Wire Connection Points
1.0 Blk	N1, X17
1.0 Red	N1, Splice
1.0 Red	N1, Splice
1.0 Red	Splice, X12
1.0 Wht	N1, X14
1.0 Wht	N1, X14

Operation and Diagnostics, Rotary Broom Electrical

Power Circuit Operation

Function:

To provide unswitched and switched power to the broom operating controls.

Unswitched Power Operation:

Unswitched power is supplied by the machine battery to the broom circuits via the 205, 210A, 210B, 210C, 210D, and 210E Red wires. This circuit is protected by the F1 fusible link.

From the machine battery current flows through the F1 fusible link, 205 Red wire, X1 connector, and 210A Red wire to the 210 Splice.

From the 210 splice current flows to the K3 power relay on the 210B Red wire, the K2 motor relay on the 210C Red wire, the K1 motor relay on the 210D Red wire, and the N1 voltage regulator/rectifier on the 210E Red wire, X12 connector and the red wires of the W5 engine wiring harness.

The ground circuit for all the broom components is also unswitched and is completed using the 100 Blk and the 110 Blk series of wires.

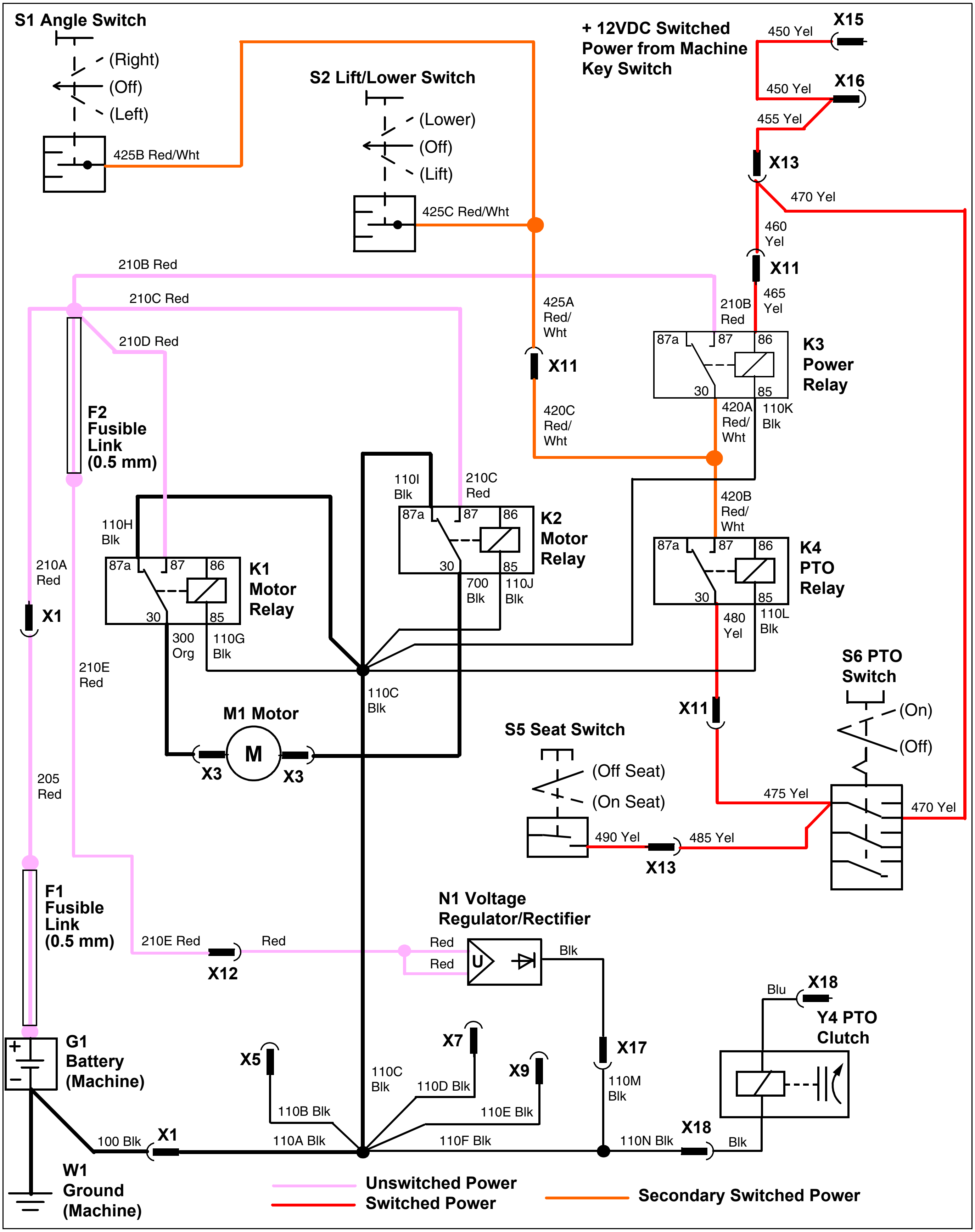
Switched Power Operation:

Switched power is provide controlled by the machine key switch. When the machine key switch is placed in the run position, power is provided the broom controls through the 450, 455, 465, 470, 475, 480, 485, and 490 Yel wires.

The 450, 455, 460, and 465 Yel wires supply power to the K3 power relay. This energizes the power relay which closes its contacts and supplies secondary switched power to the broom control switches by connecting unswitched power from the 210B Red wire to the 420A Red/Wht wire. The 420A Red wire splices to the 420B and 420C Red/Wht wires. The 420B Red/Wht wire connects to the K4 PTO relay, while the 420C Red/Wht wire connects to the 425A Red/Wht wire which splices to the 425B and 425C Red/Wht wires. The 425B Red/Wht wire connects to the S1 angle switch and the 425C Red/Wht wire connects to the S2 lift/lower switch.

At the same time the power relay is receiving power, the 450, 455, and 470 Yel wires are providing power to the S6 PTO switch. From the 470 Yel wire power flows across the S6 PTO switch normally closed contacts to the 475 and 485 Yel wires. The 475 Yel wire connects to the 480 Yel wire and the K4 PTO relay, while the 485 Yel wire connects to the 490 Yel wire and the S5 seat switch.

Power Circuit Electrical Schematic

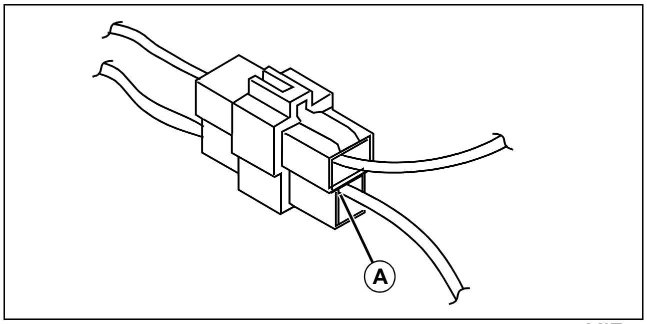


Power Circuit Diagnosis

Test Conditions:

- Machine parking brake locked.
- Machine key switch in off position.

System: Unswitched power circuit.

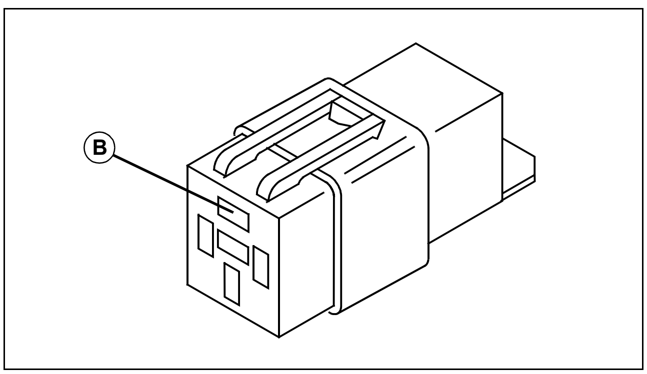


MIF

(1) Is battery voltage present at X1 connector (A)?

Yes - Go to step (2).

No - Check F1 fusible link. Check 205 Red wire and connections. Test machine battery. Go to step (2) to continue test.



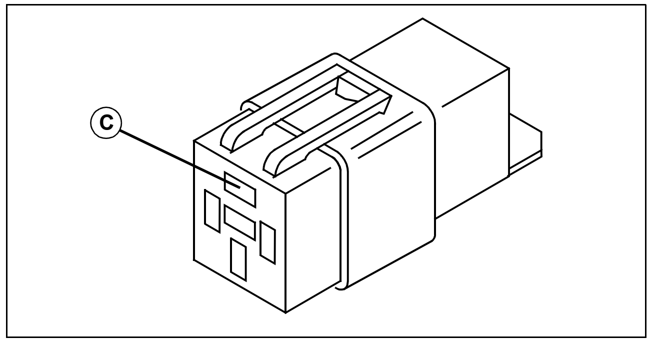
MIF

(2) Is battery voltage present at K3 power relay (B)?

Yes - Go to step (3).

No - Check 210A and 210B Red wires and connections. Go to step (3) to continue test.

System: Unswitched power circuit.

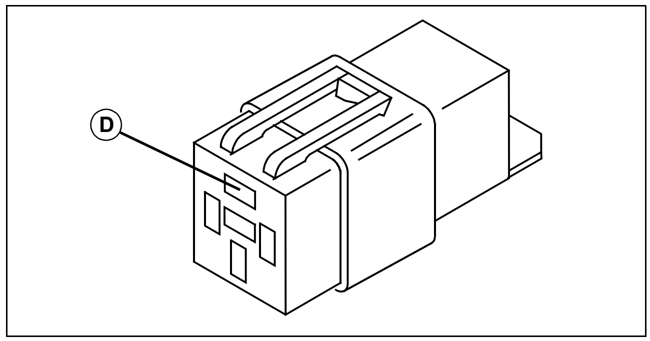


MIF

(3) Is battery voltage present at K2 motor relay (C)?

Yes - Go to step (4).

No - Check 210A and 210C Red wires and connections. Go to step (4) to continue test.

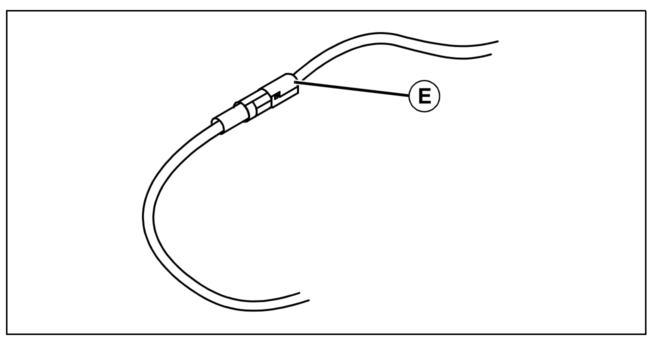


MIF

(4) Is battery voltage present at K1 motor relay (D)?

Yes - Go to step (5).

No - Check 210A and 210D Red wires and connections. Go to step (5) to continue test.



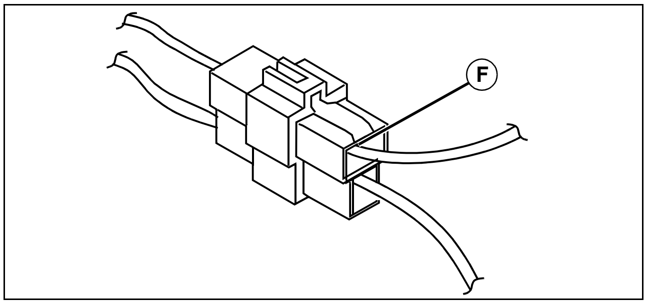
MIF

(5) Is battery voltage present at X12 connector (E)?

Yes - Go to step (6).

No - Check F2 fusible link. Check 210A and 210E Red wires and connections. Go to step (6) to continue test.

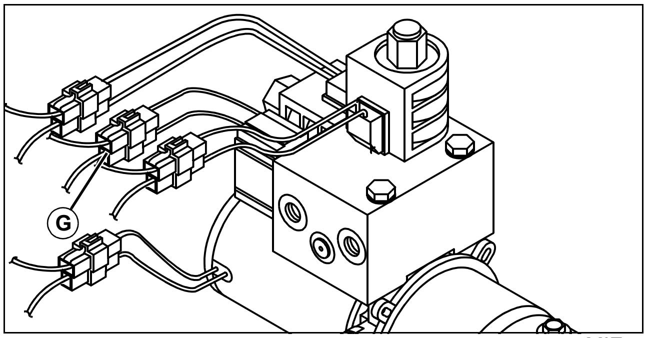
System: Unswitched power circuit.



(6) Is continuity to ground present at X1 connector (F)?

Yes - Go to step (7).

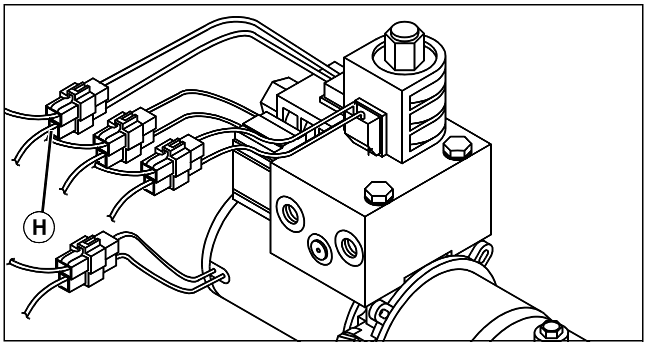
No - Check 100 Blk wires and connections. Go to step (7) to continue test.



(7) Is continuity to ground present at X5 connector (G)?

Yes - Go to step (8).

No - Check 100, 110A, and 110B Blk wires and connections. Go to step (8) to continue test.

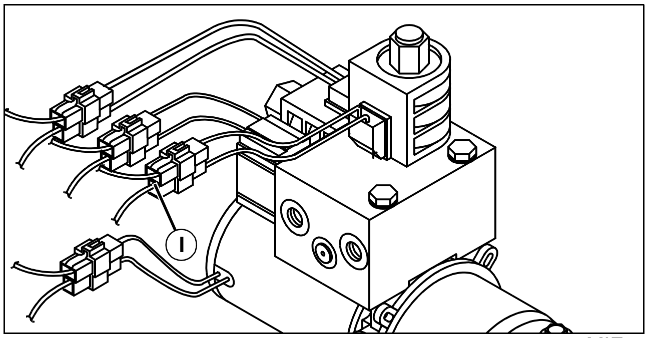


(8) Is continuity to ground present at X7 connector (H)?

Yes - Go to step (9).

No - Check 100, 110A, and 110D Blk wires and connections. Go to step (9) to continue test.

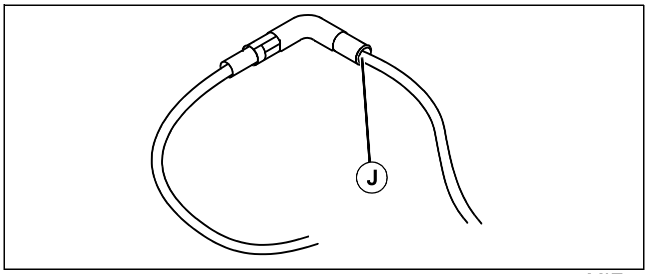
System: Unswitched power circuit.



(9) Is continuity to ground present at X9 connector (I)?

Yes - Go to step (10).

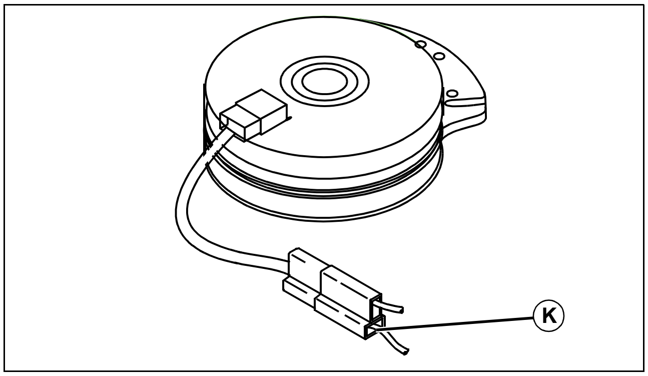
No - Check 100, 110A, and 110E Blk wires and connections. Go to step (10) to continue test.



(10) Is continuity to ground present at X17 connector (J)?

Yes - Go to step (11).

No - Check 100, 110A, 110F, and 110M Blk wires and connections. Go to step (11) to continue test.

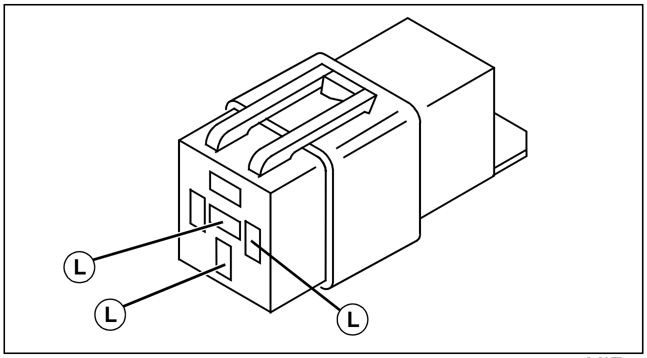


(11) Is continuity to ground present at X18 connector (K)?

Yes - Go to step (12).

No - Check 100, 110A, 110F, and 110N Blk wires and connections. Go to step (12) to continue test.

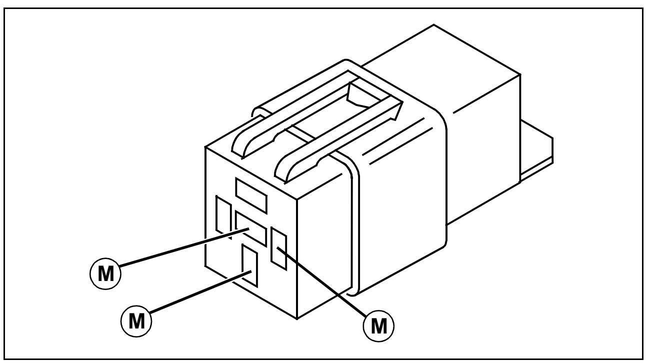
System: Unswitched power circuit.



(12) Is continuity to ground present at 3 places on K1 motor relay (L)?

Yes - Go to step (13).

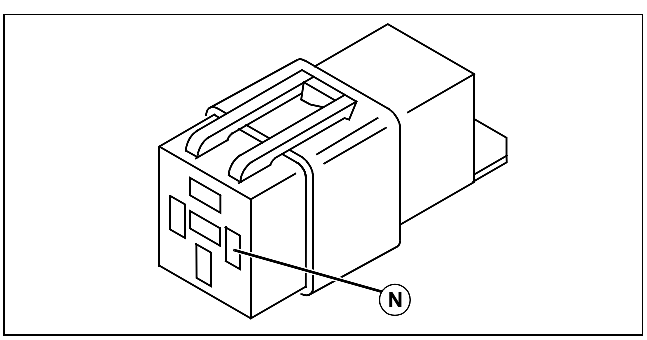
No - Check 100, 110A, 110C, 110H and 110G Blk wires and connections. Test the K1 relay. Go to step (13) to continue test.



(13) Is continuity to ground present at 3 places on K2 motor relay (M)?

Yes - Go to step (14).

No - Check 100, 110A, 110C, 110I and 110J Blk wires and connections. Test the K2 relay. Go to step (14) to continue test.

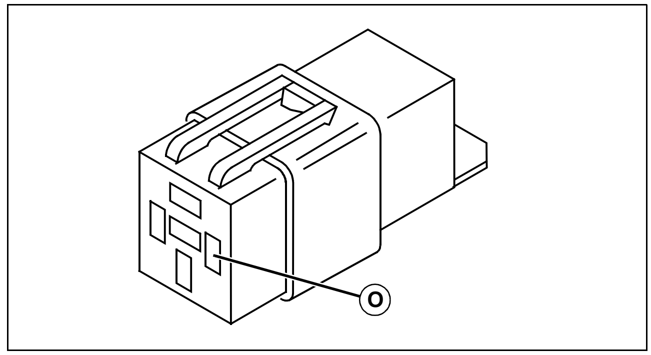


(14) Is continuity to ground present at K3 power relay (N)?

System: Unswitched power circuit.

Yes - Go to step (15).

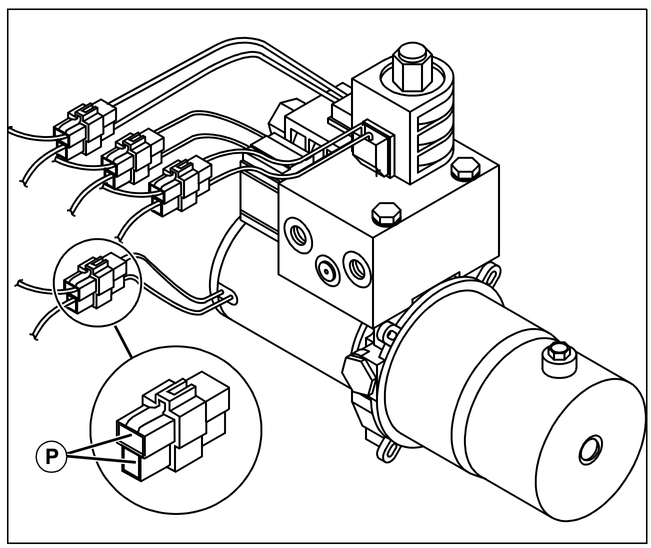
No - Check 100, 110A, 110C, and 110K Blk wires and connections. Go to step (15) to continue test.



(15) Is continuity to ground present at K4 PTO relay (O)?

Yes - Go to step (16).

No - Check 100, 110A, 110C, and 110L Blk wires and connections. Go to step (16) to continue test.



(16) Is continuity to ground present at X3 connector (P)?

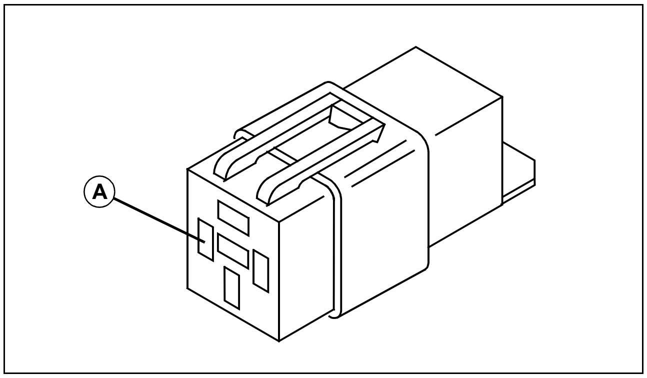
Yes - Go to step (1) of switched power circuit diagnosis to continue test.

No - Check 100, 110A, 110C, 110H, and 110I Blk wires and connections. Check 300 Org and 700 Blk wires and connections. Test the K1 and K2 relays. Go to step (1) of switched power circuit diagnosis to continue test.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in run position, engine off.
- Operator off machine seat.
- Broom PTO off.

System: Switched power circuit.

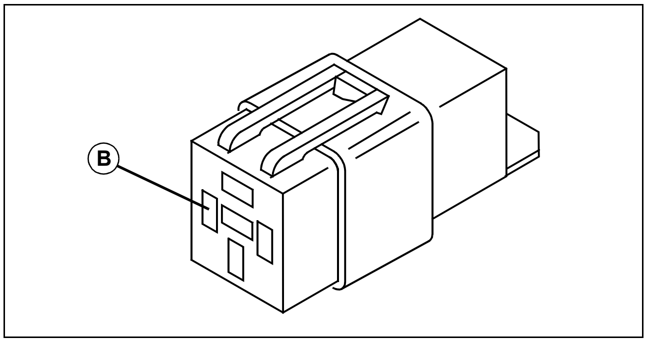


MIF

(1) Is battery voltage present at K3 power relay (A)?

Yes - Go to step (2).

No - Check 450, 455, 460, and 465 Yel wires and connections. Test machine power circuit. Go to step (2) to continue test.



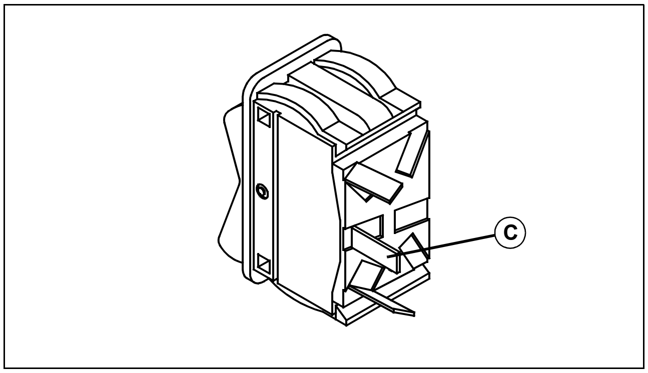
MIF

(2) Is battery voltage present at K4 PTO relay (B)?

Yes - Go to step (3).

No - Check 420A and 420B Red/Wht wires and connections. If ok, replace power relay. Go to step (3) to continue test.

System: Switched power circuit.

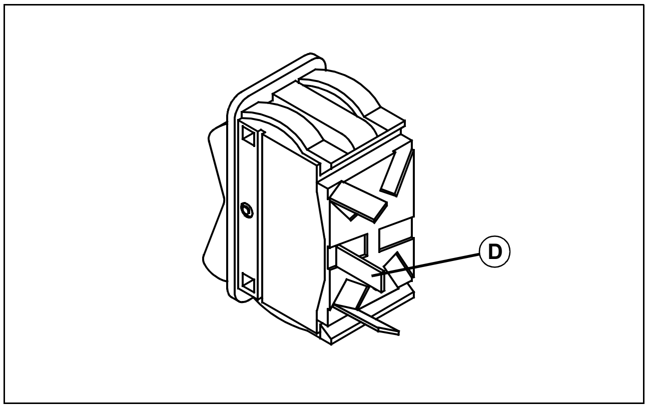


MIF

(3) Is battery voltage present at S1 angle switch (C)?

Yes - Go to step (4).

No - Check 420A, 420C, 425A, and 425B Red/Wht wires and connections. If ok, replace power relay. Go to step (4) to continue test.



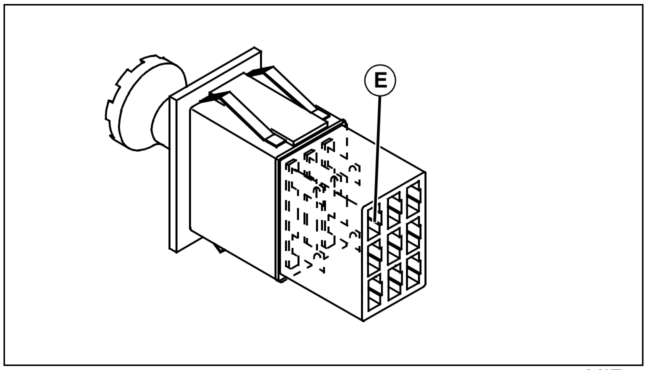
MIF

(4) Is battery voltage present at S2 lift/lower switch (D)?

Yes - Go to step (5).

No - Check 420A, 420C, 425A, and 425C Red/Wht wires and connections. If ok, replace power relay. Go to step (5) to continue test.

System: Switched power circuit.

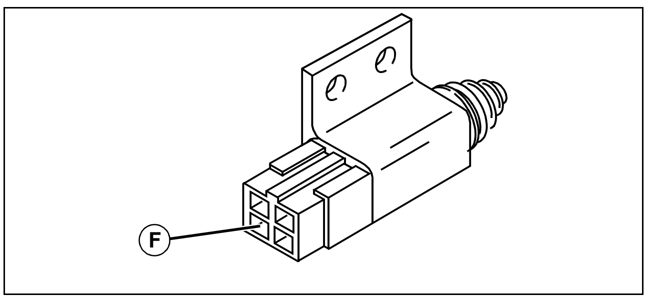


MIF

(5) Is battery voltage present at S6 PTO switch (E)?

Yes - Go to step (6).

No - Check 450, 455, and 470 Yel wires and connections. Test machine power circuit. Go to step (6) to continue test.

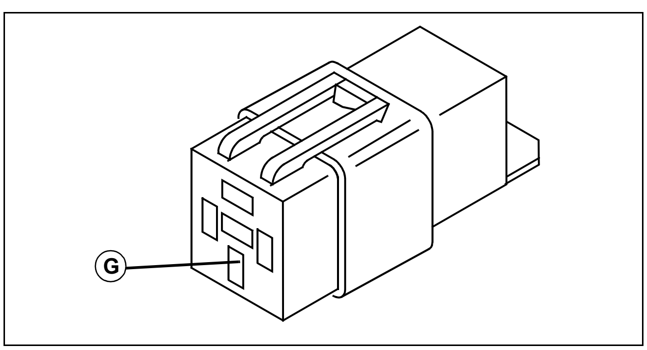


MIF

(6) Is battery voltage present at S5 seat switch (F)?

Yes - Go to step (7).

No - Check 485 and 490 Yel wires and connections. If ok, replace PTO switch. Go to step (7) to continue test.



MIF

(7) Is battery voltage present at K4 PTO relay (G)?

Yes - Test complete.

No - Check 475 and 480 Yel wires and connections. If ok, replace PTO switch. Test complete.

Charging Circuit Operation

Function:

To maintain battery voltage between 12.4 and 13.2 volts.

Operating Conditions:

The ignition switch in the run position with the engine running for the charging system to operate.

System Operation:

The charging system is a permanent magnet and stator design. Charging output is controlled by the N1 voltage regulator/rectifier.

The battery sensing/charging circuit is unswitched. The battery sensing circuit current flows from battery positive terminal to F1 and F2 fusible links and N1 voltage regulator/rectifier.

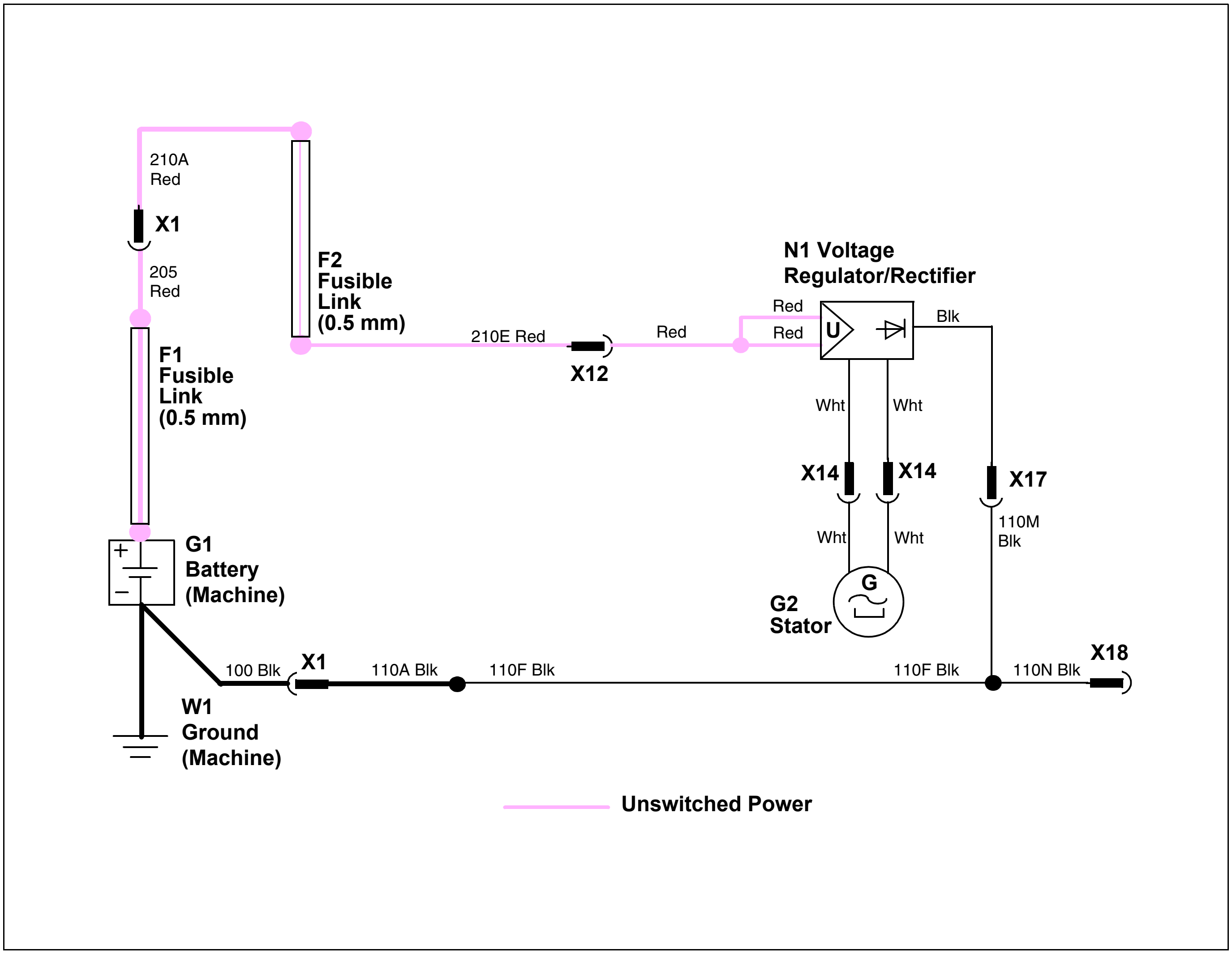
The battery sensing circuit allows the voltage regulator/ rectifier to monitor battery voltage.

As the flywheel turns, a permanent magnet located in the flywheel induces AC current in the stator. The AC current flows to the voltage regulator/rectifier. The voltage regulator/rectifier converts AC current to DC current needed to charge the battery.

If battery voltage is low, the voltage regulator/rectifier allows DC current to flow to the battery to charge it through the battery charging circuit. 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.

Charging Circuit Electrical Schematic



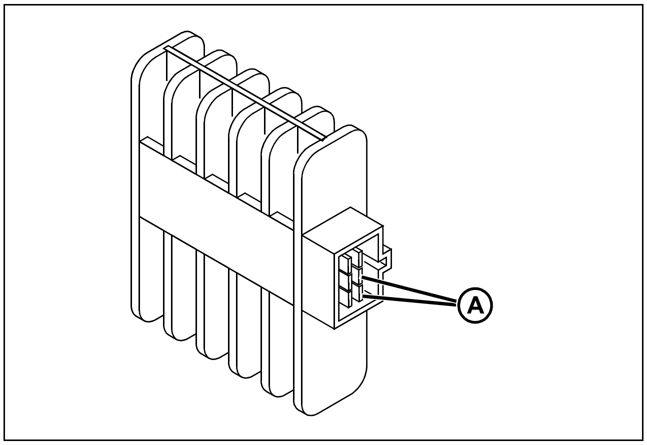
MIF

Charging Circuit Diagnosis

Test Conditions:

- Machine key switch in off position.
- Broom engine off.

System: Unswitched power and ground connections.

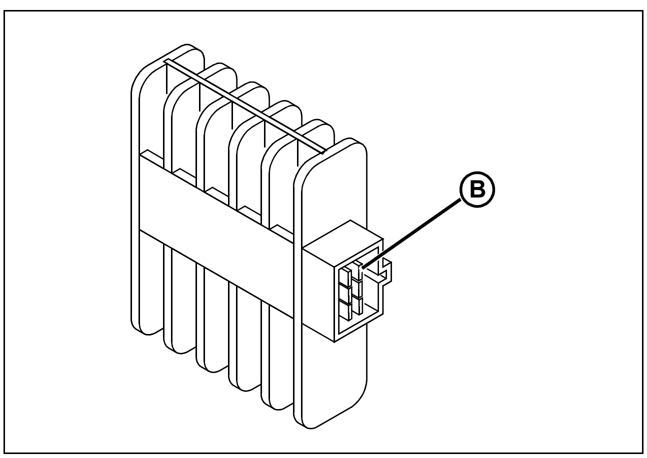


MIF

(1) Is battery voltage present at Red wires (A) at N1 voltage regulator/rectifier?

Yes - Go to step (2).

No - Check F2 fusible link. Check 210A and 210E Red, and W5 engine wiring harness Red wires and connections. Go to step (2) to continue test.



MIF

(2) Is continuity to ground present at Blk wire (B) at N1 voltage regulator/rectifier?

Yes - Go to step (1) of regulated voltage output diagnosis to continue test.

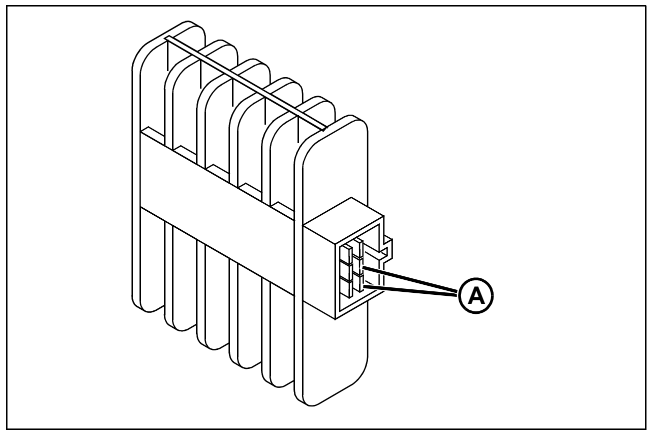
System: Unswitched power and ground connections.

No - Check 100, 110A, 110F, and 110M Blk, and W5 engine wiring harness Blk wires and connections. Go to step (1) of regulated voltage output diagnosis to continue test.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in off position.
- Broom engine running at high idle.

System: Stator DC regulated voltage output.



MIF

(1) Does the DC voltage read 14.0 - 15.0 VDC at Red wires (A) at N1 voltage regulator/rectifier?

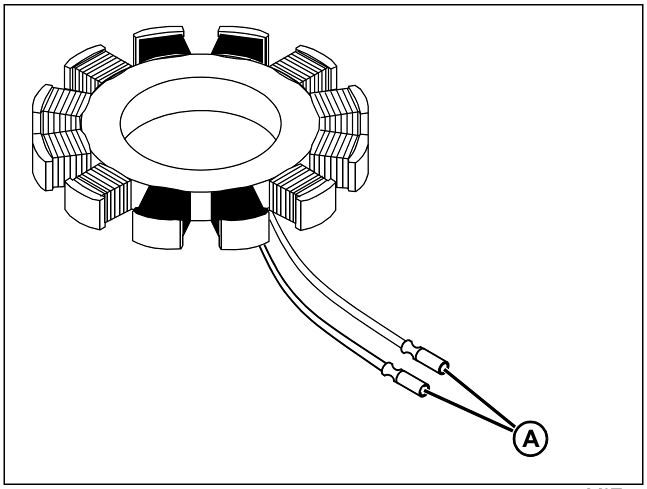
Yes - Go to step (1) of unregulated voltage output diagnosis to continue test.

No - Go to step (1) of unregulated voltage output diagnosis to continue test.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in off position.
- Broom engine running at high idle.
- Disconnect X14 Wht wires from G2 stator.

System: Stator AC unregulated voltage output.



MIF

(1) Does the AC voltage across the stator Wht wires (A) measure at least 20 VAC?

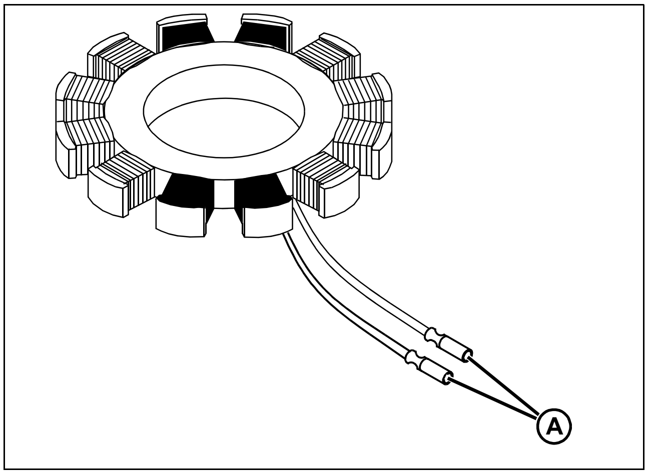
Yes - Test complete.

No - Check flywheel stator magnets for damage. Replace as needed. Go to step (1) of stator winding resistance diagnosis to continue test.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in off position.
- Broom engine off.
- Disconnect X14 Wht wires from G2 stator.
- Ohmmeter set to RX1 scale.

System: Stator Winding Resistance



MIF

(1) Does the resistance across the stator windings (A) measure approximately 0.08 - 0.26 ohms.

Yes - Stator is OK. Test complete.

No - If the resistance is infinity ohms, the stator is open. Replace stator. Test complete.

No - If the resistance is 0 ohms, the stator is shorted. Replace stator. Test complete.

Lift/Lower Circuit Operation

Function:

To engage the hydraulic pump motor and energize the lift solenoid causing the broom head to be raised, or to energize the lowering solenoid and allow the broom head to lower to the ground.

Operation - Lift:

The lift circuit is controlled by both the unswitched and switched power circuits.

The switched power circuit provides power to the S2 lift/lower switch from the machine switched power circuit through the 450, 455, 460, and 465 Yel wires to the K3 power relay to energize the relay.

Current flow from the unswitched power circuit then flows to the S2 lift/lower switch from the machine battery using the F1 fusible link, 205, 210A, and 210B Red wires, K3 power relay, 420A, 420C, 425A, and 425C Red/Wht wires.

With the S2 lift/lower switch toggled to the lift position, current flows from the 425C Red/Wht wire across the S2 lift/lower switch to the 730, 735A, 735B, and 735C Gry wires. The 735B Gry wire provides current to the Y2 lift solenoid to energize the solenoid and shift the lift valve. At the same time, the 735C Gry wire provides current flow across the V6 diode, 740 Blk/Wht wire to the K2 motor relay. This energizes the K2 motor relay which in turn provides current to the 700 Blk wire and the M1 motor causing the motor to run.

The ground for the M1 motor is provided through the 300 Org wire, K1 motor relay normally closed contacts, 110H, 110C, 110A, and 100 Blk wires.

With the motor running and the lift valve shifted, hydraulic fluid is pumped to the lift cylinder causing the cylinder to extend.

Operation - Lower:

The lowering circuit is controlled by both the unswitched and switched power circuits.

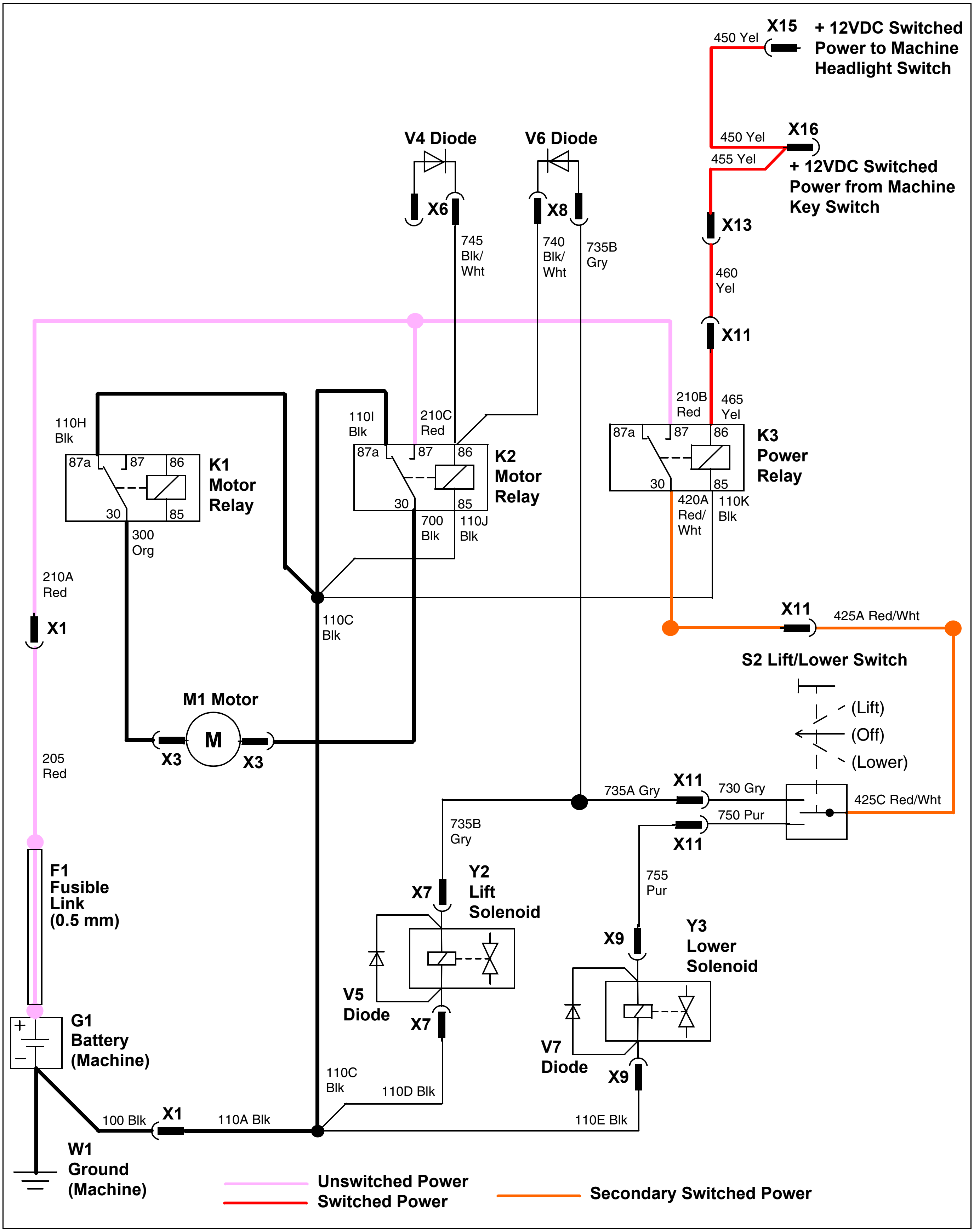
The switched power circuit provides power to the S2 lift/lower switch from the machine switched power circuit through the 450, 455, 460, and 465 Yel wires to the K3 power relay to energize the relay.

