JOHN DEERE

WORLDWIDE COMMERCIAL & CONSUMER EQUIPMENT DIVISION

John Deere Select Series™Tractors
Ultimate™ Series
X700, X720, X724 and X728

TM2349 SEPTEMBER 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

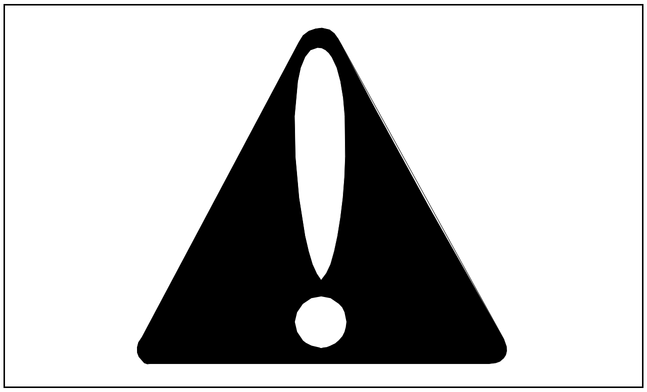
Note: Depending on the particular section or system being covered, not all of the above groups may be used.

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.

Safety

Recognize Safety Information



MIF

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

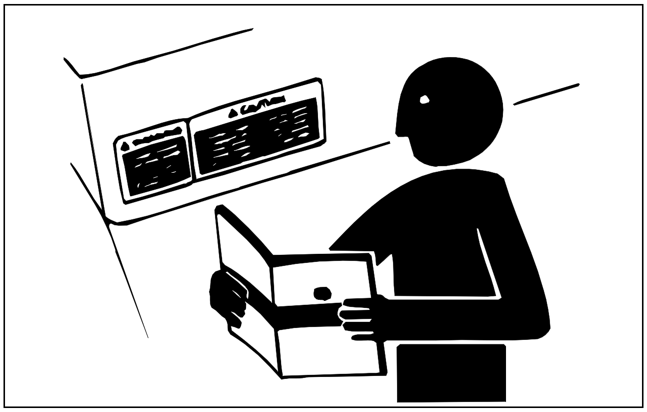
Follow recommended precautions and safe servicing practices.

Understand Signal Words

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

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

Replace Safety Signs



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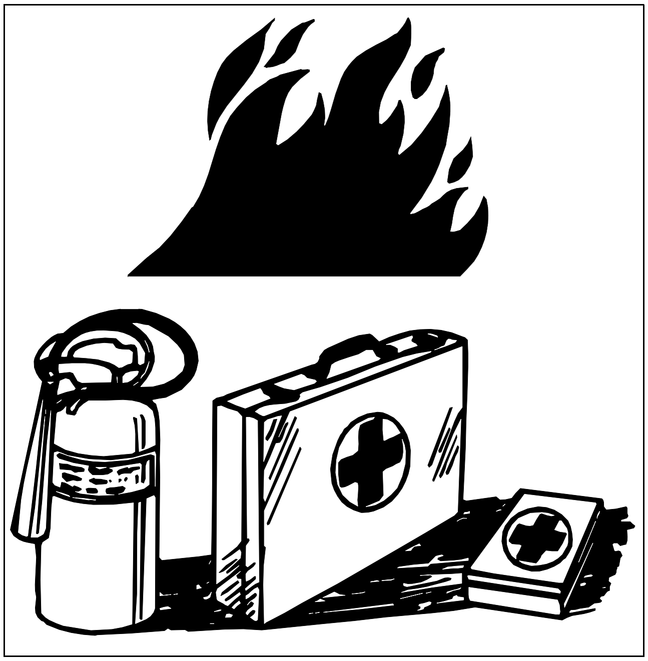
Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

Handle Fluids Safely - Avoid Fires

Be Prepared For Emergencies



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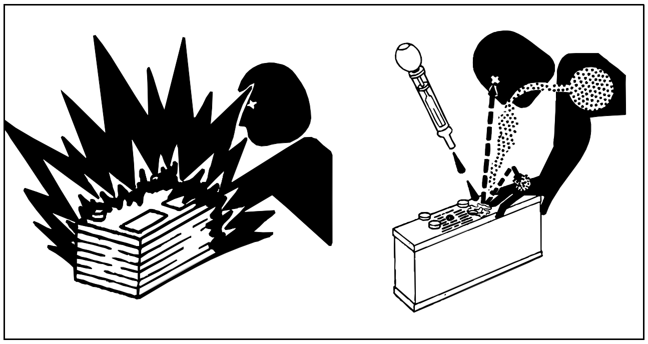
- When you work around fuel, do not smoke or work near heaters or other fire hazards.
- Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.
- Make sure machine is clean of trash, grease, and debris.
- Do not store oily rags; they can ignite and burn spontaneously.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

Use Care In Handling And Servicing Batteries



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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.

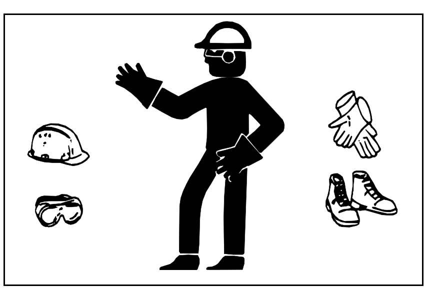
If you spill acid on yourself:

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



MIF

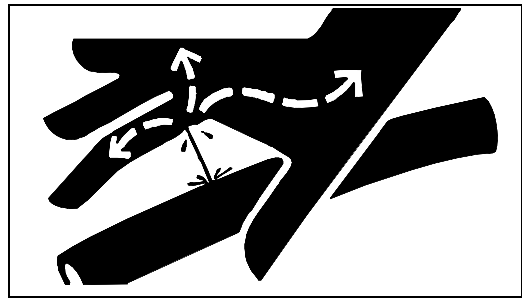
Wear close fitting clothing and safety equipment appropriate to the job.

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

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

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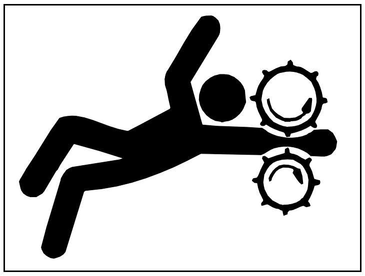
Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can be accidentally cut when heat goes beyond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

Service Machines Safely



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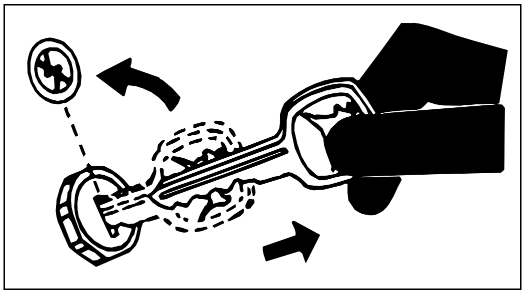
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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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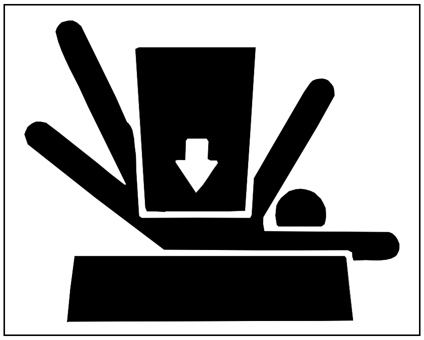
Before working on the machine:

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.

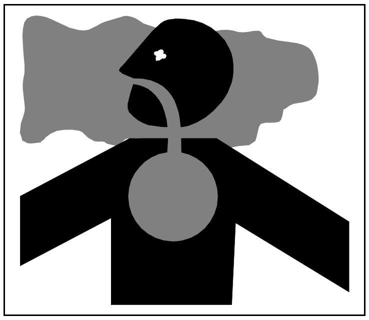
Using High Pressure Washers

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.

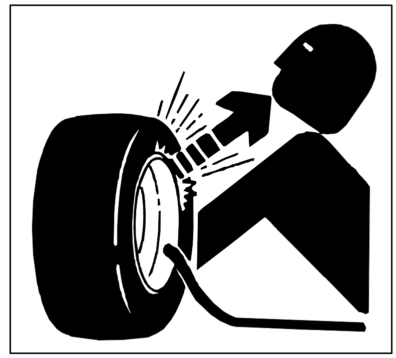
Avoid Harmful Asbestos Dust

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.

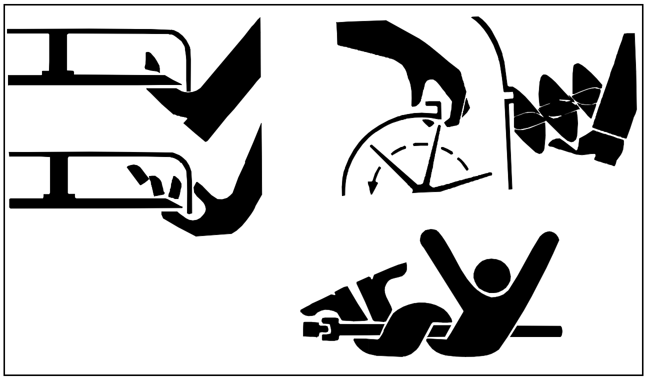
Do not attempt to mount a tire unless you have the proper equipment and experience to perform the job.

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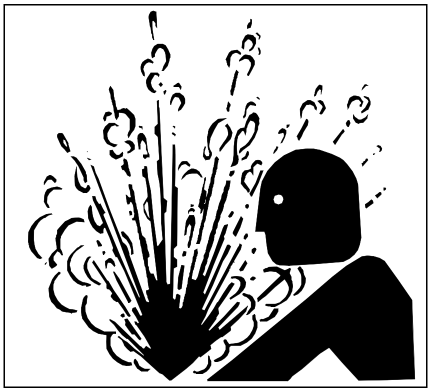
Keep hands and feet away while machine is running. Shut off power to service, lubricate or remove mower blades, augers or PTO shafts.

Service Cooling System Safely



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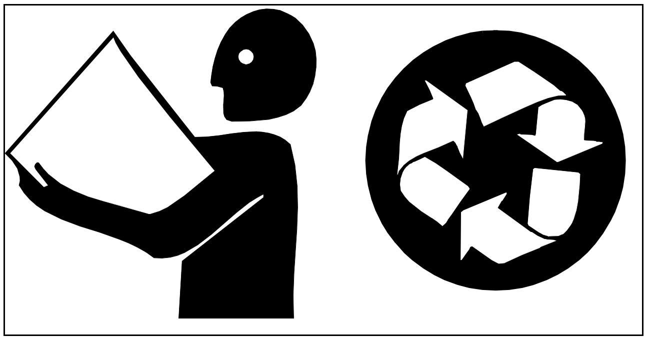
Explosive release of fluids from pressurized cooling system can cause serious burns.

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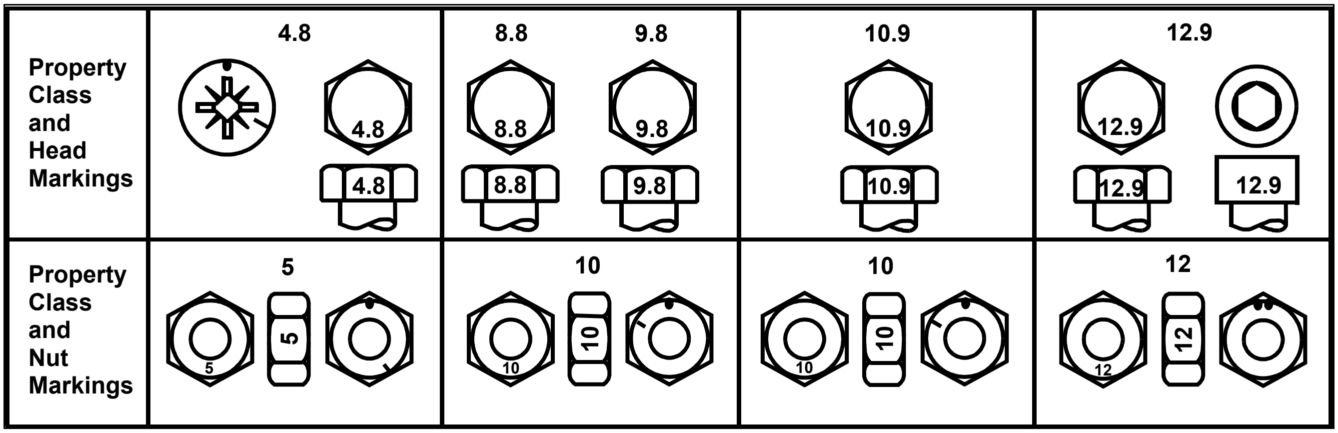
Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

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.

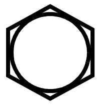
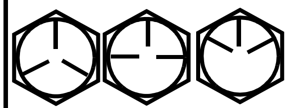
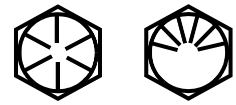
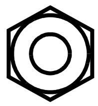
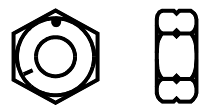
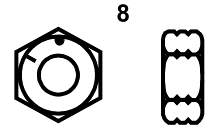
When bolt and nut combination fasteners are used, torque values should be applied to the NUT instead of the bolt head.

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 2b** **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.

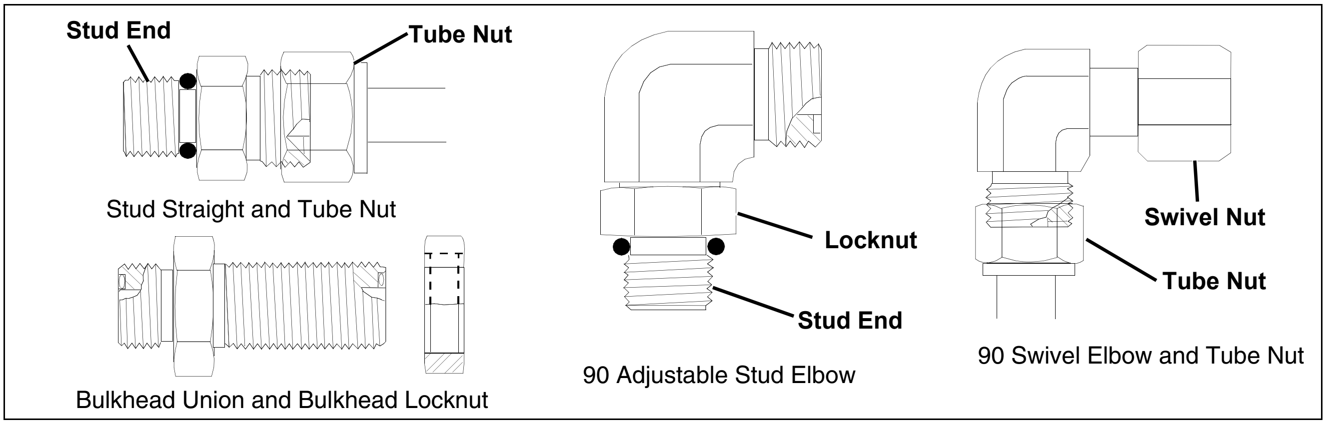
a *"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication*.

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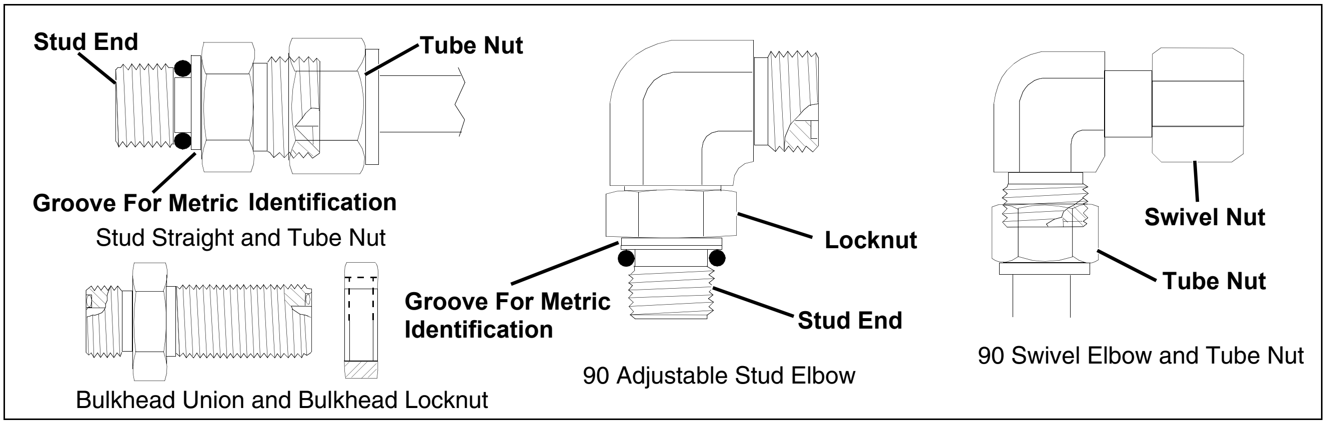
Nominal Tube OD/Hose ID				Face Seal Tube/Hose End					O-Ring Stud Ends		
Metric Tube OD	Inch Tube OD			Thread Size	Tube Nut/ Swivel Nut Torque		Bulkhead Lock Nut Torque		Thread Size	Straight Fitting or Lock Nut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
5	-3	0.188	4.76						3/8-24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

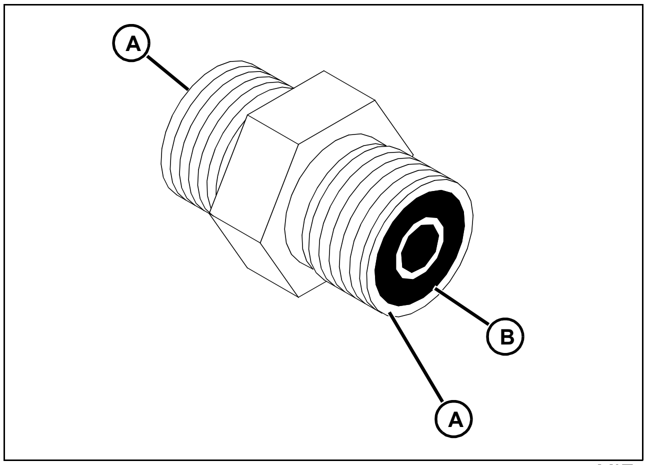


MIF

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.

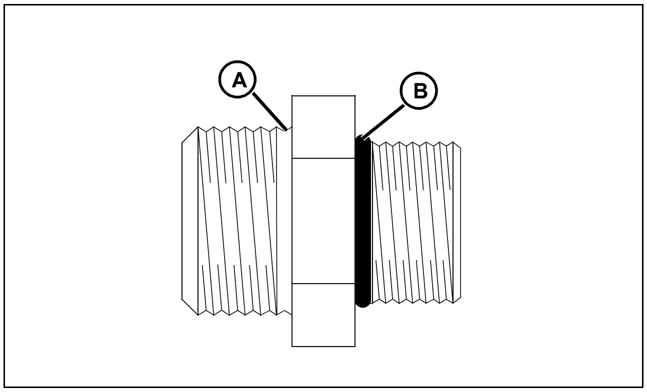
4. Index angle fittings and tighten by hand pressing joint together to insure O-ring remains in place.

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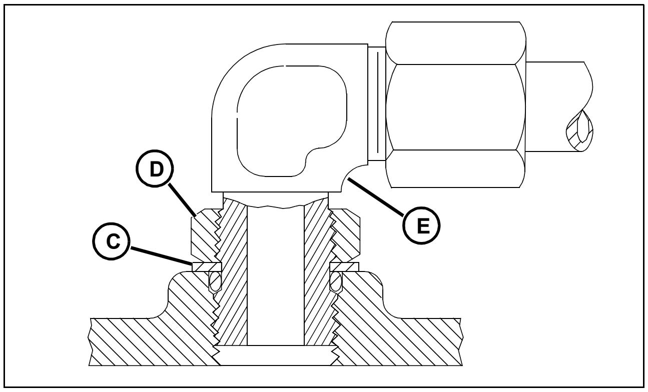
2. Put hydraulic oil or petroleum jelly on the O-ring (B). Place electrical tape over the threads to protect O-ring from nicks. Slide O-ring over the tape and into the groove (A) of fitting. Remove tape.



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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.**

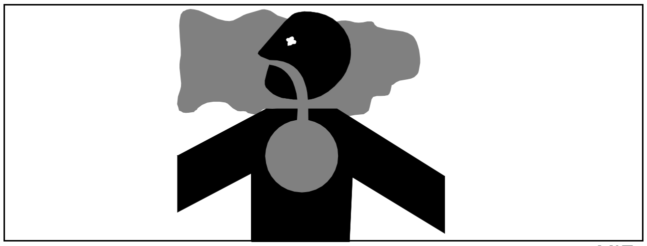
To avoid engine damage:

- 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:

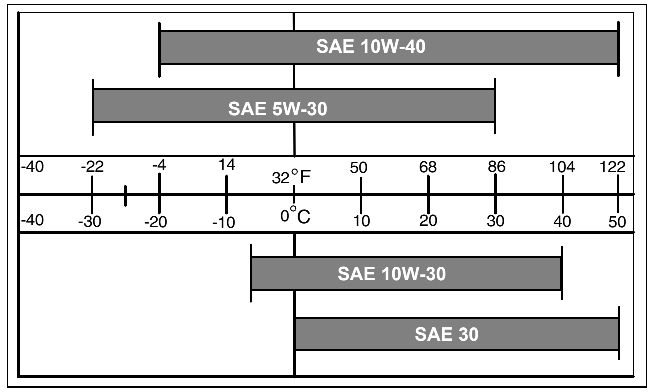
- **PLUS - 4 - SAE 10W-40**;
- **TORQ - GARD SUPREME - SAE 5W-30**.

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.



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.

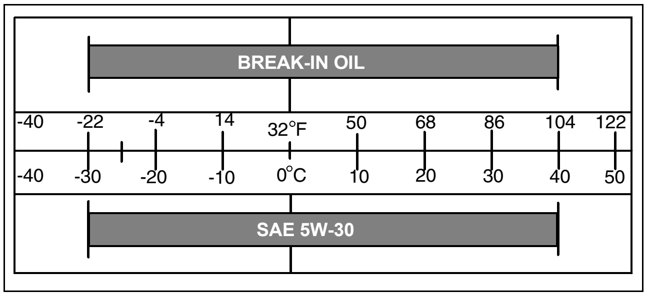
The following John Deere oil is **also recommended**:

- **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.



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**:

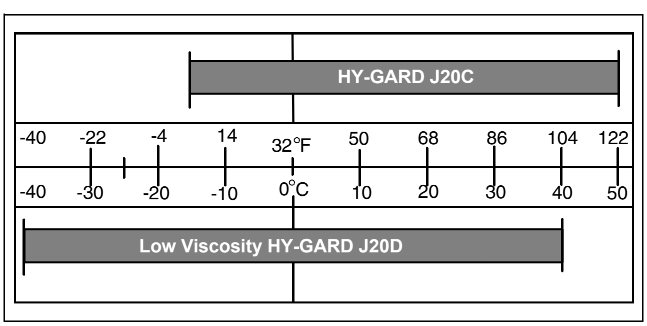
- **LOW VISCOSITY HY-GARD® - JDM J20D**.

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.



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:

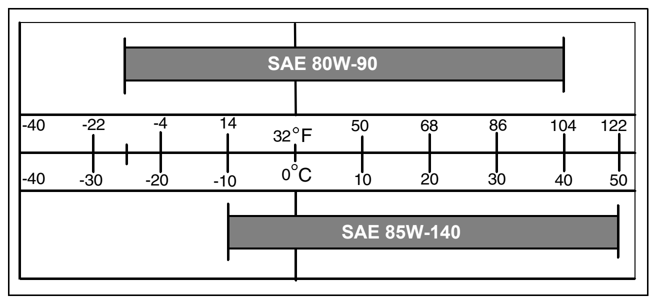
- **GL-5 GEAR LUBRICANT® - SAE 80W-90.**

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.



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.

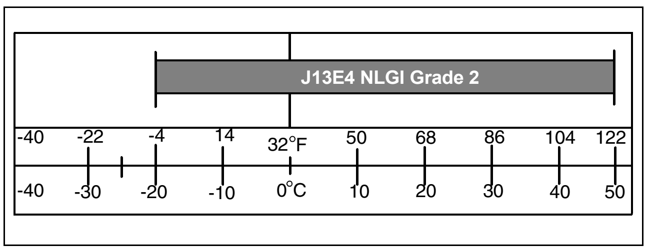
Important: Avoid Damage! ONLY use a quality gear grease in this transmission. DO NOT mix any other greases in this transmission. DO NOT use any BIO - GREASE in this transmission.

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.



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.

Anti-Corrosion Grease

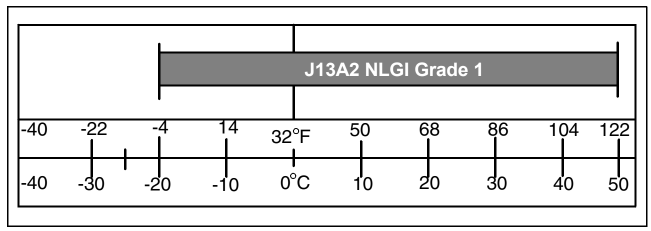
This anti-corrosion grease is formulated to provide the best protection against absorbing moisture, which is one of the major causes of corrosion. This grease is also superior in its resistance to separation and migration.

The following anti-corrosion grease is **preferred:**

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

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

- John Deere Standard JDM J13A2, NLGI Grade 1.



Mower Spindle Grease

This premium, multi-purpose grease is specially formulated as a high-temperature, extreme-pressure grease, especially effective in rolling contact applications.

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

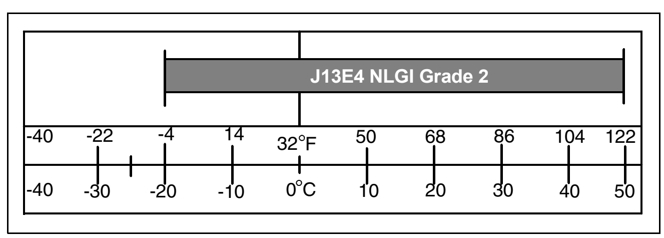
- Multi-Purpose SD Polyurea Grease - TY6341.

The following multi-purpose grease may also be used:

- Multi-Purpose HD Lithium Complex Grease - TY24416.

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

- John Deere Standard JDM J13E4, NLGI Grade 2.



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

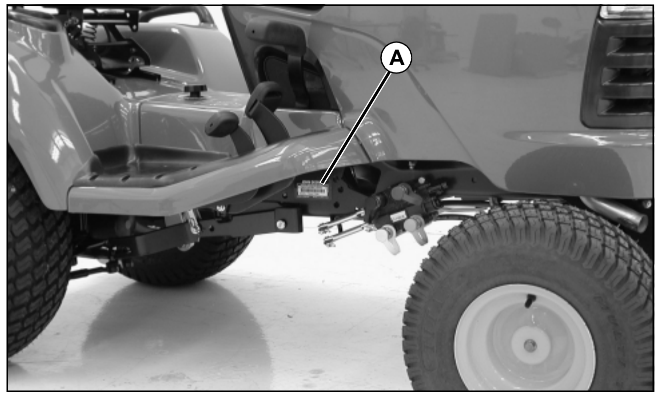
When using John Deere Pre-Diluted (TY16036) Automobile and Light Duty Engine Service coolants, drain and flush the cooling system and refill with fresh coolant mixture every 36 months or 3,000 hours of operation, whichever comes first.

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.

Serial Number Locations

Product Serial Number



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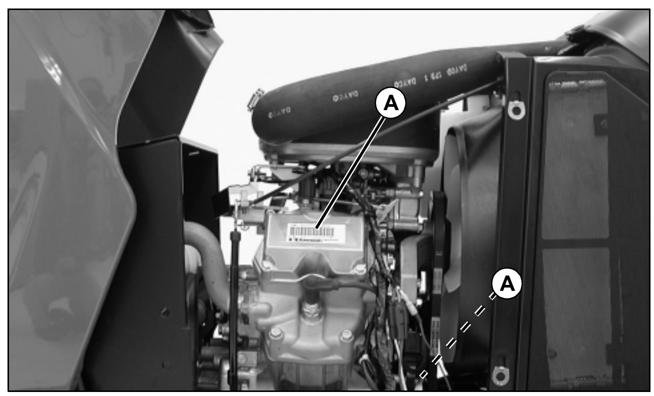
The 13-digit product identification number (A) is located on the right-hand side frame, just below engine compartment.

Gasoline Engine Serial Number Location



MX13637

Engine serial number (A) is located on the valve cover or on the front of the engine crankcase.

Table of Contents

Specifications

General Specifications

Engine General Specifications:

Engine Use (FD671D)	X700
Engine Use (FD750D)	X720, X724, and X728
Model	Kawasaki
Model Number	FD671D
Model Number	FD750D
Displacement	745 cm^3 (45.5 cu-in.)
Cylinders	2
Stroke/Cycle	4
Valves	Overhead Valves
Bore	78 mm (3.07 in.)
Stroke	78 mm (3.07 in.)
Compression Ratio	8: 1
Compression Release	Automatic
Crankshaft Type	Horizontal (Counterbalanced)
Lubrication	Pressurized by Positive Displacement Pump
Oil Pressure	276 kPa (40 psi minimum)
Oil Filter	Cartridge Type, Full Flow, Spin-On Filter
Crankcase Capacity (With Filter)	1.8 L (1.9 qt)
Cooling System	Liquid Cooled
Cooling System Capacity	4.0 L (4.2 qt)
Air Cleaner	Dual Element replaceable paper
Muffler	Horizontal; discharge frame side
Maximum Angle of Operation (With Full Crankcase):	
Continuous (All Directions)	20°
Intermittent (All Directions)	35°
Fuel Filter	Replaceable (In-Line Type)
Fuel Pump	Electromagnetic Pump (In-Tank Type)
Fuel Shut-Off Solenoid	Replaceable (Below Carburetor Float Bowl)
Carburetor (FD671D)	Float type, fixed main jet, two barrel
Fuel Injection (FD750D)	Simultaneous port fuel injection
Spark Plug	NGK BPR4ES
Charging System	12V - 20 amps with regulator

Tests and Adjustments Specifications

Engine:

Spark Plug Gap	0.75 mm (0.030 in.)
Fan Belt Deflection	12 - 19 mm (0.48 - 0.75 in.)
Valve Adjustment	0.15 mm (0.006 in.)
Oil Pressure (Minimum at 1250 rpm)	276 kPa (40 psi)
Cylinder Compression (Minimum, with Engine Warm)	620 kPa (90 psi)

Fuel/Air System:

Slow Idle Speed . . . . 1600 ± 25 rpm
Fast Idle Speed . . . . 3550 ± 25 rpm

Repair Specifications

Cylinder Head:

Cylinder Head Flatness (Maximum Warp) . . . . 0.050 mm (0.002 in.)

Valves and Valve Lifters:

Valve Clearance (Intake/Exhaust Cold) . . . . 0.15 mm (0.006 in.)
Valve Stem Runout (Maximum) . . . . 0.050 mm (0.002 in.)
Valve Stem OD (Exhaust and Intake, Minimum) . . . . 6.94 mm (0.273 in.)
Valve Guide ID (Intake and Exhaust) . . . . 7.08 mm (0.279 in.)
Valve Spring Free Length (Minimum) . . . . 31.0 mm (1.22 in.)
Valve Face Angle . . . . 45°
Push Rod Runout (Maximum) . . . . 0.5 mm (0.02 in.)

Crank shaft:

Crankshaft Journal Bearing ID: Crankcase . . . . 42.14 mm (1.659 in.)
Crankshaft Journal OD (Minimum)
PTO Side . . . . 41.935 mm (1.651 in.)
Flywheel Side . . . . 41.935 mm (1.651 in.)
Crankshaft Runout (TIR) (Maximum) . . . . 0.05 mm (0.002 in.)
Crankpin OD (Minimum) . . . . 39.95 mm (1.573 in.)
Crankpin Width (Maximum) . . . . 46.5 mm (1.83 in.)
Connecting Rod:
Twist (Maximum) . . . . 0.15 mm over 100 mm (0.006 over 3.94 in.)
Bend (Maximum) . . . . 0.15 mm over 100 mm (0.006 over 3.94 in.)
Connecting Rod Big End Width (Maximum) . . . . 22.35 mm (0.88 in.)

Camshaft:

Bearing ID Maximum (Crankcase) . . . . 20.081 mm (0.791 in.)
Bearing ID Maximum (Crankcase Cover) . . . . 20.081 mm (0.791 in.)
Camshaft Journal Diameter:
PTO Side (Minimum) . . . . 19.927 mm (0.785 in.)
Flywheel Side (Minimum) . . . . 19.927 mm (0.785 in.)
Cam Lobe Height (Minimum):
Intake . . . . 33.594 mm (1.323 in.)
Exhaust . . . . 33.594 mm (1.323 in.)

Oil Pump:

Inner and outer rotor clearance (Maximum) . . . . 0.3 mm (0.012 in.)
Outer rotor OD (Minimum) . . . . 40.47 mm (1.593 in.)
Outer rotor thickness (Minimum) . . . . 19.830 mm (0.781 in.)
Pump Housing inside diameter (Maximum) . . . . 40.801 mm (1.606 in.)
Pump Housing depth (Maximum) . . . . 20.230 mm (0.797 in.)
Pump Shaft outside diameter (Minimum) . . . . 10.923 mm (0.4300 in.)
Pump Shaft bearing inside diameter (Maximum) . . . . 11.072 mm (0.436 in.)

Relief Valve Spring length (Minimum) . . . . 19.50 mm (0.77 in.)

Cylinder Bore, Pistons and Rings

Cylinder Bore ID:
New . . . . 78.00 mm (3.071 in.)
Maximum. . . . . 78.08 mm (3.074 in)
Cylinder Bore Out of Round (Maximum) . . . . 0.056 mm (0.0022 in.)
Piston Pin Bore ID (Maximum) . . . . 19.080 mm (0.751 in.)
Piston Pin OD (Minimum) . . . . 18.960 mm (0.747 in.)
Top and Middle Compression Ring-To-Groove Side Clearance. . . . . 0.15 mm (0.006 in.)
Piston Ring Thickness (Top, Second) (Minimum). . . . . 1.40 mm (0.055 in.)
Top and Second Ring End Gap (Maximum). . . . . 1.0 mm (0.04 in.)
Oil Ring End Gap (Maximum) . . . . 1.2 mm (0.05 in.)
Piston OD (Minimum). . . . . 7.70 mm (3.059 in.)

Torque Specifications (Alphabetical)

Note: Use appropriate torque wrench which will read within the inch pound range given, or convert inch pounds to foot pounds as follows: Inch-pounds/12 = Foot-pounds

Air Cleaner Mounting Bolts . . . . 9.8 N•m (87 lb-in.)
Camshaft Breather Chamber Cover Bolts . . . . 20 N•m (177 lb-in.)
Carburetor to Manifold Mounting Bolts and Nuts (FD671D). . . . . 12 N•m (106 lb-in.)
Throttle Body and Intake Pipe Mounting Bolts (FD750D) . . . . 12 N•m (106 lb-in.)
Choke Valve Screw (FD671D) . . . . 0.95 N•m (8.4 lb-in.)
Throttle Valve Screw . . . . 0.90 N•m (8.0 lb-in.)
Water Temperature Sensor (FD750D) . . . . 20 N•m (177 lb-in.)
Vacuum Sensor (FD750D) . . . . 9.8 N•m (87 lb-in.)
Control Panel Mounting Bolts . . . . 5.9 N•m (52 lb-in.)
Crankcase Cover Bolts . . . . 22 N•m (195 lb-in.)
Cylinder Head Bolts (Silicone Sealant Applied . . . . 27 N•m (20 lb-ft)
Float Chamber Mounting Screw (Carburetor) . . . . 2 N•m (18 lb-in.)
Oil Drain Plug . . . . 25 N•m (221 lb-in.)
Engine Flywheel Cover Bolt (M8) . . . . 6.9 N•m (61 lb-in.)
Cooling Fan Shaft Nut . . . . 20 N•m (177 lb-in.)
Flywheel Bolt . . . . 56 N•m (41 lb-ft)
Fuel Shut Off Solenoid Valve (FD671D) Carburetor . . . . 7 N•m (61 lb-in.)
Float Chamber Mounting Screw (FD671D) Carburetor) . . . . 2 N•m (17 lb-in.)
Governor Arm Clamp Nut . . . . 8 N•m (69 lb-in.)
Ignition Coil Bolts. . . . . 3.4 N•m (30 lb-in.)
Intake Manifold Mounting Bolts . . . . 20 N•m (177 lb-in.)
Muffler Flange Nut . . . . 20 N•m (177 lb-in.)
Main Jet . . . . 0.7 N•m (6 lb-in.)
Oil Pump Cover Plate Mounting Bolts . . . . 6 N•m (52 lb-in.)
Oil Pressure Switch . . . . 15 N•m (132 lb-in.)
Rocker Arm (Valve Clearance) Adjusting Locknuts . . . . 11 N•m (96 lb-in.)
Rocker Arm Bracket Mounting Bolts . . . . 22 N•m (195 lb-in.)
Rocker Cover Mounting Bolts . . . . 6.9 N•m (61 lb-in.)

Connecting Rod Cap Bolts . . . . **21 N•m (186 lb-in.)**
Spark Plug . . . . **25 N•m (221 lb-in.)**
Starter Motor Mounting Bolts . . . . **20 N•m (177 lb-in.)**
Voltage Regulator Screws . . . . **3.4 N•m (30 lb-in.)**

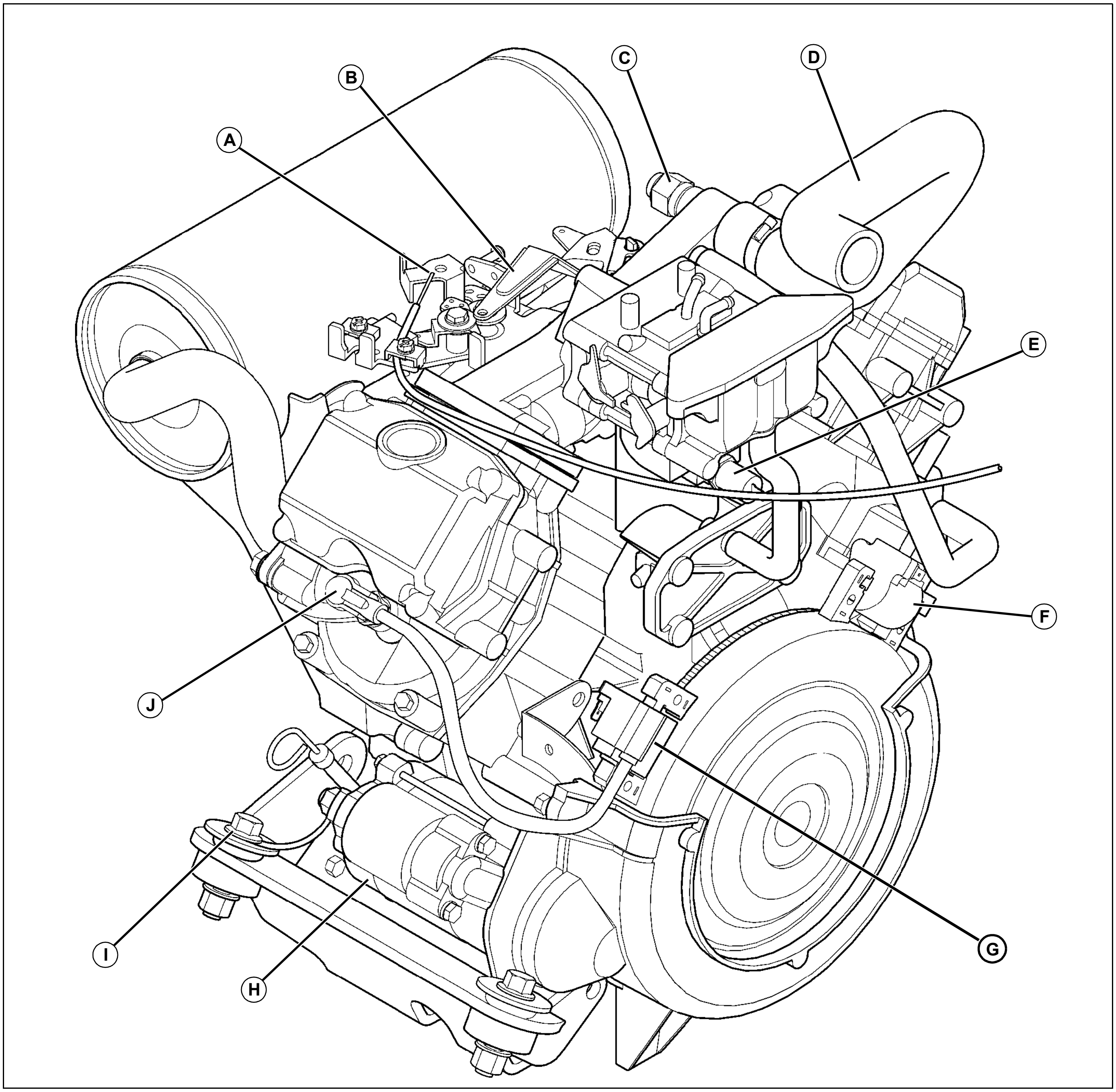
Special or Required Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Photo Tachometer	JT05719	Slow and fast idle adjustment
Cylinder Leakdown Tester	JT03502	Cylinder leakdown test
Crankcase Vacuum Test Kit	JT03503	Crankcase vacuum check
Connector Hose Assembly Pressure Gauge Assembly	JT03349 JT03017 JT03344	Oil pressure test
Compression Gauge	JDM59	Cylinder compression test
Fuel Pump Pressure Test Kit	JDG356	Fuel pump pressure test - FD671D engines
Fitting Pressure Gauge 0-400 kPa (0-60 psi) Fuel Hose	JDG41 JTO7032	Fuel pump pressure test - FD750D engines
Tension Gauge	JDST28	Fan belt tension check
Cooling System Pressure Pump Radiator Test Kit	D05104ST JDG692	Radiator cap and cooling system pressure tests
Lapping Tool		Valve lapping

Component Location

Engine (FD671D)

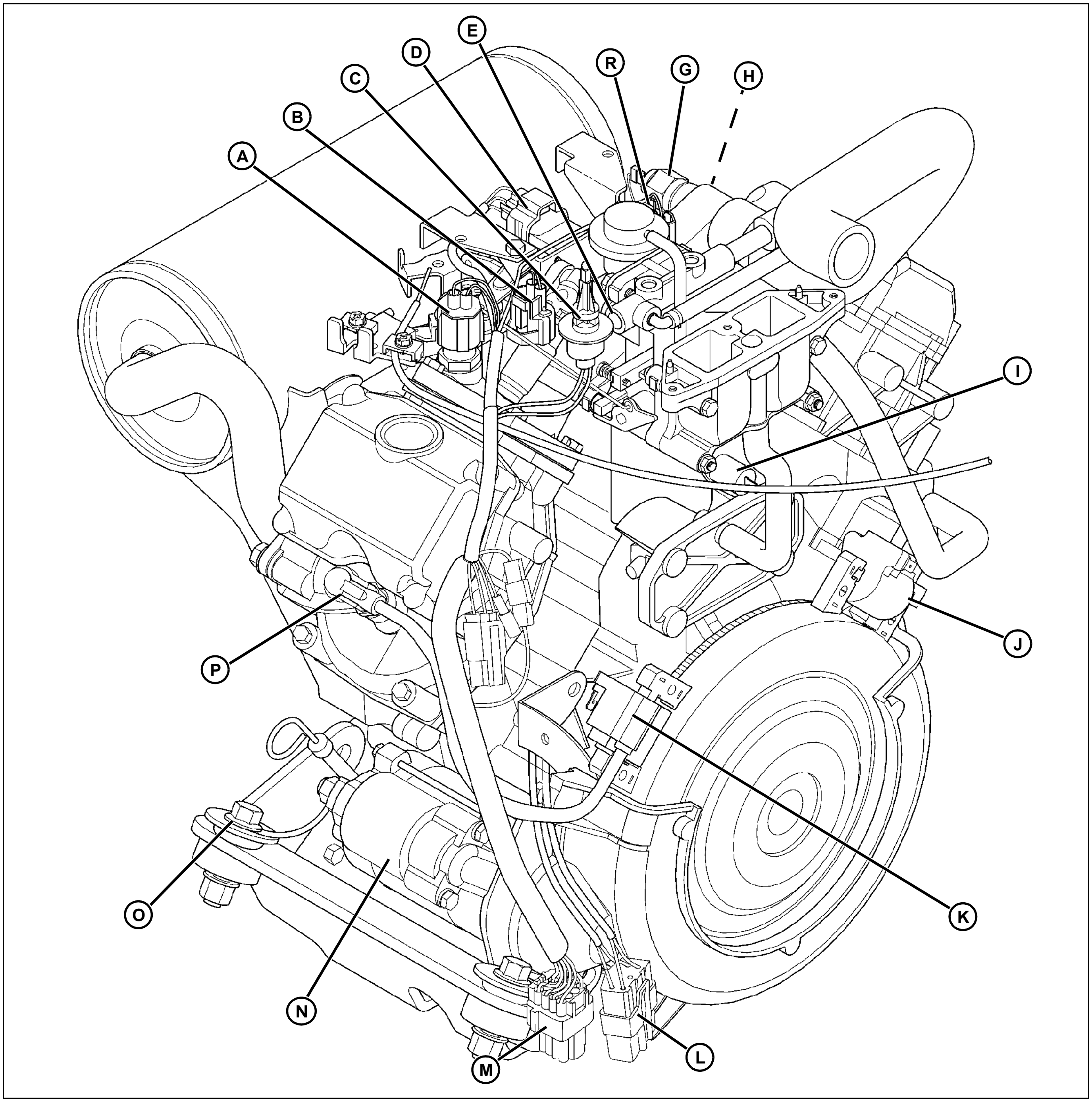


MX14278

- A- Throttle Cable
- B- Governor Arm
- C- Coolant Temperature Sensor
- D- Coolant Hose
- E- Fuel Shutoff Solenoid
- F- Ignition Module #1 Cylinder
- G- Ignition Module #2 Cylinder
- H- Starting Motor
- I- Engine Frame Ground
- J- Spark Plug #2 Cylinder

Note: Number 1 cylinder is on same side of engine as oil filter.

Engine (FD750D)



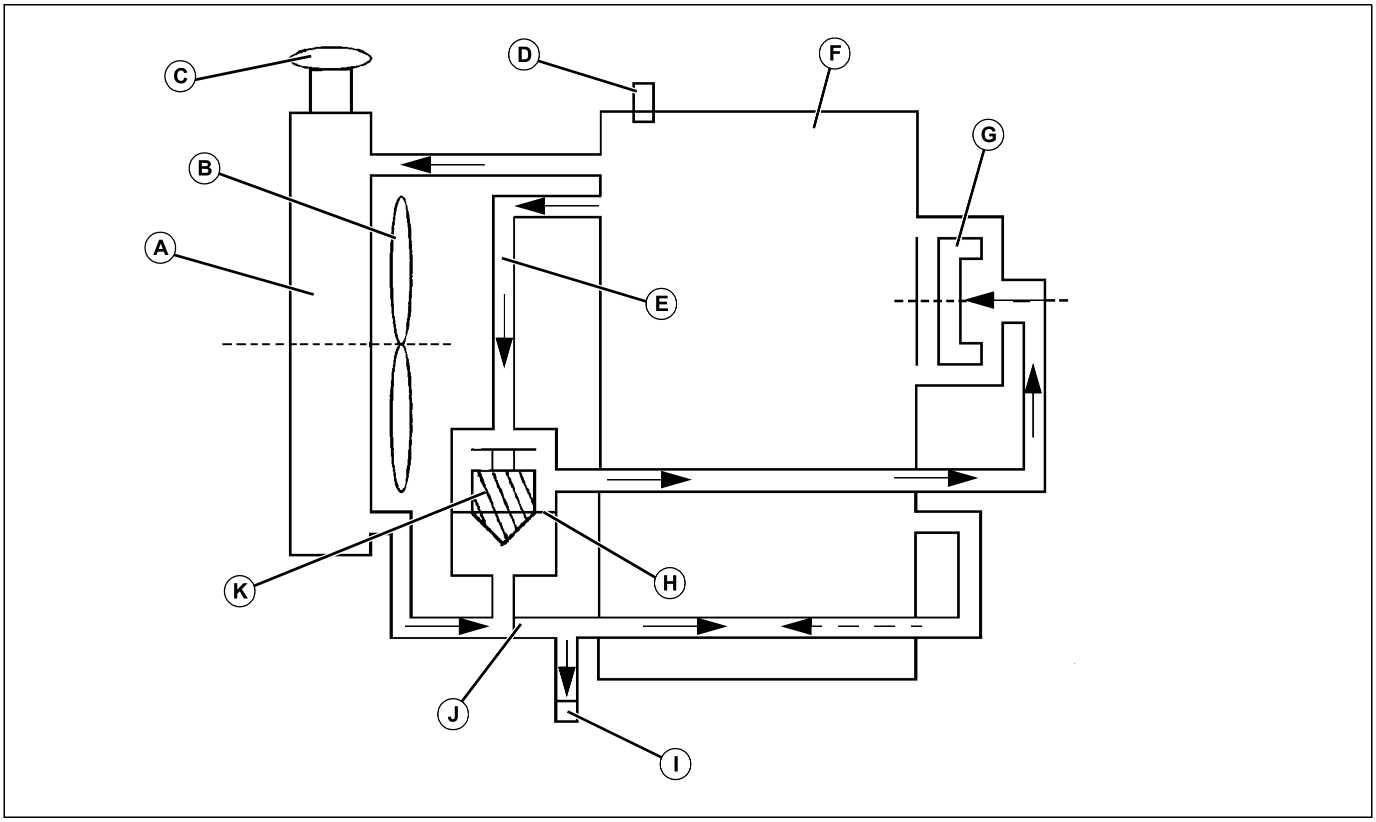
MX14312

A- Engine Coolant Temperature Sensor
B- #2 Cylinder Fuel Injector
C- Air Temperature Sensor
D- Vacuum Pressure Sensor
E- Fuel Pressure Relief Screw
F- #1 Cylinder Fuel Injector
G- Engine Coolant Temperature Sensor
H- Engine Oil Pressure Switch (RH Side)
I- Fuel Shutoff Solenoid
J- Ignition Module #1 Cylinder
K- Ignition Module #2 Cylinder
L- Wiring Harness Connector
M- Wiring Harness Connector
N- Starting Motor Solenoid
O- Frame Ground
P- Spark Plug #2 Cylinder

Note: Number 1 cylinder is on same side of engine as oil filter.

Theory of Operation

Cooling System Operation



MX14217

A- Radiator

B- Cooling Fan

C- Radiator Cap, maintains radiator pressure at 78 - 98 kPa (11.3 - 14.2 psi)

D- Thermo Switch, detects at 111°C (232°F)

E- Bypass Tube

F- Engine Body

G- Water Pump (Impeller)

H- Jiggle Valve

I- Drain Plug

J- Valve, One Way

K- Thermostat, fully open at 95°C (203°F)

Function:

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

System Operation:

The impeller-type coolant pump draws coolant from the bottom of the radiator when the thermostat is open, or from the bypass when the thermostat is closed. Coolant from the water pump flows to the water jackets in block, up through cylinder heads, intake manifold, past the coolant temperature sensor and thermostat.

When the engine temperature is below approximately 82°C (180°F), the thermostat is closed and coolant is directed back to the water pump through bypass hose to be recirculated. This allows the engine to warm up to operating temperature quickly.

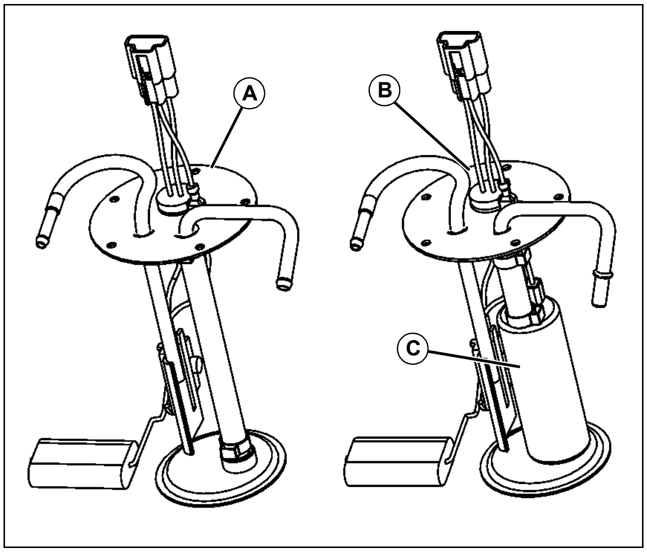
When the engine temperature is approximately 82°C (180°F), the thermostat begins to open and is fully open at 95°C (203°F). Coolant from the water jackets and cylinder heads now flow through the thermostat to the radiator, which is cooled by the radiator fan. The fan is driven by a belt off the crankshaft pulley. If the engine coolant temperature raises to 111°C (232°F), a thermo switch detects this, and turns on a warning light on the dash, warning you of a potentially dangerous overheating situation.

The radiator cap maintains a pressure of 78 - 98 kPa (11.3 - 14.2 psi) inside the radiator, which actually raises the boiling point of the coolant. The radiator cap contains a pressure valve and a vacuum valve. When the coolant is hot and pressure is above 98 kPa (14.2 psi), the pressure valve opens, allowing some coolant to flow to the recovery tank. After the engine is stopped, the coolant cools and the pressure inside the radiator decreases. The pressure difference between the radiator and recovery tank forces the vacuum valve open and some coolant from the the recovery tank flows back to the radiator.

Fuel and Air System Operation

Function:

The fuel system supplies fuel to the engine for combustion. The air intake system filters air needed for combustion.



MX14324

The fuel tank holds the fuel pick-up and fuel sensor assembly. The carburated engine has a fuel pump mounted to the side of the engine The fuel pick-up (A) consists of a fuel pick-up tube and a float type fuel sensor. The fuel pump draws fuel through the fuel pump screen. Low pressure fuel from the fuel pump flows through the fuel shut-off valve and in-line fuel filter to the carburetor. Fuel pressure is maintained at the carburetor inlet needle until the float allows more fuel in the bowl.

The fuel injected engine has pressurized fuel supplied to the engine. The fuel pick-up (B) consists of a fuel pick-up tube with an in-line electric fuel pump (C).

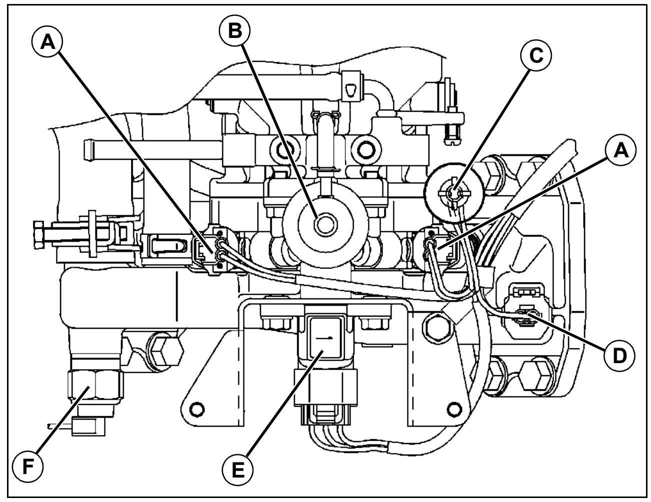
System Operation - Fuel Injection:

An electric fuel pump (C) mounted inside the fuel tank provides pressurized fuel to the carburetor. The fuel pump uses the fuel for lubrication and cooling. The fuel shutoff solenoid shuts off fuel to the main jet, preventing gas fumes from escaping into the air for emission control, while the fuel cap is vented for releasing any increased pressure within the fuel tank.

The ignition delay module is used with the fuel shut-off solenoid to prevent backfire. The ignition delay module allows the spark plugs to fire for one additional second after the key switch is turned off to burn any remaining fuel in the cylinder. When the key switch is turned off, the fuel shut-off solenoid is de-energized.

Air enters the air filter though the side panel screen and air filter inlet hose. The breather hose vents crankcase fumes into the carburetor for burning to decrease emissions.

Fuel Injection Air System Components and Operation (FD750D)



MX14223

A- Fuel Injectors
B- Fuel Pressure Regulator
C- Air Temperature Sensor
D- Water Temperature Sensor
E- Vacuum Pressure Sensor
F- Thermo Switch

Function:

The fuel injection system supplies pressurized fuel to the fuel injectors for combustion. The air intake system filters air needed for combustion.

System Operation:

An electric fuel pump mounted inside the fuel tank provides pressurized fuel to the fuel injectors (A). The fuel pump uses the fuel for lubrication and cooling. The fuel pump and fuel injectors are controlled by the fuel injection module computer. The controller monitors engine operating and environmental conditions to calculate the amount of fuel to inject. The fuel pump draws fuel through the fuel pump screen. High pressure fuel from the fuel pump flows through the in-line fuel filter to the fuel pressure regulator (B) and fuel injector. The fuel injector is a solenoid operated type valve with single point injection. Fuel is injected into the throttle body when the solenoid is energized by the controller. Fuel pressure is controlled by the fuel pressure regulator. The regulator is an overflow type regulator that maintains fuel pressure at the fuel injector at a constant 175 kPa (25 psi). Excess fuel flows through the regulator valve and fuel return hose to the fuel tank. The fuel shutoff solenoid shuts off fuel to the main jet, preventing gas fumes from escaping into the air for emission control, while the fuel cap is vented for releasing any increased pressure within the fuel tank

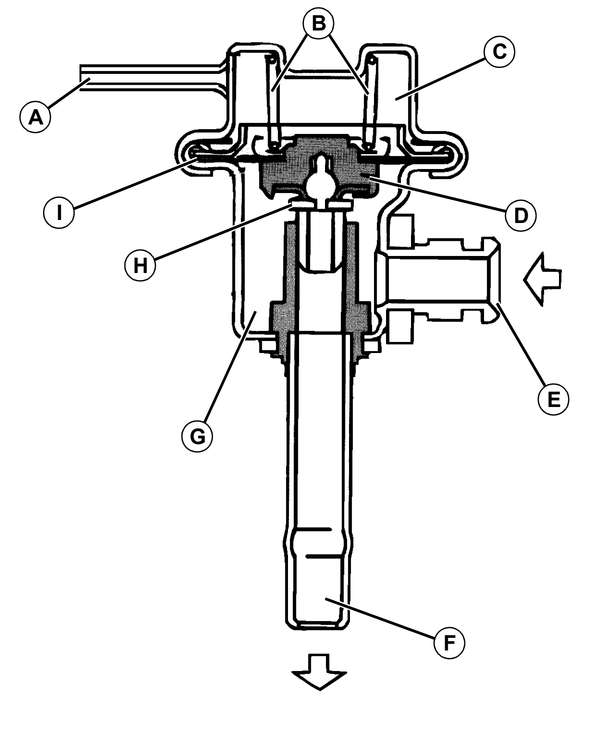
The throttle control lever, which is connected to the throttle lever and the governor lever, controls engine rpm. The governor lever is connected to the throttle valve inside the throttle body. Slow idle is adjusted by turning the slow idle stop screw and fast idle is adjusted by moving the throttle control plate.

Air enters the air filter through the side panel screen and air filter inlet hose. The primary and secondary elements filter the air before entering the throttle body. The breather hose vents crankcase fumes into the throttle body for burning to decrease emissions. A small amount is always present due to some restriction of air movement through the filter elements. The vacuum increases as the filter elements become plugged.

Fuel Pressure Regulator Operation (FD750D)

Function:

Maintains a constant differential in pressure between fuel pressure at the injector and air pressure in the throttle body. Therefore, the amount of fuel injected is determined by the opening time of the injector.



M45334

A- To Throttle Body
B- Spring
C- Spring Chamber
D- Valve Support
E- Inlet from Injector
F- Return to Tank
G- Fuel Chamber
H- Valve
I- Diaphragm

System Operation:

The pressure regulator is an overflow type of regulator. The spring chamber is connected to the throttle body to insure that they are operating at the same air pressure. High pressure fuel from the injector flows to the pressure regulator inlet and fills the fuel chamber. A hose from the vacuum inlet is connected to the intake manifold. This allows the air pressure in the spring chamber and intake manifold to be equal.

When intake manifold vacuum increases, the spring chamber vacuum also increase and overcomes spring tension, allowing the diaphragm to move upward. With the valve connected to the diaphragm, the valve moves upward and allows more fuel to flow out of the outlet and return to the fuel tank. This lowers the fuel pressure. As intake manifold vacuum decreases, the spring chamber vacuum decreases and the spring returns the diaphragm to the original position. The valve restricts fuel flow to return and fuel pressure increases.

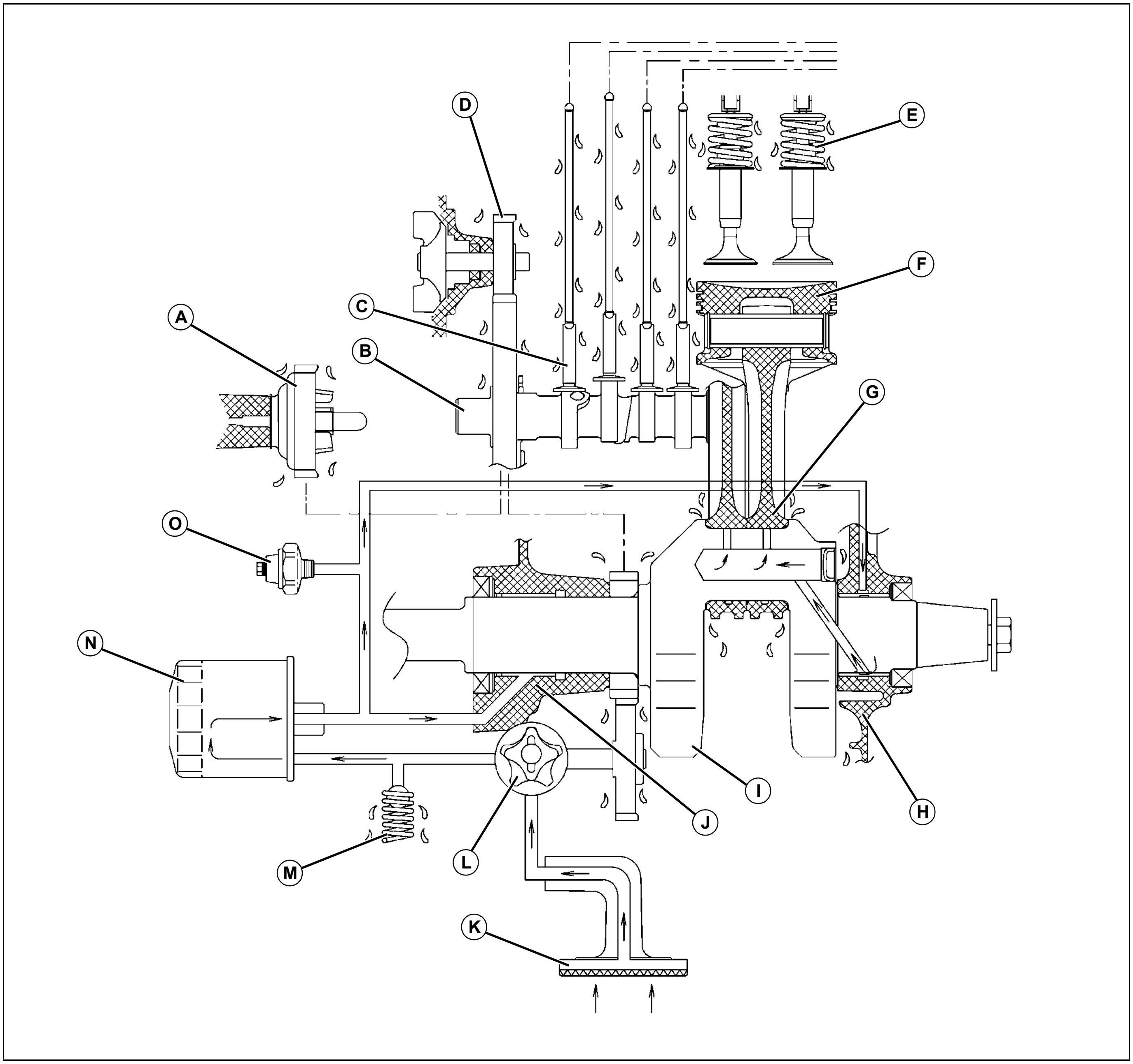
Governor Operation

System Operation:

The governor controls engine speed. Governed engine speed is a balance between governor spring tension, set by the throttle control, and actual engine speed, countered by centrifugal force of the governor flyweights. As tension is applied to governor spring, governor linkage opens carburetor/fuel injection throttle shaft and plate, increasing engine rpm. As the engine speed increases, flyweight assembly (driven by the crankshaft gear) pushes on governor arm, rotating governor shaft and lever, moving throttle shaft, closing throttle plate slightly and reducing rpm to governed operating speed. If a heavy load is encountered, engine speed drops, as does the governor assembly speed. Flyweights retract and allow shaft arm to move governor shaft and lever in opposite direction to open throttle plate and allow more air into venturi to draw in more fuel until engine peak operating speed is recovered. Springs provide a smooth yet responsive transitional control.

Important: Avoid Damage! Flyweight assembly shaft is pressed into crankcase cover and is <u>not serviceable</u>. Therefore, if it is damaged or pulled loose, the crankcase cover MUST BE replaced.

Lubrication System Operation



MX14218

System Operation:

A positive displacement gerotor pump (L) is used to pressurize the lubrication system. The lubrication system is protected by an oil pressure relief valve (M), low pressure switch (O), and an oil filter (N) with bypass.

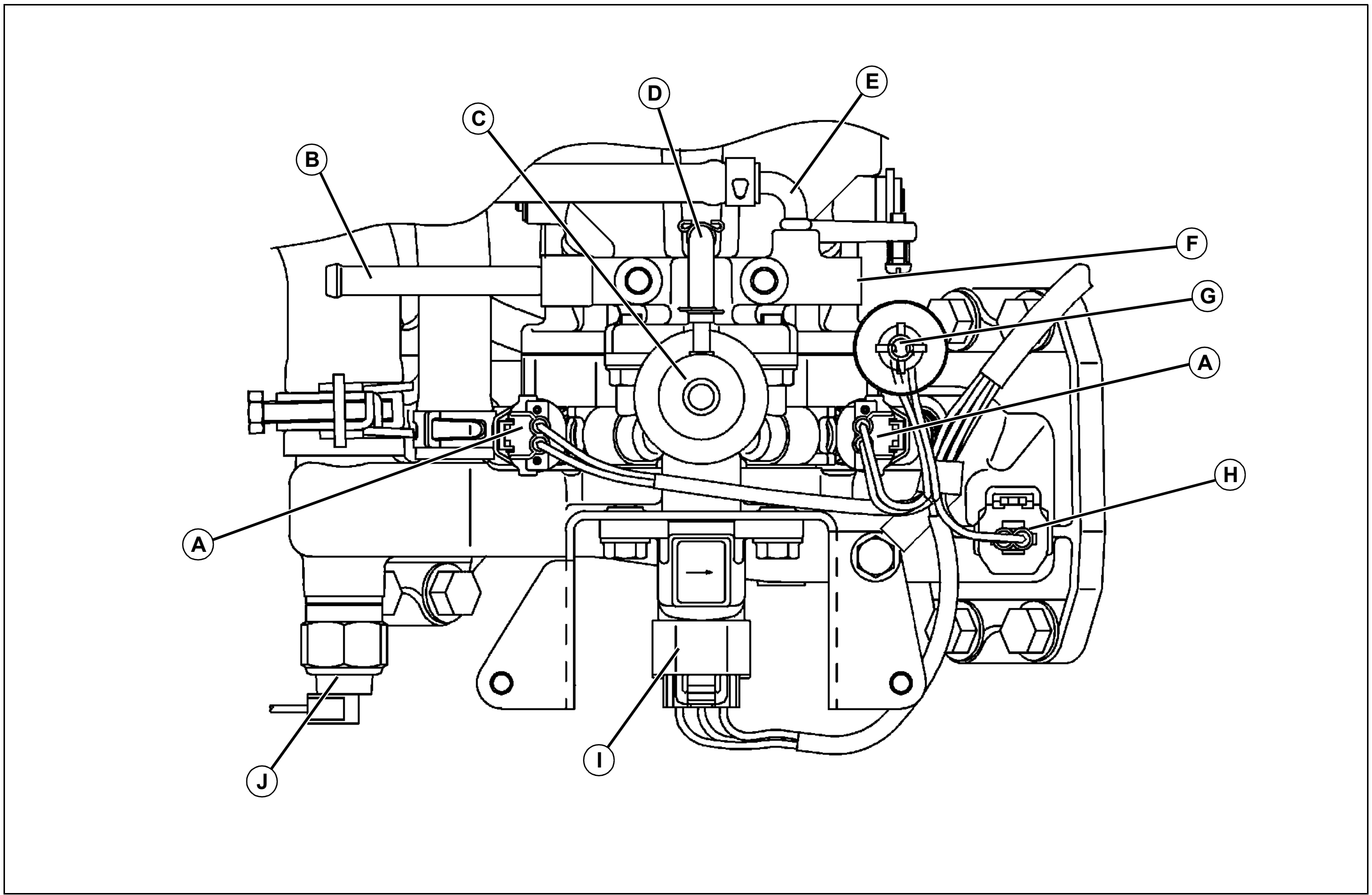
The oil pump (L) draws oil from the sump through a filter screen (K). Pressure oil from the pump flows to the oil pressure relief valve (M). Oil pressure reading should be **276 kPa (40 psi) minimum**. If oil pressure exceeds **310 kPa (45 psi)**, the relief valve (M) opens allowing oil to return to sump. The relief valve is not adjustable.

Pressure oil from the relief valve flows to the oil filter (N). The filter contains a bypass valve, which opens if the element becomes plugged to insure engine lubrication.

An oil pressure switch (O) mounted above the oil filter turns on a warning light if oil pressure is below **98 kPa (14.2 psi)**. Filtered pressure oil flows through a passage in the oil sump to the crankshaft main bearing (J) (PTO side).

Drilled passages in the crankshaft (I) distribute oil from the main bearing to the connecting rod (G) journals and crankshaft main bearing (H) (flywheel side). A drilled passage in the connecting rods allows oil from the connoting rod journal to lubricate the piston (F) and cylinder walls and camshaft (B), tappets (C), governor gear (A), water pump gear (D) and rocker arms and valves (E).

Throttle Body Operation (FD750D)



MX14223

A- Fuel Injectors
B- Fuel Inlet
C- Fuel Pressure Regulator
D- Vacuum Hose
E- Fuel Return Hose
F- Fuel Pressure Relief Screw
G- Air Temperature Sensor
H- Water Temperature Sensor
I- Vacuum Pressure Sensor
J- Thermo Switch

Function:

Injects and atomizes the fuel into the intake air for the proper combustion.

System Operation:

An electric fuel pump, controlled by the computer, supplies fuel to the inlet (B) of the throttle body to the injector. The fuel pressure regulator holds the fuel under pressure in the injectors (A). The computer receives signals from the throttle sensor and other sensors then controls the time the injector is open. The injector injects the atomized fuel into the throat of the throttle body.

Excess fuel not used by the injector flows through the pressure regulator (C) back to the fuel tank.

The FD750D has an extra passage [fuel pressure relief screw (F)] in the throttle body that allows for a means to relieve the fuel pressure in the fuel lines before any work is done on the system.

Diagnostics

Engine Diagnosis

Caution: Avoid Injury! Engine radiator fluid is extremely hot during operation. The engine may start to rotate at any time. Keep hands away from all moving parts when testing.

Symptom: Engine Starting Problems

Problem	Cause - Solution
1. Engine will not crank?	a. No: Go to next step. b. Yes: Battery weak or discharged. Fusible link defective. Check key switch or wiring. Starter solenoid defective. Starter motor defective.
2. Engine will not start; plug wet?	a. No: Go to next step. b. Yes: Mixture too rich. Clean under engine shrouding. Check spark plug gap and spark (see Electrical section). Inlet needle and seat sticking (FD671D engine). Clean carburetor (FD671D engine).
3. Engine is hard to start when cold?	a. No: For additional tests, see “Engine Tests” on page 38. b. Yes: Mixture too rich. Mixture too lean. Clean under engine shrouding. Choke is not completely shut, adjust choke (FD671D engine). Inlet needle and seat sticking (FD671D engine). Clean carburetor (FD671D engine).

Symptom: Engine Starting Problems

Problem	Cause - Solution
4. Engine cranks but will not start?	a. No: Go to next step. b. Yes: Battery weak or discharged. Fuel shut-off valve closed (in-line valve). Fuel shut-off solenoid not allowing fuel into main jet (FD671D engine). Fuel shut-off solenoid not allowing fuel into fuel injector (FD750D engine). Improper use of choke (FD671D engine). Float level too high (FD671D engine). Check spark (See Electrical section). Weak or faulty spark plug. Faulty high tension leads. Faulty ignition module (FD671D engine). Faulty fuel injection module (FD750D engine). Faulty ignition coil. Faulty pulsar coil. Contaminated fuel or faulty fuel supply system. Defective fuel pump. Air being drawn in through a hole in fuel line(s). Clogged fuel line or filter. Fuel tank vent line clogged. Air filter restricted. Defective head gasket. Cylinder head loose. Broken valve spring. Warped cylinder head. Poor compression. Worn piston/piston rings stuck or not seated. Worn cylinder bore. Worn or burned valves, or improper clearance.

Symptom: Engine Performance Problems

Problem	Cause - Solution
1. Loss of power?	a. No: Go to next step.
	b. Yes: Low oil level. Too much oil in crankcase. Carburetor out of adjustment (FD671D engine). Air/Fuel passages plugged. Carbon deposits in exhaust pipe/ muffler. Carbon deposits in combustion chamber. Weak or faulty spark plug. Faulty high tension leads. Faulty ignition module (FD671D engine). Faulty fuel injection module (FD750D engine). Faulty ignition coil. Faulty pulsar coil. Contaminated fuel or faulty fuel supply system. Defective fuel pump. Air being drawn in through a hole in fuel line(s). Clogged fuel line or filter. Fuel tank vent line clogged. Vapor lock. Air filter restricted. Defective breather valve. Cylinder head loose. Mixture too lean. Check and clean air cleaner. Adjust idle mixture and check engine performance (FD671D engine). Choke is not completely open, adjust choke (FD671D engine). Clean carburetor (FD671D engine). Worn or burned valves, or improper clearance. Broken valve spring. Warped cylinder head. Defective head gasket. Poor compression. Worn piston/piston rings stuck or not seated. Worn cylinder bore.

Symptom: Engine Performance Problems

Problem	Cause - Solution
2. Engine runs erratically?	a. No: Go to next step.
	b. Yes: Carburetor out of adjustment (FD671D engine). Lack of coolant. Governor linkage out of adjustment. Faulty governor spring. Governor gear assembly binding or broken. Check spark (See Electrical section). Carburetor flange loose or leaking at gasket (FD671D engine). Throttle body flange loose or leaking at gasket (FD750D engine). Carburetor body and throttle shaft worn (FD671D engine). Throttle body and throttle shaft worn (FD750D engine). Weak or faulty spark plug. Faulty high tension leads. Faulty ignition module (FD671D engine). Faulty fuel injection module (FD750D engine). Faulty ignition coil. Faulty pulsar coil. Contaminated fuel or faulty fuel supply system. Defective fuel pump. Air being drawn in through a hole in fuel line(s). Clogged fuel line or filter. Fuel tank vent line clogged. Vapor lock. Oil leakage around governor shaft. Defective oil seal.
3. Engine misses at high rpm?	a. No: Go to next step.
	b. Yes: Check spark (See Electrical section). Weak or faulty spark plug. Faulty high tension leads. Faulty ignition module (FD671D engine). Faulty fuel injection module (FD750D engine). Faulty ignition coil. Faulty pulsar coil. Carburetor out of adjustment (FD671D engine). Clogged fuel line or filter. Fuel tank vent line clogged. Defective fuel pump. Warped cylinder head.

Symptom: Engine Performance Problems

Problem	Cause - Solution
4. Engine misses at low rpm?	a. No: Go to next step. b. Yes: Carburetor out of adjustment (FD671D engine). Air/Fuel passages plugged. Air being drawn through carburetor or intake manifold flanges (FD671D engine). Air being drawn through throttle body or intake manifold flanges (FD750D engine). Incorrect timing gear alignment. Check spark (See Electrical section). Weak or faulty spark plug. Faulty high tension leads. Faulty ignition module (FD671D engine). Faulty fuel injection module (FD750D engine). Faulty ignition coil. Faulty pulsar coil. Worn or burned valves, or improper clearance. Warped cylinder head.
5. Engine rpm low or engine stalls?	a. No: Go to next step. b. Yes: Battery weak or discharged.
6. Engine speed unstable (surging)?	a. No: Go to next step. b. Yes: Mixture too lean. Clean under engine shrouding. Adjust idle mixture and check engine performance (FD671D engine). Clean carburetor (FD671D engine).
7. Engine is sluggish?	a. No: Go to next step. b. Yes: Mixture too rich. Check and clean air cleaner. Adjust idle mixture and check engine performance (FD671D engine). Choke is not completely open, adjust choke (FD671D engine). Clean carburetor (FD671D engine).
8. Black, smoky exhaust?	a. No: Go to next step. b. Yes: Check spark plug gap and spark (see Electrical section). Mixture too rich. Check and clean air cleaner. Choke is not completely open, adjust choke (FD671D engine).

Symptom: Engine Performance Problems

Problem	Cause - Solution
9. Spark plug fouled black?	a. No: Go to next step. b. Yes: Check spark plug gap and spark (see Electrical section). Mixture too rich. Check and clean air cleaner. Adjust idle mixture and check engine performance (FD671D engine). Choke is not completely open, adjust choke (FD671D engine). Inlet needle and seat sticking (FD671D engine).
10. Spark plug burned white?	a. No: Go to next step. b. Yes: Check spark plug gap and spark (see Electrical section). Mixture too lean. Clean under engine shrouding. Clean carburetor (FD671D engine).
11. Runs better without air cleaner?	a. No: Go to next step. b. Yes: Mixture too rich. Check and clean air cleaner.
12. Runs worse when warm?	a. No: Go to next step. b. Yes: Mixture too rich. Check and clean air cleaner. Adjust idle mixture and check engine performance (FD671D engine). Choke is not completely open, adjust choke (FD671D engine). Inlet needle and seat sticking (FD671D engine).
13. Engine overheats?	a. No: Go to next step. b. Yes: Mixture too lean. Clean under engine shrouding. Water pump nylon impeller defective.
14. Engine backfires?	a. No: Go to next step. b. Yes: Carburetor out of adjustment (FD671D engine). Check spark (See Electrical section). Faulty pulsar coil. Air being drawn in through a hole in fuel line(s). Cylinder head loose. Warped cylinder head. Defective head gasket. Intake valve burned or sticking.

Symptom: Engine Performance Problems

Problem	Cause - Solution
15. Engine knocks?	a. No: Go to next step.
	b. Yes: Excessive engine load. Faulty ignition module (FD671D engine). Faulty fuel injection module (FD750D engine). Contaminated fuel or faulty fuel supply system. Defective head gasket.
16. Engine overheats?	a. No: For additional tests, see “Engine Tests” on page 38.
	b. Yes: Lack of coolant. Excessive engine load. Fan belt slippage. Defective radiator hose or clamp. Improper or defective radiator cap. Broken or missing fan shroud. Defective radiator. Loose stud bolts and cap screw. Cracked or porous casting. Damaged water pump seals. Improperly installed gasket. Warped cylinder head. Broken valve spring. Defective head gasket. Worn or burned valves, or improper clearance.

Symptom: Engine fuel/oil/coolant problems

Problem	Cause - Solution
1. Coolant leakage?	a. No: For additional tests, see “Engine Tests” on page 38.
	b. Yes: Lack of coolant. Improper or defective radiator cap. Defective radiator hose or clamp. Defective radiator. Cracked or porous casting. Loose stud bolts and cap screw. Engine overheating. Damaged water pump seals. Improperly installed gasket. Cylinder head loose.

Symptom: Engine fuel/oil/coolant problems

Problem	Cause - Solution
2. Excessive oil consumption?	a. No: Go to next step.
	b. Yes: Too much oil in crankcase. Incorrect oil viscosity. Drain-back in breather chamber plugged. Defective breather valve. Worn valve stems(s) or valve guide(s). Plugged oil ring groove. Poor compression. Worn piston/piston rings stuck or not seated. Worn cylinder bore.
3. Excessive fuel consumption?	a. No: Go to next step.
	b. Yes: Check spark (See Electrical section). Weak or faulty spark plug. Faulty high tension leads. Faulty ignition module (FD671D engine). Faulty fuel injection module (FD750D engine). Faulty ignition coil. Faulty pulsar coil. Improper use of choke (FD671D engine). Air filter restricted. Carburetor out of adjustment (FD671D engine). Float level too high (FD671D engine). Cylinder head loose. Broken valve spring. Worn or burned valves, or improper clearance. Poor compression. Worn piston/piston rings stuck or not seated. Worn cylinder bore.

Engine Tests

Test Procedure - A:

Test Conditions:

- Machine parked on level surface.
- PTO Switch off
- Key switch off unless indicated otherwise.
- Spark plug connected to D-05351ST Spark Tester

Engine

1. When checking dipstick, oil at proper level and viscosity? No leakage? Clean oil and filter?

Yes: Go to next step.

No: Change oil and inspect for source of contamination.

No: Change oil filter.

No: Check gaskets, seals, plugs, cylinder head, block, and intake manifold and breather.

2. Air filter outlet hose not cracked; clamps tight?

Yes: Go to next step.

No: Replace hose and/or tighten clamps.

3. Air filter elements not plugged? Air filter housing sealed; no dirt tracking inside filter element?

Yes: Go to next step.

No: Replace element or housing.

4. Air filter restriction indicator not leaking?

Yes: Go to next step.

No: Replace indicator.

5. Does fuel shutoff solenoid pull in and stay in when key is returned to “ON”? (Listen for clicking as key is cycled.)

Yes: Go to next step.

No: If solenoid will not pull in and hold in, see Fuel Shutoff Solenoid Circuit Diagnosis in Electrical section.

6. Check hand throttle control lever linkage. Full movement of governor control arm from idle to full speed?

Yes: Go to next step.

No: Repair; replace or adjust linkage.

7. Check intake and exhaust valves. Valve clearance within specification (engine cold)? Valves not sticking?

Yes: Go to next step.

No: Adjust valves. See “Tests and Adjustments” in this section.

No: Check valve guides and stems.

8. Is fuel is reaching injectors (FD750D)? (Crack fuel injection lines at injectors. Crank engine. Be sure fuel shutoff solenoid has pulled in. Fuel leaks out.)

Yes: Go to next step.

No: No fuel present: Check fuel shutoff valve is open, fuel level in tank, inspect filter/separator element. Test fuel pump.

9. Check flywheel and starting motor: Minimum cranking rpm within specification?

Yes: Go to next step.

No: See “Starter Amp Draw Test” in Electrical section.

10. Carburetor choke and governor linkage, (FD671D). Linkage not binding and adjusted correctly?

Yes: Go to next step.

No: Repair, replace or adjust linkage.

11. Carburetor - fuel filter, fuel pump, and carburetor bowl drain screw (key switch on), (FD671D). Fuel level increases in filter? Fuel pump operating - listen for humming sound near fuel cap? Fuel present in float bowl when screw is opened?

Yes: Go to next step.

No: See “Shutoff Circuit Diagnosis” in the Electrical section.

No: Test fuel pump pressure and flow.

No: Check carburetor for debris.

12. Fuel injection pump static timing test, (FD750D). Timing should be correct? (Remove pump as the LAST possible solution.)

Yes: Go to next step.

No: Have injection pump static timing adjustment performed by a qualified service repair shop. See “Tests and Adjustments” in this section.

13. Carburetor/Throttle body (engine running). Low idle at 1550 rpm? High idle at 3600 rpm?

Yes: Go to next step.

No: See “Low Idle Speed Adjustment” on page 42 and “High Idle Speed Adjustment” on page 42 in this section.

14. Engine runs smoothly through out rpm range with low smoke and good power?

Yes: Go to next step.

No: Adjust governor.

15. Test oil pressure switch port. Minimum oil pressure

within specifications?

Yes: Go to next step.

No: Test engine oil pressure. (See “Engine Oil Pressure Test” on page 46 in this section.)

16. Thermostat opening temperature within specifications?

Yes: Go to next step.

No: Perform thermostat opening test. See “Tests and Adjustments” in this section.

17. Muffler not restricted?

Yes: Go to next step.

No: Replace muffler.

18. When performing cylinder compression test: Cylinder compression within specification? Pressure difference between cylinders within specification?

Yes: Engine tests completed.

No: Rebuild engine.

Coolant tank and radiator

1. Coolant level between marks on tank when engine is warm? Coolant in radiator full to top?

Yes: Go to next step.

No: Add proper coolant mix.

2. Coolant not contaminated with oil, fuel or discolored brown?

Yes: Go to next step

No: Drain and flush system. Check for source of contamination.

3. Radiator screen free of debris?

Yes: Go to next step.

No: Clean or replace.

4. Hoses not cracked or leaking; clamps and radiator cap tight?

Yes: Go to next step.

No: Pressure test radiator and cap.

5. Water pump/alternator belt tight; not glazed or cracked?

Yes: Go to next step.

No: Replace and adjust belt tension.

6. Fan blades not damaged or warped?

Yes: Coolant tests completed.

No: Replace fan.

Fuel tank, pump, lines and filter

1. Fuel level correct; not contaminated or stale smelling; no water in fuel?

Yes: Go to next step.

No: Drain and clean fuel tank. Add fresh fuel.

2. Fuel pump filter and in-line filter free of debris?

Yes: Go to next step.

No: Replace filters.

3. Fuel hoses not cracked or leaking?

Yes: Go to next step.

No: Replace.

4. Fuel hose clamps tight?

Yes: Go to next step.

No: Replace or tighten.

5. Fuel tank does not have vacuum?

Yes: Fuel tank, pump, lines and filter tests completed.

No: Replace vented fuel cap.

Tests and Adjustments

Throttle Lever Adjustment

Reason:

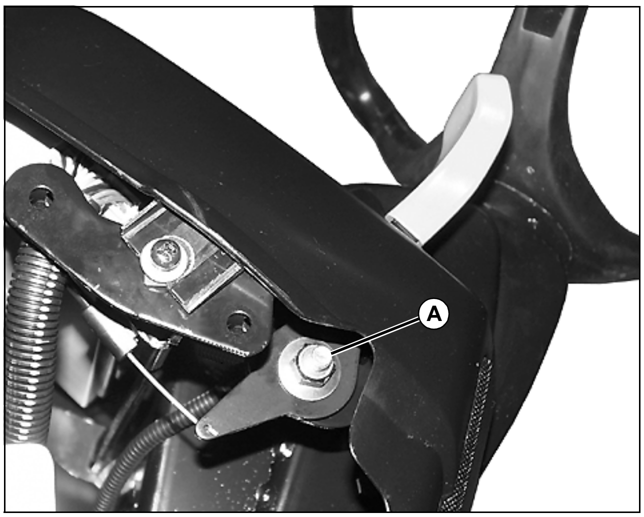
To achieve smooth throttle lever movement with enough tension to maintain throttle setting.

Test Equipment:

- Spring Scale

Procedure:

1. Connect a scale near the end of the throttle lever.
2. Move throttle lever to slow idle position.



MX14234A

3. Adjust friction disks by tightening or loosening lock nut (A) until throttle lever movement in forward direction is **18 - 35 N (4 - 8 lb force)**.

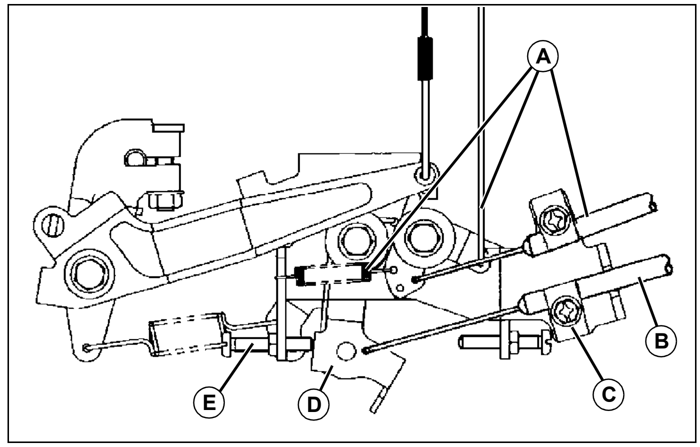
Note: Make sure throttle cable is not binding or stuck.

Throttle Cable Adjustment

Reason:

To insure that the throttle lever cable moves the governor linkage from slow to fast idle position.

Procedure:



MX14227

Picture Note: FD671D engine shown; FD750D engine does not have choke assembly parts (A).

1. Set the throttle lever in the slow idle position. Check that the throttle control lever (D) contacts the idle speed adjustment screw (E) at the slowest throttle lever setting.

2. If the throttle control lever (D) is not touching the screw (E) at the slowest setting, loosen the throttle cable clamp (C). Pull throttle cable (B) to left. When the control lever contacts the control plate idle adjustment screw, retighten the cable clamp.

3. Set the throttle lever to the fastest idle position and check that the throttle control lever is advancing to the full open position.

4. If the control lever is not advancing to the fully open position, loosen the cable clamp and readjust cable.

5. If the cable cannot be adjusted to obtain a fully open throttle lever position at fastest idle while maintaining contact with the adjustment screw at lowest idle position, it will be necessary to adjust the control plate idle speed adjustment screw.

6. Turn the idle adjustment screw (E) clockwise until it contacts the throttle control lever when set in the slow idle position. After completing the idle screw adjustment, check to make certain the motor is maintaining a 1550 RPM governed low idle setting. Follow the Low Idle Speed Adjustment sequence in this chapter if corrections are necessary.

Choke Adjustment (FD671D)

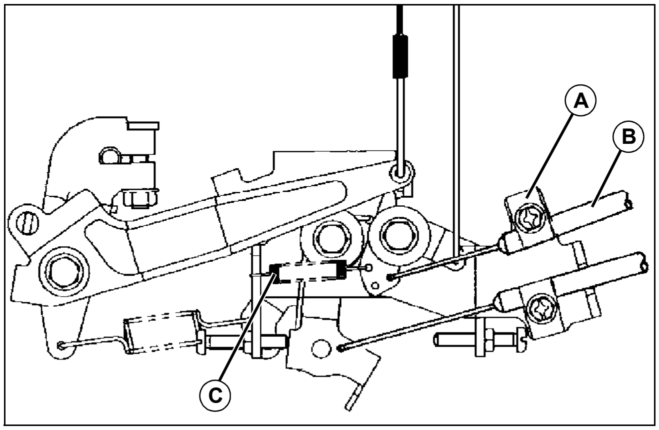
Reason:

To make sure the choke plate is fully closed when the choke lever is in the full choke position. Correct adjustment also makes sure choke is completely open in the fast idle position.

Procedure:

Note: Adjust throttle cable before adjusting choke.

1. Remove air cleaner assembly.
2. Move choke lever forward to full choke position and check that choke butterfly in carburetor is fully closed.



MX14227

3. If adjustment is necessary, loosen the choke cable clamp (A) and move the cable (B) to obtain a fully closed position. Retighten the cable clamp.
4. Release the choke lever and make certain the return spring (C) on the governor control plate is returning the choke butterfly to the fully open position.
5. Reinstall air cleaner assembly and check choke operation while starting machine.

Governor Adjustment

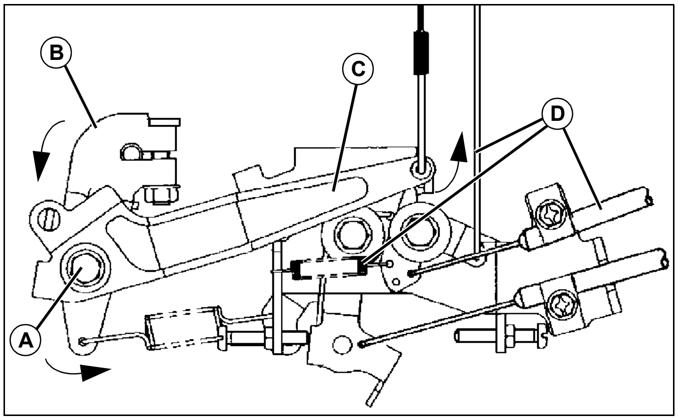
Reason:

To make sure the governor shaft contacts the flyweight plunger when the engine is stopped.

Note: Adjust throttle cable before adjusting governor linkage.

Procedure:

Note: It is not necessary to remove the throttle or choke cables from the governor plate assembly to reach the governor arm. The governor plate can be swung away with the cables installed when accessing the governor arm components.



MX14227

Picture Note: FD671D engine shown; FD750D engine does not have choke assembly parts (D).

1. Loosen bolt (A), and fully turn the bracket (B) counterclockwise and hold it there.
2. Turn the top end of the governor arm (C) counterclockwise to fully open the carburetor/EFI throttle valve and tighten the bolt (A).

Low Idle Speed Adjustment

Reason:

To set engine slow idle mixture rpm.

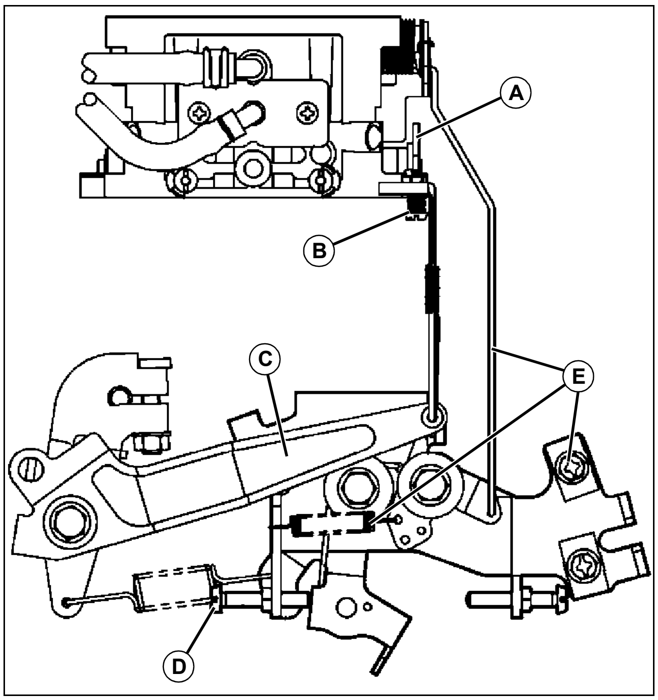
Equipment:

- JTO5719 Photo Tachometer

Procedure:

1. Disconnect all external loads from engine.
2. Put reflective tape on blower housing screen.
3. Start and run engine at MEDIUM idle for five minutes.

Caution: Avoid Injury! Engine will be HOT. Be careful not to burn skin.



Picture Note: FD671D engine shown; FD750D engine does not have choke assembly parts (E).

4. Move throttle lever on dash to idle position. Hold the throttle lever (A) on the carburetor in the closed position, turn governor arm (C) clockwise all the way.

5. Adjust the low idle speed screw (B) until the engine idles at 1450 rpm (carburetor idle rpm). Use the photo tachometer to check engine rpm at the blower housing screen.

6. Release the throttle lever and adjust the low idle speed set screw (D) on the control plate to obtain a 1550 rpm governed low idle speed.

High Idle Speed Adjustment

Reason:

To set engine high idle mixture and rpm.

Equipment:

- JTO5719 Photo Tachometer

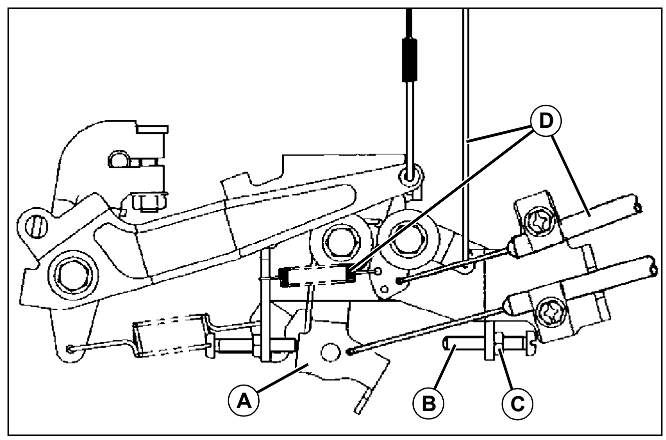
Procedure:

Note: High idle speed adjustment should be made after the low idle speed adjustment is performed.

Caution: Avoid Injury! Always keep hands clear of moving parts.

1. Start and run engine at MEDIUM idle for five minutes.

Important: Avoid Damage! Do Not adjust high idle speed with air cleaner removed.



Picture Note: FD671D engine shown; FD750D engine does not have choke assembly parts (D).

2. Loosen the lock nut (C), and unscrew the high idle set screw (B) a few turns.

3. Use a photo tachometer to check engine rpm at the blower housing screen.

4. Move the throttle lever on dash to obtain the a **3600 RPM** high idle speed and leave it there.

5. Turn the high idle set screw (B) so that the end of it just touches the speed control lever (A). Tighten the lock nut (C).

6. Recheck the idle speed and readjust if necessary.

Specifications:

High idle setting . . . . 3550 rpm
Carburetor idle setting. 1450 rpm
Governed idle setting . . . . 1600 rpm

Note: For high altitude operation above 4000 feet, use high altitude carburetor kit, to prevent over rich fuel mixture and black exhaust smoke.

Compression Test

Reason:

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

Test Equipment:

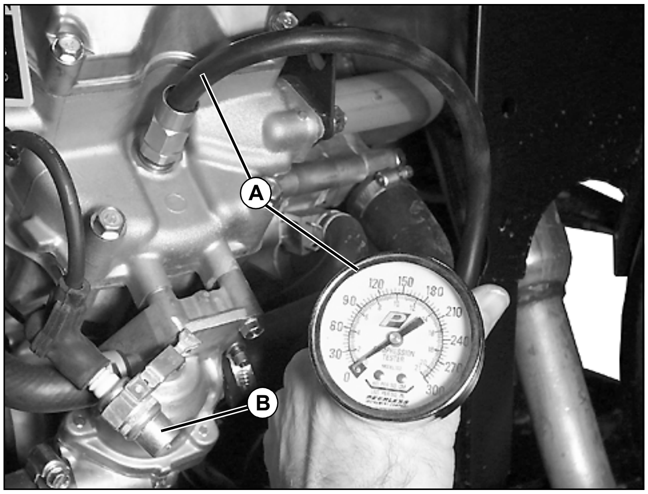
- JDM59 Compression Gauge

Procedure:

1. Adjust valve clearance to **0.15 mm (0.006 in.)** with engine at top dead center (TDC) compression stroke. Engine must be "cold" (shop temperature, about 60 - 85°F (16 - 30°C). See "Valve Clearance Adjustment" on page 43 for procedure.

Note: Be sure the battery is fully charged before performing procedure.

2. Run engine until it reaches operating temperature (thermostat opens, and both radiator hoses hot).



MX14235

3. Stop the engine, remove both spark plugs, and ground leads to block or use a spark tester (B).

4. Attach the compression gauge assembly (A) firmly into one plug hole.

5. Put throttle lever in fast idle (wide open) position. On FD671D engines, choke must be properly adjusted and fully open. Air filter must be clean.

Important: Avoid Damage! DO NOT overheat starting motor during test. Starter duty is 5 seconds one, 10 seconds off. Additionally, if throttle lever is left in slow idle position (air flow into carburetor restricted), compression could read up to 483 kPa (70 psi) below specification.

6. Crank hot engine until highest compression reading is obtained.

7. Record pressure readings for each cylinder.

Specifications:

Minimum Compression . . . . 620 kPa (90 psi)

Results:

- If pressure readings are above specification, adjust valves and check fuel and intake air systems. Check exhaust for restriction.
- If pressure readings are below specification, squirt clean engine oil into cylinders and repeat test.
- If pressure increases significantly, check piston rings and cylinder walls for wear or damage.
- If pressure does NOT increase after retest, check for leaking valves, valve seats or cylinder head gaskets.
- Install spark plugs and reconnect ignition coils when finished with testing procedure.

Valve Clearance Adjustment

Reason:

Check and adjust valve clearance for proper engine operation.

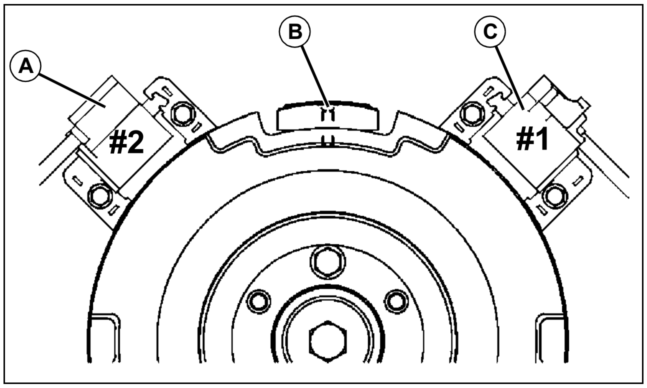
Important: Avoid Damage! Perform valve clearance measurement or adjustment when the engine is at room temperature, 16 - 27°C (60 - 80°F). Proper valve clearance is essential for the engine to operate properly. Check valve clearance for each cylinder separately.

Procedure:

1. Remove spark plugs.

2. Remove valve covers.

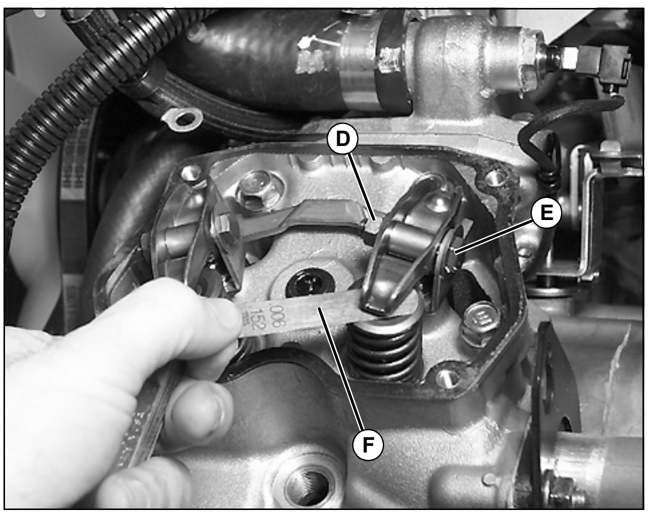
3. Turn the crankshaft clockwise until piston, visible in the spark plug hole, is at TDC (top dead center) of the compression stroke.



MX14236

4. Align the flywheel magnet (B) with #1 ignition coil (C) and #2 ignition coil (A).

5. Both intake and exhaust valves will be closed and the rocker arms will be loose. If one rocker arm is tight, the piston is on the exhaust stroke and the crankshaft must be turned another revolution (360 degrees).



MX14237

6. Loosen the lock nut (D) and valve clearance adjustment bolt (E).

7. Insert a **0.15 mm (.006 in.)** feeler gauge (F) between rocker arm and valve stem, and turn the adjusting bolt (E) until the thickness gauge begins to bind between the rocker arm and valve stem end.

8. Holding the adjusting bolt, tighten the locknut to **11 N•m (96 lb-in.)**. Repeat for either exhaust or intake valve.

9. Repeat procedure for other cylinder.

Specifications:

Valve Clearance
(at 16 - 27°C (60 - 80°F). . . . . 0.15 mm (0.006 in.)
Nut Torque. . . . . 11 N•m (96 lb-in.)
Spark Plug Torque . . . . 25 N•m (221 lb-in.)

Crankcase Vacuum Test

Reason:

To measure the amount of crankcase vacuum, to ensure the crankcase is not pressurized. A pressurized crankcase will force oil to leak past the seals.

Equipment:

- JTO5697 U-Tube Manometer Test Kit; or,
- JT03503 Crankcase Vacuum Test Kit

Procedure 1:

Important: Avoid Damage! Test must be run with the engine at normal operating temperature, if not, test will be inaccurate. DO NOT use more than 3 feet of manometer tubing. If a longer hose is used the readings will be inaccurate.

1. Park machine on level surface.

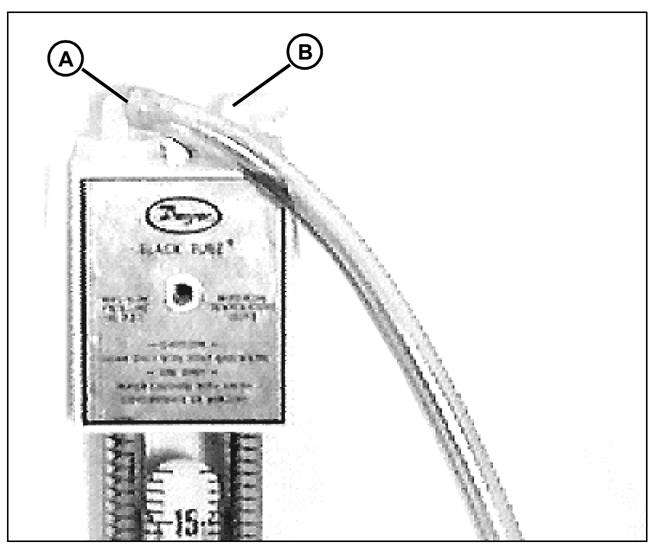
2. Raise engine hood and remove dipstick. Check dipstick/ oil fill cap and O-ring for cracks or damage, replace as necessary.

3. Install appropriate size rubber plug in dipstick tube.

4. Insert barbed fitting in rubber plug so that clear line to fitting (A) can be connected at a later step.

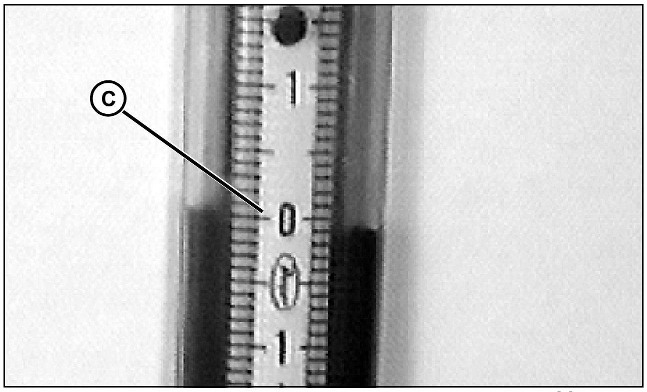
Important: Avoid Damage! DO NOT make connection between U-Tube Manometer clear line and engine crankcase BEFORE engine is running or fluid in manometer could be drawn into crankcase.

5. Attach manometer magnets to a solid metal surface.



M88761

6. Open top valves (A) and (B) one turn.

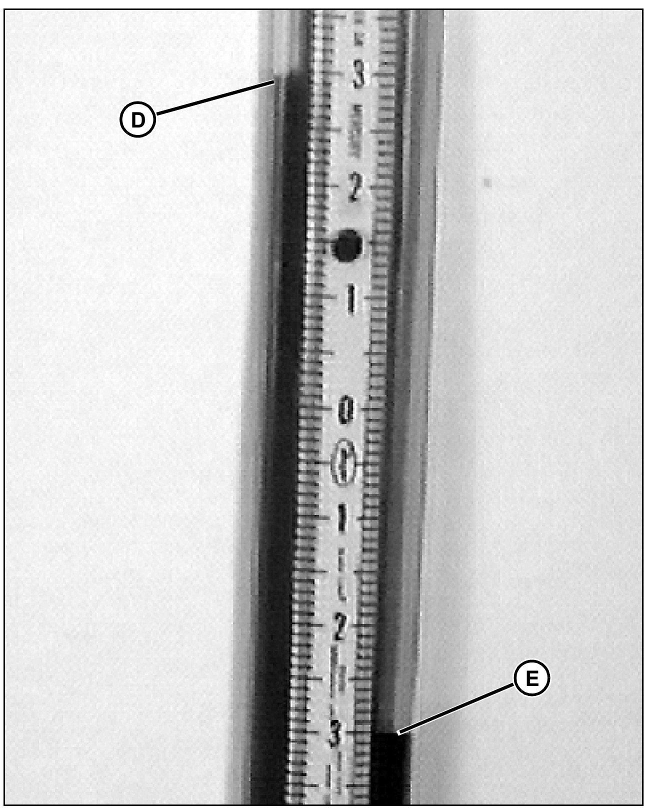


M88762

7. Zero the manometer by sliding the ruled scale up or down so “0” (C) is located where water level on both sides is even.

8. Hold finger over rubber plug hole to keep oil from spraying out. Start engine, move the throttle lever to fast idle **(3400 rpm)** and allow engine to reach operating temperature.

9. Quickly attach clear line from manometer to rubber plug in dipstick opening.



M88764

Picture Note: Example: 3 + 3 = 6 in. of vacuum

10. 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.

Important: Avoid Damage! Repeat test at least three times for accuracy. To repeat test, remove the manometer tube from top of manometer at “A”. DO NOT remove manometer tube from engine. Perform step #7 then reattach manometer tube to side “A”. Continue with step #10.

11. Remove line from manometer before stopping engine. Then remove dipstick hose connection and install dipstick.

Procedure 2:

1. Park machine on level surface.
2. Raise engine hood and remove dipstick. Check dipstick/ oil fill cap and O-ring for cracks or damage, replace as necessary.
3. Install appropriate size rubber plug in dipstick tube.
4. Insert barbed fitting in rubber plug so that clear line to fitting can be connected at a later step.

Important: Avoid Damage! DO NOT make connection between test gauge and rubber plug BEFORE engine is running at FAST idle or gauge damage may result.

After test reading is made, DO disconnect test gauge WHILE engine is running at FAST idle to prevent damage to gauge.

5. Hold finger over rubber plug hole to keep oil from spraying out. Start engine, move the throttle lever to fast idle and allow engine to reach operating temperature.
6. Connect gauge, clear line, and barbed fitting to rubber plug.
7. Record crankcase vacuum reading. Gauge should show a minimum vacuum of **10.2 cm (4 in.)** of water movement.
8. Disconnect barbed fitting, clear line, and gauge from rubber plug while engine is running at FAST idle. Hold finger over rubber plug hole to keep oil from spraying out.
9. Move throttle to SLOW idle and turn engine OFF.
10. Remove rubber plug and install dipstick.

Specification:

Minimum Crankcase Vacuum at 3400 rpm
. . . . . 10.2 cm (4 in. water)

Results:

If crankcase vacuum does not meet specification, check the following:

Note: A new engine may have low vacuum readings due to the fact that the rings are not seated.

- Seals and gaskets for leakage

- Rocker arm cover O-ring for leakage
- Rings, piston, and cylinder bore for wear or damage

Engine Oil Pressure Test

Reason:

To determine condition of lubrication system.

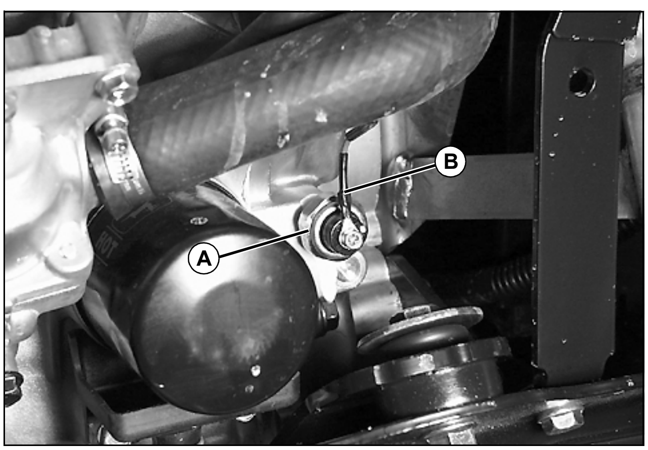
Equipment:

- JT03344 Pressure Gauge Assembly
- JT03349 Connector
- JT03017 Hose Assembly

> **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.**

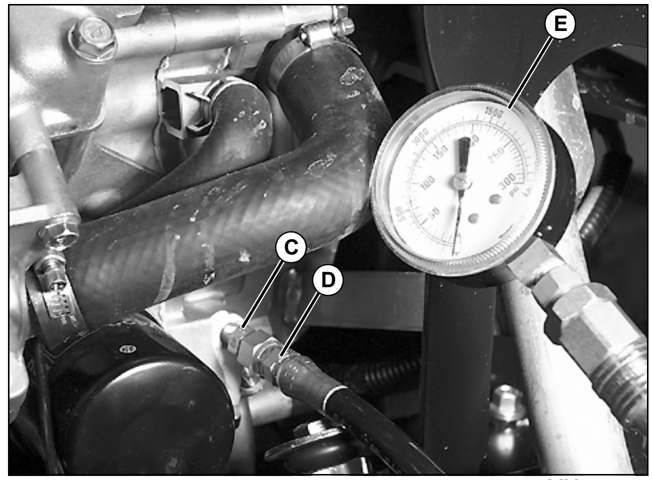
Procedure - Preliminary Check:

1. Park machine on level surface.
2. Turn key switch OFF. Allow engine to cool.
3. Move forward/reverse pedals to NEUTRAL position.
4. Engage parking brake and raise hood.
5. Check engine oil level, bring oil level to full mark.



MX14241

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



MX14242

8. Install JT03349 Connector (C).
9. Install JT03017 Hose Assembly (D) and JT03344 pressure gauge assembly (E).
10. Monitor oil pressure while cranking engine. If no oil pressure is present discontinue cranking engine. Determine and correct cause before running engine.

> **Important: Avoid Damage! If pressure reading is below 69 kPa (10 psi), STOP ENGINE IMMEDIATELY and determine cause.**

Procedure- Engine Running:

1. Start and Run engine at medium idle for five minutes to heat engine oil to normal operating temperature.
2. Run engine at fast idle (3350 rpm) and check oil pressure. Gauge should read a minimum oil pressure of **276 kPa (40 psi)**.

Results:

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

- Oil pressure relief valve spring worn or broken

- Oil pressure relief valve stuck or broken.

- Oil pump worn or damaged

- Oil pump suction screen or oil passages plugged

- Connecting rod and main bearing journals excessively worn.

- Connecting rod and main bearing journals excessively worn.

- Oil filter plugged.

Specifications:

Minimum Oil Pressure . . . . 276 kPa (40 psi)
Oil Pressure Switch Torque . . . . 15 N•m (132 lb-in.)

Fuel Pump Flow Test for Carburetor (FD671D)

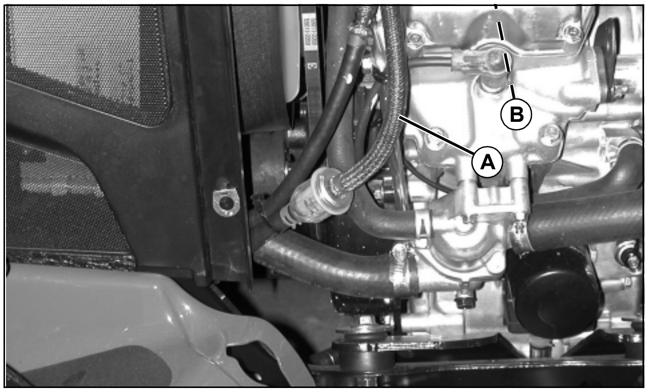
Reason:

To determine proper fuel flow from transfer pump.

Test Equipment:

- Graduated container

Procedure:



MX15403

1. Disconnect fuel supply hose (A) from carburetor (B) and put end in a graduated cylinder.

2. Turn key switch on for 10 seconds. DO NOT start engine.

Results:

- If fuel flow is **below 300 mL (10 oz)/10 seconds**, check fuel pump filter, in-line filter, hoses, and fuel shutoff valve for debris or restrictions. Replace filters; then test again.
- If fuel flow is still **below 300 mL (10 oz)/10 seconds**, replace fuel pump.

Fuel Pump Pressure Test for Carburetor (FD671D)

Reason:

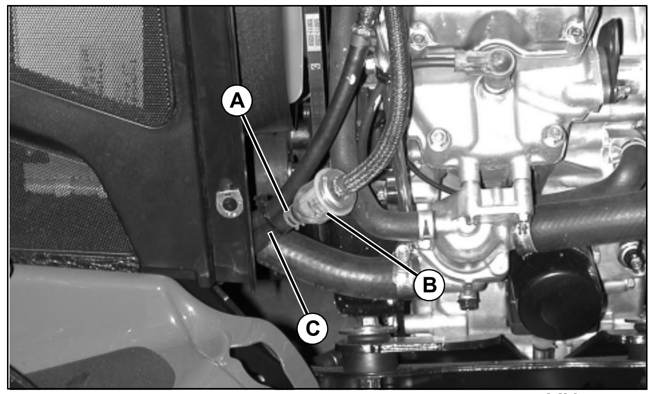
To check condition of fuel pump and determine fuel pressure.

Test Equipment:

- JDG356 Fuel Pump Pressure Test Kit

Procedure:

1. Engage parking brake.



MX15403

2. Loosen clamp (A), and disconnect fuel supply hose (C) from fuel filter (B).

3. Connect fuel pump pressure test kit to end of supply hose (C).

4. Turn key switch on. DO NOT start engine. Observe pressure reading.

Results:

- If fuel pressure is below **10 kPa (1.5 psi)**, check fuel pump filter, in-line filter, hoses, and fuel shutoff valve for debris or restrictions. Replace filters; then test again.
- If pressure is still below **10 kPa (1.5 psi)**, replace fuel pump.

Fuel Pump Pressure Test For Fuel Injection (FD750D)

Reason:

To check condition of fuel pump and fuel pressure regulator which determines fuel pressure.

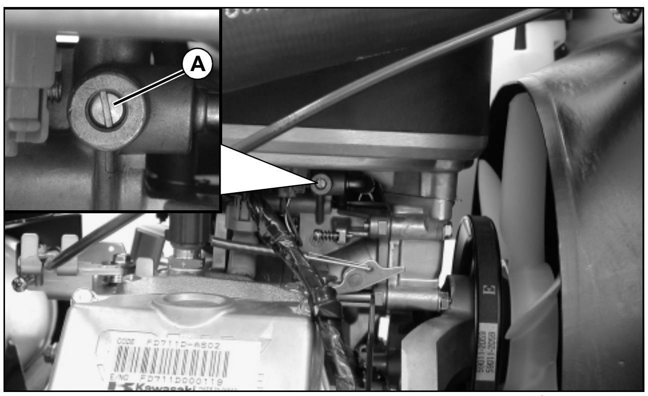
Test Equipment:

- JT07032 400 kPa (60 psi) Pressure Gauge
- JDG41 1/4 M NPT X 1/8 ID Barbed Fitting
- Fuel Hose and Hose Clamps

Procedure:

1. Engage park brake. Put PTO in OFF position.

Note: Be sure the battery is fully charged.

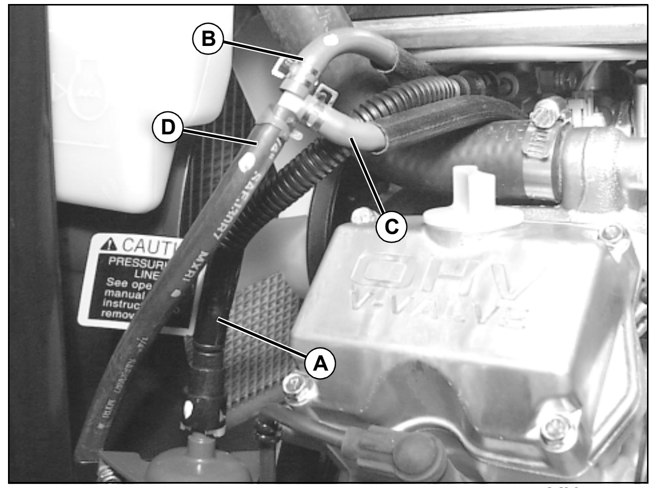


MX15401/MX15402

Picture Note: Left side of engine shown.

2. Loosen the fuel pressure relief screw (A) to relieve the high pressure in the return fuel hose; Do Not close it at this time, leave open.

> **Caution: Avoid Injury! Be prepared for spilling fuel. Wipe up any fuel immediately. DO NOT try to start engine with the fuel hoses disconnected.**



MX31772

A- Fuel Line from Pump/Filter
B- From Relief Screw on Throttle Body
C- Excess Pressure Return from Pressure Regulator
D- Main Return Line to Fuel Tank

3. Disconnect the fuel line (B) from the tee fitting.
4. Cap the tee fitting open port with a short piece of fuel line and fuel line cap.
5. Install the pressure gauge into the fuel relief line (B).
6. Tighten the hose clamp in the correct position.

Note: The fuel pump will run for two seconds and then shut off.

7. Turn the key to the RUN position and read fuel pressure.
8. Fuel pressure should be **172 - 186 kPa (25 - 27 psi)**.
   - If fuel pressure is higher than specified, check fuel return hose for sharp bends, kinking or clogging or; vacuum hose for air leaks.
   - If fuel pressure is much lower than specified, inspect for fuel line leakage or clogs in fuel filter or fuel pump.

   If the inspection turns out good, replace entire pressure regulator or fuel pump. See “Fuel Pressure Regulator Removal and Installation (FD750D)” on page 64 in this section, or “Fuel Pump/Fuel Gauge Sensor Removal and Installation” on page 461 in the Miscellaneous section.
9. Remove pressure gauge.
10. Connect the fuel relief hose to the tee fitting and clamp it.
11. Tighten the fuel pressure relief screw (A).

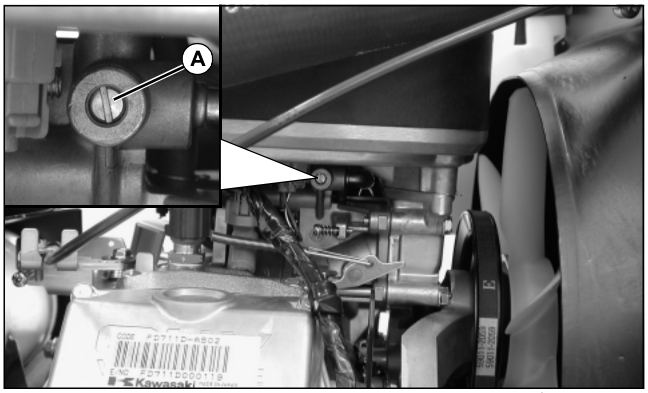
Bleed Fuel System (FD750D)

Reason:

When the engine is run out of fuel, injection components fail, or fuel system opened, this procedure purges air from fuel system.

Procedure:

Note: This procedure should not be necessary, but may be used when the engine does not start after ten seconds of trying.



MX15401/MX15402

Picture Note: Left side of engine shown.

1. Loosen the pressure release screw (A).

Note: Cycling the key switch is necessary because power is supplied to the fuel pump for only a few seconds.

2. With screw loosened, cycle the key switch back and forth (on-off, on-off). Do not turn the engine over.

3. After the system has been “refueled”, tighten the relief screw (A).

Fan Belt Tension Adjustment

Reason:

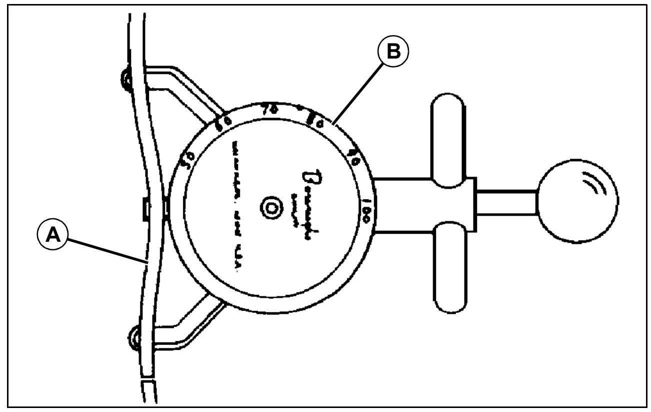
To keep proper tension on belt to drive cooling fan.

Test Equipment:

- JDST28 Belt Tension Gauge

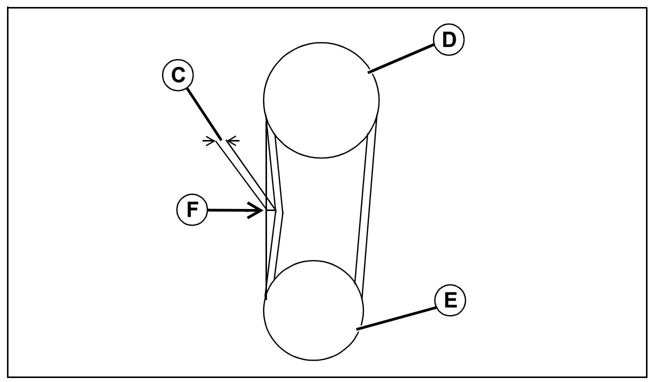
Procedure:

> **Caution: Avoid Injury! Fingers or loose clothing can get caught in rotating parts. Park safely, stop engine, wait for all moving parts to stop, and allow engine to cool before servicing.**



MX14230

1. Use JDST28 Belt Tension Gauge (B) to check belt (A) tension midway between fan and drive sheaves. Belt tension should be between **25 kg (55 lb) and 40 kg (88 lb)**. If belt tension is **below 18 kg (40 lb)**, adjust or replace the belt. See full specifications below.



MIF

2. If the tension gauge is not available, apply moderate pressure (F) to belt between driveshaft sheave (D) and fan pulley (E). Belt should deflect inward (C) as follows:

Specifications:

Belt Tension Measurement Slacks	
25 kg (55 lb) force and	**12 mm (0.47 in.)** deflection
40 kg (88 lb) force and	**9 mm (0.35 in.)** deflection
18 kg (40 lb) force and	**17 mm (0.67 in.)** deflection (adjust or replace belt)

Results:

- If deflection is not within specifications, disconnect drive shaft and remove outer sheave half of fan drive pulley. Remove shim(s) to increase belt tension or add shim(s) to decrease tension. If proper belt tension cannot obtained, replace belt. See “Fan Belt Removal and Installation” on page 53 for procedure and component explode for adjustment.

Thermostat Test

Reason:

To determine opening temperature of thermostat.

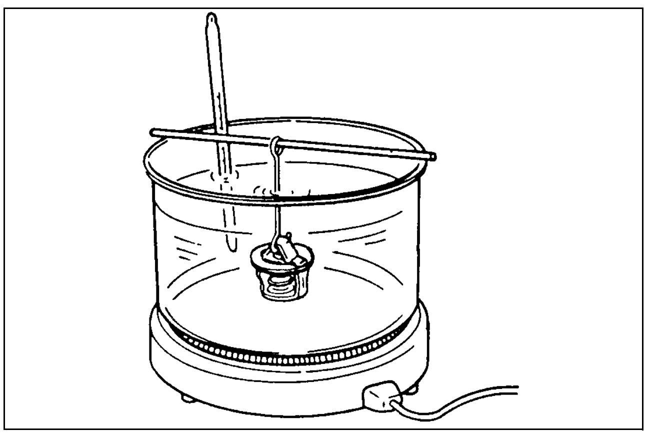
Equipment:

- Thermometer
- Glass Container
- Heating Unit

> **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.**

Procedure:

1. Remove thermostat. See “Thermostat Removal and Installation” on page 52.



M82122a

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

Specifications:

Begin Opening . . . . 80.5 - 83.5° C (177- 182° F)
Fully Open. . . . . 95° C (203° F)
Minimum Lift Height Above 95° C (203° F)
. . . . . 8 mm (0.31 in.)

Results:

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

Cooling System Test

Reason:

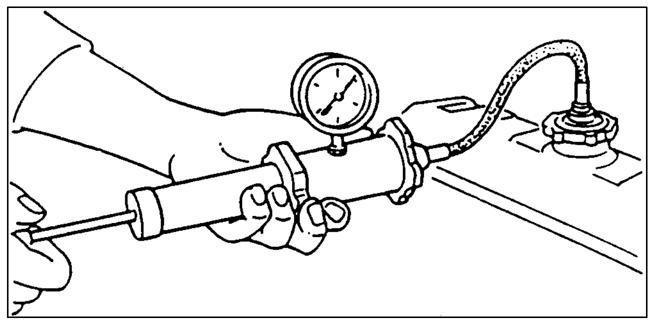
To inspect cooling system for leaks.

Equipment:

- D05104ST Cooling System Pressure Pump
- JDG692 Radiator Pressure Test Kit (Adapters)

Procedure:

> **Caution: Avoid Injury! Coolant may be above boiling temperature and under pressure in --- cooling system. DO NOT remove pressure cap when system is hot. Escaping steam will burn unprotected skin. Always wear protective clothing and goggles when servicing cooling system**



M87350

1. Check cooling system is cool and squeeze top radiator hose to check system pressure has dropped.
2. Remove cap. Top off coolant if low. Wet the cap sealing surfaces with water or coolant to prevent pressure leaks. Attach D05104ST pressure pump to radiator filler neck.

> **Caution: Avoid Injury! During testing procedure, do not exceed the pressure for which the system was designed. The maximum pressure is 102.7 kPa (14.9 psi).**

3. Pressurize system with tester to **60 kPa (8.7 psi)**.
4. Check for leaks throughout cooling system.

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.

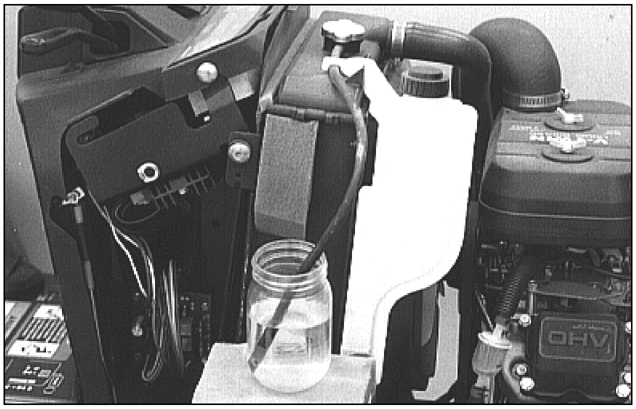
Radiator Bubble Test

Reason:

To determine if compression pressure is leaking past head gaskets and into cooling system.

Procedure:

1. With coolant at proper level and radiator cap tight, start and run engine to bring it to operating temperature.
2. Disconnect overflow hose from coolant recovery tank.



M55592a

3. Put end of hose in a container of water.
4. Check for bubbles coming from hose.

Results:

- If bubbles are present, replace head gaskets.

Radiator Cap Pressure Test

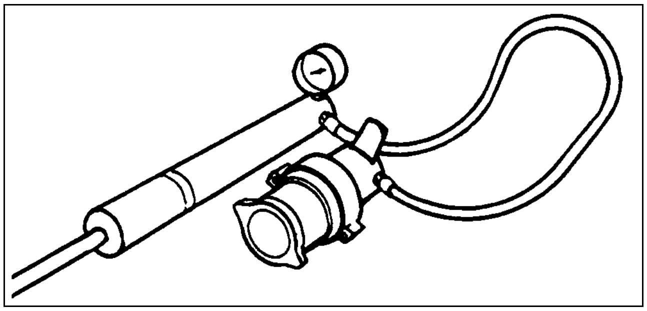
Reason:

To test radiator cap for operating in correct pressure range.

Test Equipment:

- D05104ST Cooling System Pressure Pump
- JDG692 Radiator Pressure Test Kit (Adapters)

Procedure:



T6333AX

1. Install radiator cap on appropriate adapter.
2. Attach adapter to D05104ST pressure pump.
3. Apply pressure. Pressure valve in cap should open according to specification.

Specification:

Relief Valve Opening Pressure
. . . . . 78 - 98 kPa (11.3 - 14.2 psi)

Results:

- If cap leaks, relieve pressure and retighten cap. Test again. Replace cap if pressure is not within specification.

Water Pump/Alternator Drive Belt Adjustment

Reason:

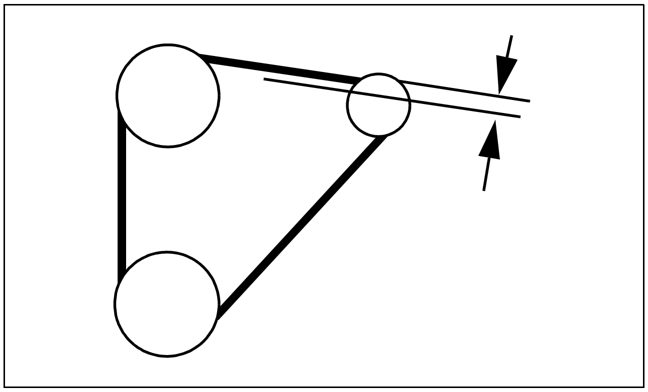
To keep proper tension on belt to drive water pump and alternator. To prevent shortened belt and bearing life.

Equipment:

- JDG529 or JDST28 Belt Tension Gauge
- Straight Edge

Procedure:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Allow engine to cool.
3. Raise hood.



MIF

4. Check belt tension between water pump and alternator using Belt Tension Gauge and a straight edge.

Belt Tightening Specifications:

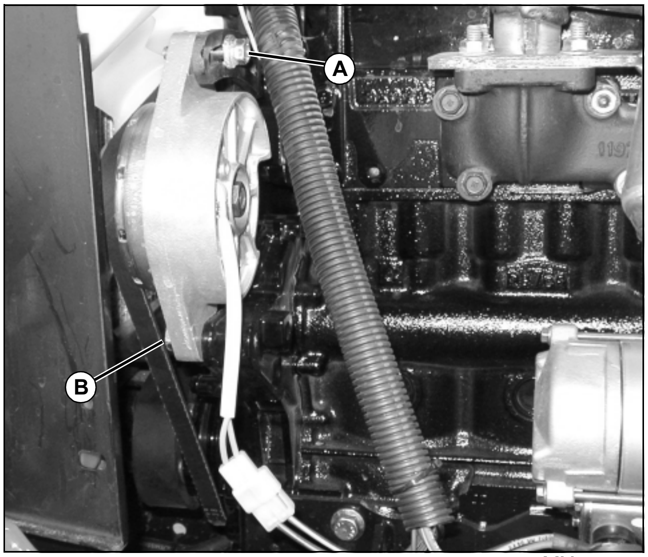
Applied Force . . . . 98 N (22 lb-force)
Deflection . . . . 10 - 15 mm (0.400 - 0.600 in.)

Results:

If deflection is not within specifications:

- Adjust belt tension.

Adjusting Belt Tension:



MX34242

1. Loosen adjusting bolt (A).
2. Loosen alternator bolts (B).
3. Push alternator inward to loosen belt, and outward to tighten belt.
4. Tighten bolts.
5. Check belt tension.

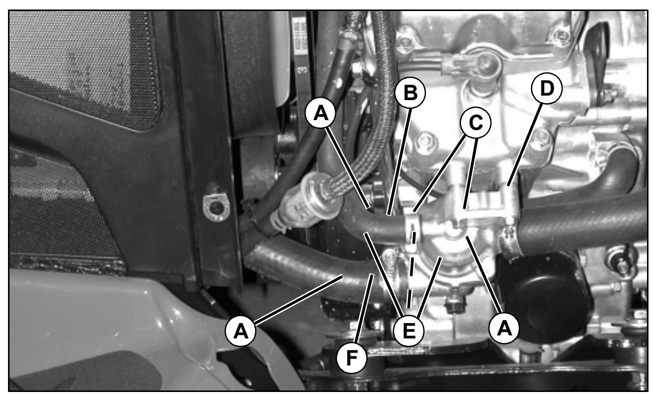
Repair

Thermostat Removal and Installation

1. Park machine with park brake ON, transmission in NEUTRAL, and engine OFF.

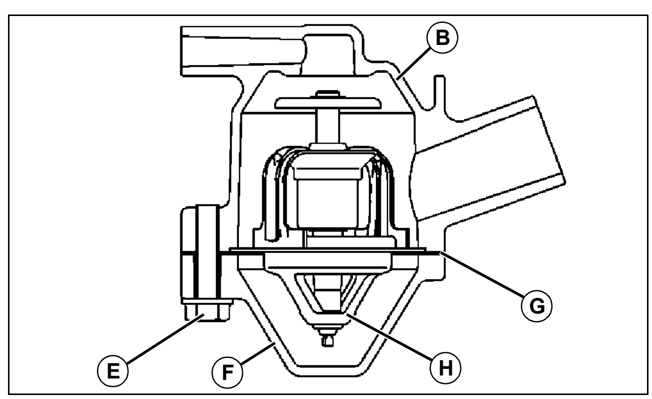
Caution: Avoid Injury! Coolant may be above boiling temperature and under pressure in --- cooling system. DO NOT remove pressure cap when system is hot. Escaping steam will burn unprotected skin. Always wear protective clothing and goggles when servicing cooling system

2. Allow engine to cool before servicing cooling system. Squeeze top radiator hose to verify the system pressure has dropped before opening radiator cap.
3. Place container under cooling system drain and open valve. Open radiator cap to speed up draining. Drain only enough coolant to lower coolant level below thermostat housing.



MX15403

4. Loosen the hose clamps (A), and remove the three coolant hoses.
5. Unscrew the mounting bolts (C), and remove the thermostat body, enough to remove final clamp and hose (D). Remove thermostat body from engine.



MX14243

6. Remove the bolts (E), and separate the thermostat upper body (B) from the lower body (F).

7. Remove thermostat (G) from upper body (B). Test or replace thermostat. See "Thermostat Test" on page 50.

8. When installing thermostat, replace gasket (G) with a new one.

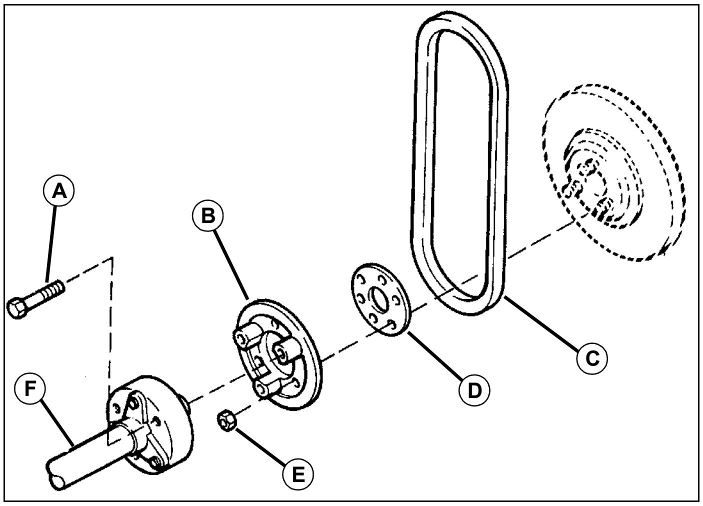
9. Tighten bolts (E) to **10 N•m (87 lb-in.)**.

Fan Belt Removal and Installation

Note: Disconnect and remove spark plugs to allow for easy flywheel rotation during outer sheave half installation.

1. Remove spark plugs.

Note: Rotate outer sheave half as nuts are tightened to allow belt to center in sheave halves.



M81225a

A- Mounting Cap Screws
B- Outer Sheave Half
C- Fan Belt
D- Shim
E- Mounting Nuts
F- Drive Shaft

2. Remove three (3) cap screws (A) holding drive shaft (F) onto outer sheave half (B).

3. Remove three (3) nuts (E) holding outer sheave half (B) and shim (D) to inner sheave half attached to flywheel.

4. Remove fan belt (C). Remove shim (D) if belt is to be tightened. Leave shim in if installing a new belt.

5. Install fan belt.

Note: Rotate sheave assembly as nuts are tightened to allow belt to center in sheave halves and not be pinched in an off-center position.

6. Loosely install belt between sheave halves and start installing the three outer sheave-retaining nuts (E).

7. Install and tighten mounting nuts (E) to **15 N•m (130 lb-in.)**.

8. Install driveshaft, and tighten mounting cap screws (A) to **20 N•m (15 lb-ft)**.

9. Check and adjust fan belt tension. See "Fan Belt Tension Adjustment" on page 49.

10. Install and tighten spark plugs to **25 N•m (18 lb-ft)**.

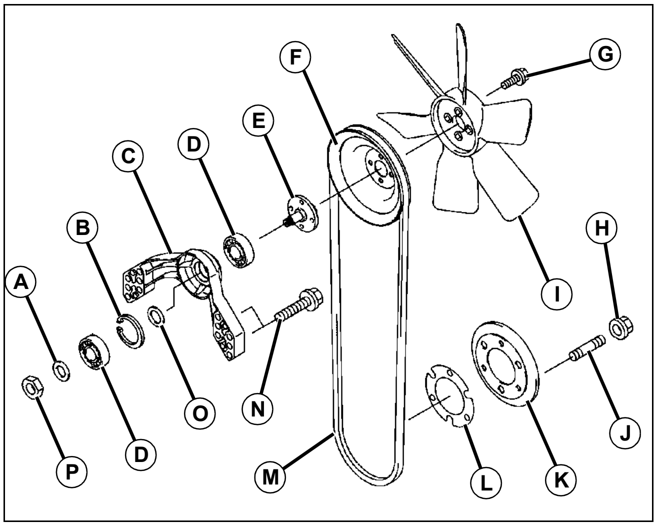
Specifications:

Sheave Mounting Nuts (E). . . . . 15 N•m (130 lb-in.)
Driveshaft Mounting Bolts (A). . . . . 20 N•m (15 lb-ft)
Spark Plug Torque . . . . 25 N•m (18 lb-ft)

Cooling Fan and Bracket Removal and Installation

Important: Avoid Damage! Bearings are a press fit. Remove only if being replaced. To avoid pinching fan belt between flywheel and outer sheave half, rotate flywheel while tightening outer sheave half mounting cap screws.

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.



MX14252

A- Washer
B- Snap Ring
C- Bracket

D- Bearing (2 used)
E- Mounting Flange
F- Pulley
G- Cap Screw
H- Flanged Nut
I- Fan
J- Stud
K- Pulley (outer half)
L- Shim(s)
M- Fan Belt
N- Cap Screw
O- Spacer
P- Nut

1. Heat mounting bracket (C) with bearings (D) in hot oil to remove bearings. Tap bearings from mounting bracket.

2. Install bearings using a bushing, bearing and seal driver set and press.

3. Assemble fan (I), and belt sheave (F) to mounting flange (E) and install fan assembly to engine. Tighten hardware to standard torque specifications.

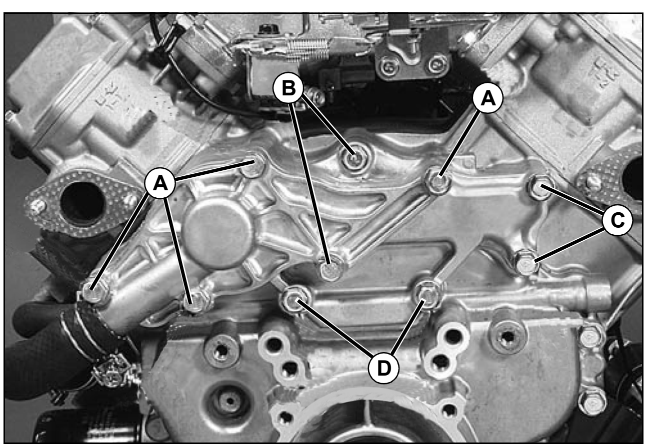
4. Install fan belt, shim(s) (L), and outer sheave half (K) to flywheel. Tighten flange nuts (H) to 15 N•m (130 lb-in.).

5. Adjust belt tension. See “Fan Belt Tension Adjustment” on page 49.

Coolant Pump Removal and Installation

Removing:

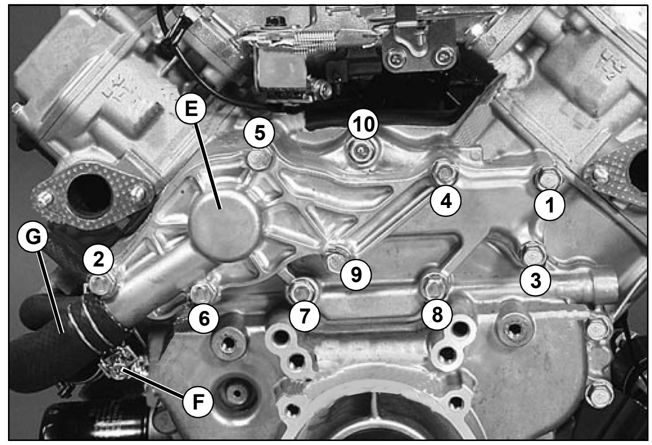
1. Remove muffler. See “Muffler Removal and Installation” on page 58.



MX14253

A- Bolt, M8, 80 mm (3.15 in.)
B- Bolt, M8, 45 mm (1.77 in.)
C- Bolt, M8, 60 mm (2.36 in.)
D- Bolt, M8, 30 mm (1.18 in.)

- Note the position of different lengths of bolts so they can be installed in their original positions.



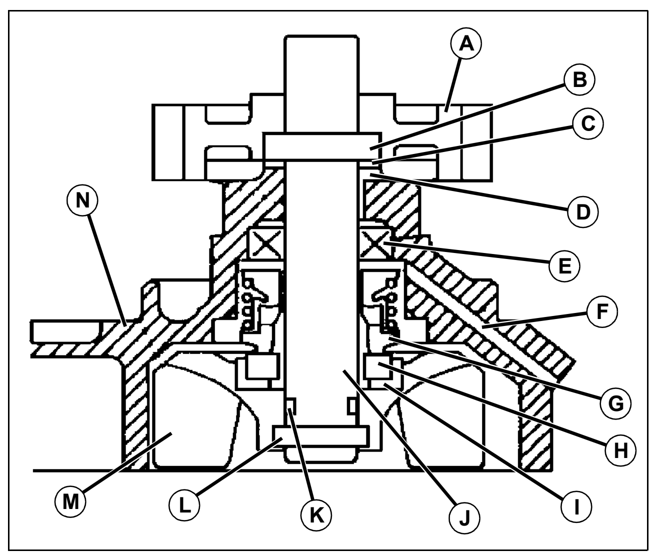
MX14253

2. Loosen the hose clamp (F) and disconnect the water hose (G) at the coolant inlet port of the water pump (E).

3. Unscrew the water pump bolts in the order shown, and remove the water pump assembly.

Disassembly:

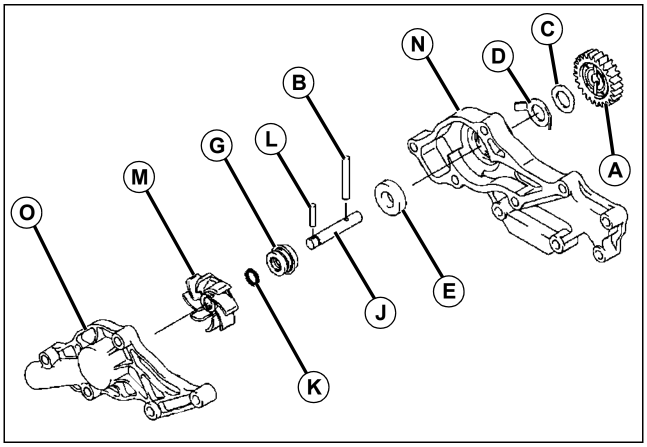
Note: Do not attempt to remove the mechanical seal (F), oil seal (D), and O-Ring (J), unless they are to be replaced.



MX14256

A- Pump Gear
B- Dowel Pin
C- Washer
D- Claw Washer
E- Oil Seal
F- Drainage Outlet Passage
G- Mechanical Seal Cartridge
H- Mating Ring

I- Cup Gasket
J- Pump Shaft
K- O-Ring
L- Dowel Pin
M- Impeller
N- Pump Housing



MX14255

1. Remove pump gear (A).
2. Remove dowel pin (B), washer (C), claw washer (D).

Note: Mechanical seal (G) is sealed into place and will be difficult to remove. If mechanical seal parts are damaged, replace the seal as a set.

3. Drive mechanical seal assembly (G) and remove oil seal (K) from the housing (N).
   - If the mechanical seal (G) is damaged, the coolant leaks through the seal, and drains through the drainage outlet passage (F).
   - If the oil seal (E) is damaged, the engine oil drains through the drainage oil passage (F).

Important: Avoid Damage! Check impeller for material break- down or deterioration. Replace the complete coolant pump if impeller is damaged. Flush cooling system to remove debris and add new coolant.

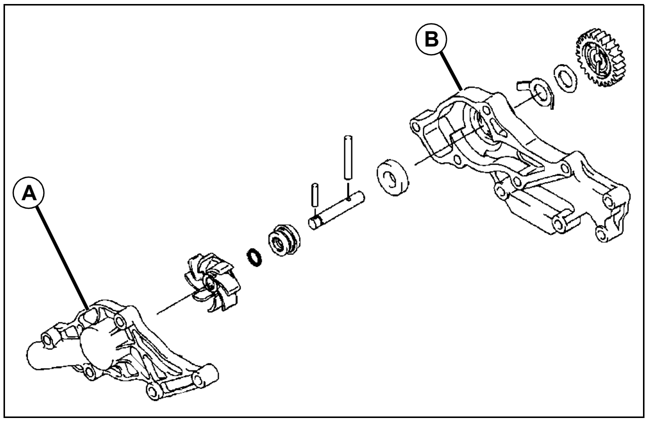
4. Remove dowel pin (L) from the pump shaft (J), and remove impeller (M).
5. Measure outside diameter of shaft (J). If less than specification or if it shows any signs of corrosion, replace it.
6. Measure pump shaft bore in housing (N). Replace housing if greater than specifications.
7. Inspect all parts for wear or damage. Replace as necessary.

Note: When installing impeller assembly to housing, coat mating surfaces with clean water.

Pump Specifications:

Shaft OD (Minimum). . . . . 9.94 mm (0.391 in.)
Housing Shaft Bore/ID (Maximum) 10.09 mm (0.397 in.)

Installing:



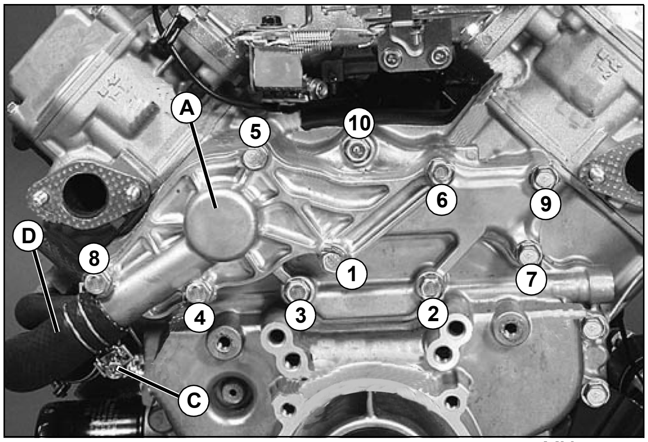
MX14255

1. Remove the old gasket from pump cover and pump housing.

Important: Avoid Damage! Do not get the sealant into the water line hole on the crankcase or the crankcase cover.

2. Apply sealant bead to the mating surfaces of the pump cover and pump housing.

Note: Recall position of different lengths of bolts (in removal procedure above).



MX14253

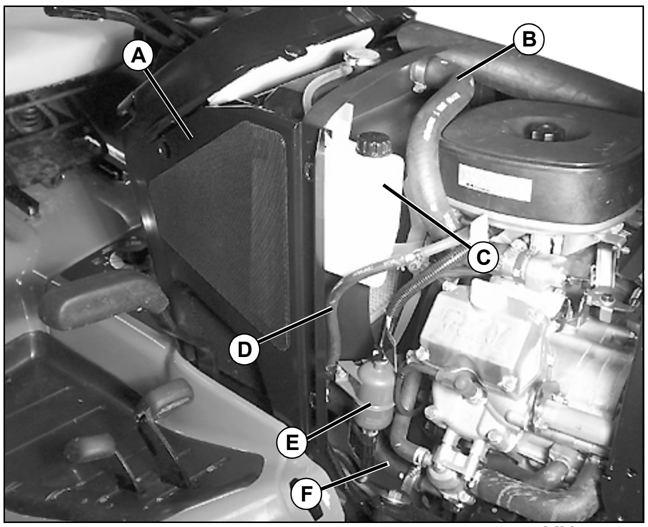
3. Install the mounting bolts, and tighten them in the order shown to **20 N•m (15 lb-ft)**.
4. Install hose (D) and hose clamp (C) to the coolant inlet port of the water pump cover (A).

Radiator Removal and Installation

Caution: Avoid Injury! Coolant may be above boiling temperature and under pressure in --- cooling system. DO NOT remove pressure cap when system is hot. Escaping steam will burn unprotected skin. Always wear protective clothing and goggles when servicing cooling system.

Note: Cooling system capacity is approximately 2.8 L (3.0 qt).

1. Drain coolant.



MX14397

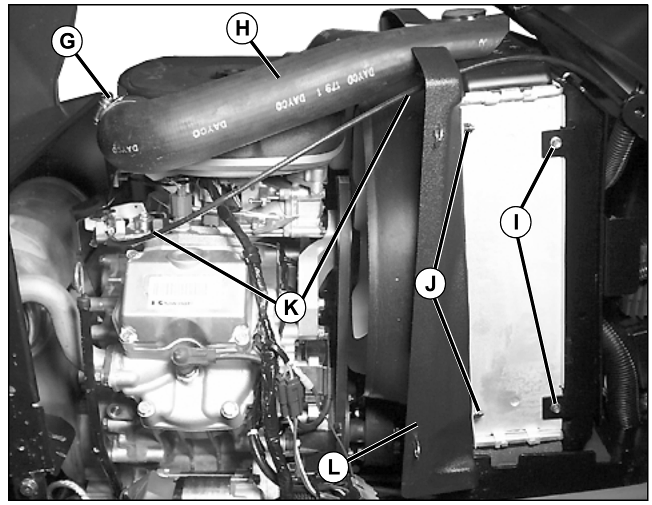
Picture Note: FD750D engine shown

2. Remove hoses (B and F).

3. Remove side panel (A) and side panel on opposite side of machine.

4. Remove recovery tank (C).

5. FD750D engine: Remove screw holding bracket for fuel filter (E) and fuel line (D). Move fuel filter and fuel lines toward engine to be able to move radiator shroud forward.



MX14398

6. Loosen clamp (G), and remove air cleaner hose (H) from air cleaner housing.

7. Loosen throttle cable clamp at throttle linkage and move throttle cable (K) from top of radiator shroud (L).

Note: There is also a choke control cable equipped on FD671D engines that will need to be moved in order to move radiator shroud.

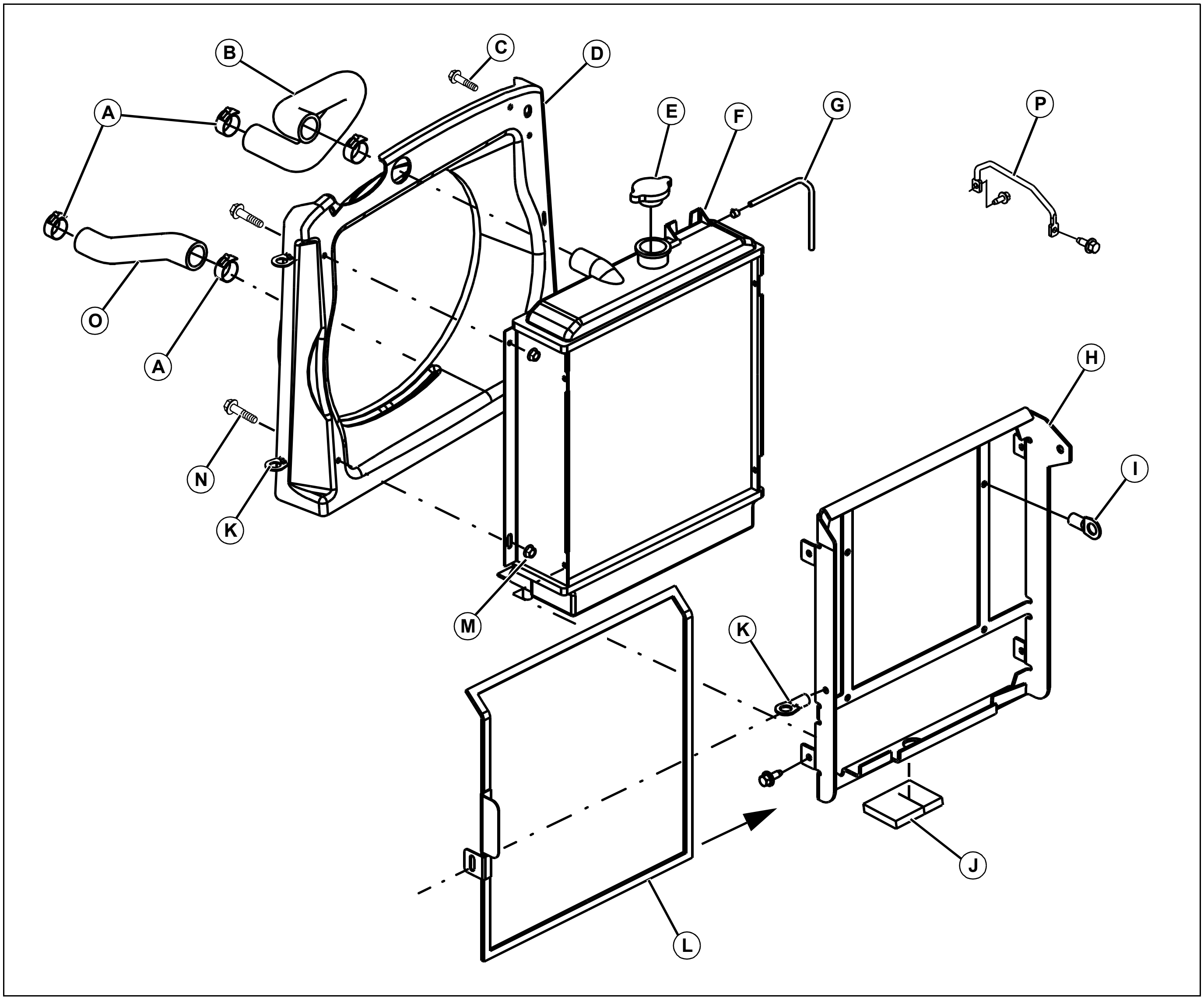
8. Remove bolts and nuts (J) on both sides of machine. Move radiator shroud (L) towards front of machine, over engine fan.

9. Remove four screws (I) holding radiator to pedestal, and remove radiator from machine.

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

10.Check radiator for debris lodged in fins. Clean radiator using compressed air or pressure washer.

11.Inspect radiator for bent fins, cracks and damaged seams. Repair as necessary.



MIF

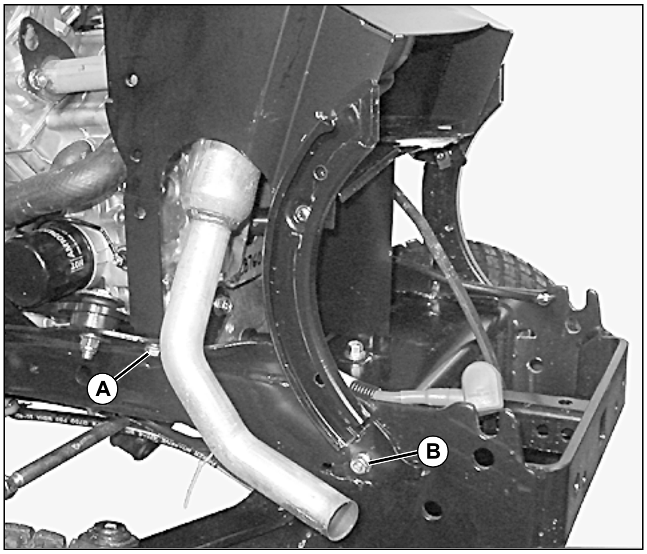
A- Hose Clamp
B- Radiator Hose (Return)
C- Screw (3 used
D- Radiator Shroud
E- Filler Cap
F- Radiator
G- Overflow Hose
H- Bracket
I- Clip, Oil Radiator Mount
J- Foam Pad
K- Clip
L- Screen
M- Flange Nut
N- Screw
O- Radiator Hose (Supply)
P- Support Bracket

Installation is done in the reverse order of removal.

- Close drain valve and fill radiator with proper coolant to top of filler neck.
- Start engine and allow it to reach proper operating temperature. Check radiator, hoses and connections for leaks. Adjust coolant level in recovery tank.

Muffler Removal and Installation

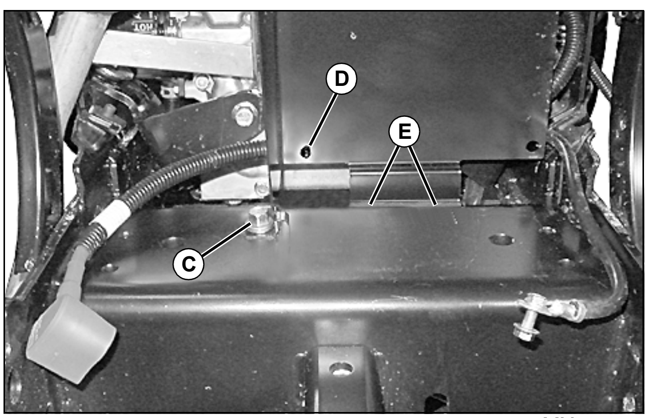
1. Disconnect headlight connector and remove hood.
2. Disconnect and remove battery.



MX14370

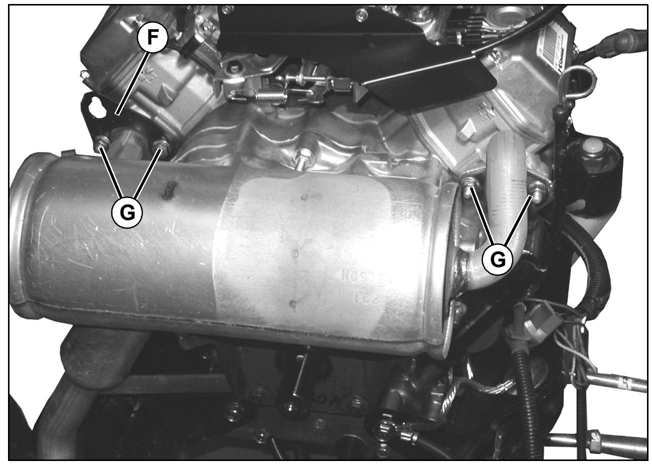
Picture Note: Battery shield, right side view.

3. Remove two cap screws (A) securing side brackets of battery shield to frame and two nuts (B) securing hood brackets to frame.



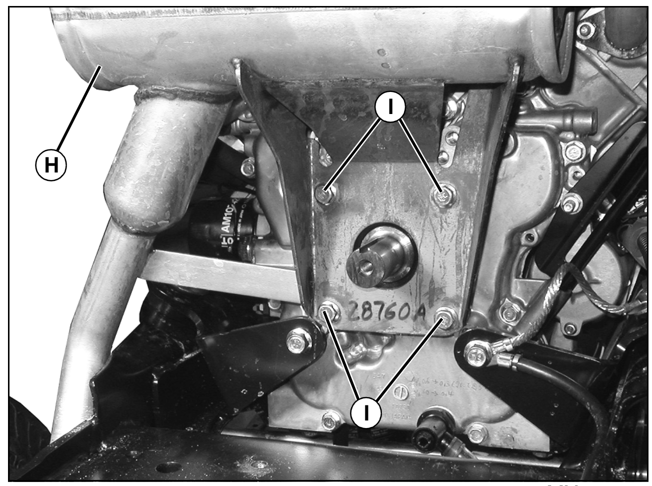
MX14374

4. Remove cap screw (C) that secures battery shield to top of frame.
5. Compress positive battery cable retainer clip (D) and separate cable from battery shield.
6. Loosen two cap screws that secure slotted mounting holes in battery shield to back of frame at locations marked (E).
7. Lift and remove battery shield.



MX16206

8. Unscrew the four (4) flange nuts (G), and remove the spring washers and engine hook (F) on No. 1 cylinder side.



MX16207

9. Remove the four (4) bolts (I) on the muffler bracket and take off the muffler assembly (H).

10.Remove the gaskets.

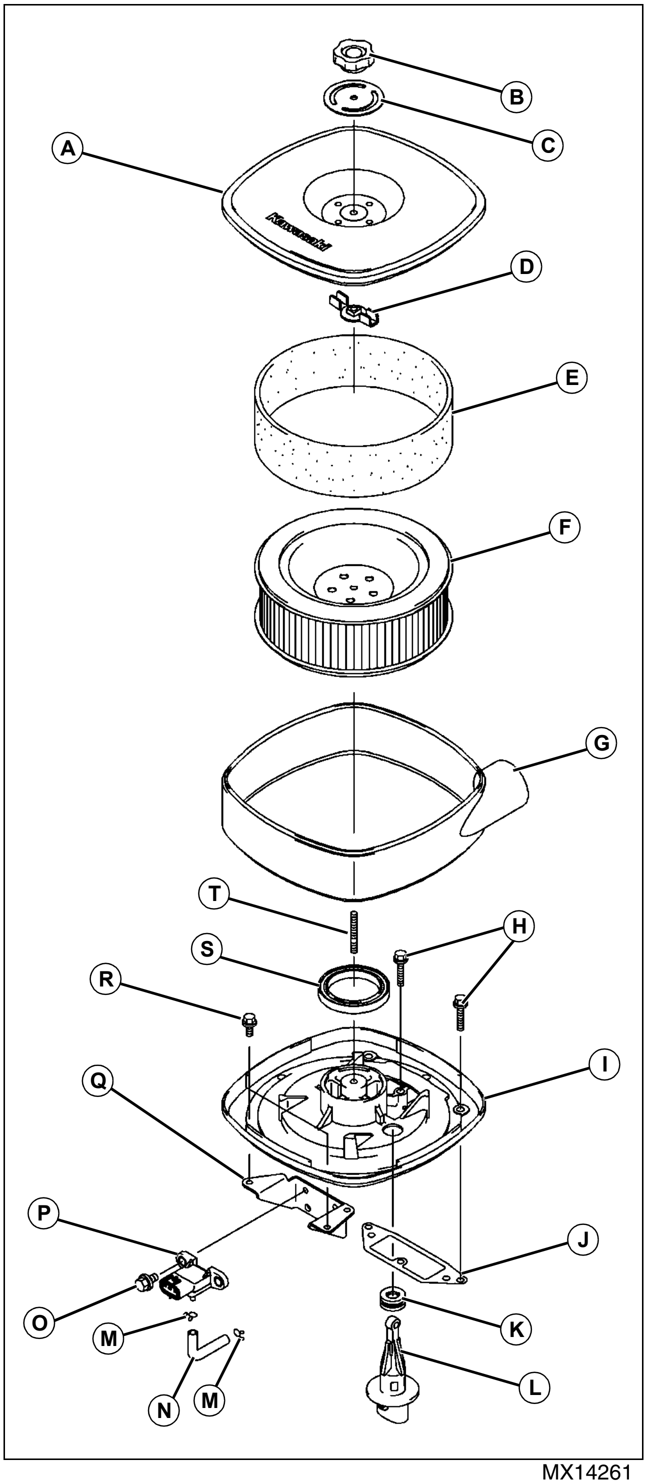
11.Inspect the exhaust pipe or muffler for dents, cracks, rust or holes. check for breaks in seems and loose internal components. Replace muffler if any considerable damage is found.

12.Clean the exhaust pipe flanges to the exhaust port gasket surfaces, and install new gaskets each time the muffler is installed.

Note: To prevent mis-threading, finger tight the flange nuts first. Next tighten the bolts on the muffler bracket.

13.Install the muffler, engine hook, spring washers, and nuts. Tighten nuts (G) to **20 N•m (180 lb-in.)**.

Air Cleaner Removal and Installation



Picture Note: FD750D air cleaner assembly shown

A- Nut
B- Washer
C- Cover
D- Wing Nut
E- Foam Filter
F- Paper Filter
G- Case
H- Cap Screw
I- Case
J- Gasket
K- Grommet
L- Air Temperature Sensor, FD750D only
M- Clamp
N- Hose
O- Cap Screw
P- Vacuum Sensor, FD750D only
Q- Bracket
R- Cap Screw
S- Seal
T- Stud

1. Inspect precleaner and paper element for dirt and dust.

2. Clean precleaner if necessary by washing in warm, soapy water.

3. Rinse in clean water. Squeeze to remove water.

4. Let air dry.

5. Apply **30 mL (1 oz)** of clean engine oil to precleaner. Squeeze to distribute oil evenly and to remove excess oil.

Important: Avoid Damage! DO NOT wash paper element. Clean or replace paper element as necessary.

6. Tap paper element gently to remove dust.

7. Replace element if oily, dirty or damaged.

8. Apply Thread Lock and Sealer (Medium Strength) on mounting screws before installation.

9. When installing breather hose, Make certain hose end is fully seated in the air cleaner base and the hose is not kinked.

Carburetor Removal and Installation (FD671D)

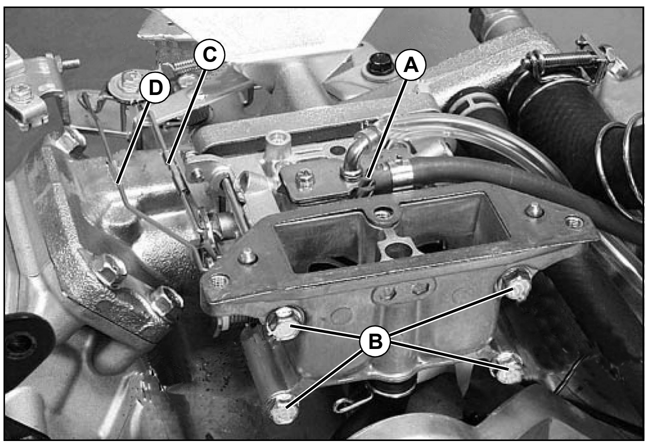
Caution: Avoid Injury! Gasoline is extremely flammable and can be explosive under certain conditions. Turn the ignition switch OFF. Do not smoke, and make sure the area is well ventilated and free from any source of flame or sparks.

Removing:

1. Remove air cleaner and related parts. See “Air Cleaner Removal and Installation” on page 58.

2. Remove radiator. See “Radiator Removal and Installation” on page 56.

3. Remove cooling fan and fan belt. See “Cooling Fan and Bracket Removal and Installation” on page 53.



MX16196

4. Turn the fuel shut off valve to the off position.

5. Drain the carburetor.

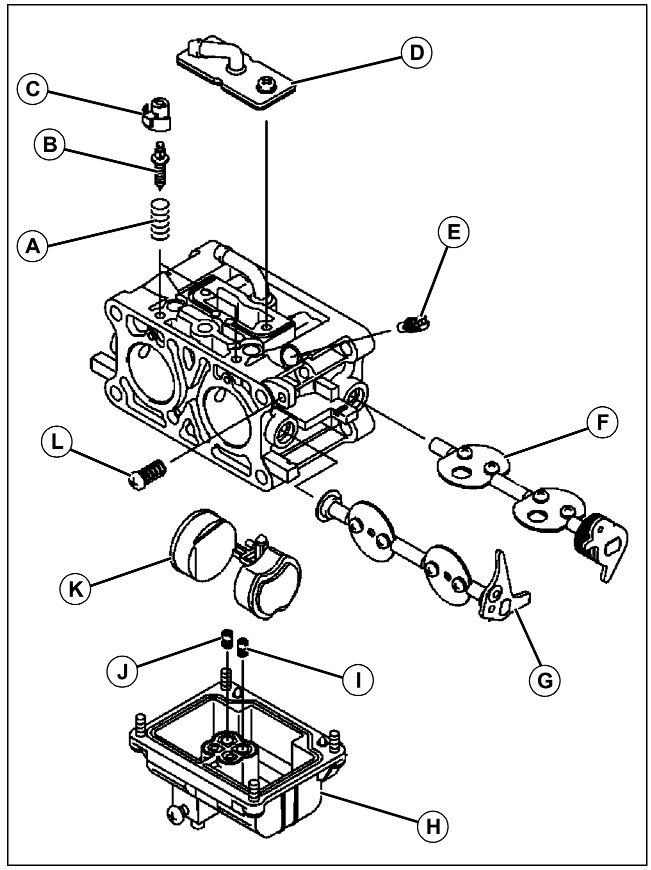
6. Disconnect the fuel tube at the fuel inlet joint (A) of the carburetor.

7. Disconnect the solenoid valve lead terminal.

8. Unscrew the intake pipe and carburetor mounting bolts (B).

9. Unhook the throttle (C) and choke link rod (D) at the ends of their arms while pulling off the carburetor.

Disassembly and Assembly:



MX16197

A- Spring
B- Pilot Screw
C- Limiter
D- Cover Assembly
E- Pilot Jet
F- Choke Valve Assembly
G- Throttle Valve Assembly
H- Float Chamber Assembly
I- Main Jet (L)
J- Main Jet (R)
K- Float Assembly
L- Screw

1. Refer to the illustration shown for disassembly and assembly.

Important: Avoid Damage! Do Not clean holes or passages in the carburetor body with sharp objects such as wire or small drill bits.

- There are several passage plugs (ball plugs) in the carburetor body. Do not remove them.
- Before disassembly, mark the outside of the choke valve and throttle valves for assembling them.

Caution: Avoid Injury! When cleaning rubber and plastic carburetor parts, use a cleaning solvent with a high flash point that will not damage the components.

2. Inspect moving parts such as shafts, choke and throttle plates etc. for wear or damage. Replace if necessary.

3. Check the carburetor body and float chamber for cracks, nicks or other damage. Replace components as necessary.

4. Remove all rubber and plastic parts from the carburetor. Soak all metal carburetor parts in cleaning solvent for a maximum of 1/2 hour.

5. Spray all internal passages and jets in the carburetor body with a spray carburetor cleaner to verify that passages and jets are open.

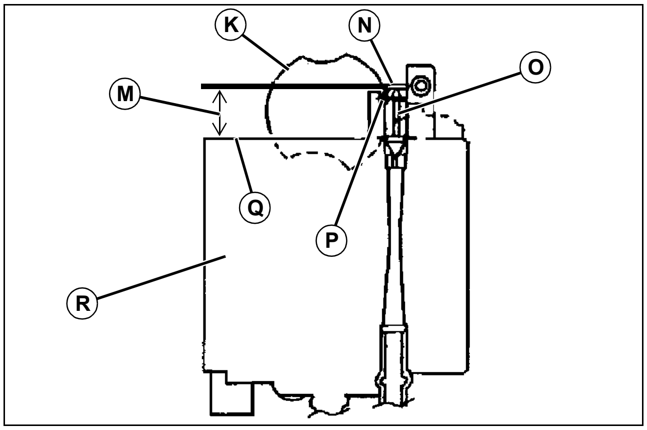
Important: Avoid Damage! Rinse carburetor body in warm water immediately after using carburetor cleaning solvent or spray to neutralize corrosive action of cleaner on aluminum.

6. Rinse carburetor with warm water and dry with compressed air. Do Not use rags or paper to dry parts as lint may plug holes or passages.

7. Inspect all parts for wear or damage, replace as necessary.

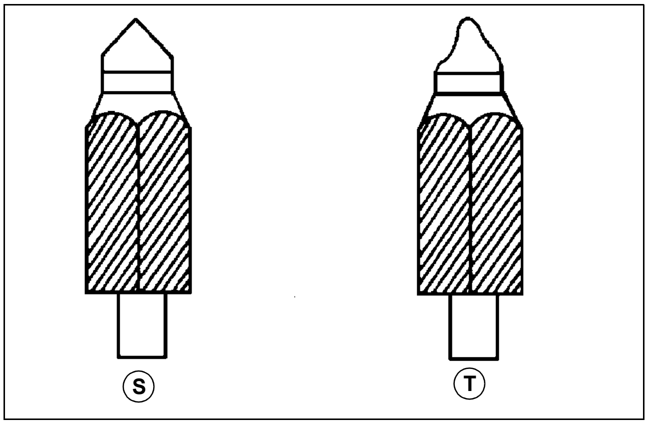
8. Clean and check the float level as follows:

Caution: Avoid Injury! Do not push down on the float (K) during float level checking.



MX16198

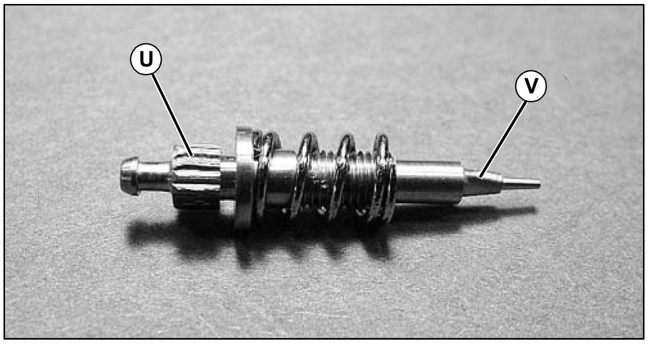
- With the float (K) assembly installed onto the carburetor body (R), hold the carburetor upside down at an eye level. Gently support the float with a finger and bring it down slowly so that the float arm tab (P) just touched the float valve (O). The float arm surface (N) should be parallel (M) with the carburetor body mating surfaces (Q).
- If the float position is not correct, bend the tab as required for correct adjustment.



MX16199

9. Inspect the float valve for excessive wear or damage.
   - The tip should be smooth, without any grooves, scratches, or tears (S). The rod at the opposite end of the needle should move smoothly when pushed in and released.
   - If either the valve or the valve seat is worn or damaged (T), replace the float assembly and carburetor as a set.

10. Replace the pilot screw in accordance with the following procedure, if necessary:
    - Carefully mark the position of the pilot screw limiter on the carburetor body so that it can be installed and set to its original position later.
    - Remove the limiter, being careful not to turn the pilot screw at this time.
    - Turn the pilot screw clockwise and count the number of turns until screw is gently seated in the pilot passage. Record the number of turns needed to close the screw.
    - Turn out the pilot screw to replace it with a new one.



MX16200

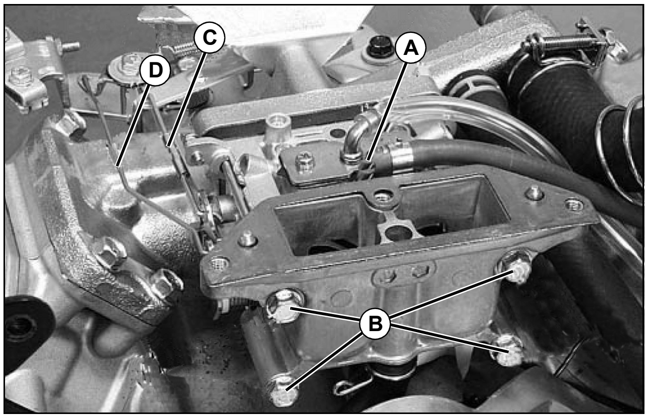
11. Inspect the tapered portion (V) of the pilot screw (U) for wear or damage.
    - If the pilot screw is worn or damaged on the taper portion of it, replace it.

- Check the spring for a weakened condition; replace it, if necessary.

12.Install the new pilot screw until the screw is gently seated. Then open the screw the same number of turns as recorded prior to removal.

- Align the limiter with the mark on the carburetor body to install, taking care not to turn the pilot screw.

Installing:

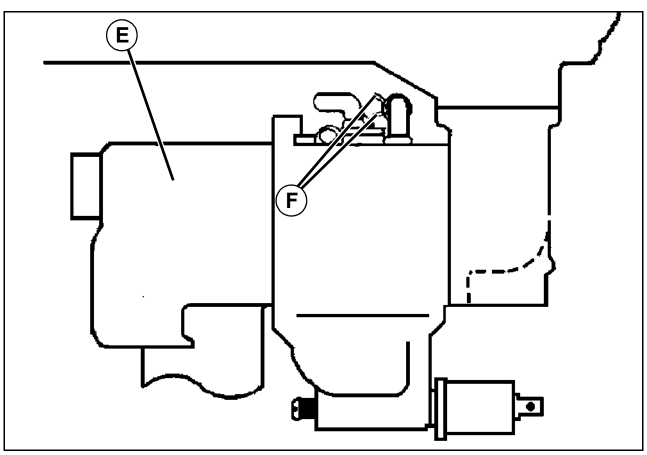


MX16196

1. Clean the mating surfaces of the carburetor, insulator and intake pipe, and fit new gaskets.

Important: Avoid Damage! Take care not to bend the throttle (C) and choke (D) link rods during installation.

2. Install the gaskets, insulator, carburetor and intake pipe with mounting bolts (B), and tighten them to **12 N•m (106 lb-in.)**.
3. Install fuel tube at the fuel inlet joint (A).



MX16201

- Be sure the fuel tube clip ends (F) face toward the intake manifold (E) as shown.

4. Adjust idle speed.
5. Install remaining components reverse of removal.

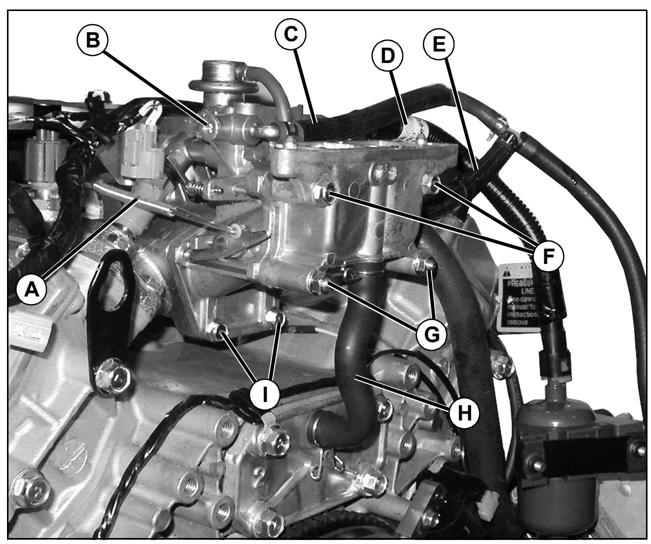
Throttle Body Removal and Installation (FD750D)

Removing:

Caution: Avoid Injury! Gasoline is extremely flammable and can be explosive under certain conditions. Turn the ignition switch OFF. Do not smoke, and make sure the area is well ventilated and free from any source of flame or sparks.

1. Remove air cleaner and related parts. See “Air Cleaner Removal and Installation” on page 58.
2. Remove radiator. See “Radiator Removal and Installation” on page 56.
3. Remove cooling fan and fan belt. See “Cooling Fan and Bracket Removal and Installation” on page 53.
4. Remove fan mounting holder.
5. Turn the fuel shut off valve to the OFF position.

Caution: Avoid Injury! Release of fluids from pressurized fuel system can cause serious injuries. Relieve fuel system pressure before servicing.



MX16210

6. Loosen the fuel pressure relief screw (B) to relieve the high pressure in the return fuel hose (C), and then tighten it.
7. Disconnect the fuel return hose (C).
8. Disconnect the inlet fuel hose (D) coming from the fuel pump, and the fuel return hose (E), and drain all the fuel in the hoses into a suitable container.

9. Disconnect the breather hose (H).

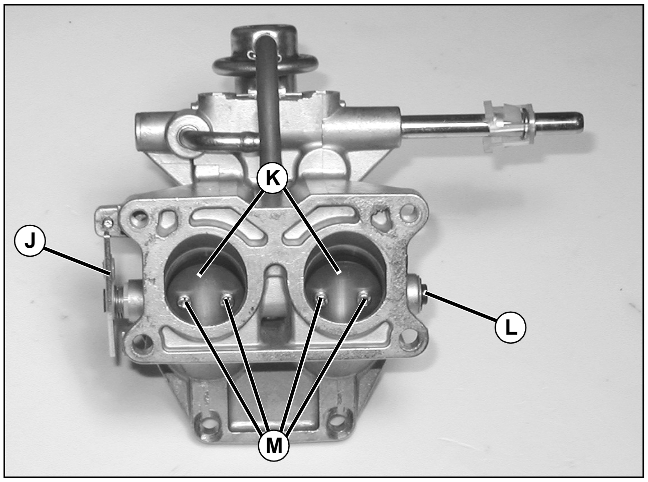
Note: Recall position of longer and shorter cap screws when removing throttle body assembly.

10.Unscrew the intake pipe and throttle body assembly long mounting bolts (F), short mounting bolts (I), and nuts (G).

11.Unhook the throttle link rod (A) at both ends before pulling off the throttle body assembly and fuel pressure regulator.

Disassembly and Assembly:

Note: Do not attempt to remove the throttle valve and shaft unless they appear to be damaged.



MX16211

1. Remove the screws (M), and remove the throttle valves (K).

2. Remove the circlip (L), and pull out the throttle shaft (J).

3. Before assembling, thoroughly clean the throttle body of dirt by applying compressed air.

Note: Replace the dust seal of the throttle shaft with a new one.

4. Apply engine oil to the new dust seal and insert the throttle shaft (J).

5. Install the throttle shaft into the throttle body.

Note: After tightening screws (M), be sure that the throttle valves are positioned properly, and the throttle shaft moves freely without any irregularities.

6. Install the throttle valves (K). Applying a non-permanent locking agent to the screws (M), secure valves with screws. Tighten screws to **0.9 N•m (8 lb-in.)**.

Installing:

1. Clean the mating surfaces of the throttle body assembly and intake pipe, and install new gaskets.

Note: Take care not to bend the throttle link rod during installation.

2. Install the gaskets, throttle body assembly, and intake pipe with mounting bolts and tighten them to **12 N•m (106 lb-in.)**.

3. Install remaining fuel hoses and be sure they are clamped securely in place.

4. Adjust idle speed. See “Low Idle Speed Adjustment” on page 42.

Fuel Injector Removal and Installation (FD750D)

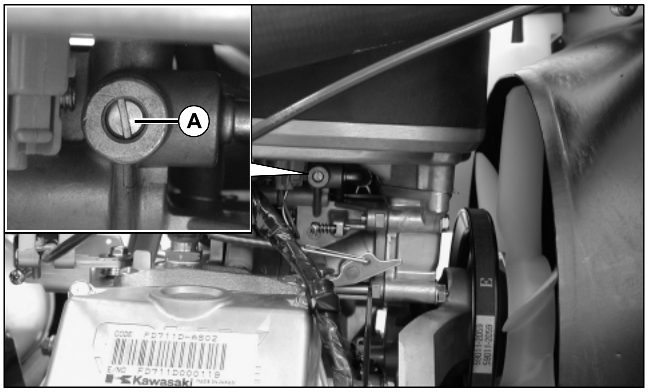
Caution: Avoid Injury! Gasoline is extremely flammable and can be explosive under certain conditions. Turn the ignition switch OFF. Do not smoke, and make sure the area is well ventilated and free from any source of flame or sparks.

Procedure:

Caution: Avoid Injury! Release of fluids from pressurized fuel system can cause serious injuries. Relieve fuel system pressure before servicing.

1. Turn the fuel shut off valve to the OFF position.

2. Relieve fuel line pressure:



MX15401, MX15402

a. Loosen fuel pressure relief screw (A) on left side of machine to relieve pressure.

b. Tighten relief screw.

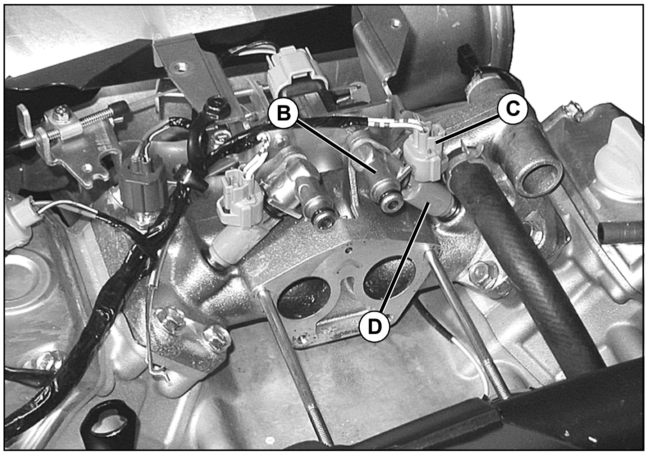
3. Remove air cleaner and related parts. See “Air Cleaner Removal and Installation” on page 58.

4. Remove radiator. See “Radiator Removal and Installation” on page 56.

5. Remove cooling fan and fan belt. See “Cooling Fan and Bracket Removal and Installation” on page 53.

6. Remove fan mounting holder.

7. Remove throttle body assembly. See “Throttle Body Removal and Installation (FD750D)” on page 62.



MX16215

8. Remove the injector cap (B).

9. Disconnect the injector connector (C).

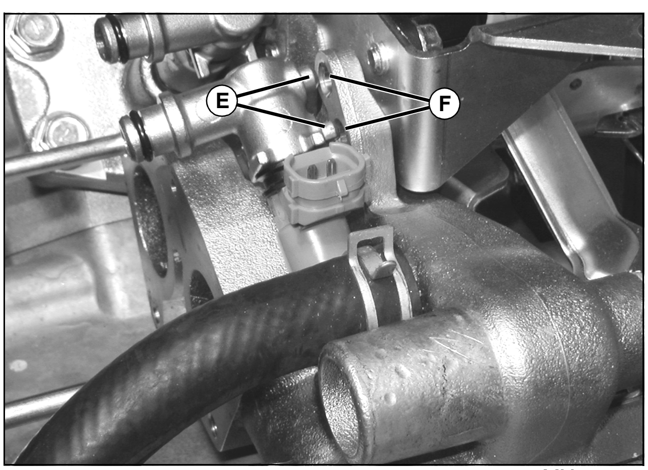
Important: Avoid Damage! Never drop the injector, especially on a hard surface. This can permanently damage the injector.

10. Pull out the fuel injector (D) from the intake manifold.

Note: Take care not to damage the injector inserts when they are pulled from the throttle body.

11. Inspect injector for damage and test injector. See “Fuel Injector Test - X720/X724/X728” on page 225 in the Electrical section.

12. Before assembly, replace any seals and O-Rings with new ones. Apply engine oil to the seal(s) and O-Ring(s).



MX16217

13. Install the injector into the intake manifold.

14. Securely place the projections (E) of the injector cap into the holes (F) of the intake.

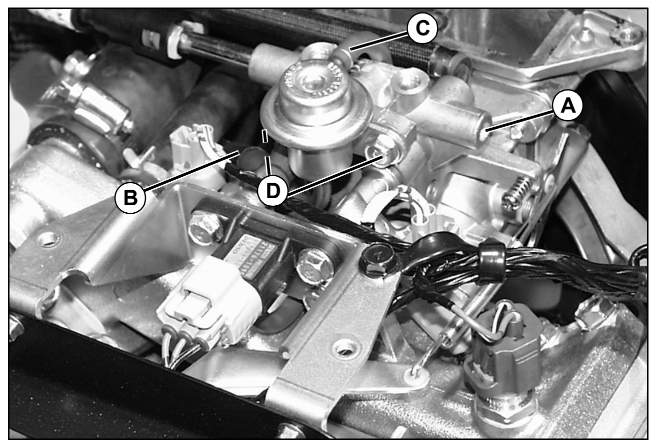
15. Connect the injector connector and injector cap.

16. Install the throttle body, control panel assembly, radiator, and air cleaner assemblies reverse of removal.

Fuel Pressure Regulator Removal and Installation (FD750D)

1. Remove air cleaner assembly. See “Air Cleaner Removal and Installation” on page 58.

Caution: Avoid Injury! Release of fluids from pressurized fuel system can cause serious injuries. Relieve fuel system pressure before servicing.



MX14288

2. Loosen the fuel pressure relief screw (A) to relieve the high pressure in the return fuel hose, and then tighten it.

3. Remove vacuum hose (B) and fuel return hose (C).

4. Remove two bolts (D) and remove the regulator.

5. Check the vacuum tube hose (B), fuel return hose (C) and O-Ring for brittleness, cracks, or damage, and replace if necessary.

6. Apply engine oil to the O-Ring.

7. Install fuel pressure regulator, vacuum hose (B) and clamp, and fuel return hose (C) and clamp.

8. Tighten the two bolts (D).

Cylinder Head Removal and Installation

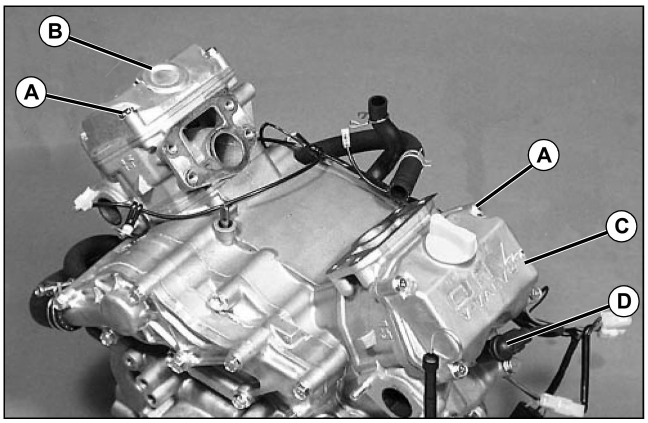
Removing:

1. Remove radiator and it's bracket.

2. Remove air cleaner and carburetor assemblies See "Carburetor Removal and Installation (FD671D)" on page 60 or See "Throttle Body Removal and Installation (FD750D)" on page 62.

3. Remove muffler. See "Muffler Removal and Installation" on page 58.

4. Remove intake manifold. See "Intake Manifold Removal and Installation (FD671D)" on page 66 or "Intake Manifold Removal and Installation (FD750D)" on page 67.

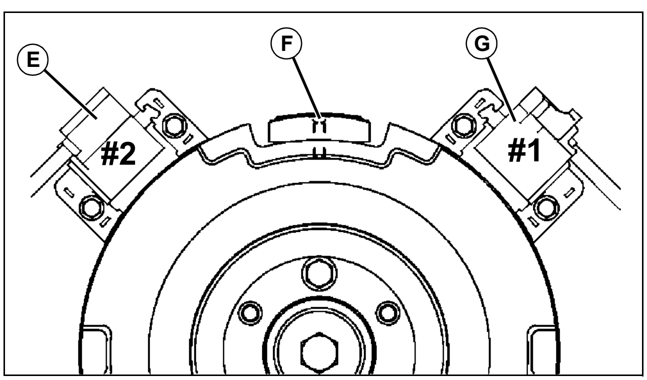


MX16112

5. Remove spark plug(s) (D).

6. Unscrew the eight (8) rocker cover mounting bolts (A), and remove the left (B) and right (C) covers and gaskets.

Note: No. 1 cylinder is the left cylinder when sitting in the drivers seat, No. 2 cylinder is the right.

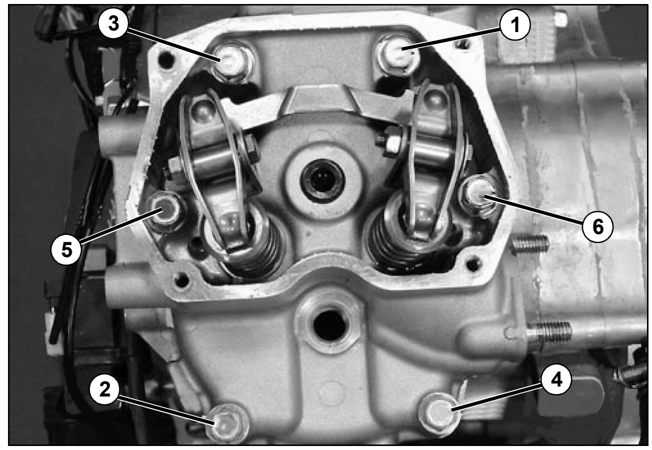


MX14236

7. Before removing the cylinder head, the piston should be set to TDC (Top Dead Center) on the intake stroke for the cylinder you are working on. This can be determined by the position of the flywheel magnet (F) in relation to the coils.

- When setting the flywheel a TDC of the #1 cylinder, align the flywheel magnet (F) with the #1 ignition coil (G). If it is not at TDC, turn the flywheel clockwise one turn (360°).
- When setting the flywheel a TDC of the #2 cylinder, turn the flywheel magnet (F) clockwise from position at TDC. of #1 cylinder to the #2 ignition coil (E). If it is not at TDC, turn the flywheel clockwise one turn (360°).

Important: Avoid Damage! Cylinder head can be warped during removal if the correct head bolt removal procedure is not followed.



MX11613

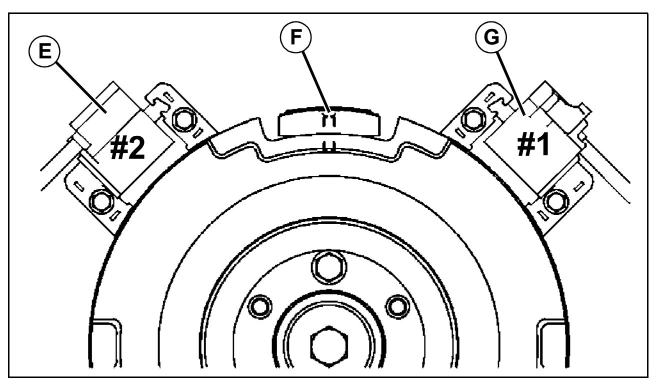
8. Loosen the cylinder head bolts 1/4 turn in the sequence shown. Repeat the sequence until all bolts are removed and lift off the cylinder head assembly.

Note: If removing push rods, Mark each rod for assembly in original location.

9. Clean the mating surfaces of the cylinder heads and cylinder of all old gasket material and sealing compound.

Installing:

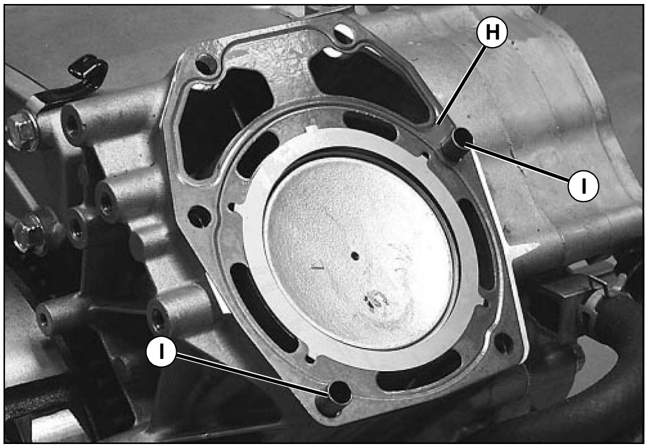
1. Install push rods in their original positions if removed. See "Push Rod/Rocker Arm Removal and Installation" on page 77.



MX14236

2. Set the cylinder you are working on to TDC of intake power stroke.

- When setting the flywheel a TDC of the #1 cylinder, align the flywheel magnet (F) with the #1 ignition coil (G). If it is not at TDC, turn the flywheel clockwise one turn (360°).
- When setting the flywheel a TDC of the #2 cylinder, turn the flywheel magnet (F) clockwise from position at TDC of #1 cylinder to the #2 ignition coil (E). If it is not at TDC, turn the flywheel clockwise one turn (360°).



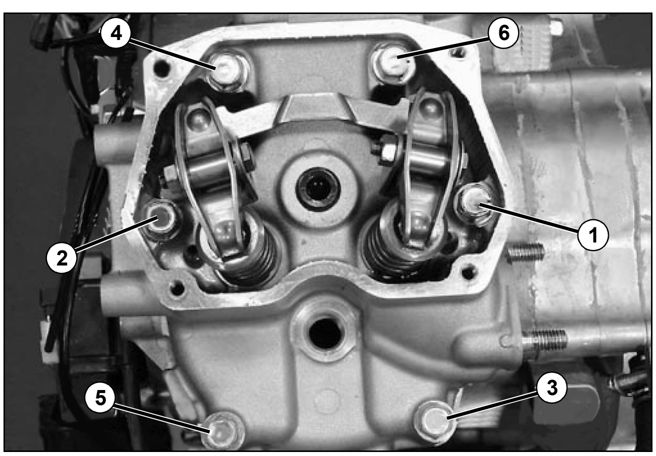
MX16114

3. Install the two alignment pins (I) in the cylinder head assemblies (if removed).

Important: Avoid Damage! Cylinder head gaskets (H) are coated with sealing agents. Gasket leaks could occur if the sealing compound is scratched or damaged.

4. Position new gaskets (H) on the cylinders.

5. Lower the cylinder head, with push rods aligned under the rocker arms.



MX11613

6. Install the cylinder head bolts, noting the position of different length bolts. Tighten in the sequence shown above. Use a torque wrench and tighten in the following steps to prevent warping the head:

- **3 N•m (27 lb-in.)**
- **15 N•m (11 lb-ft)**
- **27 N•m (20 lb-ft)**

7. Check valve clearance and adjust if necessary. See “Valve Clearance Adjustment” on page 43.

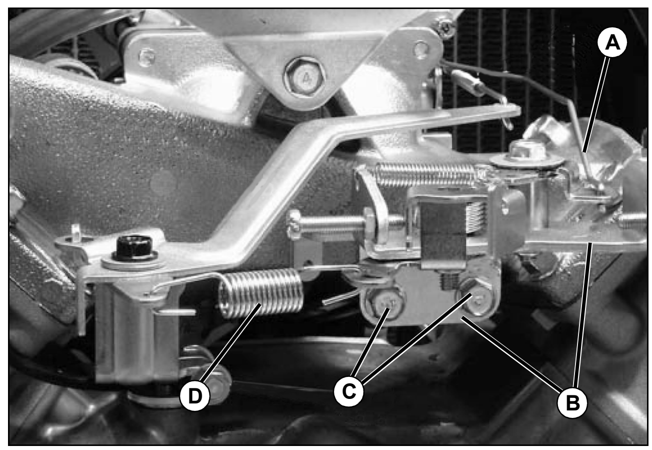
8. Install gasket and rocker cover, tightening rocker cover mounting bolts to **6.9 N•m (61 lb-in.)**.

9. Install spark plugs, intake manifold, muffler, carburetor, air cleaner, and radiator in reverse order of disassembly.

Intake Manifold Removal and Installation (FD671D)

Removing:

1. Remove air cleaner assembly. See “Air Cleaner Removal and Installation” on page 58.



MX16110

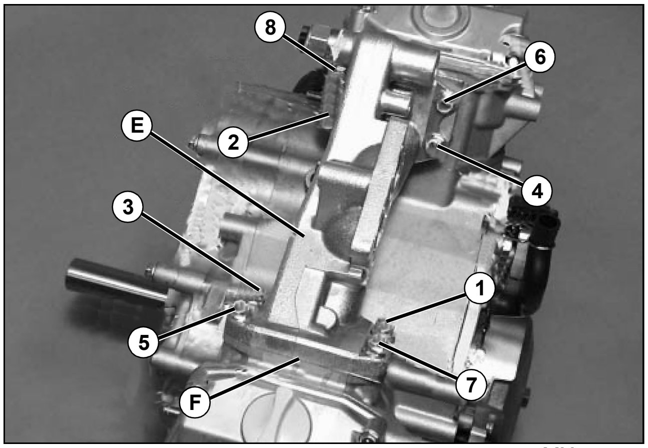
2. Remove muffler and two cap screws (C) securing control panel.

3. Remove the control panel assembly (B), while unhooking the governor spring (D) end loop at the panel bracket.

4. Clear the choke link rod end (A) form the choke lever.

5. Remove carburetor. See “Carburetor Removal and Installation (FD671D)” on page 60.

6. Drain the coolant in the engine.



MX16111

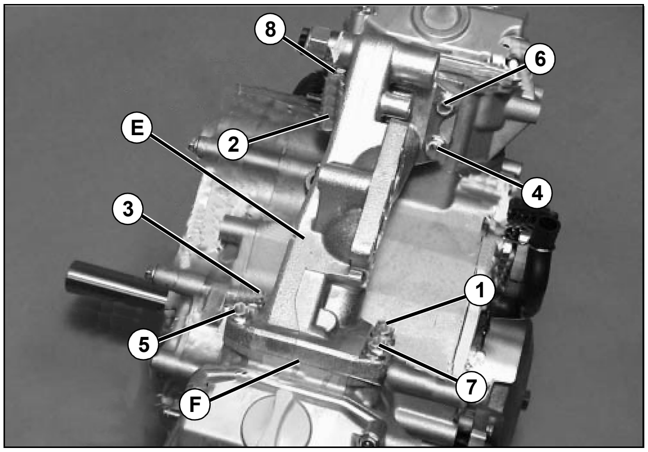
7. Unscrew the manifold mounting nuts in numerical sequence, 1/4 turn at a time, until all bolts are loose.

8. Remove the manifold (E) and gaskets (F).

9. Inspect the intake manifold for signs of cracks or porous spots. Fuel stains on the surface of the manifold often indicate a suspect area. Inspect the manifold gasket mounting surfaces for burned areas or nicks and gouges. Replace the intake manifold if it is cracked, or the gasket mounting surfaces are damaged to the point they will not seal properly with new gaskets. Visually inspect the coolant passage in the manifold for deposits or corrosion in layer inside the passage; clean the passage if necessary.

10.Clean all old gasket residue off the mating surfaces of the intake manifold and the cylinder heads. Install new gaskets.

Installing:



MX16111

1. If removed, install the cylinder heads on each cylinder and tighten the head bolts. See “Cylinder Head Removal and Installation” on page 65.

2. Place new gaskets (F) on each mating surface, and install the manifold (E).

3. Tighten the manifold mounting bolts in sequence above, **3.0 N•m (27 lb-in.)** at a time, until the torque on each bolt is **20 N•m (15 lb-ft)**.

4. Fill engine coolant.

5. Install the carburetor, control panel assembly, and air cleaner assembly reverse of removal.

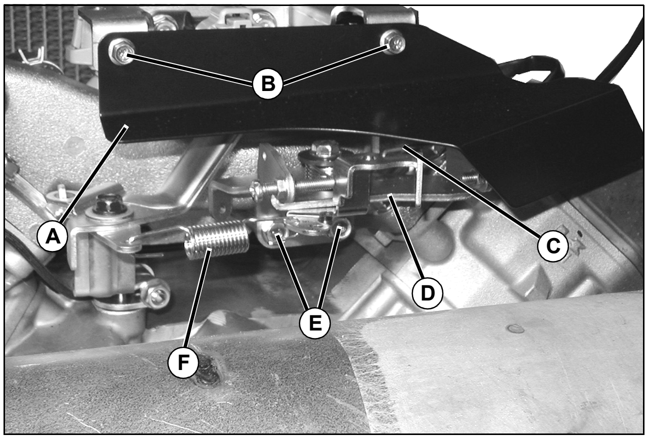
Intake Manifold Removal and Installation (FD750D)

Removing:

> **Caution: Avoid Injury! Release of fluids from pressurized fuel system can cause serious injuries. Relieve fuel system pressure before servicing.**

1. Remove air cleaner assembly. See “Air Cleaner Removal and Installation” on page 58.

2. Drain the coolant in the engine, and remove radiator. See “Radiator Removal and Installation” on page 56.



MX16214

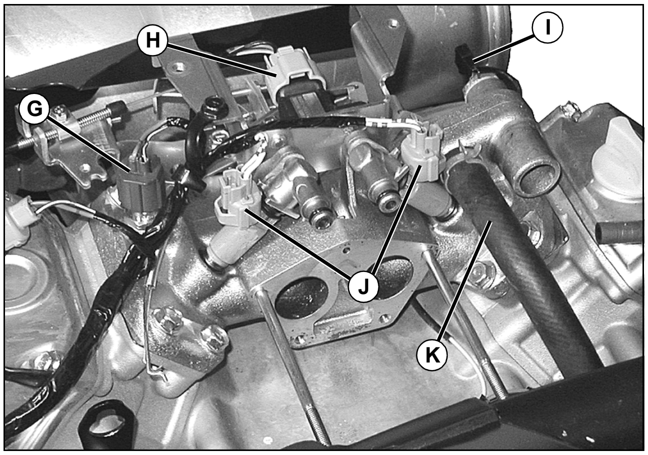
3. Remove two cap screws (B) and bracket (A).

