JOHN DEERE
WORLDWIDE COMMERCIAL & CONSUMER EQUIPMENT DIVISION

Front Mowers
1420, 1435, 1445, 1545 and 1565

TM1806 NOVEMBER 2002

TECHNICAL MANUAL

JOHN DEERE

North American Version
Litho in U.S.A.

INTRODUCTION

Manual Description

This technical manual is written for an experienced technician and contains sections that are specifically for this product. It is a part of a total product support program.

The manual is organized so that all the information on a particular system is kept together. The order of grouping is as follows:

- Table of Contents
- Specifications and Information
- Identification Numbers
- Tools and Materials
- Component Location
- Schematics and Harnesses
- Theory of Operation
- Operation and Diagnostics
- Diagnostics
- Tests and Adjustments
- Repair
- Other

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

The bleed tabs for the pages of each section will align with the sections listed on this page. Page numbering is consecutive from the beginning of the Safety section through the last section.

We appreciate your input on this manual. If you find any errors or want to comment on the layout of the manual please contact us.

All information, illustrations and specifications in this manual are based on the latest information at the time of publication. The right is reserved to make changes at any time without notice.

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Safety
Specifications and Information
Gas Engine
Diesel Engine (3TNE74 / 3TNE78)
Diesel Engine (3TNE88)
Electrical
Power Train - Hydro
Power Train (2 Speed) - Hydro
Steering
Brakes
Hydraulics
Attachments
Miscellaneous

Recognize Safety Information



MIF

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

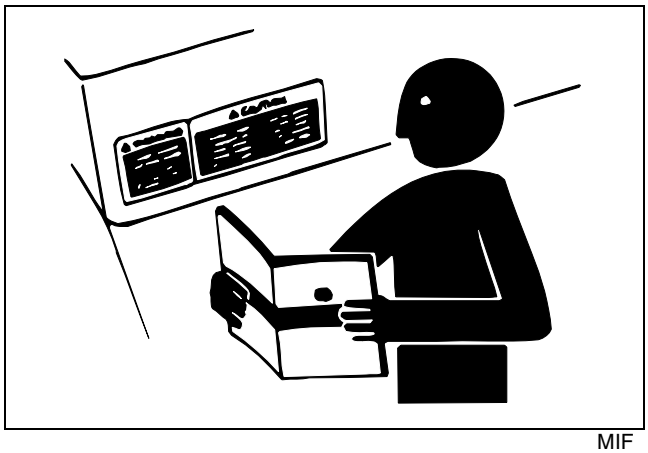
Follow recommended precautions and safe servicing practices.

Understand Signal Words

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

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

Replace Safety Signs

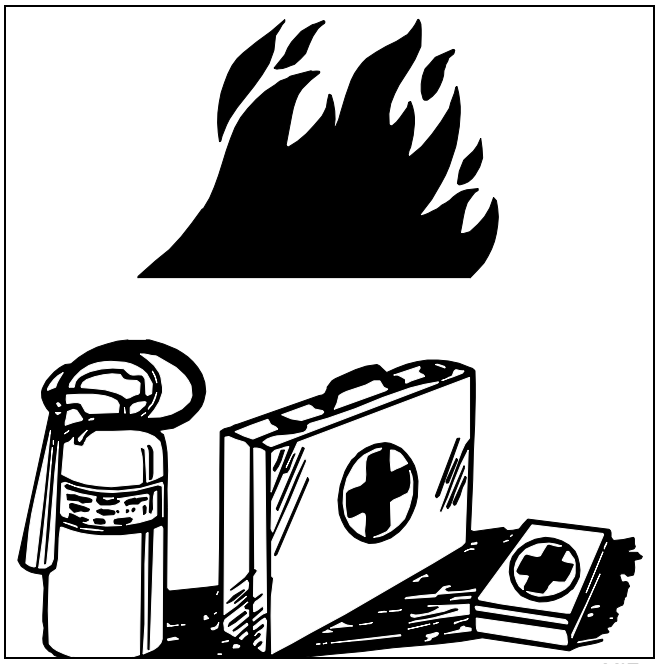


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Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

Handle Fluids Safely - Avoid Fires

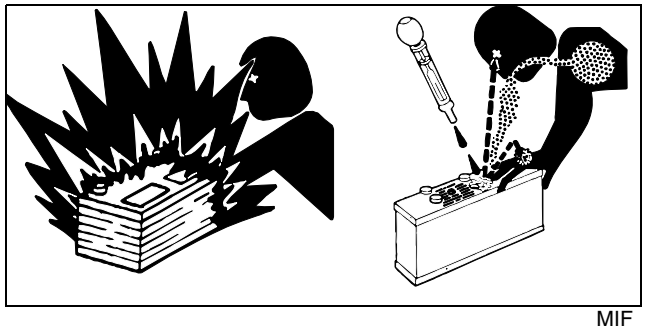
Be Prepared For Emergencies



MIF

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

Use Care In Handling and Servicing Batteries



MIF

Prevent Battery Explosions

- Keep sparks, lighted matches, and open flame away from the top of battery. Battery gas can explode.
- Never check battery charge by placing a metal object across the posts. Use a volt-meter or hydrometer.
- Do not charge a frozen battery; it may explode. Warm battery to 16°C (60°F).

Prevent Acid Burns

- Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid acid burns by:

1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling or dripping electrolyte.
5. Use proper jump start procedure.

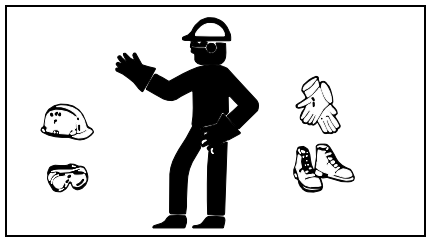
If you spill acid on yourself:

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

If acid is swallowed:

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

Wear Protective Clothing



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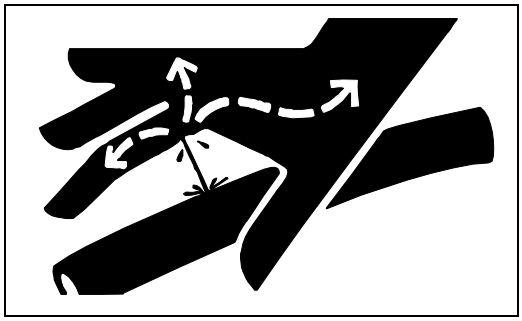
Wear close fitting clothing and safety equipment appropriate to the job.

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

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

Use Care Around High-Pressure Fluid Lines

Avoid High-Pressure Fluids



MIF

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

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

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

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

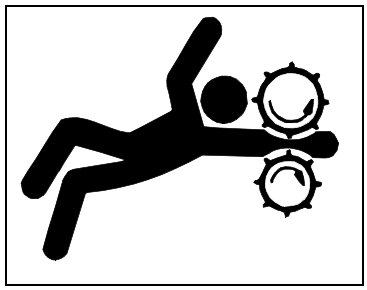
Avoid Heating Near Pressurized Fluid Lines



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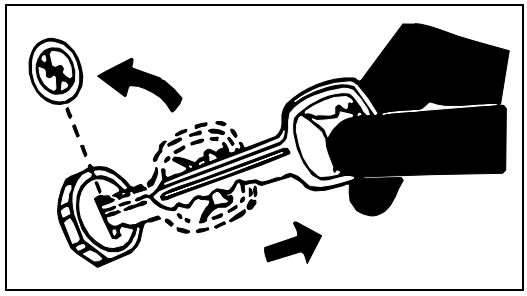
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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

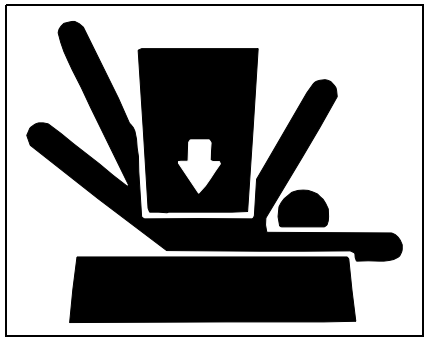


MIF

Before working on the machine:

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

Support Machine Properly and Use Proper Lifting Equipment



MIF

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

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

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

Work In Clean Area

Before starting a job:

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

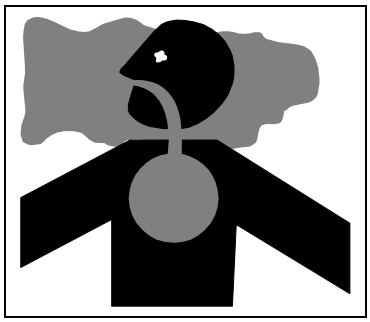
Using High Pressure Washers

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

Illuminate Work Area Safely

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

Work In Ventilated Area



MIF

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

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

Warning: California Proposition 65 Warning

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.

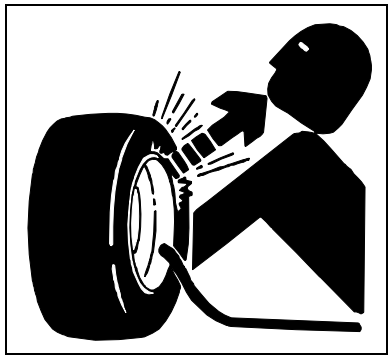
Avoid Harmful Asbestos Dust

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.

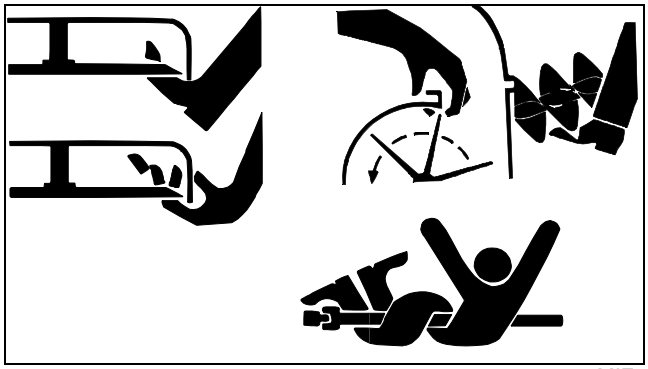
Do not attempt to mount a tire unless you have the proper equipment and experience to perform the job.

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.

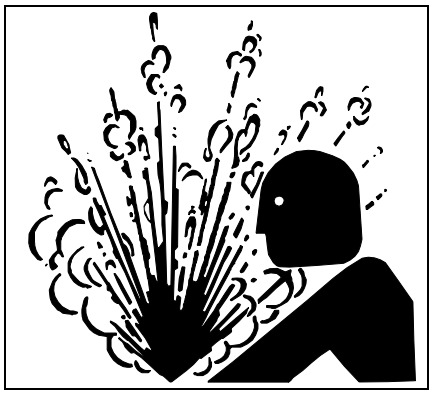
Avoid Injury From Rotating Blades, Augers and PTO Shafts



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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

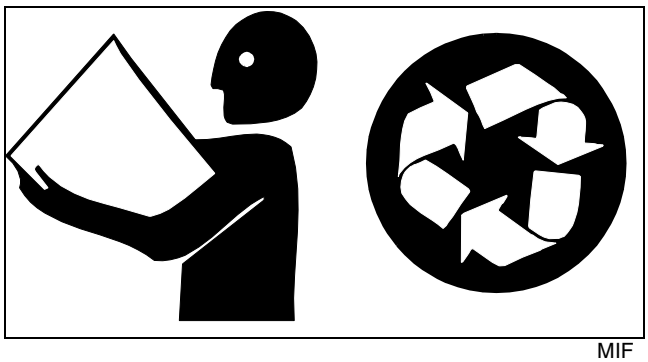


MIF

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

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

Handle Chemical Products Safely



MIF

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

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

Dispose Of Waste Properly

Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment 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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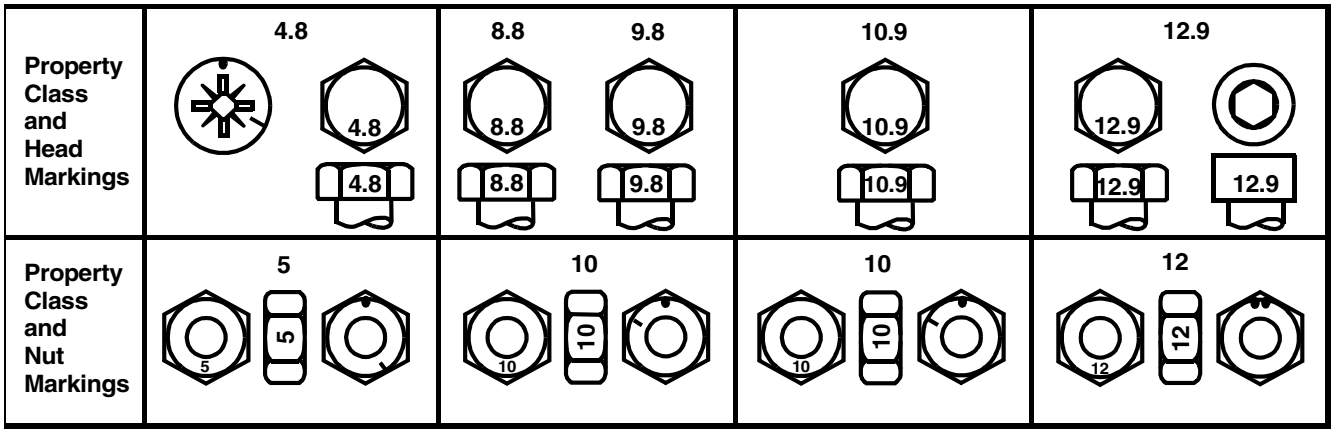
Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

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General Specifications

Metric Fastener Torque Values



	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	190
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 class. Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.
- When bolt and nut combination fasteners are used, torque values should be applied to the nut instead of the bolt head.
- Tighten toothed or serrated-type lock nuts to the full torque value.

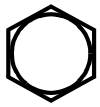
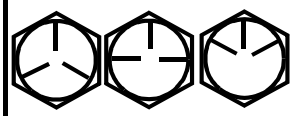
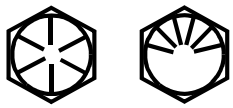
[a] **"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.**

Reference: JDS-200

Metric Fastener Torque Values - Grade 7

Size	Steel or Gray Iron Torque	Aluminum Torque
	N•m (lb-ft)	N•m (lb-ft)
M6	11 (8)	8 (6)
M8	24 (18)	19 (14)
M10	52 (38)	41 (30)
M12	88 (65)	70 (52)
M14	138 (102)	111 (82)
M16	224 (165)	179 (132)

Inch Fastener Torque Values

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

	Grade 1				Grade 2[b]				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 class. Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.
- When bolt and nut combination fasteners are used, torque values should be applied to the nut instead of the bolt head.
- Tighten toothed or serrated-type lock nuts to the full torque value.

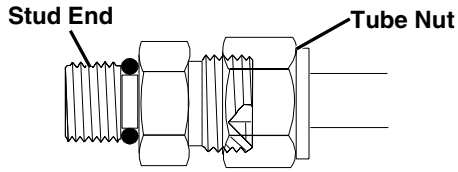
[a] **"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.**

[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.**

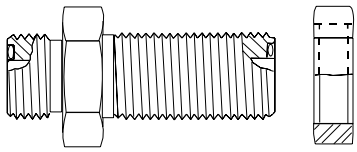
Reference: JDS-G200

O-Ring Seal Service Recommendations

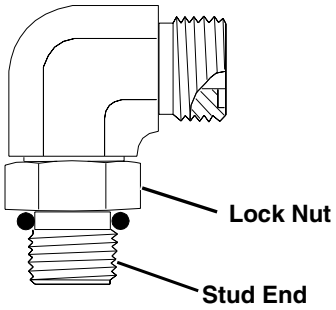
Face Seal Fittings with Inch Stud Ends Torque



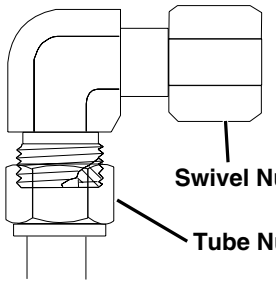
Straight Stud and Tube Nut



Bulkhead Union and Bulkhead Lock Nut



90° Adjustable Stud Elbow



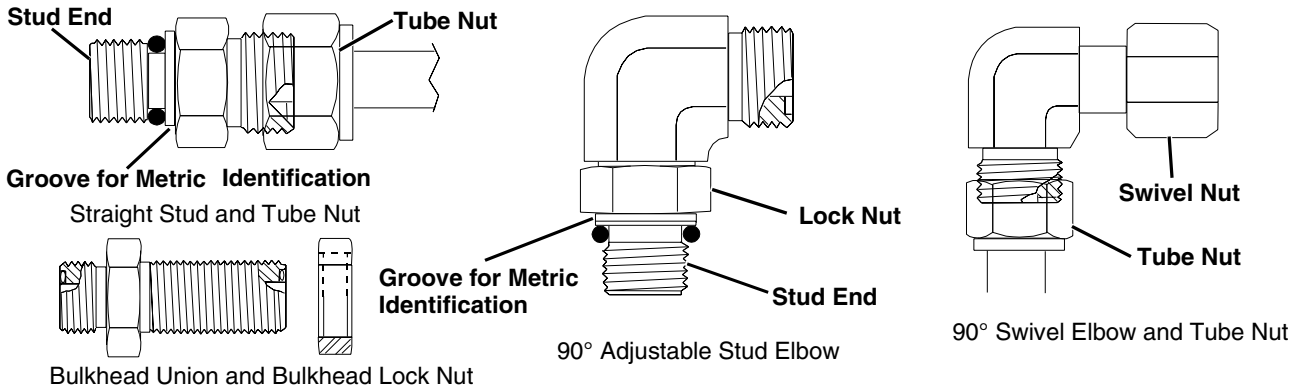
90° Swivel Elbow and Tube Nut

MIF

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
	-3	0.188	4.76						3/8-24	8	6
6	-4	0.250	6.35	9/16-18	16	12	12	9	7/16-20	12	9
8	-5	0.312	7.94						1/2-20	16	12
10	-6	0.375	9.52	11/16-16	24	18	24	18	9/16-18	24	18
12	-8	0.500	12.70	13/16-16	50	37	46	34	3/4-16	46	34
16	-10	0.625	15.88	1-14	69	51	62	46	7/8-14	62	46
	-12	0.750	19.05	1-3/16-12	102	75	102	75	1-1/16-12	102	75
22	-14	0.875	22.22	1-3/16-12	102	75	102	75	1-3/16-12	122	90
25	-16	1.000	25.40	1-7/16-12	142	105	142	105	1-5/16-12	142	105
32	-20	1.25	31.75	1-11/16-12	190	140	190	140	1-5/8-12	190	140
38	-24	1.50	38.10	2-12	217	160	217	160	1-7/8-12	217	160

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

Face Seal Fittings with Metric Stud Ends Torque

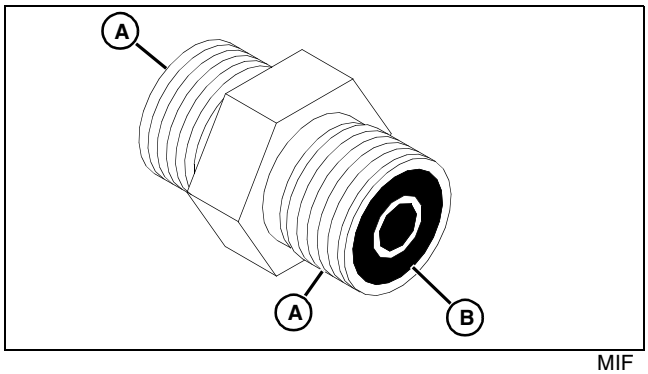


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Nominal Tube OD/Hose ID				Face Seal Tube/Hose End						O-Ring Stud Ends, Straight Fitting or Lock Nut					
Metric Tube OD	Inch Tube OD			Thread Size	Hex Size	Tube Nut/ Swivel Nut Torque		Bulkhead Lock Nut Torque		Thread Size	Hex Size	Steel or Gray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

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

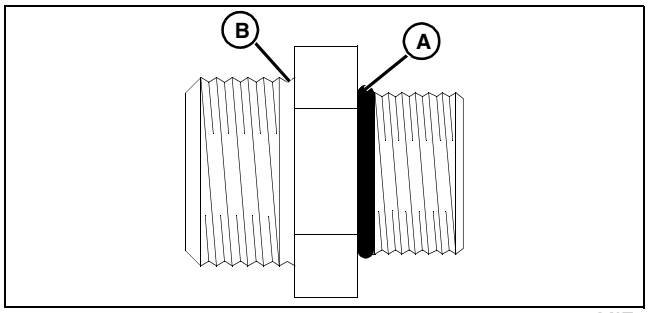
5. Index angle fittings and tighten by hand-pressing joint together to ensure O-ring remains in place.

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

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

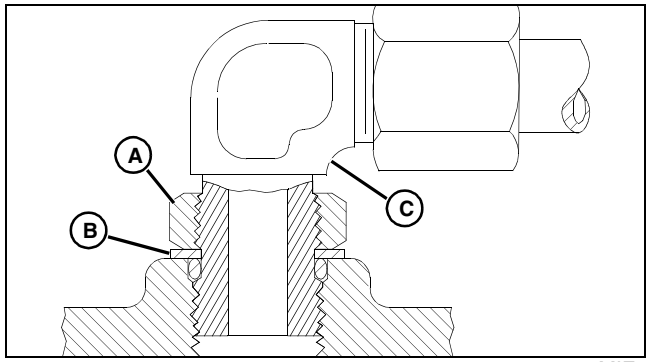
O-Ring Boss Fittings

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



MIF

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



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

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

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

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

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.

Seal Tight Connector Fittings

Service Recommendations for STC Fittings

Special or Required Tools:

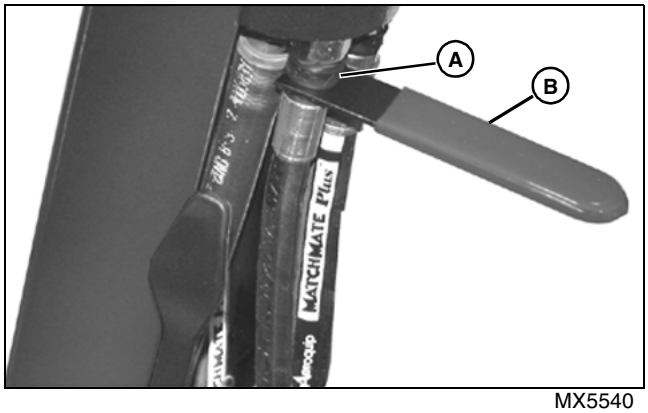
Tool Name	Tool No.	Tool Use
Hose Removal Tool	JDG1386	Used to remove hoses.

Seal Tight Connector (STC)® Fittings:

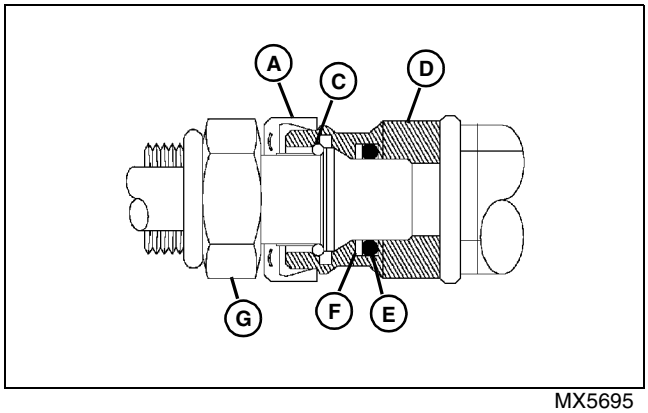
STC fittings are used on this machine. The fittings are designed for quick leak-proof connections.

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

Fittings are easily disconnected using hose removal tool JDG1386. To connect fittings, simply push each half of fitting together.



MX5540



MX5695

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

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

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

1. Disconnect STC-type fittings:

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

   b. While keeping hose removal tool JDG1386 (B) perpendicular to the fitting, insert tool under release sleeve until tool stops.

   c. Pull hose away from fitting to disconnect.

2. Inspect STC fittings:

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

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

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

3. Connect STC fittings:

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

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

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

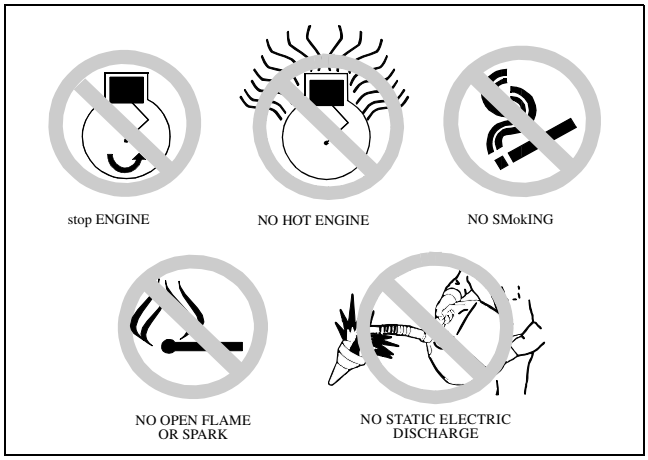
   c. Push fitting halves together until definite, solid stop is felt.

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

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

Fuel Specifications

Gasoline Specifications



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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.**

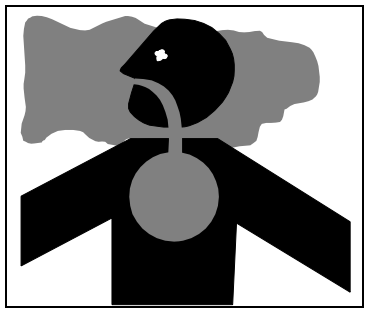
To prevent fire or explosion caused by static electric discharge during fueling:

- **Only use a clean, approved polyethylene plactic fuel container and funnel without any metal screen or filter.**

CAUTION: Avoid injury! 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.

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.



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CAUTION: Avoid injury! Do not use METHANOL gasoline because METHANOL is harmful to the environment and to your health

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.

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 machine or gasoline, it is recommended that you add **John Deere Gasoline Conditioner and Stabilizer (TY15977)** or an equivalent to the gasoline. **Be sure** to follow directions on container and to properly discard empty container.

Diesel Fuel Specifications

CAUTION: Avoid injury! 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.

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

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

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

- **Cetane Number 40 (minimum)**

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

- **Cold Filter Plugging Point (CFPP)**

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

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

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

If diesel fuel being used has a sulfur content **greater than 0.05%, reduce the service interval for engine oil and filter by 50%.**

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

Diesel Fuel Lubricity

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

Diesel Fuel Storage

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

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

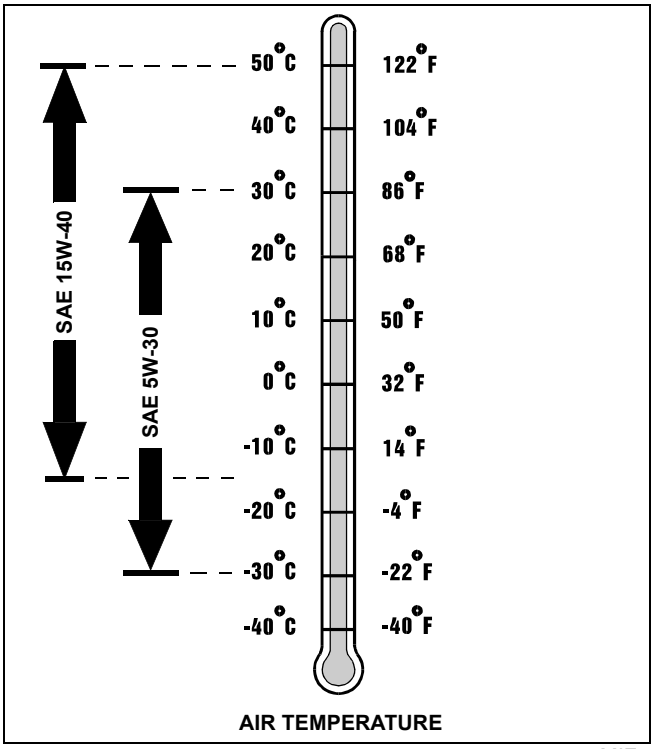
IMPORTANT: Avoid damage! Keep all dirt, scale, water or other foreign material out of fuel.

Keep fuel in a safe, protected area and in a clean, properly marked **("DIESEL FUEL")** container. **Do not** use de-icers to attempt to remove water from fuel. **Do not** depend on fuel filters to remove water from fuel. It is recommended that a water separator be installed in the storage tank outlet. **Be sure** to properly discard unstable or contaminated diesel fuel and/or their containers when necessary.

Oil and Lubricant Specifications

Engine Oil

Use oil viscosity based on the expected air temperature range during the period between oil changes.



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The Following John Deere Oils are preferred:

Diesel Engines

- TORQ-GARD SUPREME®
- PLUS-4®
- PLUS-50®

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

- API Service Classification CF or higher.

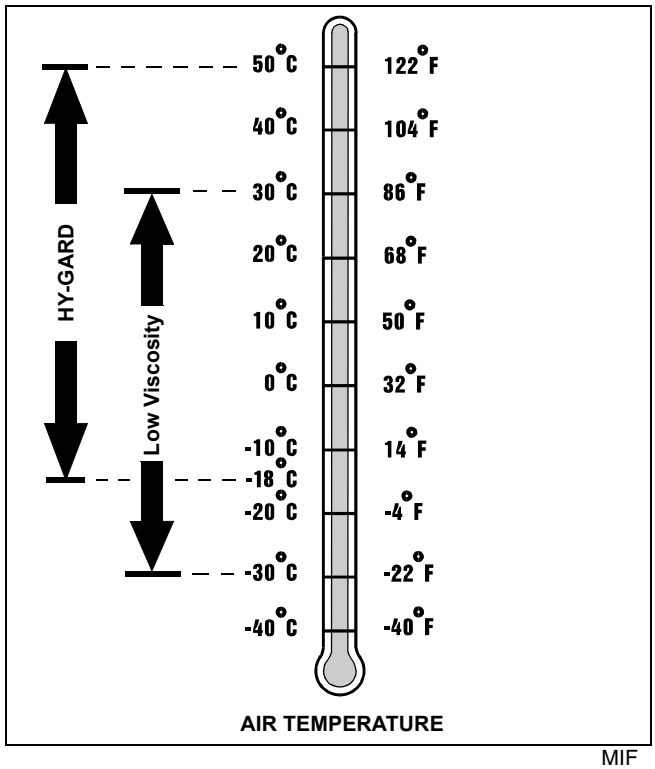
Gasoline Engines

- TURF-GARD®
- PLUS-4®

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

- API Service Classification SG or higher.

Hydrostatic Transaxle Oil



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IMPORTANT: Avoid damage! Transaxle is filled with John Deere HY-GARD® (J20C) transmission oil at the factory. Do not mix oils

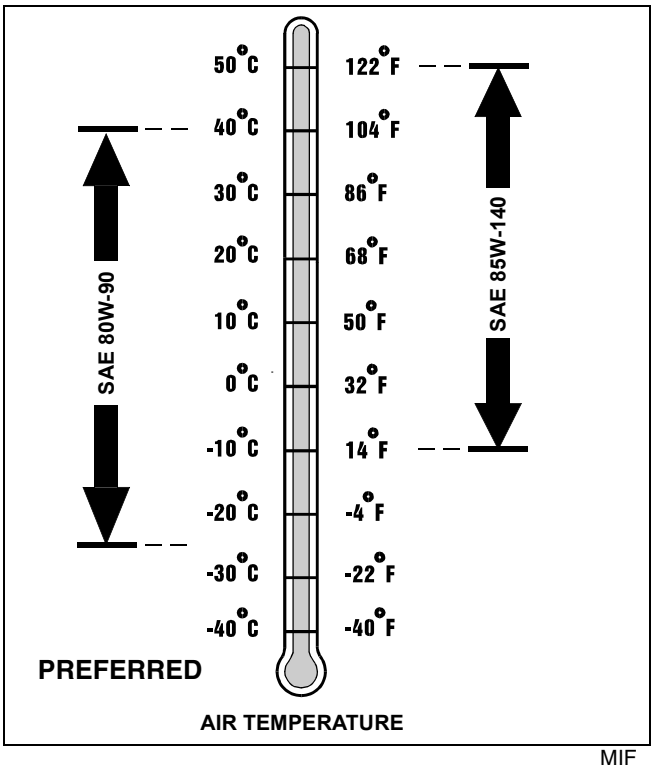
Use only HY-Gard® (J20C) transmission.

Do not use type “F” automatic transmission fluid.

John Deere HY-GARD (J20C) transmission oil is specially formulated to provide maximum protection against mechanical wear, corrosion, and foaming.

IMPORTANT: Avoid damage! If operating temperatures are below -18°C (0°F), you must use Low Viscosity HY-GARD® (J20D) or transmission damage will occur.

4WD Rear Axle Oil



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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-G 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.

Anti-Corrosion Grease

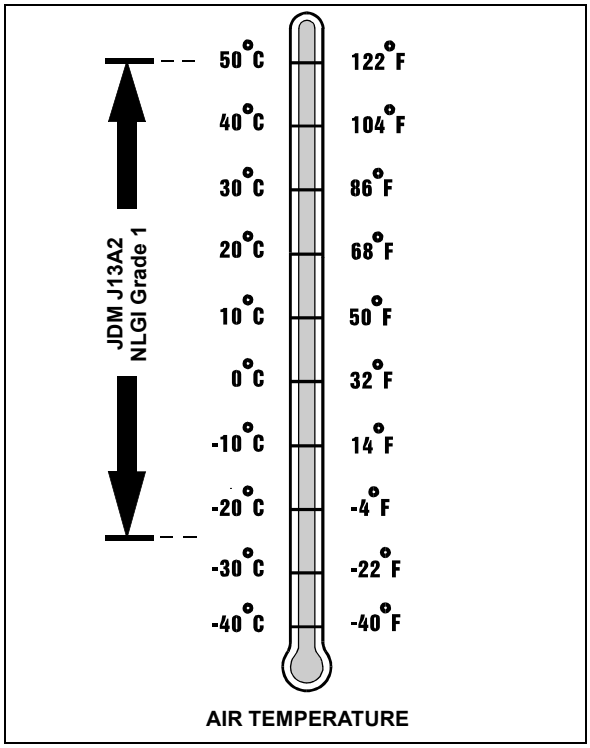
This anti-corrosion grease is formulated to provide the best protection against absorbing moisture, which is one of the major causes of corrosion. This grease is also superior in its resistance to separation and migration.

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.



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Chassis Water Resistant Grease

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

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

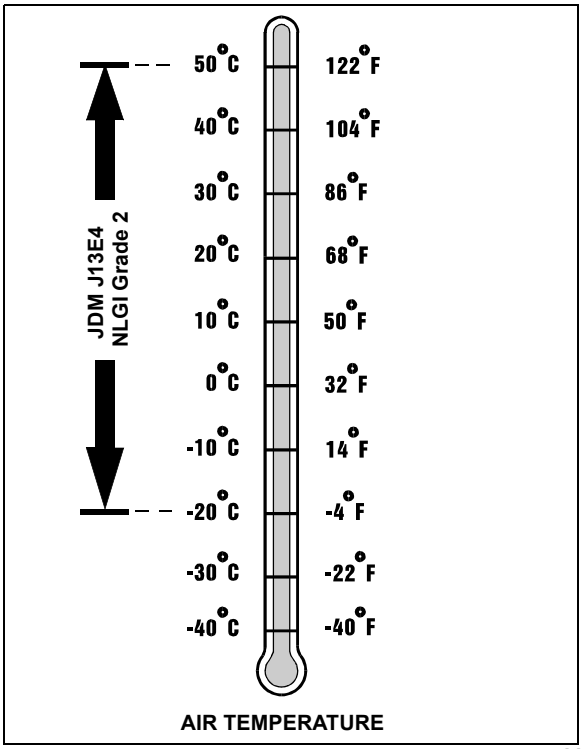
- Special Purpose HD Water Resistant Grease - TY24425.

The following water resistant grease may also be used:

- Multi-Purpose HD Lithium Complex Grease - TY24416.

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

- John Deere Standard JDM J13E4, NLGI Grade 2.



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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:**

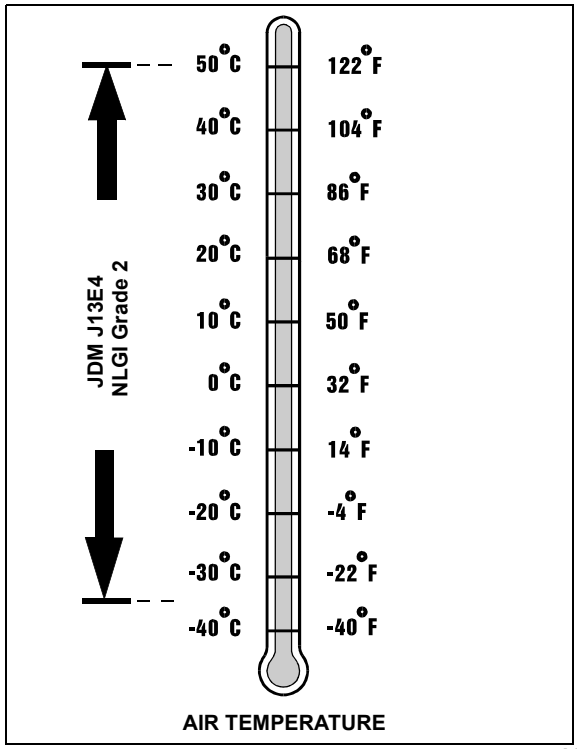
- Multi-Purpose SD Polyurea Grease - TY6341.

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.



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Coolant Specifications

Engine Coolant

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

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

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

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

The above preferred pre-diluted anti-freeze provides:

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

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

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

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

- ASTM D3306 (JDM H24C1).

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

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

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 SO_4), Maximum	100 ppm (5.8 grns/gal)

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

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

Engine Coolant Drain Interval

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

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

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

Serial Number Locations

Machine Identification Number

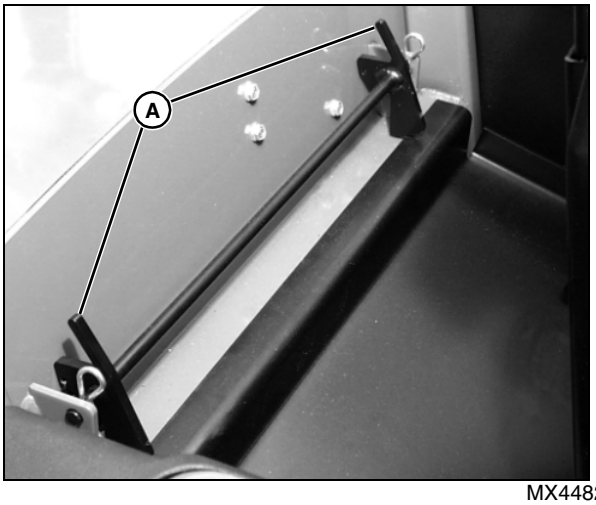
Product Identification Number

Front Mower:



MX7053

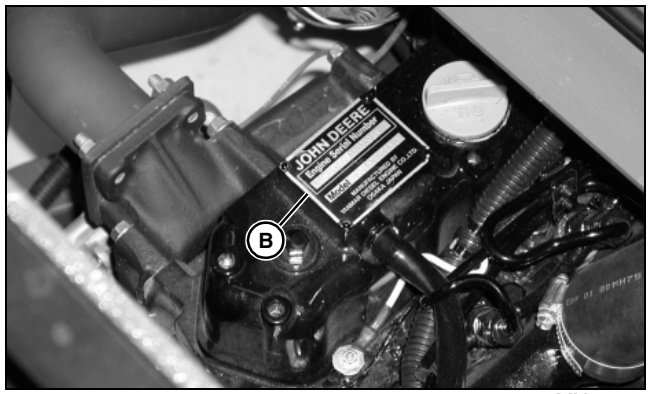
The machine identification number is located on the rear frame plate.



MX4482

To access the engine serial number plate, raise the operator's seat platform, pull forward on release lever (A), while pulling forward on the backrest of operator's seat.

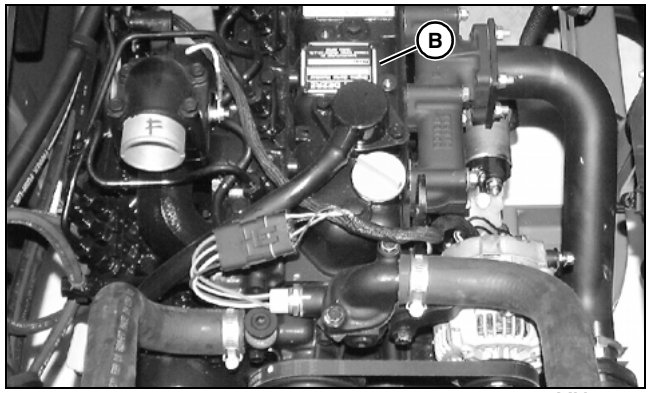
Gasoline Engine Serial Number



MX7086

The gasoline engine serial number plate (B) is located on top of the valve cover near the engine oil filler cap.

Diesel Engine Serial Number



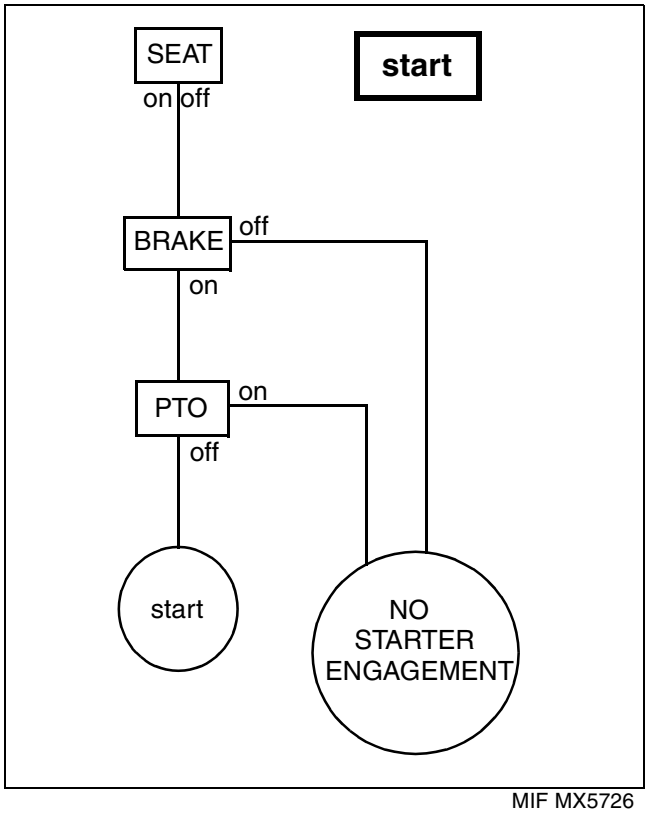
MX5446

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

Interlock System

Interlock System

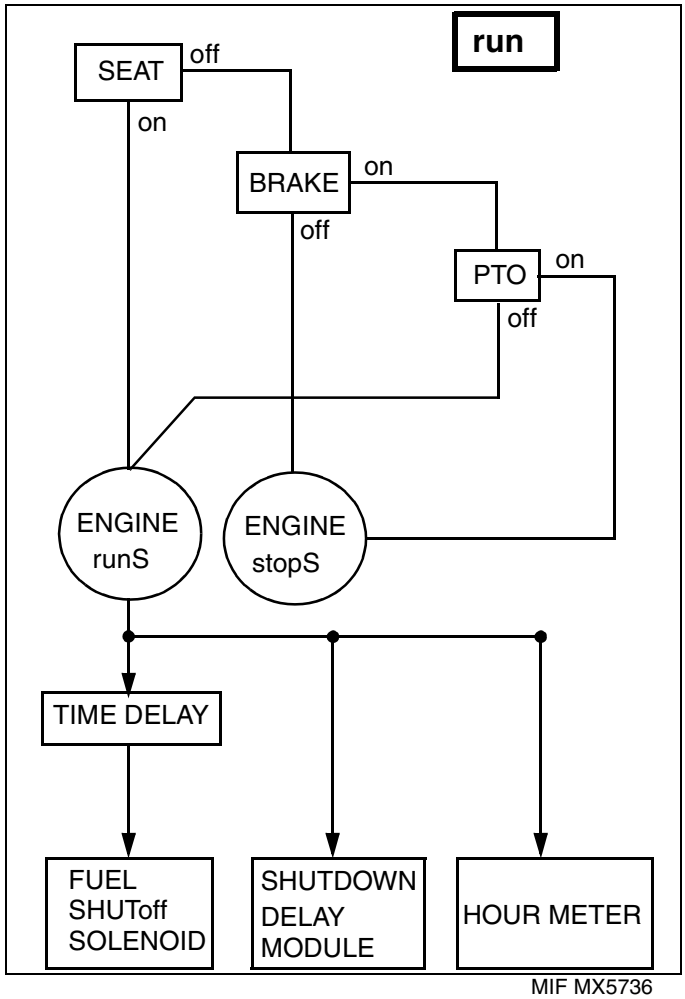
It is important to understand the interlock system and how it works. Before performing the checkout procedures, become familiar with the interlock system so that an interlock function will not be mistaken for a machine problem.



MIF MX5726

For the starting motor to engage and the engine to run, the following conditions must be met simultaneously:

- Operator on seat and park brake locked.
- PTO switch in off position.



MIF MX5736

For the engine to run, one of the following must occur:

- Operator must be on seat when PTO is engaged and/or park brake is unlocked.
- When operator is not on seat, the PTO must be disengaged and park brake locked.

When the park brake is unlocked and the operator rises off the seat, the engine will stop.

If the operator is operating an attachment and rises off the seat, the attachment and engine will stop.

In order to operate attachments, the following conditions must occur:

- Operator sitting on operator seat.
- Throttle lever moved to the fast position.
- Park brake unlocked.
- PTO switch in the on position.

If the operator is operating attachments and the park brake is depressed, the attachment will stop operating. The PTO switch must be cycled (Off/On) before attachment will operate.

ENGINE - GAS TABLE OF CONTENTS

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Specifications

General Specifications

Front Mower

1420

Make	**John Deere/Yanmar**
Model/Model Number	**3TG72-JMA**
Type	**4-cycle gasoline**
Bore	**72 mm (2.84 in.)**
Stroke	**72 mm (2.84 in.)**
Cylinders	**3**
Valves	**Overhead**
Displacement	**879 cm^3 (53.6 cu-in.)**
Gross Output Power	**19.9 kW (26.7 hp)**
Maximum Torque @ 2300 rpm	**64.5 N•m (47.6 lb-ft)**
Lubrication	**Full pressure**
Oil Filter	**Full flow, spin-on filter**
Engine Oil Capacity (With Filter)	**3.1 L (3.3 qt)**
Cooling System	**Liquid w/pump and radiator**
Cooling System Capacity	**6.6 L (7.0 qt)**
Fuel Filter	**Replaceable (in-line type)**
Air Filter	**Dry replaceable primary and secondary elements**

Test and Adjustment Specifications

Front Mower

1420

Engine

Valve Clearance	**0.2 mm (0.008 in.)**
Oil Pressure (Minimum at Fast Idle)	**290 ± 50 kPa (42 ± 7 psi)**
Thermostat Begin Open Temperature	**71°C (160°F)**
Thermostat Fully Open Temperature	**85°C (185°F)**

Fuel/Air System

Fuel Pressure (Minimum)	**10.4 kPa (1.5 psi)**
Fuel Flow (Minimum, 15 seconds)	**105 mL (3.5 oz)**
Slow Idle Speed	**1500 ± 50 rpm**
Fast Idle Speed	**3425 ± 25 rpm**
Spark Plug Gap	**0.76 mm (0.030 in.)**
Spark Plug Torque	**20 N•m (180 lb-in.)**

Repair Specifications

Front Mower

1420

Cylinder Head and Valves

Cylinder Head Flatness (Maximum Warp)	0.10 mm (0.004 in.)
Mill Cylinder Head No More Than	0.2 mm (0.008 in.)
Valve Stem OD (Minimum)	6.90 mm (0.272 in.)
Valve Guide ID (Maximum)	7.08 mm (0.279 in.)
Valve Stem-to-Guide Clearance (Maximum)	0.15 mm (0.006 in.)
Valve Guide ID (Maximum)	7.08 mm (0.279 in.)
Valve Guide Height	9.00 mm (0.354 in.)
Valve Recession (Maximum)	0.60 mm (0.024 in.)
Intake Valve Face Angle	30°
Exhaust Valve Face Angle	45°
Intake Valve Seat Angle	30°
Exhaust Valve Seat Angle	45°
Intake Valve Seat Width	1.43 mm (0.056 in.)
Exhaust Valve Seat Width	1.73 mm (0.068 in.)
Valve Spring Free Length (Approximately)	36.9 mm (1.453 in.)
Valve Spring Test Length @ 299 N (67 lb-force)	22.5 mm (0.866 in.)

Push Rod

Maximum T.I.R.	0.3 mm (0.012 in.)
Maximum Length	141 mm (5.55 in.)

Rocker Arm

Rocker Arm Shaft OD (Minimum)	11.9 mm (0.469 in.)
Shaft Support ID (Maximum)	12.1 mm (0.476 in.)
Arm ID (Maximum)	12.1 mm (0.476 in.)
Shaft Clearance (Maximum)	0.12 mm (0.005 in.)

Crankshaft

End Play (Maximum)	0.50 mm (0.020 in.)
Main Bearing Clearance (Maximum)	0.12 mm (0.005 in.)
Main Bearing Journal OD (Minimum)	43.93 mm (1.730 in.)
Main Bearing ID (Maximum)	40.07 mm (1.578 in.)

Camshaft

End Play (Maximum)	0.5 mm (0.02 in.)
Gear Backlash (Maximum)	0.2 mm (0.008 in.)
Journal Clearance (Maximum)	0.18 mm (0.007 in.)
Intermediate and Flywheel End Bore ID (Maximum)	40.075 mm (1.578 in.)
End Journals OD (Minimum)	39.84 mm (1.568 in.)
Intermediate Journals OD (Minimum)	39.81 mm (1.567 in.)
Journal Clearance (Maximum)	0.18 mm (0.007 in.)
Lobe Height (Minimum)	33.6 mm (1.323 in.)
Bushing ID (Maximum)	41.115 mm (1.619 in.)

Cylinder Bore, Piston, and Rings

Cylinder Bore ID (Maximum)	72.15 mm (2.841 in.)
Piston OD (Minimum)	71.9 mm (2.831 in.)
Piston-to-Cylinder Clearance (Maximum)	0.15 mm (0.006 in.)
Piston Pin OD (Minimum)	20.90 mm (0.823 in.)
Piston Pin Bushing ID (Maximum)	21.10 mm (0.831 in.)
Piston Pin Bushing Clearance (Maximum)	0.15 mm (0.006 in.)
Piston Pin Bore ID (Maximum)	21.08 mm (0.830 in.)
Piston Pin Bore Clearance (Maximum)	0.10 mm (0.004 in.)
Top Ring Groove Clearance (Maximum)	0.25 mm (0.010 in.)
Second Ring Groove Clearance (Maximum)	0.25 mm (0.010 in.)
Oil Control Ring Groove Clearance (Maximum)	0.25 mm (0.010 in.)
Top Ring End Gap (Maximum)	1.25 mm (0.049 in.)
Second Ring End Gap (Maximum)	1.25 mm (0.049 in.)
Oil Control Ring End Gap (Maximum)	1.90 mm (0.075 in.)

Connecting Rod

Maximum Side Play	0.8 mm (0.031 in.)
Bearing Clearance (Maximum)	0.12 mm (0.005 in.)
Journal OD (Minimum)	39.93 mm (1.572 in.)
Bearing ID (Maximum)	40.07 mm (1.577 in.)

Timing Gear

Governor Backlash	0.38 mm (0.015 in.)
Idler Backlash	0.2 mm (0.008 in.)
Camshaft Backlash	0.2 mm (0.008 in.)
Crankshaft Backlash	0.2 mm (0.008 in.)
Oil Pump Backlash	0.3 mm (0.012 in.)
Idler Gear Bushing Maximum ID	20.08 mm (0.791 in.)
Idler Shaft Minimum OD	19.9 mm (0.783 in.)
Idler Shaft Oil Clearance	0.1 mm (0.004 in.)

Governor

New Governor Gear Backlash . . . . . 0.11 - 0.30 mm (0.004 - 0.012 in.)
Maximum Governor Gear Backlash . . . . . 0.38 mm (0.015 in.)

Oil Pressure Regulating Valve

Valve Spring Free Length . . . . . 43.5 - 48.5 mm (1.7 - 1.9 in.)
Valve Spring Test Length @ 20.5 N (9.6 lb-force) . . . . . 27.5 mm (1.08 in.)

Oil Pump

Gear Backlash (Maximum). . . . . 0.30 mm (0.012 in.)
Rotor Recess (Maximum) . . . . . 0.25 mm (0.10 in.)
Outer Rotor-to-Pump Body Clearance (Maximum) . . . . . 0.25 mm (0.010 in.)
Inner Rotor-to-Outer Rotor Clearance (Maximum) . . . . . 0.25 mm (0.010 in.)

Torque Specifications

Front Mower

1420

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 ³ 12 = Foot-pounds

Camshaft Attaching Cap Screw . . . . . 11 N•m (96 lb-in.)
Camshaft Gear Housing Cover Cap Screw . . . . . 9 N•m (78 lb-in.)
Connecting Rod End Cap Screw. . . . . 23 N•m (200 lb-in.)
Crankshaft Main Bearing Cap Screw . . . . . 79 N•m (58 lb-ft)
Cylinder Head Cap Screw Initial Torque. . . . . 20 N•m (177 lb-in.)
Cylinder Head Cap Screw Final Torque . . . . . 61 N•m (45 lb-ft)
Exhaust Manifold Cap Screw . . . . . 26 N•m (230 lb-in.)
Flywheel Cap Screw . . . . . 83 N•m (61 lb-ft)
Gear Housing Cap Screw. . . . . 9 N•m (78 lb-in.)
Intake Manifold Cap Screw . . . . . 11 N•m (96 lb-in.)
Oil Pan Cap Screw . . . . . 9 N•m (78 lb-in.)
Oil Pressure Switch . . . . . 7.9 N•m (70 lb-in.)
Oil Pump Attaching Cap Screw. . . . . 11 N•m (96 lb-in.)
Rocker Arm Assembly Cap Screw and Nut . . . . . 25 N•m (221 lb-in.)
Spark Plug. . . . . 20 N•m (180 lb-in.)
Starting Motor Mounting Cap Screw . . . . . 24 N•m (216 lb-in.)
Thermostat Cover Cap Screw . . . . . 20 N•m (177 lb-in.)
Valve Cover Special Nut. . . . . 18 N•m (160 lb-in.)
Water Pump Plate Screw . . . . . 9 N•m (78 lb-in.)
Water Pump Sheave Cap Screw . . . . . 11 N•m (96 lb-in.)
Water Pump Attaching Cap Screw . . . . . 20 N•m (177 lb-in.)

Special or Required Tools

Front Mower

1420

Special or Required Tools

Tool Name	Tool No.	Tool Use
Reaming Tool (7.05 m)	D20020WI	Used to clean or size valve guides.
Valve Spring Compressor	JDM70	Used to remove and install valve springs.
Digital Pulse Tachometer	JT07270	Used for slow idle adjustment and to check fast idle.
Pressure Test Kit	JDG356	Used to check fuel pump pressure.
Spark Plug Ground	JDM74A5	Used to prevent accidental engine starting during tests.
Compression Gauge	JDM59	Used for cylinder compression test.
Connector	JT03349	Used for oil pressure test.
Hose Assembly	JT03017	Used for oil pressure test.
0 - 700 kPa (0 - 100 psi) Gauge	JT07034	Used for oil pressure test.
Dial Indicator	NA	Used for valve lift, end play, and backlash measurements.
PLASTIGAGE® Bearing Clearance Measurement Tool	NA	Used to measure bearing clearance.

Other Materials

Front Mower

1420

Other Material

Part No.	Part Name	Part Use
NA	SCOTCH-BRITE® Abrasive Sheets/Pads	Used to clean cylinder head.
TY15130/395	LOCTITE® Form-In-Place Gasket	Used to seal timing cover, timing gear housing, and oil pan mating surfaces.

Available Kits

Front Mower

1420

- High Altitude Jet: 1000 - 2000 m (3280 - 6561 ft)
- High Altitude Jet: 2000 m (6561 ft) and above
- Engine Gasket Set
- Carburetor Repair Kit
- Carburetor Gasket Kit

Diagnostics

Engine Troubleshooting Guide

Front Mower

1420

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

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

Test Conditions:

- Operator on seat
- PTO switch in off position
- Brake on

Symptom: Engine Doesn't Crank

(1) Are battery cables loose or dirty?

Yes - Tighten or clean.

No - Go to next step.

(2) Is battery fully charged? (See "Battery Test" on page 467 in the Electrical section.)

No - Charge battery. (See "Charge Battery" on page 468 in the Electrical section.)

Yes - Go to next step.

(3) Is key switch working correctly?

Yes - Go to next step.

No - Test switch. (See "Cranking Circuit Operation" on page 357 in the Electrical section.) Replace as needed.

(4) Has engine seized?

Yes - See Engine Repair Section.

No - Go to next step.

(5) Is starting motor or solenoid defective?

Yes - Repair or replace. (See Electrical section.)

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

Symptom: Engine Hard To Start

(1) Is there a strong blue spark?

Yes - Go to step 3.

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

(2) Is there a strong blue spark?

Yes - Check engine starting.

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

(3) Check compression. See "Cylinder Compression Test" on page 43. Is compression sufficient?

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

No - Go to step 5.

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

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

No - Check fuel tank and lines.

(5) Compression is low?

Yes - Check piston rings and cylinder for wear. (See "Piston and Connecting Rod Removal and Installation" on page 79.) Inspect cylinder head. (See "Cylinder Head Removal and Installation" on page 62.)

Symptom: Engine Runs Erratically

(1) Is fuel delivery correct. See "Fuel Pump Pressure Test" on page 40.

Yes - Check for plugged air/fuel passages in carburetor. (See "Carburetor Inspection" on page 46.)

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

Symptom: Engine Malfunctions At Low Speed

(1) Is unusual smoke emitted out of muffler?

Yes - Check choke. (See “Choke Cable Adjustment” on page 36.)

No - Go to next step.

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

Yes - Plug in carburetor interior, clean carburetor. (See “Carburetor Inspection” on page 46.)

No - Go to next step.

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

Yes - Tighten manifold flange nuts or replace damaged gasket.

No - Go to next step.

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

No - Adjust valves.

Symptom: Oil Consumption Is Excessive

(1) Check compression. (See “Cylinder Compression Test” on page 43.) Is compression sufficient?

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

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

Starting Motor Troubleshooting Guide

Front Mower

1420

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

IMPORTANT: Avoid damage! If starting motor does not by turning ignition switch to off position, disconnect negative (-) lead from battery as soon as possible.

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

Symptom: Starter Does Not Rotate

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

Yes - Repair starting motor. (See “Starting Motor (1420 and 1435):” on page 284 in the Electrical section.)

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

(2) Are battery cables loose or dirty?

Yes - Tighten or clean.

No - Go to next step.

(3) Is battery fully charged? (See “Battery Test” on page 467 in the Electrical section.)

No - Charge battery. (See “Charge Battery” on page 468 in the Electrical section.)

Yes - Go to next step.

(4) Is key switch working correctly?

Yes - Go to next step.

No - Test switch. (See “Cranking Circuit Operation” on page 357 in the Electrical section.) Replace as needed.

(5) Has engine seized?

Yes - See “Repair” on page 45.

Symptom: Starter Rotates Slowly

(1) Are battery cables loose or dirty?

Yes - Tighten or clean.

No - Go to next step.

Symptom: Starter Rotates Slowly

(2) Is battery fully charged? (See “Battery Test” on page 467 in the Electrical section.)

Yes - Go to next step.

No - Charge battery. (See “Charge Battery” on page 468 in the Electrical section.)

(3) Has engine seized?

Yes - See Engine Repair Section.

No - Go to next step.

(4) Is starting motor or solenoid defective?

Yes - Repair or replace. (See “Starting Motor No-Load Amperage Draw and RPM Test” on page 471 in the Electrical section.)

Symptom: Starter Rotates But Does Not Crank

(1) Does the pinion mesh with ring gear?

Yes - Faulty bendix. Replace.

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

Tests and Adjustments

Alternator Belt Tension Check and Adjustment

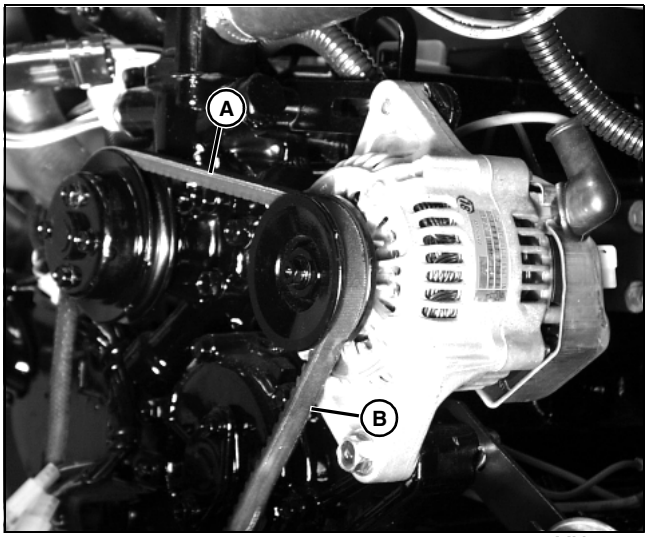
Front Mower

1420

CAUTION: Avoid injury! Fingers or loose clothing can get caught in rotating parts. Stop engine and wait for all moving parts to stop.

Check Belt Tension:

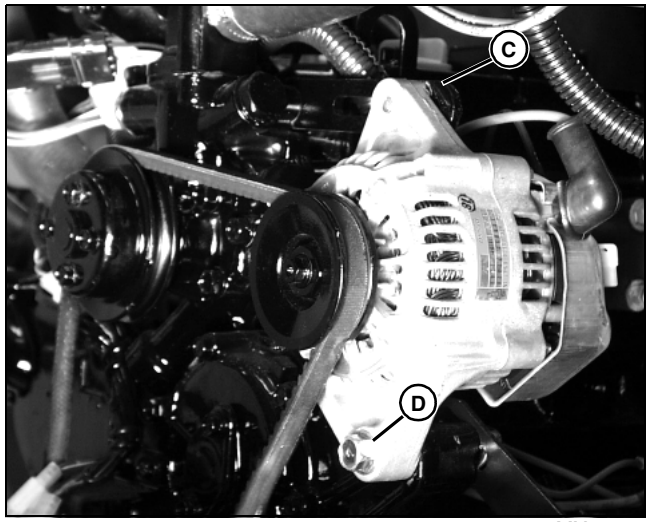
1. Park machine safely. (See “Park Machine Safely” on page 3 in the Safety section.)
2. Allow engine to cool.
3. Open engine cover.



MX7016

4. Check alternator belt (B).
   - Inspect belt for excessive wear, damage, or stretching while mounted on engine.
   - Apply finger pressure to the belt approximately halfway between the alternator and water pump pulleys at (A). Belt should deflect within specification. Adjust if too tight or too loose.

Adjust Belt Tension:



MX7016

1. Loosen adjustment cap screw (C).
2. Loosen alternator mounting cap screw (D).
3. Apply outward pressure to the alternator housing.
4. Tighten adjustment cap screw and mounting cap screw.
5. Check belt tension:
   - Apply finger pressure to the belt approximately halfway between the alternator and water pump pulleys. Belt deflection should be within specification.
6. Close engine cover.

Specifications:

Alternator Belt Deflection . . . 10 - 15 mm (0.38 - 0.5 in.)

Throttle Cable and Governor Adjustment

Front Mower

1420

Reason:

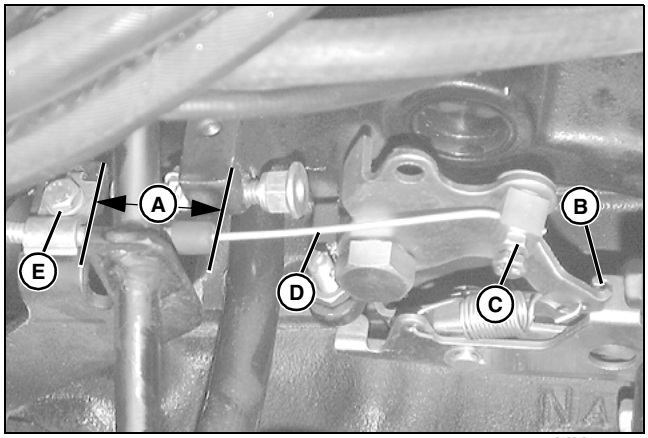
To make sure the throttle cable moves the throttle lever through its full range of movement.

Procedure:

1. Park machine safely.
2. Stop engine.
3. Open engine cover.

CAUTION: Avoid injury! Stay clear of rotating parts during tests.

4. Move hand throttle on control console to idle position.



MX5581

5. Measure distance (A) between throttle cable clamp and end of throttle cable housing. Distance should be to specification.

6. Loosen throttle cable clamp (E). Adjust cable housing length as necessary. Tighten throttle cable clamp.

7. Throttle arm should contact governor linkage stop (B).

8. If throttle arm does not contact governor linkage stop, loosen screw and jam nut on throttle cable arm clamp (C).

9. Tighten jam nut and screw on throttle cable (D).

10.Move hand throttle and check for full and proper movement of throttle cable.

11.Close engine cover.

Specifications:

Throttle Cable Clamp-to-Housing Distance
. . . . . 3.18 cm (1.25 in.)

Choke Cable Adjustment

Front Mower

1420

Reason:

To ensure choke cable moves choke valve through its full range of movement.

Procedure:

1. Park machine safely.

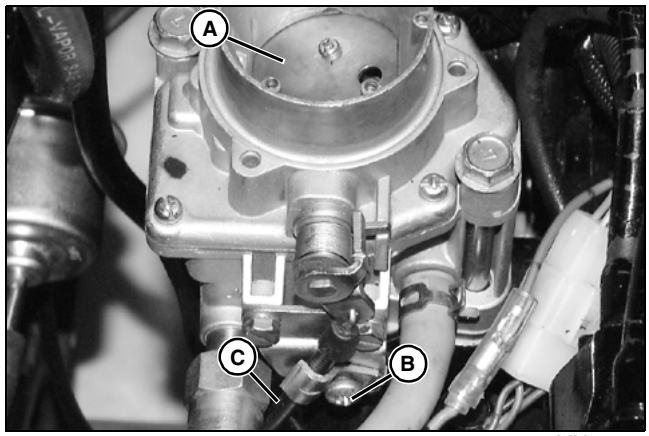
2. Stop engine.

3. Open engine cover.

CAUTION: Avoid injury! Stay clear of rotating parts during tests.

4. Remove air cleaner. (See “Air Cleaner Removal:” on page 45.)

5. Move manual choke lever on operator console to full closed position.



MX5560

6. Choke valve (A) inside carburetor should be in full closed position.

7. If choke valve is not fully closed, loosen choke cable clamp (B) and pull choke cable (C) down until choke valve is closed. Tighten choke cable clamp.

8. Move manual choke lever. Check for full and proper movement of the choke valve.

9. Install air cleaner. (See “Air Cleaner and Carburetor Installation:” on page 46.)

10.Close engine cover.

Slow Idle Speed Adjustment

Front Mower

1420

Reason:

To set engine slow idle speed rpm.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Digital Pulse Tachometer	JT07270	Used to check and adjust slow idle speed.

Procedure:

1. Park machine safely.

IMPORTANT: Avoid damage! Do not remove air cleaner for tests.

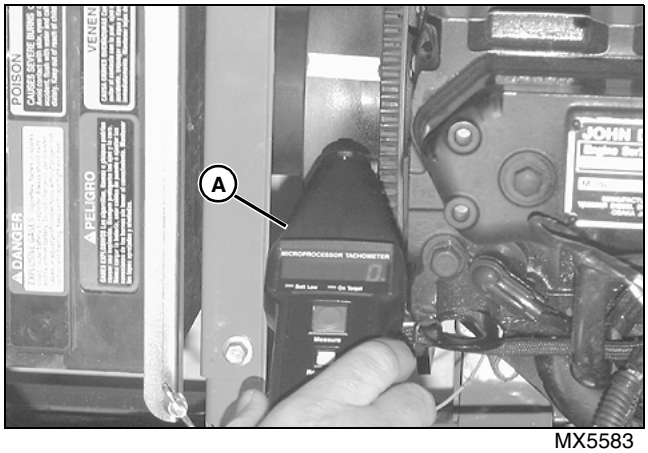
2. Stop engine.

3. Open engine cover.

4. Put a piece of white reflective tape on engine flywheel.

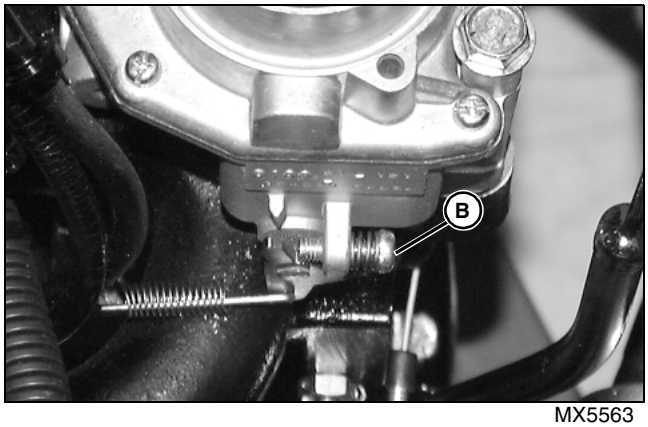
5. Start and warm engine.

CAUTION: Avoid injury! Stay clear of rotating parts during tests.



MX5583

6. Check engine rpm using the digital pulse tachometer (A).



MX5563

7. Turn slow idle stop screw (B) in either direction until slow idle speed is reached.

8. Move hand throttle on operator console between slow idle and fast idle several times.

9. Move hand throttle to idle.

10. Check slow idle rpm again. Adjust slow idle stop screw as necessary.

11. Replace engine cover.

Specifications:

Slow Idle Speed . . . . . 1500 ± 50 rpm

Fast Idle Speed Adjustment

Front Mower

1420

Reason:

To set engine fast idle speed rpm.

Special or Required Tools:

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

Procedure:

CAUTION: Avoid injury! Stay clear of rotating parts during tests.

1. Park machine safely.

IMPORTANT: Avoid damage! Do not remove air cleaner for tests.

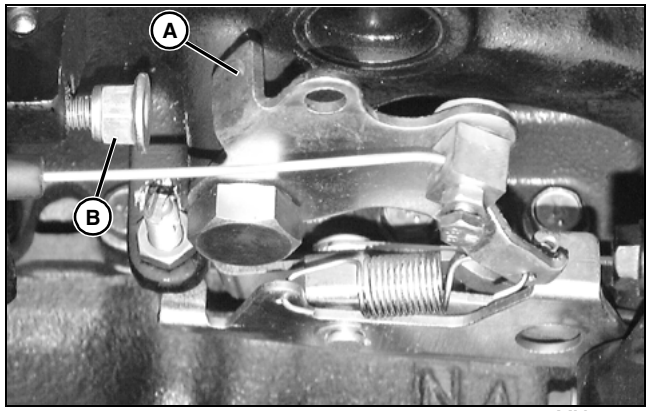
2. Stop engine.

3. Open engine cover.

4. Put a piece of white reflective tape on engine flywheel.

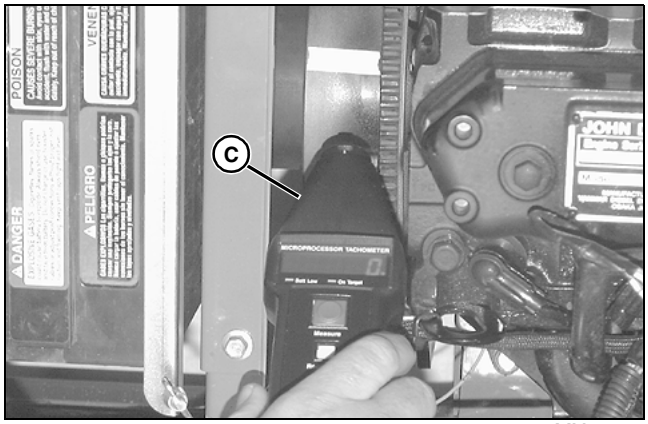
5. Start and warm engine.

6. Push hand throttle forward on operator console to full throttle.



MX5561

7. Throttle arm (A) should contact throttle arm stop (B).



MX5583

8. Check rpm with digital pulse tachometer (C). Fast idle speed should be to specification.

9. If fast idle speed is above or below specified rpm, turn throttle arm stop clockwise to increase or counterclockwise to decrease engine rpm.

10.Advance or retard the hand throttle as necessary after throttle arm stop is adjusted until the specification is attained.

11.Close engine cover.

Specifications:

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

Throttle Start Position Screw Adjustment

Front Mower

1420

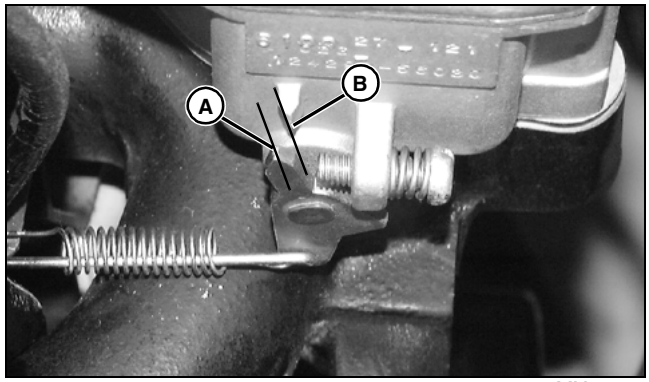
Procedure:

1. Park machine safely.

2. Stop engine.

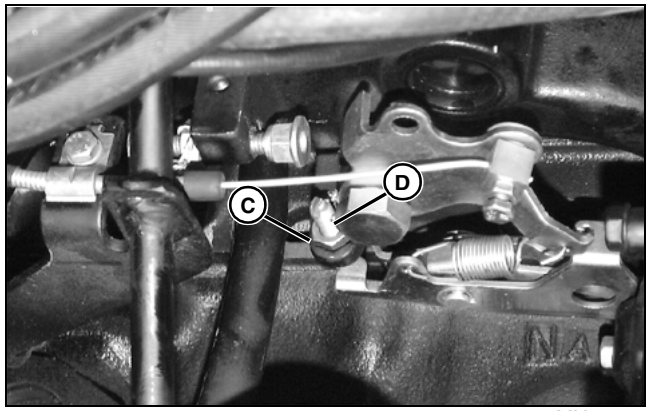
3. Open engine cover.

4. Move hand throttle forward to at least half-throttle. Hold or block lever.



MX5564

5. Measure distance between pointer (A) on throttle shaft and pointer (B) on carburetor. Compare distance to specification.



MX5559

6. If distance is not to specification, loosen lock nut (C) on throttle start position screw. Adjust screw (D) until distance between the throttle shaft pointer and pointer on carburetor is to specification.

7. Hold throttle start position screw stationary and tighten lock nut.

8. Close engine cover.

Specifications:

Throttle Shaft Pointer-to-Carburetor Pointer Distance . . . . . 4.0 mm (0.157 in.)

Valve Clearance Adjustment

Front Mower

1420

Reason:

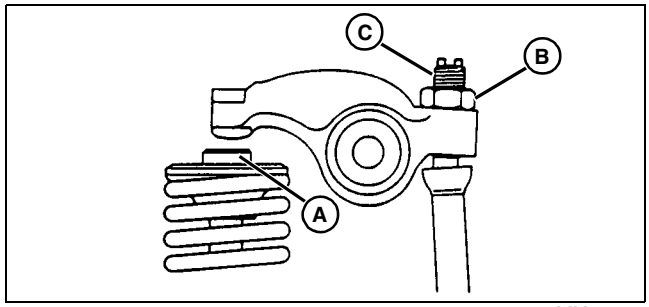
To be sure valves are fully opening at the correct time, but not remaining open too long or wearing valve train unnecessarily.

Special or Required Tools:

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

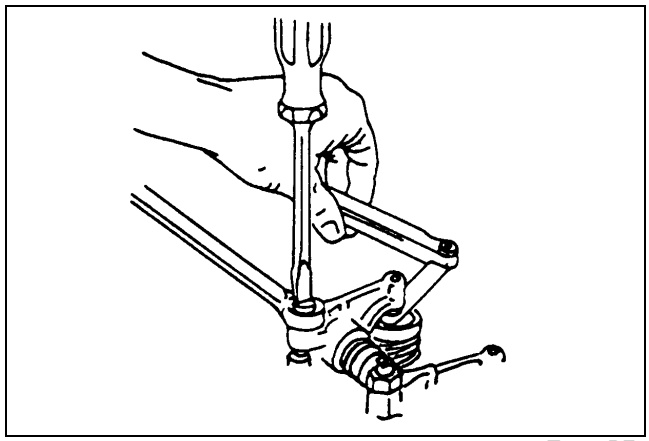
Procedure:

1. Park machine safely.
2. Stop engine.
3. Remove engine cover.
4. Engine must be cool (room temperature) before valve clearance is checked.
5. Be sure ignition is off and key is removed before attempting to turn engine by hand.
6. Remove rocker arm cover. (See “Rocker Arm Cover Removal and Installation” on page 59.)
7. Using a 17 mm wrench, turn the crankshaft pulley in the direction of engine rotation while watching the rocker arms of the number one cylinder. When the intake valve has completely closed (raised up), turn the crankshaft an additional half turn.
8. Try to move rocker arms and/or push rods for the cylinder to be adjusted.
   - If both rocker arms and push rods are loose, the piston is near TDC on the compression stroke and you may proceed to step 11.
   - If rocker arms and/or push rods are not loose, repeat step 7.

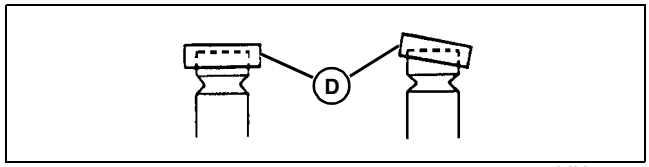


MX0737

9. Slide feeler gauge of appropriate size between valve cap (A) and rocker arm. There should be a slight drag on the feeler gauge when the clearance is to specification.


T6105BF

10. To adjust valves, loosen lock nut (B) and turn adjusting screw (C) until blade of feeler gauge has a slight drag when inserted between rocker arm and valve cap. Hold adjusting screw while tightening lock nut.
11. Recheck valve clearance after tightening lock nut.



MX5696

Picture Note: Left Valve Cap Shows Normal Position

12. Check that valve cap (D) on end of valve stem remained seated on valve and inside valve spring retainer.
13. Repeat steps 7 through 12 for number two and three cylinders.
14. Install rocker arm cover.

Specifications:

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

Cooling System Pressure Test

Front Mower

1420

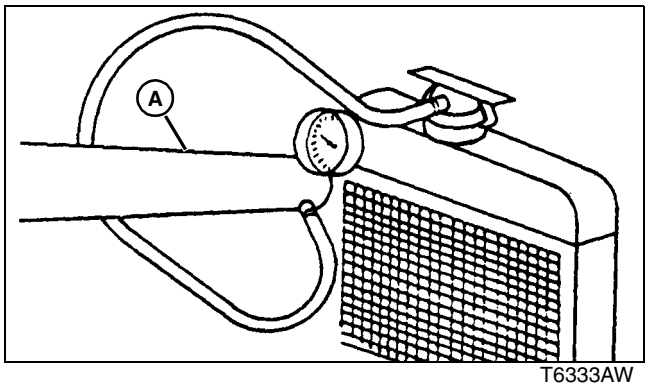
Reason:

Inspect the cooling system for leaks.

Special or Required Tools:

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

Procedure:



T6333AW

1. Remove the cap and attach the pressure pump (A) to radiator.

2. Apply pressure according to minimum specification, but not in excess of maximum specification.

3. Check for leaks throughout the cooling system. After 15 seconds, the minimum pressure should be to specification.

Results:

- Pressure should hold to minimum specification. If pressure decreases, check for leaks. Repair leaks or replace parts as necessary.
- If the pressure test still indicates leakage after all external leaks have been stopped, a defective head gasket, cracked block, or cylinder head may be the cause. (See “Radiator Bubble Test” on page 45.)

Specifications:

Cooling System Pressure (Maximum Applied) . . . . . 97 kPa (14 psi)

Cooling System Pressure (Minimum after 15 Sec) . . . 88 ± 15 kPa (12.8 ± 2.2 psi)

Fuel Pump Pressure Test

Front Mower

1420

Reason:

To determine fuel pump pressure to the carburetor.

Special or Required Tools:

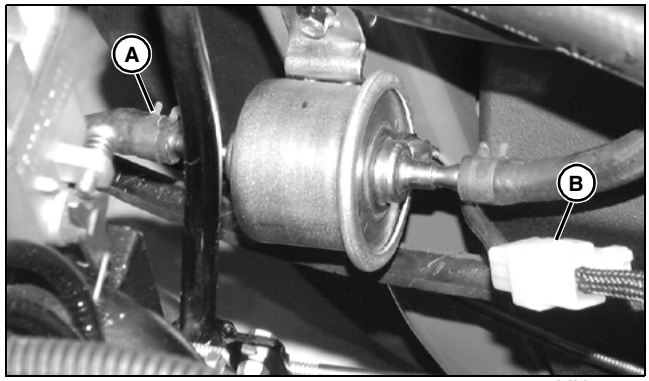
Tool Name	Tool No.	Tool Use
Pressure Test Kit	JDG356	Used to measure fuel pump pressure.
Voltmeter	NA	Used to check for voltage at fuel pump connector.

Procedure:

1. Park machine safely.
2. Stop engine.
3. Open engine cover.
4. Allow engine to cool.

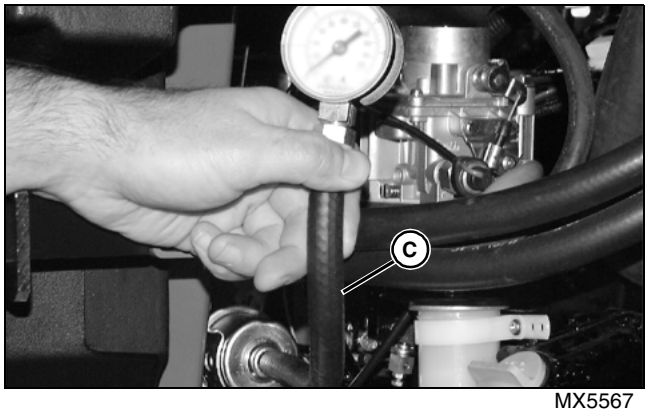
CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a well ventilated area away from open flame or spark producing equipment, including equipment that utilizes pilot lights.

5. Check for sufficient fuel in tank to perform test.



MX5566

6. Disconnect hose from fuel pump outlet (A). Wipe up any spilled fuel **immediately**.



MX5567

7. Connect JDG356 Pressure Gauge (C) to fuel pump outlet.

8. Turn key switch to on position. Fuel pump should make a clicking sound.

9. If fuel pump does not make a clicking sound, check for voltage at fuel pump connector (B). If no voltage is present, see electrical section for diagnosis of electrical problem.

10.Run fuel pump for 15 seconds and observe pressure reading on gauge. Compare reading to minimum specification.

11.Close engine cover.

Results:

- If fuel pressure is below minimum, check fuel hoses for kinks or blockages.
- If no blockage is found in inlet hose or stand pipe in tank, replace fuel pump. (See “Fuel Pump Removal and Installation” on page 54.)

Specifications:

Fuel Pump Pressure (Minimum) . . . . . 10 kPa (1.5 psi)

Fuel Pump Flow Test

Front Mower

1420

Reason:

To determine fuel pump flow to the carburetor.

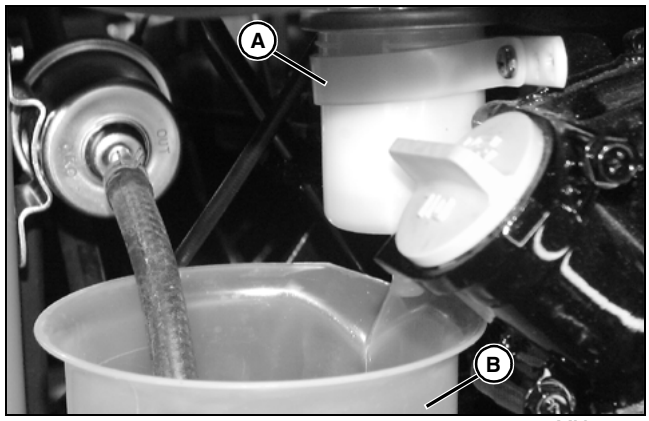
Special or Required Tools

Tool Name	Tool No.	Tool Use
Graduated Container	NA	Used to hold and measure fuel flow during test.

Procedure:

1. Park machine safely.
2. Stop engine.
3. Open engine cover.

CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a well ventilated area away from open flame or spark producing equipment, including equipment that utilizes pilot lights.



MX5568

4. Loosen clamp and disconnect fuel pump outlet hose from fuel filter (A). Put hose into a graduated container (B).

5. Turn key to on position for 15 seconds. Record fuel flow and compare to specification. If flow is to specification, proceed to step 7.

6. If flow is not to specification, check fuel hoses, fuel tank, pickup tube, and fill cap vent for restrictions. Retest.

7. Remove test equipment. Reconnect hose to fuel filter.

8. Close engine cover.

Results:

- If fuel pump pressure and flow do meet specifications, replace filter, check carburetor inlet tube, inlet needle, and float for proper function, obstructions, varnish/sticking conditions, or other problems. (See “Carburetor Removal and Replacement” on page 45 and “Carburetor Inspection” on page 46 in this section.)
- If, after retest, fuel pump pressure and flow do not meet specifications, replace fuel pump. (See “Fuel Pump Removal and Installation” on page 54 in this section.)

Specifications:

Fuel Pump Flow (Minimum in 15 Sec) . 105 mL (3.5 oz)

Oil Pressure Test

Front Mower

1420

Reason:

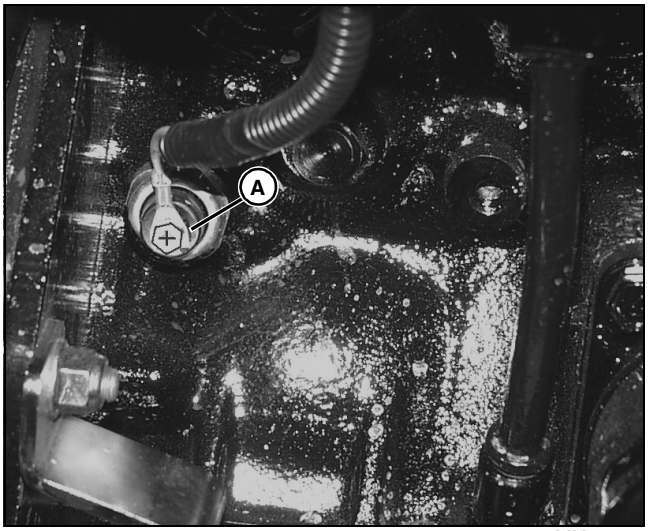
To verify that the engine has enough oil pressure to lubricate the internal engine components.

Special or Required Tools:

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

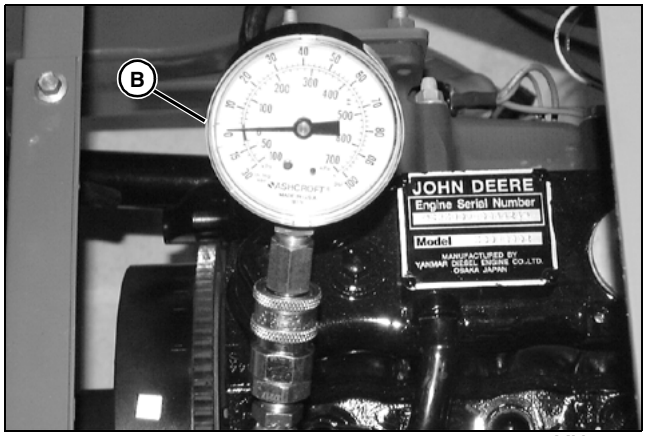
NOTE: The connector, hose assembly, coupler, and gauge are found in other SERVICEGARD™ test kits.

Procedure:



MX0639

1. Park machine safely.
2. Stop engine.
3. Open engine cover.
4. Disconnect and remove oil pressure switch (A).



MX5569

5. Install connector, hose assembly, and gauge (B) into oil pressure switch port.
6. Check crankcase oil level and adjust to full mark.
7. Start engine, monitor oil pressure during start-up. If oil pressure is below specification after 5 seconds running, stop engine immediately and correct cause before continuing.

CAUTION: Avoid injury! Engine components are hot. do not touch with bare skin. Wear protective eyeglasses and clothing.

8. Warm engine by running at medium idle for five minutes.
9. Record oil pressure readings at fast idle.
10. Stop engine and allow to cool.
11. Remove hose assembly and gauge.
12. Install oil pressure switch.
13. Run engine for 30 seconds and stop engine.
14. Check crankcase oil level and adjust to full mark.
15. Close engine cover.

Results:

- If oil pressure reading at fast idle is not to specification, inspect and/or replace the oil pump assembly. (See “Oil Pressure Regulating Valve” on page 69 and “Oil Pump” on page 69.)

Specifications:

Engine Oil Pressure
(Minimum after 5 Sec Running) . . . . . 69 kPa (10 psi)

Engine Oil Pressure
(at Fast Idle) . . . . . 290 ± 50 kPa (42 ± 7 psi)

Cylinder Compression Test

Front Mower

1420

Reason:

To check pressure capacity of piston rings and cylinder bore for efficient engine operation.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Compression Gauge	JDM59	Used to measure cylinder compression pressure.

Procedure:

1. Park machine safely.
2. Stop engine.
3. Open engine cover.
4. Start engine and warm to operating temperature.

CAUTION: Avoid injury! Engine will be hot. Do not touch with bare skin, especially the exhaust pipe or muffler, while making test.

5. Stop engine.



MX5565

6. Remove air cleaner. (See “Air Cleaner Removal:” on page 45.)
7. Remove spark plugs.
8. Install compression gauge (A) into spark plug holes one at a time and crank engine with starter for 4 or 5 compression strokes.
9. Record reading for each cylinder.

Results:

- If compression is low, squirt about one-half ounce of clean engine oil into cylinder through spark plug hole and retest compression. If compression significantly increases, the piston rings/cylinder are worn.
- If compression does not change with oil added to cylinders, check valves and head gasket for leaks.

Specifications:

Cylinder Compression Pressure (Minimum) . . . . . 779 kPa (112 psi)

Cylinder Compression Pressure Differential (Maximum) . . . . . 97 kPa (14 psi)

Radiator Cap Pressure Test

Front Mower

1420

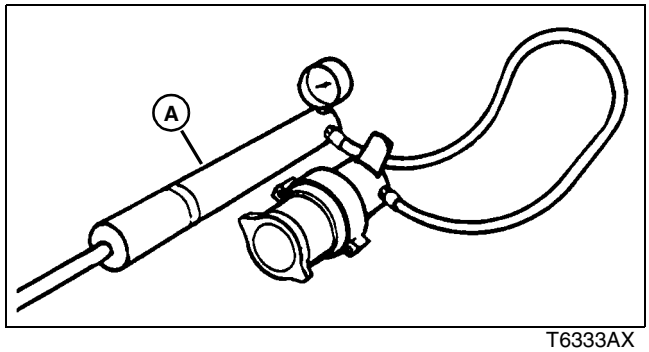
Reason:

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

Special or Required Tools:

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

Procedure:



T6333AX

1. Install the radiator cap on the pressure pump (A).
2. Apply pressure. Pressure valve in the cap should open at specification.

Results:

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

Specifications:

Radiator Cap Valve
Opening Pressure. . . . . 88 kPa (12.8 psi)

Thermostat Opening Test

Front Mower

1420

Reason:

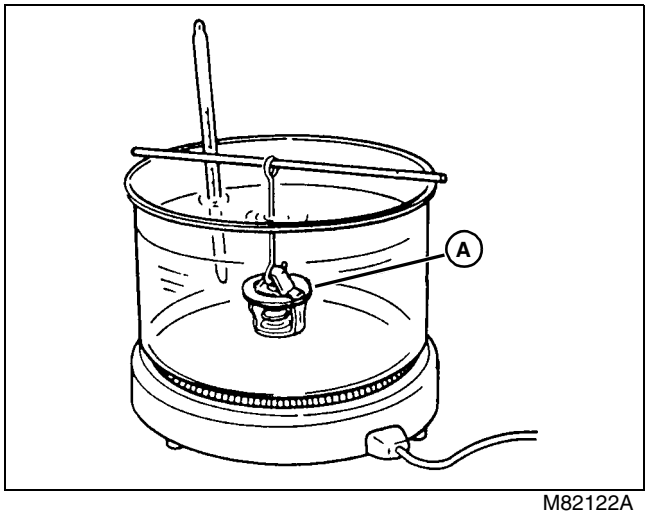
To determine opening temperature of thermostat.

Special or Required Tools

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

Procedure:

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



M82122A

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

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

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

Results:

• If thermostat does not open according to specifications, replace.

• If closing action is not smooth and slow, replace thermostat.

Specifications:

Thermostat Begin
Opening Temperature . . . . . 69.5 - 72.5°C (157 - 163°F)

Thermostat Fully Open Temperature . . . . . 85°C (185°F)

Minimum Lift Height
Above 85°C (185°F) . . . . . 8 mm (0.315 in.)

Radiator Bubble Test

Front Mower

1420

Reason:

To determine if compression pressure is leaking from combustion cylinder into water jacket of cylinder block.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Adapter	JDG472	Used to connect compressed air source to cylinder injection port.

Procedure:

1. With coolant at proper level and radiator cap tight, run engine for 5 minutes to bring to operating temperature.
2. Remove cap from recovery tank.
3. Check for bubbles coming from overflow hose at bottom of tank. If bubbles are present, isolate source of compression leak:
   a. Remove injection nozzles.
   b. Install JDG472 Adapter in injection port of cylinder to be tested.
   c. Move piston to bottom of stroke with intake and exhaust valves closed.
   d. Connect hose from compressed air source to adapter. Do not exceed rated pressure of hoses and tools being used. Do not exceed maximum cylinder pressure specification.
   e. Check for bubbles in coolant recovery tank, or air escaping from muffler, air cleaner, or oil fill opening.
   f. Repeat for each cylinder.

Results:

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

Specifications:

Cylinder Pressure
(Maximum Applied) . . . . . 2448 kPa (355 psi)

Repair

Carburetor Removal and Replacement

Front Mower

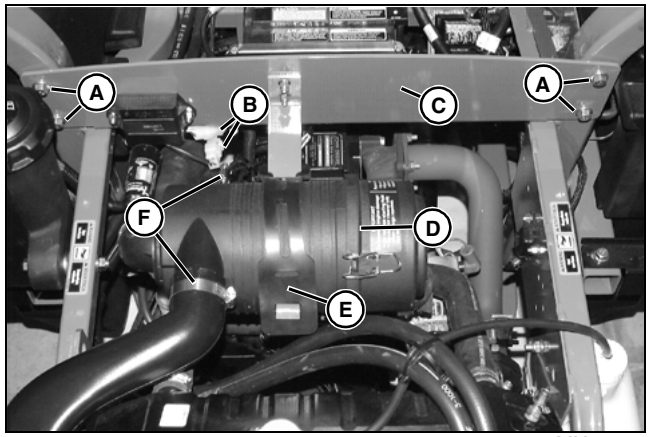
1420

CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a well ventilated area away from open flame or spark producing equipment, including equipment that utilizes pilot lights.

Procedure:

1. Park machine safely.
2. Stop engine.
3. Open engine cover.
4. Tilt seat forward.
5. Disconnect battery negative (-) cable from battery.

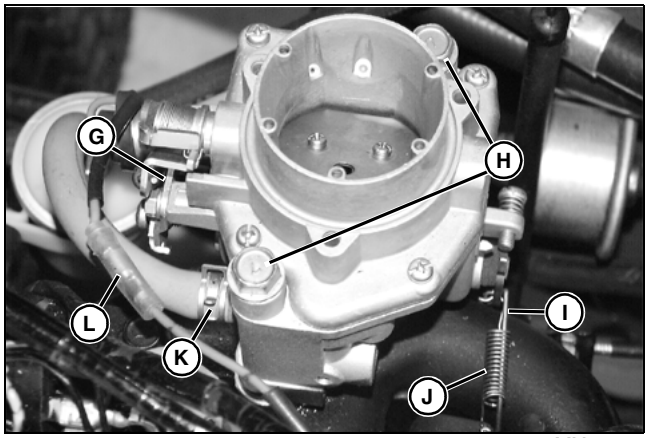
Air Cleaner Removal:



MX5570

1. Disconnect two ignition module leads (B).
2. Loosen clamps (F).
3. Detach strap (E) on air cleaner.
4. Remove air cleaner (D).
5. Remove four cap screws (A) and seat bracket (C).

Carburetor Removal:



MX5571

1. Disconnect wire (L) to fuel shutoff solenoid.
2. Loosen clamp (K) and disconnect fuel hose to carburetor.
3. Loosen choke cable clamp and disconnect choke cable (G) to carburetor.
4. Remove mounting cap screws (H).
5. Disconnect spring (J) and linkage rod (I) from throttle lever. It may be necessary to rotate the carburetor to disconnect the linkage rod.
6. Remove and discard gaskets between carburetor and intake manifold.

Air Cleaner and Carburetor Installation:

1. Install carburetor in reverse order of removal.
2. Clean gasket mating surfaces. Install new gaskets.
3. Connect linkage rod and spring.
4. Tighten cap screws securing carburetor to specification.
5. Connect fuel hose to carburetor and secure with clamp.
6. Connect fuel shutoff solenoid wire.
7. Connect choke cable to carburetor and tighten choke cable clamp.
8. Install air cleaner in reverse order of removal.
9. Connect battery negative (-) cable to battery.
10. Close engine cover.

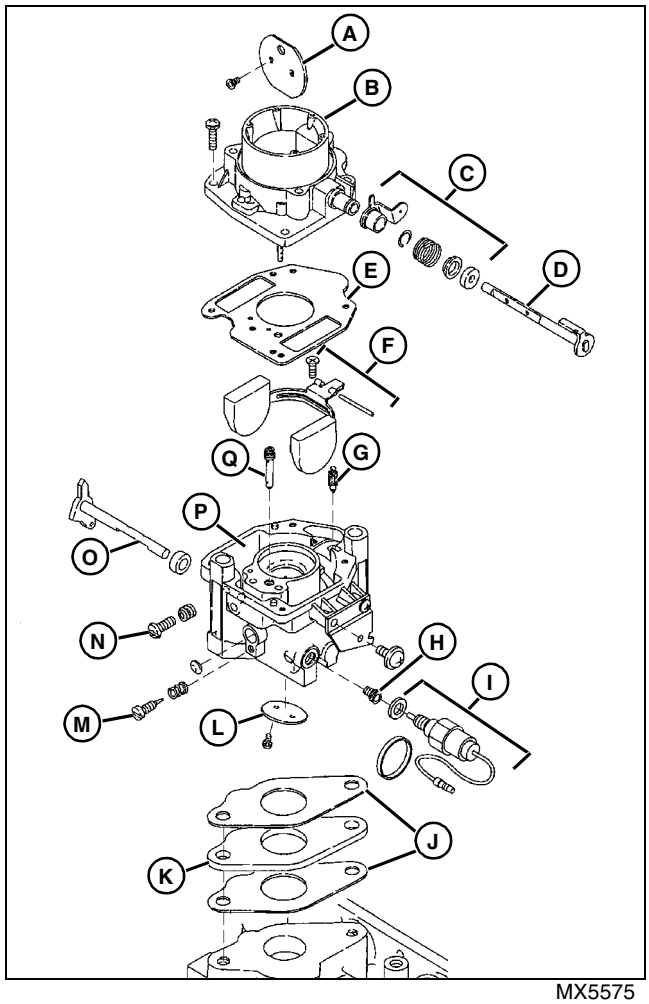
Specifications:

Carburetor Mounting
Cap Screw Torque . . . . . 21 N•m (180 lb-in.)

Carburetor Inspection

Front Mower

1420



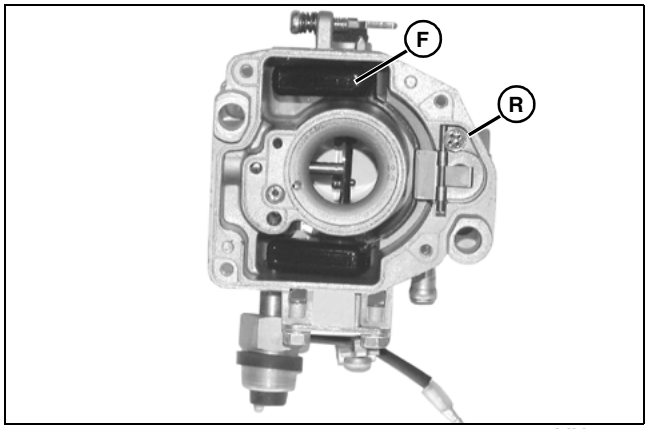
MX5575

A - Choke Valve
B - Air Horn
C - Lever Spring and Felt
D - Choke Shaft
E - Gasket
F - Float and Hinge Pin
G - Needle Valve
H - Main Jet
I - Fuel Shutoff Solenoid
J - Gasket (2 used)
K - Spacer
L - Throttle Valve
M - Idle Mixture Screw
N - Idle Speed Screw
O - Throttle Shaft
P - Carburetor Body
Q - Low Speed Jet

Disassembly:

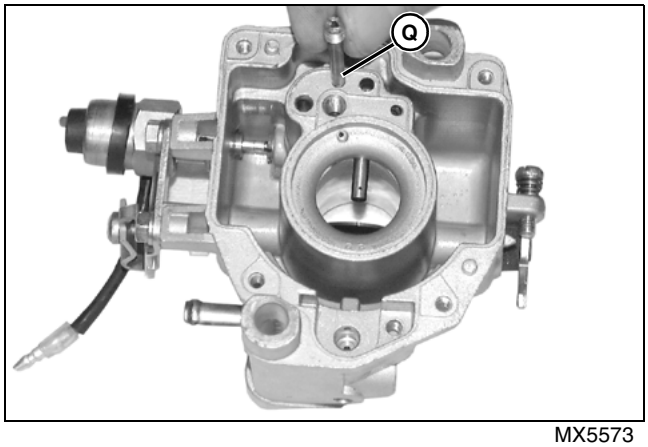
CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a well ventilated area away from open flame or spark producing equipment, including equipment that utilizes pilot lights.

1. Park machine safely.
2. Stop engine.
3. Open engine cover.
4. Tilt seat forward.
5. Disconnect battery negative (-) cable from battery.
6. Remove air cleaner. (See “Air Cleaner Removal:” on page 45.)
7. Remove carburetor. (See “Carburetor Removal:” on page 46.)
8. Remove four screws on carburetor top and lift off top of carburetor.



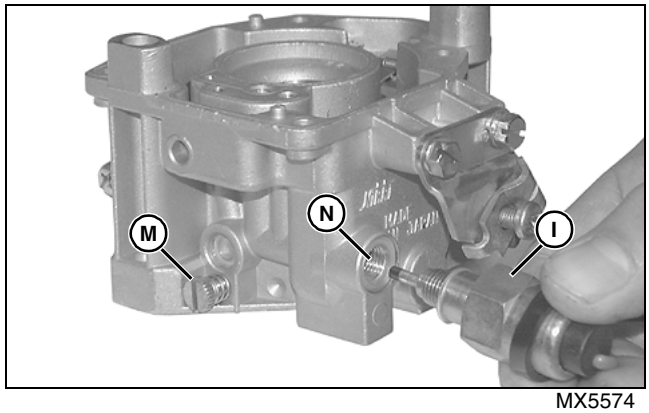
MX5572

9. Remove retaining screw (R).
10. Remove float assembly (F) and inlet needle.



MX5573

11. Remove low speed jet (Q).



MX5574

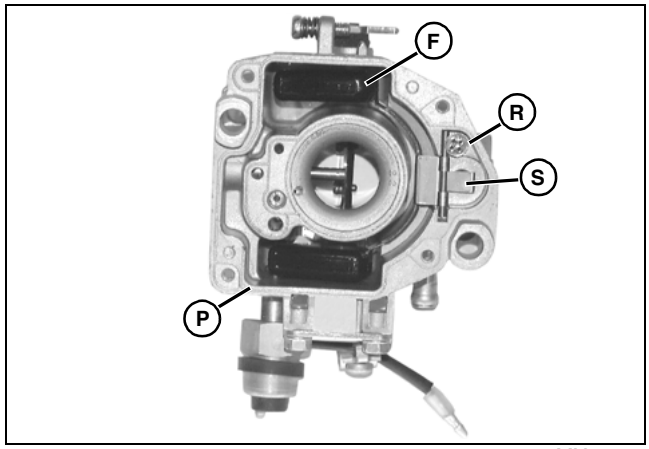
12. Remove fuel shutoff solenoid (I) and main jet (N), accessible through fuel shutoff solenoid hole.

NOTE: The idle mixture screw (M) has a precision taper. If the idle mixture screw is grooved, bent, or broken, this may indicate seat damage and carburetor may need to be replaced.

13. Remove idle mixture screw (M).
14. Clean carburetor using pressurized carburetor cleaner and compressed air. Clean out all passages. Clean all gasket mating surfaces.
15. If throttle and choke valves were removed, install screws slightly loose. Apply pressure on shafts to center plates in bore, then tighten screws.

Assembly:

1. Assemble carburetor in the reverse order of disassembly.



MX5572

2. Install float assembly (F) and inlet needle . Install retaining screw (R). Press down on tab (S) and check float level. Top of floats should be even with top edge of carburetor (P). If floats are not even with top edge of carburetor, adjust by bending tab.
3. Install carburetor on engine.

4. Install air cleaner.
5. Connect battery negative (-) cable to battery.
6. Close engine cover.

High Altitude Jet Installation

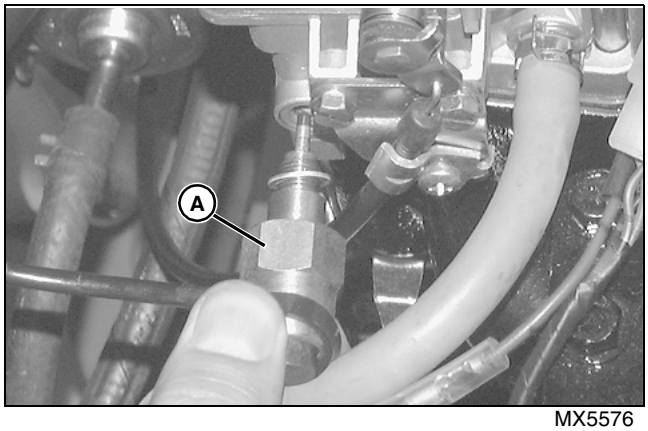
Front Mower

1420

Procedure:

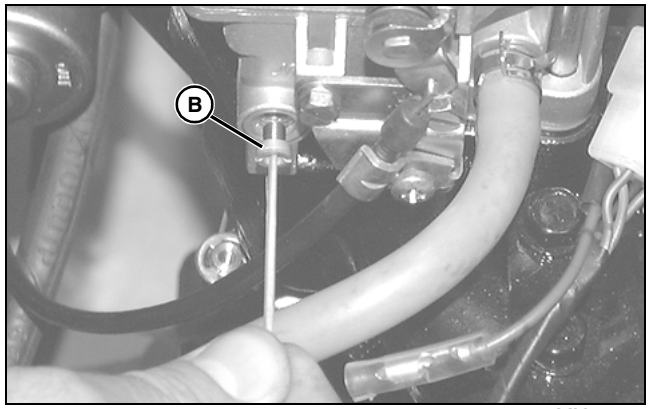
CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a well ventilated area away from open flame or spark producing equipment, including equipment that utilizes pilot lights.

1. Park machine safely.
2. Stop engine.
3. Open engine cover.
4. Tilt seat forward.
5. Disconnect battery negative (-) cable from battery.
6. Allow engine to cool.
7. Place suitable container under carburetor to catch fuel that will drain from carburetor.



MX5576

8. Disconnect and remove fuel shutoff solenoid (A).



MX5577

9. Loosen main jet one-half turn only with screwdriver.
10. Place round toothpick snugly into main jet and remove main jet (B).
11. Installation of new jet is reverse of removal procedure.
12. Connect battery negative (-) cable to battery.
13. Close engine cover.

Radiator Removal, Installation and Inspection

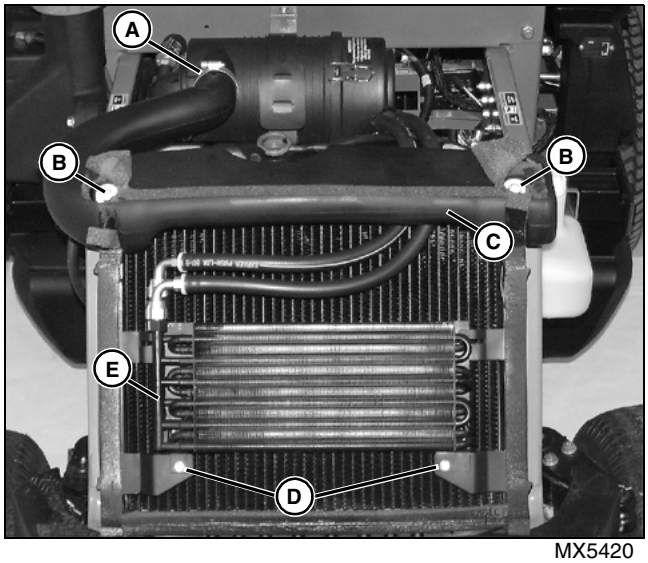
Front Mower

1420

Removal:

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

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

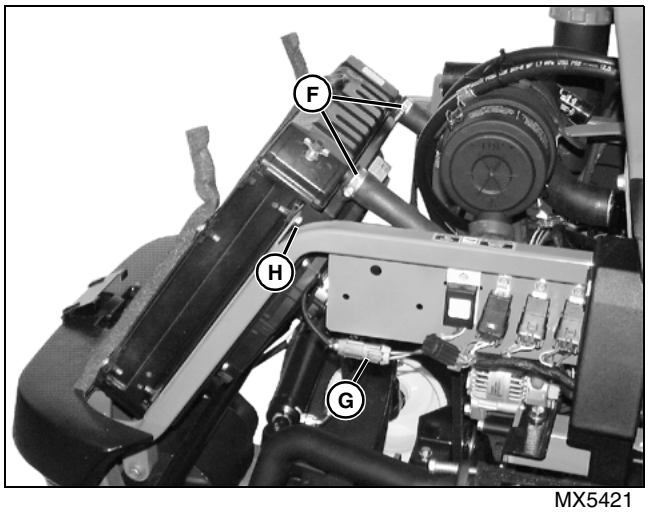


MX5420

7. Loosen clamp (A).
8. Peel back foam and remove two cap screws (B).
9. Remove air box (C).

IMPORTANT: Avoid damage! Use caution when moving oil cooler aside to prevent damaging fins.

10. Remove two cap screws (D) and tilt the oil cooler (E) away from radiator.



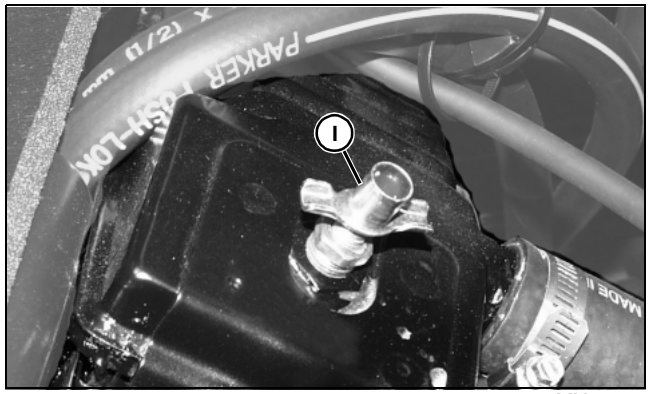
MX5421

Picture Note: Coolant Overflow Tank Removed for Photo Clarity

11. Disconnect overflow hose from radiator.
12. Disconnect cooling fan electrical connector (G).
13. Loosen hose clamps (F).
14. Disconnect hoses from radiator.
15. Remove four cap screws (H).
16. Remove radiator and cooling fan as an assembly.

Installation:

NOTE: Installation is done in the reverse order of removal.



MX7051

1. Open air bleed valve (I) on top of radiator.
2. Fill cooling system until coolant drains out of air bleed valve.
3. Close air bleed valve.
4. Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.

Inspection:

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

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

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

Specifications:

Cooling System Capacity (Approximately) . 6.6 L (7 qt)

Thermostat Removal and Installation

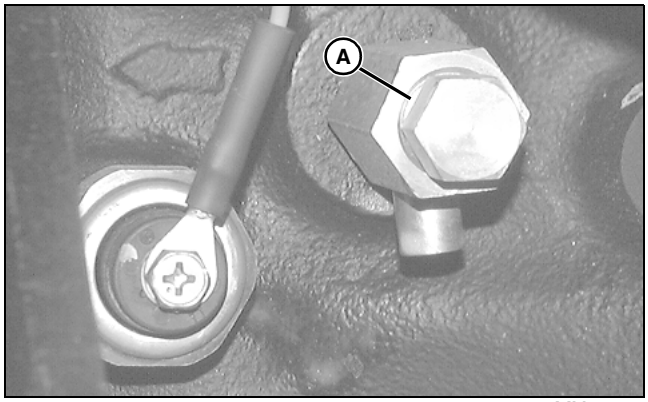
Front Mower

1420

Removal:

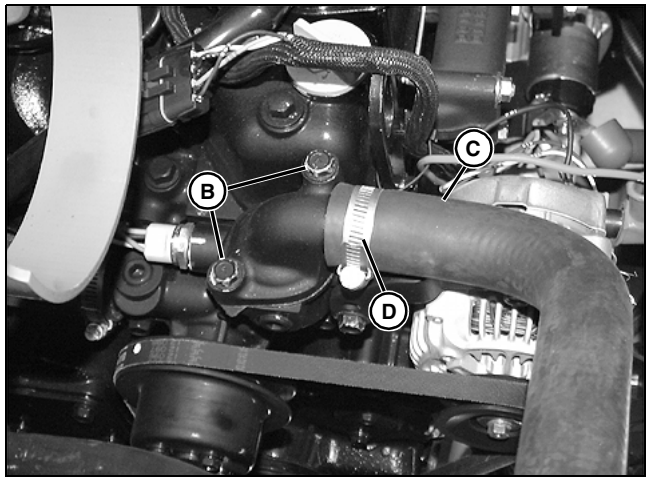
CAUTION: Avoid injury! Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Remove filler cap only when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

1. Park machine safely.
2. Turn key switch to stop position and allow the engine to cool.
3. Remove engine cover.
4. Loosen radiator cap to first stop to relieve pressure.
5. Remove radiator cap.
6. Remove air cleaner assembly.
7. Attach a 12-inch hose to drain valve located on the lower left side of the radiator.
8. Drain coolant from radiator into an appropriate container.



MX5578

9. Drain coolant from engine. Drain plug (A) is located on the left side of the engine.



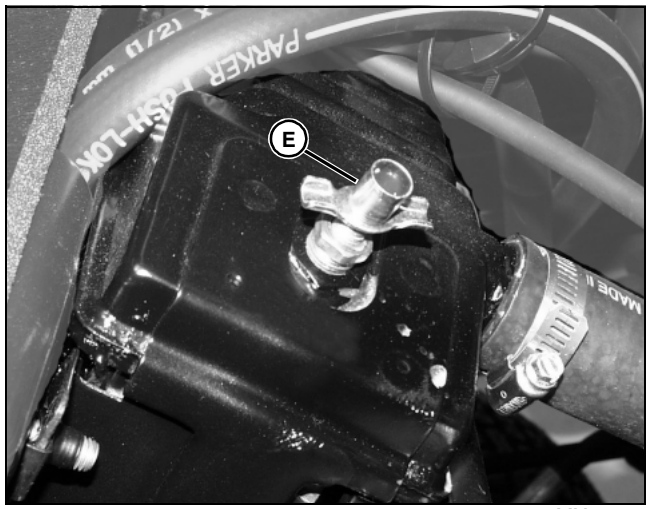
MX5422

10. Loosen hose clamp (D).
11. Remove radiator hose (C) from thermostat cover.
12. Remove two cap screws (B) from cover and remove cover and gasket.
13. Remove thermostat from housing.
14. If thermostat is to be reinstalled, test thermostat.

Installation:

NOTE: Installation is done in reverse order of removal.

1. Install thermostat in housing with spring end inside coolant pump.
2. Place gasket over thermostat and place cover over thermostat on coolant pump.



MX7051

3. Open air bleed valve (E) on top of radiator.
4. Fill cooling system until coolant drains out of air bleed valve.
5. Close air bleed valve.
6. Start engine and watch coolant level in radiator. Add

coolant if necessary to bring coolant level up to filler neck.

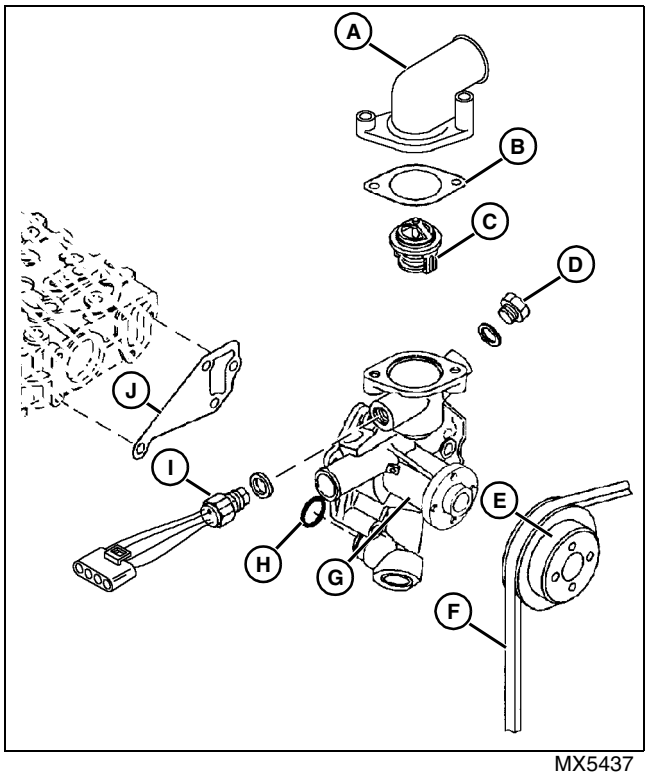
Specifications:

Cooling System Capacity (Approximately) . 6.6 L (7 qt)

Water Pump Removal and Installation (Thermostat Included)

Front Mower

1420



MX5437

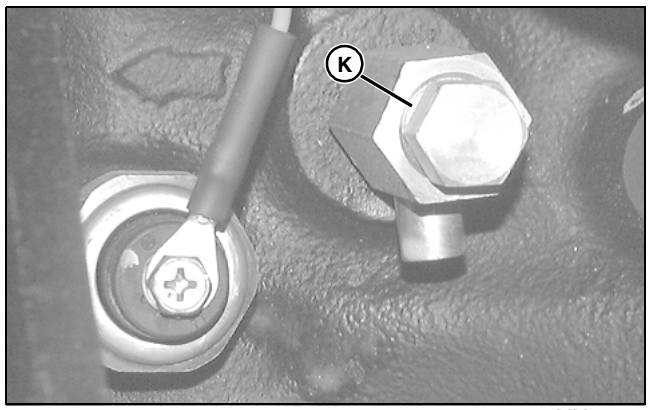
- **A - Thermostat Housing**
- **B - Gasket**
- **C - Thermostat**
- **D - Plug**
- **E - Sheave**
- **F - Belt**
- **G - Water Pump**
- **H - O-Ring**
- **I - Dual Temperature Switch**
- **J - Gasket**

Removal:

1. Park machine safely.

2. Allow engine to cool and pressure in cooling system to drop before working on water pump.

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



MX5578

4. Open engine drain valve (K) to drain coolant from cylinder block.

5. Disconnect upper and lower radiator hoses from water pump.

6. Loosen alternator mounting bolts and remove water pump/alternator drive belt.

7. Disconnect coolant temperature switch leads. Remove switch and plug from water pump if water pump is to be replaced.

8. Remove four cap screws and remove sheave.

9. Remove pump mounting cap screws, pump, and gasket.

10. Inspect all parts for wear or damage.

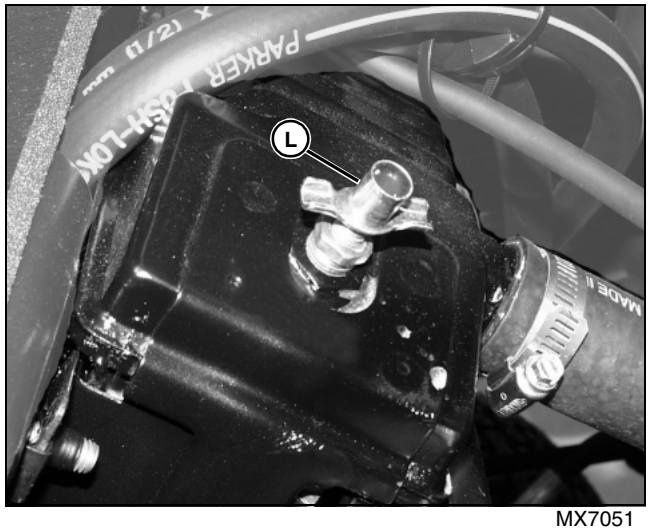
Installation:

NOTE: Installation is done in the reverse order of removal.

1. Clean cylinder block mating surfaces of all old gasket material.

2. Install coolant temperature switch and plug.

3. Adjust water pump/alternator drive belt tension.



MX7051

4. Open air bleed valve (L) on top of radiator.

5. Fill cooling system until coolant drains out of air bleed valve.

6. Close air bleed valve.

7. Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.

Specifications:

Cooling System Capacity (Approximately) . 6.6 L (7 qt)

Fuel Filter Removal and Installation

Front Mower

1420

CAUTION: Avoid injury! Avoid possible death from fumes, fire, or explosion when working on fuel-related parts:

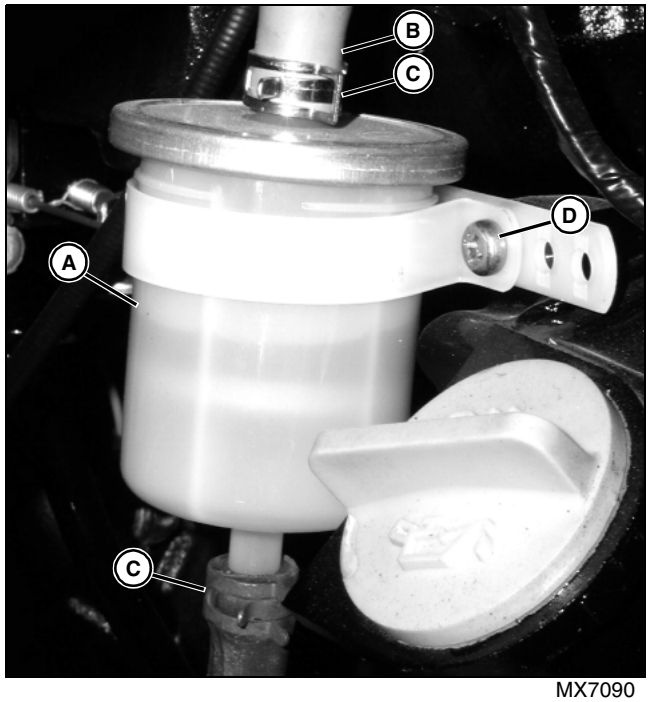
- **Do not smoke.**
- **Keep away from flames or sparks.**
- **Shut off engine.**
- **Cool engine before servicing.**
- **Work in a well ventilated area.**
- **Clean up spilled fuel immediately.**
- **Drain fuel into an approved non-metallic container.**

NOTE: Change filter when fuel level is low.

1. Park machine safely. (See “Park Machine Safely” on page 3 in the Safety section.)

2. Allow engine to cool.

3. Open engine cover.



MX7090

4. Locate the fuel filter (A) on the left side of the engine.

5. Clamp the fuel hose (B) above fuel filter using locking pliers.

6. Loosen the clamps (C) on fuel hoses above and below fuel filter.

7. Pull the fuel hoses from the top and bottom fuel filter fittings.

8. Loosen the screw (D) holding the filter mounting strap to the engine block and remove fuel filter from engine.

9. Install new fuel filter into mounting strap, making sure large end of filter is at the top.

10. Install fuel hoses onto fuel filter fittings. Secure hoses with clamps.

11. Remove locking pliers.

12. Turn key switch to run position to start electrical fuel pump. Wait for filter to fill with fuel and check for leaks.

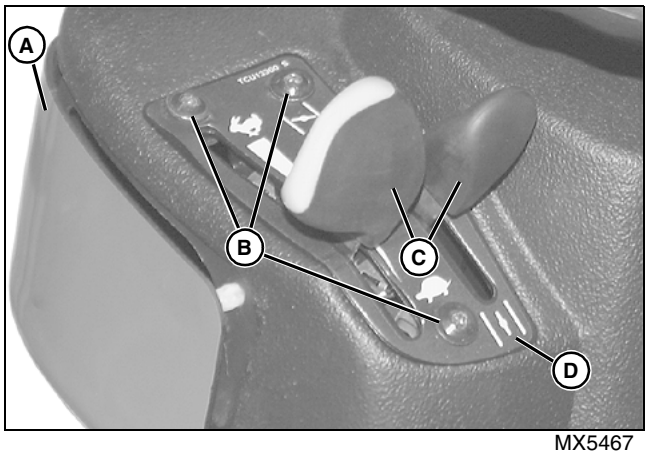
Throttle Cable Assembly Removal and Installation

Front Mower

1420

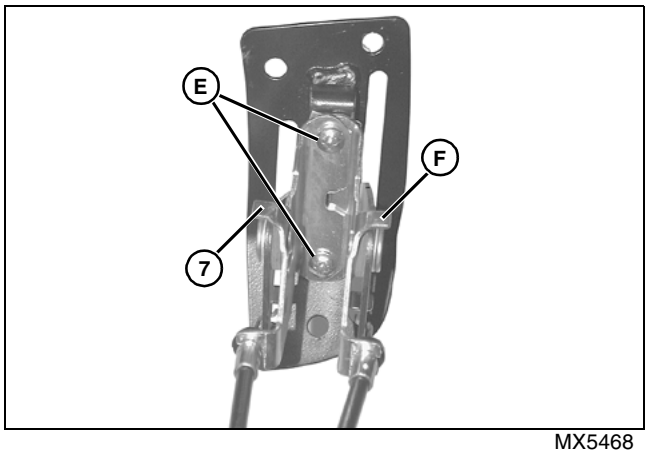
NOTE: Both the throttle cable and the choke cable need to be disconnected from the carburetor to remove the throttle cable assembly.

1. Park machine safely.
2. Stop engine.
3. Open engine cover.
4. Disconnect throttle cable assembly from carburetor.
5. Disconnect choke cable assembly from carburetor.



MX5467

6. Remove throttle and choke lever handles (C).
7. Remove upper console cover (A).
8. Remove three screws (B) of throttle and choke control faceplate (D).
9. Loosen clamp in left front wheel well.



MX5468

10. Pull throttle and choke control assemblies and faceplate up from console far enough to access two screws (E) on underside of faceplate.
11. Remove screws securing choke and throttle cable assemblies to faceplate.
12. Remove choke cable assembly (G) from faceplate.
13. Remove throttle cable assembly (F) from faceplate.
14. Install and route new throttle cable assembly.
15. Secure new throttle cable assembly and choke cable assembly to faceplate with screws.
16. Install faceplate in console and tighten screws.
17. Install throttle and choke lever handles.
18. Remove slack from routing of throttle and choke cable assemblies.
19. Install upper console cover.
20. Tighten clamp in left front wheel well.
21. Connect throttle cable assembly to carburetor. (See “Throttle Cable and Governor Adjustment” on page 35.)
22. Connect choke cable assembly to carburetor. (See “Choke Cable Adjustment” on page 36.)
23. Close engine cover.

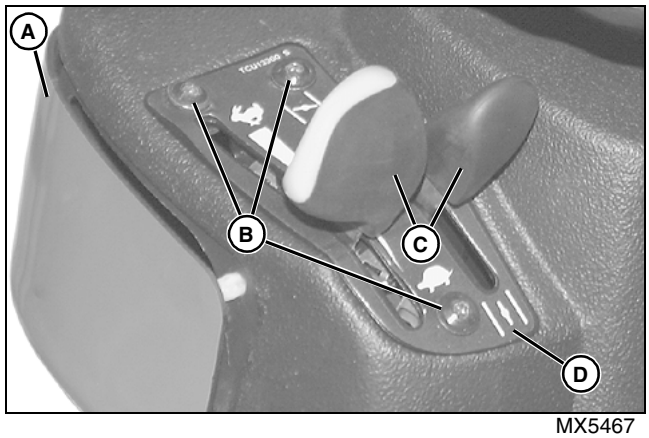
Choke Cable Assembly Removal and Installation

Front Mower

1420

NOTE: Both the choke cable and the throttle cable need to be disconnected from the carburetor in order to remove the choke cable assembly.

1. Park machine safely.
2. Stop engine.
3. Open engine cover.
4. Disconnect choke cable assembly from carburetor.
5. Disconnect throttle cable assembly from carburetor.



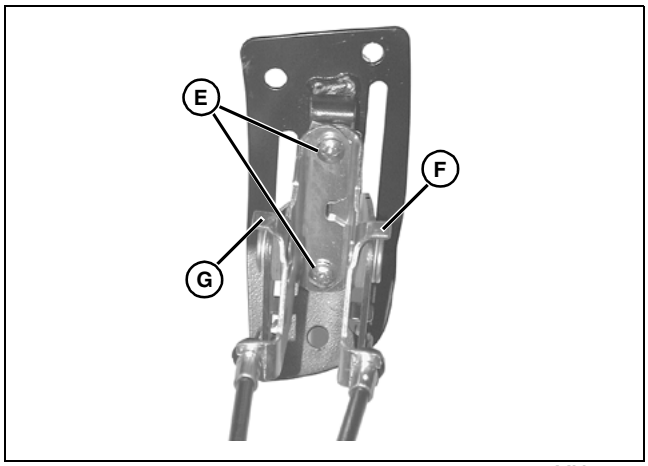
MX5467

6. Remove choke and throttle lever handles (C).

7. Remove upper console cover (A).

8. Remove three screws (B) of choke and throttle control faceplate (D).

9. Loosen clamp in left front wheel well.



MX5468

10.Pull choke and throttle assemblies and faceplate up from control console far enough to access two screws (E).

11.Remove screws securing choke and throttle cable assemblies to faceplate.

12.Remove choke cable assembly (G) from faceplate.

13.Remove throttle cable assembly (F) from faceplate.

14.Install and route new choke cable assembly.

15.Secure throttle cable assembly and new choke cable assembly to faceplate with screws.

16.Install faceplate in console and tighten screws.

17.Install choke and throttle lever handles.

18.Remove slack from routing of choke and throttle cable assemblies.

19.Install upper console cover.

20.Tighten clamp in left front wheel well.

21.Connect choke cable assembly to carburetor. (See “Choke Cable Adjustment” on page 36.)

22.Connect throttle cable assembly to carburetor. (See “Throttle Cable and Governor Adjustment” on page 35.)

23.Close engine cover.

Fuel Pump Removal and Installation

Front Mower

1420

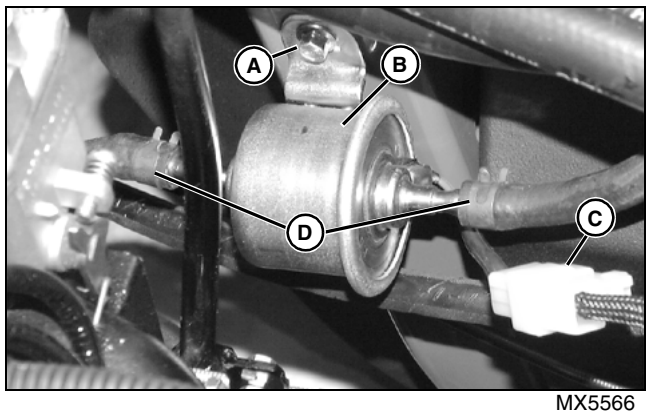
CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a well ventilated area away from open flame or spark producing equipment, including equipment that utilizes pilot lights.

1. Park machine safely.

2. Stop engine.

3. Open engine cover.

4. Place suitable container under fuel pump to catch fuel that will drain from fuel pump and hoses.



MX5566

5. Disconnect wire connector (C).

6. Loosen clamps and remove fuel hoses (D).

7. Remove cap screw (A) and remove pump (B).

8. Install components in reverse order of removal.

9. Close engine cover.

Engine Removal and Installation

Front Mower

1420

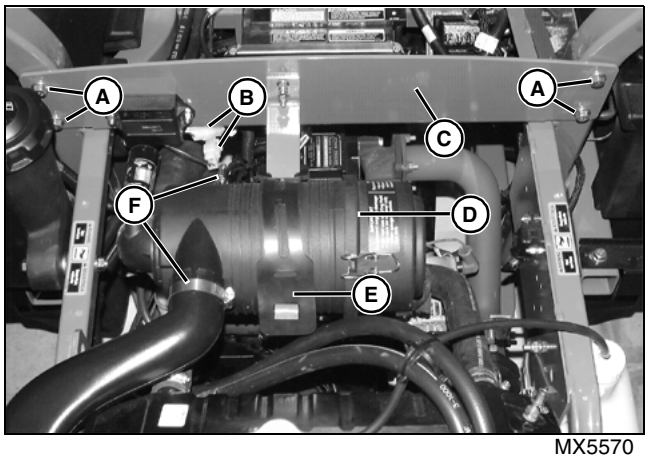
Special or Required Tools:

Tool Name	Tool No.	Tool Use
Engine Alignment Tool Base	JD1389-1	Used with JD1389-2 Engine Alignment Tool Long Pointer to align the engine and transaxle.
Engine Alignment Tool Long Pointer	JD1389-2	Used with JD1389-1 Engine Alignment Tool Base to align the engine and transaxle.

Removal:

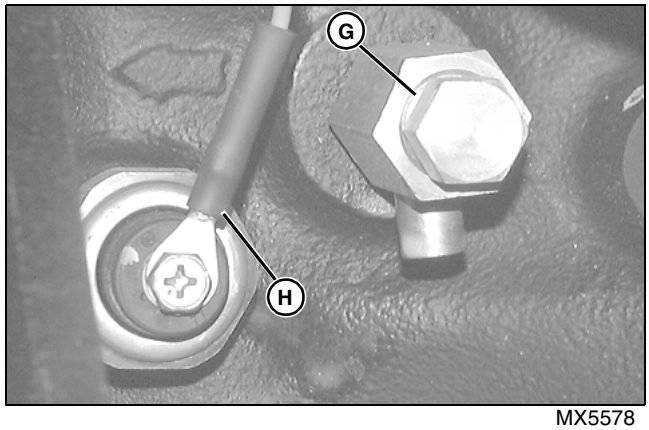
CAUTION: Avoid injury! Use caution around moving parts. Stop engine. Remove ignition key. Wait for all moving parts to stop.

1. Park machine safely.
2. Stop engine.
3. Open engine cover.
4. Tilt seat forward.
5. Disconnect battery negative (-) cable from battery.



MX5570

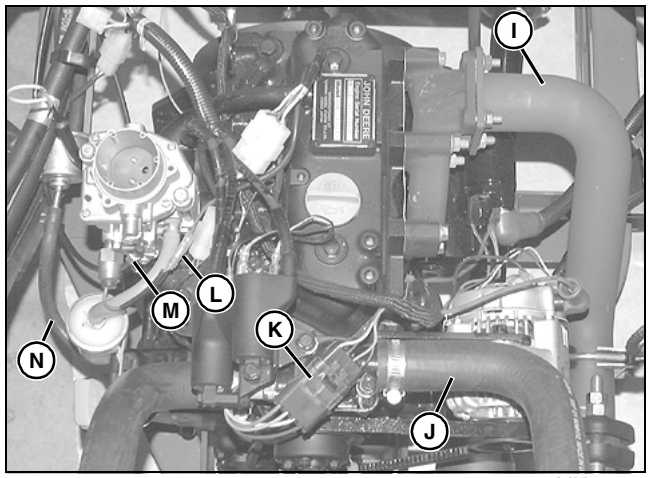
6. Disconnect the two ignition module leads (B).
7. Loosen clamps (F).
8. Detach strap (E) over the air cleaner.
9. Remove air cleaner (D).
10. Remove cap screws (A) and remove seat bracket (C).



MX5578

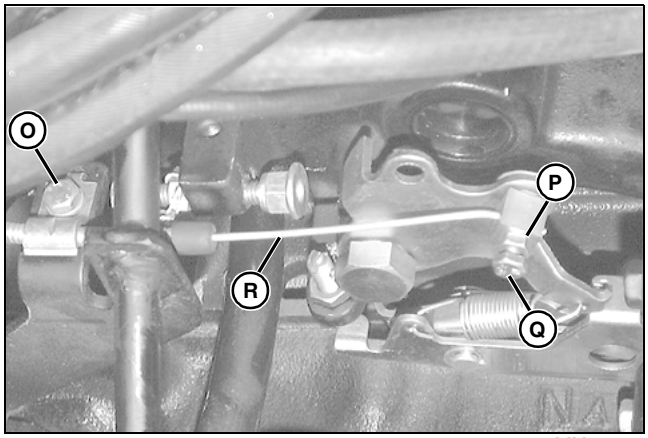
11. Drain coolant from engine drain valve (G) and radiator drain valve.
12. Disconnect wire terminal (H) from oil pressure switch.

CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a well ventilated area away from open flame or spark producing equipment, including equipment that utilizes pilot lights.



MX5579

13. Disconnect connector from dual temperature switch (K).
14. Disconnect fuel shutoff solenoid (L).
15. Loosen choke cable clamp and disconnect choke cable (M).
16. Disconnect incoming fuel hose (N) from fuel filter.
17. Remove radiator hoses (J) from engine and radiator.
18. Remove exhaust pipe (I).
19. Follow wire harness to ensure all wire connectors are disconnected. Remove wire ties securing electrical harness to engine.

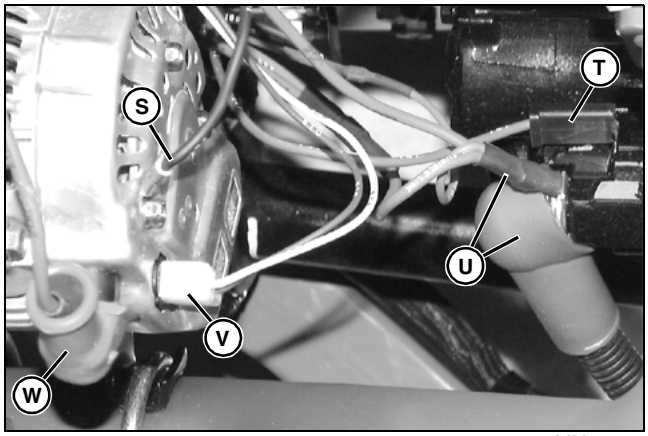


MX5581

20.Loosen jam nut (P) and cap screw (Q) on throttle arm lever.

21.Loosen throttle cable clamp (O).

22.Remove throttle cable (R) from linkage.



MX5587

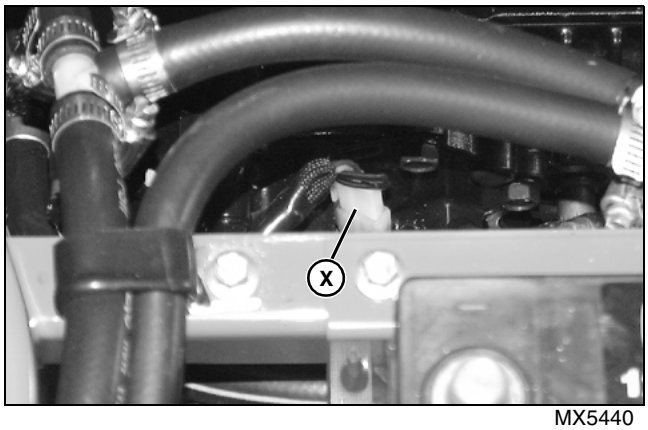
23.Disconnect red wire (W) from alternator.

24.Disconnect wire connector (V) from alternator.

25.Disconnect black ground wire (S) from alternator.

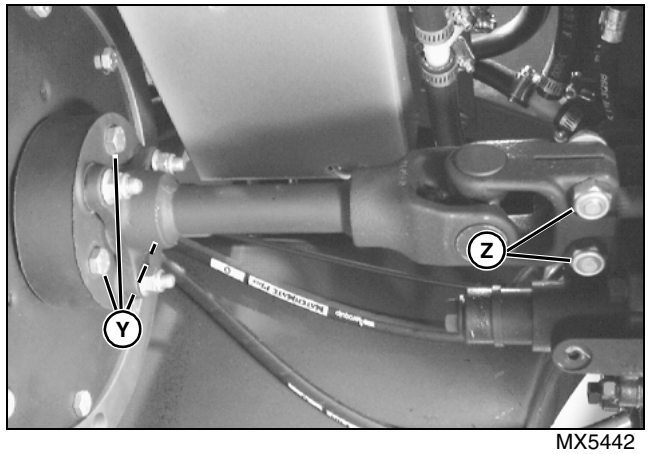
26.Disconnect violet wire (T) from solenoid.

27.Disconnect wires (U) from solenoid battery terminal.



MX5440

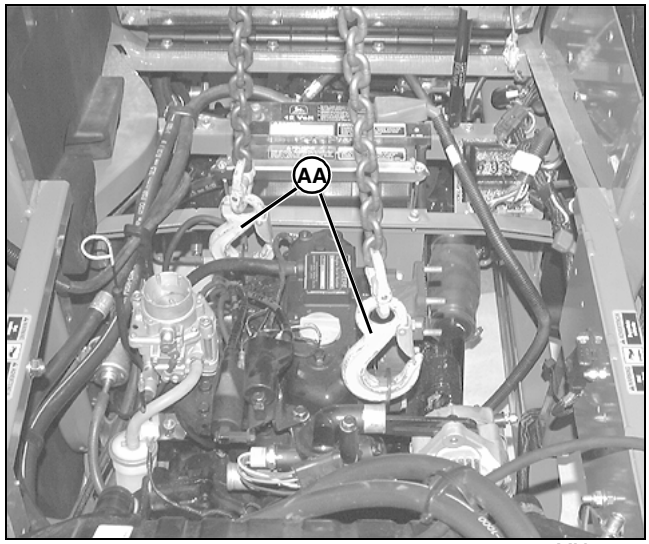
28.Disconnect wire connector (X) from transaxle.



MX5442

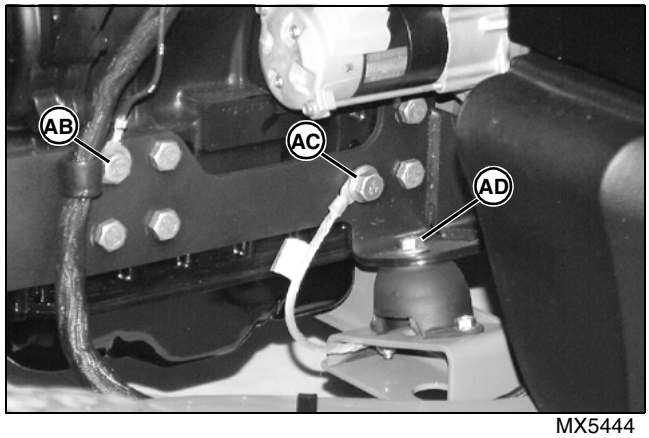
29.Remove three cap screws (Y) from drive shaft damper.

30.Loosen two cap screws (Z) at transaxle. Slide drive shaft toward transaxle to remove.



MX5580

31.Attach hoist to engine lifting eyes (AA).



MX5444

32.Disconnect ground wire (AB) and cable (AC) from engine support plate.

33.Remove three mounting cap screws (AD) from engine mounts.

34.Remove engine from machine.

35.If the engine is to be repaired, remove oil drain plug and drain crankcase into container large enough to hold full capacity.

36.Inspect engine mount pads for wear or damage. Replace as necessary.

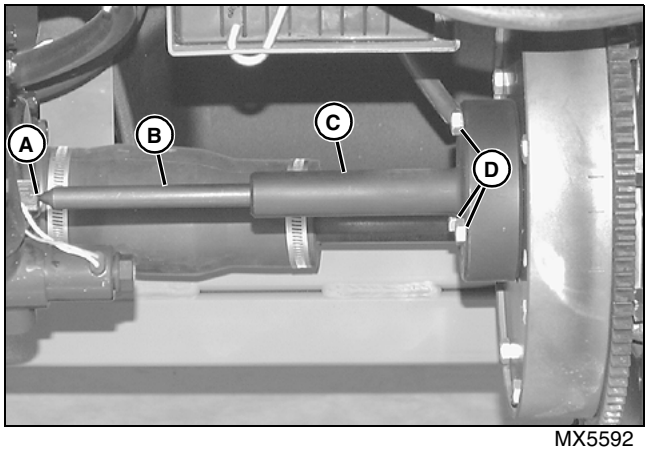
Installation:

IMPORTANT: Avoid damage! When installing the engine, the John Deere Engine Alignment Tool must be used to properly align the engine and the transaxle.

1. Install engine in reverse order of removal.

2. Install three motor mount cap screws and washers through the isolators and engine mounting plates. Loosely install nuts on the cap screws. Do not tighten.

3. Install JD1389-2 Engine Alignment Tool Long Pointer in the JD1389-1 Engine Alignment Tool Base.



MX5592

4. Install engine alignment tool (C) on flex plate with three cap screws (D).

5. Grasp the alignment tool pointer (B) and move engine as necessary to center pointer in transaxle input shaft (A). If pointer will not center in transaxle input shaft, replace engine isolators and realign engine.

6. When engine and transaxle are aligned, tighten engine mount cap screws to specification.

7. Remove engine alignment tool.

8. Install drive shaft.

9. Clean exhaust manifold and upper exhaust pipe of any old gasket material. Install a new gasket.

10.Install upper exhaust pipe section.

11.Connect throttle cable assembly to carburetor. (See “Throttle Cable and Governor Adjustment” on page 35.)

12.Connect choke cable assembly to carburetor. (See “Choke Cable Adjustment” on page 36.)

13.Connect all engine wiring harness connectors.

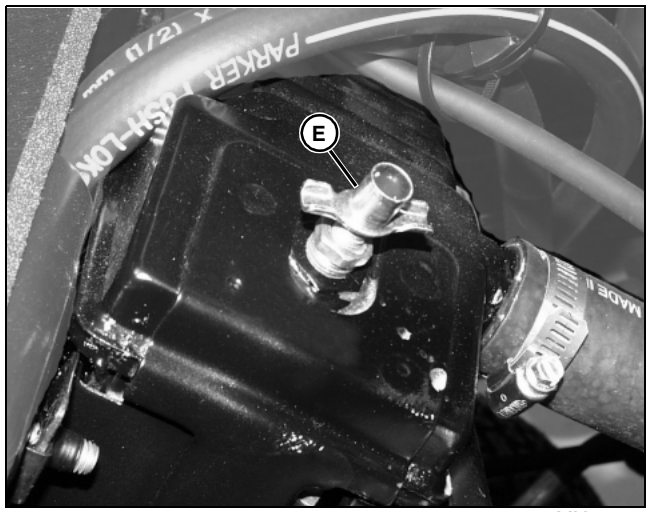
14.Attach wiring harness to alternator and starter solenoid. (See “Alternator Removal and Installation - 1420 and 1435” on page 480 in the Electrical section.)

15.Connect battery negative (-) cable and ground wires to motor mount frame.

16.Connect fuel hose from fuel pump to fuel filter.

17.Fill engine to proper level with oil of correct specification.

NOTE: If the engine has been rebuilt (cylinder rebored or deglazed, etc.), the oil should be changed after the first 20 hours (maximum) of operation.



MX7051

18.Open air bleed valve (E) on top of radiator.

19.Fill cooling system until coolant drains out of air bleed valve.

20.Close air bleed valve.

21.Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.

Specifications:

Crankcase Capacity (With Filter) . . . . . 3.1 L (3.3 qt)

Engine Mount Cap Screw Torque . . . . . 80 N•m (60 lb-ft)

Cooling System Capacity (Approximately) . 6.6 L (7 qt)

Flywheel Removal and Installation

Front Mower

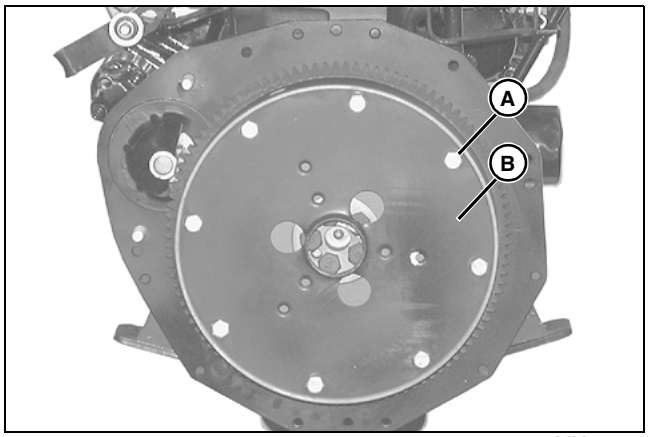
1420

Procedure:

CAUTION: Avoid injury! The flywheel is very heavy. Use caution when removing it from the crankshaft to prevent possible injury.

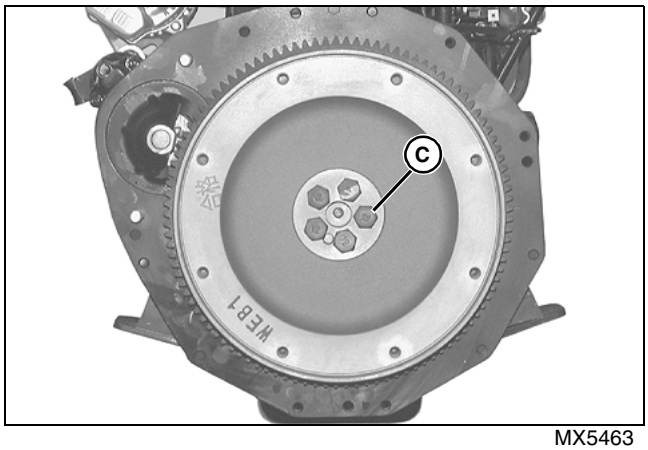
IMPORTANT: Avoid damage! Always install new flywheel mounting cap screws.

1. Park machine safely.
2. Stop engine.
3. Open engine cover.
4. Disconnect battery negative (-) cable from battery.
5. Flywheel can be removed without removing engine from machine. If removing flywheel in machine, see “Engine Drive Shaft Removal and Installation” on page 518 in the Power Train section.



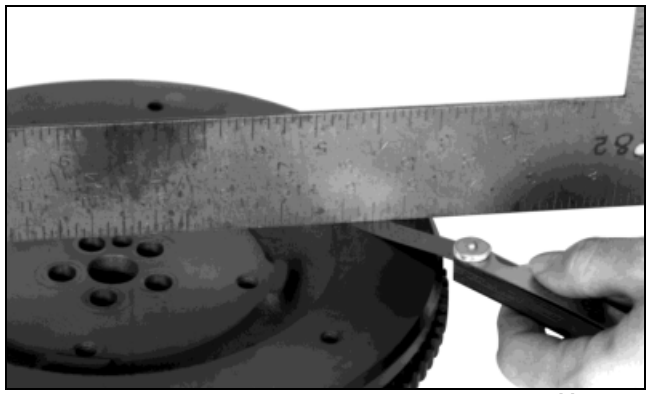
MX5462

6. Remove eight cap screws (A) and remove flex plate (B).



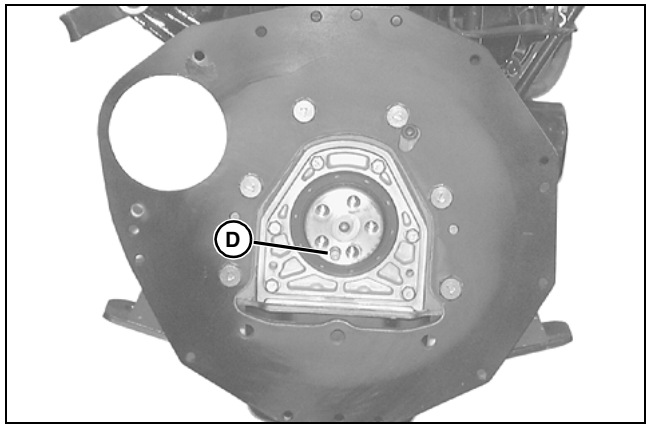
MX5463

7. Remove five mounting cap screws (C). Remove flywheel from crankshaft.



M35337

8. Measure flywheel flatness. Place a straightedge across the flywheel surface opposite of ring gear. Measure clearance between straightedge and flywheel surface with a feeler gauge. Replace flywheel if clearance exceeds specification.



MX5464

9. Use pin (D) in crankshaft to correctly locate flywheel on crankshaft.
10. Install flywheel. Apply lubrication oil to flywheel cap screws and tighten to specification.
11. Install flex plate with raised hub facing away from flywheel.
12. Install drive shaft. (See “Engine Drive Shaft Removal and Installation” on page 518 in the Power Train section.)

Specifications:

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

Flywheel Cap Screw Torque . 83 - 88 N•m (62 - 65 lb-ft)

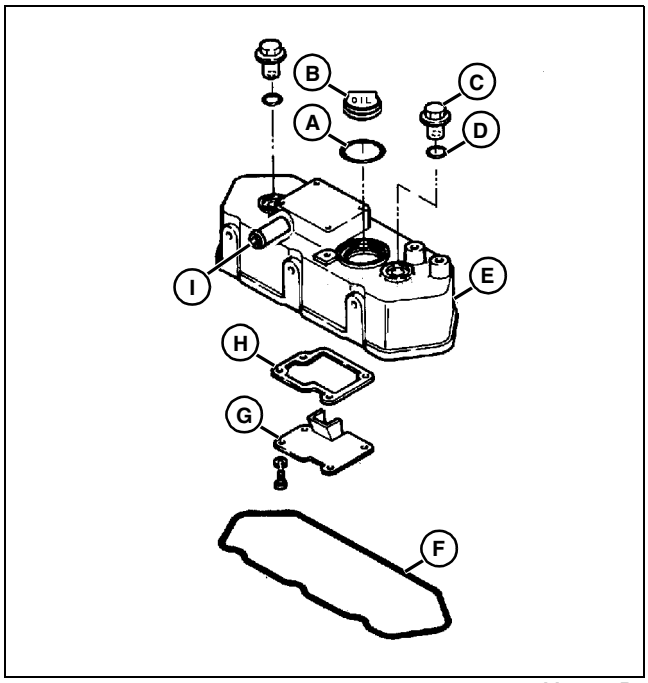
Rocker Arm Cover Removal and Installation

Front Mower

1420

Removal:

1. Park machine safely.
2. Stop engine.
3. Open engine cover.
4. Allow engine to cool.
5. Remove air cleaner. (See “Air Cleaner Removal:” on page 45.)



M82004B

6. Remove crankcase breather tube from breather fitting (I) on rocker cover.
7. Remove two special nuts (C) securing cover to cylinder head.
8. Remove rocker cover (E).
9. Inspect O-rings (A and D) for wear or damage. Replace if necessary.
10. Disassemble breather baffle (G) and clean all parts.
11. Replace gaskets (F and H).

Installation:

1. Assembly is in reverse order of disassembly.
2. Tighten special nuts to specification.
3. Close engine cover.

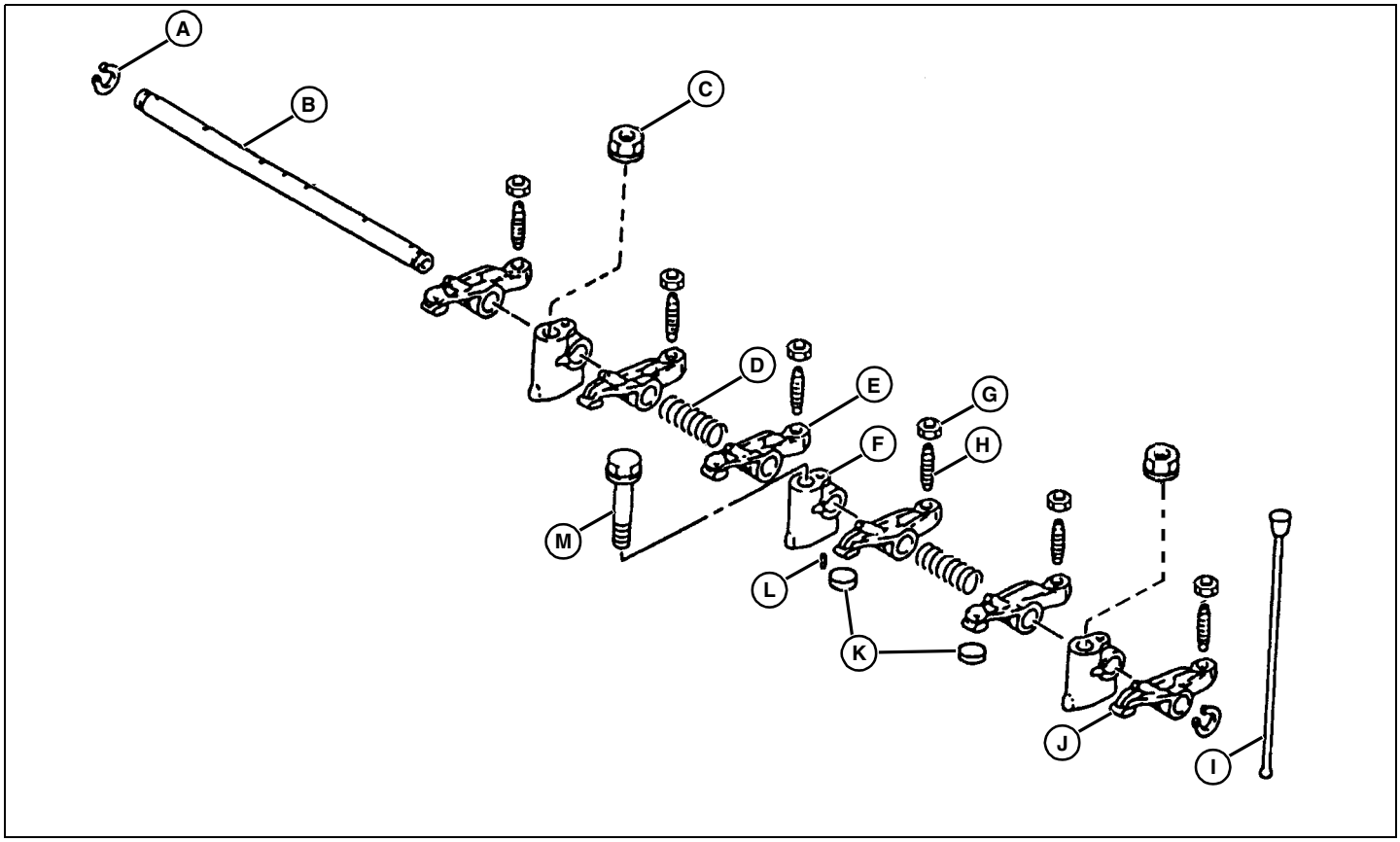
Specifications:

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

Rocker Arm and Push Rods

Front Mower

1420



M82257B

- **A - Snap Ring**
- **B - Rocker Shaft**
- **C - Nut**
- **D - Spring**
- **E - Exhaust Rocker Arm**
- **F - Shaft Support**
- **G - Lock Nut**
- **H - Adjusting Screw**
- **I - Push Rod**
- **J - Intake Rocker Arm**
- **K - Valve Caps**
- **L - Set Screw**
- **M - Cap Screw**

Procedure:

1. Park machine safely.
2. Stop engine.
3. Open engine cover.
4. Allow engine to cool.

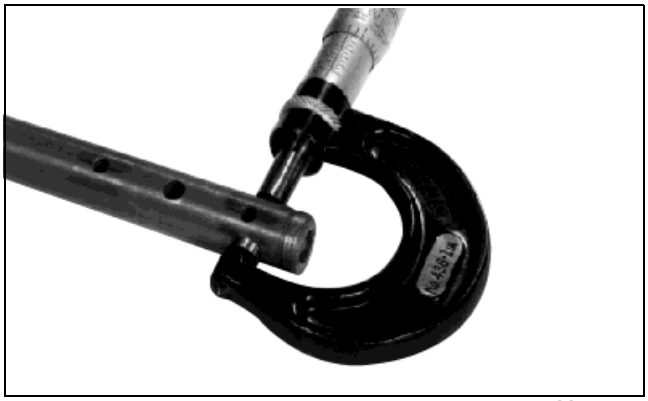
Rocker Arm Removal:

1. Remove rocker arm cover. (See “Rocker Arm Cover Removal and Installation” on page 59.)
2. Alternately loosen and remove two rocker arm mounting nuts (C) and center cap screw (M).
3. Pull rocker arm assembly straight up off mounting studs on cylinder head.

Rocker Arm Disassembly:

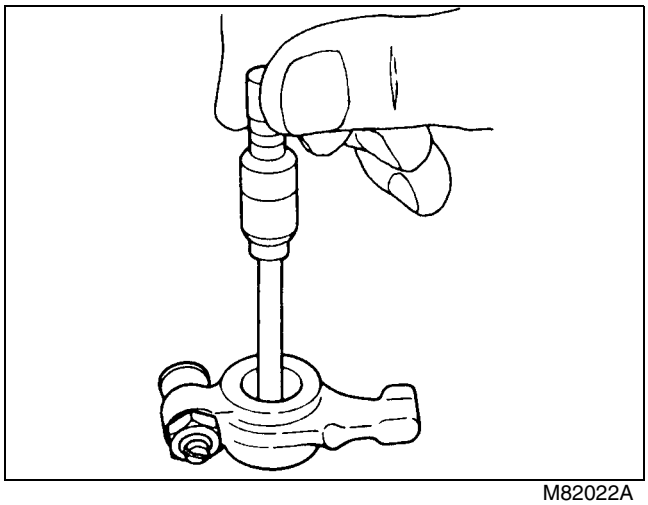
1. Mark all parts for location before disassembly, to aid assembly.
2. Remove snap rings (A) from rocker shaft (B) and slide components off rocker shaft.
3. Remove set screw (L) from center support. Remove rocker shaft from center support (F).
4. Clean all parts.

Rocker Arm Inspection:



M35262

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

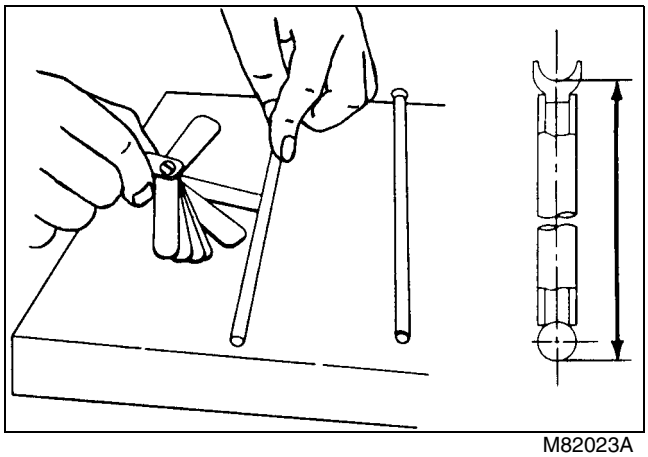


M82022A

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

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

Push Rod Inspection:



M82023A

1. Lay push rod on flat surface and roll while checking for a gap under center of rod. Use feeler gauge to check dimension. Replace push rod if not within specification.

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

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

Rocker Arm Assembly:

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

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

Rocker Arm Installation:

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

1. Align rocker arm supports with studs on cylinder head. Align rockers with valve stems.

2. Install push rods in block and align into rocker arms.

3. Install mounting nuts on rocker arm supports and evenly tighten nuts to specification to pull rocker assembly to head.

4. Adjust valve clearance. (See “Valve Clearance Adjustment” on page 39.)

5. Install rocker arm cover. (See “Rocker Arm Cover Removal and Installation” on page 59.)

Specifications:

Rocker Arm Shaft OD

Standard . . . . . 11.966 - 11.984 mm (0.471 - 0.472 in.)

Wear Limit. . . . . 11.95 mm (0.470 in.)

Rocker Arm and Shaft Support

Standard ID . . . . . 12.00 - 12.020 mm (0.472 - 0.473 in.)

ID Wear Limit . . . . . 12.09 mm (0.476 in.)

Oil Clearance . . . . . 0.16 - 0.054 mm (0.006 - 0.002 in.)

Clearance Wear Limit. . . . . 0.14 mm (0.006 in.)

Push Rod

Length (Minimum) . . . . . 141 mm (5.55 in.)

Bend . . . . . 0.0 - 0.3 mm (0.0 - 0.012 in.)

Rocker Assembly

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

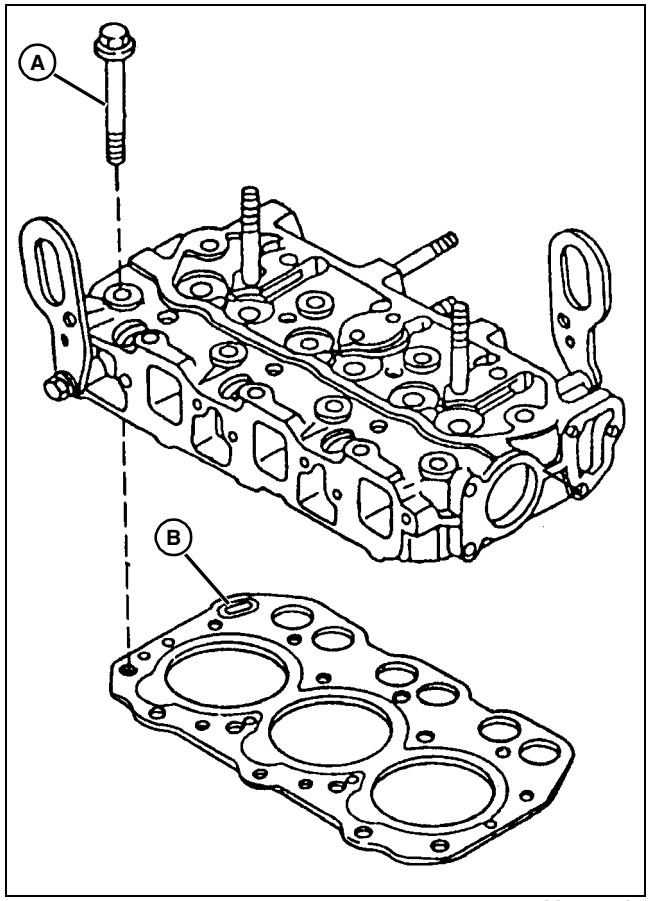
Cylinder Head Removal and Installation

Front Mower

1420

Removal:

1. Park machine safely.
2. Stop engine.
3. Remove engine cover.
4. Tilt seat forward.
5. Disconnect battery negative (-) cable from battery.
6. Allow engine to cool, and cooling system pressure to return to zero.
7. Drain coolant from radiator and engine block drain valves.
8. Remove air cleaner. (See “Air Cleaner Removal:” on page 45.)
9. Remove carburetor. (See “Carburetor Removal:” on page 46.)
10. Remove alternator belt.
11. Remove upper exhaust pipe from exhaust manifold.
12. Remove exhaust manifold. (See “Exhaust Manifold Removal and Installation” on page 63.)
13. Disconnect spark plug wires from spark plugs.
14. Remove ignition coil bracket.
15. Remove intake manifold. (See “Intake Manifold Removal and Installation” on page 63.)
16. Disconnect coolant temperature sensor.
17. Remove upper and lower coolant hoses from water pump and radiator.
18. Remove water pump.
19. Remove rocker arm cover. (See “Rocker Arm Cover Removal and Installation” on page 59.)
20. Remove rocker arm assembly, push rods, and valve caps from cylinder head. (See “Rocker Arm and Push Rods” on page 60.)



M82259A

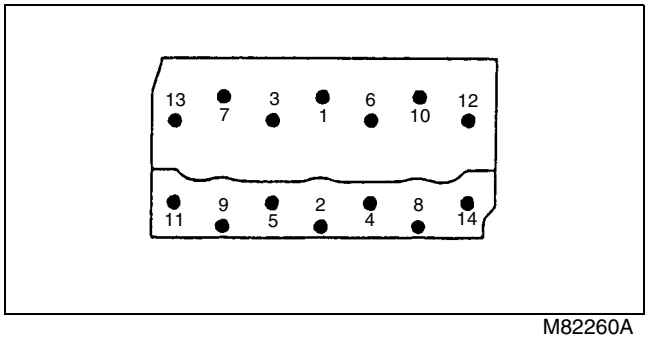
21. Loosen and remove cylinder head cap screws (A).
22. Using lift brackets and hoist, pull cylinder head straight up from block.
23. Disassemble and inspect cylinder head and valves. (See “Cylinder Head Recondition” on page 64.)

Installation:

1. Clean all threads in top of cylinder block with a flat bottom tap, and blow debris from hole.
2. Clean top of cylinder block and check for flatness.
3. Place a new cylinder head gasket on cylinder block with locating pins on front and rear of block inside holes in gasket. Line up oil port on left rear of block with oil port (B) in gasket.

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

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



M82260A

Picture Note: Top of Drawing Is Exhaust Manifold Side, Bottom Is Intake Manifold Side

5. Lubricate cylinder head cap screws and tighten to specification in sequence shown above in three steps.

Specifications:

Torque Sequence

First . . . . . 27 N•m (20 lb-ft)

Second. . . . . 41 N•m (30 lb-ft)

Final . . . . . 59 - 64 N•m (43 - 47 lb-ft)

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

Exhaust Manifold Removal and Installation

Front Mower

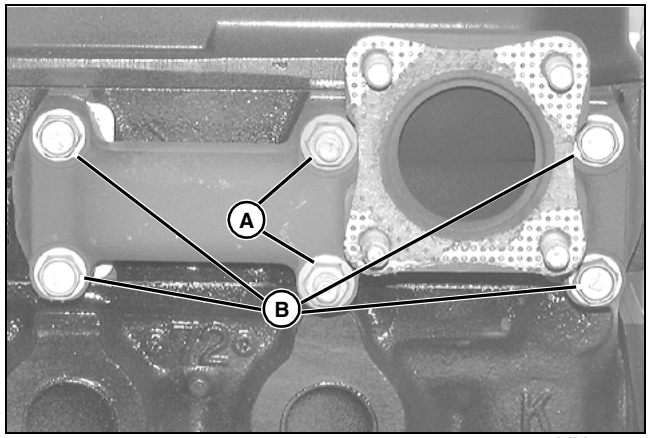
1420

Procedure:

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

CAUTION: Avoid injury! Engine parts are hot.

4. Allow engine to cool.
5. Tilt seat forward.
6. Disconnect battery negative (-) cable from battery.
7. Remove upper exhaust pipe section from flange to exhaust manifold.



MX5466

8. Remove four cap screws (B) and two nuts (A) from exhaust manifold.
9. Remove exhaust manifold from cylinder head.
10. Remove gaskets and clean mating surfaces.
11. Check flange for flatness with straightedge.
12. Check exhaust manifold for cracks, holes, or damage. Replace as needed.
13. Install new gaskets and install manifold on cylinder head.
14. Install upper exhaust pipe.
15. Connect battery negative (-) cable to battery.
16. Install engine cover.

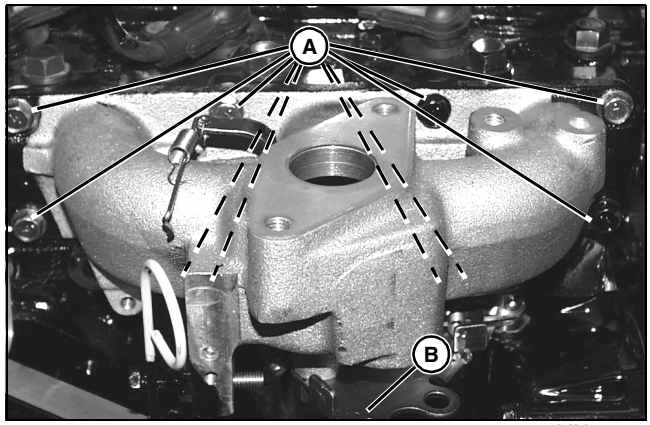
Intake Manifold Removal and Installation

Front Mower

1420

Procedure:

1. Park machine safely.
2. Stop engine.
3. Remove engine cover.
4. Tilt seat forward.
5. Disconnect battery negative (-) cable from battery.
6. Remove carburetor. (See “Carburetor Removal:” on page 46.)
7. Remove ignition coil bracket from top of intake manifold.



MX0746

8. Disconnect throttle linkage and spring (B) from bellcrank on bottom of intake manifold.

9. Remove ten mounting cap screws (A), and remove intake manifold.

10.Remove gasket and clean mating surfaces. Check flange for flatness with straightedge. Check intake manifold for cracks or damage.

11.Install new gasket and install manifold on cylinder head.

12.Tighten mounting cap screws to specification.

13.Connect battery negative (-) cable to battery.

14.Close engine cover.

Specifications:

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

Cylinder Head Recondition

Front Mower

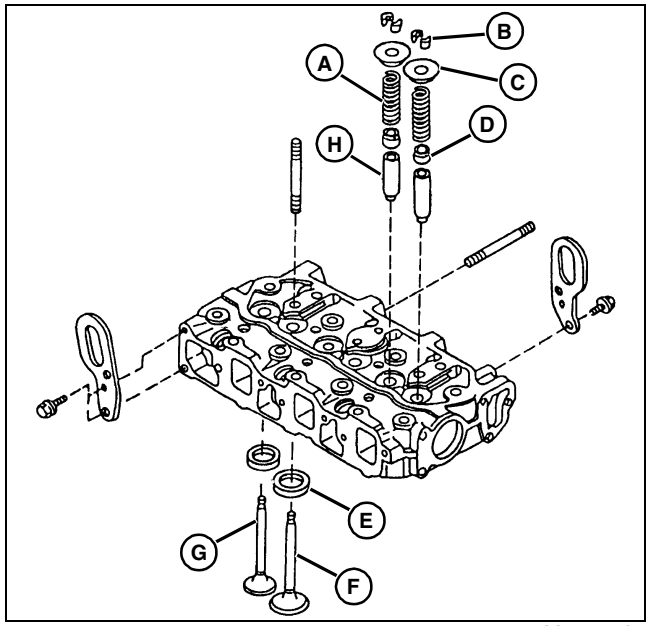
1420

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Valve Spring Compressor	JDE138	Used to compress valve springs for removal and installation.
Valve Guide Driver	JDE504	Used to install valve guides.

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

Disassembly and Assembly:



M82261A

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

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

2. Remove collet halves (B) from retainer.

3. Slowly release compressor and valve spring.

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

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

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

IMPORTANT: Avoid damage! Do not reuse stem seals (4). Used seals will leak.

7. Apply clean engine oil on intake (F) and exhaust (G) valve stems during assembly.

8. Install new stem seals (D).

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

NOTE: If new valves are installed, measure valve recession. (See “Valve Recession Measurement:” on page 66.)

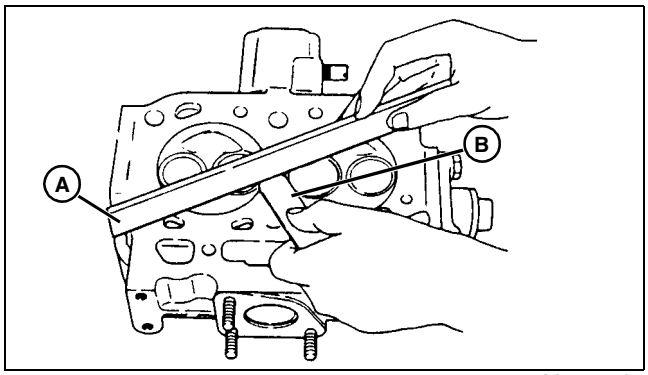
10.Use valve spring compressor to compress spring and retainer, and install collets as removed.

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

Inspection/Replacement:

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

Cylinder Head:



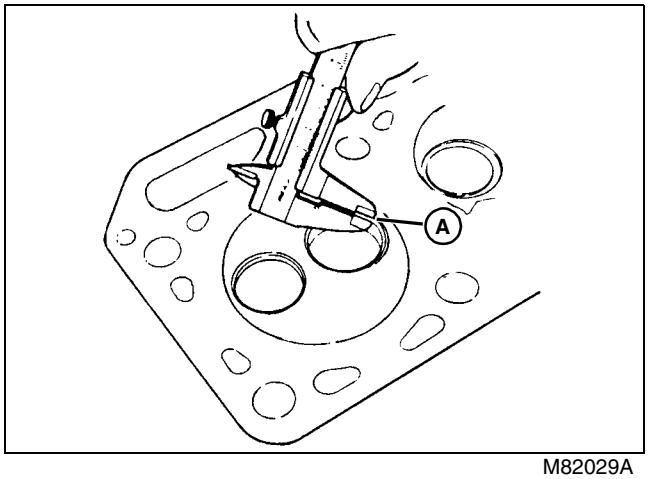
M82028A

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

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

- Measure valve recession. (See “Valve Recession Measurement:” on page 66.)
- Measure valve seat width. (See “Valve Seat Width:” on page 68.)