Current flow from the unswitched power circuit then flows to the S2 lift/lower switch from the machine battery using the F1 fusible link, 205, 210A, and 210B Red wires, K3 power relay, 420A, 420C, 425A, and 425C Red/Wht wires.

With the S2 lift/lower switch toggled to the lower position, current flows from the 425C Red/Wht wire across the S2 lift/lower switch to the 750 and 755 Pur wires. The 755 Pur wire provides current to the Y3 lower solenoid to energize the solenoid and shift the lower valve.

With the lower valve shifted, the weight of the broom head causes the hydraulic fluid to flow back to the reservoir and retract the lift cylinder.

Lift Circuit Electrical Schematic



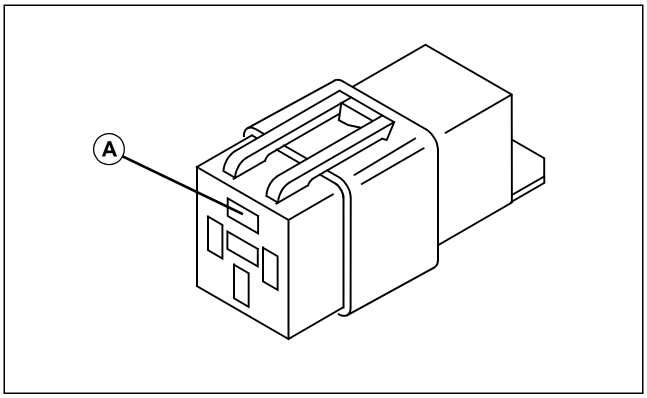
MIF

Lift Circuit Diagnosis

Test Conditions:

- Machine parking brake locked.
- Machine key switch in off position.
- Broom engine not running.

System: Lift/Lower circuit unswitched power.

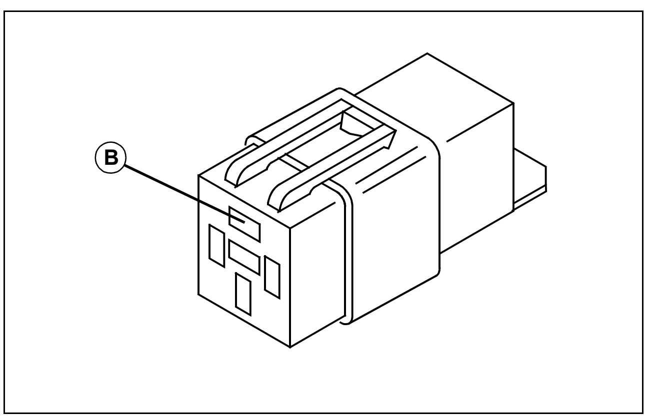


MIF

(1) Is battery voltage present at K3 power relay (A)?

Yes - Go to step (2).

No - Check F1 fusible link, 205, 210A and 210B Red wires and connections. Go to step (2) to continue test.



MIF

(2) Is battery voltage present at K2 motor relay (B)?

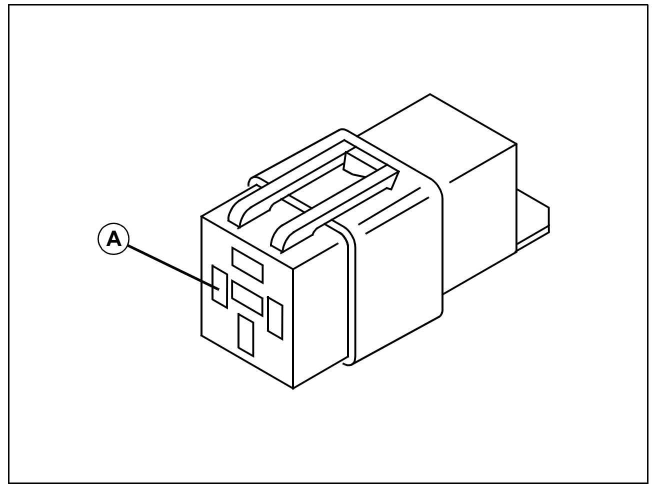
Yes - Go to step (1) of Lift/Lower switched power circuit diagnosis to continue test.

No - Check F1 fusible link, 205, 210A and 210C Red wires and connections. Go to step (1) of Lift/Lower switched power circuit diagnosis to continue test.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in run position, engine off.
- Broom engine not running.

System: Lift/Lower circuit switched power.

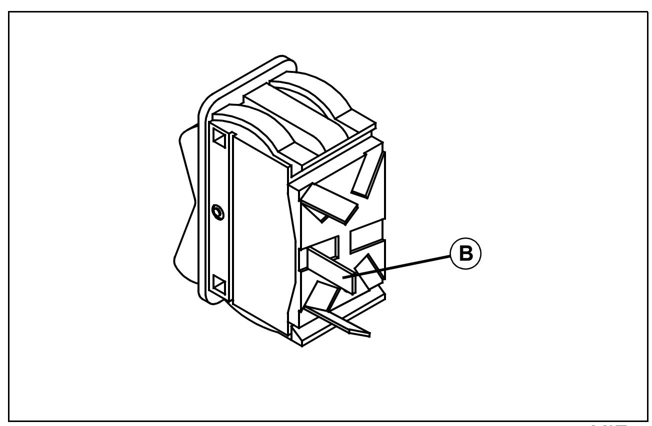


MIF

(1) Is battery voltage present at K3 power relay (A)?

Yes - Go to step (2).

No - Check 450, 455, 460, and 465 Yel wires and connections. Test machine power circuit. Go to step (2) to continue test.



MIF

(2) Is battery voltage present at S2 lift/lower switch (B)?

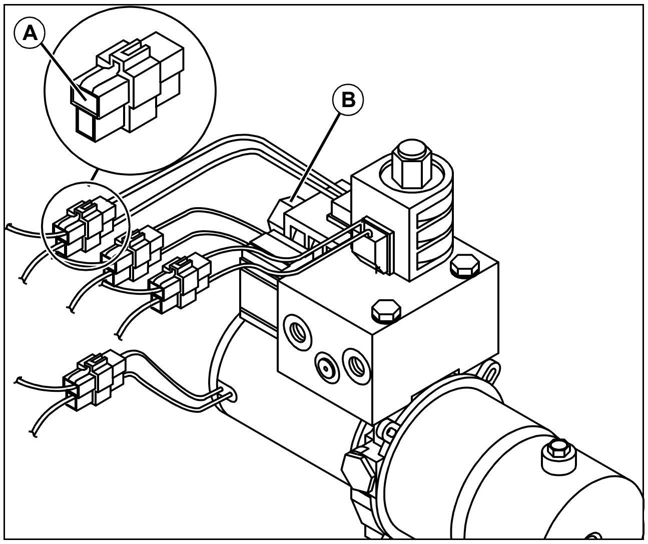
Yes - Go to step (1) of Lift circuit diagnosis to continue test.

No - Check 420A, 420C, 425A, and 425C Red/Wht wires and connections. If ok, replace power relay. Go to step (1) of Lift circuit diagnosis to continue test.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in run position, engine off.
- Lift/lower switch in lift position during each test.
- Broom engine not running.

System: Lift circuit.

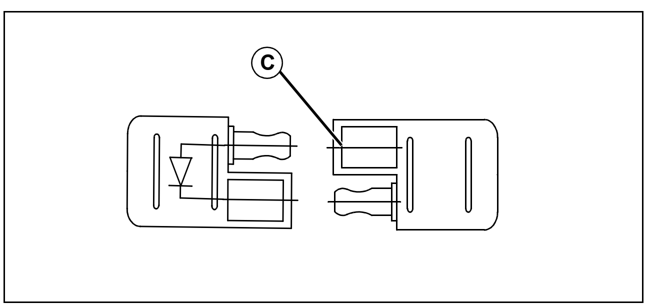


MIF

(1) Is battery voltage present at X7 connector (A) to the Y2 lift solenoid? Is lift solenoid magnetized (B)?

Yes - Go to step (2).

No - Check 730, 735A, and 735B Gry wires and connections. If ok, replace lift/lower switch. Go to step (2) to continue test.



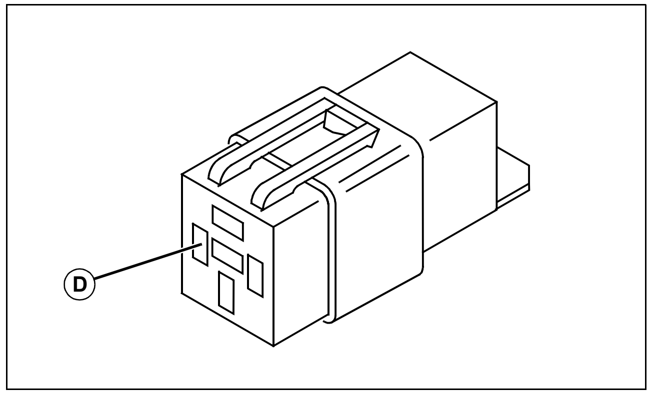
MIF

(2) Is battery voltage present at X8 connector (C) to the V6 diode?

Yes - Go to step (3).

No - Check 730, 735A, and 735C Gry wires and connections. If ok, replace lift/lower switch. Go to step (3) to continue test.

System: Lift circuit.

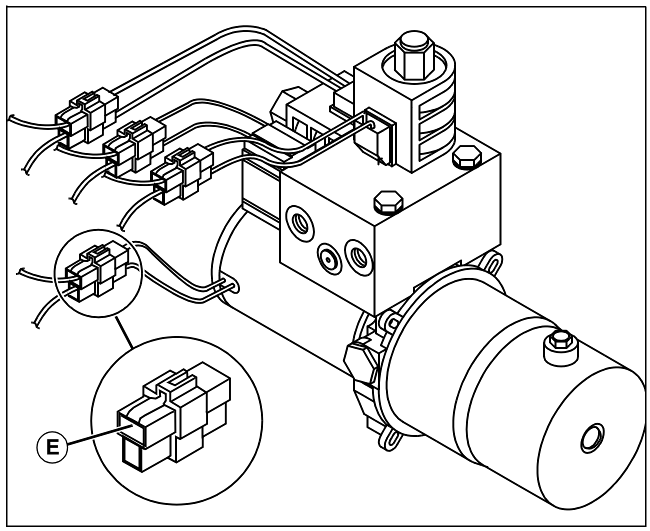


MIF

(3) Is battery voltage present at K2 motor relay (D)?

Yes - Go to step (4).

No - Check 740 Blk/Wht wire and connections. Test the V6 diode. Go to step (4) to continue test.



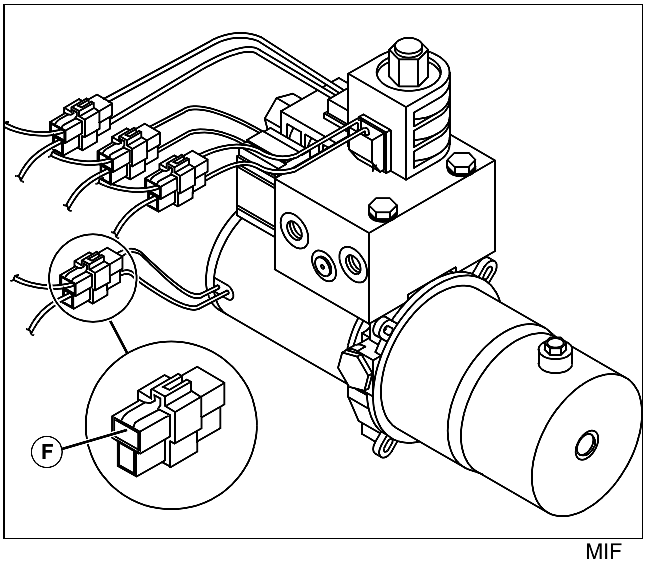
MIF

(4) Is battery voltage present at X3 connector (E) to the M1 motor?

Yes - Go to step (5).

No - Check 700 Blk wire and connections. If ok, replace K2 relay. Go to step (5) to continue test.

System: Lift circuit.



(5) Is continuity to ground present at X3 connector (F)?

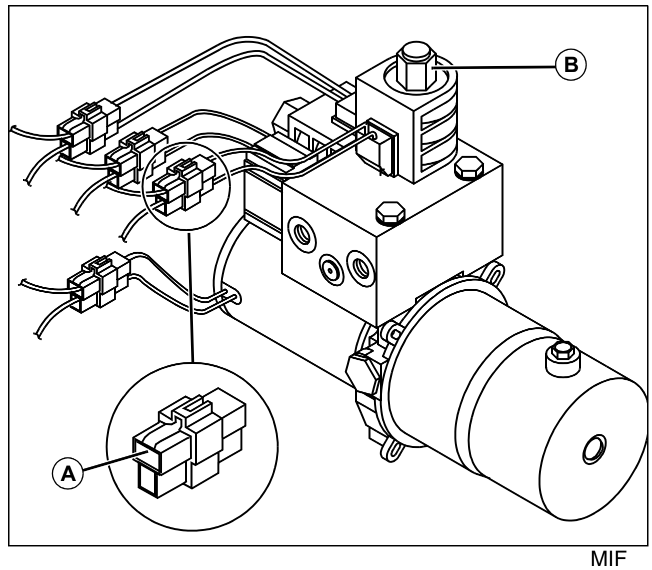
Yes - Lift circuit test complete.

No - Check 100, 110A, 110C, and 110H Blk wires and connections. Check 300 Org wire and connections. Test the K1 relays. Lift circuit test complete.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in run position, engine off.
- Lift/lower switch in lower position during each test.
- Broom engine not running.

System: Lower circuit.



(1) Is battery voltage present at X9 connector (A) to the Y3 lift solenoid? Is lower solenoid magnetized (B)?

Yes - Lower circuit test complete.

No - Check 750 and 755 Pur wires and connections. If ok, replace lift/lower switch. Lower circuit test complete.

Right and Left Angle Circuit Operation

Function:

To engage the hydraulic pump motor and energize the angle solenoid causing the broom head to be turned to the left or right.

Operation - Right Angle:

The right angle circuit is controlled by both the unswitched and switched power circuits.

The switched power circuit provides power to the S1 angle switch from the machine switched power circuit through the 450, 455, 460, and 465 Yel wires to the K3 power relay to energize the relay.

Current flow from the unswitched power circuit then flows to the S1 angle switch from the machine battery using the F1 fusible link, 205, 210A, and 210B Red wires, K3 power relay, 420A, 420C, 425A, and 425B Red/Wht wires.

With the S1 angle switch toggled to the right position, current flows from the 425B Red/Wht wire across the S1 angle switch to the 710, 715A, 715B, and 715C Gry/Wht wires. The 715B Gry/Wht wire provides current flow across the V4 diode, 745 Blk/Wht wire to the K2 motor relay. This energizes the K2 motor relay which in turn provides current from the unswitched power circuit 210C Red wire across the K2 motor relay to the 700 Blk wire and the M1 motor causing the motor to run. At the same time, the 715C Gry/Wht wire provides current flow across the V3 diode, 720B and 720A Grn wires to the Y1 angle solenoid to energize the solenoid and shift the angle valve.

The ground for the M1 motor is provided through the 300 Org wire, K1 motor relay normally closed contacts, 110H, 110C, 110A, and 100 Blk wires.

With the motor running and the angle valve shifted, hydraulic fluid is pumped to the angle cylinder causing the cylinder to extend.

Operation - Left Angle:

The left angle circuit is controlled by both the unswitched and switched power circuits.

The switched power circuit provides power to the S1 angle switch from the machine switched power circuit through the 450, 455, 460, and 465 Yel wires to the K3 power relay to energize the relay.

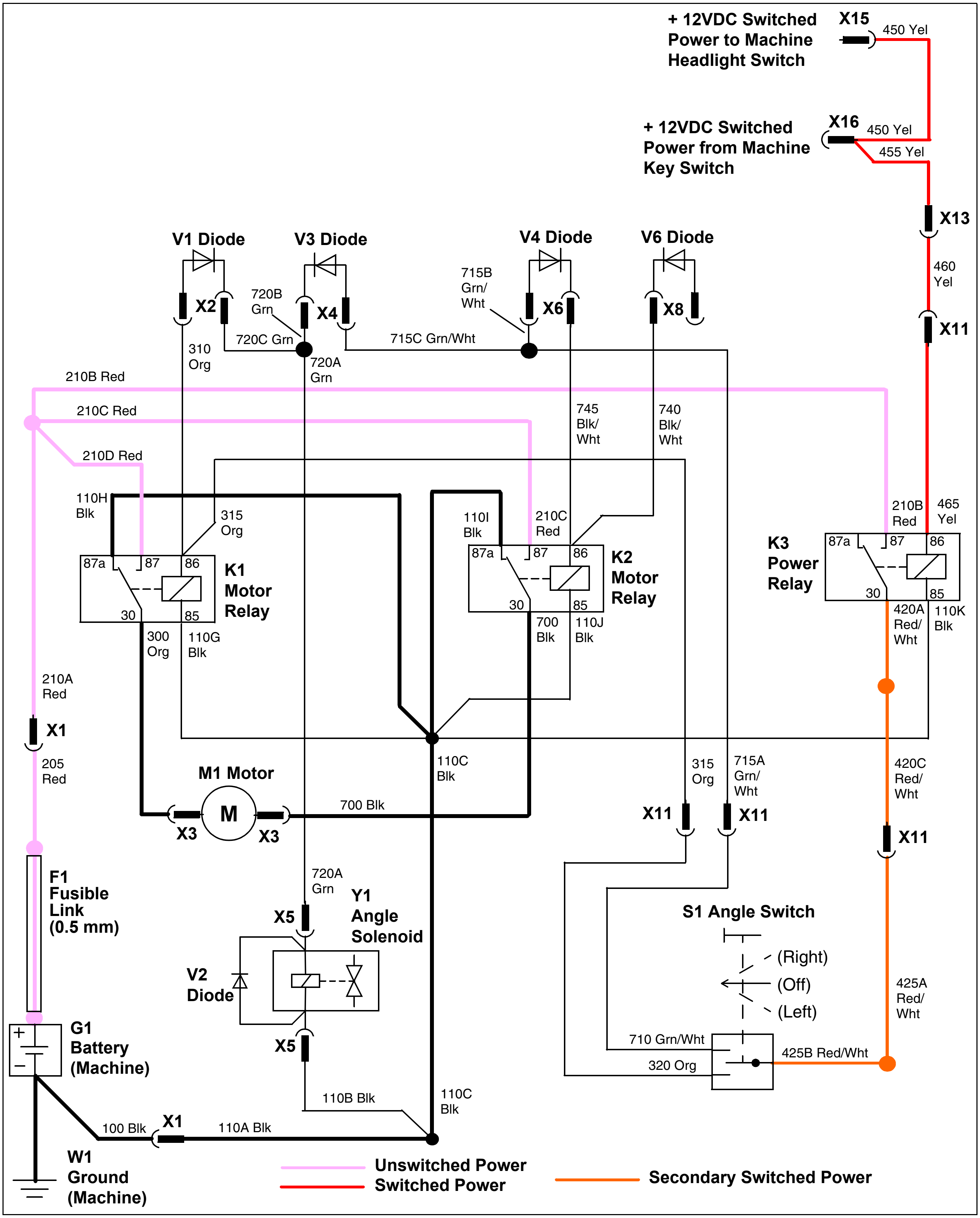
Current flow from the unswitched power circuit then flows to the S1 angle switch from the machine battery using the F1 fusible link, 205, 210A, and 210B Red wires, K3 power relay, 420A, 420C, 425A, and 425B Red/Wht wires.

With the S1 angle switch toggled to the left position, current flows from the 425B Red/Wht wire across the S1 angle switch to the 320, 315, and 310 Org wires. The 315 Org wire provides current flow to K1 motor relay. This energizes the K1 motor relay which in turn provides current from the unswitched power circuit 210D Red wire across the K1 motor relay to the 300 Org wire and the M1 motor causing the motor to run. At the same time, the 310 Org wire provides current flow across the V1 diode, 720C and 720A Grn wires to the Y1 angle solenoid to energize the solenoid and shift the angle valve.

The ground for the M1 motor is provided through the 700 Blk wire, K2 motor relay normally closed contacts, 110I, 110C, 110A, and 100 Blk wires.

With the motor running and the angle valve shifted, hydraulic fluid is pumped to the angle cylinder causing the cylinder to retract.

Right and Left Angle Circuit Electrical Schematic



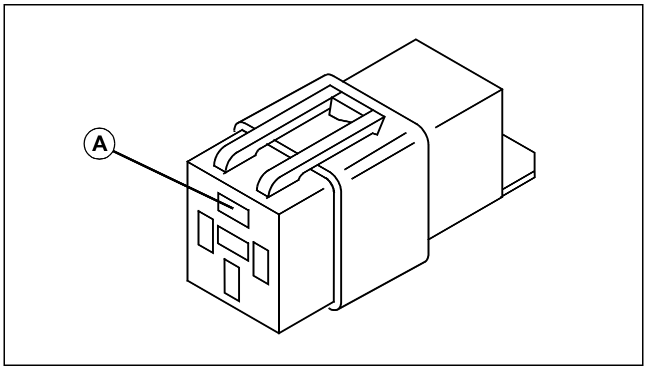
MIF

Right and Left Angle Circuit Diagnosis

Test Conditions:

- Machine parking brake locked.
- Machine key switch in off position.
- Broom engine not running.

System: Angle circuit unswitched power.

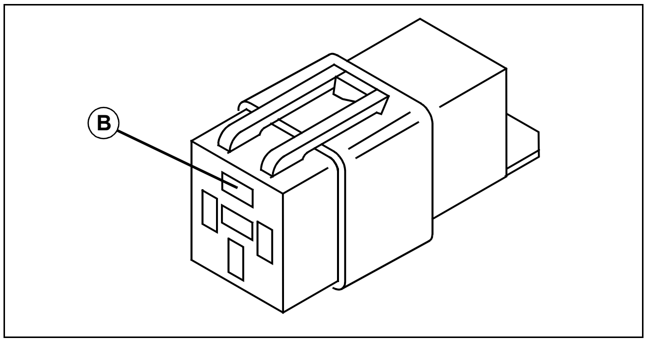


MIF

(1) Is battery voltage present at K3 power relay (A)?

Yes - Go to step (2).

No - Check F1 fusible link, 205, 210A and 210B Red wires and connections. Go to step (2) to continue test.



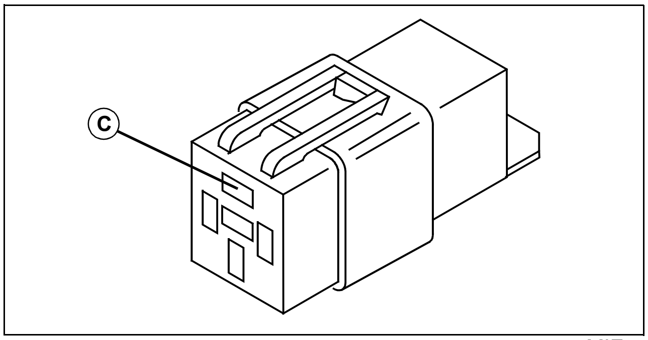
MIF

(2) Is battery voltage present at K2 motor relay (B)?

Yes - Go to step (3).

No - Check F1 fusible link, 205, 210A and 210C Red wires and connections. Go to step (3) to continue test.

System: Angle circuit unswitched power.



MIF

(3) Is battery voltage present at K1 motor relay (C)?

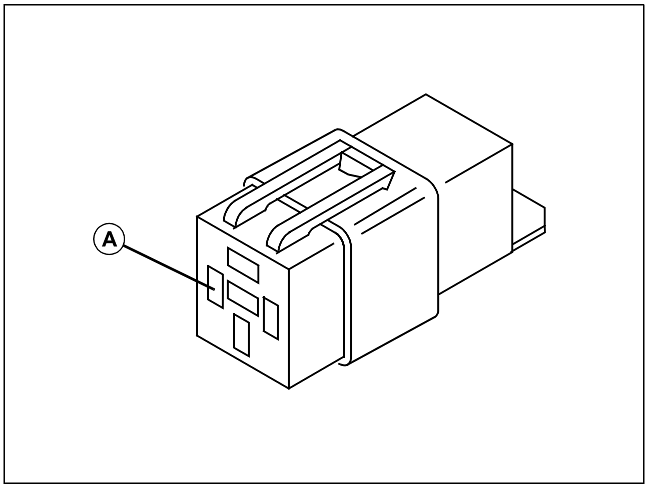
Yes - Go to step (1) of angle circuit switched power diagnosis to continue test.

No - Check F1 fusible link, 205, 210A and 210D Red wires and connections. Go to step (1) of angle circuit switched power diagnosis to continue test.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in run position, engine off.
- Broom engine not running.

System: Angle circuit switched power.



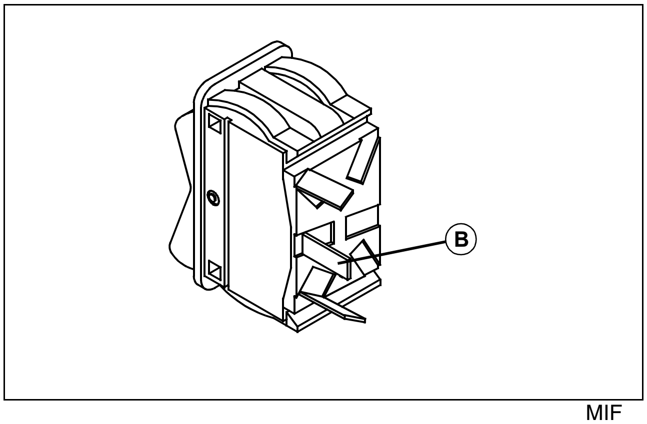
MIF

(1) Is battery voltage present at K3 power relay (A)?

Yes - Go to step (2).

No - Check 450, 455, 460, and 465 Yel wires and connections. Test machine power circuit. Go to step (2) to continue test.

System: Angle circuit switched power.



(2) Is battery voltage present at S1 angle switch (B)?

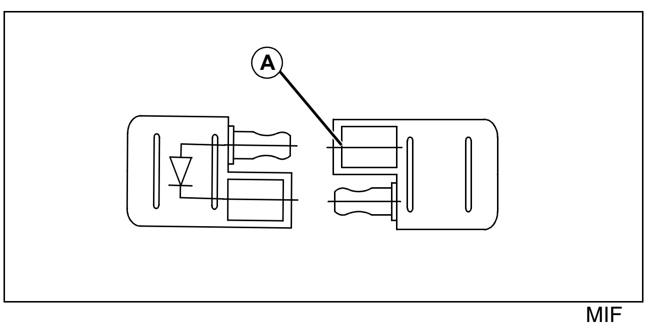
Yes - Go to step (1) of right angle circuit diagnosis to continue test.

No - Check 420A, 420C, 425A, and 425B Red/Wht wires and connections. If ok, replace power relay. Go to step (1) of right angle circuit diagnosis to continue test.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in run position, engine off.
- Angle switch in right position during each test.
- Broom engine not running.

System: Right angle circuit.

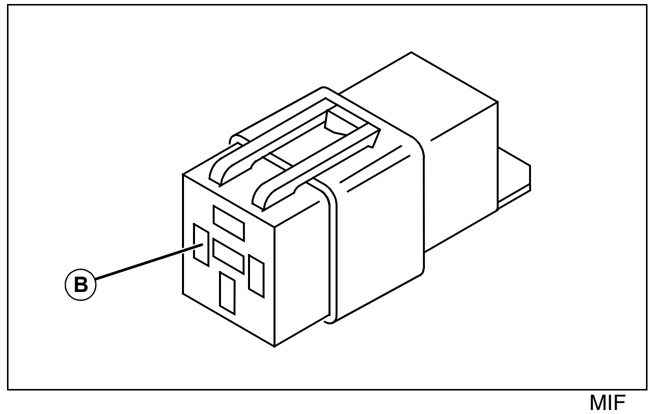


(1) Is battery voltage present at X6 connector (A) to the V4 diode?

Yes - Go to step (2).

No - Check 710, 715A, and 715B Grn/Wht wires and connections. If ok, replace angle switch. Go to step (2) to continue test.

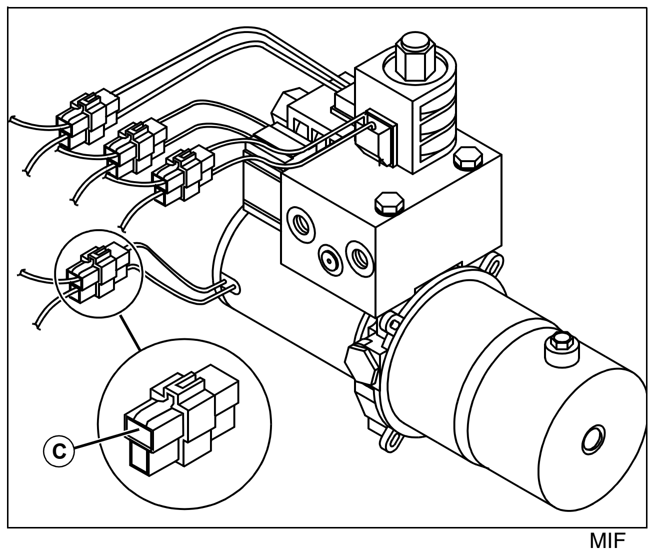
System: Right angle circuit.



(2) Is battery voltage present at K2 motor relay (B)?

Yes - Go to step (3).

No - Check 745 Blk/Wht wire and connections. Test V4 diode. Go to step (3) to continue test.

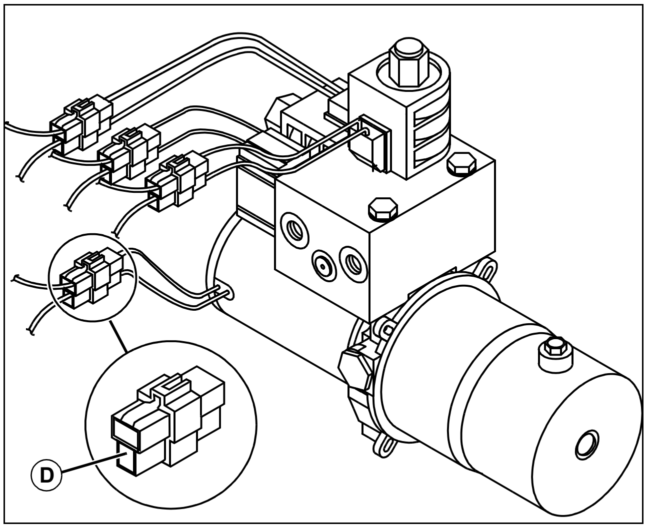


(3) Is battery voltage present at X3 connector (C) to the M1 motor?

Yes - Go to step (4).

No - Check 700 Blk wire and connections. If ok, replace K2 relay. Go to step (4) to continue test.

System: Right angle circuit.

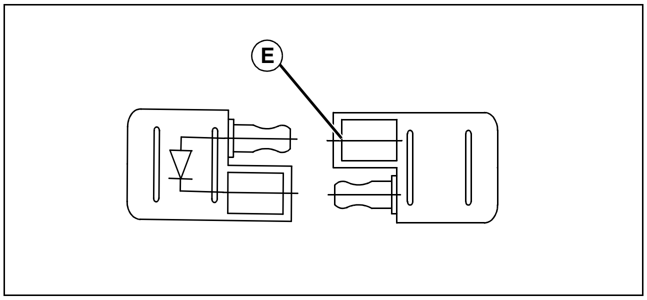


MIF

(4) Is continuity to ground present at X3 connector (D)?

Yes - Go to step (5).

No - Check 100, 110A, 110C, and 110H Blk wires and connections. Check 300 Org wire and connections. Test the K1 relays. Go to step (5) to continue test.



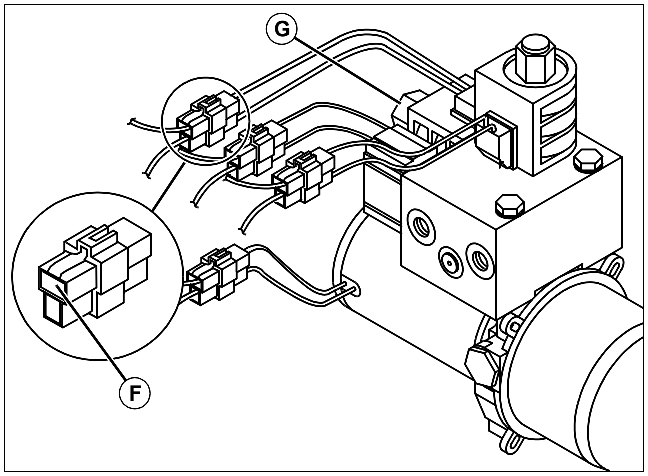
MIF

(5) Is battery voltage present at X4 connector (E) to the V3 diode?

Yes - Go to step (6).

No - Check 710, 715A, and 715C Grn/Wht wires and connections. Go to step (6) to continue test.

System: Right angle circuit.



MIF

(6) Is battery voltage present at X5 connector (F) to the Y1 angle solenoid? Is angle solenoid magnetized (G)?

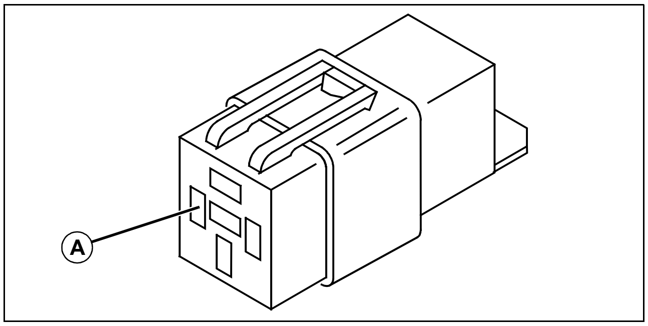
Yes - Right angle circuit test complete.

No - Check 720B and 735A Grn wires and connections. Test V3 diode. Right angle circuit test complete.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in run position, engine off.
- Angle switch in right position during each test.
- Broom engine not running.

System: Left angle circuit.



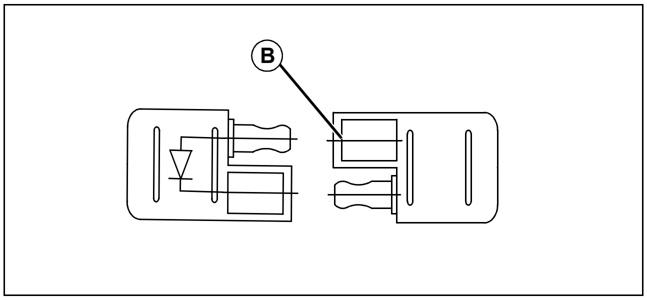
MIF

(1) Is battery voltage present at K1 motor relay (A)?

Yes - Go to step (2).

No - Check 320 and 315 Org wires and connections. If ok, replace angle switch. Go to step (2) to continue test.

System: Left angle circuit.

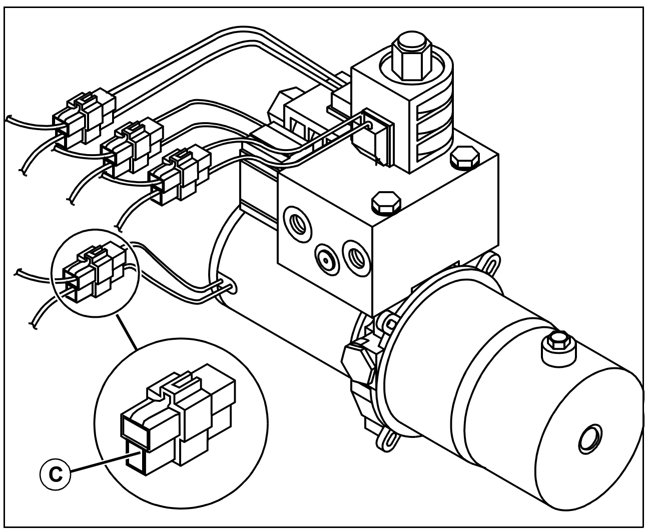


MIF

(2) Is battery voltage present at X2 connector (B) to the V1 diode?

Yes - Go to step (3).

No - Check 310 Org wires and connections. Go to step (3) to continue test.



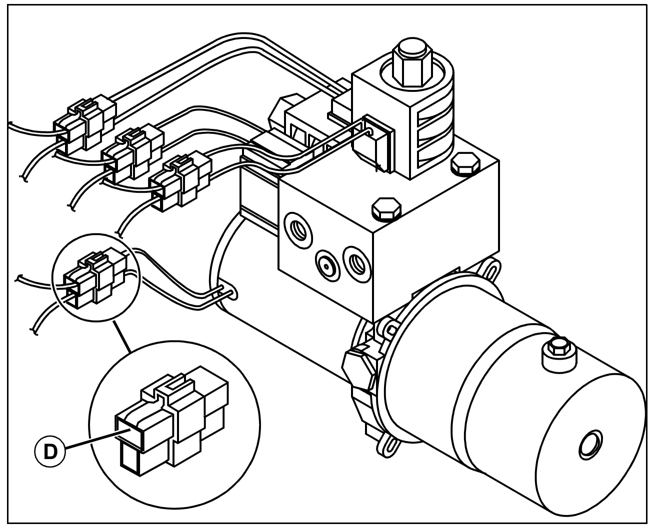
MIF

(3) Is battery voltage present at X3 connector (C) to the M1 motor?

Yes - Go to step (4).

No - Check 300 Org wire and connections. If ok, replace K1 relay. Go to step (4) to continue test.

System: Left angle circuit.

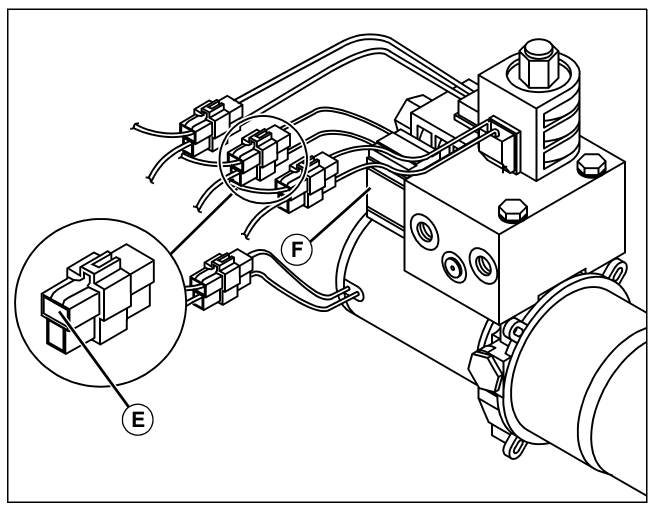


MIF

(4) Is continuity to ground present at X3 connector (D)?

Yes - Go to step (5).

No - Check 100, 110A, 110C, and 110I Blk wires and connections. Check 700 Blk wire and connections. Test the K2 relays. Go to step (5) to continue test.



MIF

(5) Is battery voltage present at X5 connector (E) to the Y1 angle solenoid? Is angle solenoid magnetized (F)?

Yes - Left angle circuit test complete.

No - Check 720C and 735A Grn wires and connections. Test V1 diode. Left angle circuit test complete.

PTO Circuit Operation

Function

To provide power to energize the PTO clutch.

Operation

The PTO circuit is controlled by both the unswitched and switched power circuits.

The switched power circuit provides power to the S6 PTO switch from the machine switched power circuit through the 450, 455, and 470 Yel wires across the S6 PTO switch to the 485 and 490 Yel wires to the S5 seat switch. With the operator on the seat, the seat switch is closed and current is provided to the 720, 715, and 710 Pnk wires to the K4 PTO relay to energize the relay. At the same time switched power is used to energize the K3 power relay to provide current flow to the K4 PTO relay using the 450, 455, 460, and 465 Yel wires.

Current flow from the unswitched power circuit then flows across the K3 power relay contacts to the K4 PTO relay from the machine battery using the F1 fusible link, 205, 210A, and 210B Red wires, K3 power relay, 420A and 420B Red/Wht wires.

With the operator on the seat and the K4 PTO relay energized, a latch circuit is created to keep the K4 PTO relay energized and provide current flow to the Y4 PTO clutch.

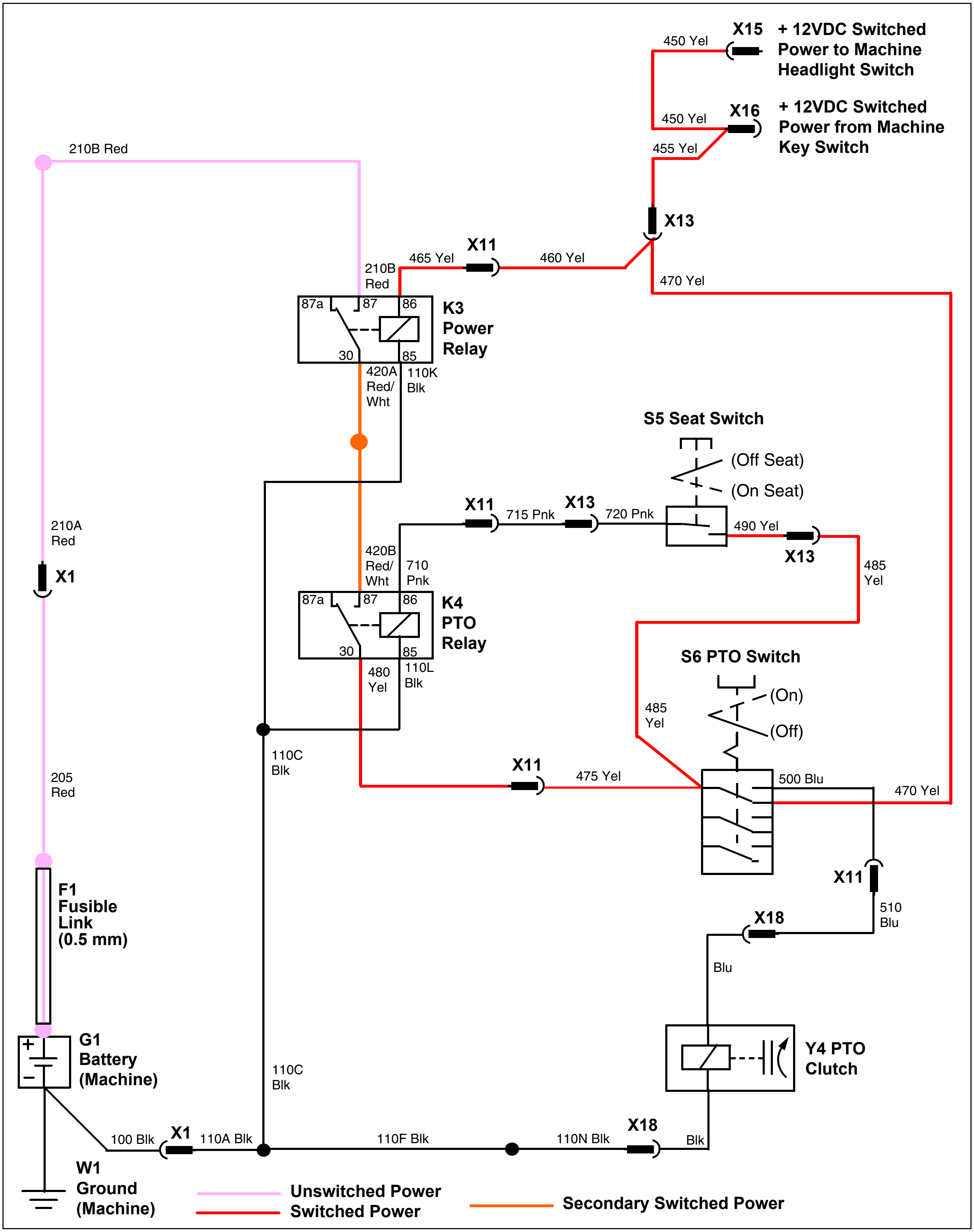
The latch circuit is created from the K4 PTO relay. Current is provided from the K3 power relay, 420A and 420B Red/Wht wires across the K4 PTO relay to the 480, 475, 485, and 490 Yel wires, across the S5 seat switch to the 720, 715, and 710 Pnk wires to the K4 PTO relay to energize the relay.