4. Remove two cap screws (E) securing control panel.

5. Clear the throttle link rod end (C) from the choke lever.

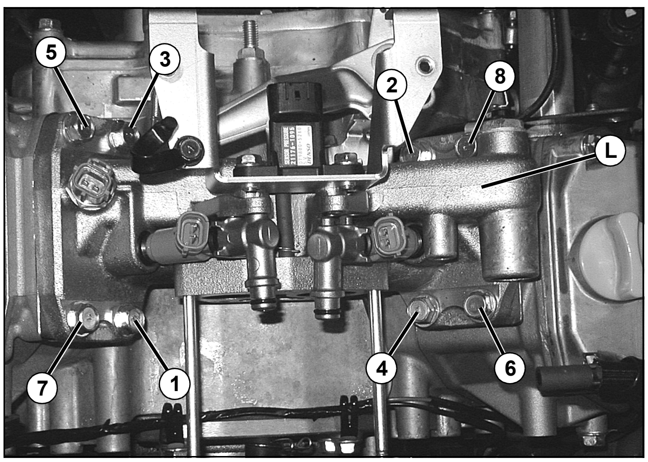
6. Remove the control panel assembly (D), while unhooking the governor spring (F) end loop at the panel bracket.

7. Remove throttle body assembly. See “Throttle Body Removal and Installation (FD750D)” on page 62.



MX16215

8. Disconnect fuel injector leads (J), water temperature lead (G), vacuum sensor lead (H), and thermo switch lead (I).



MX16216

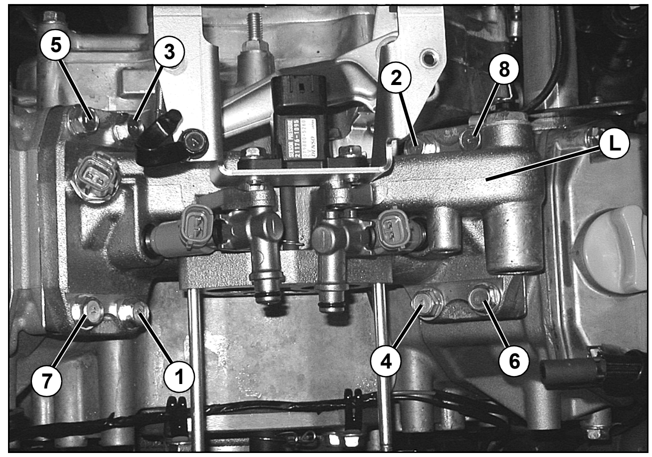
9. Unscrew the manifold mounting nuts in numerical sequence, 1/4 turn at a time, until all bolts are loose.

10.Remove the manifold (L) and gaskets.

11.Inspect the intake manifold for signs of cracks or porous spots. Fuel stains on the surface of the manifold often indicate a suspect area. Inspect the manifold gasket mounting surfaces for burned areas or nicks and gouges. Replace the intake manifold if it is cracked, or the gasket mounting surfaces are damaged to the point they will not seal properly with new gaskets. Visually inspect the coolant passage in the manifold for deposits or corrosion in layer inside the passage; clean the passage if necessary.

12.Clean all old gasket residue off the mating surfaces of the intake manifold and the cylinder heads. Install new gaskets.

Installing:

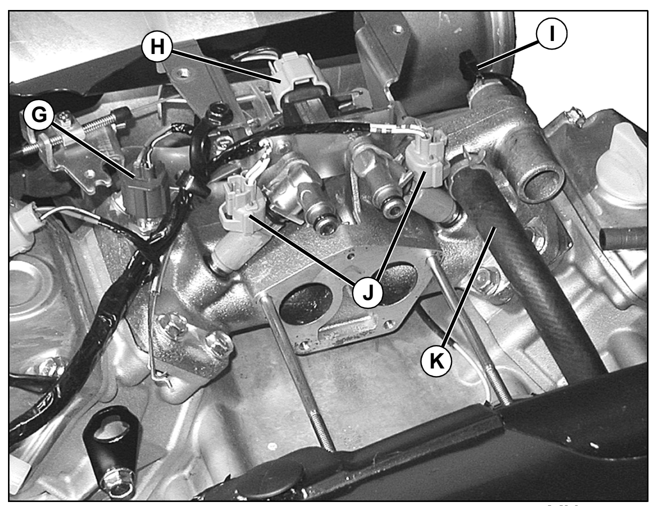


MX16216

1. If removed, install the cylinder heads on each cylinder and tighten the head bolts. See “Cylinder Head Removal and Installation” on page 65.

2. Place new gaskets on each mating surface, and install the manifold (L).

3. Tighten the manifold mounting bolts in sequence above, **3.0 N•m (27 lb-in.)** at a time, until the torque on each bolt is **20 N•m (15 lb-ft)**.



MX16215

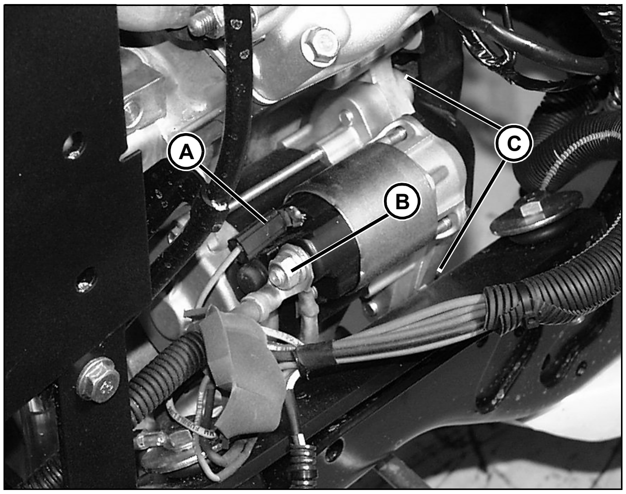
4. Connect fuel injector leads (J), water temperature lead (G), vacuum sensor lead (H), and thermo switch lead (I).

5. Fill engine coolant.

6. Install the throttle body, control panel assembly, radiator, and air cleaner assembly reverse of removal.

Starting Motor Removal and Installation

1. Disconnect battery negative terminal (-).



MX14279

2. Disconnect battery terminal and leads from starting motor solenoid terminal (B).

3. Disconnect switch lead (A) from starting motor.

4. Remove the two (2) mounting bolts (C) and pull the starter motor from the engine.

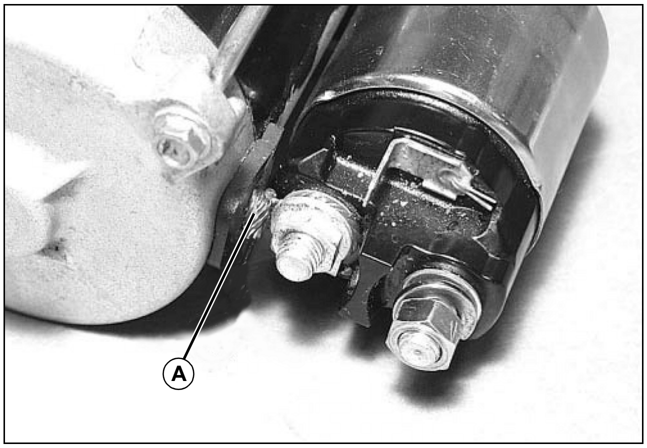
5. Clean the starter motor and engine mounting flanges to ensure good electrical contact when installing starter. If corrosion is evident on either machined mounting surface, clean the area with emery cloth or sandpaper.

6. Install the starter, and two mounting bolts (C). Tighten mounting bolts to **20 N•m (180 lb-in.)**.

7. Install all electrical leads in reverse order of removal. Install negative battery terminal (-).

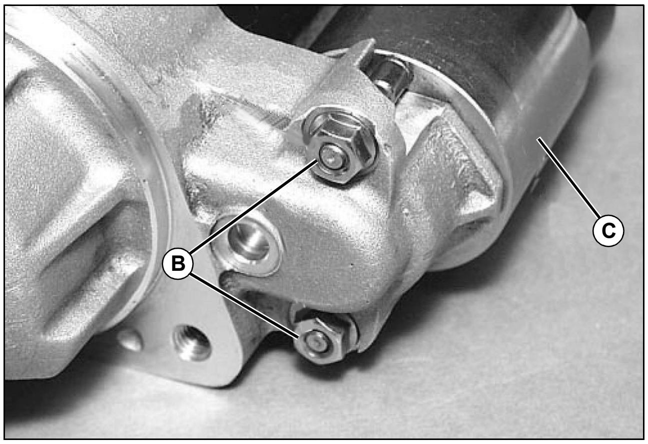
Starter Motor Disassembly and Assembly

1. Remove the starter motor from the engine. See “Starting Motor Removal and Installation” on page 69.



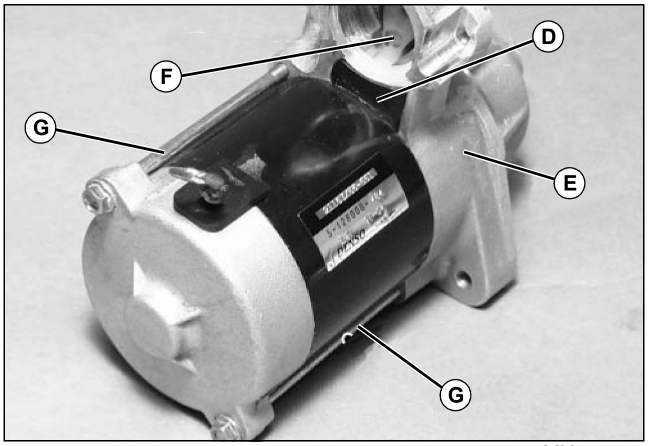
MX11970

2. Pull back the rubber boot and remove the lead (A) from the starter motor to the solenoid.



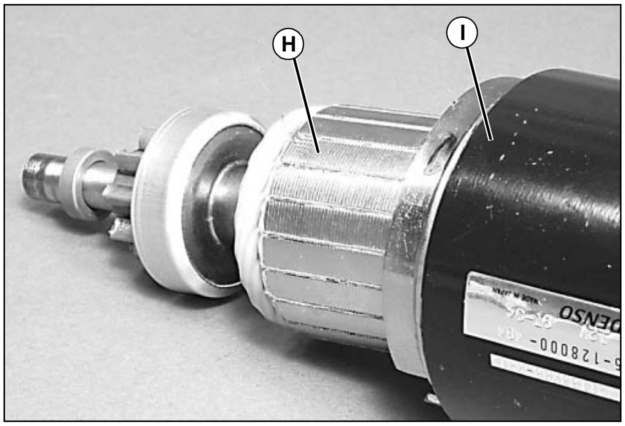
MX11971

3. Unscrew the mounting nuts (B) and remove the solenoid assembly (C).



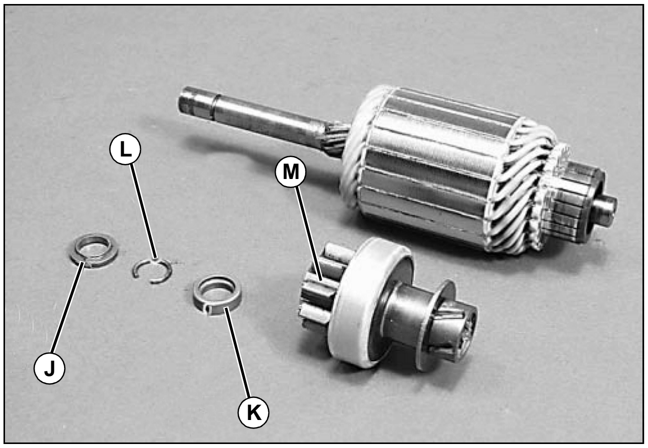
MX11972

4. Pull the rubber insert (D) from the starter motor and remove the pinion gear cover (E). Slip the actuating arm (F) from the pinion gear. Remove the motor through bolts (G).



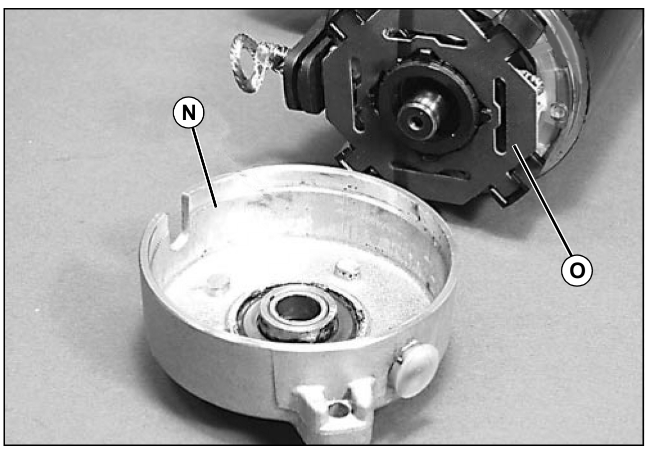
MX11973

5. Pull the armature (H) from the yoke (I).



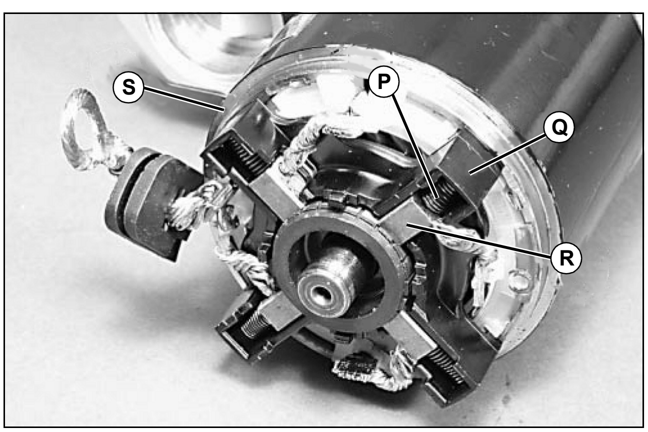
MX11974

6. Separate the front stopper (J) from the rear stopper (K) and remove the front stopper from the armature shaft. Push the rear stopper down the shaft and remove the snap ring (L). Pull the rear stopper and pinion gear (M) from the armature shaft.



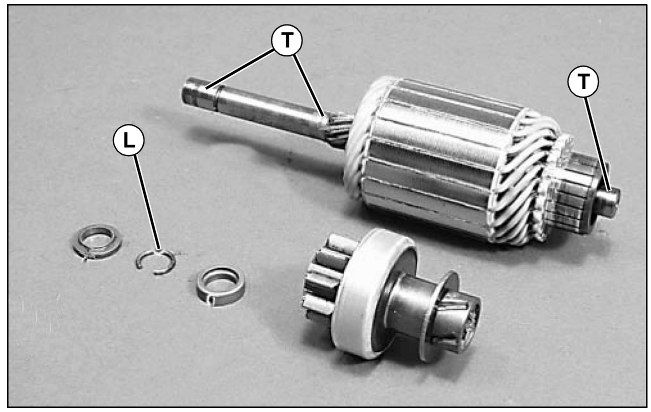
MX11975

7. Pull the end cover (N) from the yoke and remove the insulator (O).



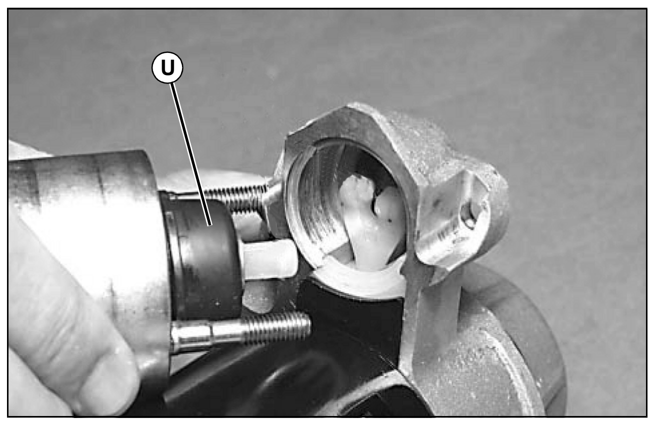
MX11976

8. Remove the brush springs (P) from the brush holder (Q). Separate the brushes (R) from the holder and remove the holder from the yoke (S).



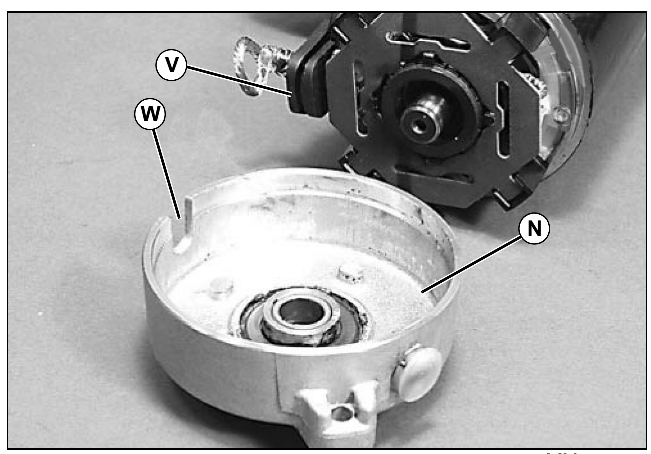
MX11974

9. Before beginning assembly apply a small amount of electric grease to the indicated areas (T) of the armature shaft. Obtain a new snap ring (L). Assemble the pinion gear on the armature shaft with the new snap ring and install the pinion assembly and actuating arm. Slide the yoke over the armature.



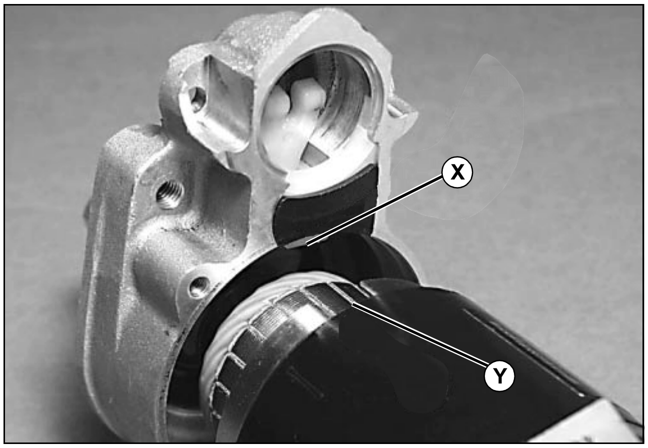
MX11979

10. Inspect the solenoid rubber boot (U) for visible damage (hole, rips, dry rot etc.); replace if necessary.



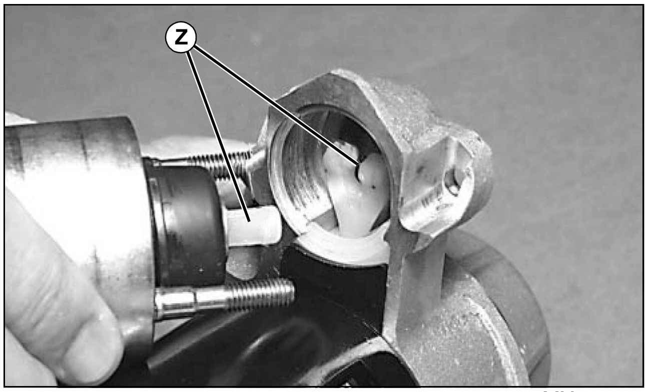
MX11975

11. Install the brush assembly and insulator on the yoke. Fit the notch (V) in the (-) lead grommet onto the projection (W) on the end cover (N). Install the end cover.



MX11981

12. Grease the pinion gear fork fingers, and set the pinion gear fork so that the fingers fit into the groove in the gear. Fit the notch (Y) in the yoke onto the projection (X) on the pinion gear fork. Install the through bolts through the rear cover and thread into the pinion gear cover.



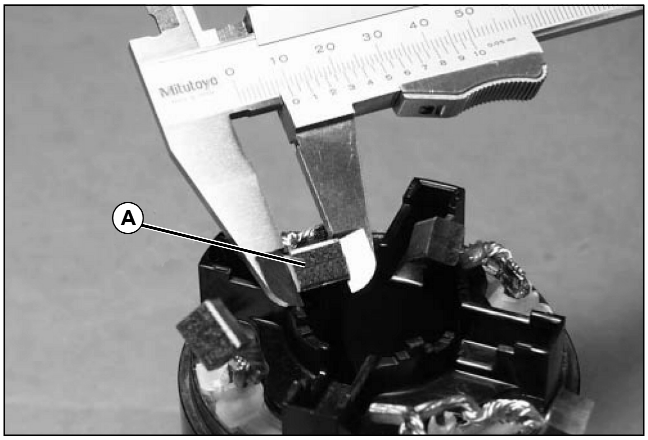
MX11979

13. Engage the hook (Z) on the starter solenoid with the pinion gear fork. Install the solenoid mounting nuts.

14. Install the solenoid to starter motor lead. Install the starter assembly onto the engine. See "Starting Motor Removal and Installation" on page 69.

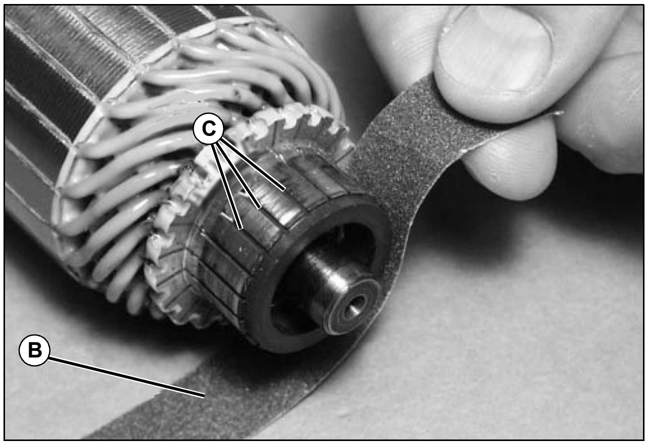
Starting Motor Inspection

1. Disassemble starter. See "Starter Motor Disassembly and Assembly" on page 69.



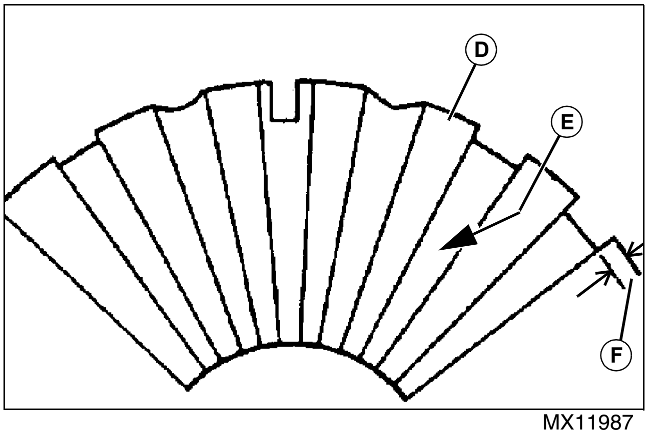
MX11984

2. Measure length of brush (A). If any brush is shorter than **6 mm (0.24 in.)**, replace all brushes. Inspect the brush springs for any distortion or damage. Replace if necessary.



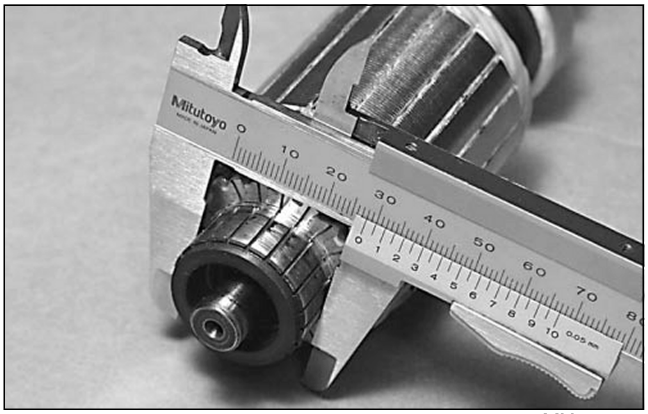
MX11980

3. Inspect the surface of the commutator. If the surface is scratched or dirty, polish it with very fine emery cloth (B) and then clean out the grooves (C).



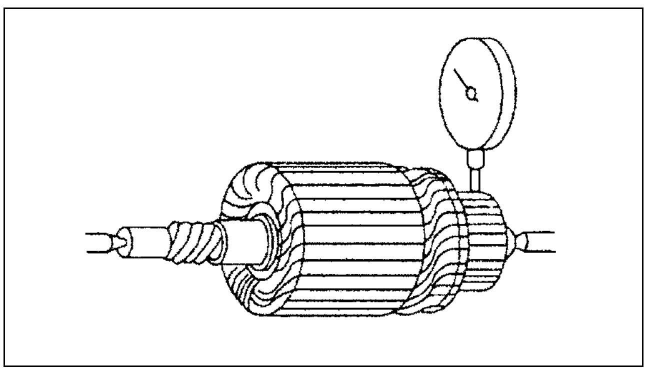
MX11987

4. Measure the depth of the grooves between the commutator segments (D). If groove depth is less than **0.2 mm (0.008 in.)** undercut the insulating mica (E) to the standard depth (F) of **0.5 to 0.8 mm (0.012 to 0.031 in.)** using a thin file. If grooves are only dirty, clean them carefully and measure depth before cutting the mica.



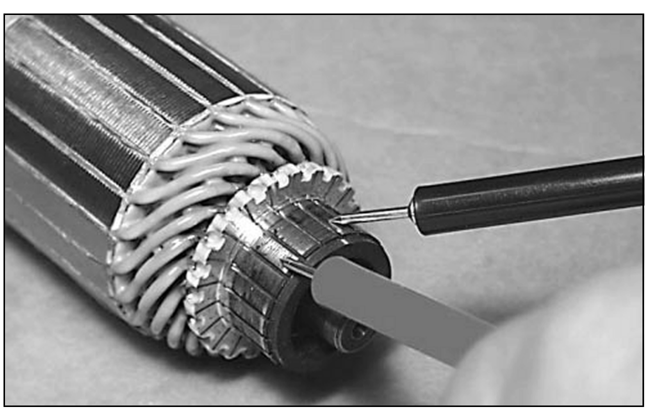
MX11988

5. Measure the commutator outside diameter at several points. If the diameter is less than **27 mm (1.06 in.)** replace the armature with a new one.



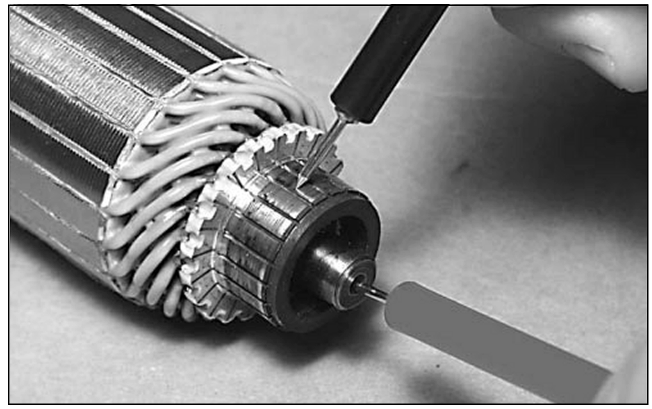
MX11989

6. Support the armature in an alignment jig at each end of the shaft as shown. Position a dial indicator perpendicular to the commutator. Rotate the armature slowly and read the commutator runout. If runout is more than **0.4 mm (0.016 in.)** replace the armature.



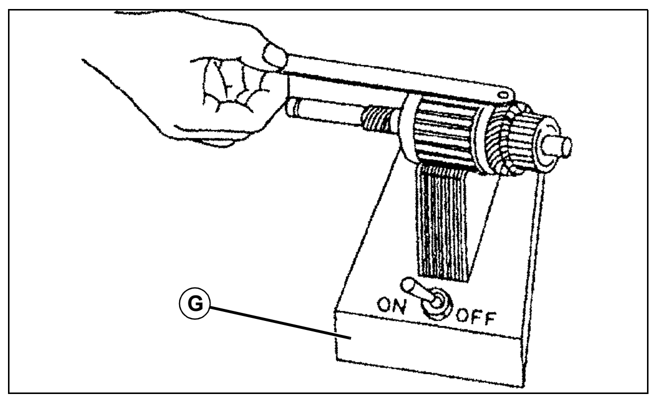
MX11990

7. Set a multimeter to the R x 1 ohm position and check the resistance between each segment and all others. If the armature winding resistance registers either infinite or much greater than 0 ohms the starter motor should be replaced.



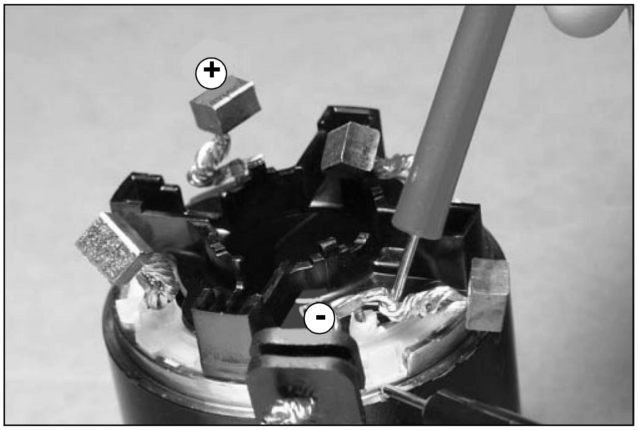
MX11991

8. With the multimeter in the R x 1 ohm position measure the resistance between the armature shaft and the commutator. If the resistance is less than infinite, the armature is shorted and must be replaced.



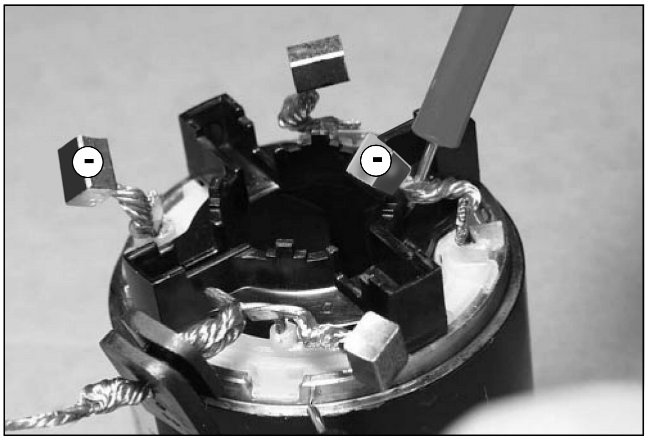
MX11992

9. Place the armature on a growler (G) and hold a thin metal strip (e.g. a hack saw blade) on top of the armature. Turn on the growler and rotate the armature one complete turn. If the metal strip vibrates, the windings are internally shorted to each other and the starter must be replaced.



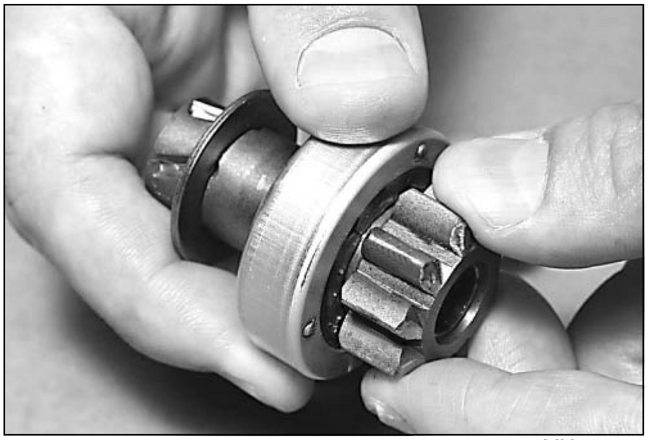
MX11998

10.With the multimeter in the Rx 1k ohm position, measure the resistance between the positive brushes and starter motor yoke. If resistance is less than infinite on any brush, the brush is shorted and the complete yoke assembly must be replaced.



MX12000

11.With the multimeter in the Rx 1 ohm position, measure the resistance between the negative brushes and starter motor yoke. If resistance is less than infinite on any brush, the brush is shorted and the complete yoke assembly must be replaced.



MX14440

12.Remove the pinion clutch and turn it by hand. The clutch should turn freely counterclockwise, and lock up and not turn in a clockwise direction. If the clutch does not operate correctly or is noisy when freewheeling, replace it.

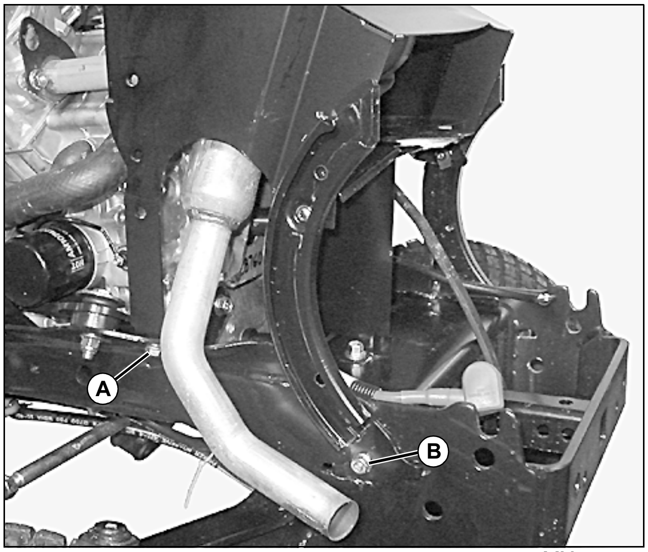
Engine Removal and Installation

Prepare Machine:

- Park machine safely. See “Park Machine Safely” in the SAFETY section.
- Allow engine to cool.
- Open hood.

Removing:

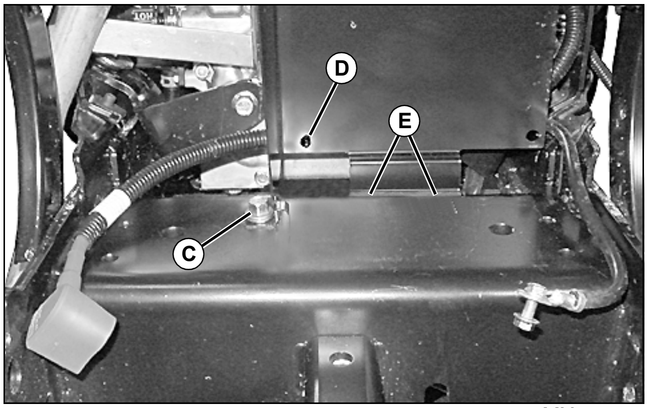
1. Disconnect headlight connector and remove hood.
2. Remove radiator cap and drain coolant into a clean container.
3. Disconnect and remove upper and lower radiator hoses.
4. Loosen clamp and remove air cleaner intake hose.
5. Disconnect and remove battery.



MX14370

Picture Note: Battery shield, right side view.

6. Remove two cap screws (A) securing side brackets of battery shield to frame and two nuts (B) securing hood brackets to frame.



MX14374

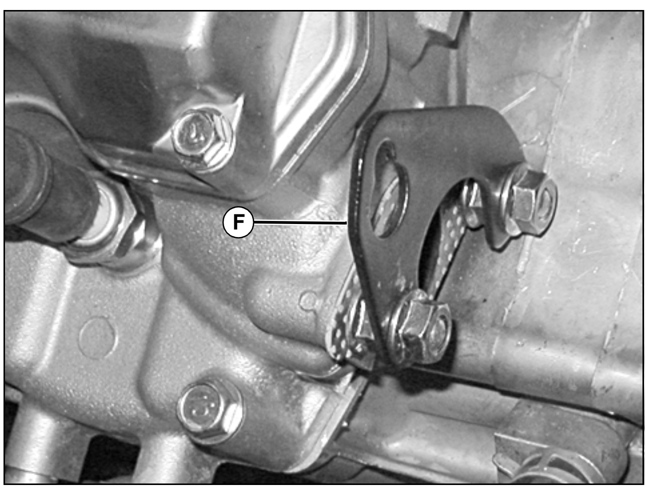
7. Remove cap screw (C) that secures battery shield to top of frame.

8. Compress positive battery cable retainer clip (D) and separate cable from battery shield.

9. Loosen two cap screws that secure slotted mounting holes in battery shield to back of frame at locations marked (E).

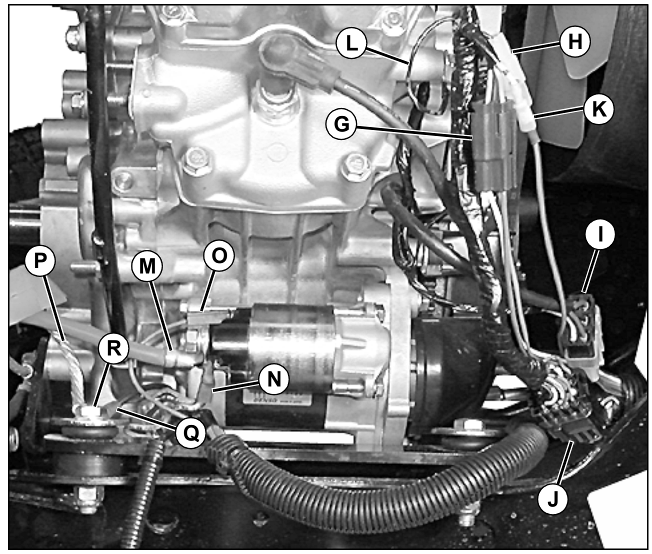
10.Lift and remove battery shield.

11.Remove right side lift bracket and muffler. See "Muffler Removal and Installation" on page 58.



MX14375

12.Install lift bracket (F) back onto right side muffler flange studs. Use two muffler flange nuts as spacers, then bracket, then two remaining nuts to secure bracket to studs. This will prevent damage to valve cover from lifting hook during removal and installation.



MX14376

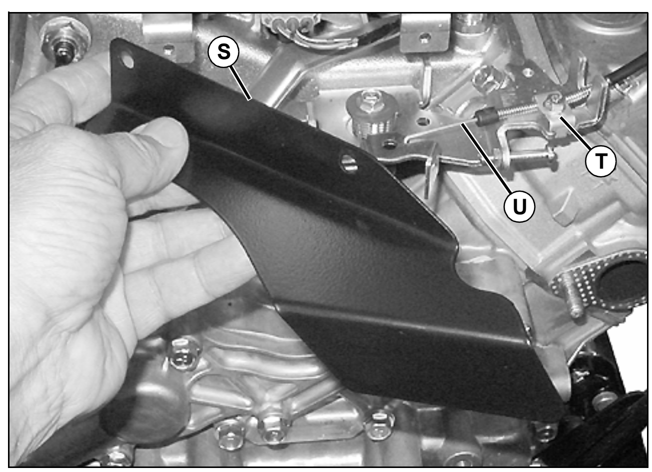
Picture Note: Fuel injected engine, left side.

13.Disconnect the wiring harness plug-in connectors (G, H, I, J) and bullet connector (K). Note: The carburated engine will have fewer connectors than the fuel injected engine shown.

14.Remove the retaining bolt at the rear of the left cylinder head, remove wire harness J-clip and disconnect ground wire (L).

15.Disconnect positive battery cable (M) and power lead bundle (N) at the starting motor terminal and unplug solenoid wire (O).

16.Disconnect the engine ground strap (P) and the main wiring harness ground wire bundle (Q) by removing the left front engine mount bolt (R), washer and nut.

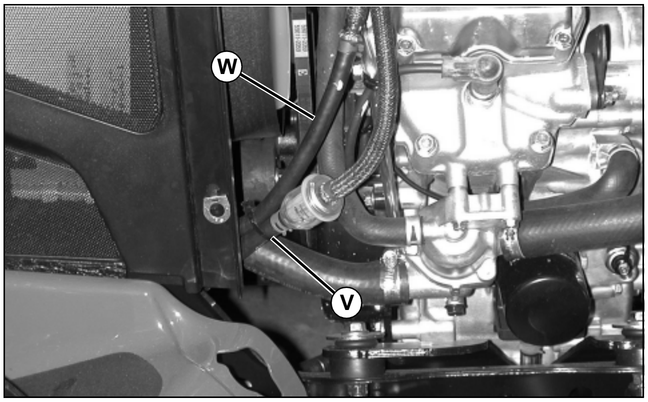


MX14378

Picture Note: Throttle cable and shield, fuel injected engine.

17.Remove two cap screws retaining throttle linkage shield (S) and remove shield.

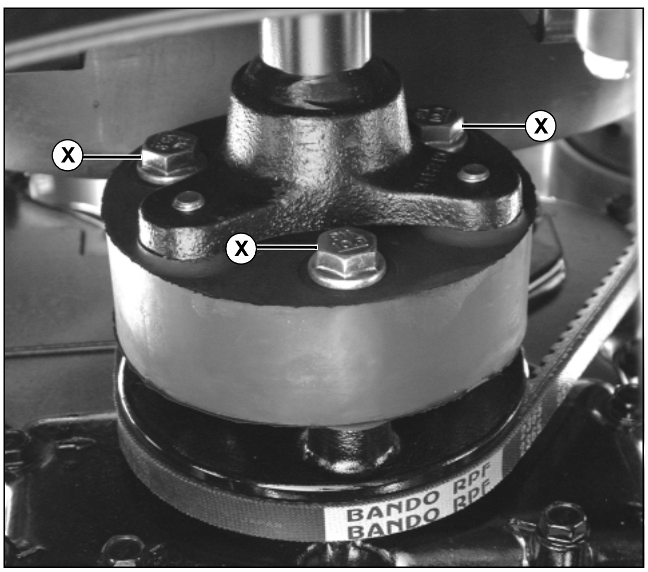
18.Loosen throttle cable clamp (T) and disconnect cable (U).



MX15403

Picture Note: Carburated engine fuel lines.

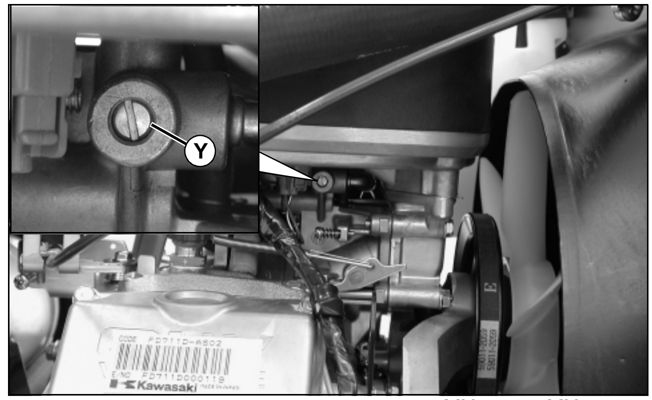
19.Disconnect and plug the fuel supply line (V) and fuel return line (W) on carburated engine.



MX13614

20.Remove the three cap screws (X) at the rear of the drive coupler and disconnect drive shaft from engine sheave.

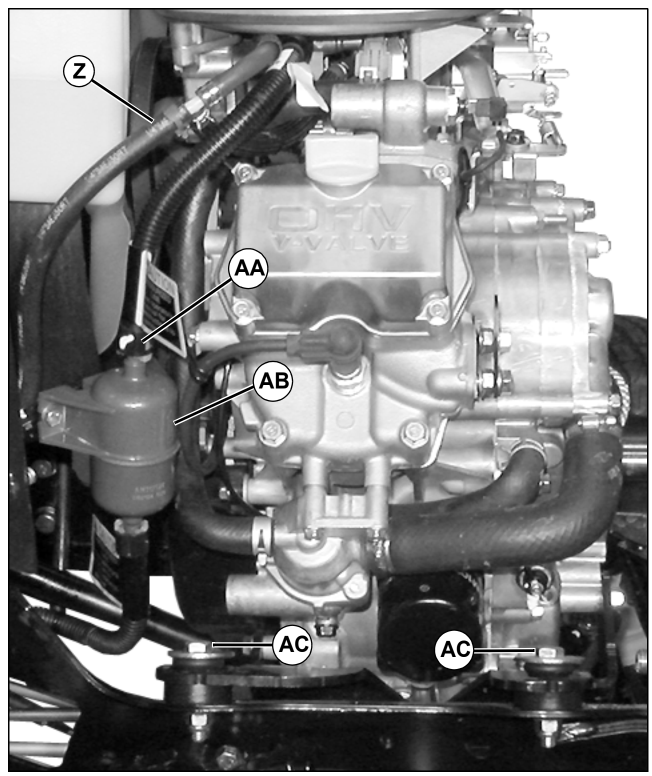
Note: Fuel lines may be pressurized on the fuel injected engine. Relieve pressure prior to servicing fuel lines or components.



MX15401, MX14502

Picture Note: Fuel pressure relief screw, fuel injected engine.

21.Release fuel pressure by loosening pressure relief screw (Y), then tighten screw.



MX16001

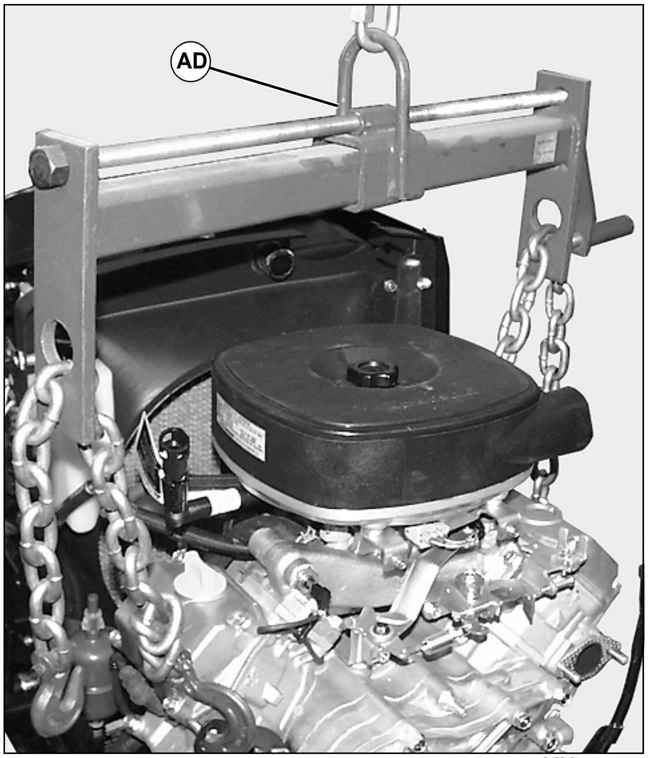
Picture Note: Fuel injected engine, right side.

22.Disconnect and plug the fuel return line (Z), and disconnect the supply line quick-coupler (AA) at the top of the fuel filter (AB), on the fuel injected engine.

23.Remove the two right side engine mount bolts (AC), washers and nuts, and the left rear motor mount bolt, washer and nut.

24.Detach any hydraulic lines that may be supported by J-clips or other hardware connected to the bottom of the engine.

Note: If no spreader bar is available, remove air cleaner assembly and cover fuel injection air intake hole with a clean shop rag to prevent entry of foreign objects.



MX16004

25.Connect engine hoist to lift hooks on engine using spreader bar (AD) with lift chains to avoid damage to air cleaner during removal.

26.Lift engine slightly and pull away from radiator to clear shroud and fuel filter, then remove engine from machine.

Installing:

1. Lower the engine so that it rests slightly on the engine mounts.

2. Align the engine and mounts, then install the two right side and the left rear engine mount bolts, washers and nuts finger tight.

3. Lower engine fully, disconnect hoist from engine lifting brackets and remove hoist.

4. Route ground wire bundle from main wiring harness to original position by left front engine mount.

5. Install engine ground strap and ground wire bundle from main wiring harness with left front engine mount hardware, tighten hardware finger tight.

6. Tighten all engine mount bolts to **50 N•m (37 lb-ft)**.

7. Align drive coupler with engine sheave, install drive coupler mounting bolts and tighten to **40 N•m (30 lb-ft)**.

8. Unplug and connect fuel return hose and connect fuel supply hose quick-coupler to fuel filter.

9. Secure any hydraulic hoses, if removed in an earlier step, to appropriate hardware attached to the bottom of the engine.

10.Secure wire harness J-clip and ground wire to back of left cylinder head with retaining bolt and tighten.

11.Connect main wire harness plug-in connectors and bullet connector to the corresponding engine connectors.

12.Connect the main wiring harness power lead bundle and positive battery cable to the starter terminal, and connect the solenoid plug.

13.Connect and adjust throttle cable. See “Throttle Cable Adjustment” on page 40.

14.Install throttle cable shield.

15.Remove the right side lift bracket and four flange nuts from the muffler flange studs.

16.Install new muffler gaskets.

17.Install the muffler and the right side lifting bracket in their original locations and tighten mounting hardware. See “Muffler Removal and Installation” on page 58.

18.Install battery shield and attach positive battery cable retainer clip.

19. Install battery and connect positive battery cable.

20.Install and tighten upper and lower radiator hoses.

21.Replace radiator coolant.

22.Install hood and connect headlight plug.

23.Connect negative battery cable.

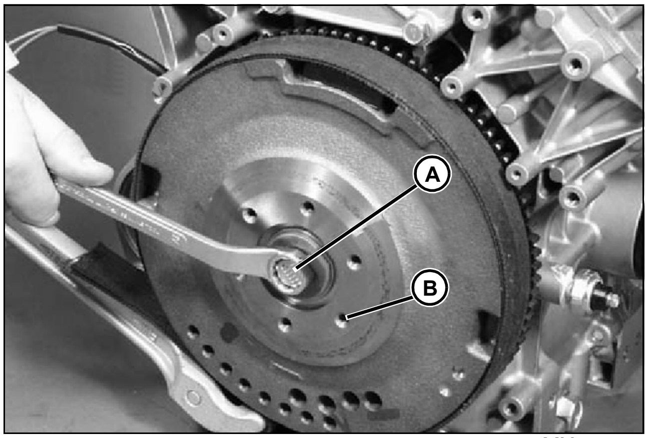
Flywheel Removal and Installation

Procedure:

1. Park machine safely. See Parking Machine Safely in Safety section.

2. Remove engine from machine. See "Engine Removal and Installation" on page 73.

3. Remove plastic cover surrounding lower half of flywheel, and outer sheave attached to flywheel.



MX16077

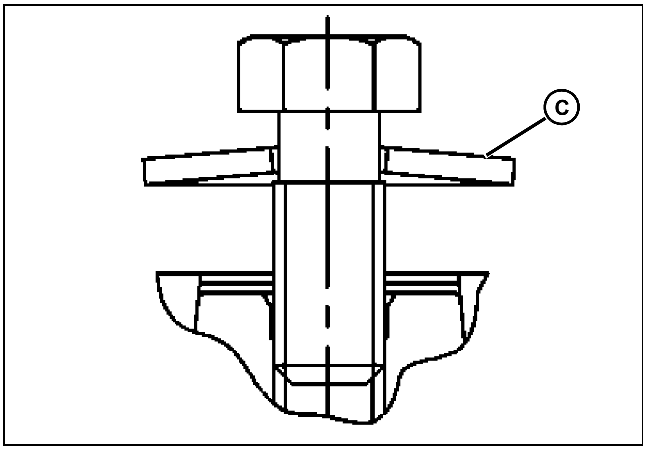
4. Hold flywheel with strap and remove flywheel bolt (A).

5. Thread a flywheel puller into the pulling holes (B) and remove the flywheel.

6. To remove stator coil, see "Stator Replacement" on page 230 in the Electrical section.

7. To remove ignition coil, see "Ignition Coil Replacement and Adjustment" on page 230 in the Electrical section.

8. Align the flywheel keyway with the key on the crankshaft and install flywheel.



MX16079

9. Install spring washer (C) as shown.

10. Install and tighten the flywheel bolt.

11. Install engine into machine.

Specification:

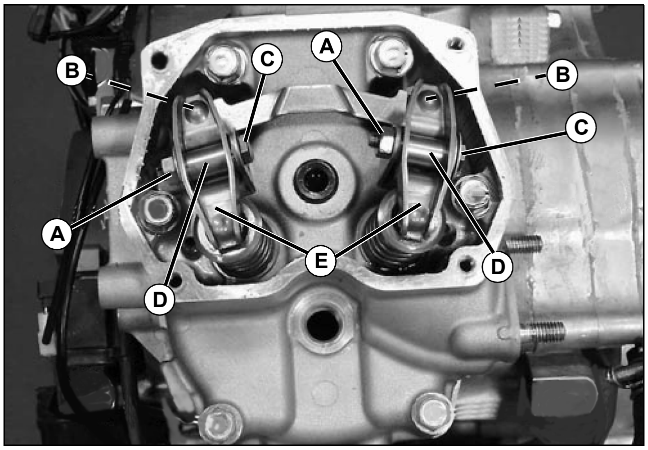
Flywheel Bolt . . . . 56 N•m (41 lb-ft)

Push Rod/Rocker Arm Removal and Installation

Removing:

1. Set the piston on the cylinder you are working on at top dead center (TDC) of the power stroke.

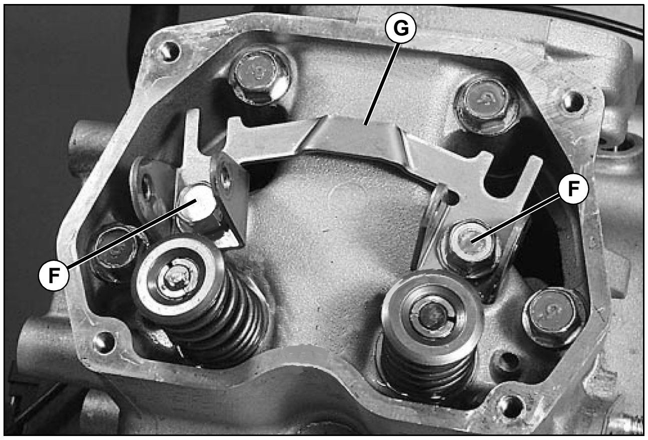
2. Remove rocker covers. See "Cylinder Head Removal and Installation" on page 65.



MX11613

3. Remove the valve clearance adjusting nuts (A), washers, and bolts (C).

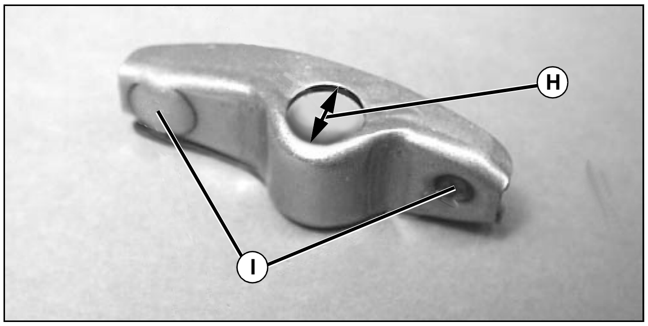
4. Remove the rocker arms (E), along with collars (D), to provide access to the push rods (B). Pull out the push rods and mark each rod so it can be installed in the original position during reassembly.



MX16115

5. Remove two bolts (F) and rocker arm bracket (G).

Inspection:

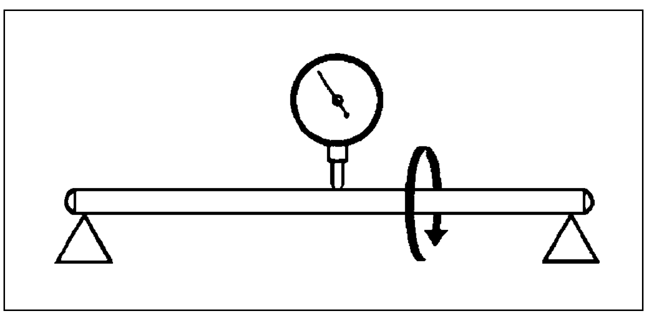


MX16116

- Clean the rocker arms and inspect the push rod and valve stem contact points (I). If the contact surfaces are excessively worn or show signs of galling or surface flaking, replace the rocker arm.
- Measure the inside diameter of the rocker arm bearing (B) at several points using a dial bore gauge or inside micrometer. If the inside diameter is more than the service limit, replace the rocker arm.

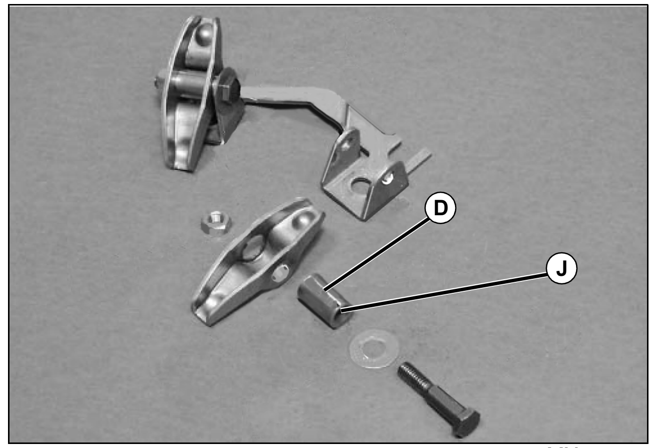
Rocker Arm Bearing Inside Diameter:

Service Limit . . . . 11.05 mm (0.435 in.)



MX11799

- Inspect the push rods for damage or excessive runout. Place each push rod in V blocks set as near to the ends of the rod as possible. Set up a dial gauge at the center point of the push rod. Turn the rod to measure the runout. Check the difference between the highest and lowest dial readings to determine runout. If this figure exceeds **0.5 mm (0.02 in.)** the push rod must be replaced.



MX16117

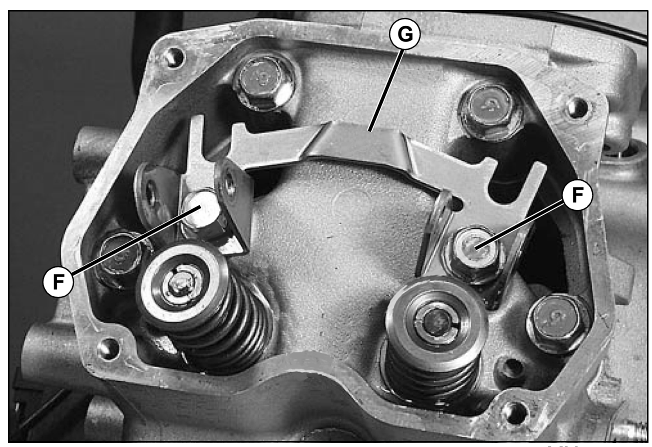
- Measure the inside diameter (J) of the rocker arm collar (D) with a micrometer at several points of the bearing of the rocker arm. If the outside diameter is less than the service limit, replace the rocker arm collar.

Rocker Arm Collar Outside Diameter:

Service Limit. . . . . 10.91 mm (0.43 in.)

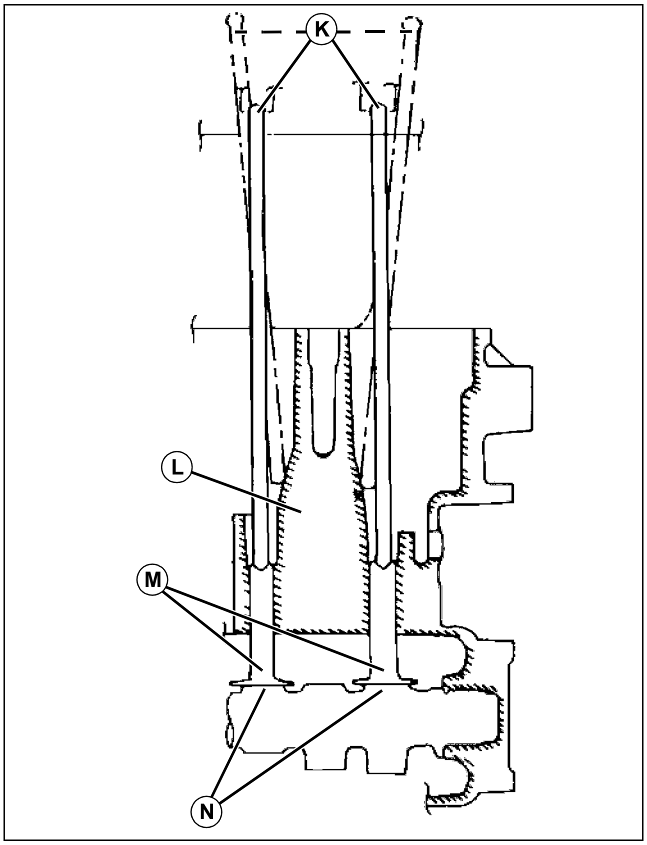
Installing:

1. Set the piston at TDC on the cylinder you are working on before beginning push rod installation.



MX16115

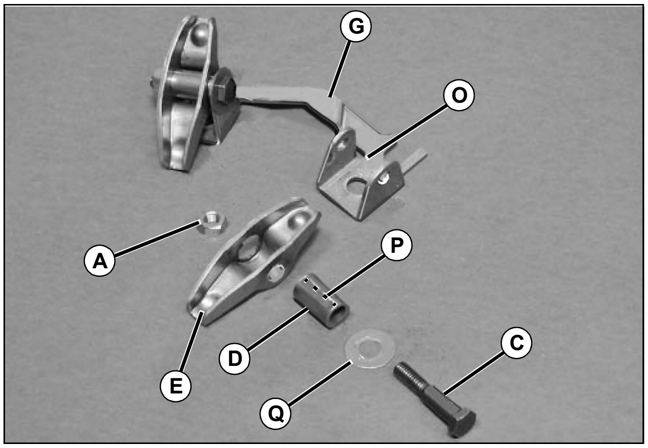
2. If removed, install bracket (G) and two bolts (F). Tighten bolts to **22 N•m (16 lb-ft)**.



MX11802

3. Install each push rod (K) in its original position by inserting the end of the rod so it is sliding along the inside wall of the crankcase (L). Position the push rod on the tappet (M).

4. Check that both intake and exhaust push rods on the cylinder you are assembling are at the lowest position on the cam lobes (N). If not, turn the flywheel clockwise one turn (360^o) and reset the piston at TDC of the power stroke.



MX16117

5. Insert the collar (D) into the rocker arm hole so that the groove (P) of the collar faces upward, then set them on the bracket (O), positioning the push rod ends onto the rocker arm detents.

6. Insert the washer (Q) onto the bolt (C), and insert the bolt into the hole at the right side of the bracket and through the collar installed with the rocker arm.

7. Install the nut (A) onto the bolt and tighten the nut temporarily.

8. Apply clean engine oil to the rocker arm pivot seat area and the contact points on the arm when reinstalling the rocker arms. Perform a valve clearance adjustment as detailed in the Engine Tests and Adjustments section of this manual.

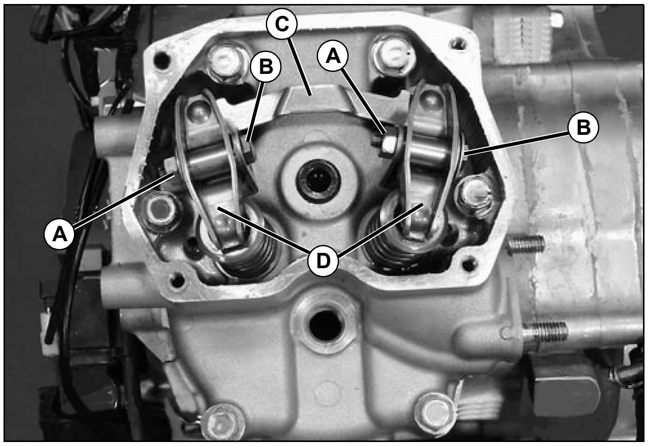
9. Install rocker covers.

Valve Train Removal and Installation

Procedure:

1. Remove cylinder head. See "Cylinder Head Removal and Installation" on page 65.

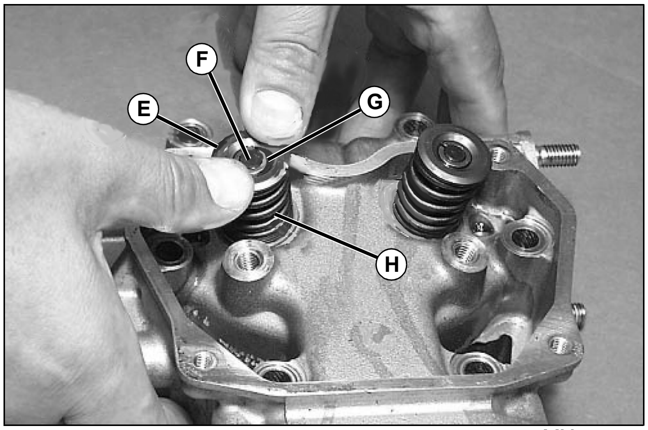
Note: When removing valve train, mark all parts so they can be reinstalled in their original position.



MX11613

2. Remove valve clearance adjusting nuts (A), bolts (B) and associated hardware to remove rocker arms (D).

3. Remove rocker arm bracket (C).



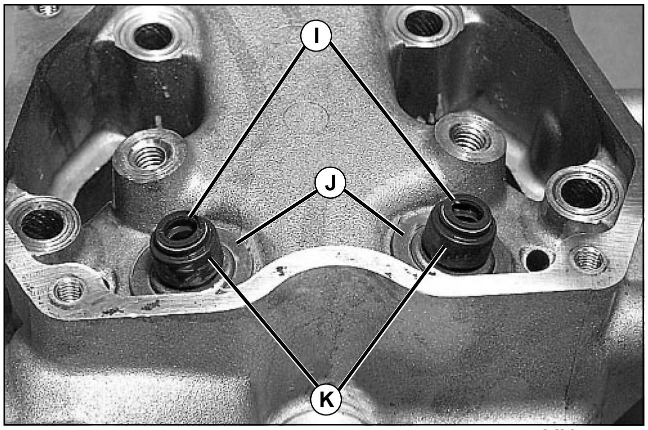
MX16119

4. Support the valve heads inside the combustion chamber with a suitable block such as a piece of wood.

5. Remove the spring retainer (E) by pushing down with your thumbs and removing the collets (G).

6. Remove the spring (H) and valve (F).

Note: Bottom spring retainer (J) can only be removed with stem seal.



MX16120

7. Remove the stem seals (I). Stem seal replacement is not mandatory on a low hour engine, but is recommended, particularly if a new valve has been installed.

Note: Valve guides (K) are not replaceable. If a valve guide is damaged or worn beyond maximum specifications, the head casting must be replaced.

8. Check to see if the valve seats properly in the valve seat. If not, resurface the valve seat and/or replace the valve.

9. Install new stem seals if necessary.

10.Apply engine oil to the valve stem to avoid damaging the valve stem seal. Install the valve and check for smooth operation in the valve guide. Replace valve if valve binds in guide, or guide to stem clearance is excessive.

11.Install valve spring, collets and spring retainer on the valve.

12.Install rocker arm bracket (C).

13.Apply clean engine oil to the rocker arm at the spherical pivot seat, and the points where the arm contacts the push rod and the valve stem end.

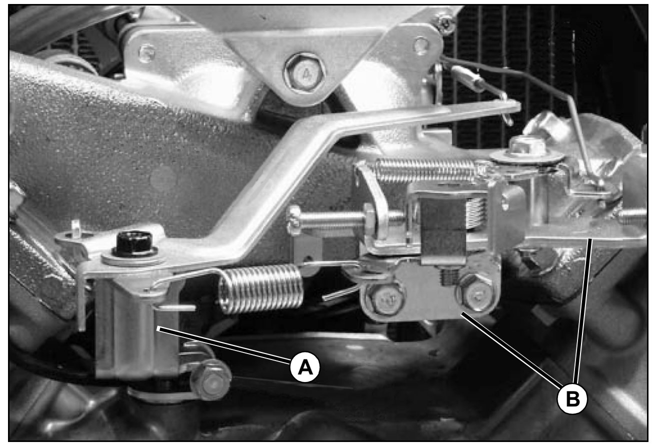
14.Install the rocker arm (and associated hardware) on the rocker arm bracket, and tighten the bolt and nut temporarily. Perform a valve adjustment as detailed in Valve Clearance Inspection and Adjustment in the Engine Tests and Adjustments section.

Crankcase Cover Removal and Installation

Procedure:

1. Remove engine from machine. See “Engine Removal and Installation” on page 73.

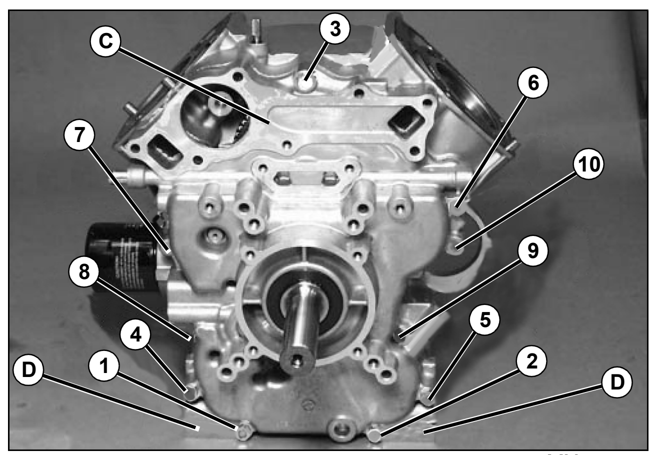
2. Drain engine oil.



MX16110

3. Remove governor control panel (B) and governor arm (A). See “Governor Assembly Removal and Installation” on page 82.

4. Remove rocker covers. See “Cylinder Head Removal and Installation” on page 65.



MX16129

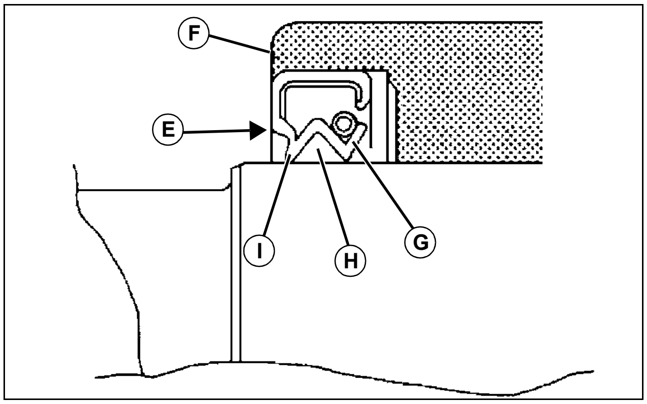
5. Remove the ten (10) cover mounting bolts and remove the crankcase cover (C) from the crankcase. There are two knock points (D) on the cover where a plastic or wood mallet can be used to gently tap the cover loose.

6. Remove the crankcase cover gasket and any gasket residue from both the cover and the crankcase mating area.

Caution: Avoid Injury! Clean the crankcase and cover in a well ventilated area where no sparks or flames are present including appliance pilot lights. Never use gasoline or a low flash-point solvent to clean parts. A fire or explosion could result.

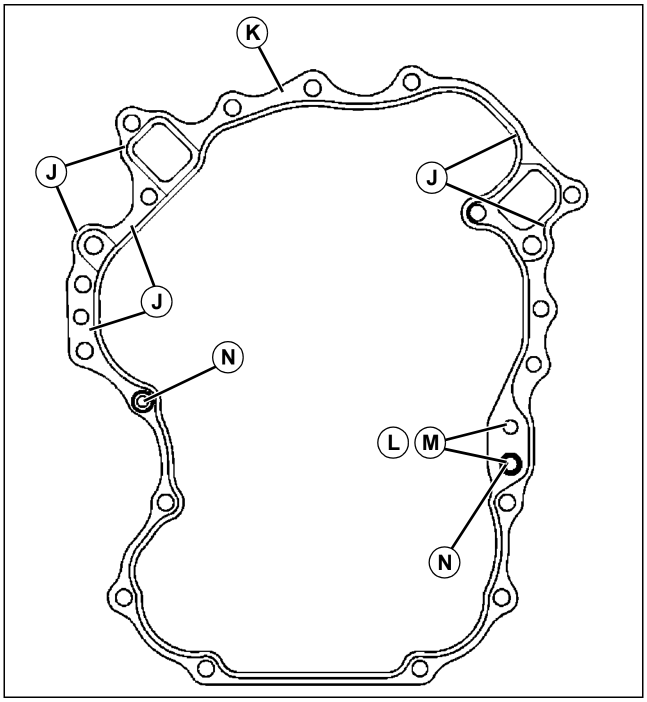
7. Clean the mating surfaces of the cover and the crankcase using a high flash point solvent. Blow out the oil passage in the cover using compressed air.

8. Replace the crankshaft PTO oil seal if necessary. Note the following while replacing this seal:



MX11847

- The crankshaft PTO oil seal is installed with the marks (E) facing out. Press the new seal into the cover until it is flush with the flange surface (F). Pack high temperature grease (H) into the space between the seal lip (G) and the dust lip (I).



MX16130

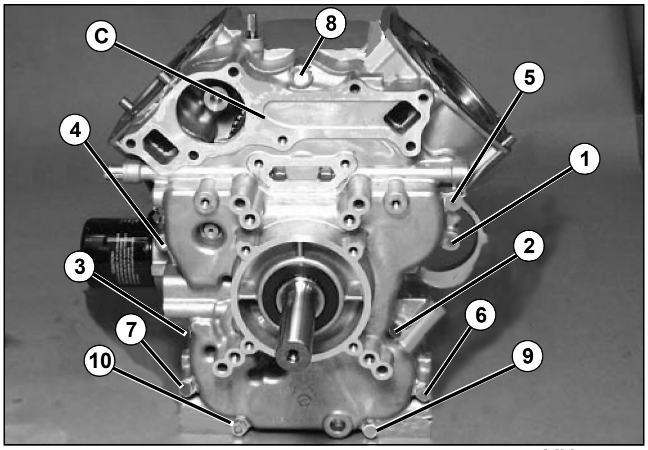
9. Check to see that the O-Rings (L) are in place on the crankcase as shown above.

10.Apply silicone sealant bead (J), **1 - 2 mm (0.04 - 0.08 in.)** wide, to mating surface (K) of the crankcase (in areas shown above).

Caution: Avoid Injury! Do not get the sealant into the oil line hole (M) on the crankcase or crankcase cover.

11.Check that the crankshaft dowels (N) are in place on the crankcase and install a new gasket on the crankcase.

Important: Avoid Damage! If one cover bolt at a time is tightened completely, the cover could be warped.



MX16129

12. Install the crankcase cover (C). Noting the different length of bolts, tighten the bolts $^{1}/_{2}$ turn at a time in the sequence shown, and to a final torque of **22 N•m (16.0 lb-ft)** when all bolts are tight.

13.Install rocker covers. See “Cylinder Head Removal and Installation” on page 65.

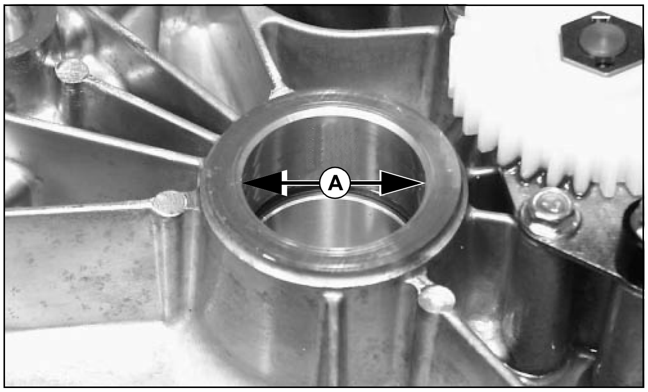
14.Remove governor control panel and governor arm. See “Governor Assembly Removal and Installation” on page 82.

15.Fill engine with **approximately 1.8 L (1.9 qt)** of oil.

16.Install engine onto machine. See “Engine Removal and Installation” on page 73.

Crankcase Cover Inspection

Procedure:



MX16135

1. Drain engine oil and remove the crankcase cover. See “Crankcase Cover Removal and Installation” on page 80.

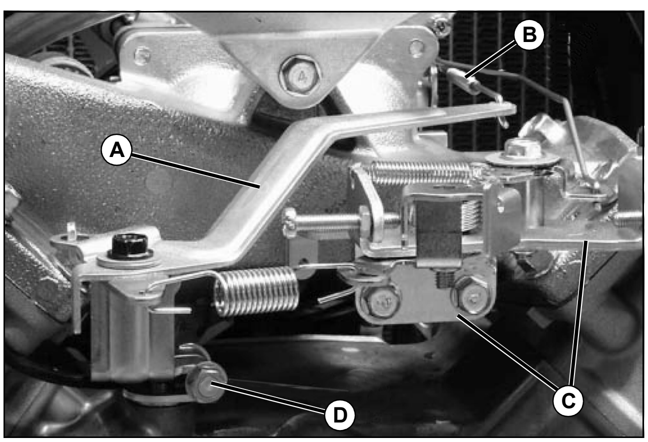
2. Measure the inside diameter (A) of the PTO shaft bearing at several points. This bearing is not replaceable. If it is damaged, or the inside diameter is more than **42.09 mm (1.66 in.)** the crankcase cover must be replaced.

3. Install crankcase cover. See “Crankcase Cover Removal and Installation” on page 80.

4. Replace engine oil.

Governor Assembly Removal and Installation

Governor Arm Removal and Installation:



MX16110

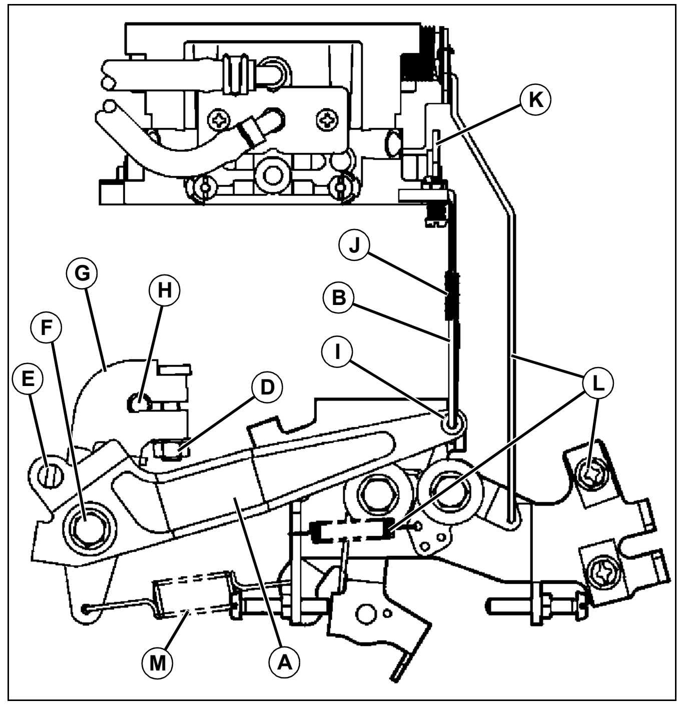
Picture Note: FD671D engine shown; FD750D engine does not have choke assembly.

1. To remove the governor arm, remove governor control panel (C).

2. Loosen the clamp nut (D) and take off the governor arm (A).

3. Clear the throttle link rod (B) from the governor arm and choke lever.

4. Disassemble remaining parts, and visually inspect for wear or damage; replace, as necessary.



MX14226

Picture Note: FD671D engine shown; FD750D engine does not have choke assembly parts (L).

5. Insert the bracket (G) onto the governor shaft (H) to the bottom of the woodruff are of the shaft, and tighten the clamp nut (D) to **8 N•m (69 lb-in.)**.

6. Install the control panel assembly, and connect the bracket with the governor spring (M).

7. Install the end of throttle link rod (B) with the link spring (J) around it into the governor arm hole (I) and the other end into the carburetor throttle lever (K) hole.

8. Install the governor arm (A) on the bracket (G) with the bolt (F) and washer by turning the bolt counterclockwise so the projection of the bracket fits into the governor arm hole (E).

9. Loosen the bolt (F), and fully turn the bracket (G) counterclockwise and hold it there.

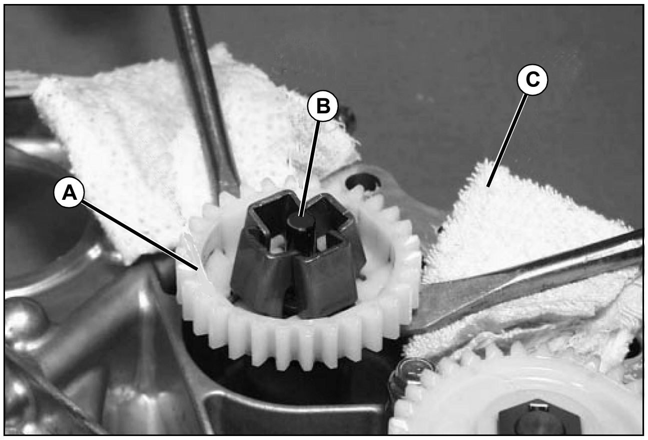
10.Turn the top end of the governor arm (A) counterclockwise to fully open the carburetor throttle valve and tighten the bolt (F).

Governor Removal and Installation:

> **Caution: Avoid Injury! Do not remove the governor assembly unless it is necessary. Once it has been removed, it must be replaced.**

1. Remove crankcase cover. See “Crankcase Cover Removal and Installation” on page 80.

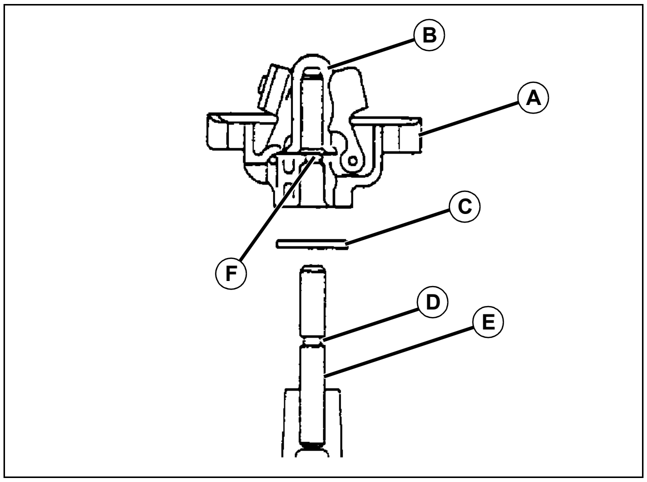
Note: To avoid damage to the surface of crankcase cover, use suitable soft mats (C) as shown below.



MX16191

2. Remove the governor assembly (A) with the sleeve (B) by prying the gear with two proper size screw drivers.

3. Remove the thrust washer.



MX16192

4. Install thrust washer (C).

5. Fit the sleeve (B) into the governor assembly (A), and install them as a set.

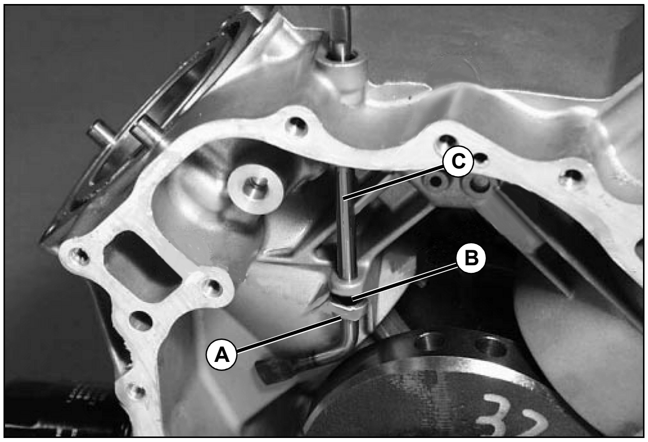
Note: The sleeve (B) and the governor assembly (A) cannot be installed separately. Push the set onto the shaft (E) until inner flange (F) snaps into the groove (D) securely.

6. Spin the governor assembly by hand and check that the flyweights operate freely and the center sleeve moves outward.

Governor Shaft Removal and Installation:

1. Remove camshaft. See “Camshaft/Tappet Removal and Installation” on page 90.

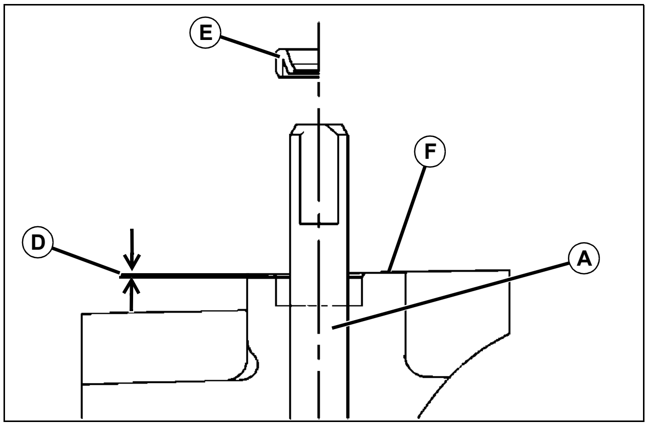
2. Unscrew the governor arm clamp nut, and remove the governor arm. See “Governor Arm Removal and Installation:” on page 82.



MX16193

3. Remove the circlip (B) on the governor shaft (C), and remove the governor shaft and washer (A).

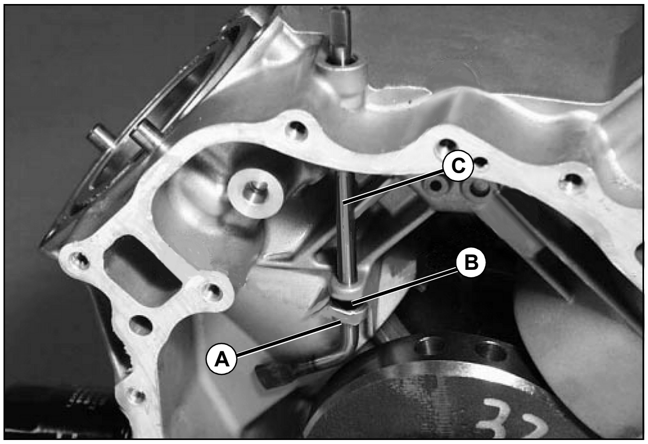
Note: Replace the oil seal only if the lip shows signs of leakage or it has been damaged. If the oil seal is removed, install it after the shaft (C) is installed.



MX16194

4. The oil seal (E) must be assembled with the seal lip towards inside of the engine.

5. Press in the oil seal approximately 1.0 mm (0.04 in.) (D) flush or below the crankcase surface (F).



MX16193

6. Apply engine oil to the governor shaft (C).

7. Insert the governor shaft into the crankcase and washer (A).

8. Fit the circlip (B) securely into the groove of the governor shaft (C), as shown above.

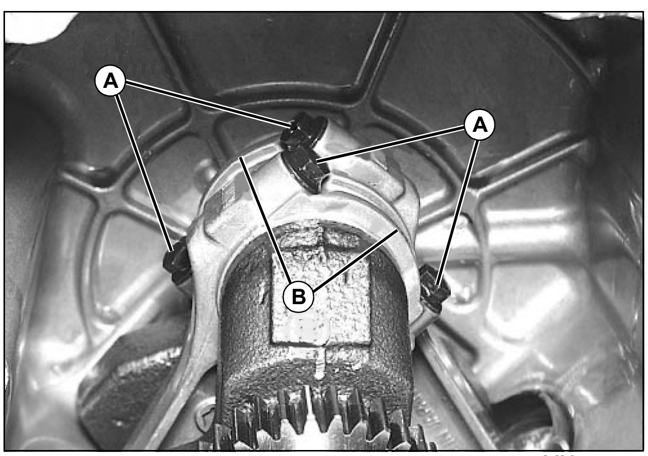
9. Check that the governor shaft moves freely in its operating range.

Piston Removal and Installation

Removing:

1. Remove cylinder heads. See “Cylinder Head Removal and Installation” on page 65.

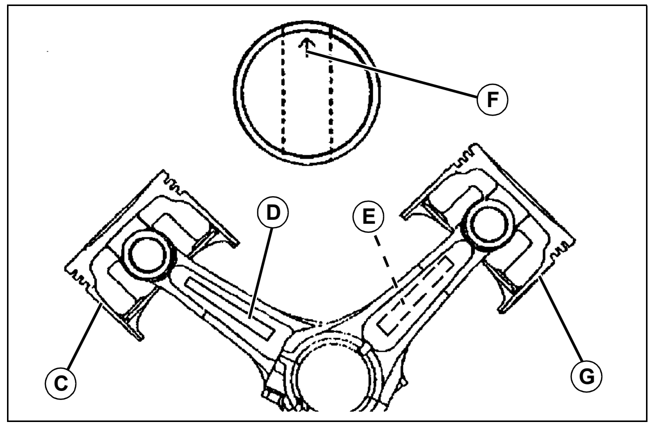
2. Remove the crankcase cover and the camshaft. See “Camshaft/Tappet Removal and Installation” on page 90.



MX16122

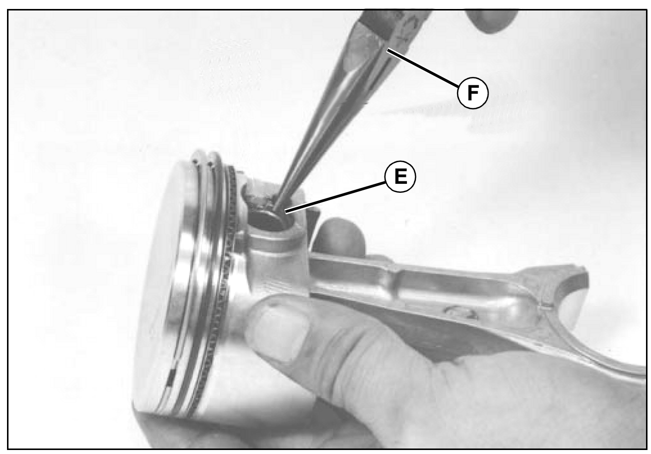
3. Turn the crankshaft to expose the connecting rod cap bolts (A). Remove the bolts and take off the connecting rod caps (B).

Important: Avoid Damage! Note location of the arrow mark (F) on the piston head in relation to the “Made in Japan” mark on the connecting rod. The “Made in Japan” mark (D) on the No. 1 cylinder (C) connecting rod must be face to face with the “Made in Japan” mark (E) on the No. 2 cylinder (G) connecting rod. Keep components together as a matched set.

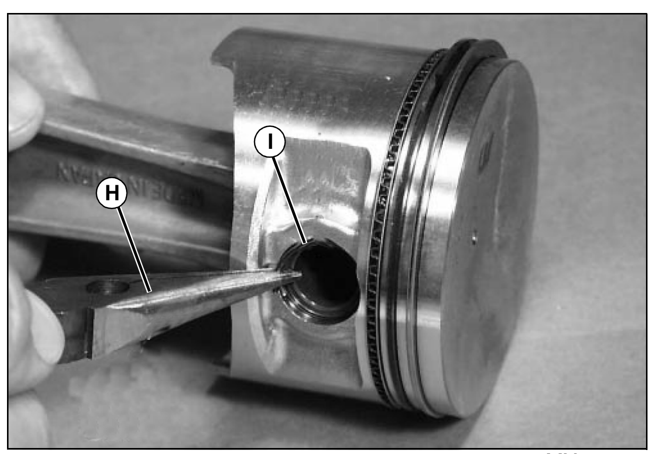


MX16123

4. Push the connecting rod end up into the cylinder, and pull the piston and connecting rod assembly out the top of the cylinder.



MX11819

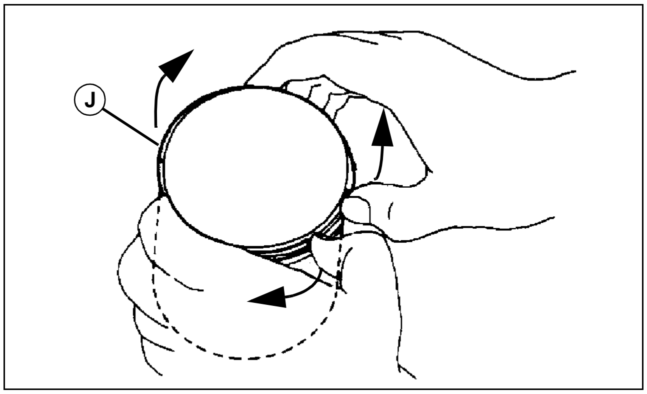


MX16124

5. Remove one of the piston snap rings (I) with a needle nose pliers (H).

6. Push the piston pin out the side where the snap ring was removed and remove the piston from the rod.

7. Remove the top and second rings with piston ring pliers.



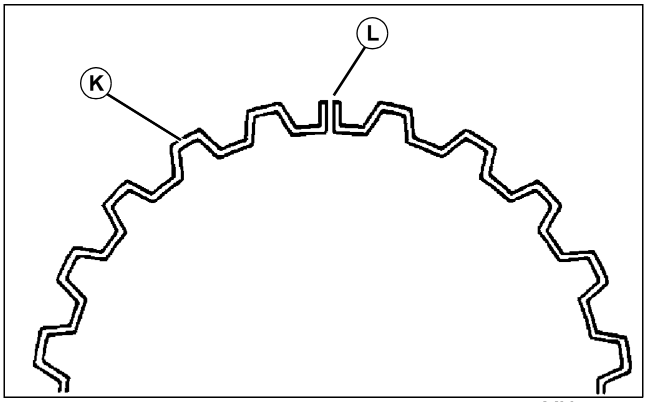
MX11820

8. If piston ring pliers are not available, carefully spread the ring opening with your thumbs and push up on the back side of the ring (J) to remove it.

9. Remove the 3-piece oil ring using the thumb method.

Installing:

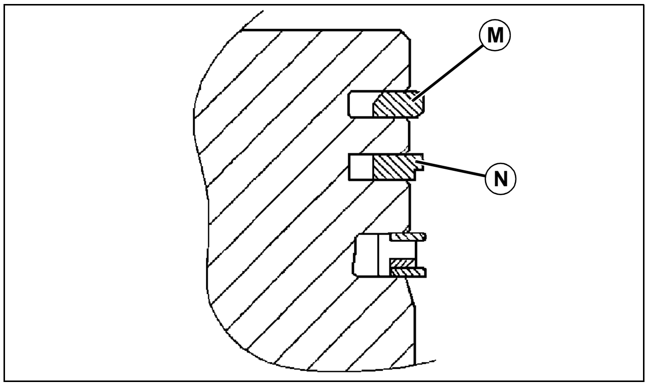
1. Inspect and clean the piston and rings before installation. See “Inspect Piston and Cylinder” on page 87.



MX11821

2. Install a new oil control ring on the piston in the following sequence:

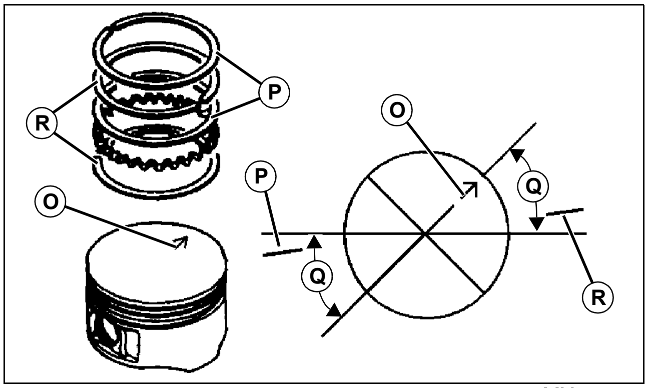
- Install the expander (K) in the oil ring groove with the ends (L) touching together, not overlapping.
- Install the upper and lower steel rails. Rails are interchangeable and do not have an up or down orientation.



MX11822

3. Install the scraper ring (N) in the second groove with the notch facing down.

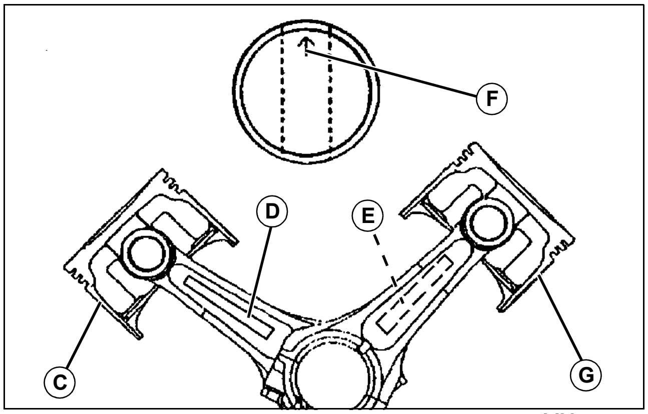
4. Install the compression ring (M) in the first groove with the bevel facing down.



MX11823

5. Orient the ring gaps on the piston as shown:

- O - piston arrow mark
- P - top ring and upper steel rail end gaps
- Q - 30^o - 45^o
- R - second ring and lower steel rail end gaps

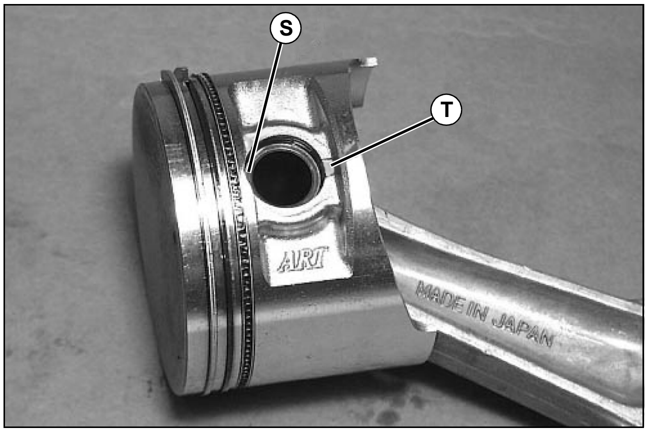


MX16123

6. Apply fresh engine oil to the piston pin and assemble the piston for the #1 cylinder (C) with the arrow mark (F) facing away from the “Made in Japan” mark (D) on the

connecting rod.

7. Apply fresh engine oil to the piston pin and assemble the piston for the #2 cylinder (G) with the arrow mark (F) facing the “Made in Japan” mark (E) on the connecting rod.

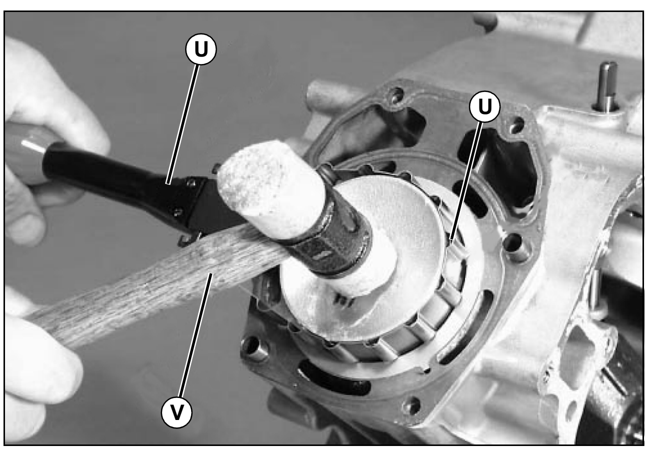


MX16125

8. Fit new piston pin snap rings to both pistons. Align the snap ring gap (S) so it does not align with the piston pin hole notch (T).

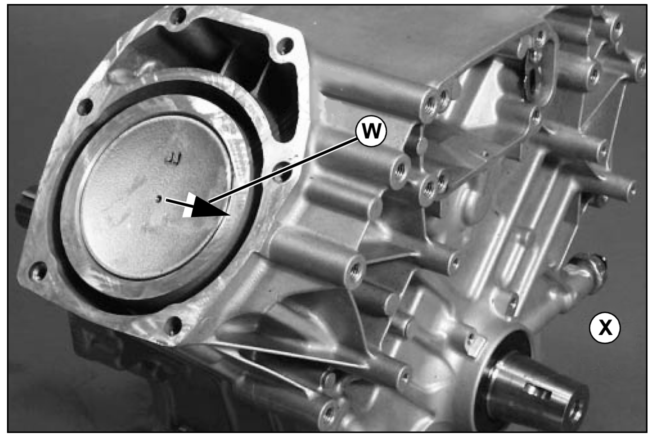
Important: Avoid Damage! Do Not reuse piston pin snap rings. Weakened and deformed snap rings could fall out causing engine damage. Use only new snap rings when reinstalling pistons.

9. Apply fresh engine oil to the piston skirt and cylinder bore.



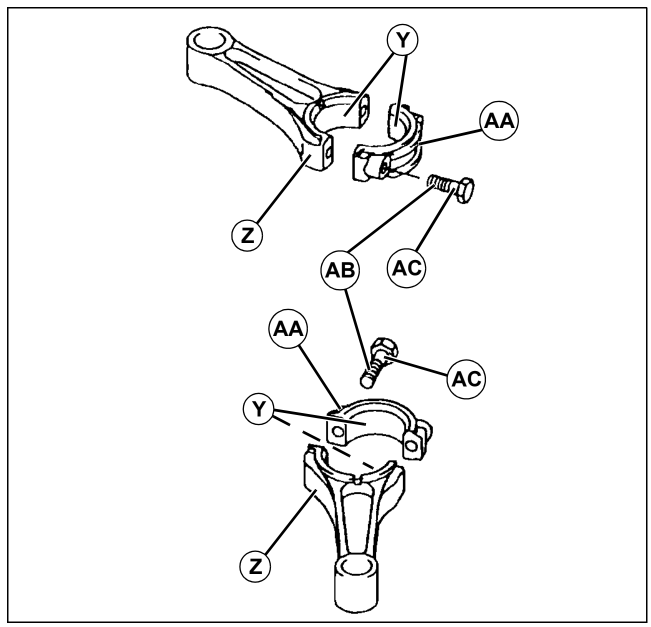
MX16126

10..Use a piston ring compression tool (U) to compress the piston rings.



MX16127

11..Insert the piston and rod assembly in the cylinder bore with the arrow mark on the piston (W) facing the flywheel (X). Lightly tap the top of the piston with a plastic mallet (V) to insert the piston assembly in the bore.



MX11830

12.Apply engine oil to the inner surface (Y) of the connecting rod big end (Z) and caps (AA).

Important: Avoid Damage! The connecting rod and rod big end cap are machined as a matched set. They must be replaced as a set in their original position on the crankshaft.

13.Align the rods on the crankshaft, and install the big end rod caps in their original position.

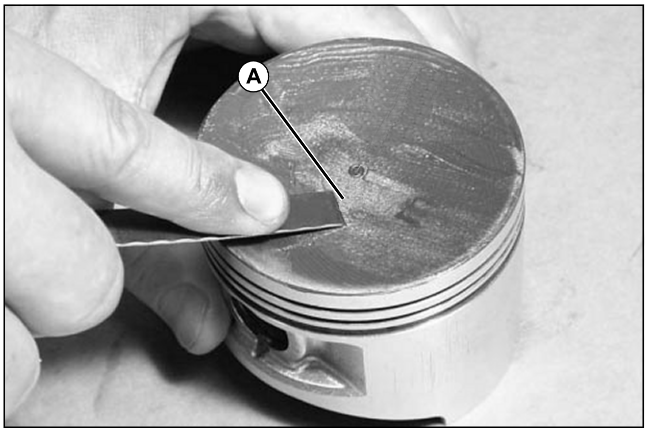
14.Apply a small amount of engine oil to the thread (AB) and seating surface of the rod cap bolts. Install bolts (AC) and tighten to **21 N•m (186 lb-in.)**.

15.Install the camshaft and the crankcase cover. See “Camshaft/Tappet Removal and Installation” on page 90.

16.Install cylinder heads. See “Cylinder Head Removal and Installation” on page 65.

Inspect Piston and Cylinder

Procedure:



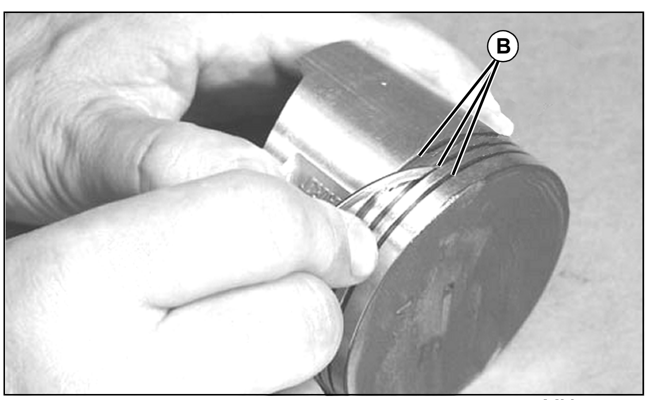
MX11831

1. Remove the piston and piston rings. See “Piston Removal and Installation” on page 84.

Important: Avoid Damage! Never attempt to clean carbon deposits with the piston in the engine. Carbon particles will fall between the piston and cylinder and could damage crankshaft bearings and seals.

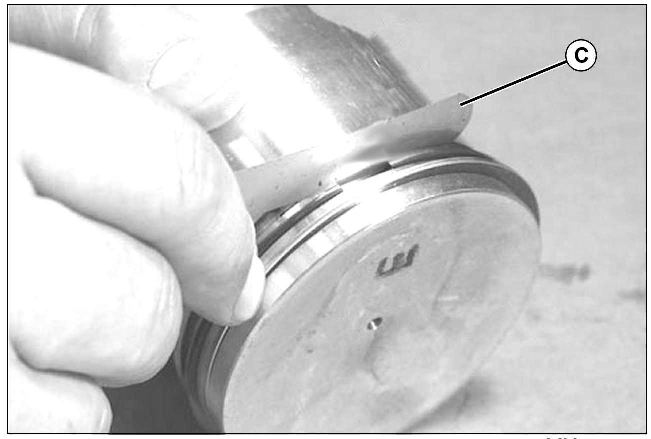
2. Scrape carbon deposits off the piston head (A) using an appropriate scraper that will not gouge or scratch the piston.

Caution: Avoid Injury! The top and bottom edges of the ring may be extremely sharp.



MX11832

3. Clean the piston ring grooves (B) with a broken ring or a suitable tool.



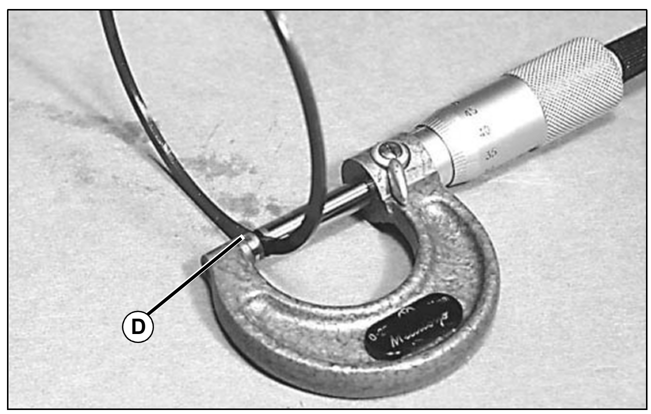
MX11833

4. Check piston ring grooves for wear by inserting a new ring in the piston and measuring the clearance between piston and ring with a feeler gauge (C). Wear should not exceed:

- Top and Second Ring - **0.15 mm (0.006 in.)**

  If piston ring groove clearance is greater than specified, replace the piston.

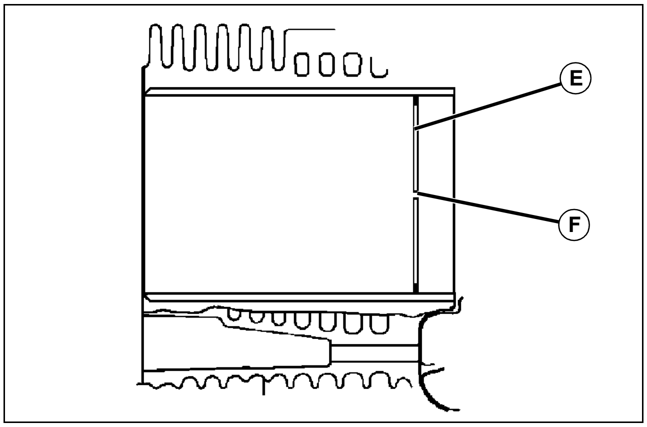
Note: The three piece oil ring is difficult to measure for ring groove clearance. Check both ring and piston groove visually for damage or wear and replace either component as necessary.



MX11834

5. Worn rings normally show visual evidence of wear such as surface scratches or an extremely shiny sealing surface. If you are considering reusing rings measure the following:

- Ring Thickness - Use a micrometer to measure at several points around the ring (D). The minimum service limit for both the top and second ring is **1.40 mm (0.055 in.)**. If any measurement is less than the service limit, replace the entire set of rings.



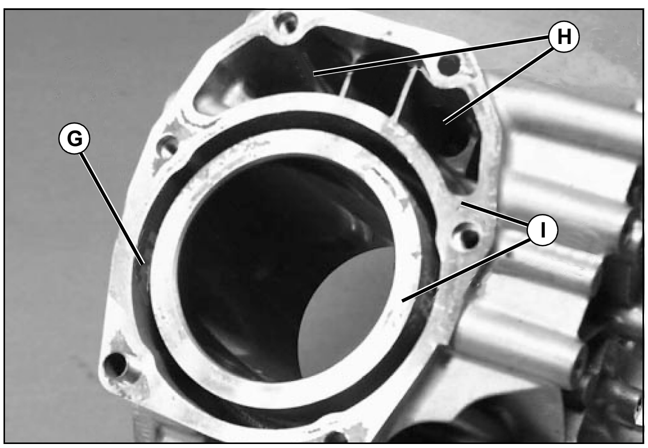
MX16128

• Piston Ring End Gap - Use the piston to push each piston ring (E) into the cylinder bore to a point close to the bottom of the cylinder bore. Measure the gap (F) between the ends of the ring with a feeler gauge.

Top and Second Ring End Gap - **1.00 mm (0.04 in.)** service limit

Oil Ring End Gap - **1.2 mm (0.05 in.)** service limit

If any measurement is greater than the service limit, replace the entire set of rings.



MX16149

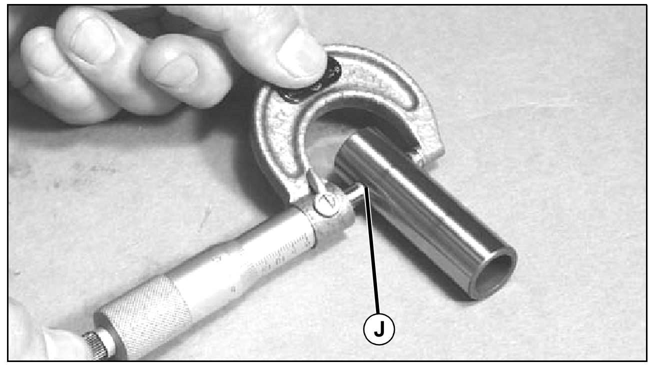
6. Inspect the crankcase for an accumulation of dust, scale, and lime in the water jacket (G). If this accumulation is observed, flush the cooling system.

Note: A cracked or porous casting is not visible to the eye. If evidence of leakage of coolant from any suspected area is found, replace the crankcase.

• Inspect the crankcase for coolant leakage outside the water jacket. Small leaks may appear only as rust, corrosion or stains, due to evaporation. If this is observed, tighten bolts and/or replace the cylinder head gasket.

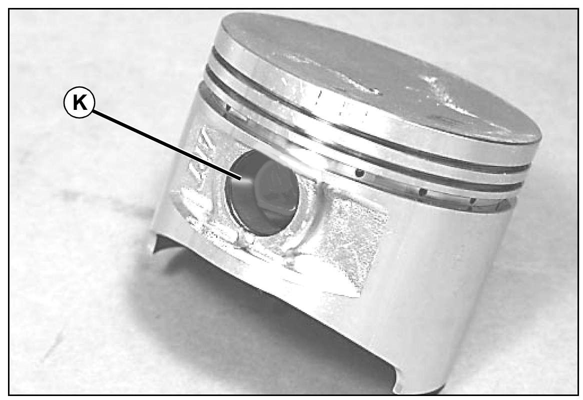
• Inspect the crankcase for coolant leakage into the engine. Leakage occurs through a loose cylinder head, cracked or porous casting, and through the push rod compartment (H). If coolant leakage appears in the push rod compartment, replace the crankcase.

• Check the cylinder head gasket. If coolant is leaking through gasket surfaces, check the gasket surfaces (I) for traces of the leakage, and check to make sure the cylinder head and block surfaces are smooth, clean and level.



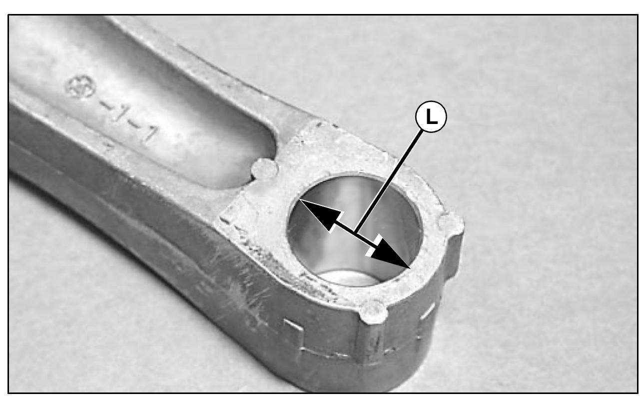
MX11838

7. Measure the outside diameter of the piston pin with a micrometer at several points (J). If the outside diameter is less than **18.96 mm (0.747 in.)** the piston pin must be replaced.



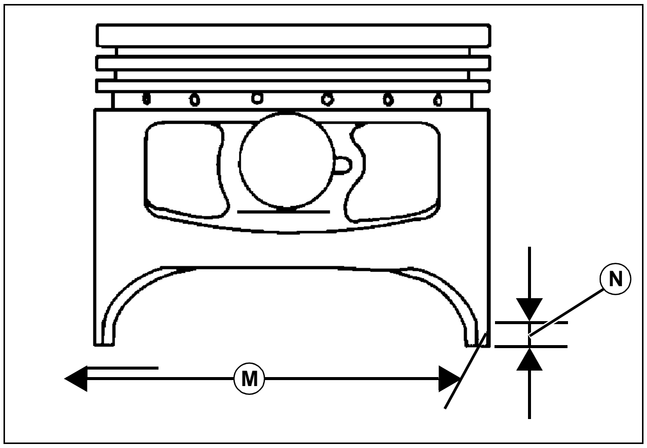
MX11839

8. Measure the inside diameter of the piston pin with a dial bore gauge at several points (K) on both sides of the piston. If the inside diameter is greater than **19.08 mm (0.751 in.)** the piston must be replaced.



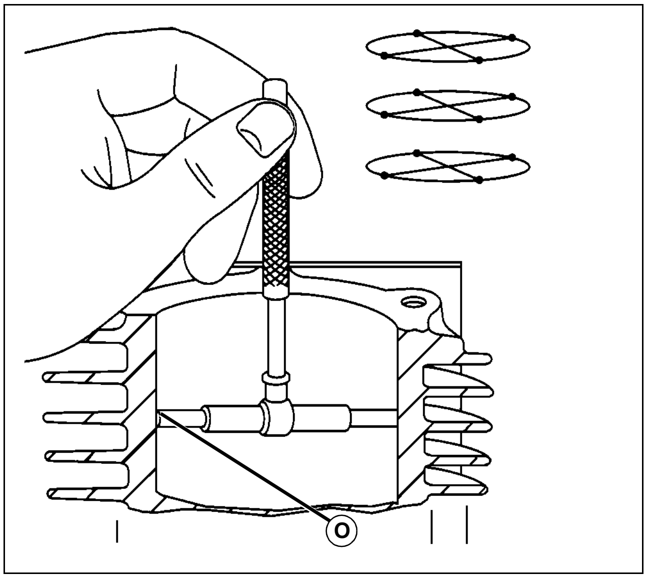
MX11840

9. Measure the inside diameter of the connecting rod small end with a dial bore gauge (L) at several points. If the inside diameter is greater than **19.06 mm (0.75 in.)** the piston must be replaced.



MX11841

10.Measure the outside diameter of the piston (M) at a point (N), **11 mm (0.43 in.)** up from the bottom of the piston and 90 degrees from the piston pin hole. If the outside diameter is less than **77.7 mm (3.06 in.)**, the piston must be replaced.



M86883

11.Clean the cylinder and inspect the bores for scoring, signs of seizure or ridges at the top or bottom of the cylinder.

12.Measure the cylinder inside diameter (O) using a dial bore gauge. Measure the cylinder front to back and side to side at the following points:

- 10 mm (0.394 in.) from top of cylinder
- 10 mm (0.394 in.) from bottom of cylinder
- 55 mm (2.165 in.) from top of cylinder

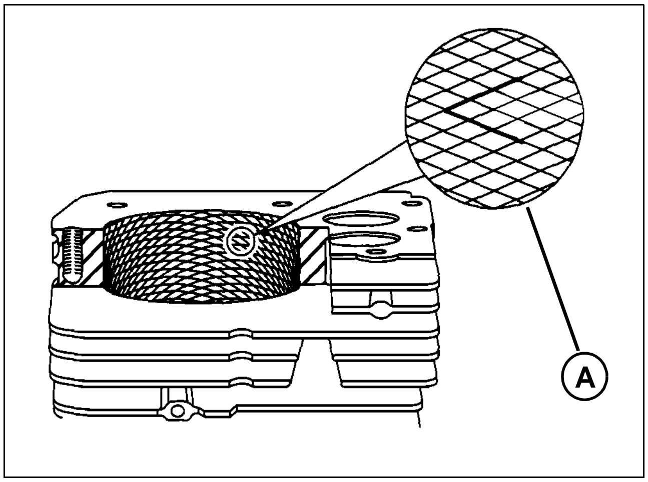
13.If any of the cylinder bore measurements are greater than the following service limits, the cylinder must be bored and honed (see Resizing Cylinder Bore and Cylinder Bore Honing). If cylinder bores are within specifications and show no signs of damage, new piston rings may be fitted provided the cylinder bores are honed. This will restore the proper cross hatch angle in the cylinder bores ensuring proper lubrication and piston ring rotation.

- Standard Cylinder Bore Inside Diameter: **78.00 mm (3.071 in.)**
- Standard Cylinder Bore Service Limit: **78.08 mm (3.074 in.)**
- Standard Cylinder Bore Out-of-Round Service Limit: **0.056 mm (0.022 in.)**

Cylinder Bore Honing

Procedure:

Note: To produce the proper cross hatch finish use a drill speed of approximately 200 rpm and 40 - 60 strokes per minute. Lubricate hone liberally to prevent build up on finishing stones.



M86885

1. The cylinder finish, (Cross Hatch) should be applied when reconditioning a cylinder bore. The finishing stones will produce the correct cross hatch necessary for proper lubrication and piston ring rotation. The correct hatch angle is approximately 45° (A).

2. It is recommended that the cylinder bores be reconditioned to restore the cross hatch when new piston rings are to be installed in a cylinder that is within specification. Be careful not to hone oversize.

Important: Avoid Damage! Ensure that the entire cylinder and crankcase are thoroughly cleaned after honing. First wash the cylinder and crankcase carefully in a solvent such as kerosene or commercial solvent. Then thoroughly wash cylinder and crankcase using a stiff brush with soap and hot water. Rinse thoroughly with hot running water. Repeat washing and rinsing until all traces of honing grit are gone. Honing grit is highly abrasive and will cause rapid wear to all of the internal components of the engine unless it is completely removed.

3. When cylinder and crankcase have been thoroughly cleaned, use a white rag or napkin and wipe the cylinder bore. If honing grit is present, it will appear as a grey residue on rag. If any honing grit is evident, re-wash and rinse entire cylinder and crankcase and check again. When cleaning is complete, oil cylinder bore to prevent rusting.

Camshaft/Tappet Removal and Installation

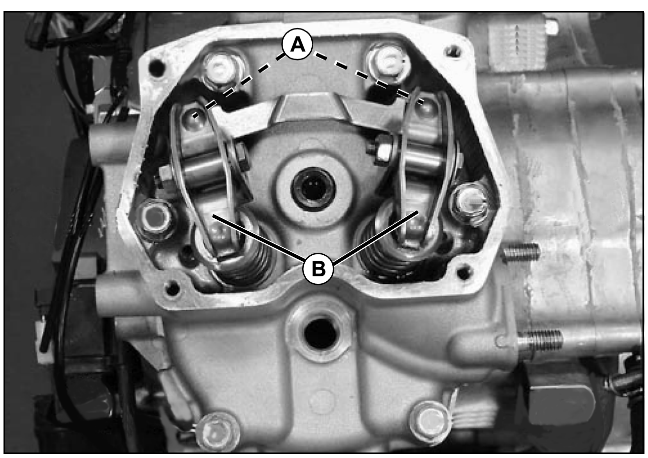
Procedure:

1. Remove engine and drain oil. See “Engine Removal and Installation” on page 73.

2. Remove crankcase cover. See “Crankcase Cover Removal and Installation” on page 80.

3. Remove rocker covers. See “Cylinder Head Removal and Installation” on page 65.

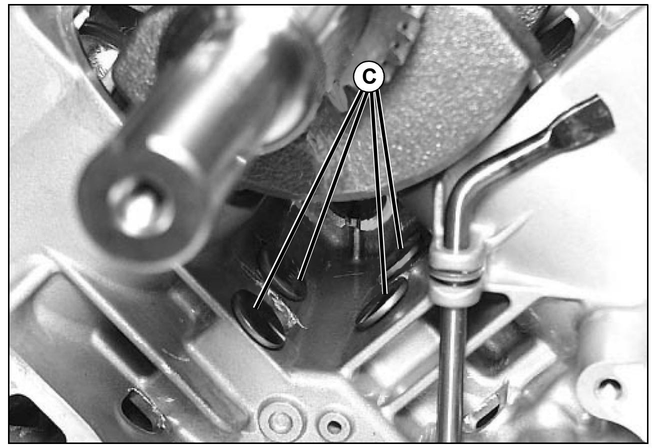
4. Place the piston at Top Dead Center (TDC) for the cylinder you are working on.



MX16113

5. Remove rocker arms (B) and push rods (A). See “Push Rod/Rocker Arm Removal and Installation” on page 77.

6. Turn the crankcase up side down so that tappets fall away from cam lobes. Pull the camshaft out of the crankcase.



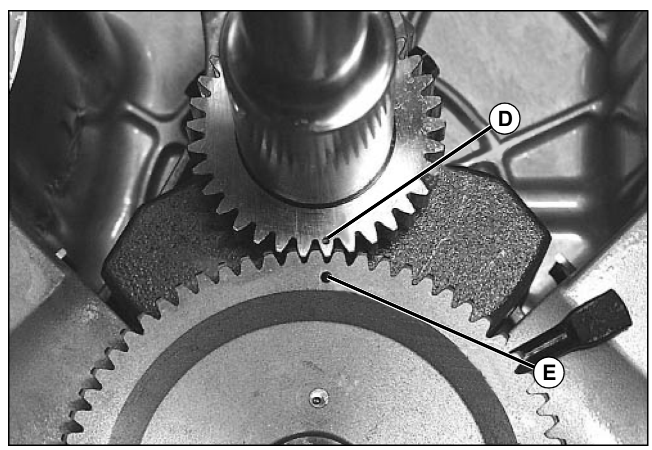
MX16139

7. Remove the tappets (C) and mark them for reinstallation.

8. Before reinstalling tappets and camshaft apply fresh engine oil to:

- Tappet Journals
- Camshaft Journals
- Cam Lobe Surface
- Camshaft Gear

9. With the crankcases turned upside down, install the tappets in their original positions.



MX16141

10.Slide the camshaft into position in the crankcase, aligning the punch marks on the crankshaft gear (D) and camshaft gear (E).

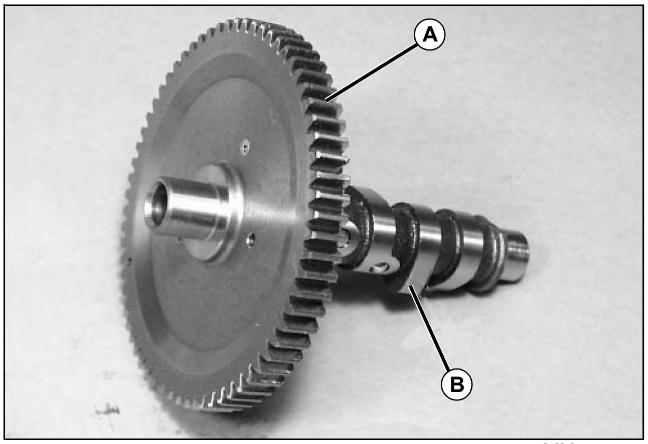
11.Install crankcase cover with a new gasket.

12.Install pushrods and check valve clearances before reinstalling rocker covers. See “Valve Clearance Adjustment” on page 43.

13.Install remaining components in the order they were removed. Fill engine with new oil.

Camshaft Disassembly and Inspection

Procedure:

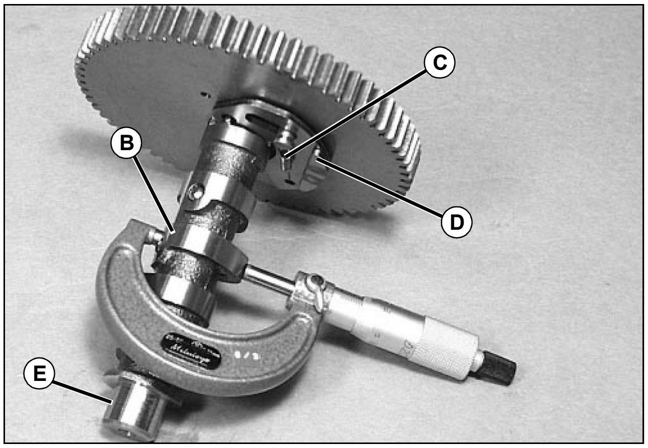


MX16142

1. Inspect camshaft gear (A) for pitting, fatigue cracks, burrs or uneven wear due to improper tooth contact. Replace camshaft if necessary.

Important: Avoid Damage! Damaged or worn cam lobes usually indicate damaged tappets. Check tappets when replacing camshaft.

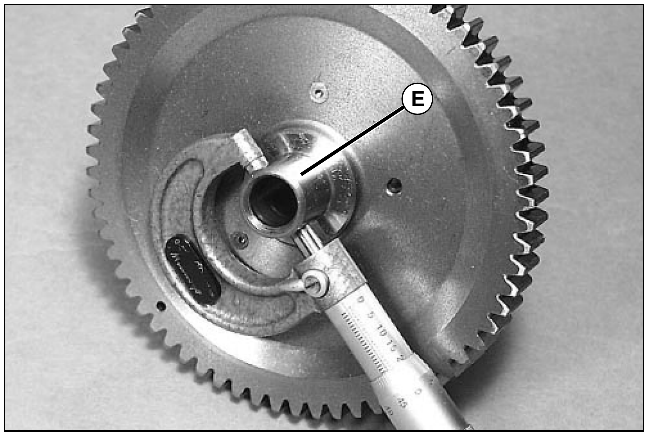
2. Check the top of the cam lobes (B) for signs of uneven wear, grooving, pitting or flaking of hardened wear area. Replace camshaft if any of these conditions exist.



MX16143

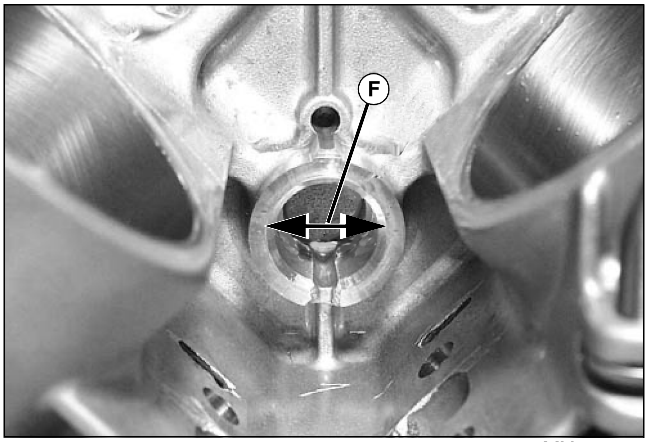
3. Remove the spring (C) from the ACR (Automatic Compression Release) assembly. DO NOT attempt to remove the ACR weight. If the ACR weight (D) is damaged, or does not swing freely when shaking the cam, the camshaft must be replaced.

4. Measure the height of each cam lobe (B), if less than service limit replace camshaft.



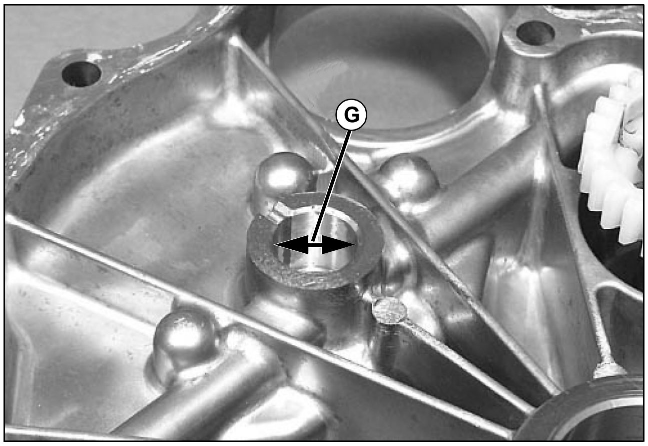
MX16144

5. Measure both camshaft journals (E) at several points around the journal circumference. If any journal is worn less than the service limit, replace the camshaft.



MX16145

6. Measure inside diameter (F) of the camshaft bearing bore in crankcase at several points. This bearing is not serviceable, so it will be necessary to replace the crankcase if the inside diameter is greater than the service limit.



MX16146

7. Measure inside diameter (G) of the camshaft bearing bore in crankcase cover at several points. This bearing is

not serviceable, so it will be necessary to replace the crankcase cover if the inside diameter is greater than the service limit.

8. Install a new spring on the ACR assembly.

9. Install the camshaft in the crankcase. See "Camshaft/Tappet Removal and Installation" on page 90.

Cam Lobe Height:

Service Limit Intake . . . . IN 33.594 mm (1.323 in.)
Service Limit Exhaust . . . . . . EX 33.594 mm (1.323 in.)

Camshaft Journal Diameters:

PTO Side . . . . 19.927 mm (0.785 in.)
Flywheel Side . . . . 19.927 mm (0.785 in.)

Camshaft Bearing Bores:

Crankcase Camshaft Bore . . . . . . 20.081 mm (0.791 in.)
Crankshaft Cover Camshaft Bore 20.081 mm (0.791 in.)

Crankshaft Removal and Replacement

Procedure:

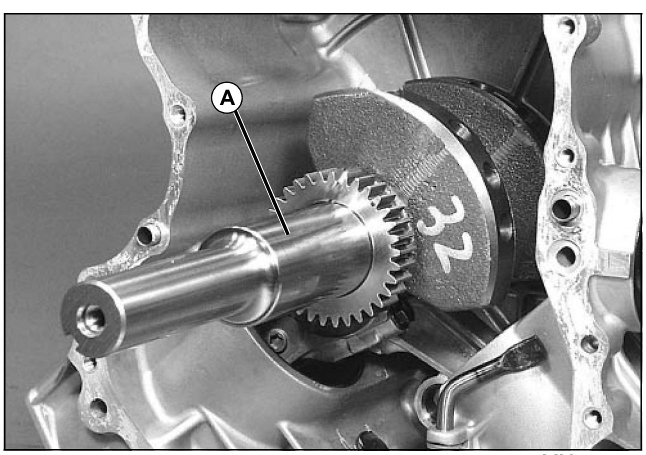
1. Remove engine and drain oil. See "Engine Removal and Installation" on page 73.

2. Remove flywheel. See "Flywheel Removal and Installation" on page 77.

Caution: Avoid Injury! Used tappets are mated to their camshaft lobes. Mark them for installation in the same bore they were removed from.

3. Remove camshaft and tappets. See "Camshaft/Tappet Removal and Installation" on page 90.

4. Remove connecting rod and piston assemblies. See "Piston Removal and Installation" on page 84.



MX16147

5. Pull the crankshaft (A) out of the crankcase. It may be necessary to tap on the crankshaft with a wood or plastic mallet to loosen the crankshaft.

6. Before installing the crankshaft, clean the crankshaft journals and the crankcase bearing surfaces thoroughly.

7. Pack high temperature grease into the crankcase oil seal.

8. Apply engine oil to the crank journals and bearing surfaces and carefully insert crank (A) into the main bearing and oil seal in the crankcase.

9. Install pistons and rods on crankshaft (see Piston Removal/Replacement).

10.Install camshaft and tappets. See "Camshaft/Tappet Removal and Installation" on page 90.

11.Install a new crank oil seal if necessary in the crankcase cover. Install the crankcase cover. See "Crankcase Cover Removal and Installation" on page 80.

Crankshaft Inspection

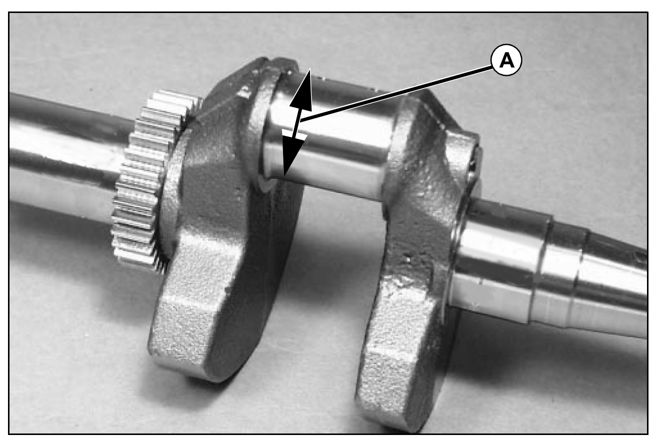
Procedure:

1. Remove crankshaft. See "Crankshaft Removal and Replacement" on page 92.

2. Clean the crankshaft and connecting rods with a high flash point solvent and dry with compressed air.

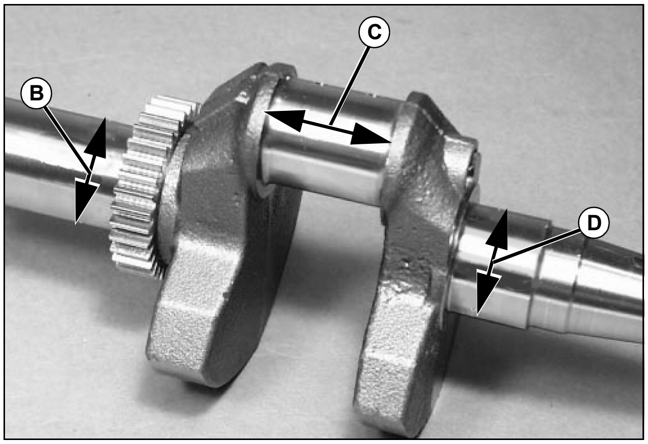
3. Inspect the teeth of the crankshaft gear for fatigue cracks, pitting or signs of uneven tooth contact. Replace crank gear if necessary.

4. Inspect the crankshaft and connecting rod bearing surfaces for excessive wear, uneven contact or gouging and scratching. Components should be replaced if any of these conditions exist.



MX16148

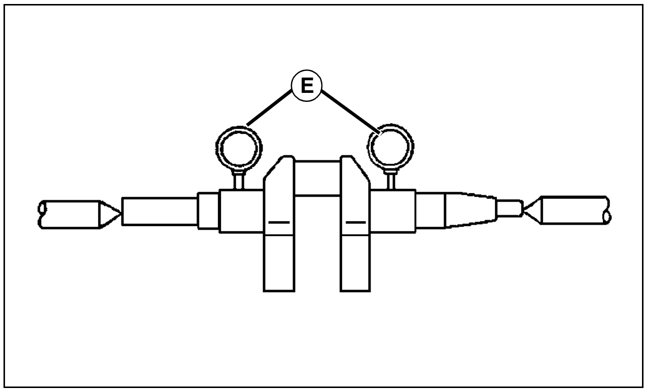
5. Measure the crankpin outside diameter (A) at several points around the circumference. If the crankpin diameter is less than the service limit at any point, replace the crankshaft.



MX16148

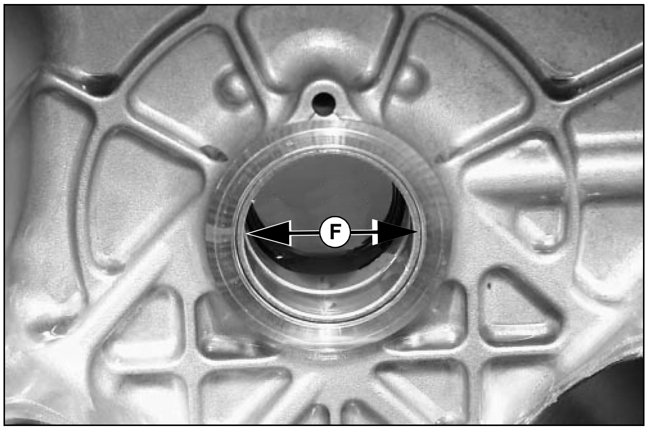
6. Measure the crankpin width (C) at several points with a dial caliper. If crankpin width exceeds the service limit at any point, replace the crankshaft.

7. Measure the flywheel side (B) and PTO side (D) main journals at several points. If either journal is less than the service limit, the crankshaft must be replaced.



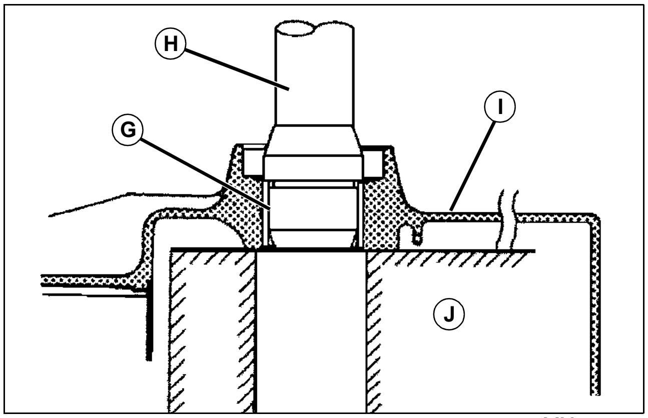
MX11892

8. Measure the crankshaft runout. Set the crankshaft in a flywheel alignment jig or on V blocks. Set up dial gauges (E) at both bearing journals. Turn the crankshaft slowly by hand and measure the runout. The difference between the highest and lowest dial gauge reading is the amount of runout. If the measurement at either journal exceeds the service limit, the crankshaft must be replaced.



MX16150

9. Measure the inside diameter (F) of the crankshaft journal bearing on the crankcase at several points. Replace the journal bearing if the inside diameter is more than the service limit.



MX16151

10.The journal bearing (G) is press fit into the crankcase (I).

- Remove the oil seal on the crankcase. (Note: The oil seal should be replaced once removed.)
- Place the crankcase on a support block (J), with the oil seal side up.
- Using a bushing tool (H), drive out the bearing as shown.

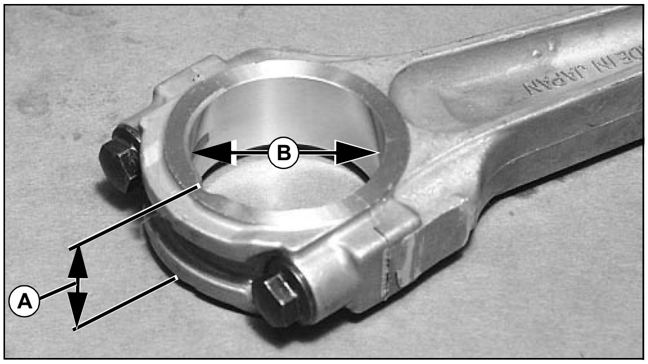
Specifications:

Crankpin Outside Diameter (Service Limit)
. . . . . 39.950 mm (1.573 in.)
Crankpin Width (Service Limit). . . . 46.50 mm (1.83 in.)
Crank Main Journal PTO Side (Service Limit)
. . . . . 41.935 mm (1.651 in.)
Crank Main Journal Flywheel Side (Service Limit)
. . . . . 41.935 mm (1.651 in.)
Crank shaft Runout (Service Limit) 0.05 mm (0.002 in.)
Crankcase Journal Bearing Inside Diameter
(Service Limit) . . . . 42.14 mm (1.659 in.)

Connecting Rod Inspection

Procedure:

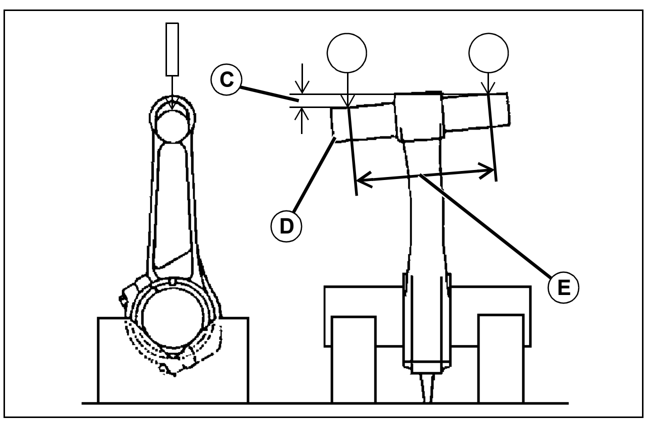
1. Remove pistons and connecting rods. See “Piston Removal and Installation” on page 84.



MX16152

2. Measure the connecting rod big end width (A) with a micrometer or dial caliper. If the measurement is less than the service limit, the rod must be replaced.

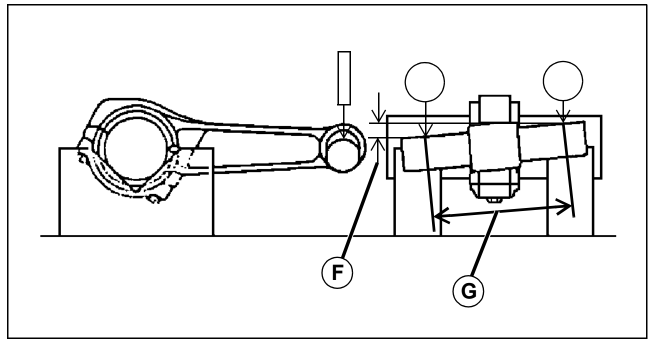
3. Apply a light film of oil to the threads of the cap bolts. Install the rod cap and the cap bolts and tighten the bolts to **21 N•m (180 lb-in.)**. Measure the inside diameter (B) of the big end at several points with a telescoping gauge or inside micrometer. If the inside diameter is greater than the service limit, the rod and cap must be replaced.



MX11898

4. Measure connecting rod bend. Insert an arbor the same size as the big end through the connecting rod big end. Insert an arbor (D) **100 mm (3.397 in.)** (E) or longer the same diameter as the small end through the connecting rod small end. Place V blocks on a surface plate, and support the big end arbor in the V blocks.

5. Hold the small end of the rod straight up vertically and measure from the surface plate to the small end arbor on both sides of the connecting rod. Measurement must be taken at a point that is exactly **100 mm (3.397 in.)** apart. The difference between the two measurements determines the rod bend (C). If the connecting rod bend exceeds the service limit the rod and rod cap must be replaced.



MX11901

6. Measure connecting rod twist. With the big end mounted in V blocks, hold the connecting rod horizontally and measure the amount that the small end arbor varies (F) from being parallel with the surface plate over a 100 mm length (G). If twist exceeds the service limit the rod and cap must be replaced.

7. Install the connecting rods and pistons. See “Piston Removal and Installation” on page 84.

Specifications:

Connecting Rod Big End Width Service Limit
. . . . . 22.35 mm (0.88 in.)

Connecting Rod Big End Inside Diameter Service Limit
. . . . . 40.055 mm (1.577 in.)

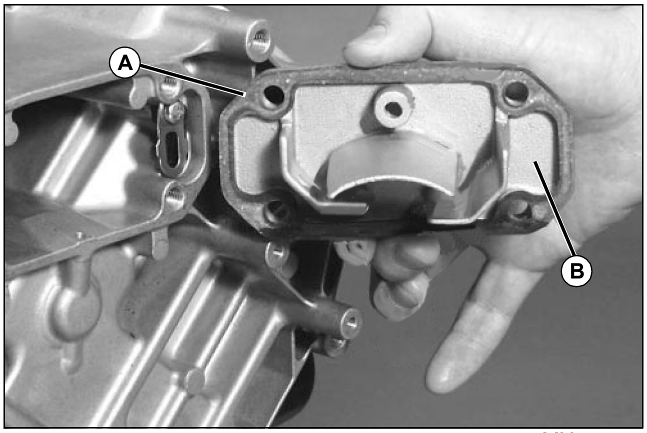
Connecting Rod Bend Service Limit
. . . . . 0.15. mm (0.006 in.) over 100 mm (3.94 in.)

Connecting Rod Twist Service Limit
. . . . . 0.15 mm (0.006 in.) over 100 mm (3.94 in.)

Breather Valve Removal and Installation

Procedure:

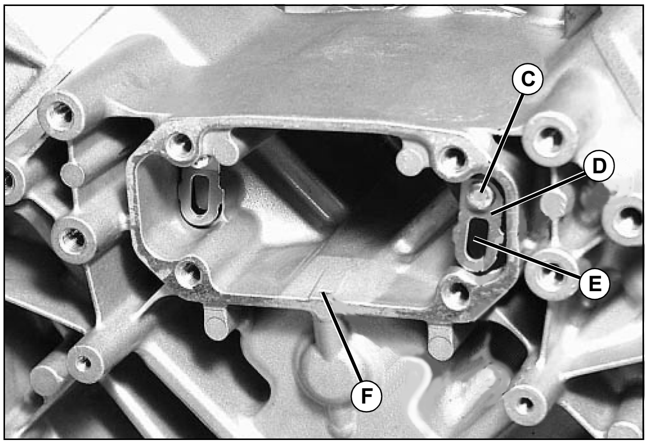
1. Remove engine from machine. See “Engine Removal and Installation” on page 73.



MX16153

2. Remove the four (4) bolts holding the breather cover (B) to the crankcase.

3. Inspect gasket (A) for damage, and replace if necessary.



MX16154

4. Unscrew the mounting screw (C), and remove the back plate (D) and reed valve (E).

- Inspect the reed valve (E) for breakage, hair cracks or distortion. Replace valve if any signs of wear or damage are present.
- Inspect the back plate (D) for damage or a rough contact surface. Replace if necessary.
- Inspect the valve seating surface for nicks, burrs, scratches or fretting. If damage or wear is evident, remove the reed valve and backing plate and clean the surface with fine emery paper.

Note: The mounting screw (C) is self-tapping. Be aware that mis-threading or overtightening the screw will strip the female threads and ruin the hole.

5. To install assembly, align the center of the valve seat with the center of the reed valve (E) and back plate (D), then tighten the mounting screw (C).

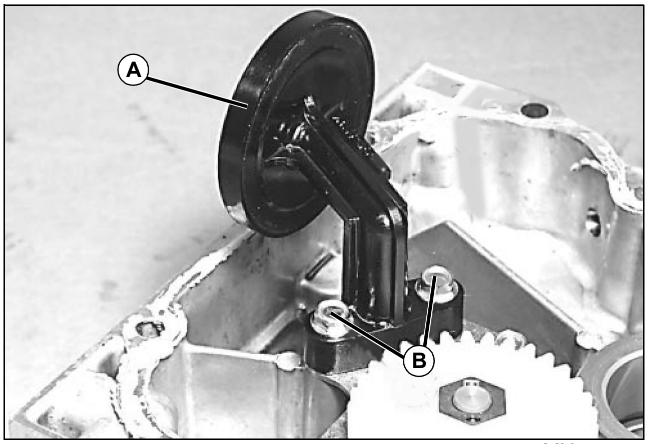
6. Before installing cover, be sure the drain hole (F) does not accumulate any debris.

7. Install a new cover gasket (A) and install cover (B). Tighten four breather valve cover mounting bolts to **20 N•m (180 lb-in.)**.

Oil Pump Removal and Installation

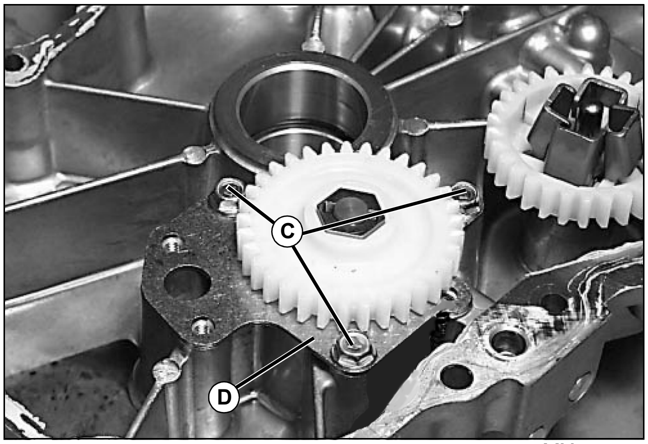
Procedure:

1. Remove crankcase cover. See “Crankcase Cover Removal and Installation” on page 80.



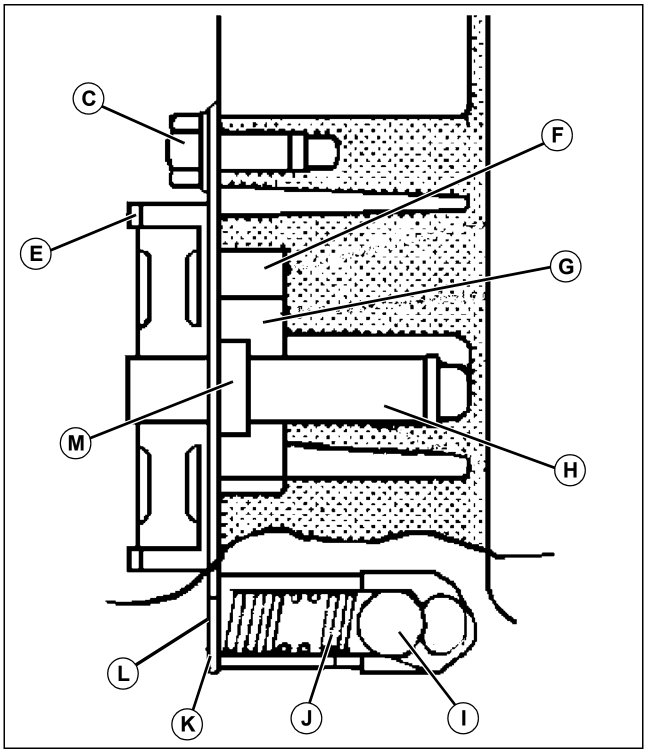
MX16156

2. Remove two cap screws (B) holding oil screen filter (A) onto crankcase cover.



MX16155

3. Remove the remaining three (3) bolts (C) holding the oil pump assembly (D) to the crankcase cover and remove pump assembly.



MX11912

4. Remove the relief valve ball (I) and spring (J) from the crankcase cover.

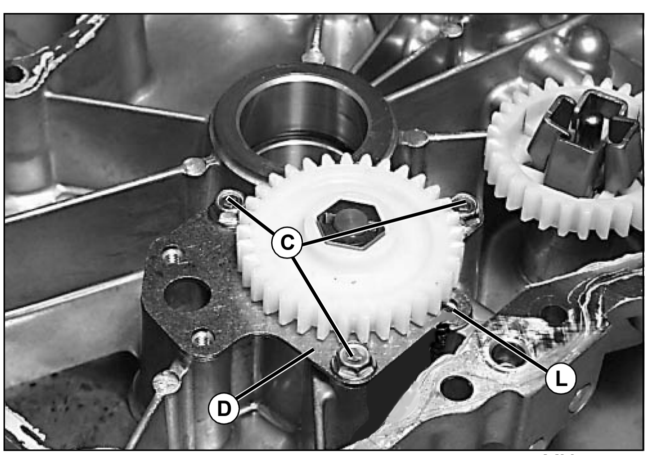
5. The pump can be disassembled by removing the pin (M) and separating the pump gear (E) from the pump shaft (H) and the cover plate (K).

6. Remove the inner (G) and outer rotor (F) from the pump cavity.

7. Assemble the pump in reverse order of disassembly.

8. Fill the rotor housing in the crankcase cover with fresh oil for initial lubrication.

Note: When installing the pump parts assembly, align the 6 mm diameter hole (L) on the cover plate with the center of the relief valve.



MX16155

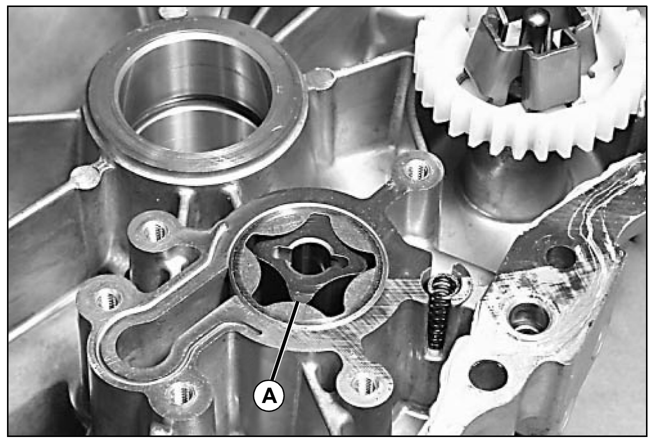
9. Install the relief valve and ball in the crankcase cover, then install the pump parts assembly into the cover.

10.Install the pump assembly into the crankcase cavity making certain to align the 6 mm diameter hole (L) in the cover plate with center of the relief valve. Put the oil screen filter in position, and install the five (5) mounting bolts tightening to **6 N•m (52 lb-in.)**.

11.Install the crankcase cover with a new gasket. See “Crankcase Cover Removal and Installation” on page 80.

Oil Pump Inspection

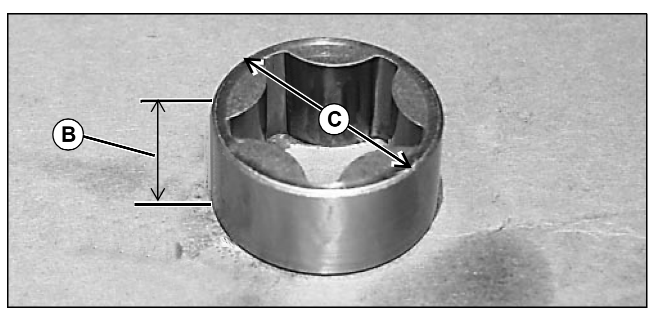
Procedure:



MX16157

1. Remove the oil pump assembly from the crankcase cover. See “Oil Pump Removal and Installation” on page 95. Visually inspect the pump gear, inner and outer rotor and cover plate for wear or damage. Replace components as necessary.

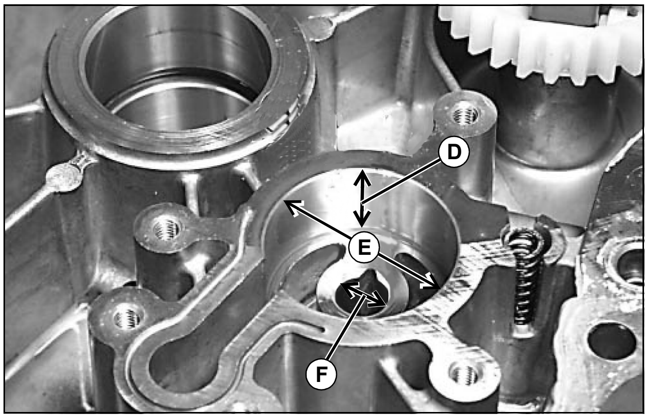
2. Install inner and outer rotor in crankcase cavity and check clearance between inner and outer rotor with a feeler gauge. Take this measurement at the point where the high point of the inner rotor meets the high point of the outer rotor (A). If the clearance exceeds the service limit replace the inner and outer rotors as a set.



MX16158

3. Measure the thickness (B) of the outer rotor with a micrometer at several points. If the thickness is less than the service limit at any point, replace the inner and outer rotors.

4. Measure the outside diameter (C) of the outside rotor at several points with a micrometer. If the rotor diameter is less than the service limit, replace the inner and outer rotor as a set.

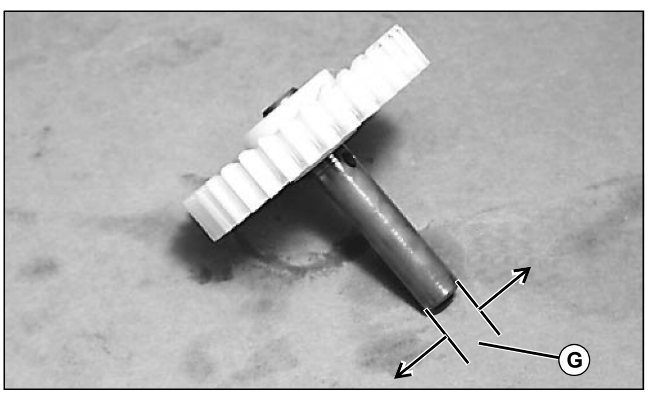


MX16159

5. Measure the inside diameter (E) of the pump housing with an inside micrometer at several points. If the inside diameter of the cover is greater than the service limit the crankcase cover must be replaced.

6. Measure the depth (D) of the pump housing with a depth micrometer at several points. If any measurement is greater than the service limit the crankcase cover must be replaced.

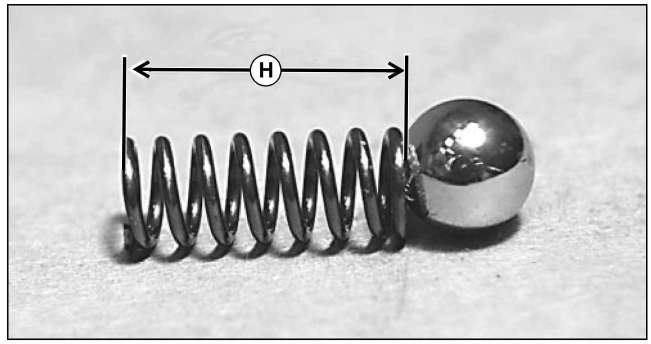
7. Measure the inside diameter (F) of the pump shaft bearing in the crankcase cover at several points with an inside micrometer. If the inside diameter exceeds the service limit at any point it will be necessary to replace the crankcase cover.



MX16160

8. Measure the outside diameter (G) of the pump shaft with a micrometer at several points. If the diameter is less than the service limit, replace the pump shaft.

Caution: Avoid Injury! Clean parts in a well ventilated area using a high flash point solvent. Make certain no spark or flame such as pilot light is near the work area.



MX16161

9. Remove the relief valve spring and steel ball from the crankcase cover. Clean the valve seat and valve components with a high flash point solvent, and blow any foreign particles out of the seat with compressed air. Inspect the steel ball for wear or dimpling. Replace the steel ball and spring if any wear or damage is evident.

10.Measure the free length (H) of the spring with a vernier caliper. If the free length of the spring is less than the service limit, replace the spring.

11.Install oil pump assembly in crankcase cover. See “Oil Pump Removal and Installation” on page 95.

Specifications:

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

Outer Rotor Outside Diameter (Service Limit) (C)
. . . . . .40.47 mm (1.593 in.)

Outer Rotor Thickness (Service Limit) (B)
. . . . . 19.830 mm (0.781 in.)

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

Pump Housing Depth (Service Limit) (D)
. . . . . 20.230 mm (0.797 in.)

Pump Shaft Outside Diameter (Service Limit) (G)
. . . . . 10.923 mm (0.4300 in.)

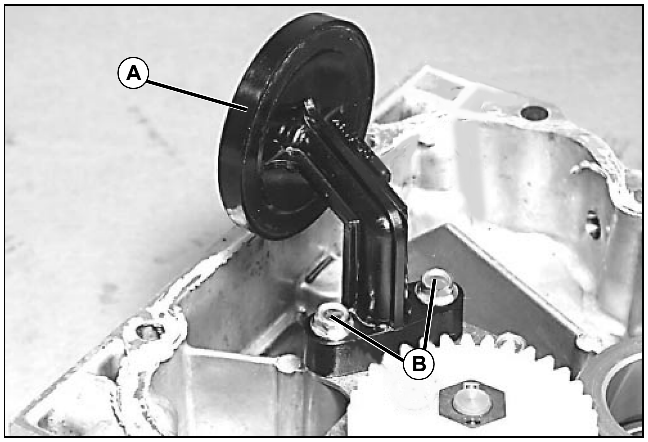
Pump Shaft Bearing Inside Diameter (Service Limit) (F)
. . . . . 11.072 mm (0.436 in.)

Spring Free Length (H) . . . . 19.50 mm (0.77 in.)

Oil Screen Removal and Installation

Procedure:

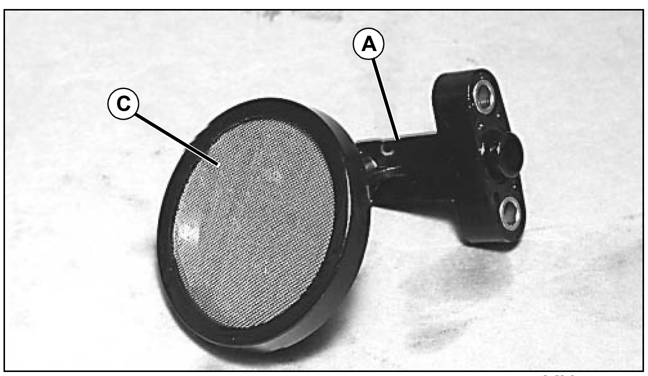
1. Remove the crankcase cover. See “Crankcase Cover Removal and Installation” on page 80.



MX16156

2. Remove two cap screws (B) holding oil screen filter (A) onto crankcase cover.

Caution: Avoid Injury! Clean parts in a well ventilated area using a high flash point solvent. Make certain no spark or flame such as pilot light is near the work area.



MX16163

3. Clean the oil screen (C) with a high flash-point solvent and remove any particles stuck to it. Check the screen carefully for any damage, or metal particles that might indicate internal engine damage. If the screen is damaged, replace entire oil screen filter (A).

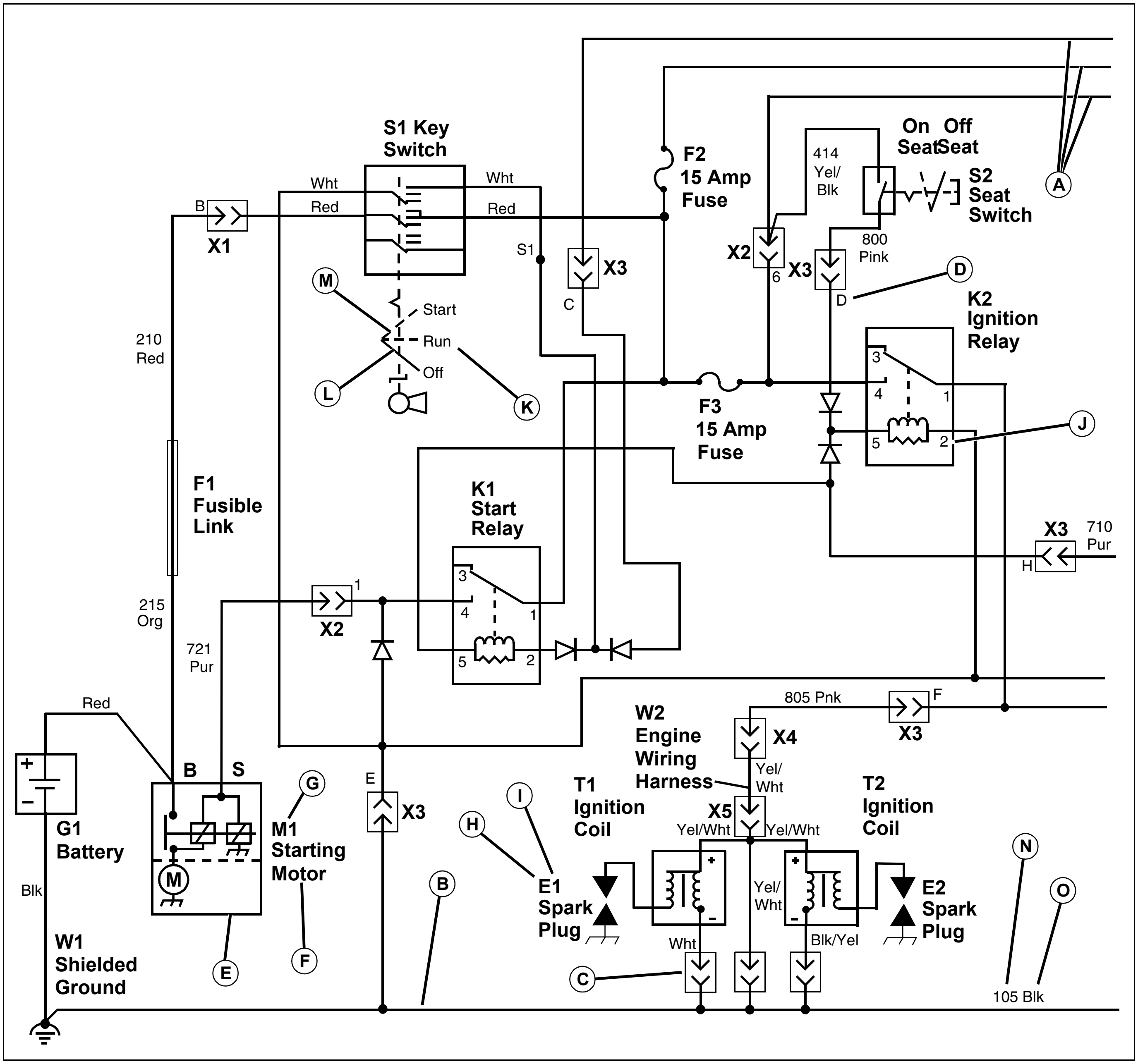
4. Install the pipe on the oil pump assembly with the two cap screws. Tighten the cap screws to **6 N•m (52 lb-in.)**.

5. Install crankcase cover. See “Crankcase Cover Removal and Installation” on page 80.

Table of Contents

General Information

Reading Electrical Schematics



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The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all ground wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in the off position. The diagram does not list connector (C) information unless needed to avoid confusion. If the connector is shown, the number next to it is the terminal pin location (D) in the connector.

Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

The identifying letter is always the same for a specific component, but the identifying numbers are numbered consecutively from upper left to lower right. The terminal designation (J) is placed directly inside or outside the symbol next to the connecting wire path. Switch positions (K) are also placed directly inside or outside the symbol. The solid line (L) shows the position the switch is currently in and dash lines (M) represent other switch positions.

The circuit number (N) and wire color (O) of the wires are shown directly next to the wire path.

The same component name and identification code are used consistently on all diagrams in this section. Components can be easily cross-referenced.

Theory of Operation Information

The theory of operation stories divide the electrical system into individual circuits by function. Each circuit is isolated from the main wiring schematic and only shows the components that are used in it. The story contains information on function, operating conditions, and theory of operation. The circuit schematics are drawn with the components in the operating position, with the power, or battery positive, into them across the top and the ground, or battery negative, across the bottom.

Diagnostic Information

The diagnostic procedures 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

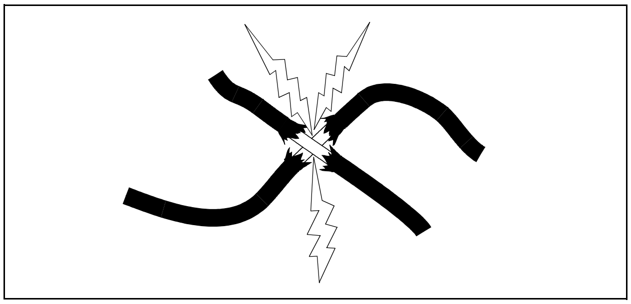
When performing the test or check, be sure to set your machine up to the TEST POINT/PROCEDURES listed in the first column and follow the sequence carefully. The middle RESULTS column gives the reading or condition that should be obtained in **BOLD** print. If the results of the test or check are not normal, perform the test, check, or adjustment listed below the **BOLD** print. The system diagram that accompanies each test procedure is drawn to resemble machine components. 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

Common Circuit Tests

Shorted Circuit:

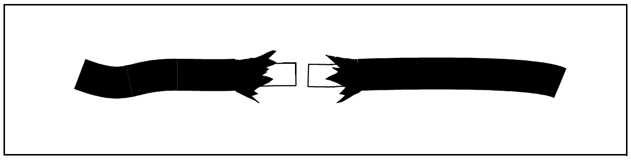


M85600 MIF

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:

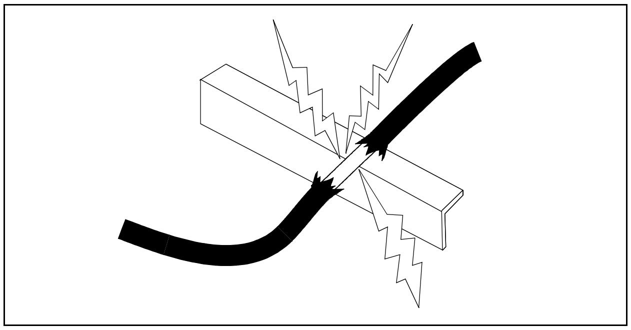


M85601 MIF

High resistance or open circuits usually result in slow, dim or no component operation (i.e. poor, corroded, or disconnected connections). Voltage at the component will be low when the component is in operation. To test for high resistance and open circuits:

1. Check all terminals and grounds of the circuit for corrosion.
2. If terminals are not corroded or loose, the problem is in the component or wiring.

Grounded Circuit:



M85602 MIF

Grounded circuits usually result in no component operation or a blown fuse.

Conductors For 12 Volt Circuits

Stranded Conductors For 12 Volt Circuits						
SAE Wire Size (Gauge)	20	18	16	14	12	10
Metric Wire Size (MM)	0.5	0.8	1.0	2.0	3.0	5.0
Typical Stranding	7 X 28	16 X 30	19 X 29	19 X 27	19 X 25	19 X 23
Minimum Conductor Area In Circular Mils	1072	1537	2336	3702	5833	9343

Specifications

General Specifications

Ignition . . . . Electronic
Starter Type . . . . Solenoid Shift
Charging System . . . . 15-amp Stator

Battery:

Type . . . . BCI Group U1
Voltage 12V
Reserve Capacity @25A . . . . 44 Minutes
Cold Cranking Amps @ 0° 342

Headlights:

Incandescent . . . . Standard
Halogen Bulbs . . . . 37.5 watt (optional)
Tail Lights . . . . 5 watt Bayonet Base
Turn Signal/Hazard Lights . . . . 32 Cd/m^2, Single Element, Type 1156
Instrument Panel Lamps . . . . 1.7 watt Bayonet Base

Test and Adjustment Specifications

Stator:

Regulated Amperage . . . . 13.5 amps (minimum) at high idle
Regulated Voltage . . . . 15 volts DC (maximum)
Unregulated Voltage . . . . 26 VAC (minimum)
Stator Coil Resistance . . . . 0.11 - 0.18 ohms

Auxiliary Alternator (Optional):

Regulated Amperage . . . . 20 amps (minimum) at high idle
Regulated Voltage . . . . 15 volts DC (maximum)
Unregulated Voltage . . . . 26 VAC (minimum)

Starter:

Loaded Amp Draw/RPM . . . . 85 amps (maximum) at 500 RPM
No-Load Amps/RPM . . . . 50 amps (maximum) at 6000 RPM
No-Load RPM . . . . 6000 Minimum

Ignition Coil:

Primary Winding Resistance . . . . 2.2 - 3.6 k-ohms
Secondary Winding Resistance . . . . 13 - 21 k-ohms
Air Gap . . . . 0.25 - 0.40 mm (0.010 - 0.016 in.)

Engine Coolant Temperature Sensor:

Variable Resistance . . . . 40 - 700 ohms
Off to On Closing Temperature . . . . 108 - 114 °C (226 - 237°F)
On to Off Opening Temperature . . . . 101 - 197°C (214 - 225°F)

Engine Oil Pressure Switch:

Switch Opening Pressure . . . . 98 kPa (14.2 psi)

PTO Clutch Solenoid:

Resistance. . . . . 8 - 10 ohms

Spark Plug:

Spark Plug Gap. . . . . 0.75 mm (0.030 in.)

Spark Plug Type . . . . NGK BPR2Es

Fuel Gauge Sender:

Resistance. . . . . Approximately 6 - 103 ohms

EFI Vacuum Pressure Sensor - X720/X724/X728:

Left and Center Terminals . . . . 2986 - 3034 ohms

Left and Right Terminals . . . . 773 - 787 ohms

Center and Right Terminals. . . . . 3774 - 3798 ohms

Input Voltage . . . . about 5 volts DC

Output Voltage . . . . 0.5 - 4.9 volts DC depending on air pressure

EFI Air Temperature Sensor - X720/X724/X728:

Resistance at 0°C (32 °F) . . . . 5.29 - 6.47 k-ohms

Resistance at 20°C (68°F) . . . . 2.21 - 2.69 k-ohms

Resistance at 80°C (176°F) . . . . 133 - 163 ohms

EFI Coolant Temperature Sensor - X720/X724/X728:

Resistance at 20°C (68°F) . . . . 2.21 - 2.69 k-ohms

Resistance at 80°C (176°F) . . . . 292 - 354 ohms

Resistance at 110°C (230°F). . . . . 133 - 163 ohms

Fuel Injectors - X720/X724/X728:

Resistance at 20°C (68°F) . . . . 12.5 ohms

RIO Switch:

Air Gap. . . . . 12 mm (0.47 in.)

Repair Specifications

Starter:

Minimum Brush Length. 6.0 mm (0.24 in.)

Display Code Chart:

Test Conditions

- Brake on
- PTO switch in RIO position (pulled out)
- Key switch on

Code	Action	Test Point	Fault Cause
brAHE	Depress brake pedal.	S8 brake switch, 765 Pur wire, 504 Yel wire, and switched power circuits.	S8 brake switch OK.
crAnH	Turn key switch to start.	S1 key switch, 720 Pur wire, 591 Yel wire, switched and unswitched power circuits.	S1 key switch OK.
SEAt	Operator on seat.	S4 seat switch, 800 Pnk wire, 502 Yel wire, and switched power circuits.	S4 seat switch OK.
Pto o	Pull up RIP switch.	S3 PTO/RIP switch, 754 Blu wire, 501 Yel wire, and switched power circuits.	S3 PTO/RIP switch OK (RIP position).
Pto	Activate PTO switch.	S3 PTO/RIP switch, 755 Blu wire, 501 Yel wire, and switched power circuits.	S3 PTO/RIP switch OK (PTO position).
rEu	Depress reverse pedal.	S7 RIO switch, 772 Blu wire, 402 Yel wire, and switched power circuits.	S7 RIO switch OK.
EoP	Remove oil pressure sensor wire.	B1 engine oil pressure switch and 620 Tan wire.	B1 engine oil pressure switch OK.
COOL	Remove and ground coolant temperature switch wire.	B2 engine water temperature sensor and 310 Org wire.	B2 engine water temperature switch OK.
L iGht	Turn on back up light switch.	S9 light switch, 400 Yel/Blu wire, and switched power circuits.	S9 light switch OK (back up lights position).
Pto ii	****	Rear PTO jumper (if installed)	
Pto r	Engage rear PTO.	S6 rear PTO switch, 740 Blu wire, 520 and 521 Yel wires, and switched power circuits.	S6 rear PTO switch OK.
------	No action	End of tests	End of tests

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
Spark Tester	D-05351ST	Test ignition system and spark plugs.
Current Gun Photo Tachometer	JTO5712 JTO5719	Starting motor tests.
Battery Tester	JTO5685	Starting motor amp draw test and battery tests.
Current Gun Battery Tester	JTO5712 JTO5685	Regulated amp and voltage tests.

Other Materials

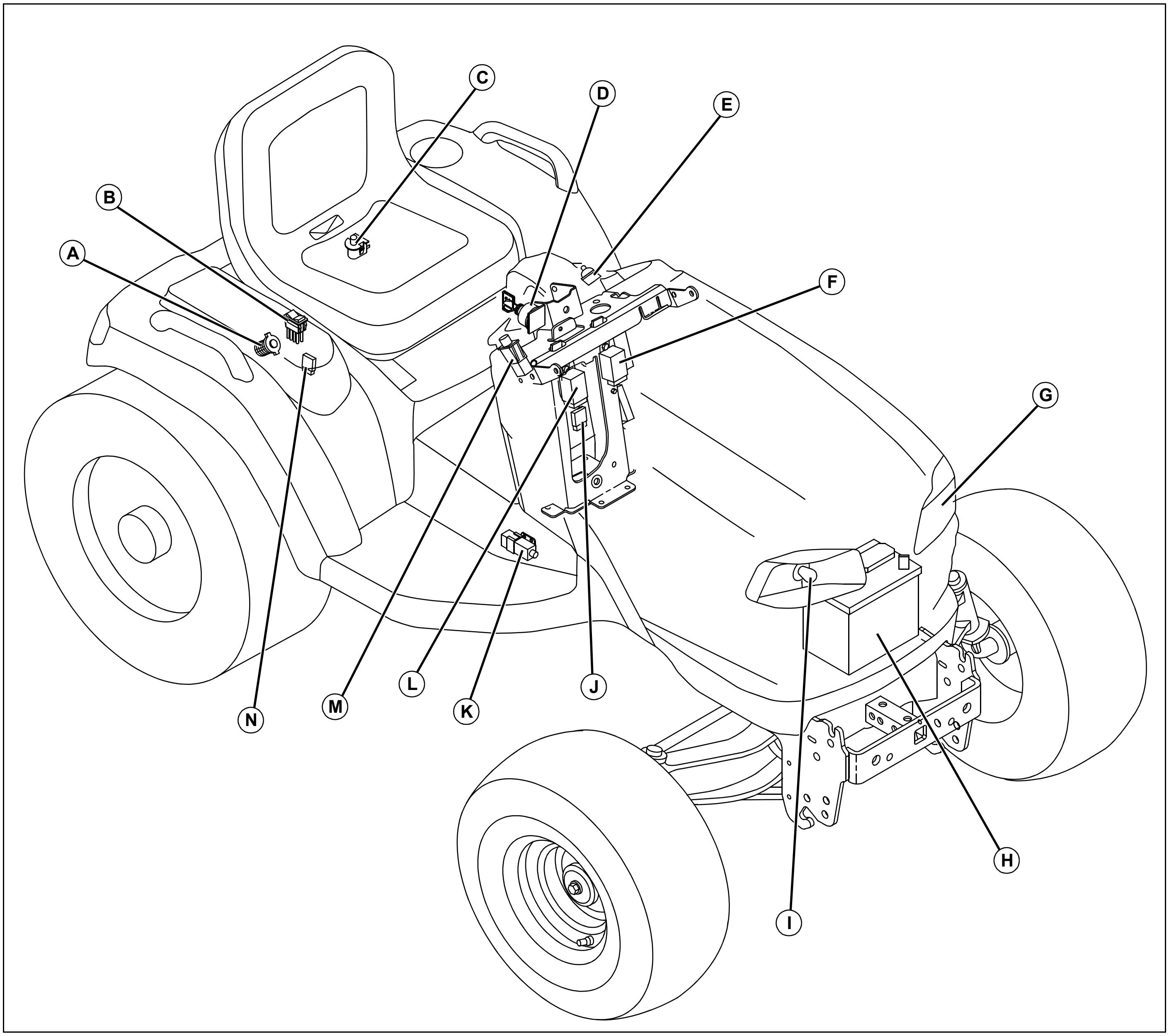
Other Material

Part No.	Part Name	Part Use
TY9374/ TY9375	Pipe sealant with Teflon™	Seal threads on temperature sensor and oil pressure switches.

Note: Teflon™ is a registered trademark of the Du Pont Company.