Valve Seat Width:

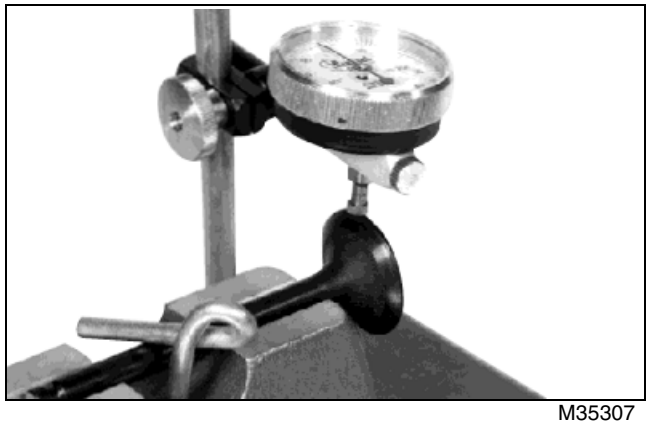


M82029A

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

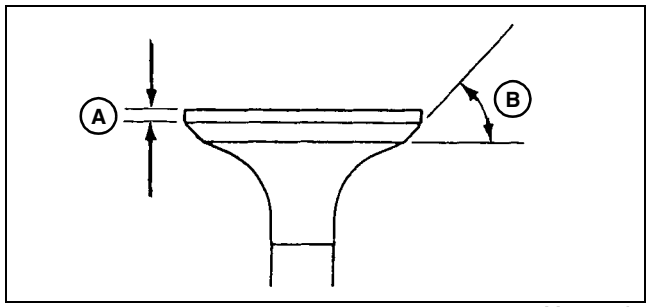
2. If necessary, grind valve seats to meet specification. (See “Valve Seat Grinding:” on page 67.)

Intake and Exhaust Valves:



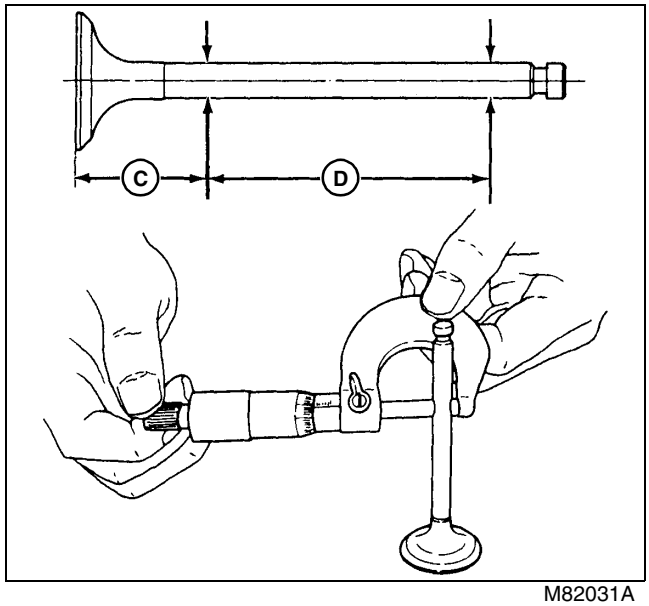
M35307

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



M82030A

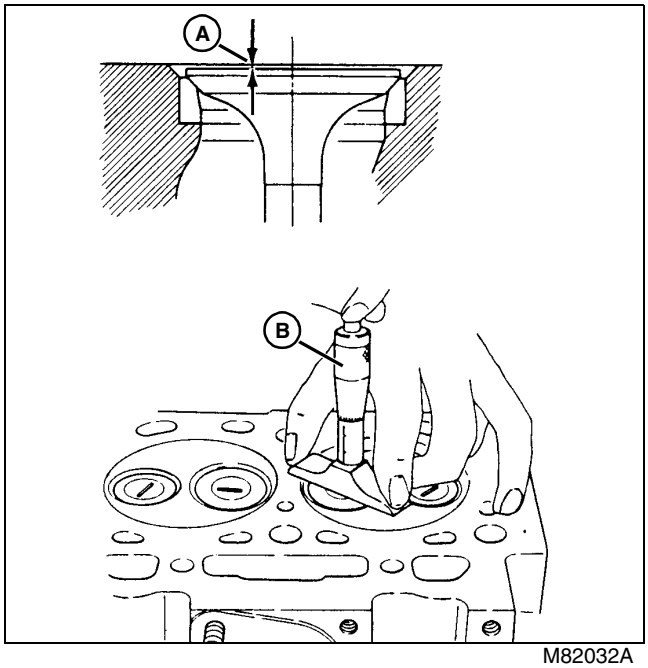
- If valve faces are worn, burned, or pitted, grind valves to proper face angle (B). If valve face margin (A) is less than specification after grinding, replace valve.



M82031A

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

Valve Recession Measurement:



M82032A

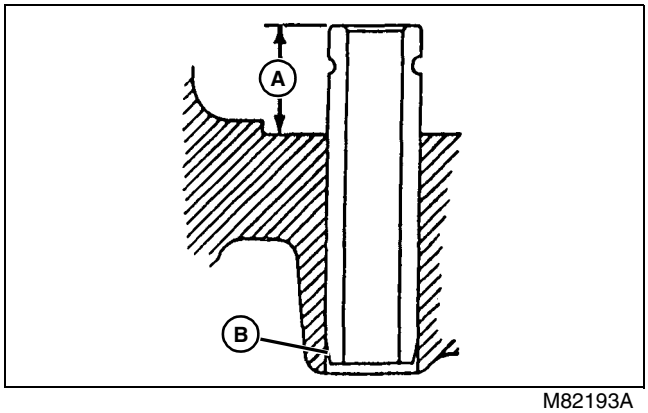
Measure valve recession (A) using a depth gauge (B). Replace valve or cylinder head if measurement exceeds wear limit.

Valve Guide Measurement:

1. Clean valve guides using a valve guide brush.

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

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

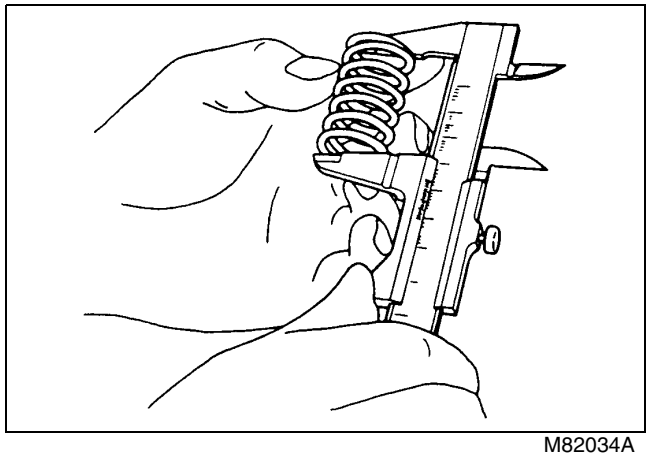


M82193A

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

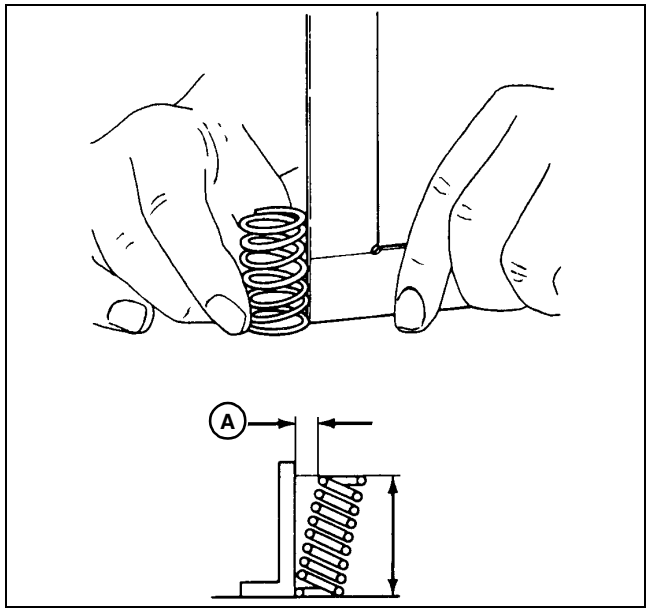
4. Ream inside diameter of valve guides using a 7 mm valve guide reamer.

Valve Springs:



M82034A

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

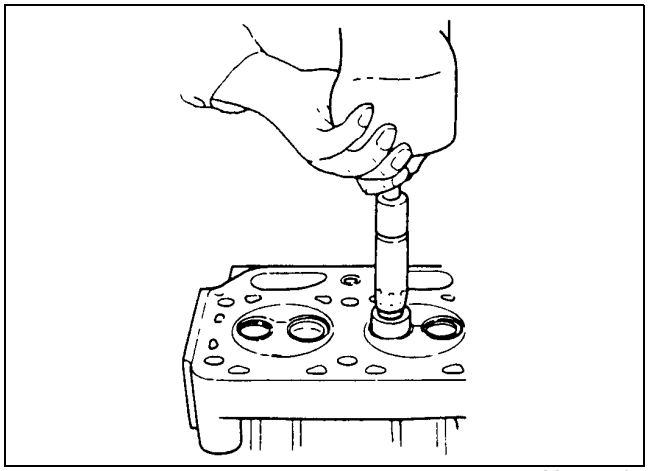


M82035A

2. Measure spring inclination (A). Replace spring if measurement exceeds specification.

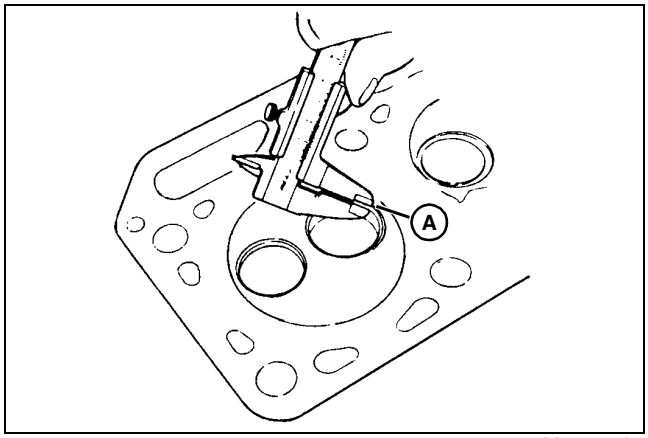
Valve Seat Grinding:

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



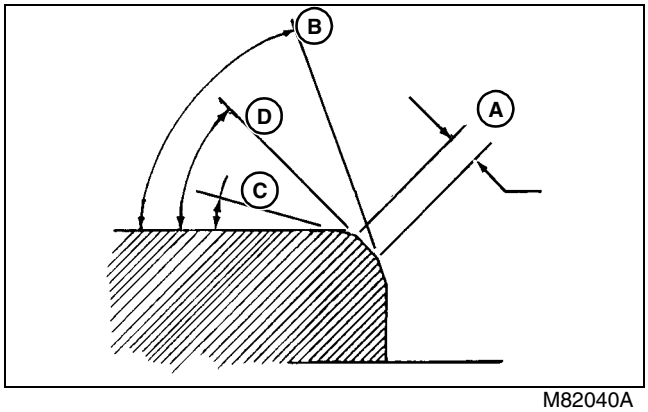
M82039A

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



M82029A

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



M82040A

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

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

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

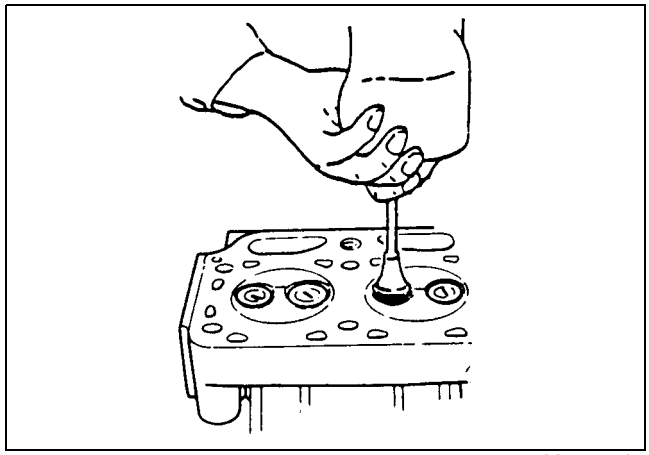
NOTE: If valve recession exceeds maximum specification, replace cylinder head.

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

7. Lap valves. (See "Valve Lapping:" on page 67.)

Valve Lapping:

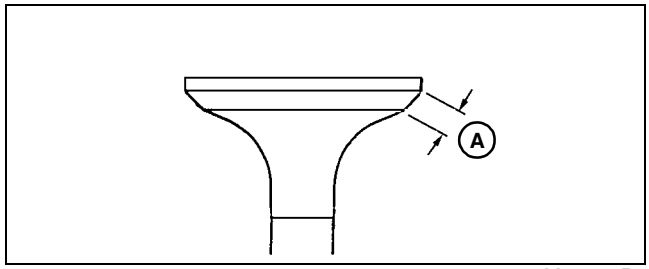
NOTE: If seat does not make proper contact, lap the valve into the seat.



M82041A

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

2. Turn valve to lap valve to seat.



M82030B

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

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

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

Specifications:

Cylinder Head Distortion:

Standard (Maximum) . . . . . 0.05 mm (0.002 in.)

Wear Limit . . . . . 0.10 mm (0.004 in.)

Allowable Removed Material (Maximum). . . . . 0.20 mm (0.008 in.)

Valve Seat Width:

Intake Standard. . . . . 1.43 mm (0.056 in.)

Intake Wear Limit . . . . . 1.98 mm (0.078 in.)

Exhaust Standard . . . . . 1.73 mm (0.068 in.)

Exhaust Wear Limit . . . . . 2.27 mm (0.089 in.)

Valve Grinding:

Intake Valve Face Margin. . . . . 0.99 - 1.29 mm (0.038 - 0.050 in.)

Exhaust Valve Face Margin. . . . . 0.95 - 1.25 mm (0.037 - 0.049 in.)

Valve Face Margin Wear Limit . . . . . 0.51 mm (0.020 in.)

Intake Valve Face Angle. . . . . 30°

Exhaust Valve Face Angle . . . . . 45°

Valve Stems:

Measuring Point (3) Distance . . . . . 20 mm (0.787 in.)

Measuring Point (4) Distance . . . . . 40 mm (1.575 in.)

Intake Valve Stem Standard Diameter . . . 6.96 - 6.98 mm (0.274 - 0.275 in.)

Intake Valve Stem Diameter Wear Limit . . . . . 6.90 mm (0.272 in.)

Exhaust Valve Stem Standard Diameter . . . 6.95 - 6.96 mm (0.273 - 0.276 in.)

Exhaust Valve Stem Diameter Wear Limit . . . . . 6.90 mm (0.272 in.)

Valve Recession (Maximum) . . . . . 0.60 mm (0.024 in.)

Valve Guides:

Standard Valve Guide ID . . . . . 7.01 - 7.02 mm (0.275 - 0.276 in.)

Valve Guide ID Wear Limit . . . . . 7.08 mm (0.279 in.)

Intake Valve Guide-to-Valve Stem Oil Clearance. . . . . 0.030 - 0.060 mm (0.001 - 0.002 in.)

Exhaust Valve Guide-to-Valve Stem Oil Clearance. . . . . 0.045 - 0.075 mm (0.002 - 0.003 in.)

Valve Guide-to-Valve Stem Oil Clearance Wear Limit (Both) . . . 0.15 mm (0.006 in.)

Valve Guide Knurling Clearance (Maximum) . . . . . 0.127 - 0.178 mm (0.005 - 0.007 in.)

Valve Guide Replacement Clearance. . . . . 0.20 mm (0.008 in.)

Valve Guide Height. . . . . 9 mm (0.354 in.)

Valve Springs:

Free Length. . . . . 36.9 mm (1.453 in.)

Inclination (Maximum) . . . . . 1.0 mm (0.039 in.)

Oil Pan and Strainer

Front Mower

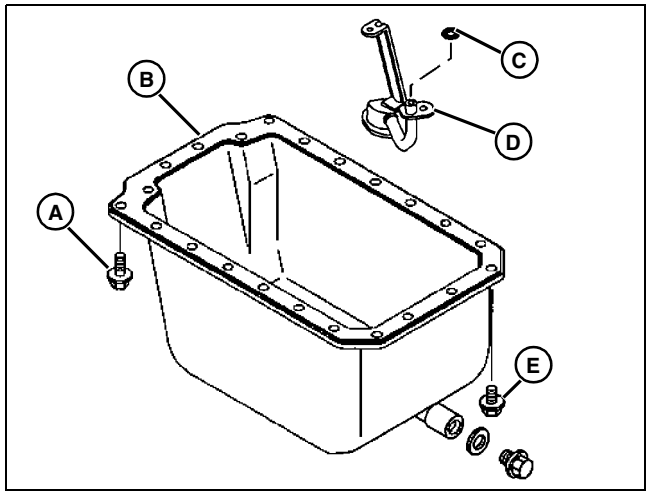
1420

Other Material:

Part No.	Part Name	Part Use
TY24344	John Deere Form-in-Place Gasket	Applied to gasket mating surfaces.

Removal:

NOTE: Engine does not need to be removed from machine.



MX5451

1. Park machine safely.
2. Stop engine.
3. Open engine cover.
4. Tilt seat forward.
5. Disconnect battery negative (-) cable from battery.
6. Drain engine oil.
7. Remove flywheel and engine backplate to access oil pan cap screws. (See “Flywheel Removal and Installation” on page 58.)

8. Remove 16 cap screws (A) and six cap screws (E).

9. Remove oil pan (B).

10.Remove cap screws from strainer and remove strainer (D) and O-ring (C).

Installation:

1. Clean gasket mating surfaces and apply TY24344 John Deere Form-in-Place Gasket on all mating surfaces.

2. Replace O-ring on strainer.

3. Install oil pan. Tighten cap screws to specification.

4. Fill engine with oil to proper level.

5. Reconnect battery negative (-) cable to battery.

6. Close engine cover.

Specifications:

Cap Screws Threading in Block Torque . . . . . 11 N•m (96 lb-in.)

Cap Screws Threading in Aluminum Torque . . . . . 9 N•m (78 lb-in.)

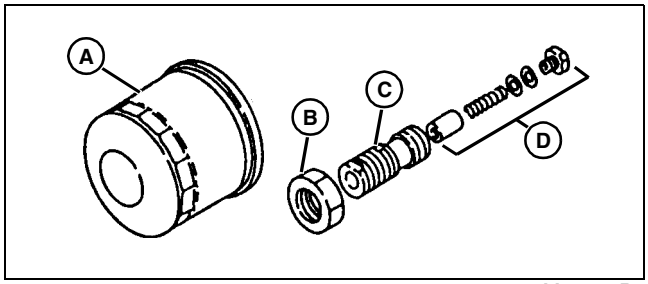
Engine Oil Capacity with Filter . . . . . 3.1 L (3.3 qt)

Oil Pressure Regulating Valve

Front Mower

1420

Procedure:



M82311B

1. Remove oil filter (A).

2. Remove retaining nut (B) and valve assembly (C).

NOTE: Valve components (D) are not serviced individually. Replace complete regulating valve if any components are defective.

3. Check spring free and compressed length.

4. Inspect all parts for wear or damage. Replace complete valve if necessary.

5. Installation is done in the reverse order of removal.

Specifications:

Valve Spring Free Length . 43.5 - 48.5 mm (1.7 - 1.9 in.)

Valve Spring Test Length @ 20.5 N (9.6 lb-force) . . . . . 27.5 mm (1.08 in.)

Retaining Nut Torque . . . . . 30 N•m (22 lb-ft)

Oil Pump

Front Mower

1420

Removal and Installation:

1. Park machine safely.

2. Stop engine.

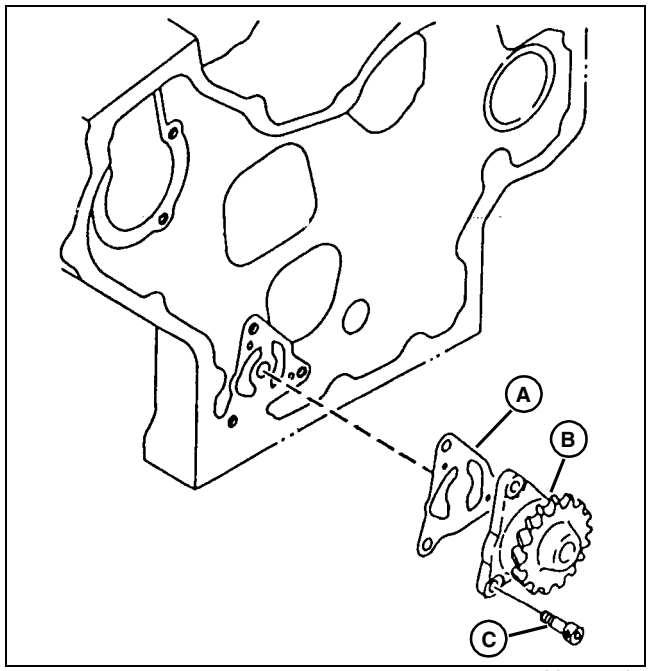
3. Open engine cover.

4. Tilt seat forward.

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

6. Remove timing gear cover. (See “Timing Gear Cover Removal and Installation” on page 70.)

7. Check oil pump gear backlash. Replace entire oil pump assembly if backlash exceeds specification.

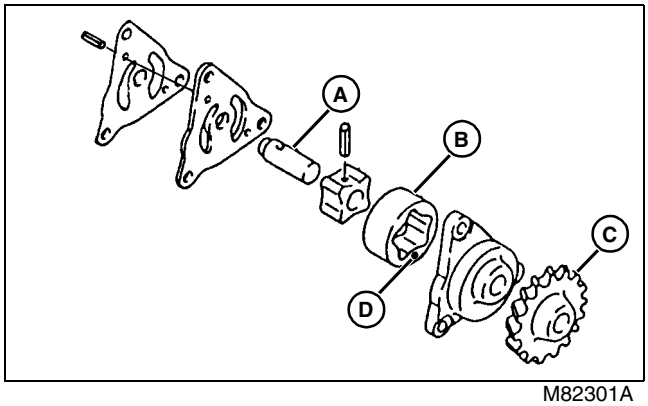


M82309A

8. Remove three mounting cap screws (C), oil pump (B), and gasket (A).

9. Inspect all parts for wear or damage. (See Disassembly/ Assembly and Inspection procedures below.)

Disassembly/Assembly:



M82301A

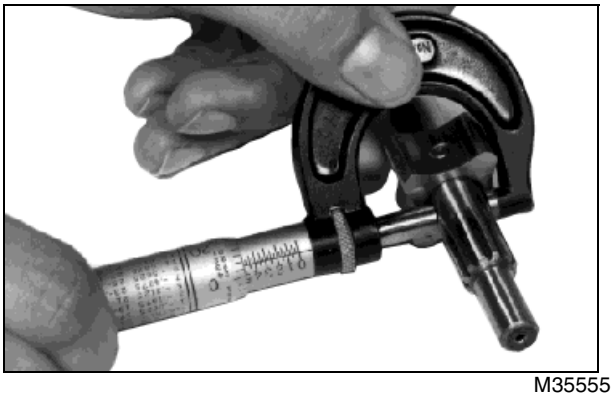
1. Gear (C) is a press fit on rotor shaft (A). Remove gear using a knife edge puller and a press.

2. Inspect parts for wear or damage. (See Inspection procedure below.)

3. Coat all parts with clean engine oil.

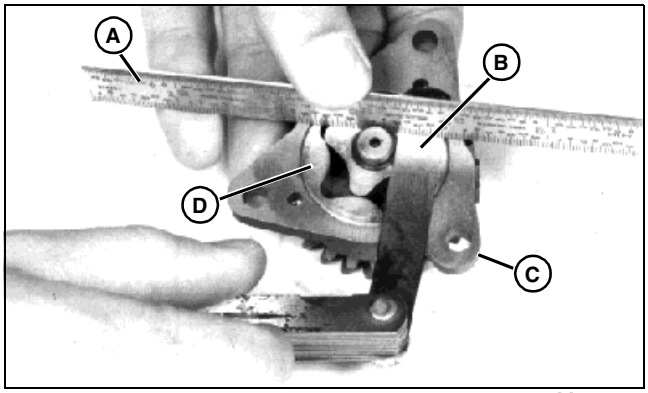
4. Install outer rotor (B) with identification mark (D) facing toward gear.

Inspection:



M35555

1. Measure the inside diameter of the rotor shaft bore in the backing plate, and subtract the outside diameter of the rotor shaft. If the clearance is more than the wear limit, replace entire assembly.



M37775

2. Lay a straightedge (A) across pump housing (C). Using a feeler gauge (B), check side clearance of inner and outer rotor (D). If rotor side clearance is beyond wear limit, replace rotor assembly.

Specifications:

Oil Pump Gear Backlash
(Maximum) . . . . . 0.30 mm (0.012 in.)

Standard Rotor Shaft OD-to-Housing
ID Clearance . . . . . 0.013 - 0.043 mm (0.0005 - 0.002 in.)

Rotor Shaft OD-to-Housing Clearance
Wear Limit. . . . . 0.2 mm (0.008 in.)

Standard Rotor-to-Pump Housing
Side Clearance . . . . . 0.03 - 0.9 mm (0.001 - 0.004 in.)

Rotor-to-Pump Housing
Side Clearance Wear Limit . . . . . 0.25 mm (0.010 in.)

Timing Gear Cover Removal and Installation

Front Mower

1420

Other Material:

Part No.	Part Name	Part Use
TY24344	John Deere Form-in-Place Gasket	Applied to timing gear cover during installation.

Procedure:

1. Park machine safely.

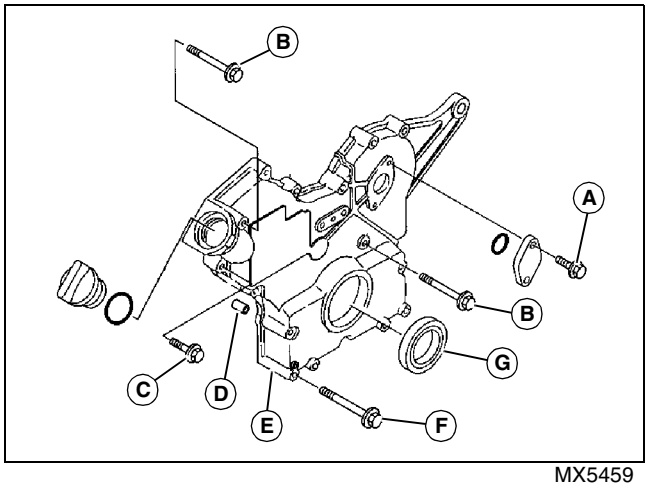
2. Stop engine.

3. Open engine cover.

IMPORTANT: Avoid damage! When removing the alternator, the pick-up coils must be disconnected. Mark the pick-up coil connectors 1, 2, and 3 for proper reconnection. If the pick-up coils are not properly connected, the engine will not run.

4. Remove alternator. (See “Alternator Removal and Installation - 1420 and 1435” on page 480 in the Electrical section.)

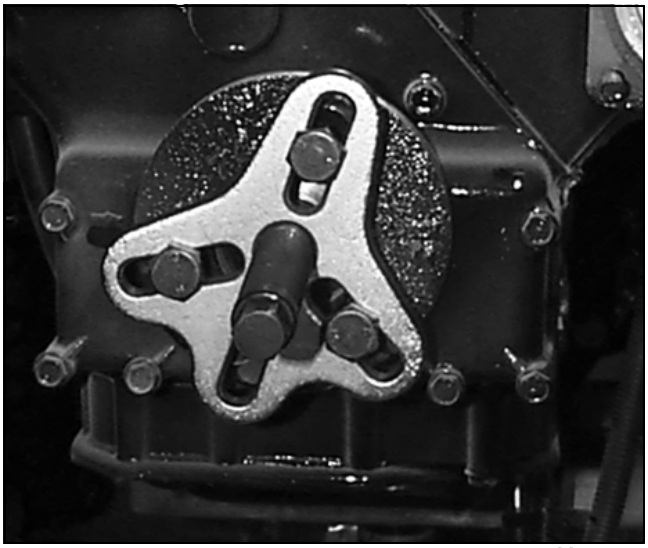
5. Remove alternator belt.



MX5459

A - M8 x 16 Cap Screw (2 used)
B - M8 x 60 Cap Screw (4 used)
C - M8 x 30 Cap Screw (8 used)
D - Dowel Pin (2 used)
E - Cover
F - M8 x 80 Cap Screw (6 used)
G - Seal

6. Remove crankshaft pulley mounting cap screw and washer.



M89691

7. Install puller to crankshaft sheave and remove sheave.

8. Remove timing cover mounting cap screws.

9. Remove timing gear cover.

10.Clean all old gasket material from timing cover and timing cover housing on block.

11.Apply a thin bead of TY24344 John Deere Form-in-Place Gasket to timing cover prior to installation.

12.Tighten all timing cover mounting cap screws to specification.

13.Install crankshaft pulley, lining up pin on crankshaft. Install flat washer and cap screw and tighten to specification.

14.Install alternator and belt.

15.Close engine cover.

Specifications:

Timing Cover
Mounting Cap Screw Torque. . . . . 9 N•m (78 lb-in.)
Crankshaft Pulley Cap Screw Torque. . 88 N•m (65 lb-ft)

Timing Gear Backlash Check

Front Mower

1420

Reason:

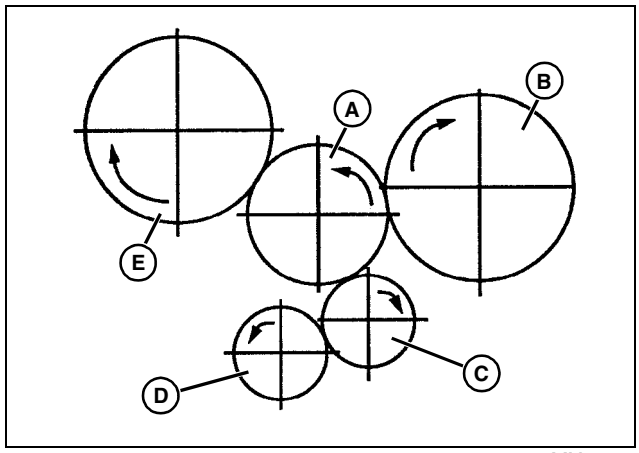
To check wear of timing gear teeth, resulting in excessive noise, improper valve timing, and poor engine performance.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Dial Indicator	NA	Used to measure backlash between meshing gears.

Procedure:

1. Remove timing gear cover. (See “Timing Gear Cover Removal and Installation” on page 70.)



MX5627

A - Idler Gear
B - Camshaft Gear
C - Crankshaft Gear
D - Oil Pump
E - Governor Gear

2. Place dial indicator magnetic base on cylinder block with tip of indicator on tooth of gear being measured.

3. Holding opposite gear stationary, move measured gear back and forth while measuring backlash between meshing gears.

Results:

If backlash exceeds specifications, replace worn gears as a complete set: Idler Gear, Camshaft Gear, Crankshaft Gear, Oil Pump Gear, Governor Gear.

Specifications:

Standard Backlash for All Timing Gears (Except Crankshaft Gear-to-Oil Pump Gear) . . . . . 0.04 - 0.12 mm (0.002 - 0.005 in.)

Standard Crankshaft Gear-to-Oil Pump Gear Backlash. . . . . 0.11 - 0.19 mm (0.004 - 0.008 in.)

Camshaft End Play Check

Front Mower

1420

Reason:

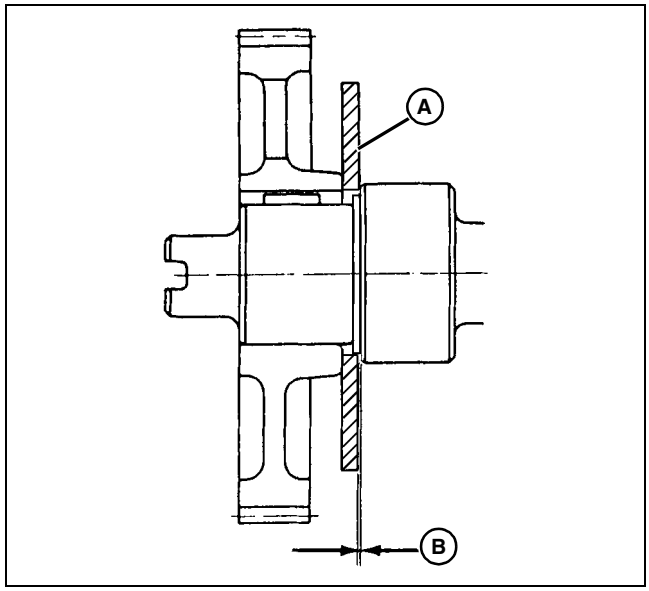
To determine proper side clearance between camshaft gear and camshaft thrust plate, to prevent excessive camshaft-to-camshaft follower wear.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Dial Indicator	NA	Used to measure camshaft end play.

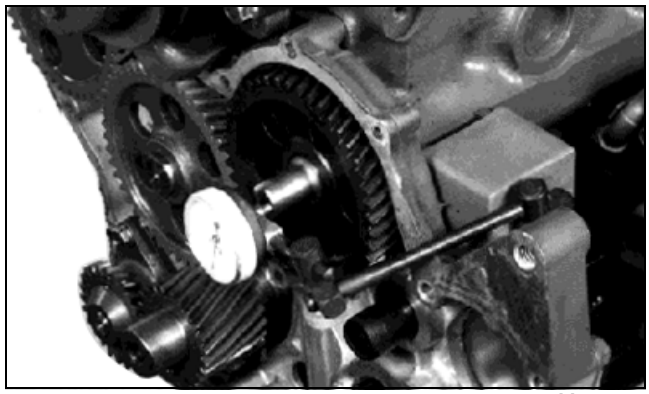
Procedure:

NOTE: Follow this procedure if camshaft is installed in cylinder block. If camshaft is removed from cylinder block, check end play (B) using a feeler gauge between camshaft thrust plate (A) and front side of first camshaft bearing journal.



M82067A

1. Remove timing gear cover. (See “Timing Gear Cover Removal and Installation” on page 70.)



M37512

2. Fasten dial indicator base to cylinder block and position indicator tip on end of camshaft.

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

4. Set the dial indicator to zero.

5. Pull camshaft forward as far as possible.

Results:

If camshaft end play exceeds specification, remove camshaft and inspect thrust plate, camshaft, and camshaft gear for wear. Replace parts as needed.

Specifications:

Camshaft End Play. . . 0.05 - 0.25 mm (0.002 - 0.010 in.)

Camshaft

Front Mower

1420

IMPORTANT: Avoid damage! Always replace camshaft followers when installing a new camshaft. Always replace camshaft when replacing camshaft followers. The components wear as a set and replacing only one will accelerate the wear of the other.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Magnetic Follower Holder Kit	D15001NU	Used to hold cam followers away from camshaft.
Knife-Edge Puller	NA	Used with arbor press for removing gear from camshaft.
Arbor Press	NA	Used with knife-edge puller for removing gear from camshaft.
V-Block (2 used)	NA	Used to hold camshaft during inspection.
Dial Indicator	NA	Used to measure camshaft bend.
Micrometer	NA	Used to measure camshaft lobe height.
Bushing Driver Set	NA	Used to replace worn camshaft bushing.

Other Material:

Part No.	Part Name	Part Use
TY24344	John Deere Form-in-Place Gasket	Applied to camshaft bore plug before reinstallation.

Camshaft Removal:

1. Remove rocker arm assembly and push rods. (See “Rocker Arm and Push Rods” on page 60.)

2. Remove timing gear cover. (See “Timing Gear Cover Removal and Installation” on page 70.)

3. Check camshaft end play. (See “Camshaft End Play Check” on page 72.)

4. Check backlash of timing gears. (See “Timing Gear Backlash Check” on page 71.)

NOTE: If camshaft is being removed with cylinder head installed, use a magnetic follower holder tool, or turn engine until oil pan is upward, to hold cam followers away from camshaft.

5. Hold cam followers away from camshaft using a magnetic follower holder kit such as D15001NU.

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically.

6. Remove idler gear.

IMPORTANT: Avoid damage! Do not allow camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces can be damaged.

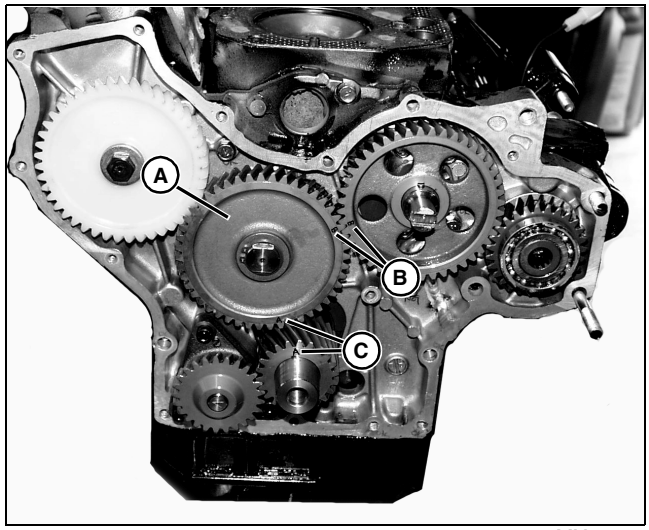
7. Remove two cap screws holding camshaft mounting flange to block (through holes in camshaft gear).

8. Inspect all parts for wear or damage. (See “Camshaft Inspection:” on page 74.)

Camshaft Installation:

IMPORTANT: Avoid damage! Do not allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces can be damaged.

NOTE: Apply clean engine oil on all parts during installation.



MX0660

1. Install camshaft into cylinder block, being careful not to allow camshaft lobes to scratch camshaft bushings. Align camshaft gear timing marks with timing marks on idler gear.

2. Install two camshaft thrust plate cap screws through holes in cam gear. Tighten to specification.

3. Align timing marks (B and C) with gears on crankshaft and camshaft while installing idler gear (A).

4. Install timing gear cover. (See “Timing Gear Cover Removal and Installation” on page 70.)

5. If cam followers were removed, replace into same holes as removed.

6. Install push rods and rocker arm assembly. (See “Rocker Arm and Push Rods” on page 60.)

Camshaft End Play Measurement:

Check camshaft end play measurement. (See “Camshaft End Play Check” on page 72.)

Camshaft Gear Removal:

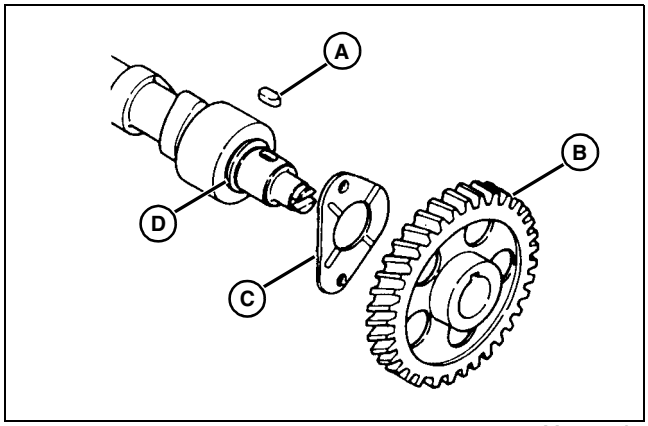
1. Inspect gear for chipped or broken teeth. Replace if necessary.

2. Remove gear from camshaft using a knife-edge puller and an arbor press. Place fat side of puller against camshaft gear.

Camshaft Gear Installation:

CAUTION: Avoid injury! Do not heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

1. Heat gear to approximately 150°C (300°F).



M82068A

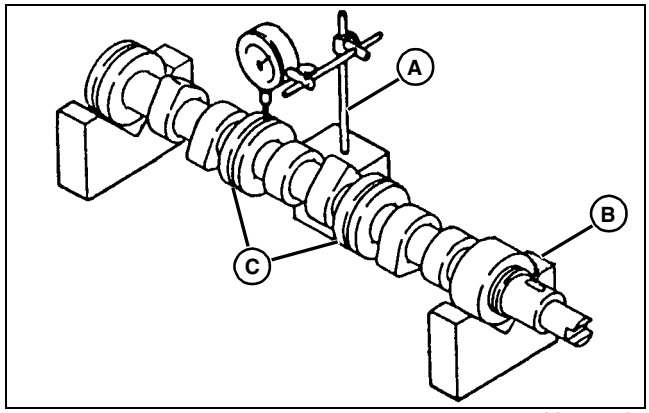
2. Install key (A) into slot of camshaft.

3. Install thrust plate (C) onto camshaft, centering onto stepped shoulder (D). (Thrust plate has no “front” or “rear” side.)

IMPORTANT: Avoid damage! Be sure thrust plate is not trapped between camshaft gear and stepped shoulder while gear is being pressed on.

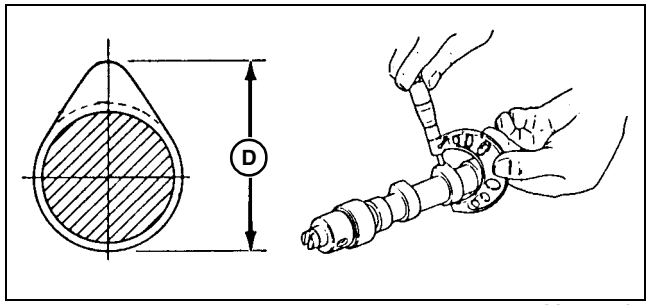
4. Install heated camshaft gear (B) with longer hub of camshaft gear facing camshaft. Align slot in gear with key in shaft. Press camshaft into gear until hub of gear is tight against camshaft shoulder. Thrust plate must spin freely on camshaft.

Camshaft Inspection:



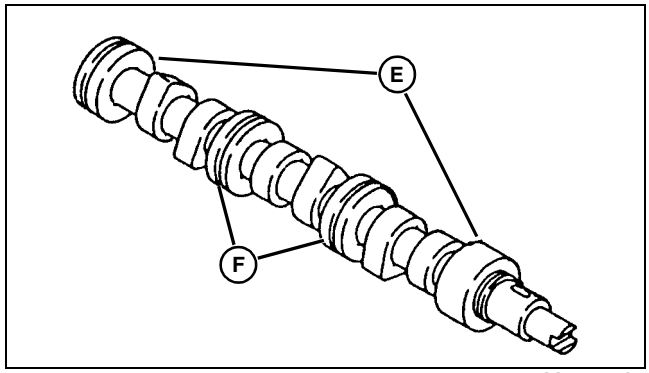
M82291A

1. Inspect camshaft for bend by using a pair of V-blocks (B) and a dial indicator (A). Turn camshaft slowly and read variation of camshaft bearing journals (C) on indicator. If variation is greater than wear limit, replace camshaft.



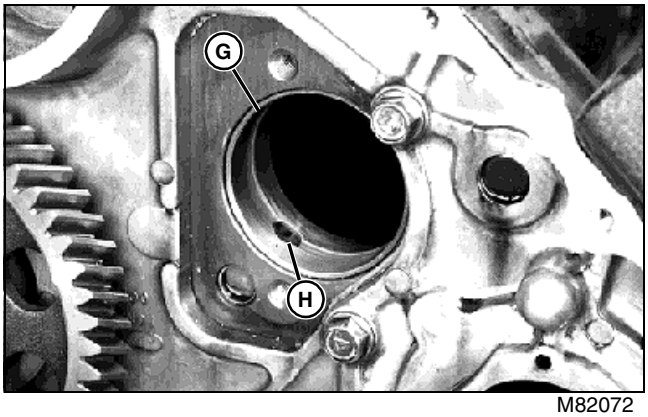
M82070A

2. Measure camshaft lobe height (D) using a micrometer. If lobe height is less than wear limit, or if there are chips or scratches in lobes or bearing journals, replace camshaft.



M82292A

3. Measure camshaft end journal (E) and intermediate journal (F) outside diameters. If journal diameters are less than wear limit, replace camshaft.



M82072

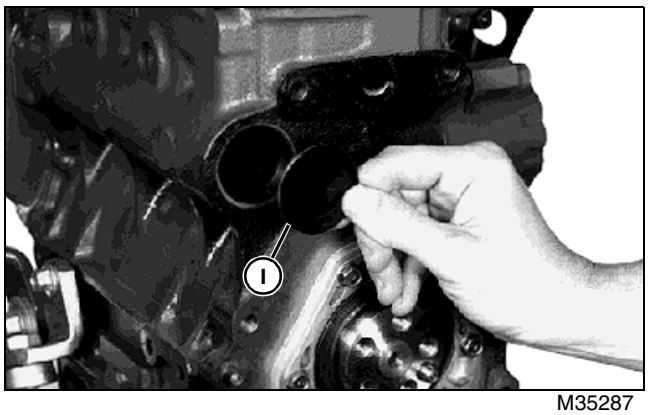
4. Measure camshaft bushing diameter (G) at gear housing end. If bushing diameter exceeds wear limit, replace bushing using a bushing driver:

a. Align oil holes (H) in new bushing and cylinder block.

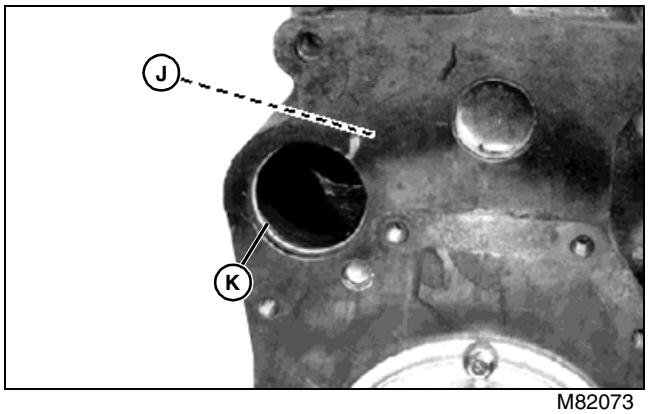
b. Install bushing flush with surface of idler gear.

5. If bushing oil clearance (bushing ID minus camshaft journal OD) exceeds specification, replace bushing, camshaft, or both.

NOTE: Engine back plate must be removed to measure camshaft intermediate (J) and flywheel end (K) bearing diameters.



M35287



M82073

6. Remove engine back plate.

7. Remove plug (I).

8. Measure intermediate (J) and flywheel end (K) camshaft bore diameters. If bore diameter exceeds wear limit, replace cylinder block.

9. If bore clearance (bore ID minus camshaft journal OD) exceeds oil clearance specification, replace camshaft, cylinder block, or both.

10. Apply TY24344 John Deere Form-in-Place Gasket, or equivalent, on outer edge of plug. Install plug until it bottoms in bore.

11. Install engine back plate.

Specifications:

Camshaft Thrust Plate
Cap Screw Torque . . . . . 11 N•m (96 lb-in.)

Camshaft
Standard Bend . . . . . 0.00 - 0.02 mm (0.00 - 0.0008 in.)

Camshaft Bend Wear Limit . . . . . 0.05 mm (0.002 in.)

Camshaft Standard
Lobe Height . . . . . 33.95 - 34.05 mm (1.336 - 1.341 in.)

Camshaft Lobe Height Wear Limit 33.75 mm (1.329 in.)

Camshaft Bearing Journal Specifications

Gear Housing and Flywheel End Journal
Standard OD . . . . . 39.94 - 39.96 mm (1.572 - 1.573 in.)

Gear Housing and Flywheel End Journal
OD Wear Limit . . . . . 39.85 mm (1.569 in.)

Intermediate Journal
Standard OD . . . . . 39.91 - 39.94 mm (1.571 - 1.572 in.)

Intermediate Journal
OD Wear Limit . . . . . 39.85 mm (1.569 in.)

Camshaft Intermediate Bore
Standard ID . . . . . 39.98 - 40.05 mm (1.57 - 1.58 in.)

Camshaft Intermediate Bore
ID Wear Limit . . . . . 40.05 mm (1.58 in.)

Camshaft Intermediate Bore
Oil Clearance . . . . . 0.065 - 0.115 mm (0.003 - 0.005 in.)

Camshaft Flywheel-End Bore
Standard ID . . . . . 39.98 - 40.09 mm (1.57 - 1.58 in.)

Camshaft Flywheel-End Bore
ID Wear Limit . . . . . 40.09 mm (1.58 in.)

Camshaft Flywheel-End
Oil Clearance . . . . . 0.040 - 0.125 mm (0.002 - 0.005 in.)

Governor Removal, Inspection and Installation

Front Mower

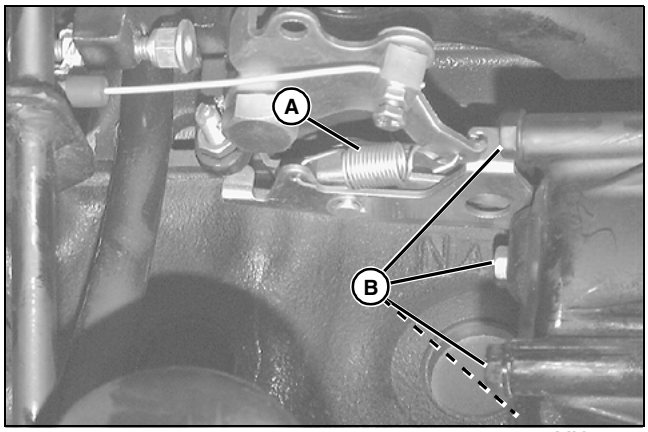
1420

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Knife-Edge Puller	NA	Used with press to remove bearings.
Press	NA	Used with knife-edge puller to remove bearings.

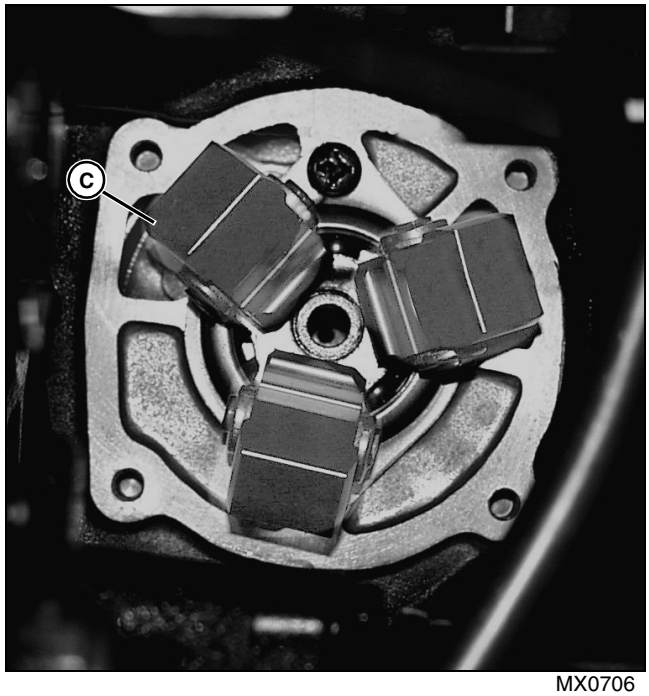
Removal/Inspection:

1. Park machine safely.
2. Stop engine.
3. Remove engine cover.
4. Remove air cleaner. (See “Air Cleaner Removal:” on page 45.)
5. Remove carburetor. (See “Carburetor Removal:” on page 46.)



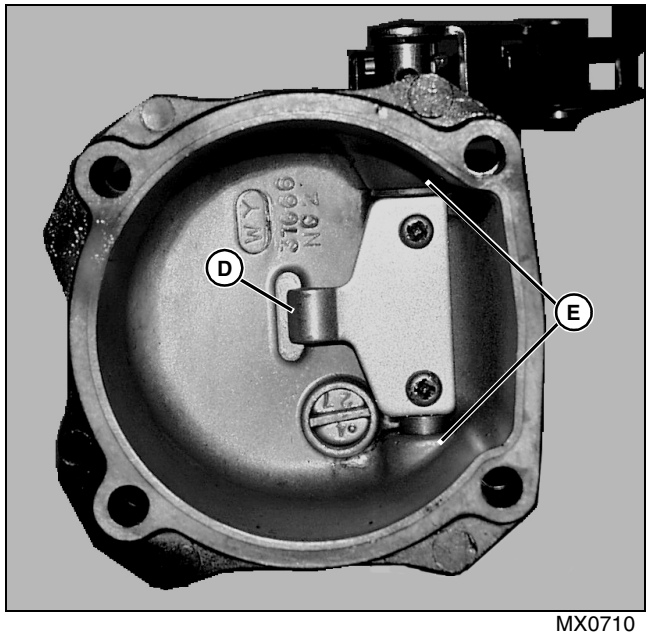
MX5461

6. Disconnect spring (A).
7. Remove governor cap screws (B), linkage, and governor cover.



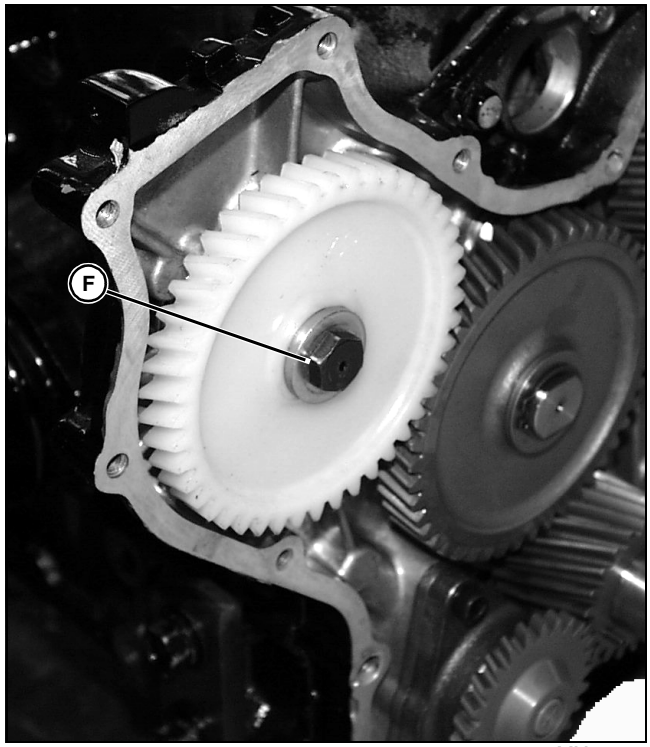
MX0706

8. Inspect governor weights (C) and remove spindle.



MX0710

9. Inspect yoke (D) and governor cover shaft bores (E) for wear.

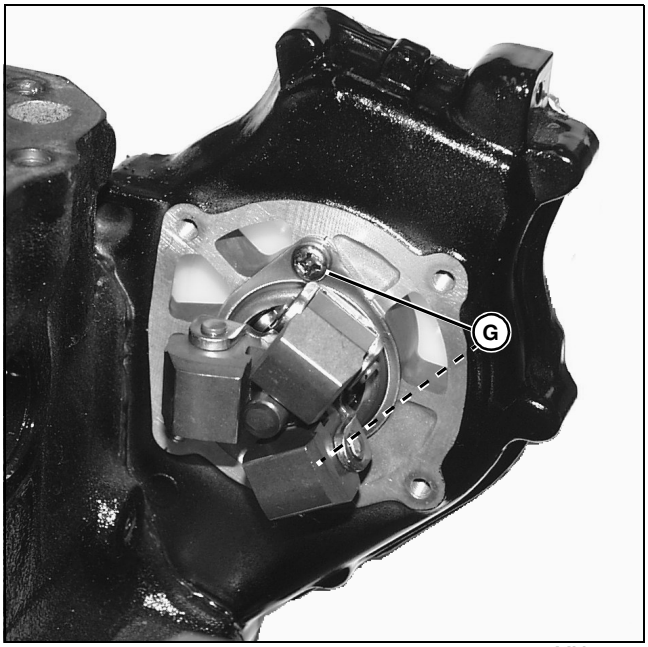


MX0691

10.Remove timing gear cover. (See “Timing Gear Cover Removal and Installation” on page 70.)

11.Remove cap screw (F) from governor gear.

12.Slide governor gear from shaft assembly.



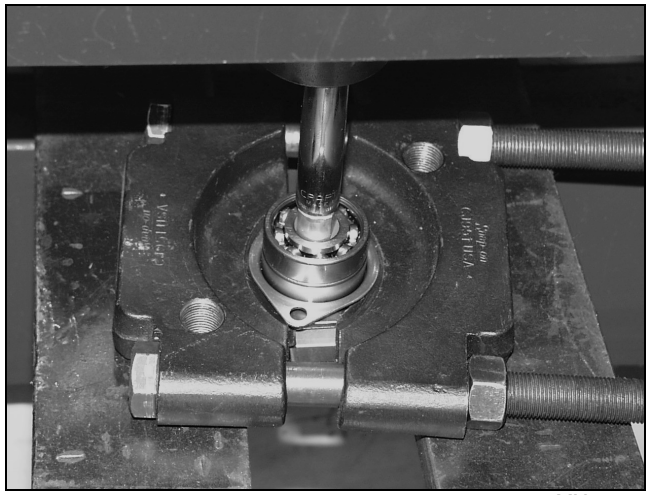
MX0690

13.Remove two screws (G) from bearing retainer to remove weight/shaft assembly from housing.



MX0708

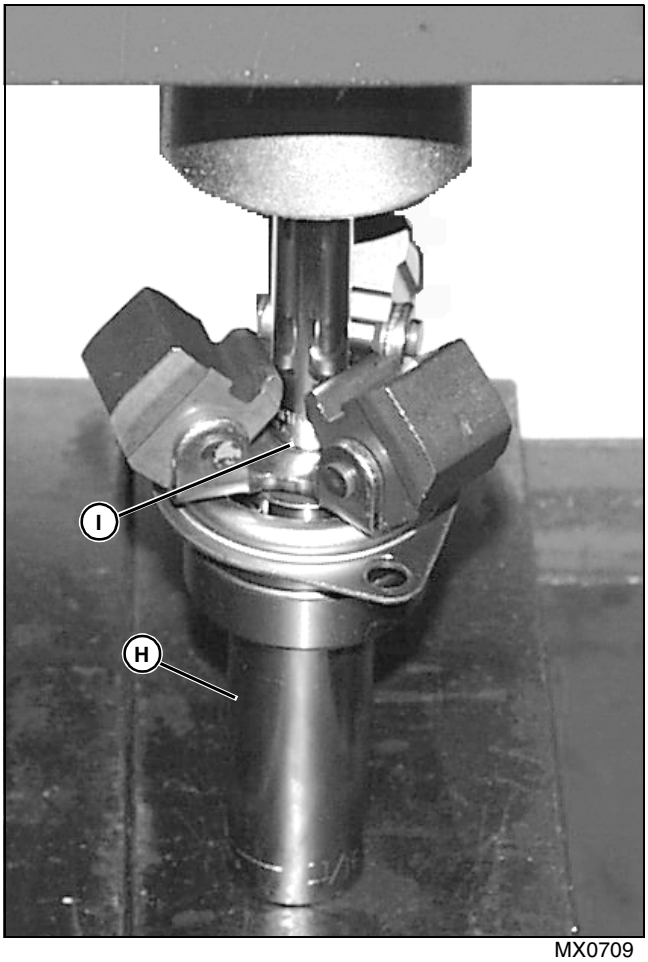
14.Turn bearings by hand and check for smooth operation. Visually inspect for damaged balls or cages. Replace as required.



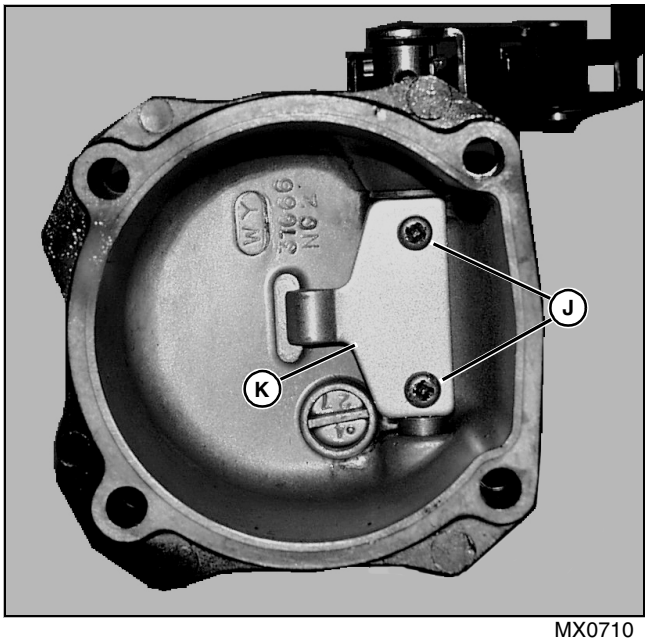
MX0707

15.If replacement is required, remove bearings with a knife-edge puller and a press, as shown.

NOTE: When pressing bearings on, support the inner race of the bearing with an appropriate size socket (H) that will support the inner race and allow the shaft to come through. Press the weight/shaft assembly down from inside the weights on the flat part of the weight support (I). Do not press on, or support, by weights or damage will occur to weight assembly.

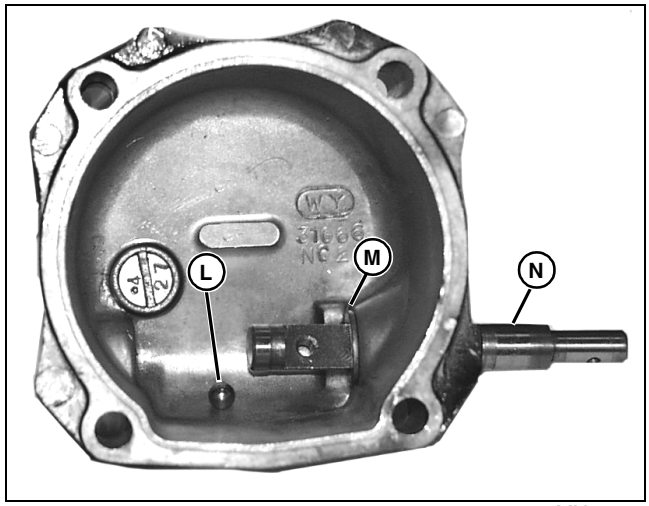


MX0709



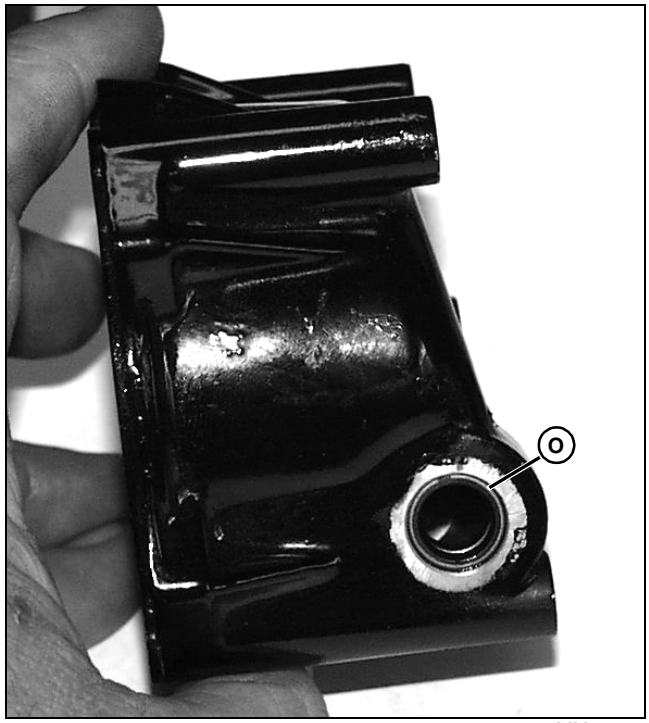
MX0710

16.Remove screws (J) and yoke (K).



MX0712

17.Observe location of ball (L) and washer (M) for reassembly. Check shaft (N) for wear. Replace parts as required.



MX0711

18.Remove oil seal (O). Check shaft bores for wear. Replace oil seal.

Installation:

Installation is done in reverse order of removal.

Piston and Connecting Rod Removal and Installation

Front Mower

1420

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Ridge Reamer	NA	Used to remove ridges from cylinder bore.

Procedure:

1. Remove oil pan and strainer tube. (See “Oil Pan and Strainer” on page 68.)

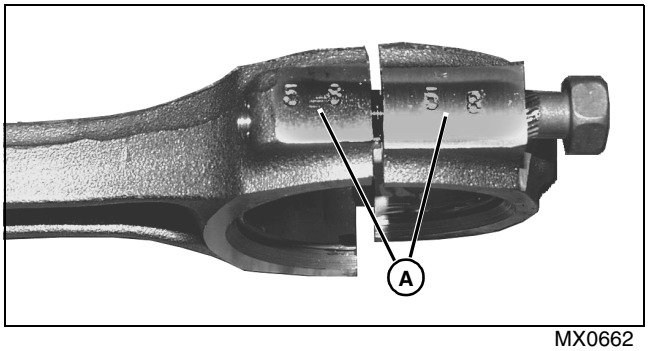
2. Remove cylinder head. (See “Cylinder Head Removal and Installation” on page 62.)

3. Check cylinder bore for ridges. These ridges can damage piston and rings if not removed. If necessary, remove ridge from top of cylinder bore using a ridge reamer.

4. Measure connecting rod side play. (See “Connecting Rod Side Play Check” on page 81.)

5. Measure connecting rod bearing clearance. (See “Connecting Rod Bearing Clearance Check” on page 80.)

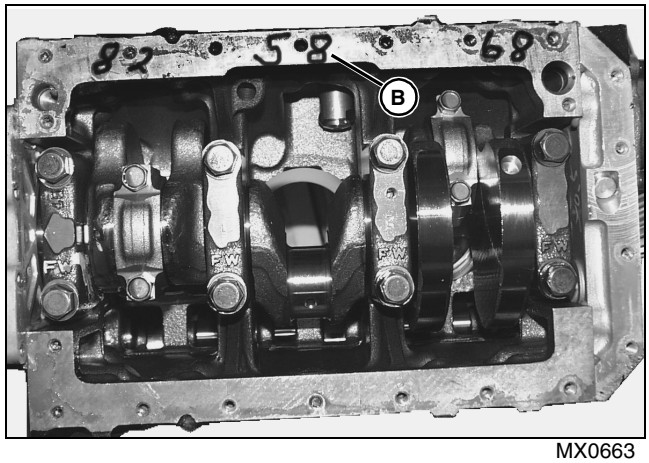
IMPORTANT: Avoid damage! Keep connecting rods and caps together. Rods and caps are a matched set. Note matching numbers (A) on each part.



MX0662

6. Remove two cap screws, connecting rod cap, and bearing inserts.

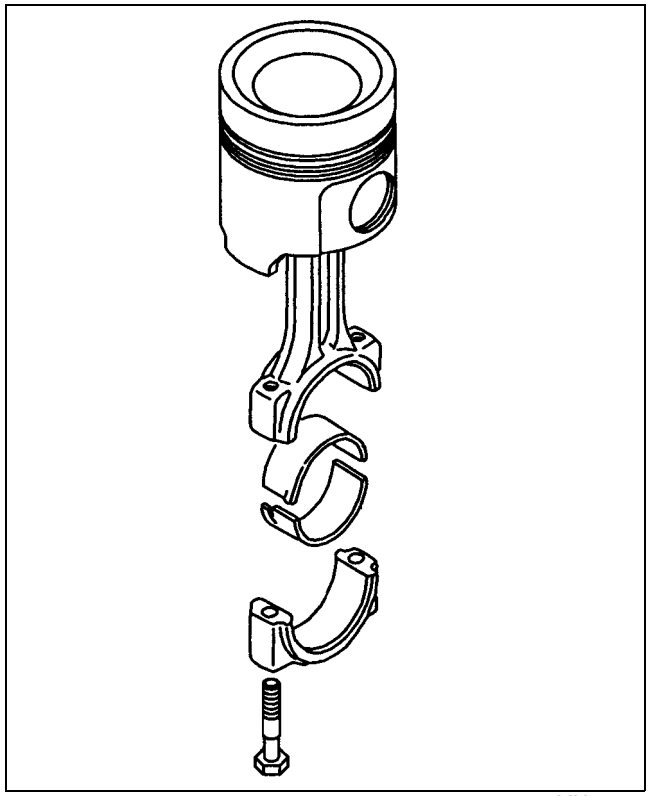
IMPORTANT: Avoid damage! Pistons and cylinders are matched. Pistons must be installed in the cylinders from which they are removed.



MX0663

7. Note connecting rod matching numbers in relation to the cylinders. Mark the block on the side the numbers face with corresponding numbers (B).

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



MX0630

9. Disassemble and inspect all parts for wear or damage. (See Disassembly and Inspection/Replacement procedures in “Connecting Rod Side Play Check” on page 81.)

Connecting Rod Bearing Clearance Check

Front Mower

1420

Reason:

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

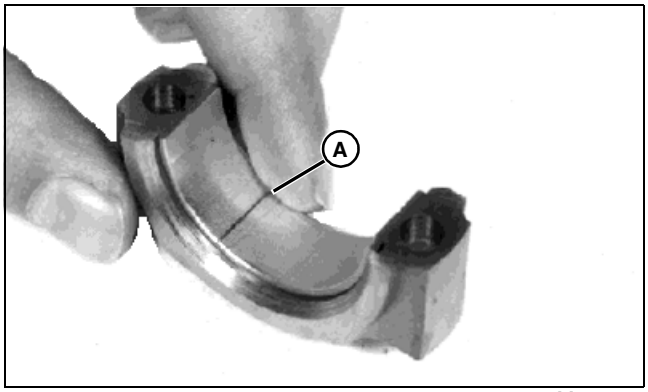
Special or Required Tools:

Tool Name	Tool No.	Tool Use
PLASTIGAGE® Bearing Clearance Measurement Tool (or equivalent)	NA	Used between bearing insert and crankshaft journal to measure clearance.

Procedure:

IMPORTANT: Avoid damage! Connecting rod caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

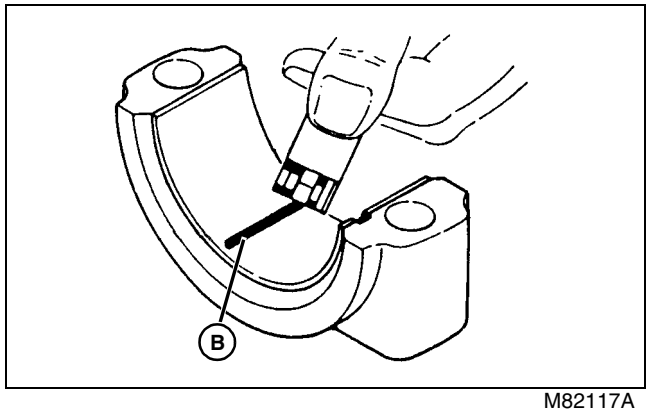
1. Remove connecting rod cap.
2. Wipe oil from bearing insert and crankshaft journal.



M35351

3. Put a piece of PLASTIGAGE (A), or an equivalent, along the full length of the bearing insert approximately 6 mm (0.250 in.) off center.
4. Turn crankshaft approximately 30° from bottom dead center.
5. Install connecting rod end cap and original cap screws. Tighten cap screws to specification.
6. Remove cap screws and connecting rod cap.

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



M82117A

7. Use the graduation marks on the envelope to compare the width of the flattened PLASTIGAGE (B) at its widest point.
8. Determine bearing clearance. The number within the graduation marks indicates the bearing clearance in inches or millimeters, depending on which side of the envelope is used.
9. Remove PLASTIGAGE.

Results:

If clearance exceeds specification, replace bearing inserts.

Specifications:

Connecting Rod End Cap
Cap Screw Torque . . . . . 23 N•m (203 lb-in.)

Connecting Rod Bearing
Standard Clearance . . 0.03 - 0.06 mm (0.001 - 0.002 in.)

Connecting Rod Bearing
Clearance Wear Limit. . . . . 0.15 mm (0.006 in.)

Connecting Rod Side Play Check

Front Mower

1420

Reason:

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

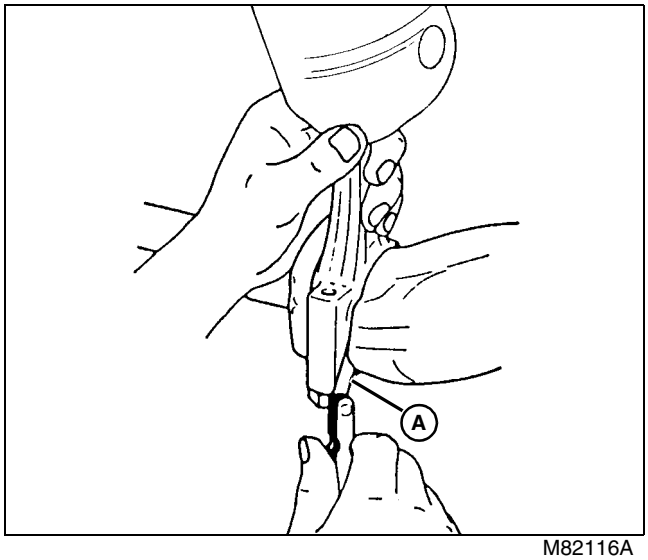
Special or Required Tools:

Tool Name	ToolNo.	Tool Use
Feeler Gauge	NA	Used between connecting rod cap and crankshaft to measure clearance.
Piston Ring Compressing Tool	NA	Used to install piston and connecting rod into cylinder.
Bushing, Bearing, and Seal Driver Set	NA	Used to replace piston pin bushing.

Side Play Check:

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

1. Remove the oil pan and oil pickup tube.



M82116A

2. Insert a feeler gauge (A) between the connecting rod cap and the crankshaft.

3. Measure connecting rod side play and compare to specification.

Side Play Check Results:

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

Piston Installation:

1. If new rings were installed, deglaze cylinder bore. (See “Deglazing:” on page 86.)

2. Install piston rings so piston ring end gaps are staggered 120° apart.

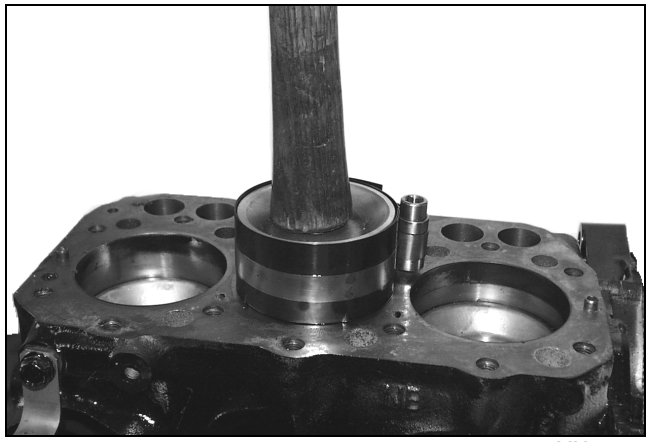
IMPORTANT: Avoid damage! Pistons must be installed in cylinders from which they were removed and in the same direction. Be careful not to damage crankshaft rod journal while installing piston.

3. Coat cylinder, piston skirt, rod, and cap bearing surfaces with oil.

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

4. Install bearing inserts on connecting rod and rod cap, aligning tangs with grooves.

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



MX0689

5. Install ring compressor on piston and install piston and connecting rod into the cylinder from which it was removed. Make sure matching numbers on connecting rod are facing away from camshaft.

6. Match the connecting rod and caps using matching numbers. Install caps.

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

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

9. Install cylinder head. (See “Cylinder Head Removal and Installation” on page 62.)

10. Install oil pan, spacer, and strainer tube.

Disassembly:

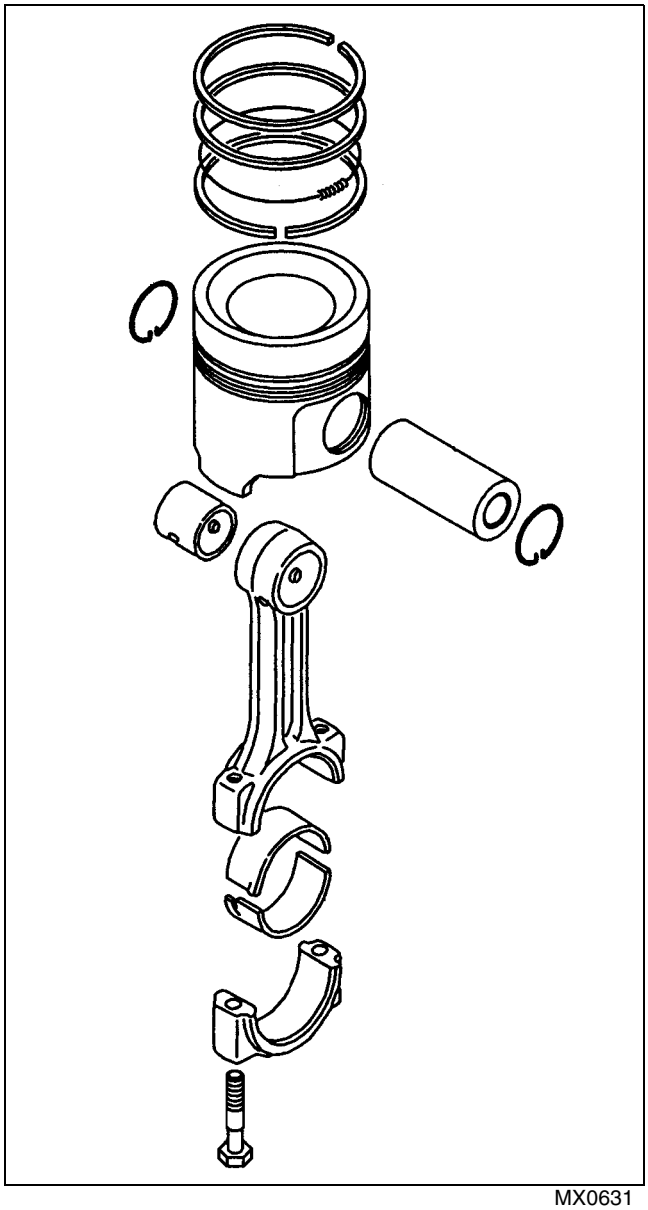
IMPORTANT: Avoid damage! Pistons must be installed on the same connecting rod they were removed from.

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

2. Piston pin bushing is press fit in connecting rod. Remove bushing only if replacement is necessary. (See "Inspection/Replacement:" on page 83.)

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

Assembly:

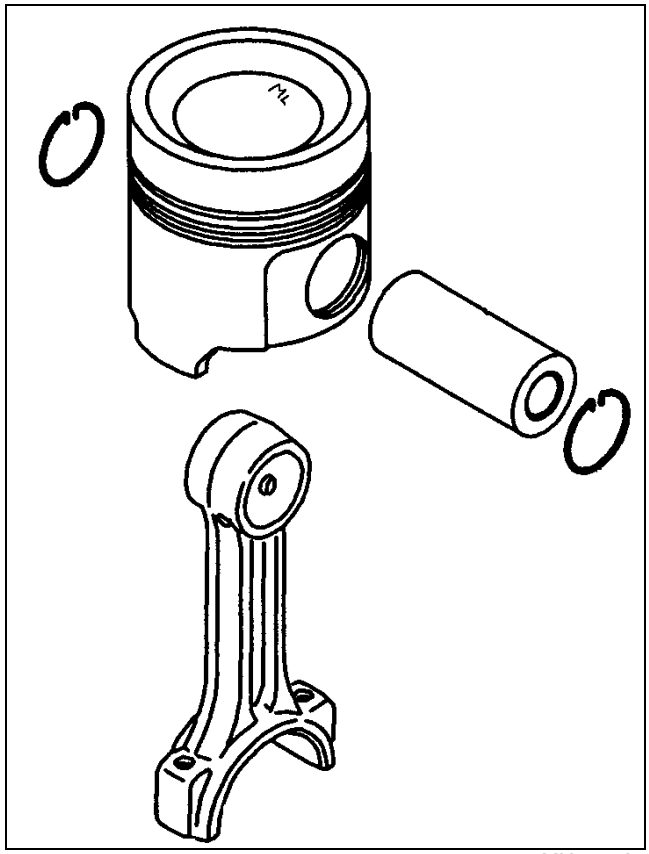


MX0631

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

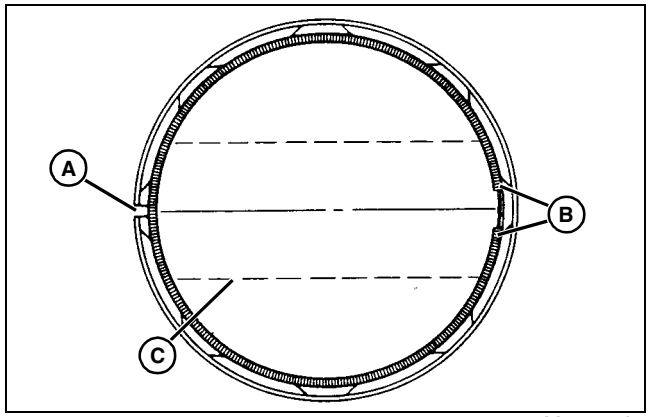
IMPORTANT: Avoid damage! Pistons must be installed on the same connecting rod they were removed from.

2. Assemble piston to connecting rod with piston size mark on same side as connecting rod "punched" alignment mark. If new connecting rod is used, assemble piston to connecting rod with piston size mark opposite connecting rod bearing insert groove.



MX0631A

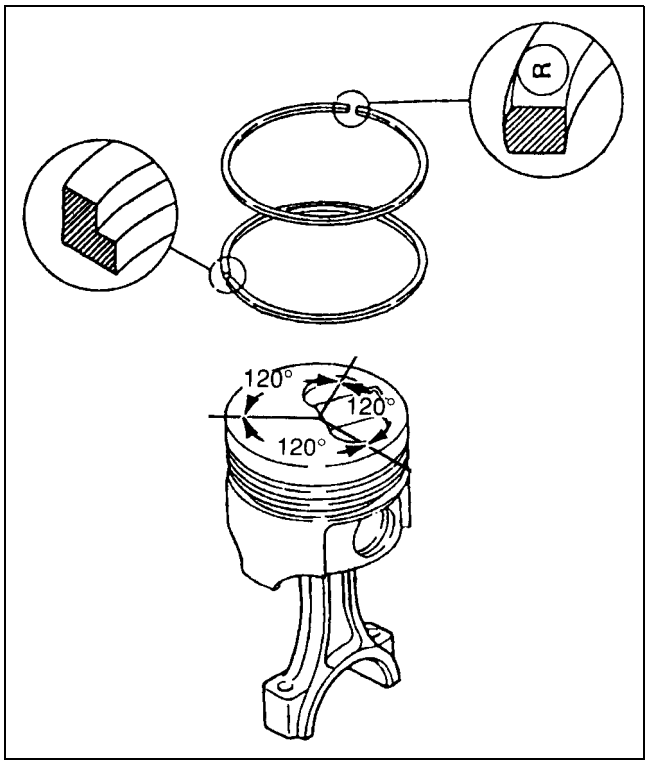
3. Install piston pin and retaining/snap rings.



M82046A

4. Install oil ring expander in bottom ring groove of piston with ends (B) above either end of piston pin (C).

5. Install oil ring over expander with ring gap (A) opposite (180°) of expander ends.



M82276A

6. Install second compression ring, with small diameter of taper toward top of piston, in middle groove. Turn ring until gap is 120° away from oil ring gap.

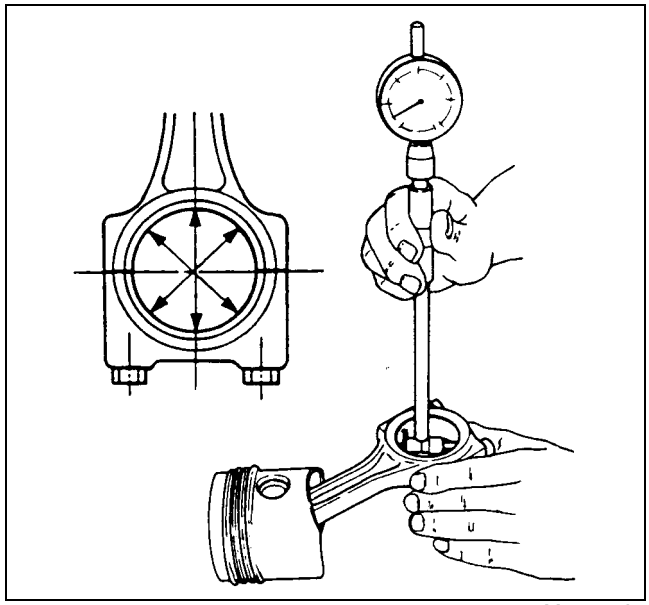
7. Install first compression ring (chrome plated), with manufacturer's mark "R," "T," or "RN" (near ring gap) toward top of piston, in top groove. Turn ring until gap is 120° away from second ring gap.

Inspection/Replacement:

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

2. Measure crankshaft connecting rod journal diameter. (See "Crankshaft and Main Bearings" on page 88.)

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

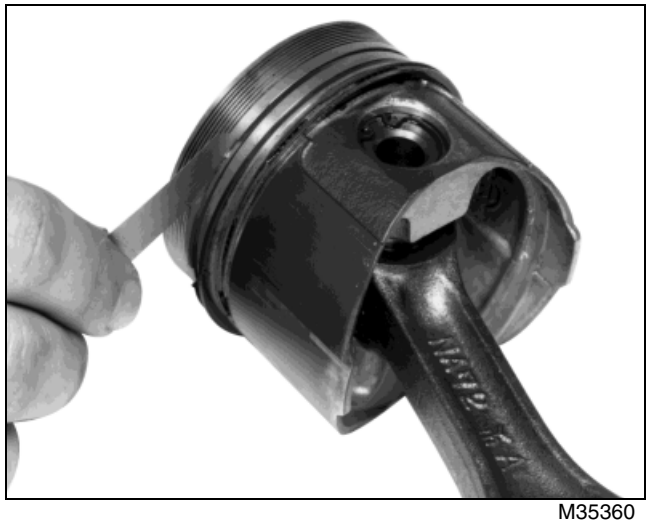


M82048A

4. Measure connecting rod bearing diameter.

5. If bearing diameter exceeds wear limit and crankshaft is within specification, replace bearing inserts.

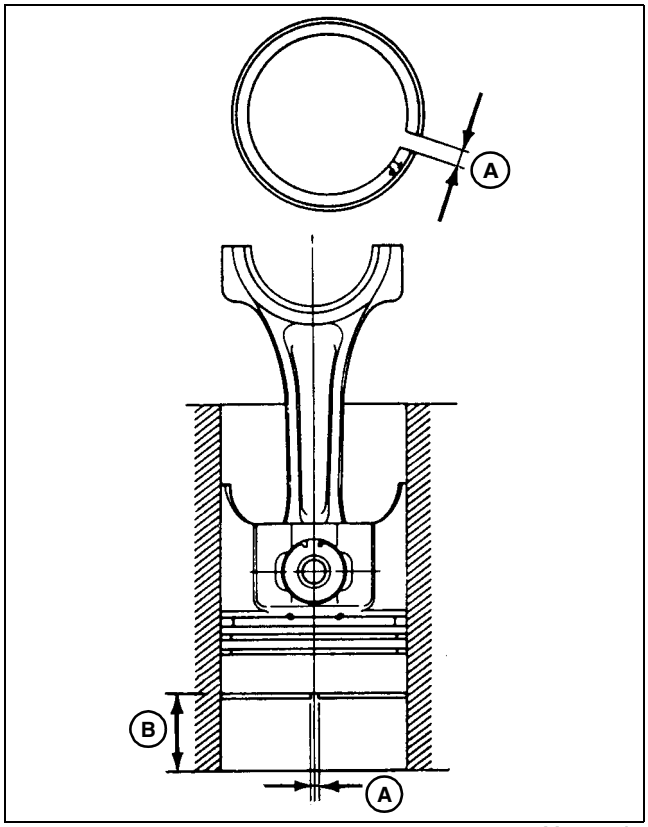
6. If crankshaft journal OD does not meet minimum specification, grind crankshaft connecting rod journals and install undersized bearings inserts, or replace bearing inserts and crankshaft.



M35360

7. With rings installed on piston, measure piston ring groove clearance. Measure several places around each piston.

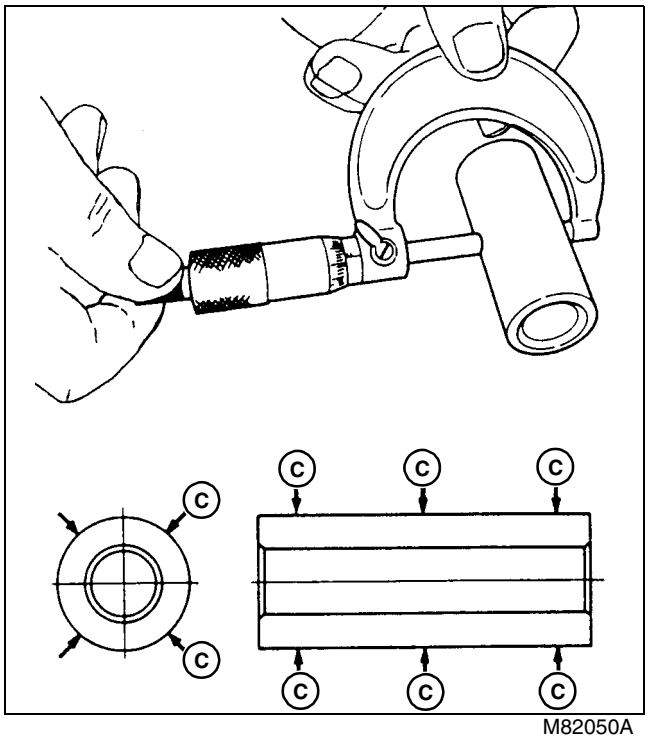
8. If clearance exceeds maximum limit, replace rings or piston.



M82049A

9. Measure piston ring end gap (A). Push ring into cylinder bore, using a piston, until ring installed depth (B) is approximately 30 mm (1.181 in.) from bottom of cylinder bore.

10.If end gap exceeds wear limit, replace rings.



M82050A

11. Measure piston pin diameter. Measure diameter in six places (C).

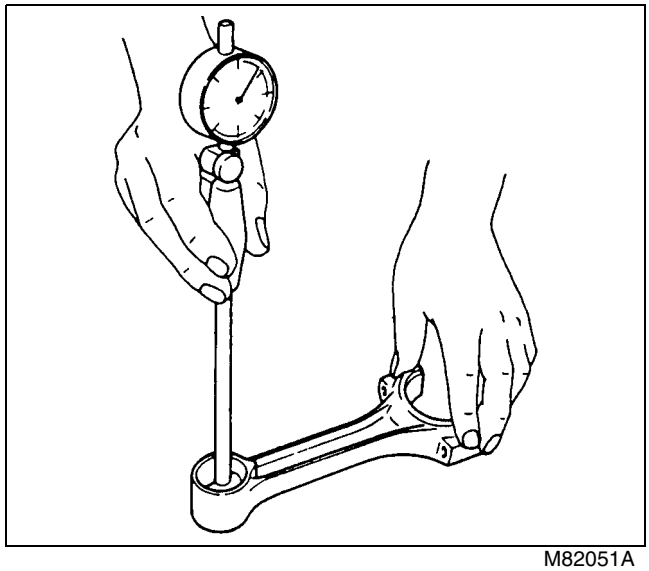
12.If pin diameter is less than wear limit at any measurement, replace pin.


M37683

13.Measure piston pin bore diameter in piston.

14.If piston pin bore exceeds wear limit, replace piston.

15.If bore clearance (bore ID minus pin OD) exceeds specification, replace piston, piston pin, or both.


M82051A

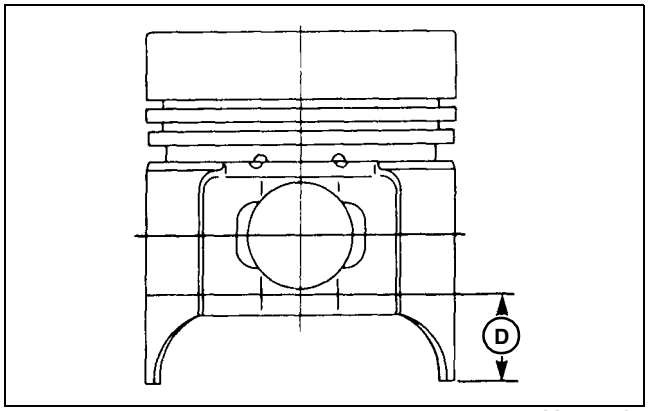
16.Measure piston pin bushing diameter in connecting rod.

17.If bushing diameter exceeds wear limit, replace bushing.

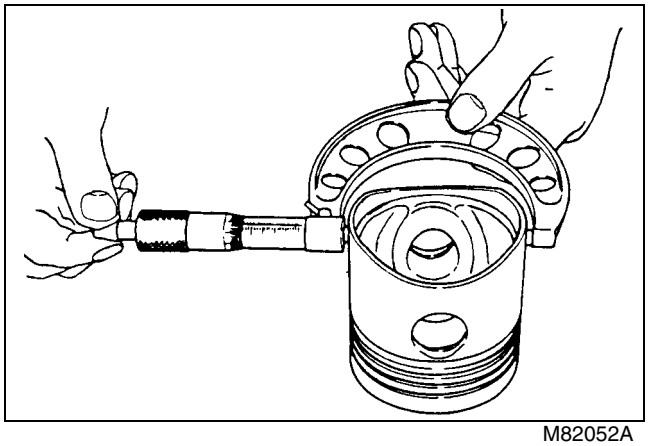
18.If bushing clearance (bushing ID minus pin OD) exceeds specification, replace bushing, piston pin, or both.

19.Piston pin bushing is press fit. Replace bushing using a driver set. When installing bushing, make sure to align oil hole in bushing with hole in connecting rod.

NOTE: If engine has had a previous major overhaul, oversize pistons and rings may have been installed. Oversize pistons are available in 0.25 mm (0.010 in.) and 0.50 mm (0.020 in.) sizes.



M82200A



M82052A

20.Measure piston diameter perpendicular to piston pin bore at distance (D).

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

22.Measure cylinder bore diameter. (See “Cylinder Bore” on page 86.)

Specifications:

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

Connecting Rod
Side Play (Maximum) . . . . . 0.8 mm (0.031 in.)

Connecting Rod Cap Screw Torque 23 N•m (200 lb-in.)

Connecting Rod Bearing
Clearance (Maximum) . . . . . 0.12 mm (0.005 in.)

Crankshaft Journal
OD (Minimum) . . . . . 39.93 mm (1.572 in.)

Connecting Rod Bearing
ID (Maximum) . . . . . 40.07 mm (1.577 in.)

Connecting Rod Standard
Oil Clearance. . . . . 0.033 - 0.059 mm (0.001 - 0.002 in.)

Connecting Rod
Oil Clearance Wear Limit . . . . . 0.15 mm (0.006 in.)

Top Piston Ring Groove
Side Clearance . . . . 0.060 - 0.100 mm (0.002 - 0.004 in.)

Second Piston Ring Groove
Side Clearance . . . . 0.090 - 0.125 mm (0.004 - 0.005 in.)

Oil Control Ring Groove
Side Clearance . . 0.020 - 0.055 mm (0.0008 - 0.0022 in.)

Top Ring End Gap (Maximum) . . . . 1.25 mm (0.049 in.)

Second Ring End Gap (Maximum) . 1.25 mm (0.049 in.)

Oil Control Ring End Gap
(Maximum) . . . . . 1.90 mm (0.075 in.)

Piston Pin
Standard OD . . . . . 20.99 - 21.00 mm (0.826 - 0.827 in.)

Piston Pin
OD Wear Limit . . . . . 20.90 mm (0.823 in.)

Piston Pin Bore
Standard ID . . . . . 21.00 - 21.01 mm (0.827 - 0.827 in.)

Piston Pin Bore ID Wear Limit . . . 21.02 mm (0.828 in.)

Piston Pin Bore
Standard Oil Clearance 0.0 - 0.017 mm (0.0 - 0.0018 in.)

Piston Pin Bore
Oil Clearance Wear Limit . . . . . 0.12 mm (0.005 in.)

Piston Pin Bushing
Standard ID . . . . 21.025 - 21.038 mm (0.828 - 0.8283 in.)

Piston Pin Bushing ID
Wear Limit . . . . . 21.10 mm (0.831 in.)

Piston Pin Bushing Standard
Oil Clearance . . . . . 0.025 - 0.047 mm (0.001 - 0.002 in.)

Piston Pin Bushing
Oil Clearance Wear Limit . . . . . 0.2 mm (0.008 in.)

Piston OD
Measurement Distance (4). . . . . 6.0 mm (0.236 in.)

Cylinder Bore ID Wear Limit . . . . . 72.15 mm (2.841 in.)

Piston-to-Cylinder Bore Clearance
(Maximum) . . . . . 0.15 mm (0.006 in.)

Piston OD Wear Limit . . . . . 71.90 mm (2.831 in.)

Cylinder Bore

Front Mower

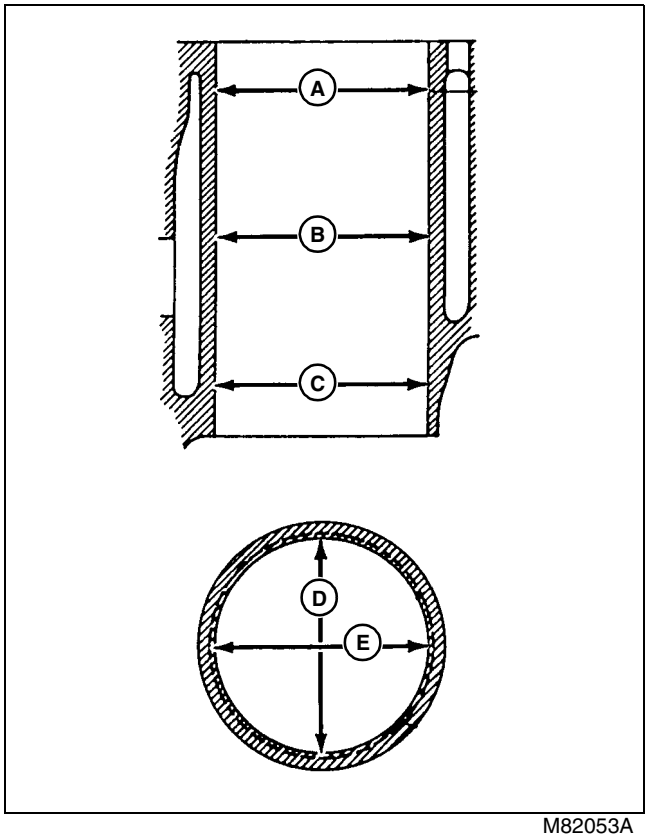
1420

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Flex Hone (with 180 Grit Stones)	NA	Used to deglaze cylinder bores.
Rigid Hone (with 300 Grit Stones)	NA	Used with drill press to rebore cylinder to use oversize pistons and rings.
Drill Press	NA	Used with rigid hone to rebore cylinder to use oversize pistons and rings.

Inspection:

NOTE: If engine has had a previous major overhaul, oversize pistons and rings may have been installed. Oversize pistons are available in 0.25 mm (0.010 in.) and 0.50 mm (0.020 in.) sizes.



M82053A

1. Measure cylinder bore diameter at three positions: top (A), middle (B), and bottom (C). At these three positions, measure in both directions: along crankshaft center line (E) and direction of crankshaft rotation (D).

2. If cylinder bore exceeds wear limit, replace cylinder block or have cylinder rebored. (See “Reboring:” on page 87.)

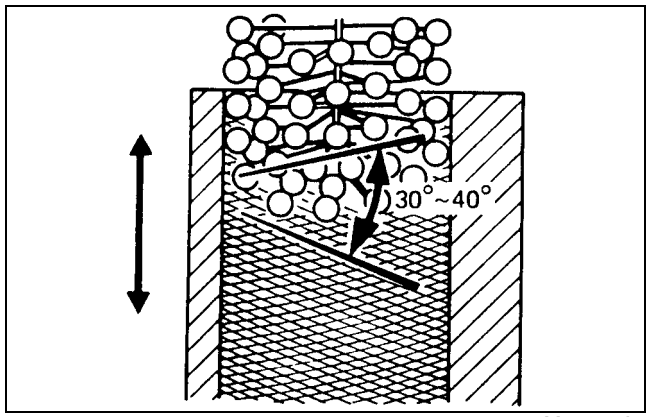
3. If cylinder is rebored, oversize pistons and rings must be installed. Oversize pistons and rings are available in 0.25 mm (0.010 in.) and 0.50 mm (0.020 in.) sizes.

4. If clearance (cylinder bore ID minus piston OD) exceeds specification, replace cylinder block, piston, or both; or rebore cylinder and install oversize pistons and rings.

Deglazing:

IMPORTANT: Avoid damage! If cylinder bores are to be deglazed with crankshaft installed in engine, put clean shop towels over crankshaft to protect journal and bearing surfaces from any abrasives.

1. Deglaze cylinder bores using a flex hone with 180 grit stones.



M82054A

2. Use flex hone as instructed by manufacturer to obtain a 30 - 40° crosshatch pattern as shown.

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

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

Reboring:

NOTE: The cylinder block can be rebored to use oversize pistons and rings. Oversize pistons and rings are available in 0.25 mm (0.010 in.) and 0.50 mm (0.020 in.) sizes. (See "Specifications:" on page 88 for cylinder bore ID for each piston size.)

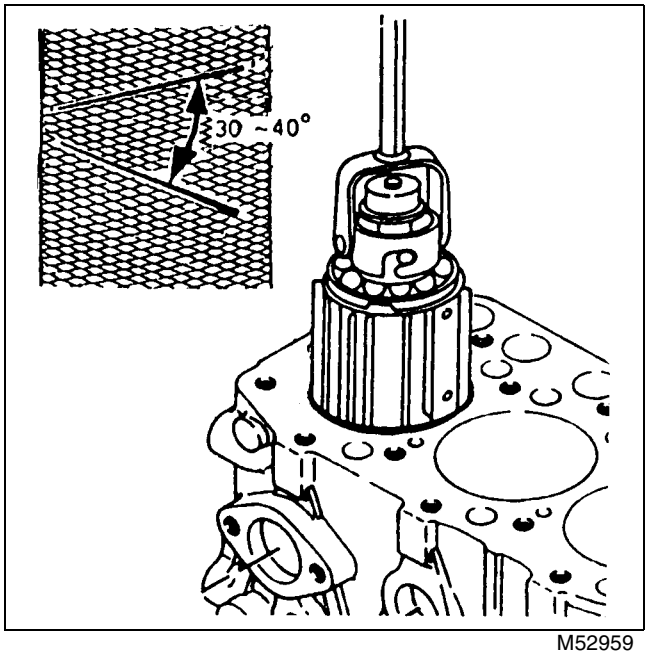
1. Align center of bore to drill press center.

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

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

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

4. Coat cylinder with honing oil. Rigid hone should turn by hand. Adjust if too tight.



M52959

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

NOTE: Measure bore when cylinder is cool.

6. Stop press and check cylinder diameter.

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

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

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

9. Check bore for size, taper, and out-of-round. (See "Inspection:" on page 86.)

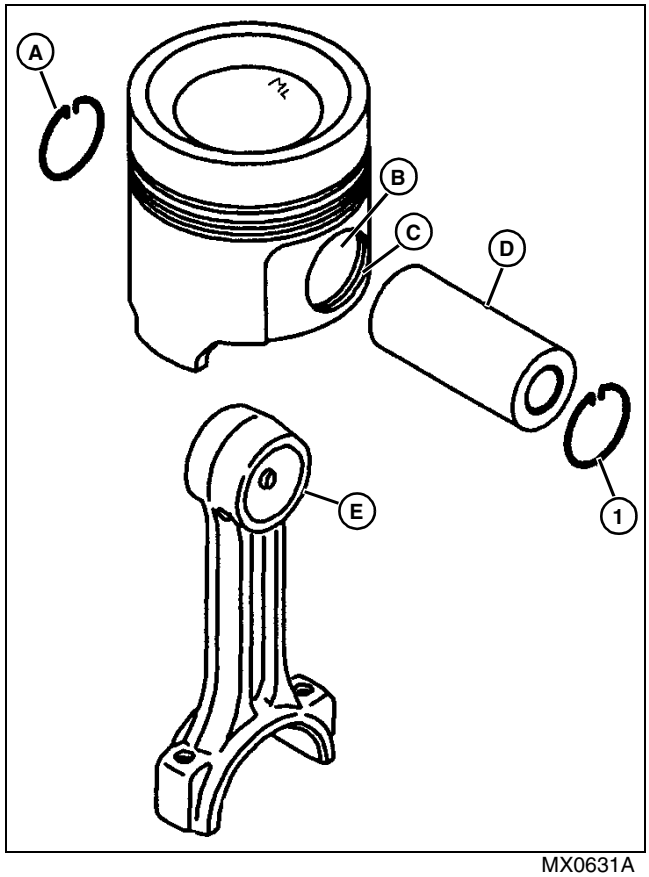
IMPORTANT: Avoid damage! Do not use solvents to clean cylinder bore. Solvents will not remove all metal particles and abrasives produced during honing.

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

11. Dry cylinder and apply engine oil.

IMPORTANT: Avoid damage! Install piston pin (D) before retaining ring (A) to prevent possible scoring of bore (B).

Retaining rings (A) should be installed with end gap pointing up.



MX0631A

12. Install one piston pin retaining ring (A) in groove of piston bore (C).

13. Install pin (D) through piston bore (B) and connecting rod (E). Pin should install easily with thumb pressure.

14. Install remaining retaining ring (A) in opposite side.

Specifications:

Piston-to-Cylinder Bore Clearance
(Maximum). . . . . 0.15 mm (0.006 in.)

Cylinder Standard
Roundness . . . . . 0.00 - 0.01 mm (0.0000 - 0.0004 in.)

Cylinder Roundness Wear Limit . . . 0.03 mm (0.001 in.)

Standard Size Piston

Cylinder Bore
Standard ID . . . . . 72.00 - 72.03 mm (2.834 - 2.836 in.)

Cylinder Bore ID Wear Limit . . . . . 72.15 mm (2.841 in.)

0.25 mm (0.010 in.) Oversize Piston

Cylinder Bore
Standard ID . . . . . 72.25 - 72.28 mm (2.844 - 2.845 in.)

Cylinder Bore ID Wear Limit . . . . . 72.45 mm (2.852 in.)

0.50 mm (0.020 in.) Oversize Piston

Cylinder Bore
Standard ID . . . . . 72.50 - 72.53 mm (2.854 - 2.855 in.)

Cylinder Bore ID Wear Limit . . . . . 72.70 mm (2.862 in.)

Crankshaft and Main Bearings

Front Mower

1420

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Knife-Edge Puller	NA	Used with press to remove gear from crankshaft.
Press	NA	Used with knife-edge puller to remove gear from crankshaft.
Dial Indicator	NA	Used with V-blocks to inspect crankshaft for bend.
V-Block (2 used)	NA	Used with dial indicator to inspect crankshaft for bend.

Removal:

1. Check crankshaft end play.

2. Remove flywheel. (See “Flywheel Removal and Installation” on page 58.)

3. Remove rear oil seal case. (See “Crankshaft Rear Oil Seal” on page 91.)

4. Remove timing gear cover, timing gears, timing gear housing, and flywheel of engine.

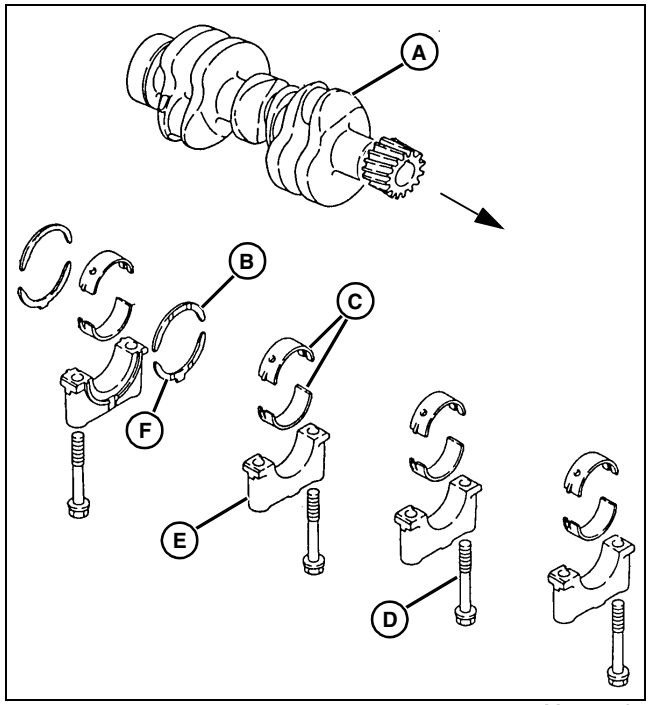
5. Check crankshaft bearing clearance. (See “Inspection/ Replacement:” on page 89.)

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

6. Remove connecting rod cap screws and end caps.

7. Push pistons and connecting rods away from crankshaft.

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



M82283A

Picture Note: Arrow Points to Front of Engine

8. Remove main bearing cap screws (D), caps (E), and cap thrust bearings (F).

9. Remove crankshaft (A).

10. Remove block thrust bearings (B) and main bearing inserts (C).

11. Inspect all parts for wear or damage. (See “Inspection/ Replacement:” on page 89.)

Installation:

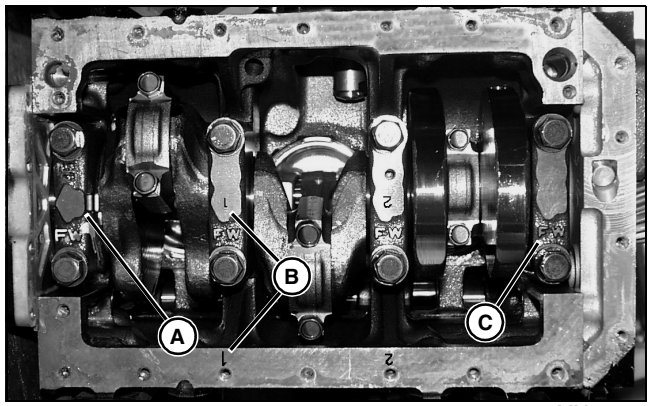
1. Apply clean engine oil on all parts during installation.

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

2. Install bearing inserts drilled with oil passage in cylinder block bearing bores, aligning tangs with slots in bores.

3. Apply grease to smooth sides of thrust bearings to hold them in place on block. Install block thrust bearings with oil grooves facing away from engine block.

NOTE: Main bearing caps have the letters FW cast on the camshaft side (C). Both correspond to their location on the engine block. The flywheel end bearing (A) has the thrust bearing inserts. The two center bearing caps have the numbers 1 and 2 on them, which correspond to the numbers stamped on the block (B). The main bearing cap at gear train end does not have a number.



MX0661

4. Install crankshaft.

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

6. Apply grease to smooth side of thrust bearings to hold them in place on bearing cap during assembly. With oil grooves facing away from cap, install thrust bearings on main bearing cap.

7. Install main bearing caps in their original locations with “FW” toward camshaft side (C) of engine.

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

8. Dip entire main bearing cap screws in clean engine oil. Install cap screws and tighten. Do not tighten to specification at this time.

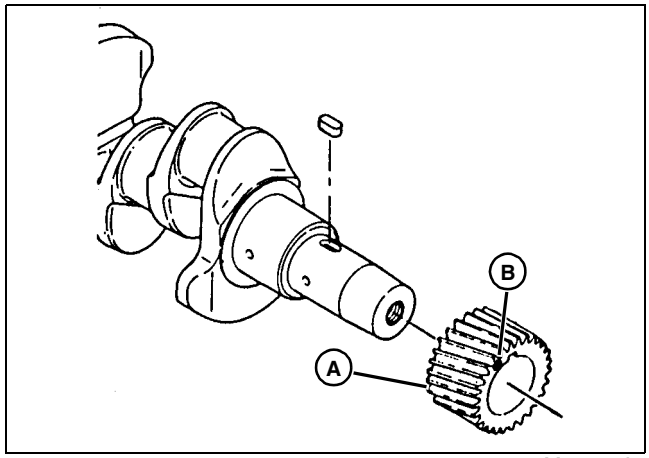
9. Using a soft-faced hammer, tap the front end of the crankshaft and then the rear end of the crankshaft to align the thrust bearings.

10. Tighten main bearing cap screws to specification. When tightening, start at center main bearing cap and work your way out, alternating to the ends. Turn crankshaft by hand. If it does not turn easily, disassemble the parts and find the cause.

Inspection/Replacement:

1. Inspect crankshaft gear for chipped or broken teeth. If replacement is necessary, remove gear from crankshaft using a knife-edge puller and a press.

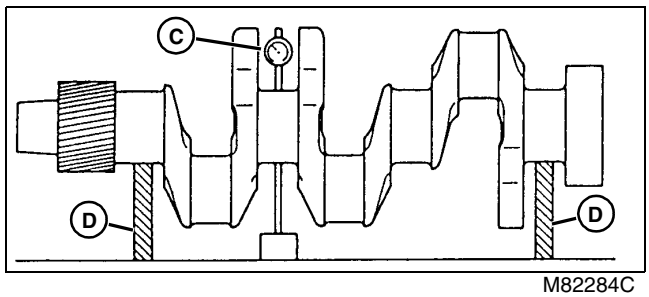
CAUTION: Avoid injury! Do not heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.



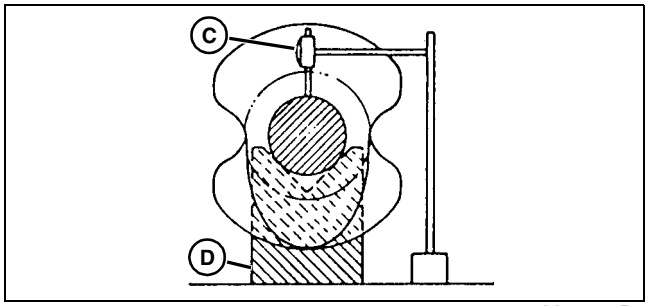
M82060A

2. Heat gear to approximately 150°C (300°F). Install gear (A) with timing mark (B) toward press table.

3. Align slot in gear with key in shaft. Press crankshaft into gear until gear is tight against crankshaft shoulder.



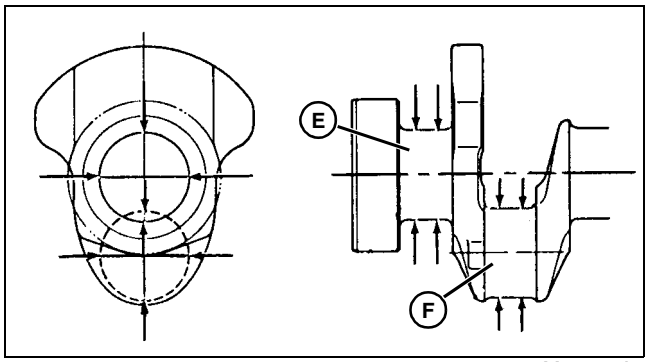
M82284C



M82284B

4. Inspect crankshaft for bend using V-blocks (D) and a dial indicator (C). Turn crankshaft slowly and read variation on indicator. If variation is greater than specification, replace crankshaft.

NOTE: If engine has had a previous major overhaul, journals may have been ground and undersize bearing inserts installed.



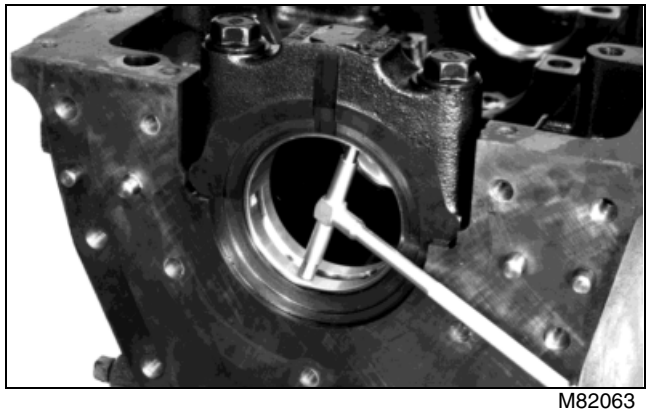
M82062A

5. Measure crankshaft connecting rod journals (F) and main bearing journal (E) diameters. Measure several places around each journal.

6. If journal diameter is less than wear limit, replace crankshaft or have journals ground undersize by a qualified machine shop.

7. If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.

8. Install bearing inserts and main bearing cap on main bearing. Tighten main bearing cap screws to specification.


M82063

9. Measure main bearing diameter.

10.If bearing diameter exceeds wear limit, replace bearing inserts.

11.If bearing clearance (bearing ID minus crankshaft main bearing journal OD) exceeds specification, replace bearing inserts and crankshaft or have crankshaft journals ground undersize by a qualified machine shop and install undersize bearing inserts. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.

12.Clean and inspect oil passages in main bearing journals, connecting rod journals, and main bearing bores in cylinder block.

13.Inspect crankshaft for cracks or damage. Replace if necessary.

Specifications:

Crankshaft Bend (Maximum) . . . . 0.02 mm (0.0008 in.)

Crankshaft Connecting Rod Journal
Standard OD . . . . . 39.97 - 39.98 mm (1.573 - 1.574 in.)

Crankshaft Connecting Rod Journal
OD Wear Limit . . . . . 39.91 mm (1.571 in.)

Crankshaft Main Bearing Journal
Standard OD . . . . . 43.97 - 43.98 mm (1.728 - 1.732 in.)

Crankshaft Main Bearing Journal
OD Wear Limit . . . . . 43.90 mm (1.728 in.)

Main Bearing
Cap Screw Torque . . . . . 79 - 83 N•m (58 - 62 lb-ft)

Main Bearing Standard ID . . . . . 43.93 mm (1.729 in.)

Main Bearing Oil Clearance. . . . . 0.12 mm (0.005 in.)

Crankshaft Rear Oil Seal

Front Mower

1420

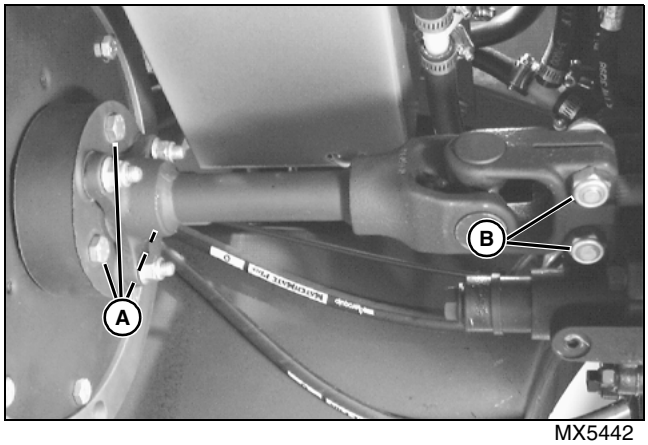
Special or Required Tools:

Tool Name	Tool No.	Tool Use
Hoist	NA	Used with lifting brackets to remove flywheel from crankshaft.
Lifting Bracket (2 used)	JT01748	Used with hoist to remove flywheel from crankshaft.
Bushing, Bearing, and Seal Driver Set	NA	Used to install crankshaft rear oil seal.

Other Material:

Part No.	Part Name	Part Use
TY16021 (U.S.)/ LOCTITE ® 17430/ TY9484 (Canada)	John Deere High Flex Form-in-Place Gasket	Applied to seal case-to-engine block mating surfaces before installing seal case.

Rear Oil Seal Removal and Installation:



MX5442

1. Remove three cap screws (A) from drive shaft damper.

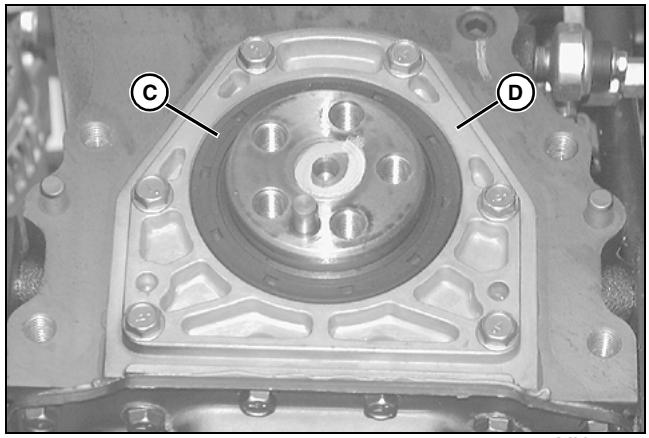
2. Loosen two cap screws (B) at transaxle. Slide drive shaft toward transaxle to remove.

IMPORTANT: Avoid damage! Flywheel is heavy! Do not remove flywheel mounting cap screws unless flywheel is secure. Use a hoist and lifting brackets to lift flywheel from crankshaft.

3. Remove flex plate from flywheel. Note that longer center hub of flex plate is facing out. (See “Flywheel Removal and Installation” on page 58.)

4. Remove flywheel. (See “Flywheel Removal and Installation” on page 58.)

NOTE: It is not necessary to remove oil seal case to remove oil seal.



MX5465

5. Carefully pry oil seal (C) from oil seal case (D).

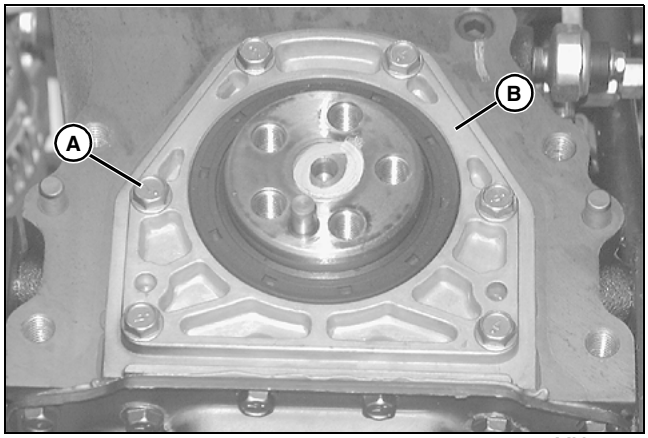
NOTE: Oil seal is normally installed flush with surface of oil seal case. If oil seal has worn a groove in crankshaft at oil seal contact point, seal can be installed 3 mm (0.120 in.) deeper into oil seal case.

Lubricate seal with engine oil prior to installation.

6. Replace oil seal using a driver set. Install seal with lip toward cylinder block. Install seal flush with surface of oil seal case.

Rear Oil Seal Case Removal and Installation:

NOTE: It is not necessary to remove oil seal case to remove oil seal. It is not necessary to remove oil seal to remove oil seal case.



MX5465

1. Remove six oil seal case-to-cylinder block cap screws (A).
2. Pry oil seal case (B) from engine block.
3. Clean all old gasket material from oil seal case and engine block.
4. Apply TY16021 John Deere High Flex Form-in-Place Gasket to seal case-to-engine block mating surfaces. Install seal case.
5. Install new oil seal after oil seal case is installed.
6. Install flywheel and flex plate. (See “Flywheel Removal and Installation” on page 58.)
7. Install drive shaft.

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Specifications

General Specifications

1435

Make	**Yanmar**
Model	**3TNE74C-JUV**
Type	**4-cycle diesel**
Bore	**74 mm (2.91 in.)**
Stroke	**78 mm (3.07 in.)**
Cylinders	**3**
Valves	**Overhead**
Displacement	**1.006 L (61.4 cu in.)**
Gross Output Power	**16.6 kW (22.2 hp)**
Maximum Torque at 2400 RPM	**61.7 N•m (45.5 lb-ft)**
Firing Order	**1 - 3 - 2**
Direction of Rotation	**Counterclockwise (viewed from flywheel)**
Combustion System	**Indirect injection type**
Compression Ratio	**23:1**
Oil Capacity with Filter (Approximately)	**2.7 L (2.8 qt)**
Cooling	**Liquid with pump and radiator**
Governor	**Centrifugal**
Slow Idle (No Load)	**1525 ± 50 rpm**
Fast Idle (No Load)	**3200 ± 50 rpm**
Fuel Filter	**Replaceable element fuel water separator**
Air Filter	**Dry replaceable primary and secondary elements**
Weight (Approximately)	**100 kg (220 lb)**

1445 and 1545

Make	**Yanmar**
Model	**3TNE78A**
Type	**4-cycle diesel**
Gross Power @ 2700 RPM	**19.6 kW (26.3 hp)**
Torque @ 2700 RPM (Rated Speed)	**63.2 N•m (46.6 lb-ft)**
Torque @ 1600 RPM (Maximum)	**78.5 N•m (57.9 lb-ft)**
Number of Cylinders	**3**
Bore	**78 mm (3.07 in.)**
Stroke	**84 mm (3.31 in.)**
Displacement	**1.204 L (73.5 cu in.)**
Firing Order	**1 - 3 - 2**
Direction of Rotation	**Counterclockwise (viewed from flywheel)**
Combustion System	**Direct injection type**

Compression Ratio 18:1
Cooling . . . . . Liquid
Oil Capacity with Filter (Approximately) . . . . . 3.6 L (3.8 qt)
Governor . . . . . Centrifugal
Slow Idle (No Load) . . . . . 1525 ± 50 rpm
Fast Idle (No Load) . . . . . 3200 ± 50 rpm

Test and Adjustment Specifications

1435

Alternator Drive Belt Deflection at 98 N (22 lb-force) . . . . . 10 - 15 mm (0.40 - 0.60 in.)
Valve Clearance . . . . . 0.2 mm (0.008 in.)
Cylinder Compression Pressure . . . . . 3432 ± 98 kPa (498 ± 14 psi)
Cylinder Compression Pressure (Minimum) . . . . . 2746 ± 98 kPa (398 ± 14 psi)
Pressure Difference Between Cylinders (Maximum) . . . . . 197 - 294 kPa (29 - 43 psi)
Engine Oil Pressure at Rated Speed . . . . . 0.29 ± 0.05 MPa (42 ± 7.2 psi)
Fuel Pump Pressure (Minimum) . . . . . 29 kPa (4.3 psi)
Slow Idle Speed . . . . . 1525 ± 50 rpm
Fast Idle Speed . . . . . 3200 ± 50 rpm

Fuel Injection Nozzles

Opening Pressure . . . . . 11 800 + 1000 - 0 kPa (1712 + 145 - 0 psi)
Leakage at 11 032 kPa (1600 psi) . . . . . No leakage for 10 seconds (Minimum)

Chatter and Spray Pattern
At 11 800 ± 1000 kPa (1712 ± 145 psi)

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

Cooling System Pressure (Maximum Applied) . . . . . 97 kPa (14 psi)
Cooling System Pressure (Minimum after 15 Sec) . . . . . 88 ± 15 kPa (12.8 ± 2.2 psi)
Radiator Cap Valve Opening Pressure . . . . . 88 kPa (12.8 psi)
Thermostat Begin Opening Temperature . . . . . 69.5 - 72.5°C (157 - 163°F)
Thermostat Fully Open Temperature . . . . . 85°C (185°F)
Lift Height Above 85°C (185°F) (Minimum) . . . . . 8 mm (0.315 in.)
Cylinder Pressure (Maximum Applied) . . . . . 2448 kPa (355 psi)

1445 and 1545

Alternator Drive Belt Deflection at 98 N (22 lb-force) . . . . . 10 - 15 mm (0.40 - 0.60 in.)
Valve Clearance . . . . . 0.2 mm (0.008 in.)
Cylinder Compression Pressure . . . . . 3138 ± 98 kPa (455 ± 14 psi)
Cylinder Compression Pressure (Minimum) . . . . . 2555 ± 98 kPa (370 ± 14 psi)
Pressure Difference Between Cylinders (Maximum) . . . . . 245 ± 49 kPa (36 ± 7 psi)
Engine Oil Pressure at Rated Speed . . . . . 0.29 ± 0.05 MPa (42 ± 7.2 psi)
Fuel Pump Pressure (Minimum) . . . . . 29 kPa (4.3 psi)

Slow Idle Speed	1525 ± 50 rpm
Fast Idle Speed	3200 ± 50 rpm
Fuel Injection Nozzles	
Nozzle Opening Pressure	19 600 + 1000/- 0 kPa (2843 + 145/ - 0 psi)
Leakage at 19 500 kPa (2828 psi)	None
Chatter and Spray Pattern at 19 600 ± 1000 kPa (2843 ± 145 psi)	
Slow Hand Lever Movement	Chatter sound
Slow Hand Lever Movement	Fine stream
Fast Hand Lever Movement	Fine atomized spray, 150° spray pattern
Cooling System Pressure (Maximum Applied)	97 kPa (14 psi)
Cooling System Pressure (Minimum after 15 Sec)	88 ± 15 kPa (12.8 ± 2.2 psi)
Radiator Cap Valve Opening Pressure	88 kPa (12.8 psi)
Thermostat Begin Opening Temperature	69.5 - 72.5°C (157 - 163°F)
Thermostat Fully Open Temperature	85°C (185°F)
Lift Height Above 85°C (185°F) (Minimum)	8 mm (0.315 in.)
Cylinder Pressure (Maximum Applied)	2448 kPa (355 psi)

Repair Specifications

1435	
Cooling System Capacity (Approximately)	6.6 L (7 qt)
Exhaust Manifold Mounting Cap Screw Torque	28 N•m (240 lb-in.)
Intake Manifold Mounting Cap Screw Torque	11 N•m (97 lb-in.)
Engine Oil Capacity with Filter (Approximately)	2.7 L (2.8 qt)
Rocker Arm Cover Special Nut Torque	18 N•m (160 lb-in.)
Rocker Arm Assembly Mounting Nut Torque	26 N•m (226 lb-in.)
Cylinder Head Mounting Cap Screw Torque Sequence	
First	27 N•m (20 lb-ft)
Second	41 N•m (30 lb-ft)
Final	59 - 64 N•m (43 - 47 lb-ft)
Cylinder Head Distortion	
Standard (Maximum)	0.05 mm (0.002 in.)
Wear Limit	0.15 mm (0.006 in.)
Allowable Removed Material (Maximum)	0.20 mm (0.008 in.)
Valve Seat Width	
Intake Standard	1.44 mm (0.057 in.)
Intake Wear Limit	1.98 mm (0.078 in.)
Exhaust Standard	1.77 mm (0.07 in.)
Exhaust Wear Limit	2.27 mm (0.089 in.)

Valve Grinding

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

Valve Stem

Measuring Point (3) Distance	20 mm (0.787 in.)
Measuring Point (4) Distance	40 mm (1.575 in.)
Intake Valve Stem Standard OD	6.96 - 6.98 mm (0.274 - 0.275 in.)
Intake Valve Stem OD Wear Limit	6.90 mm (0.272 in.)
Exhaust Valve Stem Standard OD	6.95 - 6.96 mm (0.273 - 0.274 in.)
Exhaust Valve Stem OD Wear Limit	6.90 mm (0.272 in.)

Valve Recession

Intake Valve Standard Recession	0.40 - 0.60 mm (0.016 - 0.024 in.)
Intake Valve Recession Wear Limit	1.0 mm (0.039 in.)
Exhaust Valve Standard Recession	0.75 - 0.95 mm (0.030 - 0.037 in.)
Exhaust Valve Recession Wear Limit	1.0 mm (0.039 in.)

Valve Guides

Valve Guide Standard ID	7.01 - 7.02 mm (0.275 - 0.276 in.)
Valve Guide ID Wear Limit	7.08 mm (0.279 in.)
Intake Valve Guide-to-Valve Stem Standard Oil Clearance	0.03 - 0.06 mm (0.001 - 0.002 in.)
Exhaust Valve Guide-to-Valve Stem Standard Oil Clearance	0.045 - 0.075 mm (0.002 - 0.003 in.)
Valve Guide-to-Valve Stem Oil Clearance Wear Limit (Both)	0.18 mm (0.007 in.)
Valve Guide Knurling Clearance (Maximum)	0.127 - 0.178 mm (0.005 - 0.007 in.)
Valve Guide Replacement Clearance	0.20 mm (0.008 in.)
Valve Guide Height	9 mm (0.354 in.)

Valve Springs

Spring Free Length	37.4 mm (1.472 in.)
Spring Inclination (Maximum)	1.0 mm (0.039 in.)

Piston-to-Cylinder Head Clearance	0.66 - 0.78 mm (0.026 - 0.031 in.)
Connecting Rod Cap Screw Torque	23 - 28 N•m (17 - 20 lb-ft)

Connecting Rod Bearings

Connecting Rod Bearing ID	43.00 - 43.02 mm (1.693 - 1.694 in.)
Connecting Rod Bearing Standard Oil Clearance	0.033 - 0.059 mm (0.001 - 0.002 in.)
Connecting Rod Bearing Oil Clearance Wear Limit	0.15 mm (0.006 in.)

Piston Rings

Top Piston Ring Groove Side Clearance	0.06 - 0.10 mm (0.002 - 0.004 in.)
Middle Piston Ring Groove Side Clearance	0.090 - 0.125 mm (0.004 - 0.005 in.)

Oil Control Ring Groove Side Clearance	**0.020 - 0.055 mm (0.0008 - 0.0022 in.)**
Piston Ring Standard End Gap (All Except Oil Control Ring)	**0.20 - 0.40 mm (0.008 - 0.016 in.)**
Oil Control Ring Standard End Gap	**0.15 - 0.35 mm (0.006 - 0.014 in.)**
Piston Ring End Gap Wear Limit	**1.50 mm (0.059 in.)**

Piston Pins

Piston Pin Standard OD	**20.99 - 21.00 mm (0.826 - 0.827 in.)**
Piston Pin OD Wear Limit	**20.90 mm (0.823 in.)**

Piston Pin Bores

Bore Standard ID	**21.00 - 21.01 mm (0.827 - 0.827 in.)**
Bore ID Wear Limit	**21.02 mm (0.828 in.)**

Piston Pin Bushings

Bushing Standard ID	**21.025 - 21.038 mm (0.828 - 0.828 in.)**
Bushing ID Wear Limit	**21.10 mm (0.831 in.)**
Piston Pin-to-Rod Bore Standard Oil Clearance	**0.025 - 0.047 mm (0.001 - 0.002 in.)**
Piston Pin-to-Rod Bore Oil Clearance Wear Limit	**0.20 mm (0.008 in.)**

Pistons

Diameter Measuring Point (1) Distance	**5 mm (0.197 in.)**
Standard Size Piston Standard OD	**73.96 - 73.98 mm (2.912 - 2.913 in.)**
Standard Size Piston OD Wear Limit	**73.90 mm (2.91 in.)**
Oversize Piston Standard OD	**74.21 - 74.23 mm (2.921 - 2.922 in.)**
Oversize Piston OD Wear Limit	**74.15 mm (2.92 in.)**

Connecting Rods

Side Play	**0.20 - 0.40 mm (0.008 - 0.016 in.)**
Connecting Rod Cap Screw Torque	**23 - 28 N•m (17 - 20 lb-ft)**
Bearing Standard Clearance	**0.03 - 0.06 mm (0.001 - 0.002 in.)**
Bearing Clearance Wear Limit	**0.15 mm (0.006 in.)**

Cylinder Bore

Piston-to-Cylinder Bore Clearance	**0.03 - 0.06 mm (0.001 - 0.002 in.)**
Cylinder Standard Roundness	**0.00 - 0.01 mm (0.0000 - 0.0004 in.)**
Cylinder Roundness Wear Limit	**0.03 mm (0.001 in.)**
Cylinder Standard Taper	**0.00 - 0.01 mm (0.0000 - 0.0004 in.)**
Cylinder Taper Wear Limit	**0.03 mm (0.001 in.)**
Standard Size Cylinder Bore Standard ID	**74.00 - 74.03 mm (2.913 - 2.915 in.)**
Standard Size Cylinder Bore ID Wear Limit	**74.20 mm (2.921 in.)**
Oversize Cylinder Bore Standard ID	**74.25 - 74.28 mm (2.923 - 2.925 in.)**
Oversize Cylinder Bore ID Wear Limit	**74.45 mm (2.931 in.)**

Flywheel

Mounting Cap Screw Torque	**83 - 88 N•m (62 - 65 lb-ft)**
Out-of-Flat (Maximum)	**0.02 mm (0.001 in.)**

Crankshaft and Main Bearings

Crankshaft Sheave Cap Screw Torque	88 N•m (65 lb-ft)
Main Bearing Cap Screw Torque	79 - 83 N•m (58 - 61 lb-ft)
Crankshaft Bend (Maximum)	0.02 mm (0.0008 in.)
Crankshaft Connecting Rod Journal Standard OD	39.97 - 39.98 mm (1.573 - 1.574 in.)
Crankshaft Connecting Rod Journal OD Wear Limit	39.91 mm (1.571 in.)
Crankshaft Main Bearing Journal Standard OD	43.97 - 43.98 mm (1.728 - 1.732 in.)
Crankshaft Main Bearing Journal OD Wear Limit	43.90 mm (1.728 in.)
Main Bearing Standard Oil Clearance	0.04 - 0.09 mm (0.002 - 0.004 in.)
Main Bearing Oil Clearance Wear Limit	0.25 mm (0.010 in.)

Camshaft

Thrust Plate Cap Screw Torque	11 N•m (96 lb-in.)
Standard Bend	0.00 - 0.02 mm (0.00 - 0.0008 in.)
Bend Wear Limit	0.05 mm (0.002 in.)
Standard Lobe Height	33.95 - 34.05 mm (1.336 - 1.341 in.)
Lobe Height Wear Limit	33.75 mm (1.329 in.)
Gear Housing and Flywheel End Journal Standard OD	39.94 - 39.96 mm (1.572 - 1.573 in.)
Gear Housing and Flywheel End Journal OD Wear Limit	39.85 mm (1.569 in.)
Intermediate Journal Standard OD	39.91 - 39.94 mm (1.571 - 1.572 in.)
Intermediate Journal OD Wear Limit	39.85 mm (1.569 in.)
Camshaft Bushing Standard ID	39.98 - 40.05 mm (1.57 - 1.58 in.)
Camshaft Bushing ID Wear Limit	40.05 mm (1.58 in.)
Camshaft Intermediate Bore Standard ID	39.98 - 40.05 mm (1.57 - 1.58 in.)
Camshaft Intermediate Bore ID Wear Limit	40.05 mm (1.58 in.)
Camshaft Flywheel-End Bore Standard ID	39.98 - 40.05 mm (1.57 - 1.58 in.)
Camshaft Flywheel-End Bore ID Wear Limit	40.05 mm (1.58 in.)
Bore Oil Clearance (Maximum)	0.20 mm (0.008 in.)

Camshaft Followers

Standard OD	20.93 - 20.96 mm (0.824 - 0.825 in.)
OD Wear Limit	20.90 mm (0.823 in.)
Bore Standard ID	21.00 - 21.02 mm (0.827 - 0.828 in.)
Bore ID Wear Limit	21.05 mm (0.829 in.)
Tappet-to-Bore Standard Oil Clearance	0.04 - 0.09 mm (0.002 - 0.004 in.)
Tappet-to-Bore Oil Clearance Wear Limit	0.15 mm (0.006 in.)

Timing Gear Cover Mounting Cap Screw Torque	9 N•m (78 lb-in.)
Timing Gear Housing Mounting Cap Screw Torque	11 N•m (96 lb-in.)

Idler Gear

Shaft Standard OD	19.96 - 19.98 mm (0.786 - 0.787 in.)
Shaft OD Wear Limit	19.93 mm (0.785 in.)
Bushing Standard ID	20.00 - 20.02 mm (0.787 - 0.788 in.)

Oil Clearance	0.020 - 0.062 mm (0.0008 - 0.002 in.)
Oil Clearance Wear Limit	0.15 mm (0.006 in.)
Oil Pump	
Gear Backlash	0.11 - 0.19 mm (0.004 - 0.007 in.)
Standard Rotor Shaft OD-to-Housing ID Clearance	0.013 - 0.043 mm (0.0005 - 0.002 in.)
Rotor Shaft OD-to-Housing Clearance Wear Limit	0.2 mm (0.008 in.)
Standard Rotor-to-Pump Housing Side Clearance	0.03 - 0.9 mm (0.001 - 0.004 in.)
Rotor-to-Pump Housing Side Clearance Wear Limit	0.13 mm (0.005 in.)
Standard Outer Rotor-to-Pump Body Clearance	0.10 - 0.16 mm (0.004 - 0.006 in.)
Outer Rotor-to-Pump Body Clearance Wear Limit	0.25 mm (0.006 in.)
Inner Rotor-to-Outer Rotor Clearance (Maximum)	0.15 mm (0.006 in.)
Oil Pressure Regulating Valve Retaining Nut Torque	30 N•m (22 lb-ft)
Fuel Control and Governor Linkage	
Governor Shaft OD Wear Limit	8.01 mm (0.315 in.)
Governor Shaft Bore ID Wear Limit	8.50 mm (0.33 in.)
Governor Shaft Bore Clearance	0.09 mm (0.003 in.)
Sleeve Bore ID Wear Limit	9.00 mm (0.354 in.)
Injection Pump Camshaft OD Wear Limit	7.90 mm (0.311 in.)
Injection Pump Camshaft Clearance	0.15 mm (0.006 in.)
Fuel Injection Nozzles	
Injection Nozzle Body Torque	50 N•m (37 lb-ft)
Leak-Off Fitting Nut Torque	40 N•m (30 lb-ft)
Separator Plate Contact Surface	0.10 mm (0.0039 in.)
1445 and 1545	
Cooling System Capacity 1445 (Approximately)	7.1 L (7.5 qt)
Cooling System Capacity 1545 (Approximately)	7.5 L (8 qt)
Exhaust Manifold Mounting Cap Screw Torque	28 N•m (240 lb-in.)
Intake Manifold Mounting Cap Screw Torque	11 N•m (97 lb-in.)
Engine Oil Capacity with Filter (Approximately)	3.6 L (3.8 qt)
Rocker Arm Cover Special Nut Torque	18 N•m (160 lb-in.)
Rocker Arm Support Cap Screw Torque	26 N•m (226 lb-in.)
Cylinder Head Mounting Cap Screw Torque Sequence	
First	34 N•m (25 lb-ft)
Second	54 N•m (40 lb-ft)
Final	67 - 71 N•m (49 - 52 lb-ft)
Cylinder Head Distortion	
Standard (Maximum)	0.05 mm (0.002 in.)
Wear Limit	0.15 mm (0.006 in.)

Allowable Removed Material (Maximum)	**0.20 mm (0.008 in.)**
Valve Seat Width	
Intake Standard	**1.36 - 1.53 mm (0.054 - 0.060 in.)**
Intake Wear Limit	**1.98 mm (0.078 in.)**
Exhaust Standard	**1.66 - 1.87 mm (0.065 - 0.074 in.)**
Exhaust Wear Limit	**2.27 mm (0.089 in.)**
Valve Grinding	
Intake Valve Face Margin	**0.99 - 1.29 mm (0.039 - 0.051 in.)**
Exhaust Valve Face Margin	**0.95 - 1.25 mm (0.037 - 0.049 in.)**
Valve Face Margin Wear Limit	**0.50 mm (0.020 in.)**
Intake Valve Face Angle	**30°**
Exhaust Valve Face Angle	**45°**
Valve Stem	
Measuring Point (3) Distance	**43 mm (1.70 in.)**
Measuring Point (4) Distance	**60 mm (2.40 in.)**
Intake Valve Stem Standard OD	**6.95 - 6.96 mm (0.274 - 0.274 in.)**
Intake Valve Stem OD Wear Limit	**6.90 mm (0.272 in.)**
Exhaust Valve Stem Standard OD	**6.94 - 6.96 mm (0.273 - 0.274 in.)**
Exhaust Valve Stem OD Wear Limit	**6.90 mm (0.272 in.)**
Valve Recession	
Intake Valve Standard Recession	**0.30 - 0.50 mm (0.012 - 0.020 in.)**
Intake Valve Recession Wear Limit	**1.0 mm (0.039 in.)**
Exhaust Valve Standard Recession	**0.30 - 0.50 mm (0.012 - 0.020 in.)**
Exhaust Valve Recession Wear Limit	**1.0 mm (0.039 in.)**
Valve Guides	
Valve Guide Standard ID	**7.000 - 7.015 mm (0.275 - 0.276 in.)**
Valve Guide ID Wear Limit	**7.08 mm (0.279 in.)**
Intake Valve Guide-to-Valve Stem Standard Oil Clearance	**0.04 - 0.07 mm (0.001 - 0.003 in.)**
Exhaust Valve Guide-to-Valve Stem Standard Oil Clearance	**0.05 - 0.08 mm (0.002 - 0.003 in.)**
Valve Guide-to-Valve Stem Oil Clearance Wear Limit (Both)	**0.18 mm (0.007 in.)**
Valve Guide Knurling Clearance (Maximum)	**0.15 - 0.20 mm (0.006 - 0.008 in.)**
Valve Guide Replacement Clearance	**0.20 mm (0.008 in.)**
Valve Guide Height	**12 mm (0.472 in.)**
Valve Springs	
Spring Free Length	**44.4 mm (1.75 in.)**
Spring Inclination (Maximum)	**1.10 mm (0.044 in.)**
Piston-to-Cylinder Head Clearance	**0.64 - 0.82 mm (0.025 - 0.032 in.)**
Connecting Rod Cap Screw Torque	**37 - 41 N•m (27 - 30 lb-ft)**
Connecting Rod Bearings	
Connecting Rod Bearing ID	**46.00 - 46.02 mm (1.811 - 1.812 in.)**

Connecting Rod Bearing Standard Oil Clearance	**0.04 - 0.09 mm (0.002 - 0.004 in.)**
Connecting Rod Bearing Oil Clearance Wear Limit	**0.25 mm (0.010 in.)**

Piston Rings

Top Ring Groove Side Clearance	**0.08 - 0.11 mm (0.003 - 0.004 in.)**
Middle Ring Groove Side Clearance	**0.04 - 0.07 mm (0.001 - 0.003 in.)**
Oil Control Ring Groove Side Clearance	**0.03 - 0.06 mm (0.001 - 0.002 in.)**
Piston Ring Standard End Gap	**0.20 - 0.40 mm (0.008 - 0.016 in.)**
Piston Ring End Gap Wear Limit	**1.50 mm (0.059 in.)**

Piston Pins

Piston Pin Standard OD	**22.99 - 23.00 mm (0.905 - 0.906 in.)**
Piston Pin OD Wear Limit	**22.90 mm (0.902 in.)**

Piston Pin Bores

Bore Standard ID	**23.00 - 23.01 mm (0.906 - 0.906 in.)**
Bore ID Wear Limit	**23.02 mm (0.906 in.)**

Piston Pin Bushings

Bushing Standard ID	**23.02 - 23.04 mm (0.906 - 0.907 in.)**
Bushing ID Wear Limit	**23.10 mm (0.909 in.)**
Piston Pin-to-Rod Bore Standard Oil Clearance	**0.03 - 0.05 mm (0.001 - 0.002 in.)**
Piston Pin-to-Rod Bore Oil Clearance Wear Limit	**0.20 mm (0.008 in.)**

Pistons

Diameter Measuring Point (1) Distance	**23 mm (0.905 in.)**
Standard Size Piston Standard OD	**77.95 - 77.98 mm (3.069 - 3.070 in.)**
Standard Size Piston OD Wear Limit	**77.90 mm (3.067 in.)**
Oversize Piston Standard OD	**78.20 - 78.23 mm (3.079 - 3.080 in.)**
Oversize Piston OD Wear Limit	**78.15 mm (3.077 in.)**

Connecting Rods

Side Play	**0.20 - 0.40 mm (0.008 - 0.016 in.)**
Connecting Rod Cap Screw Torque	**37 - 41 N•m (27 - 30 lb-ft)**
Connecting Rod End Cap, Cap Screw Torque	**39 N•m (29 lb-ft)**
Bearing Standard Clearance	**0.04 - 0.09 mm (0.002 - 0.004 in.)**
Bearing Clearance Wear Limit	**0.25 mm (0.010 in.)**

Cylinder Bore

Piston-to-Cylinder Bore Clearance (Maximum)	**0.050 mm (0.002 in.)**
Cylinder Standard Roundness	**0.00 - 0.01 mm (0.0000 - 0.0004 in.)**
Cylinder Roundness Wear Limit	**0.03 mm (0.001 in.)**
Cylinder Standard Taper	**0.00 - 0.01 mm (0.0000 - 0.0004 in.)**
Cylinder Taper Wear Limit	**0.03 mm (0.001 in.)**
Standard Size Cylinder Bore Standard ID	**78.00 - 78.03 mm (3.071 - 3.072 in.)**
Standard Size Cylinder Bore ID Wear Limit	**78.20 mm (3.079 in.)**
Oversize Cylinder Bore ID	**78.25 - 78.28 mm (3.081 - 3.082 in.)**

ENGINE - DIESEL (3TNE74 / 3TNE78) SPECIFICATIONS

Flywheel

Mounting Cap Screw Torque	83 - 88 N•m (62 - 65 lb-ft)
Out-of-Flat (Maximum)	0.02 mm (0.001 in.)

Crankshaft and Main Bearings

Main Bearing Cap Screw Torque	76.5 - 80.4 N•m (56 - 59 lb-ft)
Crankshaft Bend (Maximum)	0.02 mm (0.0008 in.)
Crankshaft Connecting Rod Journal Standard OD	42.95 - 42.96 mm (1.691 - 1.691 in.)
Crankshaft Connecting Rod Journal OD Wear Limit	42.91 mm (1.689 in.)
Crankshaft Main Bearing Journal Standard OD	46.95 - 46.96 mm (1.848 - 1.849 in.)
Crankshaft Main Bearing Journal OD Wear Limit	46.91 mm (1.847 in.)
Main Bearing Standard Oil Clearance	0.04 - 0.09 mm (0.002 - 0.004 in.)
Main Bearing Oil Clearance Wear Limit	0.25 mm (0.010 in.)

Camshaft

Thrust Plate Cap Screw Torque	11 N•m (96 lb-in.)
Standard Bend	0.00 - 0.02 mm (0.00 - 0.0008 in.)
Bend Wear Limit	0.05 mm (0.002 in.)
Standard Lobe Height	38.64 - 38.77 mm (1.521 - 1.526 in.)
Lobe Height Wear Limit	38.40 mm (1.512 in.)
Gear Housing and Flywheel End Journal Standard OD	44.93 - 44.95 mm (1.769 - 1.770 in.)
Gear Housing and Flywheel End Journal OD Wear Limit	44.85 mm (1.766 in.)
Intermediate Journal Standard OD	44.91 - 44.94 mm (1.768 - 1.769 in.)
Intermediate Journal OD Wear Limit	44.85 mm (1.766 in.)
Camshaft Bushing Standard ID	44.99 - 45.06 mm (1.771 - 1.774 in.)
Camshaft Bushing ID Wear Limit	45.10 mm (1.776 in.)
Camshaft Intermediate Bore Standard ID	45.00 - 45.03 mm (1.772 - 1.773 in.)
Camshaft Intermediate Bore ID Wear Limit	45.10 mm (1.776 in.)
Camshaft Flywheel-End Bore Standard ID	45.00 - 45.03 mm (1.772 - 1.773 in.)
Camshaft Flywheel-End Bore ID Wear Limit	45.10 mm (1.776 in.)
Bore Oil Clearance (Maximum)	0.20 mm (0.008 in.)

Camshaft Followers

Stem Standard OD	11.98 - 11.99 mm (0.471 - 0.472 in.)
Stem OD Wear Limit	11.93 mm (0.47 in.)
Bore Standard ID	12.00 - 12.02 mm (0.472 - 0.473 in.)
Bore ID Wear Limit	12.05 mm (0.474 in.)
Bore Standard Oil Clearance	0.01 - 0.04 mm (0.0004 - 0.002 in.)
Bore Oil Clearance Wear Limit	0.12 mm (0.005 in.)

Idler Gear

Shaft Standard OD	45.95 - 45.98 mm (1.809 - 1.810 in.)
Shaft OD Wear Limit	45.93 mm (1.808 in.)
Bushing Standard ID	46.00 - 46.03 mm (1.811 - 1.812 in.)

Bushing ID Wear Limit . . . . . 46.03 mm (1.812 in.)
Bore Clearance (Maximum) . . . . . 0.15 mm (0.006 in.)

Oil Pump

Gear Backlash. . . . . 0.12 mm (0.005 in.)
Rotor Shaft Standard Clearance . . . . . 0.01 - 0.04 mm (0.001 - 0.002 in.)
Rotor Shaft Clearance Wear Limit. . . . . 0.20 mm (0.008 in.)
Standard Rotor Recess . . . . . 0.03 - 0.09 mm (0.001 - 0.004 in.)
Rotor Recess Wear Limit . . . . . 0.15 mm (0.006 in.)
Outer Rotor-to-Pump Body Standard Clearance . . . . . 0.10 - 0.16 mm (0.004 - 0.006 in.)
Outer Rotor-to-Pump Body Clearance Wear Limit . . . . . 0.25 mm (0.010 in.)
Inner-to-Outer Rotor Clearance. . . . . 0.15 mm (0.006 in.)

Fuel Injection Nozzles

Retaining Plate Nut Torque . . . . . 5 N•m (44.25 lb-in.)
Retaining Nut Torque . . . . . 7 - 9 N•m (62 - 80 lb-in.)

Special or Required Tools

Front Mower

1435

1445

1545

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

Special or Required Tools:

Tool Name	Tool No.	Tool Use
0 - 700 kPa (0 - 100 psi) Pressure Gauge	JT05577	Used for engine oil pressure test.
Adapter	JDG472 (Model 1435) or JDG560 (Models 1445 and 1545)	Used for cylinder compression check and radiator bubble test.
Adapter Set	D01110AA	Used for fuel injection nozzle test.
Belt Tension Gauge	JDG529 or JDST28	Used to adjust the water pump/alternator drive belt tension.
Bushing, Bearing, and Seal Driver Set	NA	Used for removing and installing bushings, bearings, and seals.
Compression Gauge Assembly	JT01682	Used for cylinder compression check.
Connector	JT03349	Used for engine oil pressure test.
Cooling System Pressure Pump	D05104ST	Used for cooling system pressure test.
Cylinder Leakdown Tester	JT03502	Used to test cylinders for compression pressure leakdown.
Dial Indicator with Magnetic Base	NA	Used to measure valve lift, end play, and backlash.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Diesel Fuel Injection Nozzle Tester	D01109AA	Used for fuel injection nozzle test.
Digital Pulse Tachometer	JT07270	Used to set slow idle speed and check fast idle speed.
Flex Hone (with 180 Grit Stones)	NA	Used to deglaze cylinder bores.
Fuel Pump Pressure Test Kit	JDG356	Used for fuel pump pressure test.
Hose Assembly	JT03017	Used for engine oil pressure test.
Lifting Bracket (2 used)	JT01748	Used with hoist for removing and installing cylinder head and flywheel.
Magnetic Follower Holder Kit	D15001NU	Used to hold cam followers when removing and installing camshaft.
Nozzle Cleaning Kit	JDF13	Used to clean fuel injection nozzles.
PLASTIGAGE® Bearing Clearance Measurement Tool	NA	Used to measure clearances.
Radiator Pressure Test Kit Adapters	JDG692	Used for cooling system pressure test.
Ridge Reamer	NA	Used to remove ridges from cylinder bore.
Rigid Hone (with 300 Grit Stones)	NA	Used with drill press to rebore cylinder to use oversize pistons and rings.
Straight Adapter	23622	Used for fuel injection nozzle test.
Valve Guide Driver	JDE504 (Model 1435) or JDE118 (Models 1445 and 1545)	Used to install valve guides in cylinder head.
Valve Guide Knurler	D-20019WI	Used to knurl inside diameter of valve guides.
Valve Guide Reamer	D-20021WI	Used to ream out valve guides.
Valve Spring Compressor	JDE138	Used to remove valves.

Other Material

Front Mower

1435

1445

1545

Other Material:

Part No.	Part Name	Part Use
TY16021 (U.S.)/ LOCTITE® 17430/ TY9484 (Canada)	John Deere High Flex Form-in-Place Gasket	Used to seal crankcase extension housing, rear oil seal case, and flywheel housing to engine block. Used to seal oil pan to timing gear housing and engine block.
T43512 (U.S.)/ LOCTITE® 242/ TY9473 (Canada)	Thread Lock and Sealer (Medium Strength)	Applied to threads of crankshaft sheave cap screws before installation.

Other Material:

Diagnostics

Part No.	Part Name	Part Use
TY9375 (U.S.)/ LOCTITE® 592/ TY9480 (Canada)	Pipe Sealant	Applied to threads of dual temperature coolant switch before installation.

Engine Troubleshooting

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

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

Engine System

Symptom: Engine Starting Problems

(1) Engine starts?

No - Battery voltage low - recharge battery.

No - Starting motor defective - repair or replace starting motor.

No - Alternator defective - repair or replace alternator.

No - Open circuit in wiring - repair wiring.

No - Fuel filter clogged - replace fuel filter.

No - Clogged or cracked fuel lines - clean or replace fuel lines.

No - Fuel volume to injection pump low - check or replace fuel transfer pump.

No - Water in fuel - check and repair.

No - Improper engine oil viscosity/type - replace engine oil and filter.

No - Improper intake or exhaust valve clearance - adjust valve clearance.

No - Improper timing between injection pump, intake and exhaust valves - adjust valve clearance. Check valve timing.

No - Seized intake/exhaust valve - replace valve and check valve guide.

No - Broken or seized piston ring - replace rings and check cylinder.

No - Piston ring, piston or cylinder worn - bore or hone cylinder and replace piston.

No - Crankshaft pin or bearing seized - regrind crank and replace bearings.

No - Air entering fuel system - check and repair fuel supply system.

Yes - Engine starting procedure ok. Go to next procedure.

Symptom: Engine Starts But Does Not Continue Running

(1) Exhaust smoke absent?

No - Go to next step.

Yes - Fuel filter clogged - replace fuel filter.

Yes - Clogged or cracked fuel lines - clean or replace fuel lines.

Yes - Water in fuel - check and repair.

Yes - Air entering fuel system - check and repair fuel supply system.

Yes - Fuel volume to injection pump low - check or replace fuel transfer pump.

Yes - Improper engine oil viscosity/type - replace engine oil and filter.

Yes - Improper intake or exhaust valve clearance - adjust valve clearance.

Yes - Crankshaft pin or bearing seized - regrind crank and replace bearings.

Yes - Piston ring end gaps not correct - stagger piston ring gaps.

Yes - Governor not functioning properly - repair or replace governor.

Yes - Improper intake or exhaust valve clearance - adjust valve clearance.

(2) Excess exhaust smoke?

Yes - Clogged air filter - clean or replace air filter.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Piston ring, piston or cylinder worn - bore or hone cylinder and replace piston.

Symptom: Low Engine Output

(1) Exhaust color normal?

No - Go to next step.

Yes - Fuel filter clogged - replace fuel filter.

Yes - Air entering fuel system - check and repair fuel supply system.

Yes - Clogged or cracked fuel lines - clean or replace fuel lines.

Yes - Improper intake or exhaust valve clearance - adjust valve clearance.

Yes - Compression leakage from valve seat - grind valve seat; regrind valves.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Leaking cylinder head gasket - replace head gasket.

Yes - Crankshaft pin or bearing worn - regrind crank and replace bearings.

Yes - Improper engine oil viscosity/type - replace engine oil and filter.

Yes - Wrong type of fuel - drain and replace fuel.

Yes - Fuel volume to injection pump low - check or replace fuel transfer pump.

(2) Exhaust color white?

No - Go to next step.

Yes - Water in fuel - check and repair.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

Yes - Retarded fuel injection pump timing - check and adjust fuel injection pump timing.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Piston ring, piston or cylinder worn - bore or hone cylinder and replace piston.

Yes - Piston ring end gaps not correct - stagger piston ring gaps.

Yes - Piston rings installed incorrectly - install piston rings correctly.

Yes - Intake/Exhaust valves worn - check valve guides and stems.

Symptom: Low Engine Output

Yes - Improper timing between injection pump, intake and exhaust valves - adjust valve clearance. Check valve timing.

Yes - Wrong type of fuel - drain and replace fuel.

(3) Exhaust color black?

Yes - Clogged air filter - clean or replace air filter.

Yes - Water pump/alternator belt loose - adjust fan belt tension.

Yes - Engine running too hot - check thermostat, fan belt tension.

Yes - Improper timing between injection pump, intake and exhaust valves - adjust valve clearance. Check valve timing.

Yes - Coolant level low - check cooling system for level/leaks.

Yes - Malfunctioning thermostat - check or replace thermostat.

Yes - Engine at high altitude/temperature - use higher output engine.

Yes - Clogged exhaust pipe - clean exhaust pipe.

Yes - Retarded fuel injection pump timing - check and adjust fuel injection pump timing.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

Yes - Compression leakage from valve seat - grind valve seat; regrind valves.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Wrong type of fuel - drain and replace fuel.

Symptom: Exhaust Problems

(1) Exhaust color white under load?

No - Go to next step.

Yes - Water in fuel - check and repair.

Yes - Engine running too cool - check thermostat.

Yes - Wrong type of fuel - drain and replace fuel.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Yes - Improper timing between injection pump, intake and exhaust valves - adjust valve clearance. Check valve timing.

Yes - Retarded fuel injection pump timing - check and adjust fuel injection pump timing.

Yes - Advanced fuel injection pump timing - check and adjust fuel injection pump timing.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Piston ring, piston or cylinder worn - bore or hone cylinder and replace piston.

Yes - Piston rings installed incorrectly - install piston rings correctly.

(2) Exhaust color black under load?

Yes - Engine at high altitude/temperature - use higher output engine.

Yes - Clogged air filter - clean or replace air filter.

Yes - Wrong type of fuel - drain and replace fuel.

Yes - Clogged exhaust pipe - clean exhaust pipe.

Yes - Excessive volume of fuel injected - check fuel injector pump and injectors.

Yes - Advanced fuel injection pump timing - check and adjust fuel injection pump timing.

Yes - Retarded fuel injection pump timing - check and adjust fuel injection pump timing.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Yes - Improper timing between injection pump, intake and exhaust valves - adjust valve clearance. Check valve timing.

Symptom: Exhaust Problems

Yes - Compression leakage from valve seat - grind valve seat; regrind valves.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Symptom: Engine Runs Rough

(1) Loud knocking noise during combustion?

No - Go to next step.

Yes - Advanced fuel injection pump timing - check and adjust fuel injection pump timing.

(2) Misfiring

No - Go to next step.

Yes - Improper timing between injection pump, intake and exhaust valves - adjust valve clearance. Check valve timing.

Yes - Improper intake or exhaust valve clearance - adjust valve clearance.

Yes - Compression leakage from valve seat - grind valve seat; regrind valves.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Crankshaft pin or bearing seized - regrind crank and replace bearings.

Yes - Crankshaft pin or bearing worn - regrind crank and replace bearings.

Yes - Connecting rod bolt loose - check for damage and re-torque bolts.

Yes - Foreign matter in combustion chamber - remove head and inspect for damage.

Yes - Excessive timing gear backlash - measure timing gear backlash.

(3) Uneven combustion sound?

No - Go to next step.

Yes - Clogged air filter - clean or replace air filter.

Yes - Clogged exhaust pipe - clean exhaust pipe.

Yes - Water in fuel - check and repair.

Yes - Wrong type of fuel - drain and replace fuel.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Symptom: Engine Runs Rough

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

(4) Engine surges during idle?

No - Go to next step.

Yes - Water in fuel - check and repair.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Crankshaft pin or bearing seized - regrind crank and replace bearings.

Yes - Crankshaft pin or bearing worn - regrind crank and replace bearings.

Yes - Governor not functioning properly - repair or replace governor.

(5) Engine surges under load?

No - Go to next step.

Yes - Water in fuel - check and repair.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Yes - Governor not functioning properly - repair or replace governor.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Crankshaft pin or bearing seized - regrind crank and replace bearings.

Yes - Crankshaft pin or bearing worn - regrind crank and replace bearings.

(6) Excessive engine vibration?

No - Go to next step.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Symptom: Engine Runs Rough

Yes - Crankshaft pin or bearing seized - regrind crank and replace bearings.

Yes - Crankshaft pin or bearing worn - regrind crank and replace bearings.

Yes - Connecting rod bolt loose - check for damage and re-torque bolts.

Yes - Governor not functioning properly - repair or replace governor.

Yes - Advanced fuel injection pump timing - check and adjust fuel injection pump timing.

(7) Poor return to low speed?

Yes - Governor not functioning properly - repair or replace governor.

Yes - Go through diagnostic procedures and/or go back to steps procedures for “Engine Runs Rough”.

Fuel Consumption

System: Fuel Consumption Excessive

(1) Excessive fuel consumption?

Yes - Compression leakage from valve seat - grind valve seat; regrind valves.

Yes - Engine running too cool - check thermostat.

Yes - Excessive volume of fuel injected - check fuel injector pump and injectors.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

No - Go through diagnostic procedures.

Lubrication

System: Lubricating Oil

(1) Excessive oil consumption?

No - Go to next step.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Piston ring, piston or cylinder worn - bore or hone cylinder and replace piston.

Yes - Piston ring end gaps not correct - stagger piston ring gaps.

Yes - Piston rings installed incorrectly - install piston rings correctly.

Yes - Foreign matter in combustion chamber - remove head and inspect for damage.

Yes - Intake/Exhaust valves worn - check valve guides and stems.

Yes - Improper engine oil viscosity/type - replace engine oil and filter.

Yes - External/Internal oil leak - repair.

Yes - Excessive volume of fuel injected - check fuel injector pump and injectors.

(2) Fuel in crankcase?

No - Go to next step.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Piston ring, piston or cylinder worn - bore or hone cylinder and replace piston.

(3) Water in crankcase?

No - Go to next step.

Yes - Leaking cylinder head gasket - replace head gasket.

Yes - Cracked water jacket - repair or replace water jacket.

(4) Low oil pressure?

Yes - Oil level low - add oil.

Yes - Oil filter clogged - replace oil filter.

Yes - Improper engine oil viscosity/type - replace engine oil and filter.

Yes - External/Internal oil leak - repair.

System: Lubricating Oil

Yes - Crankshaft pin or bearing worn - regrind crank and replace bearings.

Yes - Connecting rod bolt loose - check for damage and re-torque bolts.

Yes - Cracked water jacket - repair or replace water jacket.

Yes - Oil pressure relief valve worn - clean, adjust or replace relief valve.

Coolant

Symptom: Temperature Problems

(1) Overheating?

No - Go to next step.

Yes - Leaking cylinder head gasket - replace head gasket.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Engine running too hot - check thermostat, fan belt tension.

Yes - Coolant level low - check cooling system for level/leaks.

Yes - Cracked water jacket - repair or replace water jacket.

Yes - Malfunctioning thermostat - check or replace thermostat.

Yes - Water pump/alternator belt loose - adjust fan belt tension.

Yes - Excessive volume of fuel injected - check fuel injector pump and injectors.

Yes - Engine at high altitude/temperature - use higher output engine.

(2) Low water temperature?

Yes - Engine running too cool - check thermostat.

Yes - Malfunctioning thermostat - check or replace thermostat.

Compression

Symptom: Overall Compression Problems

(1) Low Compression?

Yes - Oil filter clogged - replace oil filter.

Yes - Improper engine oil viscosity/type - replace engine oil and filter.

Yes - Excessive volume of fuel injected - check fuel injector pump and injectors.

Yes - Compression leakage from valve seat - grind valve seat; regrind valves.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Piston ring, piston or cylinder worn - bore or hone cylinder and replace piston.

Yes - Crankshaft pin or bearing seized - regrind crank and replace bearings.

Yes - Piston ring end gaps not correct - stagger piston ring gaps.

Yes - Piston rings installed incorrectly - install piston rings correctly.

Yes - Foreign matter in combustion chamber - remove head and inspect for damage.

Yes - Intake/Exhaust valves worn - check valve guides and stems.

Symptom: Intake Manifold Pressure Problem

(1) Low pressure?

No - Go to next step.

Yes - Improper intake or exhaust valve clearance - adjust valve clearance.

Yes - Compression leakage from valve seat - grind valve seat; regrind valves.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Clogged air filter - clean or replace air filter.

Yes - Engine at high altitude/temperature - use higher output engine.

(2) High pressure?

Yes - Excessive volume of fuel injected - check fuel injector pump and injectors.

Air Intake System Check

Front Mower

1435

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Test Conditions:

- Machine parked on level surface.
- Key switch in off position unless indicated otherwise.

Check air filter restriction indicator. (Engine running.)	**Plunger in green area of gauge. Go to next step.** • Plunger in red area. Replace air cleaner filter elements.
Check air cleaner housing for damage.	**Air cleaner housing sealed, not damaged. Go to next step.** • If housing is damaged and not sealing, replace air cleaner housing assembly.
Check air cleaner hoses and clamps.	**Hoses not cracked, clamps tight.** • Hoses cracked or clamps loose. Replace hoses and/or tighten clamps.

Cooling System Check

Front Mower

1435

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Test Conditions:

- Machine parked on level surface.
- Key switch in off position.

Check coolant level in radiator.	**Radiator is full to top of filler neck. Go to next step.** • Coolant level low. Add proper coolant mix.
Check coolant for discoloration (brown) or contamination with oil or fuel.	**Coolant not contaminated. Go to next step.** • Coolant contaminated or discolored. Drain and flush system. Check for source of contamination. Refill cooling system with correct coolant.
Check radiator screen for debris.	**Radiator screen free of debris. Go to next step.** • Radiator screen full of debris. Clean or replace.
Check radiator for damage or leakage.	**Radiator not damaged or leaking. Go to next step.** • Radiator damaged or leaking. Repair or replace radiator.
Check if radiator cap is loose.	**Radiator cap tight. Go to next step.** • Radiator cap not tight. Pressure test radiator and cap. (See “Cooling System Pressure Test” on page 130, and “Radiator Cap Pressure Test” on page 132.)
Check radiator hoses for leaks.	**Hoses not cracked or leaking, clamps tight. Go to next step.** • Hoses leak. Replace hoses and tighten clamps. Pressure test cooling system. (See “Cooling System Pressure Test” on page 130.)
Check fan.	**Fan blades not damaged. Go to next step.** • Blades are damaged. Replace fan.
Check thermostat for corrosion, rust, or debris. Check opening temperature. (See “Thermostat Opening Test” on page 132.)	**Free of corrosion, rust, or debris. Opening temperature within specification.** • Thermostat corroded or not opening within specification. Replace thermostat.

Engine Exterior Inspection

Front Mower

1435

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Test Conditions:

- Machine parked on a level surface.
- Key switch in off position.

Check gaskets, seals, plugs, cylinder head, block, and intake manifold and breather.	**No external leakage. Go to next step.** • If leakage exists, replace gaskets as needed.
Check muffler.	**Not restricted.** • If restricted, replace muffler.

Engine Oil and Lubrication System Check

Front Mower

1435

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Test Conditions:

- Machine parked on a level surface.
- Key switch in off position.

Engine dipstick - engine oil check.	**Oil level between "ADD" and "FULL" marks. Oil not burnt, nor contaminated with metal particles, fuel, or coolant. Go to next step.** • Change oil and inspect for source of contamination.
Check oil pressure.	**Oil pressure to correct specification.** • Test engine oil pressure. (See "Engine Oil Pressure Test" on page 122.)

Engine Performance Check

Front Mower

1435

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Test Conditions:

- Machine parked on level surface.
- Key switch in off position unless indicated otherwise.

Check glow plug indicator light. (Key in run position.)	**Indicator light should come on up to 30 seconds, depending on air temperature. When ready to start, light will go out. Go to next step.** • Glow plug light inoperative or will not turn off. (Go to “Air Preheater/Glow Plug Circuit Diagnosis - Diesel Engine” in the Electrical section.)
Check intake and exhaust valve adjustment. (See “Valve Clearance Adjustment” on page 119.)	**Cold engine. Valve clearance within specification. Go to next step.** • Valve clearance not within specification. Adjust valve clearance.
Check intake and exhaust valves sticking.	**Valves not sticking. Go to next step.** • Valves sticking. Check valve guides and stems.
Check cylinder compression. (See “Cylinder Compression Test” on page 121.)	**Cylinder compression within specification. Pressure difference between cylinders within specification. Go to next step.** • Compression not within specification. Rebuild engine.
Check flywheel and starter cranking rpm.	**Minimum cranking rpm within specification. Go to next step.** • Cranking rpm not within specification. (See “Starting Motor Loaded Amperage Draw Test” on page 470 in Electrical section.)
Check injection pump idle settings. (Engine running.)	**Engine runs smooth under load. Engine rpm to specifications.** • Engine runs rough. (See “Slow Idle Speed Adjustment” on page 125, and “Throttle Cable Adjustment” on page 126.)

Fuel System Check

Front Mower

1435

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Test Conditions:

- Machine parked on level surface.
- Key switch in off position unless indicated otherwise.

Check fuel tank for contamination or water.	**Fuel level correct, not contaminated. Correct grade of fuel, no water. Go to next step.** • Incorrect fuel grade, contamination or water exists. Drain and clean fuel tank. Add fresh fuel.
Check fuel filter.	**Fuel in-line filter free of debris. Go to next step.** • Debris in fuel filter. Replace fuel filter.
Check filter shutoff valve.	**Fuel shutoff valve in on position. Go to next step.** • Fuel shutoff valve off. Move valve to on position.
Check for loose clamps and leaking fuel lines.	**Fuel hoses not cracked or leaking and clamps are tight. Go to next step.** • If leaks exist, tighten clamps or replace fuel lines.
Check throttle cable for binding and correct adjustment. (See “Throttle Cable Adjustment” on page 126.)	**Cable adjusted correctly and not binding. Go to next step.** • Cable binds or is misadjusted. Adjust or replace throttle cable.
Check injection pump timing. (See “Injection Pump Timing Adjustment” on page 130.)	**Timing should be correct. Remove pump as the last possible solution. Go to next step.** • Injection pump out of time. Perform injection pump static timing adjustment. Have pump tested by a qualified service repair shop.
Check fuel shutoff solenoid for engagement. (Key switch in run position.)	**Fuel shutoff solenoid engages. Go to next step.** • If solenoid will not pull in and hold, go to “Fuel Shutoff Solenoid Circuit Diagnosis - Diesel Engine” in Electrical section.
Check operation of fuel filter and fuel pump. (Engine cranking.)	**Fuel pump operating and fuel level increases in filter. Fuel present in return hose at fuel pump. Go to next step.** • No fuel in filter. Test fuel pump pressure. (See “Fuel Pump Pressure Test” on page 124.) • Fuel in filter but not in return hose. Replace fuel filter.
Check fuel injection nozzles. (Key switch in start position - engine cranking.)	**Fuel is present in fuel injection lines at nozzles.** • If no fuel at nozzles, check spray pattern and cracking pressure. (See “Fuel Injection Nozzle Test - 1435” on page 127, or “Fuel Injection Nozzle Test - 1445 and 1545” on page 129.)

Tests and Adjustments

Alternator Drive Belt Tension Check and Adjustment

Front Mower

1435

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Reason:

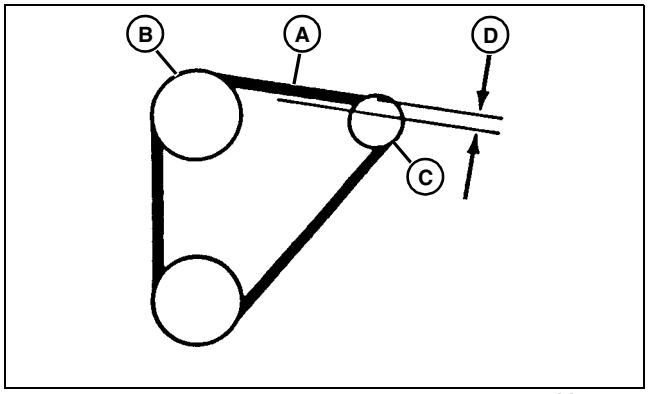
To maintain correct alternator drive belt tension.

Special or Required Tools:

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

Check Procedure:

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



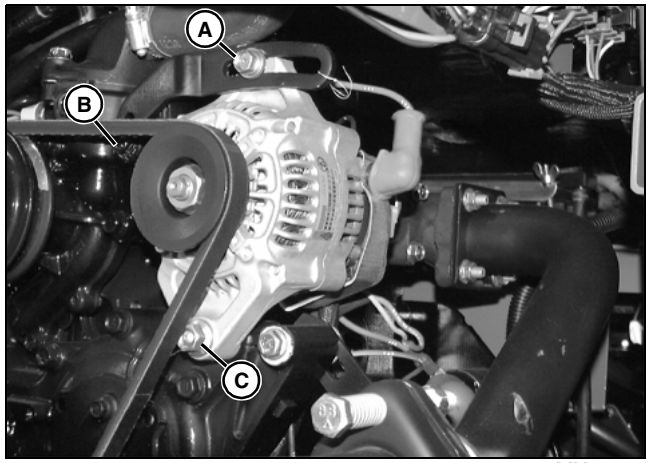
M54014

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

Check Results:

If deflection is not within specification, perform Adjustment Procedure.

Adjustment Procedure:



MX5411

1. Loosen top cap screw (A), mounting bracket cap screw (B), and lower nut (C).
2. Apply force to the alternator housing until tension is correct.
3. Tighten cap screws and nut.

Specifications:

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

Valve Clearance Adjustment

Front Mower

1435

1445

1545

Reason:

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

Special or Required Tools:

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

Procedure:

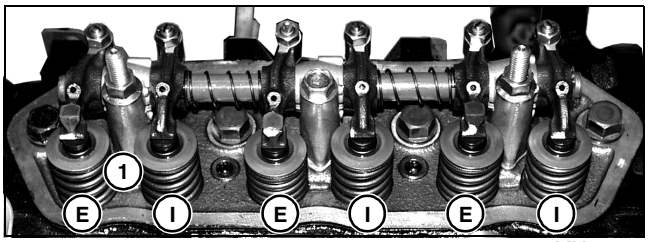
1. Engine must be cool (room temperature) before valve clearance is checked.

2. Be sure ignition is off and key is removed before attempting to turn engine by hand.

3. Remove rocker arm cover. (See “Rocker Arm Cover Removal and Installation” on page 145.)

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

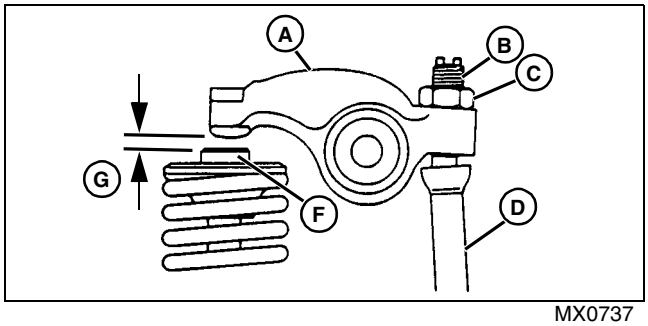
Number one cylinder is located towards front of machine (flywheel side).