The Y4 PTO clutch receives current from the latch circuit at the connection of the 475 and 485 Yel wires at the S6 PTO switch. If the operator is on the seat to create the latch circuit, when the PTO is placed in the on position, current flows from the 475 Yel wire across the S6 PTO switch to the 500 and 510 Blu wires to the Y4 PTO clutch.

The ground for the Y4 PTO clutch is provided through the 110F, 110A, and 100 Blk wires.

With the motor running and the PTO engaged, the broom will rotate as long as the operating conditions are maintained.

PTO Circuit Electrical Schematic



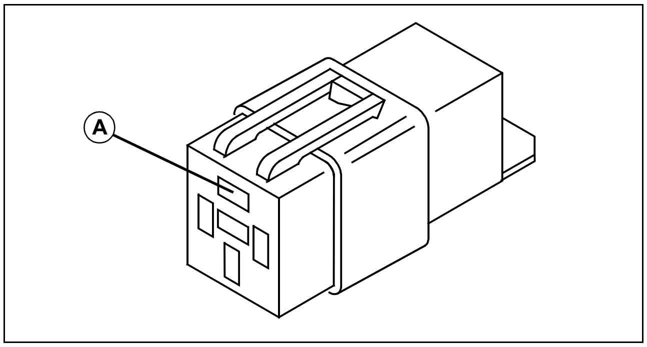
MIF

PTO Circuit Diagnosis

Test Conditions:

- Machine parking brake locked.
- Machine key switch in run position, engine off.
- Operator off seat.
- PTO switch in off position.
- Broom engine not running.

System: PTO power supply circuit.

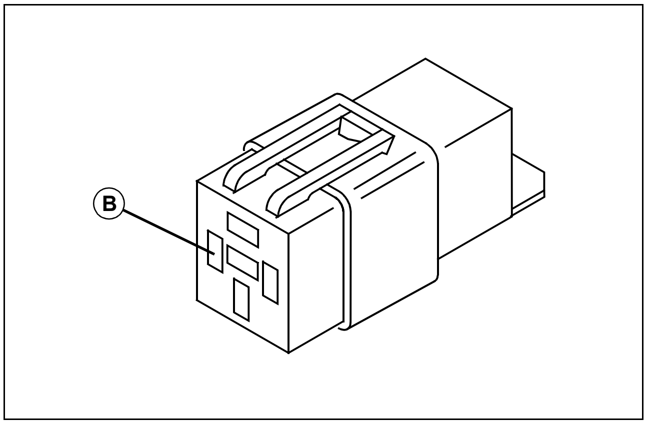


MIF

(1) Is battery voltage present at K3 power relay (A)?

Yes - Go to step (2).

No - Check F1 fusible link, 205, 210A and 210B Red wires and connections. Go to step (2) to continue test.



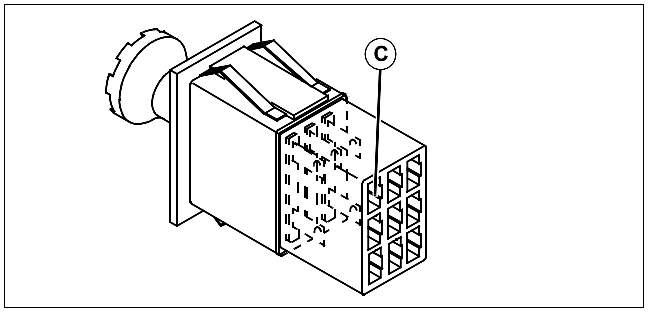
MIF

(2) Is battery voltage present at K3 power relay (B)?

Yes - Go to step (3).

No - Check 450, 455, 460, and 465 Yel wires and connections. Test machine power circuit. Go to step (3) to continue test.

System: PTO power supply circuit.

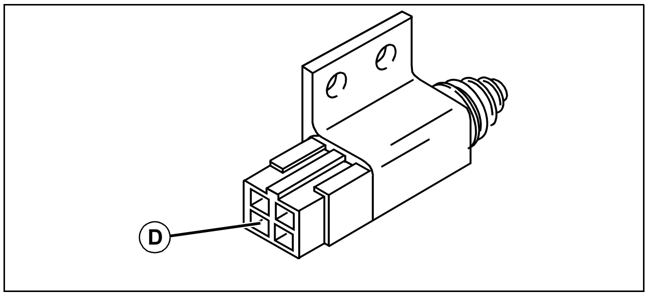


MIF

(3) Is battery voltage present at S6 PTO switch (C)?

Yes - Go to step (4).

No - Check 450, 455, and 470 Yel wires and connections. Test machine power circuit. Go to step (4) to continue test.

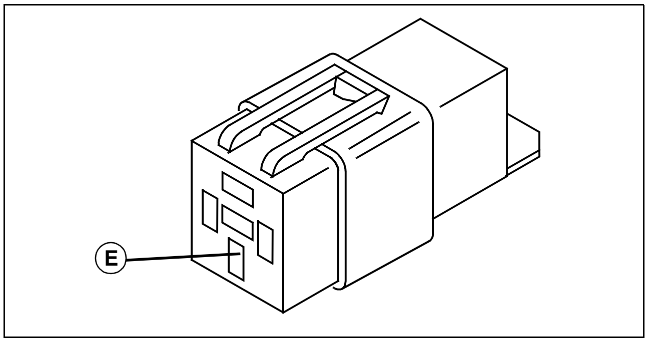


MIF

(4) Is battery voltage present at S5 seat switch (D)?

Yes - Go to step (5).

No - Check 485 and 490 Yel wires and connections. If ok, replace PTO switch. Go to step (5) to continue test.



MIF

(5) Is battery voltage present at K4 PTO relay (E)?

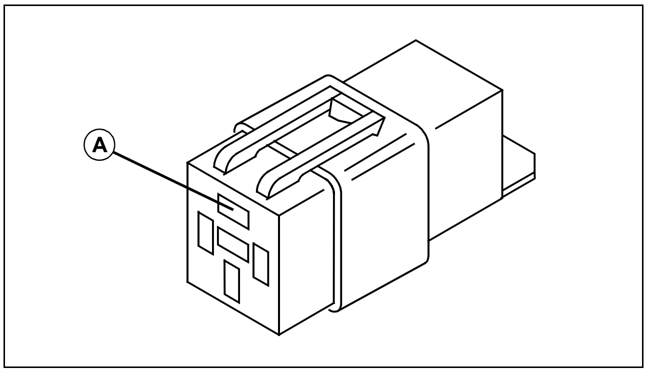
Yes - Go to step (1) of PTO circuit on diagnosis to continue test.

No - Check 475 and 480 Yel wires and connections. If ok, replace PTO switch. Go to step (1) of PTO circuit on diagnosis to continue test.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in run position, engine off.
- Operator on seat and then,
- PTO switch in placed in the on position.
- Broom engine not running.

System: PTO circuit on.

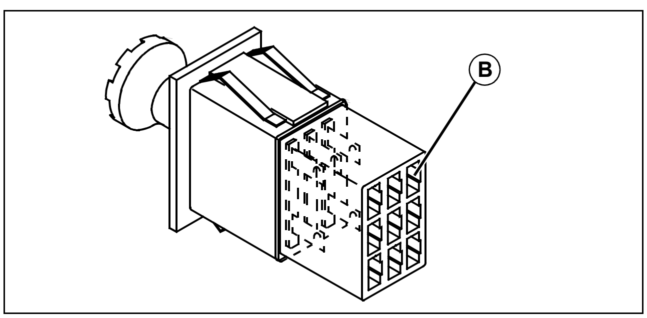


MIF

(1) Is battery voltage present at K4 PTO relay (A)?

Yes - Go to step (2).

No - Check 710, 715, and 720 Pnk wires and connections. If ok, replace seat switch. Go to step (2) to continue test.



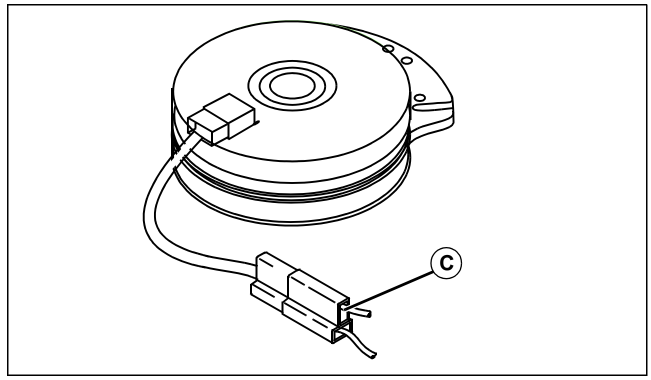
MIF

(2) Is battery voltage present at S6 PTO switch (B)?

Yes - Go to step (3).

No - Check 480 and 475 Yel wires and connections. Test PTO relay. Go to step (3) to continue test.

System: PTO circuit on.



MIF

(3) Is battery voltage present at X18 connector (C)?

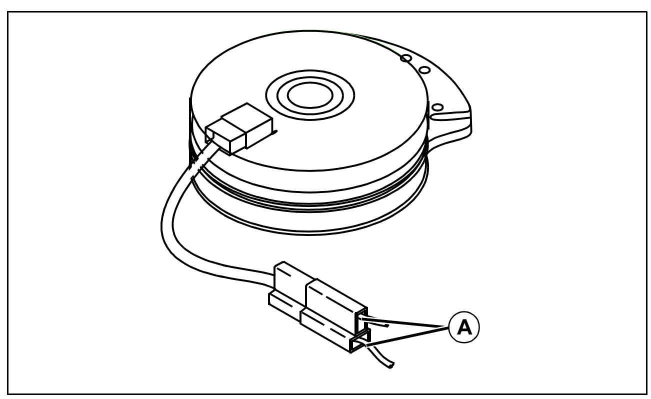
Yes - Go to step (1) of PTO clutch continuity diagnosis to continue test.

No - Check 500 and 510 Blu wires and connections. If ok, replace PTO switch. Go to step (1) of PTO clutch continuity diagnosis to continue test.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in run position, engine off.
- Operator off seat.
- PTO switch in off position.
- Broom engine not running.
- PTO clutch connector, X18, disconnected.

System: PTO clutch continuity.



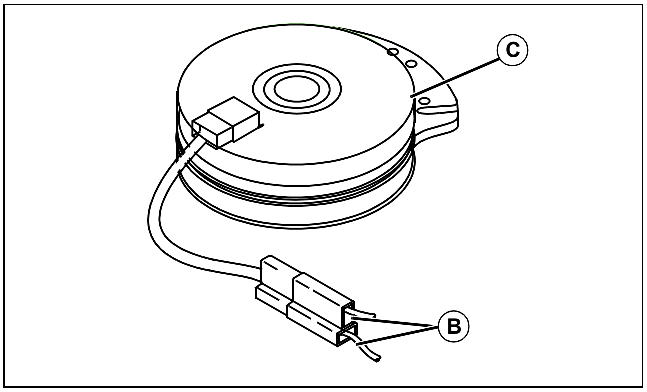
MIF

(1) Is 2.5 to 3.0 ohms resistance measured across the PTO clutch coil leads (A)?

Yes - Go to step (2).

No - Replace PTO clutch. Go to step (2) to continue test.

System: PTO clutch continuity.



MIF

(2) Is infinite resistance measured from coil (B) to clutch body (C)?

Yes - Test complete.

No - Replace PTO clutch. Test complete.

Tests and Adjustments, Rotary Broom Electrical

Angle and Lift/Lower Switch Test

Reason:

To verify the functional switches are operating properly.

Equipment:

- Ohmmeter or continuity tester

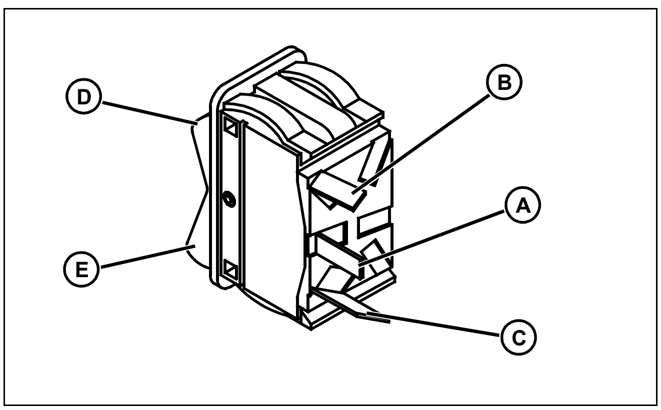
Procedure:

1. Park machine safely. (See Parking Safely in the SAFETY section.

2. Remove four screws securing dash panel to steering column support and lift enough to access turn signal switch connector.

3. Disconnect switch to be tested from wiring harness.

4. Use an ohmmeter or continuity tester to test switch continuity in off and each toggled positions.



MIF

Switch Continuity:

Switch Position	Terminal Continuity
Off	none
Top of Switch Pressed (D)	A and B
Bottom of Switch Pressed (E)	A and C

Results:

- If any continuity is not correct, replace the switch.

PTO Switch Test

Reason:

To verify PTO switch functions are operating properly.

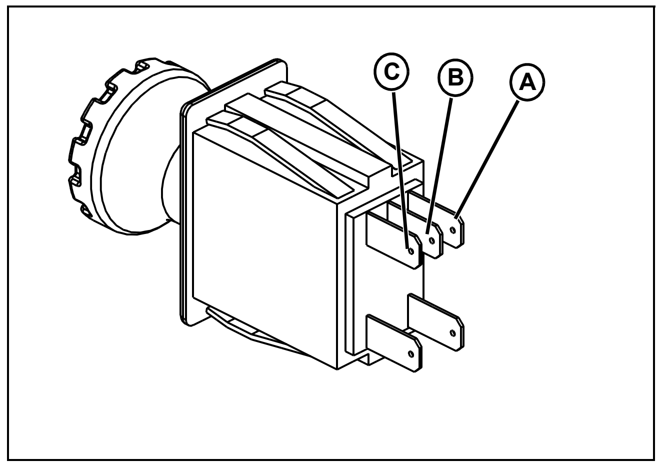
Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely. (See Parking Safely in the SAFETY section.

2. Disconnect PTO switch connector.



MIF

3. Use an ohmmeter to test switch continuity in off and on positions.

PTO Switch Continuity:

Switch Position	Terminal Continuity
OFF	A and C
ON	A and B

Results:

- All other possible combinations have infinite resistance. If any continuity is not correct, replace switch.

Relay Test

Reason:

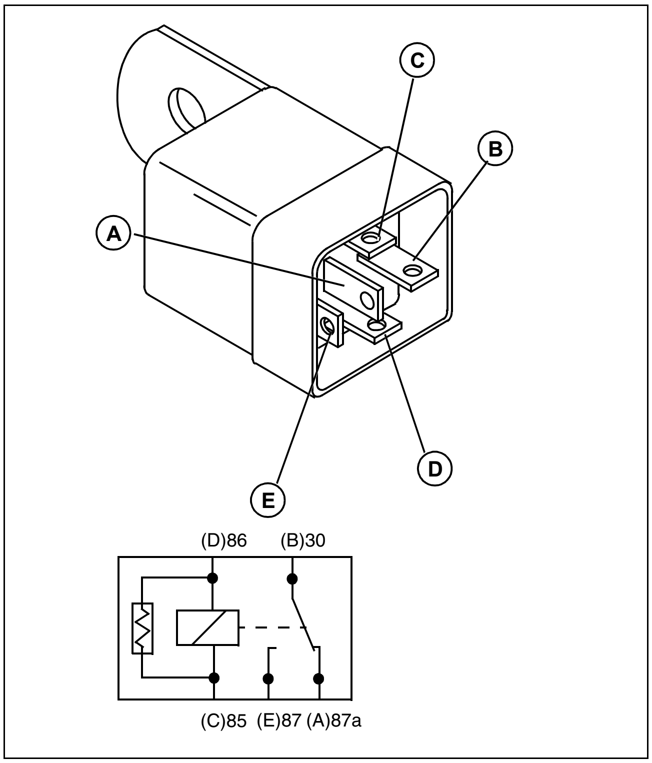
To check relay terminal continuity in the energized and de-energized condition.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Park machine safely. (See Parking Safely in the SAFETY section.
2. Disconnect relay connector.



MIF

3. Check terminal continuity using an ohmmeter or continuity tester
   - There should be continuity between terminals (A) and (B), and between terminals (C) and (D)
   - There should not be continuity between terminals (E) and (B)
4. Connect a jumper wire from battery positive (+) terminal to relay terminal (C). Connect a jumper wire from relay terminal (D) and ground (-).
   - There should be continuity between terminals (E) and (B)
   - If continuity is not correct, replace relay

Seat Switch Test

Reason:

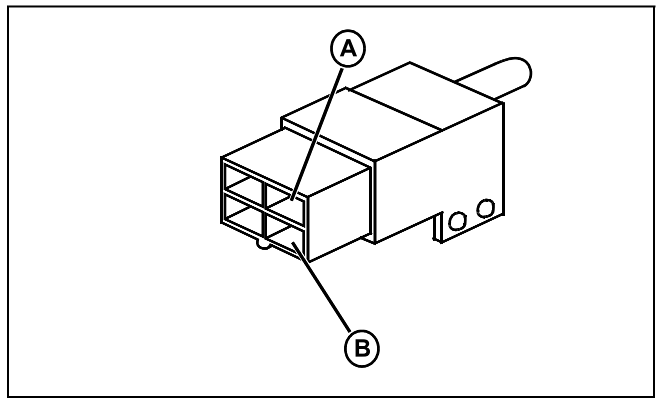
To verify seat switch functions are operating properly.

Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely. (See Parking Safely in the SAFETY section.
2. Disconnect seat switch connector.



MIF

3. Use an ohmmeter to test switch continuity in off and on positions.

Seat Switch Continuity:

Switch Position	Terminal Continuity
Switch plunger not pressed	None
Switch plunger pressed.	A and B

Results:

- Switch is open (infinite resistance) when switch is depressed. If continuity is not correct, replace switch.

PTO Clutch Test

Reason:

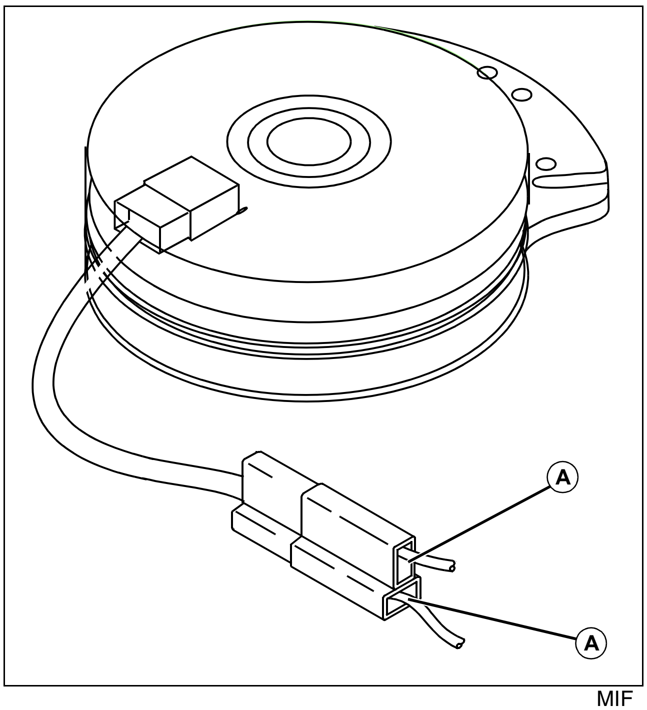
To check condition of PTO clutch coil.

Equipment:

- Ohmmeter
- JT05712 Current Gun

Procedure:

1. Park machine safely. (See Parking Safely in the SAFETY section.



2. Disconnect PTO clutch connector X18.
3. Set ohmmeter for 1x ohms scale.
4. Measure resistance across PTO clutch terminals (A).
5. Resistance should measure within specification. If resistance is not within specification, replace PTO clutch.

Results:

- Resistance should measure **2.5 - 3.0 ohms**.

Diode Test

Reason:

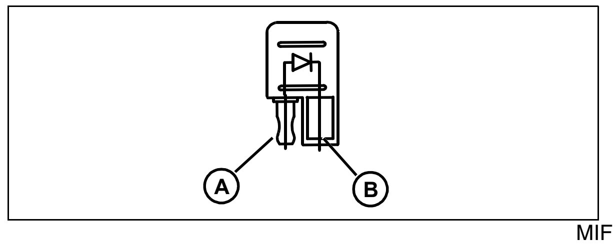
To verify that diode has proper continuity.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Park machine safely. (See Parking Safely in the SAFETY section.
2. Remove diode from connector.



3. Connect ohmmeter red (+) lead to pin (A) of diode.
4. Connect ohmmeter black (-) lead to pin (B) of diode. Check for continuity.
5. Reverse test leads. Check for continuity.

Results:

Diode must have continuity in one direction only. Replace defective diode.

Ignition On/Off Switch Test

Reason:

To verify ignition on/off switch is operating properly.

Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely. (See Parking Safely in the SAFETY section.
2. Trace the two black leads from the on/off switch to the connectors.
3. Disconnect the switch leads
4. Use an ohmmeter to test switch continuity in off and on positions.

Results:

- If continuity is not found in the off position, replace switch.
- If continuity is found in the on position, replace switch.

Solenoid Coil Test

Reason:

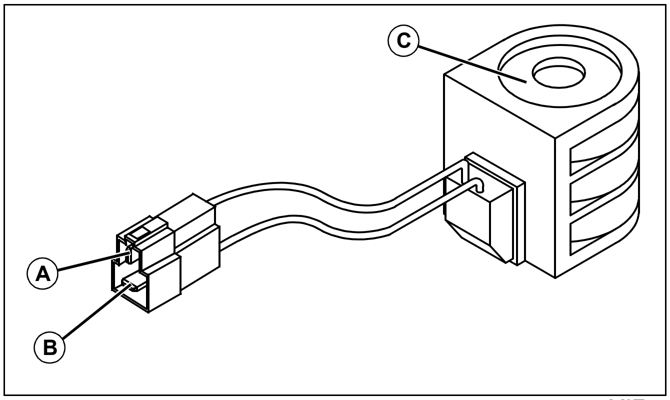
To verify that the solenoid coil has proper resistance and is not shorted to ground.

Equipment:

- Ohmmeter

Procedure:

1. Park machine safely. (See Parking Safely in the SAFETY section.
2. Disconnect solenoid coil.



MIF

3. Check resistance between coil terminals (A and B).
4. Check for continuity between either terminal and solenoid coil case (C).

Results

- If resistance does not meet specifications, replace solenoid.
- If continuity exists between either terminal and coil case, replace solenoid.

Specifications

Coil Resistance. . . . . 6.7 ohms

Engine Oil Switch Test

Reason:

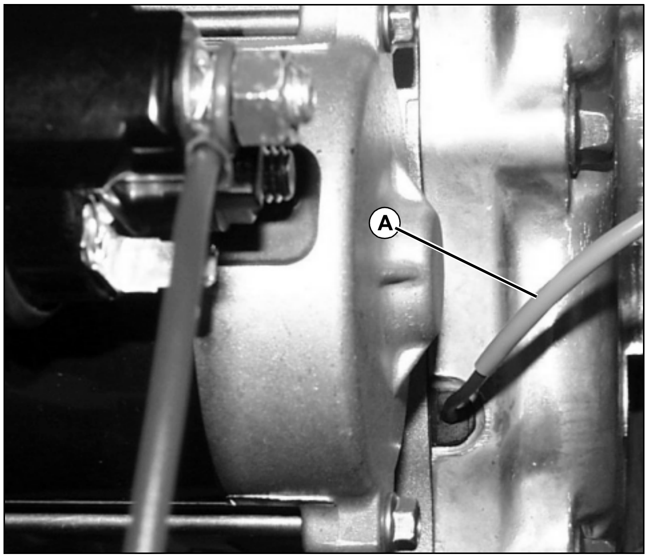
To ensure that the engine oil switch is working properly. The engine oil switch monitors the engine oil level with a float. If the engine oil drops below a predetermined level, the switch will provide a ground circuit for the engine ignition coil and eliminate current to the spark plug, thereby shutting off the engine.

Equipment

- Ohmmeter

Procedure:

1. Check engine oil level. Add oil if needed to bring it to the correct level.



MX17392

2. Disconnect lead wire to engine oil switch. Oil switch wire (A) will exit the engine near the PTO clutch.
3. Set VOM to the lowest ohms scale.
4. Check continuity between oil switch and suitable engine ground. There should be no continuity.
5. Drain the engine oil and check continuity between oil switch and suitable engine ground. There should be no more than 2 ohms of resistance. Replace switch as necessary.

Stator Output Test

Reason:

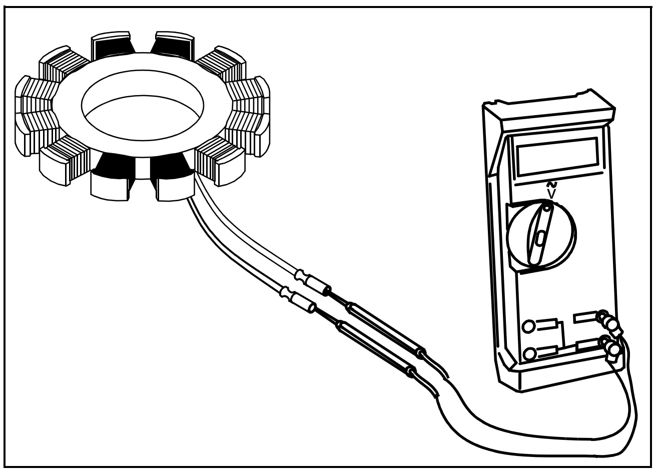
To measure AC voltage output of stator and verify correct resistance of stator.

Equipment:

- Multi-Meter (Set to AC volt scale)

Procedure:

1. Park machine safely. (See Parking Safely in the SAFETY section.
2. Set meter to 50 VAC or Autorange scale.
3. Disconnect regulator/rectifier connector.



MIF

4. Start and run at fast idle.
5. Measure stator voltage. Voltage should read a minimum of 20 volts AC.

Results:

- If voltage is less than specification, test stator with an ohmmeter.
- Stop engine.
- Change meter to ohms scale.
- Measure resistance across stator leads. Resistance should read 0.08 to 0.26 ohms.

Results:

- If resistance is infinite ohms, stator is open. Replace stator.
- Measure resistance from each stator lead to ground. Resistance should read infinite ohms.

Results:

- If resistance (or continuity) is measured, stator leads are shorted to ground. Replace stator.

Spark Test

Reason:

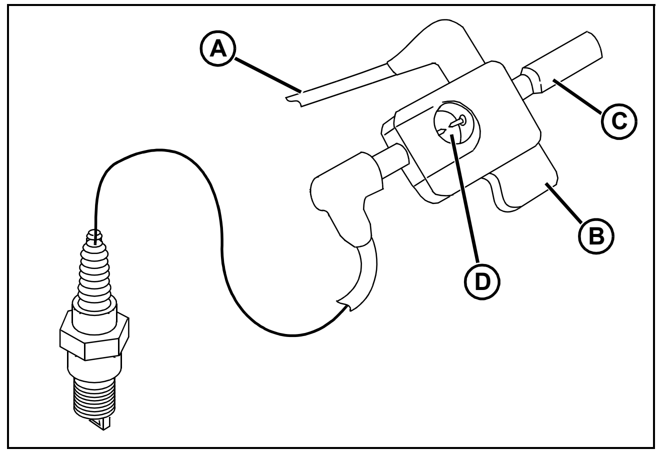
To check overall condition of ignition system.

Equipment:

- D-05351ST Spark Tester

Procedure:

1. Park machine safely. (See Parking Safely in the SAFETY section.



MIF

2. Remove high tension lead (A) from spark plug and connect to spark tester (B).
3. Connect spark tester lead to spark plug.

NOTE: Do not adjust spark tester gap beyond 5.0 mm (0.200 in.) as damage to ignition system components could occur.

4. Adjust spark tester gap to 4.2 mm (0.166 in.) with screw (C).
5. Turn ignition switch to on position and start engine.
6. 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, tests ignition armature.

Ignition Coil Air Gap Adjustment

Reason:

To adjust air gap between ignition coil and flywheel magnets to a specified tolerance needed for proper ignition timing and sufficient spark voltage.

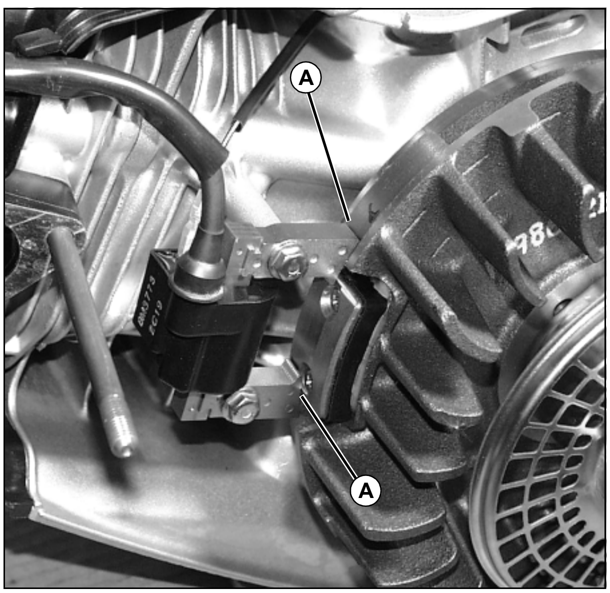
Equipment:

- Flat blade feeler gauge

Procedure:

1. Place engine switch in OFF position.
2. Remove flywheel housing.
3. Turn flywheel magnet away from coil.
4. Loosen ignition coil cap screws.

IMPORTANT: Avoid damage! The engine is very sensitive to this adjustment so both legs of the coil must have the same air gap.



MX19675

5. Select the 0.5 mm (0.020 in.) feeler gauge blade and insert it between the flywheel and coil legs (A).

6. Turn flywheel until magnet aligns with the legs of the ignition coil and feeler gauge spans both legs of coil and the flywheel magnet at the same time.

7. Allow the magnet to draw the module against the gauge.

8. Hold the coil in position and tighten the cap screws. Rotate the flywheel to remove the feeler gauge.

9. Tighten the lower screw first.

10. Rotate the flywheel back and forth, checking to make sure the magnet does not strike the module.

- Tighten the screws to 10 N•m (88 lb-in.).

Spark Plug Gap Adjustment

Reason:

To maintain the correct gap between the center electrode and the tab needed to produce a good spark.

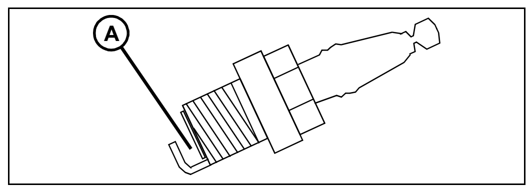
Equipment:

- 0.76 mm (0.030 in.) feeler gauge

Procedure:

IMPORTANT: Avoid damage! Do not clean spark plug with sand paper or abrasives. Engine scoring can result.

1. Scrape or wire brush deposits from spark plug.
2. Inspect spark plug for:
   - Cracked porcelain.
   - Pitted or damaged electrodes.



MIF

3. Check spark plug gap (A) using a feeler gauge. Set gap to specifications.

4. Install and tighten spark plug to specifications.

Specifications:

Spark Plug Gap. . . . . 0.76 mm (0.030 in.)

Spark plug torque. . . . . 20 N•m (177 lb-in.)

Spark Plug Cap Test

Spark plugs should not be burned, blistered, or have cracked insulator tips or badly eroded electrode.

Make sure the plug is correctly gapped.

Specifications:

Spark Plug Gap . . . . 0.76 mm (0.030 in.)

NOTE: Bending center wire or hitting plug with gapping tool can break insulator.

Reason:

To determine if spark plug cap is defective.

Equipment:

- Ohmmeter

Procedure:

1. Park machine safely. (See Parking Safely in the SAFETY section.
2. Pull the insulator boot back off of spark plug cap.
3. Remove spark plug cap by unscrewing the cap from the lead.

M48364

4. Measure resistance across spark plug cap terminals. Resistance should be about the same as marked on the spark plug cap.

Specifications:

Spark plug cap resistance . . . . 4.0 - 6.0 k-ohms

Results:

- If resistance does not meet specification, replace spark plug cap.

Ignition Coil Test

Reason:

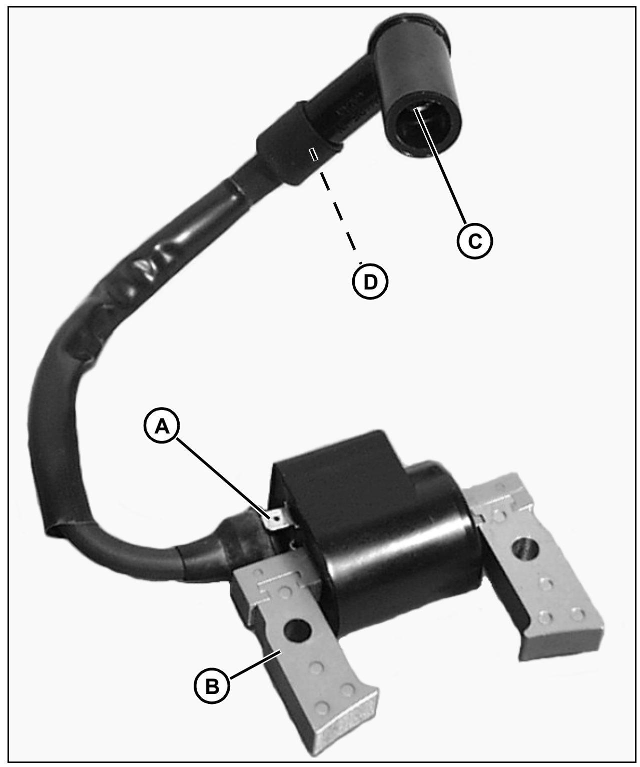
To determine condition of ignition coil windings.

Equipment:

- Ohmmeter

Procedure:

1. Remove ignition coil from engine.
2. Disconnect wires from ignition coil terminal.



MX19676

3. Measure resistance between ground terminal (A) and laminations (B).
4. Measure resistance between ground terminal (A) and spark plug cap (C).
5. Remove spark plug cap and measure resistance between ground terminal (A) and spark plug lead (D).

Specifications:

Laminations to Ground Terminal . . . . 0.7 ohms

Ground Terminal to Spark Plug Cap . . . . 13.5 - 18.0 K-ohms

Ground Terminal to Spark Plug Lead . . . . 9.5 - 12.9 K-ohms

Results:

- If resistance does not meet specifications, replace the ignition coil.

Flywheel Magnet Test

Reason:

To make sure the flywheel magnet has enough force to induce current into ignition coil.

Procedure:

MX17357

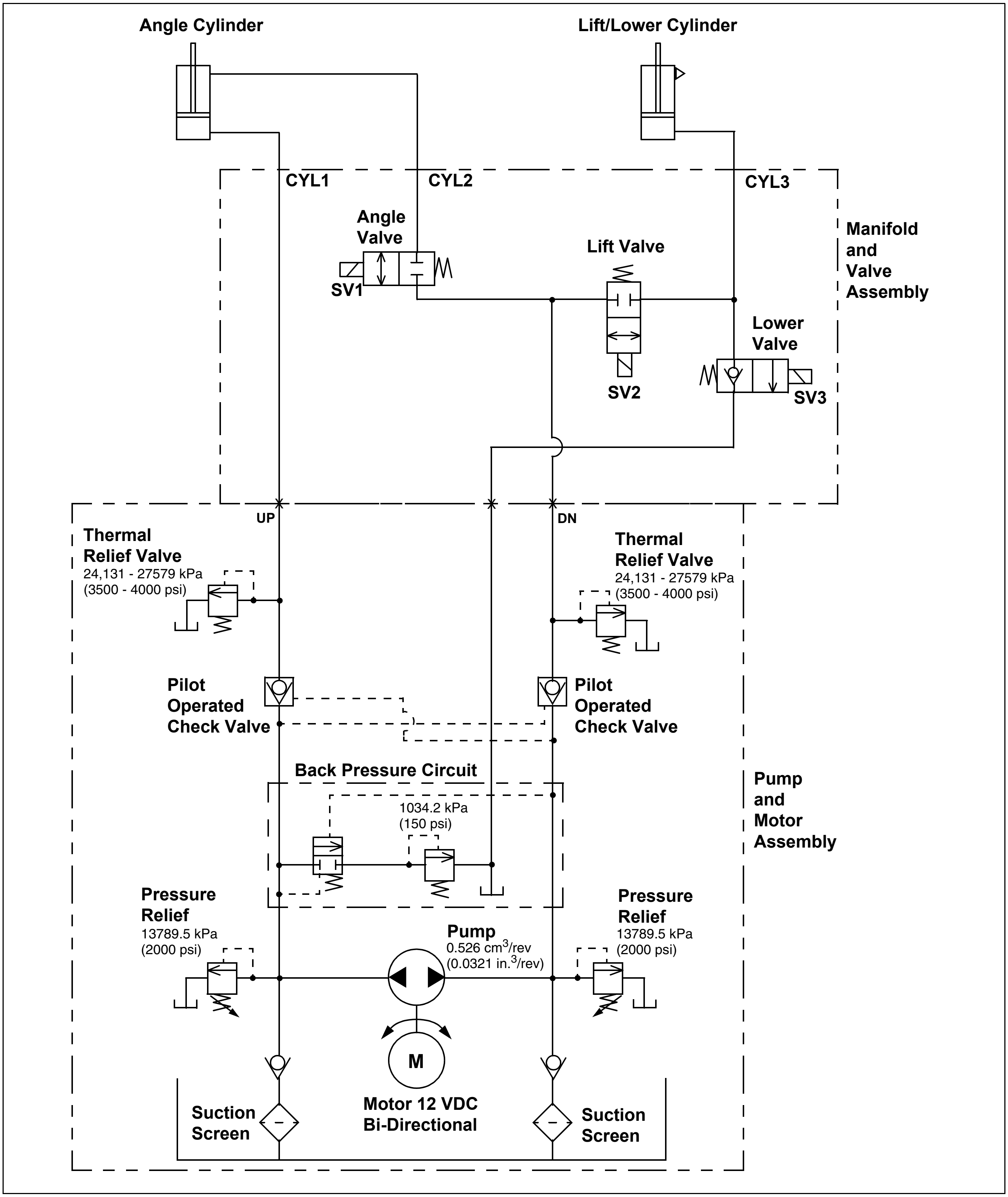
1. Loosely hold a screwdriver blade about 25 mm (1.0 in.) from the magnet (A).

Results:

- Magnet should attract blade to it.
- If blade is not attracted to magnet, flywheel must be replaced.

Hydraulics, Rotary Broom

Hydraulic Schematic



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Operation and Diagnostics, Rotary Broom Hydraulics

Hydraulic System

Function:

The hydraulic system provides fluid power to lift and lower the broom head as well as angle the broom head from left to right. The hydraulic system consists of an electric motor, pump, and reservoir assembly, manifold and valve assembly, and two cylinders.

System Operation:

The hydraulic systems is a self-contained bi-directional 12VDC motor, gear pump, and reservoir system. The pump and motor are mounted to the primary manifold which contains the pressure relief and check valves used to control operating pressure and initial operating flow direction. A secondary manifold and valve assembly is mounted to the primary manifold and is used to control the flow of oil to the operating cylinders.

The electrical system is used to control the operation of the hydraulic system. Always verify the electrical system before troubleshooting the hydraulic system.

Lift and Lower Operation:

The lift/lower circuit is a pressure up and gravity down system. The motor and pump provide fluid flow out the primary manifold port labeled DN to the secondary manifold which diverts the flow (lift valve SV2 energized) out the port lobed CYL3 to the base of the lift cylinder causing the lift cylinder to extend. When the lift switch is released, the lift solenoid is de-energized allowing it to close. This lock the fluid into the lift cylinder holding the cylinder at the position it has been extended to.

When the lift/lower switch is toggled to the lower position, the lower valve (SV3) is energized. This opens the lower valve and allows fluid to drain back to the reservoir. The weight of the broom head is used to put pressure on the lift/ lower cylinder causing the cylinder to retract until the brush contacts the ground or until the brush contact adjustment rod reaches the stop knob.

Right Angle Operation:

During right angle operation, the pump provides fluid flow directly out the port labeled CYL1 to the base of the angle cylinder causing it to extend. The angle solenoid (SV1) is energized to open the valve and allow return fluid from the rod end of the angle cylinder in the port labeled CYL2. This fluid flows back to the suction side of the pump. Because this volume of fluid is less than what is needed to fill the base of the cylinder, the extra fluid needed to fill the cylinder is drawn out of the reservoir.

When the angle switch is released, the angle solenoid is de-energized allowing it to close. This lock the fluid into the angle cylinder holding the cylinder at the position it has been extended to.

Left Angle Operation:

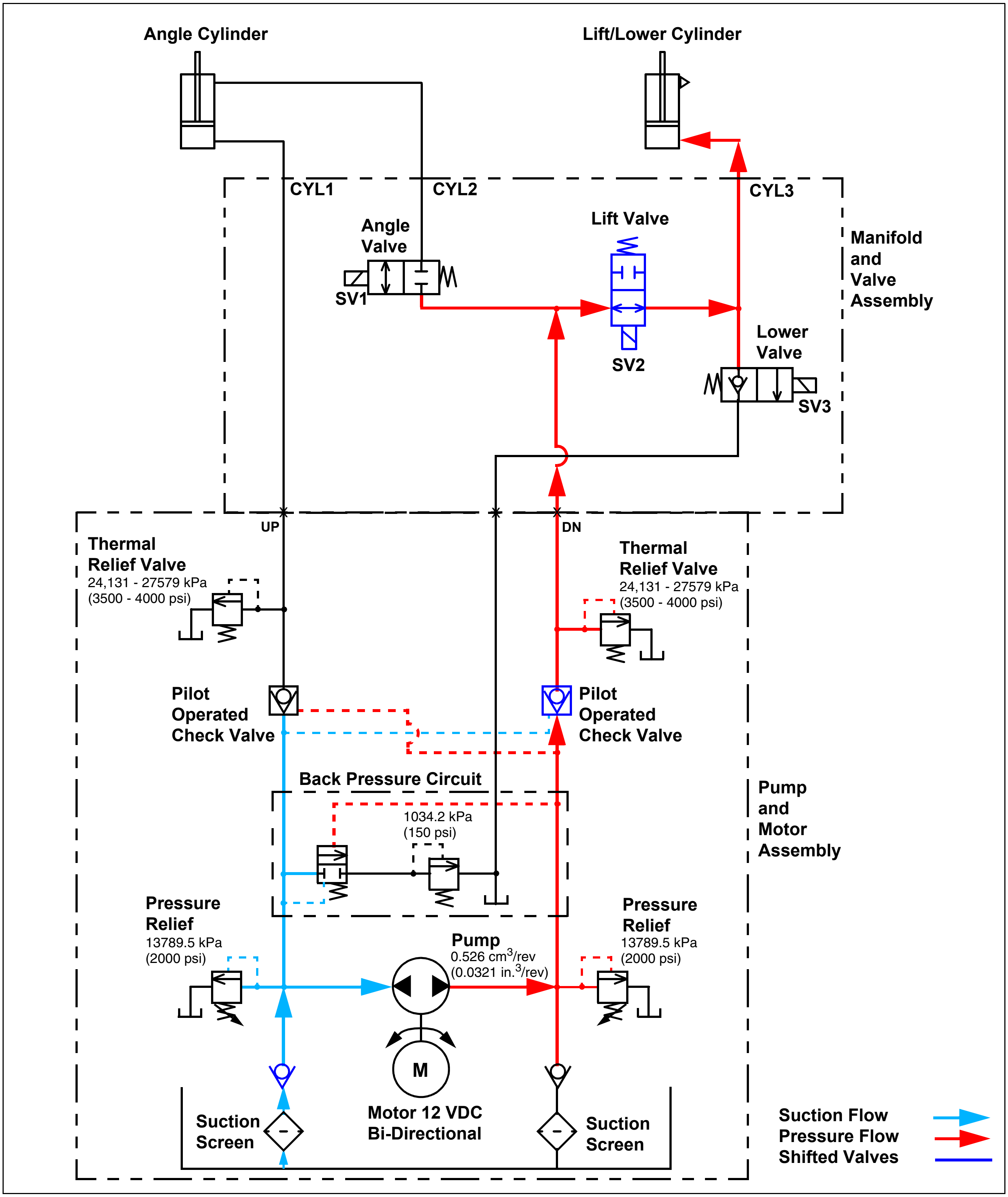
During left angle operation, the angle solenoid (SV1) is energized to open the valve and allow fluid to flow from the pump, out the port labeled CYL2 to the angle cylinder causing it to retract.

The return fluid from the base end of the angle cylinder flows in at the port labeled CYL1 and flows back to the suction side of the pump. Because this volume of fluid is greater than what is needed to fill the rod end of the cylinder, the extra fluid is routed across the back pressure circuit to the reservoir.