Component Location

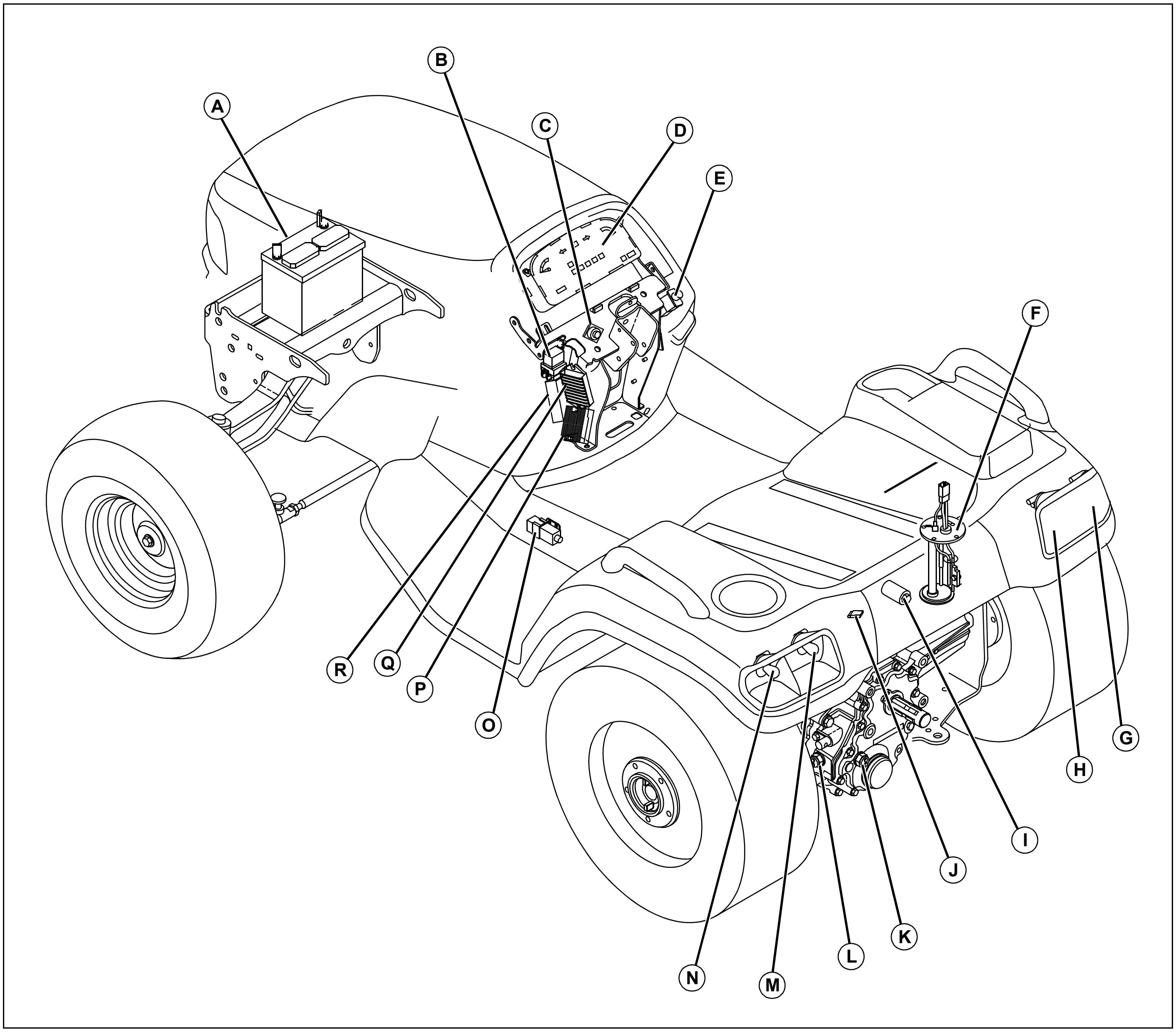
Right Side



MIF

A- X13 Power Port
B- S2 Power Port Switch
C- S4 Seat Switch
D- S1 Key Switch
E- S9 Light Switch
F- K1 Main Relay (EFI)
G- E2 LH Headlight
H- G1 Battery
I- E1 RH Headlight
J- F5 Fuse - (X720/X724/X728)
K- S7 RIO Switch
L- K2 Fuel Relay (EFI)
M- S3 PTO/RIP Switch
N- F6 Fuse

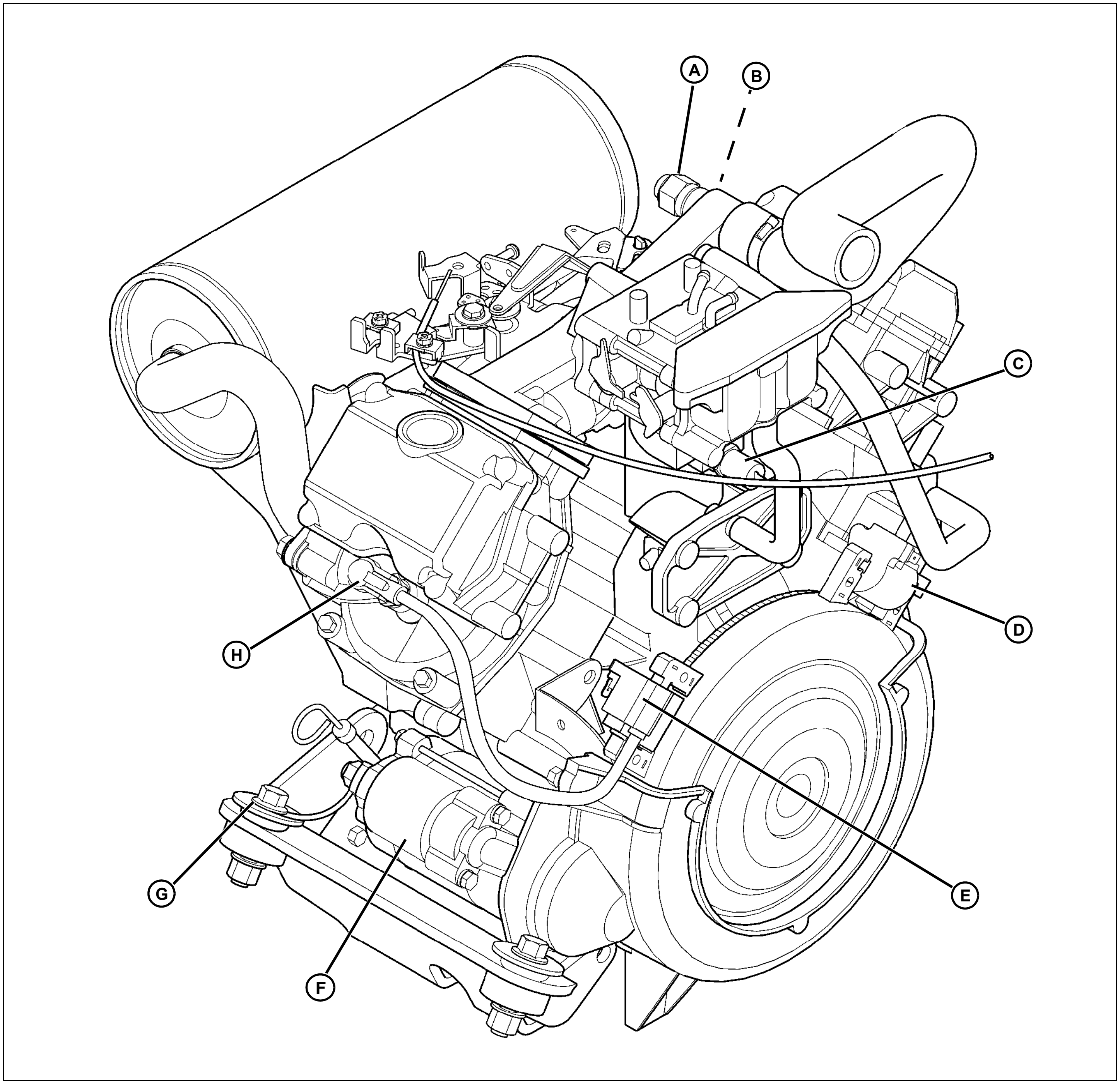
Left Side



MIF

A- G1 Battery
B- K3 Safety Relay (EFI)
C- S9 Light Switch
D- A1 Display Panel
E- S3 PTO/RIP Switch
F- B3 Fuel Gauge Sender
G- E3 RH Tail Light
H- E5 RH Backup Light
I- Y2 PTO Clutch Solenoid
J- V1 Diode
K- S5 Front PTO Switch (optional)
L- S6 Rear PTO Switch (optional)
M- E6 LH Backup Light
N- E4 LH Tail Light
O- S8 Brake Switch
P- N1 Voltage Regulator/Rectifier
Q- N2 Voltage Regulator/Rectifier (optional)
R- A2 EFI Module (EFI)

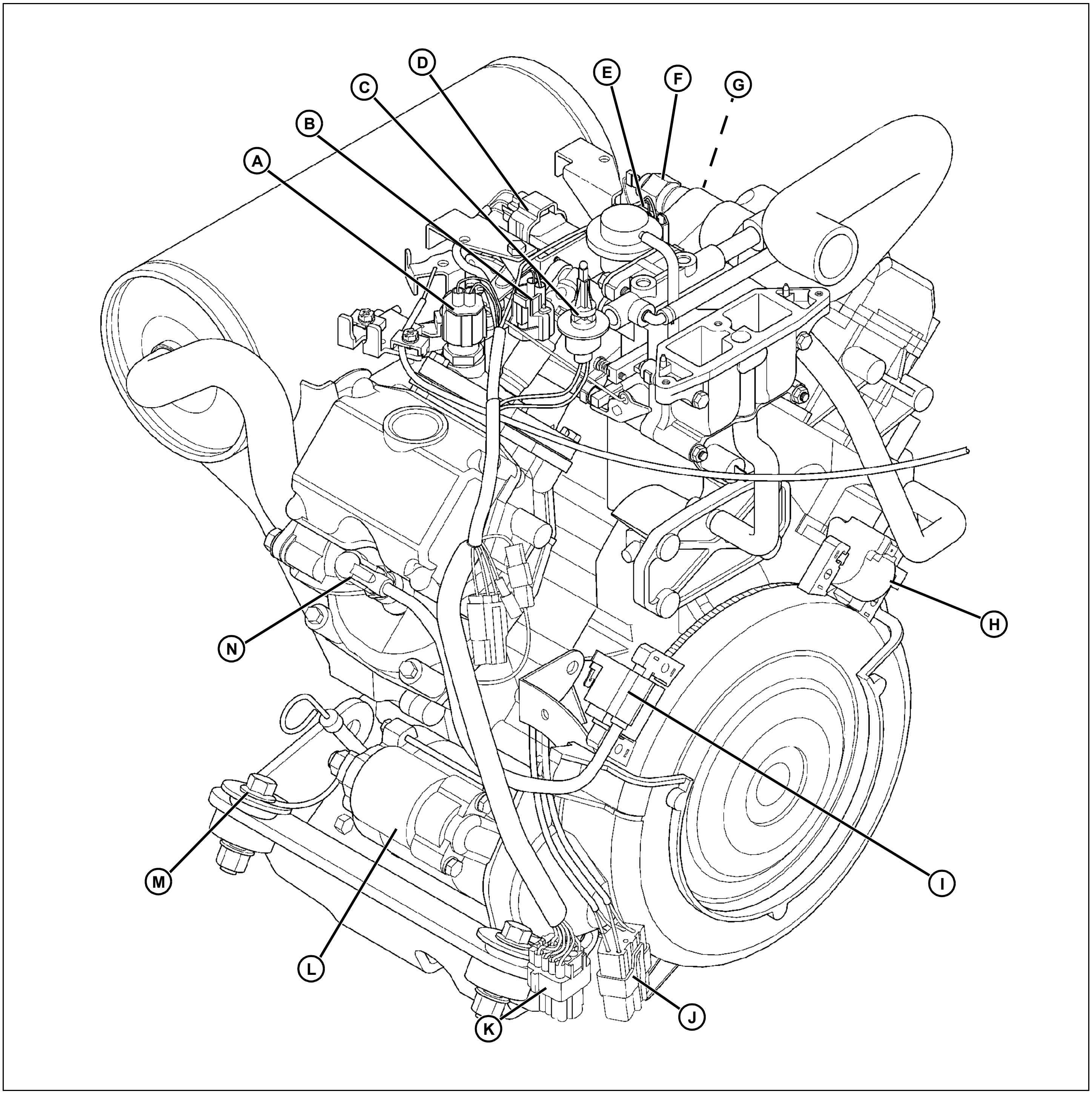
Engine Components (FD671D)



MX14278

A- B2 Engine Coolant Temperature Sensor
B- B1 Engine Oil Pressure Switch (RH Side)
C- Y3 Fuel Shutoff Solenoid
D- T2 Ignition Module
E- T1 Ignition Module
F- Y1 Starting Motor Solenoid
G- W1 Frame Ground
H- E1 Spark Plug

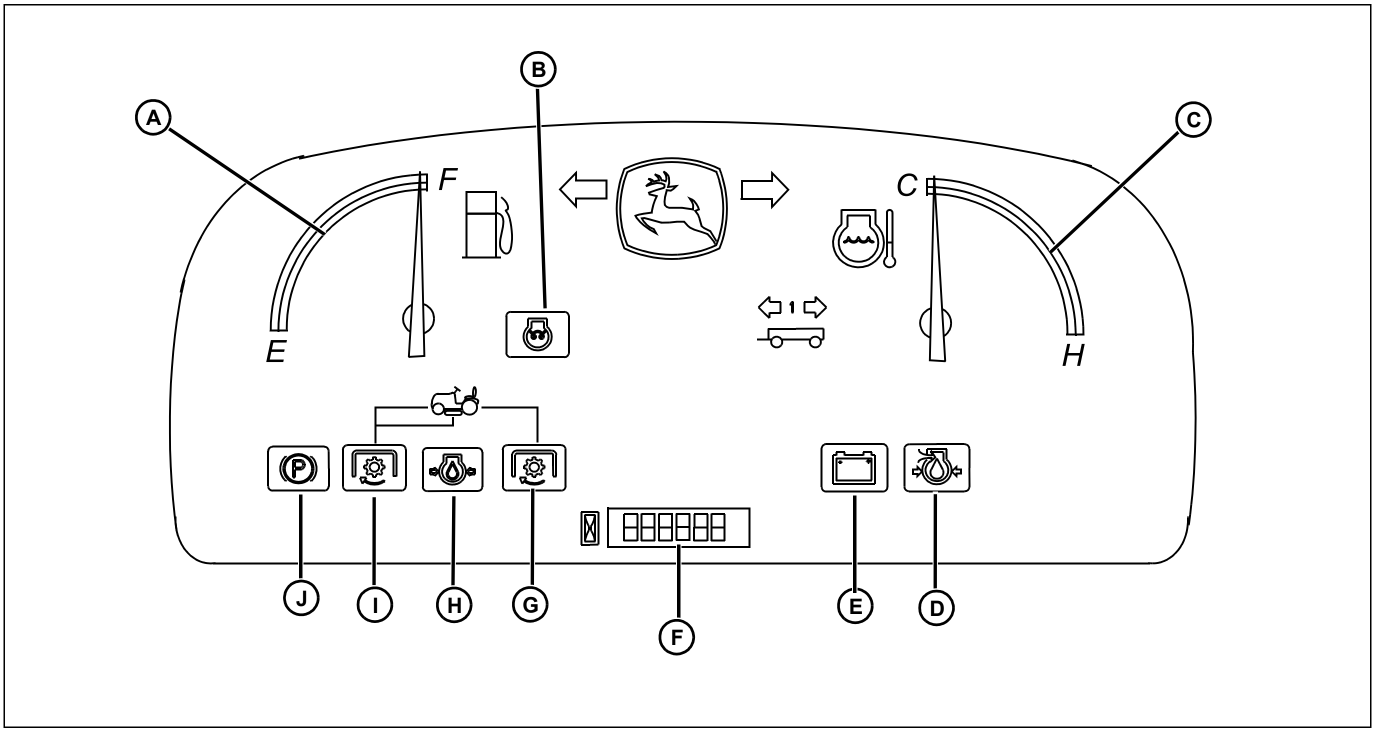
Engine Components (FD750D EFI)



MX14312

- A- B4 Engine Coolant Temperature Sensor
- B- Y3 #1 Cylinder Fuel Injector
- C- B5 Air Temperature Sensor
- D- B6 Vacuum Pressure Sensor
- E- Y4 #2 Cylinder Fuel Injector
- F- B2 Engine Coolant Temperature Sensor
- G- B1 Engine Oil Pressure Switch (RH Side)
- H- T2 Ignition Module
- I- T1 Ignition Module
- J- X2 Wiring Harness Connector
- K- X10 Wiring Harness Connector
- L- Y1 Starting Motor Solenoid
- M- W1 Frame Ground
- N- E1 Spark Plug

Instrument Panel



MX13564

A- Fuel Gauge
B- Oil Pressure Indicator Light
C- Coolant Temperature Gauge
D- EFI Diagnostic Light (X720/X724/X728)
E- Battery Discharge Indicator Light
F- Hour Meter
G- Rear PTO Indicator Light
H- Reverse Implement Option (RIO) Indicator Light
I- Front and Mid PTO Indicator Light
J- Park Brake Indicator Light

Schematics and Harnesses

Schematic and Wiring Harness Legend - X700

A1 - Display Panel

B1 - Engine Oil Pressure Switch

B2 - Engine Coolant Temperature Sensor

B3 - Fuel Gauge Sender

E1 - RH Headlight

E2 - LH Headlight

E3 - RH Tail Light

E4 -LH Tail Light

E5 - RH Back Up Light

E6 - LH Back Up Light

E7 - Spark Plug

E8 - Spark Plug

F1 - Fuse 15A

F2 - Fuse 15A

F3 - Fuse 30A

F4 - Fuse 20A

F5 - Fuse 15A

G1 - Battery

G2 - Alternator

G3 - Auxiliary Alternator (Option)

M1 - Starting Motor

M2 - Fuel Pump

N1 - Voltage Regulator/Rectifier

S1 - Key Switch

S2 - Power Port Switch

S3 - PTO/RIP Switch

S4 - Seat Switch

S5 - Front PTO Switch

S6 - Rear PTO Switch (Option)

S7 - RIO Switch

S8 - Brake Switch

S9 - Light Switch

T1 - Ignition Coil

T2 - Ignition Coil

V1 - PTO Diode

W1 - Frame Ground

Y1 - Starting Motor Solenoid

Y2 - PTO Clutch Solenoid

Y3 - Fuel Shutoff Solenoid

Connectors:

J1 - A1 Display Panel

J2 - A1 Display Panel

J3 - A1 Display Panel

X1 - W1 Main Wiring Harness to W4 Rear Wiring Harness

X2 - W1 Main Wiring Harness to N1 Voltage Regulator/ Rectifier

X3 - W1 Main Wiring Harness to W2 Engine Wiring Harness

X4 - W1 Main Wiring Harness to W5 PTO Solenoid Wiring Harness

X5 - Rear PTO Jumper

X6 - M2 Fuel Pump to Fuel Pump Adaptor

X13 - Power Port

X14 - W6 Auxiliary Alternator (Option) Wiring Harness to G3 Auxiliary Alternator

X15 - W6 Auxiliary Alternator (Option) Wiring Harness to N1 Voltage Regulator/Rectifier

X16 - W6 Auxiliary Alternator (Option) Wiring Harness to N2 Voltage Regulator/Rectifier

X17 - Auxiliary Alternator (Option) Wiring Harness to W2 Engine Wiring Harness

Wiring Harnesses:

W1 - Main Wiring Harness

W2 - Engine Wiring Harness

W3 - Headlight Wiring Harness

W4 - Rear Wiring Harness

W6 - Auxiliary Alternator Wiring Harness (Option)

Schematic And Wiring Harness Legend - X720/X724/X728

A1 -Display Panel

A2 - Electronic Fuel Injection Module (EFI)

B1 - Engine Oil Pressure Switch

B2 - Engine Coolant Temperature Sensor

B3 - Fuel Gauge Sender

B4 - EFI Engine Coolant Temperature Sensor

B5 - EFI Air Temperature Sensor

B6 - EFI Vacuum Pressure Sensor

E1 - RH Headlight

E2 - LH Headlight

E3 - RH Tail Light

E4 - LH Tail Light

E5 - RH Back Up Light

E6 - LH Back Up Light

E7 - Spark Plug

E8 - Spark Plug

F1 - Fuse 15A

F2 - Fuse 15A

F3 - Fuse 30A

F4 - Fuse 20A

F5 - Fuse 10A

F6 - Fuse 15A

G1 - Battery

G3 - Auxiliary Alternator (Option)

G2 - Alternator

K1 - Main Relay

K2 - Fuel Pump Relay

K3 - Safety Relay

M1 - Starting Motor

M2 - Fuel Pump

N1 - Voltage Regulator/Rectifier

S1 - Key Switch

S2 - Power Port Switch

S3 - PTO/RIP Switch

S4 - Seat Switch

S5 - Front PTO Switch

S6 - Rear PTO Switch (Option)

S7 - RIO Switch

S8 - Brake Switch

S9 - Light Switch

T1 - Ignition Coil

T2 - Ignition Coil

V1 - PTO Diode

W1 - Frame Ground

W2 - Frame Ground

Y1 - Starting Motor Solenoid

Y2 - PTO Clutch Solenoid

Y3 - #1 Cylinder Fuel Injection Solenoid

Y4 - #2 Cylinder Fuel Injection Solenoid

Connectors:

J1 - A1 Display Panel

J2 - A1 Display Panel

J3 - A1 Display Panel

X1 - W1 Main Wiring Harness to W4 Rear Wiring Harness

X2 - W1 Main Wiring Harness to N2 Voltage Regulator/ Rectifier

X3 - W1 Main Wiring Harness W2 Main Wiring Harness

X4 - W1 Main Wiring Harness to W5 PTO Solenoid Wiring Harness

X5 - Rear PTO Jumper

X6 - W1 Main Wiring Harness to M2 Fuel Pump

X7 - W1 Main Wiring Harness to W3 Headlight Wiring Harness

X8 - W1 Main Wiring Harness to X10 EFI Connector

X9 - W1 Main Wiring Harness to X10 EFI Connector

X10 - W1 Main Wiring Harness to A2 EFI Module

X11 - A2 EFI Module to X10 Connector

X12 - X10 Connector to T1 and T2 Ignition Coils

X13 - Power Port

X14 - W6 Auxiliary Alternator (Option) Wiring Harness to G3 Auxiliary Alternator

X15 - W6 Auxiliary Alternator (Option) Wiring Harness to N1 Voltage Regulator/Rectifier

X16 - W6 Auxiliary Alternator (Option) Wiring Harness to N2 Voltage Regulator/Rectifier

X17 - Auxiliary Alternator (Option) Wiring Harness to W2 Engine Wiring Harness

Wiring Harnesses:

W1 - Main Wiring Harness

W2 - Engine Wiring Harness

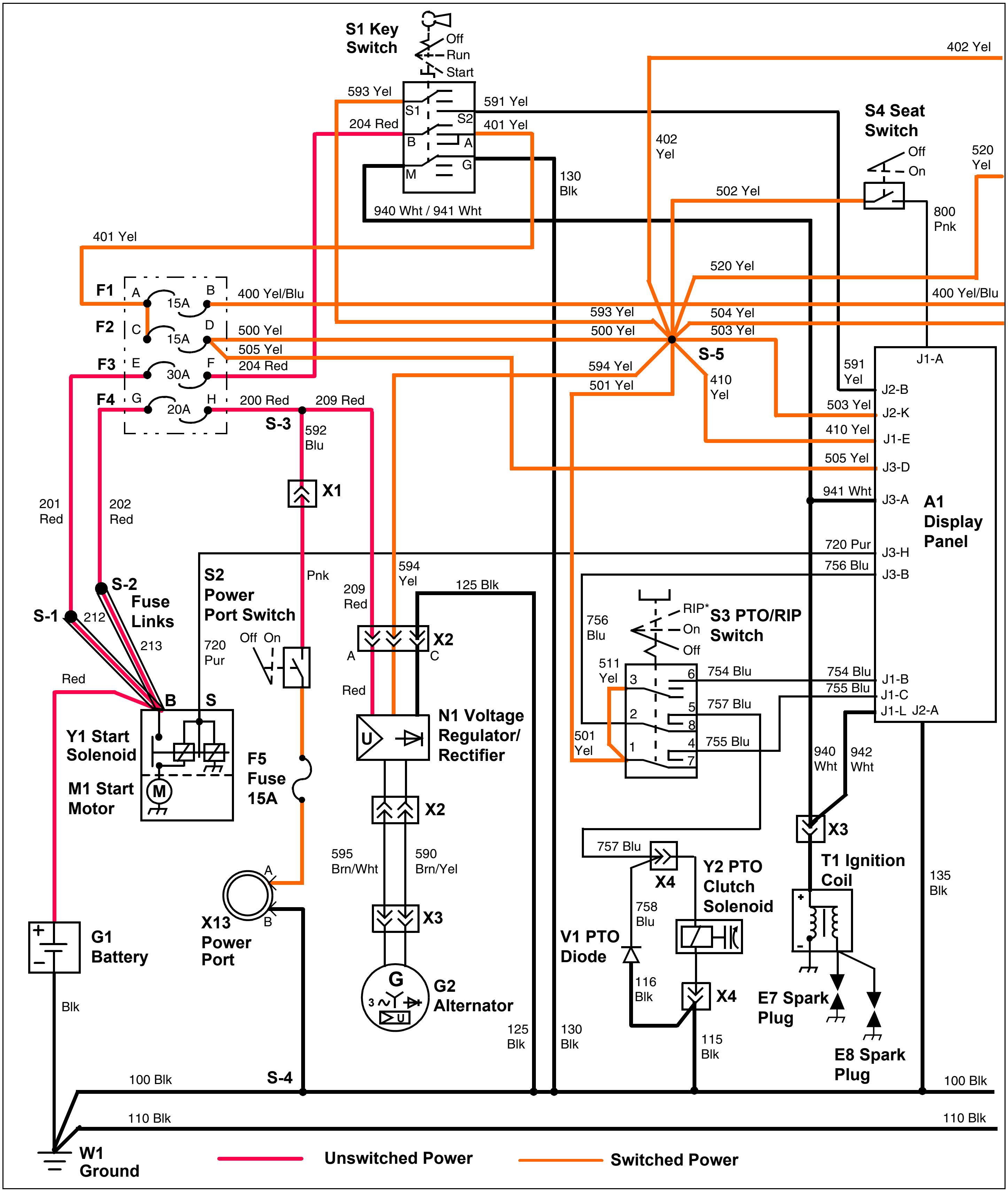
W3 - Headlight Wiring Harness

W4 - Rear Wiring Harness

W5 - PTO Solenoid Wiring Harness

W6 - Auxiliary Alternator Wiring Harness

Electrical Schematic - X700 Carbureted (1 of 2)



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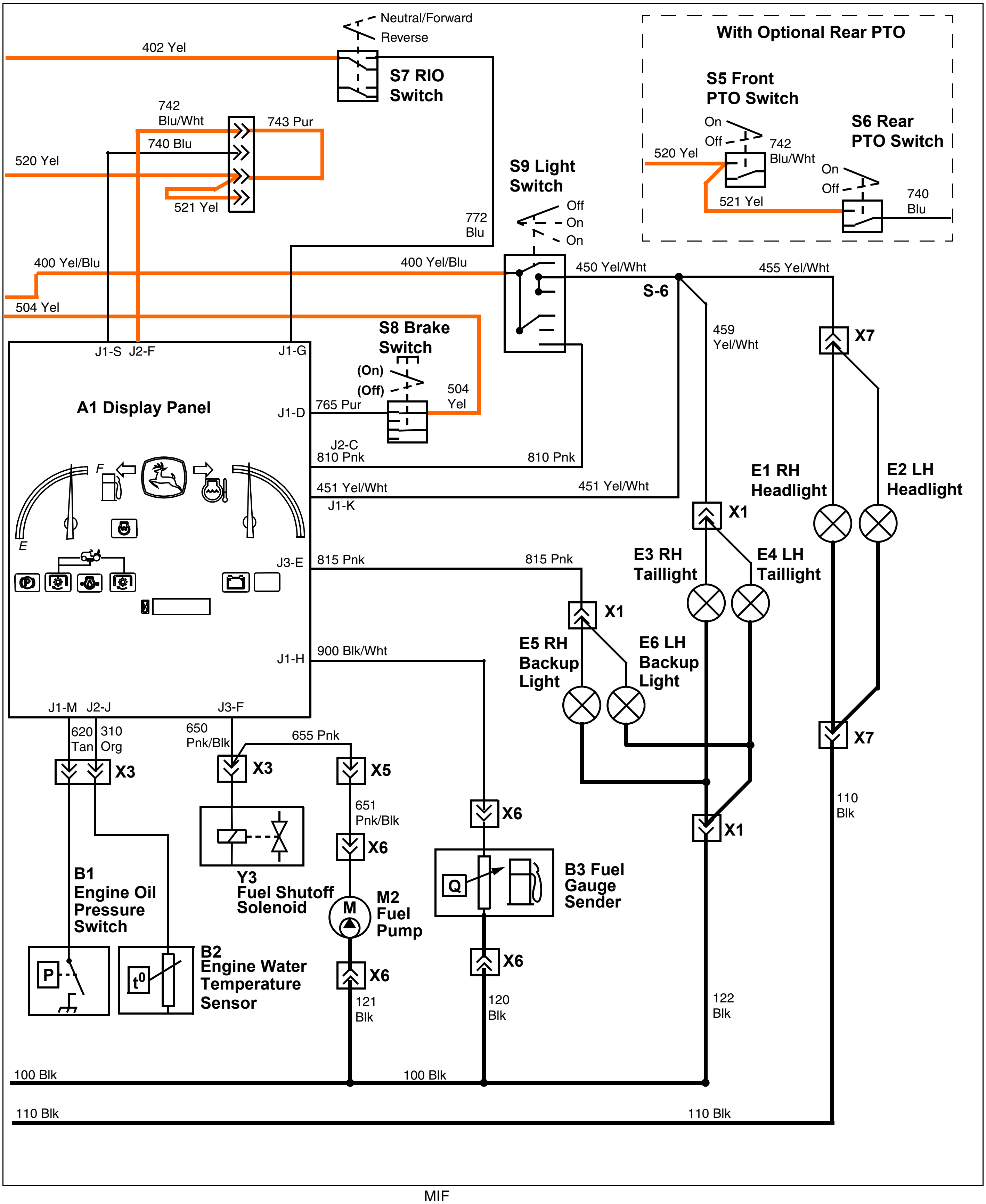
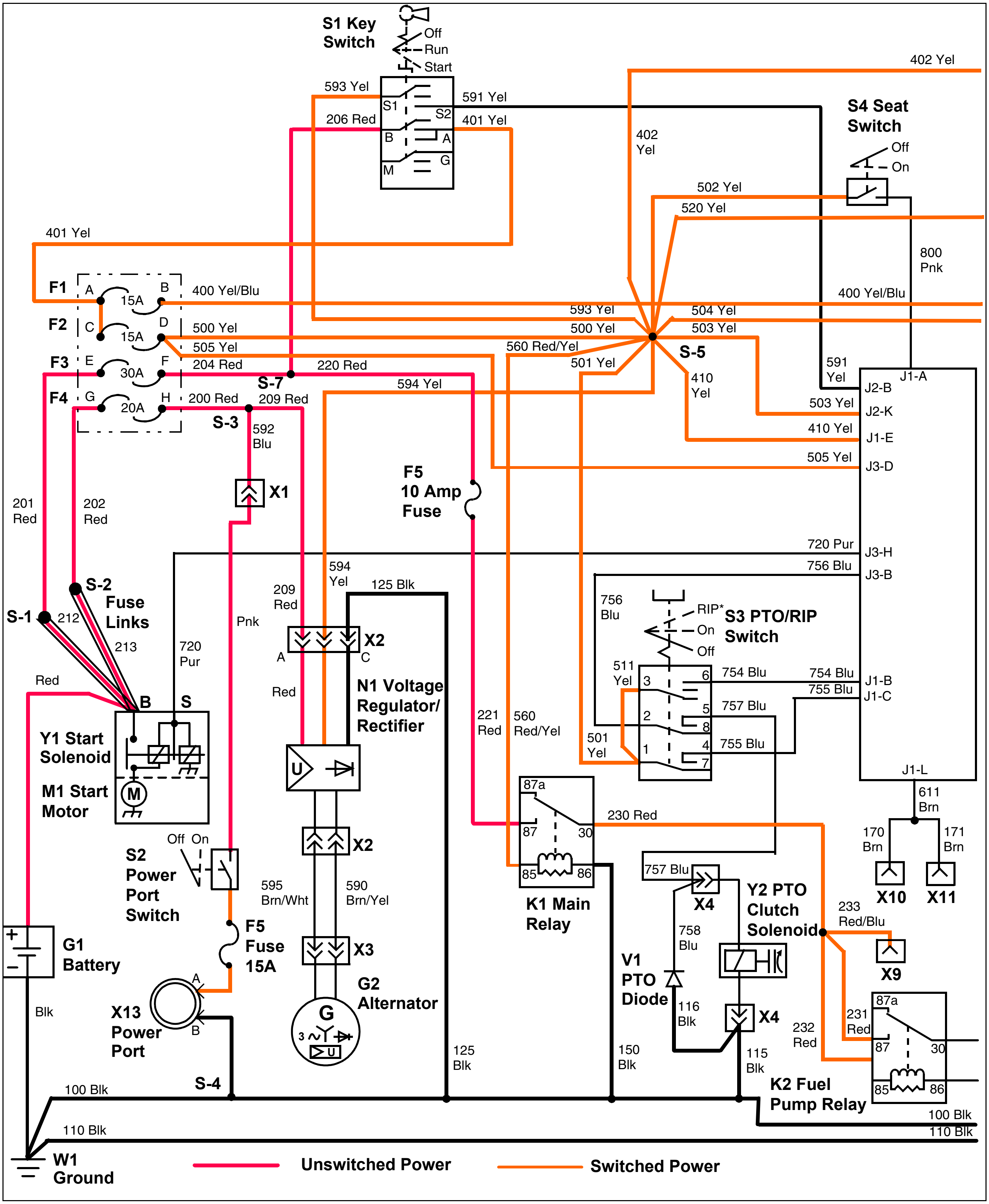
Electrical Schematic - X700 Carbureted (2 of 2)



W1 Main Wiring Schematic - 720/X724/X728 EFI (1 of 2)



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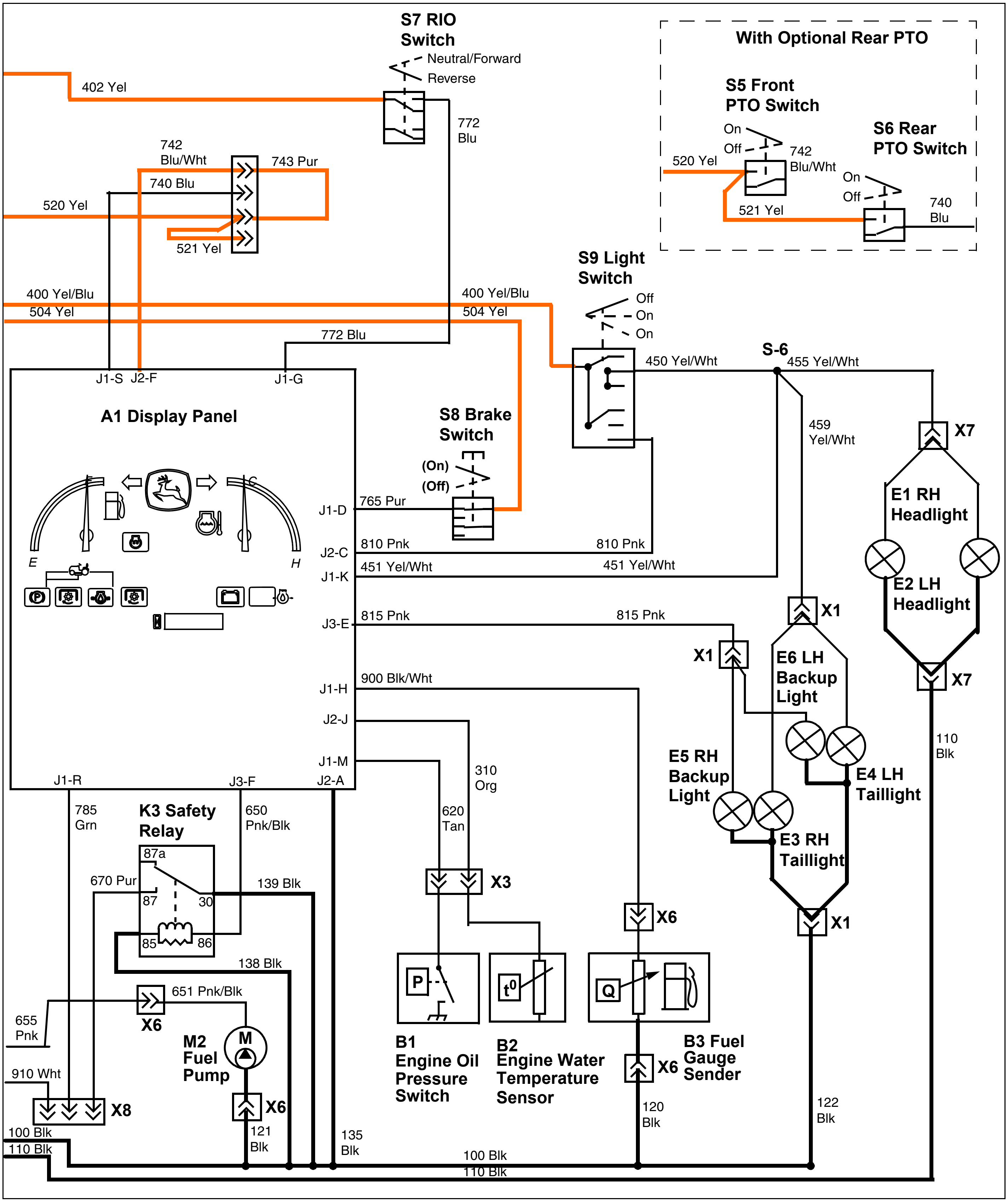
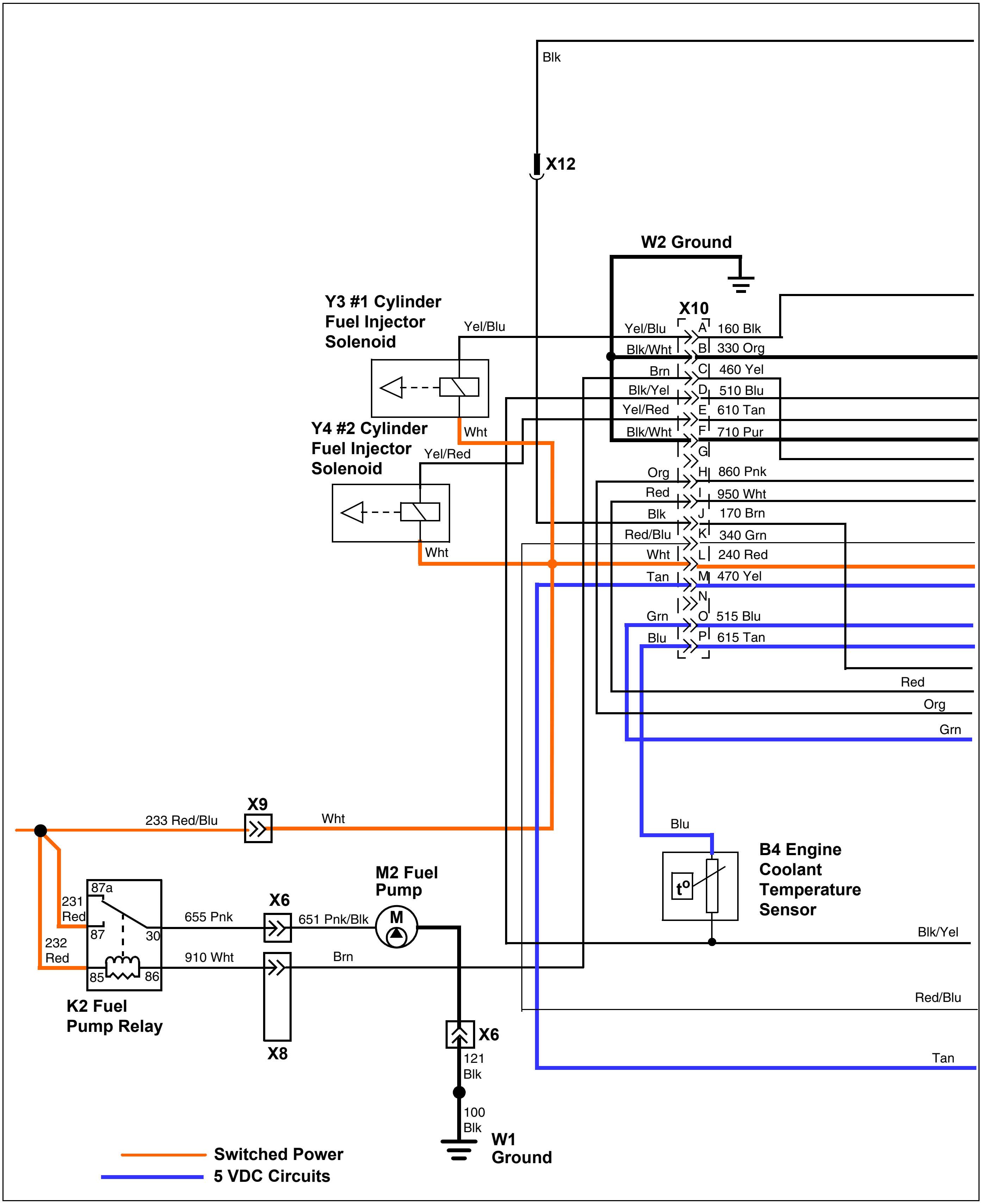
W1 Main Wiring Schematic - 720/X724/X728 EFI (2 of 2)



MIF

Liquid Cooled EFI Schematic (1 of 2)



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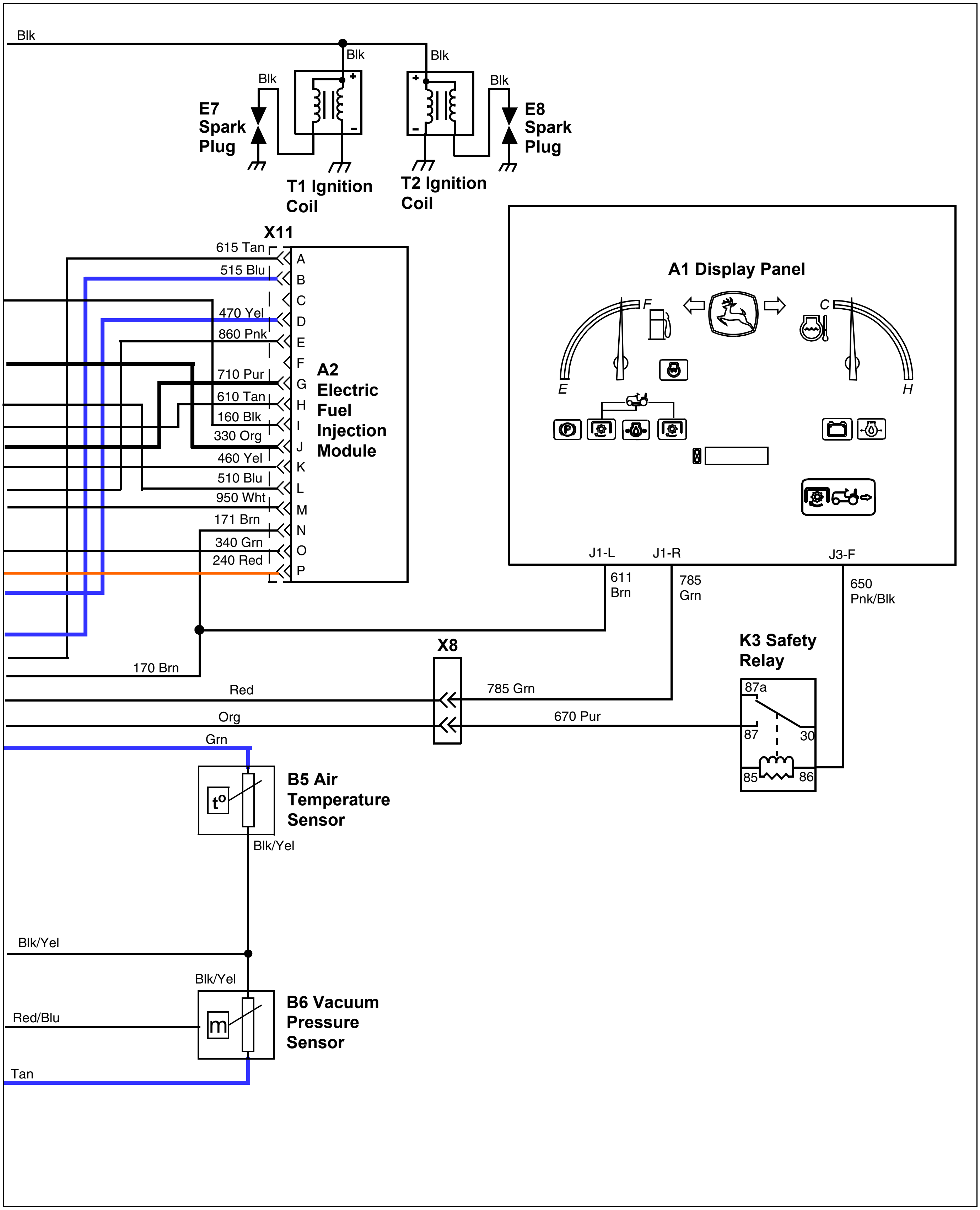
Liquid Cooled EFI Schematic (2 of 2)



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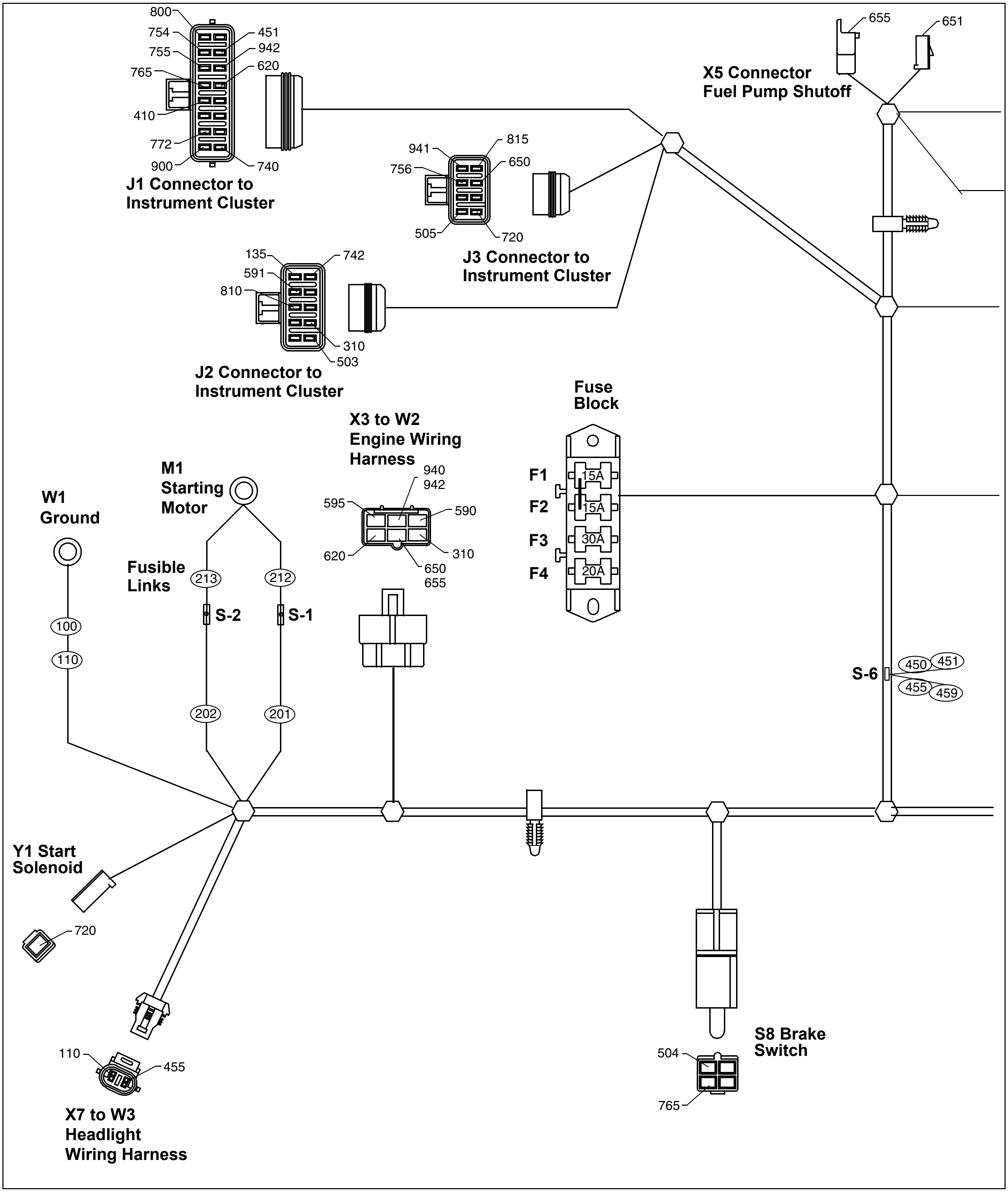
W1 Main Wiring Harness - X700 Carbureted (1 of 2)



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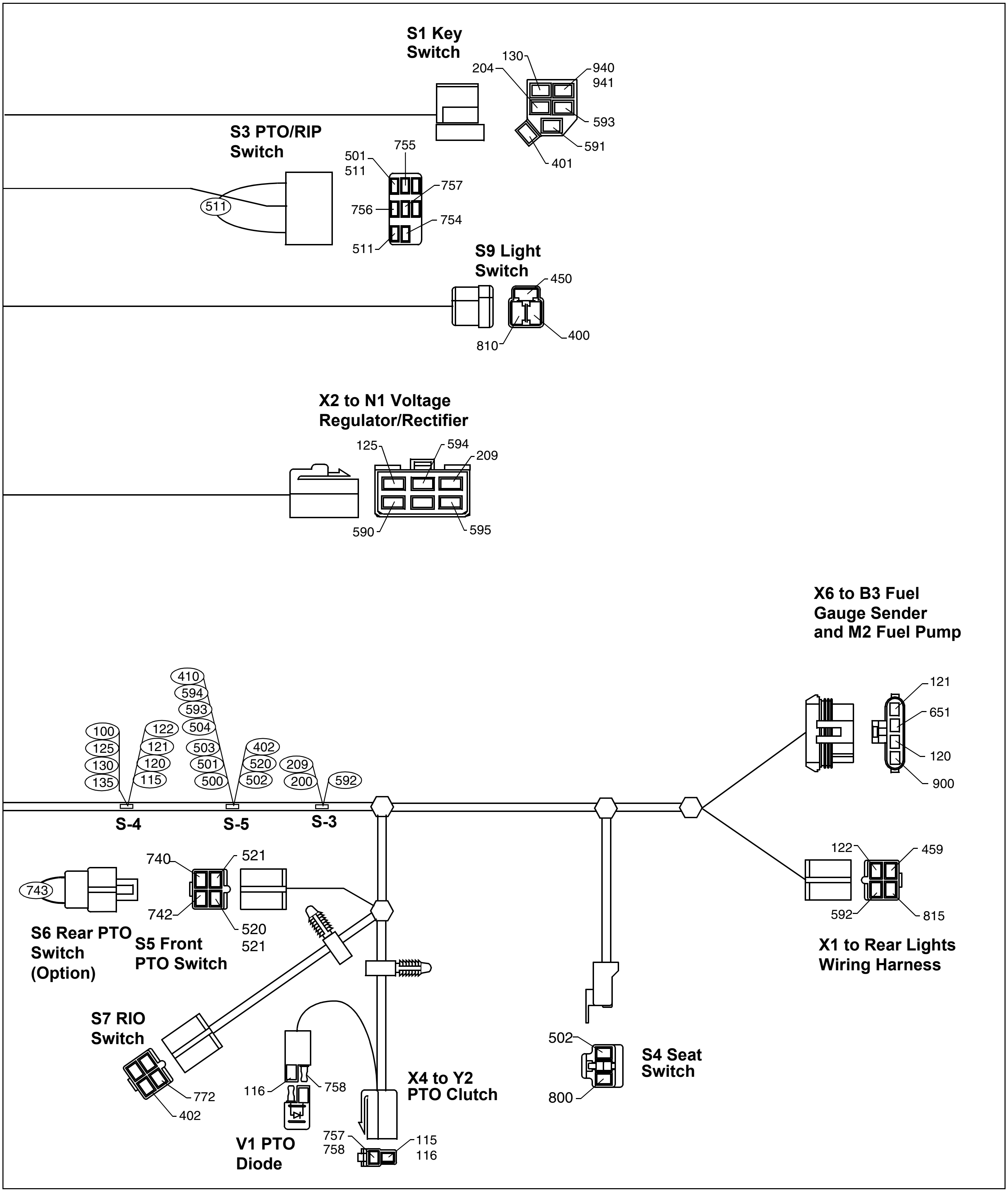
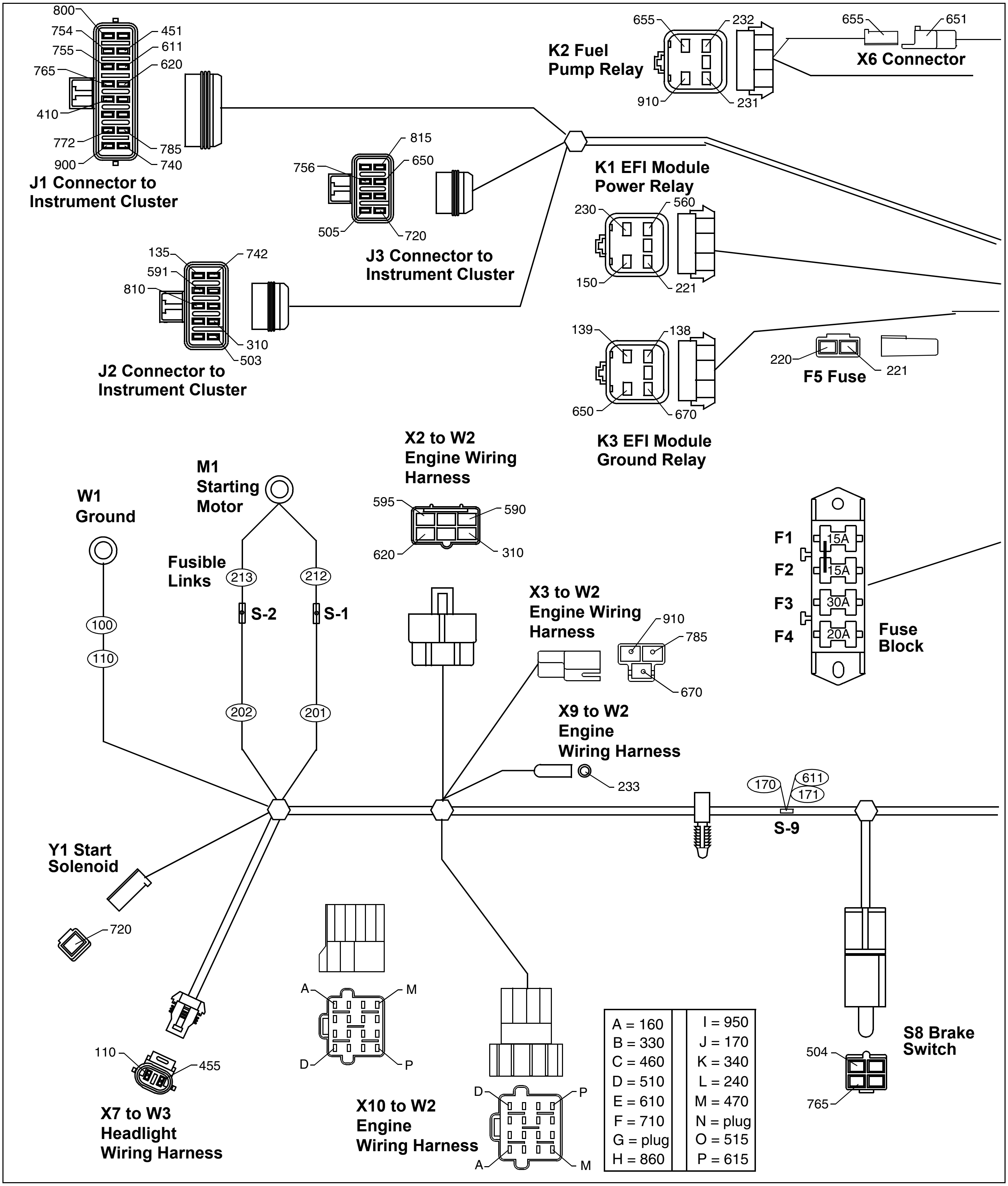
W1 Main Wiring Harness - X700 Carbureted (2 of 2)



MIF

W1 Main Wiring Harness - X720/X724/X728 EFI (1 of 2)



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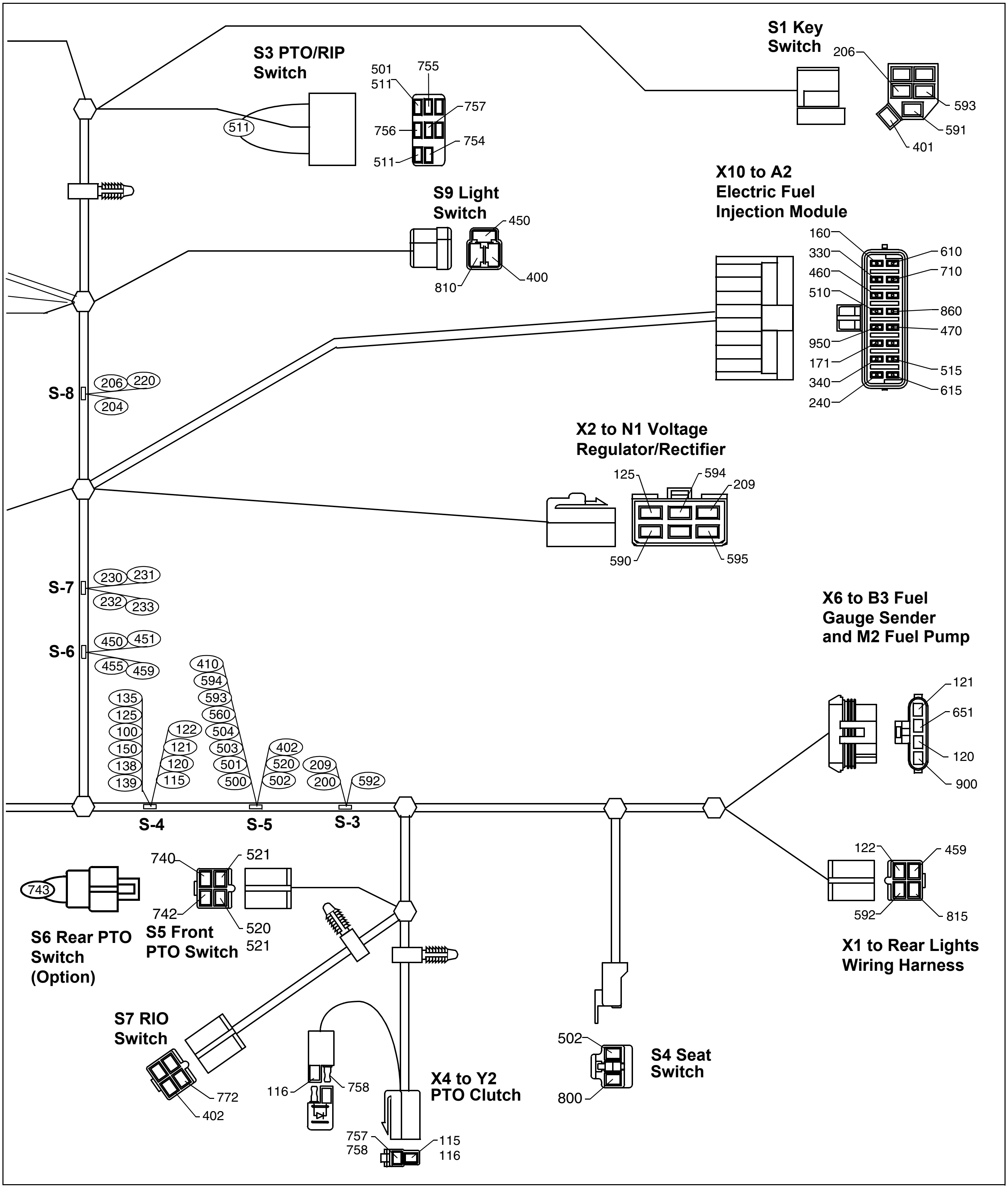
W1 Main Wiring Harness - X720/X724/X728 EFI (2 of 2)



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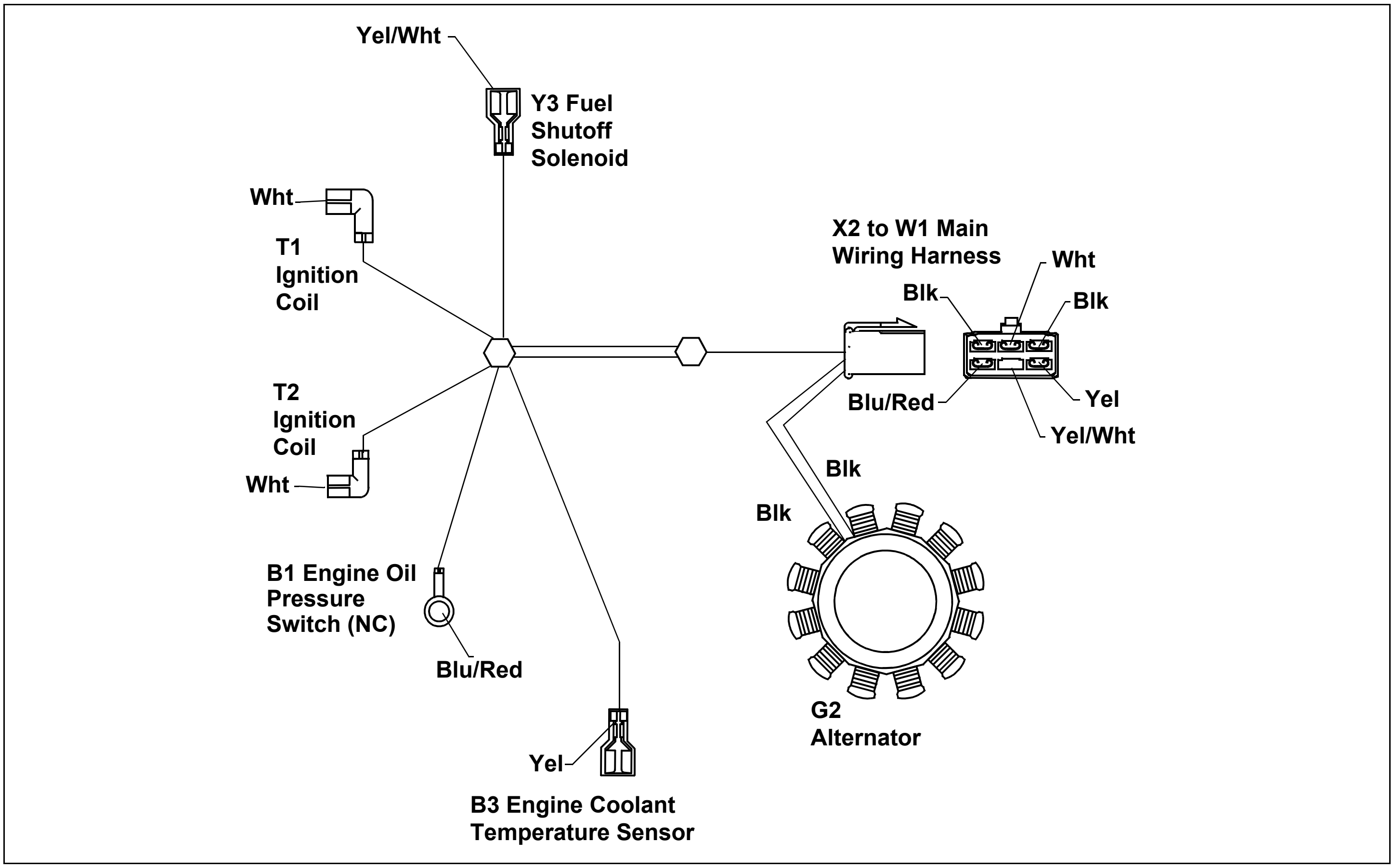
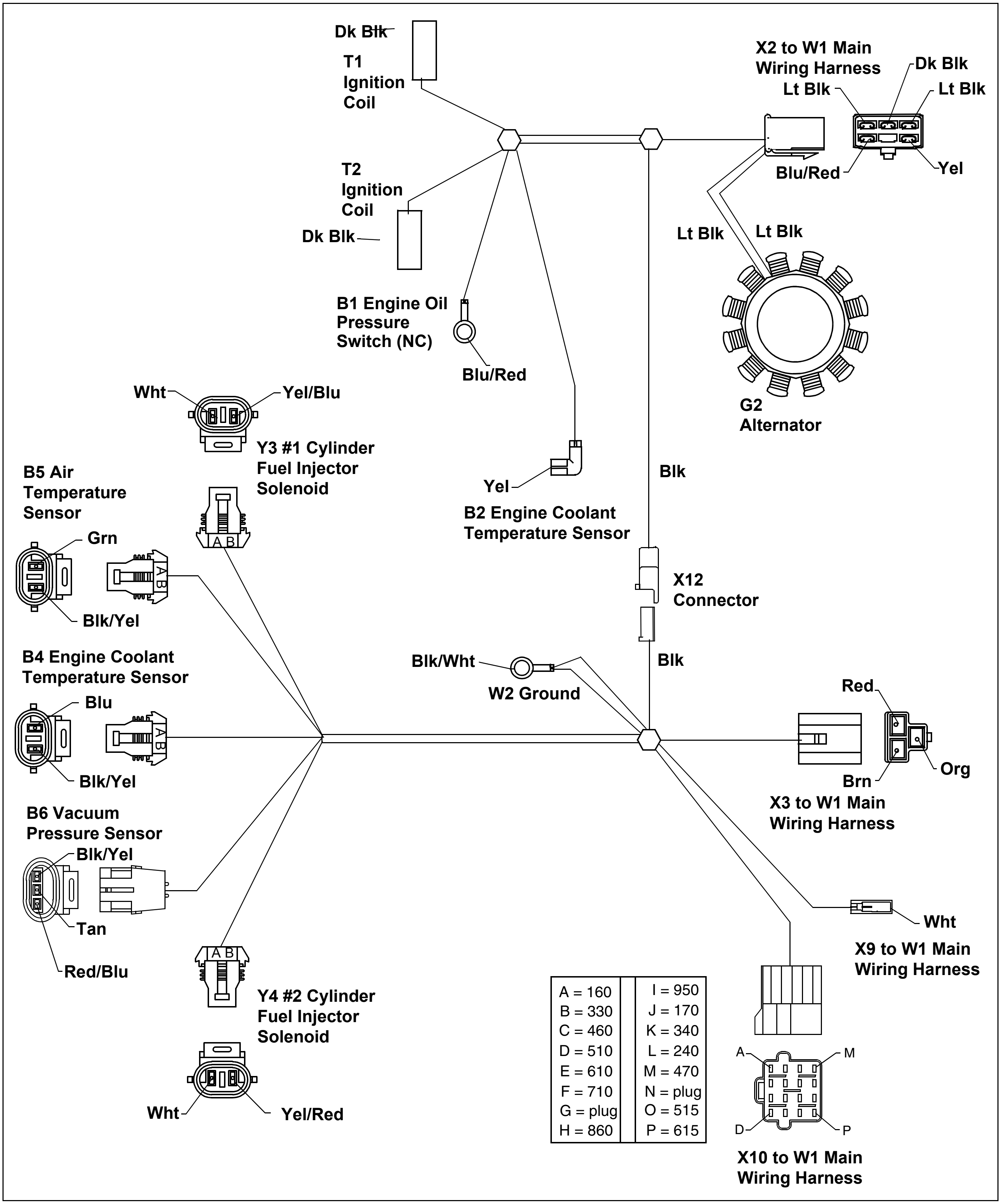
W2 Engine Wiring Harness - X700



MIF

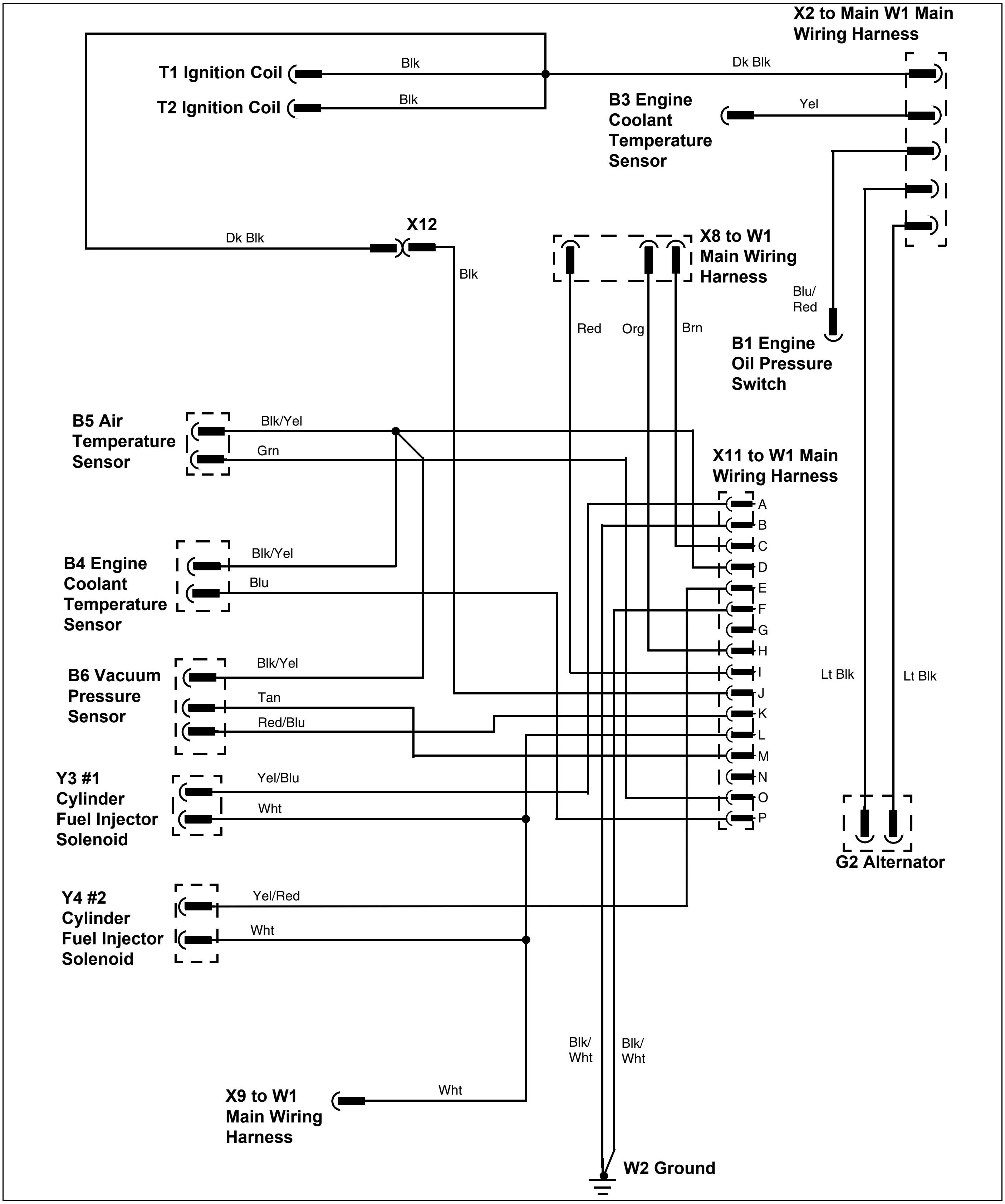
W2 Engine Wiring Harness - X720/X724/X728 EFI



A = 160	I = 950
B = 330	J = 170
C = 460	K = 340
D = 510	L = 240
E = 610	M = 470
F = 710	N = plug
G = plug	O = 515
H = 860	P = 615

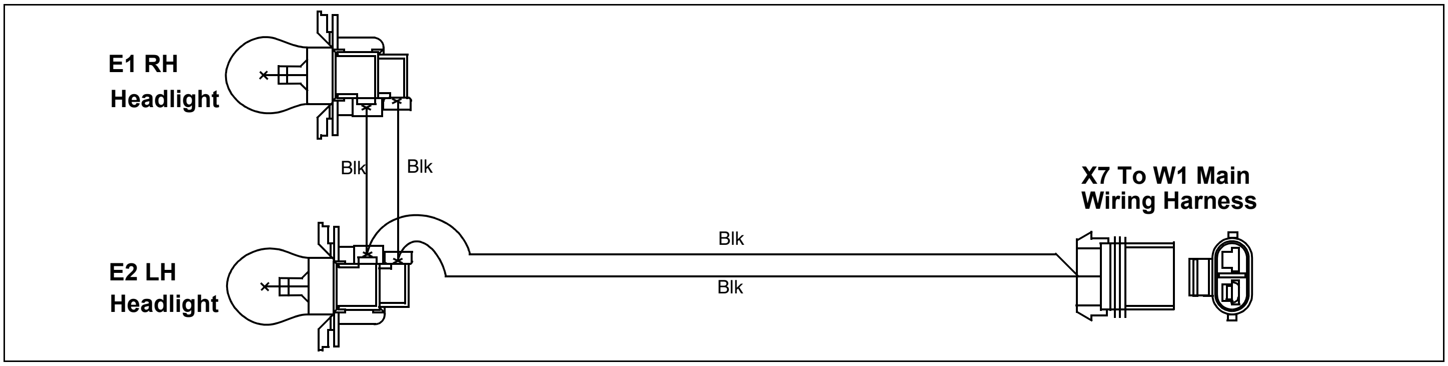
MIF

W2 Engine Wiring Harness Circuit Schematic - X720/X724/X728



MIF

W3 Headlight Wiring Harness



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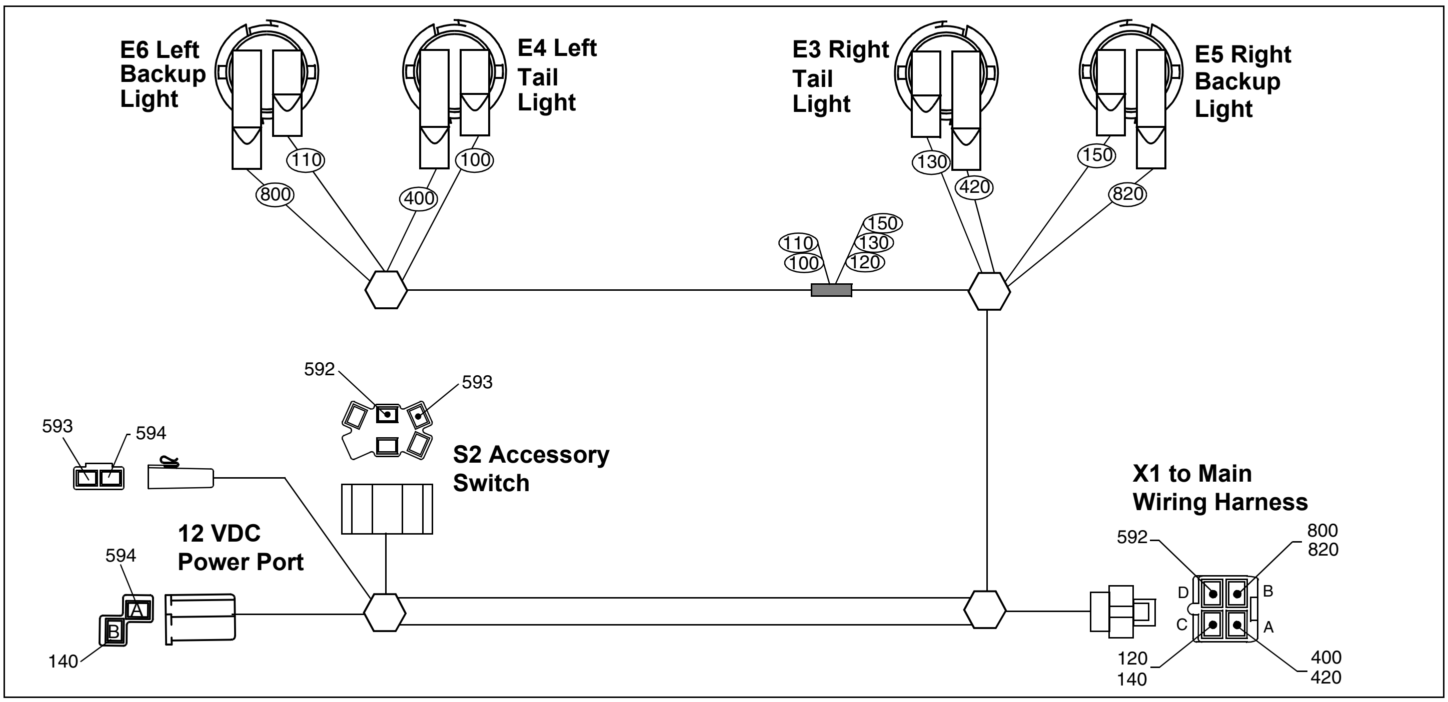
W4 Rear Wiring Harness



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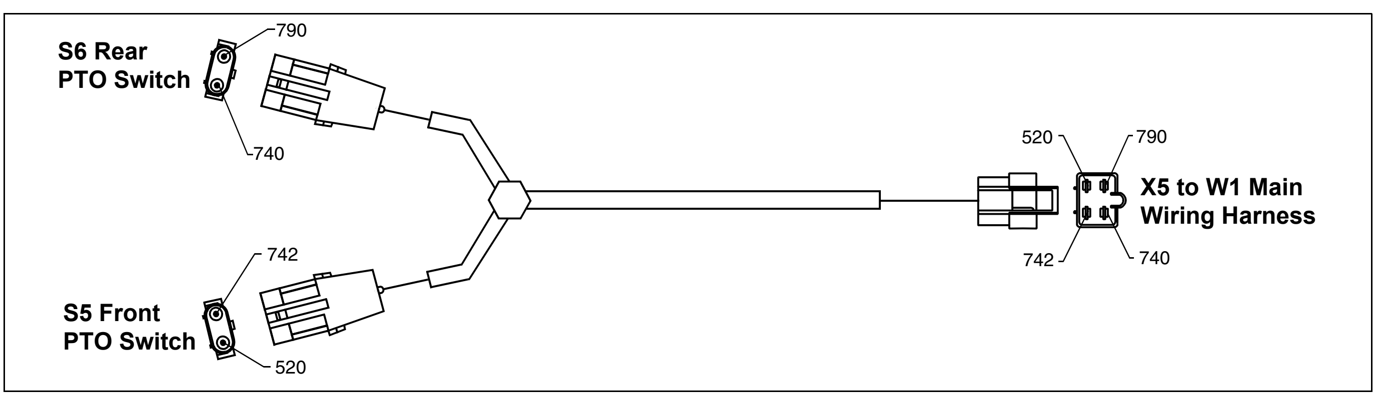
W5 PTO Option Wiring Harness



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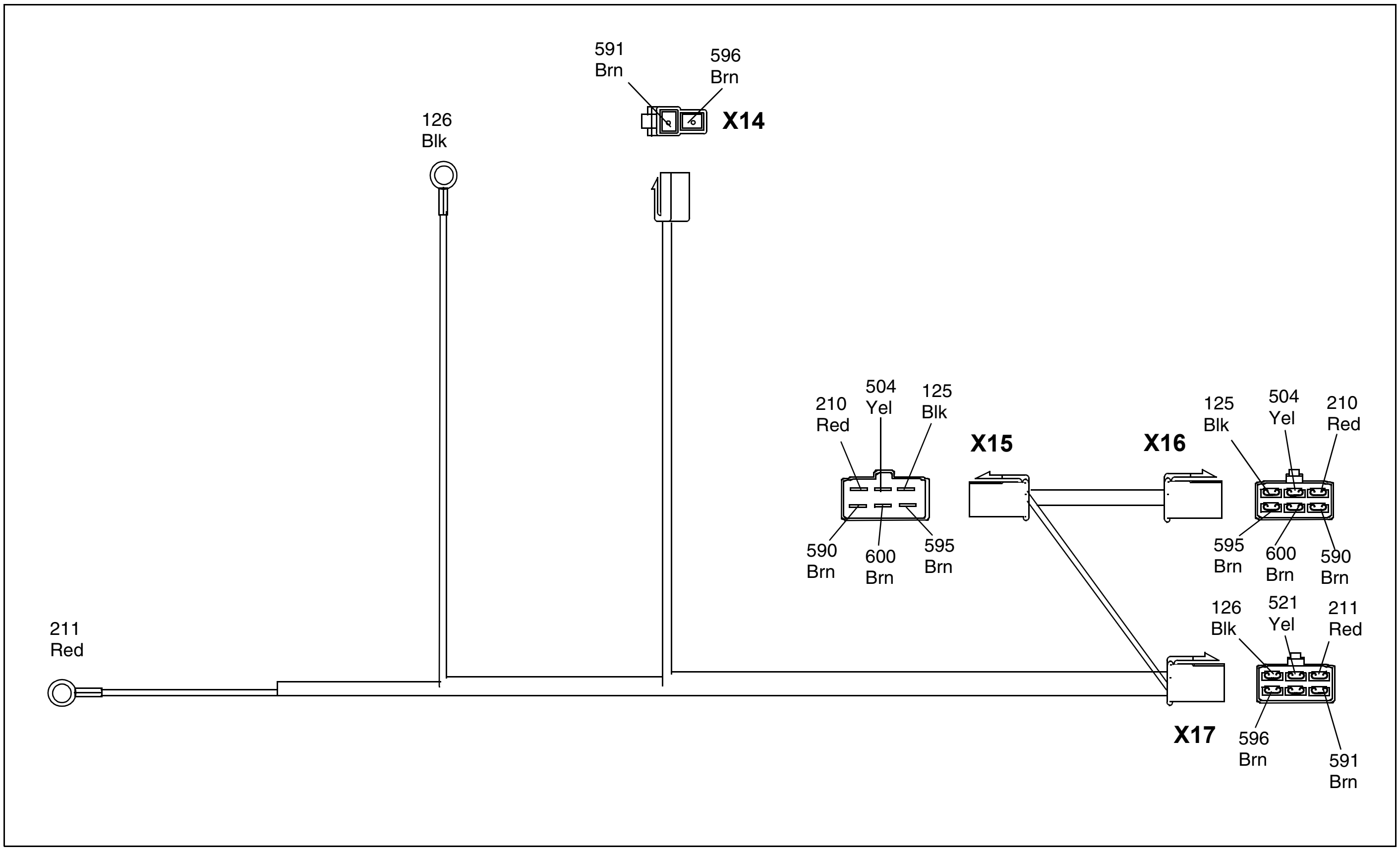
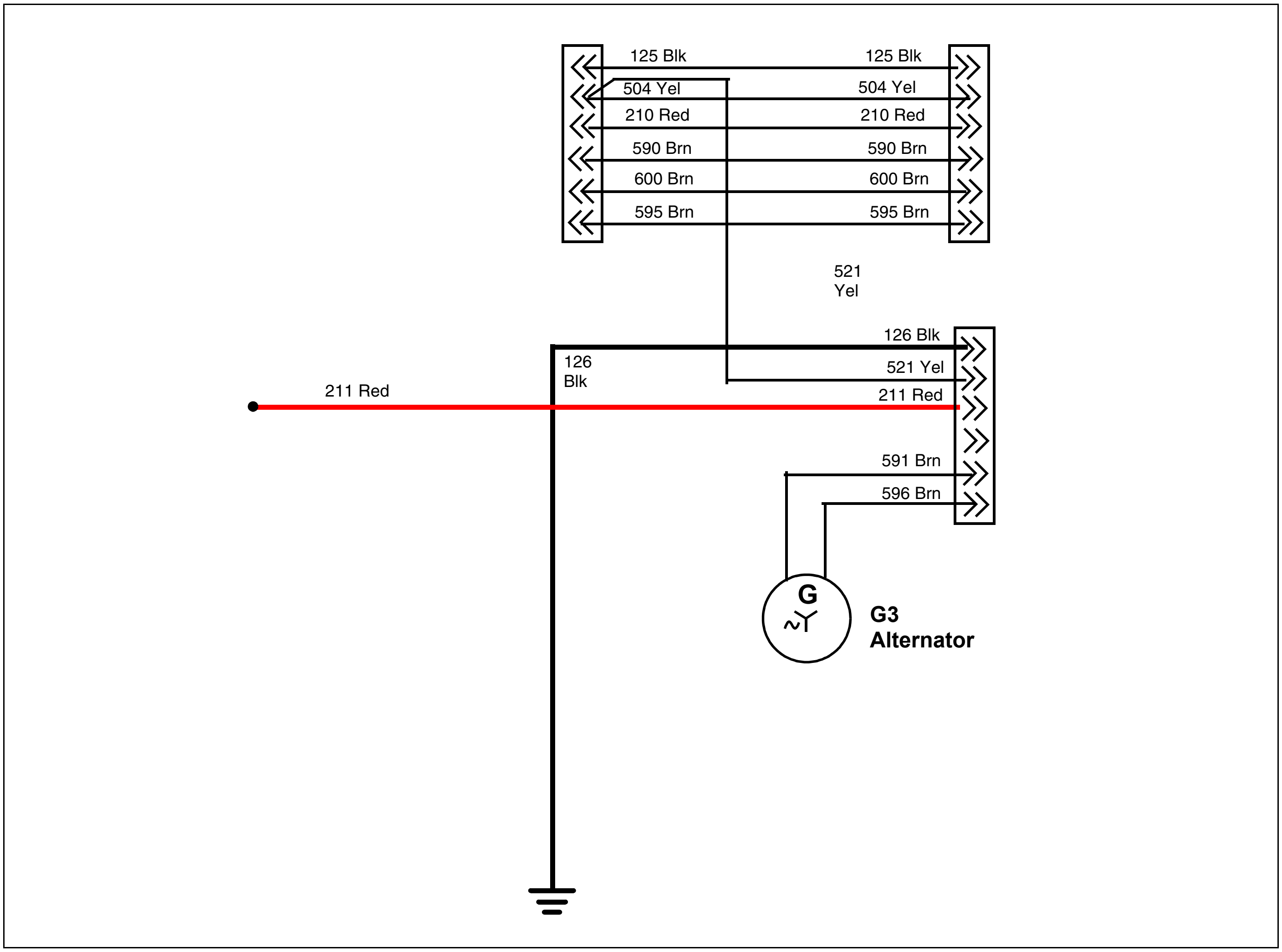
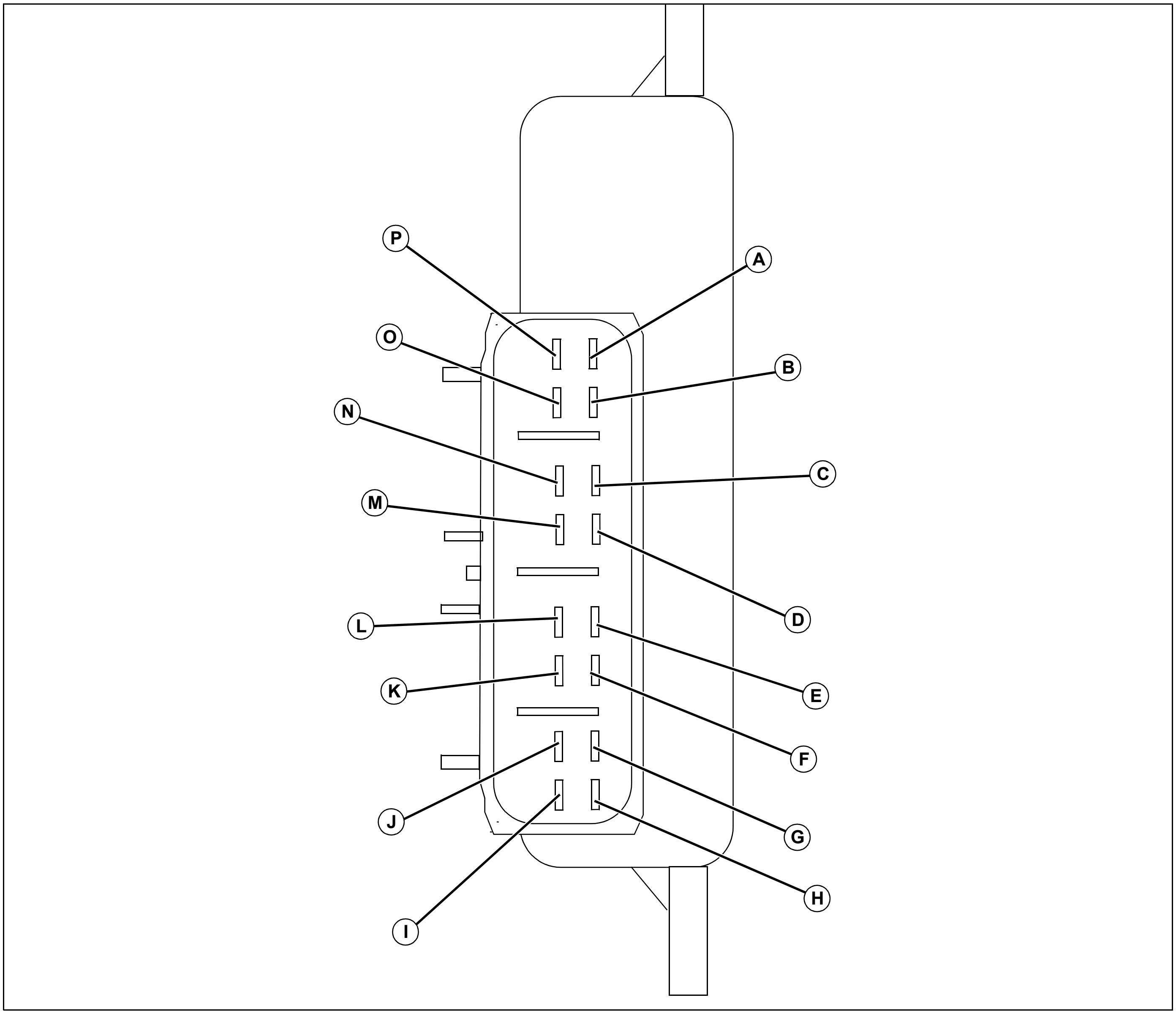
W6 Auxiliary Alternator Wiring Harness



W6 Auxiliary Alternator Wiring Harness Circuit Schematic



A2 EFI Module Pin and Signal Location



A- 615 Tan -Engine Coolant Temp Sensor In
B- 515 Blu - Air Temp Sensor In
C- Not Used
D- 470 Yel - Vacuum Pressure Sensor Operational Voltage
E- 860 Pnk - Machine Interlock Safety Ground
F- Not Used
G- 710 Pur - EFI Module Ground
H- 610 Tan - #2 Injector Control (Ground)
I- 160 Blk - #2 Injector Control (Ground)
J- 330 Org - EFI Module Ground
K- 460 Yel - Fuel Pump Relay Control (Ground)
L- 510 Blu - EFI Sensor Ground
M- 950 Wht -Fault Light Out
N- 171 Brn - Tach In
O- 340 Grn -Vacuum Pressure Sensor In
P- 240 Red - Power Out to Fuel Injectors

W1 Main Wiring Harness Color Codes - X700

Size/No./Color	Wire Connection Points
3.0 100 Blk	W1, Splice (S-4)
1.0 110 Blk	W1, X7
0.8 115 Blk	Splice (S-4), X4
0.8 116 Blk	V1, X4
0.8 120 Blk	Splice (S-4), X6
0.8 121 Blk	Splice (S-4), X6
3.0 122 Blk	Splice (S-4), X1
2.0 125 Blk	Splice (S-4), X2
0.8 130 Blk	Splice (S-4), S1
0.8 135 Blk	Splice, X3
3.0 200 Red	F4, Splice (S-3)
3.0 201 Red	F3, Splice (S-1)
3.0 202 Red	Splice (S-2), F4
3.0 204 Red	F3, S1
3.0 209 Red	Splice (S-3), X2
1.0 212 Fusible Link	Y1, Splice (S-1)
1.0 213 Fusible Link	Y1, Splice (S-2)
0.8 310 Org	J2, X3
2.0 400 Yel/Blu	F1, S9
3.0 401 Yel	F1, S1
0.8 402 Yel	Splice (S-5), S7
0.8 410 Yel	Splice (S-5), J1
1.0 450 Yel/Wht	S9, Splice (S-6)
0.8 451 Yel/Wht	Splice (S-6), J1
1.0 455 Yel/Wht	Splice (S-6), X7
0.8 459 Yel/Wht	Splice (S-6), X1
2.0 500 Yel	F5, Splice (S-5)
0.8 501 Yel	Splice (S-5), S3
0.8 502 Yel	Splice (S-5), S4
1.0 503 Yel	Splice (S-5), J2
0.8 504 Yel	Splice (S-5), S8

Size/No./Color	Wire Connection Points
1.0 505 Yel	F2, J3
0.8 511 Yel	S3, S3
0.8 520 Yel	Splice (S-5), S5
0.8 521 Yel	S5, S6
3.0 590 Brn/Yel	X3, X2
0.8 591 Pur	S1, J2
3.0 592 Blu	Splice (S-3), X1
0.8 593 Yel	S1, Splice (S-5)
0.8 594 Yel	Splice (S-5), X2
3.0 595 Brn/Wht	X3, X2
0.8 620 Tan	J1, X3
0.8 650 Pnk/Blk	J3, X3
0.8 651 Pnk/Blk	X5, X6
0.8 655 Pnk	X3, X5
1.0 720 Pur	Y1, J3
0.8 740 Blu	S6, J1
0.8 742 Blu/Wht	S5, J2
0.8 743 Pur	Rear PTO Jumper
0.8 754 Blu	S3, J1
0.8 755 Blu	S3, J1
0.8 756 Blu	S3, J3
0.8 757 Yel	S3, X4
0.8 758 Blu	X4, V1
0.8 765 Pur	J1, S8
0.8 772 Blu	S7, J1
0.8 800 Pnk	S4, J1
0.8 810 Pnk	J2, S9
1.0 815 Pnk	J3, X1
0.8 900 Blk/Wht	J1, X6
0.8 940 Wht	Splice, X3
0.8 941 Wht	J3, Splice
0.8 942 Wht	X3, J1

W1 Main Wiring Harness Color Codes - X720/X724/X728 EFI

Size/No./Color	Wire Connection Points
3.0 100 Blk	W1, Splice (S-4)
1.0 110 Blk	W1, X7
0.8 115 Blk	Splice (S-4), X4
0.8 116 Blk	V1, X4
0.8 120 Blk	Splice (S-4), X6
0.8 121 Blk	Splice (S-4), X6
3.0 122 Blk	Splice (S-4), X1
2.0 125 Blk	Splice (S-4), X2
0.8 135 Blk	Splice (S-4), J2
1.0 138 Blk	Splice (S-4), K3
1.0 139 Blk	Splice (S-4), K3
0.8 150 Blk	Splice (S-4), K1
0.8 160 Blk	X10, X11
0.8 170 Brn	X10, Splice
0.8 171 Brn	X11, Splice
3.0 200 Red	F4, Splice (S-3)
5.0 201 Red	Splice (S-1), F3
3.0 202 Red	Splice (S-2), F4
5.0 204 Red	F3, Splice (S-3)
3.0 206 Red	Splice (S-3), S1
3.0 209 Red	Splice (S-3), X2
2.0 212 Fusible Link	Y1, Splice (S-1)
1.0 213 Fusible Link	Y1, Splice (S-2)
1.0 220 Red	Splice (S-7), F5
1.0 221 Red	F5, K1
0.8 230 Red	K1, Splice
0.8 231 Red	Splice, K2
0.8 232 Red	Splice, K2
0.8 233 Red/Blu	Splice, X9
0.8 240 Red	X10, X11

Size/No./Color	Wire Connection Points
0.8 310 Org	J2, X3
0.8 330 Org	X10, X11
0.8 340 Grn	X10, X11
2.0 400 Yel/Blu	F1, S9
3.0 401 Yel	F1, S1
0.8 402 Yel	Splice (S-5), S7
0.8 410 Yel	Splice (S-5), J1
1.0 450 Yel/Wht	S9, Splice (S-6)
0.8 451 Yel/Wht	Splice (S-6), J1
1.0 455 Yel/Wht	Splice (S-6), X7
0.8 459 Yel/Wht	Splice (S-6), X1
0.8 460 Yel	X10, X11
0.8 470 Yel	X10, X11
2.0 500 Yel	F2, Splice (S-5)
0.8 501 Yel	Splice (S-5), S3
0.8 502 Yel	Splice (S-5), S4
1.0 503 Yel	Splice (S-5), J2
0.8 504 Yel	Splice (S-5), S8
1.0 505 Yel	F2, J3
0.8 510 Blu	X10, X11
0.8 511 Blu	S3, S3
0.8 515 Blu	X10, X11
0.8 520 Yel	Splice (S-5), S5
0.8 521 Blu	S5, S6
0.8 560 Red/Yel	Splice (S-5), K1
3.0 590 Brn/Yel	X2, X3
0.8 591 Pur	S1, J2
3.0 592 Blu	Splice (S-3), X1
0.8 593 Yel	S1, Splice (S-5)
0.8 594 Yel	X2, Splice (S-5)
3.0 595 Brn/Wht	X2, X3
0.8 610 Tan	X10, X11

W2 Engine Wiring Harness Color Codes - X700

Size/No./Color	Wire Connection Points
0.5 Blk	X2, G2
0.5 Blk	X2, G2
0.5 Wht	X2, T1
0.5 Wht	X2, T2
0.5 Yel/Wht	X2, Y2
0.5 Blu/Red	X2, B1
0.5 Yel	X2, B3

W2 Engine Wiring Harness Color Codes - X720/X724/X728

Size/No./Color	Wire Connection Points
0.5 Lt Blk	X2, G2
0.5 Lt Blk	X2, G2
0.5 Dk Blk	X2, T1
0.5 Dk Blk	X2, T2
0.5 Dk Blk	X2, X24
0.5 Blu/Red	X2, B1
0.5 Yel	X2, B3
0.5 Yel/Blu	X10, Y3
0.5 Blk/Wht	X10, Splice
0.5 Blk/Wht	Splice, W2
0.5 Blk/Wht	X10, Splice
0.5 Brn	X10, X8
0.5 Blk/Wht	X10, Splice
0.5 Blk/Yel	Splice, B4
0.5 Blk/Yel	Splice, B5
0.5 Blk/Yel	Splice, B6
0.5 Yel/Red	X10, Y4
0.5 Org	X10, X8
0.5 Red	X10, X8
0.5 Blk	X10, X12
0.5 Red/Blu	X10, B6
0.5 Wht	X10, Splice
0.5 Wht	Splice, X10
0.5 Wht	Splice, Y3
0.5 Wht	Splice, Y4
0.5 Tan	X10, B6
0.5 Grn	X10, B5
0.5 Blu	X10, B4

W3 Headlight Wiring Harness Color Codes

Size/Color	Wire Connection Points
0.8 Blk	X7, E1
0.8 Blk	X7, E2
0.8 Blk	E1, X7
0.8 Blk	E2, X7

W4 Rear Lights Wiring Harness Color Codes

Size/No./Color	Wire Connection Points
0.8 100 Blk	Splice, E4
0.8 110 Blk	Splice, E6
0.8 120 Blk	Splice, X1
0.8 130 Blk	Splice, E3
2.0 140 Blk	X13, X1
0.5 150 Blk	Splice, E6
0.8 400 Yel	X1, E4
0.8 420 Yel	X1, E3
2.0 592 Pnk	X1, S2
2.0 593 Pnk	S2, X13
0.8 800 Pur	X1, E6
0.8 820 Pur	X1, E5

W5 PTO Option Wiring Harness Color Codes

Size/No./Color	Wire Connection Points
0.8 520 Yel	Splice (S-5), S5
0.8 740 Blu	S6, J1
0.8 742 Pur	Jumper
0.8 521 Yel	S5, J2

W6 Auxiliary Alternator Wiring Harness Color Codes

Size/No./Color	Wire Connection Points
3.0 125 Blk	X15, X16
3.0 126 Blk	X17, W1 Ground
3.0 210 Red	X15, X16
3.0 211 Red	X17, Splice
1.0 212 Red	Splice (Fusible Link), 212
0.8 504 Yel	X15, X16
0.8 521 Yel	X15, X17,
3.0 590 Brn	X15, X16
3.0 591 Brn	X17, X14
3.0 595 Brn	X15, X16
3.0 596 Brn	X17, X14
0.8 600 Brn	X15, X16

Operation and Diagnostics

Power Circuit Operation - X700

Function:

To provide unswitched and switched power to the primary electrical components whenever the battery is properly connected. The power circuits are divided among the unswitched power circuit, switched power circuits (key switch in run position), and secondary power circuits. The secondary power circuits become energized when switched power circuits energize signal wires to the A1 display panel, providing current paths to the secondary circuits. The secondary power circuits will not be energized if the A1 display panel fails.

Operating Conditions, Unswitched Circuits:

Voltage must be present at the following components with the key switch in the off position.

- G1 battery positive terminal
- M1 starting motor - B terminal
- S1 key switch - B terminal
- N1 voltage regulator/rectifier - X2 connector, 209 Red
- F3 and F4 fuses
- S2 power port switch

The positive battery cable connects the battery to the starting motor. The starting motor bolt is used as the 12 volt DC tie point for the rest of the electrical system. These circuits are protected by the 212 and 213 fusible links and the F3 and F4 fuses respectively. The battery cables and the starting motor tie point connections must be good for the machine's electrical system to work properly. Proper starting motor operation depends on the battery cables to carry high current. The ground cable connection is equally as important as the positive cable connection in maintaining electrical system integrity

Operating Conditions, Switched Circuits:

With the key switch in run position, PTO switch(es) in the off position, brake locked, and operator off the seat, switched voltage should be present at the following components:

- S1 key switch - terminal "A"
- A1 display panel - J1 connector, 410 Yel wire
- A1 display panel - J2 connector, 503 Yel wire
- A1 display panel - J3 connector, 505 Yel wire
- F1 and F2 fuses
- S9 light switch - 400 Yel/Blu wire
- S6 brake switch - 504 Yel wire
- S5 PTO/RIP switch - 501 and 511 Yel wires
- S4 seat switch - 502 Yel wire
- S7 RIO switch - 402 Yel wire
- N1 voltage rectifier/regulator - X2 connector, 594 Yel wire
- A1 display panel - J1 connector, 410 Yel wire
- A1 display panel - J2 connector, 503 Yel wire
- A1 display panel - J3 connector, 505 Yel wire
- A1 display panel - J2 connector, 742 Blu/Wht wire (If rear PTO option not installed)
- S6 rear PTO switch (rear PTO option installed) - 520 Yel wire
- S5 front PTO switch (rear PTO option installed) - 521 Yel wire

These circuits are controlled by the key switch and are protected by the F3 and F4 fuses and the unswitched circuits.

With power now available at various locations on the machine, the electrical system is ready to perform the different functions of starting and running the engine, engine monitoring lights, the PTO clutch and the PTO system interlocks, and the headlights.

The ground circuit is equally important as the power circuit connections. Proper systems operation depends on good wires and connections in order to carry the current needed to operate the various components.

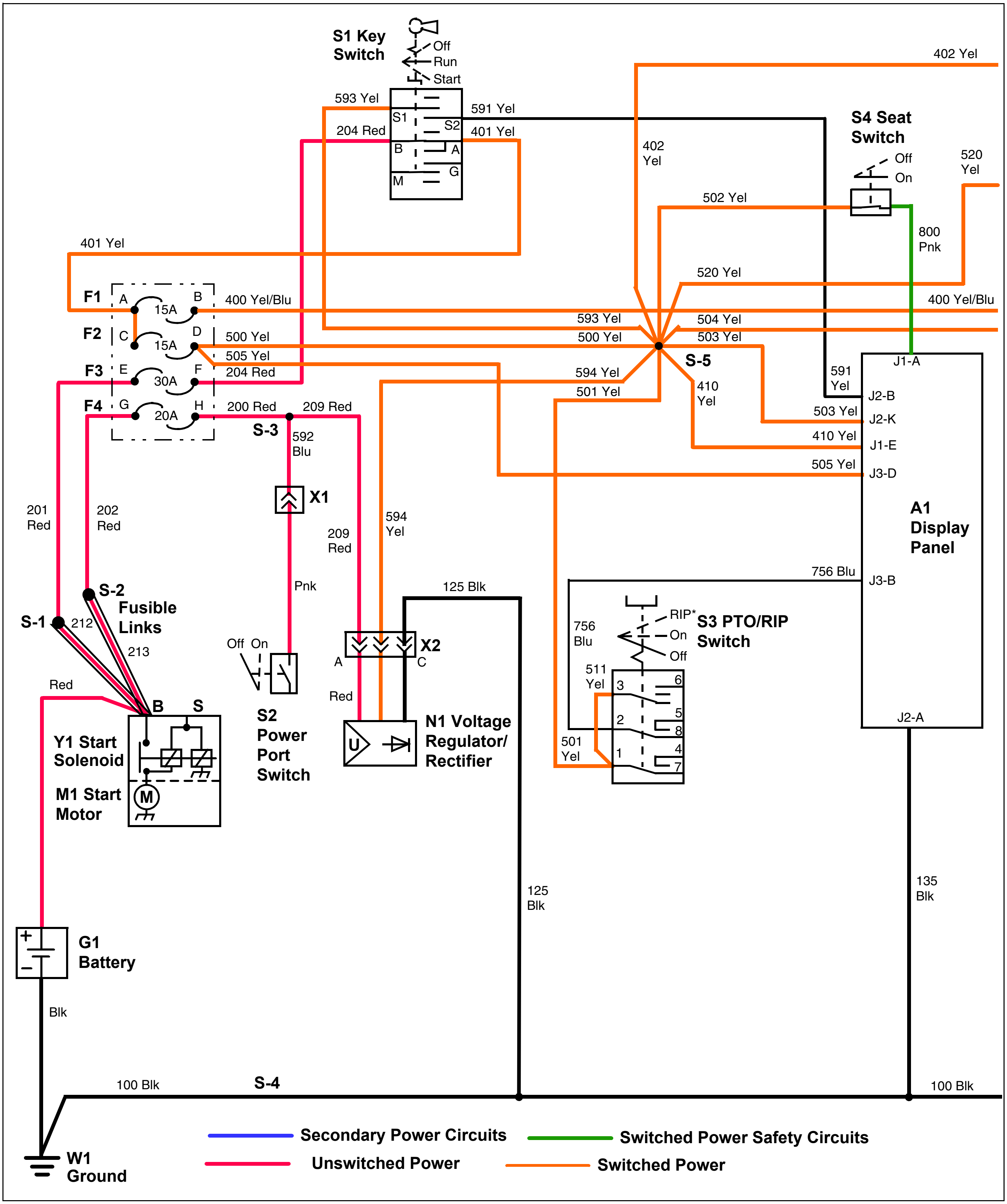
Operating Conditions, Secondary Switched Circuits:

Secondary switched voltage must be present at the following components during the following conditions: Key switch in run position, transmission in neutral, PTO in off position, brake locked, and operator off seat:

- S3 PTO/RIP switch - 756 Blu wire
- Y3 fuel shutoff solenoid - 650 Pnk/Blk and 655 Pnk wires
- M2 fuel pump - 651 Pnk/Blk wire
- B3 fuel gauge sender - 900 Blk/Wht wire
- B2 engine coolant temperature sensor - X3 connector, 310 Org wire
- B1 engine oil pressure switch - X3 connector, 620 Tan wire
- S6 brake switch - 765 Pur wire

These circuits are controlled by the A1 display panel and are protected by the fusible links and the F1, F2, F3, and F4 fuses.

Power Circuit Electrical Schematic - X700



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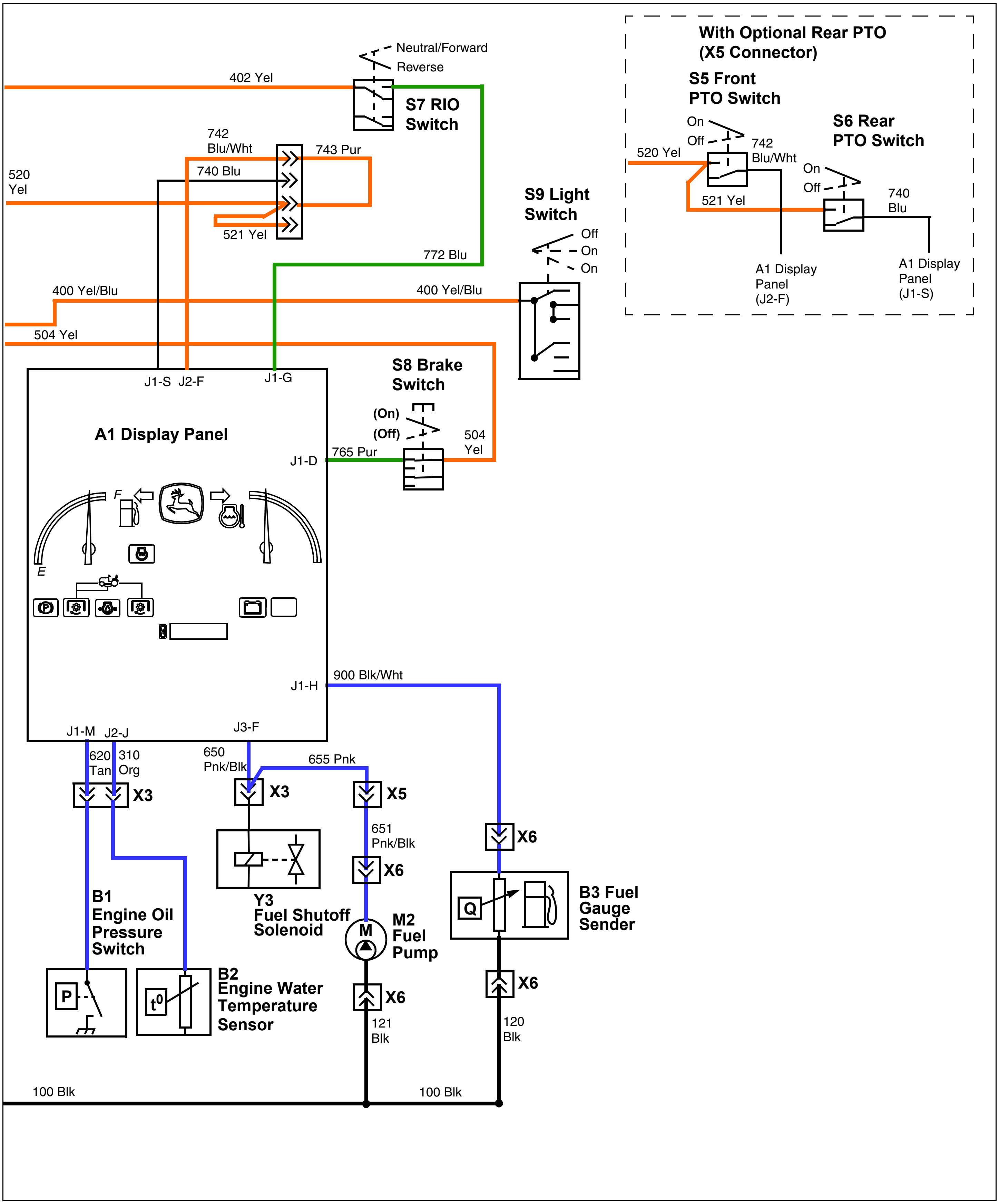


With Optional Rear PTO
(X5 Connector)
S5 Front
PTO Switch
On
Off
520 Yel
742
Blu/Wht
521 Yel
S6 Rear
PTO Switch
On
Off
740
Blu
A1 Display
Panel
(J2-F)
A1 Display
Panel
(J1-S)
Neutral/Forward
Reverse
402 Yel
S7 RIO
Switch
742
Blu/Wht
743 Pur
740 Blu
520
Yel
521 Yel
772 Blu
S9 Light
Switch
Off
On
On
400 Yel/Blu
400 Yel/Blu
504 Yel
J1-S J2-F
J1-G
S8 Brake
Switch
(On)
(Off)
504
Yel
765 Pur
J1-D
A1 Display Panel
F
E
J1-H
900 Blk/Wht
J1-M J2-J
J3-F
620
Tan
310
Org
650
Pnk/Blk
655 Pnk
X3
X3
X5
651
Pnk/Blk
X6
X6
B1
Engine Oil
Pressure
Switch
P
Y3
Fuel Shutoff
Solenoid
M
M2
Fuel
Pump
Q
B3 Fuel
Gauge
Sender
B2
Engine Water
Temperature
Sensor
X6
X6
121
Blk
120
Blk
100 Blk
100 Blk

MIF

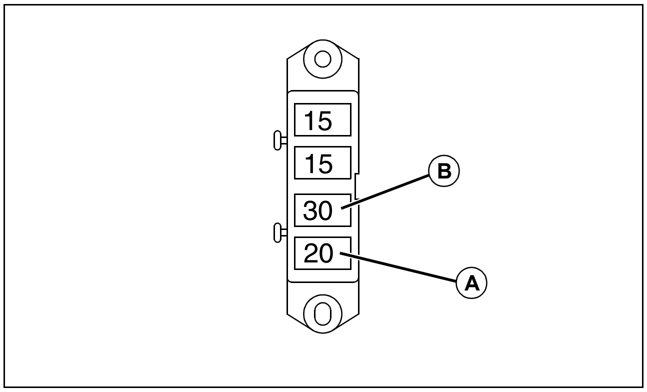
Power Circuit Diagnosis - X700

Test Procedure A:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in off position.
- Battery fully charged.
- Follow procedure in sequence.
- Ensure all circuit grounds are in good condition and have continuity.

Unswitched Power Circuits:



1. Is battery voltage present at F4 20A fuse, 200 Red wire (A)?

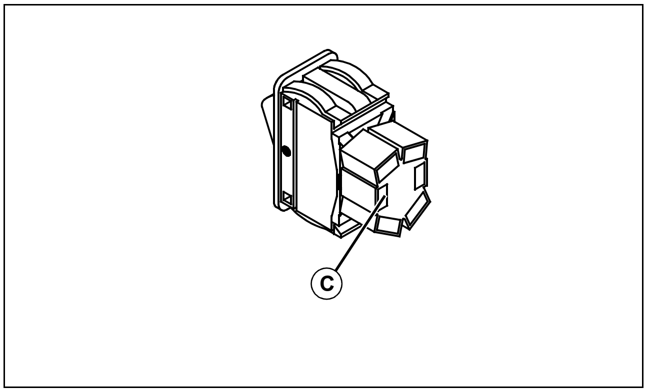
Yes: Go to next step.

No: Check 213 fusible link, 202 Red wire and F4 fuse.

2. Is battery voltage present at F3 30A fuse, 204 Red wire (B)?

Yes: Go to next step.

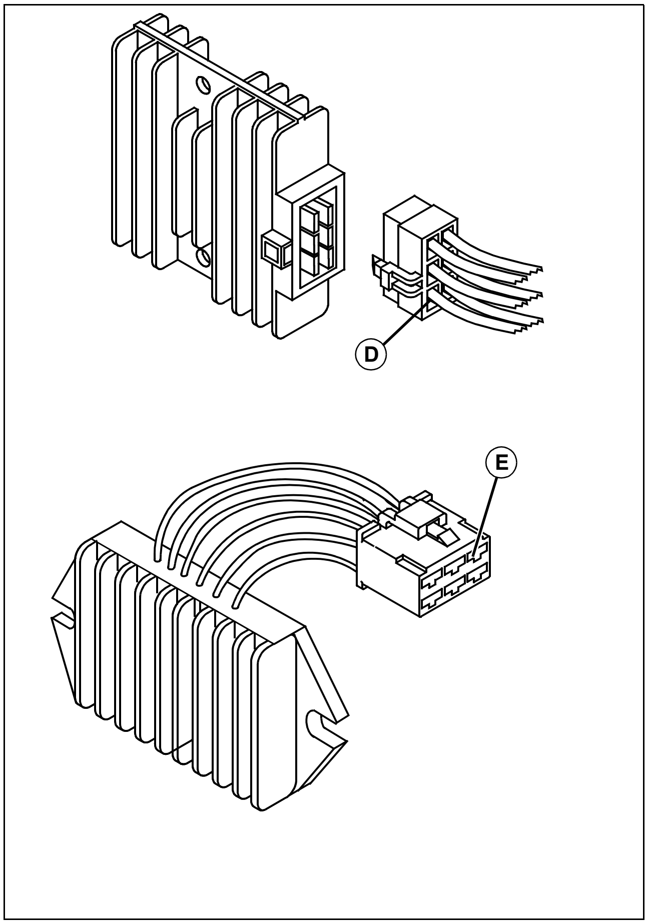
No: Check 212 fusible link, 201 Red wire, and F3 fuse.



3. Is battery voltage present at S2 power port switch 592 Pnk wire (C)?

Yes: Go to next step.

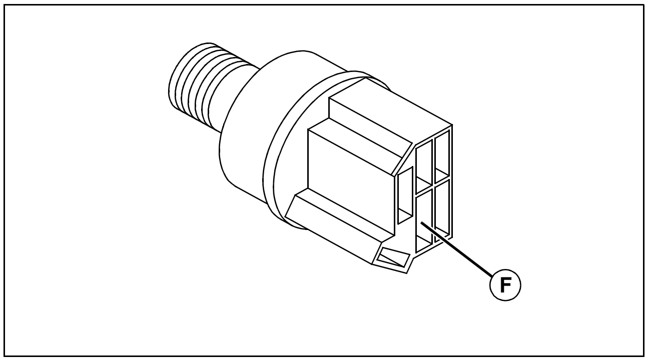
No: Check 200 Red wire, 592 Pnk wire, and X1 connector.



4. Is battery voltage present at N1 voltage regulator/rectifier X2 connector Red wire (D)? If auxiliary alternator is installed, check for battery voltage at N2 voltage regulator/rectifier Red wire (E) as well.

Yes: Go to next step.

No: Check 209 and 200 Red wires and connections.



5. Is battery voltage present at S1 key switch, 204 Red wire (F)?

Yes: End of unswitched power circuit diagnosis.

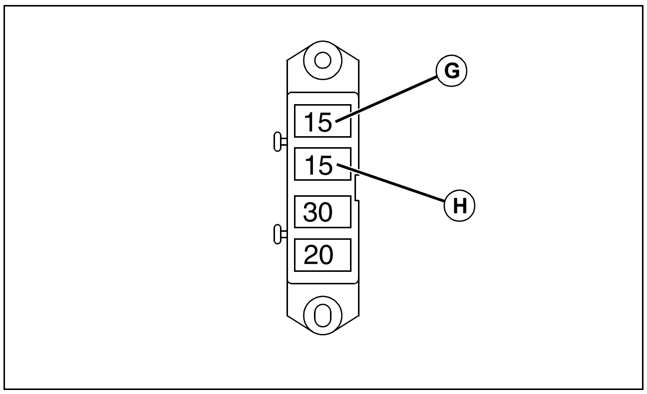
No: Check 204 Red wire and connections.

Test Procedure B:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in run position.
- Follow procedure in sequence.
- Ensure all ground circuits are in good condition and have continuity.

Switched Power Circuits:



1. Is battery voltage present F1 15A fuse, 400 Yel/Blu wire (G)?

Yes: Go to next step.

No: Test F1 fuse.

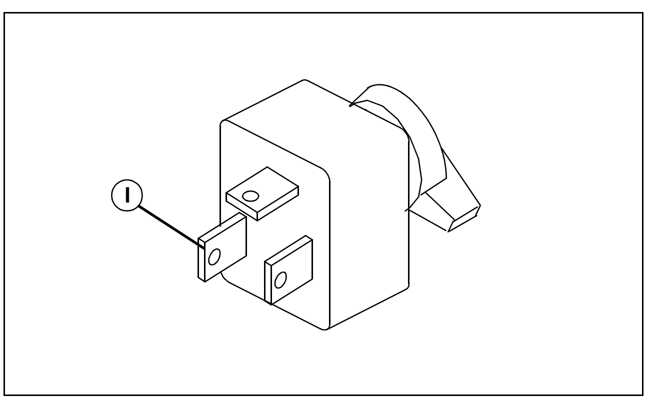
No: Test S1 key switch. See “Key Switch Test” on page 219.

No: Check 401 Yel wire and connections.

2. Is battery voltage present at F2 15A fuse, 500 and 505 Yel wires (H)?

Yes: Go to next step.

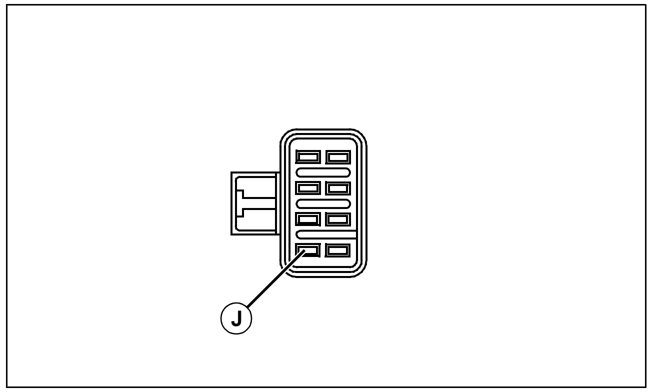
No: Test F2 fuse.



3. Is battery voltage present at S9 light switch, 400 Yel/Blu wire (I)?

Yes: Go to next step

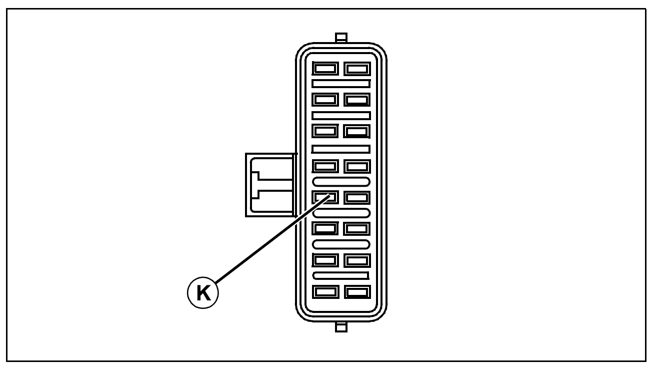
No: Check 400 Yel/Blu wire and connections.



4. Is battery voltage present at A1 display panel, J3 connector 505 Yel wire (J)?

Yes: Go to next step.

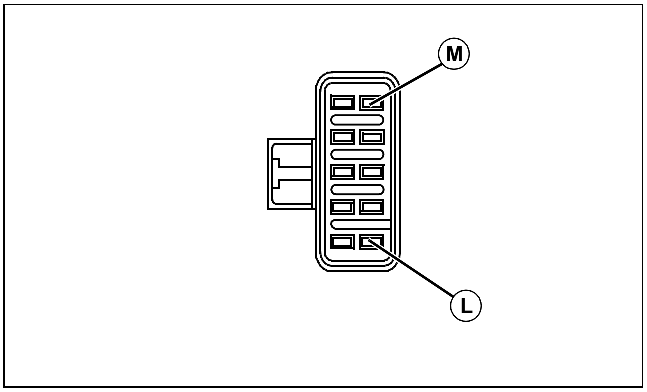
No: Check 505 Yel wire and connections.



5. Is battery voltage present at A1 display panel, J1 connector 410 Yel wire (K)?

Yes: Go to next step.

No: Check 500 Yel wire, S-5 splice, and 410 Yel wire and connections.



6. Is battery voltage present at A1 display panel, J2 connector 503 Yel wire (L)?

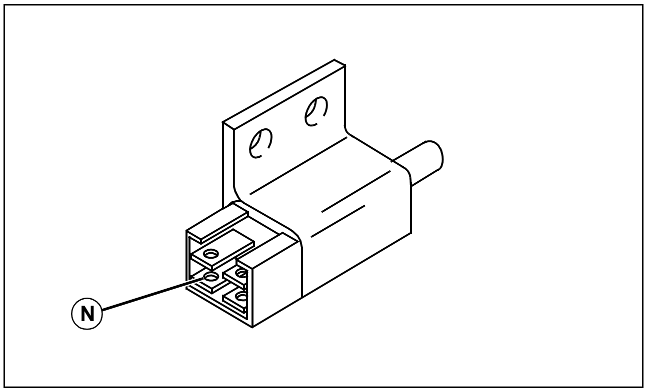
Yes: Go to next step.

No: Check 500 Yel wire, S-5 splice, and 503 Yel wire and connections.

7. If rear PTO option is not installed - Is battery voltage present at A1 display panel, J2 connector 742 Blu/Wht wire?

Yes: Go to next step.

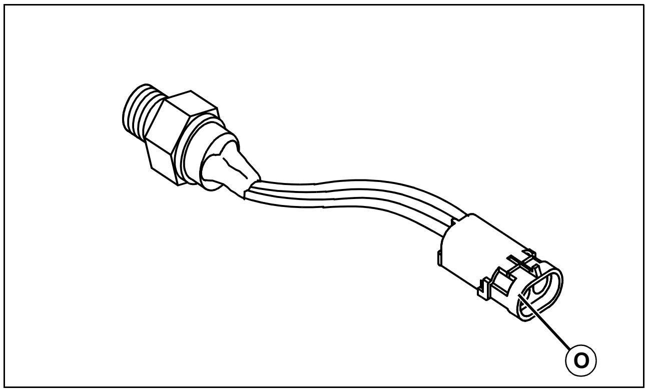
No: Check 500 and 520 Yel, 743 Pur, and 742 Blu/Wht wires and connections.



8. Is battery voltage present at S7 RIO switch, 402 Yel wire (N)?

Yes: Go to next step.

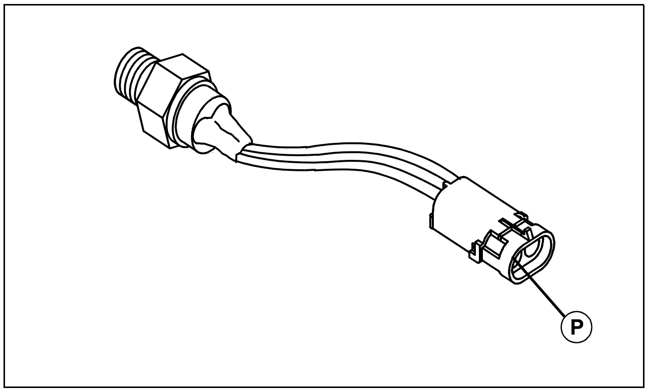
No: Check 500 Yel wire, S-5 splice, and 402 Yel wire and connections.



9. If rear PTO option is installed - Is battery voltage present at S5 front PTO switch, 520 Yel wire (O)?

Yes: Go to next step.

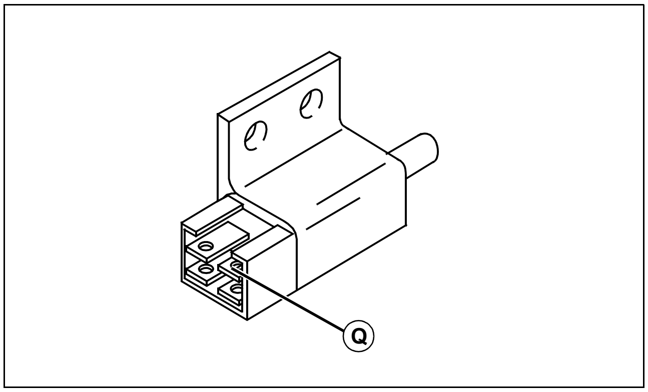
No: Check 500 Yel wire, S-5 splice, and 520 Yel wire and connections.



10. If rear PTO option is installed - Is battery voltage present at S6 rear PTO switch, 521 Yel wire (P)?

Yes: Go to next step.

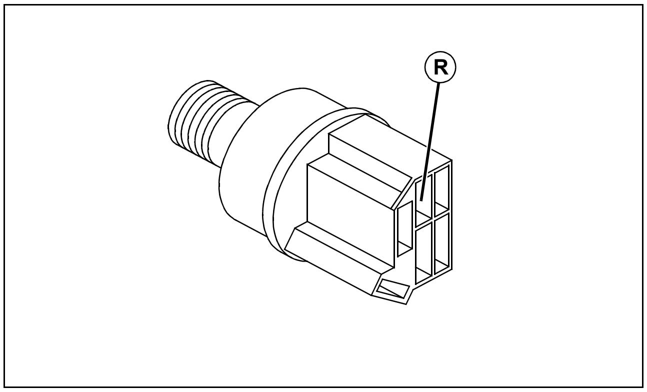
No: Check 521 Yel wire and connections.



11. Is battery voltage present at S8 brake switch, 504 Yel wire (Q)?

Yes: Go to next step.

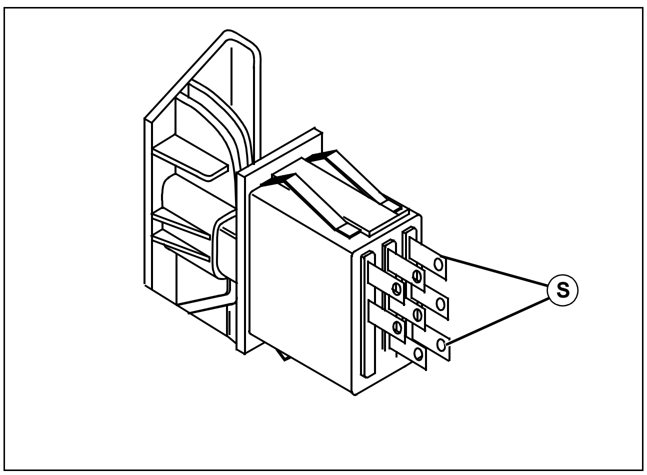
No: Check 500 Yel wire, S-5 splice, and 504 Yel wire and connections.



12. Is battery voltage present at S1 key switch, 593 Yel wire (R)?

Yes: Go to next step.

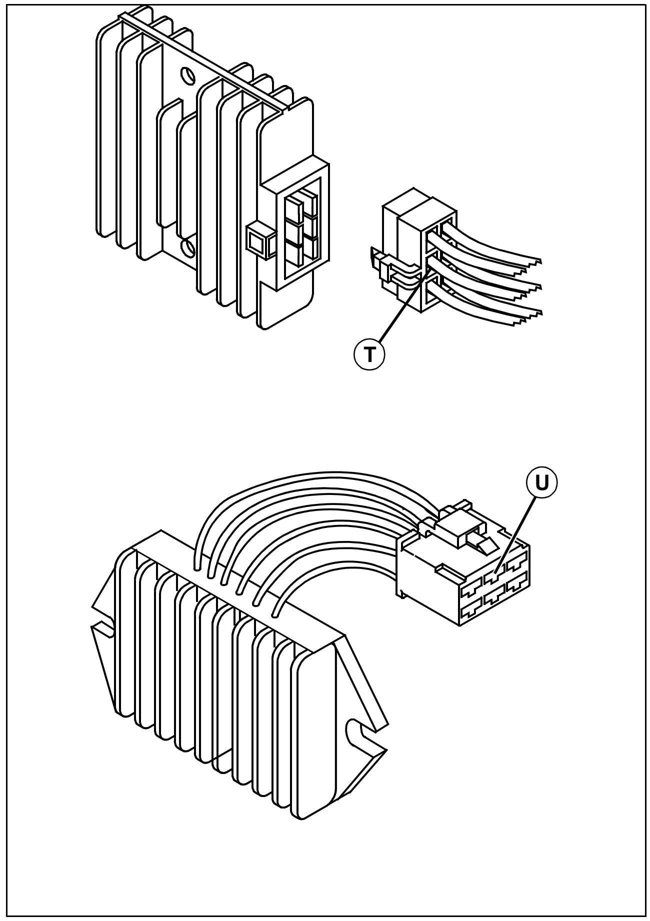
No: Check 500 Yel wire, S-5 splice, and 593 Yel wire and connections.



13. Is battery voltage present at S3 PTO/RIP switch 501 and 511 Yel wires (S)?

Yes: Go to next step.

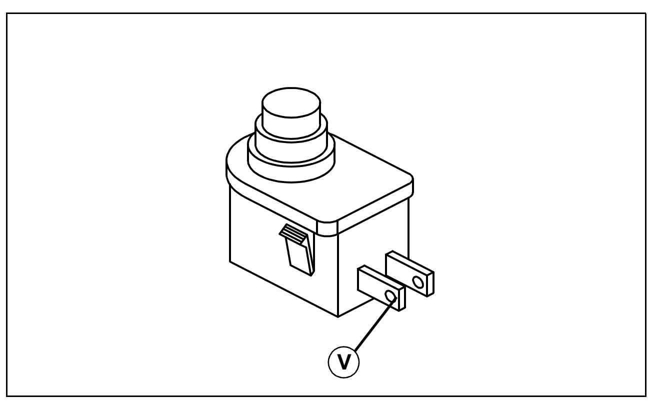
No: Check 500 Yel wire, S-5 splice, 501 and 511 Yel wires and connections.



14. Is battery voltage present at X2 connector of N1 voltage regulator/rectifier, 594 Yel wire (T)? If G2 auxiliary alternator is installed, check for battery voltage at N2 voltage regulator/rectifier, 521 Yel wire (U) as well.

Yes: End of switched power tests.

No: Check 500 Yel wire, S-5 splice, and 594 Yel wire and connections. If G2 auxiliary alternator is installed, check 521 Yel wire as well.



15. Is battery voltage present at S4 seat switch, 502 Yel wire (V)?

Yes: Go to next procedure.

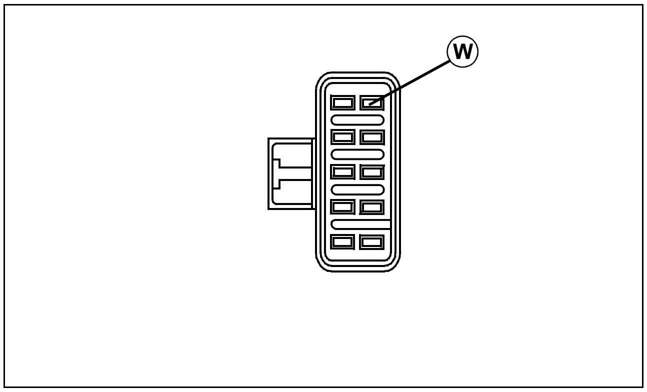
No: Check 500 Yel wire, S-6 splice, and 502 Yel wire and connections.

Test Procedure C:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in run position, engine off.
- Battery fully charged.
- Component under test in active position. De-activate circuit when done testing.
- Follow procedure in sequence.
- Ensure all circuit grounds are in good condition and have continuity.

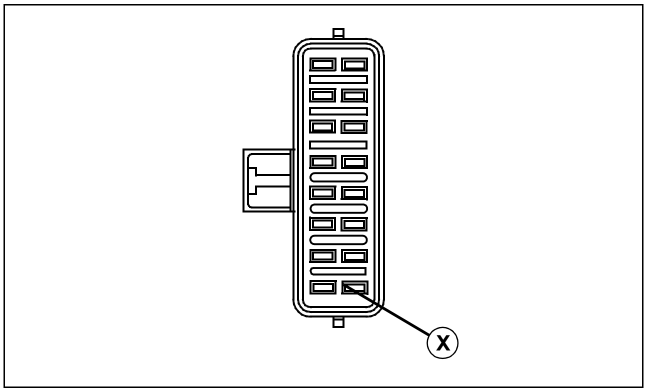
Secondary Power Circuits:



1. Place S5 front PTO switch in on position. Is battery voltage present at A1 display panel J2 connector, 742 Blu/Wht wire (W)?

Yes: Go to next step.

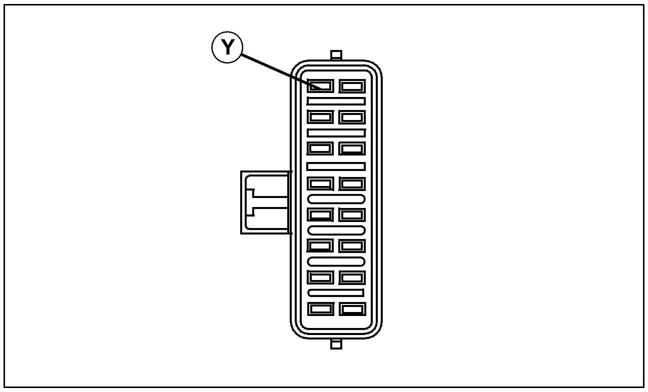
No: Test S5 front PTO switch. See “PTO Switch Test (Optional Rear PTO Installed)” on page 223. If OK, check 742 Blu/Wht wire and connections.



2. If installed, engage rear PTO (S6 rear PTO switch in the on position). Is battery voltage present at A1 display panel J1 connector, 740 Blu wire (X)?

Yes: Go to next step.

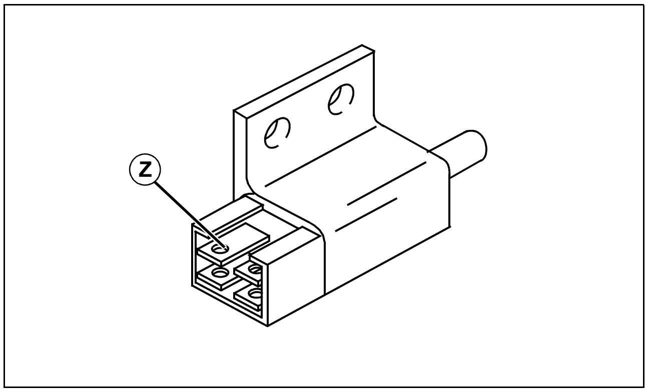
No: Test S6 rear PTO switch. See “PTO Switch Test (Optional Rear PTO Installed)” on page 223. If OK, check 740 Blu wire and connections.



3. Close S4 seat switch (operator on seat). Is battery voltage present at A1 display panel J1 connector, 800 Pnk wire (Y)?

Yes: Go to next step.

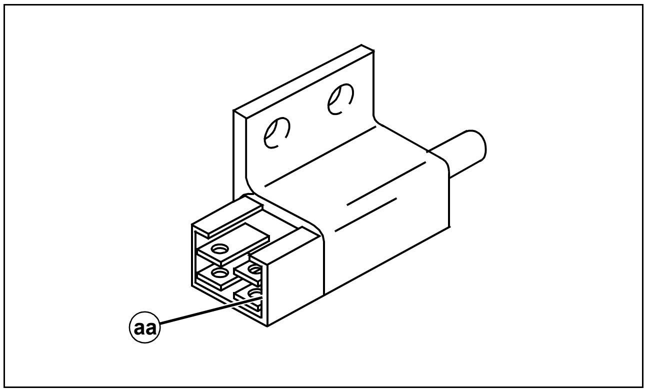
No: Test S4 seat switch. If OK, check 800 Pnk wire and connections.



4. Place transmission in neutral (S7 RIO switch closed). Is battery voltage present at A1 display panel J1 connector, 772 Blu wire (Z)?

Yes: Go to next step.

No: Test S7 RIO switch. See “RIO Switch Test” on page 221. If OK, check 772 Blu wire and connections.



5. Close S8 brake switch (brake pedal depressed). Is battery voltage present at A1 display panel J1 connector, 765 Pur wire (aa)?

Yes: Go to next procedure.

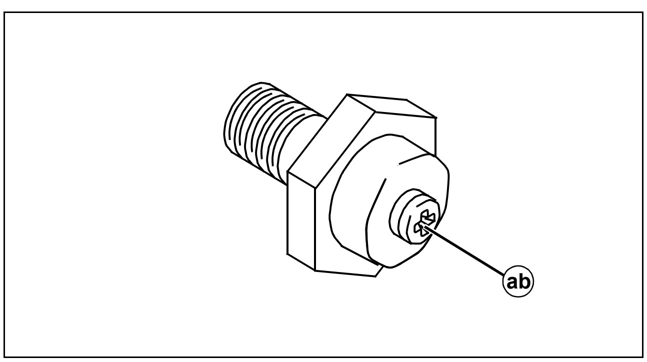
No: Test S8 brake switch. See “Brake Switch Test and Adjustment” on page 220. If OK, check 765 Pur wire and connections.

Test Procedure D:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in run position, engine off.
- Battery fully charged.
- Component under test in active position. De-activate circuit when done testing.
- Follow procedure in sequence.
- Ensure all circuit grounds are in good condition and have continuity.

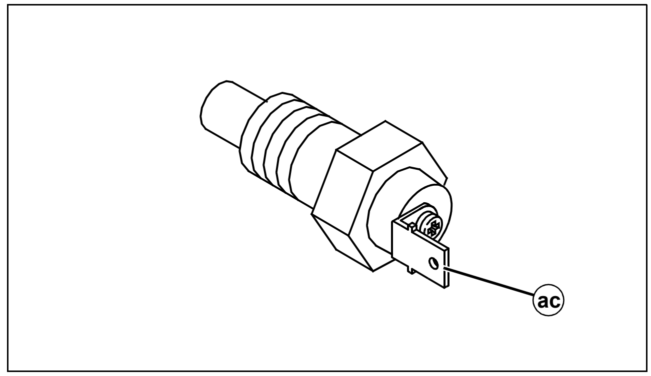
Sensor Circuits:



1. Is battery voltage present at X3 connector, 620 Tan wire (AB) of B1 engine oil pressure switch?

Yes: If necessary, test B1 engine oil pressure switch. See “Engine Oil Pressure Switch Test” on page 217. If OK, go to next step.

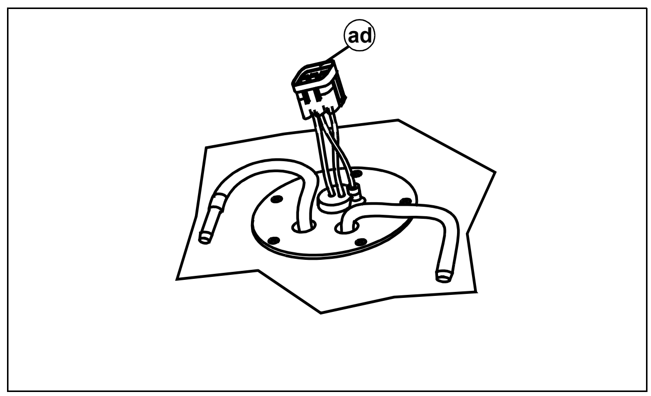
No: Check 620 Tan wire and connections. If OK, replace A1 display panel.



2. Is battery voltage present at X3 connector, 310 Org wire (AC) of B2 engine coolant temperature sensor?

Yes: If necessary, test B2 engine coolant temperature sensor. See “Engine Coolant Temperature Sensor Test” on page 216. Go to next step.

No: Check 310 Org wire and connections. If OK, replace A1 display panel.



3. Is battery voltage present at B3 fuel gauge sender, X6 connector 900 Blk/Wht wire (AD)?

Yes: If necessary, test B3 fuel gauge sender. See “Fuel Tank Sensor Test” on page 224. If OK, go to next procedure.

No: Check 900 Blk/Wht wire and connections. If OK, replace A1 display panel.

Secondary Switched Power Safety Circuits:

Note: Due to the various combinations of the switched safety circuits, refer to the specific diagnostic procedures for that circuit in this section.

Power Circuit Operation - X720/X724/X728

Function:

To provide unswitched and switched power to the primary electrical components whenever the battery is properly connected.

The power circuits are divided among the unswitched power circuit, switched power circuits (key switch in run position), and secondary power circuits. The secondary power circuits become energized when switched power circuits energize relays or modules providing current paths to the secondary circuits. The secondary power circuits will not be energized if the relays or modules controlling the current path(s) fail.

Operating Conditions, Unswitched Circuits:

Voltage must be present at the following components with the key switch in off position.

- G1 battery positive terminal
- M1 starting motor - B terminal
- S1 key switch - B terminal
- N1 voltage regulator/rectifier
- F3, F4, F5, and F6 fuses
- S2 power port switch
- K1 EFI module power relay - 87 terminal, 221 Red wire

The positive battery cable connects the battery to the starting motor. The starting motor bolt is used as the 12 volt DC tie point for the rest of the electrical system. These circuits are protected by the 212 and 213 fusible links and the F3 and F4 fuses.

The battery cables and the starting motor tie point connections must be good for the machine's electrical system to work properly. Proper starting motor operation depends on the battery cables to carry high current. The ground cable connection is equally as important as the positive cable connection in maintaining electrical system integrity.

Operating Conditions, Switched Circuits:

With the key switch in run position, PTO switch in off position, brake locked, and operator off the seat, switched voltage should be present at the following components:

- S1 key switch - terminals “A” and “S1”
- A1 display panel - J1 connector, 410 Yel wire
- A1 display panel - J2 connector, 503 Yel wire
- A1 display panel - J3 connector, 505 Yel wire
- A1 display panel - J2 connector, 742 Blu/Wht wire (If rear PTO option not installed)
- S9 light switch - 400 Yel/Blu wire
- S8 brake switch - 504 Yel and 765 Pur wires
- S5 PTO/RIP switch - 501 and 511 Yel wires
- S4 seat switch - 502 Yel wire
- S7 RIO switch - 402 Yel wire
- N1 voltage rectifier/regulator - 594 Yel wire
- K1 EFI module power relay - 560 Red/Yel wire
- S5 front PTO switch (optional rear PTO installed) - 521 Yel wire
- S6 Rear PTO switch (optional rear PTO installed) - 520 and 521 Yel wire

These circuits are controlled by the key switch and are protected by the 212 fusible link and the F and F2 fuses.

With power now available at various locations on the machine, the electrical system is ready to perform the different functions of starting and running the engine, engine monitoring lights, the PTO clutch and the PTO system interlocks, and the headlights.

The ground circuit is equally important as the power circuit connections. Proper systems operation depends on good wires and connections in order to carry the current needed to operate the various components.

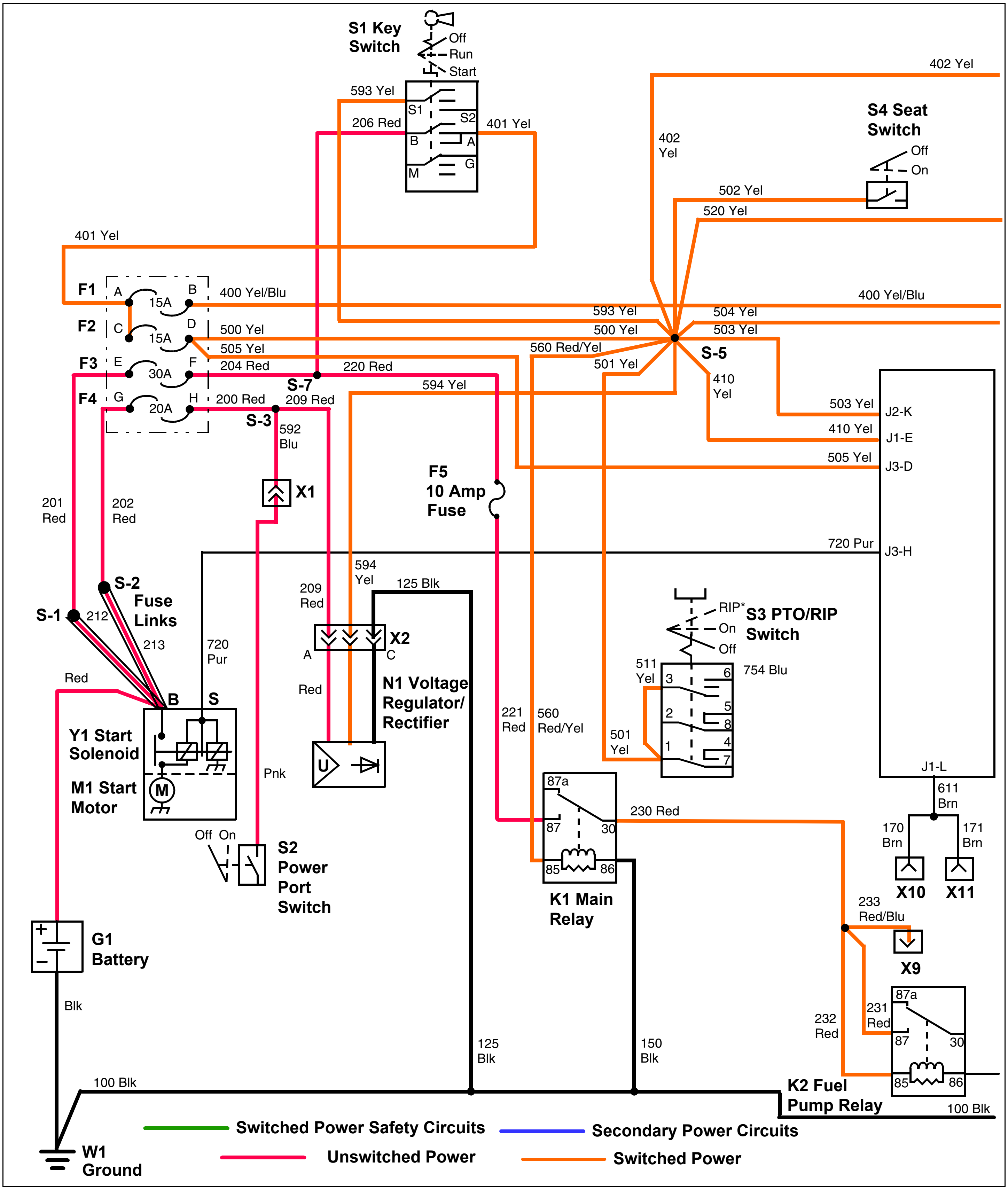
Operating Conditions, Secondary Switched Circuits:

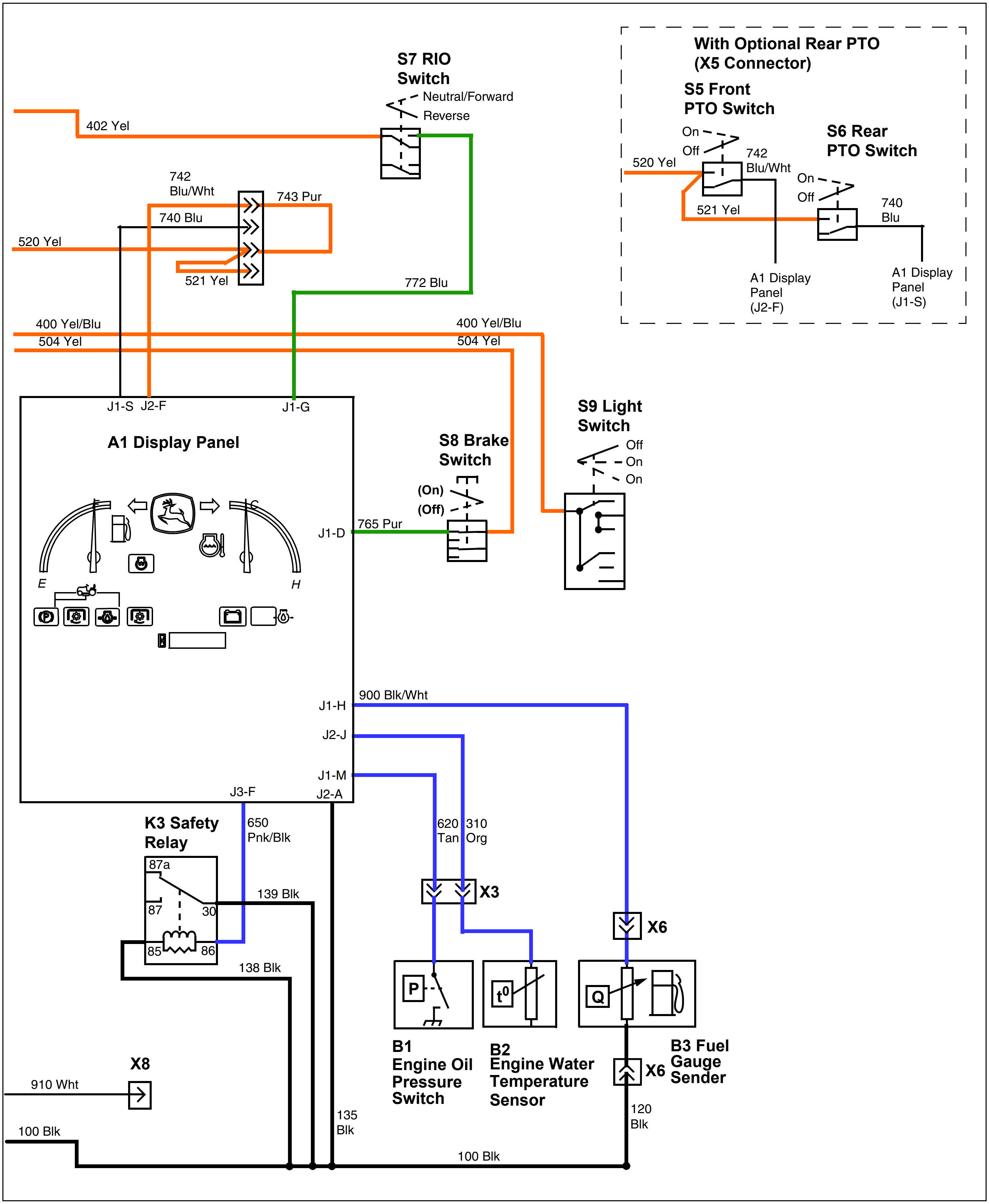
Secondary switched voltage must be present at the following components during the following conditions: Key switch in run position, transmission in neutral, PTO in off position, brake locked, and operator off seat:

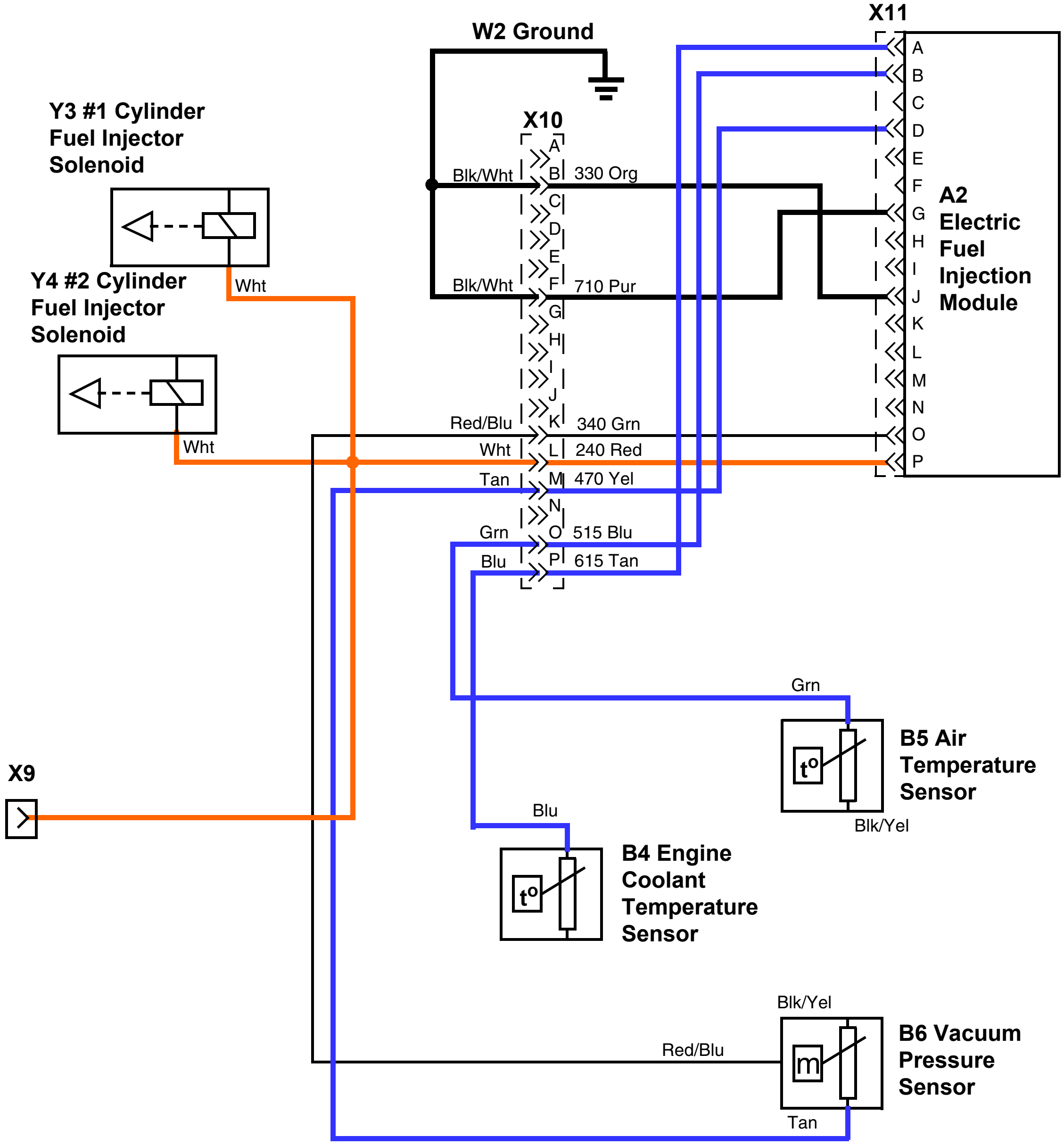
- K1 EFI module power relay - 230 Red wire
- K2 fuel pump relay - 231 and 232 Red and 655 Pnk wires
- X9 connector - 233 Red/Blu wire
- M2 fuel pump - 651 Pnk/Blk wire
- B1 engine oil pressure switch - 620 Tan wire
- B2 engine water temperature sensor - 310 Org wire
- B3 fuel gauge sender - 900 Blk/Wht wire
- A1 display panel - 650 Pnk/Blk wire
- A1 display panel - 611 Brn wire
- K3 safety relay - 650 Pnk/Blk wire
- Y3 and Y4 fuel injector solenoids - Wht wires
- A2 EFI module - 240 Red wire
- B4 engine coolant temperature sensor (5 VDC or less) - Blu wire
- B5 air temperature sensor (5 VDC or less) - Grn wire
- B6 vacuum pressure sensor (5 VDC or less) - Tan wire

These circuits are controlled by the key switch and their respective controlling components. They are protected by the unswitched and switched power fusible links and fuses.

Power Circuit Electrical Schematic - X720/X724/X728 EFI




S7 RIO Switch
Neutral/Forward
Reverse
402 Yel
742 Blu/Wht
743 Pur
740 Blu
520 Yel
521 Yel
772 Blu
400 Yel/Blu
504 Yel
With Optional Rear PTO (X5 Connector)
S5 Front PTO Switch
On
Off
520 Yel
742 Blu/Wht
521 Yel
S6 Rear PTO Switch
On
Off
740 Blu
A1 Display Panel (J2-F)
A1 Display Panel (J1-S)
J1-S J2-F
J1-G
A1 Display Panel
S8 Brake Switch
(On)
(Off)
765 Pur
J1-D
S9 Light Switch
Off
On
On
E
H
C
900 Blk/Wht
J1-H
J2-J
J1-M
J3-F
J2-A
K3 Safety Relay
87a
87
30
85
86
650 Pnk/Blk
139 Blk
138 Blk
620 Tan
310 Org
X3
X6
B1 Engine Oil Pressure Switch
B2 Engine Water Temperature Sensor
B3 Fuel Gauge Sender
X6
X8
910 Wht
100 Blk
135 Blk
120 Blk
100 Blk



W2 Ground
X11
X10
Y3 #1 Cylinder Fuel Injector Solenoid
Y4 #2 Cylinder Fuel Injector Solenoid
A2 Electric Fuel Injection Module
Blk/Wht
330 Org
710 Pur
Wht
Red/Blu
340 Grn
240 Red
Tan
470 Yel
Grn
515 Blu
Blu
615 Tan
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
X9
B5 Air Temperature Sensor
Blk/Yel
B4 Engine Coolant Temperature Sensor
B6 Vacuum Pressure Sensor

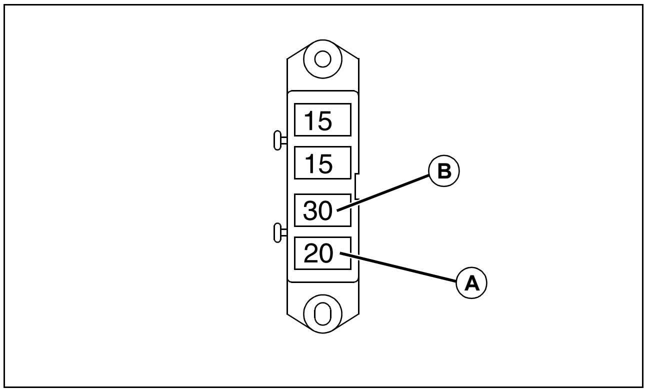
Power Circuit Diagnosis - X720/X724/X728 EFI

Test Procedure A:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in off position.
- Battery fully charged.
- Follow procedure in sequence.
- Ensure all circuit grounds are in good condition and have continuity.

Unswitched Power Circuits:



1. Is battery voltage present at F4 20A fuse, 200 Red wire (A)?

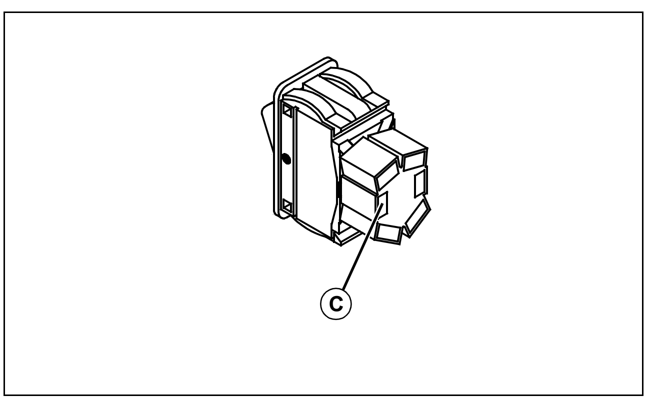
Yes: Go to next step.

No: Check 213 fusible link, 202 Red wire and F4 fuse.

2. Is battery voltage present at F3 30A fuse, 204 Red wire (B)?

Yes: Go to next step.

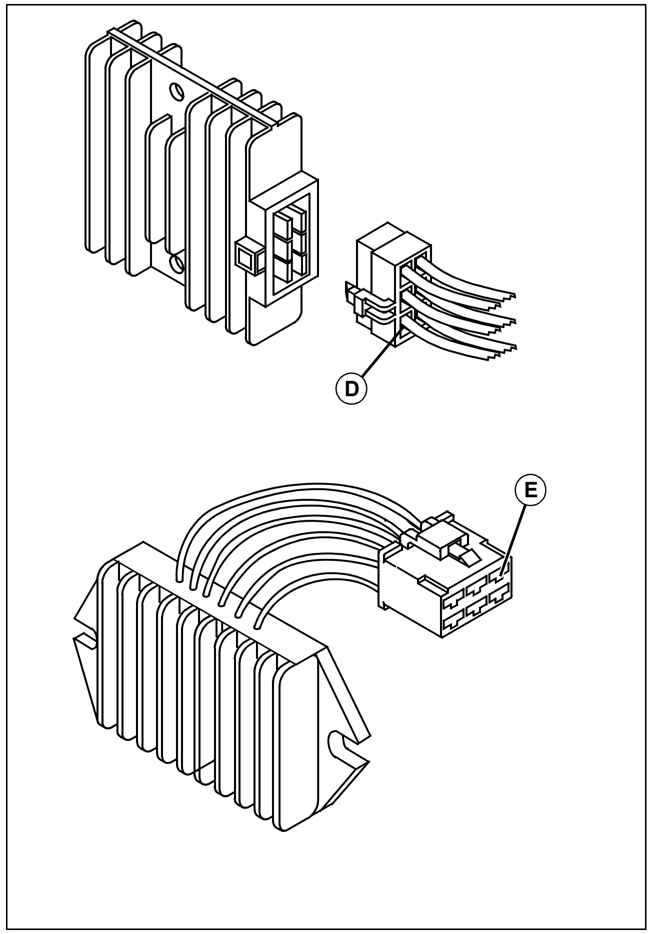
No: Check 212 fusible link, 201 Red wire, and F3 fuse.



3. Is battery voltage present at S2 power port switch 592 Blu wire (C)?

Yes: Go to next step.

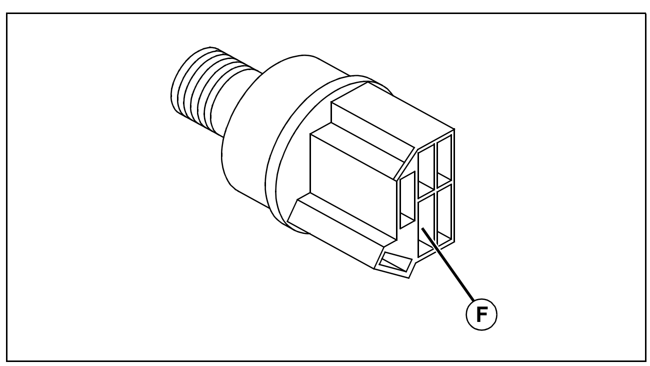
No: Check 200 Red wire, 592 Pnk wire, and X1 connector.



4. Is battery voltage present at N1 voltage regulator/rectifier X2 connector Red wire (D)? If auxiliary alternator is installed, check for battery voltage at N2 voltage regulator/rectifier Red wire (E) as well.

Yes: Go to next step.

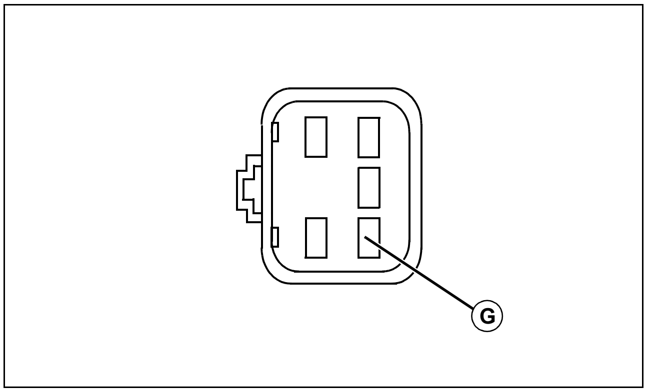
No: Check 209 and 200 Red wires and connections.



5. Is battery voltage present at S1 key switch, 206 Red wire (F)?

Yes: Go to next step.

No: Check 206 and 204 Red wires and connections.



6. Is battery voltage present at K1 main relay, 221 Red wire (G)?

Yes: End of unswitched power circuit diagnosis.

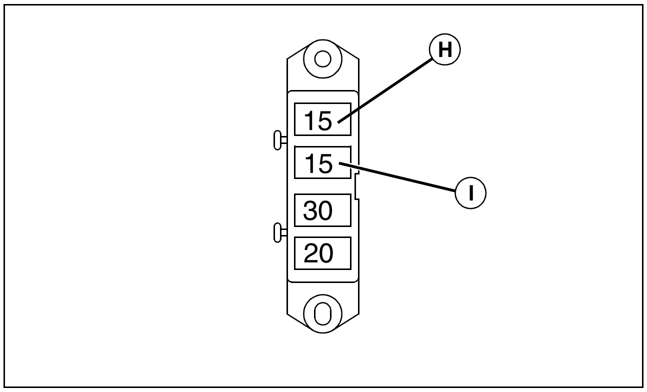
No: Check 204 and 220 Red wires, F5 10A fuse, and 221 Red wire and connections.

Test Procedure B:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in run position,
- Follow procedure in sequence.
- Ensure all ground circuits are in good condition and have continuity.

Switched Power Circuits:



1. Is battery voltage present F1 15A fuse, 400 Yel/Blu wire (H)?

Yes: Go to next step.

No: Test F1 fuse.

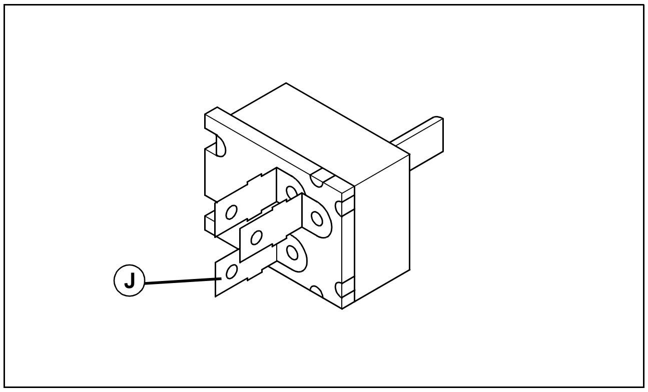
No: Test S1 key switch. See “Key Switch Test” on page 219.

No: Check 401 Yel wire and connections.

2. Is battery voltage present at F2 15A fuse, 500 and 505 Yel wires (I)?

Yes: Go to next step.

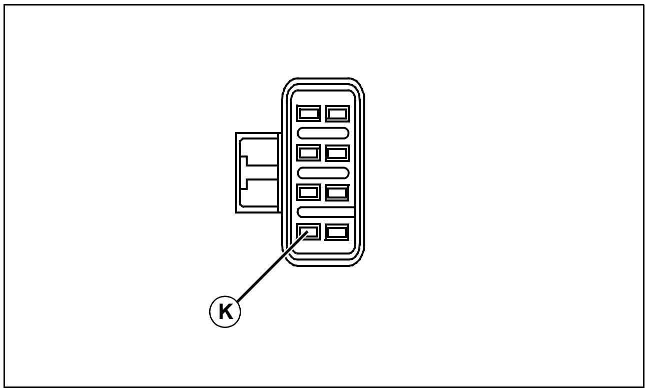
No: Test F2 fuse.



3. Is battery voltage present at S9 light switch, 400 Yel/Blu wire (J)?

Yes: Go to next step

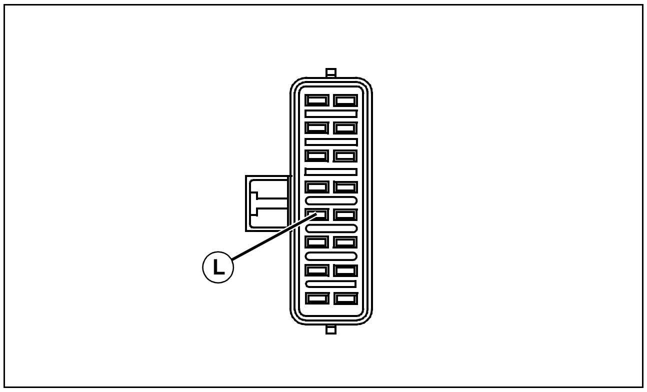
No: Check 400 Yel/Blu wire and connections.



4. Is battery voltage present at A1 display panel, J3 connector 505 Yel wire (K)?

Yes: Go to next step.

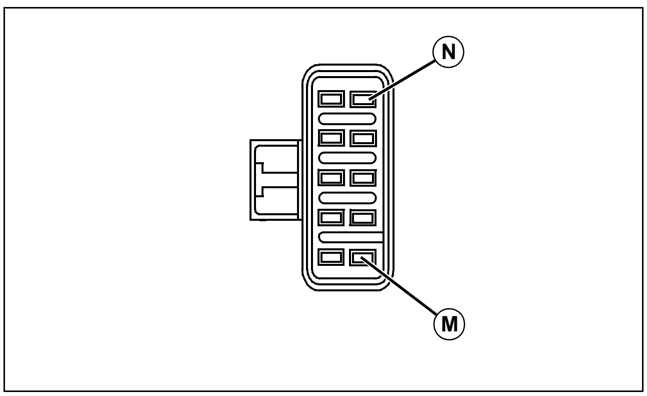
No: Check 505 Yel wire and connections.



5. Is battery voltage present at A1 display panel, J1 connector 410 Yel wire (L)?

Yes: Go to next step.

No: Check 500 Yel wire, S-5 splice, and 410 Yel wire and connections.



6. Is battery voltage present at A1 display panel, J2 connector 503 Yel wire (M)?

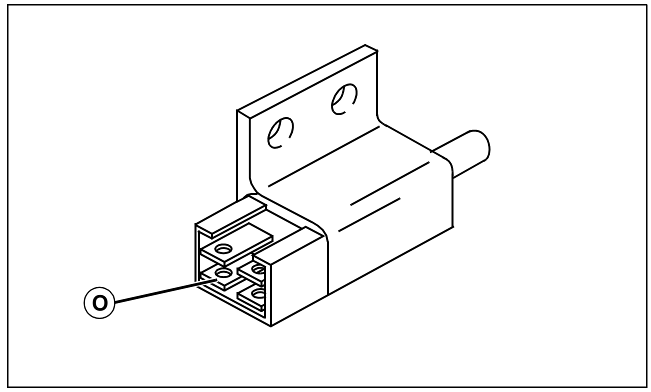
Yes: Go to next step.

No: Check 500 Yel wire, S-5 splice, and 503 Yel wire and connections.

7. If rear PTO option is not installed - Is battery voltage present at A1 display panel, J2 connector 742 Blu/Wht wire (N)?

Yes: Go to next step.

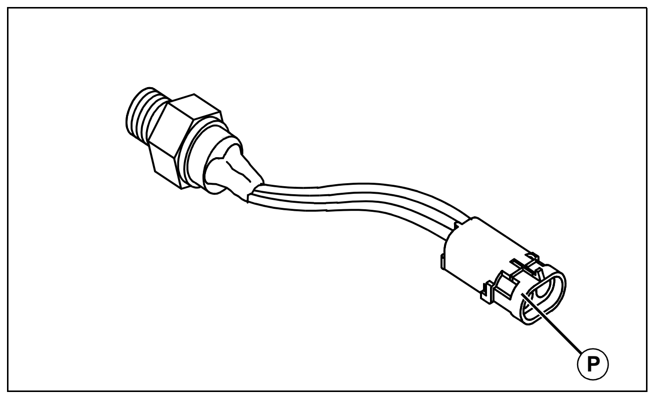
No: Check 500 and 520 Yel, 743 Pur, and 742 Blu/Wht wires and connections.



8. Is battery voltage present at S7 RIO switch, 402 Yel wire (O)?

Yes: Go to next step.

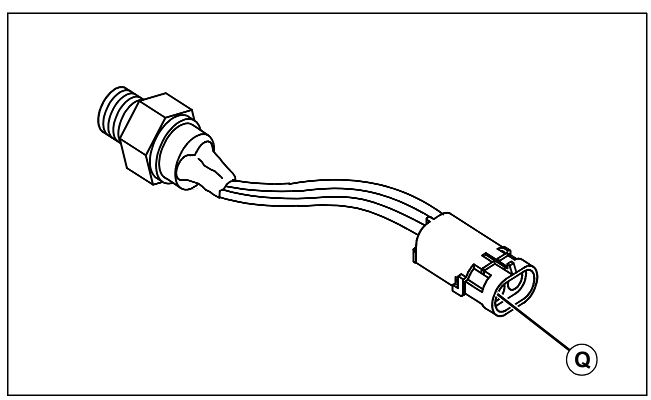
No: Check 500 Yel wire, S-5 splice, and 402 Yel wire and connections.



9. If rear PTO option is installed - Is battery voltage present at S5 front PTO switch, 520 Yel wire (P)?

Yes: Go to next step.

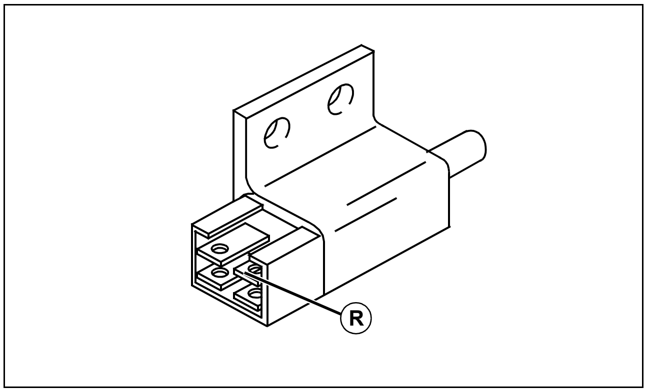
No: Check 500 Yel wire, S-5 splice, and 520 Yel wire and connections.



10. If rear PTO option is installed - Is battery voltage present at S6 rear PTO switch, 521 Yel wire (Q)?

Yes: Go to next step.

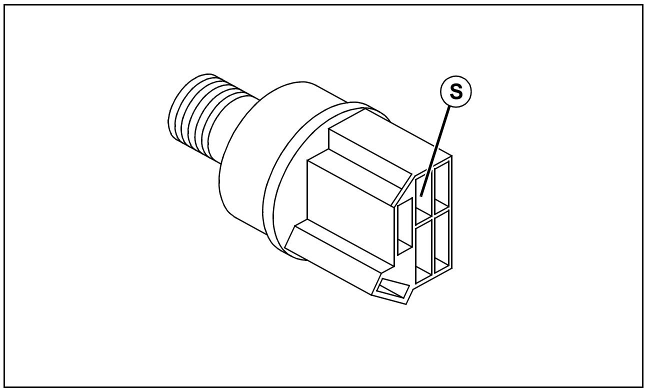
No: Check 521 Yel wire and connections.



11. Is battery voltage present at S8 brake switch, 504 Yel wire (R)?

Yes: Go to next step.

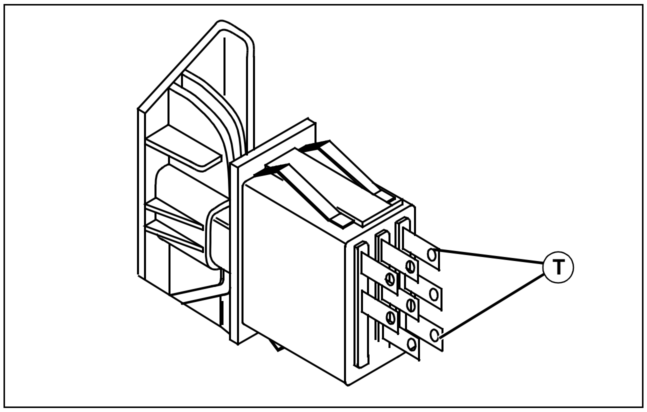
No: Check 500 Yel wire, S-5 splice, and 504 Yel wire and connections.



12. Is battery voltage present at S1 key switch, 593 Yel wire (S)?

Yes: Go to next step.

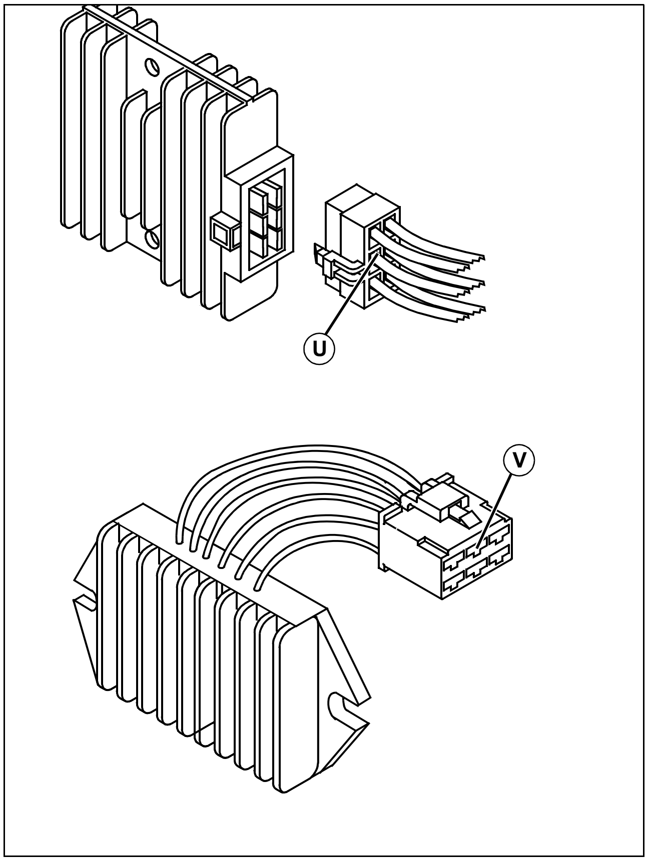
No: Check 500 Yel wire, S-5 splice, and 593 Yel wire and connections.



13. Is battery voltage present at S3 PTO/RIP switch 501 and 511 Yel wires (T)?

Yes: Go to next step.

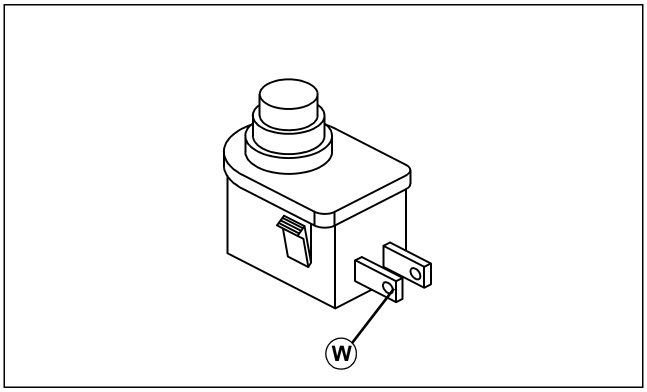
No: Check 500 Yel wire, S-5 splice, 501 and 511 Yel wires and connections.



14. Is battery voltage present at X2 connector of N1 voltage regulator/rectifier, 594 Yel wire (U)? If G2 auxiliary alternator is installed, check for battery voltage at N2 voltage regulator/rectifier, 521 Yel wire (V) as well.

Yes: End of switched power tests.

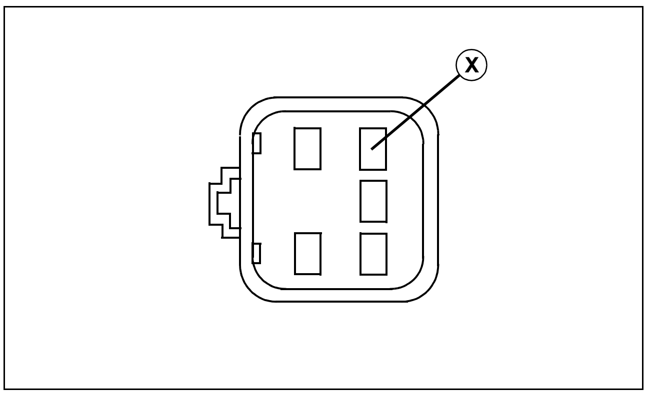
No: Check 500 Yel wire, S-5 splice, and 594 Yel wire and connections. If G2 auxiliary alternator is installed, check 521 Yel wire as well.



15. Is battery voltage present at S4 seat switch, 502 Yel wire (W)?

Yes: Go to next procedure.

No: Check 500 Yel wire, S-5 splice, and 502 Yel wire and connections.



16. Is battery voltage present at K1 main relay, 560 Red/Yel wire (X)?

Yes: End of switched power diagnosis.

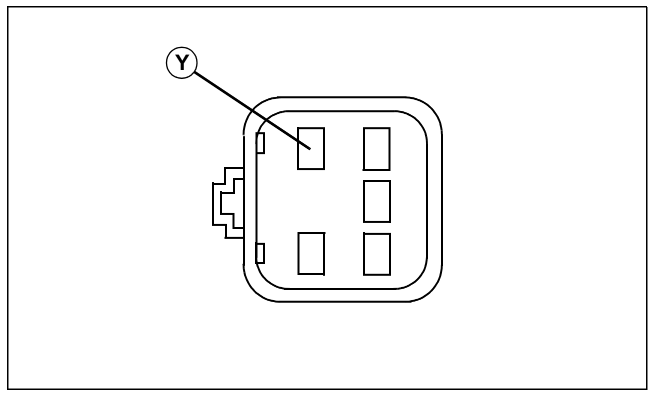
No: Check 500 Yel wire, S-5 splice, and 560 Red/Yel wire and connections.

Test Procedure C:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in off position.
- Battery fully charged.
- Component under test in active position. De-activate circuit when done testing.
- Follow procedure in sequence.
- Ensure that A1 display panel, J2 connector 135 Blk wire has continuity to ground.
- Ensure all circuit grounds are in good condition and have continuity.

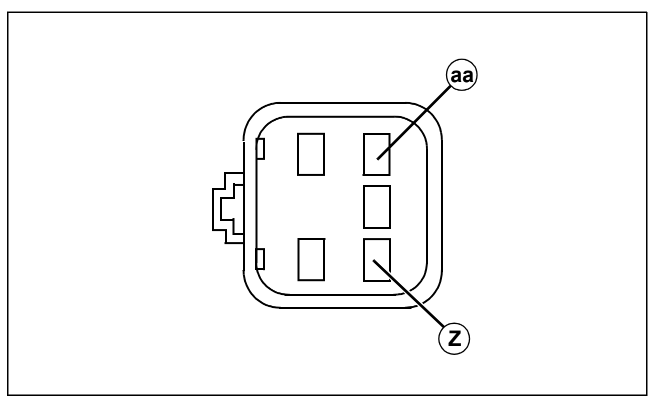
Secondary Power Circuits:



1. Is battery voltage present at K1 main relay, 230 Red wire (Y)?

Yes: Go to next step.

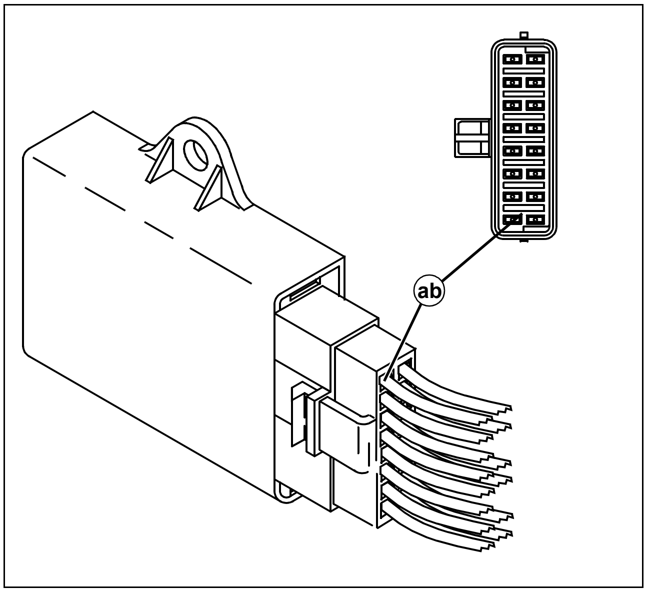
No: Check all connections on K1 main relay. If OK, test relay.



2. Is battery voltage present at K2 fuel pump relay, 231 (Z) and 232 (AA) Red wires?

Yes: Go to next step.

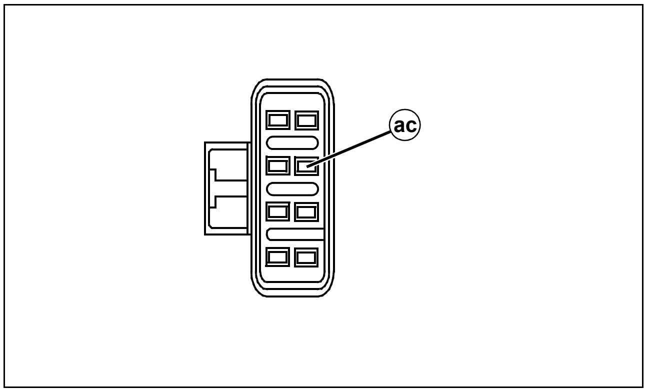
No: Check 230, 231, and 232 Red wires and connections.



3. Is battery voltage present at A2 EFI module X11 connector, 240 Red wire (AB)?

Yes: Go to next step.

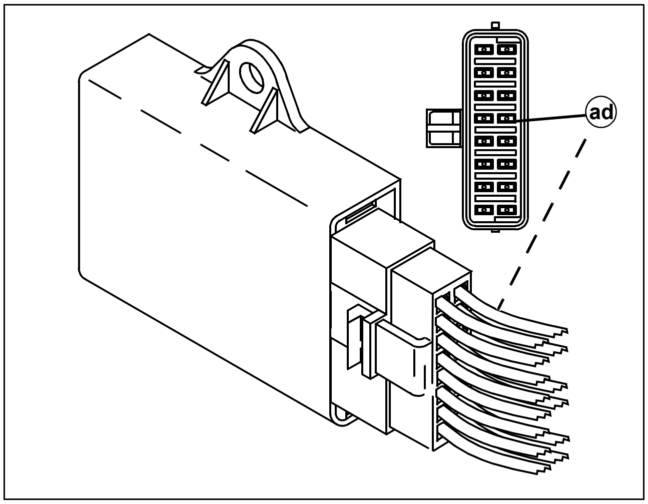
No: Check 233 Red/Blu wire, X9 connector, Wht wire X10 connector, and 240 Red wire.



4. Is battery voltage present at A1 display panel, J3 connector 650 Pnk/Blk wire (AC)?

Yes: Go to next step.

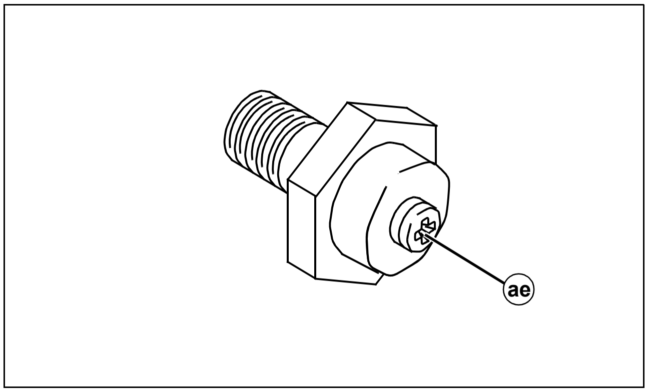
No: Replace A1 display panel.



5. Is there continuity to between A2 EFI module, X11 connector 860 Pnk wire (AD) and ground?

Yes: Go to next step.

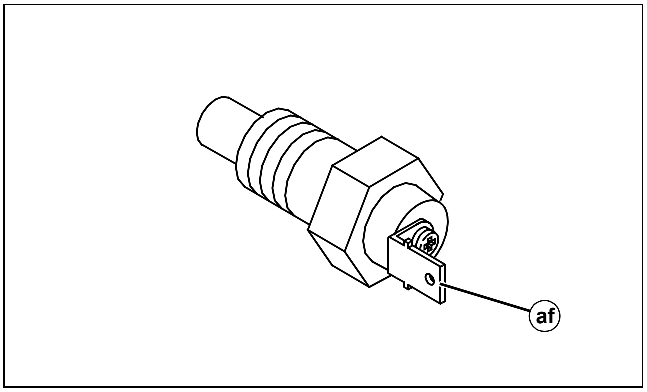
No: Check 860 Pnk, Org, and 670 Pur wires, X11, X10, and X8 connectors and connections. If OK, test K3 safety relay. See “Relay Test” on page 218.



6. Is battery voltage present at X3 connector, 620 Tan wire (AE) of B1 engine oil pressure switch?

Yes: If necessary, test B1 engine oil pressure switch. See “Engine Oil Pressure Switch Test” on page 217. If OK, go to next step.

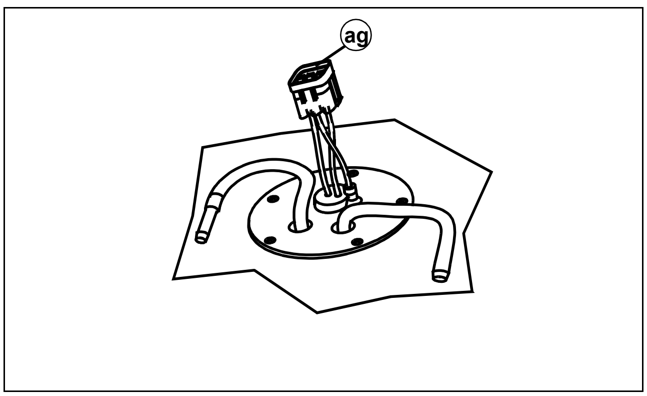
No: Check 620 Tan wire and connections. If OK, replace A1 display panel.



7. Is battery voltage present at X3 connector, 310 Org wire (AF) of B2 engine coolant temperature sensor?

Yes: If necessary, test B2 engine coolant temperature sensor. See “Engine Coolant Temperature Sensor Test” on page 216. Go to next step.

No: Check 310 Org wire and connections. If OK, replace A1 display panel.



8. Is battery voltage present at B3 fuel gauge sender, X6 connector 900 Blk/Wht wire (AG)?

Yes: If necessary, test B3 fuel gauge sender. See “Fuel Tank Sensor Test” on page 224. If OK, go to next step.

No: Check 900 Blk/Wht wire and connections. If OK, replace A1 display panel.

Cranking Circuit Operation - All Models

Function:

To energize the starting motor solenoid and engage the starting motor to crank the engine.

Operating Conditions:

- Key switch in start position.
- Brake locked, switch closed.
- PTO/RIP switch in off position.

Theory of Operation:

The starting motor is a solenoid shift design. The power circuit provides current to the S1 key switch and protects the cranking circuit with the 212 fusible link and F3 fuse. Current flows from the battery positive (+) terminal to the starter solenoid battery terminal, 212 fusible link, 201 Red wire, F3 fuse, 204 Red wire and to the key switch.

With the key switch in the start position, the secondary power circuit is energized, thereby providing power to the the A1 display panel. At the same time, secondary power is provided to through the key switch over the 593 Yel wire and exiting the switch over the 591 Yel wire and providing a start signal to the A1 display panel.

To provide the start signal, the following conditions must be met:

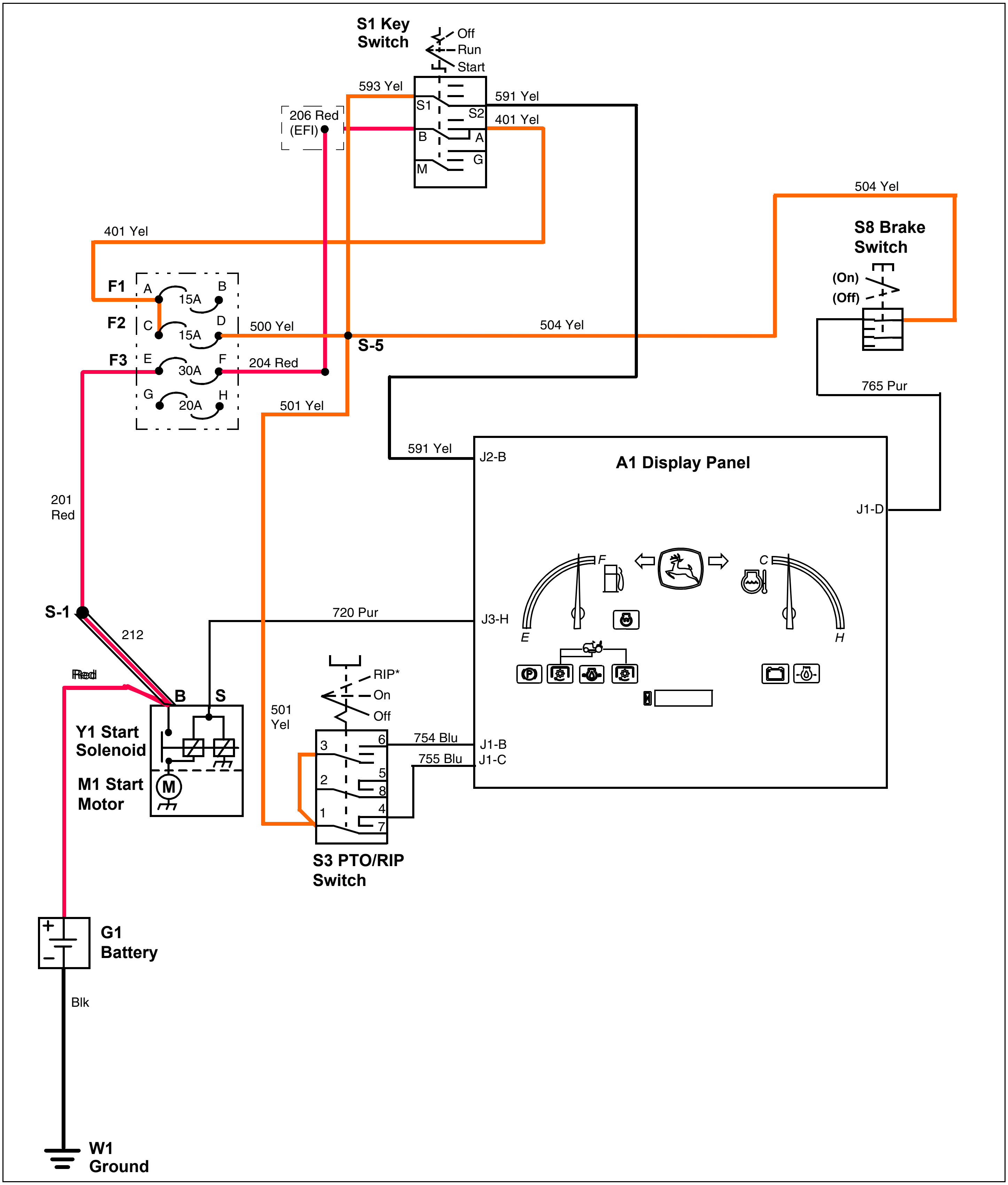
- The S8 brake switch must be closed (brake pedal depressed), providing 12 VDC to the A1 display panel J1 connector over the 765 Pur wire.
- The S3 PTO/RIP switch must be in the off position. This will prevent the 754 and 755 Blu wires (J1) from supplying power to the A1 display panel, thereby indicating that the PTO is off.

The A1 display panel will then output power over the 720 Pur wire to he starting Y1 motor solenoid.

The Y1 starting motor solenoid is engaged by current flowing through the coil windings, pulling the plunger inward. The plunger closes the solenoid main contacts. Current flows through the hold-in windings, keeping the solenoid engaged.

With the solenoid main contacts closed, high current from the battery flows across the main contacts to the M1 starting motor causing it to turn.

Cranking Circuit Electrical Schematic - All Models



MIF

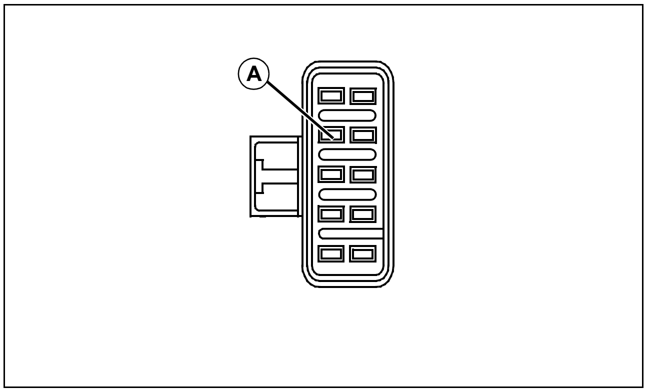
Cranking Circuit Diagnosis - All Models

Test Procedure A:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in start position.
- PTO(s) off.
- Battery fully charged.
- Power circuits functioning properly.
- Follow procedure in sequence.
- Ensure that A1 display panel, J2 connector 135 Blk wire has continuity to ground.
- Ensure all circuit grounds are in good condition and have continuity.

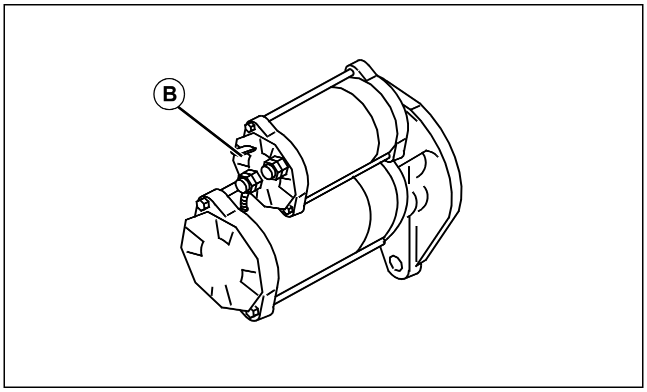
Cranking Circuit:



1. Is battery voltage present at A1 display panel, J2 connector 591 Yel wire (A)?

Yes: Go to next step.

No: Check 591 Yel wire and connections. If OK, test S1 key switch. See “Key Switch Test” on page 219.



2. Is battery voltage present at Y1 starting motor solenoid, 720 Pur wire (B)?

Yes: Test starting motor and solenoid. See “Starting Motor Condition” on page 214 and related tests.

No: If all power circuits are OK and operating conditions are met, replace A1 display panel.

Charging Circuit Operation - All Models (Standard Configuration)

Function:

To maintain battery voltage between 12.4 volts DC and 15 volts DC.

Operating Conditions:

The key switch must be in the run position, with the engine running, for the charging system to operate.

Theory of Operation:

The main charging system components are the G1 battery, G2 alternator and the N1 voltage regulator/rectifier. Charging output is controlled by the regulator/rectifier. The status of the charge rate is indicated by the discharge light on the display panel.

With the key switch in the run position, battery sensing circuit current flows from battery positive terminal to the starting motor terminal, 212 fusible link, F3 fuse, 204 Red wire, S1 key switch, 401 Yel wire, F2 fuse, 500 and 594 Yel wires, and the N1 voltage regulator/rectifier. The battery sensing circuit allows the voltage regulator/rectifier to monitor battery voltage.

With the engine running, 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.

Current flows from the voltage regulator/rectifier to the battery positive (+) terminal through the 209 and 200 Red wires, F4 fuse, 202 Red wire and 213 fusible link. When the battery is fully charged, the voltage regulator/rectifier halts current flow to the battery.

If the voltage on the sensing circuit falls below system usage or is insufficient to maintain a preset voltage, the A1 display panel will sense the lowered voltage and illuminate the discharge light.

The ground circuit 125 and 100 Blk wires provide a path to ground for the voltage regulator/rectifier.

Charging Circuit Operation - All Models (With Auxiliary Alternator)

Function:

To maintain battery voltage between 12.4 volts DC and 14.8 volts DC.

Operating Conditions:

The key switch must be in the run position, with the engine running, for the auxiliary charging system to operate.

Theory of Operation:

The auxiliary charging system components are the G1 battery, G3 alternator and the N2 voltage regulator/rectifier. Charging output is controlled by the regulator/rectifier. The status of the charge rate is indicated by the discharge light on the display panel.

Note: If one of the two charging systems fail, the discharge indicator on the A1 display panel may not illuminate due to the functioning charging circuit supplying current to the battery.

With the key switch in the run position, battery sensing circuit current flows from battery positive terminal to the starting motor terminal, 212 fusible link, F3 fuse, 204 Red wire, S1 key switch, 401 Yel wire, F2 fuse, 500, 594, and 521 Yel wires, and the N2 voltage regulator/rectifier. The battery sensing circuit allows the voltage regulator/rectifier to monitor battery voltage.

Note that at this point, dual charging systems are running in parallel but share the same voltage sensing circuit over the 521, 504, and 594 Yel wires.

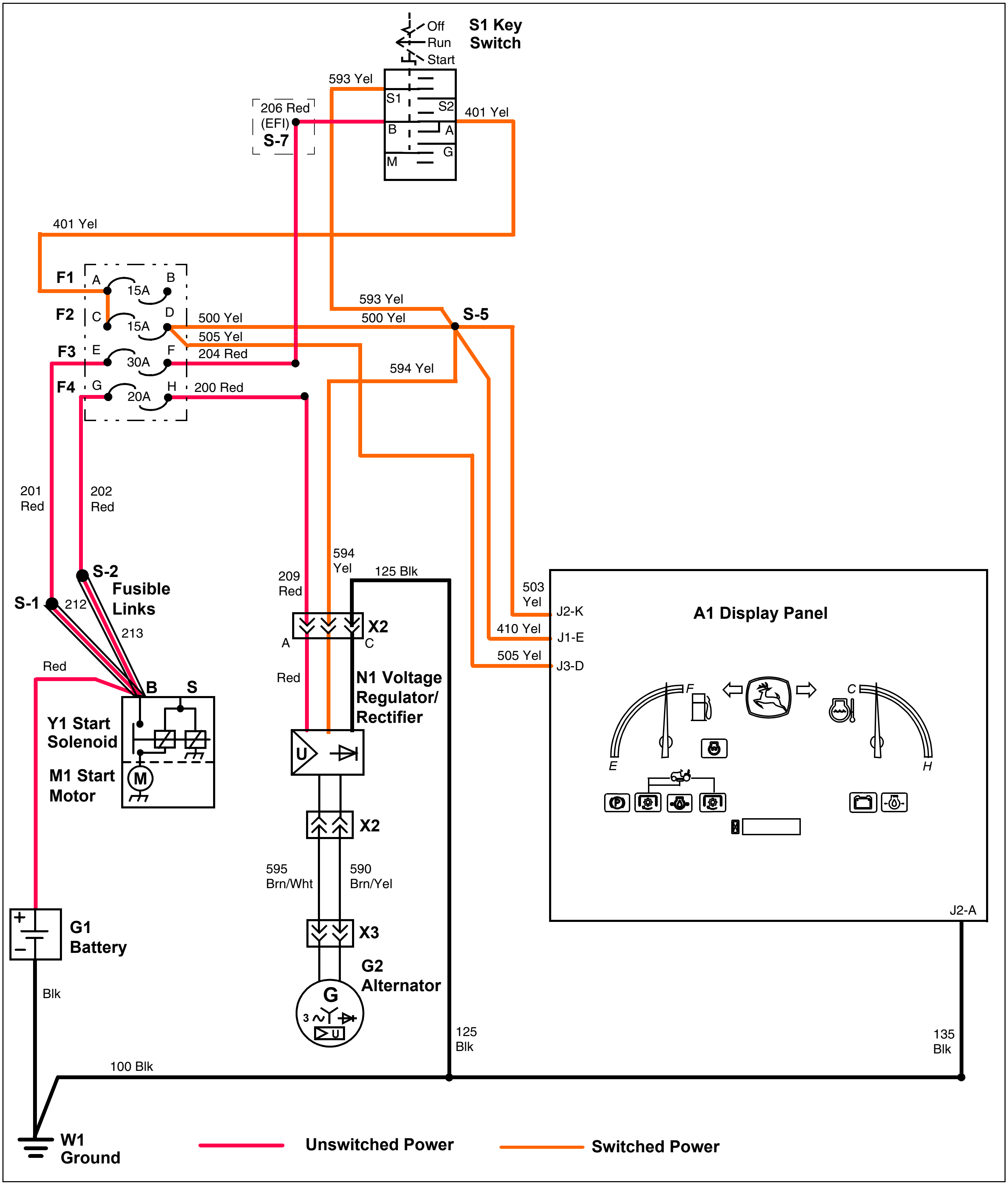
With the engine running, a rotating permanent magnet in the alternator induces AC current in the alternator stator coils. The AC current flows to the voltage regulator/rectifier. The voltage regulator/rectifier converts AC current to DC current needed to charge the battery.

Current flows from the voltage regulator/rectifier to the battery positive (+) terminal through the 211, 209 and 200 Red wires, F4 fuse, 202 Red wire and 213 fusible link. When the battery is fully charged, the voltage regulator/rectifier halts current flow to the battery.

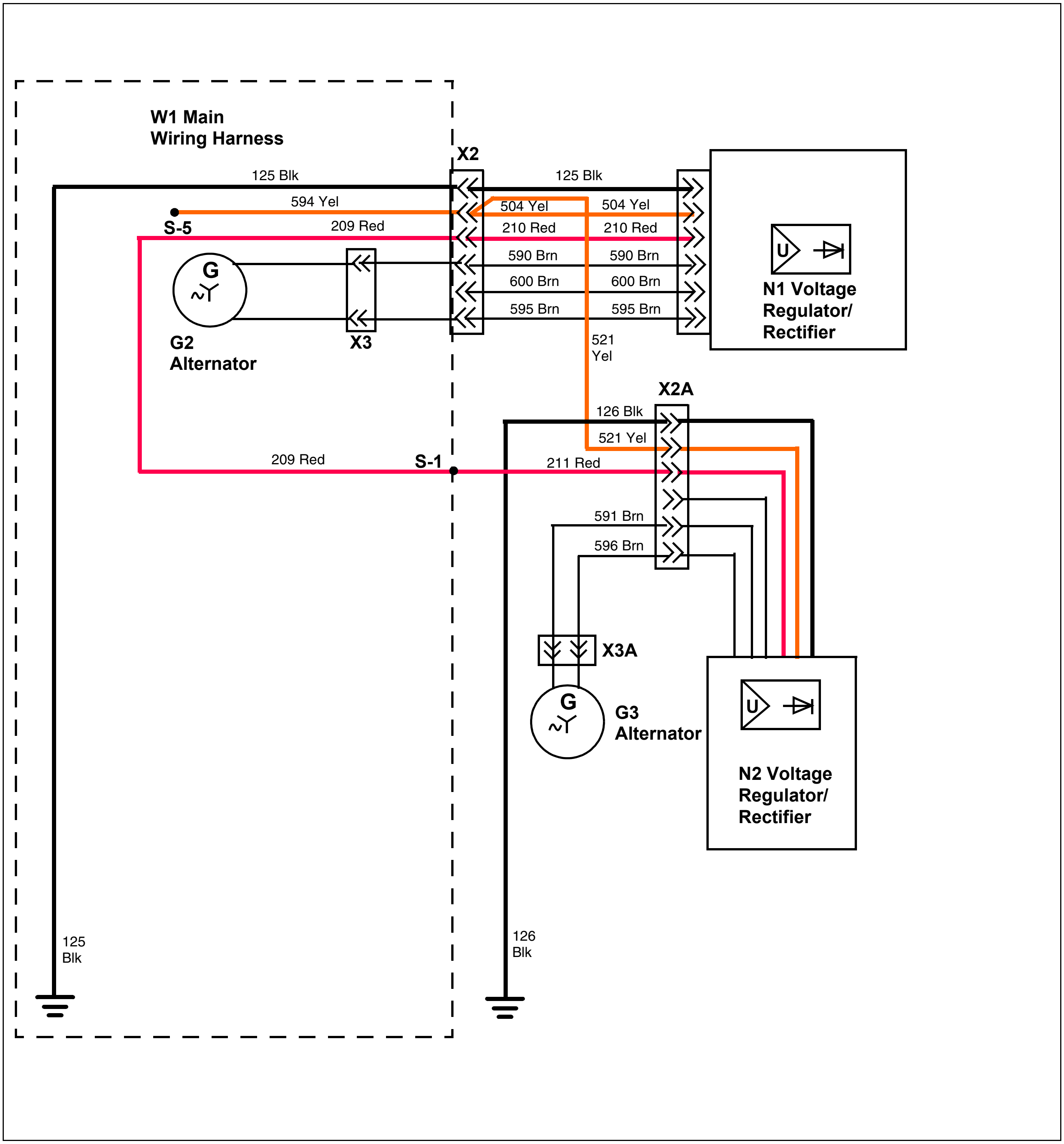
If the voltage on the sensing circuit falls below system usage or is insufficient to maintain a preset voltage, the A1 display panel will sense the lowered voltage and illuminate the discharge light.

The ground circuit 126 Blk wire provides a path to ground for the voltage regulator/rectifier.

Charging Circuit Electrical Schematic - All Models



Charging Circuit Electrical Schematic - All Models (With Optional Auxiliary Alternator)



Charging Circuit Diagnosis - All Models (Standard Configuration)

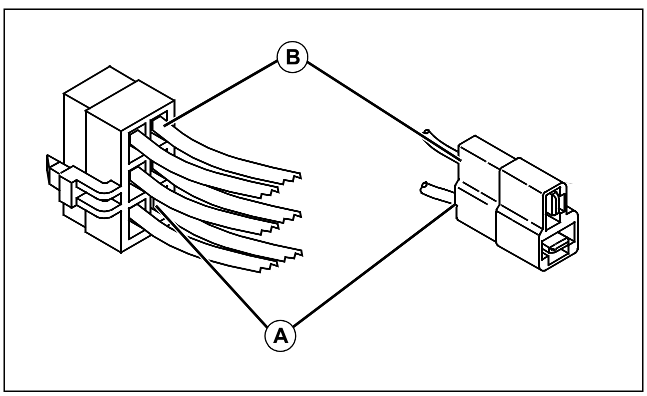
Test Procedure A:

Test Conditions:

- Machine parked safely with park brake locked.
- Operator may be on or off seat.
- Key switch in off position.
- PTO(s) off.
- Battery fully charged.
- Power circuits functioning properly. See “Power Circuit Operation - X700” on page 140 or See “Power Circuit Operation - X720/X724/X728” on page 149.
- Follow procedure in sequence.
- Ensure that A1 display panel, J2 connector 135 Blk wire has continuity to ground.
- Ensure all circuit grounds are in good condition and have continuity.

Note: If the discharge light is illuminated and no fault can be found with the power circuit and charging circuit, replace A1 display panel.

Charging Circuit:



1. Is there continuity between X2 and X3 connectors, 595 Brn/Wht wire (A)?

Yes: Go to next step.

No: Check 595 Brn/Wht wire and connections. Repair or replace as necessary.

2. Is there continuity between X2 and X3 connectors, 590 Brn/Yel wire (B)?

Yes: See “Tests and Adjustments” on page 208 for alternator tests.

No: Check 590 Brn/Yel wire and connections. Repair or replace as necessary.

Charging Circuit Diagnosis - All Models (With Optional Alternator)

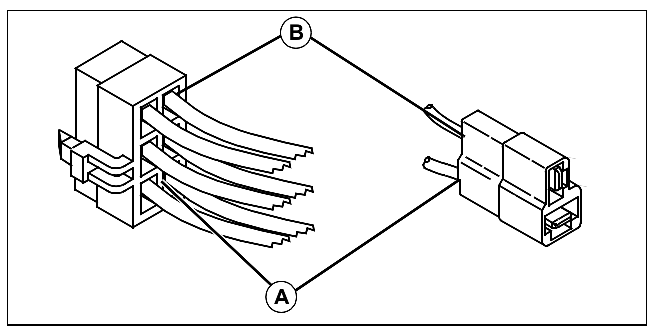
Test Procedure A:

Test Conditions:

- Machine parked safely with park brake locked.
- Operator may be on or off seat.
- Key switch in off position.
- PTO(s) off.
- Battery fully charged.
- Power circuits functioning properly. See “Power Circuit Operation - X700” on page 140 or See “Power Circuit Operation - X720/X724/X728” on page 149.
- Perform standard configuration charging circuit diagnosis first.
- Follow procedure in sequence.
- Ensure that A1 display panel, J2 connector 135 Blk wire has continuity to ground.
- Ensure all circuit grounds are in good condition and have continuity.

Note: If the discharge light is illuminated and no fault can be found with the power circuit and charging circuit, replace A1 display panel.

Charging Circuit:



1. Is there continuity between X2A and X3A connectors, 596 Brn wire (A)?

Yes: Go to next step.

No: Check 596 Brn/Wht wire and connections. Repair or replace as necessary.

2. Is there continuity between X2A and X3A connectors, 591 Brn wire (B)?

Yes: See “Tests and Adjustments” on page 208 for alternator tests.

No: Check 591 Brn wire and connections. Repair or replace as necessary.

Ignition Circuit Operation - X700

Function:

To control the ignition coils ability to create a spark while also controlling the fuel supply to the engine.

Operating Conditions, Stopping Engine:

- Key switch in off position,

or,

- Operator off seat with PTO engaged,

and,

- Park braked unlocked.

Theory of Operation, Stopping Engine

The engine is shut off by grounding the T1 and T2 ignition coils. With the ignition primary coil grounded, a spark cannot be produced.

When the S1 key switch is in the off position, a path to ground is created through the key switch Wht wire (M) solder connection and back to the interlock module through the Wht wire (S2) solder connection. In addition the power circuit current flow is stopped at the key switch. This de-energizes the magneto relay providing a path to ground for ignition coil through the magneto relay.

The magneto relay coil is energized by current from the seat switch circuit or brake circuit. If the operator gets off the seat (seat switch opens) with the PTO engaged without the park brake locked, current flow to the magneto relay coil is stopped.

The seat switch or brake switch also energize the ignition relay. Whenever the ignition relay is de-energized, the fuel shutoff solenoid is also de-energized and fuel flow to the carburetor is stopped.

Operating Conditions, Running Engine:

- Key switch in run or start position,
- Operator on seat,

or,

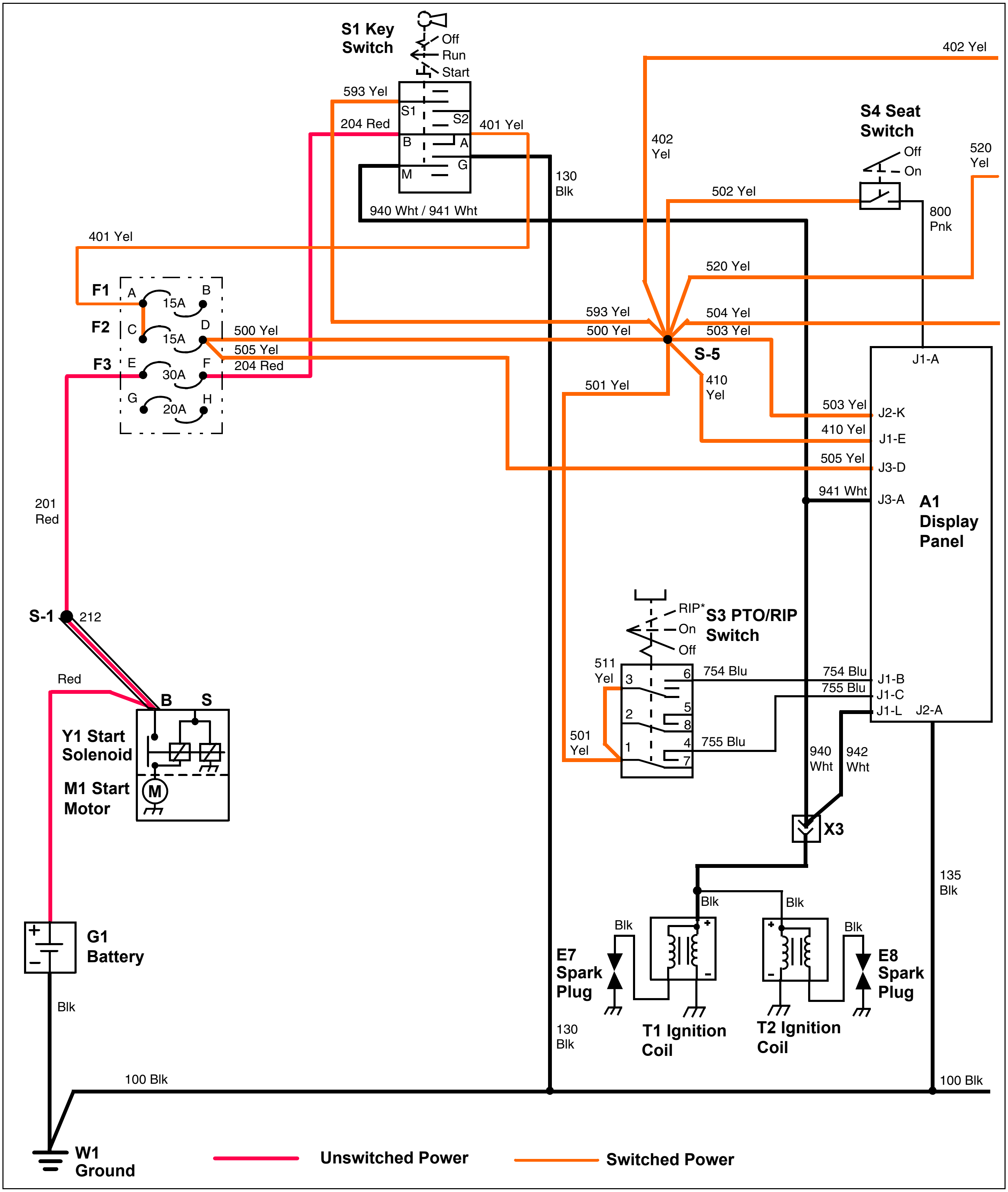
- Key switch in run or start position,
- Operator off seat,
- Park braked locked.

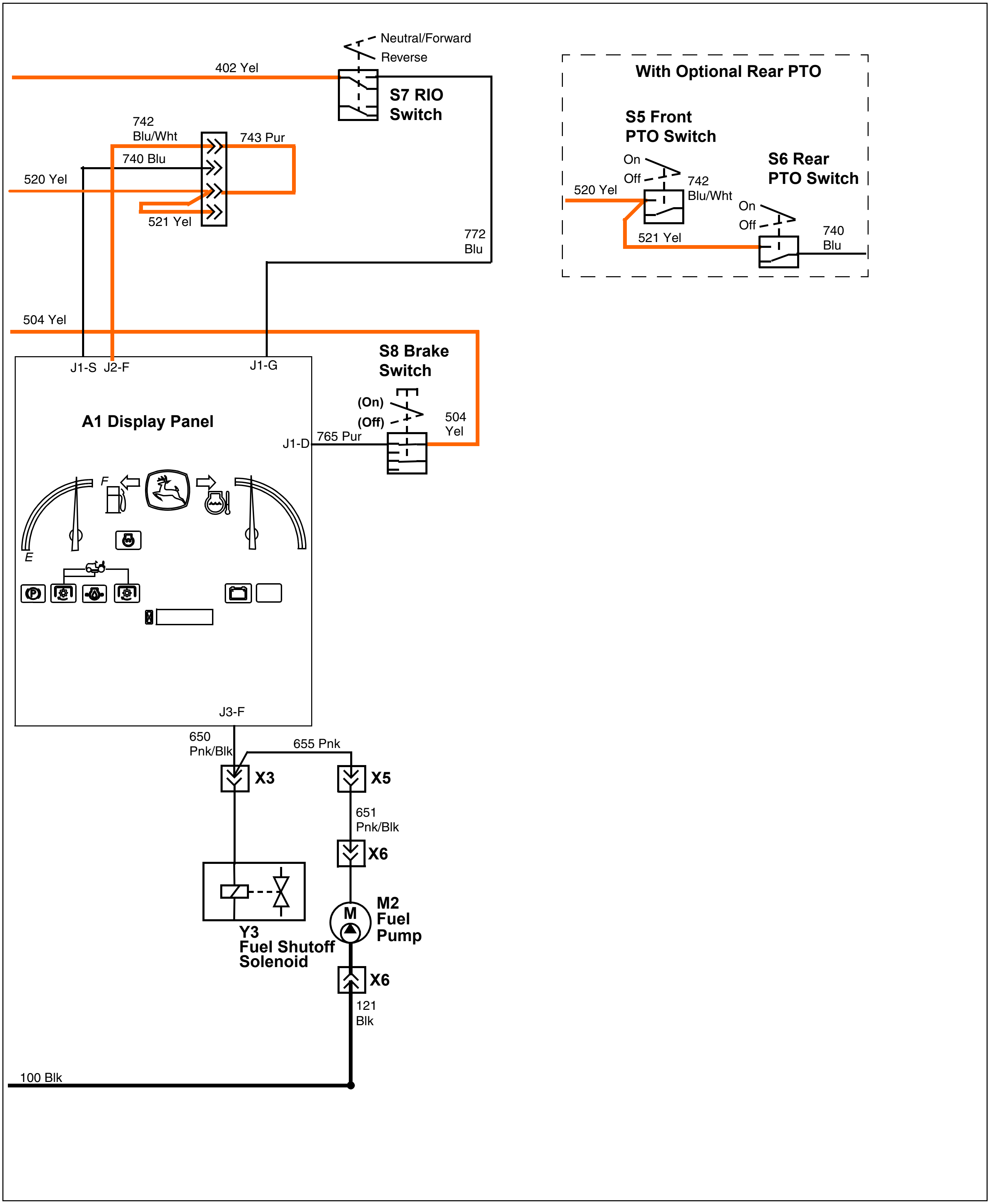
Theory of Operation, Running Engine

The key switch is connected to the A1 ignition interlock module by soldered wire connections. The components are solid state and are not serviced separately except for the 15 amp fuses. Lines within the border of the A1 ignition interlock module except for key switch connections are circuit paths on the circuit board and are not wires in the harness.

The ignition system is a transistor-controlled magneto design. Ignition timing is controlled by the transistor and is not adjustable. As the engine turns over the flywheel magnet induces current into the magneto ignition coil, which in turn produces current high enough to jump the spark plug(s) gap, creating spark to ignite the engine fuel/air mixture.

Ignition Circuit Electrical Schematic - X700





Neutral/Forward
Reverse
402 Yel
S7 RIO Switch
742 Blu/Wht
743 Pur
740 Blu
520 Yel
521 Yel
772 Blu
504 Yel
J1-S J2-F
J1-G
S8 Brake Switch
(On)
(Off)
504 Yel
765 Pur
J1-D
A1 Display Panel
F
E
J3-F
650 Pnk/Blk
655 Pnk
X3
X5
651 Pnk/Blk
X6
M
M2 Fuel Pump
Y3 Fuel Shutoff Solenoid
X6
121 Blk
100 Blk
With Optional Rear PTO
S5 Front PTO Switch
On
Off
520 Yel
742 Blu/Wht
S6 Rear PTO Switch
On
Off
521 Yel
740 Blu

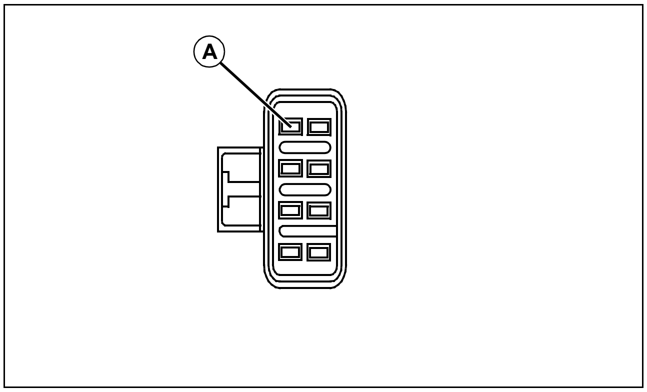
Ignition Circuit Diagnosis - X700

Test Procedure A:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in off position.
- PTO(s) off.
- Battery fully charged.
- Power circuits functioning properly.
- Follow procedure in sequence.
- Ensure that A1 display panel, J2 connector 135 Blk wire has continuity to ground.
- Ensure all circuit grounds are in good condition and have continuity.

Ignition Off:



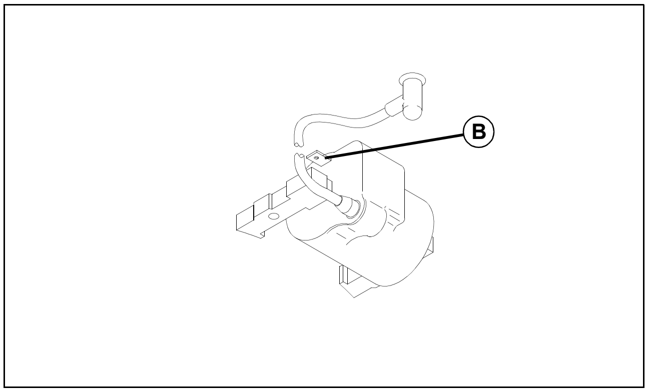
1. Is there continuity between A1 display panel, J3 connector 941 Wht wire (A) and ground?

Yes: Go to next step.

No: Check 941 and 940 Wht wires.

No: Test S1 key switch. See “Key Switch Test” on page 219.

No: Test 130 Blk wire at S1 key switch for continuity to ground.



2. Is there continuity between T1 and T2 ignition coil’s Wht wires and ground?

Yes: Go to next procedure.

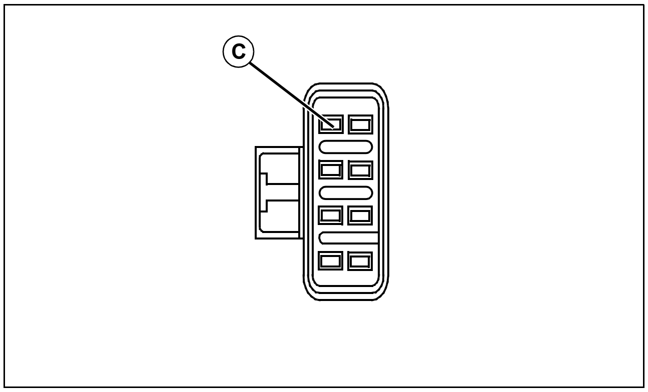
No: Check Wht wires, X3 connector, and 940 Wht wire and connections.

Test Procedure B:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in run position, engine off.
- PTO(s) off.
- Battery fully charged.
- Power circuits functioning properly.
- Follow procedure in sequence.
- Ensure that A1 display panel, J2 connector 135 Blk wire has continuity to ground.
- Ensure all circuit grounds are in good condition and have continuity.

Ignition On:



1. Is there continuity between A1 display panel, J3 connector 941 Wht wire (C) and ground?

No: Go to next step.

Yes: Test S1 key switch. See "Key Switch Test" on page 219.

Yes: Replace A1 display panel.

If problems persist, test T1 and T2 ignition coils. See "Ignition Coil Test" on page 229.

Ignition Circuit Operation - X720/X724/X728 EFI

Function:

To control the ignition coils ability to create a spark while also controlling the fuel supply to the engine.

Operating Conditions, Stopping Engine:

- Key switch in off position,

or,

- Operator off seat with PTO engaged,

and,

- Park braked unlocked.

Theory of Operation, Stopping Engine:

The engine is shut off by grounding the T1 and T2 ignition coils. With the ignition primary coil grounded, a spark cannot be produced.

When the S1 key switch is in the off position, the power circuit current flow is stopped at the key switch. This de-energizes the A1 display panel thereby turning of the output signal to the K3 safety relay. This will also de-energize the K1 main relay turning off power to the A2 EFI module.

Operating Conditions, Running Engine:

- Key switch in run or start position,
- Operator on seat,

or,

- Key switch in run or start position,
- Operator off seat,
- Park braked locked.

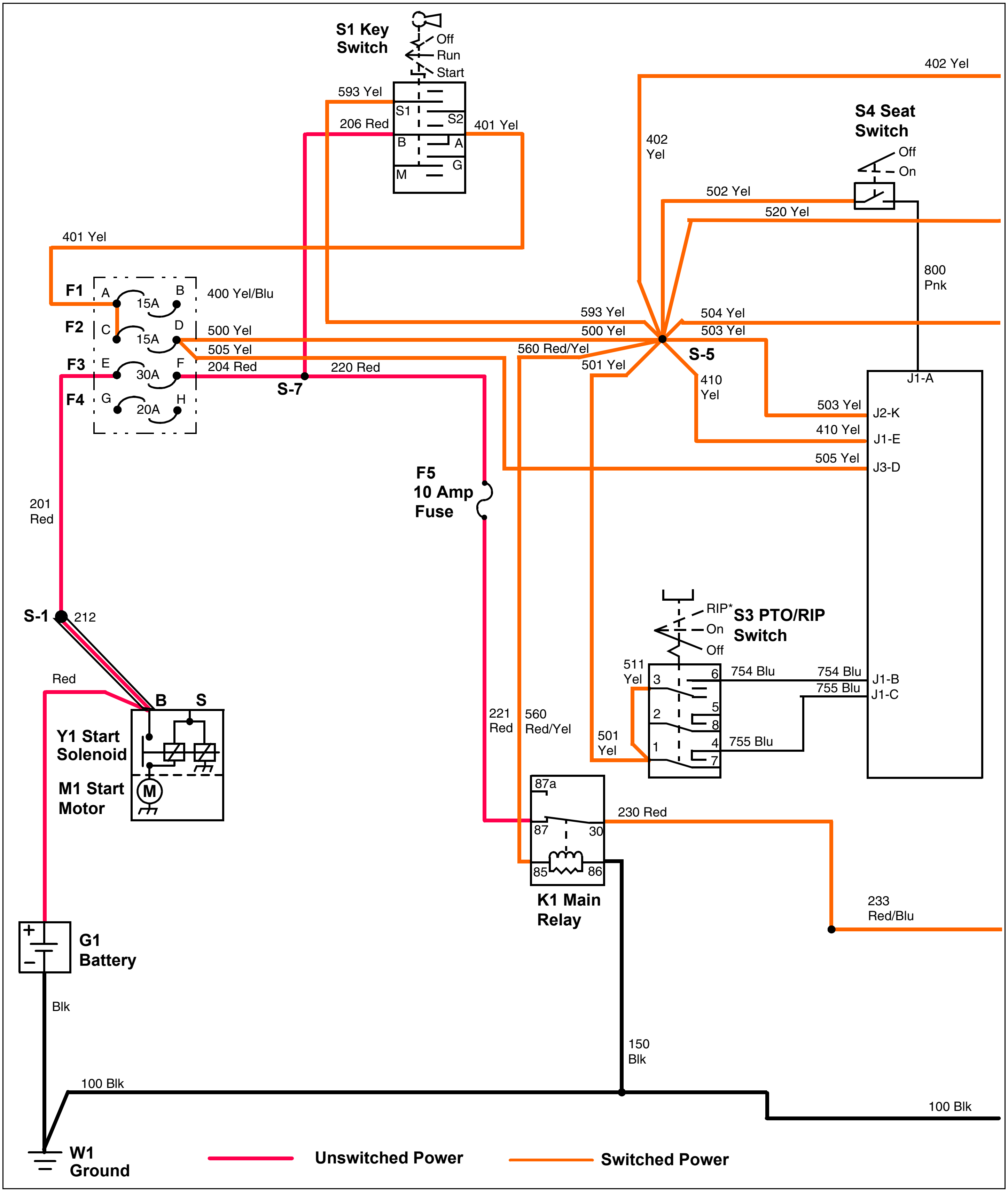
Theory of Operation, Engine Running:

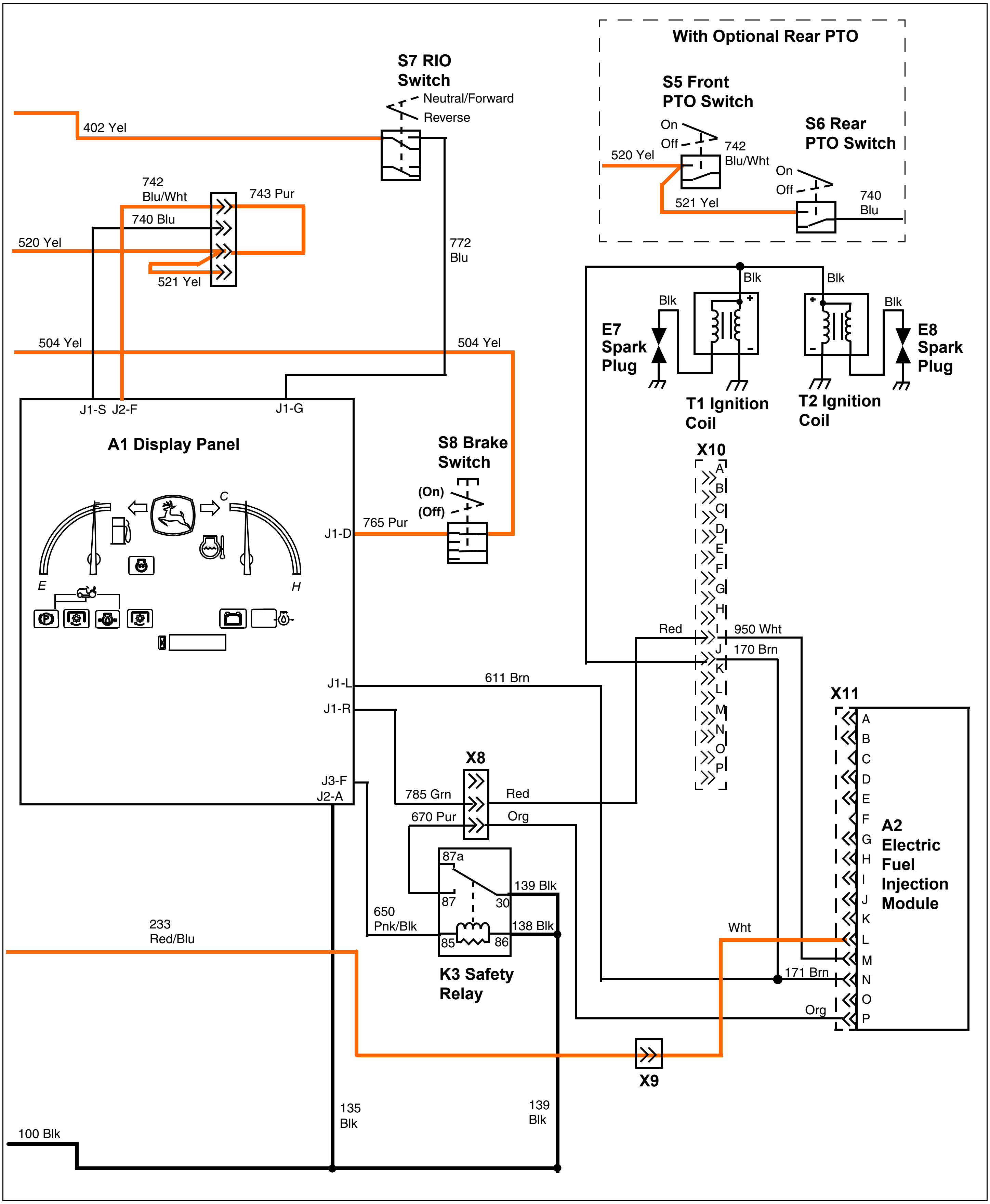
When the key switch is in the run position, with the engine is running, power flows through the switched power circuit to the A1 display panel (See “Power Circuit Operation - X720/X724/X728” on page 149). The A1 display panel outputs 12 VDC to the K3 safety relay over the 650 Pnk/Blk wire thereby energizing it and providing a path to ground for the A2 EFI module as long as this signal is present. This path is accomplished by the 138 and 139 Blk wires. This provides a path to ground over the 670 Pur wire, X8 connector, Org wire, X11 connector, and to the A2 EFI module.