MX0738

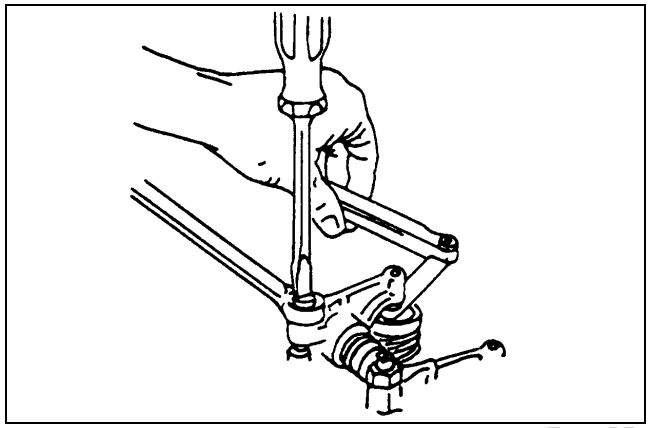
Picture Note: E Identifies the Exhaust Valves, I the Intake Valves

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



MX0737

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

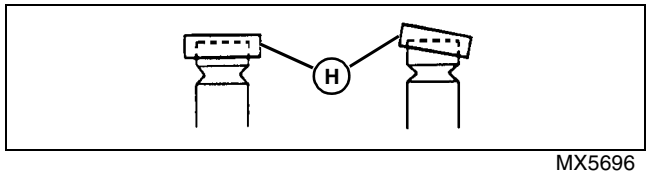


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6. Slide feeler gauge of appropriate size between valve cap (F) and rocker arm. There should be a slight drag on the feeler gauge when the clearance (G) is to specification.

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

8. Recheck valve clearance after tightening lock nut.



MX5696

Picture Note: Left Valve Cap Shows Normal Position

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

10. Repeat steps 4 through 9 for number two and three cylinders.

11. Install rocker arm cover.

Specifications:

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

Valve Lift Check

Front Mower

1435

1445

1545

Reason:

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

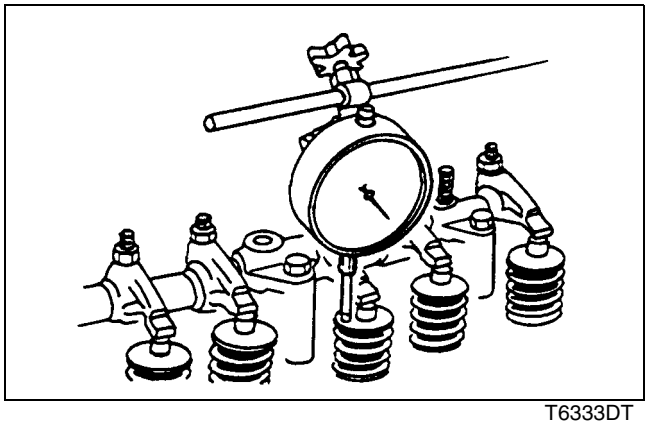
Special or Required Tools:

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

Procedure:

1. Remove rocker arm cover. (See “Rocker Arm Cover Removal and Installation” on page 145.)

2. Check that valve clearance is within specification. Adjust if necessary. (See “Valve Clearance Adjustment” on page 119.)



T6333DT

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

4. Set the dial indicator to zero.

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

6. Repeat for each valve.

Results:

The valve lift should be the same for all valves. If one or more valves have less travel than the others, remove and inspect the camshaft, followers, and push rods. (See “Camshaft” on page 174.) If camshaft, followers, and push rods are within specification, remove and inspect the cylinder head. (See “Cylinder Head Removal and Installation” on page 150.)

Cylinder Compression Test

Front Mower

1435

1445

1545

Reason:

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

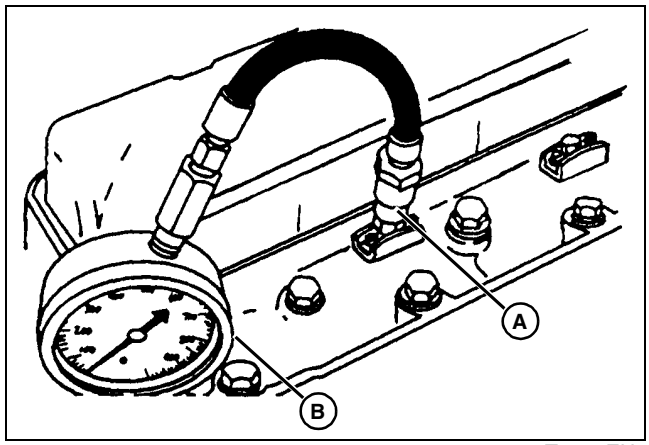
Special or Required Tools:

Tool Name	Tool No.	Tool Use
Compression Gauge Assembly	JT01682	Used to measure cylinder compression pressure.
Adapter	JDG472 (Model 1435) or JDG560 (Models 1445 and 1545)	Used to install gauge assembly.

Procedure:

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

2. Remove injection nozzles.



T6333EU

Picture Note: Models 1445 and 1545 Shown

3. Install the heat protector from end of injector and install JDG472 or JDG560 Adapter (A).

4. Install JT01682 Compression Gauge Assembly (B) and JDG472 or JDG560 Adapter.

5. Disconnect the fuel control solenoid connector.

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

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

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

Results:

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

Specifications:

Model 1435

Cylinder Compression Pressure. . . . . 3432 ± 98 kPa (498 ± 14 psi)

Cylinder Compression Pressure (Minimum) . . . . . 2746 ± 98 kPa (398 ± 14 psi)

Pressure Difference Between Cylinders (Maximum). . . . . 197 - 294 kPa (29 - 43 psi)

Models 1445 and 1545

Cylinder Compression Pressure . . . . . 3138 ± 98 kPa (455 ± 14 psi)

Cylinder Compression Pressure (Minimum) . . . . . 2555 ± 98 kPa (370 ± 14 psi)

Pressure Difference Between Cylinders (Maximum). . . . . 245 ± 49 kPa (36 ± 7 psi)

Engine Oil Pressure Test

Front Mower

1435

1445

1545

Reason:

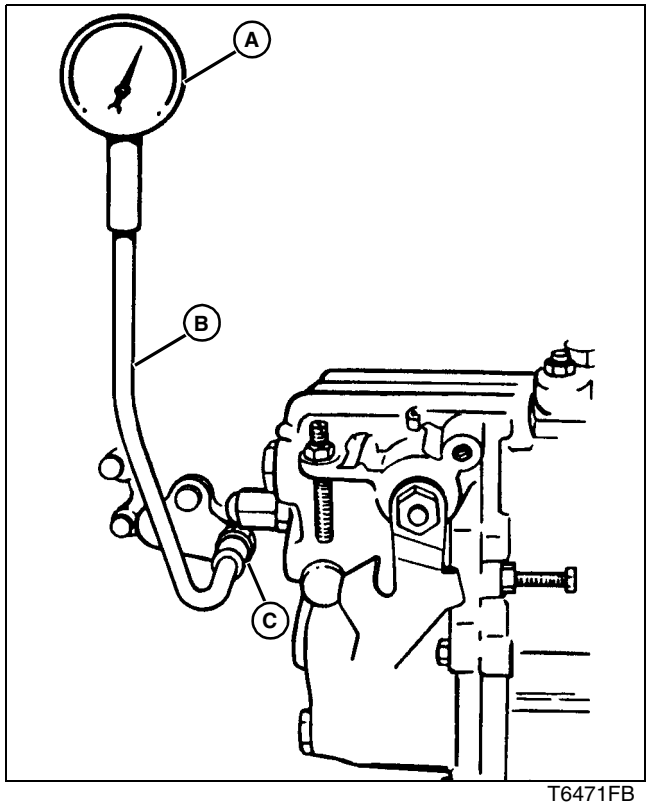
To determine if the engine bearings or the lubrication system components are worn.

Special or Required Tools:

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

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

Procedure:



T6471FB

1. Remove the oil pressure sender.

2. Install JT03349 Connector (C).

3. Connect JT03017 Hose Assembly (B) and JT07034 Gauge (A).

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

4. Start the engine. If the pressure reading is below 0.06 MPa (8.7 psi) at slow idle rpm, stop the engine.

5. If the oil pressure is at least 0.06 MPa (8.7 psi), run the engine approximately five minutes to heat the oil. Check the oil pressure at engine rated speed.

Results:

- If oil pressure is not within specification, inspect the oil pump.
- If oil pump is within specifications, the engine may have parts worn beyond specification. (See “Diagnostics” on page 107 in this section for more information.)

Specifications:

Engine Oil Pressure
at Rated Speed . . . . . 0.29 ± 0.05 MPa (42 ± 7.2 psi)

Air Intake System Leakage Test

Front Mower

1435

1445

1545

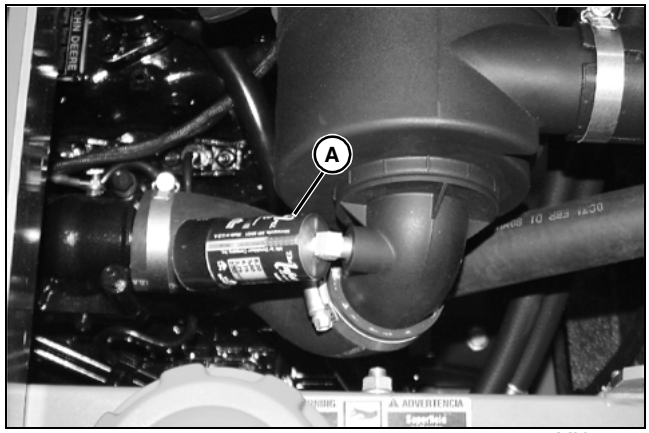
Reason:

Check for leaks in the air intake system.

Special or Required Tools:

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

Procedure:

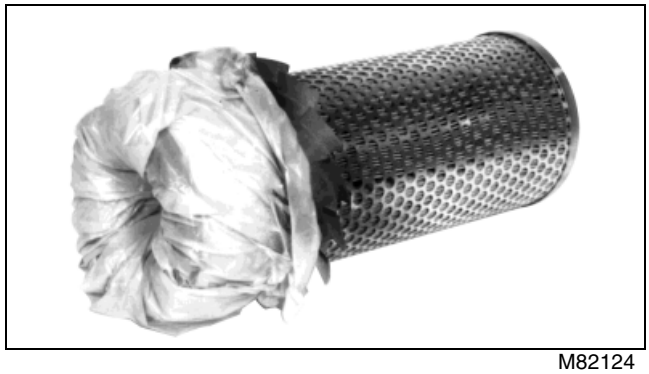


MX5413

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

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

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


M82124

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

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

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

Results:

Find leaks and repair or replace parts as necessary.

Fuel Pump Pressure Test

Front Mower

1435

1445

1545

Reason:

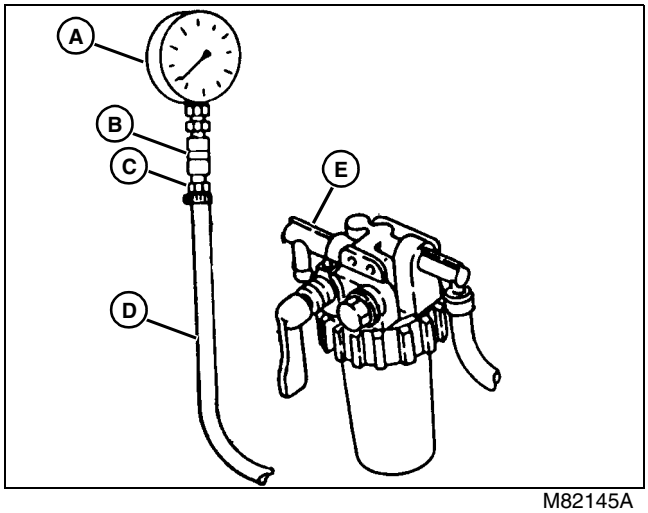
To determine supply pump operating pressure.

Special or Required Tools:

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

Procedure:

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



M82145A

3. Disconnect supply pump-to-filter hose (D) at fuel filter (E).
4. Assemble hose coupling (C), coupling reducer (B), and gauge (A).
5. Connect gauge/fitting assembly to supply pump-to-filter hose.
6. Disconnect wire connector to fuel shutoff solenoid.

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

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

Results:

If pressure is below specification, replace fuel pump.

Specifications:

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

Fuel System Leakage Test

Front Mower

1435

1445

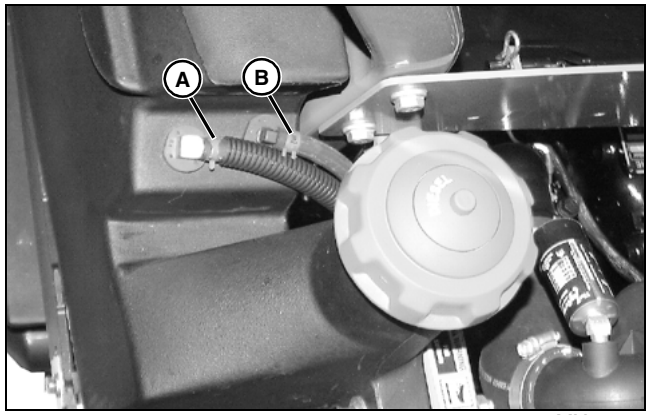
1545

Reason:

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

Procedure:

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



MX5428

3. Disconnect the fuel supply line (A) and return line (B) at the fuel tank.
4. Place the fuel return line into a suitable container to catch drained fuel.

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

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

Results:

Find leaks and repair or replace parts as necessary.

Fuel System Bleeding Procedure

Front Mower

1435

1445

1545

Reason:

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

Procedure:

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

1. Park machine safely.
2. Remove engine cover.
3. Verify that all fuel line connections are tight.
4. Turn fuel filter shutoff valve to open position.
5. Fill fuel tank.
6. Operate hand primer lever on the fuel supply pump for approximately one minute to bleed most of the air back to the tank through the fuel return lines.

Slow Idle Speed Adjustment

Front Mower

1435

1445

1545

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

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

Reason:

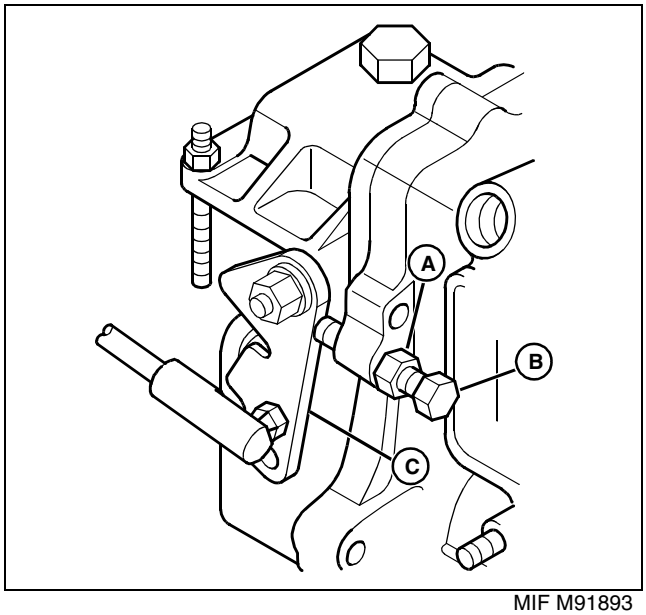
To achieve proper slow idle speed setting. Provides adequate rpm to keep engine running smoothly without stalling.

Special or Required Tools:

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

Procedure:

1. Park machine safely.
2. Start engine and run for five minutes to bring machine to operating temperature.
3. Remove engine cover.
4. Move throttle lever to slow idle position.
5. Use JT07270 Digital Pulse Tachometer to check engine speed at crankshaft pulley.



MIF M91893

6. Visually check that the injection pump throttle lever (C) is against the slow idle stop screw. Check slow idle speed and compare to specification.
7. If slow idle speed does not meet specification, loosen jam nut (A) and turn screw (B). After adjustment, tighten jam nut.
8. After slow idle speed adjustment, adjust throttle cable. (See “Throttle Cable Adjustment” on page 126.)

Specifications:

Slow Idle Speed . . . . . .1525 ± 50 rpm

Throttle Cable Adjustment

Front Mower

1435

1445

1545

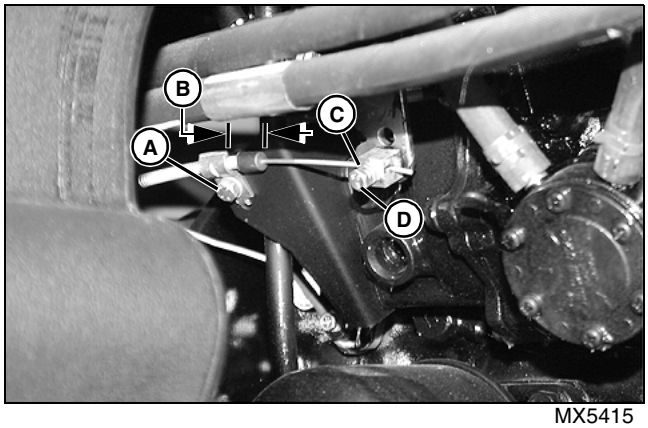
Reason:

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

Procedure:

1. Park machine on level surface with key switch off, transmission in neutral, and park brake on.

2. Remove engine cover.



MX5415

3. Place throttle control in slow idle position.

4. Loosen clamp screw (A), jam nut (C), and cap screw (D).

5. Move cable housing **13.0 mm (0.50 in.)** (B) from edge of clamp to end of cable housing.

6. Tighten clamp screw.

7. With throttle control at slow idle position, and injection pump lever fully seated against slow idle stop, tighten cap screw and jam nut.

8. Move throttle control to fast idle position, making sure injection pump lever is fully seated against fast idle stop.

Fuel Injection System Test

Front Mower

1435

1445

1545

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

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

Reason:

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

Special or Required Tools:

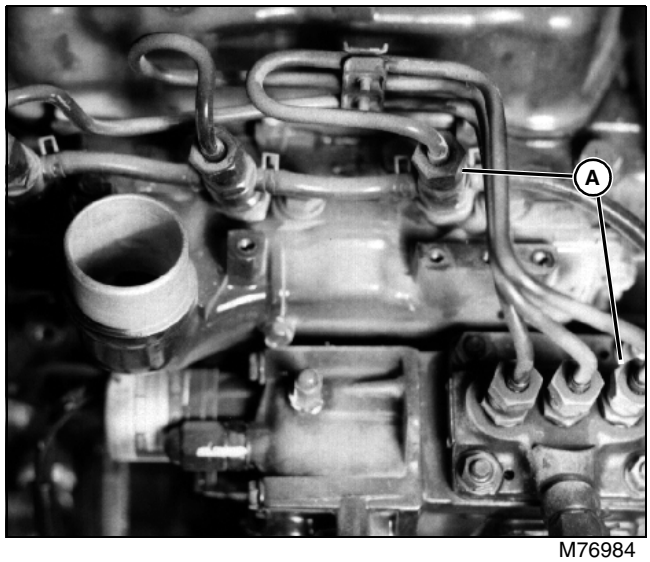
Tool Name	Tool No.	Tool Use
17 mm Open End Wrench (2 used)	NA	Used to loosen nut on high pressure fuel injector line.

Procedure:

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

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

2. Start engine and run at slow idle.



M76984

Picture Note: Model 1435 Shown

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

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

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

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

7. Tighten fuel line nuts and stop engine.

Results:

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

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

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

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

- Fuel injector nozzle opening pressure, spray pattern, and leakage for that cylinder. (See "Fuel Injection Nozzle Test - 1435" on page 127, or "Fuel Injection Nozzle Test - 1445 and 1545" on page 129.)
- Cylinder compression or cylinder leakage. (See "Cylinder Compression Test" on page 121.)
- Fuel supply pump pressure.
- Fuel shutoff solenoid opening fully.
- Fuel control and governor linkage flyweights allowing full fuel flow to injector pump.
- Injection pump timing correct.

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

Fuel Injection Nozzle Test - 1435

Reason:

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

Special or Required Tools:

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

Connections:

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



M35913

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

Pressure Test Procedure:

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

Pressure Test Results:

If pressure reading does not meet specification, disassemble injection nozzle and inspect nozzle assembly for contamination or stuck valve. (See "Fuel Injection Nozzle Removal, Inspection and Installation - 1435" on page 201.) If necessary, add or remove shims to change opening pressure.

Leakage Test Procedure:

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

1. Dry nozzle completely using a lint-free cloth.
2. Pressurize nozzle to 11032 kPa (1600 psi).
3. Watch for leakage from nozzle spray orifice. Keep track of time elapsed before leakage begins. Compare to specification.

Leakage Test Results:

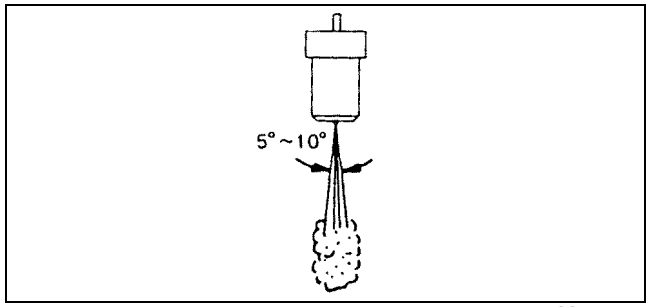
If leakage time does not meet specification, disassemble injection nozzle and inspect nozzle assembly for contamination. Replace nozzle assembly if necessary. (See "Fuel Injection Nozzle Removal, Inspection and Installation - 1435" on page 201.)

Chatter and Spray Pattern Test Procedure:

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

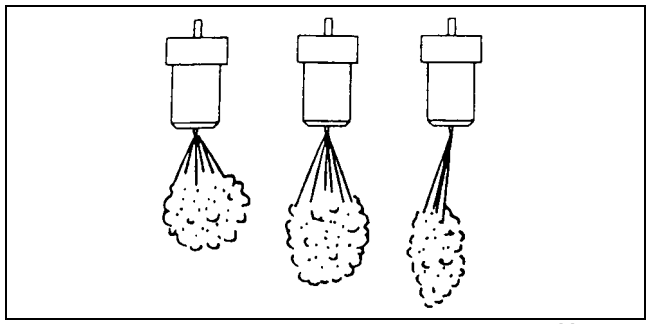
1. Pressurize nozzle until nozzle opening pressure is reached.
2. Listen for "chatter" sound and watch spray pattern.

Chatter and Spray Pattern Test Results:



M76981

Picture Note: Correct Spray Pattern



M76985

Picture Note: Incorrect Spray Patterns

- If nozzle chatter or spray pattern does not meet specifications, disassemble injection nozzle and inspect nozzle assembly for contamination. Inspect valve seating surface. Replace nozzle assembly if necessary. (See "Fuel Injection Nozzle Removal, Inspection and Installation - 1435" on page 201.)
- If there is excessive difference in spray angle or injection angle, incomplete atomizing, or sluggish starting/stopping of injection, disassemble injection nozzle and inspect nozzle assembly for contamination. Replace nozzle assembly if necessary. (See "Fuel Injection Nozzle Removal, Inspection and Installation - 1435" on page 201.)

Specifications:

Fuel Injection Nozzle

Nozzle Opening
Pressure . . . . 11 800 + 1000 - 0 kPa (1712 + 145 - 0 psi)

Leakage at 11 032 kPa
(1600 psi). . . . . No leakage for 10 sec (Minimum)

Chatter and Spray Pattern at 11 800 ± 1000 kPa (1712 ± 145 psi)

Slow Hand Lever Movement . . . . . Chatter sound

Slow Hand Lever Movement . Fine stream, 5 - 10° spray pattern

Fast Hand Lever Movement . . . Fine atomized spray, 5 - 10° spray pattern

Fuel Injection Nozzle Test - 1445 and 1545

Reason:

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

Special or Required Tools:

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

Connections:

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



M35913

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

Pressure Test Procedure:

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

Pressure Test Results:

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

Leakage Test Procedure:

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

1. Dry the nozzle completely using a lint-free cloth.
2. Pressurize the nozzle to 19500 kPa (2828 psi).
3. Watch for leakage from nozzle spray orifice.

Leakage Test Results:

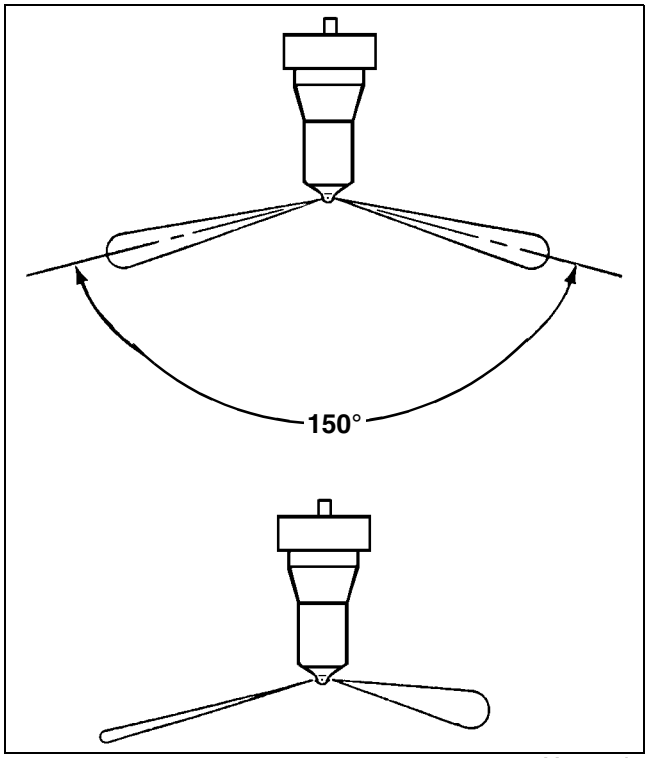
- Fuel should not leak from the nozzle when the nozzle is pressurized.
- If injection nozzle leaks fuel, disassemble and inspect nozzle assembly for contamination. Inspect the valve seating surface. Replace the nozzle assembly if necessary. (See "Fuel Injection Nozzle Removal, Inspection and Installation - 1445 and 1545" on page 204.)

Chatter and Spray Pattern Test Procedure:

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

1. Pressurize nozzle until opening pressure is reached.
2. Listen for "chatter" sound and watch spray pattern. Place a sheet of white paper 30 cm (12 in.) below nozzle. Spray should form a perfect circle on paper.

Chatter and Spray Pattern Test Results:



M82121A

Picture Note: Top Picture Shows Correct Spray Pattern

- If nozzle chatter or spray pattern does not meet specifications, disassemble injection nozzle and inspect nozzle assembly for contamination. (See "Fuel Injection Nozzle Removal, Inspection and Installation - 1445 and 1545" on page 204.) Inspect valve seating surface. Replace nozzle assembly if necessary.
- If there is excessive difference in spray angle or injection angle, incomplete atomizing, or sluggish starting/stopping of injection, disassemble injection nozzle and inspect nozzle assembly for contamination. Replace nozzle assembly if necessary. (See "Fuel Injection Nozzle Removal, Inspection and Installation - 1445 and 1545" on page 204.)

Specifications:

Fuel Injection Nozzle

Nozzle Opening
Pressure . . . . 19 600 + 1000 - 0 kPa (2843 + 145 - 0 psi)

Leakage at 19 500 kPa (2828 psi) . . . . . None

Chatter and Spray Pattern
at 19 600 ± 1000 kPa (2843 ± 145 psi)

Slow Hand Lever Movement . . . . . Chatter sound

Slow Hand Lever Movement . . . . . Fine stream

Fast Hand Lever
Movement . . . . Fine atomized spray, 150° spray pattern

Injection Pump Timing Adjustment

Front Mower

1435

1445

1545

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

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

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

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

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

Cooling System Pressure Test

Front Mower

1435

1445

1545

Reason:

Inspect the cooling system for leaks.

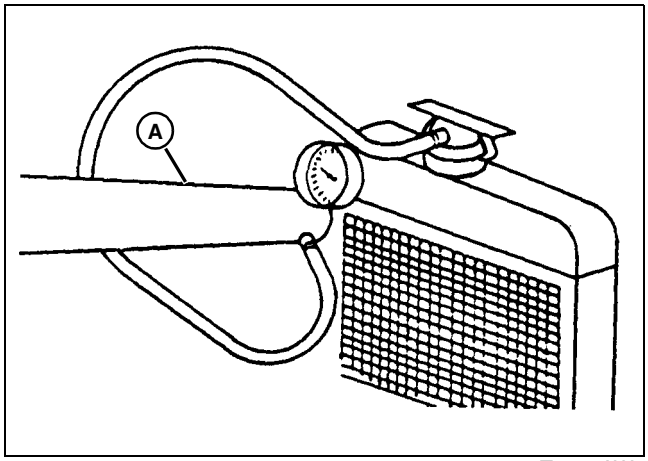
Special or Required Tools:

Tool Name	Tool No.	Tool Use
Cooling System Pressure Pump	D05104ST	Used to pressurize cooling system to check for leaks.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Radiator Pressure Test Kit (Adapters)	JDG692	Used to connect pressure pump to radiator.

Procedure:



T6333AW

1. Remove the cap and attach the pressure pump (A) to radiator.

2. Apply pressure according to minimum specification, but not in excess of maximum specification.

3. Check for leaks throughout the cooling system. After 15 seconds, the minimum pressure should be to specification.

Results:

- Pressure should hold to minimum specification. If pressure decreases, check for leaks. Repair leaks or replace parts as necessary.
- If the pressure test still indicates leakage after all external leaks have been stopped, a defective head gasket, cracked block, or cylinder head may be the cause. (See “Cylinder Leakdown Test” on page 131.)

Specifications:

Cooling System Pressure (Maximum Applied) . . . . . 97 kPa (14 psi)

Cooling System Pressure (Minimum after 15 Sec) . . . 88 ± 15 kPa (12.8 ± 2.2 psi)

Cylinder Leakdown Test

Front Mower

1435

1445

1545

Reason:

To determine if compression pressure is leaking from the cylinder.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Cylinder Leakdown Tester	JT03502	Used to test cylinder for compression pressure leakage.
Adapter	JDG472 (Model 1435) or JDG560 (Models 1445 and 1545)	Used to install gauge assembly.

Procedure:

1. Park machine safely.

2. Remove engine cover.

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

4. Remove cap from recovery tank.

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

   a. Remove fuel injection nozzles.

   b. Install JDG472 (Model 1435) or JDG560 (Models 1445 and 1545) adapter in injection port of cylinder to be tested.

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

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

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

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

6. Repeat for each cylinder.

Results:

- If bubbles are present in the recovery tank, check for cracks in cylinder head and block. Check for damaged

head gasket.

- If air escapes from muffler, check for worn exhaust valve.
- If air escapes from air cleaner, check for worn intake valve.
- If air escapes from engine oil dipstick tube, check for worn piston rings.

Radiator Cap Pressure Test

Front Mower

1435

1445

1545

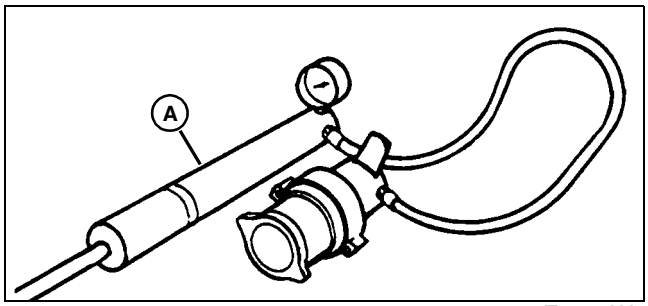
Reason:

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

Special or Required Tools:

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

Procedure:



T6333AX

1. Install the radiator cap on the pressure pump (A).
2. Apply pressure. Pressure valve in the cap should open at specification.

Results:

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

Specifications:

Radiator Cap Valve
Opening Pressure . . . . . 88 kPa (12.8 psi)

Thermostat Opening Test

Front Mower

1435

1445

1545

Reason:

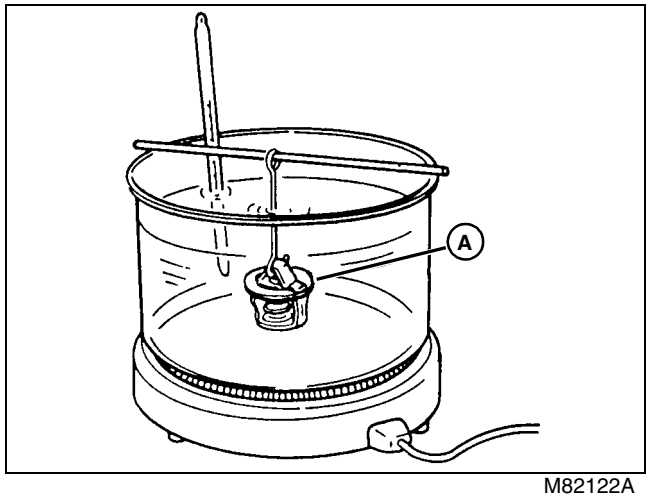
To determine opening temperature of thermostat.

Special or Required Tools:

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

Procedure:

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



M82122A

1. Suspend thermostat (A) and thermometer in a container of water.
2. Heat and stir the water. Observe opening action of thermostat and compare temperatures with specifications.

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

Results:

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

Specifications:

Thermostat Begin Opening Temperature . . . . . 69.5 - 72.5°C (157 - 163°F)

Thermostat Fully Open Temperature . . . . 85°C (185°F)

Lift Height Above 85°C (185°F) (Minimum) . . . . . 8 mm (0.315 in.)

Repair

Alternator Drive Belt Removal and Installation

Front Mower

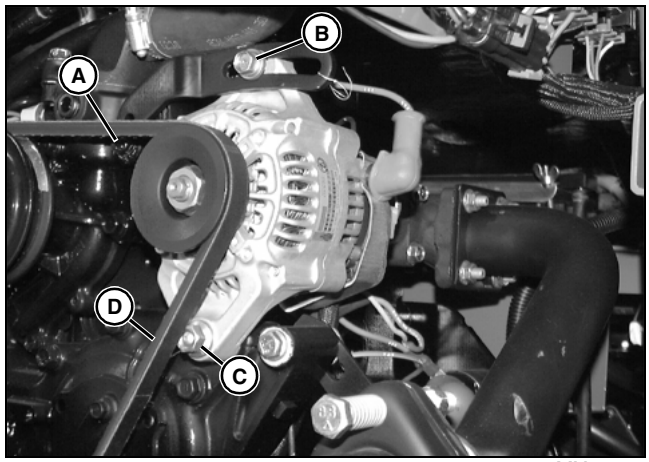
1435

1445

1545

Removal:

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



MX5411

3. Loosen top cap screw (B), mounting bracket cap screw (A), and lower nut (C).
4. Push alternator toward engine to loosen belt.
5. Remove drive belt (D) from alternator pulley.

Installation:

1. Install alternator drive belt. Installation is done in the reverse order of removal.
2. Adjust belt tension. (See “Alternator Drive Belt Tension Check and Adjustment” on page 119.)

Throttle Cable Assembly Removal and Installation

Front Mower

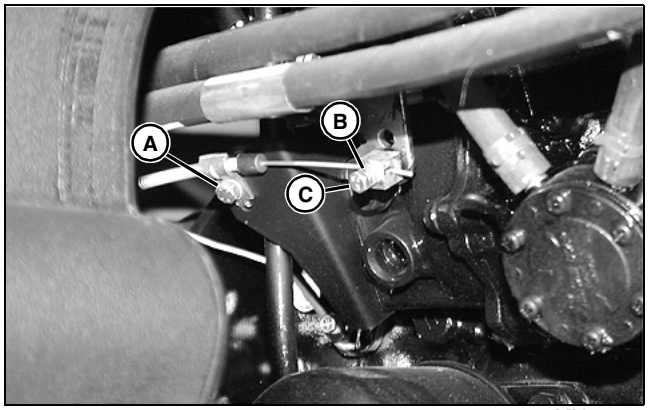
1435

1445

1545

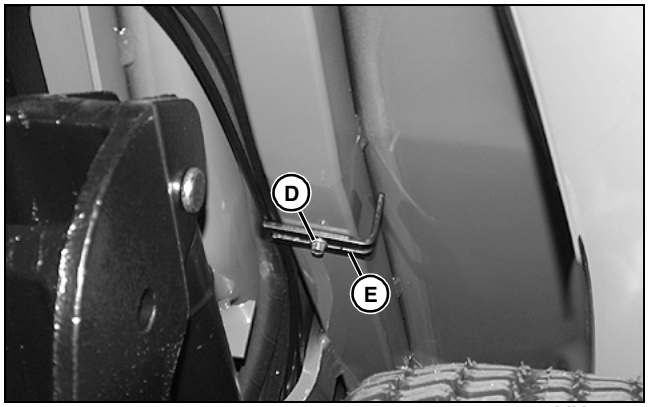
Removal:

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



MX5415

3. Loosen clamp screw (A).
4. Loosen jam nut (B) and cap screw (C).
5. Remove cable from bracket.



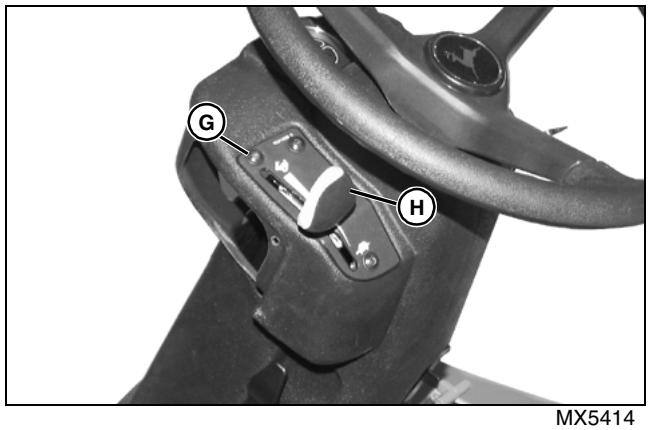
MX5417

6. Loosen cap screw (D) and slide cable retainer (E) on left frame rail.



MX5416

7. Remove steering console cover (F) using a screwdriver as shown.



MX5414

8. Remove control knob (H).
9. Remove three screws (G).
10. Remove throttle cable assembly up through steering console.

Installation:

1. Install throttle cable assembly. Installation is done in the reverse order or removal.
2. Adjust throttle cable. (See “Throttle Cable Adjustment” on page 126.)

Radiator Removal, Installation and Inspection

Front Mower

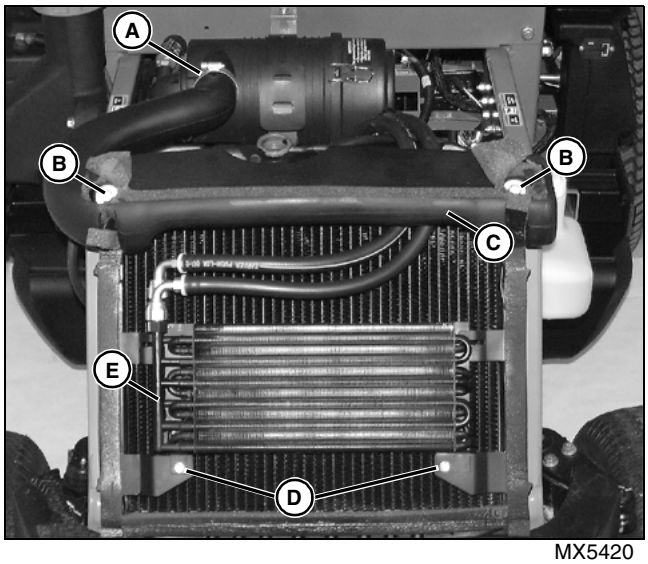
1435

1445

Removal:

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

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

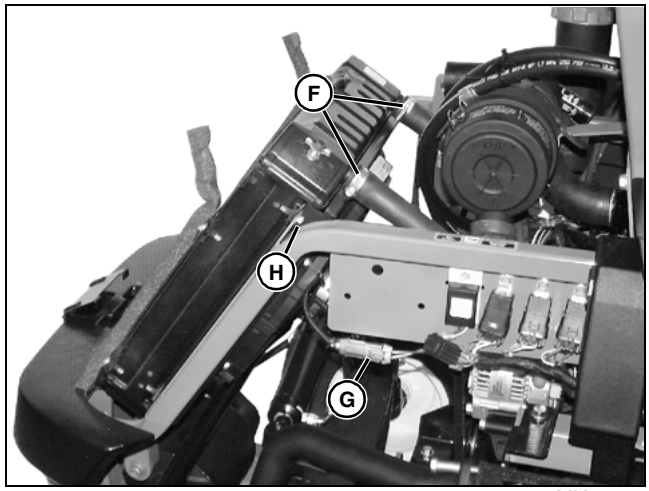


MX5420

7. Loosen clamp (A).
8. Peel back foam and remove two cap screws (B).
9. Remove air box (C).

IMPORTANT: Avoid damage! Use caution when moving oil cooler aside to prevent damaging fins.

10. Remove two cap screws (D) and tilt the oil cooler (E) away from radiator.



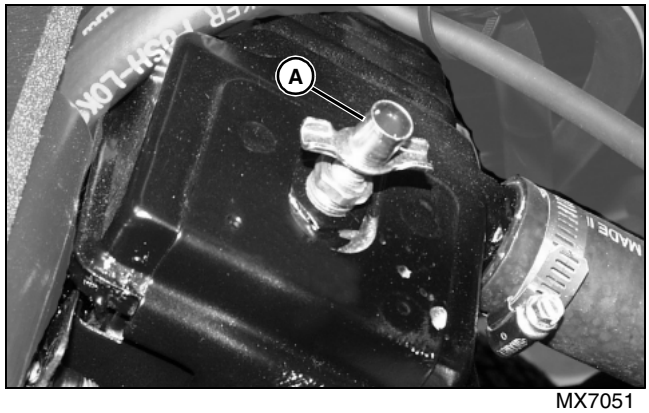
MX5421

Picture Note: Coolant Overflow Tank Removed for Photo Clarity

11. Disconnect overflow hose from radiator.
12. Disconnect cooling fan electrical connector (G).
13. Loosen hose clamps (F).
14. Disconnect hoses from radiator.
15. Remove four cap screws (H).
16. Remove radiator and cooling fan as an assembly.

Installation:

NOTE: Installation is done in the reverse order of removal.



MX7051

1. Open air bleed valve (A) on top of radiator.
2. Fill cooling system until coolant drains out of air bleed valve.
3. Close air bleed valve.
4. Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.

Inspection:

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

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

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

2. Inspect radiator for bent fins, cracks, and damaged seams. Repair or replace radiator if necessary.

Specifications:

Model 1435

Cooling System Capacity (Approximately) . . . . . 6.6 L (7 qt)

Model 1445

Cooling System Capacity (Approximately) . . . . . 7.1 L (7.5 qt)

Model 1545

Cooling System Capacity (Approximately) . . . . . 7.5 L (8 qt)

Radiator Removal, Installation and Inspection

Front Mower

1545

Removal:

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

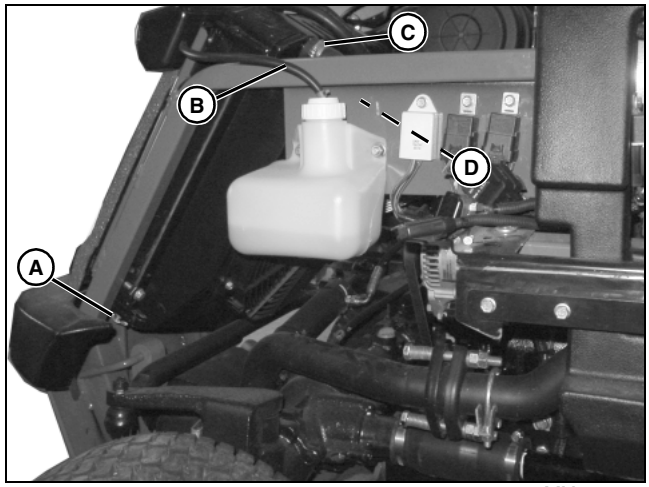
1. Park machine safely.

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

3. Remove engine cover.

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

5. Remove radiator cap.



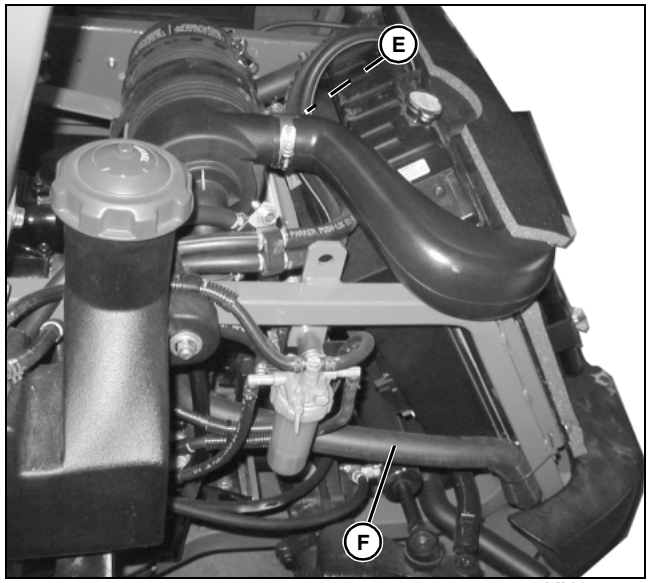
MX16375

6. Attach a 12-inch hose to drain valve (A) located on lower right side of radiator. Drain coolant from radiator into container large enough to hold full capacity of cooling system.

7. Disconnect overflow hose (B) from radiator.

8. Loosen hose clamp and remove hose (C) from radiator.

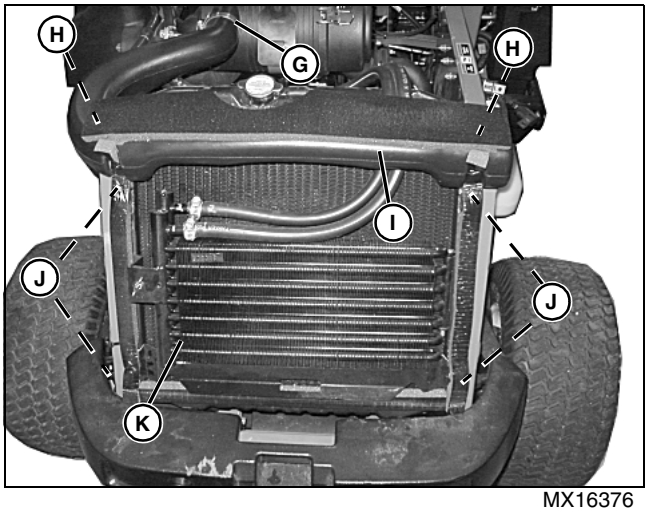
9. Disconnect cooling fan electrical connector (D).



MX16374

10. Remove clamp (E) holding oil cooler hoses to radiator fan housing.

11. Loosen hose clamp and remove hose (F) on left side of radiator.



MX16376

12.Loosen clamp (G).

13.Peel back foam and remove two cap screws (H).

14.Remove air box (I).

IMPORTANT: Avoid damage! Use caution when moving oil cooler aside to prevent damaging fins.

15.Peel back foam and remove four bolts (J) securing radiator and oil cooler to frame. Carefully move the oil cooler (K) and associated brackets away from radiator.

16.Remove radiator and cooling fan as an assembly.

Installation:

NOTE: Installation is done in the reverse order of removal.

- Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.

Inspection:

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

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

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

2. Inspect radiator for bent fins, cracks, and damaged seams. Repair or replace radiator if necessary.

Specifications:

Cooling System Capacity (Approximately) . . . . . 7.5 L (8 qt)

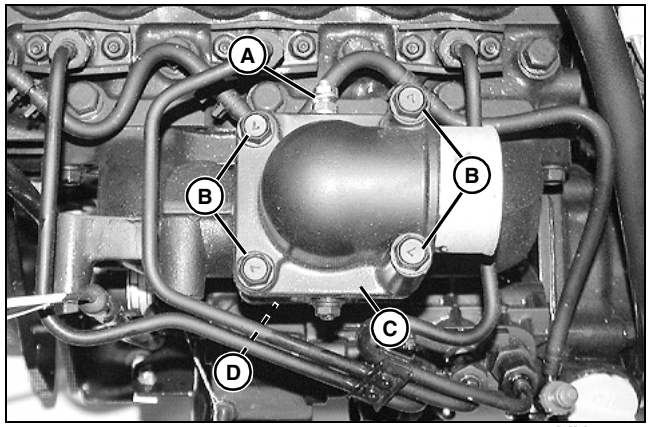
Air Preheater Removal and Installation

Front Mower

1445

1545

Removal:



MX5425

1. Disconnect wire from terminal (A).
2. Remove four cap screws (B).
3. Remove air heater assembly (C) and gasket (D).
4. Test air preheater element.

Installation:

NOTE: Use a new gasket for installation.

Install air preheater. Installation is done in reverse order of removal.

Air Filter Restriction Indicator Removal and Installation

Front Mower

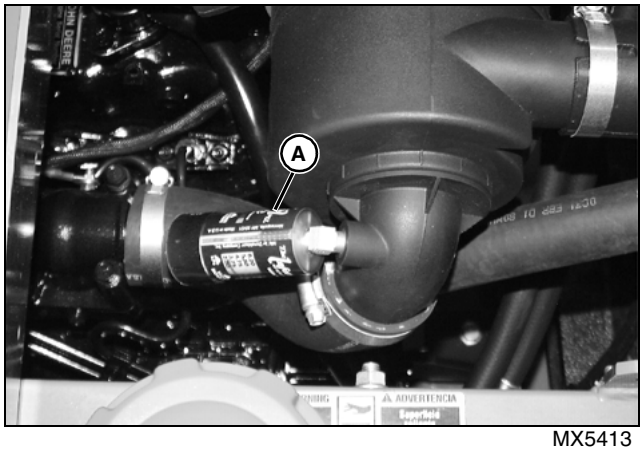
1435

1445

1545

Removal:

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



MX5413

3. Remove air restriction indicator (A).

4. Inspect housing for cracks or other damage. Replace as needed.

Installation:

NOTE: Installation is done in reverse order of removal.

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

Air Cleaner Assembly Removal and Installation

Front Mower

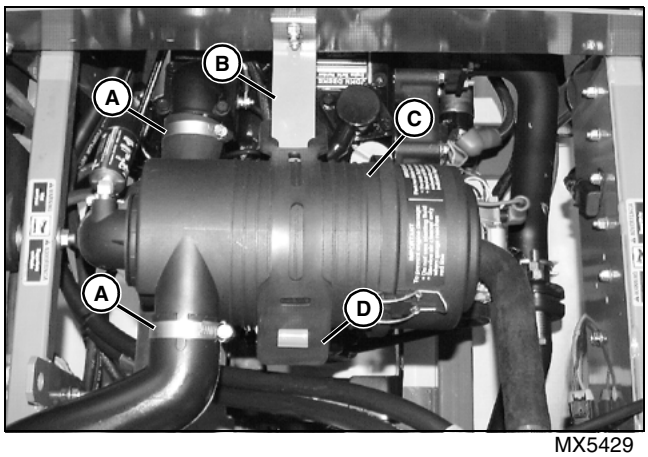
1435

1445

1545

Removal:

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



MX5429

3. Loosen hose clamps (A).
4. Disconnect rubber strap (D) from bracket.
5. Remove air cleaner assembly (C).
6. If greater access to the engine is required, remove support bracket (B).

Installation:

Install air cleaner assembly. Installation is done in reverse order of removal.

Muffler Removal and Installation

Front Mower

1435

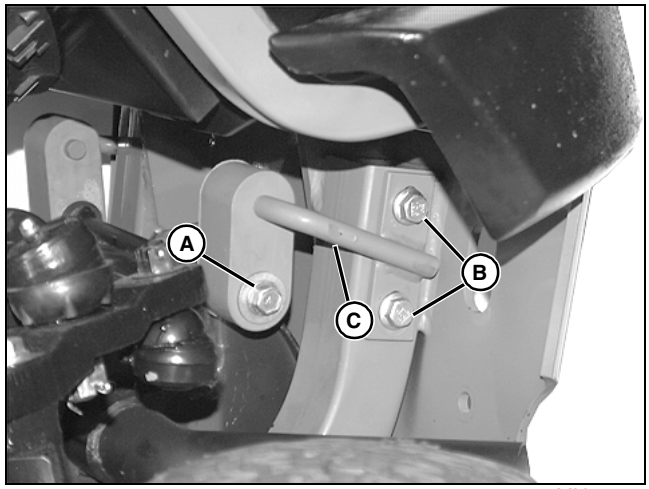
1445

1545

Removal:

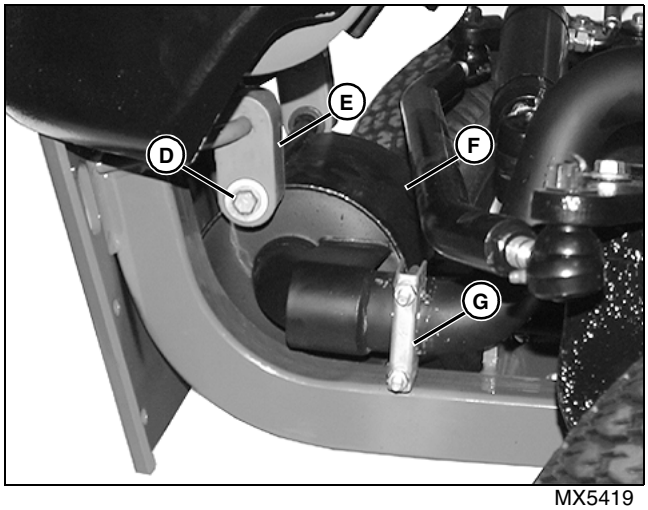
CAUTION: Avoid injury! To prevent possible burns, allow engine to cool before removing muffler.

1. Park machine safely.
2. Turn wheels to the full right turn position to access muffler.
3. Remove engine cover.



MX5418

4. Remove flange-head cap screws (A and B).
5. Remove bracket (C) with rubber hanger from muffler.



MX5419

6. Loosen pipe clamp (G).
7. Remove flange-head cap screw (D).
8. Remove rubber hanger (E) from muffler.
9. Remove muffler (F).

Installation:

Install muffler. Installation is done in reverse order of removal.

Exhaust Pipe Removal and Installation

Front Mower

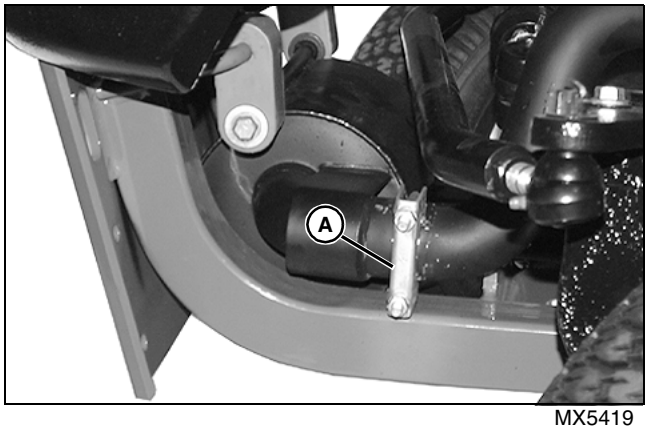
1435

1445

1545

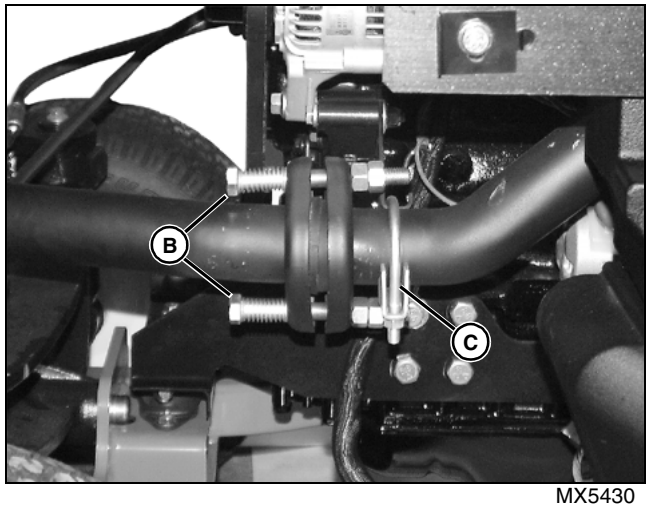
Removal:

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



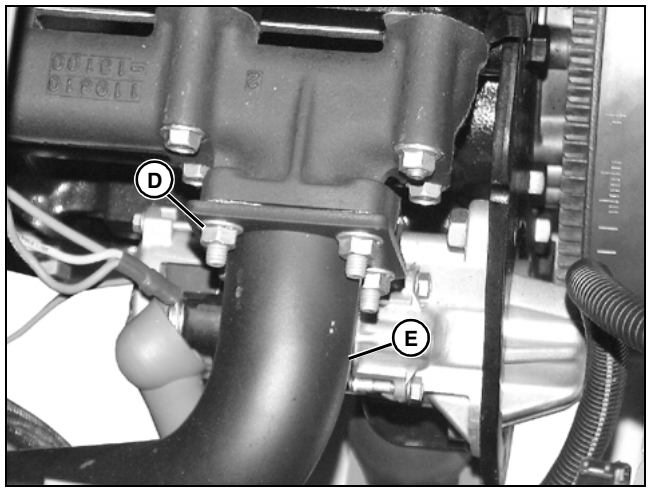
MX5419

3. Remove pipe clamp (A).



MX5430

4. Remove cap screws (B).
5. Remove pipe clamp (C).



MX5431

6. Remove four flange nuts (D).
7. Remove exhaust pipe (E) and gasket.
8. Remove lower exhaust pipe from muffler.

Installation:

NOTE: Install new gasket on exhaust manifold.

Install exhaust pipe. Installation is done in the reverse order of removal.

Exhaust Manifold Removal and Installation

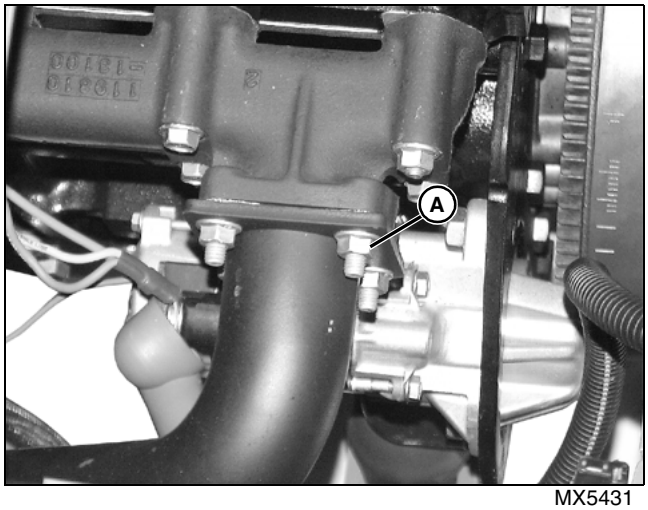
Front Mower

1435

1445

1545

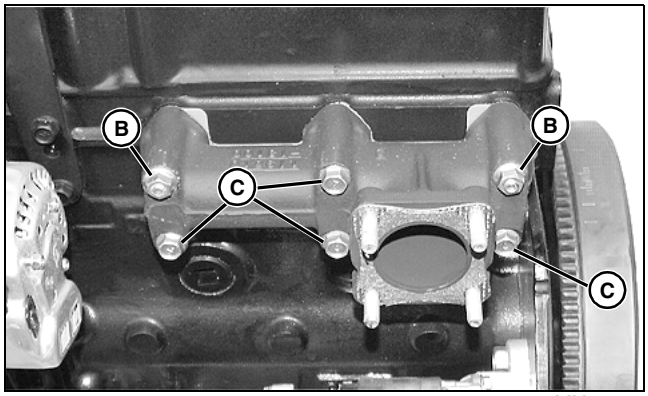
Removal:



MX5431

Picture Note: Models 1445 and 1545 Shown

1. Remove four nuts (A). Slide exhaust pipe off studs. Remove gasket.



MX5427

Picture Note: Models 1445 and 1545 Shown

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

Installation:

NOTE: Installation is done in the reverse order of removal.

1. Install new gasket between exhaust manifold, cylinder head, and exhaust pipe.
2. Tighten mounting cap screws to specification.

Specifications:

Exhaust Manifold Mounting
Cap Screw Torque . . . . . 28 N•m (240 lb-in.)

Intake Manifold Removal and Installation - 1435

Removal:

1. Remove cylinder head. (See “Cylinder Head Removal and Installation” on page 150.)
2. Remove six M6 x 20 intake manifold mounting cap screws.
3. Remove gasket and clean mating surfaces. Check flange for flatness with a straightedge.

Installation:

NOTE: Use a new gasket.

1. Install intake manifold. Installation is done in reverse order of removal.
2. Tighten all mounting cap screws to specification.

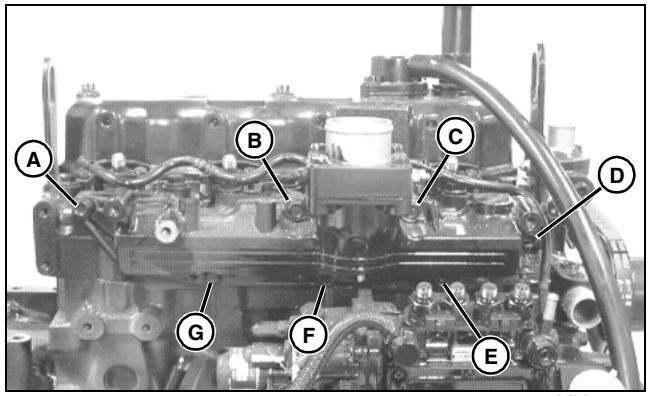
Specifications:

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

Intake Manifold Removal and Installation - 1445 and 1545

Removal:

1. Remove fuel injection lines.



MX2349

2. Remove seven cap screws (A - G).
3. Remove intake manifold and gasket.

Installation:

NOTE: Use a new gasket.

1. Install intake manifold. Installation is done in reverse order of removal.

2. Tighten all mounting cap screws to specification.

Specifications:

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

Thermostat Removal and Installation

Front Mower

1435

1445

1545

Removal:

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

1. Park machine safely.

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

3. Remove engine cover.

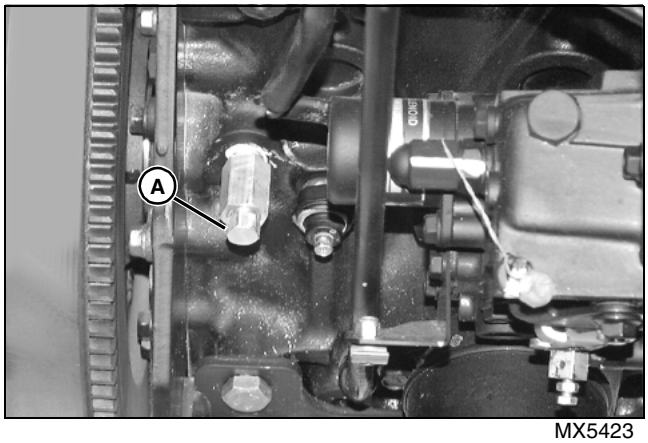
4. Loosen radiator cap to first stop to relieve pressure.

5. Remove radiator cap.

6. Remove air cleaner assembly.

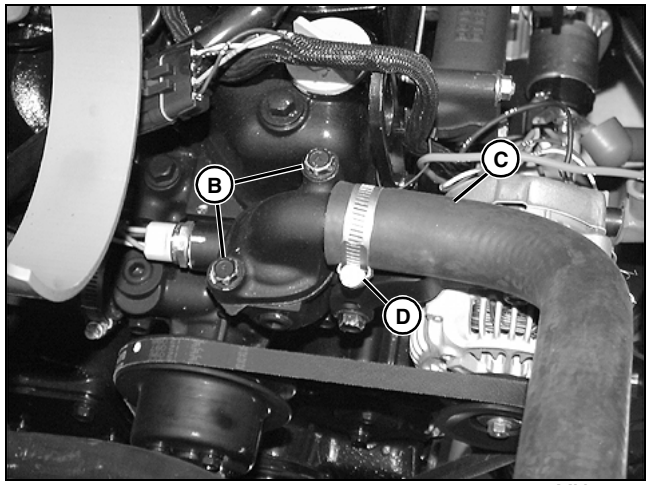
7. Attach a 12-inch hose to drain valve located on lower left side of radiator.

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



MX5423

9. Drain coolant from engine. Drain plug (A) is located on the left side of the engine.



MX5422

10. Loosen hose clamp (D).

11. Remove radiator hose (C) from thermostat cover.

12. Remove two cap screws (B) from cover and remove cover and gasket.

13. Remove thermostat from housing.

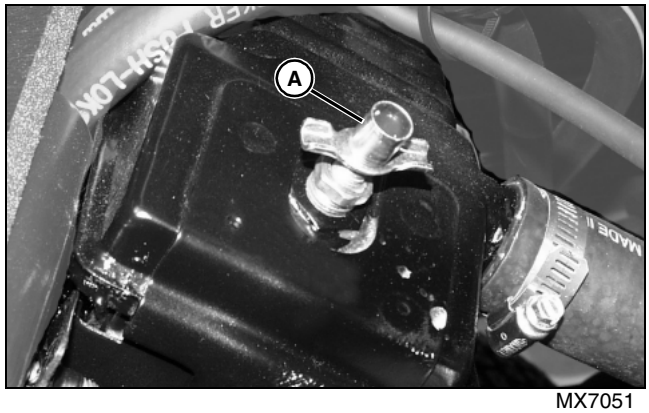
14. If thermostat is to be reinstalled, test thermostat. (See “Thermostat Opening Test” on page 132.)

Installation:

NOTE: Installation is done in reverse order of removal.

1. Install thermostat in housing with spring end inside coolant pump.

2. Place gasket over thermostat and place cover over thermostat on coolant pump.



MX7051

3. Open air bleed valve (A) on top of radiator.

4. Fill cooling system until coolant drains out of air bleed valve.

5. Close air bleed valve.

6. Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.

Specifications:

Model 1435

Cooling System Capacity (Approximately) . . . . . 6.6 L (7 qt)

Model 1445

Cooling System Capacity (Approximately) . . . . . 7.1 L (7.5 qt)

Model 1545

Cooling System Capacity (Approximately) . . . . . 7.5 L (8 qt)

Dual Temperature Coolant Switch Removal and Installation

Front Mower

1435

1445

1545

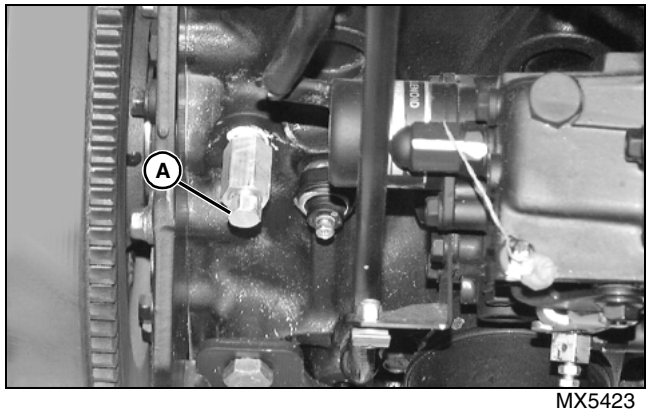
Other Material:

Part No.	Part Name	Part Use
TY9375 (U.S.)/ LOCTITE® 592/TY9480 (Canada)	Pipe Sealant	Applied to threads of dual temperature coolant switch before installation.

Removal:

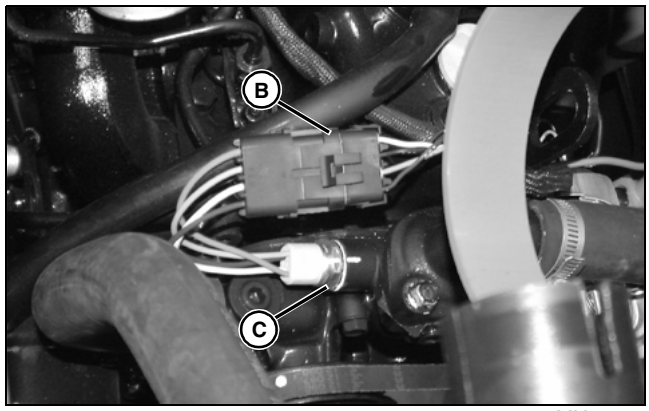
CAUTION: Avoid injury! Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Remove filler cap only when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

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



MX5423

9. Drain coolant from engine. Drain plug (A) is located on the left side of the engine.

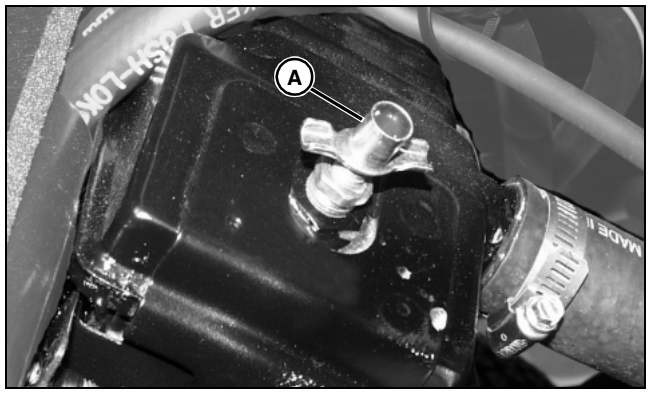


MX5424

10. Disconnect electrical connector (B).
11. Remove switch (C).
12. Test switch. (See “Dual Temperature Coolant Switch Test” on page 475 in the Electrical section.)

Installation:

1. Apply TY9375 Pipe Sealant to dual temperature coolant switch threads.
2. Install switch. Installation is done in reverse order of removal.



MX7051

3. Open air bleed valve (A) on top of radiator.

4. Fill cooling system until coolant drains out of air bleed valve.

5. Close air bleed valve.

6. Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.

Specifications:

Model 1435

Cooling System Capacity (Approximately) . . . . . 6.6 L (7 qt)

Model 1445

Cooling System Capacity (Approximately) . . . . . 7.1 L (7.5 qt)

Model 1545

Cooling System Capacity (Approximately) . . . . . 7.5 L (8qt)

Engine Removal and Installation

Front Mower

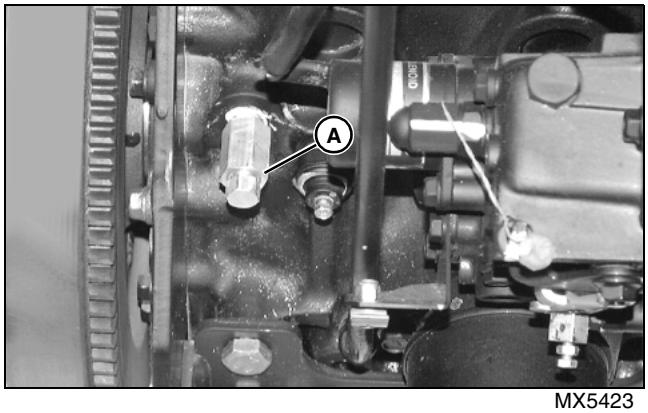
1435

1445

1545

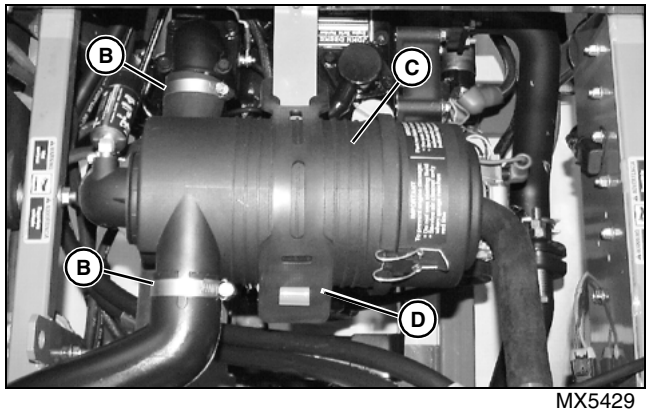
Removal:

1. Park machine on a hard, level surface. Lock park brake.
2. Tilt operator's seat forward.
3. Disconnect battery negative (-) cable from the battery.
4. Remove engine cover.



MX5423

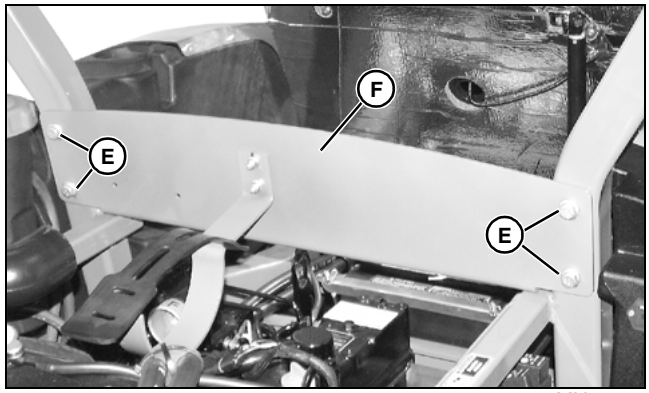
5. Drain coolant from engine drain valve (A) and radiator.



MX5429

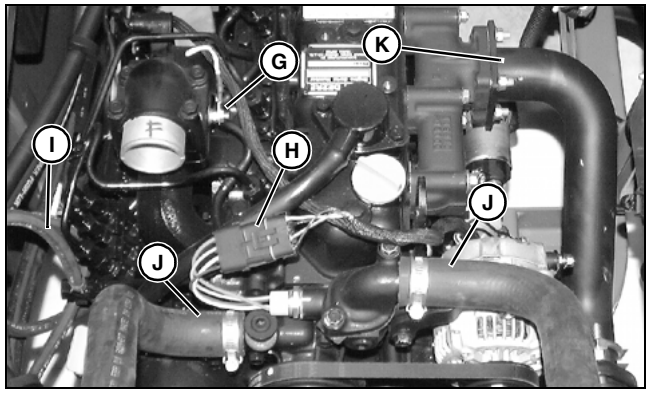
6. Loosen hose clamps (B) on air cleaner hoses.

7. Disconnect rubber strap (D) and remove air cleaner assembly (C).



MX5439

8. Remove four cap screws (E) and remove seat support plate (F).



MX5446

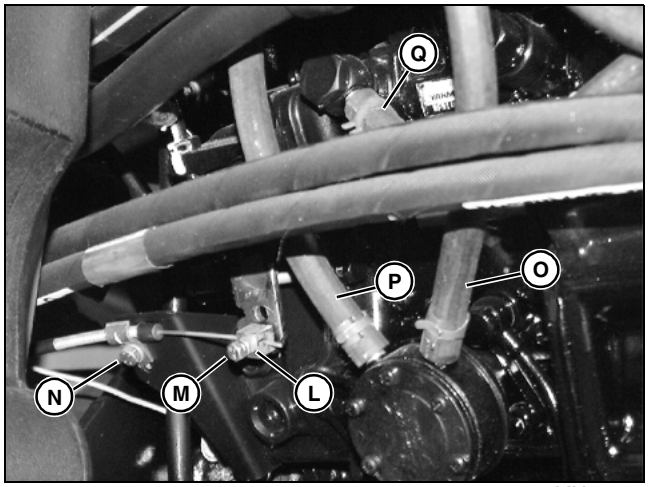
9. Disconnect wire terminal (G) from air preheater.

10. Disconnect wire connector (H) from dual temperature switch.

11. Disconnect fuel return hose (I) from injection pump.

12. Remove radiator hoses (J) from engine and radiator.

13. Remove exhaust pipe (K) from manifold to joint. (See "Exhaust Pipe Removal and Installation" on page 139.)

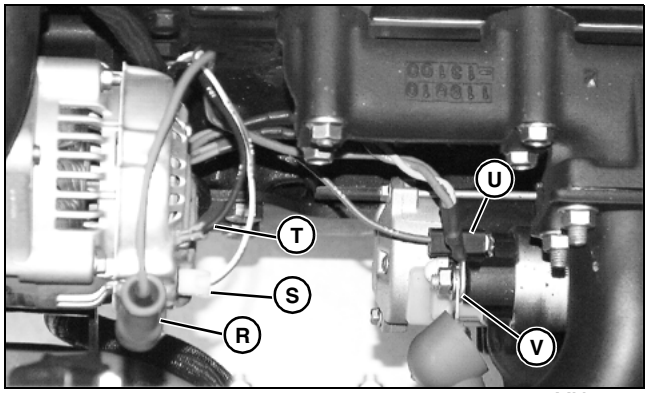


MX5445

14.Loosen jam nut (L) and bolt (M) at injection pump lever.

15.Loosen cable clamp bolt (N). Remove throttle cable from engine.

16.Disconnect fuel inlet hose (O), fuel outlet hose (P) and injection pump fuel inlet hose (Q).



MX5441

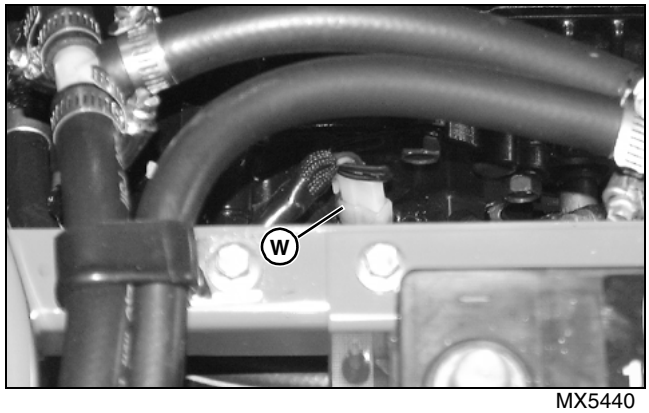
17.Disconnect red wire (R) from alternator.

18.Disconnect wire connector (S).

19.Disconnect black ground wire (T).

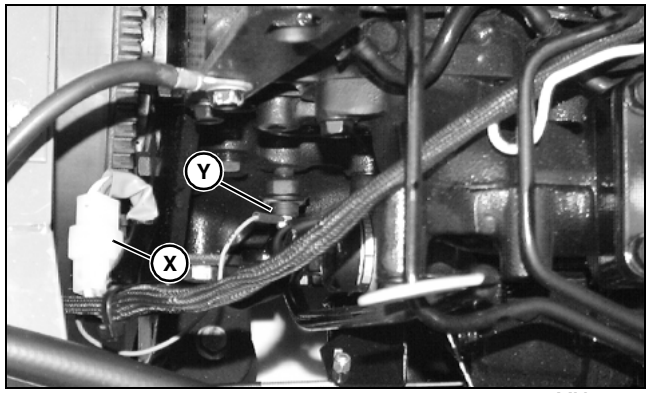
20.Disconnect violet wire (U) from solenoid battery terminal.

21.Disconnect wires (V) from solenoid battery terminal.



MX5440

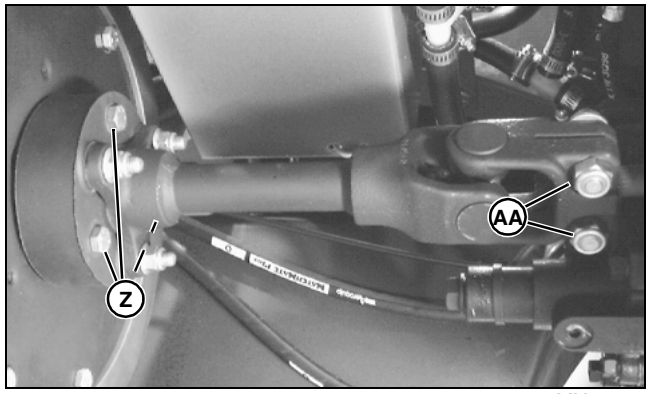
22.Disconnect wire connector (W) from transaxle.



MX5412

23.Disconnect wire connector (X) from fuel shutoff solenoid.

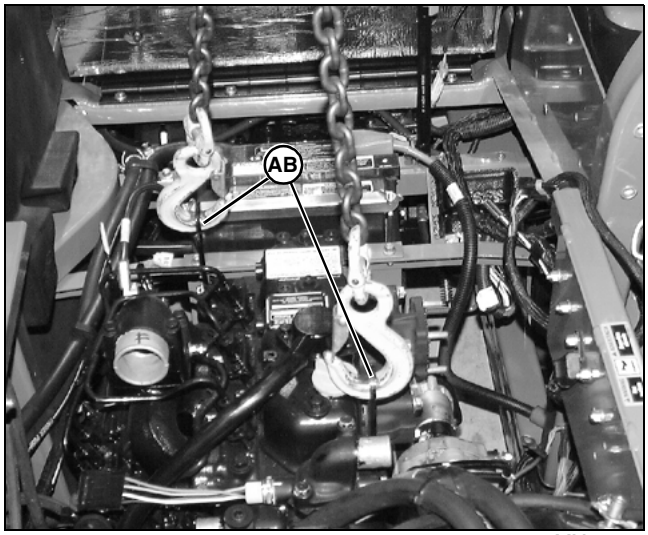
24.Disconnect wire terminal (Y) from oil pressure switch.



MX5442

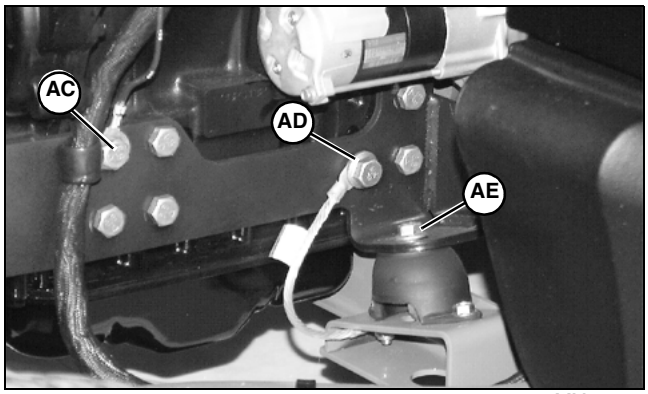
25.Remove three cap screws (Z) from drive shaft damper.

26.Loosen two cap screws (AA) at transaxle. Slide drive shaft toward transaxle to remove.



MX5443

27.Attach a hoist to the engine lifting straps (AB).



MX5444

28.Disconnect ground wire (AC) and cable (AD) from engine support plate.

29.Remove three engine mounting cap screws (AE) from engine mounts.

30.Remove engine from machine.

31.If the engine is to be repaired, remove oil drain plug and drain crankcase into a container large enough to hold full capacity.

32.Inspect engine mount pads for wear or damage. Replace as necessary.

Installation:

IMPORTANT: Avoid damage! Alignment of engine and transaxle must be checked with alignment tool.

1. Install engine in reverse order of removal.

NOTE: If the engine has been rebuilt (cylinder rebored or deglazed, etc.), the oil should be changed after the first 20 hours (maximum) of operation.

2. Fill engine to proper level with oil of correct specification.

3. Fill cooling system to correct level with coolant of correct specification.

4. Adjust throttle cable. (See “Throttle Cable Adjustment” on page 126.)

5. **Models 1445 and 1545:** Bleed air from fuel system. (See “Fuel System Bleeding Procedure” on page 125.)

Specifications:

Model 1435

Engine Oil Capacity with Filter (Approximately) . . . . . 2.7 L (2.8 qt)

Models 1445 and 1545

Engine Oil Capacity with Filter (Approximately) . . . . . 3.6 L (3.8 qt)

Rocker Arm Cover Removal and Installation

Front Mower

1435

1445

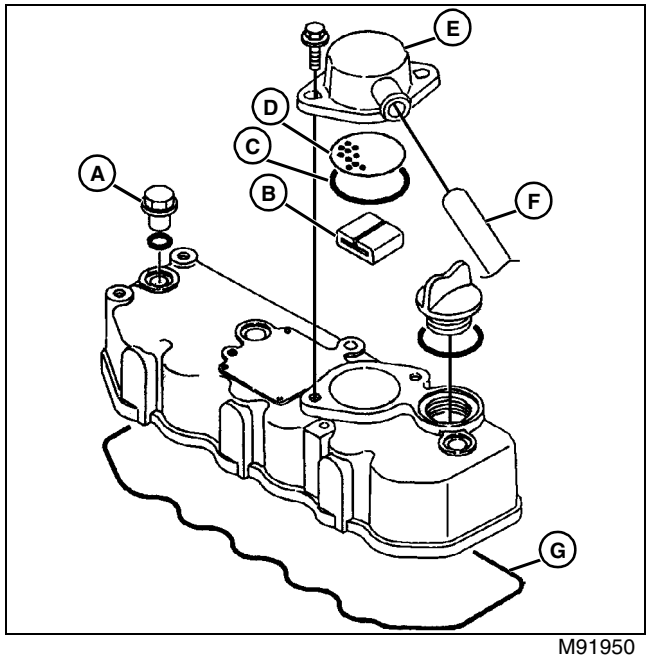
1545

Procedure:

1. Park machine safely.

2. Remove engine cover.

3. Remove air cleaner. (See “Air Cleaner Assembly Removal and Installation” on page 138.)



M91950

4. Remove three special nuts (A) securing cover to cylinder head.

5. Remove the breather hose (F).

6. Remove the rocker arm cover from the cylinder head.

7. Remove the breather cap (E), plate (D), and baffle (B).

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

9. Install the baffle.

10. Install the breather plate and a new O-ring (C) before replacing the breather cover.

11. Inspect the rocker arm cover gasket (G) before reinstalling the rocker arm cover. Replace if damaged.

12. Clean the cylinder head surface and install the rocker arm cover to the cylinder head. Tighten the special nuts to specification.

Specifications:

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

Rocker Arm Assembly Removal and Installation - 1435

Procedure:

1. Remove rocker arm cover. (See “Rocker Arm Cover Removal and Installation” on page 145.)

2. Remove three M8 rocker arm mounting nuts.

3. Pull rocker arm assembly straight up off mounting studs on cylinder head.

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

4. Align rocker arm supports with studs on cylinder head. Align rockers with valve stems.

5. Install push rods in block and align into rocker arms.

6. Install mounting nuts on rocker arm supports and evenly tighten nuts to pull rocker assembly to head. Tighten nuts to specification.

7. Adjust valve clearance. (See “Valve Clearance Adjustment” on page 119.)

8. Install rocker arm cover. (See “Rocker Arm Cover Removal and Installation” on page 145.)

Specifications:

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

Rocker Arm Assembly Removal and Installation - 1445 and 1545

Procedure:

1. Remove rocker arm cover. (See “Rocker Arm Cover Removal and Installation” on page 145.)

2. Remove the rocker arm end support and rocker arm center support mounting cap screws.

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

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

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

6. Lubricate all parts with clean oil during assembly.

7. Place the rocker arm assembly on the cylinder head.

- Align the rocker arms with the valves and push rods.
- Align the rocker arm end supports and center supports with the corresponding holes in the head.

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

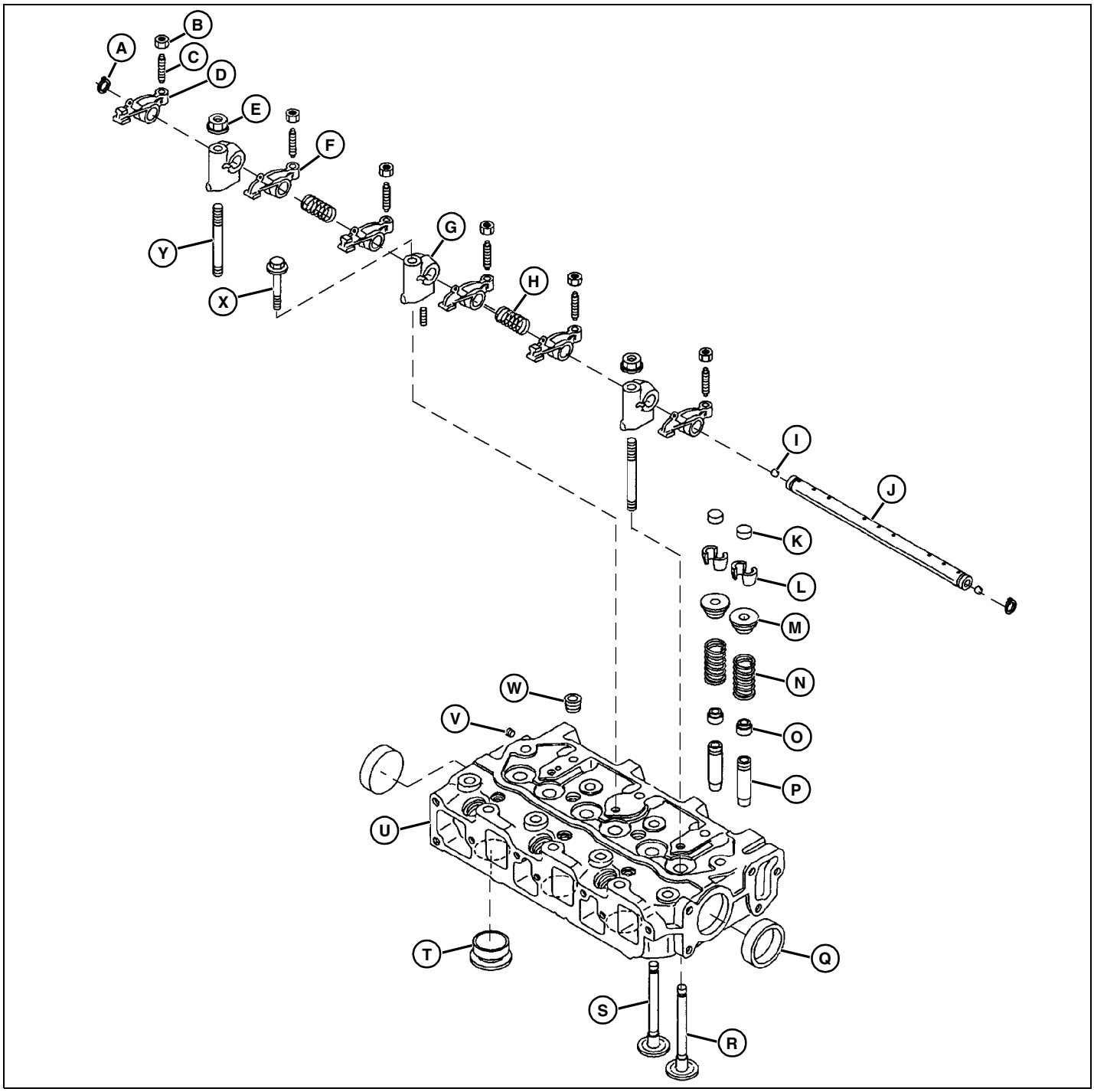
9. Adjust the valve clearance. (See “Valve Clearance Adjustment” on page 119.)

Specifications:

Rocker Arm Support
Cap Screw Torque . . . . . 26 N•m (226 lb-in.)

Rocker Arm Disassembly and Assembly - 1435

Disassembly:



MX5432

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

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

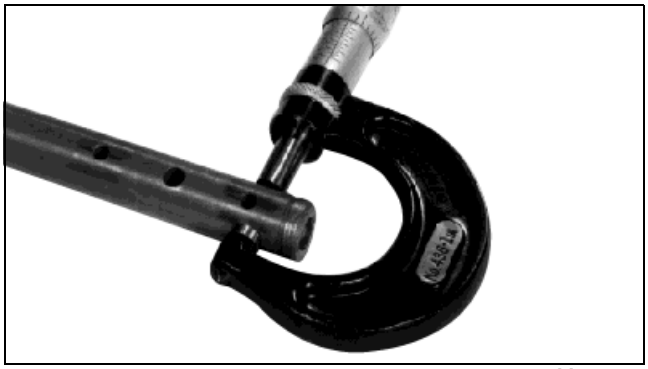
1. Mark all parts for location before disassembly to aid assembly.

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

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

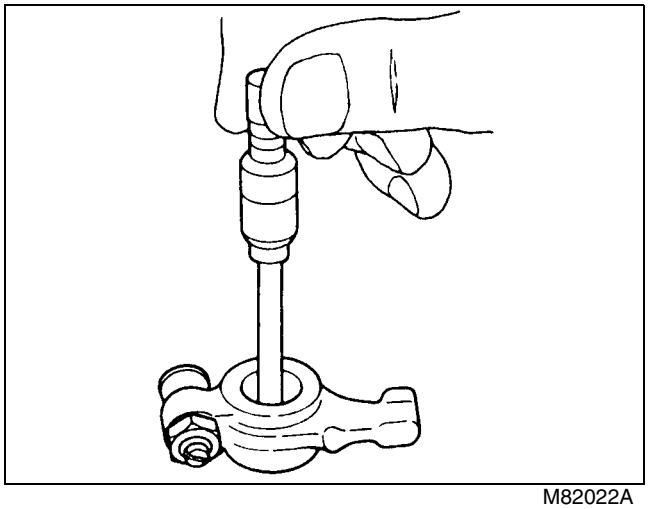
4. Clean all parts of varnish and oil.

Rocker Arm Inspection:



M35262

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

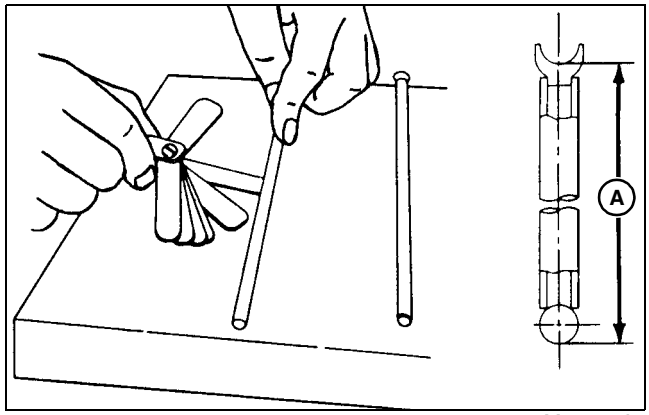


M82022A

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

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

Push Rod Inspection:



M82023A

1. Lay push rod on flat surface and roll while checking for a gap under center of rod. Use feeler gauge to check dimension. Replace push rod if not within length (A) and bend specifications.

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

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

Assembly:

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

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

Specifications:

Rocker Arm Shaft
Standard OD . . . . 11.966 - 11.984 mm (0.471 - 0.472 in.)

Rocker Arm Shaft OD Wear Limit . . 11.95 mm (0.47 in.)

Rocker Arm and Shaft Support
Standard ID . . . . . 12.00 - 12.02 mm (0.472 - 0.473 in.)

Rocker Arm and Shaft Support
ID Wear Limit . . . . . 12.09 mm (0.476 in.)

Rocker Arm and Shaft Support Standard
Oil Clearance . . . . . 0.160 - 0.054 mm (0.006 - 0.002 in.)

Rocker Arm and Shaft Support Oil Clearance Wear
Limit. . . . . 0.14 mm (0.006 in.)

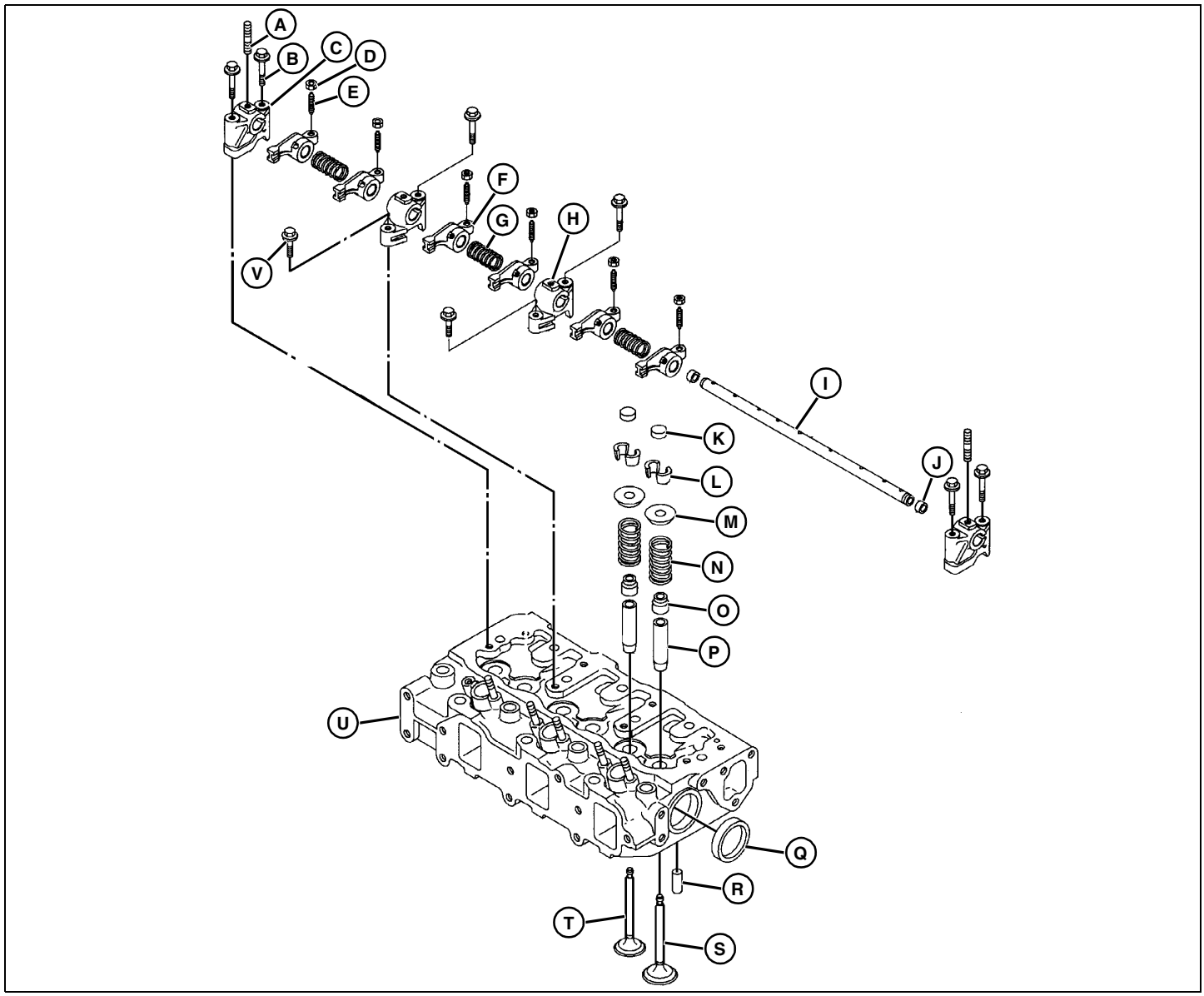
Push Rod Length . . . . . 114 - 115 mm (4.488 - 4.528 in.)

Push Rod Bend . . . . . 0.00 - 0.03 mm (0.000 - 0.001 in.)

Rocker Arm Disassembly and Assembly - 1445 and 1545

Disassembly:

NOTE: Replace components in same location on the rocker arm shaft from which they were removed.



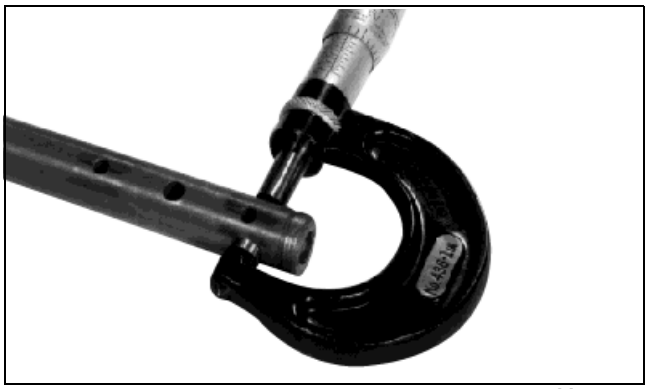
MX5741

A - Stud (3 used)
B - M8 x 50 Cap Screw (6 used)
C - Rocker Arm End Support (2 used)
D - Nut (6 used)
E - Adjusting Screw (6 used)
F - Rocker Arm (6 used)
G - Rocker Arm Shaft Spring (3 used)
H - Rocker Arm Center Support (2 used)
I - Rocker Arm Shaft
J - Plug (2 used)
K - Cap (6 used)
L - Collet
M - Spring Retainer
N - Spring
O - Seal (3 used)
P - Valve Guide (3 used)
Q - Plug
R - Spring Pin
S - Intake Valve (3 used)
T - Exhaust Valve (3 used)
U - Cylinder Head
V - M8 x 25 Cap Screw (2 used)

1. Slide components off the rocker arm shaft.

2. Clean all parts of varnish and oil.

Rocker Arm Inspection:



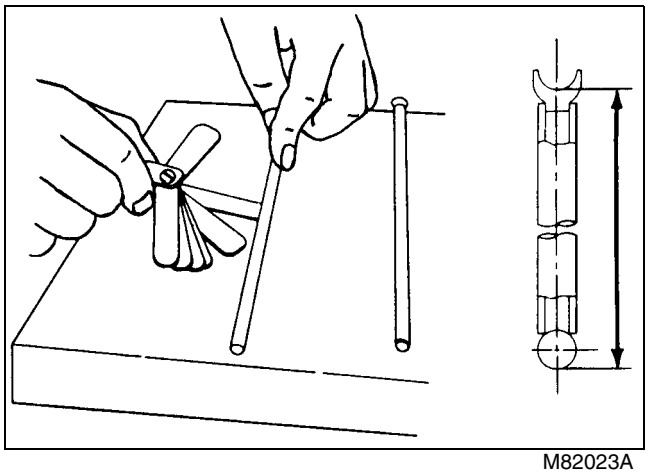
M35262

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

2. Measure the inner diameters of the rocker arms and supports. Replace the rocker arms or supports if the inner diameters are not within specification.

3. If the rocker arm shaft-to-rocker arm bushing oil clearance (rocker arm/support OD minus rocker arm ID) exceeds specification, replace the rocker arm shaft and rocker arms.

Push Rod Inspection:



M82023A

1. Place the push rod on a flat surface. Use a feeler gauge to measure any gaps between the push rod and flat surface.

2. If push rod bend exceeds specification, replace push rod.

Assembly:

Assemble rocker arm components. Assembly is done in reverse order of removal.

Specifications:

Rocker Arm Shaft
Standard OD . . . . . 15.97 - 15.98 mm (0.628 - 0.629 in.)

Rocker Arm Shaft OD Wear Limit . 15.95 mm (0.628 in.)

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

Rocker Arm and Support ID
Wear Limit . . . . . 16.09 mm (0.633 in.)

Rocker Arm and Support Standard
Oil Clearance . . . . . 0.02 - 0.05 mm (0.001 - 0.002 in.)

Rocker Arm and Support Oil Clearance
Wear Limit . . . . . 0.14 mm (0.006 in.)

Push Rod Bend . . . . . 0.00 - 0.03 mm (0.000 - 0.001 in.)

Cylinder Head Removal and Installation

Front Mower

1435

1445

1545

Special or Required Tools:

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

Removal:

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

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

3. Shut off fuel valve on fuel filter.

4. Allow engine to cool, and cooling system pressure to return to zero. Drain coolant from drain valves located on left side (1435 and 1445) or right side (1545) of engine and radiator.

5. Remove pipe from exhaust manifold. (See “Exhaust Pipe Removal and Installation” on page 139.)

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

7. Disconnect wiring from coolant temperature sensor.

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

9. Remove water pump. (See “Water Pump Removal and Installation (Thermostat Included) - 1435” on page 190, or “Water Pump Removal and Installation (Thermostat

Included) - 1445 and 1545” on page 191.)

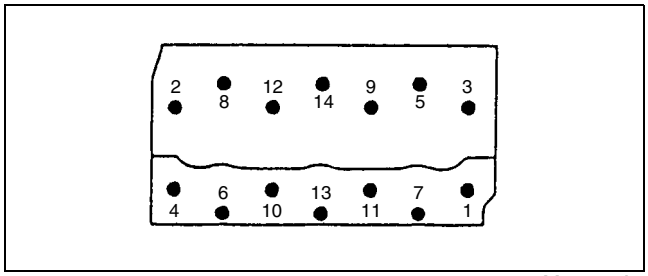
10.Remove high pressure fuel lines and fuel leak-off line running from fuel injection pump to nozzles.

11.**Model 1435:** Disconnect glow plug wiring harness from engine harness.

12.**Models 1445 an 1545:** Disconnect air preheater wire terminal.

13.Remove rocker arm cover. (See “Rocker Arm Cover Removal and Installation” on page 145.)

14.Remove rocker arm assembly, push rods, and valve caps from cylinder head. (See “Rocker Arm Assembly Removal and Installation - 1435” on page 146, or “Rocker Arm Assembly Removal and Installation - 1445 and 1545” on page 146.)



M82260A

Picture Note: Top of Drawing Is Exhaust Manifold Side, Bottom Is Intake Manifold Side

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

16.Using lift brackets and hoist, pull head straight up from block.

17.Remove exhaust and intake manifolds. (See “Exhaust Manifold Removal and Installation” on page 140, and “Intake Manifold Removal and Installation - 1435” on page 140 or “Intake Manifold Removal and Installation - 1445 and 1545” on page 140.)

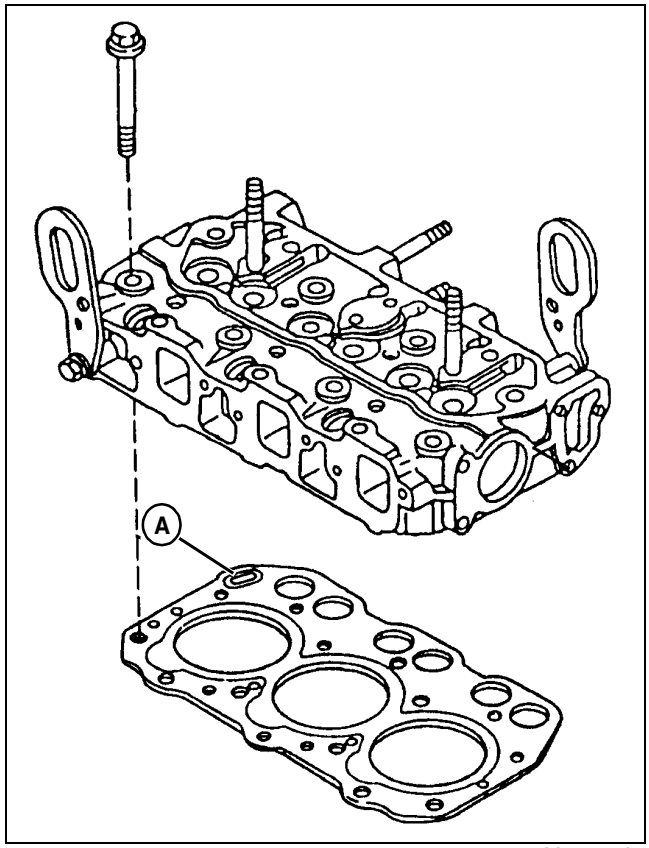
18.Disassemble and inspect cylinder head and valves. (See “Cylinder Head Recondition” on page 152.)

Installation:

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

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

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

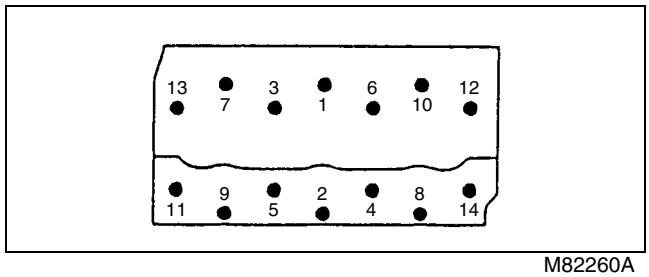


M82259A

Picture Note: Model 1435 Shown

3. Place a new cylinder head gasket on cylinder block with locating pins on front and rear of block inside holes in gasket. Line up oil passage (A) on left rear of block with oil passage in gasket.

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



M82260A

Picture Note: Top of Drawing Is Exhaust Manifold Side, Bottom Is Intake Manifold Side

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

6. Install rocker arm assembly, push rods, and valve caps. (See “Rocker Arm Assembly Removal and Installation - 1435” on page 146 or “Rocker Arm Assembly Removal and Installation - 1445 and 1545” on page 146.)

7. Install rocker arm cover. (See “Rocker Arm Cover Removal and Installation” on page 145.)

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

9. Install water pump. (See “Water Pump Removal and Installation (Thermostat Included) - 1435” on page 190, or “Water Pump Removal and Installation (Thermostat Included) - 1445 and 1545” on page 191.)

10. Install exhaust pipe to manifold. (See “Exhaust Pipe Removal and Installation” on page 139.)

11. Install upper alternator bracket and belt.

Specifications:

Model 1435 Torque Sequence

First . . . . . 27 N•m (20 lb-ft)

Second. . . . . 41 N•m (30 lb-ft)

Final . . . . . 59 - 64 N•m (43 - 47 lb-ft)

Models 1445 and 1545 Torque Sequence

First . . . . . 34 N•m (25 lb-ft)

Second. . . . . 54 N•m (40 lb-ft)

Final . . . . . 67 - 71 N•m (49 - 52 lb-ft)

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

Cylinder Head Recondition

Front Mower

1435

1445

1545

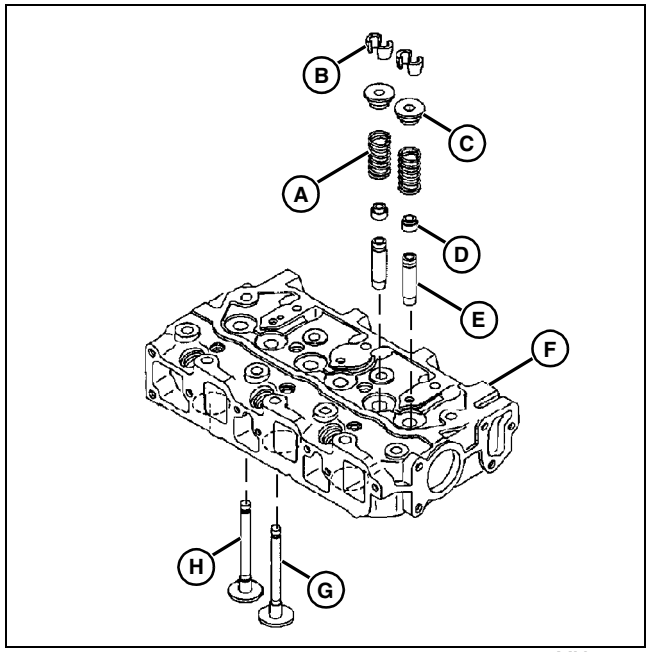
Special or Required Tools:

Tool Name	Tool No.	Tool Use
Valve Spring Compressor	JDE138	Used to remove valves.
Valve Guide Driver	JDE504 (Model 1435) or JDE118 (Models 1445 and 1545)	Used to install valve guides in cylinder head.

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

Disassembly/Assembly:

1. Check valve recession before disassembly. (See “Valve Recession Measurement:” on page 154.)



MX5433

Picture Note: Model 1435 Shown

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

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

3. Remove collet halves (B) from retainer.

4. Slowly release compressor and valve spring.

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

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

NOTE: Valve seats are not replaceable.

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

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

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

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

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

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

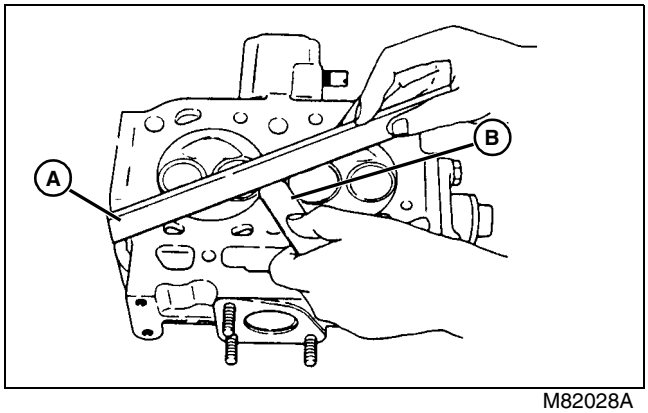
12.Repeat for remaining valves.

13.Measure valve recession if new valves were installed. (See “Valve Recession Measurement:” on page 154.)

Inspection/Replacement:

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

Cylinder Head:



M82028A

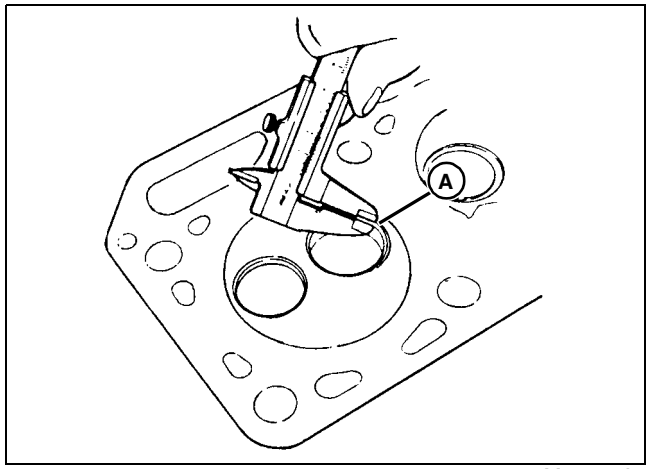
1. Measure cylinder head flatness. Place a straightedge (A) along each of the four sides and each diagonal. Measure clearance between straightedge and combustion surface with a feeler gauge (B).

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

3. If cylinder head was resurfaced:

- Measure piston-to-cylinder head clearance. (See “Piston-to-Cylinder Head Clearance Measurement” on page 157.)
- Measure valve recession. (See “Valve Recession Measurement:” on page 154.)
- Measure valve seat width. (See “Valve Seat Width:” on page 153.)

Valve Seat Width:

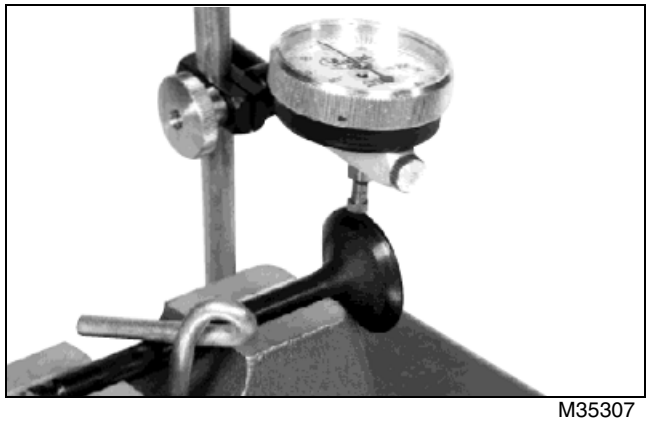


M82029A

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

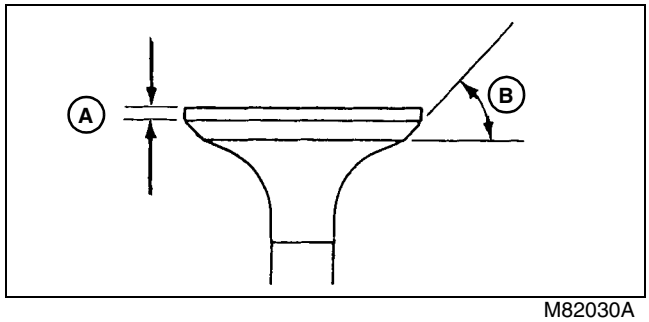
2. If necessary, grind valve seats to meet specification. (See “Valve Seat Grinding:” on page 155.)

Intake and Exhaust Valves:



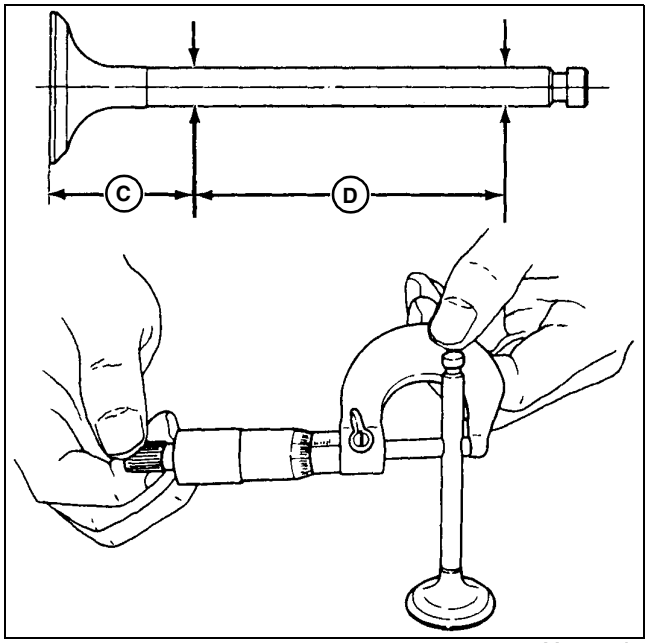
M35307

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



M82030A

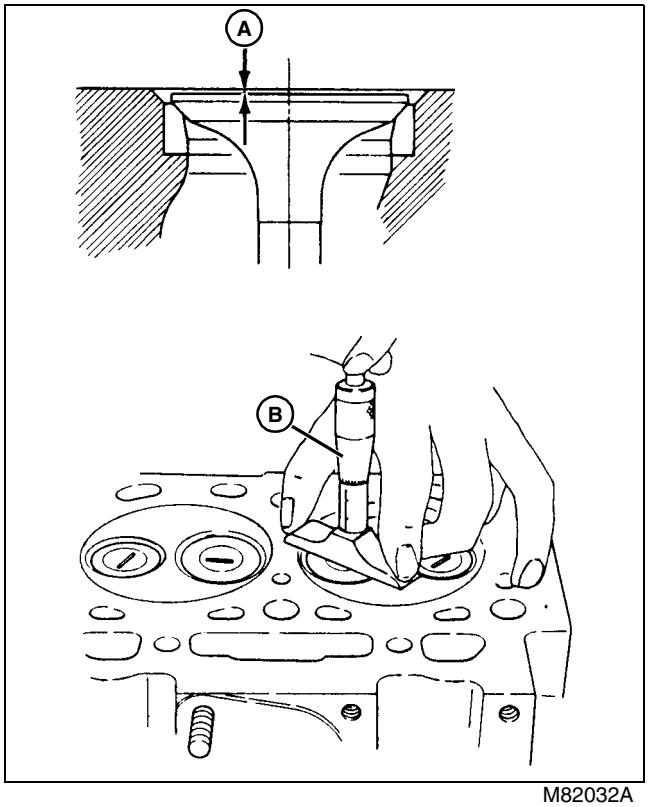
2. If valve faces are worn, burned, or pitted, grind valves to proper face angle (B). If valve face margin (A) is less than specification after grinding, replace valve.



M82031A

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

Valve Recession Measurement:



M82032A

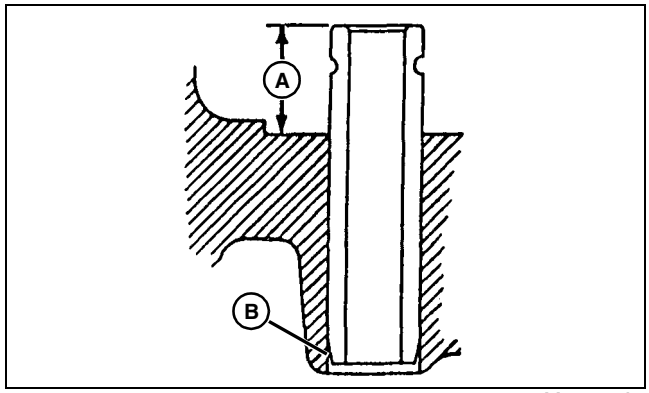
Measure valve recession (A) using a depth gauge (B). Replace valve or cylinder head if measurement exceeds wear limit.

Valve Guide Measurement:

1. Clean valve guides using a valve guide brush.

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

- If valve guide inside diameter exceeds wear limit, knurl or replace guide.
- If valve guide inside diameter is less than wear limit, determine guide-to-stem clearance (valve guide diameter minus valve stem diameter).
- If clearance exceeds knurl specification, knurl valve guides using a 7 mm (Model 1435) or 12 mm (Models 1445 and 1545) valve guide knurling tool.
- If clearance exceeds replacement specification, replace valve guides.

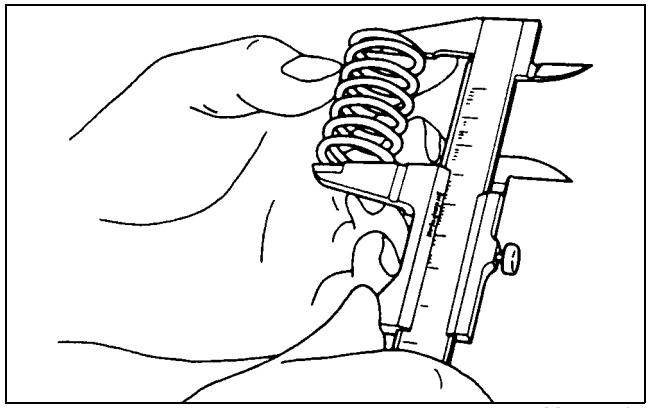


M82193A

3. Install valve guides with tapered end (B) down using JDE504 (Model 1435) or JDE118 (Models 1445 and 1545) Valve Guide Driver. Push valve guides down until tops of valve guides are projecting the specified height (A) from the valve spring seat in the cylinder head.

4. Ream inside diameter of valve guides using a 7 mm (Model 1435) or 12 mm (Models 1445 and 1545) valve guide reamer.

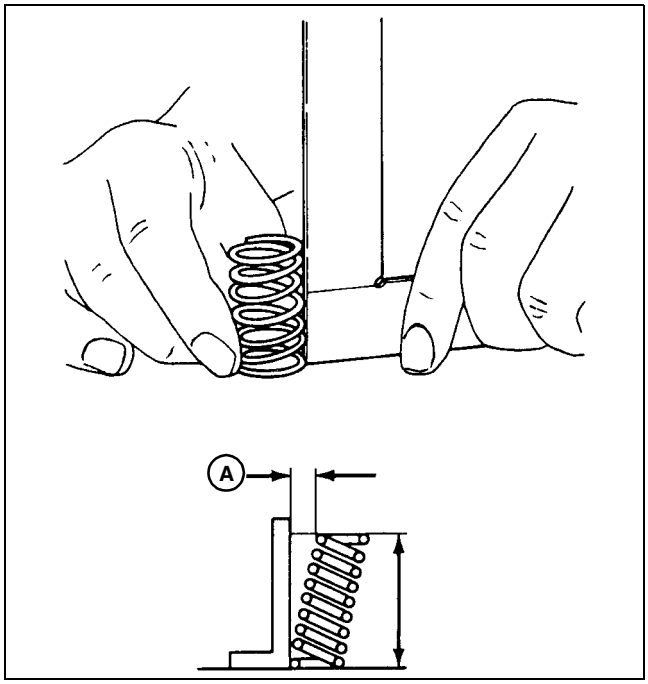
Valve Springs:



M82034A

1. Measure spring free length. Replace spring if

measurement exceeds specification.

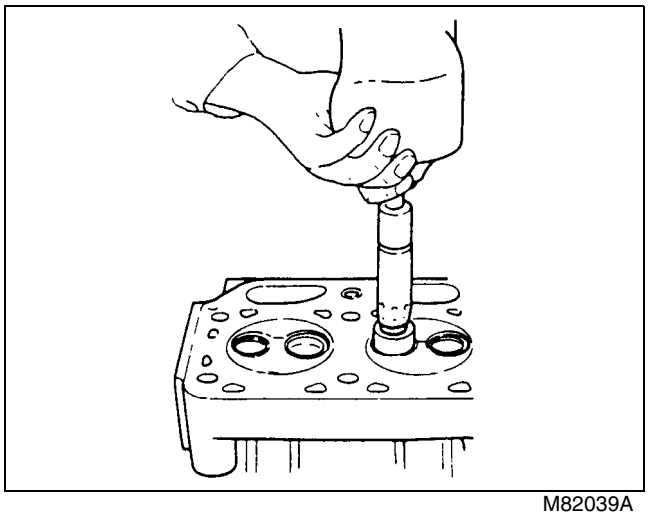


M82035A

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

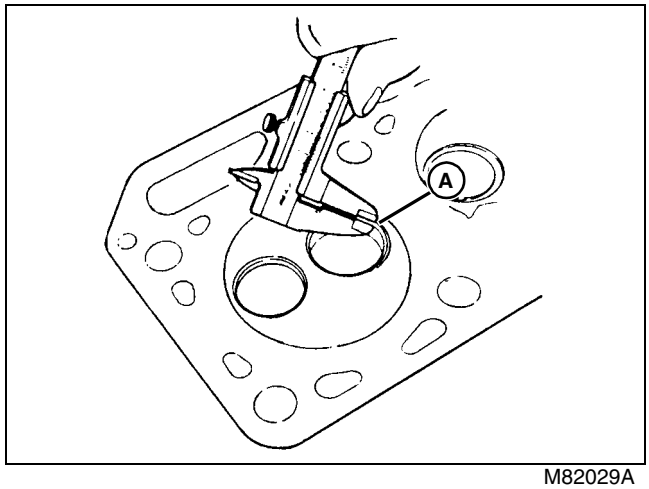
Valve Seat Grinding:

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



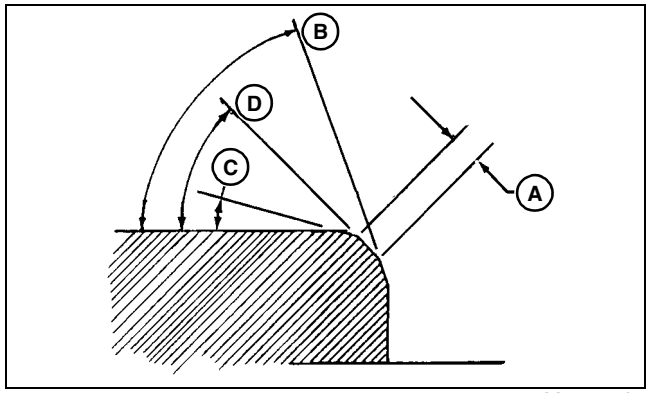
M82039A

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



M82029A

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



M82040A

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

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

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

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

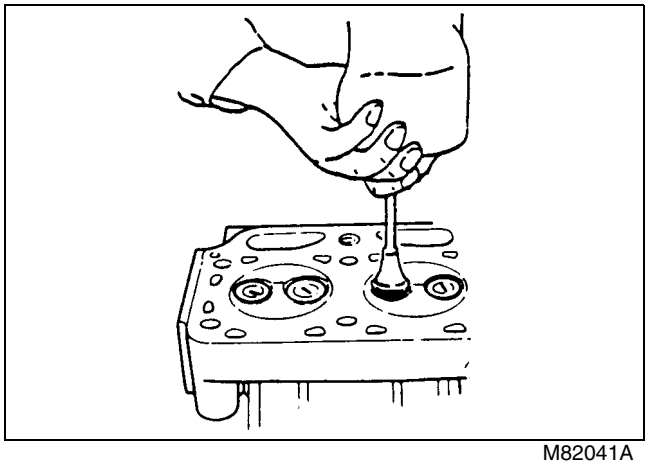
6. If valve seats are ground, measure valve recession and check contact pattern between the seat and valve with bluing dye.

7. Lap valves. (See "Valve Lapping:" on page 156.)

Valve Lapping:

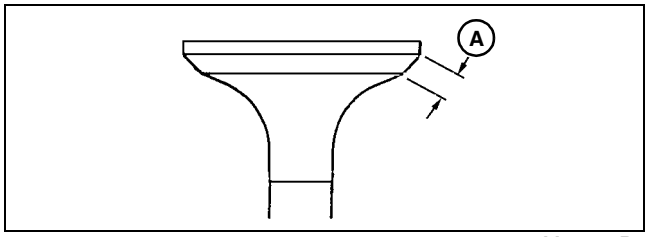
NOTE: Use a rubber-type lapping tool for valves without a lapping tool groove slit.

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



M82041A

1. Apply small amount of fine lapping compound to face of valve.
2. Turn valve to lap valve to seat.



M82030B

3. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface (A) of the valve face.
4. Wash all parts in solvent to remove lapping compound. Dry parts.
5. Check position of lap mark on valve face. Lap mark must be on or near center of valve face.

Specifications:

Cylinder Head Distortion

Standard (Maximum) . . . . . 0.05 mm (0.002 in.)

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

Allowable Removed Material (Maximum). . . . . 0.20 mm (0.008 in.)

Model 1435 Valve Seat Width

Intake Standard. . . . . 1.44 mm (0.057 in.)

Intake Wear Limit . . . . . 1.98 mm (0.078 in.)

Exhaust Standard. . . . . 1.77 mm (0.07 in.)

Exhaust Wear Limit . . . . . 2.27 mm (0.089 in.)

Models 1445 and 1545 Valve Seat Width

Intake Standard . . . . . 1.36 - 1.53 mm (0.054 - 0.060 in.)

Intake Wear Limit . . . . . 1.98 mm (0.078 in.)

Exhaust Standard. . . . 1.66 - 1.87 mm (0.065 - 0.074 in.)

Exhaust Wear Limit . . . . . 2.27 mm (0.089 in.)

Valve Grinding

Intake Valve
Face Margin . . . . . 0.99 - 1.29 mm (0.039 - 0.051 in.)

Exhaust Valve
Face Margin . . . . . 0.95 - 1.25 mm (0.037 - 0.049 in.)

Valve Face Margin Wear Limit. . . . . 0.50 mm (0.020 in.)

Intake Valve Face Angle . . . . . 30°

Exhaust Valve Face Angle. . . . . 45°

Model 1435 Valve Stem

Measuring Point (3) Distance . . . . . 20 mm (0.787 in.)

Measuring Point (4) Distance . . . . . 40 mm (1.575 in.)

Intake Valve Stem
Standard OD . . . . . 6.96 - 6.98 mm (0.274 - 0.275 in.)

Intake Valve Stem OD Wear Limit . . 6.90 mm (0.272 in.)

Exhaust Valve Stem
Standard OD . . . . . 6.95 - 6.96 mm (0.273 - 0.274 in.)

Exhaust Valve Stem
OD Wear Limit . . . . . 6.90 mm (0.272 in.)

Models 1445 and 1545 Valve Stem

Measuring Point (3) Distance . . . . . 43 mm (1.70 in.)

Measuring Point (4) Distance . . . . . 60 mm (2.40 in.)

Intake Valve Stem
Standard OD . . . . . 6.95 - 6.96 mm (0.274 - 0.274 in.)

Intake Valve Stem OD Wear Limit . . 6.90 mm (0.272 in.)

Exhaust Valve Stem
Standard OD . . . . . 6.94 - 6.96 mm (0.273 - 0.274 in.)

Exhaust Valve Stem
OD Wear Limit . . . . . 6.90 mm (0.272 in.)

Model 1435 Valve Recession

Intake Valve
Standard Recession. . 0.40 - 0.60 mm (0.016 - 0.024 in.)

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

Exhaust Valve
Standard Recession. . 0.75 - 0.95 mm (0.030 - 0.037 in.)

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

Models 1445 and 1545 Valve Recession

Intake Valve
Standard Recession . . 0.30 - 0.50 mm (0.012 - 0.020 in.)

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

Exhaust Valve
Standard Recession . . 0.30 - 0.50 mm (0.012 - 0.020 in.)

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

Model 1435 Valve Guides

Valve Guide
Standard ID . . . . . 7.01 - 7.02 mm (0.275 - 0.276 in.)

Valve Guide ID Wear Limit . . . . . 7.08 mm (0.279 in.)

Intake Valve Guide-to-Valve Stem Standard Oil Clearance . . . . . 0.03 - 0.06 mm (0.001 - 0.002 in.)

Exhaust Valve Guide-to-Valve Stem Standard Oil Clearance . . . . . 0.045 - 0.075 mm (0.002 - 0.003 in.)

Valve Guide-to-Valve Stem Oil Clearance Wear Limit (Both). . . . . 0.18 mm (0.007 in.)

Valve Guide Knurling Clearance (Maximum). . . . . 0.127 - 0.178 mm (0.005 - 0.007 in.)

Valve Guide Replacement Clearance . . . . . 0.20 mm (0.008 in.)

Valve Guide Height. . . . . 9 mm (0.354 in.)

Models 1445 and 1545 Valve Guides

Valve Guide
Standard ID . . . . . 7.000 - 7.015 mm (0.275 - 0.276 in.)

Valve Guide ID Wear Limit . . . . . 7.08 mm (0.279 in.)

Intake Valve Guide-to-Valve Stem Standard Oil Clearance . . . . . 0.04 - 0.07 mm (0.001 - 0.003 in.)

Exhaust Valve Guide-to-Valve Stem Standard Oil Clearance . . . . . 0.05 - 0.08 mm (0.002 - 0.003 in.)

Valve Guide-to-Valve Stem Oil Clearance Wear Limit (Both). . . . . 0.18 mm (0.007 in.)

Valve Guide Knurling Clearance (Maximum). . . . . 0.15 - 0.20 mm (0.006 - 0.008 in.)

Valve Guide Replacement Clearance . . . . . 0.20 mm (0.008 in.)

Valve Guide Height. . . . . 12 mm (0.472 in.)

Model 1435 Valve Springs

Spring Free Length. . . . . 37.4 mm (1.472 in.)

Spring Inclination (Maximum) . . . . . 1.0 mm (0.039 in.)

Models 1445 and 1545 and Valve Springs

Spring Free Length. . . . . 44.4 mm (1.75 in.)

Spring Inclination (Maximum) . . . . . 1.10 mm (0.044 in.)

Piston-to-Cylinder Head Clearance Measurement

Front Mower

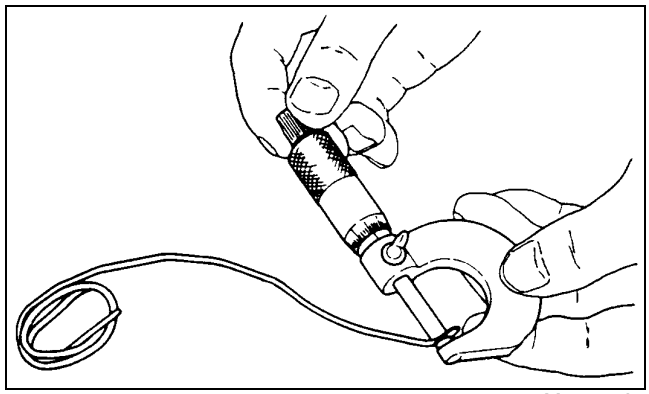
1435

1445

1545

Procedure:

1. Place three 10 mm (0.4 in.) long pieces of 1.5 mm (0.06 in.) diameter soft wire in three positions on the flat part of the piston head.
2. Install the cylinder head and old gasket. Install cylinder head cap screws and tighten in proper sequence. (See “Cylinder Head Removal and Installation” on page 150.)
3. Slowly turn the crankshaft one complete revolution.
4. Remove the cylinder head and gasket.



M82042A

5. Measure the thickness of the flattened section of each piece of wire. Calculate the average thickness of the wires to obtain the piston-to-cylinder head clearance specification.
6. If clearance is less than specification, replace cylinder head. (See “Cylinder Head Removal and Installation” on page 150.)

Specifications:

Model 1435

Piston-to-Cylinder Head
Clearance . . . . . 0.66 - 0.78 mm (0.026 - 0.031 in.)

Models 1445 and 1545

Piston-to-Cylinder Head
Clearance . . . . . 0.64 - 0.82 mm (0.025 - 0.032 in.)

Piston and Connecting Rod Removal and Installation

Front Mower

1435

1445

1545

Special or Required Tools:

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

Removal:

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

1. Remove the oil pan and oil pickup tube. (For Model 1435, see “Oil Pan and Strainer - 1435” on page 186. For Models 1445 and 1545, see “Oil Pan, Crankcase Extension, and Strainer - 1445 and 1545” on page 186.)

2. Remove the cylinder head. (See “Cylinder Head Removal and Installation” on page 150.)

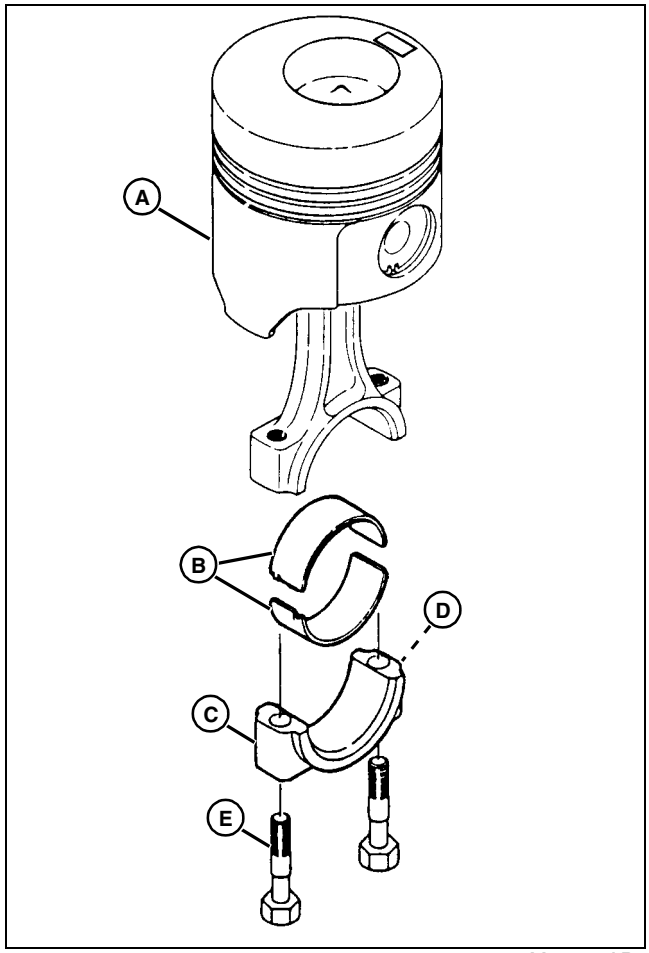
3. Check the cylinder bore for ridges. These ridges can cause damage to piston if ridge is not removed. If necessary, remove any ridge from top of cylinder bore using a ridge reamer.

4. Measure the connecting rod side play. (See “Connecting Rod Side Play Check” on page 164.)

5. Measure the crankshaft end play.

6. Measure the connecting rod bearing clearance. (See “Connecting Rod Bearing Clearance Check” on page 165.)

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



M82196AB

Picture Note: Models 1445 and 1545 Shown

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

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

8. Note the connecting rod alignment mark (D) in relation to the cylinders. Start at the flywheel end with cylinder number one, then two, etc.

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

10. Disassemble and inspect all parts for wear or damage. (See Disassembly and Inspection/Replacement procedures below.)

11. Inspect the cylinder bore. (See “Cylinder Bore” on page 166.)

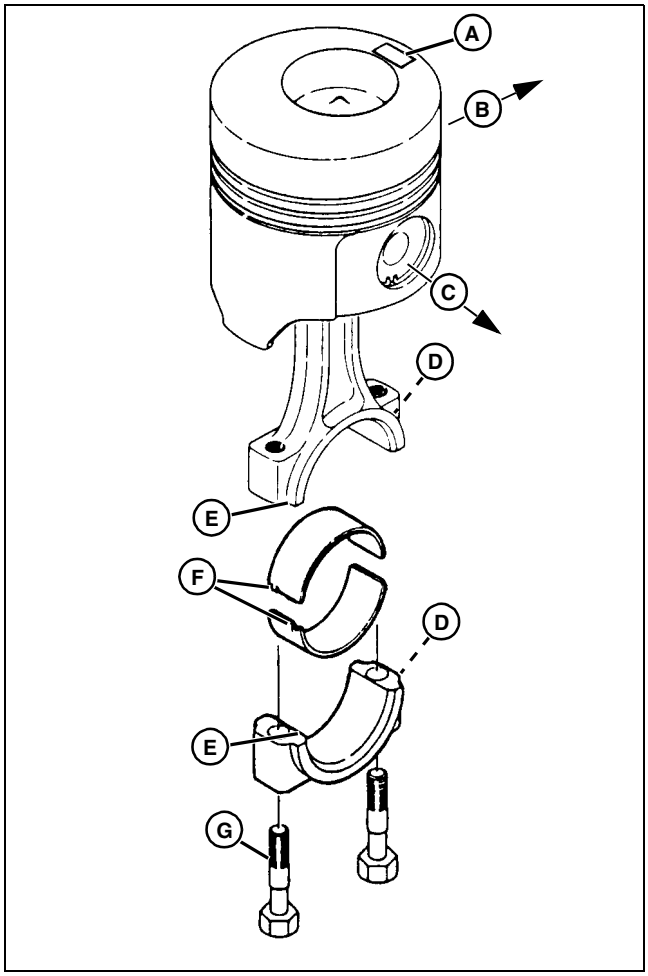
Installation:

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

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

3. Assemble the piston and connecting rod. (See “Assembly:” on page 160.)

IMPORTANT: Avoid damage! Pistons must be installed in the cylinders from which they were removed and in the same direction. Be careful not to damage the crankshaft rod journals while installing pistons.



M82196AB

Picture Note: Models 1445 and 1545 Shown

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

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

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

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

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

6. Match the connecting rods to caps using alignment marks (D). Install the rod caps.

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

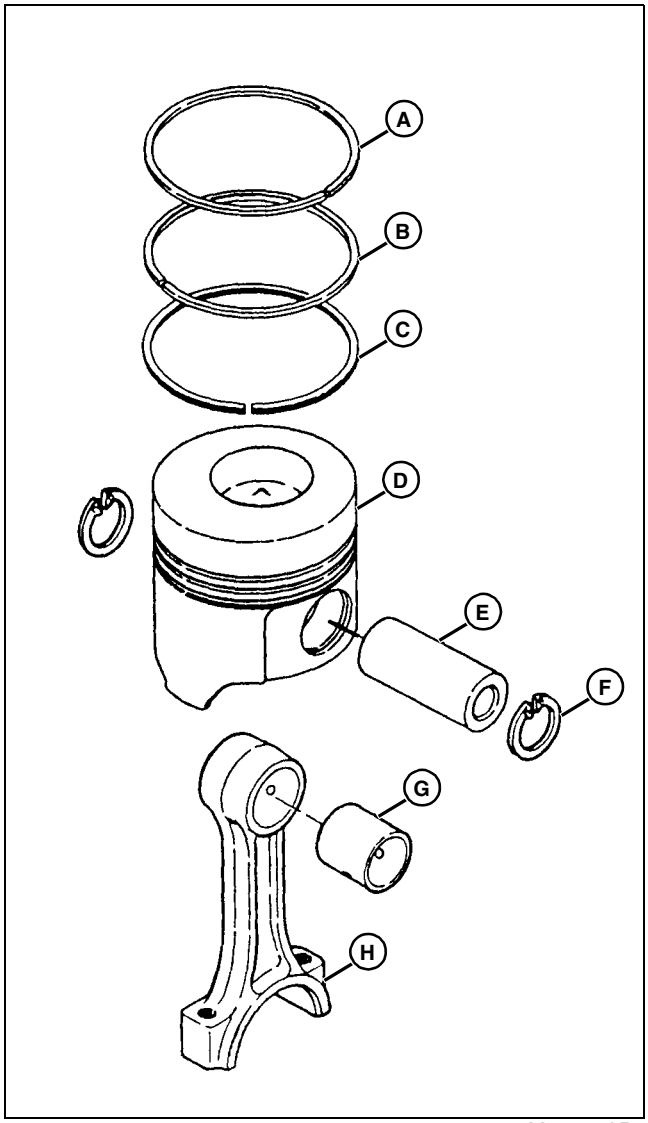
8. If a new piston and connecting rod were installed, stamp a number corresponding to the cylinder number on the connecting rod and rod cap.

9. Install the cylinder head. (See “Cylinder Head Removal and Installation” on page 150.)

10. Install the oil pan and oil pickup tube. (For Model 1435, see “Oil Pan and Strainer - 1435” on page 186. For Models 1445 and 1545, see “Oil Pan, Crankcase Extension, and Strainer - 1445 and 1545” on page 186.)

Disassembly:

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



M82197AB

Picture Note: Models 1445 and 1545 Shown

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

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

2. The piston pin bushing is a press fit in the connecting rod. Remove the bushing only if replacement is necessary. (See “Piston Pin Bushing:” on page 163.)

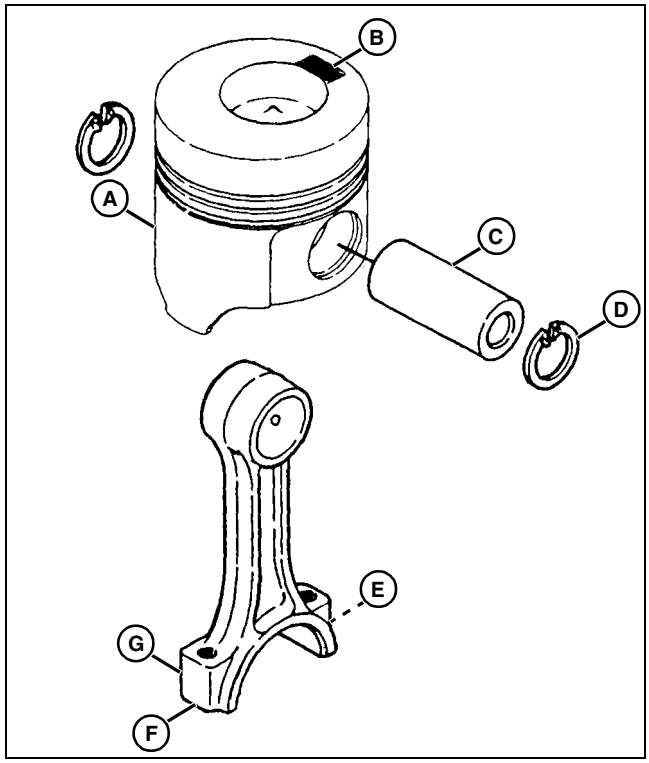
3. Inspect all parts for wear or damage. Replace as necessary.

Assembly:

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

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

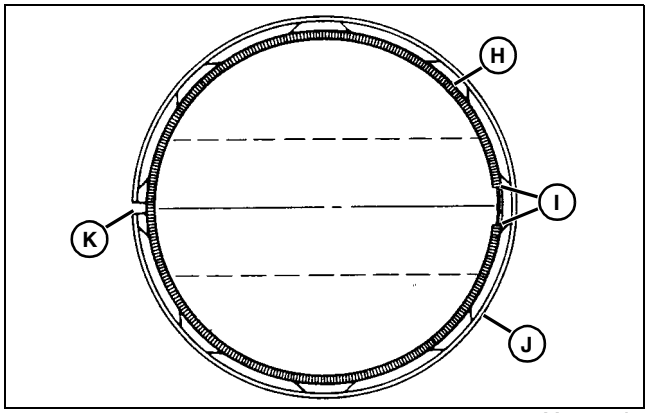
2. Install piston pin bushing in connecting rod with oil holes aligned.



M82198AB

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

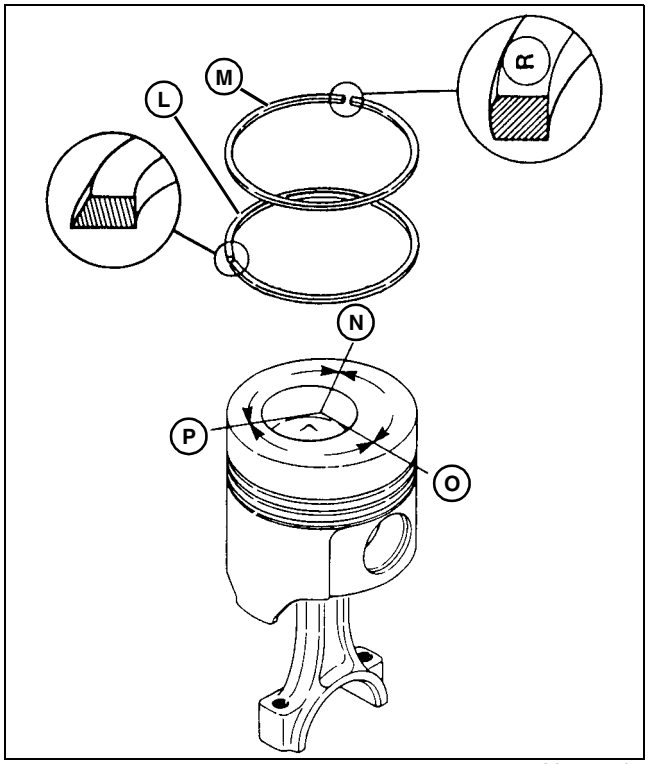
4. Install piston pin (C) and snap rings (D).



M82046A

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

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



M82199A

Picture Note: Models 1445 and 1545 Shown

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

8. Install the top piston ring (chrome plated) (M), with the manufacturer's mark "R," "T," or "RN" (near the ring gap) toward the top of the piston, in the top groove. Turn the ring until the top piston ring gap (N) is 120° away from the second ring gap (P).

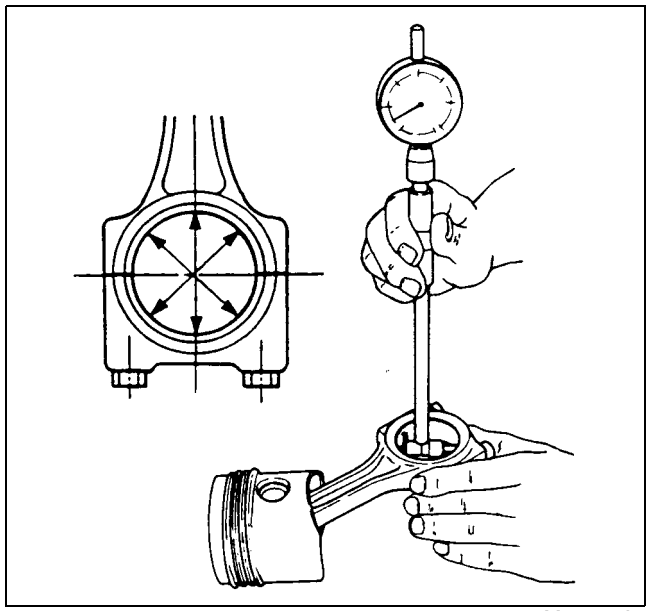
Inspection/Replacement:

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

2. Measure the crankshaft connecting rod journal diameter. (See "Crankshaft and Main Bearings" on page 170.)

Connecting Rod Bearing:

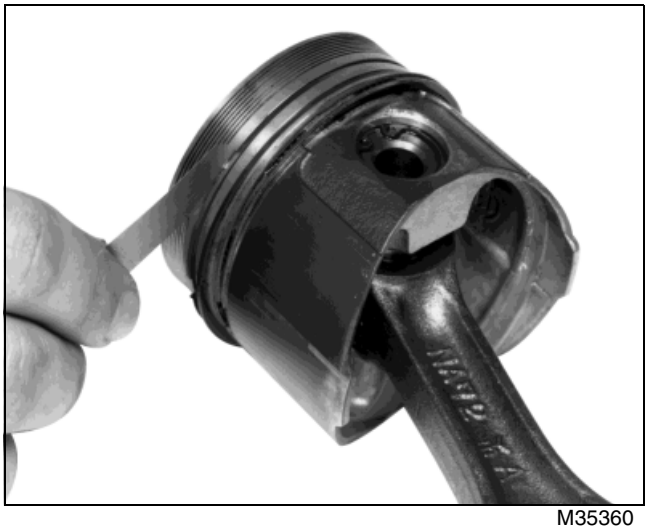
1. Install the connecting rod cap and bearing inserts on the connecting rod. Install the old connecting rod cap screws and tighten to specification.


M82048A

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

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

Piston Ring Groove:

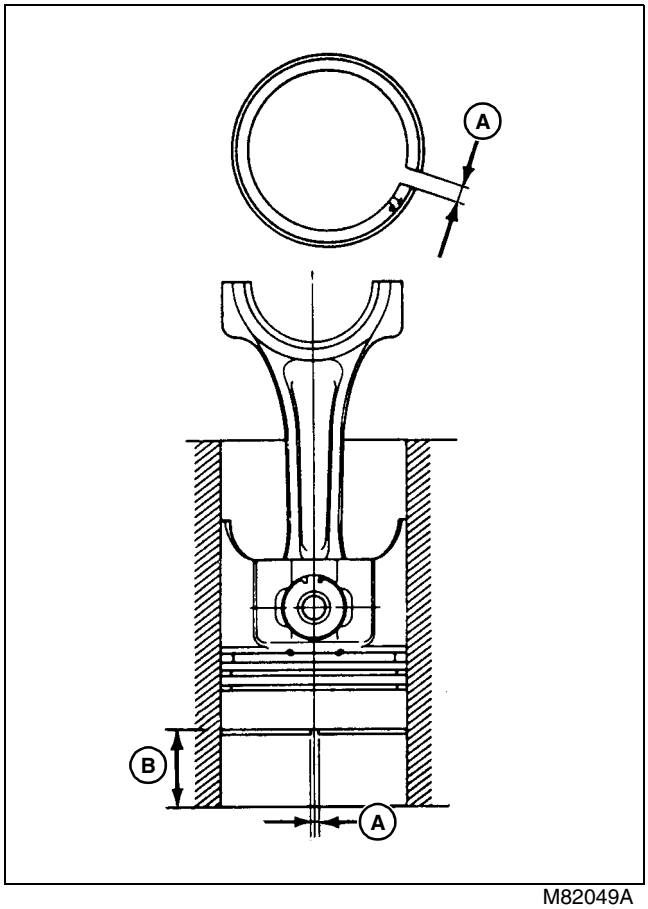


M35360

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

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

Piston Ring End Gap:

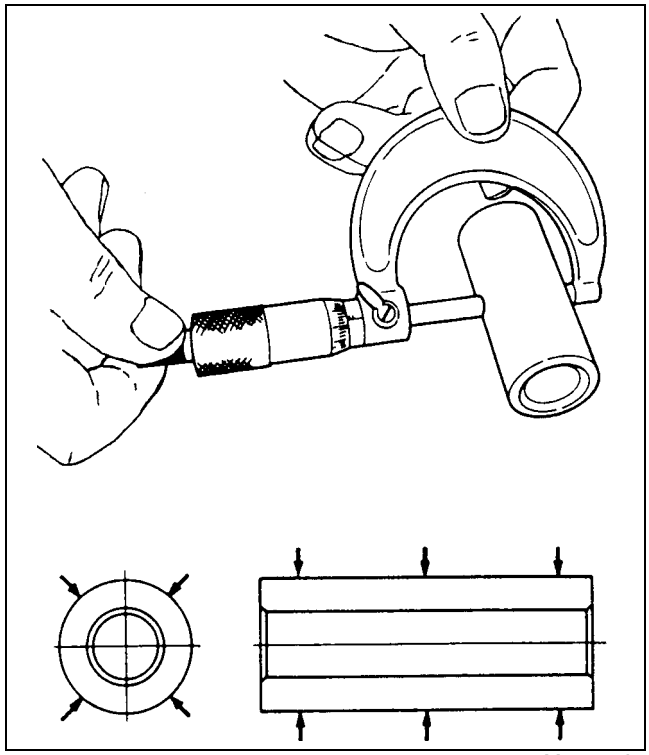


M82049A

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

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

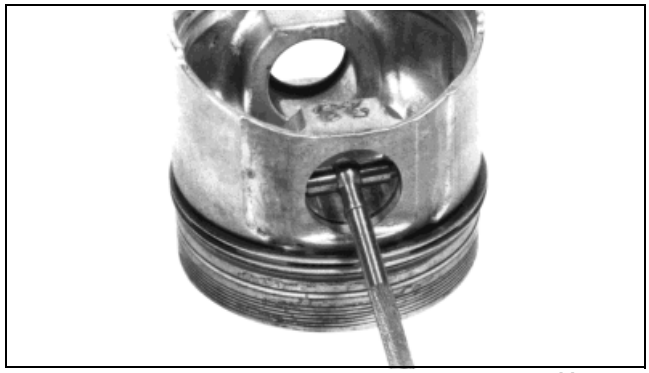
Piston Pin:



M82050A

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

Piston Pin Bore:



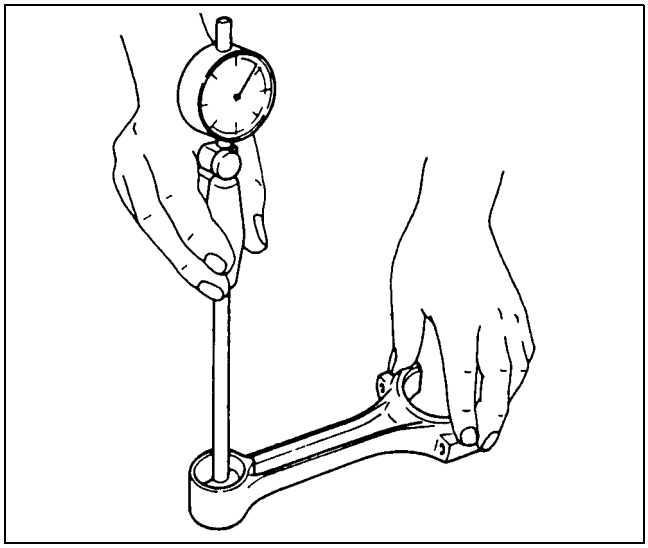
M37683

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

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

Piston Pin Bushing:

NOTE: The piston pin bushing is a press fit. Replace the bushing using a driver set. When installing the bushing, make sure to align the oil hole in the bushing with the hole in the connecting rod.



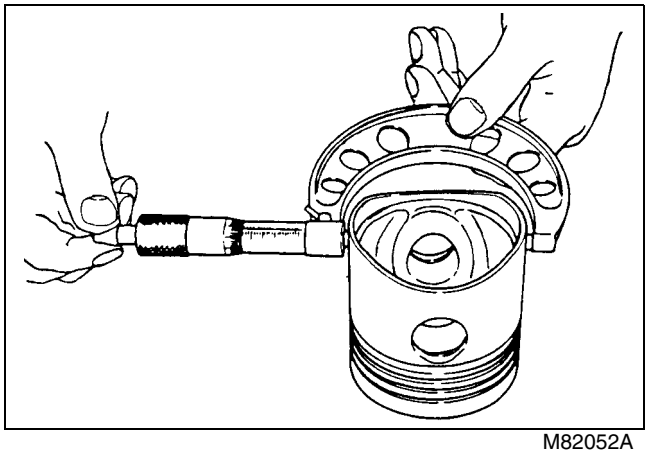
M82051A

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

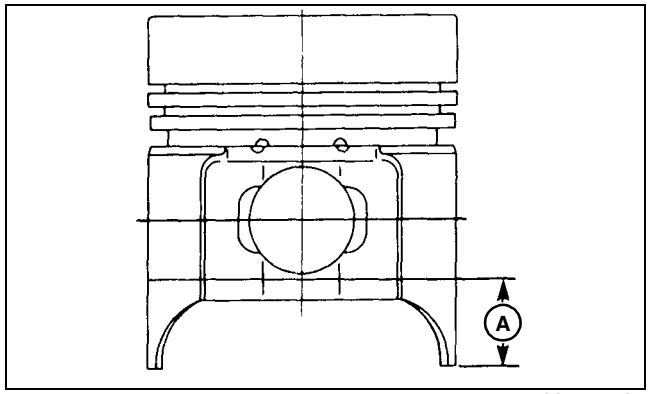
2. If piston pin-to-rod bore oil clearance (bushing ID minus pin OD) exceeds specification, replace the bushing or the piston pin.

Piston Diameter:

NOTE: If the engine has had a previous major overhaul, oversize pistons and rings may have been installed. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.



M82052A



M82200A

Measure the piston diameter perpendicular to the piston pin bore at distance (A). If the piston diameter is less than the wear limit, install a new piston.

Specifications:

Model 1435 Connecting Rods:

Connecting Rod
Cap Screw Torque . . . . . 23 - 28 N•m (17 - 20 lb-ft)

Models 1445 and 1545 Connecting Rods:

Connecting Rod
Cap Screw Torque . . . . . 37 - 41 N•m (27 - 30 lb-ft)

Model 1435 Connecting Rod Bearings:

Connecting Rod
Bearing ID . . . . . 43.00 - 43.02 mm (1.693 - 1.694 in.)

Connecting Rod Bearing Standard Oil
Clearance . . . . . 0.033 - 0.059 mm (0.001 - 0.002 in.)

Connecting Rod Bearing Oil Clearance
Wear Limit . . . . . 0.15 mm (0.006 in.)

Models 1445 and 1545 Connecting Rod Bearings:

Connecting Rod Bearing
ID . . . . . 46.00 - 46.02 mm (1.811 - 1.812 in.)

Connecting Rod Bearing Standard Oil
Clearance . . . . . 0.04 - 0.09 mm (0.002 - 0.004 in.)

Connecting Rod Bearing Oil Clearance
Wear Limit . . . . . 0.25 mm (0.010 in.)

Model 1435 Piston Rings:

Top Piston Ring Groove
Side Clearance . . . . . 0.06 - 0.10 mm (0.002 - 0.004 in.)

Middle Piston Ring Groove
Side Clearance . . . . 0.090 - 0.125 mm (0.004 - 0.005 in.)

Oil Control Ring Groove
Side Clearance . . 0.020 - 0.055 mm (0.0008 - 0.0022 in.)

Piston Ring Standard End Gap (All Except Oil Control Ring) . . . . . 0.20 - 0.40 mm (0.008 - 0.016 in.)

Oil Control Ring
Standard End Gap . . . 0.15 - 0.35 mm (0.006 - 0.014 in.)

Piston Ring End Gap Wear Limit. . . 1.50 mm (0.059 in.)

Models 1445 and 1545 Piston Rings:

Top Ring Groove
Side Clearance . . . . . 0.08 - 0.11 mm (0.003 - 0.004 in.)

Middle Ring Groove
Side Clearance . . . . . 0.04 - 0.07 mm (0.001 - 0.003 in.)

Oil Control Ring Groove
Side Clearance . . . . . 0.03 - 0.06 mm (0.001 - 0.002 in.)

Piston Ring Standard End Gap . 0.20 - 0.40 mm (0.008 - 0.016 in.)

Piston Ring End Gap Wear Limit. . . 1.50 mm (0.059 in.)

Model 1435 Piston Pins:

Piston Pin Standard OD . . . . . 20.99 - 21.00 mm (0.826 - 0.827 in.)

Piston Pin OD Wear Limit . . . . . 20.90 mm (0.823 in.)

Models 1445 and 1545 Piston Pins:

Piston Pin
Standard OD . . . . . 22.99 - 23.00 mm (0.905 - 0.906 in.)

Piston Pin OD Wear Limit . . . . . 22.90 mm (0.902 in.)

Model 1435 Piston Pin Bores:

Bore Standard ID . . 21.00 - 21.01 mm (0.827 - 0.827 in.)

Bore ID Wear Limit . . . . . 21.02 mm (0.828 in.)

Models 1445 and 1545 Piston Pin Bores:

Bore Standard ID . . 23.00 - 23.01 mm (0.906 - 0.906 in.)

Bore ID Wear Limit . . . . . 23.02 mm (0.906 in.)

Model 1435 Piston Pin Bushings:

Bushing Standard ID . . . . . 21.025 - 21.038 mm (0.828 - 0.828 in.)

Bushing ID Wear Limit . . . . . 21.10 mm (0.831 in.)

Piston Pin-to-Rod Bore Standard
Oil Clearance. . . . . 0.025 - 0.047 mm (0.001 - 0.002 in.)

Piston Pin-to-Rod Bore Oil Clearance
Wear Limit . . . . . 0.20 mm (0.008 in.)

Models 1445 and 1545 Piston Pin Bushings:

Bushing
Standard ID . . . . . 23.02 - 23.04 mm (0.906 - 0.907 in.)

Bushing ID Wear Limit . . . . . 23.10 mm (0.909 in.)

Piston Pin-to-Rod Bore Standard
Oil Clearance. . . . . 0.03 - 0.05 mm (0.001 - 0.002 in.)

Piston Pin-to-Rod Bore
Oil Clearance Wear Limit . . . . . 0.20 mm (0.008 in.)

Model 1435 Pistons:

Diameter Measuring Point Distance (1) 5 mm (0.197 in.)

Standard Size Piston
Standard OD . . . . . 73.96 - 73.98 mm (2.912 - 2.913 in.)

Standard Size Piston
OD Wear Limit . . . . . 73.90 mm (2.91 in.)

Oversize Piston
Standard OD . . . . . 74.21 - 74.23 mm (2.921 - 2.922 in.)

Oversize Piston OD Wear Limit . . . 74.15 mm (2.92 in.)

Models 1445 and 1545 Pistons:

Diameter Measuring Point
Distance (1). . . . . 23 mm (0.905 in.)

Standard Size Piston
Standard OD . . . . . 77.95 - 77.98 mm (3.069 - 3.070 in.)

Standard Size Piston
OD Wear Limit . . . . . 77.90 mm (3.067 in.)

Oversize Piston
Standard OD . . . . . 78.20 - 78.23 mm (3.079 - 3.080 in.)

Oversize Piston OD Wear Limit . . 78.15 mm (3.077 in.)

Connecting Rod Side Play Check

Front Mower

1435

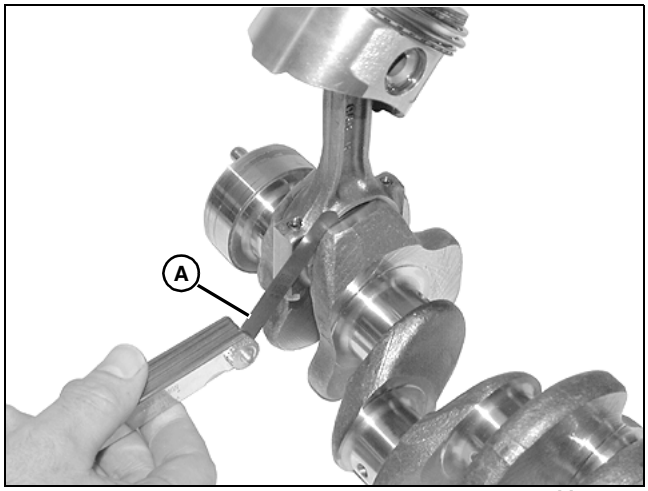
1445

1545

Procedure:

1. Remove crankshaft from cylinder block. (See “Crankshaft and Main Bearings” on page 170.)

2. Install connecting rod on crankshaft. Tighten connecting rod cap screws to specification.



M98862

3. Measure connecting rod side play using a feeler gauge (A). Replace connecting rod and/or crankshaft if side play exceeds specification.

Specifications:

Connecting Rod
Side Play . . . . . 0.20 - 0.40 mm (0.008 - 0.016 in.)

Model 1435

Connecting Rod
Cap Screw Torque . . . . . 23 - 28 N•m (17 - 20 lb-ft)

Models 1445 and 1545

Connecting Rod
Cap Screw Torque . . . . . 37 - 41 N•m (27 - 30 lb-ft)

Connecting Rod Bearing Clearance Check

Front Mower

1435

1445

1545

Reason:

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

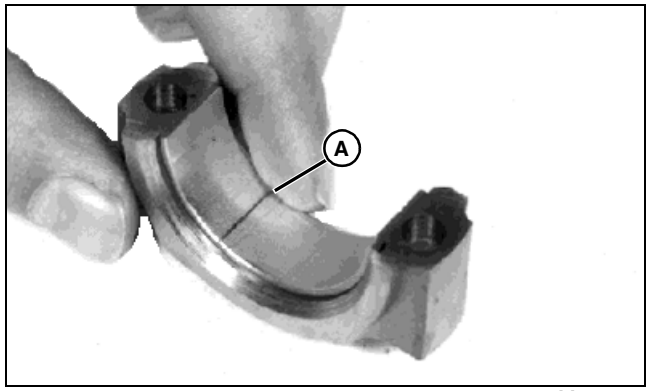
Special or Required Tools:

Tool Name	Tool No.	Tool Use
PLASTIGAGE® Bearing Clearance Measurement Tool (or equivalent)	NA	Used between bearing insert and crankshaft journal to measure clearance.

Procedure:

IMPORTANT: Avoid damage! Connecting rod caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

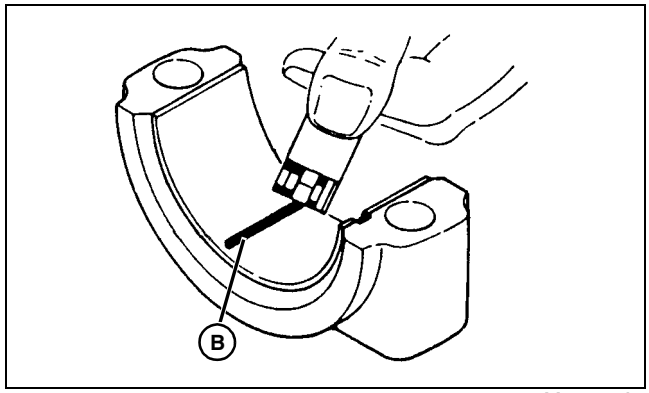
1. Remove connecting rod cap.
2. Wipe oil from bearing insert and crankshaft journal.



M35351

3. Put a piece of PLASTIGAGE (A), or an equivalent, along the full length of the bearing insert approximately 6 mm (0.250 in.) off center.
4. Turn crankshaft approximately 30° from bottom dead center.
5. Install connecting rod end cap and original cap screws. Tighten cap screws to specification.
6. Remove cap screws and connecting rod cap.

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



M82117A

7. Use the graduation marks on the envelope to compare the width of the flattened PLASTIGAGE (B) at its widest point.
8. Determine bearing clearance. The number within the graduation marks indicates the bearing clearance in inches or millimeters, depending on which side of the envelope is

used.

9. Remove PLASTIGAGE.

Results:

If clearance exceeds specification, replace bearing inserts.

Specifications:

Model 1435

Connecting Rod End Cap
Cap Screw Torque . . . . . 23 N•m (203 lb-in.)

Connecting Rod Bearing
Standard Clearance . . 0.03 - 0.06 mm (0.001 - 0.002 in.)

Connecting Rod Bearing
Clearance Wear Limit . . . . . 0.15 mm (0.006 in.)

Models 1445 and 1545

Connecting Rod End Cap
Cap Screw Torque . . . . . 39 N•m (29 lb-ft)

Connecting Rod Bearing
Standard Clearance . . 0.04 - 0.09 mm (0.002 - 0.004 in.)

Connecting Rod Bearing
Clearance Wear Limit . . . . . 0.25 mm (0.010 in.)

Cylinder Bore

Front Mower

1435

1445

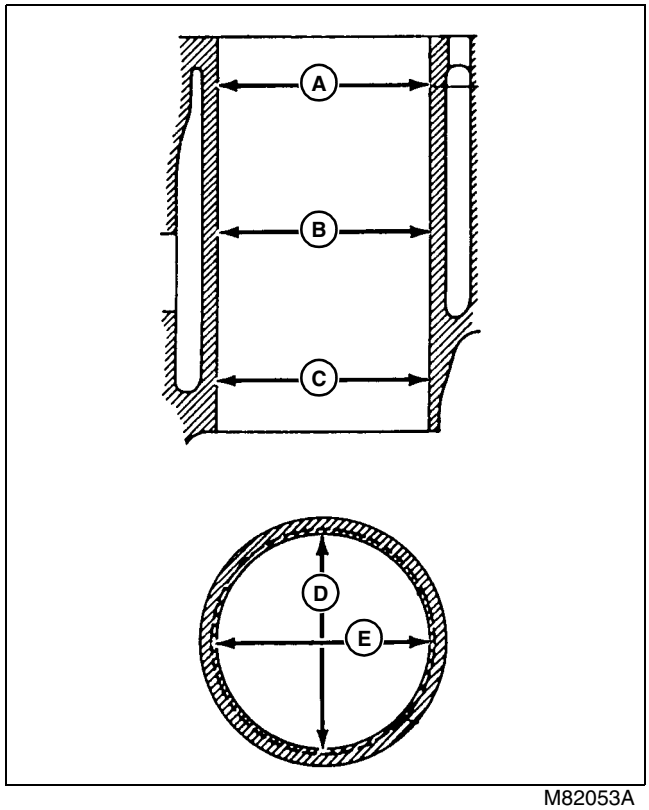
1545

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Flex Hone (with 180 Grit Stones)	NA	Used to deglaze cylinder bores.
Rigid Hone (with 300 Grit Stones)	NA	Used with drill press to rebore cylinder to use oversize pistons and rings.
Drill Press	NA	Used with rigid hone to rebore cylinder to use oversize pistons and rings.

Inspection:

NOTE: If engine has had a previous major overhaul, the cylinders may have been bored oversize. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.



M82053A

1. Measure cylinder bore diameter at three positions: top (A), middle (B), and bottom (C). At these three positions, measure in both directions: along crankshaft centerline (D) and direction of crankshaft rotation (E).

2. If cylinder bore inner diameter exceeds wear limit, have cylinder rebored. (See “Reboring:” on page 167.)

3. If cylinder is rebored, oversize pistons and rings must be installed.

4. If cylinder bore exceeds oversize bore inner diameter, replace the cylinder block.

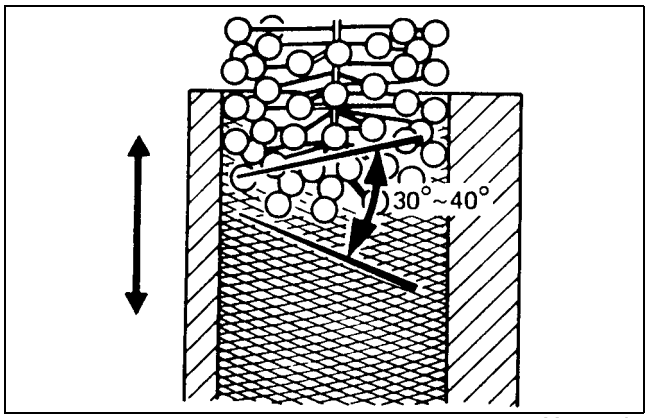
5. If clearance (cylinder bore ID minus piston OD) exceeds specification, replace cylinder block, piston, or both; or rebore cylinder and install oversize pistons and rings.

6. Slightly uneven wear, flaws, or minor damage may be corrected by deglazing. (See “Deglazing:” on page 167.)

Deglazing:

IMPORTANT: Avoid damage! If cylinder bores are to be deglazed with crankshaft installed in engine, put clean shop towels over crankshaft to protect journal and bearing surfaces from any abrasives.

1. Deglaze cylinder bores using a flex hone with 180 grit stones.



M82054A

2. Use flex hone as instructed by manufacturer to obtain a 30 - 40° crosshatch pattern as shown.

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

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

Reboring:

NOTE: The cylinder block can be rebored to use oversize pistons and rings. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

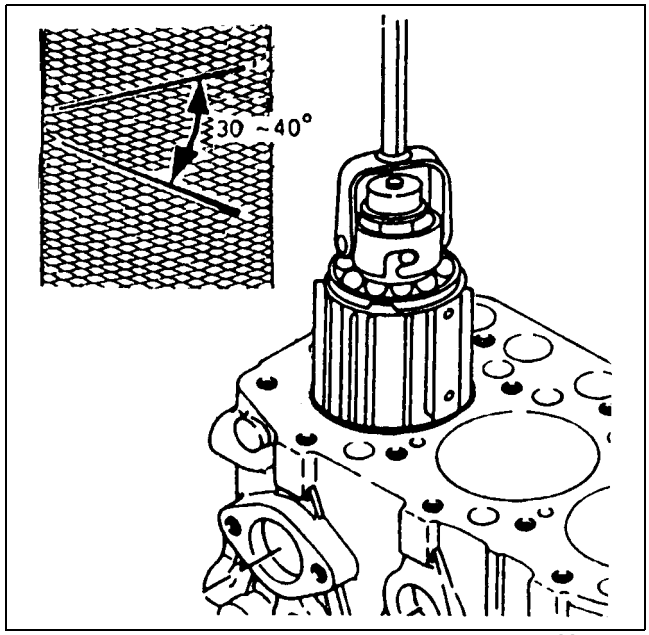
1. Align center of bore to drill press center.

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

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

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

4. Coat cylinder with honing oil. Rigid hone should turn by hand. Adjust if too tight.



M52959

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

NOTE: Measure bore when cylinder is cool.

6. Stop press and check cylinder diameter.

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

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

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

9. Check bore for size, taper, and out-of-round. (See “Inspection:” on page 166.)

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

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

Specifications:

Model 1435

Piston-to-Cylinder Bore Clearance . . . . . 0.03 - 0.06 mm (0.001 - 0.002 in.)

Cylinder Standard Roundness . . . . . 0.00 - 0.01 mm (0.0000 - 0.0004 in.)

Cylinder Roundness Wear Limit. . . 0.03 mm (0.001 in.)

Cylinder Standard Taper . . . . 0.00 - 0.01 mm (0.0000 - 0.0004 in.)

Cylinder Taper Wear Limit . . . . . 0.03 mm (0.001 in.)

Standard Size Cylinder Bore
Standard ID . . . . . 74.00 - 74.03 mm (2.913 - 2.915 in.)

Standard Size Cylinder Bore
ID Wear Limit. . . . . 74.20 mm (2.921 in.)

Oversize Cylinder Bore
Standard ID . . . . . 74.25 - 74.28 mm (2.923 - 2.925 in.)

Oversize Cylinder Bore
ID Wear Limit. . . . . 74.45 mm (2.931 in.)

Models 1445 and 1545

Piston-to-Cylinder Bore Clearance
(Maximum). . . . . 0.050 mm (0.002 in.)

Cylinder Standard
Roundness . . . . . 0.00 - 0.01 mm (0.0000 - 0.0004 in.)

Cylinder Roundness
Wear Limit . . . . . 0.03 mm (0.001 in.)

Cylinder
Standard Taper . . . . 0.00 - 0.01 mm (0.0000 - 0.0004 in.)

Cylinder Taper Wear Limit . . . . . 0.03 mm (0.001 in.)

Standard Size Cylinder Bore
Standard ID . . . . . 78.00 - 78.03 mm (3.071 - 3.072 in.)

Standard Size Cylinder Bore
ID Wear Limit. . . . . 78.20 mm (3.079 in.)

Oversize Cylinder Bore
ID . . . . . 78.25 - 78.28 mm (3.081 - 3.082 in.)