When the angle switch is released, the angle solenoid is de-energized allowing it to close. This lock the fluid into the angle cylinder holding the cylinder at the position it has been extended to.

Diagnostics

Lift Circuit



MIF

NOTE: The electrical system is used to control the operation of the hydraulic system. Always verify the electrical system before troubleshooting the hydraulic system.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in run position, engine off.
- Broom engine not running.
- Lift/lower switch in lift position during test.

System: Lift Circuit.

(1) Does broom head raise?

Yes - Go to step (2).

No - Test pressure on lift cylinder hose at manifold port CYL3. See “System Pressure Relief Test and Adjustment” on page 622. If the system does not pass the pressure test, replace the motor and pump assembly. Go to next answer.

No - Test fluid flow on lift cylinder hose at manifold port CYL3. See “Pump Flow Test” on page 623. If the system does not pass the flow test, replace the motor and pump assembly. Go to step (2) to continue test.

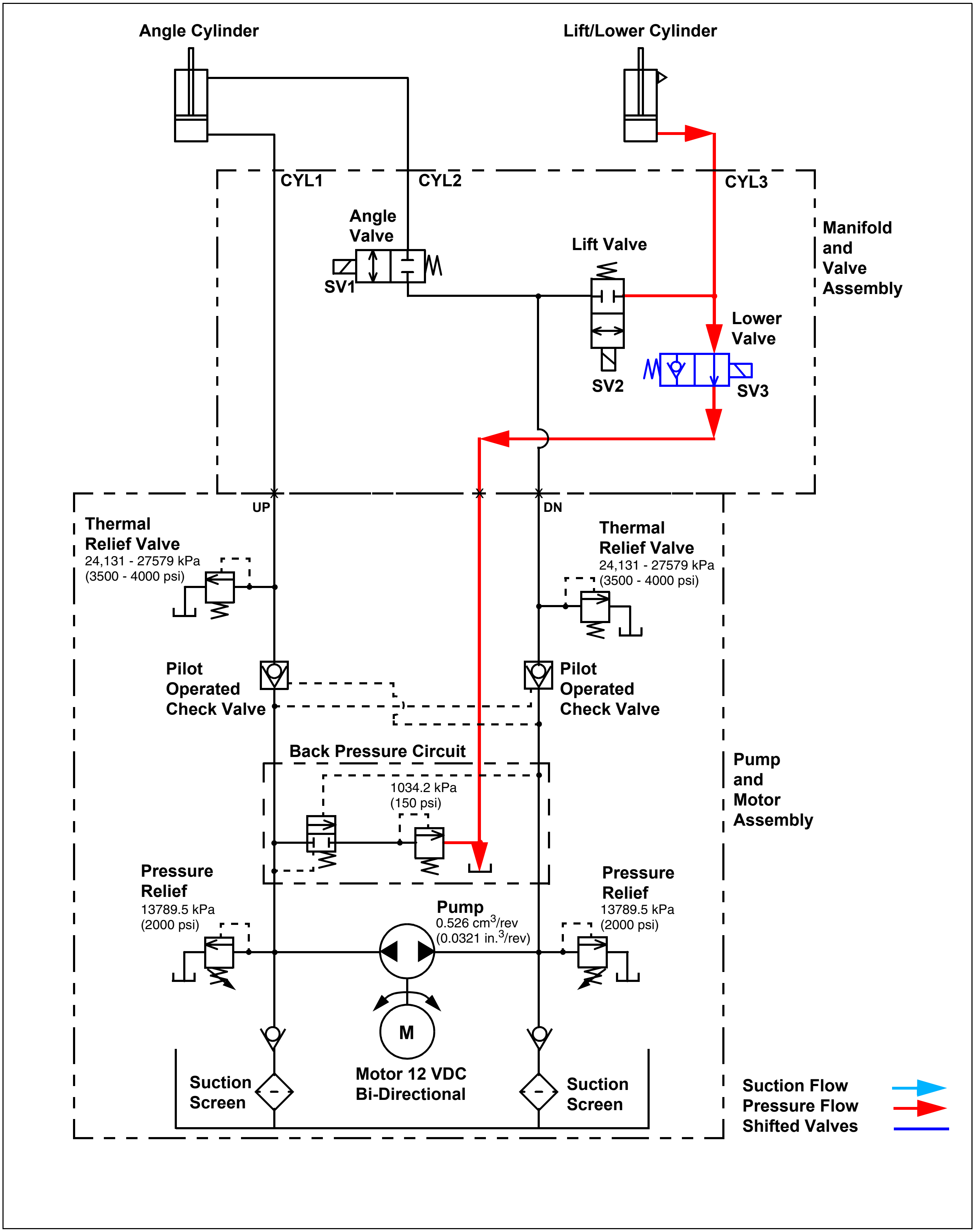
(2) Does broom head hold in position when lift switch is released?

Yes - Test complete.

No - Check for oil dripping from breather at rod end of lift cylinder. If oil is dripping, replace lift cylinder. Test complete.

No - Remove and clean the lower valve and retest. If the head continues to drift down, replace the lower valve. Test Complete.

Lower Circuit



MIF

NOTE: The electrical system is used to control the operation of the hydraulic system. Always verify the electrical system before troubleshooting the hydraulic system.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in run position, engine off.
- Broom engine not running.
- Lift/lower switch in lower position during test.

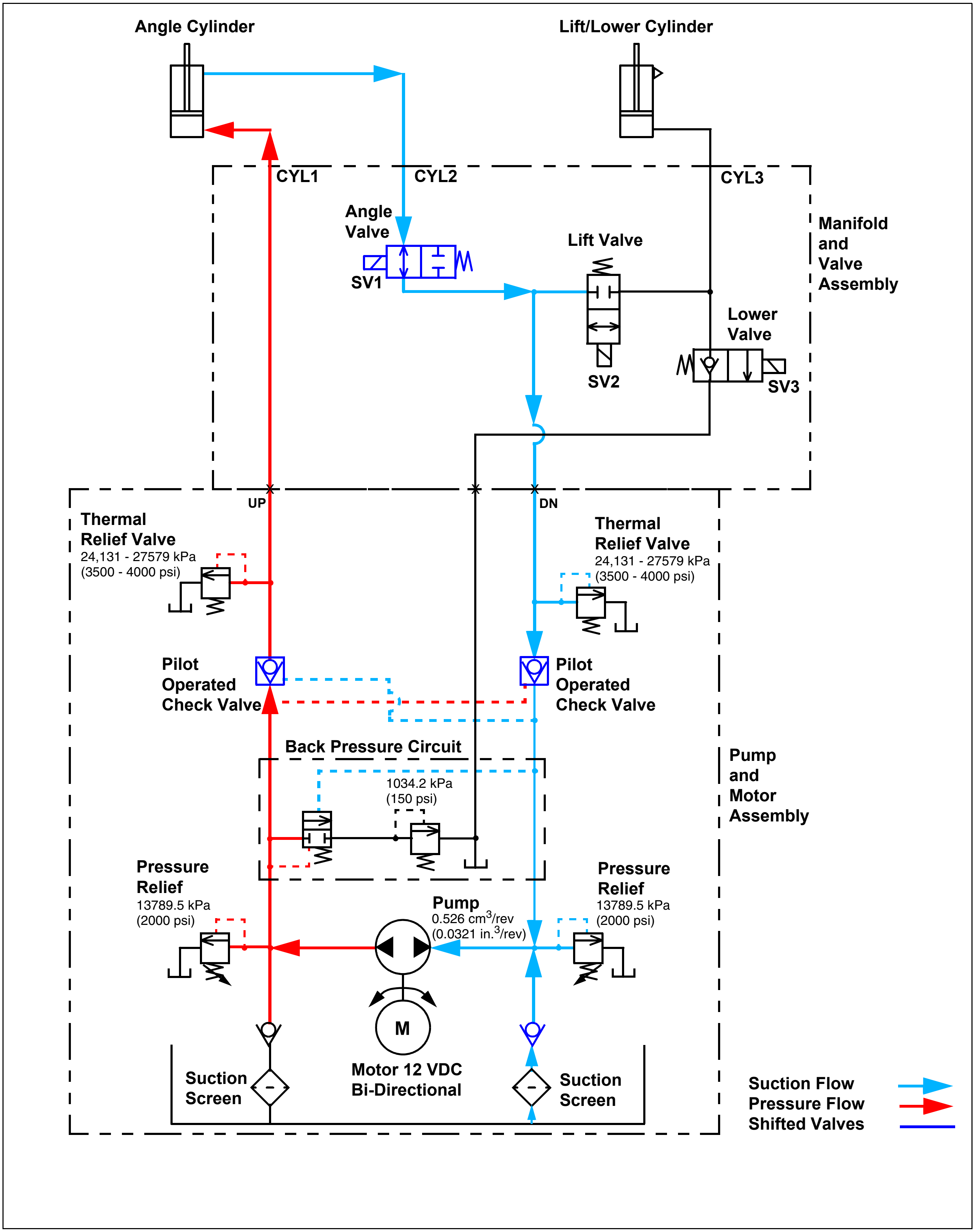
System: Lower Circuit.

(1) Does broom head lower?

Yes - Test complete.

No - Remove and clean the lower valve and retest. If the head continues to drift down, replace the lower valve. Test Complete.

Right Angle Circuit



MIF

NOTE: The electrical system is used to control the operation of the hydraulic system. Always verify the electrical system before troubleshooting the hydraulic system.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in run position, engine off.
- Broom engine not running.
- Angle switch in right position during test.

System: Right Angle Circuit.

(1) Does broom head turn to the right?

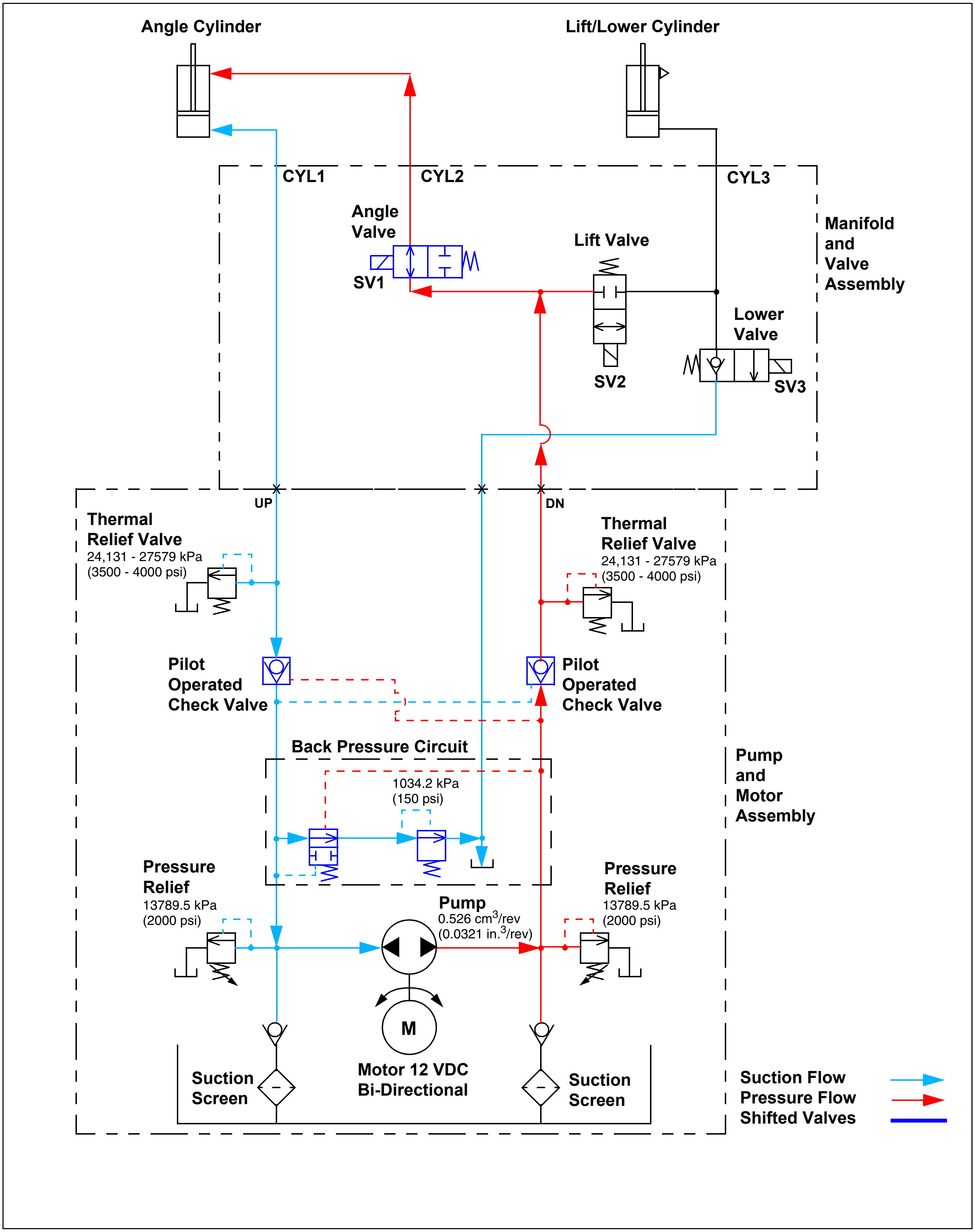
Yes - Test complete.

No - Remove and clean the angle valve and retest. If head does not turn, swap the angle valve with the lift valve if the lift circuit function properly. Retest. If angle function operates now, replace the valve placed in the lift port. If the function does not operate, test for pressure and flow at manifold port CYL1.

No - Test pressure on angle cylinder hose at manifold port CYL1. See “System Pressure Relief Test and Adjustment” on page 622. If the system does not pass the pressure test, replace the motor and pump assembly. Go to next answer.

No - Test fluid flow on angle cylinder hose at manifold port CYL1. See “Pump Flow Test” on page 623. If the system does not pass the flow test, replace the motor and pump assembly.

Left Angle Circuit



MIF

NOTE: The electrical system is used to control the operation of the hydraulic system. Always verify the electrical system before troubleshooting the hydraulic system.

Test Conditions:

- Machine parking brake locked.
- Machine key switch in run position, engine off.
- Broom engine not running.
- Angle switch in left position during test.

System: Left Angle Circuit.

(1) Does broom head turn to the left?

Yes - Test complete.

No - Remove and clean the angle valve and retest. If head does not turn, swap the angle valve with the lift valve if the lift circuit function properly. Retest. If angle function operates now, replace the valve placed in the lift port. If the function does not operate, test for pressure and flow at manifold port CYL2.

No - Test pressure on angle cylinder hose at manifold port CYL2. See “System Pressure Relief Test and Adjustment” on page 622. If the system does not pass the pressure test, replace the motor and pump assembly. Go to next answer.

No - Test fluid flow on angle cylinder hose at manifold port CYL2. See “Pump Flow Test” on page 623. If the system does not pass the flow test, replace the motor and pump assembly.

Tests and Adjustments, Rotary Broom Hydraulics

System Pressure Relief Test and Adjustment

Reason:

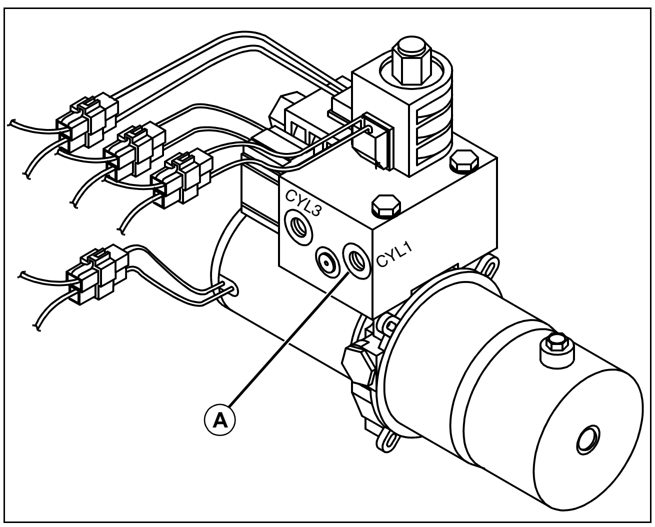
To make sure that the hydraulic system pressure relief valve is correctly set.

Equipment:

- JT03345 - 3000 psi gauge
- JT03017 - Hose with coupler
- JT05486 - Connector, 7/16-20M ORB x 7/16-20M 37°
- JT03262 - Coupler, 7/16 x 1/4F NPT

Procedure:

IMPORTANT: Avoid damage! Oil in system should be at normal operating temperature.



MIF

1. Remove the hose and fitting from the CYL1 port (A) on the manifold block.

2. Install pressure gauge into the CYL1 port on the manifold block.

3. Turn the machine key switch to the on position.

IMPORTANT: Avoid damage! The following step dead heads the hydraulic pump. Do not operate in this condition for more than 5 seconds!

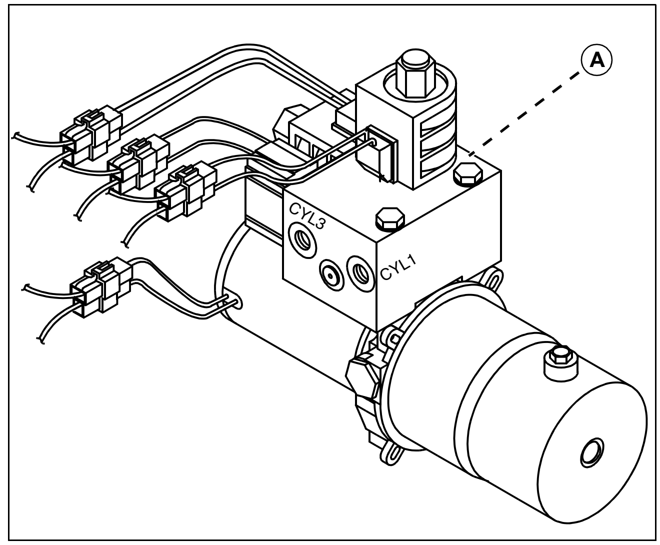
4. Check pressure on gauge by pressing the angle switch to the right angle position.

5. Note reading on pressure gauge.

6. Turn the machine key switch to the off position.

7. Remove the pressure gauge from the CYL1 port on the manifold block.

8. Connect the hose and fitting to the CYL1 port on the manifold block.



MIF

9. Remove the hose and fitting from the CYL2 port (B) on the manifold block.

10.Install pressure gauge into the CYL2 port on the manifold block.

11.Turn the machine key switch to the on position.

IMPORTANT: Avoid damage! The following step dead heads the hydraulic pump. Do not operate in this condition for more than 5 seconds!

12.Check pressure on gauge by pressing the angle switch to the left angle position.

13.Note reading on pressure gauge.

Results:

System pressure should be between 13100 - 13789 kPa (1900 - 2000 psi) in both ports. If not, replace pump, motor, and reservoir assembly.

Pump Flow Test

Reason:

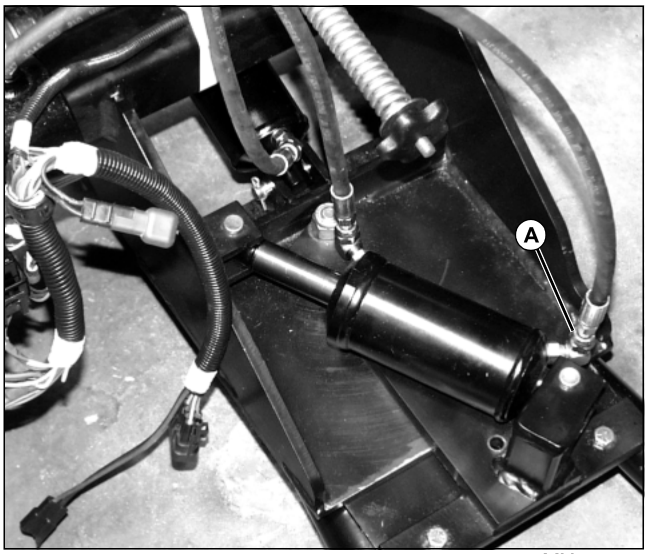
To determine if hydraulic pump is providing adequate flow under pressure.

Equipment:

- Stop Watch or Watch with a second hand
- 1L (35 oz) Graduated container

Procedure - Right Angle:

IMPORTANT: Avoid damage! Oil in system should be at normal operating temperature.



MX19757

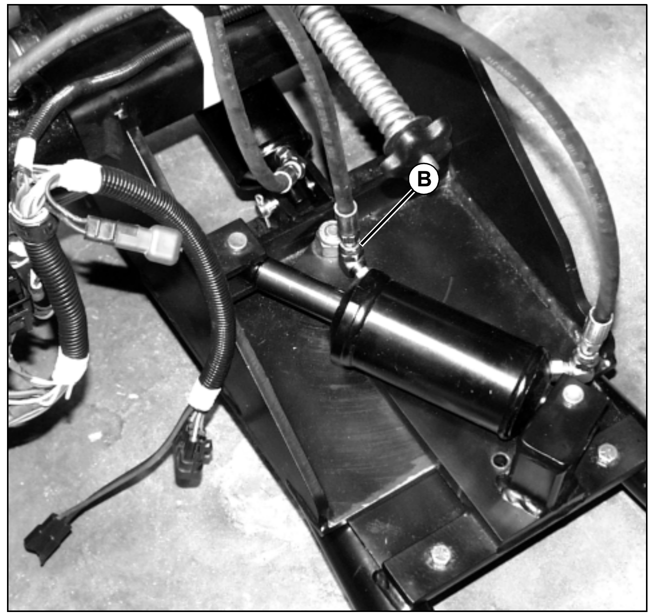
1. Remove the hose (A) from the base end of the angle cylinder.
2. Route the hose end into a clean graduated container.
3. Turn the machine key switch to the on position.

IMPORTANT: Avoid damage! The reservoir contains a limited amount of oil. If the test is run longer than 15 seconds, the pump may run out of oil and be damaged.

4. Check hydraulic flow by pressing the angle switch to the right angle position for 15 seconds.
5. After 15 seconds release switch.
6. Turn the machine key switch to the off position.
7. Compare oil level in container to specification.
8. Pour oil from container into reservoir.
9. Connect hose to the base end of the angle cylinder.
10. Check the oil level in the reservoir. Adjust oil level as needed.

Procedure - Left Angle:

IMPORTANT: Avoid damage! Oil in system should be at normal operating temperature.



MX19757

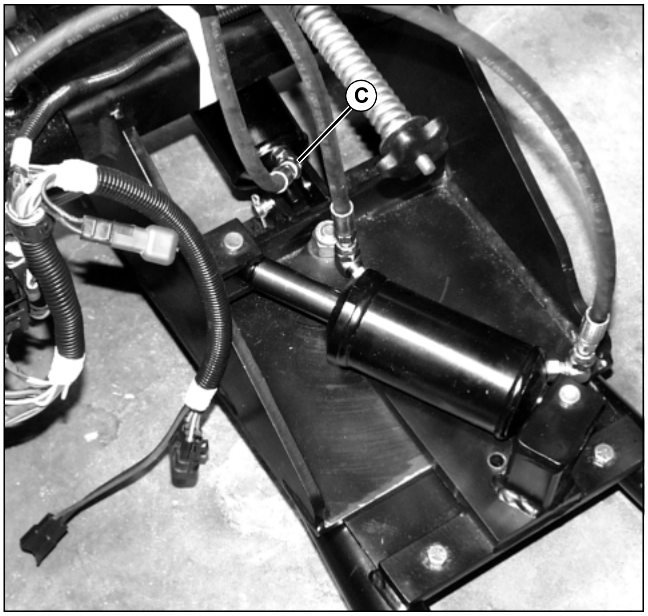
1. Remove the hose (B) from the rod end of the angle cylinder.
2. Route the hose end into a clean graduated container.
3. Turn the machine key switch to the on position.

IMPORTANT: Avoid damage! The reservoir contains a limited amount of oil. If the test is run longer than 15 seconds, the pump may run out of oil and be damaged.

4. Check hydraulic flow by pressing the angle switch to the right angle position for 15 seconds.
5. After 15 seconds release switch.
6. Turn the machine key switch to the off position.
7. Note oil level in container.
8. Pour oil from container into reservoir.
9. Connect hose to the rod end of the angle cylinder.
10. Check the oil level in the reservoir. Adjust oil level as needed.

Procedure - Lift:

IMPORTANT: Avoid damage! Oil in system should be at normal operating temperature.



MX19757

1. Remove the hose (C) from the base end of the lift cylinder.
2. Route the hose end into a clean graduated container.
3. Turn the machine key switch to the on position.

IMPORTANT: Avoid damage! The reservoir contains a limited amount of oil. If the test is run longer than 15 seconds, the pump may run out of oil and be damaged.

4. Check hydraulic flow by pressing the lift/lower switch to the lift position for 15 seconds.
5. After 15 seconds release switch.
6. Turn the machine key switch to the off position.
7. Note oil level in container.
8. Pour oil from container into reservoir.
9. Connect hose to the base end of the lift cylinder.
10. Check the oil level in the reservoir. Adjust oil level as needed.

Results:

Pump flow should be a minimum of 355 mL (12 oz) in 15 seconds, if not:

- Check suction screens for obstruction, clean and/or replace as required.
- Replace pump as required.

Repair, Rotary Broom Hydraulics

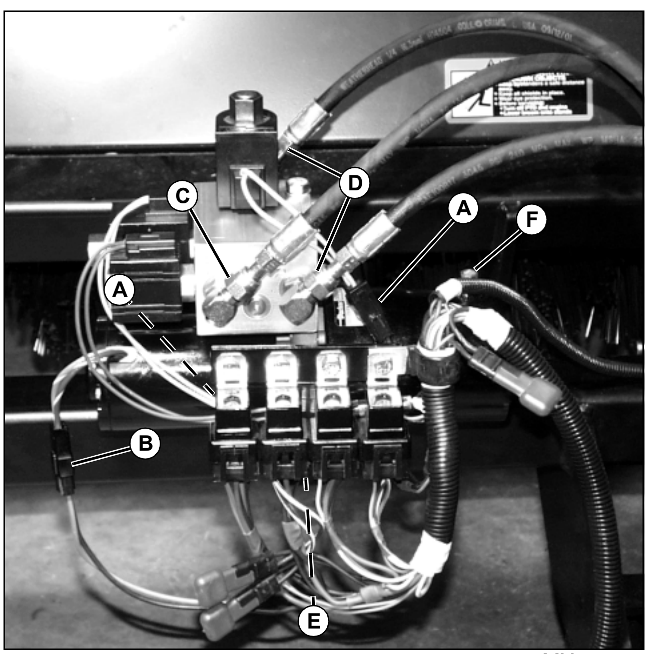
Motor and Pump Assembly Removal and Installation

CAUTION: Avoid injury! Escaping hydraulic 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 using 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 injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, USA. Information may be obtained in the United States and Canada by calling 1-800-822-8262.

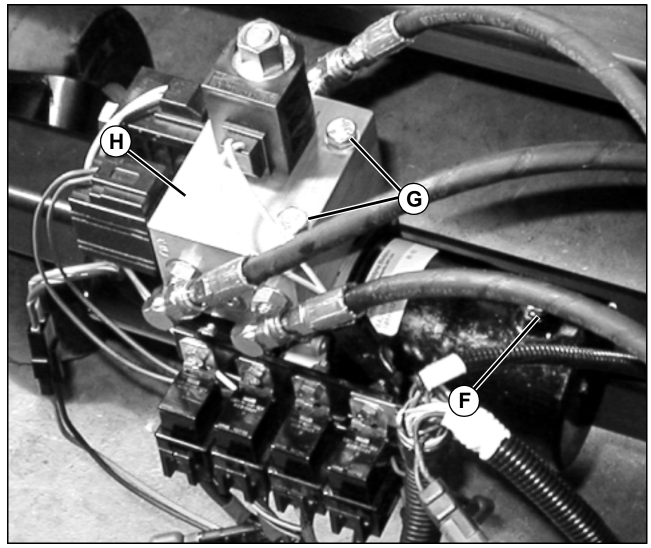
Removal:

1. Lower broom to the ground.
2. Remove broom from machine.
3. Label the electrical connectors to the manifold block for identification during installation.



MX19758

4. Disconnect the connectors to the solenoids (A) and the electric motor (B).
5. Disconnect the hoses to the lift (C) and angle (D) cylinders at the manifold block.
6. Remove the two cap screws (E) securing the motor and pump assembly to the frame and remove motor and pump.



MX19755

7. Remove reservoir breather plug (F) and drain reservoir into a suitable container.
8. Remove the manifold mounting banjo bolts (G) and remove manifold assembly (H) from motor and pump assembly.

Installation:

1. Installation is done in reverse of removal.
2. Install the manifold assembly and tighten the banjo bolts to specification.
3. Hose connections are as follow:
    - CYL1 = hose from base of angle cylinder.
    - CYL2 = hose from rod end of angle cylinder.
    - CYL3 = hose from base of lift cylinder.
4. Connect the electrical connector to the valve solenoid and the electric motor.
    - SV1 = plug with a Grn and Blk wire.
    - SV2 = plug with a Gry and Blk wire.
    - SV3 = plug with a Pur and Blk wire.

Specifications:

Banjo Bolts . . . . 14 N•m (124 lb-in.)

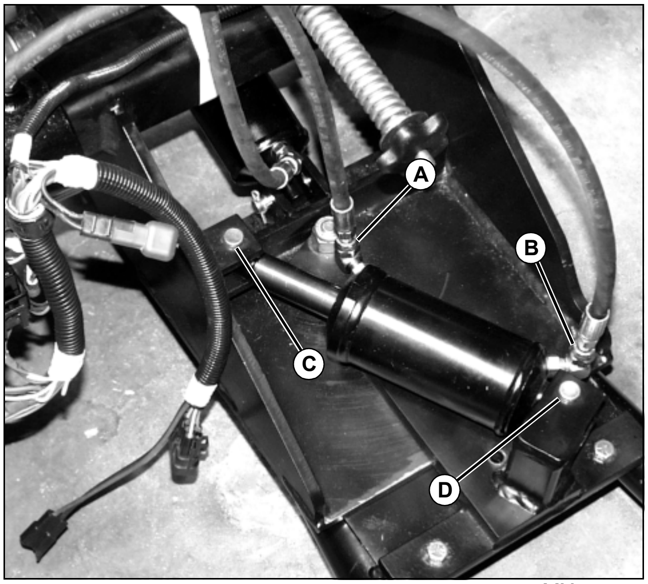
Hose Fittings . . . . 12 N•m (106 lb-in.)

Motor and Pump Mounting Cap Screws. . . . . 17 N•m (150 lb-in.)

Angle Cylinder Removal and Installation

Removal:

1. Lower broom to the ground.
2. Remove broom from machine.



MX19757

3. Remove the hose (A) from the rod end of cylinder.
4. Remove the hose (B) from the base end of cylinder.
5. Remove cotter pin and drilled pin (C) from rod end of cylinder.
6. Remove cotter pin and drilled pin (D) from base end of cylinder.
7. Remove cylinder.

Installation:

1. Installation is done in reverse of removal.
2. Hose connections are as follow:
   - CYL1 = hose to base of angle cylinder.
   - CYL2 = hose to rod end of angle cylinder.

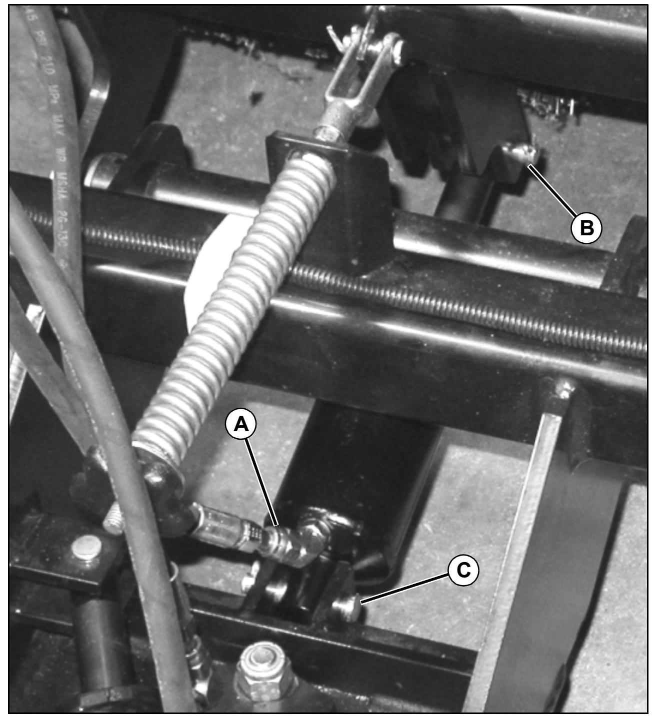
Specifications:

Hose Fittings. . . . . 12 N•m (106 lb-in.)

Lift Cylinder Removal and Installation

Removal:

1. Lower broom to the ground.
2. Remove broom from machine.



MX19756

3. Remove the hose (A) from the base end of cylinder.
4. Remove cotter pin and drilled pin (B) from rod end of cylinder.
5. Remove cotter pin and drilled pin (C) from base end of cylinder.
6. Remove cylinder.
7. Remove breather plug from rod end of cylinder.

Installation:

1. Installation is done in reverse of removal.
2. Hose connections are as follow:
   - CYL3 = hose to base of lift cylinder.

Specifications:

Hose Fittings . . . . 12 N•m (106 lb-in.)

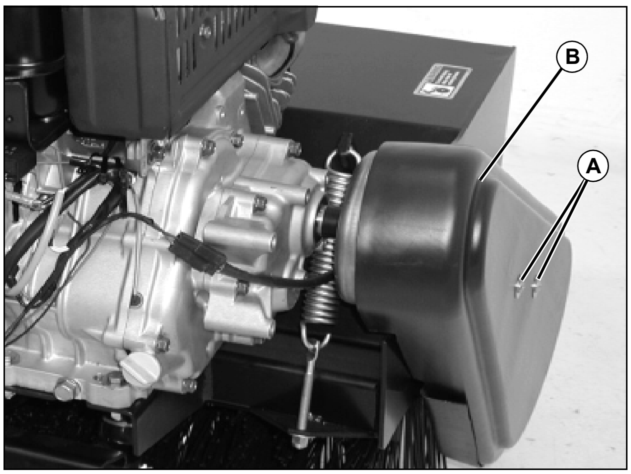
Repair, Rotary Broom Miscellaneous

Bearing Replacement

NOTE: Replacement of bearings is easiest with the brush head mounted on the machine.

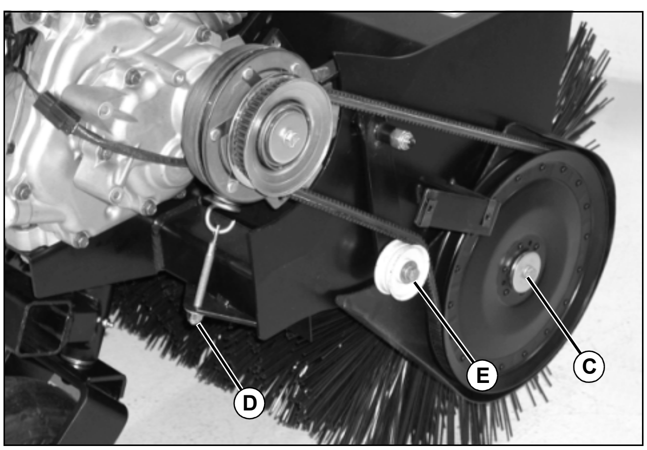
Removal:

1. Park machine safely. (See Parking Safely in the SAFETY section.)
2. Lower broom to 76 mm (3 in.) off the ground.
3. Support brush head in raised position with wood blocks or a safe lifting device.



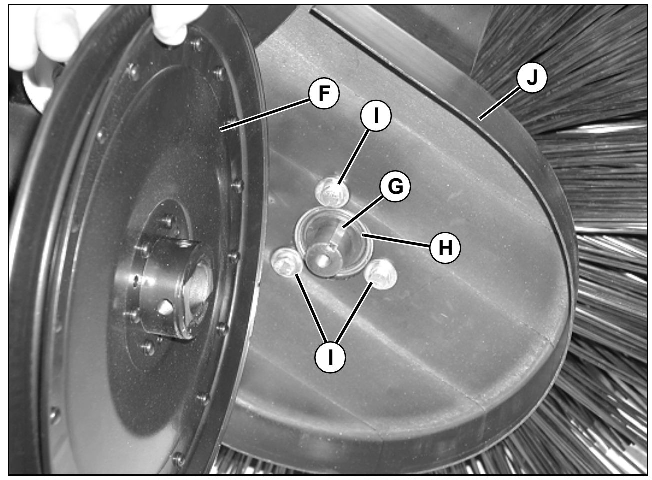
MX12647

4. Remove two screws (A) and belt guard (B) from drive side of broom.



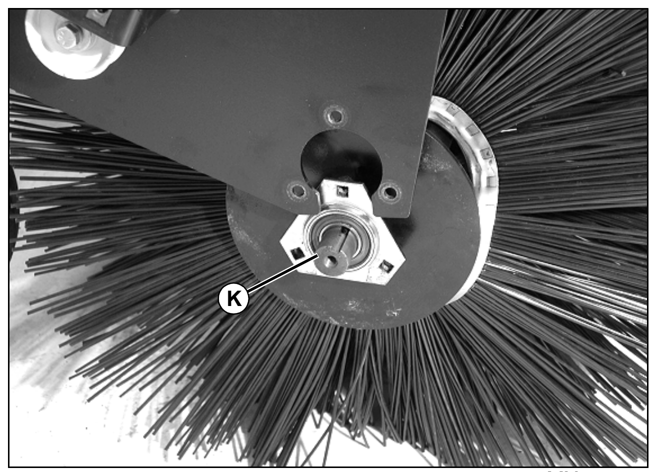
MX12651

5. Remove the cap screw and retaining washer (C) from the brush core shaft.
6. Loosen the belt tension nut (D) to the end of the adjustment stud.
7. Pull down and back on the idler pulley (E) to relieve the belt tension and remove the drive belt.



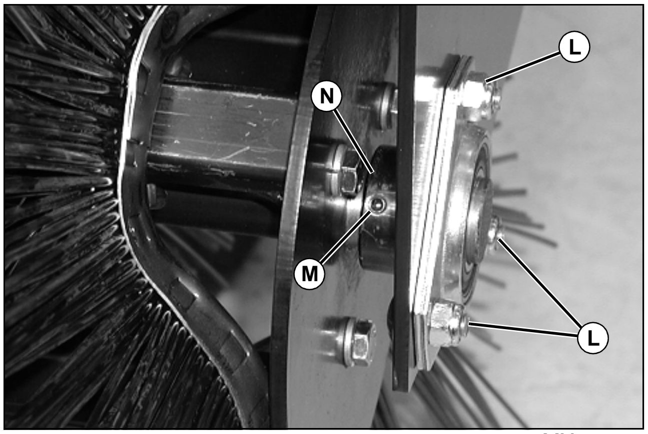
MX12652

8. Remove the brush pulley (F), key (G), and washer (H).
9. Remove the three brush bearing mounting cap screws (I) and inner belt guard (J).



MX12653

10. Guide the brush core shaft (K) down and out of the broom housing so that the brush is setting on the ground.
11. Using a bearing puller if needed, remove the drive side bearing.
12. Continue with next step if replacing idler side bearing, otherwise go to installation procedure.



MX12654

13.Remove the three brush bearing mounting cap screws (L) at idler end of brush core.

14.Guide the brush core shaft down and out of the broom housing so that the brush is setting on the ground.

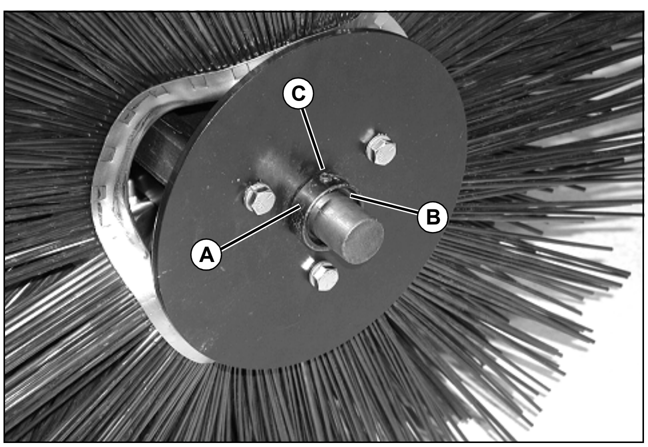
15.Loosen the set screw (M).

16.Rotate the bearing lock collar (N) until it is lose on the brush core shaft.

17.Using a bearing puller if needed, remove the left side bearing.

Installation:

1. Position the brush core in front of the broom housing with brush retainer plate toward the idler end of broom housing.

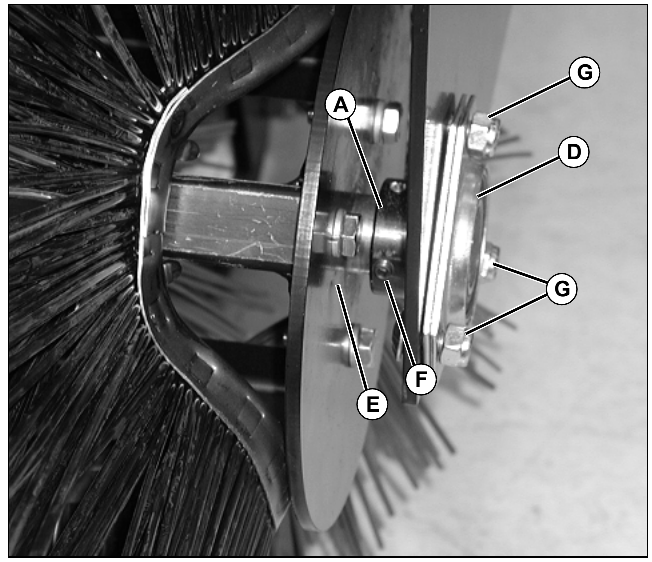


MX14096

2. Install the bearing collar (A) onto the idler end of brush core with the locking groove (B) outward. Do not tighten set screws (C) at this time.

3. Install the idler side bearing and bearing flanges to the outside face of the broom housing.

4. Install the mounting cap screws finger tight.



MX14097

5. Install idler end of brush core into broom housing by inserting brush core shaft into bearing (D).

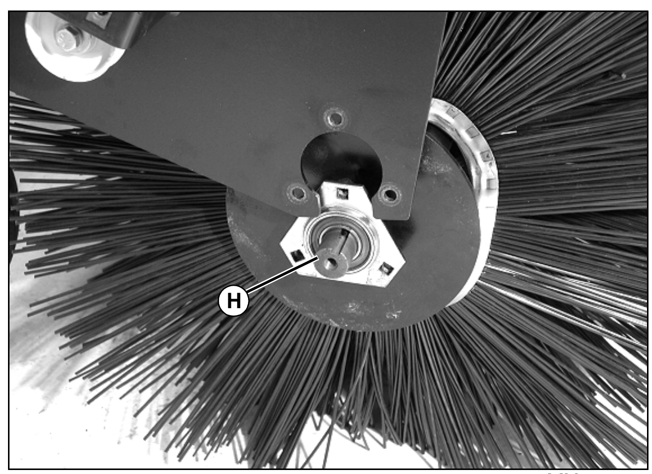
6. Slide bearing collar (A) over bearing. The bearing collar may need to be rotated.

7. Slide brush core into the bearing until the bearing collar (A) is tight against the brush retainer plate (E).

8. Hold the brush core in place and rotate the bearing collar on the shaft to lock the bearing to the shaft.

9. Tighten the set screw (F).

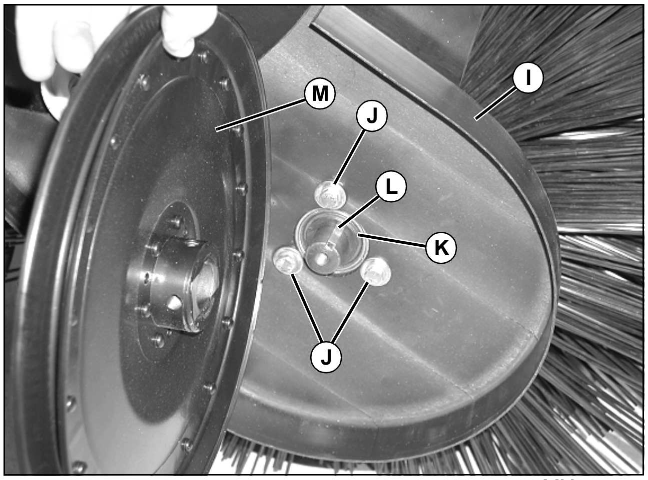
10.Tighten the three hex nuts (G) on the idler side bearing flange to 15.5 N•m (138 lb-in.).



MX12653

11.Position the drive end bearing and bearing flanges onto the brush core shaft (H).

12.Position the drive end of the brush core shaft (H) under the broom housing.



MX12652

13.Raise the brush head into position and install the inner belt guard (I) and secure with three brush bearing mounting cap screws (J).