The key switch in the on position will also energize the K1 main relay which provides power to the A2 EFI module over the 230 Red and 233 Red/Blu wires.

With these signal present, the EFI module provides power to the T1 and T2 ignition coils over the 171 and 170 Brn wires, X10 connector, and the Blk wire to the coils. As the flywheel rotates, magnets located on the flywheel pass underneath the ignition coils and cause them to induce current to their respective spark plugs. Ignition timing is not adjustable.

Ignition Circuit Electrical Schematic - X720/X724/X728 EFI





With Optional Rear PTO
S7 RIO Switch
Neutral/Forward
Reverse
402 Yel
S5 Front PTO Switch
On
Off
520 Yel
742 Blu/Wht
S6 Rear PTO Switch
On
Off
521 Yel
740 Blu
742 Blu/Wht
743 Pur
740 Blu
520 Yel
521 Yel
772 Blu
504 Yel
504 Yel
Blk
Blk
Blk
Blk
E7 Spark Plug
E8 Spark Plug
T1 Ignition Coil
T2 Ignition Coil
J1-S J2-F
J1-G
A1 Display Panel
S8 Brake Switch
(On)
(Off)
765 Pur
J1-D
C
E
H
X10
A B C D E F G H I J K L M N O P
Red
950 Wht
170 Brn
J1-L
611 Brn
J1-R
X11
A B C D E F G H I J K L M N O P
A2 Electric Fuel Injection Module
J3-F
J2-A
X8
785 Grn
Red
670 Pur
Org
87a
87
30
139 Blk
650 Pnk/Blk
138 Blk
85
86
K3 Safety Relay
Wht
171 Brn
Org
233 Red/Blu
X9
135 Blk
139 Blk
100 Blk

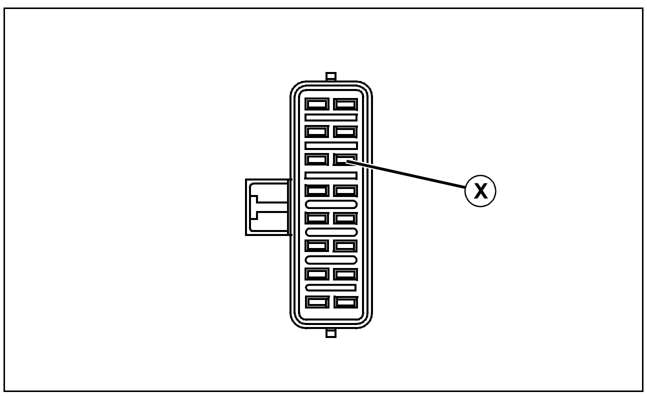
Ignition Circuit Diagnosis - X720/X724/X728 EFI

Test Procedure A:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in run position, engine off.
- PTO(s) off.
- Battery fully charged.
- Power circuits functioning properly.
- Follow procedure in sequence.
- Ensure that A1 display panel, J2 connector 135 Blk wire has continuity to ground.
- Ensure that A2 EFI module, X11 connector 710 Pur and 330 Org wires have continuity to ground.
- Ensure all circuit grounds are in good condition and have continuity.

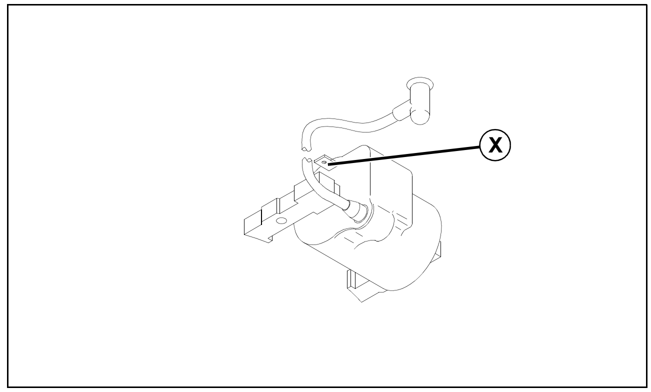
Ignition On:



1. Is battery voltage present at A1 display panel, J1 connector 611 Brn wire?

Yes: Go to next step.

No: Check 611 Brn wire at A1 display panel and 171 Brn wire at A2 EFI module. If power circuits all check out OK, replace A2 EFI module.



2. Is battery voltage present at T1 and T2 ignition coil Blk wires?

Yes: Check ignition coil(s) air gap(s). See “Ignition Coil Replacement and Adjustment” on page 230.

Yes: Check ignition coil(s) resistance. See “Ignition Coil Test” on page 229.

Yes: Replace A2 EFI module.

No: Check Blk wires, X12 connector, 170 Brn wire at X10 connector to splice. Ensure that continuity exists between 170 Brn wire and 611 Brn wire at A1 display panel.

No: Replace A2 EFI module.

PTO/RIP Circuit Operation - All Models

Without Optional Rear PTO Installed:

Function:

To provide power to energize the PTO clutch solenoid and visually alert the operator that the PTO is functioning.

Operating Conditions:

- Key switch in run position,
- PTO/RIP switch on,
- Operator on seat,

or,

- Park brake locked.

Theory of Operation:

With the S3 PTO/RIP switch in the on position, current flows from the switched 501 Yel wire through the switch to the 755 Blu wire to the A1 display panel. This will allow the operator engage the PTO.

In order for the PTO to be engaged with the machine transmission in the neutral or forward positions, the A1 display panel must receive voltage over the 772 Blu wire out of the closed S7 RIO switch.

The A1 display panel, J2 connector, receives PTO ‘on’ logic voltage, regardless of the S3 PTO/RIP switch position, at the 742 Blu/Wht wire by the switched power circuit. This will cause the display panel to output current over the 756 Blu wire to the S3 PTO/RIP switch. The power flows out of the switch over the 757 Blu wire to the Y2 PTO solenoid. The 115 and 100 Blk wires complete the path to ground, thereby energizing the clutch and activating the PTO.

The parallel 758 Blu, V1 diode, and 116 Blk circuit prevents current from feeding back into other circuits on the machine due to the low impedance of the PTO clutch.

With Optional Rear PTO Installed:

Function:

To provide power to energize the PTO clutch solenoid and visually alert the operator that the PTO(s) are functioning.

Operating Conditions:

- Key switch in run position,
- PTO/RIP switch on,
- Operator on seat,

or,

- Park brake locked.

Theory of Operation:

With the S3 PTO/RIP switch in the on position, current flows from the switched 501 Yel wire through the switch to the 755 Blu wire to the A1 display panel. This will allow the operator to then turn on the PTO switch to engage the desired PTO.

In order for the PTO to be engaged with the machine transmission in the neutral or forward positions, the A1 display panel must receive voltage over the 772 Blu wire out of the closed S7 RIO switch.

If the S5 front PTO switch is closed (on position), power will be sent to the A1 display panel via the 742 Blu/Wht wire. This will cause the display panel to output current over the 756 Blu wire to the S3 PTO/RIP switch. The power flows out of the switch over the 757 Blu wire to the Y2 PTO solenoid. The 115 and 100 Blk wires complete the path to ground, thereby energizing the clutch and activating the PTO.

The parallel 758 Blu, V1 diode, and 116 Blk circuit prevents current from feeding back into other circuits on the machine due to the low impedance of the PTO clutch.

Circuit Function - RIO (All Configurations):

To provide a safety interlock with the machine being repositioned in reverse while the PTO is engaged, by deactivating the PTO circuit. If an operator chooses to keep the PTO engaged while operating the machine in reverse, a deliberate action must be taken by actuating the PTO/RIP switch momentarily while pressing the reverse pedal.

Operating Conditions - RIO:

- Key switch in the run position,
- Operator on the seat,
- PTO/RIP switch in the RIP (momentary) position while placing the machine in reverse.

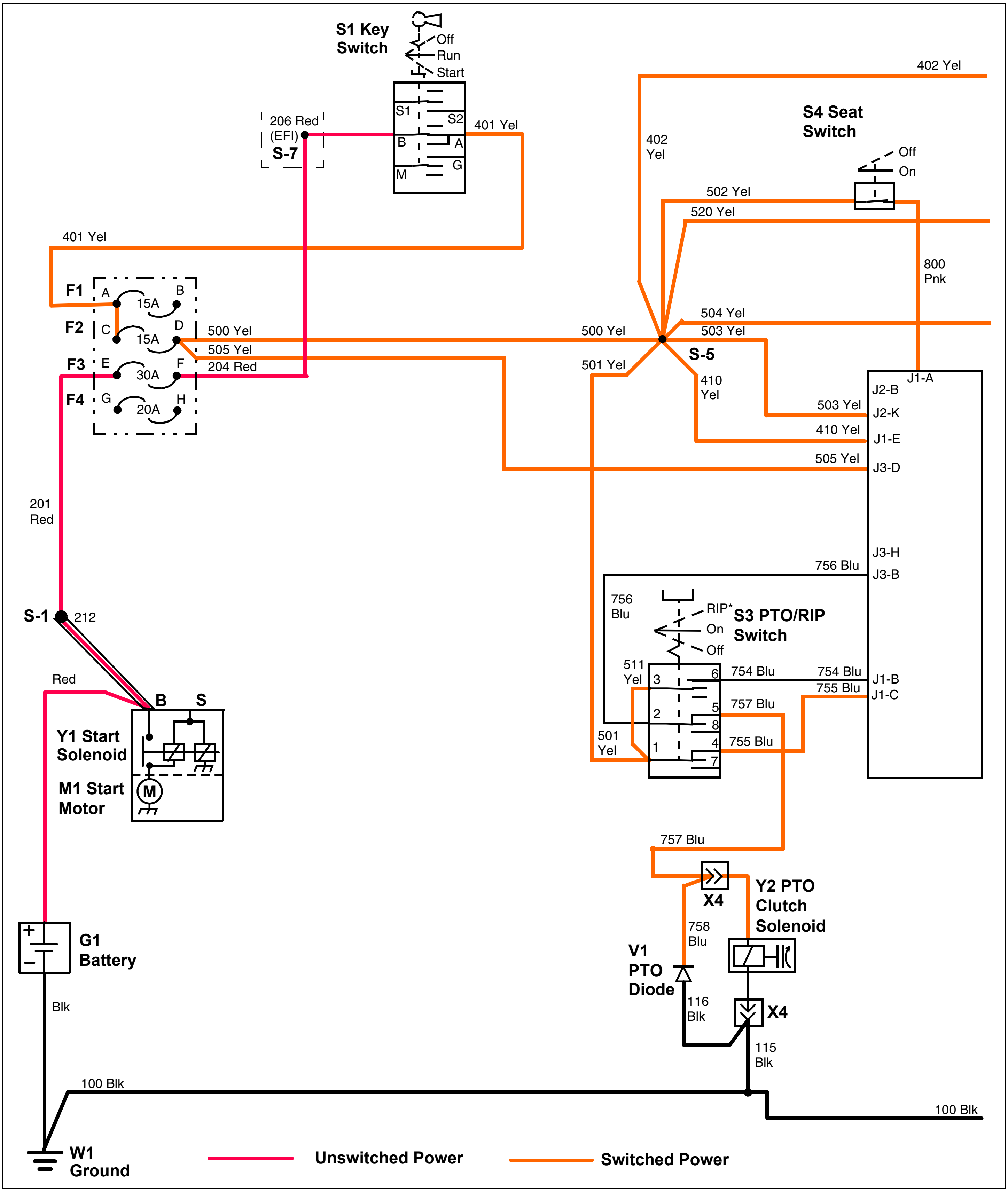
Theory of Operation - RIO:

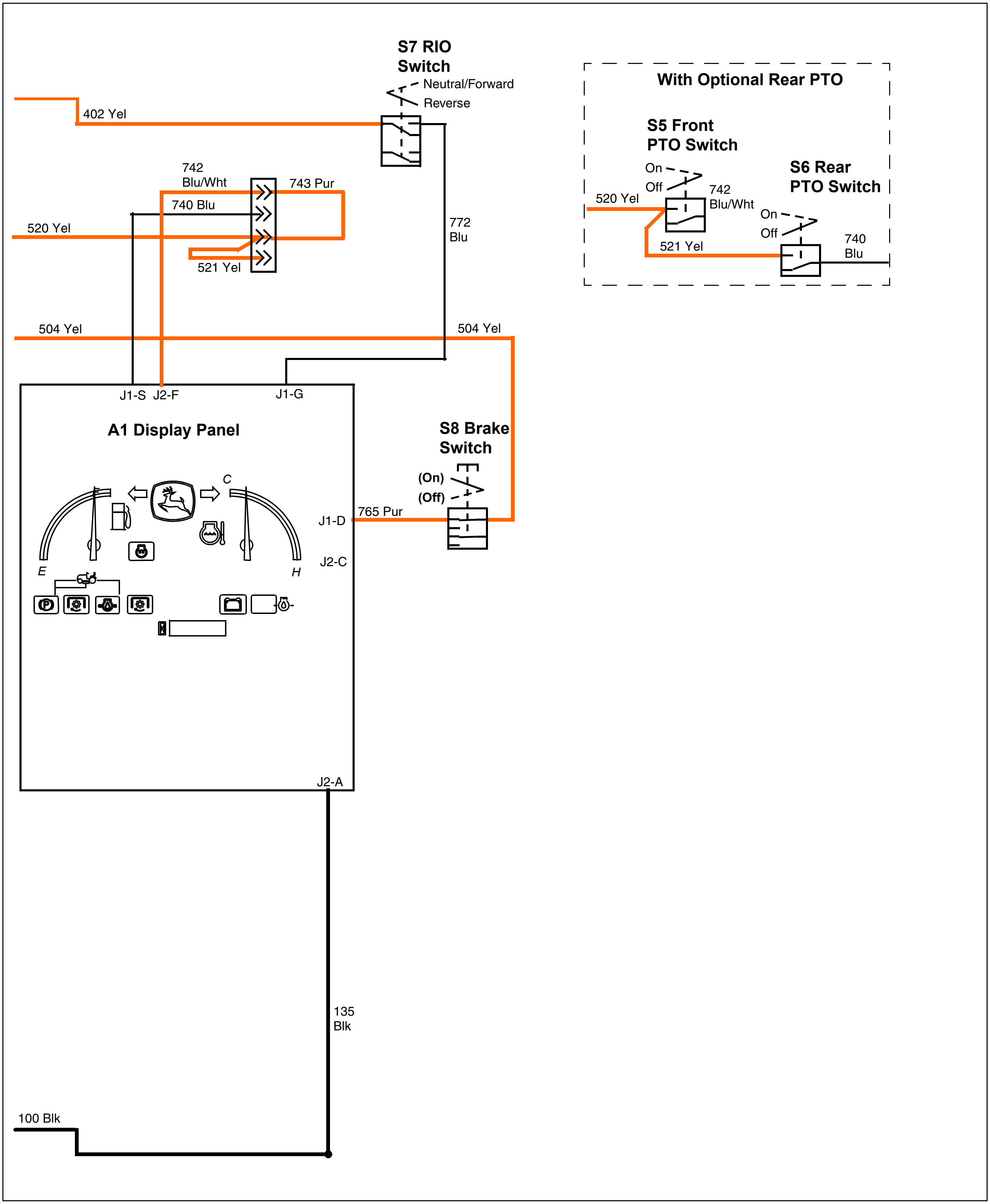
If the operator deems it necessary to operate the machine in reverse, the S3 PTO/RIP switch must be placed in the RIP position. This will maintain all of the circuits necessary for normal PTO operation as well as provide power to the A1 display panel over the 754 Blu wire. This signal indicates to the display panel that the operator intends to operate the PTO with the machine in reverse while the PTO is engaged.

When the reverse pedal is pressed, it opens the S7 RIO switch and removes power from the 772 Blu wire to the A1 display panel.

Once the machine is travelling in the reverse direction, the RIP switch my be released. When the operator resumes travel in the forward direction, the S7 RIO switch again closes it’s contacts, applying voltage to the display panel over the 772 Blu wire. This resets internal circuitry in the display panel and the procedure will have to be repeated if the machine is to be operated in reverse again.

PTO/RIP Circuit Electrical Schematic - All Models




S7 RIO Switch
Neutral/Forward
Reverse
402 Yel
742 Blu/Wht
743 Pur
740 Blu
520 Yel
521 Yel
772 Blu
504 Yel
504 Yel
With Optional Rear PTO
S5 Front PTO Switch
On
Off
520 Yel
742 Blu/Wht
S6 Rear PTO Switch
On
Off
740 Blu
521 Yel
J1-S
J2-F
J1-G
A1 Display Panel
C
E
H
J1-D
J2-C
765 Pur
S8 Brake Switch
(On)
(Off)
J2-A
135 Blk
100 Blk

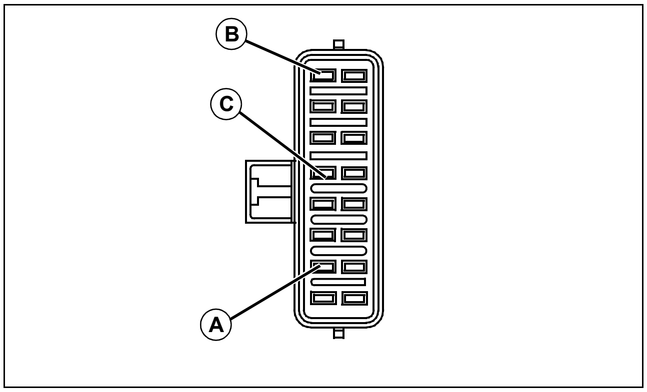
PTO/RIP Circuit Diagnosis - All Models

Test Procedure A (If Optional Rear PTO is Installed):

Test Conditions:

- Machine parked safely with park brake locked.
- Transmission in neutral.
- Key switch in run position, engine off.
- PTOs off.
- Operator on seat.
- Battery fully charged.
- Power circuits functioning properly. See “Power Circuit Operation - X700” on page 140 or See “Power Circuit Operation - X720/X724/X728” on page 149.
- Follow procedure in sequence.
- Ensure that A1 display panel, J2 connector 135 Blk wire has continuity to ground.
- Ensure all circuit grounds are in good condition and have continuity.

PTO(s) Off, Engine Off:



1. Is battery voltage present at A1 display panel, J1 connector 772 Blu wire (A)?

Yes: Go to next step.

No: Check 772 Blu wire and connections. If OK, test S7 RIO switch. See “RIO Switch Test” on page 221.

2. Is battery voltage present at A1 display panel, J1 connector 800 Pnk wire?

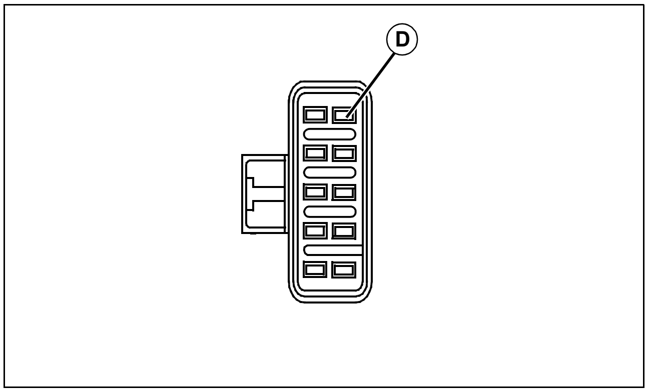
Yes: Go to next step.

No: Check 800 Pnk wire (B) and connections. If OK, test S4 seat switch. See “Seat Switch Test” on page 220.

3. Is battery voltage present at A1 display panel, J1 connector 765 Pur wire (C)?

Yes: Go to next step.

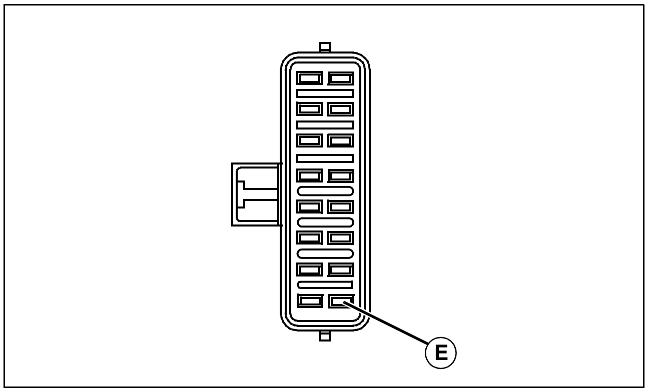
No: Check 765 Pur wire and connections. If OK, test S8 brake switch. See “Brake Switch Test and Adjustment” on page 220.



4. Is battery voltage present at A1 display panel, J2 connector 742 Blu/Wht wire (D)?

No: Go to next step.

Yes: Test S5 front PTO switch. See “PTO Switch Test (Optional Rear PTO Installed)” on page 223.



5. Is battery voltage present at A1 display panel, J1 connector 740 Blu wire (E)?

No: Go to next procedure.

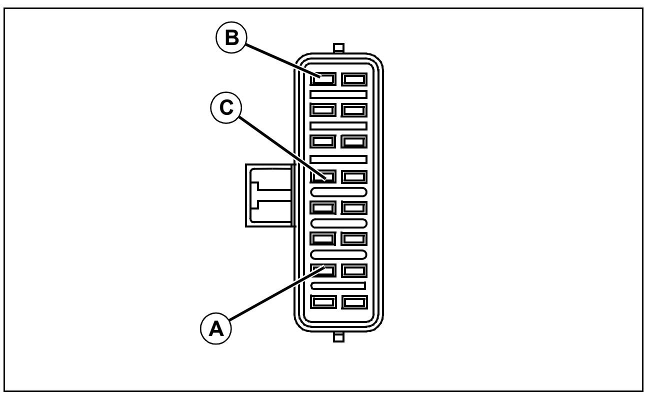
Yes: Test S6 rear PTO switch. See “PTO Switch Test (Optional Rear PTO Installed)” on page 223.

Test Procedure A (Without Rear PTO Installed):

Test Conditions:

- Machine parked safely with park brake locked.
- Transmission in neutral.
- Key switch in run position, engine off.
- PTO off.
- Operator on seat.
- Battery fully charged.
- Power circuits functioning properly. See “Power Circuit Operation - X700” on page 140 or See “Power Circuit Operation - X720/X724/X728” on page 149.
- Follow procedure in sequence.
- Ensure that A1 display panel, J2 connector 135 Blk wire has continuity to ground.
- Ensure all circuit grounds are in good condition and have continuity.

PTO Off, Engine Off:



1. Is battery voltage present at A1 display panel, J1 connector 772 Blu wire (A)?

Yes: Go to next step.

No: Check 772 Blu wire and connections. If OK, test S7 RIO switch. See “RIO Switch Test” on page 221.

2. Is battery voltage present at A1 display panel, J1 connector 800 Pnk wire?

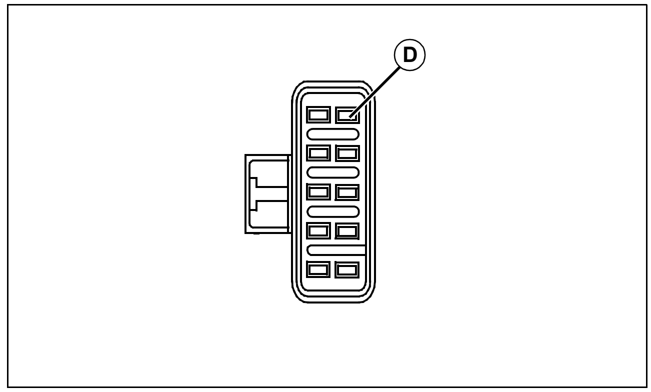
Yes: Go to next step.

No: Check 800 Pnk wire (B) and connections. If OK, test S4 seat switch. See “Seat Switch Test” on page 220.

3. Is battery voltage present at A1 display panel, J1 connector 765 Pur wire (C)?

Yes: Go to next step.

No: Check 765 Pur wire and connections. If OK, test S8 brake switch. See “Brake Switch Test and Adjustment” on page 220.



4. Is battery voltage present at A1 display panel, J2 connector 742 Blu/Wht wire (D)?

No: Go to next step.

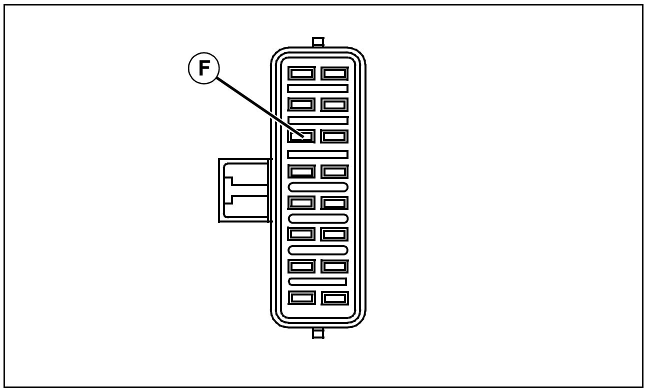
Yes: Test S5 front PTO switch. See “PTO Switch Test (Optional Rear PTO Installed)” on page 223.

Test Procedure B (Any Configuration):

Test Conditions:

- Machine parked safely with park brake locked.
- Transmission in neutral.
- Key switch in run position, engine off.
- S3 PTO switch in on position.
- S5 PTO switch in on position (If installed).
- Operator on seat.
- Battery fully charged.
- Power circuits functioning properly. See “Power Circuit Diagnosis - X700” on page 143 or See “Power Circuit Operation - X720/X724/X728” on page 149.
- Follow procedure in sequence.
- Ensure that A1 display panel, J2 connector 135 Blk wire has continuity to ground.
- Ensure all circuit grounds are in good condition and have continuity.

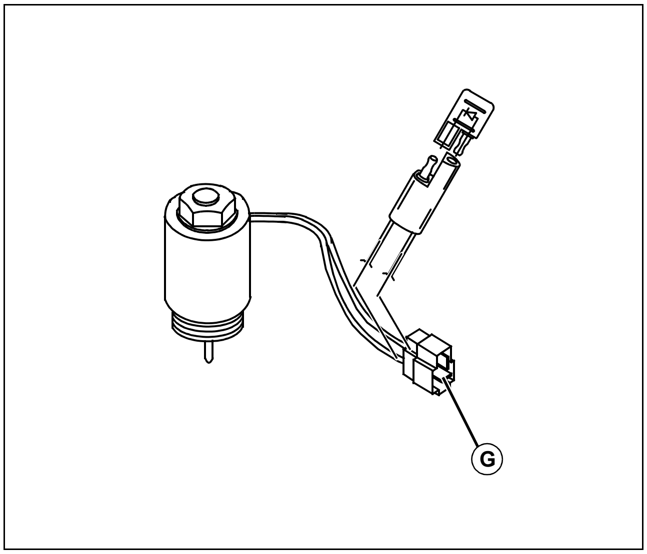
S3 PTO/RIP Switch in On Position, S5 PTO Switch in On Position (If Rear Optional Rear PTO is Installed), Engine Off:



1. Is battery voltage present at A1 display panel, J1 connector 755 Blu wire (F)?

Yes: Go to next step.

No: Check 755 Blu wire and connections. If OK, test S3 PTO/RIP switch. See “PTO/RIP Switch Test” on page 218.



2. Is battery voltage present at X4 connector, 757 Blu wire (G)?

Yes: Test V1 PTO diode. See “Diode Test” on page 224. If OK, go to next procedure.

No: Check 757 Blu wire and connections. If OK, test S3 PTO/RIP switch. See “PTO/RIP Switch Test” on page 218.

No: If all test conditions have been met, replace A1 display panel.

3. Does Y2 PTO clutch engage?

Yes: Go to next procedure.

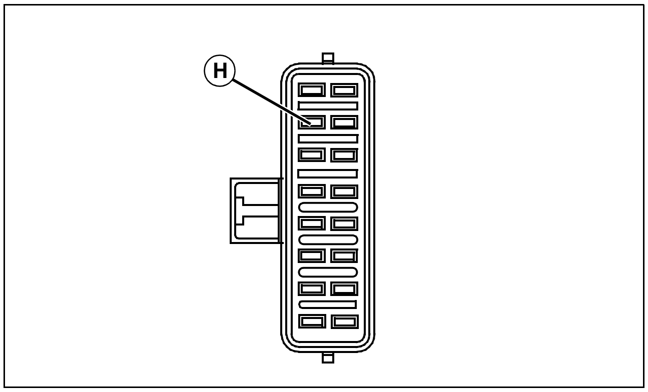
No: Test Y2 PTO solenoid and wiring. See “PTO Solenoid Test (Standard Front PTO)” on page 222.

Test Procedure C (Any Configuration):

Test Conditions:

- Machine parked safely with park brake locked.
- Transmission in neutral.
- Key switch in run position, engine off.
- S3 PTO switch in RIP position.
- Front and rear PTO(s) engaged (If installed).
- Transmission in reverse (S7 RIO switch open).
- Operator on seat.
- Battery fully charged.
- Power circuits functioning properly. See “Power Circuit Operation - X700” on page 140 or See “Power Circuit Operation - X720/X724/X728” on page 149.
- Follow procedure in sequence.
- Ensure that A1 display panel, J2 connector 135 Blk wire has continuity to ground.
- Ensure all circuit grounds are in good condition and have continuity.

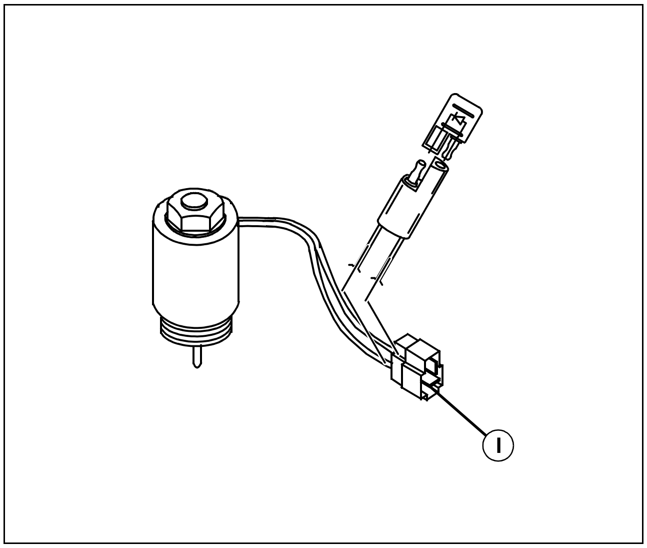
S3 PTO/RIP Switch in RIP Position, S5 PTO Switch in On Position (If Optional Rear PTO is Installed), Engine Off:



1. Is battery voltage present at A1 display panel, J1 connector 754 Blu wire (H)?

No: Go to next step.

Yes: Test S7 RIO switch. See “RIO Switch Test” on page 221.



2. Is battery voltage present at X4 connector, 757 Blu wire (I)?

Yes: Test V1 PTO diode. See “Diode Test” on page 224. If OK, go to next procedure.

No: Check 757 Blu wire and connections. If OK, test S3 PTO/RIP switch. See “PTO/RIP Switch Test” on page 218.

No: If all test conditions have been met, replace A1 display panel.

3. Does Y2 PTO clutch engage?

Yes: Go to next procedure.

No: Test Y2 PTO solenoid and wiring. See “PTO Solenoid Test (Standard Front PTO)” on page 222.

Display Panel Circuit Operation - All Models

Function - Instrument Panel:

To inform the operator of various machine operating conditions. There are no serviceable components on the display panel. It must be replaced as an assembly.

Operating Condition - Instrument Panel:

The key switch must be in run or start position.

Theory of Operation - Instrument Panel:

The instrument panel receives current from the power circuit. Power is supplied to the instrument panel from the battery positive (+) terminal to the 212 fusible link, 201 Red wire, F3 fuse, 204 Red wire, and to the S1 key switch. Power then leaves the switch on the 401 Yel wire to the F2 fuse, and leaves the fuse on the 500 Yel wire to a common splice. From the splice, the 503 and 410 Yel wires provide switched power to the A1 display panel. From the F2 fuse, power is also sent to the display panel over the 505 Yel wire. The circuit traces on the instrument panel then supply current to the individual lights and gauges.

The A1 display panel also contains logic circuits that control certain functions such as PTO, safety, and reverse lighting operations. In addition, the display panel outputs on-board diagnostic codes to aid in troubleshooting the machine. See “Display Code Chart:” on page 109.

The ground path for the instrument panel is completed by the 135 and 100 Blk wires to frame ground.

Function - Engine Oil Pressure Light:

To alert operator of low engine oil pressure.

Theory of Operation - Engine Oil Pressure Light:

The engine oil pressure light circuit uses a pressure activated switch to provide a path to ground for the engine oil pressure light. The switch is closed when engine oil pressure is at or below 98 kPa (14.2 psi).

If the engine is not running or engine oil pressure is at or below 98 kPa (14.2 psi), the B1 engine oil pressure switch will be closed. The engine oil pressure switch completes the path to ground and the engine oil pressure light comes on.

When the engine starts and engine oil pressure increases above 98 kPa (14.2 psi), the engine oil pressure switch opens, breaking the path to ground and the light goes out.

Function - Engine Coolant Temperature Gauge:

Inform the operator of engine and coolant operating temperature.

Theory of Operation - Engine Coolant Temperature Gauge:

The B2 engine coolant temperature sensor is a variable resistor, providing a ground circuit path for the temperature gauge. As the engine coolant heats, the resistance decreases. As the resistance decreases, more current is allowed to flow across the B2 engine coolant temperature gauge causing the needle raise and indicate a higher temperature. The temperature gauge is part of the instrument panel.

The engine coolant temperature sensor resistance is approximately 40 - 700 ohms.

Function - Fuel Gauge:

Inform the operator of the fuel level in the fuel tank.

Theory of Operation - Fuel Gauge:

The fuel level in the fuel tank is measured by the B2 fuel gauge sensor. The sensor is a variable resistor. The resistance is set by movement of a mechanical linkage connected to a float in the fuel tank. The 5 to 95 ohm variable resistance creates a variable voltage difference across the fuel gauge. The voltage difference ranges from approximately 5.72 VDC (fuel tank full) to approximately 0.87 VDC (fuel tank empty). The fuel gauge is part of the instrument panel.

Function - Hour Meter:

To record the number of hours the key switch is in the run position. The hour meter also displays on-board diagnostic codes for the X720/X724/X728 EFI models. See “Fuel Injection Sensor and Diagnostic Circuit Operation - X720/X724/X728” on page 203 for more information.

Theory of Operation - Hour Meter:

The P1 hour meter counts the total number of hours the key switch is in the run position.

The P1 hour meter receives power from the switched power circuit.

Function - Brake Light:

Inform the operator that the brake pedal is depressed or the park brake is engaged.

Theory of Operation - Brake Light:

The brake light will illuminate whenever the brake pedal is depressed or the park brake is engaged with the key switch in the on position. It is activated by the S8 brake switch and receives its power from the 504 Yel wire, and when closed (brake applied), and sends power over the 765 Pur wire to the brake light on the instrument panel. A path to ground is provided by the 135 Blk wire on the instrument panel and to frame ground.

Function - Discharge Light:

To inform the operator if the battery is not charging.

Theory of Operation - Discharge Light:

The battery discharge light will illuminate when the battery is not receiving a sufficient charge from the charging circuit. See "Charging Circuit Operation - All Models (Standard Configuration)" on page 164 for more information.

Function - PTO Light(s):

To inform the operator that the PTO(s) are engaged.

Theory of Operation:

The PTO light(s) will illuminate when a PTO is engaged. See "PTO/RIP Circuit Operation - All Models" on page 177 for more information.

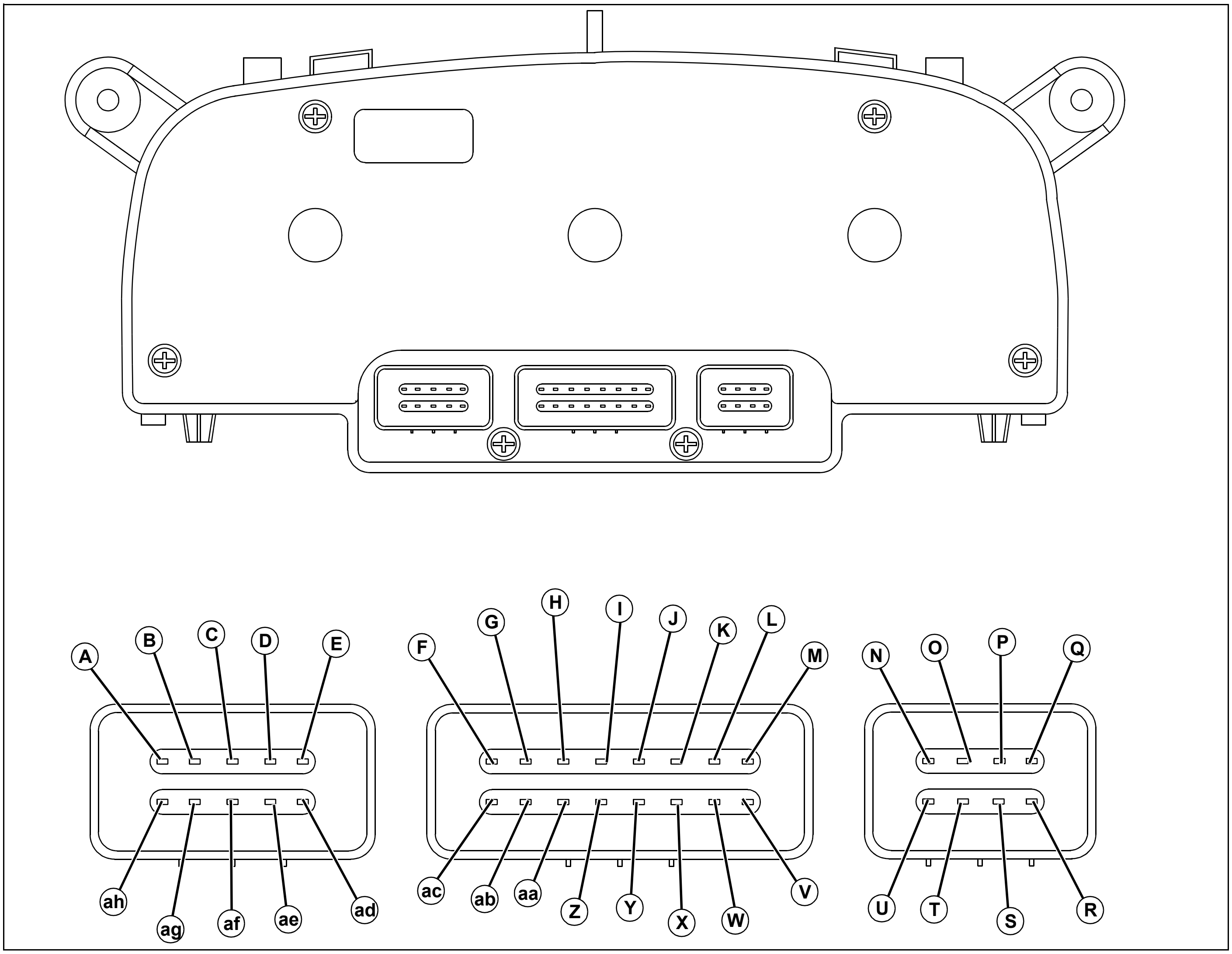
Function - Fuel Injection System Error Light (EFI Models Only):

To inform the operator that an error has occurred with the fuel injection system.

Theory of Operation - Fuel Injection System Error Light (EFI Models Only):

The light will flash a code or series of codes to inform the operator that there is a problem with the fuel injection system. See "Fuel Injection Sensor and Diagnostic Circuit Operation - X720/X724/X728" on page 203.

A1 Display Panel Pin and Signal Location



A- J2-K 503 Yel, Switched Power In
B- J2-J 310 Org, Coolant Temperature In
C- J2-H, Not Used
D- J2-G, Not Used
E- J2-F 742 Blu/Wht, Front PTO In
F- J1-S 740 Blu, Rear PTO In
G- J1-R, 785 Grn (EFI Only), Fault Light In
H- J1-P, Not Used
I- J1-N, Not Used
J- J1-M 620 Tan, Oil Pressure In
K- J1-L 611 Brn (EFI) or 942 Wht (Carb), Tach In
L- J1-K 451 Yel/Wht, Illumination In
M- J1-J, Not Used
N- J3-H 720 Pur, Start Out
O- J3-G, Not Used
P- J3-F 650 Pnk/Blk, Ignition Out (EFI) or Fuel Circuit Out (Carb)
Q- J3-E 815 Pnk, Backup Lights Out
R- J3-A 941 Wht, Ignition Out (Carb Only)
S- J3-B 756 Blu, PTO Out
T- J3-C, Not Used
U- J3-D 505 Yel, Switched Power In
V- J1-A 800 Pnk, Seat Switch In
W- J1-B 754 Blu, RIO Overide In
X- J1-C 755 Blu, PTO In
Y- J1-D 765 Pur, Brake Switch In
Z- J1-E 410 Yel, Switched Power In
AA- J1-F, Not Used
AB- J1-G 772 Blu, Reverse In
AC- J1-H 900 Blk/Wht, Fuel Sender In
AD- J2-A 135 Blk, Ground
AE- J2-B 591 Pur, Start In
AF- J2-C 810 Pnk, Back Up Lights In
AG- J2-D, Not Used
AH- J2-E, Not Used

Lights Circuit Operation - All Models

Function:

Provides current to the headlights, tail lights, backup lights, and instrument panel lights, in combinations depending upon the position the light switch or transmission (RIO switch).

Operating Conditions:

- Machine parked safely with park brake locked - key switch in run position, engine off.
- Light switch in ‘on’ or ‘on with backup lights’ position, or,
- Transmission in reverse.

Theory of Operation:

Power is provided to the S9 light switch through the unswitched and switched power circuits and is protected by the 212 fusible link and the F3 and F1 fuses. The 400 Yel/Blu wire connects to the S9 light switch. The key switch must be in the run position in order for the lights to function. See “Power Circuit Operation - X700” on page 140 or “Power Circuit Operation - X720/X724/X728” on page 149.

With the S9 light switch in the on position, current is provided to the 450 Yel/Wht wire which splices into the 451, 455, and 459 Yel/Wht wires.

The 451 Yel/Wht wire supplies current to the A1 display panel to illuminate the display panel lights. The 135 and 100 Blk wires provide the ground from the display panel.

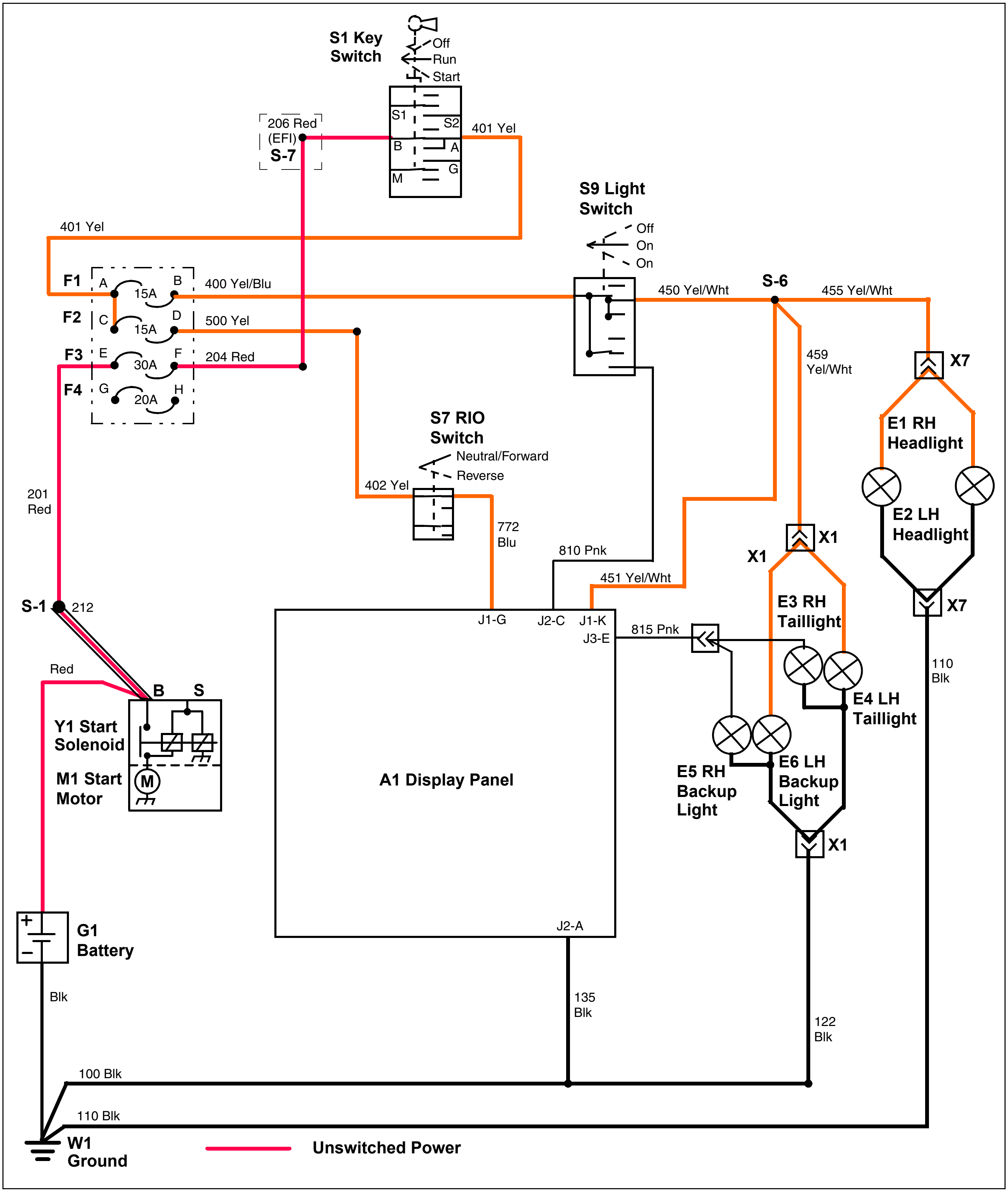
The 455 Yel/Wht wire supplies current to the X7 connector to illuminate the E1 and E2 headlights. The ground is provided through the X7 connector to the 110 Blk wire and frame ground.

The 459 Yel/Wht wire supplies current to the X1 connector to illuminate the E3 and E4 tail lights. The ground is provided through the X1 connector to the 122 and 100 Blk wires to frame ground.

With the light switch in the ‘on with backup lights’ position, in addition to the display panel light, E1 and E2 headlights, and the E3 and E4 tail lights, current is provided to the to the E5 and E6 backup lights. The A1 display panel provides current via the 815 Pnk wire to the X1 connector and the backup lights. Ground is provided through the X1 connector and the 122 and 100 Blk wires to frame ground.

The backup lights can also be activated by the S7 RIO switch. When the machine is placed in reverse and the RIO switch is opened, power over the 772 Blu wire to the A1 display panel is removed. This signals the display panel that the machine is travelling in reverse and the display panel will output voltage over the 815 Pnk wire to the E5 and E6 backup lights. Ground is provided by the 122 and 100 Blk wires to frame ground.

Lights Circuit Electrical Schematic - All Models



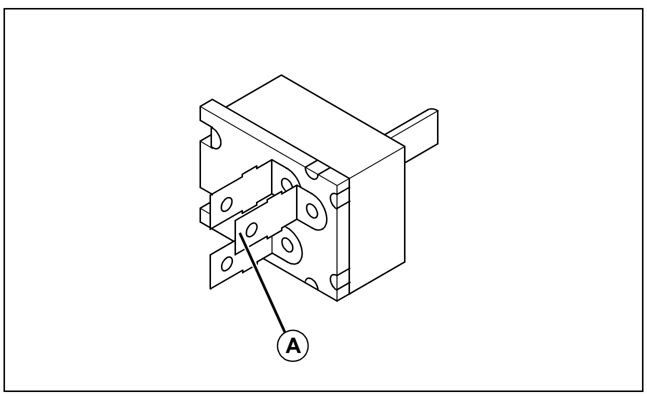
Lights Circuit Diagnosis - All Models

Test Procedure A:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in off position.
- S9 light switch in on position.
- Battery fully charged.
- Power circuits functioning properly.
- Follow procedure in sequence.
- Ensure that A1 display panel, J2 connector 135 Blk wire has continuity to ground.
- Ensure all circuit grounds are in good condition and have continuity.

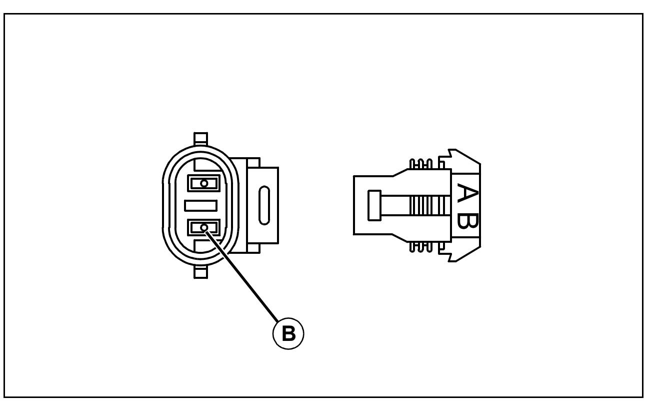
Light Switch in On Position:



1. Is battery voltage present at S9 light switch, 450 Yel/Wht wire (A)?

Yes: Go to next step.

No: Test S9 light switch. See “Key Switch Test” on page 219.



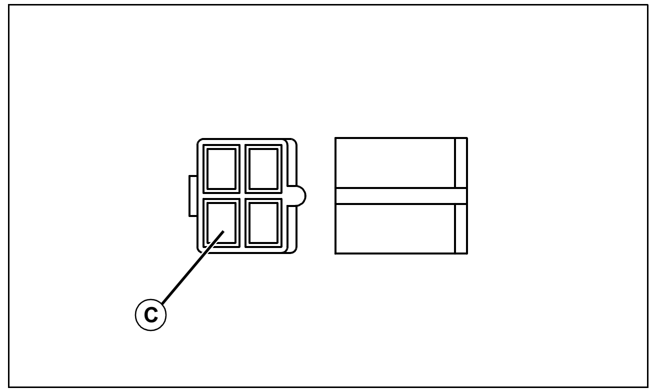
2. Is battery voltage present at X7 connector, 455 Yel/Wht wire (B)?

No: Check 455 Yel/Wht wire and connections.

Yes: Check headlight grounds. If OK, replace bulb(s).

Yes: If bulb(s) do not illuminate, repair or replace W3 headlight wiring harness.

Yes: Go to next step.

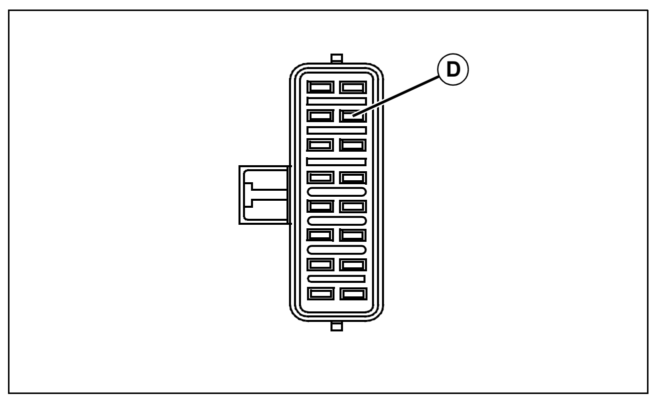


3. Is battery voltage present at X1 connector, 459 Yel/Wht wire (C)?

No: Check 459 Yel/Wht wire and connections.

Yes: Check tail light grounds. If Ok, replace bulb(s).

Yes: If bulb(s) do not illuminate, repair or replace W4 rear wiring harness.



4. Is battery voltage present at A1 display panel, J1 connector 451 Yel/Wht wire (D)?

Yes: If voltage is present and A1 display panel does not illuminate, replace display panel.

Yes: Go to next procedure.

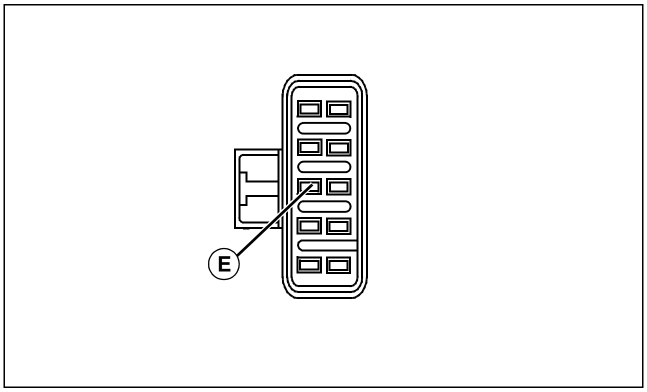
No: Check 451 Yel/Wht wire and connections.

Test Procedure B:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in off position.
- S9 light switch in on with back up lights position.
- Battery fully charged.
- Power circuits functioning properly.
- Follow procedure in sequence.
- Ensure that A1 display panel, J2 connector 135 Blk wire has continuity to ground.
- Ensure all circuit grounds are in good condition and have continuity.

Light Switch in On with Back Up Lights Position:

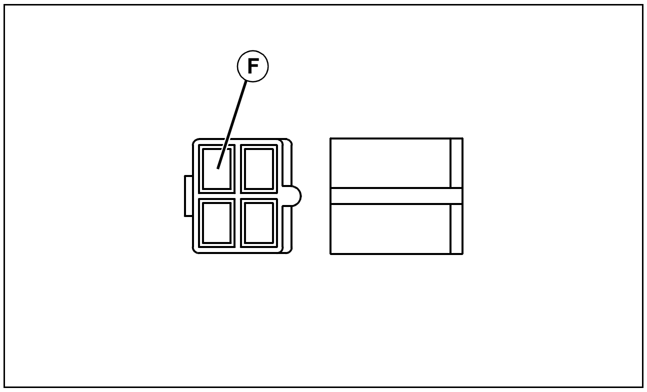


1. Is battery voltage present at A1 display panel, J2 connector 810 Pnk wire (E)?

No: Check 810 Pnk wire and connections.

No: Test S9 light switch. “Lights Switch Test” on page 217.

Yes: Go to next step.



2. Is battery voltage present at X1 connector, 815 Pnk wire (F)?

Yes: Check tail light grounds. If OK, replace bulb(s).

Yes: If bulb(s) do not illuminate, repair or replace W4 tail light wiring harness.

Yes: Go to next procedure.

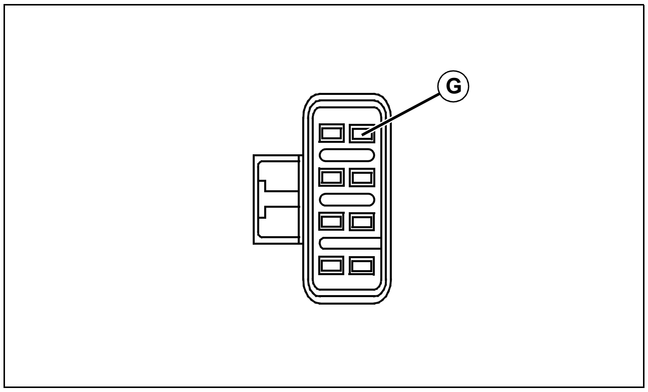
No: Check 815 Pnk wire and connections. If OK, replace A1 display panel.

Test Procedure C:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in off position.
- S9 light switch in on with back up lights position.
- Battery fully charged.
- Power circuits functioning properly.
- Follow procedure in sequence.
- Ensure that A1 display panel, J2 connector 135 Blk wire has continuity to ground.
- Ensure all circuit grounds are in good condition and have continuity.

Light Switch Off, Machine in Reverse:



1. Is battery voltage present at A1 display panel, J3 connector 815 Pnk wire (G)?

Yes: End of tests.

No: Test S7 RIO switch. See “RIO Switch Test” on page 221.

No: Check 772 Blu wire and connections from S7 RIO switch to A1 display panel J1 connector for battery voltage.

No: Replace A1 display panel.

Power Port Circuit Operation - All Models

Function:

Provides a receptacle to power small auxiliary electrical devices.

Operating Conditions:

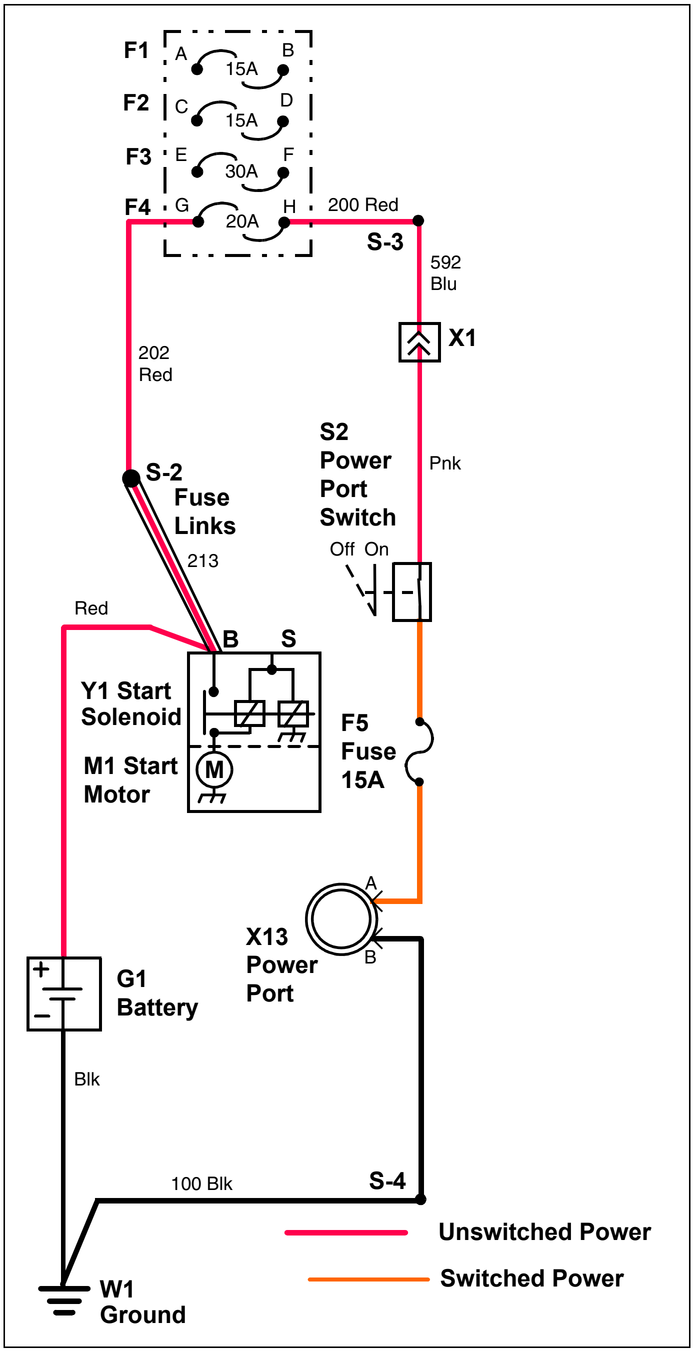
- Key switch in on or off position
- Power port switch in on position

Theory of Operation:

The X13 power port will power small 12 VDC electrical devices up to 15A and is controlled by the S2 power port switch.

Current to the S2 power port switch is provided by the 213 fusible link, 202 Red wire, F4 fuse, 200 Red and 592 Blu wires, and X1 connector to the switch. With the switch in the closed position (power on), current then flows through the F6 fuse and to the power port. Ground is provided by the 100 Blk wire to frame ground. This circuit is only completed if there is a device plugged into the power port receptacle.

Power Port Circuit Electrical Schematic - All Models



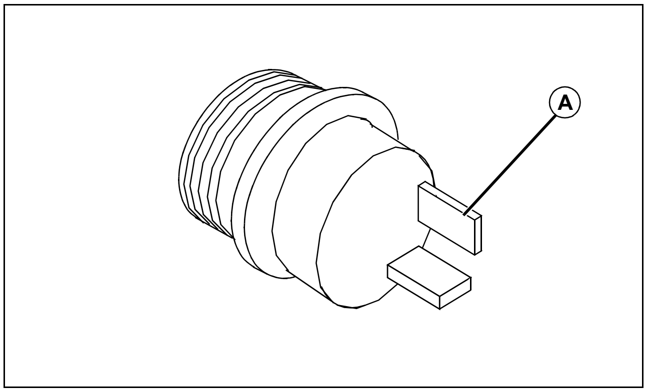
Power Port Circuit Diagnosis - All Models

Test Procedure:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in off position.
- S2 power port switch in on position.
- Battery fully charged.
- Power circuits functioning properly.
- Follow procedure in sequence.
- Ensure all circuit grounds are in good condition and have continuity.

Power Port Circuit:



1. Is battery voltage present at Red wire (A) of X13 power port?

Yes: If ground circuit is OK, replace power port.

No: Test F6 15A inline fuse. See "Fuse Test" on page 222.

No: Test S2 power port switch. See "Power Port Switch Test" on page 219.

No: Check wires and connections.

Fuel Pump and Fuel Shutoff Circuit Operation - X700

Function:

To provide power to the fuel shutoff solenoid and the fuel pump to supply fuel to the engine.

Operating Conditions:

- Key switch in run or start position,
- Operator on seat,

or,

- Key switch in run or start position,
- Operator off seat,
- Park braked locked.

Theory of Operation:

The fuel shutoff solenoid and fuel pump circuit is controlled by the A1 display panel in one of two ways:

Current from the switched power circuit is supplied to the S4 seat switch from the 500 and 502 Yel wires. When the operator is on the seat, current flows across the seat switch to the 800 Pnk wire and into the A1 display panel. The display panel will then output voltage over the 650 Pnk/Blk wire to the X3 connector. This will engage the Y3 fuel shutoff solenoid, allowing the free flow of fuel. The solenoid is grounded through the engine.

At the same time, the 655 Pnk wire, spliced at the X3 connector, carries power to the X5 connector, 651 Pnk/Blk wire, and finally the X6 connector at the M2 fuel pump. the pump is grounded through the X6 connector, and the 121 and 100 Blk wires to frame ground.

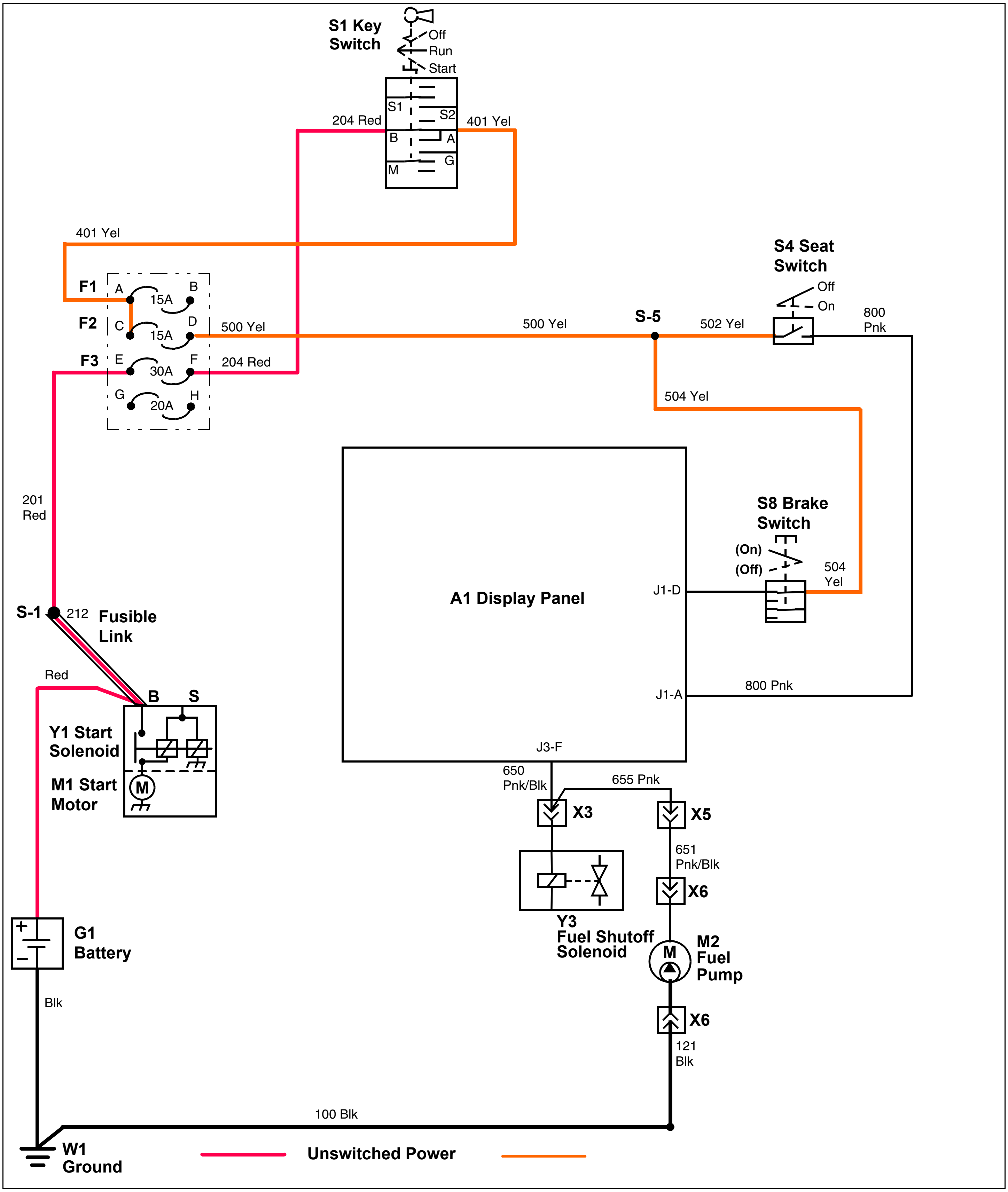
With both the fuel pump and fuel shutoff solenoid energized, fuel is now able to flow to the carburetor and into the combustion chamber.

Current can also be supplied to the A1 display panel through the S8 brake switch.

Current from the switched power circuit is supplied to the S8 brake switch from the 500 and 504 Yel wires. When the brake is on, current flows across the brake switch to the 765 Pur wire. The 765 Pur wire supplies current to the A1 display panel. The display panel will then output voltage over the 650 Pnk/Blk wire to the X3 connector. This will engage the Y3 fuel shutoff solenoid, allowing the free flow of fuel. The solenoid is grounded through the engine.

At the same time, the 655 Pnk wire, spliced at the X3 connector, carries power to the X5 connector, 651 Pnk/Blk wire, and finally the X6 connector at the M2 fuel pump. the pump is grounded through the X6 connector, and the 121 and 100 Blk wires to frame ground.

Fuel Pump and Fuel Shutoff Circuit Electrical Schematic - X700



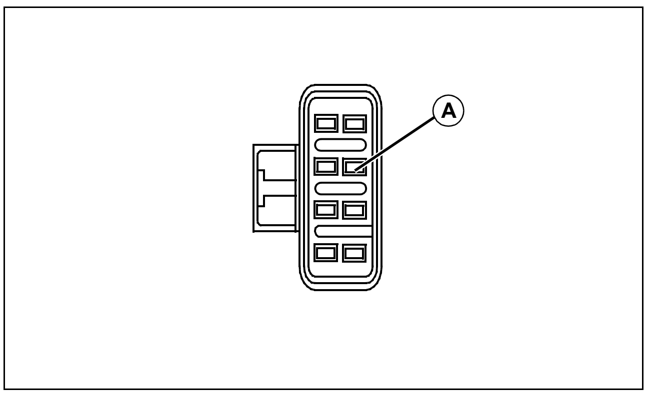
Fuel Pump and Fuel Shutoff Circuit Diagnosis - X700

Test Procedure:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in on position, engine off.
- Operator on seat.
- PTO off.
- Battery fully charged.
- Power circuits functioning properly.
- Follow procedure in sequence.
- Ensure all circuit grounds are in good condition and have continuity.

Fuel Circuit:



1. Is battery voltage present at A1 display panel, J3 connector 650 Pnk/Blk wire (A)?

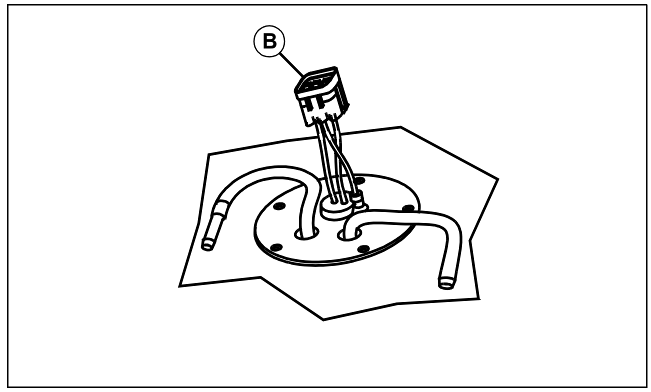
Yes: Go to next step.

No: If all operating conditions have been met, replace A1 display panel.

2. Does the Y3 fuel shutoff solenoid make an audible ‘click’ when the key switch is turned to the run position?

Yes: If necessary, test Y3 fuel shutoff solenoid. See “Fuel Shutoff Solenoid Test - X700” on page 224.

No: Check 650 Pnk/Blk wire, X3 connector, and Y3 fuel shutoff solenoid wires. If OK, test or replace fuel shutoff solenoid.



3. Is battery voltage present at 651 Pnk/Blk wire (B) of M2 fuel pump?

Yes: Test M2 fuel pump. See fuel pump tests in Engine section.

No: Check 655 Pnk wire, X5 connector, 651 Pnk/Blk wire, X6 connector and connections.

Fuel Pump and Fuel Injector Circuit Operation - X720/X724/X728

Function:

To provide power to the fuel pump and fuel injectors to supply fuel to the engine. These circuits provide the inputs to the EFI module which in turn provides the proper output to the injectors.

Operating Conditions:

- Key switch in run or start position.
- Operator on seat.

Or,

- Key switch in run or start position.
- Operator off seat.
- Park braked locked.

Theory of Operation:

The fuel pump and fuel injector circuit is controlled by the A2 electric fuel injection (EFI) module which is powered through the A1 display panel.

Current from the switched power circuit is supplied to the S4 seat switch from the 500 and 502 Yel wires. When the operator is on the seat (switch closed), current flows across the seat switch to the 800 Pnk wire and into the A1 display panel. The A1 display panel then outputs voltage to the 650 Pnk/Blk wire. The 650 Pnk/Blk wire supplies current to the K3 safety relay. The K3 safety relay closes and provides a path to ground for the A2 EFI module through the 860 Pnk, Org, and 670 Pur wires, K3 EFI module safety relay, 139 and 100 Blk wires to frame ground.

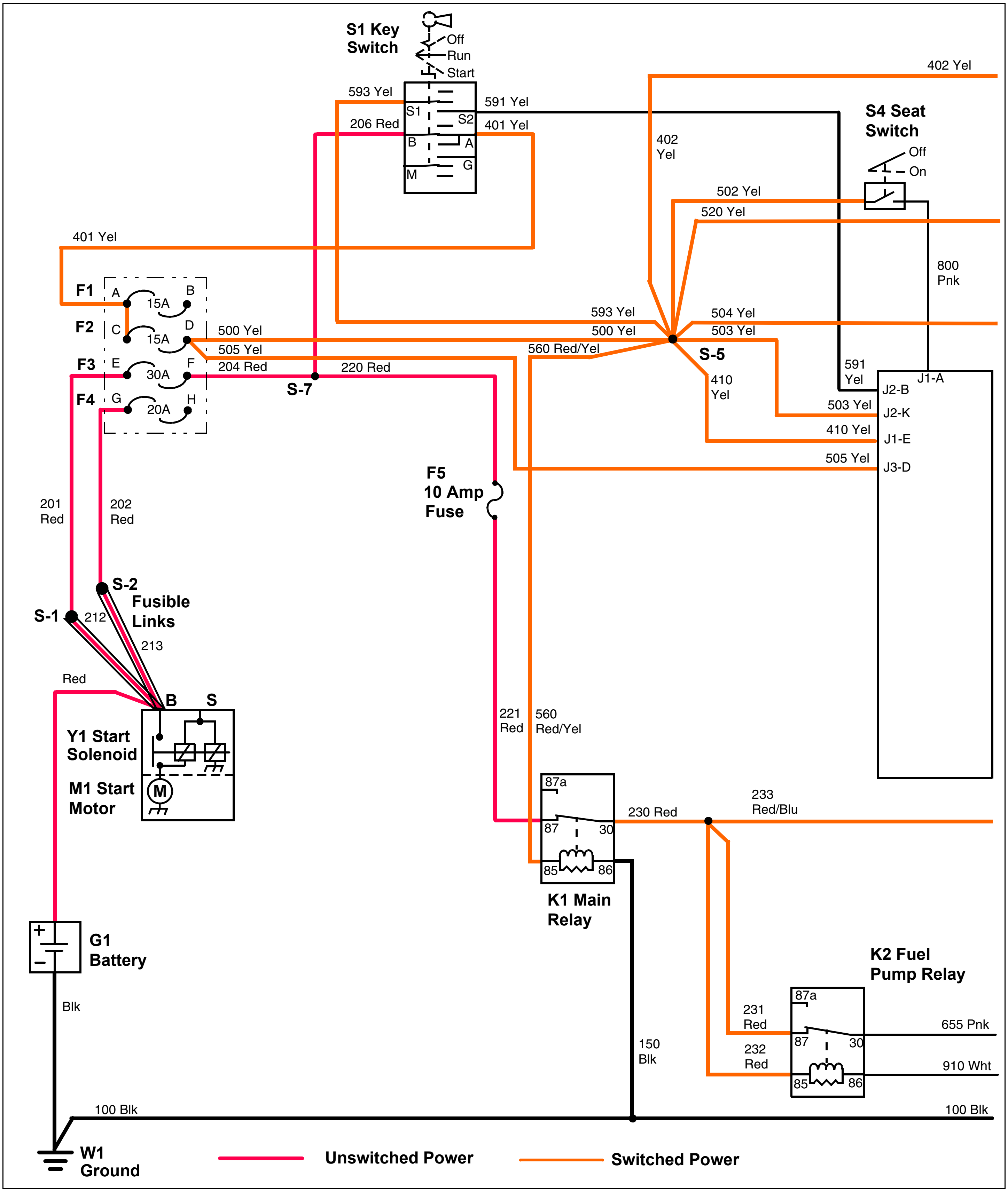
At the same time power is being supplied to the A2 EFI module through the K1 main relay. With the key in the run position, switched power is provided to the K1 main relay from the 500 Yel and 560 Red/Yel wires. This energizes the K1 main relay to supply unswitched power from the 212 fusible link, 201 Red wire, F3 fuse, 204 and 220 Red wires, F5 fuse, and 221 Red wire to the 230 Red and 233 Red/Blu wires to the X9 connector to the Wht wire in the W2 engine wiring harness. The Wht wire provides power to the Y3 and Y4 fuel injector solenoids and the 240 Red wire to the A2 EFI module. With power to the A2 EFI module, internal circuitry provides a ground circuit for the K2 fuel pump relay. The power input for the for the K2 fuel pump relay is provided from the K1 main relay and 230 and 231 and 232 Red wires. With the K2 fuel pump relay energized, current flows from the 231 Red wire to the 655 Pnk, X6 connector, and 651 Pnk/Blk wires to the M2 fuel pump.

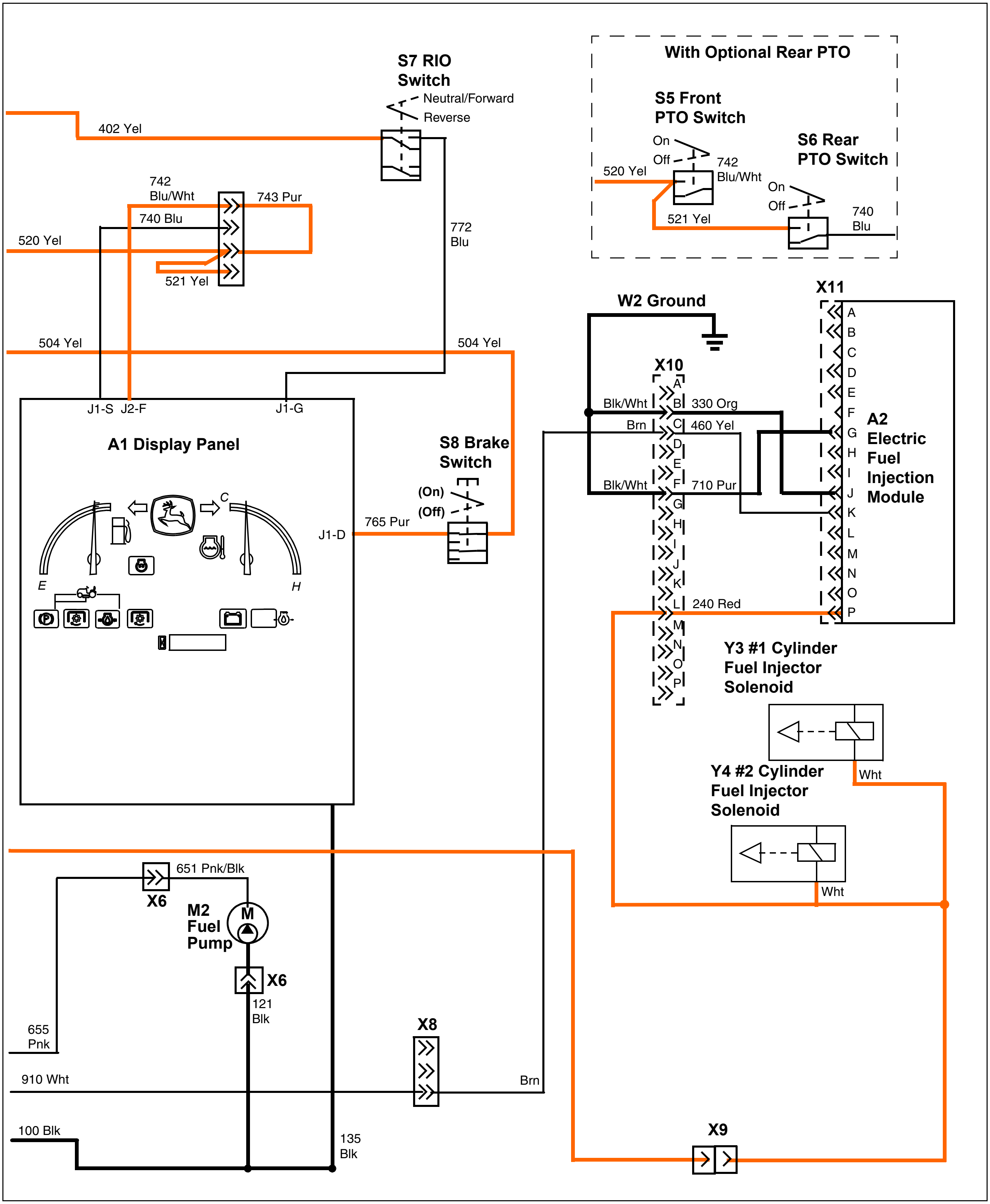
With the fuel pump, fuel injectors, and the EFI module energized, fuel is now able to be delivered into the combustion chamber.

The fuel pump and injectors can also be controlled by the S8 brake switch.

Current from the switched power circuit is supplied to the S8 brake switch from the 500 and 504 Yel wires. When the brake is engaged (switch closed), current flows across the S8 brake switch to the 765 Pur wire and into the A1 display panel. The A1 display panel then outputs voltage to the 650 Pnk/Blk wire. The 650 Pnk/Blk wire supplies current to the K3 safety relay. The K3 safety relay closes and provides a path to ground for the A2 EFI module through the 860 Pnk, Org, and 670 Pur wires, K3 EFI module safety relay, 139 and 100 Blk wires to frame ground.

Fuel Pump and Fuel Injector Circuit Electrical Schematic - X720/X724/X728




S7 RIO Switch
Neutral/Forward
Reverse
402 Yel
742 Blu/Wht
743 Pur
740 Blu
520 Yel
521 Yel
772 Blu
504 Yel
504 Yel
J1-S J2-F
J1-G
A1 Display Panel
J1-D
765 Pur
S8 Brake Switch
(On)
(Off)
With Optional Rear PTO
S5 Front PTO Switch
On
Off
520 Yel
742 Blu/Wht
521 Yel
S6 Rear PTO Switch
On
Off
740 Blu
W2 Ground
X11
X10
Blk/Wht
330 Org
Brn
460 Yel
Blk/Wht
710 Pur
240 Red
A2 Electric Fuel Injection Module
Y3 #1 Cylinder Fuel Injector Solenoid
Wht
Y4 #2 Cylinder Fuel Injector Solenoid
Wht
651 Pnk/Blk
X6
M2 Fuel Pump
M
X6
121 Blk
655 Pnk
910 Wht
X8
Brn
100 Blk
135 Blk
X9

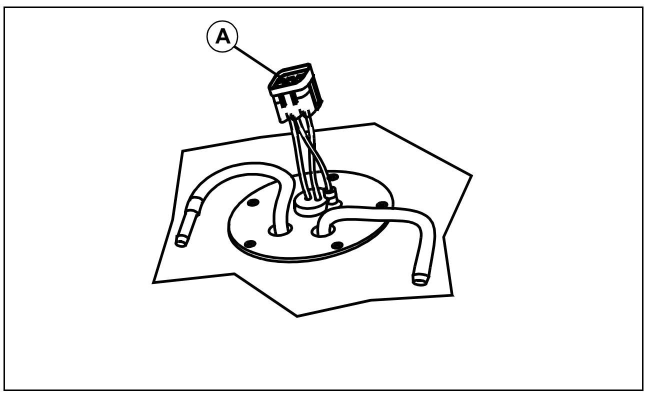
Fuel Pump and Fuel Injector Circuit Diagnosis - X720/X724/X728

Test Procedure A:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in run position, engine off.
- Operator on seat.
- PTO off.
- Battery fully charged.
- Power circuits functioning properly.
- No fault codes from on-board self diagnostics.
- Follow procedure in sequence.
- Ensure all circuit grounds are in good condition and have continuity.

Fuel Pump Circuit:

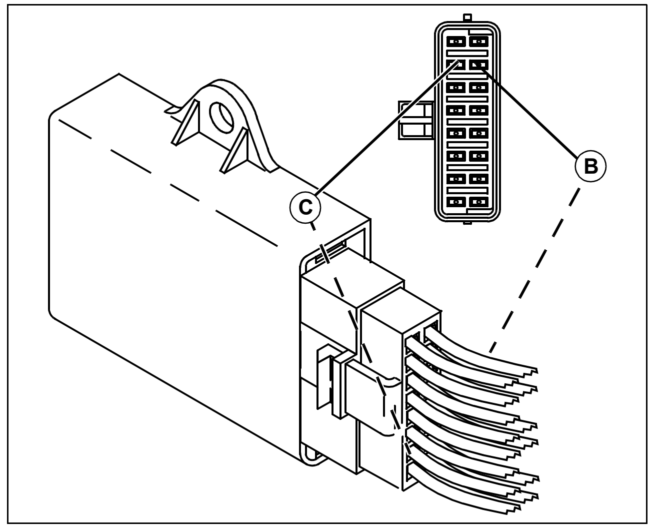


1. Is battery voltage present at 651 Pnk/Blk wire (A) of M2 fuel pump?

Yes: If ground circuit is OK, test or replace M2 fuel pump. See fuel pump tests in Engine section.

No: Check fuel pump wiring, 651 Pnk/Blk wire, and 655 Pnk wire and connections.

Fuel Injector Control Circuit:



1. Is there continuity between A2 EFI module X11 connector, 710 Pur wire (B) and 330 Org wire (C) and ground?

Yes: Go to next step.

No: Check 710 Pur wire, 330 Org wire, X10 connector and connections.

2. Is battery voltage present at Wht wires of Y3 and Y4 fuel injector solenoids?

Yes: Go to next step.

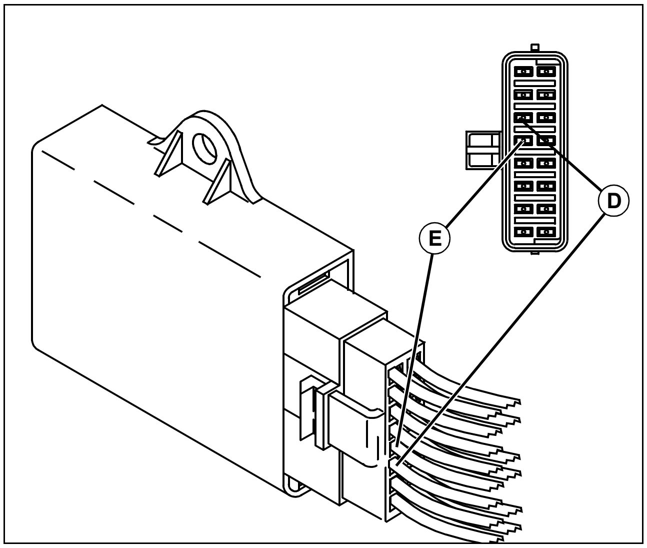
No: Re-check power circuits. Also, ensure that battery voltage is present at A2 EFI module, X11 connector 240 Red wire.

3. Is a problem suspected with one or both of the fuel injector solenoids?

No: Go to next procedure.

Yes: Test fuel injector solenoid(s). See “Fuel Injector Test - X720/X724/X728” on page 225.

EFI Module and Sensors:



1. Is continuity to ground present at A2 EFI module, X11 connector 460 Yel wire (D)?

Yes: Go to next step.

No: Check 460 Yel wire, Brn wire and connections.

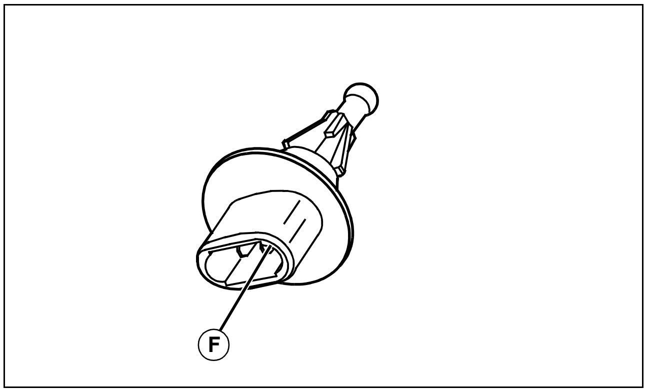
No: Re-check power circuits. See “Power Circuit Diagnosis - X720/X724/X728 EFI” on page 154.

2. Is there continuity between A2 EFI module, X11 connector 510 Blu wire (E) and ground?

Yes: Go to next step.

No: Check 510 Blu wire, X10 connector, Blk/Yel wire and connection.

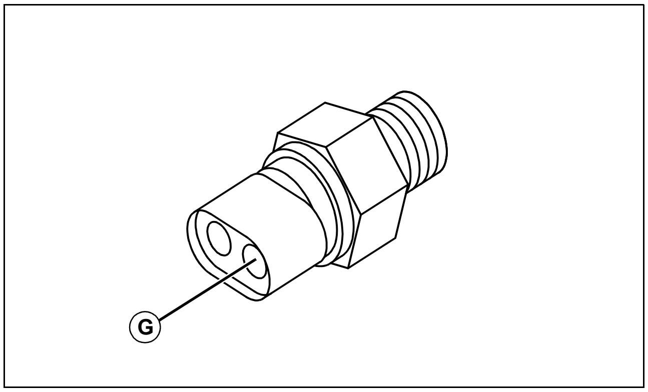
No: Replace A2 EFI module.



3. Is 2.26 - 2.5 VDC present at B5 air temperature sensor, Grn wire (F)?

Yes: Go to next step.

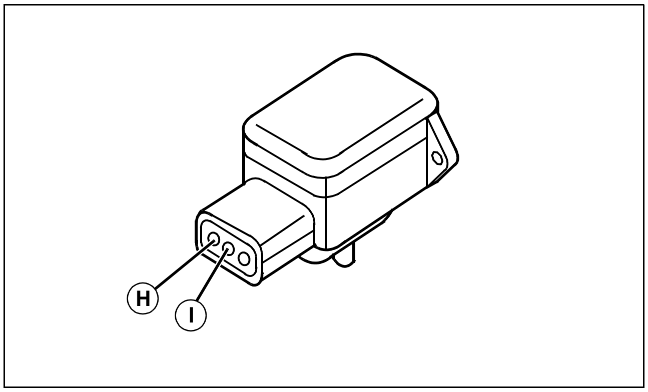
No: Check Grn wire, 515 Blu wire and connections. Test B5 air temperature sensor. See “Air Temperature Sensor Test - X720/X724/X728” on page 227. If OK, replace A2 EFI module.



4. Is 2.26 - 2.5 VDC present at Blu wire (G) of B4 engine coolant temperature sensor?

Yes: Go to next step.

No: Check Blu wire, 615 Tan wire and connections. Test B4 engine coolant temperature sensor. See “Coolant Temperature Sensor Test - X720/X724/X728” on page 227. If OK, replace A2 EFI module.



5. Is 3.5 - 3.8 VDC present measured at B6 vacuum pressure sensor Tan wire (H)?

Yes: Go to next step.

No: Check Tan wire, 470 Yel wire and connections. Test B6 vacuum pressure sensor. See “Vacuum Pressure Sensor Test - X720/X724/X728” on page 226. If OK, replace A2 EFI module.

6. Measure battery voltage at B6 vacuum pressure sensor. Red/Blu wire (I). Is voltage between 0.5 - 4.9 VDC?

Yes: Go to next procedure.

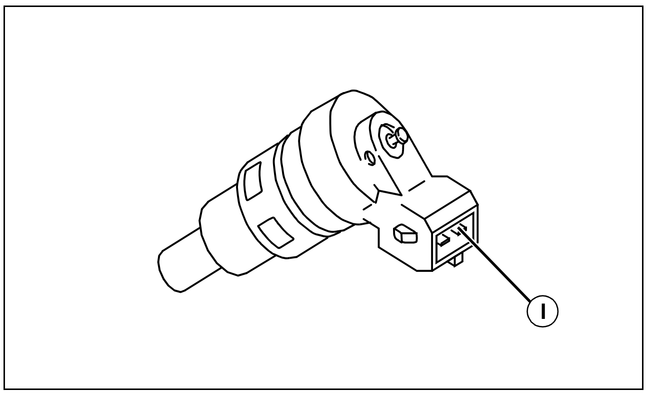
No: Replace B6 vacuum pressure sensor.

Test Procedure B:

Test Conditions:

- Machine parked safely with park brake locked.
- Key switch in run position, engine running.
- Operator on seat.
- PTO off.
- Battery fully charged.
- Power circuits functioning properly.
- No fault codes from on-board self diagnostics.
- Follow procedure in sequence.
- Ensure all circuit grounds are in good condition and have continuity.

Fuel Injectors:



1. Place a test light on a fuel injector Yel/Blu wire (I). Does the light rapidly pulse on and off? Repeat for other injector on Yel/Red wire.

Yes: Remove fuel injectors and test. See "Fuel Injector Test - X720/X724/X728" on page 225.

No: Check Yel/Red, 510 Blu wires and connections for Y4, #2 cylinder injector.

No: Check Yel/Blu, 160 Blk wires, and connections for Y3, #1 cylinder injector.

No: If wires are OK, replace A2 EFI module.

Fuel Injection Sensor and Diagnostic Circuit Operation - X720/X724/X728

Function:

Provides the inputs to the EFI module which in turn provides the proper output to the injectors.

The circuit integrity indicators (hour meter and EFI diagnostic light) display a code to provide a visual indication of circuit integrity. These fault codes will aid in the diagnosis of operational problems that may occur.

Operating Conditions:

- Key in run or start position,
- Engine running.

Theory of Operation:

Power is supplied to the electric fuel injection module when the key is in the run or start positions and the K1 main relay has been energized. At the same time the ground circuit is controlled by the K3 safety relay which is controlled by the A1 display panel and the A2 EFI module.

When the operating conditions have been met, the fuel injector sensors provide the input to the EFI module so that the EFI module will provide the ground path for the injectors at the correct time and duration.

The EFI module also has a self diagnostic mode that will display a code on the display panel if any of the three input sensors is not operating properly. When the circuit is operating normally, this light will remain off. If a fault exists, the fuel injection diagnostic light will display all the fault codes that are detected by the EFI module starting with the lowest numbered code. When all the fault codes have been displayed, the hourmeter will be off for approximately 5 seconds and then the fault codes will repeat.

The B4 coolant temperature, B5 air temperature and B6 vacuum pressure sensors are all resistance operated components that change their signal voltages to the EFI module. The fault codes for these components are based on the EFI module reading either a open or shorted circuit. This means that the EFI module is receiving either sensor voltage (5 VDC) or no voltage from the sensors.

Diagnostic Circuit Operation:

During normal operation the display panel will illuminate all indicator lights for 2 seconds and the gauges will sweep. Then the light will not be illuminated. The hourmeter will begin to display a specific fault code when the input from any one or more sensors is not operating properly. If more than one fault exists, each fault will be displayed before the controller repeats the fault codes.

The EFI module has the capability to test on board circuits and display a message indicating that circuit's status.

The EFI module also has 4 different fault codes available to assist with diagnostics. If a code is displayed, this means that the EFI is receiving either battery voltage or no voltage from the sensor.

Once a code has been read, it can be matched to the fault code chart.

EFI Module On Board Circuit Status Code Chart:

Fault Code	Flash Sequence	Test Point	Fault Cause
intH	N/A	B5 air temperature sensor Grn and Blk/Yel wires to A2 EFI module	B5 air temperature sensor circuit malfunctioning. Circuit either open or shorted
Ecool	N/A	B4 coolant temperature sensor, Blu and Blk Yel wires to A2 EFI module	B4 coolant temperature sensor circuit malfunctioning. Circuit either open or shorted.
uAc	N/A	B6 vacuum pressure sensor, Tan, Red Blu, and Blk/Yel wires to A2 EFI module	B6 vacuum pressure sensor circuit malfunctioning. Circuit either open or shorted.
A ir	N/A		EFI module air/fuel pressure calculation error. To reset: Stop engine, wait for fault indicator light to go off and fuel pump to stop (approximately 0.5 to 1 second). Start engine.

Fault Code	Flash Sequence	Test Point	Fault Cause
Error	N/A		EFI module air/fuel pressure calculation error. To reset: Stop engine, wait for fault indicator light to go off and fuel pump to stop (approximately 0.5 to 1 second). Start engine.
------	N/A	None	End of tests. All sensors functioning normally.

Display Code Chart:

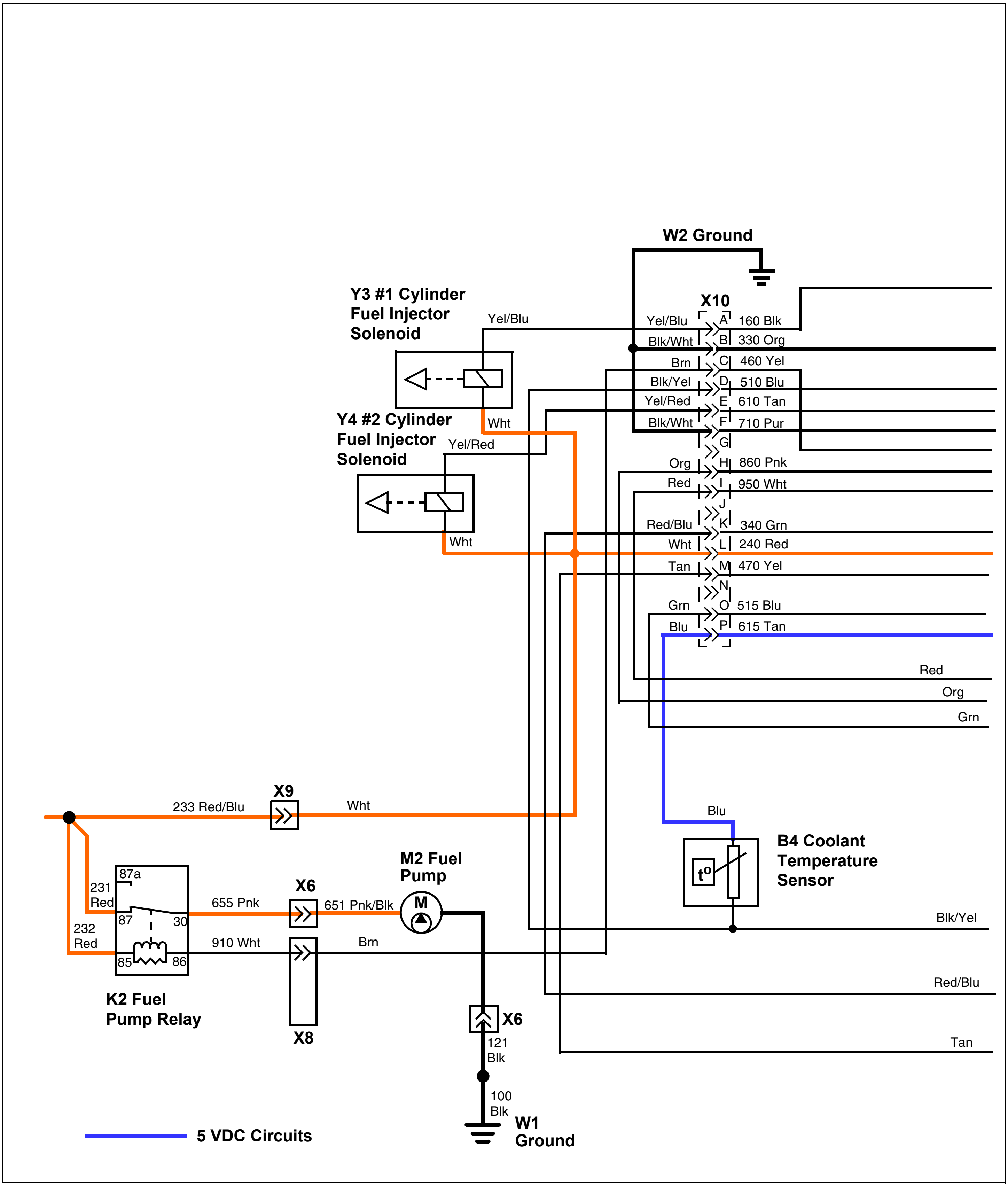
Test Conditions

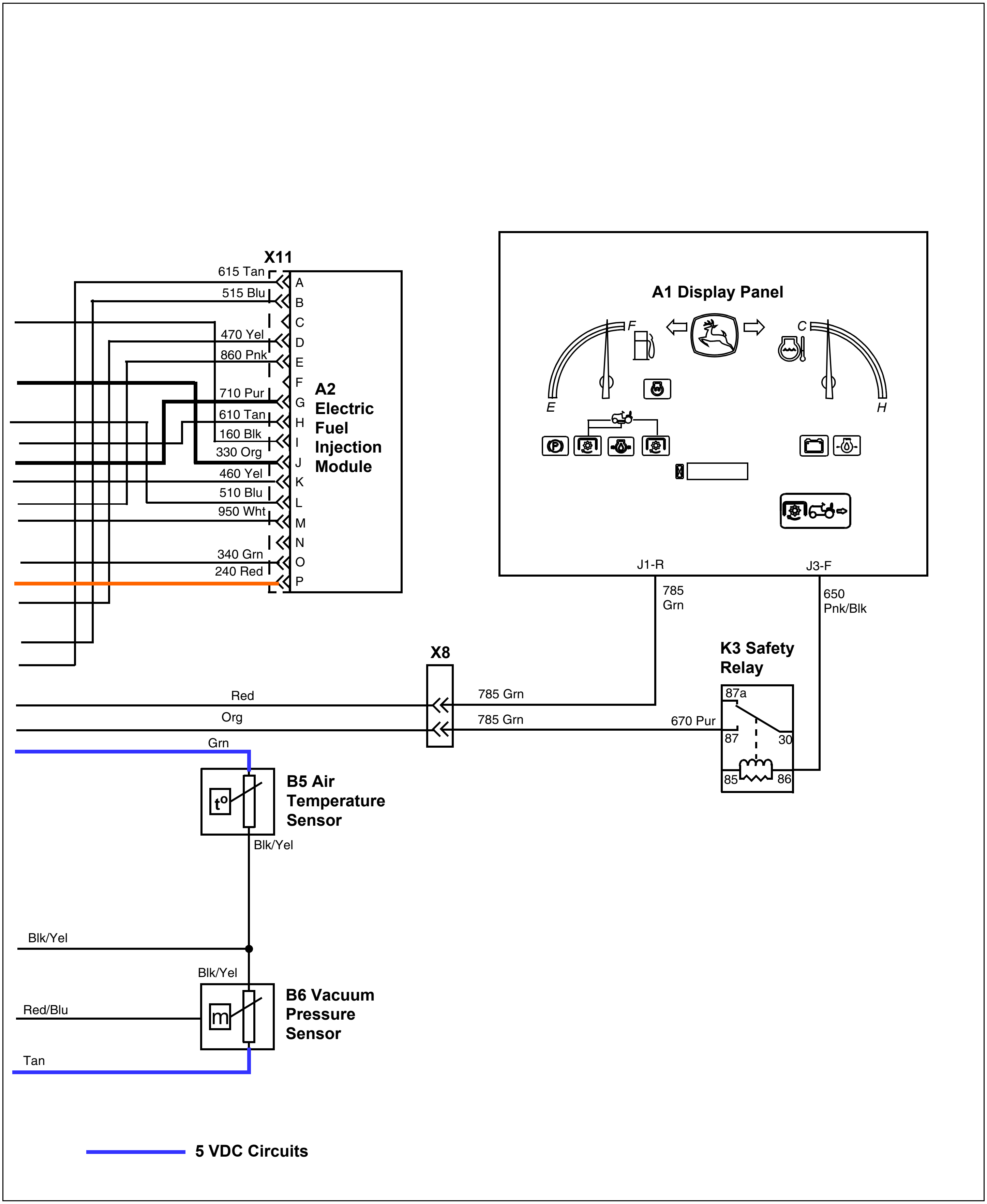
- Brake on
- PTO switch in RIO position (pulled out)
- Key switch on

Code	Action	Test Point	Fault Cause
brAHE	Depress brake pedal.	S8 brake switch, 765 Pur wire, 504 Yel wire, and switched power circuits.	S8 brake switch OK.
crAnH	Turn key switch to start.	S1 key switch, 720 Pur wire, 591 Yel wire, switched and unswitched power circuits.	S1 key switch OK.
SEAt	Operator on seat.	S4 seat switch, 800 Pnk wire, 502 Yel wire, and switched power circuits.	S4 seat switch OK.
Pto o	Pull up RIP switch.	S3 PTO/RIP switch, 754 Blu wire, 501 Yel wire, and switched power circuits.	S3 PTO/RIP switch OK (RIP position).
Pto	Activate PTO switch.	S3 PTO/RIP switch, 755 Blu wire, 501 Yel wire, and switched power circuits.	S3 PTO/RIP switch OK (PTO position).
rEu	Depress reverse pedal.	S7 RIO switch, 772 Blu wire, 402 Yel wire, and switched power circuits.	S7 RIO switch OK.
EoP	Remove oil pressure sensor wire.	B1 engine oil pressure switch and 620 Tan wire.	B1 engine oil pressure switch OK.

Code	Action	Test Point	Fault Cause
COOL	Remove and ground coolant temperature switch wire.	B2 engine water temperature sensor and 310 Org wire.	B2 engine water temperature switch OK.
L iGht	Turn on back up light switch.	S9 light switch, 400 Yel/Blu wire, and switched power circuits.	S9 light switch OK (back up lights position).
PtO ii	****	Rear PTO jumper (if installed)	
PtO r	Engage rear PTO.	S6 rear PTO switch, 740 Blu wire, 520 and 521 Yel wires, and switched power circuits.	S6 rear PTO switch OK.
------	No action	End of tests	End of tests
888888			

Fuel Injection Sensor and Diagnostic Circuit Electrical Schematic - X720/X724/X728




X11
615 Tan
515 Blu
470 Yel
860 Pnk
710 Pur
610 Tan
160 Blk
330 Org
460 Yel
510 Blu
950 Wht
340 Grn
240 Red
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
A2 Electric Fuel Injection Module
A1 Display Panel
F
C
E
H
J1-R
J3-F
785 Grn
650 Pnk/Blk
X8
Red
Org
Grn
785 Grn
785 Grn
670 Pur
K3 Safety Relay
87a
87
30
85
86
B5 Air Temperature Sensor
Blk/Yel
Blk/Yel
Blk/Yel
B6 Vacuum Pressure Sensor
Red/Blu
Tan
5 VDC Circuits

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 Tests

Reason:

To check for opens, loose terminal wire crimps, poor connections, or corrosion in the ground circuit. The voltmeter method checks ground connections under load.

Equipment:

- Ohmmeter or Voltmeter

Ohmmeter Procedure:

1. Turn key switch to OFF position. Lock park brake.
2. Connect ohmmeter negative (black) lead to negative (-) terminal of battery. Put meter positive (red) lead on negative terminal of battery and record reading. Reading should be 0.1 ohm or less.
3. Put meter red lead on ground terminal of circuit or component to be tested that is closest to the battery negative terminal. Resistance reading must be very close to or the same as the battery negative terminal reading. Work backwards from the battery on the ground side of the problem circuit until the resistance reading increases above 0.1 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 connectors closely as disconnecting and connecting may temporarily solve problem.

Voltmeter Procedure:

1. Put transmission in neutral. Lock park brake. Put PTO switch in off position. Turn key switch to on position.
2. Connect voltmeter negative (black) lead to negative terminal of battery.
3. Put meter positive (red) lead on ground terminal of component to be tested. Be sure the component circuit is activated (key in run position, switches closed) so voltage will be present at the component. Record voltage. Voltage must be greater than 0 but less than 1 volt. Some components will have a very small voltage reading on the ground side and still be operating correctly.

Results:

- If resistance is above 0.1 ohms, check for open wiring, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.
- If voltage is 0, the component is open.
- If voltage is greater than 1 volt, the ground circuit is bad. Check for open wiring, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

Battery Voltage and Specific Gravity Test

Reason:

To check voltage and determine condition of battery.

Equipment:

- Voltmeter or JTO5685 Battery Tester
- Hydrometer Procedure
- Clean battery terminals and top of battery

Procedure:

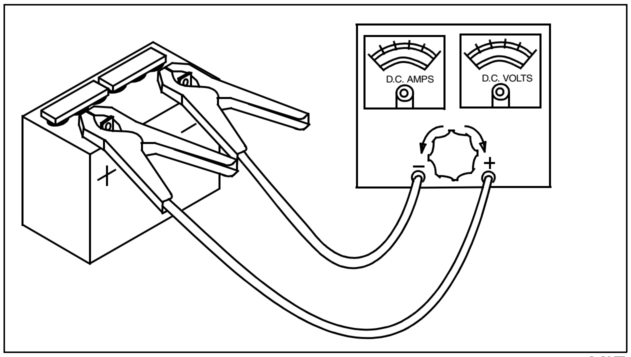
> **Caution: Avoid Injury! Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into the eyes.**
>
> **Avoid the hazard by:**
> **Filling batteries in a well-ventilated area,**
> **Wearing eye protection and rubber gloves,**
> **Avoiding breathing fumes when electrolyte is added.**
> **Avoid spilling or dripping electrolyte.**
> **Use proper jump-start procedure.**
>
> **If you spill acid on yourself:**
> **Flush your skin with water.**
> **Apply baking soda or lime to help neutralize the acid.**
> **Flush your eyes with water for 10 - 15 minutes. Get medical attention immediately.**
>
> **If acid is swallowed:**
> **Drink large amounts of water or milk.**
> **Then drink milk of magnesia, beaten eggs, or vegetable oil.**
> **Get medical attention immediately.**

1. Park machine safely with park brake locked.

2. Inspect battery terminals and case for breakage or cracks.

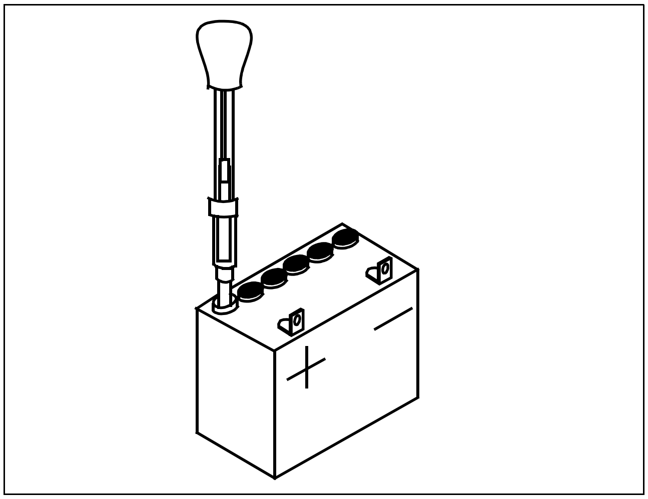
3. Check electrolyte level in each battery cell. Add clean, soft water as needed. If water added, charge battery for 20 minutes at 10 amps.

4. Remove surface charge by placing a small load on the battery for 15 seconds.



MIF

5. Check battery voltage with voltmeter or JTO5685 battery tester.



MIF

6. Use an hydrometer to check for a minimum specific gravity of **1.265** with less than **50** point variation in each cell at full charge at **26.7°C (80°F)**.

Results:

- Battery voltage less than **12.4 VDC**, charge battery.
- Battery voltage more than **12.4 VDC**, test specific gravity.
- All cells less than **1.175**, charge battery at 10 amp rate.
- All cells less than **1.225** with less than 50 point variation, charge battery at 10 amp rate.
- All cells more than **1.225** with less than 50 point variation, load test battery.
- More than **50** point variation: replace battery.

Specifications:

Minimum battery voltage . . . . .12.4 volts
Minimum specific gravity . . . . 1.225 with less than 50 point variation

Battery - Charge

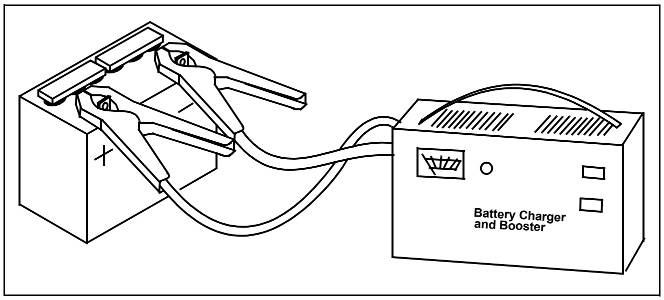
Reason:

To increase battery charge after battery has been discharged.

Equipment:

- Battery charger (variable rate)

Procedure:



MIF

1. Connect variable rate charger to battery.

Note: Maximum charge time at boost setting is 10 minutes. Allow an additional 5 minutes for each 10 degrees below 70 degrees F.

2. Start charger at slow rate. Increase charge rate one setting at a time. Check charger ammeter after 1 minute at each setting. Maintain 10 amp charge rate. Use boost setting as necessary.

3. Check if battery is accepting a 10 amp charge after 10 minutes at boost setting.

- Battery will not accept 10 amp charge after 10 minutes at boost setting: replace battery
- Battery is accepting 10 amp charge after 10 minutes at boost setting, and battery did not need water: go to steps 6 and 7
- 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 4 and 5

Important: Avoid Damage! Decrease charge rate if battery gases or bubbles excessively or becomes too warm to touch.

4. Set charger at 15 - 25 amps.

5. Check specific gravity after 30 minutes (60 minutes for maintenance-free battery).

Note: If battery was discharged at slow or unknown rate, charge at 10 - 15 amps for 6 - 12 hours (Maintenance-free battery: 12 - 24 hours). If battery was discharged at fast rate, charge at 20 - 25 amps for 2 - 4 hours (Maintenance-free battery: 4 - 8 hours).

- More than 50 point variation between cells: replace battery
- Less than 50 point variation between cells: go to steps 6 and 7

6. Continue charging battery until specific gravity is **1.230 - 1.265 points**.

7. Load test battery.

Battery - Load Test

Reason:

To check condition of battery under load.

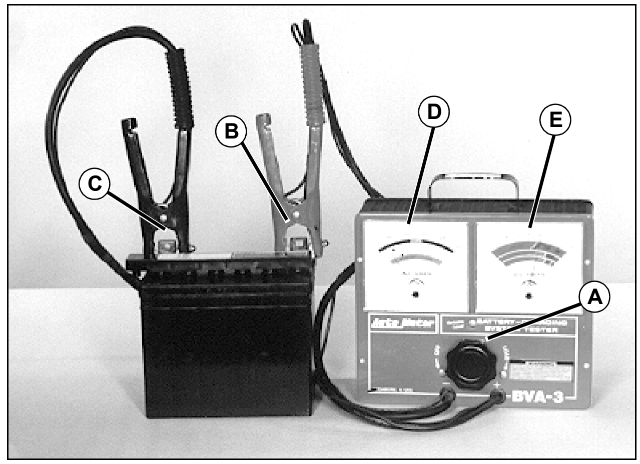
Note: Charge battery before performing load test.

Equipment:

- JTO5685 Battery Tester

Note: Use the procedures given with the tester.

Connections:



M49597

1. Turn load knob (A) of tester counter-clockwise to off.

2. Connect tester positive cable (B) to battery positive terminal.

3. Connect tester negative cable (C) to battery negative terminal.

Procedure:

1. Turn load knob of tester clockwise until amperage reading is equal to:

   - Cold cranking amperage rating (blue scale).

   or

   - Three times ampere hour rating (black scale).

2. Hold for 15 seconds and turn load knob of tester off.

3. Read battery voltage.

Results:

- If the battery does not indicate 9.6 volts or more, replace battery

Regulated Amperage and Voltage Test

Reason:

To determine the regulated charging output of the alternator.

Note: Battery must be in a good state of charge.

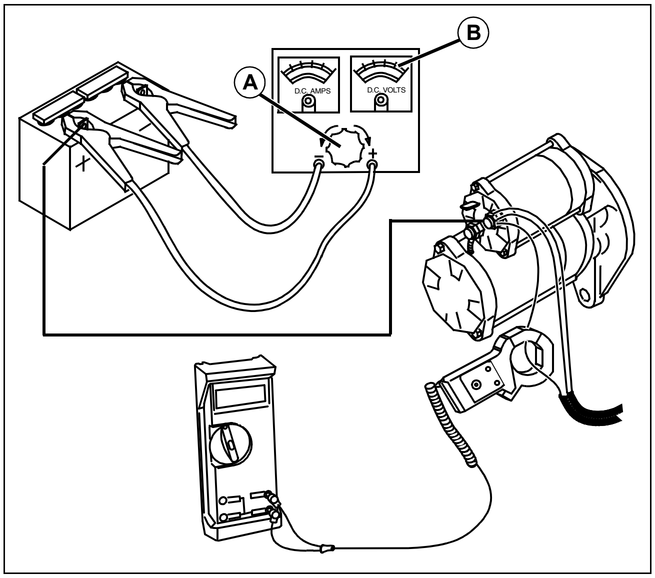
Equipment:

- JTO5712 Current Gun
- Voltmeter
- JTO5685 Battery Tester

Procedure:

1. Park machine safely with park brake locked.
2. Raise hood.

Important: Avoid Damage! Turn load knob (A) fully counterclockwise (out) into OFF position BEFORE making any test connections.



MIF

3. Connect JTO5712 Current Gun to voltmeter and put around red wire going to voltage rectifier/regulator. Set current gun for DC current.
4. Connect battery tester to battery.

Important: Avoid Damage! Perform these tests quickly to prevent damage to battery tester. DO NOT apply full load to battery for more than 5 - 10 seconds.

5. Turn load knob clockwise (in) until voltage on voltage tester scale reads 11 volts DC for 5 seconds only to partially drain battery.
6. Quickly turn load knob completely counter-clockwise (out) to off position.
7. Start and run engine at high idle. Battery voltage should read between 14.2 -14.8 VDC.
8. Turn load knob (A) clockwise (in) until voltage on tester voltage scale (B) reads 11 volts DC and look at current gun to see if output meets specifications.
9. Quickly turn load knob (A) completely counter-clockwise (out) to off position.
10. After load test, battery voltage (B) should return to the voltage level prior to test.

Results:

- If current gun amp reading is below specification, test for unregulated voltage output. If unregulated voltage output test meets specifications and you have verified voltage to ground to regulator/rectifier(s), replace regulator/rectifier(s).
- If at any time voltage increase exceeds 14.8 VDC, replace regulator/rectifier(s).

Specifications (Standard):

High Idle Voltage . . . . .14.2 - 14.8 VDC
Minimum High Idle Amperage. . . . . 13.5 Amps

Specifications (With Auxiliary Alternator):

High Idle Voltage . . . . .14.2 - 14.8 VDC
Minimum High Idle Amperage. . . . . 33.5 Amps

Regulated Voltage Test

Reason:

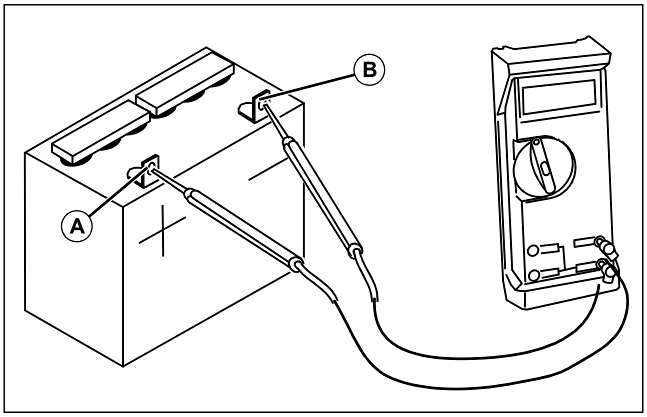
To determine regulated voltage output of the regulator/rectifier.

Equipment:

- Voltmeter

Procedure:

1. Park machine with park brake locked.
2. Raise hood.
3. Remove surface charge from battery by placing a small load on the battery for 15 seconds.
4. Set voltmeter to DC volts scale.



MIF

5. Connect meter red lead (A) to positive battery terminal.

6. Connect meter black lead (B) to negative battery terminal.

7. Start and run engine at low idle.

8. Read meter while increasing engine speed to fast idle.

Voltage should increase from battery voltage at low idle to maximum regulated voltage at fast idle.

Important: Avoid Damage! Do not allow the battery voltage to exceed 15.5 volts DC or the battery and charging system will be damaged.

Specifications:

Regulated voltage (maximum) . . . . .14.8 VDC

Results:

- If the DC voltage stays below the minimum specification, test unregulated voltage output. If ok, replace the voltage rectifier/regulator(s).
- If the DC voltage goes above the maximum specification, replace the regulator/rectifier(s).

Unregulated Voltage Test (Standard Configuration)

Reason:

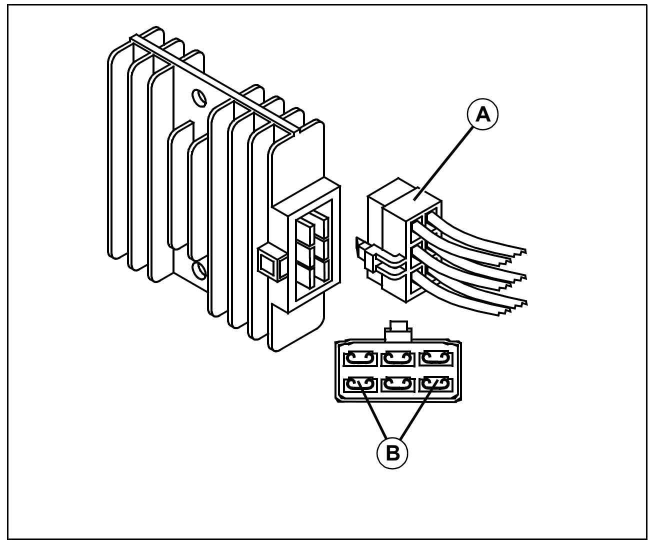
To determine charging output of the alternator stator.

Test Equipment:

- Voltmeter

Procedure:

1. Park machine with park brake locked.
2. Raise hood.



MIF

3. Disconnect connector (A) from voltage rectifier/ regulator.
4. Set voltmeter to AC volts.
5. Connect voltmeter to stator terminals (B).
6. Start and run engine at 3000 rpm.
7. Record stator voltage.

Specification:

Unregulated voltage (minimum) . . . . 26 VAC

Results:

- If voltage is less than specification, replace stator.

Unregulated Voltage Test (Optional Auxiliary Alternator)

Reason:

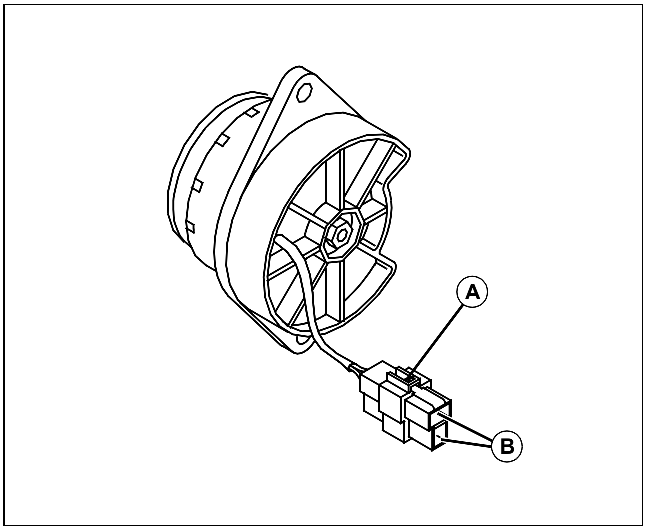
To determine charging output of the alternator.

Test Equipment:

- Voltmeter

Procedure:

1. Park machine with park brake locked.
2. Raise hood.



3. Disconnect connector (A) from alternator.
4. Set voltmeter to AC volts.
5. Connect voltmeter to alternator terminals (B).
6. Start and run engine at 3000 rpm.
7. Record alternator voltage.

Specification:

Unregulated voltage (minimum) . . . . 26 VAC

Results:

- If voltage is less than specification, replace alternator.

Stator Resistance Test (Standard Configuration)

Reason:

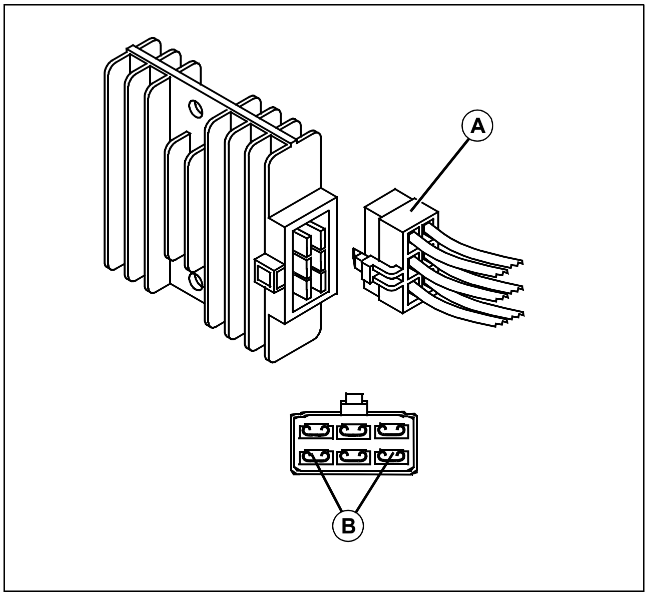
To determine if stator windings are open or grounded.

Equipment:

- Voltmeter

Procedure:

1. Park machine safely with engine off and park brake locked.
2. Raise hood.



3. Disconnect connector (A) from voltage rectifier/ regulator.
4. Set voltmeter to ohms.
5. Connect meter across terminals (B) of connector.
6. If reading is not within specification, replace stator.
7. Connect meter to either terminal (B) of alternator connector and to frame ground.
8. If meter does show continuity, replace stator.

Specification:

Stator Resistance . . . . 0.11 - 0.18 ohms

Alternator Resistance Test (Optional Auxiliary Alternator)

Reason:

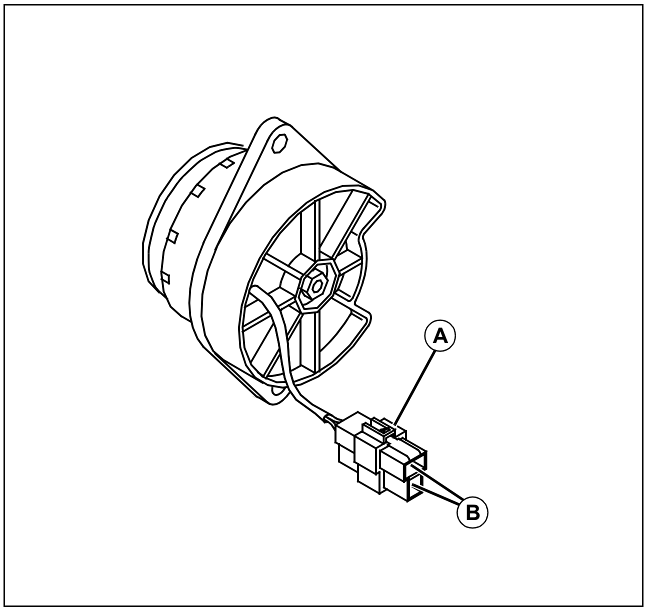
To determine if alternator windings are open or grounded.

Equipment:

- Voltmeter

Procedure:

1. Park machine safely with engine off and park brake locked.
2. Raise hood.



MIF

3. Disconnect connector (A) from auxiliary alternator.
4. Set voltmeter to ohms.
5. Connect meter across terminals (B) of alternator.
6. If reading is not within specification, replace alternator.
7. Connect meter to either terminal of alternator connector and to frame ground.
8. If meter does show continuity, replace alternator.

Specification:

Alternator Resistance . . . . .0.11 - 0.18 ohms

Starting Motor Condition

1. The starting motor overheats because of:
   - Long cranking.
   - Armature binding.
2. The starting motor operates poorly because of:
   - Armature binding.
   - Dirty or damaged starter drive.
   - Badly worn brushes or weak brush springs.
   - Excessive voltage drop in cranking system.
   - Battery or wiring defective.
   - Shorts, opens, or grounds in armature.

Note: Starting motor repair is limited to brushes, end caps, and starter drive. Fields in starting motor are permanent magnets and are not serviceable. If housing or armature is damaged, replace starting motor.

Starter Solenoid Test

Reason:

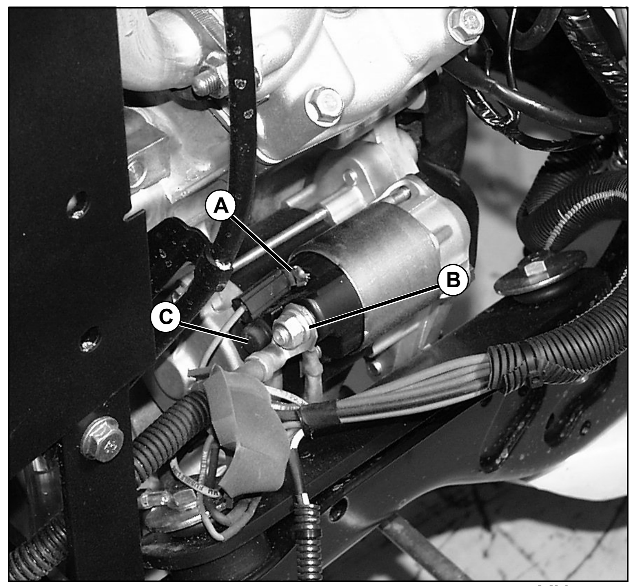
To determine if starter solenoid or starting motor is defective.

Equipment:

- Jumper wire

Procedure:

1. Put transmission in neutral. Lock park brake. Move key switch to off position.
2. Raise hood.
3. Disconnect and ground spark plug leads.



MX14279

4. Disconnect 720 Pur wire from starter solenoid terminal (A).
5. Connect jumper wire to positive battery terminal and briefly jump to starter solenoid terminal (A).
   - Starting motor runs: solenoid is good, check cranking circuit.
   - Starting motor does not run: go to next step.
6. Remove red and black rubber boots from starter solenoid terminals (B and C).
7. Connect jumper wire between starter solenoid large terminals (B and C).
   - Starter runs: Replace solenoid.
   - Starting motor does not run: Check battery cables then replace starting motor.

Starting Motor Amp Draw Test

Reason:

To determine the amperage required to crank the engine and check starter motor operation under load.

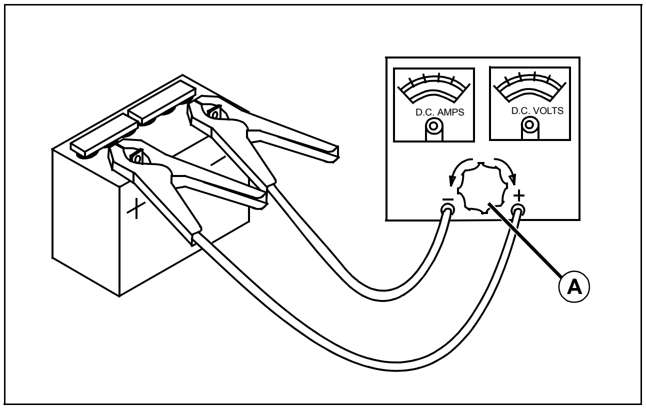
Equipment:

- JTO5685 Battery Tester

Procedure:

1. Put transmission in neutral. Lock park brake. Put key switch in off position.
2. Raise hood.
3. Disconnect and ground spark plug leads.

Important: Avoid Damage! Turn load knob (A) fully counterclockwise before making any test connections



MIF

4. Connect JTO5685 Battery Tester to battery.
5. Crank engine and read voltage.
6. Turn key switch to off position. Adjust load knob until battery voltage reads the same as when cranking.
7. Read amperage on meter.
8. Turn load knob fully counterclockwise.

Specification:

Starter amp draw (maximum) . . . . 85 amps

Results:

- If amperage is above specification, check starting motor no load amperage draw to determine if starting motor is binding or damaged.
- If starting motor is good, check internal engine components for binding or damage.

Starting Motor No-load Amperage and RPM Test

Reason:

To determine if starting motor is binding or has excessive amperage draw under no-load.

Equipment:

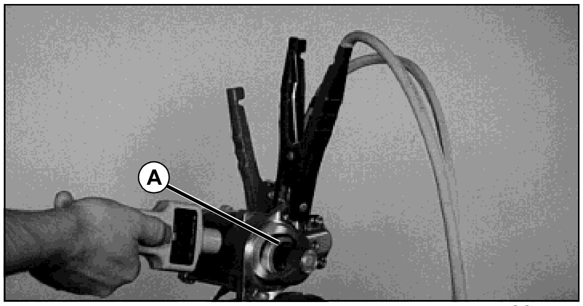
- JTO5712 Current Gun
- JTO5719 Photo Tachometer

Procedure:

1. Remove starter from engine.

Note: Check that battery is fully charged and of proper size to ensure accuracy of test.

2. Connect jumper cables to battery.



M45864a

3. Put screwdriver between gear and bendix drum (A) and pull outward. Install reflective tape on drum.
4. Connect negative cable to starter body.
5. Connect positive cable to solenoid battery terminal.
6. Attach current gun to positive jumper cable.

Important: Avoid Damage! Complete this test in 20 seconds or less to prevent starter damage.

7. Use jumper wire to briefly connect solenoid battery terminal and solenoid engagement terminal.
8. Measure starter amperage and rpm.

Specifications:

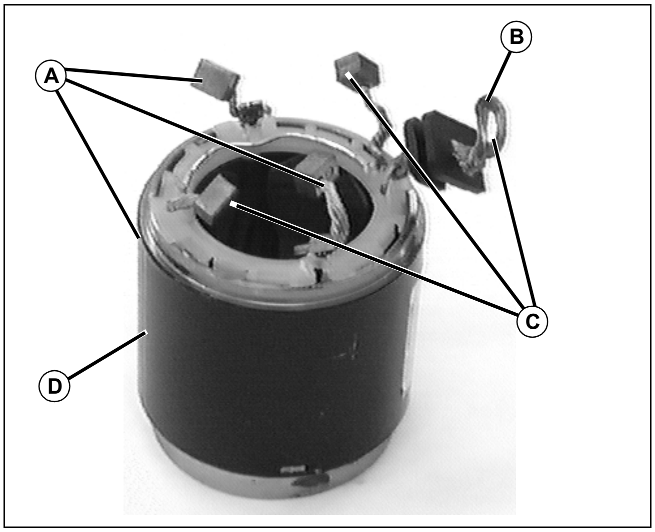
Starter amperage (maximum) . . . . 50 amps at 6000 rpm
Starter rpm (minimum). . . . . .6000 rpm

Results:

- If amperage or rpm is out of specification, check for binding or seizing bearings, sticking brushes, dirty or worn commutator. Repair or replace starter.

Starting Motor Field Windings Test

Note: Field winding case is a tie point for many separate field coils. It may be difficult to detect one bad coil. If rpm was slow and armature tests are normal, replace field coil assembly.



M57356

A- Field brushes (Continuity between brushes and to case)

B- To solenoid

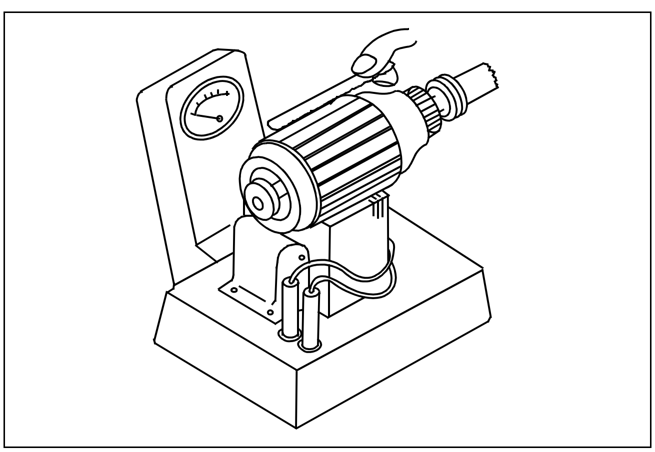
C- Armature brushes (Continuity between brushes and solenoid lead. Open to case.)

D- Starter case

Replace field coil if not according to specifications.

Starter Armature Test

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



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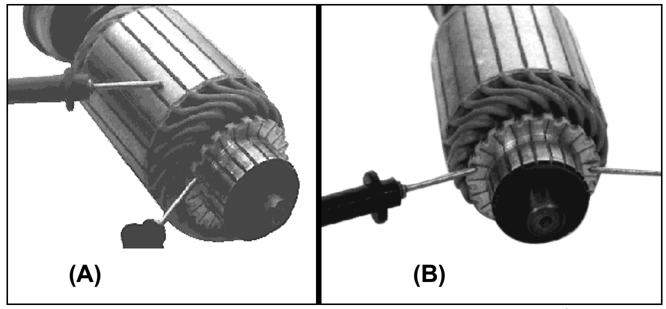
1. Locate short circuits by rotating armature on a growler while holding a hacksaw blade or steel strip on armature. The hacksaw blade will vibrate in area of short circuit.

2. Shorts between bars are sometimes caused by dirt or copper between bars. Inspect for this condition.

3. If test indicates short circuit in windings, clean the commutator of dust and fillings. Check armature again. If test still indicates short circuit, replace armature.



M50112/M50113

A- Test for grounds

B- Test for open

4. Using an ohmmeter, test each individual armature winding for grounded or open circuits.

Note: Armature windings are connected in parallel, so each commutator bar needs to be checked.

5. If either test fails, armature must be replaced.

Engine Coolant Temperature Sensor Test

Reason:

To verify coolant temperature sensor is functioning properly.

Equipment:

- Ohmmeter

Procedure:

Note: Perform test with engine at room temperature.

1. Park machine safely in neutral with park brake locked.

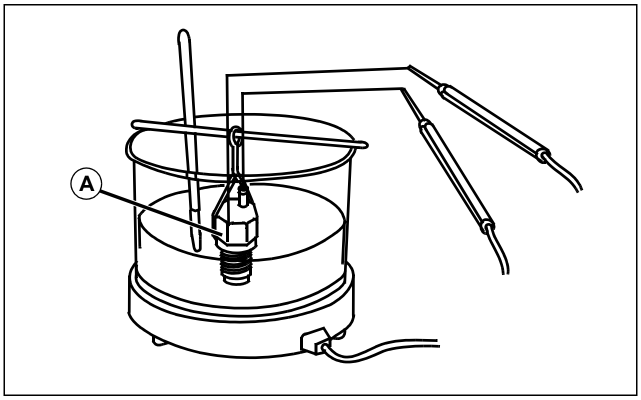
2. Raise hood.

3. Disconnect 310 Org wire from engine coolant temperature sensor.

4. Measure resistance between terminal and sensor body.

5. If resistance does not meet specification, replace coolant temperature switch.

6. Drain engine coolant and remove coolant temperature switch.



M91295

7. Place sensor (A) in antifreeze solution heated to approximately 110°C (230°F). Measure resistance while sensor is heated.

8. If resistance does not meet specification, replace coolant temperature sensor.

Specification:

Variable Resistance . . . . 40 - 700 ohms

Engine Oil Pressure Switch Test

Reason:

To determine the proper operation of the oil pressure switch.

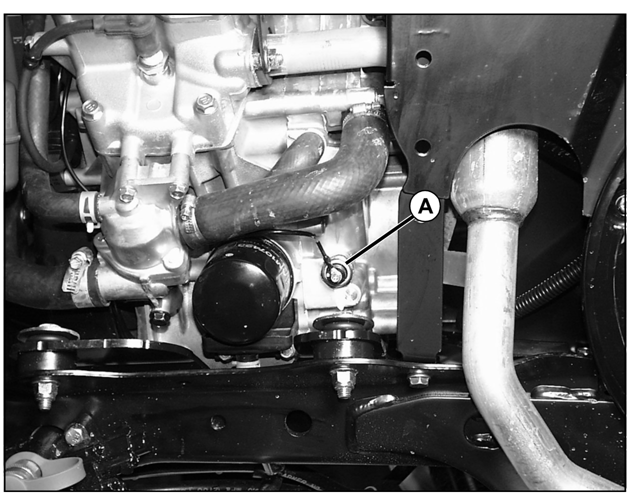
Equipment:

- Ohmmeter

Procedure:

Note: Perform test with engine at room temperature.

1. Park machine safely in neutral with park brake locked.
2. Raise hood.



MX14287

3. Disconnect Blu/Red wire from engine oil pressure switch (A) located near oil filter.

4. Connect black lead of ohmmeter to engine block and red lead of ohmmeter to terminal of switch.

5. Measure resistance between terminal and engine block.

Results:

- There should be continuity between terminal and ground.
- If there is no continuity between terminal and ground; replace the oil pressure switch.

Note: Be sure to apply Pipe Sealant with TEFLON® to threads of switch anytime it is installed.

TEFLON® is a registered trademark of the DuPont Company.

Important: Avoid Damage! Do not allow connector of wire to contact the engine or frame as there will be voltage on it during the test.

1. Start and run engine.
2. Measure resistance between terminal and engine block.

Results:

There should be no continuity between switch terminal and ground with the engine running.

- If the switch does have continuity to engine block (ground) with engine running, check engine oil pressure.
- If oil pressure meets specification, replace the oil pressure switch.

Lights Switch Test

Reason:

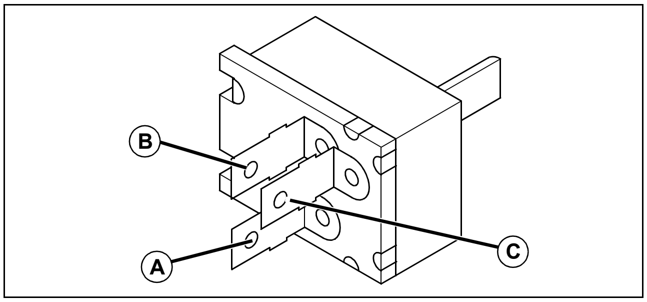
To verify terminal continuity is correct for each switch position.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Park machine safely in neutral with park brake locked.
2. Raise hood.
3. Remove left side panel.
4. Disconnect lights switch connector.
5. Put light switch in off position.



MIF

6. Use and ohmmeter to test switch continuity in off, headlights on, and backup lights on positions.

Specifications:

Switch PositionTerminal Continuity

Off . . . . no continuity between terminals

Headlights On . . . . .A and B

Backup lights on. . . . . .A and B

. . . . . .A and C

. . . . . .B and C

Results:

- If continuity is not correct, replace lights switch.

PTO/RIP Switch Test

Reason:

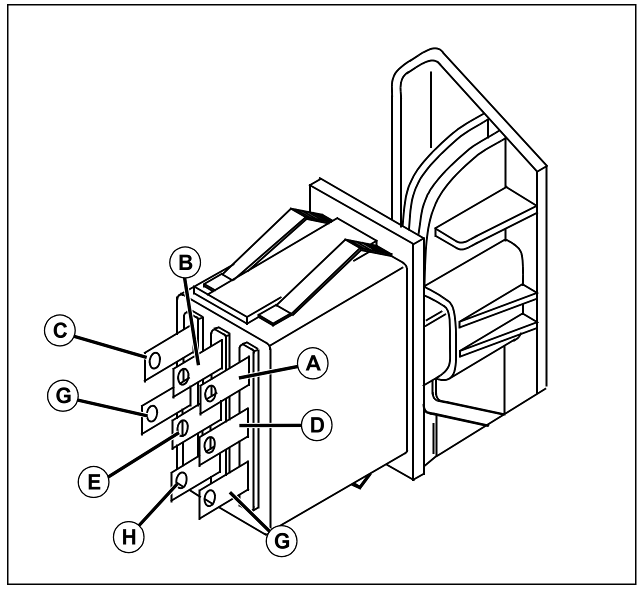
To verify terminal continuity is correct for each switch position.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Park machine safely in neutral with park brake locked.
2. Raise hood.
3. Disconnect PTO switch connector.
4. Put PTO switch in the off position.



MIF

5. Use and ohmmeter to test switch continuity in off, on, and momentary (RIP) positions.

Specifications:

Switch PositionTerminal Continuity

Off . . . . .A and C

. . . . . D and F

On . . . . .A and B

. . . . . D and E

Momentary (RIP). . . . . .A and B

. . . . . D and E

. . . . . .G and H

Results:

All other possible combinations have infinite resistance. If any continuity is NOT correct, replace switch.

Relay Test

Reason:

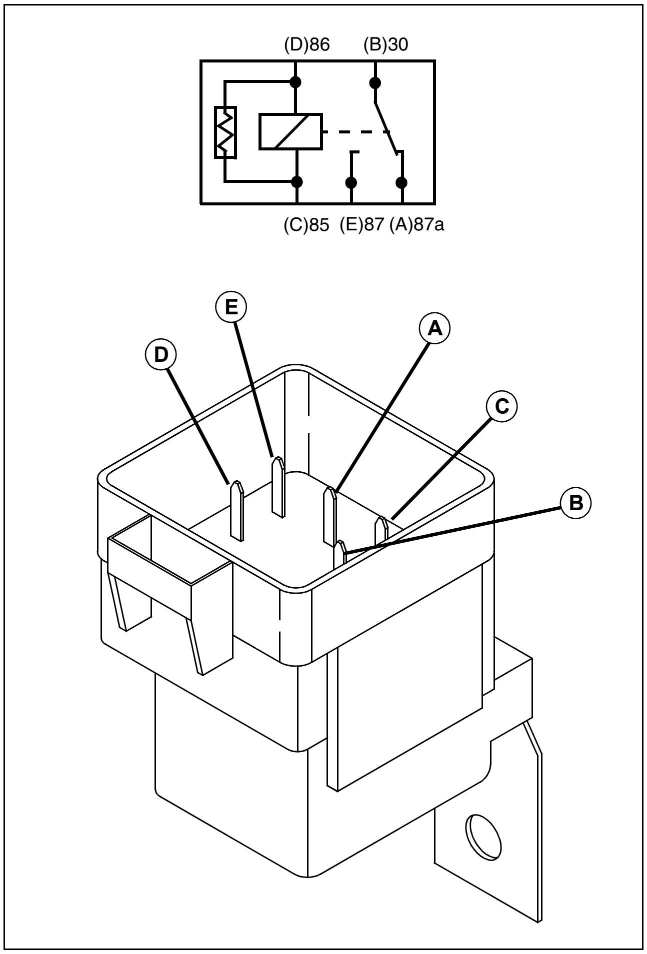
To check relay terminal continuity in the energized and de-energized condition.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Park machine safely in neutral with park brake locked.
2. Raise hood.
3. Disconnect relay connector.
4. Check terminal continuity using an ohmmeter or continuity tester.



M56817

5. There should be continuity between terminals 87A (A) and 30 (B), and 85 (C) and 86 (D).

6. There should not be continuity between terminals 87 (E) and 30 (B).

7. Connect a jumper wire from battery positive (+) terminal to relay terminal 85 (C). Connect a jumper wire from relay terminal 86 (D) to ground (-).

8. There should be continuity between terminals 87 (E) and 30 (B).

Results:

- If continuity is not correct, replace relay.

Power Port Switch Test

Reason:

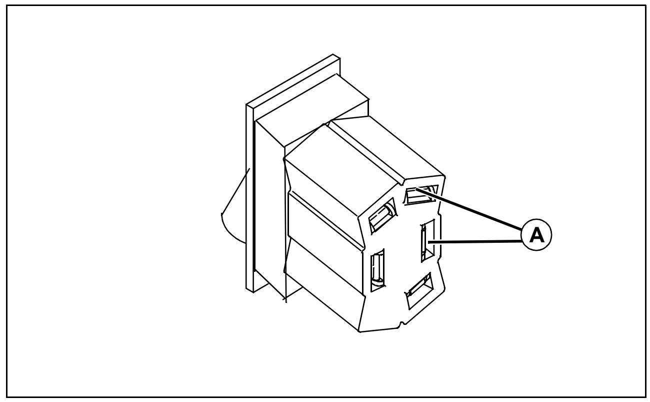
To ensure that the power port switch will break the circuit when switched off to prevent inadvertent battery drain.

Equipment:

- Ohmmeter

Procedure:

1. Park machine safely with park brake locked.
2. Disconnect power port switch connector.



MIF

3. With switch in off position, check for continuity across terminals (A).

4. With switch in on position, check for continuity across terminals (A).

Specifications:

Switch in off position. . . . . No Continuity
Switch in on position. Continuity

Key Switch Test

Reason:

To verify key switch functions are operating properly.

Equipment:

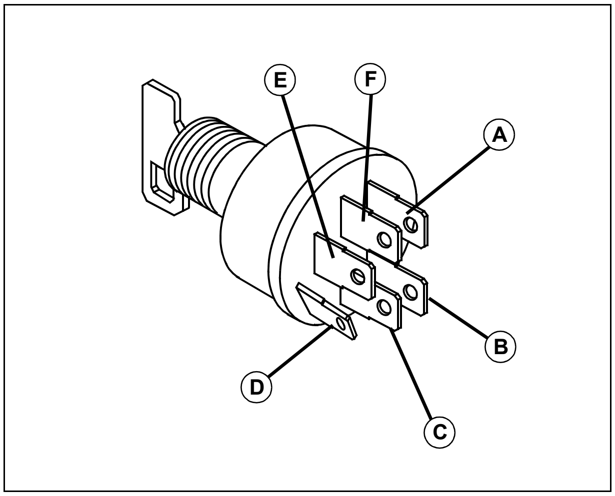
- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely. See "Park Machine Safely" on page 3 in the Safety section.
2. Open hood and remove storage tray.
3. Disconnect key switch connector.

Note: DO NOT refer to markings stamped on terminals. Identify terminals by art keys ONLY. Terminal combinations other than those listed in chart should

NOT have continuity.



MIF

4. Use an ohmmeter to test switch continuity in OFF, RUN, and START positions.

Switch Position Terminal Continuity:

- OFF: A and B
- RUN: C and D
- START: C and D
- E and F

Results:

- If any continuity is not correct, replace switch.

Seat Switch Test

Reason:

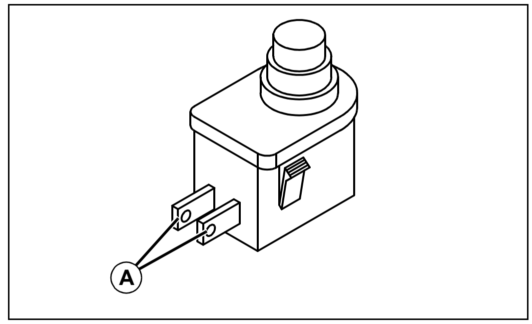
To verify proper operation of seat switch.

Equipment:

- Ohmmeter

Procedure:

1. Park machine safely in neutral with park brake locked.
2. Disconnect seat switch connector.
3. Depress the seat switch plunger.



MIF

4. Check continuity across seat switch connector terminals (A). There should be continuity.
5. Release the seat switch plunger.
6. Check continuity across connector terminals. There should not be continuity.

Specifications:

Seat switch plunger depressed . . . . continuity
Seat switch plunger released . . . . no continuity

Results:

- If the seat switch does not have continuity with the operator on the seat, check the seat switch bracket and spring for damage.
- If the seat switch does not have continuity with the plunger depressed, replace the switch.

Brake Switch Test and Adjustment

Reason:

To make sure the brake switch has continuity when the brake pedal is depressed.

Equipment:

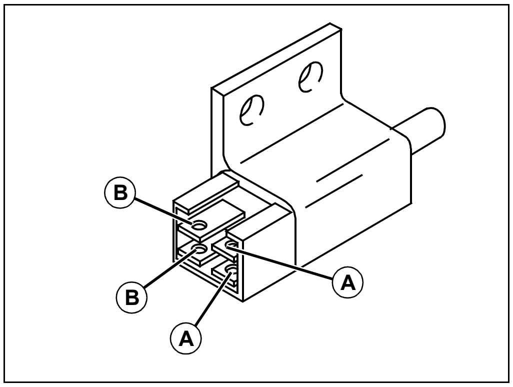
- Ohmmeter

Procedure:

1. Park machine safely in neutral with park brake locked.

Note: Brake switch is located on left side of frame under footrest.

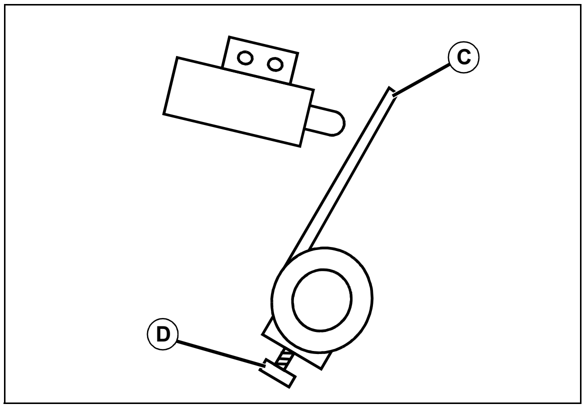
2. Remove footrest.
3. Disconnect brake switch connector.



MIF

4. Check continuity across terminals (A). Check continuity across terminals (B).

Note: Be sure actuator (C) contacts switch plunger (plunger depressed) and not switch body.



MIF

Picture Note: NOTE: Side view shown

5. Release park brake pedal.

6. Check continuity across terminals. Be sure actuator does not contact switch plunger (plunger released).

Specifications:

Brake pedal depressed (plunger depressed) continuity between terminals . . . .(A) only

Brake pedal released (plunger released) continuity between terminals . . . .(B) only

Results:

- If continuity is not correct, replace switch.
- If actuator position is not correct, loosen cap screw (D). Depress brake pedal and lock park brake. Rotate actuator (C) until the switch plunger is depressed, but not bottomed out. The actuator must not contact the switch body. Hold actuator in position and tighten cap screw.

RIO Switch Test

Reason:

To make sure the RIO switch has proper continuity.

Equipment:

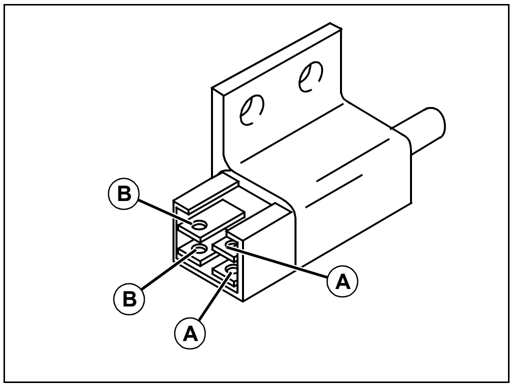
- Ohmmeter

Procedure:

1. Park machine safely in neutral with park brake locked.

Note: RIO switch is located on right side of frame under footrest.

2. Remove footrest.
3. Disconnect RIO switch connector.



MIF

4. Press switch plunger and check continuity across terminals (A) and then check continuity across terminals (B).
5. Press switch plunger and check continuity across terminals.

Specifications:

Plunger depressed) continuity between terminals . . . . (A) only

Plunger released) continuity between terminals . . . . (B) only

Results:

- If continuity is not correct, replace switch.
- Adjust switch to specification if needed.

RIO Switch Adjustment

Reason:

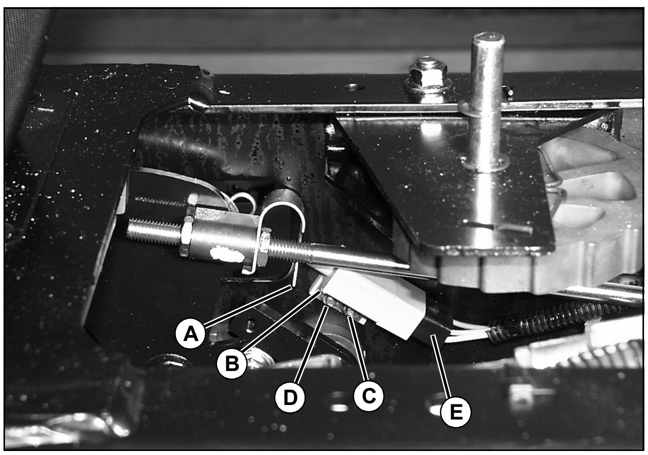
To set the proper air gap so that the RIO switch is activated at the proper time.

Equipment:

- Ruler
- Continuity tester

Procedure:

1. Stop engine and lock park brake.
2. Remove fender deck.



MX16074

3. Measure the gap between the bottom edge (A) of the spring and the bottom edge (B) of the RIO switch body.
   - The gap should be 12 mm (0.47 in.).
4. The bottom edge of the switch should be in line with the bottom edge of the spring.
5. Slightly loosen the back nut (C) and then the front nut (D).
6. Position the RIO switch at the proper angle with a 12 mm (0.47 in.) gap.
7. Tighten the nuts to 13.5 N•m (10 lb-ft) while maintaining the position of the switch.
8. Perform RIO switch test.
9. Install the fender deck.

Specifications:

Air Gap. . . . . 12 mm (0.47 in.)
Torque . . . . 13.5 N•m (10 lb-ft)

Fuse Test

Reason:

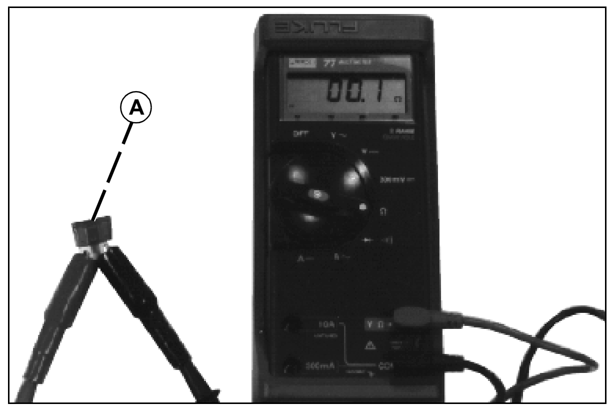
To verify that fuse has continuity.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Park machine safely in neutral with park brake locked.
2. Raise hood.
3. Remove fuse from fuse holder.



M49391

4. Check visually for broken filament (A).
5. Connect ohmmeter or continuity tester to each end of fuse.
6. Check for continuity.

Results:

- If continuity is not indicated, replace the fuse.

PTO Solenoid Test (Standard Front PTO)

Reason:

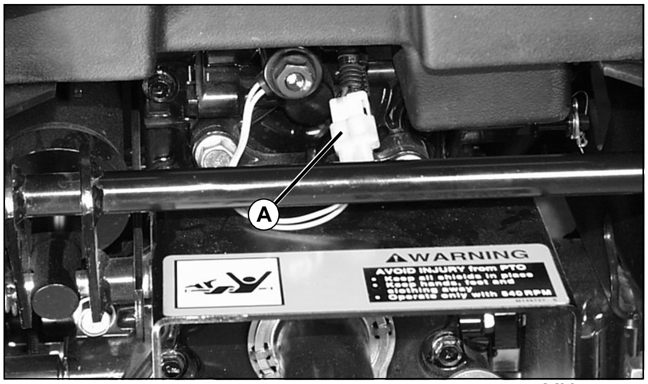
To verify that the solenoid is operating properly.

Equipment:

- Ohmmeter or continuity tester

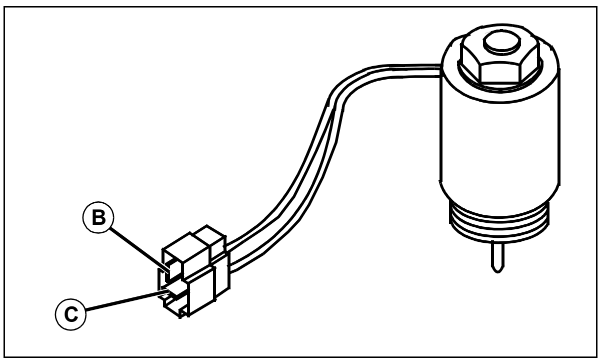
Procedure:

1. Park machine safely in neutral with park brake locked.



MX14285

2. Disconnect PTO solenoid connector (A) at rear of machine.



M91222

3. Using an ohmmeter or continuity tester, check if continuity exists between solenoid terminals.

Results:

- If resistance does not meet specifications, replace solenoid.

PTO Solenoid Continuity:

B to C . . . . 8.0 - 10.0 ohms

Short to Case Test

1. Check for grounds or shorts by connecting tester to one coil terminal and the other to bare metal of coil case or frame.

Results:

- Replace fuel shutoff solenoid if continuity is present from either terminal to coil case.

Audibility Test:

1. Connect PTO solenoid connector (A).
2. Listen for click when PTO solenoid pulls in.

Results:

- If click when PTO solenoid pulls in is not heard, replace solenoid.

PTO Switch Test (Optional Rear PTO Installed)

Reason:

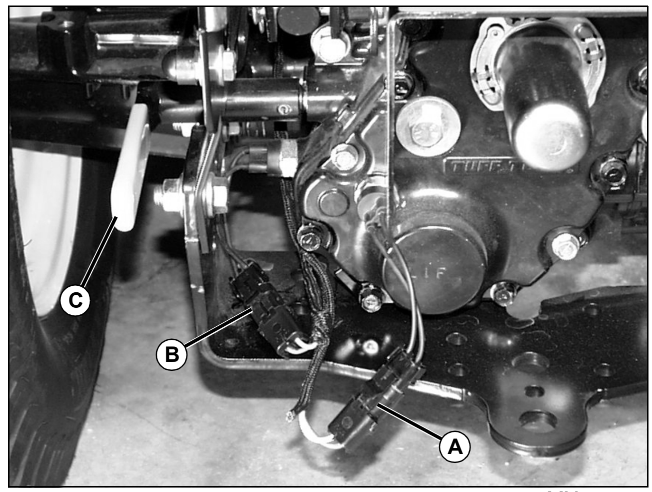
To verify that mid and rear PTO switches function properly.

Equipment:

- Ohmmeter or continuity tester

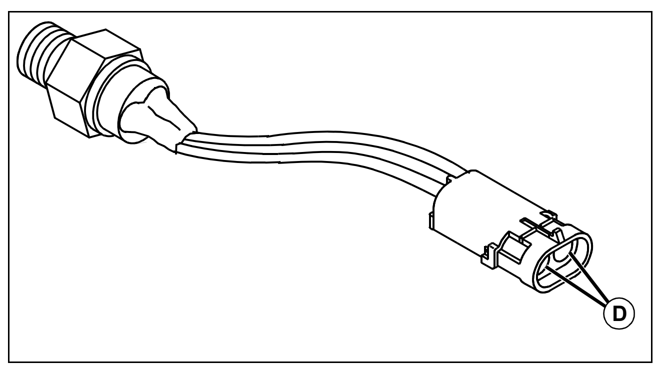
Procedure:

1. Park machine safely in neutral with park brake locked.



MX14286

2. Locate rear PTO switches at rear left side of transaxle and disconnect front PTO switch connector (A) and rear PTO switch connector (B).
3. Move PTO selector lever (C) to top position.



MIF

4. Check for continuity between switch terminals (D) and compare to specification.
5. Move PTO selector lever (C) to front position.
6. Check for continuity between switch terminals (D) and compare to specification.
7. Move PTO selector lever (C) to bottom position.
8. Check for continuity between switch terminals (D) and compare to specification.

Replace switch if correct continuity can not be obtained.

Front PTO Switch Continuity:

PTO Lever Position	Terminal Continuity
Top	No Continuity
Middle	Continuity
Bottom	Continuity

Rear PTO Switch Continuity:

PTO Lever Position	Terminal Continuity
Top	Continuity
Middle	Continuity
Bottom	No Continuity

Fuel Shutoff Solenoid Test - X700

Reason:

To determine if the fuel shutoff plunger retracts when the solenoid is energized.

Equipment:

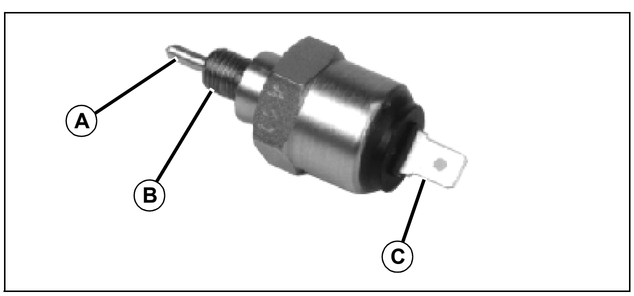
- 2 jumper wires

Procedure:

1. Park machine safely in neutral with park brake locked.
2. Raise hood.

> **Caution: Avoid Injury! Keep gasoline away from sparks, flame, or hot engine parts or personal injury can result.**

3. Remove drain screw and spring to drain gasoline from float bowl.
4. Disconnect fuel shutoff solenoid connector.
5. Remove fuel shutoff solenoid, washer and float bowl.



M82845

6. Connect a jumper wire from the battery positive (+) terminal to solenoid terminal (C). It may be necessary to push plunger (A) inward slightly for plunger to retract.

Note: It may be necessary to push plunger (A) inward slightly for plunger to retract.

7. Connect a jumper wire from the battery negative (-) terminal to solenoid threads (B). Plunger should now retract with the solenoid energized.
8. Remove jumper wire from the battery negative (-) terminal. Plunger should extend.

Results:

If plunger does not move, replace solenoid.

Diode Test

Reason:

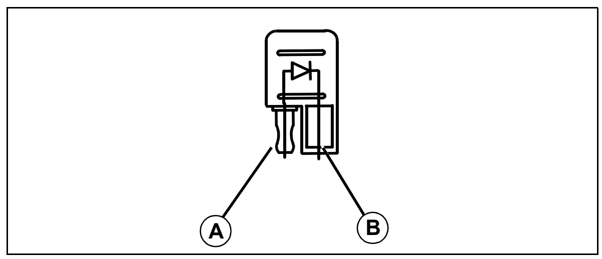
To verify that diode has proper continuity.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Park machine safely in neutral with park brake locked.
2. Raise hood.
3. Remove diode from connector.



MIF

4. Connect ohmmeter red (+) lead to pin (A) of diode.
5. Connect ohmmeter black (-) lead to pin (B) of diode. Check for continuity.
6. Reverse test leads. Check for continuity.

Results:

Diode must have continuity in one direction only. Replace defective diode.

Fuel Tank Sensor Test

Reason:

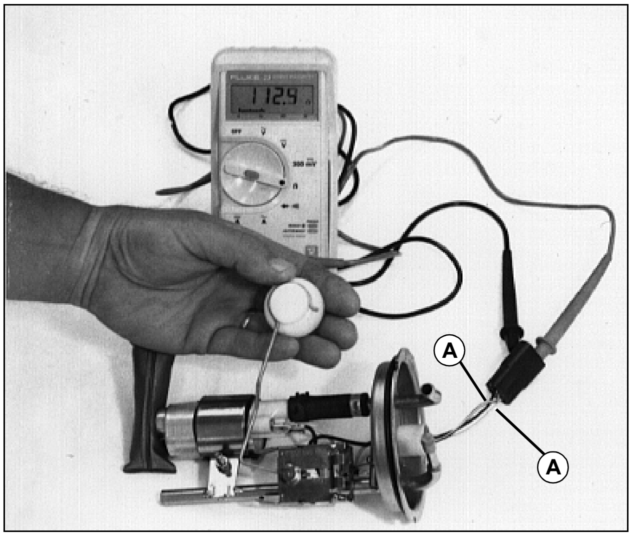
To make sure the fuel tank sensor resistance changes as the float is raised or lowered.

Equipment:

- Ohmmeter

Procedure:

1. Park machine safely in neutral with park brake locked.
2. Remove fender deck.
3. Disconnect fuel tank sensor connector.
4. Remove fuel tank sensor.



M46303a

5. Measure resistance across fuel tank sensor terminals with black and black/white wires (A).
6. Move sensor float arm up and down.
7. Meter must show resistance increase and decrease as float moves up and down. Resistance is the lowest when the float is in the lowest (empty) position.

Specification:

Sensor resistance (approximately). . . . . . .6 - 103 ohms

Results:

If the resistance does not change or does not meet the specifications, replace the fuel tank sensor.

Fuel Injector Test - X720/X724/X728

Reason:

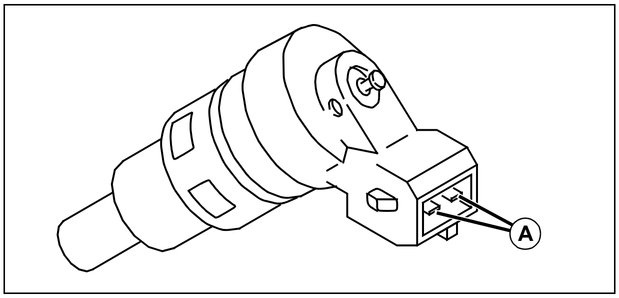
To verify fuel injector continuity and operation.

Equipment:

- Ohmmeter

Procedure:

1. Park machine safely in neutral with park brake locked.
2. Raise hood.
3. Remove air cleaner assembly.
4. Disconnect fuel injector connector.



MIF

5. Measure resistance across fuel injector terminals (A).
6. Connect a jumper wire from battery negative terminal to one of the fuel injector terminals.
7. Briefly and repeatedly connect a jumper wire from battery positive terminal to the other fuel injector terminal.
8. The fuel injector must click each time the jumper wire contacts the terminal.

Specification:

Resistance at 20°C (68°F) . . . . 12.5 ohms

Results:

- If resistance does not meet specifications, check fuel injector operation before replacing the fuel injector. The tested resistance values may vary from the specifications due to type of meter used or temperature.
- If the fuel injector does not click, replace the fuel injector.

Fuel Injection Module Test - X720/X724/X728

Reason:

To determine if fuel injection module is defective.

Procedure:

The fuel injection module is very sensitive to the type of meter used to check resistance. Due to variations in the meters, the best way to determine if the fuel injection module is good is to replace the questionable fuel injection module with a known good module.

Results:

- If the new fuel injection module does not solve the problem, check the other fuel injection components.

Vacuum Pressure Sensor Test - X720/X724/X728

Reason:

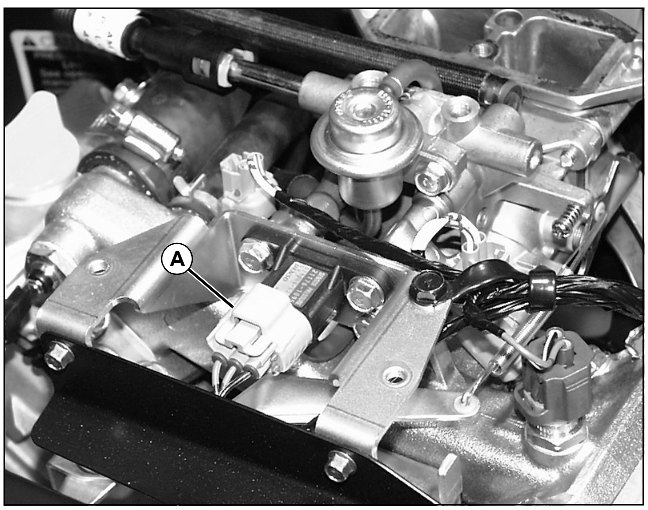
To verify vacuum pressure sensor continuity and operation.

Equipment:

- Ohmmeter
- Voltmeter

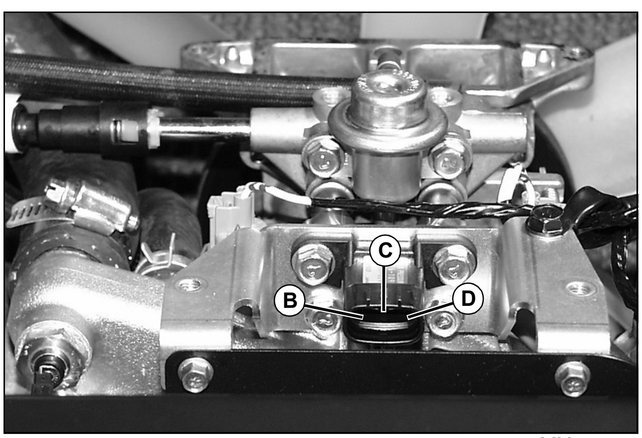
Procedure:

1. Park machine safely in neutral with park brake locked.
2. Raise hood.
3. Remove air cleaner assembly.



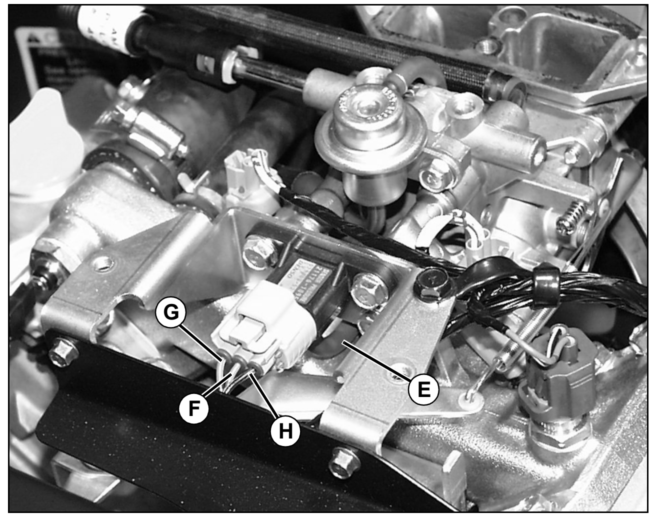
MX14288

4. Disconnect air pressure sensor connector (A).



MX14289

5. Measure resistance between left (B), center (C), and right (D) terminals on vacuum sensor.
6. Connect wire harness to air pressure sensor.



MX14288

7. Disconnect air pressure sensor hose (E).
8. Turn key switch to run position.

Note: It will be necessary to remove the rubber seals around the wires to take the voltage readings.

9. Connect voltmeter negative lead to wire terminal (F).
10. Connect voltmeter positive lead to wire terminal (G).
11. Measure input voltage. Voltage should be about 5 volts DC.
12. Connect voltmeter positive lead to wire terminal (H).
13. Measure output voltage. Voltage should be something less than 5 volts DC depending on air pressure.
14. Apply slight air pressure to sensor hose. Voltage should increase.
15. Apply slight vacuum to hose and voltage should decrease.

Specifications:

Terminal resistance (Approximation):

Left (B) and center (C) . . . . 2986 - 3034 ohms
Left (B) and right (D) . . . . 773 - 787 ohms
Center (C) and right (D) . . . . 3774 - 3798 ohms
Input voltage (G). . . . . about 5 volts DC
Output voltage (H . . . . 3.46 - 3.82 volts DC depending on air pressure

Results:

- If resistance does not meet specifications, check output voltage before replacing the air pressure sensor. The tested resistance values may vary from the specifications due to type of meter used or temperature.
- If the output voltage does not increase or decrease, replace the air pressure sensor.

Air Temperature Sensor Test - X720/X724/X728

Reason:

To verify air temperature sensor continuity.

Equipment:

- Ohmmeter

Procedure:

1. Park machine safely in neutral with park brake locked.
2. Raise hood.
3. Remove air cleaner assembly.

MX14290

4. Disconnect air temperature sensor connector (A).

MX14291

5. Measure resistance across air temperature sensor terminals (B).

Specifications:

Resistance at 0°C (32 °F) . . . . 5.29 - 6.47 k-ohms
Resistance at 20°C (68°F) . . . . 2.21 - 2.69 k-ohms
Resistance at 80°C (176°F) . . . . .133 - 163 ohms

Results:

- If resistance does not meet specifications, replace the air temperature sensor. The tested resistance values may vary from the specifications due to type of meter used or temperature.

Coolant Temperature Sensor Test - X720/X724/X728

Reason:

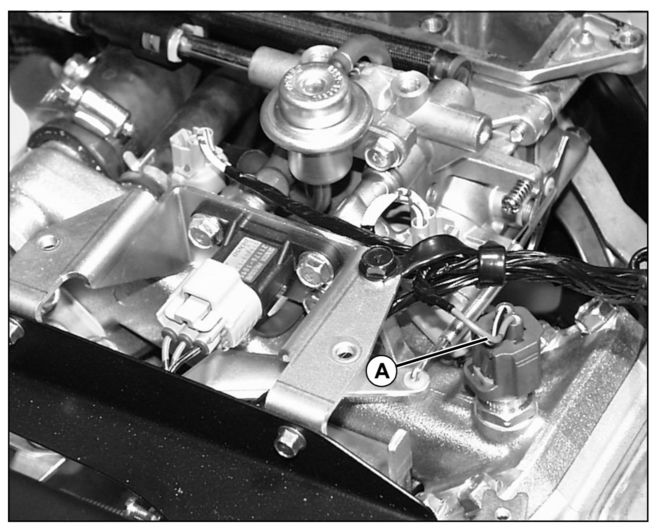
To verify coolant temperature sensor continuity.

Equipment:

- Ohmmeter

Procedure:

1. Park machine safely in neutral with park brake locked.
2. Raise hood.
3. Remove air cleaner assembly.



MX14288

4. Disconnect coolant temperature sensor connector (A).
5. Measure resistance across coolant temperature sensor terminals.

Specifications:

Resistance at 20°C (68°F) . . . . 2.21 - 2.69 k-ohms

Resistance at 80°C (176°F) . . . . .292 - 354 ohms

Resistance at 110°C (230°F) . . . . .133 - 163 ohms

Results:

- If resistance does not meet specifications, replace the coolant temperature sensor. The tested resistance values may vary from the specifications due to type of meter used or temperature.

Spark Plug Gap Test

Spark plugs should not be burned, blistered, or have cracked insulator tips or badly eroded electrode.

Make sure the plug is correctly gapped.

Specification:

Spark Plug (NGK BPR4ES) . . . . 0.75 mm (0.030 in.)

Note: Bending center wire or hitting plug with gapping tool can break insulator.

John Deere recommended plug is the best heat range for the engine application.

If hotter plug is used, go no more than (1) one range hotter.

- For NGK plugs: the lower the number the hotter the plug.
- For Champion Plugs: The higher the number the hotter the plug.

If spark plugs are burning improperly:

- Use known good grade and source of fuel.
- Test fuel for alcohol content. Tester is available at an auto parts store. Alcohol content should be a maximum of 10%. This rating should be listed on service station pumps.
- Try a different grade (octane) fuel, or a different fuel manufacturer.
- With electronic ignition, check ground connections, ignition components, and a possible sheared flywheel key (unlikely).

Reason:

To determine if spark plug cap is defective.

Equipment:

- Ohmmeter

Procedure:

1. Park machine safely in neutral with park brake locked.
2. Raise hood.
3. Disconnect spark plug cap.

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. . . . . marked on cap

Results:

- If resistance does not meet specification, replace spark plug cap.

Spark Plug Gap Adjustment

Reason:

To maintain the correct gap between the center electrode and the tab needed to produce a good spark.

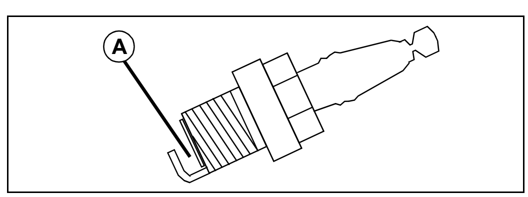
Equipment:

- 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 . . . . 0.75 mm (0.030 in.)
Spark plug torque . . . . 25 N•m (221 lb-in.)

Ignition Coil Test

Reason:

To determine condition of ignition coil windings.

Equipment:

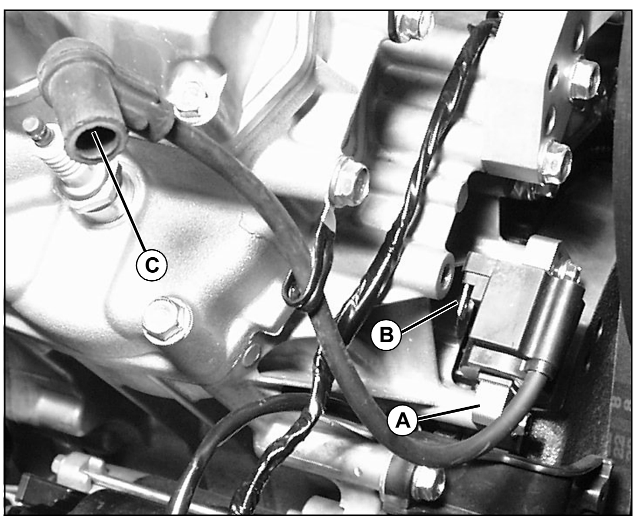
- Ohmmeter

Procedure:

1. Put transmission in neutral. Put key switch in off position.

2. Remove spark plug cap from spark plug wire.

3. Disconnect wires from ignition coil terminal.



MX16073

4. Measure primary coil resistance between laminations (A) and terminal (B).

5. Measure secondary coil resistance between laminations (A) and spark plug wire (C).

Specifications:

Primary coil resistance . . . . 2.2 - 3.6 k-ohms
Secondary coil resistance . . . . 13 - 21 k-ohms

Results:

- If resistance does not meet specifications, replace the ignition coil.

Spark Test

Reason:

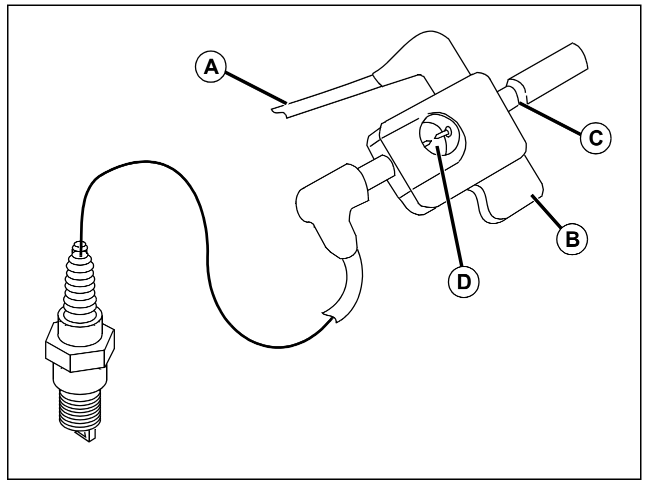
Check overall condition of ignition system.

Equipment:

- D-05351ST Spark Tester

Connections:

1. Brake locked. PTO(s) disengaged.



MIF

2. Remove high tension lead (A) from spark plug and connect to spark tester (B).

3. Connect spark tester to spark plug.

4. Adjust spark tester gap to 4.2 mm (0.166 in.) with screw (C).

Important: Avoid Damage! Do not adjust spark tester gap beyond 5.0 mm (0.200 in.) as damage to ignition system components could occur.

Procedure:

1. Turn key switch to start position and watch spark (D) at spark tester. If engine will start, watch spark with engine running.

Specifications:

- Steady, strong, blue spark.

Results:

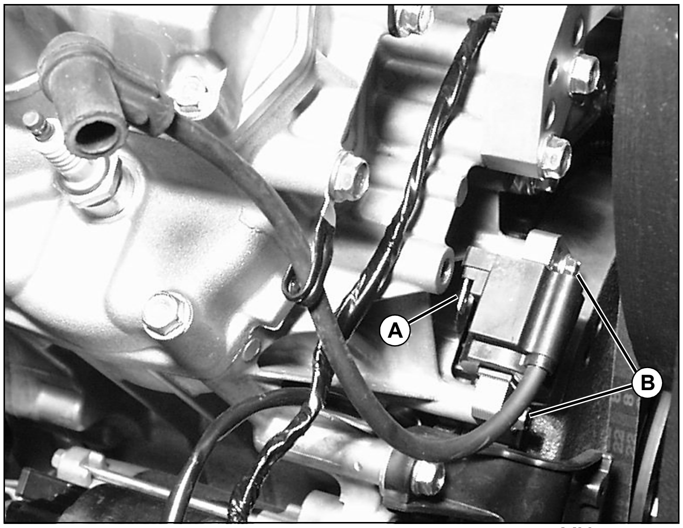
- If spark is weak, or if no spark, install a new spark plug and test again.
- If spark is still weak, or still no spark, run tests on individual components to find cause of malfunction.

Repair

Ignition Coil Replacement and Adjustment

Removal:

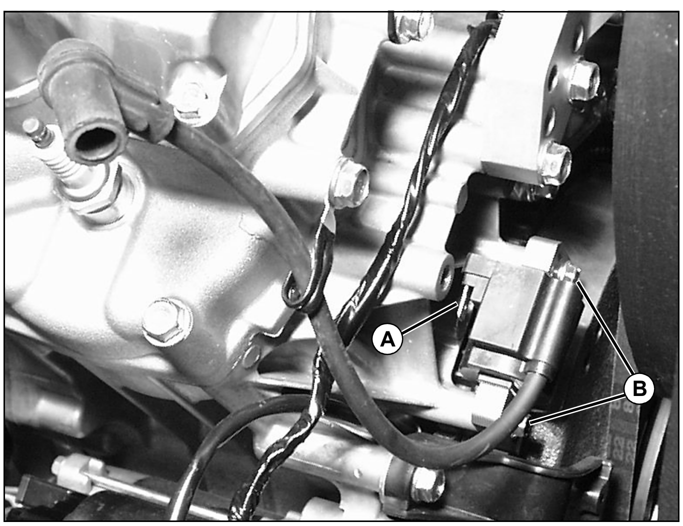
1. Park machine safely. See “Park Machine Safely” on page 3 in safety section.



MX16073

2. Disconnect plug wire from spark plug.
3. Disconnect ignition lead from primary coil terminal (A).
4. Remove ignition coil mounting capscrews (B).

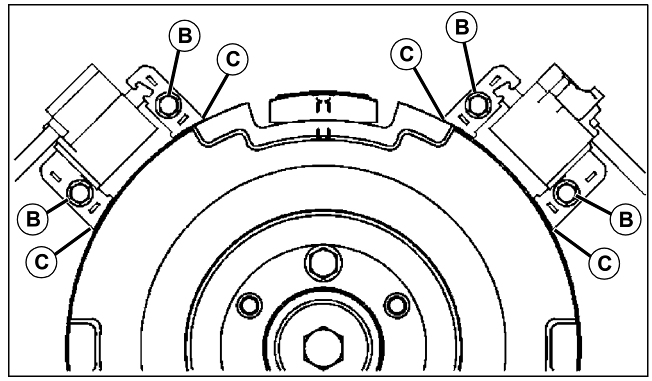
Installation:



MX16073

1. Align ignition coil with mounting holes on crankcase.
2. Loosely install mounting capscrews (B).
3. Connect ignition lead from primary coil terminal (A).
4. Connect plug wire to spark plug.

Adjustment:



MX14236

1. Place feeler gauge between ignition coil legs (C) and flywheel.
2. Hold ignition coil in place and tighten the mounting capscrews (B) to **3.4 N•m (30 lb-in.)**.
3. Check air gap again after tightening. Readjust if needed.

Specifications:

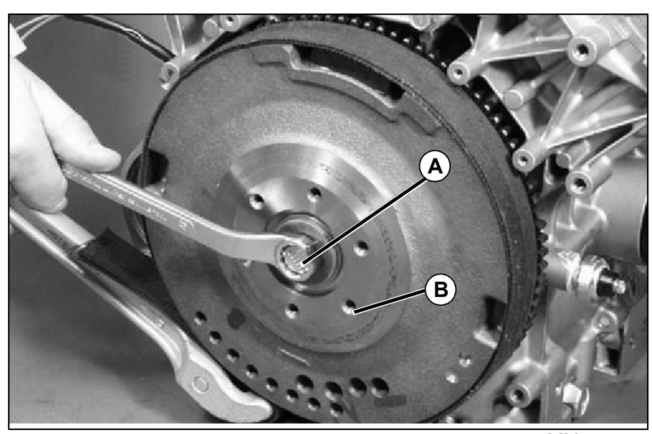
Air Gap . . . . .0.25 - 0.40 mm (0.010 - 0.016 in.)
Capscrew Torque . . . . 3.4 N•m (30 lb-in.)

Stator Replacement

Note: The charging system is a permanent magnet and stator design. As the flywheel rotates, a permanent magnet in the flywheel induces AC current in the stator windings. This current flows to the regulator-rectifier where it is converted to DC current needed to charge the battery. Component may differ from illustration.

Removal:

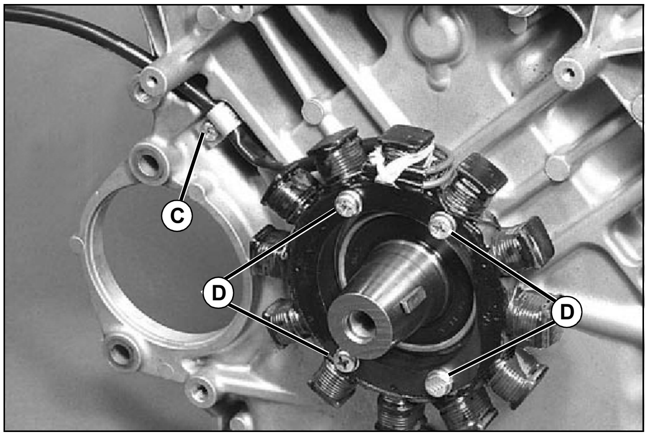
1. Park machine safely. See “Park Machine Safely” on page 3 in Safety section.
2. Remove engine from machine. See engine removal in appropriate engine section.



MX16077

3. Hold flywheel with strap and remove flywheel bolt (A).

4. Thread a flywheel puller into the pulling holes (B) and remove the flywheel.



MX16078

5. Remove the wire clamp (C).

6. Remove the four mounting capscrews (D) and remove stator from crankcase.

Installation:

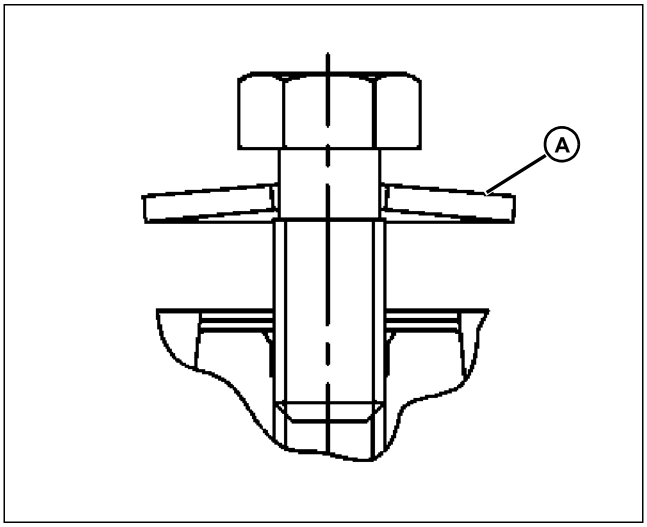
1. Place stator over crankshaft and onto crankcase.

Align the four mounting holes with the threaded holes in the crankcase and the stator wires routed towards the clamp.

2. Install and tighten the four capscrews.

3. Install and tighten the wire clamp.

4. Align the flywheel keyway with the key on the crankshaft and install flywheel.



MX16079

5. Install spring washer (A) as shown.

6. Install and tighten the flywheel bolt.

7. Install engine into machine.

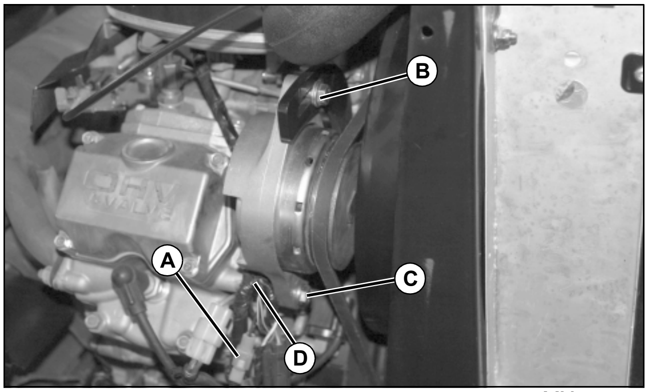
Specifications:

Stator Capscrew . . . . 3.4 N•m (30 lb-in.)
Wire Clamp Capscrew . . . . 3.4 N•m (30 lb-in.)
Flywheel Bolt . . . . 56 N•m (41 lb-ft)

Alternator Removal, Inspection, and Installation (Optional)

Removal:

1. Park machine safely. See “Park Machine Safely” on page 3 in Safety section.



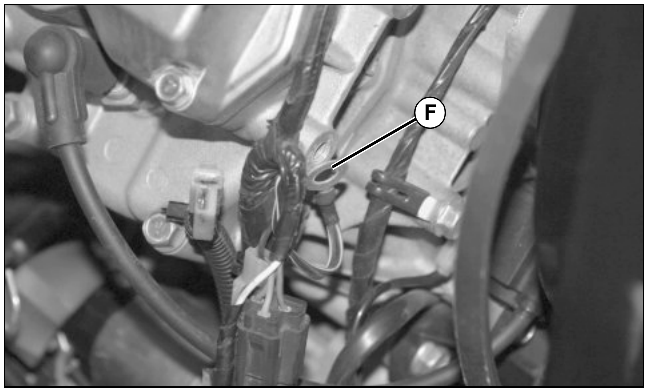
MX36050

2. Disconnect alternator electrical connector (A).

3. Loosen alternator adjustment cap screw (B). Slide alternator towards engine.

4. Remove belt from alternator.

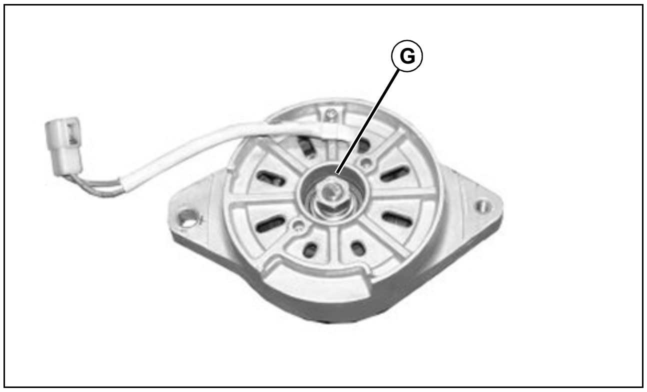
5. Remove adjustment cap screw, mounting cap screw (C), and spacer (D).



MX36056

6. Remove alternator from machine. Note location of engine ground wire (F) for reassembly.

Disassembly and Inspection:



MX36051

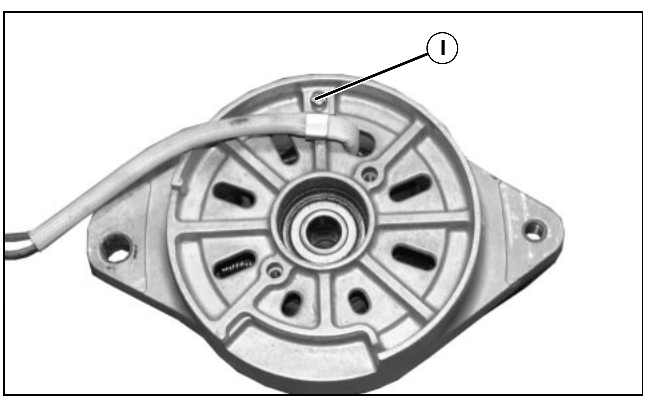
1. Remove nut (G), lock washer, and washer from rear of alternator.

Note: Rotor magnets will provide some resistance when separating rotor from alternator body.

2. Separate rotor from alternator body.

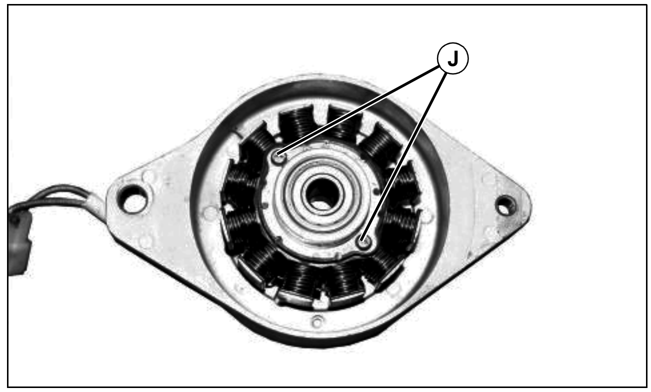
MX36053

3. Inspect rotor and magnets (H) for damage. Replace if necessary.



MX36055

4. Remove screw (I) securing stator wiring to rear of alternator case.



MX56054

5. Remove two screws (J) securing stator to alternator case. Remove stator.

6. Inspect bearing for rough spots or looseness. Replace as necessary.

Assembly and Installation:

- Assembly is in the reverse of disassembly.
- Installation is in the reverse of removal.
- Adjust alternator belt tension. See Tests and Adjustments in the in the Engine section.

Table of Contents

Specifications

General Specifications

Transaxle Capacity:

Two-Wheel Steer	6.6 L (7.0 qt)
All-Wheel Steer	5.6 L (6.0 qt)
Four-Wheel Drive	6.6 L (7.0 qt)
Hydraulic Oil	J20D Low Viscosity HY-GARD

Front Axle:

Gear Oil	John Deere GL5 Gear Lubricant (80W-90
Capacity	2.4 L (2.5 qt)

Test And Adjustment Specifications

Hydrostatic Transmission:

Pump and Motor Displacement	18 mL (0.6 oz)/rev

Charge Pump:

Displacement (2-WD)	6 mL/rev (0.2 oz)/rev
Displacement (MFWD)	8 mL/rev (0.27 oz)/rev
Charge Pressure Control Valve (minimum)	1958 kPa (284 psi)
Charge Pressure Relief Valve (Implement Pressure) (minimum)	63710 kPa (924 psi)
Charge Pump Flow 2-WD)	17 L/m (4.5 gpm)
Minimum Flow	13 L/m (3.4 gpm)
Charge Pump Flow (MFWD)	22.7 L/m (6.0 gpm)
Minimum Flow	17 L/m (4.5 gpm)

PTO:

PTO Pressure Control Valve (minimum)	14698 kPa (213 psi)
PTO Circuit Flow	1.9 L/m (0.5 gpm)

Repair Specifications

Control Arm Cap Screw Torque	73 N•m (54 lb-ft)
PTO Solenoid Armature Torque	22 N•m (195 lb-in.)
PTO Solenoid Nut Torque	4.9 N•m (43 lb-in.)
Transaxle Cover Cap Screws: Used Transaxle Case Torque	25 N•m (221 lb-in.)
Transaxle Cover Cap Screws: New Transaxle Case Torque	30 N•m (22 lb-ft)
PTO Output Shaft Retaining Cap Screws Torque	27 N•m (20 lb-ft)
PTO Shifter Shaft Cap Screw Torque	25 N•m (221 lb-in.)
PTO Ball Switches Torque	34 N•m (25 lb-ft)
PTO Clutch Pack Wear Clearance Between Plate and Bottom of Gear/Hub Groove	2.7 mm (0.106 in.) maximum
Charge Pump Cap Screws: Short Cap Screws Torque	25 N•m (221 lb-in.)
Long Cap Screw Torque	39 N•m (29 lb-ft)
Hydrostatic Motor Seal Cap Depth below Housing	4 mm (5/32 in.)
Hydrostatic Center Valve Block: Directional Control Valves Torque	35 N•m (26 lb-ft)

POWER TRAIN - HYDROSTATIC SPECIFICATIONS

Bottom Suction Plug Torque . . . . 50 N•m (37 lb-ft)
Charge Pressure Relief Valve Plug Torque . . . . 25 N•m (221 lb-in.)
Mounting Cap Screws Torque . . . . 39 N•m (29 lb-ft)
Axle Housing Cap Screws Torque . . . . 54 N•m (40 lb-ft)
King Pin Cap Screws Torque . . . . 54 N•m (40 lb-ft)
Transaxle to Frame Mounting Cap Screws and Nuts Torque . . . . 71 - 106 N•m (52 - 78 lb-ft)
Differential Cap Screws Torque . . . . 88 N•m (65 lb-ft)
Drive Shaft Cap Screws Torque . . . . 40 N•m (30 lb-ft)
Hydraulic Line Fittings Torque . . . . 24 N•m (212 lb-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
Temperature Gauge	JDG282	Used to test the hydraulic oil temperature.
Solenoid Valve Socket	JDG757A	Used to install solenoid armature.
Transmission Gear Spacer	JDT39	Used to disassemble and assemble PTO clutch assembly.
Bushing, Bearing and Seal Driver Set		Used to service bearings and seals.
Press		Used to remove and install axle shaft and bearings.
Snap Ring Pliers Set		Used to remove snap rings.
Knife-Edge Puller		Used to remove bearings.
Jack Stands		Used to support machine.
Lift Brackets or 8 mm Eyebolts		Used to remove and install transaxle.
Hoist		Used to remove and install transaxle.

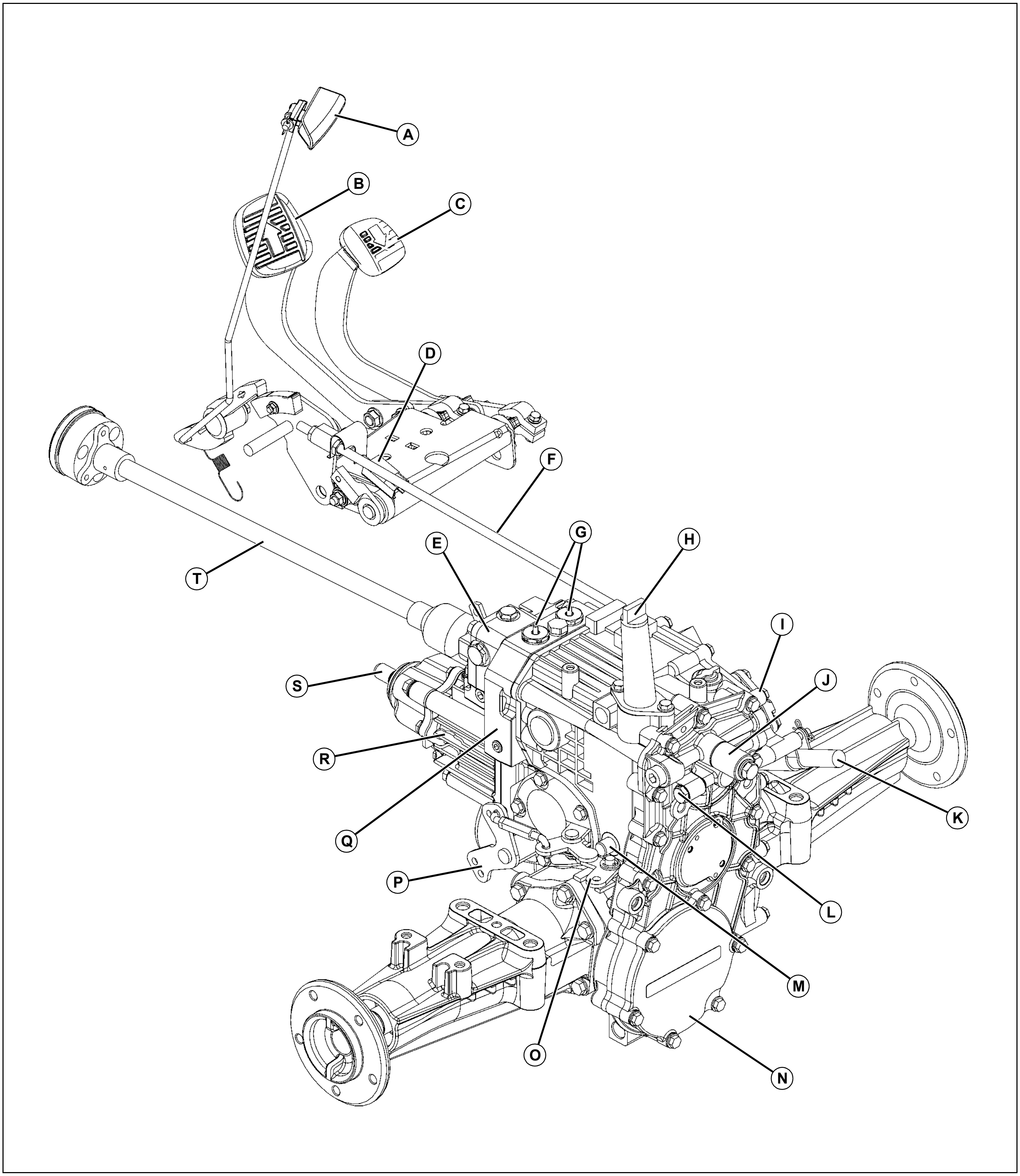
Other Materials

Other Material

Part No.	Part Name	Part Use
TY15130	John Deere Form-in-Place Gasket	Seal mating surfaces of transaxle.
TY6305/TY9485/#764	Cure primer	Clean thread of sealing surfaces.
TY9370/TY9477/#242	Thread Lock and Sealer (Medium Strength)	To seal threads on control valve screws, spool detent, and small plugs.