Crankshaft Rear Oil Seal

Front Mower

1435

1445

1545

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Hoist	NA	Used with lifting brackets to remove flywheel from crankshaft.
Lifting Bracket (2 used)	JT01748	Used with hoist to remove flywheel from crankshaft.
Bushing, Bearing, and Seal Driver Set	NA	Used to install crankshaft rear oil seal.

Other Material:

Part No.	Part Name	Part Use
TY16021 (U.S.)/ LOCTITE ® 17430/ TY9484 (Canada)	John Deere High Flex Form-in-Place Gasket	Applied to seal case-to-engine block mating surfaces before installing seal case.

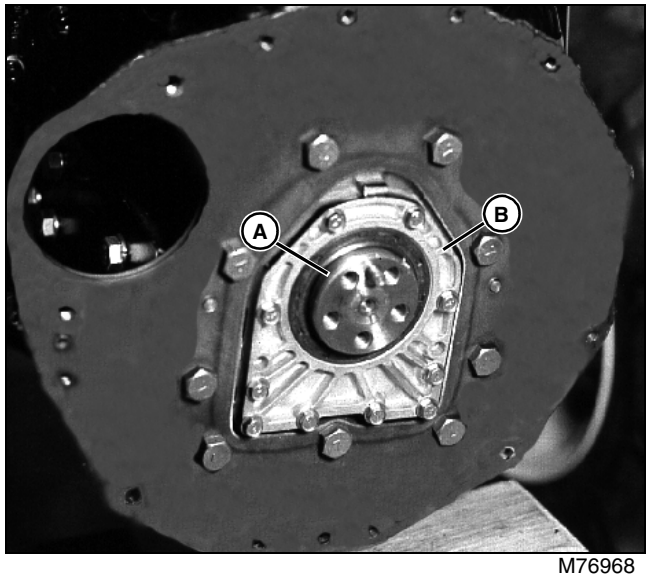
Rear Oil Seal Removal/Installation:

IMPORTANT: Avoid damage! Flywheel is heavy! Do not remove flywheel mounting cap screws unless flywheel is secure. Use a hoist and lifting brackets to lift flywheel from crankshaft.

NOTE: Engine removal is not necessary to replace rear oil seal.

1. Remove flywheel. (See “Flywheel Removal and Installation” on page 173.)

NOTE: It is not necessary to remove oil seal case (B) to remove oil seal (A).



M76968

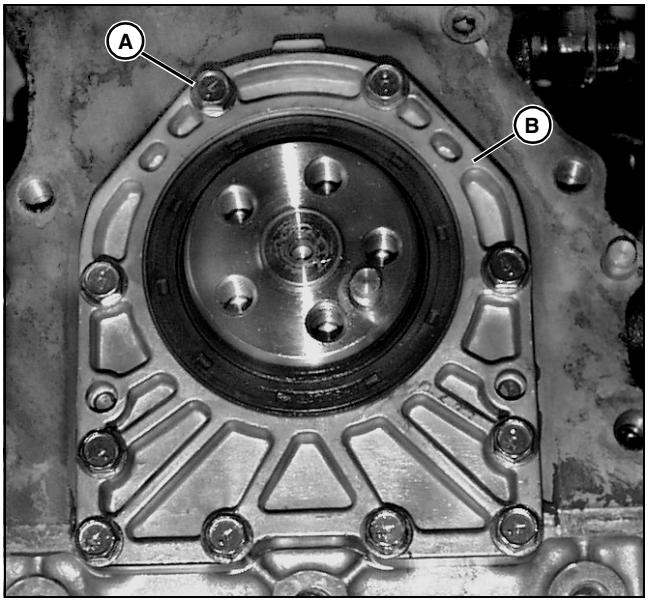
2. Carefully pry oil seal (A) from oil seal case (B).

NOTE: Oil seal is normally installed flush with surface of oil seal case. If oil seal has worn a groove in crankshaft at oil seal contact point, seal can be installed 3 mm (0.120 in.) deeper into oil seal case.

3. Replace oil seal using a driver set. Install seal with lip toward cylinder block. Install seal flush with surface of oil seal case.

Rear Oil Seal Case Removal/Installation:

NOTE: It is not necessary to remove oil seal case to remove oil seal. It is not necessary to remove oil seal to remove oil seal case.



MX0749

1. Remove oil seal case-to-cylinder block cap screws (A).
2. Pry oil seal case (B) from engine block.
3. Clean all old gasket material from oil seal case and engine block.
4. Apply TY16021 John Deere High Flex Form-in-Place Gasket to seal case-to-engine block mating surfaces. Install seal case.
5. Install new oil seal after oil seal case is installed.
6. Install flywheel onto crankshaft, aligning crankshaft pin into flywheel mounting flange. Tighten mounting cap screws to specification.
7. Install flex plate with longer center hub facing out.
8. Install drive shaft.

Specifications:

Flywheel Mounting Cap Screw
Torque . . . . . 83 - 88 N•m (62 - 65 lb-ft)

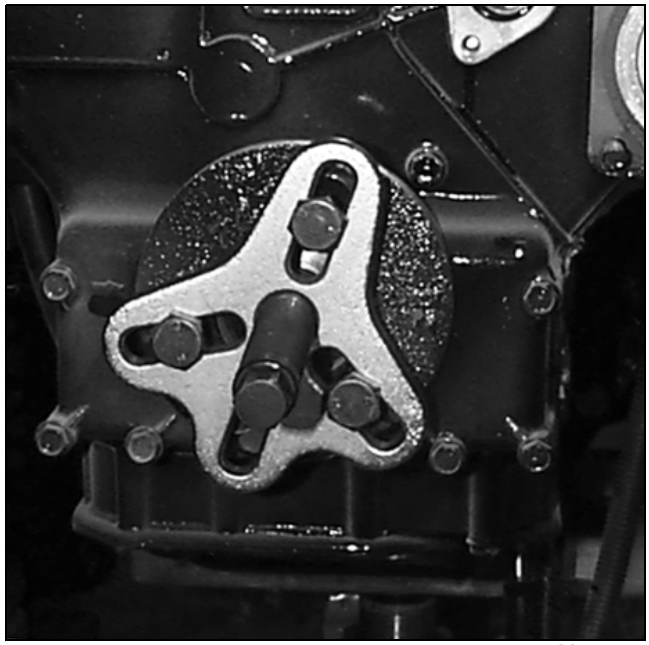
Crankshaft Front Oil Seal - 1435

Special or Required Tools:

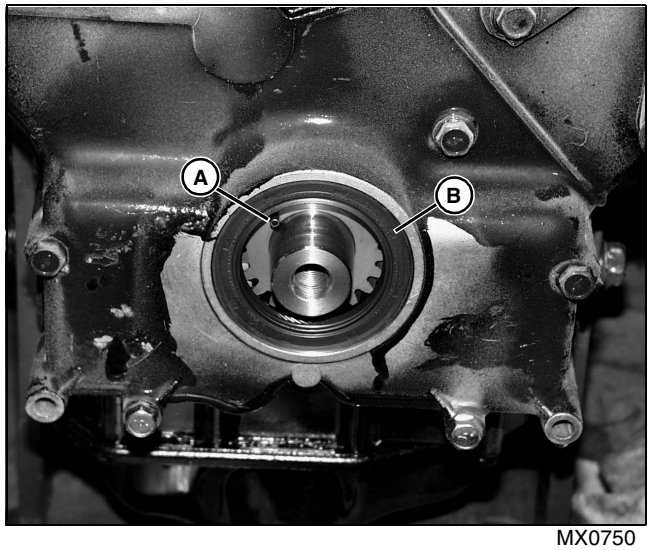
Tool Name	Tool No.	Tool Use
Pulley Puller	NA	Used to remove crankshaft sheave.
Bushing, Bearing, and Seal Driver Set	NA	Used to install crankshaft front oil seal.

Procedure:

1. Park machine with engine off and park brake on.
2. Remove alternator belt. (See “Alternator Drive Belt Removal and Installation” on page 133.)


M89691

3. Remove crankshaft sheave cap screw. Install puller to crankshaft sheave and remove sheave.



MX0750

4. Carefully pry oil seal (B) from timing gear cover.

5. Install new oil seal using a bushing, bearing, and seal driver set. Install seal with lip toward engine. Install seal flush with surface of cover.

6. Coat lip of seal with clean engine oil.

7. Install crankshaft sheave on crankshaft, lining up pin (A) on crankshaft timing gear with hole in crankshaft sheave.

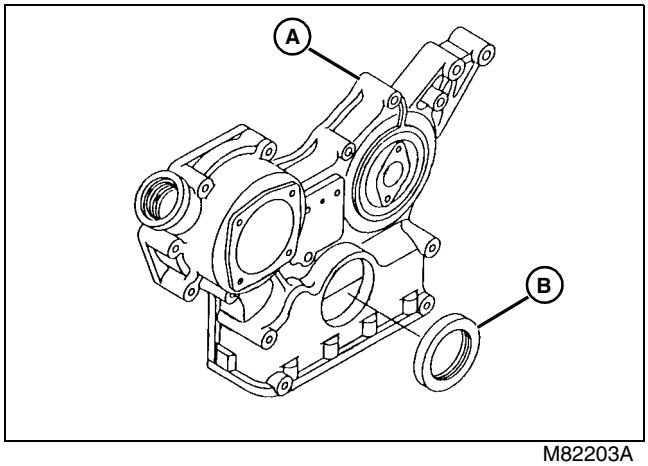
8. Install flat washer and cap screw. Tighten cap screw to specification.

9. Install alternator belt and adjust belt. (See “Alternator Drive Belt Removal and Installation” on page 133, and “Alternator Drive Belt Tension Check and Adjustment” on page 119.)

Specifications:

Crankshaft Sheave
Cap Screw Torque . . . . . 88 N•m (65 lb-ft)

Crankshaft Front Oil Seal - 1445 and 1545



M82203A

1. Remove the timing gear cover (A). (See “Timing Gear Cover Removal and Installation - 1435” on page 181, or “Timing Gear Cover Removal and Installation - 1445 and 1545” on page 182.)

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

Crankshaft and Main Bearings

Front Mower

1435

1445

1545

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Knife-Edge Puller	NA	Used with press to remove gear from crankshaft.
Press	NA	Used with knife-edge puller to remove gear from crankshaft.
Dial Indicator	NA	Used with V-blocks to inspect crankshaft for bend.
V-Block (2 used)	NA	Used with dial indicator to inspect crankshaft for bend.

Removal:

1. Check crankshaft end play.

2. Remove flywheel. (See “Flywheel Removal and Installation” on page 173.)

3. Remove rear oil seal case. (See “Crankshaft Rear Oil Seal” on page 168.)

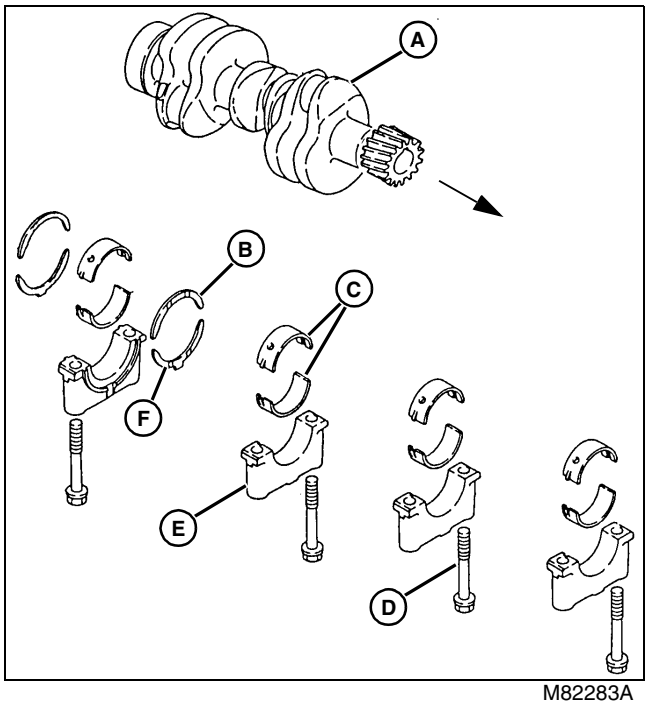
4. Remove timing gear cover, timing gears, timing gear housing, and flywheel of engine.

5. Check crankshaft bearing clearance. (See “Inspection/ Replacement:” on page 172.)

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

6. Remove connecting rod cap screws and end caps. Push pistons and connecting rods away from crankshaft.

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



M82283A

Picture Note: Arrow Points to Front of Engine

7. Remove main bearing cap screws (D), caps (E), and cap thrust bearings (F).

8. Remove crankshaft (A).

9. Remove block thrust bearings (B) and main bearing inserts (C).

10. Inspect all parts for wear or damage. (See "Inspection/ Replacement:" on page 172.)

Installation:

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

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

2. Install bearing inserts drilled with oil passage in cylinder block bearing bores, aligning tangs with slots in bores.

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

NOTE: Main bearing caps have raised arrows that are stamped with numbers. Both correspond to their location on the engine block. The number "1" main bearing bore is at flywheel end. Install bearing caps beginning with number 1, then 2, etc. The main bearing cap at gear train end does not have a number. Also install bearing caps with the arrow toward the flywheel end.

4. Install crankshaft.

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

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

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

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

8. Dip entire main bearing cap screws in clean engine oil. Install cap screws and tighten. Do not tighten to specification at this time.

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

10. Tighten main bearing cap screws to specification. When tightening, start at center main bearing cap and work your way out, alternating to the ends. Turn crankshaft by hand. If it does not turn easily, disassemble the parts and find the cause.

IMPORTANT: Avoid damage! The connecting rod caps must be installed on the same connecting rods from which they were removed. Never reuse connecting rod cap screws. Replace with new.

11. Match the connecting rod caps to the rods using alignment marks. Install the caps to the rods.

12. Dip entire connecting rod cap screws in clean engine oil. Install new cap screws to the rods, and tighten to specification.

13. **Models 1445 and 1545:** Install the timing gear cover mounting plate. (See "Timing Gear Cover Mounting Plate Removal and Installation - 1445 and 1545" on page 186.)

14. Install the rear oil seal. (See "Crankshaft Rear Oil Seal" on page 168.)

15. Install the flywheel. (See "Flywheel Removal and Installation" on page 173.)

16. Install the timing gear cover. (See "Timing Gear Cover Removal and Installation - 1435" on page 181 or "Timing Gear Cover Removal and Installation - 1445 and 1545" on page 182.)

17. Install the front oil seal. (See "Crankshaft Front Oil Seal - 1435" on page 169 or "Crankshaft Front Oil Seal - 1445 and 1545" on page 170.)

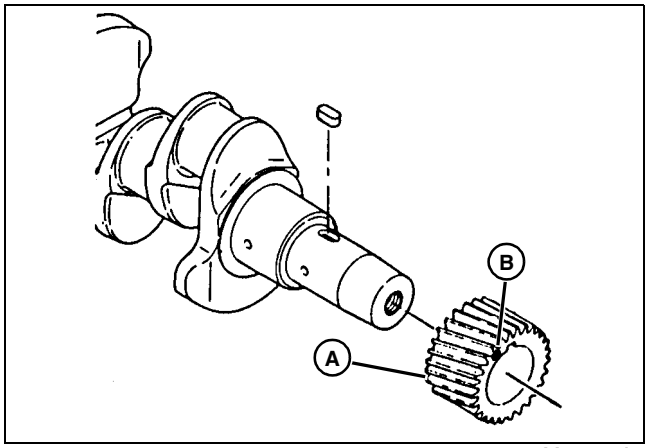
18. Install the oil pan. (For Model 1435, see "Oil Pan and

Strainer - 1435" on page 186. For Models 1445 and 1545, see "Oil Pan, Crankcase Extension, and Strainer - 1445 and 1545" on page 186.)

Inspection/Replacement:

1. Inspect crankshaft gear for chipped or broken teeth. If replacement is necessary, remove gear from crankshaft using a knife-edge puller and a press.

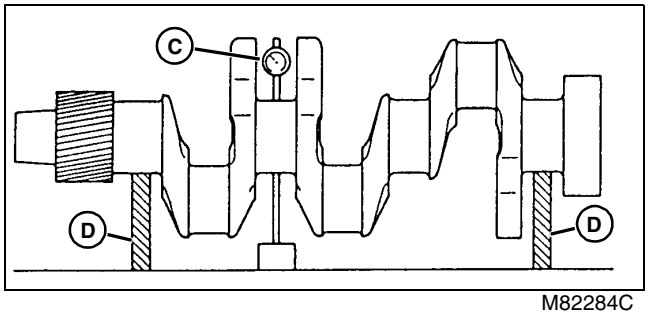
CAUTION: Avoid injury! Do not heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.



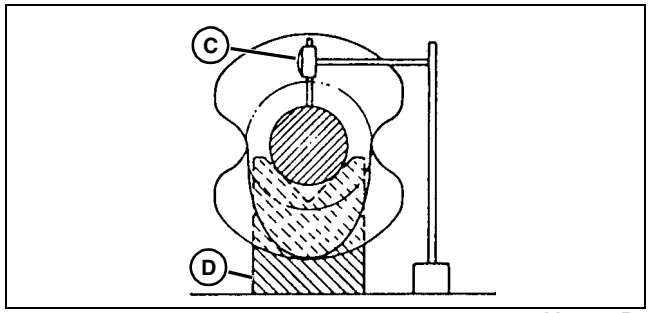
M82060A

2. Heat gear to approximately 150°C (300°F). Install gear (A) with timing mark (B) toward press table.

3. Align slot in gear with key in shaft. Press crankshaft into gear until gear is tight against crankshaft shoulder.



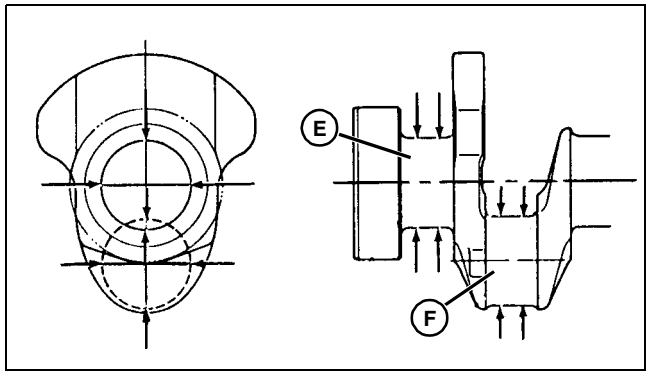
M82284C



M82284B

4. Inspect crankshaft for bend using V-blocks (D) and a dial indicator (C). Turn crankshaft slowly and read variation on indicator. If variation is greater than specification, replace crankshaft.

NOTE: If engine has had a previous major overhaul, journals may have been ground and undersize bearing inserts installed.



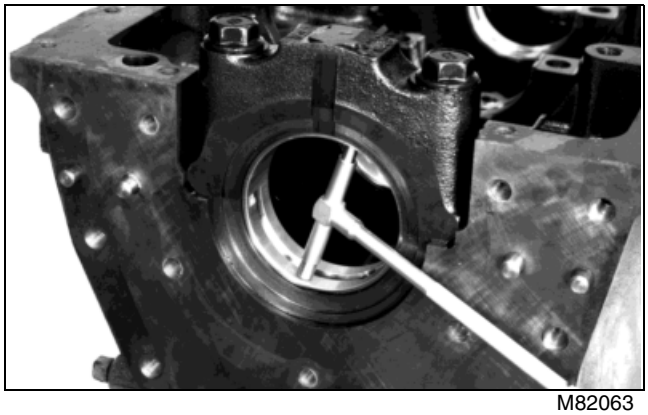
M82062A

5. Measure crankshaft connecting rod journals (F) and main bearing journal (E) diameters. Measure several places around each journal.

6. If journal diameter is less than wear limit, replace crankshaft or have journals ground undersize by a qualified machine shop.

7. If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.

8. Install bearing inserts and main bearing cap on main bearing. Tighten main bearing cap screws to specification.



M82063

9. Measure main bearing diameter.

10.Subtract the crankshaft main bearing journal outer diameter from the main bearing inner diameter to obtain the main bearing oil clearance.

- If crankshaft is within specification but main bearing oil clearance exceeds the wear limit, replace the bearing inserts.
- If crankshaft is not within specification, have crankshaft journals ground undersize by a qualified machine shop and install undersize bearing inserts.
- If crankshaft is worn past the wear limit, replace the crankshaft.

11.Clean and inspect oil passages in main bearing journals, connecting rod journals, and main bearing bores in cylinder block.

12.Inspect crankshaft for cracks or damage. Replace if necessary.

Specifications:

Model 1435

Connecting Rod
Cap Screw Torque . . . . . 23 - 28 N•m (17 - 20 lb-ft)

Main Bearing
Cap Screw Torque . . . . . 79 - 83 N•m (58 - 61 lb-ft)

Crankshaft Bend (Maximum). . . . . 0.02 mm (0.0008 in.)

Crankshaft Connecting Rod Journal
Standard OD . . . . . 39.97 - 39.98 mm (1.573 - 1.574 in.)

Crankshaft Connecting Rod Journal
OD Wear Limit. . . . . 39.91 mm (1.571 in.)

Crankshaft Main Bearing Journal
Standard OD . . . . . 43.97 - 43.98 mm (1.728 - 1.732 in.)

Crankshaft Main Bearing Journal
OD Wear Limit. . . . . 43.90 mm (1.728 in.)

Main Bearing Standard Oil
Clearance . . . . . 0.04 - 0.09 mm (0.002 - 0.004 in.)

Main Bearing Oil Clearance
Wear Limit. . . . . 0.25 mm (0.010 in.)

Models 1445 and 1545

Connecting Rod
Cap Screw Torque . . . . . 37 - 41 N•m (27 - 30 lb-ft)

Main Bearing
Cap Screw Torque . . . . . 76.5 - 80.4 N•m (56 - 59 lb-ft)

Crankshaft Bend (Maximum) . . . . 0.02 mm (0.0008 in.)

Crankshaft Connecting Rod Journal
Standard OD . . . . . 42.95 - 42.96 mm (1.691 - 1.691 in.)

Crankshaft Connecting Rod Journal
OD Wear Limit . . . . . 42.91 mm (1.689 in.)

Crankshaft Main Bearing Journal
Standard OD . . . . . 46.95 - 46.96 mm (1.848 - 1.849 in.)

Crankshaft Main Bearing Journal
OD Wear Limit . . . . . 46.91 mm (1.847 in.)

Main Bearing Standard
Oil Clearance . . . . . 0.04 - 0.09 mm (0.002 - 0.004 in.)

Main Bearing Oil Clearance
Wear Limit. . . . . 0.25 mm (0.010 in.)

Flywheel Removal and Installation

Front Mower

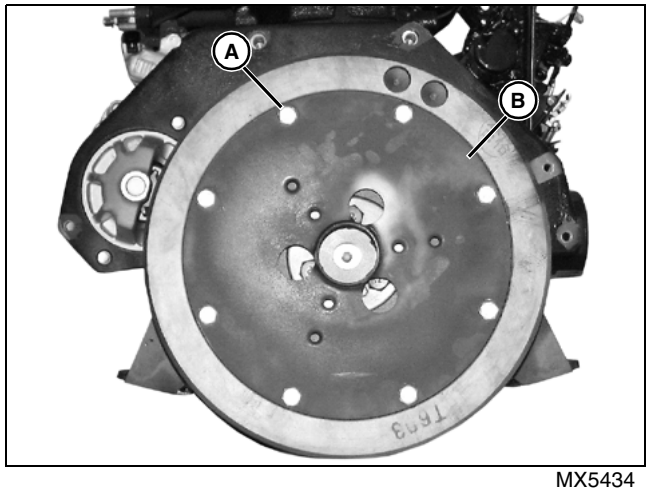
1435

1445

1545

Removal/Installation:

1. Flywheel can be removed without removing engine from machine. If removing flywheel in machine, see “Engine Drive Shaft Removal and Installation” on page 518 in the Power Train section.

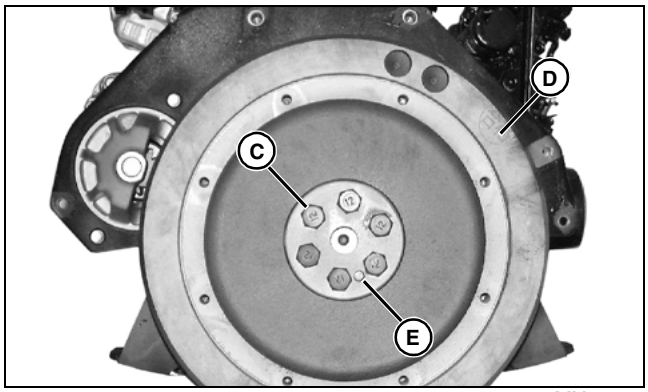


MX5434

Picture Note: Models 1445 and 1545 Shown

2. Remove eight cap screws (A) and flex plate (B).

IMPORTANT: Avoid damage! Always install new flywheel mounting cap screws.



MX5435

Picture Note: Models 1445 and 1545 Shown

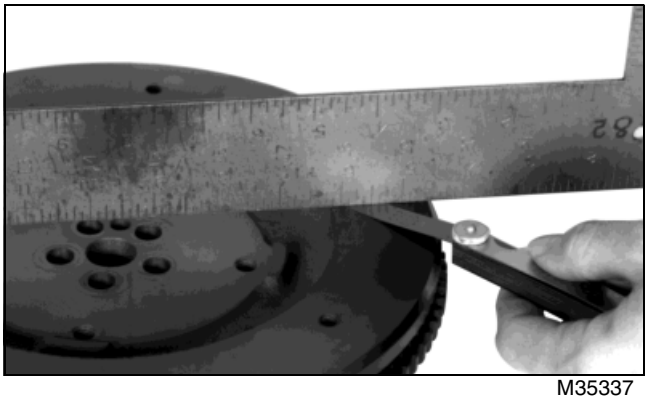
3. Remove the flywheel mounting cap screws (C) and remove the flywheel (D) from crankshaft.

4. Use pin (E) in crankshaft to correctly locate the flywheel on the crankshaft.

5. Install the flywheel. Apply lubrication oil to the mounting cap screws and tighten to specification.

6. Install flex plate with raised hub facing away from flywheel.

7. Install cap screws and tighten to specification.



M35337

8. Measure flywheel flatness. Place a straightedge across the flywheel surface opposite of ring gear. Measure the clearance between the straightedge and the flywheel surface with a feeler gauge. Replace the flywheel if the clearance exceeds specification.

Specifications:

Flywheel Mounting
Cap Screw Torque . . . . . 83 - 88 N•m (62 - 65 lb-ft)

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

Camshaft

Front Mower

1435

1445

1545

IMPORTANT: Avoid damage! Always replace camshaft followers when installing a new camshaft. Always replace camshaft when replacing camshaft followers. The components wear as a set and replacing only one will accelerate the wear of the other.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Magnetic Follower Holder Kit	D15001NU	Used to hold cam followers away from camshaft.
Knife-Edge Puller	NA	Used with arbor press for removing gear from camshaft.
Arbor Press	NA	Used with knife-edge puller for removing gear from camshaft.
V-Block (2 used)	NA	Used to hold camshaft during inspection.
Dial Indicator	NA	Used to measure camshaft bend.
Micrometer	NA	Used to measure camshaft lobe height.
Bushing Driver Set	NA	Used to replace worn camshaft bushing.

Other Material:

Part No.	Part Name	Part Use
TY16021 (U.S.)/ LOCTITE® 17430/TY9484 (Canada)	John Deere High Flex Form-in-Place Gasket	Applied to camshaft bore plug before reinstallation.

Camshaft Removal:

1. Remove engine. (See “Engine Removal and Installation” on page 143.)

2. Remove rocker arm assembly and push rods. (See “Rocker Arm Assembly Removal and Installation - 1435” on page 146 or “Rocker Arm Assembly Removal and Installation - 1445 and 1545” on page 146.)

3. Remove timing gear cover. (See “Timing Gear Cover Removal and Installation - 1435” on page 181, or “Timing Gear Cover Removal and Installation - 1445 and 1545” on page 182.)

4. Check camshaft end play. (See “Camshaft End Play Check:” on page 177.)

5. Check backlash of timing gears. (See “Timing Gear Backlash Check:” on page 178.)

NOTE: If camshaft is being removed with cylinder head installed, use a magnetic follower holder tool, or turn engine until oil pan is upward, to hold cam followers away from camshaft.

6. Hold cam followers away from camshaft using a magnetic follower holder kit such as D15001NU.

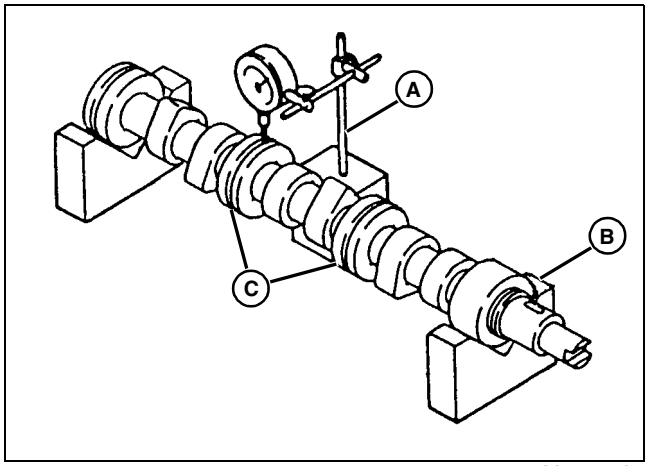
7. Rotate the crankshaft and align the timing marks.

IMPORTANT: Avoid damage! Do not allow camshaft lobes to hit bearing surfaces while removing camshaft. Machined surfaces can be damaged.

8. Remove two thrust plate mounting cap screws, the thrust plate, and the camshaft.

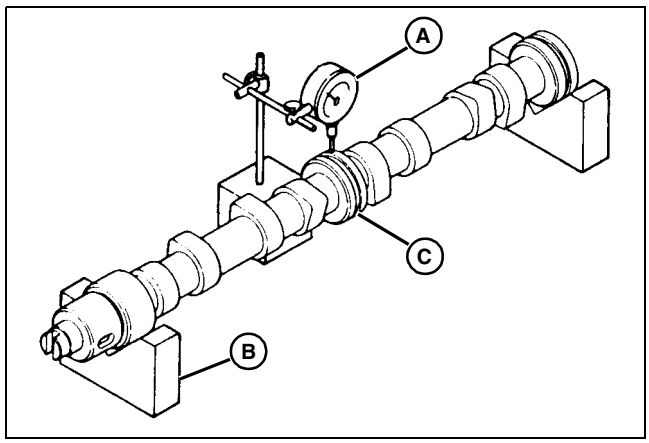
9. Inspect all parts for wear or damage. (See “Camshaft Inspection:” on page 175.)

Camshaft Inspection:



M82291A

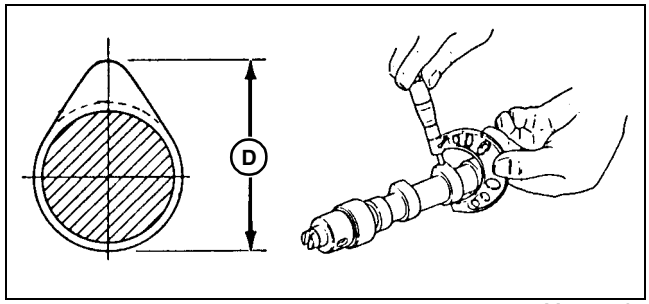
Picture Note: Model 1435



M82069A

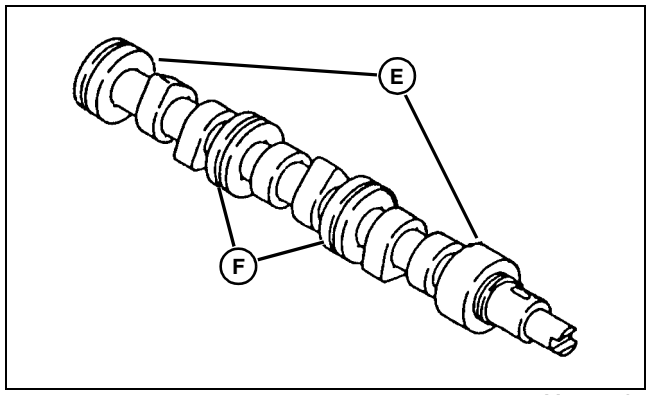
Picture Note: Models 1445 and 1545

1. Inspect camshaft for bend by using a pair of V-blocks (B) and a dial indicator (A). Turn camshaft slowly and read variation of camshaft bearing journals (C) on indicator. If variation is greater than wear limit, replace camshaft.



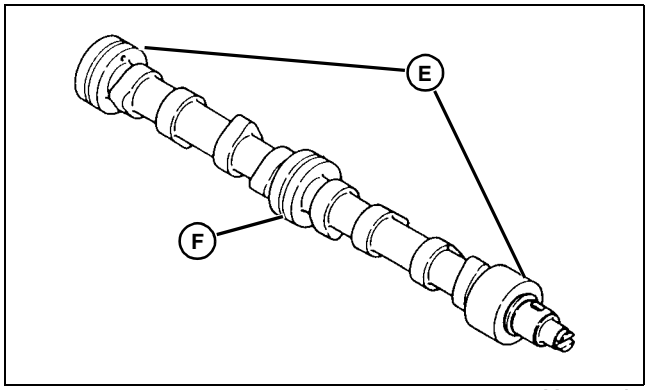
M82070A

2. Measure camshaft lobe height (D) using a micrometer. If lobe height is less than wear limit, or if there are chips or scratches in lobes or bearing journals, replace camshaft.



M82292A

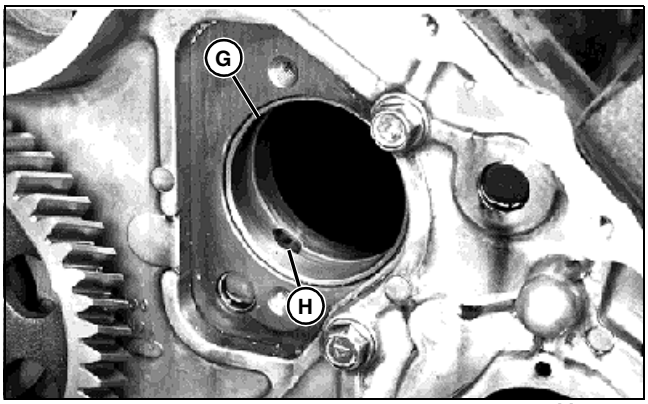
Picture Note: Model 1435



M82071A

Picture Note: Models 1445 and 1545

3. Measure camshaft end journal (E) and intermediate journal (F) outside diameters. If journal diameters are less than wear limit, replace camshaft.



M82072

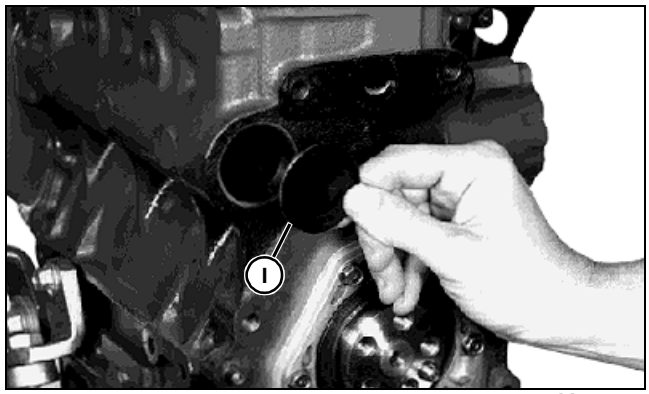
4. Measure camshaft bushing diameter (G) at gear housing end. If bushing diameter exceeds wear limit, replace bushing using a driver set.

a. Align oil holes (H) in new bushing and cylinder block.

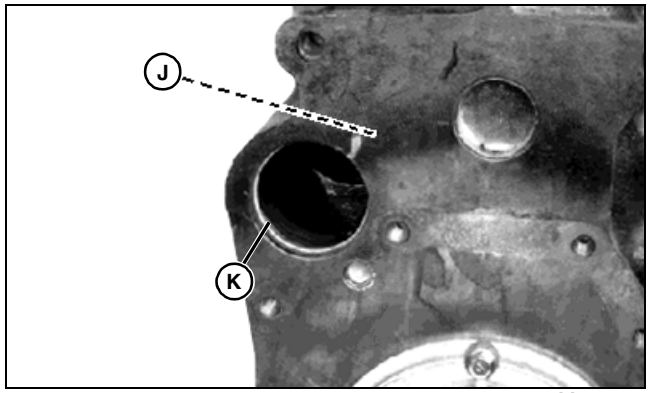
b. Install bushing flush with surface of idler gear.

5. If bushing oil clearance (bushing ID minus camshaft journal OD) exceeds specification, replace bushing, camshaft, or both.

NOTE: Engine back plate must be removed to measure camshaft intermediate (J) and flywheel end (K) bearing diameters.



M35287



M82073

6. Remove engine back plate.

7. Remove plug (I).

8. Measure intermediate (J) and flywheel end (K) camshaft bore diameters. If bore diameter exceeds wear limit, replace cylinder block.

9. If bore clearance (bore ID minus camshaft journal OD) exceeds oil clearance specification, replace camshaft, cylinder block, or both.

10.Apply TY16021 John Deere High Flex Form-in-Place Gasket, or equivalent, on outer edge of plug. Install plug until it bottoms in bore.

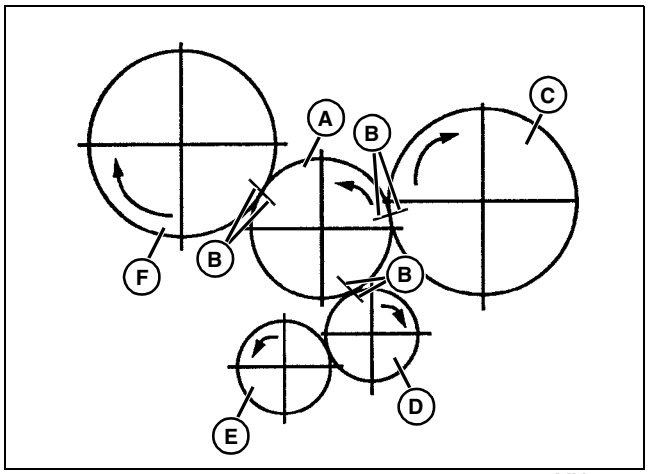
11.Install engine back plate.

Camshaft Installation:

IMPORTANT: Avoid damage! Do not allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces can be damaged.

NOTE: Apply clean engine oil on all parts during installation.

The fuel injection drive gear, camshaft gear, and crankshaft gear all must be correctly timed to the idler gear. It is not necessary to time the oil pump gear. Due to the odd number of teeth on the idler gear, timing marks will only align periodically. (See "Timing Gear Backlash Check:" on page 178.)



MX5627

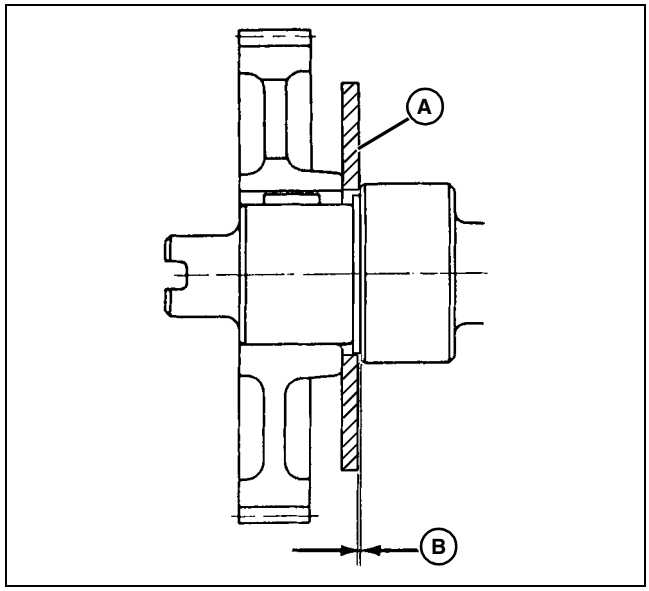
Picture Note: Arrows Indicate Direction of Rotation (Viewed from Gear Case)

A - Idler Gear
B - Timing Marks
C - Camshaft Gear
D - Crankshaft Gear
E - Oil Pump Gear
F - Fuel Injection Drive Gear

1. Rotate the crankshaft to align the timing marks.
2. Install the camshaft.
3. Install the thrust plate and cap screws. Tighten to specification.
4. Install timing gear cover. (See "Timing Gear Cover Removal and Installation - 1435" on page 181, or "Timing Gear Cover Removal and Installation - 1445 and 1545" on page 182.)
5. If cam followers were removed, replace into same holes as removed.
6. Install push rods and rocker arm assembly. (See "Rocker Arm Assembly Removal and Installation - 1435" on page 146, or "Rocker Arm Assembly Removal and Installation - 1445 and 1545" on page 146.)

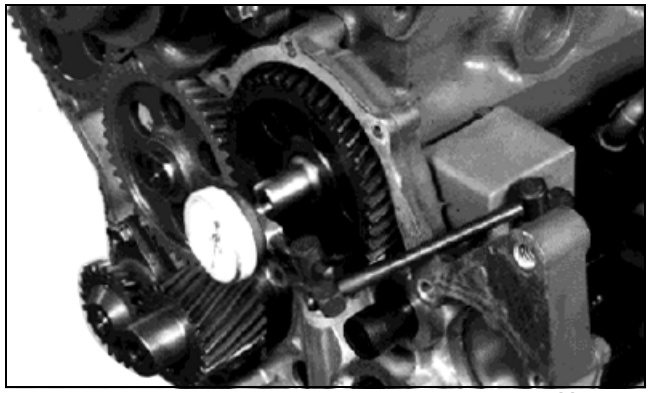
Camshaft End Play Check:

NOTE: Follow this procedure if camshaft is installed in cylinder block. If camshaft is removed from cylinder block, check end play (B) using a feeler gauge between camshaft thrust plate (A) and front side of first camshaft bearing journal.



M82067A

1. Remove timing gear cover. (See "Timing Gear Cover Removal and Installation - 1435" on page 181, or "Timing Gear Cover Removal and Installation - 1445 and 1545" on page 182.)



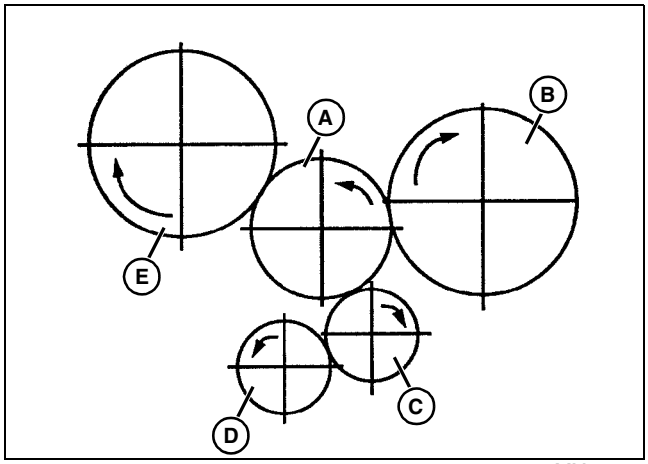
M37512

2. Fasten dial indicator base to cylinder block and position indicator tip on end of camshaft.
3. Push camshaft toward the rear as far as possible.
4. Set the dial indicator to zero.
5. Pull camshaft forward as far as possible.
6. If camshaft end play exceeds specification, remove camshaft and inspect thrust plate, camshaft, and camshaft

gear for wear. Replace parts as needed.

Timing Gear Backlash Check:

1. Remove timing gear cover. (See “Timing Gear Cover Removal and Installation - 1435” on page 181, or “Timing Gear Cover Removal and Installation - 1445 and 1545” on page 182.)



MX5627

Picture Note: Arrows Indicate Direction of Rotation (Viewed from Gear Case)

A - Idler Gear
B - Camshaft Gear
C - Crankshaft Gear
D - Oil Pump Gear
E - Fuel Injection Drive Gear

2. Place dial indicator magnetic base on cylinder block with tip of indicator on tooth of gear being measured.

3. Holding opposite gear stationary, move measured gear back and forth while measuring backlash between meshing gears.

4. If backlash exceeds specifications, replace worn gears as a complete set: Idler Gear, Camshaft Gear, Crankshaft Gear, Oil Pump Gear, and Fuel Injection Drive Gear.

Camshaft Gear Removal:

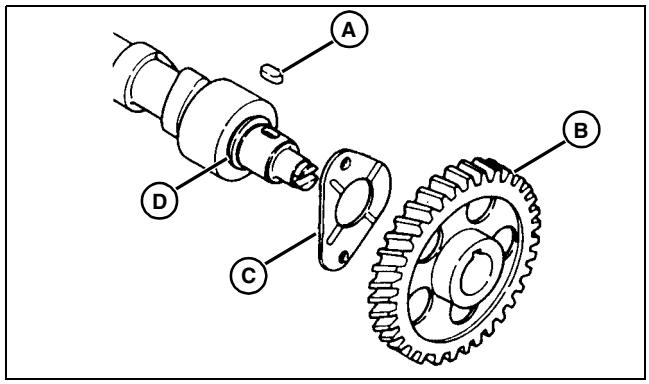
1. Remove gear from camshaft using a knife-edge puller and an arbor press. Place fat side of puller against camshaft gear.

2. Inspect gear for chipped or broken teeth. Replace if necessary.

Camshaft Gear Installation:

CAUTION: Avoid injury! Do not heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

1. Heat gear to approximately 150°C (300°F).



M82068A

2. Install key (A) into slot of camshaft.

3. Install thrust plate (C) onto camshaft, centering onto stepped shoulder (D). (Thrust plate has no “front” or “rear” side.)

IMPORTANT: Avoid damage! Be sure thrust plate is not trapped between camshaft gear and stepped shoulder while gear is being pressed on.

4. Install heated camshaft gear (B) with longer hub of camshaft gear facing camshaft. Align slot in gear with key in shaft. Press camshaft into gear until hub of gear is tight against camshaft shoulder. Thrust plate must spin freely on camshaft.

Specifications:

Model 1435

Camshaft Thrust Plate
Cap Screw Torque . . . . . 11 N•m (96 lb-in.)

Camshaft
Standard Bend . . . . . 0.00 - 0.02 mm (0.00 - 0.0008 in.)

Camshaft Bend Wear Limit . . . . . 0.05 mm (0.002 in.)

Camshaft Standard
Lobe Height . . . . . 33.95 - 34.05 mm (1.336 - 1.341 in.)

Camshaft Lobe Height
Wear Limit. . . . . 33.75 mm (1.329 in.)

Gear Housing and Flywheel End Journal
Standard OD . . . . . 39.94 - 39.96 mm (1.572 - 1.573 in.)

Gear Housing and Flywheel End Journal
OD Wear Limit. . . . . 39.85 mm (1.569 in.)

Intermediate Journal
Standard OD . . . . . 39.91 - 39.94 mm (1.571 - 1.572 in.)

Intermediate Journal
OD Wear Limit. . . . . 39.85 mm (1.569 in.)

Camshaft Bushing
Standard ID . . . . . 39.98 - 40.05 mm (1.57 - 1.58 in.)

Camshaft Bushing ID Wear Limit . . 40.05 mm (1.58 in.)

Camshaft Intermediate Bore
Standard ID . . . . . 39.98 - 40.05 mm (1.57 - 1.58 in.)

Camshaft Intermediate Bore
ID Wear Limit. . . . . 40.05 mm (1.58 in.)

Camshaft Flywheel-End Bore
Standard ID . . . . . 39.98 - 40.05 mm (1.57 - 1.58 in.)

Camshaft Flywheel-End Bore
ID Wear Limit. . . . . 40.05 mm (1.58 in.)

Bore Oil Clearance (Maximum) . . . . 0.20 mm (0.008 in.)

Models 1445 and 1545

Camshaft Thrust Plate
Cap Screw Torque . . . . . 11 N•m (96 lb-in.)

Camshaft
Standard Bend . . . . . 0.00 - 0.02 mm (0.00 - 0.0008 in.)

Camshaft Bend Wear Limit . . . . . 0.05 mm (0.002 in.)

Camshaft Standard
Lobe Height. . . . . 38.64 - 38.77 mm (1.521 - 1.526 in.)

Camshaft Lobe Height
Wear Limit . . . . . 38.40 mm (1.512 in.)

Gear Housing and Flywheel End Journal
Standard OD . . . . . 44.93 - 44.95 mm (1.769 - 1.770 in.)

Gear Housing and Flywheel End Journal
OD Wear Limit. . . . . 44.85 mm (1.766 in.)

Intermediate Journal
Standard OD . . . . . 44.91 - 44.94 mm (1.768 - 1.769 in.)

Intermediate Journal
OD Wear Limit. . . . . 44.85 mm (1.766 in.)

Camshaft Bushing
Standard ID . . . . . 44.99 - 45.06 mm (1.771 - 1.774 in.)

Camshaft Bushing ID Wear Limit . 45.10 mm (1.776 in.)

Camshaft Intermediate Bore
Standard ID . . . . . 45.00 - 45.03 mm (1.772 - 1.773 in.)

Camshaft Intermediate Bore
ID Wear Limit. . . . . 45.10 mm (1.776 in.)

Camshaft Flywheel-End Bore
Standard ID . . . . . 45.00 - 45.03 mm (1.772 - 1.773 in.)

Camshaft Flywheel-End Bore
ID Wear Limit. . . . . 45.10 mm (1.776 in.)

Bore Oil Clearance (Maximum) . . . . 0.20 mm (0.008 in.)

Camshaft Follower Removal, Inspection and Installation - 1435

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Magnetic Pick-Up Tool	NA	Used to remove cam followers from cylinder block.

Removal/Installation:

1. Remove cylinder head. (See “Cylinder Head Removal and Installation” on page 150.)

IMPORTANT: Avoid damage! Cam followers must be installed in the same bores from which they were removed. Put a mark on each cam follower and cylinder block bore to aid in installation.

Always replace camshaft when replacing cam followers. Always replace cam followers when installing new camshaft. The components wear as a set and replacing only one will accelerate the wear of the other.

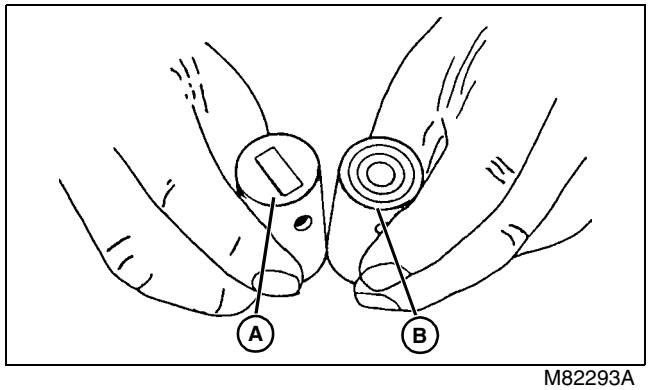
2. Remove cam followers from cylinder block with magnetic pick-up tool.

3. Inspect all parts for wear or damage. (See Inspection procedure below.)

4. Apply clean engine oil on all parts during installation.

5. Install cam followers after camshaft is installed. Installation is done in the reverse order of removal.

Inspection:



M82293A

1. Inspect cam follower contact surface for abnormal wear (A). Normal wear (B) has light circular lines and flat surface.



M35268

2. Measure cam follower diameter. If outside diameter is less than wear limit, replace cam follower.

3. Measure cam follower bore diameter in cylinder block. If cam follower bore diameter exceeds wear limit, replace cylinder block.

4. If tappet-to-bore oil clearance (bore ID minus follower OD) exceeds specification, replace cam follower, cylinder block, or both.

Specifications:

Cam Follower
Standard OD . . . . . 20.93 - 20.96 mm (0.824 - 0.825 in.)

Cam Follower OD Wear Limit . . . . 20.90 mm (0.823 in.)

Cam Follower Bore
Standard ID . . . . . 21.00 - 21.02 mm (0.827 - 0.828 in.)

Cam Follower Bore ID Wear Limit. 21.05 mm (0.829 in.)

Tappet-to-Bore
Standard Oil
Clearance . . . . . 0.04 - 0.09 mm (0.002 - 0.004 in.)

Tappet-to-Bore Oil Clearance
Wear Limit . . . . . 0.15 mm (0.006 in.)

Camshaft Follower Removal, Inspection and Installation - 1445 and 1545

Removal/Installation:

1. Remove camshaft. (See “Camshaft” on page 174.)

2. Remove the oil pan and strainer. (See “Oil Pan, Crankcase Extension, and Strainer - 1445 and 1545” on page 186.)

IMPORTANT: Avoid damage! Cam followers must be installed in the same bores from which they were removed. Put a mark on each cam follower and cylinder block bore to aid in installation.

Always replace camshaft when replacing cam followers. Always replace cam followers when installing new camshaft. The components wear as a set and replacing only one will accelerate the wear of the other.

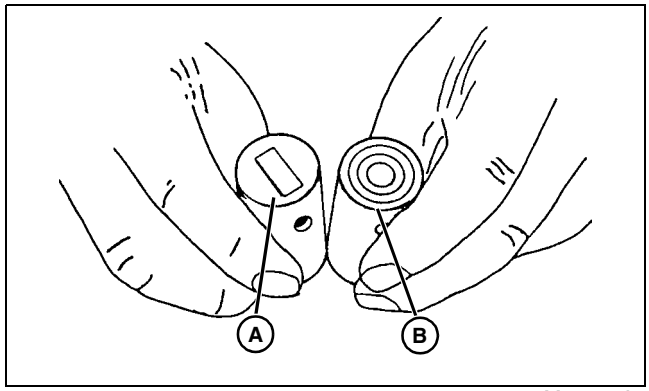
3. Remove the cam followers.

4. Inspect all parts for wear or damage. (See Inspection procedure below.)

5. Apply clean engine oil on all parts during installation.

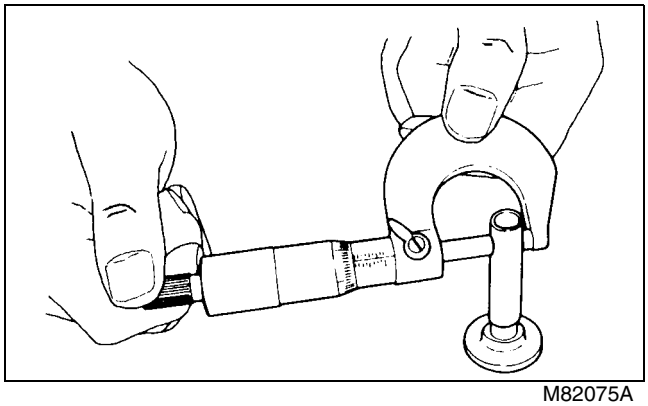
6. Install cam followers after camshaft is installed. Installation is done in the reverse order of removal.

Inspection:



M82293A

1. Inspect cam follower contact surface for abnormal wear (A). Normal wear (B) has light circular lines and flat surface.



M82075A

2. Measure cam follower stem diameter. If outside diameter is less than wear limit, replace cam follower.

3. Measure cam follower bore diameter in cylinder block. If cam follower bore diameter exceeds wear limit, replace cylinder block.

4. If bore oil clearance (bore ID minus follower OD) exceeds specification, replace cam follower, cylinder block, or both.

Specifications:

Cam Follower Stem
Standard OD . . . . . 11.98 - 11.99 mm (0.471 - 0.472 in.)

Cam Follower OD Wear Limit . . . . . 11.93 mm (0.47 in.)

Cam Follower Bore
Standard ID . . . . . 12.00 - 12.02 mm (0.472 - 0.473 in.)

Cam Follower Bore ID Wear Limit. 12.05 mm (0.474 in.)

Bore Standard
Oil Clearance. . . . . 0.01 - 0.04 mm (0.0004 - 0.002 in.)

Bore Oil Clearance Wear Limit . . . . 0.12 mm (0.005 in.)

Timing Gear Cover Removal and Installation - 1435

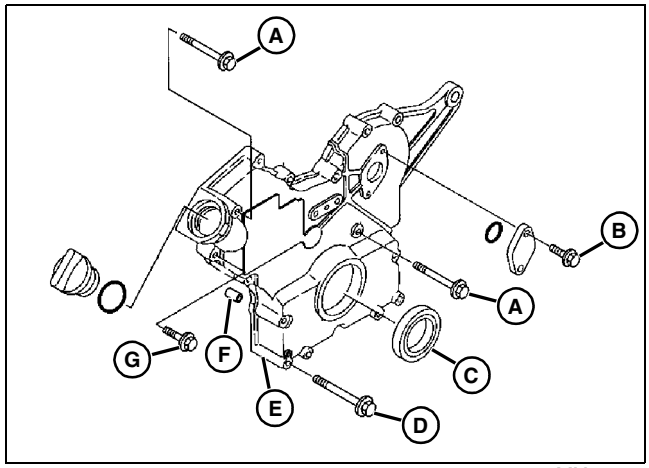
Other Material:

Part No.	Part Name	Part Use
TY16021 (U.S.)/ LOCTITE ® 17430/ TY9484 (Canada)	John Deere High Flex Form-in-Place Gasket	Applied to timing cover before installation.

Procedure:

1. Remove alternator. (See “Alternator Removal and Installation - 1420 and 1435” on page 480 in the Electrical section.)

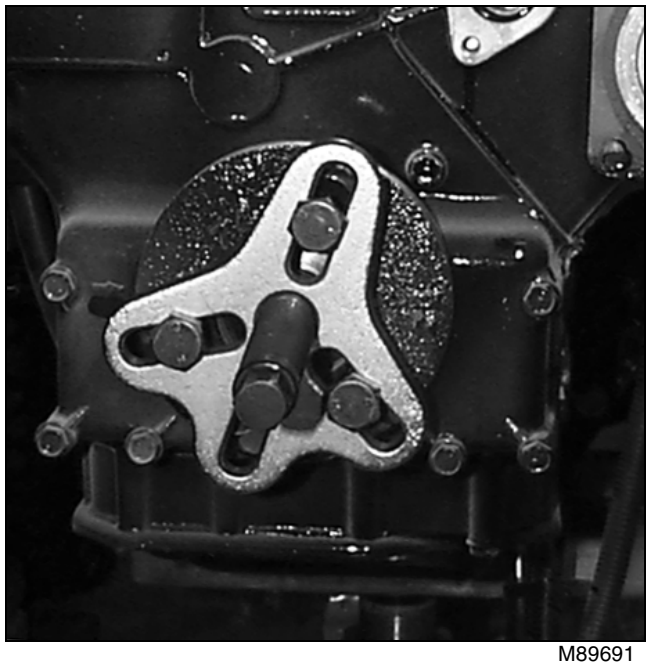
2. Remove alternator belt. (See “Alternator Drive Belt Removal and Installation” on page 133.)



MX5459

A - M8 x 60 Cap Screw (4 used)
B - M8 x 16 Cap Screw (2 used)
C - Seal
D - M8 x 80 Cap Screw (6 used)
E - Cover
F - Dowel Pin (2 used)
G - M8 x 30 Cap Screw (8 used)

3. Remove crankshaft sheave mounting cap screw and washer.



M89691

4. Install puller to crankshaft sheave and remove sheave.

5. Remove timing gear cover mounting cap screws.

6. Remove timing gear cover.

7. Clean all old gasket material from timing gear cover and timing gear cover housing on block.

8. Apply a thin bead of TY16021 John Deere High Flex Form-in-Place Gasket to timing gear cover prior to installation.

9. Tighten all timing gear cover mounting cap screws to specification.

10.Install crankshaft sheave, lining up pin on crankshaft. Install flat washer and cap screw and tighten to specification.

11.Install alternator and belt. (See “Alternator Removal and Installation - 1420 and 1435” on page 480 in the Electrical section, and see “Alternator Drive Belt Removal and Installation” on page 133.)

12.Adjust belt tension. (See “Alternator Drive Belt Tension Check and Adjustment” on page 119.)

Specifications:

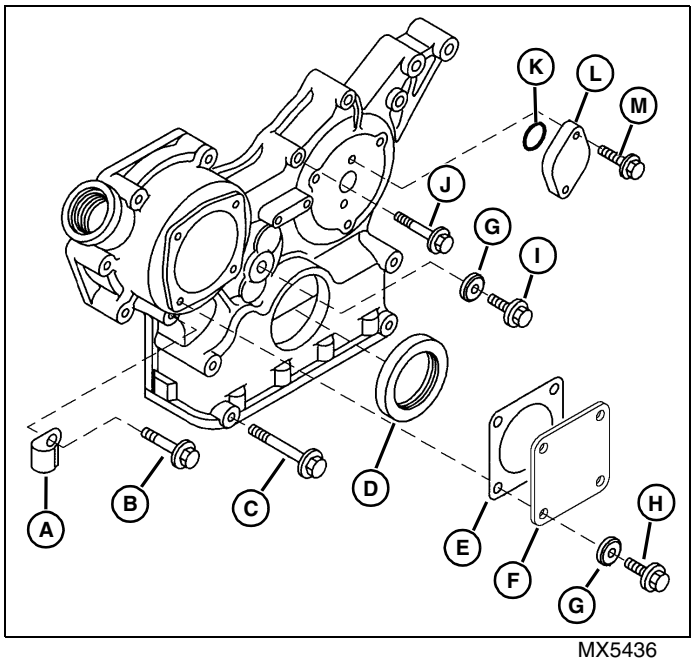
Timing Gear Cover Mounting Cap Screw Torque . . . . . 9 N•m (78 lb-in.)

Crankshaft Sheave Cap Screw Torque . . . . . 88 N•m (65 lb-ft)

Timing Gear Cover Removal and Installation - 1445 and 1545

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Two-Jaw Puller	NA	Used to remove crankshaft pulley.
Bushing, Bearing, and Seal Driver Set	NA	Used to replace crankshaft oil seal.



MX5436

A - Clamp
B - M8 x 45 Cap Screw (6 used)
C - M8 x 85 Cap Screw (4 used)
D - Seal
E - Gasket
F - Cover
G - Seal Washer (2 used)
H - M8 x 12 Cap Screw (4 used)
I - M8 x 16 Cap Screw (4 used)
J - M8 x 55 Cap Screw (3 used)
K - O-Ring
L - Cover
M - M6 x 16 Cap Screw (2 used)

Procedure:

1. Remove alternator. (See “Alternator Removal and Installation - 1445/1545/1565” on page 481 in the Electrical section.)

2. Remove alternator belt. (See “Alternator Drive Belt

Removal and Installation" on page 133.)

3. Remove the crankshaft pulley cap screw and washer.

4. Remove the crankshaft pulley using a two-jaw puller.

NOTE: It is not necessary to remove end cover and O-ring or fuel injection pump gear cover to remove timing gear cover.

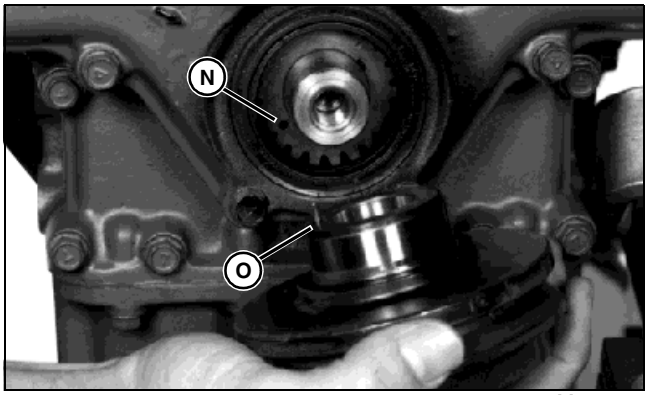
5. Remove mounting cap screws and timing gear cover.

6. Inspect crankshaft oil seal for wear or damage. Replace if necessary, using a driver set. Install the seal with lip toward inside of gear housing cover. Install the seal flush with surface of cover.

7. Clean all gasket mating surfaces.

8. Replace seal washers (G).

9. Install timing gear cover. Installation is done in the reverse order of removal.



M35295

10.Align pin (O) in crankshaft sheave with hole (N) in crankshaft gear. Install the crankshaft sheave.

11.Install alternator and belt. (See "Alternator Removal and Installation - 1445/1545/1565" on page 481 in the Electrical section, and see "Alternator Drive Belt Removal and Installation" on page 133.)

12.Adjust alternator belt tension. (See "Alternator Drive Belt Tension Check and Adjustment" on page 119.)

Idler Gear Removal and Installation - 1435

Special or Required Tools:

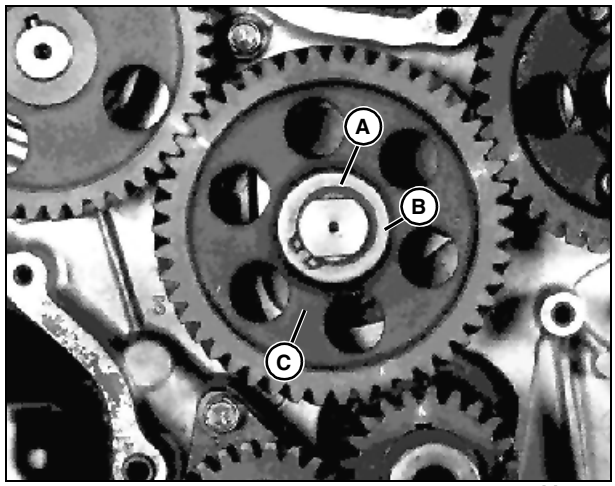
Tool Name	Tool No.	Tool Use
Bushing Driver Set	NA	Used to replace worn idler gear bushing.

Removal/Installation:

1. Remove timing gear cover. (See "Timing Gear Cover Removal and Installation - 1435" on page 181.)

2. Check backlash of timing gears. (See "Timing Gear Backlash Check:" on page 178.)

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically. When all timing marks on gears align, the piston closest to the water pump, number three, is at TDC on compression stroke. (Number one cylinder is closest to the flywheel.)



M37516

3. Rotate crankshaft and align timing marks.

NOTE: Timing mark on crankshaft gear is on front of tooth used for timing, but since gear is spiral cut it will appear to not be aligned with mark on idler gear.

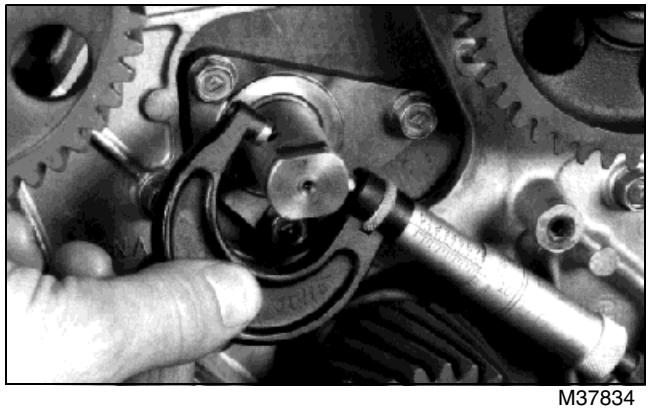
4. Remove snap ring (A), washer (B), and gear (C).

5. Inspect all parts for wear or damage. (See "Inspection/Replacement:" on page 183.)

6. Installation is done in the reverse order of removal. It is not necessary to time oil pump gear.

Inspection/Replacement:

1. Inspect gear for chipped or broken teeth. Replace if necessary.


M37834

2. Measure idler gear shaft diameter. If shaft diameter is less than wear limit, replace idler gear shaft.



M35492

3. Measure idler gear bushing diameter. If bushing diameter exceeds wear limit, replace bushing using a driver set:

a. Align oil holes in bushing and idler gear.

b. Install bushing flush with surface of idler gear.

4. If bushing oil clearance (bushing ID minus shaft OD) exceeds specification, replace bushing, shaft, or both.

Specifications:

Idler Gear Shaft
Standard OD . . . . . 19.96 - 19.98 mm (0.786 - 0.787 in.)

Idler Gear Shaft OD Wear Limit . . . 19.93 mm (0.785 in.)

Idler Gear Bushing
Standard ID . . . . . 20.00 - 20.02 mm (0.787 - 0.788 in.)

Oil Clearance. . . . . 0.020 - 0.062 mm (0.0008 - 0.002 in.)

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

Idler Gear Removal and Installation - 1445 and 1545

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Bushing, Bearing, and Seal Driver Set	NA	Used to replace idler gear bushing.

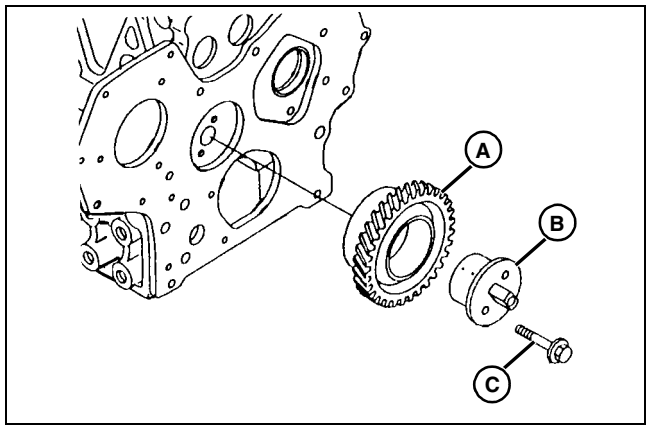
Procedure:

1. Remove the timing gear cover. (See “Timing Gear Cover Removal and Installation - 1445 and 1545” on page 182.)

2. Check the backlash of timing gears. (See “Timing Gear Backlash Check:” on page 178.)

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically. When all timing marks on gears align, the piston closest to the water pump is at TDC on compression stroke. Number one cylinder is closest to the flywheel.

3. Rotate the crankshaft to align the timing marks.

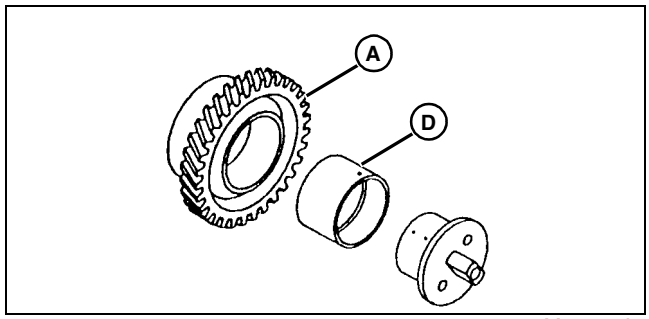


M82209A

4. Remove two cap screws (C), shaft (B), and gear (A).

5. Inspect gear for chipped or broken teeth. Replace if necessary.

6. Measure the idler gear shaft diameter. If shaft diameter is less than wear limit, replace idler gear shaft.



M82210A

7. Measure the idler gear bushing (D) diameter. Using a driver set, replace bushing if diameter exceeds wear limit.

a. Align oil holes in bushing and idler gear (A).

b. Install bushing flush with surface of idler gear.

8. Install idler gear. Installation is done in the reverse order of removal.

Specifications:

Idler Gear Shaft
Standard OD . . . . . 45.95 - 45.98 mm (1.809 - 1.810 in.)

Idler Gear Shaft OD Wear Limit. . . 45.93 mm (1.808 in.)

Idler Gear Bushing
Standard ID . . . . . 46.00 - 46.03 mm (1.811 - 1.812 in.)

Idler Gear Bushing
ID Wear Limit . . . . . 46.03 mm (1.812 in.)

Bore Clearance (Maximum). . . . . 0.15 mm (0.006 in.)

Timing Gear Housing Removal and Installation - 1435

Other Material:

Part No.	Part Name	Part Use
TY16021 (U.S.)/ LOCTITE ® 17430/ TY9484 (Canada)	John Deere High Flex Form-in-Place Gasket	Applied to timing gear housing before installation.

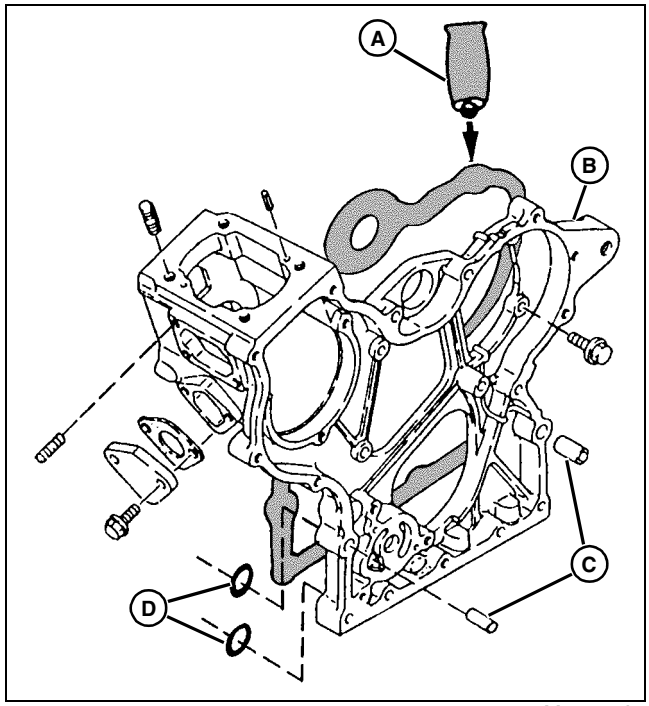
Removal:

1. Remove engine. (See “Engine Removal and Installation” on page 143.)
2. Remove timing gear cover. (See “Timing Gear Cover Removal and Installation - 1435” on page 181.)
3. Remove fuel injector lines from engine. (See “Fuel Injection Nozzle Removal, Inspection and Installation - 1435” on page 201.)
4. Remove engine camshaft. (See “Camshaft” on page 174.)
5. Remove water pump. (See “Water Pump Removal and Installation (Thermostat Included) - 1435” on page 190.)
6. Remove oil pan. (See “Oil Pan and Strainer - 1435” on page 186.)
7. Remove timing gear housing mounting cap screws and remove housing from cylinder block.
8. If replacing timing housing, remove fuel injection pump and governor.

Installation:

NOTE: Installation is done in the reverse order of removal.

1. Clean all parts of old gasket sealer, gasket material, oil, and dirt before attempting installation.



M82299A

2. Install alignment dowels (C) in timing gear housing (B).
3. Replace O-rings (D) behind oil pump.
4. Apply TY16021 John Deere High Flex Form-in-Place Gasket (A) to timing gear housing when installing to cylinder block.
5. Tighten mounting cap screws to specification.

Specifications:

Timing Gear Housing Mounting Cap Screw Torque . . . . . 11 N•m (96 lb-in.)

Timing Gear Cover Mounting Plate Removal and Installation - 1445 and 1545

1. Remove the camshaft. (See “Camshaft” on page 174.)

2. Remove the idler gear. (See “Idler Gear Removal and Installation - 1445 and 1545” on page 184.)

3. Remove the fuel injection pump. (See “Fuel Injection Pump Removal and Installation - 1445 and 1545” on page 195.)

4. Remove the oil pump. (See “Oil Pump - 1445 and 1545” on page 188.)

5. Remove the mounting cap screws and plate.

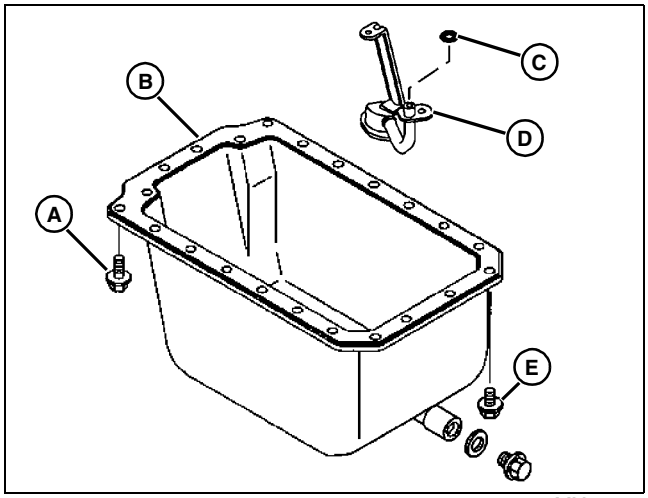
6. Clean gasket mating surface.

7. Replace the O-rings.

8. Install timing gear cover mounting plate. Installation is done in the reverse order of removal.

Oil Pan and Strainer - 1435

NOTE: Engine must be removed from machine to remove oil pan.



MX5451

A - Cap Screw (16 used)
B - Oil Pan
C - O-Ring
D - Strainer
E - Cap Screw (6 used)

1. Remove flywheel and flywheel housing to access oil pan cap screws. (See “Flywheel Removal and Installation” on page 173.)

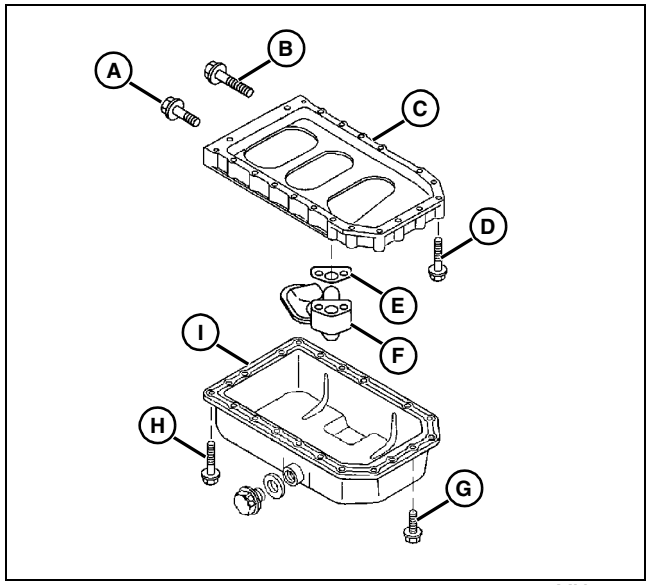
2. Remove 16 cap screws (A) and six cap screws (E).

3. Remove oil pan (B).

4. Remove cap screws from strainer and remove strainer (D) and O-ring (C).

Oil Pan, Crankcase Extension, and Strainer - 1445 and 1545

NOTE: Engine must be removed from machine to remove the oil pan.



MX5452

A - Cap Screw (4 used)
B - Cap Screw (3 used)
C - Crankcase Extension
D - Cap Screw (6 used)
E - Gasket
F - Strainer
G - Cap Screw (6 used)
H - Cap Screw (16 used)
I - Oil Pan

1. Remove six (G) and sixteen (H) cap screws. Remove oil pan (9).

2. Remove cap screws for strainer and remove strainer (F) and gasket (E).

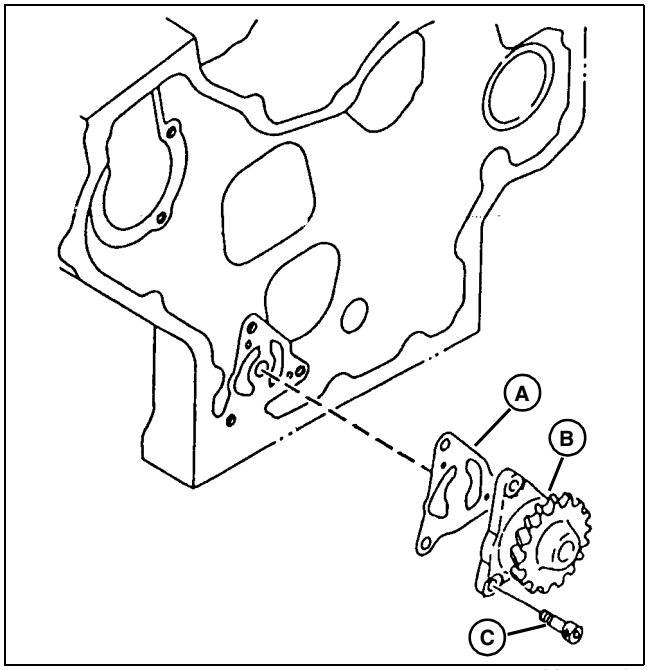
3. If crankcase extension (C) is being removed, remove: flywheel, three lower cap screws (B) in rear oil seal housing, four flywheel housing cap screws (A), and six cap screws (D) in front. Then remove crankcase extension.

Oil Pump - 1435

Removal/Installation:

1. Remove timing gear cover. (See “Timing Gear Cover Removal and Installation - 1435” on page 181.)

2. Check oil pump gear backlash. Replace entire oil pump assembly if backlash exceeds specification.



M82309A

3. Remove three mounting cap screws (C), oil pump (B), and gasket (A).

4. Inspect all parts for wear or damage. (See Inspection procedure below.)

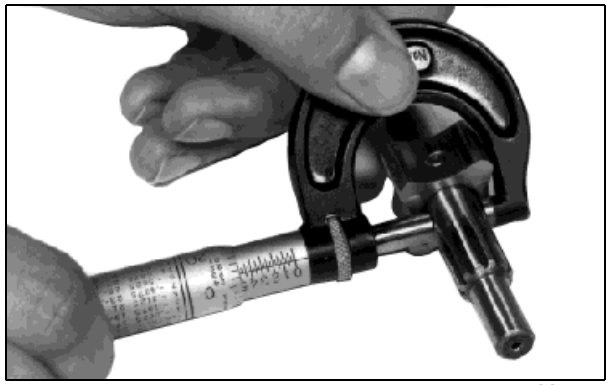
Disassembly/Assembly:

1. Inspect parts for wear or damage. (See Inspection procedure below.)

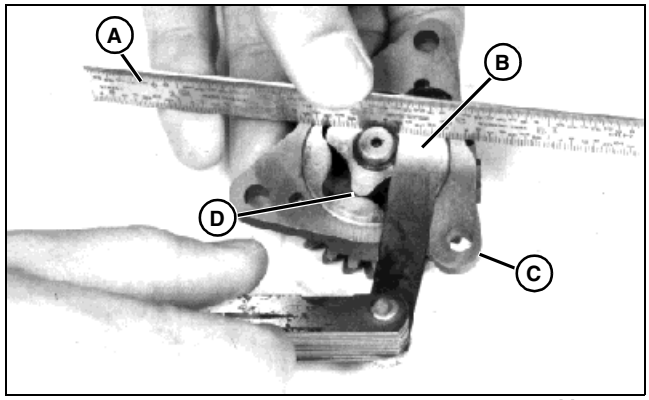
2. Coat all parts with clean engine oil.

3. Install outer rotor with identification mark facing toward inside of housing assembly.

Inspection:

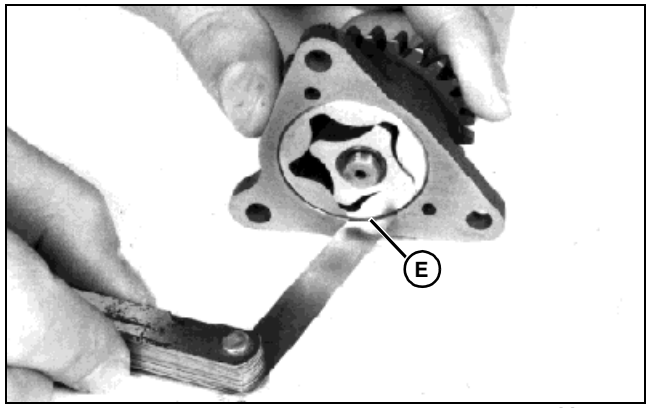

M35555

1. Measure the inside diameter of the rotor shaft bore in the backing plate, and subtract the outside diameter of the rotor shaft. If the clearance is more than the wear limit, replace entire assembly.



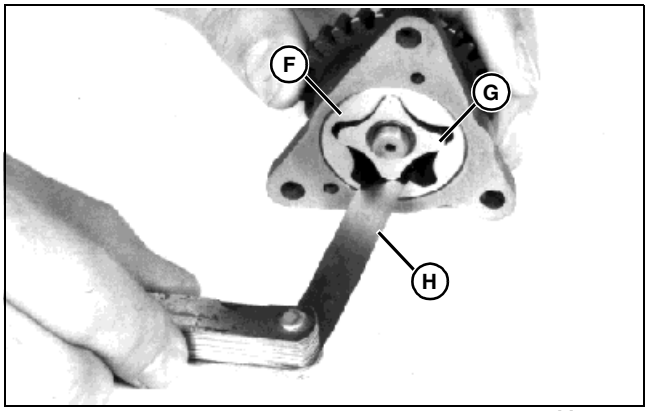
M37775

2. Lay a straightedge (A) across pump housing (C). Using a feeler gauge (B), check side clearance of inner and outer rotors (D). If rotor side clearance is beyond wear limit, replace rotor assembly.



M37776

3. Check outer rotor-to-pump housing clearance (E). If clearance is more than wear limit, replace oil pump assembly.



M37777

4. Check clearance between inner rotor (G) and outer rotor (F) with feeler gauge (H). If clearance exceeds specification, replace oil pump assembly.

Specifications:

Oil Pump Gear
Backlash . . . . . 0.11 - 0.19 mm (0.004 - 0.007 in.)

Standard Rotor Shaft OD-to-Housing
ID Clearance . . . . . 0.013 - 0.043 mm (0.0005 - 0.002 in.)

Rotor Shaft OD-to-Housing Clearance
Wear Limit . . . . . 0.2 mm (0.008 in.)

Standard Rotor-to-Pump Housing
Side Clearance . . . . . 0.03 - 0.9 mm (0.001 - 0.004 in.)

Rotor-to-Pump Housing
Side Clearance Wear Limit . . . . . 0.13 mm (0.005 in.)

Standard Outer Rotor-to-Pump Body
Clearance . . . . . 0.10 - 0.16 mm (0.004 - 0.006 in.)

Outer Rotor-to-Pump Body
Clearance Wear Limit . . . . . 0.25 mm (0.006 in.)

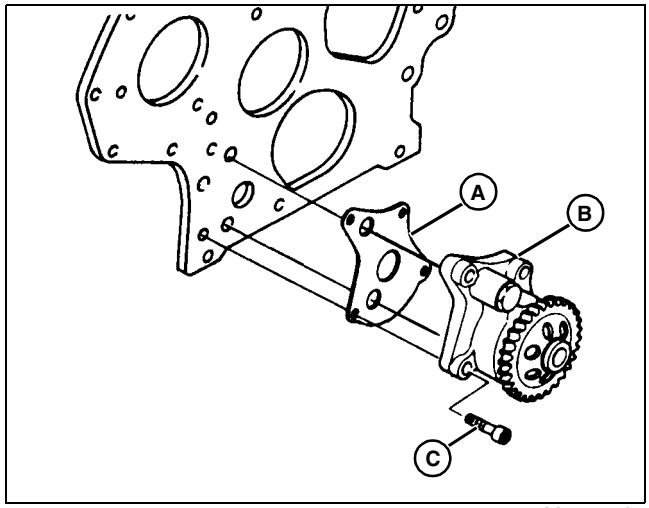
Inner Rotor-to-Outer Rotor
Clearance (Maximum) . . . . . 0.15 mm (0.006 in.)

Oil Pump - 1445 and 1545

Removal/Installation:

1. Remove the timing gear cover. (See “Timing Gear Cover Removal and Installation - 1445 and 1545” on page 182.)

2. Check the oil pump gear backlash. Replace the oil pump assembly if backlash exceeds specification.

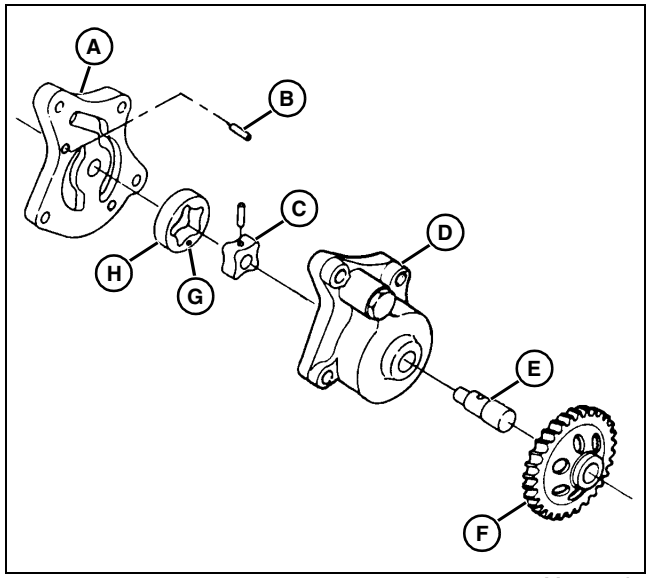


M82215A

3. Remove the mounting cap screws (C), oil pump (B), and gasket (A).

4. Inspect all parts for wear or damage.

Disassembly/Assembly:



M82216A

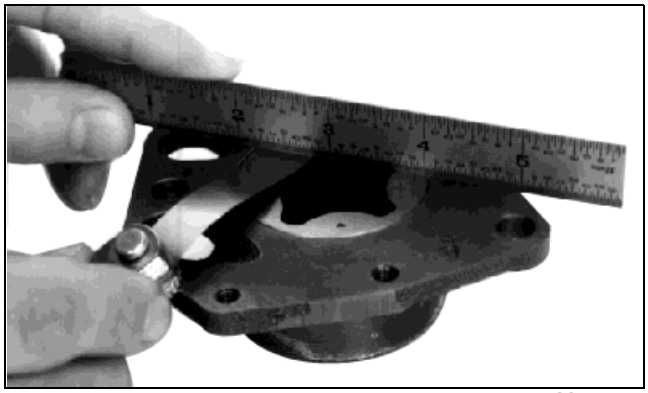
A - Backing Plate
B - Alignment Pin (2 used)
C - Inner Rotor
D - Pump Body
E - Rotor Shaft
F - Gear
G - Identification Mark
H - Outer Rotor

1. Gear (F) is press fit on rotor shaft (E). Remove gear using a knife-edge puller and a press.

2. Inspect all parts for wear or damage.

3. Coat all parts with clean engine oil.

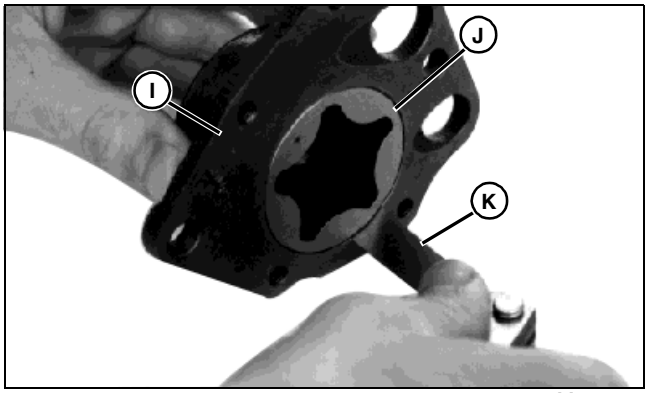
4. Install the outer rotor (H) with identification mark (G) facing toward rotor shaft assembly.



M51571

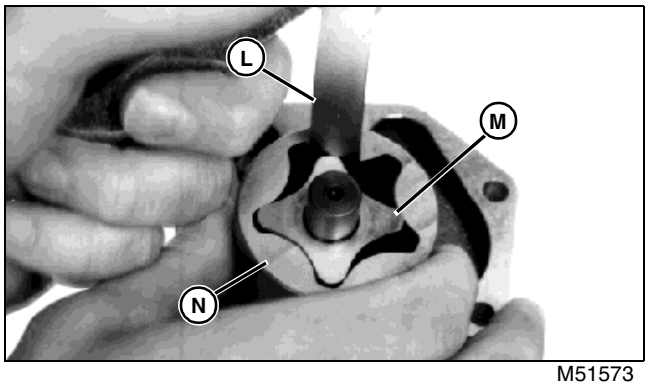
5. Measure the rotor shaft outer diameter and the shaft hole diameter in cover. Replace pump if clearance exceeds wear limit.

6. Check the rotor recess. Replace pump if recess exceeds wear limit.



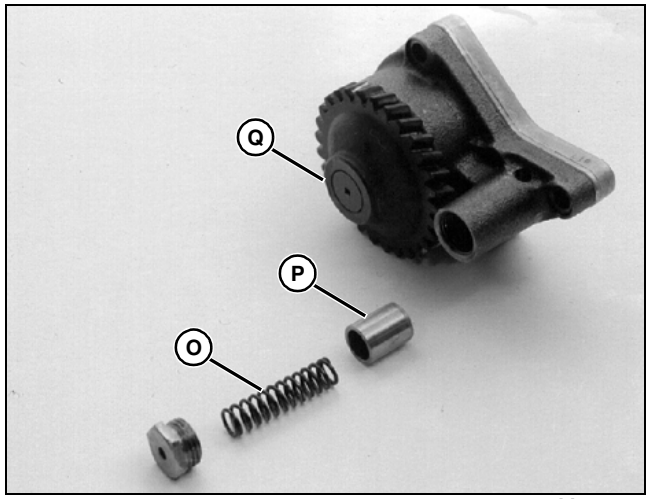
M51572

7. Measure clearance between outer rotor (J) and pump body (I) using a feeler gauge (K). Replace pump if clearance exceeds wear limit.



M51573

8. Check clearance between inner rotor (M) and outer rotor (N) using a feeler gauge (L). Replace pump if clearance exceeds specification.



M76428

9. Check the oil pressure relief valve. If the relief valve piston (P) is sticking in the pump body (Q), clean parts to allow free movement of the piston in pump body.

10. Inspect spring (O) for cracks. The spring is not serviceable. If damage is identified, replace the oil pump assembly.

Specifications:

Oil Pump Gear Backlash . . . . . 0.12 mm (0.005 in.)

Rotor Shaft
Standard Clearance . . 0.01 - 0.04 mm (0.001 - 0.002 in.)

Rotor Shaft Clearance Wear Limit . 0.20 mm (0.008 in.)

Standard Rotor
Recess. . . . . 0.03 - 0.09 mm (0.001 - 0.004 in.)

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

Outer Rotor-to-Pump Body
Standard Clearance . . 0.10 - 0.16 mm (0.004 - 0.006 in.)

Outer Rotor-to-Pump Body
Clearance Wear Limit. . . . . 0.25 mm (0.010 in.)

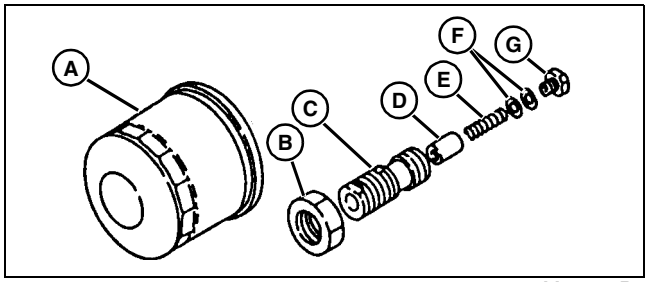
Inner-to-Outer Rotor Clearance . . . 0.15 mm (0.006 in.)

Oil Pressure Regulating Valve Removal and Installation

Front Mower

1435

Removal:



M82311B

1. Remove oil filter (A).
2. Remove retaining nut (B) and valve assembly (C).

NOTE: Valve components (D - G) are not serviced individually. Replace complete regulating valve if any components are defective.

3. Inspect all parts for wear or damage. Replace complete valve if any parts are bad.

Installation:

1. Install oil pressure regulating valve. Installation is done in the reverse order of removal.
2. Tighten retaining nut to specification.

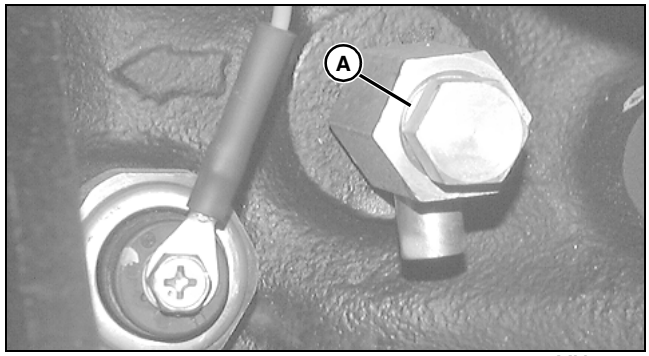
Specifications:

Oil Pressure Regulating Valve
Retaining Nut Torque . . . . . 30 N•m (22 lb-ft)

Water Pump Removal and Installation (Thermostat Included) - 1435

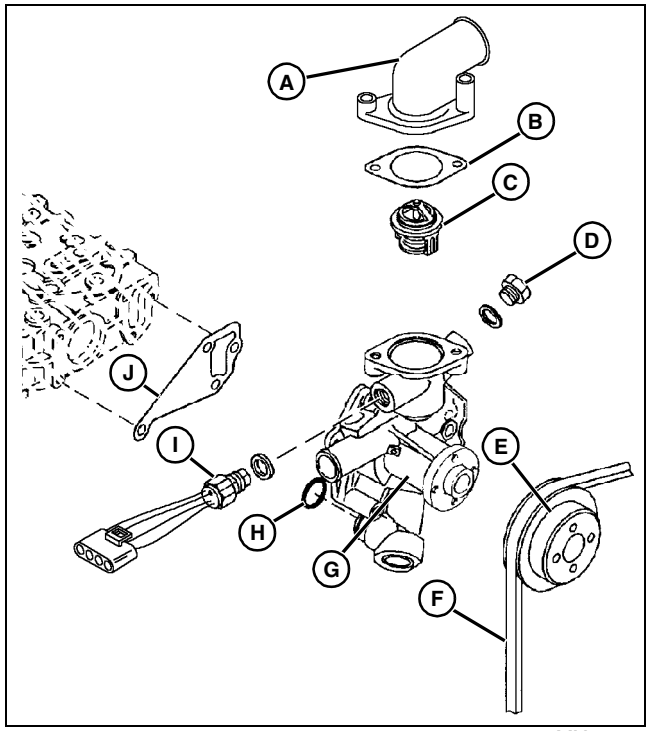
Removal:

1. Park machine on level surface with park brake locked.
2. Allow engine to cool and pressure in cooling system to drop before working on water pump.
3. Disconnect battery negative (-) cable from battery.



MX5578

4. Open engine drain valve (A) to drain coolant from cylinder block.
5. Disconnect upper and lower radiator hoses from water pump.
6. Loosen alternator mounting cap screws and remove water pump/alternator drive belt.



MX5437

A - Thermostat Housing
B - Gasket
C - Thermostat
D - Plug
E - Sheave
F - Belt
G - Water Pump
H - O-Ring
I - Dual Temperature Coolant Switch
J - Gasket

7. Disconnect dual temperature coolant switch connector. Remove switch and plug.

8. Remove four cap screws and remove sheave.

9. Remove pump mounting cap screws, pump, and gasket.

10. Inspect all parts for wear or damage.

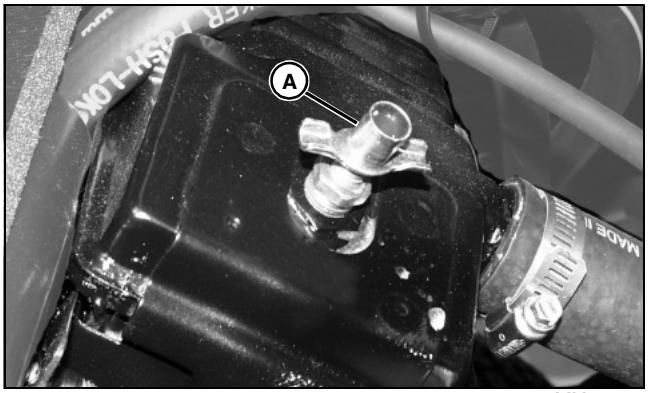
11. Clean cylinder block mating surfaces of all old gasket material.

Installation:

1. Install water pump and thermostat. Installation is done in the reverse order of removal.

2. Install dual temperature coolant switch and plug.

3. Adjust water pump/alternator drive belt tension. (See "Alternator Drive Belt Tension Check and Adjustment" on page 119.)



MX7051

4. Open air bleed valve (A) on top of radiator.

5. Fill cooling system until coolant drains out of air bleed valve.

6. Close air bleed valve.

7. Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.

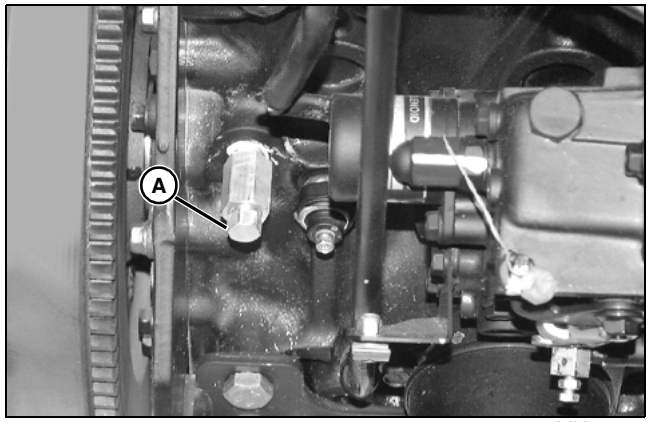
Water Pump Removal and Installation (Thermostat Included) - 1445 and 1545

Removal/Installation:

1. Park machine on level surface with park brake locked.

2. Allow engine to cool and pressure in cooling system to drop before working on water pump.

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



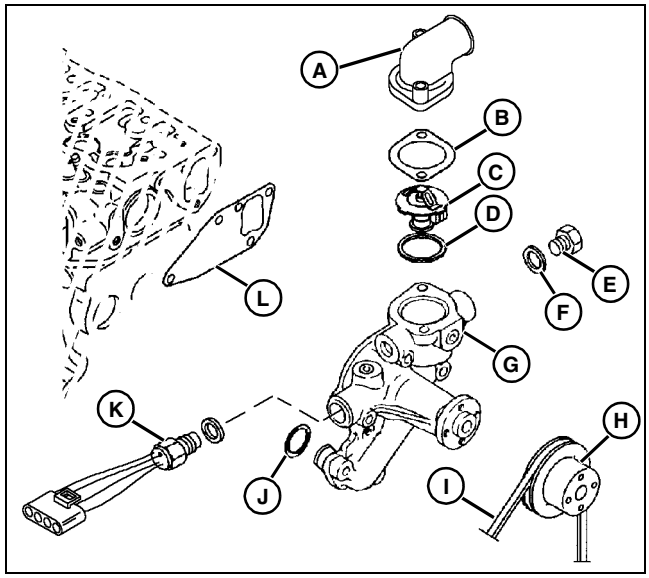
MX5423

4. Open the engine drain valve (A) to drain coolant.

5. Disconnect the dual temperature coolant switch connector.

6. Disconnect the upper and lower radiator hoses.

7. Remove alternator drive belt. (See "Alternator Drive Belt Removal and Installation" on page 133.)



MX5438

A - Thermostat Housing
B - Gasket
C - Thermostat
D - Gasket
E - Plug
F - Gasket
G - Water Pump
H - Pulley
I - Fan Belt
J - Gasket
K - Dual Temperature Coolant Switch
L - Gasket

8. Remove the cap screws to remove pulley.

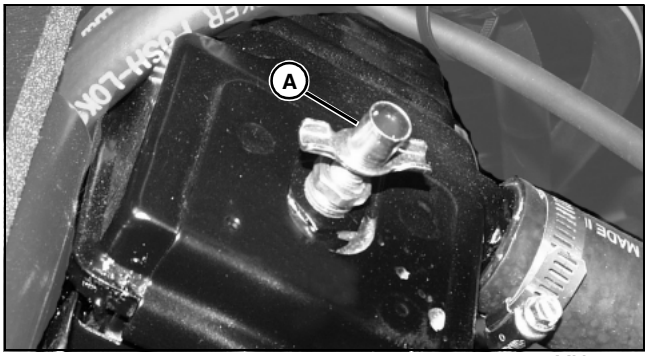
9. Remove mounting cap screws, pump, and gasket.

10.Inspect the pump for wear or damage. (See Inspection procedure below.)

11.Test the thermostat for proper operation. (See “Thermostat Opening Test” on page 132.)

12.Install water pump and thermostat. Installation is done in the reverse order of removal.

13.Adjust alternator drive belt tension. (See “Alternator Drive Belt Tension Check and Adjustment” on page 119.)



MX7051

14.Open air bleed valve (A) on top of radiator.

15.Fill cooling system until coolant drains out of air bleed valve.

16.Close air bleed valve.

17.Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.

Inspection:

1. Inspect the water pump for coolant leakage. If the origin of the leak cannot be determined, test the cooling system. (See “Cooling System Pressure Test” on page 130.)

- If coolant is leaking at the pulley flange, the shaft seal is defective. Replace the water pump.
- If coolant is leaking between the cylinder head and the pump housing, the gasket between the head and the pump is defective. Remove the water pump and replace the gasket.

2. Inspect the water pump for a worn bearing shaft by removing the fan belt and checking for excessive movement of the fan. Replace the water pump if excessive movement is noticed.

3. If the bearing shaft is making noise when operating, check the fan belt tension. If adjustment does not relieve the noise, the bearing shaft is defective. Replace the water pump.

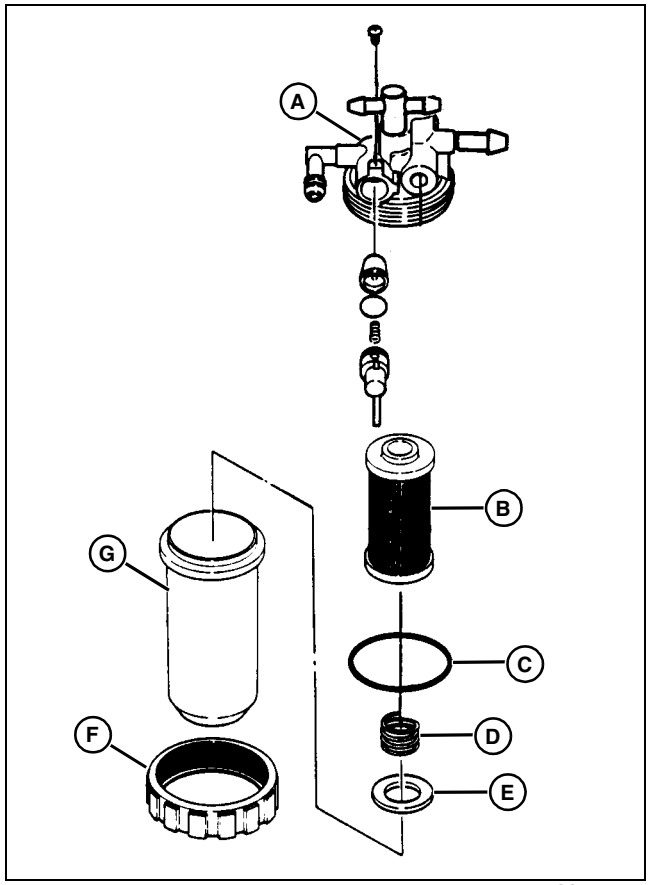
Fuel Filter Assembly

Front Mower

1435

1445

1545



M76799

1. Remove the retaining ring (F) from the mounting base (A) while holding on to the filter cover (G).

2. Remove the filter cover from the mounting base.

3. Remove and replace O-ring (C) and filter element (B).

4. Be sure the ring (E) and spring (D) are in the filter cover.

IMPORTANT: Avoid damage! Tighten retaining nut only enough to keep the filter assembly from leaking. Overtightening the nut may damage the filter cover or retaining ring.

5. Place the filter element on mounting base.

6. Install the filter cover and retaining ring.

Fuel Injection Pump Removal and Installation - 1435

Removal:

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

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

CAUTION: Avoid injury! Do not attempt to remove the CARB/EPA Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service CARB/ EPA Certified Emissions engines.

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

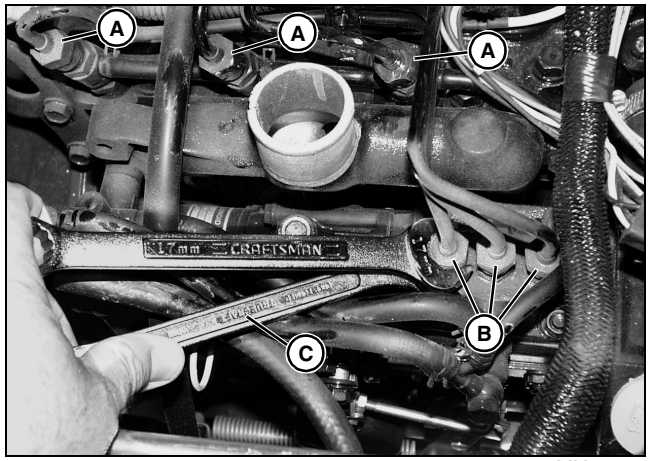
1. Park machine on level surface with park brake locked and key switch off.

2. Turn the fuel shut-off valve on the fuel filter/water separator to the closed position.

3. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner (cold engine).

4. Remove air cleaner hose.

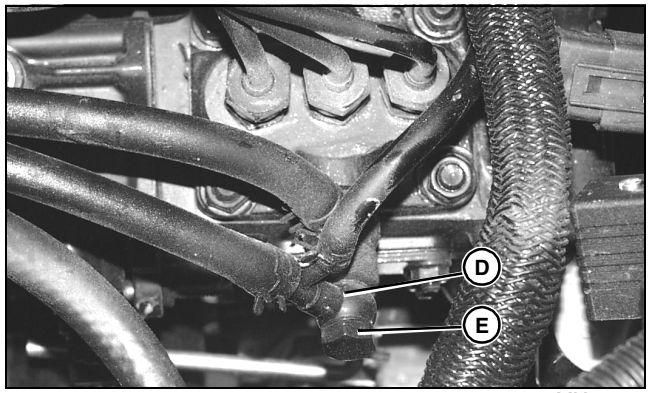
IMPORTANT: Avoid damage! When removing injection lines, Do not turn pump delivery valve fittings. Turning fittings may damage pump internally. Always use a backup wrench when removing lines.



MX0770

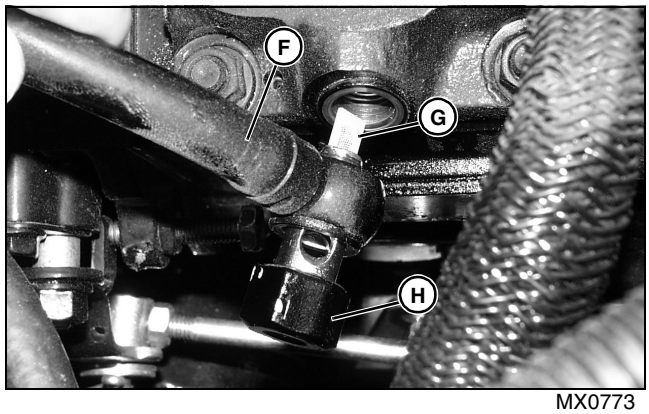
5. Loosen fuel line nuts at fuel injection pump (B) and on the injector nozzles (A). When loosening connectors on the injector pump, use a backup wrench (C) to keep delivery valves from loosening.

6. Remove injector lines.



MX0772

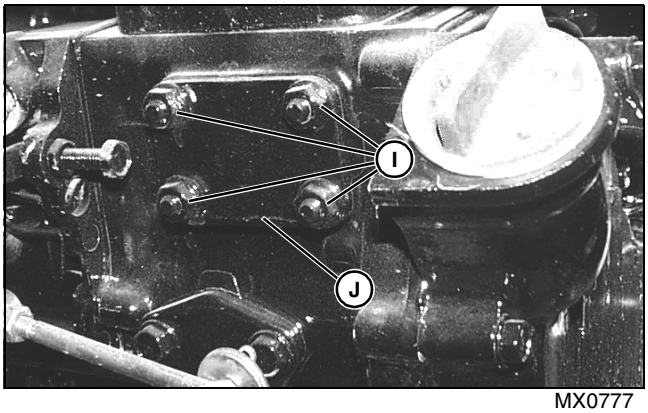
7. Remove cap screw (E) and return line fitting (D) from injection pump.



MX0773

8. Remove special cap screw (H) and fuel supply line (F). Be careful not to damage screen (G).

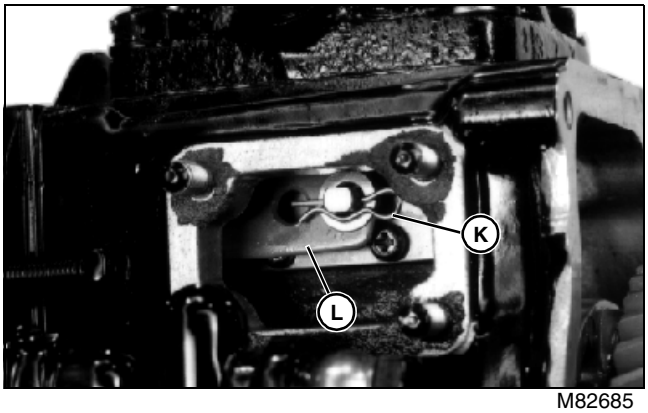
NOTE: Note location of copper washers on each side of both fittings.



MX0777

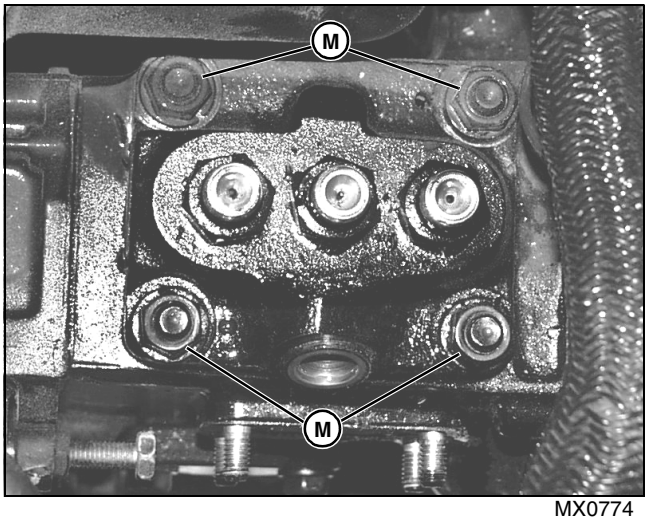
9. Remove four cap screws (I) and cover (J).

NOTE: Washer may or may not be fixed to linkage. Do not drop pin or washer during removal.



M82685

10.Remove spring pin (K) and washer, if removable. Disconnect governor linkage (L) from injection pump.

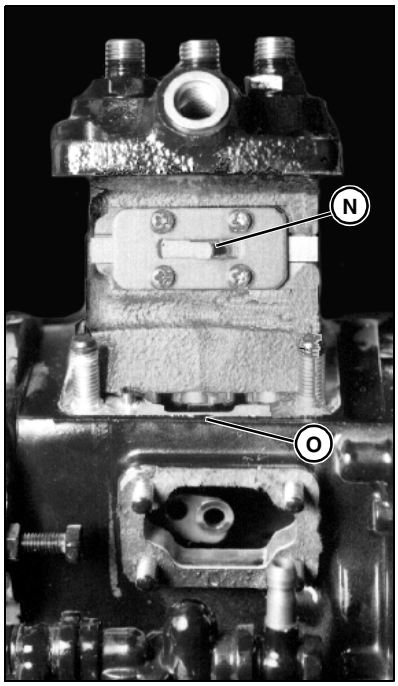


MX0774

11.Remove four cap screws (M) and washers from injector pump mounting flange.

CAUTION: Avoid injury! Do not attempt to adjust the CARB/EPA Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service CARB/ EPA Certified Emissions engines.

IMPORTANT: Avoid damage! Do not pry fuel injection pump from governor housing with sharp edge tool. Timing shims and/or housing may be damaged. Make sure rack pin is lined up with notch in center of housing, or it may catch and break pin.



M76983

12.Carefully pull injector pump straight up from governor housing. Make sure pin (N) is lined up with notch in housing (O).

Installation:

CAUTION: Avoid injury! Do not attempt to adjust the CARB/EPA Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service CARB/ EPA Certified Emissions engines.

IMPORTANT: Avoid damage! If serviced or replacement fuel injection pump is installed, measure old shim thickness and install new shims of the same thickness.

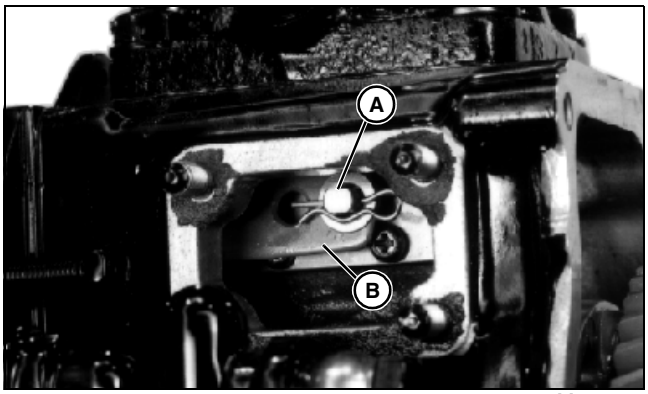
NOTE: Governor linkage has two holes. Connect governor linkage to injection pump rack at hole in end

of linkage.

Do not drop pin or washer into housing during installation. Place a small amount of engine assembly grease on washer to help it stick in place while assembling.

1. Install fuel injection pump. Installation is done in the reverse order of removal.

2. Install shims on top of governor housing to match thickness of original shims.



M82685

3. When connecting governor linkage (B) to injection pump rack (A), attach link to rack at hole in end of linkage.

4. If new injection pump is being installed, check and adjust injection pump timing. (See “Injection Pump Timing Adjustment” on page 130.)

Fuel Injection Pump Removal and Installation - 1445 and 1545

Removal:

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

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

CAUTION: Avoid injury! Do not attempt to remove the CARB/EPA Certified Emissions fuel injection pump unless you are a factory trained technician with authorization to service CARB/ EPA Certified Emissions engines.

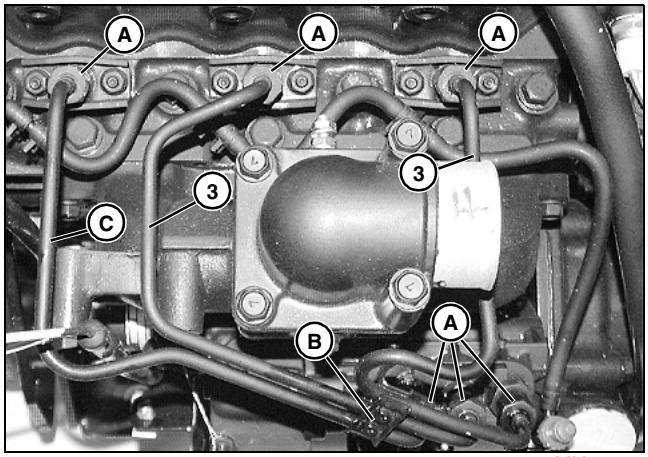
IMPORTANT: Avoid damage! Never steam clean or pour cold water on injection pump while pump is running or warm. Doing so can damage the pump.

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

2. Turn the fuel shut-off valve on the fuel filter/water separator to the closed position.

3. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner (cold engine).

IMPORTANT: Avoid damage! When removing injection lines, Do not turn pump delivery valve fittings. Turning fittings may damage pump internally. Always use a backup wrench when removing lines.



MX5425

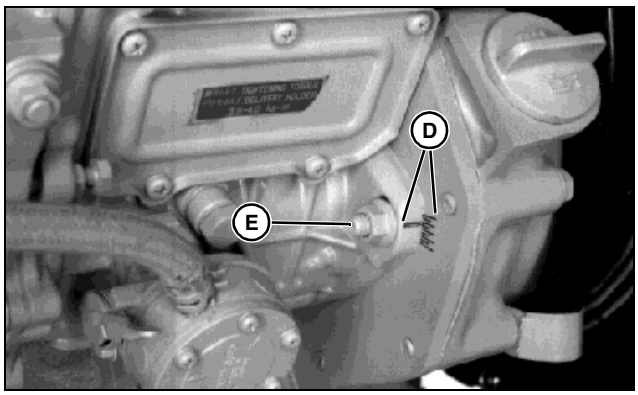
4. Loosen the fuel injection line connectors (A) slightly to release pressure in the fuel system. When loosening connectors on the injector pump, use a backup wrench to keep delivery valves from loosening.

5. Loosen the line clamps (B), and remove the fuel injection lines (C).

6. Disconnect the fuel filter hoses.

7. Remove the external lube line.

8. Disconnect the fuel shutoff solenoid link.

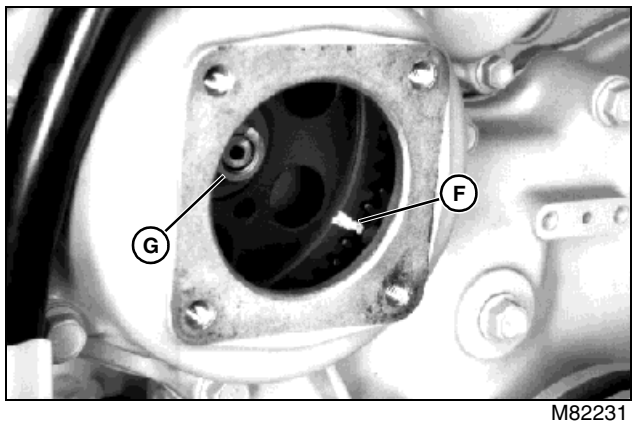


M82230

9. Note the position of the timing marks (D) on the injection pump and the gear cover mounting plate.

10. Remove three mounting nuts (E).

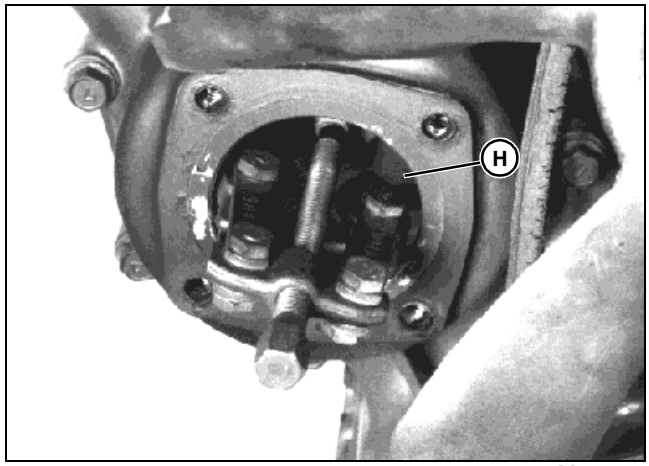
11. Remove four cap screws, washers, the cover and gasket.



M82231

12. Use chalk or paint to mark (F) the injection pump gear to the idler gear.

13. Remove the nut and lock washer (G).



M37794

14. Use a puller to remove the gear (H) from the injection pump shaft.

CAUTION: Avoid injury! Do not attempt to service the injection pump or governor. If the unit is in need of repair, it must be serviced by a qualified fuel injection repair shop.

15. Remove the injection pump and O-ring.

Installation:

NOTE: If a new injection pump is being installed, check and adjust injection pump static timing. (See "Injection Pump Timing Adjustment" on page 130.)

1. Install a new O-ring on the injection pump.

2. Put the injection pump onto the back of gear cover mounting plate. Align the key on the shaft with the keyway in the gear. Be sure to align the marks on gears made during removal.

3. Install lock washer and nut. Tighten to specification.

4. Install a new gasket, cover, four washers, and cap screws.

5. Install three mounting nuts. Do not tighten.

6. Align the timing marks on the mounting plate and injection pump to the same place as when removed. Tighten the mounting nuts to specification.

7. Connect the fuel shutoff solenoid link.

8. Connect the fuel filter hoses.

9. Install fuel injection lines and tighten line clamp cap screws.

IMPORTANT: Avoid damage! If the oil has been drained out of the fuel injection pump housing, add oil as necessary. The fuel injection pump can be damaged if operated without the proper amount of oil.

10.Remove the fill plug and add clean engine oil to the housing. Add until the oil begins to drip out of external lube line inlet.

11.Install the external lube line. When installing the line, put one copper washer between the mounting cap screw head and lube line and the other between the lube line and housing.

Fuel Injection Pump Camshaft Removal, Inspection and Installation

Front Mower

1435

Special or Required Tools:

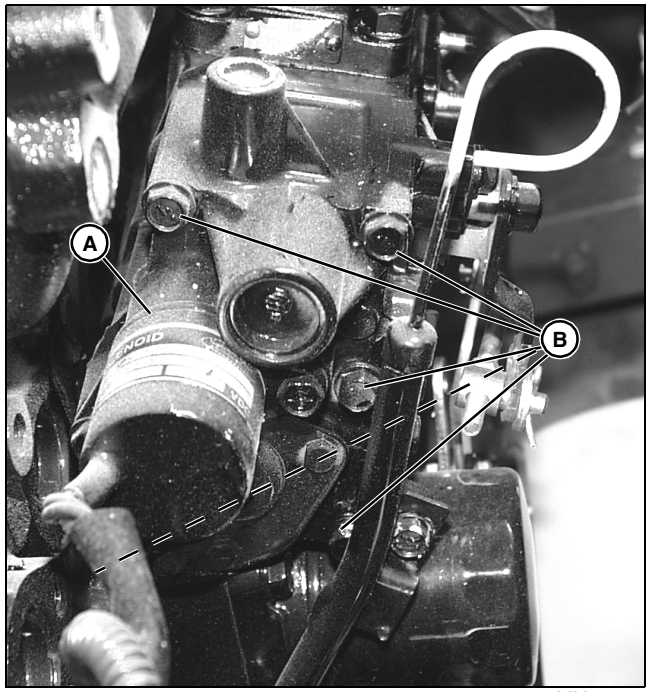
Tool Name	Tool No.	Tool Use
Knife-Edge Puller	NA	Used with press to pull fuel injection pump camshaft gear and bearings.
Press	NA	Used with knife-edge puller to install gear and bearings.
3/4-Inch Deep Well Socket	NA	Used with press to install bearings on camshaft.
Micrometer	NA	Used to measure camshaft lobe height.

Removal:

1. Remove timing gear cover. (See "Timing Gear Cover Removal and Installation - 1435" on page 181.)

2. Remove fuel injection pump. (See "Fuel Injection Pump Removal and Installation - 1435" on page 193.)

3. Remove fuel transfer pump. (See "Fuel Filter Assembly" on page 192.)

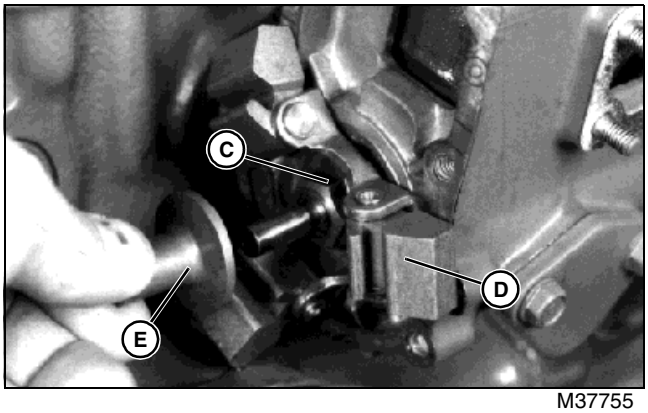


MX0775

4. Disconnect electrical lead and remove fuel shutoff solenoid (A). (See “Fuel Shutoff Solenoid Removal and Installation” on page 207.)

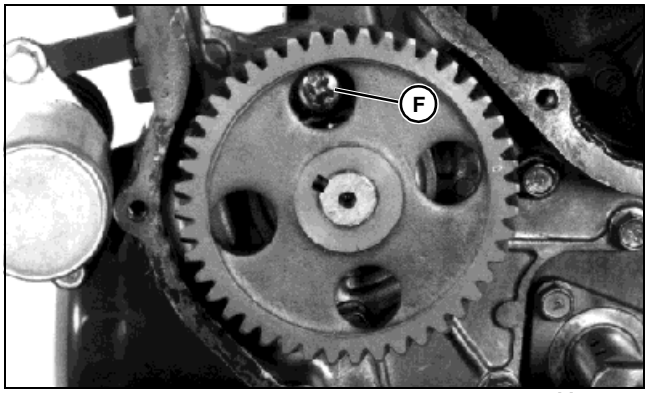
5. Remove five remaining cap screws (B) attaching governor assembly to timing gear housing.

6. Remove governor housing assembly.



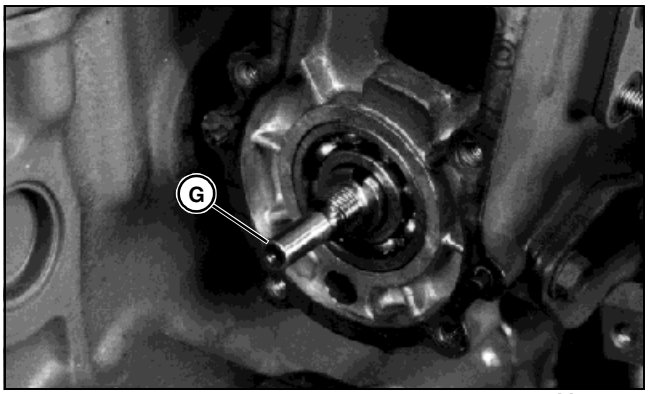
M37755

7. Remove sleeve (E), nut (C), and governor weights (D) from end of injection pump camshaft.



M37804

8. Remove bearing retaining screw (F).



M37796

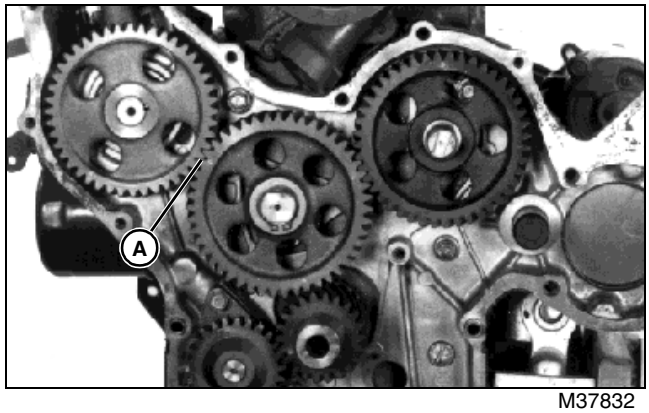
9. Carefully tap the rear of camshaft (G) with a plastic hammer to remove camshaft from housing.

10.Disassemble and inspect all parts for wear or damage. (See Disassembly and Inspection procedures below.)

Installation:

1. Install fuel injection pump camshaft. Installation is done in the reverse order of removal.

2. After installing camshaft assembly into housing, tap on end of camshaft gear with a plastic hammer to seat bearings in bores.



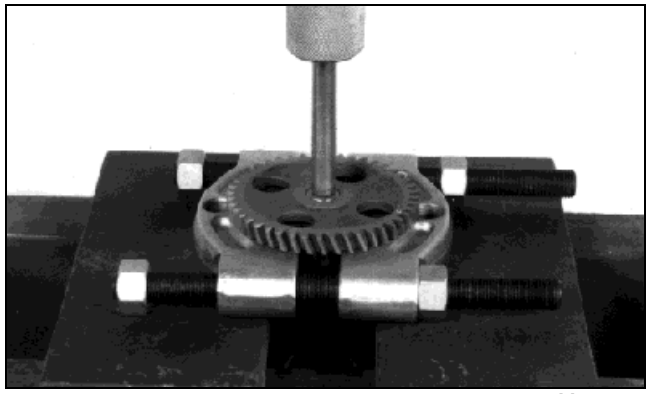
M37832

3. Align timing marks (A) on injection pump gear and idler gear when installing camshaft.

Disassembly:

IMPORTANT: Avoid damage! Hold camshaft while removing gear and bearings. Shaft can be damaged if dropped.

NOTE: Gear and bearings are press fit on shaft.


M37797

1. Remove gear using knife-edge puller and a press.

2. Remove key.

3. Remove bearings using a knife-edge puller and a press.

4. Inspect all parts for wear or damage. (See Inspection procedure below.)

Assembly:

IMPORTANT: Avoid damage! When pressing bearings, apply pressure on the inner bearing race only.

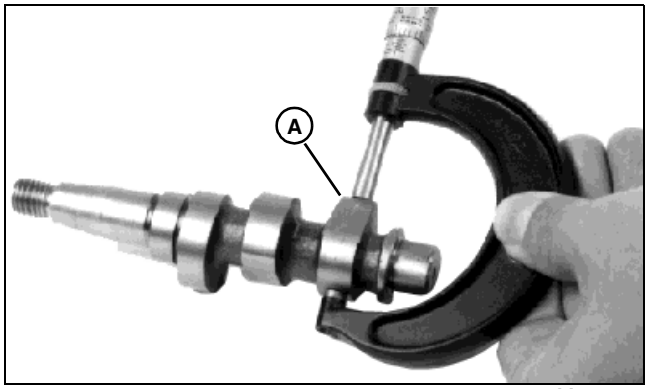
NOTE: Install large bearing on gear end.

1. Install bearings on ends of camshaft using a 3/4-in. deep well socket and a press. Press until bearing races bottom on camshaft shoulder.

2. Install key.

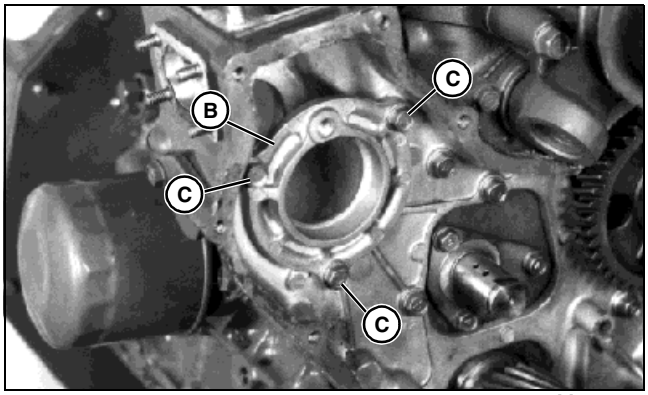
3. Put camshaft gear on a flat surface and press camshaft assembly into gear. Press until gear shoulder bottoms against inner bearing race.

Inspection:



M35905

1. Measure height of each camshaft lobe (A). Replace camshaft if lobe height is less than specification.



M37803

2. Inspect camshaft bearing supports (B) in timing gear housing. Check for cracks, damage, or indications that bearings have spun support.

- If rear bearing bore is damaged, replace timing gear housing.
- If front bearing bore is damaged, remove three cap screws (C) and replace support.

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

Specifications:

Camshaft Lobe Height (Minimum) 30.90 mm (1.217 in.)

Fuel Control and Governor Linkage Removal and Installation

Front Mower

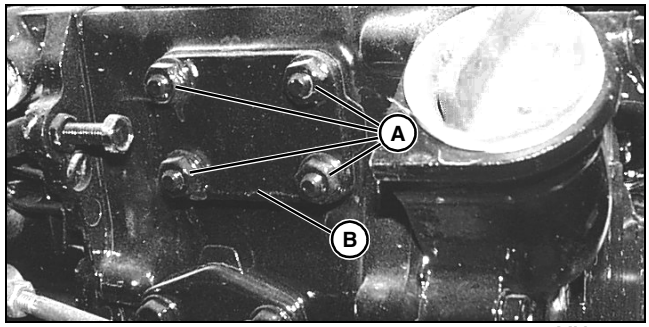
1435

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Micrometer	NA	Used to measure outside diameter of governor shaft, inside diameter of governor shaft bore and sleeve, and injection pump camshaft diameter.

Removal:

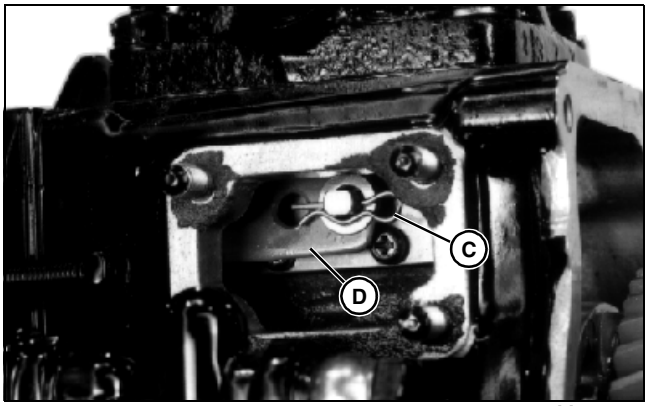
1. Disconnect and remove fuel shutoff solenoid. (See “Fuel Shutoff Solenoid Removal and Installation” on page 207.)



MX0777

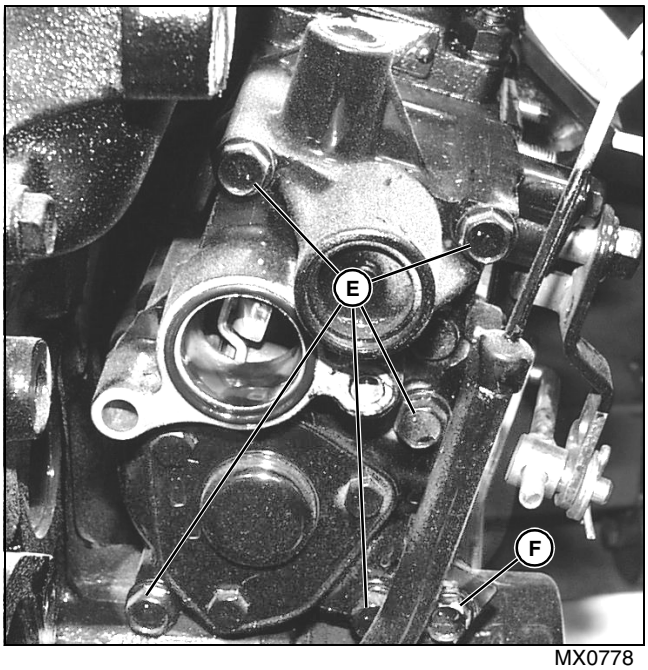
2. Remove four nuts (A), governor linkage cover (B), and gasket.

NOTE: Washer may or may not be fixed to linkage. Do not drop spring pin or washer during removal.



M82685

3. Remove spring pin and washer (C) to disconnect governor linkage (D).

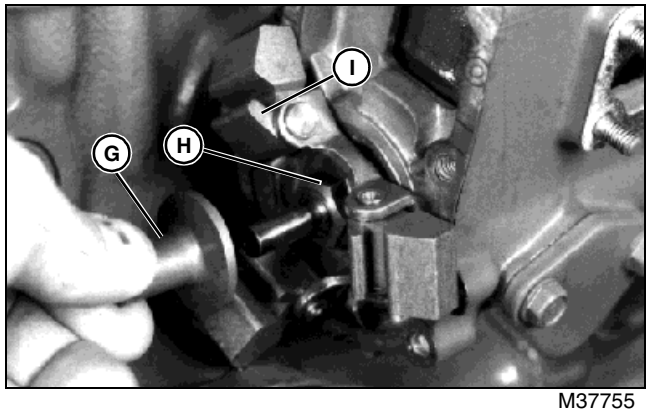


MX0778

4. Remove cap screw securing dipstick tube (F) and remove dipstick tube.

5. Remove five cap screws (E) attaching governor housing.

6. Remove governor housing and gasket.



M37755

7. Remove sleeve (G).

8. Remove nut (H) and governor weights (I).

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

Installation:

NOTE: Do not drop spring pin or washer into housing during installation. Place a small amount of engine assembly grease on washer to help it stick in place while assembling.

1. Install fuel control and governor linkage. Installation is done in the reverse order of removal.

2. Governor linkage has two holes. Connect governor linkage to injection pump rack using hole closest to front of engine.

3. Check and adjust slow idle settings. (See “Slow Idle Speed Adjustment” on page 125.)

Specifications:

Governor Shaft OD Wear Limit . . . . 8.01 mm (0.315 in.)

Governor Shaft Bore ID Wear Limit . 8.50 mm (0.33 in.)

Governor Shaft Bore Clearance . . . 0.09 mm (0.003 in.)

Sleeve Bore ID Wear Limit. . . . . 9.00 mm (0.354 in.)

Injection Pump Camshaft OD Wear Limit . . . . . 7.90 mm (0.311 in.)

Injection Pump Camshaft Clearance . . . . . 0.15 mm (0.006 in.)

Fuel Injection Nozzle Removal, Inspection and Installation - 1435

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Nozzle Cleaning Kit	JDF13	Used to clean fuel injection nozzles.

Removal:

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

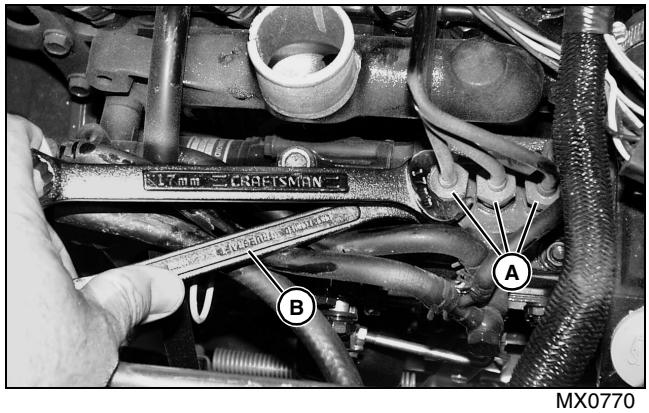
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical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

IMPORTANT: Avoid damage! Never steam clean or pour cold water on injection pump while the pump is running, or engine is warm. Doing so can damage the pump.

When removing injection lines, Do not turn pump delivery valve fittings. Turning fittings may damage pump internally. Always use a backup wrench when removing lines.

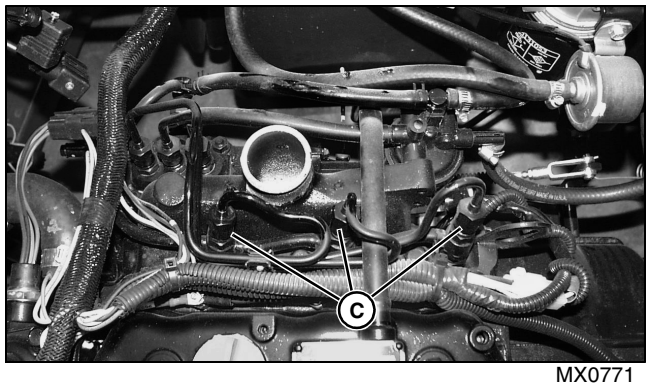
1. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner (cold engine).

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



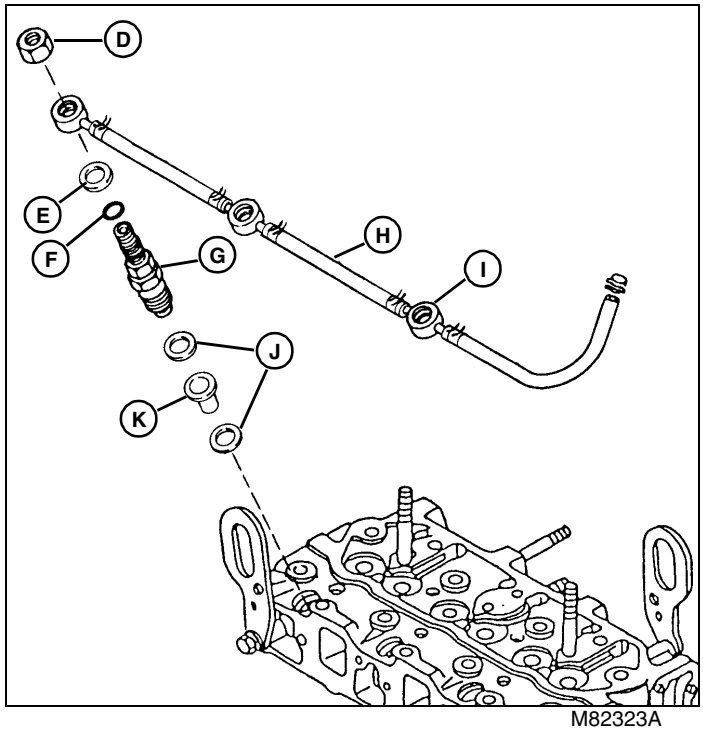
MX0770

2. Loosen fuel line connectors (A) at injection pump to release pressure in the fuel system. When loosening connectors, use a backup wrench (B) to prevent delivery valves from turning.



MX0771

3. Remove fuel line nuts at injector nozzles (C) and remove injector lines.



M82323A

4. Remove three nuts (D) and leak-off hoses (H) and fittings (I).

5. Remove bronze washers (E) and O-rings (F).

6. Remove injection nozzle (G), washers (J), and heat protector (J).

7. Test injection nozzles. (See "Fuel Injection Nozzle Test - 1435" on page 127.)

Installation:

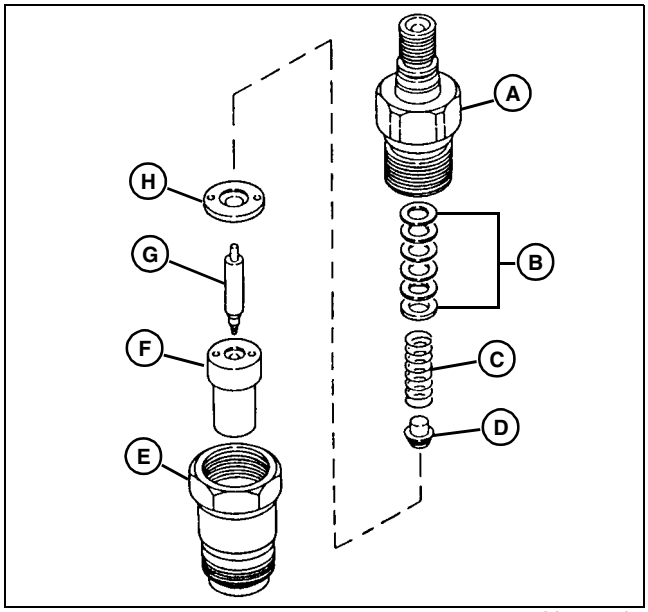
NOTE: Installation is done in the reverse order of removal.

1. Replace heat protectors, washers, and O-rings.
2. Tighten injector nozzle body to specification.
3. Tighten leak-off fitting nut to specification.

Repair:

IMPORTANT: Avoid damage! If injection nozzles are disassembled to be cleaned, the same number and thickness of shims must be installed.

NOTE: If servicing more than one nozzle, keep parts for each nozzle separate from one another.

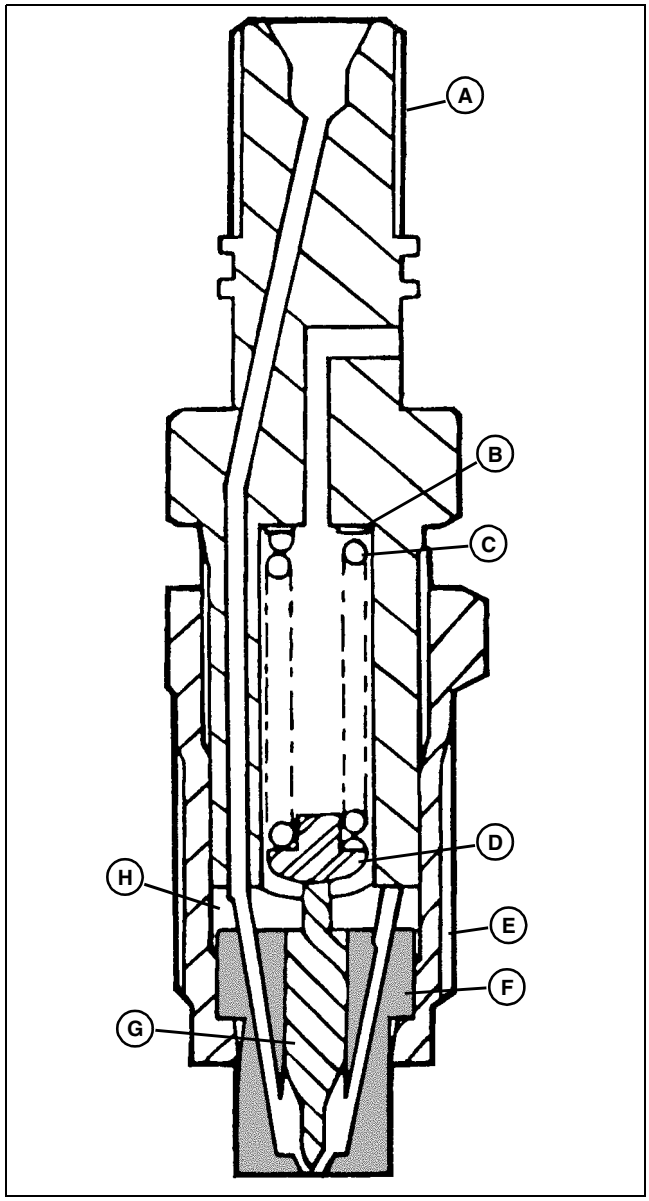


M82324A

A - Injector Body
B - Shims (as required)
C - Spring
D - Spring Seat
E - Nozzle Fitting
F - Nozzle Body
G - Nozzle Valve
H - Separator Plate

- Clean and inspect nozzle assembly. (See Cleaning and Inspection procedure below.)
- After assembly is complete, test injection nozzle. (See "Fuel Injection Nozzle Test - 1435" on page 127.)

Injection Nozzle Cross Section:



M82325A

A - Injector Body
B - Shims (as required)
C - Spring
D - Spring Seat
E - Nozzle Fitting
F - Nozzle Body
G - Nozzle Valve
H - Separator Plate

Cleaning and Inspection:

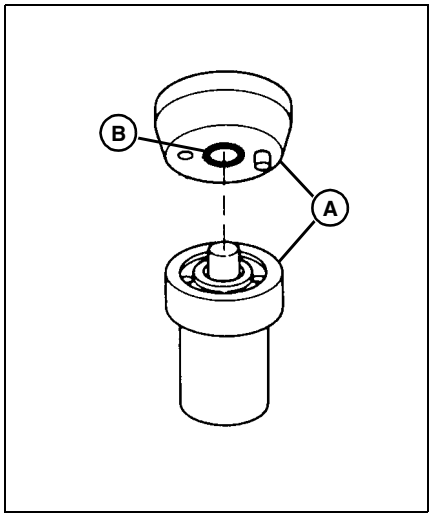
NOTE: To clean nozzles properly, JDF13 Nozzle Cleaning Kit is recommended. The Cleaning Kit is available through the John Deere SERVICEGARD™ Catalog.

1. Remove anti-corrosive grease from new or reconditioned nozzles by washing them thoroughly in diesel fuel.

IMPORTANT: Avoid damage! Never use a steel brush to clean nozzles as this will distort the spray hole.

2. Remove carbon from used nozzles, and clean by washing in diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush (supplied in JDF13 Nozzle Cleaning Kit).

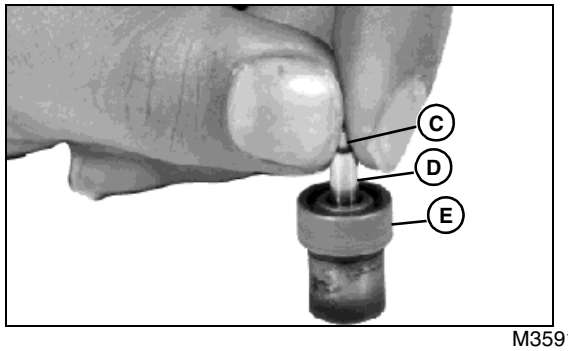
3. After removing carbon or lacquer from the exterior of nozzle, inspect sealing surfaces between separator plate and nozzle body for nicks or scratches.



M82326A

4. Inspect condition of separator plate and nozzle body. Contact area of separator plate (A) (both parts) must not be scored or pitted. Use an inspection magnifier (No. 16487 or equivalent) to aid in making the inspection.

5. Check nozzle contact surface (B) on separator plate for wear. If contact surface is more than the specified measurement, replace nozzle assembly.



M35919

6. Inspect the piston (D) (large) part of nozzle valve to see that it is not scratched or scored and that lower (tip) end of valve is not broken. If any of these conditions are present, replace the nozzle assembly.

7. Further inspect the nozzle assembly by performing a slide test.

- Dip the nozzle valve (C) in clean diesel fuel. Insert valve in nozzle body (E).
- Hold nozzle vertical, and pull valve out about 1/3 of its engaged length.
- Release valve. Valve should slide down to its seat by its own weight.

Replace nozzle assembly if the valve does not slide freely to its seat.

Specifications:

Injection Nozzle Body Torque . . . . . 50 N•m (37 lb-ft)

Leak-Off Fitting Nut Torque. . . . . 40 N•m (30 lb-ft)

Separator Plate Contact Surface . 0.10 mm (0.0039 in.)

Fuel Injection Nozzle Removal, Inspection and Installation - 1445 and 1545

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Nozzle Cleaning Kit	JDF13	Used to clean fuel injection nozzles.

Removal:

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

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

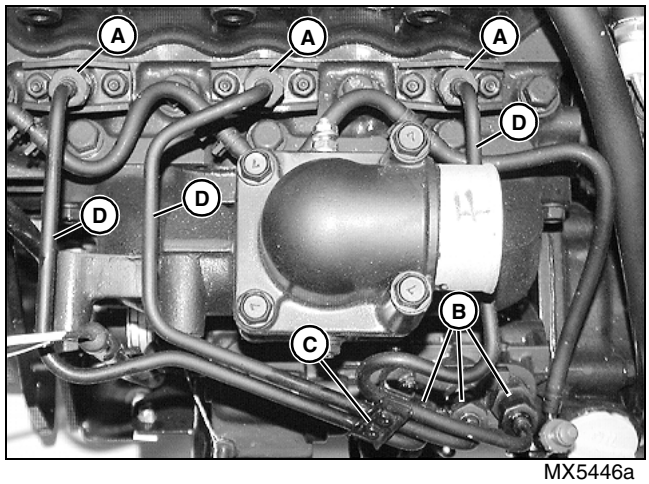
IMPORTANT: Avoid damage! Never steam clean or pour cold water on injection pump while the pump is running, or engine is warm. Doing so can damage the pump.

When removing injection lines, Do not turn pump delivery valve fittings. Turning fittings may damage pump internally. Always use a backup wrench when removing lines.

1. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner (cold engine).

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

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



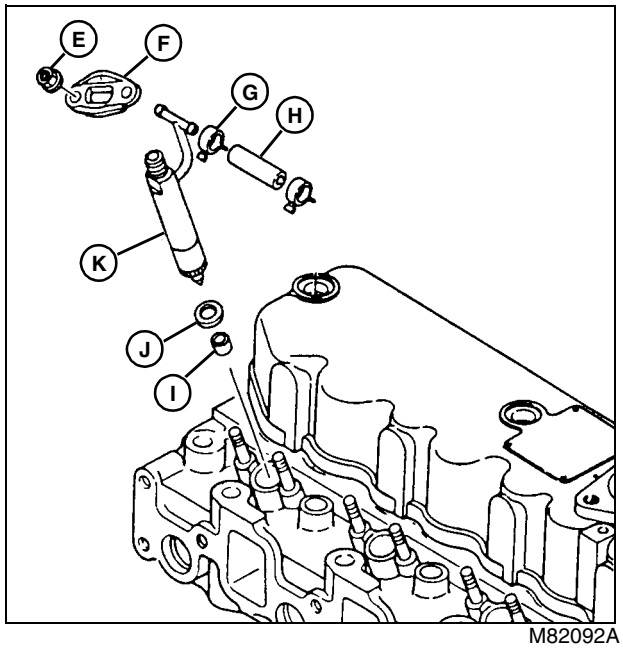
MX5446a

2. Disconnect fuel injection line connectors (B) at injection pump.

3. Remove fuel line nuts at injector nozzles (A).

4. Loosen the line clamps (C) and remove the fuel injection lines (D).

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

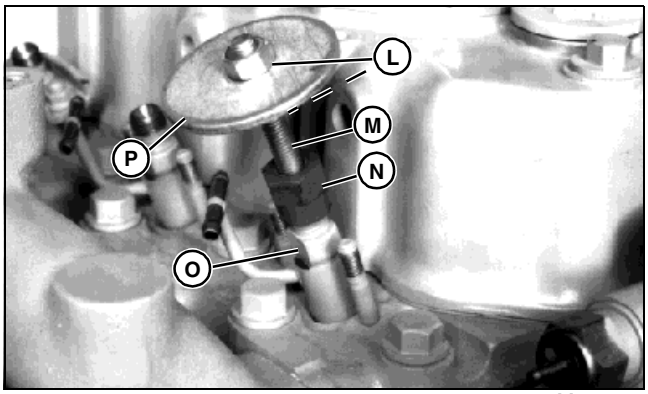


M82092A

5. Remove the clamps (G) and leak-off hoses (H) from fittings.

6. Remove nuts (E) and retaining plates (F).

7. Remove injection nozzle (K), seat (J), and seal (I). If the seat and seal stay in the cylinder head, thread a cap screw into the seat and pull it from cylinder head.



M82126

8. If any nozzles are stuck in the cylinder head:

- Grind the head of a cap screw (M) so it fits inside a nut (N) from an old injection line.
- Use two nuts (L) to attach a large flat washer (P) to the cap screw.
- Install the assembly onto the nozzle (O) and use a puller and slide hammer to pull the nozzle from the cylinder head.

9. Test injection nozzles. (See "Fuel Injection Nozzle Test - 1445 and 1545" on page 129.)

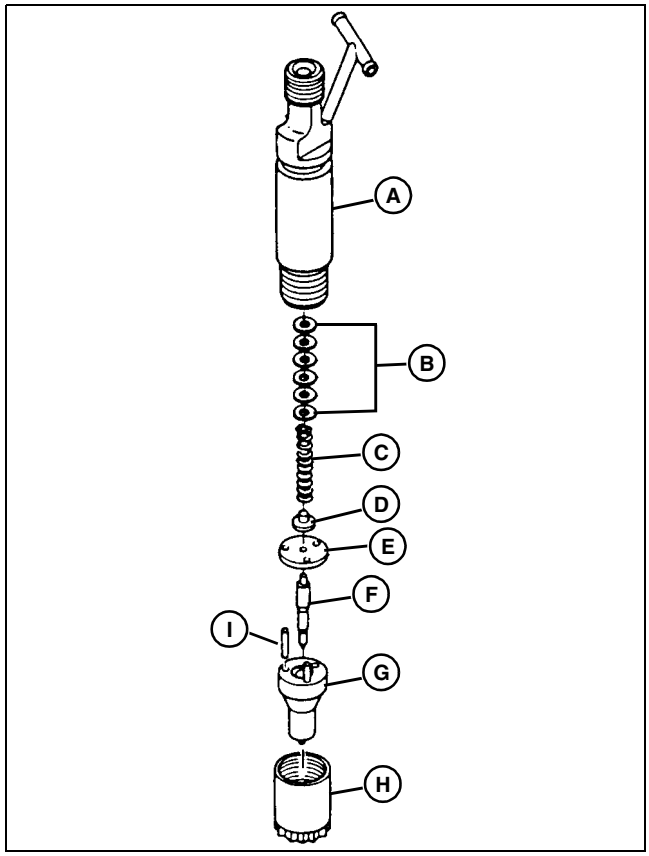
Installation:

NOTE: Install a new seat and seal when installing injection nozzles.

Install fuel injection nozzles. Installation is done in reverse order of removal.

Disassembly and Assembly:

NOTE: If servicing more than one nozzle, keep the parts for each nozzle separate from one another.



M82093A

A - Injector Body
B - Shims (as required)
C - Spring
D - Spring Seat
E - Separator Plate
F - Nozzle Valve
G - Nozzle Body
H - Retaining Nut
I - Index Pin (2 used)

1. Remove retaining nut (8) and disassemble internal parts (1 - 7 and 9) of the injection nozzle. Keep the parts organized for ease of assembly.

2. Clean and inspect the nozzle assembly. (See Cleaning and Inspection procedure below.)

3. Carefully clamp the injector body in a soft-jawed vise.

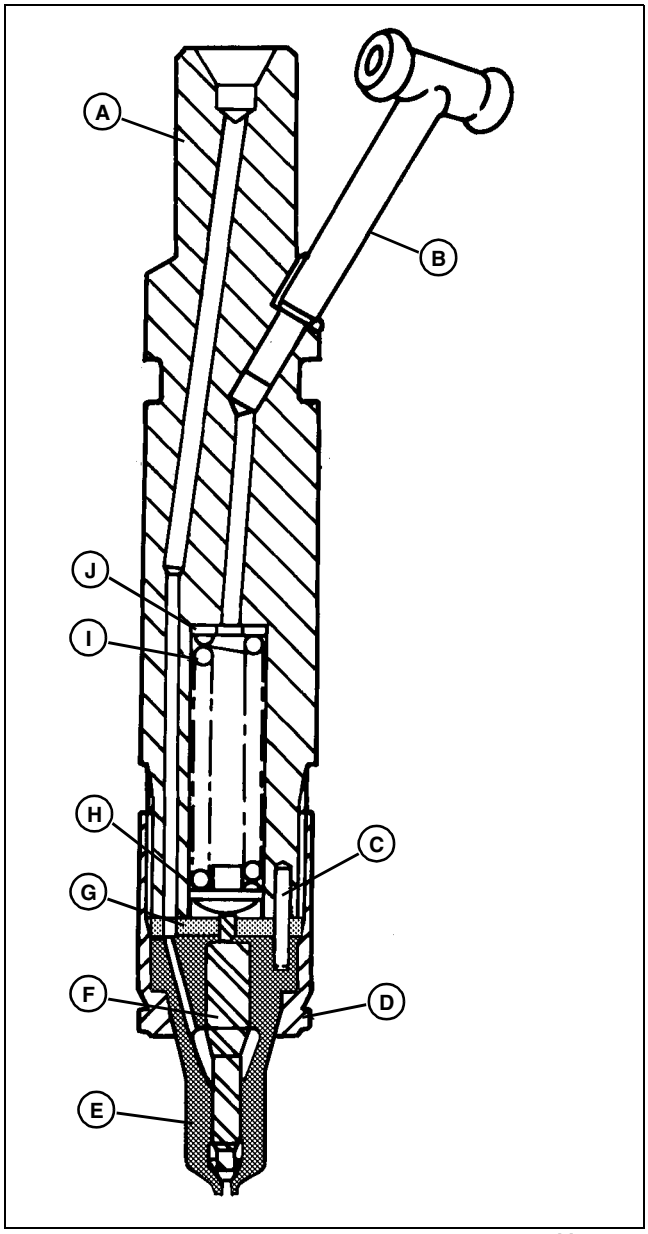
NOTE: Insert the same number of shims that were removed from injector. The number of shims will affect the opening pressure of the fuel nozzle and will be tested after assembly.

4. Reassemble the fuel nozzle in the order shown above.

5. Tighten the retaining nut to specification.

6. After assembly is complete, test the injection nozzle. (See "Fuel Injection Nozzle Test - 1445 and 1545" on page 129.)

Injection Nozzle Cross Section:



M37684

- **A - Injector Body**
- **B - Fuel Return Pipe**
- **C - Index Pin (2 used)**
- **D - Retaining Nut**
- **E - Nozzle Body**
- **F - Nozzle Valve**
- **G - Separator Plate**
- **H - Spring Seat**
- **I - Spring**
- **J - Shim (as required)**

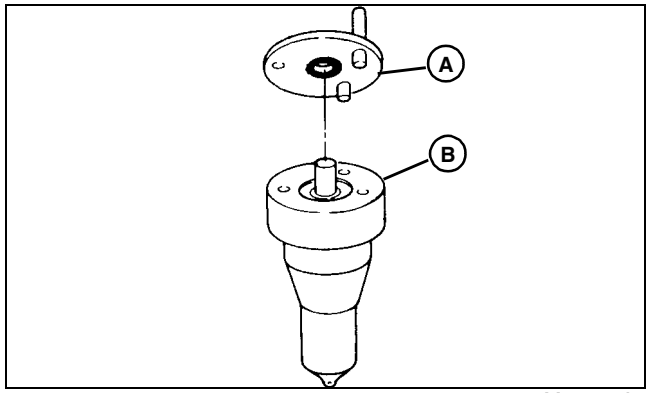
Cleaning and Inspection:

NOTE: To clean nozzles properly, JDF13 Nozzle Cleaning Kit is recommended. The Cleaning Kit is available through the John Deere SERVICEGARD™ Catalog.

1. Remove anti-corrosive grease from new or reconditioned nozzles by washing them thoroughly in diesel fuel.

IMPORTANT: Avoid damage! Never use a steel brush to clean nozzles as this will distort the spray hole.

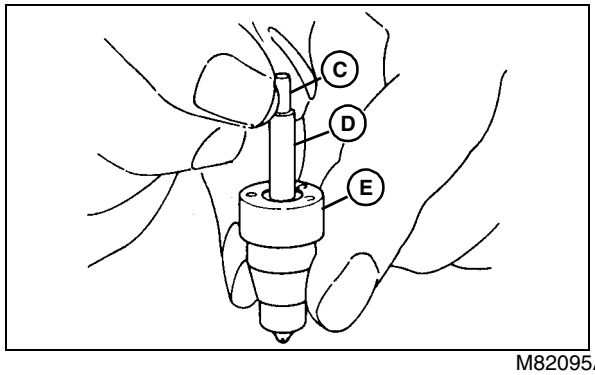
2. Remove any carbon from used nozzles, and clean the nozzles by washing in diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush (supplied in Nozzle Cleaning Kit).



M82094A

3. After removing carbon or lacquer from the exterior of nozzle, inspect the sealing surfaces between the separator plate (A) and the nozzle body (B) for nicks or scratches.

4. Inspect the condition of the separator plate and nozzle body. The contact area of the separator plate (both parts) must not be scored or pitted. Use an inspection magnifier (No. 16487 or equivalent) to aid in making the inspection.



M82095A

5. Inspect the piston (D) (large) part of the nozzle valve to see that it is not scratched or scored and that the lower (tip) end of the valve is not broken. If any of these conditions are present, replace the nozzle assembly.

6. Further inspect the nozzle assembly by performing a slide test:

- Dip the nozzle valve (C) in clean diesel fuel. Insert valve in nozzle body (E).
- Hold nozzle vertical, and pull valve out about 1/3 of its engaged length.
- Release the valve. The valve should slide down to its seat by its own weight.

Replace the nozzle assembly if the valve does not slide freely to its seat.

Specifications:

Retaining Plate Nut Torque . . . . . 5 N•m (44.25 lb-in.)

Retaining Nut Torque . . . . . 7 - 9 N•m (62 - 80 lb-in.)

Fuel Shutoff Solenoid Removal and Installation

Front Mower

1435

1445

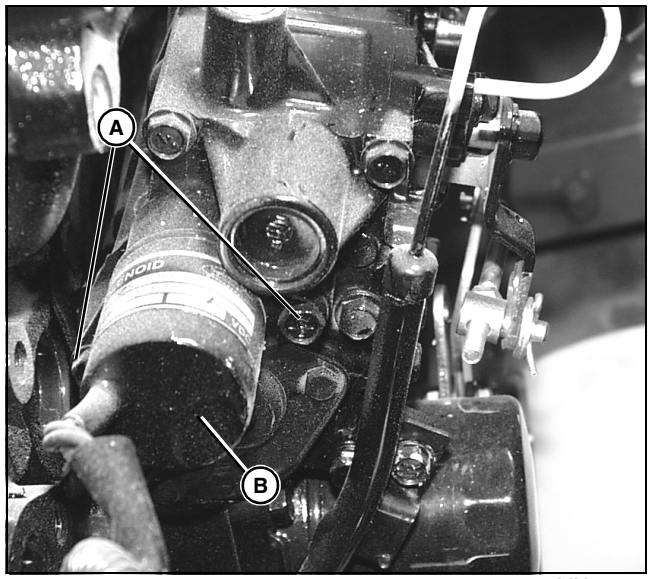
1545

Removal:

1. Park machine on level surface, park brake locked, key switch in off position.

2. Clean around the fuel shutoff solenoid using a parts cleaning solvent or steam cleaner.

3. Disconnect the electrical lead to the fuel shutoff solenoid.



MX0775

Picture Note: Model 1435 Shown

4. Disconnect electrical lead and remove fuel shutoff solenoid.

5. Remove the two solenoid mounting cap screws (A) and remove solenoid (B) from governor housing.

6. Test fuel solenoid. (See “Fuel Shutoff Solenoid Test” on page 479 in the Electrical section.)

Installation:

NOTE: Check condition of O-ring on solenoid before installing.

Install fuel shutoff solenoid. Installation is done in the reverse order of removal.

Fuel Pump Removal and Installation

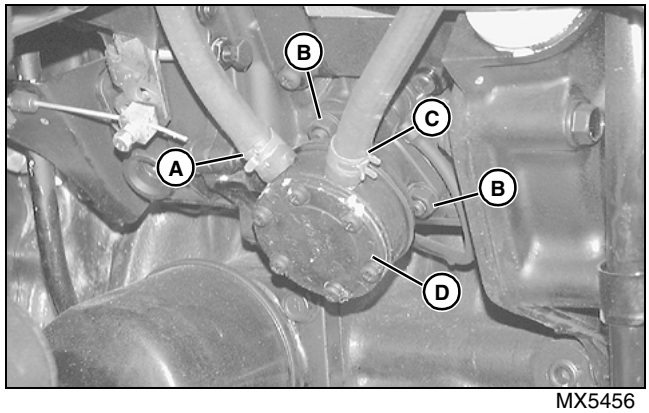
Front Mower

1435

1445

1545

Removal:



MX5456

1. Disconnect line-to-filter (A) and line-from-tank (C).

2. Remove two nuts (B).

3. Remove fuel pump (D).

Installation:

1. Install fuel pump. Installation is done in the reverse order of removal.

2. Remove gasket residue from fuel pump and fuel injection pump mating surfaces.

3. Use a new gasket for installation.

4. **Models 1445 and 1545:** Bleed air from fuel system. (See “Fuel System Bleeding Procedure” on page 125.)

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ENGINE - DIESEL (3TNE88) SPECIFICATIONS

Specifications

General Specifications

Front	Mower
Make	Yanmar
Model	3TNE88
Type	4-Cycle Diesel
Bore	88 mm (3.46 in.)
Stroke	90 mm (3.54 in.)
Cylinders	3
Displacement	1.642 L (100.2 cu in.)
Gross Output Power	27.0 kW (36.3 hp)
Torque @ 2600 rpm	87.9 N•m (64.8 lb-ft)
Torque (maximum) @ 1700 rpm	104.9 N•m (77.4 lb-ft)
Firing Order	1-3-2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Combustion System	Direct Injection Type
Compression Ratio	18.5 to 1
Oil capacity with Filter (Approximately)	3.8 L (4 qt)
Cooling	Liquid with pump and radiator
Cooling System Capacity	7.5 L (8 qt)
Governor	Centrifugal
Slow Idle	1500 ± 50 rpm
High Idle (No Load)	3200 ± 50 rpm
Fuel Filter	Replaceable element fuel water separator
Air Filter	Dry replaceable primary and secondary elements

Tests and Adjustment Specifications

Valve Clearance	0.15 - 0.25 mm (0.006 - 0.010 in.)
Connecting Rod Side Play	0.2 - 0.4 mm (0.008 - 0.016 in.)
Connecting Rod Bearing Clearance	0.04 - 0.07 mm (0.002 - 0.003 in.)
Crankshaft End Play	0.09 - 0.27 mm (0.004 - 0.011 in.)
Crankshaft Main Bearing Clearance	0.04 - 0.07 mm (0.001 - 1.003 in.)
Camshaft End Play	0.05 - 0.25 mm (0.002 - 0.010 in.)
Timing Gear Backlash:	
All Except Oil Pump Gear	0.07 - 0.15 mm (0.003 - 0.005 in.)
Oil Pump Gear	0.11 - 0.19 mm (0.004 - 0.008 in.)
Fuel Injection Nozzle Opening Pressure	19600 + 1000/-0 kPa (2843 + 145/-0 psi)
Leakage at 11032 kPa (1600 psi)	None for a minimum of 10 seconds
Chatter and Spray Pattern at 19600 ± 1000 kPa (2843 ± 145 psi):	
Slow Hand Lever Movement	Chatter Sound
Slow Hand Lever Movement	Fine Stream

Fast Hand Lever Movement	Fine Atomized Spray; 150° Spray Pattern
Alternator Drive Belt Deflection	10 - 15 mm (0.4 - 0.6 in.)
Fuel Injection Pump Timing	11° ± 1° BTDC

Operational Tests

Cooling System Test Pressure	88 ± 15 kPa (12.8 ± 2.2 psi)
Thermostat Opening Temperature	69.5 - 72.5° C (157 - 163° F)
Thermostat Fully Open Temperature	85° C (185° F)
Minimum Lift Height above 85° C (185° F)	8.0 mm (0.135 in.)
Radiator Cap Opening Pressure	0.9 ± 0.15 kg/cm^2 88 ± 15 kPa (12.8 ± 2.2 psi)
Cylinder Compression Pressure @250 rpm	3530 kPa (512 psi)
Cylinder Compression Pressure @250 rpm (Minimum)	3334 kPa (483 psi)
Difference Between Cylinders (Maximum)	294 kPa (42 psi)
Oil Pressure (Rated Speed)	338 ± 50 kPa (49 ± 7.2 psi)
Slow Idle (Minimum)	60 kPa (8.7 psi)
Oil Relief Valve Opening Pressure	294 - 392 kPa (43 - 57 psi)
Oil Pressure Switch Opening Pressure	41 - 62 kPa (6 - 9 psi)

Repair Specifications

Valve Train:

Rocker Arm Shaft OD	15.97 - 15.98 mm (0.628 - 0.629 in.)
Rocker Arm Shaft Wear Limit	15.95 mm (0.628 in.)
Rocker Arm and Shaft Support Bushing ID	16.00 - 16.02 mm (0.630 - 0.631 in.)
Wear Limit	16.09 mm (0.633 in.)
Oil Clearance	0.02 - 0.05 mm (0.001 - 0.002 in.)
Wear Limit	0.15 mm (0.006 in.)
Push Rod Bend	0.0 - 0.03 mm (0.0 - 0.001 in.)

Cylinder Head and Valves:

Cylinder Head Distortion	0.0 - 0.05 mm (0.0 - 0.002 in.)
Wear Limit	0.15 mm (0.006 in.)
Intake Valve Seat Width	1.07 - 1.24 mm (0.042 - 0.049 in.)
Intake Valve Seat Width (Wear Limit)	1.74 mm (0.069 in.)
Exhaust Valve Seat Width	1.24 mm - 1.45 mm (0.042 - 0.049 in.)
Exhaust Valve Seat Width (Wear Limit)	1.94 mm (0.076 in.)
Intake Valve Stem OD	7.96 - 7.98 mm (0.313 - 0.314 in.)
Intake Valve Stem OD (Wear Limit)	7.9 mm (0.311 in.)
Exhaust Valve Stem OD	7.96 - 7.97 mm (0.313 - 0.314 in.)
Exhaust Valve Stem OD (Wear Limit)	7.9 mm (0.311 in.)
Valve Head Thickness:	
Intake	1.24 - 1.44 mm (0.049 - 0.057 in.)
Exhaust	1.35 - 1.55 mm (0.053 - 0.061 in.)
Wear Limit	0.50 mm (0.020 in.)

Intake Valve Recession	0.31 - 0.51 mm (0.012 - 0.020 in.)
Intake Valve Recession (Wear Limit)	1.00 mm (0.039 in.)
Exhaust Valve Recession	0.3 - 0.5 mm (0.012 - 0.020 in.)
Exhaust Valve Recession (Wear Limit)	1.00 mm (0.039 in.)
Valve Guide Stem-To-Guide Oil Clearance:	
Intake	0.04 - 0.07 mm (0.001 - 0.003 in.)
Exhaust	0.05 - 0.08 mm (0.002 - 0.003 in.)
Exhaust (Wear Limit)	0.20 mm (0.008 in.)
Valve Guide ID	8.01 - 8.03 mm (0.315 - 0.316 in.)
Valve Guide ID (Wear Limit)	8.10 mm (0.319 in.)
Valve Guide Projection	15 mm (0.591 in.)
Valve Spring Free Length	42.0 mm (1.654 in.)
Maximum Spring Inclination	1.10 mm (0.044 in.)
Valve Spring Tension (Measured With Spring Compressed 1.0 mm (0.039 in.)	2.36 - 3.10 kg (5.20 - 6.83 lb)
Valve Seat Surface Angle:	
Exhaust Valve	45°
Intake Valve	30°
Valve Timing:	
Intake Valve Opens	10° - 20° BTDC
Intake Valve Closes	40° - 50° ABDC
Exhaust Valve Opens	51° - 61° BBDC
Exhaust Valve Closes	13° - 23° ATDC
Piston-to-Cylinder Head Clearance	0.66 - 0.78 mm (0.026 - 0.031 in.)

Connecting Rod

Large End Bearing ID	51 - 51.01 mm (2.008 - 2.008 in.)
Large End Bearing Thickness	1.49 - 1.50 mm (0.059 - 0.059 in.)
Oversize	1.625 mm (0.064 in.)
Oil Clearance	0.04 - 0.07 mm (0.002 - 0.003 in.)
Oil Clearance (Wear Limit)	0.16 mm (0.006 in.)
Connecting Rod Side Play	0.2 - 0.4 mm (0.008 - 0.016 in.)

Piston Rings

First Compression Piston Ring Groove Width	2.06 - 2.075 mm (0.081 - 0.082 in.)
First Compression Piston Ring Width (All)	1.97 - 1.99 mm (0.078 - 0.078 in.)
First Compression Ring Minimum Side Clearance	0.070 - 0.105 mm (0.003 - 0.004 in.)
Second Compression Piston Ring Groove Width	2.025 - 2.04 mm (0.080 - 0.080 in.)
Second Compression Piston Ring Width	1.97 - 1.99 mm (0.078 - 0.078 in.)
Second Compression Piston Ring Minimum Side Clearance	0.045 - 0.08 mm (0.002 - 0.003 in.)
Oil Control Piston Ring Groove Width	4.015 - 4.03 mm (0.158 - 0.159 in.)
Oil Control Piston Ring Width	3.97 - 3.99 mm (0.156 - 0.157 in.)
Oil Control Piston Ring Minimum Side Clearance	0.025 - 0.06 mm (0.001 - 0.002 in.)
Piston Ring End Gap	0.20 - 0.40 mm (0.008 - 0.016 in.)
Wear Limit	1.50 mm (0.059 in.)