14.Tighten mounting cap screws to 15.5 N•m (138 lb-in.).

15.Install the washer (K), square key (L), and brush pulley (M).

MX12651

16.Install and tighten the cap screw and retaining washer (N) into the brush core shaft to 19 N•m (168 lb-in.).

17.Install the drive belt.

18.Adjust the drive belt tension.

19.Install the belt guard and secure with two screws.

Table of Contents

Specifications

General Specifications

Make . . . . **Kohler**
Model . . . . **Command Pro 10 CS10RT**
Power @ 3600 rpm, Corrected to SAE J1349 . . . . **7.45 kW (10 hp)**
Peak Torque @ 2000 rpm . . . . **19.66 N•m (14.5 lb-ft)**
Bore . . . . **78.0 mm (3.07 in.)**
Stroke . . . . **63.0 mm (2.48 in.)**
Displacement . . . . **301 cc (18.37 cu in.)**
Cylinders **1**
Stroke/Cycle **4**
Valves . . . . **Overhead**
Crankshaft Type . . . . **Horizontal (Counterbalanced)**
Compression Ratio **8:1:1**
Standard Compression Pressure (With ACR in Operation) . . . . **400 - 600 kPa (57 - 85 psi)**
Compression Release . . . . **Automatic/Centrifugal**
Cooling System . . . . **Air Cooled**
Lubrication . . . . **Splash System**
Starting . . . . **Recoil**
Fuel Capacity . . . . **6.9 L (7.3 US qt)**
Weight (Approximate) . . . . **31.9 kg (70.5 lb)**
Oil Capacity . . . . **1.1 L (1.2 US qt)**
Angle of Operation (maximum) at Full Oil Level . . . . **20°**
Spark Plug Type NGK . . . . **BPR4ES (13/16 in. hex)**
Spark Plug Type Champion® . . . . **RN14YC (13/16 in. hex)**
Spark Plug Type Champion® . . . . **RC14YC (5/8 in. hex)**

Adjustment Specifications

Spark Plug Gap . . . . **0.76 mm (0.030 in.)**
Ignition Module Air Gap . . . . **0.4 - 0.6 mm (0.015 - 0.023 in.)**

Repair Specifications

Camshaft:
End Play . . . . **0.05 mm (0.0020 in.)**
Bore ID . . . . **15.965 - 15.990 mm (0.6285 - 0.6295 in.)**
Bore ID - Maximum Wear LImit . . . . **15.95 mm (0.628 in.)**
Camshaft Bearing Surface OD - Maximum Wear LImit . . . . **16.05 mm (0.649 in.)**
Cam Lobe Lift - Intake and Exhaust . . . . **32.55 ± 0.05 mm (1.28 ± 0.002 in.)**
Cam Lobe Diameter - Intake and Exhaust . . . . **26.08 ± 0.05 mm (1.03 ± 0.002 in.)**

ROTARY BROOM ENGINE SPECIFICATIONS

Connecting Rod:

Connecting Rod to Crankpin Running Clearance New. 0.016 - 0.046 mm (0.0006 - 0.0018 in.)

Connecting Rod to Crankpin Running Clearance Maximum Wear Limit . . . . 0.1 mm (0.004 in.)

Connecting Rod to Crankpin Side Clearance . . . . 0.20 - 0.65 mm (0.0079 - 0.0256 in.)

Connecting Rod to Piston Pin Running Clearance . . . . 0.006 - 0.025 mm (0.0002 - 0.0001 in.)

Piston Pin End ID:

New . . . . 20.006 - 20.020 mm (0.7867 - 0.7882 in.)

Maximum Wear Limit . . . . 20.10 mm (0.791 in.)

Connecting Rod Journal End ID:

New . . . . 36.000 - 36.015 mm (1.4173 - 1.4179 in.)

Maximum Wear Limit . . . . 36.115 mm (1.4219 in.)

Crankshaft:

End Play (Free) . . . . 0.04 mm (0.0015 in.)

Flywheel End Main Bearing Journal ID:

New . . . . 80 mm (3.149 in.)

Maximum Wear Limit . . . . 80.05 mm (3.1515 in.)

PTO End Main Bearing Journal ID:

New . . . . 72 mm (2.834 in.)

Maximum Wear Limit . . . . 72.05 mm (2.836 in.)

Connecting Rod Journal OD:

New . . . . 35.969 - 35.984 mm (1.4161 - 1.4167 in.)

Maximum Wear Limit . . . . 35.9 mm (1.4134 in.)

Crankshaft:

Runout (Either End) . . . . 0.02 mm (0.0008 in.)

Limit (Either End) . . . . 0.04 mm (0.0016 in.)

Cylinder Bore ID:

New . . . . 78.00 - 78.02 mm (3.0709 - 3.0717 in.)

Maximum Wear Limit . . . . 78.65 mm (3.096 in.)

Maximum Out of Round . . . . 0.05 mm (0.002 in.)

Cylinder Head:

Maximum Out of Flatness . . . . 0.1 mm (0.004 in.)

Governor Shaft:

Governor Shaft Position Exposed Length . . . . 36.0 ± 0.6 mm (1.47 ± 0.023 in.)

Piston to Piston Pin:

Clearance . . . . 0.004 - 0.020 mm (0.0002 - 0.0008 in.)

Piston Pin Bore ID:

New . . . . 20.004 - 20.015 mm (0.7876 - 0.7880 in.)
Maximum Wear Limit . . . . 20.03 mm (0.7886 in.)

Piston Pin OD:

New . . . . 19.995 - 20.000 mm (0.7872 - 0.7874 in.)
Maximum Wear Limit . . . . 19.98 mm (0.787 in.)

Ring to Groove Side Clearance:

Top Compression Ring . . . . 0.04 - 0.08 mm (0.0016 - 0.003 in.)
Middle Compression Ring . . . . 0.03 - 0.07 mm (0.0012 - 0.0028 in.)
Maximum Wear Limit . . . . 0.1 mm (0.004 in.)

Ring End Gap:

Top Compression Ring . . . . 0.25 - 0.4 mm (0.010 - 0.016 in.)
Middle Compression Ring . . . . 0.25 - 0.4 mm (0.010 - 0.016 in.)
Oil Control Ring . . . . 0.2 - 0.7 mm (0.0079 - 0.028 in.)

Piston Thrust Face OD:

New . . . . 77.954 - 77.998 mm (3.0691 - 3.0708 in.)
Maximum Wear Limit . . . . 77.898 mm (3.0669 in.)

Piston Thrust Face to Cylinder Bore Running Clearance . . . . 0.002 - 0.066 mm (0.0001 - 0.0026 in.)

Intake Valve:

Head Diameter . . . . 32.0 mm (1.26 in.)
Stem Diameter . . . . 5.948 - 5.963 mm (0.2342 - 0.2348 in.)
Length . . . . 88.1 mm (3.47 in.)
Face/Seat Width . . . . 0.7 - 0.9 mm (0.0276 - 0.354 in.)
Face/Seat Limit . . . . 1.4 mm (0.055 in.)
Face Seat Angle (Insert Area) . . . . .90°
Valve Stem Bend Limit . . . . 0.01 mm (0.0004 in.)
Valve Seat Contact Width (Standard) . . . . 0.7 mm (0.03 in.)
Valve Seat Contact Width (Limit). . . . . 1.7 mm (0.067 in.)

Intake Valve Guide ID:

New . . . . 6.0 - 6.012 mm (0.2362 - 0.2367 in.)
Maximum Wear Limit . . . . 6.10 mm (0.240 in.)
Valve Stem to Valve Guide Clearance. . . . . 0.037 - 0.064 mm (0.0015 - 0.0025 in.)

Exhaust Valve:

Head Diameter . . . . 27.0 mm (1.06 in.)
Stem Diameter . . . . 5.940 - 5.955 mm (0.2339 - 0.2344 in.)
Length . . . . 87.9 mm (3.46 in.)
Face/Seat Width . . . . 0.7 - 0.9 mm (0.0276 - 0.0354 in.)
Face/Seat Limit . . . . 1.4 mm (0.055 in.)
Face/Seat Angle (Insert Area) . . . . 90°
Valve Stem Bend Limit . . . . 0.01 mm (0.0004 in.)
Valve Seat Contact Width (Standard) . . . . 0.7 mm (0.03 in.)
Valve Seat Contact Width (Limit). . . . . 1.7 mm (0.067 in.)

Exhaust Valve Guide ID:

New . . . . 6.0 - 6.012 mm (0.2362 - 0.2367 in.)
Maximum Wear Limit . . . . 6.0 mm (0.236 in.)
Valve Stem to Valve Guide Clearance. . . . . 0.045 - 0.072 mm (0.0018 - 0.0028 in.)

Valve Guide Reamer Size. . . . . 6.0 mm (0.236 in.)
Intake Valve Minimum Lift . . . . 2.7 mm (0.106 in.)
Exhaust Valve Minimum Lift . . . . 2.9 mm (0.114 in.)
Nominal Valve Seat Angle . . . . 45°
Valve to Tappet Clearance (Cold) . . . . 0.1 mm (0.004 in.)

Torque Specifications

Air Cleaner:

Base Bolt Torque . . . . 5 - 8 N•m (44 - 71 lb-in.)
Base Nut Torque . . . . 10 - 12 N•m (88 - 106 lb-in.)

Carburetor:

Fuel Bowl Retaining Screw Torque . . . . 9 N•m (79 lb-in.)
Throttle/Choke Plate Screws . . . . 1.5 - 2.5 N•m (13 - 22 lb-in.)

Engine Block and Internal:

Closure Plate Fastener Torque . . . . 30 N•m (265 lb-in.)
Oil Drain Plug Torque . . . . 20 N•m (177 lb-in.)
Cylinder Head Bolt Torque . . . . 50 N•m (36 lb-ft)
Timing Drive Gear Mounting Bolt . . . . 60 - 70 N•m (44 - 51 lb-ft)
Connecting Rod Fastener Torque . . . . 20 N•m (177 lb-in.)

Flywheel:

Flywheel Retaining Screw Torque. . . . . 120 N•m (85 lb-ft)

Governor:

Governor Lever Bolt Torque . . . . 10 N•m (88.5 lb-in.)

ROTARY BROOM ENGINE SPECIFICATIONS

Ignition:

Spark Plug Torque . . . . 20 N•m (177 lb-in.)

Ignition Module Mounting Screws Torque . . . . 10 N•m (88 lb-in.)

Muffler:

Muffler Torque (Flange Nuts and Bracket Bolts) . . . . 18 - 22 N•m (159 - 195 lb-in.)

Retractable Starter:

Mounting Screws to Blower Housing Torque . . . . 7 N•m (62 lb-in.)

Retractable Starter Center Screw . . . . 5 - 6 N•m (44 - 53 lb-in.)

Retractable Starter Housing Mounting Screws . . . . 5.5 N•m (48 lb-in.)

Rocker Arm:

Stud Into Cylinder Head Torque . . . . 10 N•m (88 lb-in.)

Adjusting Jam Nut Torque . . . . 7 N•m (62 lb-in.)

Stator:

Stator Mounting Screws . . . . 5 - 8 N•m (44 - 70 lb-in.)

Wire Shield . . . . 10 N•m (88 lb-in.)

Throttle Control:

Throttle Control Lever Fastener Torque . . . . 9 - 11 N•m (80 - 97 lb-in.)

Valve Cover:

Valve Cover Fastener Torque . . . . 11 N•m (97 lb-in.)

Tools and Materials

Special or Required Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Compression Gauge	JDM59	Used to check engine compression.
Crankcase Vacuum Test Kit	JT03503	Used to measure crankcase vacuum.
Valve Spring Compressor	JDM70	Used to remove and install valve springs.
Dial Indicator	Obtain Locally	Automatic compression relief test, valve inspection, and crankshaft end play
Digital Pulse Tachometer	JT07270	Slow and/or fast idle adjustment
Photo Tachometer	JT05719	Slow and/or fast idle adjustment
Spark Plug Ground	JDM74A5	Used to prevent accidental engine starting during tests.
Oil Pressure Test Adapter	JT07262	Oil pressure test
Lapping Tool	Obtain Locally	Valve lapping
Flywheel Puller Kit	Obtain Locally	Flywheel Removal
Rocker Arm Spanner Wrench	Obtain Locally	Lifting Rocker Arms and Turning Flywheel
Water Manometer	JT05690	Engine Crankcase Vacuum Test
Flywheel Holding Tool	Fabricate Locally	Flywheel Removal and Installation

Other Materials

Other Material

Part No.	Part Name	Part Use
M79792	MPG-2® Multipurpose Grease	Apply to engine crankshaft.
PT569	John Deere NEVER-SEEZ® Lubricant	Apply to crankshaft end.
TY9375/TY9480/LOCTITE® 592	Thread sealant (General Purpose) with TEFLON®	Apply to threads of oil pressure switch.
	SCOTCH-BRITE® Abrasive Sheets/Pads	Clean cylinder head
TY15130/LOCTITE® 395	Form-n-Place Gasket	Rocker arm cover mating surfaces
T43512/TY9473/LOCTITE® 242	Thread Lock and Sealer (Medium Strength)	Apply to governor shaft and stator support bracket.

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LOCTITE® is a registered trademark of the Loctite Corp.

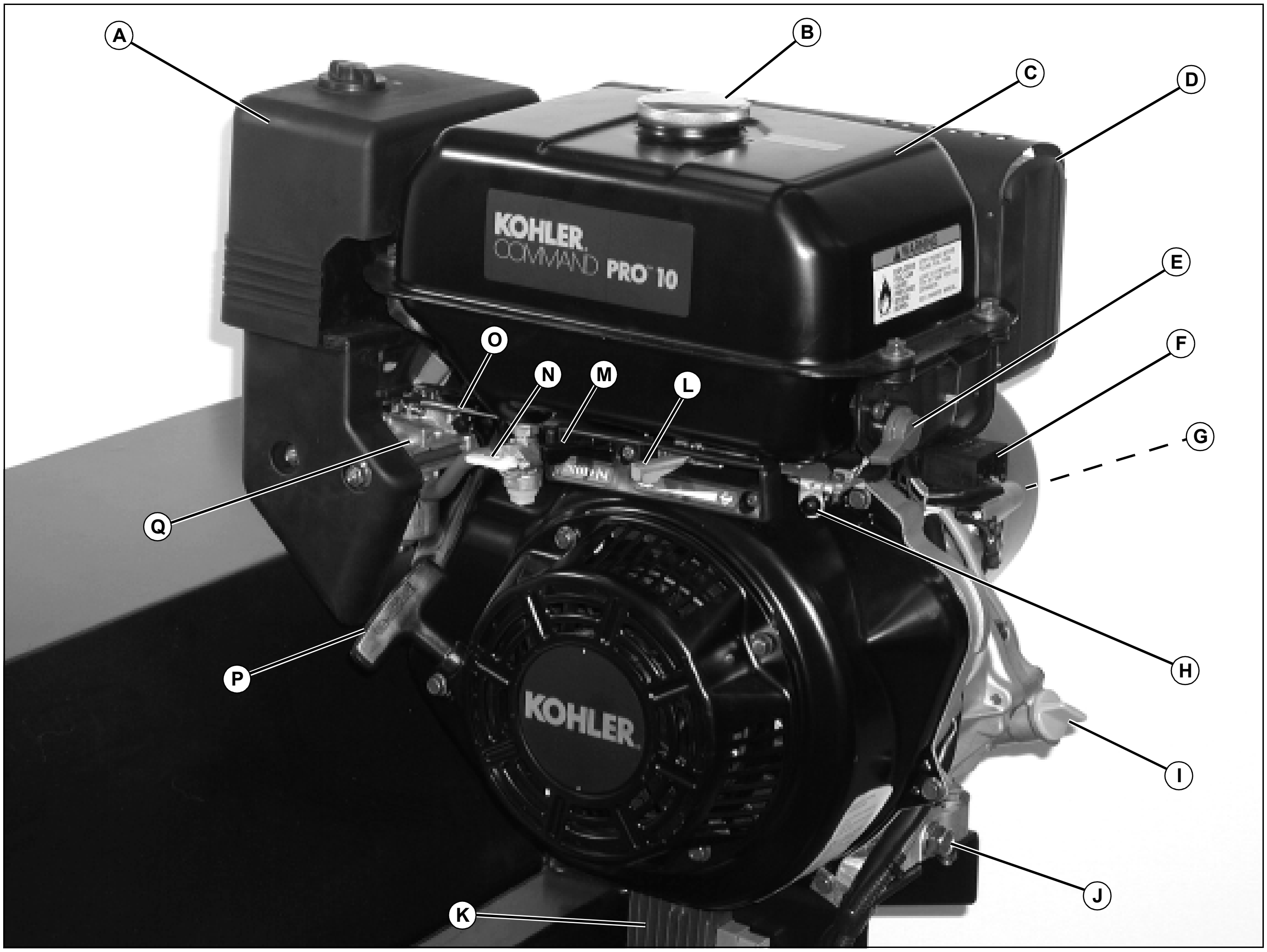
TEFLON® is a registered trademark of DuPont.

SCOTCH-BRITE® is a registered trademark of the 3M Co.

NEVER-SEEZ® is a registered trademark of Bostik Findley Inc.

Component Location

Engine Components



MX12643

A - Air Cleaner Assembly
B - Fuel Filler Cap
C - Fuel Tank
D - Muffler
E - Ignition On/Off Switch
F - Oil Warning Module
G - PTO Clutch
H - Oil Warning Light
I - Oil Filler Cap
J - Oil Drain Plug
K - Voltage Regulator/Rectifier
L - Throttler Lever
M - Choke Lever
N - Fuel Shutoff Valve and Screen Assembly
O - Governor Linkage
P - Retractable Starter Handle
Q - Carburetor

Diagnostics

Engine Troubleshooting

- Remove spark plug and inspect.
- Perform a compression test on the engine.

Engine is hard to start

Symptom: Engine is hard to start

(1) Does the engine run but is hard to start?

Yes - Check for dirt or water in the fuel system.

Yes - Restricted fuel filter or clogged fuel line.

Yes - Loose or faulty wires or connections.

Yes - Faulty choke or throttle controls. Check carburetor adjustment.

Yes - Faulty spark plug or weak spark. Check ignition system.

Yes - Check for low compression. Check cylinder compression.

Yes - Faulty ACR mechanism. Test ACR.

Engine Does Not Start

Symptom: Engine does not start (fuel system).

(1) Ensure that there is adequate fuel in the tank.

Yes - Go to next step.

(2) Is fuel getting to the carburetor?

Yes - Go to next step.

No - Check fuel level in tank.

No - Fuel shut-off valve closed.

No - Restricted fuel cap vent.

No - Test fuel filter for restrictions.

No - Check the fuel line.

(3) Check the air filter for restrictions.

Symptom: Engine does not start (ignition system).

(1) Test for proper ignition spark. Is the spark good?

Yes - Faulty spark plug.

Yes - Go to next step.

No - Check the ignition coil air gap.

Symptom: Engine does not start (ignition system).

No - Loose wires or connections that short the kill terminal of the ignition module to ground.

(2) Test the ignition switch. Does it work correctly?

No - Repair or replace switch.

Symptom: Engine does not start (electrical system).

(1) Test the engine run - start switch. Is the switch good?

No - Repair or replace switch.

Yes - Go to next step.

(2) Check engine oil level and oil switch. Is the level OK and the switch functioning?

No - Add oil as needed or repair or replace switch.

Engine Runs Poorly

Start engine and run for 3 minutes to allow it to reach operating temperature.

Symptom: Engine runs poorly (idle control).

(1) Does the engine idle but stops?

Yes - The idle fuel adjusting needle is improperly set.

Yes - The idle speed adjusting screw is improperly set.

Yes - Check the engine for low compression.

Yes - Check the fuel supply for contamination.

(2) Place throttle lever in idle position. Does engine rpm decrease to normal idle speed?

No - Engine appears to be under load or engine rpm remains at high speed. Check governor adjustment. Check PTO clutch.

Engine oil problems

Symptom: Engine uses excessive amounts of oil.

(1) Does the engine consume excessive amounts of oil?

Yes - Incorrect viscosity or type of oil being used in engine.

Yes - The crankcase is overfilled.

Yes - Check the breather for clogging.

Yes - Worn or broken piston rings.

Symptom: Engine uses excessive amounts of oil.

Yes - The cylinder bore is worn.

Yes - The valve stems and/or valve guides are worn.

(2) Does oil leak from seals or gaskets?

Yes - Check the crankcase breather for restrictions.

Yes - Loose or improperly tightened fasteners.

Yes - Piston blowby or leaky valves.

Yes - Check the exhaust for restrictions.

Engine Knocks

Symptom: Engine Knock

(1) Does the engine knock while running?

Yes - Excessive engine load.

Yes - Low crankcase oil level.

Yes - The fuel could be old, improper, or contaminated.

Yes - Check for internal engine wear.

Engine Overheats

Symptom: Engine is overheating

(1) Does the engine run but overheats?

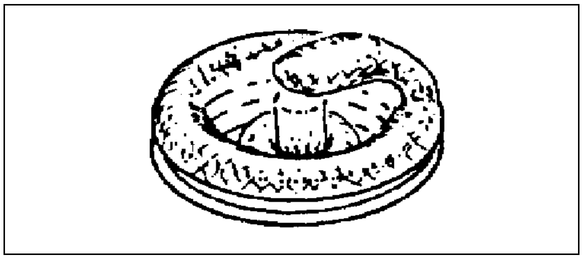
Yes - Check air intake/grass screen, cooling fins, or cooling shroud for clogs.

Yes - The crankcase oil level is either too high or too low.

No - The carburetor is faulty or set improperly.

Spark Plug Troubleshooting

Symptom: Poor engine performance



M91490

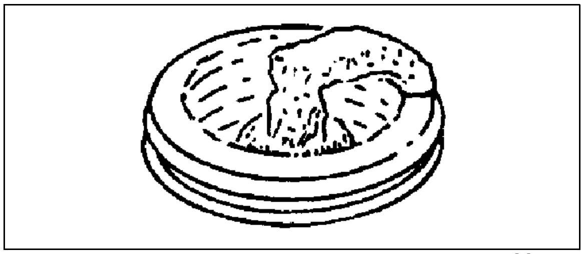
(1) Are there excessive deposits on the electrodes yet the electrodes aren't worn (Oxide Fouling)?

Yes - Inspect the combustion chamber for excessive deposits.

Symptom: Poor engine performance

Yes - Inspect muffler and exhaust for clogging.

Yes - Verify that the air/fuel mixture is correct and that the recommended oils are used.

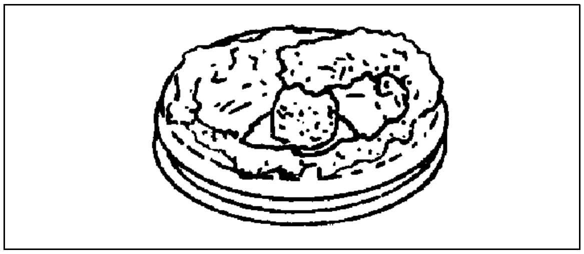


M91491

(2) Is the sparking gap shorted out by combustion particles fused between electrodes (Gap Bridging)?

Yes - Ensure that the recommended oils and/or fuels are used.

Yes - Inspect muffler and exhaust for clogging.



M91492

(3) Is the insulation tip black with a carbon layer over the entire nose and a damp oily film over the firing end (Wet Fouling)?

Yes - Engine may be running too rich. Check air/fuel mixture.

Yes - Check idle speed.

Yes - Test ignition module.

Yes - Check air filter for clogging.

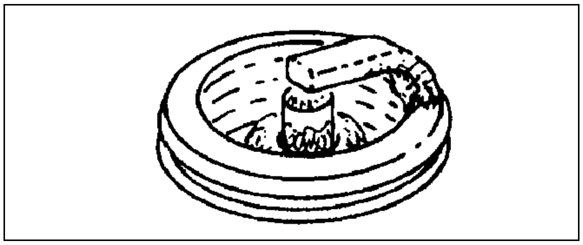
Yes - Verify that the recommended oils are used.

Yes - The plug may be too cold for the type of work being performed.

Yes - The low speed jet may not be adjusted properly (too rich).

Yes - The idle speed may be too low.

Symptom: Poor engine performance



M91493

(4) Is the electrode burned with the insulator tip color light grey or chalk white (Overheated)?

Yes - Inspect muffler and exhaust for clogging.

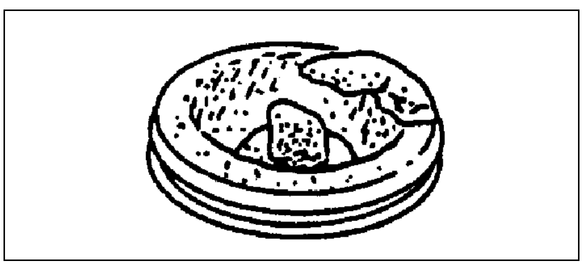
Yes - Check the cylinder fins for dirt. Clean as required.

Yes - Carburetor may be adjusted too lean.

Yes - Check for an air leak in the fuel line.

Yes - Inspect the carburetor for a ruptured fuel hose or filter diaphragm.

Yes - Ensure that the spark plug heat range is correct (too hot).



M91494

(5) Do the electrodes appear to be worn out?

Yes - This condition requires more voltage than the ignition system can produce. Replace with new plug of the same heat range.

Tests and Adjustments

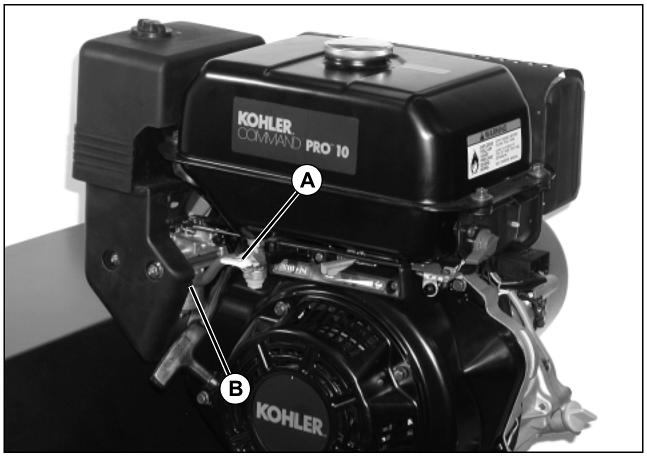
Fuel System Tests

NOTE: This engine uses a fixed jet MIKUNI carburetor. The fixed main jet carburetor is designed to deliver the correct air to fuel mixture to the engine under all operating conditions. The high idle mixture is set at the factory an cannot be adjusted. The low idle fuel adjusting needle is also set by the factory and normally does not need adjustment.

Fuel Flow Test

CAUTION: Avoid injury! Gasoline is explosive. Do not expose to flame or spark.

Procedure



MX12643

1. Turn fuel shut-off valve (A) to off position to prevent fuel flow.

IMPORTANT: Avoid damage! Ensure that container is clean if fuel is to be returned to the tank after test.

2. Disconnect fuel line from carburetor (B) and place in container.
3. Turn fuel shut off valve to the on position.
4. Fuel should flow freely into container.
5. Turn fuel shut-off valve to off position.
6. Pour captured fuel into tank.

If fuel flow is slow, check the following:

- Clean fuel screen.
- Check fuel lines, shut-off valve, fuel tank outlet, and fuel tank cap for restrictions.

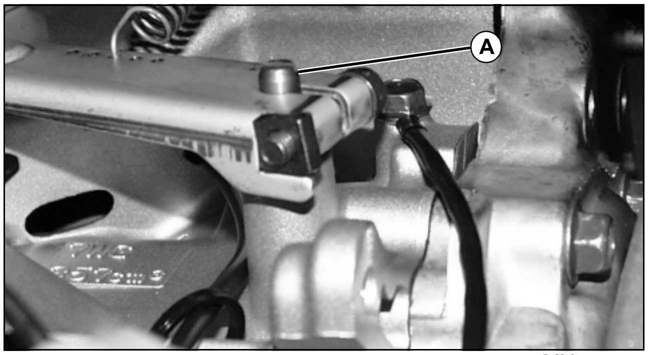
Governor Cross Shaft Position Adjustment

Reason:

To make sure the governor shaft contacts the flyweight plunger when the engine is stopped.

Procedure:

NOTE: The governor shaft is pressed into the closure plate to a specified height and normally should not require removal or servicing. The position is critical to proper operation of the governor gear and the entire governor assembly. If for any reason the mounted position of the governor shaft is changed, it must be reset to the specified height.



MX17508

1. Adjust governor shaft (A) so it protrudes 36.0 ± 0.6 mm (1.417 ± 0.023 in.) above the crankcase.

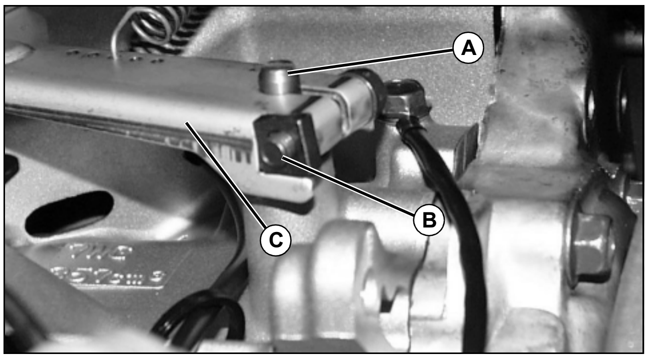
Governor Lever Adjustment

Reason:

Make this adjustment whenever the governor lever is loosened or removed from the cross shaft. To ensue proper setting, make sure the throttle linkage is connected to the governor lever and the carburetor throttle lever.

Procedure:

1. Close the fuel shut off valve.



MX17508

2. Loosen the governor lever mounting bolt (B).
3. Move the governor lever (C) clockwise until it stops.
4. Rotate the governor shaft (A) clockwise until it stops.
5. Hold both in this position and tighten the governor lever bolt.

- Tighten the bolt to 10 N•m (88 lb-in.).

Slow Idle Speed Adjustments

Reason:

To set engine slow idle mixture and rpm.

Equipment:

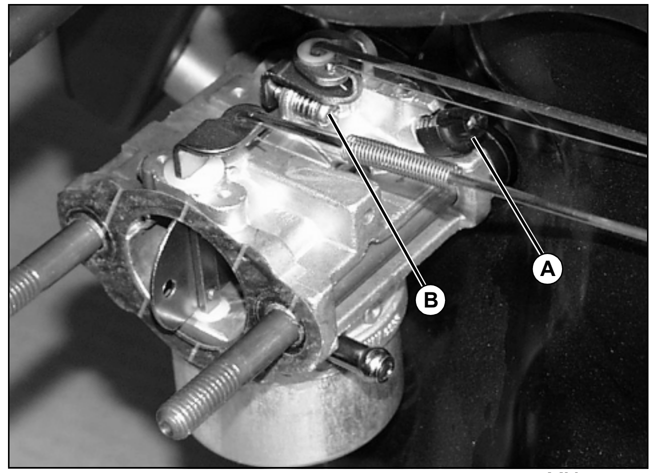
- JT07270 Pulse Tachometer; or,
- JT05719 Photo Tachometer

Procedure:

NOTE: Carburetor adjustments should only be made after the engine is warmed up.

The carburetor is designed to deliver the correct fuel to air mixture to the engine under all operating conditions. The high idle mixture is set at the factory and cannot be adjusted. The low idle fuel adjusting needle is also set at the factory and has a limiting cap. It normally does not need adjustment.

1. Start engine and run at half throttle for 5 to 10 minutes to warm up. The engine must be warm before making final settings.
2. When engine is at operating temperature, move throttle to the slow idle position.
3. Check the speed using a tachometer when engine is at operating temperature.



MX19677

Picture Note: Air cleaner assembly removed for clarity.

4. Turn the low idle fuel adjusting needle (A) in or out within the adjustment range to obtain the best low speed performance.
5. Set the low idle speed to specification by turning the low idle speed adjusting screw (B) in or out.

Specifications:

Slow Idle Speed . . . . 2000 ± 150 rpm

Fast Idle Speed Adjustments

Reason:

To set engine fast idle rpm.

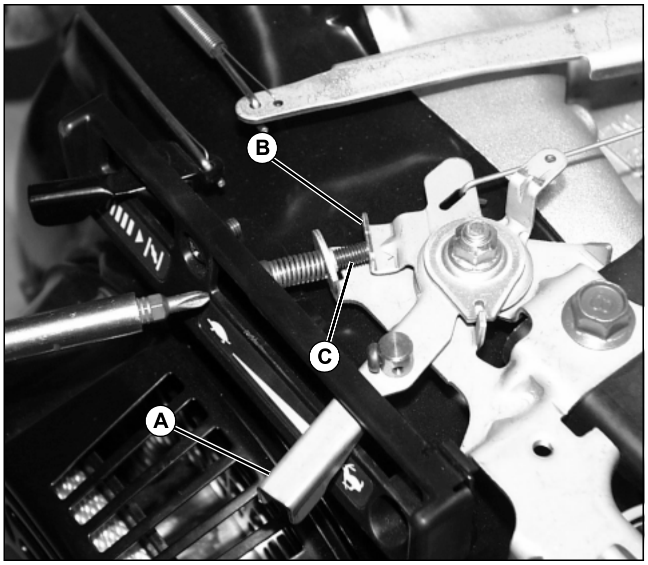
Equipment:

- JT07270 Pulse Tachometer; or,
- JT05719 Photo Tachometer

Procedure:

NOTE: Carburetor adjustments should only be made after the engine is warmed up.

1. Start engine and run at half throttle for 5 to 10 minutes to warm up. The engine must be warm before making final settings.
2. When engine is at operating temperature, move throttle to the high idle position.
3. Check the speed using a tachometer when engine is at operating temperature.



MX19678

Picture Note: Fuel tank removed for clarity.

4. Apply light pressure to throttle lever (A) to ensure the throttle stop (B) is contacting the throttle stop screw (C).

5. Turn the throttle stop screw in to decrease the high idle speed or out to increase the high idle speed.

Specifications:

High Idle Speed. .3800 ± 100 rpm

Cylinder Compression Test

Reason:

To determine condition of piston, piston rings, cylinder wall, valves, valve guides, gaskets, and seals.

Equipment:

- JDM59 Compression Gauge
- JDM74A5 Spark Plug Wire Test Tool

Procedure:

1. Run engine at idle for 5 minutes to reach operating temperature.

2. 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 eyeglasses and clothing.

IMPORTANT: Avoid damage! Spark plug wire Must be grounded or ignition module could be damaged.

3. Disconnect spark plug wire and ground with JDM74A5 tool.

4. Remove spark plug and install JDM59 compression gauge.

5. Hold throttle in fast idle position and verify choke is off.

6. Crank engine until compression gauge stops rising.

7. If compression is low, remove compression gauge. Squirt clean engine oil into cylinder.

8. Repeat cylinder compression test procedure.

Results:

- Minimum compression should be 400 - 600 kPa (57 - 85 psi).
- If compression pressure increases after oil is put in cylinder, check rings, piston, and cylinder bore for wear or damage.
- If compression pressure is still low after oil is put in cylinder, check valves, valve seats, valve seals, and cylinder head gasket.

Crankcase Vacuum Test

Reason:

To measure the amount of crankcase vacuum to ensure that the crankcase is not pressurized. A pressurized crankcase will force oil to leak past the seals.

Equipment:

- JT05697 U-Tube Manometer Test Kit; or,
- JT03503 Crankcase Vacuum Test Kit

Procedure:

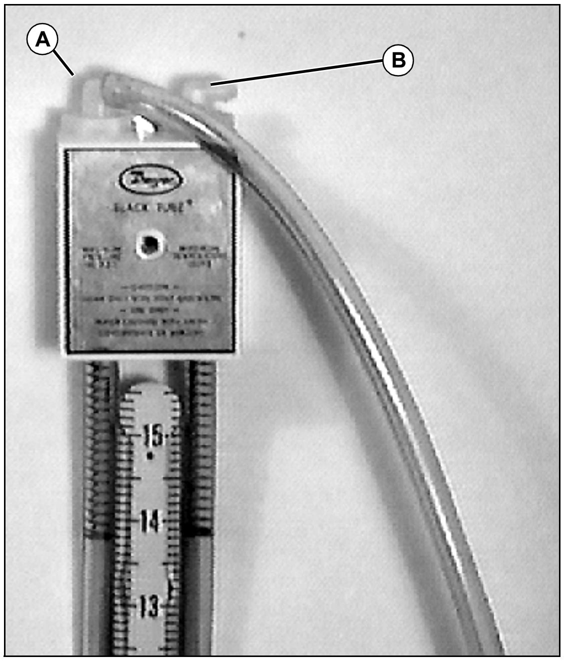
NOTE: Test must be run with the engine at normal operating temperature. If not, the test will be inaccurate. Do not use more than 3 ft. of manometer tubing. If a longer hose is used, the readings will be inaccurate.

1. Remove oil fill cap and check cap and O-Ring for cracks or damage. Replace as necessary.

2. Install appropriate size rubber plug in dipstick tube.

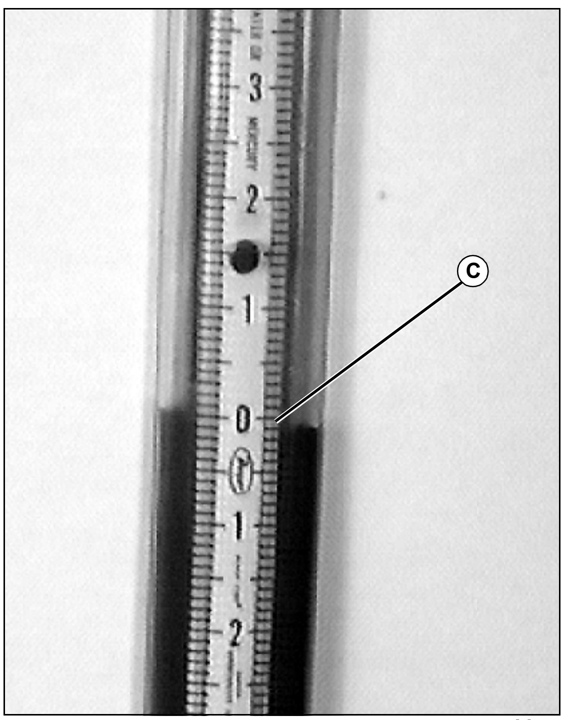
3. Insert barbed fitting in rubber plug so that clear line to fitting can be connected at a later step.

NOTE: Do not make connection between U-Tube manometer clear line and engine crankcase before engine is running or fluid in manometer could be drawn into crankcase.



M88761

4. Open top valves (A) and (B) one turn.

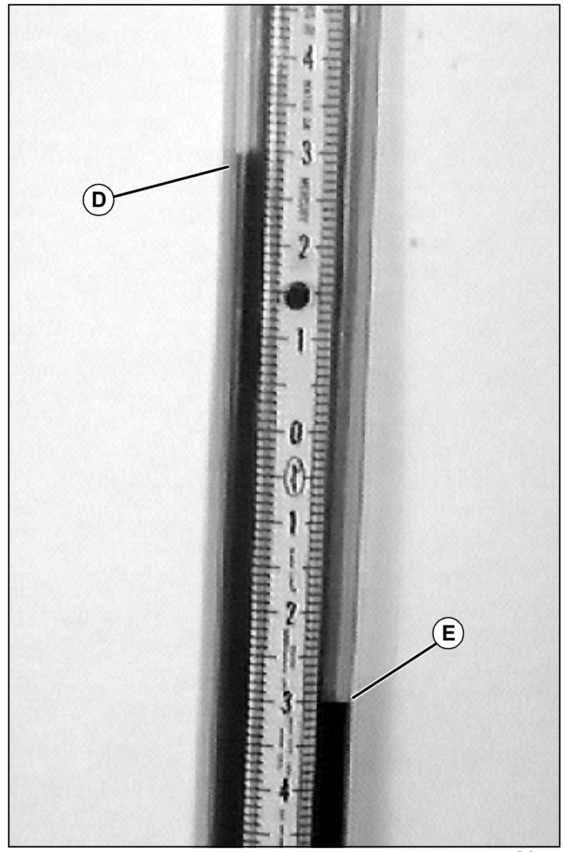


M88762

5. Zero out the manometer by sliding the ruled scale up or down so “0” (C) is located where water level on both sides is even.

6. Hold finger over rubber plug hole to keep oil from spraying out. Start engine, move throttle to fast idle and allow engine to reach operating temperature.

7. Quickly attach clear line from manometer to rubber plug in dipstick opening.



M88764

8. Record vacuum reading. Gauge should show a minimum vacuum of 10.2 cm (4 in.) of water movement. The reading is obtained by adding (D) and (E) water movement from “0” position.

NOTE: Repeat test at least three times for accuracy.

9. Remove line from manometer before stopping engine. Then remove dipstick hose connection and install oil check cap.

Automatic Compression Release (ACR) Check

Reason:

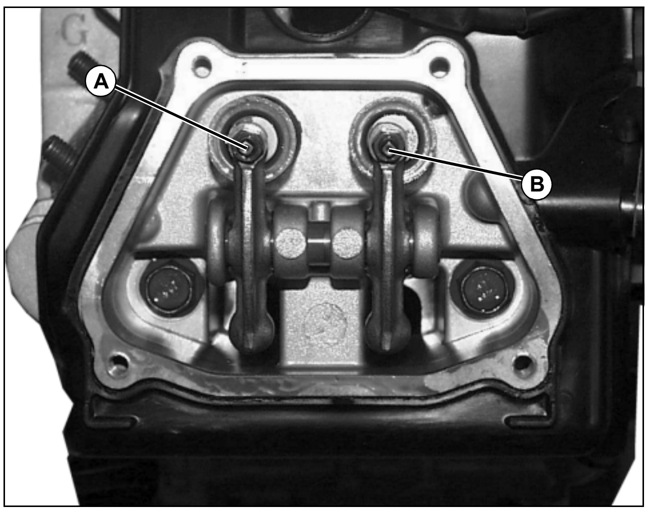
To determine if the automatic compression release is opening the exhaust valve.

Equipment:

- Dial Indicator

Procedure:

1. Remove the valve cover and spark plug. Rotate crankshaft slowly to observe ACR operation.



MX17518

2. The exhaust valve (A) must open briefly just after the intake valve (B) closes.

3. Use a dial indicator to measure exhaust valve ACR movement.

4. Install valve cover. See “Valve Cover/Breather Removal and Installation” on page 659.

- Exhaust valve ACR movement (minimum) 0.25 mm (0.01 in.).

Results:

If the exhaust valve does not open or depress properly, the automatic compression release tab is faulty and camshaft assembly must be replaced.

Valve Tappet Clearance Adjustment

Procedure:

NOTE: This adjustment should only be performed on a cold engine.

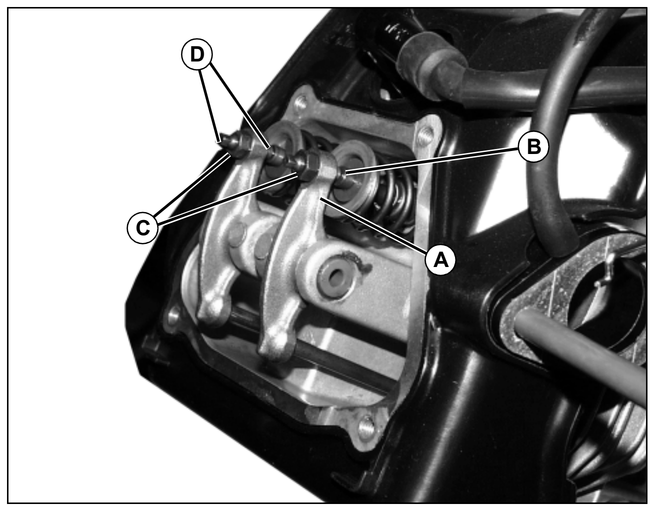
1. Remove air cleaner base assembly. See “Air Cleaner Assembly Removal and Installation” on page 650.

2. Disconnect spark plug lead.

3. Remove spark plug. See “Spark Plug Removal and Installation” on page 652.

4. Remove valve cover. See “Valve Cover/Breather Removal and Installation” on page 659.

5. Rotate the flywheel until the piston is at TDC of the compression stroke.



MX17423

6. Insert a flat feeler gauge between the rocker arm (A) and the valve stem (B).

NOTE: The rocker arm must be held up when making adjustments.

7. Adjust the clearance as required by loosening the locknut (C) and turning the adjuster (D). Turn clockwise to decrease clearance and counterclockwise to increase clearance.

8. After clearance is set, tighten the locknut.

9. Gap and install a new spark plug.

10. Install the cylinder air shroud by matching the alignment slots on the ends with the corresponding raised grooves in the crankcase.