Component Location

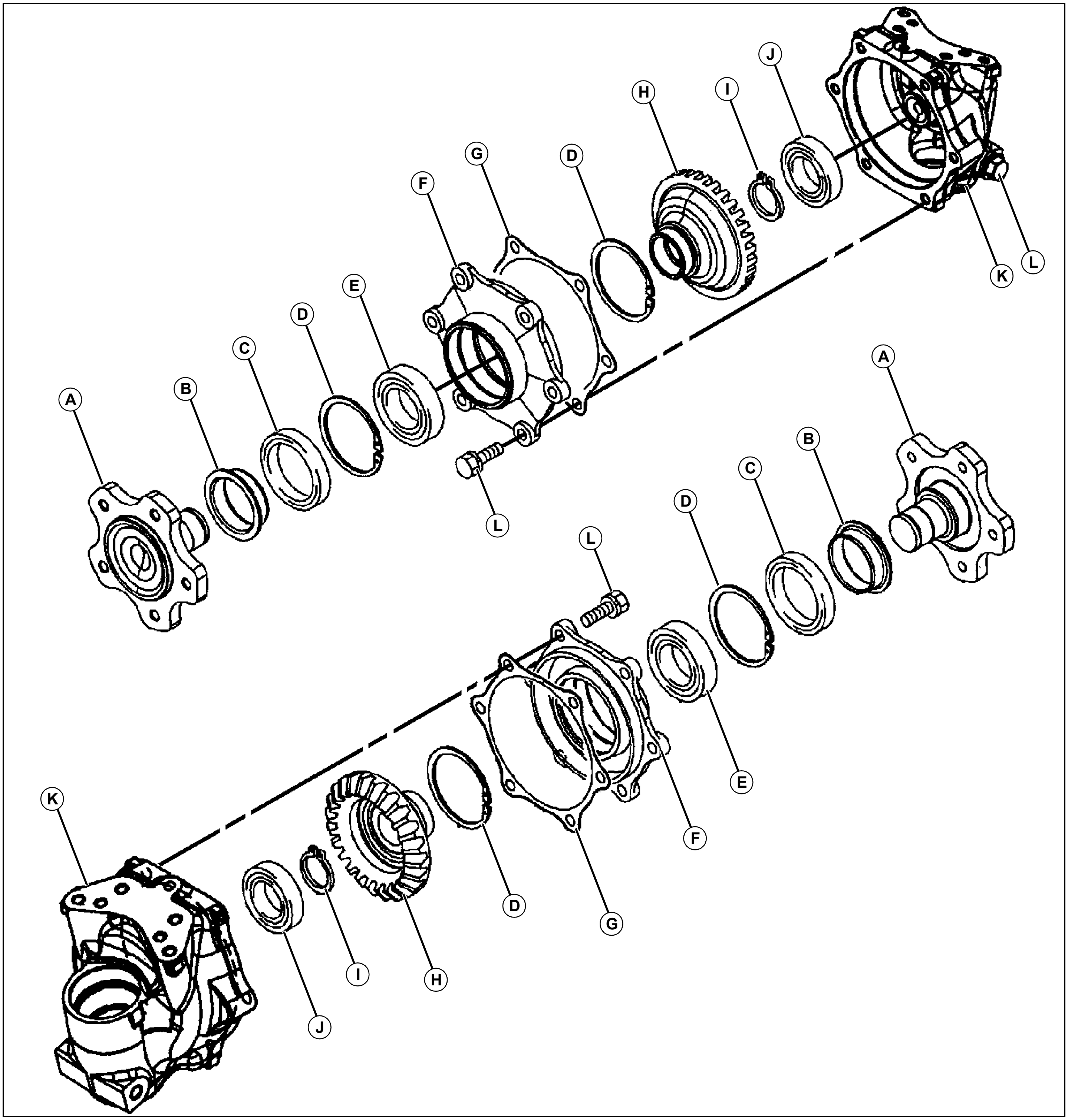
Hydrostatic Power Train



MX14200

A- Cruise Control Latch
B- Forward Pedal
C- Reverse Pedal
D- RIO Switch
E- Charge Pump
F- Control Rod
G- Control Valves
H- Oil Fill Tube
I- PTO Brake Cover
J- PTO Solenoid
K- Control Arm Damper
L- Control Valve
M- Differential Lock Shaft
N- Rear Cover Plate
O- Differential Lock Arm
P- Brake Arm
Q- Center Valve Block
R- Motor Case Assembly
S- Center PTO Shaft
T- Drive Shaft

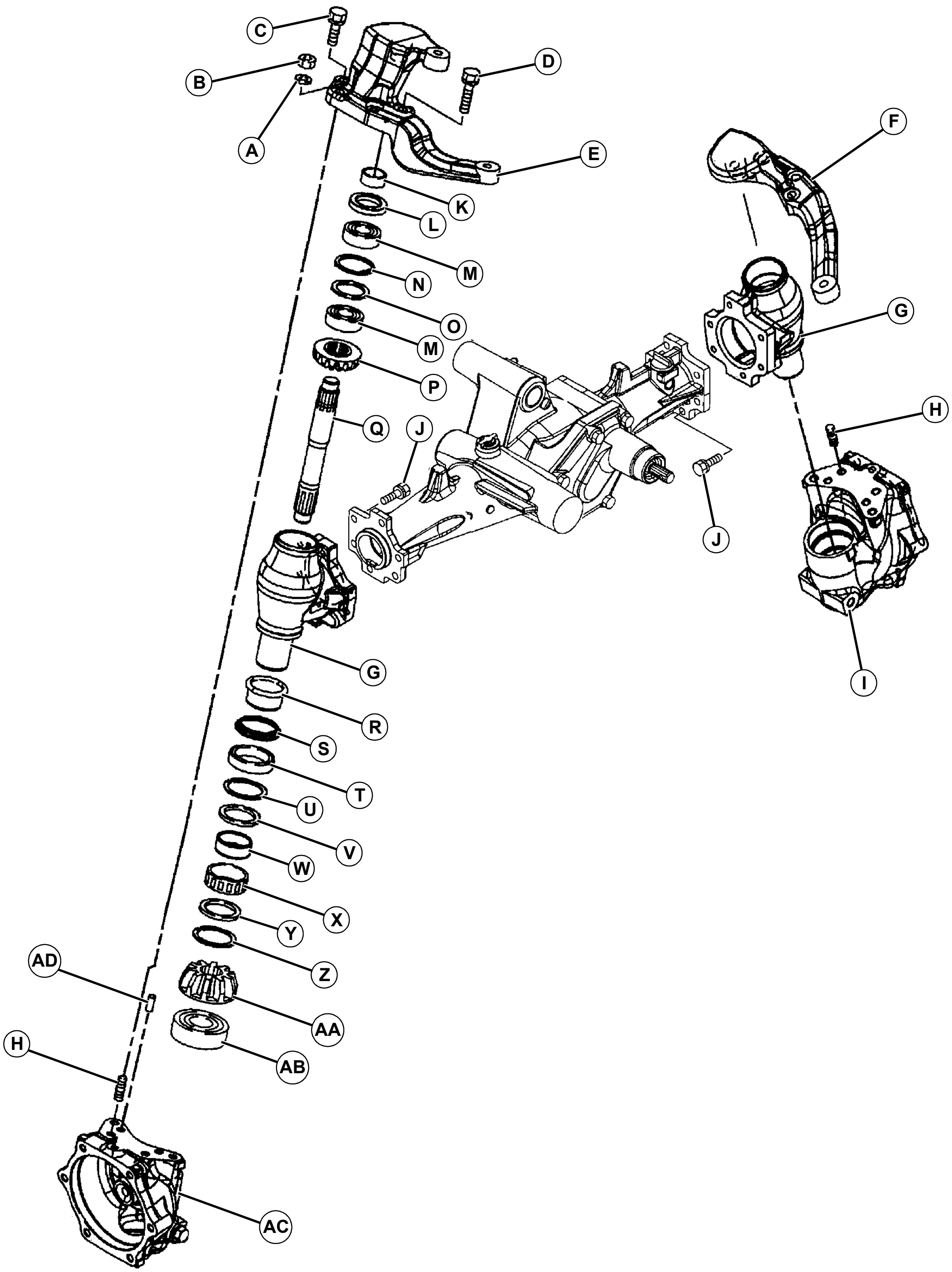
Final Drive (MFWD)



MX14348

A- Spindle
B- Sleeve
C- Seal
D- Snap Ring (4 used)
E- Ball Bearing
F- Case
G- Gasket
H- Final Gear
I- Snap Ring
J- Ball Bearing
K- Gearbox
L- Drain Plug

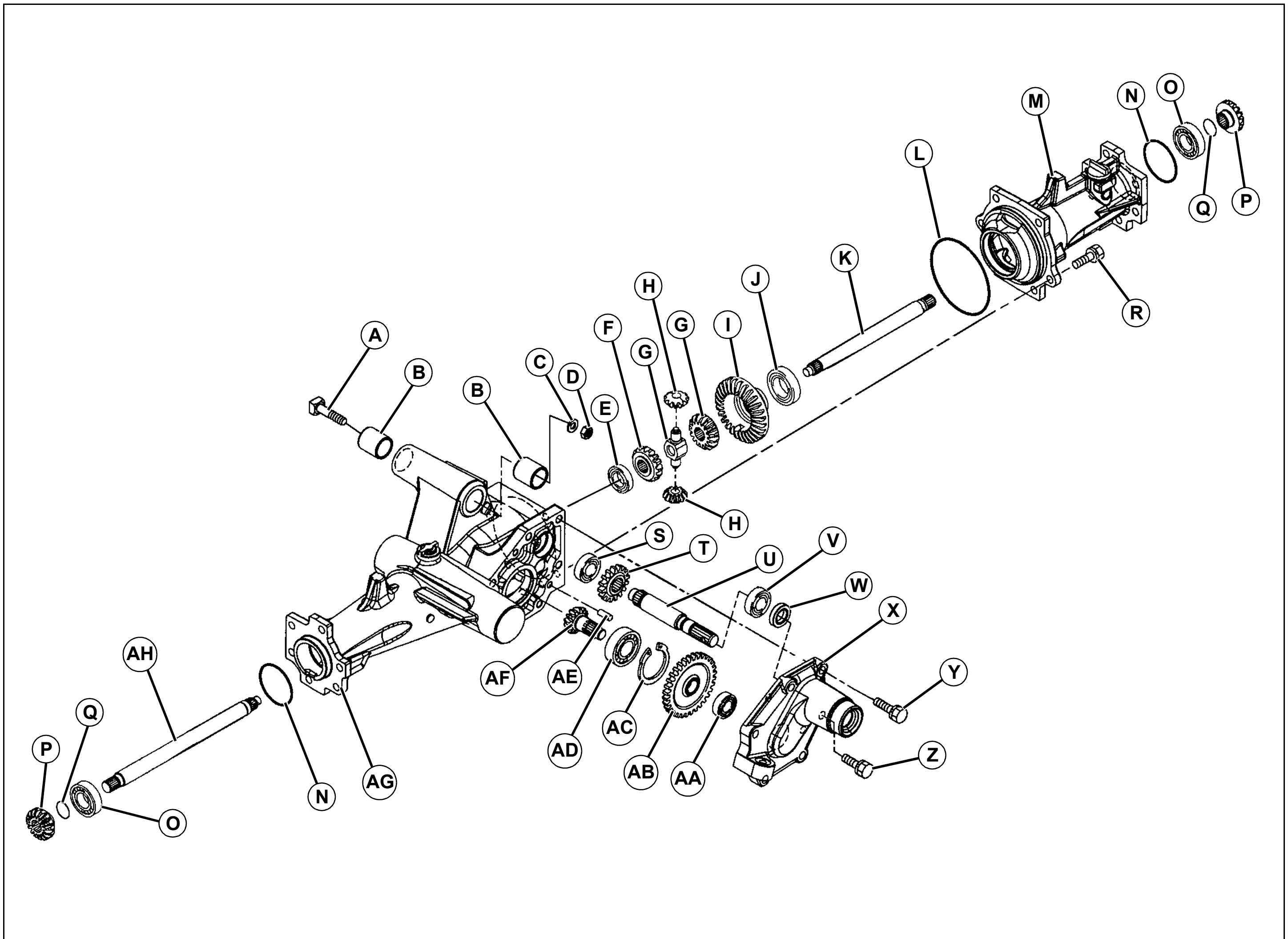
Front Axle Gear Case (MFWD)



MX14349

A- Washer
B- Nut
C- Cap Screw
D- Cap Screw
E- Bracket, Left
F- Bracket, Right
G- Gear Case, Front
H- Stud
I- Gear Box, Front Right
J- Cap Screw (12 used)
K- Sleeve
L- Seal
M- Ball Bearing
N- Snap Ring
O- Washer
P- Gear
Q- Shaft
R- Sleeve
S- Collar
T- Seal
U- Snap Ring
V- Washer
W- Bearing Race
X- Needle Bearing
Y- Washer
Z- Snap Ring
AA- Pinion, Final
AB- Ball Bearing
AC- Gear Box, Front Left
AD- Pin (4 used)

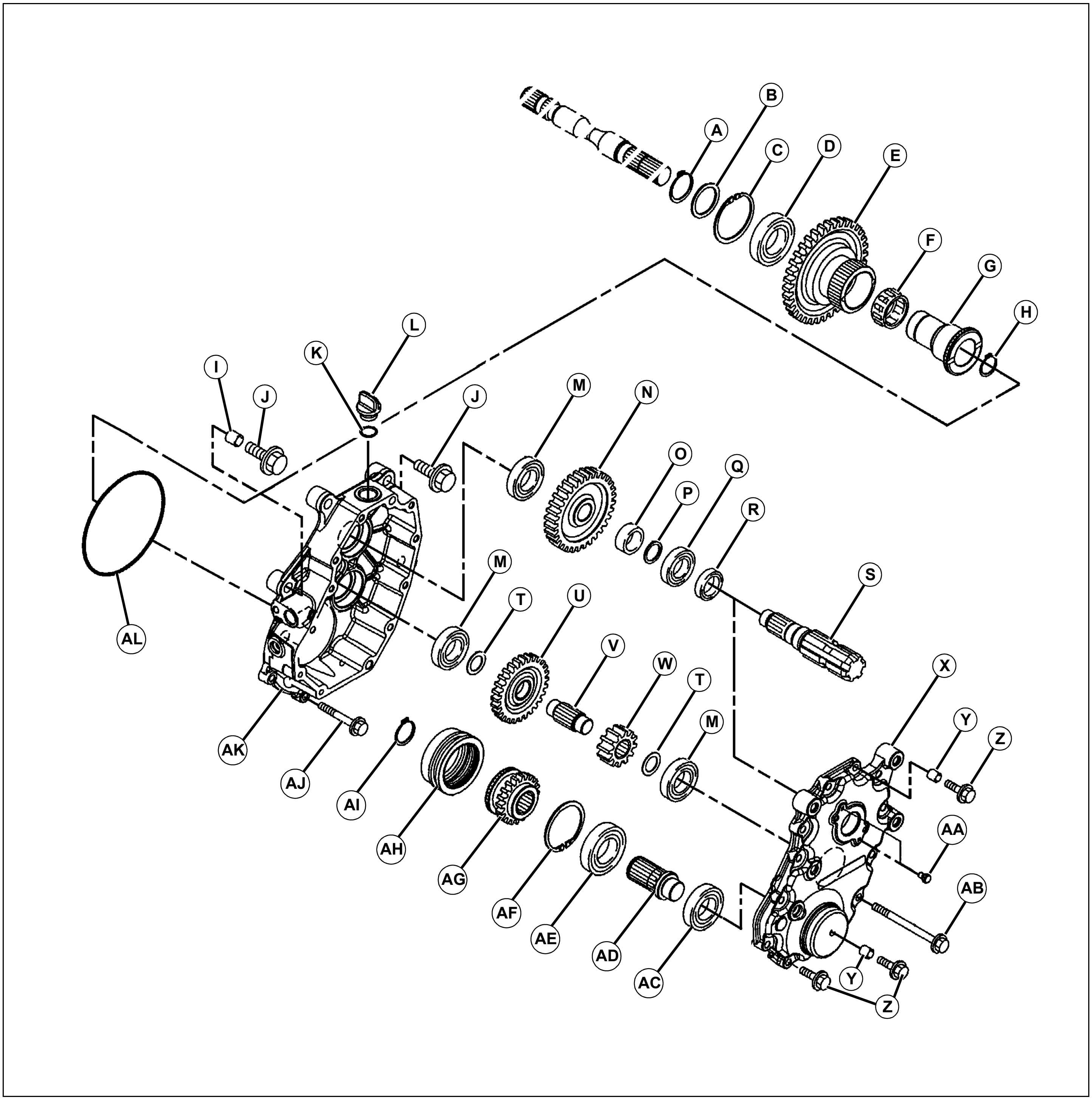
Front Axle Assembly (MFWD)



MX14350

A- Bolt
B- Bushing (2 used)
C- Washer
D- Lock Nut
E- Ball Bearing
F- Gear, Differential (2)
G- Shaft, Differential
H- Pinion, Differential (2)
I- Gear, Differential
J- Ball Bearing
K- Shaft, Right
L- O-Ring (2)
M- Axle Housing, Right
N- O-Ring
O- Ball Bearing
P- O-Ring
Q- Gear, Front
R- Cap Screw (6 used)
S- Ball Bearing
T- Gear
U- Input Shaft
V- Bearing
W- Seal
X- Cover
Y- Bolt
Z- Bolt
AA- Ball Bearing
AB- Gear
AC- Snap Ring
AD- Ball Bearing
AE- Dowel Pin
AF- Drive Pinion
AG- Differential Housing
AH- Shaft, Left

Rear PTO Gear Case Assembly

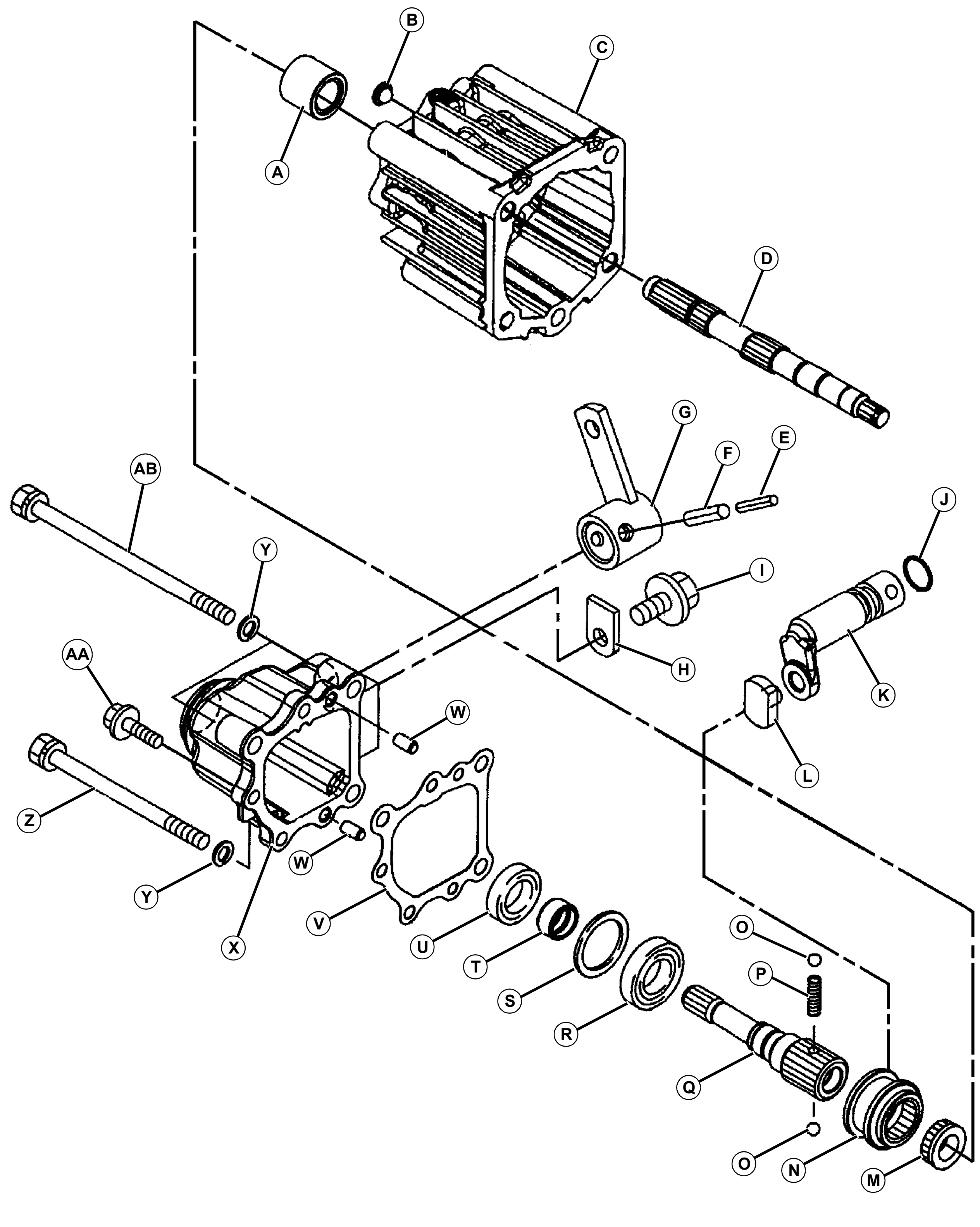


MX14322

- A- Snap Ring
- B- Spacer
- C- Snap Ring
- D- Bearing
- E- PTO Gear
- F- Needle Bearing
- G- Spline Collar
- H- Snap Ring
- I- Bushing
- J- Bolt
- K- O-Ring
- L- Cap
- M- Bearing (3 used)
- N- Gear, Rear PTO (35T)
- O- Bushing

P- Snap Ring
Q- Ball Bearing
R- Seal
S- PTO Shaft
T- Washer
U- Gear, Rear PTO (29T)
V- Idle Shaft, Rear PTO
W- Gear, Rear PTO (14T)
X- Cover
Y- Bushing
Z- Cap Screw
AA- Pin
AB- Cap Screw
AC- Ball Bearing
AD- Shaft, Rear PTO
AE- Ball Bearing
AF- Snap Ring
AG- PTO Gear (20T)
AH- Shift Collar
AI- Snap Ring
AJ- Cap Screw
AK- Case, Rear PTO
AL- O-Ring

MFWD Output Shaft



MX14346

A- Spacer
B- Strainer
C- Motor Housing
D- Motor Shaft
E- Spring Pin
F- Pin
G- Arm
H- Strap
I- Screw
J- O-Ring
K- Shaft
L- Shifter
M- Spline Collar
N- Shift Collar
O- Ball
P- Spring
Q- Front Drive Shaft
R- Ball Bearing
S- Washer
T- Sleeve
U- Seal
V- Gasket
W- Locating Sleeve (2 used)
X- Front Cover
Y- Lock Washer
Z- Bolt
AA- Cap Screw
AB- Bolt

Theory of Operation

Center Section and Directional Control Valves - Reverse System Operation

Note: Hydrostatic theory is not covered. See FOS Series Manuals.

Function:

The center section contains the closed loop passages between the variable displacement pump and the bi-directional, fixed displacement motor. It also contains the directional control valves. These valves control the flow of charge oil into the closed loop and block closed loop pressure from the charge circuit oil.

System Operation:

Charge oil from the charge pump enters the center section at port (C). Charge oil will open the closed loop check valve and enter the forward side of the closed loop when the reverse side has been pressurized by the hydrostatic pump. When the direction is reversed to provide forward direction, charge oil will then pressurize the reverse side of the closed loop.

The variable displacement hydrostatic pump pressurizes the reverse side loop, causing the fixed displacement motor to rotate. The reverse directional check valve blocks the closed loop pressure oil from entering the charge circuit.

The reverse directional check valve cartridge has a leak-off orifice. This orifice bleeds off a small amount of high pressure oil from the reserve closed loop back into the charge circuit. This provides for a wider neutral band to help prevent creep. This small leakage does not slow down reverse.

Free-Wheeling:

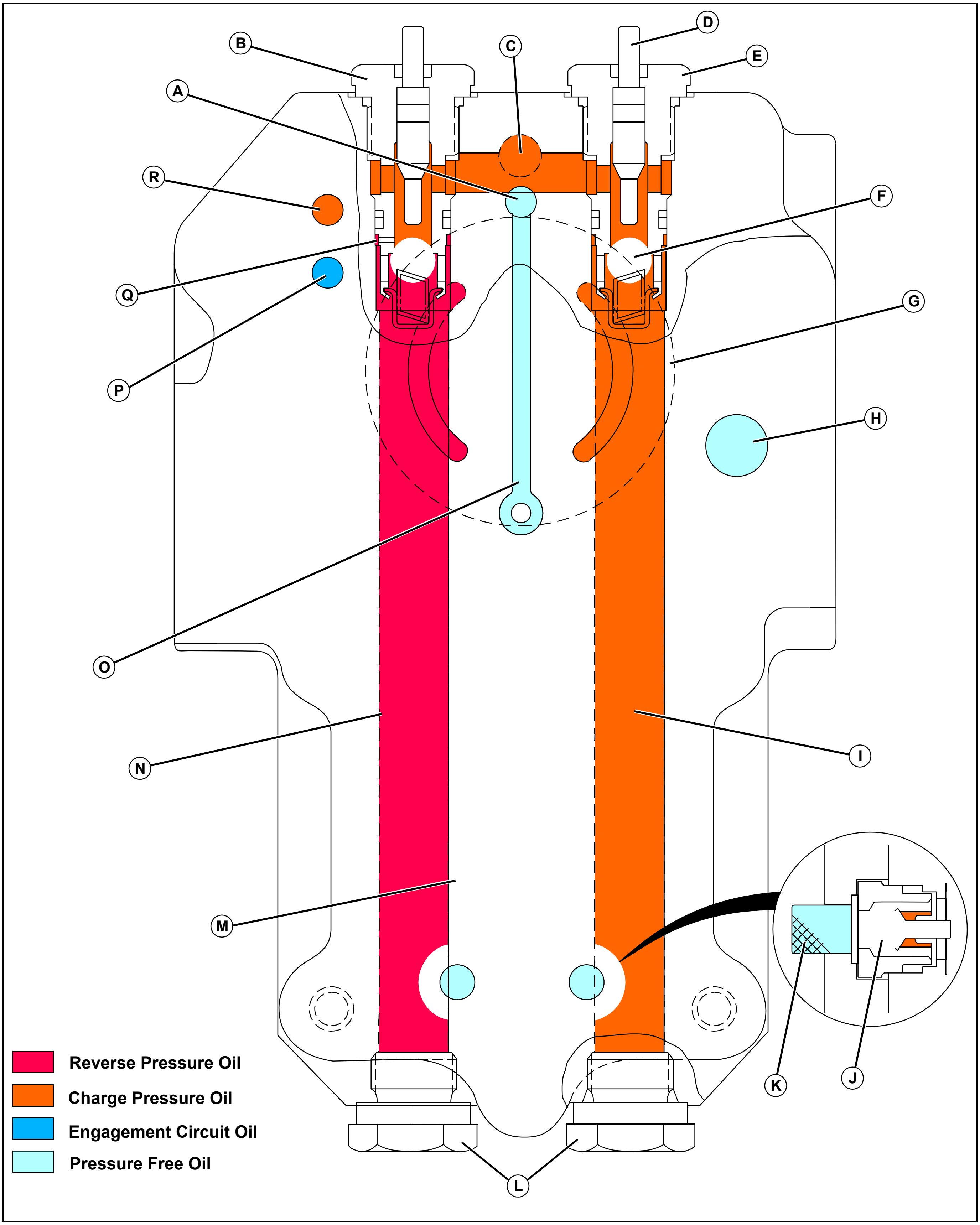
When the free-wheeling push pins are pushed down, the pins unseat the closed loop check valves, allowing oil flow created by the motor to escape into the charge circuit. This prevents oil pressure from building between the pump and motor, allowing the machine to be pushed.

Anti-Cavitation Valves:

These valves prevent cavitation of the motor during free-wheeling or when the motor overruns the pump (machine going down hill).

During free-wheeling, the free-wheeling valves are depressed and the engine is not turning the charge pump that supplies the charge oil. The hydrostatic motor pumps the closed loop oil out into the charge circuit; the anti-cavitation valves open, letting oil from the transaxle sump into the closed loop, preventing motor cavitation.

When the machine goes down a hill, the motor becomes the pump, going into a braking mode, and tries to overrun the pump. Closed loop pressure increases higher than the charge pressure, closing off the charge oil. Anti-cavitation valve then opens to make up oil lost through the pump, preventing pump cavitation.


A
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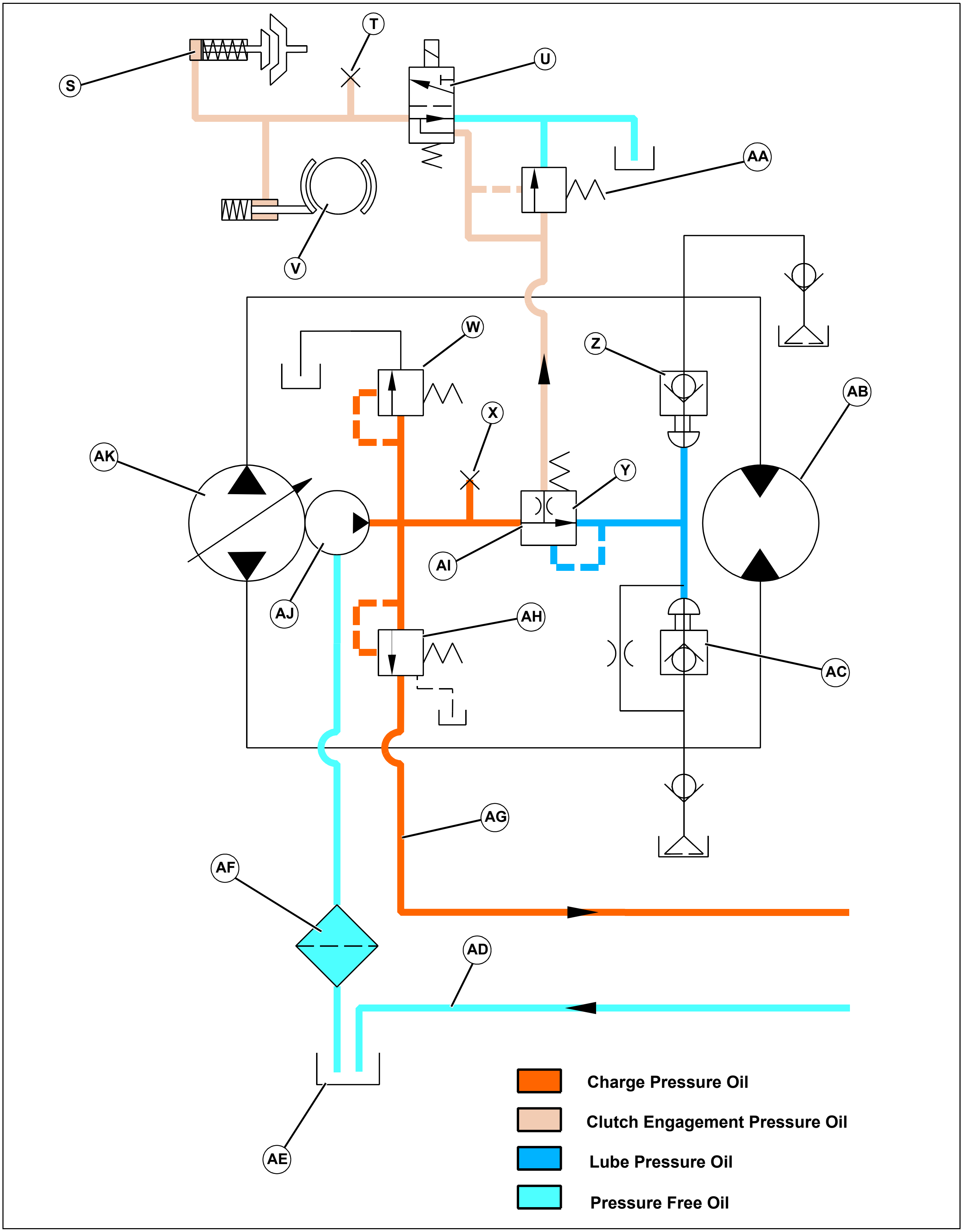
Reverse Pressure Oil
Charge Pressure Oil
Engagement Circuit Oil
Pressure Free Oil

MIF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Charge Pressure Oil
Clutch Engagement Pressure Oil
Lube Pressure Oil
Pressure Free Oil

MIF

A- Charge Pressure Relief Sump Passage
B- Reverse Directional Control Valve
C- Pressure Oil From Charge Pump
D- Freewheeling Manual Push Pins
E- Forward Directional Control Valve
F- Closed Loop Check Valve
G- Hydrostatic Pump
H- Inlet To Charge Pump
I- Forward Side Loop
J- Anti-Cavitation Check Valves
K- Screen
L- Plugs
M- Motor
N- Reverse Loop
O- Valve Plate Cooling Passage
P- Return From Oil Cooler
Q- Reverse Leakoff Orifice
R- To PTO Engagement Solenoid
S- Clutch Piston
T- PTO Pressure Test Port
U- PTO Engagement Solenoid
V- PTO Brake
W- Charge Pressure Relief Valve
X- Charge Pressure Test Port
Y- Lube Reduction Valve
Z- Directional Valve - Forward
AA- PTO Pressure Control Valve
AB- Hydrostatic Motor
AC- Directional Valve - Reverse
AD- Return From Steering Valve and Control Valve To Sump
AE- Transaxle Case
AF- Hydraulic Oil Filter
AG- Outlet To Steering Control Unit
AH- Charge Pressure Control Valve
AI- PTO Flow Orifice
AJ- Charge Pump
AK- Hydrostatic Variable Pump

Transaxle Oil Flow System Operation

Function:

Provide pressure oil to charge and lubricate the hydrostatic transmission, operate the hydraulic system and engage the PTO clutch and brake.

System Operation:

The charge pump draws oil from the transaxle case, through the filter and provides pressure oil to outlet galley of the pump. Three valves control the flow and pressure from the pump.

Charge Pressure Control Valve:

If charge pressure is below **1910 kPa (277 psi)**, the charge pressure control valve will block oil flow from leaving the “OUT” port to the steering valve. This will insure priority oil flow to the lube reduction valve for transmission lubrication.

When charge pressure is at **a minimum of 1958 kPa (284 psi)**, it will allow oil flow out the “OUT” port to steering and hydraulic control valve.

Charge Pressure Relief Valve:

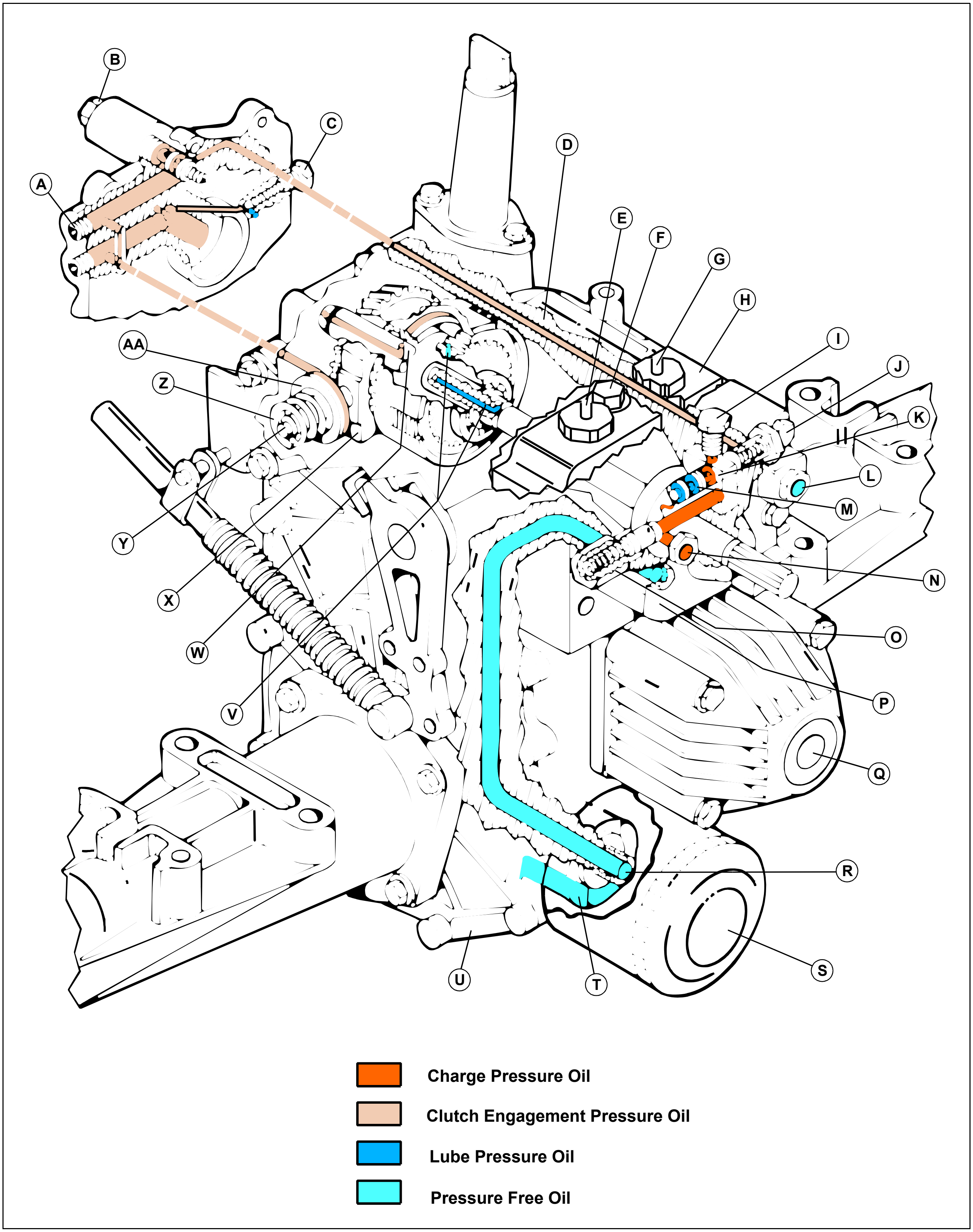
Charge pressure relief valve protects the hydraulic system and charge pump from excessive pressure. High pressure in the hydraulic circuit can be caused by an excessive load on the hydraulic outlets, or with nothing connected to the outlets when the control lever is moved.

Lube Reduction Valve:

The lube reduction valve has two functions:

1. If pressure in the lube and charge port exceeds **586 kPa (85 psi)**, it will close off the flow to the port, reducing lube and charge pressure.

2. This valve also has a small orifice that allows a small flow of oil to the engagement solenoid. Oil is available for clutch and brake engagement when PTO is engaged.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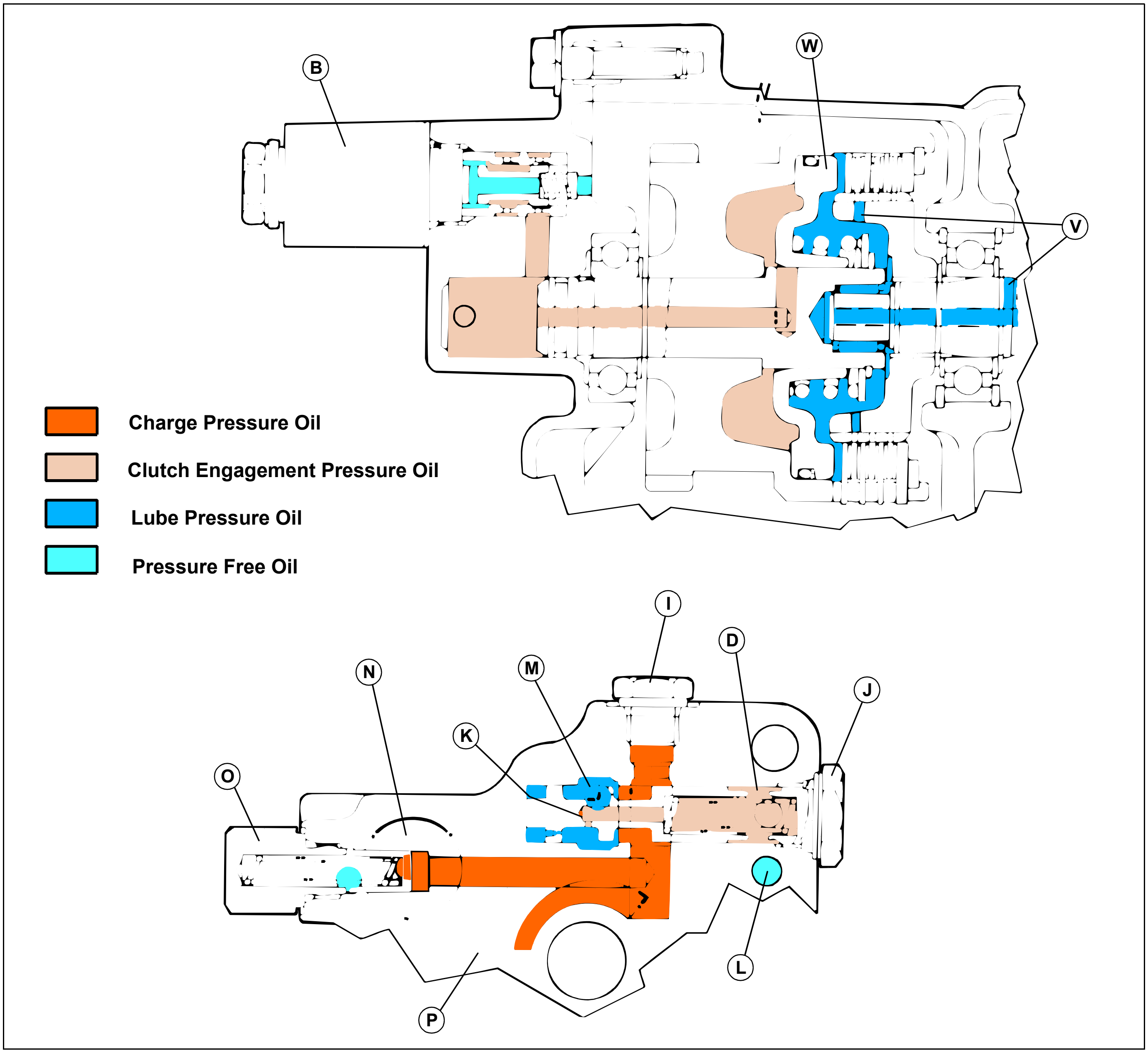
AA
Charge Pressure Oil
Clutch Engagement Pressure Oil
Lube Pressure Oil
Pressure Free Oil

MIF



MIF

A- Clutch and Brake Pressure Test Port
B- PTO Engagement Solenoid Valve
C- PTO Pressure Control Valve
D- Passage to Solenoid
E- Directional Valve - Forward
F- Charge Pressure Relief Valve
G- Directional Valve - Reverse
H- Center Section
I- Charge Pressure Test Port
J- Lube Reduction Valve
K- PTO Flow Orifice
L- Return From Cooler To Sump
M- Lube Passage To Hydrostatic Pump
N- Out to Steering
O- Charge Pressure Control Valve
P- Charge Pump
Q- Hydrostatic Motor
R- To Charge Pump
S- Filter
T- Inlet From Case
U- Transaxle Case
V- Clutch Lube Passage
W- Clutch Piston
X- Brake Shoe
Y- Brake Piston
Z- Brake Spring
AA- PTO Brake

External Power Train System Operation

System Operation:

The transaxle is a combination of a hydrostatic transmission, differential and axle assemblies. It also contains a hydraulic operated PTO clutch and brake with all associated drive train gears.

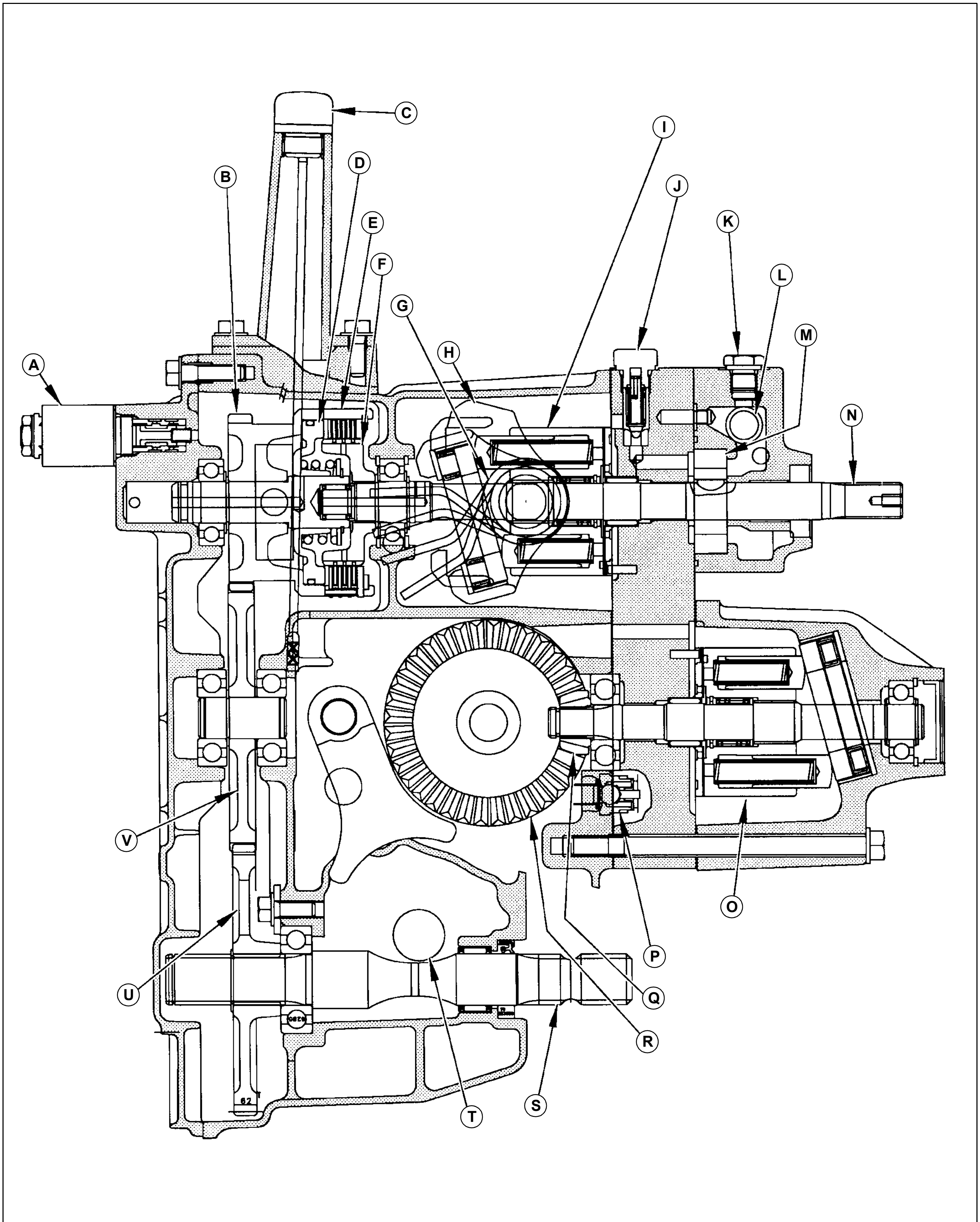
The drive shaft connects the engine to the input shaft of the transaxle. The input shaft rotates the charge pump, hydrostatic pump and PTO clutch drive hub. These components provide the power to operate the transaxle.

The transaxle is controlled by foot operated forward and reverse pedals. The pedal linkage is connected to the swash plate control lever that operates the internal swash plate shaft, controlling the direction and amount of output of the hydrostatic pump to the hydrostatic motor. The damper (shock absorber) provides for a smooth operation of the control linkage and also provides the pedal “feel”.

The differential lock pedal and linkage are located on the left-hand side of the transaxle. When the pedal is depressed, the linkage holds the internal differential lock lever, collar and pins under spring tension. This is done because if the lock pins do not line up with the holes in the differential, the lock will not engage. When the holes do line up with the pins, the spring will force the pins to engage.

The free-wheeling linkage is accessible from the right rear of the machine. When the linkage is moved up, the directional control valves are depressed, allowing the closed loop circuit to by-pass, allowing the machine to be pushed.

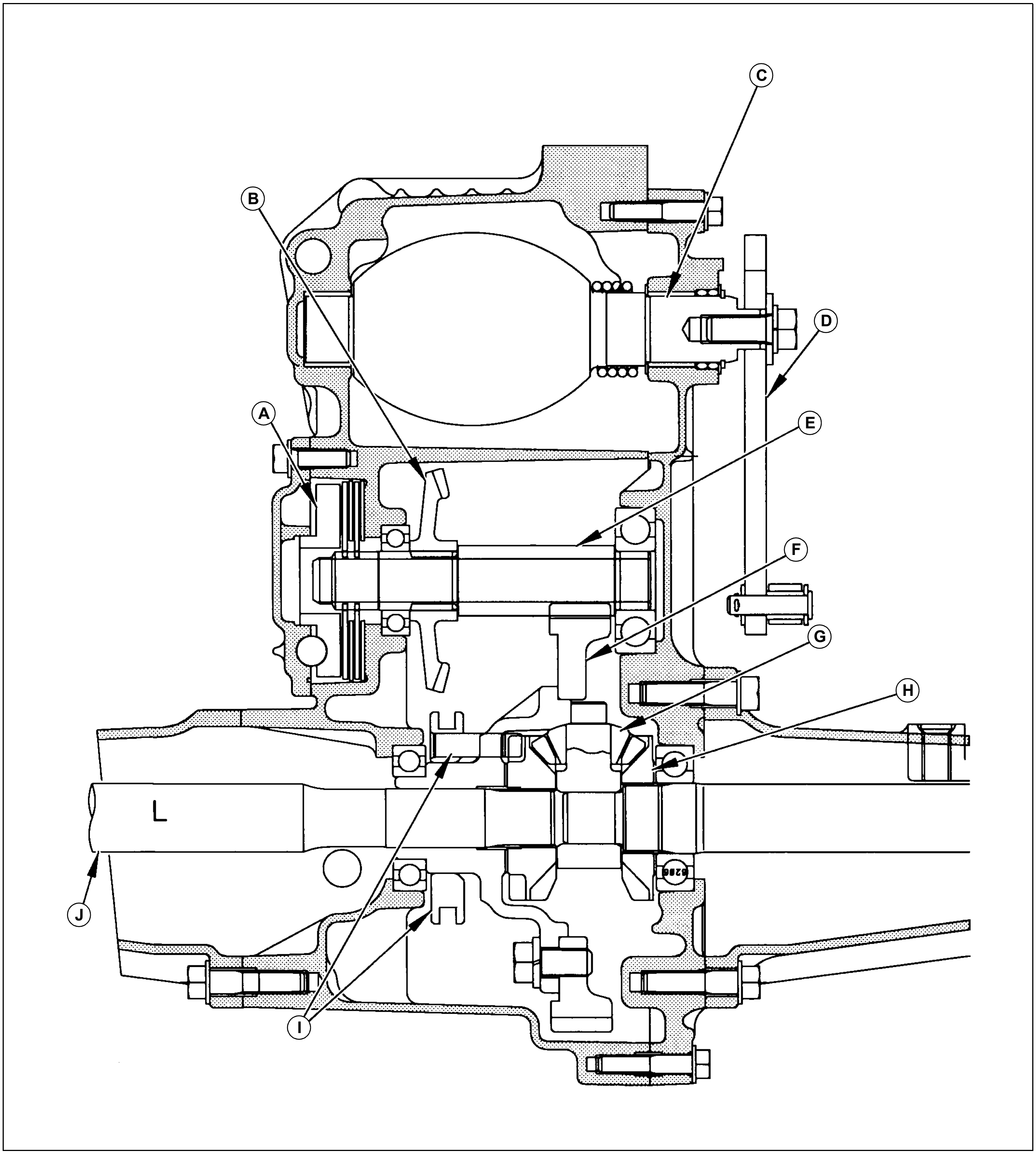
Transaxle Internal System Operation



MX11457

Picture Note: Side View Shown

A- PTO Electrical Engagement Solenoid
B- PTO Clutch Hub and Gear
C- Dip Stick
D- PTO Piston
E- PTO Clutch
F- PTO Drive Gear
G- Neutral Centering Spring
H- Swash Plate
I- Hydrostatic Pump
J- Charge Pressure Relief Valve
K- Charge Pressure Test Port
L- Lube Reduction Valve
M- Charge Pump
N- Input Shaft
O- Hydrostatic Motor
P- Anti-Cavitation Valves
Q- Input Pinion Gear
R- Ring Gear
S- PTO Output Shaft
T- Left Axle
U- PTO Driven Gear
V- PTO Idler Gear



MX14458

Picture Note: Rear View Shown

A- Brakes
B- PTO Output Shaft
C- Swash Plate Shaft
D- Swash Plate Control Lever
E- Differential Input Gear
F- Differential Ring Gear
G- Differential Bevel Pinions
H- Differential Side Gears
I- Differential Shift Collar and Pin
J- Left Axle

Transaxle Operation:

The transaxle consists of an internal hydrostatic pump and external hydrostatic motor, differential assembly and a hydraulic PTO clutch and gearing to the PTO output shaft.

Whenever the engine is running, the drive shaft is turning the input shaft, charge pump and PTO drive gear.

The charge pump provides charge and lubrication oil for the hydrostatic pump, motor and PTO clutch lube. It also provides pressure oil to operate the PTO clutch and supply oil for the steering valve and hydraulic control valve. See Steering and/or Hydraulics sections.

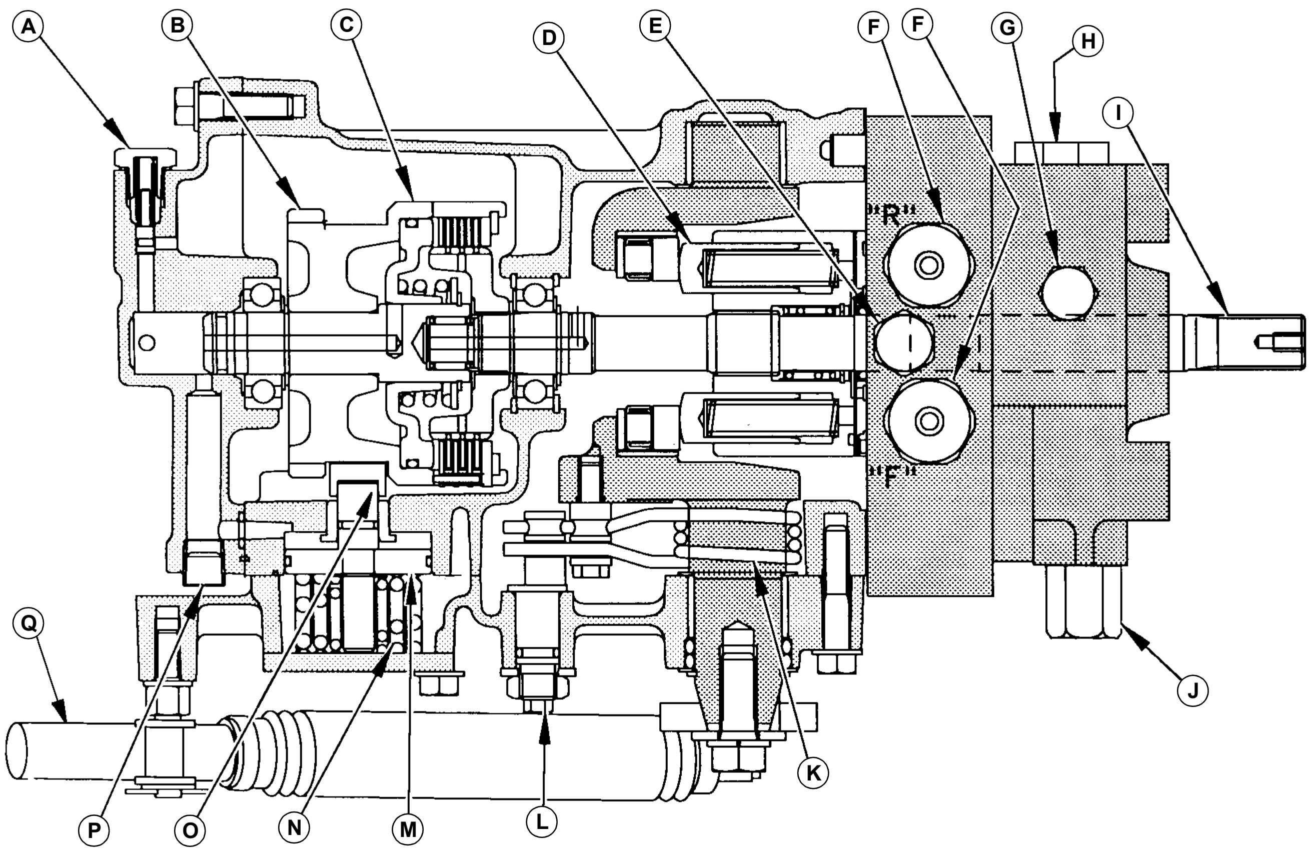
The hydrostatic pump, controlled by the foot control linkage and swash plate, provides direction and speed of the closed loop pressure oil to the hydrostatic motor. The motor drives the input pinion gear. Power is then transmitted through the ring gear, differential input gear and differential ring gear. Differential action to the rear axles and wheels is provided through the bevel pinions and side gears.

When the differential lock is engaged, the differential collar and pins lock the left-hand axle and side gear to the differential carrier, turning both axles at the same rate.

PTO Operation:

When the PTO is engaged, the electrical engagement solenoid allows pressure oil, supplied by the charge pump, to engage the PTO clutch and release the PTO brake. The PTO clutch is applied when pressure oil moves the PTO piston, squeezing the clutch disk together. With the disks locked together, power is then transmitted by the PTO clutch hub and gear, through the idler gear and driven gear and out the case through the output shaft.

The PTO brake is released at the same time the clutch is applied. Pressure oil moves the brake piston out against brake spring pressure, releasing the brake. When the PTO is shut off, the engagement solenoid blocks the pressure oil and the brake springs push the piston and brake shoe against the PTO clutch hub and gear. Frictional force stops the rotation of the PTO drive train. See “Transaxle Oil Flow System Operation” on page 250.



M55426a

A- PTO Pressure Control Valve
B- PTO Clutch, Hub and Gear
C- PTO Clutch
D- Hydrostatic Pump
E- Charge Pressure Relief Valve
F- Directional Control Valves
G- Charge Pressure Test Port
H- Lube Reduction Valve
I- Input Shaft
J- Charge Pressure Control Valve
K- Neutral Centering Spring
L- Neutral Adjustment Eccentric
M- PTO Brake Piston
N- PTO Brake Springs
O- PTO Brake
P- PTO Pressure Test Port
Q- Damper (Shock Absorber)

Rear PTO Component Location and Operation - Optional

Function:

To provide 540 rear PTO drive.

Theory of Operation:

The mid-PTO and the rear PTO kits, use a common power flow up to the shift collar. To have power to either or both PTO's the operator must be on the seat and PTO clutch must be engaged. Power is then transmitted from the input shaft through the clutch disks and out the clutch hub and gear, idler gear, PTO drive gear and into shift collar. The shift collar has three detented positions. It is moved by the shift fork that is controlled by the external shift lever.

Rear PTO:

When the shift collar is positioned in the rear detent (shift lever up), the collar connects and drives only the rear PTO drive gear. Power then flow through the reduction gear set and PTO output gear, out the rear coupler. A boss on the shift fork depresses the mid-PTO switch, turning off the mid-PTO indicator light on the dash.

Mid- and Rear PTO:

When the shift collar is in the middle detent position, the shift collar picks up both the rear and mid-PTO drive gears. Both PTO output shafts are powered. The shift fork boss is not depressing either of the PTO switches, leaving both PTO indicator lights on.

Mid-PTO:

When the collar is positioned in forward detent (shift lever down) the collar connects and drives only the mid-PTO shaft. A boss on the shift fork depresses the rear PTO switch and turns the indicator light on the dash off.

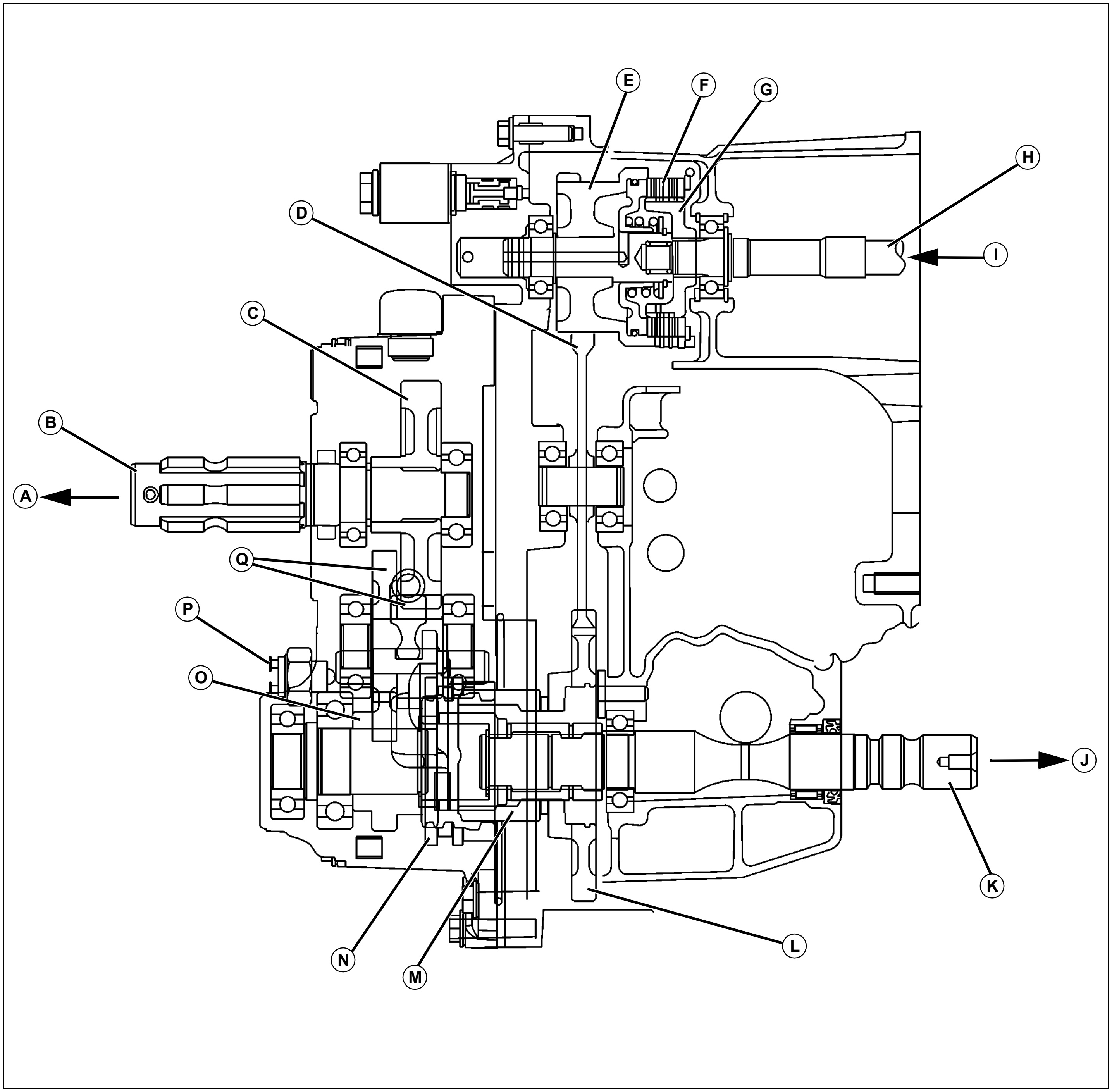
Stationary PTO Operation:

For the rear PTO to operate with operator off seat, a start-up sequence must be followed:

1. Engine off. PTO switch off. PTO drive line connected and shields in place.
2. Park brake set.
3. Rear PTO lever positioned up for rear PTO operation.
4. Engine can be started with operator on or off seat.
5. Operator off seat. Pull PTO switch on.

Note: If seat switch is activated by touching or sitting on seat, PTO will disengage. Repeat procedure to engage PTO.

540 Rear PTO



MX16044

A- Rear PTO Power Flow
B- Rear PTO Shaft
C- PTO Output Gear
D- Idler Gear
E- Clutch and Hub Gear
F- Clutch Disk
G- PTO Clutch Gear
H- Input Shaft
I- Common Power Flow to Shift Collar
J- Mid-PTO Power Flow
K- Mid-PTO Shaft
L- PTO Drive Gear
M- Mid-PTO Drive Gear
N- Shift Collar
O- Rear PTO Drive Gear
P- Rear PTO Switch
Q- Reduction Gear Set

Diagnostics

Hydrostatic Transmission Diagnosis

Symptom: Hydrostatic Transmission Problems

Problem	Cause - Solution
1. Machine will not move on its own power?	a. No: Go to next step. b. Yes: Free-wheeling linkage set for push or partially set. Control pedal linkage bent, binding or disconnected. Directional control valves leaking or stuck down. Brakes set or not releasing. See Brakes section. Anti-cavitation valves leaking or stuck open. Charge pump scored or worn. Pump or motor valve plates scored or worn. Filter pugged or suction side air leak. Check filter, charge pump or case seal. Charge pressure relief valve leaking. Seat valve or spring damaged. Drive shaft not turning pump input shaft or charge pump key sheared.
2. Machine will not move. Wheels locked up. Can not be pushed?	a. No: Go to next step. b. Yes: Brakes set or not releasing. See Brakes section.
3. Will not move in one direction?	a. No: Go to next step. b. Yes: Free-wheeling linkage set for push or partially set. Control pedal linkage bent, binding or disconnected. Directional control valves leaking or stuck down. Directional valve in wrong location. Anti-cavitation valves leaking or stuck open. Pump or motor valve plates scored or worn.

Symptom: Hydrostatic Transmission Problems

Problem	Cause - Solution
4. Too aggressive in reverse?	a. No: Go to next step. b. Yes: Free-wheeling linkage set for push or partially set. Linkage damper (shock absorber) failed. Directional control valves leaking or stuck down. Pump or motor valve plates scored or worn.
5. Slow forward under load, or speed drops when load is applied?	a. No: Go to next step. b. Yes: Forward pedal height needs to be adjusted. Free-wheeling linkage set for push or partially set. Control pedal linkage bent, binding or disconnected. Directional control valves leaking or stuck down. Drive shaft not turning pump input shaft or charge pump key sheared. Anti-cavitation valves leaking or stuck open. Directional valve in wrong location. Charge pump scored or worn. Pump or motor valve plates scored or worn. Filter pugged or suction side air leak. Check filter, charge pump or case seal. Engine performance is poor or not operating or set at correct operating speeds. See Engine diagnosis.

Symptom: Hydrostatic Transmission Problems

Problem	Cause - Solution
6. Erratic speed?	a. No: Go to next step.
	b. Yes: Free-wheeling linkage set for push or partially set. Linkage damper (shock absorber) failed. Control pedal linkage bent, binding or disconnected. Brakes set or not releasing. See Brakes section. Directional control valves leaking or stuck down Drive shaft not turning pump input shaft or charge pump key sheared. Anti-cavitation valves leaking or stuck open Charge pump scored or worn Pump or motor valve plates scored or worn Filter pugged or suction side air leak. Check filter, charge pump or case seal Charge pressure relief valve leaking. Seat valve or spring damaged Swash plate control shaft or bushing worn. Engine performance is poor or not operating or set at correct operating speeds. See Engine diagnosis
7. Machine will not stop?	a. No: Go to next step.
	b. Yes: Free-wheeling linkage set for push or partially set. Control pedal linkage bent, binding or disconnected. Brakes set or not releasing. See Brakes section. Neutral adjustment not correct. Anti-cavitation valves leaking or stuck open. Swash plate control shaft or bushing worn.
8. PTO problem or complaint?	a. No: Go to next step.
	b. Yes: For mid or rear PTO problems or complaints, see "Mid-PTO System Diagnosis" on page 262.

Symptom: Hydrostatic Transmission Problems

Problem	Cause - Solution
9. Transaxle or differential lock problem or complaint?	a. No: Go to next step.
	b. Yes: See "Hydrostatic Transmission Test" on page 264.
10. Transmission operating hot?	a. No: Go to next step.
	b. Yes: Free-wheeling linkage set for push or partially set. Control pedal linkage bent, binding or disconnected. Brakes set or not releasing. See Brakes section. Neutral adjustment not correct. Oil cooler may be plugged with debris. Directional control valves leaking or stuck down. Anti-cavitation valves leaking or stuck open. Charge pump scored or worn. Pump or motor valve plates scored or worn. For mid or rear PTO problems or complaints, see "Mid-PTO System Diagnosis" on page 262.
11. Hydraulic noise?	a. No: Go to next step.
	b. Yes: Free-wheeling linkage set for push or partially set. Brakes set or not releasing. See Brakes section. Neutral adjustment not correct. Drive shaft not turning pump input shaft or charge pump key sheared. Directional control valves leaking or stuck down. Anti-cavitation valves leaking or stuck open. Charge pump scored or worn. Pump or motor valve plates scored or worn. Filter pugged or suction side air leak. Check filter, charge pump or case seal. Charge pressure relief valve leaking. Seat valve or spring damaged. Swash plate control shaft or bushing worn. For mid or rear PTO problems or complaints, see "Mid-PTO System Diagnosis" on page 262.

Symptom: Hydrostatic Transmission Problems

Problem	Cause - Solution
12. Gear noise, dependant on speed, direction of travel or during turn?	a. No: Go through procedures in "Hydrostatic Transmission Test" on page 264 for additional tests. b. Yes: Brakes set or not releasing. See Brakes section. Drive shaft not turning pump input shaft or charge pump key sheared. Charge pump scored or worn. Pump or motor valve plates scored or worn. Filter pugged or suction side air leak. Check filter, charge pump or case seal. For mid or rear PTO problems or complaints, see "Mid-PTO System Diagnosis" on page 262.

Mid-PTO System Diagnosis

Symptom: Mid PTO Engagement Problems

Problem	Cause - Solution
1. PTO will not engage?	a. No: Go to next step. b. Yes: Check engagement solenoid circuit. See Electrical section. PTO switch not working. PTO lube reduction valve orifice plugged. Engagement valve installed incorrectly. PTO pressure control valve faulty. PTO clutch piston leaking, input shaft seal leaking or clutch disk worn. Low charge pump output. PTO shaft, gear or bearing failure.
2. Engine stalls when PTO is engaged?	a. No: Go to next step. b. Yes: Excessive load on PTO output. Remove load. Use higher engine rpm. Check engine performance. Hydraulic circuit in relief. Remove restriction or load. PTO brake not releasing. Check brake piston, O-Rings. PTO shaft, gear or bearing failure.

Symptom: Mid PTO Engagement Problems

Problem	Cause - Solution
3. PTO will not stay engaged?	a. No: Go to next step. b. Yes: Check engagement solenoid circuit. See Electrical section. Engagement valve installed incorrectly. PTO clutch piston leaking, input shaft seal leaking or clutch disk worn. PTO lube reduction valve orifice plugged. Low charge pump output. PTO pressure control valve faulty.
4. Gear or bearing noise with PTO engaged?	a. No: See "Mid-PTO System Test" on page 265. b. Yes: PTO brake not releasing. Check brake piston, O-Rings. PTO brake springs faulty.

Symptom: Mid PTO Speed Problems

Problem	Cause - Solution
1. PTO shaft slows down?	a. No: Go to next step. b. Yes: Excessive load on PTO output. Remove load. Use higher engine rpm. Check engine performance. PTO lube reduction valve orifice plugged. Low charge pump output. PTO pressure control valve faulty. PTO clutch piston leaking, input shaft seal leaking or clutch disk worn.
2. PTO shaft will not stop, or slow to stop?	a. No: Go through procedures in "Mid-PTO System Test" on page 265 for additional tests. b. Yes: Check engagement solenoid circuit. See Electrical section. Engagement valve installed incorrectly. PTO brake not releasing. Check brake piston, O-Rings. Excessive load on PTO output. Remove load. PTO brake springs faulty.

Transaxle Diagnosis

Symptom:

Problem	Cause - Solution
1. PTO complaint?	a. No: Go to next step. b. Yes: See Mid-PTO or rear PTO diagnosis. See Transaxle Repair.
2. Hydrostatic transmission complaint?	a. No: Go to next step. b. Yes: Brakes are applied or mis-adjusted. See Brakes section.
3. Rear drive wheel are locked up; will not move directional pins down?	a. No: Go to next step. b. Yes: Brakes are applied or mis-adjusted. See Brakes section. Differential lock collar, pin or differential carrier failure. Check axle or differential gear failure. See axle or differential repair. See "Transaxle Test" on page 266. See "Repair" on page 275.
4. Rear wheel free-wheel; no transaxle drive; hydraulic control valve pins are up?	a. No: Go to next step. b. Yes: Check axle or differential gear failure. See axle or differential repair. Differential lock collar, pin or differential carrier failure. See "Transaxle Test" on page 266. See "Repair" on page 275.
5. Differential lock will not engage?	a. No: Go to next step. b. Yes: Differential lock linkage is mis-adjusted. Differential lock collar, pin or differential carrier failure. See "Repair" on page 275.
6. Differential lock will not disengage?	a. No: See "Transaxle Test" on page 266. b. Yes: Brakes are applied or mis-adjusted. See Brakes section. Differential lock linkage is mis-adjusted. Differential is engaged. Check adjustment. Adjustment ok = repair differential lock. Differential lock collar, pin or differential carrier failure. See Repair section for repair procedures.

Symptom: Transaxle Noise Problems

Problem	Cause - Solution
1. Ratcheting noise as machine moves?	a. No: Go to next step. b. Yes: Brakes are applied or mis-adjusted. See Brakes section. Differential lock linkage is mis-adjusted. Differential is engaged. Check adjustment. Adjustment ok = repair differential lock. Differential lock collar, pin or differential carrier failure. Check axle or differential gear failure. See axle or differential repair. See "Repair" on page 275 for repair procedures.
2. Ratcheting noise as machine turns?	a. No: Go through procedures in "Transaxle Test" on page 266 for additional tests. b. Yes: Differential lock linkage is mis-adjusted. Differential is engaged. Check adjustment. Adjustment ok = repair differential lock. Differential lock collar, pin or differential carrier failure. Check axle or differential gear failure. See axle or differential repair. See Repair section for repair procedures.

Hydrostatic Transmission Test

Engine NOT running:

Test Conditions:

- Park brake disengaged.
- Engine not running.
- Machine on hard level surface.

Hydrostatic Transmission

1. When checking transmission dipstick, correct type, viscosity of oil, and oil level? No signs of leaks from transaxle?

Yes: Go to next step.

No: Add or change hydraulic oil. Repair all external leaks.

2. Oil cooler/radiator intake screen and cooler fins free of debris and clean? Fins not bent?

Yes: Go to next step.

No: Clean as required.

3. Hydraulic control levers return to neutral position?

Yes: Go to next step.

No: Hydraulic control levers not in neutral; hydraulic system could be in relief. See Hydraulics section and check linkage for binding.

4. With free-wheeling lever disengaged (DOWN), machine free-wheels in both directions?

No: Go to next step.

Yes: Free-wheeling linkage not releasing directional control valve pins.

Yes: Directional control pins stuck down.

5. With free-wheeling lever disengaged (DOWN), machine pushes in reverse but not forward?

No: Go to next step.

Yes: Directional control valves are installed in wrong ports. Switch valves around.

Yes: Forward valve is leaking. Replace forward valve.

6. With free-wheeling lever disengaged (DOWN), machine free-wheels with brakes applied?

No: Go to next step.

Yes: Adjust brakes. (See Brakes section.)

Yes: If brakes do not stop machine, check for the following: (NOTE: Push machine until differential lock engages.) Failed brake shaft or bearing, failed differential input gear or differential carrier, or check differential bevel gears.

7. With free-wheeling lever disengaged (DOWN), machine stops after differential lock engages?

No: Go to next step.

Yes: Differential bevel gears or axles will not push in either direction.

Yes: Brakes are on or dragging.

Yes: Reverse orifice is plugged.

8. With free-wheeling lever engaged (UP), machine pushes easily forward and backward?

Yes: Go to next step.

No: Free-wheel lever is bent, disconnected from Left-Hand bracket, or not pushing directional control valve pins. Repair linkage.

No: Check directional control valve pins for dirt or corrosion that would bind pins.

No: Check brakes for dragging.

9. Transmission control pedals (brakes disengaged) and linkage move smoothly with slight resistance to movement? (NOTE: Linkage will return slower at colder temperatures.) No free-play in linkage between pedals and swash plate shaft?

Yes: Go to next step.

No: Inspect linkage for bent, binding or looseness

No: If pedals do not return to neutral, disconnect damper (shock). Pedals should return sharply.

No: Disconnect control rod from swash plate arm. Check linkage for binding and repair.

No: Linkage not binding - check swash plate shaft for binding or internal return/centering spring or swash plate bushing binding.

10. Transmission control pedals and linkage: With brake pedal engaged, forward and reverse pedal should be locked in neutral? (Engage free-wheeling lever and push machine to verify.)

Yes: Go to next step.

No: Pedals not locked in neutral. See “Transaxle Control Linkage Adjustment” on page 272.

No: Brakes not holding machine. See Brakes section and adjust.

11. To check cruise control lever and linkage (if equipped), push forward pedal slightly and set cruise. (Brake pedal released.) Does cruise control release when forward pedal is pressed and released or brake pedal is depressed?

Yes: Hydrostatic transmission (engine OFF) checks completed.

No: Check linkage for bent, binding or disconnected links.

No: Check cam teeth for wear if cruise will not stay engaged.

Engine running:

Test Conditions:

- Start engine.
- Release park brake.
- Move machine to open area for driving test.

Hydrostatic Transmission

1. With parking brake applied, does machine have excessive noise when operated?

No: Go to next step.

Yes: Transmission neutral return linkage bolt is out of adjustment.

2. Test forward and reverse pedals. Drive machine forward, then stop. Reverse and stop. Does machine respond to pedal movement? (Gradual increase in speed FORWARD up to 13.2 km/h (8.2 mhp). Should stop within 2.2 - 4 m (7 - 10 ft) without using brake. Gradual speed increase; speed in REVERSE to 8.8 km/h (5.5 mph). Should stop within 1.2 - 1.8 m (4 - 8 ft).)

Yes: Go to next step.

No: Check free-wheeling linkage if machine will not move or if hydrostatic is jerky.

No: If machine still will not move, continue testing sequence. If machine does not stop within distance, check linkage for binding, replace dampener and retest.

No: Check swash plate shaft for binding, or neutral return spring weak or broken.

3. Are drive shaft cap screws tight? No wear or damage to splines? Drive shaft turning input shaft?

Yes: Go to next step.

No: Tighten cap screws. Repair or replace as necessary

4. Test charge pump pressure port. Is there charge pressure?

Yes: Go to next step.

No: Check hydraulic oil level.

No: Replace hydraulic filter.

No: Check vent for plugging.

No: Check charge pump seal.

No: Check for sheared pump drive key.

No: Check charge pressure relief valve for broken spring or debris.

5. Test charge pump pressure port. Is there charge pressure, but no drive?

No: Hydrostatic transmission (engine running) tests completed.

Yes: Replace directional control valves.

Yes: Lube reduction valve stuck.

Yes: Inspect pump and motor for wear.

Yes: See “Hydrostatic Transmission Diagnosis” on page 260.

Yes: Anti-cavitation valve stuck open.

Yes: See “Charge Pump Flow and Pressure Test - At Charge Pump” on page 268.

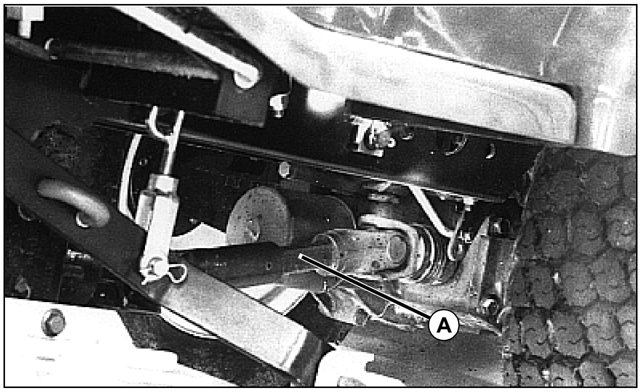
Yes: Extreme wear of valve plates or rotating groups.

Mid-PTO System Test

Test Conditions:

- Park brake disengaged.
- Engine running approximately half throttle.
- Deck or PTO driven implement installed.
- PTO switch off.

Mid-PTO



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1. Is PTO shaft (A) turning?

No: Go to next step.

Yes: Perform “Mid-PTO Engagement Pressure and Brake Test” on page 270.

Yes: Check brake springs, brake shoes, solenoid valve and clutch return spring.

2. With PTO switch on, brake off, and being on the seat, is PTO engaging?

Yes: Go to next step.

No: Perform PTO engagement pressure test. See "Mid-PTO Engagement Pressure and Brake Test" on page 270.

No: If there is no engagement, and/or no engagement pressure check: Electrical solenoid in Electrical section; PTO pressure control valve leaking to sump; Lube reduction valve orifice plugged; For no charge pressure. Perform "Charge Pump Flow and Pressure Test - At Charge Pump" on page 268.; Clutch or brake packing leaking; Packing on end of clutch hub shaft missing or leaking.

3. Observe PTO shaft. (Engine at full rpm; PTO on, then off.) Does PTO shaft and implement stop within four seconds?

Yes: Go to next step.

No: Check brake springs and brake facing. Repair PTO inertia brake.

4. Observe PTO shaft. (Engine at full rpm; PTO on.) Is PTO driving implement satisfactory under load? PTO clutch not slipping? No vibration?

Yes: Mid-PTO test completed.

No: PTO pressure low; adjust pressure control valve.

No: Check clutch disk for wear. (NOTE: Check lube passage in input shaft and in clutch input gear for blockage.)

No: Vibration: Disconnect implement drive shaft and operate PTO. Check shaft U-joints or implement for vibration.

Transaxle Test

Test Conditions:

- Park brake engaged.
- Engine not running.

Transaxle

1. When checking dipstick, oil at proper level and viscosity?

Yes: Go to next step.

No: Add or change hydraulic oil and filter.

2. Check transaxle (drive machine). No leaks? Transaxle engages in 0.5 - 1. 0 seconds?

Yes: Go to next step.

No: Replace leaking and worn seals.

3. Differential lock engages within a short distance when differential lock pedal is depressed? (Machine wants to continue in a straight line. Differential lock will disengage when you release the traction pedal.)

Yes: Go to next step.

No: Check linkage springs and all linkage connections. Inspect differential and lock collar and pins. Check for broken differential shift fork return spring.

4. Check differential and axles (jack one wheel off ground). During a turn, any noise from axles or differential? (AWS wheel hubs in knuckle housing should have movement (wobble)).

No: Go to next step.

Yes: Noise in the turn: Check all bearings then differential side gears and bevel pinions.

5. Check brake pedals. Any noise in differential when brakes are released and rear wheels are rotated?

No: Transaxle test completed.

Yes: Ratcheting noise: See "Brake/Differential Linkage Adjustment:" on page 391 in the Brakes section.

Yes: Brakes adjusted properly - disassemble and repair transaxle.

Tests and Adjustments

Hydraulic Oil Warm-Up Procedure

Reason:

When making hydraulic tests the oil must be heated to normal operating temperature for the tests to be accurate.

Test Equipment:

- JDG282 Temperature Gauge

Procedure:

1. Install JDG282 Temperature Gauge on transmission oil filter.

Important: Avoid Damage! DO NOT overheat engine.

2. Apply park brake. Start engine and run at full throttle.
3. Move and hold hydraulic lever in implement raise position.
4. Periodically cycle all hydraulic functions to distribute heated oil.
5. Heat oil to operating temperature before performing tests.

Charge Pump Pressure Test

Reason:

To determine charge pressure control valve operation and help determine condition of hydraulic charge pump. This also checks charge pump pressure relief valve operation and determines if there is sufficient pressure to operate implements.

Test Equipment:

- JT05489 Connector, 7/16-20 x M 37° 1/2-20 M ORB
- JT03017 Hose
- JT03117-13790 kPa (2000 psi) Pressure Gauge

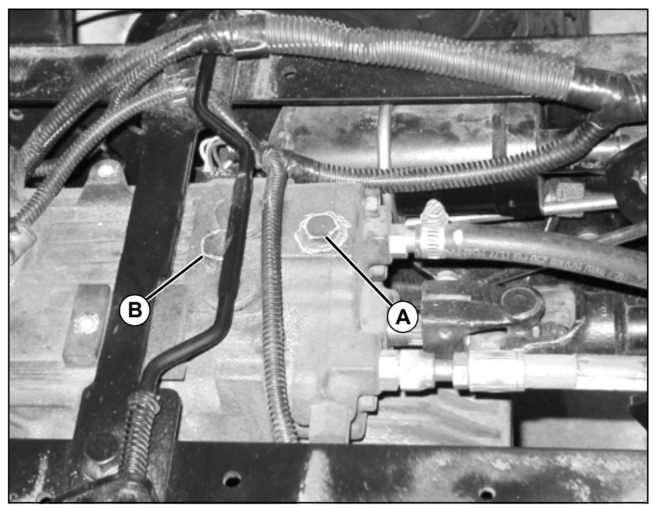
Pressure Test Procedure:

Warm hydraulic oil to operating temperature before performing this test. When done “cold” or at shop temperature, most machines (especially when new) will likely be close to **3450 kPa (500 psi)**.

1. Park machine safely. See “Park Machine Safely” in the Safety section.
2. Remove seat and fender deck.
3. Attach seat switch and set up machine so engine can be run.

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

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



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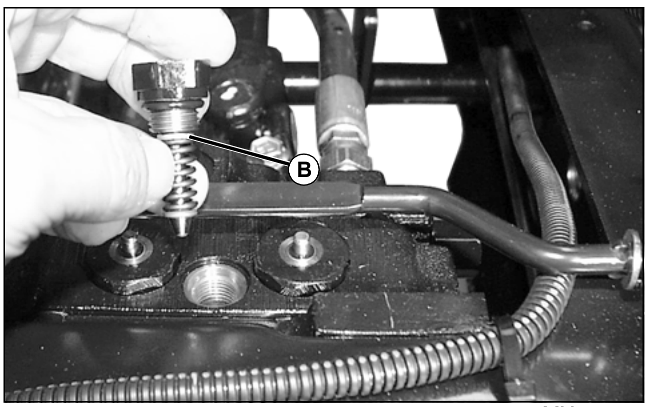
4. Install connector, hose and pressure gauge to charge pressure test port (A).
5. Start engine and run at high idle. Do not operate steering or hydraulic control valves.
6. Observe gauge reading. This is charge pressure.
7. Move hydraulic control lever to raise or lower position. Hold until pump pressure is in relief.
8. Observe gauge reading and release control. This is charge pressure relief pressure (implement operation pressure).

Specifications:

Charge Pressure (minimum) . . . . . . 19588 kPa (284 psi)
Charge Relief (Implement) Pressure (minimum) . . . . 6371 kPa (924 psi)

Results:

- If charge pressure is to specifications, **1958 kPa (284 psi) minimum**, in transaxle, charge pressure control valve is operating properly.
  - Note: Charge pressure gauge reading may be higher than specification due to cold oil temperature. Warm oil and retest.
- If charge pressure is too high, and oil is at operating temperature, there is a potential problem with the charge pressure control valve, or a restriction in the system. See "Charge Pump Flow and Pressure Test - At Charge Pump" in the Hydraulic Power Train section."
- If relief pressure is within charge relief (implement) pressure specifications, **6371 kPa (924 psi) minimum**, pump and charge pressure relief valve are in good condition.



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- If relief pressure is below **5881 kPa (853 psi)**, check charge pressure relief valve (B), shim relief pressure spring. If pressure cannot be increased, check charge pump for damage.

Charge Pump Flow and Pressure Test - At Charge Pump

Reason:

To check condition of charge pump and setting of the charge pump relief valve. Isolates possible restrictions of flow in the steering control valve and/or hydraulic control valve.

Test Equipment:

- JT01765 Consumer Products Hydraulic Fitting Kit
- JT05469 Flowcharter Kit
- JT03216 Connector, 9/16-18 M 37° x 9/16-18 M ORB
- JT03341 Elbow, 90° 9/16-18 M 37° x 9/16-18 F 37°
- JT03342 Coupler, 3/4" F NPT x 9/16-18 F 37°

Procedure:

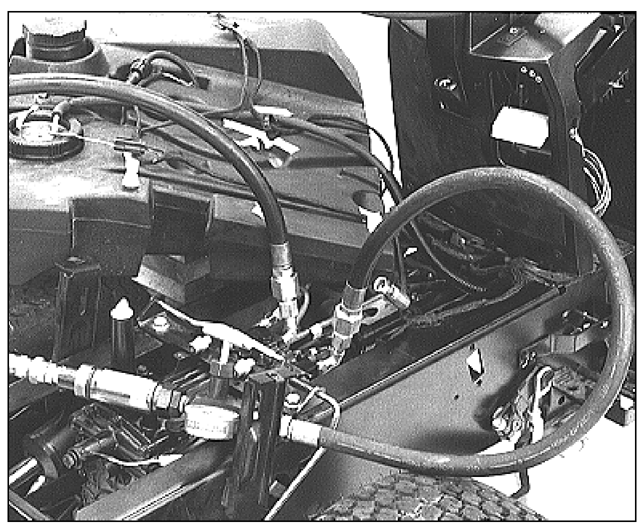
Note: To save time and help with diagnosis, perform charge pump flow and pressure test at hydraulic control valve quick disconnect fittings before performing this test. See "Charge Pump Pressure and Flow Test at Couplers" on page 351 in the Hydraulics section.

1. Remove fender deck. Support fuel tank to one side.

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

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

2. Disconnect the pressure and return line from the charge pump housing.



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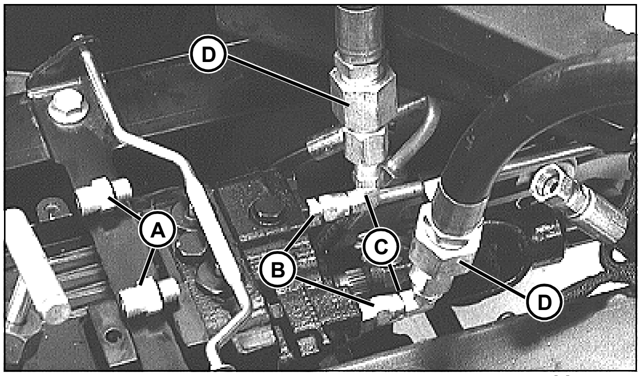

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A- ORB Connectors (removed from charge pump)

B- JT03216 Connector, 9/16 - 18 M 37° x 9/16 - 18 F 37°

C- JT03341 90° Elbow, 9/16 - 18 M 37° x 9/16 - 18 F 37°

D- JT03342 Coupler, 3/4” F NPT x 9/16 - 18 F 37°

3. Remove the ORB fittings and install JT03216 and JT03341.

Important: Avoid Damage! After connecting flowmeter, keep disconnected lines away from drive shaft.

4. Connect flowmeter inlet hose to pump outlet (right-hand side).

5. Connect return hose of flowmeter to return port (left-hand side).

Flow Test Procedure:

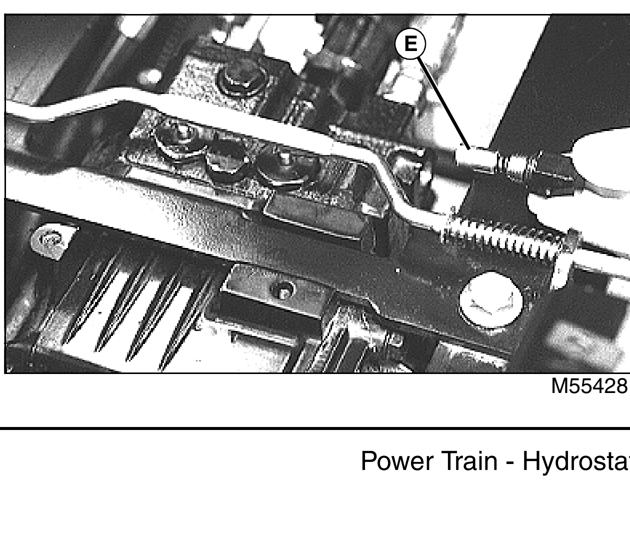
1. Open flowmeter control valve.

2. Start engine and run at wide open throttle. Oil must be at normal operating temperature.

3. Observe flowmeter reading.

Results:

- If pump flow is between **13 - 17 L/m (3.4 - 4.5 gpm)** for 2-WD machines OR **17 - 22.7 L/m (4.5 - 6 gpm)** for MFWD machines, pump is in good condition.



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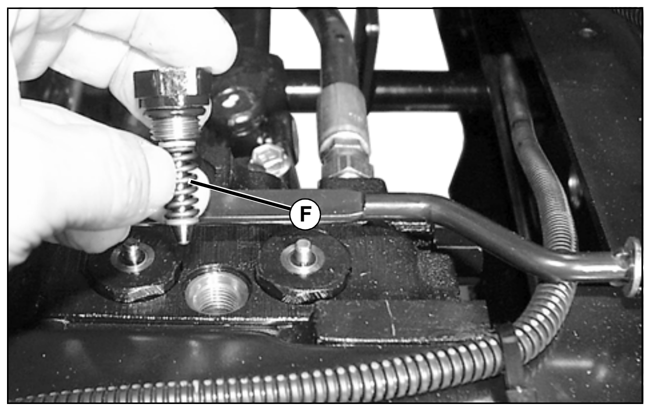
- If there is no pump flow, check for:
  - Drive shaft not turning input shaft
  - Sheared charge pump drive key
  - Charge pressure control valve (E) stuck closed
- If pump flow is below **13 L/m (3.4 gpm)** for 2-WD machines, OR **17 L/m (4.5 gpm)** for MFWD machines, foamy or erratic, match specifications by checking:
  - If O-Ring is damaged.
  - Hydraulic oil level; replace filter and repeat test.
  - Transaxle vent not plugged, filter seal for leaks.
  - Oil ring at inlet of charge pump for leak in case passage between filter and charge pump.
  - If dipstick is loose.



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- If pump flow is still below **13 L/m (3.45 gpm)** for 2-WD machines, OR **17 L/m (4.5 gpm)** for MFWD machines, match specifications by checking charge pressure relief valve (F) for damage or debris that could be holding valve open.
- Replace pump and repeat test.

Pressure Test Procedure:

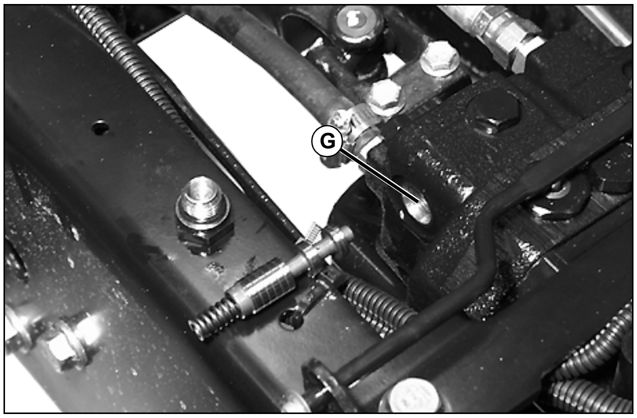
1. Flowmeter still connected as in flow test.

2. Start engine and run at wide open throttle.

3. Slowly close flowmeter valve until maximum pressure is reached. Observe pressure reading.

Results:

- If pressure is **6371 kPa (924 psi)** minimum, pump and valve are in good condition.
- If pressure is below **5881 kPa (853 psi)**, shim charge pressure relief pressure spring. If pressure cannot be increased, check charge pump for damage.



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- If pump seems in good condition, check condition of lube reduction valve modulation orifice (G) for plugging.
- Replace charge pump and repeat test.

Specifications:

Charge Pump Flow (2-WD) . 13 - 17 L/m (3.4 - 4.5 gpm)
Charge Pump Flow (MFWD) 17 - 22.7 L/m (4.5 - 6 gpm)
Charge Pressure Relief Pressure (minimum)
. . . . . 6371 kPa (924 psi)

Mid-PTO Engagement Pressure and Brake Test

PTO Engagement Pressure Test

Reason:

To check for adequate clutch engagement pressure and brake release pressure.

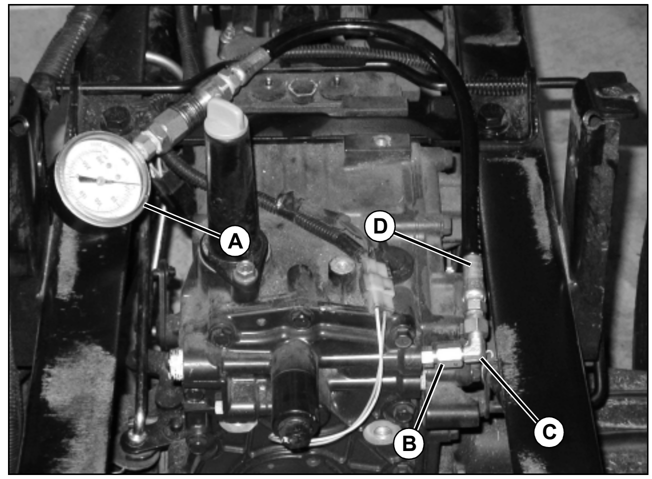
Test Equipment:

- JT05486 Connector, 1/4 M NPT x 7/16-20 M 37°
- JT05483 Connector, 90° elbow, 7/16-20 M 37°, 7/16-20 F 37° Swivel
- JT03017 Hose
- JT03115 2758 kPa (400 psi) Pressure Gauge

Procedure:

1. Remove hex-plug upper right-hand port on rear transmission case.

Important: Avoid Damage! Do not overtighten fittings.



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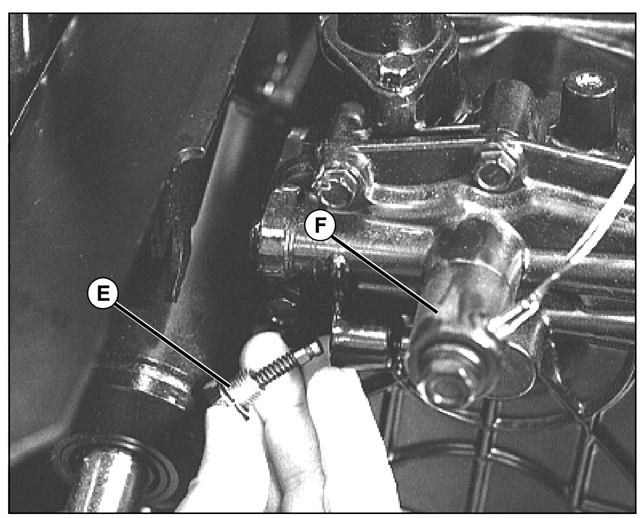
2. Install JT05486 (B) and JT05483 (C) Connectors.
3. Install JT03017 Hose (D) with JT03115, 2758 kPa (400 psi) Pressure Gauge (A).
4. Run engine at wide open throttle.
5. With brake pedal released and operator on seat, engage PTO switch.
6. Observe pressure gauge.

Results:

- If pressure is at or above **1420 - 1517 kPa (206 - 220 psi)** engagement valve is operating and engagement pressure is OK. If there is a PTO engagement complaint, inspect clutch disk for wear.
- If there is no pressure on gauge, see Electrical Section to check engagement solenoid and circuit. Inspect PTO engagement valve for proper installation, scoring, or damage to solenoid shaft. If solenoid is operating, check lube reduction valve orifice for plugging. Perform “Charge Pump Flow and Pressure Test - At Charge Pump” on page 268.



M55462

- If pressure is low, perform same test on left-hand port opposite test port checked above and compare pressure differential. If different, check solenoid valve (F) for sticking or shim missing, or solenoid not functioning. If both pressures are low, check PTO pressure control valve (E).
- If pressure is low, inspect PTO pressure control valve spring or seat for damage and valve for scoring. Add shims to increase pressure. If shims will not increase pressure, check lube reduction valve orifice. Perform “Charge Pump Flow and Pressure Test - At Charge Pump” on page 268.

Mid-PTO Brake Test

Reason:

PTO brake is not stopping implement within five seconds. Also, insure PTO shaft does not rotate when PTO is off.

Procedure:

1. With implement installed, PTO on and engine at wide open throttle.
2. Shut PTO off.
3. Observe the time it takes for implement to come to complete stop.

Results:

- Implement stops within five seconds and stays stopped, PTO brake is OK.
- Implement takes longer than specified time to stop or continues to run, check the following:

- Size of the implement may be too large or requires its own brake.

- Weak or broken brake springs.

- Worn brake shoe or scored PTO clutch hub and gear assembly.

- Weak or broken clutch piston return spring.

- Engagement solenoid valve not releasing pressure, keeping clutch engaged.

Transaxle Neutral Adjustment

Reason:

To ensure that machine does not creep when pedals are in neutral.

Test Equipment:

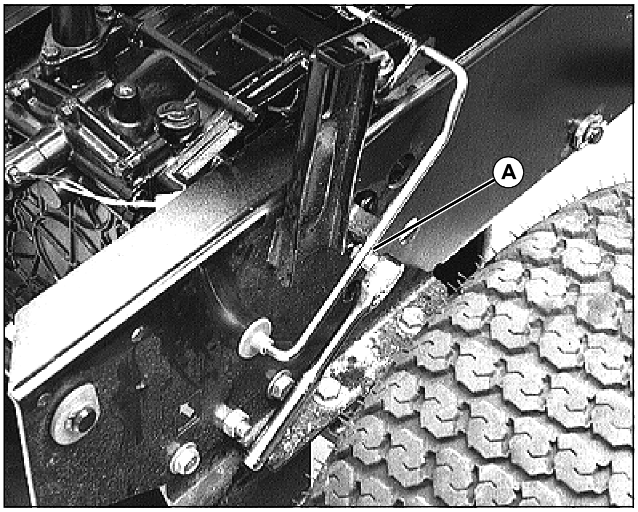
- Hoist
- Jackstands (2)

Note: If creep is intermittent, inspect transmission control linkage for binding or damage. Repair linkage before adjusting transmission neutral.

Procedure:

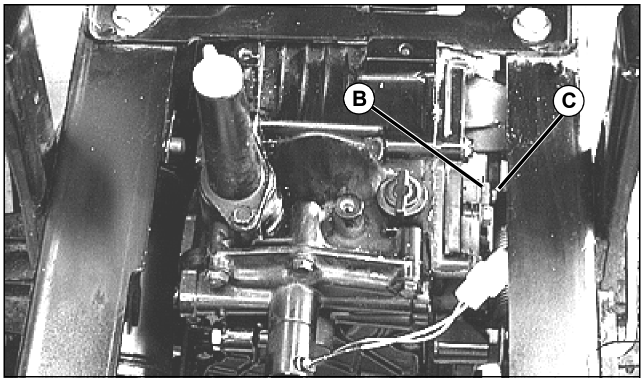
Caution: Avoid Injury! Rear wheels will rotate during adjustment or if transaxle is out of adjustment. Always support rear wheels with jackstands. Be cautious of rotating wheels.

1. Lift machine with a hoist and support rear wheels off the ground.
2. Support rear axle with jackstands.



M55443

Picture Note: NOTE: Fender deck was removed to illustrate adjustment location. Adjustment can be made through right-hand side frame cutout (A).



M55442

3. Loosen lock nut (B).

Caution: Avoid Injury! Use extreme caution when doing this adjustment. Drive wheels are free to rotate.

4. Have someone activate seat safety switch, or use a jumper wire to bypass the seat switch.
5. Start engine and run at low idle.

6. With brakes disengaged, turn eccentric nut (C) forward and backward until rear wheels stop turning.

7. Tighten lock nut. Make sure adjustment did not change. If adjustment changes, use wrench from rear of machine to tighten lock nut.

8. Depress both forward and reverse speed pedals then release to verify adjustment. Repeat adjustment as necessary.

9. Lower machine to the ground. Remove seat switch jumper wire if used.

Results:

- If neutral will not hold, turn eccentric 180° and repeat adjustment.
- If drive wheels continue to rotate, check for worn or binding control linkage. Disconnect linkage and repeat adjustment.
- Wheels rotate after adjustment with control linkage disconnected. Check swash plate shaft bushing for binding or wear. Check neutral return spring, pump and motor valve plate wear.

Caution: Avoid Injury! Remove jumper wire from seat switch if installed.

Transaxle Control Linkage Adjustment

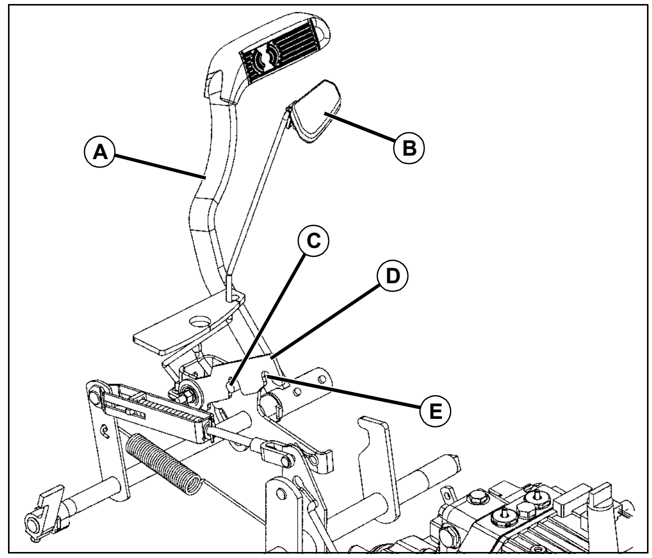
Reason:

To insure transmission returns to neutral and control pedals are locked in neutral when brake is set.

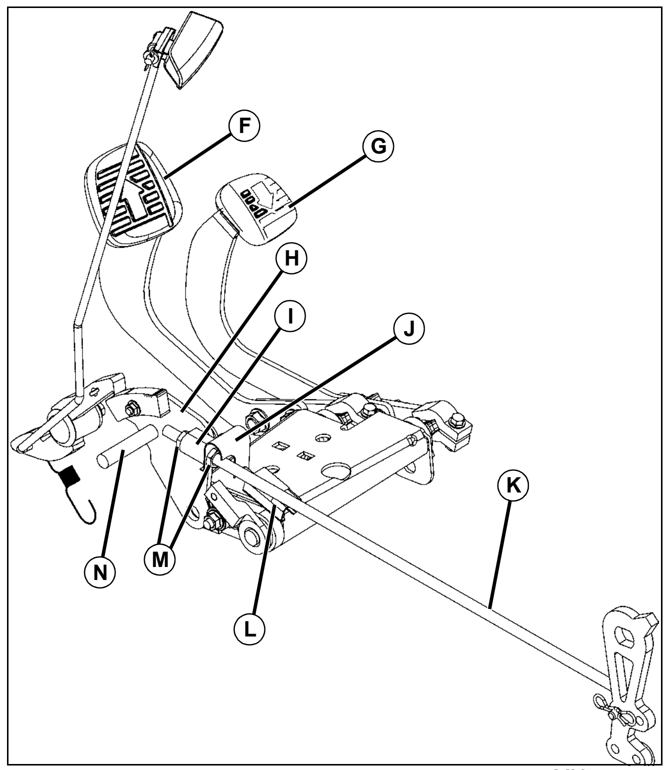
Procedure:

1. Park machine safely.

2. Check transmission neutral adjustment and readjust if not correct. See “Transaxle Neutral Adjustment” on page 271.



MX14384



MX14163

3. Press brake pedal (A) and pull up on lever (B) to set parking brake. Be sure that brake pin (C) on brake shaft is in latch (D) and forward shaft (H) pin (N) aligns in slot (E).

4. Press forward (F) and reverse (G) pedals and check for movement. Pedals should remain locked in position.

5. Remove spring pin holding pivot onto forward shaft (H), and loosen jam nuts (M) on pivot (I), until pivot can be moved freely into slot on forward shaft (H).

6. Tighten jam nuts (M) on brake rod (K) to pivot (I), making sure leaf spring (J) is positioned correctly to press against RIO switch (L).

Transaxle Linkage Full Forward Adjustment

Reason:

To set forward pedal height to insure maximum forward speed.

Procedure:

1. Turn engine off.

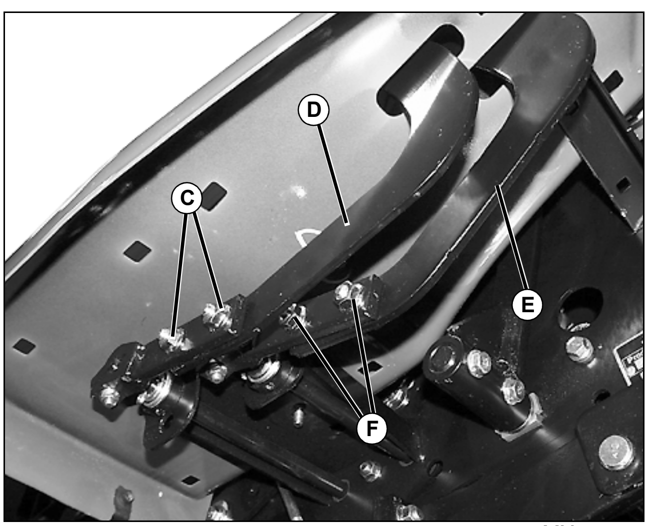
MX13638

2. Measure the distance (A) between the front side of forward pedal and top of pedestal and distance (B) between the front side reverse pedal and top of pedestal.

Specifications:

Forward pedal to pedestal (A) . . . . . . 101.6 mm (4.0 in.)
Reverse pedal to pedestal (B) . . . . . . 57.2 mm (2.25 in.)

Results:



MX14269

- If forward pedal (E) is not within specifications, loosen nuts (F) and move slotted front side (toward front of machine) of pedal up or down as needed. Tighten nuts.
- If reverse pedal (D) is not within specifications, loosen nuts (C) and move slotted front side of pedal up or down as needed. Tighten nuts.

Cruise Control Linkage Check and Adjustment

Reason:

To ensure that cruise control will engage and disengage properly.

First Procedure:

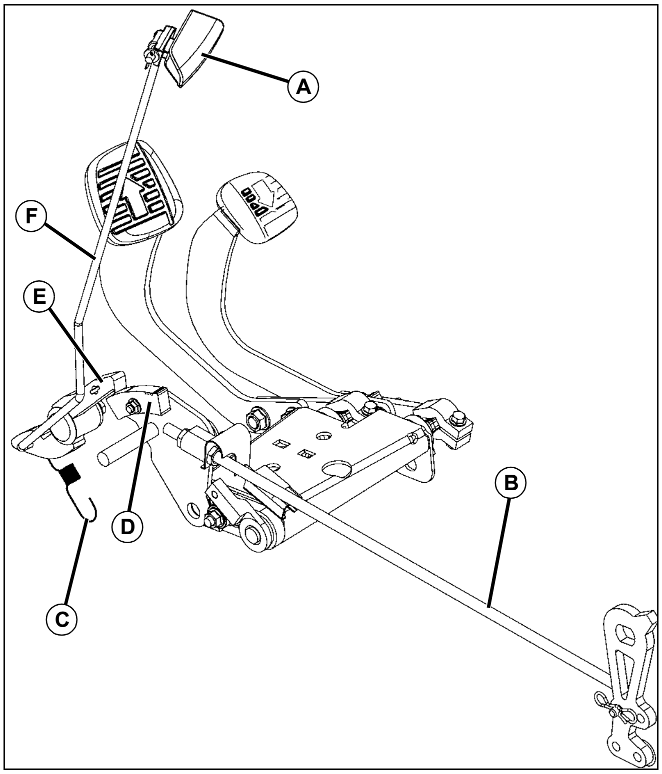
1. Put service-park brake in disengaged position, transaxle in neutral.

MX14396

2. With engine not running, push down forward drive pedal and engage cruise control lever (A) in several locations and with forward pedal all the way down. Release cruise control lever.

Results:

- Drive pedal should remain in down position.



MX14163

A- Cruise Control Lever
B- Control Rod
C- Return Spring
D- Cruise Control Stop
E- Cruise Control Latch
F- Cruise Control Disconnect Rod

• If pedal will not stay engaged, check condition of teeth on cruise control latch (E) and stop (D). Replace if worn.

Second Procedure:

1. Reset cruise control.
2. Engage service-park brake.

Results:

- Forward drive pedal should disengage.
- If cruise control does not disengage, check hydrostatic control linkage adjustment or for a disconnected cruise control disconnect rod (F).

Third Procedure:

1. Reset cruise control.
2. Tap forward pedal down and release.

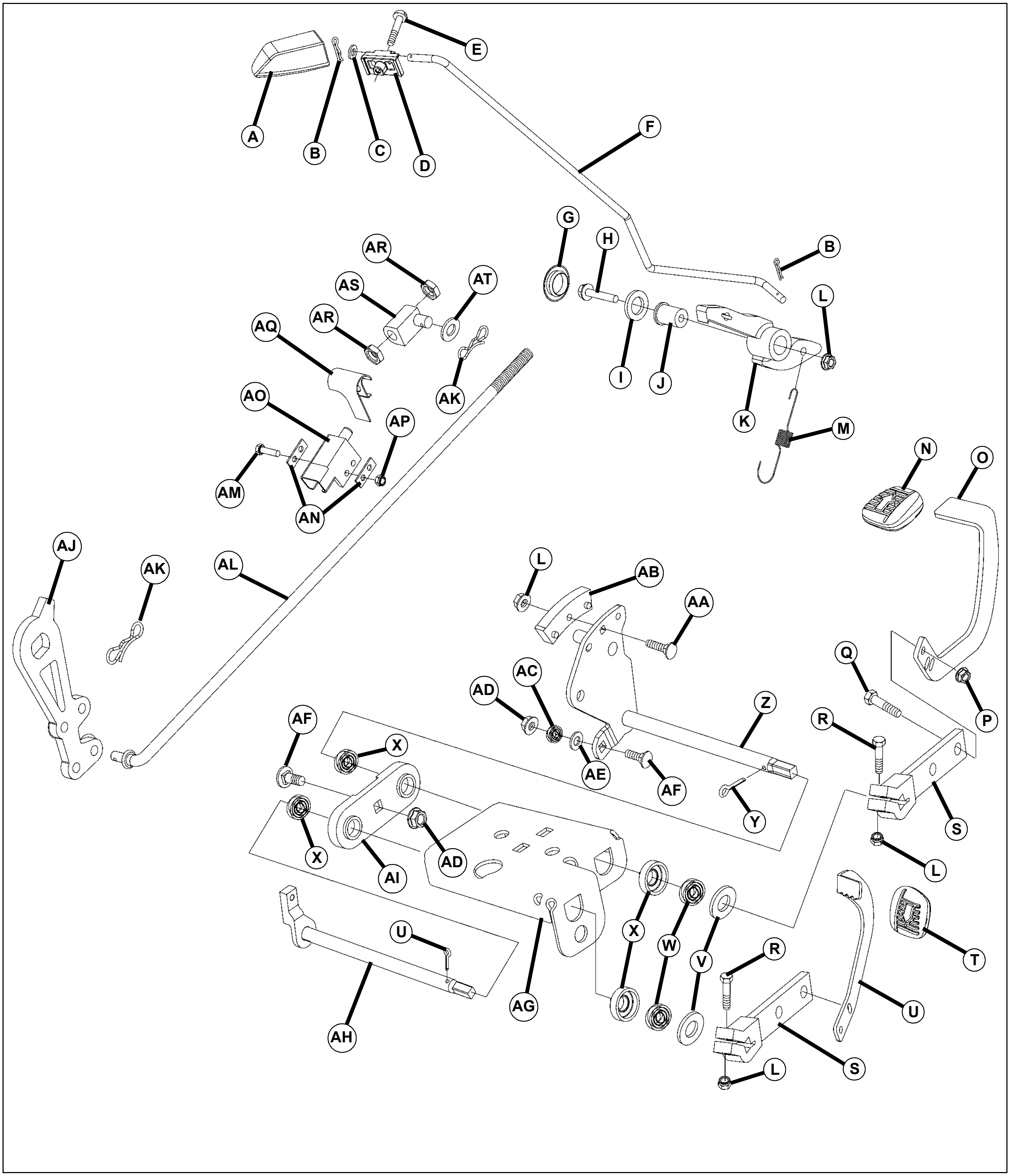
Results:

- Cruise should disengage.
- If cruise does not disengage check for binding pivots.

Inspect linkage component for wear or damaged conditions. Replace as necessary.

Repair

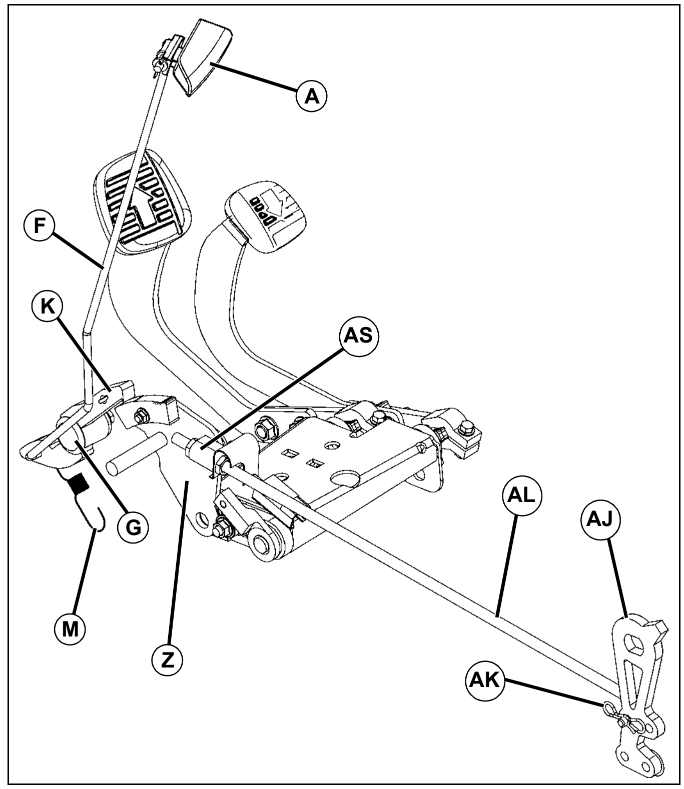
Foot Control Linkage Removal and Installation



MX14417

A- Knob
B- Spring Pin
C- Washer
D- Coupling
E- Screw
F- Rod, Cruise Control
G- Plug
H- Screw
I- Seal
J- Bushing
K- Latch, Cruise Control
L- Flange Nut
M- Extension Spring
N- Pad
O- Pedal, Forward
P- Flange Nut
Q- Screw
R- Screw
S- Bracket
T- Pad
U- Pedal, Reverse
V- Washer (6 used)
W- Ball Bearing
X- Bearing Support
Y- Cotter Pin
Z- Shaft, Forward
AA- Carriage Bolt
AB- Stop
AC- Ball Bearing
AD- Flange Nut
AE- Washer
AF- Carriage Bolt
AG- Bracket (welded to frame)
AH- Shaft, Reverse Pedal
AI- Bearing Housing
AJ- Arm, Transaxle
AK- Spring Locking Pin
AL- Rod, Control
AM- Cap Screw
AN- Strap
AO- Switch, Stop
AP- Lock Nut
AQ- Leaf Spring
AR- Nut
AS- Pivot
AT- Washer

Removing:



MX14163

1. Block machine wheels and release parking brake.

Note: Remove cruise control linkage. Then, disassemble foot control linkage.

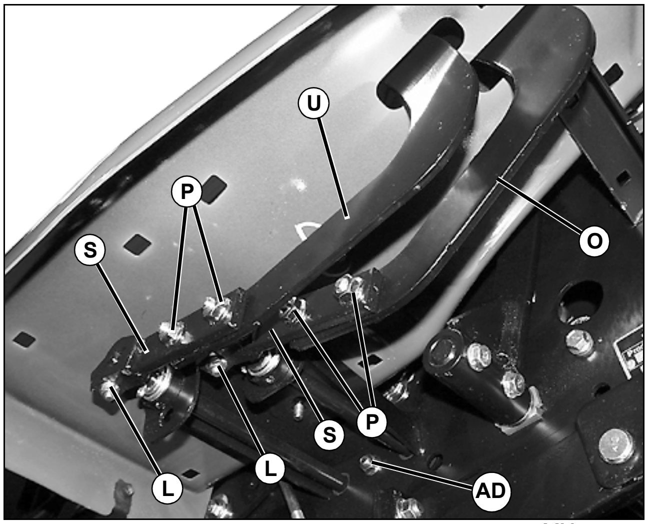
2. Remove extension spring (M) from forward shaft (Z) and cruise control latch (K).

3. Remove handle (A), and cotter pin holding cruise control rod (F) in position on machine. Lower rod assembly from under machine frame.

4. Remove spring locking pin (AK) and disconnect control rod (AL) from transaxle control arm (AJ).

5. To remove cruise control latch (K), remove plug (G) and cap screw/lock nut and associated parts holding it onto machine frame.

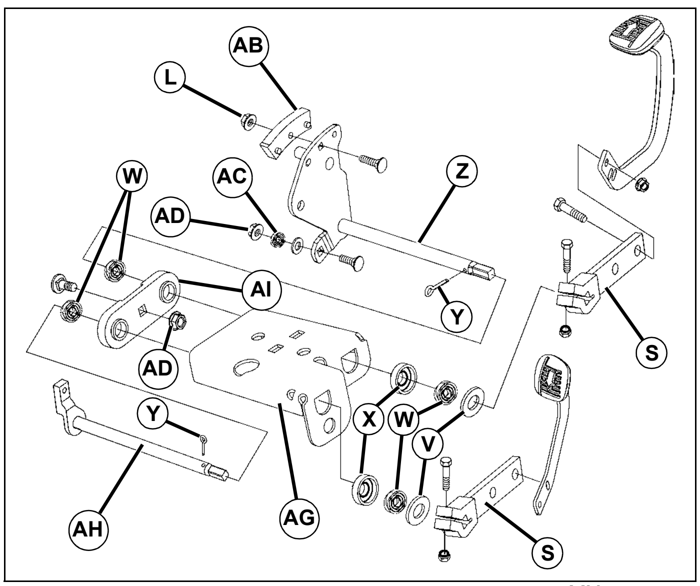
6. Remove spring locking pin and pivot (AS) from forward shaft (Z), and remove control rod (AL) and pivot from machine.



MX14269

7. Remove nuts (P) and bolts holding forward (O) and reverse (U) pedals onto brackets (S).

8. Loosen nuts (L) and remove brackets (S) from both forward and reverse shafts.



MX14305

9. Remove cotter pin (Y), washer(s) (V), and remove reverse (AH) and/or forward (Z) shaft.

10.Remove bearings (W), and inspect for damage or wear. Replace as necessary.

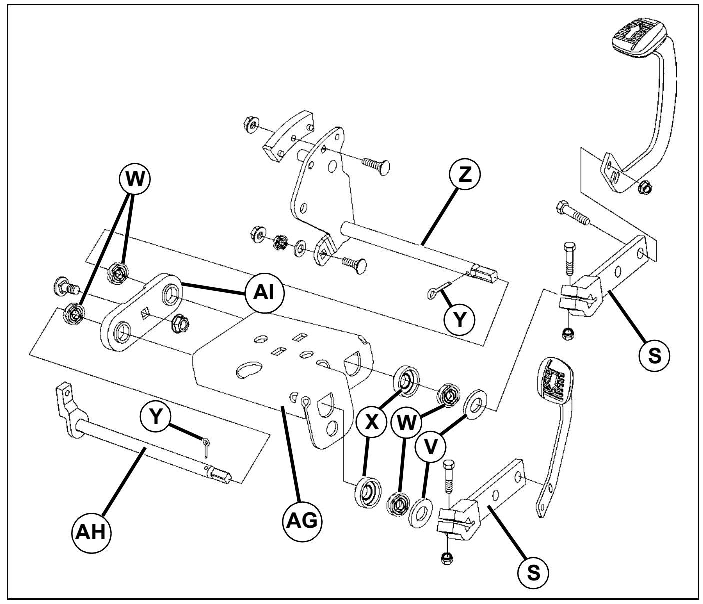
11.Bearing supports (X) are press fit into welded frame bracket (AG). If worn or damaged, replace. Press new support onto bracket.

12.To remove bearing (AC), remove lock nut (AD), and inspect bearing for wear or damage. Replace, as necessary.

13.To remove stop (AB), remove lock nut (L), and inspect stop for broken or worn teeth. Replace, as necessary.

14.To remove bearing housing (AI), remove lock nut (AD), and inspect housing for wear or damage. Replace, as necessary.

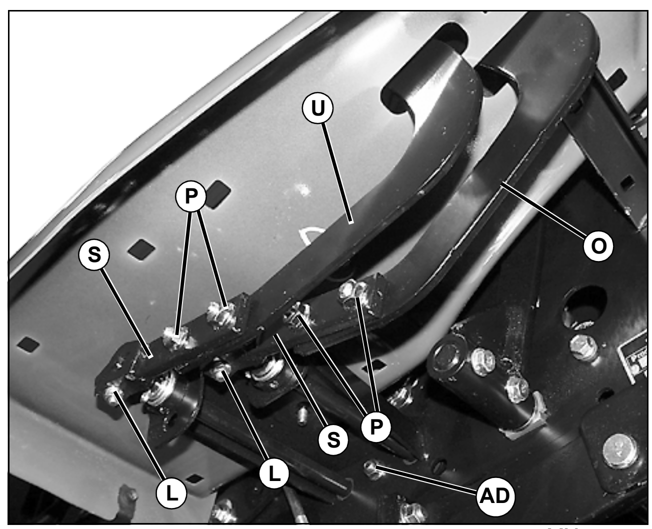
Installing:



MX14305

1. After replacing all worn/damaged parts, install forward shaft (Z) and reverse shaft (AH) through welded frame bracket (AG).

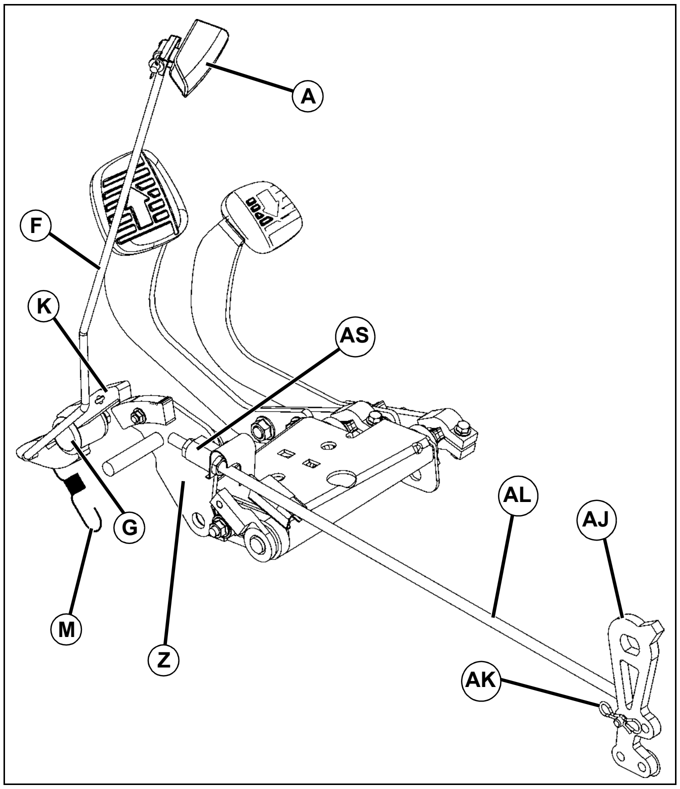
2. Making sure all bearings (W) and supports (X and AI) are in place, install washer(s) (V) and cotter pins (Y) securing both forward and reverse shafts in place.



MX14269

3. Install brackets (S) onto forward and reverse shafts, and tighten nuts (L) securing brackets to shafts.

4. Install forward (O) and reverse (U) pedals onto brackets (S), and secure with nuts (P) and bolts.



MX14163

5. Raise control rod (AL) into position, and secure pivot (AS) onto forward shaft (Z) with spring locking pin.

6. Raise control rod (AL) onto transaxle control arm (AJ), and secure with spring locking pin (AK).

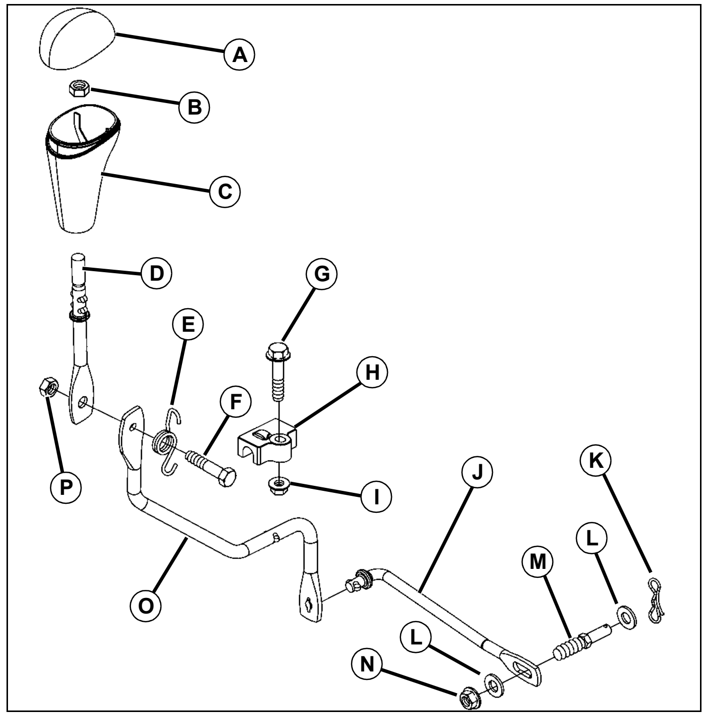
7. Secure cruise control latch (K), with associated hardware, with cap screw and lock nut. Install plug (G).

8. Raise cruise control rod (F) into position, and secure onto end of cruise control latch (K) with cotter pin. Install handle (A).

9. Install extension spring (M) onto forward shaft (Z) and cruise control latch.

10.Set parking brake, and adjust foot control linkage. See “Transaxle Control Linkage Adjustment” on page 272.

Shift Lever Linkage (MFWD) Removal and Installation



MX14347

- A- Cap
- B- Lock Nut
- C- Knob
- D- Lever
- E- Torsion Spring
- F- Bolt
- G- Cap Screw
- H- Pivot
- I- Lock Nut
- J- Linkage
- K- Spring Locking Pin
- L- Washer (2 used)
- M- Stud
- N- Nut
- O- Lever
- P- Flange Nut

1. Pull off cap (A), and remove nut (B) and knob (C).

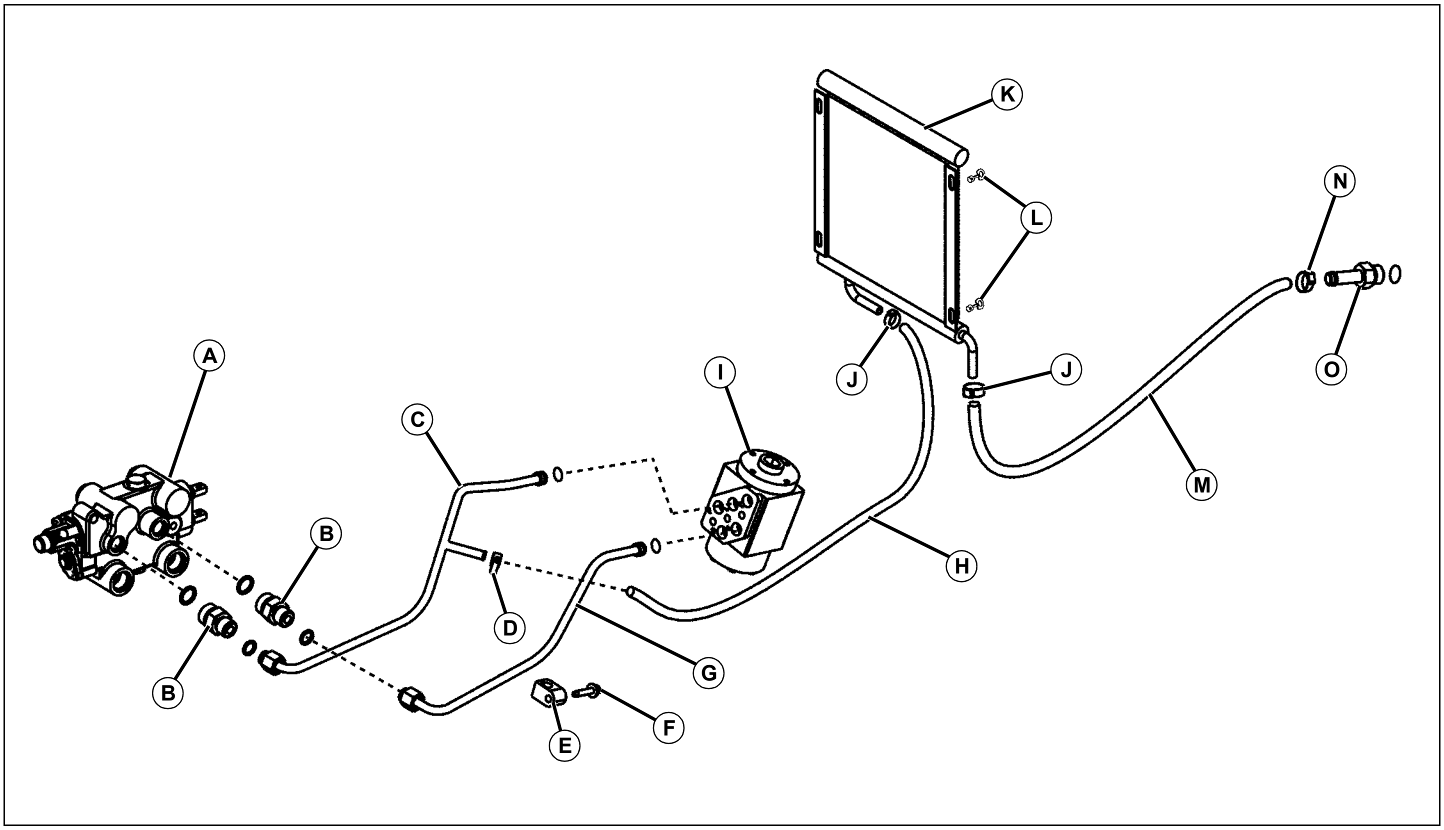
2. Remove fender deck. See “Fender Deck Removal and Installation” on page 459 in the Miscellaneous section.

3. Remove spring pin (K) and washer (L), and remove pin (M) from shift arm on hydrostatic transmission motor.

4. Remove lock nut (I), cap screw (G), and pivot (H) holding components to top of frame.

5. Disassemble components as necessary. Replace worn or defective parts and reassemble in reverse order.

Oil Cooler Removal and Installation

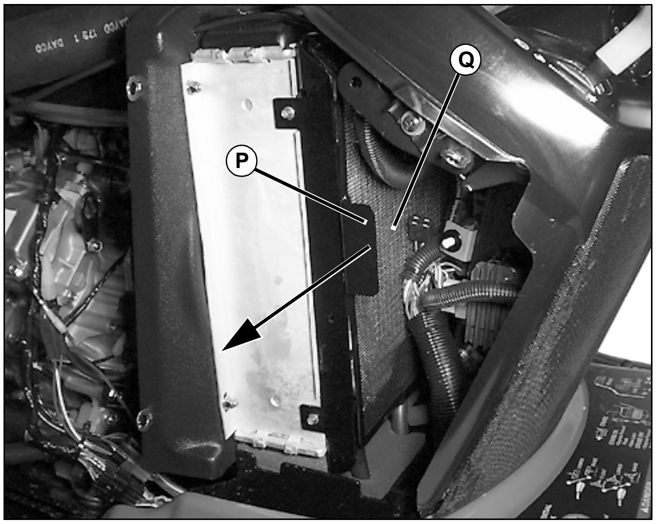


MX14392

A- Selective Control Valve
B- Fitting
C- Hydraulic LIne
D- Hose Clamp
E- Clamp
F- Screw
G- Hydraulic LIne
H- Hose
I- Power Steering Control Valve
J- Hose Clamp
K- Oil Cooler
L- Retainer
M- Hose
N- Hose Clamp
O- Adapter

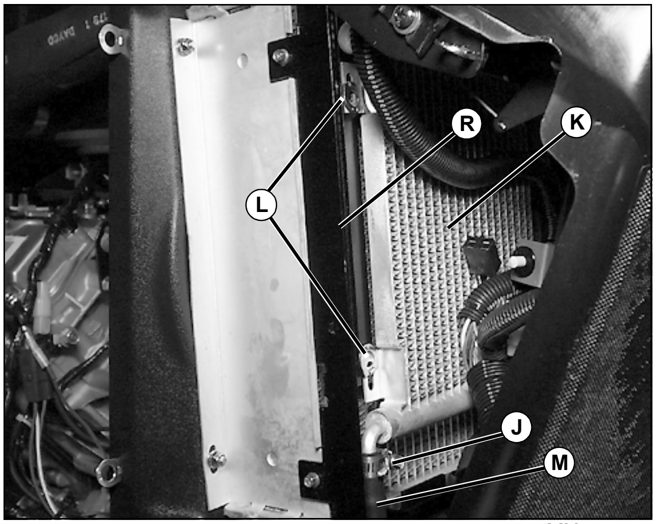
1. Loosen and move clamp (D) slightly to remove hose (H) from hydraulic line (C), and drain transaxle (cooler) fluid into a clean container.

2. Loosen and move clamp (N) slightly to remove hose (M) from adapter (O) on transaxle, and drain transaxle (cooler) fluid into the same clean container as in step 1.



MX14393

3. Remove side panel from instrument panel assembly, and pull handle (P) to remove screen (Q).



MX14394

4. Loosen and move clamps (J) on both sides of cooler and remove lines (M and H) from cooler (K).

5. Pull and turn fasteners (L) so that cooler assembly can be removed from radiator coolant frame (R).

Installation is done in the reverse order of removal.

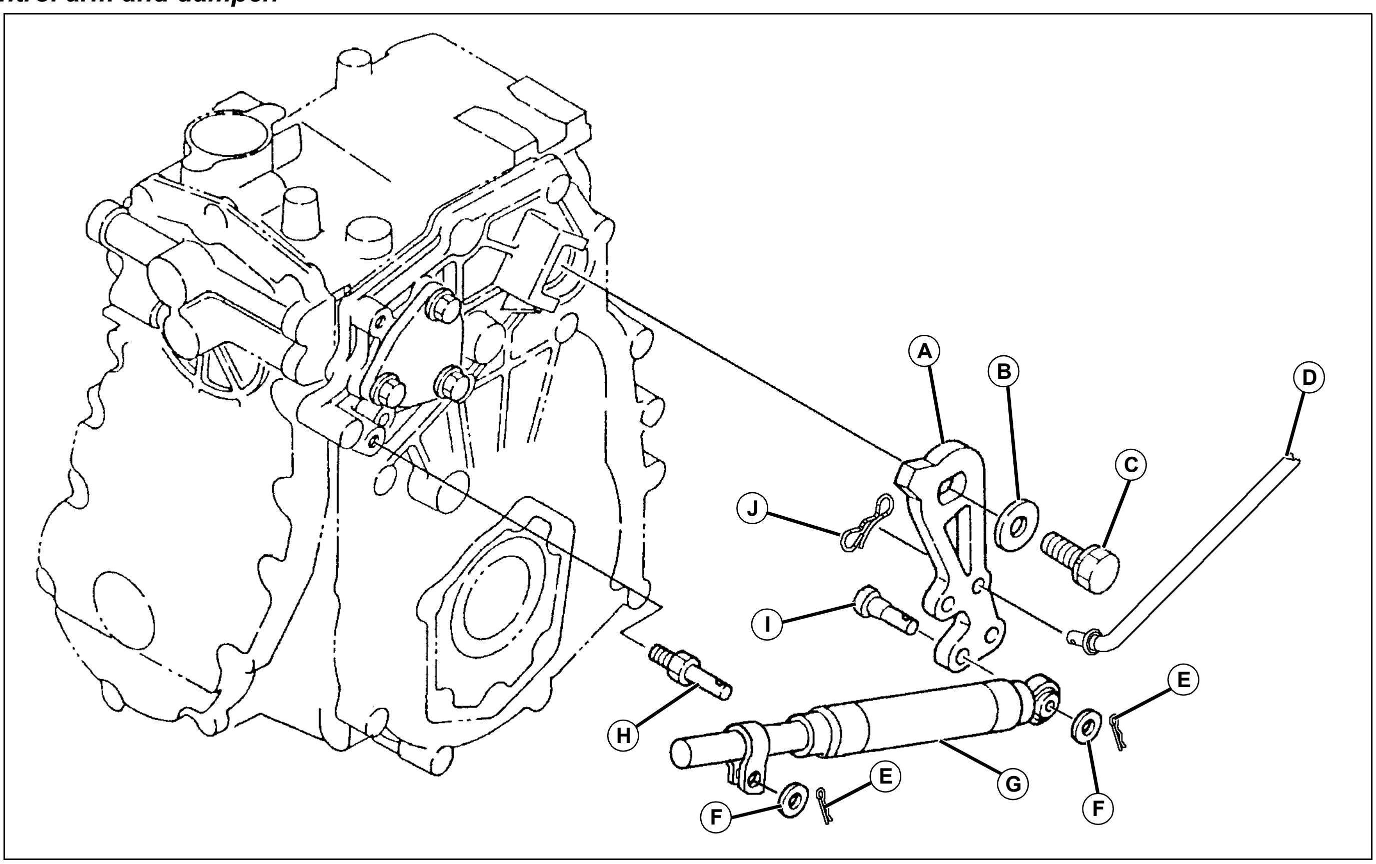
- If removed, tighten fittings on selective control valve (A) and power steering control valve (I) to specification.
- Fill transaxle fluid up to appropriate level.

Specifications:

Selective Control Valve Fittings . . . . . . 38 N•m (28 lb-ft)

Control Arm and Damper Removal and Installation

Note: Fuel tank can be removed for easier access to control arm and damper.



MX14183

A- Control Arm

B- Washer

C- Main Cap Screw

D- Foot Control Rod
E- Spring Locking Pin
F- Washer
G- Damper
H- Pivot Stud
I- Clevis Pin
J- Spring Locking Pin

1. Remove spring locking pins (E) and washers (F) from both sides of damper (G).

2. Slide damper off of pivot stud (H) and clevis pin (I). Inspect and, if defective, replace damper as an assembly.

3. To remove control arm (A), remove spring locking pin (J) and disconnect foot control rod (D) from control arm.

Note: Access to cap screw (C) is through hole in right frame.

4. Remove cap screw (C) and washer (B) from control arm.

5. Remove control arm.

6. Install control arm the same as removal, and install washer and cap screw. Tighten cap screw (C) to specification.

Note: If removed, use medium strength thread lock and sealer on pivot stud (H) threads.

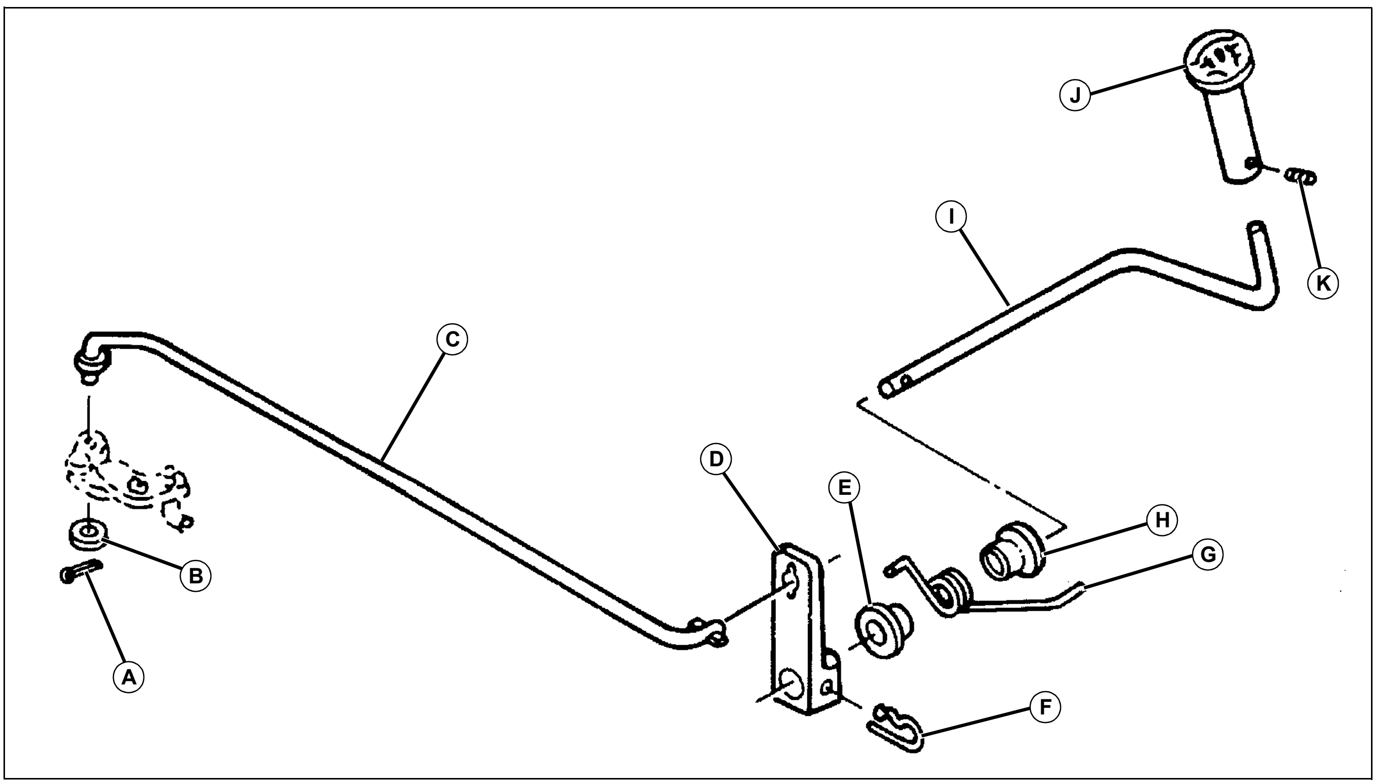
7. Install damper with open end of clamp facing down.

8. Install remaining washers and spring locking pins.

Specifications:

Control Arm Cap Screw. . . . . 73 N•m (54 lb-ft)

Differential Lock Linkage Inspection



MX14418

A- Pin
B- Washer
C- Rear Differential Lock Rod
D- Differential Lock Arm
E- Bushing
F- Spring Locking Pin
G- Torsion Spring
H- Bushing
I- Differential Lock Pedal Rod
J- Knob
K- Screw

1. Disassemble parts from differential lock linkage.

2. Inspect linkage components for wear or damaged conditions. Replace as necessary.

3. Install short leg of spring to the rear of arm.

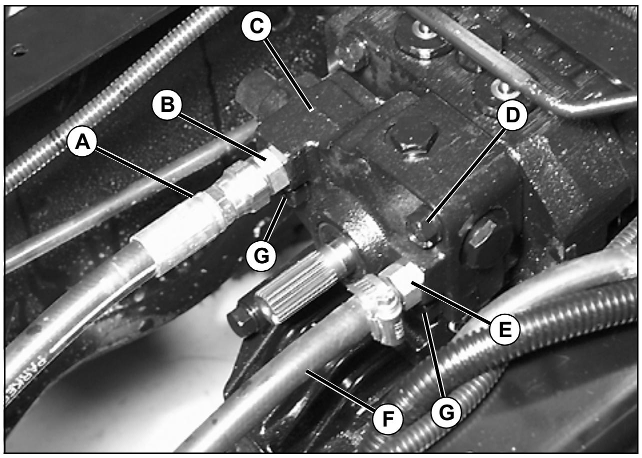
Charge Pump Removal and Installation

Note: Approximate capacity of hydrostatic powertrain is 6.6L (7.0 qt) for two-wheel steering and 5.6L (6.0 qt) for all-wheel steering.

1. Remove fender deck. See “Fender Deck Removal and Installation” on page 459 in the Miscellaneous section.

2. Remove drain plug to drain oil from transaxle.

3. Remove drive shaft. See “Drive Shaft Removal and Installation” on page 285.



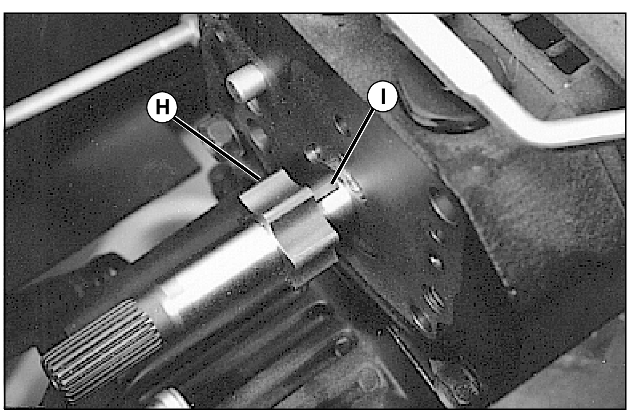
MX14308

4. Disconnect hose (A) and loosen clamp for hose (F) from pump housing (C).

5. Remove tube adapter (E) and adapter (B).

6. Remove two short (G) and one long (D) cap screw.

> **Important: Avoid Damage! Do not drop pump gerotor (H) or lose key (I). Damage to machined surfaces will cause poor performance and premature failure.**



M81188

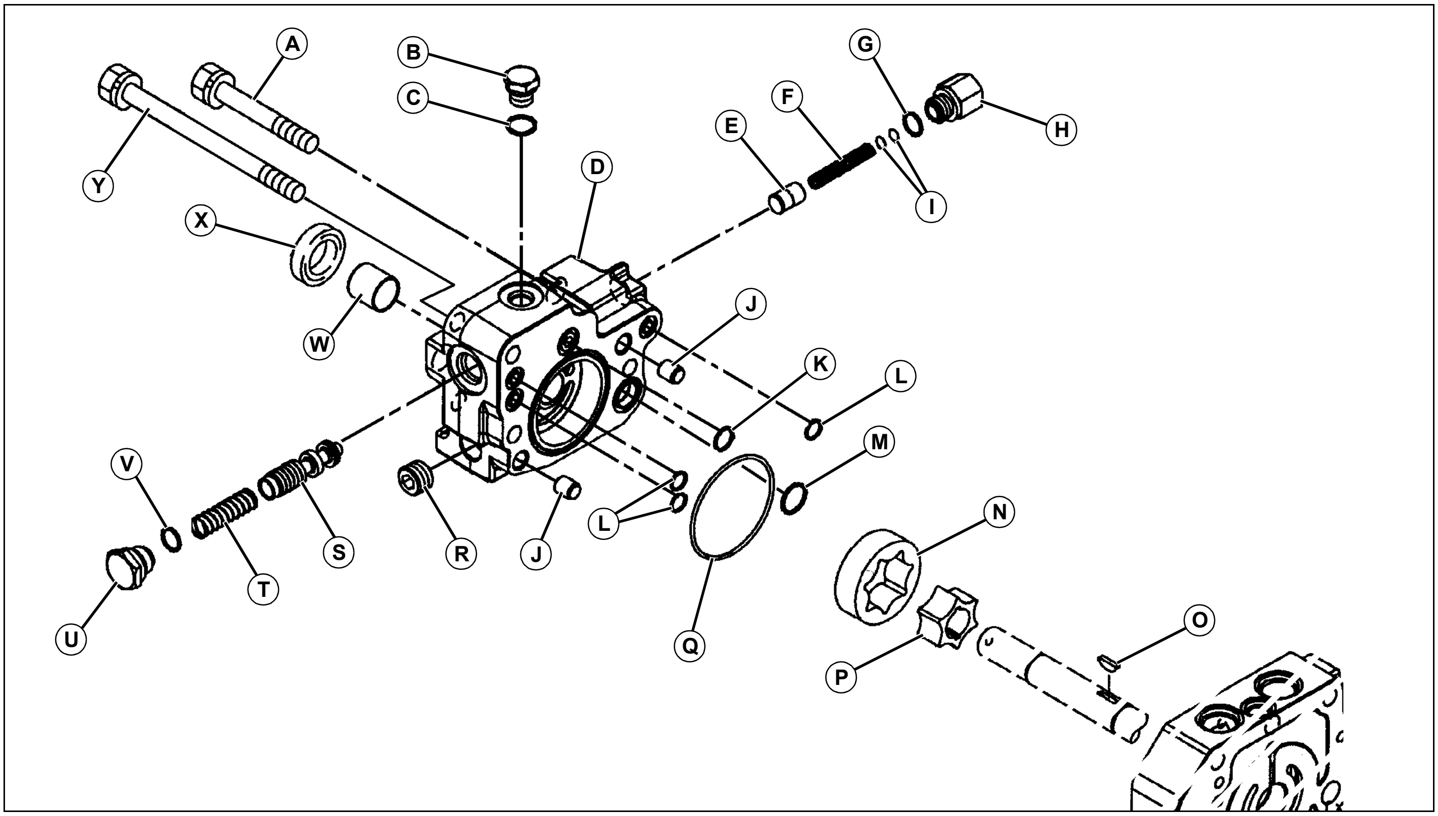
Installation is done in the reverse order of removal.

- Tighten two short cap screws (G) to specification.
- Tighten long cap screw (D) to specification.
- Tighten tube adapter (E) and adapter (B) to specification.
- Tighten hose (A) to specification.

Specifications:

Short Cap Screws	**25 N•m (18 lb-ft)**
Long Cap Screw	**39 N•m (29 lb-ft)**
Tube Adapter	**24 - 35 N•m (18 - 26 lb-ft)**
Hose	**24 - 35 N•m (18 - 26 lb-ft)**

Charge Pump Disassembly and Assembly



MX14321

A- Cap Screw (2 used), M10 x 65
B- Plug
C- O-Ring
D- Pump Body
E- Pressure Valve
F- Spring
G- O-Ring
H- Plug
I- Shims
J- Pin
K- O-Ring
L- O-Ring
M- O-Ring
N- Outer Rotor
O- Key
P- Inner Rotor
Q- O-Ring
R- Plug
S- Reducing Valve
T- Spring
U- Reducing Plug
V- O-Ring
W- Bushing
X- Seal
Y- Cap Screw, M10 x 105

Note: Charge pressure control valve and pressure reducing valve can be removed when the charge pump is in the machine. To inspect valve seats and bores, the pump must be removed.

1. Disassemble all parts of charge pump (D).

2. Inspect O-rings (C, K, L, M, and Q) for cuts or damage. Replace as necessary.

Note: Pump gerotor (N and P), seal (X), body (D), and pressure reducing valve (S) parts must be replaced as a set.

3. Inspect gerotor charge pump parts (N- P). Replace parts if worn, chipped, scored or damaged.

4. Remove plug (U) to remove pressure reducing valve parts (V, S, and T).

5. Inspect parts for scoring, wear or damage.

6. Check small orifice in reducing valve (S) spool for obstruction.

7. Replace parts if necessary.

8. Remove plug (H) to remove charge pressure relief valve parts (E, F, G, and I).

9. Inspect parts for scoring, wear or damage.

10. Replace parts if necessary.

11. Inspect seal (X) and bushing (W) for wear or damage.

12. If bushing is removed, apply clean hydraulic oil to bushing and use a disk driver to install bushing to bottom of bore.

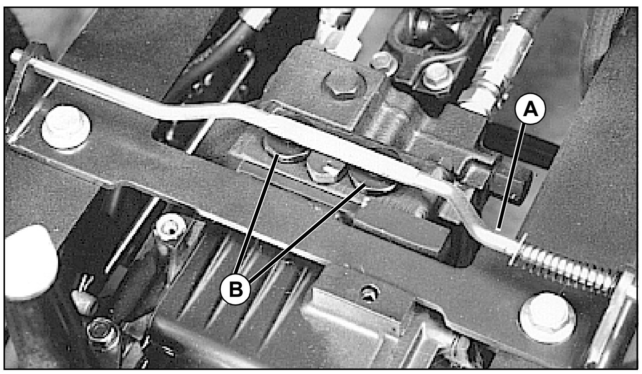
13. If seal is replaced, apply clean hydraulic oil to new seal. Install seal with open side into pump body. Push seal to bottom of bore.

14. Apply clean hydraulic oil to all machined surfaces before assembly.

Directional Control Valves

Removal:

1. Remove fuel tank. See "Fuel Tank Removal and Installation" on page 460 in the Miscellaneous section.



M81180

2. Remove free-wheeling control lever (A).
3. Remove directional control valves (B).

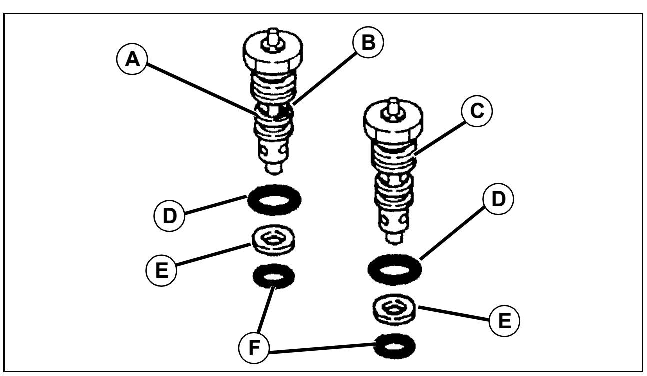
Installation:

- Installation is done in the reverse order of removal.

Specification:

Directional Control Valves . . . . 35 N•m (26 lb-ft)

Disassembly, Inspection and Assembly:



M81181ae

A- Reverse Control Valve (with orifice)
B- Orifice
C- Forward Control Valve
D- O-Ring
E- Backup Ring
F- O-Ring

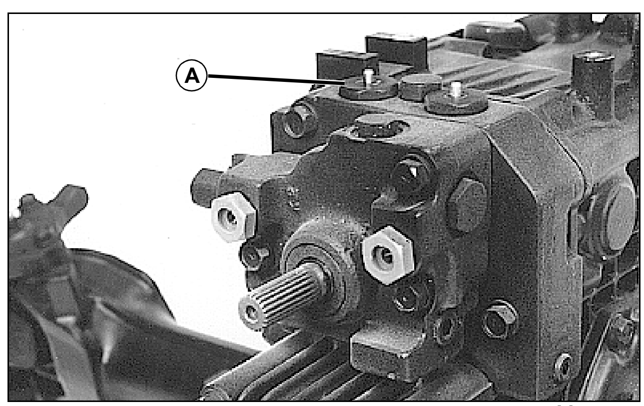
1. Disassemble parts from directional control valves.
2. Inspect O-rings and backup rings for damage.
3. Plunger pin must move freely.
4. Internal valve must move freely when valve is shaken.
5. Make sure orifice and all passages are free of any obstruction.

Important: Avoid Damage! The reverse control valve must be installed in the left port. The control valve can be identified by a small orifice drilled into a land between the two sets of valve passageways.

6. Assemble parts.

Hydrostatic Pressure Relief Valve (45 Loader) Installation

Important: Avoid Damage! The 45 loader is shipped complete with a hydrostatic pressure relief valve which must be installed in place of the transaxle's forward control valve. The relief valve limits the peak hydrostatic pressures in the transaxle. This protects the transaxle from unnecessary stress for longer life. Operation of a front end loader on a machine without the transaxle hydrostatic pressure relief valve will void the machine warranty. If a 45 loader is taken off one machine and used on another, or another brand of loader is used, it is important that the loader machine be equipped with the transaxle relief valve.



M81183

1. Remove forward control valve and replace with hydrostatic pressure relief valve (A).
2. Tighten valve to specification.

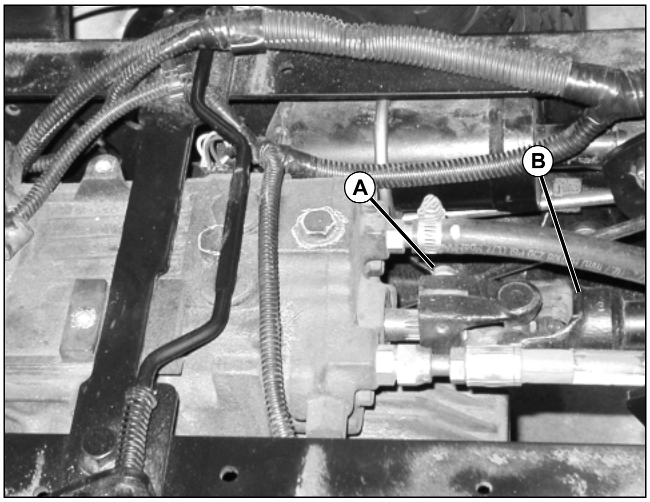
Specification:

Pressure Relief Valve . . . . 35 N•m (26 lb-ft)

Drive Shaft Removal and Installation

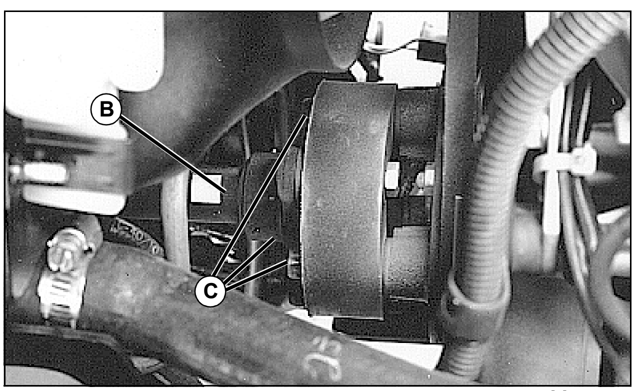
Removing:

1. Remove fuel tank. See "Fuel Tank Removal and Installation" on page 460 in the Miscellaneous section.



MX35901

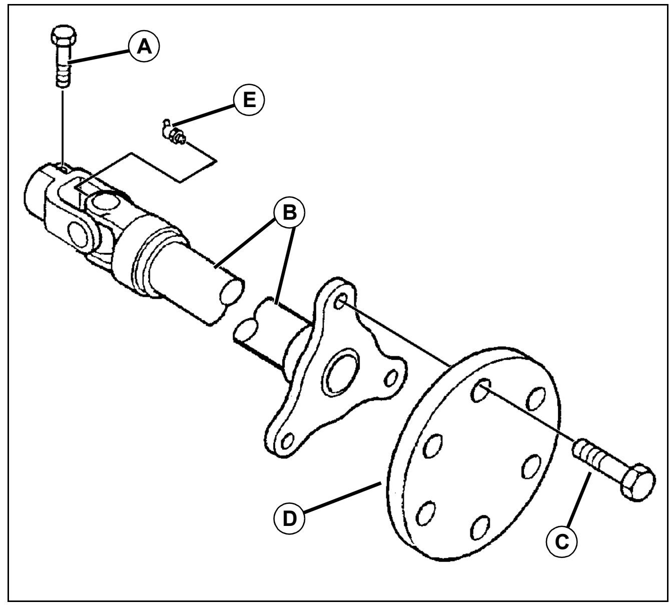
2. Loosen cap screw (A).



M81174

3. Remove three cap screws (C) to remove drive shaft (B) from under machine frame.

Disassembly, Inspection and Assembly:



M81172ae

A- Cap Screws (2 used)
B- Drive Shaft
C- Cap Screws (3 used)
D- Isolator
E- Lube Fitting

1. Disassemble drive shaft.
2. Inspect U-joint for wear.
3. Inspect isolator for cracks or wear.
4. Install isolator with bosses toward drive shaft.
5. Assemble drive shaft.

Installing:

1. Install drive shaft from under frame and attach to transaxle pump shaft.
2. Raise front of drive shaft to engine pulley and tighten cap screws (C) to specification.
3. Tighten cap screw (A) to specification.

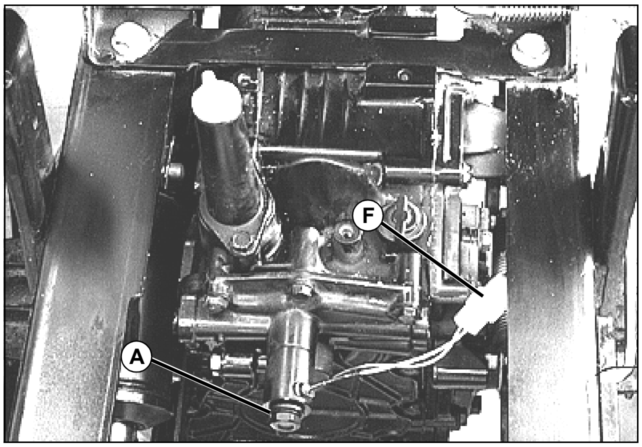
Specifications:

Drive Shaft to Engine Pulley Cap Screws . . . . 40 N•m (30 lb-ft)
Drive Shaft to Transaxle Cap Screw. . . 35 N•m (26 lb-ft)

PTO Solenoid Valve

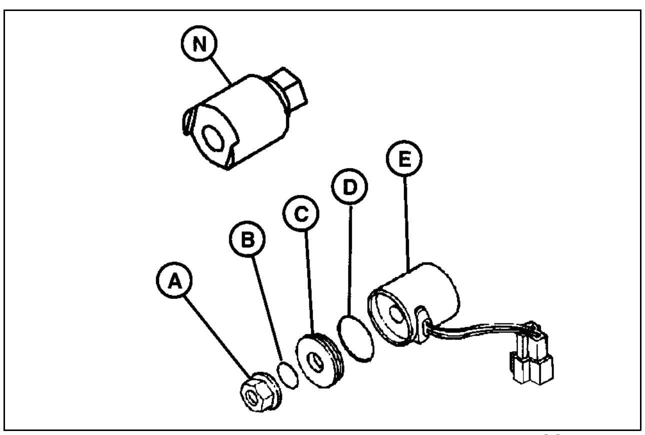
Removal and Installation:

Important: Avoid Damage! Do not bend, twist or damage solenoid armature. Do not damage machined surfaces or sharp edges of spool or sleeve. PTO will not function or will function erratically if spool, sleeve or armature is damaged.



M55442

1. Disconnect solenoid connector (F) from wiring harness.
2. Remove nut (A) and O-ring (B).



M81115a

Picture Note: NOTE: Nut (A) and O-ring (B) were already removed in step 2.

3. Remove solenoid cover (C), O-ring (D), and solenoid coil (E). Note order and direction of valve components for reassembly.
4. Remove solenoid armature assembly using JDG757A Solenoid Valve Socket (N).
5. Carefully remove valve components from PTO cover.

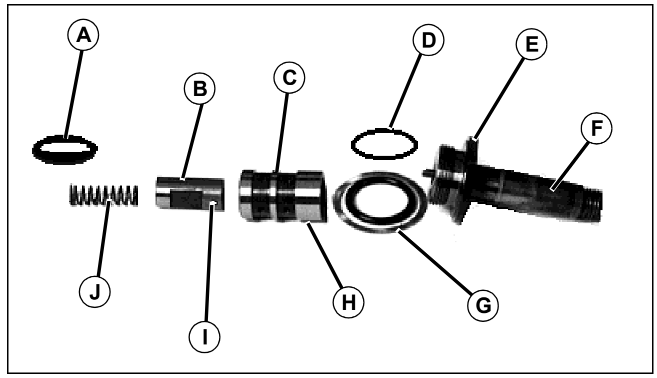
Note: Check bottom of bore for "wave" washer.

6. Clean and inspect parts for damage. Replace if necessary.
7. Place wave washer in case cover.

Disassembly, Inspection and Assembly:

Note: Sleeve and spool must be replaced as a set.

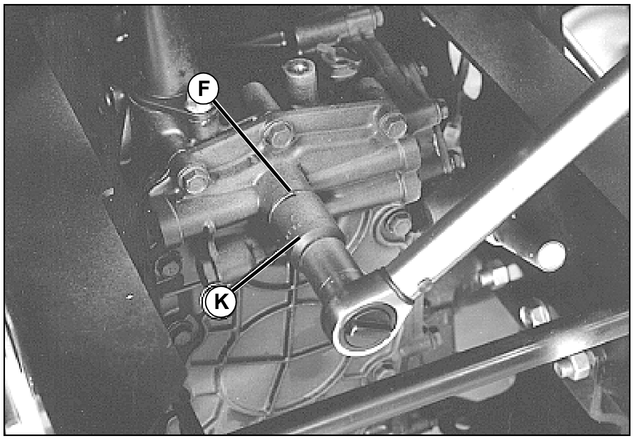
Important: Avoid Damage! Be sure large land (H) on sleeve and oil hole in spool are facing away from PTO case cover.



M78316a

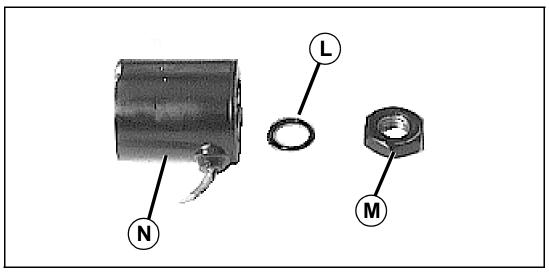
A- Wave Washer
B- Spool
C- Sleeve
D- O-Ring
E- Flats
F- Solenoid Armature
G- Gasket
H- Large Land on Sleeve
I- Oil Hole
J- Spring

1. Disassemble PTO solenoid valve.
2. Inspect parts for wear or damage.
3. Install spool into sleeve so the end with the oil hole is toward the large land on the sleeve.
4. Place spring into recess in end of spool.
5. Install sleeve assembly so smaller lands go into the PTO cover first.
6. Install gasket and O-ring.



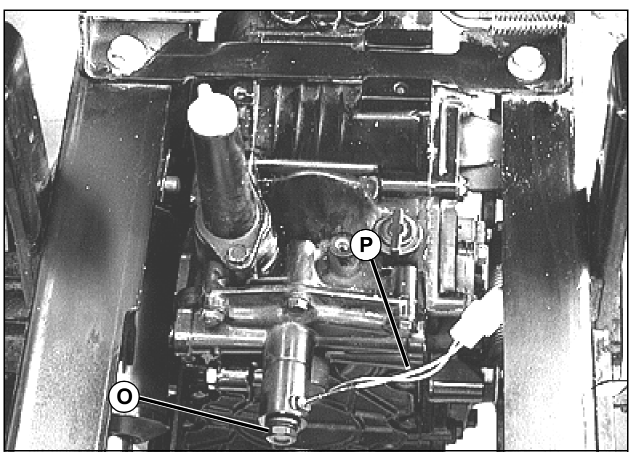
M81123

7. Use JDG757A Solenoid Valve Socket (K) to tighten solenoid armature (A) to specification.



M78310

8. Slide solenoid coil (N) onto solenoid armature. Install O-ring (L) and plastic nut (M) (do not tighten plastic nut at this time.)



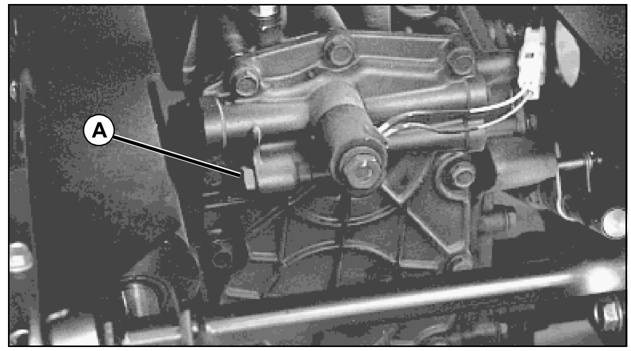
M55442

9. Position solenoid coil wire leads (P) to the right and approximately **45°** above horizontal.

Important: Avoid Damage! When tightening plastic nut be sure to tighten nut to exact specifications. Nut has a very low torque. Any overtightening will damage the armature coil.

10.Tighten plastic nut (O) to specification.

PTO Relief Valve Removal and Installation



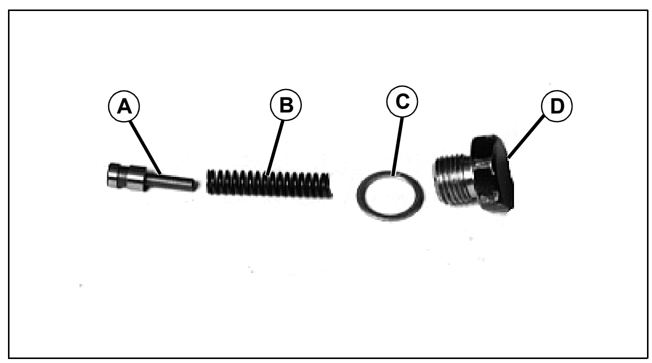
M81189a

1. Remove relief valve plug.
2. Install relief valve plug (A) and tighten to specification.

Specifications:

Solenoid Valve Armature. . . . . 22 N•m (195 lb-in.)
Valve Coil Plastic Nut. . . . . 4.9 N•m (43 lb-in.)
Relief Valve Plug . . . . 25 N•m (19 lb-ft)

PTO Relief Valve Disassembly, Inspection and Assembly



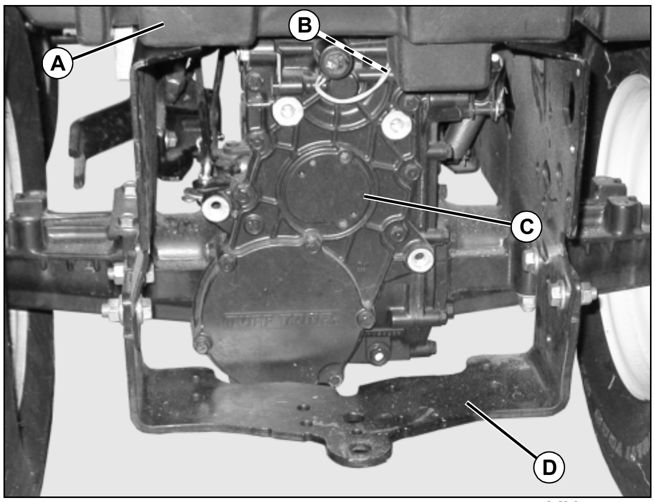
M78309

1. Disassemble PTO relief valve.
2. Check relief valve plunger and bore for scoring, nicks or burrs. Replace if necessary.
3. Install spring (B), gasket (C), relief valve plunger (A), and plug (D) in PTO cover.

PTO Brake Removal and Installation

Note: Approximate capacity of hydrostatic powertrain is 6.6 L (7.0 qt) for two-wheel steering and 5.7 L (6.0 qt) for all-wheel steering.

Caution: Avoid Injury! Allow transaxle to cool before draining fluid. Hot fluid can cause serious burns.



MX35903

1. Remove plug to drain oil from transaxle.
2. Remove fuel tank (A). See “Fuel Tank Removal and Installation” on page 460 in the Miscellaneous section.
3. Remove hitch plate (D).

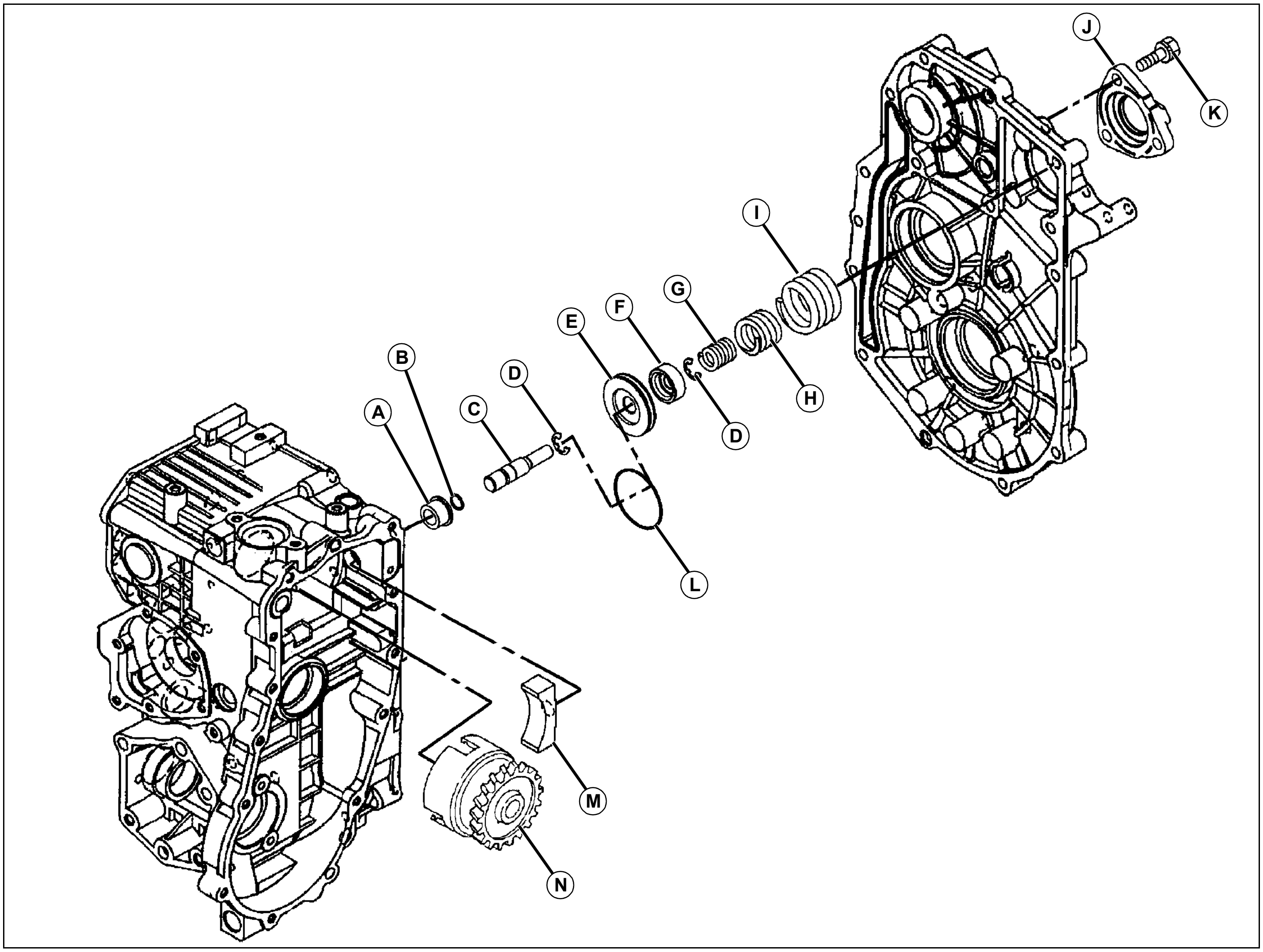
Note: If rear PTO is installed, remove necessary rear PTO components before rear transaxle cover removal. See “Rear PTO Removal and Installation” on page 294.

4. Remove PTO solenoid harness (B) and rear transaxle cover (C). If optional rear PTO is installed (not shown above), remove rear PTO. See “Rear PTO Removal and Installation” on page 294.
5. Remove control arm damper, to gain access to three cap screws holding PTO brake cover to transaxle side cover. See “Control Arm and Damper Removal and Installation” on page 280.

Caution: Avoid Injury! PTO brake cover is spring loaded. Remove cap screws evenly to release spring force.

6. Installation is reverse of removal.

PTO Brake Disassembly, Inspection and Assembly



MX14331

A- Collar, Brake Pin
B- O-Ring
C- Pin, PTO Brake
D- Snap Ring (2 used)
E- Piston
F- Stopper
G- Spring, Inner
H- Spring, Middle
I- Spring, Outer
J- Cover
K- Cap Screw (3 used)
L- O-Ring
M- PTO Brake Shoe
N- PTO Clutch Assembly

1. Carefully pull piston assembly from case using a pliers. Do not damage pin.

2. Remove PTO clutch assembly (N) and brake shoe (M) together.

Note: PTO brake pin, piston, springs, and O-Rings, etc., (parts C through I), must be replaced as a set.

3. Check pin and piston for burrs, scoring or wear.

4. Replace brake shoe if grooves in shoe contact surface are not visible.

5. Inspect O-rings for cuts or damage.

6. Inspect springs for cracks or damage.

7. Apply petroleum jelly to O-rings and seal on end of PTO clutch shaft.

8. Install piston assembly and clutch assembly.

9. Clean mating surface of cover and case. Be sure threaded holes are clean.

10.Apply a bead of John Deere Form-in-Place Gasket to cover mating surface.

Important: Avoid Damage! Be sure cover is aligned with transaxle case and installed within 3 mm (1/8 in.) of case before tightening cap screws. Major damage can occur to cover and/or case if cover is not installed properly before tightening cap screws.

Transaxle Cover Cap Screw Specifications:

Used Transaxle Case . . . . 25 N•m (18 lb-ft)

New Transaxle Case. . . . . 30 N•m (22 lb-ft)

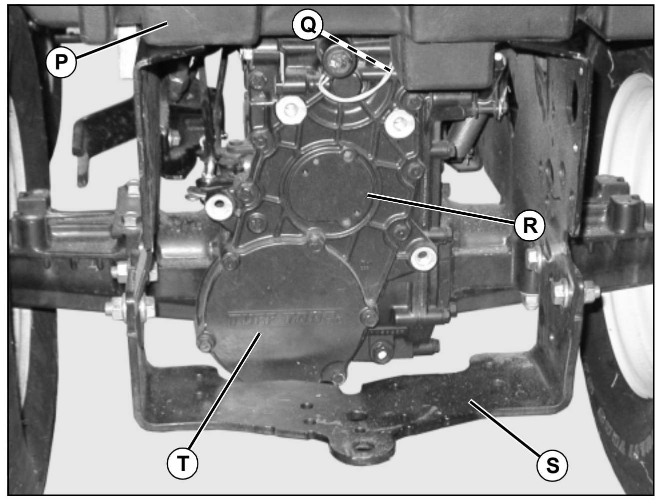
PTO Drive Train (Mid-PTO) Removal and Installation

Note: Approximate capacity of hydrostatic powertrain is 6.6L (7.0 qt) for two-wheel steering and 5.6L (6.0 qt) for all-wheel steering.

Removing:

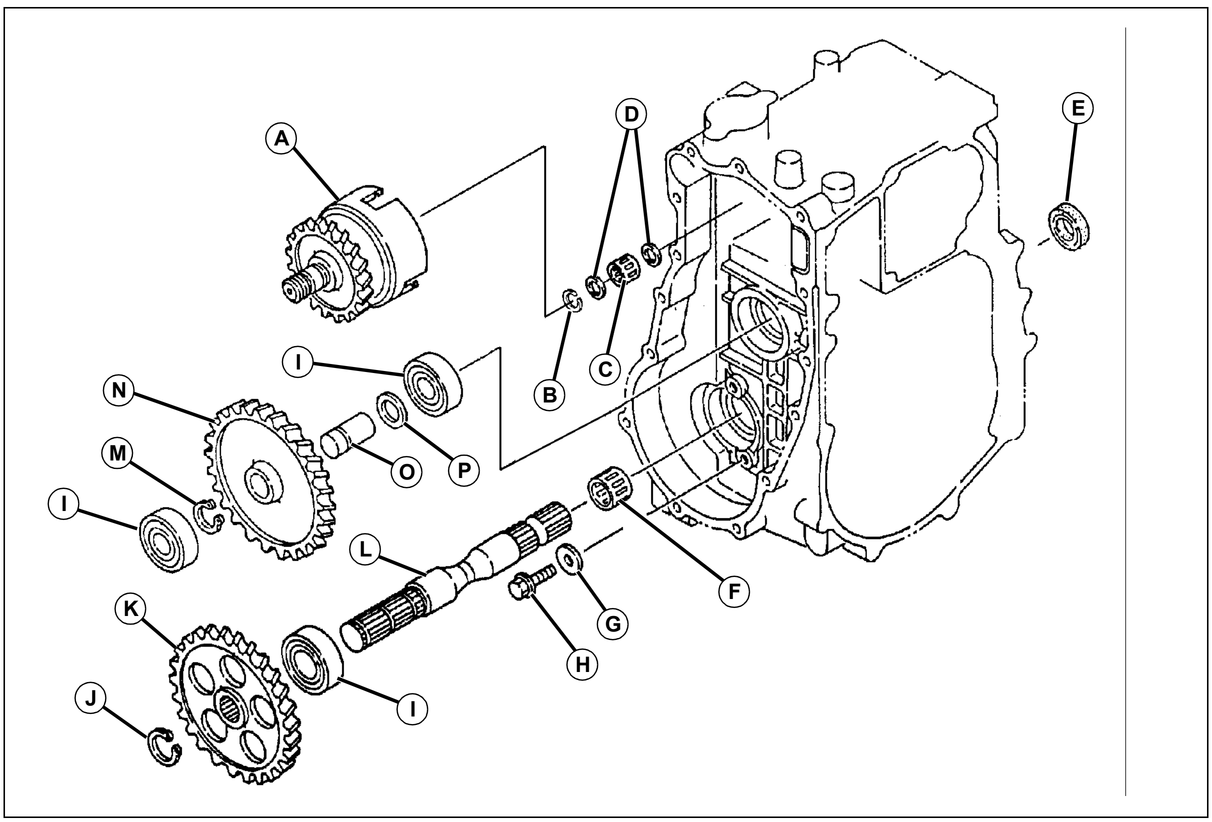
Caution: Avoid Injury! Allow transaxle to cool before draining fluid. Hot fluid can cause serious burns.

1. Remove plug to drain oil from transaxle.



MX35903

2. Remove fuel tank (P).
3. Remove hitch plate (S).
4. Disconnect PTO solenoid harness (Q).
5. Remove rear transaxle cover (R) or transaxle cover plate (T).



MX16046

A- PTO Clutch Assembly
B- Snap Ring
C- Needle Bearing
D- Washer
E- Seal
F- Needle Bearing
G- Washer

H- Cap Screw
I- Ball Bearing
J- Snap Ring
K- Mid-Mount PTO Gear
L- PTO Output Shaft
M- Snap Ring
N- PTO Idler Gear
O- PTO Idler Shaft
P- Washer

6. Remove PTO clutch assembly.

Important: Avoid Damage! When removing snap ring (B), be sure not to lose needle bearing (C) or washers (D).

7. Remove PTO idler gear assembly.

8. Remove PTO gear.

9. Left axle must be removed to remove PTO output shaft assembly. See "Rear Axle Assembly (Two Wheel Steer Models) Removal and Installation" on page 319.

10. Inspect ball bearings and needle bearing for smooth rotation.

Note: Idler gear and shaft must be replaced as a set.

11. Inspect gears and splines for missing or chipped teeth, wear or damage. Replace parts if necessary.

Installing:

1. If replaced, install new needle bearing from inside case with bearing identification marks toward the inside of the case. Push bearing tight against shoulder in bore.

2. Install new seal with the open, spring side towards the inside of the case.

3. Push seal against shoulder in bore.

4. Install mid-mount PTO gear so side with the longer center hub is towards bearing.

5. Clean mating surfaces of rear cover and case. Be sure threaded holes are clean and two O-rings are in position in rear cover.

6. Apply petroleum jelly to seal on shaft of PTO clutch assembly.

7. Apply a bead of John Deere Form-in-Place Gasket to cover mating surface.

Important: Avoid Damage! Be sure cover is aligned with transaxle case and installed within 3 mm (1/8 in.) of case before tightening cap screws. Major damage can occur to cover and/or case if cover is not installed properly before tightening cap screws.

8. Install transaxle drain plug. Refill transaxle with approximately **6.6L (7 qts)** for two-wheel steer models and **5.6L (6 qts)** for all-wheel steering models using JOHN DEERE LOW VISCOSITY HY-GARD™ (J20D as required) to cross-hatched area of dipstick.

Rear Cover Cap Screws Specifications:

Used Transaxle Case . . . . 25 N•m (18 lb-ft)
New Transaxle Case. . . . . 30 N•m (22 lb-ft)
Internal Cap Screws. . . . . 27 N•m (20 lb-ft)

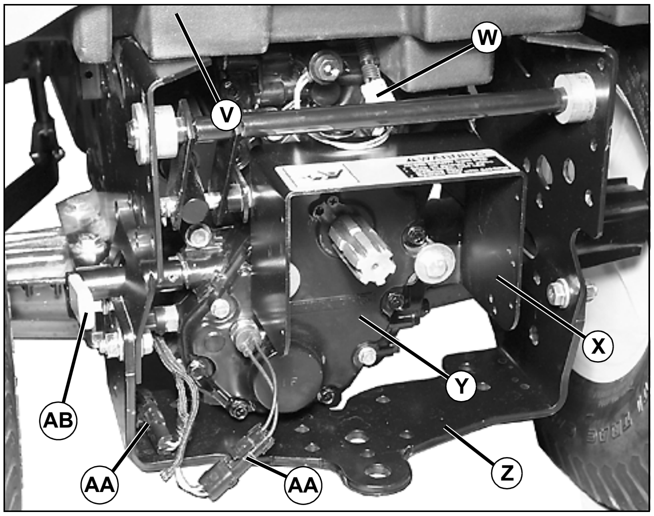
PTO Drive Train (Mid and Rear PTO) Removal and Installation

Note: Approximate capacity of hydrostatic powertrain is 6.6L (7.0 qt) for two-wheel steering and 5.6L (6.0 qt) for all-wheel steering.

Removing:

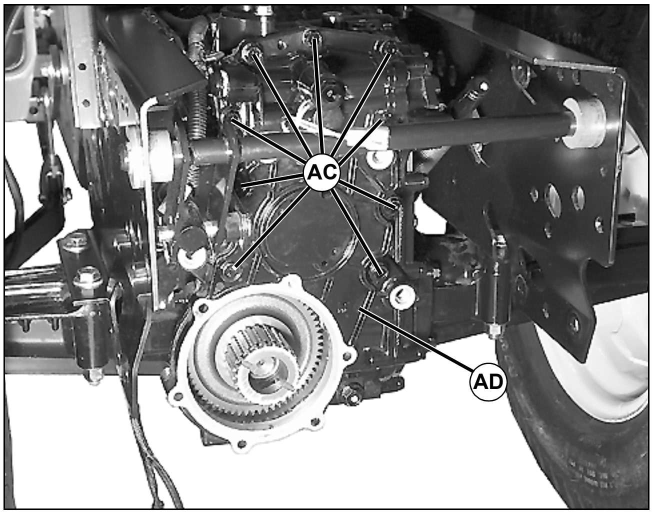
Caution: Avoid Injury! Allow transaxle to cool before draining fluid. Hot fluid can cause serious burns.

1. Remove plug to drain oil from transaxle.



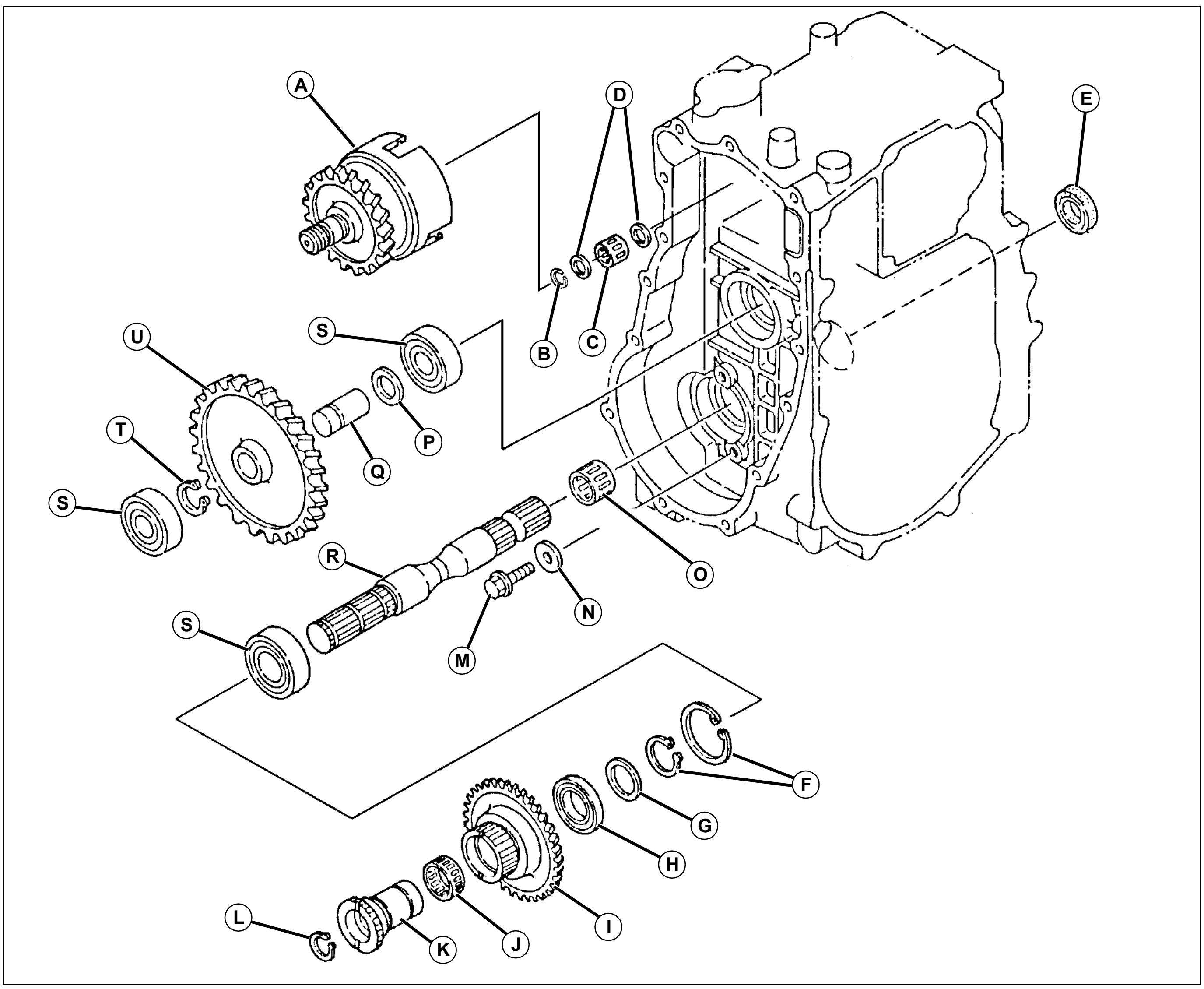
MX14332

2. Remove fender deck and fuel tank (V).
3. Remove roll pin and rear PTO control rod (AB).
4. Remove rear PTO shield (X).
5. Remove hitch plate (Z).
6. Disconnect two PTO switch connectors (AA).
7. Remove rear PTO cover (Y).
8. Disconnect PTO solenoid harness (W).



MX16048

9. Remove cap screws (AC) (9 used) to remove rear cover (AD).



MX16047

A- PTO Clutch Assembly
B- Snap Ring
C- Needle Bearing
D- Washer
E- Seal

F- Snap Ring
G- Spacer
H- Ball Bearing
I- Mid-Mount and Rear-Mount PTO Gear
J- Needle Bearing
K- Spline Collar
L- Snap Ring
M- Cap Screw (2 used)
N- Washer
O- Needle Bearing
P- Washer
Q- PTO Idler Shaft
R- PTO Output Shaft
S- Ball Bearing
T- Snap Ring
U- PTO Idler Gear

10.Remove PTO clutch assembly.

Important: Avoid Damage! When removing snap ring (B), be sure not to lose needle bearing (C) or washers (D).

11.Remove PTO idler gear assembly.

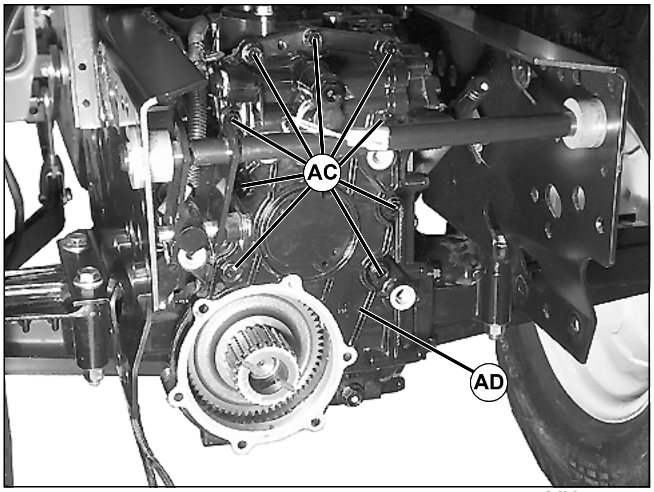
12.Remove snap ring (L), spline collar (K), and remove mid-mount and rear-mount PTO gear assembly (I).

13.Left axle must be removed to remove PTO output shaft assembly. Inspect ball bearings and needle bearings for smooth rotation.

14.Inspect gears and splines for missing or chipped teeth, wear or damage. Replace parts if necessary.

Installing:

Important: Avoid Damage! Be careful not to get too much sealant in area of two upper O-rings in rear cover (AD). Sealant should be applied outside of the grooves surrounding each O-ring. DO NOT fill groove with sealant. Purpose of groove is to stop excess sealant from moving O-ring during reassembly.



MX16048

1. Clean mating surfaces of rear cover (AD) and transaxle case. Be sure threaded holes are clean and two O-rings are in position in rear cover.

2. Apply petroleum jelly to seal on shaft of PTO clutch assembly.

3. Apply a bead of John Deere Form-in-Place Gasket to rear cover mating surface.

Important: Avoid Damage! Be sure rear cover (AD) is aligned with transaxle case and installed within 4 mm (1/8 in.) of case before tightening cap screws (AC). Major damage can occur to cover and/or case if cover is not installed properly before tightening cap screws.

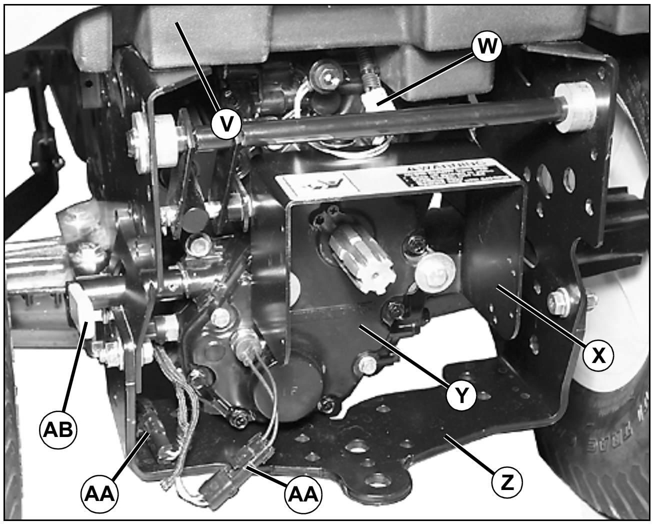
4. Carefully position the rear cover (AD) on the transaxle and onto the lower dowel pin. Use a pry bar between the PTO and frame to carefully move the PTO approximately **1.5 mm (1/16-in.)** to the right to align the top of the cover with the upper dowel pin. Secure with cap screws (AC) (9 used).

Rear Cover Cap Screw Torque Specifications:

Used Transaxle Case . . . . 25 N•m (18 lb-ft)

New Transaxle Case. . . . . 30 N•m (22 lb-ft)

Internal Cap Screws. . . . . 27 N•m (20 lb-ft)



MX14332

5. Apply a bead of John Deere Form-in-Place Gasket to PTO gear case (Y) mating surface.

6. Shift PTO lever (AB) to the middle position.

7. Carefully position the PTO gear case assembly (Y) on the transaxle.

Important: Avoid Damage! Be sure PTO gearbox cover (Y) is aligned with rear cover and installed within 4 mm (1/8 in.) of cover before tightening cap screws. Major damage can occur to both covers and transaxle case, if PTO cover is not installed properly before tightening cap screws.

8. Secure PTO to transaxle with cap screws.

Rear PTO Gear Case Cap Screw Torque Specifications:

Used Transaxle Case . . . . 25 N•m (18 lb-ft)

New Transaxle Case . . . . 30 N•m (22 lb-ft)

9. Install shifter (AB), PTO shield (X), and hitch plate (Z).

10.Connect PTO switch connectors (AA).

11.Disconnect PTO solenoid harness (W).

12.Install transaxle drain plug. Refill transaxle with approximately **6.6L (7 qts)** for two-wheel steer models and **5.6L (6 qts)** for all-wheel steering models using JOHN DEERE LOW VISCOSITY HY-GARD™ (J20D as required) to cross-hatched area of dipstick.

13.Install any additional items removed prior to PTO.

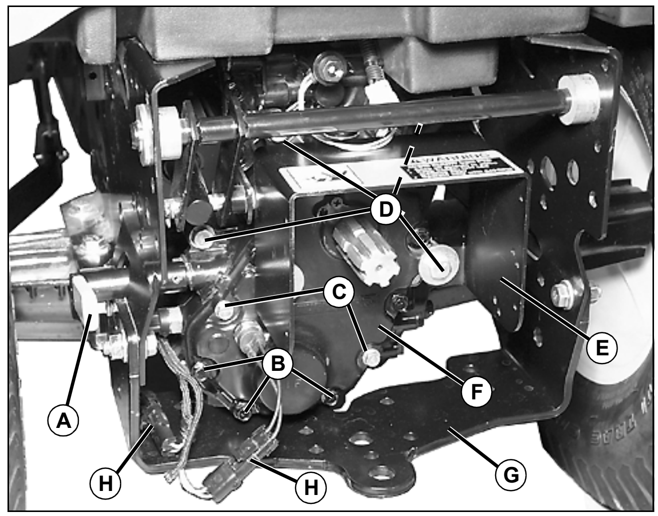
Rear PTO Removal and Installation

Note: Approximate capacity of hydrostatic powertrain is 6.6L (7.0 qt) for two-wheel steering and 5.6L (6.0 qt) for all-wheel steering.

Removing:

Caution: Avoid Injury! Allow transaxle to cool before draining fluid. Hot fluid can cause serious burns.

1. Remove plug to drain oil from transaxle.



MX14332

2. Remove roll pin and rear PTO control rod (A).

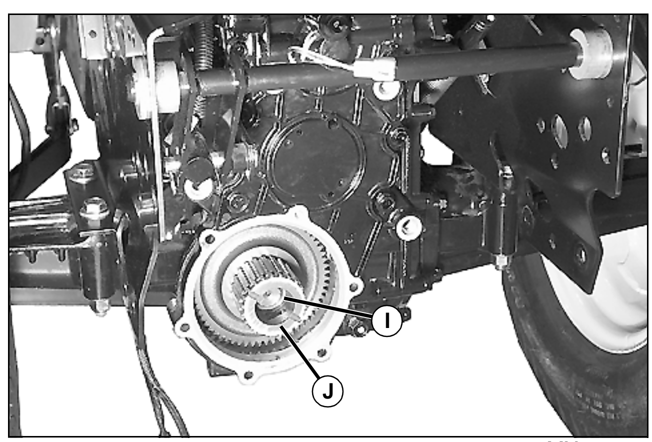
3. Remove rear PTO shield (E).

4. Remove hitch plate (G).

5. Disconnect two PTO switch connectors (H).

Note: Remember to install three different sized cap screws in original holes as removal.

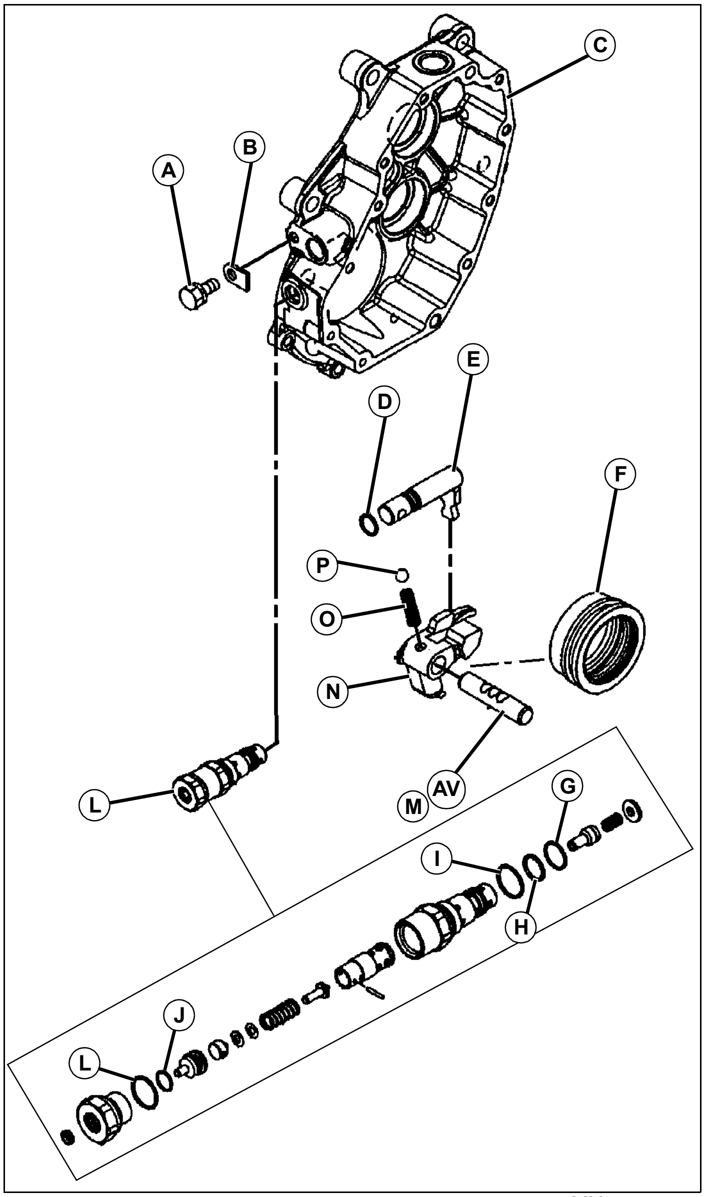
6. Remove four M12 x 40 (D), two M8 x 110 (C), and three M8 x 50 (B) cap screws and PTO assembly (F).



MX16048

7. Remove snap ring (I) and drive gear set (J). Inspect parts and replace as necessary.

Disassembly and Assembly:



MX14325

1. Remove cover from PTO gear case (C).

2. Remove cap screw (A) and plate (B), and pull shifter shaft (E) from PTO gear case (C). Replace O-Ring (D).

3. Remove shift collar (F) and shifter fork (N) assembly together.

4. Remove tow relief valve (L) if necessary. Remove and replace O-rings (G through L).

Note: If shift collar replacement is necessary, the rear PTO idler gear and rear PTO input gear (in the rear PTO cover) must be replaced also. The three gears are available as a set.

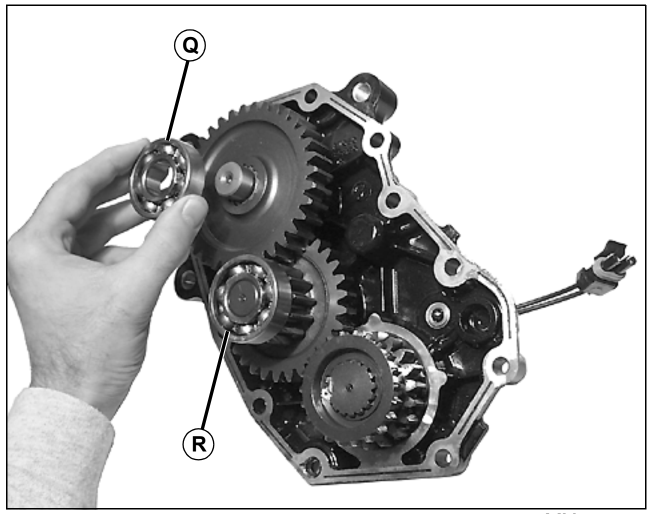
5. Inspect rear PTO case (C) components. Replace as necessary.

6. Apply clean hydraulic oil to O-ring (D) before installation.

7. If shifter fork (N) was disassembled, install spring (O) and ball (P) in fork. While compressing ball and spring, install fork shaft (M). Be sure ball fits into grooves of shaft.

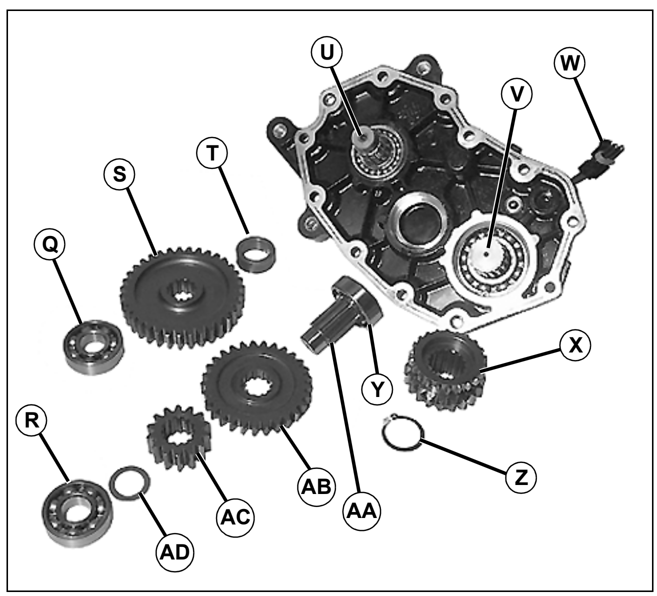
8. With fork groove of shift collar away from case, install shifter fork and collar. Be sure arm of shifter shaft (E) fits into slot of shifter fork.

Note: Install bearings with writing/numbers facing gears in cover assembly.



MX16059

9. Remove bearing (Q) and bearing (R), noting markings on outer bearing races.



MX16060

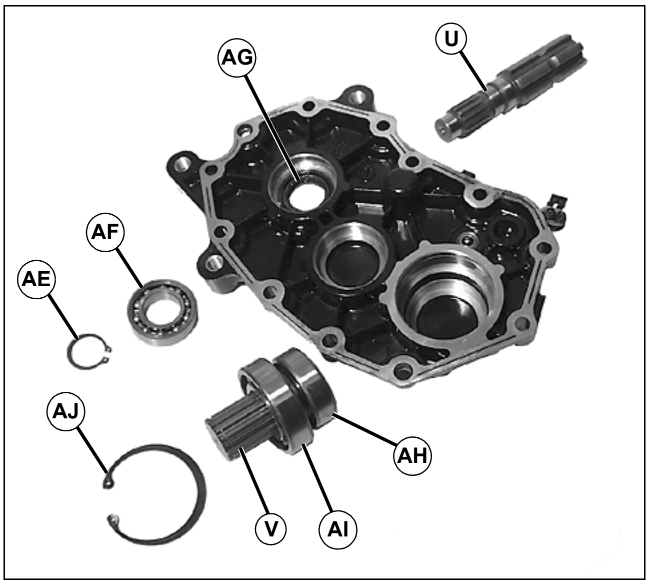
10.Remove rear PTO gear (S), and collar (T) from PTO shaft (U).

Note: If rear PTO input gear (AB) replacement is necessary, the shift collar (F) (in the rear PTO case) and rear PTO idler gear (X) must be replaced also. The three gears are available as a set. Rear PTO gear (S) and rear PTO idler pinion (AC) must be replaced as a set.

11.Remove washer (AD), PTO idler pinion (AC), PTO input gear (AB). Remove idle shaft (AA), and bearing (Y) from cover. Press bearing from shaft.

12.Remove snap ring (Z), and PTO idler gear (X) from rear PTO shaft (V).

13.If necessary, remove ball switch (W) and O-Ring.



MX16061

14.Remove snap ring (AE) and press bearing (AF) from PTO shaft (U). Inspect shaft for wear or damage, and replace if necessary.

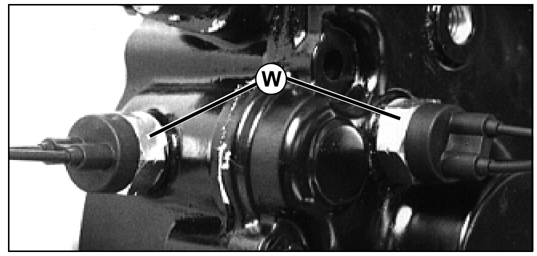
15.Remove and replace oil seal (AG) from cover. Install new seal into cover with the closed side of the seal into the bore first. Use a disk driver to push seal to bottom of bore.

Note: Recall writing/numbers on all outer bearing races, and install bearings in reverse order as removal.

16.Remove snap ring (AJ), and remove rear PTO input shaft (U) from cover. Remove bearing (AH) and large bearing (AI) from shaft.

17.Inspect all parts and replace as necessary. Assembly is reverse order of disassembly.

- Install bearings (AI and AH) on rear PTO input shaft (V) tight against shoulder.

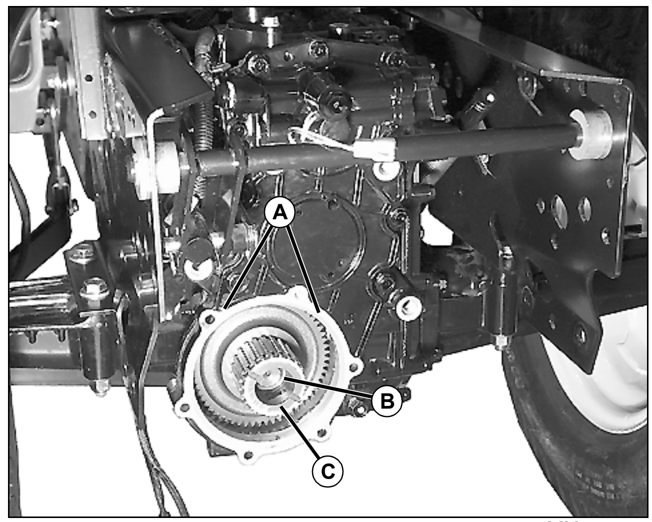


M78313

- If removed, install O-rings and ball switches (W). DO NOT overtighten. Tighten to **34 N•m (25 lb-ft)**.