Piston Pin

Piston Pin OD	**25.99 - 26.00 mm (1.023 - 1.024 in.)**
Piston Pin OD (Wear Limit)	**25.90 mm (1.020 in.)**
Piston Pin Bushing ID	**23.025 - 23.038 mm (0.906 - 0.907 in.)**
Wear Limit	**23.10 mm (0.909 in.)**
Piston Pin-To-Rod Bore Oil Clearance	**0.025 - 0.047 mm (0.001 - 0.002 in.)**
Wear Limit	**0.2 mm (0.008 in.)**
Piston Pin Bore (In Piston) ID	**26.00 - 26.009 mm (1.023 - 1.024 in.)**
Piston Pin Bore (In Piston) ID (Wear Limit)	**26.02 mm (1.024 in.)**
Piston Pin-To-Piston Oil Clearance	**0.00 - 0.022 mm (0.0 - 0.0009 in.)**
Wear Limit	**0.12 mm (0.005 in.)**

Piston

Standard Piston OD	**87.95 - 87.98 mm (3.462 - 3.464 in.)**
Standard Piston OD (Wear Limit)	**87.90 mm (3.461 in.)**
Oversize Piston OD	**88.20 - 88.23 mm (3.472 - 3.474 in.)**
Oversize Piston OD (Wear Limit)	**88.10 mm (3.469 in.)**

Cylinder Bore ID

Standard Bore ID	**88.00 - 88.03 mm (3.465 - 3.466 in.)**
Standard Bore ID (Wear Limit)	**88.20 mm (3.472 in.)**
Oversize Bore ID	**88.25 - 88.28 mm (3.474 - 3.476 in.)**
Piston-to-Cylinder Clearance	**0.040 - 0.070 mm (0.0016 - 0.0027 in.)**
Cylinder Roundness	**0.01 - 0.03 mm (0 - 0.001 in.)**
Wear Limit	**0.03 mm (0.001 in.)**
Cylinder Taper	**0.00 - 0.01 mm (0 - 0.0004 in.)**
Wear Limit	**0.03 mm (0.001 in.)**
Deglazing	**30 - 40° crosshatch pattern**
Boring	**30 - 40° crosshatch pattern**

Crankshaft and Main Bearings

Connecting Rod Crankshaft Journal OD	**47.95 - 47.96 mm (1.888 - 1.888 in.)**
Connecting Rod Crankshaft Journal OD (Wear Limit)	**47.91 mm (1.886 in.)**
Main Bearing Journal OD	**53.95 - 53.96 mm (2.124 - 2.124 in.)**
Main Bearing Journal OD (Wear Limit)	**53.91 mm (2.122 in.)**
Main Bearing Oil Clearance	**0.04 - 0.07 mm (0.002 - 0.003 in.)**
Main Bearing Oil Clearance (Wear Limit)	**0.16 mm (0.006 in.)**
Crankshaft Bend (Maximum)	**0.02 mm (0.001 in.)**
Crankshaft End Play	**0.09 - 0.27 mm (0.004 - 0.011 in.)**

ENGINE - DIESEL (3TNE88) SPECIFICATIONS

Camshaft

Camshaft End Play	**0.05 - 0.25 mm (0.002 - 0.010 in.)**
Camshaft Bend	**0 - 0.02 mm (0 - 0.001 in.)**
Wear Limit)	**0.05 mm (0.002 in.)**
Camshaft Side Gap	**0.05 - 0.25 mm (0.002 - 0.010 in.)**
Lobe Height (Intake and Exhaust)	**38.64 - 38.77 mm (1.521 - 1.526 in.)**
Wear Limit	**38.40 mm (1.512 in.)**
Bearing Journal OD:	
Flywheel Side and Gear Side	**44.93 - 44.95 mm (1.769 - 1.770 in.)**
Intermediate Journal	**44.91 - 44.94 mm (1.768 - 1.769 in.)**
Wear Limit	**44.85 mm (1.766 in.)**
Oil Clearance (Gear and Flywheel Ends	**0.04 - 0.13 mm (0.002 - 0.005 in.)**
Oil Clearance (Intermediate)	**0.07 - 0.12 mm (0.003 - 0.005 in.)**

Camshaft Followers

Stem OD	**11.98 - 11.99 mm (0.471 - 0.472 in.)**
Wear Limit	**11.93 mm (0.470 in.)**
Bore ID	**12.00- 12.02 mm (0.472 - 0.473 in.)**
Wear Limit	**12.05 mm (0.474 in.)**
Oil Clearance	**0.01 - 0.04 mm (0.0004 - 0.0016 in.)**
Wear Limit	**0.12 mm (0.005 in.)**

Idler Gear

Shaft OD	**45.95 - 45.98 mm (1.809 - 1.810 in.)**
Wear Limit	**45.93 mm (1.808 in.)**
Bushing ID	**46.00 - 46.03 mm (1.811 - 1.812 in.)**
Wear Limit	**46.08 mm (1.814 in.)**
Clearance	**0.15 mm (0.006 in.)**

Oil Pump

Rotor Shaft OD to Side Cover Hole ID Clearance	**0.01 - 0.04 mm (0.001 - 0.002 in.)**
Wear Limit	**0.20 mm (0.08 in.)**
Inner Rotor and Outer Rotor-to-Pump Body Side Clearance	**0.03 - 0.09 mm (0.001 - 0.004 in.)**
Wear Limit	**0.15 mm (0.006 in.)**
Outer Rotor to Pump Body Clearance	**0.10 - 0.16 mm (0.004 - 0.006 in.)**
Wear Limit	**0.25 mm (0.010 in.)**
Inner Rotor to Outer Rotor Clearance Wear Limit	**0.15 mm (0.006 in.)**

Torque Values, Non-Standard Fasteners

Cylinder Head Bolts (Lubricating Oil Applied) . . . . . 85 - 91 N•m (63 - 67 lb-ft)
Connecting Rod Bolts (Lubricating Oil Applied). . . . . 44 - 54 N•m (33 - 40 lb-ft)
Flywheel Mounting Bolts (Lubricating Oil Applied) . . . . . 83 - 88 N•m (62 - 65 lb-ft)
Main Bearing Bolts (Lubricating Oil Applied) . . . . . 96 - 100 N•m (71 - 74 lb-ft)
Crankshaft Pulley Bolt (Lubricating Oil Applied) . . . . . 113 - 122 N•m (83 - 90 lb-ft)
Fuel Injector Nozzle Nut. . . . . 6.8 - 8.8 N•m (60 - 78 lb-in.)
Governor Weight Support Nut. . . . . 44 - 49 N•m (33 - 36 lb-ft)
Rocker Arm Mounting Cap Screw and Nut . . . . . 26 N•m (19 lb-ft)
Oil Pump Mounting Cap Screw . . . . . 25 N•m (18 lb-ft)
Starting Motor Mounting Bolts . . . . . 47 N•m (35 lb-ft)

Special Tools

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

Number	Name	Use
D15001NU	Magnetic Follower Holder Kit	Hold cam followers when removing and installing camshaft
JDF13	Nozzle Cleaning Kit	Use to clean fuel injection nozzles.
D-20019WI	Valve Guide Knurler	Use to knurl inside diameter of valve guides.
JDE118	Valve Guide Driver	Use to remove and install valve guides in cylinder head.
D-20021WI	Valve Guide Reamer	Use to ream out valve guides.

Other Materials

Number	Name	Use
TY15130 LOCTITE®	John Deere Form-In-Place Gasket	Seals rear oil seal case and flywheel housing to engine block. Seals oil pan to timing gear housing and engine block.
TY9370 LOCTITE® No. 242	Thread Lock and Sealer (Medium Strength)	Apply to threads of crankshaft pulley cap screw.

LOCTITE® is a registered trademark of the Loctite Corp.

Theory of Operation

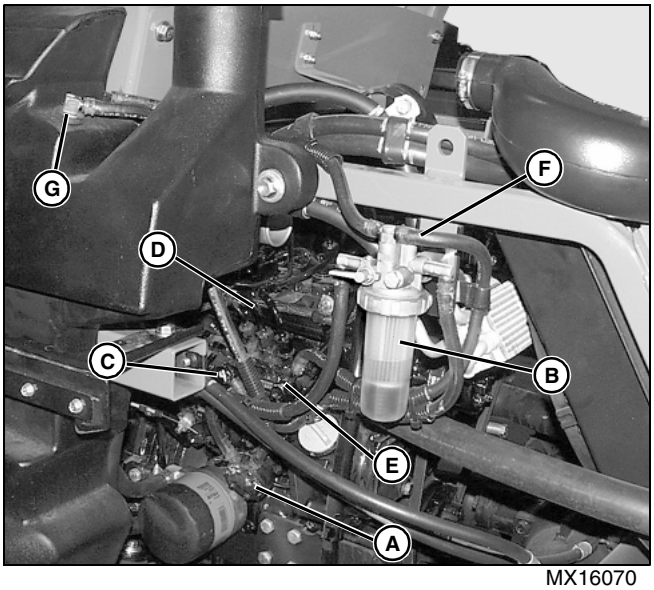
Fuel and Air System Operation

Function:

Fuel system supplies fuel to injection nozzles.

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

Theory of Operation:



MX16070

Fuel System:

A mechanical fuel transfer pump (A) draws fuel from the tank outlet (G). The low pressure fuel from the fuel pump flows through the filter/water separator (B) to the fuel injector pump inlet (C). The injection pump then directs high pressure fuel through the injector lines (D) for combustion. Excess fuel from injector pump is teed together with return fuel from the injectors, at return line connection (E) at injector pump. Return fuel flows through line (F) through the top of fuel filter body to the fuel tank.

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

The engine speed is controlled by the throttle lever and cable. The cable is connected to the injection pump governor control lever. The fuel shutoff solenoid controls the injection pump shutoff shaft. When the solenoid is retracted (key in the start or on position), the engine can be started. When the key is turned off, return springs on the shutoff shaft, extend the solenoid, moving the shutoff linkage to the shutoff position. The solenoid also closes if the machine is operated in an unsafe condition. (See “Fuel Shutoff Solenoid Circuit Operation - Diesel Engine” on page 439 in the Electrical section.)

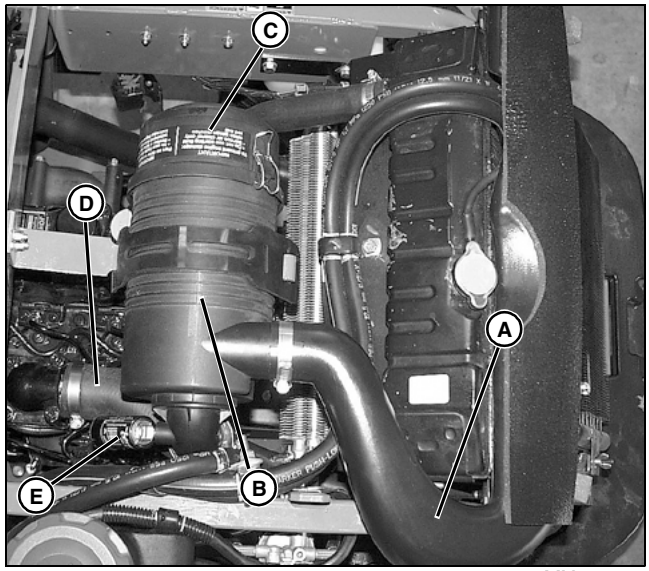
The injection pump meters fuel as determined by the governor and delivers it at high pressure to the injection nozzles.

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

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

A fuel level sensor mounted in the fuel tank informs the operator of the fuel level.

Air Intake System:



MX16075

Engine intake air enters the inlet pipe (A) behind the radiator, and flows into the air filter body (B). The air cleaner also has a rubber, one way, unloading valve at the bottom of cover (C), that ejects heavy dirt particles from the air stream during engine operation before they reach the filters. The operator can squeeze the valve to remove the large particles. The air cleaner elements filter the air, which then flows through hose (D) to the intake manifold.

An air filter restriction indicator (E) at outlet elbow of the air cleaner informs the operator when the air filter needs servicing.

Cooling System Operation

Function:

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

Theory of Operation:

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

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

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

From the block, coolant is then directed through the cylinder head, and into thermostat housing. With the thermostat open;

Start To Open . . . . . .69.5 - 72.5° C (157 - 163° F)

Fully Opened. . . . . 85° C (185° F)

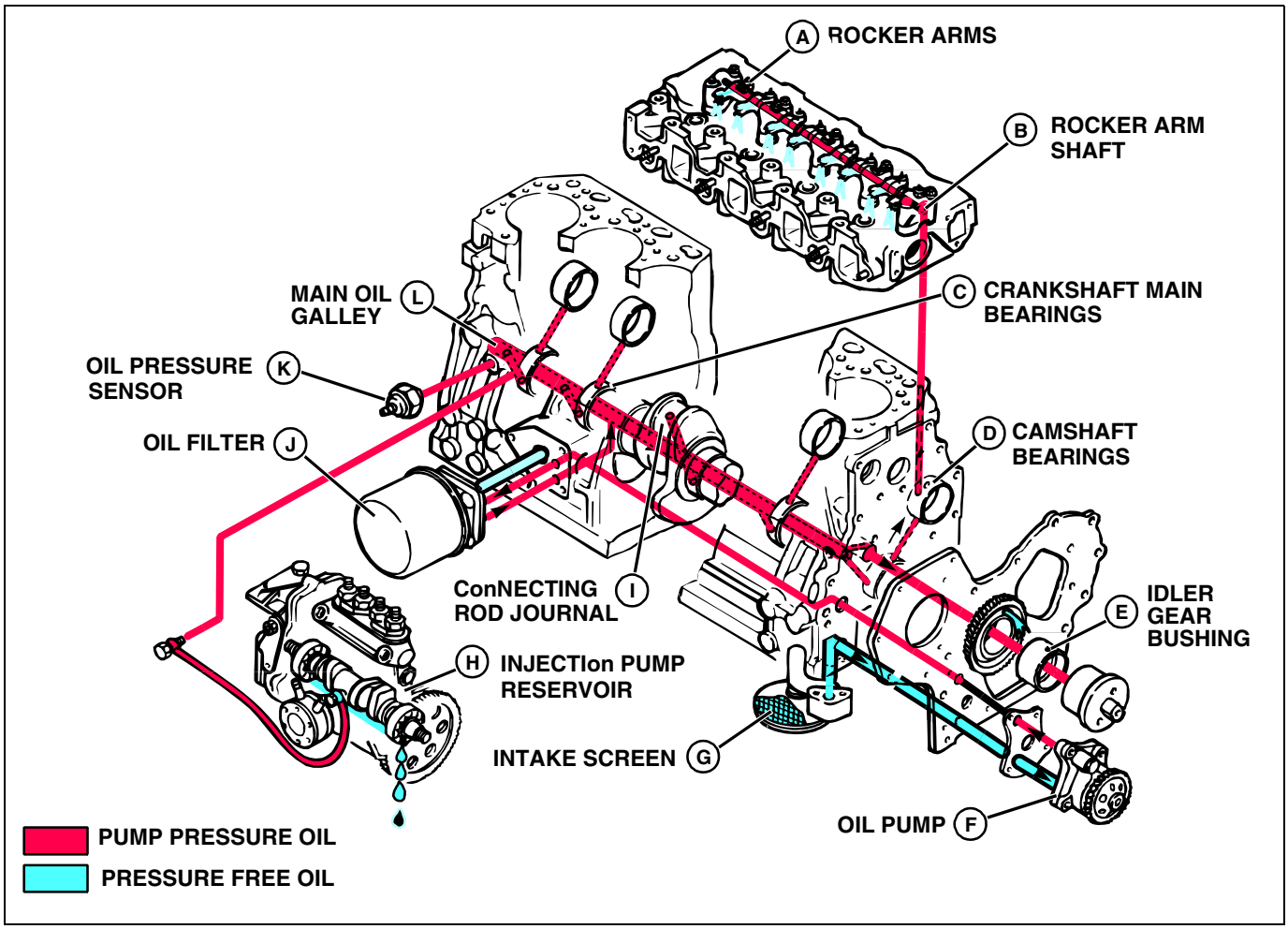
warm engine coolant passes through the housing into the top of the radiator where it is circulated to dissipate heat.

A coolant temperature sensor at the top of the water pump housing is used to turn on the electric cooling fan, and if a overheating condition exists, warns the operator by lighting the high temperature warning lamp.

When coolant system pressure exceeds **88.3 kPa (12.8 psi)**, a valve in the radiator cap opens to allow coolant to discharge into the coolant recovery tank.

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

Lubrication System Operation



MIF

Function:

A full pressure system lubricates engine parts with filtered oil.

Theory of Operation:

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

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

From the main oil galley, oil is forwarded under pressure to the crankshaft main bearing journals (C) and idler gear bushing (E). Drilled cross-passages in the crankshaft (I) distribute the oil from the main bearings to connecting rod bearings.

Lube oil holes in main bearing oil grooves direct oil to the camshaft bearings (D).

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

Lubrication oil is supplied to the fuel injection pump (H) from the main oil galley through an external oil line.

An oil pressure sensor (K) activates an indicator light to alert the operator to shut down the engine if oil pressure drops below specification.

Diagnostics

Engine Troubleshooting

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

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

Engine System

Symptom: Engine Starting Problems

(1) Engine starts?

No - Battery voltage low - recharge battery.

No - Starting motor defective - repair or replace starting motor.

No - Alternator defective - repair or replace alternator.

No - Open circuit in wiring - repair wiring.

No - Fuel filter clogged - replace fuel filter.

No - Clogged or cracked fuel lines - clean or replace fuel lines.

No - Fuel volume to injection pump low - check or replace fuel transfer pump.

No - Water in fuel - check and repair.

No - Improper engine oil viscosity/type - replace engine oil and filter.

No - Improper intake or exhaust valve clearance - adjust valve clearance.

No - Improper timing between injection pump, intake and exhaust valves - adjust valve clearance. Check valve timing.

No - Seized intake/exhaust valve - replace valve and check valve guide.

No - Broken or seized piston ring - replace rings and check cylinder.

No - Piston ring, piston or cylinder worn - bore or hone cylinder and replace piston.

No - Crankshaft pin or bearing seized - regrind crank and replace bearings.

No - Air entering fuel system - check and repair fuel supply system.

Symptom: Engine Starting Problems

Yes - Engine starting procedure ok. Go to next procedure.

Symptom: Engine Starts But Does Not Continue Running

(1) Exhaust smoke absent?

No - Go to next step.

Yes - Fuel filter clogged - replace fuel filter.

Yes - Clogged or cracked fuel lines - clean or replace fuel lines.

Yes - Water in fuel - check and repair.

Yes - Air entering fuel system - check and repair fuel supply system.

Yes - Fuel volume to injection pump low - check or replace fuel transfer pump.

Yes - Improper engine oil viscosity/type - replace engine oil and filter.

Yes - Improper intake or exhaust valve clearance - adjust valve clearance.

Yes - Crankshaft pin or bearing seized - regrind crank and replace bearings.

Yes - Piston ring end gaps not correct - stagger piston ring gaps.

Yes - Governor not functioning properly - repair or replace governor.

Yes - Improper intake or exhaust valve clearance - adjust valve clearance.

(2) Excess exhaust smoke?

Yes - Clogged air filter - clean or replace air filter.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Piston ring, piston or cylinder worn - bore or hone cylinder and replace piston.

Symptom: Low Engine Output

(1) Exhaust color normal?

No - Go to next step.

Yes - Fuel filter clogged - replace fuel filter.

Yes - Air entering fuel system - check and repair fuel supply system.

Yes - Clogged or cracked fuel lines - clean or replace fuel lines.

Yes - Improper intake or exhaust valve clearance - adjust valve clearance.

Yes - Compression leakage from valve seat - grind valve seat; regrind valves.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Leaking cylinder head gasket - replace head gasket.

Yes - Crankshaft pin or bearing worn - regrind crank and replace bearings.

Yes - Improper engine oil viscosity/type - replace engine oil and filter.

Yes - Wrong type of fuel - drain and replace fuel.

Yes - Fuel volume to injection pump low - check or replace fuel transfer pump.

(2) Exhaust color white?

No - Go to next step.

Yes - Water in fuel - check and repair.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

Yes - Retarded fuel injection pump timing - check and adjust fuel injection pump timing.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Piston ring, piston or cylinder worn - bore or hone cylinder and replace piston.

Yes - Piston ring end gaps not correct - stagger piston ring gaps.

Yes - Piston rings installed incorrectly - install piston rings correctly.

Yes - Intake/Exhaust valves worn - check valve guides and stems.

Symptom: Low Engine Output

Yes - Improper timing between injection pump, intake and exhaust valves - adjust valve clearance. Check valve timing.

Yes - Wrong type of fuel - drain and replace fuel.

(3) Exhaust color black?

Yes - Clogged air filter - clean or replace air filter.

Yes - Water pump/alternator belt loose - adjust fan belt tension.

Yes - Engine running too hot - check thermostat, fan belt tension.

Yes - Improper timing between injection pump, intake and exhaust valves - adjust valve clearance. Check valve timing.

Yes - Coolant level low - check cooling system for level/leaks.

Yes - Malfunctioning thermostat - check or replace thermostat.

Yes - Engine at high altitude/temperature - use higher output engine.

Yes - Clogged exhaust pipe - clean exhaust pipe.

Yes - Retarded fuel injection pump timing - check and adjust fuel injection pump timing.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

Yes - Compression leakage from valve seat - grind valve seat; regrind valves.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Wrong type of fuel - drain and replace fuel.

Symptom: Exhaust Problems

(1) Exhaust color white under load?

No - Go to next step.

Yes - Water in fuel - check and repair.

Yes - Engine running too cool - check thermostat.

Yes - Wrong type of fuel - drain and replace fuel.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Yes - Improper timing between injection pump, intake and exhaust valves - adjust valve clearance. Check valve timing.

Yes - Retarded fuel injection pump timing - check and adjust fuel injection pump timing.

Yes - Advanced fuel injection pump timing - check and adjust fuel injection pump timing.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Piston ring, piston or cylinder worn - bore or hone cylinder and replace piston.

Yes - Piston rings installed incorrectly - install piston rings correctly.

(2) Exhaust color black under load?

Yes - Engine at high altitude/temperature - use higher output engine.

Yes - Clogged air filter - clean or replace air filter.

Yes - Wrong type of fuel - drain and replace fuel.

Yes - Clogged exhaust pipe - clean exhaust pipe.

Yes - Excessive volume of fuel injected - check fuel injector pump and injectors.

Yes - Advanced fuel injection pump timing - check and adjust fuel injection pump timing.

Yes - Retarded fuel injection pump timing - check and adjust fuel injection pump timing.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Yes - Improper timing between injection pump, intake and exhaust valves - adjust valve clearance. Check valve timing.

Symptom: Exhaust Problems

Yes - Compression leakage from valve seat - grind valve seat; regrind valves.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Symptom: Engine Runs Rough

(1) Loud knocking noise during combustion?

No - Go to next step.

Yes - Advanced fuel injection pump timing - check and adjust fuel injection pump timing.

(2) Misfiring

No - Go to next step.

Yes - Improper timing between injection pump, intake and exhaust valves - adjust valve clearance. Check valve timing.

Yes - Improper intake or exhaust valve clearance - adjust valve clearance.

Yes - Compression leakage from valve seat - grind valve seat; regrind valves.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Crankshaft pin or bearing seized - regrind crank and replace bearings.

Yes - Crankshaft pin or bearing worn - regrind crank and replace bearings.

Yes - Connecting rod bolt loose - check for damage and re-torque bolts.

Yes - Foreign matter in combustion chamber - remove head and inspect for damage.

Yes - Excessive timing gear backlash - measure timing gear backlash.

(3) Uneven combustion sound?

No - Go to next step.

Yes - Clogged air filter - clean or replace air filter.

Yes - Clogged exhaust pipe - clean exhaust pipe.

Yes - Water in fuel - check and repair.

Yes - Wrong type of fuel - drain and replace fuel.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Symptom: Engine Runs Rough

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

(4) Engine surges during idle?

No - Go to next step.

Yes - Water in fuel - check and repair.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Crankshaft pin or bearing seized - regrind crank and replace bearings.

Yes - Crankshaft pin or bearing worn - regrind crank and replace bearings.

Yes - Governor not functioning properly - repair or replace governor.

(5) Engine surges under load?

No - Go to next step.

Yes - Water in fuel - check and repair.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Yes - Governor not functioning properly - repair or replace governor.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Crankshaft pin or bearing seized - regrind crank and replace bearings.

Yes - Crankshaft pin or bearing worn - regrind crank and replace bearings.

(6) Excessive engine vibration?

No - Go to next step.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

Yes - Uneven volume of fuel injected - check fuel injector pump and injectors.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Symptom: Engine Runs Rough

Yes - Crankshaft pin or bearing seized - regrind crank and replace bearings.

Yes - Crankshaft pin or bearing worn - regrind crank and replace bearings.

Yes - Connecting rod bolt loose - check for damage and re-torque bolts.

Yes - Governor not functioning properly - repair or replace governor.

Yes - Advanced fuel injection pump timing - check and adjust fuel injection pump timing.

(7) Poor return to low speed?

Yes - Governor not functioning properly - repair or replace governor.

Yes - Go through diagnostic procedures and/or go back to steps procedures for “Engine Runs Rough”.

Fuel Consumption

System: Fuel Consumption Excessive

(1) Excessive fuel consumption?

Yes - Compression leakage from valve seat - grind valve seat; regrind valves.

Yes - Engine running too cool - check thermostat.

Yes - Excessive volume of fuel injected - check fuel injector pump and injectors.

Yes - Poor fuel injection pattern - clean or replace fuel injector nozzles.

No - Go through diagnostic procedures.

Lubrication

System: Lubricating Oil

(1) Excessive oil consumption?

No - Go to next step.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Piston ring, piston or cylinder worn - bore or hone cylinder and replace piston.

Yes - Piston ring end gaps not correct - stagger piston ring gaps.

Yes - Piston rings installed incorrectly - install piston rings correctly.

Yes - Foreign matter in combustion chamber - remove head and inspect for damage.

Yes - Intake/Exhaust valves worn - check valve guides and stems.

Yes - Improper engine oil viscosity/type - replace engine oil and filter.

Yes - External/Internal oil leak - repair.

Yes - Excessive volume of fuel injected - check fuel injector pump and injectors.

(2) Fuel in crankcase?

No - Go to next step.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Piston ring, piston or cylinder worn - bore or hone cylinder and replace piston.

(3) Water in crankcase?

No - Go to next step.

Yes - Leaking cylinder head gasket - replace head gasket.

Yes - Cracked water jacket - repair or replace water jacket.

(4) Low oil pressure?

Yes - Oil level low - add oil.

Yes - Oil filter clogged - replace oil filter.

Yes - Improper engine oil viscosity/type - replace engine oil and filter.

Yes - External/Internal oil leak - repair.

System: Lubricating Oil

Yes - Crankshaft pin or bearing worn - regrind crank and replace bearings.

Yes - Connecting rod bolt loose - check for damage and re-torque bolts.

Yes - Cracked water jacket - repair or replace water jacket.

Yes - Oil pressure relief valve worn - clean, adjust or replace relief valve.

Coolant

Symptom: Temperature Problems

(1) Overheating?

No - Go to next step.

Yes - Leaking cylinder head gasket - replace head gasket.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Engine running too hot - check thermostat, fan belt tension.

Yes - Coolant level low - check cooling system for level/leaks.

Yes - Cracked water jacket - repair or replace water jacket.

Yes - Malfunctioning thermostat - check or replace thermostat.

Yes - Water pump/alternator belt loose - adjust fan belt tension.

Yes - Excessive volume of fuel injected - check fuel injector pump and injectors.

Yes - Engine at high altitude/temperature - use higher output engine.

(2) Low water temperature?

Yes - Engine running too cool - check thermostat.

Yes - Malfunctioning thermostat - check or replace thermostat.

Compression

Symptom: Overall Compression Problems

(1) Low Compression?

Yes - Oil filter clogged - replace oil filter.

Yes - Improper engine oil viscosity/type - replace engine oil and filter.

Yes - Excessive volume of fuel injected - check fuel injector pump and injectors.

Yes - Compression leakage from valve seat - grind valve seat; regrind valves.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Broken or seized piston ring - replace rings and check cylinder.

Yes - Piston ring, piston or cylinder worn - bore or hone cylinder and replace piston.

Yes - Crankshaft pin or bearing seized - regrind crank and replace bearings.

Yes - Piston ring end gaps not correct - stagger piston ring gaps.

Yes - Piston rings installed incorrectly - install piston rings correctly.

Yes - Foreign matter in combustion chamber - remove head and inspect for damage.

Yes - Intake/Exhaust valves worn - check valve guides and stems.

Symptom: Intake Manifold Pressure Problem

(1) Low pressure?

No - Go to next step.

Yes - Improper intake or exhaust valve clearance - adjust valve clearance.

Yes - Compression leakage from valve seat - grind valve seat; regrind valves.

Yes - Seized intake/exhaust valve - replace valve and check valve guide.

Yes - Clogged air filter - clean or replace air filter.

Yes - Engine at high altitude/temperature - use higher output engine.

(2) High pressure?

Yes - Excessive volume of fuel injected - check fuel injector pump and injectors.

Diagnostic Table

Test Conditions:

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

Test/Check Point	Normal Condition	If Not Normal
Engine dipstick and exterior engine surface	Oil level between “L” and “H” marks. Oil not burnt, or contaminated with metal particles, fuel, or coolant. No external leakage, filter clean.	Change oil and inspect for source of contamination. Check gaskets, seals, plugs, cylinder head, block, and intake manifold and breather. Change oil filter.
Coolant tank and radiator	Coolant level between marks on tank when engine is warm. Coolant in radiator full to top. Coolant not contaminated with oil, fuel or discolored brown.	Add proper coolant mix. Drain and flush system. Check for source of contamination.
	Radiator screen free of debris.	Clean or replace.
	Hoses not cracked or leaking; clamps and radiator cap tight.	Pressure test radiator and cap.
	Water pump/alternator belt tight; not glazed or cracked.	Replace and adjust belt tension.
	Fan blades not damaged or warped.	Replace fan.
Fuel tank, pump, lines, filter, filter shutoff valve	Fuel level correct, not contaminated; correct grade of fuel; no water or debris in filter bowl/ water separator. Filter shutoff valve in “on” position.	Drain and clean fuel tank. Add fresh fuel. Replace filters. Move to “on” position.
	Fuel hoses not cracked or leaking.	Replace.
	Fuel hose clamps tight.	Replace or tighten.
	Fuel tank does not have vacuum.	Replace fuel tank vent hose.
Air filter and air intake	Air filter outlet hose not cracked; clamps tight. Elements not plugged. Air filter housing sealed; no dirt tracking inside filter element. Air filter restriction indicator not leaking	Replace hose and/or tighten clamps. Replace element or housing. Replace indicator.
Fuel shutoff solenoid (Key in “start” position	Fuel shutoff solenoid must pull in and stay in when key is returned to “on”. Listen for clicking as key is cycled.	If solenoid will not pull in and hold in, see “Fuel Shutoff Solenoid Circuit Operation - Diesel Engine” on page 439 in Electrical section.

Test/Check Point	Normal Condition	If Not Normal
Fuel filter/water separator	Fuel level visible in filter bowl. Fuel bowl not full of water. Fuel present at injector pump inlet hose.	Drain water from bowl. Replace fuel filter. Recheck. Test fuel pump.
Hand throttle control lever and cable.	Full movement of governor control arm from idle to full speed.	Repair; replace or adjust cable.
Intake and exhaust valves	Valve clearance within specification (engine cold). Valves not sticking.	Adjust valves. (See “Valve Clearance Adjustment” on page 230.) Check valve guides and stems.
Fuel is reaching injectors	Crack fuel injection lines at injectors. Crank engine. (Be sure fuel shutoff solenoid has pulled in.) Fuel leaks out.	No fuel present: Check fuel shutoff valve is open, fuel level in tank, inspect filter/separator element. Test fuel pump.
Injectors are working properly	Injector spray pattern is normal and cracking pressure is within specifications.	Check spray pattern and cracking pressure. (See “Fuel Injection Nozzle Test” on page 236.) Replace injectors.
Perform cylinder compression test at fuel injector ports	Cylinder compression within specification. Pressure difference between cylinders within specification.	Rebuild engine.
Flywheel and starting motor	Minimum cranking rpm within specification.	See “Starting Motor Loaded Amperage Draw Test” on page 470 or “Starting Motor No-Load Amperage Draw and RPM Test” on page 471 in Electrical section.
Fuel injection pump static timing test	Timing should be correct. (Remove pump as the LAST possible solution.)	Have injection pump static timing adjustment performed by a qualified service repair shop. See “Injection Pump Timing Adjustment” on page 230.
Injection pump slow idle speed (engine running)	Engine runs at **1500 ± 50 rpm**.	See “Slow Idle Adjustment” on page 229.
Injection pump fast idle speed (engine running)	Engine runs at **3200 ± 50 rpm**.	Have fast idle speed adjusted by a certified CARB/EPA service center.
Governor	Engine runs smoothly throughout rpm range with low smoke and good power.	Have governor torque capsule checked/replaced by a certified CARB/EPA service center.
Oil pressure sender port	Oil pressure to specification. See “Oil Pressure Test” on page 239.	See “Oil Pump Disassembly/ Assembly:” on page 270.
Thermostat	Opening temperature within specification.	Perform thermostat opening test. (See “Thermostat Opening Test” on page 237.)
Muffler	Not restricted.	Replace muffler.

Tests and Adjustments

Fan and Alternator Drive Belt Adjustment

Reason:

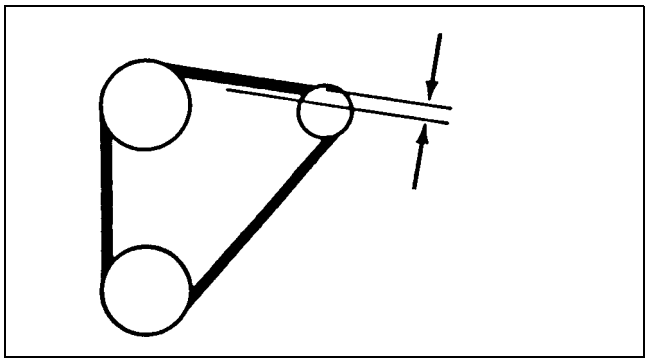
To keep proper tension on the belt to drive the water pump and the alternator. To prevent shortened belt and bearing life.

Equipment:

- JDG529 or JDST28 Belt Tension Gauge
- Straight Edge

Procedure:

1. Park machine safely.
2. Remove engine cover.
3. Disconnect battery negative (-) cable.
4. Check the belt tension between the fan and alternator using a belt tension gauge and a straight edge.



M54014

5. With applied force of **98 N (22 lb-force)** the belt deflection is **10 - 15 mm (0.4 - 0.6 in.)**.

Results:

- If deflection is not within specifications, loosen both alternator mounting cap screws/nuts. Apply force to front alternator housing only (near the belt) until tension is correct. Tighten cap screws/nuts.

Cylinder Compression Test

Reason:

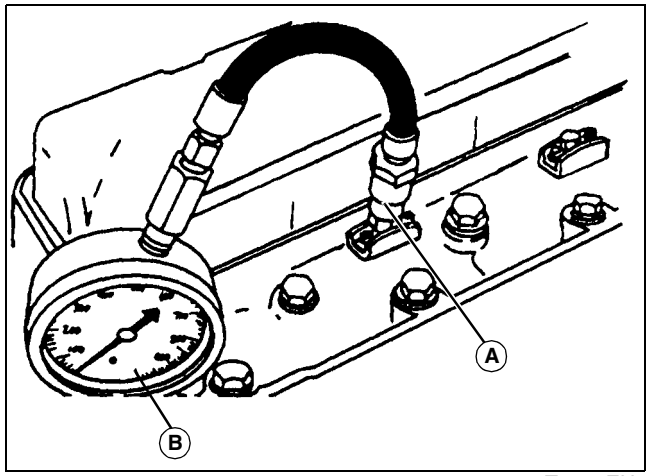
To determine the condition of the pistons, rings, cylinder walls and valves.

Equipment:

- JT01682 Compression Gauge Assembly
- JDG560 Adapter

Procedure:

1. Remove the injection nozzles.



T6333EU

2. Install the heat protector from end of injector and install JDG560 adapter (A).
3. Install JT01682 Compression Gauge Assembly (B) and JDG560 Adapter.
4. Disconnect the fuel control solenoid connector.

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

5. Crank the engine for five seconds with the starting motor. Minimum cranking speed is 250 rpm.
6. Record the pressure reading for each cylinder.

Specifications:

Cylinder Compression Pressure . . . 3530 kPa (512 psi)

(Minimum) . . . . . 3334 kPa (483 psi)

Difference Between Cylinders
(Maximum) . . . . . 294 kPa (42 psi)

Results:

- If the pressure reading is below specification, perform “Radiator Bubble Test” to help determine the cause of compression loss.

Slow Idle Adjustment

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

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

Reason:

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

Equipment:

- JT05719 Hand Held Digital Tachometer

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

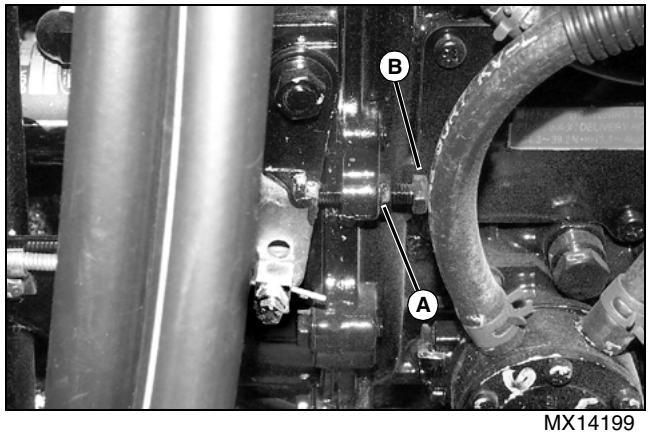
Procedure:

1. Place a small piece of reflective tape on the crankshaft pulley.
2. Start the engine and run for 5 minutes to attain operating temperature.
3. Move the throttle lever to slow idle position.
4. Use JT05719 Hand Held Digital Tachometer to check engine speed at the crankshaft pulley.
5. Visually check that the injection pump throttle lever is against slow idle stop screw. If not, adjust throttle cable. (See “Throttle Cable Adjustment “ below.)
6. Check if slow idle speed is set to specification.

Specification:

Slow Idle . . . . . 1500 ± 50 rpm

Results:



MX14199

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

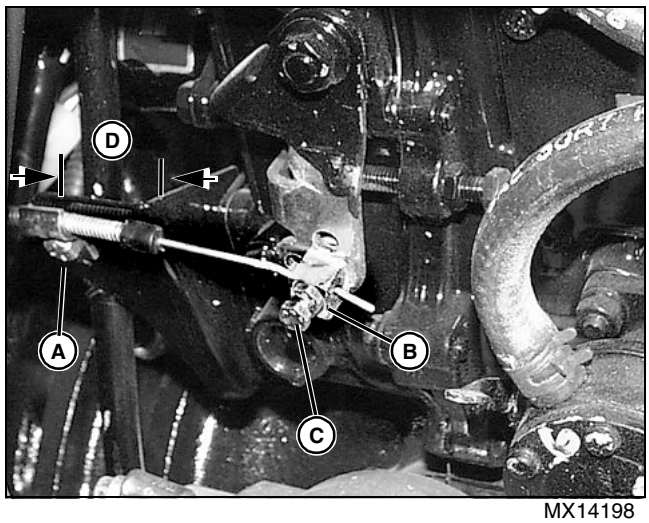
Throttle Cable Adjustment

Reason:

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

Procedure:

1. Park machine on level surface with key switch off, transmission in neutral, and park brake locked.
2. Remove engine cover.



MX14198

3. Place throttle control in slow idle position.

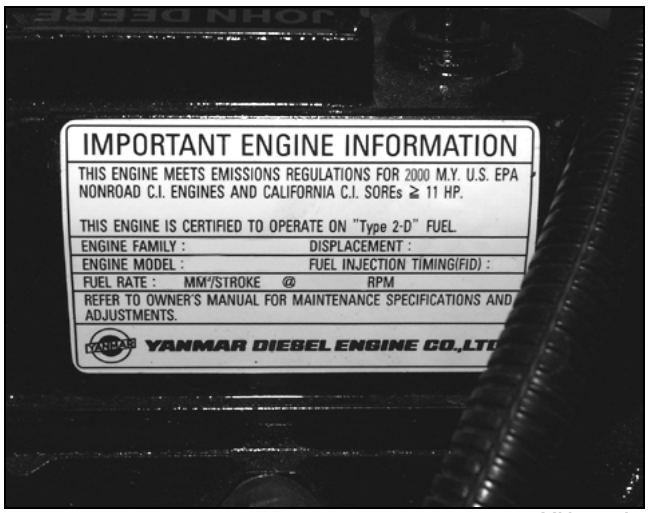
4. Cable housing should be approximately **13.0 - 19.0 mm (0.50 - 0.75 in.)** (D) from edge of clamp to end of cable housing. If necessary, loosen clamp cap screw (A) and move cable housing to specification. Retighten clamp bolt.

5. Loosen jam nut (B), and cap screw (C).

6. With throttle control at slow idle position, and injection pump lever fully seated against slow idle stop, tighten cap screw and jam nut.

7. Move throttle control to fast idle position, making sure injection pump lever is fully seated against fast idle stop.

Injection Pump Timing Adjustment



MX1339A

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

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

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

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

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

Valve Clearance Adjustment

Reason:

To be sure the valves are fully opening and closing at the correct time, and not wearing the valve train unnecessarily.

Equipment:

- Feeler Gauge
- 10 mm End Wrench
- Flat Blade Screwdriver
- 17 mm Wrench

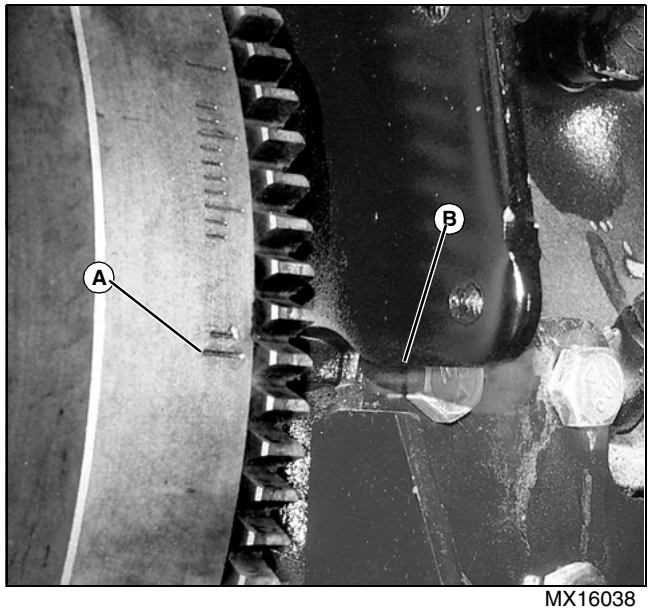
Procedure:

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

2. Be sure ignition key is off before attempting to turn engine by hand.

3. Remove the engine cover.

4. Remove the rocker arm cover. (See “Rocker Arm Cover Removal and Installation” on page 244.)



MX16038

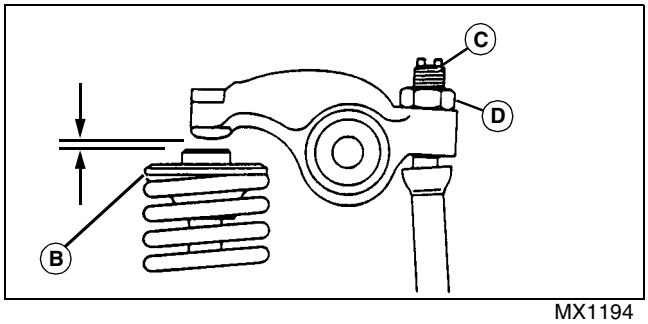
5. Turn the crankshaft in the direction of engine rotation (counterclockwise). Align number one TDC mark on the flywheel (A) with bottom edge of engine back plate (B).

NOTE: "Top dead center (TDC)" is when the piston is at its' highest point of travel in the cylinder on the compression stroke.
Number one cylinder is cylinder closest to flywheel.

When top dead center is reached, the rocker arms for that cylinder will be motionless as the crankshaft if rotated. If rocker arms are still moving when TDC mark is approached, engine is on exhaust stroke. Rotate crankshaft one full revolution and try again.

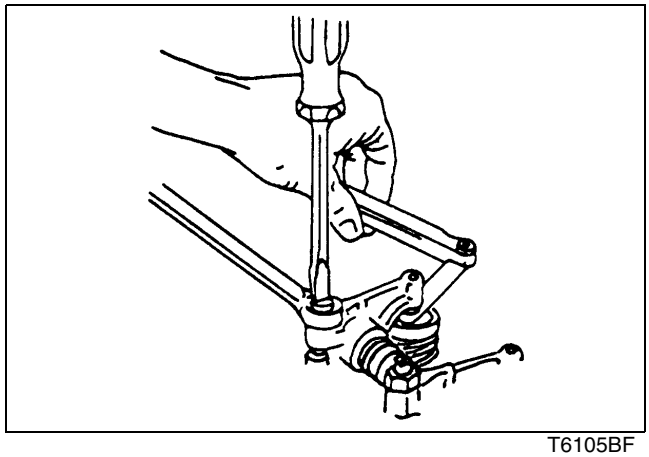
6. Try to move rocker arms and/or push rods for No. 1 cylinder:

- If the rocker arms and push rods are loose, the piston is at TDC on the compression stroke. Go to step 7.
- If the rocker arms and push rods are not loose, rotate the flywheel one revolution (360°), and recheck the rocker arms and push rods.



MX1194

7. Slide a feeler gauge between the valve cap (B) and rocker arm to measure the clearance.

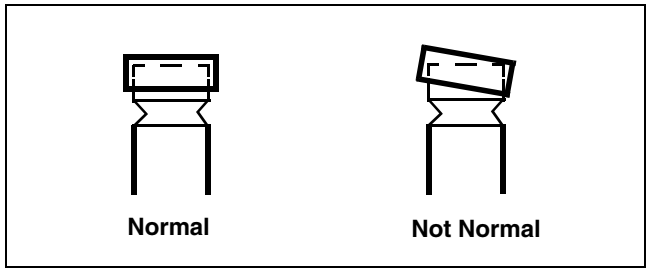

T6105BF

8. To adjust the valves, loosen the lock nut (D) and turn the adjusting screw (C) until the blade of the feeler gauge can be inserted between the rocker arm and valve cap. Hold the adjusting screw while tightening the lock nut.

9. Recheck the valve clearance after tightening the lock nut.

Specification:

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



MIF

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

11. Repeat steps 5 - 10 for number two and three cylinders using the appropriate cylinder number timing mark on the flywheel.

12. Reinstall the rocker arm cover, air cleaner bracket and housing.

13. Replace the engine cover.

Connecting Rod Side Play Check

Reason:

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

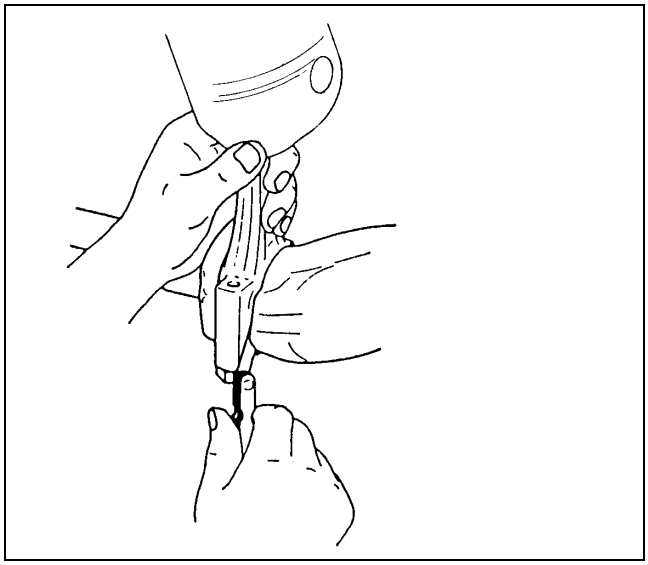
Equipment:

- Feeler Gauge

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

Procedure:

1. Remove the oil pan, crankcase extension, oil pick-up, and balancer assembly.
2. Insert a feeler gauge, according to specifications, between the connecting rod cap and the crankshaft.



M82116A

3. Connecting rod side play is **0.2 - 0.4 mm (0.008 - 0.016 in.)**.

Results:

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

Connecting Rod Bearing Clearance Check

Reason:

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

Equipment:

- PLASTIGAGE®

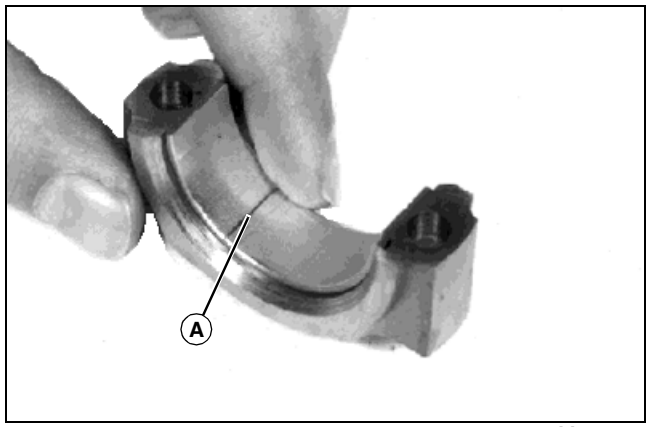
NOTE: The engine must be removed from the machine to perform this procedure.

Procedure:

1. Remove the oil pan, and oil pickup.

IMPORTANT: Avoid damage! The connecting rod caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

2. Remove the connecting rod cap.
3. Wipe oil from the bearing insert and the crankshaft journal.
4. Put a piece of PLASTIGAGE® (A), or an equivalent, along the full length of the bearing insert approximately **6 mm (0.25 in.)** off center.



M35351

5. Turn the crankshaft approximately 30° from bottom dead center.
6. Install the connecting rod end cap and original rod bolts. Tighten the rod bolts to specification.

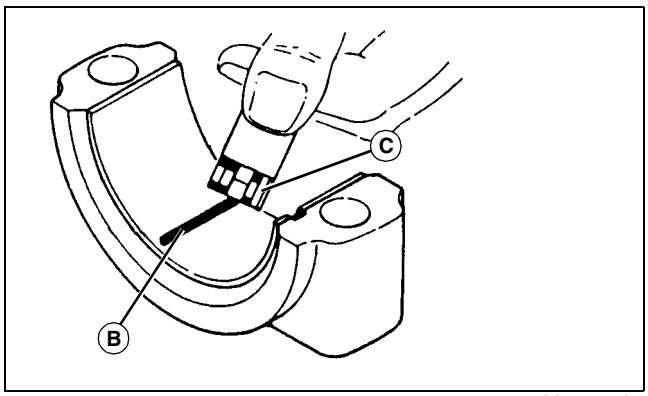
Specifications:

Connecting Rod
Bolt Torque: . . . . . 44 - 54 N•m (33 - 40 lb-ft)

7. Remove the rod bolts and the connecting rod cap.

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

8. Use the graduation marks on the envelope (C) to compare the width of the flattened PLASTIGAGE at its widest point. The number within the graduation marks indicates the bearing clearance in inches or millimeters depending on which side of the envelope is used.



M82117A

9. Measure the connecting rod bearing oil clearance.

Specification:

Connecting Rod Bearing
Oil Clearance: . . . . . 0.04 - 0.07 mm (0.002 - 0.003 in.)

Wear Limit . . . . . 0.16 mm (0.006 in.)

Results:

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

Crankshaft End Play Check

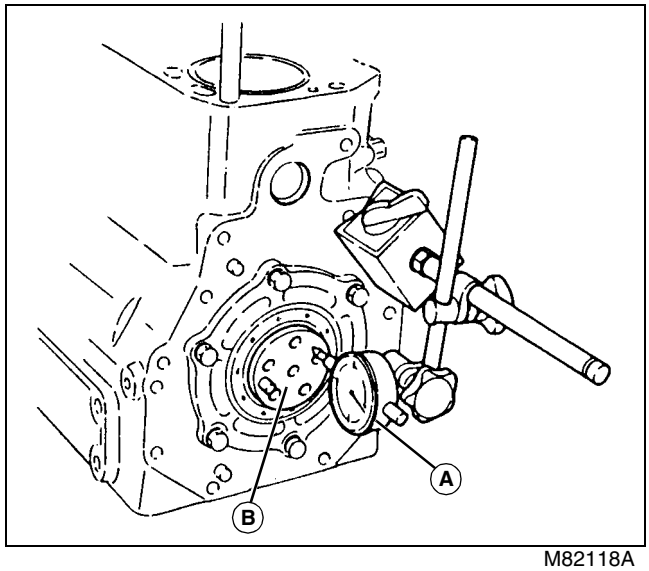
Reason:

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

Equipment:

- Dial Indicator

Procedure:



M82118A

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

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

2. Push the crankshaft toward rear as far as possible.
3. Zero the dial indicator.
4. Using a bar, gently pry the crankshaft as far forward as possible.
5. Crank shaft end play is **0.09 - 0.27 mm (0.004 - 0.011 in.)**.

Results:

- If the end play exceeds **0.27 mm (0.011 in.)**, replace the thrust bearings.

Crankshaft Main Bearing Clearance Check

Reason:

To measure oil clearance between main bearing and crankshaft journal.

Equipment:

- PLASTIGAGE®

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

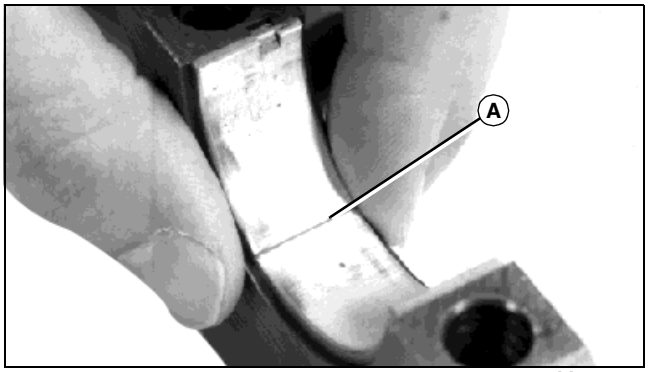
Procedure:

1. Remove the oil pan, and oil pickup.

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

2. Remove the main bearing cap.

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



M35382

4. Put a piece of PLASTIGAGE® (A), or an equivalent, along the full length of the bearing insert approximately **6 mm (0.25 in.)** off center.

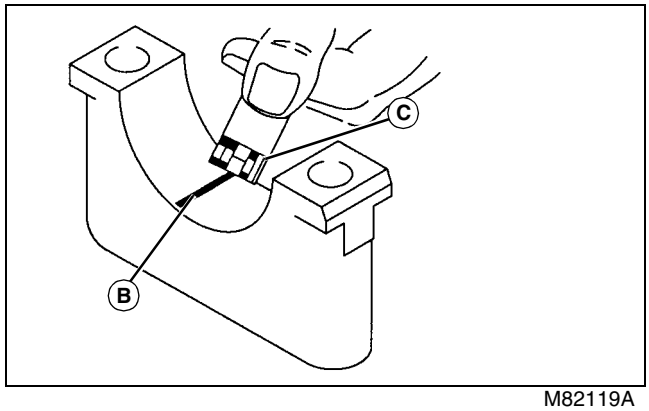
5. Install the main bearing cap and bolts. Tighten the bolts to specification.

Specification:

Main Bearing
Bolt Torque:. . . . . 96 - 100 N•m (71 - 74 lb-ft)

6. Remove the bolts and main bearing caps.

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



M82119A

7. Use the graduation marks (C) on the envelope to compare the width of the flattened PLASTIGAGE® at its widest point. The number within the graduation marks indicates the bearing clearance in inches or millimeters, depending on which side of the envelope is used.

Specification:

Main Bearing
Oil Clearance:. . . . . 0.04 - 0.07 mm (0.002 - 0.003 in.)
Wear Limit. . . . . 0.16 mm (0.006 in.)

Results:

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

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Valve Lift Check

Reason:

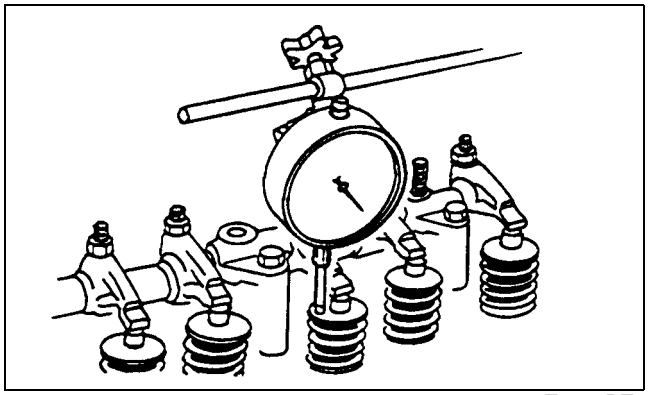
Check wear on cam lobes, followers, and/or push rods.

Equipment:

- Dial Indicator

Procedure:

1. Remove the rocker arm cover. (See “Rocker Arm Cover Removal and Installation” on page 244.)
2. Adjust the valve clearance.



T6333DT

3. Fasten the dial indicator to the engine and position the indicator tip on the valve retainer. The valve must be fully closed and the rocker arm must move freely.
4. Zero the dial indicator.
5. Manually turn the crankshaft pulley clockwise (from the fan end).
6. Observe the dial indicator as the valve is moved to the full open position. Repeat for each valve.

Results:

- The valve lift should be the same for all valves. If one or more valves have less travel than the others, remove and inspect the camshaft, followers and push rods. See “Camshaft” on page 264. Replace any worn or damaged parts.

Camshaft End Play Check

Reason:

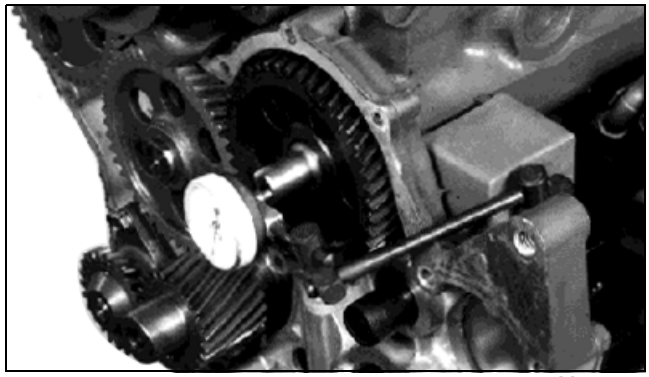
To determine proper side clearance between camshaft gear end journal and thrust plate.

Equipment:

- Dial Indicator

Procedure:

1. Remove the timing gear cover. (See “Timing Gear Cover” on page 268.)
2. Fasten the dial indicator to the engine and position indicator tip on end of camshaft.
3. Push the camshaft toward the rear as far as possible.
4. Zero the dial indicator.
5. Pull the camshaft forward as far as possible.



M37512

6. Standard end play is **0.05 - 0.25 mm (0.002 - 0.010 in.)**.

Results:

- If the end play exceeds **0.25 mm (0.010 in.)**, remove the camshaft and replace the thrust plate.

Timing Gear Backlash Check

Reason:

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

Equipment:

- Dial Indicator

Procedure:

1. Measure the backlash between meshing gears.
2. The backlash for all gears except the oil pump gear is **0.07 - 0.15 mm (0.003 - 0.006 in.)**.
3. The backlash for the oil pump gear is **0.11 - 0.19 mm (0.004 - 0.008 in.)**.

Results:

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

Idler Gear, Camshaft Gear, Crankshaft Gear, Oil Pump Gear and/or Idler Gear, Fuel Injection Pump Gear.

Fuel Injection Nozzle Test

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

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

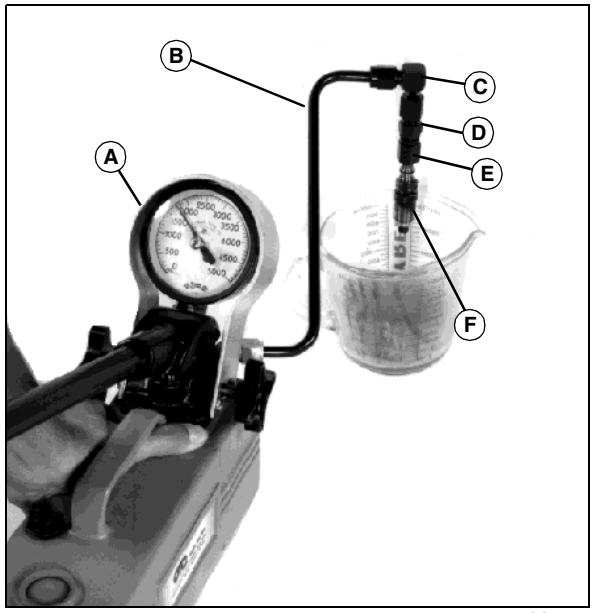
Reason:

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

Equipment:

- D01110AA Adapter Set
- D01109AA Diesel Fuel Injection Nozzle Tester
- 23622 Straight Adapter
- Container

Connections:



M35913

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

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

Procedure 1:

Test the fuel injection nozzle opening pressure following the Nozzle Tester manufacturer's instructions.

The opening pressure is **19600 + 1000/-0 kPa (2843 + 145/-0 psi)**.

Results:

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

Procedure 2:

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

1. Dry the nozzle completely using a lint-free cloth.
2. Pressurize the nozzle to **19600 kPa (2843 psi)**.
3. Watch for leakage from nozzle spray orifice.

Results:

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

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

Procedure 3:

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

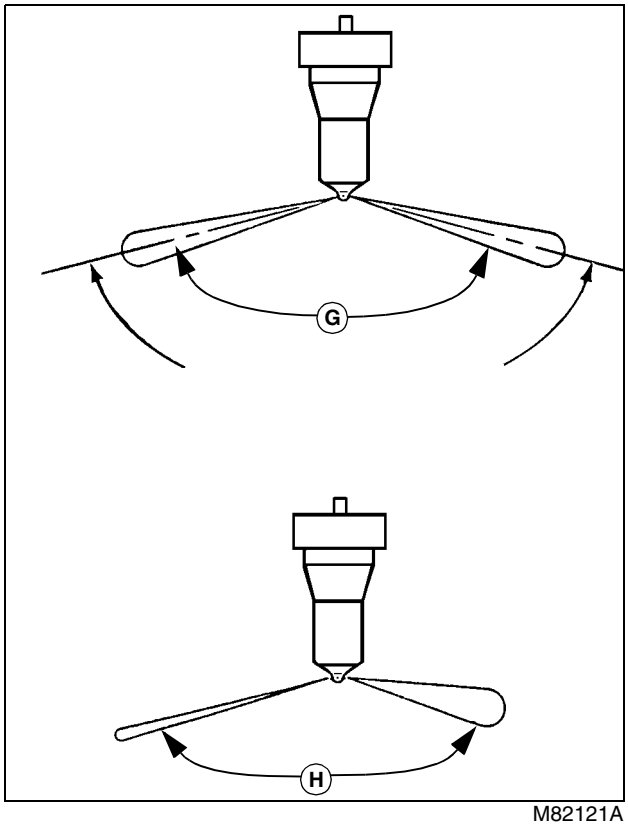
1. Pressurize nozzle to**19600 kPa (2843 psi)**.

2. With slow hand lever movement there should be a “chatter” sound.

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

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

Results:



M82121A

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

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

Thermostat Opening Test

Reason:

To determine opening temperature of thermostat.

Equipment:

• Thermometer

• Glass Container

• Heating Unit

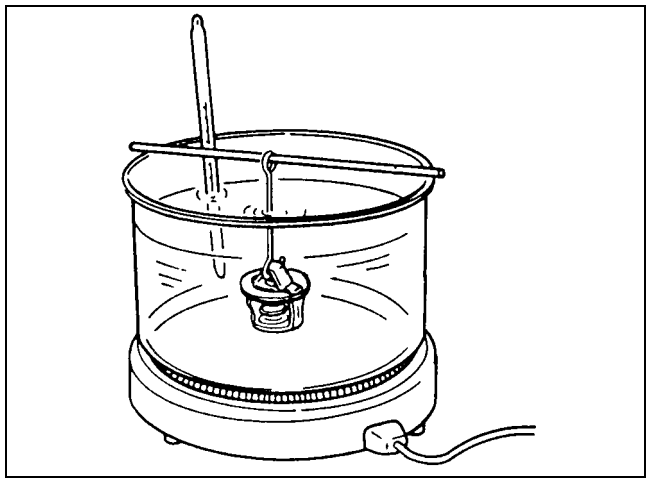
Procedure:

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

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

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

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



M82122A

Results:

• The thermostat should begin opening at **69.5 - 72.5° C (157 - 163° F)** and be fully open at **85° C (185° F)**.

• Replace the thermostat if the fully open lift height is less than **8 mm (0.31 in.)**, or if the closing action is not smooth and slow.

Radiator Bubble Test

Reason:

To determine if compression pressure is leaking from cylinder.

Equipment:

- JDG560 Adapter

Procedure:

1. With the coolant at the proper level and the radiator cap tight, run the engine for 5 minutes to bring it to operating temperature.
2. Remove the cap from the recovery tank.
3. Check for bubbles coming from the overflow hose at the bottom of the tank.
   - If bubbles are present, isolate the source of the compression leak.
4. Remove the injection nozzles.
5. Install JDG560 Adapter in the injection port of the cylinder to be tested.
6. Move the piston to the bottom of the stroke with intake and exhaust valves closed.
7. Connect the hose from a compressed air source to the adapter.
8. Apply shop air pressure into the cylinder.
9. Check for bubbles in the recovery tank or air escaping from the muffler, air cleaner or oil fill opening.
10. Repeat for each cylinder.

Results:

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

Cooling System Pressure Test

Reason:

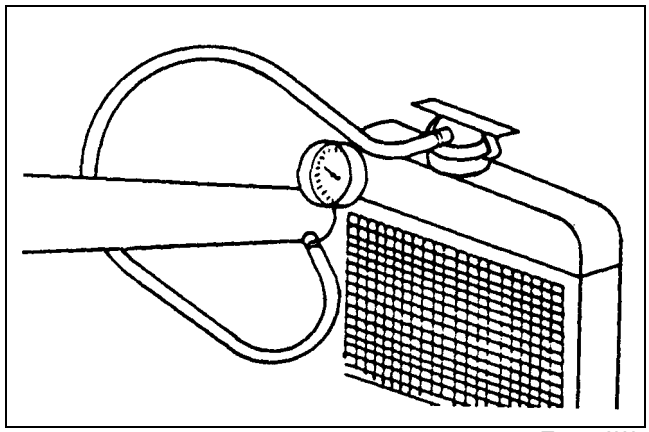
Inspect the cooling system for leaks.

Equipment:

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

Procedure:

1. Remove the cap and attach the pressure pump to radiator.
2. Apply pressure according to specifications, not to exceed **97 kPa (14 psi)**.
3. Check for leaks throughout the cooling system. After 15 seconds the minimum pressure is **88 kPa (12.8 psi)**.



T6333AW

Results:

- Pressure should hold to **88 ± 15 kPa (12.8 ± 2.2 psi)**. If pressure decreases, check for leaks. Repair leaks or replace parts as necessary.
- If the pressure test still indicates leakage after all external leaks have been stopped, a defective head gasket, cracked block, or cylinder head may be the cause. (See “Radiator Bubble Test” on page 238.)

Radiator Pressure Cap Test

Reason:

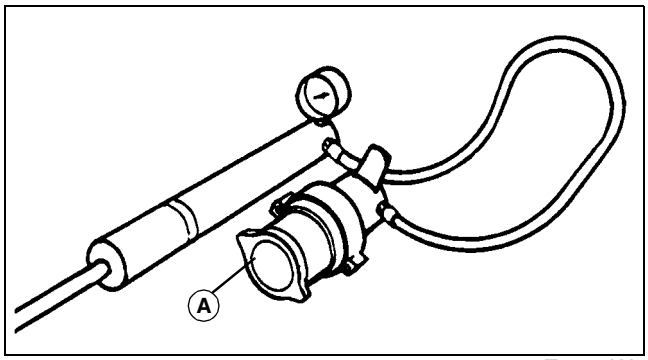
Test the radiator cap for operating in the correct pressure range.

Equipment:

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

Procedure:

1. Install the radiator cap (A) on the pressure pump.
2. Apply pressure. Pressure valve in the cap should open at **88 kPa (12.8 psi)**.



T6333AX

Results:

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

Oil Pressure Test

Reason:

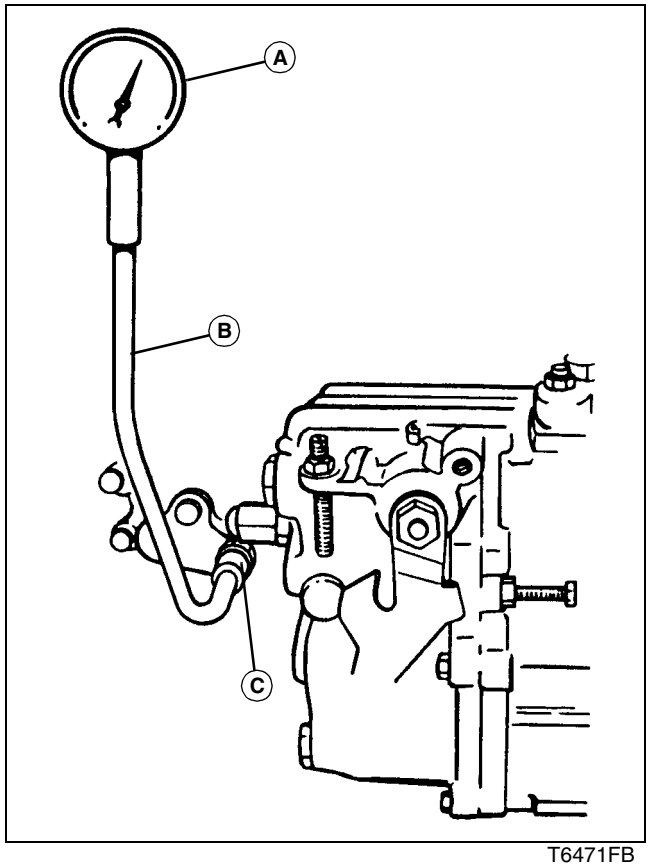
To determine if the engine bearings or the lubrication system components are worn.

Equipment:

- JT03017 Hose Assembly
- JT05577 Pressure Gauge (100 psi)
- JT03349 Connector

Procedure:

1. Remove the oil pressure sender.



T6471FB

2. Install JTO3349 Connector (C).
3. Connect JTO3017 Hose Assembly (B) and JTO5577 Pressure Gauge (A).

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

4. Start the engine. If the pressure reading is below **0.06 MPa (8.7 psi)** at slow idle rpm, stop the engine.
5. If the oil pressure is at least **0.06 MPa (8.7 psi)** run the engine approximately five minutes to heat the oil. Check the oil pressure at full throttle.

Specification:

Oil Pressure . . . . . 0.34 ± 0.05 MPa (49 ± 7.2 psi)

Results:

- If the oil pressure is not within specifications, inspect the oil pump.
- If the oil pump is within specifications, the engine may have parts worn beyond specifications.

Fuel Transfer Pump Tests

Pressure Test

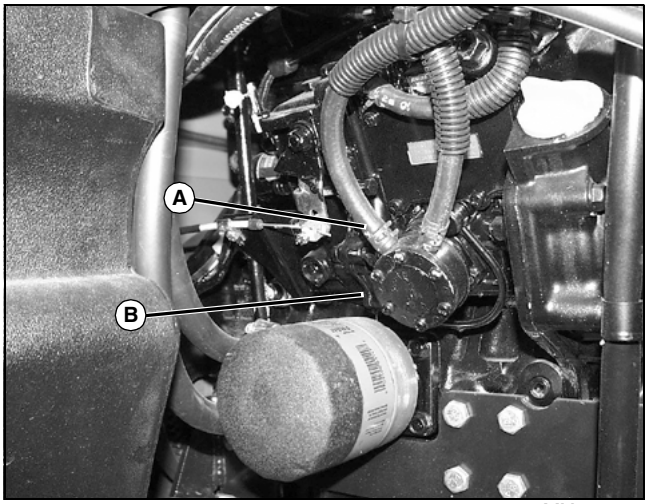
Reason:

To determine fuel transfer pump operating pressure.

Equipment:

- JDG356 Fuel Pump Pressure Test Kit

Procedure:



MX16172

1. Disconnect transfer pump hose (A) from outlet side of transfer pump.
2. Install the hose and gauge to outlet side of transfer pump.
3. Crank or start engine, or operate transfer pump with hand primer lever (B) if equipped.
4. Record fuel pressure reading on gauge.

Results:

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

Specification:

Fuel Pressure (minimum) . . . . . 29 kPa (4.2 psi)

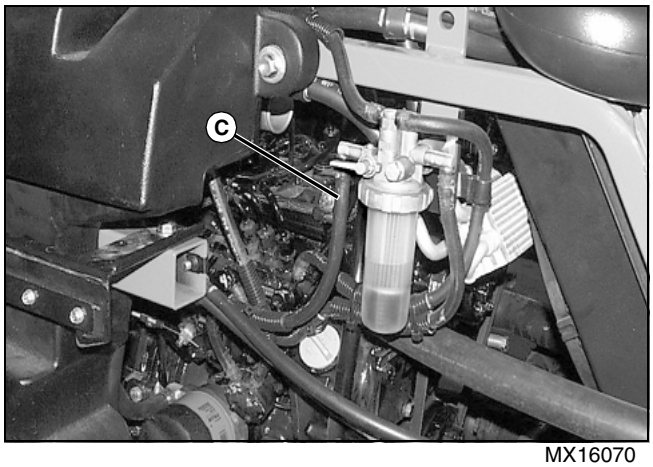
Flow Test

Conditions:

Fuel Temperature For Tests . . . . . 15 - 25°C (59 - 77°F)

Procedure:

1. Disconnect fuel shutoff solenoid wire.



MX16070

2. Turn the fuel shutoff valve to the “off “ position and disconnect fuel transfer pump outlet hose (C) from fuel filter. Place hose in graduated container as key switch is turned to “start” position to crank engine 15 seconds. Compare fuel amount to specification.

Specification:

Fuel Flow 15 sec (minimum). . . . . 50 mL (1.5 oz)

Fuel System Leakage Test

Reason:

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

Procedure:

1. Disconnect the fuel supply line and return line at the fuel tank.

2. Place the fuel return line into a suitable container to catch drained fuel.

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

3. Apply **34 - 69 kPa (5 - 10 psi)** air pressure to fuel supply hose until all fuel is drained from the system.

4. Plug the end of the fuel return hose.

5. Apply **34 - 69 kPa (5 - 10 psi)** air pressure to the fuel system at the fuel supply line. Do not exceed a maximum pressure of **103 kPa (15 psi)**.

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

Results:

- Find leaks and repair or replace parts as necessary.

Bleed Fuel System

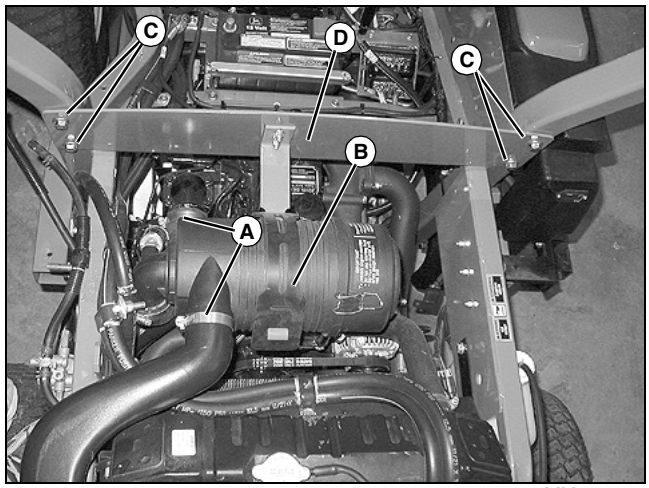
All engines are equipped with an automatic air venting system which makes the fuel system self-bleeding.

- Assure that all fuel line connections are securely tightened.
- Add fuel to the fuel tank.
- Operate the primer lever on the side of the fuel transfer pump for 30 seconds to allow fuel system to bleed itself.

Repair

Engine Removal

1. Raise seat and disconnect negative battery cable.



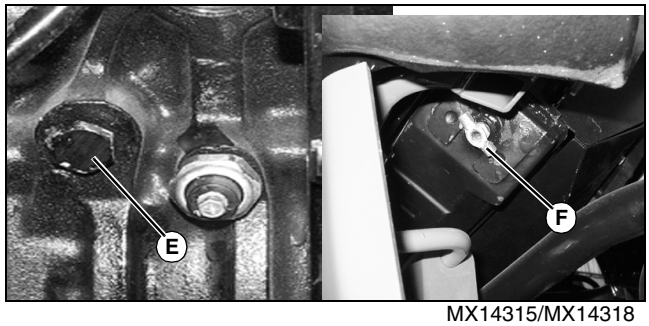
MX14311

2. Remove engine cover.

3. Loosen the clamps (A) at the air cleaner inlet and intake manifold. Remove the air cleaner assembly (B).

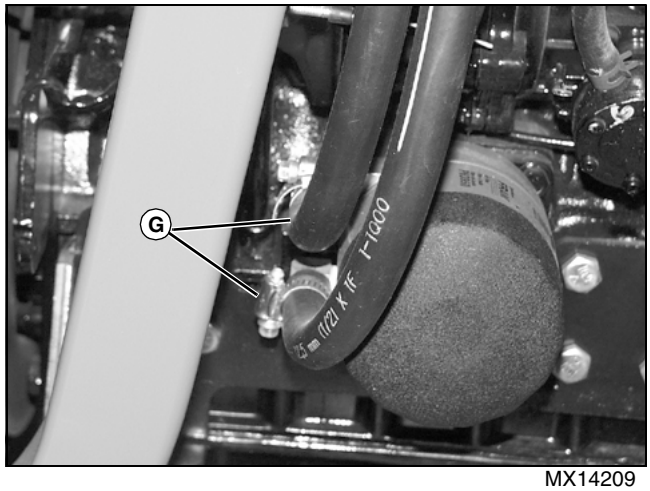
4. Remove the four cap screws (C) and the air cleaner mounting bracket and plate (D).

5. Drain the engine oil.



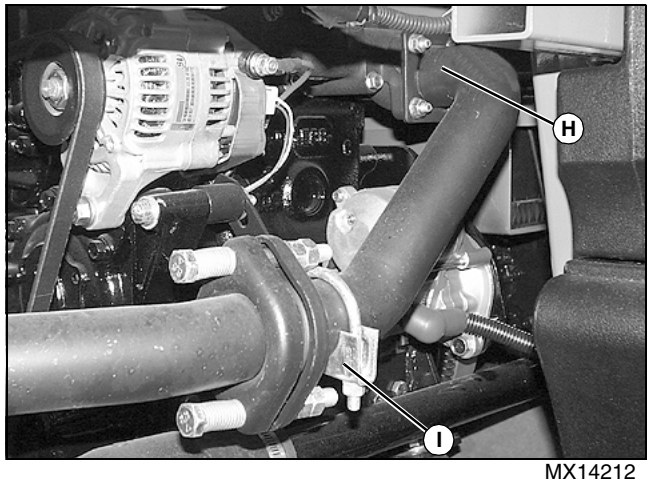
MX14315/MX14318

6. Drain coolant from radiator drain valve (F) on lower left corner of radiator, and engine block drain (E).



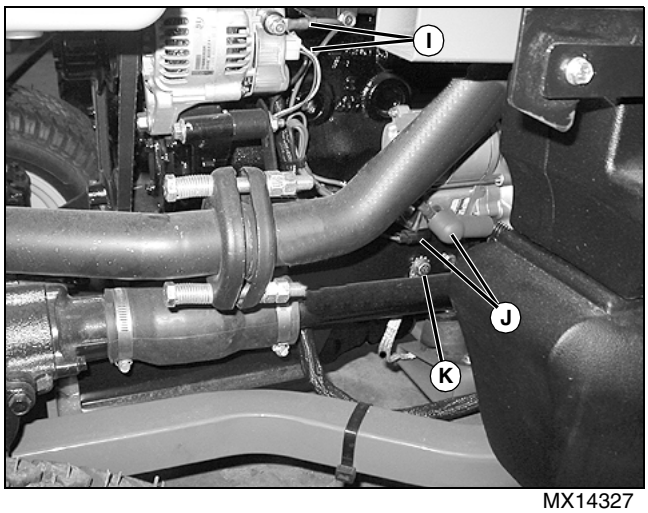
MX14209

7. Disconnect oil cooler lines (G) from engine.



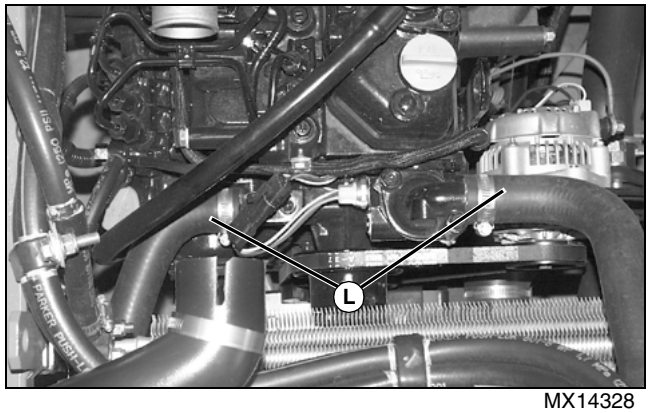
MX14212

8. Remove exhaust support clamp (I). Disconnect exhaust pipe (H) from manifold and pull pipe away from engine.



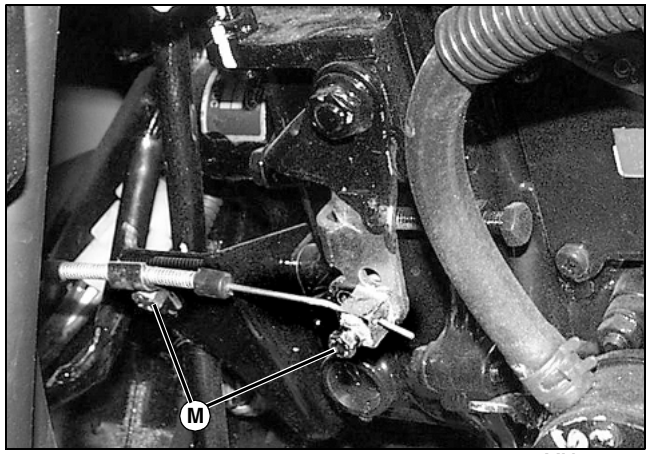
MX14327

9. Disconnect the wires from the alternator (I), and starter (J). Disconnect engine ground strap (K).



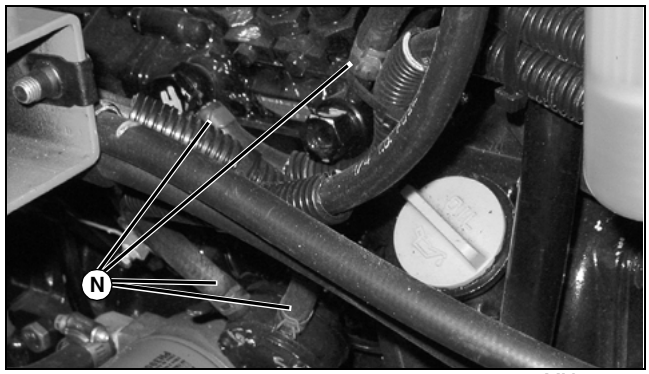
MX14328

10. Disconnect the radiator coolant hoses (L).



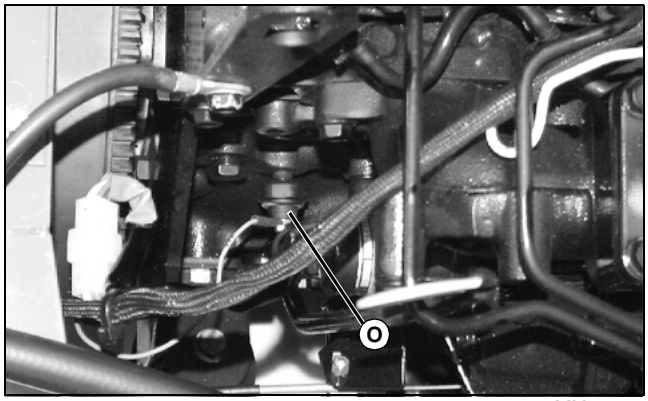
MX14329

11. Disconnect the throttle cable at the injector pump and the cable clamp (M).



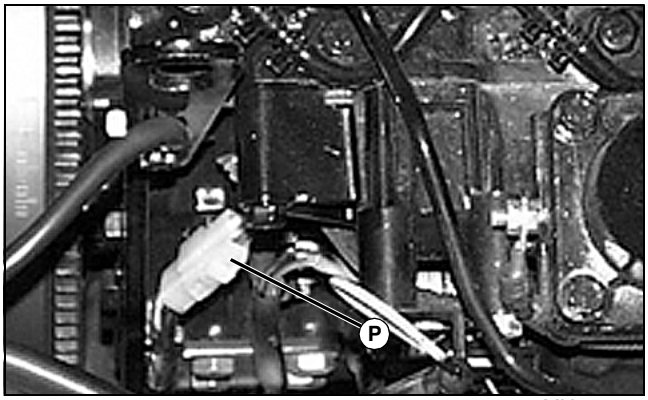
MX14330

12. Label and disconnect the fuel hoses (N).



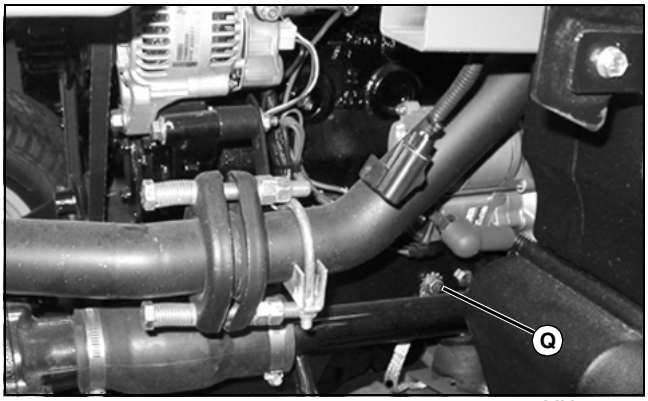
MX5412

13.Disconnect the oil pressure switch (O).



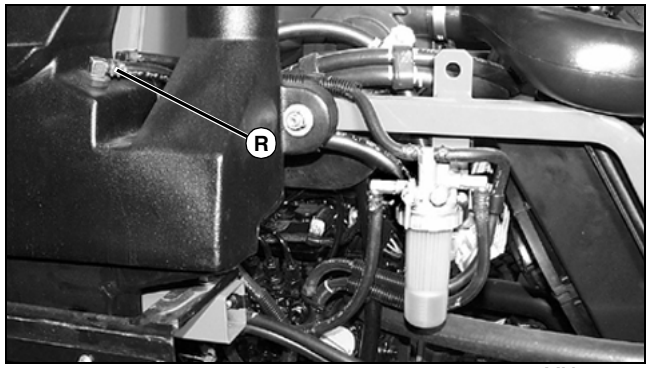
MX14351

14.Disconnect the fuel solenoid (P).



MX14352

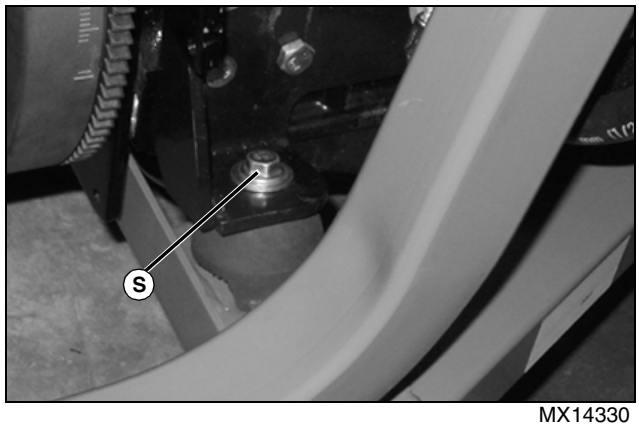
15.Disconnect the intake manifold air heater and engine ground wires (Q) from the engine.



MX14353

16.Label and remove the fuel hoses from the fuel tank.

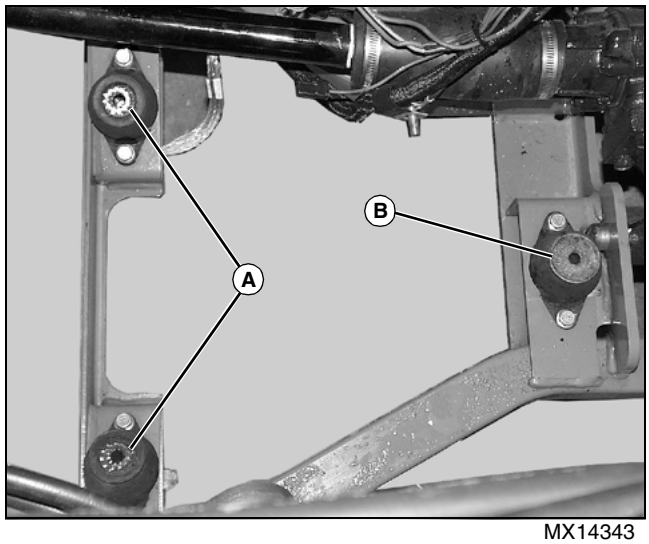
17.Install the engine hoist to the lift brackets.



MX14330

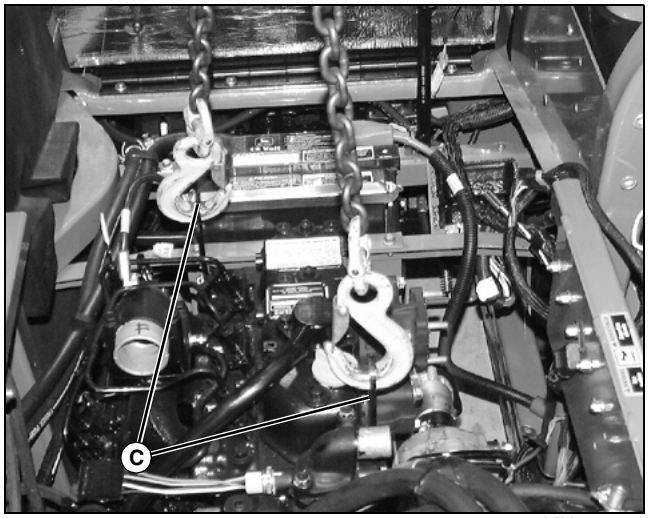
18. Remove the engine mounting cap screws (S). Lift the engine out of the of the machine. Place the engine on a bench or suitable engine stand.

Engine Installation



MX14343

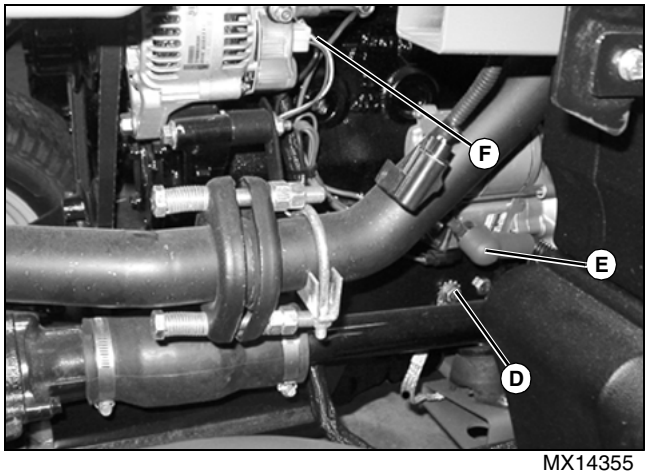
1. Before installing engine make sure star washers (A) are in place on rear engine mounts, and large flat washer (B) is on front engine mount.



MX14343

2. Hook the engine hoist to the lift bracket mounting points (C) and lower the engine into position on the motor mounts.

3. Install the engine mounting cap screws.

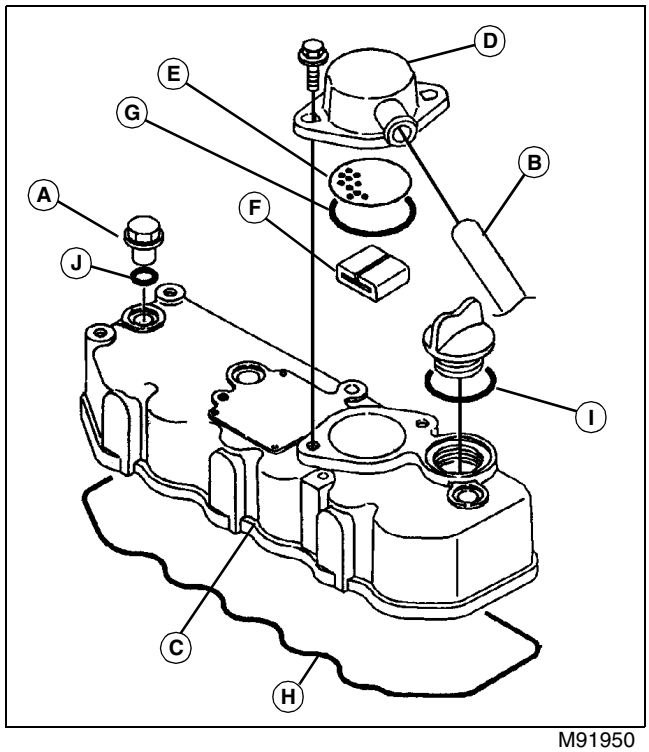


MX14355

4. Install The engine ground strap (D), The starter lead (E) and the engine wiring harness connections at the alternator (F).

Rocker Arm Cover Removal and Installation

Removing:



M91950

1. Remove the air cleaner and muffler.

2. Remove three rocker cover nuts (A).

3. Remove the breather hose (B).

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

5. Remove the breather cap (D), plate (E), and baffle (F).

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

Installing:

1. Install the baffle.

2. Install the breather plate and a new O-Ring (G) before replacing breather cover.

3. Inspect the rocker cover gasket (H), and O-rings (I) and (J) for before reinstalling the rocker arm cover. Replace if damaged.

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

Rocker Arm Assembly

Removal/Installation and Disassembly/Assembly:

1. Remove the rocker cover. (See “Rocker Arm Cover Removal and Installation” on page 244.)

2. Remove the rocker arm end support and rocker arm center support mounting cap screws.

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

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

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

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

6. Inspect the rocker arm components and push rods.

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

8. Lubricate all parts with clean oil during assembly.

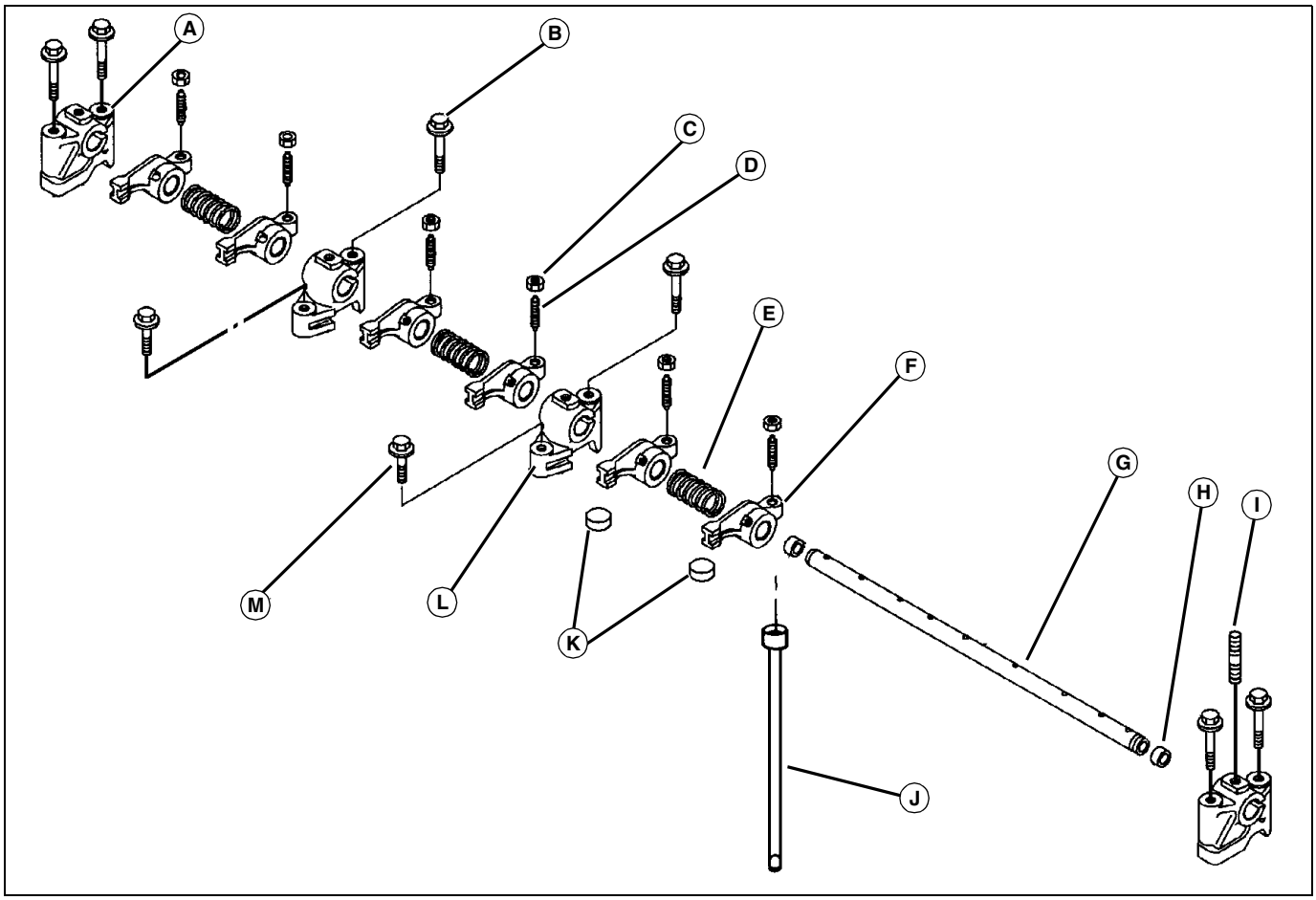
9. Assemble the rocker arm assembly components in the reverse order of removal.

10. Place the rocker arm assembly on the cylinder head.

- Align the rocker arms with the valves and push rods.
- Align the rocker arm end supports and center supports with the corresponding holes in the head.

11. Install the rocker arm support cap screws. Tighten the cap screws to **26 N•m (19 lb-ft)**.

12. Adjust the valve clearance.



M91949B

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

Inspection:

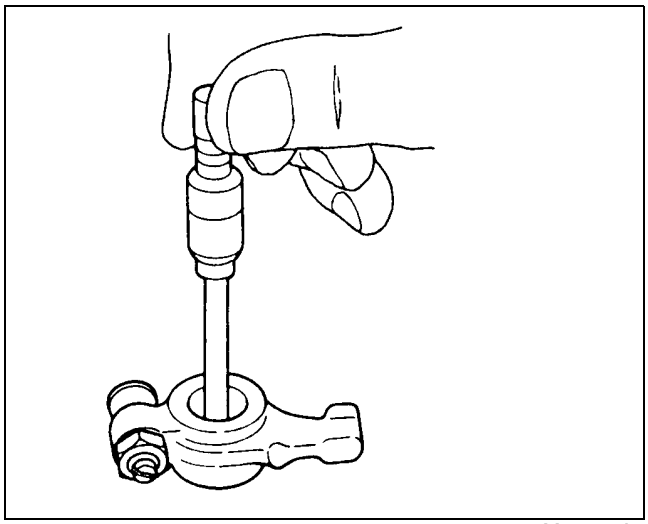


M35262

1. Measure the outer diameter of the rocker arm shaft.

   • Rocker arm shaft OD is **15.97 - 15.98 mm (0.628 - 0.629 in.)**.

   • Replace the rocker arm shaft if the OD is less than **15.95 mm (0.628 in.)**.



M82022A

2. Measure the inner diameters of the rocker arms and supports.

   • Standard ID is **16.00 - 16.02 mm (0.630 - 0.631 in.)**.

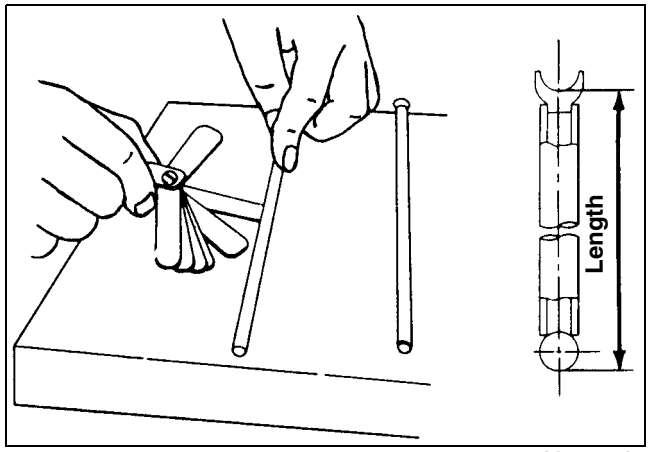
   • Replace the rocker arms or supports if the ID is more than **16.09 mm (0.633 in.)**.

3. Measure the rocker arm shaft to rocker arm bushing oil clearance. Oil clearance is the difference between the OD of the rocker arm shaft and the ID of the rocker arms.

   • Standard oil clearance is **0.02 - 0.05 mm (0.001 - 0.002 in.)**.

   • If the clearance exceeds **0.14 mm (0.006 in.)** replace the rocker arm shaft and rocker arms.

Measure bending of push rod:

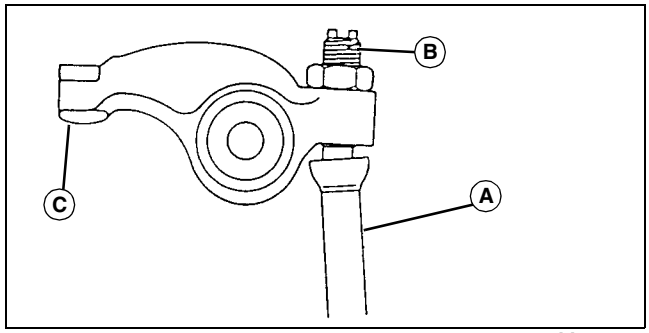


M82023A

1. Place the push rod on a flat surface. Use a feeler gauge to measure any gaps between the push rod and flat surface.

   • Replace any push rod with more than **(0.03 mm (0.001 in.)** bend.

Inspect Rocker Arm Contact Surfaces:



M76398

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

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

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

Cylinder Head and Valves Removal and Installation

Removing:

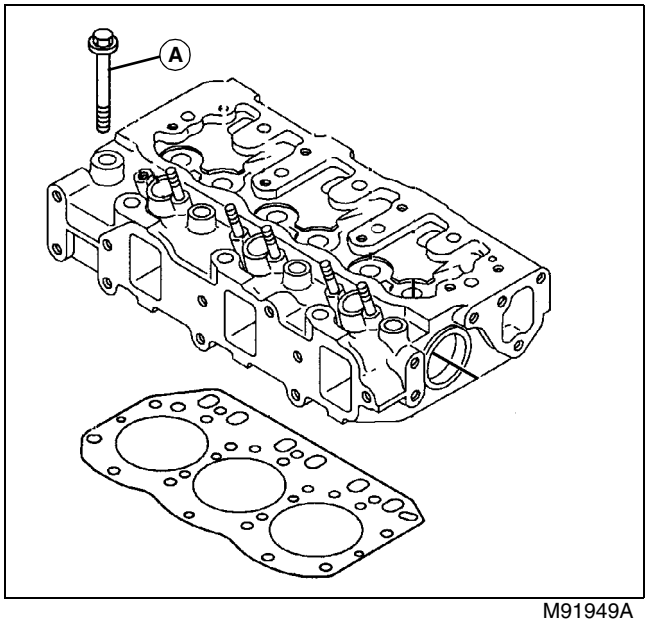
1. Remove the rocker arm cover. (See “Rocker Arm Cover Removal and Installation” on page 244.)

2. Remove the rocker arm assembly, push rods and valve caps. (See “Rocker Arm Assembly” on page 245.)

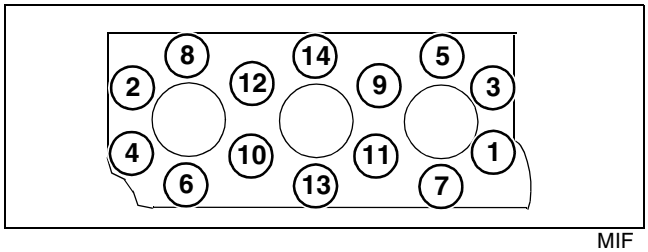
3. Remove the exhaust and intake manifolds. (See “Exhaust Manifold” on page 251.)

4. Remove the water pump. (See “Thermostat and Water Pump” on page 271.)

5. Remove the fuel injection nozzles. (See “Fuel Injection Nozzles” on page 276.)



M91949A



MIF

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

7. Remove the cylinder head from the engine block.

8. Disassemble and inspect the cylinder head and valves. (See “Cylinder Head and Valves Disassembly and Assembly” on page 248.)

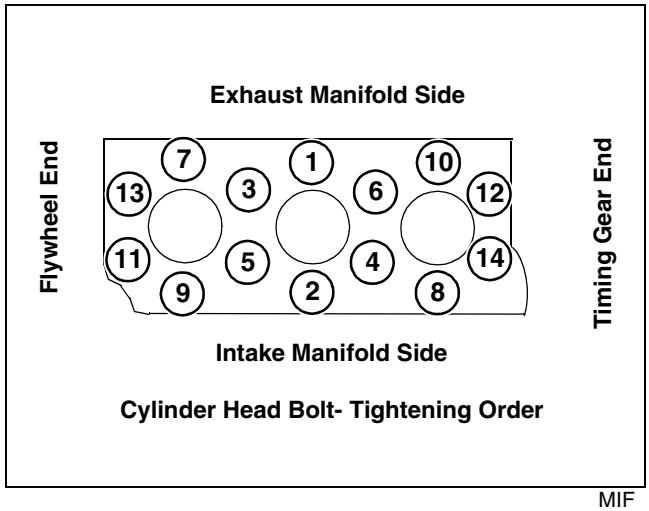
Installing:

1. Reassemble the cylinder head and valves. (See “Cylinder Head and Valves Disassembly and Assembly” on page 248.)

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

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

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



MIF

4. Dip the head bolts in clean engine oil, install and tighten in the sequence shown, in three stages of gradually-increasing torque. Tighten the head bolts to specification.

Specification:

Initial Torque . . . . . 44 N•m (33 lb-ft)

Second Step Torque. . . . . 62 N•m (45 lb-ft)

Final Torque . . . . . 88 N•m (65 lb-ft)

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

5. Install the fuel injection nozzles. (See “Fuel Injection Nozzles” on page 276.)

6. Install the water pump. (See “Thermostat and Water Pump” on page 271.)

7. Install the exhaust and intake manifolds. (See “Exhaust Manifold” on page 251, and “Intake Manifold” on page 251.)

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

Cylinder Head and Valves Disassembly and Assembly

Removing:

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

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

3. The intake and exhaust valve guides are press fit. Replace the guides only if necessary. (See “Valve Guides” on page 250.)

NOTE: The valve seats are not replaceable. If inspection of the cylinder head reveals valve seats that are damaged or worn beyond repair, the cylinder head must be replaced. (See “Valve Seats” on page 249 for inspecting valve seats.)

4. Inspect all remaining parts for wear or damage.

Installing:

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

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

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

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

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

5. Carefully release the tension on the spring compressor.

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

7. Repeat for the remaining valves.

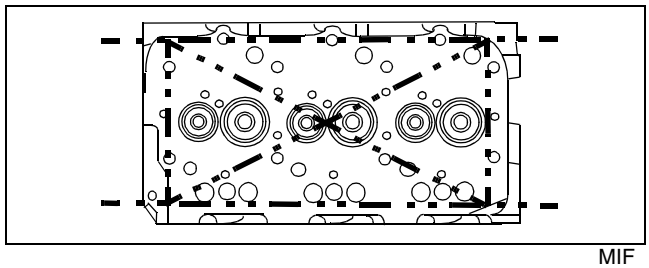
8. Measure valve recession if new valves were installed. (See “Valve Recession” on page 250.)

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

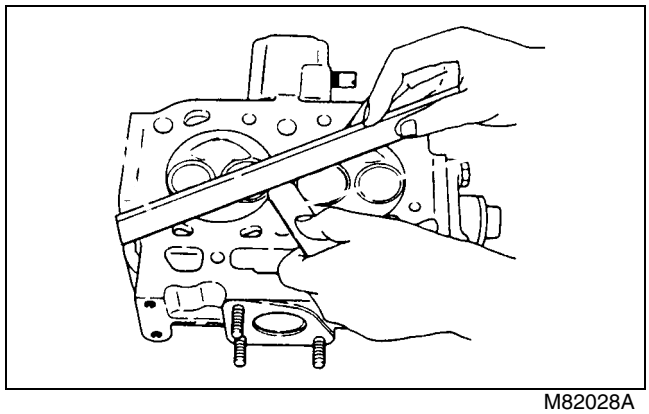
Inspection/Replacement:

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

Cylinder Head:



MIF



M82028A

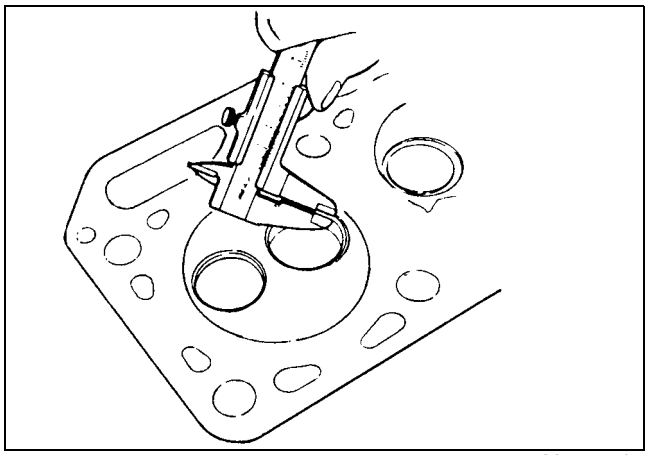
1. To measure the cylinder head flatness, place a straightedge along each of the four sides and each diagonal. Measure clearance between straight edge and combustion surface with a feeler gauge.

   - Standard distortion is **0.05 mm (0.002 in.)** or less.
   - If the distortion exceeds **0.05 mm (0.002 in.)**, but is less than **0.15 mm (0.006 in.)** resurface the cylinder head.
   - If the distortion is **0.15 mm (0.006 in.)** or more, replace the cylinder head.

2. If the cylinder head was resurfaced:

   - Measure piston-to-cylinder head clearance.
   - Measure valve recession. (See “Cylinder Head and Valves Disassembly and Assembly” on page 248.)
   - Measure valve seat width. (See “Valve Seats” on page 249.)

Valve Seats



M82029A

1. Measure the valve seat widths.

Specification:

Valve Seat Width:
. . . . . 1.07 - 1.24 mm (0.042 - 0.049 in.)

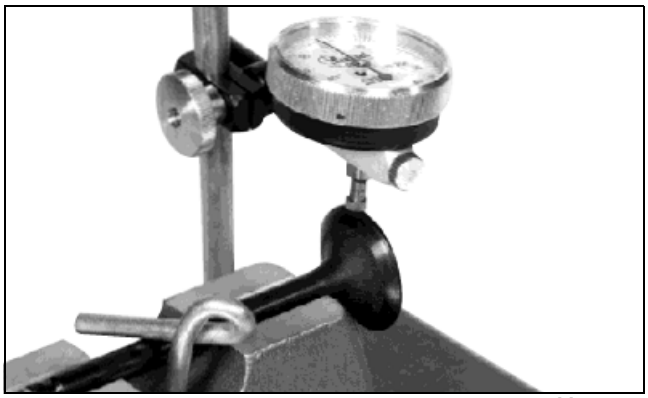
Wear Limit . . . . . 1.74 mm (0.069 in.)

Exhaust Valve Seat Width:
. . . . . 1.24 - 1.45 mm (0.049 - 0.057 in.)

Wear Limit . . . . . 1.94 mm (0.076 in.)

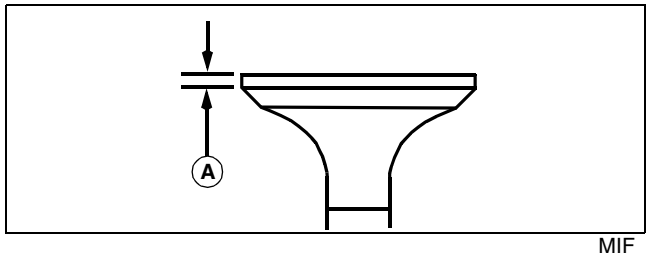
2. If necessary, grind the valve seats to meet specifications. (See “Grind Valve Seats” on page 252.)

Intake and Exhaust Valves:



M35307

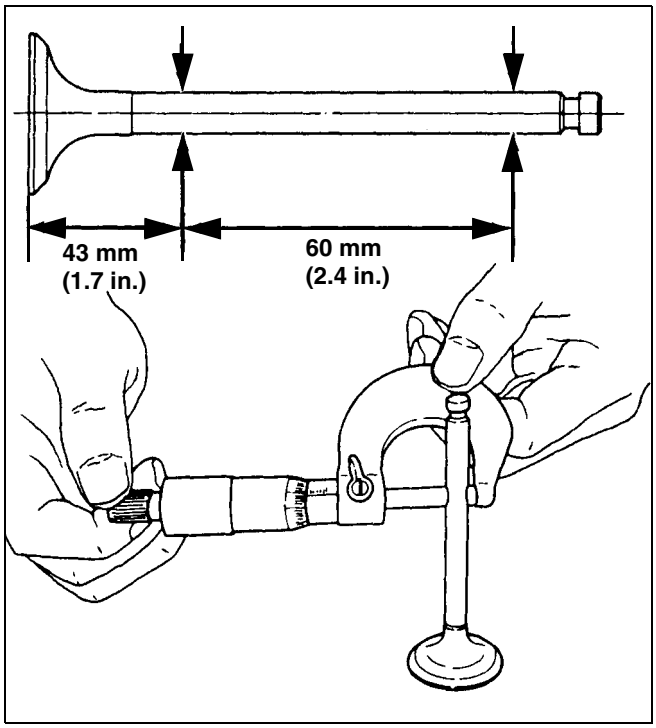
1. Check the valves for out-of-round, bent or warped condition using a valve inspection center. Replace valve if necessary.



MIF

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

- If the valve head thickness (A) is less than **0.50 mm (0.020 in.)** after grinding, replace the valve.



M82031A

3. Measure the valve stem diameter at two locations, as shown.

Specification:

Intake Valve:
Stem OD . . . . . 7.96 - 7.98 mm (0.313 - 0.314 in.)

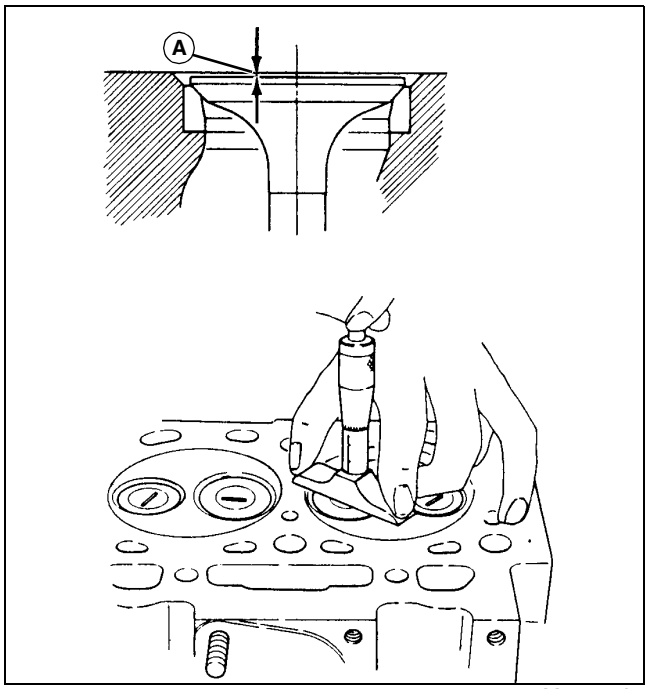
Wear Limit. . . . . 7.90 mm (0.311 in.)

Exhaust Valve:
Stem OD . . . . . 7.96 - 7.97mm (0.313 - 0.314 in.)

Wear Limit. . . . . 7.90 mm (0.311 in.)

- If the valve stem diameter is less than the wear limit, replace the valve.

Valve Recession



M82032A

1. Measure valve recession (A) using a depth gauge.

Specification:

Intake Valve:
Recession . . . . . 1.07 - 1.24 mm (0.042 - 0.049 in.)
Wear Limit . . . . . 1.00 mm (0.039 in.)
Exhaust Valve:
Recession . . . . . 0.3 - 0.5 mm (0.012 - 0.020 in.)
Wear Limit . . . . . 1.00 mm (0.039 in.)

Valve Guides

1. Clean the valve guides using a valve guide brush.
2. Measure the valve guide inside diameter.

Specification:

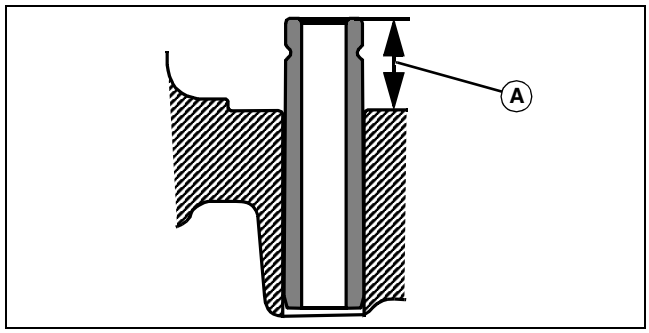
Intake Valve ID . . . . . 8.01 - 8.03 mm (0.315 - 0.316 in.)
Wear Limit . . . . . 8.10 mm (0.319 in.)
Exhaust Valve
Recession . . . . . 0.3 - 0.5 mm (0.012 - 0.020 in.)
Wear Limit . . . . . 1.00 mm (0.039 in.)

3. Subtract the valve stem OD from the valve guide ID to obtain the oil clearance.

Specification:

Valve Stem-To-Guide Oil Clearance
Intake Valve. . . . . 0.04 - 0.07 mm (0.001 - 0.003 in.)
Wear Limit. . . . . 0.20 mm (0.008 in.)
Exhaust Valve. . . . . 0.05 - 0.08 mm (0.002 - 0.003 in.)
Wear Limit. . . . . 0.20 mm (0.008 in.)

- If the ID of the valve guide is less than the wear limit, determine the guide-to-stem oil clearance (guide diameter minus stem diameter).
- If the oil clearance exceeds **0.15 mm (0.006 in.)** but is less than **0.20 mm (0.008 in.)**, knurl the valve guides using D-20019WI Valve Guide Knurler
- If clearance exceeds **0.20 mm (0.008 in.)**, replace valve guides using JDE118 Valve Guide Driver.



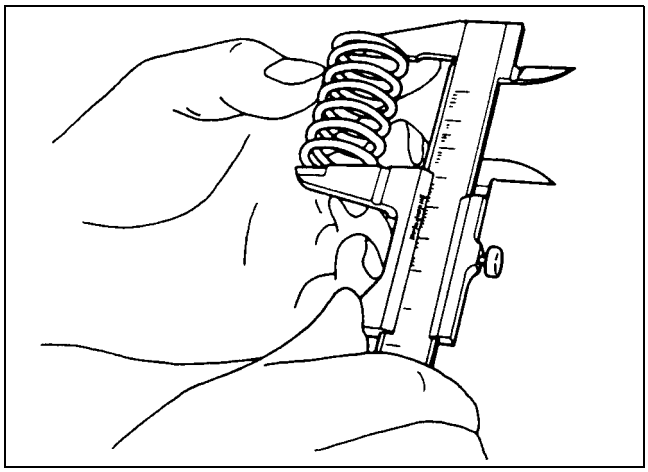
- New valve guides must be cooled in a container of liquid nitrogen or equivalent before driving into cylinder head.
- The intake and exhaust valve guides are different. The exhaust valve guide has one groove and the intake valve guide has none.
- Install the valve guides with the tapered ends down. Push the valve guides into the cylinder head until the valve guide projection (A) is within specification.

Specification:

Valve Guide Projection . . . . . 15 mm (0.591 in.)

- Ream the inside diameter of valve guides using D-20021WI Valve Guide Reamer.

Valve Springs

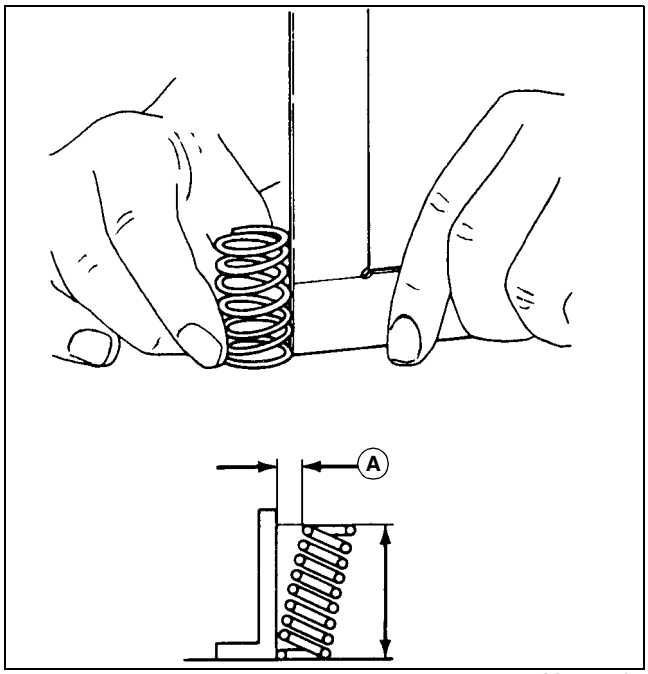


M82034A

1. Measure the valve spring free length.

Specification:

Valve Spring Free Length . . . . . 42 mm (1.654 in.)

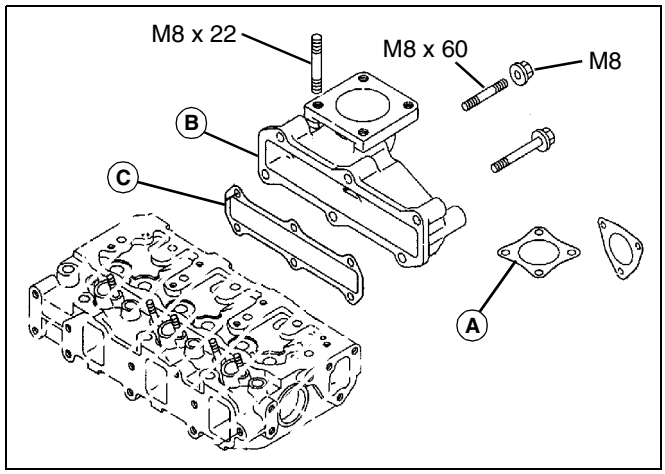


M82035A

2. Measure the spring inclination (A).

   • Replace the spring if the measurement exceeds **1.10 mm (0.044 in.)**.

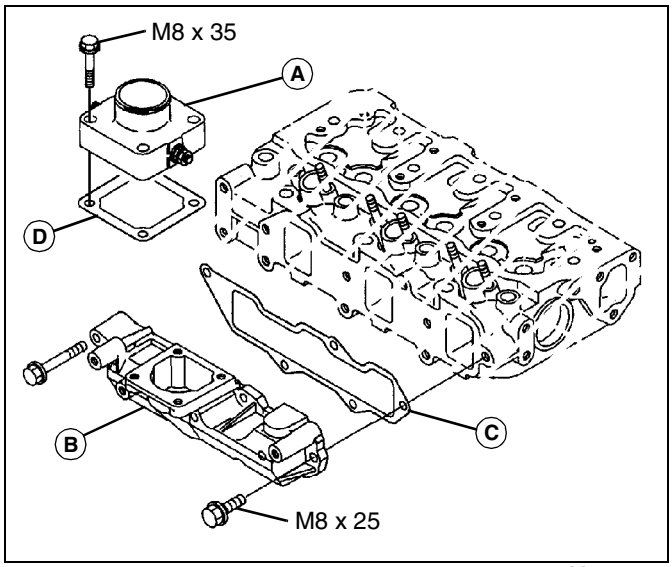
Exhaust Manifold



M94810

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

Intake Manifold



M94811

1. Remove the fuel filter bracket (not shown).
2. Remove the intake air heater (A).
3. Remove the fuel injection lines (not shown).
4. Remove the intake manifold (B).
5. Clean the mating surfaces, and replace the intake manifold gasket (C).
6. Install the intake manifold.

7. Replace the intake air heater gasket (D), and install the intake air heater.

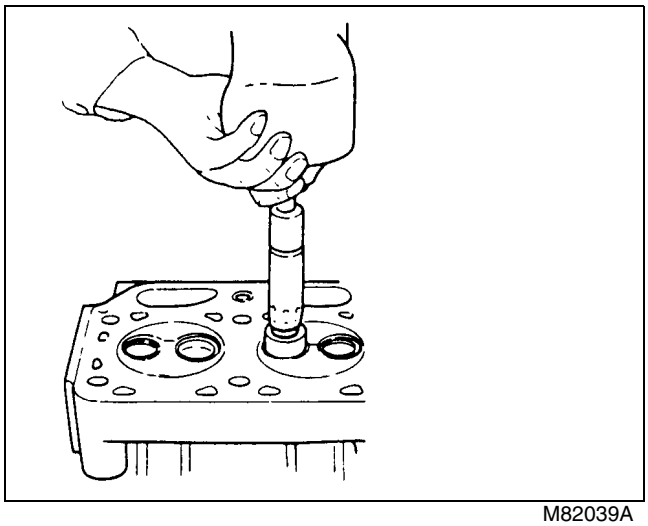
8. Install the fuel injection lines.

9. Tighten all fasteners to specification.

Grind Valve Seats

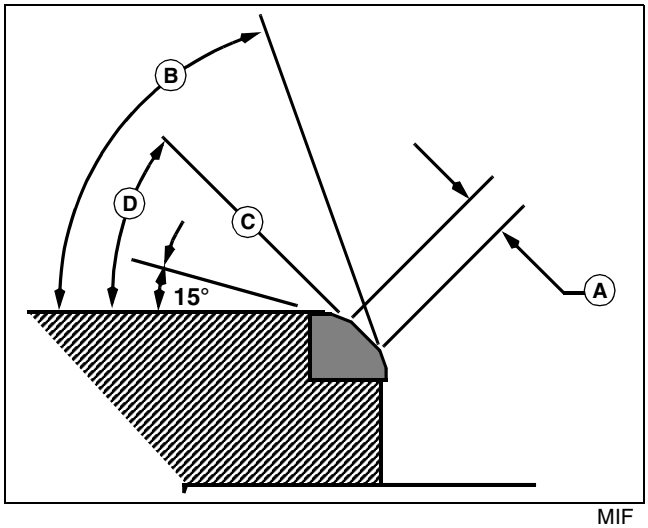
NOTE: LIGHTLY grind the valve seats for only a few seconds to avoid excessive valve seat width.

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



M82039A

2. Measure the valve seat width after grinding.



MIF

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

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

5. If the valve seats (D) are ground, measure valve recession. (See “Cylinder Head and Valves Disassembly and Assembly” on page 248.) Check the contact pattern between the seat and valve with bluing dye.

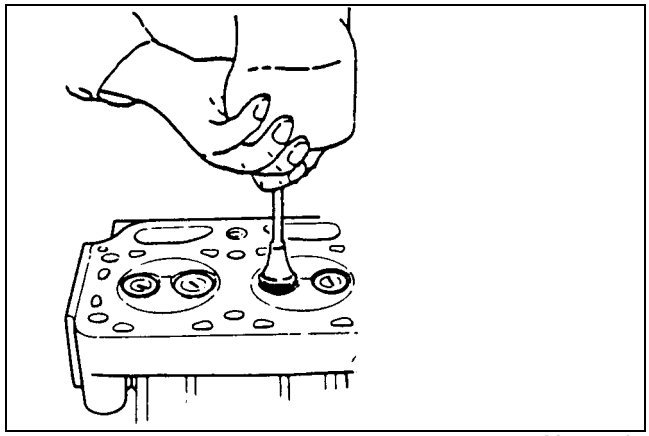
6. Lap the valves. (See “Lap Valves” on page 252.)

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

Lap Valves

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

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



M82041A

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

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

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

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

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

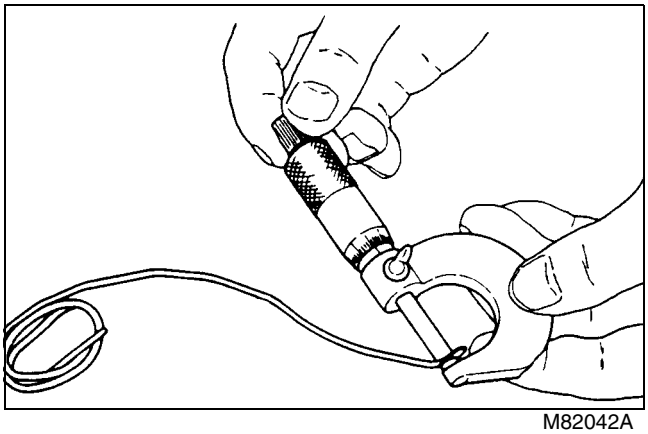
Measure Piston-To-Cylinder Head Clearance

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

2. Install the cylinder head and old gasket. Install cylinder head bolts and tighten in proper sequence. (See “Cylinder Head and Valves Removal and Installation” on page 247.)

3. Slowly turn the crankshaft one complete revolution.

4. Remove the cylinder head and gasket.



M82042A

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

- If the clearance is less than **0.64 - 0.82 mm (0.025 - 0.032 in.)**, replace cylinder head. (See “Cylinder Head and Valves Removal and Installation” on page 247.)

Piston and Connecting Rod

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

Removing:

1. Remove the oil pan, and oil pickup tube.

2. Remove the cylinder head. (See “Cylinder Head and Valves Removal and Installation” on page 247.)

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

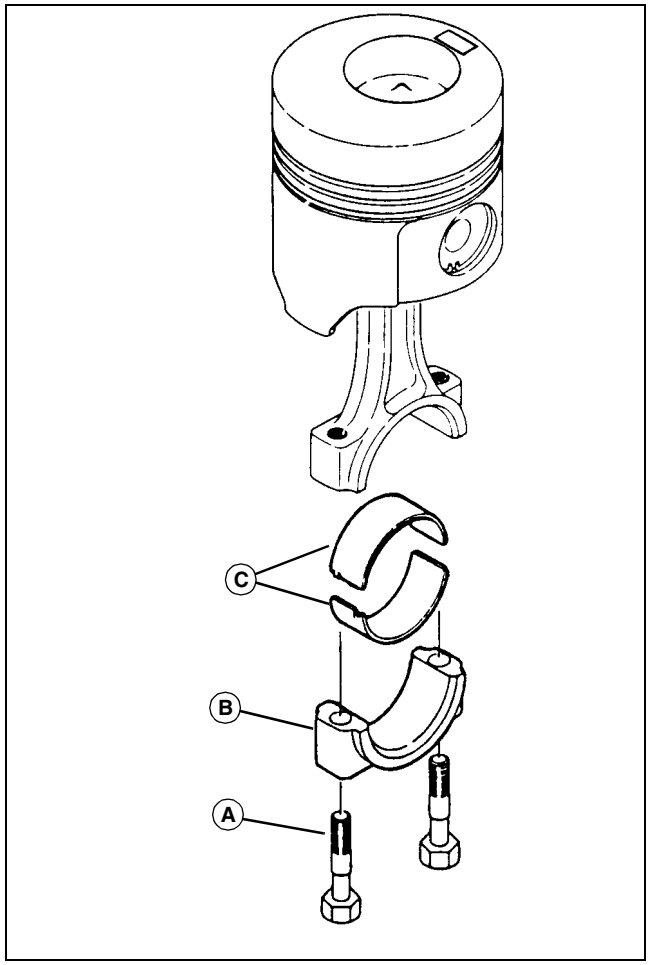
4. If necessary, remove any ridge from the top of the cylinder bore using a ridge reamer.

5. Measure the connecting rod side play. (See “Connecting Rod Side Play Check” on page 232.)

6. Measure the crankshaft end play. (See “Crankshaft End Play Check” on page 233.)

7. Measure the connecting rod bearing clearance. (See “Connecting Rod Bearing Clearance Check” on page 232.)

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



M82196AB

8. Remove the rod bolts (A), connecting rod cap (B) and bearing inserts (C).

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

9. Note the connecting rod alignment mark in relation to the cylinders. Starting at the flywheel end with cylinder number one, then two, etc.

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

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

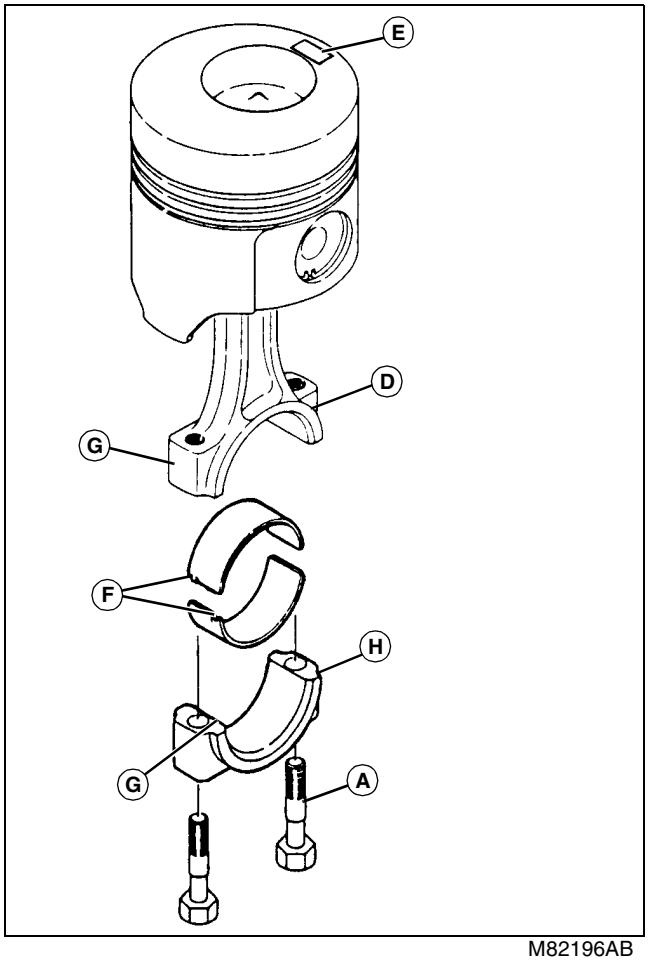
12. Inspect the cylinder bore. (See “Cylinder Bore” on page 259.)

Installation:

- Apply clean engine oil to all parts during installation.
- Always replace the connecting rod bolts. Do not reuse the bolts.

IMPORTANT: Avoid damage! Pistons must be installed in the cylinders from which they were removed and in the same direction. Be careful not to damage the crankshaft rod journals while installing pistons.

1. Assemble the piston and connecting rod. (See "Disassembly" below.)



M82196AB

2. Install the piston and connecting rod into the cylinder from which it was removed. The alignment mark on the connecting rod (D) and/or the piston size mark (E) on top of piston should point toward the fuel injection pump.

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

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

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

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

5. Dip the entire connecting rod bolt in clean engine oil. Install new bolts and tighten to specification.

Specification:

Connecting Rod Bolt Torque. 44 - 54 N•m (33 - 40 lb-ft)

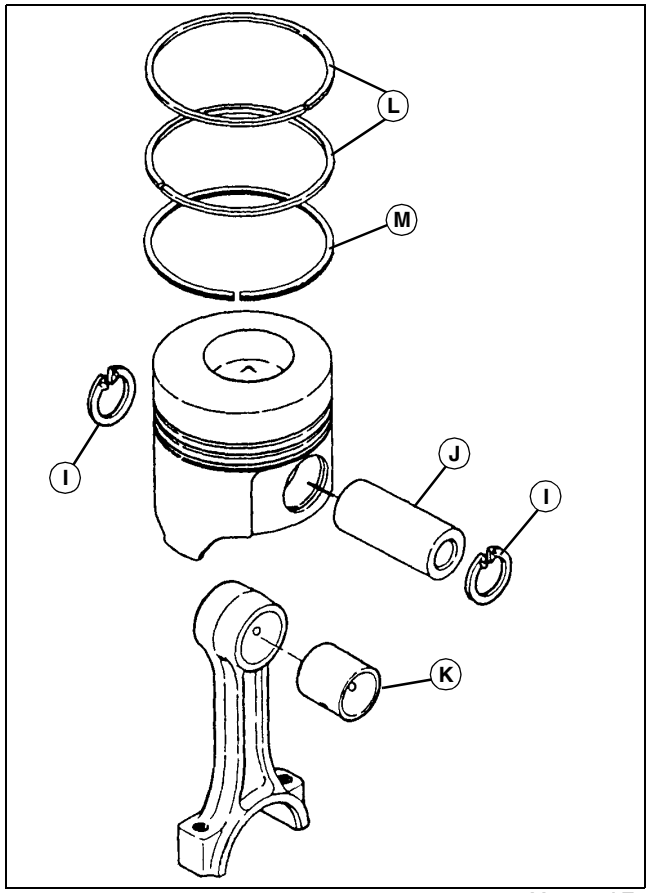
6. If a new piston and connecting rod were installed, stamp a number corresponding to the cylinder number on the connecting rod and rod cap.

7. Install the cylinder head. (See "Cylinder Head and Valves Removal and Installation" on page 247.)

8. Install the oil pan, and oil pickup tube.

Disassembly:

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



M82197AE

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

• Remove snap rings (I) from piston pin (J) and remove pin.

• The piston pin bushing (K) is a press fit in the connecting rod. Remove the bushing only if replacement is necessary.

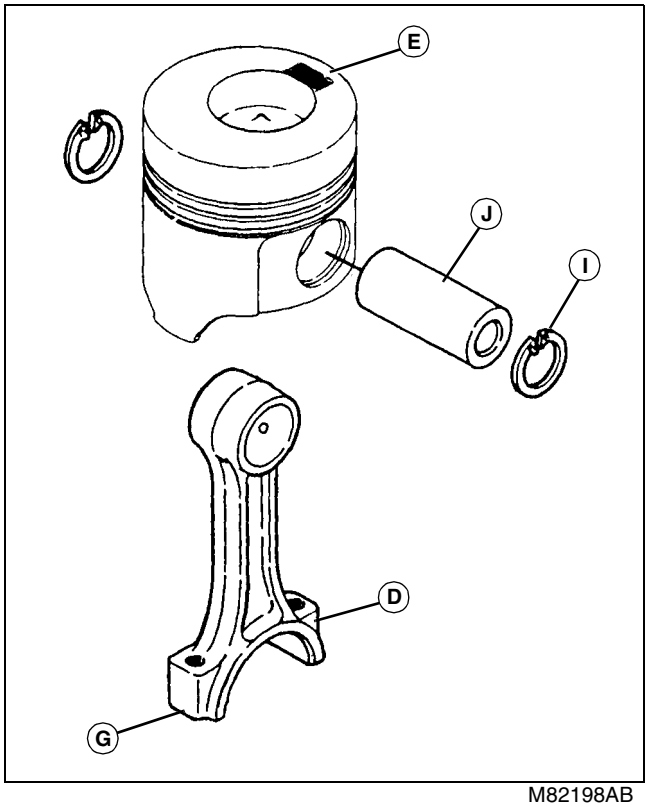
• Inspect all parts for wear or damage. Replace as necessary.

• Remove the 1st and 2nd compression rings (L) and oil ring with expander (M).

Assembly:

• Apply clean engine oil to all parts during assembly.

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

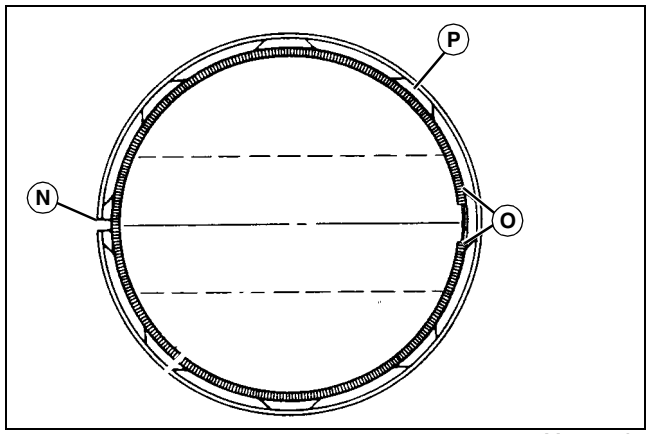


M82198AB

1. Assemble the piston to the connecting rod with piston mark (E) on the same side as the connecting rod stamped mark (D). If a new connecting rod is used, assemble the piston to the connecting rod with piston mark opposite the connecting rod bearing insert groove (G). Be sure the oil hole in the piston pin bushing is aligned with the hole in the connecting rod.

2. Install the piston pin (J) and retaining/snap rings.

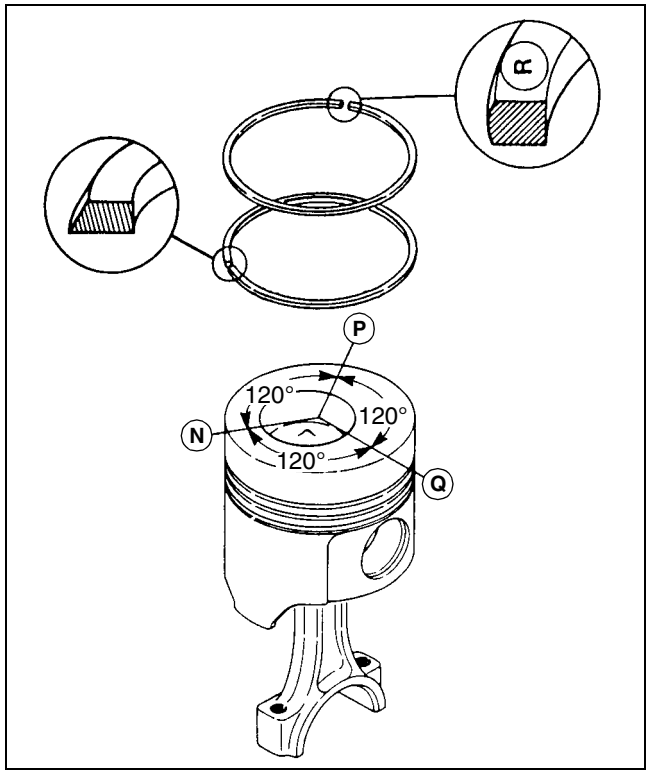
3. Install an oil ring expander (M) in the bottom ring groove of the piston, with the ends above either end of the piston pin.



M82046A

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

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



M82199A

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

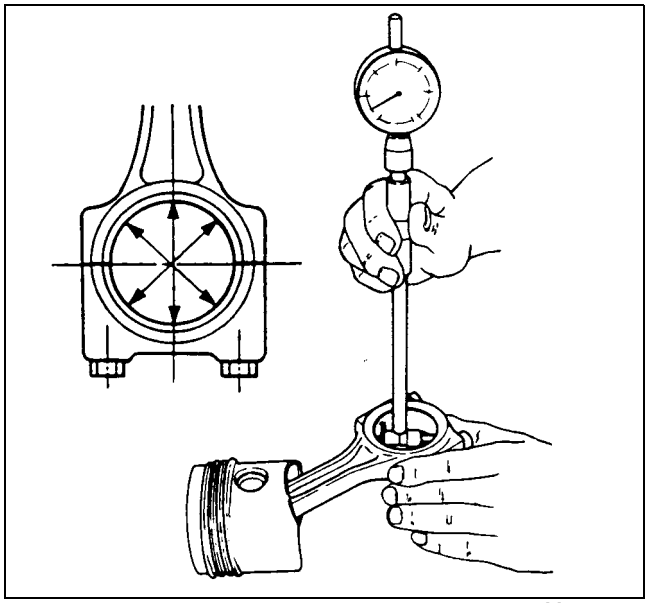
Piston Inspection

Connecting Rod Bearing:

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

Specification:

Connecting Rod Bolt Torque. 44 - 54 N•m (33 - 40 lb-ft)



M82048a

2. Measure the connecting rod bearing diameter.

Specification:

Connecting Rod
Bearing ID . . . . . 51.00 - 51.01 mm (2.008 - 2.008 in.)

Result:

- Replace the bearing inserts if the bearing diameter is not within specification.

3. Measure the oil clearance between the bearing inserts and the crankshaft, and verify that the clearance is within specification.

Specification:

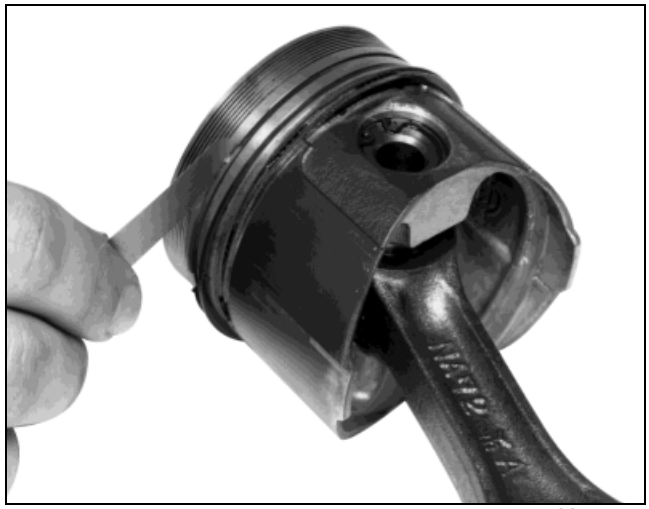
Connecting Rod Bearing
Oil Clearance. . . . . 0.04 - 0.07mm (0.002 - 0.003 in.)

Wear Limit . . . . . 0.16 mm (0.006 in.)

Result:

- If the bearing oil clearance exceeds the wear limit grind the crankshaft connecting rod journals and install undersized bearing inserts, or replace the bearing inserts and the crankshaft.

Piston Ring Groove:



M35360

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

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

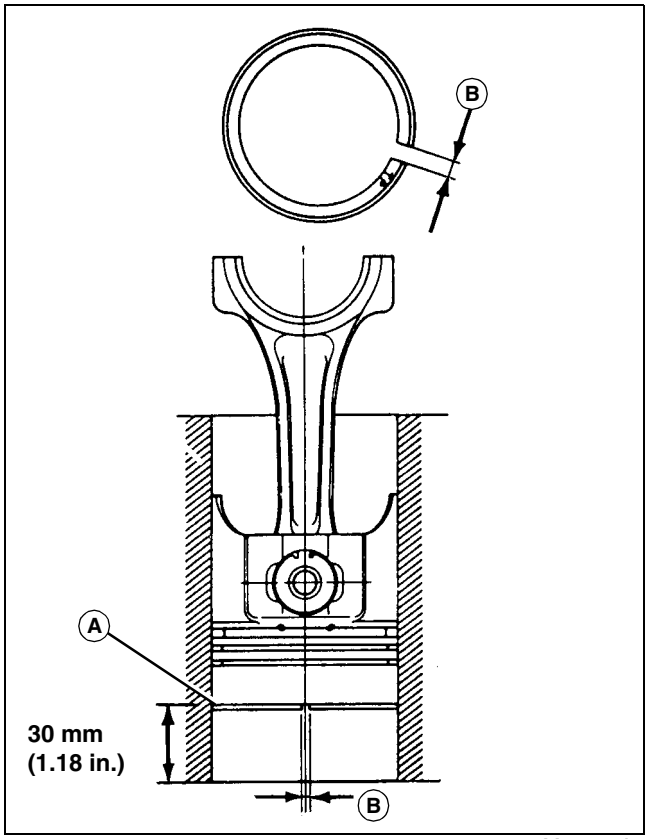
Specification:

First Compression Ring Groove-
Side Clearance . . . . . 0.08 - 0.11 mm (0.003 - 0.004 in.)

Second Compression Ring Groove-
Side Clearance . . . . . 0.05 - 0.08 mm (0.002 - 0.003 in.)

Oil Control Ring Groove-
Side Clearance . . . . . 0.03 - 0.06 mm (0.001 - 0.002 in.)

Piston Ring End Gap:



M82049A

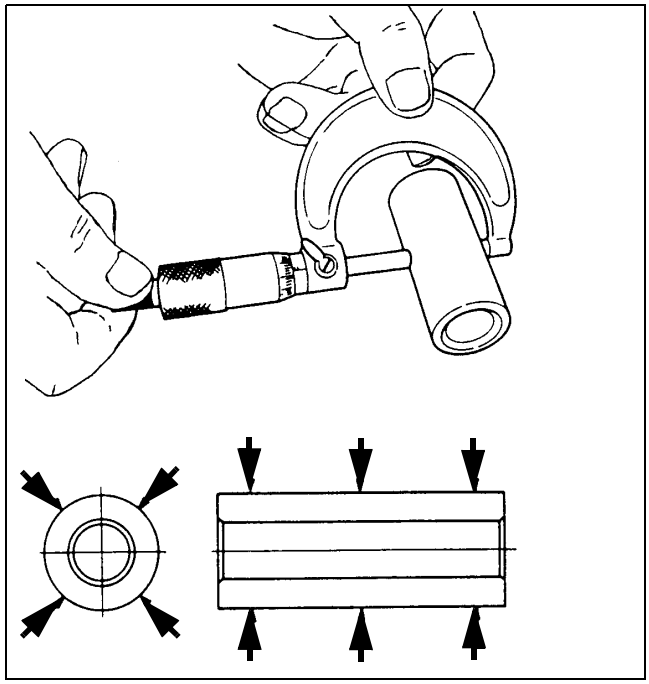
1. Use a piston to push the ring (A) approximately **30 mm (1.18 in.)** from the bottom of the cylinder bore. Measure the piston ring end gap (B).

Specification:

Piston Ring End Gap . 0.20 - 0.40 mm (0.008 - 0.016 in.)

Wear Limit . . . . . 1.50 mm (0.059in.)

Piston Pin Diameter:



M82050A

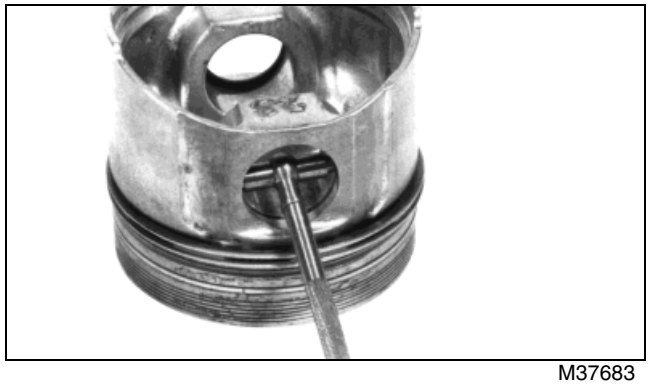
1. Measure the piston pin diameter. Measure the diameter at six places. Replace any pin that is not within specification.

Specification:

Piston Pin OD . . . . . 25.99 - 26.00 mm (1.023 - 1.024 in.)

Wear Limit. . . . . 25.90 mm (1.020 in.)

Piston Pin Bore:



M37683

1. Measure the pin bore diameter in the piston.

Specification:

Piston Pin Bore ID . 26.00 - 26.01 mm (1.024 - 1.024 in.)

Wear Limit. . . . . 26.02 mm (1.024 in.)

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

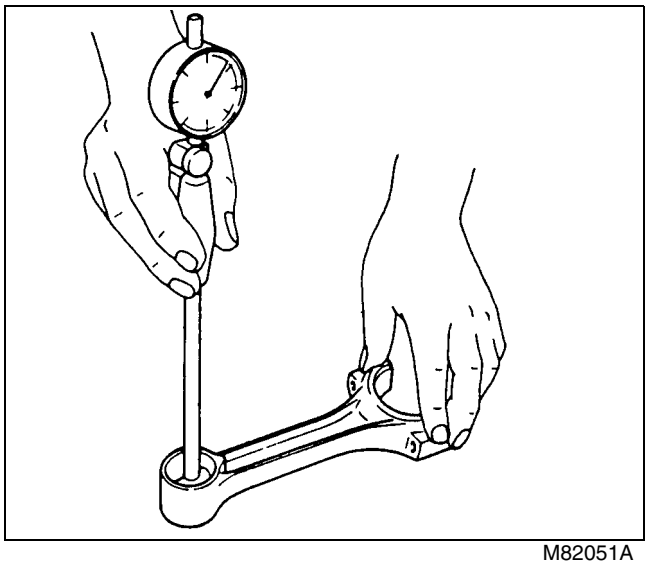
Specification:

Piston Pin-to-Piston
Oil Clearance. . . . . 0.00 - 0.02 mm (0.00 - 0.001 in.)

Wear Limit . . . . . 0.12 mm (0.005 in.)

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

Piston Pin Bushing:



M82051A

1. Measure the piston pin bushing diameter in the connecting rod.

Specification:

Piston Pin Bushing ID . . . . . 26.03 - 26.04 mm
. . . . . (1.025 - 1.025 in.)

Wear Limit . . . . . 26.10 mm (1.028 in.)

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

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

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

Specification:

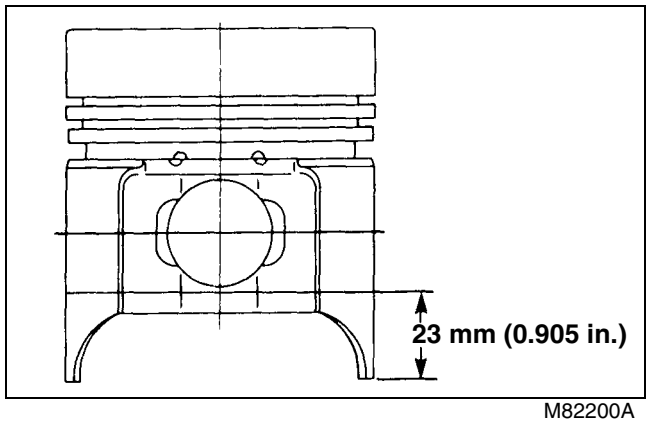
Piston Pin-to-Rod Bore
Oil Clearance. . . . . 0.03 - 0.05 mm (0.001 - 0.002 in.)

Wear Limit . . . . . 0.20 mm (0.008 in.)

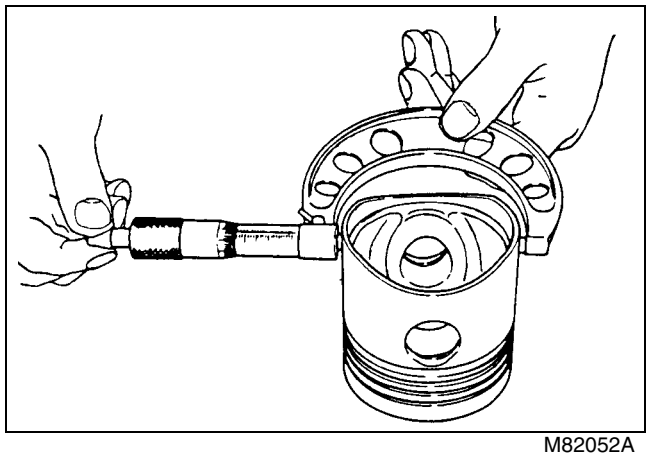
NOTE: The piston pin bushing is a press fit. Replace the bushing using a driver set. When installing the bushing, make sure to align the oil hole in the bushing with the hole in the connecting rod.

Piston Diameter:

NOTE: If the engine has had a previous major overhaul, oversize pistons and rings may have been installed. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.



M82200A



M82052A

1. Measure the piston diameter perpendicular to the piston pin bore **23 mm (0.905 in.)** from the bottom of the piston skirt.

Specification:

Standard Piston:
OD . . . . . 87.95 - 87.98 mm (3.462 - 3.464 in.)

Wear Limit. . . . . 87.90 mm (3.461 in.)

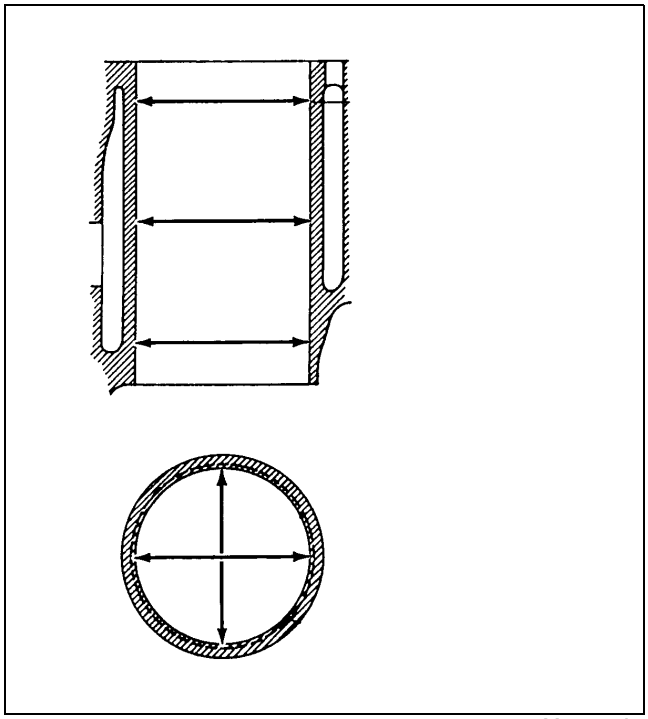
Oversize Piston:
OD . . . . . 88.20 - 88.23 mm (3.472 - 3.474 in.)

Wear Limit. . . . . 88.10 mm (3.469 in.)

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

Cylinder Bore

NOTE: If the engine has had a previous major overhaul, the cylinders may have been bored oversize. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.



M82053A

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

Specification:

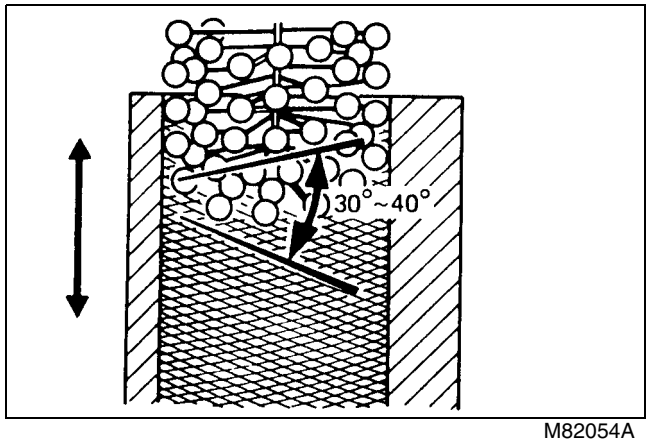
Standard Cylinder Bore
ID . . . . . 88.00 - 88.03 mm (3.465 - 3.466 in.)
Wear Limit . . . . . 88.20 mm (3.472 in.)
Oversize Cylinder Bore
ID . . . . . 88.25 - 88.28 mm (3.474 - 3.476 in.)
Piston-to-Cylinder Clearance . . . . 0.055 mm (0.002 in.)
Cylinder Roundness. . 0.00 - 0.01 mm (0.00 - 0.000 4in.)
Wear Limit . . . . . 0.03 mm (0.001 in.)
Cylinder Taper. . . . . 0.00 - 0.01 mm (0.00 - 0.0004 in.)
Wear Limit . . . . . 0.03 mm (0.001 in.)

- If the cylinder bore standard ID exceeds the wear limit, have the cylinder rebored.
- If the cylinder is rebored, oversize pistons and rings must be installed.
- If the cylinder bore exceeds the oversize bore ID, replace the cylinder block.
- If the piston-to-cylinder bore clearance (cylinder bore ID minus piston OD) exceeds specification, replace the cylinder block, piston or both; or rebore cylinder and install oversize piston and rings.
- Slight uneven wear, flaws, or minor damage may be corrected by deglazing. (See “Deglazing” below.)

Deglazing:

IMPORTANT: Avoid damage! If the cylinder bores are to be deglazed with crankshaft installed in engine, put clean shop towels over crankshaft to protect journal and bearing surfaces from any abrasives.

1. Deglaze the cylinder bores using a flex-hone with 180 grit stones.



M82054A

2. Use the flex-hone as instructed by the manufacturer to obtain a **30 - 40° crosshatch pattern** as shown.

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

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

Reboring:

NOTE: The cylinder block can be rebored to use oversize pistons and rings. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

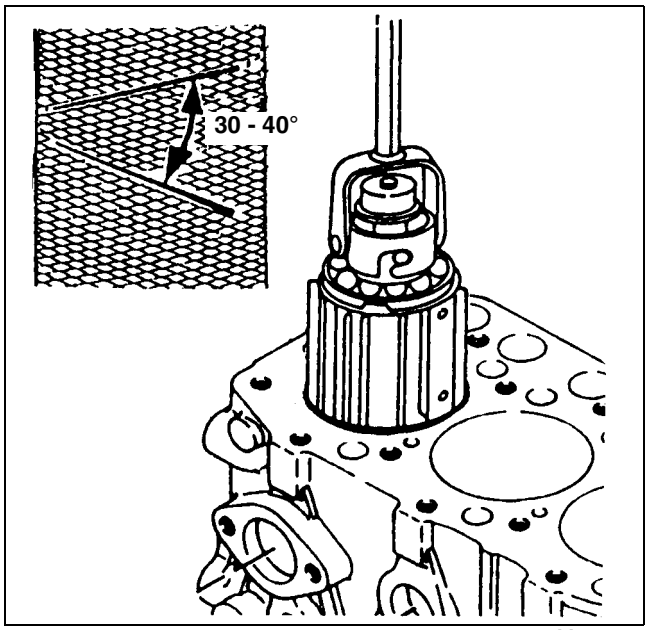
1. Align the center of bore to the drill press center.

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

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

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

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



M52959

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

NOTE: Measure the bore when the cylinder is cool.

6. Stop the press and check the cylinder diameter.

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

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

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

9. Check the bore for size, taper and out-of-round. (See "Cylinder Bore" on page 259.)

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

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

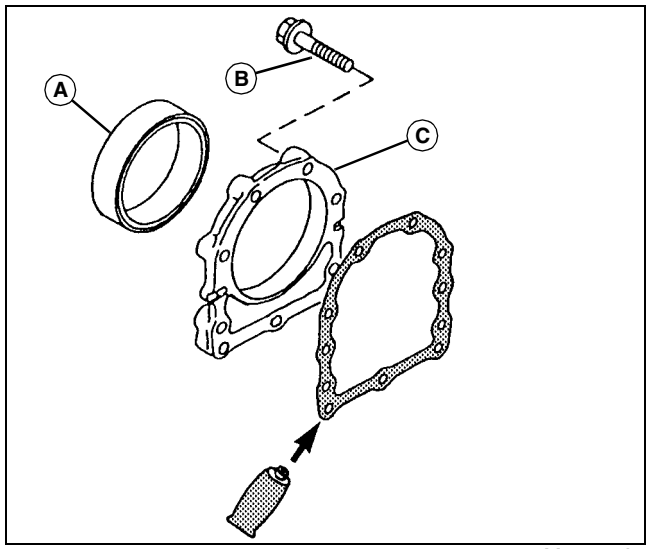
11.Dry the cylinder and apply engine oil.

Crankshaft Rear Oil Seal

Replacement:

1. Remove the drive shaft.

2. Remove flywheel. (See "Flywheel and Flex Plate" on page 263.)



M82349A

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

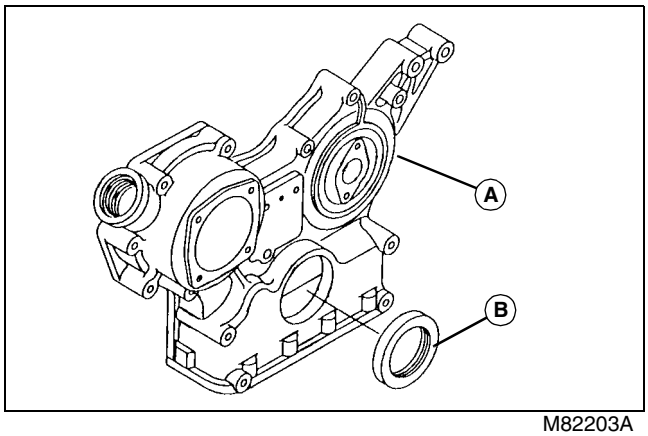
4. Remove the rear oil seal case (C).

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

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

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

Crankshaft Front Oil Seal



M82203A

1. Remove the timing gear cover (A). (See “Timing Gear Cover” on page 268.)

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

Crankshaft and Main Bearings

Removing:

1. Check the crankshaft end play. (See “Crankshaft End Play Check” on page 233.)

2. Remove the cylinder head. (See “Cylinder Head and Valves Removal and Installation” on page 247.)

3. Remove the rear oil seal. (See “Crankshaft Rear Oil Seal” on page 260.)

4. Remove the timing gear cover mounting plate. (See “Timing Gear Cover” on page 268.)

5. Check the crankshaft rod bearing clearance. (See “Connecting Rod Bearing Clearance Check” on page 232.)

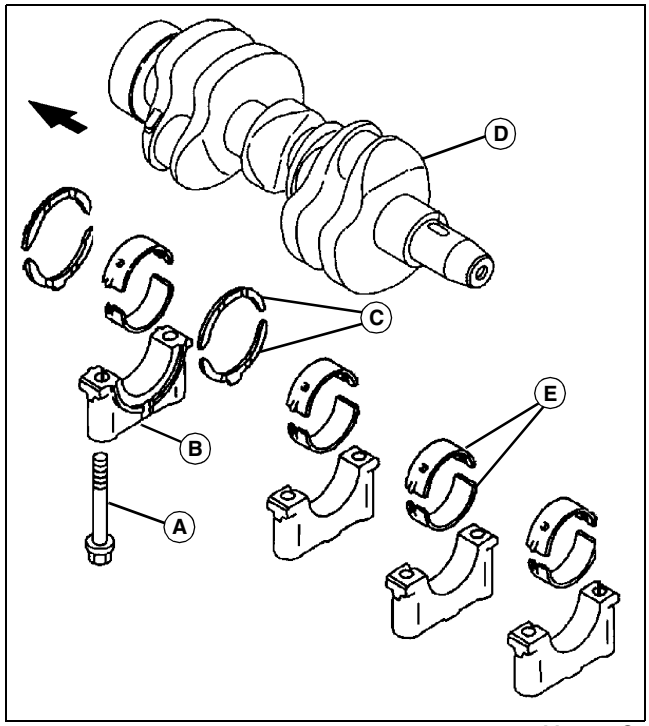
IMPORTANT: Avoid damage! Connecting rod caps must be installed on the same connecting rods from which they were removed. Note the alignment marks on the caps and rods.

6. Check the crankshaft main bearing clearance. (See “Crankshaft Main Bearing Clearance Check” on page 234.)

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

7. Remove the connecting rod bolts and rod caps. Discard the connecting rod bolts.

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



M91948C

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

10. Remove the crankshaft (D).

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

12. Inspect all parts for wear or damage.

Installing:

- Apply clean engine oil to all parts during installation.

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

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

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

3. Install the crankshaft.

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

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

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

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

IMPORTANT: Avoid damage! Do not use high speed power tools or air wrenches to tighten main bearing bolts.

7. Dip each main bearing bolt entirely in clean engine oil. Install the bolts and tighten. Do not tighten to specifications.

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

9. Tighten the main bearing bolts to specification. When tightening, start at the center main bearing cap and work your way out, alternating to the ends. Turn the crankshaft by hand. If it does not turn easily, disassemble the parts and find the cause.

Specification:

Main Bearing Bolt Torque . . 96 - 100 N•m (71 - 74 lb-ft)

IMPORTANT: Avoid damage! The connecting rod caps must be installed on the same connecting rods they were removed from.
Never reuse connecting rod bolts, replace with new.

10.Match the connecting rod caps to the rods using alignment marks. Install the caps to the rods.

11.Dip entire connecting rod bolt in clean engine oil. Install new bolts to the rods, and tighten to specification.

Specification:

Connecting Rod Bolt Torque. 44 - 54 N•m (33 - 40 lb-ft)

12.Install the timing gear cover mounting plate. (See “Timing Gear Cover Mounting Plate” on page 269.)

13.Install the rear oil seal. See “Crankshaft Rear Oil Seal” on page 260.

14.Install the flywheel. (See “Flywheel and Flex Plate” on page 263.)

15.Install the timing gear cover. (See “Timing Gear Cover” on page 268.)

16.Install the front oil seal. (See “Crankshaft Front Oil Seal” on page 261.)

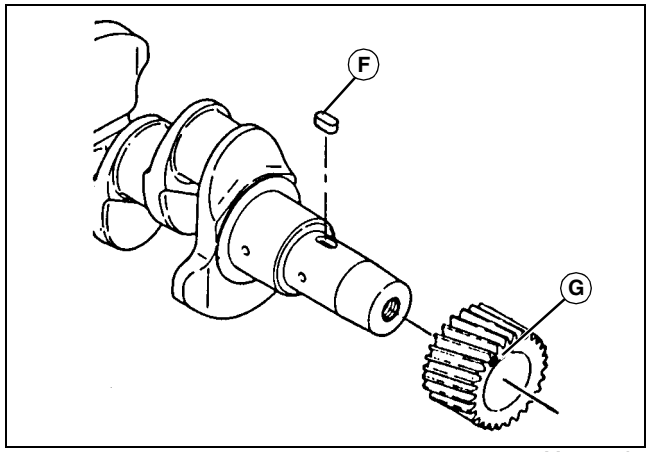
17.Install the oil pan.

Inspection/Replacement:

- Inspect the crankshaft gear for chipped or broken teeth. Replace if necessary.

To Replace Gear:

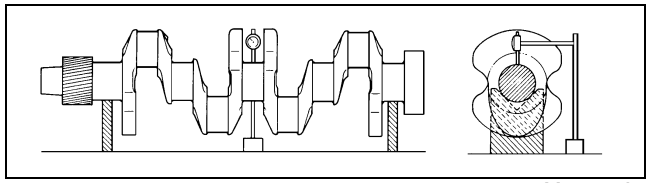
1. Remove the gear from crankshaft using a knife-edge puller and a press.



M82060A

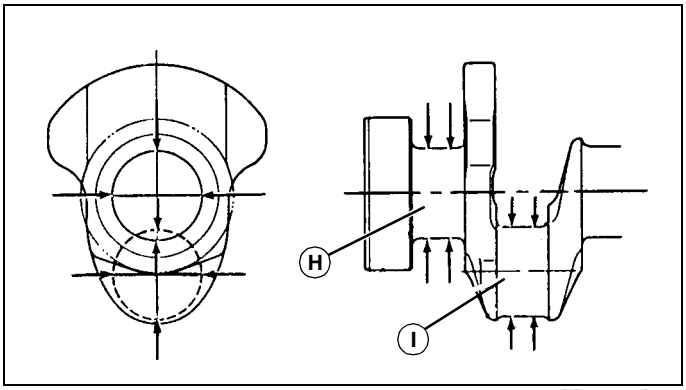
2. Heat new gear to approximately 150°C (302°F). Install gear with timing mark (G) toward press table. Align slot in gear with key (F) in shaft. Press crankshaft into gear until gear is tight against crankshaft shoulder.

CAUTION: Avoid injury! Do not heat oil over 182° C (360° F). Oil fumes or oil can ignite above 193° C (380° F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.


M82061A

3. Inspect the crankshaft for bend using V-blocks and a dial indicator. Turn the crankshaft slowly and read variations on the indicator. If the variation is greater than **0.02 mm (0.001 in.)**, replace the crankshaft.

4. Measure the crankshaft connecting rod journal and main bearing journal diameters at several places around each journal.



M82062A

- If the journal diameter (I) is less than the specification, but greater than the wear limit, have the journals ground undersize by a qualified machine shop.
- If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in **0.25 mm (0.010 in.)** undersize.
- If the journal diameter is less than the wear limit, replace the crankshaft.

Specification:

Connecting Rod Journal OD (I) . . . . . 47.95 - 47.96 mm (1.888 - 1.888 in.)

Wear Limit . . . . . 47.91 mm (1.886 in.)

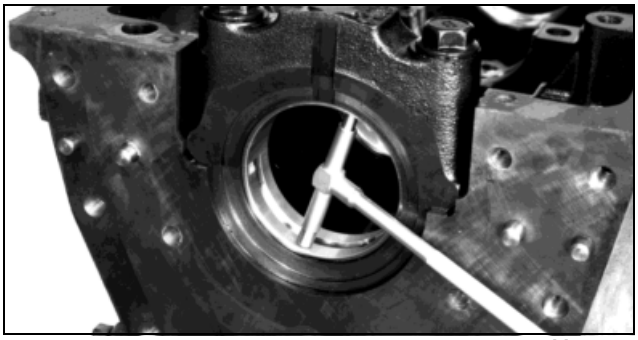
Main Bearing Journal OD (H). . . . . 53.95 - 53.96 mm (2.124 - 2.124 in.)

Wear Limit . . . . . 53.91 mm (2.122 in.)

5. Install the bearing inserts and main bearing caps on the main bearings. Tighten the main bearing bolts to specification.

Specification:

Main Bearing Bolt Torque . . 96 - 100 N•m (71 - 74 lb-ft)


M82063

6. Measure the main bearing inner diameter.
   - Subtract the main bearing journal OD of the crankshaft from the main bearing ID to obtain the main bearing oil clearance.

Specification:

Main Bearing Oil Clearance. . . . . 0.04 - 0.07 mm (0.002 - 0.003 in.)

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

- If the crankshaft is within specification, but the main bearing oil clearance exceeds the wear limit, replace the bearing inserts.
- If the crankshaft is not within specification, have crankshaft journals ground undersize by a qualified machine shop and install undersized bearing inserts.
- If the crankshaft is worn past the wear limit, replace the crankshaft.

7. Clean and inspect the oil passages in the main bearing journals, connecting rod journals and main bearing bores in cylinder block.

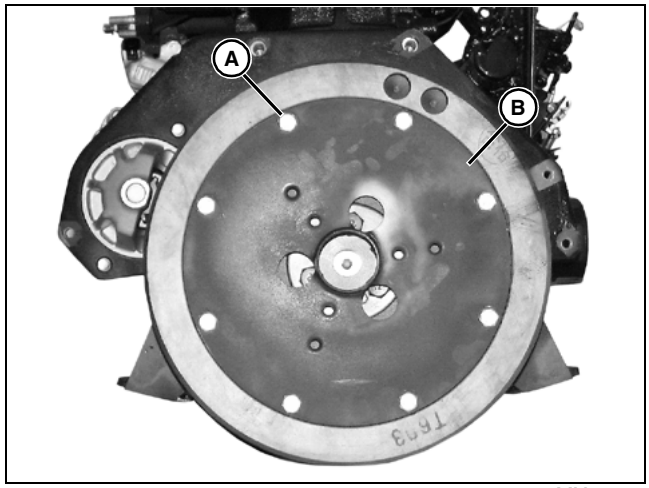
8. Inspect the crankshaft for cracks or damage. Replace if necessary.

Flywheel and Flex Plate

Removal/Installation:

IMPORTANT: Avoid damage! Always install new flywheel mounting bolts.

1. Flywheel can be removed without removing engine from machine. If removing flywheel in machine. (See “Engine Drive Shaft Removal and Installation” on page 518 in the Power Train section.)

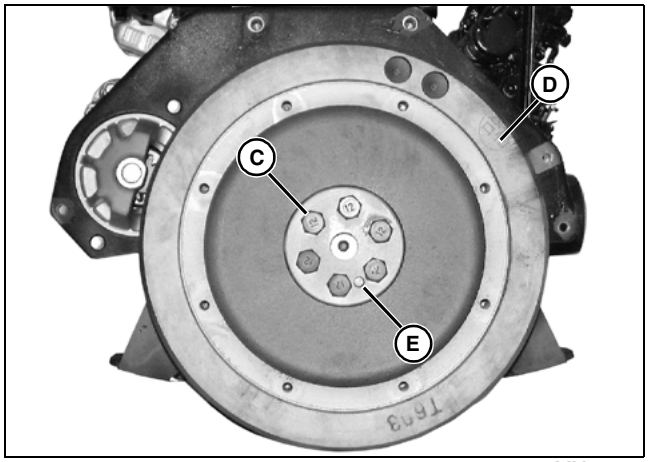


MX5434

Picture Note: Model 1445 Shown

2. Remove eight cap screws (A) and flex plate (B).

IMPORTANT: Avoid damage! Always install new flywheel mounting cap screws.



MX5435

Picture Note: Model 1445 Shown

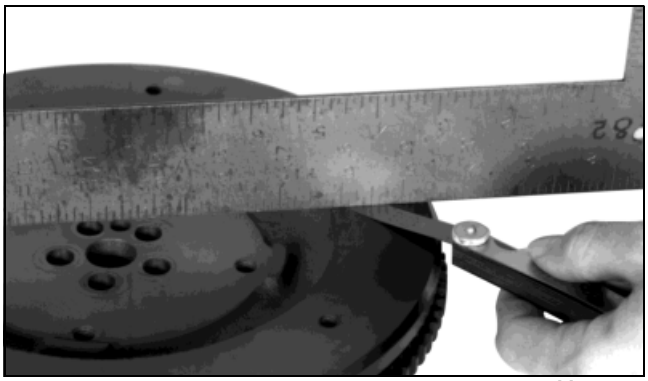
3. Remove the flywheel mounting cap screws (C) and remove the flywheel (D) from crankshaft.

4. Use pin (E) in crankshaft to correctly locate the flywheel on the crankshaft.

5. Install the flywheel. Apply lubrication oil to the mounting cap screws and tighten to specification.

6. Install flex plate with raised hub facing away from flywheel.

7. Install cap screws and tighten to specification.



M35337

8. Measure flywheel flatness. Place a straightedge across the flywheel surface opposite of ring gear. Measure the clearance between the straightedge and the flywheel surface with a feeler gauge. Replace the flywheel if the clearance exceeds specification.