11. Position the spark plug lead within the corresponding cutout in the shroud.

12. Adjust both intake and exhaust valve clearances to 0.1 mm (0.004 in.).

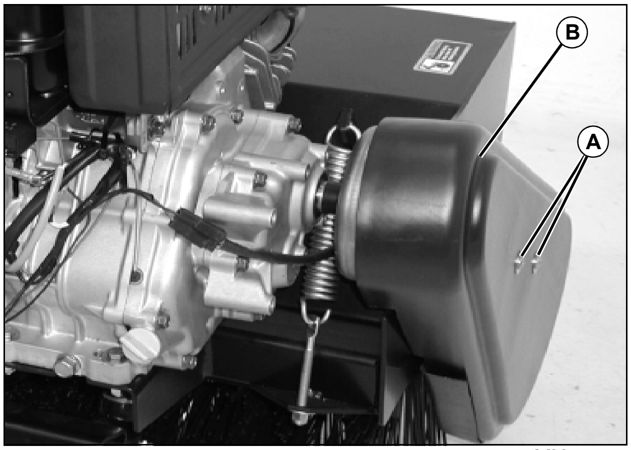
13. Tighten locknuts to 7 N•m (62 lb-in.).

Adjusting Drive Belt Tension

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

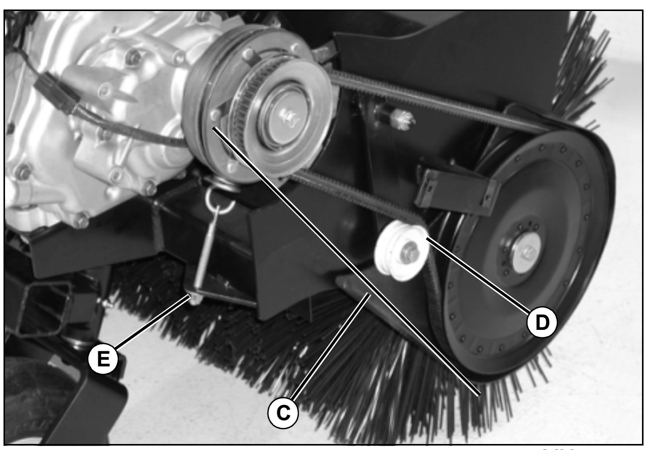
2. Lower brush head until bristles are approximately 76 mm (3 in.) off the ground.

3. Support brush head in raised position with wood blocks or a safe lifting device.



MX12647

4. Remove two screws (A) and belt guard (B) from right side of broom.



MX12651

5. Place a straight edge on the bottom edge of each pulley (C).

6. Measure the amount of deflection (D) placed on the belt by the idler pulley. Belt should deflect inward 6.35 - 7.62 cm (2.5 - 3.0 in.).

7. Adjust belt tension if deflection is more or less than specified.

8. Adjust belt tension by turning the adjustment nut (E).

   - If belt tension is greater than 7.62 cm (3.0 in.), turn the nut clockwise.
   - If belt tension is less than 6.35 cm (2-1/2 in.), turn the nut counterclockwise.

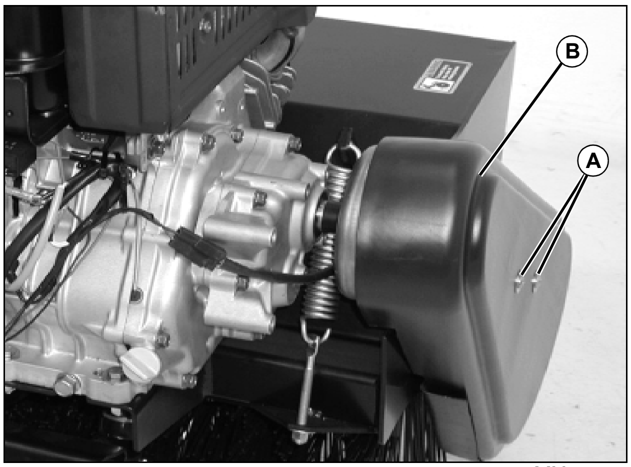
Repair

Brush Head Drive Belt Removal and Installation

Removal:

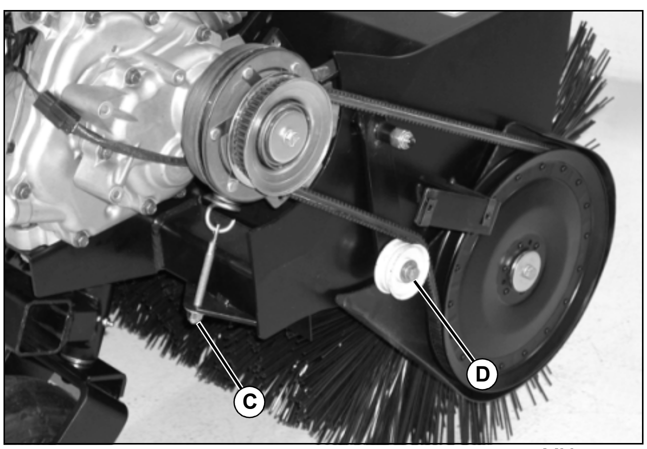
1. Park machine safely. (See Parking Safely in the SAFETY section.)

2. Support brush head in raised position with wood blocks or a safe lifting device.



MX12647

3. Remove two screws (A) and belt guard (B) from right side of broom.



MX12651

4. Loosen the belt tension nut (C) to the end of the adjustment stud.

5. Pull down and back on the idler pulley (D) to relieve the belt tension and remove the drive belt.

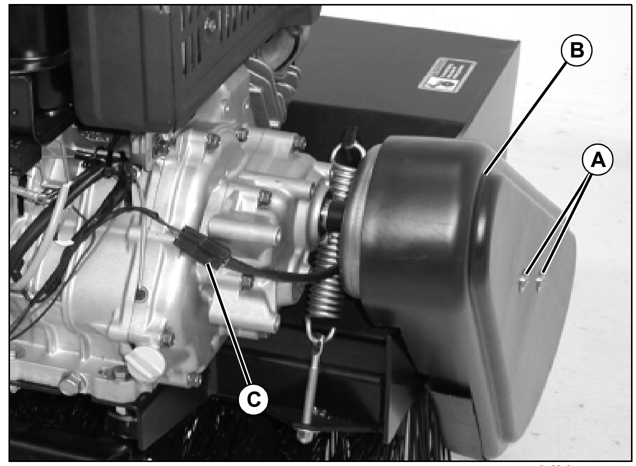
Installation:

1. Install the drive belt in reverse order of removal.
2. Adjust the drive belt tension.
3. Install the belt guard and secure with two screws.

PTO Clutch Removal and Installation

Removal:

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

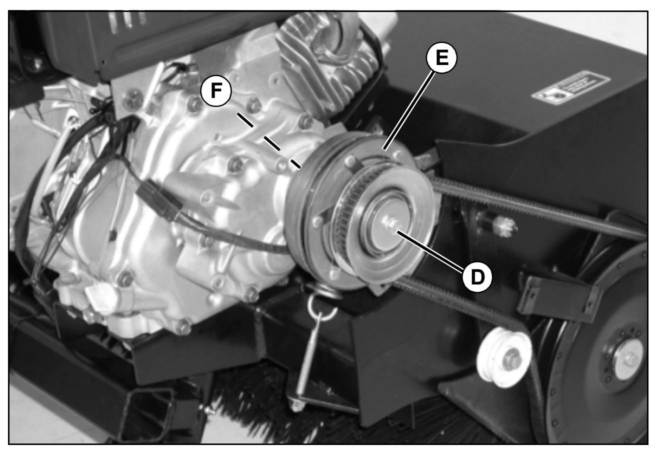


MX12647

2. Remove two screws (A) and belt guard (B) from right side of broom.

3. Remove the drive belt.

4. Disconnect the PTO clutch connector (C).



MX12651

5. Remove cap screw (D) securing clutch assembly (E) to engine output shaft.

NOTE: Drive key is a part of the clutch. Do not attempt to remove key from clutch bore.

6. Remove the clutch assembly and spacer (F).

Installation:

1. Install the PTO clutch in reverse order of removal.
2. Apply NEVER-SEEZ® lubricant to engine output shaft.
3. Adjust the drive belt tension.
4. Install the belt guard and secure with two screws.

Air Cleaner Assembly Removal and Installation

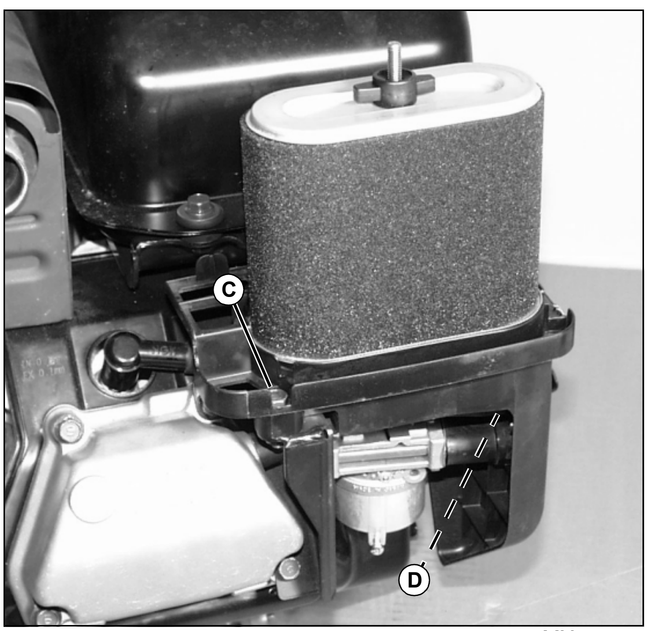
Removal:

MX19679

1. Remove the wing nut (A) securing air cleaner cover to air cleaner assembly.

2. Remove the air cleaner cover.

3. Remove the two nuts (B) securing the base to the carburetor mounting studs.



MX19680

4. Remove the bolt (C) securing the base to the mounting bracket.

5. Disconnect the breather hose (D) from the air cleaner base.

NOTE: The air filter assembly does not need to be removed to remove the air cleaner assembly.

6. Slide the air cleaner base off of the studs.

Cleaning:

IMPORTANT: Avoid damage! Do not wash the paper element or use pressurized air as this will damage the element. Replace a dirty, bent, or damaged element with a new one. Handle new elements carefully; do not use if the sealing surfaces are bent or damaged.

NOTE: every 50 hours of operation (more often under extremely dusty or dirty conditions), check the paper element. Replace the element as necessary. Remove and service the pre-cleaner.

1. Wash the pre-cleaner in warm water with detergent.

2. Rinse the pre-clean thoroughly until all traces of detergent are eliminated.

3. Squeeze out excess water (do not wring).

4. Allow the pre-cleaner to air dry.

5. Clean the paper air cleaner element by tapping the element to remove dust.

6. Replace the element if damaged, bent, or extremely dirty.

7. Handle new element carefully; do not use if the sealing surfaces are bent or damaged.

8. Check the air cleaner base and cover/housing assembly to ensure that they are not bent or damaged.

9. Make sure the air slots are open.

10.Saturate the pre-cleaner with new engine oil. Squeeze out all excess oil.

11.Install the foam damper and pre-cleaner over the paper element.

Installation:

IMPORTANT: Avoid damage! Operating the engine with loose or damaged air cleaner components could allow unfiltered air into the engine causing premature wear and failure.

NOTE: Before the air cleaner is reassembled make sure the rubber seal is in position on the stud. Also inspect the foam seal on the base of the filter element.

Installation is in the reverse of removal.

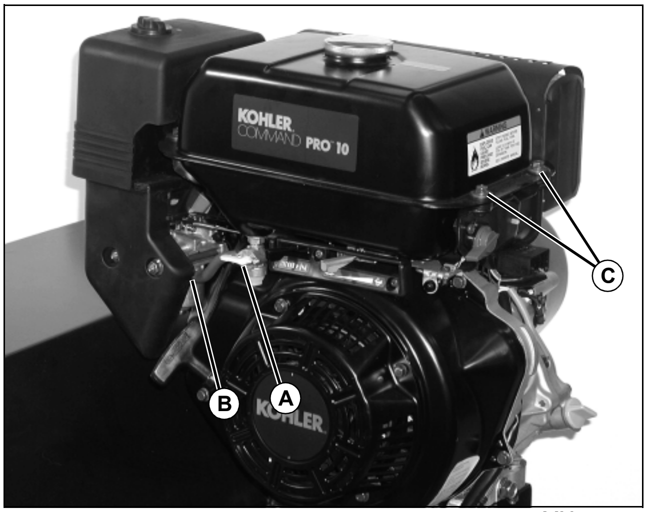
- Tighten the carburetor mounting nuts to 10 - 12 N•m (88 - 106 lb-in.).
- Tighten hex flange screw to 5 - 8 N•m (44 - 71 lb-in.).

Fuel Tank Removal and Installation

CAUTION: Avoid injury! Gasoline is extremely flammable and its vapors can explode if ignited. Spilled fuel could ignite if it comes in contact with hot parts. Allow engine to cool before servicing. Drain all fuel from the fuel tank before removing or installing.

Removal:

1. Park machine safely. (See Parking Safely in the SAFETY section.



MX12643

2. Close fuel shut off valve (A) and disconnect fuel line from carburetor inlet (B).

3. Route fuel line into a suitable container and open fuel shutoff valve to drain fuel from fuel tank.

4. Close fuel shut off valve.

5. Remove the two cap screws on each end (C) securing the fuel tank support brackets.

6. Remove the fuel tank.

Installation:

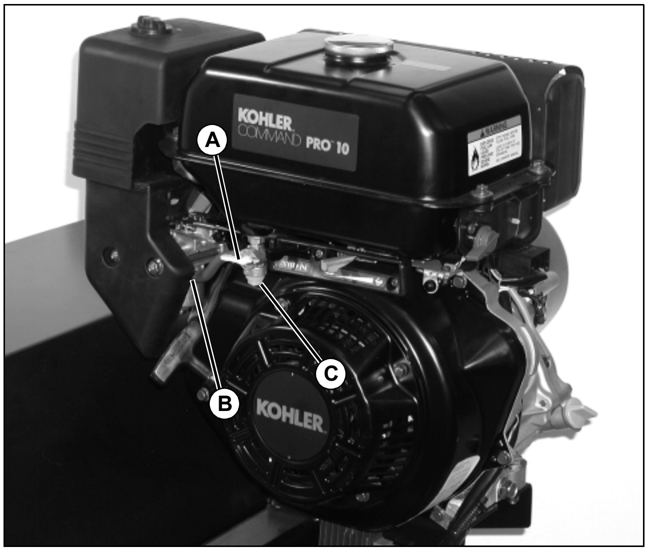
- Installation is in the reverse of removal.

Fuel Sediment Bowl Cleaning

CAUTION: Avoid injury! Gasoline is extremely flammable and its vapors can explode if ignited. Spilled fuel could ignite if it comes in contact with hot parts. Allow engine to cool before servicing.

Removal:

1. Park machine safely. (See Parking Safely in the SAFETY section.



MX12643

2. Close fuel shut off valve (A) and disconnect fuel line from carburetor inlet (B).

3. Route fuel line into a suitable container and open fuel shutoff valve to drain fuel from fuel tank.

4. Close fuel shut off valve.

5. Remove the fuel sediment bowl (C).

6. Clean the sediment bowl using carburetor cleaner to clean out any dirt or contamination.

Installation:

- Installation is in the reverse of removal.
- Ensure that fuel line retaining clips are securely in place and there are no leaks.

Muffler Removal and Installation

Removal:

MX19681

1. Remove the hex flange nuts (A) from the exhaust studs at the engine muffler bracket.
2. Remove the muffler support nut (B) from the block.
3. Remove the muffler assembly from the exhaust outlet.
4. Remove exhaust gasket from outlet.

Installation:

1. Install a new gasket onto the exhaust studs.
2. Install the muffler assembly.
3. Install all fasteners finger tight.
4. Tighten the hex flange nuts (A) at the exhaust studs to 18 - 22 N•m (159 - 195 lb-in.).
5. Tighten the muffler support nut (B) to 18 - 22 N•m (159 - 195 lb-in.).

Spark Plug Removal and Installation

Procedure:

Engine misfire or starting problems are often caused by a spark plug that is in poor condition or has an improper gap setting.

Every 100 hours of operation, remove the spark plug, check its condition and reset gap, or replace it with a new plug as necessary.

1. Before removing the spark plug, clean the area around the base of the plug to keep dirt and debris out of the engine.

IMPORTANT: Avoid damage! Do not clean the spark plug with a machine that uses abrasive grit. Some grit could remain in/on the spark plug and enter the engine, causing extensive wear and damage.

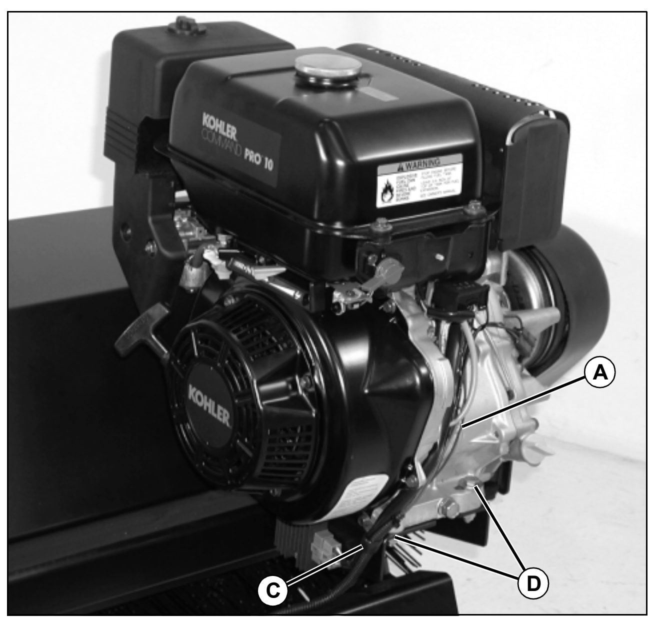
2. Remove the plug and check its condition. Replace the plug if worn or reuse is questionable. See "Spark Plug Troubleshooting" on page 641.
3. Check the gap using a wire feeler gauge. Adjust the gap by carefully bending the ground electrode.
4. Set the spark plug gap to 0.76 mm (0.030 in.).
5. Reinstall the spark plug into the cylinder head and tighten to 20 N•m (177 lb-in.).

Engine Removal and Installation

Removal:

CAUTION: Avoid injury! Gasoline is extremely flammable and its vapors can explode if ignited. Spilled fuel could ignite if it comes in contact with hot parts. Allow engine to cool before servicing. Drain all fuel from the fuel tank before removing or installing.

1. Drain fuel tank into a suitable container.
2. Remove the brush head drive belt. See "Brush Head Drive Belt Removal and Installation" on page 649.
3. Remove the PTO clutch assembly. See "PTO Clutch Removal and Installation" on page 649.



MX12648

4. Disconnect main wiring harness from engine wiring harness (A).

5. Remove main wiring harness from harness clamps (C).

6. Remove four engine mounting bolts and nuts (D). (Two on each end.)

7. Remove engine from mounting plate.

Installation:

1. Install engine in reverse order of removal.

2. Adjust the drive belt tension.

3. Install the belt guard and secure with two screws.

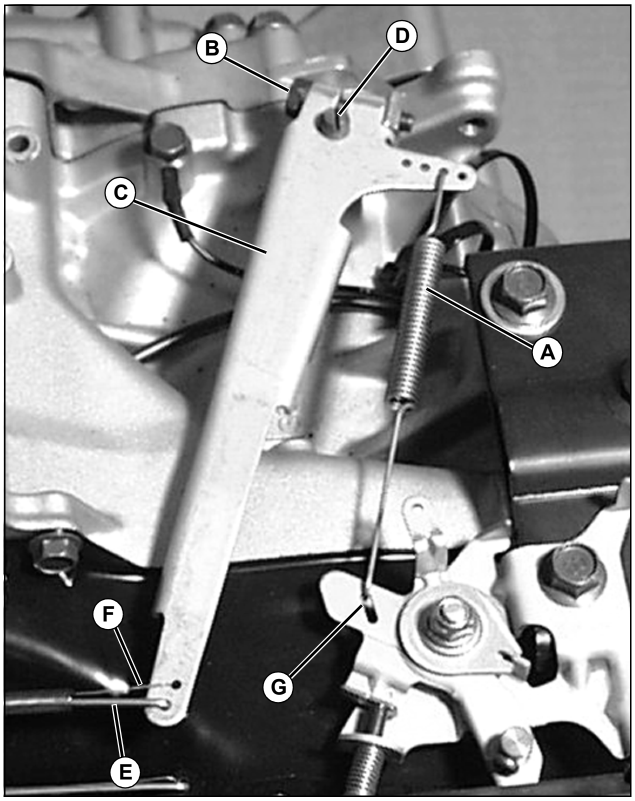
External Governor and Throttle Linkage Removal and Installation

Removal:

1. Remove air cleaner assembly. See “Air Cleaner Assembly Removal and Installation” on page 650.

2. Drain fuel tank into a suitable container.

3. Remove fuel tank assembly. See “Fuel Tank Removal and Installation” on page 651.



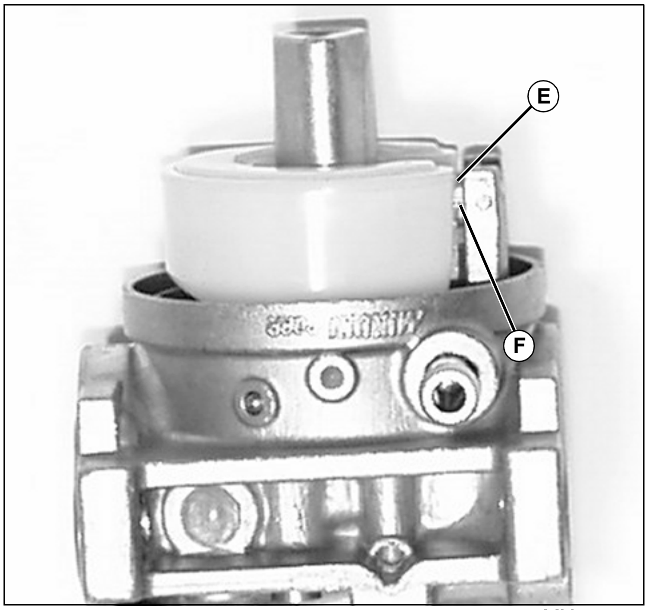
MX19683

4. Mark which hole location the governor spring (A) is in.

5. Loosen the hex flange screw (B) securing the governor lever (C) to the governor shaft (D).

6. Lift off the governor lever with throttle linkage (E) and dampening spring (F) attached.

7. Remove the governor spring from the throttle lever (G).



MX19682

8. Remove the throttle linkage (E) and dampening spring (F) from the carburetor throttle shaft.

9. Remove the throttle linkage and dampening spring from the governor lever.

Installation:

1. Connect the throttle linkage and dampening spring to the carburetor throttle shaft.

2. Connect the throttle linkage and dampening spring to the governor lever.

3. Install the governor lever onto the shaft. Do not tighten at this time.

NOTE: Installing the governor spring in the correct hole is critical for proper generator operation. If the spring is installed in the wrong location, the engine will not rotate at the proper rpm.

4. Connect the governor spring to the arm of the governor lever into the hole marked at disassembly.

5. Connect the governor spring to the arm of the governor lever into the hole marked at disassembly.

6. Connect the governor spring to the throttle lever.

7. Perform governor lever adjustment. See “Governor Lever Adjustment” on page 644.

8. Install fuel tank assembly. See “Fuel Tank Removal and Installation” on page 651.

9. Install air cleaner assembly. See “Air Cleaner Assembly Removal and Installation” on page 650.

Carburetor Removal and Installation

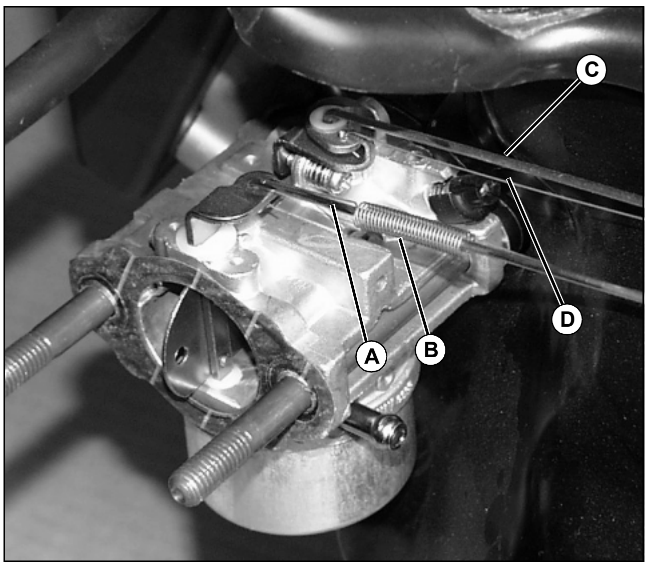
CAUTION: Avoid injury! Gasoline may be present in the carburetor and fuel system. Gasoline is extremely flammable and its vapors can explode if ignited. Keep sparks, open flames, and other sources of ignition away from the engine.

Removal:

1. Remove air cleaner assembly. See “Air Cleaner Assembly Removal and Installation” on page 650.

2. Close the fuel shutoff valve.

3. Remove fuel tank assembly. See “Fuel Tank Removal and Installation” on page 651.



MX19677

4. Disconnect the choke linkage (A) and dampening spring (B) from the choke shaft.

5. Slide the carburetor off of the mounting studs far enough to allow the carburetor to rotate and disconnect the throttle linkage (C) and dampening spring (D) from the throttle shaft.

6. Remove the spacer block and gaskets from the studs.

Installation:

Installation is in the reverse of removal.

- Be sure to install new carburetor spacer gaskets when installing.

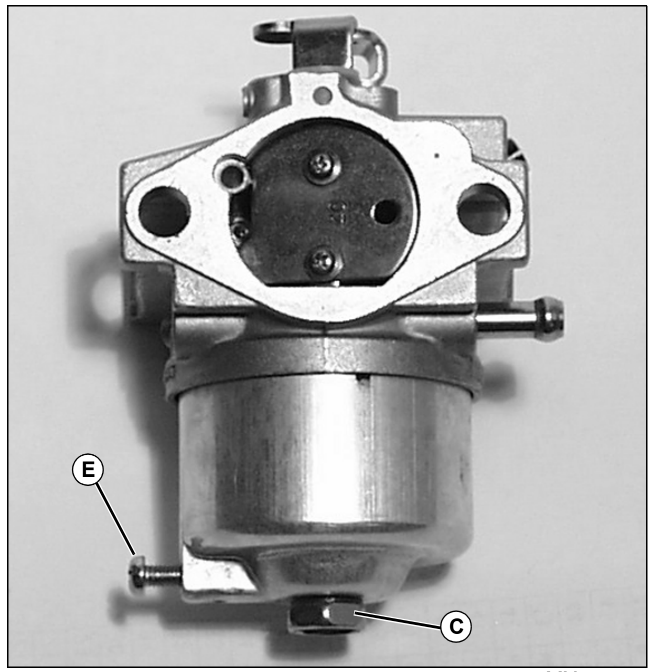
Carburetor Disassembly and Assembly

CAUTION: Avoid injury! Gasoline may be present in the carburetor and fuel system. Gasoline is extremely flammable and its vapors can explode if ignited. Keep sparks, open flames, and other sources of ignition away from the engine.

Procedure:

1. Remove carburetor assembly.

2. Clean all dirt and debris from exterior of carburetor.



MX19684

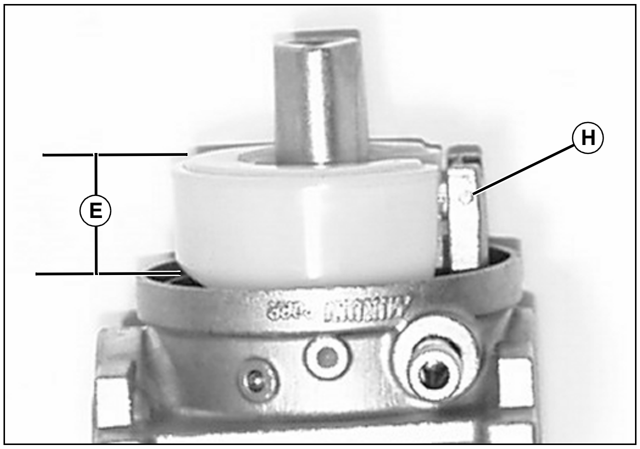
3. Remove the drain screw (E) from the float bowl and drain the fuel from the float bowl into a suitable container.

4. Remove the bowl retaining screw (F).

5. Carefully separate the bowl from the main body and remove the bowl gasket from the body.

IMPORTANT: Avoid damage! Do not bend the float in an attempt to reset the height. The correct float height is determined by the design of the inlet needle and float. There is no provision for physical adjustment.

6. Place the carburetor in an inverted position. Lift up the float so that the tip of the float valve lightly contacts the float arm.



MX19682

7. Measure the float height (G). The height should be 14.9 mm (0.59 in.).

8. If the float height is incorrect, use a float kit during assembly.

9. Grab the exposed end of the float pin (H) with a needle nose pliers and pull it out.

10.Lift out the float and inlet needle.

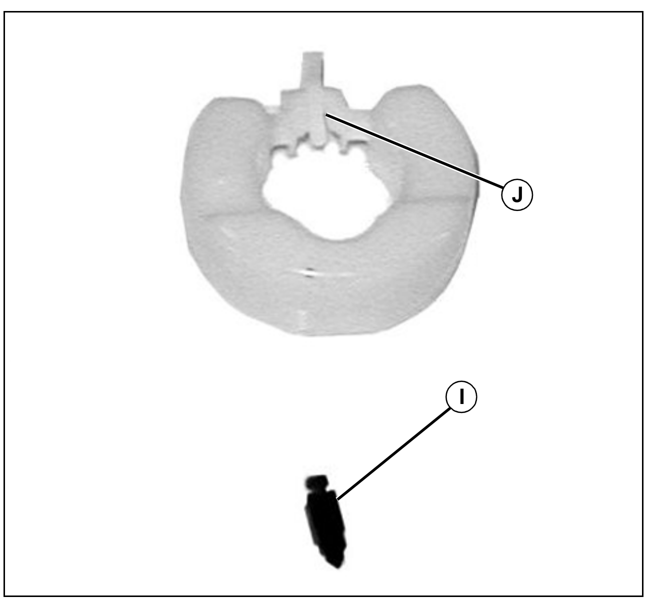
11.Slide the inlet needle and the clip off of the float tab.

12.Check components for wear, contamination, or damage.

13.Use carburetor cleaner to clean out any dirt or contamination.

14.Use a float kit if the inlet needle or float is damaged or worn.

15.If the inlet seat is damaged or worn, the carburetor must be replaced.



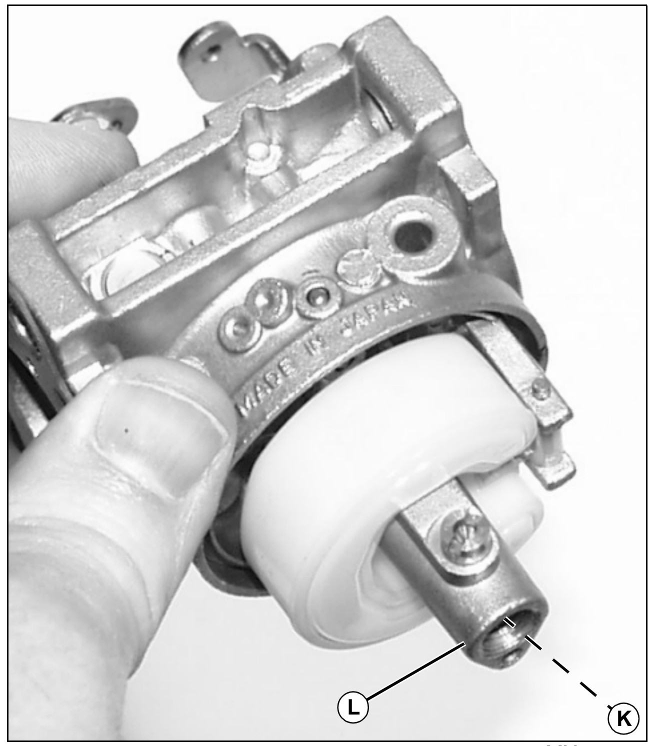
MX17516

16.After the parts have been cleaned or exchanged, slide the inlet needle (I) onto the float tab (J).

17.Install the float assembly into the carburetor and verify that the correct float height has been restored.

18.If there were gum or varnish deposits in the area of the inlet needle and seat, there is a good possibility that the main nozzle may also need cleaning before the bowl is installed.

NOTE: If the main nozzle does not turn easily, use carburetor cleaner to clean the exposed threads in the tower.

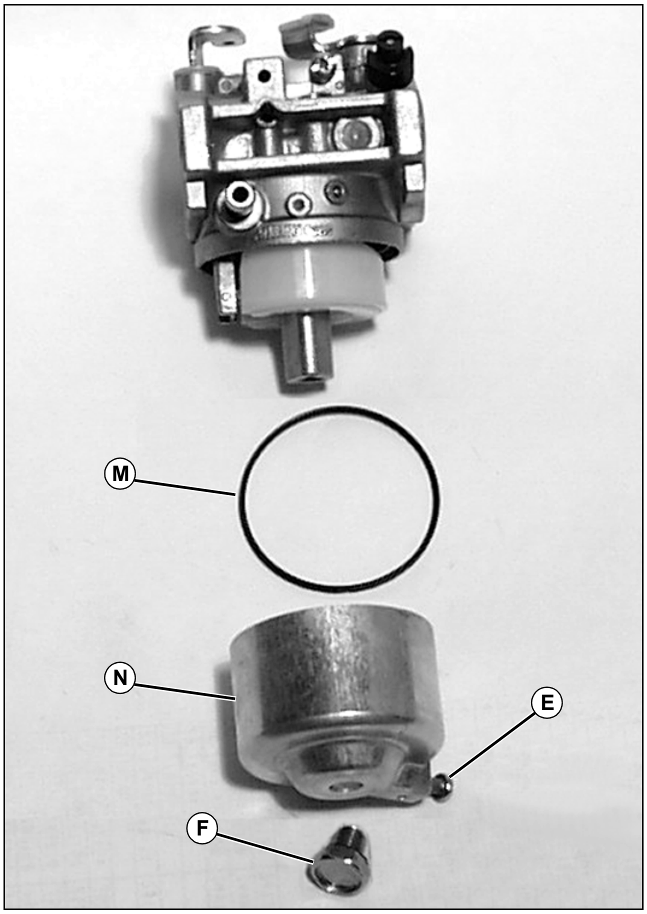


MX19685

19. Use a thin, flat blade screwdriver to remove the nozzle (K) from the tower (L).

20. Soak the nozzle in carburetor cleaner to remove any deposits and blow dry it with compressed air.

21. Install nozzle in the tower and thread it in until it bottoms.



MX19686

22.Install the bowl gasket (M) in groove in carburetor body.

23.Assemble the bowl (N) to the carburetor. Position the bowl so the drain screw (E) will be accessible after the carburetor is mounted to the engine.

24. Install the bowl retaining screw (F) and tighten to 9 N•m (79 lb-in.).

25. Install carburetor.

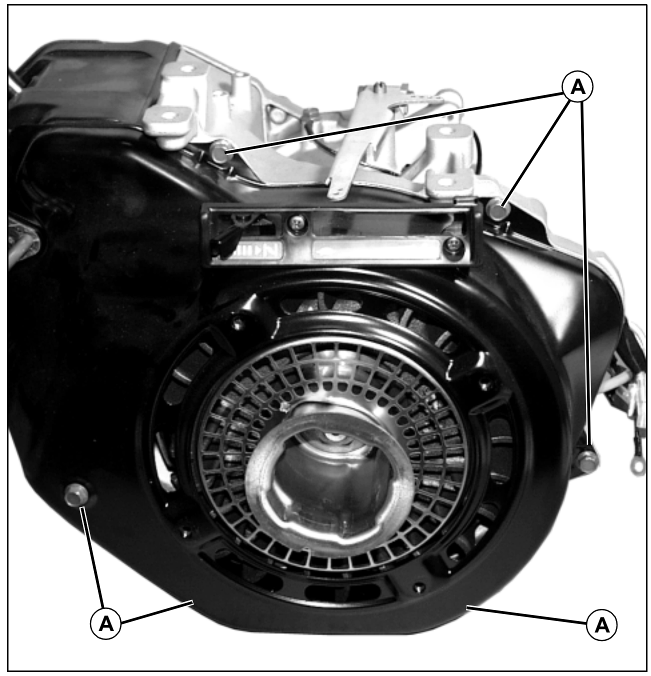
Blower Housing Removal and Installation

Removal:

1. Remove air cleaner assembly. See “Air Cleaner Assembly Removal and Installation” on page 650.

2. Close the fuel shutoff valve.

3. Remove fuel tank assembly. See “Fuel Tank Removal and Installation” on page 651.



MX19687

4. Remove the six hex flange screws (A) securing the blower housing.

5. Remove blower housing.

Installation:

Installation is in the reverse of removal.

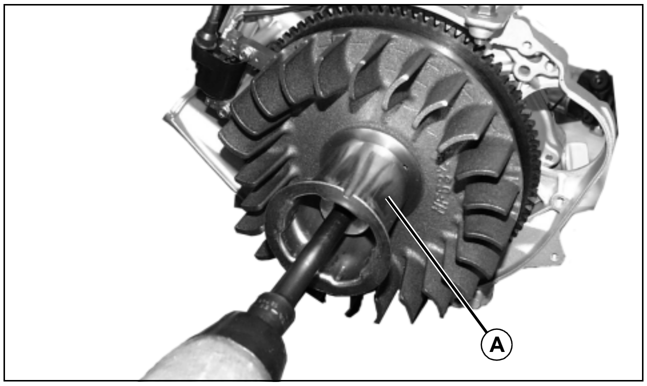
- Tighten hex flange screws to 7 N•m (62 lb-in.).

Flywheel Removal, Inspection, and Installation

Removal:

1. Remove air cleaner assembly. See “Air Cleaner Assembly Removal and Installation” on page 650.
2. Close the fuel shutoff valve.
3. Remove fuel tank assembly. See “Fuel Tank Removal and Installation” on page 651.
4. Remove ignition coil. See “Ignition Coil Removal and Installation” on page 658.

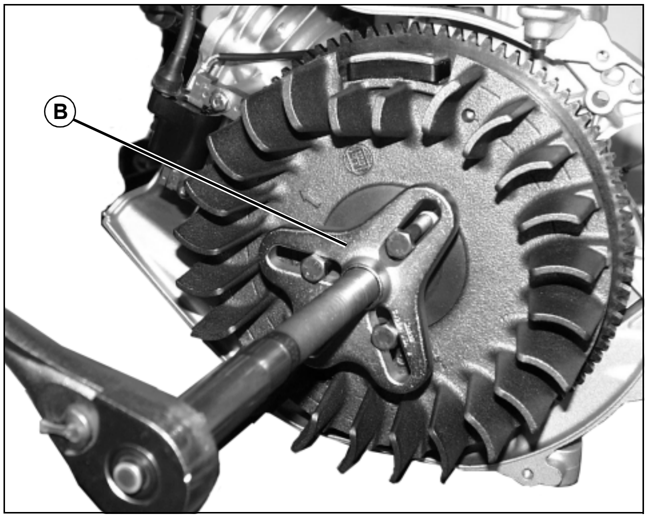
NOTE: An impact wrench should be used to loosen the flywheel retaining nut. A flywheel strap wrench or an approved holding tool may be used to hold the flywheel when loosening or tightening the flywheel retaining nut.



MX17358

5. Remove the flywheel nut, washer, and drive cup (A).

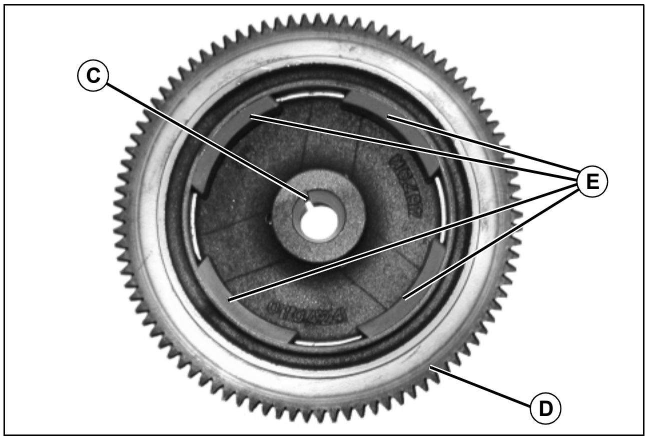
IMPORTANT: Avoid damage! Always use a puller to remove the flywheel from the crankshaft. Do not strike the flywheel or crankshaft as these parts could become cracked or damaged.



MX17357

6. Remove the flywheel from the crankshaft using a puller (B).
7. Remove the flywheel key from the keyway.

Inspection:



MX17363

1. Inspect the flywheel for cracks and the flywheel keyway (C) for damage. Replace flywheel if cracked.
2. Replace the flywheel, crankshaft, and the key if flywheel or crankshaft keyway is damaged.
3. Inspect the ring gear (D) for wear, cracks, or damage. Replace the flywheel if the ring gear is damaged.
4. Inspect the stator magnets (E) and ignition magnet for damage. Repair or replace as necessary.

Installation:

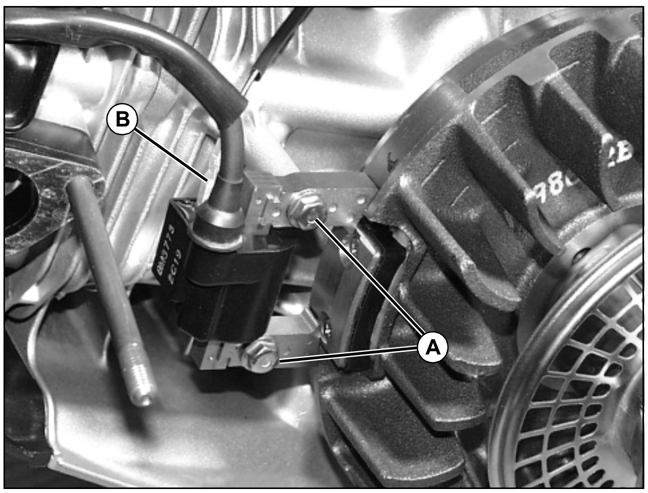
IMPORTANT: Avoid damage! Check that crankshaft end and flywheel hub are clean and free of lubricant, and flywheel key is installed properly in keyway. Improperly installed flywheel can cause machine damage and serious personal injury

1. Install the woodruff key into the keyway of the crankshaft.
2. Install the flywheel onto the crankshaft being careful not to shift the woodruff key.
3. Use a flywheel holding tool and torque wrench to tighten flywheel nut to 120 N•m (88 lb-ft).

Ignition Coil Removal and Installation

Removal

1. Remove air cleaner assembly. See “Air Cleaner Assembly Removal and Installation” on page 650.
2. Close the fuel shutoff valve.
3. Remove fuel tank assembly. See “Fuel Tank Removal and Installation” on page 651.
4. Remove blower housing. See “Blower Housing Removal and Installation” on page 656.
5. Remove spark plug cap from spark plug.



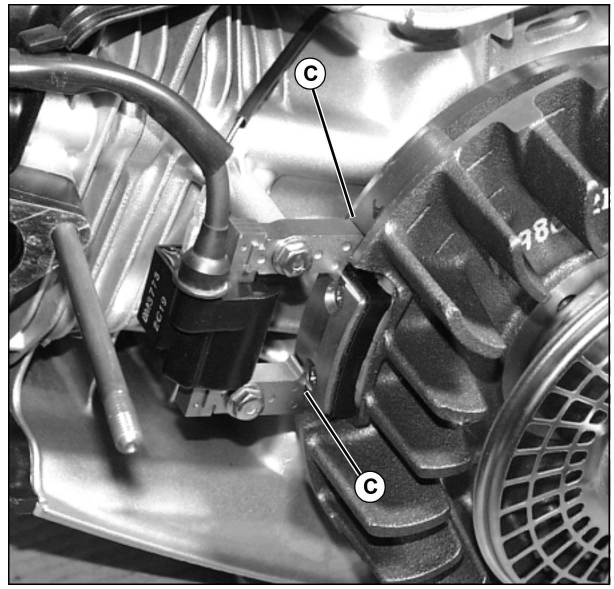
MX19675

6. Remove the two hex flange screws (A) securing the ignition module to the crankcase.
7. Remove ignition module kill wire (B).
8. Remove ignition module.

Installation:

1. Turn the flywheel so the magnet is away from the location where the ignition module will be installed.
2. Install the ignition module loosely to the bosses with the two hex flange screws.
3. Move the module as far away from the flywheel as possible, then tighten the screws just enough to hold it in position.
4. Rotate the flywheel in a clockwise direction until the magnet is under the legs of the ignition module.

IMPORTANT: Avoid damage! The engine is very sensitive to this adjustment so both legs of the coil must have the same air gap.