Installing:

1. Clean mating surface of cover and gear case. Be sure threaded holes are clean.

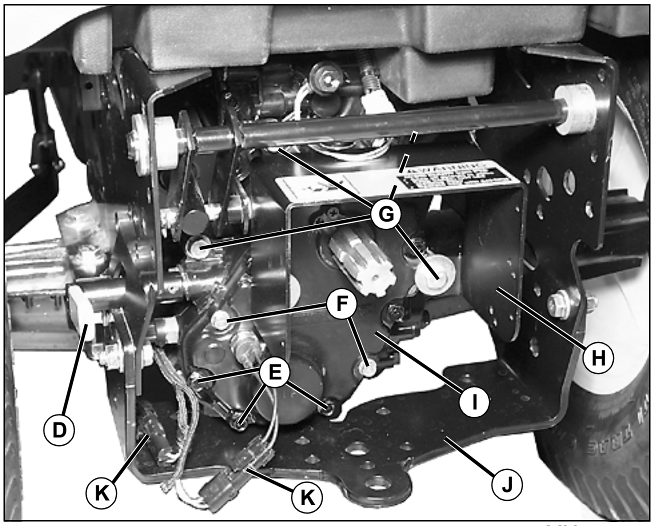


MX16048

2. If removed, install drive gear set (C) and snap ring (B).

3. Apply a bead of John Deere Form-in-Place Gasket to PTO cover to gear case, and gear case to transaxle (A) mating surfaces.

Important: Avoid Damage! Carefully lower cover assembly onto case, making sure bearings fit into bores and gears mesh properly. Be sure cover is installed within 3 mm (1/8 in.) of case before tightening all cap screws to 25 N•m (18 lb-ft). Major damage can occur to cover and/or case if cover is not installed properly before tightening cap screws.



MX14332

4. Install PTO assembly (I) on the two alignment bushings, and tighten four M12 x 40 (G), two M8 x 110 (F), and three M8 x 50 (E) cap screws to specification below.

5. Connect two PTO switch connectors (K).

6. Install rear PTO control rod (D), and roll pin.

7. Install rear PTO shield (H), and secure with four cap screws to specification below.

8. Install hitch plate (J).

9. Install transaxle drain plug. Refill transaxle with approximately **6.6L (7 qts)** for two-wheel steer models and **5.6L (6 qts)** for all-wheel steering models using JOHN DEERE LOW VISCOSITY HY-GARD™ (J20D as required) to cross-hatched area of dipstick.

Specifications:

PTO Shield Cap Screws	**54 N•m (40 lb-ft)**
M8 Bolts	**24 N•m (18 lb-ft)**
M12 Bolts	**54 N•m (40 lb-ft)**

Transaxle Removal and Installation

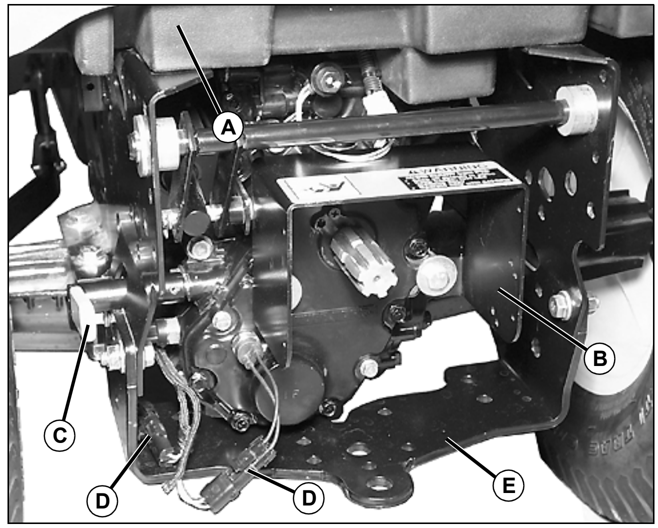
Removal:

Note: Approximate capacity of hydrostatic powertrain is 6.6L (7.0 qt) for two-wheel steering and 5.6L (6.0 qt) for all-wheel steering.

1. Park machine safely, and disconnect negative battery cable.

> **Caution: Avoid Injury! Allow transaxle to cool before draining fluid. Hot fluid can cause serious burns.**

2. Remove plug to drain oil from transaxle.

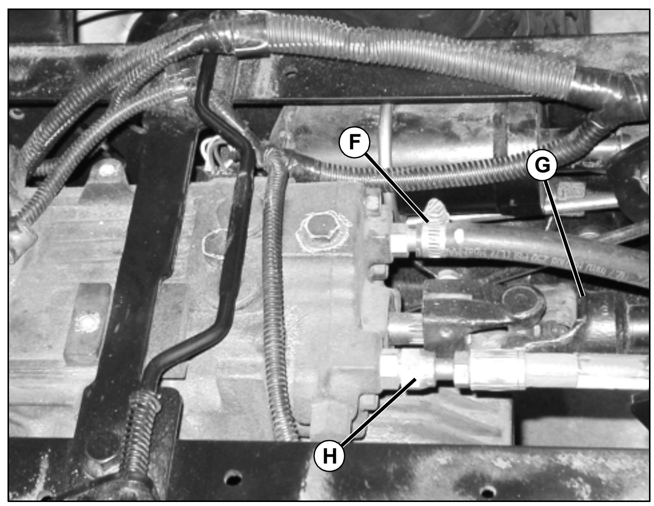


MX14332

3. Remove fuel tank (A). See “Fuel Tank Removal and Installation” on page 460 in the Miscellaneous section.

4. If equipped, remove rear PTO shield (B), disconnect rear PTO control rod (C), and the two (2) PTO switch connectors (D).

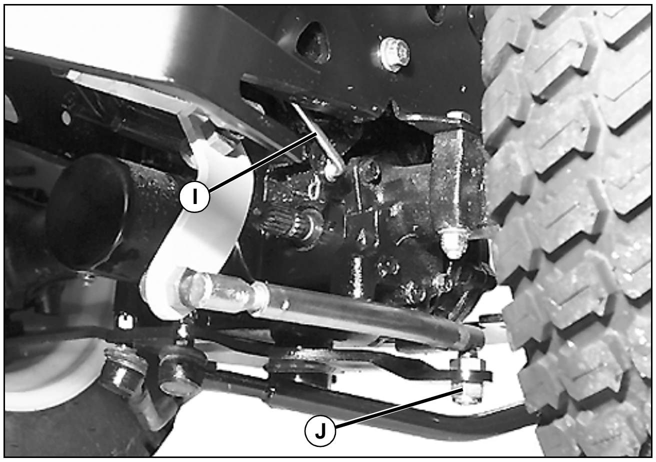
5. Remove hitch plate (E).



MX35901

6. Disconnect charge pump-to-steering valve hose (H) and oil cooler-to-charge pump hose (F).

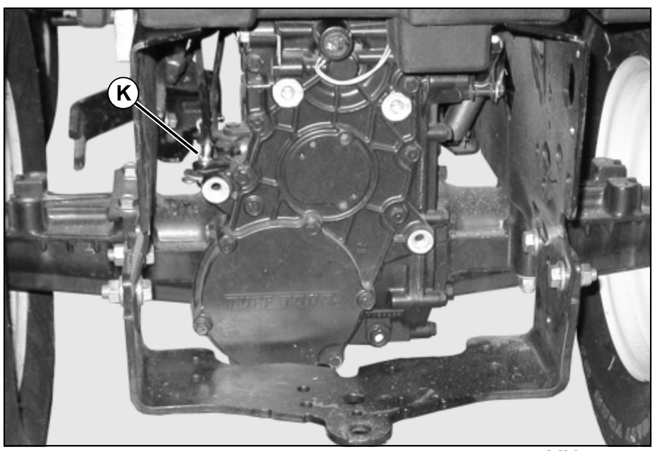
7. Remove drive shaft (G) from transaxle. See “Drive Shaft Removal and Installation” on page 285.



MX16087

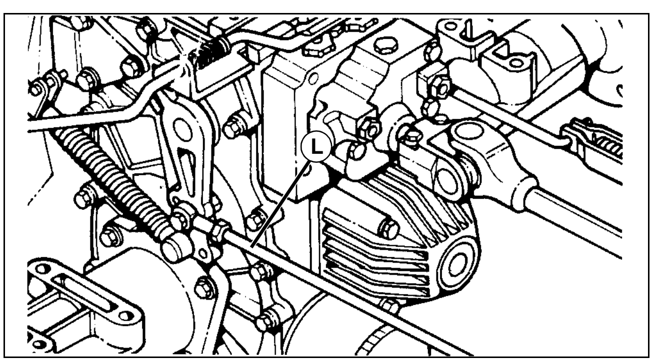
8. Disconnect brake linkage (I).

9. For AWS machines only, remove nut (J) and disconnect rear intermediate linkage.



MX35903

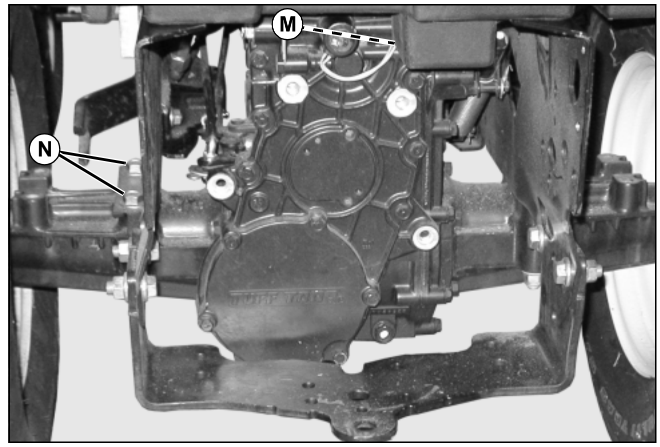
10.Remove spring locking pin and washer, and disconnect differential lock linkage (K).



MX16051

11.Disconnect foot control linkage (L).

12.Lift rear of machine, and install jack stands.



MX35903

13.Remove rear tires.

14.Disconnect PTO solenoid connector (M).

15.Attach transaxle to a hoist.

16.Remove four cap screws (N) and lock nuts on both sides of transaxle, and carefully remove transaxle.

17.Repair transaxle as necessary.

Installation:

Installation is done in the reverse order of removal.

- Connect drive shaft while installing transaxle.
- Tighten four transaxle mounting lock nuts to specification.

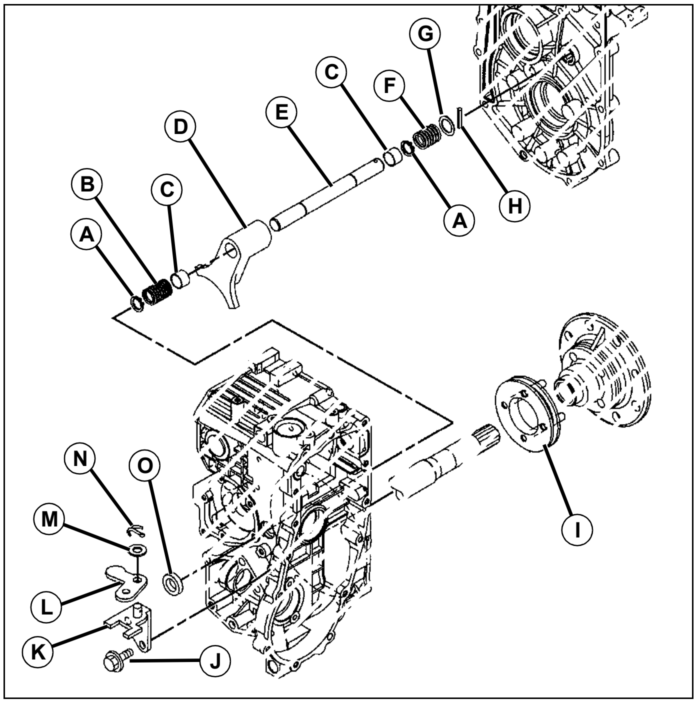
Specifications:

Transaxle Mounting Lock Nuts
. . . . **71 - 106 N•m (52 - 78 lb-ft)**

Differential Lock Shaft Disassembly and Assembly

Disassembly:

> **Caution: Avoid Injury! Springs are under compression. Carefully remove roll pin and release spring force slowly to prevent personal injury.**



MX14317

A- Snap Ring (2 used)
B- Spring
C- Sleeve (2 used)
D- Fork
E- Shaft
F- Spring
G- Washer
H- Roll Pin
I- Shift Collar
J- Cap Screw
K- Plate
L- Fulcrum, Differential Lock
M- Washer
N- Cotter Pin
O- Seal

1. Remove roll pin (H), washer (G), and spring (F).

2. Remove snap rings (A), sleeves (C), spring (B), shaft (E), and fork (D).

3. Inspect shaft (E) and fork for wear or damage. Replace parts as necessary.

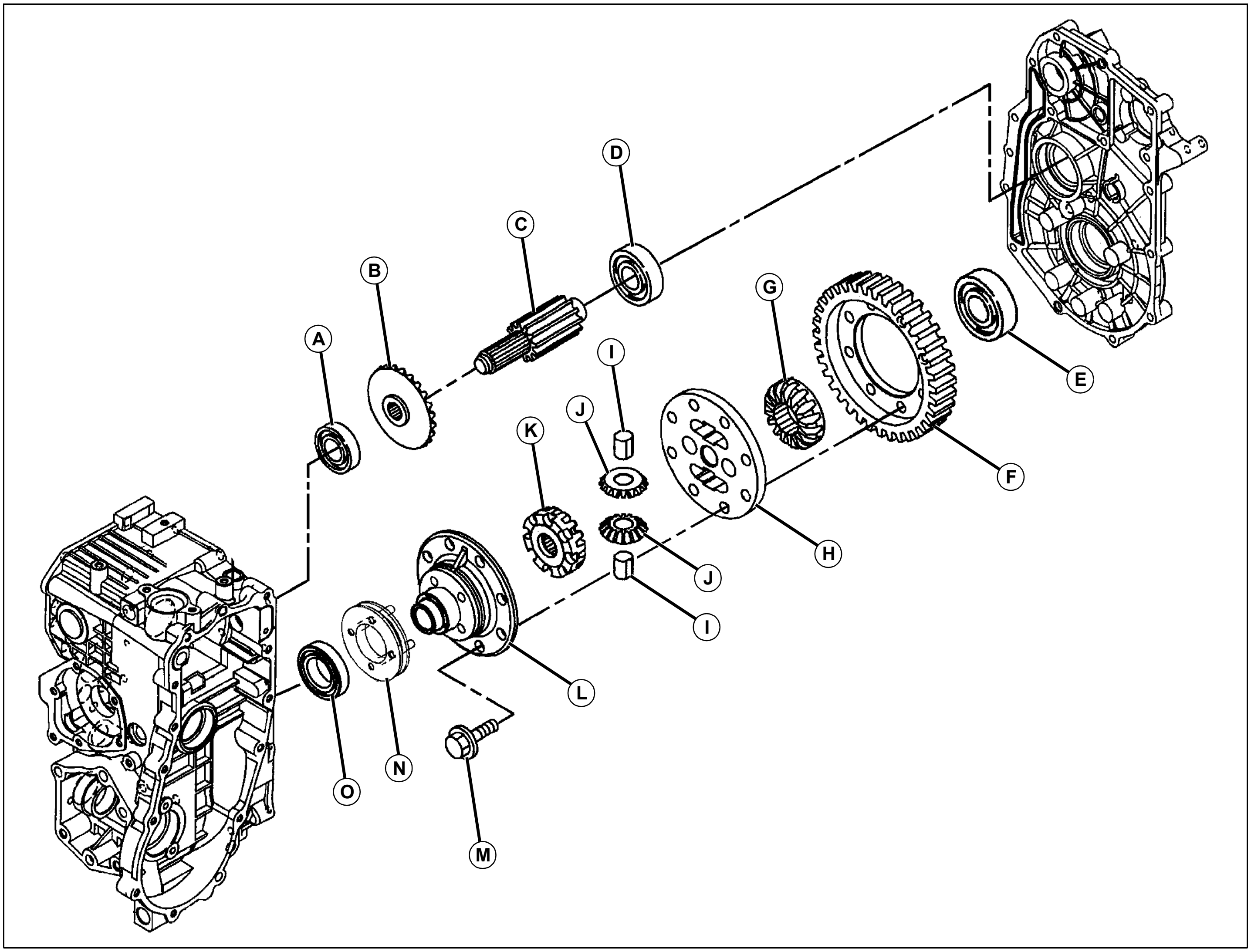
Assembly:

Assembly is reverse of disassembly.

Note: Install long hub of fork towards transaxle.

Differential (2-Wheel Drive) Disassembly and Assembly

Disassembly:



MX14340

A- Ball Bearing
B- Bevel Input Gear
C- Final Pinion Shaft
D- Ball Bearing
E- Right Ball Bearing
F- Final Gear
G- Right Differential Gear
H- Differential Carrier
I- Pins (2 used)
J- Pinion Gear (2 used)
K- Left-Notched Differential Gear
L- Differential Holder
M- Cap Screws w/Washers (8 used)
N- Differential Lock Collar
O- Left Ball Bearing

1. Use a puller to remove left ball bearing from differential holder.
2. Inspect differential components.
3. Bearings must rotate free and smoothly. Replace as necessary.
4. Check differential components for wear or damage. If replacement is necessary, all parts must be replaced as set.
5. Inspect differential lock collar for wear or loose or sheared off pins.
6. Check differential holder (L) and carrier (H) for wear, cracks or damage.
7. Inspect final gear (F) for worn or damaged teeth.

Note: Pinion gears (J) (2 used) and pins (I) (2 used) must be replaced as a set.

8. Inspect ball bearings (A and D) for smooth rotation.

Note: Final pinion shaft (C) and final gear (F) must be replaced as a set. Bevel input gear (B) and bevel input pinion (not shown) must be replaced as a set.

9. Check bevel input gear (B) and final pinion shaft (C) for worn or damaged condition. Replace parts as necessary.

Assembly:

Note: Use medium strength thread lock and sealer.

1. Install final gear on differential holder and carrier with the deeper offset of gear center away from the holder. Tighten eight differential cap screws (M) to specification.

2. Install differential lock collar (N) and left bearing (O). Push bearing tight against shoulder of differential holder.

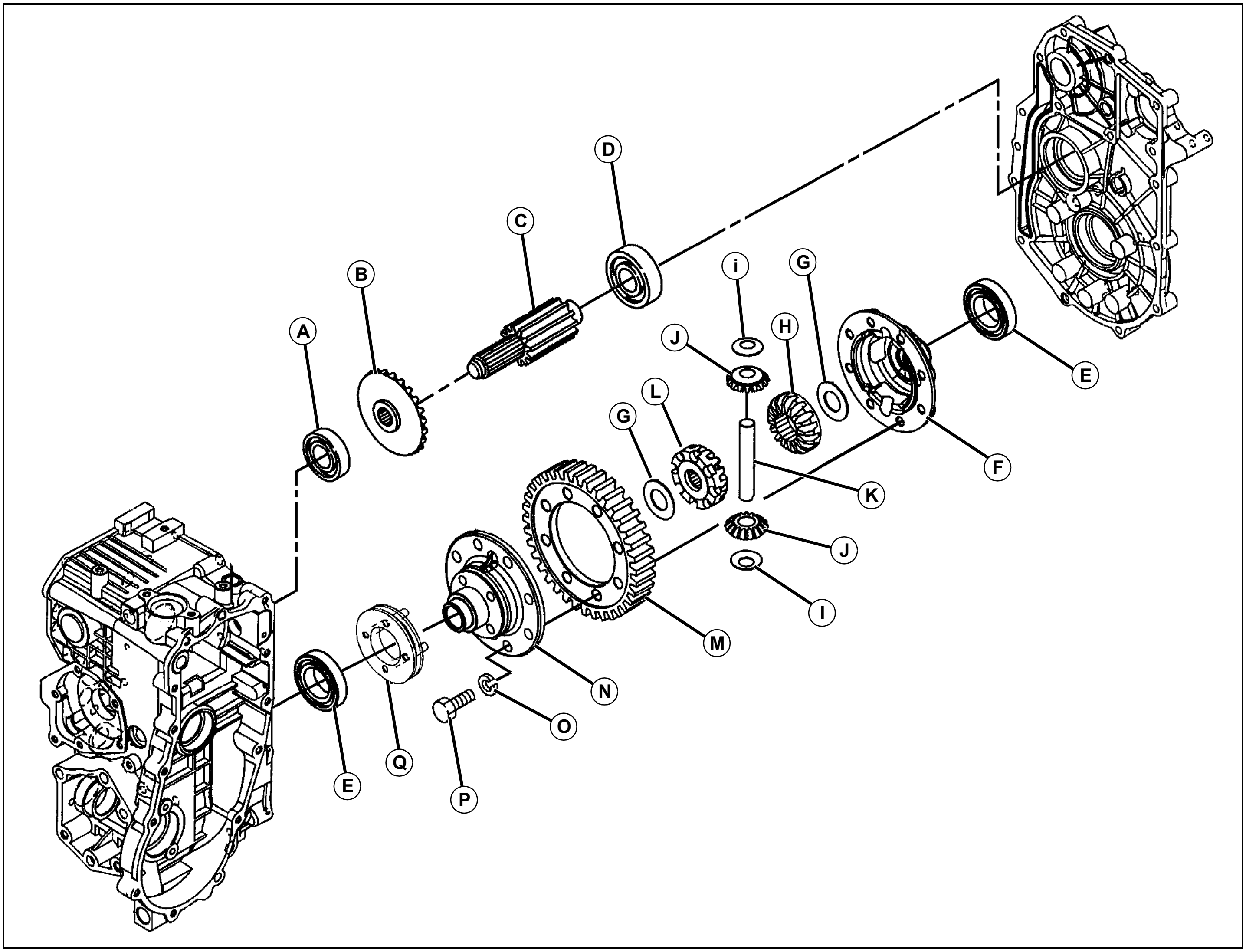
3. Install remaining components.

Specifications:

Differential Cap Screws . . . . 88 N•m (65 lb-ft)

Differential (MFWD) Disassembly and Assembly

Disassembly:



MX14341

A- Ball Bearing
B- Bevel Input Gear
C- Final Pinion Shaft
D- Ball Bearing
E- Ball Bearing (2 used)
F- Differential Holder, Right
G- Liner (2 used)
H- Right Differential Gear
I- Washer (2 used)
J- Pinion Gear (2 used)
K- Differential Pinion Shaft

L- Left-Notched Differential Gear
M- Final Gear
N- Differential Holder, Left
O- Washers (8 used)
P- Cap Screws (8 used)
Q- Differential Lock Collar

1. Use a puller to remove ball bearings (E) from differential holders (F and N).

2. Inspect differential components.

3. Bearings must rotate free and smoothly. Replace as necessary.

4. Check differential components for wear or damage. If replacement is necessary, all parts must be replaced as a set.

5. Inspect differential lock collar for wear or loose or sheared off pins.

6. Check differential holders (F and N) and differential pinion shaft (K) for wear, cracks or damage.

7. Inspect final gear (M) for worn or damaged teeth.

Note: Pinion gears (J), washers (I), and differential pinion shaft (K) must be replaced as a set.

8. Inspect ball bearings (A and D) for smooth rotation.

Note: Final pinion shaft (C) and final gear (M) must be replaced as a set. Bevel input gear (B) and bevel input pinion (not shown) must be replaced as a set.

9. Check bevel input gear (B) and final pinion shaft (C) for worn or damaged condition. Replace parts as necessary.

Assembly:

Note: Use medium strength thread lock and sealer.

1. Install final gear on differential holder and carrier with the deeper offset of gear center away from the holder. Tighten eight differential cap screws (P) to specification.

2. Install differential lock collar (Q) and left and right bearings (E). Push bearing tight against shoulder of differential holder.

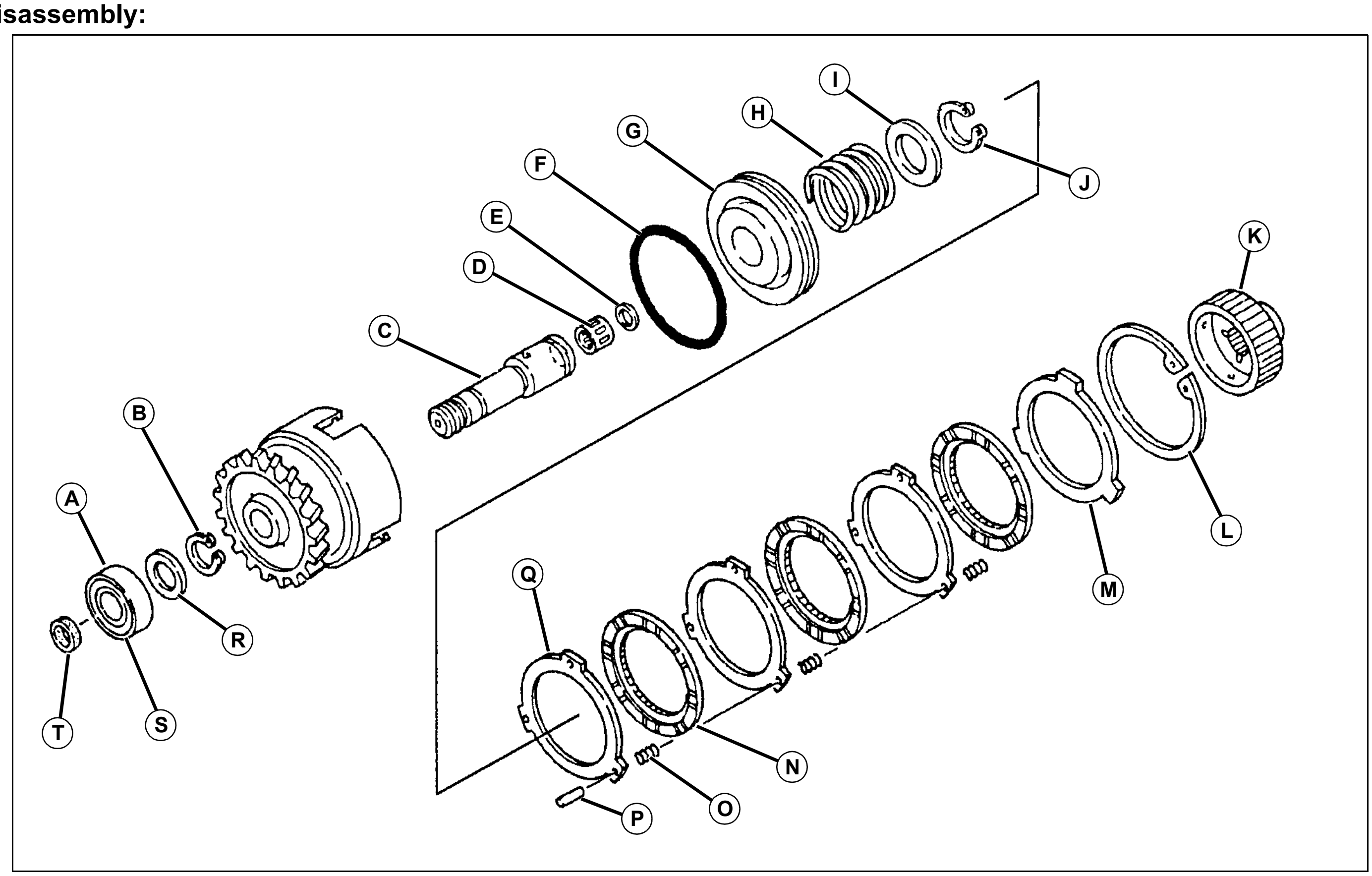
3. Install remaining components.

Specifications:

Differential Cap Screws . . . . 88 N•m (65 lb-ft)

PTO Clutch Disassembly, Inspection and Assembly

Disassembly:



M81113ae

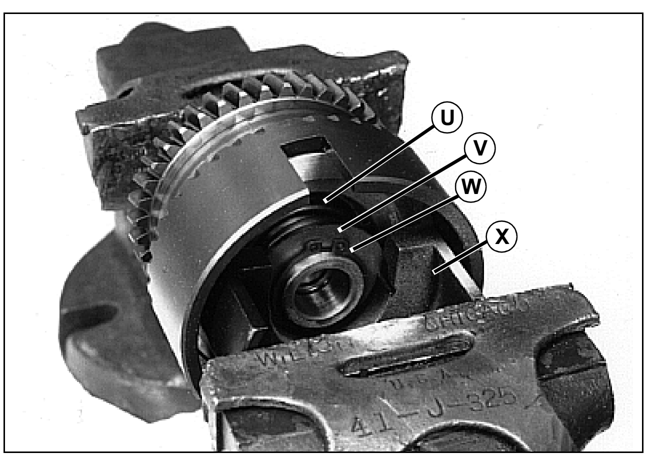
- A- Ball Bearing
- B- Snap Ring
- C- Clutch Shaft
- D- Needle Bearing
- E- Washer
- F- O-Ring
- G- Piston
- H- Spring
- I- Washer
- J- Snap Ring
- K- Input Shaft Collar
- L- Snap Ring
- M- Thick Steel Plate
- N- Friction Plate
- O- Spring
- P- Pin
- Q- Steel Plate
- R- Clutch Gear/Hub
- S- Washer
- T- Seal Ring

1. Remove PTO clutch assembly. See “PTO Brake Removal and Installation” on page 288.
2. Remove large snap ring (L) and thick steel plate (M).
3. Remove parts.

Note: Friction plates, springs, steel plates and pins must be replaced as a set.

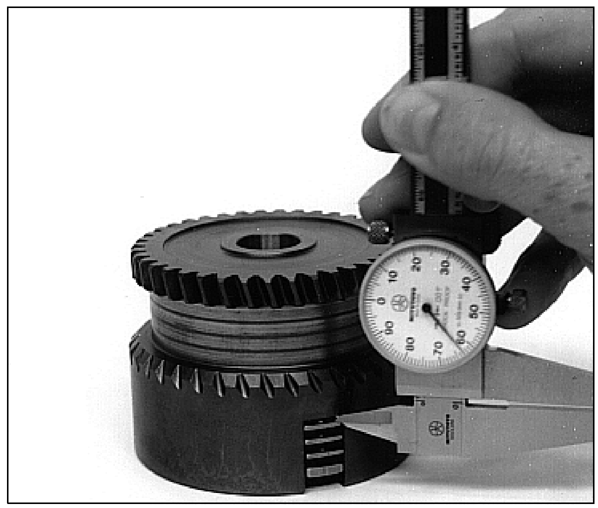
4. Replace clutch gear/hub if brake surface is badly scored or teeth are chipped or damaged.

Caution: Avoid Injury! Piston is under spring force. Use care during disassembly.



M81124

5. Remove piston from clutch gear/hub. Use JDT39 Transmission Gear Spacer (X) to compress spring (U) and washer (V) in a vise. Remove snap ring (W) and slowly release force of spring.
6. Remove remaining clutch parts.
7. Check bearings for smooth rotation.
8. Inspect clutch gear for worn or damaged teeth.
9. Check inner piston bore for scoring or wear.
10. Check steel plates for scoring, discoloration, warping or wear.
11. Replace worn or damaged springs.
12. Check input shaft collar for burrs, wear or damaged teeth or splines.
13. Check clutch pack wear. Assemble parts.



M81186

14. Put clutch gear/hub on bench so steel and friction plates are against snap ring. Measure clearance between inner steel plate and bottom of clutch gear/hub.
15. If clearance measures **2.7 mm (0.106 in.)** or more, replace PTO clutch plates.
16. Apply clean hydraulic oil to all parts.

Assembly:

Assembly is done in the reverse order of disassembly.

MFWD Output Shaft Removal and Installation

Removal:

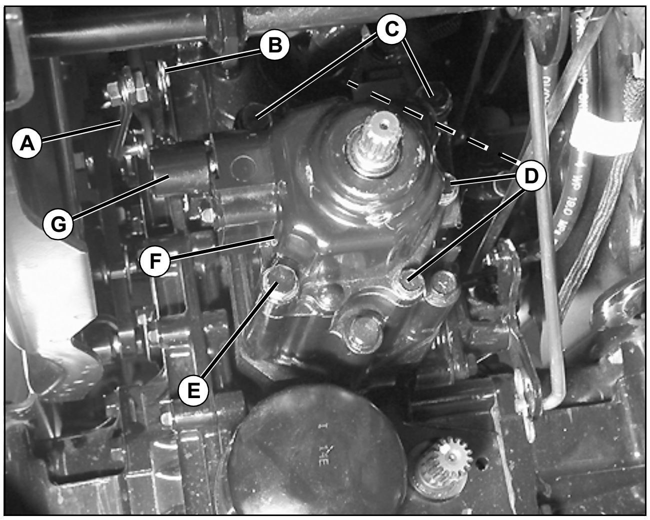
1. Park machine safely, and remove negative battery cable.

Note: Approximate capacity of hydrostatic powertrain is 6.6L (7.0 qt) for two-wheel steering and 5.6L (6.0 qt) for all-wheel steering.

2. Remove front drive shaft assembly.

Caution: Avoid Injury! Allow transaxle to cool before draining fluid. Hot fluid can cause serious burns.

3. Drain transaxle.

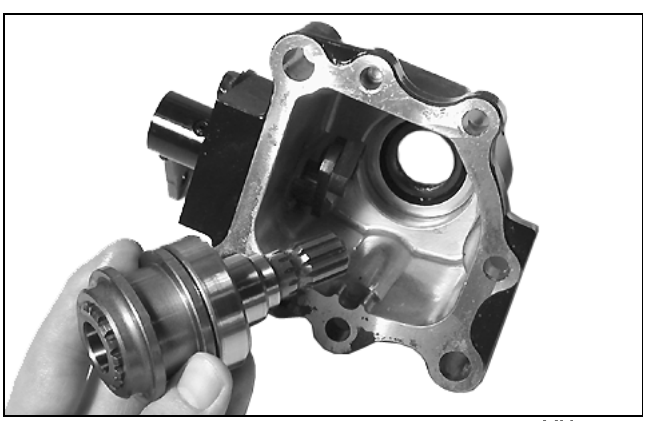


MX16018

4. Remove spring pin (B) and washer, and remove end of linkage (A) off of shift arm (G).

5. Remove two long cap screws (C) and washers, cap screw (E) and washer, and three short cap screws (D) holding cover assembly (F) onto motor case.

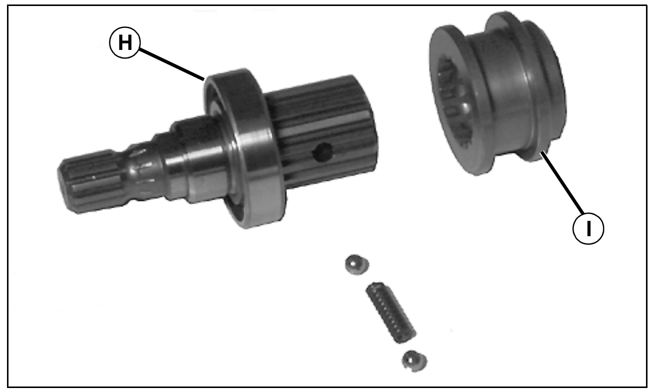
Disassembly and Assembly:



MX16019

1. Remove front wheel drive output shaft assembly from front wheel drive housing by driving assembly into housing from the front.

Note: Front wheel drive output shaft has two spring loaded detent balls located under shift collar. Use care when removing shift collar from front wheel drive output shaft. Note that flat end of shift collar goes toward bearing.



MX16020

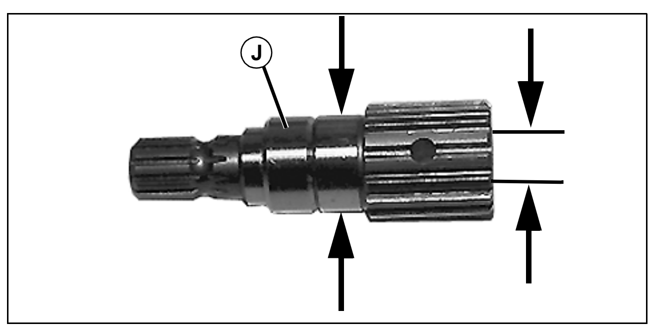
2. Remove shift collar (I), detent balls, spring, and bearing (H) from front wheel drive output shaft.

Note: Flat end of shift collar goes toward bearing.

3. Clean bearings in a suitable solvent. Dry with compressed air.

Important: Avoid Damage! DO NOT spin bearing using compressed air. Damage to bearing balls, cage, and races could result.

4. Inspect bearings for discolored, burned, balls and/or races. Check balls and races for spalling or cracking. Roll bearing by hand to check for rough turning or excessive looseness or play between balls and races. Replace bearings as required.



MX16034

5. Measure OD of bearing surface. If not within specifications, replace front wheel drive output shaft.

6. Measure ID of pilot hole. If not within specifications, replace front wheel drive output shaft.

7. Inspect sleeve (J) for wear. Replace, as necessary.

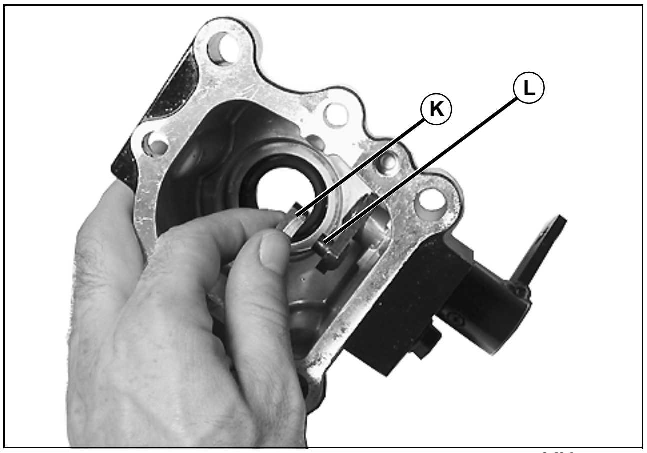
8. Inspect spines on front wheel drive output shaft and shift collar for damage. Replace as required.

9. Inspect groove in shift collar for scoring or damage. Replace as required.

Specifications:

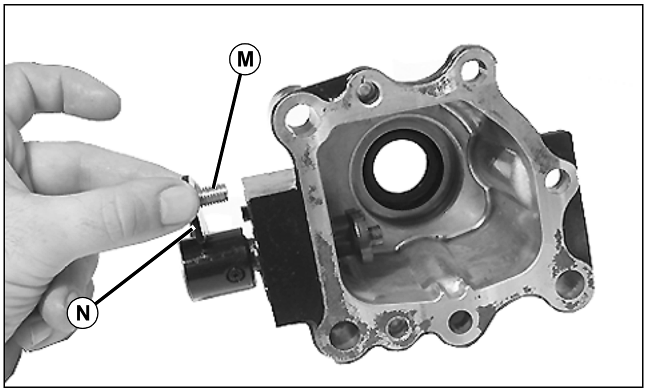
Front Wheel Drive Output Shaft:
OD at Bearing . . . . 24.98 - 25.0 mm (0.983 - 0.984 in.)

ID Pilot Hole . . . . 17 - 17.02 mm (0.669 - 0.670 in.)



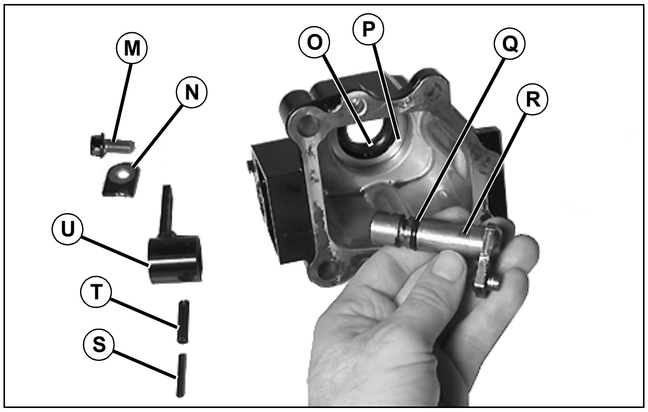
MX16035

10.Slide bearing block (K) from pin (L) on shift arm. Replace if damaged or worn.



MX16036

11.Remove cap screw (M) securing keeper (N) to housing.



MX16037

12.Use drift to drive out spring pin (S) and roll pin (T) securing pivot (U) to shaft.

13.Slide shaft (R) from housing and pivot (U).

14.Replace O-Ring (Q) on shaft.

15.Remove washer (P) and inspect seal (O) for wear or damage. Replace, as necessary.

16.Measure shaft bore in housing. If not in specifications, replace housing.

17.Measure OD of shaft in bearing area. If not in specifications, replace shaft.

Specifications:

Shaft OD . . . . 16.93 - 17 mm (0.667 - 0.669 in.)
Housing Shaft Bore ID . . . 17 - 17.043 mm (0.669 - 0.671 in.)

Assembly and Installation:

Assembly and installation of the front MFWD output assembly is carried out in reverse order of disassembly and removal.

Replace the gasket, or use a thin bead of RTV silicone gasket maker between center case and front PTO output housing.

Tighten cap screws to specification.

Specification:

Cap Screws. . . . . 16 - 22 N•m (144 - 192 lb-in.)

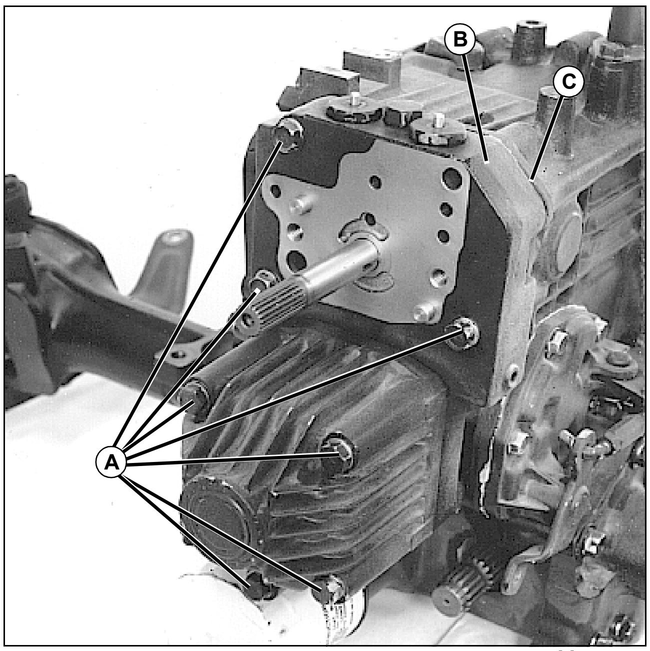
Hydrostatic Transmission 2-WD and MFWD

Hydrostatic Transmission Removal:

1. Remove transaxle. See "Transaxle Removal and Installation" on page 297.

2. Remove charge pump. See "Charge Pump Removal and Installation" on page 282.

Important: Avoid Damage! Do not drop or damage pump valve plate when removing center valve block assembly. Do not nick or scratch lapped or machined surfaces of the valve plates or cylinder block components. The slightest damage can cause poor performance.



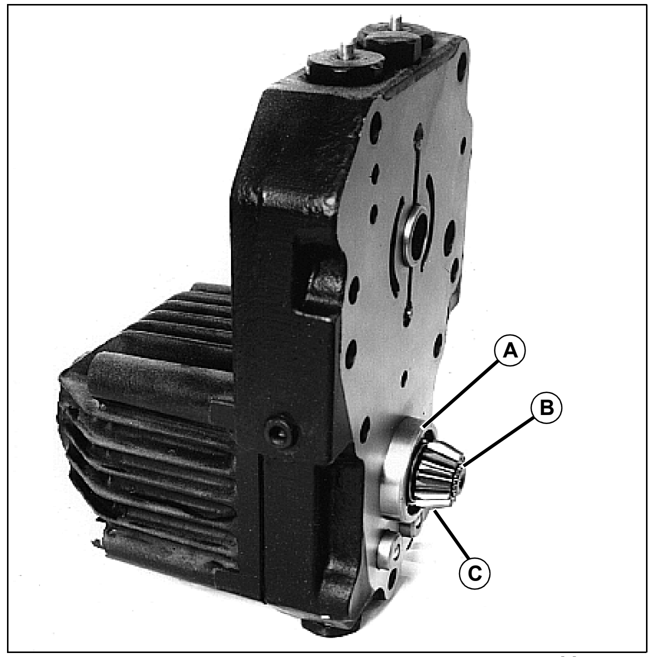
M81182

Picture Note: 2-Wheel Drive Shown (MFWD similar)

3. Remove cap screws (A) and carefully remove center valve block (B) and motor assembly from transaxle.

4. Replace gasket (C) if torn or damaged.

Hydrostatic Transmission Motor Removal:



M81104

Picture Note: 2-Wheel Drive Shown

1. Remove retaining ring (B), bevel input pinion (C), and ball bearing (A).

2. Inspect bearing for smooth rotation.

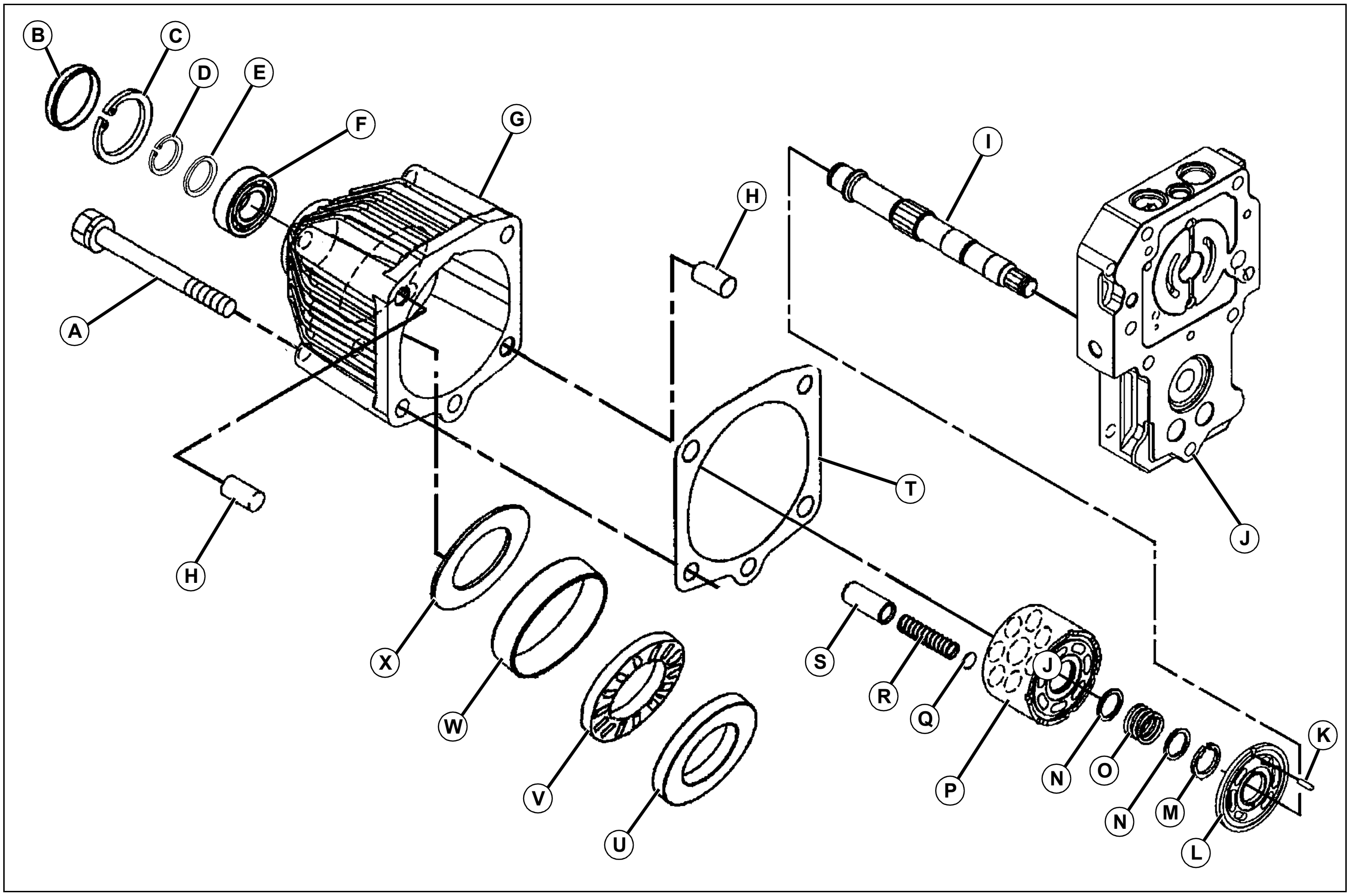
Note: Bevel input pinion and bevel input gear must be replaced as a set.

3. Check pinion for wear or damage.

4. Replace retaining ring if ring is distorted during removal.

Hydrostatic Transmission Motor Disassembly and Assembly (2-Wheel Drive):

Important: Avoid Damage! Do not drop or damage motor valve plate when removing motor assembly. Do not nick or scratch lapped or machined surfaces of the valve plate or cylinder block components. The slightest damage can cause poor performance.



MX14345

A- Cap Screw
B- Seal Cap
C- Snap Ring
D- Snap Ring
E- Washer
F- Ball Bearing
G- Motor Case
H- Locating Sleeve (2 used)
I- Motor Shaft
J- Center Valve Block Assembly
K- Locating Pin
L- Motor Valve Plate
M- Snap Ring
N- Washer
O- Spring
P- Cylinder Block
Q- Shim
R- Piston Spring
S- Piston
T- Gasket
U- Thick Thrust Plate
V- Thrust Bearing
W- Bushing
X- Thin Thrust Plate

1. Remove two cap screws (A).

Important: Avoid Damage! Keep pistons (S) matched with bore of cylinder block (P). Do not interchange motor pistons and valve plate (L) with pump pistons and valve plate. Pistons and cylinder blocks are a matched set.

2. Remove cylinder block assembly.

Note: Motor rotating components must be replaced as a set.

3. Inspect rotating components:

Note: Scoring is fine scratches or grooves cut into the highly machined surface. When the scratches can be detected by feel using a lead pencil or fingernail, the part must be replaced.

4. Check valve plate and cylinder block for grooves, scoring, discoloration or pitting.

5. Check for free movement of pistons in cylinder bore.

6. Check pistons for flat areas, scoring or discoloration.
7. Thrust bearing (V) must rotate freely.

Note: Thin thrust plate (X), bushing (W) and motor case (G) must be replaced as a set.

8. Inspect thin thrust washer for wear or damage. Replace as necessary.

Important: Avoid Damage! Do not damage ball bearing (F) when removing seal cap (B).

9. Remove seal cap (B) and snap ring (C) to remove shaft assembly components.
10. Inspect bushing (W), thrust bearing (V) and shaft (I) for wear or damage. Replace if necessary.

Note: Apply John Deere Form-in-Place Gasket to outer edge of new seal cap. Install seal cap until cap is approximately 4 mm (5/32 in.) below surface of motor case.

Apply clean hydraulic oil to all mating surfaces.

11. Assemble parts in reverse order of removal.

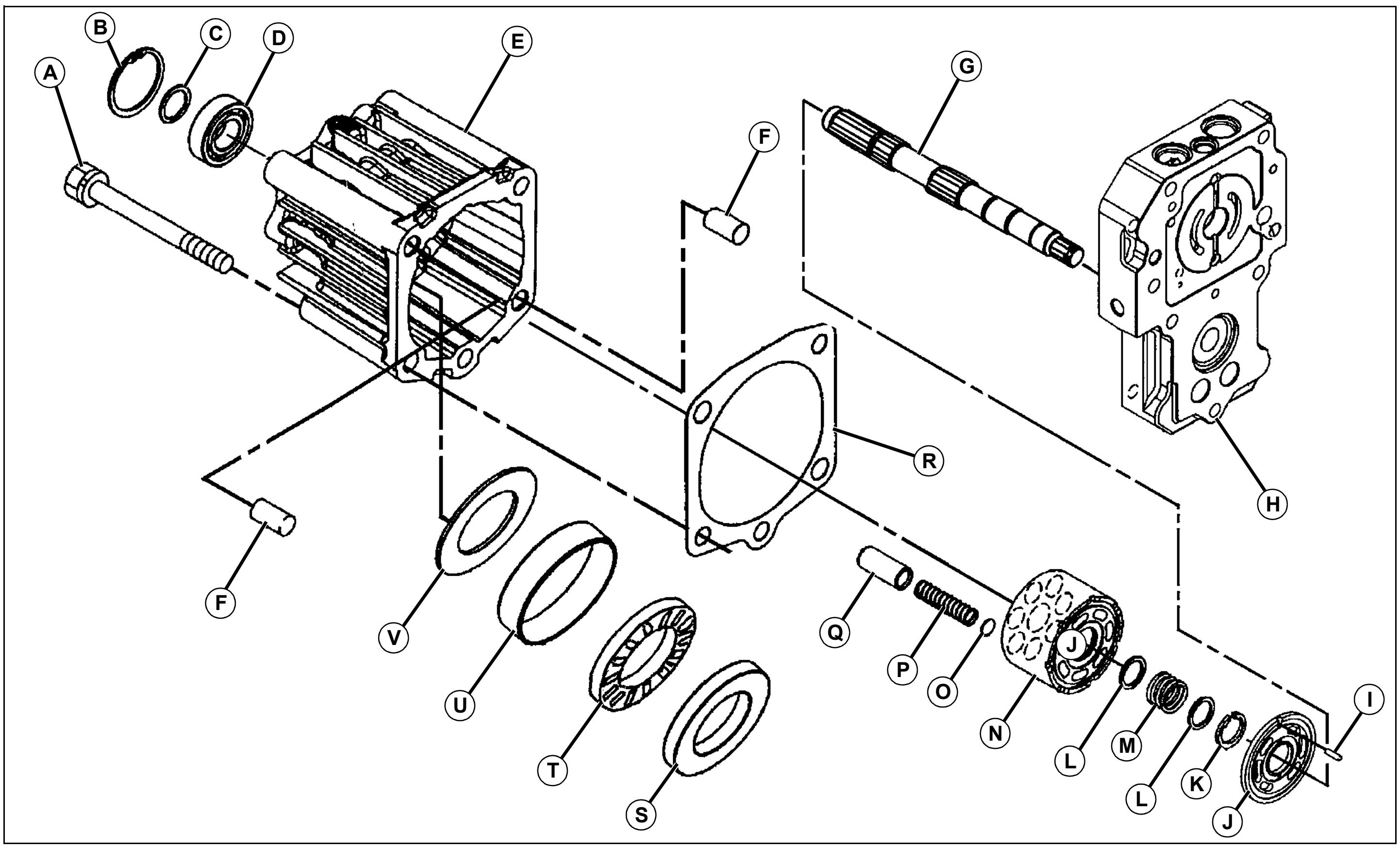
Note: Use petroleum jelly to hold valve plate in position.

- Put motor valve plate (L) on center valve block. Make sure bronze surface is away from valve block and notch in valve plate fits on locating pin of valve block.

Important: Avoid Damage! Pump and motor valve plates are not interchangeable. The pump valve plate has two leading grooves into two of the slotted ports. The motor valve plate (L) has no leading grooves.

Note: Motor case will seem springy because the springs inside the cylinder block are being compressed.

Hydrostatic Transmission Motor Disassembly and Assembly (MFWD):



MX14344

A- Cap Screw
B- Snap Ring
C- Snap Ring
D- Ball Bearing
E- Motor Case
F- Locating Sleeve (2 used)
G- Motor Shaft
H- Center Valve Block Assembly
I- Locating Pin
J- Motor Valve Plate
K- Snap Ring

L- Washer
M- Spring
N- Cylinder Block
O- Shim
P- Piston Spring
Q- Piston
R- Gasket
S- Thick Thrust Plate
T- Thrust Bearing
U- Bushing
V- Thin Thrust Plate

1. Remove front drive shaft assembly. See “Removal:” on page 304.

Important: Avoid Damage! Do not drop or damage motor valve plate when removing motor assembly. Do not nick or scratch lapped or machined surfaces of the valve plate or cylinder block components. The slightest damage can cause poor performance.

2. Remove two cap screws (A).

Important: Avoid Damage! Keep pistons (Q) matched with bore of cylinder block (N). Do not interchange motor pistons and valve plate (J) with pump pistons and valve plate. Pistons and cylinder blocks are a matched set.

3. Remove cylinder block assembly.

Note: Motor rotating components must be replaced as a set.

4. Inspect rotating components:

Note: Scoring is fine scratches or grooves cut into the highly machined surface. When the scratches can be detected by feel using a lead pencil or fingernail, the part must be replaced.

5. Check valve plate and cylinder block for grooves, scoring, discoloration or pitting.
6. Check for free movement of pistons in cylinder bore.
7. Check pistons for flat areas, scoring or discoloration.
8. Thrust bearing (T) must rotate freely.

Note: Thin thrust plate (V), bushing (U) and motor case (E) must be replaced as a set.

9. Inspect thin thrust plate (V) for wear or damage. Replace as necessary.

Important: Avoid Damage! Do not damage ball bearing (D) when removing snap ring (B).

10. Remove snap ring (B) to remove shaft assembly components.
11. Inspect bushing (U), thrust bearing (T) and shaft (G) for wear or damage. Replace if necessary.

Note: Apply clean hydraulic oil to all mating surfaces.

12. Assemble parts in reverse order of removal.

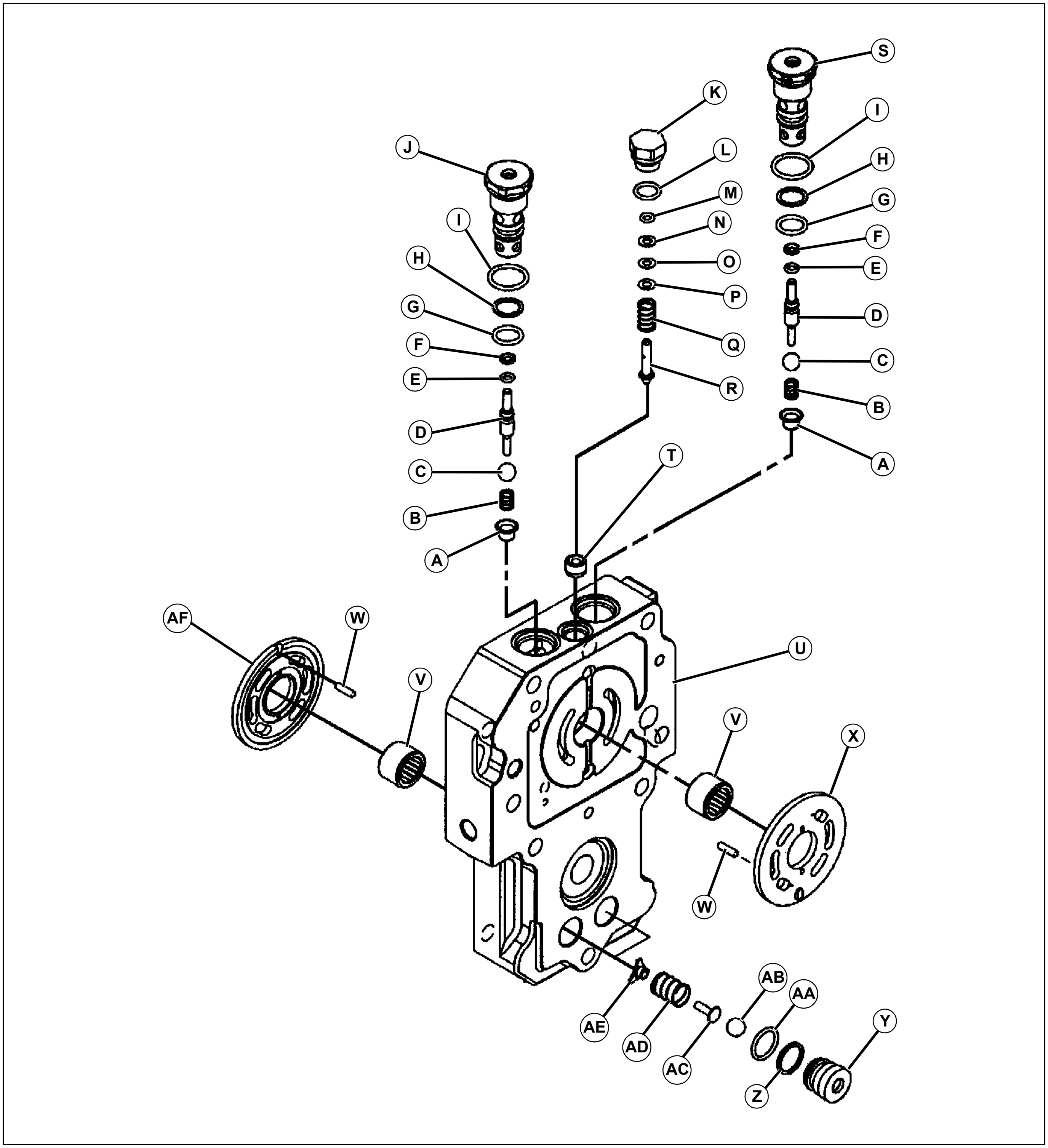
Note: Use petroleum jelly to hold valve plate in position.

- Put motor valve plate (J) on center valve block. Make sure bronze surface is away from valve block and notch in valve plate fits on locating pin of valve block.

Important: Avoid Damage! Pump and motor valve plates are not interchangeable. The pump valve plate has two leading grooves into two of the slotted ports. The motor valve plate (J) has no leading grooves.

Note: Motor case will seem springy because the springs inside the cylinder block are being compressed.

Center Valve Block Disassembly and Assembly:



MX14326

A- Holder
B- Spring
C- Ball
D- Push Pin
E- O-Ring
F- Seal
G- O-Ring
H- Back-up Ring
I- O-Ring
J- Forward Check Valve
K- Top Plug
L- O-Ring
M- O-Ring

N- Washer
O- Shim (0.5)
P- Shim (0.2)
Q- Spring
R- Charge Pressure Relief Valve Plunger
S- Reverse Check Valve
T- Seat
U- Center Valve Block
V- Needle Bearing (2 used)
W- Locating Pin (2 used)
X- Pump Valve Plate
Y- Anti-Cavitation Valve Body
Z- Backup Ring
AA- O-Ring
AB- Ball
AC- Ball Holder
AD- Spring
AE- Retainer
AF- Motor Valve Plate

Note: Remove motor assembly if necessary to inspect needle bearing. See "Hydrostatic Transmission Motor Removal:" on page 306.

1. Remove and inspect directional check valves.

Important: Avoid Damage! The reverse check valve must be installed in the left port. The check valve can be identified by a small orifice drilled into a land between the two sets of valve passageways.

2. Replace locator pins if missing or damaged.

3. Inspect needle bearings for wear or damage. If bearings are replaced, install new bearings with the stamped end away from center valve block.

4. Push bearings into bore until end of bearing is approximately **3 mm (7/64 in.)** above the surface of the valve block.

5. Inspect anti-cavitation valve assemblies.

Note: Screens may be located in bores of transaxle case.

6. Check suction screens for blockage.

7. Carefully pull anti-cavitation valve body from center valve block so as not to lose parts.

8. Replace parts as necessary.

9. Apply oil to O-rings and push assembly to bottom of bore.

10. Inspect center valve block where charge pump contacts block for scoring.

11. Replace center valve block if necessary.

Note: Scoring is fine scratches or grooves cut into the highly machined surface. When the scratches can be detected by feel using a lead pencil or fingernail, the part must be replaced.

12. Inspect valve plate for grooves, scoring, discoloration or pitting.

Important: Avoid Damage! Pump and motor valve plates are not interchangeable. The pump valve plate has two leading grooves into two of the slotted ports. The motor valve plate has no leading grooves.

13. Put pump valve plate on center valve block. Make sure bronze surface is away from valve block and notch in valve plate fits on locating pin of valve block.

Note: Use petroleum jelly to hold valve plate in position.

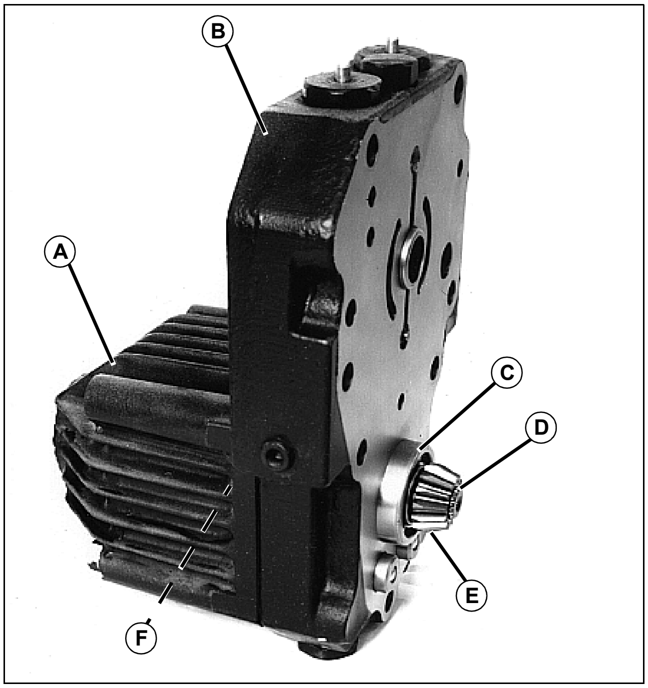
14. Remove plug to inspect charge pressure relief valve parts.

15. Check plunger for nicks, wear or damage.

16. Inspect plunger seat in center valve block. Remove any obstructions and replace center valve block if seat is worn or damaged.

Hydrostatic Transmission Motor Installation:

Note: Replace retaining ring (D) if ring is distorted during removal.

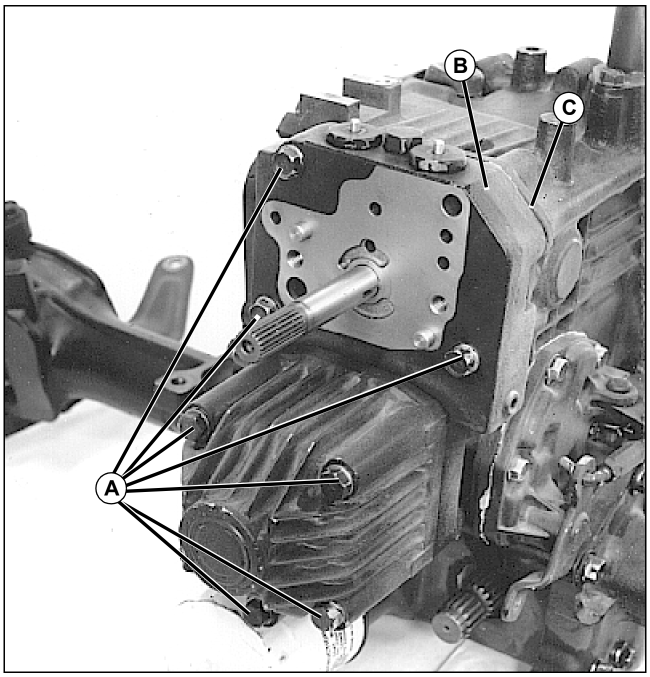


Picture Note: 2-Wheel Drive Shown

1. Secure motor housing assembly (A) and gasket (F) to center valve block (B) and install ball bearing (C) and bevel input pinion (E). Secure with retaining ring (D).

Hydrostatic Transmission Installation:

Important: Avoid Damage! Do not drop or damage pump valve plate when removing center valve block assembly. Do not nick or scratch lapped or machined surfaces of the valve plates or cylinder block components. The slightest damage can cause poor performance.



M81182

Picture Note: 2-Wheel Drive Shown (MFWD similar)

1. Install gasket (C).

2. Install center valve block (B) and motor assembly to transaxle housing and secure with cap screws (A).

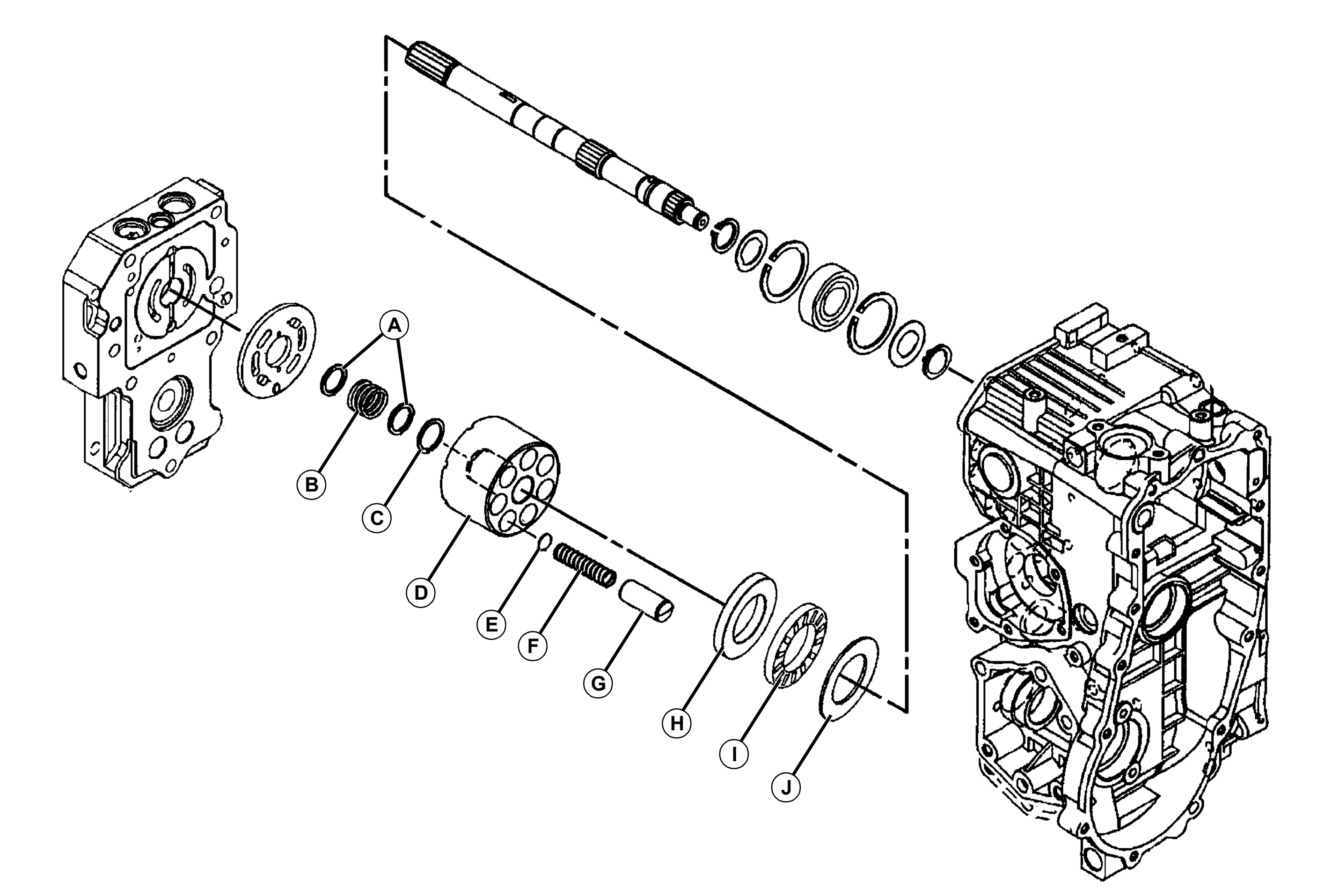
Specifications:

Mounting Cap Screws . . . . 39 N•m (29 lb-ft)

3. Install charge pump. See “Charge Pump Removal and Installation” on page 282.

4. Install transaxle. See “Transaxle Removal and Installation” on page 297.

Hydrostatic Pump Inspection



MX16066

- A- Washer
- B- Piston Spring (7 used)
- C- Snap Ring
- D- Cylinder Block
- E- Washer
- F- Spring
- G- Piston (7 used)
- H- Thick Thrust Plate
- I- Thrust Bearing
- J- Thin Thrust Plate

Important: Avoid Damage! Keep pistons matched with bore of cylinder block. Do not interchange motor pistons and valve plate with pump pistons and valve plate. Pistons and cylinder blocks are a matched set.

1. Spring is compressed. Apply an external force to compress spring farther before removing snap ring. Then slowly remove external force.

2. Remove parts from transaxle as necessary.

Note: Pump rotating components must be replaced as a set. Thin thrust plate must be replaced as a set with the pump swash plate and bushing.

3. Check cylinder block for grooves, scoring, discoloration or pitting.

Note: Scoring is fine scratches or grooves cut into the highly machined surface. When the scratches can be detected by feel using a lead pencil or fingernail, the part must be replaced.

4. Check for free movement of pistons in cylinder bores.

5. Check pistons for flat areas, scoring or discoloration. Thrust bearing must rotate freely.

For inspection of pump valve plate, refer to “Center Valve Block Disassembly and Assembly:” on page 310.

Transaxle Disassembly

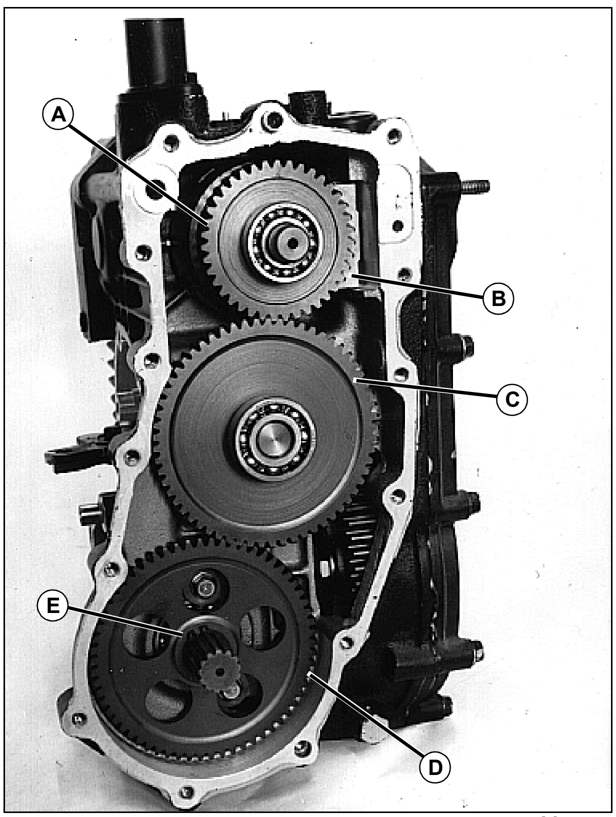
1. For AWS models, remove rear steering linkage. See “Rear Steering Linkage - All Wheel Steering” on page 383 in the Steering section.

2. Remove control arm damper. See “Control Arm and Damper Removal and Installation” on page 280.

3. Remove hydrostatic transmission and pump. See “Hydrostatic Transmission 2-WD and MFWD” on page 306.

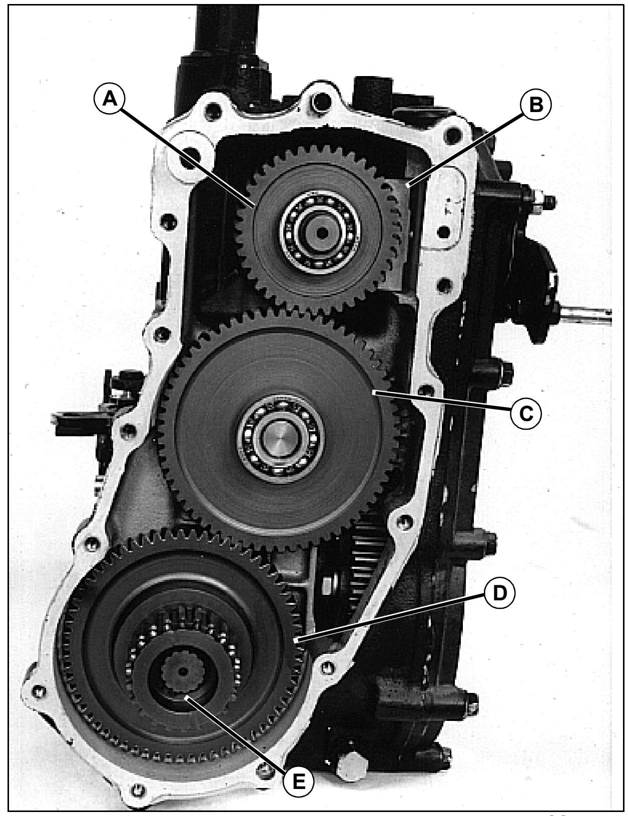
4. Remove axle housings. See “Rear Axle Assembly (Two Wheel Steer Models) Removal and Installation” on page 319, and “Rear Axle Assembly (Two Wheel Steer Models) Disassembly and Assembly” on page 319, or “Rear Axle Assembly (All Wheel Steer) Disassembly and Assembly” on page 322.

5. Remove brakes. See “Brakes Removal and Installation” on page 401 in the Brakes section.



M81088

Picture Note: Without Rear PTO option

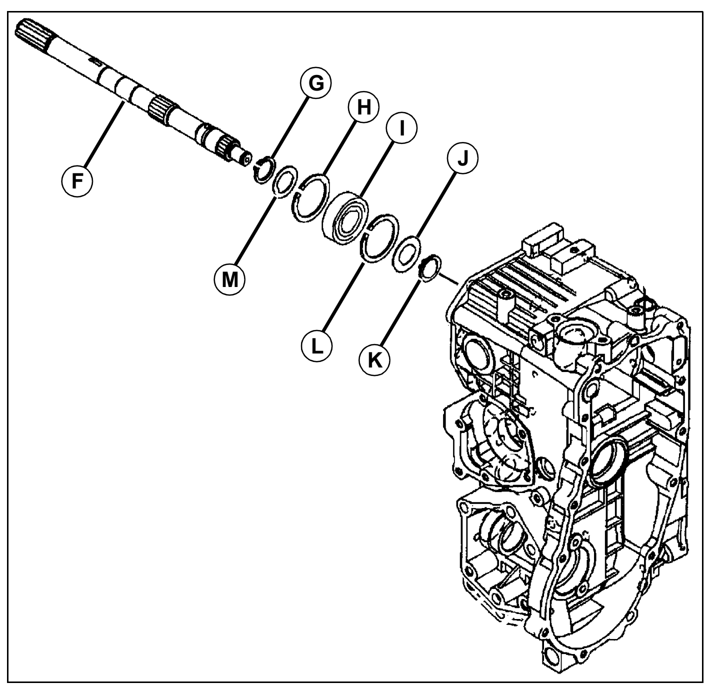


M81089

Picture Note: With Rear PTO Option

6. Remove PTO idler shaft assembly (C), snap ring (E), PTO gear (D) (or rear drive gear set).

7. Remove PTO brake shoe (B) and clutch (A). See “PTO Brake Removal and Installation” on page 288.



MX16068

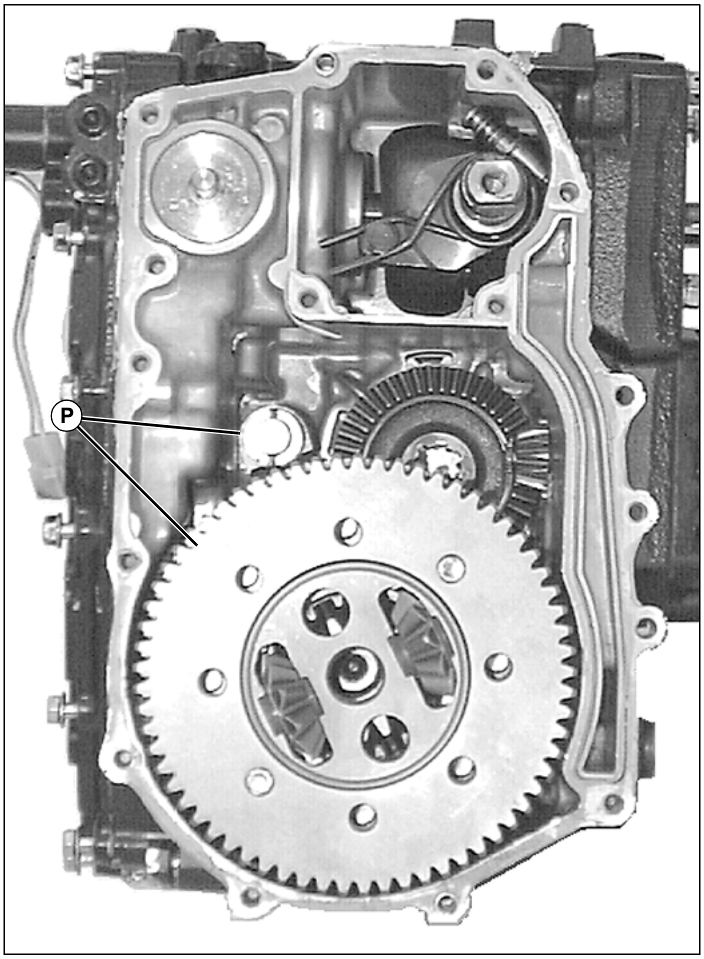
8. Remove large snap ring (H) and input shaft assembly.

9. Remove large snap ring (L), small snap rings (G and K), washers (M and J), and ball bearing (I) from input shaft (F).

M81095

10. Lay transaxle on left side and remove sixteen (16) cap screws (N) attaching right cover assembly (O).

Important: Avoid Damage! Bearing, washer and differential pinion located on top of differential assembly are loose. Do not drop or lose parts.



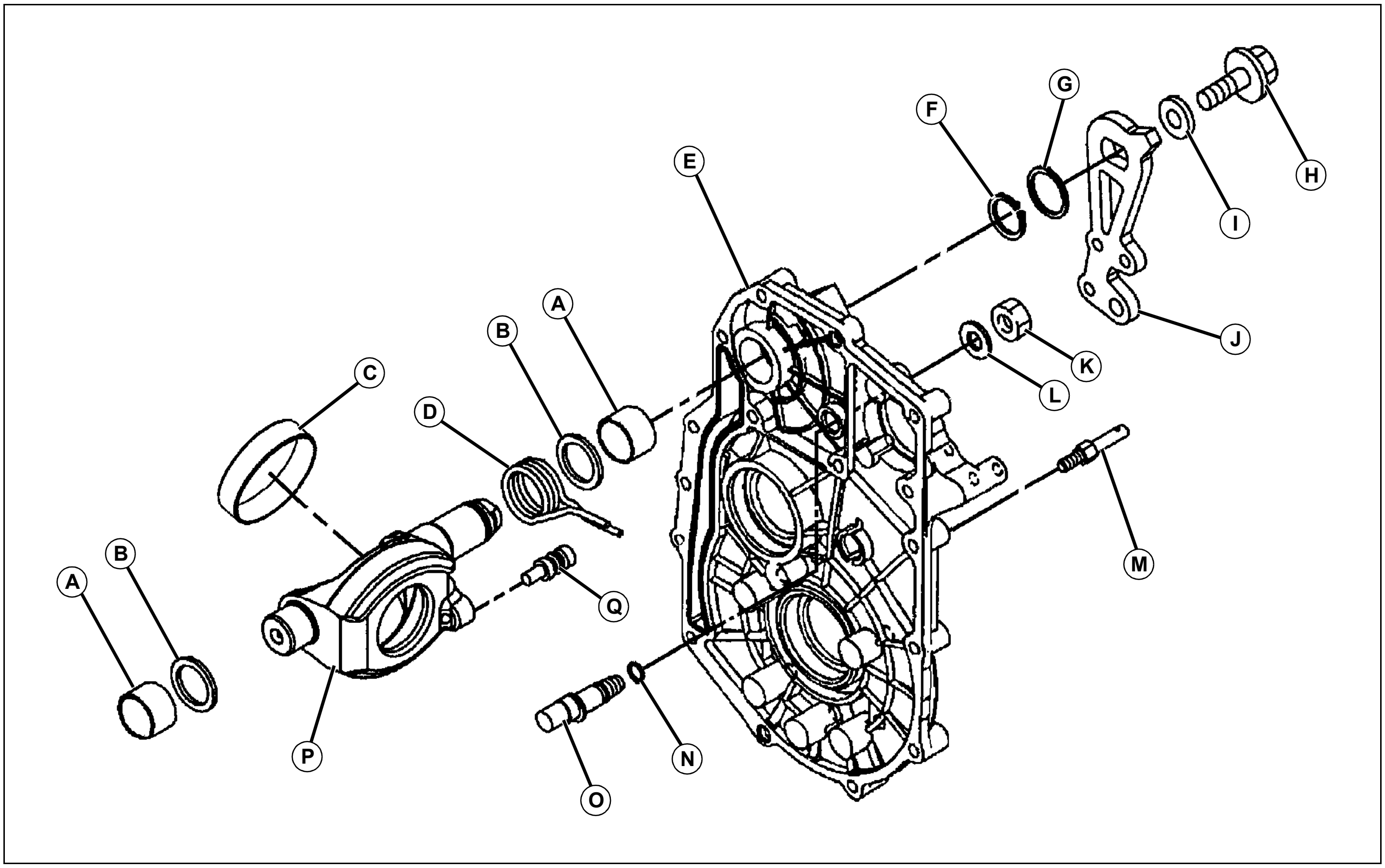
M98231

11. Remove final pinion shaft ball bearing. Bearing may remain in cover assembly.

12. Lift final gear and differential assembly and differential lock shaft (P) from transaxle case together as an assembly.

13. Remove final pinion shaft assembly.

Transaxle (Right Cover) Disassembly and Assembly



MX16069

- A- Swash Plate Bearing
- B- Washer
- C- Bushing
- D- Spring
- E- Cover
- F- Snap Ring
- G- Washer
- H- Cap Screw
- I- Washer
- J- Control Arm
- K- Nut
- L- Washer
- M- Pivot Stud
- N- O-Ring
- O- Eccentric Adjust Fulcrum
- P- Swash Plate
- Q- Fulcrum Cap Screw

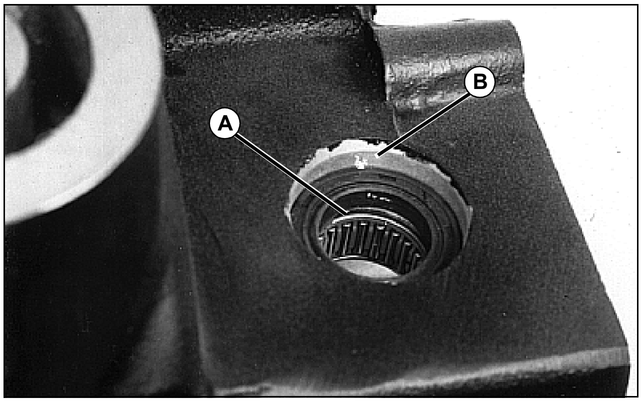
1. Remove snap ring, nut and washers.
2. Pull swash plate from cover.

Note: Pump swash plate, bushing, and thin thrust plate must be replaced as a set.

3. Inspect transaxle cover components.
4. Check bushing, bearing and swash plate contact surfaces for wear or damage. Replace as necessary.
5. Inspect O-rings on swash plate and eccentric adjust fulcrum for cuts or damage.
6. Install spring so legs are crossed and each leg of spring fits into a groove of the fulcrum cap screw.
7. If swash plate bearing was removed, install new bearing until end of bearing is even with the inside surface of the cover.
8. Put petroleum jelly on all O-rings. Install swash plate assembly and remaining components.

Note: Use medium strength thread lock and sealer.

Transaxle Case Inspection



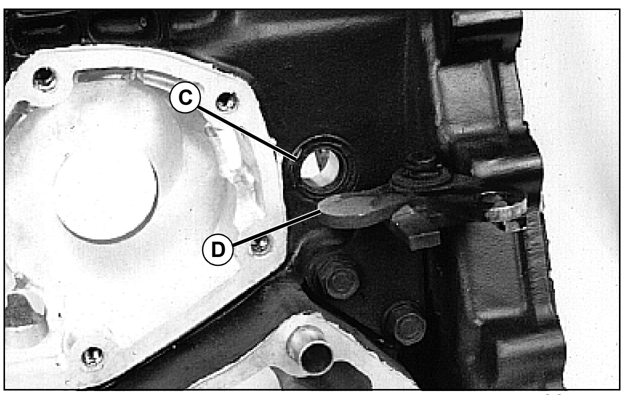
M81097

1. Remove front PTO shaft seal (B).

2. Inspect needle bearing (A) for wear or damage. Remove if necessary. Install new needle bearing from inside case with bearing identification marks toward the inside of the case. Push bearing tight against shoulder in bore.

3. Install new seal with the open, spring side towards the inside of the case.

4. Push seal against shoulder in bore.

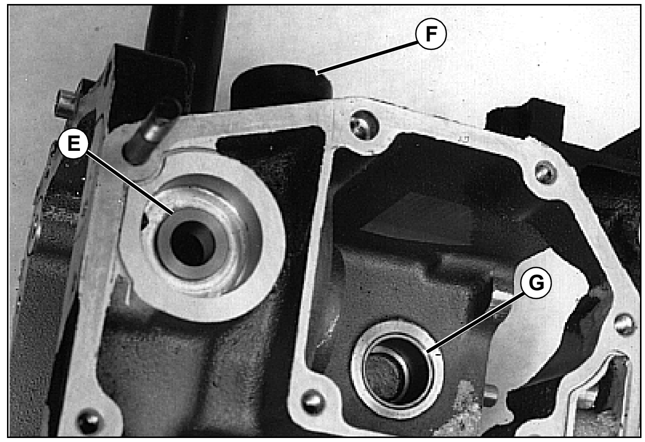


M81098

5. Replace differential lock shaft seal (C).

Note: Differential lock plate (D) may have to be removed to install new seal.

6. Install new seal with the open, spring side towards inside of case. Push seal tight against bottom of bore.



M81099

7. Inspect PTO brake pin sleeve (E) for scoring or damage. Replace if necessary.

8. Push sleeve out from inside of case.

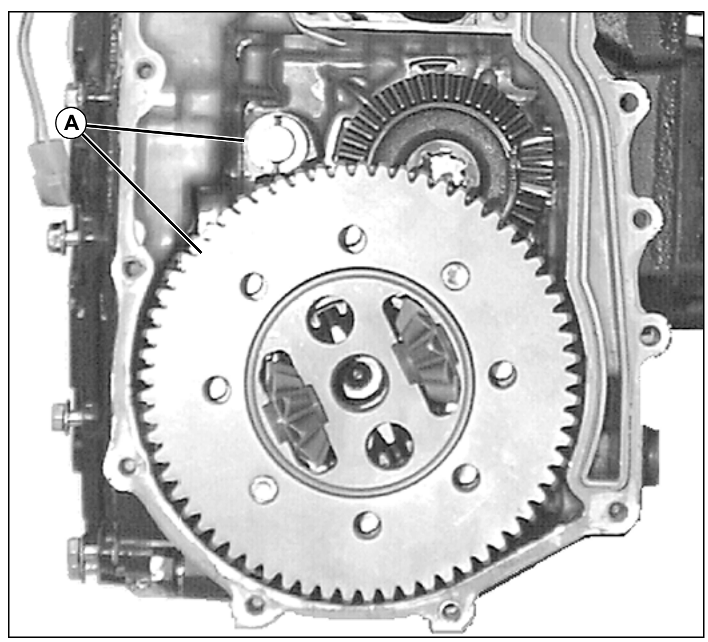
9. Install new sleeve into case until flange of sleeve is tight against case.

10. Inspect swash plate bearing (G) for wear or damage. Replace if necessary.

11. Install new bearing using a disk driver. Push bearing to bottom of bore.

12. Inspect vent cap (F) for damage or obstructions. Replace as necessary.

Transaxle Assembly



M98231

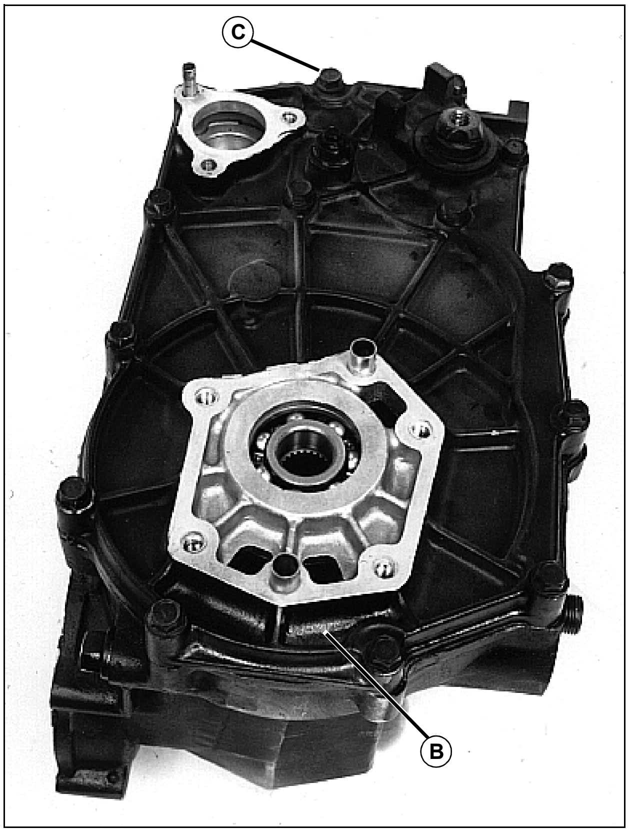
1. Apply clean hydraulic oil to all internal components.

2. Install final pinion shaft assembly (A) into transaxle case with bevel gear end in first.

Important: Avoid Damage! Bearing and washer on top of differential assembly are loose. Do not drop or lose parts.

3. Put fork of differential lock shaft into groove of collar on differential assembly. Install differential assembly and differential lock shaft together into transaxle case.

4. Install ball bearing.



M81095

5. Apply a bead of John Deere Form-in-Place Gasket to mating surface of transaxle case.

6. Carefully lower right transaxle cover assembly (B) onto case while making sure bearings and shafts fit into bores properly. Make sure washer on swash plate does not fall out of position. Secure with sixteen (16) cap screws (C), and tighten to specification below.

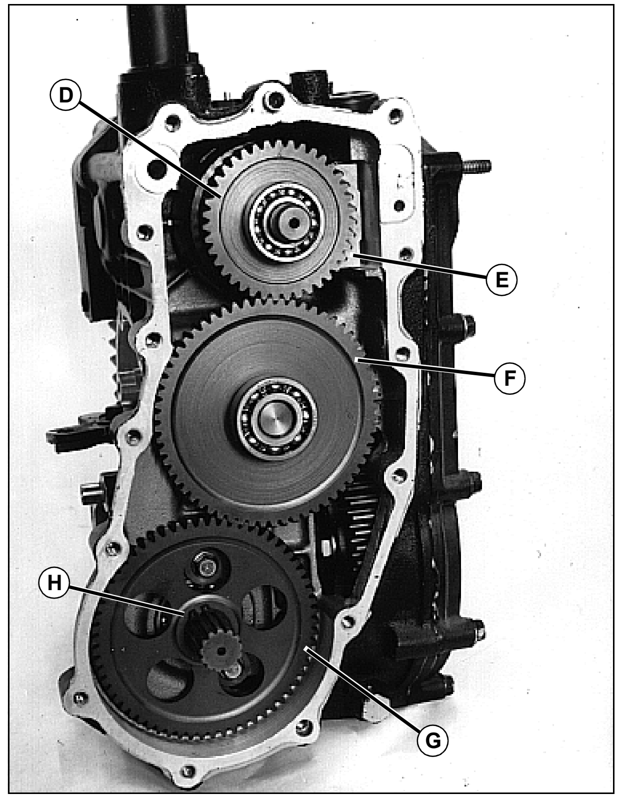
Transaxle Case Cap Screw Torque Specifications:

Used Transaxle Case . . . . 25 N•m (18 lb-ft)

New Transaxle Case. . . . . 30 N•m (22 lb-ft)

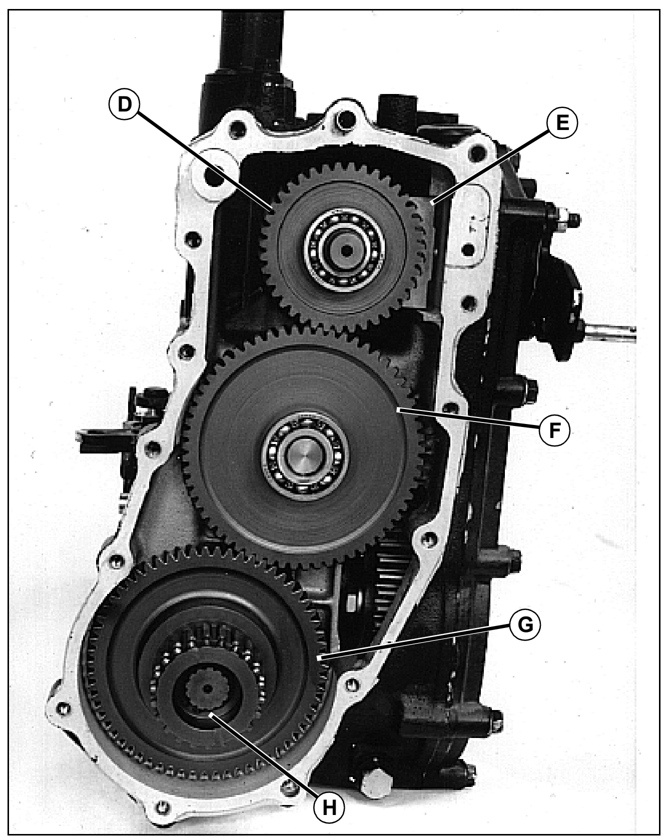
7. Assemble bearing, washers and snap rings on input shaft.

8. Install input shaft assembly and large snap ring.



M81088

Picture Note: Without Rear PTO Option



M81089

Picture Note: With Rear PTO Option

9. Install PTO brake shoe (E) and PTO clutch assembly (D). See “PTO Brake Removal and Installation” on page 288.

10.Install PTO idler shaft assembly (F), PTO gear (G) (or rear PTO gear on rear PTO option machines), and snap ring (H).

11.Install PTO drive train. See “PTO Drive Train (Mid and Rear PTO) Removal and Installation” on page 291.

12.Install brakes. See “Brakes Removal and Installation” on page 401 in the Brakes section.

13.Install axle housings. See “Rear Axle Assembly (Two Wheel Steer Models) Removal and Installation” on page 319.

14.Install hydrostatic transmission and pump.

15.Install control arm damper. See “Control Arm and Damper Removal and Installation” on page 280.

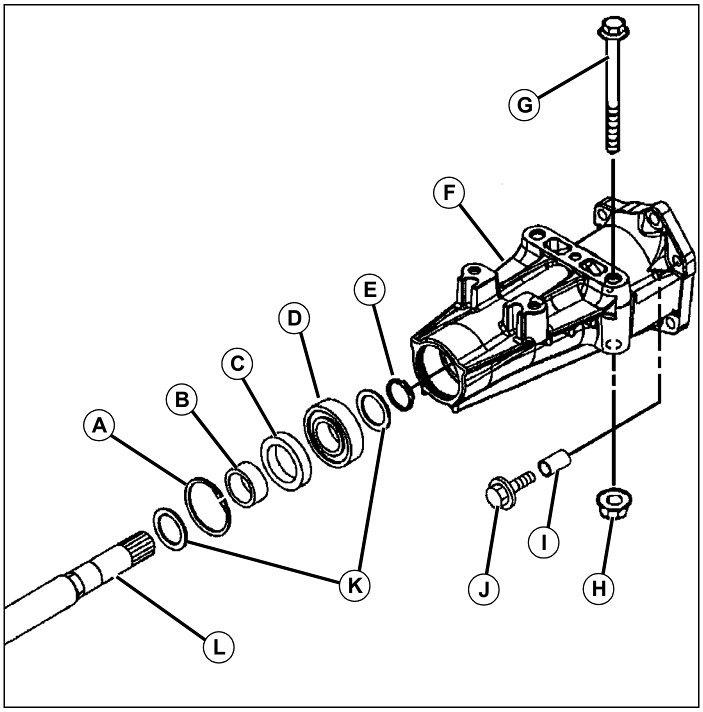
16.For AWS models, install rear steering linkage. See “Rear Steering Linkage- Installation” in the Steering section.

Rear Axle Assembly (Two Wheel Steer Models) Removal and Installation

Removal:

1. Loosen rear wheel lugs and raise rear of machine by the frame.

2. Remove lugs and rear wheel.



MX16043

A- Snap Ring
B- Sleeve
C- Seal
D- Ball Bearing
E- Snap Ring
F- Axle Housing
G- Cap Screw (2 used)
H- Lock Nut (2 used)
I- Bushing (2 used)
J- Cap Screw (6 used)
K- Washer
L- Shaft

3. Remove two bolts (G) and nuts (I) holding axle housing (H) to frame.

Note: Note position of two locator bushings (J) when removing axle housing.

4. Remove six cap screws (K) holding axle housing to transaxle housing, and remove axle assembly.

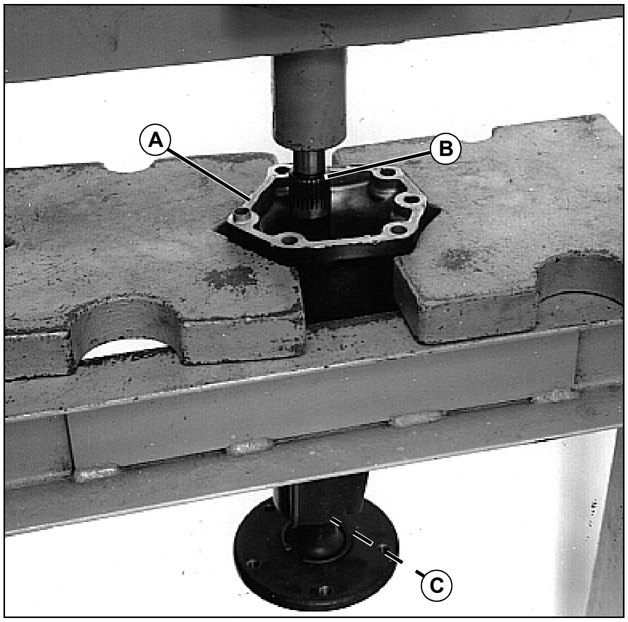
5. Clean axle housing and transaxle mating surfaces. Apply a bead of John Deere Form-in-Place Gasket to mating surface.

6. Repeat for other side if necessary.

Installation:

Installation is done in the reverse order of removal.

Rear Axle Assembly (Two Wheel Steer Models) Disassembly and Assembly



M81196

1. Remove large snap ring (C) from groove of axle housing (A).

2. Use a press to remove axle shaft (B) from axle housing.

3. Remove remaining snap ring to remove axle shaft components.

4. Inspect axle shaft and housing for wear or damage. Replace parts as necessary.

5. Inspect bearing for smooth rotation. Replace if necessary.

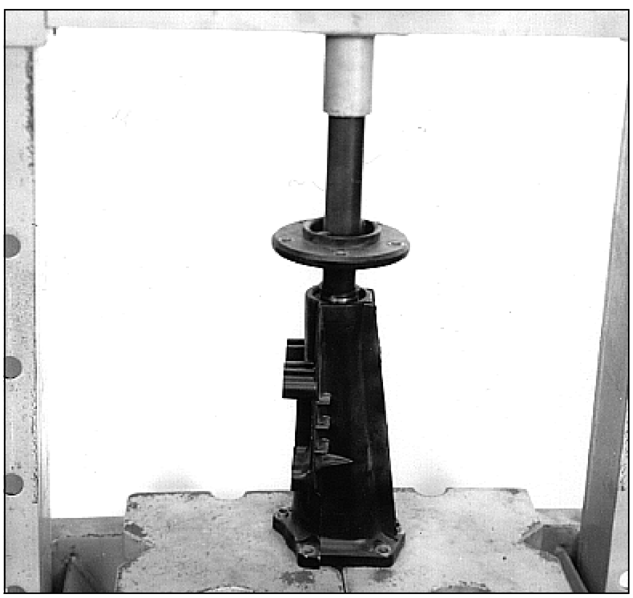
Note: Ball bearing is not pressed into housing. When placed in axle housing it may be loose. A clearance up to 0.38 mm (0.015 in.) is normal.

6. Install bearing, seal and snap ring into axle housing. Put spring-side of seal into housing first.

7. Apply petroleum jelly to lips of seal and inner diameter of sleeve.

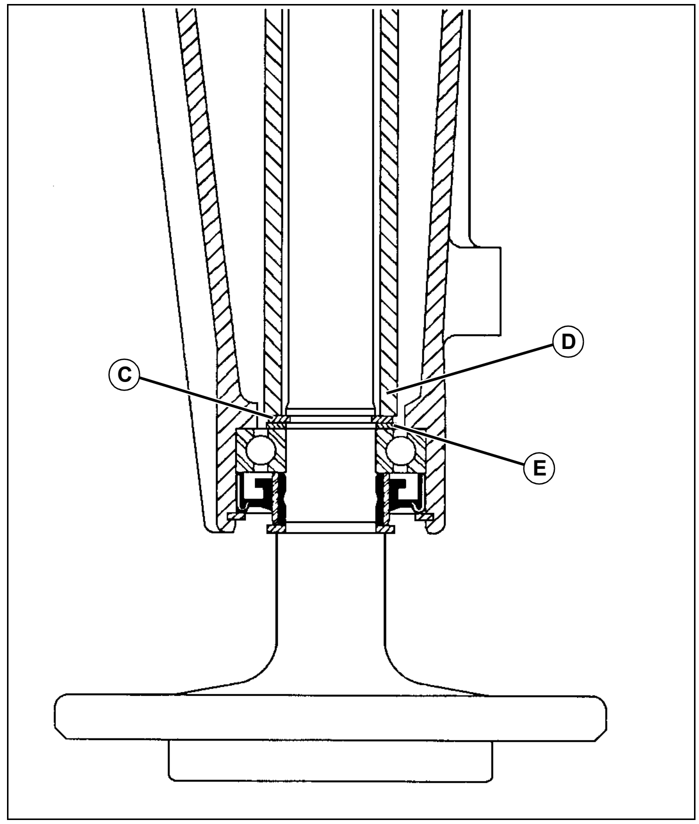
8. Install snap ring, washer and sleeve on axle shaft. Use a piece of pipe with a minimum inside diameter of **31 mm (1-3/16 in.)** to push sleeve and washer tight against shoulder of shaft.

Important: Avoid Damage! Do not use excessive force to install axle shaft. Axle housing may be cracked or damaged if too much force is used.



M81197

9. Install axle shaft assembly into axle housing using a press. Press shaft only until a rapid increase in pressure is noticed.



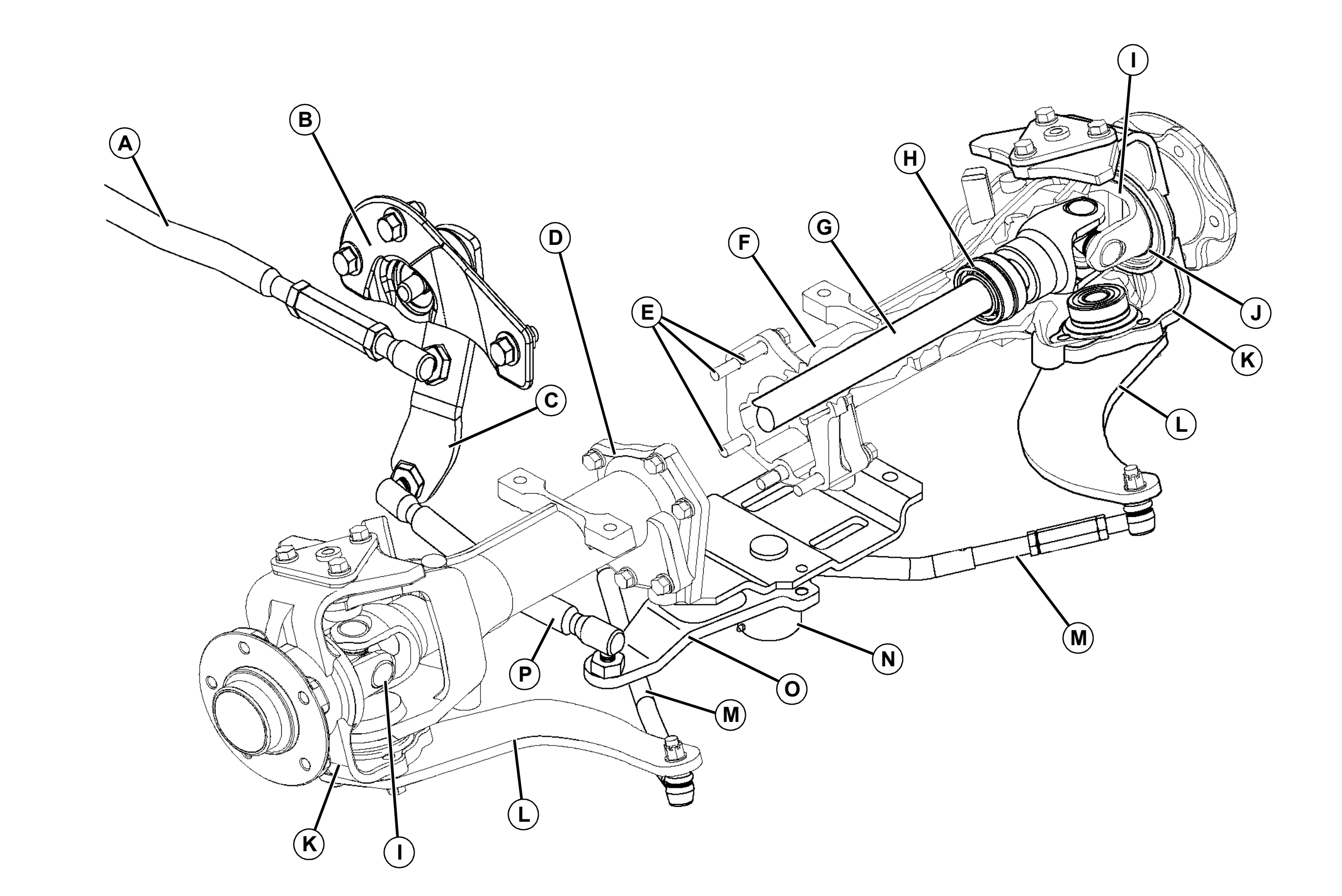
MX14320

10.Install washer (E) and snap ring (C) on axle shaft.

11.Use a piece of pipe (D) with a minimum inside diameter of **31 mm (1-3/16 in.)**, maximum outer diameter of **43 mm (1-11/16 in.)** and approximately **330 mm (13 in.)** long to install snap ring.

Rear Axle Assembly (All Wheel Steer) Removal and Installation

Removing:



MX14233

A- Link Rod, Middle
B- Bearing Housing
C- Pivot Arm
D- Left-Hand Axle
E- Cap Screws
F- Right-Hand Axle
G- Axle Shaft
H- Ball Bearing
I- Drive Shaft, U-Joint
J- Ball Bearing
K- Case, Wheel Bearing
L- Steering Arm
M- Tie Rod (2)
N- Cap, Pivot
O- Pivot Plate
P- Link Rod, Rear

Note: For AWS models, remove rear steering linkage before removing transaxle. See "Rear Steering Linkage - All Wheel Steering" on page 383 in the Steering section.

1. Remove transaxle. See "Transaxle Removal and Installation" on page 297.
2. Remove left (D) and/or right (F) rear axle assemblies.

Note: For AWS models, longer caps screws (E) are installed in the bottom three holes.

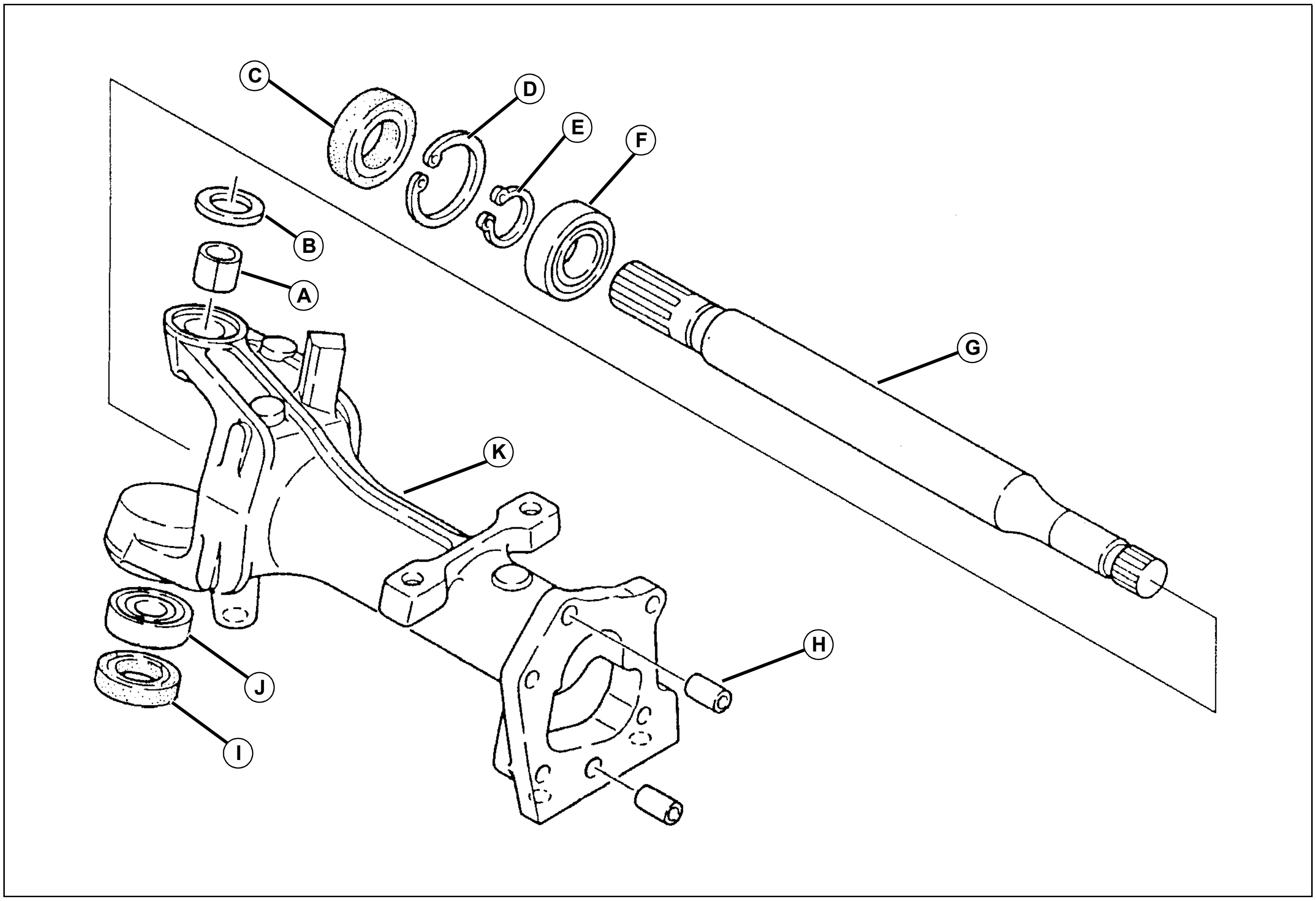
3. Clean axle housing and transaxle mating surfaces.
4. Repeat for other side if necessary.

Installing:

Note: Apply a bead of John Deere Form-in-Place Gasket to mating surfaces.

Installation is done in the reverse order of removal.

Rear Axle Assembly (All Wheel Steer) Disassembly and Assembly



M81121

1. Remove inner seal (C).

2. Remove large snap ring (D) to remove axle shaft (G) with ball bearing (F) and snap ring (E). Remove snap ring (E) if bearing or shaft must be replaced.

3. Inspect axle components for cracks, wear or damage. Replace if necessary.

4. If bushing (A) and/or washer (B) was replaced, use a disk driver to install bushing until end of bushing is even with machined surface of axle housing (K). Apply multipurpose grease to inside diameter of bushing.

5. If ball bearing was replaced, push bearing to bottom of bore.

6. Install new lower king pin seal (I) with open side of seal away from ball bearing (J). Use a disk driver to push seal into bore until even with surface of axle housing. Apply multi-purpose grease to seal lips.

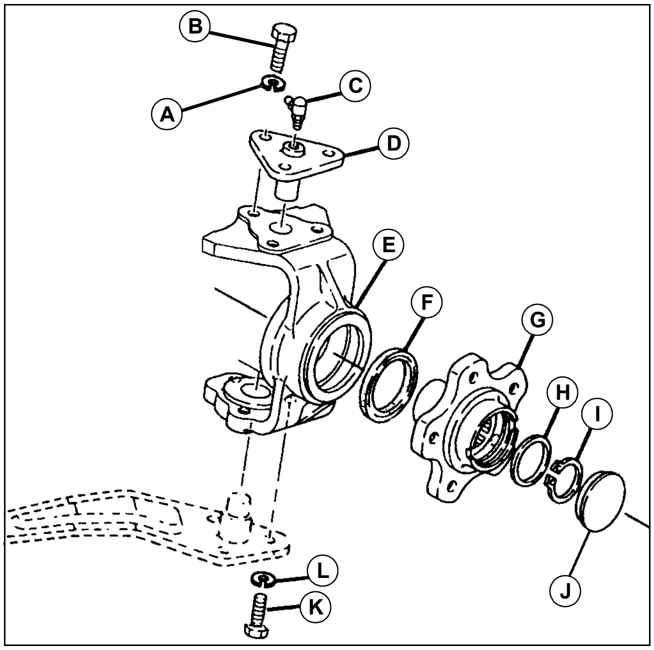
Note: Do not lose locator sleeves (H) from axle housing.

7. Install axle shaft with bearing and snap ring in axle housing.

8. Install large snap ring.

9. Apply multi-purpose grease to lips of seal. Install seal so open, spring side of seal is towards bearing. Push seal against snap ring using a tube type driver.

Knuckle Assembly (All Wheel Steer) Removal and Installation



M81120

A- Lock Washer
B- Cap Screw
C- Lubrication Fitting
D- King Pin
E- Knuckle Housing
F- Seal
G- Hub
H- Washer
I- Ring
J- Cap
K- Cap Screw
L- Lock Washer

1. Remove upper and lower king pins.
2. Pull knuckle housing from axle housing.

Installation is done in the reverse order of removal.

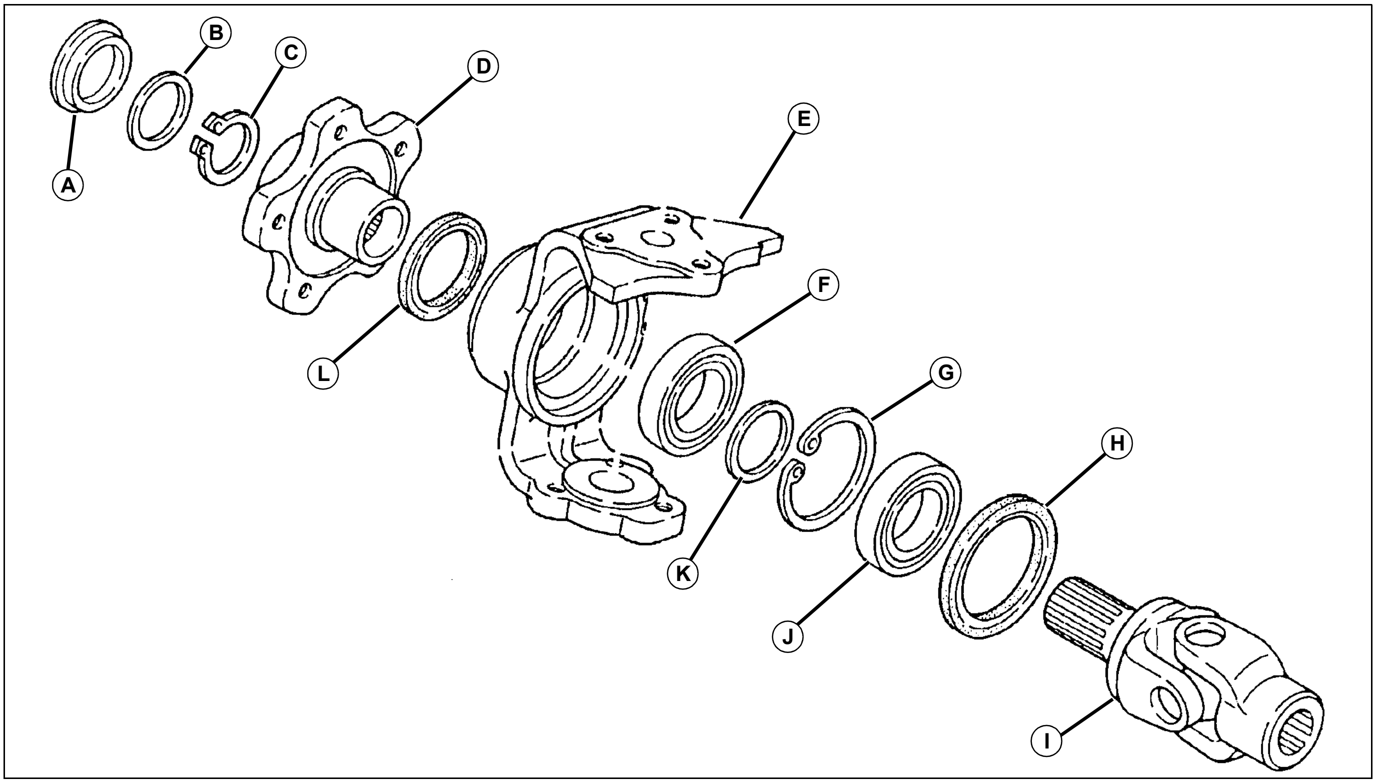
- Apply medium strength thread lock and sealer to threads of cap screws and washers.

Specifications:

Mounting Cap Screws . . . . 54 N•m (40 lb-ft)

- Apply multi-purpose grease to lube fitting until grease begins to appear at upper joint.

Knuckle Housing Disassembly and Assembly



M81122

1. Remove seal cap (A), washer (B), snap ring (C) and U-joint drive shaft (I).

2. Remove wheel hub (D) to disassemble remaining components.

3. Inspect knuckle housing (E) components for cracks, wear or damage. Replace as necessary.

Note: Inner ball bearing (F) is not press fit.

4. If inner ball bearing (F) was replaced, push new bearing to bottom of bore. Fill bearing and cavity with multipurpose grease.

5. Install snap ring (G).

6. Install bushing (K) against inner ball bearing (F).

7. Push outer ball bearing (J) tight against bushing (K).

Important: Avoid Damage! Open lip side of seal must face outward to prevent dust and moisture from getting into bearings. Push only on outer surface of seal.

8. Use a disk driver to push outer seal (L) (lip facing outward) into bore until even with the surface of knuckle housing (E).

Important: Avoid Damage! Lip on seal must not be damaged or rolled over.

9. Use a disk driver to push inner seal (H) (seal lip facing outward) to bottom of bore.

10.Apply multi-purpose grease to seal lips.

11.Rotate wheel hub while installing into knuckle housing. Check while installing that seal lip is not rolled over.

12.Apply Dubois MPG-2 (M79292) grease (water repellent) to splines of U-joint drive shaft and slide into knuckle housing assembly.

13.Install remaining components.

14.Clean all threads of knuckle housing and cap screws with clean and cure primer.

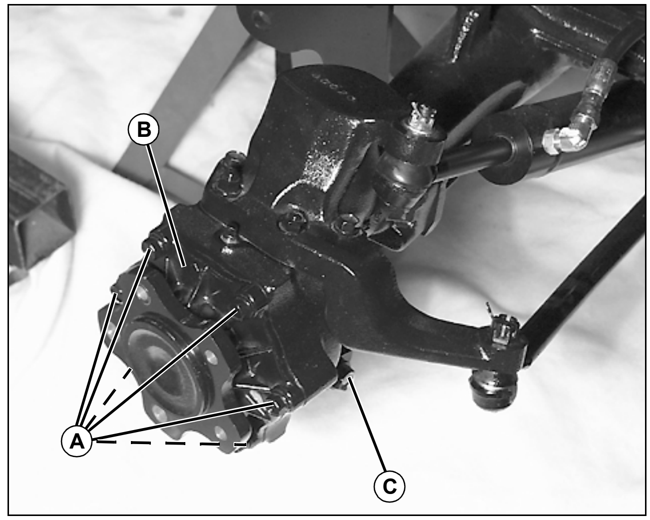
Final Drive Cover Removal and Installation - (MFWD)

Final Drive Cover Removal and Inspection:

1. Raise and safely support the front of the machine.

2. Remove the wheel and tire from the final drive requiring service.

Note: To service both of the front final drive assemblies, see "Front Wheel Removal and Installation" on page 462 in Miscellaneous section.

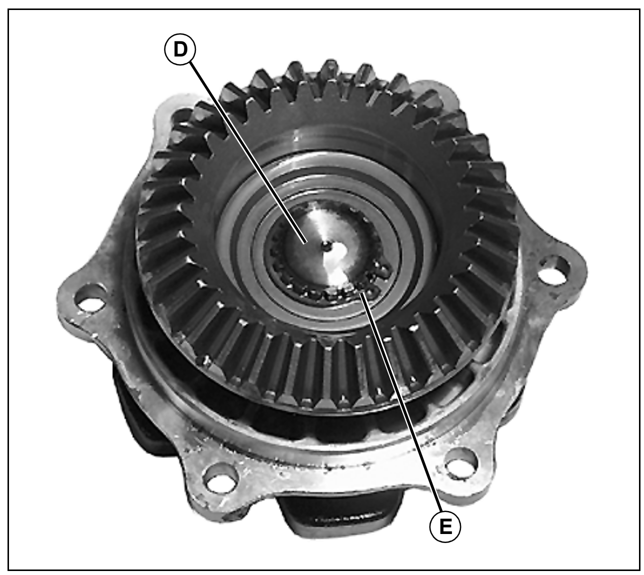


MX14359

3. Drain the differential and remove drain plug (C) to drain either final drive housing.

Note: Use a rubber hammer to loosen the cover (B). Do not force the cover off as damage may result.

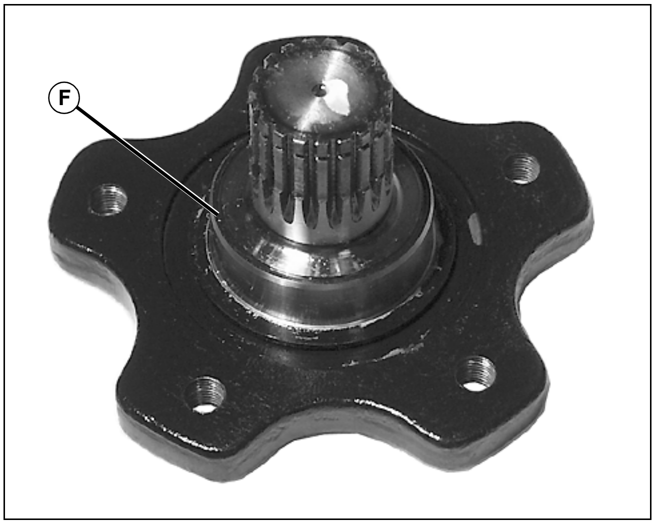
4. Remove six cap screws (A). Remove the final drive cover (B) and hub shaft from the final drive housing.



MX14362

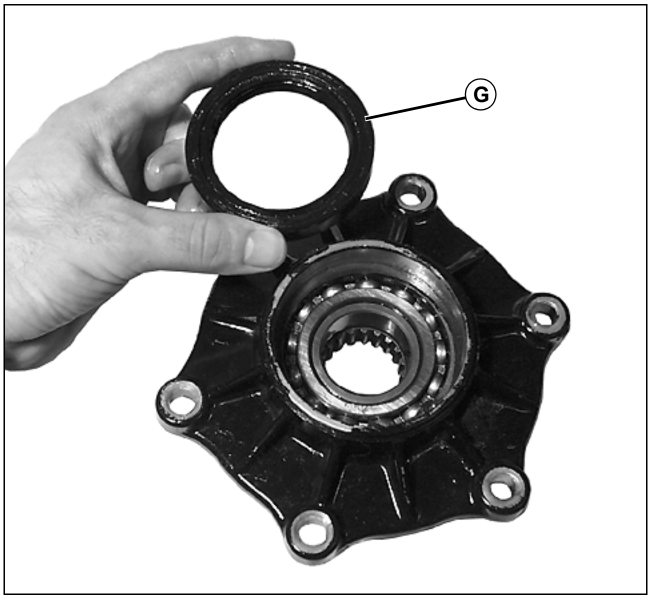
5. Remove the snap ring (E) from the hub shaft (D), and press hub shaft from the ring gear.

Note: The oil wear sleeves in the front axle assembly are lined with rubber. Using heat to remove the sleeves will damage the rubber linings and will require replacement of the sleeves.



MX14365

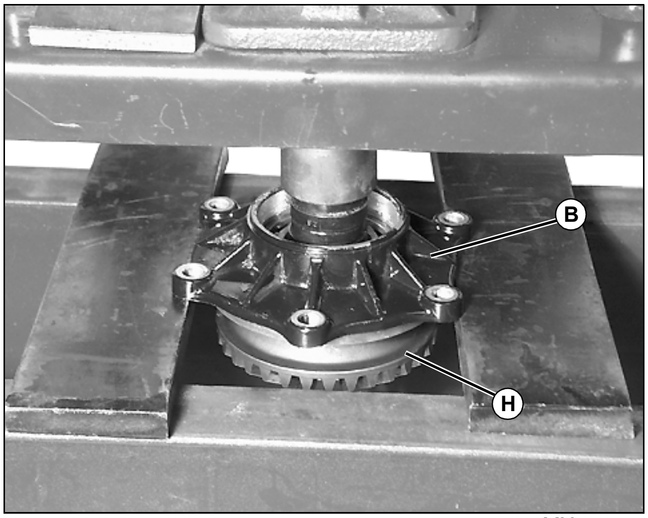
6. Inspect the oil seal wear sleeve (F) on the hub shaft for wear or damage. Inspect the seal, hub shaft, and cover. Replace any unserviceable parts.



MX14363

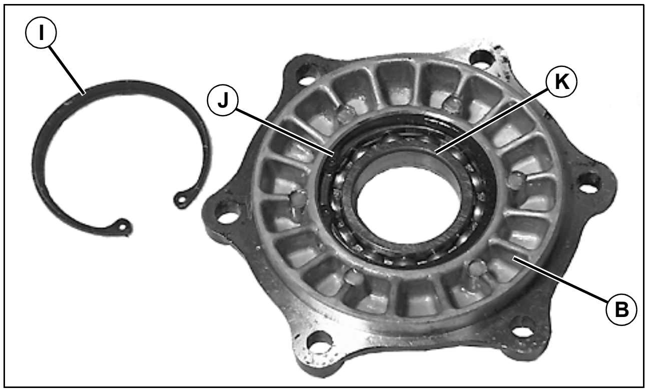
7. Remove the seal (G) from the cover.

Note: Use the correct puller and carefully remove and install the seal from the cover.



MX14364

8. Press the ring gear (H) from the inner race of the ball bearing inside the final drive cover (B).

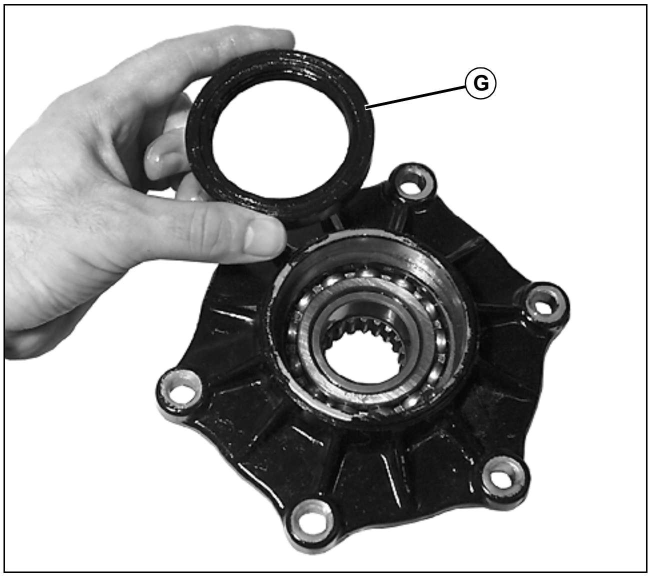


MX14366

9. Remove the outer (I) and inner (J) snap rings on both sides of bearing (K), and press bearing out of final drive cover (B).

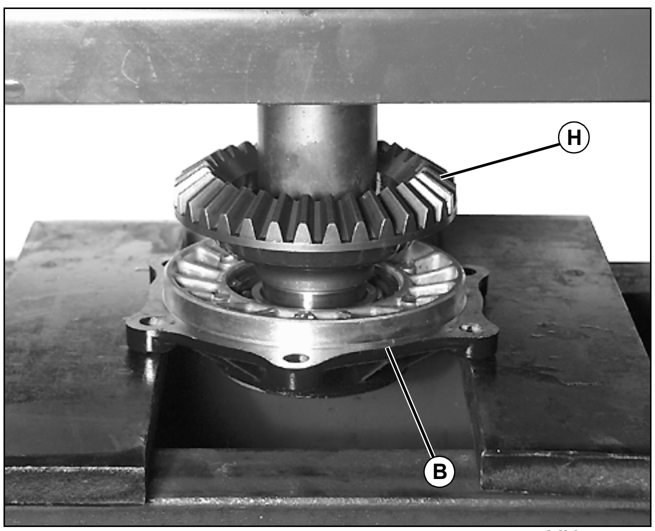
Final Drive Cover Installation:

1. Install the inner snap ring (J) onto the final drive cover (B). Press bearing (K) into housing and until it is seated against snap ring (J). Install second, outer snap ring (I) on the other side of bearing.



MX14363

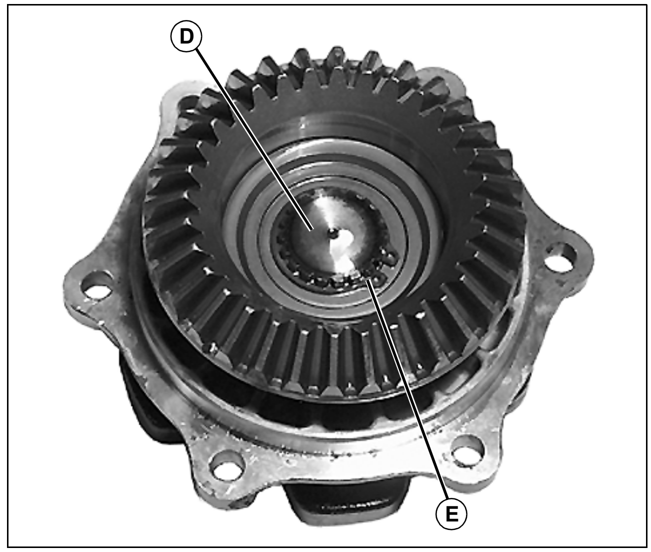
2. Install the seal (G) onto the cover.



MX14367

3. Press the ring gear (H) onto the inner race of the ball bearing inside the final drive cover (B).

Note: Press the gear flush with the ball bearing inner race. DO NOT force the gear any further.



MX14362

4. Install the hub shaft (D) and snap ring (E).

5. Install the cover to the final drive case. Tighten six (6) cap screws in a cross pattern to specification.

Note: The final drives and axle housing fill very slowly. It may be necessary to open a drain plug to allow for a faster fill. BE CERTAIN to tighten the drain plug as soon as the gear lube reaches the drain hole. Allow the entire amount of gear lube to fill the housing.

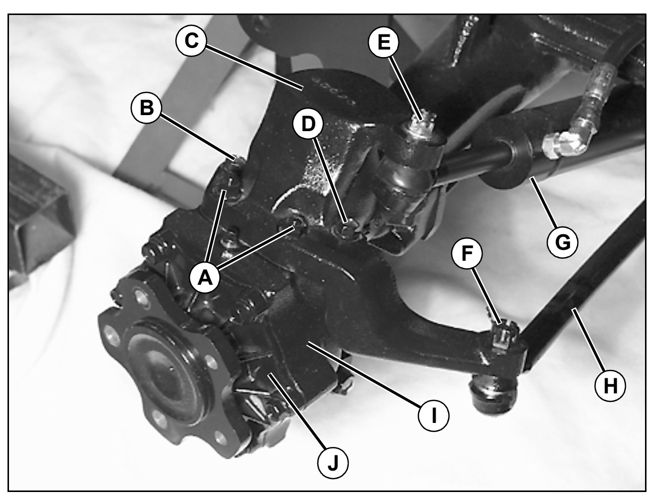
6. Fill the housing with approved gear lube.

Specifications:

Final Drive Case Cover Cap Screws
. . . . . 16 - 22 N•m (16 - 22 N•m (144 - 192 lb-in.)

Final Drive Housing Removal and Installation - (MFWD)

Removal and Inspection:



MX14359

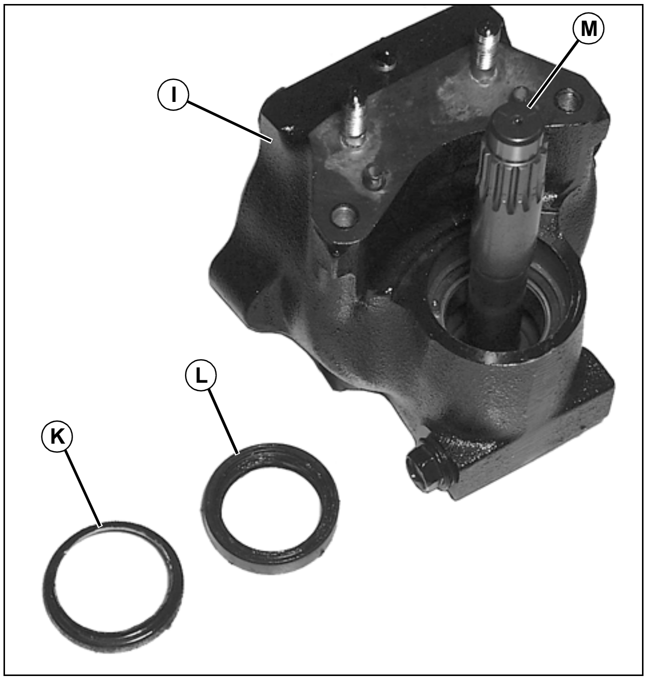
1. Drain the differential and final drive housing (I), and remove the final drive cover (J). See “Final Drive Cover Removal and Installation - (MFWD)” on page 324.

2. Remove cotter pin and castle nut (F) on machine tie rod (H) and remove tie rod from spindle arm (C).

3. Remove cotter pin and castle nut (E) and remove end of steering cylinder (G) from spindle arm (C).

4. Remove cap screw (B), long cap screw (D), and nuts/washers (A). Remove the front spindle arm (C) from top spindle housing.

5. Remove seal and bearing from top of spindle housing, and, using a punch, tap top of drive shaft (M) to remove final drive housing assembly (I) from spindle housing.

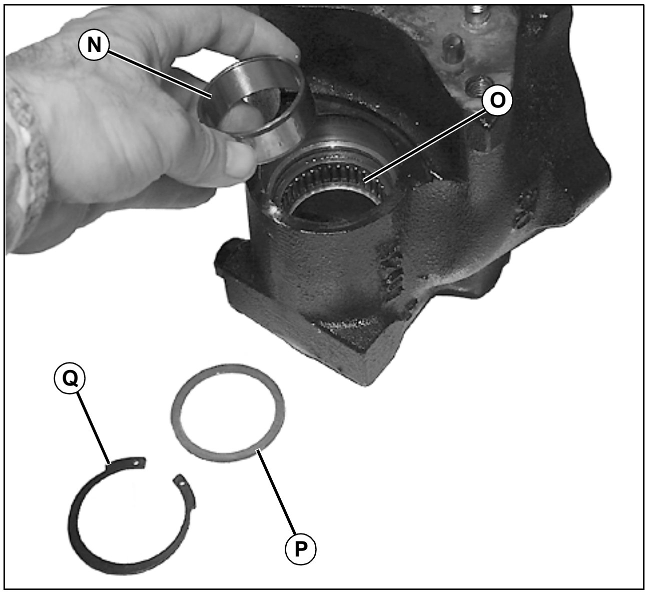


MX14368

6. Carefully remove collar (K), and seal (L) from final drive housing (I).

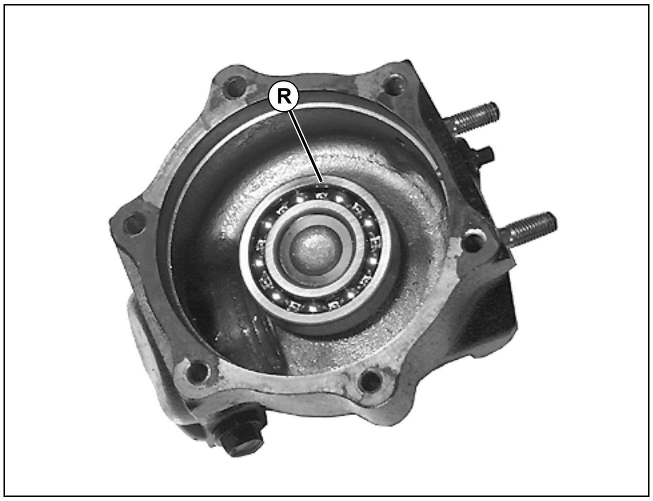
Note: Note position of writing/numbers on bearings during removal and replace with same orientation.

7. Remove drive shaft (M) from final pinion and bearing seated in bottom of housing.



MX14369

8. Remove snap ring (Q), washer (P), and bearing race (N), and inspect needle bearing (O) for wear or damage. If damaged, remove bearing and replace.



MX14371

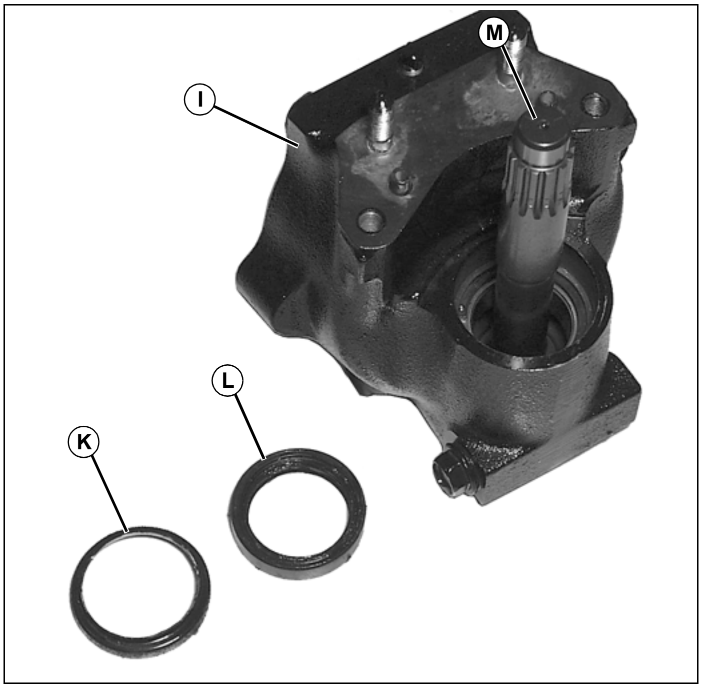
9. Remove the ring gear bearing (R) from the housing.

10.Inspect all the components of the final drive housing. Replace any unserviceable parts.

Installation:

1. Press the ring gear bearing (R) into the housing.

2. With needle bearing (O) in place, install bearing and final pinion into bottom of final drive housing (I).



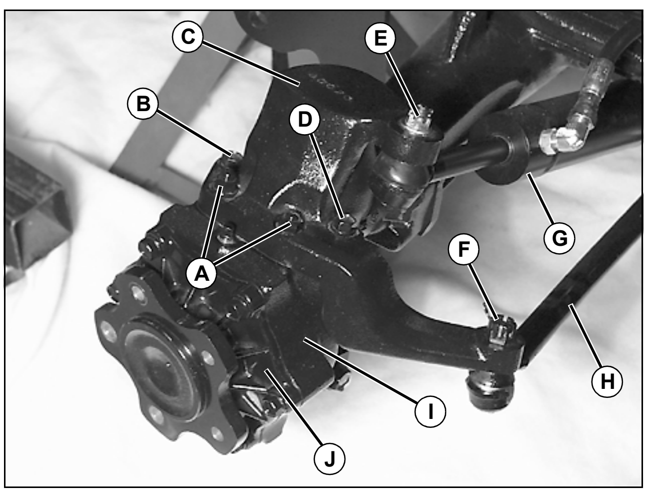
MX14368

3. Seat bearing into bottom of housing, and press shaft (M) into bearing.

4. Install seal (L) and collar (K) onto housing opening.

5. Raise assembly through spindle housing, while simultaneously orienting gear in spindle housing so final drive housing (I) mates fully with spindle housing.

6. Install bearing and seal on top of spindle housing.



MX14359

7. Install the spindle arm (C) onto spindle housing. Secure assemblies with cap screw (B), long cap screw (D), and nuts/washers (A).

8. Install tie rod (H) onto end of spindle arm (C), and secure with castle nut (F) and cotter pin.

9. Install end of steering cylinder (G) onto arm of spindle, and secure with castle nut (E) and cotter pin.

10.Install the housing cover (J). See “Final Drive Cover Installation:” on page 325.

Note: The final drives and axle housing fill very slowly. It may be necessary to open a drain plug to allow for a faster fill. BE CERTAIN to tighten the drain plug as soon as the gear lube reaches the drain hole. Allow the entire amount of gear lube to fill the housing.

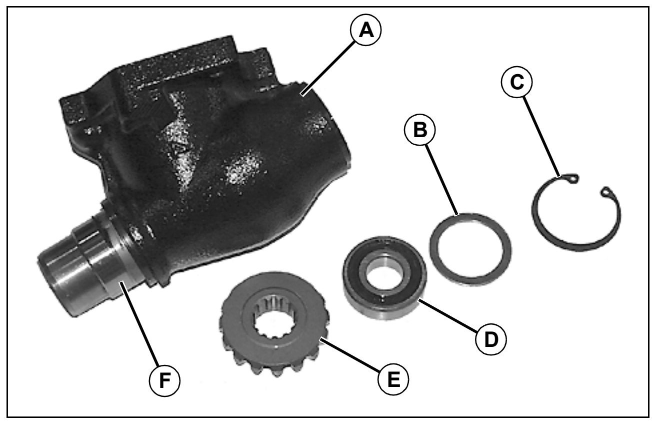
11.Fill the housing with approved gear lube.

Spindle Housing - (MFWD)

Disassembly and Inspection:

1. Remove the steering arm and final drive housing, along with spindle shaft. See “Final Drive Housing Removal and Installation - (MFWD)” on page 326.

2. Remove six cap screws holding spindle housing to differential housing.

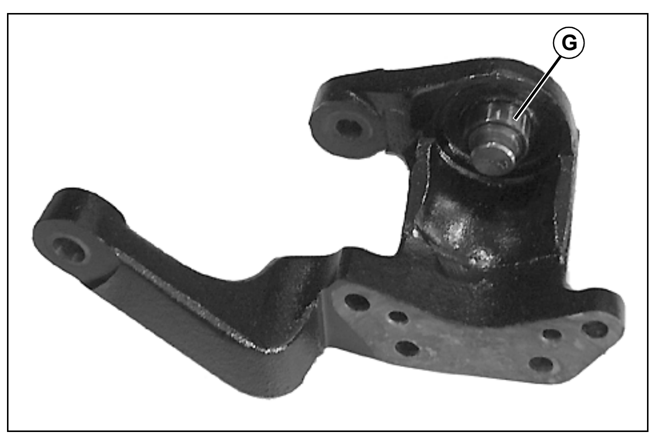


MX14372

3. Remove snap ring (C), washer (B), and bearing (D) from top of spindle housing (A).

4. Remove gear (E) through the final drive opening of the housing.

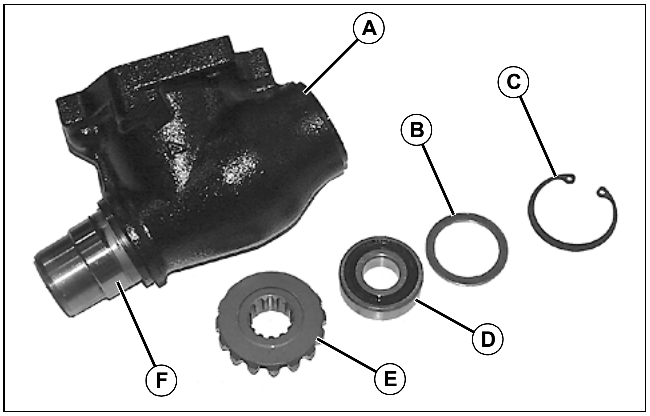
5. Inspect the sleeve (F) on spindle housing for wear or damage. Replace as needed.



MX14373

6. Inspect the steering arm and oil wear sleeve (G) for wear or damage. Replace as required.

Assembly:



MX14372

1. Install bearing (D), washer (B), and snap ring (C) through top of spindle housing (A).

2. Install gear (E) through the final drive opening of the housing, with the gear teeth facing toward the bottom of the spindle housing.

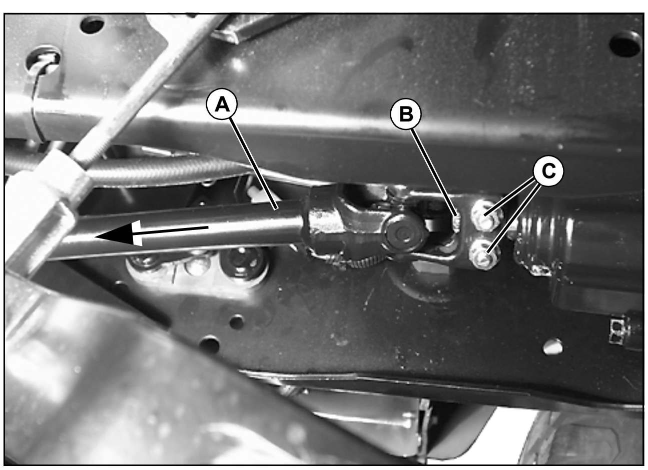
3. Install the spindle shaft, final drive housing, and steering arm. See “Final Drive Housing Removal and Installation - (MFWD)” on page 326.

Note: The final drives and axle housing fill very slowly. It may be necessary to open a drain plug to allow for a faster fill. BE CERTAIN to tighten the drain plug as soon as the gear lube reaches the drain hole. Allow the entire amount of gear lube to fill the housing.

4. Fill the housing with approved gear lube.

Drive Shaft Removal and Installation - (MFWD)

Removing:



MX14379

1. Remove nuts (C) and bolts.

2. Slide the drive shaft (A) toward the front of the machine, removing the rear drive shaft yoke from the differential drive shaft (B).

3. Slide drive shaft toward rear of machine to remove shaft from the differential input shaft.

4. Inspect all parts for wear or damage. Replace any unserviceable parts.

Note: The U-joint yokes are not serviced separately. If either yoke is damaged, replace the drive shaft.

Installing:

1. Install front drive shaft yoke into differential input shaft as far forward as it will go.

2. Slide rear drive shaft yoke onto differential drive shaft (B), until bolts can be installed.

3. Install both bolts and tighten nuts (C).

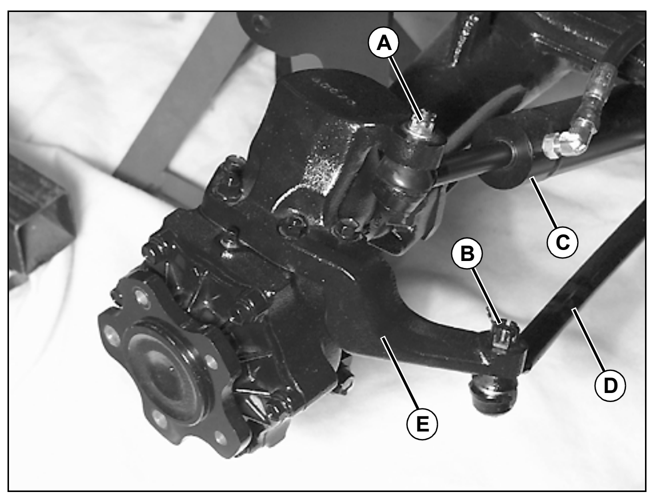
Mechanical Front Wheel Drive Removal and Installation - (MFWD)

Removal:

1. Remove the MFWD drive shaft. See “Drive Shaft Removal and Installation - (MFWD)” on page 329.

2. Loosen front wheels and raise the front of the machine by the frame to allow front axle removal.

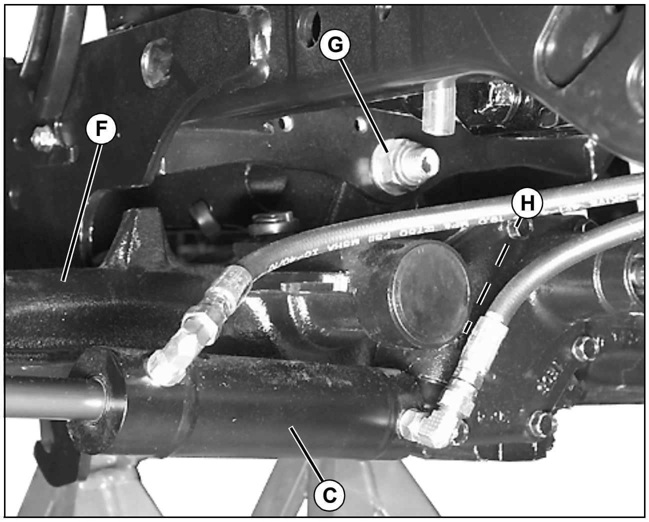
3. Remove both front wheels.



MX14359

4. Remove cotter pin and castle nut (B) from tie rod (D). Remove tie rod from steering arm (E). Repeat for other side of machine.

5. Remove cotter pin and castle nut (A) from steering cylinder (C) end. Remove steering cylinder end from steering arm.



MX16000

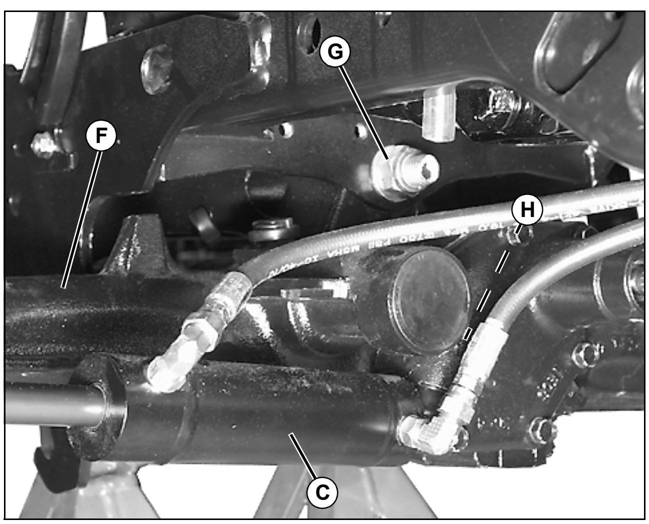
6. Remove the cotter pin and castle nut (H) from the steering cylinder end and lower cylinder (C), with hydraulic lines attached to cylinder.

7. Support the front axle (F) with a floor jack, and remove nut (G), washer, and bolt securing axle to frame.

8. Lower the axle from the frame with the floor jack. Set the axle on a workbench or blocks to drain and disassemble transaxle.

Installation:

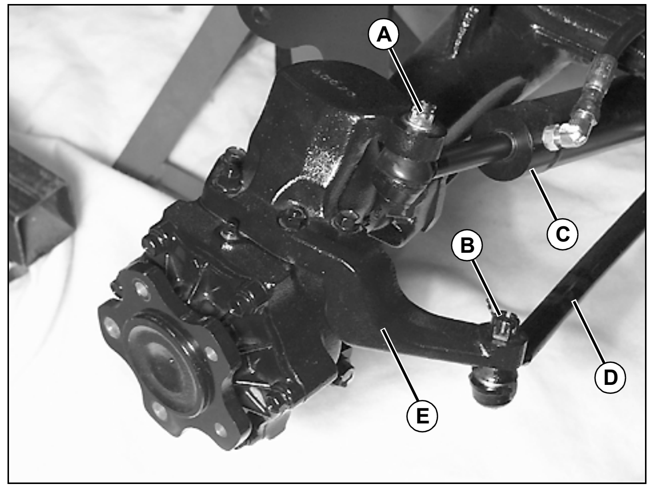
1. Set the axle on a floor jack beneath the machine.
2. Raise the axle into position.



MX16000

3. Slide the axle bolt through the frame and axle (F), and install washer and nut (G).

4. Raise steering cylinder (C) onto axle and secure with castle nut (H) and cotter pin.



MX14359

5. Install steering cylinder (C) end to steering arm (E) and secure with castle nut (A) and cotter pin.

6. Install tie rod (D) to steering arm and secure with castle nut (B) and cotter pin. Repeat for other side of machine.

7. Install the tires. Tighten lugs to specification below.

8. Install the MFWD drive shaft. See “Drive Shaft Removal and Installation - (MFWD)” on page 329.

9. Lower the front of the machine.

Note: The MFWD and axle housing fill very slowly. It may be necessary to open the drain plug to allow for a faster fill. BE CERTAIN to tighten the drain plug as soon as the gear lube reaches the drain hole. Allow the entire amount of gear lube to fill the housing.

10.Fill MFWD with approved gear lube.

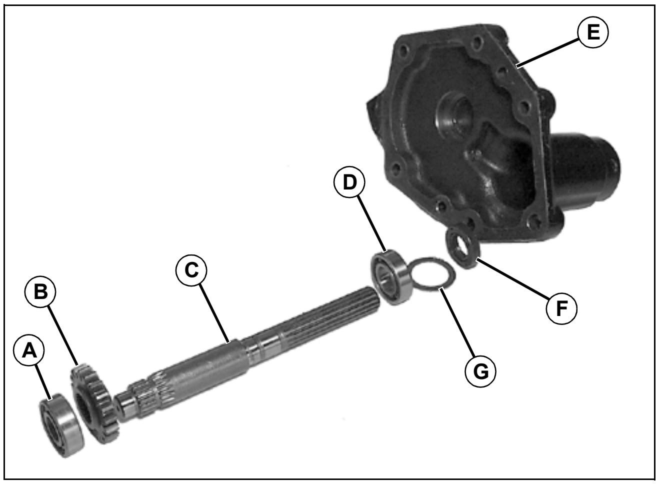
Specifications:

Tire Lugs . . . . 88 N•m (65 lb-ft)
Tie Rod Ends . . . . 53 N•m (39 lb-ft)

Differential Input Housing - (MFWD)

Disassembly:

Note: This procedure can be performed with the differential on the machine. Remove the drive shaft and follow the steps in this section.



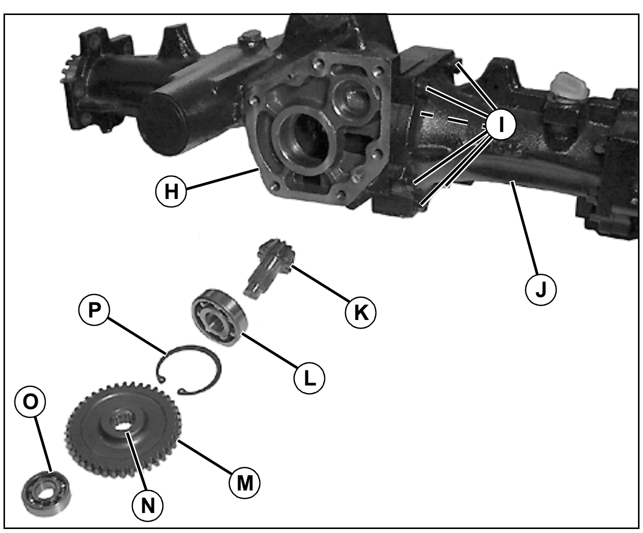
MX16005

1. Remove the differential input drive housing (E).
2. Push the input shaft (C) out of the housing.
3. Remove bearing (A) and the transfer gear (B) from the input shaft.

Note: Note location of writing/numbers on bearing (D) during removal procedure. Assemble with writing/ numbers toward transfer gear (B).

4. Remove bearing (D) from input shaft (C).
5. Remove washer (G) and seal (F) from inside housing.

Note: Note flange (N) on transfer gear (M), and install with flange toward the pinion drive shaft (K).



MX16006

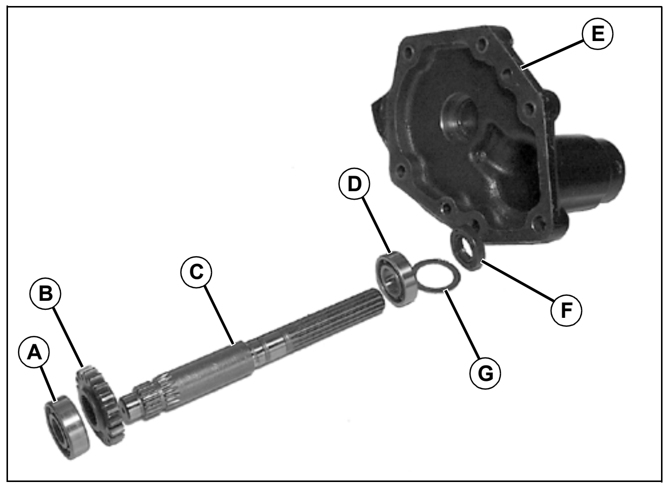
6. Remove the bearing (O) and transfer gear (M) from the input pinion shaft.
7. Remove the snap ring (P), the large bearing (L) and pinion drive shaft (K) from the differential housing (H).

Note: Note location of writing/numbers on large bearing (L) during removal procedure. Assemble with writing/numbers toward transfer gear (M).

8. Remove the large bearing (L) from the input pinion shaft (K).
9. Remove cap screws (I) and separate right axle housing (J) from differential housing (H) (for installation procedure).

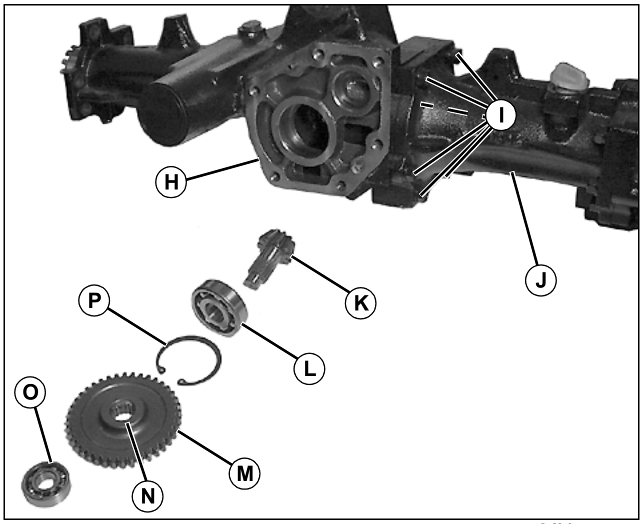
10.Inspect all parts for wear or damage and replace as required.

Assembly:



MX16005

1. Invert the input housing (E) and install a new seal (F).
2. Place the transfer gear (B) and press the 2 bearings (A and D) onto the input shaft.
3. Place the thrust washer (G) on the upper bearing.
4. Install the input shaft (C) to the housing. The upper bearing must seat inside fully in the input housing.



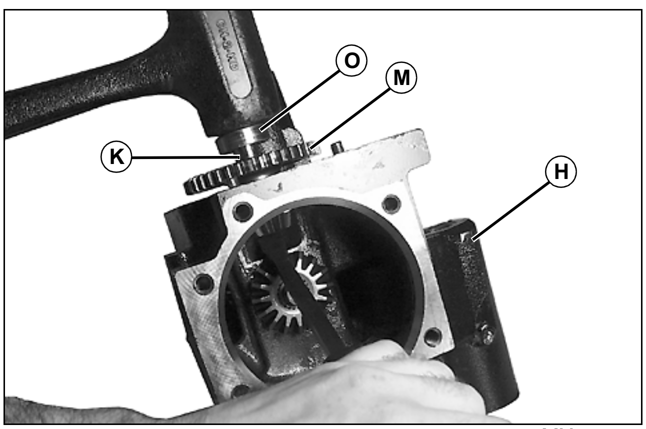
MX16006

5. Install the bearing (L) to the input pinion shaft (K), with writing/numbers facing the transfer gear (M).

6. Install the input pinion shaft (K) to the differential housing (H).

7. Install the large snap (P) ring to the differential housing.

8. Install transfer gear (M), with raised flange (N) towards input pinion shaft (K).



MX16007

9. Install the upper bearing (O) to the input pinion shaft (K) until it contacts the splines of the input pinion shaft. Support the bottom of the input pinion shaft during installation.

10.Lubricate the bearings and gears. Seal the input housing.

11.Install the input housing (I) to the differential housing (H).

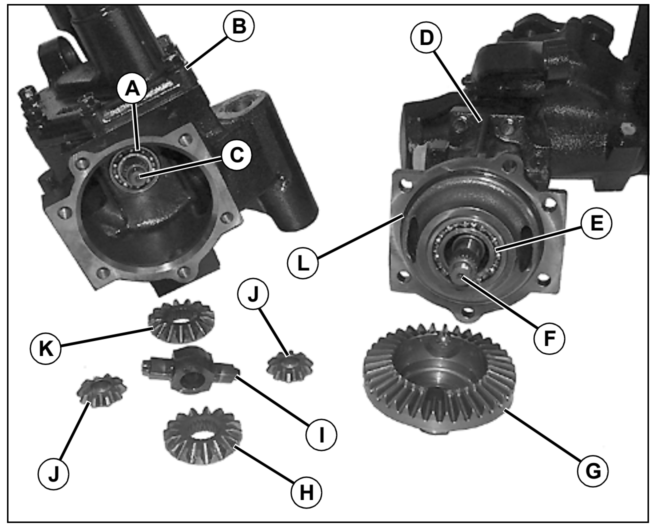
Note: The MFWD and axle housing fill very slowly. It may be necessary to open the drain plug to allow for a faster fill. BE CERTAIN to tighten the drain plug as soon as the gear lube reaches the drain hole. Allow the entire amount of gear lube to fill the housing.

12.Fill the housing with approved gear lube.

Front Axle Housing Disassembly and Assembly

Disassembly/Inspection:

1. Drain the differential and final drive housings, and remove the MFWD from the machine. See “Mechanical Front Wheel Drive Removal and Installation - (MFWD)” on page 329.



MX16008

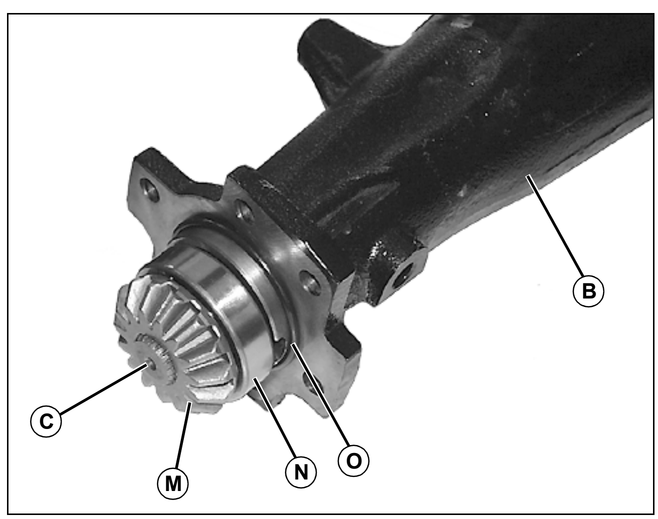
2. Separate the right axle housing (D) from the differential housing (B).

3. Remove the bevel pinion gears (J), bevel pinion shaft (I) and bevel gear (K) from the left axle (C).

4. Remove the ring gear (G) and bevel gear (H) from right axle housing (D).

5. Remove O-Ring (L) from right axle housing.

Note: Note any writing/numbers on bearings and assemble with correct orientation.



MX16009

6. To remove right (F) and left (C) axles, remove spindle assemblies from axle housings. See “Spindle Housing - (MFWD)” on page 328. Remove gear (M) and bearing (N) on outside of shafts (C and F). Remove bearing from gear.

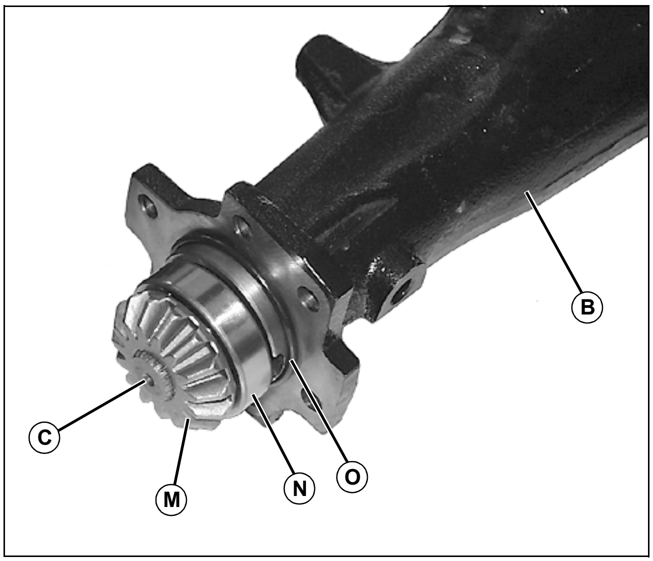
7. Remove O-Ring (O) on both housing ends.

8. Remove the left axle (C) with inner bearing (A) from the differential housing (B). Remove bearing (A) from axle (C).

9. Remove the right axle inner bearing (E) and axle (F) from the right axle housing (D).

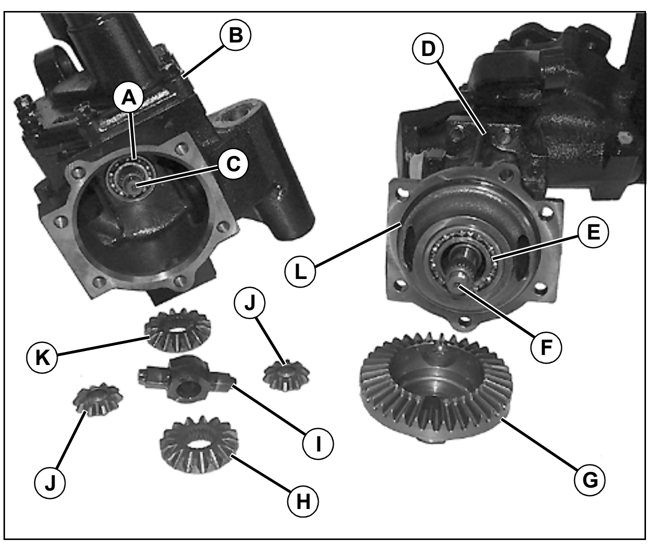
10. Inspect all parts for wear or damage. Replace as necessary.

Assembly:



MX16009

1. Install new O-Ring (O) on both housing ends.



MX16008

2. Press bearing (A) onto shaft (C), and install shaft through differential housing (B).

3. Install bearing (N) onto gear (M), and install onto shaft (C) through differential housing (B). Repeat for right axle housing.

4. Install the inner axle bearing (E) to the right axle housing.

5. Install the bevel gear (K) to the left axle (C).

6. Install new O-Ring (L) onto right axle housing.

7. Install bevel gear (H) and ring gear (G) to the right axle.

8. Install the bevel pinion gears (J) to the bevel pinion shaft (I).

9. Install the bevel pinion shaft and gears to the differential.

Note: Be certain the differential gear assembly remains intact during this installation. Some adjustment may be required to mesh the gears so the housings will match up.

10. Install the right axle housing (D) to the differential housing (B).

11. Install spindle assemblies to axle housings. See “Spindle Housing - (MFWD)” on page 328.

Note: The MFWD and axle housing fill very slowly. It may be necessary to open the drain plug to allow for a faster fill. BE CERTAIN to tighten the drain plug as soon as the gear lube reaches the drain hole. Allow the entire amount of gear lube to fill the housing.

12. Fill the housing with approved gear lube.

Table of Contents

HYDRAULICS SPECIFICATIONS

Specifications

General Specifications

Transaxle:

Hydraulic Oil J20D . . . . Low Viscosity HY-GARD
Oil Capacity (Two-Wheel Steer). . . . . 6.6 L (7.0 qt)
Oil Capacity (All-Wheel Steer) . . . . 5.6 L (6.0 qt)
Hydraulic Oil Filter . . . . Use original John Deere filters
Charge Pressure Control Valve. . . . . 1958 kPa (284 psi)

Charge Pump (Two-Wheel Drive):

Size . . . . 6 cc/rev.
Charge Pressure Relief Valve (Implement Pressure) (minimum). . . . . 6371 kPa (924psi)
Rated Flow . . . . 17 L/m (4.5 gpm)
Minimum Flow. . . . . 13 L/m (3.4 gpm) @ 3200 rpm

Charge Pump (All-Wheel Drive):

Size . . . . 8 cc/rev.
Charge Pressure Relief Valve (Implement Pressure) (minimum). . . . . 6371 kPa (924 psi)
Rated Flow . . . . 22.7 L/m (6.0 gpm)
Minimum Flow. . . . . 17 L/m (4.5 gpm) @ 3200 rpm

Hydraulic Control Valve:

Leakage (Maximum) . . . . 4 cc/minute @ 6895 kPa (0.135 oz/minute @ 1000 psi)
Couplers . . . . 0.635 cm (1/4 in.) ISO

Hydraulic Lift Cylinder:

Bore . . . . 63.5 mm (2.5 in.)
Stroke . . . . 101.6 mm (4.0 in.)
Rod. . . . . 25.4 mm (1.0 in.)

Test and Adjustment Specifications

Note: Make sure engine idle and wide-open throttle speeds are correct before performing any of the hydraulic tests.

Charge (Implement) Pressure Relief (minimum) . . . . 6371 kPa (924 psi)
Charge Pressure (minimum) . . . . 1958 kPa (284 psi)

Lift Cylinder Leakage Test:

Hydraulic Oil Temperature (Typical) . . . . 43°C (110°F)
Engine Speed . . . . Slow idle
Leakage . . . . No leakage

Control Valve Leakage Test:

Engine Speed . . . . Slow idle
Leakage . . . . No more than a drip from "out" port of control valve

Repair Torque Specifications

Control Valve Mounting Cap Screws . . . . 11 - 16 N•m (8 - 12 lb-ft)
End Cap Retaining Screws . . . . 4 N•m (36 lb-in.)
Spring Retainer Retaining Screw (Under End Cap). . . . . 4 N•m (36 lb-in.)
Detent Ball Retaining Screws . . . . 4 N•m (36 lb-in.)
Spool Detent . . . . 4 N•m (36 lb-in.)
Drain Plugs . . . . 38 N•m (28 lb-ft)
Lift Check Valves Cap Screws. . . . . 24 N•m (18 lb-ft)
90° Fitting to Control Valve . . . . 33 - 49 N•m (24 - 36 lb-ft)
Small Straight Fitting to Control Valve . . . . 24 - 30 N•m (18 - 22 lb-ft)
Large Straight Fitting to Control Valve. . . . . 33 - 49 N•m (24 - 36 lb-ft)
Quick Couplers to Control Valve. . . . . 33 - 49 N•m (24 - 36 lb-ft)

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
Temperature Gauge	JDG282	Used to measure hydraulic oil temperature.
Quick Coupler	AM102420	Used to connect pressure and flow test equipment.
9/16-18 M x 7/16-20 M 37° Orb	JT031111	Used to connect pressure and flow test equipment.
Hose	JT03017	Used to connect pressure gauge to couplers during pressure tests.
Pressure Gauge - 13790 kPa (2000 psi)	JT03117	Used to measure hydraulic oil pressure.
Consumer Products Hydraulic Fitting Kit	JT01765	Used for Charge Pump Flow and Pressure Quick Test at Couplers.
Flowmeter Kit	JT05469	Used to measure flow rate of hydraulic oil.
1/4 Male Quick-Coupler	AM102420	Used to connect flowmeter to work ports.
Connector and 9/16-18 M 37° x 9/16-18 M Orb	JT03216	Used to connect flowmeter to work ports.
Coupler and 3/4” F NPT x 9/16-18 F 37° Orb	JT03342	Used to connect flowmeter to work ports.

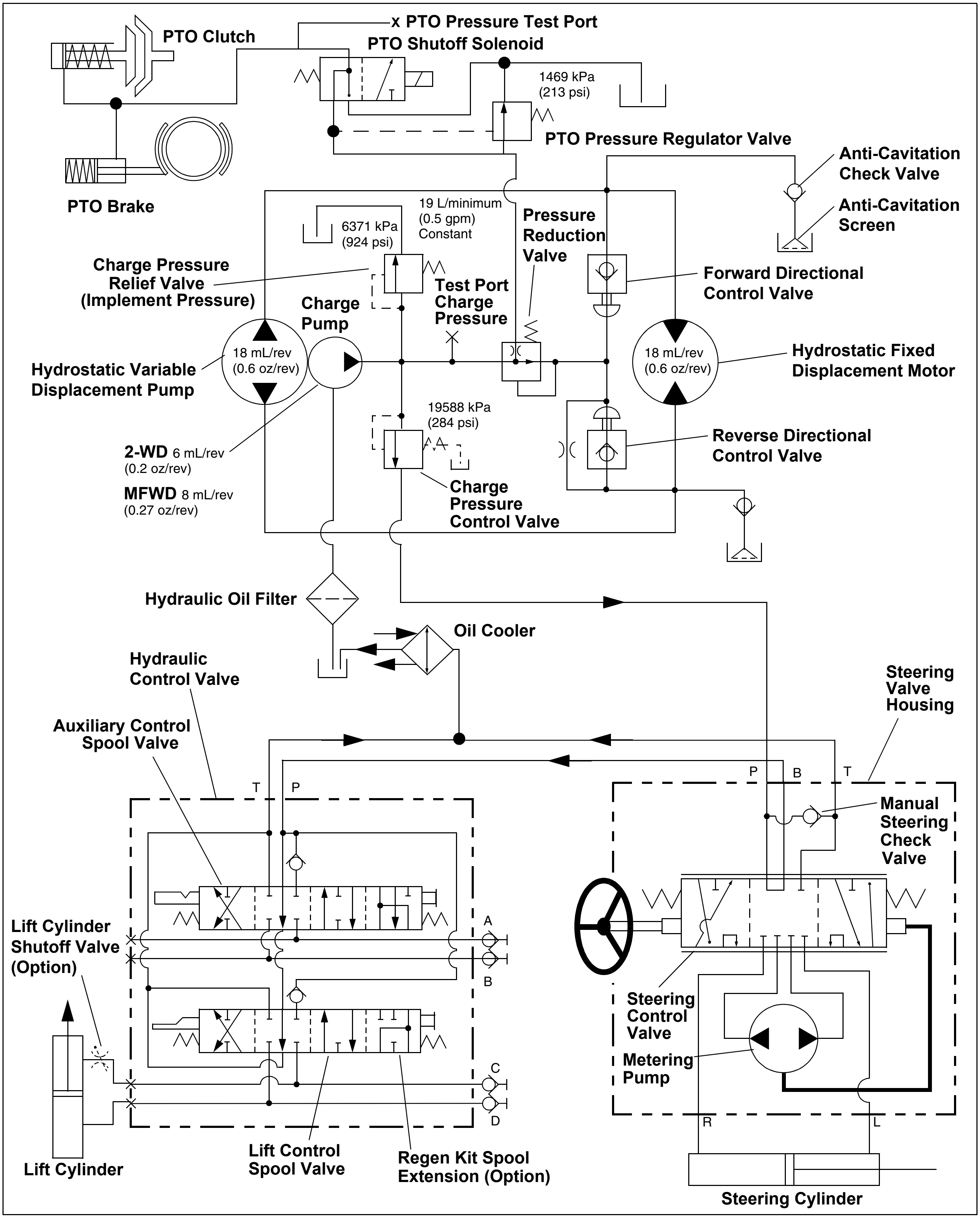
Other Materials

Other Material

Part No.	Part Name	Part Use
TY9370/ TY9477/#242	Loctite ® Products Thread Lock and Sealer (Medium Strength)	Used to seal threads on control valve screws, spool detent and small plugs.
AM132341	Control Valve Seal Kit	
AM100201	Load Check Valve Kit	
AM132340	Spool Spring Center Kit	
AM132338	Spool Detent Float Kit	

Schematics

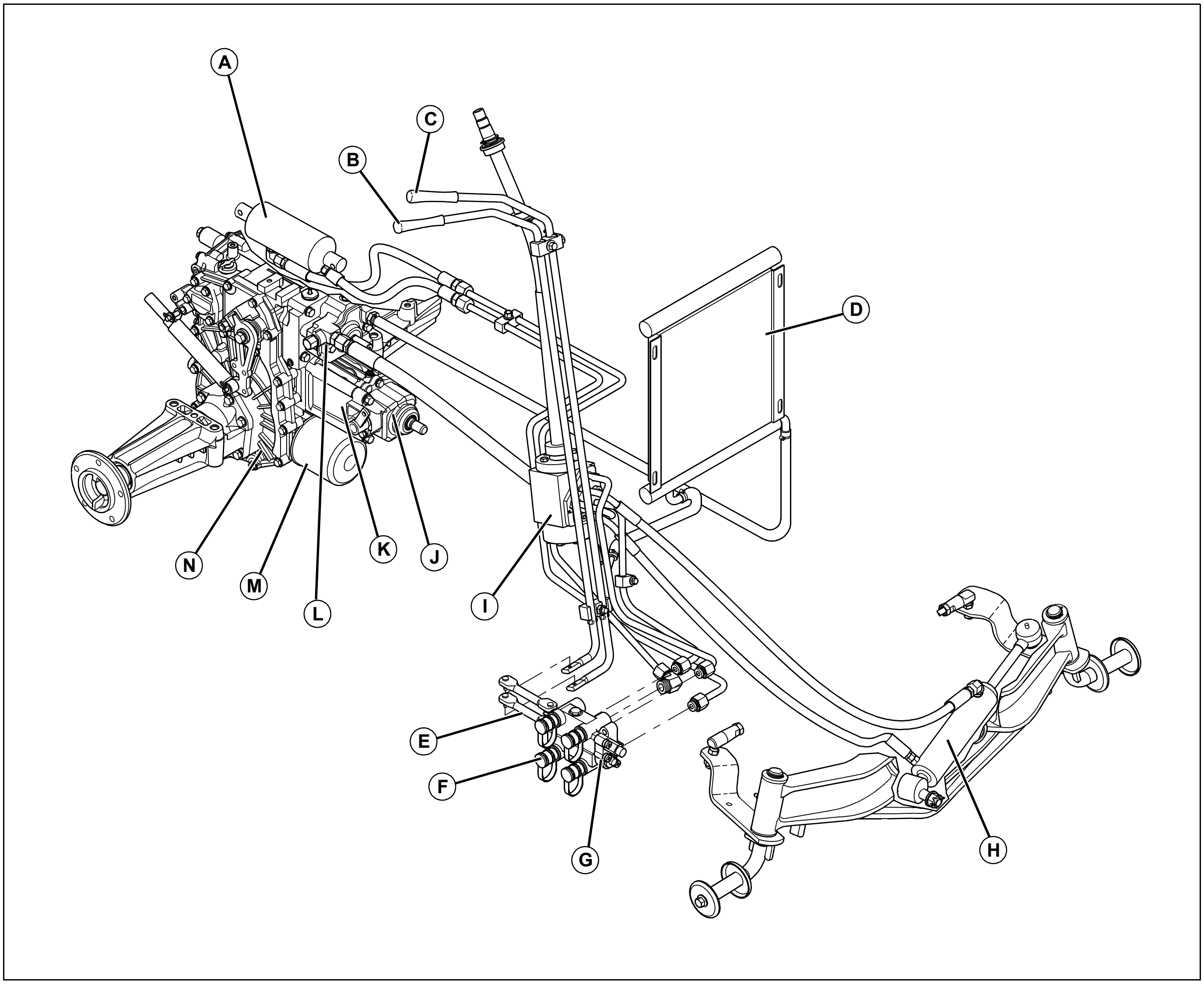
Hydraulic Schematic - Power Train



MIF

Component Location

Hydraulic System



A- Lift Cylinder
B- Auxiliary Control Valve Lever
C- Lift Control Valve Lever
D- Oil Cooler
E- Link Rods
F- Hydraulic Couplers
G- Hydraulic Control Valve
H- Steering Cylinder
I- Steering Valve
J- MFWD Drive
K- Hydrostatic Motor
L- Charge Pump
M- Oil Filter
N- Transaxle

Operation and Diagnostics

Hydraulic System

Function:

The hydraulic system provides fluid power to charge the hydrostatic pump and operate the power steering, lift cylinder and any optional auxiliary hydraulic attachments.

System Operation:

The hydraulic systems is an “open center” type system. In this type of system the charge pump provides a continuous flow of oil through a circuit that connects all of the controlling valves. If the valves are not operated, the flow of oil passes through the “open center” of each valve and then returns to the transmission case. In an open center circuit, the first controlling valve takes priority over the next valve downstream in the circuit.

The charge pump draws hydraulic oil from the transaxle case, through the filter, then supplies a constant flow of oil to the steering valve and control valve.

Return oil from the steering valve and hydraulic control valve is routed through the oil cooler then back to the transaxle case.

The hydraulic control valve is controlled by two levers on the steering column. The top lever controls the lift spool that controls the flow of oil to and from the lift cylinder. The lower lever operates the auxiliary control spool valve, used to operate hydraulic implement equipment attached to the machine. An optional shutoff valve can be installed in the line running to the lift cylinder. When in the off position, the lift cylinder is blocked out of the system, allowing attachments requiring dual function controls to be operated without the deck or hitch moving up or down.

See this section for operation, test and repair of the hydraulic control valve and charge pressure tests.

See Power Train section for operation, test and repair of charge pump and valves.

See Steering section for operation and test of the steering valve and cylinder.

Hydraulic Pump and Motor Operation:

The charge pump draws oil from the transaxle sump and provides charge oil to the center section. The charge pressure control valve maintains a minimum oil pressure, **1958 kPa (284 psi)**, in the center section.

If the implements or steering are not activated, the charge pump circulates oil through the steering control valve and the hydraulic control valve at or above the charge pressure control valve setting. When the steering and/or hydraulic control valves are activated, restrictions in the system cause the charge pressure to increase until the charge pressure relief valve opens. The charge pressure relief valve opening pressure is the implement operation pressure.

The charge pressure relief valve maintains sufficient system pressure, **6371 kPa (924 kPa)** minimum, to operate implements.

Charge oil in the transmission will open the closed loop check valve and enter the forward side of the closed loop when the reverse side has been pressurized by the hydrostatic pump. When the direction is reversed to provide forward direction, charge oil will then pressurize the reverse side of the closed loop.

The variable displacement hydrostatic pump pressurizes the reverse side loop, causing the fixed displacement motor to rotate. The reverse directional check valve blocks the closed loop pressure oil from entering the charge circuit.

The reverse directional check valve cartridge has a leak-off orifice. This orifice bleeds off a small amount of high pressure oil from the reserve closed loop back into the charge circuit. This provides for a wider neutral band to help prevent creep. This small leakage does not slow down reverse.

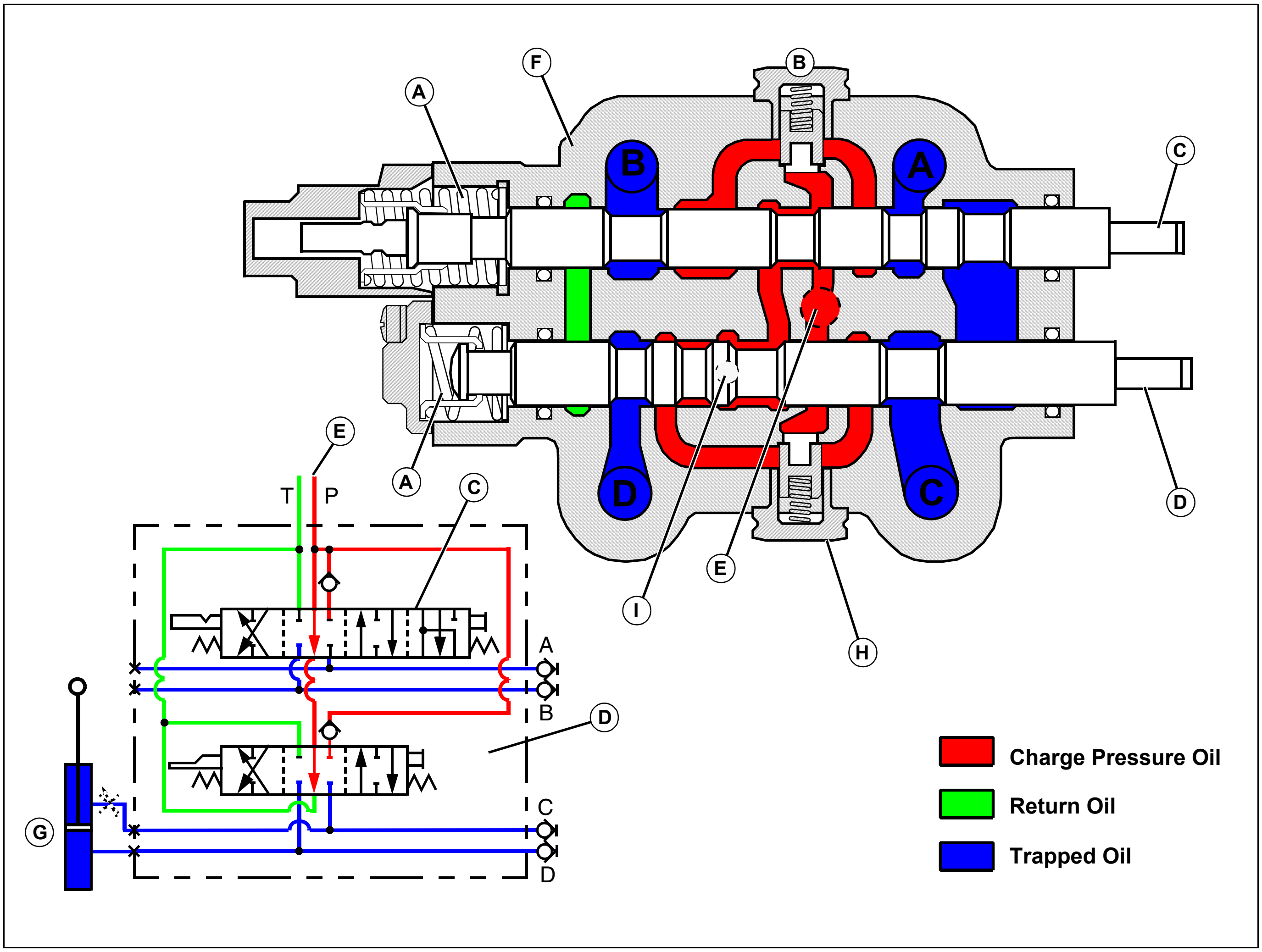
Steering Valve Operation:

The steering valve is an open center type valve. This valve consists of a self-centering fluid control valve (spool and sleeve) and a metering pump. The valve and pump are hydraulically and mechanically interconnected inside the valve.

Pressure oil comes into the steering valve body at the inlet port from the charge pressure control valve. The oil then flows through inlet passage to a series of grooves, passages, and slots in the valve body, sleeve, and spool to come out the power beyond passage and power beyond port to go on to the lift system. The amount of oil that flows this way varies with the speed of the turn. All the oil will follow this path when the steering valve is in neutral. There will be some oil when a slow turn is made, and there will be less oil when a fast turn is made. No oil is available to the power beyond port when the steering is dead headed.

When the valve is in neutral, the turn passages are closed. The oil in the steering cylinder and lines is trapped oil. The small amount of internal leakage oil will go out the return port as return oil back to the sump.

Hydraulic Control Valve Operation - Neutral



MIF

A- Return Springs
B- Load Check Valve
C- Auxiliary Spool
D- Lift Spool
E- Inlet
F- Hydraulic Control Valve Housing
G- Lift Cylinder
H- Load Check Valve
I- Outlet Port Location

Function:

The hydraulic control valve controls oil flow to the lift cylinder and the auxiliary hydraulic outlets (if equipped). When both spool valves are in the neutral position they block oil flow to the lift cylinder and to any attachments, holding them in the desired position.

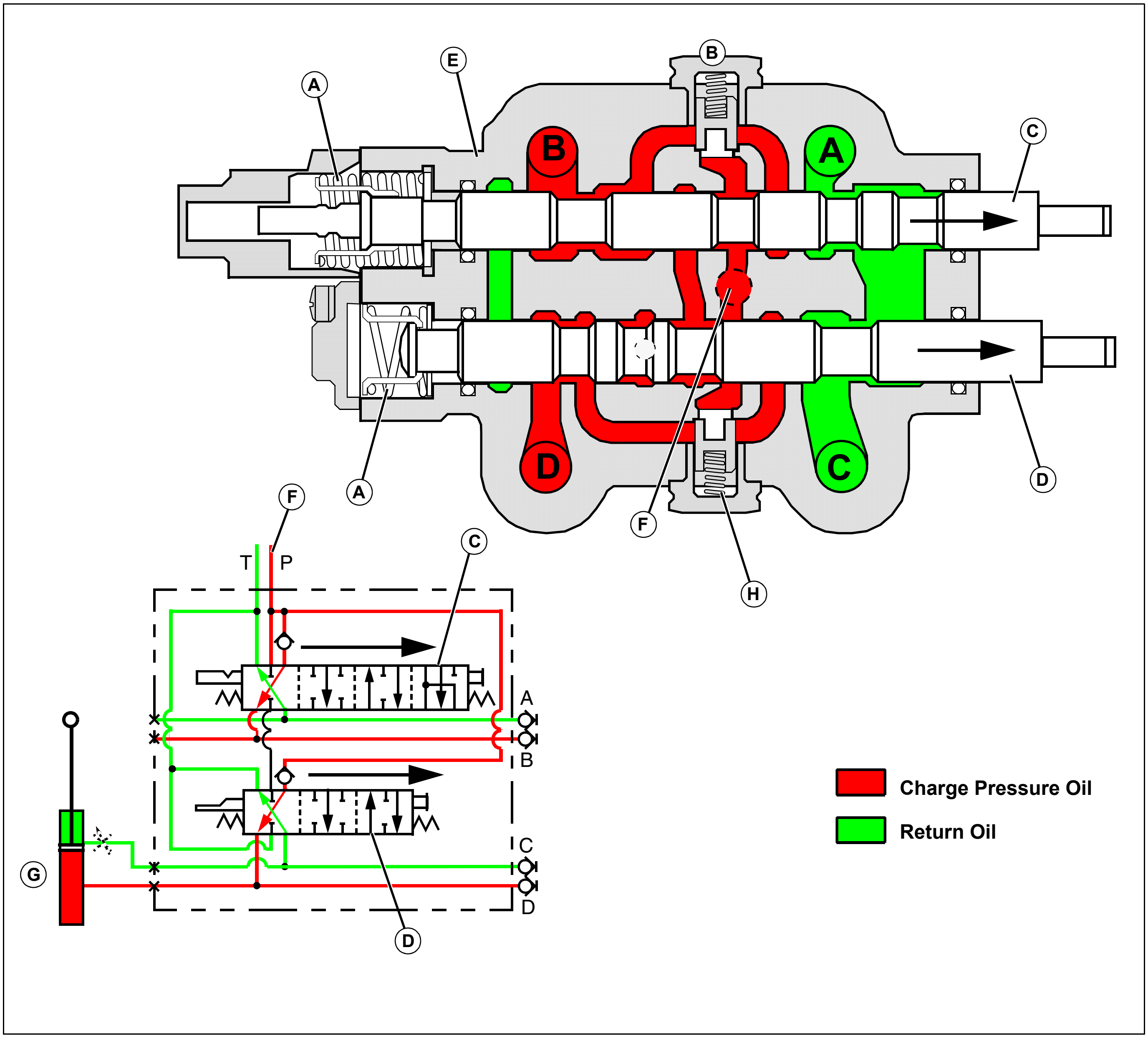
System Operation:

The hydraulic control valve housing contains two separate, open-center spools (the lift cylinder spool and the auxiliary spool). The lift spool (D) has three positions in the standard configuration, controlling the raising and lowering of the lift cylinder. It is spring-centered and is automatically returned to the neutral position when the lever is released. The fourth position is for the bucket regenerative function, which is available as a kit. See “Hydraulic Control Valve Operation - Regen” on page 345.

When in the neutral position, charge oil passes through the “open center” passage and exits the valve housing at the “OUT” port. The auxiliary spool (C) is four-position, controlling the raise, lower, and neutral functions of the couplers connected to auxiliary equipment. It is spring-centered and automatically returns to neutral, except when placed into the “float” position. See “Hydraulic Control Valve Operation - Float”.

In neutral, the passages are blocked by the spools, there is no oil flow entering the work ports. No oil is allowed to enter or leave, hydraulically locking the lift cylinder or attached implement in position.

Hydraulic Control Valve Operation - Raise



MIF

A- Return Springs
B- Load Check Valves
C- Auxiliary Spool
D- Lift Spool
E- Hydraulic Control Valve Housing
F- Inlet
G- Lift Cylinder
H- Load Check Valve

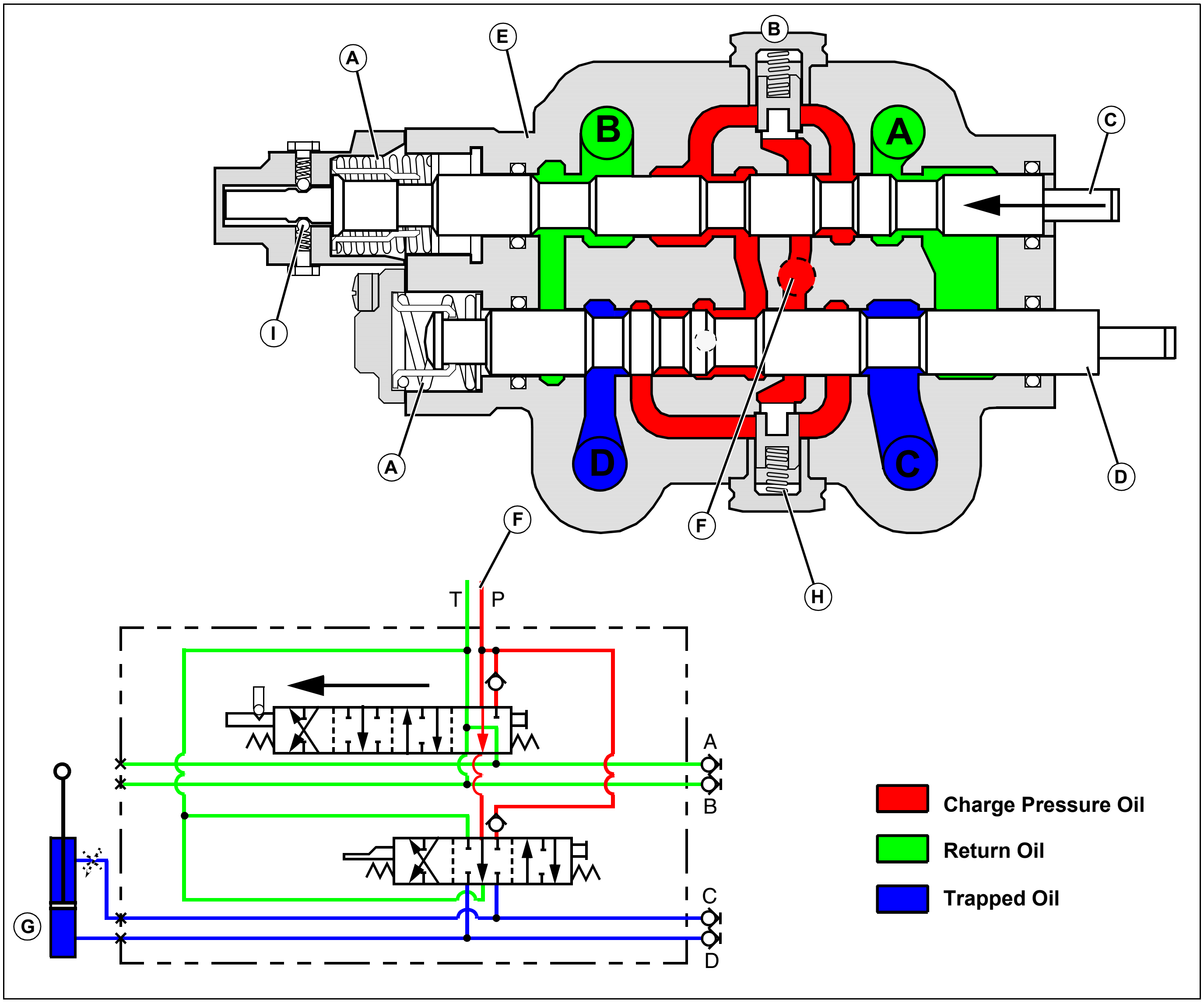
Function:

Controls the flow of pressure oil to the piston side of lift cylinder and allows return oil from the cylinder to exit the valve housing.

System Operation:

As the control lever and linkage moves either of the spools toward the lift position, the open center passage is closed off, increasing inlet pressure at work port. When inlet pressure overcomes the pressure of the work port, and oil flow starts to move the load, the lift check valve opens. The lift check valve prevents the load from dropping before inlet pressure overcomes the load or if the hydraulic system should lose pressure. High pressure oil acting against the cylinder, makes the cylinder extend. The oil from the rod end of the cylinder returns though the work port to return oil and exits the control valve.

Hydraulic Control Valve Operation - Float



A- Return Springs
B- Load Check Valve
C- Auxiliary Spool
D- Lift Spool
E- Hydraulic Control Valve Housing
F- Inlet
G- Lift Cylinder
H- Load Check Valve
I- Detent Balls

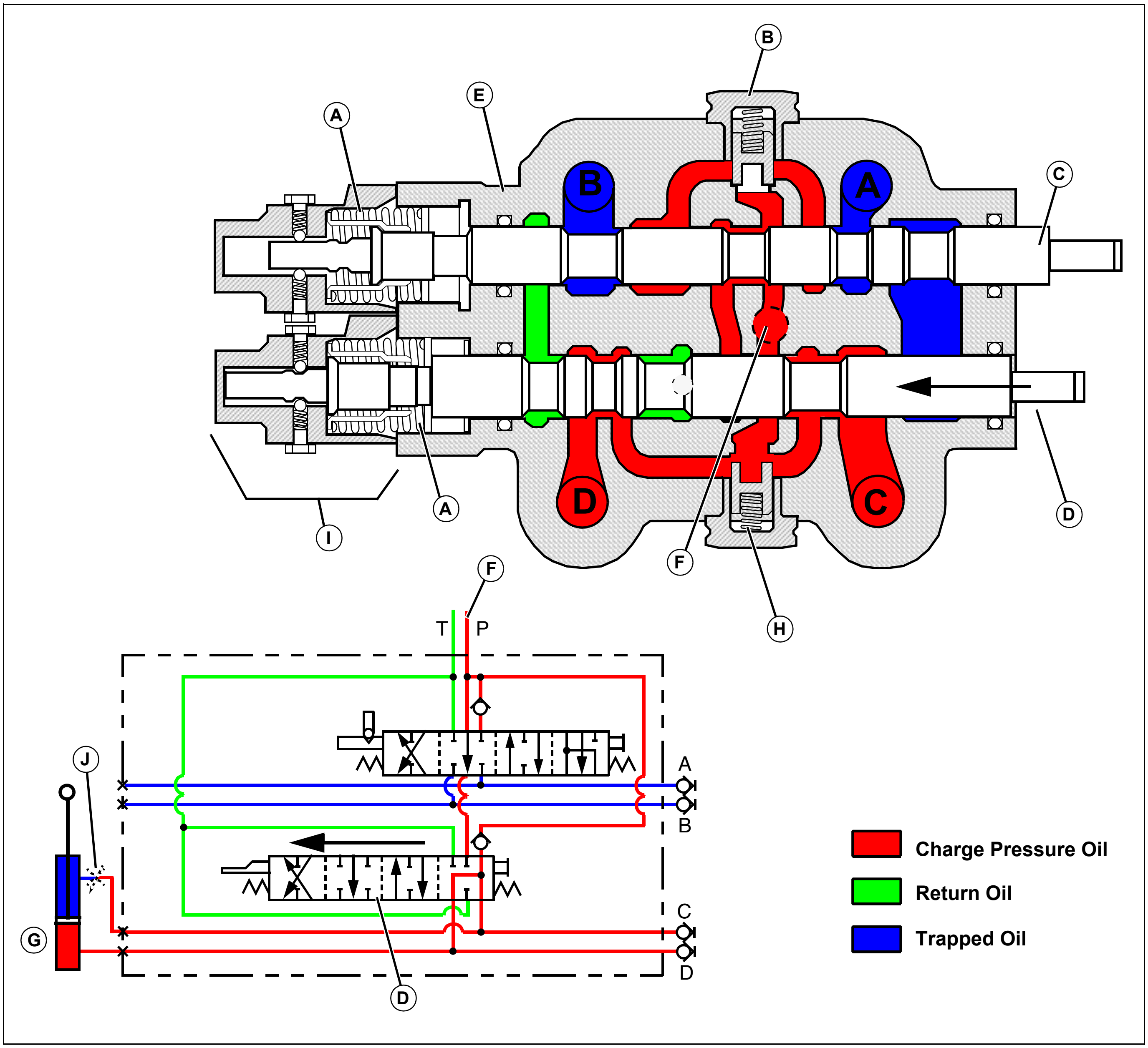
Function:

In "float" position, the spool equalizes the pressure between both work ports, allowing oil to freely enter or leave the auxiliary cylinder. This allows the implement to follow or "float" with the contour of the ground.

System Operation:

When the shift linkage moves the control spool (C) into the "float" position (lever fully forward), it is held there by detent balls. The spool will remain in this position until it is manually brought back out of the detents. In the float position, the open center circuit is still open, allowing oil flow to exit the control valve and also to be available for the operation of the lift cylinder. Both pressure and return work ports are open to the return circuit. As the cylinder extends or retracts, oil is drawn from the return circuit.

Hydraulic Control Valve Operation - Regen



MIF

A- Return Springs
B- Load Check Valve
C- Auxiliary Spool
D- Lift Spool
E- Hydraulic Control Valve Housing
F- Inlet
G- Lift Cylinder
H- Load Check Valve
I- Regen Bucket Kit (Option)
J- Shutoff Valve (Option)

Function:

In "regen" position the spool moves fully forward into the optional regen end cap (I), included in the regen kit. Going into regen, the charge pressure is going into area “C”. Return flow from area “D” gets blocked and is rerouted across the load check bridge (H) to area “C”.

System Operation:

The shift linkage moves the control spool (D) into the "regen" position (lever fully forward). The auxiliary outlet spool will not remain in this position unless held, and should return from regen position without locking.

The lift cylinder shutoff valve (J) would typically be closed. The regen function would be used with the loader to increase the speed of the bucket dump. The bucket cylinders are connected to the C and D ports.

Lift Cylinder Shut-off Valve - Optional

Function:

The shutoff valve is supplied with the front hitch kit. Its purpose is to lock the lift cylinder in a set position so when using the front coupler work ports, the deck or rear hitch will not move. This will provide a positive movement of the attachment.

Hydraulic Diagnostics

Symptom: Hydraulic Problems

Problem	Cause - Solution
1. Mower will not lift?	a. No: Go to next step. b. Yes: Shutoff valve is installed and is shut off. LIft linkage is binding or disconnected. Deck height adjustment is all the way up. Check hydraulic oil level. Replace filter. See “Charge Pump Pressure and Flow Test at Couplers” on page 351. Hydraulic line damaged, causing a restriction. Charge (implement) pressure relief valve setting incorrect. Hydraulic control spool valve scored. See “Control Valve Leakage Test” on page 354. Lift cylinder leaking. See “Lift Cylinder Leakage Test” on page 353. Air leak on suction side of charge pump. Transmission case vent plugged.