Camshaft

Removing:

1. Remove the rocker arm assembly and push rods. (See “Rocker Arm Assembly” on page 245.)

2. Remove the timing gear cover. (See “Timing Gear Cover” on page 268.)

3. Check the camshaft end play. (See “Camshaft End Play Check” on page 235.)

4. Check the backlash of the timing gears. (See “Timing Gear Backlash Check” on page 235.)

NOTE: If a magnetic follower holder kit is not available, turn engine until oil pan is upward, to hold cam followers away from camshaft.

5. Hold the cam followers away from the camshaft using a magnetic follower holder kit such as D15001NU.

6. Rotate the crankshaft and align the timing marks.

IMPORTANT: Avoid damage! Do not allow the camshaft lobes to hit any bearing surfaces while removing the camshaft. Machined surfaces can be damaged.

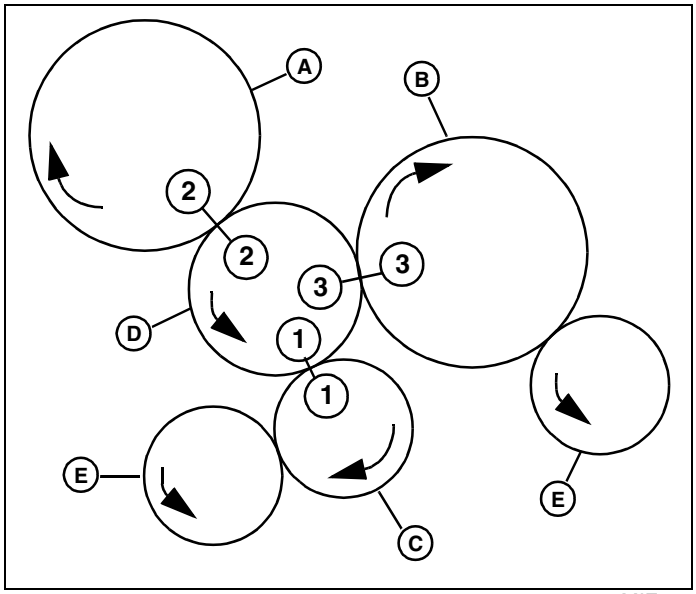
7. Remove two thrust plate mounting cap screws, the thrust plate, and the camshaft.

8. Inspect all parts for wear or damage.

Installing:

- Apply clean engine oil on all parts during installation.

IMPORTANT: Avoid damage! Do not allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces and bearings can be damaged.



MIF

Picture Note: Viewed From Gear Case

1. Rotate the crankshaft to align the timing marks (1, 2 and 3).

NOTE: The fuel injection drive gear (A), the camshaft gear (B) and the crankshaft gear (C) all must be correctly timed to the idler gear (D). It is not necessary to time the oil pump gear (E).
Due to the odd number of teeth on the idler gear, timing marks will only align periodically.

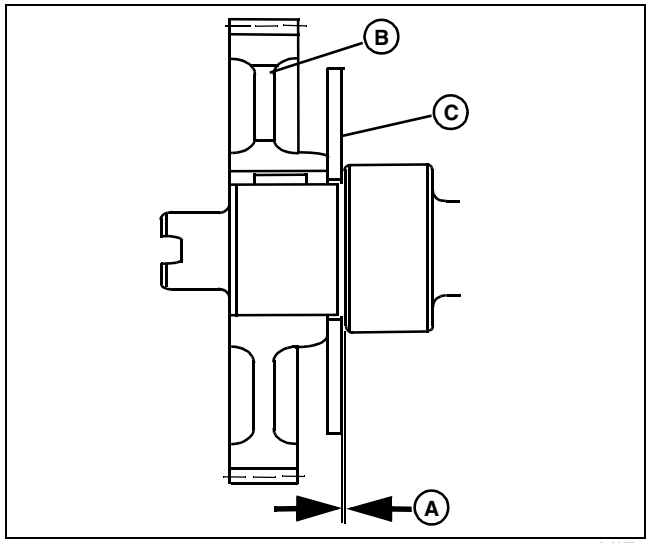
2. Install the camshaft.

3. Install the thrust plate and cap screws.

4. Install the timing gear cover. (See “Timing Gear Cover” on page 268.)

5. Install the push rods and rocker arm assembly. (See “Rocker Arm Cover Removal and Installation” on page 244.)

Inspection/Replacement:



MIF

1. Check the camshaft side gap using a feeler gauge.

   • If the side gap (A) exceeds **0.05 - 0.25 mm (0.002 - 0.010 in.)**, remove the camshaft gear (B) and replace thrust plate (C).

2. Remove the gear (if required) from camshaft using a knife-edge puller and a press.

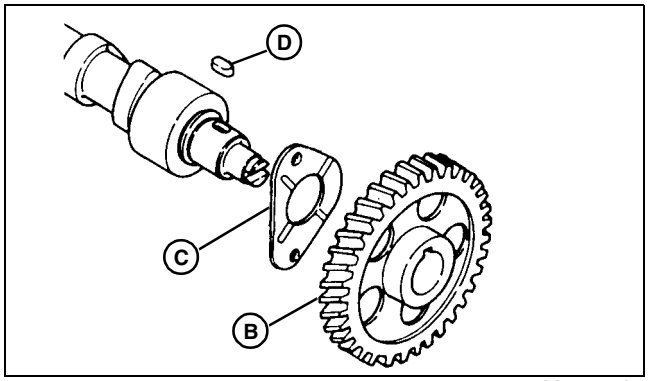
   • Inspect the gear for chipped or broken teeth. Replace the gear if necessary.

Gear Removal/Installation:

CAUTION: Avoid injury! Do not heat oil over 182° C (360° F). Oil fumes or oil can ignite above 193° C (380° F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

1. Heat the gear in oil to approximately **150°C (300°F)**.

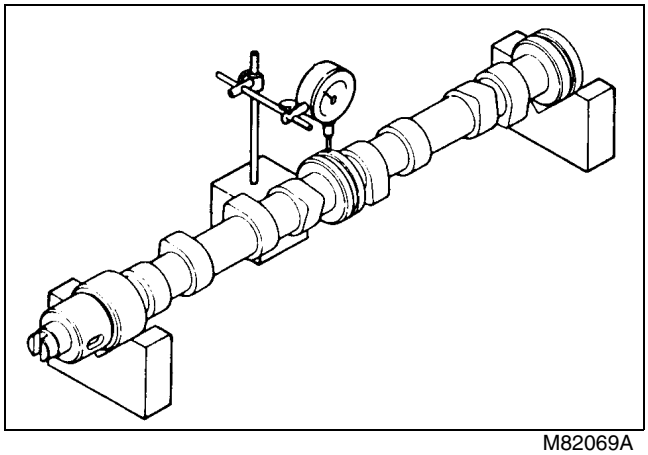
IMPORTANT: Avoid damage! Be sure thrust plate is not between camshaft gear and camshaft shoulder while installing gear.



M82068A

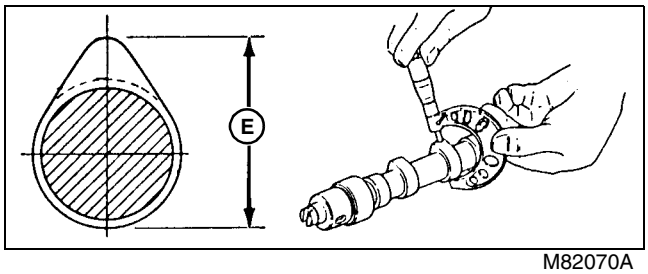
2. Install the thrust plate (C) if removed. Install the gear (B) with timing mark “C” side toward press table. Align the slot in the gear with key (D) in shaft. Press the camshaft into gear until gear is tight against camshaft shoulder.

- Thrust plate must spin freely on camshaft.


M82069A

3. Inspect the camshaft for bend using V-blocks and a dial indicator. Turn the camshaft slowly and read variations on the indicator.

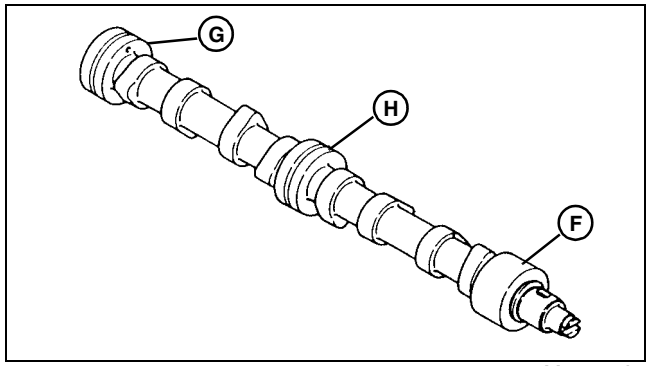
- If the variation is greater than **0.02 mm (0.001 in.)**, replace the camshaft.



M82070A

4. Measure the camshaft lobe height (E).

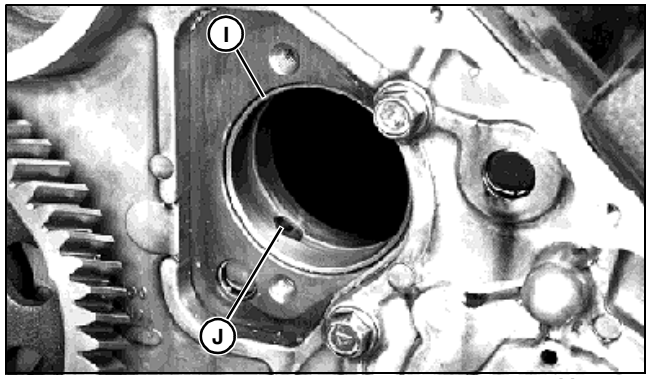
- Camshaft lobe height is **38.64 - 38.77 mm (1.521 - 1.526 in.)**.
- If the lobe height is less than **38.40 mm (1.512 in.)**, replace the camshaft.



M82071A

5. Measure the camshaft journal diameters.

- Gear housing (F) and flywheel (G) end camshaft journal OD is **44.93 - 44.95 mm (1.769 - 1.770 in.)**.
- Intermediate (H) camshaft journal OD is **44.91 - 44.94 mm (1.768 - 1.769 in.)**.
- If the journal diameters are less than **44.85 mm (1.766 in.)**, replace the camshaft.



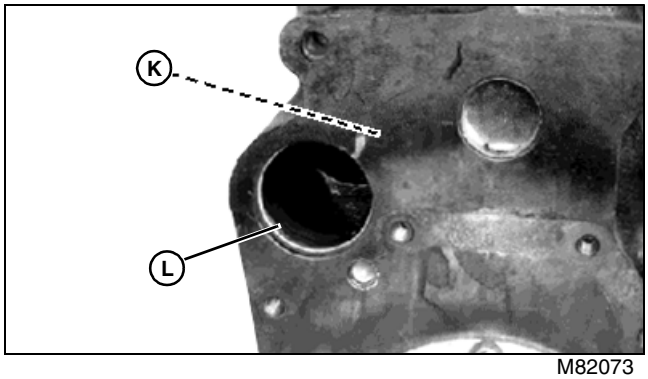
M82072

6. Measure the camshaft bushing (I) diameter at the gear housing end.

- Standard camshaft bushing ID is **44.99 - 45.06 mm (1.771 - 1.774 in.)**.
- Replace the bushing If the diameter exceeds **45.10 mm (1.776 in.)**.
- If the bushing clearance (bushing ID minus camshaft journal OD) exceeds **0.20 mm (0.008 in.)**, replace the bushing, camshaft or both.

7. Replace the camshaft bushing using a chisel. Be careful not to push the bushing inside the engine.

8. Align the oil holes (J) in new bushing and cylinder block. Install bushing using a driver set.



M82073

9. Measure the intermediate (K) and flywheel end (L) camshaft bore diameters.

- Standard camshaft bore ID is **45.00 - 45.025 mm (1.772 - 1.773 in.)**.
- If the bore diameter exceeds **45.10 mm (1.776 in.)**, replace cylinder block.
- If the bore clearance (bore ID minus camshaft journal OD) exceeds **0.20 mm (0.008 in.)**, replace camshaft, cylinder block or both.
- Apply John Deere Form-In-Place Gasket, or an equivalent, on the outer edge of the plug. Install the plug until it bottoms in the bore.

Camshaft Followers

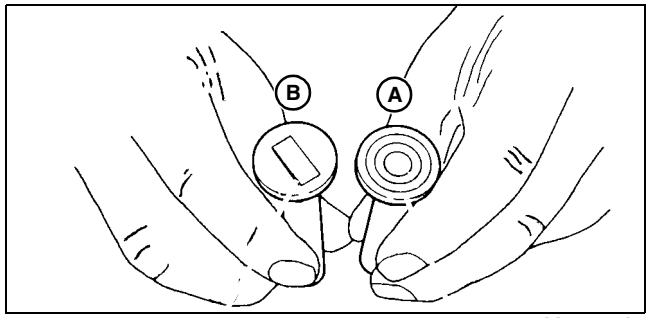
Removing/Installing:

1. Remove the camshaft. (See “Camshaft” on page 264.)
2. Remove the oil pan and strainer.

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

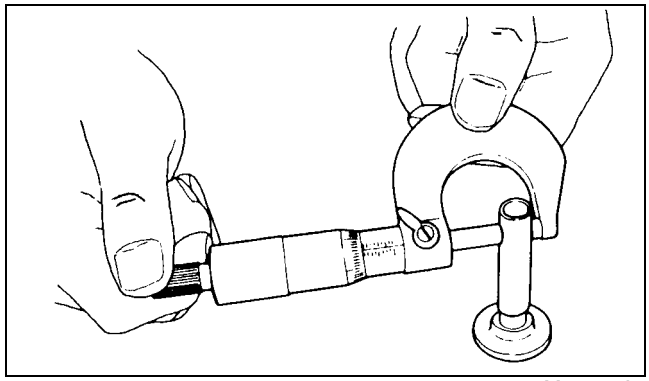
3. Put a mark on each cam follower and the cylinder block bore to aid in installation.
4. Remove the cam followers.
5. Inspect all parts for wear or damage.
6. Apply clean engine oil to all parts during installation.
   - Installation is done in the reverse order of removal.

Inspection:



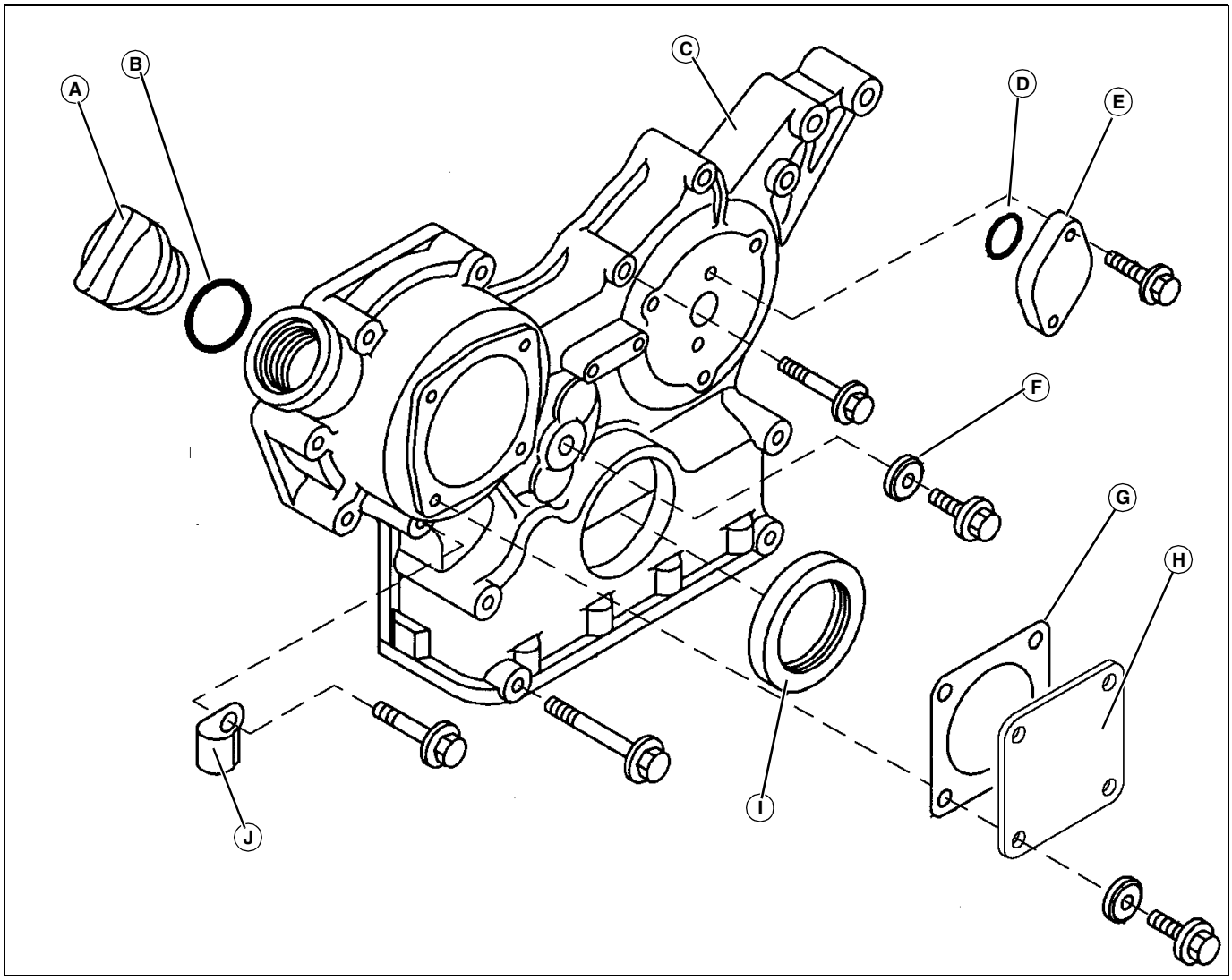
M82074A

1. Inspect the cam follower contact surface for normal contact (A) or abnormal wear (B). Replace if necessary.


M82075A

2. Measure the cam follower stem diameter.
   - Standard cam follower stem OD is **11.98 - 11.99 mm (0.471 - 0.472 in.)**.
   - If the stem diameter is less than **11.93 mm (0.470 in.)**, replace cam follower.
3. Measure the cam follower bore diameter in the cylinder block.
   - Standard cam follower bore ID is **12.00 - 12.02 mm (0.472 - 0.473 in.)**.
   - If the cam follower bore diameter exceeds **12.05 mm (0.474 in.)**, replace the cylinder block.
   - Standard cam follower bore clearance is **0.01 - 0.04 mm (0.0004 - 0.002 in.)**.
   - If the bore clearance (bore ID minus follower stem OD) exceeds **0.12 mm (0.005 in.)**, replace the cam follower, cylinder block or both.

Timing Gear Cover



MX16140

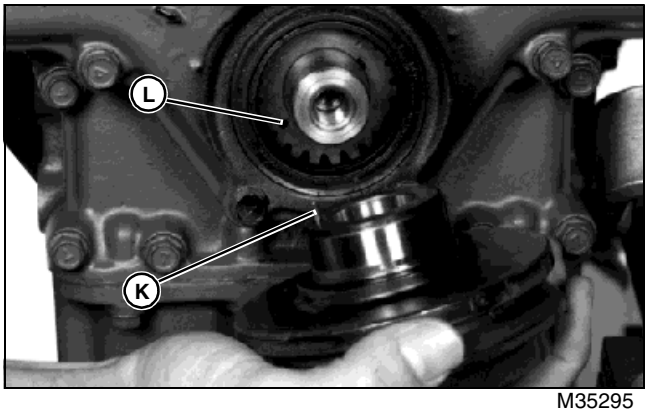
A - Oil Fill Cap
B - O-Ring
C - Timing Gear Cover
D - O-Ring
E - Cover
F - Seal Washer
G - Gasket
H - Cover
I - Front Crankshaft Seal
J - Breather Hose Retainer

Removal/Installation:

1. Remove the alternator and belt.
2. Remove the water pump pulley.
3. Remove the crankshaft pulley cap screw and washer.
4. Remove the crankshaft pulley using a puller.

NOTE: It is not necessary to remove end cover and O-ring or fuel injection pump gear cover to remove timing gear cover.

5. Remove the mounting cap screws and timing gear cover.
6. Inspect the crankshaft oil seal for wear or damage. Replace if necessary.
   - Replace the oil seal using a driver set. Install the seal with lip toward inside of gear housing cover. Install the seal flush with surface of cover.



M35295

7. Installation is done in the reverse order of removal.
   - Apply a small bead of John Deere form-in-place gasket to front cover.
   - Replace the seal washer.
   - Align the pin (K) in crankshaft pulley with the hole (L) in the crankshaft gear. Install the crankshaft pulley.
   - Adjust the fan/alternator drive belt tension.

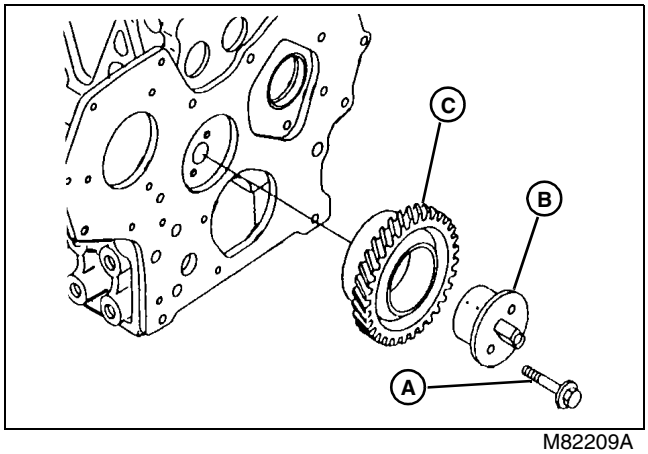
Idler Gear

Removing/Installing:

1. Remove the timing gear cover. (See “Timing Gear Cover” on page 268.)
2. Check the backlash of timing gears. (See “Timing Gear Backlash Check” on page 235.)

NOTE: Due to the odd number of teeth on the idler gear, timing marks will only align periodically. When all timing marks on gears align, the piston closest to the water pump is at TDC on compression stroke. Number one cylinder is closest to the flywheel.

3. Rotate the crankshaft and align the timing marks.



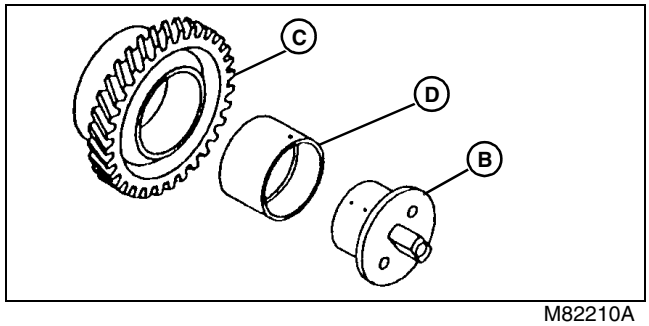
M82209A

4. Remove two cap screws (A), shaft (B) and 43T gear (C).
5. Inspect all parts for wear or damage.

Installation is done in the reverse order of removal.

6. Inspect the gear for chipped or broken teeth. Replace if necessary.
   - Measure the idler gear shaft diameter.
   - Standard idler gear shaft OD is **45.95 - 45.98 mm (1.809 - 1.810 in.)**.
   - If the shaft diameter is less than **45.93 mm (1.808 in.)**, replace idler gear shaft.
7. Measure the idler gear bushing diameter.
   - Standard idler gear bushing ID is **46.00 - 46.03 mm (1.811 - 1.812 in.)**.
   - Replace the bushing if diameter exceeds **46.03 mm (1.812 in.)**.
   - If the bore clearance (bushing ID minus shaft OD) exceeds **0.15 mm (0.006 in.)**, replace the bushing, shaft, or both.

To Replace The Bushing:



M82210A

1. Replace the bushing using a driver set.
2. Align the oil holes in bushing (D) and idler gear (C).
3. Install the bushing flush with surface of idler gear.

Timing Gear Cover Mounting Plate

Removing/Installing:

1. Remove the camshaft. (See “Camshaft” on page 264.)
2. Remove the idler gear. (See “Idler Gear” on page 269.)
3. Remove the fuel injection pump.
4. Remove the oil pump. (See “Oil Pump” on page 215.)
5. Remove the mounting cap screws and plate.
6. Replace the O-Rings.
7. Installation is the reverse of removal.

Oil Pan and Strainer

Removing/Installing:

NOTE: The engine must be removed from the machine to remove the oil pan.

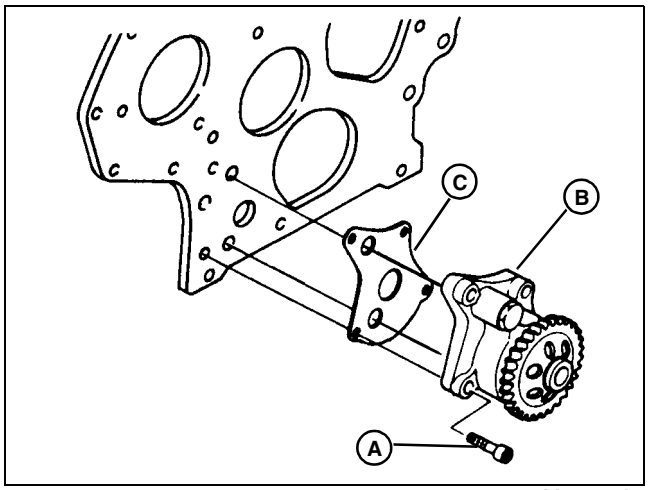
1. Remove the oil pan.
2. Remove the oil pick up strainer.
3. Clean and inspect all parts.
4. Install the oil pick up strainer.
5. Install the oil pan.
6. Fill the engine with correct engine oil.

Oil Pump

Removing/Installing:

1. Remove the timing gear cover. (See “Timing Gear Cover” on page 268.)

2. Check the oil pump gear backlash. Replace the oil pump assembly if backlash is more than **0.12 mm (0.005 in.)**.

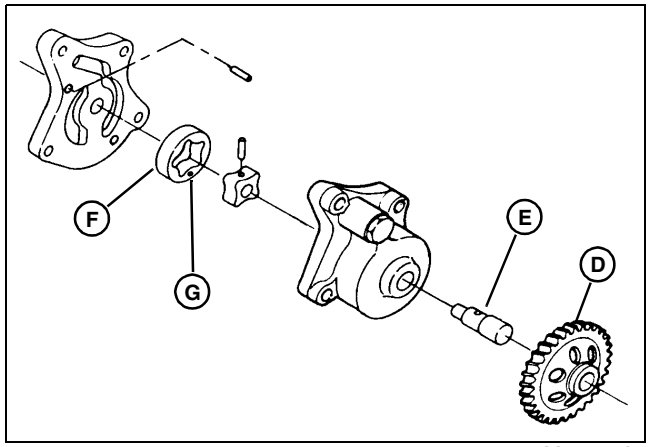


M82215A

3. Remove the mounting cap screws (A), the oil pump (B) and gasket (C).

4. Inspect all parts for wear or damage.

Oil Pump Disassembly/Assembly:



M82216A

1. The gear (D) is press fit on rotor shaft (E). Remove gear using a knife edge puller and a press.

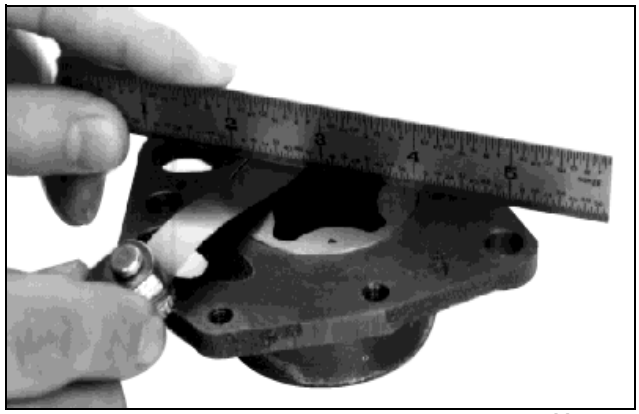
2. Inspect all parts for wear or damage.

3. Coat all parts with clean engine oil.

4. Install the outer rotor (F) with identification mark (G) facing toward rotor shaft assembly.

5. Measure the rotor shaft outer diameter and the shaft hole diameter in cover.

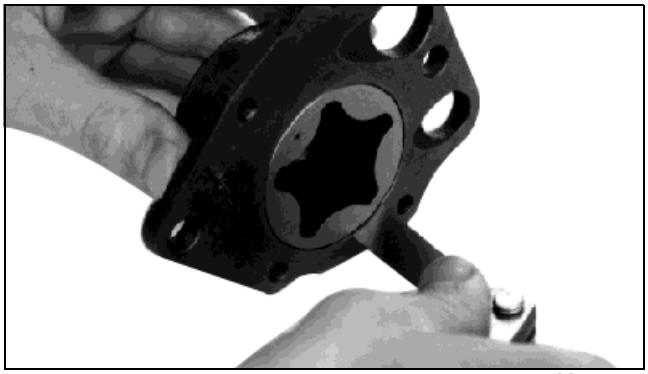
- Standard clearance is **0.01 - 0.04 mm (0.001 - 0.002 in.)**.
- Replace the pump if the clearance is greater than **0.2 mm (0.008 in.)**.



M51571

6. Check the rotor recess.

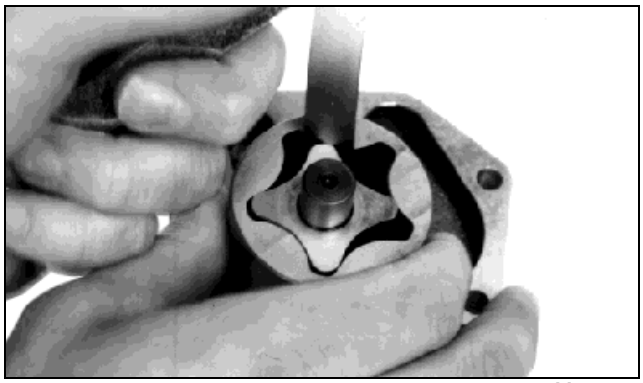
- Standard rotor recess is **0.03 - 0.09 mm (0.001 - 0.004 in.)**.
- Replace the pump if the recess exceeds **0.15 mm (0.006 in.)**.



M51572

7. Measure outer rotor-to-pump body clearance.

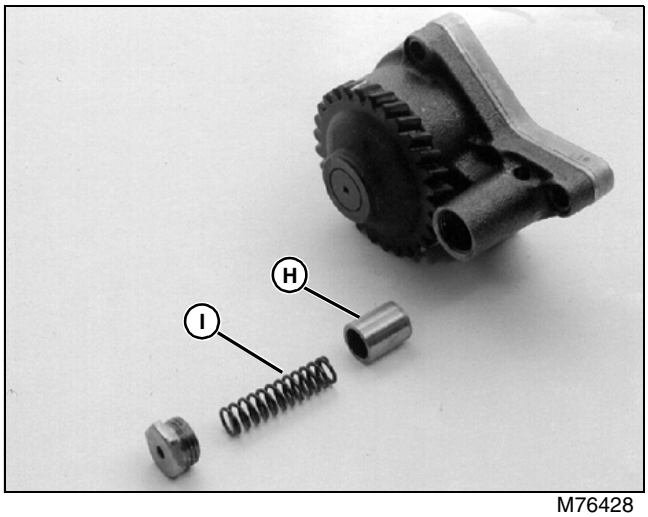
- Standard clearance is **0.10 - 0.16 mm (0.004 - 0.006 in.)**.
- Replace the pump if the clearance is more than **0.25 mm (0.010 in.)**.



M51573

8. Check inner-to-outer rotor clearance.

- Replace the pump if clearance is more than **0.15 mm (0.006 in.)**.



M76428

9. Check the oil pressure relief valve. If the relief valve piston (H) is sticking in the pump body, clean parts to allow free movement of the piston in pump body.

10. Inspect the spring (I) for cracks. The spring is not serviceable. If damage is identified, replace the oil pump assembly.

Thermostat and Water Pump

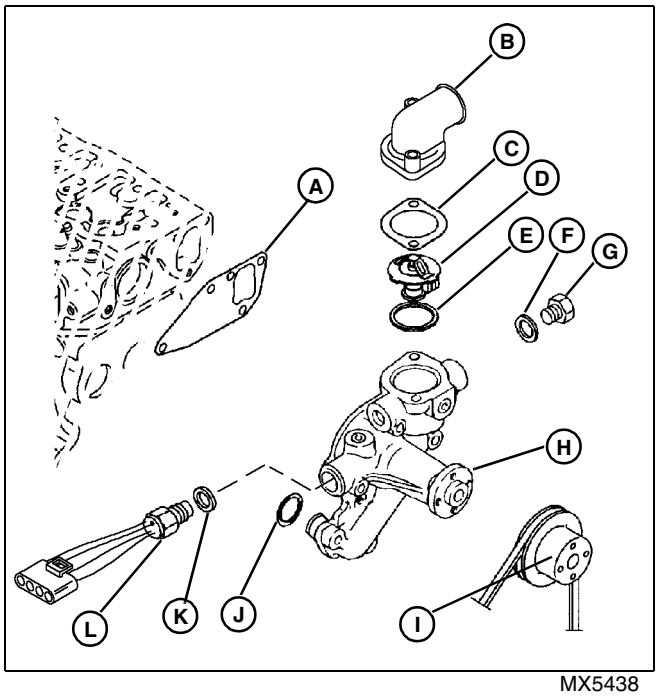
Inspection:

1. Inspect the water pump for coolant leakage. If the origin of the leak cannot be determined, test the cooling system. (See “Cooling System Pressure Test” on page 238.)

- If coolant is leaking at the pulley flange:
  The shaft seal is defective. Replace the water pump.
- If coolant is leaking between the cylinder head and the pump housing:
  The gasket between the head and the pump is defective. Remove the water pump and replace the gasket.

2. Inspect the water pump for a worn bearing shaft by removing the fan belt and checking for excessive movement of the fan. Replace the water pump if excessive movement is noticed.

- If the bearing shaft is making noise when operating:
  Check the fan belt tension. If adjustment does not relieve the noise, the bearing shaft is defective. Replace the water pump.



MX5438

A - Gasket
B - Outlet
C - Gasket
D - Thermostat
E - Gasket

F - Copper Washer
G - Plug
H - Water Pump
I - Water Pump Pulley
J - O-ring
K - Copper Washer
L - Temperature Switch

Replacement:

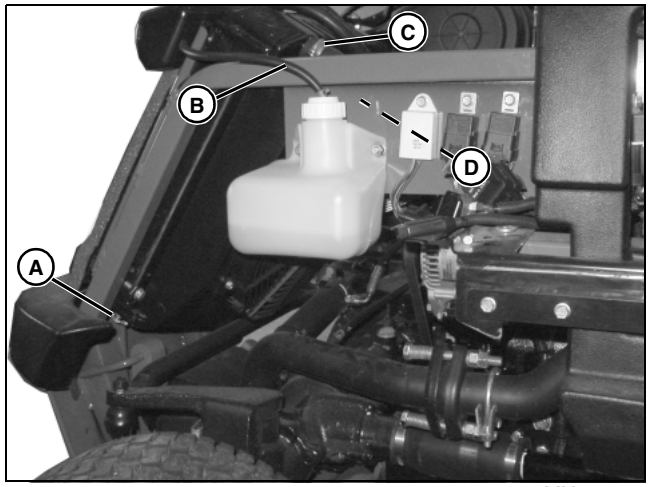
1. Open the engine drain valve to drain coolant.
2. Disconnect the coolant temperature sensor lead.
3. Disconnect the upper and lower radiator hoses.
4. Remove the water pump/alternator drive belt.
5. Remove the water pump pulley.
6. Remove the mounting cap screws, pump and gasket.
7. Inspect the pump for wear or damage.
8. Test the thermostat for proper operation. (See “Thermostat Opening Test” on page 237.)
9. Installation is done in the reverse order of removal.
10. Adjust the water pump/alternator drive belt tension.

Radiator Removal, Installation and Inspection

Removal:

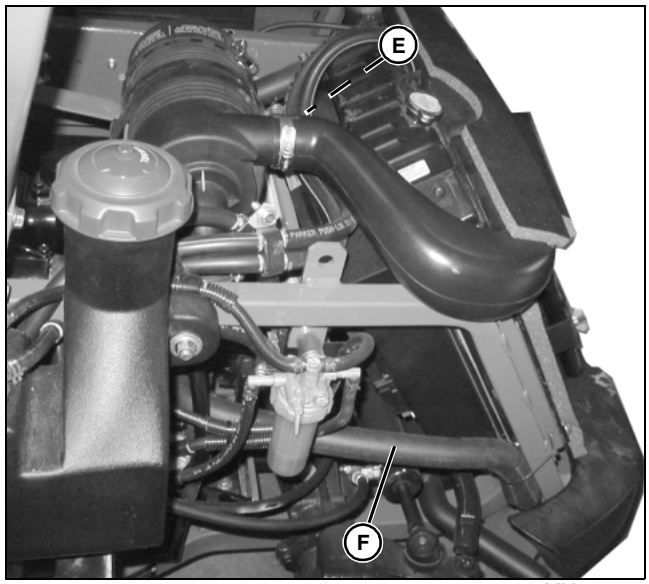
CAUTION: Avoid injury! Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Remove filler cap only when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

1. Park machine safely.
2. Turn key switch to stop position and allow the engine to cool.
3. Remove engine cover.
4. Loosen radiator cap to first stop to relieve pressure.
5. Remove radiator cap.



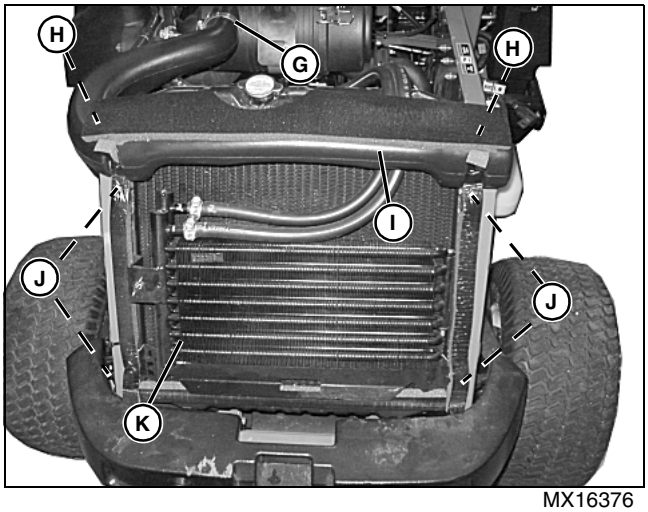
MX16375

6. Attach a 12-inch hose to drain valve (A) located on lower right side of radiator. Drain coolant from radiator into container large enough to hold full capacity of cooling system.
7. Disconnect overflow hose (B) from radiator.
8. Loosen hose clamp and remove hose (C) from radiator.
9. Disconnect cooling fan electrical connector (D).



MX16374

10. Remove clamp (E) holding oil cooler hoses to radiator fan housing.
11. Loosen hose clamp and remove hose (F) on left side of radiator.



MX16376

12.Loosen clamp (G).

13.Peel back foam and remove two cap screws (H).

14.Remove air box (I).

IMPORTANT: Avoid damage! Use caution when moving oil cooler aside to prevent damaging fins.

15.Peel back foam and remove four bolts (J) securing radiator and oil cooler to frame. Carefully move the oil cooler (K) and associated brackets away from radiator.

16.Remove radiator and cooling fan as an assembly.

Installation:

NOTE: Installation is done in the reverse order of removal.

- Start engine and watch coolant level in radiator. Add coolant if necessary to bring coolant level up to filler neck.

Inspection:

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

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

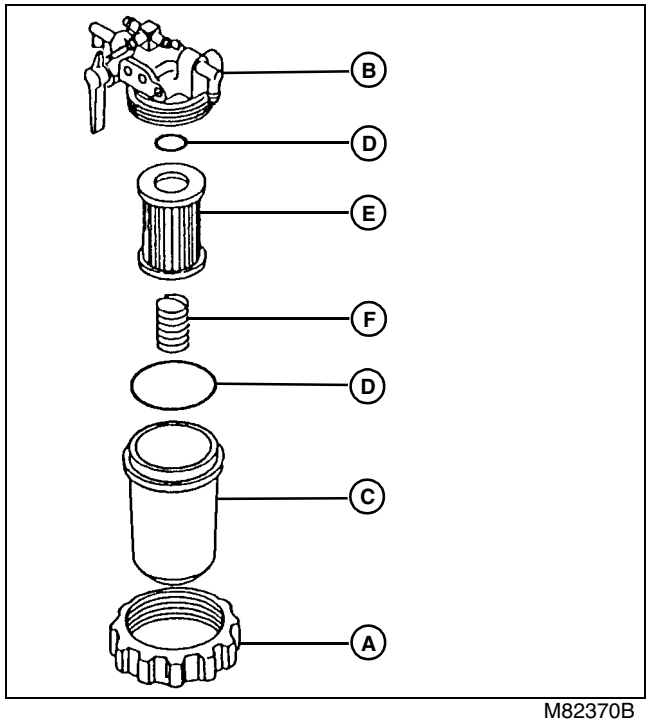
1. Check radiator for debris lodged in fins. Clean radiator using compressed air or pressure washer.

2. Inspect radiator for bent fins, cracks, and damaged seams. Repair or replace radiator if necessary.

Specifications:

Cooling System Capacity (Approximately) . . . . . 7.5 L (8 qt)

Fuel Filter Assembly



M82370B

1. Remove the retaining ring (A) from the mounting base (B) while holding on to the filter cover (C).

2. Remove the filter cover from the mounting base.

3. Remove and replace the O-rings (D) and filter element (E).

4. Be sure the spring (F) is in the filter cover and place the filter element in the filter cover.

5. Before installing the filter cover and element in the mounting base, verify the O-ring is in the groove inside the mounting base.

6. Install the filter cover and the element in the mounting base.

7. Place the retaining ring over filter cover and screw on the mounting base to retain filter cover to mounting base.

IMPORTANT: Avoid damage! Tighten only enough to keep the filter assembly from leaking. Overtightening the retaining nut may damage the filter cover or retaining ring.

Fuel Injection Pump

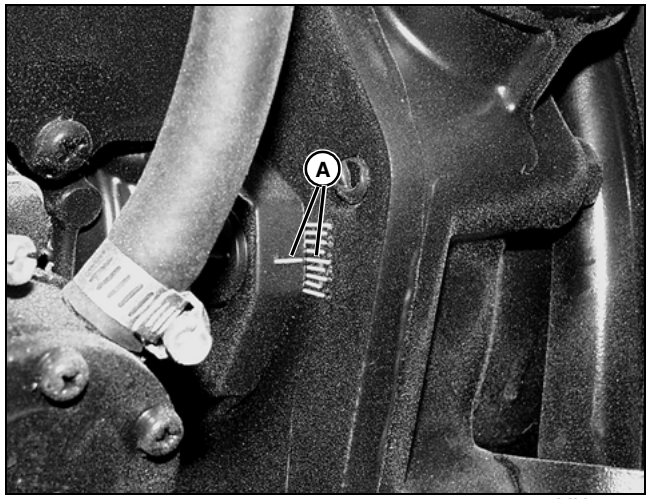
Removing:

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

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

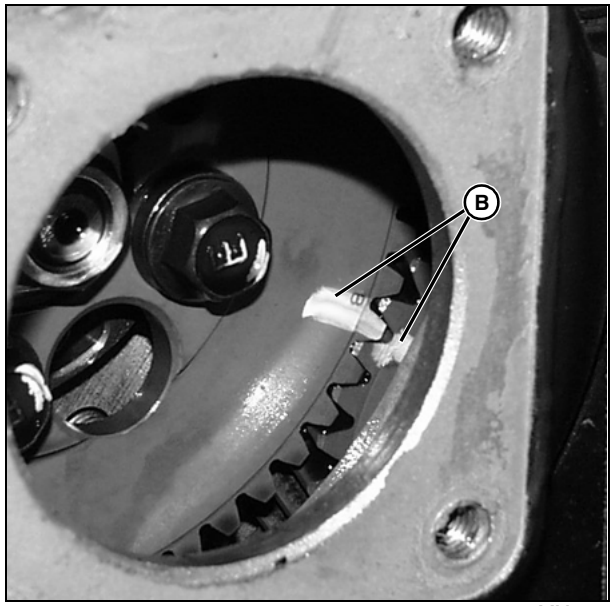
IMPORTANT: Avoid damage! Never steam clean or pour cold water on an injection pump while the pump is running or warm. Doing so can damage the pump.

1. Clean the injection pump lines and area around the pump using parts cleaning solvent or steam cleaner.
2. Loosen the fuel injection line nuts. When loosening the nuts on the injector pump, use another wrench to keep the delivery valves from loosening.
3. Loosen the line clamps, and remove the fuel injection lines.
4. Disconnect the fuel filter hoses.
5. Remove the external lube line.
6. Disconnect the fuel shutoff solenoid.



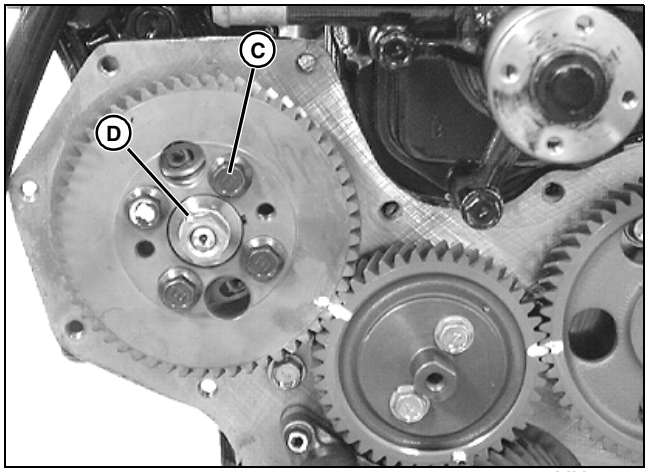
MX1399

7. Note the position of the timing marks (A) on the injection pump and the gear cover mounting plate.
8. Remove three mounting nuts (B).



MX9675

9. Remove the access cover from the front of the timing gear cover.
10. Rotate engine until “B” marks on injector pump gear and idler gear (B) are aligned.

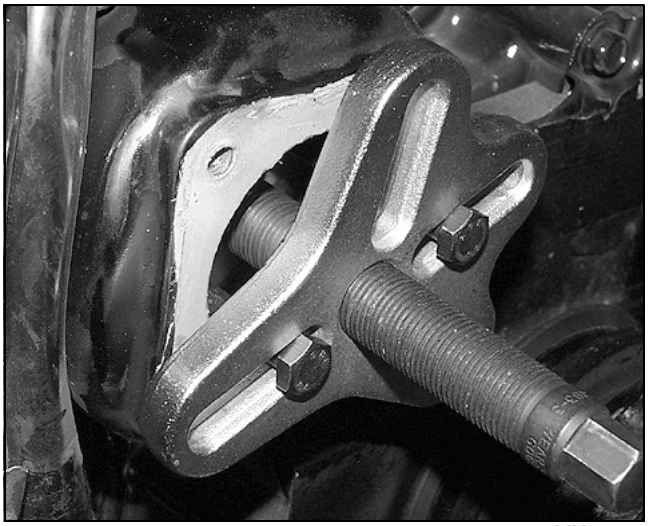


MX2355

Picture Note: Timing gear cover removed for photo only. Timing gear cover does not need to be removed for injector pump removal.

IMPORTANT: Avoid damage! Do not loosen four cap screws (C) attaching gear to hub! This gear/ hub assembly times the injector pump camshaft in relation the crankshaft for precise timing of EPA engines. This procedure is done at the pump manufacturing plant and cannot be duplicated in the field!

11.Remove nut (D).


MX9676

12.Use a puller to remove the gear from the injection pump shaft. Remove the puller. The gear remains in the timing gear cover.

13.Remove the injection pump and O-Ring.

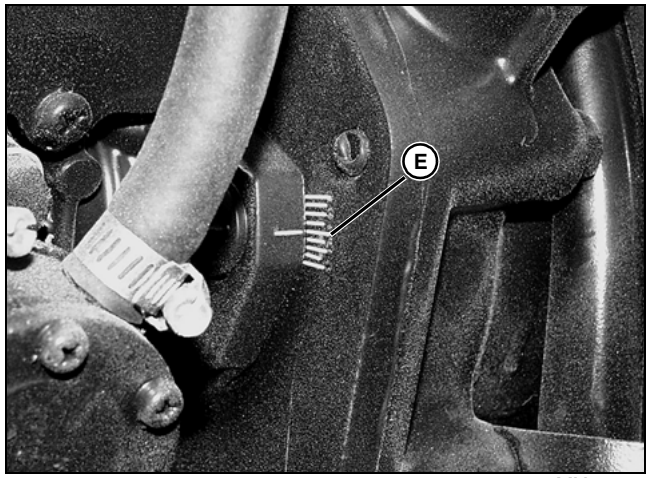
IMPORTANT: Avoid damage! Do not attempt to service the injection pump or governor. If unit is in need of repair, it must be serviced by a qualified fuel injection repair shop. If replacement is necessary, replace entire unit.

Installing:

1. Install new O-ring to the injection pump.
2. Put injection pump onto back of gear cover mounting plate. Install three mounting nuts. Do not tighten. Align key on shaft with keyway in gear. Be sure to align marks on gears made during removal.
3. Install nut on timing gear. Tighten to specification.

Specification:

Timing Gear Nut . . . . . 58 - 68 N•m (43 - 50 lb-ft)



MX1399

4. Align marks on mounting plate and injection pump, to same place as when removed, and tighten mounting nuts to specifications.
5. Place a thin bead of John Deere form in place gasket on the cover, and install the cover.
6. Connect fuel shutoff solenoid wire.
7. Connect hoses to/from fuel filter.
8. Install fuel injection lines and tighten line clamps.

Specification:

Injector Line Nuts. . . . . 30 - 35 Nm (22 - 25 lb-ft)

IMPORTANT: Avoid damage! If the oil has been drained out of the fuel injection pump housing, add oil as necessary. The fuel injection pump can be damaged if operated without the proper amount of oil.

9. Remove the fill plug and add clean engine oil to the housing. Add until the oil begins to drip out of external lube line inlet.

10.Install the external lube line. When installing the line, put one copper washer between the mounting bolt head and lube line and the other between the lube line and housing.

If a new injection pump is being installed, check injection pump timing. (See “Injection Pump Timing Adjustment” on page 230.)

Fuel Injection Nozzles

Removing:

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

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

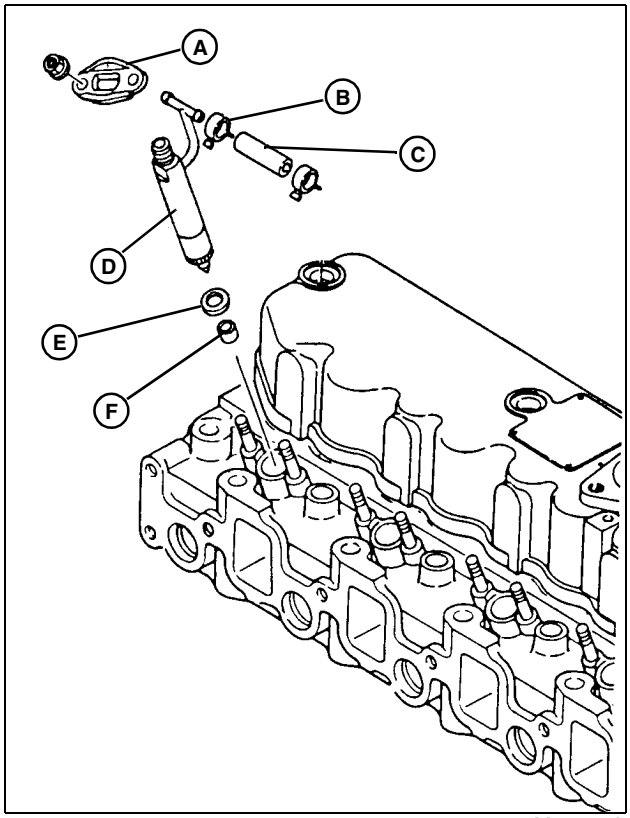
CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body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

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

2. Loosen fuel injection line connectors-to-nozzles slightly to relieve pressure in the fuel system.

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

3. Loosen line clamp(s) and remove fuel injection lines.

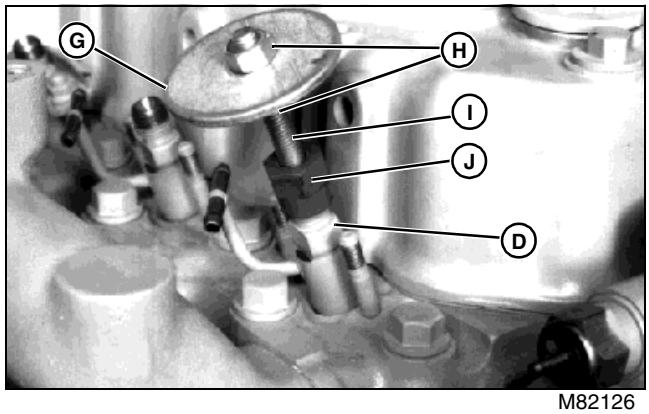


M82092A

4. Remove clamps (B) and leakoff hoses (C).

5. Remove nuts and retaining plates (A).

6. Remove injection nozzle (D), ring (E) and Teflon heat protector (F). If ring and protector stay in cylinder head, thread a cap screw into protector and pull from cylinder head.



M82126

7. If nozzles are stuck in cylinder head:

- Grind the head of a cap screw (I) so it fits inside a nut from an old injection line (J).
- Use two nuts (H) to attach a large flat washer (G) to the cap screw.
- Install assembly onto nozzle (D) and use a puller and slide hammer to pull nozzle from cylinder head.

8. Test injection nozzles. (See “Fuel Injection Nozzle Test” on page 236.)

Installing:

Installation is done in reverse order of removal.

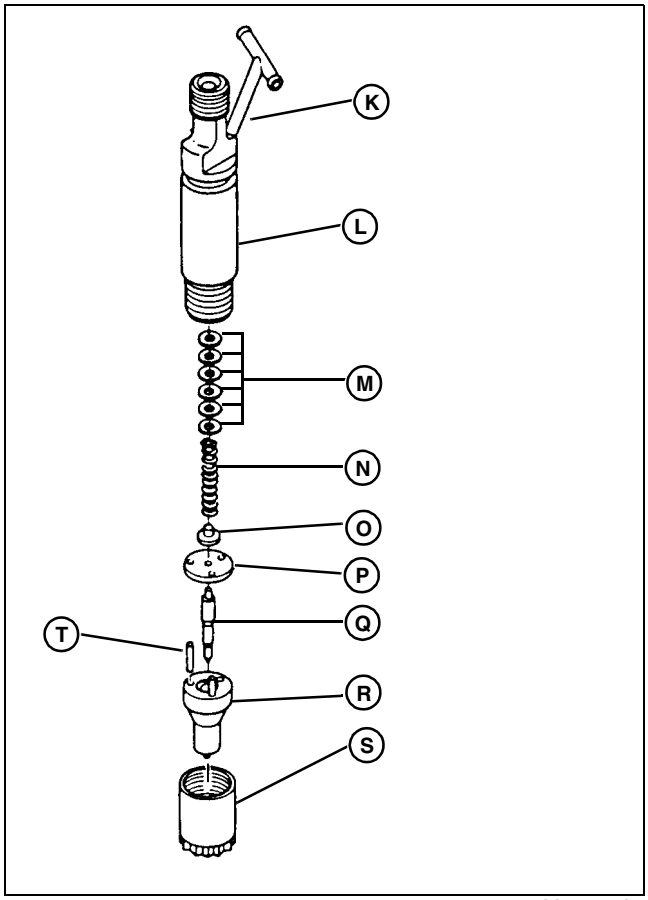
- Install a new ring and heat protector when installing injection nozzles.

Disassembly/Assembly:

NOTE: If servicing more than one nozzle, keep parts for each nozzle separate from one another.

1. Remove retaining nut (S) and disassemble internal parts of injection nozzle. Keep parts organized for ease of assembly.

2. Clean and inspect nozzle assembly. (See “Cleaning/ Inspection:” on page 278.)



M82093A

K. Return Pipe	P. Separator Plate
L. Injector Body	Q. Nozzle Valve
M. Shim(s)	R. Nozzle Body
N. Spring	S. Retaining Nut
O. Spring Seat	T. Index Pin

3. Carefully clamp injector body (L) in a soft-jaw vice.

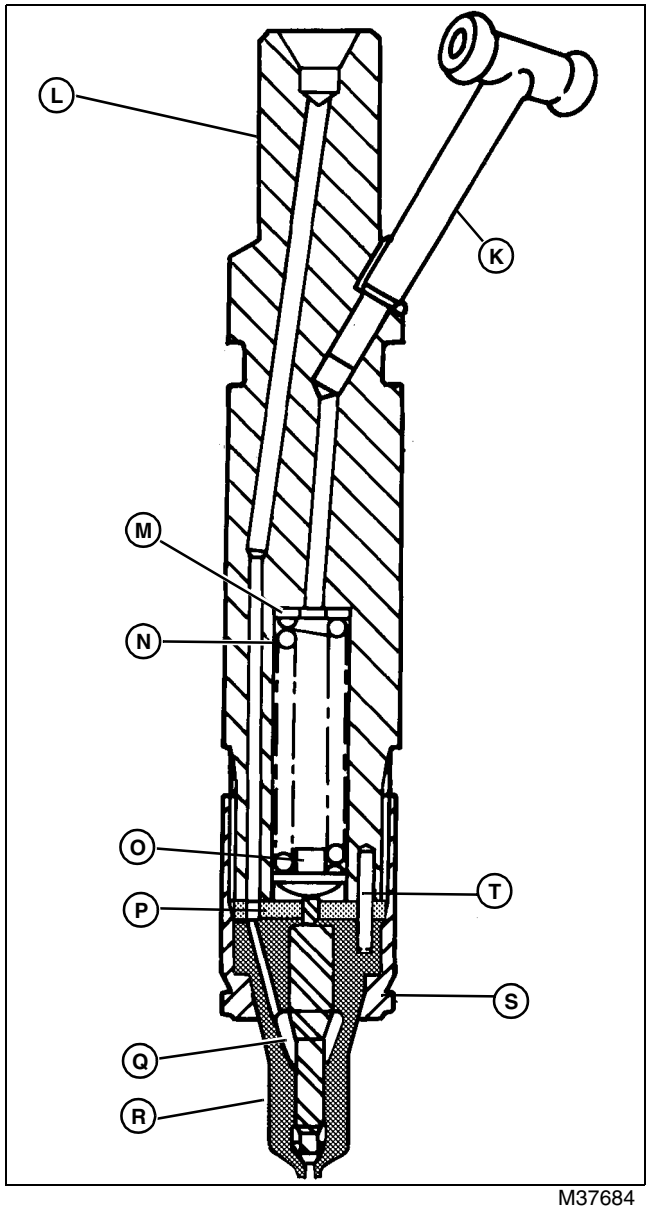
NOTE: Insert the same number of shims (M) that were removed from injector. Number of shims will affect the opening pressure of the fuel nozzle and will be tested after assembly.

4. Reassemble fuel nozzle in the order shown above.

5. Tighten retaining nut to **6.8 - 8.8 N•m (60 - 78 lb-in.)**.

6. After assembly is complete, test injection nozzle.

Cross Section:



M37684

K. Return Pipe	P. Separator Plate
L. Injector Body	Q. Nozzle Valve
M. Shim(s)	R. Nozzle Body
N. Spring	S. Retaining Nut
O. Spring Seat	T. Index Pin

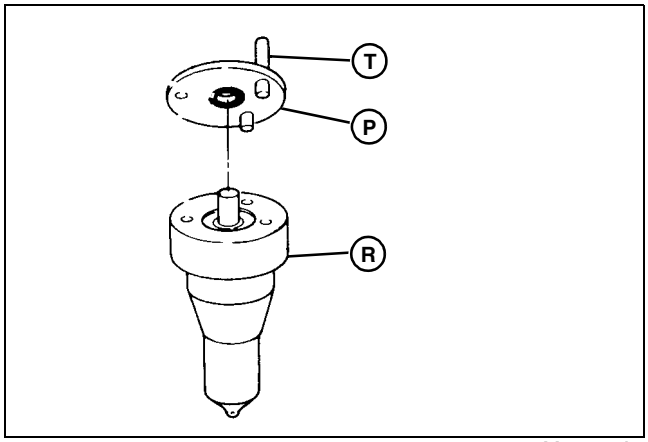
Cleaning/Inspection:

NOTE: To clean nozzles properly, JDF13 Nozzle Cleaning Kit is recommended. The Cleaning Kit is available through the John Deere SERVICEGARD™ Catalog.

1. Remove anti-corrosive grease from new or reconditioned nozzles by washing them thoroughly in diesel fuel.

IMPORTANT: Avoid damage! Never use a steel brush to clean nozzles as this will distort the spray hole.

2. Remove carbon from used nozzles, and clean by washing in diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush (supplied in Nozzle Cleaning Kit).

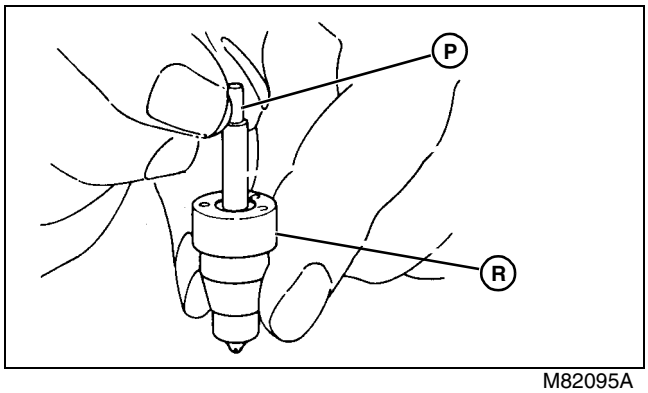


M82094A

3. After removing carbon or lacquer from the exterior of nozzle, inspect sealing surfaces between separator plate (P) and nozzle body (R) for nicks or scratches.

4. Contact area of separator plate (both parts) must not be scored or pitted. Use an inspection magnifier (No. 16487 or equivalent) to aid in making the inspection.

5. Check nozzle contact surface on separator plate for wear. If contact surface is more than **0.10 mm (0.004 in.)**, replace nozzle assembly.



M82095A

6. Inspect the piston (large) part of nozzle valve (P) to see that it is not scratched or scored and that lower (tip) end of valve is not broken. If any of these conditions are present, replace the nozzle assembly.

7. Further inspect the nozzle assembly by performing a slide test. Use the following procedure:

- Dip the nozzle valve (P) in clean diesel fuel. Insert valve in nozzle body (Q).
- Hold nozzle vertical, and pull valve out about 1/3 of its engaged length.
- Release valve. Valve should slide down to its seat by its own weight.

Replace nozzle assembly if the valve does not slide freely to its seat.

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General Information

Reading Electrical Schematics

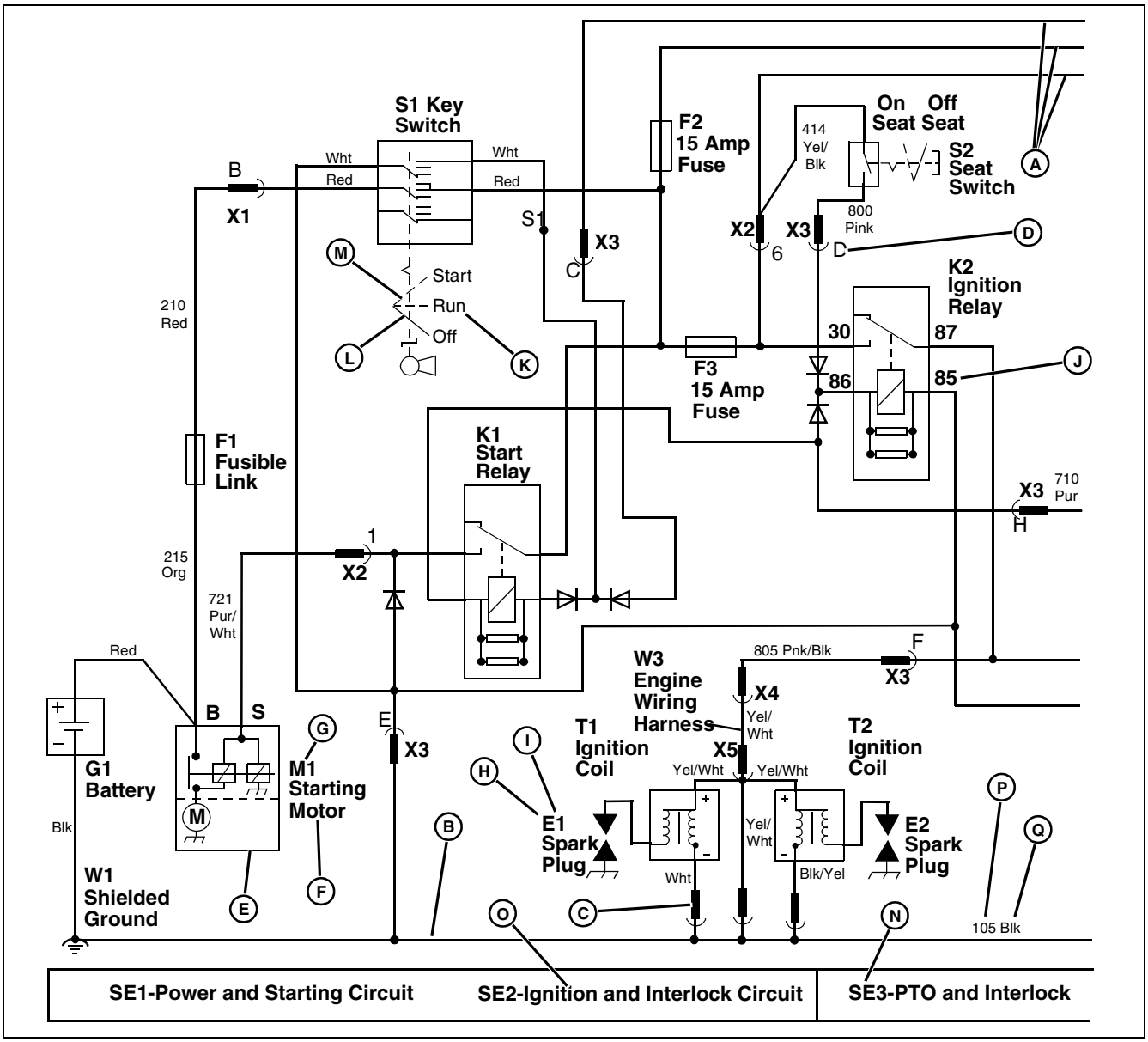
The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all ground wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in the off position. The diagram does not list connector (C) information unless needed to avoid confusion. If the connector is shown, the number next to it is the terminal pin location (D) in the connector.

Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

The identifying letter is always the same for a specific component, but the identifying numbers are numbered consecutively from upper left to lower right. The terminal designation (J) is placed directly outside the symbol next to the connecting wire path. Switch positions (K) are also placed directly outside the symbol. The solid line (L) shows the position the switch is currently in and dash lines (M) represent other switch positions.

Each circuit is identified at the bottom of the drawing by a section number (N) and section name (O).

The circuit number (P) and wire color (Q) of the wires are shown directly next to the wire path.



MIF

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

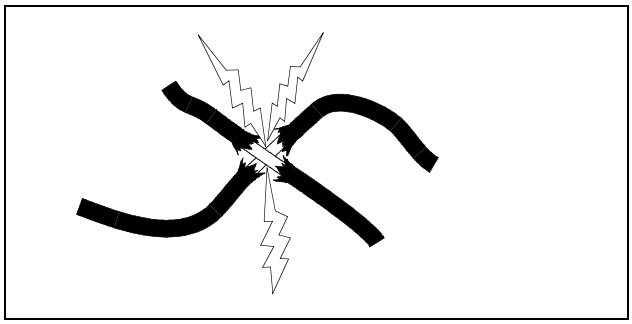
When performing the test or check, be sure to set your machine up to the Test Conditions listed in beginning of the procedure and follow the sequence carefully. If the results of the test or check are not normal, perform the test, check, or adjustment listed below. The system diagram that accompanies 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:



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:

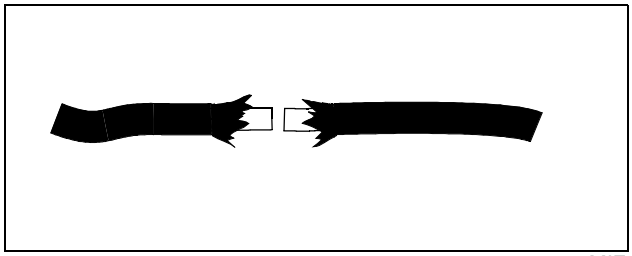
1. Turn component switch on.

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:

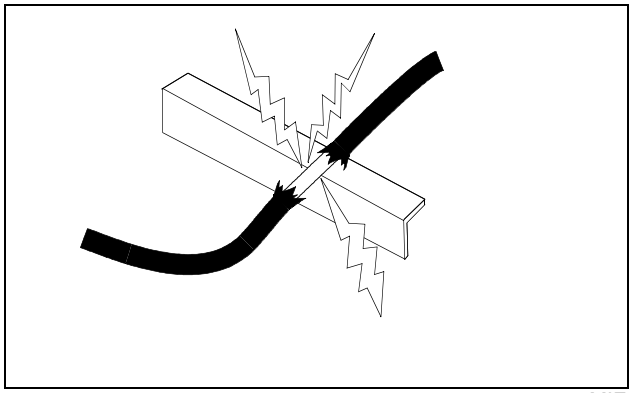


MIF

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
3. 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

Stranded Conductors For 12 Volt Circuits						
SAE Wire Size (Gauge)	20	18	16	14	12	10
Metric Wire Size (mm)	0.5	0.8	1.0	2.0	3.0	5.0
Typical Stranding	7 X 28	16 X 30	19 X 29	19 X 27	19 X 25	19 X 23
Minimum Conductor Area In Circular Mils	1072	1537	2336	3702	5833	9343

Tools and Materials

Kit Numbers

Other Material

Part No.	Part Name	Part Use
AM116760	0.5 Fuse	Fusible Link
AM107086	0.8 Fuse	Fusible Link
AM107087	1.0 Fuse	Fusible Link
AM107088	2.0 Fuse	Fusible Link

Specifications

Test and Adjustment Specifications

Battery:

Voltage . . . . . 12 VDC

Ignition (1420 Only):

Air gap . . . . . Non-adjustable

Alternator:

Type . . . . . Denso
Unregulated Current. . . . . 55 A (minimum)
Regulated Current . . . . . 13.5 A (minimum)
Unregulated Voltage at Fast Idle . . . . . .50 VAC (minimum)
Unregulated Voltage at Slow Idle . . . . . .32 VAC (minimum)
Regulated Voltage . . . . . 12.2 - 14.7 VDC at Fast Idle

Alternator (1445 and 1545 Only):

Unregulated Current. . . . . 55 A (minimum)
Regulated Current . . . . . 13.5 A (minimum)
Unregulated Voltage at Fast Idle . . . . . 50 VDC (minimum)
Unregulated Voltage at Slow Idle . . . . . 32 VAC (minimum)
Regulated Voltage . . . . . 12.2 - 14.7 VDC at Fast Idle

Starting Motor (1420 and 1435):

Type . . . . . Solenoid Shift
Manufacturer. . . . . Denso
Power Output . . . . . .1.0 kW
Starting motor amp draw (on machine) . . . . . .150 A (maximum)
Starting motor no-load amp draw (free running). . . . . 60 A (maximum) at 4300 rpm

Starting Motor (1445/1545/1565):

Type . . . . . Solenoid Shift
Manufacturer. . . . . Denso
Power Output . . . . . 1.0 kW
Starting motor amp draw (on machine) . . . . . .230 A (maximum)
Starting motor no-load amp draw (free running). . . . . 90 A (maximum) at 3000 rpm

Glow Plugs:

Resistance. . . . . 0.2 - 0.5 ohms

Cruise Control Magnet:

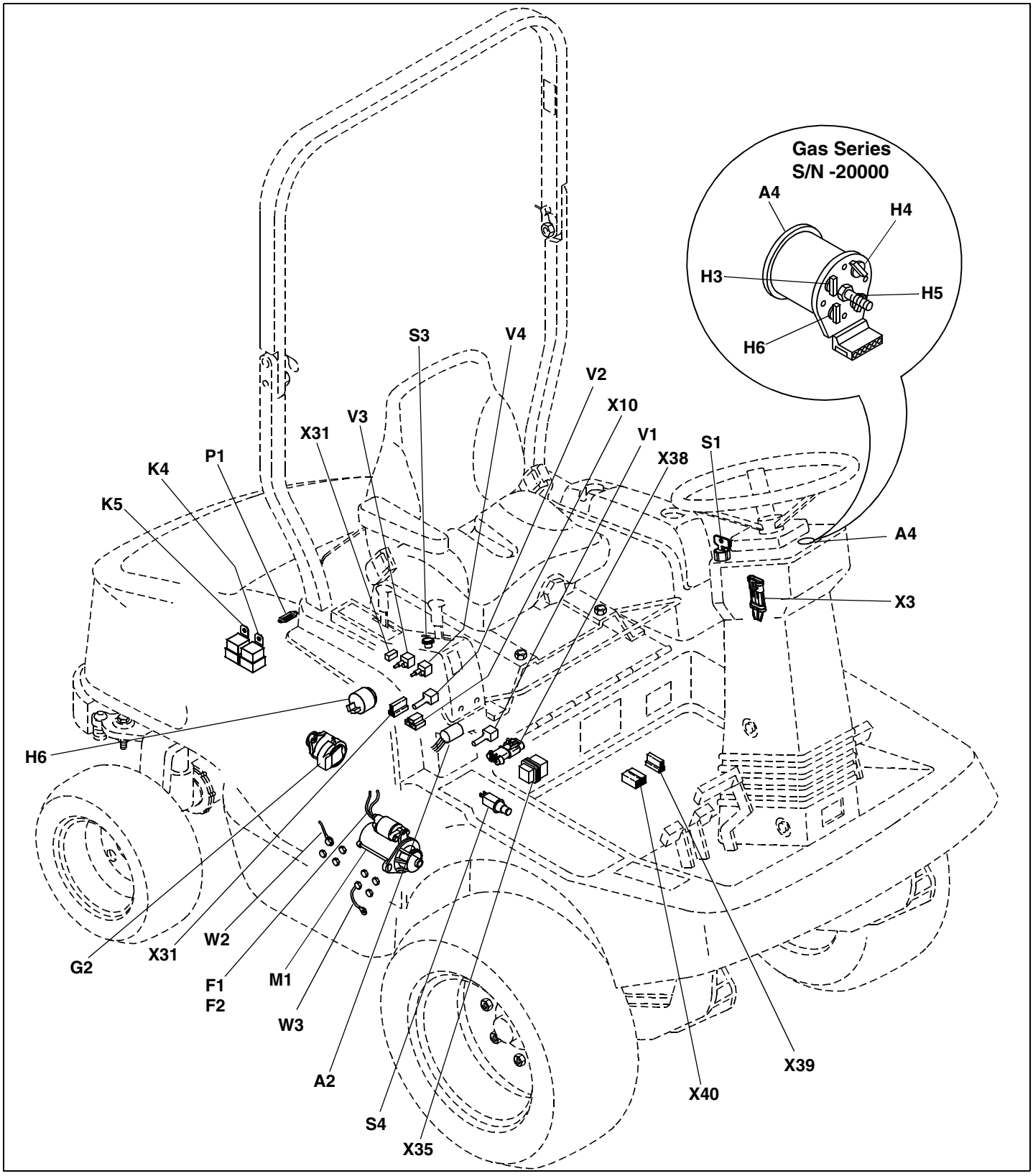
Resistance. . . . . Approximately 20 ohms

Fuel Shutoff Solenoid Resistance:

Hold-In Coil . . . . . .0.4 ohms
Combined Hold-In and Pull-In Coil . . . . . .12.4 ohms
Pull-In Coil. . . . . .12.0 ohms

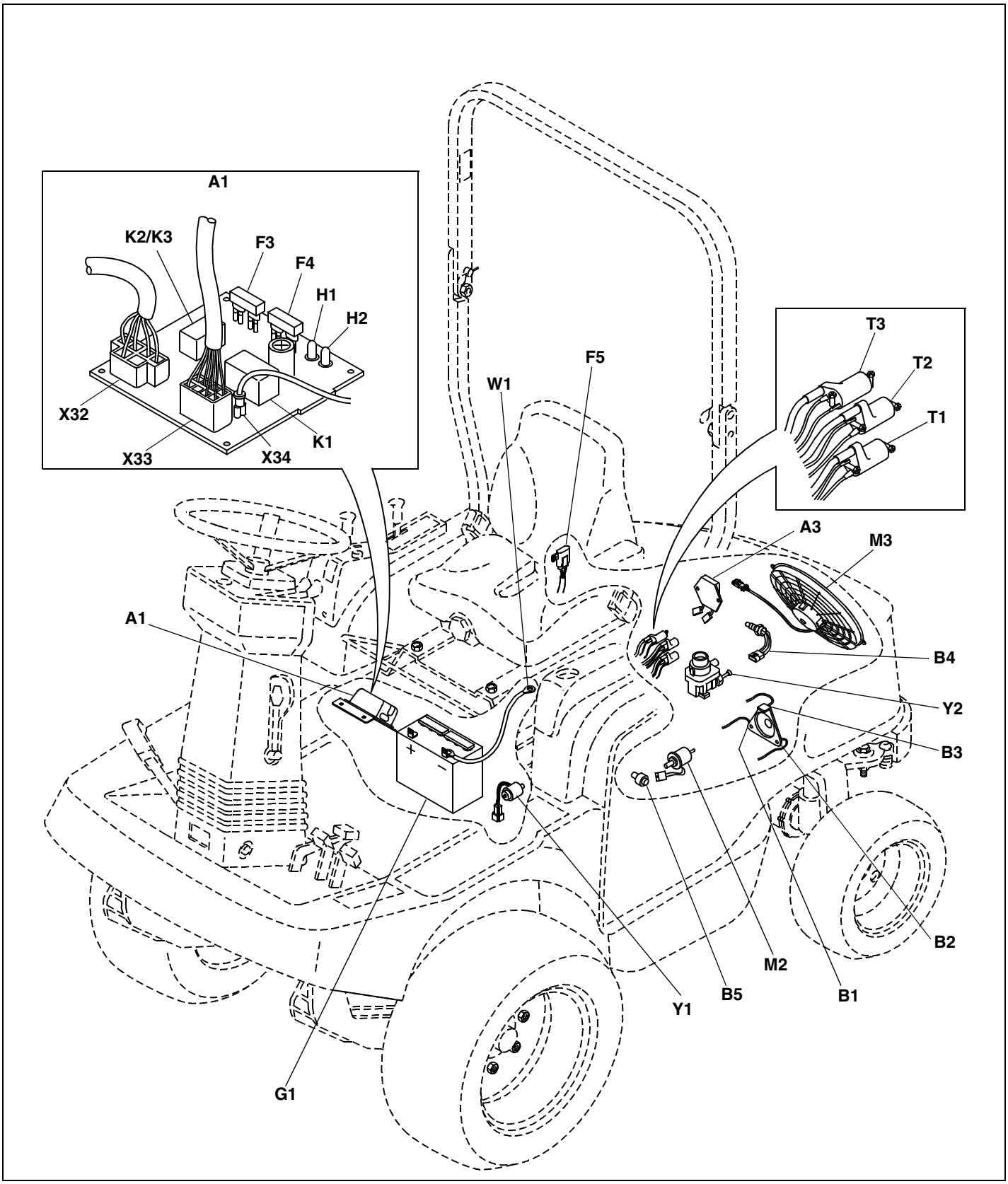
Component Location

Gas Engine Electrical Components



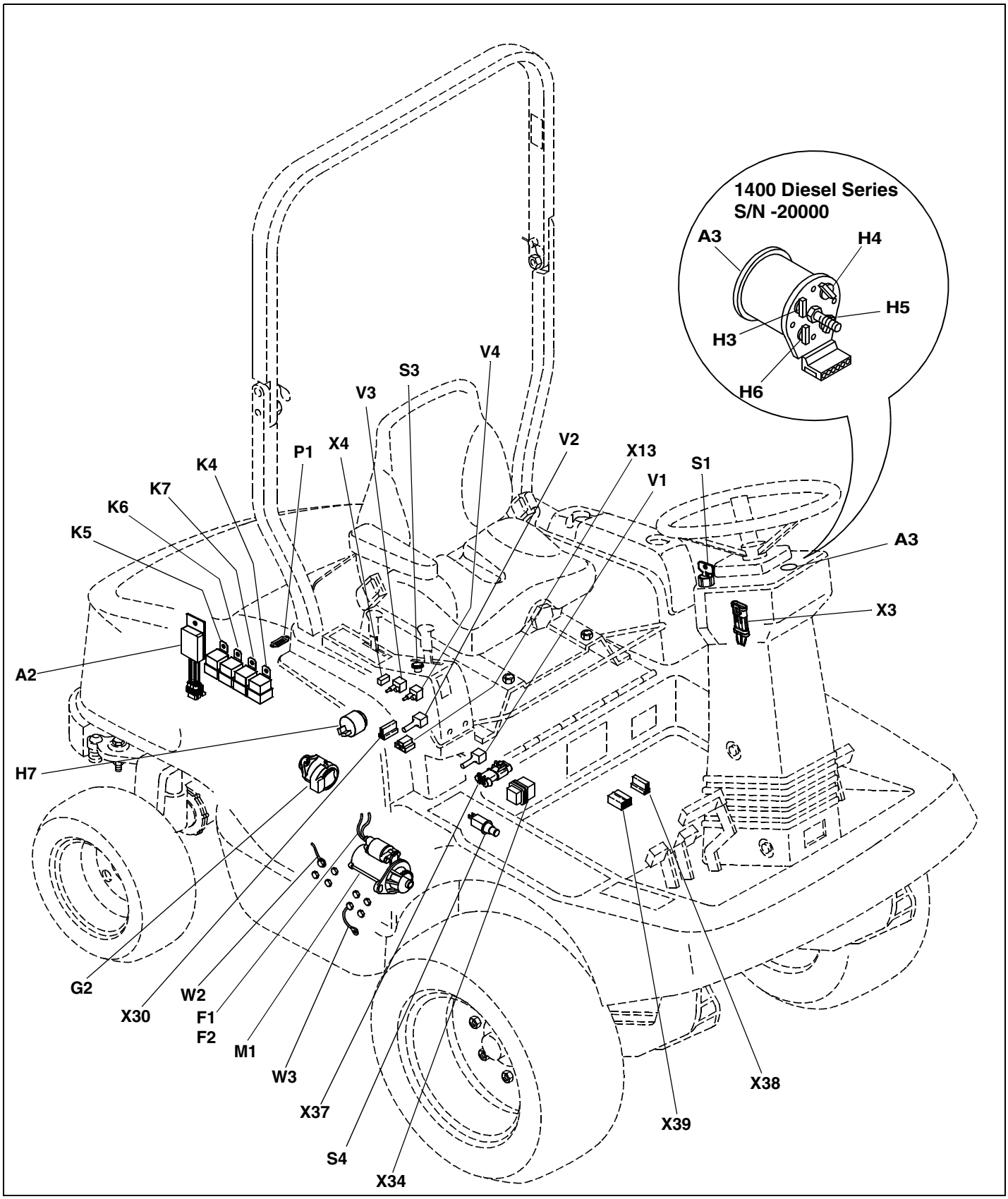
MX5515

ELECTRICAL COMPONENT LOCATION



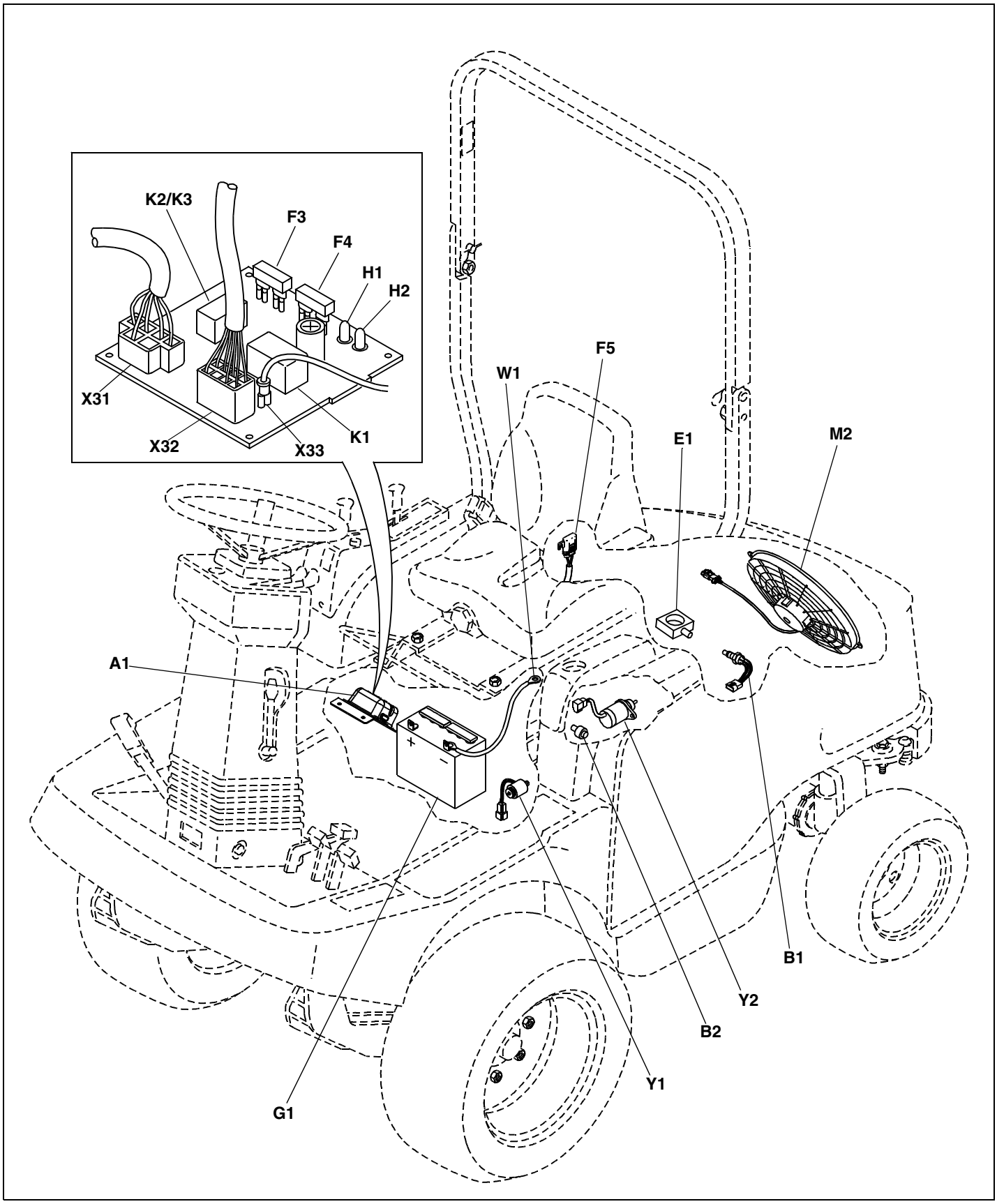
MX5516

Diesel Engine Electrical Components



MX5472

ELECTRICAL COMPONENT LOCATION



MX5473

Schematics and Harnesses

Schematic and Wiring Harness Legend - Gas Engine

Component

A1 - Control Module (SE1, SE2, W4)

A2 - Shutdown Delay Module (SE3, W4)

A3 - Ignition Module (SE3, W4)

A4 - Instrument Panel (SE6, (W4)

B1 - Right Pulser Coil (Controls T1) (SE3, W5)

B2 - Left Pulser Coil (Controls T2) (SE3, W5)

B3 - Top Pulser Coil (Controls T3) (SE3, W5)

B4 - Dual Temp. Coolant Switch (SE4, W4)

B5 - Engine Oil Pressure Switch (SE6, W4)

E1 - Spark Plug No. 1 (Flywheel End) (SE3)

E2 - Spark Plug No. 2 (SE3)

E3 - Spark Plug No. 3 (Fan End) (SE3)

E4 - Headlight (SE5, W1) (S/N 20001-)

E5 - Headlight (SE5, W1) (S/N 20001-)

F1 - Fuse Link (SE1, W4)

F2 - Fuse Link (SE1, W4)

F3 - Fuse-15A (SE2)

F4 - Fuse-15A (SE2)

F5 - Fan Fuse-30A (SE4, W4)

F5 - Fan Circuit Breaker-30A (SE4, W4) (S/N 20001-)

F6 - Auxiliary Power Fuse-10A(SE1, W1) (S/N 20001-)

G1 - Battery (SE1)

G2 - Alternator (SE5, W4)

H1 - Hold-In LED (SE2)

H2 - PTO LED (SE2)

H3 - Discharge Light (SE5)

H4 - Engine Oil Pressure Light (SE6)

H5 - Coolant Temp. Light (SE6)

H6 - Buzzer (SE6, W4)

H7 - PTO on Indicator Light (SE7, W1) (S/N 20001-)

H8 - Headlights on Light (SE7, W1) (S/N 20001-)

K1 - Start Relay (SE1)

K2 - Hold-In Relay (SE2)

K3 - PTO Relay (SE2)

K4 - PTO Overtemp Relay (SE2, W4)

K5 - Cooling Fan Relay (SE4, W4)

K6 - Cruise Control Relay (Optional) (SE7, W4)

K7 - MCS Relay (Optional) (SE8)

M1 - Starting Motor (SE1, W4)

M2 - Fuel Transfer Pump (SE3, W4)

M3 - Fan Motor (SE4, W4)

P1 - Hour Meter (SE6, W4)

S1 - Key Switch (SE1, W4)

S2 - Seat Switch (SE2, W4)

S3 - PTO Switch (SE2, W4)

S4 - Brake Switch (SE2, W4)

S5 - Cruise Control Brake Switch (Optional) (SE7, W4)

S6 - Cruise Control Switch (Optional) (SE7, W4)

S7 - MCS Switch (Optional) (SE8, W4)

S8 - Light Switch (SE5, W1) (S/N 20001-)

Splice 1 - (SE1, W4)

Splice 2 - (SE2 - SE6, W4)

Splice 3 - (SE2 - SE6, W4)

Splice 4 - (SE3, W6)

Splice 5 - (SE3, W5)

Splice 6 - (SE4, W4)

Splice 7 - (SE7, W4)

Splice 8 - (SE1 - SE5, W4)

Splice 9 - (SE2 - SE7, W4)

Splice 10 - (SE4, W4)

T1 - Ignition Coil (SE3, W6)

T2 - Ignition Coil (SE3, W6)

T3 - Ignition Coil (SE3, W6)

V1 - PTO Diode (SE2, W4)

V2 - Cooling Fan Diode (SE4, W4)

V3 - Engine Oil Pressure Buzzer Diode (SE6, W4)

V4 - Overtemp Buzzer Diode (SE6, W4)

W1 - Battery-to-Engine Ground (SE1, W4)

W2 - Main Harness-to-Frame Ground (SE1, W4)

W3 - Engine-to-Frame Ground Strap (SE1, W4)

Y1 - PTO Solenoid (SE2, W4)

Y2 - Fuel Shutoff Solenoid (SE3, W6)

Y3 - Cruise Control Magnet (Optional) (SE7)

Y4 - MCS Clutch (Optional) (SE8)

Connectors

X1 - Instrument Panel Connector (W4)
X2 - Key Switch Connector (W4)
X3 - Cruise Control Switch Connector (W4)
X4 - MCS Switch Connector (W4)
X5 - PTO Switch Connector (W4)
X6 - Engine Oil Pressure Light Diode Connector (W4)
X7 - Overtemp Buzzer Diode Connector (W4)
X8 - Hour Meter Connector (W4)
X9 - Shutdown Delay Module Connector (W4)
X10 - Lights Connector (W4)
X11 - Buzzer Connector (W4)
X12 - Fan Fuse Connector (W4)
X13 - Fan Motor Holder (W4)
X14 - Cooling Fan Relay Connector (W4)
X15 - PTO Overtemp Relay Connector (W4)
X16 - Cooling Fan Diode Connector (W4)
X17 - Alternator Connector (W4)
X18 - Alternator Ground Connector (W4)
X19 - Dual Temp. Coolant Switch Connector (W4)
X20 - Ignition Module Connector (W4)
X21 - Ignition Module Connector (W4)
X22 - Pulser Wiring Harness Connector (W4, W5)
X23 - Coil Pack Wiring Harness Connector (W4, W6)
X24 - PTO Solenoid Connector (W4)
X25 - Engine Oil Pressure Switch Connector (W4)
X26 - Fuel Transfer Pump Connector (W4)
X27 - W2 Ground Connector (W4)
X28 - Starting Motor (Solenoid) Connector (W4)
X29 - Alternator (Battery) Connector (W4)
X30 - Starting Motor (Battery) Connector (W4)
X31 - Cab Power Connector (W4)
X32 - Control Module Connector (W4)
X33 - Control Module Connector (W4)
X34 - Control Module (Ground Tab) Connector (W4)
X35 - Cruise Control Relay Connector (W4)
X36 - PTO Diode Connector (W4)
X37 - Brake Switch Connector (W4)
X38 - Seat Switch Connector (W4)
X39 - Cruise Control Magnet Connector (W4)
X40 - Cruise Control Brake Switch Connector (W4)
X41 - Pulser Coil No. 1 Connector (W5)
X42 - Pulser Coil No. 2 Connector (W5)
X43 - Pulser Coil No. 3 Connector (W5)
X44 - Ignition Coil No. 3 (+) Connector (W6)
X45 - Ignition Coil No. 3 (-) Connector (W6)
X46 - Ignition Coil No. 2 (+) Connector (W6)
X47 - Ignition Coil No. 2 (-) Connector (W6)
X48 - Ignition Coil No. 1 (+) Connector (W6)
X49 - Ignition Coil No. 1 (-) Connector (W6)
X50 - Fuel Shutoff Solenoid Connector (W6)
X51 - Headlights Connector (W1) (S/N 20001-)
X52 - Auxiliary Power Connector (W1) (S/N 20001-)

Harness

W4 - Main Wiring Harness
W5 - Pulser Wiring Harness
W6 - Coil Pack Wiring Harness

Schematic and Wiring Harness Legend - Diesel Engine

Component

A1 - Control Module (SE1, SE2, W4)

A2 - Diesel Engine Control Module (SE3, W4)

A3 - Instrument Panel (SE6, W4)

B1 - Dual Temp. Coolant Switch (SE4, W4)

B2 - Engine Oil Pressure Switch (SE6, W4)

E1 - Air Preheater (1445) (SE3, W4)

E2 - Headlight (SE5, W1) S/N 20001-

E3 - Headlight (SE5, W1) S/N 20001-

F1 - Fuse Link (SE1, W4)

F2 - Fuse Link (SE1, W4)

F3 - Fuse-15A (SE2)

F4 - Fuse-15A (SE2)

F5 - Fan Fuse-30A (SE4, W4)

F5 - Fan Circuit Breaker (SE4, W4) S/N 20001-

F6 - Auxiliary Power Fuse (SE1, W1) S/N 20001-

G1 - Battery (SE1)

G2 - Alternator (SE5, W4 / SE6, W4)

H1 - Hold-In LED (SE2)

H2 - PTO LED (SE2)

H3 - Discharge Light (SE5 / SE7)

H4 - Wait Light (SE6 / SE7)

H5 - Engine Oil Pressure Light (SE6 / SE7)

H6 - Coolant Temp. Light (SE6 / SE7)

H7 - Beeper (SE6, W4 / SE7, W4)

H8 - Headlights on Indicator Light (SE7, W1)

K1 - Start Relay (SE1)

K2 - Hold-In Relay (SE2)

K3 - PTO Relay (SE2)

K4 - PTO Overtemp Relay (SE2, W4)

K5 - Fuel Shutoff Solenoid Relay (SE3, W4)

K6 - Air Preheater Relay (SE3, W4)

K7 - Cooling Fan Relay (SE4, W4)

K8 - Cruise Control Relay (Optional) (SE7, W4 / SE8, W4)

K9 - MCS Relay (Optional) (SE8)

M1 - Starting Motor (SE1, W4)

M2 - Fan Motor (SE4, W4)

P1 - Hour Meter (SE6, W4 / SE7, W4)

R1 - Glow Plugs (1435) (SE3, W1)

S1 - Key Switch (SE1, W4)

S2 - Seat Switch (SE2, W4)

S3 - PTO Switch (SE2, W4)

S4 - Brake Switch (SE2, W4)

S5 - Cruise Control Brake Switch (Optional) (SE7, W4 / SE8, W4)

S6 - Cruise Control Switch (Optional) (SE7, W4 / SE8, W4)

S7 - MCS Switch (Optional) (SE8, W4)

S8 - Light Switch (SE5, W1) S/N 20001-

S9 - MCS Operator Presence Switch (SE9, W1) S/N 20001-

V1 - PTO Diode (SE2, W4)

V2 - Cooling Fan Diode (SE4, W4)

V3 - Engine Oil Pressure Buzzer Diode (SE6, W4 / SE7, W4)

V4 - Overtemp Buzzer Diode (SE6, W4 / SE7, W4)

W1 - Battery-to-Engine Ground (SE1, W4)

W2 - Main Harness-to-Frame Ground (SE1, W4)

W3 - Engine-to-Frame Ground Strap (SE1, W4)

Y1 - PTO Solenoid (SE2, W4)

Y2 - Fuel Shutoff Solenoid (SE3, W4)

Y3 - Cruise Control Magnet (Optional) (SE7, W4 / SE8, W4)

Y4 - MCS Clutch (Optional) (SE8)

Connector

X1 - Instrument Panel Connector (W1) S/N -20000

X2 - Key Switch Connector (W1)

X3 - Cruise Control Switch Connector (W1)

X4 - MCS Switch Connector (W1)

X4 - MCS Operator Presence Switch Connector (W1) S/N 20001-

X5 - PTO Switch Connector (W1)

X6 - Engine Oil Pressure Buzzer Diode Connector (W1)

X7 - Overtemp Buzzer Diode Connector (W1)

X8 - Fan Motor Connector (W1)

X9 - Fuel Shutoff Solenoid Relay Connector (W1)

X10 - Auxiliary Power Outlet Fuse Holder (W1)

X11 - Buzzer Connector (W1)

X12 - Hour Meter Connector (W1)

X13 - Lights Connector (W1)

X14 - Diesel Engine Control Module Connector (W1)

X15 - Air Preheater Relay Connector (W1)

X16 - Cooling Fan Relay Connector (W1)

X17 - PTO Overtemp Cutoff Relay Connector (W1)

X18 - Cooling Fan Diode Connector (W1)

X19 - Alternator Connector (W1)

X20 - Alternator Ground Connector (W1)

X21 - Dual Temp. Coolant Switch Connector (W1)

X22 - PTO Solenoid Connector (W1)

X23 - Engine Oil Pressure Switch Connector (W1)

X24 - Fuel Shutoff Solenoid Connector (W1)

X25 - Air Preheater Connector (W1)

X26 - W2 Ground Connector (W1)

X27 - Starting Motor (Solenoid) Connector (W1)

X28 - Alternator (Battery) Connector (W1)

X29 - Starting Motor (Battery) Connector (W1)

X30 - Cab Power Connector (W1)

X31 - Control Module Connector (W1)

X32 - Control Module Connector (W1)

X33 - Control Module (Ground Tab) Connector (W1)

X34 - Cruise Control Relay Connector (W1)

X35 - PTO Diode Connector (W1)

X36 - Brake Switch Connector (W1)

X37 - Seat Switch Connector (W1)

X38 - Cruise Control Magnet Connector (W1)

X39 - Cruise Control Brake Switch Connector (W1)

X40 - Headlights Connector (W1) S/N 10001-

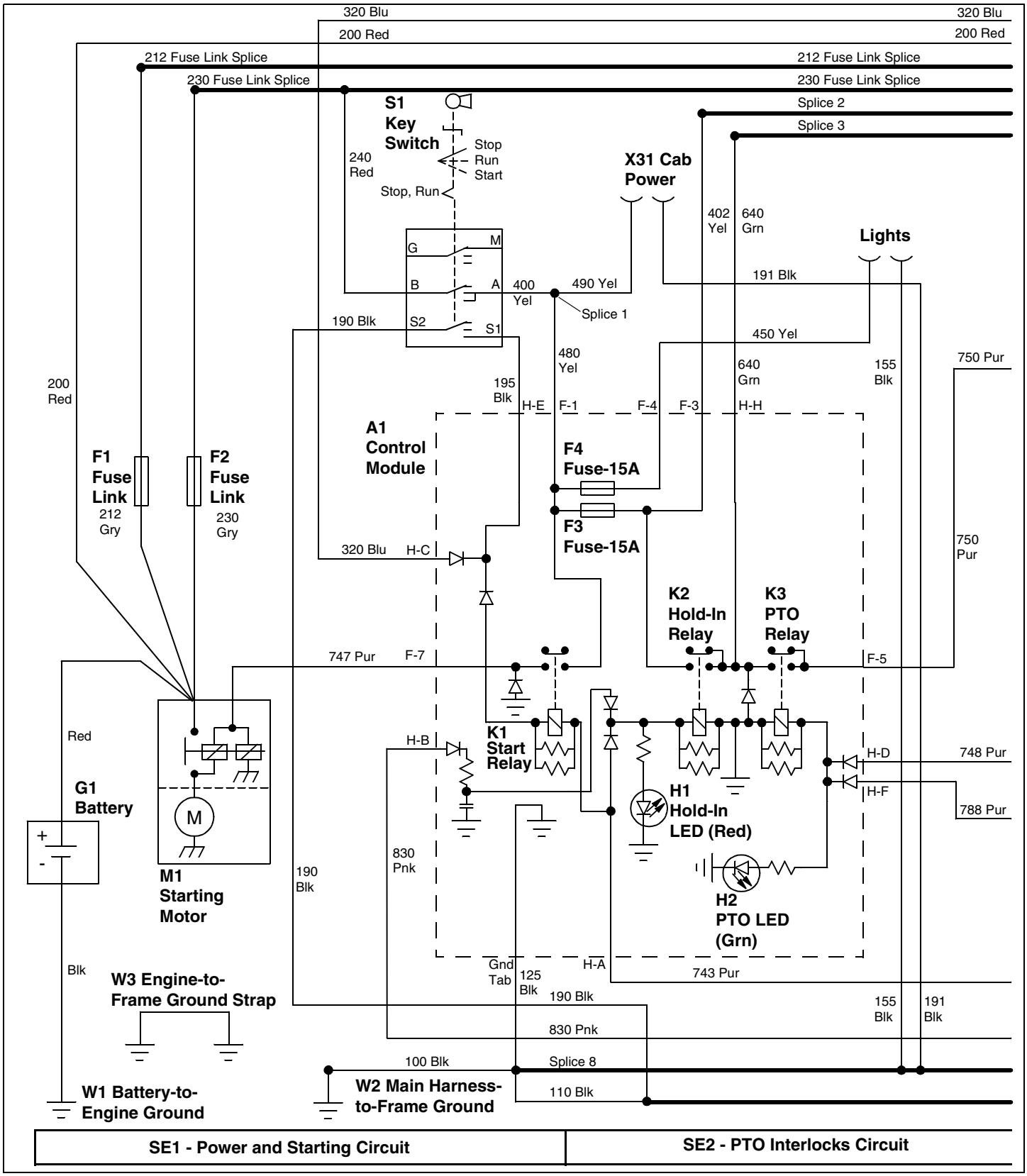
X41 - Auxiliary Outlet (W1) S/N 10001-

Harness

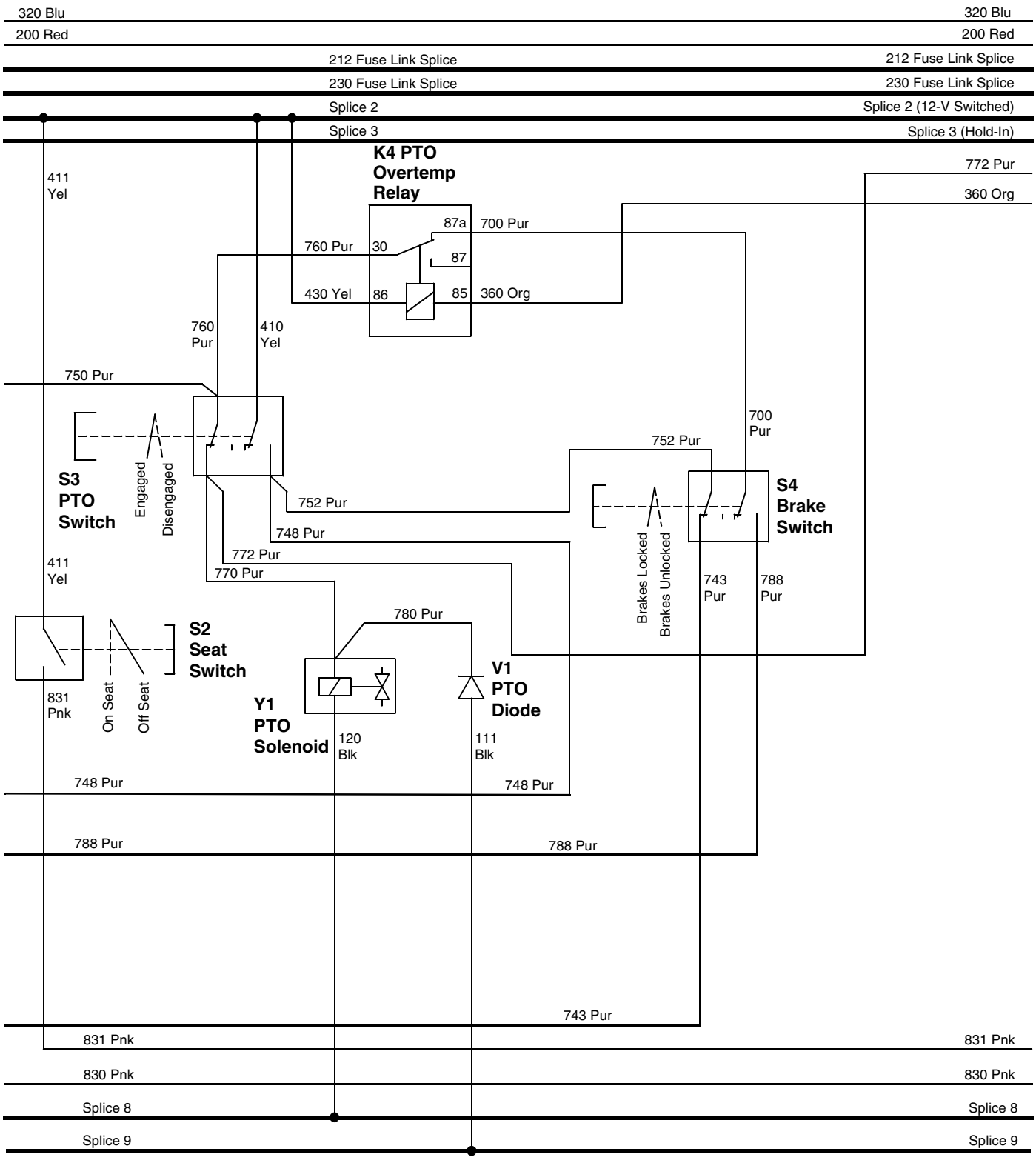
W4 - Main Wiring Harness

Schematic (1400 Gas Series S/N -20000)

Schematics - Gas Series S/N -20000 (1 of 6)

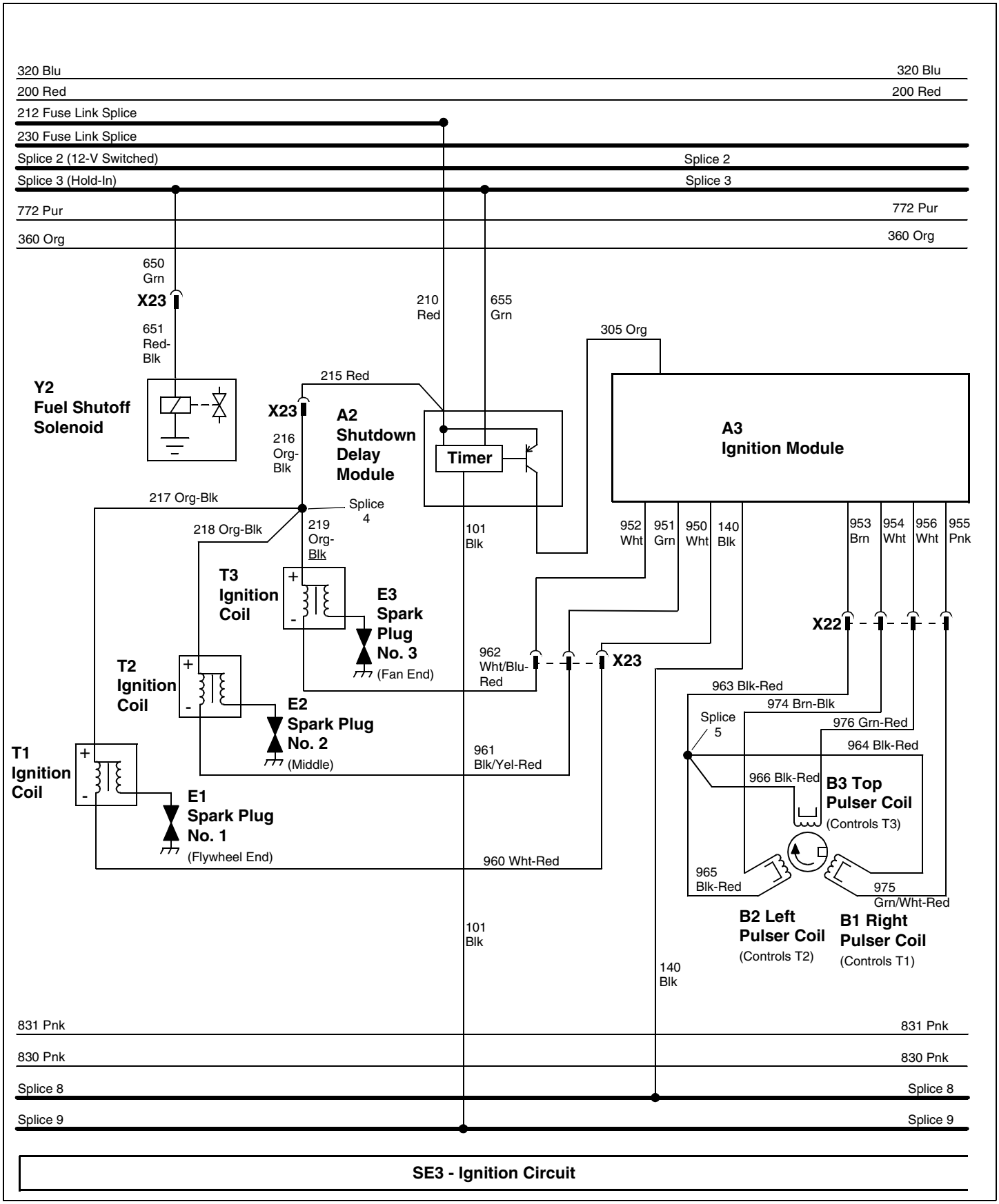


Schematics - Gas Series S/N -20000 (2 of 6)



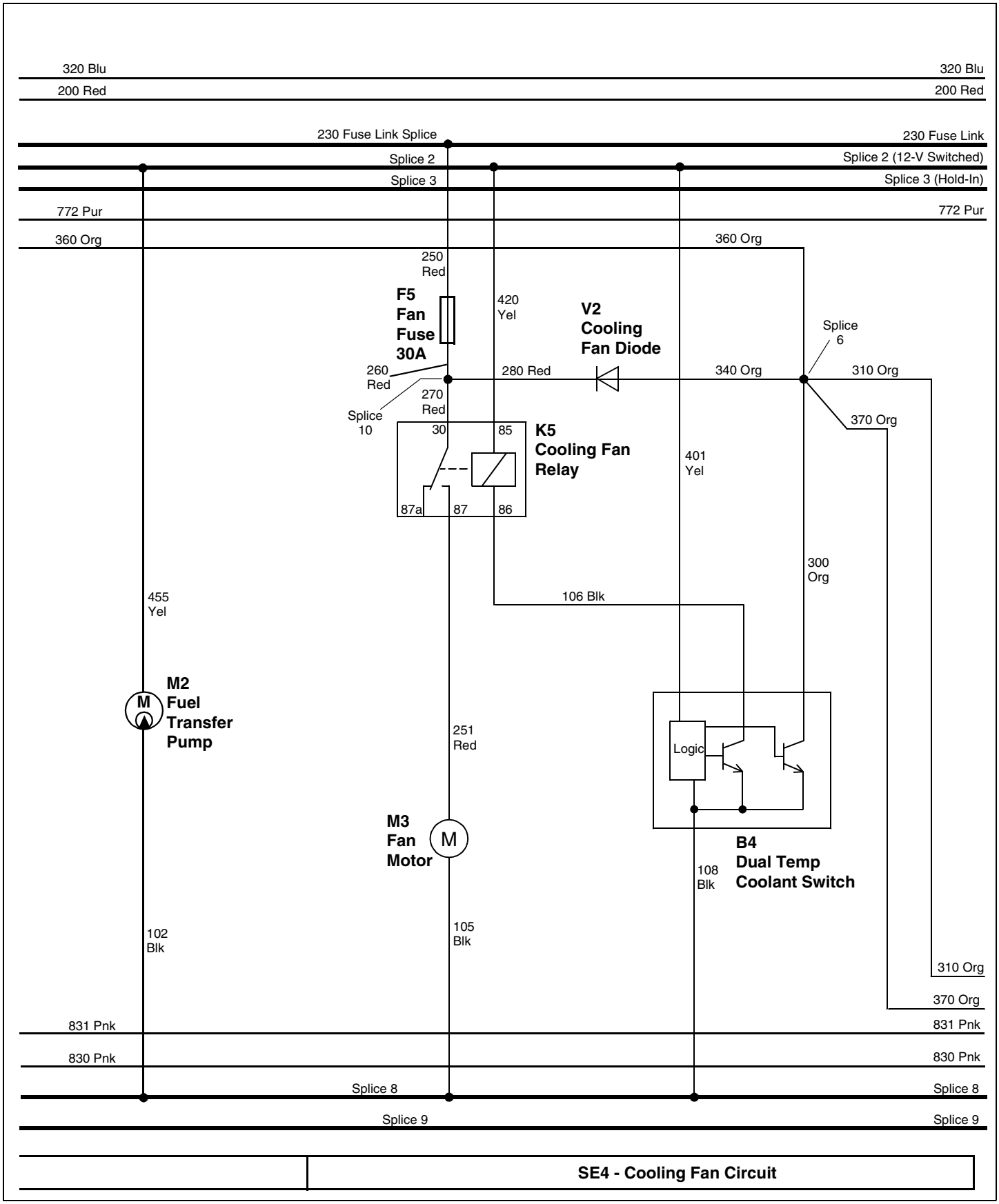
SE2 - PTO Interlocks Circuit

Schematics - Gas Series S/N -20000 (3 of 6)



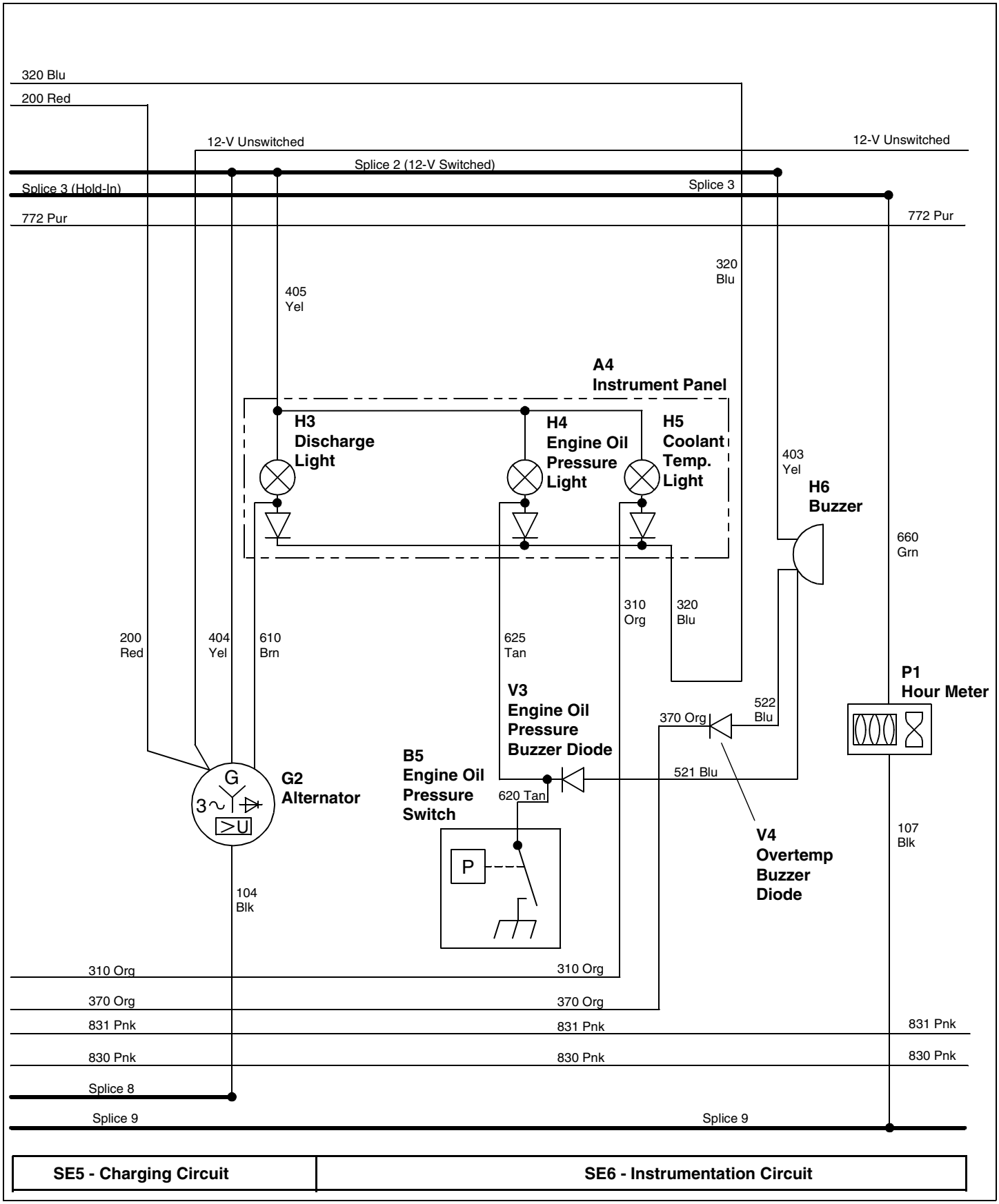
SE3 - Ignition Circuit

Schematics - Gas Series S/N -20000 (4 of 6)



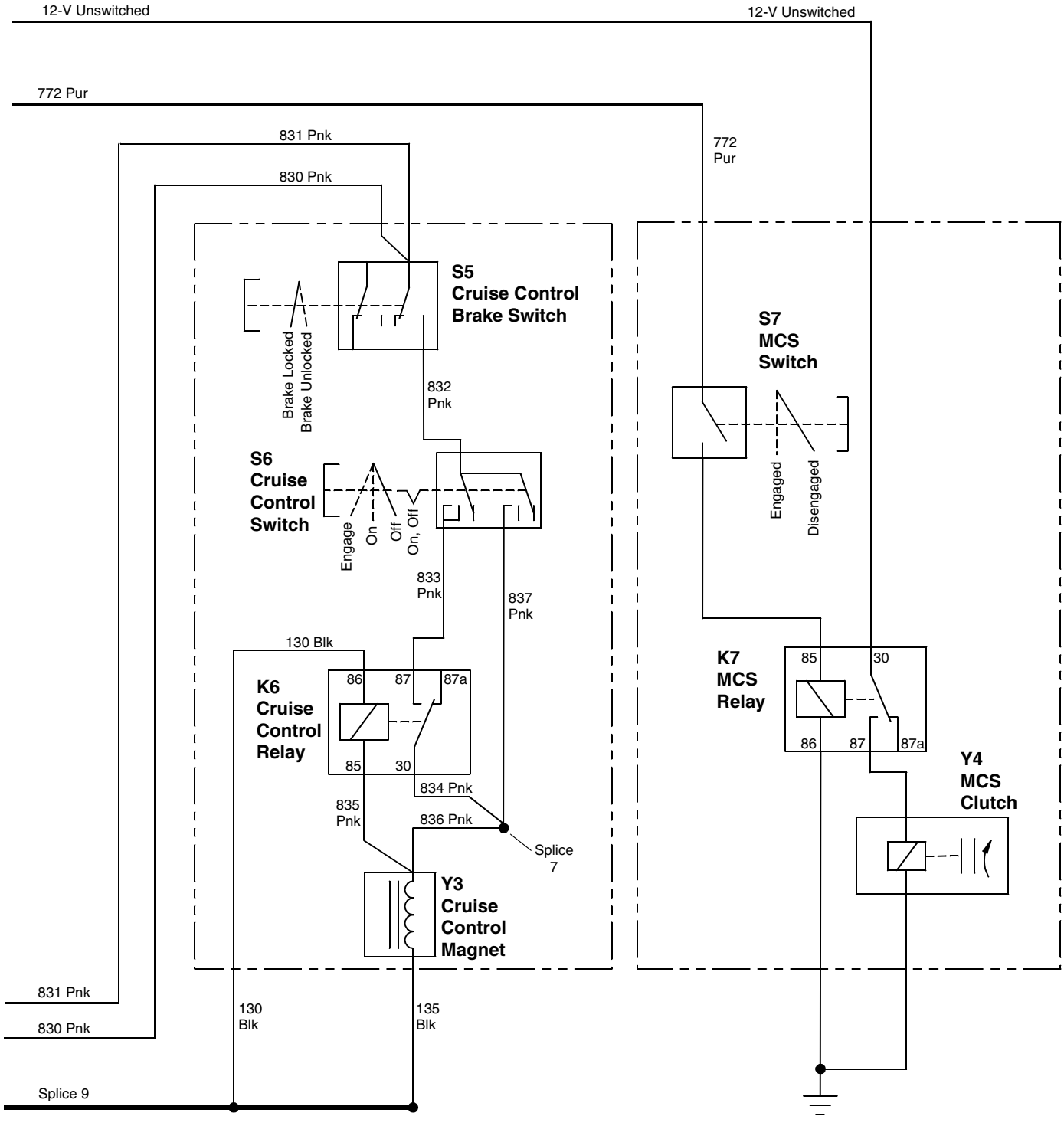
SE4 - Cooling Fan Circuit

Schematics - Gas Series S/N -20000 (5 of 6)



SE5 - Charging Circuit	SE6 - Instrumentation Circuit

Schematics - Gas Series S/N -20000 (6 of 6)



SE7 - Cruise Control Circuit (Optional)	SE8 - MCS Circuit (Optional)

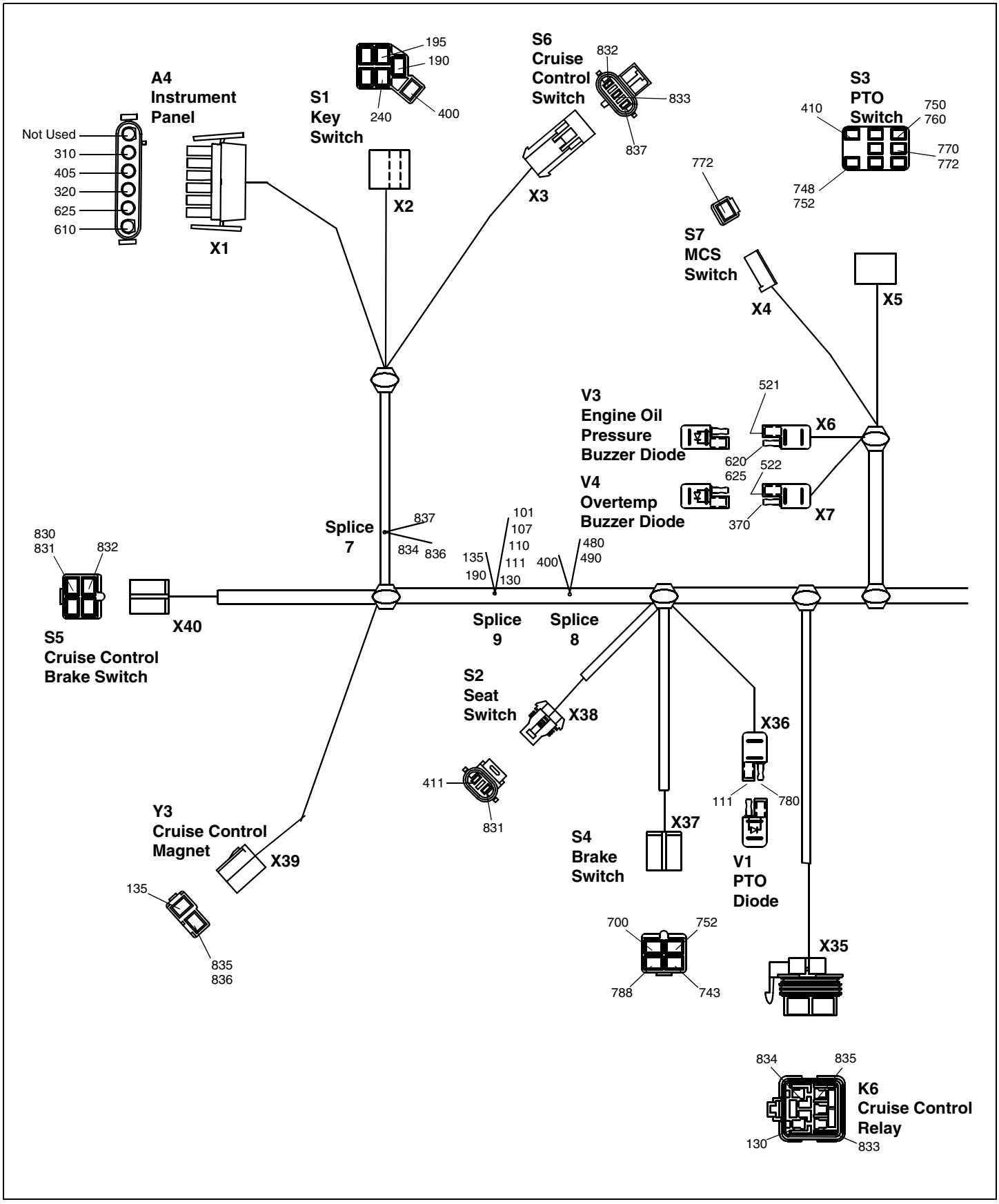
Wiring Harness (1400 Gas Series S/N -20000)

Wire Code Table

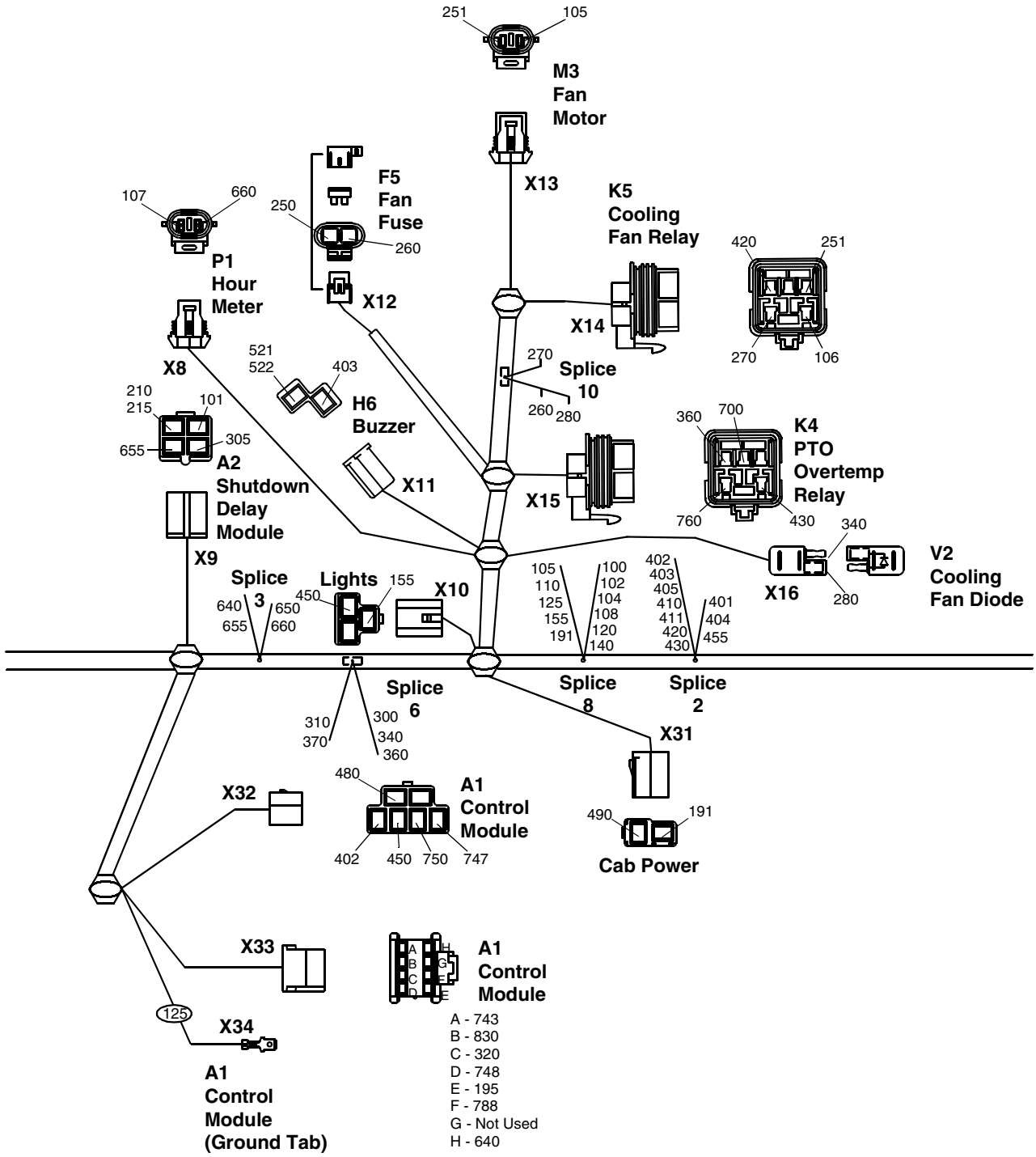
Size/No./Color	Wire Connection Points
5.0 100 Blk	W2 Gnd, Splice 8
0.8 101 Blk	X9, Splice 9
0.8 102 Blk	X26, Splice 8
3.0 104 Blk	X18, Splice 8
3.0 105 Blk	X13, Splice 8
0.8 106 Blk	X14, X19
0.8 107 Blk	X8, Splice 9
0.8 108 Blk	X19, Splice 8
5.0 110 Blk	Splice 8, Splice 9
1.0 111 Blk	X36, Splice 9
1.0 120 Blk	X24, Splice 8
0.8 125 Blk	X34, Splice 8
0.8 130 Blk	X35, Splice 9
1.0 135 Blk	X39, Splice 9
0.8 140 Blk	X20, Splice 8
2.0 155 Blk	X10, Splice 8
1.0 190 Blk	X2, Splice 9
3.0 191 Blk	X31, Splice 8
1.0 195 Blk	X2, X33
5.0 200 Red	X29, X30
1.0 210 Red	X9, 212 Fuse Link
0.5 212 Fuse Link Gry	X30, 210 Red
0.8 215 Red	X9, X23
2.0 230 Fuse Link Gry	X30, 240 Red
5.0 240 Red	X2, 230 Fuse Link
3.0 250 Red	X12, 230 Fuse Link
3.0 251 Red	X13, X14
3.0 260 Red	X12, Splice 10
3.0 270 Red	X14, Splice 10
0.8 280 Red	X16, Splice 10
0.8 300 Org	X19, 310 Org
0.8 305 Org	X9, X20
0.8 310 Org	X1, Splice 6
0.8 320 Blu	X1, X33
0.8 340 Org	X16, Splice 6
0.8 360 Org	X15, Splice 6
0.8 370 Org	X7, Splice 6
5.0 400 Yel	X2, Splice 1
0.8 401 Yel	X19, Splice 2
3.0 402 Yel	X32, Splice 2
0.8 403 Yel	X11, Splice 2
0.8 404 Yel	X17, Splice 2
0.8 405 Yel	X1, Splice 2
1.0 410 Yel	X5, Splice 2
0.8 411 Yel	X38, Splice 2
0.8 420 Yel	X14, Splice 2
0.8 430 Yel	X15, Splice 2
2.0 450 Yel	X10, X32
0.8 455 Yel	X26, Splice 2
3.0 480 Yel	X32, Splice 1
3.0 490 Yel	X31, Splice 1
0.8 521 Blu	X6, X11
0.8 522 Blu	X7, X11
0.8 610 Brn	X1, X17
0.8 620 Tan	X6, X25
0.8 625 Tan	X1, X6
1.0 640 Grn	X33, Splice 3
1.0 650 Grn	X23, Splice 3
0.8 655 Grn	X9, Splice 3
0.8 660 Grn	X8, Splice 3
0.8 700 Pur	X15, X37

Size/No./Color	Wire Connection Points
0.8 743 Pur	X33, X37
3.0 747 Pur	X28, X32
0.8 748 Pur	X5, X33
1.0 750 Pur	X5, X32
0.8 752 Pur	X5, X37
0.8 760 Pur	X5, X15
1.0 770 Pur	X5, X24
0.8 772 Pur	X4, X5
0.8 780 Pur	X24, X36
0.8 788 Pur	X33, X37
1.0 830 Pnk	X33, X40
1.0 831 Pnk	X38, X40
1.0 832 Pnk	X3, X40
1.0 833 Pnk	X3, X35
1.0 834 Pnk	X35, Splice 7
1.0 835 Pnk	X35, X39
1.0 836 Pnk	X39, Splice 7
1.0 837 Pnk	X3, Splice 7
0.8 950 Wht	X20, X23
0.8 951 Grn	X20, X23
0.8 952 Wht	X20, X23
0.8 953 Brn	X21, X22
0.8 954 Wht	X21, X22
0.8 955 Pnk	X21, X22
0.8 956 Grn	X21, X22

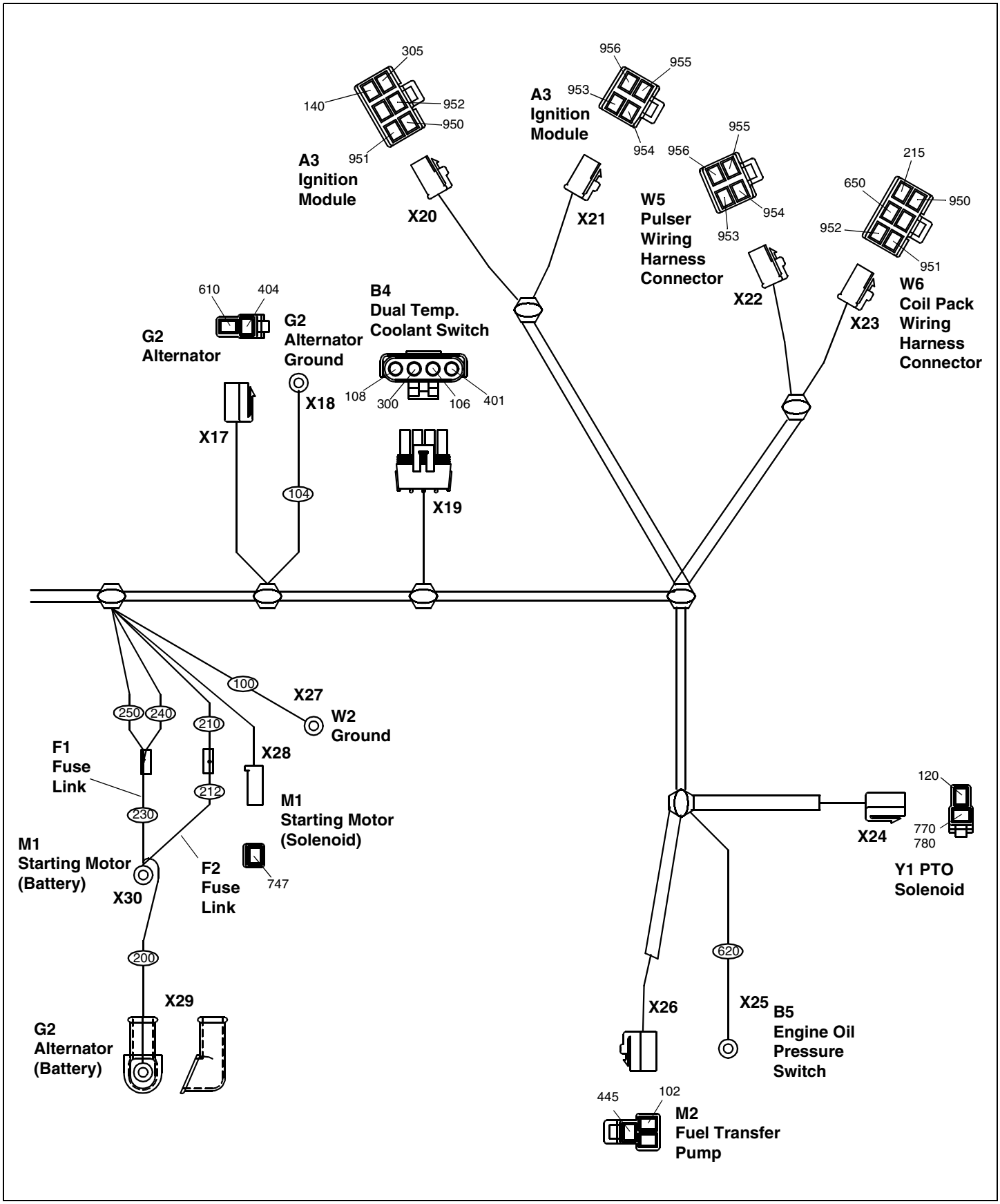
Wiring Harness - Gas Series S/N -20000 (1 of 3)



Wiring Harness - Gas Series S/N -20000 (2 of 3)

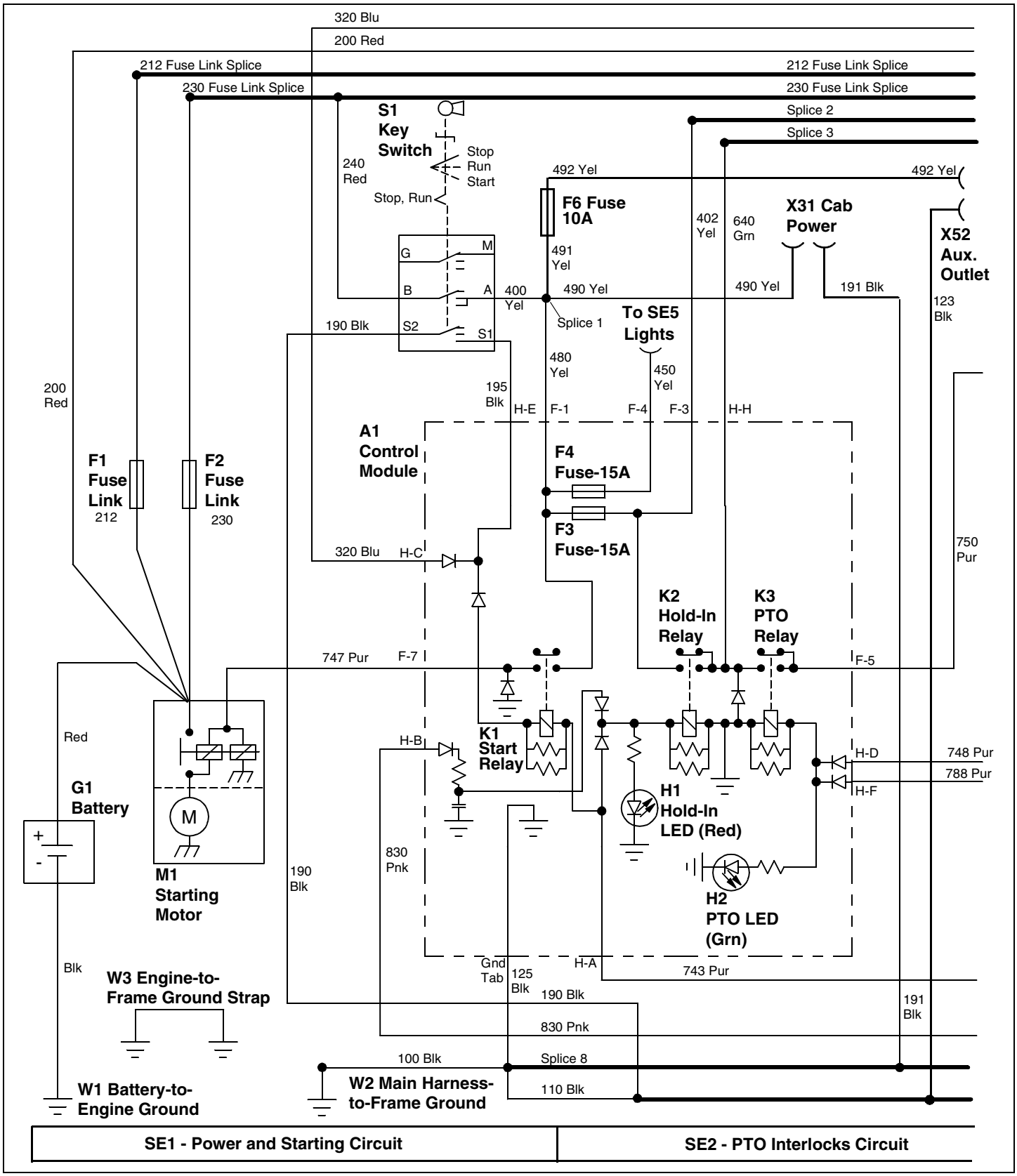


Wiring Harness - Gas Series S/N -20000 (3 of 3)

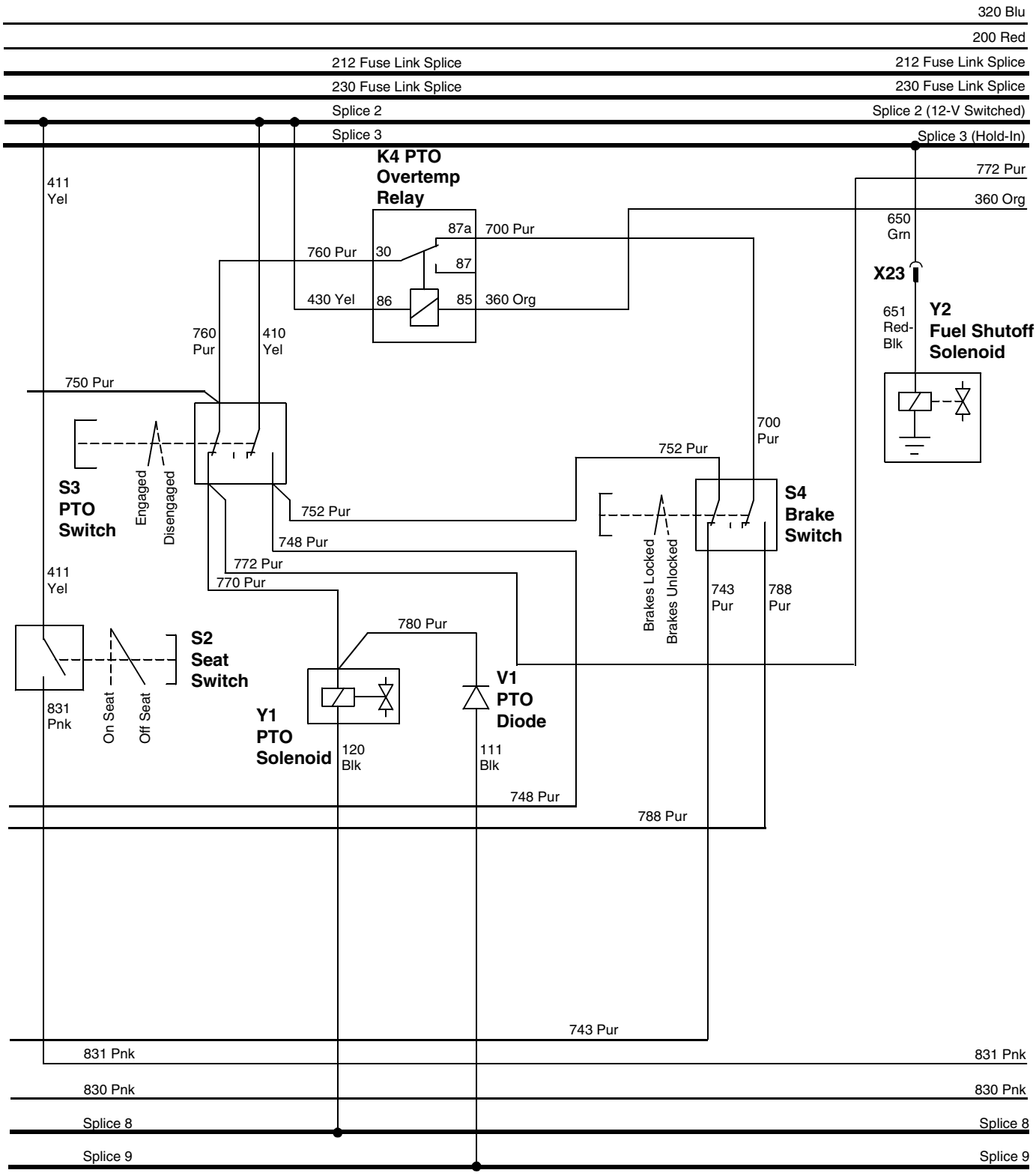


Schematic (1400 Gas Series S/N 20001-)

Schematics - Gas Series S/N 20001- (1 of 6)

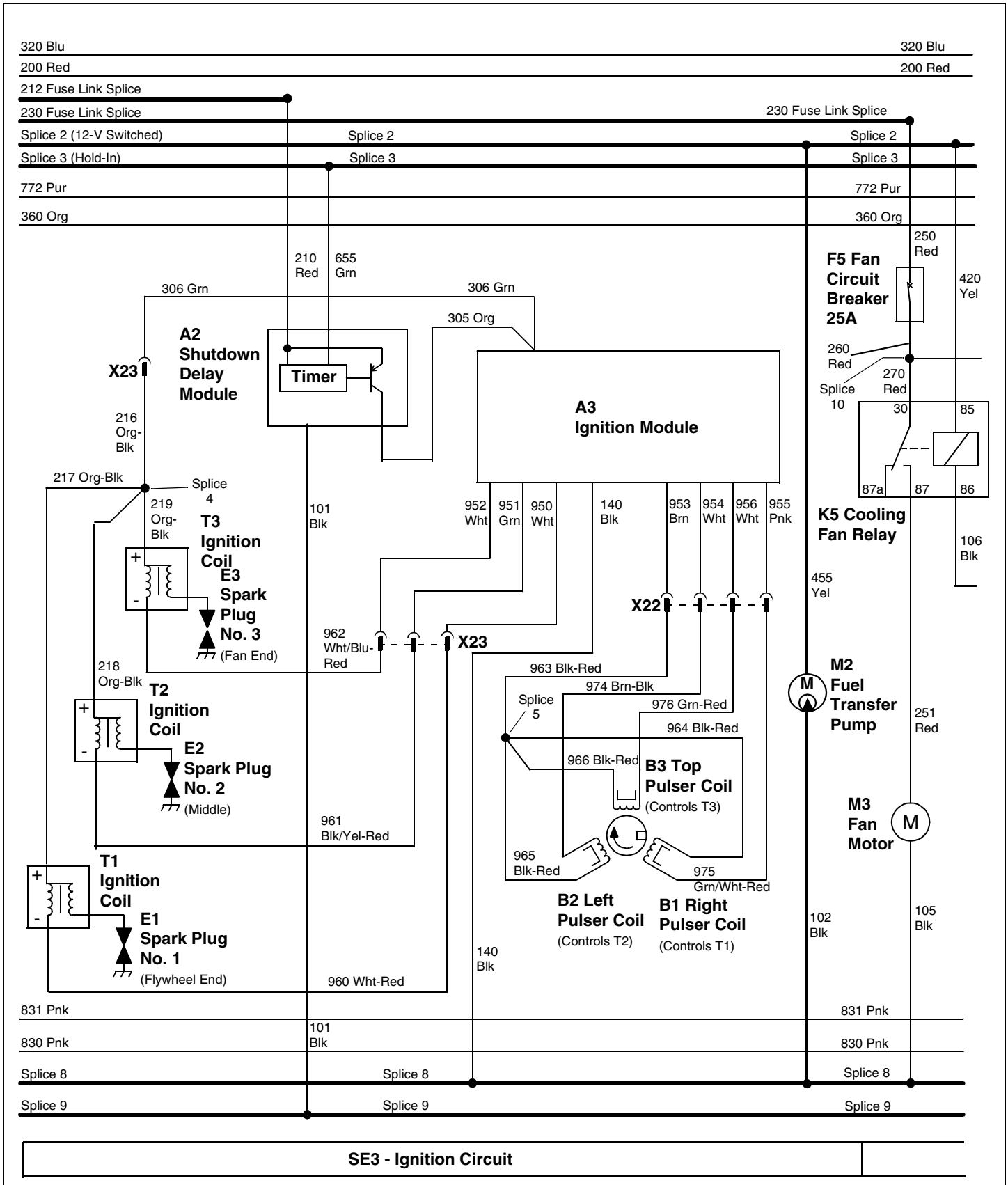


Schematics - Gas Series S/N 20001- (2 of 6)

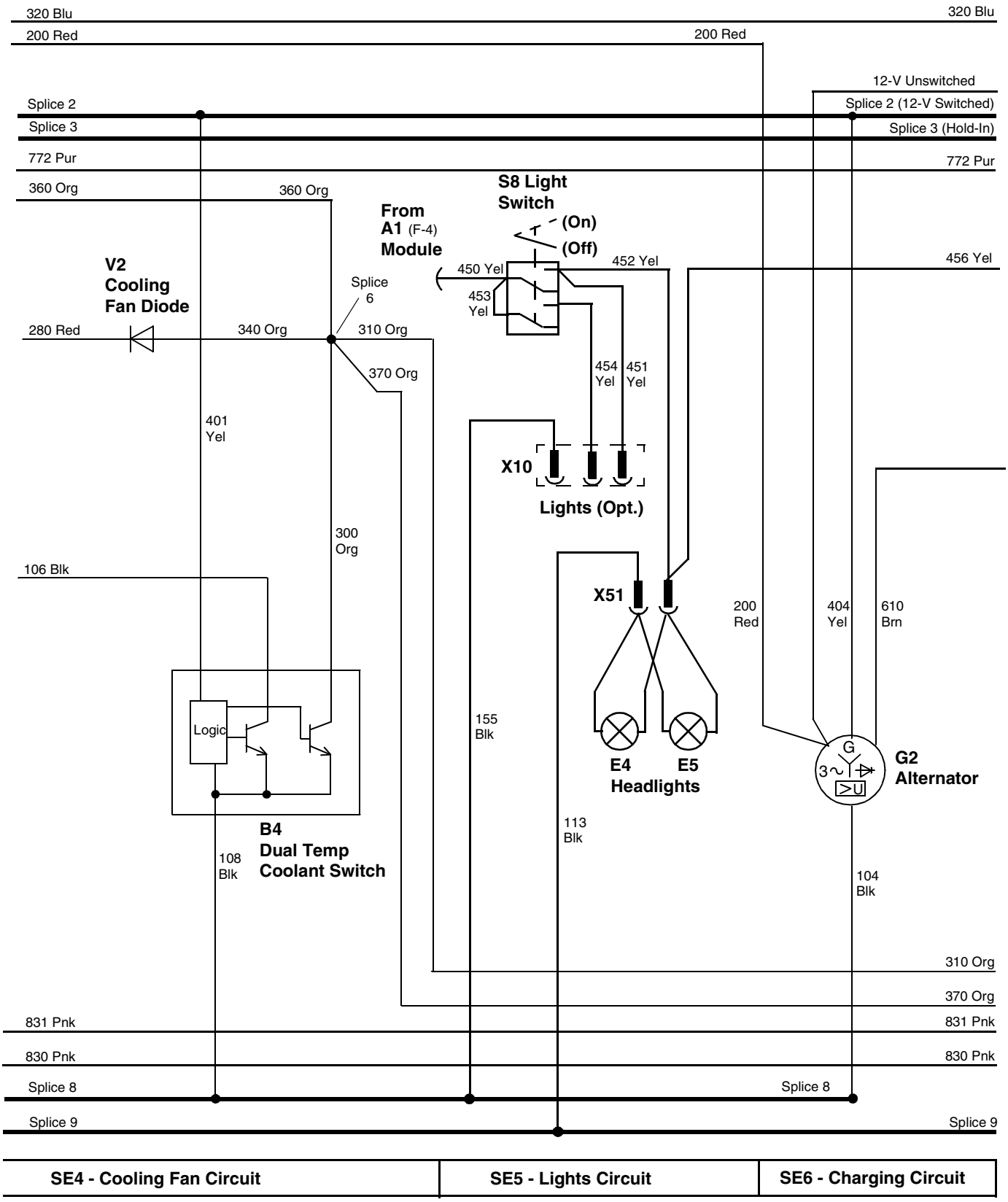


SE2 - PTO Interlocks Circuit

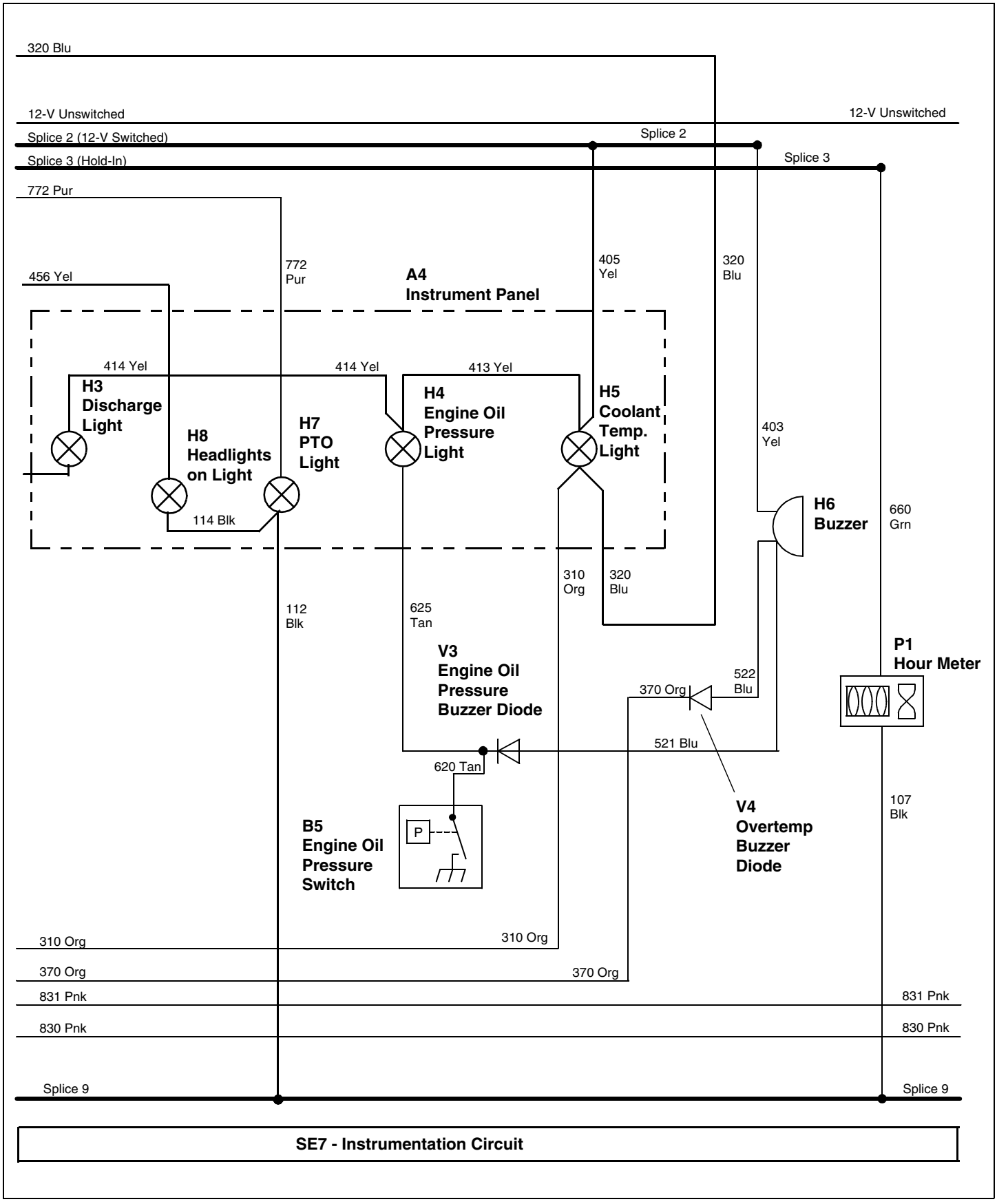
Schematics - Gas Series S/N 20001- (3 of 6)



Schematics - Gas Series S/N 20001- (4 of 6)

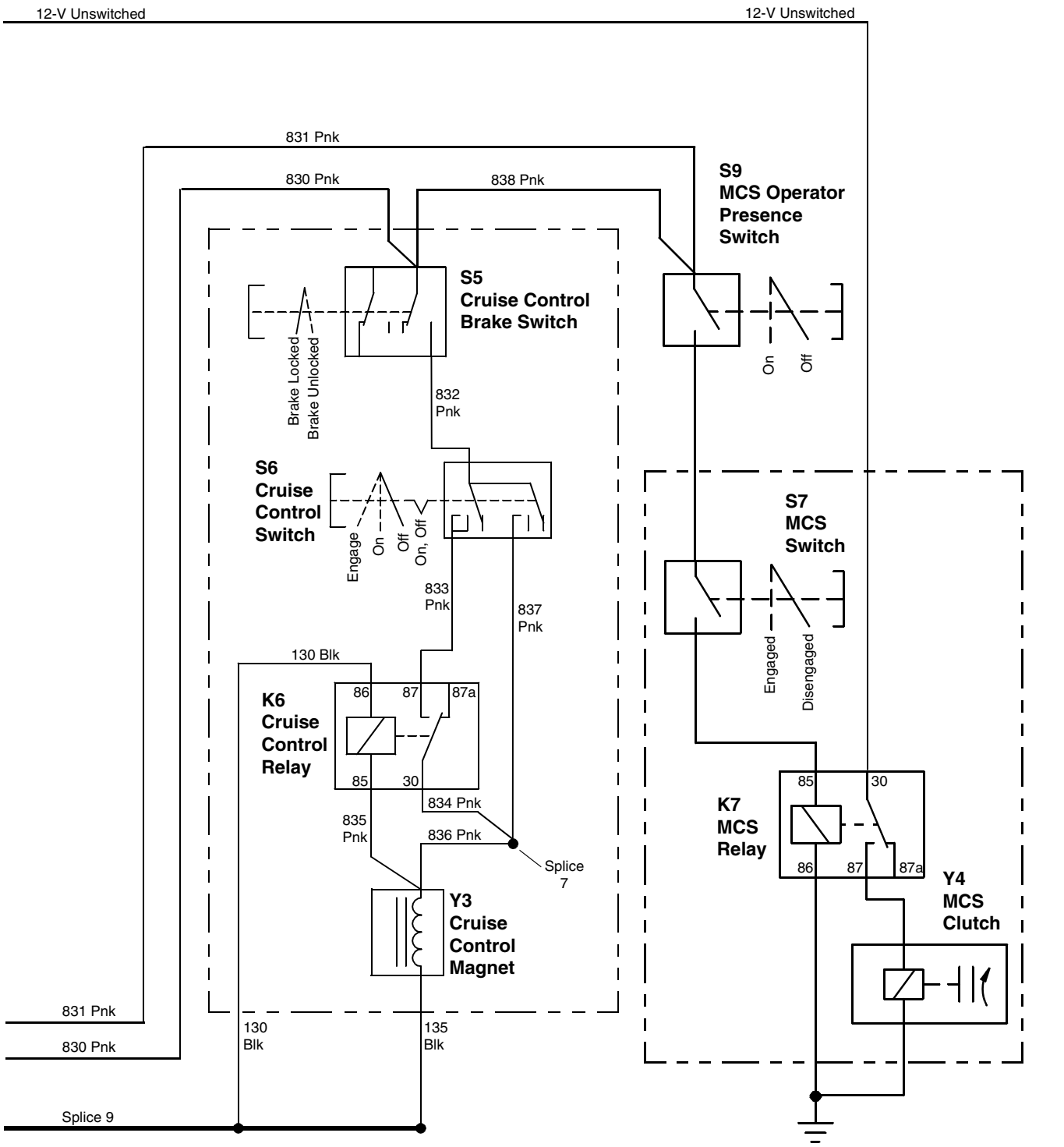


Schematics - Gas Series S/N 20001- (5 of 6)



SE7 - Instrumentation Circuit

Schematics - Gas Series S/N 20001- (6 of 6)



SE8 - Cruise Control Circuit (Optional)	SE9 - MCS Circuit (Optional)

Wiring Harness (1400 Gas Series S/N 20001-)

Wire Code Table

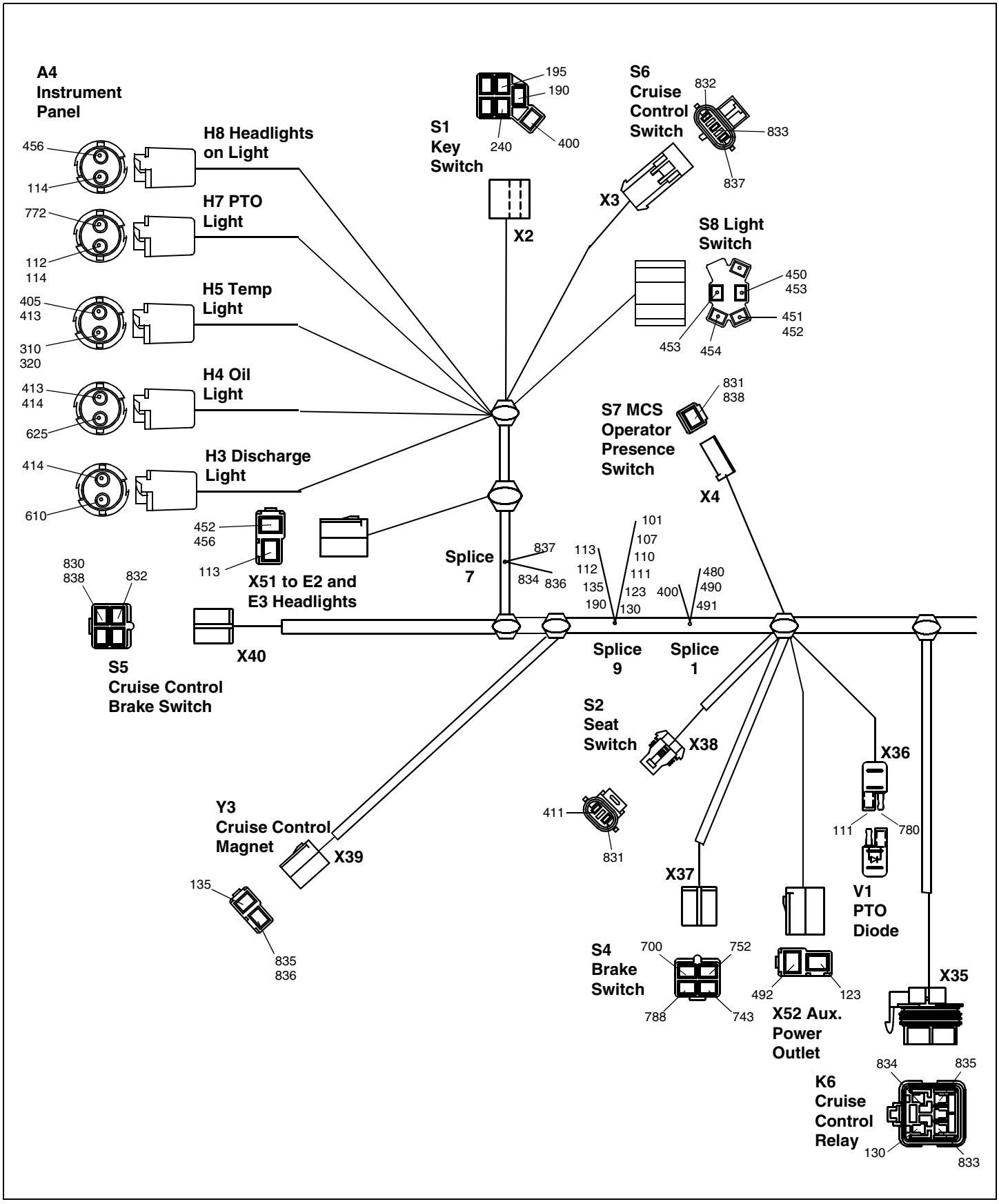
Size/No./Wire Connection Points	Wire Connection Points
5.0 100 Blk	W2 Gnd, Splice 8
0.8 101 Blk	X9, Splice 9
0.8 102 Blk	X26, Splice 8
3.0 104 Blk	X18, Splice 8
3.0 105 Blk	X13, Splice 8
0.8 106 Blk	X14, X19
0.8 107 Blk	X8, Splice 9
0.8 108 Blk	X19, Splice 8
5.0 110 Blk	Splice 8, Splice 9
1.0 111 Blk	X36, Splice 9
0.8 112 Blk	H7, Splice 9
1.0 113 Blk	X51, Splice 9
0.8 114 Blk	H7, H8
1.0 120 Blk	X24, Splice 8
3.0 123 Blk	X52, Splice 9
0.8 125 Blk	X34, Splice 8
0.8 130 Blk	X35, Splice 9
1.0 135 Blk	X39, Splice 9
0.8 140 Blk	X20, Splice 8
2.0 155 Blk	X10, Splice 8
1.0 190 Blk	X2, Splice 9
3.0 191 Blk	X31, Splice 8
1.0 195 Blk	X2, X33
5.0 200 Red	X29, X30
1.0 210 Red	X9, 212 Fuse Link
0.5 212 Fuse Link	X30, 210 Red
2.0 230 Fuse Link	X30, 240 Red
5.0 240 Red	X2, 230 Fuse Link
3.0 250 Red	X12, 230 Fuse Link
3.0 251 Red	X13, X14
3.0 260 Red	X12, Splice 10
3.0 270 Red	X14, Splice 10
0.8 280 Red	X16, Splice 10
0.8 300 Org	X19, Splice 6
1.0 305 Org	X9, X20
1.0 306 Grn	X23, X20 (A3)
0.8 310 Org	H5, Splice 6
0.8 320 Blu	H5, X33
0.8 340 Org	X16, Splice 6
0.8 360 Org	X15, Splice 6
0.8 370 Org	X7, Splice 6
5.0 400 Yel	X2, Splice 1
0.8 401 Yel	X19, Splice 2
3.0 402 Yel	X32, Splice 2
0.8 403 Yel	X11, Splice 2
0.8 404 Yel	X17, Splice 2
0.8 405 Yel	H5, Splice 2
1.0 410 Yel	X5, Splice 2
0.8 411 Yel	X38, Splice 2
0.8 413 Yel	H4, H5
0.8 414 Yel	H4, H3
0.8 420 Yel	X14, Splice 2
0.8 430 Yel	X15, Splice 2
2.0 450 Yel	S8, X32
1.0 451Yel	X10, S8
1.0 452 Yel	S8, X51
1.0 453 Yel	S8, S8 (jumper)
1.0 454 Yel	S8, X10

Size/No./Wire Connection Points	Wire Connection Points
0.8 455 Yel	X26, Splice 2
0.8 456 Yel	X51, H8
3.0 480 Yel	X32, Splice 1
3.0 490 Yel	X31, Splice 1
3.0 491 Yel	Splice 1, F6
3.0 492 Yel	F6, X52
0.8 521 Blu	X6, X11
0.8 522 Blu	X7, X11
0.8 610 Brn	H3, X17
0.8 620 Tan	X6, X25
0.8 625 Tan	H4, X6
640 1.0 Grn	X33, Splice 3
1.0 650 Grn	X23, Splice 3
0.8 655 Grn	X9, Splice 3
0.8 660 Grn	X8, Splice 3
0.8 700 Pur	X15, X37
0.8 743 Pur	X33, X37
3.0 747 Pur	X28, X32
0.8 748 Pur	X5, X33
1.0 750 Pur	X5, X32
0.8 752 Pur	X5, X37
0.8 760 Pur	X5, X15
1.0 770 Pur	X5, X24
0.8 772 Pur	H7, X5
0.8 780 Pur	X24, X36
0.8 788 Pur	X33, X37
1.0 830 Pnk	X33, X40
1.0 831 Pnk	X38, X4
1.0 832 Pnk	X3, X40
1.0 833 Pnk	X3, X35
1.0 834 Pnk	X35, Splice 7
1.0 835 Pnk	X35, X39
1.0 836 Pnk	X39, Splice 7
1.0 837 Pnk	X3, Splice 7
0.8 838 Pnk	X40, X4
0.8 950 Wht	X20, X23
0.8 951 Grn	X20, X23
0.8 952 Wht	X20, X23
0.8 953 Brn	X21, X22
0.8 954 Wht	X21, X22
0.8 955 Pnk	X21, X22
0.8 956 Grn	X21, X22

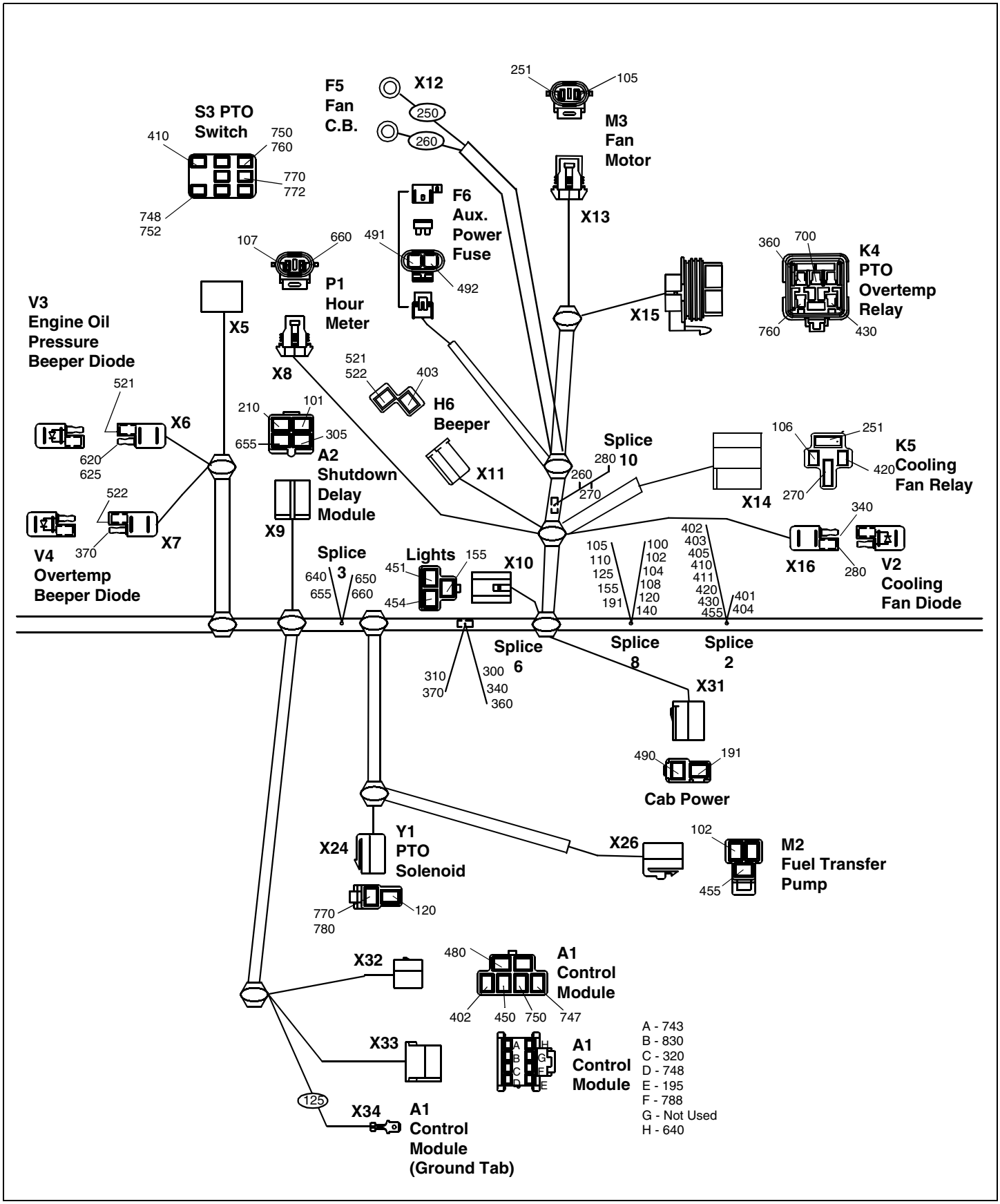
Pulser Wiring Harness Wire Code Table

Size/No./Color	Wire Connection Points
0.8 963 Blk-Red	X22, Splice
0.8 964 Blk-Red	Splice 5, X41
0.8 965 Blk-Red	Splice 5, X42
0.8 966 Blk-Red	Splice 5, X43
0.8 974 Brn-Blk	X22, X42
0.8 975 Grn/Wht-Red	X22, X41
0.8 976 Grn-Red	X22, X43

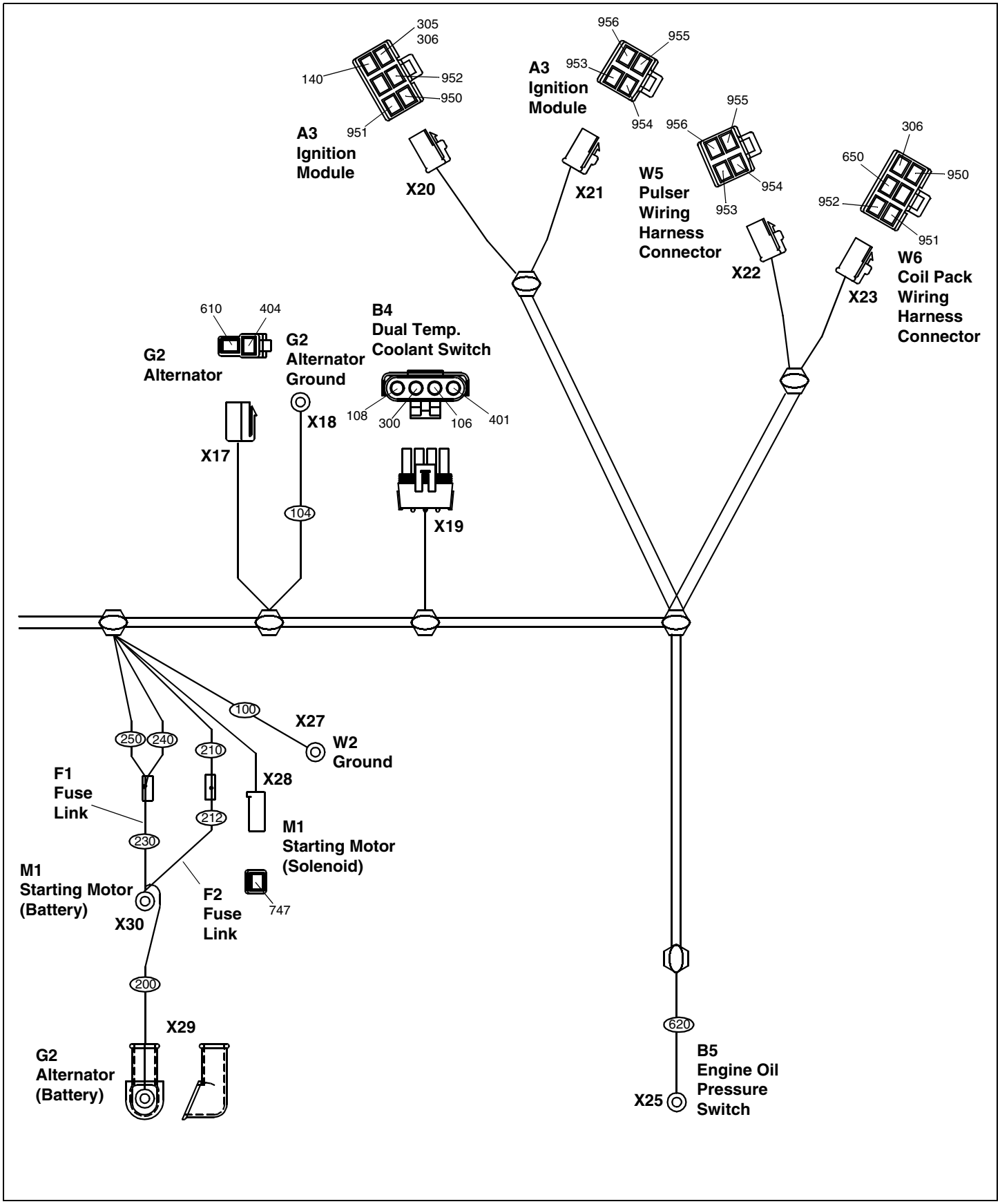
Wiring Harness - Gas Series S/N 20001- (1 of 3)



Wiring Harness - Gas Series S/N 20001- (2 of 3)