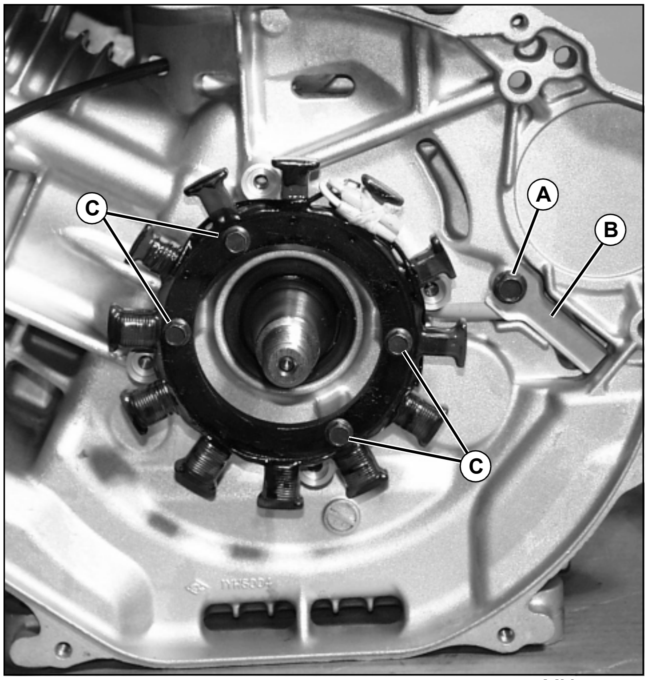


MX19675

5. Select the 0.5 mm (0.020 in.) feeler gauge blade and insert it between the flywheel and coil legs (C).
6. Turn flywheel until magnet aligns with the legs of the ignition coil and feeler gauge spans both legs of coil and the flywheel magnet at the same time.
7. Allow the magnet to draw the module against the gauge.
8. Hold the coil in position and tighten the cap screws. Rotate the flywheel to remove the feeler gauge.
9. Starting with the lower cap screw, tighten ignition module mounting screws to 10 N•m (88 lb-in.).
10. Rotate the flywheel back and forth, checking to make sure the magnet does not strike the module.
11. Connect ignition module kill wire to the coil terminal.
12. Connect the spark plug cap to the spark plug.

Stator and Protective Shield Removal and Installation

Removal:



MX19688

1. Remove the mounting screw (A) and protective shield (B) over the stator lead.

2. Remove the four hex flange screws (C) securing the stator to the crankcase.

3. Remove the stator and pull the wire through the opening in the casting.

Installation:

Installation is in the reverse of removal.

1. Ensure that the stator lead is in the 1 o'clock position and toward the crankcase.

2. Route the stator lead along the formed channel and out through the hole in the crankcase casting.

3. Tighten the stator mounting screws to 5 - 8 N•m (44 - 70 lb-in.).

4. Tighten the wire shield screw to 10 N•m (88 lb-in.).

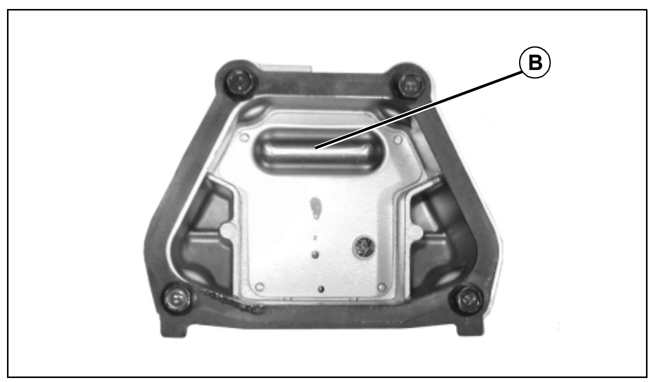
Valve Cover/Breather Removal and Installation

Removal:

1. Disconnect the breather hose from the valve cover.

MX17413

2. Remove the four hex flange screws (A) securing the valve cover.



MX17364

3. Remove the valve cover and gasket from the cylinder head. The breather assembly (B) is inside the valve cover.

Installation:

1. Install a new valve cover gasket onto the cylinder head.

2. Install the valve cover screws and tighten to 10 - 12 N•m (88 - 106 lb-in.).

Cylinder Head Removal and Installation

1. Remove valve cover. See “Valve Cover/Breather Removal and Installation” on page 659.

NOTE: The breather assembly is inside the valve cover.

2. Lift the air shroud from the cylinder head.

3. Remove the four hex flange screws securing cylinder head.

4. Remove cylinder head, dowel pins, and cylinder head gasket.

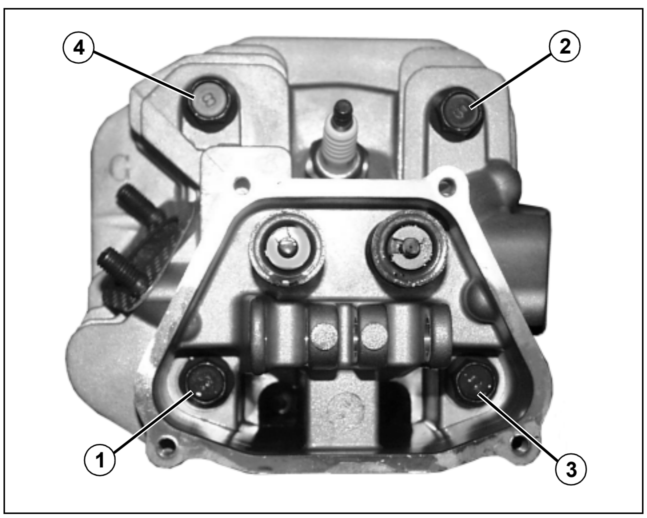
Cylinder Head Installation:

1. Check to make sure there are no nicks or burrs on the sealing surfaces of the cylinder head or crankcase.

2. Rotate the crankshaft to position the piston at TDC on the compression stroke.

3. Install the dowel pins into the recesses around the lower cylinder head bolt holes.

4. Install a new cylinder head gasket.



MX17535

5. Install the cylinder head and start the four hex flange screws.

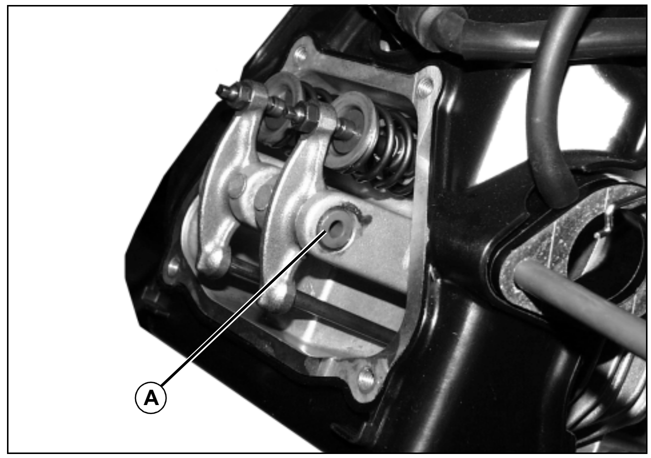
6. Tighten the screws in several increments using the sequence shown, to a final torque of 50 N•n (36 lb-ft).

Rocker Arm and Push Rod Removal and Installation

Removal:

1. Remove valve cover and gasket. See “Valve Cover/Breather Removal and Installation” on page 659.

2. Turn crankshaft until piston is at its highest position on compression stroke until valves are closed and all valve spring pressure is off valve train.



MX17423

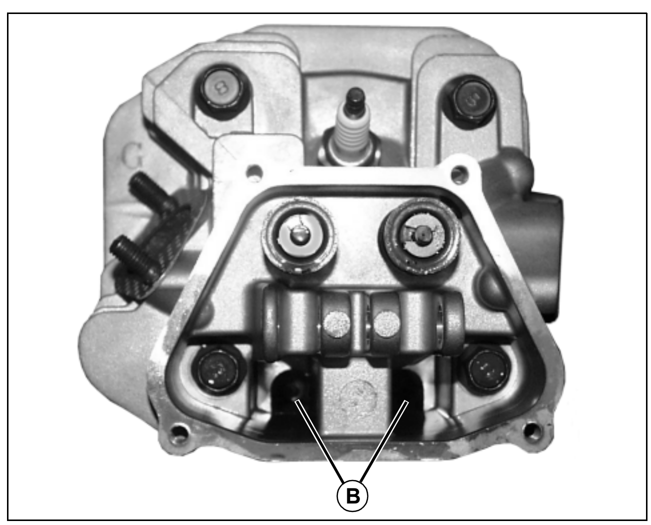
3. Holding rocker arms, slide rocker shaft (A) out of supports.

4. Remove rocker arms noting their positions.

5. Remove push rods, noting their positions.

Installation:

1. If cylinder head is on engine, ensure that the piston is at TDC with the cam lobes off of the valve tappets (TDC of compression stroke).



MX17539

2. Dip the push rods in clean engine oil and insert push rods into their respective locations (B).

3. Position rocker arm next to the rocker shaft boss, ensuring that the push rod is properly seated in the rocker arm.

4. Repeat for second rocker arm. Coat rocker arm shaft with fresh engine oil, insert it into cylinder head supports, and center the shaft so that it does not protrude out of either end of the supports.

Valve Removal, Inspection, and Installation

Removal:

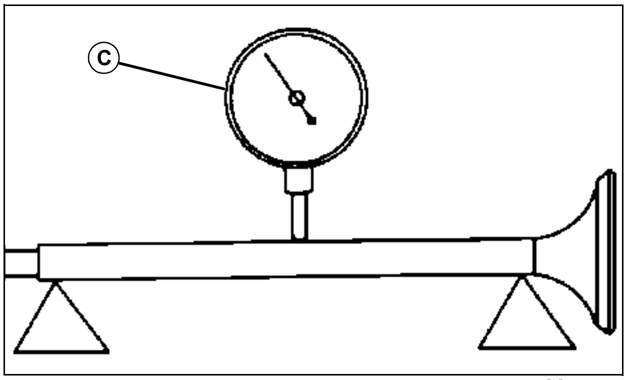
1. Remove cylinder head. See “Cylinder Head Removal and Installation” on page 660.
2. Install valve spring compressor under valve retainer.
3. Compress valve spring and remove stem cap and retainer.

NOTE: If removing intake valve, valve stem seal will be removed with retainer.

4. Pull valve out by valve head and remove valve spring and valve spring compressor.
5. Repeat for second valve if necessary.
6. Inspect valve(s). See “Valve Inspection:” on page 661.

Valve Inspection:

1. Remove carbon from valve face, head, and stem with a power operated wire brush. Be sure that carbon is removed, not merely burnished.
2. Check valve for damage. If valve face is burned, pitted, or worn, grind valve to proper face angle. See “Valve Face Reconditioning” on page 661. If valve head margin is less than 0.794 mm (0.031 in.) after grinding, replace valve.
3. Grind valve stem end square if required.



M51753

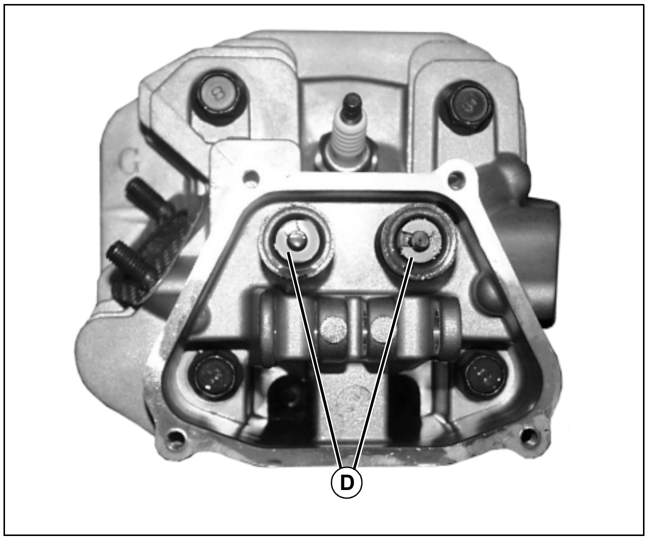
4. Check valve for out of round, bent, or warped conditions using a V-blocks and a dial indicator. Turn valve slowly and read variation on indicator (C). Replace valve if variation is greater than 0.01mm (0.0004 in.).

Installation:

1. Install valve spring into cylinder head.
2. Install valve caps onto valve springs.
3. Apply clean engine oil to valve stems.
4. Install valve into valve guide.

NOTE: If installing intake valve, be sure to reinstall the valve seal with retainer, if removed.

5. Install valve spring compressor under valve spring.
6. Compress spring until groove in valve stem is exposed.



MX17552

7. Lock each valve in place with a lock clip (D). Install lock clip with its rounded edges down.

IMPORTANT: Avoid damage! Valves must be adjusted when cylinder head is reinstalled to crankcase!

8. Reinstall rocker arms. See “Rocker Arm and Push Rod Removal and Installation” on page 660.

Valve Face Reconditioning

1. Remove all carbon from valve head and stem before attempting to grind face. Clean large carbon deposits with a wire wheel. Chuck valve stem in a drill press and spin valve while polishing stem and head with progressively finer grits of emery cloth until polished.

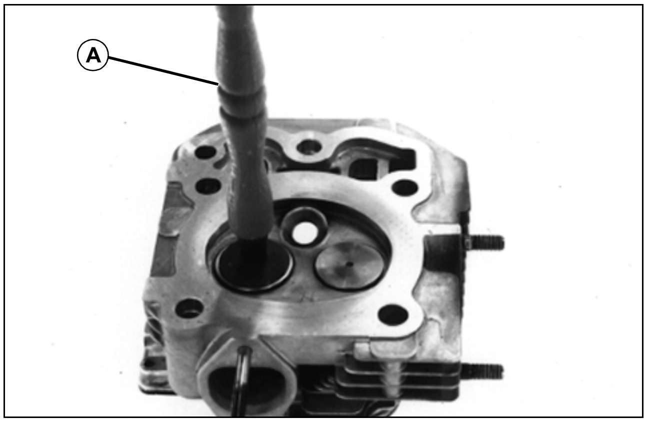
2. Valves should be ground on a valve grinder with stones that have been dressed to be flat. Use cooling lubricant to prevent overheating. Be sure valve is chucked in grinder straight. Only grind away enough material to smooth valve face around circumference of valve.

Valve Lapping

Lapping should only be done after grinding valve face and seat. See “Valve Face Reconditioning” on page 661.

NOTE: Lapping is not a substitute for a proper valve job.

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

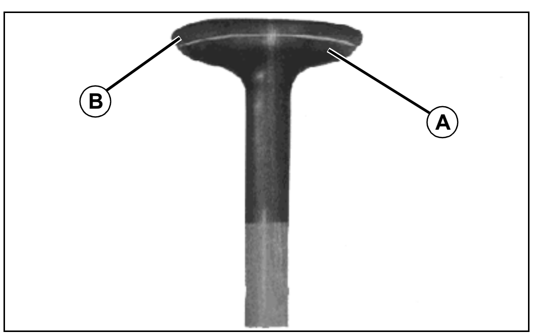


M52134

2. Insert valve in proper valve seat in head and turn using a vacuum cup tool (A).
3. Check valve every eight strokes until a uniform ring appears around the surface of the valve face.
4. Wash parts in solvent to remove lapping compound.

Valve Condition

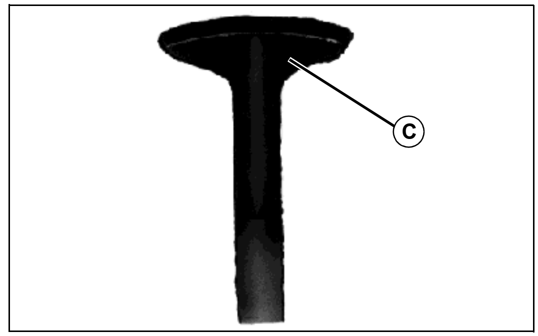
Normal:



M30024

This valve can be reconditioned and reused if the face (A) and margin (B) are in good condition. If a valve is worn to where the margin is less than 1 mm (0.04 in.), do not reuse it.

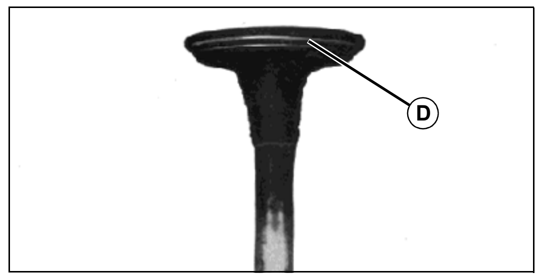
Bad Condition:



M5563

The valve depicted here should be replaced. The head (C) is warped, the margin is damaged, and it is too narrow. These conditions could be attributed to excessive hours or a combination of poor operating conditions.

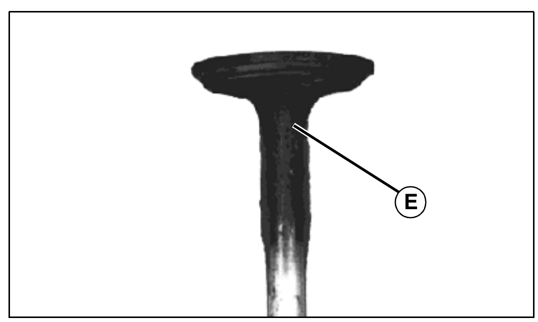
Coking:



M29934

Coking is normal on intake valves and is not harmful. If the seat (D) is good, the valve can be reused after cleaning.

Gum:



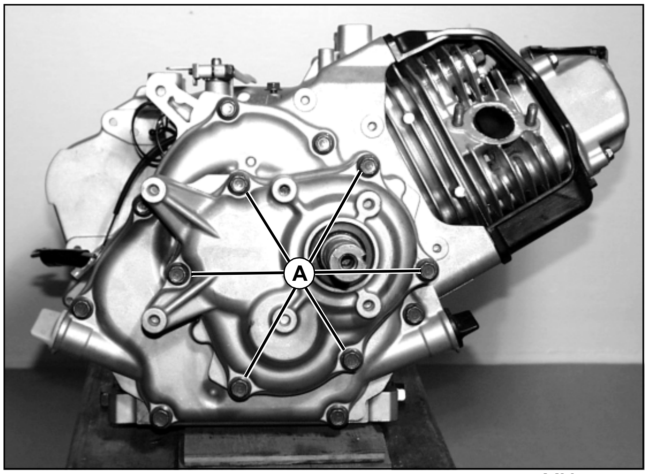
M29936

Gum deposits (E) usually result from using stale gasoline. Gum is a major cause of valve sticking. The valve guides may be reamed or replaced depending in their condition.

Gear Reduction Assembly Removal and Installation

Removal:

1. Drain engine oil into a suitable container.
2. Remove the PTO clutch.
3. remove any nicks or burrs from the output shaft.

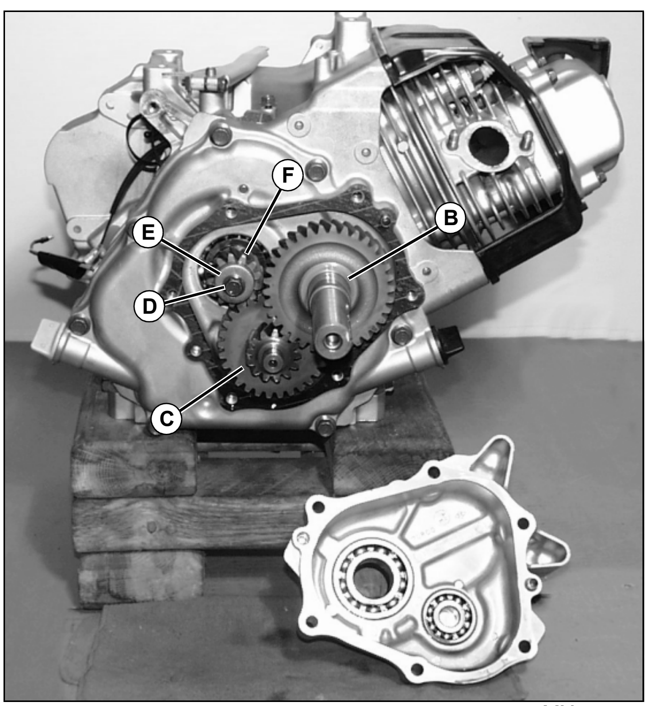


MX19689

4. Remove the six cap screws (A) securing the reduction cover to the closure plate.

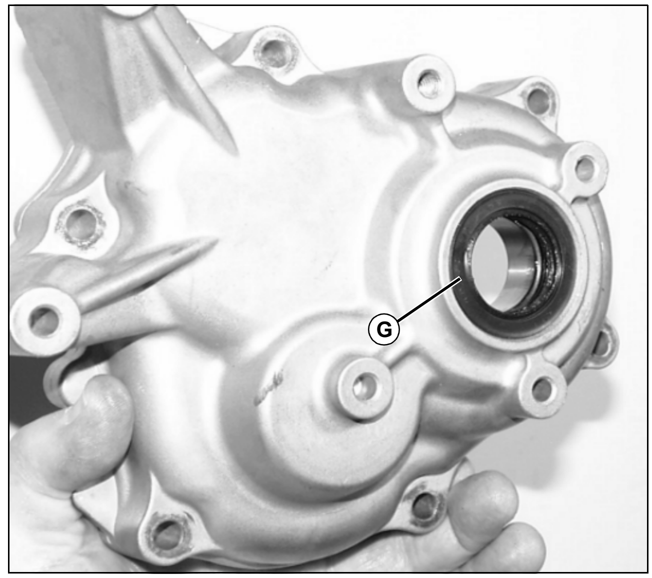
NOTE: Output shaft and reduction gear shaft may come out with the reduction cover.

5. Pull the reduction cover off of the closure plate and output shaft.



MX19690

6. Remove the output shaft (B) and reduction shaft (C).
7. Remove the cap screw (D), washer (E), and sprocket gear (F) from crankshaft.
8. Inspect the output shaft bearings and reduction shaft bearings for wear or damage. Replace as needed.
9. Use an internal bearing puller for the housing bearings. Use and arbor press to remove the remaining bearings.

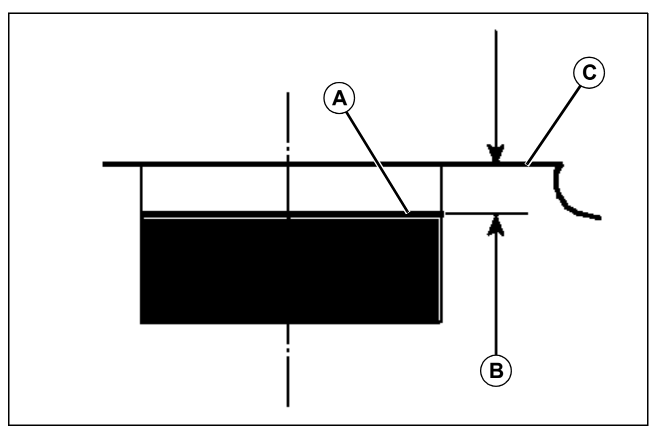


MX19691

10.Remove the output shaft seal (G) if either the inner or outer seal lip is damaged.

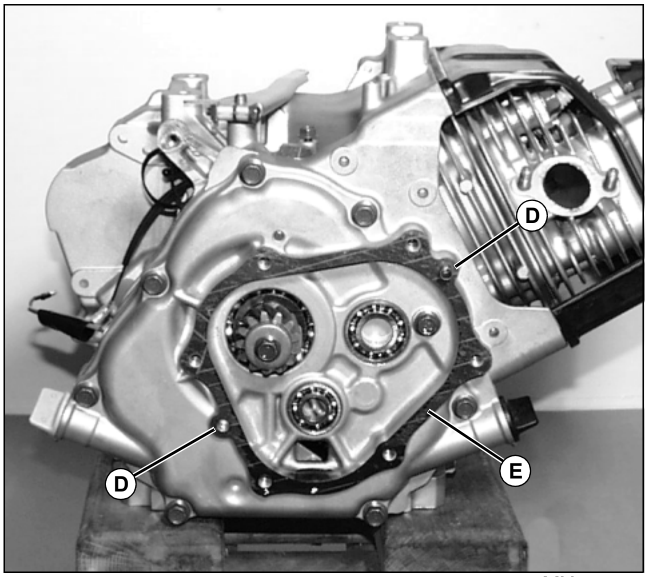
Installation:

1. Clean all components with solvent. Dry completely before installing onto engine.
2. Lightly coat each component with clean engine oil before installation.



MX17446

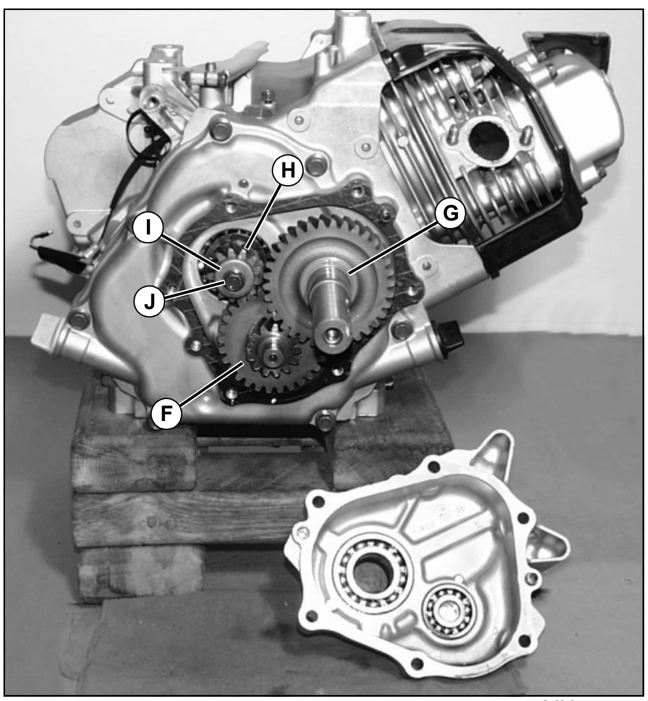
3. If remove, install a new output shaft seal (A) to a depth (B) of 2 mm (0.079 in.) below the cover shoulder (C).
4. Ensure that the sealing surfaces of the reduction cover and closure plate are clean and free of nicks/burrs.



MX19692

5. Install the two dowel pins (D) into the closure plate.

6. Install the new reduction cover gasket (E) onto the dowel pins.

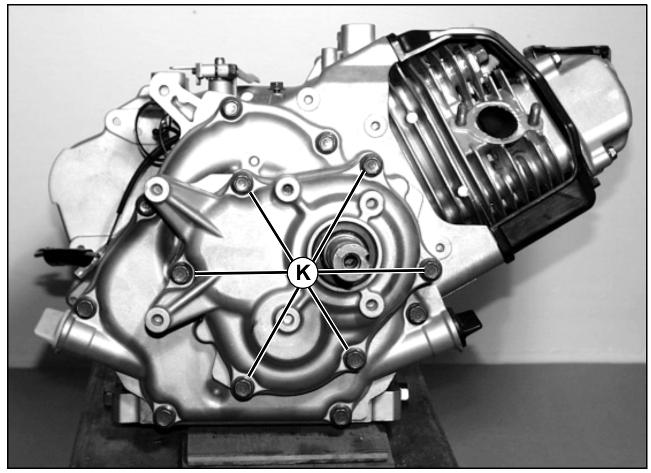


MX19690

7. Install the reduction gear (F) and output shaft (G).

8. Install the sprocket gear (H), washer (I), and cap screw (J), into crankshaft.

9. Slide the reduction cover on to output shaft, reduction shaft and dowel pins in the closure plate.

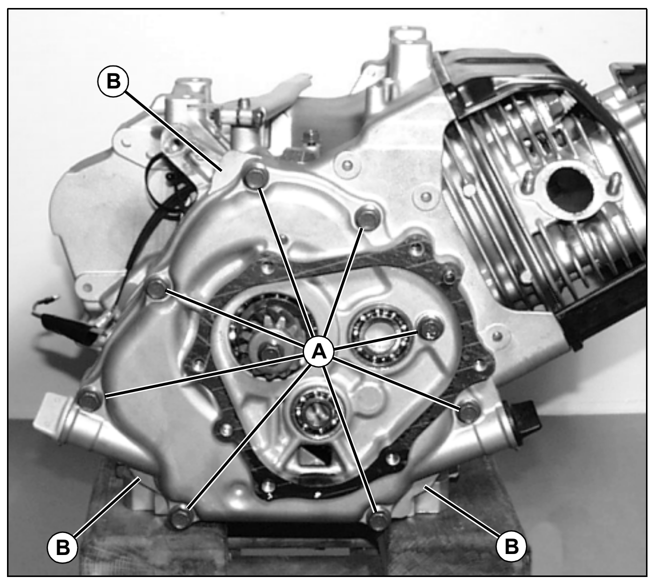


MX19689

10.Install and evenly tighten the six reduction cover cap screws (K) to 30 N•m (22 lb-ft).

Closure Plate Removal and Installation

Removal:



MX19692

1. Remove the eight cap screws (A) securing the closure plate to the crankcase.

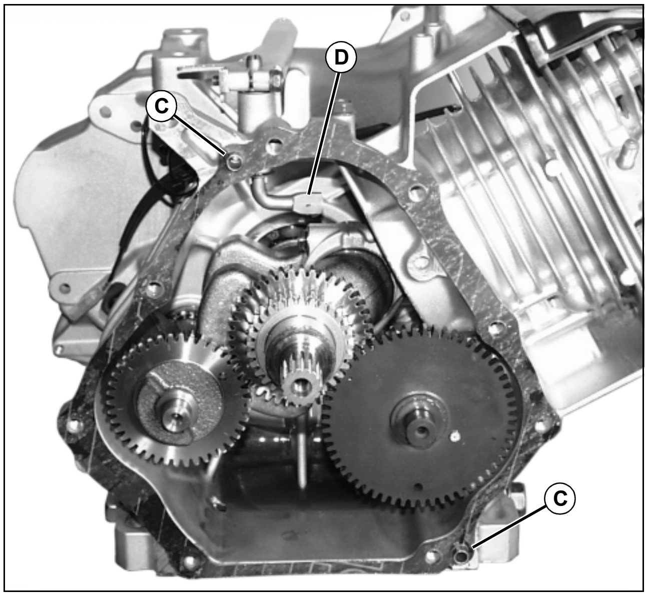
IMPORTANT: Avoid damage! Do not pry on the gasket surface of the crankcase or closure plate as this can cause damage and leakage.

2. Locate the pry/tap pads (B) on the closure plate. These areas permit separation of the closure plate from the crankcase with a flat screwdriver or by tapping with a plastic hammer.

Installation:

1. Ensure that the sealing surfaces of the crankcase and closure plate are clean and free of nicks/burrs.

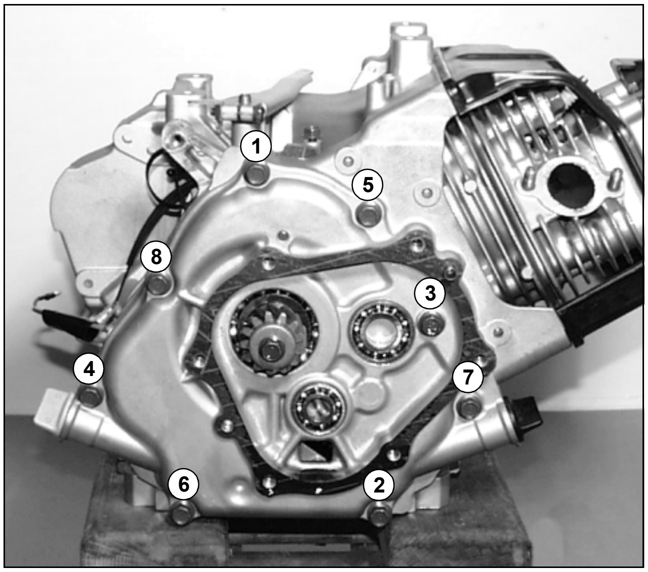
2. Install the two dowel pins into the crankcase.



MX19693

3. Install the new closure plate gasket (C) onto the dowel pins. Make sure that the governor lever (D) is facing towards the right (cylinder side).

4. Install the closure plate to the crankcase. Carefully seat the ends of the camshaft and balance shaft into their mating bearings. Rotate the crankshaft slightly to help engage the governor gear teeth.

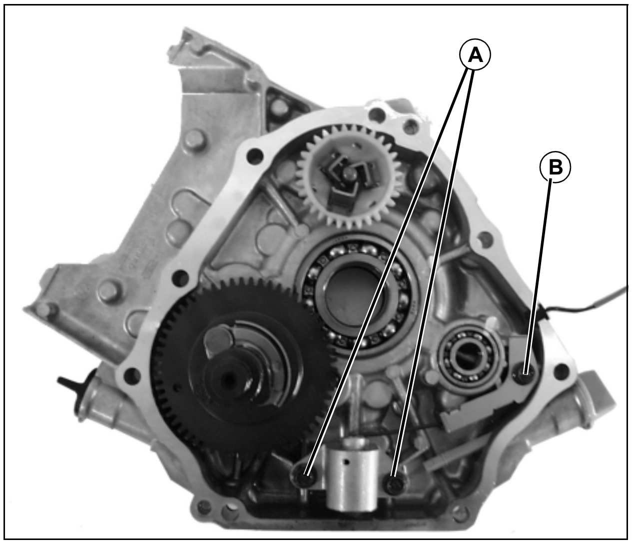


MX19692

5. Tighten the eight cap screws in the sequence shown to 30 N•m (22 lb-ft).

Oil Sensor Removal and Installation

Removal:



MX17369

1. Remove the two hex flange screws (A) mounting the oil sensor and the single screw (B) holding the wire shield in place.

2. Pull the grommet out of the cutout in the casting and remove the oil sensor. Note the routing of the wire.

Installation:

1. Mount the oil sensor into the closure plate using two hex flange screws.

2. Route the wire lead and seat the grommet into the cutout.

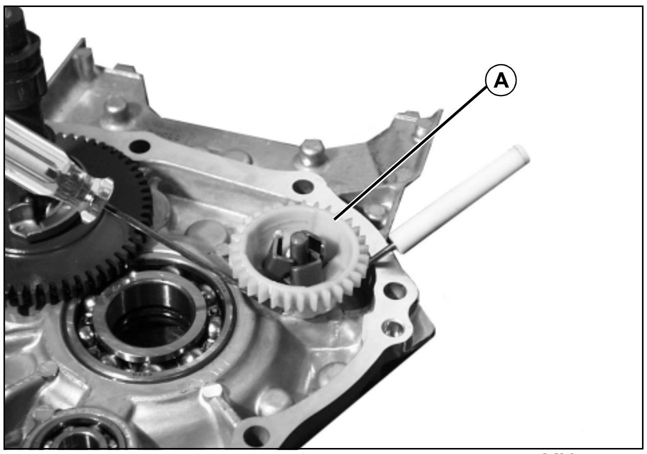
3. Install the shield for the wire lead and secure with a hex flange screw tightened to 10 N•m (88 lb-in.).

Governor Gear Removal and Installation

Removal:

IMPORTANT: Avoid damage! Do not pry against or nick/damage the gasket surface of the closure plate.

NOTE: The governor gear is held onto the governor gear shaft by a small retaining clip located near the center section of the gear, within the flyweight assemblies. The mounting of the governor gear also retains the governor regulating pin and thrust washer in place.

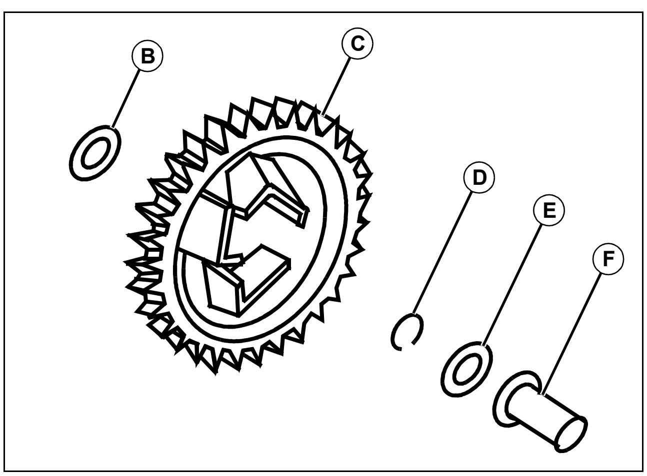


MX17372

1. Using two small screwdrivers, carefully apply upward pressure from beneath the gear (A) and against the bosses in the closure plate.

Installation:

NOTE: Before installation, clean and inspect all components for wear or damage.



MIF

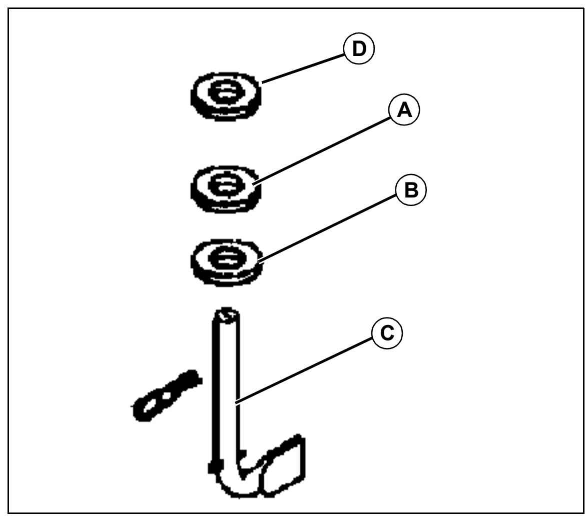
1. Install one thrust washer (B) onto the governor shaft, followed by the governor gear/flyweight assembly (C).
2. Start the retaining clip (D) over the end of the shaft.
3. Raise the gear up on the shaft sufficiently to install the other thrust washer (E) and governor regulating pin (F) under the outer fingers of the flyweights.
4. Push the governor regulating pin down until the retaining ring locks into place in the shaft groove. Governor gear should now be retained on shaft and operate freely.
5. Check gear and flyweight operation.

Governor Cross Shaft Removal and Installation

Removal:

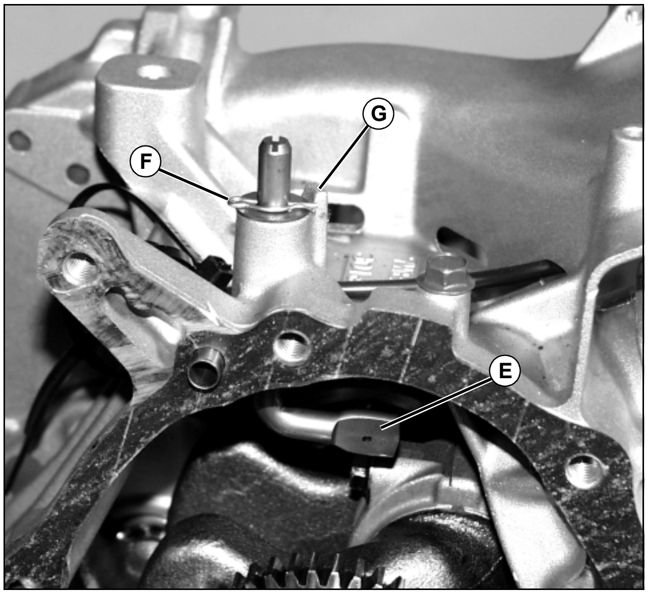
1. Remove the hitch pin and plain washer from the governor cross shaft.
2. Remove the cross shaft out through the inside of the crankcase.

Installation:



MX17529

1. Install the governor shaft seal (A), with the manufacturer’s mark out, into the governor shaft bore in crankcase until flush with the top. A 13 mm (0.5 in.) OD seal driver or round stock may be used to install.
2. Install one thrust washer (B) onto the governor cross shaft (C) and insert up through the inside of the crankcase.
3. Install second flat washer (D) up onto top of shaft.



MX19694

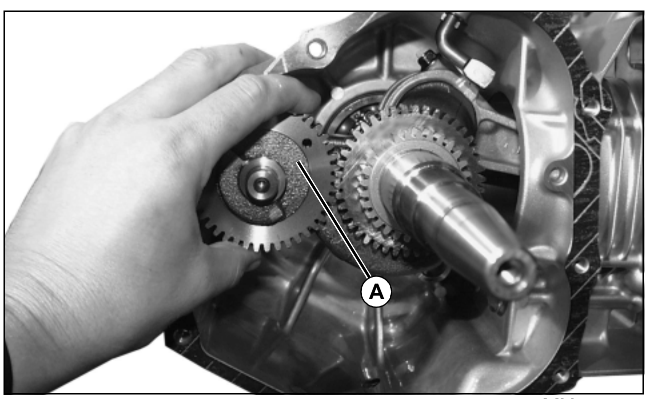
4. Position the shaft so the lower flat section (E) faces toward the cylinder.

5. Insert the hitch pin (F) so the end of the clip comes in contact with the raised section (G) of the housing boss, limiting the inward movement of the arm.

Balance Shaft Removal and Installation

Removal:

1. Align marks on balance shaft and crankshaft.

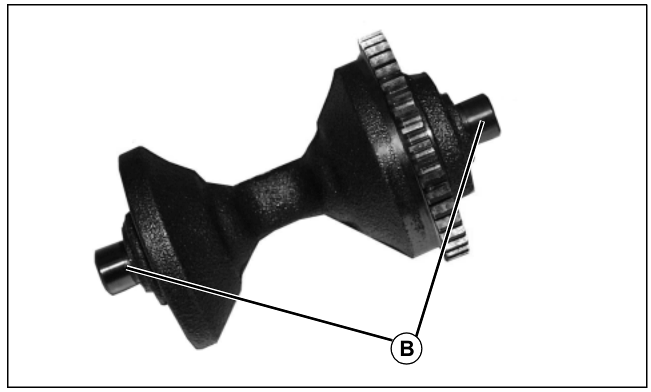


MX17371

2. Remove balance shaft (A).

NOTE: Camshaft, crankshaft, and balance shaft gears wear together as a set. If one is to be replaced, all must be replaced as a set.

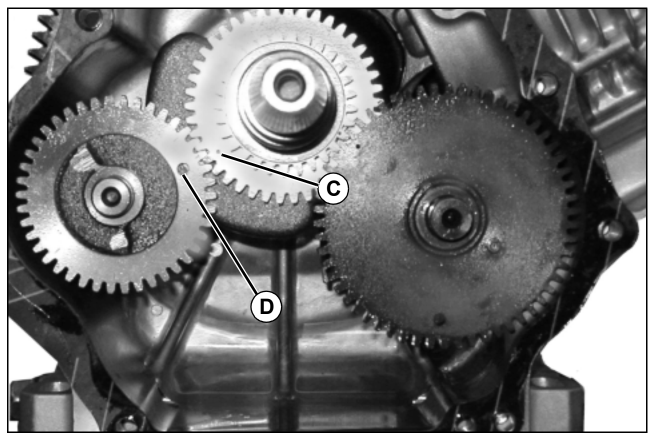
3. Inspect for cracks and broken teeth. Replace shaft if cracked or damaged.



MX17368

4. Inspect balance shaft journals (B) for wear. Replace if worn or damaged.

Installation:



MX17376

1. Position the crankshaft so the timing mark (C) on the larger crank gear is in the 8 o'clock position.

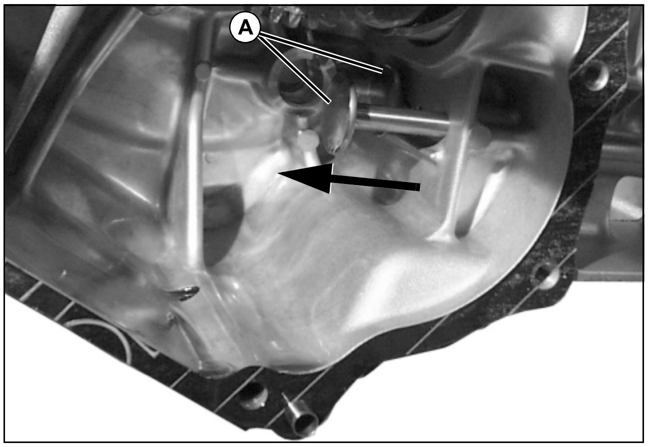
2. Install the balance shaft, aligning the timing mark (D) with the timing mark (C) on the larger crank gear.

Camshaft and Tappet Removal and Installation

Removal:

1. Rotate the camshaft until the lobes of the camshaft are off of the tappets (BTDC of the compression stroke).

2. Remove the camshaft from the crankcase.



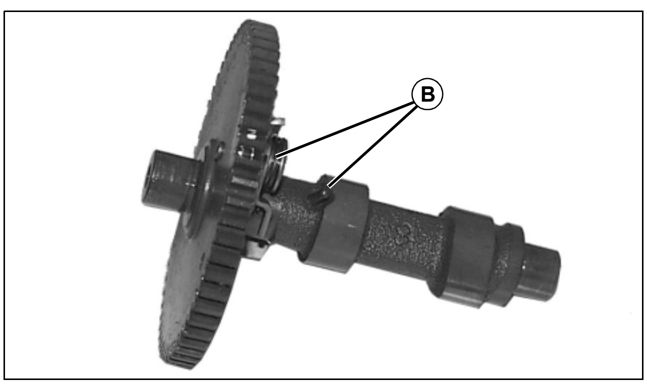
MX17370

3. Remove and mark the tappets (A) by sliding inwards towards the crankcase.

4. Inspect for scratching or wear.

Inspection:

NOTE: Camshaft, crankshaft, and balance shaft gears wear together as a set. If one is to be replaced, all must be replaced as a set.