Symptom: Hydraulic Problems

Problem	Cause - Solution
2. Hydraulic system inoperative?	a. No: Go to next step. b. Yes: Optional shutoff valve is installed and is shut off. LIft linkage is binding or disconnected. Deck height adjustment is all the way up. Check hydraulic oil level. Replace filter. See “Charge Pump Pressure and Flow Test at Couplers” on page 351. Hydraulic line damaged, causing a restriction. Charge (implement) pressure relief valve setting incorrect. Lift cylinder leaking. See “Lift Cylinder Leakage Test” on page 353. Air leak on suction side of charge pump. Transmission case vent plugged. Hydraulic oil contaminated. Flush, change oil and filter.

Symptom: Hydraulic Problems

Problem	Cause - Solution
3. Slow hydraulic functions?	a. No: Go to next step. b. Yes: Check hydraulic oil level. Replace filter. See “Charge Pump Pressure and Flow Test at Couplers” on page 351. Tapered crankshaft sheave slipping on engine crankshaft. Hydraulic line damaged, causing a restriction. Coupler tips worn or damaged. Replace couplers. Charge (implement) pressure relief valve setting incorrect. Hydraulic control spool valve scored. See “Control Valve Leakage Test” on page 354. Control valve spool not neutralizing. Check linkage for binding or repair valve. Lift cylinder leaking. See “Lift Cylinder Leakage Test” on page 353. Implement lift or operating cylinder is leaking. Air leak on suction side of charge pump. Lift cylinder not locked out. Transmission case vent plugged. Hydraulic oil contaminated. Flush, change oil and filter. Excessive load.
4. Low lift capacity?	a. No: Go to next step. b. Yes: See “Charge Pump Pressure and Flow Test at Couplers” on page 351. Charge (implement) pressure relief valve setting incorrect. Lift cylinder leaking. See “Lift Cylinder Leakage Test” on page 353. Implement lift or operating cylinder is leaking. Hydraulic oil contaminated. Flush, change oil and filter. Excessive load.

Symptom: Hydraulic Problems

Problem	Cause - Solution
5. Erratic operation of implement attached to couplers?	a. No: Go to next step. b. Yes: Check hydraulic oil level. Replace filter. See “Charge Pump Pressure and Flow Test at Couplers” on page 351. Coupler tips worn or damaged. Replace couplers. Charge (implement) pressure relief valve setting incorrect. See “Control Valve Leakage Test” on page 354. Control valve spool not neutralizing. Check linkage for binding or repair valve. Lift cylinder leaking. See “Lift Cylinder Leakage Test” on page 353. Implement lift or operating cylinder is leaking. Air leak on suction side of charge pump. Lift cylinder not locked out. Transmission case vent plugged. Hydraulic oil contaminated. Flush, change oil and filter. Excessive load.
6. Mower deck or attachment drops with control valve in neutral?	a. No: Go to next step. b. Yes: Hydraulic control spool valve scored. See “Control Valve Leakage Test” on page 354. Control valve spool not neutralizing. Check linkage for binding or repair valve. Lift cylinder leaking. See “Lift Cylinder Leakage Test” on page 353. Implement lift or operating cylinder is leaking. Air leak on suction side of charge pump.

Symptom: Hydraulic Problems

Problem	Cause - Solution
7. Hydraulic noise?	a. No: Go to next step. b. Yes: Check hydraulic oil level. Replace filter. See “Charge Pump Pressure and Flow Test at Couplers” on page 351. Hydraulic line damaged, causing a restriction. Tapered crankshaft sheave slipping on engine crankshaft causing chirping sound. Charge (implement) pressure relief valve setting incorrect. Control valve spool not neutralizing. Check linkage for binding or repair valve. Air leak on suction side of charge pump. Transmission case vent plugged. Hydraulic oil contaminated. Flush, change oil and filter. Excessive load.

Symptom: Hydraulic Problems

Problem	Cause - Solution
8. Control levers stick, hard to operate, do not align?	a. No: Go to next step. b. Yes: Optional shutoff valve is installed and is shut off. LIft linkage is binding or disconnected. Deck height adjustment is all the way up. Check hydraulic oil level. Replace filter. See “Charge Pump Pressure and Flow Test at Couplers” on page 351. Hydraulic line damaged, causing a restriction. Coupler tips worn or damaged. Replace couplers. Charge (implement) pressure relief valve setting incorrect. Hydraulic control spool valve scored. See “Control Valve Leakage Test” on page 354. Control valve spool not neutralizing. Check linkage for binding or repair valve. Lift cylinder leaking. See “Lift Cylinder Leakage Test” on page 353. Implement lift or operating cylinder is leaking. Air leak on suction side of charge pump. Lift cylinder not locked out. Hydraulic oil contaminated. Flush, change oil and filter.
9. Hydraulic oil foams?	a. No: Go to next step. b. Yes: Check hydraulic oil level. Replace filter. See “Charge Pump Pressure and Flow Test at Couplers” on page 351. Air leak on suction side of charge pump. Hydraulic oil contaminated. Flush, change oil and filter.
10. Frequent failure of hydraulic line or O-Rings?	a. No: Go to next step. b. Yes: See “Charge Pump Pressure and Flow Test at Couplers” on page 351. Charge (implement) pressure relief valve setting incorrect. Hydraulic oil contaminated. Flush, change oil and filter. Excessive load.

Symptom: Hydraulic Problems

Problem	Cause - Solution
11. Hitch drops or will not hold implement up?	a. No: Go to next step. b. Yes: Hydraulic control spool valve scored. See “Control Valve Leakage Test” on page 354. Control valve spool not neutralizing. Check linkage for binding or repair valve. Lift cylinder leaking. See “Lift Cylinder Leakage Test” on page 353. Implement lift or operating cylinder is leaking.
12. Mower will not lower?	a. No: Go through procedures in “Preliminary Hydraulic System Inspection” on page 349. b. Yes: Optional shutoff valve is installed and is shut off. LIft linkage is binding or disconnected. Deck height adjustment is all the way up. Hydraulic line damaged, causing a restriction.

Preliminary Hydraulic System Inspection

Test Conditions:

- Engine off.
- Machine on hard level surface.

Hydraulic System - Engine OFF (Preliminary Checks)

1. Hydraulic oil between marks on dipstick?

Yes: Go to step 2.

No: Add John Deere Low Viscosity HY-GARD Transmission and Hydraulic Oil (J20D). Drain and replace.

2. John Deere Low Viscosity HY-GARD Transmission and Hydraulic Oil: Foamy, milky, metal particles noted, discolored or burned?

No: Go to next step.

Yes: Check for air leak and use of correct fluid.

Yes: Check for water in oil.

Yes: Check for mechanic failure.

Yes: Check for causes of overheating: Plugged radiator, hydraulic control valve stuck, charge pressure relief valve malfunction.

3. Oil Leakage?

No: Go to next step.

Yes: Repair cause.

4. Radiator screen, cooler, and radiator free of dirt and debris?

No: Clean as required.

Yes: Engine OFF preliminary checks completed.

Test Conditions:

- Start engine.
- Operate ALL hydraulic functions.

Hydraulic System - Engine Running (Preliminary Checks)

1. Quick and positive steering response? Full right to full left with only slight effort? Steering wheel does not drift when driving in straight line?

Yes: Go to next step.

No: See the Steering section for steering system diagnosis.

2. Lift cylinder control lever: Implement should raise and lower. Holds implement up for a reasonable time (4 minutes) when in neutral?

Yes: Go to next step.

No: See “Charge Pump Pressure and Flow Test at Couplers” on page 351 and “Control Valve Leakage Test” on page 354. If lift cylinder rod leaked down 25.4 mm (1 in.) in the 1 - 2 minute range, check for cylinder leakage first, then proceed with tests.

3. Auxiliary hydraulic control lever: Adequate pressure and flow out of front couplers. Holds pressure to attachment when in neutral?

Yes: Go to next step.

No: See “Control Valve Leakage Test” on page 354.

4. Positive transmission speed control response: control forward, neutral, and reverse?

Yes: Go to next step.

No: See the Power Train section for transmission and speed control linkage diagnosis.

5. Hydraulic oil filter replaced at normal service intervals or replaced to verify filter is not restricted?

Yes: Go to next step.

No: Change hydraulic filter.

6. All hydraulic system checks normal?

No: Complaint not found and unable to duplicate complaint. Factory assistance for a dealer is available through the Dealer Technical Assistance Center (DTAC).

No: Perform all the steps in “Hydraulic Diagnostics” on page 346. Perform tests and adjustments to isolate and repair the malfunction.

Yes: Engine running preliminary checks completed.

Hydraulic System Tests

Test Conditions:

- Park brake engaged.
- Engine not running.

Hydraulics

1. Hydraulic/transmission dipstick has proper level, viscosity, type and condition per the preliminary hydraulic checks?

Yes: Go to next step.

No: Drain and replace fluid and filter.

2. Transmission drive shaft is turning hydrostatic transmission input shaft?

Yes: Go to next step.

No: Repair as necessary.

3. Constant, foam free flow from charge pump? Pump flow within specification? Pressure relief valve in specification?

Yes: Go to next step.

No: Perform “Charge Pump Pressure and Flow Test at Couplers” on page 351.

4. Steering is responsive and turns quickly full right and left?

Yes: Go to next step.

No: See the Steering section for steering system diagnosis.

5. Hydraulic control valve (deck lift): Lifts and holds deck and hitch in the raised position? Control lever returns to neutral?

Yes: Go to next step.

No: Perform “Control Valve Leakage Test” on page 354. Check linkage for binding. Repair or replace control valve.

6. Hydraulic cylinders lift and hold implement in a raised position? No leakage at rod seal or connectors?

Yes: Go to next step.

No: Perform “Lift Cylinder Leakage Test” on page 353. Replace cylinder.

7. Auxiliary couplers: Relief pressure within specification? Hydraulic flow within specification? Spool leakage within specification?

Yes: Go to next step.

No: Perform “Charge Pump Pressure and Flow Test at Couplers” on page 351 and/or perform “Control Valve Leakage Test” on page 354.

8. Hydrostatic transmission operates in forward and reverse? Returns to neutral and does not creep?

Yes: See the Power Train section for hydrostatic system diagnosis

No: Hydraulic checks completed.

Tests and Adjustments

Hydraulic Oil Warm-Up Procedure

Reason:

When making hydraulic tests the oil must be heated to normal operating temperature for the tests to be accurate.

Test Equipment:

- JDG282 Temperature Gauge

Procedure:

1. Install JDG282 Temperature Gauge on transmission oil filter.

Important: Avoid Damage! DO NOT overheat engine.

2. Apply park brake. Start engine and run at full throttle.
3. Move and hold hydraulic lever in implement raise position.
4. Periodically cycle all hydraulic functions to distribute heated oil.
5. Heat oil to operational temperature, **38 - 49° C (100 - 120° F)** typical.

Charge Pump Pressure and Flow Test at Couplers

Reason:

To check condition of the charge pump and the charge pressure relief valve setting (implement operation pressure). This determines if there is sufficient oil pressure and flow to operate implements.

Note: This test can be misleading if there is a malfunction of the steering valve, hydraulic control valve or lift cylinder.

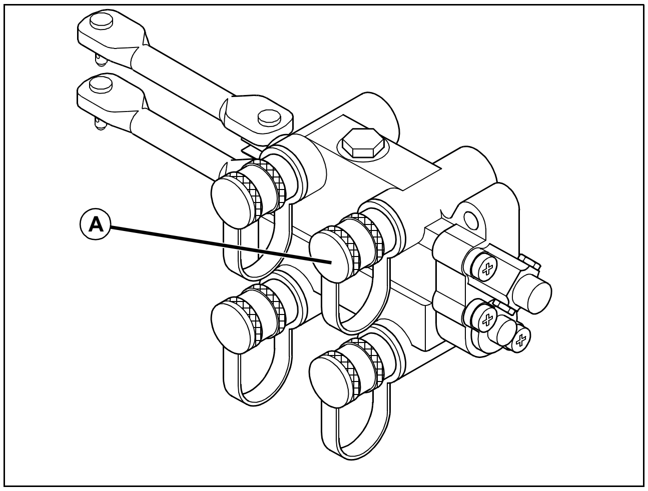
Pressure Test Equipment:

- AM102420 Quick Coupler
- JT031111 9/16-18 M x 7/16-20 M 37° Orb
- JT03017 Hose
- JT03117-13790 kPa (2000 psi) Pressure Gauge

Flow Test Equipment:

- JT01765 Consumer Products Hydraulic Fitting Kit
- JT05469 Flowmeter Kit
- AM102420 1/4 Male Quick-Coupler
- JT03216 Connector and 9/16-18 M 37° x 9/16-18 M Orb
- JT03342 Coupler and 3/4" F NPT x 9/16-18 F 37° Orb

Pressure Test:



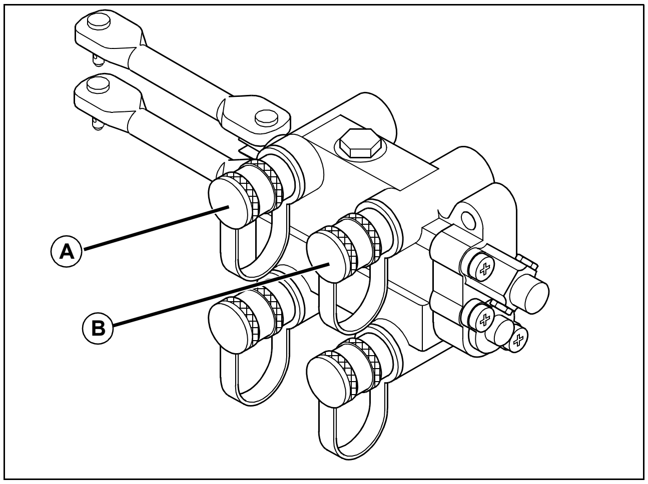
MIF

1. Locate hydraulic control valve on right side of machine frame. Install JT03117 pressure gauge into coupler (A).
2. Start and run engine at high idle.
3. Move the auxiliary hydraulic control lever to the raise or lower position.
4. Observe pressure gauge reading.

Results:

- If pressure is to charge relief (implement) pressure specifications, **6371 kPa (924 psi)** minimum, pump and charge pressure relief valve are in good condition.
- If there is no pressure, repeat test using different coupler. If pressure exists, replace coupler and repeat test.
- If pressure is below **5881 kPa (853 psi)**, See "Charge Pump Pressure Test" on page 352.

Flow Test:



MIF

1. Connect flowmeter to work ports (A and B).

Flow Test Procedure:

1. Open flowmeter control valve.

2. Start engine and run at high idle. Oil must be at normal operating temperature.

3. Move cylinder lift control lever to get oil flow through meter in correct direction.

4. Observe flowmeter reading.

Results:

- If pump flow is between minimum and rated flow specification, pump is in good condition.
- If there is no pump flow, check:
  - Drive shaft not turning input shaft
  - Sheared charge pump drive key
  - Charge pressure control valve stuck closed
- If pump flow is below minimum flow specification, foamy or erratic, check:
  - Hydraulic oil level
  - Charge pressure
  - Filter, replace and repeat test
  - Transaxle vent for plugging
  - Filter seal for leaks
  - Charge pressure relief valve for damage or debris that could be holding valve open
  - Charge pressure control valve for scoring or debris that could be holding valve closed
- If pump flow is still below minimum flow specification, check:
  - O-ring at inlet of charge pump leaking
  - Leak in case passage between filter and charge pump
- If problem cannot be found, perform flow and pressure test at charge pump to eliminate the possibility of the steering valve or hydraulic control valve malfunctioning, giving false test results. See the Hydrostatic Power Train section.
- Check charge pump for damage.

Charge Pump (Two-Wheel Drive):

Rated Flow . . . . 17 L/m (4.5 gpm)
Minimum Flow. . . . . 13 L/m (3.4 gpm) @ 3200 rpm

Charge Pump (All-Wheel Drive):

Rated Flow . . . . 22.7 L/m (6.0 gpm)
Minimum Flow. . . . . 17 L/m (4.5 gpm) @ 3200 rpm

Charge Pump Pressure Test

Reason:

To determine charge pressure control valve operation and help determine condition of hydraulic charge pump. This also checks charge pump pressure relief valve operation and determines if there is sufficient pressure to operate implements.

Test Equipment:

- JT05489 Connector, 7/16-20 x M 37° 1/2-20 M ORB
- JT03017 Hose
- JT03117-13790 kPa (2000 psi) Pressure Gauge

Pressure Test Procedure:

Warm hydraulic oil to operating temperature before performing this test. When done “cold” or at shop temperature, most machines (especially when new) will likely be close to **3450 kPa (500 psi)**. See “Hydraulic Oil Warm-Up Procedure” on page 351.

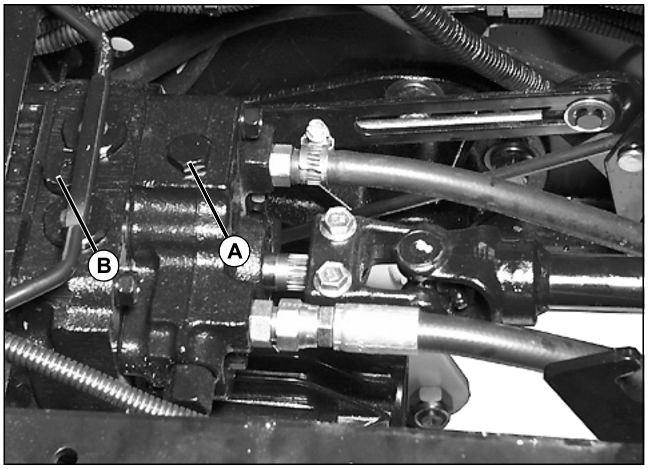
1. Park machine safely. See “Park Machine Safely” in the Safety section.

2. Remove seat and fender deck.

3. Attach seat switch and set up machine so engine can be run.

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

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



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4. Install connector, hose and pressure gauge to charge pressure test port (A).

5. Start engine and run at high idle. Do not operate steering or hydraulic control valves.

6. Observe gauge reading. This is charge pressure.

7. Move hydraulic control lever to raise or lower position. Hold until pump pressure is in relief.

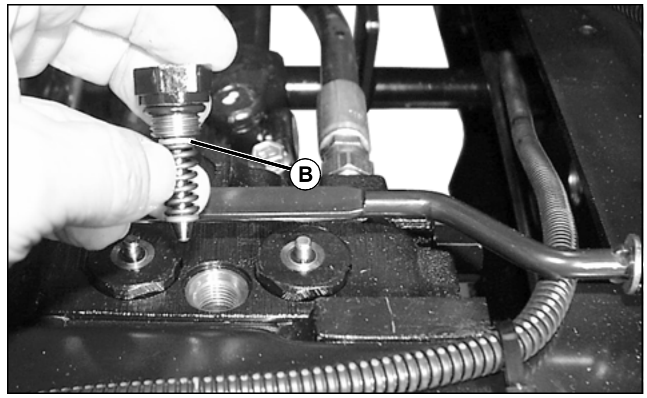
8. Observe gauge reading and release control. This is charge pressure relief pressure (implement operation pressure).

Specifications:

Charge Pressure (minimum) . . . . 1958 kPa (284 psi)
Charge Relief (Implement) Pressure (minimum)
. . . . . 6371 kPa (924 psi)

Results:

- If charge pressure is to specifications, **1958 kPa (284 psi) minimum**, in transaxle, charge pressure control valve is operating properly.
  - Note: Charge pressure gauge reading may be higher than specification due to cold oil temperature. Warm oil and retest.
- If charge pressure is too high, and oil is at operating temperature, there is a potential problem with the charge pressure control valve, or a restriction in the system. See “Charge Pump Flow and Pressure Test - At Charge Pump” in the Hydraulic Power Train section.”
- If relief pressure is to charge relief (implement) pressure specifications, **6371 kPa (924 psi)** minimum, pump and charge pressure relief valve are in good condition.



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- If relief pressure is below **5881 kPa (853 psi)**, check charge pressure relief valve (B), shim relief pressure spring. If pressure cannot be increased, check charge pump for damage.

Lift Cylinder Leakage Test

Reason:

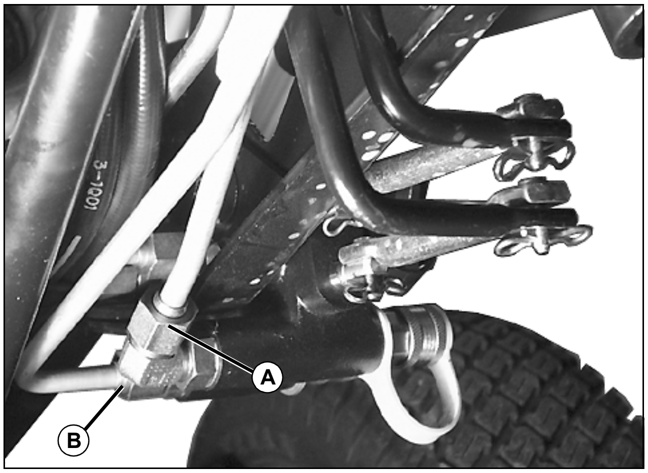
To determine if lift cylinder is leaking.

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

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

First Procedure:

1. Remove any attachment that is mounted, including mower deck.
2. With deck lift arms in raised position, shut off engine.



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3. Disconnect lift cylinder rod-end line (A) from control valve.

Important: Avoid Damage! Hold control lever in the raised position before starting engine. Also be ready to shut off engine. If valve leaks, oil will flow out open port.

4. Move hydraulic control valve lever to "lift" position.

5. Start engine. Operate at slow idle.

6. Observe cylinder rod-end line (A) for continuous oil leakage.

Results:

- If hydraulic oil continually leaks out of fitting, replace lift cylinder.
- If no leakage, go to Second Procedure.

Second Procedure:

1. Shut off engine and connect line (B).
2. Start engine and lower (retract) cylinder.
3. Shut off engine. Remove line (B).
4. Hold control lever in the lower position.
5. Start engine and observe flow from line.

Results:

- No leakage, cylinder is good.
- Leakage, replace cylinder.

Control Valve Leakage Test

Reason:

To determine the condition of spool valves and housing.

Test Equipment:

- Measuring tape or ruler

Mower Deck Lift Spool Procedure:

1. Heat hydraulic oil to specifications. See “Hydraulic Oil Warm-Up Procedure” on page 351.
2. Make sure mower deck is properly installed.
3. Make sure that mower deck lift stop is at 1.0 inch (lowest) cut height position.
4. Move lift cylinder to maximum raise position (pull top lever fully back).
5. Shut off engine.
6. Measure height from level ground to mower deck attaching pin (the pin engaged in “V” slot at the end of the lift arms).
7. Wait approximately 12 minutes.
8. Measure pin height again.

Results:

- Mower deck should drop no more than 25 mm (1.0 in.) in 12 minutes.

Front Quick Hitch Lift Cylinder Procedure:

1. Heat hydraulic oil to specifications. See “Hydraulic Oil Warm-Up Procedure” on page 351.
2. Make sure front hitch is properly installed.
3. Whatever front implement is on machine (blade, broom, snowblower, etc.) can remain mounted.
4. Move hitch lift cylinder to maximum raise position (pull bottom lever fully back).
5. Shut off engine.
6. Measure height from level ground to quick pull pin at the front/top of the quick hitch.
7. Wait approximately 7 minutes.
8. Measure pin height again.

Results:

- Attachment should drop no more than 25 mm (1.0 in.) in 7 minutes.

Repair

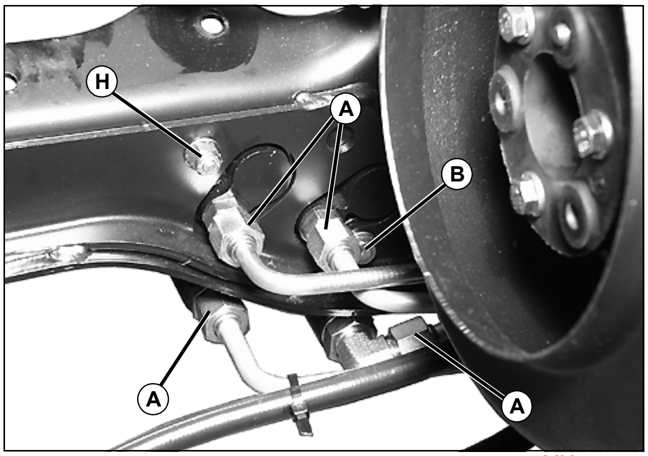
Lift Cylinder Removal and Installation

See "Lift Linkage Removal and Installation" on page 464.

Hydraulic Control Valve Removal and Installation

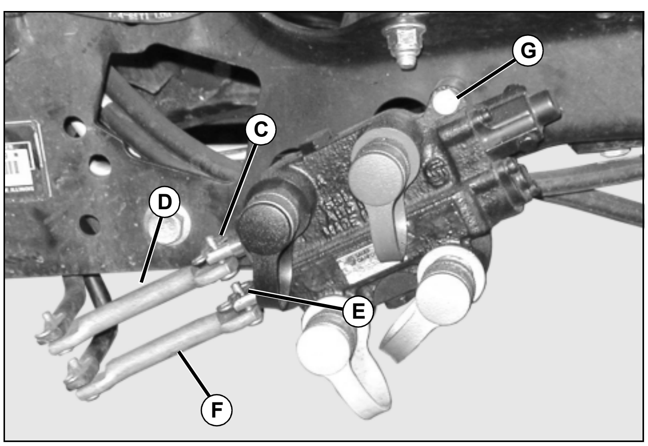
Removing:

1. Remove hood.



Picture Note: NOTE: Engine removed in photo for clarity.

2. Remove hydraulic lines at fittings (A).
3. Remove bolt (B) connecting lower half of control valve to frame.



4. Remove spring pin (C) from control arm (D).
5. Remove spring pin (E) from control arm (F).
6. Remove (G) bolt and nut (H) connecting upper half of control valve to frame.
7. Remove and make repairs to valve as necessary. See "Hydraulic Control Valve" on page 355.

Installing:

Installation is done in the reverse order of removal.

Important: Avoid Damage! Do not overtighten valve mounting bolts, valve spools may stick.

- Tighten mounting bolt (B), and lock nut (H) to mounting bolt (G), to specification.
- Tighten hydraulic line fittings (A) to specification.
- Install lower control arm (F) and hardware before installing upper control arm (D) and hardware onto valve assembly.

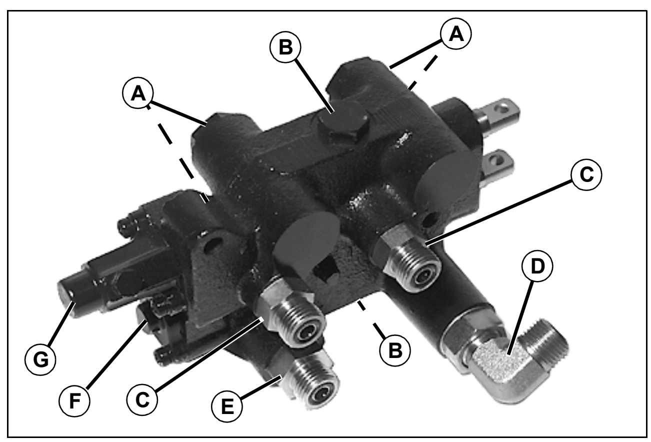
Specifications:

Control Valve Mount Cap Screw 11 - 16 N•m (8 - 12 lb-ft)
Hydraulic Lines . . . . 4 - 30 N•m (18 - 22 lb-ft)

Hydraulic Control Valve

Disassembly:

Important: Avoid Damage! Always use new O-rings. Damaged or used O-rings will leak.



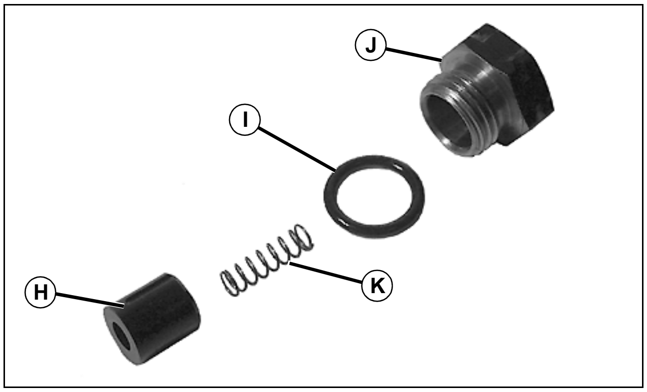
1. Remove two load check valves (B) and O-rings.
2. Remove two small straight fittings (C) with O-rings.
3. Remove one large straight fitting (E) with O-ring.
4. Remove 90° fitting (D) with O-ring.
5. Remove couplers (A) with O-rings.
6. Remove up/down float spool assembly (G).
7. Remove up/down spool assembly (F).

Installation is done in the reverse order of removal.

- Install and tighten 90° fitting (D) to specification.

- Install and tighten small straight fittings (C) to specification.
- Install and tighten large straight fitting (E) to specification.
- Install and tighten couplers to specification.

Load Check Valve:



MX11931

1. Disassemble check valve assembly, which includes a cap (J), O-rings (I), spring (K), and check valve poppet (H).

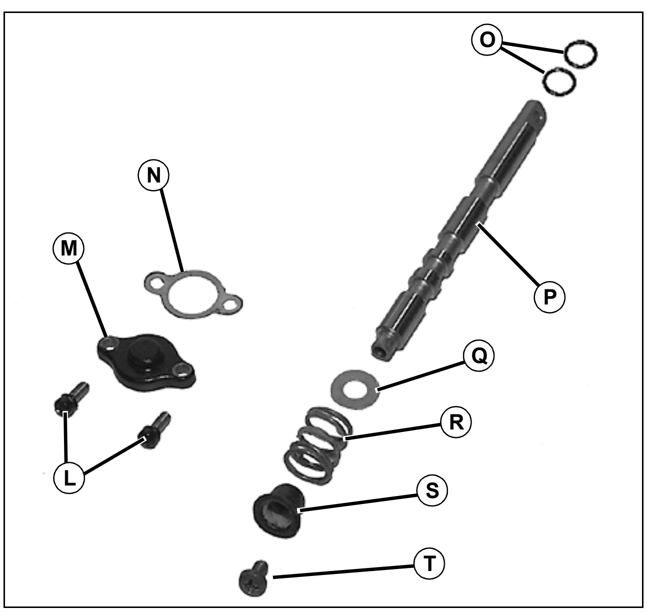
Installation is done in the reverse order of removal.

- Tighten cap to specification.

Note: The quick-coupler assembly is serviced as a separate assembly and is replaced as a kit only.

Up/Down Spool Assembly:

Important: Avoid Damage! Always use new O-rings. Damaged or used O-rings will leak.



MX11932

1. Disassemble up/down float spool assembly.

Note: O-rings (O) are located in spool bore at each end of control valve. The O-rings are serviced as a separate assembly and replaced as a kit only. The remaining parts (gasket (N), end cap (M), spring (R), spring retainer (S), and screw (T), except the spool (P) and washers (Q), are serviced as a separate assembly and are replaced as kits only.

Installation is done in the reverse order of removal.

- Tighten screws (L and T) to specification.

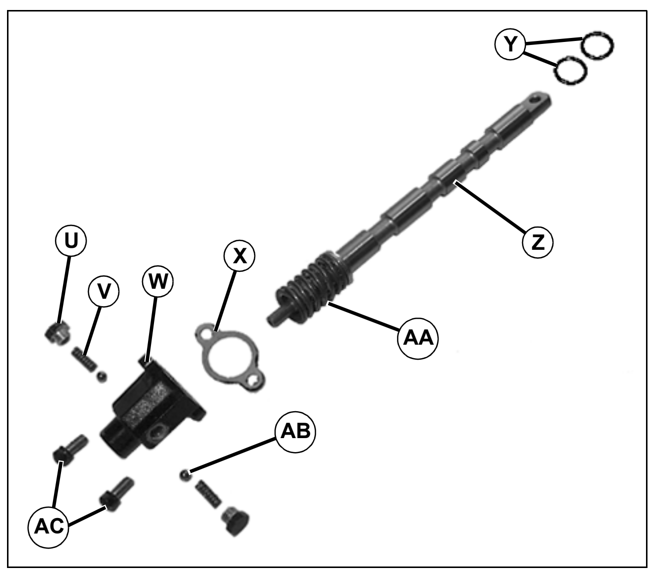
Up/Down Float Spool Assembly:

Important: Avoid Damage! Spool and housing are matched and must be replaced as an assembly. Make sure spool is installed in original bore to ensure proper operation. Always use new O-rings. Damaged or used O-rings will leak.

1. Apply thread lock and sealer (medium strength) to threads of screws.

Note: O-rings are located in spool bore at each end of control valve. The O-rings (Y) are serviced as a separate assembly and replaced as a kit only. The steel ball is serviced and the end cap is serviced. The remaining parts, except the spool (Z), end cap (W) and steel ball (AB), are serviced as a separate assembly and are replaced as kits only.

2. Apply multi-purpose grease to spring (AA) after installed on spool.



MX11933

3. Apply thread lock and sealer (medium strength) to threads of screws (AC) and two detent plugs (U).
4. Apply multi-purpose grease to two springs (V) and balls (AB).

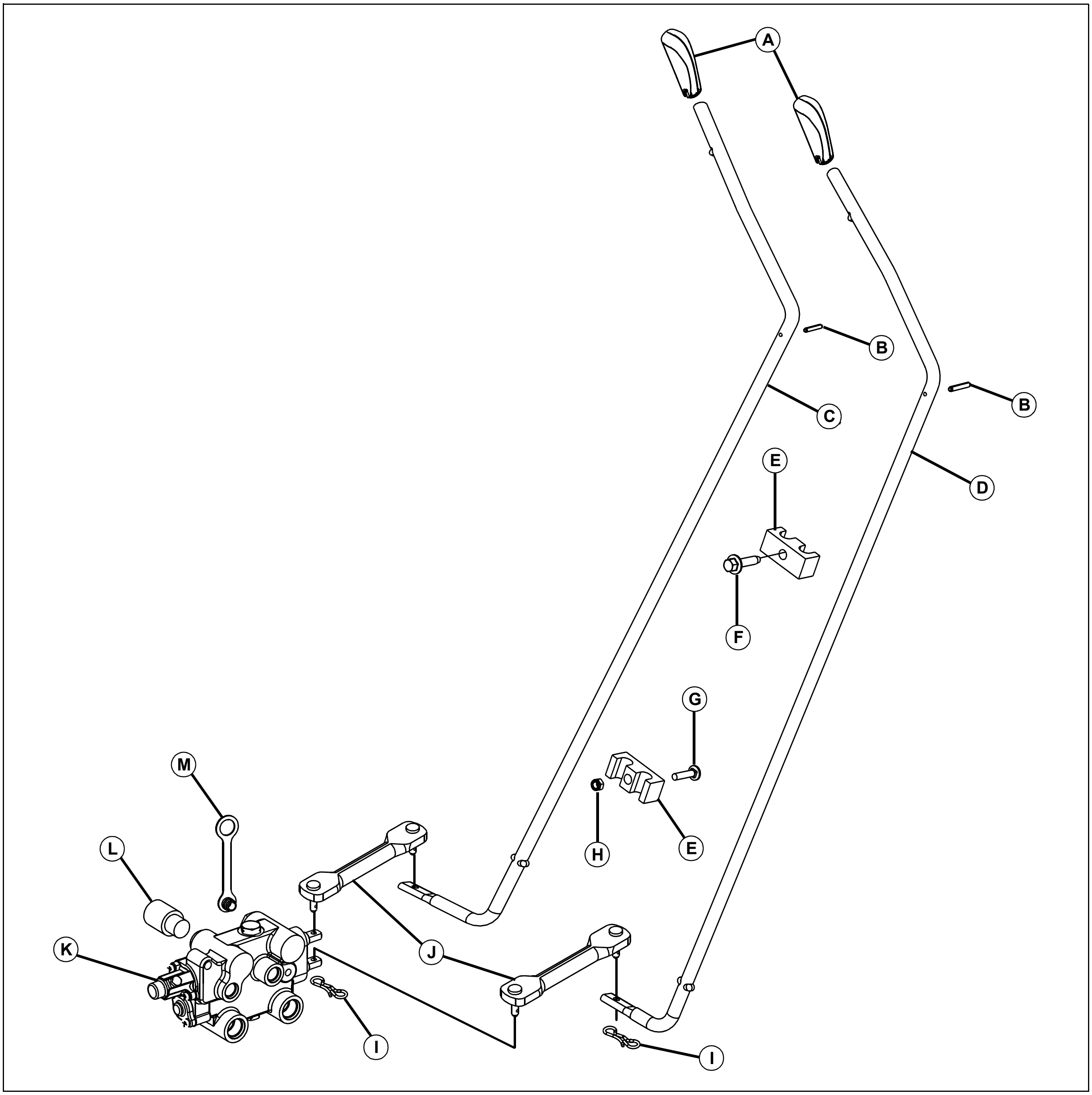
Installation is done in the reverse order of removal.

- Tighten detent ball retaining screws and detent plugs to specification.

Specifications:

90° Fitting	**33 - 49 N•m (24 - 36 lb-ft)**
Small Straight Fitting	**24 - 30 N•m (18 - 22 lb-ft)**
Large Straight Fitting	**33 - 49 N•m (24 - 36 lb-ft)**
Quick Couplers	**33 - 49 N•m (24 - 36 lb-ft)**
Load Check Valve Cap	**24 N•m (18 lb-ft)**
Spool Assembly Screws	**4 N•m (36 lb-in.)**

Hydraulic Control Levers and Linkage



MIF

Picture Note: Viewed from frame side of valve

A- Knob
B- Spring Pin
C- Lift Control Valve Lever
D- Auxiliary Control Valve Lever
E- Pivot
F- Screw
G- Carriage Bolt
H- Lock Nut
I- Spring Locking Pin
J- Link
K- Spool Valve
L- Quick Coupler
M- Dust Cap

1. Remove instrument panel to access control levers. See “Instrument Panel Removal and Installation” on page 463.
2. Inspect linkage for bent or damage parts.
3. Repair or replace.

Table of Contents

STEERING SPECIFICATIONS

Specifications

General Specifications

Type . . . . . Power
Tilt Wheel. . . . . Standard

Test and Adjustment Specifications

Steering System Leakage:

Oil Temperature (Typical). . . . . 43°C (110°F)
Engine Speed . . . . . Fast Idle
Maximum Turns with Constant Torque of 6.8 N•m (60 lb-in.) in Either Direction . . . . . 4 rpm
Charge Pressure Control Valve (minimum) . . . . . 1958 kPa (284 psi)
Steering Valve System Pressure (minimum) . . . . . 6371 kPa (924 psi)

Toe-In Adjustment:

Front Tires. . . . . 1 - 6 mm (0.04 - 0.24 in.)
Rear Tires (All Wheel Steer): Front-to-back difference from frame for each tire . . . . . 0 - 10 mm (0 - 0.4 in.)

Repair Specifications

Hydraulic Line to Steering Valve Retainer Plate Cap Screws. . . . . 30 N•m (22 lb-ft)
Steering Valve Mounting Cap Screws . . . . . 17 N•m (150 lb-in.)
Steering Wheel Nut. . . . . 38 N•m (28 lb-ft)
Steering Valve End Cover Cap Screw. . . . . 17 N•m (150 lb-in.)
Check Ball Plug . . . . . 17 N•m (150 lb-in.)
Front Axle Pivot Cap Screw and Lock Nut. . . . . 203 N•m (150 lb-ft)
Tie Rod Lock Nut . . . . . 61 N•m (45 lb-ft)
Rear Steering Link Lock Nut . . . . . 170 N•m (125 lb-ft)
Adjusting Nut Jam Nuts. . . . . 68 N•m (50 lb-ft)
Rear Steering Side Pivots Pivot Lock Nut . . . . . 108 N•m (80 lb-ft)
Rear Axle Pivot Bracket Cap Screws . . . . . 91 N•m (67 lb-ft)
2WD Pivot Nut. . . . . 200 ± 40 N•m (147.5 ± 29.5 lb-ft)
4WD Pivot Nut. . . . . 367 ± 73 N•m (271 ± 53.8 lb-ft)
2WD Steering Cylinder Nuts . . . . . 51.5 ± 6.8 N•m (38 ± 5 lb-ft)
4WD Steering Cylinder Nuts . . . . . 54.2 ± 9.5 N•m (40 ± 7 lb-ft)

Special or Essential Tools

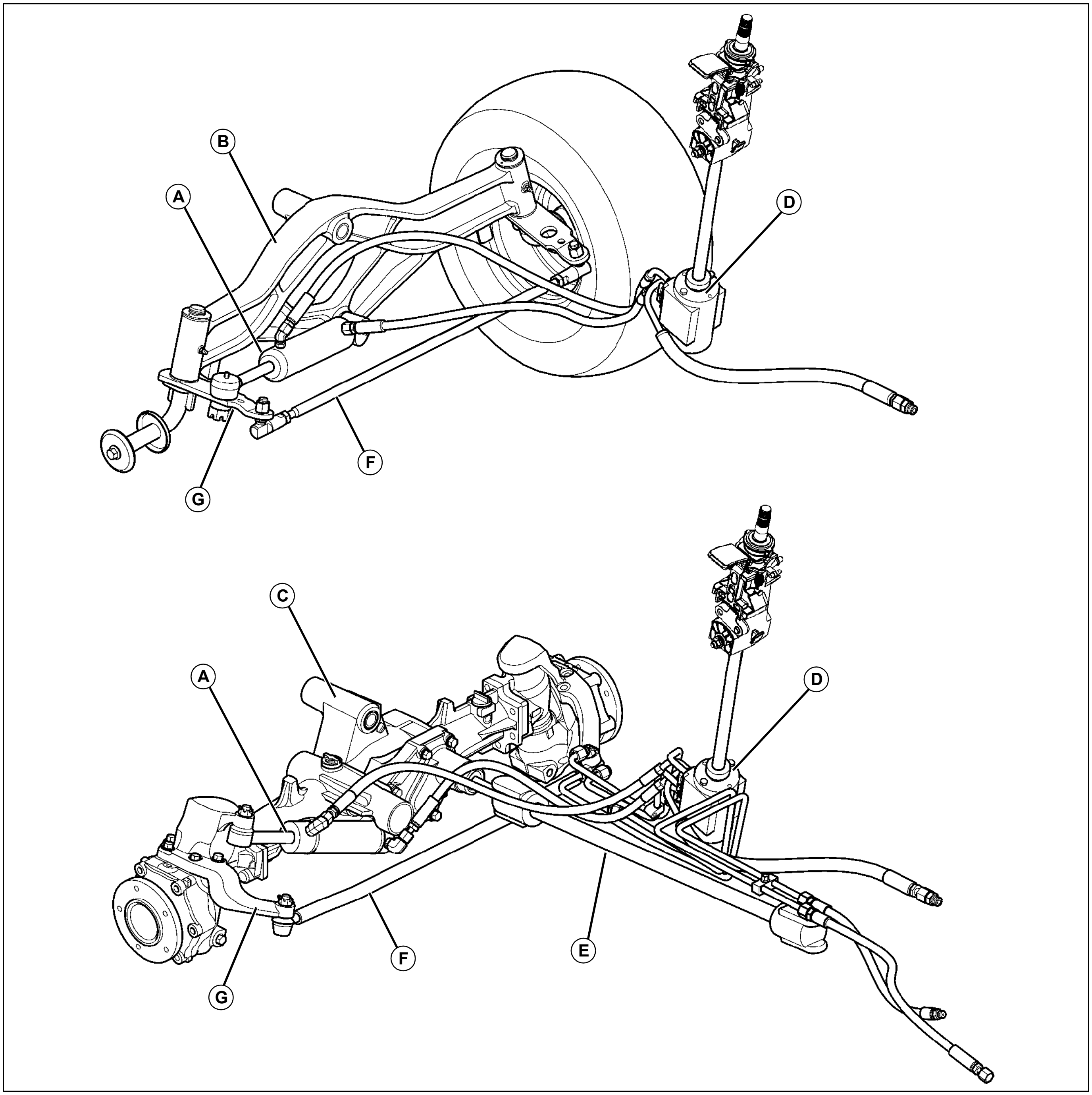
Note: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

Special or Required Tools

Tool Name	Tool No.	Tool Use
Bushing, Bearing and Seal Driver Set		Used to install seals and bushings.

Component Location

Steering Components - Front Wheel Steer



MX35904

A- Steering Cylinder

B- Front Axle (Rear Wheel Drive)

C- Front Axle (All Wheel Steering)

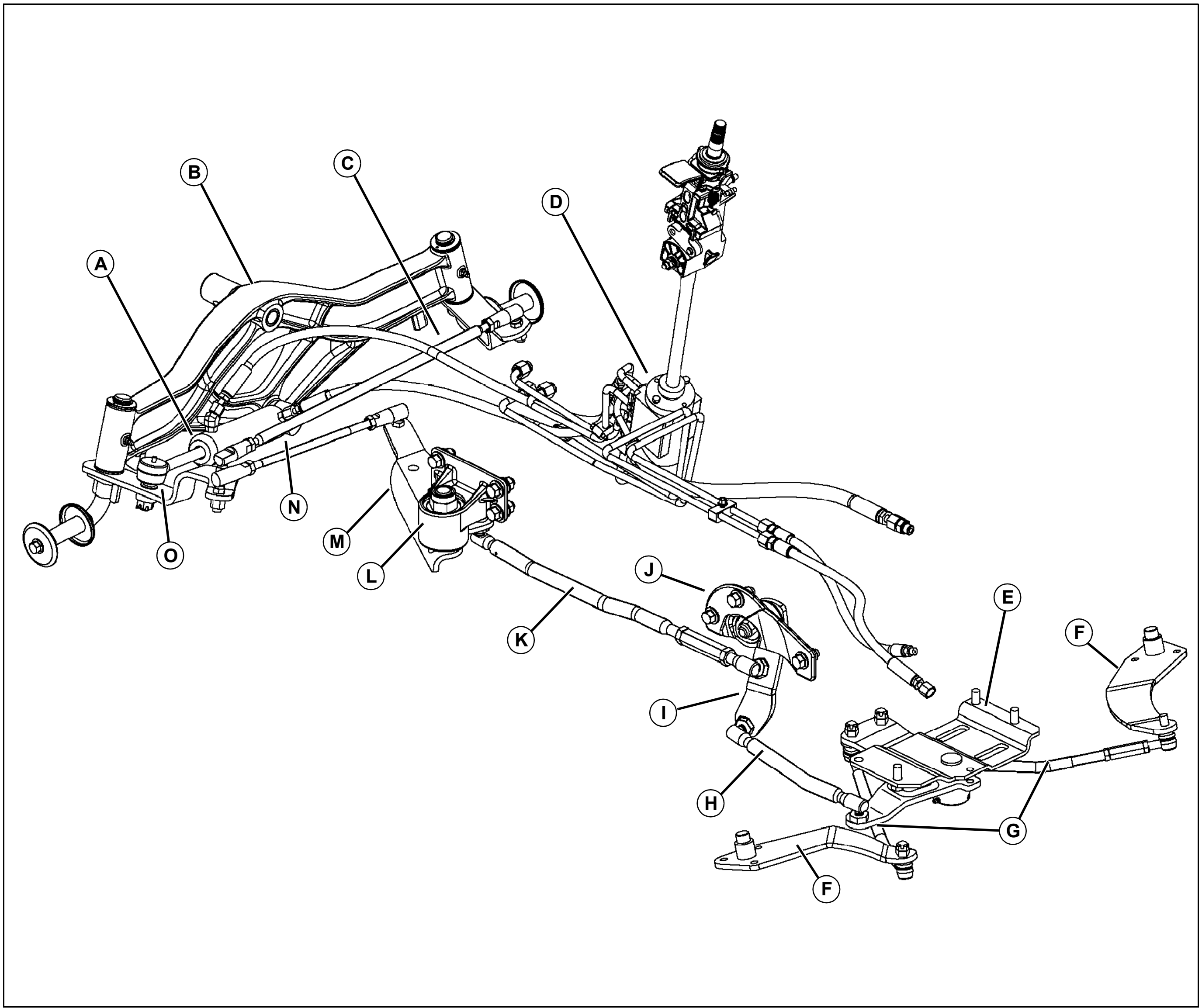
D- Steering Control Unit (SCU)

E- MFWD Drive Shaft

F- Tie Rod

G- Steering Arm

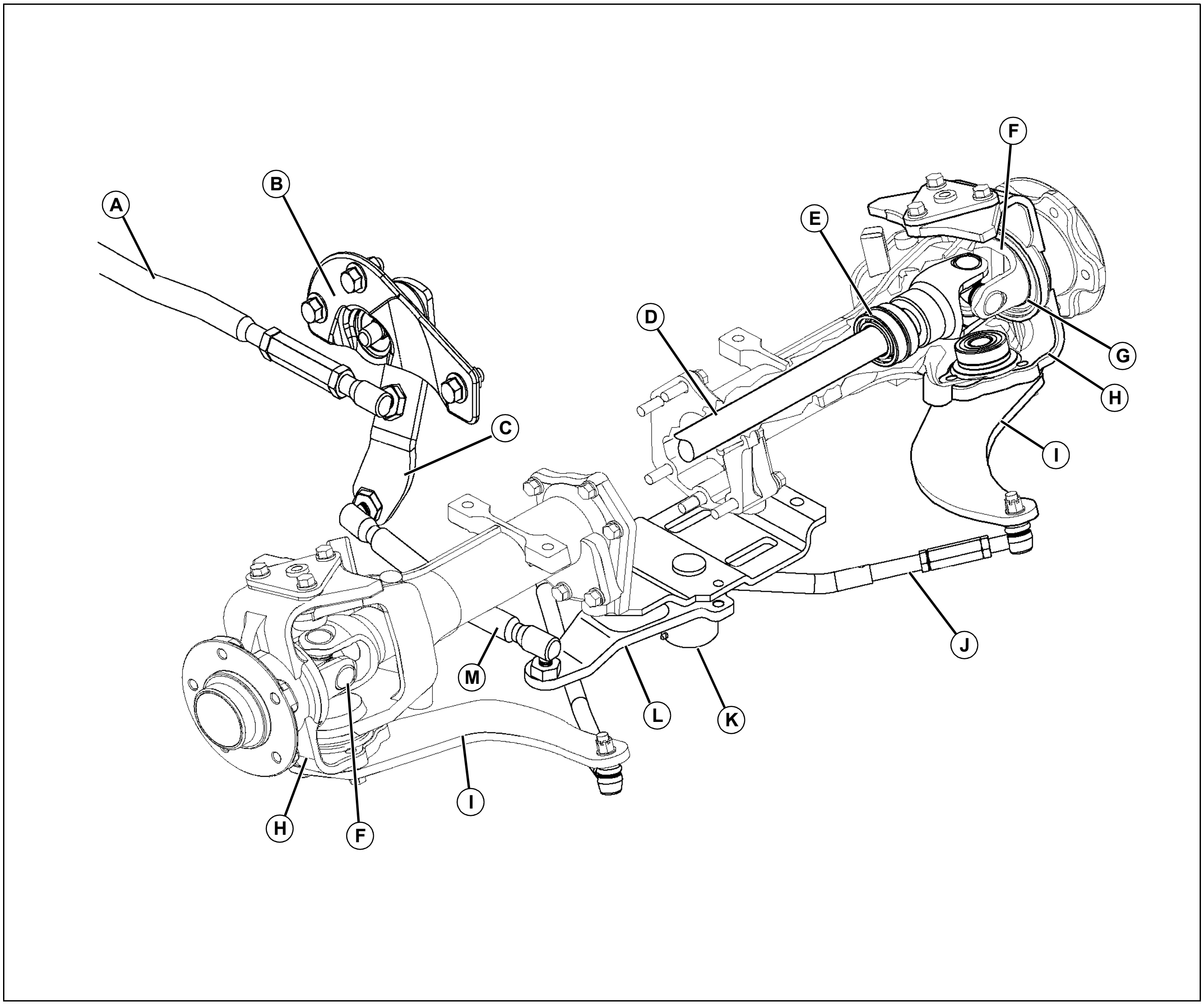
Steering Components - All Wheel Steer



MX35905

A- Steering Cylinder
B- Front Axle (2 Wheel Drive Only on AWS)
C- Tie Rod
D- Steering Control Unit (SCU)
E- Rear Tie Rod Pivot
F- Rear Wheel Steering Arm
G- Tie Rod (2)
H- Link Rod, Rear
I- Pivot Arm
J- Bearing Housing
K- Link Rod, Middle
L- Bearing Housing
M- Steering Arm, Front
N- Link Rod, Front
O- Steering Arm

Steering Components - All Wheel Steer Rear Axle



MX14233

A- Link Rod, Middle
B- Bearing Housing
C- Pivot Arm
D- Axle Shaft
E- Ball Bearing
F- Drive Shaft, U-Joint
G- Ball Bearing
H- Case, Wheel Bearing
I- Steering Arm
J- Tie Rod (2)
K- Cap, Pivot
L- Pivot Plate
M- Link Rod, Rear

Theory of Operation

Steering System Operation

Function:

Offer hydraulic all wheel power steering for ease of operation.

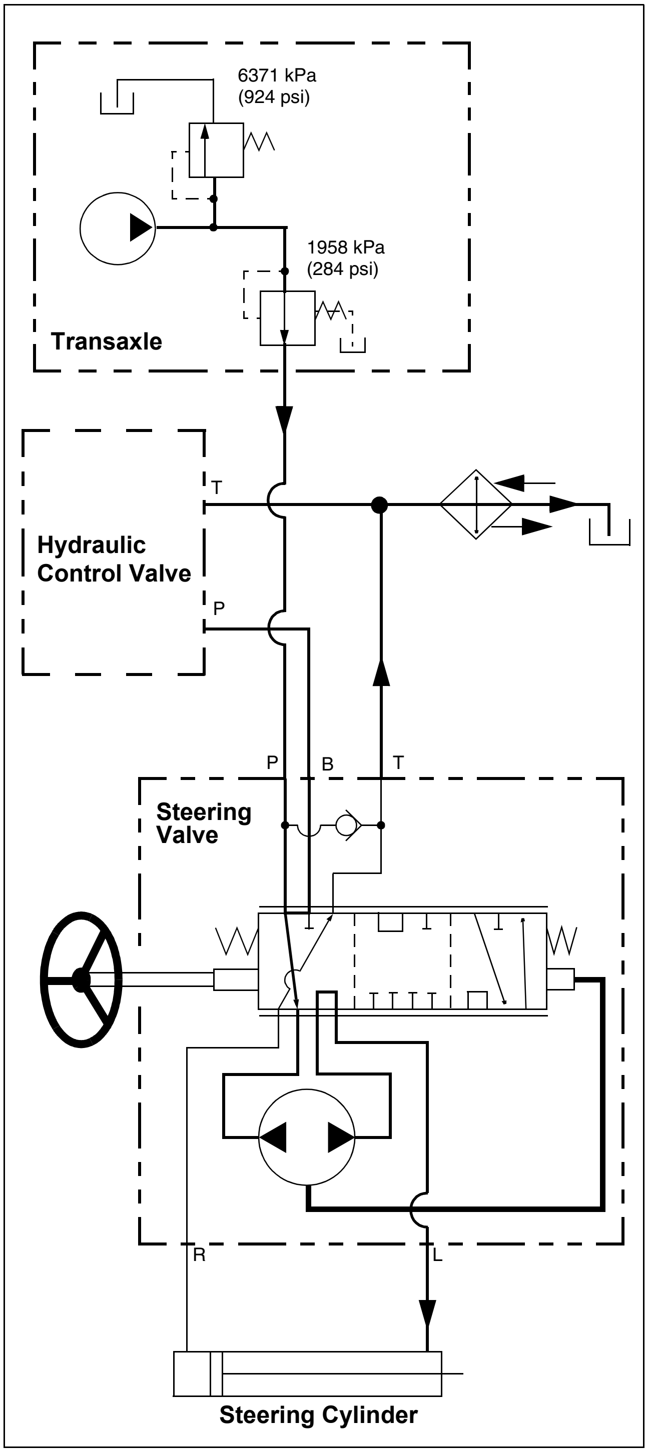
System Operation:

Pressure oil is supplied by the charge pump of the hydrostatic transmission to the inlet port of the steering valve. When the steering wheel is not turned, the oil flows directly through the valve and out to the hydraulic control valve. When the steering wheel is turned to make a left turn, the pressure oil is routed through the steering valve and out the left turn port.

The oil then flows down left turn line to the rod end of the steering cylinder. The cylinder rod is pushed out, rotating the front steering arm to the right which pulls the left tie rod and spindle and pushes the right tie rod and spindle. This turns the front wheels to the left. The return oil from the head end of the cylinder is routed through right turn line to the right turn port of the steering valve. The oil is routed through the valve to the return port.

On all wheel steer machines, linkage connects the front steering arm to the rear pivot, which allows the front and rear sets of wheels to pivot in opposite directions. When the front steering arm is rotated counterclockwise, the front link rod is pushed to the right which rotates the front steering arm clockwise. This moves the middle link rod, rear pivot arm, and rear link rod rearward. The rear pivot is rotated counterclockwise, which pushes the left rear tie rod, rear steering arm, rear spindle housing, and rear spindle hub and pulls the right side link. This turns the rear wheels to the right. With the front wheels turned to the left and the rear wheels turned to the right, a short turning radius is accomplished.

When the steering wheel is turned to make a right turn, the pressure oil is routed the opposite way through the valve. The oil comes out the right port of the valve to the head end of the cylinder. The cylinder rod is pushed out and the front pivot plate rotates the opposite way. The return oil flows through the lines to the left port of the valve and out the return port.

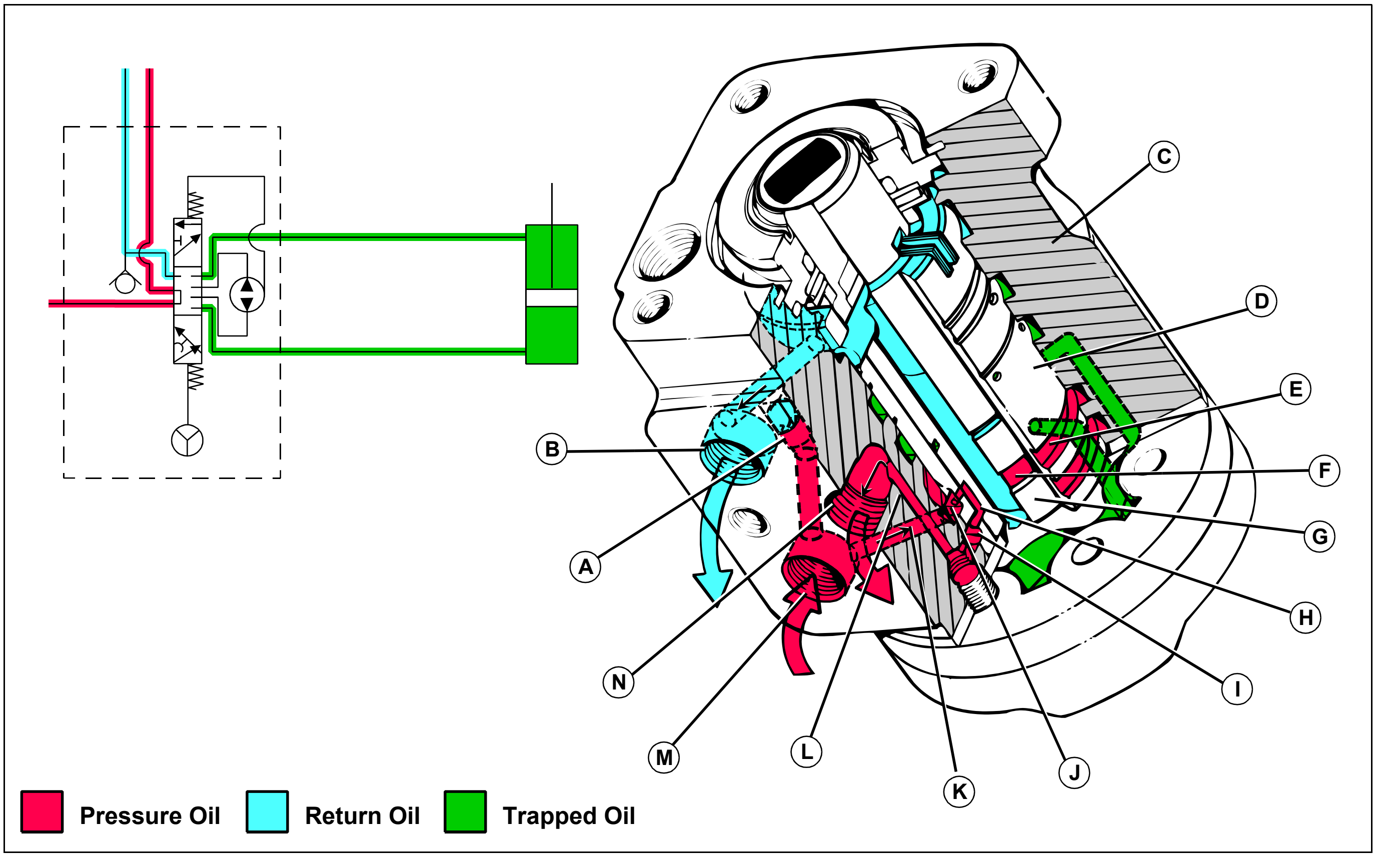


Picture Note: Left Turn Shown

The steering valve is designed to allow manual steering if the engine is not running or if there is a failure of the hydraulic pump.

The tilt steering assembly allows the steering wheel to be adjusted for operator comfort. A spring loaded rod locks the steering column in different positions.

Steering Valve Operation - Neutral



MIF

A- Check Valve
B- Return Port
C- Valve Body
D- Sleeve
E- Sleeve Inlet Groove
F- Spool Inlet
G- Spool
H- Power Beyond Slot
I- Power Beyond Groove
J- Feed Holes
K- Inlet Passage
L- Power Beyond Passage
M- Inlet Port
N- Power Beyond Port

Function:

Controls oil flow to and from the steering cylinder. In neutral, the steering valve blocks oil flow to the cylinder, holding the wheels in a fixed position and allows oil to flow to the hydraulic system.

System Operation:

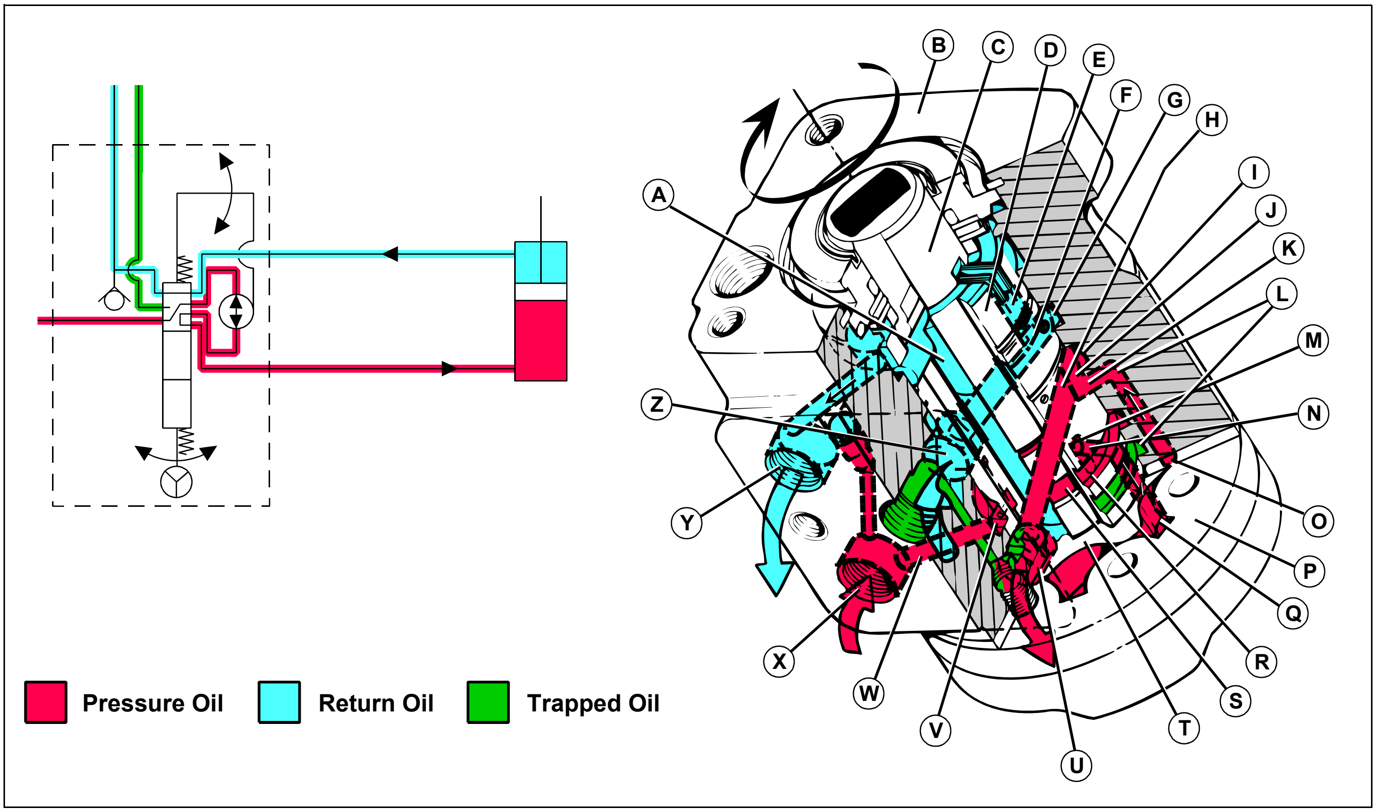
The steering valve is an open center type valve. This valve consists of a self-centering fluid control valve (spool and sleeve) and a metering pump. The valve and pump are hydraulically and mechanically interconnected inside the valve.

Pressure oil comes into the steering valve body at the inlet port. The oil then flows through inlet passage to a series of grooves, passages, and slots in the valve body, sleeve, and spool to come out the power beyond passage and power beyond port to go on to the lift system. The amount of oil that flows this way varies with the speed of the turn. All the oil will follow this path when the steering valve is in neutral. There will be some oil when a slow turn is made, and there will be less oil when a fast turn is made. No oil is available to the power beyond port when the steering is dead headed.

When the valve is in neutral, the turn passages are closed. The oil in the steering cylinder and lines is trapped oil. The small amount of internal leakage oil will go out the return port as return oil back to the sump.

Charge oil enters the steering valve at normal charge pressure of **1958 kPa (284 psi)** minimum, passes through the open center valve, then the oil cooler to return to sump. If the steering wheel is turned, oil restriction occurs, and the charge pressure increases. The charge pressure relief valve will open when the hydraulic pressure reaches **6371 kPa (924 psi)** and pass excess oil to the sump.

Steering Valve Operation - Turning



MIF

A- Center of Spool
B- Valve Body
C- Spool
D- Sleeve
E- Spool Left Turn Slot
F- Left Turn Passage
G- Left Turn Groove
H- Right Turn Passage
I- Right Turn Groove
J- Spool Outlet Slot
K- Sleeve Outlet Holes
L- Valve Body Passages
M- Spool Right Turn Slot
N- Sleeve Inlet Holes
O- Gerotor Cavity (Reducing Volume)
P- Gerotor Body
Q- Gerotor Cavity (Enlarging Volume)
R- Sleeve Inlet Groove
S- Spool Inlet Groove
T- Gerotor Gear
U- Right Turn Port
V- Feed Holes
W- Inlet Passage
X- Inlet Port
Y- Return Port
Z- Left Turn Port

Function:

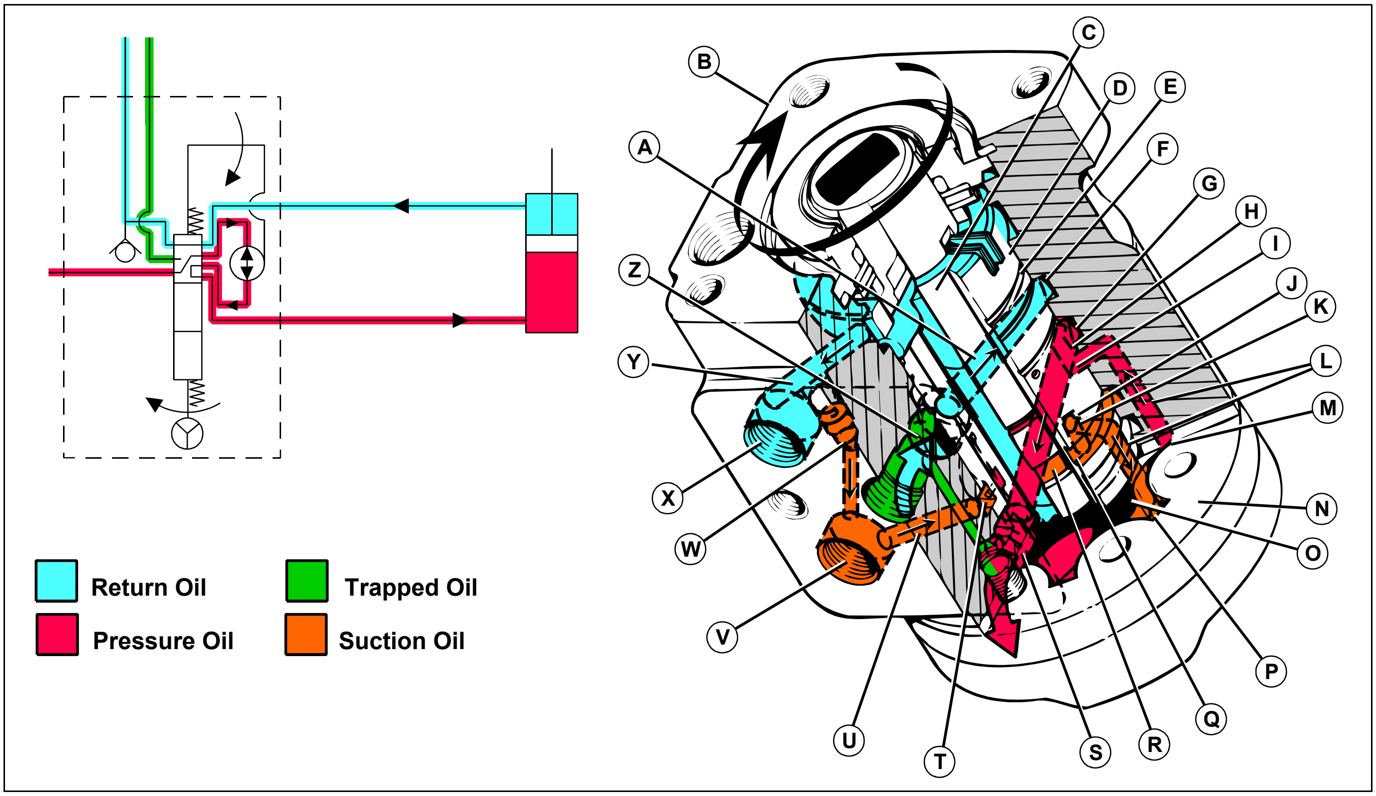
Controls pressure oil flow to the proper end of the steering cylinder to turn the front wheels.

System Operation:

Pressure oil comes into the steering valve body at the inlet port. The oil then flows through inlet passage to a series of grooves, holes, slots, and passages to the gerotor. The steering wheel is turning which turns the gerotor gear in the gerotor body so that some of the cavities are enlarging in volume and the oil fills them. At the same time, some of the gerotor cavities are reducing in volume which feeds the pressure oil out to another series of passages, grooves, slots and holes. They provide a path to one of the steering ports (in this drawing the right turn port) and on to the steering cylinder. The gerotor controls the rate at which oil flows to the steering cylinder. The return oil coming back from the steering cylinder is routed into the other steering port (in this case, left turn) to the center of the spool. From the center of the spool the oil goes out the return port back to sump.

Smooth turning is insured by the design of the gerotor. Its geometry causes it to fill and empty its cavities 6 times as fast as the steering wheel is being turned.

Steering Valve Operation - Manual



MIF

A- Left Turn Passage
B- Valve Body
C- Spool
D- Sleeve
E- Spool Left Turn Slot
F- Left Turn Groove
G- Right Turn Groove
H- Spool Outlet Slot
I- Sleeve Outlet Holes
J- Spool Right Turn Slot
K- Sleeve Inlet Holes
L- Valve Body Passages
M- Gerotor Cavity (Reducing Volume)
N- Gerotor Body
O- Gerotor Gear
P- Gerotor Cavity (Enlarging Volume)
Q- Sleeve Inlet Groove
R- Spool Inlet Groove
S- Right Turn Port
T- Inlet Holes
U- Inlet Passage
V- Inlet Port
W- Check Valve
X- Return Port
Y- Return Passage
Z- Left Turn Port

Function:

Provides manual steer operation to make a left or right turn if hydraulic oil pressure and flow is not available.

System Operation:

When the hydraulic system is not operating, engine not running or hydraulic pump failure, it is still possible to steer the machine. The gerotor must create the pressure and flow necessary to move the steering cylinder as the steering wheel is being turned. As some of the gerotor cavities reduce in volume, pressure oil is forced out of the cavities through a series of passages, holes, grooves, and slots in the valve body, sleeve, and spool to one of the steering ports (in this drawing right turn). The pressure oil is then routed to the steering cylinder. The return oil from the steering cylinder returns in the other port (in this case the left turn port) through another series of passages, grooves, slots, and holes to the center of the spool. From the center of the spool the oil is routed to the return port. The return port is connected to the inlet port through the check valve. The check valve allows the oil from return port to be drawn back into the system. This suction oil is routed through the valve body, sleeve, and spool to gerotor cavities that are enlarging in volume. As the steering wheel is turned the enlarging volume cavities become the reducing volume cavities and the oil is transferred.

Diagnostics

Steering Diagnosis

Symptom: Steering Noise or Vibration

Problem	Cause - Solution
1. Steering shimmy or vibration?	a. No: Go to next step.
	b. Yes: Front axle spindles or front pivot plate binding; not lubricated. Front steering arm, rear pivot arm, or middle link rod binding. Front tie rods bent, loose, or toe-in not correct. Rear tie rods bent, loose, or toe-in not correct. Link rods bent, loose, or adjusted incorrectly.
2. Noise during turning?	a. No: For additional procedures go to "Steering System Tests" on page 370.
	b. Yes: Steering cylinder has external or internal oil leakage. Steering cylinder lines restricted or leaking. Return lines to transmission and oil cooler restricted or leaking. Front axle spindles or front pivot plate binding; not lubricated. Rear spindle housing and rear pivot plate binding; not lubricated.

Symptom: Steering Function Problems

Problem	Cause - Solution
1. Steers hard or no steering in BOTH directions?	a. No: Go to next step.
	b. Yes: Charge pressure relief valve not opening within specification. Steering cylinder has external or internal oil leakage. Steering valve has external or internal oil leakage. Steering cylinder lines restricted or leaking. Return lines to transmission and oil cooler restricted or leaking. Front axle spindles or front pivot plate binding; not lubricated. Rear spindle housing and rear pivot plate binding; not lubricated. Front steering arm, rear pivot arm, or middle link rod binding. Front tie rods bent, loose, or toe-in not correct. Rear tie rods bent, loose, or toe-in not correct. Link rods bent, loose, or adjusted incorrectly.
2. Steers hard or no steering in ONE direction?	a. No: Go to next step.
	b. Yes: Steering cylinder has external or internal oil leakage. Steering valve has external or internal oil leakage. Steering cylinder lines restricted or leaking. Front axle spindles or front pivot plate binding; not lubricated. Rear spindle housing and rear pivot plate binding; not lubricated. Front steering arm, rear pivot arm, or middle link rod binding.
3. Steering pulls in one direction?	a. No: Go to next step.
	b. Yes: Steering cylinder has external or internal oil leakage. Steering valve has external or internal oil leakage. Front tie rods bent, loose, or toe-in not correct. Rear tie rods bent, loose, or toe-in not correct. Middle link rod bent, loose, or adjusted incorrectly.

Symptom: Steering Function Problems

Problem	Cause - Solution
4. Steering wheel creeps?	a. No: Go to next step. b. Yes: Steering cylinder has external or internal oil leakage. Steering valve has external or internal oil leakage.
5. Wheels turn on engine start-up?	a. No: Go to next step. b. Yes: Charge pressure relief valve not opening within specification. Steering cylinder has external or internal oil leakage.
6. Slow steering response?	a. No: For additional procedures go to "Steering System Tests" on page 370. b. Yes: Charge pressure relief valve not opening within specification. Steering cylinder has external or internal oil leakage. Steering valve has external or internal oil leakage. Steering cylinder lines restricted or leaking. Return lines to transmission and oil cooler restricted or leaking. Front axle spindles or front pivot plate binding; not lubricated. Rear spindle housing and rear pivot plate binding; not lubricated. Front steering arm, rear pivot arm, or middle link binding.

Steering System Tests

Test Conditions:

- Machine parked on level surface.
- Park brake engaged.
- Steering cylinder (A) disconnected.
- Hydraulic oil at room temperature.
- Engine running at fast idle.

Steering

1. Steering wheel turns smoothly with no binding? Steering cylinder extends and retracts? (Maximum of 3 revolutions of steering wheel to fully extend cylinder. Compare steering effort with cylinder connected.)

Yes: Go to next step.

No: Steering cylinder does not move or wheel revolutions are more than 3, see "Steering Valve and Cylinder Leakage Test". Steering wheel binds or will not lock in place, go to step 14.

2. Hydraulic checks: Pressure relief valve test port pressure setting to minimum specification 6371 kPa (924 psi)?

Yes: Go to next step.

No: See Charge Pump Flow and Pressure Test in the Hydraulic section.

3. Check steering cylinder. No external/internal oil leakage?

Yes: Go to next step.

No: See "Steering Valve and Cylinder Leakage Test" on page 372.

4. Check steering valve. No external/internal oil leakage?

Yes: Go to next step.

No: See "Steering Valve and Cylinder Leakage Test" on page 372.

5. Check steering lines. Not pinched, cracked or leaking?

Yes: Go to next step.

No: Replace as necessary.

6. Check return lines to transmission and oil cooler. Not restricted, pinched, cracked or leaking?

Yes: End of steering tests.

No: Replace as necessary.

Steering Link Checks

Test Conditions:

- Key switch in OFF position.
- Front link rod disconnected.
- Rear link rod disconnected.
- Front wheels off ground for front axle check.
- Rear wheels off ground for rear axle check.

Steering Links

1. Front axle spindles and front pivot plate turns with little resistance? Axle bushings lubricated, no side freeplay?

Yes: Go to next step.

No: Repair axle, spindle, or plate.

2. Rear spindle housing and rear pivot plate turns with little resistance? Bearings lubricated, no side freeplay?

Yes: Go to next step.

No: Repair spindle housing or pivot plate.

3. Front steering arm, rear pivot arm and middle link rod turns with little resistance? Bearings not rough, no side freeplay?

Yes: Go to next step.

No: Repair steering arm, pivot arm, or link rod.

4. Front tie rods are not bent? Rod ends are tight? Toe-in is 1 - 6 mm (0.04 - 0.24 in.)?

Yes: Go to next step.

No: Replace if necessary. Adjust toe-in.

5. Rear tie rods are not bent? Rod ends are tight? Wheels are straight with pin through rear pivot plate?

Yes: Go to next step.

No: Replace if necessary. Adjust toe-in.

6. Steering cylinder ball joint is tight, not worn and properly lubricated? Rod not bent?

Yes: End of steering tests.

No: Replace if necessary.

7. Steering column and tilt assembly: Steering column not binding? Snap rings in place? Universal joint not binding or worn? Tilt assembly not binding? Spring holds latch rod in notch?

Yes: Go to next step.

No: Tilt steering wheel will not lock in place, or may lock in only one position or will not hold position, see tilt steering rod repair. Replace if necessary.

8. Tires and wheels are correct size, matched circumference, and proper air pressure? Rims not bent? Tires running true (no wobble)? No excessive play in wheel hubs? Wheel bearings lubricated and not rough?

Yes: Go to next step.

No: Replace as needed. Inflate tires to recommended pressure.

9. Rear weights or wheel weights have proper rear ballast?

Yes: End of steering link tests.

No: Add or subtract weights. See Operator's Manual.

Tests and Adjustments

Hydraulic Oil Warm-Up Procedure

Reason:

When making hydraulic tests the oil must be heated to normal operating temperature for the tests to be accurate.

Test Equipment:

- JDG282 Temperature Gauge

Procedure:

1. Install JDG282 Temperature Gauge on transmission oil filter.

Important: Avoid Damage! DO NOT overheat engine.

2. Apply park brake. Start engine and run at full throttle.

3. Move and hold hydraulic lever in implement raise position.

4. Periodically cycle all hydraulic functions to distribute heated oil.

5. Heat oil to operational temperature [38 - 49° C (100 - 120° F) typical].

Steering Valve and Cylinder Leakage Test

Reason:

To check the steering valve and cylinder for internal leakage.

Test Equipment:

- Torque Wrench
- JT03375, 9/16 - 18 M ORFS x 7/16 - 20 M 37° Fitting
- JT05484, 7/16 - 20 F 37° Cap

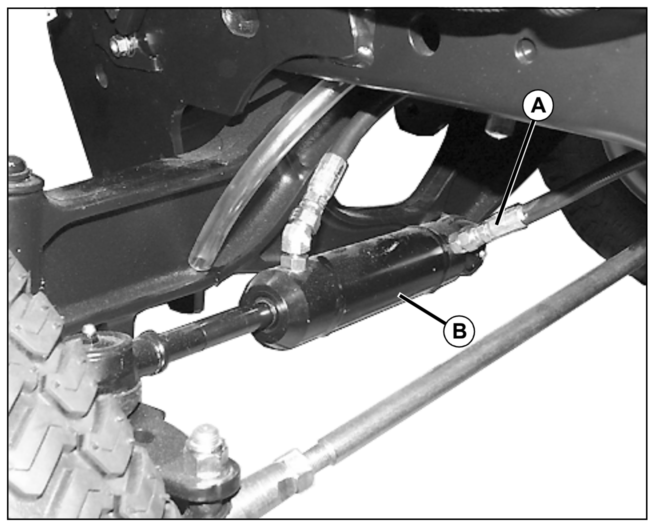
Procedure:

1. Remove steering wheel cap.

2. Turn wheels for a complete right turn.

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 may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.



MX11934

3. Disconnect return hose (A) from the steering cylinder (B).

4. Cap return hose with JT03375 Fitting and JT05484 Cap.

5. Heat hydraulic oil to approximately **43°C (110°F)**. See “Hydraulic Oil Warm-Up Procedure” on page 372.

6. Run engine at fast idle.

7. Using a torque wrench on steering wheel nut, turn steering wheel right with a constant torque of **6.8 N•m (60 lb-in.)**.

8. Observe the number of rotations of the steering wheel that occurs in one minute. Also observe leakage from cylinder return connector. Compare results to specifications.

9. Reinstall hose and tighten to **16 N•m (144 lb-in.)**.

Results:

- If steering wheel rpm is more than 4 rpm, and there is leakage (steady stream) from the cylinder return connector, the steering cylinder is leaking. Replace cylinder. Repeat test.
- If steering wheel rpm is still more than 4 rpm, repair or replace steering valve.

Toe-In Adjustment Front Wheels

Reason:

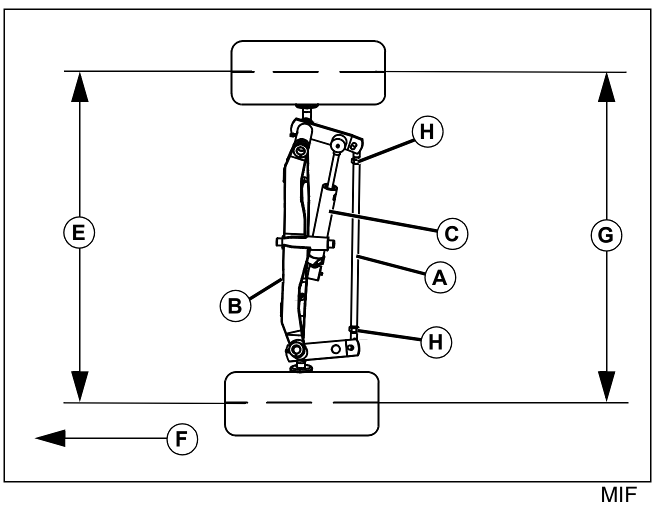
Correct toe-in adjustment prevents tire wear and steering wander.

Procedure:

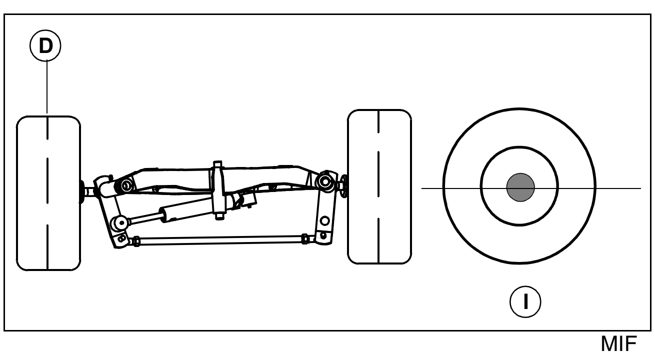
Note: Toe-in cannot be adjusted with wheels off the ground or on an uneven surface.

1. Park machine on level surface.

Note: Measuring point should be from center of tire, hub height.



2. Inspect tie rod (A), front axle (B), and steering cylinder (C) for damage.



Picture Note: I. Side View

3. Mark the center (D) on the front of the tires.

4. Measure distance between marks (E) from front (F) of right front tire to front of left front tire. Record distance.

5. Rotate the tires 180 degrees so the marks on the front of the tires are now on the rear of the tires. Measure distance between marks (G) from back of right front tire to back of left front tire. Record distance.

6. Distance (E) should be **1 - 6 mm (0.04 - 0.24 in.)** less than distance (G).

7. Loosen tie rod nuts (H) and adjust tie rods equally to achieve the specified toe-in.

Specification:

Toe-In. . . . . 1 - 6 mm (0.04 - 0.24 in.)

Toe-In Adjustment All Wheel Steering

Reason:

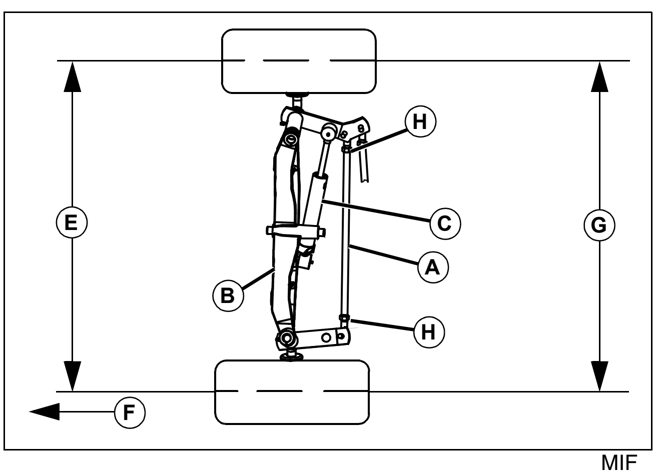
Correct toe-in adjustment prevents tire wear and steering wander.

Front Wheel Procedure:

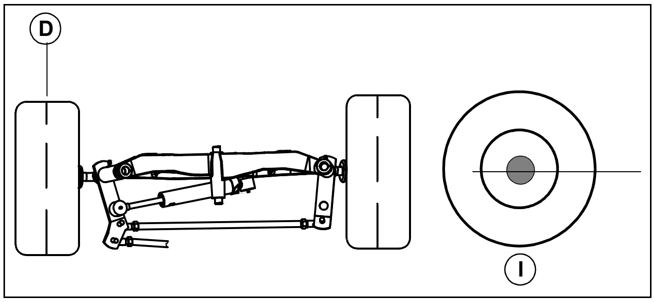
Note: Toe-in cannot be adjusted with wheels off the ground or on an uneven surface. Be sure the jam nut and cotter pin are tight. Add washers if needed.

1. Park machine on level surface.

Note: Measuring point should be from center of tire, hub height.



2. Inspect tie rod (A), front axle (B), and steering cylinder (C) for damage.



MIF

Picture Note: I. Side View

3. Mark the center (D) on the front of the tires.

4. Measure distance between marks (E) from front (F) of right front tire to front of left front tire. Record distance.

5. Rotate the tires 180 degrees so the marks on the front of the tires are now on the rear of the tires. Measure distance between marks (G) from back of right front tire to back of left front tire. Record distance.

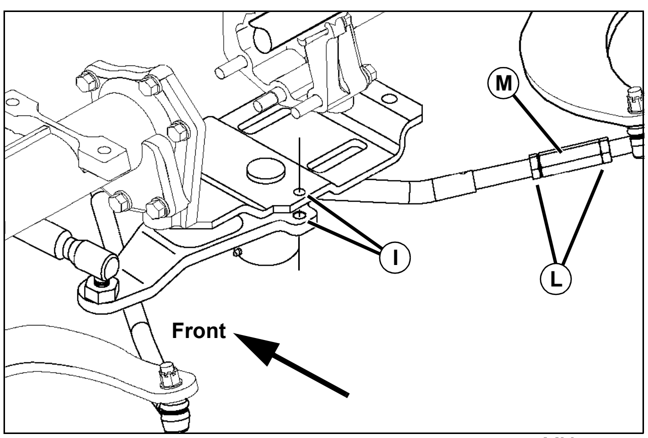
6. Distance (E) should be **1 - 6 mm (0.04 - 0.24 in.)** less than distance (G).

7. Loosen tie rod nuts (H) and adjust tie rods equally to achieve the specified toe-in.

Rear Wheel Procedure:

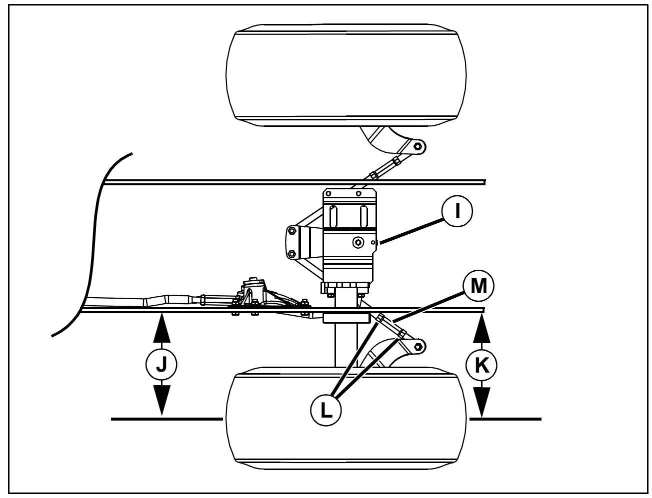
1. Set toe-in on front wheels.

Note: The 10 mm cap screw must be perpendicular to rear pivot plate and mounting plate when installed.



MX14233

2. Turn steering wheel until a 10mm cap screw can be installed through pivot plate and frame holes (I).



MIF

3. Measure from the center “bead” of left rear tire - from front of tire to machine frame (J) and then from back of tire to machine frame (K). Record measurements.

4. Front measurement (J) should be **0 - 10 mm (0 - 0.4 in.)** less then rear measurement (K).

5. If necessary, adjust linkage.

- Loosen jam nuts (L).
- Rotate adjustment nut (M) until measurement difference meets specification.
- Tighten jam nuts to **68 N•m (50 lb-ft)**.

6. Repeat exact procedure for right rear tire.

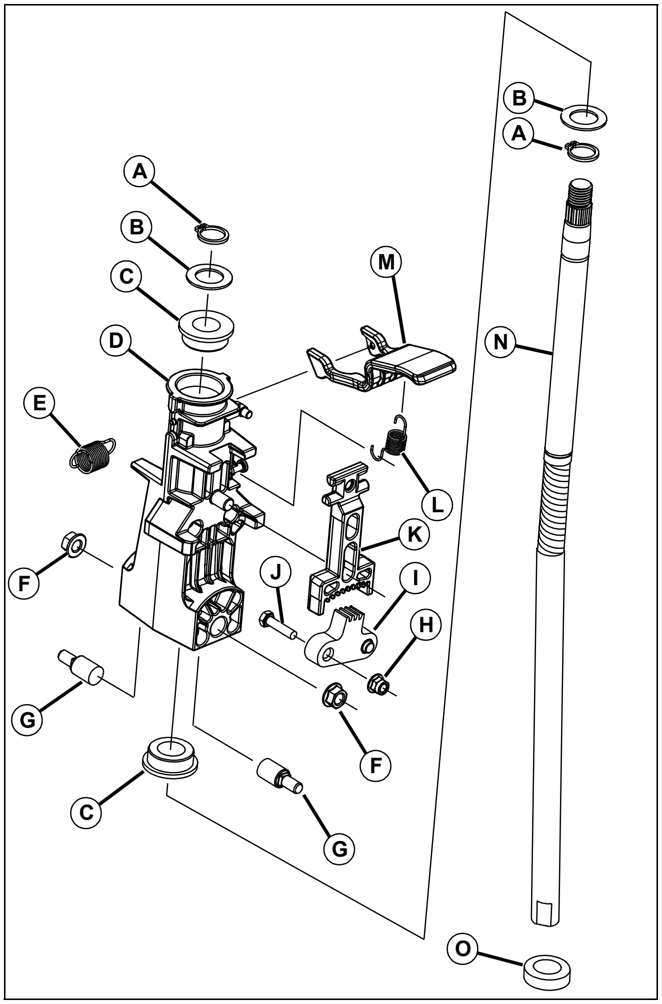
Specifications:

Front Toe-In . . . . 1 - 6 mm (0.04 - 0.24 in.)
Rear Toe-In (each tire parallel to frame) . . . . 0 - 10 mm (0 - 0.4 in.)

Repair

Steering Column Removal and Installation

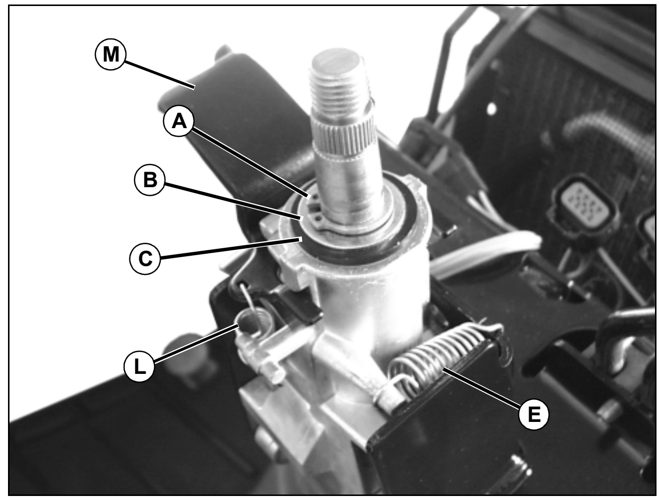
Removing:



MIF

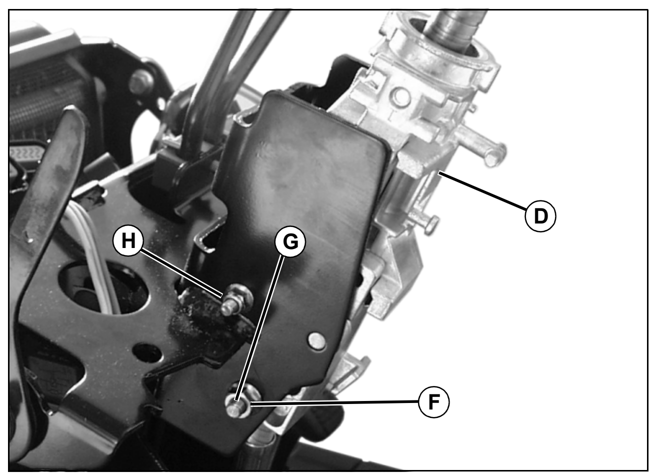
A- Snap Ring (2 used)
B- Washer (2 used)
C- Bushing (2 used)
D- Tilt Steering Housing
E- Tilt Return Spring
F- Flange Nut (2 used)
G- Pivot Bolt (2 used)
H- Nut
I- Pawl
J- Bolt
K- Sector
L- Spring
M- Lever
N- Steering Column Shaft
O- Foam Spacer

1. Remove the instrument panel and shroud to access steering assembly. See "Instrument Panel Removal and Installation" on page 463 in the Miscellaneous section.



MX35550

2. Remove snap ring (A), washer (B), and busing (C).
3. Remove springs (E and L).
4. Remove lever (M).



MX35551

5. Remove nut (F) on each side of column.

6. Push pivot bolt (G) into tilt steering housing. It may be necessary to shift steering shaft to get pivot bolt through bracket and housing. Remove pivot bolt.

7. Repeat pivot bolt removal on other side.

8. Slide tilt steering housing (D) up and off of steering column shaft.

9. Lift and remove steering column shaft.

10.If required, remove nut (H), bolt (J) and pawl (I).

Installing:

1. Apply multipurpose grease to slotted end of steering column shaft.

2. If removed, install lower bushing (C) into tilt steering housing.

3. Place steering shaft into steering control unit and if removed, install lower snap ring (A) and washer (B).

4. Lower tilt steering housing over column.

5. Install pivot bolts and nuts.

6. Install top bushing (C), washer and snap ring. Install lever (M).

7. Install springs (E and L).

8. Install instrument panel and shroud (A).

9. Install steering wheel and nut. Tighten nut to specification. Install steering wheel cover.

Specifications:

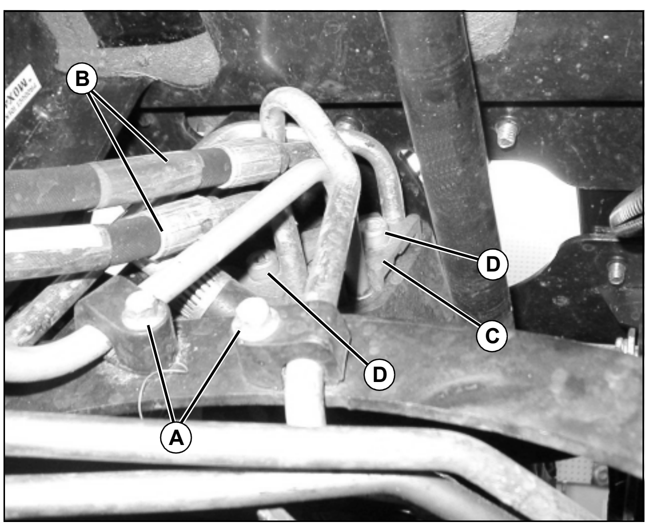
Steering Wheel Nut. . . . . 34 - 41 N•m (25 - 30 lb-ft)

Steering Valve Removal and Installation

Removing:

1. Remove the instrument panel and shroud to access steering assembly. See "Instrument Panel Removal and Installation" on page 463 in the Miscellaneous section.

2. Clean the area around the steering valve to prevent dirt and debris from getting into the hydraulic system.



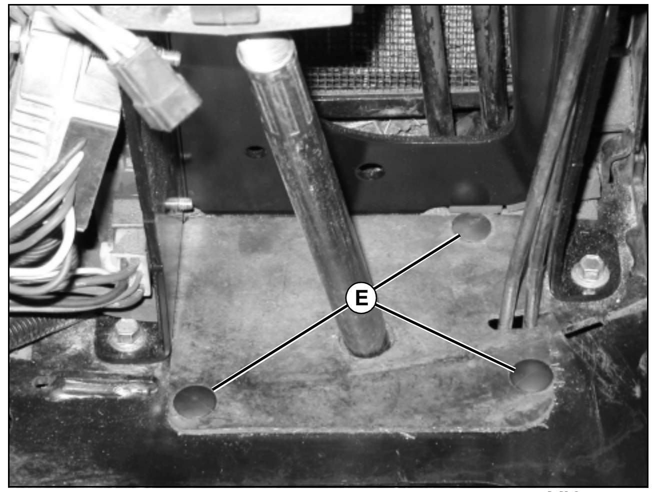
MX35897

3. Remove the two cap screws (A) and tube clamps.

4. Label the hydraulic hoses (B) for their location to the retainer plate (C). The hydraulic lines will only align to their proper locations.

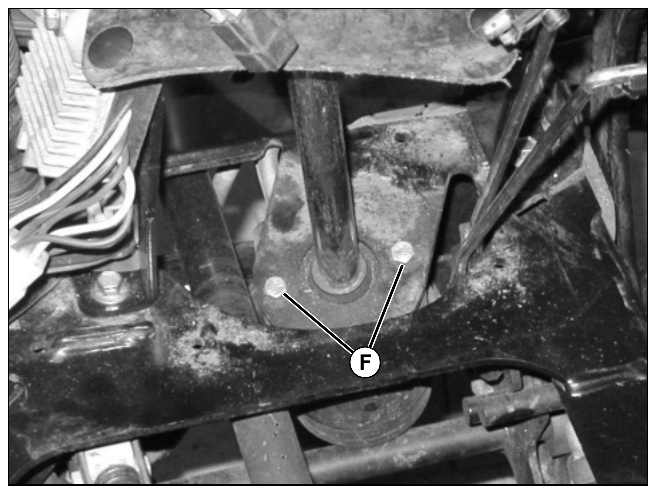
5. Remove two cap screws (D).

6. Move retainer plate (C) just enough to remove hydraulic hoses and lines.



MX35898

7. Remove three push pins (E) and slide closeout cover up on the steering shaft to access the steering valve mounting cap screws.



MX35899

8. Remove two cap screws (F) holding steering valve to machine frame.

9. Remove steering valve from machine frame, and make repairs to valve as necessary.

Installing:

Note: When installing steering valve, install cap screws finger-tight until all hydraulic lines are in place.

1. Raise steering valve into position and finger-tighten cap screws holding valve to machine frame.

Important: Avoid Damage! Always use new O-rings. Damaged or used O-rings will leak.

2. Install hydraulic hoses and lines into the steering valve.

3. Install retainer plate into position and install and tighten two cap screws to **30 N•m (22 lb-ft)**.

4. Install and tighten the tube clamp and cap screws holding line in position to machine frame.

5. Tighten two cap screws, holding steering valve to machine frame.

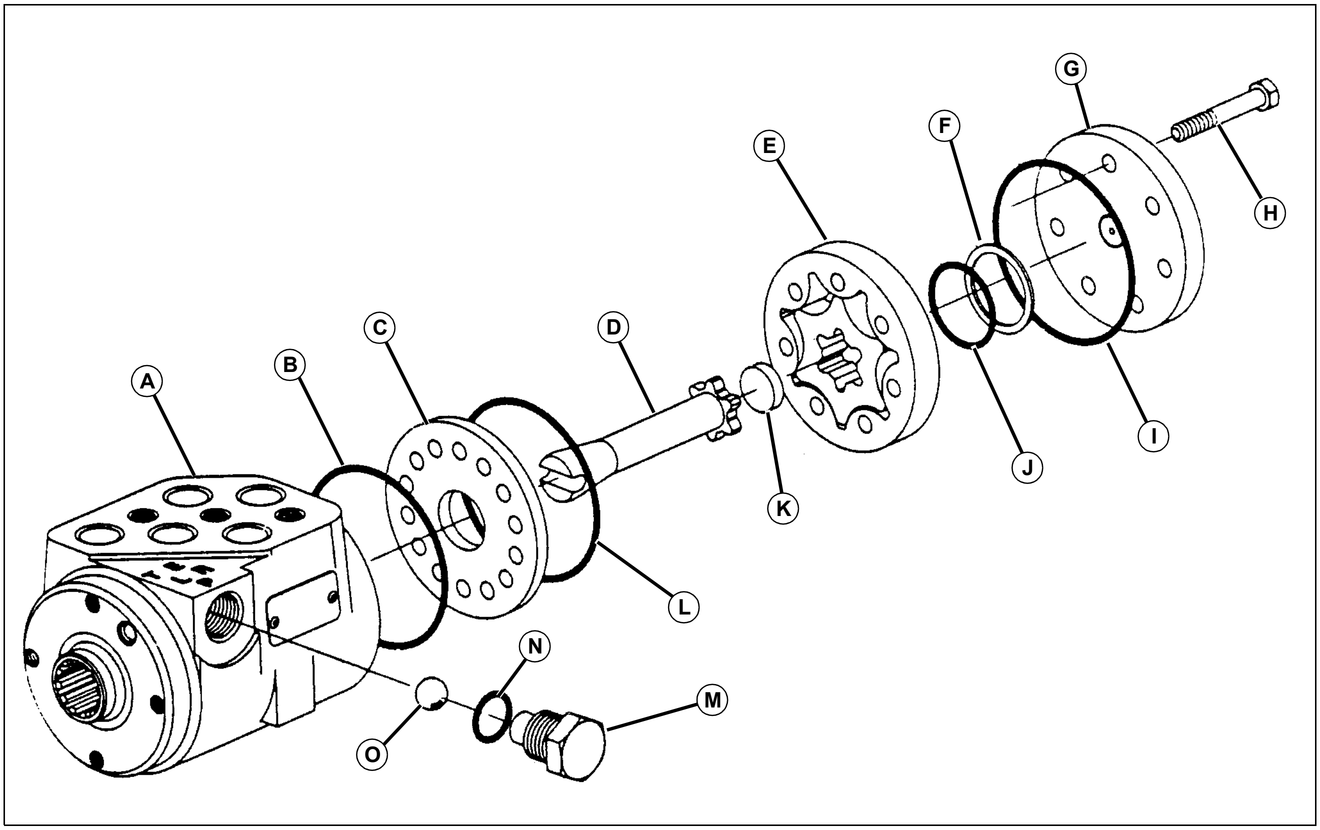
6. Slide the closeout cover down into position and secure with three push pins.

7. Install the instrument panel and shroud. See "Instrument Panel Removal and Installation" on page 463 in the Miscellaneous section.

Specifications:

Retainer Plate Cap Screws . . . . 30 N•m (22 lb-ft)
Steering Valve Mounting Cap Screws . . . . 17 N•m (150 lb-in.)

Steering Valve Disassembly and Assembly



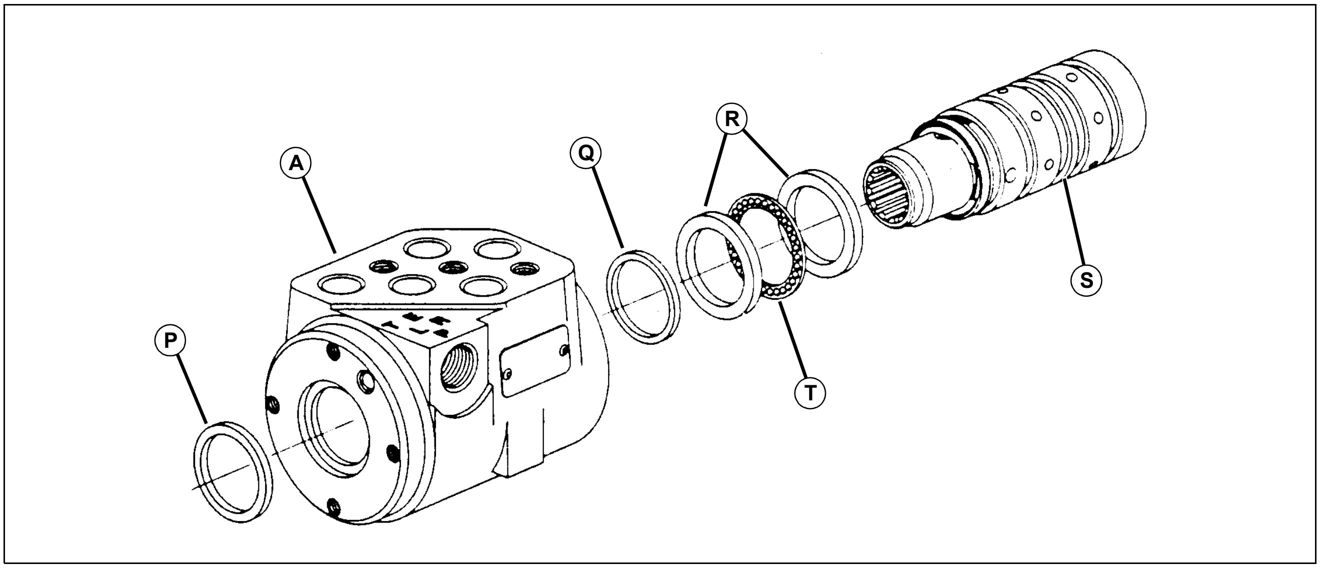
M81128

A- Steering Valve Housing
B- O-Ring
C- Wear Plate
D- Drive Shaft
E- Gerotor Set
F- Seal Ring
G- End Cover
H- Cap Screw
I- O-Ring
J- O-Ring
K- Spacer
L- O-Ring
M- Plug
N- O-Ring
O- Check Ball

1. Remove cap screws to remove components from housing.

2. Remove manual steering check components.

3. Check ball, O-ring, and plug.



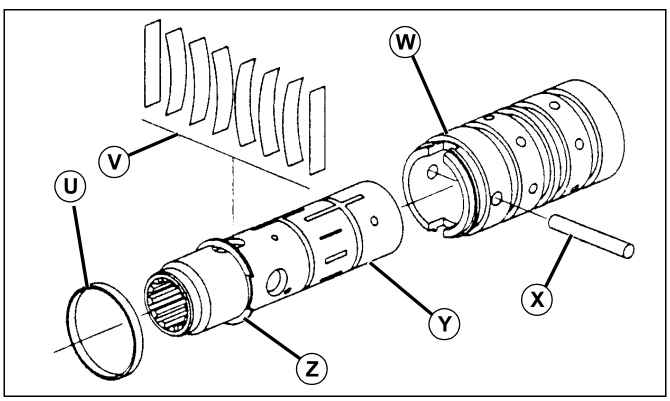
M81129

4. Pull spool and sleeve assembly (S) from steering valve housing (A).

5. Remove quad seal (Q), thrust bearing race (R), and thrust bearing (T) components.

Important: Avoid Damage! Use care not to damage seal bore during removal.

6. Pry dust seal (P) from housing.



M81130

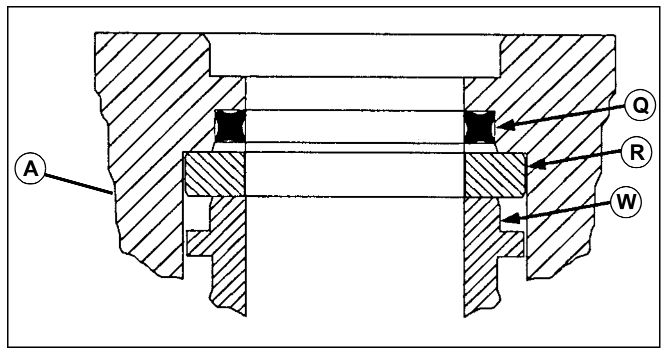
7. Remove pin (X) to separate sleeve (W) from spool (Y).

8. Remove retaining collar (U).

Caution: Avoid Injury! Use care when removing springs because springs (V) are under tension.

9. Remove retaining ring (Z).

10.Inspect all machined mating surfaces for scratches or burrs. Clean all parts in clean solvent and air dry.

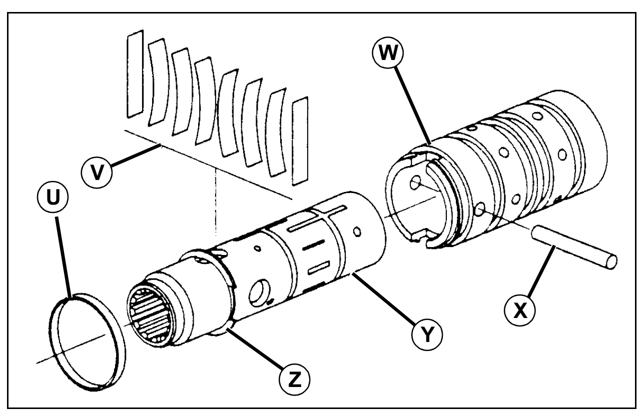


M81131ae

11.Install one bearing race (R) and sleeve (W) into valve housing (A).

12.While holding sleeve and bearing race tightly into housing, install quad seal (Q) into groove between bearing race and housing. Make sure the seal is not twisted.

13.Remove sleeve and bearing race.



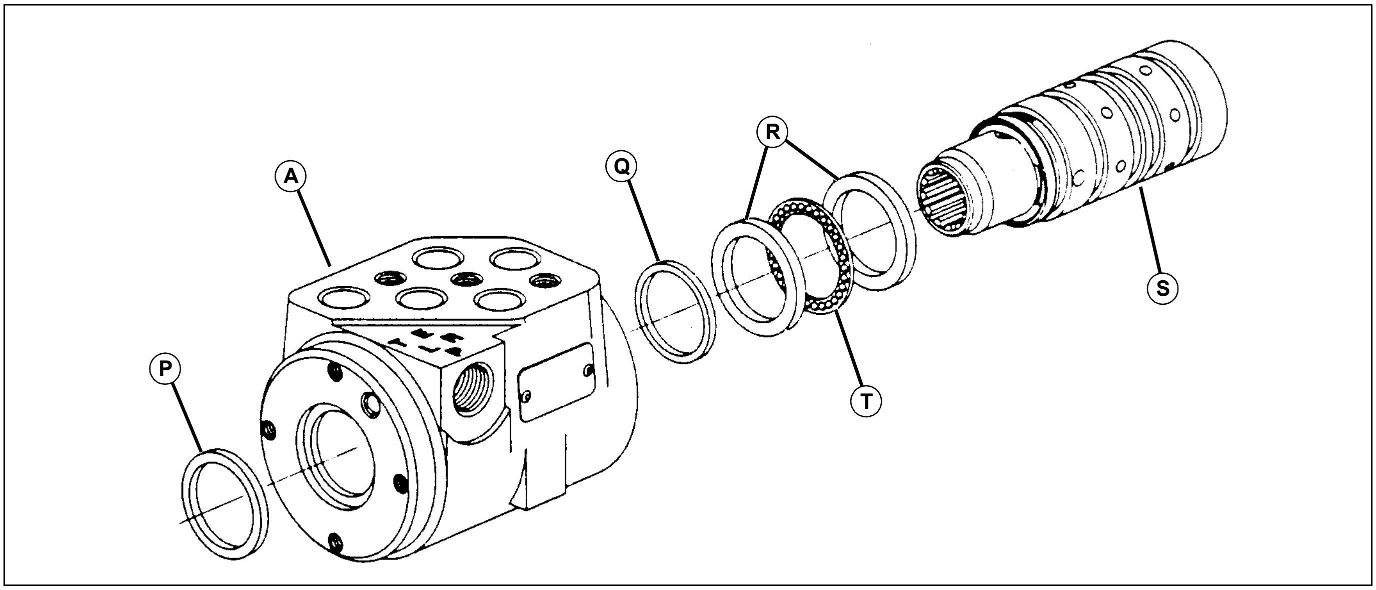
M81130

14.Install retaining ring (Z).

15.Install two flat leafs of springs (V) in slot of spool (Y). Then install curved leafs between flat leafs, three at a time. Install retaining collar (U) over springs.

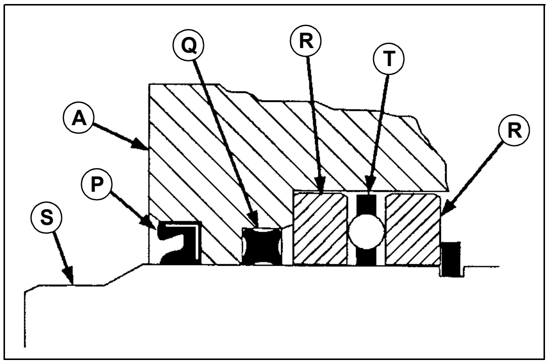
16.Apply clean hydraulic oil to spool and install spool in sleeve (W). Springs must fit into notches of sleeve.

17.Install pin (X).



M81129

18.Install dust seal (P) with open side of seal away from housing (A). Use a disk driver to push seal to bottom of bore. Apply petroleum jelly to seal lips and quad seal (Q).

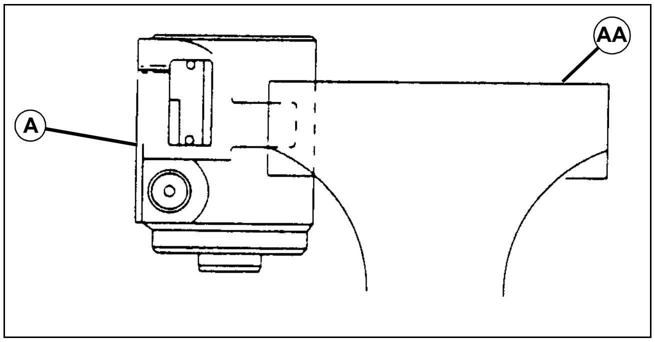


M81133ae

19.Install thrust bearing race (R), thrust bearing (T), and second thrust bearing race (R) components.

20.Apply clean hydraulic oil to spool and sleeve assembly (S). Carefully install assembly into housing (A) so not to damage seals.

Important: Avoid Damage! Tighten vise only enough to hold housing or damage may occur to housing and sleeve.



M81134

21.Put housing (A) in a vise (AA) with the gerotor end up.

22.Install parts in housing.

23.Align holes of wear plate with housing holes.

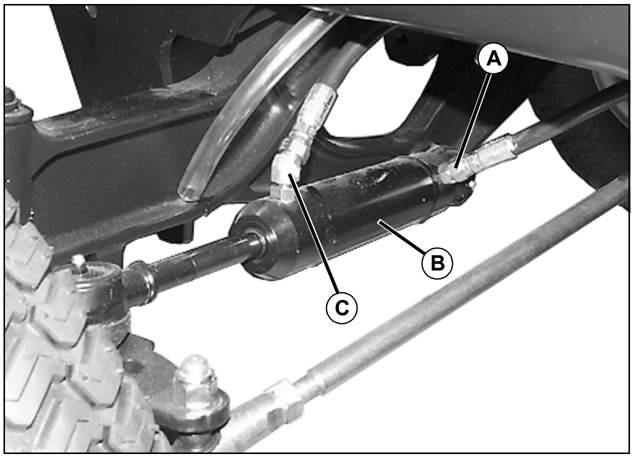
24.Make sure drive shaft slot fits on pin and holes of wear plate align with holes of housing.

25.Align holes of gerotor with holes of wear plate.

26.Install cap screws and tighten in a criss-cross pattern to **17 N•m (150 lb-in.)**.

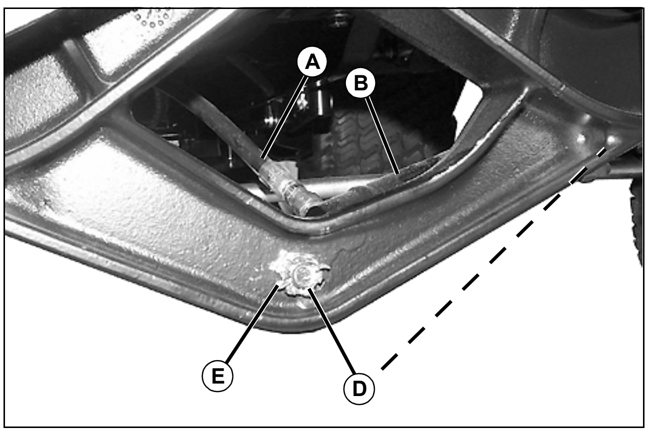
27.Remove steering valve from vise. Install ball, O-ring and plug. Tighten plug to **17 N•m (150 lb-in.)**.

Steering Cylinder Removal and Installation



MX11934

1. Disconnect hydraulic hose (C) and loosen hose (A) from steering cylinder (B).



MX11935

2. Remove cotter pin (E) and nut (D) from each end of steering cylinder.

Note: Cylinder ball joint ends are tapered. Use a forked tool or soft-faced hammer to loosen stud ends.

3. Remove steering cylinder and disconnect cylinder (B) from hose (A).

4. Replace steering cylinder if necessary.

5. Connect steering cylinder (B) to hose (A) and tighten hose to **16 N•m (144 lb-in.)**.

6. Install steering cylinder (B) to spindle arm and through axle housing.

7. Install nuts (D) and tighten to **33 N•m (24 lb-ft)**. Tighten nut to insert cotter pins (E).

8. Connect hydraulic hose (C) and tighten to **16 N•m (144 lb-in.)**.

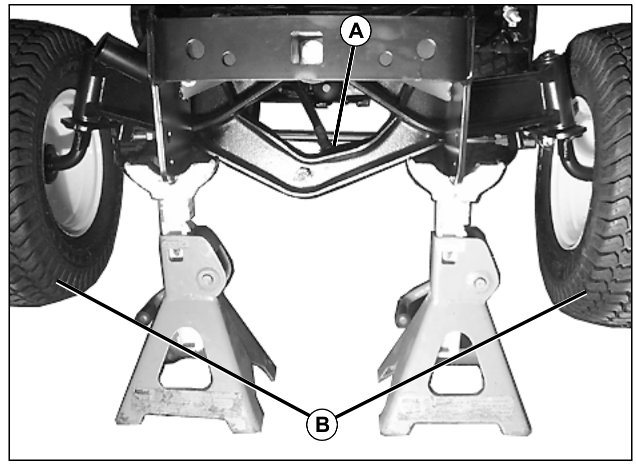
9. Bleed the steering system.

Front Axle Removal and Installation

1. Engage park brake.

2. Remove hood. See “Hood Removal and Installation” on page 458 in the Miscellaneous section.

3. Remove battery.

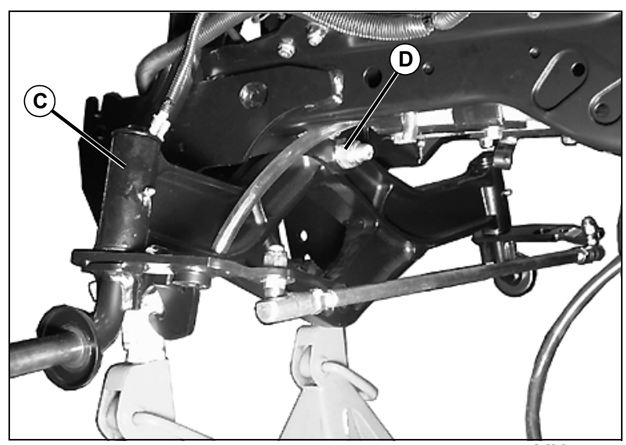


MX11936

4. Lift front of machine until front wheels (B) are off the ground. Install jack stands.

5. Remove two front wheels.

6. Remove steering cylinder (A) without disconnecting hydraulic lines. See “Steering Cylinder Removal and Installation” on page 380.



MX11937

Picture Note: 2-Wheel steer Shown; All wheel steer similar

7. Install a lift or hoist on axle. Remove lock nut (D) and bolt to remove front axle assembly (C).

8. Repair or replace axle assembly.

9. Apply multi-purpose grease to pivot bushings in axle assembly.

10.Lift axle assembly into position, while making sure machine frame fits between head of guide bolts and axle.

11.Install bolt and lock nut (D). Tighten cap screw and lock nut to **203 N•m (150 lb-ft)**.

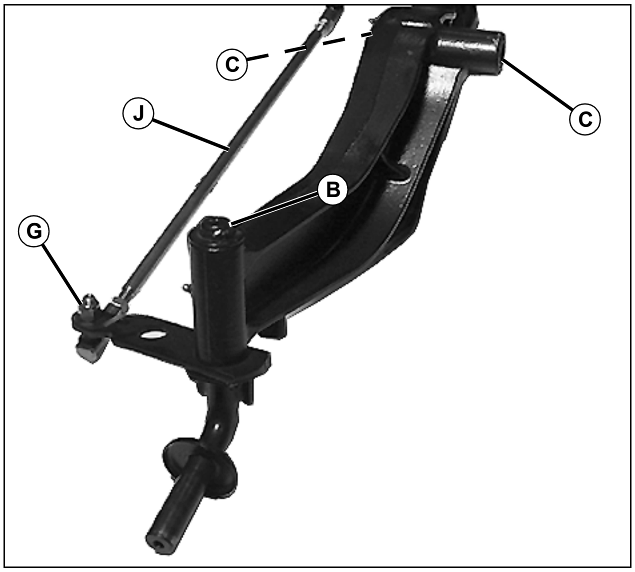
12.Install steering cylinder. See “Steering Cylinder Removal and Installation” on page 380.

13.Install front wheels and lower machine to the ground.

14.Check and adjust axle toe-in.

Front Axle Disassembly and Assembly

Note: All axle repair can be done while on the machine except for the axle pivot bushings (C).

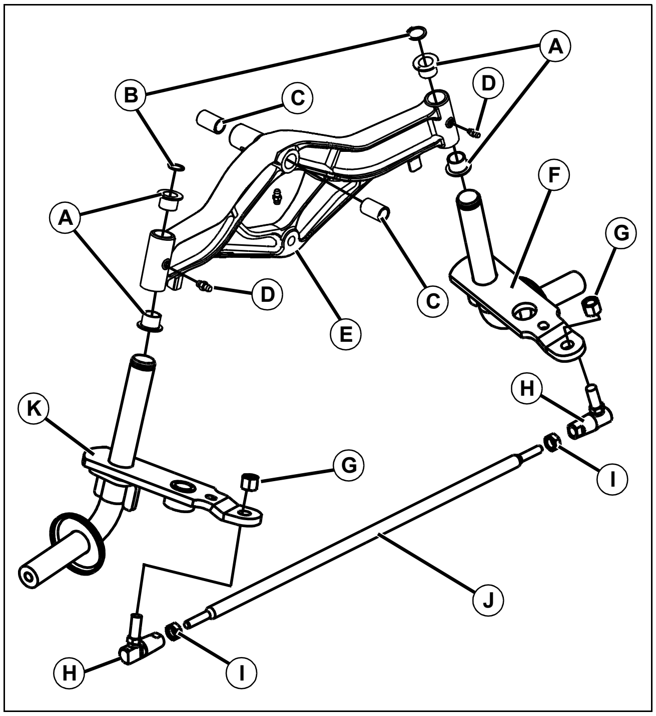


MX11938

Picture Note: 2-Wheel Steer Axle Shown

1. Remove nut (G) from both sides of axle and remove tie rod (J).
2. Remove snap ring (B) to remove spindle.
3. Repeat steps for other spindle.

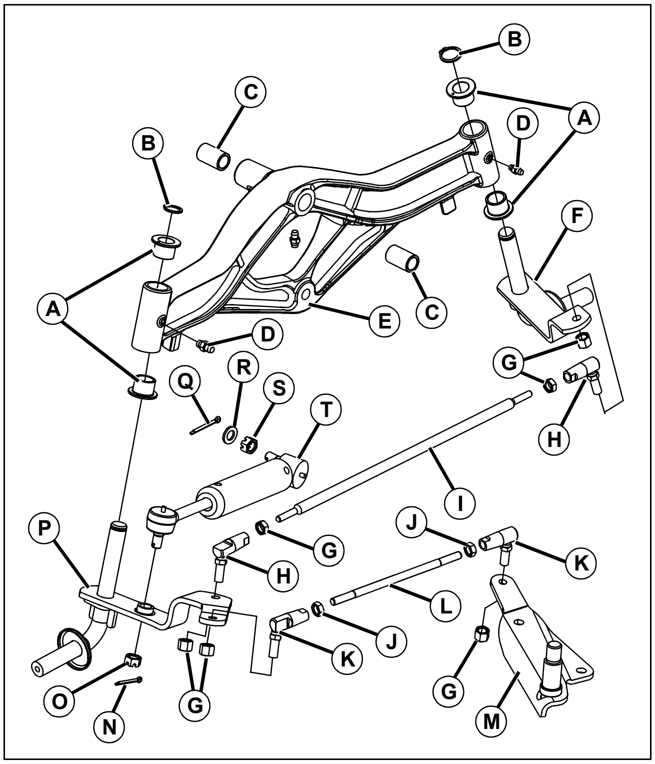
Note: Remove components from axle and replace as necessary.



MIF

Picture Note: 2-Wheel Steering Shown

A- Bushing
B- Snap Ring
C- Bushing
D- Grease Fitting
E- Front Axle
F- Front Spindle, Right
G- Nut
H- Ball Joint
I- Nut
J- Tie Rod
K- Front Spindle, Left



Picture Note: All Wheel Steering Shown

A- Bushing
B- Snap Ring
C- Bushing
D- Grease Fitting
E- Front Axle
F- Front Spindle, Right
G- Nut
H- Ball Joint
I- Tie Rod
J- Nut
K- Ball Joint
L- Steering Rod
M- Shaft
N- Cotter Pin
O- Nut
P- Front Spindle, Left
Q- Cotter Pin
R- Washer
S- Nut
T- Steering Cylinder

4. Install four flanged bushings (A) into axle until flange is tight to **1 mm (0.04 in.)** maximum gap to casting.

5. Install two bushings (C) into axle bore until end of bushing is even with casting surface.

6. If removed, install three grease fittings (D).

7. Install spindles (F and P), snap rings (B).

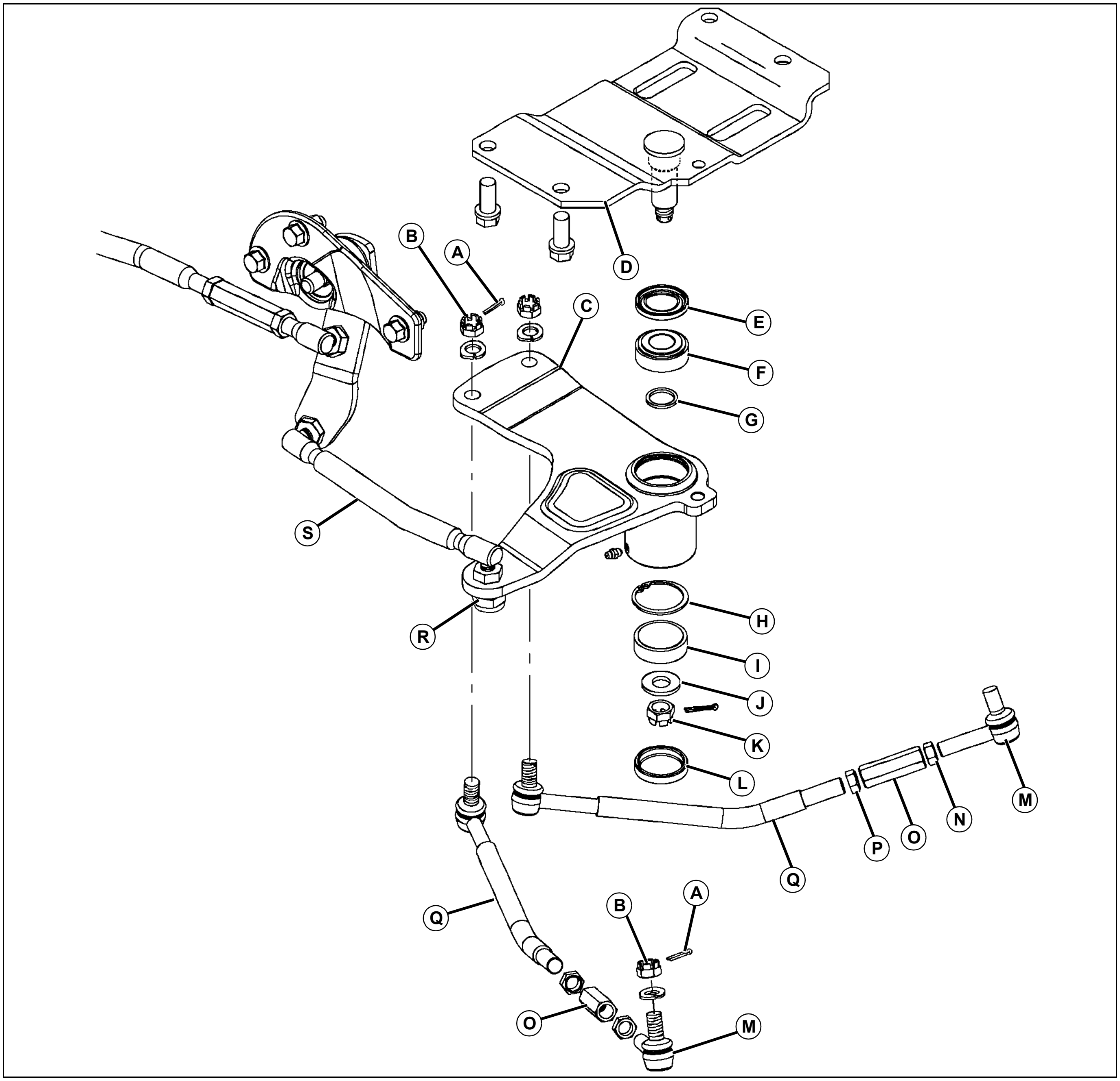
8. Attach tie rod to ends of spindles and tighten nuts (G) to **61 N•m (45 lb-ft)**.

9. Check length of tie rod from center of stud to center of stud. Adjust rod length to approximately **292 mm (11-1/2 in.)**.

10.Check and adjust axle toe-in after axle is installed.

Rear Steering Linkage - All Wheel Steering

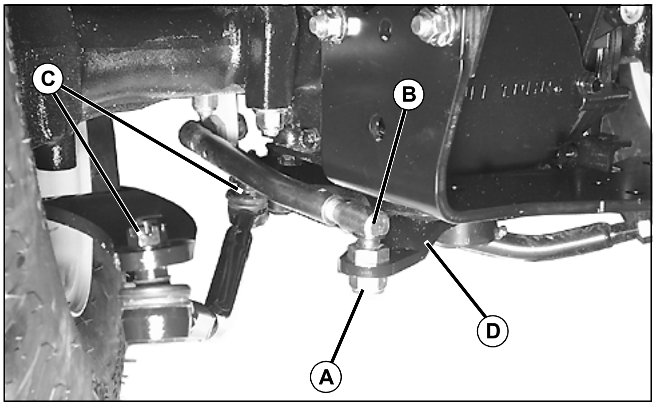
Components:



MX14246

A- Cotter Pin (4 used)
B- Castle Nut (4 used)
C- Pivot Plate
D- Pivot Bracket
E- Seal
F- Tapered Roller Bearing
G- Spacer
H- Snap Ring
I- Roller Bearing
J- Washer
K- Castle Nut
L- Cap
M- Tie Rod End
N- Nut, LH Thread
O- Nut, Adjuster
P- Nut
Q- Tie Rod
R- Lock Nut
S- Link Rod, Rear

Removal:



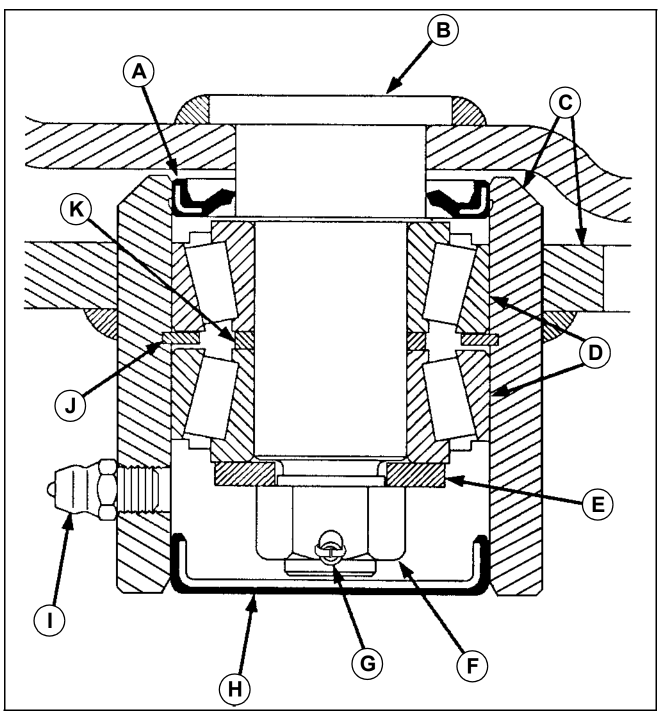
MX14386

1. Remove lock nut (A) to disconnect rear link rod (B) from pivot plate assembly (C).

2. Remove left and right tie rod assemblies by removing hardware parts (C) from knuckle arm end and parts from pivot plate end of tie rods.

3. Remove cap screws and washers to remove pivot assembly (D).

Disassembly:



MX14254

A- Seal
B- Pivot Bracket
C- Pivot Plate
D- Tapered Roller Bearing (2 used)
E- Washer
F- Castle Nut
G- Cotter Pin
H- Cap Seal
I- Grease Fitting
J- Snap Ring
K- Spacer

1. Pry cap seal (H) from pivot plate.

2. Remove cotter pin (G), castle nut (F), washer (E) and pivot plate assembly parts.

Note: Outer race of two tapered bearings (D) is slip fit.

3. Remove pivot plate components.

4. Inspect bearings and ball joints for wear. Replace as necessary.

Assembly:

1. Apply extreme pressure grease to rollers of bearings.

2. Install snap ring, upper bearing and seal into pivot plate. Install seal with closed side into bore first and even with top of pivot plate.

3. Install pivot plate, spacer, lower bearing, washer and nut. Tighten nut while making sure slot of nut aligns with hole in pivot shaft.

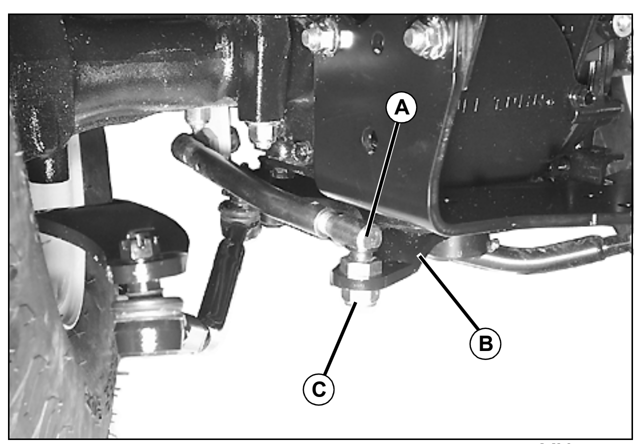
4. Install cotter pin. Fill cavity with extreme pressure grease and install cap seal.

Installation:

1. Install pivot assembly using cap screws and washers. Tighten cap screws to **91 N•m (67 lb-ft)**.

2. Install right and left tie rods with castle nuts (A) and cotter pins.

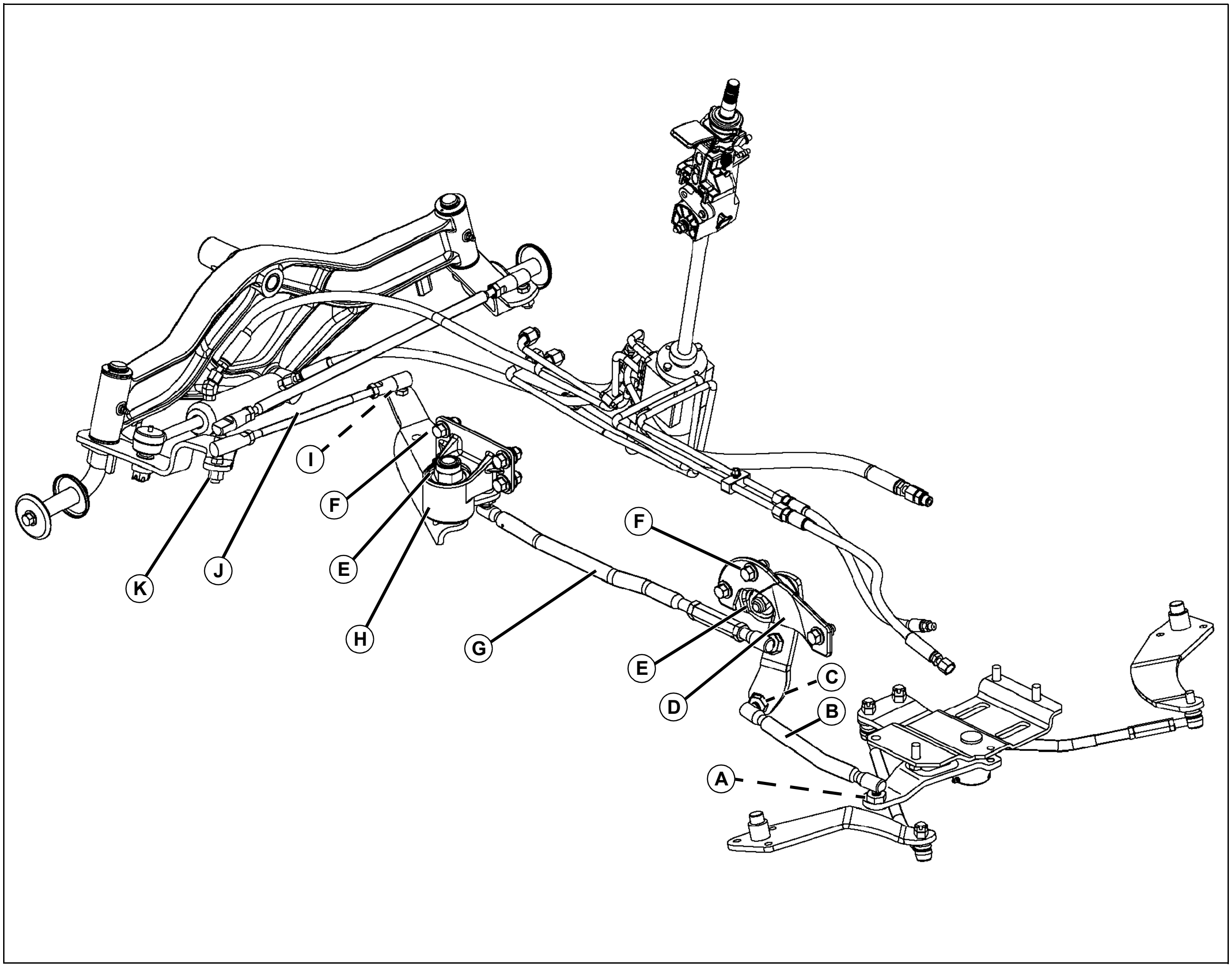
3. Check and adjust rear axle toe-in. See “Toe-In Adjustment All Wheel Steering” on page 373.



MX14386

4. Connect rear rod (A) to pivot plate (B) using lock nut (C). Tighten lock nut to **170 N•m (125 lb-ft)**.

Steering Intermediate Linkage - AWS



MX35905

A- Lock Nut - 170 N•m (125 lb-ft)
B- Rear Intermediate Link Rod
C- Lock Nut - 170 N•m (125 lb-ft)
D- Rear Pivot
E- Lock Nut - 68 N•m (50 lb-ft)
F- Cap Screw - 84 N•m (62 lb-ft)
G- Middle Link Rod
H- Front Pivot
I- Lock Nut - 170 N•m (125 lb-ft)
J- Front Intermediate Link Rod
K- Lock Nut - 170 N•m (125 lb-ft)

Note: Rear (B) intermediate link is not adjustable. Ball joint ends are peened to rod. Complete link must be replaced if any part is worn or damaged.

Removal:

1. Remove lock nut (A and C) from each end of link.

2. Remove front pivot (H) or rear pivot (D) by removing cap screws (F) and nuts.

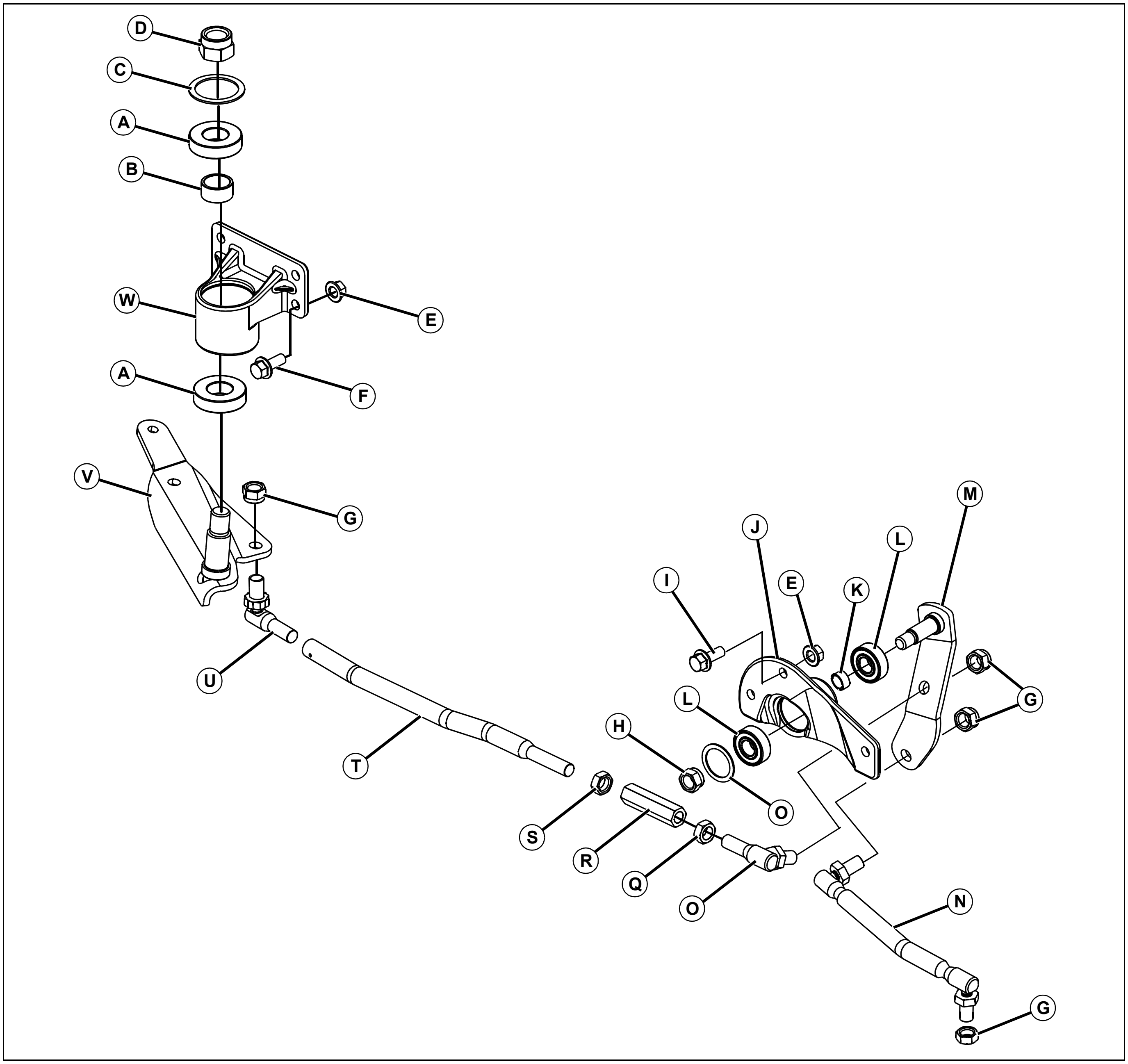
Installation:

1. Install pivot.

2. Install link rods. Make sure front and rear steering assemblies are centered. Tighten lock nut to **170 N•m (125 lb-ft)**.

3. Connect front end of middle link rod (F) to front pivot using lock nut. Tighten lock nut to **68 N•m (50 lb-ft)**.

Front and Rear Pivots



MIF

A- Ball Bearing
B- Spacer
C- Snap Ring
D- Pivot Lock Nut
E- Flange Nut
F- Screw (4 used)
G- Lock Nut
H- Pivot Lock Nut
I- Screw
J- Housing, Rear Pivot
K- Spacer
L- Ball Bearing (2 used)
M- Pivot Arm
N- Link Rod, Rear
O- Snap Ring
P- Tie Rod End
Q- Jam Nut
R- Adjustment Nut
S- Jam Nut
T- Link Rod, Middle
U- Tie Rod End
V- Shaft, Pivot Arm
W- Housing, Front Pivot

Removing:

1. Remove nut and snap ring. Replace parts as necessary.

Installing:

1. Install one bearing at a time in a press, making sure to include spacer between bearings. Seat snap ring after removing assembly from press.
2. Install pivot arm shaft and lock nut. Tighten lock nut to specification.

Specifications:

2WD Pivot Lock Nut . . . . . 200 ± 40 N•m (148 ± 30 lb-ft)
4WD Pivot Lock Nut . . . . . 367 ± 73 N•m (271 ± 54 lb-ft)
Jam Nuts . . . . 68 N•m (50 lb-ft)
Flange Nuts . . . . 80 N•m (59 lb-ft)
Lock Nuts . . . . 170 N•m (125 lb-ft)

Table of Contents

Specifications

General Specifications

Brakes:

Type . . . . Internal wet disk

Test and Adjustment Specifications

Brake/Differential Linkage Adjustment:

With 45 N (10 lb force) applied to brake and differential lock arm just contacting differential lock shaft, adjust differential lock link outward . . . . 6 turns

Repair Specifications

Transaxle Brake Cover Cap Screws Torque - Used Transaxle Case . . . . 25 N•m (221 lb-in.)
Transaxle Brake Cover Cap Screws Torque - New Transaxle Case. . . . . 30 N•m (22 lb-ft)
Brake Switch Striker Torque . . . . 12 N•m (108 lb-in.)
Brake Adjustment Gap (Pin and Brake Rod Spring Retainer) . . . . 3 - 9 mm (0.12 - 0.35 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
Gauge	F67-10-61505	For measuring gap between roll pin and brake rod spring retainer (brake adjustment).

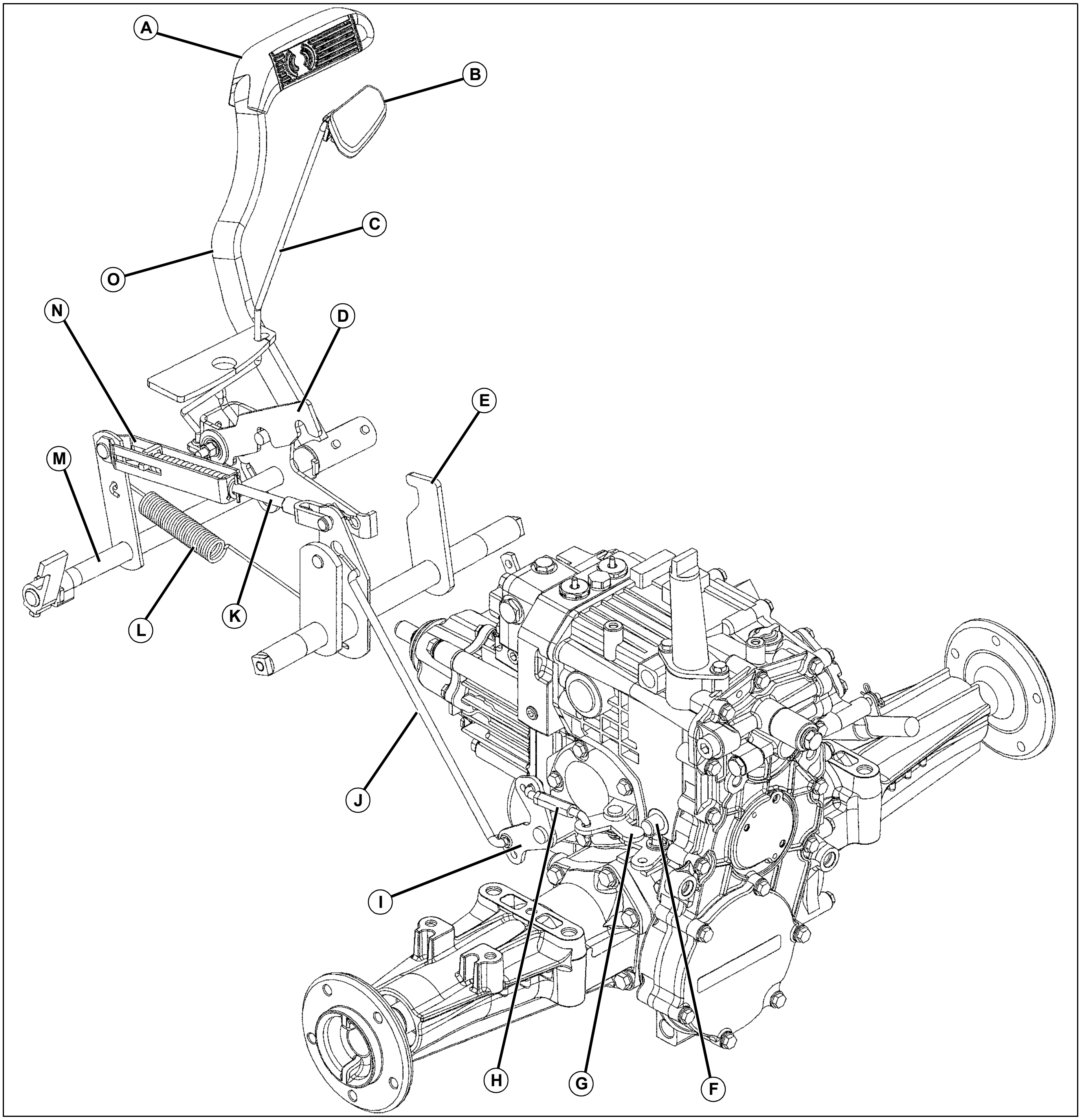
Other Materials

Other Material

Part No.	Part Name	Part Use
TY15130	John Deere Form-in-Place Gasket	Seal mating surfaces of transaxle
TY6305/TY9485/#764	Cure primer	Clean thread of sealing suraces
TY9370/TY9477/#242	Thread Lock and Sealer (Medium Strength)	Retain brake mounting cap screws

Component Location

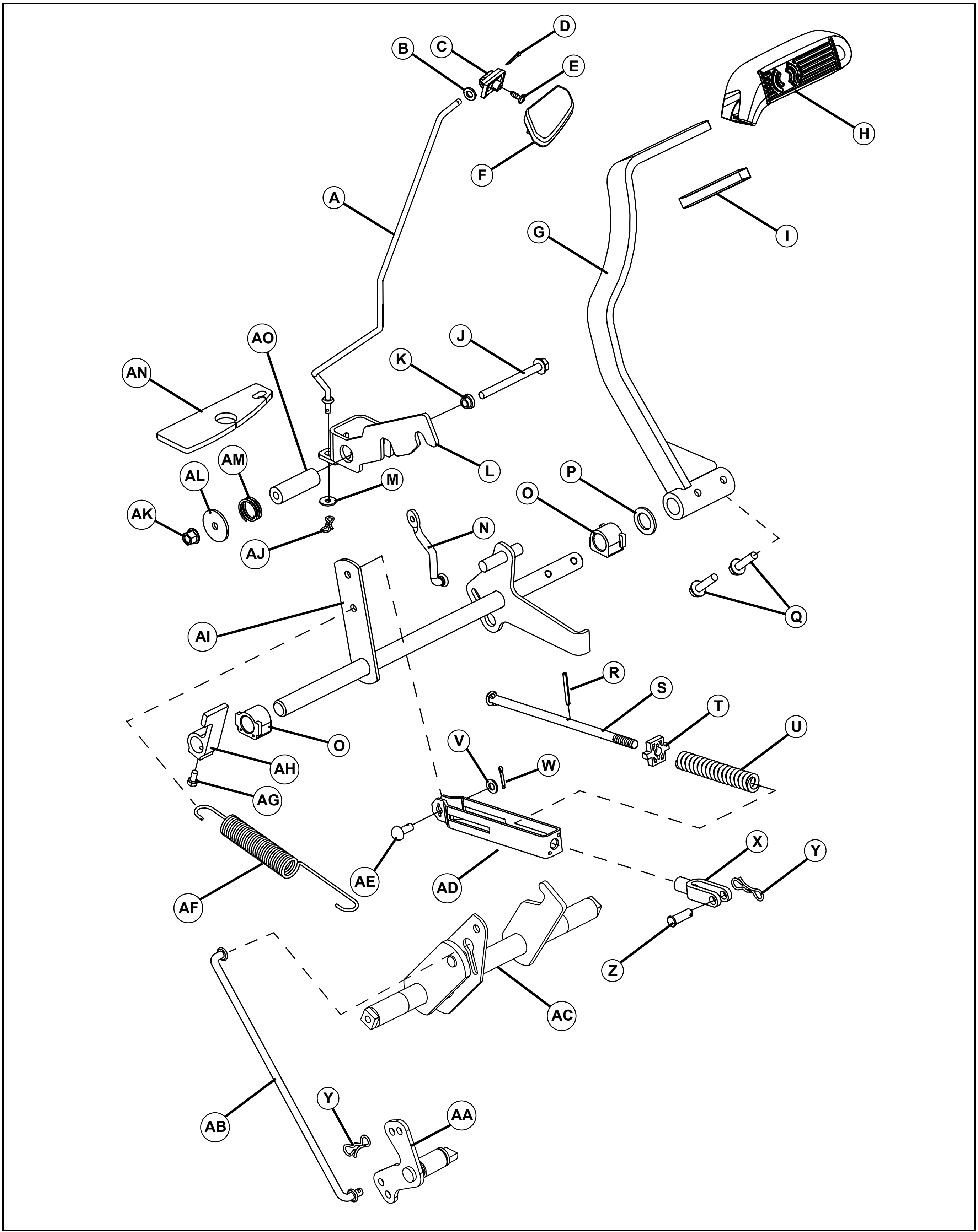
Brake System Component Location



MX14415

A- Pad, Brake Pedal
B- Handle, Park Brake Rod
C- Park Brake Rod
D- Latch
E- Mid-Lift Shaft
F- Differential Lock Shaft
G- Differential Lock Arm
H- Differential Lock Link
I- Brake Arm and Cam
J- Rod, Brake Arm
K- Brake Rod
L- Brake Return Spring
M- Brake Shaft
N- Brake Spring Retainer
O- Brake Pedal

Brake/Differential Linkage (Exploded)



MIF

A- Rod, Parking Brake
B- Washer
C- Coupling
D- Cotter Pin
E- Screw
F- Handle
G- Brake Pedal
H- Pad, Brake Pedal
I- Strip
J- Screw
K- Bushing
L- Latch
M- Washer
N- Rod, Cruise Control Disconnect
O- Bearing
P- Washer
Q- Screw
R- Spring Pin
S- Bolt
T- Guide
U- Compression Spring
V- Washer
W- Cotter Pin
X- Yoke
Y- Spring Locking Pin
Z- Pin
AA- Brake Arm and Cam
AB- Rod, Rear Brake
AC- Mid-Lift Shaft
AD- Retainer, Brake Spring
AE- Pin
AF- Extension Spring
AG- Cap Screw
AH- Striker
AI- Brake Shaft
AJ- Spring Locking Pin
AK- Lock Nut
AL- Washer
AM- Spring
AN- Foam Pad
AO- Bushing

Theory of Operation

Brake System Operation

Note: See "Component Location" on page 392.

Function:

Provide a means of stopping the machine and also prevent movement when not in use.

System Operation:

When the brake pedal is depressed, the brake spring retainer is pulled forward. The brake spring is compressed and spring tension pulls the brake rods and the brake arm and cam forward. As the brake arm and cam rotates, the cam plate rotates, rolling three balls up a ramp. When the balls move up the ramp, the cam plate pushes against the brake plates, forcing the brake plates and brake discs together.

The brake plates are attached to the transaxle housing through external tangs on the plates. The brake plates cannot rotate. Brake discs that are splined to the reduction shaft are located between the brake plates. The brake discs rotate whenever the reduction shaft rotates. The pressure of the brake plates against the brake discs stops the reduction shaft rotation.

At the same time the brake arm and cam is engaged, the differential lock is also engaged to provide braking to both rear wheels. The brake arm and cam pushes the differential lock link and arm rearward. The differential lock shaft and fork move into the transaxle and engage the differential lock pins to lock both axles together.

When the brake pedal is released, the brake return spring pulls the brake pedal and linkage to the disengaged position. The linkage pulls the cam plate away, releasing the pressure against the plates and disk.

The brake pedal can be locked in the engaged position to be used as a parking brake. When the park brake rod is engaged, the park brake pawl contacts a tab on the brake pedal to hold the pedal in the engaged position.

Diagnostics

Brakes

Symptom: Brake Problems

Problem	Cause - Solution
1. Poor or no brakes?	a. No: Go to next step. b. Yes: Brake pedal or linkage bent, binding or worn. Brake spring broken or collapsed. Brake linkage freeplay adjustment incorrect. Brake arm and cam bent, binding, or worn. Differential lock arm bent, binding, or worn. Brake plates and disks warped, grooved, or worn. Transaxle internal differential lock components binding or worn. Transaxle internal brake components binding or worn.
2. Brakes binding or brake effort excessive?	a. No: Go to next step. b. Yes: Brake pedal or linkage bent, binding or worn. Brake spring broken or collapsed. Brake linkage freeplay adjustment incorrect. Park brake rod and pawl bent or binding. Brake arm and cam bent, binding, or worn. Differential lock arm bent, binding, or worn. Brake plates and disks warped, grooved, or worn. Transaxle internal brake components binding or worn. Transaxle internal differential lock components binding or worn.

Symptom: Brake Problems

Problem	Cause - Solution
3. Brakes will not release?	a. No: Go to next step. b. Yes: Brake pedal or linkage bent, binding or worn. Brake spring broken or collapsed. Brake return spring broken or stretched. Brake linkage freeplay adjustment incorrect. Park brake rod and pawl bent or binding. Differential lock arm bent, binding, or worn. Brake arm and cam bent, binding, or worn. Brake plates and disks warped, grooved, or worn. Transaxle internal brake components binding or worn. Transaxle internal differential lock components binding or worn.
4. Brakes noisy or chatter?	a. No: Go to next step. b. Yes: Brake pedal or linkage bent, binding or worn. Brake spring broken or collapsed. Park brake rod and pawl bent or binding. Brake arm and cam bent, binding, or worn. Differential lock arm bent, binding, or worn. Brake plates and disks warped, grooved, or worn. Transaxle internal brake components binding or worn. Transaxle internal differential lock components binding or worn.

Symptom: Brake Problems

Problem	Cause - Solution
5. Excessive brake wear?	a. No: Go through diagnostic procedures or go back to step 1. b. Yes: Brake pedal or linkage bent, binding or worn. Brake return spring broken or stretched. Brake linkage freeplay adjustment incorrect. Brake arm and cam bent, binding, or worn. Differential lock arm bent, binding, or worn. Brake plates and disks warped, grooved, or worn. Transaxle internal brake components binding or worn. Transaxle internal differential lock components binding or worn.

Symptom: Parking Brake Problems

Problem	Cause - Solution
1. Parking brake will not engage?	a. No: Go to next step. b. Yes: Brake pedal or linkage bent, binding or worn. Brake spring broken or collapsed. Brake return spring broken or stretched. Brake linkage freeplay adjustment incorrect. Park brake rod and pawl bent or binding. Brake arm and cam bent, binding, or worn. Differential lock arm bent, binding, or worn. Brake plates and disks warped, grooved, or worn. Transaxle internal brake components binding or worn. Transaxle internal differential lock components binding or worn.

Symptom: Parking Brake Problems

Problem	Cause - Solution
2. Park brake will not release?	a. No: Go to next step. b. Yes: Brake pedal or linkage bent, binding or worn. Brake return spring broken or stretched. Brake linkage freeplay adjustment incorrect. Park brake rod and pawl bent or binding. Brake arm and cam bent, binding, or worn. Differential lock arm bent, binding, or worn. Brake plates and disks warped, grooved, or worn. Transaxle internal brake components binding or worn. Transaxle internal differential lock components binding or worn.
3. Parking brake will not engage?	a. No: Go through diagnostic procedures or go back to step 1. b. Yes: Brake pedal or linkage bent, binding or worn. Brake spring broken or collapsed. Brake linkage freeplay adjustment incorrect. Park brake rod and pawl bent or binding. Brake arm and cam bent, binding, or worn. Differential lock arm bent, binding, or worn. Brake plates and disks warped, grooved, or worn. Transaxle internal brake components binding or worn. Transaxle internal differential lock components binding or worn.

Tests and Adjustments

Brake/Differential Linkage Adjustment

Reason:

To adjust brake linkage for proper braking and differential lock engagement when the brake pedal is applied. Machine creeps when on a slope with park brake engaged. Brakes may not stop machine completely when operating on an incline.

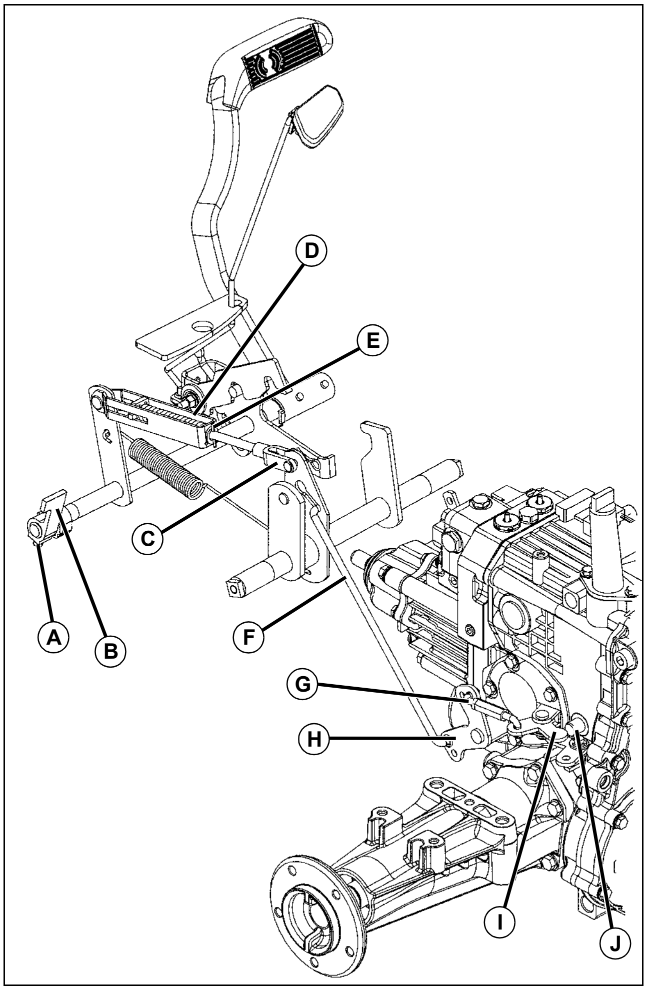
Test Equipment:

- Spring Scale

Procedure:

1. Release brake pedal.

> **Caution: Avoid Injury! Do not pre-load brakes as excessive wear of brake components will result.**



MX14384

A- Cap Screw
B- Striker
C- Brake Rod Yoke
D- Retainer, Brake Spring
E- Roll Pin
F- Brake Arm Rod
G- Link Rod
H- Brake Arm
I- Differential Lock Arm
J- Differential Lock Shaft

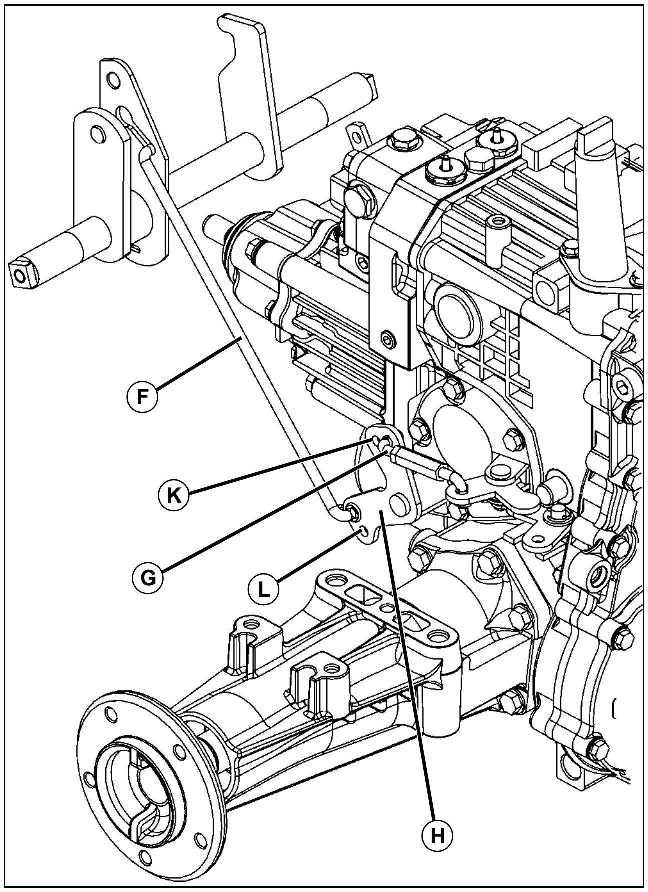
2. Disconnect brake arm rod (F) from brake arm (H). This is easiest if done from left underside of machine by pulling the cotter pin from the brake arm rod end.

3. Disconnect the forward end of link rod (G) from brake arm (H).

4. Connect spring scale to bottom of brake arm (H) and pull forward with **45 N (10 lb. force)**.

5. Push link rod (G) rearward until differential lock arm (I) contacts the differential lock shaft (J).

6. Check alignment of link rod (G) and brake arm (H) as shown below.



MX14281

7. Front of link rod (G) should be flush or up to **2 mm (0.08 in.)** behind front edge of brake arm (H) hole (K).

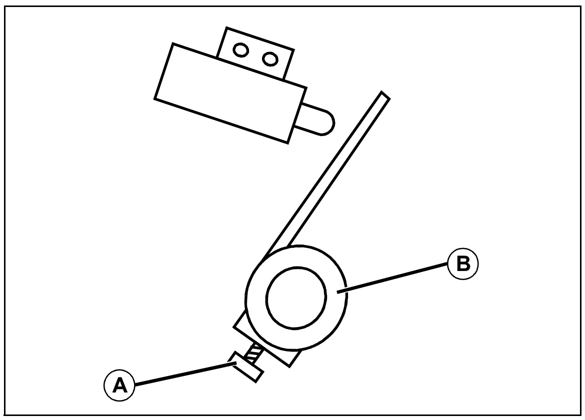
Note: It may be necessary to move link rod (G) into rear hole (as shown above), if linkage cannot be adjusted enough for proper function of brake arm.

8. Adjust rod by turning inward or outward (link has left hand threads), one full turn at a time, up to 6 turns.

9. Remove spring scale slowly to relieve tension.

10.Reinstall link rod, brake arm rod and cotter pins.

11.Adjust brake rod yoke (C) until there is no freeplay in the brake linkage with the brake pedal released. Check linkage for binding after adjustment. If rear wheels are rotated and brakes drag, linkage is too tight. Rotate rear wheels to be sure differential lock is not engaged and brakes do not drag.



MIF

Picture Note: NOTE: Side view shown

12.Loosen cap screw (A).

13.Depress brake pedal and engage park brake lock.

Note: The actuator must not contact the switch body.

14.Rotate actuator (B) until the switch plunger is depressed, but not bottomed out.

15.Hold actuator in position and tighten cap screw (A) to **12 N•m (108 lb-in.)**.

16.Retest machine on slope with park brake engaged.

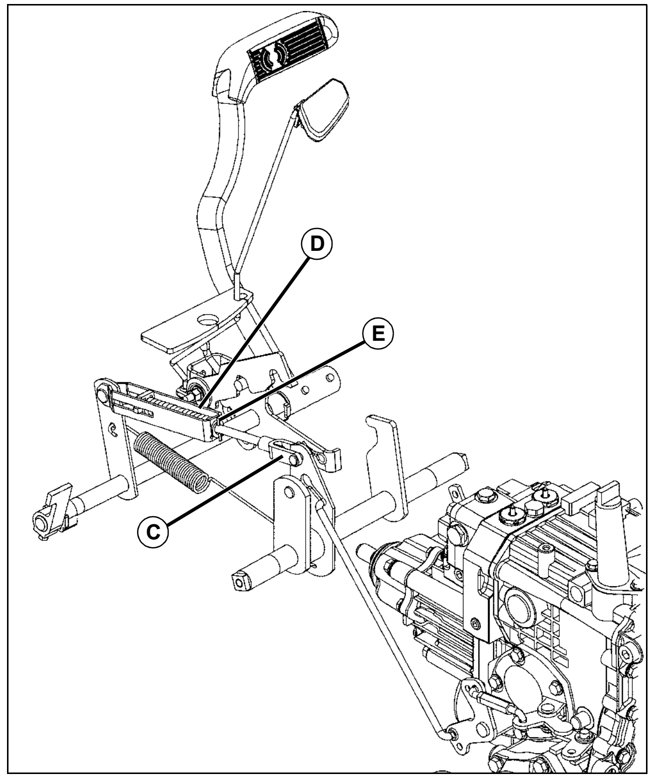
17.If machine will not hold on slope without tires creeping, repeat above steps until machine will hold.

Results:

If the brake/differential linkage adjustment is correct:

- The brake linkage should not have any freeplay with the brake pedal released and the differential lock should not be engaged.
- The differential lock will be engaged when the brakes are engaged.

Note: Brake arm rod (F) may have to be relocated to rear hole (L) if yoke (C) cannot be adjusted to pivot.



MX14384

- With the park brake locked, and using a F67-10-61505 Gauge, the brake rod roll pin (E) must be **3 - 9 mm (0.12 - 0.35 in.)** away from brake rod spring retainer (D). If not, shorten brake rod by rotating brake rod yoke (C) in either direction.
- Engage brake. See if it holds on slope in question.
- If brakes don't hold, this indicates that linkage is “bottoming out” on differential lock, preventing “full” brake engagement, OR brake service is required.

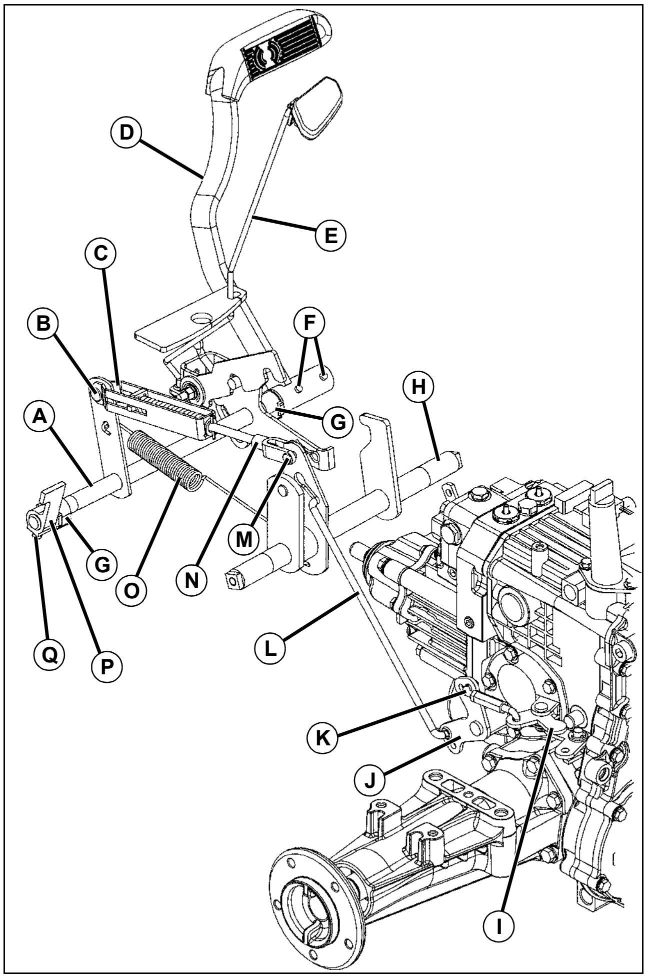
Repair

Brake/Differential Linkage Removal and Installation

Removing:

1. Disconnect negative battery terminal and remove fender deck. See “Fender Deck Removal and Installation” on page 459 in the Miscellaneous section.

2. Remove footrest.

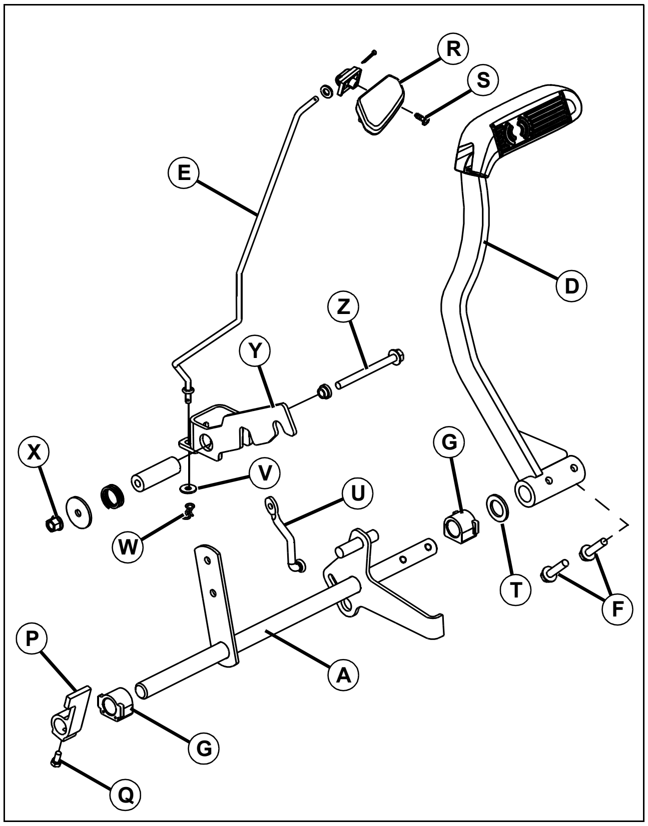


MX14384

A- Brake Shaft
B- PIn
C- Retainer, Brake Spring
D- Brake Pedal
E- Parking Brake Rod
F- Bolts (2)
G- Bearing
H- Mid-lift shaft
I- Differential Lock Arm
J- Brake Arm
K- Link Rod
L- Brake Arm Rod
M- Pin
N- Brake Rod Yoke
O- Spring, Brake Return
P- Striker
Q- Cap Screw

3. Making sure the parking brake is released, and using a suitable spring tool, disconnect brake return spring (O) from mid-Lift shaft (H) and brake shaft (A) arm.

4. Remove spring pin and pin (B) holding brake spring retainer (C) to arm on brake shaft (A).



MIF

5. Loosen nut (Q) and remove striker (P) from end of brake shaft.

6. Remove two bolts (F), washer (T), and brake pedal (D) from brake shaft.

7. Remove bushings (G) on both sides of machine and inspect for wear. Replace, as necessary.

8. Slide brake shaft to left of machine, while carefully removing cruise control disconnect rod (U) from bottom of brake shaft (A).

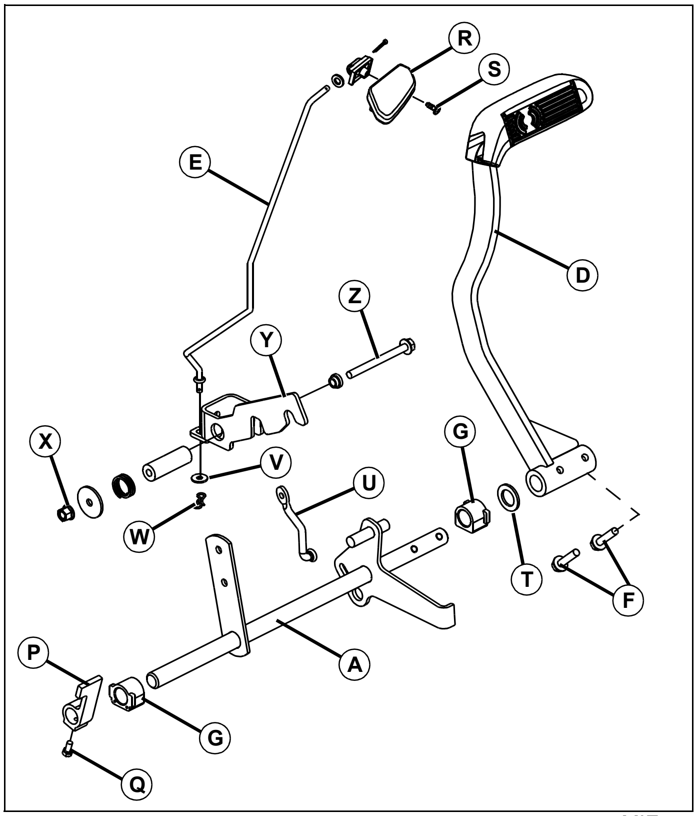
9. Remove brake shaft and inspect for wear or damage. Replace, as necessary.

10.To remove parking brake rod (E) and latch (Y):

- Remove screw (S) and parking brake handle (R).

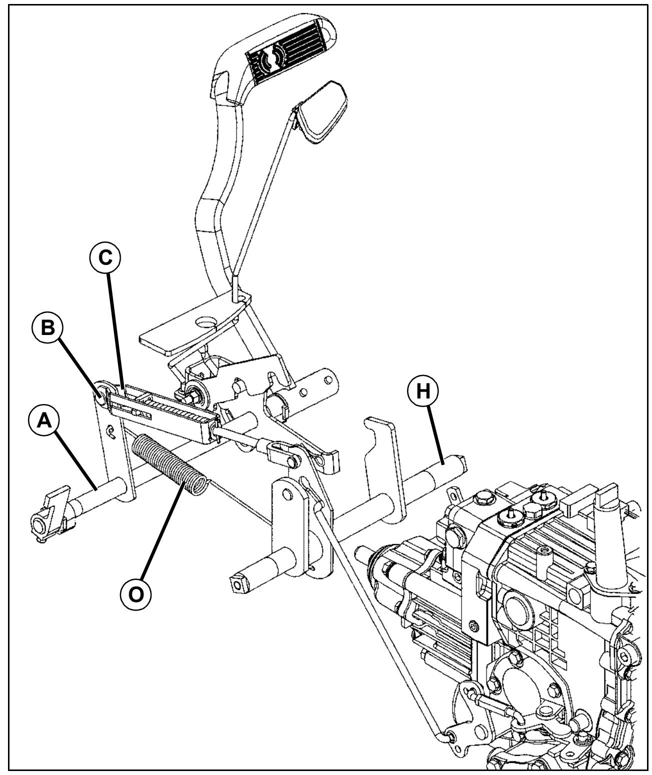
- Remove spring pin (W) and washer (V) from under latch (Y). Raise parking brake rod out of hole in latch (Y), and lower rod from beneath machine.
- Remove latch (Y), by removing nut (X), bolt (Z), and associated hardware.

Installing:



MIF

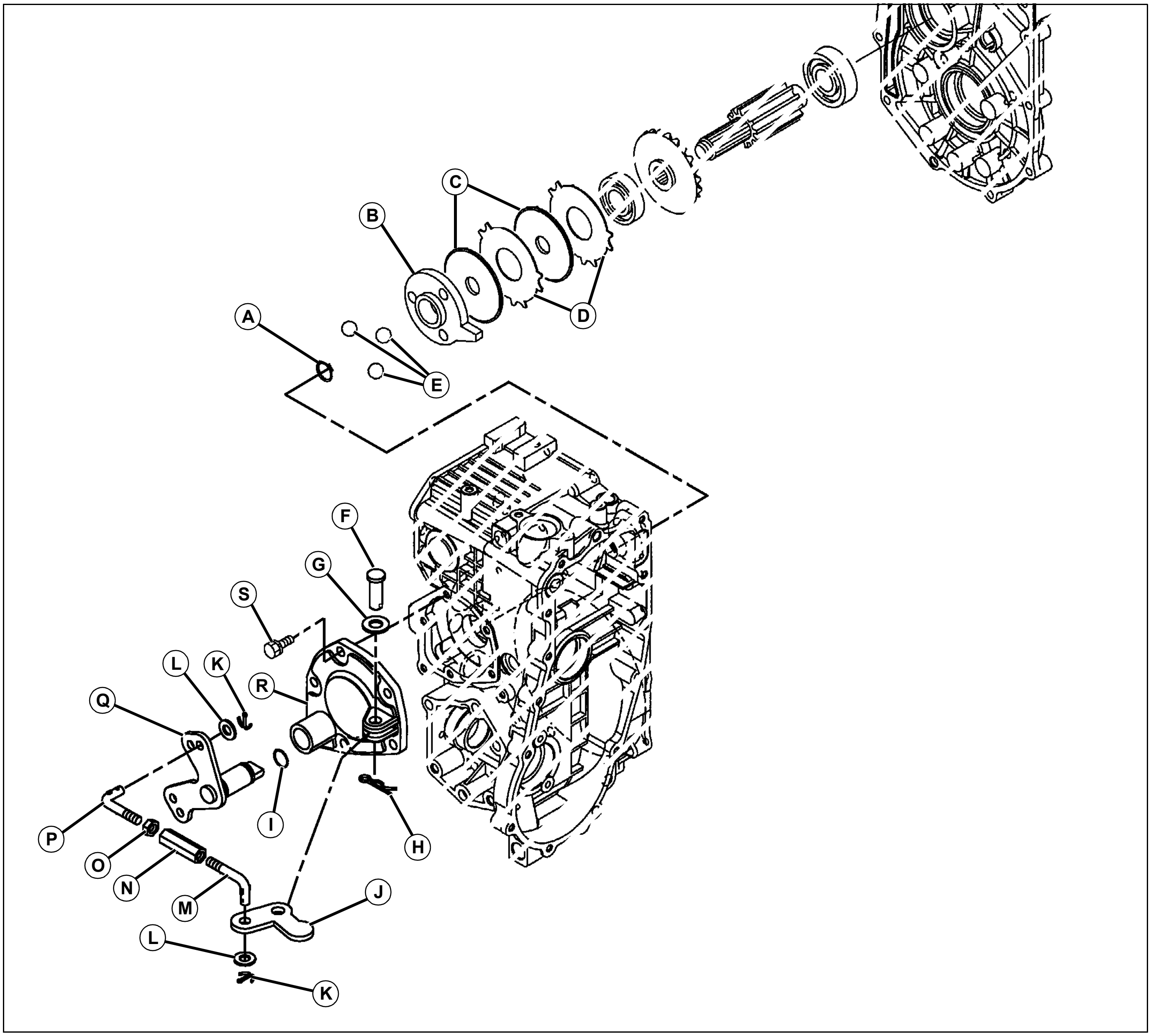
1. To install parking brake rod (E) and latch (Y):
   - Install latch (Y), by installing hardware, bolt (Z) and nut (X).
   - Raise parking brake rod from under machine, and install bottom of rod into latch (Y). Install washer (V) and spring pin (W) under latch (Y).
   - Install parking brake handle (R) and screw (S).
2. Install bushings (G) on both sides of machine.
3. Raise brake shaft (A) right side end into machine frame. Install cruise control disconnect rod (U) to bottom of brake shaft (A).
4. Install brake pedal (D) and washer (T). Secure with two bolts (F).
5. Install striker (P) onto end of brake shaft and secure with nut (Q). When entire brake assembly is installed, adjust brake switch. See “Brake Switch Test and Adjustment” on page 220 in the Electrical section.



MX14384

6. Install brake spring retainer (C) to arm on brake shaft (A), and secure with pin (B) and spring pin.
7. Making sure the parking brake is released, and using a suitable spring tool, disconnect brake return spring (O) from mid-Lift shaft (H) and brake shaft (A) arm.
8. Install footrest.
9. Install fender deck and connect negative battery terminal. See “Fender Deck Removal and Installation” on page 459 in the Miscellaneous section.

Brakes Removal and Installation



MX14424

A- Snap Ring
B- Brake Actuator Plate
C- Friction Plate
D- Steel Plate
E- Steel Ball
F- Clevis Pin
G- Washer
H- Spring Lock Pin
I- O-Ring
J- Interlock Plate
K- Cotter Pin
L- Washer
M- Rod
N- Adjusting Nut
O- Nut
P- Rod
Q- Cam Lever
R- Brake Cover
S- Cap Screw

1. Remove transaxle. See See “Transaxle Removal and Installation” on page 297 in the Hydrostatic Power Train section.

Important: Avoid Damage! Use care not to lose steel balls (E).

2. Inspect components on brake cover (R). Replace as necessary. Apply petroleum jelly to O-ring.

3. Inspect plates for wear or spline damage. If groove pattern in friction plates is no longer visible, replace plates.

4. Apply petroleum jelly to balls (E) and install balls in cover.

5. Install steel plates (D) and friction plates (C) alternately beginning with a steel plate.

6. Apply a bead of John Deere Form-in-Place Gasket to brake cover mating surface of transaxle case.

7. Install brake actuator plate (B) and brake cover assembly (R).

Brake Cover Cap Screw Torque Specifications:

Used Transaxle Case . . . . 25 N•m (18 lb-ft)

New Transaxle Case . . . . 30 N•m (22 lb-ft)

8. Check brake/differential linkage adjustment. See “Brake/ Differential Linkage Adjustment” on page 397.

Table of Contents

Specifications

General Specifications

48-Inch Mower Deck:

Discharge Type	Mulch, Bag or Side
Cutting Height Range	25 - 127 mm (1 - 5 in.)
Weight	53 kg (117 lb)
Cutting Width	122 cm (48 in.)
PTO Gearbox Capacity	0.4 L (13.5 oz)
Belt Tension Spring Length	13.8 cm (5-7/16 in.)
Blade Height	6 mm (0.25 in.) Higher in Rear
Anti-Scalp Wheel Ground Clearance	6 mm (0.25 in.)

54-Inch Mower Deck:

Discharge Type	Mulch, Bag or Side
Cutting Height Range	25 - 127 mm (1 - 5 in.)
Weight	77 kg (170 lb)
Cutting Width	137.2 cm (54 in.)
PTO Gearbox Capacity	0.4 L (13.5 oz)
Belt Tension Spring Length	13.8 cm (5-7/16 in.)
Blade Height	6 mm (0.25 in.) Higher in Rear
Anti-Scalp Wheel Ground Clearance	6 mm (0.25 in.)

62-Inch Mower Deck:

Discharge Type	Mulch, Bag or Side
Cutting Height Range	25 - 127 mm (1 - 5 in.)
Weight	91 kg (200 lb)
Cutting Width	157.5 cm (62 in.)
PTO Gearbox Capacity	0.4 L (13.5 oz)
Belt Tension Spring Length	13.8 cm (5-7/16 in.)
Blade Height	6 mm (0.25 in.) Higher in Rear
Anti-Scalp Roller Ground Clearance	Not Adjustable

Loader Specifications:

Maximum Lift Height To Pivot	1854.2 mm (73 in.)
Maximum Lift Height Under Level Bucket	1752.6 mm (69 in.)
Maximum Clearance Under Fully Dumped Bucket	1447.8 mm (57 in.)
Reach With Bucket Dumped	584.2 mm (23 in.)
Maximum Bucket Dump Angel	45 degrees
2WD: Reach with Bucket On Ground	1128.6 mm (44.43 in.)
4WD: Reach With Bucket On Ground	1098.6 mm (43.25 in.)
Bucket Roll-Back Angle On Ground	25 degrees
Digging Depth Below Ground Level	101.6 mm (4 in.)
Weight	234 kg (515 lb)

ATTACHMENTS SPECIFICATIONS

Loader Hydraulic System:

Rated Pressure	6895 kPa (1000 psi)
Lift Cylinder Diameter	44 mm (1.75 in.)
Bucket Cylinder Diameter	44 mm (1.75 in.)
Break out Force	349 kg (770 lb)
Bucket Rollback Force at Ground Line	336 kg (740 lb)
Lift Capacity at 914 mm (36 in.)	290 kg (640 lb)
Lift Capacity at Full Height	166 kg (365 lb)

Bucket:

Width	1219 mm (48 in.)
Capacity (Struck)	0.14 cu. m (5.0 cu. ft)

Recommended Lubricants:

Gearbox Oil	GL-5 (90W)

Greases - High-Speed:

Blade Spindles (3 places)	John Deere Multi-Purpose SD Polyurea Grease
	or John Deere Multi-Purpose Lithium Complex Grease
PTO Shaft Universal Joints	John Deere Multi-Purpose SD Polyurea Grease
	or John Deere Multi-Purpose HD Lithium Complex Grease

Greases - Other Applications:

Caster Wheels	John Deere Multi-Purpose HD Lithium Complex Grease
	or John Deere Moly High Temperature EP Grease
Caster Wheel Pivot	John Deere Multi-Purpose HD Lithium Complex Grease
	or John Deere Moly High Temperature EP Grease
PTO Shaft Splines	John Deere Multi-Purpose HD Lithium Complex Grease
	or John Deere Moly High Temperature EP Grease

Note: If not using any of the preferred greases, be sure to use a general purpose grease with an NLGI Grade No. 2 rating. Avoid use of John Deere Moly High Temperature EP Grease on high speed applications such as mower spindles and rear axles.

PTO Generator Specifications:

120 VAC (2)	20 Amp, NEMA 5-20R, GFCI Protected Duplex Receptacles
240 VAC (1)	40 Amp, NEMA 6-50 Receptacle
Maximum Output (Intermittent)	10560 watts
Rated Voltage (AC)	120/240
Continuous Output	9600 watts
Frequency	60 Hz
Phase	Single
Weight (Shipping)	112 kg (247 lb)
Weight (Operating)	88 kg (194 lb)
Height (approximate)	78.1 cm (30.75 in.)
Width (approximate)	68.9 cm (27.13 in.)
Length (approximate)	79.4 cm (31.25 in.)
PTO Input Shaft	6 Spline, 1 - 3/8 in. Diameter
Gear Oil	80W90 GL5 Gear Lube
Gear Oil Capacity	0.63 L (23 oz)

ATTACHMENTS SPECIFICATIONS

Circuit Breakers	Discrete Output Thermal
Indicators	Over/Under Voltage Meter
Stator Type	Self Exciting, Dual Output Brushless
Rotor Type	Self Regulating Brushless

Torque and Repair Specifications

48-Inch Mulch, Bag or Side Discharge Mower Decks:

Blade Edge	0.40 mm (0.016 in.)
Blade Cap Screw	68 N•m (50 lb-ft)
Spindle Mounting Lock Nut	26 ± 4 N•m (230 ± 4 lb-in.)
Spindle Sheave Nut	145 N•m (106 lb-ft)
Lower Seal Installation Position	7.8 mm (0.31 in.) below hub flange
Gauge Wheel Roller Shaft Nut	30 N•m (22 lb-ft)
Jack Sheave Nut	136 N•m (100 lb-ft)
Tensioning Idler Sheave Nut	27 N•m (20 lb-ft)

54-Inch Mulch, Bag or Side Discharge Mower Decks:

Blade Edge	0.40 mm (0.016 in.)
Blade Cap Screw	68 N•m (50 lb-ft)
Spindle Mounting Lock Nut	26 ± 4 N•m (230 ± 4 lb-in.)
Spindle Sheave Nut	145 N•m (106 lb-ft)
Lower Seal Installation Position	7.8 mm (0.31 in.) below hub flange
Gauge Wheel Roller Shaft Nut	30 N•m (22 lb-ft)
Jack Sheave Nut	136 N•m (100 lb-ft)
Tensioning Idler Sheave Nut	27 N•m (20 lb-ft)

62-Inch Mulch, Bag or Side Discharge Mower Decks:

Blade Edge	0.40 mm (0.016 in.)
Blade Cap Screw	68 N•m (50 lb-ft)
Spindle Mounting Lock Nut (6 used)	24 ± 4 N•m (18 ± 4 lb-ft)
Spindle Flanged Nut	255 N•m (188 lb-ft)
Support Arm Pivot Lock Nut	134 ± 20 N•m (99 ± 20 lb-ft)
Front Caster Wheel Axle	80 N•m (60 lb-ft)
PTO Gear Box to Frame Cap Screw (4 used)	99 N•m (73 lb-ft)

Loader Specifications:

Hydraulic System Rated Pressure	6895 kPa (1000 psi)
Lift Cylinder Diameter	44 mm (1.75 in.)
Bucket Cylinder Diameter	44 mm (1.75 in.)
Breakout Force	349 kg (770 lb)
Bucket Rollback Force at Ground Line	336 kg (740 lb)
Lift Capacity at 914 mm (36 in.)	290 kg (640 lb)
Lift Capacity at Full Height	166 kg (365 lb)

PTO Generator Electrical Specifications:

Watts (AC) Rated (Continuous) at power factor 1	**9600**
Watts (AC) Rated (Peak)	**10560**
Rated Voltage (AC)	**120/240**
Rated Amperage (120 VAC) at each outlet at 40° C (104° F)	**20**
Rated Amperage (240 VAC) at outlet at 40° C (104° F)	**40**
Frequency	**60 Hz**
Phase	**Single**

Diagnostics

48, 54 and 62-Inch Mower Deck Diagnosis

Special or Required Tools

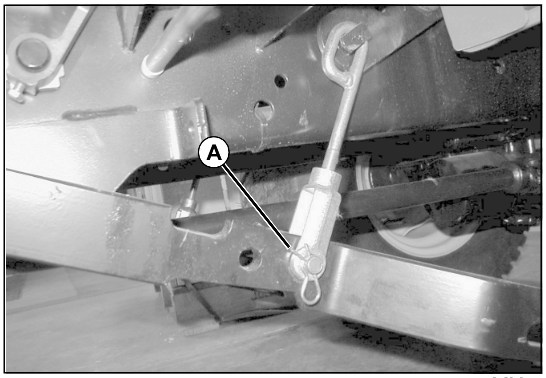
Tool Name	Tool No.	Tool Use
Leveling Gauge	AM130907	To check blade level.

Test Procedure A

Test Conditions:

- Machine parked safely.
- PTO disengaged.

Mower Deck Linkage



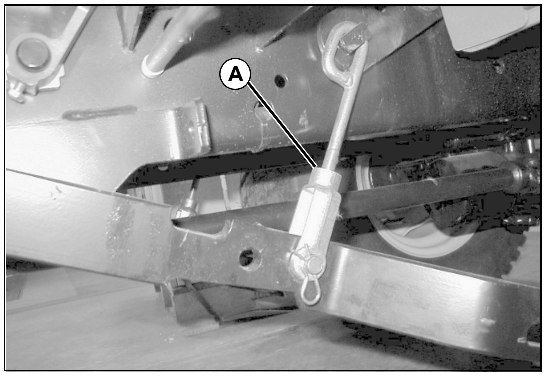
MX11041

1. Is the mounting hardware (A) in place and secure?

Yes: Go to the next step.

No: Tighten or replace hardware.

Mower Deck Level

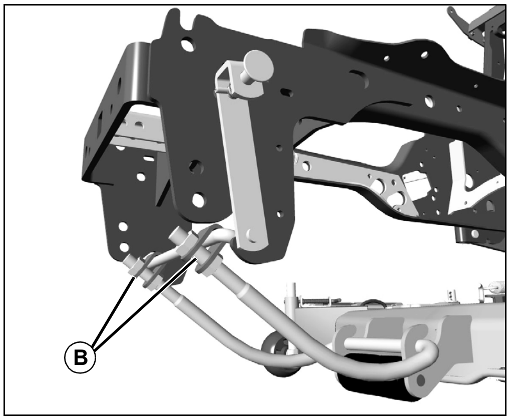


MX11041

1. Is mower deck level side-to-side?

Yes: Go to step.

No: Adjust clevis (A) as needed. See “Mower Deck Level Check and Adjustment” on page 414.



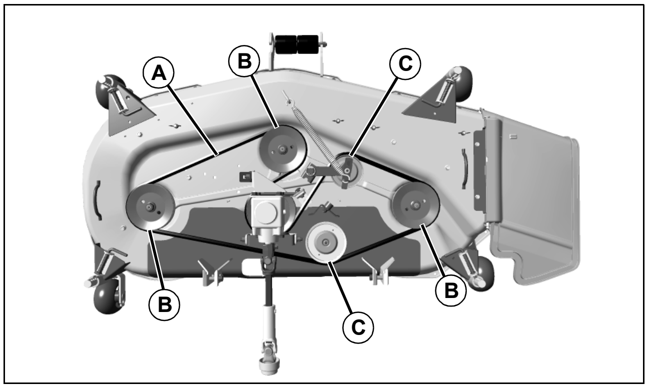
MX11040a

2. Is mower deck level front-to-back?

Yes: Go to next step.

No: Adjust linkage (B) as needed. See “Mower Deck Level Check and Adjustment” on page 414.

Mower Deck Drive Belt



MX11043a

1. Are the drive belt (A), sheaves (B), and pulleys (C) free of debris?

Yes: Go to next step.

No: Remove belt shields and remove debris.

2. Is the drive belt slipping?

Yes: Check for worn belt or debris around sheaves or mower plugged.

No: Go to the next step.

3. Is the correct belt installed?

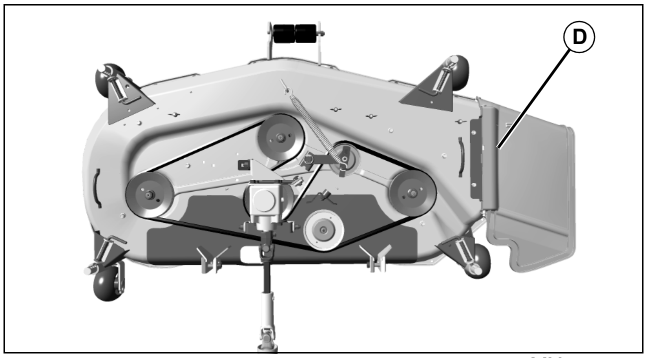
Yes: Go to the next step.

No: Replace belt.

4. Is the drive belt damaged, worn, stretched or broken?

Yes: Replace belt if necessary.

No: Go to the next step.



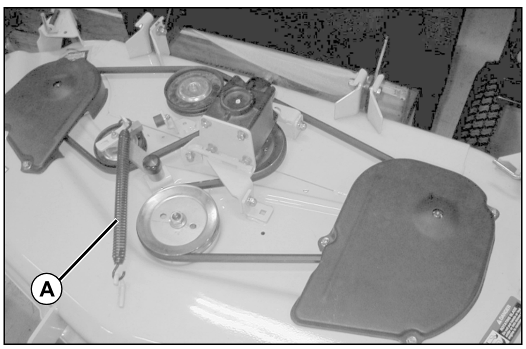
MX11043a

5. Is the discharge chute (D) plugged?

Yes: Check to see if belt is installed correctly.

No: Go to the next step.

Mower Drive Belt Tension Spring



MX11047

1. Is the tension spring (A) damaged, worn or weak?

Yes: Replace spring.

No: Go to the next step.

Spindle and Housing

1. Is the spindle sheave running straight and true, not damaged or bent?

Yes: Go to the next step.

No: Repair or replace as needed.

2. Is the belt off sheave?

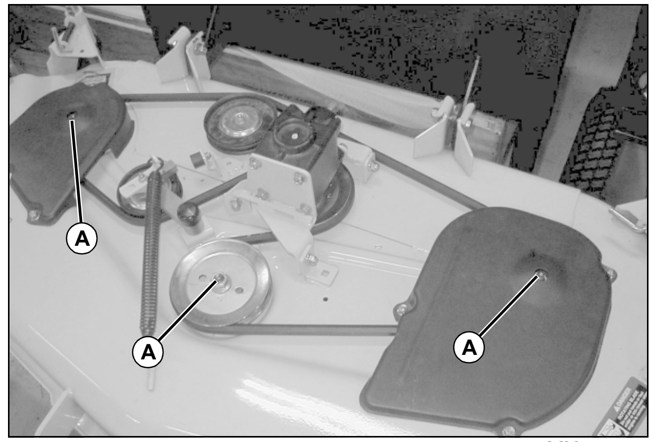
Yes: Install or replace belt.

No: Go to the next step.

3. Is there material wrapped around spindle or blade?

Yes: Remove material.

No: Go to the next step.



MX11047

4. Is the spindle (A) properly lubricated?

Yes: Go to the next step.

No: Apply specific grease to lube fittings at top of spindle.

5. Are bearing free of ware or damage and rotate smoothly?

Yes: End test.

No: Repair or replace spindles as needed.

Mower Blades

1. Are blades tight on spindle?

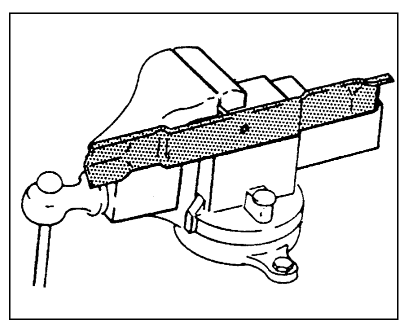
Yes: Go to the next step.

No: Tighten blade cap screw. See “Mower Deck Blade Removal and Installation” on page 420.

2. Are the blades bent, worn or damaged?

Yes: Replace blades.

No: Go to the next step.



M61524

3. Are the blades properly sharpened and balanced?

Yes: Go to the next step.

No: Sharpen and balance blades.

4. Is the cut even?

Yes: Go to the next step.

No: Sharpen and balance blades.

5. Is there too much vibration?

Yes: Balance blades.

No: Go to the next step.

6. Does the mower load down tractor?

Yes: Check for bent blades.

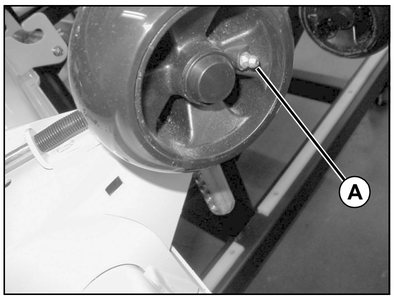
No: Go to the next step.

7. Are the blades scalping the grass?

Yes: Check for bent blades.

No: End test.

Gauge Wheel Assemblies



MX11044

1. Are the gauge wheel assemblies properly lubricated?

Yes: End test.

No: Apply specified grease to pivot lubrication fittings (A) on each gauge wheel.

Test Procedure B

Test Conditions:

- Machine parked on a clean, level surface, away from people and objects.
- Engine running at fast idle.
- Engine at operating temperature.
- Mower deck lowered to the ground.
- PTO engaged.

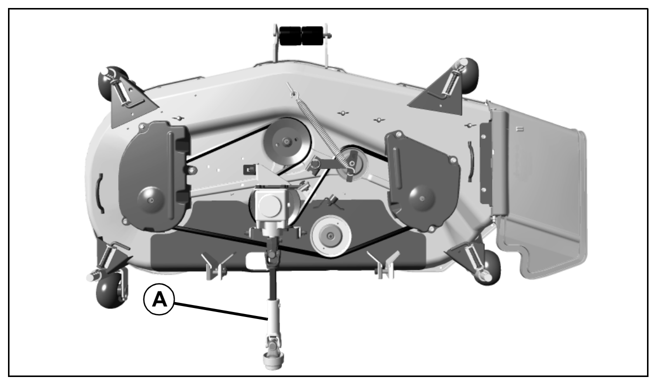
Engine

1. Is the engine running at the correct RPM?

Yes: End test.

No: Check engine operation. See Engine Section.

Mower Deck Drive Shaft



MX11043

1. Is the drive shaft (A) operating smoothly, without any unusual noises, or vibrations?

Yes: Go to the next step.

No: Slowly reduce engine rpm and listen for problem area. Disengage PTO and stop engine. Repair or replace faulty or damaged components.

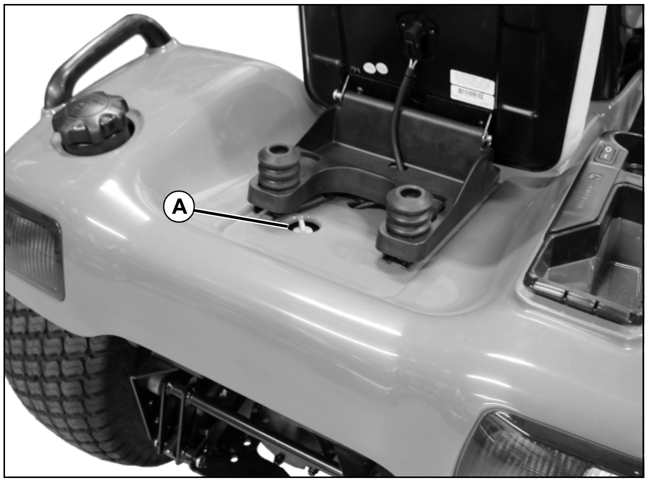
45 Loader Diagnosis

Test Procedure A

Test Conditions:

- Machine parked safely.