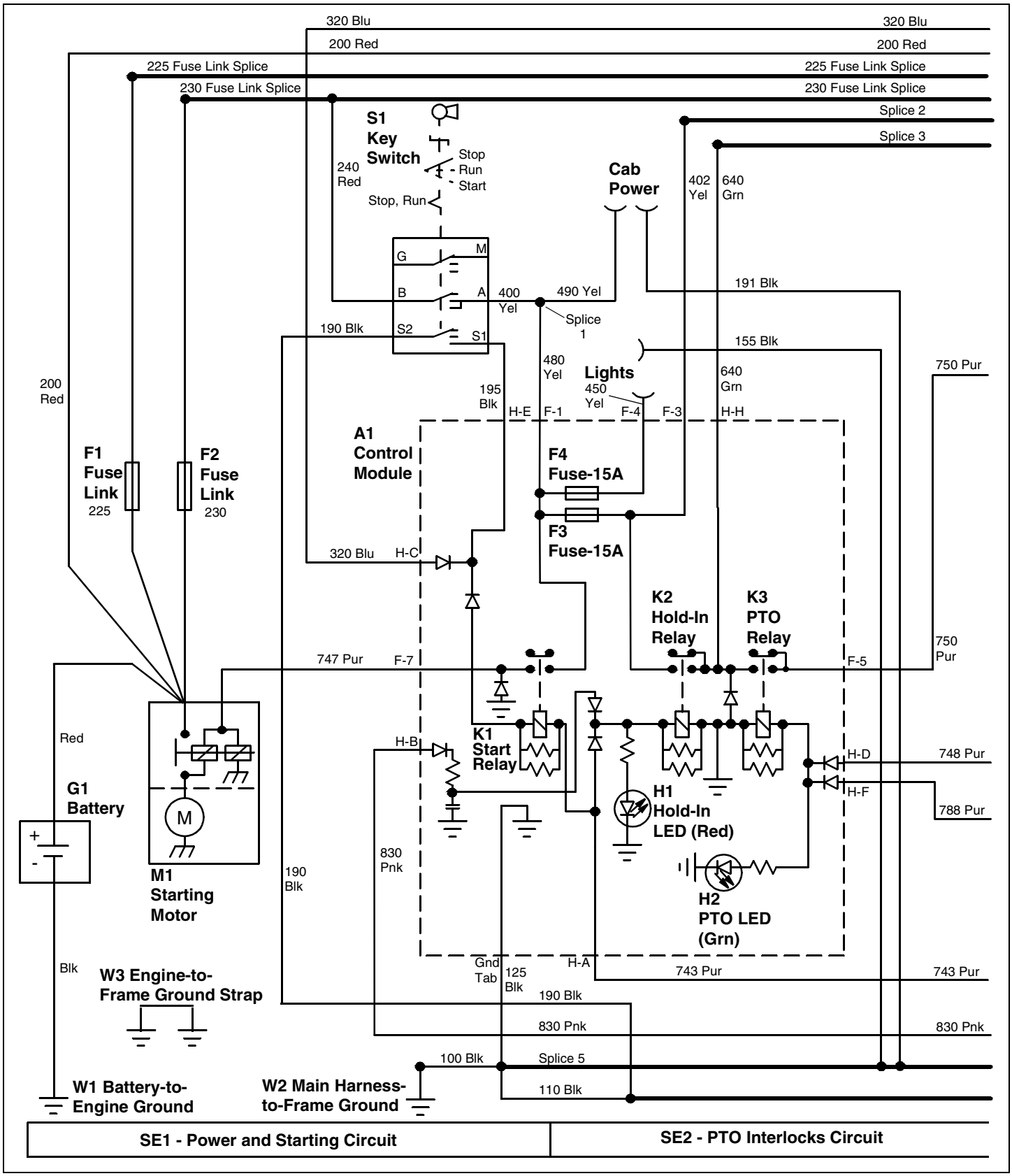


Wiring Harness - Gas Series S/N 20001- (3 of 3)

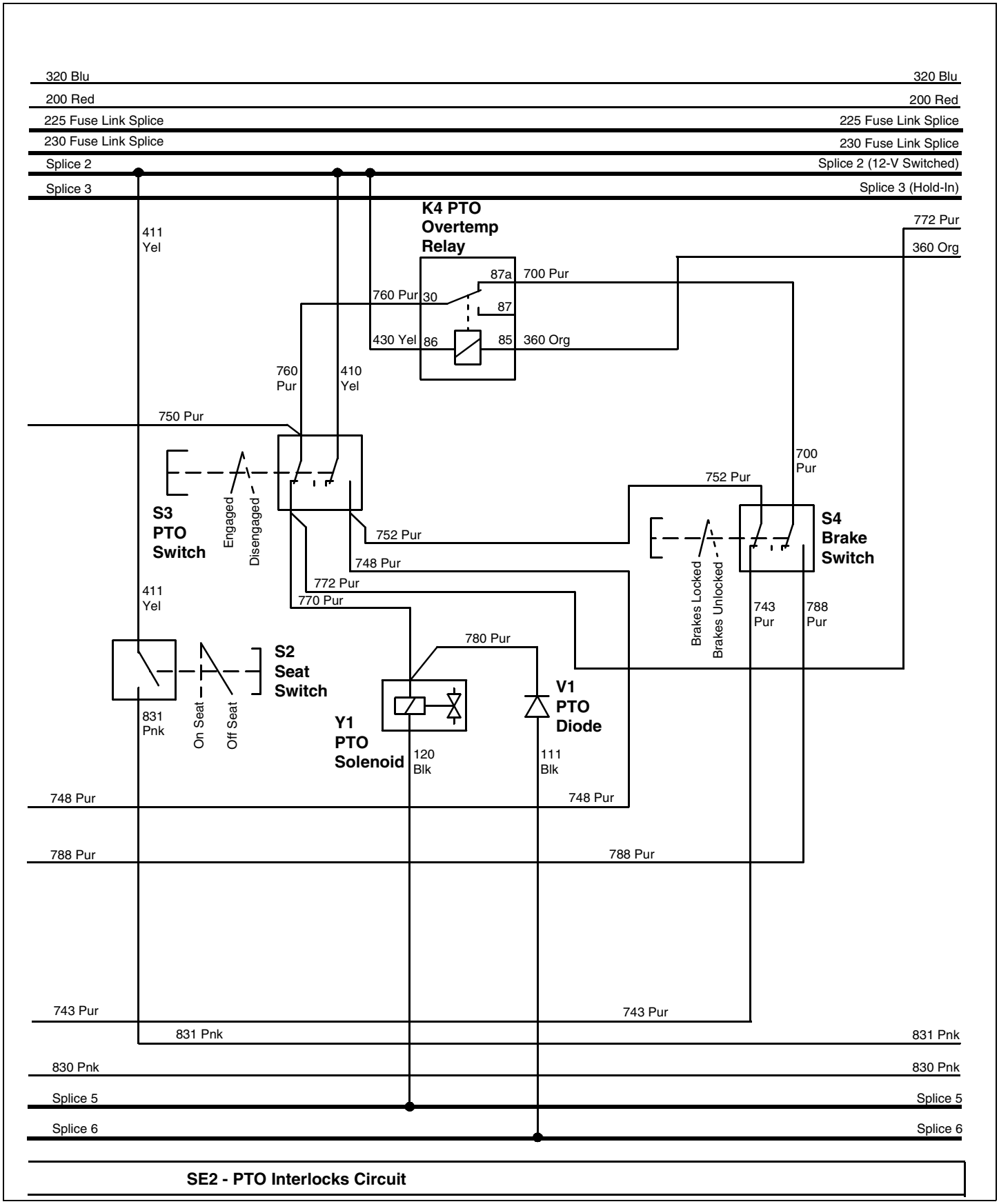


Schematic (1400 Diesel Series S/N -20000)

Schematics - 1400 Diesel Series S/N -20000 (1 of 6)

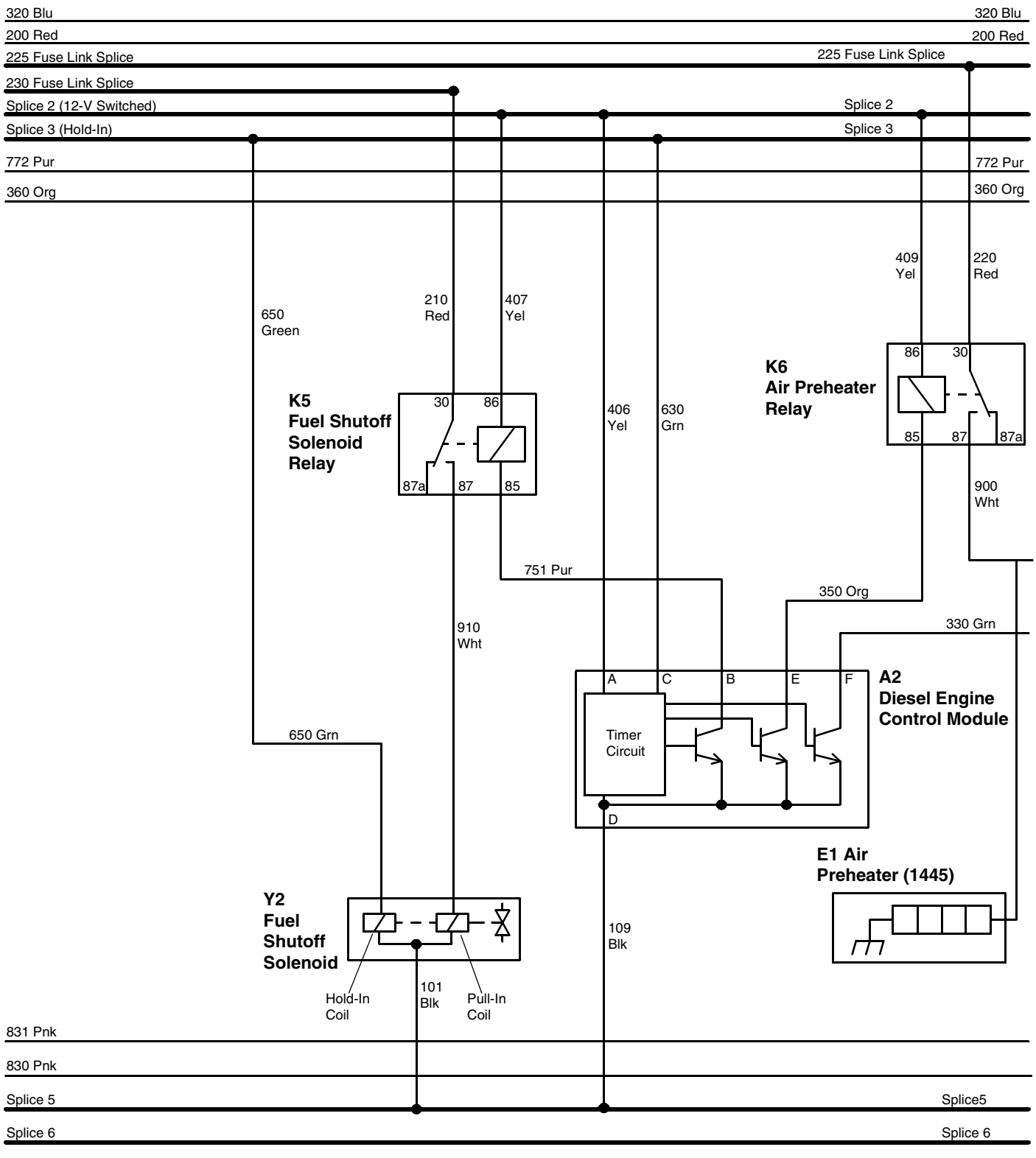


Schematics - 1400 Diesel Series S/N -20000 (2 of 6)



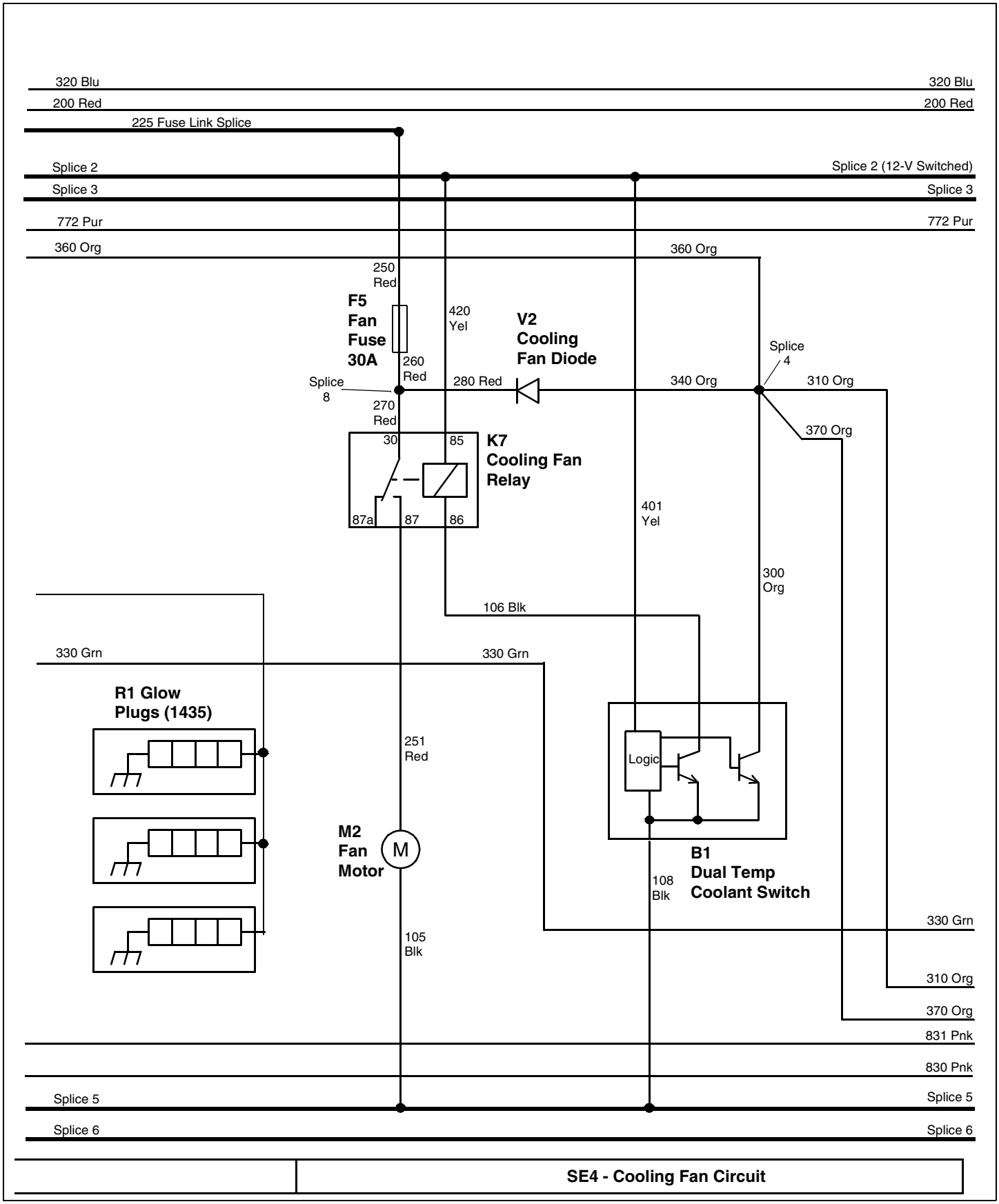
SE2 - PTO Interlocks Circuit

Schematics - 1400 Diesel Series S/N -20000 (3 of 6)



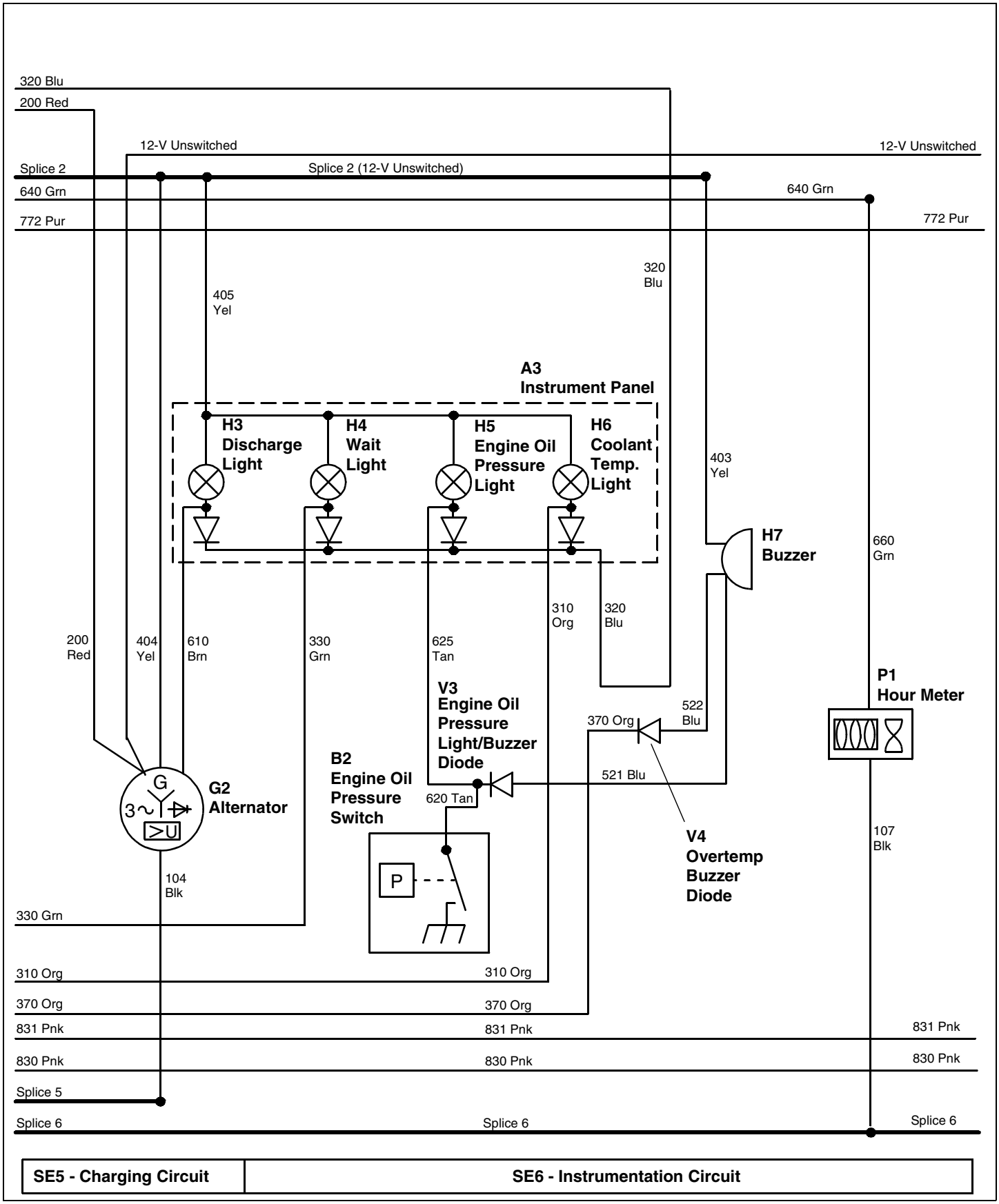
SE3 - Air Preheat and Fuel Pull-In Circuit

Schematics - 1400 Diesel Series S/N -20000 (4 of 6)



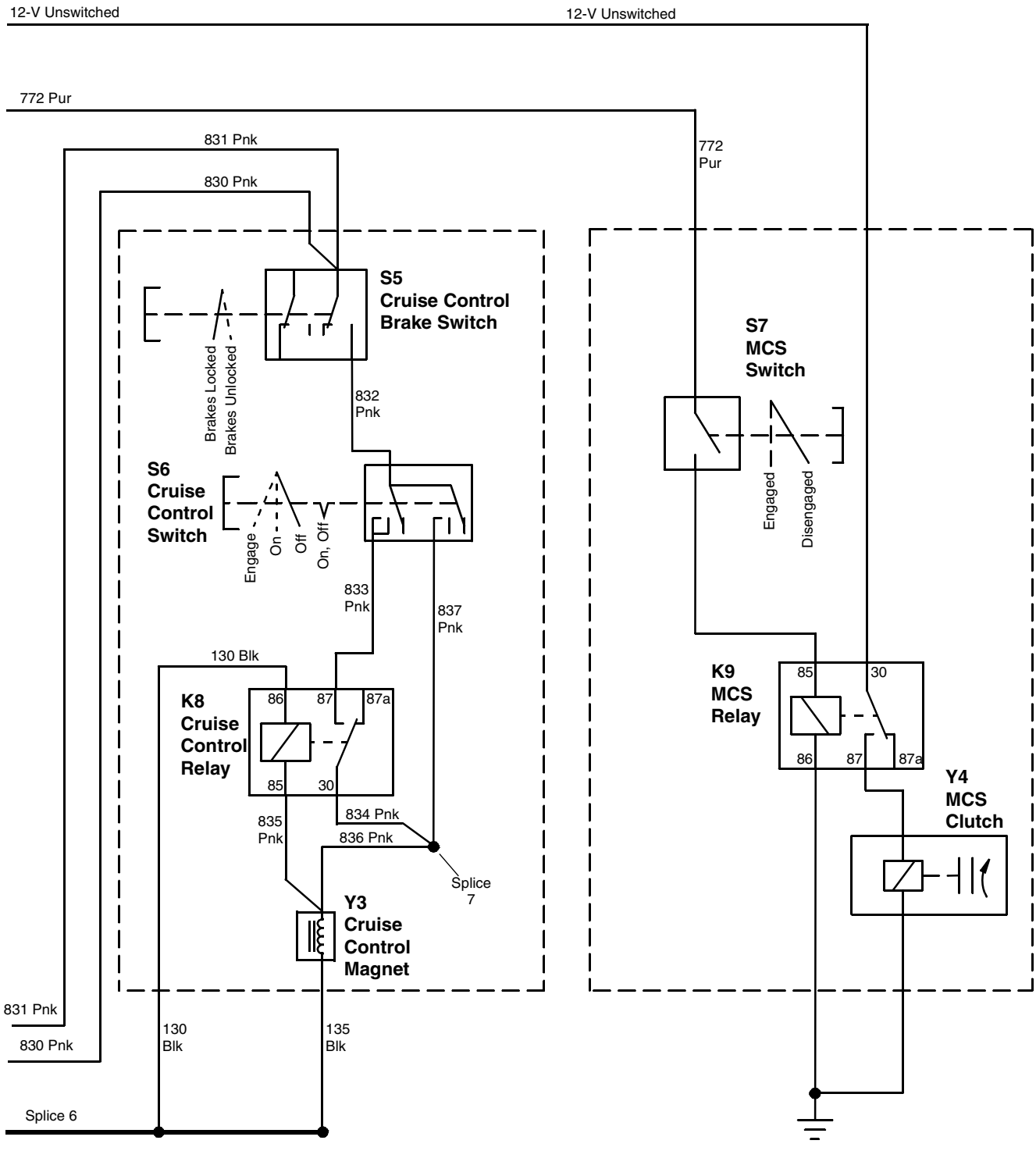
SE4 - Cooling Fan Circuit

Schematics - 1400 Diesel Series S/N -20000 (5 of 6)



SE5 - Charging Circuit	SE6 - Instrumentation Circuit

Schematics - 1400 Diesel Series S/N -20000 (6 of 6)



SE7 - Cruise Control Circuit (Optional)	SE8 - MCS Circuit (Optional)

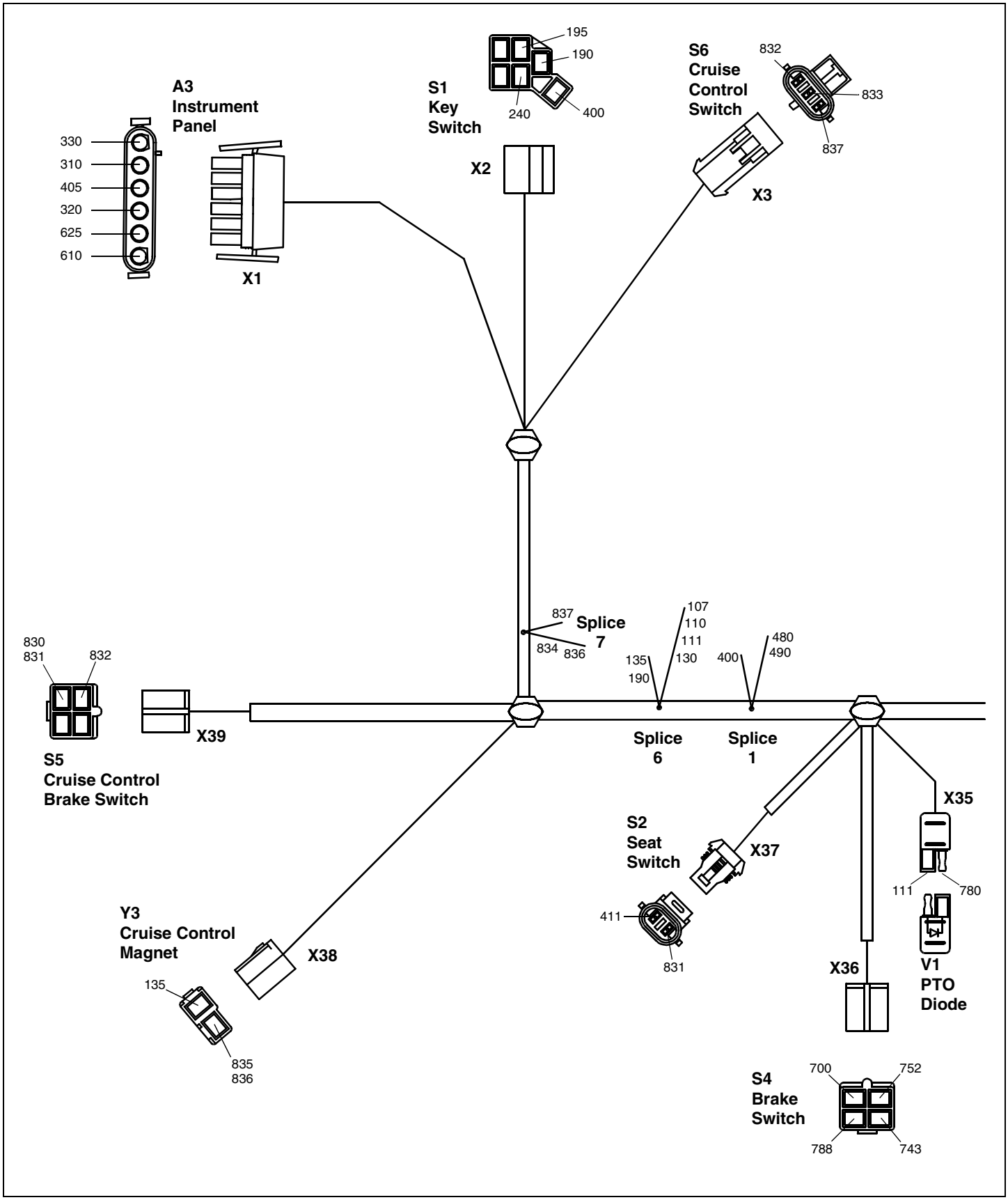
Wiring Harness (1400 Diesel Series S/N - 20000)

Wire Code Table

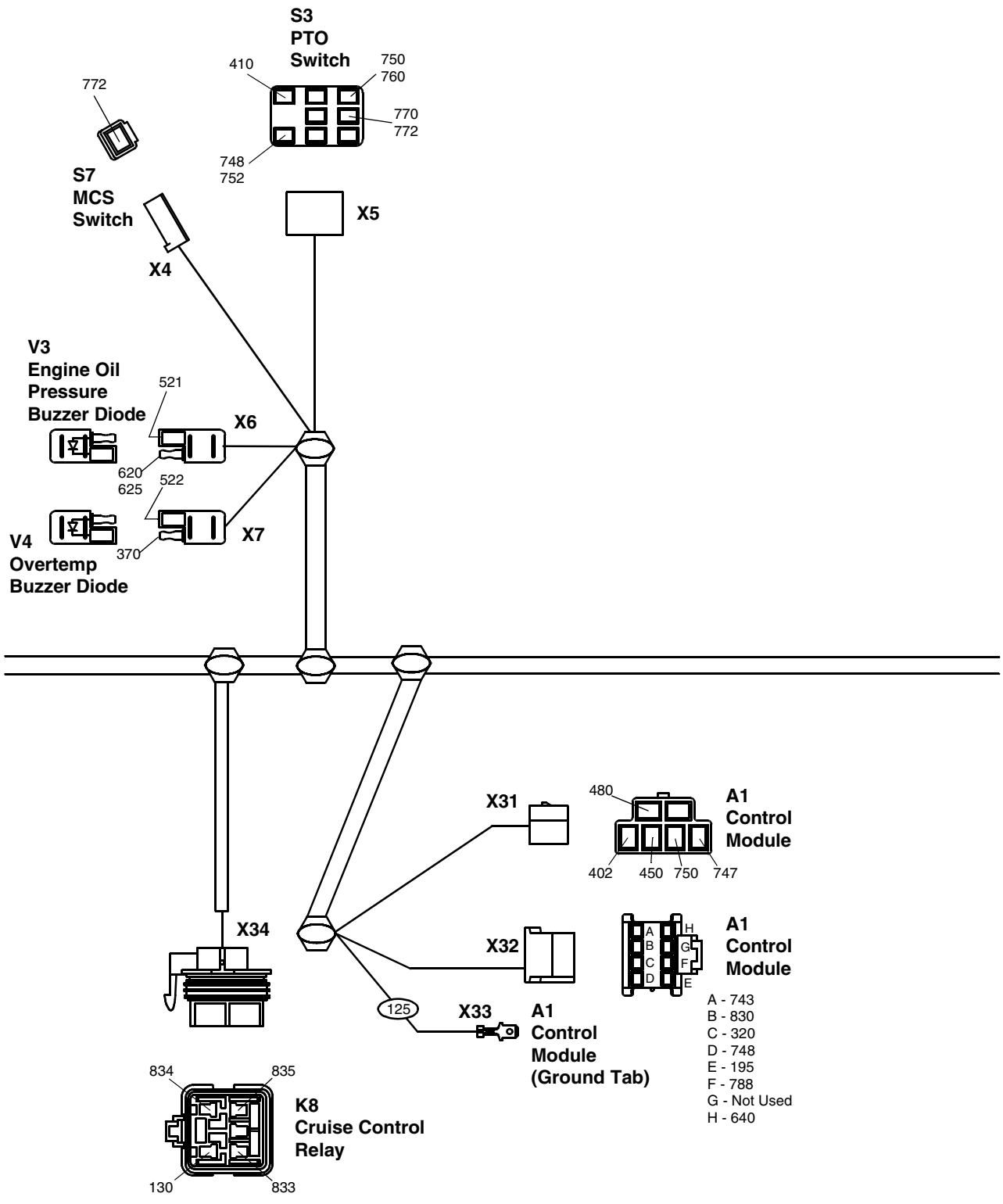
Size/No./Color	Wire Connection Points
5.0 100 Blk	W2 Gnd, Splice 5
3.0 101 Blk	X24, Splice 5
3.0 104 Blk	X20, Splice 5
3.0 105 Blk	X8, Splice 5
0.8 106 Blk	X16, X21
0.8 107 Blk	X12, Splice 6
0.8 108 Blk	X21, Splice 5
0.8 109 Blk	X14, Splice 5
5.0 110 Blk	Splice 5, Splice 6
1.0 111 Blk	X35, Splice 6
1.0 120 Blk	X22, Splice 5
0.8 125 Blk	X33, Splice 5
0.8 130 Blk	X34, Splice 6
1.0 135 Blk	X38, Splice 6
2.0 155 Blk	X13, Splice 5
1.0 190 Blk	X2, Splice 6
3.0 191 Blk	X30, Splice 5
1.0 195 Blk	X2, X32
5.0 200 Red	X28, X29
3.0 210 Red	X9, 230 Fuse Link
3.0 220 Red	X15, 225 Fuse Link
1.0 225 Fuse Link Gry	X29, 220 Red
2.0 230 Fuse Link Gry	X29, 210 Red
5.0 240 Red	X2, 230 Fuse Link
3.0 250 Red	X10, 225 Fuse Link
3.0 251 Red	X8, X16
3.0 260 Red	X10, Splice 8
3.0 270 Red	X16, Splice 8
0.8 280 Red	X18, Splice 8
0.8 300 Org	X21, Splice 4
0.8 310 Org	X1, Splice 4
0.8 320 Blu	X1, X32
0.8 330 Grn	X1, X14
0.8 340 Org	X18, Splice 4
0.8 350 Org	X14, X15
0.8 360 Org	X17, Splice 4
0.8 370 Org	X7, Splice 4
5.0 400 Yel	X2, Splice 1
0.8 401 Yel	X21, Splice 2
3.0 402 Yel	X31, Splice 2
0.8 403 Yel	X11, Splice 2
0.8 404 Yel	X19, Splice 2
0.8 405 Yel	X1, Splice 2
0.8 406 Yel	X14, Splice 2
0.8 407 Yel	X9, Splice 2
0.8 409 Yel	X15, Splice 2
1.0 410 Yel	X5, Splice 2
0.8 411 Yel	X37, Splice 2
0.8 420 Yel	X16, Splice 2
0.8 430 Yel	X17, Splice 2
2.0 450 Yel	X13, X31
3.0 480 Yel	X31, Splice 1
3.0 490 Yel	X30, Splice 1
0.8 521 Blu	X6, X11
0.8 522 Blu	X7, X11
0.8 610 Brn	X1, X19

Size/No./Color	Wire Connection Points
0.8 620 Tan	X6, X23
0.8 625 Tan	X1, X6
0.8 630 Grn	X14, Splice 3
1.0 640 Grn	X32, Splice 3
1.0 650 Grn	X24, Splice 3
0.8 660 Grn	X12, Splice 3
0.8 700 Pur	X17, X36
0.8 743 Pur	X32, X36
3.0 747 Pur	X27, X31
0.8 748 Pur	X5, X32
1.0 750 Pur	X5, X31
0.8 751 Pur	X9, X14
0.8 752 Pur	X5, X36
0.8 760 Pur	X5, X17
1.0 770 Pur	X5, X22
0.8 772 Pur	X4, X5
0.8 780 Pur	X22, X35
0.8 788 Pur	X32, X36
1.0 830 Pnk	X32, X39
1.0 831 Pnk	X37, X39
1.0 832 Pnk	X3, X39
1.0 833 Pnk	X3, X34
1.0 834 Pnk	X34, Splice 7
1.0 835 Pnk	X34, X38
1.0 836 Pnk	X38, Splice 7
1.0 837 Pnk	X3, Splice 7
3.0 900 Wht	X15, X25
3.0 910 Wht	X9, X24

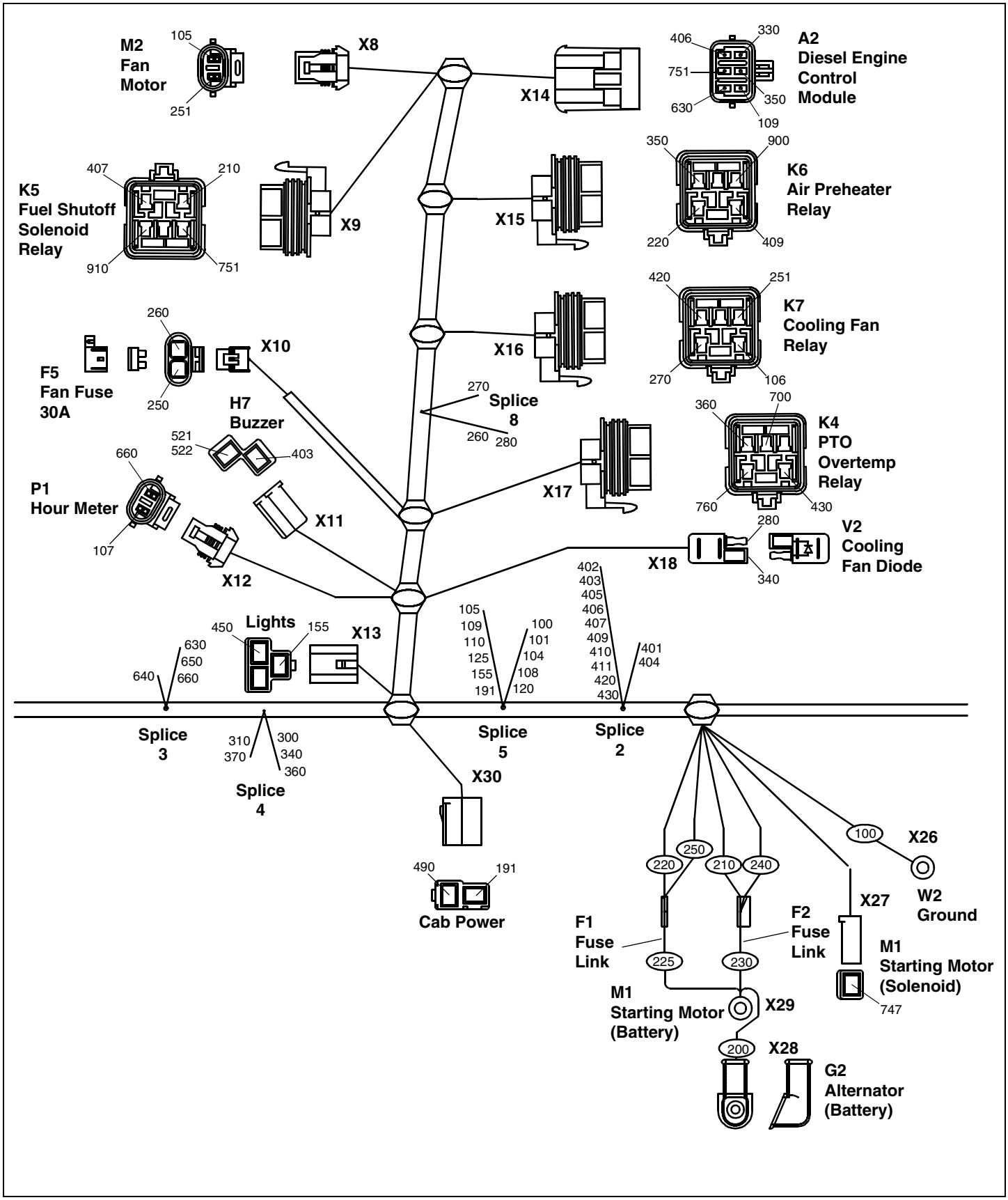
Wiring Harness - 1400 Diesel Series S/N -20000 (1 of 4)



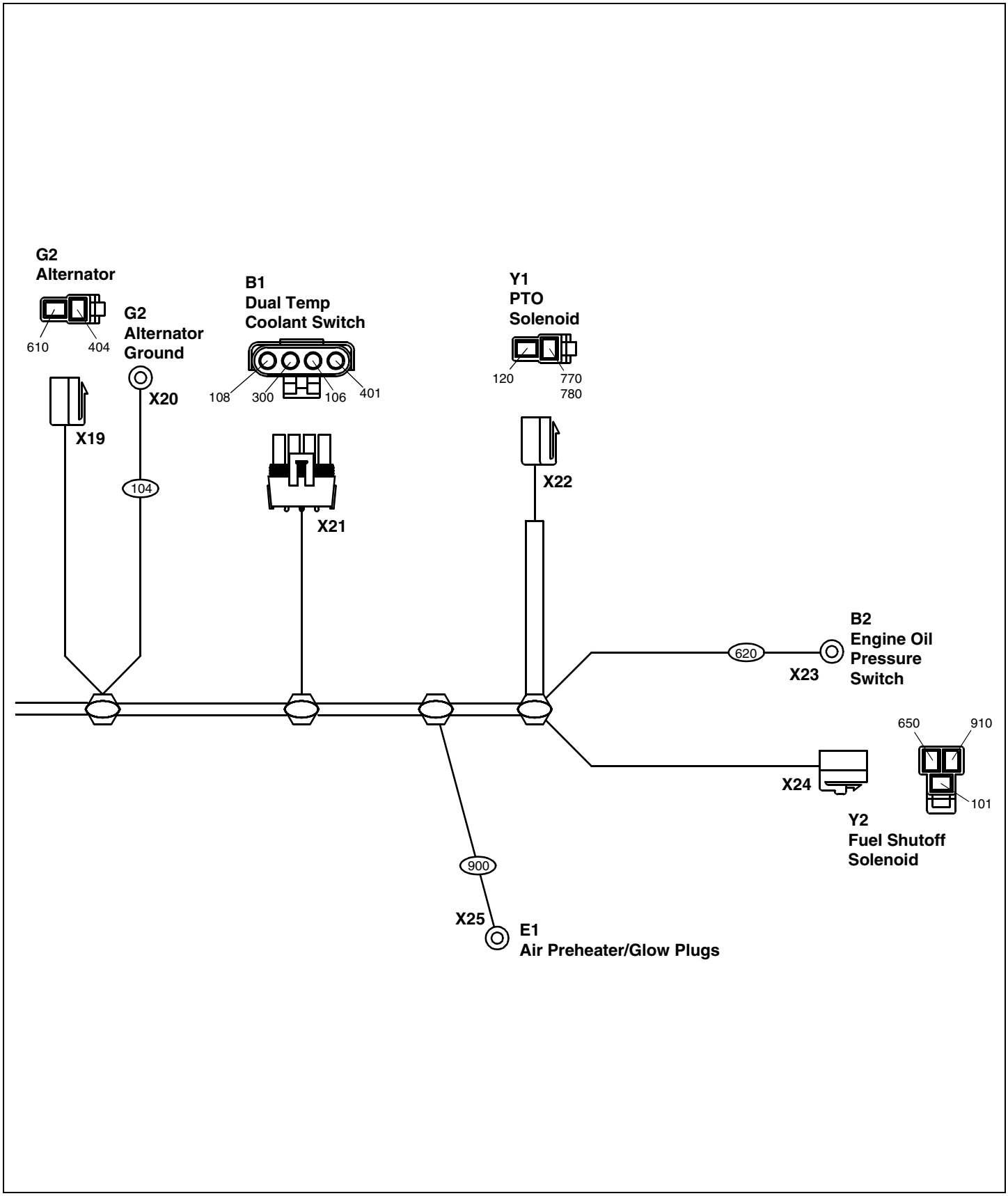
Wiring Harness - 1400 Diesel Series S/N -20000 (2 of 4)



Wiring Harness - 1400 Diesel Series S/N -20000 (3 of 4)

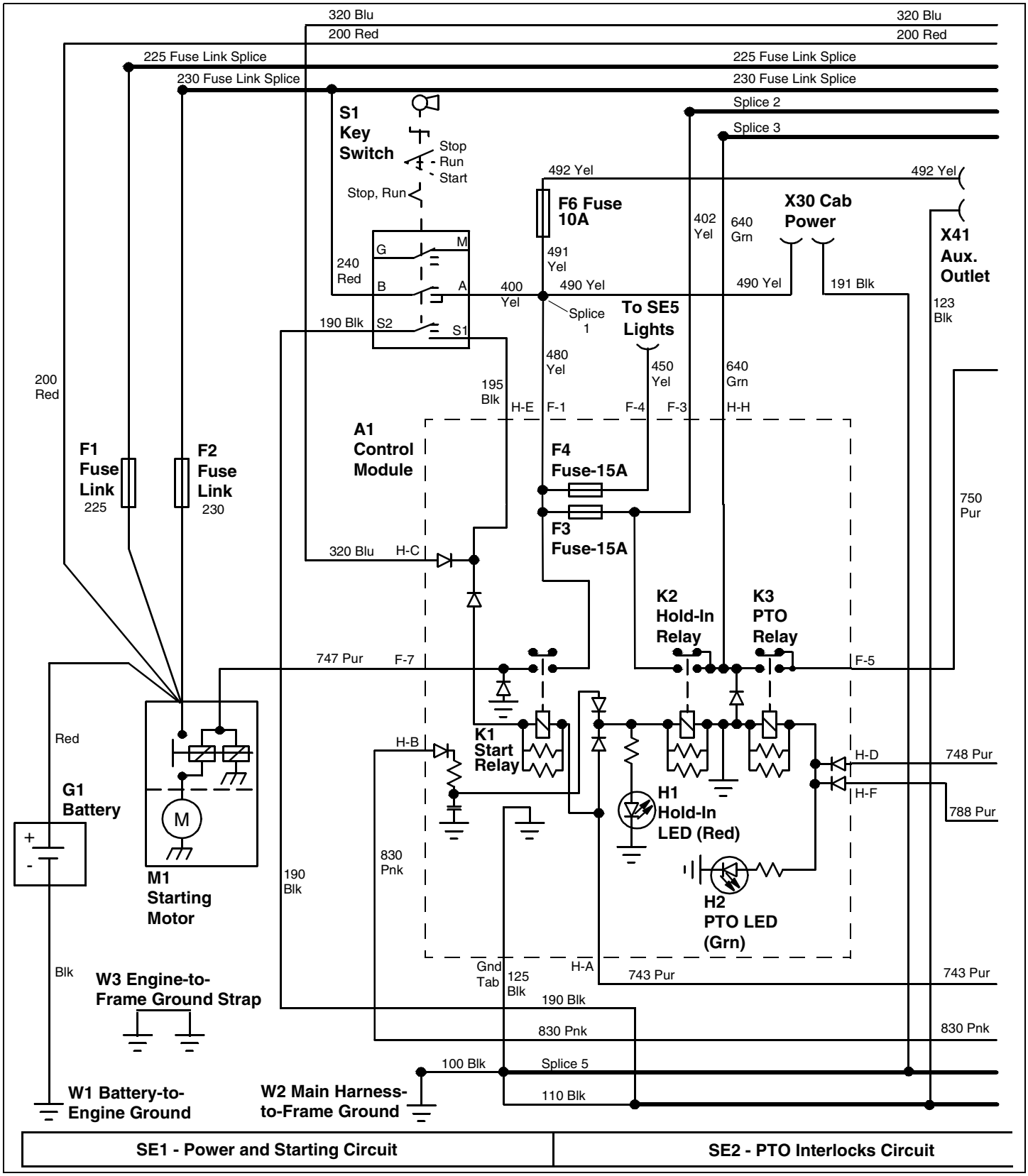


Wiring Harness - 1400 Diesel Series S/N -20000 (4 of 4)

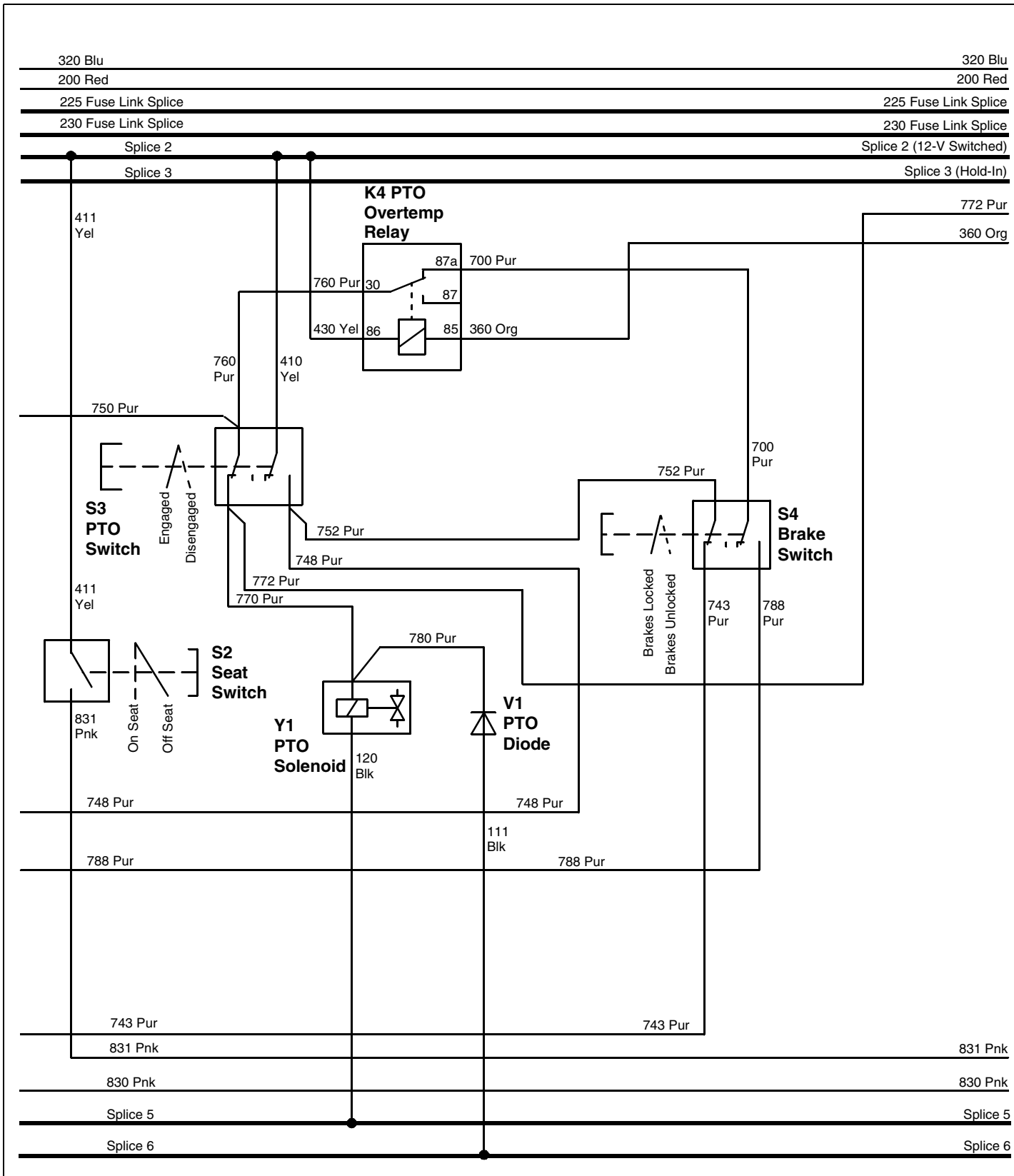


Schematic (1400 Diesel Series S/N 20001- ; 1500 Series S/N 10001- ; 1545 All)

Schematics - 1400 Diesel Series S/N 20001-; 1500 Series S/N 10001- ; 1545 All (1 of 6)

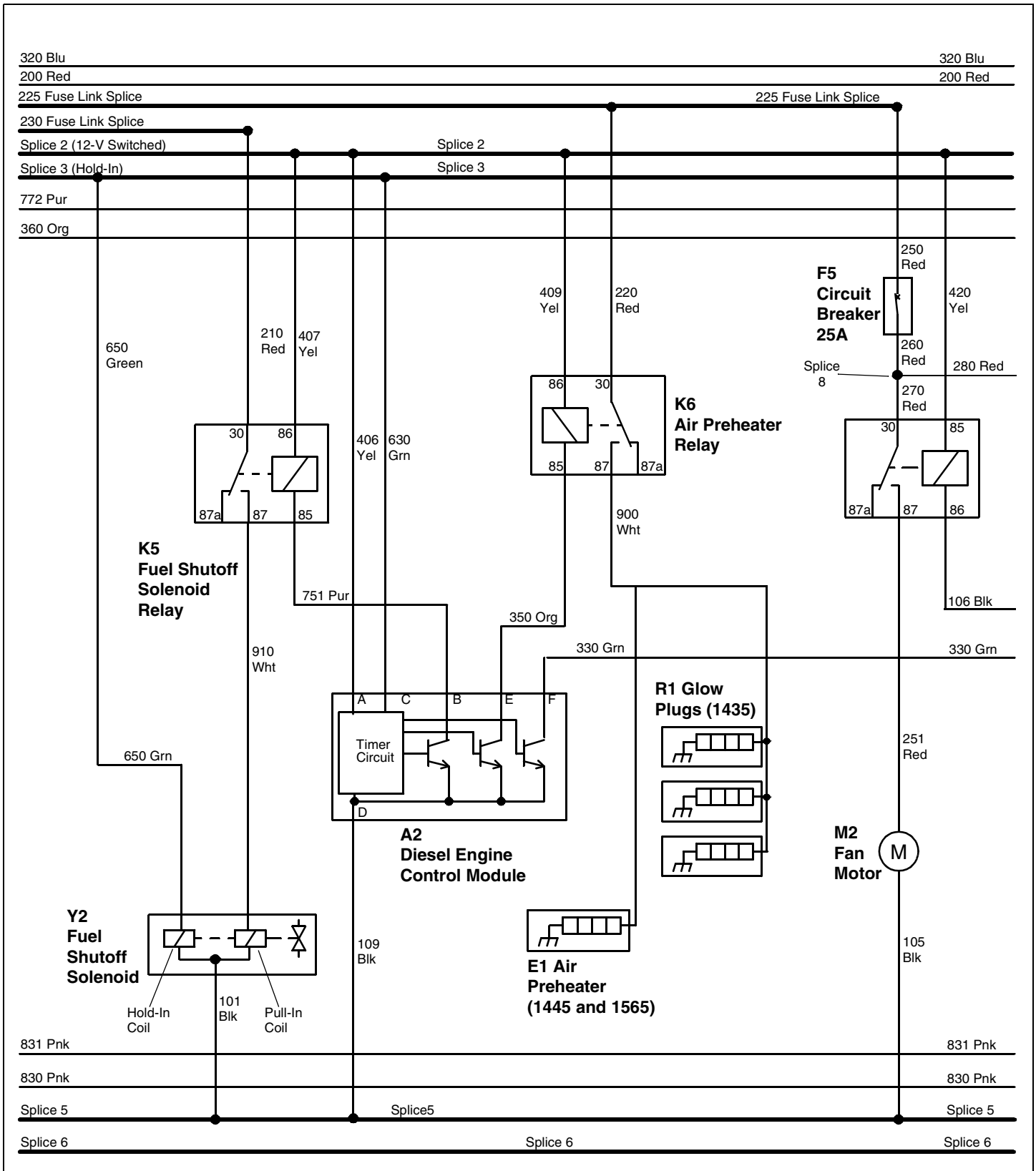


Schematics - 1400 Diesel Series S/N 20001-; 1500 Series S/N 10001- ; 1545 All (2 of 6)



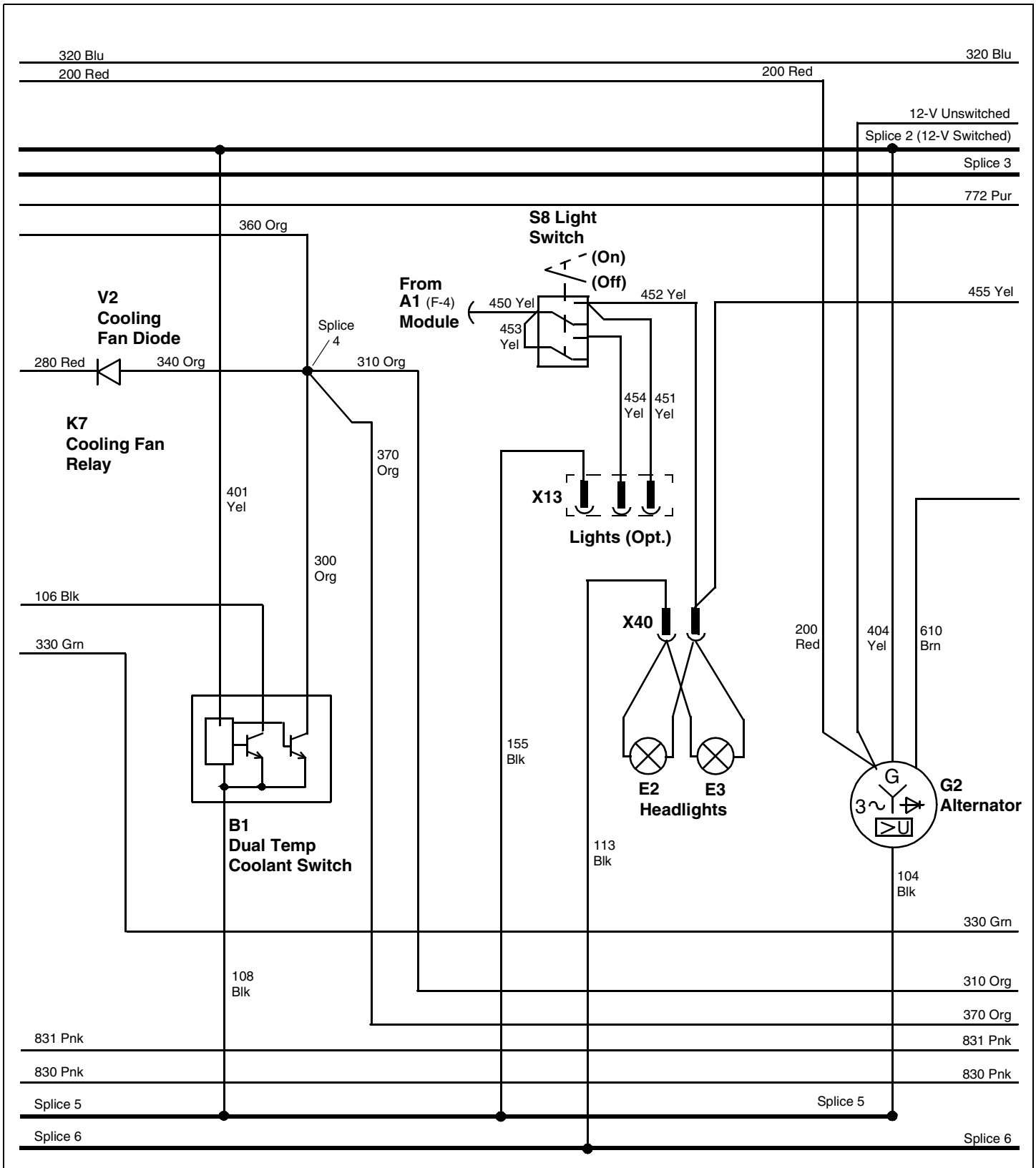
SE2 - PTO Interlocks Circuit

Schematics - 1400 Diesel Series S/N 20001-; 1500 Series S/N 10001- ; 1545 All (3 of 6)



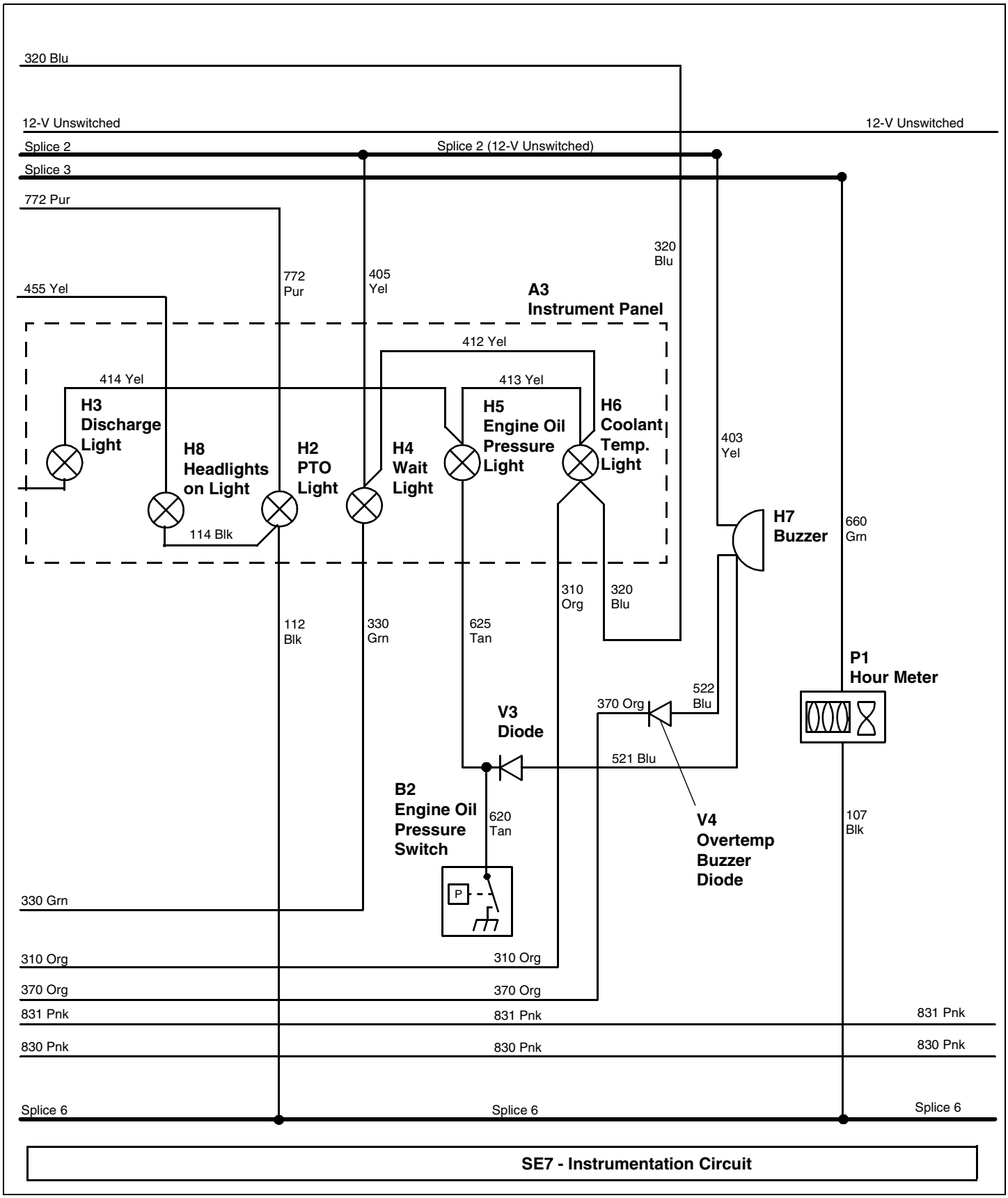
SE3 - Air Preheat and Fuel Pull-In Circuit

Schematics - 1400 Diesel Series S/N 20001-; 1500 Series S/N 10001- ; 1545 All (4 of 6)



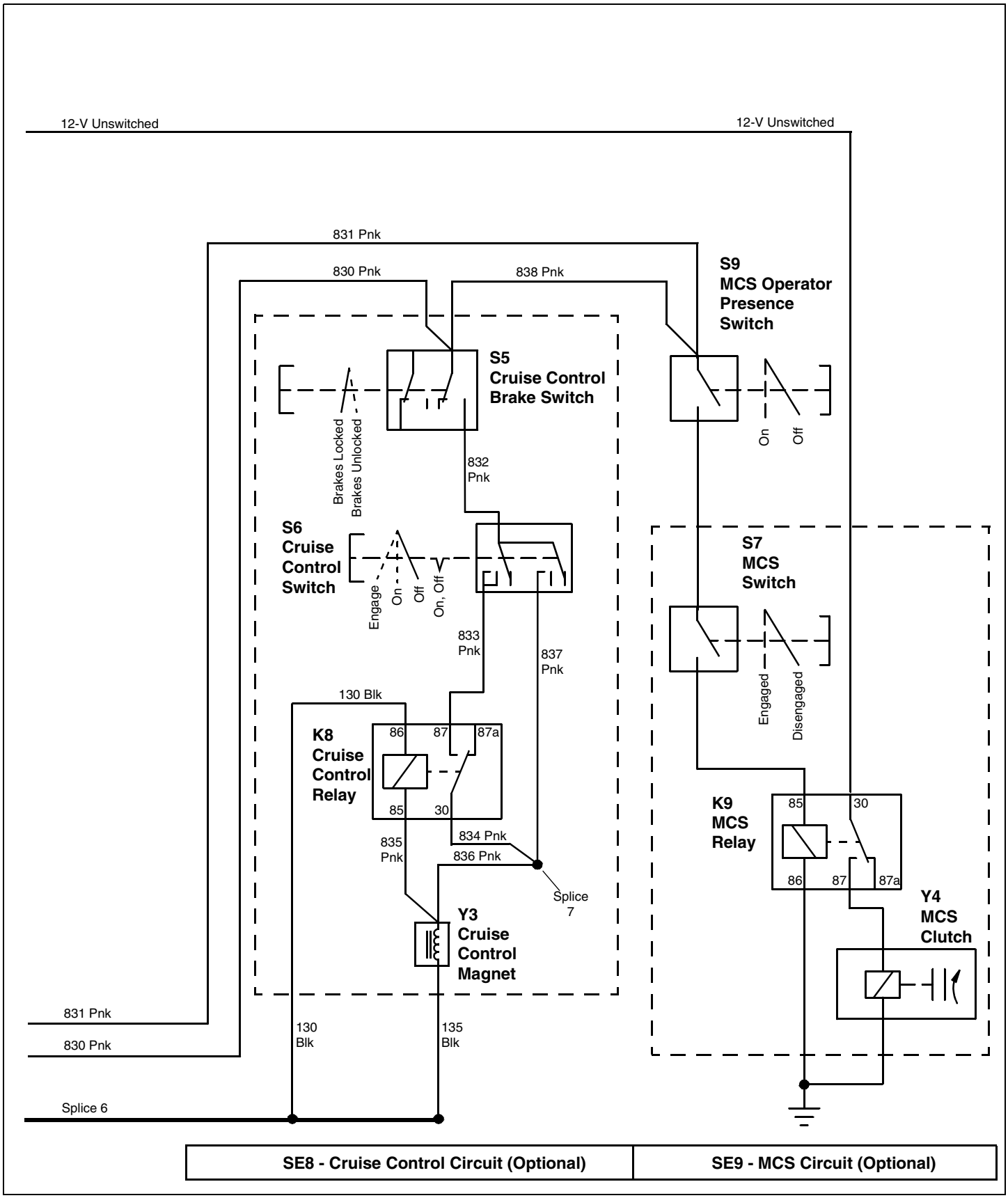
SE4 - Cooling Fan Circuit	SE5 - Lights	SE6 - Charging Circuit

Schematics - 1400 Diesel Series S/N 20001-; 1500 Series S/N 10001- ; 1545 All (5 of 6)



SE7 - Instrumentation Circuit

Schematics - 1400 Diesel Series S/N 20001-; 1500 Series S/N 10001- ; 1545 All (6 of 6)



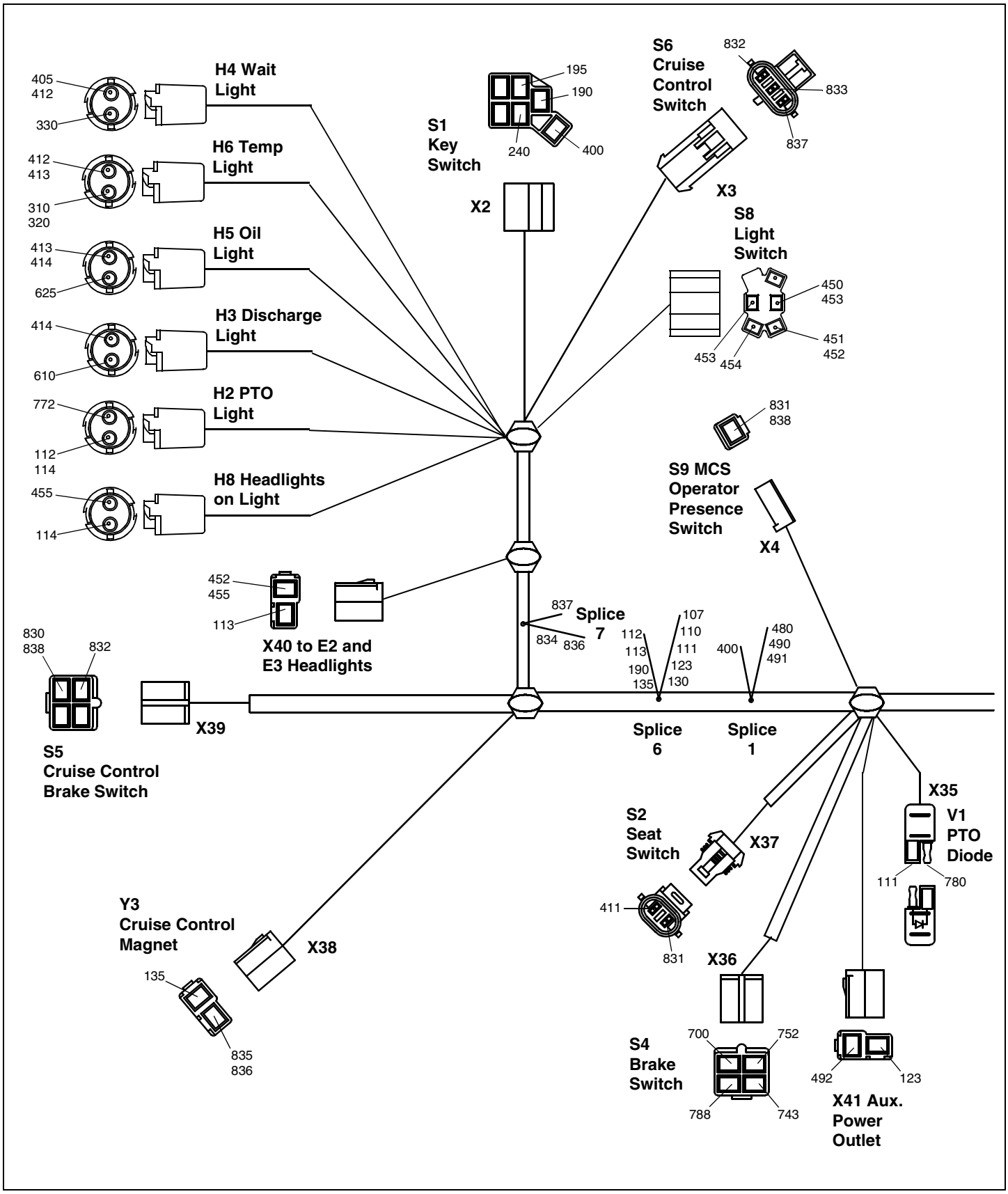
Wiring Harness (1400 Diesel Series S/N 20001- ; 1500 Diesel Series S/N 10001- ; 1545 All)

Wire Code Table: Diesel (Model Year 2002-)

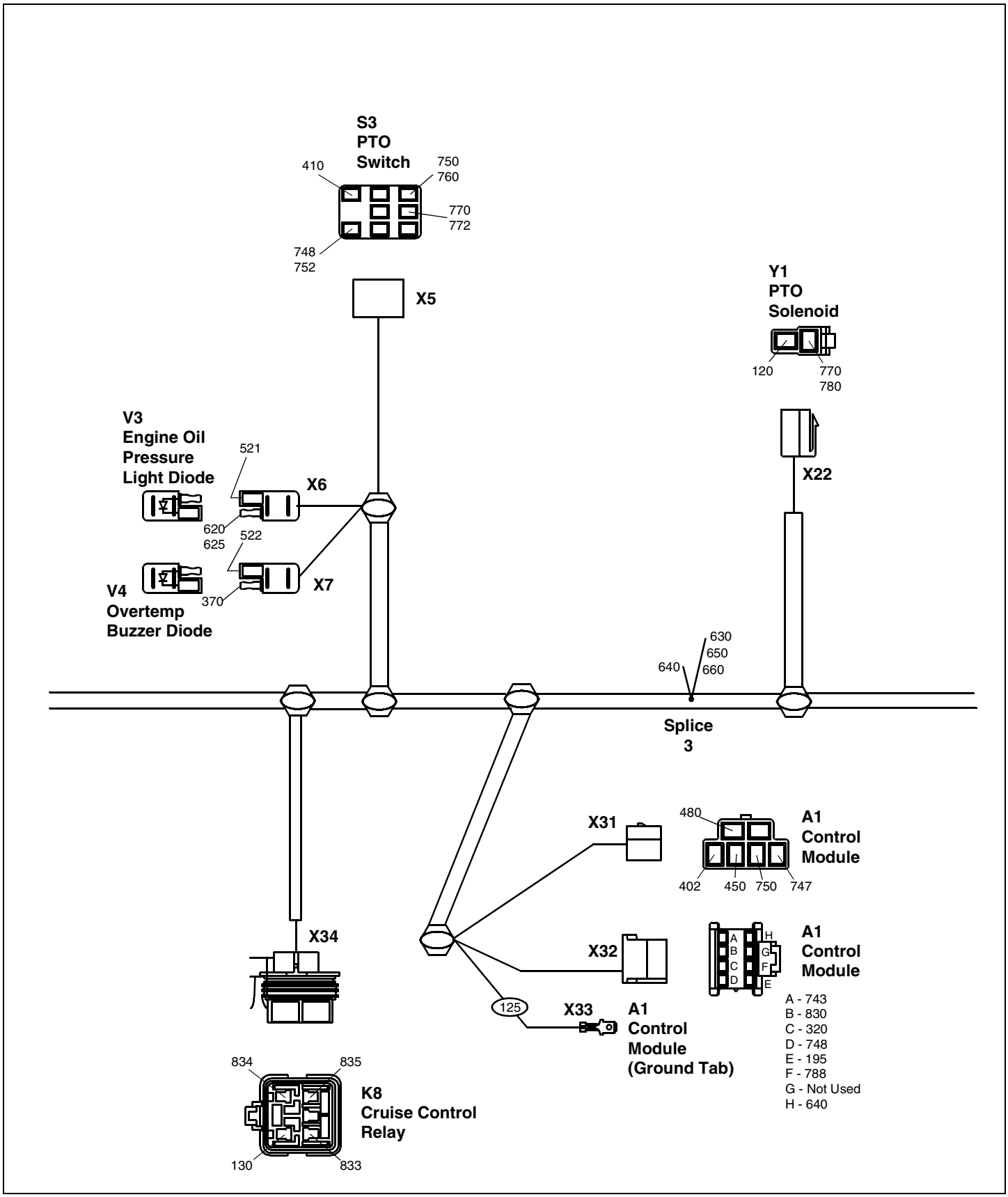
Size/No./Color	Wire Connection Points
5.0 100 Blk	W2 Gnd, Splice 5
3.0 101 Blk	X24, Splice 5
3.0 104 Blk	X20, Splice 5
3.0 105 Blk	X8, Splice 5
0.8 106 Blk	X16, X21
0.8 107 Blk	X12, Splice 6
0.8 108 Blk	X21, Splice 5
0.8 109 Blk	X14, Splice 5
5.0 110 Blk	Splice 5, Splice 6
1.0 111 Blk	X35, Splice 6
0.8 112 Blk	H2, Splice 6
2.0 113 Blk	X40, Splice 6
0.8 114 Blk	H8, H2
1.0 120 Blk	X22, Splice 5
3.0 123 Blk	X41, Splice 6
0.8 125 Blk	X33, Splice 5
0.8 130 Blk	X34, Splice 6
1.0 135 Blk	X38, Splice 6
2.0 155 Blk	X13, Splice 5
1.0 190 Blk	X2, Splice 6
3.0 191 Blk	X30, Splice 5
1.0 195 Blk	X2, X32
5.0 200 Red	X28, X29
3.0 210 Red	X9, 230 Fuse Link
3.0 220 Red	X15, 225 Fuse Link
1.0 225 Fuse Link	X29, 220 Red
2.0 230 Fuse Link	X29, 210 Red
5.0 240 Red	X2, 230 Fuse Link
3.0 250 Red	F5, 225 Fuse Link
3.0 251 Red	X8, X16
3.0 260 Red	F5, Splice 8
3.0 270 Red	X16, Splice 8
0.8 280 Red	X18, Splice 8
0.8 300 Org	X21, Splice 4
0.8 310 Org	H6, Splice 4
0.8 320 Blu	H6, X32
0.8 330 Grn	H4, X14
0.8 340 Org	X18, Splice 4
0.8 350 Org	X14, X15
0.8 360 Org	X17, Splice 4
0.8 370 Org	X7, Splice 4
5.0 400 Yel	X2, Splice 1
0.8 401 Yel	X21, Splice 2
3.0 402 Yel	X31, Splice 2
0.8 403 Yel	X11, Splice 2
0.8 404 Yel	X19, Splice 2
0.8 405 Yel	Splice 2, H4
0.8 406 Yel	X14, Splice 2
0.8 407 Yel	X9, Splice 2
0.8 409 Yel	X15, Splice 2
1.0 410 Yel	X5, Splice 2
0.8 411 Yel	X37, Splice 2
0.8 412 Yel	H4, H6
0.8 413 Yel	H6, H5
0.8 414 Yel	H5, H3
0.8 420 Yel	X16, Splice 2

Size/No./Color	Wire Connection Points
0.8 430 Yel	X17, Splice 2
2.0 450 Yel	X31, S8
2.0 451 Yel	S8, X13
2.0 452 Yel	S8, X40
2.0 453 Yel	S8, S8 Jumper
2.0 454 Yel	S8, X13
0.8 455 Yel	X40, H8
3.0 480 Yel	X31, Splice 1
3.0 490 Yel	X30, Splice 1
1.0 491 Yel	Splice 1, X10
1.0 492 Yel	X10, X41
0.8 521 Blu	X6, X11
0.8 522 Blu	X7, X11
0.8 610 Brn	H3, X19
0.8 620 Tan	X6, X23
0.8 625 Tan	H5, X6
0.8 630 Grn	X14, Splice 3
1.0 640 Grn	X32, Splice 3
1.0 650 Grn	X24, Splice 3
0.8 660 Grn	X12, Splice 3
0.8 700 Pur	X17, X36
0.8 743 Pur	X32, X36
3.0 747 Pur	X27, X31
0.8 748 Pur	X5, X32
1.0 750 Pur	X5, X31
0.8 751 Pur	X9, X14
0.8 752 Pur	X5, X36
0.8 760 Pur	X5, X17
1.0 770 Pur	X5, X22
0.8 772 Pur	X5, H2
0.8 780 Pur	X22, X35
0.8 788 Pur	X32, X36
1.0 830 Pnk	X32, X39
1.0 831 Pnk	X37, X4
1.0 832 Pnk	X3, X39
1.0 833 Pnk	X3, X34
1.0 834 Pnk	X34, Splice 7
1.0 835 Pnk	X34, X38
1.0 836 Pnk	X38, Splice 7
1.0 837 Pnk	X3, Splice 7
0.8 838 Pnk	X4, X39
3.0 900 Wht	X15, X25
3.0 910 Wht	X9, X24

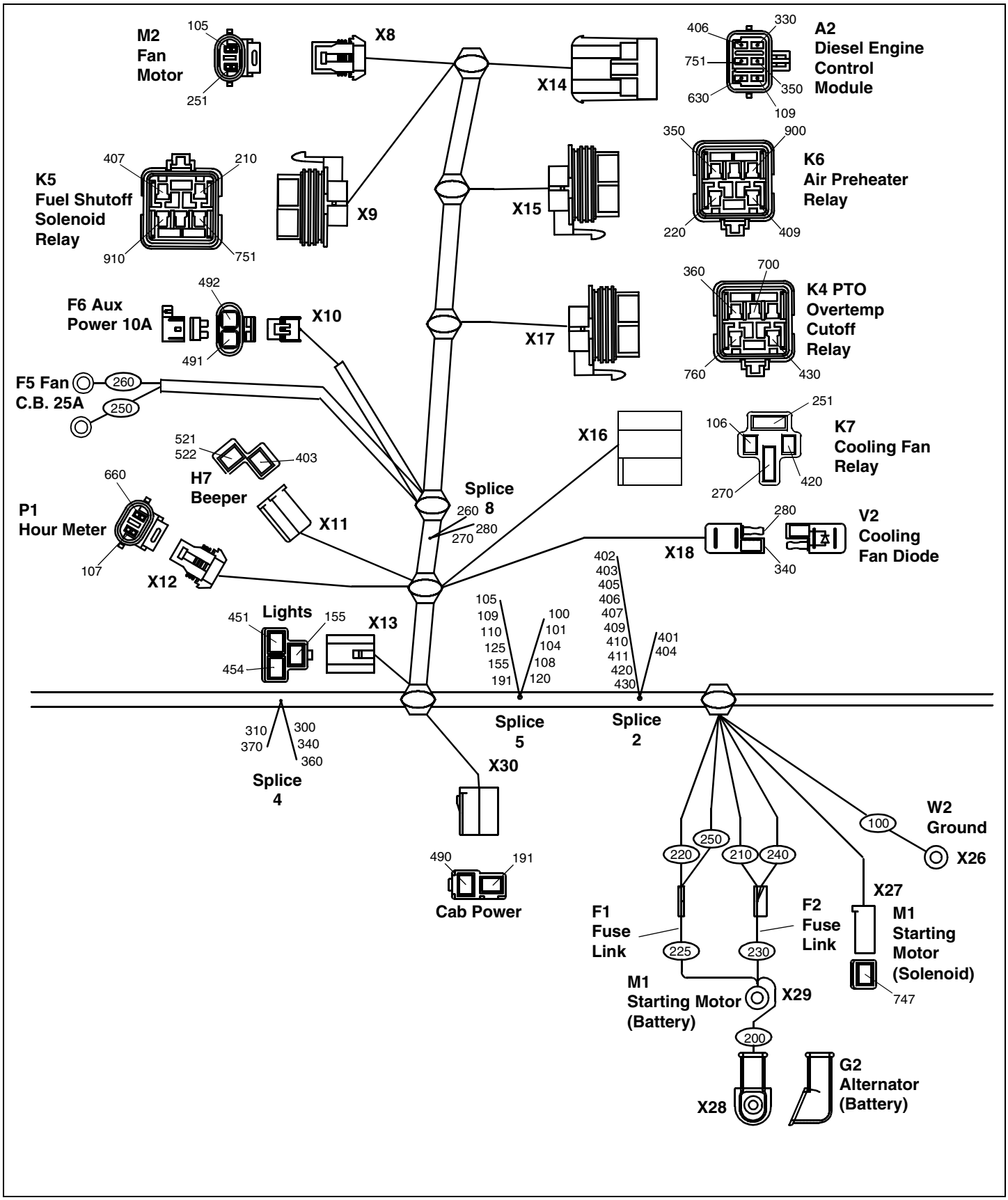
Wiring Harness - 1400 Diesel Series S/N 20001-; 1500 Series S/N 10001- ; 1545 All (1 of 4)



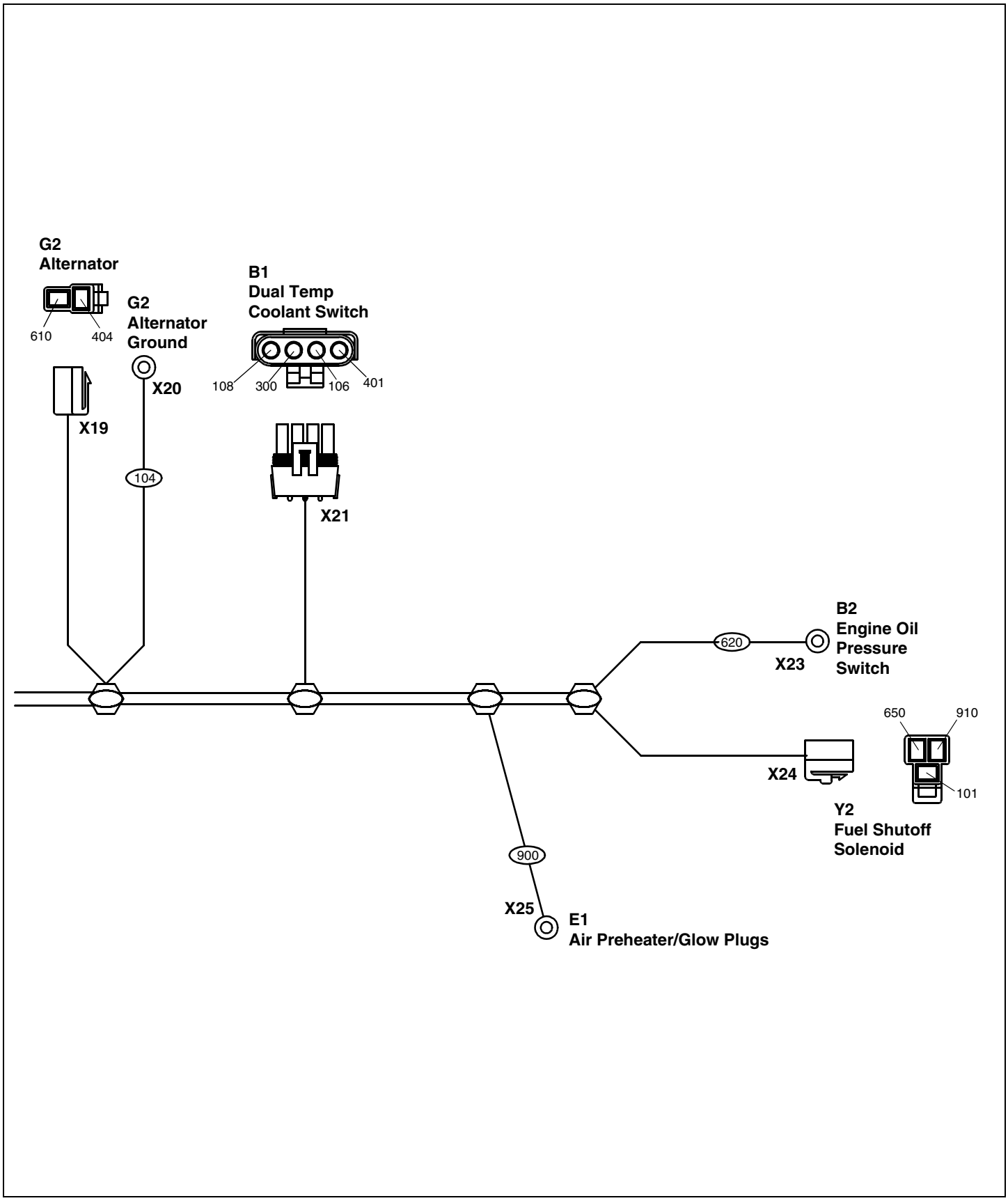
Wiring Harness - 1400 Diesel Series S/N 20001-; 1500 Series S/N 10001- ; 1545 All (2 of 4)



Wiring Harness - 1400 Diesel Series S/N 20001-; 1500 Series S/N 10001- ; 1545 All (3 of 4)

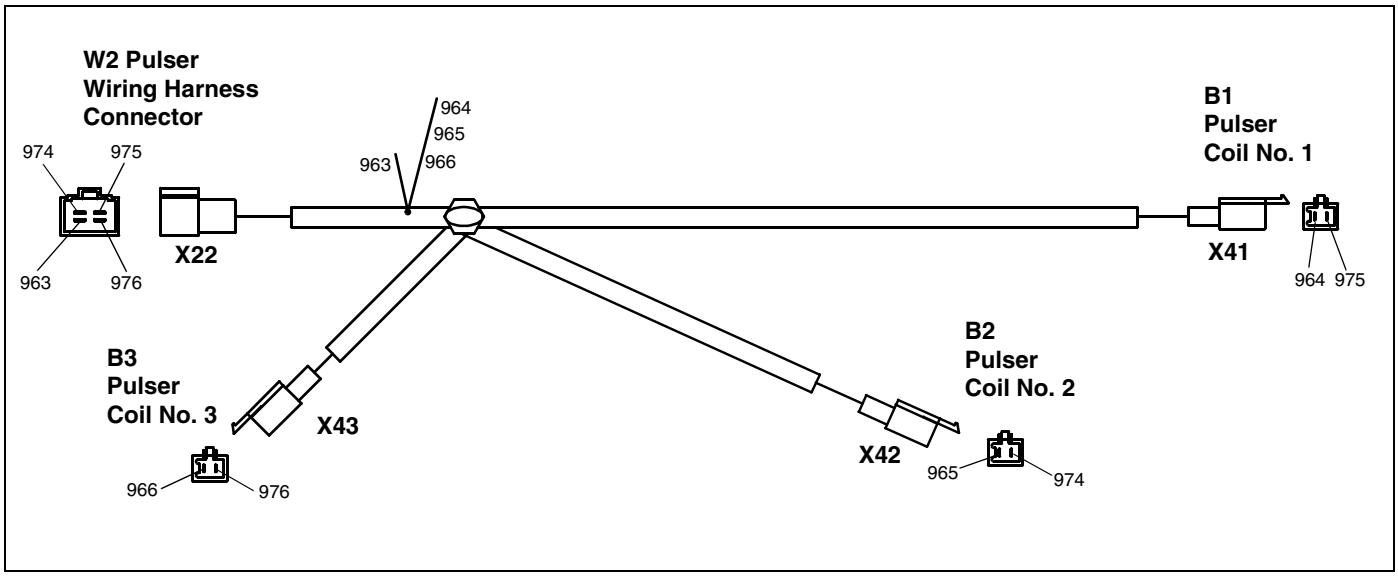


Wiring Harness - 1400 Diesel Series S/N -20000; 1500 Series S/N 10001- ; 1545 All (4 of 4)



Pulser Wiring Harness - Gas Engine

W2 Pulser Wiring Harness



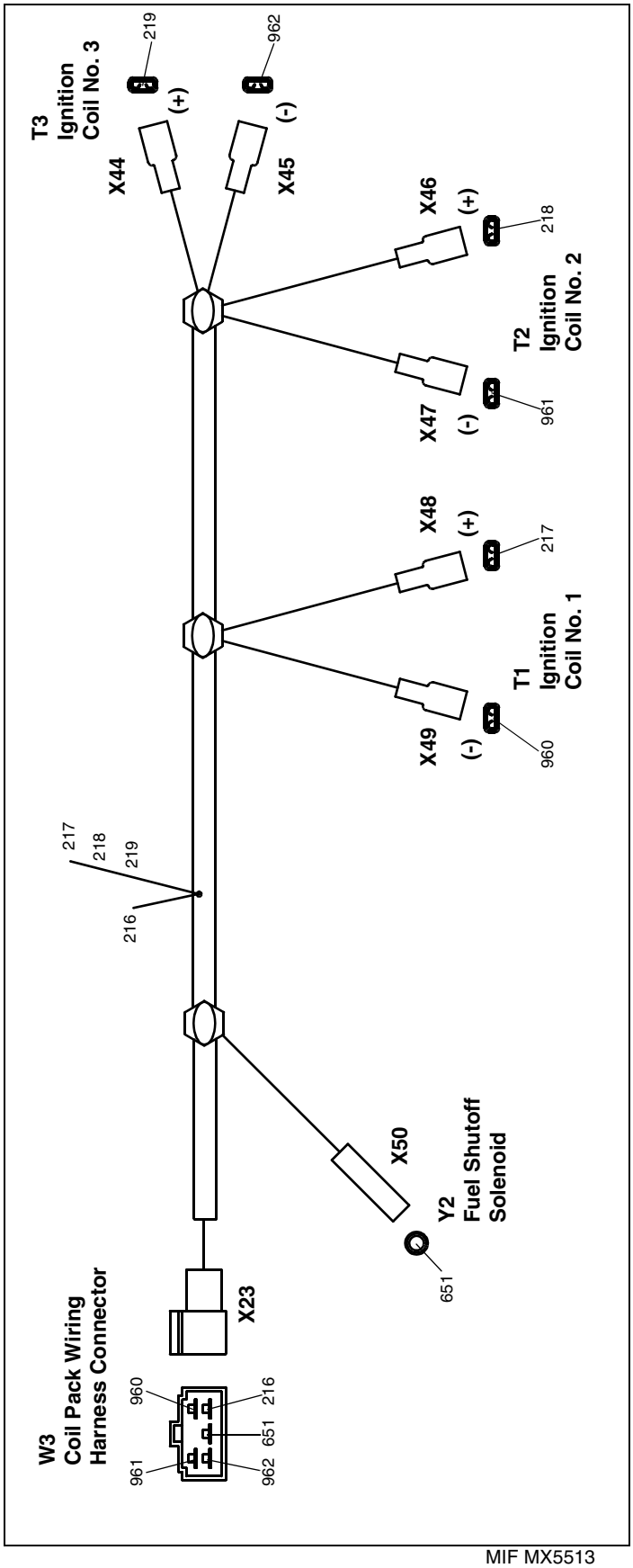
MIF MX5512

Coil Pack Wiring Harness - Gas Engine

Wire Code Table

Size/No./Color	Wire Connection Points
3.0 651 Red-Blk	X23, X50
3.0 216 Org-Blk	X23, X50
0.8 217 Org-Blk	X48, Splice 4
0.8 218 Org-Blk	X46, Splice 4
0.8 219 Org-Blk	X44, Splice 4
0.8 960 Wht-Red	X23, X49
0.8 961 Blk/Yel-Red	X23, X47
0.8 962 Wht/Blu-Red	X8, 101 Blk

W3 Coil Pack Wiring Harness



MIF MX5513

Operation and Diagnostics

Unswitched Power Circuit Operation - Gas Engine

Function:

Provides unswitched power to the primary components whenever the battery is connected.

Operating Conditions:

- Battery connected.
- Key switch in STOP position.

Theory of Operation:

Voltage must be present at the following components with the key switch in the STOP position:

- Battery (B1) positive (+) terminal.
- Battery terminal B of starting motor (M1).
- Shutdown delay module (A2).
- Ignition coils (T1, T2 and T3).
- Fan fuse (F5).
- Battery terminal B of key switch (S1).
- Red Wire at Engine Wiring Harness Connector (X23).

The positive (+) battery cable connects the battery to the starting motor battery terminal B. This connection is used as a tie point for the rest of the electrical system.

The battery cables and the starting motor connections must be in good condition for the electrical system to function properly.

The ground cable connects from the negative (-) battery terminal to the engine ground (W1). The ground connection is equally important as the positive (+) cable. The starting motor depends on these cables and connections to carry the high current necessary for operation.

The connection from starting motor (M1) to the shutdown delay module (A2) and ignition coils (T1, T2 and T3) is protected by fuse link (F1). Current flows from the fuse link through 210 Red wire to the shutdown delay module. From the shutdown delay module, current continues through 215 Red wire to the coil pack wire harness connector (X23) and flows to the ignition coils.

The connection from starting motor (M1) to the key switch (S1) and fan fuse (F5) is protected by fuse link (F2). Current flows from the fuse link through 240 Red wire to the key switch. Current also flows from the fuse link through 250 Red wire to the fan fuse.

Switched Power Circuit Operation - Gas Engine

Function:

Provides switched power to the primary components whenever the battery is connected.

Operating Conditions:

- Battery connected.
- Key switch in RUN position.

Theory of Operation:

Voltage must be present at the following components with the key switch in the RUN position:

- Cab power connector (X31).
- Control module connector (X32) terminal 1.
- Fuse (F3).
- Fuse (F4).
- Start relay (K1).
- Hold-in relay (K2).
- Control module connector (X32) terminal 4.
- Lights connector (X10).
- Control module connector (X32) terminal 3.
- Dual temp coolant switch (A4).
- Buzzer (H6).
- Alternator connector (X17).
- Instrument panel (A5).
- PTO switch (S3).
- Seat switch (S2).
- Cooling fan relay (K5).
- PTO overtemp relay (K4).

Placing the key switch (S1) in the RUN position provides voltage from 240 Red wire through the key switch to 400 Yel wire.

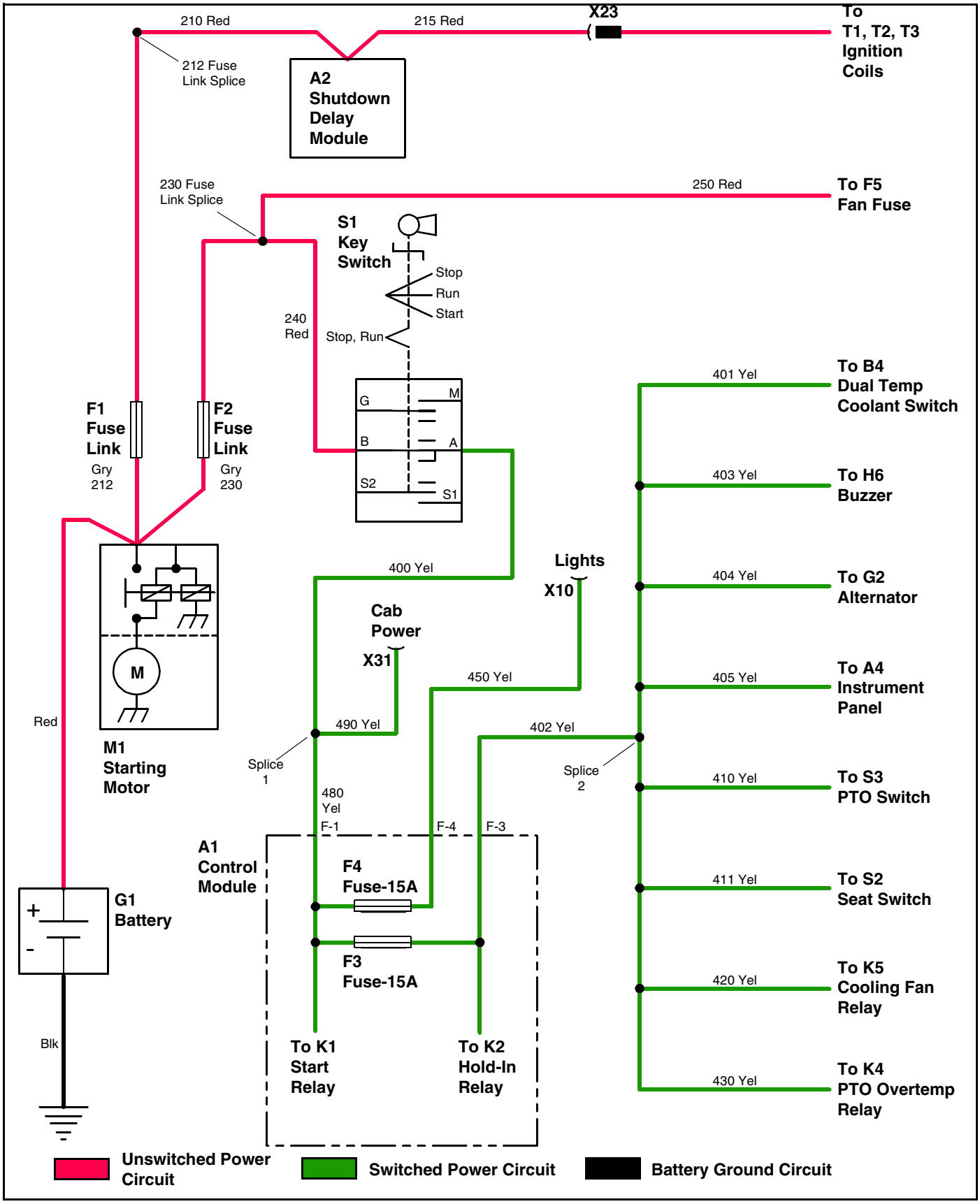
Current flows through 400 Yel wire to 490 and 480 Yel wires. Current then flows through 480 Yel wire to control module (A1) connector (X32) terminal 1 and through 490 Yel wire to cab power connector (X30).

Inside the control module (A1), current flows from connector (X32) terminal 1 to fuses (F3 and F4) and start relay (K1). Current flows from fuse (F4) to connector (X32) terminal 4, through 450 Yel wire to lights connector (X10). Current flows from fuse (F3) to hold-in relay (K2), to connector (X32) terminal 3, and through 402 Yel wire to the following components:

- Dual temp coolant switch (A4) [401 Yel wire].
- Buzzer (H6) [403 Yel wire].
- Alternator (G1) [404 Yel wire].
- Instrument panel (A5) [405 Yel wire].
- PTO switch (S3) [410 Yel wire].

- Cooling fan relay (K5) [420 Yel wire].
- PTO overtemp relay (K4) [430 Yel wire].

Power Circuit Schematic - Gas Engine



MIF MX5525

Unswitched Power Circuit - Diesel Engine

Function:

Provides unswitched power to the primary components whenever the battery is connected.

Operating Conditions:

- Battery connected.
- Key switch in STOP position.

Theory of Operation:

Voltage must be present at the following components with the key switch in the STOP position:

- Battery (B1) positive (+) terminal.
- Battery terminal B of starting motor (M1).
- Air Preheater Relay (K6).
- Fan fuse (F5).
- Battery terminal B of key switch (S1).
- Fuel Shutoff Solenoid Relay (K5).

The positive (+) battery cable connects the battery to the starting motor battery terminal B. This connection is used as a tie point for the rest of the electrical system.

The battery cables and the starting motor connections must be in good condition for the electrical system to function properly.

The ground cable connects from the negative (-) battery terminal to the engine ground (W1). The ground connection is equally important as the positive (+) cable. The starting motor depends on these cables and connections to carry the high current necessary for operation.

The connection from starting motor (M1) to the air preheater relay (K6) and fan fuse (F5) is protected by fuse link (F1). Current flows from the fuse link through 220 Red wire to the air preheater relay and through 250 Red wire to the fan fuse.

The connection from starting motor (M1) to the key switch (S1) and the fuel shutoff solenoid relay (K5) is protected by fuse link (F2). Current flows from the fuse link through 240 Red wire to the key switch. Current also flows from the fuse link through 210 Red wire to the fuel shutoff solenoid relay (K5).

Switched Power Circuit Operation - Diesel Engine

Function:

Provides unswitched power to the primary components whenever the battery is connected.

Operating Conditions:

- Battery Connected
- Key switch in RUN position

Theory of Operation:

Voltage must be present at the following components with the key switch in the RUN position:

- Cab power connector (X30).
- Control module connector (X31) terminal 1.
- Fuse (F3).
- Fuse (F4).
- Start relay (K1).
- Hold-in relay (K2).
- Control module connector (X31) terminal 4.
- Lights connector (X13).
- Control module connector (X31) terminal 3.
- Dual temp coolant switch (A3).
- Buzzer (H7).
- Alternator connector (X19).
- Instrument panel (A4).
- PTO switch (S3).
- Seat switch (S2).
- Cooling fan relay (K7).
- PTO overtemp relay (K4).

Placing the key switch (S1) in the RUN position provides voltage from 240 Red wire through the key switch to 400 Yel wire.

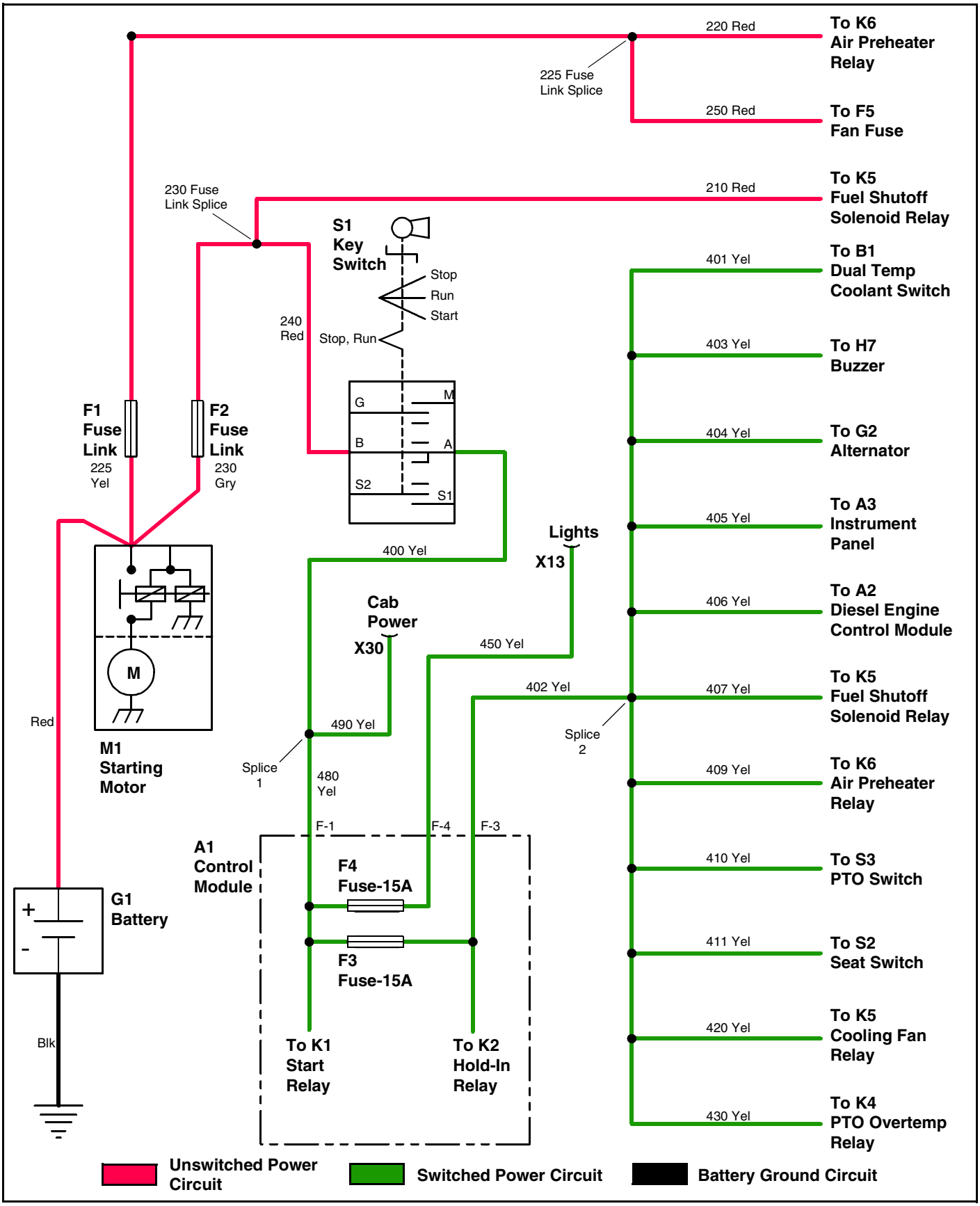
Current flows through 400 Yel wire to 490 and 480 Yel wires. Current then flows through 480 Yel wire to control module (A1) connector (X31) terminal 1 and through 490 Yel wire to cab power connector (X30).

Inside the control module (A1), current flows from connector (X31) terminal 1 to fuses (F3 and F4) and start relay (K1). Current flows from fuse (F4 to connector (X31) terminal 4, through 450 Yel wire to lights connector (X13). Current flows from fuse (F3) to hold-in relay (K2), to connector (X31) terminal 3, and through 402 Yel wire to the following components:

- Dual temp coolant switch (A3) [401 Yel wire].
- Buzzer (H7) [403 Yel wire].

- Alternator (G1) [404 Yel wire].
- Instrument panel (A4) [405 Yel wire].
- Diesel engine control module (A2) [406 Yel wire].
- Fuel shutoff solenoid relay (K5) [407 Yel wire].
- Air preheater relay (K6) [409 Yel wire].
- PTO switch (S3) [410 Yel wire].
- Cooling fan relay (K7) [420 Yel wire].
- PTO overtemp relay (K4) [430 Yel wire].

Power Circuit Schematic - Diesel Engine



MIF MX5526

Power Circuit Diagnosis - Gas Engine

Unswitched Power Circuit

IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

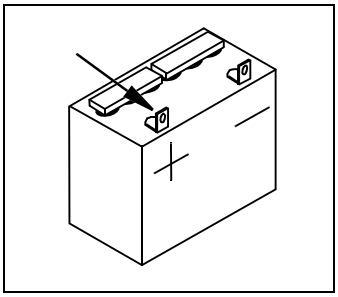
NOTE: A test light is the preferred method for testing circuits.

If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Battery fully charged.
- Key switch in STOP position.
- Meter negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Power Circuit Diagnosis - Gas Engine (Unswitched)



MIF

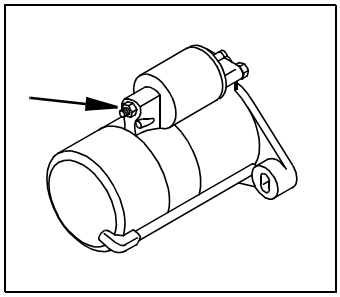
(1) Is the battery voltage, measured across the positive (+) and negative (-) terminals, 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Clean battery terminals and retest.

No - If the voltage is too high, “Charging Circuit Diagnosis - Gas Engine” on page 367.

System: Power Circuit Diagnosis - Gas Engine (Unswitched)



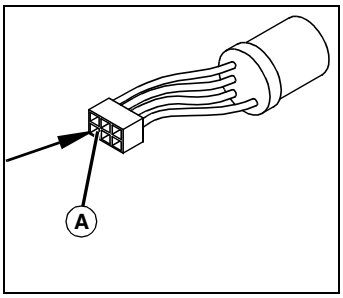
MX5518

(2) Is the battery voltage, measured between the starting motor (M1) battery terminal and ground, 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Clean, check, and tighten connections.

No - Replace battery cable.



MX5517

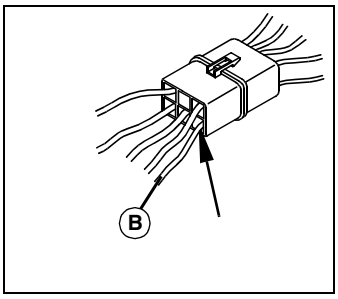
(3) Is there voltage present at the shutdown delay module (A2), 210 Red wire?

Yes - Go to the next step.

No - Check 210 Red wire (A), 212 Gry fusible link and connections.

No - Replace fusible link and /or main wiring harness (W4).

System: Power Circuit Diagnosis - Gas Engine (Unswitched)



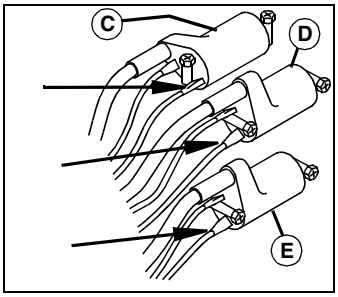
MX5519

(4) Is voltage present at coil pack wiring harness connector (X23), 215 Red wire (B)?

Yes - Go to next step.

No - Check 215 Red wire and connections.

No - Replace main wiring harness (W4).



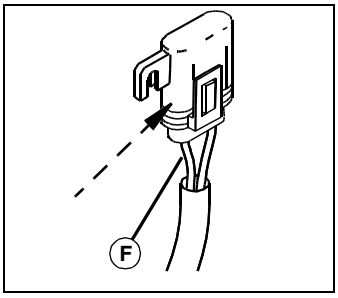
MX5520

(5) Is battery voltage present at each ignition coil (T1 (C), T2 (D), and T3 (E)?

Yes - Go to next step.

No - Check coil pack wiring harness (W3).

No - Replace coil pack wiring harness (W3).



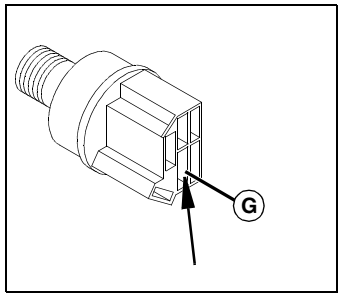
(6) Is voltage present at fan fuse (F5), 250 Red wire (F)?

Yes - Go to next step.

No - Check fuse link (F2), 230 and 250 Red wires and connections.

System: Power Circuit Diagnosis - Gas Engine (Unswitched)

No - Replace main wiring harness (W4).



MIF

(7) Is there voltage at key switch (S1), terminal B, 240 Red wire (G)?

Yes - End of test.

No - Check 240 Red wire and connections.

No - Replace main wiring harness (W4).

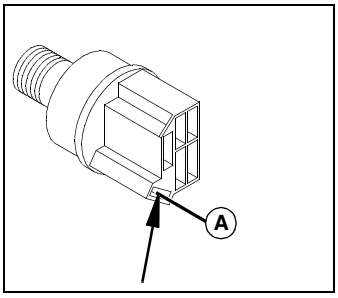
NOTE: The voltage readings may be correct when no load is present but may drop when a load is applied due to corrosion or poor connections. If the engine cranks hard or slowly, inspect the connections and clean as needed.

Switched Power Circuit

Test Conditions:

- Key switch in RUN or START position.

System: Power Circuit Diagnosis - Gas Engine (Switched)

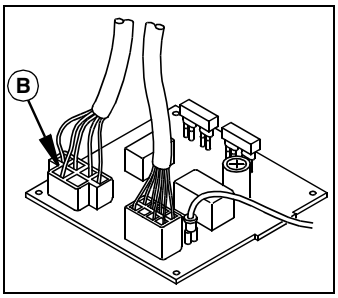


MIF

(1) Is the voltage, measured across key switch (S1), terminal A, 400 Yel wire (A) and ground, between 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Replace key switch.



MX5522

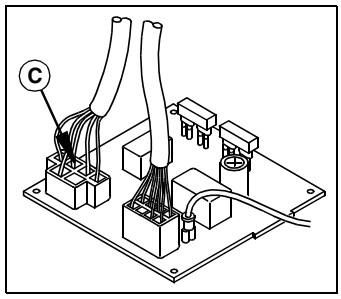
(2) Is the voltage, measured across control module connector (X32), terminal 1, 480 Yel wire (B) and ground, 11.8 - 13.2 VDC?(

Yes - Go to next step.

No - Check 400 and 480 Yel wires and connections.

No - Replace main wiring harness.

System: Power Circuit Diagnosis - Gas Engine (Switched)



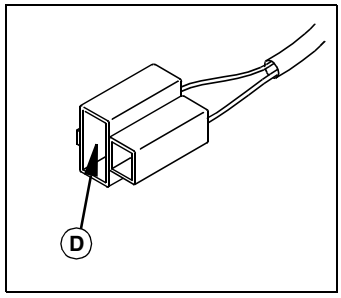
MX5522

(3) Is the voltage measured between control module connector (X32), terminal 4, 450 Yel wire (C) and ground, 11.8 - 13.2 VDC?

Yes - Go to step (5).

No - Check fuse (F4) and connections.

No - Replace control module (A1).



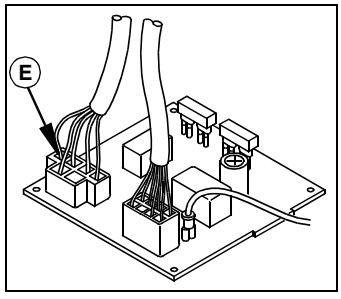
MX5523

(4) Is the voltage measured across cab power connector (X31), 490 Yel wire (D), and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 490 Yel wire and connections.

Yes - Replace (W4) main wiring harness.



MX5522

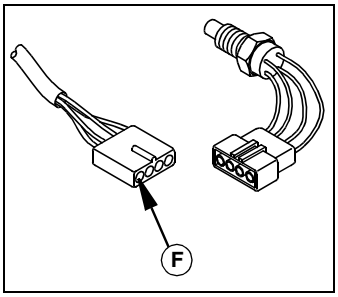
(5) Is the voltage measured between control module connector (X32), terminal 3, 402 Yel wire (E), 11.8 - 13.2 VDC?

Yes - Go to next step.

System: Power Circuit Diagnosis - Gas Engine (Switched)

No - Check fuse (F3) and connections.

No - Replace control module.



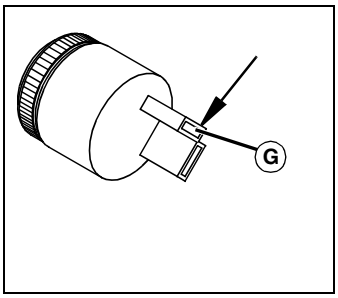
MX5524

(6) Is the voltage measured across dual temp coolant switch (A4), 401 Yel wire (F) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 401 and 402 Yel wires and connections.

No - Replace (W4) main wiring harness.



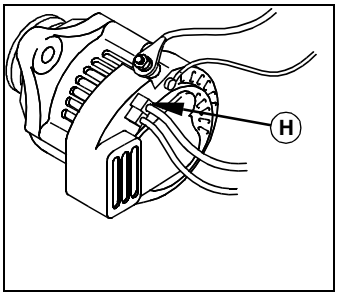
MIF

(7) is the voltage measured between buzzer (H6), 403 Yel wire (G), and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 403 Yel wire and connections.

No - Replace (W4) main wiring harness.



MX5521

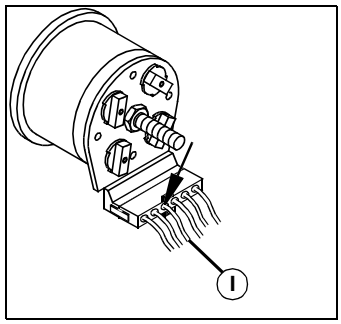
(8) Is the voltage measured across alternator (G2), 404 Yel wire (H) and ground 11.8 - 13.2 VDC?

System: Power Circuit Diagnosis - Gas Engine (Switched)

Yes - Go to next step.

No - Check 404 Yel wire and connections.

No - Replace (W4) main wiring harness.



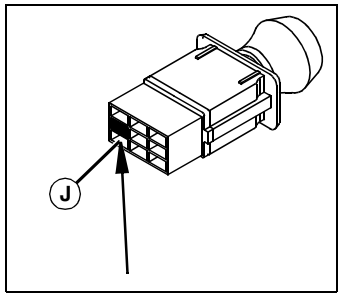
MIF

(9) Is the voltage measured between instrument panel (A5), 405 Yel wire (I) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 405 Yel wire and connections.

No - Replace (W4) main wiring harness.



MX5531

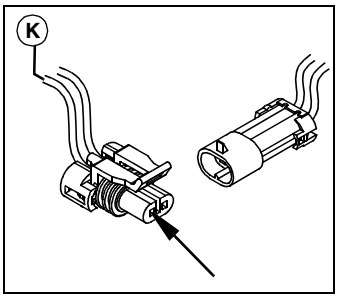
(10) Is the voltage measured across PTO switch (S3), 410 Yel wire (J) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 410 Yel wire and connections.

No - Replace (W4) main wiring harness.

System: Power Circuit Diagnosis - Gas Engine (Switched)



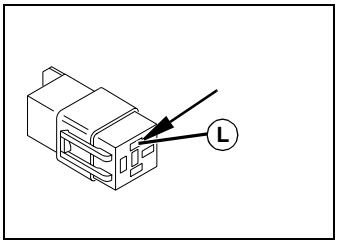
MX5533

(11) Is the voltage measured between seat switch connector (X38), 411 Yel wire (K) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 411 Yel wire and connections.

No - Replace (W4) main wiring harness.



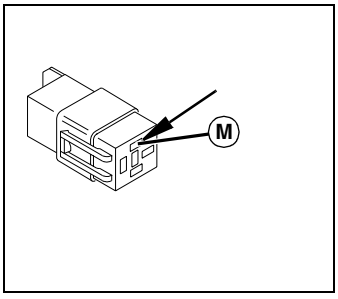
MIF

(12) Is the voltage measured across cooling fan relay (K5), 420 Yel wire (L) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 420 Yel wire and connections.

No - Replace (W4) main wiring harness.



MIF

(13) Is the voltage measured between PTO overtemp relay (K4), 430 Yel wire (M) and ground 11.8 - 13.2 VDC?

Yes - Test complete.

No - Replace (W4) main wiring harness.

Power Circuit Diagnosis - Diesel Engine

Unswitched Power Circuit

IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

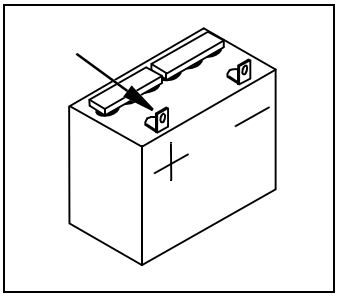
NOTE: A test light is the preferred method for testing circuits.

If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Battery fully charged.
- Key switch in STOP position.
- Meter negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections fro corrosion and looseness when testing.

System: Power Circuit Diagnosis - Diesel Engine (Unswitched)



MIF

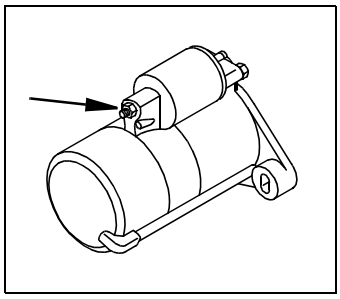
(1) Is the battery voltage, measured across the battery terminals, 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Clean battery terminals and retest.

No - If the voltage is too high, see “Charging Circuit Diagnosis - Diesel Engine” on page 370.

System: Power Circuit Diagnosis - Diesel Engine (Unswitched)



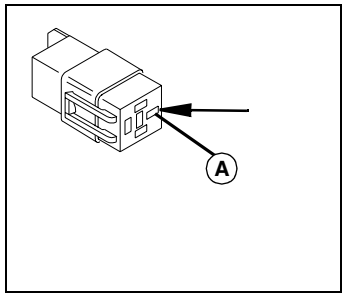
MX5518

(2) Is the battery voltage, measured between the (M1) starting motor battery terminal and ground, between 11.8 and 13.2 VDC?

Yes - Go to next step.

No - Clean, check, and tighten connections.

No - Replace battery cable.



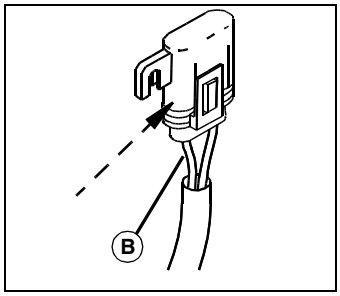
MIF

(3) Is the voltage measured across air preheater relay (K6), 220 Red wire (A) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check fuse link (F1) and 220 Red wire and connections.

No - Replace (W4) main wiring harness.



MX5519

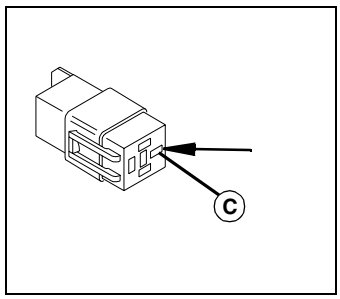
(4) Is voltage present at fan fuse (F5), 250 Red wire (B)?

Yes - Go to next step.

System: Power Circuit Diagnosis - Diesel Engine (Unswitched)

No - Check 250 Red wire and connections.

No - Replace main wiring harness.



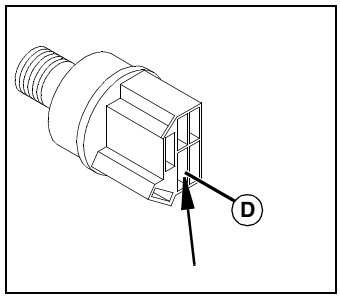
MIF

(5) Is voltage present at fuel shutoff solenoid relay (K5), 210 Red wire (C)?

Yes - Go to next step.

No - Check fuse link (F2) and 210 Red wire and connections.

No - Replace main wiring harness (W4).



MIF

(6) Is battery voltage present at key switch (S1), battery B terminal (D)?

Yes - Test complete.

No - Check 240 Red wire and connections.

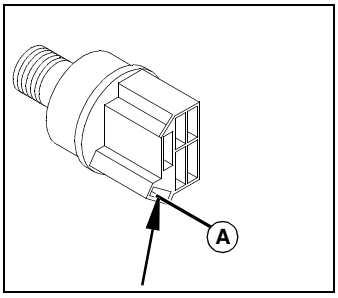
No - Replace main wiring harness (W4).

Switched Power Circuit

Test Conditions:

- Key switch in RUN or START position.

System: Power Circuit Diagnosis - Diesel Engine (Switched)



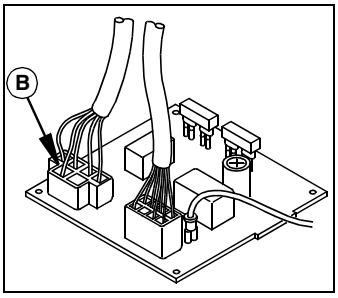
MIF

(1) Is the voltage measured across key switch (S1), terminal A, 400 Yel wire (A) 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check connections.

No - Replace key switch.



MX5522

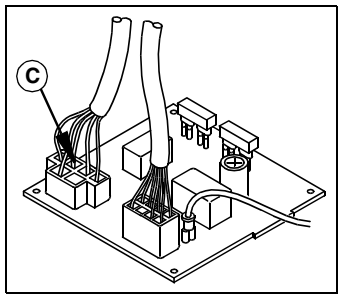
(2) Is the voltage between control module connector (X31), terminal 1, 480 Yel wire (B) 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check connections.

No - Replace main wiring harness (W4).

System: Power Circuit Diagnosis - Diesel Engine (Switched)



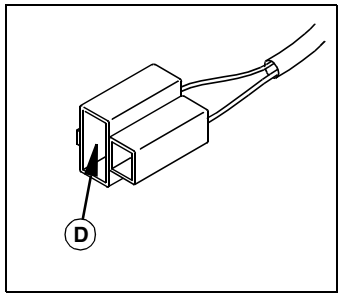
MX5522

(3) Is the voltage across control module connector (X31), terminal 4, 450 Yel wire (C) 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check fuse (F4) and connections.

No - Replace control module (A1).



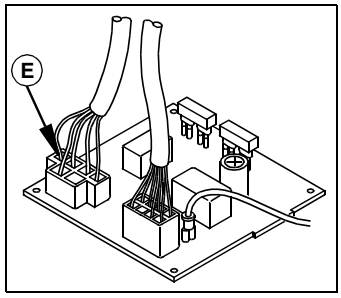
MX5523

(4) Is the voltage measured between the cab power connector (X30), 490 Yel wire (D) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 490 Yel wire and connections.

No - Replace main wiring harness (W4).



MX5522

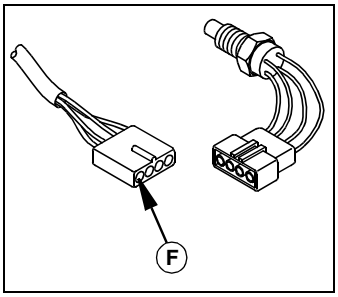
(5) Is the voltage between control module connector (X31), terminal 3, 402 Yel wire (E) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check fuse (F3) and connections.

System: Power Circuit Diagnosis - Diesel Engine (Switched)

No - Replace control module (A1).



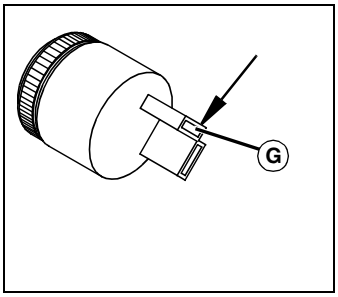
MX5524

(6) Is the voltage measured across dual coolant temperature switch (B1), 401 Yel wire (F) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 401 and 402 Yel wires and connections.

No - Replace main wiring harness (W4).



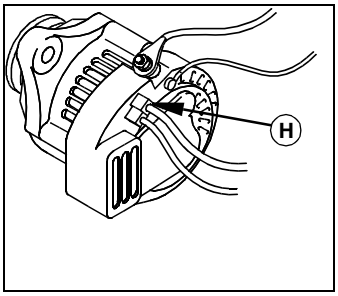
MIF

(7) Is the voltage between buzzer (H7), 403 Yel wire (G) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 403 Yel wire and connections.

No - Replace main wiring harness (W4).



MX5521

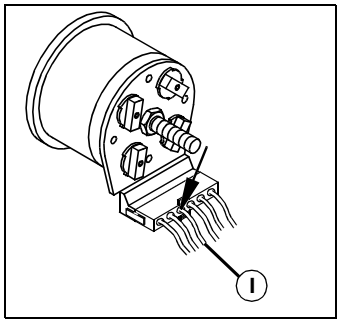
(8) Is the voltage at alternator (G2), 404 Yel wire (H) 11.8 - 13.2 VDC?

Yes - Go to next step.

System: Power Circuit Diagnosis - Diesel Engine (Switched)

No - Check 404 Yel wire and connections.

No - Replace main wiring harness (W4).



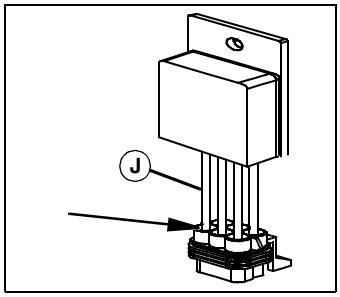
MIF

(9) Is the voltage measured between instrument panel (A3), 405 Yel wire (I) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 405 Yel wire and connections.

No - Replace main wiring harness (W4).



MIF

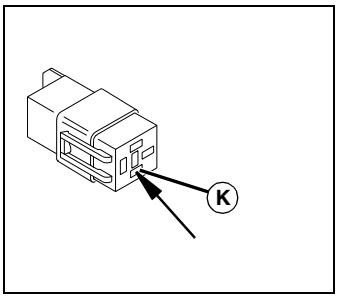
(10) Is the voltage at diesel engine control module (A2), 406 Yel wire (J) 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 406 Yel wire and connections.

No - Replace main wiring harness (W4).

System: Power Circuit Diagnosis - Diesel Engine (Switched)



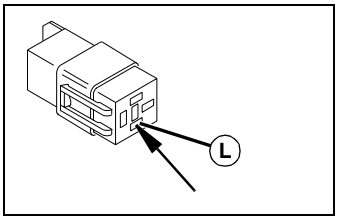
MIF

(11) Is the voltage measured at the fuel shutoff solenoid relay (K5), 407 Yel wire (K) and ground 11.8 - 13.2 VDC.

Yes - Go to next step.

No - Check 407 Yel wire and connections.

No - Replace main wiring harness (W4).



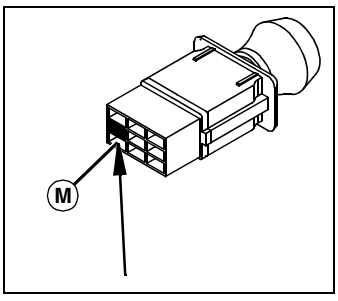
MIF

(12) Is the voltage measured across air preheater relay (K6), 409 Yel wire (L) and ground 11.8 - 13.2 VDC?

Yes - Go to step (10).

No - Check 409 Yel wire and connections.

No - Replace main wiring harness (W4).



MIF MX5531

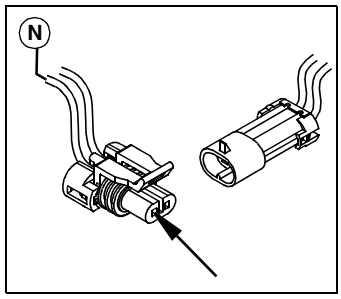
(13) Is the voltage between PTO switch (S3), 410 Yel wire (M) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 410 Yel wire and connections.

No - Replace main wiring harness (W4).

System: Power Circuit Diagnosis - Diesel Engine (Switched)



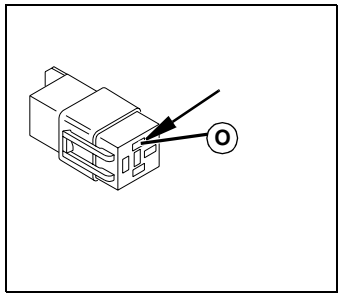
MIF MX5533

(14) Is the voltage across seat switch connector (X37), 411 Yel wire (N) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 411, Yel wire and connections.

No - Replace main wiring harness (W4).



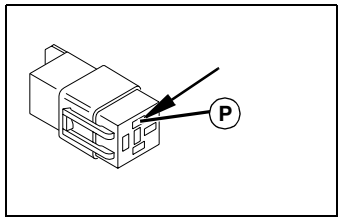
MIF

(15) Is the voltage between cooling fan relay (K7), 420 Yel wire (O) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 420, Yel wire and connections.

No - Replace main wiring harness (W4).



MIF

(16) Is the voltage between PTO overtemp relay (K4), 430 Yel wire (P) and ground 11.8 - 13.2 VDC?

Yes - Test complete.

No - Check 430 Yel wire and connections.

No - Replace main wiring harness (W4).

Cranking Circuit Operation

Function:

Provide power to the starting motor (M1) to crank the engine. Only the necessary conditions for cranking the engine is explained here. For an explanation for starting the engine and to keep it running, see “Operator Presence and PTO Interlock Circuit Operation - Gas Engine” on page 372 or “Operator Presence and PTO Interlock Circuit Operation - Diesel Engine” on page 376.

Operating Conditions:

To crank the engine, the following conditions must be met:

- Key switch in start position.
- PTO switch (S3) must be in the DISENGAGED position.
- Brake switch (S4) must be in the ON position (master brake pedal depressed).

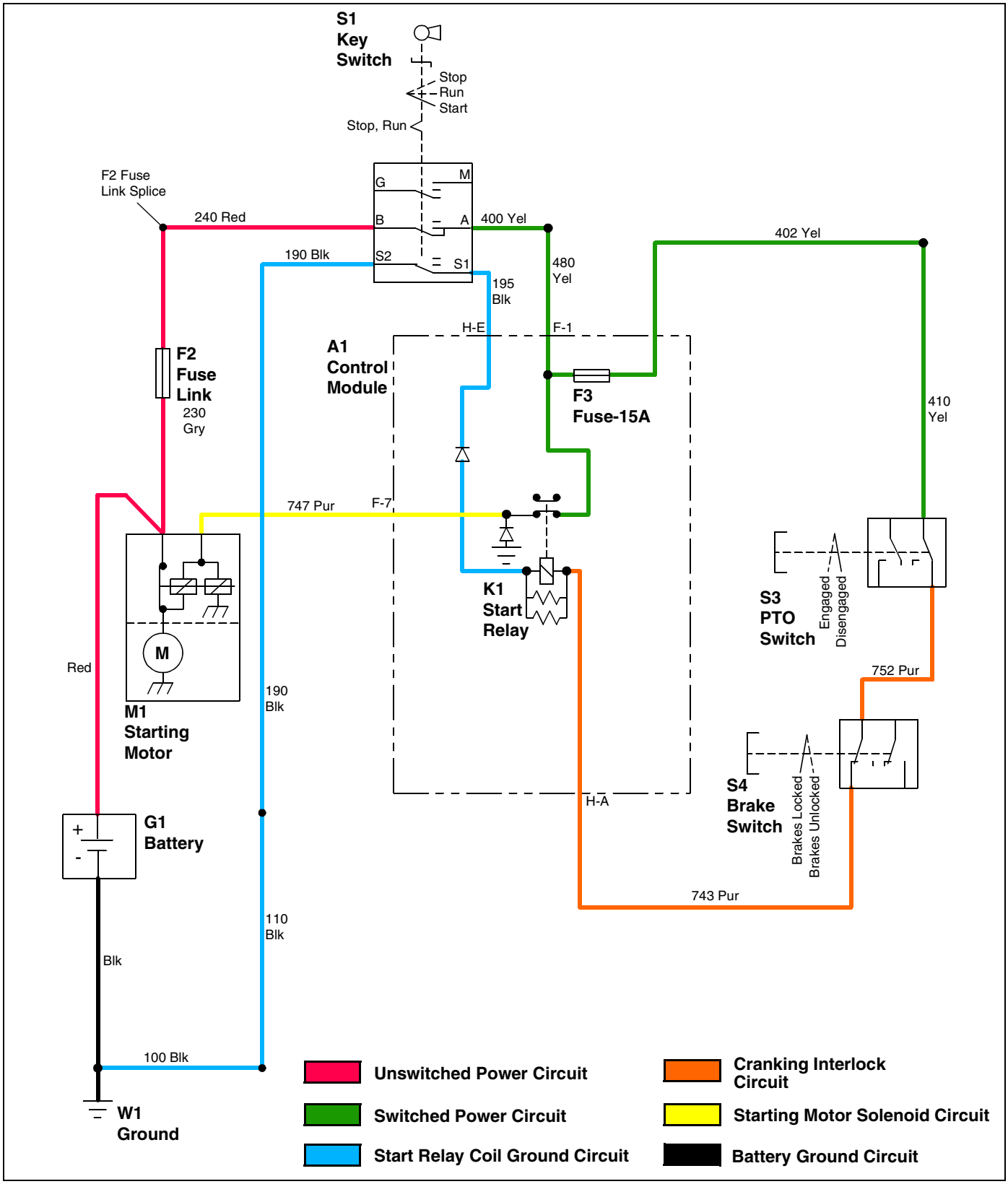
Theory of Operation:

The power circuit provides power to the starting motor solenoid and key switch. With the key switch in the start position, switched power flows from the key switch to the control module (A1) through 400 and 480 Yel wires. Within the control module power flows to the contacts of the start relay (K1) and fuse (F3). From fuse (F3), power flows out of the control module through 402 and 410 Yel wires to PTO switch (S3). With the PTO switch in the DISENGAGED position, power flows through the PTO switch and through 752 Pur wire to brake switch (S4). With the brake switch in the ON position, power flows through the brake switch and through 743 Pur wire to the control module and then to the coil of start relay (K1).

When the key switch (S1) is in the start position, ground is supplied to the coil of start relay (K1) and the relay is energized. With the relay energized, power flows from the relay contacts, out of the control module (A1) and through 747 Pur wire to the starting motor (M1) solenoid to engage the starting motor and crank the engine.

Cranking Circuit Schematic

Cranking Circuit Schematic



MIF MX5483

Cranking Circuit Diagnosis - Gas Engine

IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: A test light is the preferred method for testing circuits.

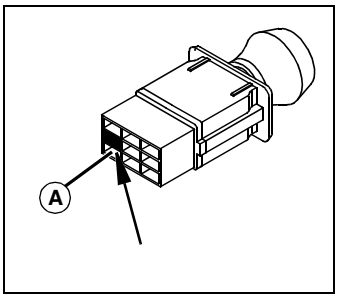
If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Procedure A

Test Conditions:

- Machine parked safely.
- Key switch in START position.
- PTO switch in DISENGAGED position.
- Brake applied (brake switch in ON position).

System: Cranking Circuit Diagnosis - Gas Engine: Test Procedure A



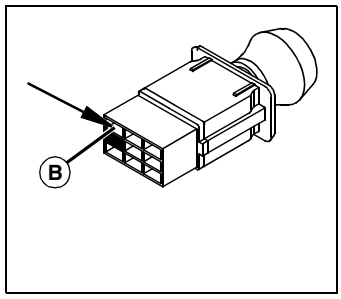
MIF MX5531

(1) Is the voltage measured across PTO switch (S3), 410 Yel wire (A) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Gas Engine” on page 347 or “Power Circuit Diagnosis - Diesel Engine” on page 352.

System: Cranking Circuit Diagnosis - Gas Engine: Test Procedure A

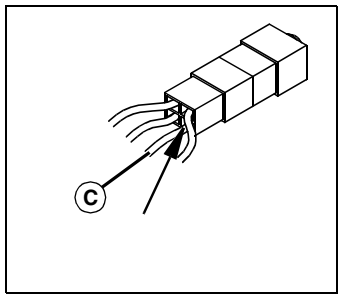


MIF MX5531

(2) Is the voltage between PTO switch (S3), 752 Pur wire (B) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Test PTO switch. See “PTO Switch Test” on page 477.

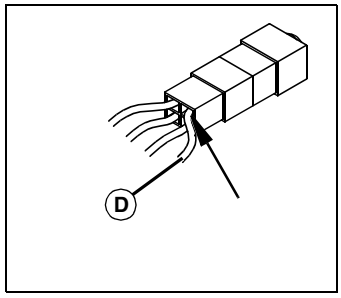


MIF MX5532

(3) Is the voltage measured across brake switch (S4), 752 Pur wire (C) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Gas Engine” on page 347 or “Power Circuit Diagnosis - Diesel Engine” on page 352.



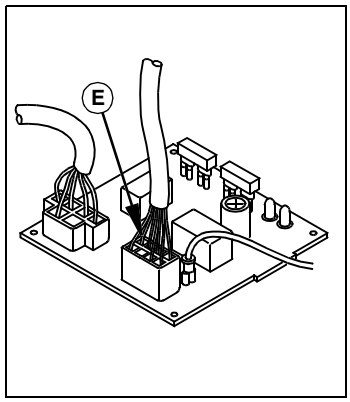
MIF MX5532

(4) Is the voltage measured between brake switch (S4), 743 Pur wire (D) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Test brake switch. See “Brake Switch Test” on page 473.

System: Cranking Circuit Diagnosis - Gas Engine: Test Procedure A



MIF

(5) Is the voltage measured across control module connector (X33) terminal A, 743 Pur wire (E) and ground 11.8 - 13.2 VDC?

Yes - See “Test Procedure B” on page 360.

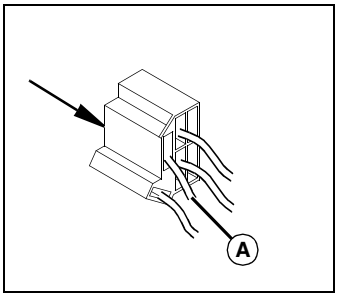
No - Check 743 Pur wire and connections.

Test Procedure B

Test Conditions:

- Key switch connector (X2), 190 Blk wire to negative (-) battery terminal.

System: Cranking Circuit Diagnosis - Gas Engine: Test Procedure B



MIF

(1) Is the resistance between key switch connector (X2), 190 Blk wire (A) and the negative (-) battery terminal 0.1 ohms or less?

Yes - See “Test Procedure C” on page 360.

No - Check 190 and 100 Blk wires (B) and connections.

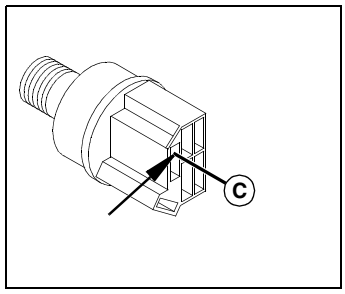
No - Replace main wiring harness (W4).

Test Procedure C

Test Conditions:

- Key switch connector (X2) connected.
- Key switch in START position.
- Control module connector (X32) DISCONNECTED.

System: Cranking Circuit Diagnosis - Gas Engine: Test Procedure C

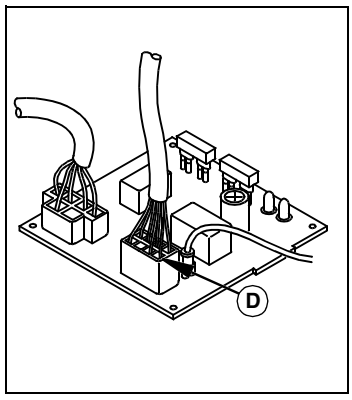


MIF

(1) Is the resistance measured between key switch connector (X2), 195 Blk wire (C) and negative (-) battery terminal 0.1 ohms or less?

Yes - Go to next step.

No - Test key switch (S1).



MIF

(2) Is the resistance between control module connector (X33), terminal E, 195 Blk wire (D) and the negative (-) battery terminal 0.1 ohms or less?

Yes - See “Test Procedure D” on page 361.

No - Check 195 Blk wire and connections.

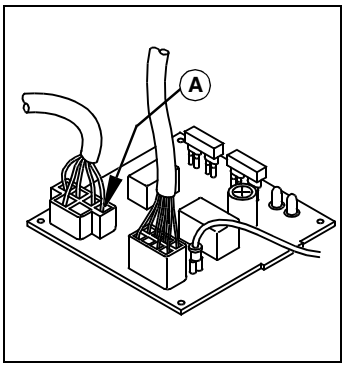
No - Replace main wiring harness (W4).

Test Procedure D

Test Conditions:

- Key switch in START position.
- Control module connector (X32) connected.

System: Cranking Circuit Diagnosis - Gas Engine: Test Procedure D

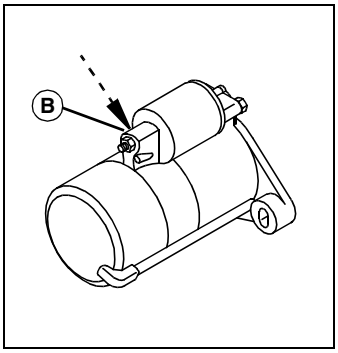


MIF

(1) Is the voltage measured across control module connector (X32), 747 Pur wire (A) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Replace control module (A1).



MIF

(2) Is the voltage measured between starting motor (M1), solenoid connector (X28), 747 Pur wire (B) and ground 11.8 - 13.2 VDC?

Yes - If OK and engine does not crank, test starting motor. See “Starting Motor Loaded Amperage Draw Test” on page 470.

No - Check 747 Pur wire and connections.

No - Replace main wiring harness (W4).

Cranking Circuit Diagnosis - Diesel Engine

Test Procedure A

IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

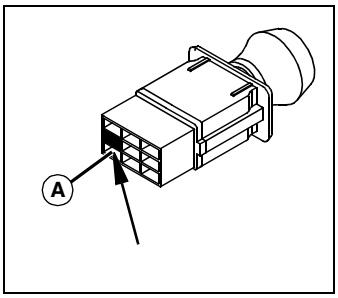
NOTE: A test light is the preferred method for testing circuits.

If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in START position.
- PTO switch in DISENGAGED position.
- Brake applied (brake switch in ON position).

System: Cranking Circuit Diagnosis - Diesel Engine: Test Procedure A



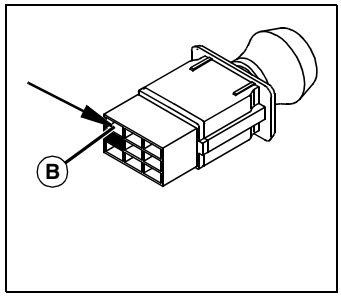
MIF MX5531

(1) Is the voltage measured across PTO switch (S3), 410 Yel wire (A) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.

System: Cranking Circuit Diagnosis - Diesel Engine: Test Procedure A

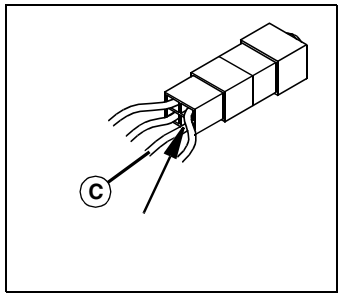


MIF MX5531

(2) Is the voltage between PTO switch (S3), 752 Pur wire (B) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Test PTO switch (S3). See “PTO Switch Test” on page 477.



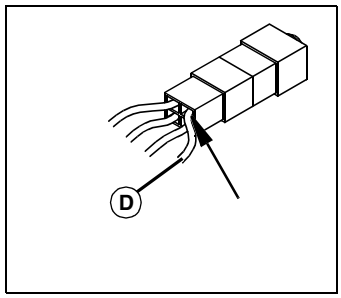
MIF MX5532

(3) Is the voltage measured across brake switch (S4) 752 Pur wire (C) and ground 11.8 - 13.2 VDC?

Yes - Go to step (5).

No - Check 752 Pur wire and connections.

No - Replace main wiring harness (W4).



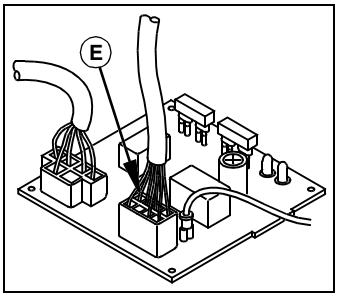
MIF MX5532

(4) Is the voltage measured between brake switch (S4), 743 Pur wire (D) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

System: Cranking Circuit Diagnosis - Diesel Engine: Test Procedure A

No - Test brake switch. See “Brake Switch Test” on page 473.



MIF

(5) Is the voltage measured across control module connector (X32), terminal A, 743 Pur wire (E) and ground 11.8 - 13.2 VDC?

Yes - See “Test Procedure B” on page 363.

No - Check 743 Pur wire and connections.

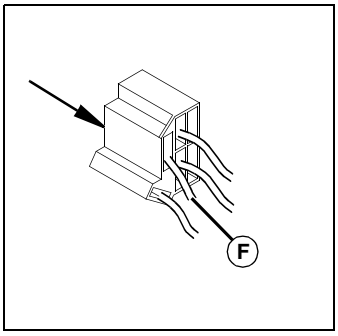
No - Replace main wiring harness (W4).

Test Procedure B

Test Conditions:

- Key switch connector (X2) DISCONNECTED.

System: Cranking Circuit Diagnosis - Diesel Engine: Test Procedure B



MIF

(1) Is the resistance measured between key switch connector (X2), 190 Blk wire (F) and negative (-) battery terminal 0.1 ohms or less?

Yes - See “Test Procedure C” on page 363.

No - Check 190 and 100 Blk wires and connections.

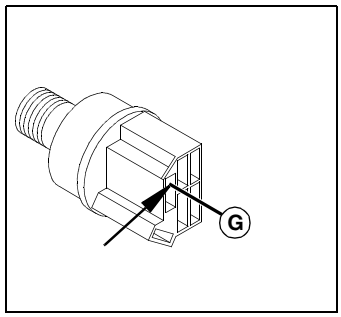
No - Replace main wiring harness (W4).

Test Procedure C

Test Conditions:

- Key switch connector (X2) connected.
- Key switch in START position.
- Control module connector (X33) DISCONNECTED.

System: Cranking Circuit Diagnosis - Diesel Engine: Procedure C

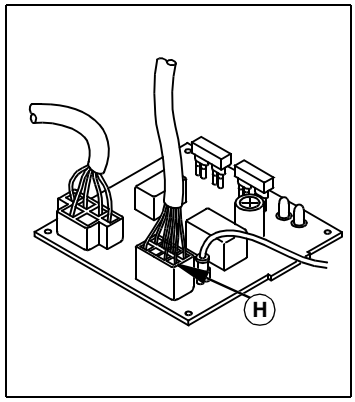


MIF

(1) Is the resistance measured between key switch connector (X2), 195 Blk wire (G) and the negative (-) battery terminal 0.1 ohm or less?

Yes - Go to next step.

No - Test key switch (S1). See “Key Switch Test” on page 473.



MIF

(2) Is the resistance measured between control module connector (X32), terminal E, 195 Blk wire (H) and negative (-) battery terminal 0.1 ohms or less?

Yes - See “Test Procedure D” on page 364.

No - Check 195 Blk wire and connections.

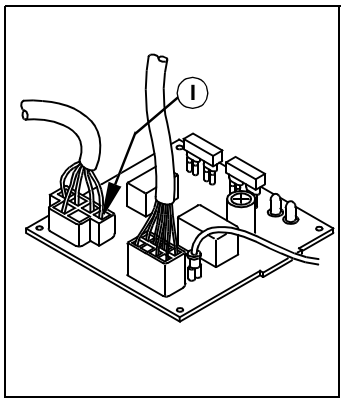
No - Replace main wiring harness (W4).

Test Procedure D

Test Conditions:

- Key switch in START position.
- Control module connector (X33) connected.

System: : Cranking Circuit Diagnosis - Diesel Engine: Test Procedure D

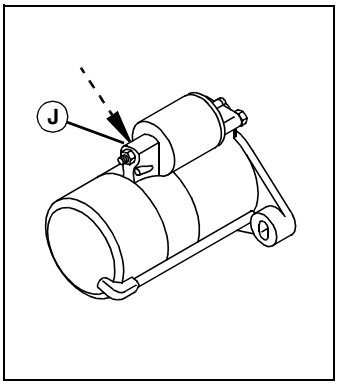


MIF

(1) Is the voltage measured between control module connector (X31), 747 Pur wire (I) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Replace control module (A1).



MIF

(2) Is the voltage measured across starting motor (M1), solenoid connector (X27), 747 Pur wire (J) and ground 11.8 - 13.2 VDC?

Yes - If OK and engine does not crank, see “Starting Motor Loaded Amperage Draw Test” on page 470.

No - Check 747 Pur wire and connections.

No - Replace main wiring harness (W4).

Charging Circuit Operation - Gas Engine

Function:

To maintain battery voltage between 12.2 and 14.7 volts DC.

Operating Conditions:

- Key switch in RUN position.
- Engine RUNNING.

Theory of Operation:

The power circuit provides switched power to the discharge light (H3) through 405 Yel wire and to the alternator (G2) through 404 Yel wire.

The alternator has an internal voltage regulator that monitors battery voltage and increases alternator output to maintain proper voltage and battery charge. Alternator output is determined by the intensity of magnetism at the field coil. As the battery voltage drops, the regulator adjusts the voltage at the field coil, which in turn intensifies the magnetic field at the field coil to increase alternator output.

The alternator produces alternating current (AC) which is then rectified to direct current (DC) by an internal rectifier in the alternator.

Charging current flows from the alternator through 200 Red wire to the battery terminal on starting motor (M1) and then to the battery positive (+) terminal through the positive (+) red battery cable.

When the alternator has no output or low output, discharge light (H3) is turned on by providing ground through 610 Brn wire. The alternator provides the ground internally.

Ground for alternator (G2) is provided by wires 104 and 100 Blk.

Charging Circuit Operation - Diesel Engine

Function:

To maintain battery voltage between 12.2 and 14.7 volts DC.

Operating Conditions:

- Key switch in RUN position.
- Engine RUNNING.

Theory of Operation:

The power circuit provides switched power to the discharge light (H3) through 405 Yel wire and to the alternator (G2) through 404 Yel wire.

The alternator has an internal voltage regulator that monitors battery voltage and increases alternator output to maintain proper voltage and battery charge. Alternator output is determined by the intensity of magnetism at the field coil. As the battery voltage drops, the regulator adjusts the voltage at the field coil, which in turn intensifies the magnetic field at the field coil to increase alternator output.

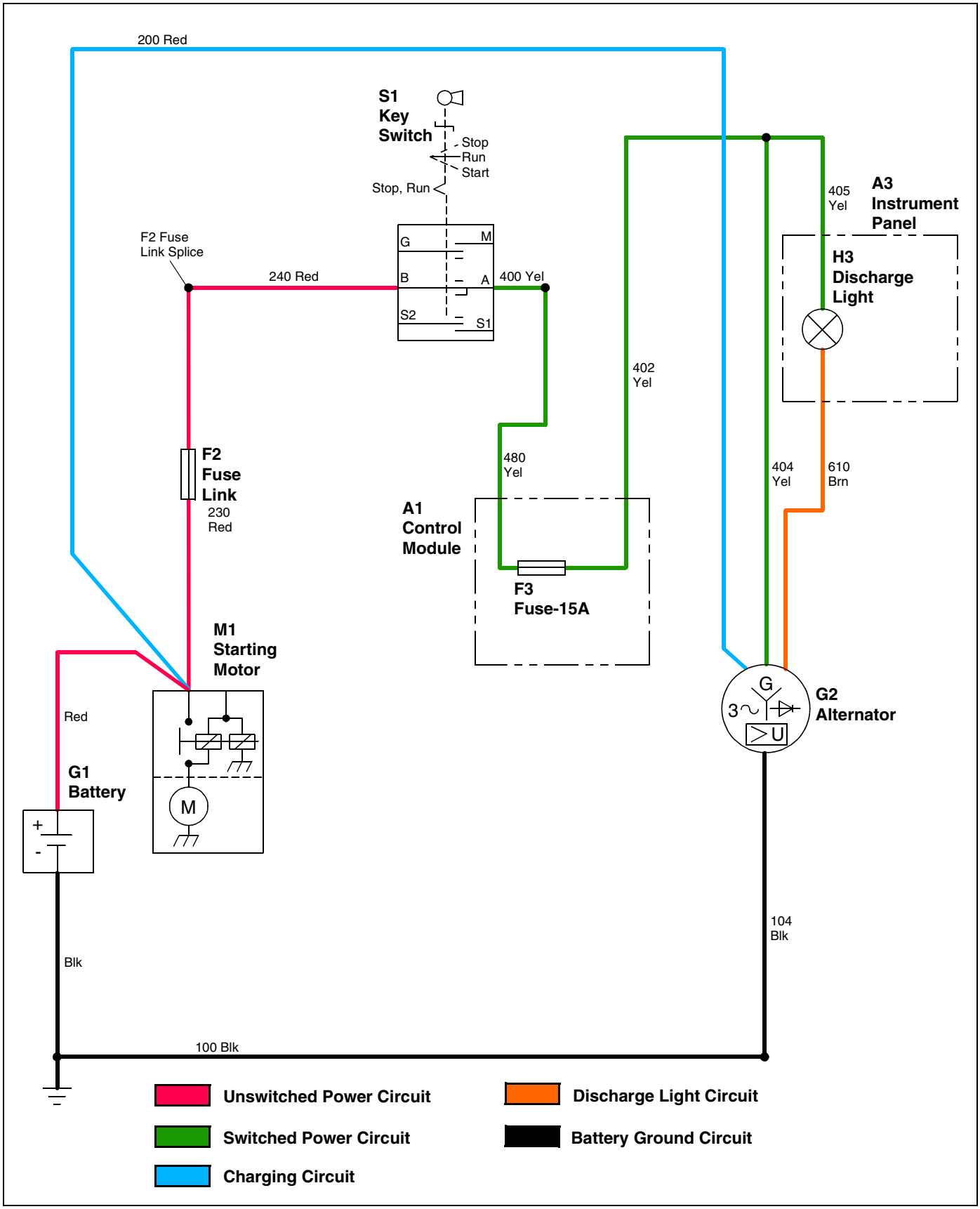
The alternator produces alternating current (AC) which is then rectified to direct current (DC) by an internal rectifier in the alternator.

Charging current flows from the alternator through 200 Red wire to the battery terminal on starting motor (M1) and then to the battery positive (+) terminal through the positive (+) red battery cable.

When the alternator has no output or low output, discharge light (H3) is turned on by providing ground through 610 Brn wire. The alternator provides the ground internally.

Ground for alternator (G2) is provided by wires 104 and 100 Blk.

Charging Circuit Schematic - Diesel Engine



MIF MX5483

Charging Circuit Diagnosis - Gas Engine

IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: A test light is the preferred method for testing circuits.

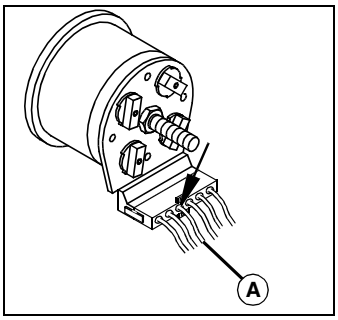
If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Procedure A

Test Conditions:

- Machine parked safely.
- Key switch in RUN position.
- Engine OFF.
- Meter negative (BLACK) lead on battery negative (-) terminal or chassis ground.

System: Charging Circuit Diagnosis - Gas Engine: Test Procedure A



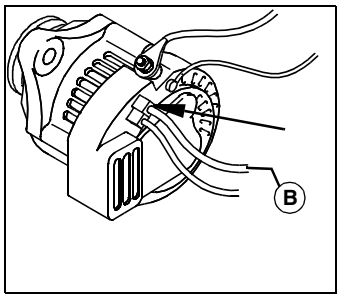
MIF

(1) Is the voltage measured across instrument panel (A4), connector (X1), 405 Yel wire (A) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Gas Engine” on page 347.

System: Charging Circuit Diagnosis - Gas Engine: Test Procedure A



MIF

(2) Is the voltage across alternator (G2), connector (X17), 404 Yel wire (B) and ground 11.8 - 13.2 VDC?

Yes - See “Test Procedure B” on page 368.

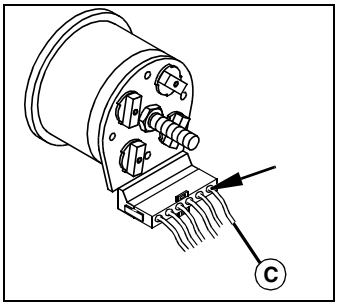
No - See “Power Circuit Diagnosis - Gas Engine” on page 347.

Test Procedure B

Test Conditions:

- Alternator connector (X17) DISCONNECTED.

System: Charging Circuit Diagnosis - Gas Engine: Test Procedure B



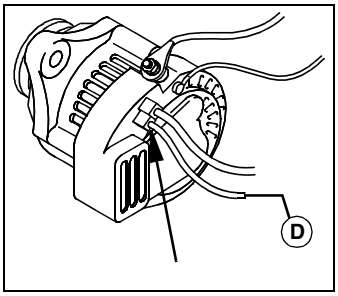
MIF

(1) Is the voltage measured between instrument panel (A4), connector (X1), 610 Brn wire (C) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check light bulbs in instrument panel (A4).

No - Replace instrument panel.



MIF

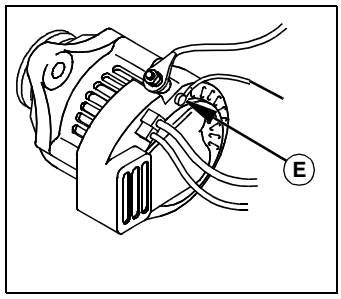
(2) Is the voltage across alternator (G2), connector (X17), 610 Brn wire (D) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 610 Brn wire and connections.

No - Replace main wiring harness (W4).

System: Charging Circuit Diagnosis - Gas Engine: Test Procedure B



MIF

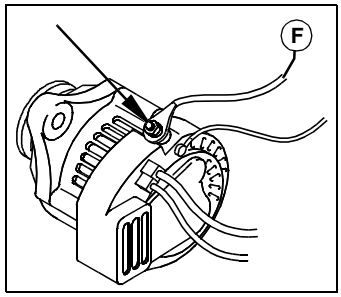
(3) Is the resistance measured between alternator (G2), ground connector (X18), 104 Blk wire (E) and negative (-) battery terminal 0.1 ohms or less?

Yes - Go to next step.

No - Verify condition of negative (-) battery cable to engine block and clean if necessary.

No - Check 104 and 100 Blk wires and connections.

No - Replace main wiring harness (W4).



MIF

(4) Reconnect alternator connector (X17) and run engine at high idle. Is the voltage measured alternator (G2) connector (X29), 200 Red wire (F) 12.2 - 14.7 VDC?

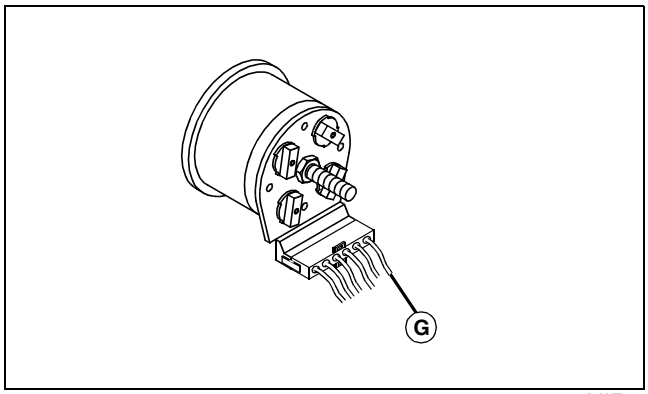
Yes - Test complete.

No - Test unregulated amperage to see if alternator or regulator is defective. See “Unregulated Amperage Test” on page 469.

Test Conditions:

- Park brake LOCKED.
- Reconnect alternator connector (X17).
- Key switch ON with engine running at high idle.

System: Charging Circuit Diagnosis - Gas Engine: Test Procedure C



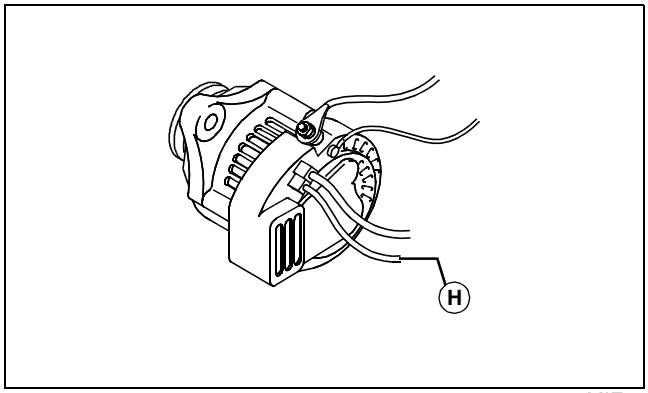
MIF

(1) Is the voltage measured at alternator (G2), connector (X29), 200 Red wire (G) to negative (-) battery terminal 12.2 - 14.7 VDC?

Yes - Test complete.

No - If voltage exceeds 14.7 VDC, replace regulator/ alternator.

No - If voltage does not increase, test unregulated amperage to determine if alternator or regulator is defective. See “Unregulated Amperage Test” on page 469.



MIF

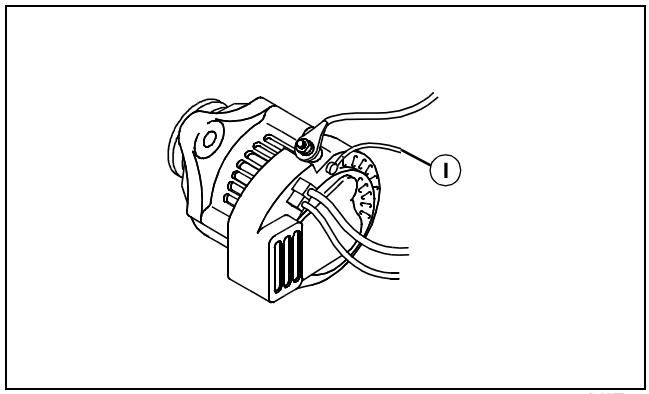
(2) Is voltage present at alternator (G2), connector (X17), 610 Brn wire (H)?

Yes - Go to next step.

No - Check 610 Brn wire and connections.

No - Replace main wiring harness (W4).

System: Charging Circuit Diagnosis - Gas Engine: Test Procedure C



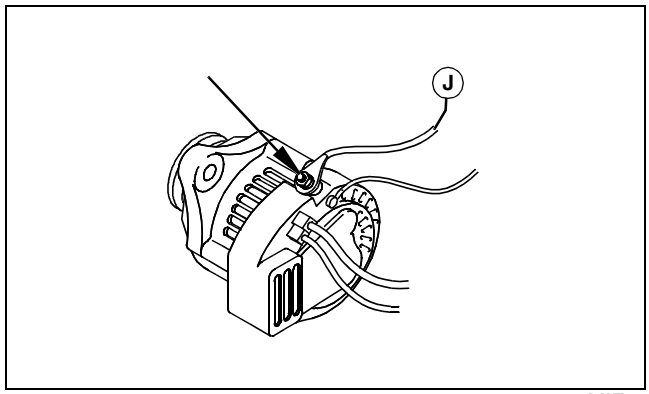
MIF

(3) Is the resistance measured between alternator (G2), ground connector (X18), 104 Blk wire (I) and the negative (-) battery terminal 0.1 ohms or less?

Yes - Go to next step.

No - Check light bulbs in instrument panel (A4).

No - Replace instrument panel (A4).



MIF

(4) Reconnect alternator connector (X17) and run engine at high idle. Measure voltage at alternator (G2), connector (X29), 200 Red wire (J). Does voltage increase to 12.2 - 14.7 VDC?

Yes - Test complete.

No - If voltage does not increase, test unregulated amperage to determine if alternator or regulator is defective. See “Unregulated Amperage Test” on page 469.

No - If voltage exceeds 14.7 VDC, replace regulator/ alternator.

Charging Circuit Diagnosis - Diesel Engine

Test Procedure A

IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

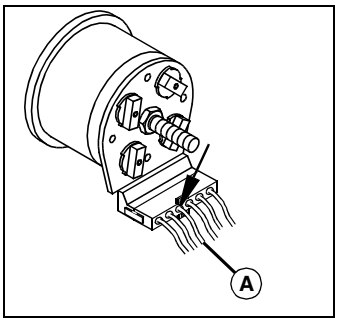
NOTE: A test light is the preferred method for testing circuits.

If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position.
- Engine OFF.
- Meter negative (BLACK) lead on battery negative (-) terminal or chassis ground.

System: Charging Circuit Diagnosis - Diesel Engine



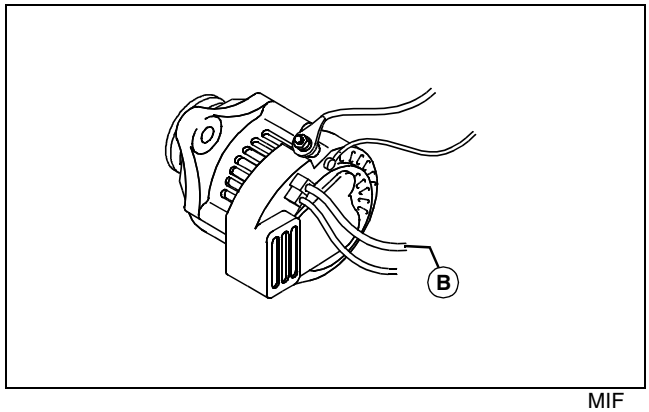
MIF

(1) Is battery voltage present at instrument panel (A3), connector (X1), 405 Yel wire (A)?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.

System: Charging Circuit Diagnosis - Diesel Engine



MIF

(2) Is there voltage present at alternator (G2), connector (X19), 404 Yel wire (B)?

Yes - See “Test Procedure B” on page 368.

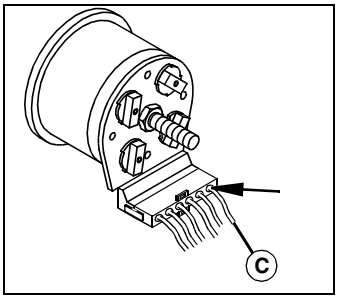
No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.

Test Procedure B

Test Conditions:

- Alternator connector (X19) DISCONNECTED.

System: Charging Circuit Diagnosis - Diesel Engine: Test Procedure B



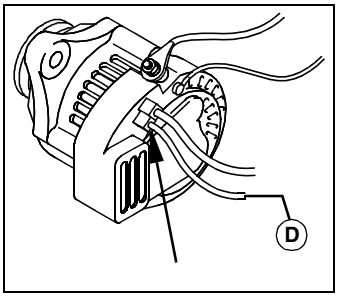
MIF

(1) Is battery voltage present at instrument panel (A3), connector (X1), 610 Brn wire (C)?

Yes - Go to next step.

No - Check light bulbs in instrument panel (A3).

No - Replace instrument panel.



MIF

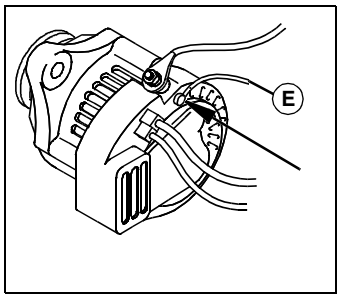
(2) Is voltage present at alternator (G2), connector (X17), 610 Brn wire (D)?

Yes - Go to next step.

No - Check 610 Brn wire and connections.

No - Replace main wiring harness.

System: Charging Circuit Diagnosis - Diesel Engine: Test Procedure B



MIF

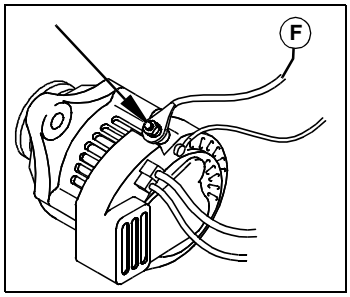
(3) Is the resistance between alternator (G2) ground connector (X20) and 104 Blk wire (E) and negative battery terminal 0.1 ohms or less?

Yes - Go to next step.

No - Verify condition of engine to frame strap connection and clean if necessary.

No - Check 104 and 100 Blk wires and connections.

No - Replace main wiring harness (W4).



MIF

(4) Reconnect alternator connector (X19) and run engine at high idle. Does the measured voltage increase to 12.2 - 14.7 VDC at alternator (G2), connector (X28), 200 Red wire (F)?

Yes - Test complete.

No - If voltage does not increase, test unregulated amperage to determine if alternator or regulator is defective.

No - If voltage exceeds 14,7 volts, replace regulator/ alternator.

Operator Presence and PTO Interlock Circuit Operation - Gas Engine

Function:

The purpose of the “operator presence” portion of this circuit is to automatically stop the engine whenever the operator rises from the seat for more than one second when PTO is ENGAGED and/or park brake is UNLOCKED.

The purpose of the “PTO interlock" portion of the circuit is to provide the following:

- Require the operator to be sitting on the seat and park brake UNLOCKED before the PTO can be ENGAGED.
- Automatically disengages the PTO whenever operator locks the park brake or if the engine coolant temperature exceeds 110°C (230°F).
- Provide a means for the engine to continue operating when operator is not on the seat.

Operating Conditions:

- Key switch in RUN position.

Theory of Operation:

Unswitched And Switched Power Circuits

Protection for operator presence and PTO interlock circuit is provided by fuse link (F2) and 15-amp switched power fuse (F3) located on control module (A1).

Turning key switch (S1) to the RUN or start position allows current from the positive (+) terminal of battery (G1) to flow through fuse link (F2), wire 240 (Red), then to terminal B of the key switch. The current flows out terminal A of the key switch, through 400 and 480 Yel wires, to switched power fuse (F3). From fuse (F3), current flows through 402 Yel wire to harness splice 2.

From harness splice 2, current flows to the following components:

- Dual temp coolant switch (B4) (401 Yel wire). This current provides power for the dual temp coolant switch.
- Seat switch (S2) (411 Yel wire).
- PTO switch (S3) (410 Yel wire).
- Coil of PTO overtemp relay (K4) (430 Yel wire).

Operator Presence And Not Present Circuits

For the engine to operate, one of the following must occur:

- Operator must be on the seat when the PTO is ENGAGED and/or park brake UNLOCKED.
- When operator is not on the seat, the PTO must be DISENGAGED and park brake LOCKED.

When the operator is sitting on the seat, current flows across the seat switch contacts, through 831 and 830 Pnk wires, to terminal B of connector (X33) on control module (A1). From connector (X33), the current flows to the coil of hold-in relay (K2), energizing the relay and charges the capacitor of control module (A1). The energy stored in the capacitor will keep the hold-in relay (K2) energized for approximately one second if the operator leaves the seat, as on rough terrain. The current will also cause hold-in LED (H1), located on control module (A1), to come on providing visual proof that the hold-in relay coil is energized to aid in troubleshooting.

If operator is not on the seat, the hold-in relay can still be energized by putting PTO switch (S3) at the DISENGAGED position and brake switch (S4) at the on (park brake LOCKED) position. When this happens, current is allowed to flow through 752 Pur wire, across the brake switch contacts, then through 743 Pur wire, to terminal A of connector (X33) of control module (A1). From connector (X33), current flows to the coil of hold-in relay (K2), energizing the relay. The current will also cause hold-in LED (H1) to come on.

Hold-in Power (Engine Run) Circuit

When the hold-in relay is energized, current from fuse (F4) is allowed to flow across the contacts of the hold-in relay, then through 640 Grn wire, to harness splice 3.

From harness splice 3, current flows to the following components:

- Fuel shutoff solenoid (650 and 651 Grn wires). (For additional information, see “Fuel Shutoff Solenoid Circuit Operation - Gas Engine” on page 437.)
- Shutdown delay module (655 Grn wire). (For additional information, see “Engine Ignition and Fuel Transfer Pump Circuit Operation - Gas Engine” on page 428.)
- Hour Meter (660 Grn wire). (For additional information, see “Hour Meter Circuit Operation” on page 425.)

PTO Interlock Circuit

NOTE: For safety reasons, the PTO interlock circuit contains a latching circuit. Because of this, the PTO switch must be at the DISENGAGED position before the PTO can be ENGAGED.

When PTO switch is at the DISENGAGED position, current from fuse (F3) is allowed to flow through 748 Pur wire, to terminal D of connector (X33) on control module (A1). From connector (X33), current flows to the coil of PTO relay (K3), energizing the relay. The current will also cause PTO LED (H2), located on control module (A1), to come on providing visual proof that the PTO relay coil is energized to aid in troubleshooting.

With the PTO relay energized, current is allowed to flow across the relay contacts, out terminal 5 of connector (X32), then through 750 and 760 Pur wires, to PTO Overtemp Relay (K4). The current flows across the normally closed contacts of the relay, then through 700 Pur wire, to brake switch (S4). If the brake switch is at the OFF position (park brake UNLOCKED), the current will flow across the switch contacts, then through 788 Pur wire, to terminal F of connector (X33) on control module (A1). From connector (X33), the current flows to the coil of PTO relay (K3), thus latching the PTO relay. At this point, the PTO can be ENGAGED by moving the P TO switch to the ENGAGED position.

PTO Solenoid Circuit

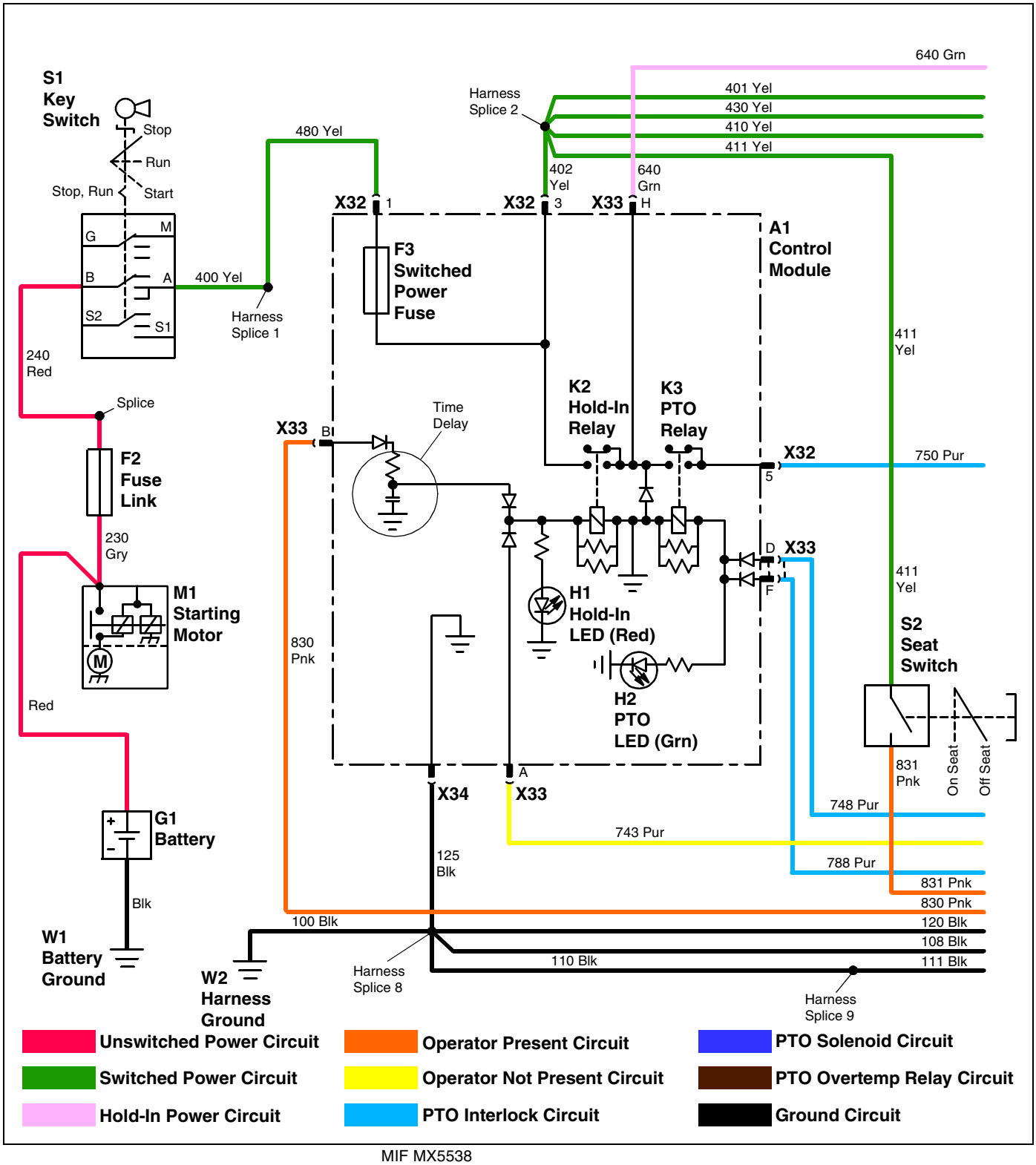
With the PTO circuit latched (see “Operator Presence and PTO Interlock Circuit Operation - Gas Engine” on page 372) and the PTO switch at the ENGAGED position, current is now allowed to flow through 770 Pur wire, to PTO solenoid (Y1), energizing the solenoid.