MX17366

1. Inspect the gear teeth off the camshaft. If the teeth are badly worn, chipped, or some are missing, replacement of the camshaft will be necessary.

2. If unusual wear or damage is evident on either lobe or the mating tappet, the camshaft and both tappets must be replaced. Severely worn lobes may indicate serious valve train problems.

3. Check the condition and operation of the ACR mechanism (B).

Installation:

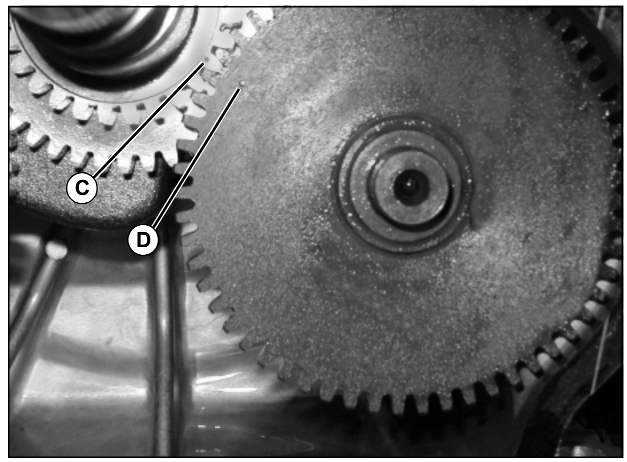
1. Identify the valve tappets as to their proper locations.

2. Lubricate the face and stem of each tappet with clean engine oil.

3. Install each tappet into their respective bores.

4. Lubricate the camshaft bearing surfaces and cam lobes as well as the camshaft bore in the crankcase with clean engine oil.

IMPORTANT: Avoid damage! The camshaft alignment mark is the small dimple on the gear face. If the camshaft is installed incorrectly, severe engine damage will result.



MX17375

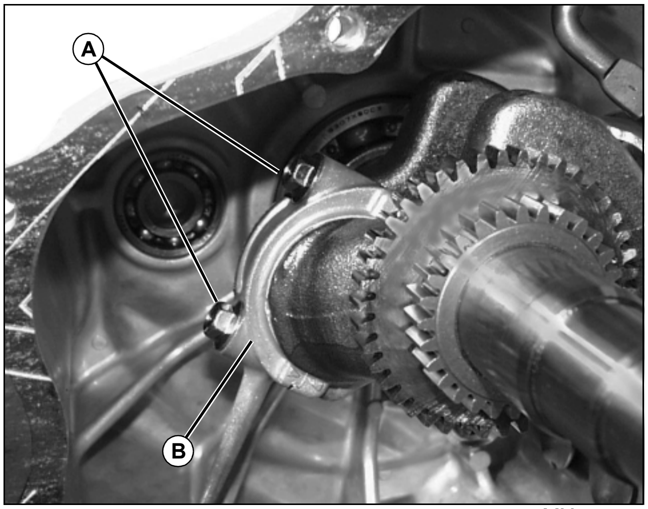
5. Rotate the crankshaft to TDC so the timing mark (C) on the crank gear (smaller gear) is in the 4 o'clock position.

6. Install the camshaft into the crankcase, aligning the camshaft timing mark (D) with the crankshaft timing mark (C).

Piston Removal and Installation

Removal:

IMPORTANT: Avoid damage! Use a ridge reamer to remove the carbon ridge from the top of the cylinder bore. The carbon ridge can damage the piston and piston rings.



MX17373

1. Remove connecting rod screws (A), and connecting rod cap (B).

IMPORTANT: Avoid damage! Remove piston assembly so connecting rod does not damage crankshaft journal or cylinder wall.

2. Remove piston assembly through top of cylinder bore.

3. Disassemble all components and inspect for wear or damage.

Assembly:

1. If new piston rings are to be installed, see “Piston Ring Installation” on page 670.

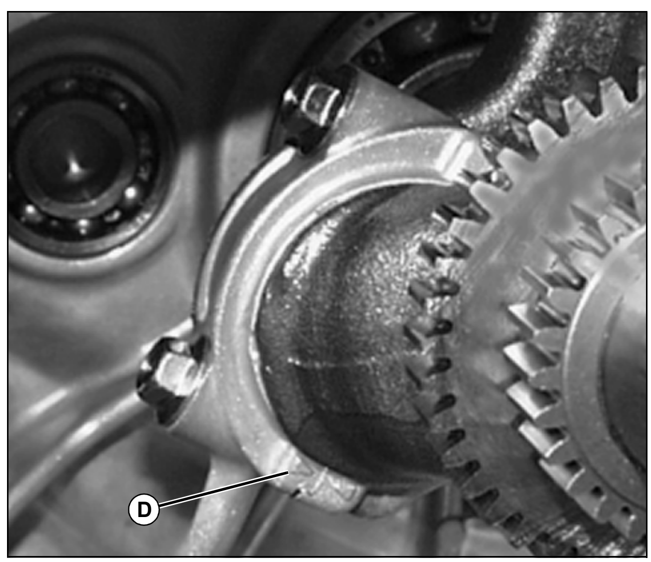
2. Clean carbon from all parts before assembly. Wipe clean engine oil on connecting rod and rod cap journals, cylinder wall, and piston rings and skirt before assembly.

3. If new piston rings are installed, de-glaze cylinder bore. See “Cylinder De-glazing” on page 670.

NOTE: Ensure that piston ring gaps are staggered 120° apart but do not align with oil ring side rail end gaps.

M87602

4. Install piston and connecting rod using ring compressor (C). Make sure stamping on the piston is facing down toward the base of the engine.



MX17534

5. Install connecting rod cap. Ensure that notches (D) on connecting rod and cap line up properly.

6. Install connecting rod cap screws.

7. Tighten cap screws to 20 N•m (177 lb-in.).

Piston Ring Installation

NOTE: Rings must be installed correctly. Ring installation instructions are usually included with new ring sets. Follow instructions carefully. Use a piston ring expander to install rings. Install the bottom (oil control) ring first and the top compression ring last.

1. Oil control ring (bottom groove):

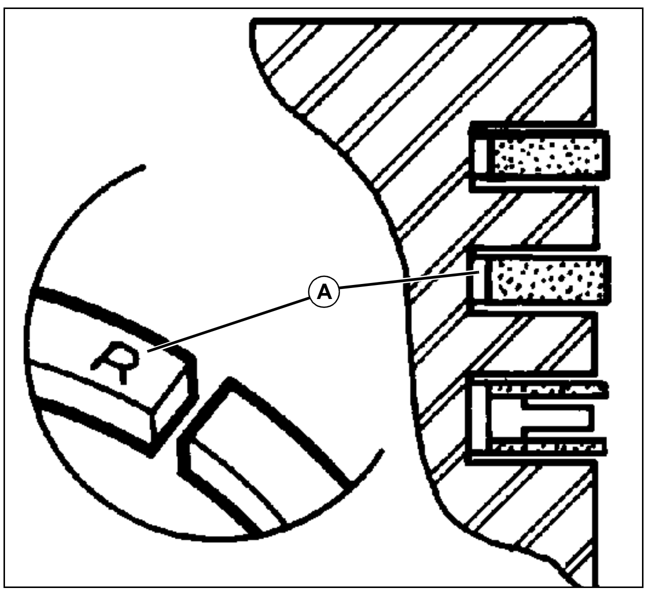
   a. Place the expander in the lowest groove. The ends of the expander must not butt. Do not allow the ends to overlap; incorrect tension and a loss of oil control will result.

   b. Place one end of a rail between the upper side of the expander and groove, and wind into position. Be careful that the end of the rail does not scratch the piston.

   c. Repeat this procedure with the second rail on the lower side of the expander.

   d. Position rail gaps 90° from the expander gap and 180° from each other.

   e. Check the assembly to ensure freedom of movement in the groove.



M80429

2. Middle compression ring:

   a. Locate and identify the compression ring with the “R” marking (A).

   b. Using a piston ring expander, install this ring in the middle groove with the “R” up towards the top of the piston.

3. Top compression ring:

   a. Using a piston ring expander, install the compression ring, with no markings, into the top groove. It is symmetrical in design, so it may be installed with either side up.

4. Stagger/position the two compression rings, so the end gaps are spaced 120° apart, as well as from the expander gap.

Measuring Piston to Bore Clearance

Before installing the piston into the cylinder bore, it is necessary that the clearance be accurately checked. This step is often overlooked, and if the clearances are not within specifications, engine failure will usually result.

NOTE: Do not use a feeler gauge to measure piston to bore clearance as it will result in inaccurate measurements. Always use a micrometer.

Use the following procedure to accurately measure the piston to bore clearance.

1. Use a micrometer and measure the diameter of the piston above the bottom of the piston skirt and perpendicular to the piston pin.

2. Use an inside micrometer, telescoping gauge, or bore gauge and measure the cylinder bore. Take the measurement approximately 40 mm (1.6 in.) below the top of the bore and perpendicular to the piston pin.

3. Piston to bore clearance is the difference between the bore diameter and the piston diameter.

Cylinder De-glazing

Procedure:

IMPORTANT: Avoid damage! If cylinder bore is to be de-glazed with crankshaft installed in engine, put clean shop towels over crankshaft to protect journal and bearing surfaces from any abrasives.

1. De-glaze cylinder bore using a rigid with a 220 to 300 grit stone.

2. Use hone as instructed by manufacturer to obtain a 45° crosshatch pattern.

IMPORTANT: Avoid damage! Do not use gasoline, kerosene, or commercial solvents to clean cylinder bore. Solvents will not remove all abrasives from cylinder wall.

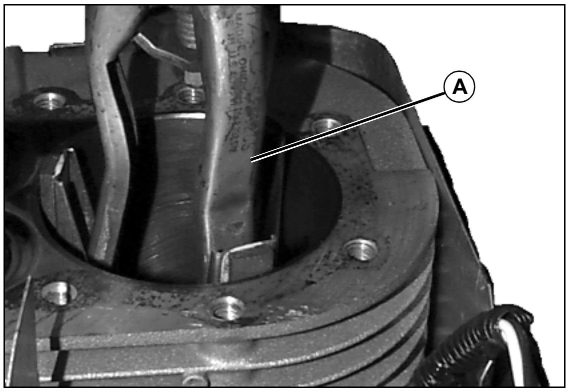
3. Remove excess abrasive residue from cylinder wall using a clean, dry rag. Clean cylinder wall using clean white rags and warm soapy water. Continue to clean cylinder until white rag shows no discoloration.

4. Dry cylinder wall and apply a light coat of clean engine oil.

Cylinder Resizing

Honing:

While most commercially available cylinder hones can be used with either portable drill or drill presses, the use of a low speed drill press is preferred as it facilitates more accurate alignment of the bore in relation to the crankshaft crossbore. Honing is best accomplished at a drill speed of about 250 rpm and 60 strokes per minute. After installing course stones in hone, proceed as follows:



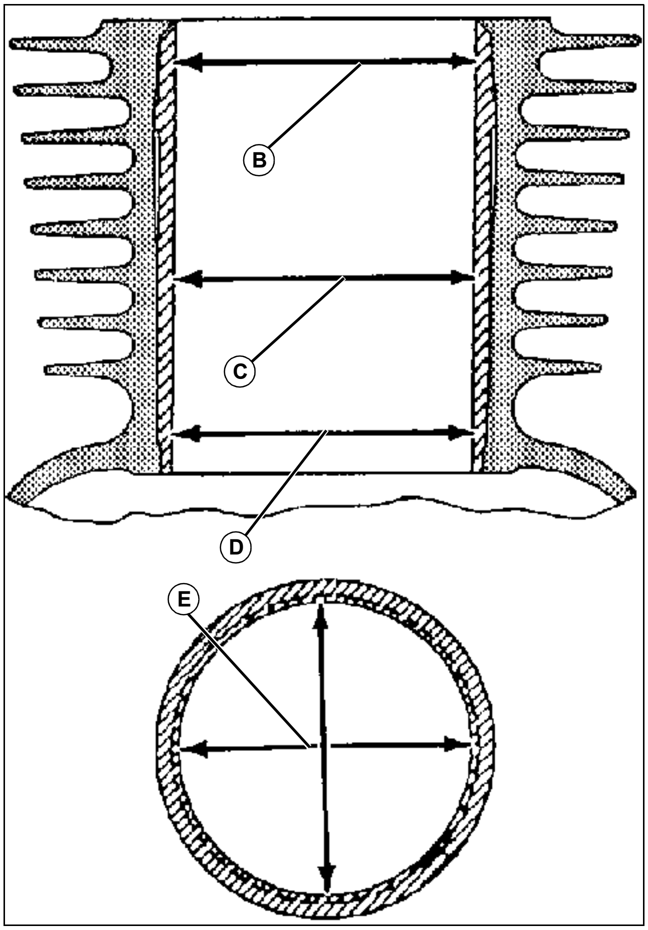
M87609

1. Lower hone (A) into bore and after centering, adjust so that the stones are in contact with the cylinder wall. Use of a commercial cutting/cooling agent is recommended.

NOTE: Keep in mind the temperatures caused by honing may cause inaccurate measurements. Make sure the bore is cool when measuring.

2. With the lower edge of each stone positioned even with the lowest edge of the bore, start drill and honing process. Move the hone up and down while resizing to prevent the formation of cutting ridges. Check the size frequently.

3. When the bore is within 0.064 mm (0.0025 in.) of desired size, remove the course stones and replace with burnishing stones. Continue with the burnishing stones until within 0.013 mm (0.0005 in.) of desired size and then use finish stones (220 - 280 grit) and polish to final size. A crosshatch should be observed if honing is done correctly. The crosshatch should intersect at approximately 20° off the horizontal. Too flat an angle could cause the rings to skip and wear excessively; too steep an angle will result in high oil consumption.



M82411A

4. After resizing, check the bore for roundness, taper, and size. Use an inside micrometer, telescoping gauge, or bore gauge to take measurements. The measurements should be taken at three locations in the cylinder - at the top (B), middle (C), and bottom (D). Two measurements should be taken (perpendicular to each other) (E) at each of the three locations.

Cleaning Cylinder Bore After Honing:

Proper cleaning of the cylinder walls following boring and/or honing is very critical to successful overhaul. Machining grit left in the cylinder bore can destroy an engine in less than one hour of operation after a rebuild.

The final cleaning operation should always be a thorough scrubbing with a brush and hot, soapy water. Use a strong detergent that is capable of breaking down the machining oil while maintaining a good level of suds. If the suds break down during cleaning, discard the dirty water and start again with more hot water and detergent. Following the scrubbing, rinse the cylinder with very hot, clear water. Dry it completely, and apply a light coating of clean engine oil to prevent rusting.

Crankshaft Removal, Inspection, and Installation

Removal:

1. After engine has been completely disassembled, carefully remove crankshaft from crankcase.

Inspection:

NOTE: Camshaft, crankshaft, and balance shaft gears wear together as a set. If one is to be replaced, all must be replaced as a set.

Inspect the gear teeth of the crankshaft. If the teeth are badly worn, chipped, or some are missing, replacement of the crankshaft will be necessary.

Inspect the crankshaft bearing surfaces for scoring, grooving, etc. Do not replace the main bearings unless they show signs of damage or are out of running clearance specifications. If the crankshaft turns easily and noiselessly, and there is no evidence of scoring, grooving, etc. on the races or bearing surfaces, the bearings can be reused. If not, See “Oil Seal and Bearing Removal and Installation” on page 672.

Inspect the crankshaft keyways. If worn or chipped, replacement of the crankshaft will be necessary.

Inspect the crank pin for score marks or metallic pickup. Slight score marks can be cleaned with crocus cloth soaked in oil. If wear limits are exceeded, it will be necessary to replace the crankshaft.

Installation:

1. Carefully slide the flywheel end of the crankshaft through the main ball bearing and seal.

Crankcase Inspection

1. Check all gasket surfaces to make sure they are free of gasket fragments. Use of a spray type gasket remover is recommended. Gasket surfaces must also be free of deep scratches or nicks.

2. Check the cylinder bore for wear, scoring, or vertical scratches. In severe cases, unburned fuel can cause scuffing and scoring of the cylinder wall as it washes the necessary lubricating oils off the piston and cylinder wall. As raw fuel seeps down the cylinder wall, the piston rings make metal to metal contact with the wall. Scoring of the cylinder wall can also be caused by localized hot spots resulting from blocked cooling fins or from inadequate or contaminated lubrication. Measure the cylinder bore using an inside micrometer or bore gauge. Compare readings with specifications. See “Measuring Piston to Bore Clearance” on page 670.

If the cylinder bore is badly scored, excessively worn, tapered, or out of round, resizing is necessary. Use a measuring device (inside micrometer, etc.) to determine the amount of wear, then select the nearest suitable oversize of either 0.25 mm (0.010 in.) or 0.50 mm (0.020 in.). Resizing to one of these over sizes will allow usage of the available oversize piston and ring assemblies.

Oil Seal and Bearing Removal and Installation

Removal:

NOTE: This procedure applies to all seals and bearings on the crankcase and reduction cover.

1. Remove the oil seal from the case.
2. Remove the bearing from the casing using a press.

Installation:

NOTE: Oil the bearings liberally when installing.

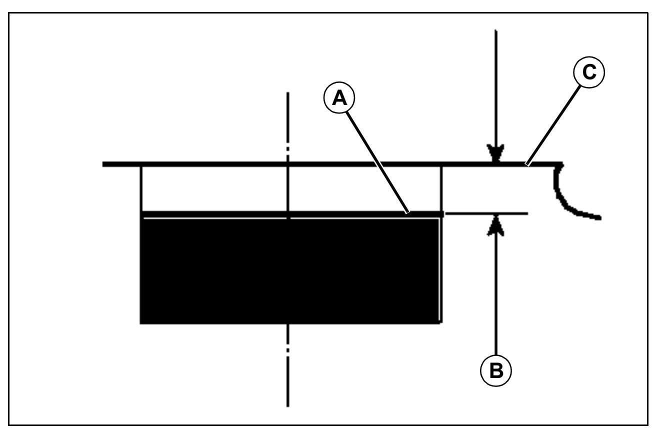
1. Make sure that there are no nicks, burrs, or damage in the bores for bearings. The closure plate and crankcase must be clean.

NOTE: Install the bearings and oil seals with their manufacturer’s marks or numbers visible, facing you.

2. Use a press to make sure the bearings are installed straight, into their respective bores, until fully seated.

3. Use a seal driver and install the crankshaft oil seals (manufacturer’s numbers visible) into crankcase or reduction cover.

4. Apply a light coating of lithium grease to seal lips when installing.



MX17446

5. Install a new seal (A) to a depth (B) of 2 mm (0.079 in.) below the outer surface (C).

Retractable Starter Removal and Installation

Removal:

MX19695

1. Remove the cap screws (A) securing the retractable starter to the blower housing.

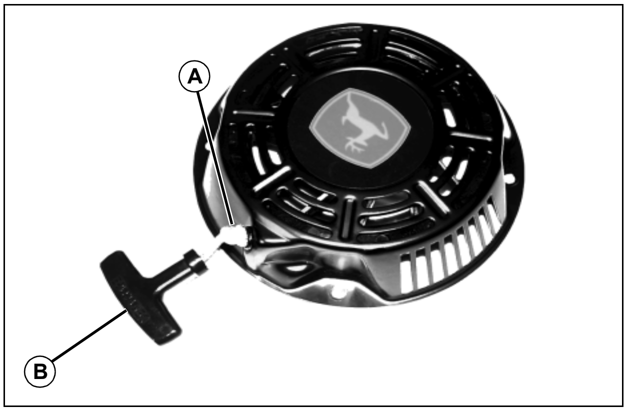
Installation:

1. Install the retractable starter cap screws finger tight only.

2. Pull the rope handle out just far enough to engage the pawls, centering the starter to the drive cup. Hold in this position and tighten the cap screws to 7 N•m (62 lb-in.).

Retractable Starter Rope Replacement

1. Remove the starter from the engine blower housing. See “Retractable Starter Removal and Installation” on page 673.



MX17548

2. Pull the rope out a few inches and tie a temporary (slip) knot (A) in it to keep it from retracting into the starter.

3. Pull the knot end (B) out of the handle, untie the knot, and slide the handle off.

4. Hold the pulley firmly in place and untie the slip knot.

5. Allow the pulley to rotate slowly as the spring tension is released.

6. When all spring tension on the starter pulley is released, remove the rope from the pulley.

7. Tie a single knot in one end of the new rope.

8. Rotate the pulley counterclockwise to pre-tension the spring (approximately 5 full turns of pulley).

9. Rotate the pulley until the rope hole in the pulley is aligned with the rope guide bushing of the starter housing.

NOTE: Do not allow the pulley/spring to unwind.

10.Feed the unknotted end of the rope through the rope hole in the starter pulley and rope guide bushing of the housing.

MX17551

11. Tie a slip knot approximately 30 cm (12 in.) from the free end of rope. Hold the pulley firmly and allow it to rotate until the slip knot reaches the guide bushing of the housing (C).

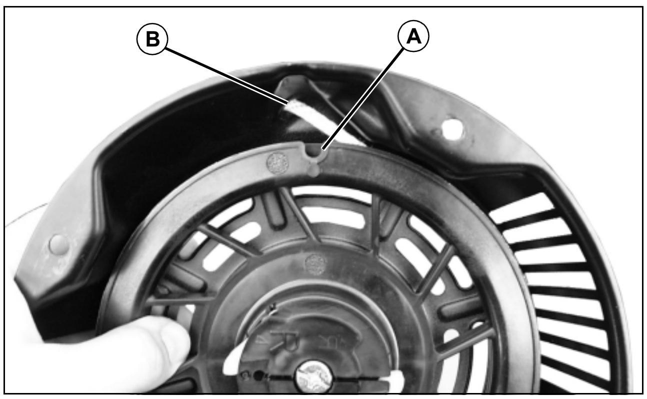
12. Slip the handle onto the rope. Tie a single knot at the end of the rope.

13. Untie the slip knot and pull on the handle until the rope is fully extended.

14. Slowly retract the rope into the starter. If the spring is properly tensioned, the rope will retract fully and the handle will stop against the starter housing.

Pawl Removal and Replacement

CAUTION: Avoid injury! Spring under tension! Do not remove the center screw from the starter until the spring tension is released. Removing the center screw before releasing spring tension, or improper starter disassembly, can cause the sudden and potentially dangerous release of the spring. Follow these instructions carefully to ensure personal safety and proper starter disassembly. Make sure adequate face protection is worn by all persons in the area.



MX17550

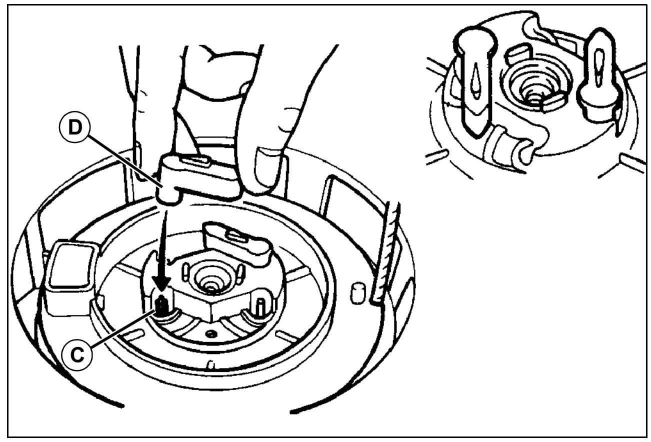
1. Rotate the pulley against spring tension until the cutout (A) in the pulley is adjacent to outlet in housing (B).

2. Lift up the slack in rope through the cutout and slowly pull pulley to unwind, releasing spring tension. Count the number of rotations for reassembly later.

3. Unscrew the center screw and lift off the drive plate. The center screw will be captured by the clip around the shoulder on the backside of plate.

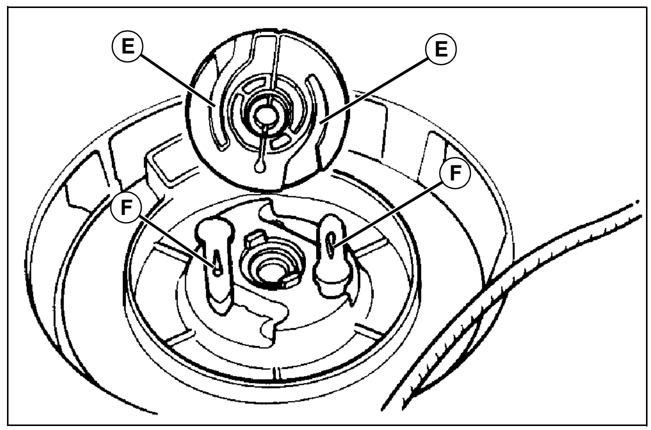
4. Note the positions of the pawls and pawl springs before removing. Remove parts from pulley.

5. Carefully inspect the components for wear, cracks, and/or damage. Replace all worn components.



MX19696

6. Install pawl springs (C) and pawls (D) onto pawl studs of pulley. All parts must be dry.



MX19697

7. Position the drive plate over the pawls, aligning the actuating slots (E) in the plate with the raised sections on each drive pawl (F).

8. Install the center screw.

9. Rotate the pulley by hand and check operation.

10.Hook the slack in rope into notch of pulley and rotate the pulley counterclockwise (viewed from pawl side) to re-tension the spring (approximately 5 full turns).

Recoil Spring, Pulley, and Housing Replacement

CAUTION: Avoid injury! Spring under tension! Do not remove the center screw from the starter until the spring tension is released. Removing the center screw before releasing spring tension, or improper starter disassembly can cause the sudden and potentially dangerous release of the spring. Follow these instructions carefully to ensure personal safety and proper starter disassembly. Make sure adequate face protection is worn by all persons in the area.

1. Release spring tension and remove the handle and starter rope. See “Retractable Starter Rope Replacement” on page 673.

2. Unscrew the center screw and lift off the drive plate. The screw will be captured within the plate by the clip on the backside.

3. Carefully note the positions of the pawls and pawl springs before removing them. Remove the parts from the starter pulley.

4. Rotate the pulley clockwise (1/2 to 1 full turn). This will ensure the spring is disengaged from the starter housing.

5. Carefully lift the pulley out of the recoil housing while reaching through the spokes of the pulley to keep the spring from coming out of the pulley.

6. Wearing adequate eye/face protection, carefully remove the spring from the pulley cavity,

7. Clean all parts including the starter spring cavity in pulley and recoil housing of all old grease and dirt.

8. Inspect all parts for wear or damage and replace as required.

Installation:

1. Generously lubricate the recoil spring with a commercially available bearing grease.

2. Engage the outer spring hook into the pulley “slit” opening, then carefully wind the spring counterclockwise into the drum of the pulley from larger to smaller diameter.

3. Carefully install pulley into recoil housing, engaging the spring hook with starter housing tab.

4. Rotating pulley counterclockwise slightly with assist engagement.

5. Install the pawl springs and pawls onto pawl studs of pulley.

6. Mount drive plate over pawls onto pulley, aligning the actuating slots in plate with the raised sections on each drive pawl.

7. Rotate the pulley by hand to check operation.

8. Tension the spring and install the rope and handle. See “Retractable Starter Rope Replacement” on page 673.

9. Install the recoil starter to engine blower housing but do not fully tighten the mounting screws.

10. Pull out on recoil handle/rope to engage the pawls to the drive cup, hold engaged and tighten the mounting screws to 7 N•m (62 lb-in.).

Table of Contents

Specifications

General Specifications

Suspension Specifications

Shock Absorber Mounting Lock Nut Torque . . . . 70 N•m (52 lb-ft)

A-Arm:
Shock Absorber to A-Arm Lock Nut Torque . . . . 70 N•m (52 lb-ft)
A-Arm to Frame Lock Nut Torque . . . . 90 N•m (67 lb-ft)

King Pin Cap Screws and Lock Nuts:
10 mm x 170 mm Cap Screw Torque . . . . 73 N•m (54 lb-ft)
12 mm x 173 mm Cap Screw Torque . . . . 130 N•m (95 lb-ft)

Front Wheel Mounting Cap Screw Torque . . . . 88 N•m (65 lb-ft)

Tests and Adjustments

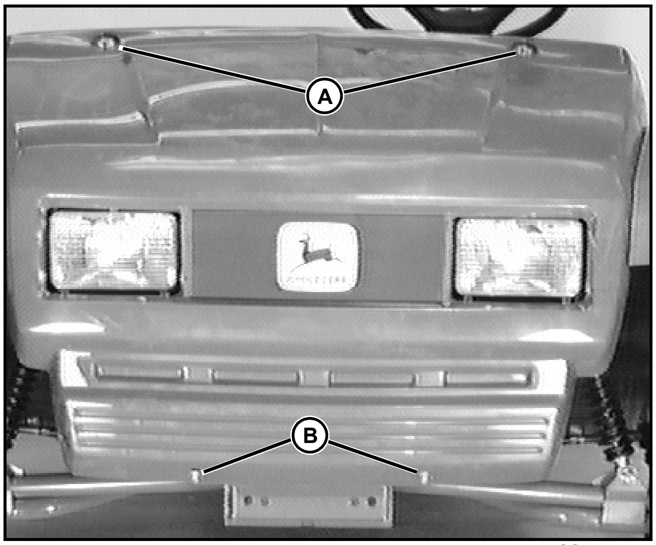
Hood Adjustment

Reason:

To position hood so openings for the headlights are centered around headlights.

Procedure:

1. Park machine on level surface, turn key switch OFF, place shift lever in NEUTRAL, and lock park brake.



M56408

2. Loosen top cap screws (A) and (B).

IMPORTANT: Avoid damage! Hood MUST NOT touch headlights or vibration may cause headlights to fail.

3. *Adjust hood so openings around headlights are equal.*

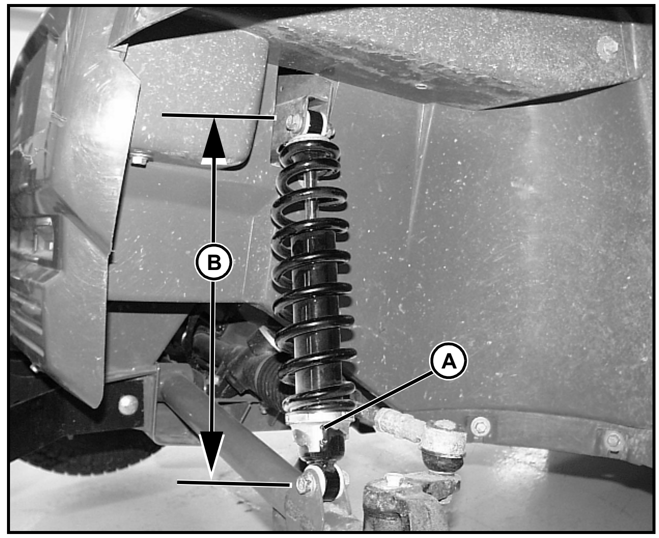
4. Tighten bottom cap screws (B), then tighten top cap screws (A)

5. Make sure hood has not shifted during tightening. Adjust again, if necessary.

Shock Ride Height and Spring Preload Adjust

(Optional HD Suspension)

1. Ensure all tires are inflated to 41 kPa (6 psi).



M97093

2. Measure center of bolt head to center of bolt head (B) on each shock and average the two dimensions.

IMPORTANT: Avoid damage! The cam position (A) on each shock needs to be the same to maintain a stable ride.

3. If average dimension is less than 305 mm (12 in.), adjust the cam to provide more spring preload. DO NOT exceed 315 mm (12-3/8 in.).

M97096

4. Use the adjusting wrench (C) to adjust the shock up to 5 levels of adjustment. Each level of the adjustment is approximately 3 mm (1/8 in.) more spring preload.

5. Drive to allow settling and setting in of the shocks, then check measurements. Adjust if necessary.

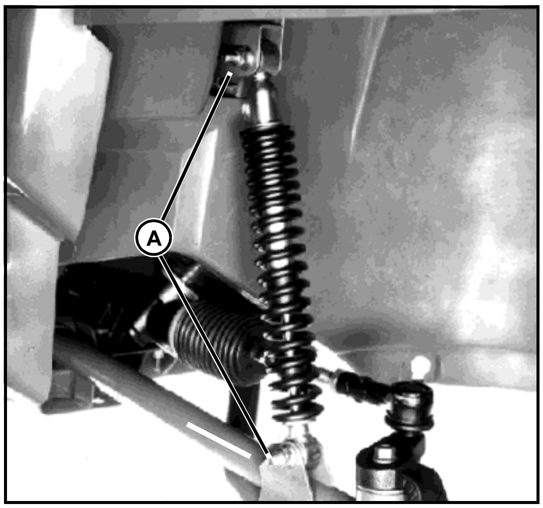
Repair

Shock Absorber Replacement

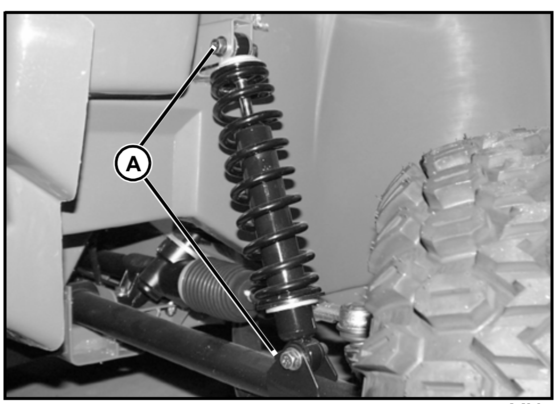
- Remove front wheel.
- Remove top and bottom mounting lock nuts and cap screws (A) (M10 x 50). If using heavy duty kit, remove lock nuts and cap screws (B) (M10 x 100) and spacer (C).
- Remove shock absorber(s).

Installation is done in the reverse order of removal.

- Tighten mounting lock nuts (A) to 70 N•m (52 lb-ft).

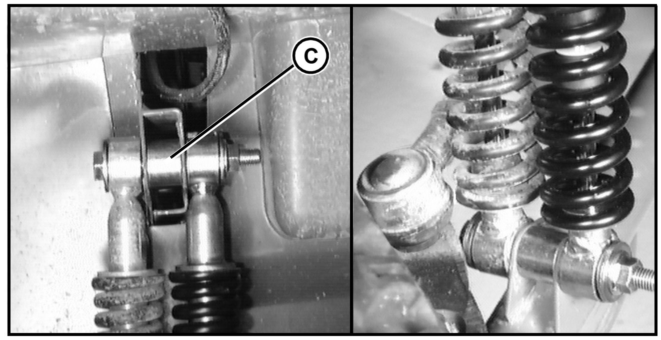


Standard Shock Absorber Mounting (Old Style)

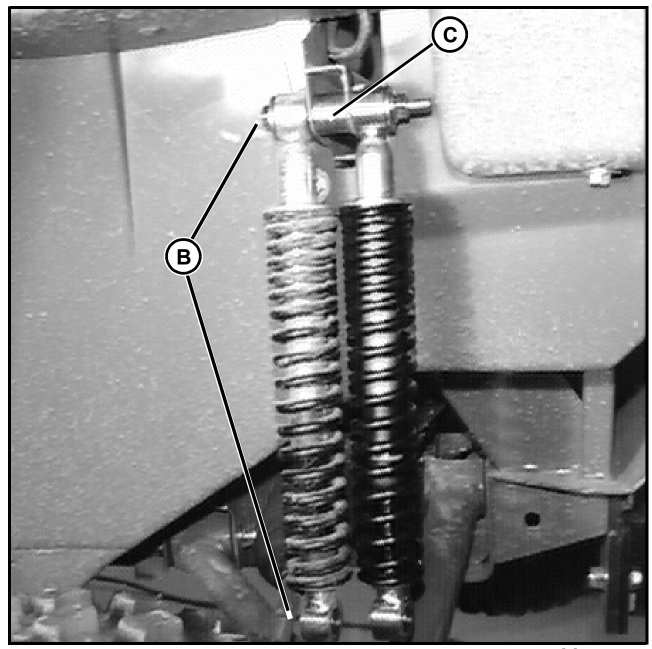


Standard Shock Absorber Mounting (New Style)

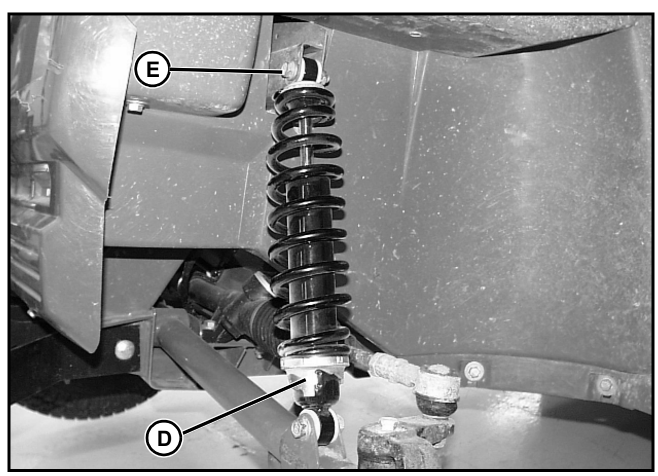
NOTE: Original (plated) shocks must be installed so rod end is down. New (black) shocks must be installed so rod end is up.



Heavy Duty Suspension Kit Mounting (Early Models)



Heavy Duty Suspension Kit Mounting (Early Models)



Heavy Duty Suspension Kit Mounting (Later Models)

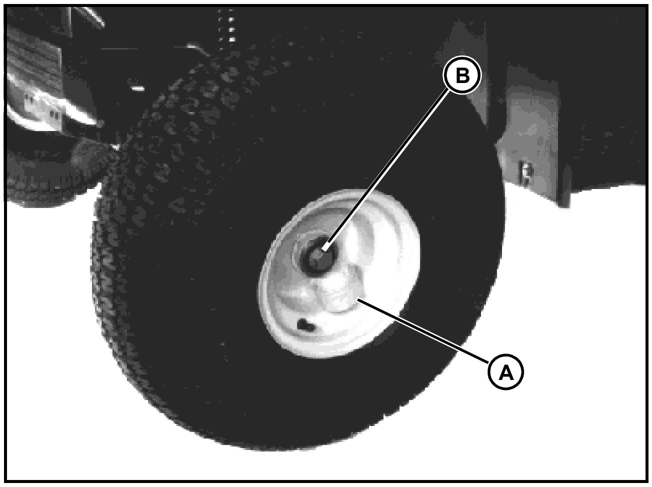
Heavy Duty Shock Installation (Later Models):

1. Install new shocks, leaving in lowest spring preload setting (D), with rod end up (E). Tighten mounting lock nuts to 70 N•m (52 lb-ft).

Front Wheel Removal and Installation

Removal:

1. Raise and support machine.



M82454

2. Remove hub cap (A).
3. Remove mounting cap screw (B).
4. Tap on backside of wheel rim with a soft-faced mallet to remove wheel.
5. Inspect and replace bearings, if necessary.

Installation:

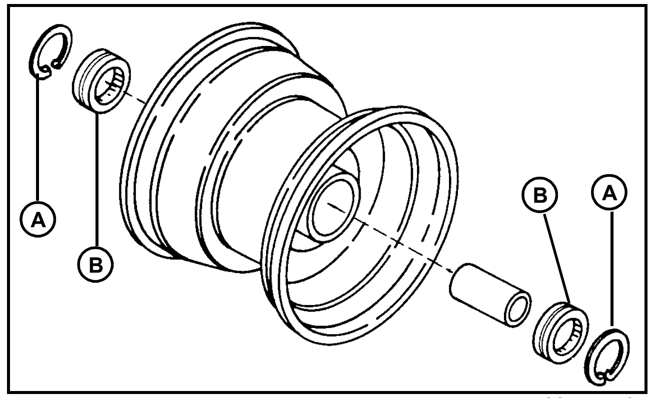
Installation is done in the reverse order of removal.

- Apply multipurpose grease to spindle shaft before installing wheel.
- Install front wheels with stems toward outside of machine. Tighten cap screw to 78 - 98 N•m (58 - 72 lb-ft).

Wheel Bearing Replacement

Removal:

1. Remove front wheel.



M82455A

2. Remove snap ring (A).
3. Remove bearing (B) on one side using an inside puller and slide hammer.

NOTE: Bearings are press fit in wheel rim.

4. Remove snap ring and bearing on opposite end using a driver set.

Installation:

Installation is done in the reverse order of removal.

- Pack inside of rim with multipurpose grease before installing spacer and bearings.

A-Arm Removal and Installation

The A-arm design was changed by lowering the spindle weldments to improve steering geometry and raise the front of the machine. The improved A-arm design was made at serial numbers:

4X2 W004X2038499-

4X6 Gas W006X4038606-

4X6 Diesel W006X4D09699-

Below these serial numbers the A-arms should be replaced as a set. Above these serial numbers, one A-arm can be replaced at a time.

Removal:

NOTE: If replacing A-Arm, remove spindle shaft and bushings. (See "Spindle Shaft and Bushing Removal and Installation" on page 546 in the Steering section.)

1. Remove front wheel.
2. Remove shock absorber mounting cap screw and lock nut.

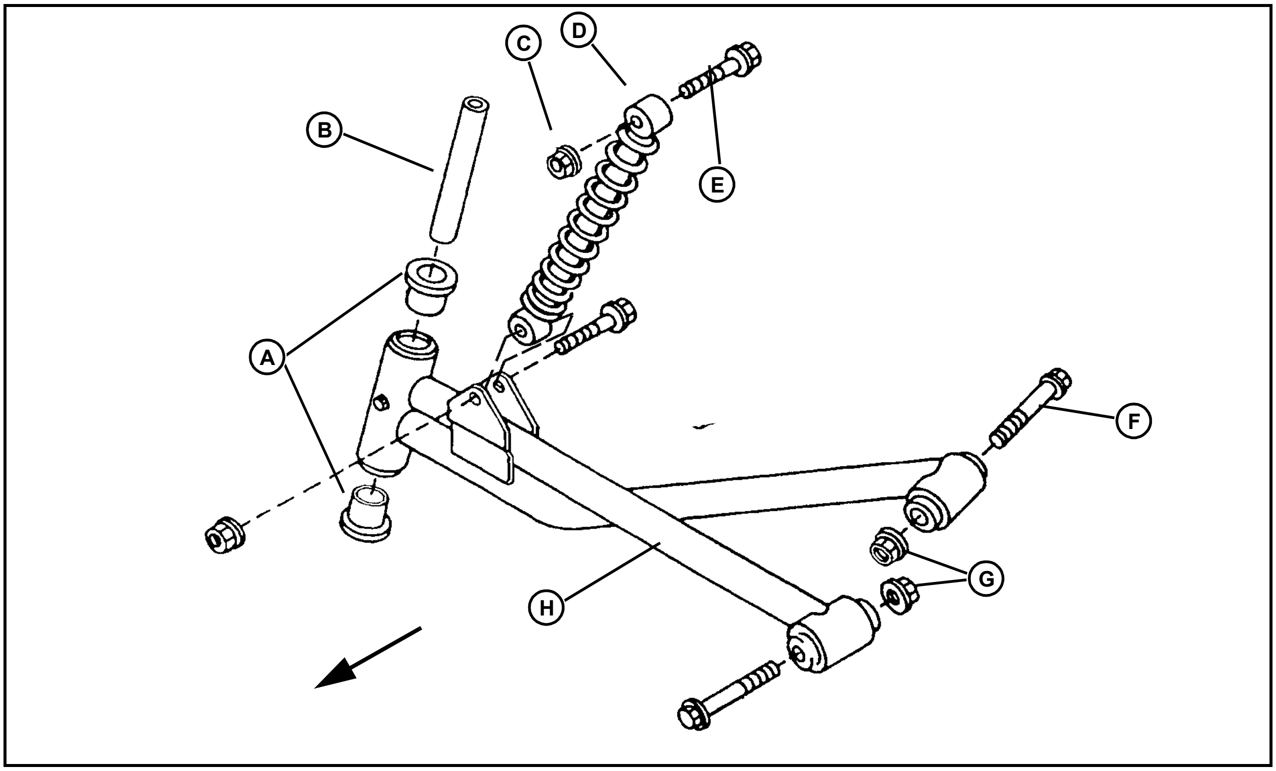
3. Remove mounting cap screws, lock nuts and A-Arm.

Installation:

Installation is done in the reverse order of removal.

- If spindles are removed, see “Spindle Shaft and Bushing Removal and Installation” on page 546 in the steering section.
- See “Shock Absorber Replacement” on page 681 for shock absorber installation.

NOTE: Shock absorber should be in place to provide proper orientation of A-Arm when tightening mounting hardware.



M82453A

Right Hand Side A-Arm Shown Above

A - Bushing (2 used)
B - King Pin
C - Lock Nut (2 used)
D - Shock Absorber
E - Cap Screw M10 x 40, Head Marked 10.9 (2 used)
F - Cap Screw M12 x 90 (2 used)
G - Lock Nut (2 used)
H - A-Arm

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