Hydraulic System



MX12364

1. Is the loader operation slow or jerky?

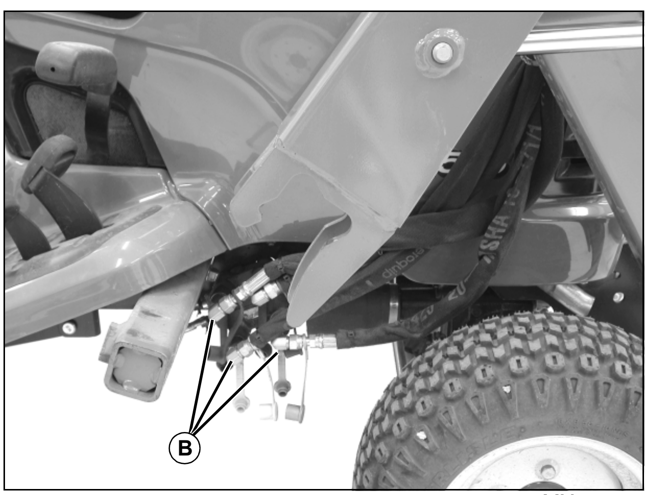
Yes: Check transaxle oil level at filler (A).

No: Go to the next step.

2. Is the loader operation slow or jerky?

Yes: Replace transaxle filter.

No: Go to the next step.

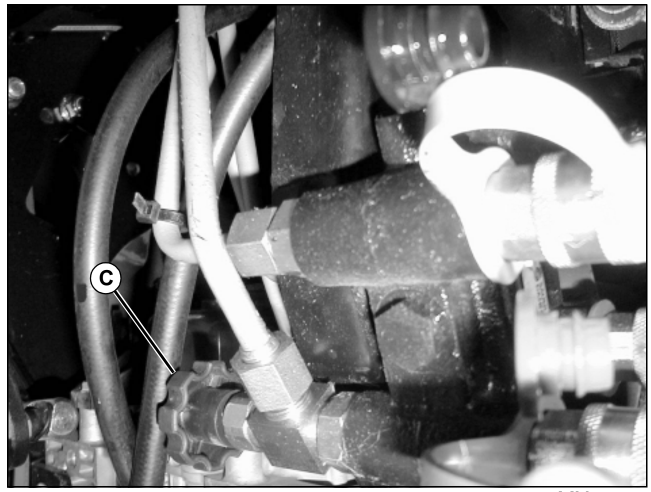


MX13537

3. Is the loader operation slow or jerky?

Yes: Check hydraulic circuit (B) for oil leaks.

No: Go to the next step.

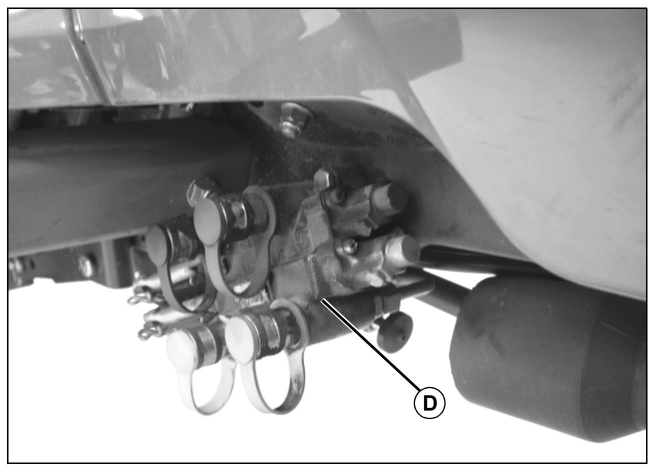


MX8268

4. Is the loader operation slow or jerky?

Yes: Check to ensure that lift cylinder shut-off valve (C) is completely closed.

No: Go to the next step.

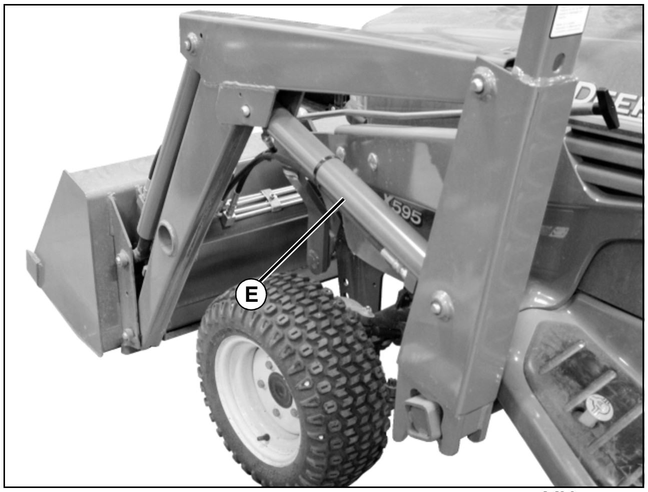


MX13535

5. Does the bucket or lift arms drift down from raised position?

Yes: Check control valve (D) for damaged O-rings, wiper seals, or internal leakage.

No: Go to the next step.

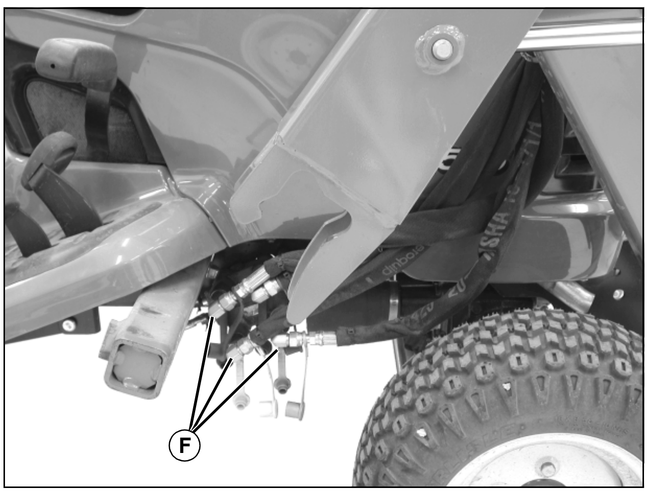


MX12362

6. Are there oil leaks or insufficient lift capacity?

Yes: Check cylinders (E) for damaged O-rings, wiper seals, or internal leakage.

No: Go to the next step.



MX13537

7. Are the cylinders inoperative?

Yes: Check the connection (F) between control valve and cylinder hoses.

No: Test complete.

Tests and Adjustments

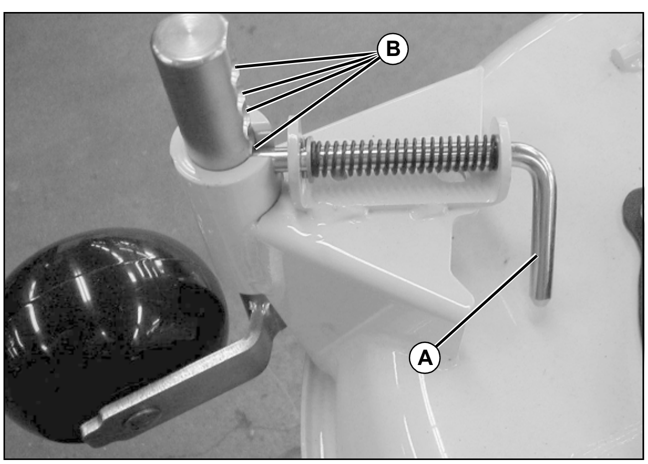
Adjusting Cutting Height (48C, 54C, and 62C Mower Deck)

Mower cutting height can be adjusted from approximately 25 - 127 mm (1-5 in.), depending on the machine. When lift lever is in highest (transport) position, cutting height is approximately 127 mm (5 in.), 114.3 mm (4.5 in.) for AWS.

1. Stop machine on a hard, level surface.
2. Pull back top hydraulic lever to raise mower deck to highest (transport) position.
3. Turn cutting height knob to desired cutting height. Mower will be at that cutting height when it is lowered.
4. Push forward top hydraulic lever to lower mower deck.
5. Park machine safely. See Parking Safely in the Safety section.
6. Check that the actual height-of-cut matches, within 6.35 mm (1/4 in.), the reading on the cutting height knob. If they do not match, adjust mower deck side-to-side and/or front-to-rear.

Adjusting Mower Deck Wheels

1. Inflate vehicle tires to correct pressure.
2. Raise mower deck to highest (transport) position and adjust cutting height.
3. Lower deck to mowing position.
4. Park machine safely. See Parking Safely in Safely section.



MX11075

5. Pull gauge wheel release rod (A) and position wheel in correct hole (B). See decal located on deck.

Mower Deck Level Check and Adjustment

Adjusting Cutting Height:

Caution: Avoid Injury! Mower blades may be sharp. Wear heavy gloves or wrap the blade edges with a rag to prevent injury during handling.

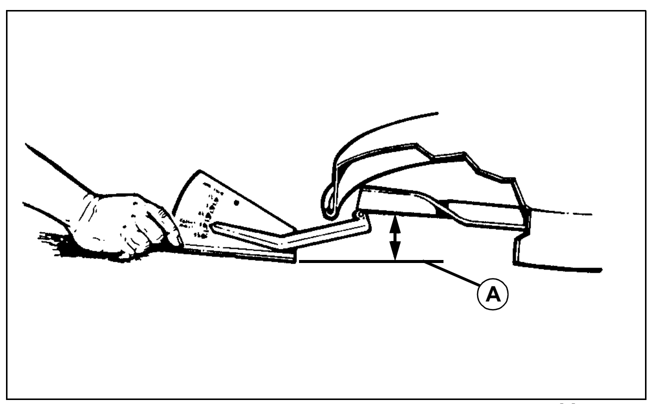
Special or Required Tools

Tool Name	Tool No.	Tool Use
Leveling Gauge	AM130907	To check blade level.

1. Park machine safely. See Parking Safely in Safely section.
2. Lower mower deck to the ground.
3. Inflate vehicle tires to correct pressure.
4. Set mower deck to desired cutting height.
5. Make sure that mower deck wheels and rear hangers are set to the same height.
6. Adjust anti-scalp wheel to proper height specification on left and right side of mower deck.

Caution: Avoid Injury! Mower blades may be sharp. Wear heavy gloves or wrap the blade edges with a rag to prevent injury during handling.

7. Turn the blade until parallel to front axle.



M40137

8. Measure distance (A) from tip of outside blade to the ground using AM130907 Leveling Gauge. Repeat steps 7 and 8 for outer blade tip on opposite side of deck.
9. Turn outer mower blades to face front-to-rear, perpendicular to front axle.
10. Measure distance from front left and right blade tips to ground. Repeat step for left and right blade tips.

Results:

- The blade cutting heights should be equal side-to-side.
- The blade height front-to-rear should be to the specified difference.

Mower Blade and Mower Deck Wheel Heights

Mower Deck Wheel
. . . . . 6-13 mm (1/4-1/2 in.) from the ground
Rear Blade Tip Higher Than Front Blade Tip
. . . . . 6 mm (0.25 in.)

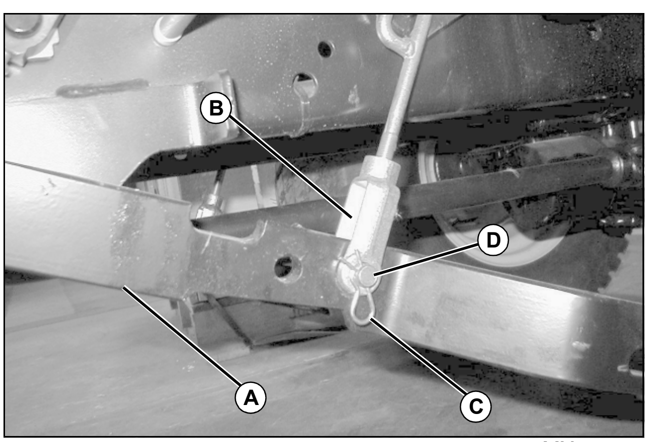
Adjusting Mower Level Side-to-Side

Caution: Avoid Injury! Rotating blades are dangerous. Before adjusting or servicing mower:

- **Disconnect spark plug wire(s) to prevent engine from starting accidently.**
- **Always wear gloves when handling mower blades or working near blades.**

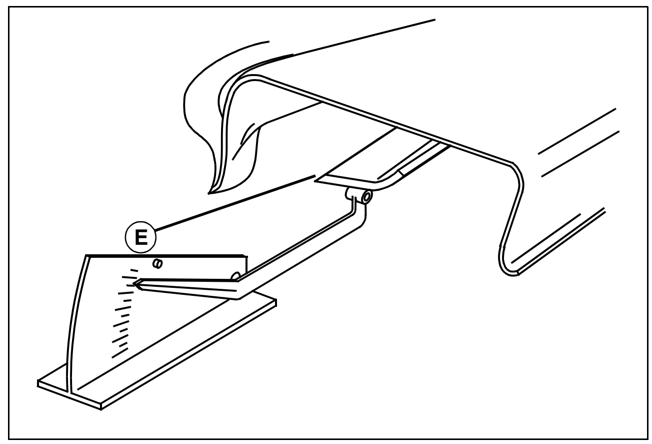
Important: Avoid Damage! Mower deck lift system can be damaged if lift arms are not adjusted correctly. Check adjustment each time mower is installed to allow gap between lift arms and frame stop at full lift height.

1. Park machine safely. See Parking Safely in Safely section.
2. Inflate vehicle tires to correct pressure.
3. Pull back top hydraulic lift lever to raise mower deck to highest (transport) position.



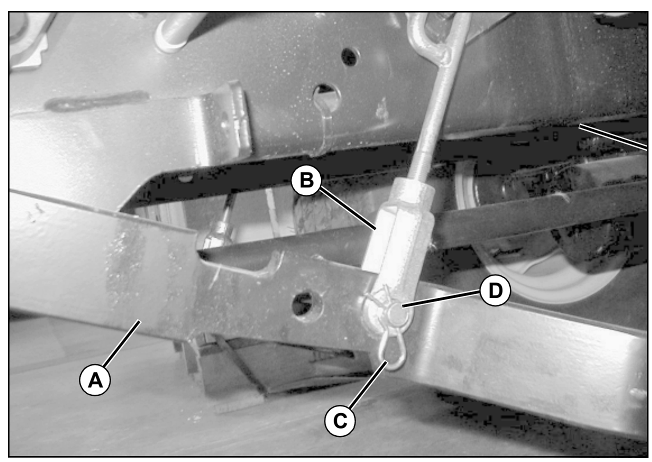
MX11041

4. Check that the lift arm (A) does not contact frame stop. If needed, adjust yokes (B) on both sides of mower until there is a slight gap of 1.6 mm (1/16 in.) on both sides.
   - Remove spring locking pin (C) and drilled pin (D) from each lift arm.
   - Turn each yoke (B) clockwise to raise lift arm.
   - Turn each yoke counterclockwise to lower the lift arm.
   - Attach each yoke to lift arm with drilled pin (D) and spring locking pin (C).
5. Lower mower deck to level surface.
6. Turn left blade parallel to axle and complete measurement. Hold drive belt and turn right blade parallel to axle and complete measurements.



MIF

7. Measure from each outside blade tip (E) to the level surface.
8. Adjust deck side to side until measurement is equal.



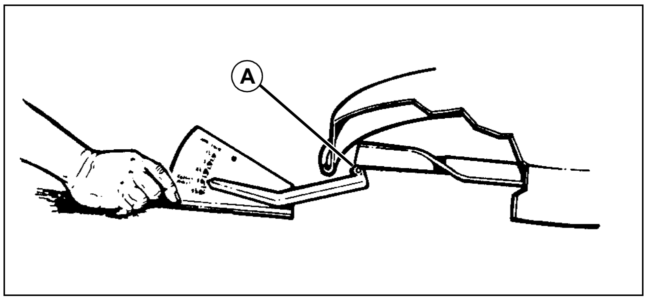
MX11041

9. Remove spring locking pin (C) and drilled pin (D) from each lift arm (A).
10. Adjust yoke until deck is level side to side.
    - Turn yoke (B) counterclockwise to lower mower deck.
    - Attach yoke to lift arm with drilled pin and spring locking pin.

Adjusting Mower Level Front-to-Rear

Checking Procedure:

1. Lower mower deck to level surface.
2. Park machine safely. See Parking Safely in Safely section.
3. Inflate vehicle tires to correct pressure.
4. Turn right blade so tip points straight forward.
5. Hold drive belt and turn left blade until blade tip also points straight forward.

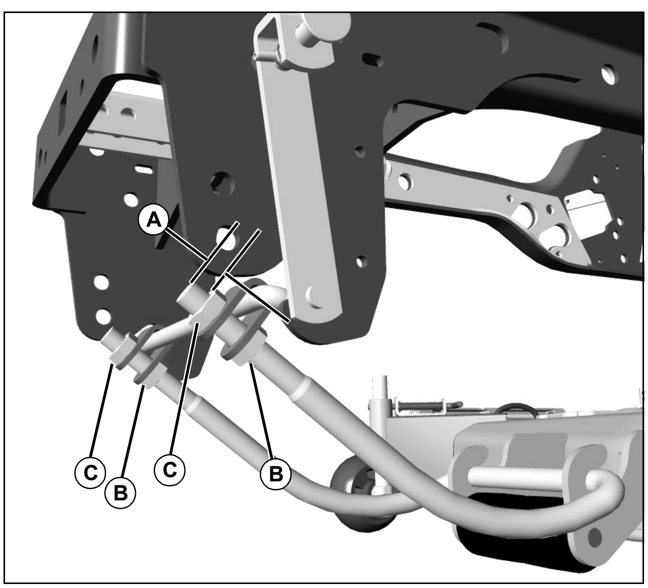


M40137a

6. Measure from front (A) and rear of each blade tip to the level surface.
7. The front of blade should be 6mm (0.25 in.) lower than the rear of blade.

Adjusting Procedure:

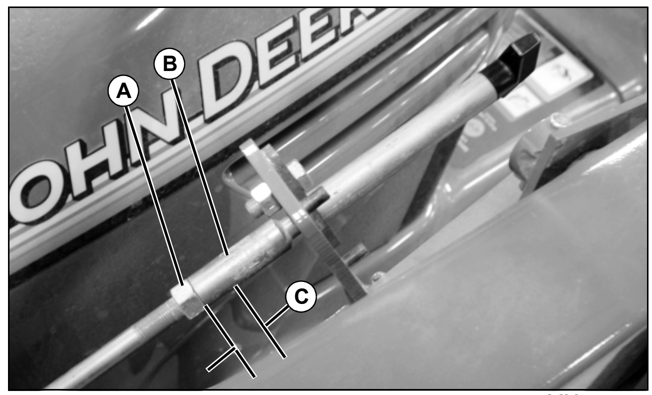
1. Lower mower deck to level surface.
2. Park machine safely. See Parking Safely in Safely section.



MX11040a

3. Measure distance (A) from end of nut to end of bolt. This measurement should be the same on each side of the front deck hanger.
4. Loosen two rear nuts (B) on front deck hanger.
5. Adjust two front nuts:
   - Turn two front nuts (C) clockwise to raise front of mower deck.
   - Attach yoke to lift arm with drilled pin and spring locking pin.
6. Measure distance (A) from end of nut to end of bolt. This measurement should be the same on each side of the front hanger.
7. Tighten rear nuts after making adjustment.
8. Measure blade tip again and adjust front deck hanger if necessary.

Adjusting Latch Rod



MX12365

1. Loosen jam nut (A) on end of latch rod (B).
2. Turn latch rod (B) in or out to obtain require length.
3. Make sure there is at least 13 mm (0.50 in.) (C) of thread engagement on end of latch rod (B).
4. Tighten jam nut.

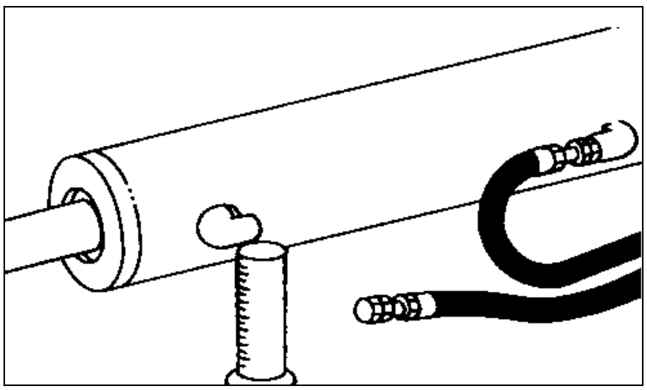
Cylinder Leakage Test

Reason

To make sure cylinder leakage is within allowable limits, allowing proper hydraulic circuit operation.

Procedure

1. Start engine and drive machine for 5 - 10 minutes to warm hydraulic oil.
2. Lock park brake.
3. Start engine and fully extend cylinder rod.
4. Stop engine and activate a hydraulic function to relieve pressure in the system.



T6222AL

5. Disconnect rod end hose and install a plug in hose end.
6. After oil stops dripping from cylinder port, put a measuring beaker under the cylinder port to catch oil.
7. Start engine and operate at slow idle. Actuate the cylinder extend function for one minute.
8. Stop engine. Measure oil collected and connect hose.
9. Repeat procedure to test each cylinder.

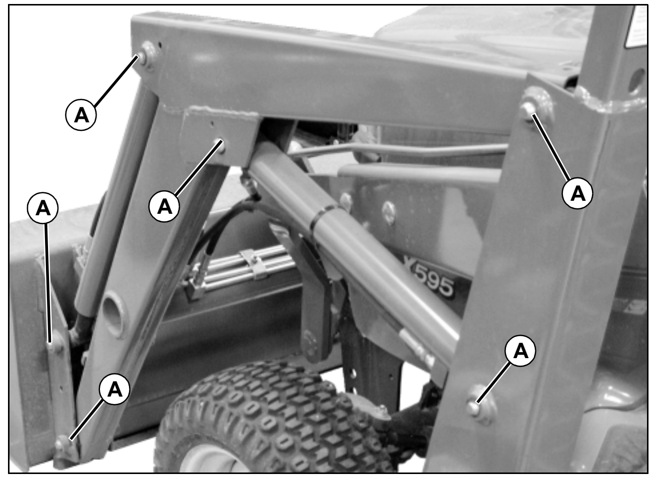
Results

If measured oil is not within specifications, repair cylinder as necessary.

Specification:

Cylinder Leakage . . . . 5 mL/min (1/6 oz/min)

45 Loader Lubrication



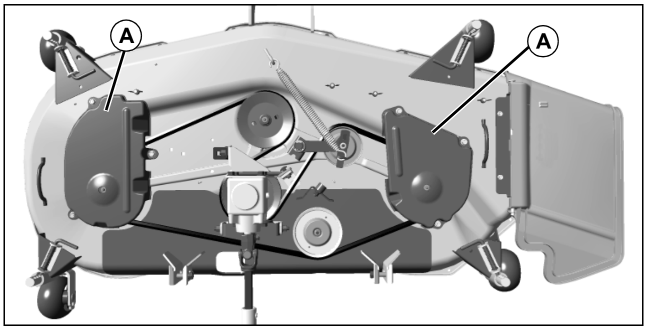
MX12362

Lubricate six pivot points (A) on each side of loader by pumping grease into grease fittings.

Repair

Cleaning Grass and Debris From Machine

Important: Avoid Damage! Clean under deck shields and in the engine compartment before each use to help prevent heavy grass and thatch build-up on the machine.



MX8825

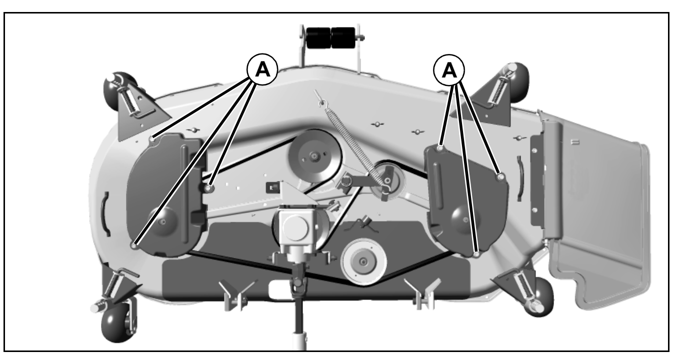
1. Remove belt shields (A) from mower deck.
2. Lift belt shields up off of the attaching bolts.
3. Inspect belt shields for cracks, wear or damage. Replace if necessary.
4. Installation is done in the reverse order of removal.

Mower Deck Belt and Shield Removal and Installation

Procedure:

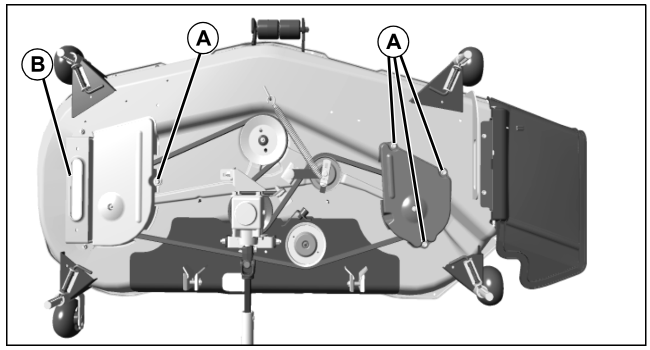
Caution: Avoid Injury! To avoid personal injury, make sure engine is off and mower deck PTO and drive belt have stopped before removing belt shields.

1. Park machine on level surface.
2. Remove mower deck from machine.



MX11043

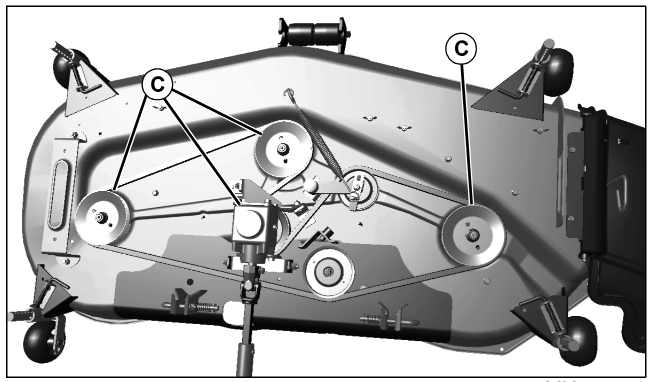
Picture Note: 54-Inch Mower Deck



MX11055

Picture Note: 62C-Inch Mower Deck

3. Loosen six hex nuts (A) securing belt guard cover to mower deck. On 62C mower deck, left belt guard has only one hex nut to remove. Do not remove step (B).



MX19469

4. Clean top of mower deck and area around all of the sheaves (C) of debris.
5. Lift belt shield up off of the attaching bolts.
6. Inspect belt shield for cracks, wear or damage. Replace if necessary.

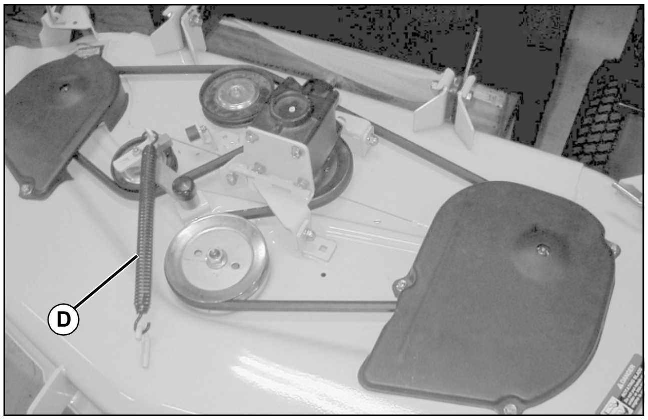
Important: Avoid Damage! To prevent damage to mower belt:

- **Do not clean belt using parts cleaning solvent or belt dressing. They soften belt and shorten belt life.**

7. Clean and inspect belt for damage.
   - If belt does not need to be replaced, stop here. Install belt shields.
   - If belt needs to be replaced, continue with next step.

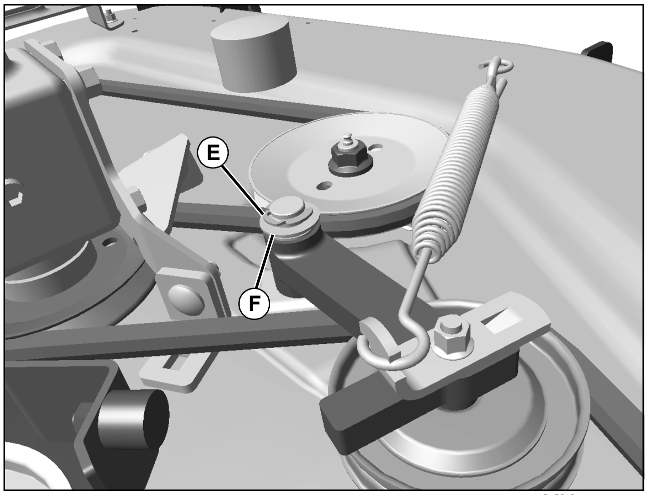
Caution: Avoid Injury! To prevent injury when removing idler spring:

- **Wear eye protection.**
- **Use a locking pliers.**



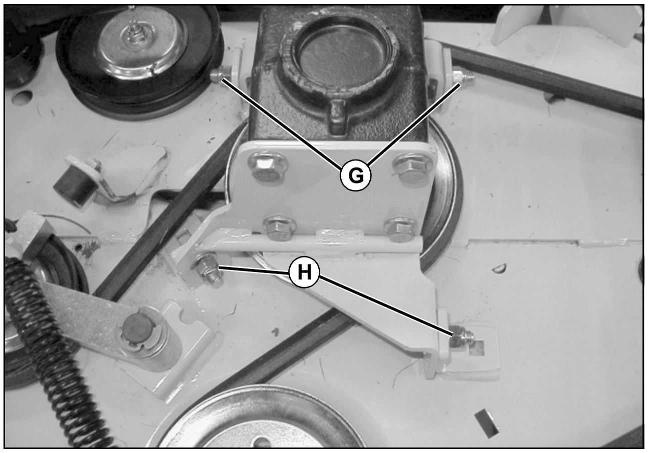
MX11047

8. Remove idler tension spring (D) to relieve tension on belt.



MX19468

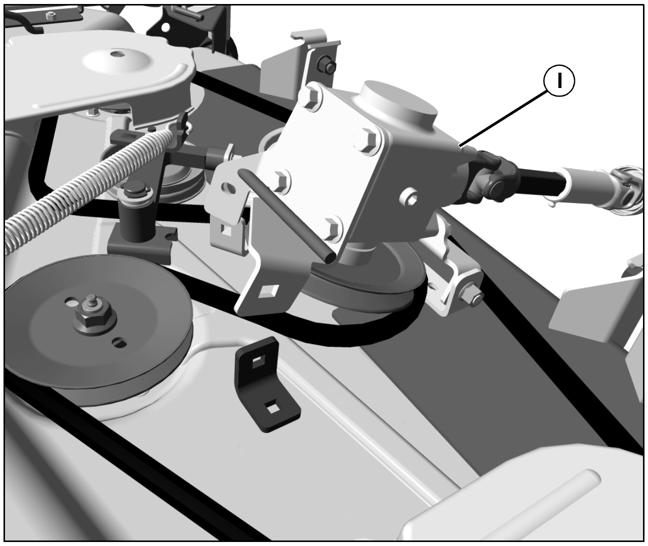
9. Remove clip (E) and washer (F). Lift idler arm up to remove belt.



MX11051

10. Loosen two nuts (G) on rear gearbox.

11. Remove two front nuts and carriage bolts (H).



MX11050

12. Tilt gearbox (I) forward and remove deck drive belt.

13. Remove belt from all spindle sheaves. Discard belt.

14. Installation is in reverse order.

Specification:

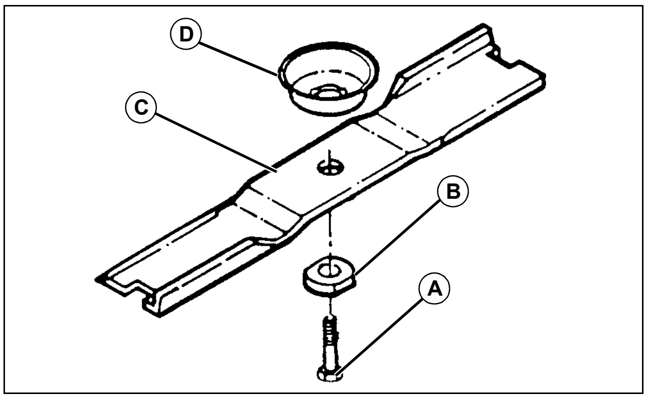
Gearbox-to-Deck Frame Cap Screws . . 73 N•m (54 lb-ft)

Mower Deck Blade Removal and Installation

Removal:

> **Caution: Avoid Injury! Service mower blades safely.**
>
> - **Disconnect spark plug wires or negative (-) battery cable to prevent accidental startup.**
> - **Mower blades are sharp. Always wear gloves when handling or working near blades.**

1. Park machine safely. See Parking Safely in the Safety section.
2. Remove mower from machine.
3. Turn mower over and place a block of wood between blade and mower deck to prevent blade from turning when removing bolt.



M74256

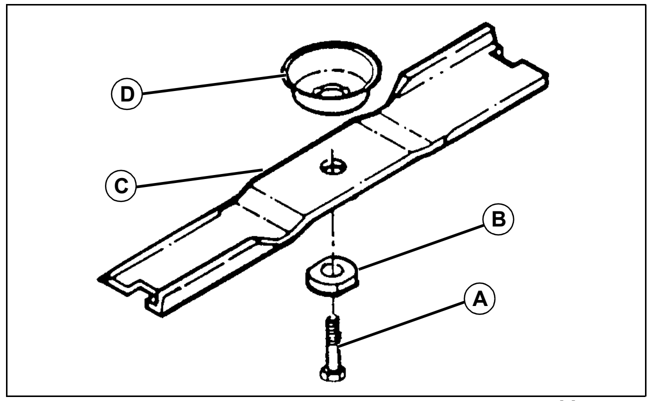
4. Remove bolt (A) with washer (B), blade (C) and deflector (D).
5. Inspect blade for cracks, wear or damage, sharpen balance or replace blades as necessary.
6. Tighten bolt to 68 N•m (50 lb-ft).

Installation:

> **Caution: Avoid Injury! The blade is sharp. To help prevent personal injury, wear heavy gloves or wrap the end of the blade with a rag.**

- Installation is done in the reverse order of removal.

> **Important: Avoid Damage! Improperly installed blades can loosen during operation. Do not lubricate or use power tools when installing the blade bolt or the bolt will be ineffective.**
>
> **Use a hand torque wrench and tighten bolts to blade bolt torque of: 68 N•m (50 lb-ft).**



M74256

- Check that deflector cup (D) is properly seated between mower spindle and blade (C).
- Install blade with bent tip up.
- Install and hand-tighten bolt (A) with washer (B) until mower blade is in full contact with spindle.
- Make sure to install blade washer with concave side toward blade.
- Tighten blade cap screw to specification.

Specification:

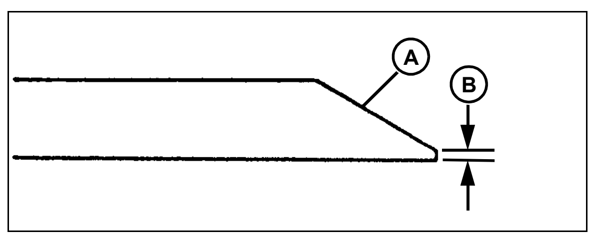
Blade Cap Screw Torque . . . . 68 N•m (50 lb-ft)

Mower Deck Blade - Sharpen

Procedure:

> **Caution: Avoid Injury! Wear goggles and gloves when sharpening mower blades.**

1. Sharpen blade using grinder, file or power sharpener.



M61830

2. Do not alter original bevel (A) of 30°. Maintain blade cutting edge (B) to specification, rather than a razor-type edge.
3. Balance blade.

Specification:

Blade Cutting Edge . . . . 0.40 mm (0.016 in.)

Mower Deck Blade - Balance

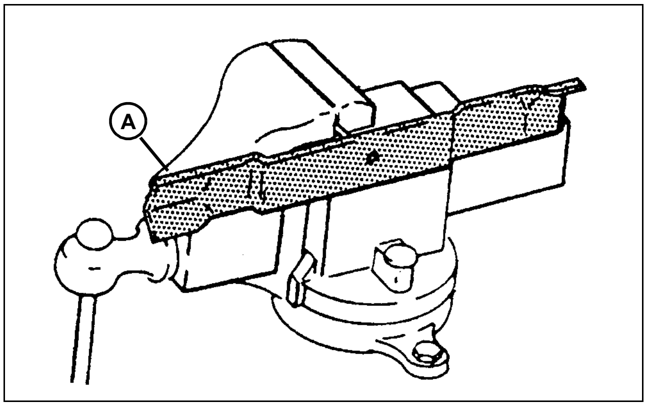
Procedure:

> **Caution: Avoid Injury! Wear gloves or wrap blade with rag to prevent personal injury.**

> **Important: Avoid Damage! Balance blades after sharpening or mower deck may vibrate excessively.**

1. Clean and inspect blade.

2. Sharpen blade. See “Mower Deck Blade - Sharpen” on page 420.



M61524

3. Put blade on a nail in a vise or wall stud.

4. Turn blade to the horizontal position (A). If the blade is not balanced, the heavy end will drop.

5. Grind blade edge of heavy end. Do not alter original blade bevel angle of 30°.

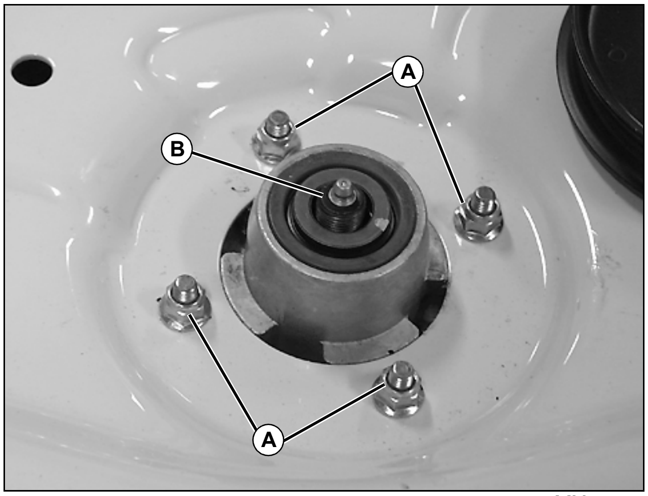
48C Mower Deck Spindle Removal and Installation

Removal 48C:

> **Caution: Avoid Injury! To help prevent personal injury, wear heavy gloves or wrap the end of the blade with a rag.**

1. Remove drive belt. See “Mower Deck Belt and Shield Removal and Installation” on page 418.

2. Remove mower blade.



MX9609

3. Remove four nuts and washers (A) and spindle (B).

4. Make repairs as necessary. See “Spindle Disassembly/ Inspection” on page 421.

Installation is done in the reverse order of removal:

- Tighten spindle mounting lock nuts to 26 N•m (230 lb-in.).

> **Important: Avoid Damage! Install blade with bent tips up. Install blade washer with concave side to blade.**

- Install blade and tighten blade cap screw to 68 N•m (50 lb-ft).

Specification:

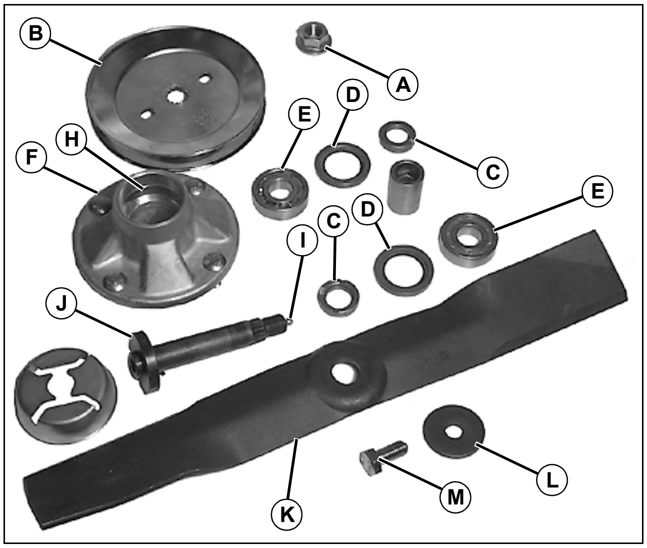
Blade Cap Screw Torque . . . . 68 N•m (50 lb-ft)
Spindle Mounting Lock Nut Torque
. . . . . 26 ± 4 N•m (230 ± 4 lb-in.)

Spindle Disassembly/Inspection

> **Caution: Avoid Injury! To help prevent personal injury, wear heavy gloves or wrap the end of the blade with a rag.**

> **Important: Avoid Damage! Do not install hexagon end of spindle shaft in a vise to remove spindle sheave nut. The hexagon end of the spindle shaft will be damaged resulting in improper blade operation.**

Note: Remove bearings only if replacement is necessary.



MX9610

1. Install blade (K), washer (L), and cap screw (M) on spindle shaft. If only the nut (A) or spindle sheave (B) need to be replaced, and the spindle is still in the deck, use a block of wood to prevent the blade from turning. If spindle is not in the deck, put blade in a soft-jaw vise. Tighten cap screw (M) to 68 N•m (50 lb-ft).

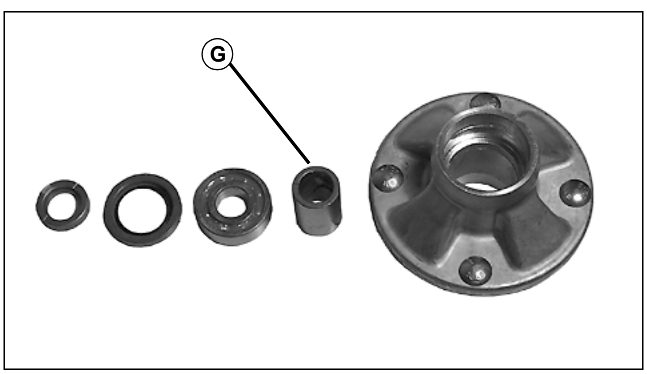
2. Hold the blade with a vise or a block of wood. Remove nut (A), spindle sheave (B), and lubrication fitting (I).

3. Remove cap screw, washer and blade.

4. Pull spindle shaft (J) out of spindle hub (F).

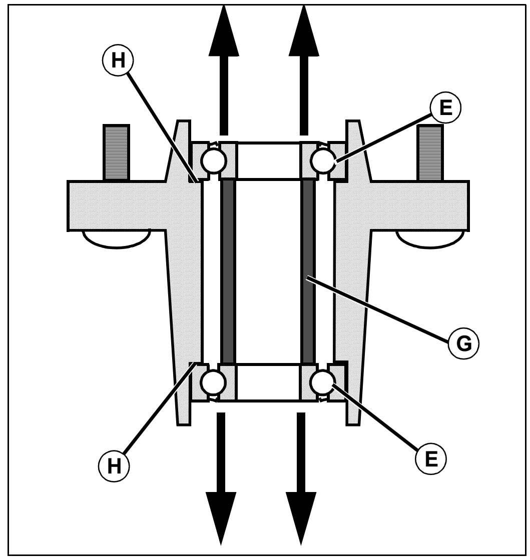
5. Remove seal rings (C) noting location of notched side.

6. Remove seals (D) and bearings (E) using a punch. Bearings (E) are seated against hub shoulder (H) and cannot be removed with a press.



MX9612

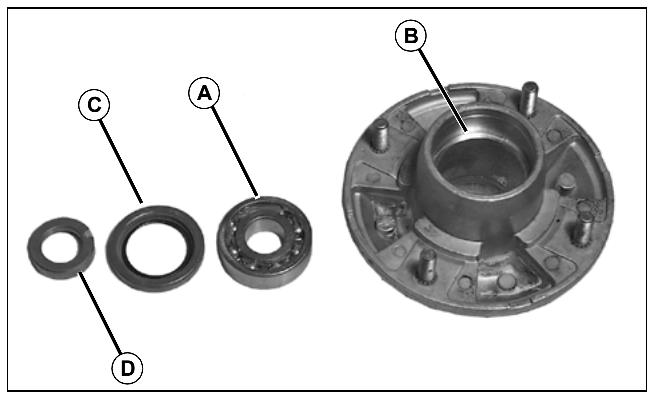
7. Remove spacer (G).



MIF

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

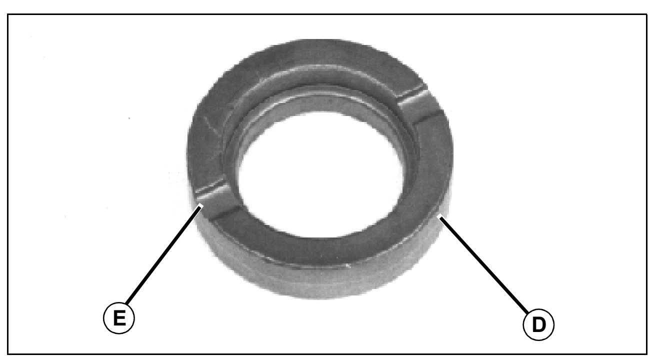
Assembly 48C:



MX9611

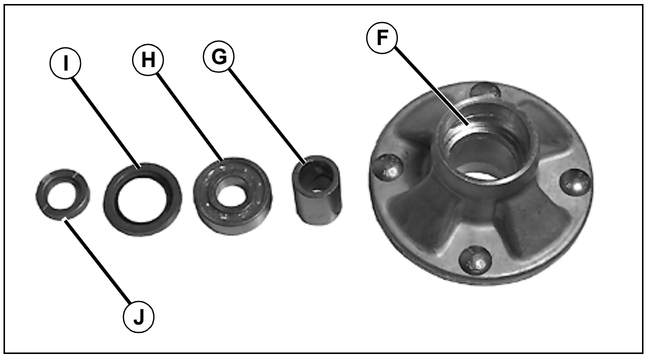
1. Install upper bearing (A) tight against spindle hub shoulder (B) using a 1-13/16 disk and press.

2. Install upper seal (C) with lip toward bearing, tight against bearing using a 1-13/16 disk and press.



M44950

3. Install upper seal ring (D), with grease notch (E) toward bearing, inside seal lip.

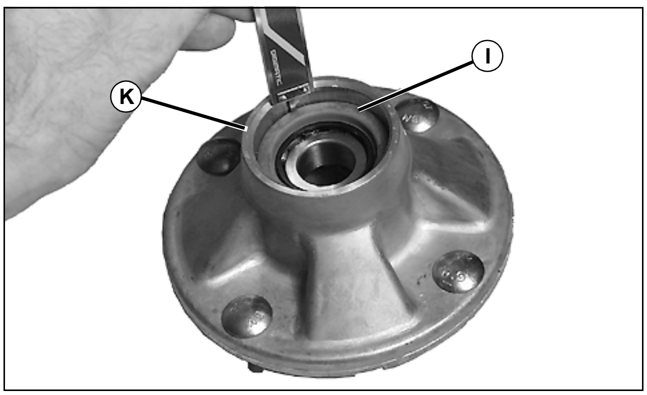


MX9612

4. Install spacer (G).

Important: Avoid Damage! Do not press lower bearing (H) tight against hub shoulder (F). The bearing and seal must be installed to a specific dimension for proper sealing of spindle.

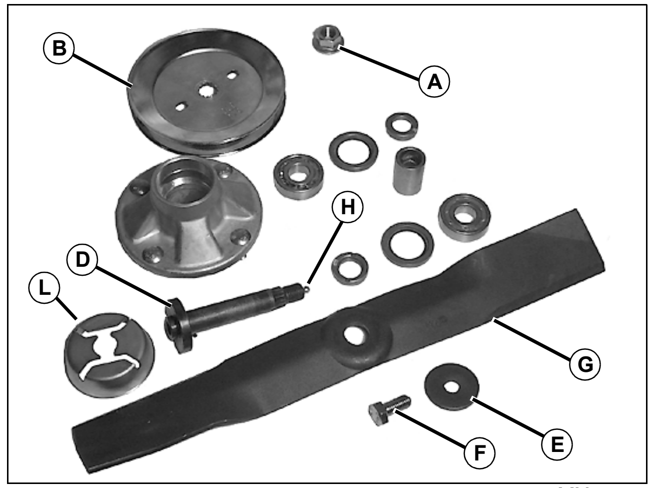
5. Install lower bearing (H) in hub using a 1-13/16 in. disk and press, just enough so the lower seal can be installed.



MX9613

6. Install lower seal (I) with lip toward bearing using a 1-13/16 in. disk and a press, until seal is 7.8 mm (0.31 in.) below hub flange (K).

7. Install lower seal ring (J), with grease notch away from bearing, inside seal lip.



MX9610

8. Install spindle shaft (D).

Important: Avoid Damage! Do not install hexagon end of spindle shaft in a vice to install spindle sheave nut. The hexagon end of the spindle shaft will be damaged resulting in improper blade operation.

9. Install blade (G), washer (E), cap screw (F) and deflector (L) on spindle shaft. Tighten cap screw to 68 N•m (50 lb-ft).

Important: Avoid Damage! Make sure the hexagon shaped hole in spindle sheave is aligned with the hexagon portion of the spindle shaft.

10. Hold the blade with a soft-jaw vise or if spindle is in the mower deck, with a block of wood. Install spindle sheave (B), nut (A), and lubrication fitting (H). Tighten nut to 145 N•m (106 lb-ft).

11. Remove cap screw, washer and blade.

12. Lubricate spindle with multipurpose grease at lubrication fitting.

Idlers

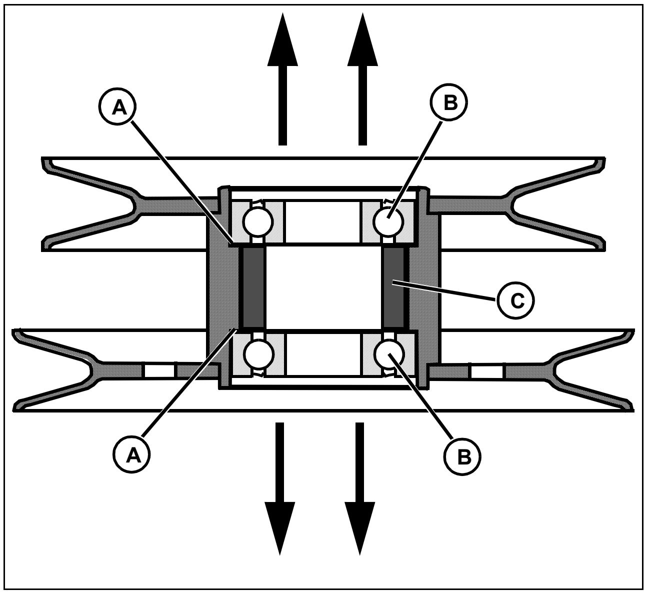
Note: Idler sheaves are welded and contain a non-serviceable bearing. If bearing replacement is needed, replace entire idler sheave.

Jacksheave

Disassembly 48C:

Note: Bearings are seated against shoulder in jack sheave, and must be removed one at a time, from either side.

Remove bearings only if replacement is necessary.



MIF

A- Shoulder
B- Upper Bearing
C- Spacer

1. Remove one bearing using a suitable puller, or a pin punch and hammer.
2. Remove spacer.
3. Remove second bearing using a press, or suitable driver and mallet.
4. Inspect all parts for wear or damage, replace as needed.

Assembly:

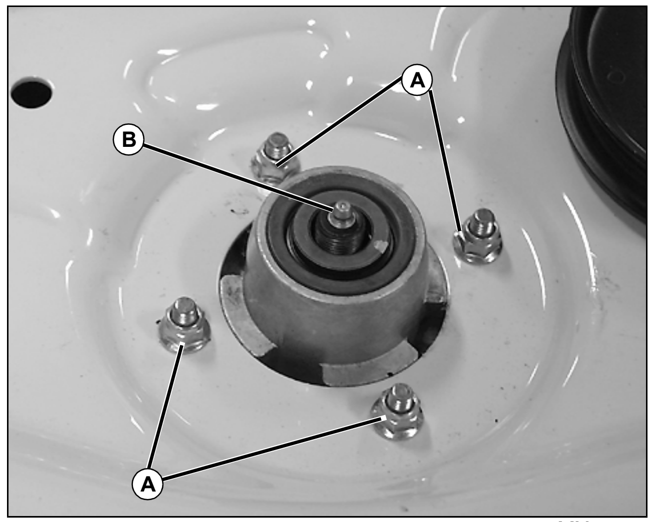
- Install bearings tight against shoulder in jack sheave using a press, or suitable driver and mallet. Be sure to install spacer between bearings.

54C Mower Deck Spindle Removal and Installation

Removal 54C:

> **Caution: Avoid Injury! To help prevent personal injury, wear heavy gloves or wrap the end of the blade with a rag.**

1. Remove drive belt. See “Mower Deck Belt and Shield Removal and Installation” on page 418.
2. Remove mower blade.



MX9609

3. Remove four nuts and washers (A) and spindle (B).
4. Make repairs as necessary. See “Spindle Disassembly/ Inspection” on page 425.

Installation is done in the reverse order of removal:

- Tighten spindle mounting lock nuts to 26 N•m (230 lb-in.).

> **Important: Avoid Damage! Install blade with bent tips up. Install blade washer with concave side to blade.**

- Install blade and tighten blade cap screw to 68 N•m (50 lb-ft).

Specification:

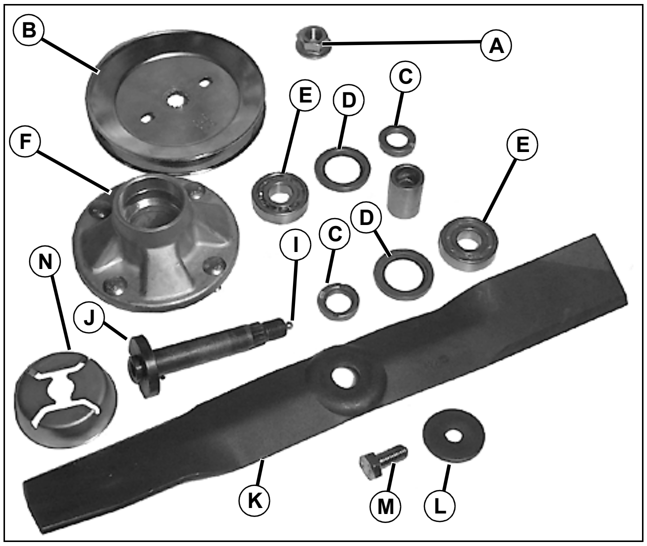
Blade Cap Screw Torque . . . . 68 N•m (50 lb-ft)
Spindle Mounting Lock Nut Torque . . . . 26 ± 4 N•m (230 ± 4 lb-in.)

Spindle Disassembly/Inspection

Caution: Avoid Injury! To help prevent personal injury, wear heavy gloves or wrap the end of the blade with a rag.

Important: Avoid Damage! Do not install hexagon end of spindle shaft in a vise to remove spindle sheave nut. The hexagon end of the spindle shaft will be damaged resulting in improper blade operation.

Note: Remove bearings only if replacement is necessary.



MX9610

1. Install blade (K), washer (L), cap screw (M) and deflector (N) on spindle shaft. If only the nut (A) or spindle sheave (B) need to be replaced, and the spindle is still in the deck, use a block of wood to prevent the blade from turning. If spindle is not in the deck, put blade in a soft-jaw vise. Tighten cap screw (M) to 68 N•m (50 lb-ft).

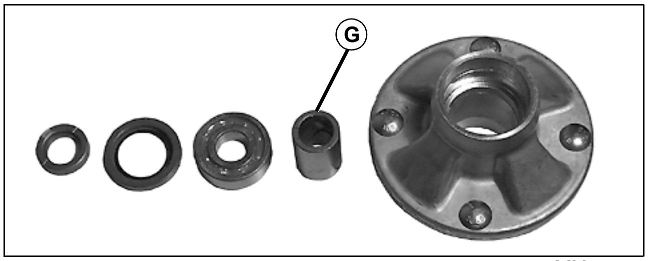
2. Hold the blade with a vise or a block of wood. Remove nut (A), spindle sheave (B), and lubrication fitting (I).

3. Remove cap screw, washer and blade.

4. Pull spindle shaft (J) out of spindle hub (F).

5. Remove seal rings (C) noting location of notched side.

6. Remove seals (D) and bearings (E) using a punch. Bearings (E) are seated against hub shoulder (H) and cannot be removed with a press.

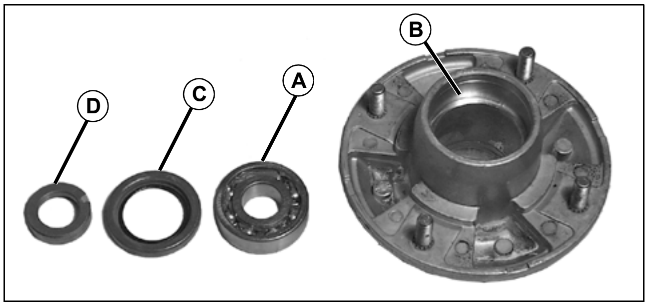


MX9612

7. Remove spacer (G).

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

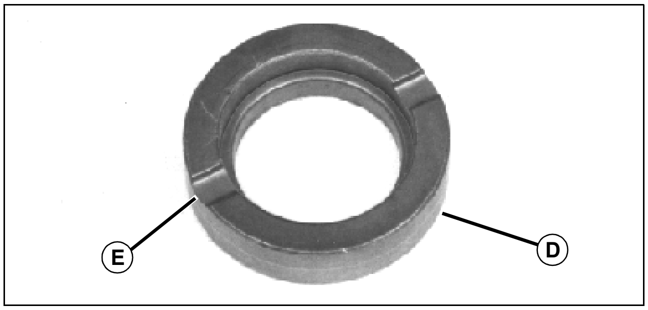
Assembly 54C:



MX9611

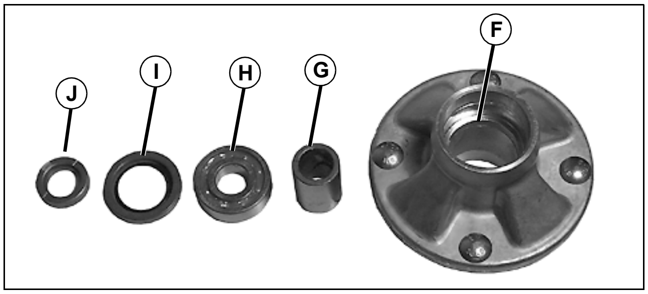
1. Install upper bearing (A) tight against spindle hub shoulder (B) using a 1-13/16 disk and press.

2. Install upper seal (C) with lip toward bearing, tight against bearing using a 1-13/16 disk and press.



M44950

3. Install upper seal ring (D), with grease notch (E) toward bearing, inside seal lip.

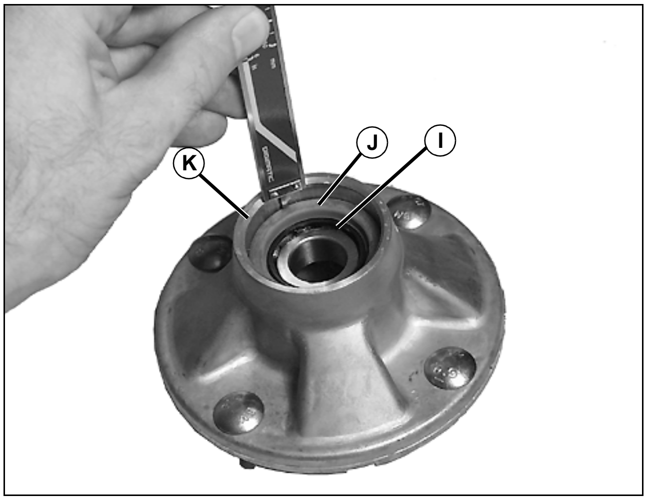


MX9612

4. Install spacer (G).

Important: Avoid Damage! Do not press lower bearing (H) tight against hub shoulder (F). The bearing and seal must be installed to a specific dimension for proper sealing of spindle.

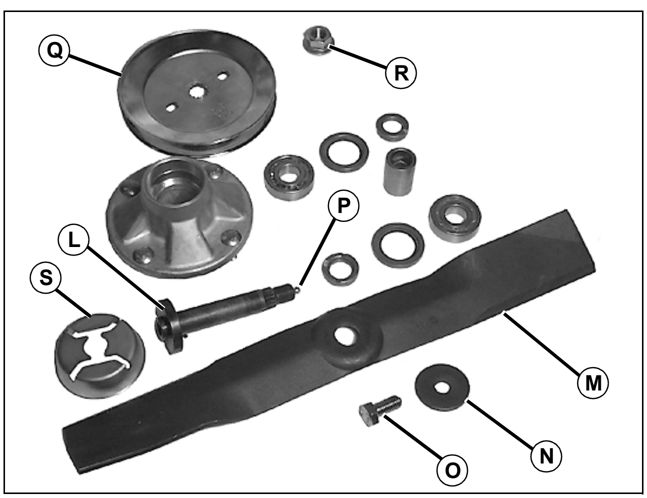
5. Install lower bearing (H) in hub using a 1-13/16 in. disk and press, just enough so the lower seal (I) can be installed.



MX9613

6. Install lower seal (I) with lip toward bearing using a 1-13/16 in. disk and a press, until seal is 7.8 mm (0.31 in.) below hub flange (K).

7. Install lower seal ring (J), with grease notch away from bearing, inside seal lip.



MX9610

8. Install spindle shaft (L).

Important: Avoid Damage! Do not install hexagon end of spindle shaft in a vice to install spindle sheave nut. The hexagon end of the spindle shaft will be damaged resulting in improper blade operation.

9. Install blade (M), washer (N), cap screw (O) and deflector (S) on spindle shaft. Tighten cap screw to 68 N•m (50 lb-ft).

Important: Avoid Damage! Make sure the hexagon shaped hole in spindle sheave is aligned with the hexagon portion of the spindle shaft.

10.Hold the blade with a soft-jaw vise or if spindle is in the mower deck, with a block of wood. Install spindle sheave (Q), nut (R), and lubrication fitting (P). Tighten nut to 145 N•m (106 lb-ft).

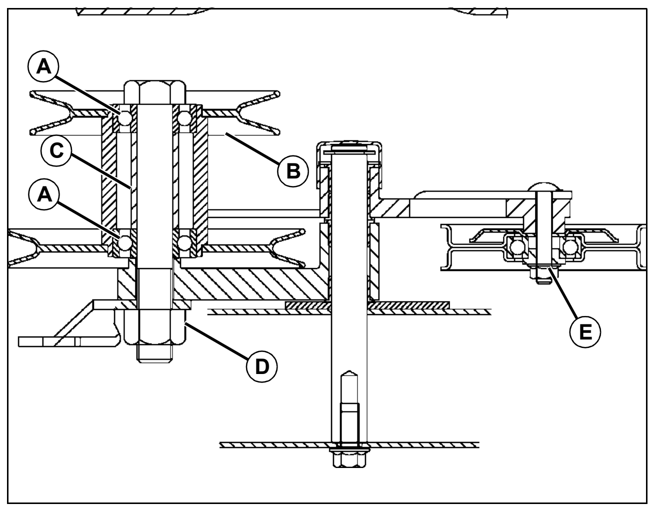
11.Remove cap screw, washer and blade.

12.Lubricate spindle with multipurpose grease at lubrication fitting.

Jacksheave

Disassembly 54C:

1. Inspect all parts for wear or damage. Replace parts if necessary.



M45998AE

2. Inspect bearing (A) for wear or damage. Replace if necessary.

Note: Bearings (A) are seated against shoulder in jack sheave (B), and must be removed one at a time, from either side.

Remove bearings (A) only if replacement is necessary.

3. Remove one bearing (A) using a suitable puller, or a pin punch and hammer.

4. Remove spacer (C).

5. Remove second bearing (A) using a press, or suitable driver and mallet.

6. Inspect all parts for wear or damage, replace as needed.

Assembly:

- Install bearings (A) tight against shoulder in jack sheave (B) using a press, or suitable driver and mallet. Be sure to install spacer between bearings.
- Tighten jack sheave nut (D) to 136 N•m (100 lb-ft).
- Tighten tensioning idler sheave nut (E) to 27 N•m (20 lb-ft).

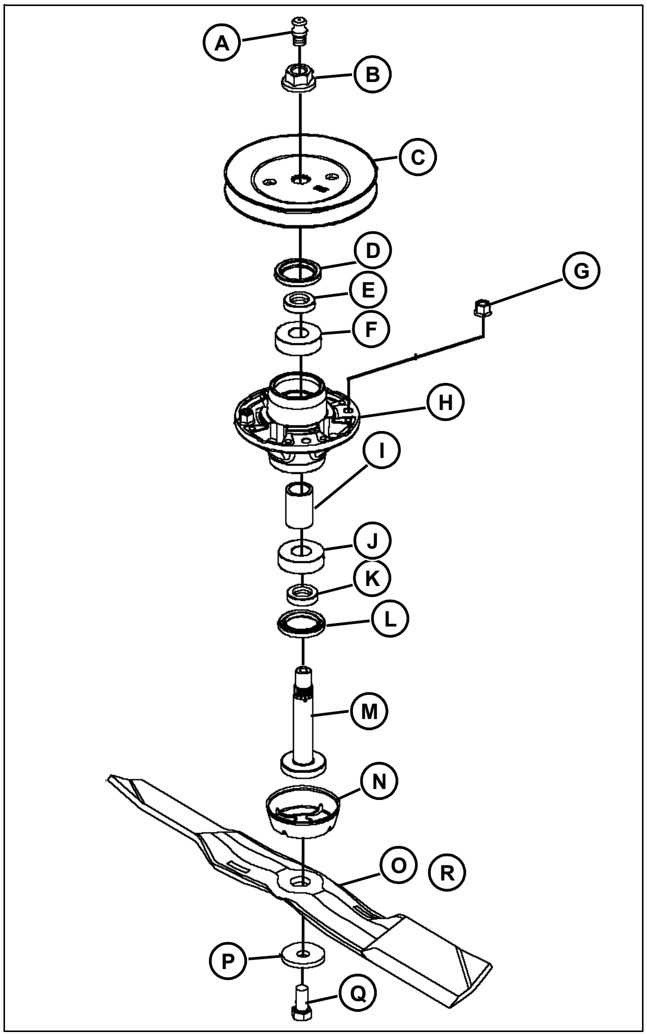
Idlers

Note: Idler sheaves are welded and contain a non-serviceable bearing. If bearing replacement is needed, replace entire idler sheave.

62C Mower Deck Spindle Removal and Installation

Removal 62C:

Important: Avoid Damage! Always install new bearings and seals when servicing spindles.



MP29544A

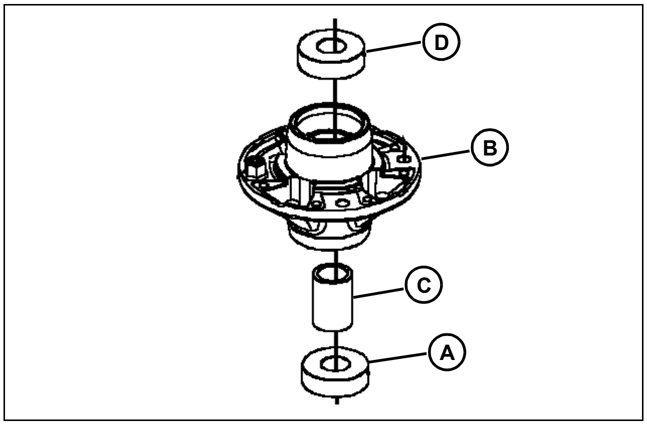
A- Lubrication Fitting (apply grease)
B- Flanged Nut
C- Sheave
D- Upper Seal
E- Bushing
F- Upper Bearing
G- Flanged Lock Nut
H- Housing
I- Spacer
J- Lower Bearing
K- Lower Seal Ring
L- Lower Seal
M- Spindle Shaft
N- Deflector
O- Blade
P- Blade Washer
Q- Cap Screw

1. Place blade (O) in a soft-jawed vise.
2. Remove flanged nut (B).
3. Remove lubrication fitting (A), sheave (C) and bushing (I).
4. Remove cap screw (Q), washer (P), deflector (N) and blade (O).
5. Remove spindle shaft from housing (J).
6. Remove lower seal ring (K) and lower seal (L).

Note: Remove upper bearing (F) and lower bearing (J) only if replacement is necessary.

7. Upper and lower bearings are seated against spindle hub shoulder and cannot be removed with a press. Remove upper seal (D) and bearings using a punch.
8. Remove spacer (I).
9. Inspect all parts for wear or damage. Replace parts as needed.

Assembly 62C:



MP29644b

1. Using a press and disk driver large enough to contact the bearing outer race, install lower bearing (A) until it is seated against the shoulder in the housing (B).

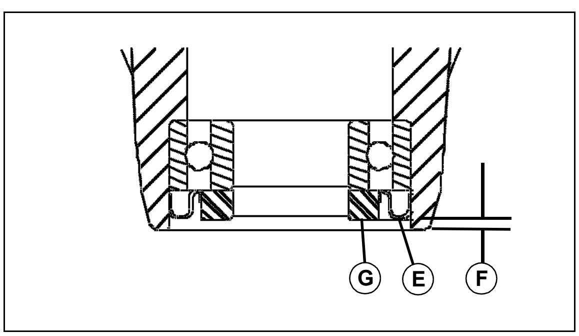
2. Turn the housing over.

3. Install spacer (C). Center the spacer over the lower bearing.

Important: Avoid Damage! Using disk drivers, support both the inner and outer races of the upper and lower bearings when installing the upper bearing. Do not support the housing by allowing it to rest on its end.

4. Using a press and disk driver, install upper bearing (D) until it rests against the bottom of the housing shoulder.

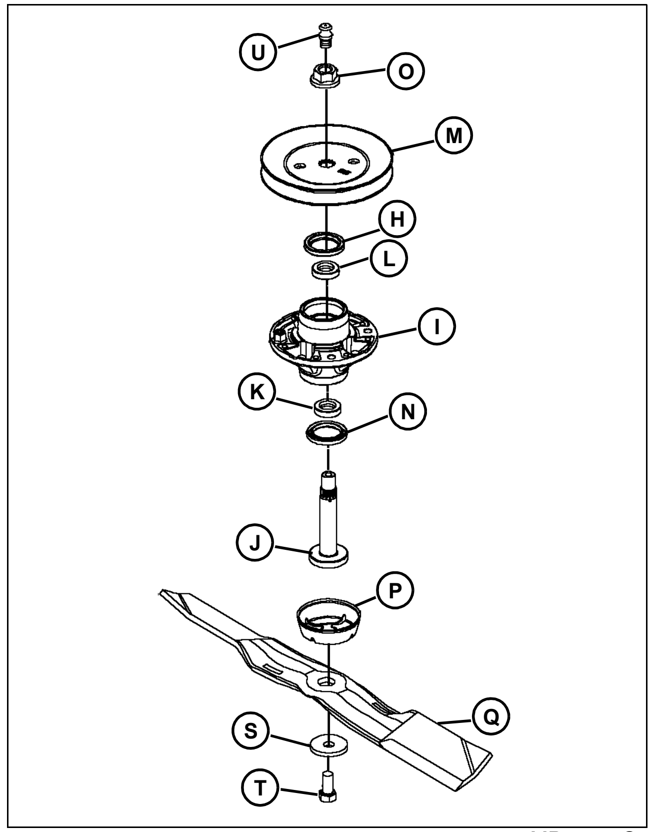
Note: The inner diameter chamfer of the seal ring is away from the bearing.



MX2537

5. Using a press and disk, install lower seal (E) with open side toward bearing until the face of the seal is at the specified height (F) from the lower end of the housing.

6. Install lower seal ring (G) with the outer diameter chamfered edge toward bearing.



MP29644C

7. Install bushing (L).

8. Using a press and disk, install upper seal (H) and lower seal (N) with open side toward bearing until the face of the seal is flush with the end of the housing (I).

9. Install spindle shaft (J) into housing.

10.Install bushing (K) and sheave (M).

11.Install flanged nut (O).

Important: Avoid Damage! Blade (Q) must be properly seated on the spindle, and concave side of blade washer (R) MUST face toward blade.

12.Install lower deflector (P), blade (Q), and washer (S) and cap screw (T).

13.Tighten blade cap screw to **320 N•m (236 lb-ft)**.

14.Place blade in a soft-jawed vise.

15.Tighten flange nut to specification.

16.Loosen blade cap screw and retighten to specification.

17.Apply specified grease to lubrication fitting (U).

Specifications:

Seal Face Distance from Lower End of Housing . . . . 2.57 mm (0.10 in.)

Blade Cap Screw Torque . . . . 68 N•m (50 lb-ft)

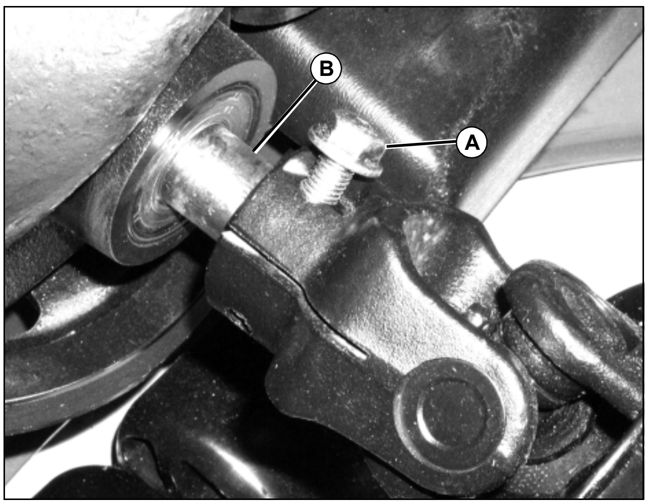
Flanged Nut Torque . . . . 255 N•m (188 lb-ft)
Recommended Grease
. . . . . John Deere Multi-Purpose SD Polyurea Grease
or John Deere Multi-Purpose Lithium Complex Grease

Mower Deck Drive Shaft Removal and Installation

Removal:

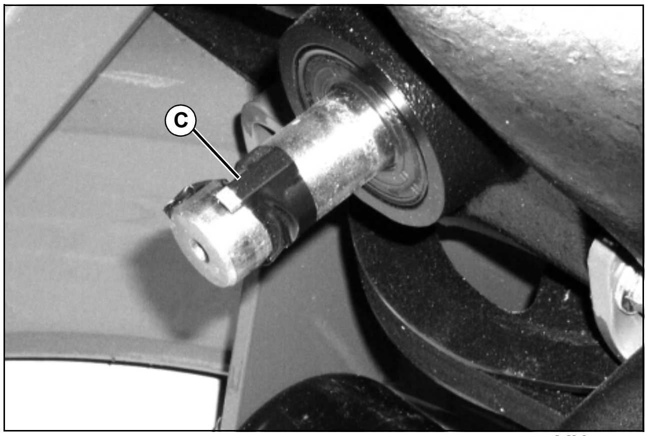
Important: Avoid Damage! Use of incorrect greases can result in premature wear of parts and component failures.

1. Lift up PTO drive shaft cover to gain access to the front PTO drive shaft universal joint.



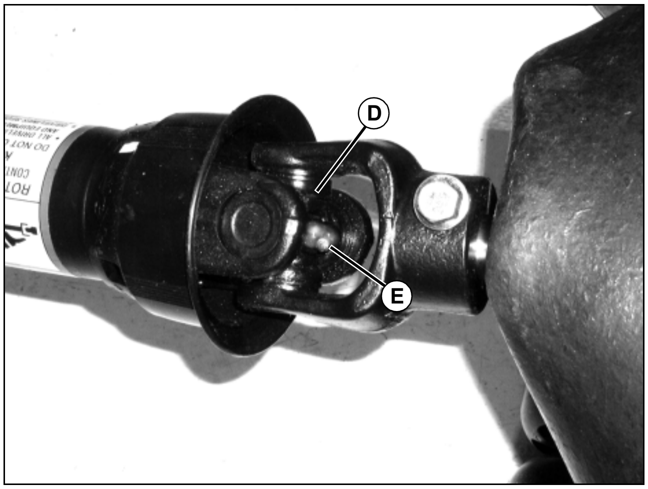
MX7111

2. Remove flanged head cap screw (A) to remove drive shaft from PTO gearbox input shaft (B).



MX7109

3. Using care not to misplace shaft key (C), wrap a piece of tape around shaft key and PTO gearbox input shaft.



MX8823

4. Inspect the universal joint (D) and lubrication fitting (E) for wear or damage. Replace as necessary.

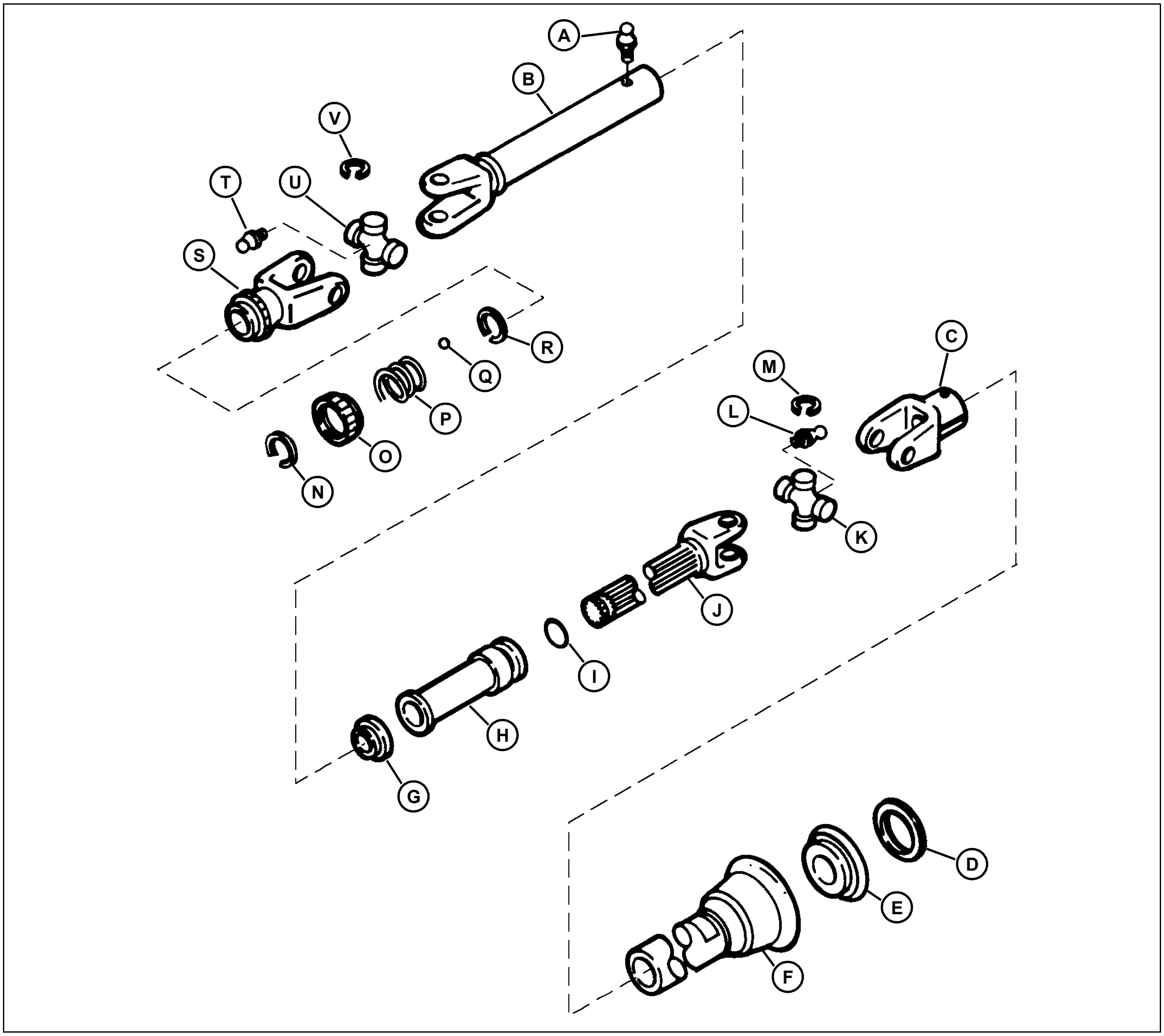
Installation:

- Installation is done in the reverse order of removal.
- Remove tape from PTO gearbox input shaft, using care not to misplace shaft key.
- Apply a light coat of MPG-2 Multi-Purpose Grease to splines of drive shaft.
- Install drive shaft onto PTO gearbox input shaft. Tighten flange head cap screw to specification.
- Apply specified grease to lubrication fitting on universal joint. See Mower Spindle Grease in Specifications and General Information section.

Specification:

Drive Shaft Flanged Head Cap Screw . 81 N•m (60 lb-ft)

Mower Deck Drive Shaft Repair



MX5733

A- Lubrication Fitting
B- Yoke, with Tube
C- Yoke
D- Snap Ring
E- Bearing
F- Guard
G- Spring Pin
H- Shaft
I- Snap Ring
J- Universal Joint Yoke
K- Universal Joint
L- Lubrication Fitting
M- Snap Ring
N- Snap Ring
O- Locking Collar
P- Compression Spring
Q- Ball
R- Snap Ring
S- Universal Joint Yoke
T- Lubrication Fitting
U- Universal Joint
V- Snap Ring

- Inspect all parts for wear or damage. Replace parts as needed.
- Apply a light coat of MPG-2 Multi-Purpose Grease to splines of drive shaft. (See Anti-Corrosion Grease in Specifications and General Information section.)

Mower Deck Gearbox Removal and Installation

Removal:

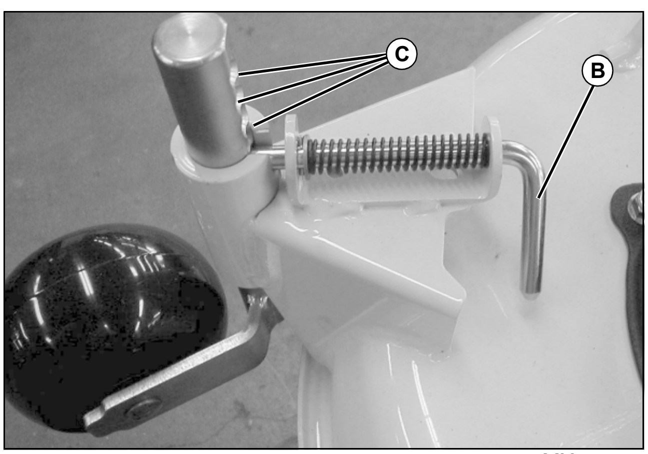
MX11076

1. Pull back top hydraulic lift lever (A) to raise mower deck to highest (transport) position.

2. Park machine safely. See Parking Safely in the Safety section of the operator's manual.

Caution: Avoid Injury! Rotating blades are dangerous. Before adjusting or servicing mower:

- **Disconnect spark plug wire(s) to prevent engine from starting accidently.**
- **Always wear gloves when handling mower blades or working near blades.**

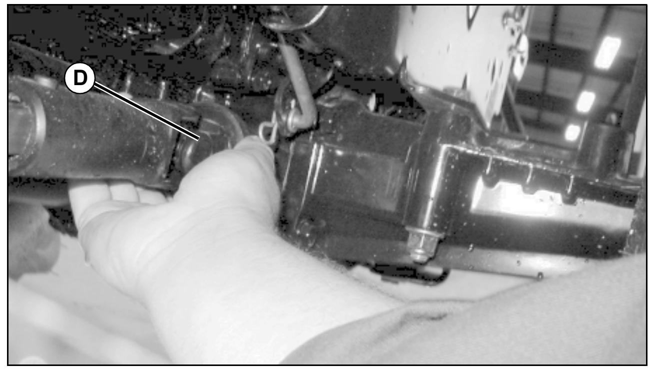


MX11075

3. Turn all gauge wheels to the deck removal position:
   - Pull back on gauge wheel release rod (B).
   - Turn gauge wheel sideways.
   - Move gauge wheel up until release rod engages in deck removal holes (C) on side of rod.

4. Adjust mower height control knob to 38.1 mm (1.5 in.).

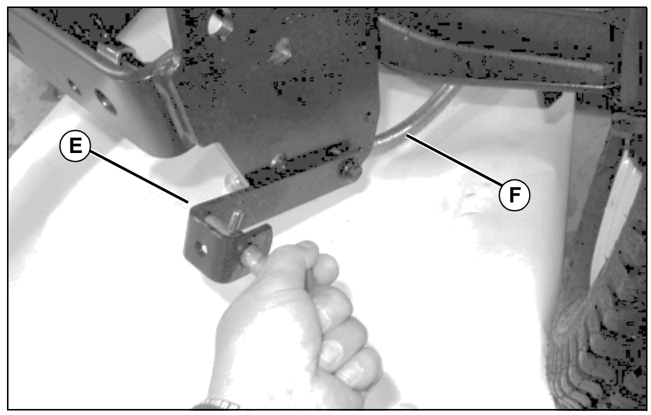
5. Push top hydraulic lever forward to lower deck to the ground.



MX11077

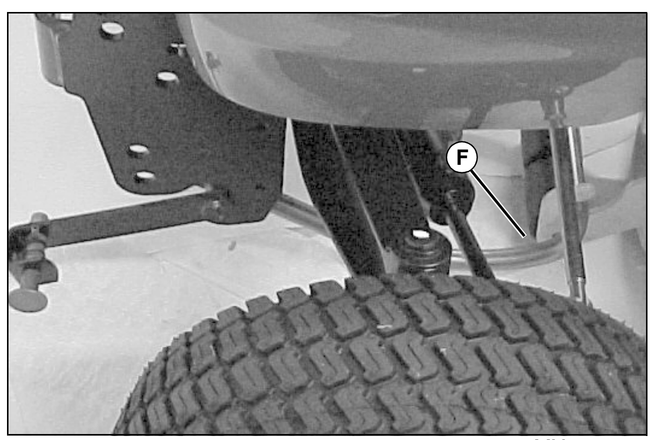
6. Reach under machine from left side and pull coupler (D) to release deck PTO driveshaft.

7. Put PTO driveshaft on top of deck.



MX11078

8. Pull out pin and pull down release latch (E) on front deck hanger bracket (F) to release deck. Rear of deck will slide off draft arms at this step.



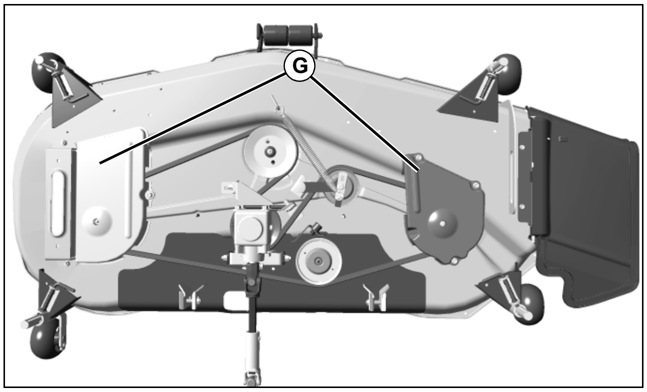
MX11052a

9. Remove front deck hanger bracket (F) from mower deck.

10.Start engine.

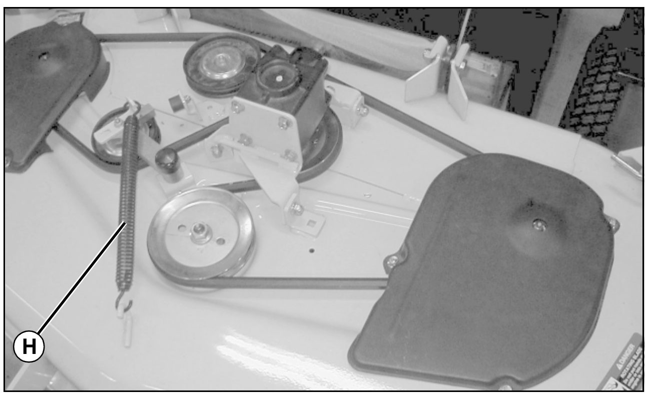
11.Pull back top hydraulic lever to raise draft arms to highest position.

12.Turn off engine.



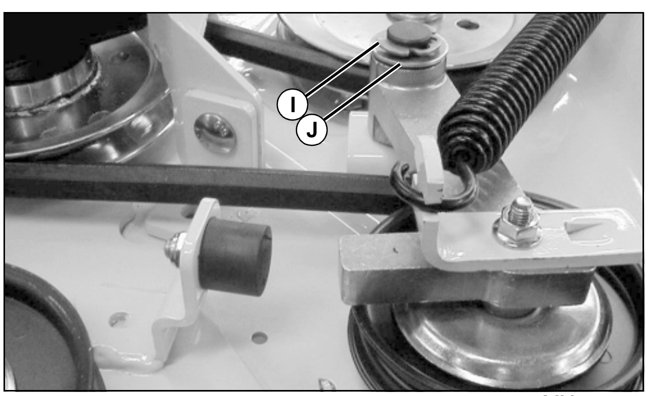
MX11055

13.Remove each belt guard cover (G).



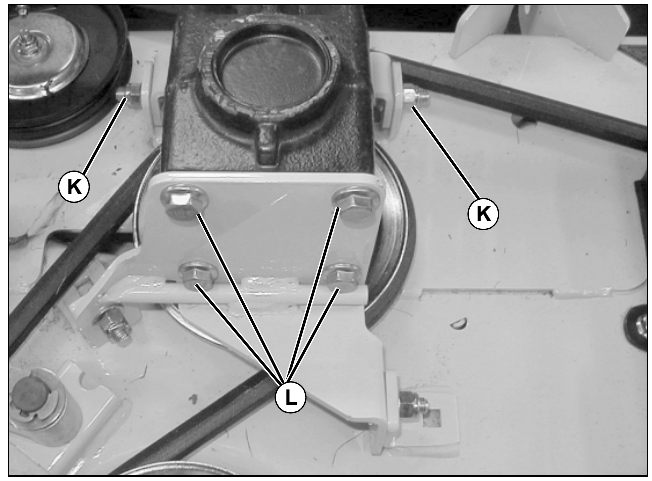
MX11047

14.Remove idler tension spring (H) to relieve tension on belt.



MX11048

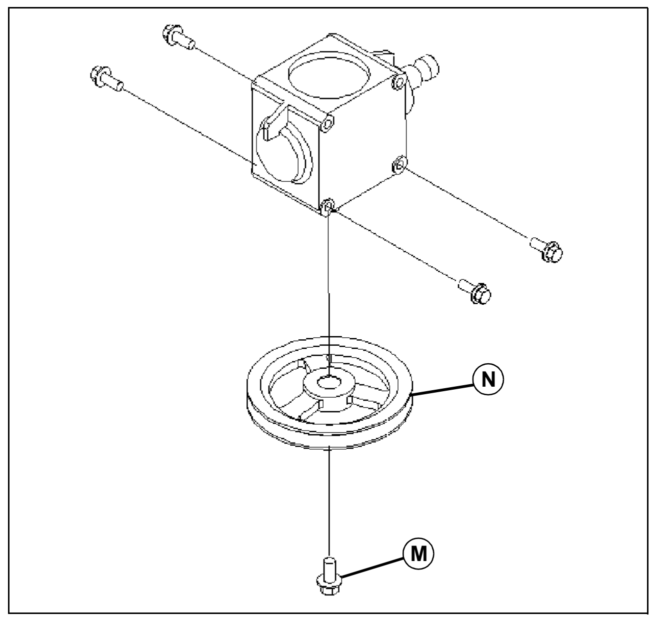
15.Remove clip (I) and washer (J). Lift idler arm up to remove belt.



MX11051

16.Remove two nuts (K) on rear of gearbox.

17.Remove four bolts (L) from front of gearbox and remove belt.



MX5735

18.Remove cap screw (M) to remove drive sheave (N) from gearbox.

19.Inspect drive sheave for wear or damage. Replace if necessary.

Installation:

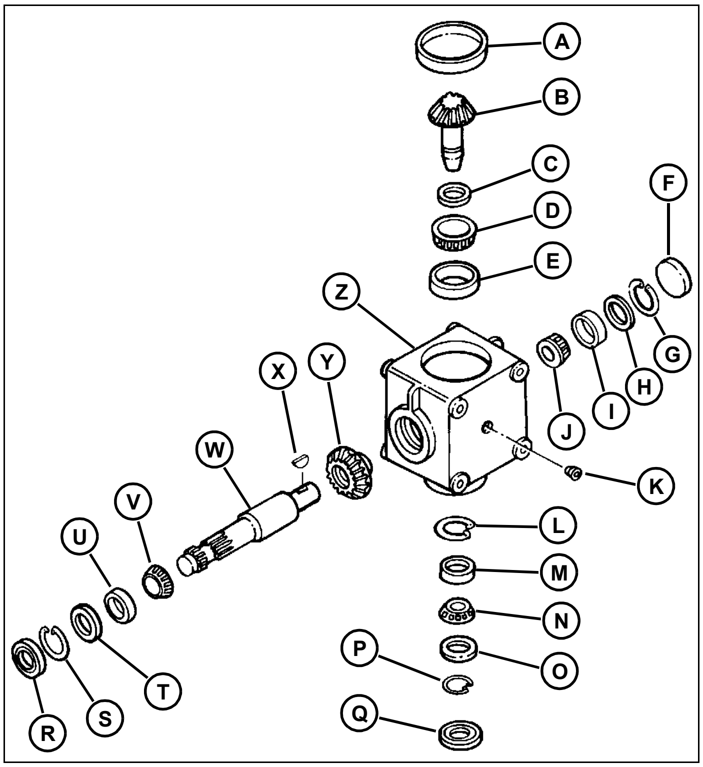
- Installation is done in the reverse order of removal.
- Install drive sheave to gearbox and tighten cap screw to specification.
- Wrap belt around drive sheave and install gearbox onto mower deck frame. Tighten cap screws to specification.
- Install tension spring, and adjust belt tension to specification.

- Install belt shield.
- Remove tape from gearbox input shaft, using care not to misplace shaft key.
- Apply a light coat of MPG-2 Multi-Purpose Grease to gearbox input shaft.
- Install drive shaft onto gearbox input shaft and tighten cap screw to specification.
- Install drive shaft onto PTO output shaft.

Specifications:

Drive Sheave Cap Screw . 129 ± 9.5 N•m (95 ± 9.5 lb-ft)
Gearbox-to-Frame Cap Screw . . . . 99 N•m (73 lb-ft)
Drive Shaft Cap Screw . . . . 81 N•m (60 lb-ft)

Mower Deck Gearbox Repair



MX5738

A- Plug
B- Output Shaft with Gear
C- Shim
D- Bearing
E- Bearing Cup
F- Plug
G- Snap Ring
H- Shim
I- Bearing Cup
J- Bearing
K- Pipe Plug (2 used)
L- Snap Ring
M- Bearing Cup
N- Bearing
O- Shim
P- Snap Ring
Q- Shaft Seal
R- Shaft Seal
S- Snap Ring
T- Shim
U- Bearing Cup
V- Bearing
W- Input Shaft
X- Keyway
Y- Gear
Z- Housing

- Inspect all parts for wear or damage. Replace seals or plugs as needed. If gears are worn or damaged, replace gearbox assembly.

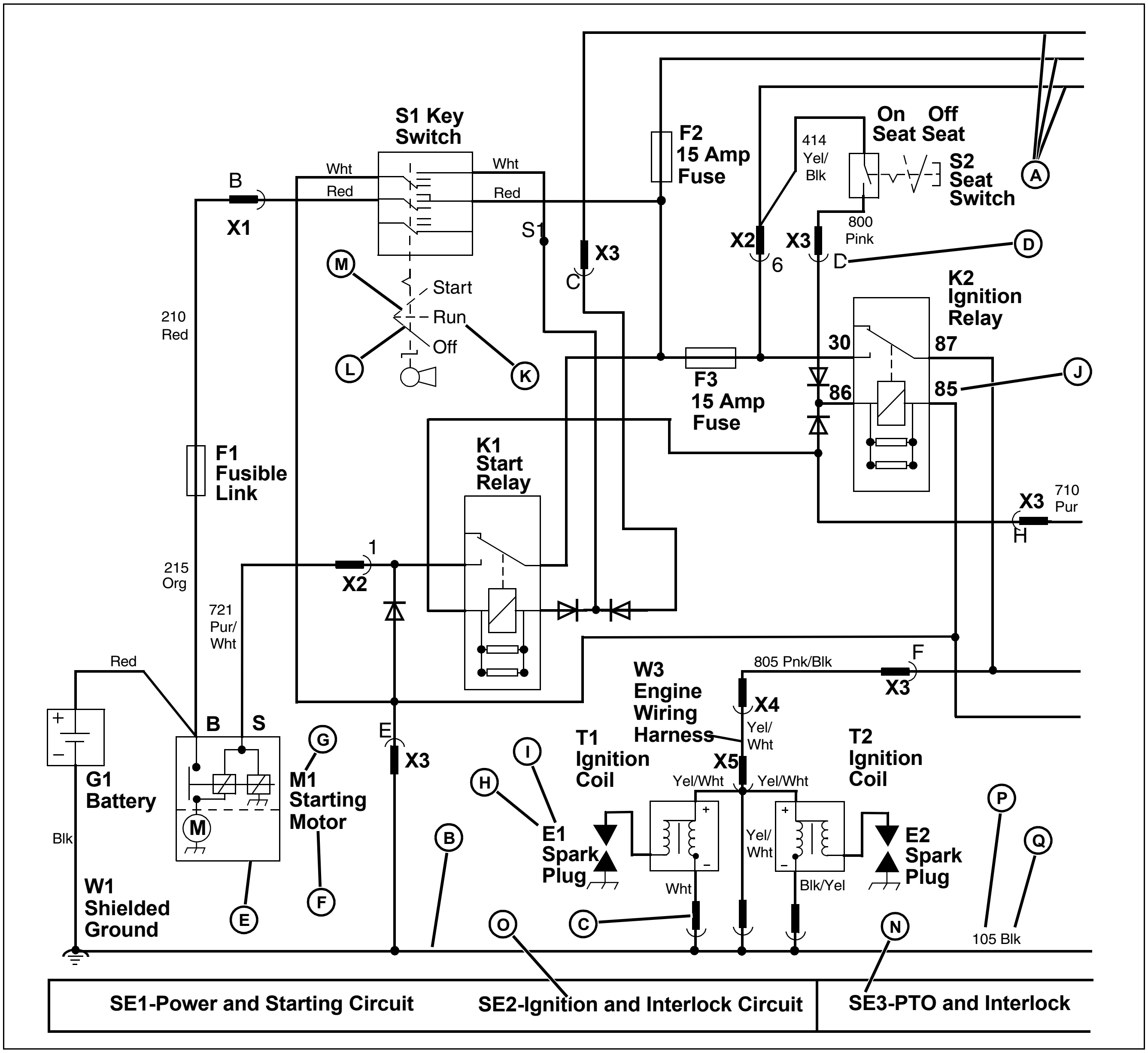
Important: Avoid Damage! Do not overfill the gearbox with oil. Damage to internal gearbox seal will result.

Note: Gearbox oil capacity is approximately 0.4 L (13.5 oz).

- Fill gearbox to proper level with approved gear oil. See Oils and Lubricants in the Specifications and General Information section.

General Information

Reading Electrical Schematics



MIF

The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all ground wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in the off position. The diagram does not list connector (C) information unless needed to avoid confusion. If the connector is shown, the number next to it is the terminal pin location (D) in the connector.

Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

The identifying letter is always the same for a specific component, but the identifying numbers are numbered consecutively from upper left to lower right. The terminal designation (J) is placed directly outside the symbol next to the connecting wire path. Switch positions (K) are also placed directly outside the symbol. The solid line (L) shows the position the switch is currently in and dash lines (M) represent other switch positions.

Each circuit is identified at the bottom of the drawing by a section number (N) and section name (O).

The circuit number (P) and wire color (Q) 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.

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 procedure 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.

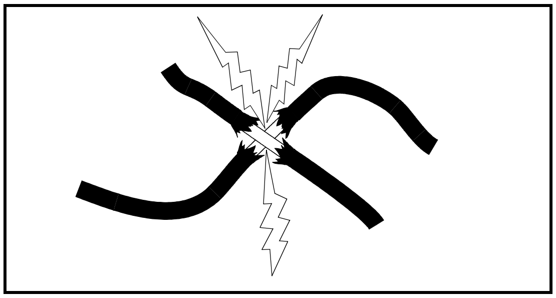
When performing the test or check, be sure to set your machine up to the test conditions listed and follow the sequence carefully.

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**

Common Circuit Tests

Shorted Circuit:

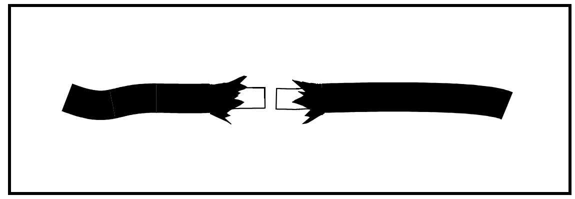


MIF

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.

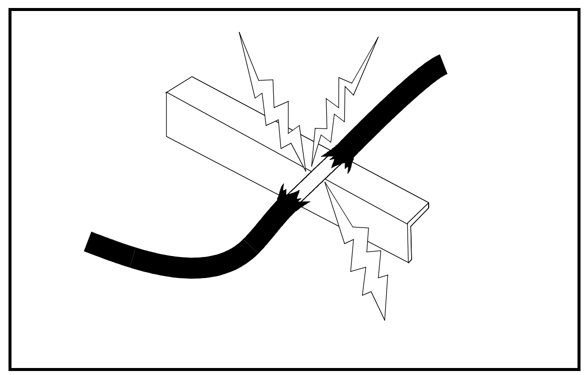
High Resistance or Open Circuit:



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

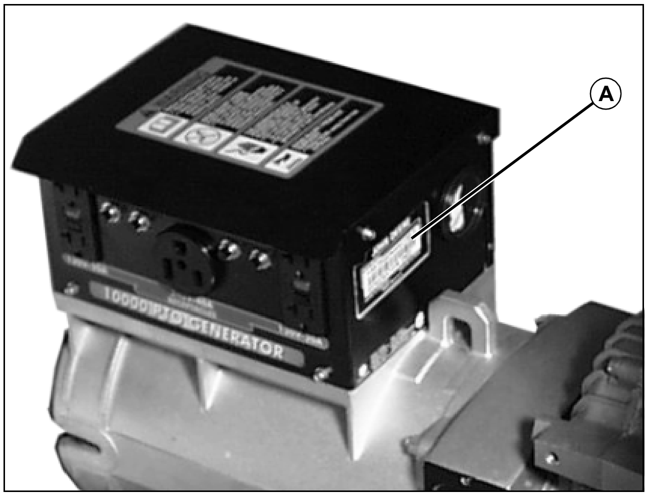
Grounded circuits usually result in no component operation or a blown fuse.

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

Identification Numbers

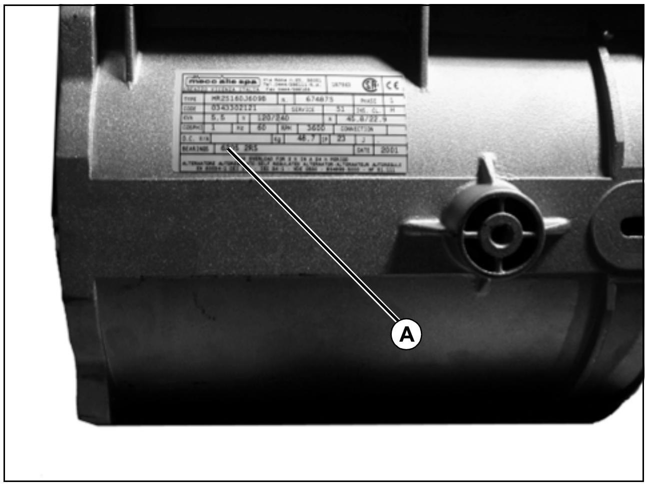
Generator



MX19672A

A- Generator Identification

Alternator

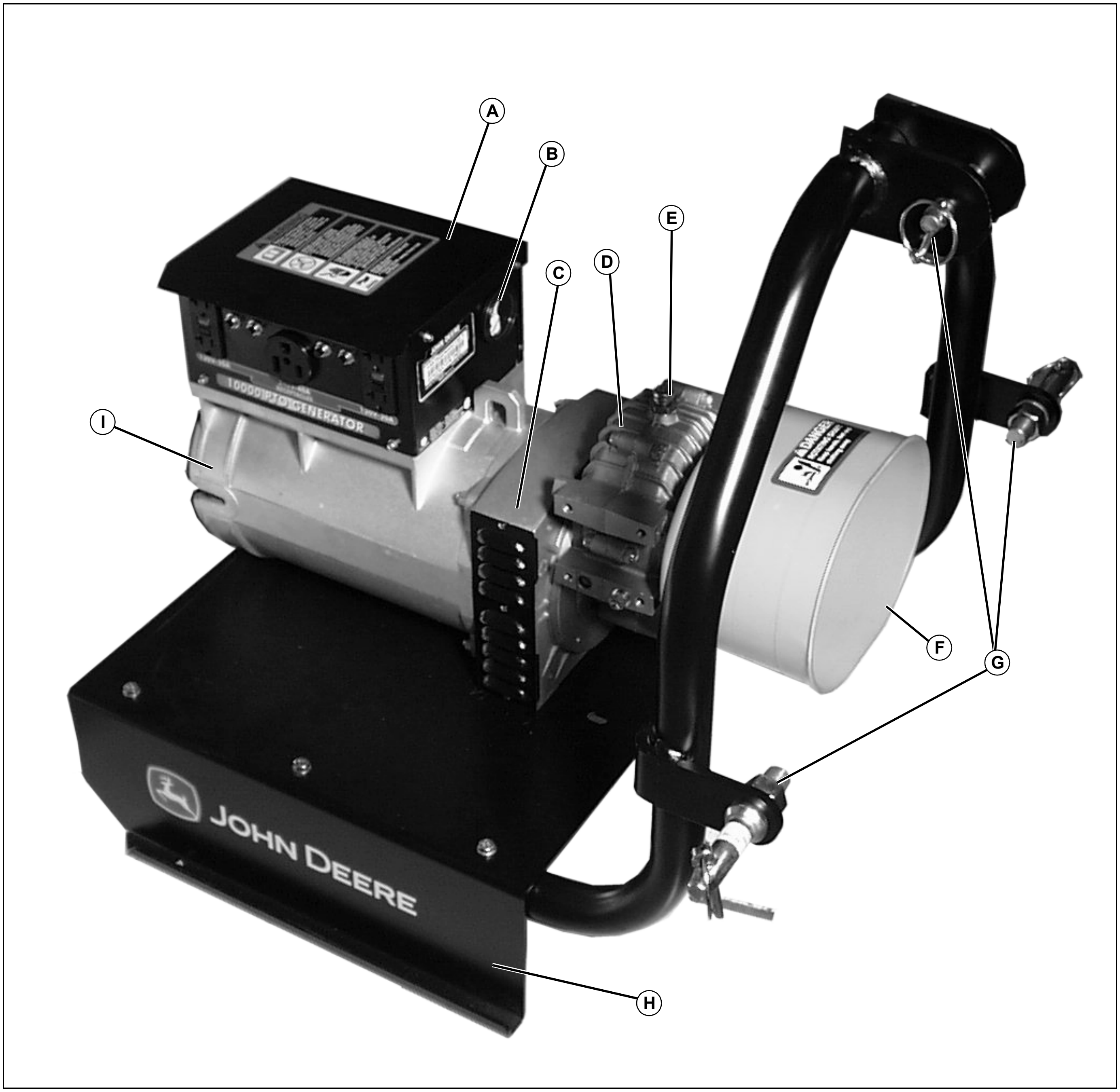


MX19203

A- Alternator Identification

Component Location

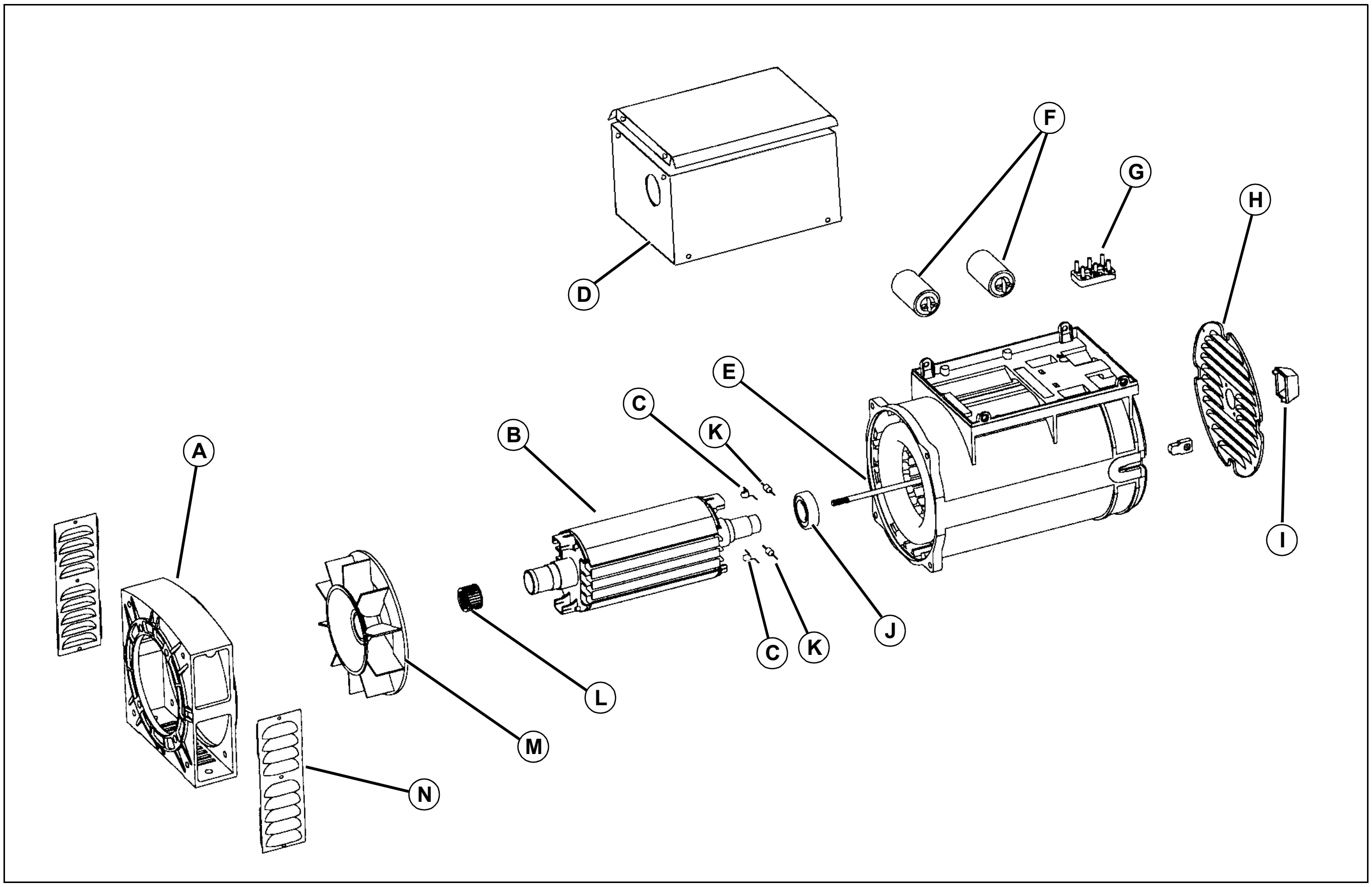
Generator



MX19672

A- Control Panel
B- Voltage Meter
C- Fan Housing
D- Transmission
E- Transmission Oil Fill Plug
F- PTO Shield
G- Mounting Pin
H- Base
I- Alternator

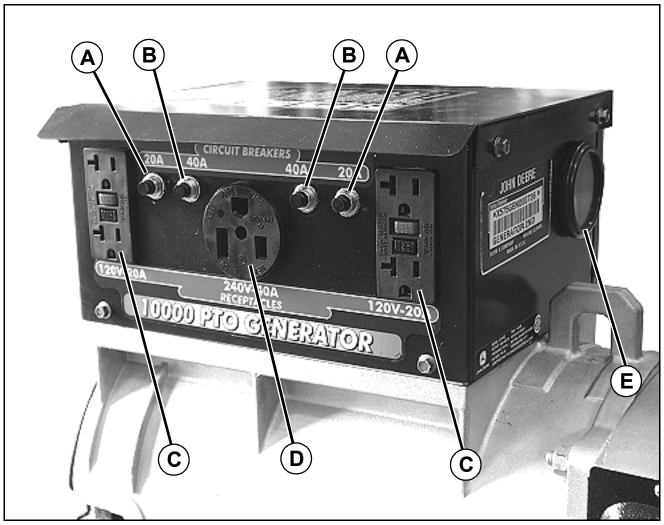
Alternator Components



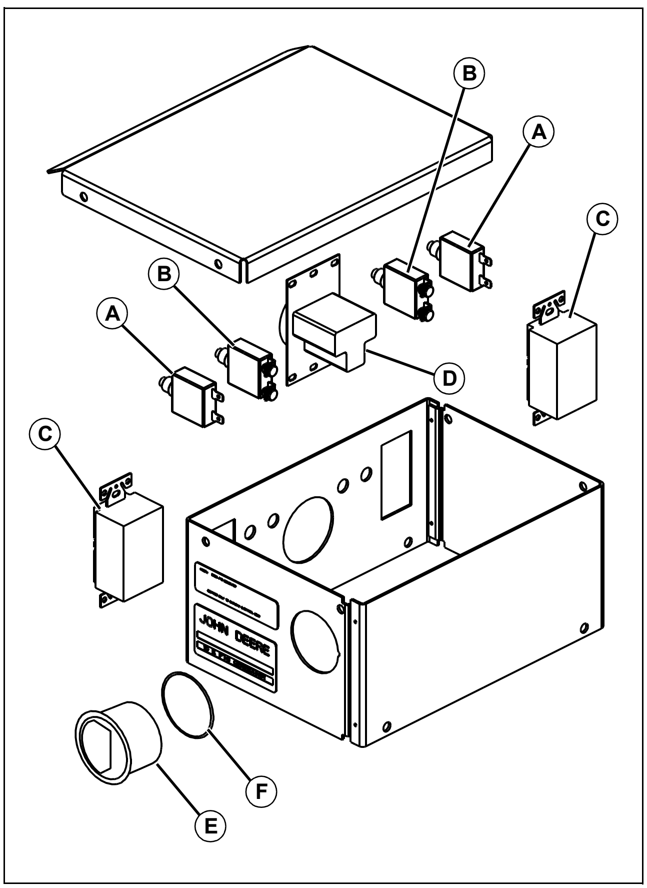
MX19887

A- Fan Housing
B- Rotor
C- Varistor (R1 and R2)
D- Control Case
E- Bolt
F- Exciter Capacitors (C1 and C2)
G- Terminal Board
H- Air Intake Vent
I- Cap
J- Bearing
K- Diode (V1 and V2)
L- Fan Friction Collar
M- Fan
N- Air Vent

Control Panel



MX19674



MIF

A- 20 Amp Circuit Breaker (F1 and F4)

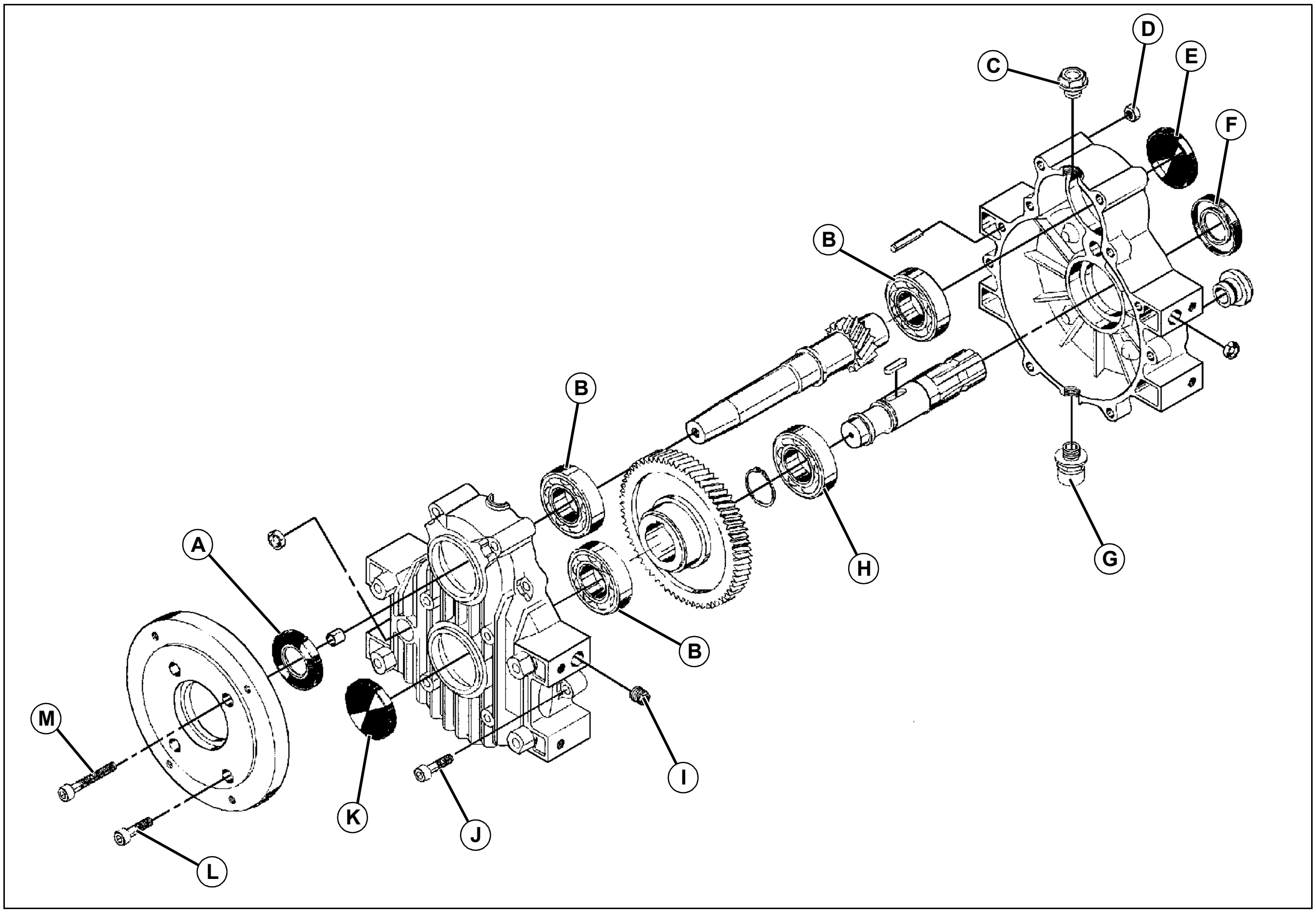
B- 40 Amp Circuit Breaker (F2 and F3)

C- 120 Volt/20 Amp GFCI Protected Duplex Receptacle (X1 and X3)

D- 240 Volt/40 Amp Receptacle (X2)

E- O-Ring

Generator Gear Box Components



MX19882

A- Seal
B- Bearing
C- Plug
D- Nut
E- Cap
F- Seal
G- Plug
H- Bearing
I- Plug (BPT)
J- Bolt
K- Cap
L- Bolt
M- Bolt

Schematics and Harnesses

Wiring Harness Legend

C1 - Capacitor (SE2)

C2 - Capacitor (SE2)

F1 - Circuit Breaker - 20 Amp (SE1)

F2 - Circuit Breaker - 40 Amp (SE1)

F3 - Circuit Breaker - 40 Amp (SE1)

F4 - Circuit Breaker - 20 Amp (SE1)

G1 - Generator

L1 - Stator Coil (SE2)

L2 - Excitation Coil (SE2)

L3 - Excitation Coil (SE2)

L4 - Stator Coil (SE2)

L5 - Rotor Coil (SE2)

L6 - Rotor Coil (SE2)

P1 - Voltmeter (SE1)

R1 - Varistor (SE2)

R2 - Varistor (SE2)

V1 - Diode (SE2)

V2 - Diode (SE2)

W1 - Control Panel Internal Ground

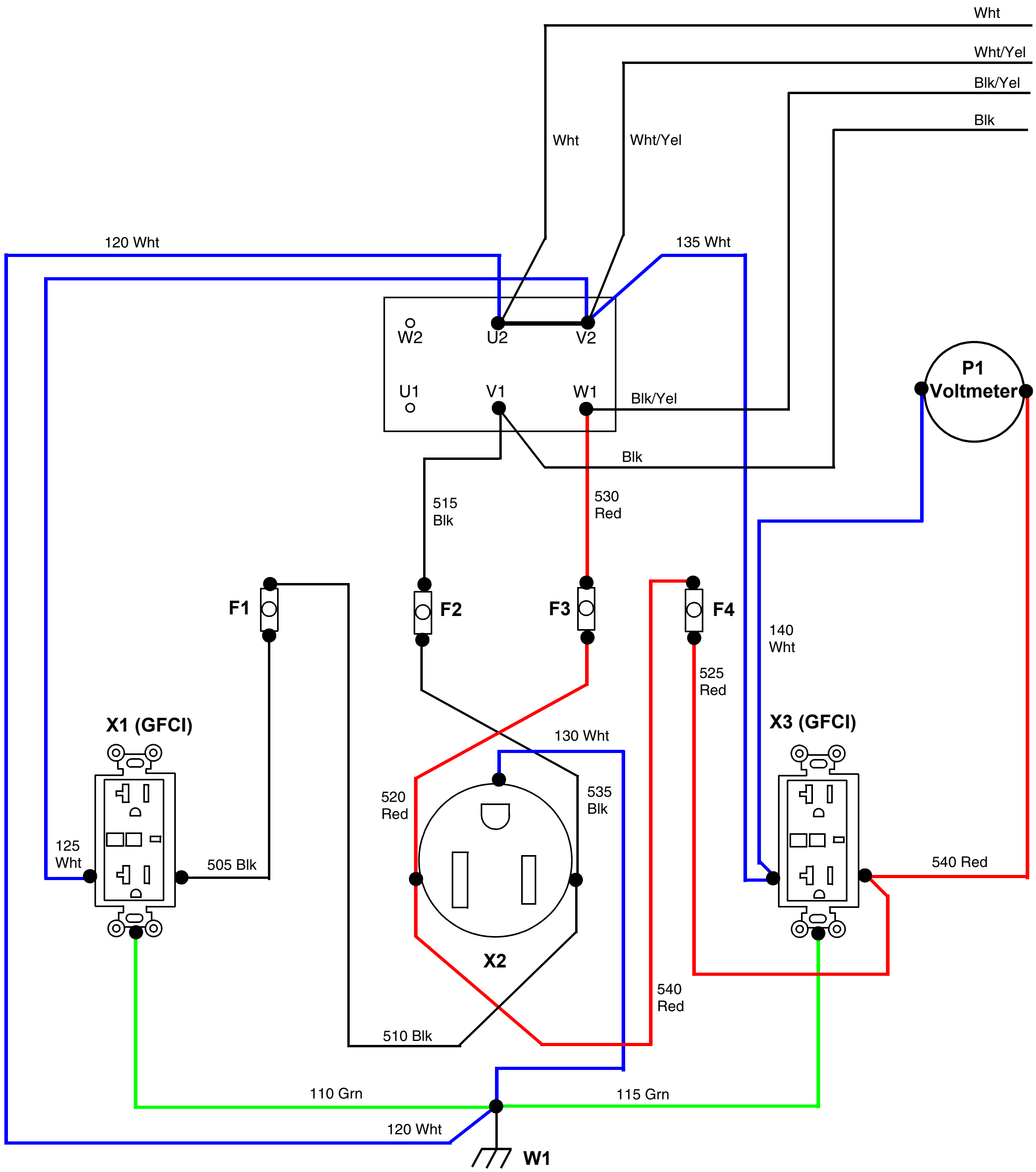
Connectors

X1 - 120 Volt, 20 Amp, GFCI Receptacle (SE1)

X2 - 240 Volt, 40 Amp Receptacle (SE1)

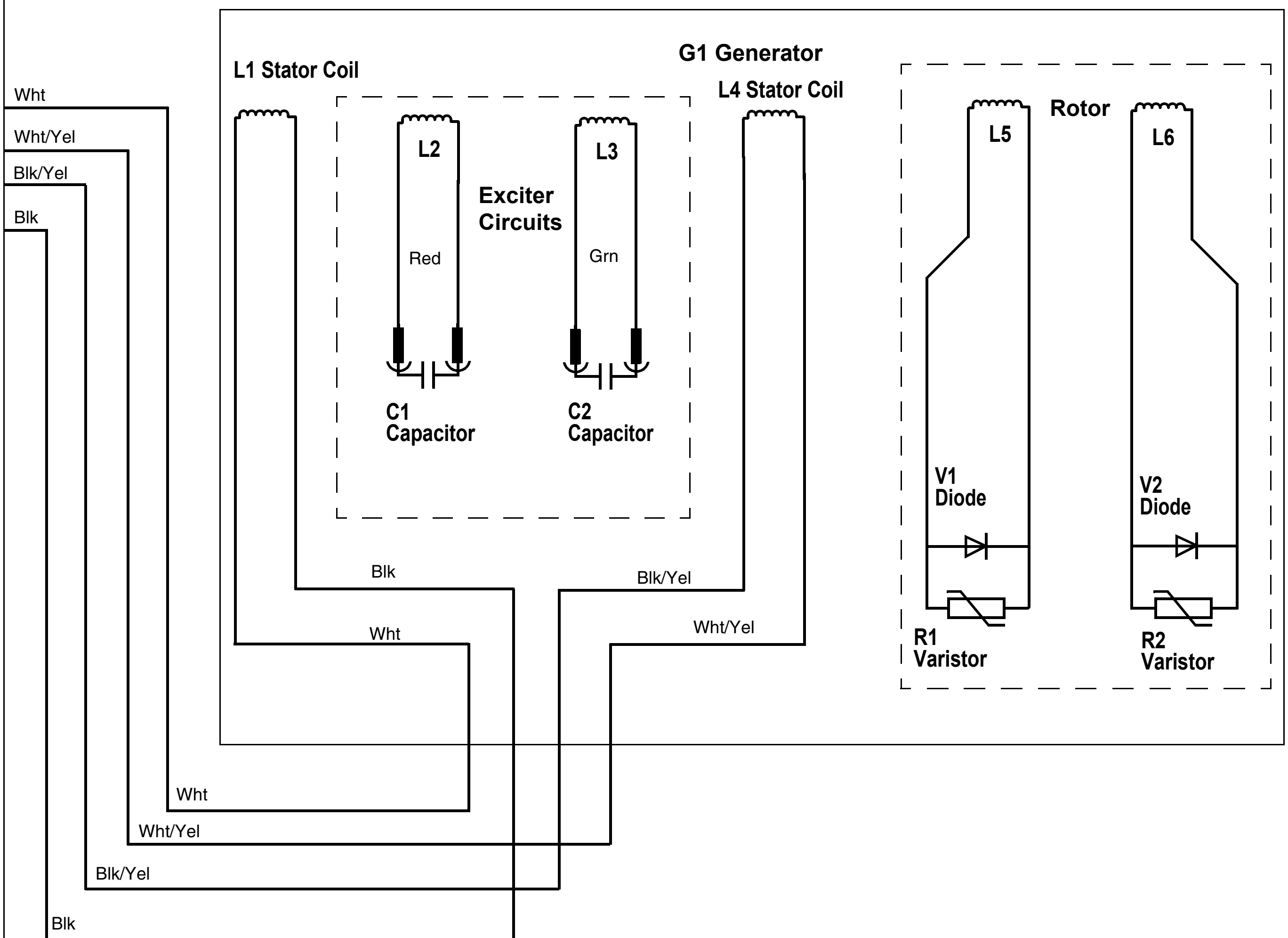
X3 - 120 Volt, 20 Amp, GFCI Receptacle (SE1)

Standard Electrical Schematic



SE1 - Output Section

MIF



SE2 - Alternator

MIF

Operation and Diagnostics

Generator Circuit Operation

Function:

To provide circuit breaker protected 120 and 240 volt AC outputs.

Operating Conditions:

The PTO must be ON and rotating at 540 rpm for the generator transmission to provide a 3600 rpm output in order to provide 60 Hz alternating current to the generator outputs. The 20 amp, 120 volt duplex outlets are GFCI protected and the unit must be connected to a suitable earth ground for these circuits to function properly.

Theory of Operation:

Caution: Avoid Injury! The field capacitors have the capability to store very high voltages. NEVER touch both capacitor terminals with bare hands as this could cause rapid discharge and result in an electrical shock. Discharge capacitors by bridging the terminals with a screwdriver shaft that has an insulated handle before servicing.

The generator is a brushless design with stator self excitation capability to provide a magnetic field within which the rotor will induce voltage. Self excitation is provided by two angle shifted, in relation to the power windings, capacitors (one per 120 VAC output). These capacitors set up the magnetic field within which the rotor turns to inductively generate AC power. Proper operation of these capacitors are essential for correct generator output. As the rotor turns, power is generated in two independent 120 volt sets of windings in the stator. These outputs are directed to the generator control panel wiring.

To obtain a 240 volt AC output, the two 120 volt outputs are combined at receptacle X2.

Unit grounding is provided by several ground straps connecting the base, generator, roll guard, and ultimately, a user installed earth ground connection.

The generator circuit is equipped with an over/under voltage warning meter.

Generator Circuit Diagnosis

Test Procedure A

Test Conditions:

- Machine warmed up and running with a minimum 50 watt load applied to generator.

Generator AC Output

1. Is the PTO running at 540 rpm to provide correct 60 Hz output from all of the AC receptacles?

Yes: Test complete.

No: Check to make sure that the PTO is running at 540 rpm. Go to test procedure B.

Test Procedure B

Test Conditions:

- Key switch in the OFF position.
- Generator excitation capacitors accessible.
- All terminal block leads disconnected.

Generator Internal Components

1. Did generator provide proper output in test procedure A?

No: The excitation field capacitors may need to be energized. See “Stator Excitation Field Restoration” on page 449. Low engine speed/PTO speed, faulty windings, or defective capacitors can cause excitation field failure.

No: Check for continuity between one Red and one Grn capacitor lead. If there is continuity, the stator is shorted. Replace stator.

No: Disconnect the excitation capacitor leads and measure the resistance between the Red wires. Repeat for the Grn pair. If the resistance is not approximately 1.2 ohms, replace the stator.

No: After discharging each capacitor, measure the resistance across each of the capacitor’s terminals. If the resistance increases (increasing as capacitor charges), the capacitor is OK. If not, replace the capacitor.

No: Check for continuity between each capacitor lead and each black stator power lead. If there is continuity, the stator is shorted and must be replaced.

No: Measure the resistance across each of the rotor’s diode ends. See “Generator Rotor Test” on page 448.

No: Check continuity between each of the rotor’s diode ends and ground. If there is continuity, the rotor is shorted and must be replaced.

No: Check for continuity between the rotor body and the stator body. If there is continuity, isolate the source of the short and repair or replace components as necessary.

No: If generator voltage no load output is too high, excitation capacitors may be holding too high a charge. Short each capacitor and recharge. See “Stator Excitation Field Restoration” on page 449.

No: Check for low no-load or low loaded voltage. Possible faulty rotor diodes. See “Generator Rotor Test” on page 448.

Yes: Go to test procedure C.

Test Procedure C

Test Conditions:

- Key switch in the OFF position.

Generator GFCI Circuit

1. Did the GFCI circuit trip during test procedure A?

Yes: Check to ensure the generator earth ground is connected properly.

Yes: Check the generator to base grounds. See “Generator Ground Test” on page 449.

Yes: Test the GFCI circuits. See “Ground Fault Circuit Interrupter (GFCI) Checks” on page 448.

Yes: Ensure that the frequency of device connected to the receptacle matches that of the generator’s output.

Yes: Ensure that the load of the device connected to the generator does not exceed the rated output of the generator or receptacle.

No: Go to test procedure D.

Test Procedure D

Test Conditions:

- Key switch in the OFF position.

Generator Circuit Breakers

1. Are the individual circuit breakers tripping?

Yes: Ensure that the load on the circuit does not exceed its respective amperage rating.

Yes: The device connected to the receptacle may be short circuiting and causing excessive current draw on the generator.

Yes: Distribute the 120 volt loads evenly across the duplex receptacles.

Yes: Ensure that the frequency of the device connected to the receptacle matches that of the generator’s output.

Yes: Remove top panel and inspect internal wiring for problems.

No: Test complete.

Tests and Adjustments

Generator Stator Test

Reason:

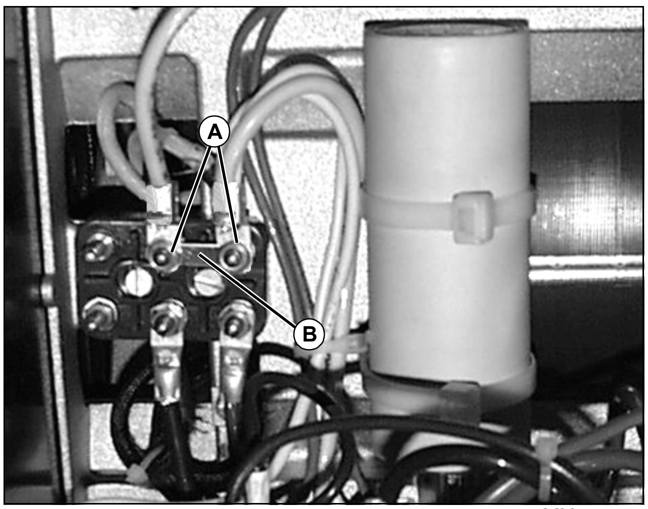
To verify that the stator coils have proper continuity (not open or shorted).

Test Equipment:

- Ohmmeter

Procedure:

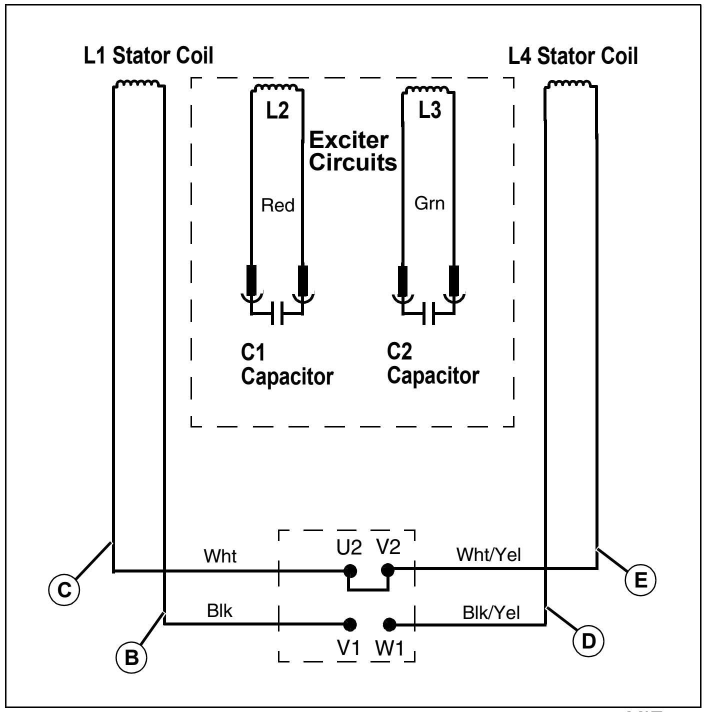
1. Remove the four screws securing the control panel cover.



MX19886

2. Disconnect white and green wires (A) and ground shunt (B) from the terminal block, noting their positions.

3. Disconnect the harness ground on stator housing.



MIF

4. With the terminal wires disconnected, check the resistance between the Blk wire (B) and Wht wire (C). There should be continuity.

5. With the terminal wires disconnected, check the resistance between the Blk wire (D) and Wht wire (E). There should be continuity.

6. Check for continuity between the two White wires (C and E). There should be no continuity. If there is, the stator is shorted.

7. Check for continuity between the stator housing and all wires. There should be no continuity. If there is, the stator is shorted.

Specifications:

Blk to Wht wire resistance (approximately). . . 1.0 ohms
White wire to White wire . . . . Infinity ohms

- If specifications are not met, replace stator.

Generator Rotor Test

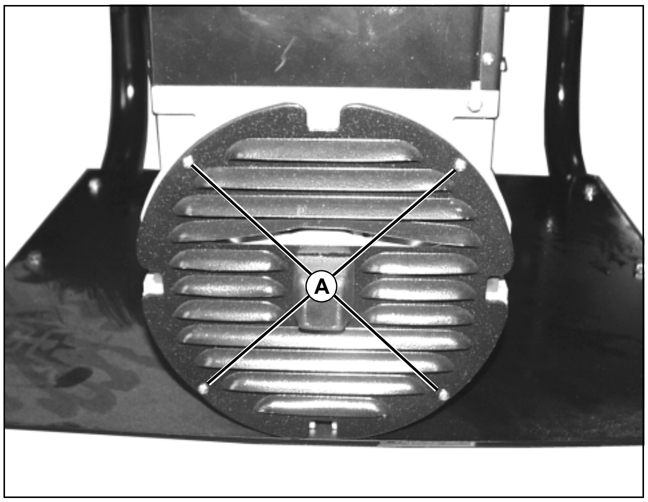
Test Equipment:

- Ohmmeter

Reason:

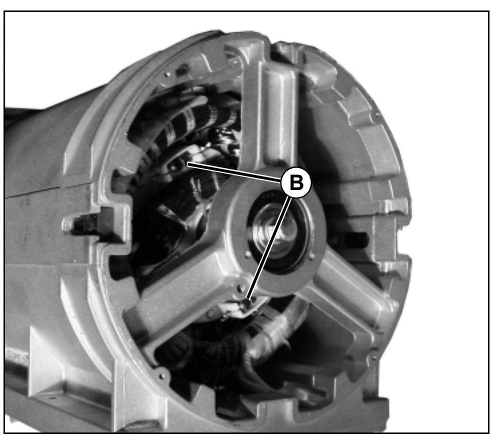
To verify that the rotor coils and components have proper continuity and resistance (not open or shorted). This test verifies circuit integrity ONLY. If specifications are not met, rotor discrete components (diodes and varistors) can not be tested individually.

Procedure:



MX19883

1. Remove the four screws securing the side cover of generator housing.



MX17383

2. Locate the diode for each of the rotor coils (B).

Note: The diodes are in a parallel circuit with the varistors and the rotor windings. Do not unsolder the diodes for testing.

3. Place an ohmmeter lead on the each end of diode. Measure resistance.

4. Repeat for second diode. The readings should meet specifications.

5. Place lead on end of diode and one end on stator housing. Repeat test with a one lead placed on the end of each diode. There should be no continuity. If there is, the rotor is shorted.

Specifications:

Resistance at each diode (approximately) . . . 1.5 ohms
Diode to stator housing. . . . . Infinity ohms
Diode to diode . . . . Infinity ohms

- If specifications are not met, replace rotor.

Ground Fault Circuit Interrupter (GFCI) Checks

Caution: Avoid Injury! The GFCI circuits may not function unless the generator is properly grounded. Situations exist where a GFCI will not afford any protection against the hazards of electrical shock. EXAMPLE: If a person touches two or more conductors from a damaged cord set and is not in direct contact with the ground, he or she may receive a shock. Since there is no path to ground for a ground fault current to flow through, the GFCI will not operate and serious injury may result.

Reason:

The 20 amp, 120 VAC outlets are protected by ground fault circuit interrupters (GFCI). The GFCI has to meet the following operational checks.

- When the test button is pressed, the reset button must pop out and the voltage to the GFCI and the 5-20R duplex receptacle must be zero.
- When the reset button is pressed back in, power must return to the GFCI duplex receptacle.
- When a 5mA “ground fault” is applied from either receptacle’s Hot Line to Frame Ground, the reset button must pop out and the receptacle power must be zero. Use tester available from electrical or building stores.

Generator Ground Test

Reason:

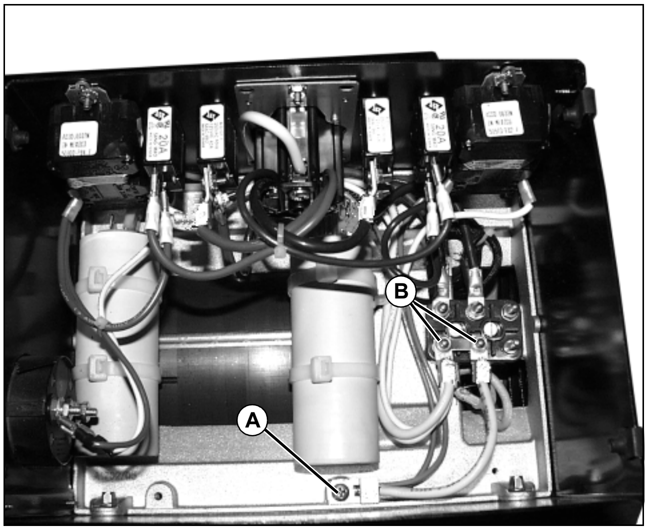
To ensure that the generator, base, and control panel share a common ground.

Equipment:

- Ohmmeter

Procedure:

1. Visually inspect all ground points to ensure that wires and cables are attached securely and are in good condition.
2. Set VOM to RX1 setting.



3. Connect one VOM lead to the ground terminal (A).
4. Connect second lead to ground test points (B).

Results:

- Resistance should not exceed 0.2 ohms.
- If resistance exceeds 0.2 ohms, check condition of affected wires and connections. Repair or replace as necessary.

Repair

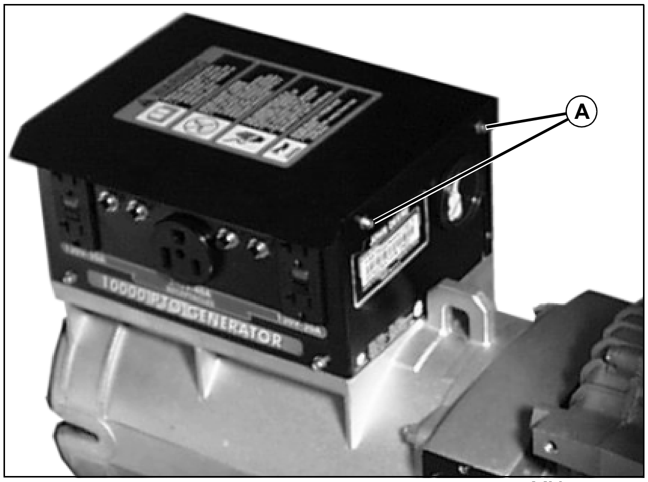
Stator Excitation Field Restoration

Reason:

To restore the stator self excitation capacitor charge in the event of no generator output.

If the generator has no AC output, it is possible that the excitation field has dissipated and the field capacitors will have to be recharged.

Procedure:

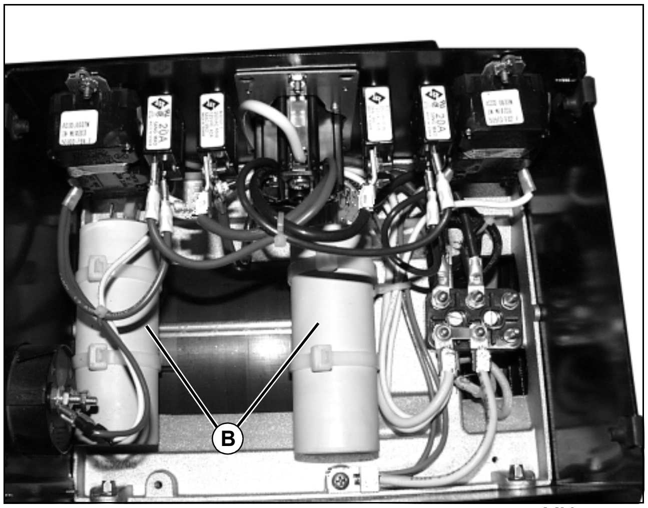


MX19672a

1. Remove the four control panel cover screws (A) and remove cover.

Caution: Avoid Injury! The field capacitors have the capability to store very high voltages. NEVER touch both capacitor terminals with bare hands. as this could cause rapid discharge and result in an electrical shock. Discharge capacitors by bridging the terminals with a screwdriver shaft that has an insulated handle before servicing.

2. Discharge the capacitors.

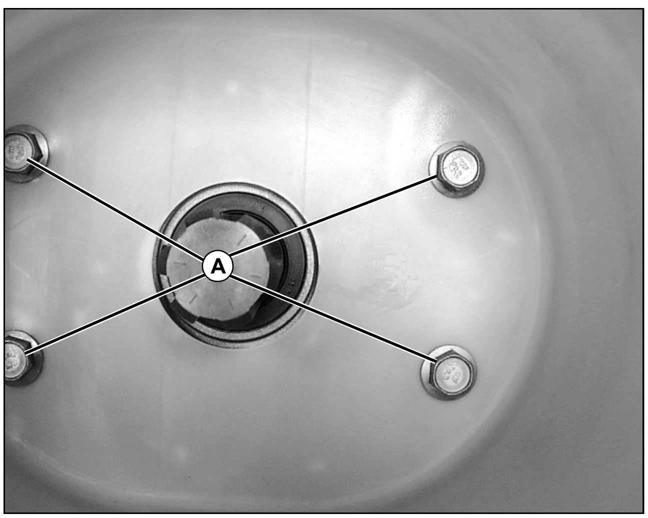


MX19885

3. Using jumper wires, apply a DC power source (such as the 12 volt starting battery) across the terminals of either of the field capacitors (B) for approximately 1 second.

4. Replace terminal block cover and secure with four mounting screws.

PTO Shield Removal and Installation



MX17182

Removal:

1. Remove the four bolts securing the protective shield to the transmission.

2. Remove shield.

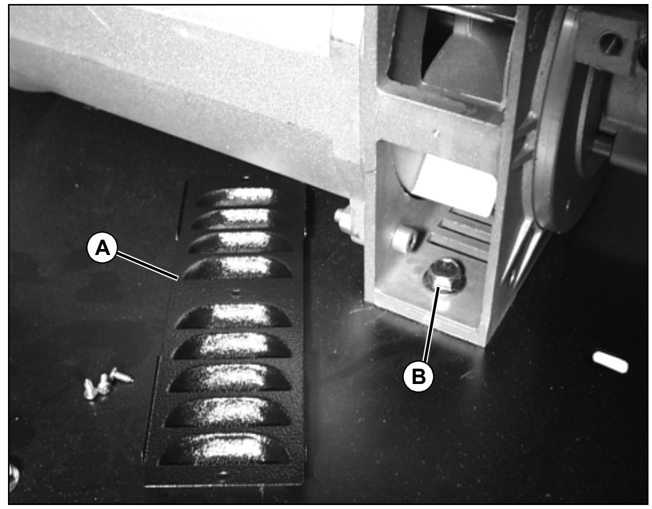
Installation:

- Installation is in the reverse of removal.

Generator Removal and Disassembly

Caution: Avoid Injury! Generator weighs approximately 49 Kg (108 lbs). Use an assistant or proper equipment to aid in generator removal.

Procedure:



MX19191

1. Remove fan cover (A) from each side of generator.

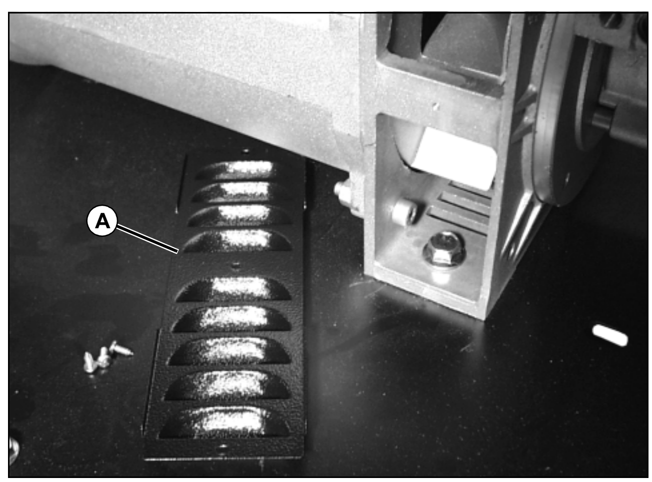
2. Remove locknuts from two bolts (B) securing generator to base bracket.

3. Remove locknut securing rear of generator to base bracket.

4. Remove generator from base bracket.

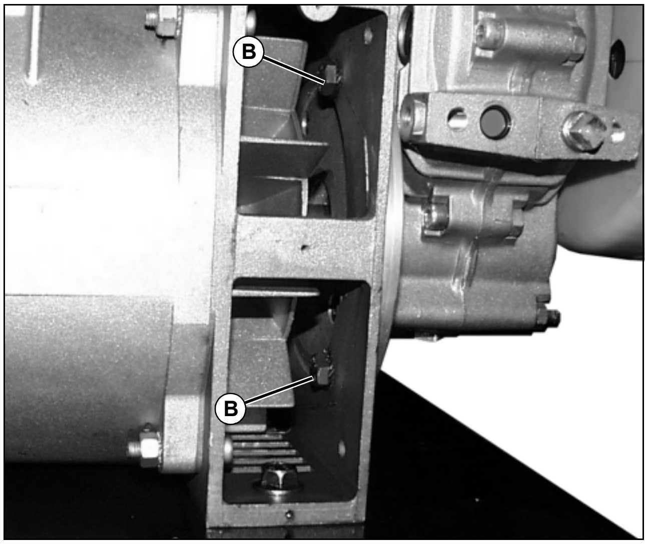
Gear Case Removal and Disassembly

Procedure:



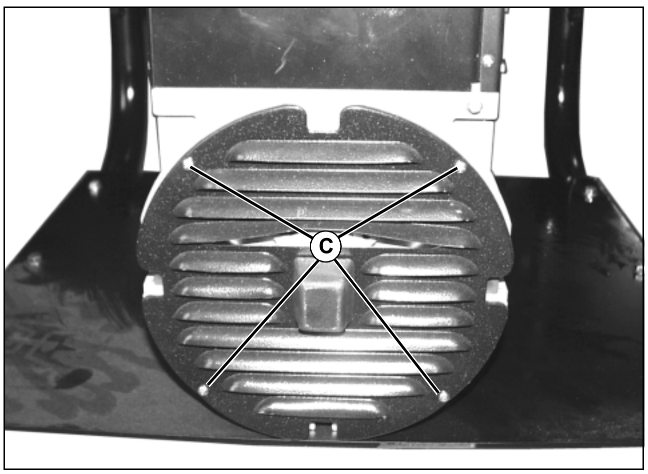
MX19191

1. Remove fan cover (A) from each side of generator.



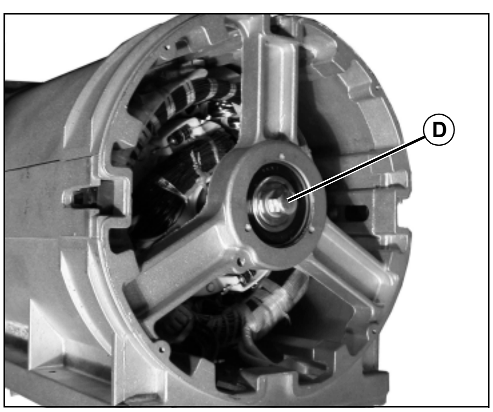
MX19884

2. Remove four bolts (B) securing gear case to generator housing.



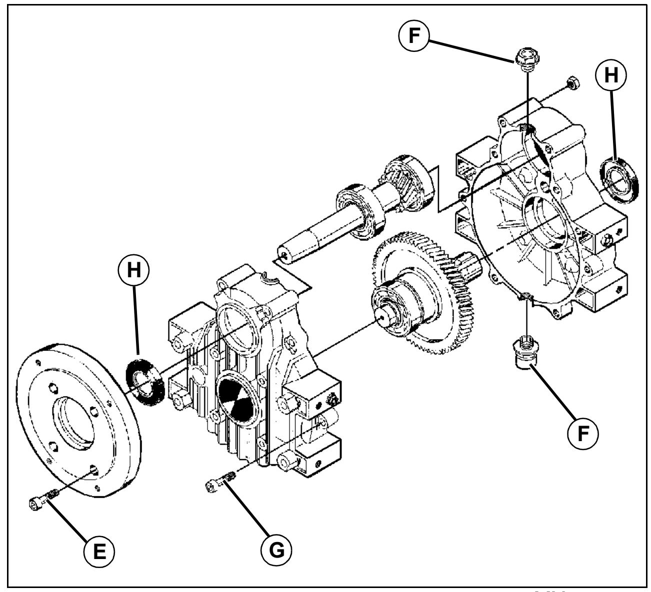
MX19883

3. Remove the four screws (C) securing the side cover of generator housing.



MX17383

4. Loosen bolt (D) approximately five full turns and tap on bolt with a soft mallet to loosen the gear case tapered shaft from the rotor. Remove bolt and gear case.



MX19882a

5. Remove four bolts (E) securing plate to housing.

6. Remove top and bottom plugs (F) and drain gear oil into a suitable container.

7. Remove bolts (G) securing case halves and separate case.

Note: If gears are damaged, replace entire gear case assembly.

8. Remove gear shaft assemblies and inspect for damage. Replace bearings as necessary.

9. Remove and replace seals (H) before assembly.

Assembly:

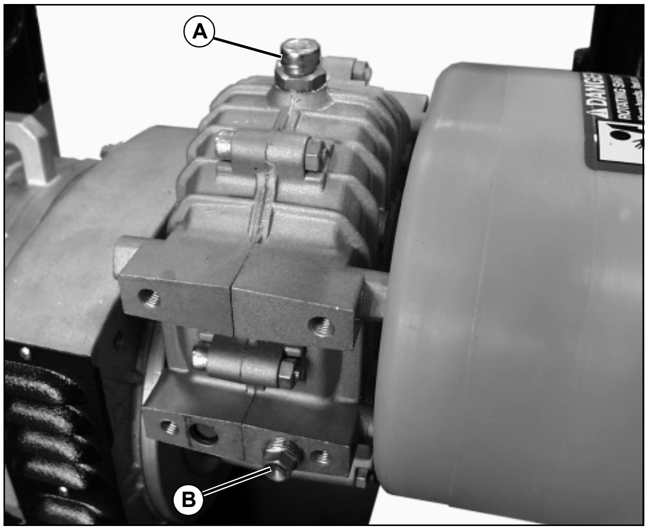
Assembly is performed in the reverse order of disassembly.

- Replace gear shaft seals.
- Clean case halves and seal with gasket compound.
- Install plugs.

Gear Case Oil Fill:

1. Install gear case to generator or place gear case on flat work surface.

Note: If gear case is overfilled, oil may come out of top vent plug during operation. If oil leaks occur during operation, check for proper oil level.



MX17188

2. Remove top (A) and side (B) case plugs.

3. Fill case with 80W90 GL5 Gear Lube (approximately 16 oz) until gear oil comes out of side plug opening (B).

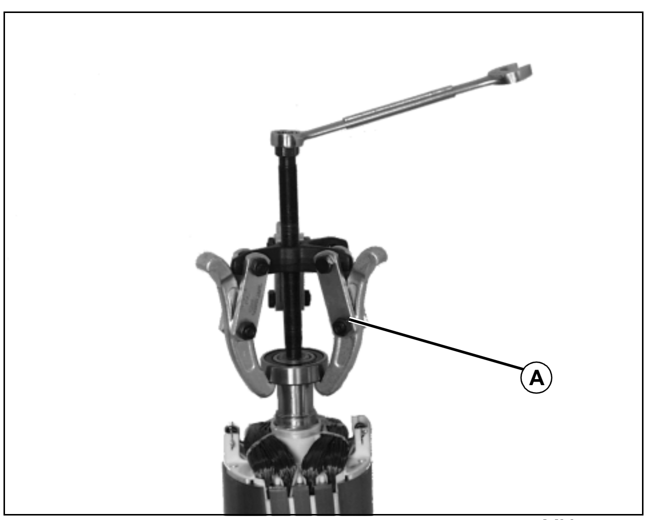
4. Install and tighten plugs.

Rotor Bearing Removal and Installation

Removal:

1. Remove gear case from generator. See “Gear Case Removal and Disassembly” on page 450.

2. Remove rotor assembly from generator.



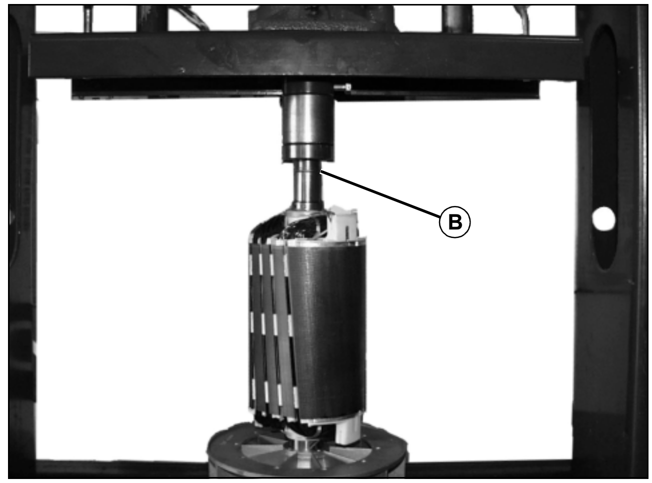
MX17352

3. Stand rotor assembly upright on a level surface and attach a suitable bearing puller (A) to rotor bearing.

4. Slowly remove bearing from rotor shaft.

Installation:

1. Place bearing evenly on rotor shaft.



MX17351

2. Using a press, install bearing on shaft until it stops on bearing seat (B).

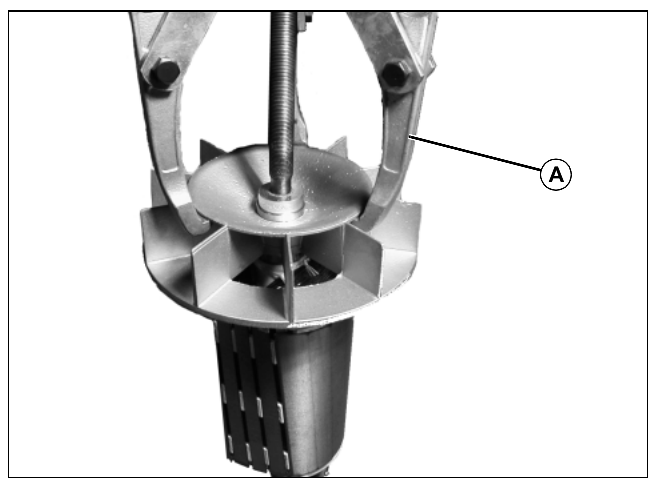
3. Ensure that bearing rotates freely and does not bind.

Rotor Fan Removal and Installation

Removal:

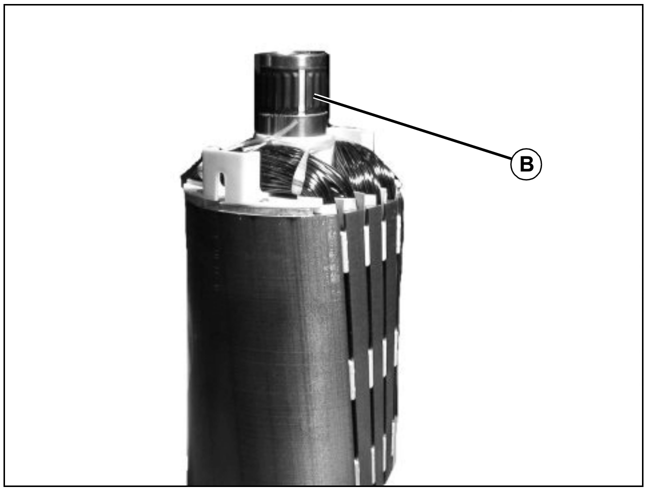
1. Clean rotor shaft and ensure that it is free of all dirt and grease.

2. Stand rotor on a level surface with the bearing end down.



MX17345

3. Using a suitable puller (A), slowly remove fan from rotor shaft.

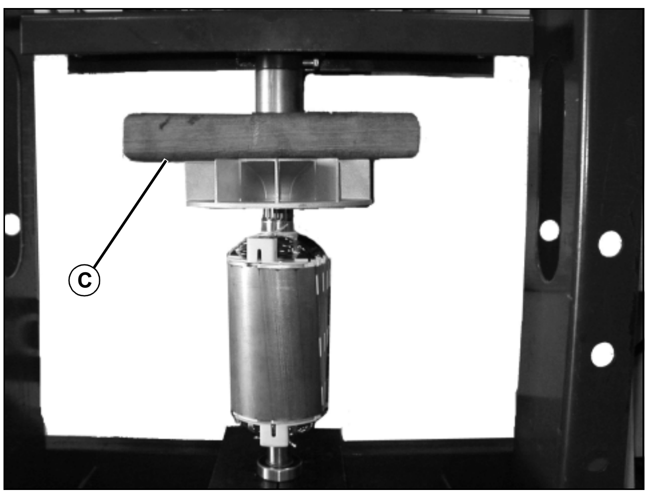


MX17347

4. Inspect the fan friction collar (B) for deformation. Replace as necessary.

Installation:

1. If removed, replace fan friction collar.
2. Place rotor and fan on press.



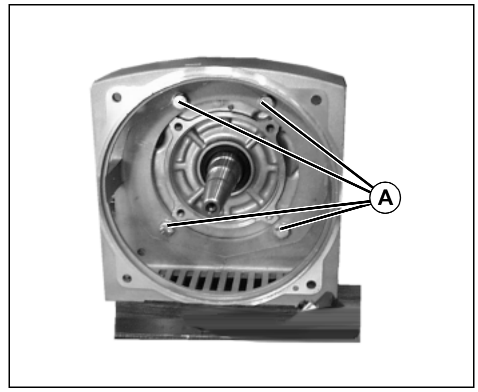
MX17348

3. Place a block of wood (C) on fan to allow for even pressure distribution.
4. Slowly apply pressure until fan seats on rotor shaft flange.

Generator Assembly and Installation

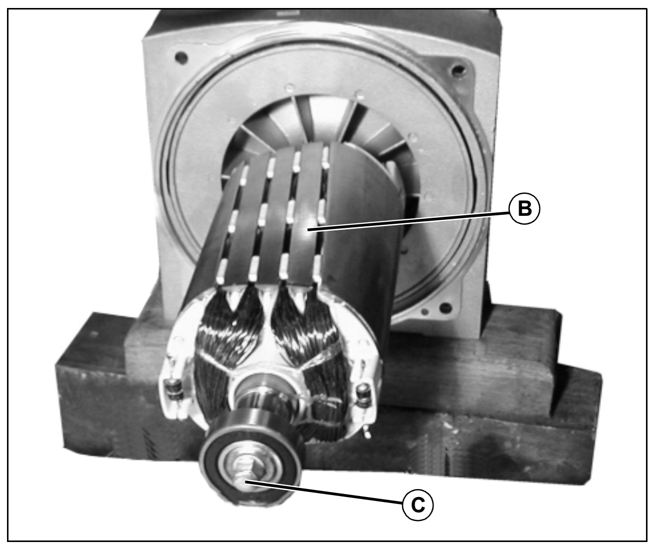
Assembly and Installation:

1. Assemble generator by applying medium strength thread lock to bolts securing generator end support bracket to transmission (if removed for transmission replacement).



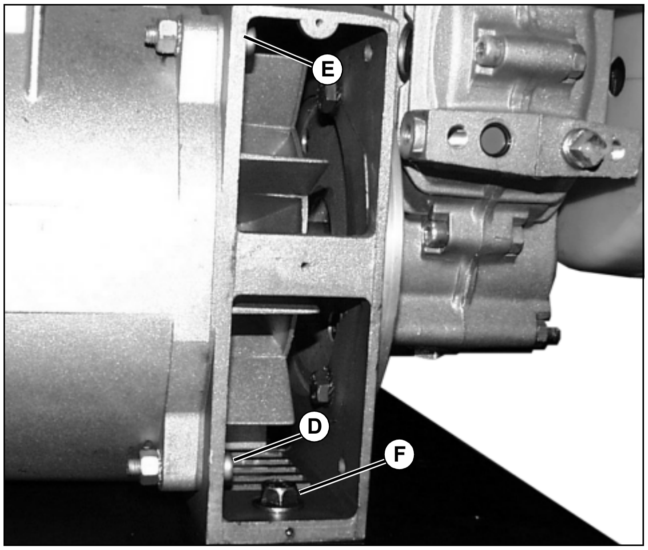
MX19708

2. Set end support bracket against gear case and insert bolts (A). Tighten bolts to specification.
3. Wipe gear case shaft taper clean of grease and debris.



MX19709

4. Slide rotor and fan assembly (B) onto crankshaft.
5. Insert rotor to gear case retaining bolt (C) through lock washer and rotor into crankshaft. Tighten finger tight.
6. Gently slide stator and end housing over rotor.



MX19884

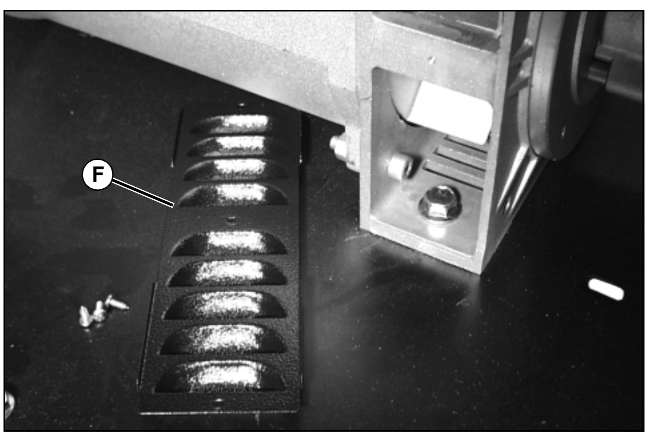
7. Slide two bolts and nuts (D) at bottom of stator housing and tighten finger tight. Install two bolts (E) into holes at top of stator housing, install nuts, and tighten. Tighten bolts to specification.

8. Tighten rotor retaining bolt slowly and ensure rotor turns smoothly inside of stator.

9. Ensure that rotor bearing is seated completely in stator housing.

10. Tighten rotor bolt to specification.

11. Install three generator support bolts (F).



MX19191

12. Install generator end cover and vent covers (F).

13. Connect all wiring in the reverse of disassembly.

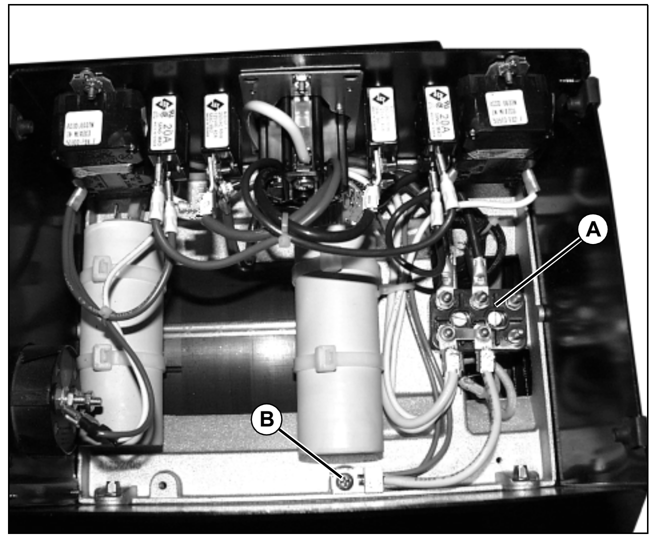
Specifications:

Generator support bracket to gear case
. . . . . 21 N•m (186 lb-in.)
Generator to support bracket . . . . . 21 N•m (186 lb-in.)
Rotor to rotor retaining bolt . . . . . . 21 N•m (186 lb-in.)

Control Panel Removal and Installation

Removal:

1. Remove the control panel cover.



MX19885

2. Disconnect wires from the terminal block (A).
3. Disconnect ground wires (B).
4. Remove control panel.

Installation:

- Installation is in the reverse of removal.

Table of Contents

MISCELLANEOUS SPECIFICATIONS

Specifications

Repair Specifications

Fuel Tank Capacity . . . . **24.6 L (6.5 gal)**
Fuel Pump/Sensor Bolts . . . . **1.4 N•m (12 lb-in.)**
Steering Wheel Nut . . . . **38 N•m (28 lb-ft)**
Front Wheel Cap Screw (2-Wheel Drive . . . . **73 N•m (54 lb-ft)**
Front Wheel Lugs (5 used) (4-Wheel Drive) . . . . **88 N•m (65 lb-ft)**
Rear Wheel Lugs . . . . **88 N•m (65 lb-ft)**

Other Materials

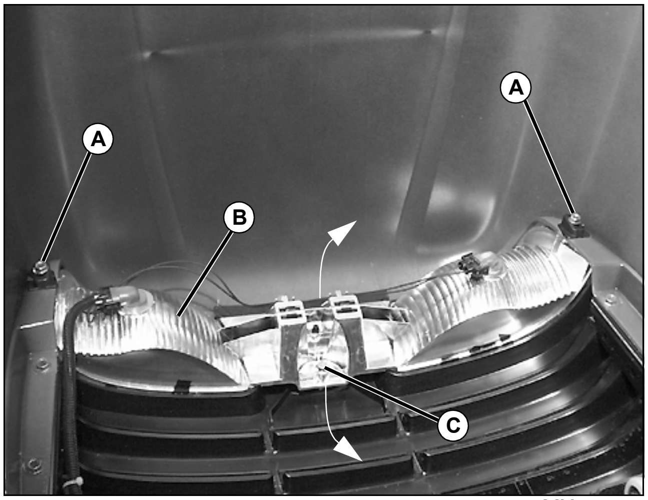
Other Material

Part No.	Part Name	Part Use
LOCTITE® PRODUCTS Loctite#/U.S. #/Canadian TY9370/TY9477/#242	Thread Lock and Sealer (Medium Strength)	To seal threads on control valve screws, spool detent, and small plugs

Repair

Headlights Adjustment

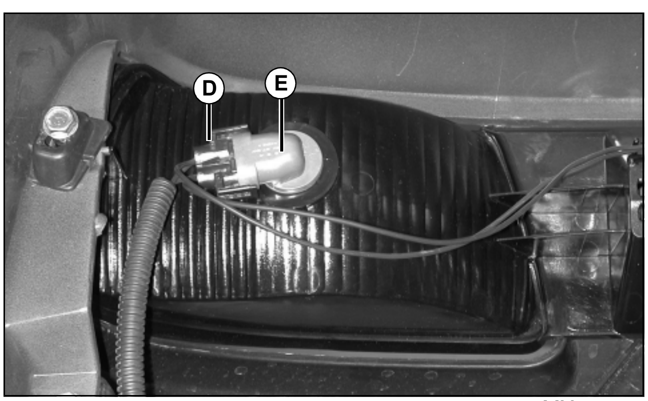
1. Park machine safely. See Parking Safely in the Safety Section.
2. Raise hood.



MX14303

3. Loosen both cap screws (A) holding headlight fixture (B) securely to hood.
4. To adjust headlights, loosen cap screw (C), and rotate headlight fixture (B) up or down. Tighten cap screw (C).
5. Tighten cap screws (A) holding fixture to hood.
6. To replace headlights:

Caution: Avoid Injury! Halogen light bulb contains gas under pressure. The bulb may shatter if the glass is scratched or dropped. Wear eye protection and handle bulb with care when removing or replacing.



MX13624

- Disconnect wire harness (D) from defective bulb assembly (E).
- Turn bulb assembly 1/4 turn counterclockwise to remove.
- Insert new bulb assembly into housing and turn 1/4 turn clockwise to install.
- Connect wire harness.

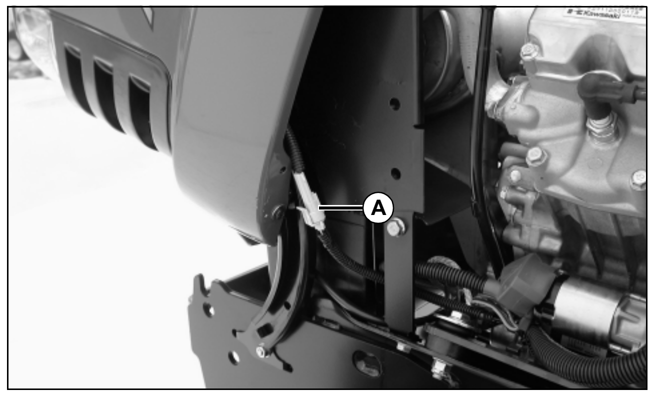
7. Lower hood.

Hood Removal and Installation

Removing:

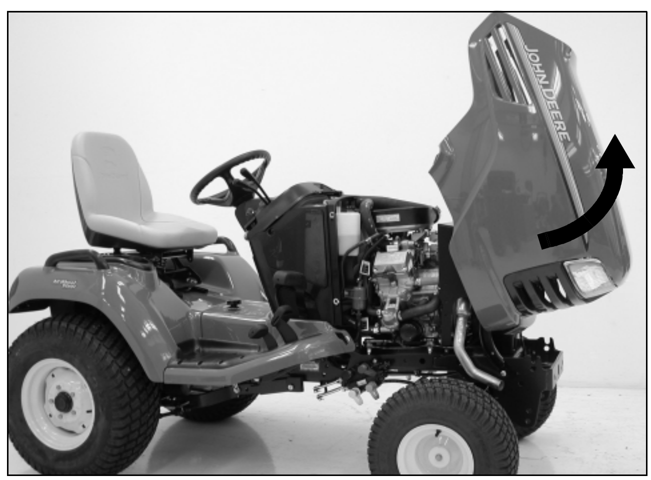
1. Raise hood.

Important: Avoid Damage! Disconnect headlight harness before removing hood.



MX13552

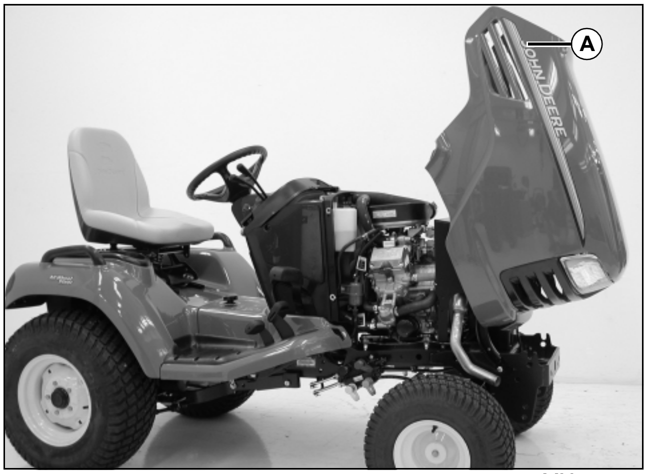
2. Disconnect headlight harness (A) on left side of machine.



MX13551

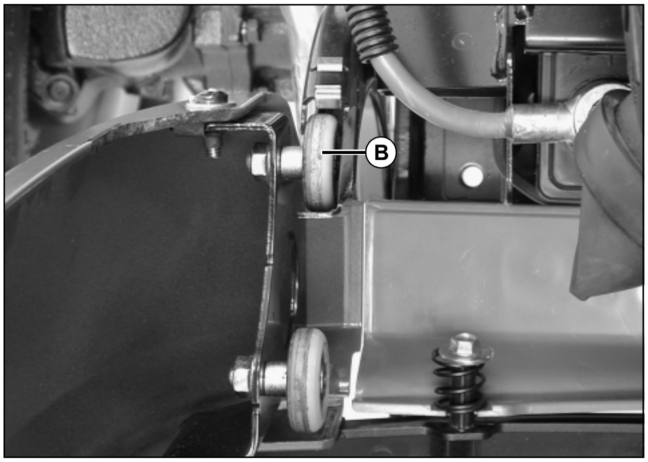
3. Pull hood forward and roll hood up and out of rail.

Installing:



MX13551

1. Position hood (A) upright.



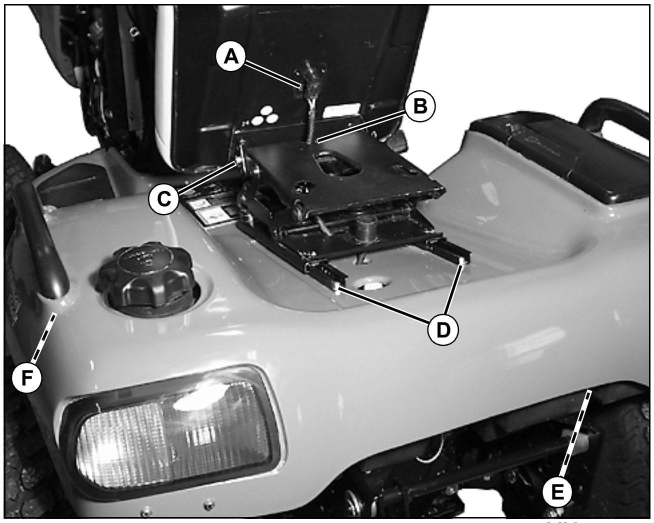
MX13629

2. Install first set of rollers (B) on hood into rail.
3. Connect headlight harness on left side of machine.
4. Tilt rear of hood toward steering wheel and lift hood up and drop second set of rollers into rail.
5. Allow hood to roll downward on rail.
6. Lower hood.

Fender Deck Removal and Installation

Removal:

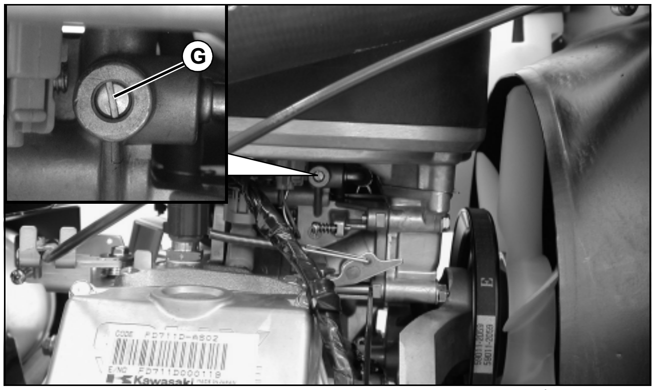
1. Park machine safely. See Parking Safely in the Safety Section.
2. Raise hood and disconnect negative battery terminal.



MX14169

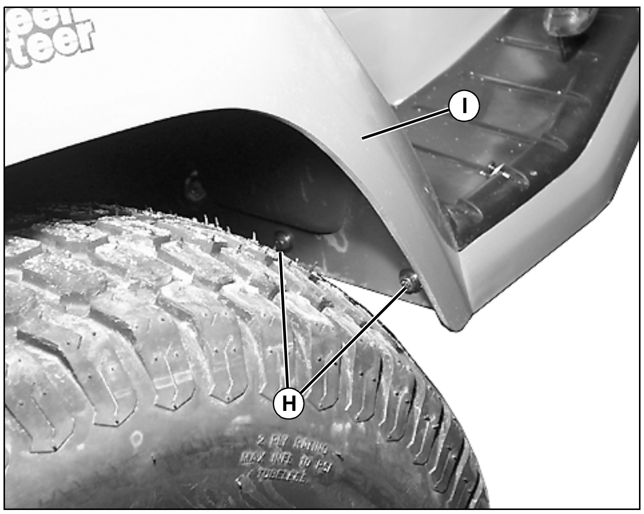
3. Slide seat fully forward and tip up.
4. Disconnecting seat switch wiring connector (A), remove wire and sheath from notched area (B) in seat platform.
5. Remove spring pin (C) and pivot rod. Remove seat.
6. Remove two rear cap screws (D).
7. Slide seat fully rearward and remove two front cap screws and seat platform.
8. MFWD machines only: Remove shift lever knob on right side of fender deck before fender deck removal. See "Shift Lever Linkage (MFWD) Removal and Installation" on page 278 in the Power Train section.
9. Disconnect tail light wiring harness connector (E).
10.Remove fuel tank support bracket (F), under left rear tire and fuel cap.

Caution: Avoid Injury! Machines with (FD711D) EFI engines: Release of fluids from pressurized fuel system can cause serious injuries. Relieve fuel system pressure before servicing.



MX15401/MX15402

11.(FD711D) EFI Engines Only: Loosen the fuel pressure relief screw (G) to relieve the high pressure in the return fuel hose; then tighten it.



MX14172

12.Remove cap screws (H).

13.Remove fender deck (I), being careful to guide seat switch wiring through hole in bottom of platform.

14.Immediately install fuel cap, being sure to not allow dirt or other debris to enter fuel tank.

Installation:

Note: Route wires and hoses in fuel tank slots to prevent pinching.

1. Installation is the reverse of removal.

Foot Deck Removal and Installation

Removal:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Raise hood and disconnect negative battery terminal.
3. Remove fender deck. See "Fender Deck Removal and Installation" on page 459.
4. Remove the rubber foot mats from each side.
5. Remove the two carriage bolts from each side, securing the foot deck to the frame.
6. Remove the foot deck from the frame.

Installation:

Note: Route wires and hoses to prevent pinching.

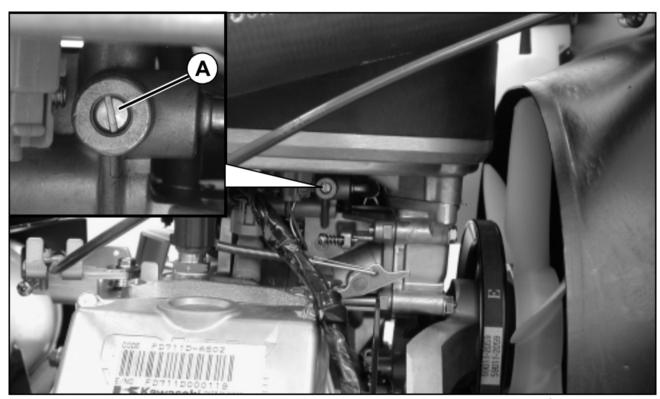
1. Installation is the reverse of removal.

Fuel Tank Removal and Installation

Removal:

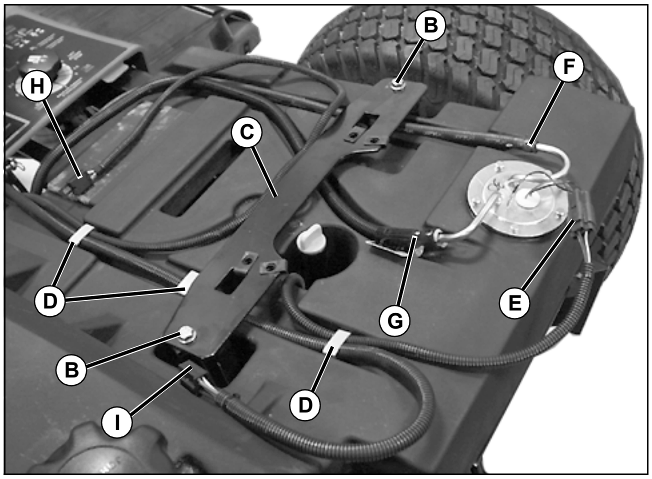
1. Park machine safely. See Parking Safely in the Safety Section.
2. Raise hood and disconnect negative battery terminal.

Caution: Avoid Injury! Machines with (FD711D) EFI engines: Release of fluids from pressurized fuel system can cause serious injuries. Relieve fuel system pressure before servicing.



MX15401/MX15402

3. (FD711D) EFI Engines Only: Loosen the fuel pressure relief screw (A) to relieve the high pressure in the return fuel hose; then tighten it.
4. Remove fender deck. See "Fender Deck Removal and Installation" on page 459.



MX14173

5. Remove two cap screws (B) and bracket (C).

6. Remove three clips (D) holding wiring harnesses in place.

7. Disconnect sending unit wiring harness connector (E).

> **Caution: Avoid Injury! Fuel Vapors are explosive and flammable.**
>
> - **Do not smoke while handling fuel.**
> - **Keep fuel away from flames or sparks.**
> - **Fill fuel tank outdoors or in a well ventilated area.**
> - **Clean up spilled fuel immediately.**
> - **Use clean approved non-metal container to prevent static electric charge.**
> - **Use clean approved plastic funnel without screen or filter, to prevent static electric discharge.**

8. Loosen hose clamp and remove drain-back hose (F). Cap hose to keep fuel from draining.

9. Squeeze tabs on end of fuel supply hose and disconnect hose (G) from stationary line on sending unit. Cap hose to keep fuel from draining.

10.Remove fuel tank, taking care to move all fuel lines and wiring harnesses, including seat switch (H) and tail light (I) harnesses, out of the way to avoid damaging them.

Installation:

Note: Route wires and hoses in fuel tank slots to prevent pinching.

1. Installation is the reverse of removal.

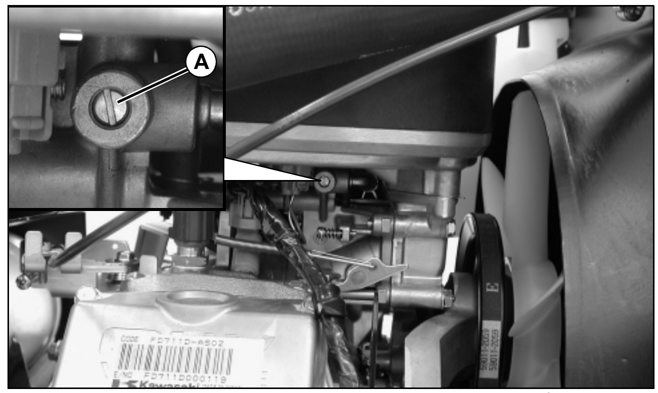
Fuel Pump/Fuel Gauge Sensor Removal and Installation

Removal:

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

2. Raise hood and disconnect negative battery terminal.

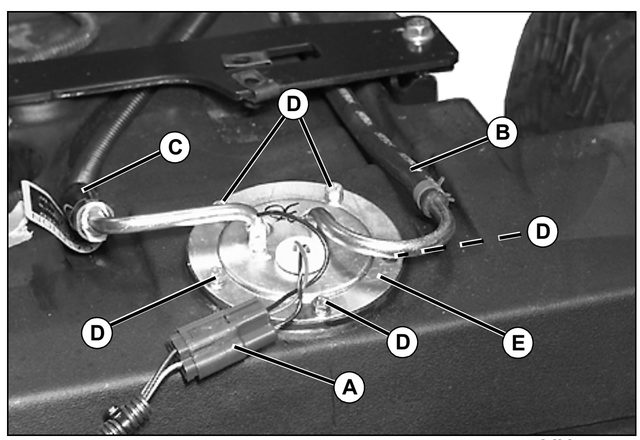
> **Caution: Avoid Injury! Machines with (FD711D) EFI engines: Release of fluids from pressurized fuel system can cause serious injuries. Relieve fuel system pressure before servicing.**



MX15401/MX15402

3. (FD711D) EFI Engines Only: Loosen the fuel pressure relief screw (A) to relieve the high pressure in the return fuel hose; then tighten it.

4. Remove fender deck. See “Fender Deck Removal and Installation” on page 459.



MX14174

Picture Note: (FD711D) EFI supply hose (C) shown; (FD671D) engines have standard clamped hose.

5. Disconnect sending unit wiring connector (A).

6. Loosen clamp and disconnect drain-back hose (B).

7. (FD711D) EFI Engines Only: Squeeze tabs on end of supply hose (C) and disconnect hose.

8. Remove five cap screws (D) and fuel pump/sensor (E).

9. Inspect parts for wear or damage. Replace if necessary.

Installation:

Note: Route wires and hoses in fuel tank slots to prevent pinching.

1. Installation is the reverse of removal.

2. Tighten five cap screws (D) in a star pattern to specification. Do not overtighten.

Specifications:

Mounting Cap Screws . . . . 1.4 N•m (12 lb-in.)

Rear Wheel Removal and Installation

1. Lift machine high enough to remove weight from wheels. Place jack stands under machine frame.

MX11940

2. Remove five lug bolts (A) and rear wheel assembly

Installation is done in the reverse order of removal.

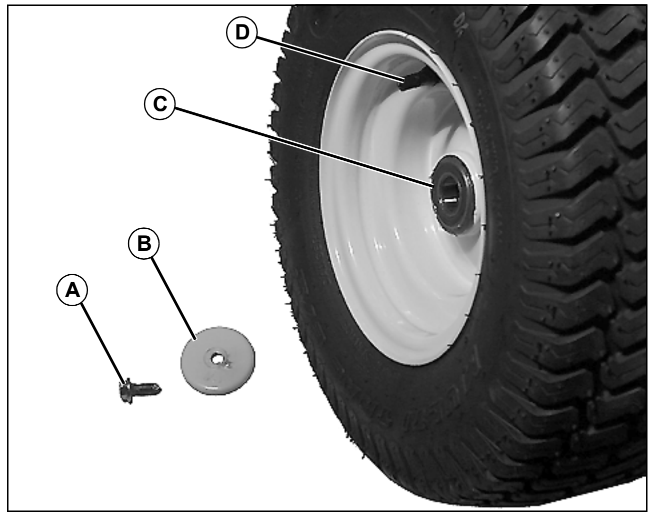
- Install wheels with valve stems (B) facing away from machine and tighten lug bolts to specification.

Specifications:

Lugs . . . . 88 N•m (65 lb-ft)

Front Wheel Removal and Installation

1. Lift machine high enough to remove weight from wheels. Place jack stands under machine frame.



MX11939

Picture Note: 2-wheel drive shown; 4-wheel drive has five lugs securing wheel to hub similar to rear wheels.

2. Remove cap screw (A) and plate (B).

Note: Remove bearings only if replacement is necessary.

3. Inspect bearings (C) for wear or damage. Replace if necessary.

- Remove either bearing (C) using a slide hammer and inside puller.
- Remove bearing on opposite end using a driver set and a press.
- Install bearings flush to wheel hub.
- Pack inside areas of wheel hub bearings with multipurpose grease.

Installation is done in the reverse order of removal.

- Install wheels with valve stems (D) facing away from machine and tighten fastener(s) to specification.

Specifications:

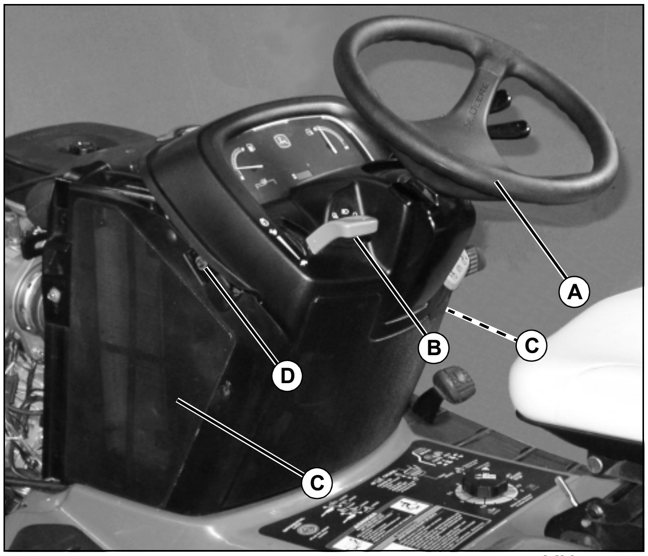
Two-Wheel Drive Cap Screw . . . . 73 N•m (54 lb-ft)
Four-Wheel Drive Lugs . . . . 88 N•m (65 lb-ft)

Instrument Panel Removal and Installation

Removing:

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

2. Raise hood and disconnect negative battery terminal.



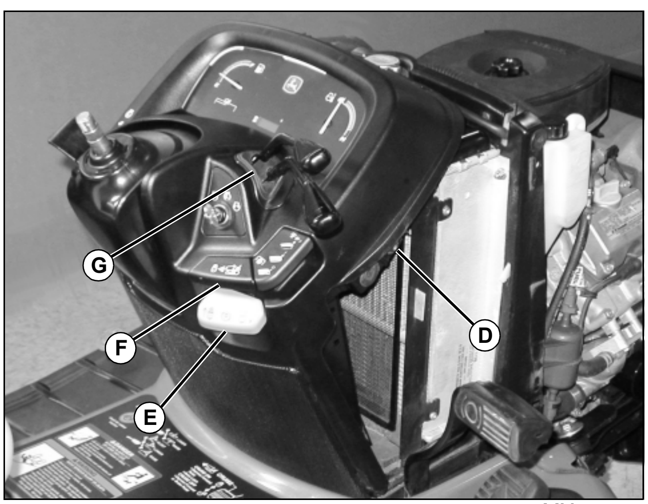
MX35886

3. Remove steering wheel cover and steering wheel (A). See “Steering Column Removal and Installation” on page 375 in Steering section.

4. Remove throttle handle (B).

5. Pull top of left and right side panels (C) out to remove pins from holes in machine frame.

6. Remove screw (D) holding instrument panel onto pedestal.

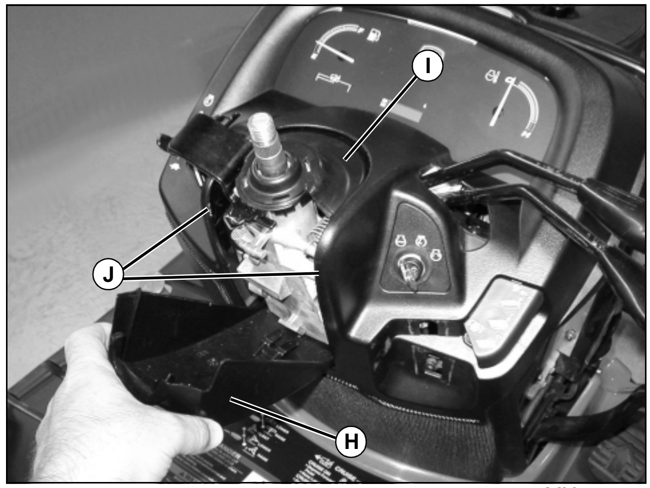


MX35887

7. Remove screw securing cruise control latch (E) and parking brake latch (F).

8. Remove SCV lever boot (G).

9. Remove screw (D) holding instrument panel onto pedestal.



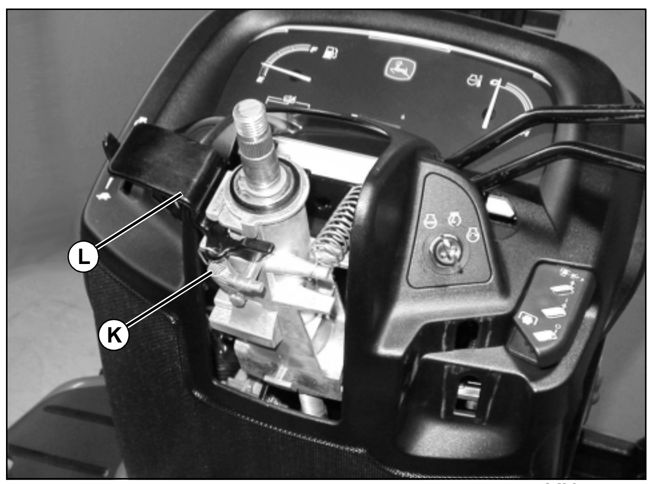
MX35888

10.The steering column shields snap onto the steering column.

   a. Grasp the front shield (H) and firmly pull the top of the shield out and then lift the shield off of the steering column.

   b. Lift the top shield (I) up to unsnap it from the steering column.

   c. Pivot the steering column down (toward the seat) and firmly flex the top shield (I) and the instrument panel (J) to remove the shield.



MX35889

11.Remove the latch spring (K).

12.Unsnap the latch (L) from the steering column.

MX35890

13.Slowly raise instrument panel, being careful to remove all electrical connections beneath panel and guiding panel past SCV levers (M).

Installation:

Note: Route wires to prevent pinching.

1. Installation is the reverse of removal.

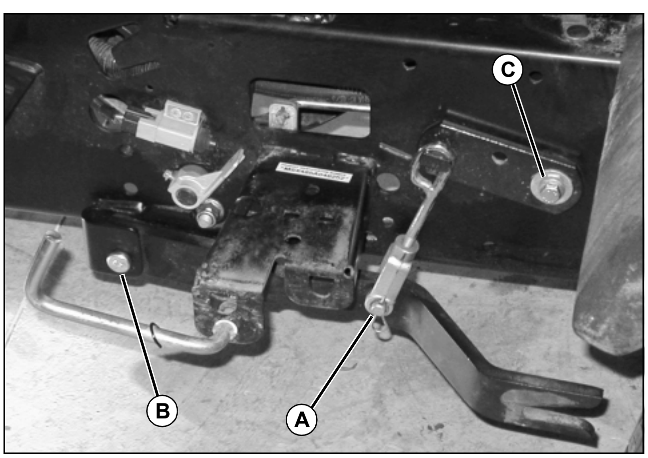
Specifications:

Steering Wheel Nut. . . . . 38 N•m (28 lb-ft)

Lift Linkage Removal and Installation

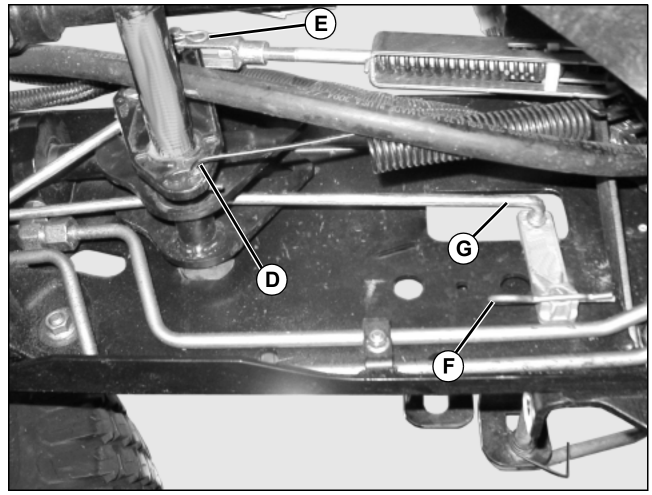
Removal:

1. Park machine safely. See Parking Safely in the Safety Section.
2. Raise hood and disconnect negative battery terminal.
3. Remove fender deck. See “Fender Deck Removal and Installation” on page 459.
4. Remove foot deck. See “Foot Deck Removal and Installation” on page 460.



MX35891

5. Remove the spring pins and drilled pins securing the draft arms to the lift link (A) and the frame (B).
6. Turn lift link 45°, and remove from end of lift arm.
7. Remove cap screw, washer (C) and lift arm from end of mid-lift shaft.



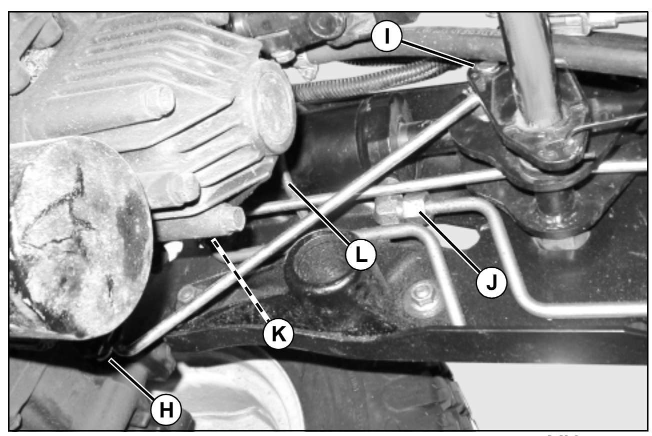
MX35892

8. Disconnect the return spring (D) from the intermediate brake bellcrank.
9. Remove the spring pin and drilled pin (E) and disconnect the brake actuator link from the intermediate brake bellcrank.

10.Remove the spring pin (F) and differential lock bellcrank from the differential lock pedal rod.

11.Rotate the differential lock bellcrank 90° and remove bellcrank from differential link (G).

12.At the transaxle, remove the spring pin and washer and remove the differential link from the machine.



MX35893

13.Remove spring pin (H) from end of brake rod at transaxle arm and cam, and remove brake rod from intermediate brake bellcrank (I).

14.Disconnect the front (J) and rear (K) hydraulic lines from the cylinder.

15.Remove the two nuts and u-bolt (L) allowing the cylinder to be free of the frame.

16.Remove bearings from each end of the mid-lift shaft.

17.Remove the mid-lift shaft and cylinder from the machine as an assembly.

Installation:

1. Installation is the reverse of removal.

2. Perform “Lift Linkage Adjustment:” procedure below.

Specifications:

Lift Arm Cap Screws . . . . 38 N•m (28 lb-ft)

Lift Linkage Adjustment:

Reason:

To make sure that lift system linkage is adjusted properly.

Procedure:

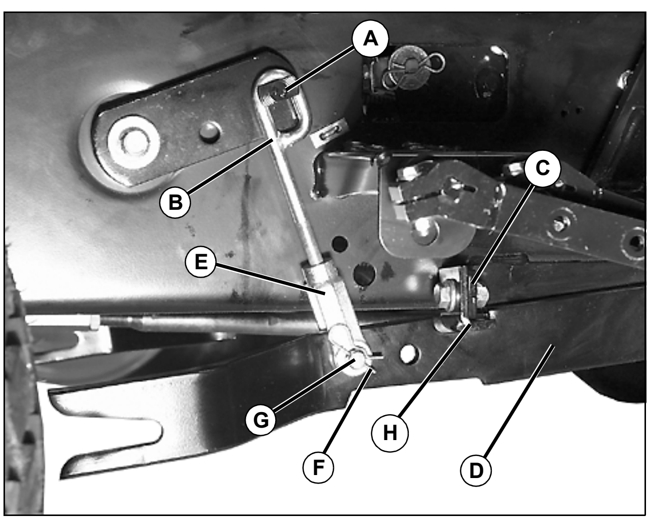
1. Inspect for bent or broken mid-shaft, height indicator, etc. Replace components if necessary.

2. Remove fender deck and footrest.

3. Extend rockshaft cylinder completely (pull back on top SCV lever).

4. Rotate the height indicator to make sure it rotates freely at full transport height.

5. Locate strap underneath machine (this strap is the link that connects the rockshaft cylinder to the mid-lift welded shaft). This strap has a slot in it pointing towards the front of the machine. The welded pin in the mid-lift shaft travels within this slot.



MX14280

6. The lift arms have headed pins (A) welded to them that support the lift links. Check to make sure the P-hooks on lift links (B) move freely about the pins.

Important: Avoid Damage! Mower deck lift system can be damaged if lift arms are not adjusted correctly. Check adjustment each time mower is installed to allow gap between lift arms and frame stop (C) at full lift height.

7. Check that the lift arm (D) does not contact the frame stop (C). If needed, adjust yokes (E) on both sides of mower until there is a slight gap of **1.6 mm (1/16 in.)** on both sides.

- Remove spring locking pin (F) and drilled pin (G) from each lift arm.
- Turn each yoke (E) clockwise to raise the lift arm.
- Turn each yoke (E) counterclockwise to lower the lift arm.
- Attach each yoke to lift arm with drilled pin (G) and spring locking pin (F).

Note: On AWS machines there is an additional bracket (H) mounted to the machine frame that limits lift arm rise.

Deck Height Stop Removal and Installation

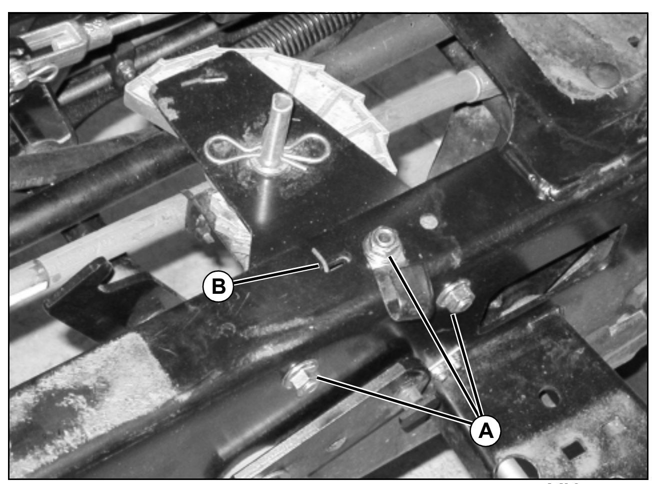
Removal:

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

2. Raise hood and disconnect negative battery terminal.

3. Remove fender deck. See “Fender Deck Removal and Installation” on page 459.

4. Remove foot deck. See “Foot Deck Removal and Installation” on page 460.

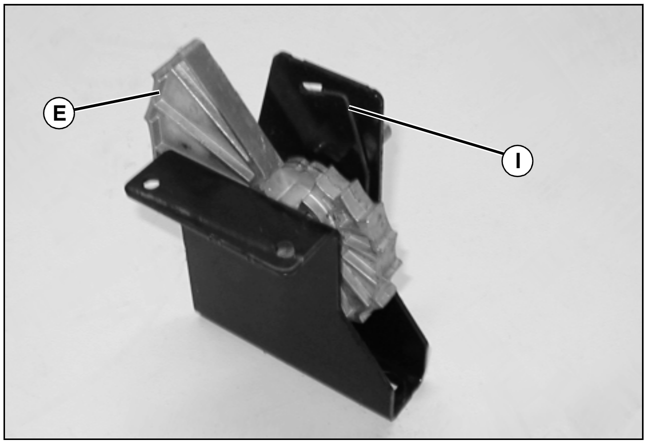


MX35894

5. Remove the three nuts and carriage bolts (A).

6. Rotate the height stop assembly up and disconnect the detent spring (B) from the frame slot.

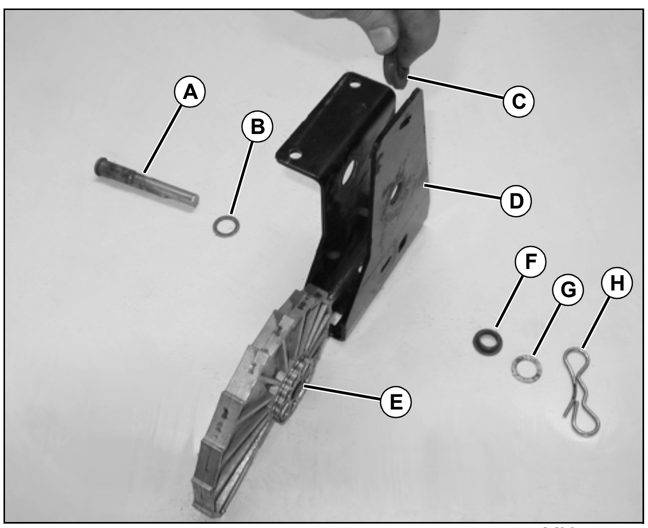
Disassembly:



MX35895

1. Rotate the stop cam (E) to expose the detent spring (I).

2. Disconnect the detent spring (I) from the mounting bracket. Pivot the detent spring downward and rotate the stop cam (E) to expose the opposite end of the spring. Disconnect the spring from the mounting bracket (D).



MX35896

A- Pivot Pin
B- Spacer
C- Bushing
D- Mounting Bracket
E- Stop Cam
F- Bushing
G- Spacer
H- Bowtie Spring Pin

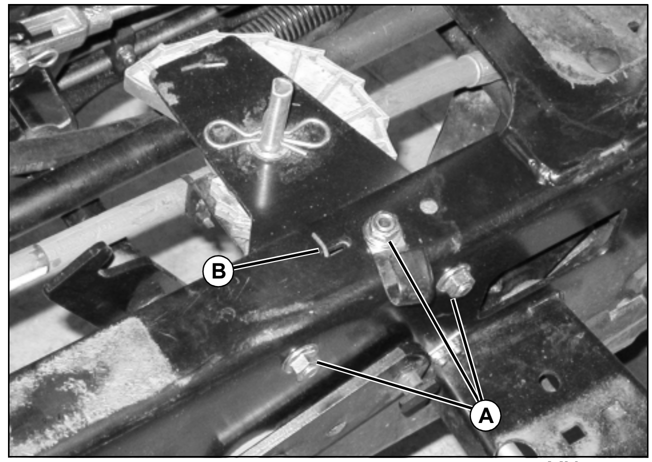
3. Remove the bowtie spring pin (H).

4. Remove the pivot pin (A), spacers (B and G), bushings (C and F), and stop cam (E) from the mounting bracket (D).

5. Inspect all parts for wear and damage. Replace as needed.

Installation:

1. Installation is the reverse of removal.



MX35894

2. Insert the detent spring (B) through the frame slot and secure height stop assembly with the three carriage bolts and nuts (A).

INDEX

Numerics

A

B

C

D

E

INDEX

INDEX

F

G

H

T

U

V

W