PTO Overtemp Relay Circuit

When the engine coolant temperature exceeds 110°C (230°F), dual temp coolant switch (B4) provides a path to ground for the coil of PTO overtemp relay (K4), thus energizing the relay. With the overtemp relay energized, the normally closed contacts of the relay are now open, causing current to stop flowing to the coil of PTO relay (K3). This de-energizes the PTO relay, which stops current flow to the PTO solenoid, thus stopping the PTO system.

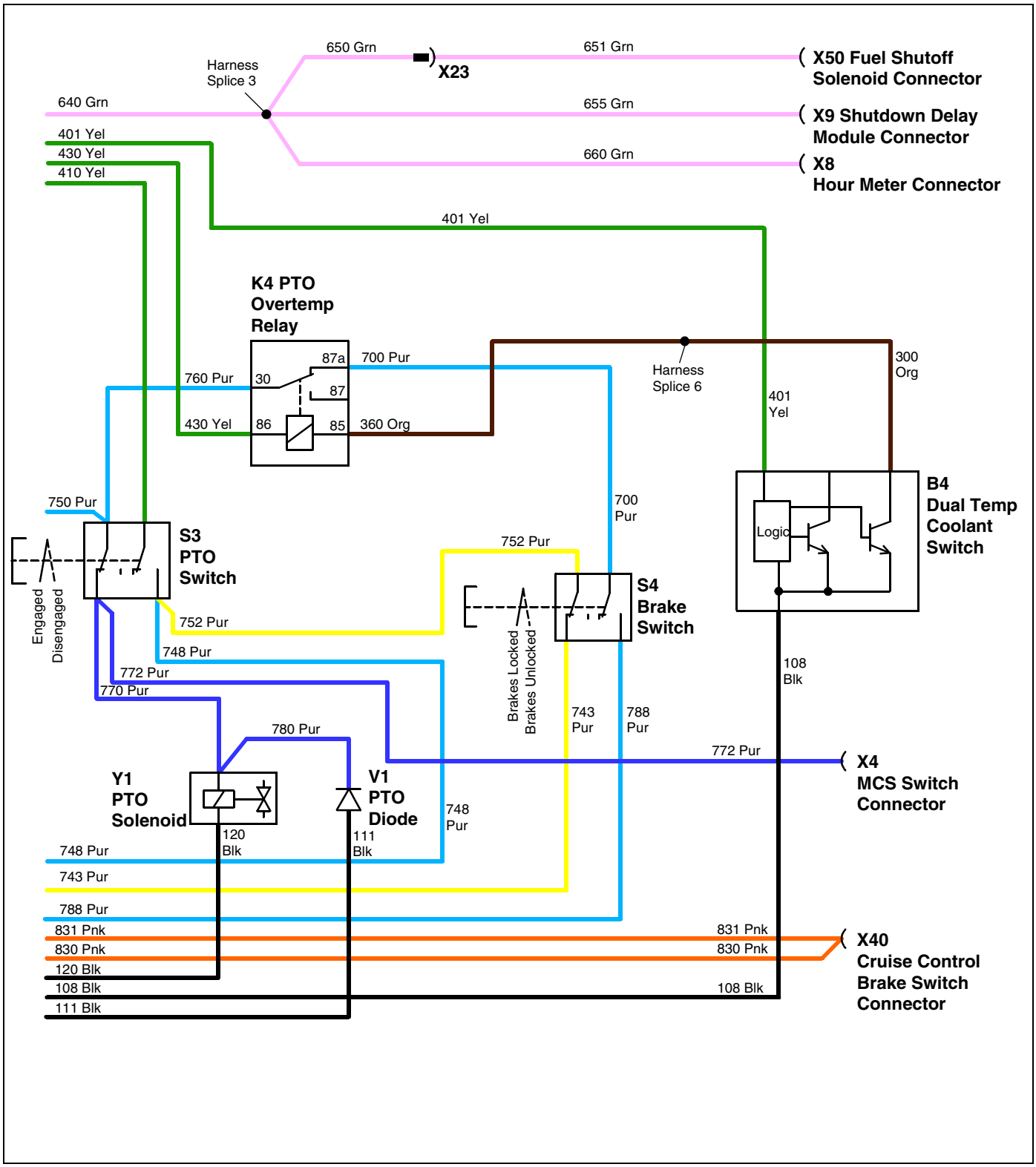
Operator Presence and PTO Interlock Circuit Schematics - Gas Engine

Operator Presence and PTO Interlock Circuit Schematic (1 of 2)



MIF MX5538

Operator Presence and PTO Interlock Circuit Schematic (2 of 2)



MIF MX5538

Operator Presence and PTO Interlock Circuit Operation - Diesel Engine

Function:

The purpose of the “operator presence” portion of this circuit is to automatically stop the engine whenever the operator rises from the seat for more than one second when PTO is ENGAGED and/or park brake is UNLOCKED.

The purpose of the "PTO interlock" portion of the circuit is to provide the following:

- Require the operator to be sitting on the seat and park brake UNLOCKED before the PTO can be ENGAGED.
- Automatically disengages the PTO whenever operator locks the park brake or if the engine coolant temperature exceeds 110°C (230°F).
- Provide a means for the engine to continue operating when operator in not on the seat.

Operating Conditions:

- Key switch in RUN position.

Theory of Operation:

Unswitched And Switched Power Circuits

Protection for operator presence and PTO interlock circuit is provided by fuse link (F2) and 15-amp switched power fuse (F3) located on control module (A1).

Turning key switch (S1) to the RUN or start position allows current from the positive (+) terminal of battery (G1) to flow through fuse link (F2), wire 240 (Red), then to terminal B of the key switch. The current flows out terminal A of the key switch, through 400 and 480 Yel wires, to switched power fuse (F3). From fuse (F3), current flows through 402 Yel wire to harness splice 2.

From harness splice 2, current flows to the following components:

- Dual temp coolant switch (B4) (401 Yel wire). This current provides power for the dual temp coolant switch.
- Seat switch (S2) (411 Yel wire).
- PTO switch (S3) (410 Yel wire).
- Coil of PTO overtemp relay (K4) (430 Yel wire).

OPERATOR PRESENCE AND NOT PRESENT CIRCUITS

For the engine to operate, one of the following must occur:

- Operator must be on the seat when the PTO is ENGAGED and/or park brake UNLOCKED.
- When operator is not on the seat, the PTO must be DISENGAGED and park brake LOCKED.

When the operator is sitting on the seat, current flows across the seat switch contacts, through 831 and 830 Pnk wires, to terminal B of connector (X32) on control module (A1). From connector (X32), the current flows to the coil of hold-in relay (K2), energizing the relay and charges the capacitor of control module (A1). The energy stored in the capacitor will keep the hold-in relay (K2) energized for approximately one second if the operator leaves the seat, as on rough terrain. The current will also cause hold-in LED (H1), located on control module (A1), to come on providing visual proof that the hold-in relay coil is energized to aid in troubleshooting.

If operator is not on the seat, the hold-in relay can still be energized by putting PTO switch (S3) at the DISENGAGED position and brake switch (S4) at the ON (park brake LOCKED) position. When this happens, current is allowed to flow through 752 Pur wire, across the brake switch contacts, then through 743 Pur wire, to terminal A of connector (X32) of control module (A1). From connector (X32), current flows to the coil of hold-in relay (K2), energizing the relay. The current will also cause hold-in LED (H1) to come on.

Hold-in Power (Engine Run) Circuit

When the hold-in relay is energized, current from fuse (F3) is allowed to flow across the contacts of the hold-in relay, then through 640 Grn wire, to harness splice 3.

From harness splice 3, current flows to the following components:

- Fuel shutoff solenoid (650 Grn wire). (For additional information, see “Fuel Shutoff Solenoid Circuit Operation - Diesel Engine” on page 439.)
- Diesel engine control module (630 Grn wire). (For additional information, see “Fuel Shutoff Solenoid Circuit Operation - Diesel Engine” on page 439 and “Air Preheater Circuit Operation - Diesel Engine” on page 419.)
- Hour Meter (660 Grn wire). (For additional information, see “Hour Meter Circuit Operation” on page 425.)

PTO Interlock Circuit

NOTE: For safety reasons, the PTO interlock circuit contains a latching circuit. Because of this, the PTO switch must be at the DISENGAGED position before the PTO can be ENGAGED.

When PTO switch is at the DISENGAGED position, current from fuse (F4) is allowed to flow through 748 Pur wire, to terminal D of connector (X32) on control module (A1). From connector (X32), current flows to the coil of PTO relay (K3), energizing the relay. The current will also cause PTO LED (H2), located on control module (A1), to come on providing visual proof that the PTO relay coil is energized to aid in troubleshooting.

With the PTO relay energized, current is allowed to flow across the relay contacts, out terminal 5 of connector (X31), then through 750 and 760 Pur wires, to PTO Overtemp Relay (K4). The current flows across the normally closed contacts of the relay, then through 700 Pur wire, to brake switch (S4). If the brake switch is at the OFF position (park brake UNLOCKED), the current will flow across the switch contacts, then through 788 Pur wire, to terminal F of connector (X32) on control module (A1). From connector (X32), the current flows to the coil of PTO relay (K3), thus latching the PTO relay. At this point, the PTO can be ENGAGED by moving the PTO switch to the ENGAGED position.

PTO Solenoid Circuit

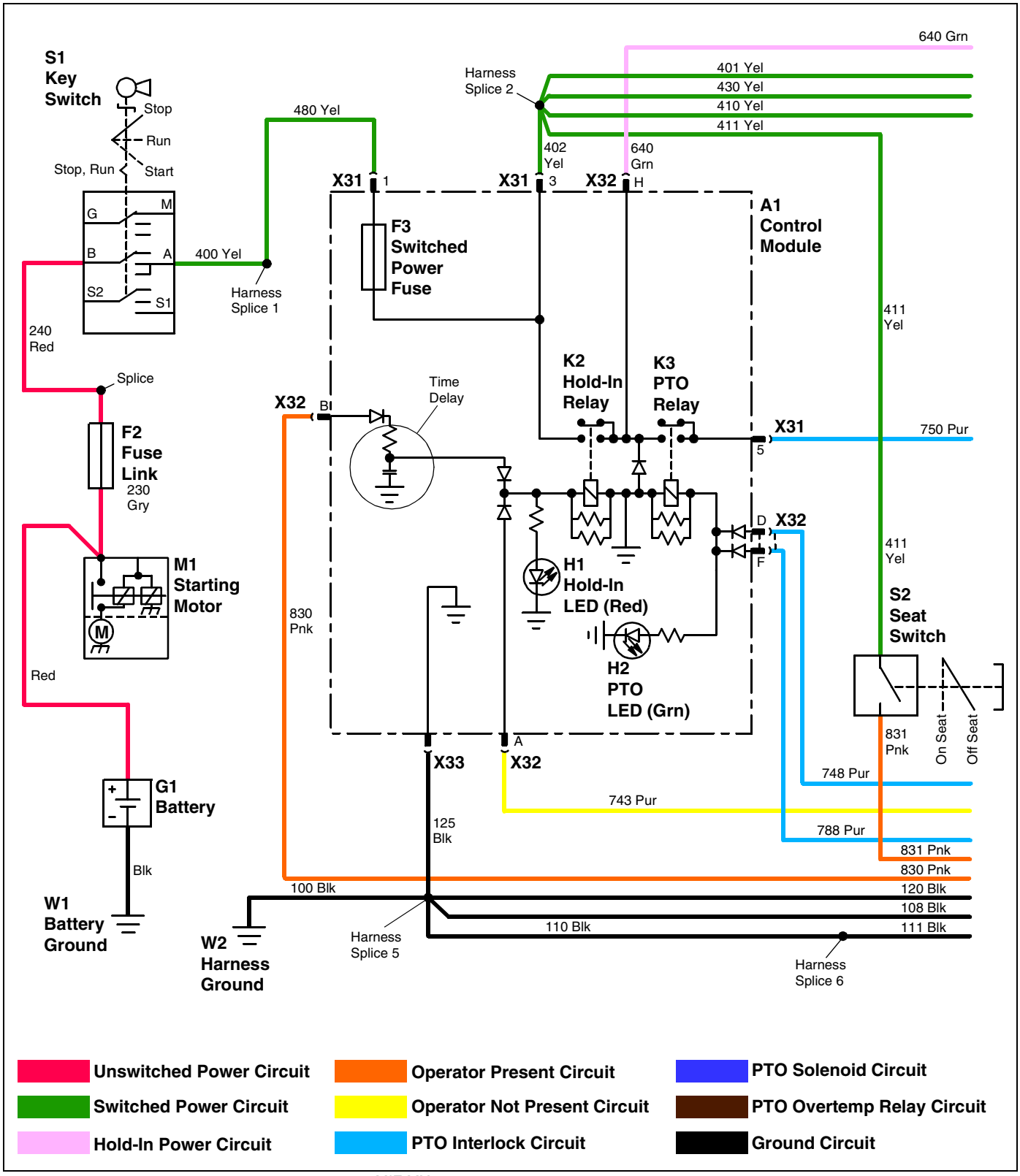
With the PTO circuit latched (see “Operator Presence and PTO Interlock Circuit Operation - Diesel Engine” on page 376), and the PTO switch at the ENGAGED position, current is now allowed to flow through 770 Pur wire, to PTO solenoid (Y1), energizing the solenoid.

PTO Overtemp Relay Circuit

When the engine coolant temperature exceeds 110°C (230°F), dual temp coolant switch (B1) provides a path to ground for the coil of PTO overtemp relay (K4), thus energizing the relay. With the overtemp relay energized, the normally closed contacts of the relay are now open, causing current to stop flowing to the coil of PTO relay (K3). This de-energizes the PTO relay, which stops current flow to the PTO solenoid, thus stopping the PTO system.

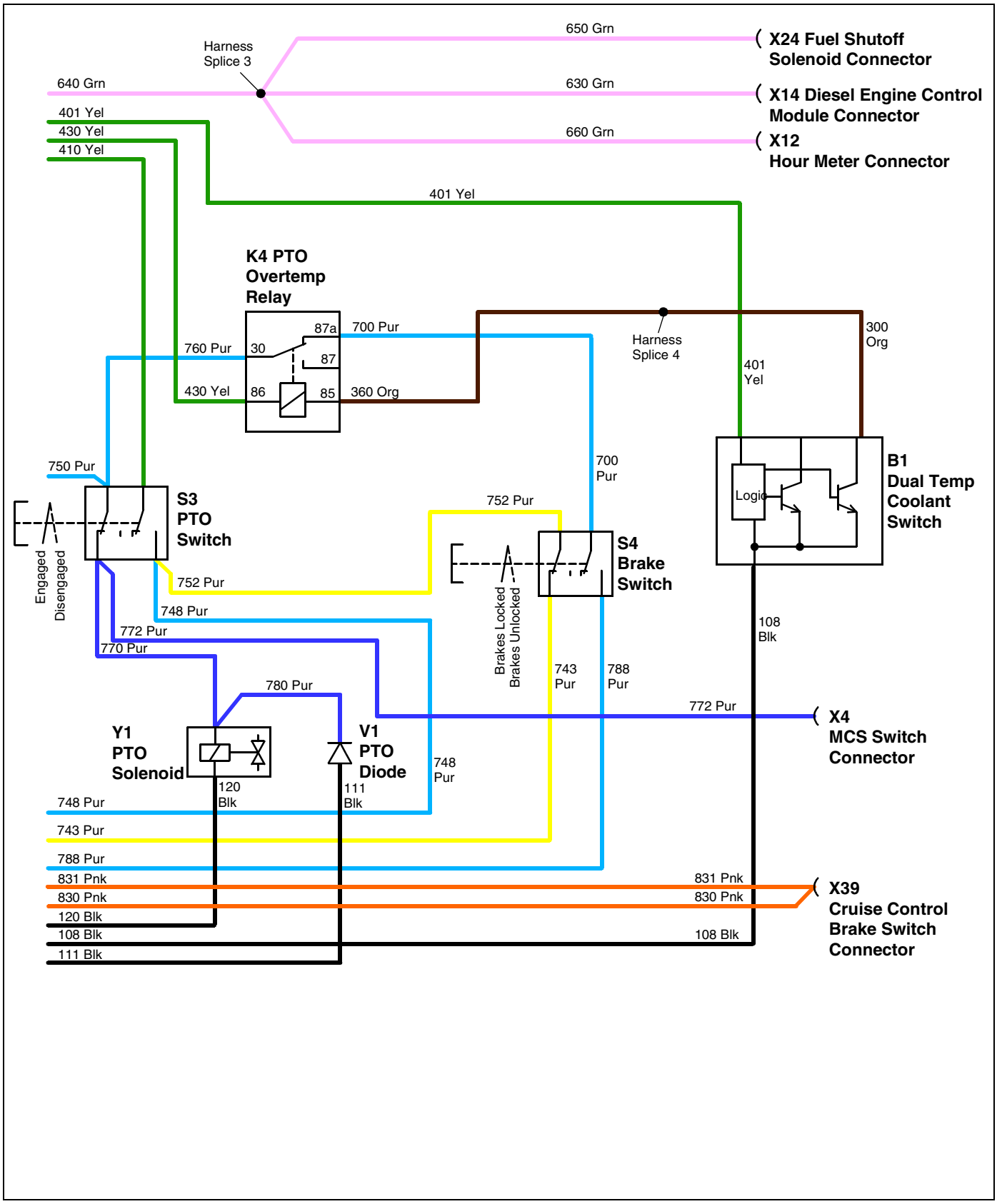
Operator Presence and PTO Interlock Circuit Schematic - Diesel Engine

Operator Presence and PTO Interlock Circuit Schematic (1 of 2)



MIF MX5539

Operator Presence and PTO Interlock Circuit Schematic (2 of 2)



MIF MX5539

Operator Presence and PTO Interlock Circuit Diagnosis - Gas Engine

Front Mower

1420

- If machine does not run when operator is on the seat and park brake is UNLOCKED and/or PTO is ENGAGED, go to “Test Procedure A” on page 380.
- If machine does not run when park brake is LOCKED, PTO is DISENGAGED, and operator is not on the seat, go to “Test Procedure B” on page 382.
- If PTO does not operate, go to “Test Procedure C” on page 384.

IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

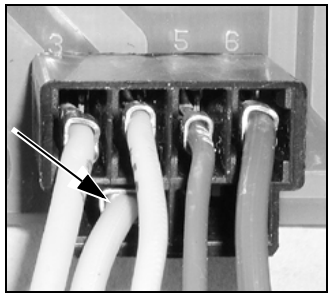
Test Procedure A

Perform this procedure if machine does not run when operator is on the seat, and park brake is UNLOCKED and/or PTO is ENGAGED.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- Park brake UNLOCKED.
- PTO switch at the ENGAGED position.
- Meter negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Operator Presence and PTO Interlock Diagnosis - Gas Engine: Test Procedure A

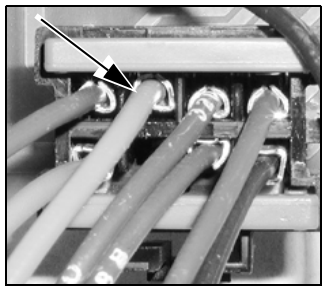


MX5650

(1) Is the voltage between terminal 1, 480 Yel wire of control module (X32) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Gas Engine” on page 347.

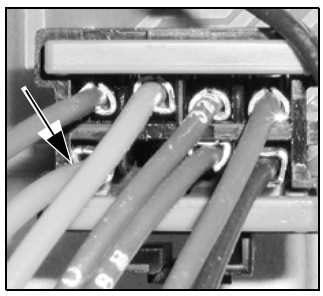


MX5651

(2) Is the voltage across terminal B, 830 Pnk wire of control module connector (X33) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Go to step (4) to continue test.



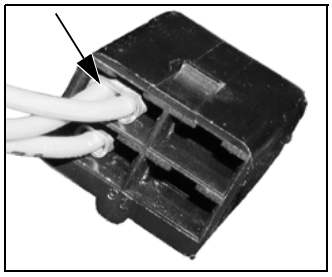
MX5651

(3) Is the voltage measured between terminal H, 640 Grn wire of control module connector (X33) and ground 11.8 - 13.2 VDC?

System: Operator Presence and PTO Interlock Diagnosis - Gas Engine: Test Procedure A

Yes - See “Fuel Shutoff Solenoid Circuit Diagnosis - Gas Engine” on page 441 and “Hour Meter Circuit Diagnosis” on page 427.

No - Replace control module (A1).

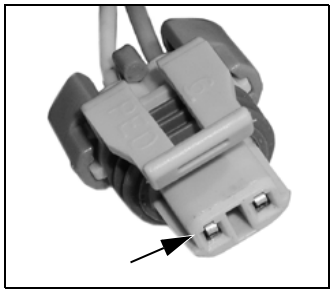


MX5652

(4) Is the voltage across 830/831 Pnk wires on cruise control brake switch connector (X40) and ground 11.8 - 13.2 VDC?

Yes - Replace main wiring harness (W4).

No - Go to next step.



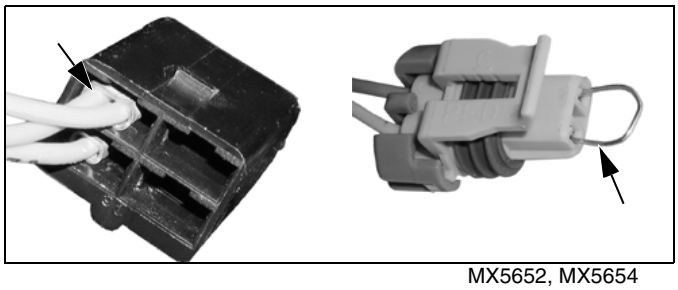
MX5653

(5) After disconnecting seat switch connector (X38), is the voltage measured between terminal A (411 Yel) on harness side of connector and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Go to step (7) to continue test.

System: Operator Presence and PTO Interlock Diagnosis - Gas Engine: Test Procedure A

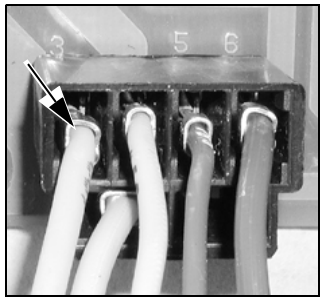


MX5652, MX5654

(6) After installing a jumper wire across terminals A and B on seat switch side of connector (X38), is the voltage at 830/831 Pnk wires on the cruise control brake switch connector (X40) and ground 11.8 - 13.2 VDC?

Yes - Replace seat switch (S2).

No - Replace the main wiring harness (W4).



MX5650

(7) Is the voltage measured at terminal 3, 402 Yel wire of control module connector (X32) and ground 11.8 - 13.2 VDC?

Yes - Replace main wiring harness (W4).

No - Check fuse (F3).

No - Replace control module (A1).

Test Procedure B

Perform this procedure if machine does not run when park brake is LOCKED, PTO is DISENGAGED, and operator is not on the seat.

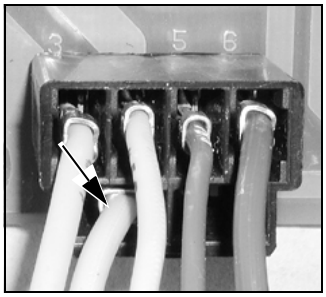
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF>
- Park brake LOCKED.
- PTO switch at DISENGAGED position.
- Meter negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Operator Presence and PTO Interlock Diagnosis - Gas Engine: Test Procedure B



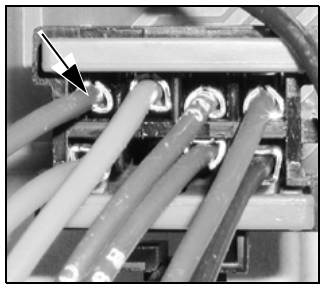
MX5650

(1) Is the voltage measured between terminal 1, 480 Yel wire of control module connector (X32) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Gas Engine” on page 347.

System: Operator Presence and PTO Interlock Diagnosis - Gas Engine: Test Procedure B

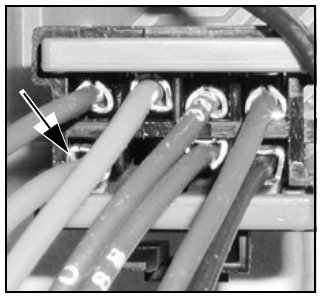


MX5651

(2) Is the voltage measured across terminal A, 743 Pur wire of control module connector (X33) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Go to step (4) to continue test.

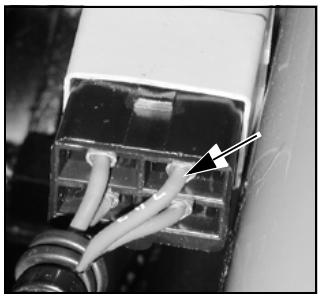


MX5651

(3) Is the voltage measured at terminal H, 640 Grn of control module connector (X33) and ground 11.8 - 13.2 VDC?

Yes - See “Hour Meter Circuit Diagnosis” on page 427 and “Fuel Shutoff Solenoid Circuit Diagnosis - Gas Engine” on page 441.

No - Replace control module (A1).



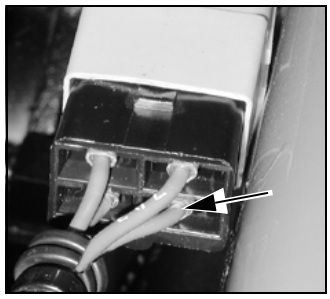
MX5655

(4) Is the voltage measured between 743 Pur wire on brake switch connector (X37) and ground 11.8 - 13.2 VDC?

Yes - Replace main wiring harness (W4).

No - Go to next step.

System: Operator Presence and PTO Interlock Diagnosis - Gas Engine: Test Procedure B



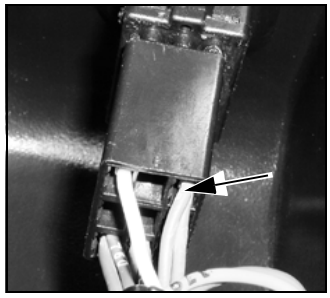
MX5655

(5) Is the voltage measured across 752 Pur wire on brake switch connector (X37) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check brake switch adjustment.

No - Test brake switch (S4). See “Brake Switch Test” on page 473.

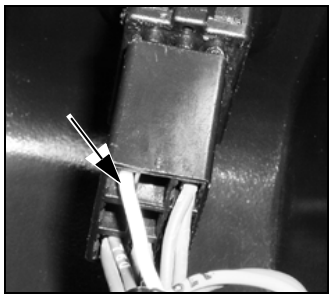


MX5656

(6) Is the voltage measured between 752/748 Pur wires on PTO switch and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Replace main wiring harness (W4).



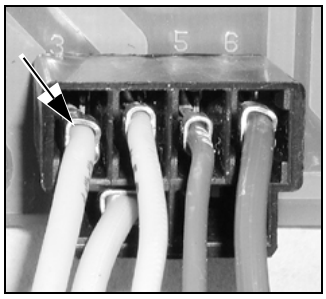
MX5656

(7) Is the voltage across 410 Yel wire on PTO switch (S3) and ground 11.8 - 13.2 VDC?

Yes - Replace PTO switch (S3).

No - Go to next step.

System: Operator Presence and PTO Interlock Diagnosis - Gas Engine: Test Procedure B



MX5650

(8) Is the voltage at terminal 3, 402 Yel wire of control module connector (X32) and ground 11.2 - 13.8 VDC?

Yes - Replace main wiring harness.

No - Test complete.

Test Procedure C

Perform this procedure if PTO does not operate.

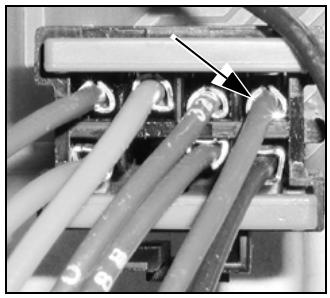
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- Park brake UNLOCKED.
- Operator on the seat.
- PTO switch at DISENGAGED position (Steps 1, 2, 14, and 15).
- Meter negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Operator Presence and PTO Interlock Diagnosis - Gas Engine: Test Procedure C



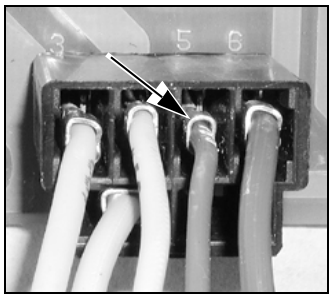
MX5651

(1) Is the voltage measured across terminal D, 748 Pur wire of control module connector (X33) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Go to step (14) to continue test.

System: Operator Presence and PTO Interlock Diagnosis - Gas Engine: Test Procedure C

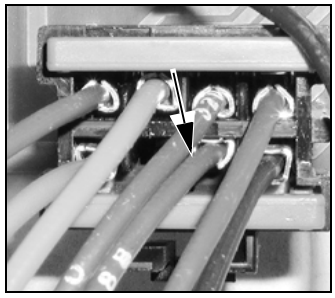


MX5650

(2) Is the voltage measured at terminal 5, 750 Pur of control module connector (X32) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Replace control module (A1).

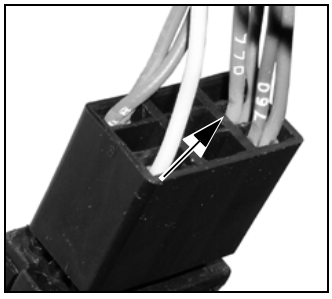


MX5651

(3) Is the voltage measured between terminal F, 788 Pur wire of control module connector (X33) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Go to step (7) to continue test.



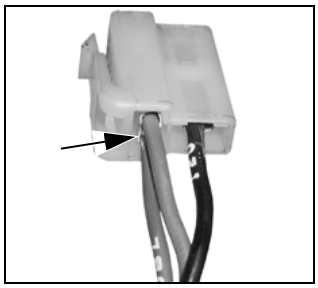
MX5657

(4) Is the voltage measured at 770/772 Pur wires on PTO switch (S3) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Replace PTO switch (S3).

System: Operator Presence and PTO Interlock Diagnosis - Gas Engine: Test Procedure C



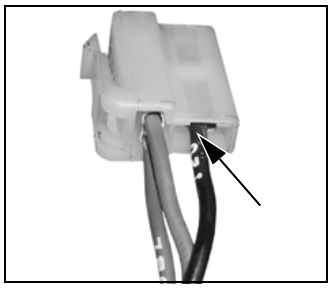
MX5658

(5) Is the voltage measured across 770/780 Pur wires on PTO solenoid connector (X24) and ground 11.8 - 13.2 VDC? Test both sides of connectors.

Yes - Go to next step.

No - Repair or replace connector (X24).

No - Replace main wiring harness (W4).



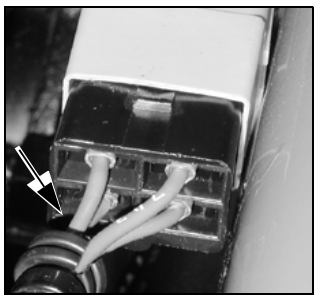
MX5658

(6) Is there continuity between 120 Blk wire on PTO solenoid connector (X24) and ground. Check both sides of connector.

Yes - Replace PTO solenoid (Y1).

No - Repair or replace connector (X24).

No - Replace main wiring harness (W4).



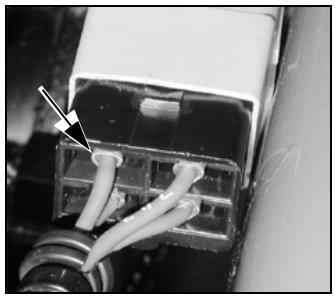
MX5655

(7) Is there voltage between 788 Pur wire on brake switch connector (X37)?

Yes - Replace main wiring harness (W4).

No - Go to next step.

System: Operator Presence and PTO Interlock Diagnosis - Gas Engine: Test Procedure C

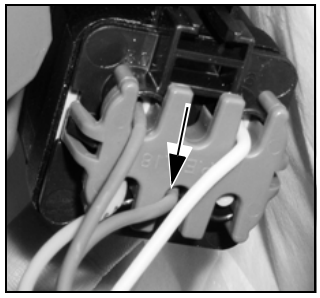


MX5655

(8) Is there voltage across 700 Pur wire on brake switch connector (X37) and ground?

Yes - Replace brake switch (S4).

No - Go to next step.

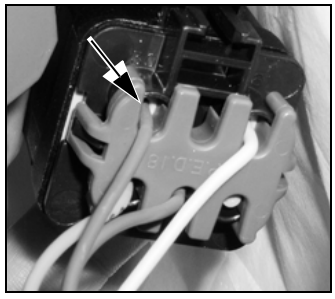


MX5659

(9) Is there voltage between terminal 87a, 700 Pur wire of PTO overtemp relay (K4) and ground? This is checked by inserting a small diameter probe between wire and relay socket seal.

Yes - Replace main wiring harness (W4).

No - Go to next step.



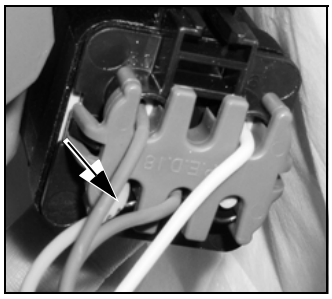
MX5659

(10) Is there voltage at terminal 30, 760 Pur wire of PTO overtemp relay (K4) and ground. This is checked by inserting a small diameter probe between wire and relay socket seal.

Yes - Go to next step.

No - Go to step (12) to continue test.

System: Operator Presence and PTO Interlock Diagnosis - Gas Engine: Test Procedure C

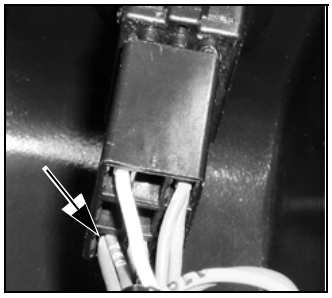


MX5659

(11) Is there continuity between terminal 85, 360 Org on PTO overtemp relay (K4) and ground?

Yes - Replace dual temp coolant switch. (B1).

No - Replace PTO overtemp relay (K4).

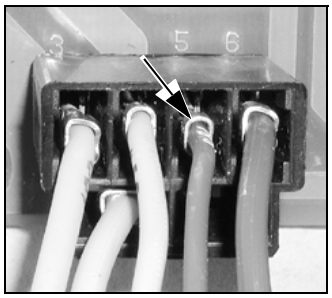


MX5656

(12) Is the voltage between 760/750 Pur wires on PTO switch (S3) and ground? 11.8 - 13.2 VDC?

Yes - Replace main wiring harness (W4).

No - Go to next step.



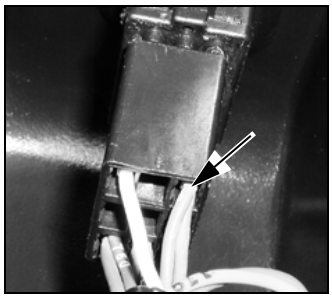
MX5650

(13) Is the voltage at terminal 5, 750 Pur wire of control module connector (X32) and ground 11.8 - 13.2 VDC?

Yes - Replace main wiring harness (W4).

No - Replace control module (A1).

System: Operator Presence and PTO Interlock Diagnosis - Gas Engine: Test Procedure C

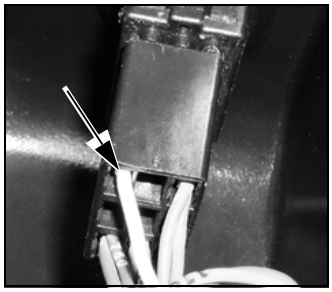


MX5656

(14) Is the voltage measured at 748/752 Pur wires on PTO switch (S3) and ground 11.8 - 13.2 VDC?

Yes - Replace main wiring harness (W4).

No - Go to next step.



MX5656

(15) Is the voltage across 410 Yel wire on PTO switch (S3) and ground 11.8 - 13.2 VDC?

Yes - Replace PTO switch (S3).

No - Replace main wiring harness (W4).

Operator Presence and PTO Interlock Circuit Diagnosis - Diesel Engine

Front Mower

1420

- If machine does not run when operator is on the seat and park brake is UNLOCKED and/or PTO is ENGAGED, see “Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure A” on page 387.
- If machine does not run when park brake is LOCKED, PTO is DISENGAGED, and operator is not on the seat, see “Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure B” on page 389.
- If PTO does not operate, “Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure C” on page 391.

Test Procedure A

Perform this procedure if machine does not run when operator is on the seat, and park brake is UNLOCKED and/or PTO is ENGAGED.

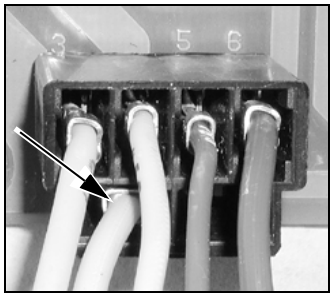
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- Park brake UNLOCKED.
- PTO switch at the ENGAGED position.
- Meter negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure A



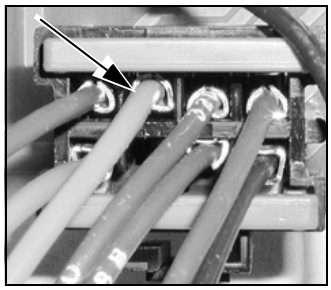
MX5650

(1) Is the voltage between terminal 1, 480 Yel wire of control module (X31) and ground 11.8 - 13.2 VDC?

System: Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure A

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Gas Engine” on page 347.

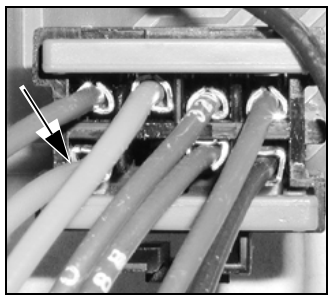


MX5651

(2) Is the voltage across terminal B, 830 Pnk wire of control module connector (X32) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Go to step (4) to continue test.



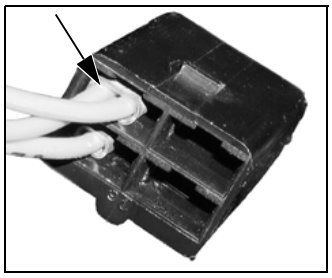
MX5651

(3) Is the voltage measured between terminal H, 640 Grn wire of control module connector (X32) and ground 11.8 - 13.2 VDC?

Yes - See “Fuel Shutoff Solenoid Circuit Diagnosis - Diesel Engine” on page 443 and “Hour Meter Circuit Diagnosis” on page 427.

No - Replace control module (A1).

System: Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure A

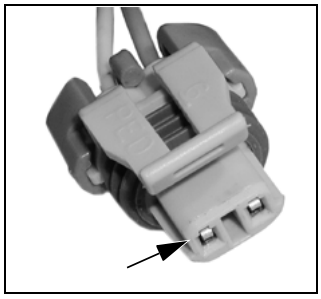


MX5652

(4) Is the voltage across 830/831 Pnk wires on cruise control brake switch connector (X39) and ground 11.8 - 13.2 VDC?

Yes - Replace main wiring harness (W4).

No - Go to next step.

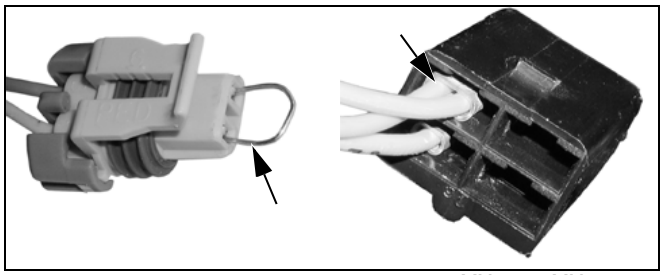


MX5653

(5) After disconnecting seat switch connector (X38), is the voltage measured between terminal A (411 Yel) on harness side of connector and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Go to step (7) to continue test.



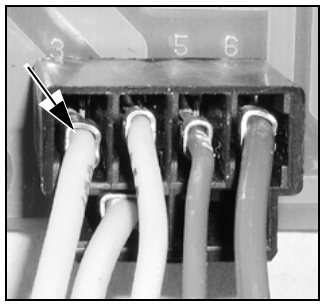
MX5654, MX5652

(6) After installing a jumper wire across terminals A and B on seat switch side of connector (X38), is the voltage at 830/831 Pnk wires on the cruise control brake switch connector (X40) and ground 11.8 - 13.2 VDC?

Yes - Replace seat switch (S2).

No - Replace the main wiring harness (W4).

System: Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure A



MX5650

(7) Is the voltage measured at terminal 3, 402 Yel wire of control module connector (X31) and ground 11.8 - 13.2 VDC?

Yes - Replace main wiring harness (W4).

No - Check fuse (F3).

No - Replace control module (A1).

Test Procedure B

Perform this procedure if machine does not run when park brake is LOCKED, PTO is DISENGAGED, and operator is not on the seat.

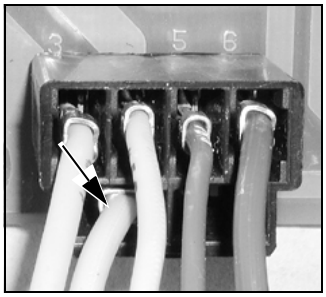
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF>
- Park brake LOCKED.
- PTO switch at DISENGAGED position.
- Meter negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure B



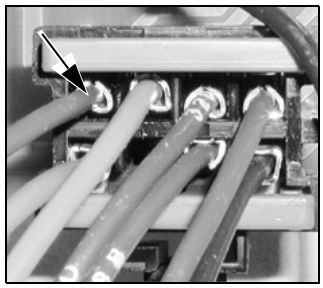
MX5650

(1) Is the voltage measured between terminal 1, 480 Yel wire of control module connector (X31) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Gas Engine” on page 347.

System: Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure B

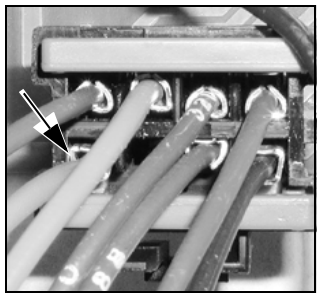


MX5651

(2) Is the voltage measured across terminal A, 743 Pur wire of control module connector (X32) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Go to step (4) to continue test.

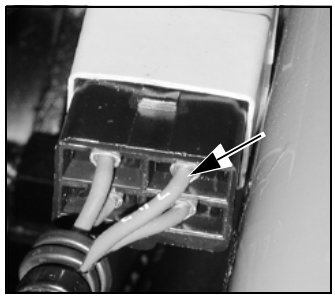


MX5651

(3) Is the voltage measured at terminal H, 640 Grn of control module connector (X32) and ground 11.8 - 13.2 VDC?

Yes - See “Hour Meter Circuit Diagnosis” on page 427 and “Fuel Shutoff Solenoid Circuit Diagnosis - Diesel Engine” on page 443.

No - Replace control module (A1).



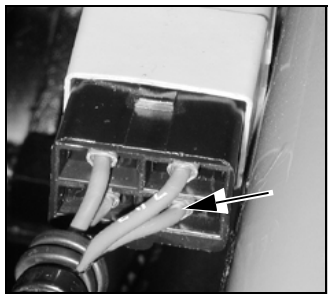
MX5655

(4) Is the voltage measured between 743 Pur wire on brake switch connector (X36) and ground 11.8 - 13.2 VDC?

Yes - Replace main wiring harness (W4).

No - Go to next step.

System: Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure B



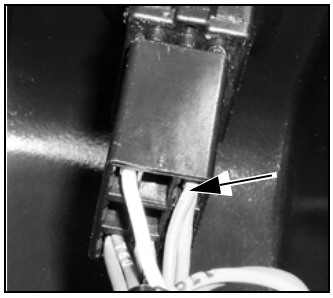
MX5655

(5) Is the voltage measured across 752 Pur wire on brake switch connector (X36) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check brake switch adjustment.

No - Test brake switch (S4). See “Brake Switch Test” on page 473.



MX5656

(6) Is the voltage measured between 752/748 Pur wires on PTO switch and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

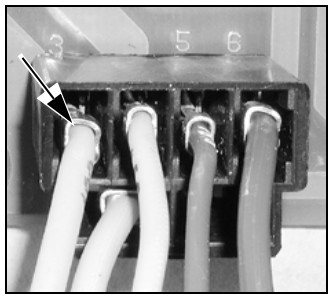
No - Replace main wiring harness (W4).

(7) Is the voltage across 410 Yel wire on PTO switch (S3) and ground 11.8 - 13.2 VDC?

Yes - Replace PTO switch (S3).

No - Go to next step.

System: Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure B



MX5650

(8) Is the voltage at terminal 3, 402 Yel wire of control module connector (X31) and ground 11.2 - 13.8 VDC?

Yes - Replace main wiring harness.

No - Test complete.

Test Procedure C

Perform this procedure if PTO does not operate.

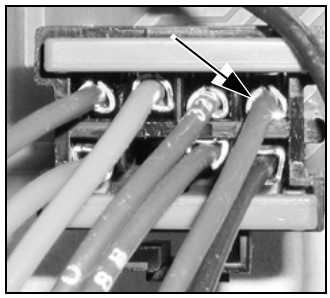
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- Park brake UNLOCKED.
- Operator on the seat.
- PTO switch at DISENGAGED position (Steps 1, 2, 14, and 15).
- Meter negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure C



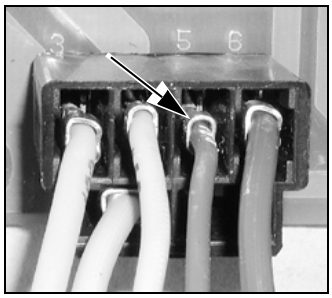
MX5651

(1) Is the voltage measured across terminal D, 748 Pur wire of control module connector (X32) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Go to step (14) to continue test.

System: Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure C

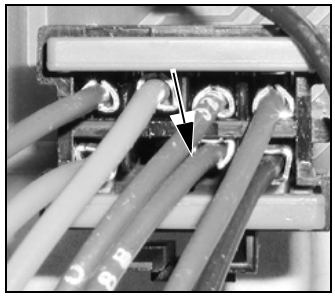


MX5650

(2) Is the voltage measured at terminal 5, 750 Pur of control module connector (X32) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Replace control module (A1).

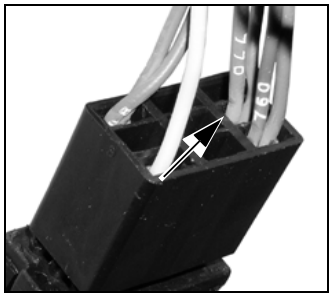


MX5651

(3) Is the voltage measured between terminal F, 788 Pur wire of control module connector (X32) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Go to step (7) to continue test.



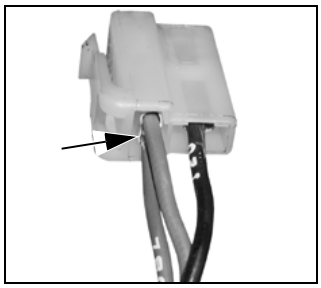
MX5657

(4) Is the voltage measured at 770/772 Pur wires on PTO switch (S3) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Replace PTO switch (S3).

System: Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure C



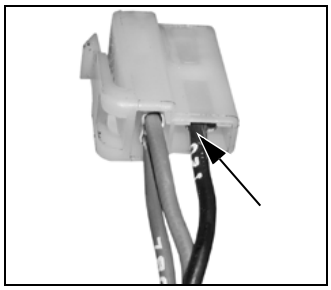
MX5658

(5) Is the voltage measured across 770/780 Pur wires on PTO solenoid connector (X23) and ground 11.8 - 13.2 VDC? Test both sides of connectors.

Yes - Go to next step.

No - Repair or replace connector (X23).

No - Replace main wiring harness (W4).



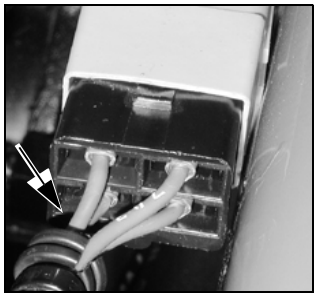
MX5658

(6) Is there continuity between 120 Blk wire on PTO solenoid connector (X23) and ground. Check both sides of connector.

Yes - Replace PTO solenoid (Y1).

No - Repair or replace connector (X23).

No - Replace main wiring harness (W4).



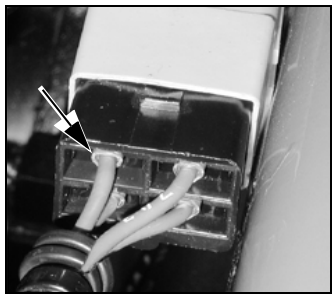
MX5655

(7) Is there voltage between 788 Pur wire on brake switch connector (X36)?

Yes - Replace main wiring harness (W4).

No - Go to next step.

System: Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure C

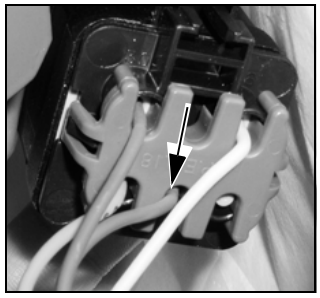


MX5655

(8) Is there voltage across 700 Pur wire on brake switch connector (X36) and ground?

Yes - Replace brake switch (S4).

No - Go to next step.

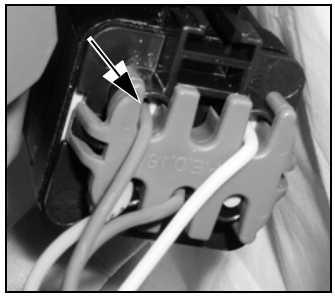


MX5659

(9) Is there voltage between terminal 87a, 700 Pur wire of PTO overtemp relay (K4) and ground? This is checked by inserting a small diameter probe between wire and relay socket seal.

Yes - Replace main wiring harness (W4).

No - Go to next step.



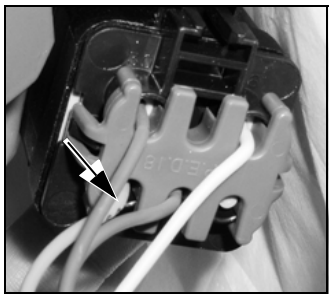
MX5659

(10) Is there voltage at terminal 30, 760 Pur wire of PTO overtemp relay (K4) and ground. This is checked by inserting a small diameter probe between wire and relay socket seal.

Yes - Go to next step.

No - Go to step (12) to continue test.

System: Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure C

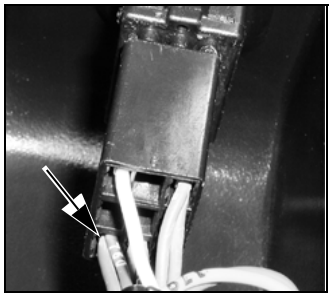


MX5659

(11) Is there continuity between terminal 85, 360 Org on PTO overtemp relay (K4) and ground?

Yes - Replace dual temp coolant switch. (B1).

No - Replace PTO overtemp relay (K4).

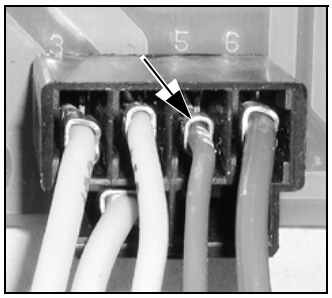


MX5656

(12) Is the voltage between 760/750 Pur wires on PTO switch (S3) and ground? 11.8 - 13.2 VDC?

Yes - Replace main wiring harness (W4).

No - Go to next step.



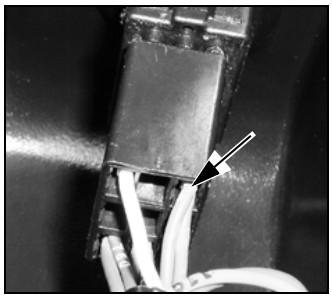
MX5650

(13) Is the voltage at terminal 5, 750 Pur wire of control module connector (X31) and ground 11.8 - 13.2 VDC?

Yes - Replace main wiring harness (W4).

No - Go to next step.

System: Operator Presence and PTO Interlock Diagnosis - Diesel Engine: Test Procedure C

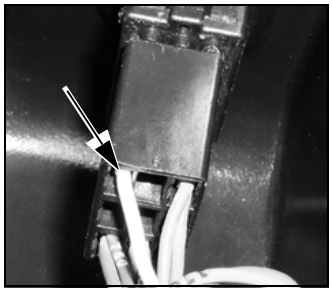


MX5656

(14) Is the voltage measured at 748/752 Pur wires on PTO switch (S3) and ground 11.8 - 13.2 VDC?

Yes - Replace main wiring harness (W4).

No - Go to next step.



MX5656

(15) Is the voltage across 410 Yel wire on PTO switch (S3) and ground 11.8 - 13.2 VDC?

Yes - Replace PTO switch (S3).

No - Replace main wiring harness (W4).

Operator Presence and PTO Interlock Circuit Diagnosis - Diesel Engine

Front Mower

1435

1445

1545

- If machine does not run when operator is on the seat and park brake is UNLOCKED and/or PTO is ENGAGED, go to “Test Procedure A” on page 394.
- If machine does not run when park brake is LOCKED, PTO is DISENGAGED, and operator is not on the seat, go to “Test Procedure B” on page 396.
- If PTO does not operate, go to “Test Procedure C” on page 398.

Test Procedure A

Perform this procedure if machine does not run when operator is on the seat, but park brake is UNLOCKED and/or PTO is ENGAGED.

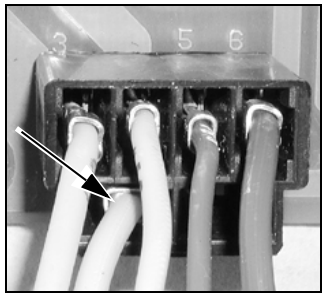
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Operator on the seat.
- Key switch in the RUN position with the engine OFF.
- Park brake UNLOCKED.
- PTO switch at the ENGAGED position.
- Meter negative (BLACK) lead on the battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Operator Presence and PTO Interlock Circuit Diagnosis - Diesel Engine: Test Procedure A

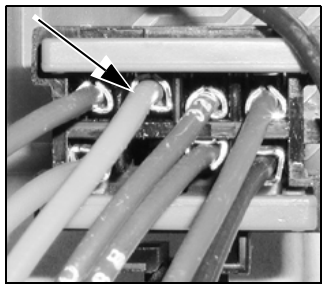


MX5650

(1) Is voltage present at terminal 1, 480 Yel of control module connector (X31)?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.

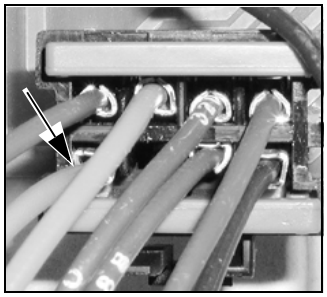


MX5651

(2) Is voltage present at terminal B, 830 Pnk wire of control module connector (X32)?

Yes - Go to next step.

No - Go to step (4) to continue test.



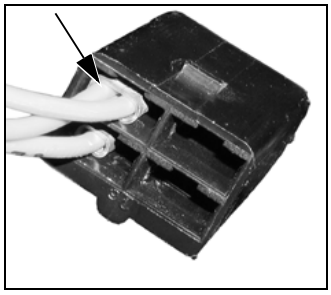
MX5651

(3) Is voltage present at terminal H, 640 Grn of control module connector (X32)?

System: Operator Presence and PTO Interlock Circuit Diagnosis - Diesel Engine: Test Procedure A

Yes - See “Fuel Shutoff Solenoid Circuit Diagnosis - Gas Engine” on page 441 and “Hour Meter Circuit Diagnosis” on page 427.

No - Replace control module (A1).

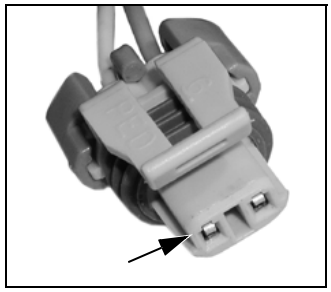


MX5652

(4) Is voltage present at 830/831 Pnk wire on cruise control brake switch connector (X39)?

No - Go to next step.

Yes - Replace main wiring harness (W4).

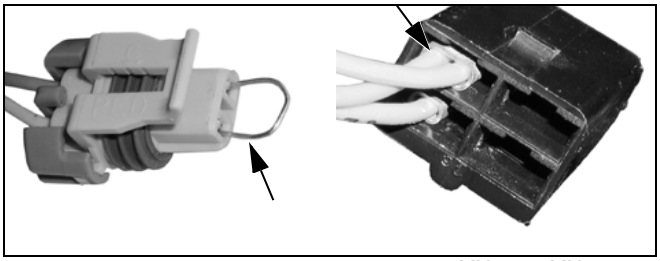


MX5653

(5) Disconnect seat switch connector (X37). Is voltage present at terminal A, 411 Yel wire on harness side of connector?

Yes - Go to next step.

No - Go to step (7) to continue test.



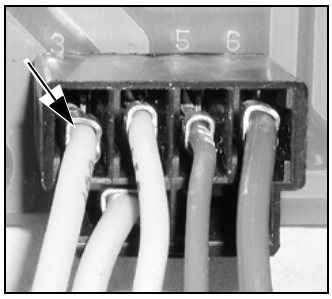
MX5654, MX5652

(6) Install jumper wire across terminals A and B on seat switch side of connector (X37). Is voltage present at 830/831 Pnk wires on cruise control brake switch connector (X39)?

System: Operator Presence and PTO Interlock Circuit Diagnosis - Diesel Engine: Test Procedure A

Yes - Replace seat switch (S2).

No - Replace main wiring harness (W$).



MX5650

(7) Is voltage present at terminal 3, 402 Yel wire of control module connector (X31)?

Yes - Replace main wiring harness (W4).

No - Replace control module (A1) if fuse (F3) is good.

Test Procedure B

Perform this procedure if machine does not run when park brake is LOCKED, PTO is DISENGAGED, and operator is not on the seat.

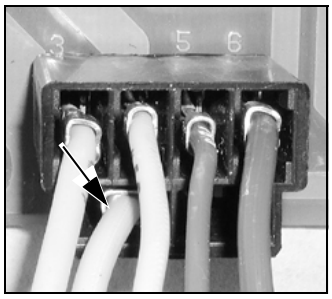
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- Park brake LOCKED.
- PTO switch at DISENGAGED position.
- Meter negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Operator Presence and PTO interlock Circuit Diagnosis - Diesel Engine: Test Procedure B



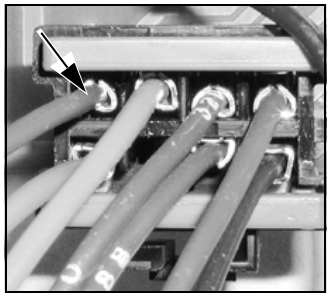
MX5650

(1) Is voltage present at terminal 1, 480 Yel wire of control module connector (X31)?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.

System: Operator Presence and PTO interlock Circuit Diagnosis - Diesel Engine: Test Procedure B

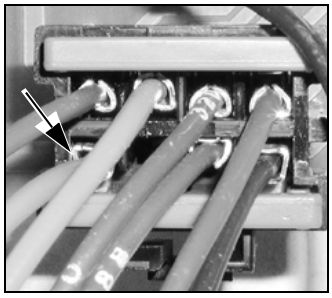


MX5651

(2) Is voltage present at terminal A, 743 Pur wire of control module connector (X32)?

Yes - Go to next step.

No - Go to step (4) to continue test.

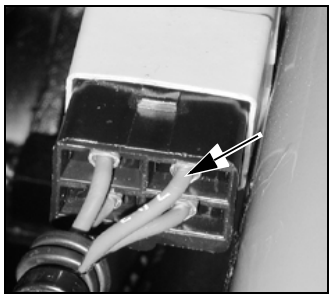


MX5651

(3) Is voltage present at terminal H, 640 Grn wire of control module connector (X32)?

Yes - See “Fuel Shutoff Solenoid Circuit Diagnosis - Diesel Engine” on page 443 and “Hour Meter Circuit Diagnosis” on page 427.

No - Replace control module (A1).



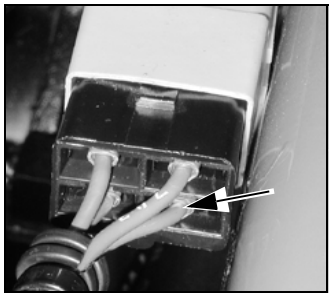
MX5655

(4) Is voltage present at 743 Pur wire on brake switch connector (X36)?

No - Go to next step.

Yes - Replace main wiring harness (W4).

System: Operator Presence and PTO interlock Circuit Diagnosis - Diesel Engine: Test Procedure B



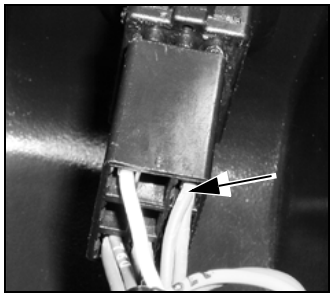
MX5655

(5) Is voltage present at 752 Pur wire on brake switch connector (X36)?

No - Go to next step.

Yes - Check brake switch adjustment.

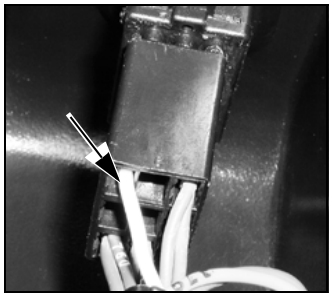
Yes - Check brake switch (S4). See “Brake Switch Test” on page 473.



MX5656

(6) Is voltage present at 752/748 Pur wires on PTO switch (S3)?

Yes - Replace main wiring harness (W4).



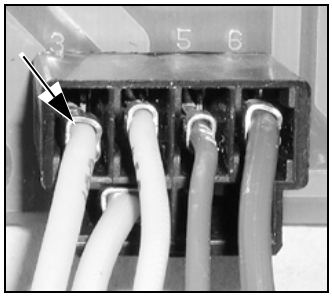
MX5656

(7) Is voltage present at 410 Yel wire on PTO switch (S3)?

No - Go to next step.

Yes - Replace PTO switch (S3).

System: Operator Presence and PTO interlock Circuit Diagnosis - Diesel Engine: Test Procedure B



MX5650

(8) Is voltage present at terminal 3, 402 Yel wire of control module connector (X31)?

Yes - Replace main wiring harness (W4).

No - Replace control module (A1) if fuse (F3) is good.

Test Procedure C

Perform this procedure if PTO does not operate.

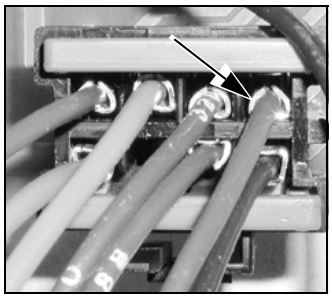
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- Operator on the seat.
- PTO switch at the DISENGAGED position (Steps 1, 2, 14, and 15).
- PTO switch at the ENGAGED position (Steps 3 - 13).
- Meter negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Operator Presence and PTO Interlock Circuit Diagnosis - Diesel Engine: Test Procedure C



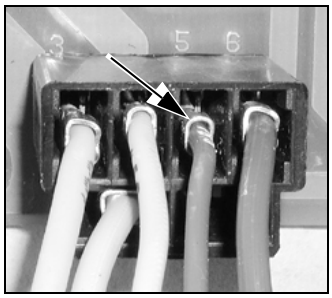
MX5651

(1) Is voltage present at terminal D, 748 Pur wire of control module connector (X32)?

Yes - Go to next step.

No - Go to step (14) to continue test.

System: Operator Presence and PTO Interlock Circuit Diagnosis - Diesel Engine: Test Procedure C

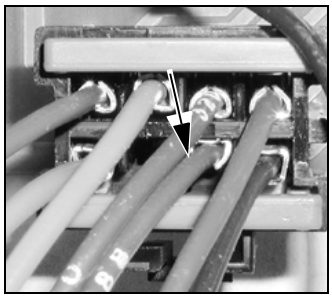


MX5650

(2) Is voltage present at terminal 5, 750 Pur of control module connector (X31)?

Yes - Go to next step.

No - Replace control module (A1).

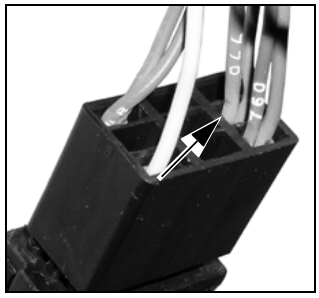


MX5651

(3) Is voltage present at terminal F, 788 Pur wire of control module connector (X32)?

Yes - Go to next step.

No - Go to step (8) to continue test.



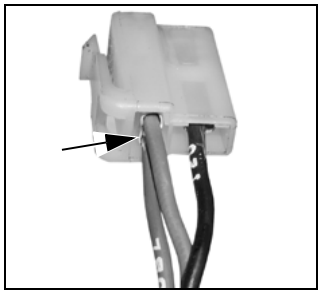
MX5657

(4) Is voltage present at 770/772 Pur wires on PTO switch (S3)?

Yes - Go to next step.

No - Replace PTO switch (S3).

System: Operator Presence and PTO Interlock Circuit Diagnosis - Diesel Engine: Test Procedure C



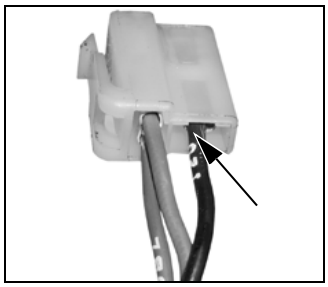
MX5658

(5) Checking both sides of connector, is voltage present at 770/780 Pur wires on PTO solenoid connector (X22)?

Yes - Go to next step.

No - If voltage is present at only one side of connector, repair or replace connector.

No - Replace main wiring harness (W4).



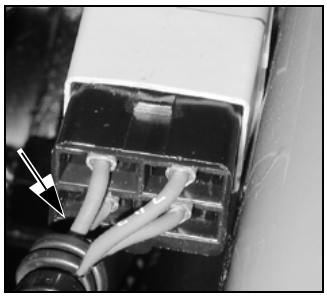
MX5658

(6) Checking both sides of the connector, is there continuity between 120 Blk wire on PTO solenoid connector (X22) and ground?

Yes - Replace PTO solenoid (Y1).

No - If continuity is only indicated on one side of the connector, repair or replace connector.

No - Replace main wiring harness (W4).

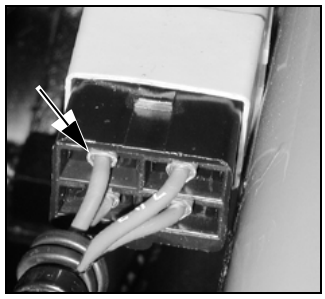


MX5655

(7) Is voltage present at 788 Pur wire on brake switch connector (X36)?

No - Go to next step.

Yes - Replace main wiring harness (W4).



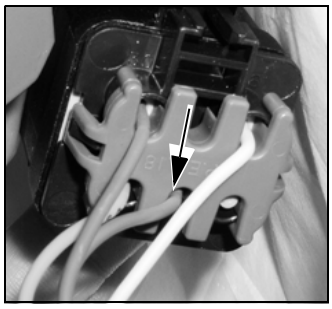
MX5655

(8) Is voltage present at Pur 700 Pur wire on brake switch connector (X36)?

No - Go to next step.

Yes - Check brake switch adjustment.

Yes - Test brake switch (S4). See “Brake Switch Test” on page 473.



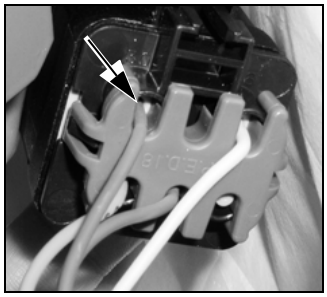
MX5659

(9) Using a small diameter probe inserted between wire and relay socket seal, is voltage present at terminal 87a, 700 Pur wire of PTO overtemp relay (K4)?

Yes - Go to next step.

No - Replace main wiring harness (W4).

System: Operator Presence and PTO Interlock Circuit Diagnosis - Diesel Engine: Test Procedure C

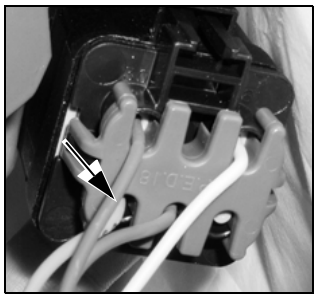


MX5659

(10) Using a small diameter probe inserted between wire and relay socket seal, is voltage present at terminal 30, 760 Pur wire of PTO overtemp relay (K4)?

Yes - Go to next step.

No - Go to step (12) to continue test.

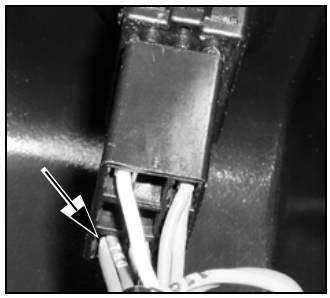


MX5659

(11) Is there continuity between terminal 85, 360 Org wire on PTO overtemp relay (K4) and ground?

Yes - Replace dual temp coolant switch (B1).

No - Replace PTO overtemp relay (K4).



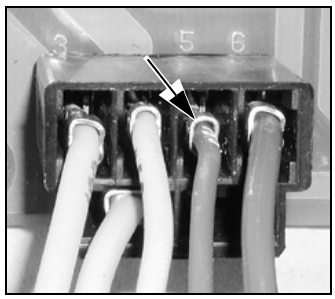
MX5656

(12) Is voltage present at 760/750 Pur wires on PTO switch (S3)?

No - Go to next step.

Yes - Replace main wiring harness (W4).

System: Operator Presence and PTO Interlock Circuit Diagnosis - Diesel Engine: Test Procedure C

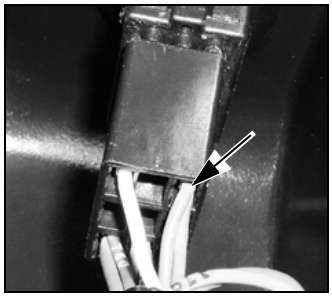


MX5650

(13) Is voltage present at terminal 5, 750 Pur wire of control module connector (X31)?

Yes - Replace main wiring harness (W4).

No - Replace control module (A1).

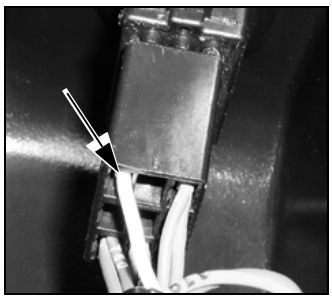


MX5656

(14) Is voltage present at 748,752 Pur wires on PTO switch (S3)?

No - Go to net step.

Yes - Replace main wiring harness (W4).



MX5656

(15) Is voltage present at 410 Yel wire on PTO switch (S3)?

Yes - Replace PTO switch (S3).

No - Replace main wiring harness (W4).

Engine Oil Pressure Light and Buzzer Circuit Operation

Function:

To warn the operator if the engine oil pressure drops below the safe operating level.

Operating Conditions:

- Key switch in RUN position.
- Engine RUNNING.

Theory of Operation:

The engine oil pressure light and buzzer circuit is controlled by engine oil pressure switch [(B5, gas) (B2, diesel)]. When engine oil pressure is below the safe operating level, the engine oil pressure switch will provide a path to ground for the engine oil pressure light [(H4), gas) (H5, diesel)] and buzzer [(H6), gas) (H7, diesel)]. Protection for the engine oil pressure light circuit is provided by fuse link (F2) and fuse (F3).

When key switch (S1) is in the RUN position and engine oil pressure is low, current flows from the positive (+) terminal of battery (G1), through fuse link (F2), through 240 Red wire to terminal B of the key switch.

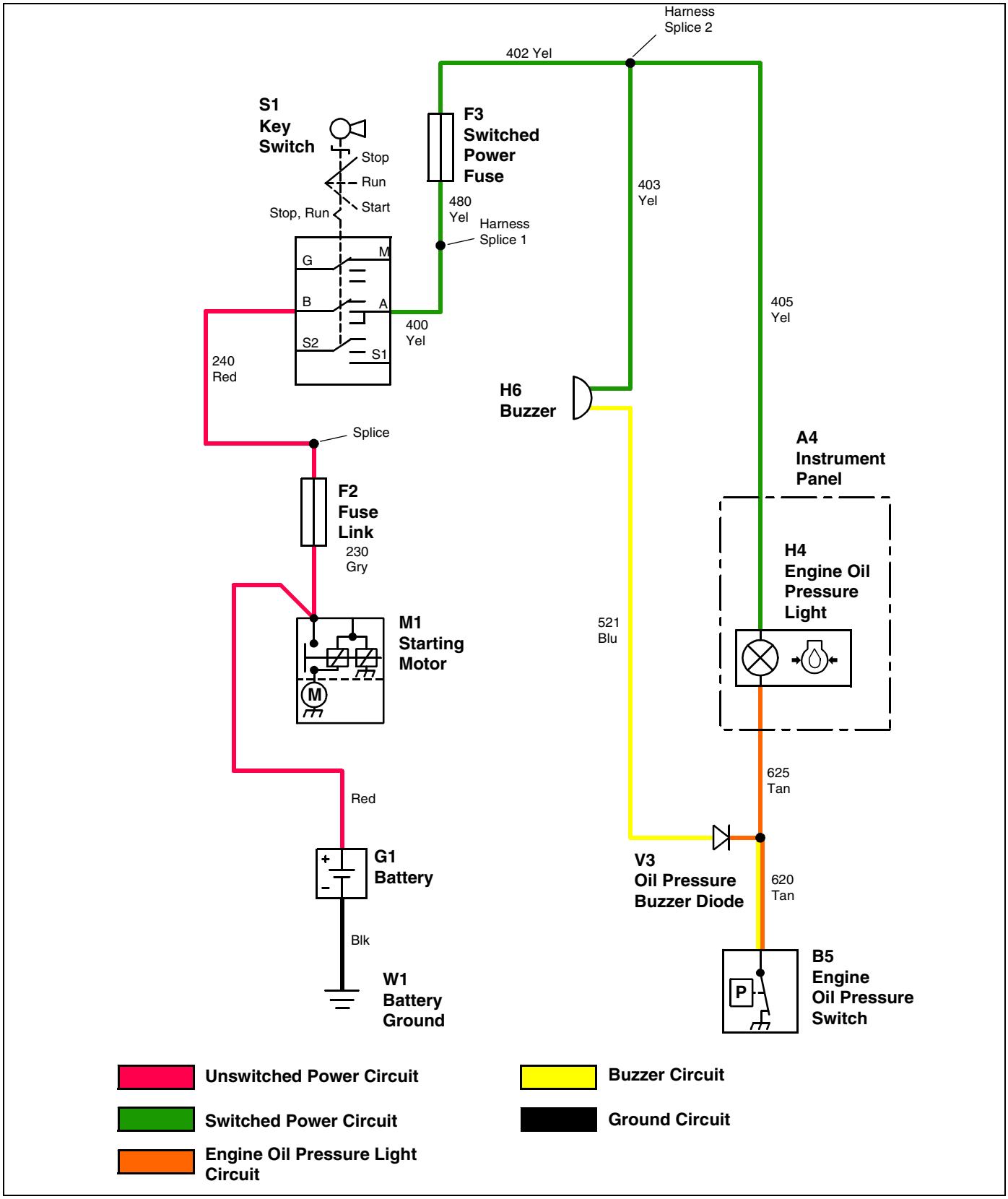
The current flows out terminal A of key switch (S1), through 400 and 480 Yel wires, to fuse (F3). From fuse (F3), current flows though 402 and 405 Yel wires, to engine oil pressure light [(H4, gas) (H5, diesel)]. The current flows though the engine oil pressure light, through 625 and 620 Tan wires, then through the closed contacts of engine oil pressure switch [(B5, gas) (B2, diesel)] to ground, causing the engine oil pressure light to come on.

Current from fuse (F3) also flows to buzzer [(H6, gas) (H7, diesel)] through 403 Yel wire. The current flows through the buzzer, through oil pressure buzzer diode (V3), through 521 Blu wire, then through engine oil pressure switch to ground, thus activating the buzzer.

When the engine oil pressure rises to a safe operating level, such as when the engine is initially started, the contacts of engine oil pressure switch open, causing the engine oil pressure light to go off and the buzzer to de-activate.

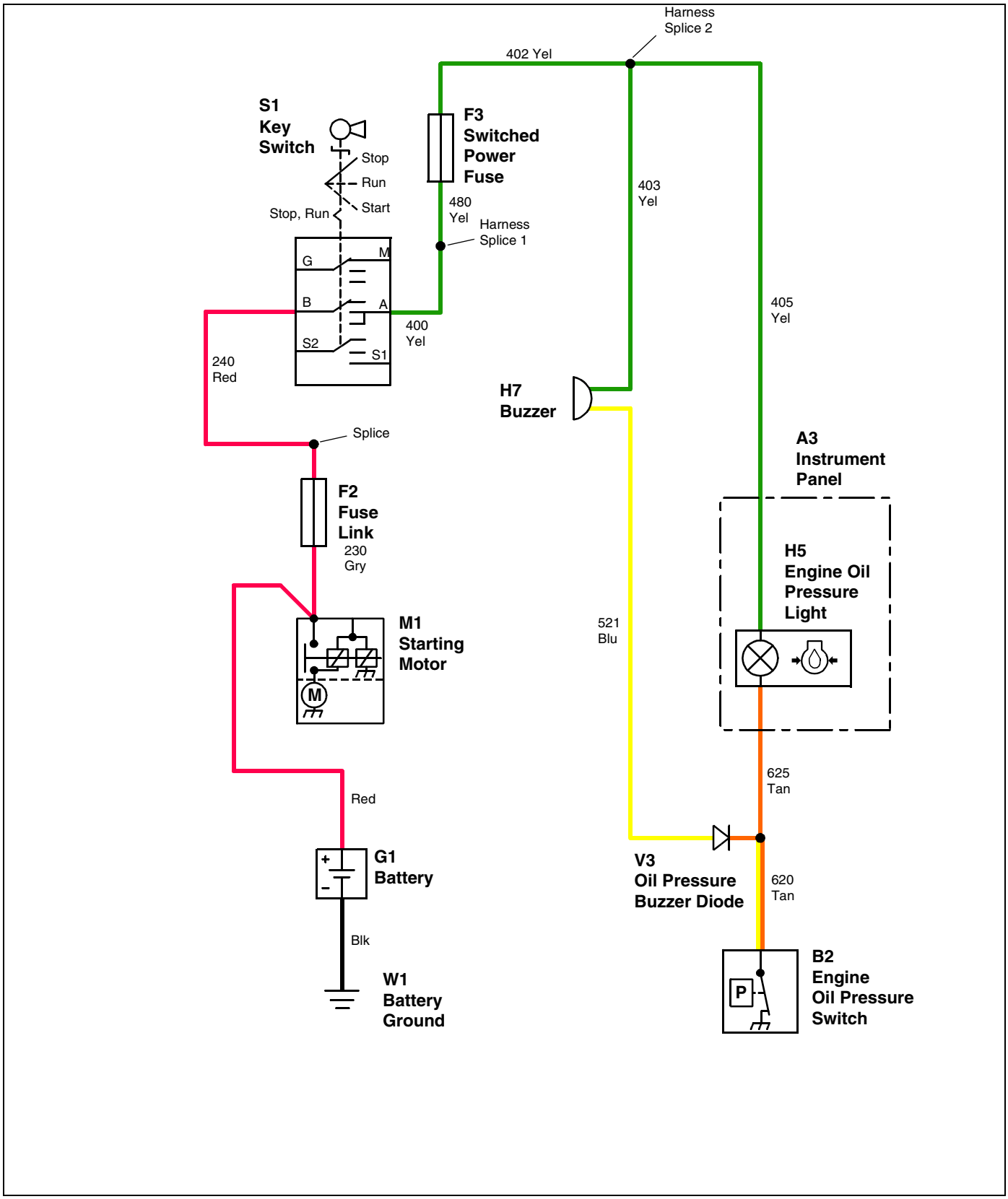
Engine Oil Pressure Light and Buzzer Circuit Schematic

Engine Oil Pressure Light and Buzzer Circuit Schematic - Gas Engine



MX5506

Engine Oil Pressure Light and Buzzer Circuit Schematic - Diesel Engine



MX5506

Engine Oil Pressure Light and Buzzer Circuit Diagnosis - Gas Engine

Test Procedure A

IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

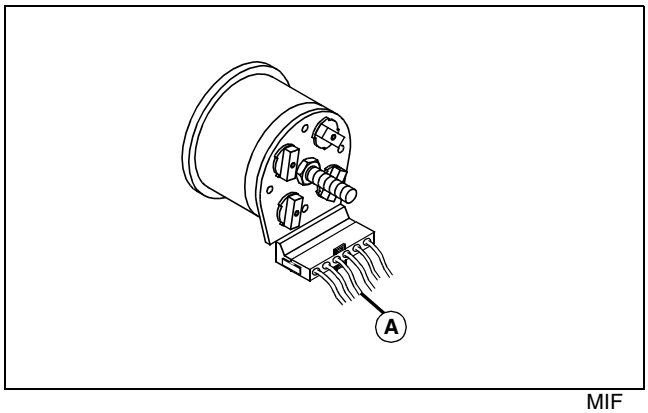
NOTE: A test light is the preferred method for testing circuits.

If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in the RUN position with engine OFF.
- Meter negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Engine Oil Pressure Light and Buzzer Circuit Diagnosis - Gas Engine



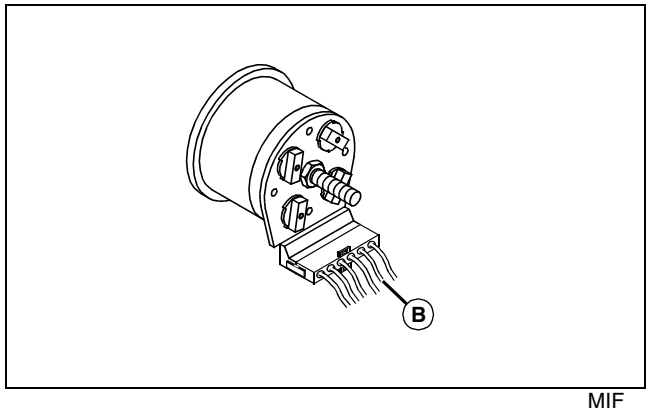
MIF

(1) Is the voltage between instrument panel (A4), connector (X1), terminal 3 and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Gas Engine” on page 347.

System: Engine Oil Pressure Light and Buzzer Circuit Diagnosis - Gas Engine



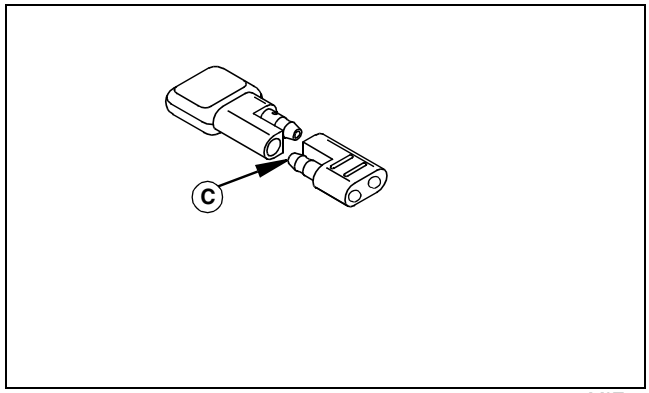
MIF

(2) After disconnecting engine oil pressure switch connector (X25) and removing engine oil pressure diode (V3), is the measured at instrument panel (A4), connector (X1), terminal 5 (B) 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check light bulbs in instrument panel (A4).

No - Replace instrument panel.



MIF

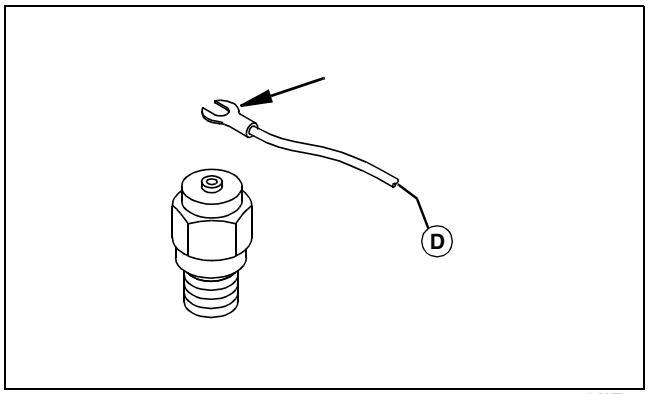
(3) Is the voltage between engine oil pressure buzzer diode (V3), connector (X6), male terminal (C) and ground 11.8 -13.2 VDC?

Yes - Go to next step.

No - Check 625 tan wire and connections.

No - Replace main wiring harness (W4).

System: Engine Oil Pressure Light and Buzzer Circuit Diagnosis - Gas Engine



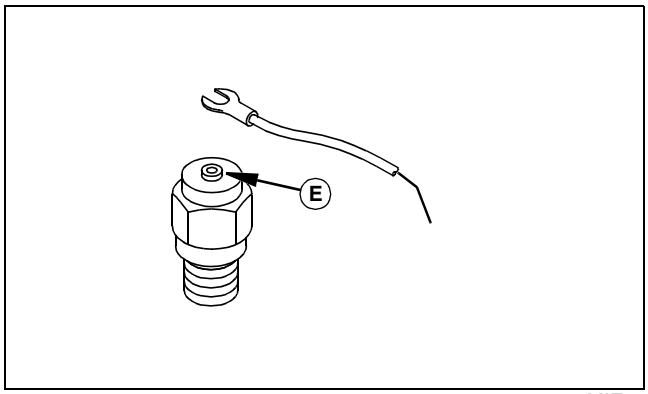
MIF

(4) After disconnecting engine oil pressure switch (B5), connector (X25), is the voltage measured at engine oil pressure switch connector (D) (X25) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 620 tan wire and connections.

No - Replace main wiring harness (W4).



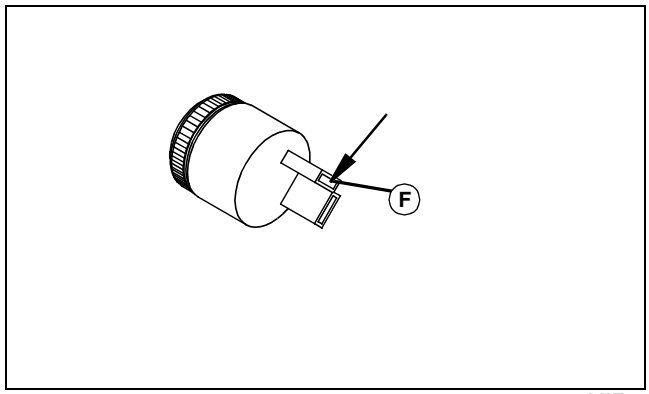
MIF

(5) Is the resistance between engine oil pressure switch (E) (B5) and ground o.1 ohms or less?

Yes - Go to next step.

No - Replace engine oil pressure switch (B5).

System: Engine Oil Pressure Light and Buzzer Circuit Diagnosis - Gas Engine



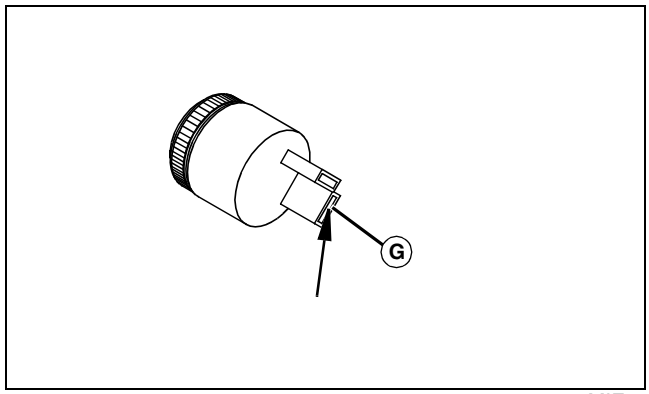
MIF

(6) After disconnecting buzzer (H6), connector (X11) and installing buzzer diode (V3), is the voltage between buzzer connector (X11), 403 Yel wire (F) and ground 11.8 - 13.2 VDC?

No - Go to next step.

No - Check 403 Yel wire and connections.

No - Replace main wiring harness (W4).



MIF

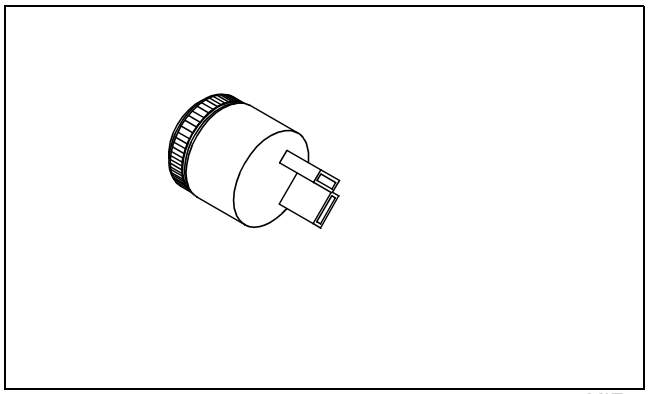
(7) After removing over temperature buzzer diode (V3) is the resistance between buzzer (H6), connector (X11), 521 Blu wire (G) and diode (V3), connector (X6), 0.8 ohms?

Yes - Go to next step.

No - If more than 0.8 ohms resistance, check 521 Blu wire and connections.

No - If wire tested good, test oil pressure buzzer diode (V3).

System: Engine Oil Pressure Light and Buzzer Circuit Diagnosis - Gas Engine



MIF

(8) After reconnecting buzzer connector (X11) to buzzer (H6) and installing buzzer diode (V3) does buzzer sound?

Yes - Replace buzzer (H6).

No - Test complete.

Engine Oil Pressure Light and Buzzer Circuit Diagnosis - Diesel Engine

IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: A test light is the preferred method for testing circuits.

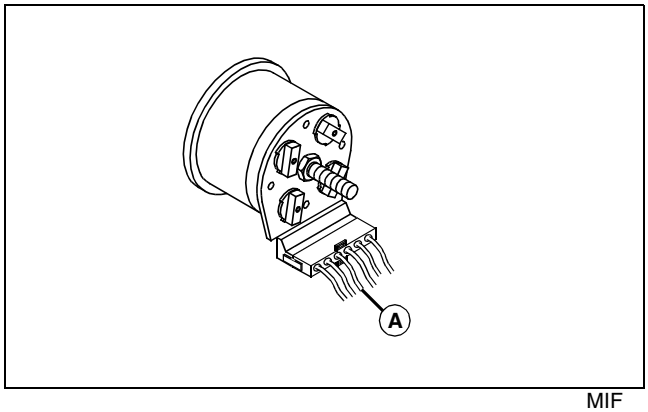
If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Procedure A

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- Meter negative (BLACK) lead on battery negative (-) terminal or chassis ground.

System: Engine Oil Pressure Light and Buzzer Circuit Diagnosis - Diesel Engine



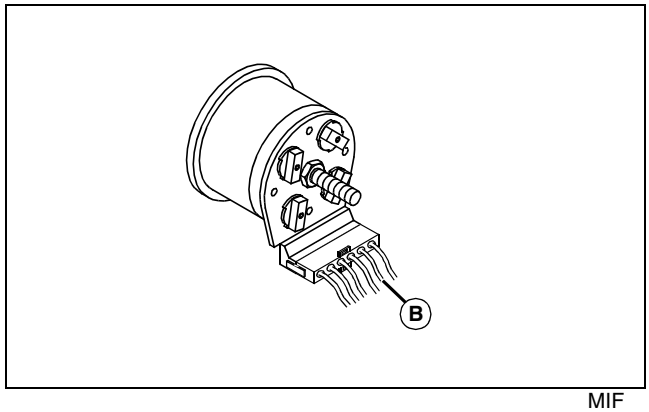
MIF

(1) Is the voltage between instrument panel (A4), connector (X1), terminal 3 and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.

System: Engine Oil Pressure Light and Buzzer Circuit Diagnosis - Diesel Engine



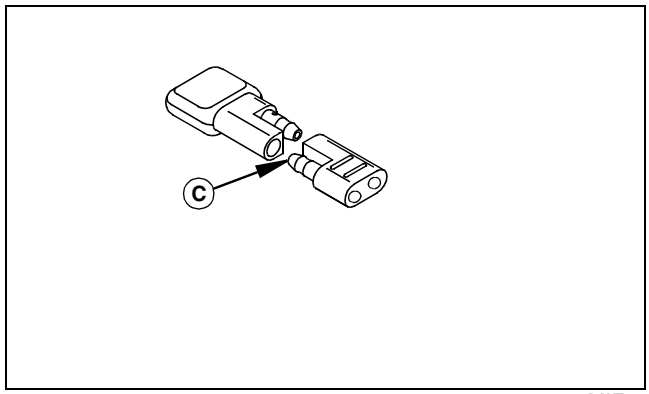
MIF

(2) After disconnecting engine oil pressure switch connector (X23) and removing engine oil pressure diode (V3), is the voltage measured at instrument panel (A3), connector (X1), terminal 5 (B) 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check light bulbs in instrument panel (A3).

No - Replace instrument panel.



MIF

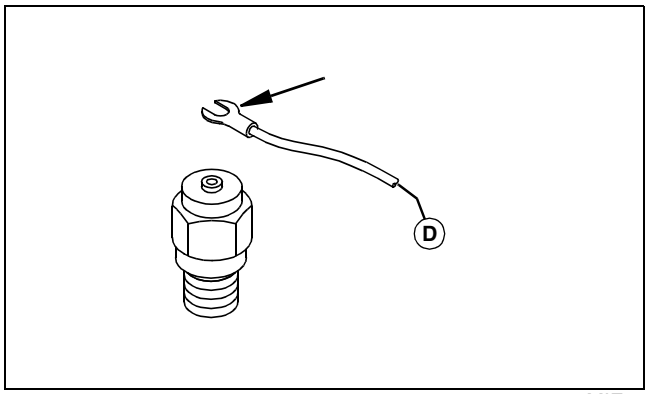
(3) Is the voltage between engine oil pressure buzzer diode (V3), connector (X6), male terminal (C) and ground 11.8 -13.2 VDC?

Yes - Go to next step.

No - Check 625 tan wire and connections.

No - Replace main wiring harness (W4).

System: Engine Oil Pressure Light and Buzzer Circuit Diagnosis - Diesel Engine



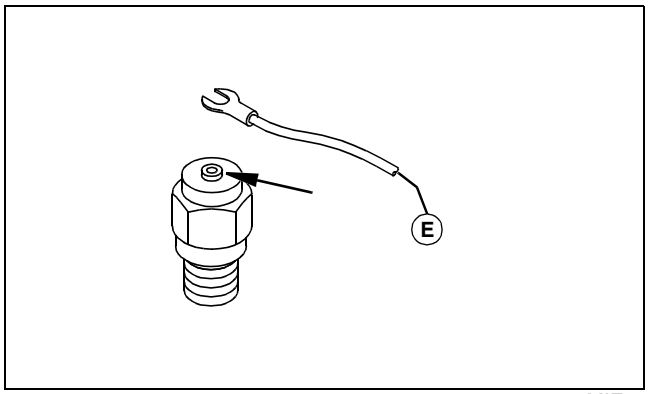
MIF

(4) After disconnecting engine oil pressure switch (B2), connector (X23), is the voltage measured at engine oil pressure switch connector (D) (X23) and ground 11.8 - 13.2 VDC?

Yes - Go to next step.

No - Check 620 tan wire and connections.

No - Replace main wiring harness (W4).



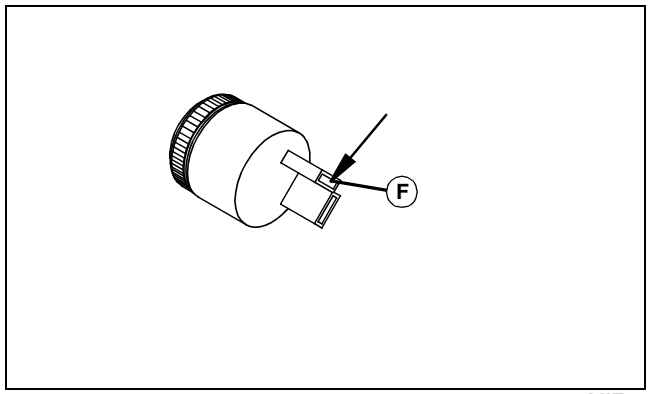
MIF

(5) Is the resistance between engine oil pressure switch (E) (B2) and ground o.1 ohms or less?

Yes - Go to next step.

No - Replace engine oil pressure switch (B2).

System: Engine Oil Pressure Light and Buzzer Circuit Diagnosis - Diesel Engine



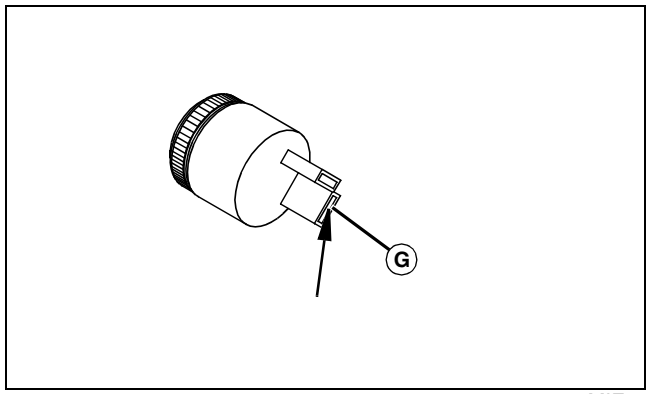
MIF

(6) After disconnecting buzzer (H7), connector (X11) and installing buzzer diode (V3), is the voltage between buzzer connector (X11), 403 Yel wire (F) and ground 11.8 - 13.2 VDC?

No - Go to next step.

No - Check 403 Yel wire and connections.

No - Replace main wiring harness (W4).



MIF

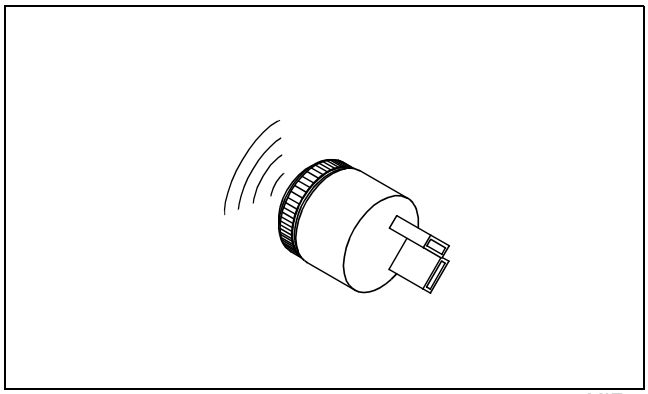
(7) After removing over temperature buzzer diode (V3) is the resistance between buzzer (H7), connector (X11), 521 Blu wire (G) and diode (V3), connector (X6), 0.8 ohms?

Yes - Go to next step.

No - If more than 0.8 ohms resistance, check 521 Blu wire and connections.

No - If wire tested good, test oil pressure buzzer diode (V3).

System: Engine Oil Pressure Light and Buzzer Circuit Diagnosis - Diesel Engine



MIF

(8) After reconnecting buzzer connector (X11) to buzzer (H7) and installing buzzer diode (V3) does buzzer sound?

Yes - Replace buzzer (H7).

No - Test complete.

Coolant Temperature Light and Buzzer Circuit Operation

Function:

To warn the operator if the engine coolant temperature exceeds the safe operating level.

Operating Conditions:

- Key switch in RUN position.
- Engine RUNNING.
- Engine coolant temperature greater than 110°C (230°F).

Theory of Operation:

The engine coolant temperature light circuit is controlled by dual temp coolant switch [(B4, gas) (B1, diesel)]. The switch is located in the base of the engine thermostat housing where it senses the engine coolant temperature.

Protection for the engine coolant temperature light circuit is provided by fuse link (F2) and 15-amp switched power fuse (F3).

When key switch (S1) is at the RUN position and engine coolant temperature exceeds 110°C (230°F), current flows from the positive (+) terminal of battery (G1), through fuse link (F2), 240 Red wire, then to terminal B of the key switch.

The current flows out terminal A of the key switch, through 400 Yel and 480 Yel wires, to switched power fuse (F3). From fuse (F3), current flows through 402 Yel and 401 Yel wires, to the dual temp coolant switch, thus providing power for the solid state switch.

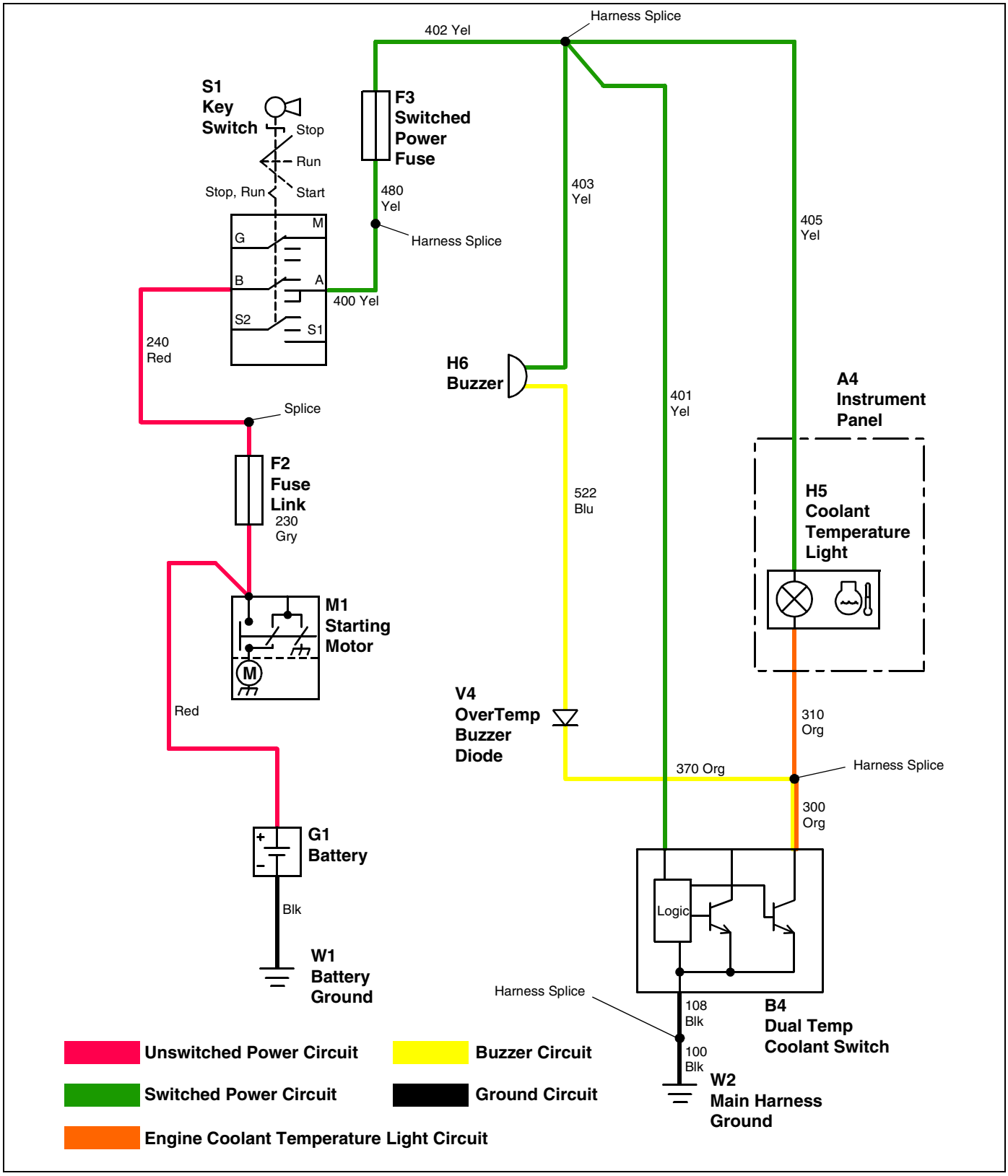
Current from fuse (F3), also flows through 402 Yel and 405 Yel wires, to coolant temperature light [(H5, gas) (H6, diesel)]. The current flows through the coolant temperature light, through 310 Org and 300 Org wires, then through the circuitry of the dual temp coolant switch to ground, thus causing the coolant temperature light to come on.

Current from switched power fuse (F3) also flows to buzzer [(H6, gas) (H7, diesel)] through 403 Yel wire. The current flows through the buzzer, through overtemp buzzer diode (V4), through 522 Blu and 300 Org wires, through the circuitry of the dual temp coolant switch, then to ground, thus activating the buzzer.

When the engine coolant temperature decreases to 100°C (212°F), the dual temp coolant switch stops current flow, causing the engine coolant temperature light to go off and the buzzer to de-activate.

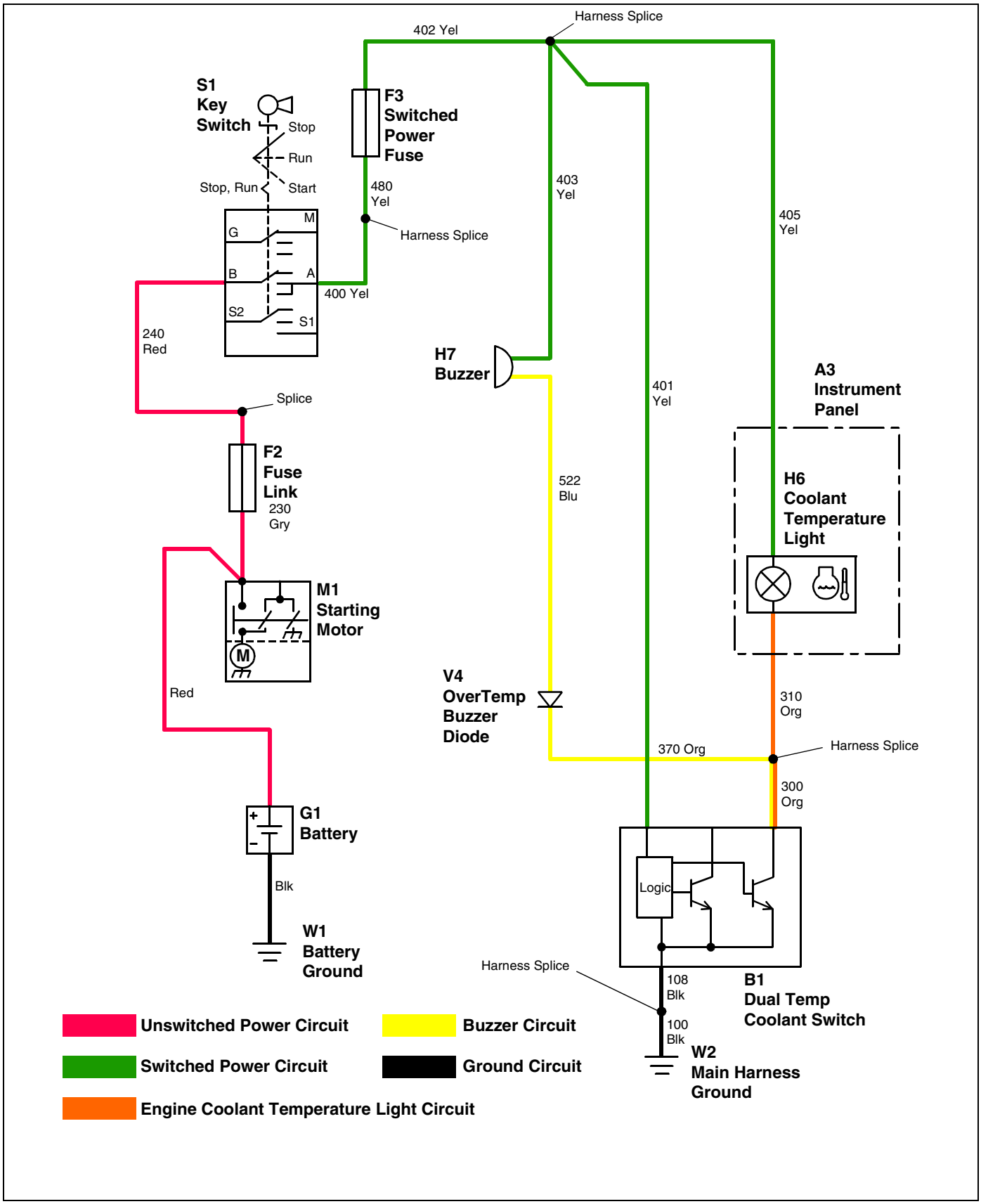
Coolant Temperature Light and Buzzer Circuit Schematic

Coolant Temperature Light and Buzzer Circuit Schematic - Gas Engine



MIF MX5508

Coolant Temperature Light and Buzzer Circuit Schematic - Diesel Engine



MIF MX5507

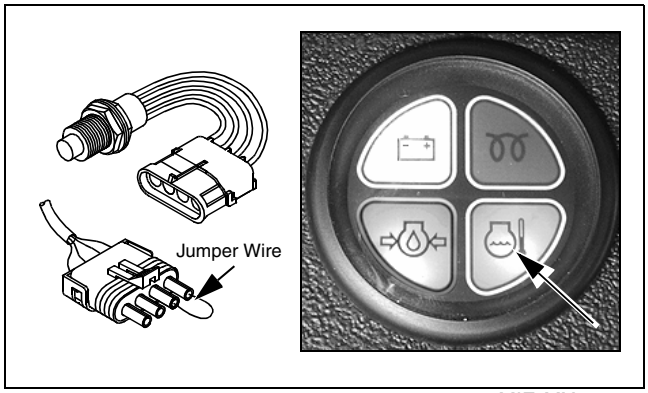
Coolant Temperature Light and Buzzer Circuit Diagnosis - Gas Engine

Test Procedure A

Test Conditions:

- Machine parked safely.
- Dual temp coolant switch connector (X19) DISCONNECTED.
- Engine oil pressure buzzer diode (V3) DISCONNECTED.
- Key switch in RUN position.

System: Coolant Temperature Light And Buzzer Circuit Diagnosis - Gas Engine: Test Procedure A



MIF, MX5505

(1) After installing a jumper wire between terminals C, 300 Org wire and D, 108 Blk wire of temp coolant switch connector (X19) harness side, are the coolant temperature light (H5) and buzzer (H6) activated?

Yes - Go to step (5). (Test procedure C)

No - If the indicator light is not on and the buzzer is not activated: Go to step (1) to continue test. (Test procedure B)

No - If the indicator light is on and buzzer is not activated: Go to step (2) to continue test. (Test procedure B)

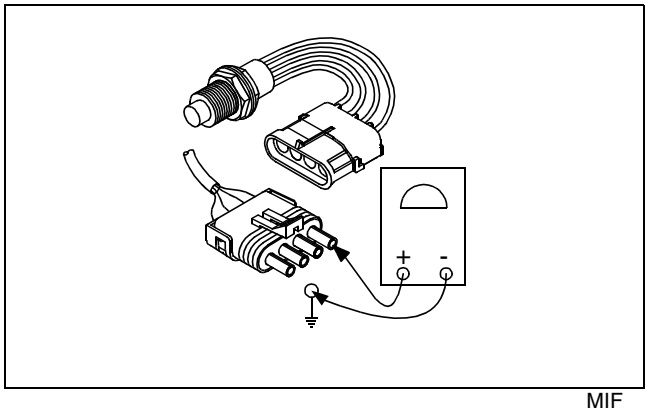
No - If the indicator is not on and the buzzer is activated: Go to step (1) to continue test. (Test procedure C)

Test Procedure B

Test Conditions:

- Machine parked safely.
- Key switch in STOP position.
- Dual temp coolant switch connector (X19) disconnected.
- Over temperature buzzer diode (V4) DISCONNECTED.

System: Coolant Temperature Light and Buzzer Circuit Diagnosis - Gas Engine: Test Procedure B



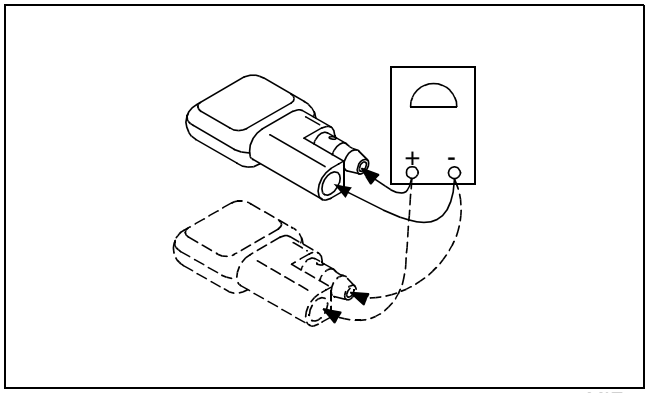
MIF

(1) Is there continuity between terminal D of dual temp coolant switch connector (X19) harness side and ground?

Yes - Replace main wiring harness.

No - Check ground connection (W2).

No - Replace main wiring harness (W4).



MIF

(2) Is there continuity, in one direction only, between terminals of overtemp buzzer diode (V4)?

Yes - Test complete.

System: Coolant Temperature Light and Buzzer Circuit Diagnosis - Gas Engine: Test Procedure B

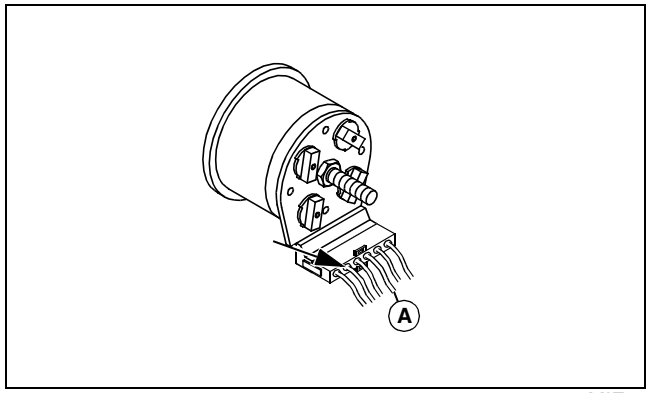
Yes - If continuity is indicated in both directions or not at all, replace diode.

Test Procedure C

Test Conditions:

- Machine parked safely.
- Key switch in RUN position.
- Dual temp coolant switch connector (X19) disconnected.
- Over temperature buzzer diode (V4) DISCONNECTED.

System: Coolant Temperature Light and Buzzer Circuit Diagnosis - Gas Engine: Test Procedure C



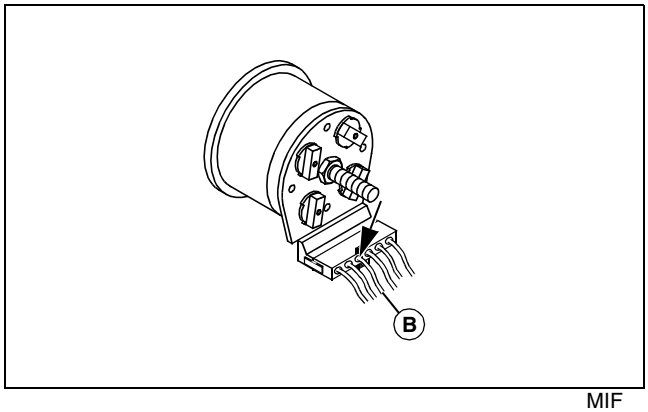
MIF

(1) Is the voltage measured between terminal 2 (A) of instrument panel connector (X1) and ground 11.8 - 13.2 VDC?

Yes - Replace main wiring harness (W4).

No - Go to next step.

System: Coolant Temperature Light and Buzzer Circuit Diagnosis - Gas Engine: Test Procedure C



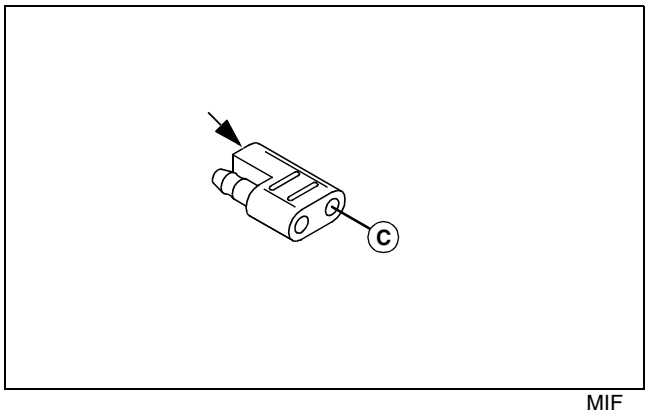
MIF

(2) Is the voltage between terminal 3 (B) of instrument panel connector (X1) 11.8 -13.2 VDC?

Yes - Check indicator bulb (H5).

Yes - Replace instrument panel (A4).

No - Check power circuit.



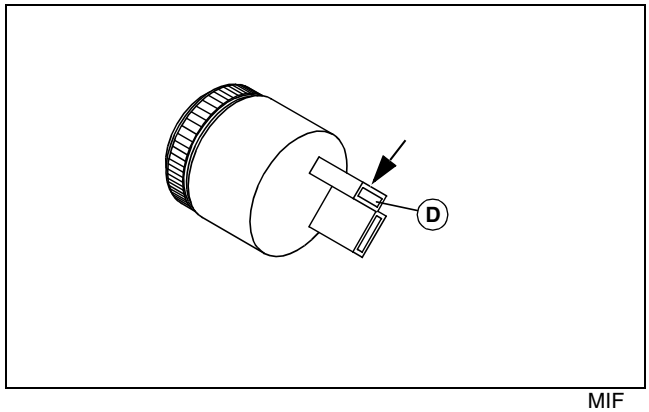
MIF

(3) Is voltage present between 522 Blu wire (female terminal) (C) of overtemp buzzer diode connector (X7) and ground?

No - Go to next step.

Yes - Replace main wiring harness (W4).

System: Coolant Temperature Light and Buzzer Circuit Diagnosis - Gas Engine: Test Procedure C

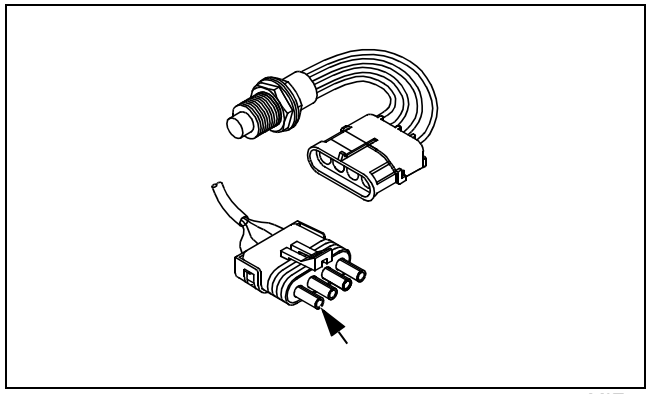


MIF

(4) Is voltage present across 403 Yel wire (D) terminal of buzzer connector (X11) and ground?

Yes - Replace buzzer (H6).

No - Check power circuit.



MIF

(5) Is voltage present at terminal A, 401 Yel wire of dual temp coolant switch connector (X19) harness side and ground?

Yes - Replace dual temp coolant switch (B2).

No - Check power circuit.

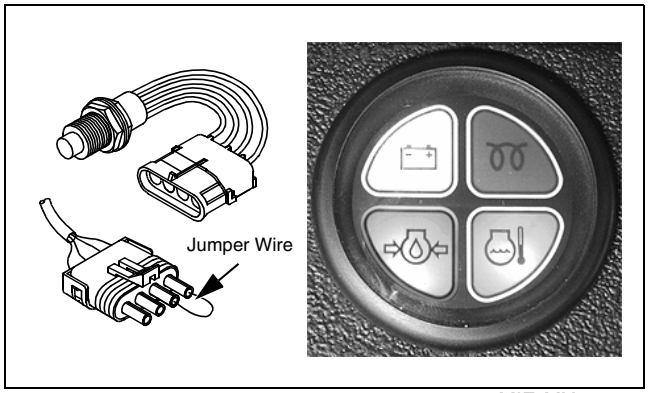
Coolant Temperature Light and Buzzer Circuit Diagnosis - Diesel Engine

Test Procedure A

Test Conditions:

- Machine parked safely.
- Dual temp coolant switch connector (X21) DISCONNECTED.
- Engine oil pressure buzzer diode (V3) DISCONNECTED.
- Key switch in RUN position.

System: Coolant Temperature Light And Buzzer Circuit Diagnosis - Diesel Engine: Test Procedure A



MIF, MX5505

(1) After installing a jumper wire between terminals C, 300 Org wire and D, 108 Blk wire of temp coolant switch connector (X21) harness side, are the coolant temperature light (H6) and buzzer (H7) activated?

Yes - Go to step (5). (Test procedure C)

No - If the indicator light is not on and the buzzer is not activated: Go to step (1) to continue test. (Test procedure B)

No - If the indicator light is on and buzzer is not activated: Go to step (2) to continue test. (Test procedure B)

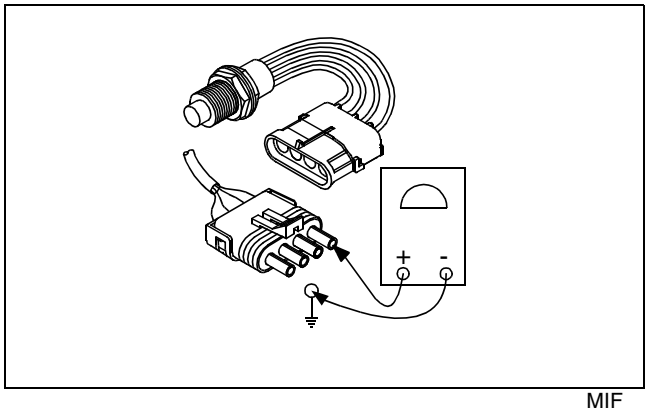
No - If the indicator is not on and the buzzer is activated: Go to step (1) to continue test. (Test procedure C)

Test Procedure B

Test Conditions:

- Machine parked safely.
- Key switch in STOP position.
- Dual temp coolant switch connector (X21) DISCONNECTED.
- Over temperature buzzer diode (V4) DISCONNECTED.

System: Coolant Temperature Light and Buzzer Circuit Diagnosis - Diesel Engine: Test Procedure B



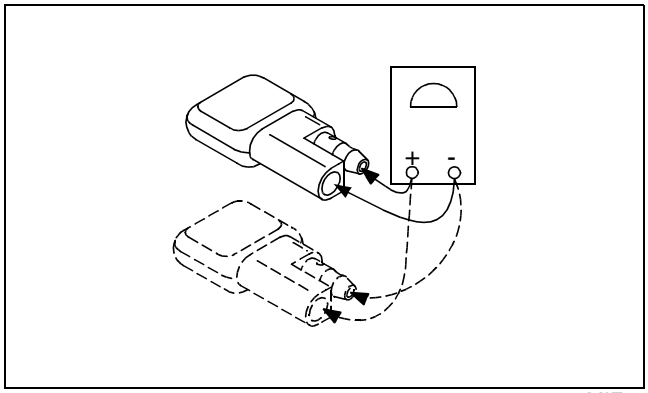
MIF

(1) Is there continuity between terminal D of dual temp coolant switch connector (X21) harness side and ground?

Yes - Replace main wiring harness.

No - Check ground connection (W2).

No - Replace main wiring harness (W4).



MIF

(2) Is there continuity, in one direction only, between terminals of overtemp buzzer diode (V4)?

Yes - Test complete.

System: Coolant Temperature Light and Buzzer Circuit Diagnosis - Diesel Engine: Test Procedure B

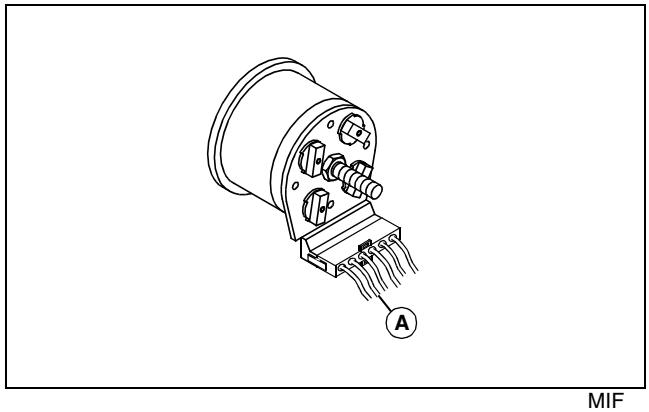
Yes - If continuity is indicated in both directions or not at all, replace diode.

Test Procedure C

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- Dual temp coolant switch connector (X21) DISCONNECTED.
- Over temperature buzzer diode (V4) DISCONNECTED.

System: Coolant Temperature Light and Buzzer Circuit Diagnosis - Diesel Engine: Test Procedure C



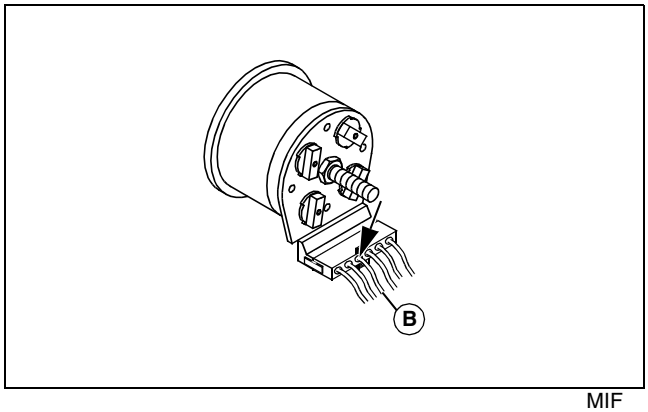
MIF

(1) Is the voltage measured between terminal 2 of instrument panel connector (X1) and ground 11.8 - 13.2 VDC?

Yes - Replace main wiring harness (W4).

No - Go to next step.

System: Coolant Temperature Light and Buzzer Circuit Diagnosis - Diesel Engine: Test Procedure C



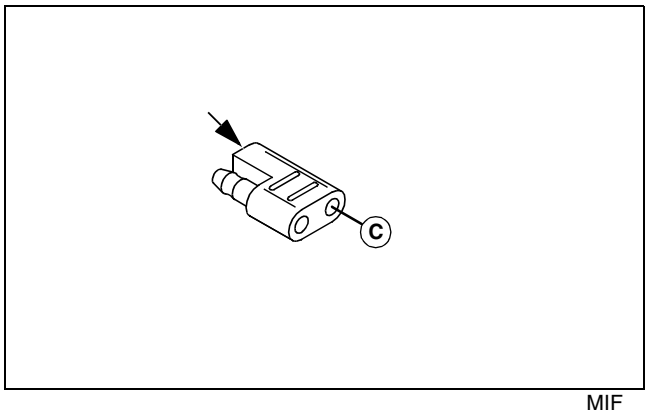
MIF

(2) Is the voltage between terminal 3 (B) of instrument panel connector (X1) 11.8 -13.2 VDC?

Yes - Check indicator bulb (H6).

Yes - Replace instrument panel (A3).

No - Check power circuit.



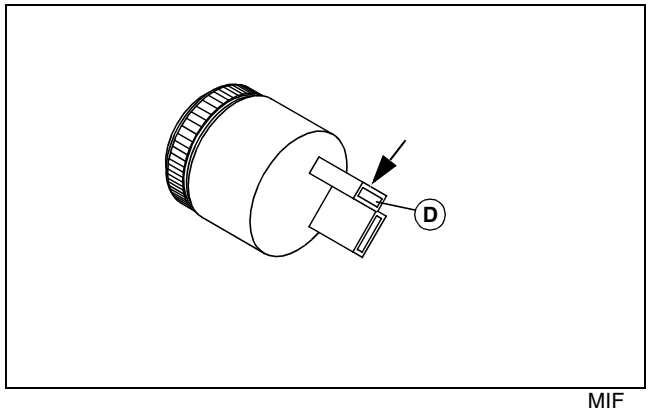
MIF

(3) Is voltage present between 522 Blu wire (C) (female terminal) or overtemp buzzer diode connector (X7) and ground?

No - Go to next step.

Yes - Replace main wiring harness (W4).

System: Coolant Temperature Light and Buzzer Circuit Diagnosis - Diesel Engine: Test Procedure C

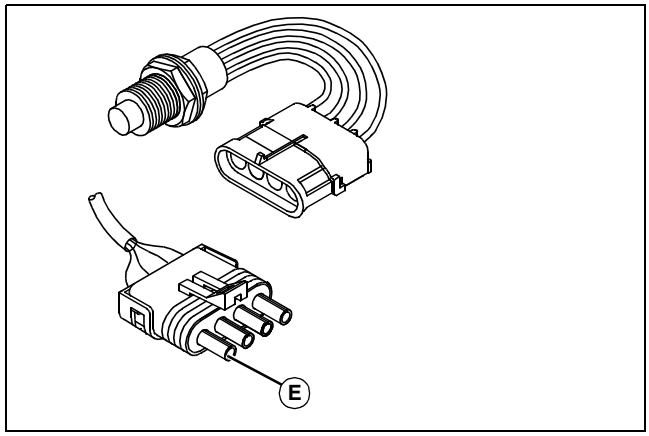


MIF

(4) Is voltage present across 403 Yel wire (D) terminal of buzzer connector (X11) and ground?

Yes - Replace buzzer (H6).

No - Check power circuit.



MIF

(5) Is voltage present at terminal A, 401 Yel wire (E) of dual temp coolant switch connector (X21) harness side and ground?

Yes - Replace dual temp coolant switch (B2).

No - Check power circuit.

Air Preheater Circuit Operation - Diesel Engine

Function:

To preheat the air entering the engine air intake manifold to make starting easier during cold operation conditions.

Operating Conditions:

- Key switch in RUN position.

Theory of Operation:

Protection for engine air preheater circuit is provided by fuse links (F1 and F2) and 15-amp switched power fuse (F3).

NOTE: Fuse (F3) is located on control module (A1).

Turning key switch (S1) to the RUN or start position allows current from the positive (+) terminal of battery (G1) to flow through fuse link (F2), 240 Red wire, then to terminal B of the key switch. The current flows out terminal A of the key switch, through 400 Yel and 480 Yel wires, to switched power fuse (F3).

From fuse (F3), current flows through 402 Yel wire to a harness splice. From the harness splice, current flows through the following:

- 406 Yel wire to terminal A of the diesel engine control module (A2), to provide power for the control module.
- 405 Yel wire to wait light (H4) located on instrument panel (A3). From the wait light, current flows through 330 Grn wire to terminal F of the diesel engine control module. Initially, the control module allows the current to flow to ground, which causes the wait light to come on.
- 409 Yel wire to the coil of air preheater relay (K6). The current flows through the relay, through 350 Org wire, to terminal E of the diesel engine control module. Initially, the control module allows the current to flow to ground, thus energizing the air preheater relay.

With the air preheater relay energized, unswitched battery current from fuse link (F2) is allowed to flow across the relay contacts to air preheater (E1).

At the same time, current from fuse (F3) flows to hold-in relay (K2). When the operator presence or PTO interlock circuits energize the hold-in relay, current from fuse (F3) is allowed to flow across the contacts of the hold-in relay, through 640 Grn and 630 Grn wires, to terminal C of the diesel engine control module.

NOTE: For information on how the hold-in circuit operates, see Operator Presence and PTO Interlock Circuit Operation in this group.

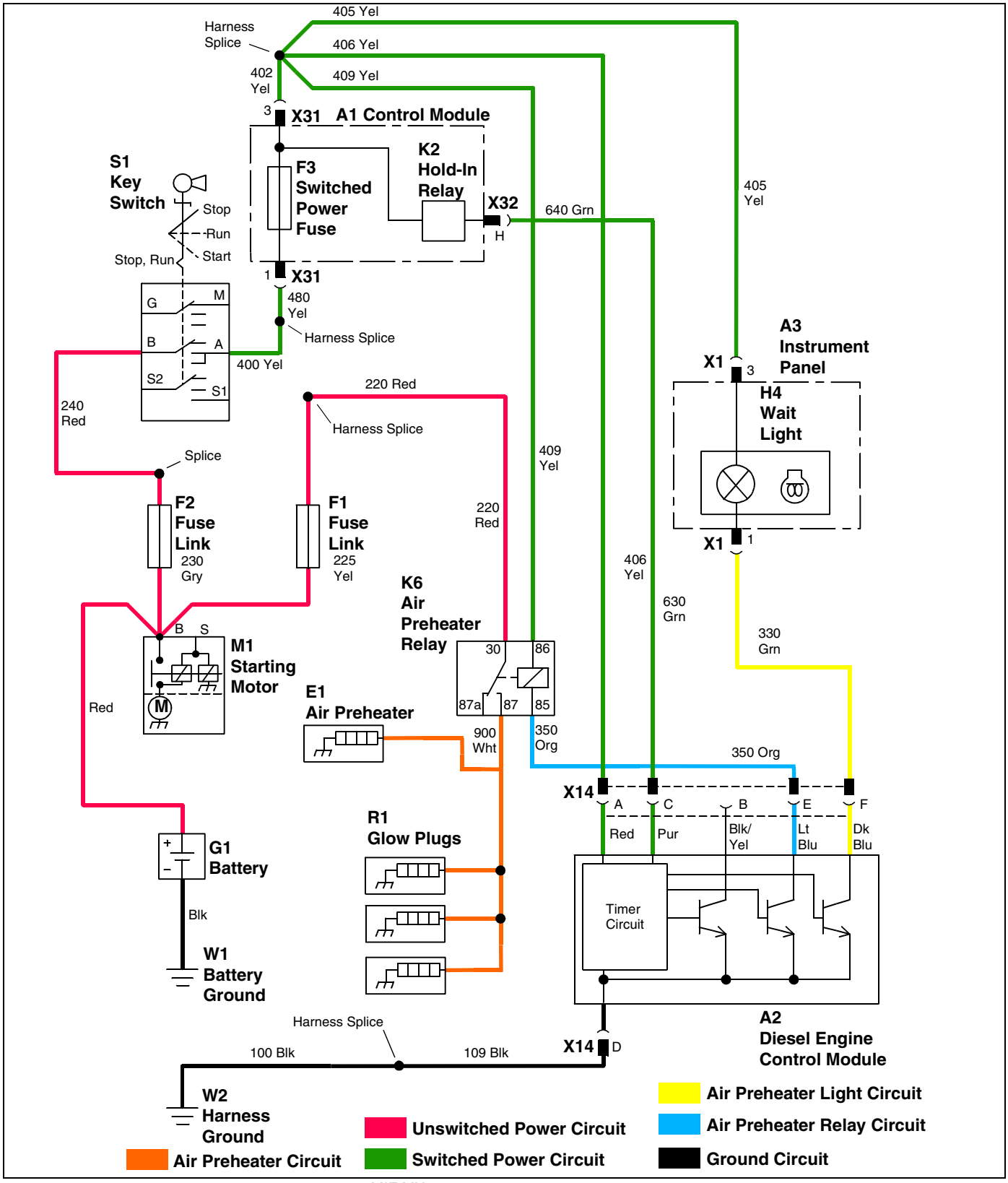
Hold-in relay (K2) is located on control module (A1).

Current at terminal C of the diesel engine control module enables a timer circuit within the control module. After approximately 16 seconds has elapsed from the time current began to flow to terminal C, the control module will break the path to ground causing the wait light to go off. The moment the wait light goes off indicates the minimum amount of time has elapsed to allow the engine intake air temperature to rise sufficiently for engine start-up.

After approximately 32 seconds has elapsed from the time current began to flow to terminal C, the control module will break the air preheater relay's path to ground, causing the relay to de-energize and stop current flowing to the air preheater.

Air Preheater Circuit Schematic - Diesel Engine

Air Preheater Circuit Schematic - Diesel Engine



MIF MX5510

Air Preheater/Glow Plug Circuit Diagnosis - Diesel Engine

Front Mower

1435

1445

1545

IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

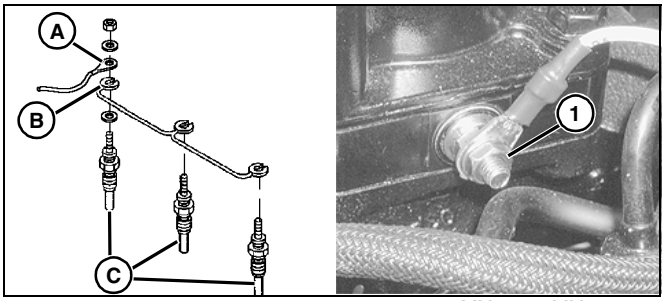
Test Conditions:

- Machine parked safely.
- Key switch in RUN position[1, 2] with engine OFF.
- Park brake LOCKED.
- PTO switch at the DISENGAGED position.
- Meter or test light negative (BLACK) lead on battery negative (-) terminal or chassis ground.

1. Voltage will only be present at terminal (A) for approximately 32 seconds from the moment the key switch is turned to the RUN position.

2. Wait light (H4) will only be on for approximately 16 seconds from the moment the key switch is turned to the RUN position.

System: Air Preheater/Glow Plug Circuit Diagnosis - Diesel



MX5681, MX5282

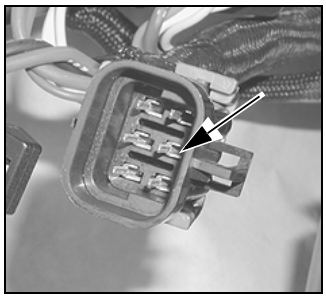
(1) Is the voltage[1] at (E1), 900 Wht wire (A) for model 1445 (B) or at each glow plug[2] (C) on model 1435 11.8 - 13.2 VDC?

Yes - Ensure that wait light (H4), 1435 only, goes off after approximately 20 seconds or if voltage is present at terminal (A) after 40 seconds, 1445 only, replace diesel control module.

System: Air Preheater/Glow Plug Circuit Diagnosis - Diesel

No - Model 1435 only: If battery voltage is at terminal (A) but not at the other glow plugs, replace glow plug wiring harness (B).

No - Model 1435 only: If wait light (H4) does not come on, “After connecting a jumper wire between terminal F, 330 Grn wire at diesel engine control module connector (X14) and ground, does wait light (H4) come on?” on page 422.

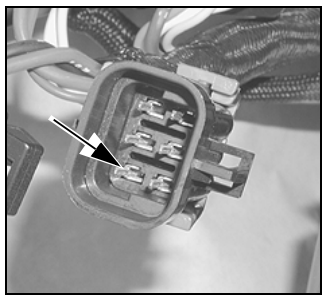


MX5683

(2) After disconnecting diesel engine control module connector (X14) and connecting a jumper between terminal E and ground, measure for voltage at preheater/glow plug terminal, 900 Wht wire.

Yes - Go to next step.

No - Go to step (7) to continue test.



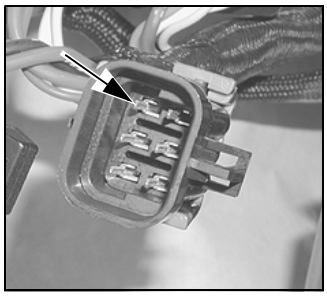
MX5683

(3) Is voltage present between terminal C, 630 Grn, of diesel engine control module connector (X14) and ground?

Yes - Go to next step.

No - Go to step (13) to continue test.

System: Air Preheater/Glow Plug Circuit Diagnosis - Diesel

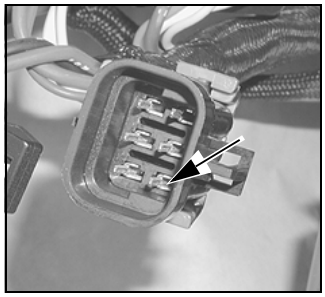


MX5683

(4) Is voltage present at terminal A, 406 Yel wire of diesel engine control module connector (X14) and ground?

Yes - Go to next step.

No - Go to step (11) to continue test.

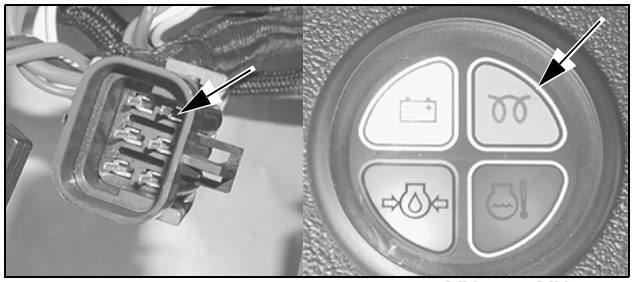


MX5683

(5) Is continuity present between terminal D, 109 Blk wire of diesel engine control module connector (X14) and ground?

Yes - Replace diesel engine control module (A2).

No - Replace main wiring harness (W4).



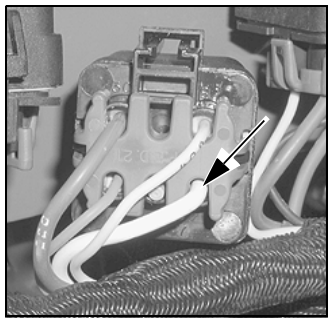
MX5683, MX5687

(6) After connecting a jumper wire between terminal F, 330 Grn wire at diesel engine control module connector (X14) and ground, does wait light (H4) come on?

Yes - Disconnect jumper wire and: Go to step (5).

No - Go to step (15) to continue test.

System: Air Preheater/Glow Plug Circuit Diagnosis - Diesel

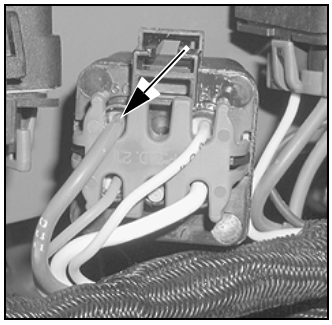


MX5684

(7) Insert a small diameter probe between wire and relay socket seal at terminal 87 (900 Wht wire) of air preheater relay (K6). Is battery voltage present?

No - Go to next step.

Yes - Replace main wiring harness (W4).

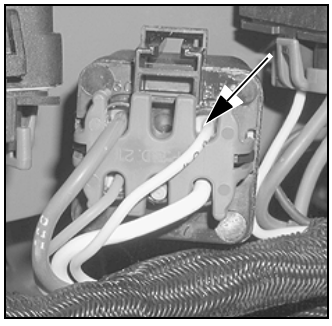


MX5684

(8) Insert a small diameter probe between wire and relay socket seal at terminal 30 (220 Red wire) of air preheater relay (K6). Is battery voltage present?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.



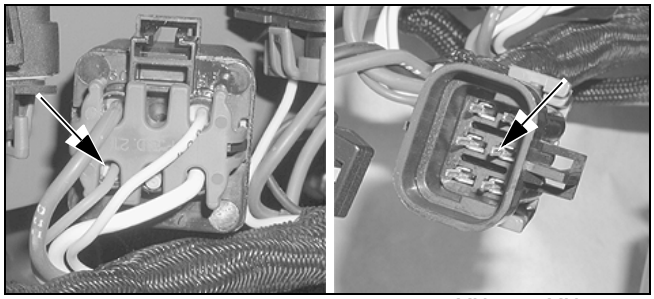
MX5684

(9) Insert a small diameter probe between wire and relay socket seal at terminal 86 (409 Yel wire) of air preheater relay (K6). Is battery voltage present?

Yes - Go to next step.

System: Air Preheater/Glow Plug Circuit Diagnosis - Diesel

No - Go to step (11) to continue test.

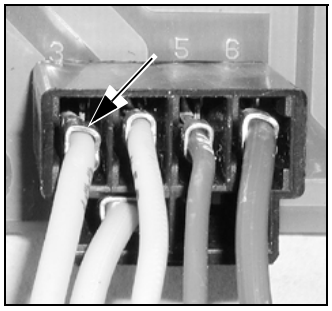


MX5684, MX5683

(10) Is continuity present between terminal 85, 350 Org wire of air preheater relay (K6) and terminal E of diesel engine control module connector (X14)?

Yes - Test air preheater relay (K6).

No - Replace main wiring harness (W4).

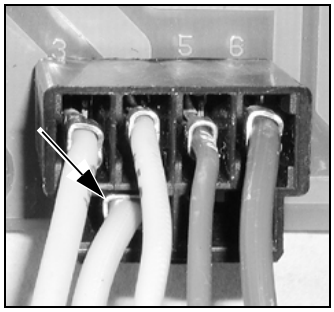


MX5650

(11) Is voltage present at terminal 3, 402 Yel wire of control module connector (X31)?

Yes - Replace main wiring harness (W4).

No - Go to step (12) to continue test.



MX5650

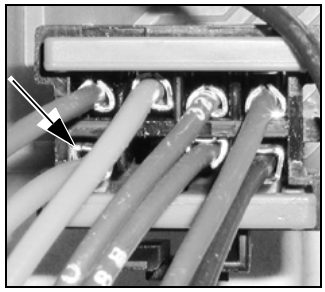
(12) Is voltage present at terminal 1, 480 Yel of control module connector (31)?

Yes - Check fuse (F3).

Yes - Replace control module.

System: Air Preheater/Glow Plug Circuit Diagnosis - Diesel

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.

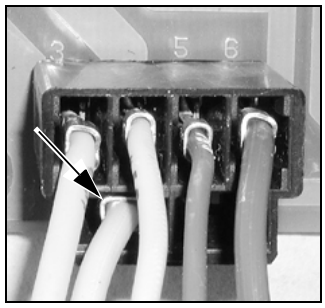


MX5651

(13) Is voltage present at terminal H, 640 Grn wire of control module connector (X32)?

No - Go to next step.

Yes - Replace main wiring harness (W4).



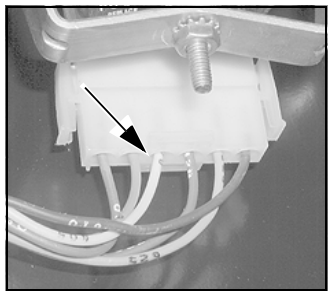
MX5650

(14) Is voltage present at terminal 1, 480 Yel wire of control module connector (X31)?

Yes - Check fuse (F3).

Yes - See “Operator Presence and PTO Interlock Circuit Diagnosis - Diesel Engine” on page 387.

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.



MX5685

(15) Is voltage present at terminal 3, 405 Yel wire of instrument panel connector (X1)?

No - Go to step (12) to continue test.

System: Air Preheater/Glow Plug Circuit Diagnosis - Diesel

Yes - Go to next step.



MX5686, MX5683

(16) Does continuity exist between terminal 1, 330 Grn wire of instrument panel connector (X1) and terminal F of diesel engine control module connector (X14)?

Yes - Check wait light (H4) bulb.

Yes - Replace instrument panel.

No - replace main wiring harness (W4).

Hour Meter Circuit Operation

Function:

To record the number of hours the engine has been operating (hold-in relay coil or ignition energized).

Operating Conditions:

- Key switch in RUN or start position.
- Operator on seat, or park brake LOCKED and PTO DISENGAGED.

Theory of Operation:

The hour meter gets its power from the hold-in circuit. For information on how the hold-in circuit operates, see “Operator Presence and PTO Interlock Circuit Operation - Gas Engine” on page 372 or “Operator Presence and PTO Interlock Circuit Operation - Diesel Engine” on page 376.

Protection for the hour meter circuit is provided by fuse link (F2) and 15-amp switched power fuse (F3).

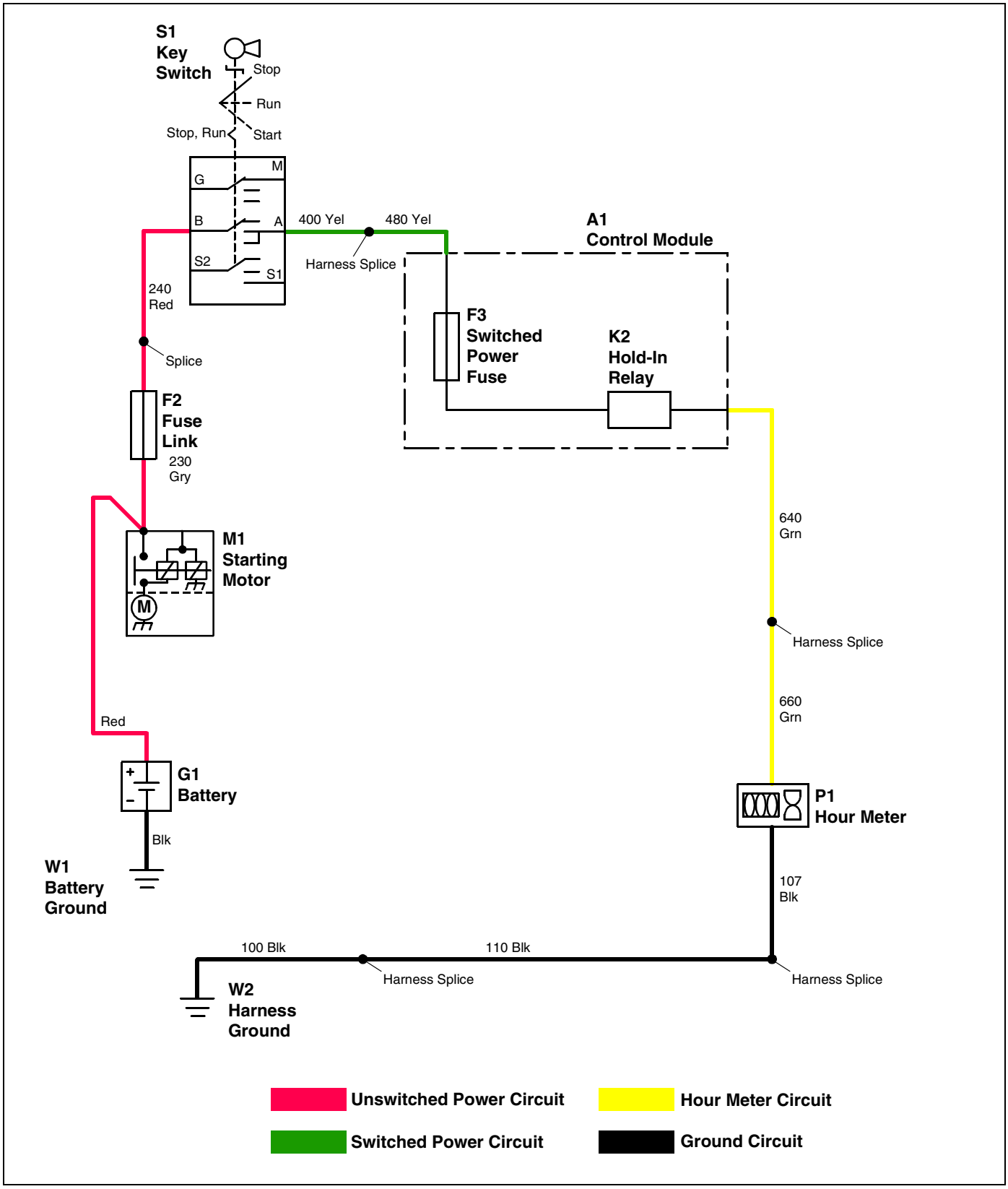
Turning key switch (S1) to the RUN or start position allows current from the positive (+) terminal of battery (G1) to flow through fuse link (F2), 240 Red wire, then to terminal B of the key switch.

The current flows out terminal A of the key switch, through 400 Yel and 480 Yel wires, to switched power fuse (F3). As long as the hold-in relay (K2) is energized, current from fuse (F3) is allowed to flow across the contacts of the hold-in relay, through 640 Grn and 660 Grn wires, to hour meter (P1), thus energizing the hour meter.

NOTE: Both fuse (F3) and hold-in relay (K2) are located on control module (A1).

Hour Meter Circuit Schematic

Hour Meter Circuit Schematic



MIF MX5511

Hour Meter Circuit Diagnosis

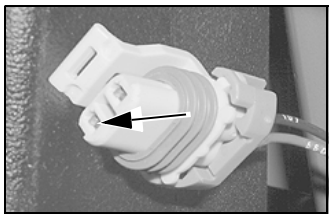
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in the RUN position with the engine OFF.
- Park brake LOCKED.
- PTO switch in the DISENGAGED position.
- Meter or test light negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Hour Meter Circuit Diagnosis

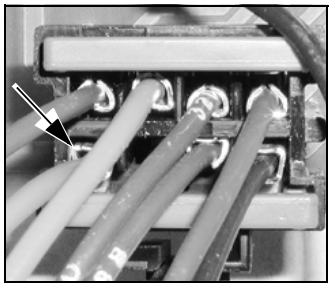


MX5678

(1) After disconnecting hour meter connector (X8 gas) or (X12 diesel), is the voltage measured across 660 Grn wire and ground 11.8 - 13.2 VDC?

Yes - Go to step (4).

No - Go to next step.



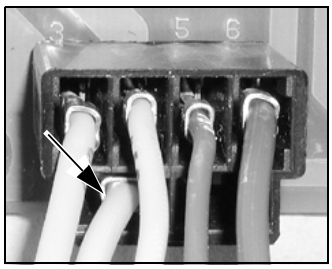
MX5651

(2) Is voltage present at terminal H, 640 Grn of control module connector (X33 gas) or (X32 Diesel)?

No - Go to next step.

Yes - Replace main wiring harness (W4).

System: Hour Meter Circuit Diagnosis

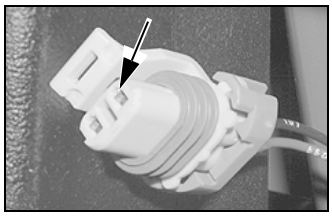


MX5650

(3) Is voltage present at terminal 1, 480 Yel wire of control module connector (X32 gas) or (X31 diesel)?

Yes - See “Operator Presence and PTO Interlock Circuit Diagnosis - Gas Engine” on page 380.

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.



MX5678

(4) After disconnecting hour meter connector, is there continuity between terminal A, 107 Blk on hour meter connector and ground?

Yes - Replace hour meter.

No - Replace main wiring harness (W4).

Engine Ignition and Fuel Transfer Pump Circuit Operation - Gas Engine

Function:

To produce a spark across the gap of each spark plug at the correct time during engine operation.

Operating Conditions:

- Key switch in RUN position with engine RUNNING.
- Operator on seat, or park brake LOCKED and PTO DISENGAGED.

Theory of Operation:

The ignition circuit is made up of three separate circuits, one for each cylinder. Each spark plug has its own pulser, circuitry inside the ignition module, and ignition coil.

The pulser coils trigger the ignition coil's primary circuit. The pulsers are mounted at fixed locations around the crankshaft pulley. The positions of the pulsers provide the correct ignition timing for each cylinder. Because the pulser coils are fixed, ignition timing is not adjustable.

NOTE: Because the operation is the same for the three individual ignition circuits, only the operation of the circuit consisting of pulser coil (B1), ignition coil (T1), and spark plug (E1), will be discussed here.

Protection for the ignition circuit is provided by fuse links (F1 and F2) and 15-amp switched power fuse (F3) located on control module (A1).

Turning key switch (S1) to the RUN or start position allows unswitched current from the positive (+) terminal of battery (G1) to flow through fuse link (F2), through the 240 Red wire, then to terminal B of the key switch.

The now switched current flows out terminal A of the key switch, through 400 Yel and 480 Yel wires, to switched power fuse (F3). From fuse (F3), current flows through 402 Yel and 455 Yel wires to fuel transfer pump (M2), activating the pump.

NOTE: For information on how the hold-in circuit operates, see See “Operator Presence and PTO Interlock Circuit Operation - Gas Engine” on page 372.

At the same time, the switched current from fuse (F3) flows to hold-in relay (K2) located on control module (A1). When the operator presence or PTO interlock circuits energize the hold-in relay, current from fuse (F3) is allowed to flow across the hold-in relay contacts, through 640 Grn and 655 Grn wires, to a timer circuit inside shutdown delay module (A2). Current to the timer circuit causes a transistor (also located inside the shutdown delay module) to "switch on".

With the shutdown delay module transistor "switched on", unswitched current from the positive (+) terminal of battery (G1) is allowed to flow through fuse link (F1), the 210 Red wire, the transistor, then through 305 Org wire to ignition module (A3).

The circuitry inside the ignition module allows current from fuse link (F1) to flow through 215 Red and 216 Org-Blk wires, to harness splice 4.

From harness splice 4, the current flows through 217 Org-Blk wire, to ignition coil (T1). The current flows through the primary windings of the ignition coil, the 960 Wht-Red and 950 Wht wires, then to the ignition module. The circuitry inside the ignition module allows the current to flow to ground through 140 Blk and 100 Blk wires. During the time current is allowed to flow through the primary windings of the ignition coil, a magnetic field exists around the primary and secondary windings.

The ignition module receives a signal from each pulser coil at the appropriate time and uses this information to make and break the path to ground for each ignition coil’s primary circuit.

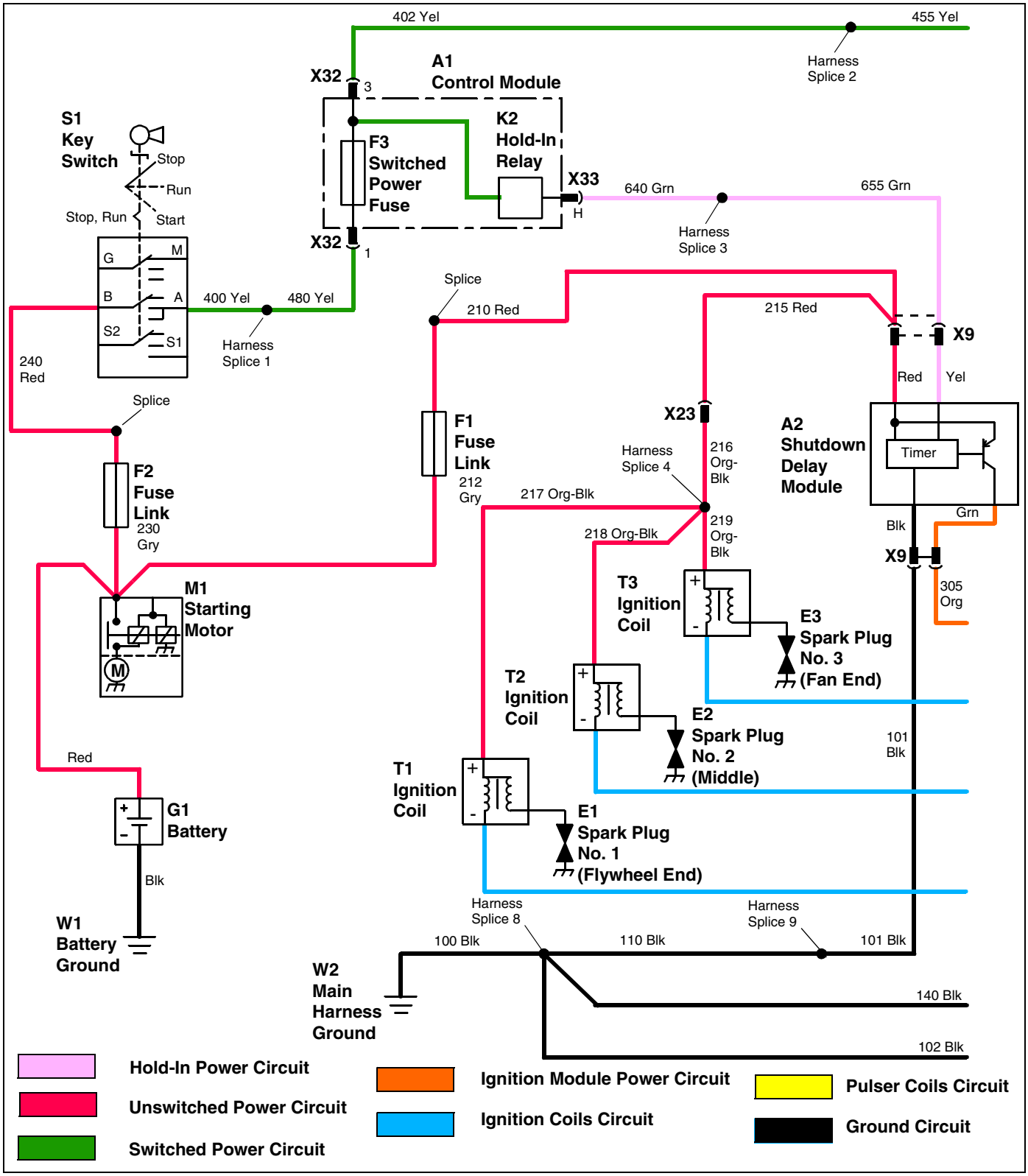
Each pulser contains a permanent magnet and a coil. The magnetic field generated by the permanent magnet cuts across the pulser’s coil. When the engine crankshaft is turning, a notch in the crankshaft pulley travels past each pulser and distorts the pulser’s magnetic field. The distortion in the magnetic field produces a small current (pulse) that is sensed by the circuitry inside the ignition module.

For pulser (B1), this “pulse” flows through 975 Grn/Wht-Red and 955 Pnk wires to the ignition module, causing the circuitry inside the ignition module to break the path to ground for the primary windings of ignition coil (T1), thus interrupting the current flowing through the primary windings. When this happens, the magnetic field produced by the primary windings collapses across the ignition coil's secondary windings, thus inducing a high voltage into the secondary winding. The high voltage travels to ground by jumping the gap in spark plug (E1).

When the key switch is turned to the off position, the timer inside the shutdown control module continues to allow unswitched current from fuse link (F1) to flow to the ignition module, which allows the engine to operate. After approximately 2 seconds has elapsed from the time the key switch was turned to the off position, the timer "switches off" the shutdown delay module transistor, thus stopping current flow to the ignition module and stopping the engine. This additional 2 seconds prevents the build up of unburned air/fuel mixture in the exhaust system which can lead to backfire.

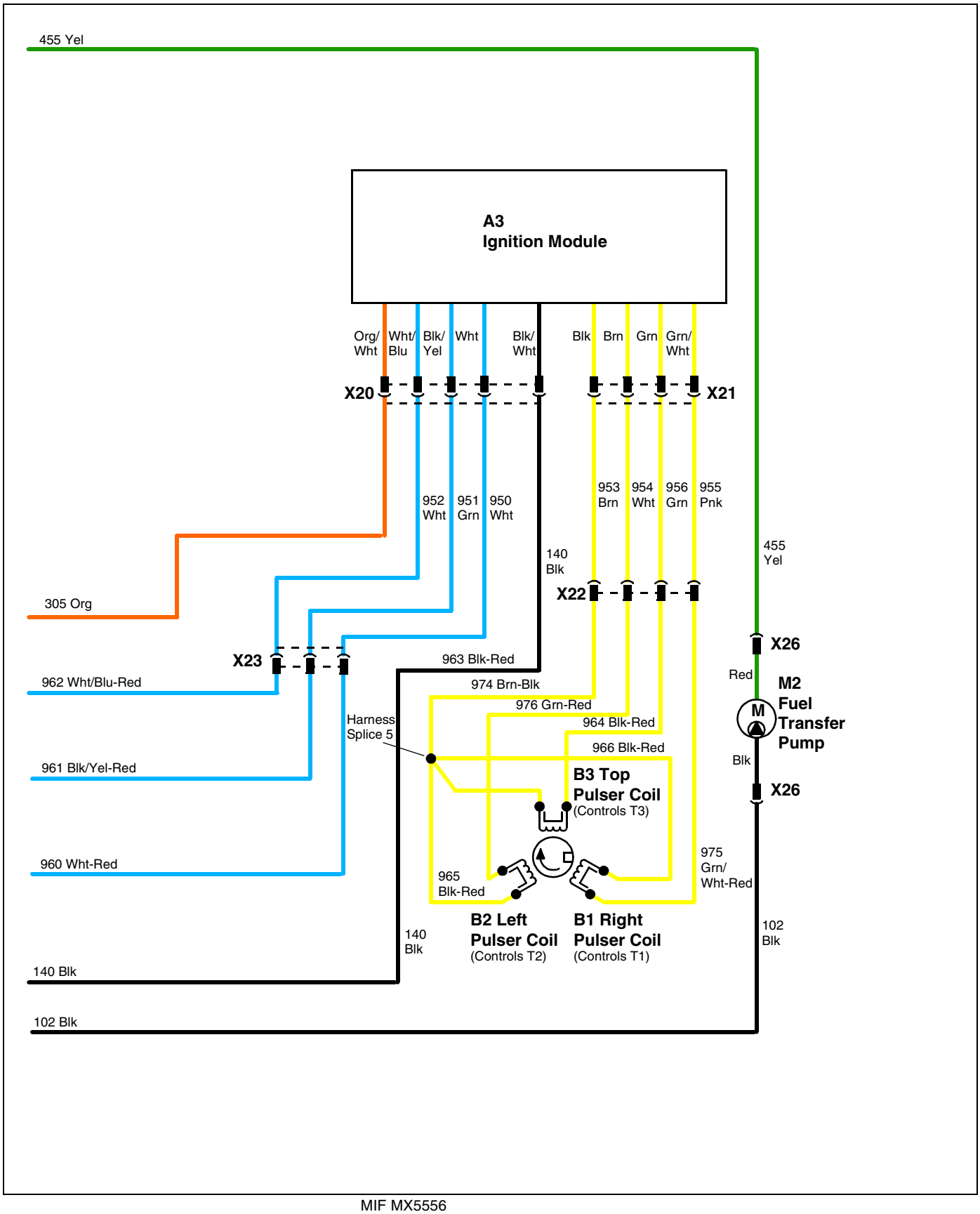
Engine Ignition and Fuel Transfer Pump Circuit Schematic - Gas Engine

Engine Ignition and Fuel Transfer Pump Circuit Schematic - Gas Engine (1 of 2)



MIF MX5556

Engine Ignition and Fuel Transfer Pump Circuit Schematic - Gas Engine (2 of 2)



MIF MX5556

Engine Ignition and Fuel Transfer Pump Circuit Diagnosis - Gas Engine

Front Mower

1420

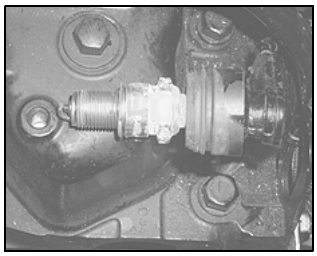
Test Procedure A

Test Conditions:

- Machine parked safely.
- Park brake LOCKED>
- PTO switch at the DISENGAGED position.
- Key switch in START position (engine cranking).
- Meter or test light negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.
- Spark plug wire disconnected from spark plug of cylinder being tested.
- Spark plug wire being tested hooked up to a known good spark plug.
- Spark plug grounded against engine block.
- Org/Blk wire from ignition coil positive (+) terminals of cylinders not being tested.

CAUTION: Avoid injury! To avoid electric shock, use an insulated pliers to hold plug when performing spark test.

System: Engine Ignition and Fuel Transfer Pump Circuit Diagnosis - Gas Engine: Test Procedure A



MX5894

(1) While cranking the engine, is a sharp, blue spark present at the grounded plug being tested?

Yes - Repeat test for remaining cylinders.

No - If there is no spark from all cylinders: Go to step (1) to continue test. (Procedure B)

No - If there is no spark from one cylinder: Go to step (1) to continue test. (Procedure C)

System: Engine Ignition and Fuel Transfer Pump Circuit Diagnosis - Gas Engine: Test Procedure A

No - If the spark is weak and/or yellow: Go to step (1) to continue test. (Test procedure D)

Test Procedure B

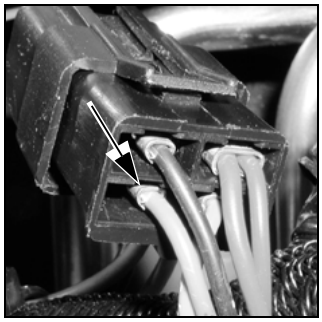
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine off.
- Park brake LOCKED.
- PTO switch at the DISENGAGED position.
- Meter or test light negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Engine Ignition and Fuel Transfer Pump Circuit Diagnosis - Gas Engine: Test Procedure B



MX5669

(1) Is voltage present on both sides of the shutdown delay module connector (X9), 305 Org wire?

Yes - Go to step (7).

No - If voltage is present on only one side of connector, repair or replace connector.

No - Go to next step.

System: Engine Ignition and Fuel Transfer Pump Circuit Diagnosis - Gas Engine: Test Procedure B



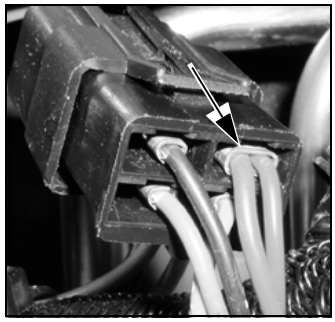
MX5669

(2) Is voltage present on both sides shutdown delay module connector (X9), 655 Grn wire?

Yes - Go to next step.

No - If voltage is present on only one side of connector, repair or replace connector.

No - Go to step (5) to continue test.



MX5669

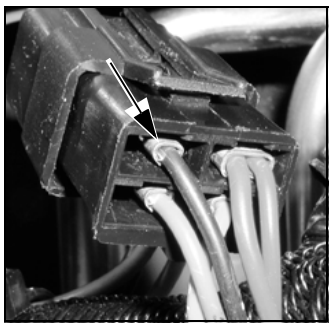
(3) Is voltage present on both sides of connector at 210/215 Red wires of shutdown delay module connector (X9)?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Gas Engine” on page 347.

No - If voltage is present on only one side of connector, repair or replace connector.

System: Engine Ignition and Fuel Transfer Pump Circuit Diagnosis - Gas Engine: Test Procedure B

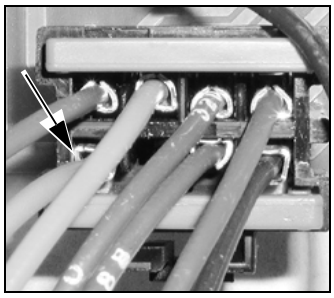


MX5669

(4) After disconnecting shutdown delay module connector (X9),is continuity present between 101 Blk wire of harness side of connector and ground?

Yes - Replace shutdown delay module (A2).

No - replace main wiring harness (W4).

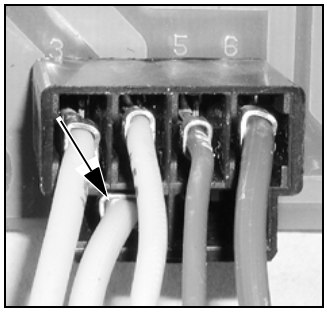


MX5651

(5) Is there battery voltage between terminal H, 640 Grn of control module connector (X33) and ground?

No - Go to next step.

Yes - Replace main wiring harness (W4).



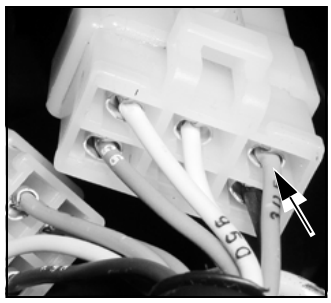
MX5650

(6) Is there voltage present at terminal 1, 480 Yel of control module connector (X32) and ground.

No - See “Power Circuit Diagnosis - Gas Engine” on page 347.

System: Engine Ignition and Fuel Transfer Pump Circuit Diagnosis - Gas Engine: Test Procedure B

Yes - See “Operator Presence and PTO Interlock Circuit Diagnosis - Gas Engine” on page 380.



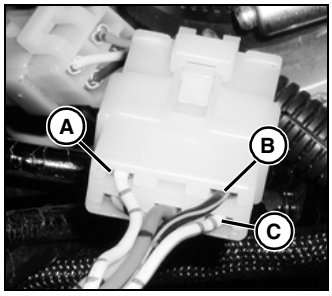
MX5670

(7) Checking both sides of the connector, is voltage present at 305 Org wire of ignition module connector (X20)?

Yes - Go to step (1). (Procedure C)

No - Replace main wiring harness (W4).

No - If voltage is present on only one side of connector, repair or replace connector.



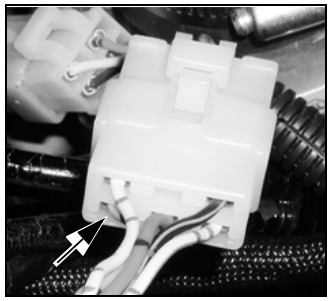
MX5671

(8) Check both sides of the connector, is voltage present at 960 Wht/Red wire (A), 961 Blk/Yel wire (B), and 962 Wht/Blu-Red wire (C) of coil pack wiring harness connector (X23)?

Yes - Go to next step.

No - If there is voltage on only one side of the connector, repair or replace connector.

System: Engine Ignition and Fuel Transfer Pump Circuit Diagnosis - Gas Engine: Test Procedure B



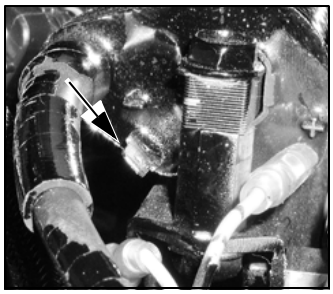
MX5671

(9) Checking both sides of the connector, is voltage present at 216 Org-Blk wire of coil pack wiring harness connector (X23)?

Yes - Go to next step.

No - Replace main wiring harness (W4).

No - If voltage is present on only one side of the connector, repair or replace connector.

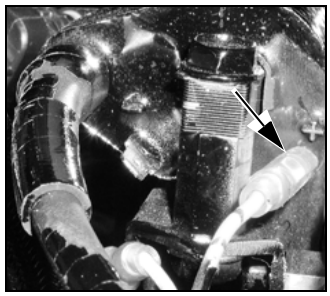


MX5672

(10) Is voltage present at negative (-) terminal of ignition coils (T1, T2, T3)?

No - Go to next step.

Yes - Replace coil pack wiring harness.



MX5672

(11) Is voltage present at Org-Blk wire on positive (+) terminal of ignition coils (T1, T2, and T3)?

Yes - Replace coil.

No - Replace coil pack wiring harness (W5).

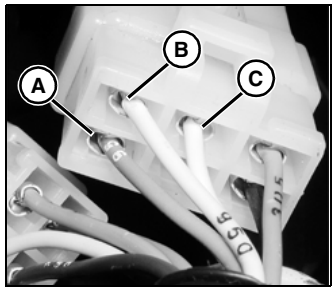
Test Procedure C

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Park brake LOCKED.
- PTO switch at DISENGAGED position.
- Key switch in RUN position (engine RUNNING) or in start position (engine cranking).
- Test light negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Engine Ignition and Fuel Transfer Pump Circuit Diagnosis - Gas Engine: Test Procedure C



MX5670

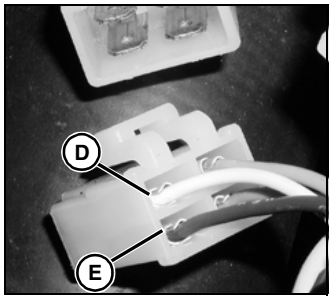
(1) After placing a test light on the terminal containing 951 Grn wire (A) of ignition module connector (X20), crank the engine. Repeat for 950 and 952 Wht wires (B and C). Does the light blink of and on?

Yes - Go to step (1).

No - If test light stays off: Go to step (8) to continue test. (Test procedure B)

No - If test light stays lit continuously, go to next step.

System: Engine Ignition and Fuel Transfer Pump Circuit Diagnosis - Gas Engine: Test Procedure C

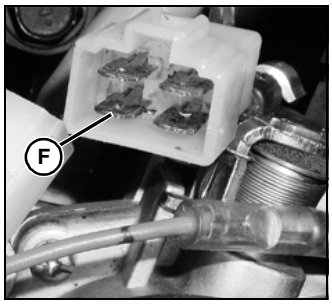


MX5673

(2) Disconnect ignition module connector (X21). Attach BLACK lead of voltmeter to terminal with Brn wire (E). Attach RED lead of voltmeter to terminal with Wht wire (D). Crank engine. Repeat for Grn and Pnk wires. Is the approximate voltage 0.050 VAC?

Yes - Go to next step.

No - Replace ignition module (A3).



MX5674

(3) Disconnect pulser wiring harness connector (X22). Attach BLACK lead of voltmeter to terminal with Blk-Red wire (F). Attach RED lead of voltmeter to one of the three remaining terminals. Crank the engine. Repeat for the other terminals. Is the approximate voltage 0.050 VAC?

No - Replace main wiring harness (W4).

No - Check wiring between connector (X22) and pulser connectors. If OK: Go to step (4) to continue test. (Procedure D)

No - If wiring or connectors are faulty, repair or replace as necessary.

Yes - Test complete.

Test Procedure D

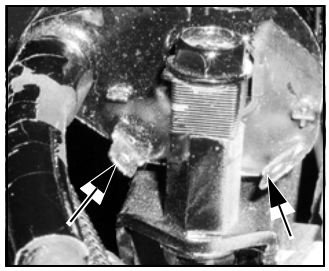
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Park brake LOCKED.
- Key switch in OFF position.

System: Engine Ignition and Fuel Transfer Pump Circuit Diagnosis - Gas Engine: Test Procedure D

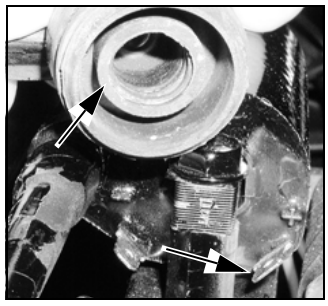


MX5675

(1) Disconnect ignition coil's positive (+) and negative (-) terminal connectors. Measure resistance between the positive (+) terminal and the negative terminal. Is the resistance 3.8 - 5.2 ohms?

Yes - Go to next step.

No - Replace coil.



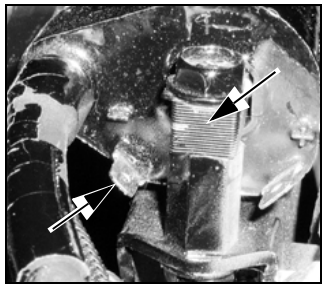
MX5676

(2) Measure resistance between primary positive (+) terminal and terminal at end of spark plug wire. Is the resistance 10.8 - 16.2 ohms?

Yes - Go to next step.

No - Replace coil.

System: Engine Ignition and Fuel Transfer Pump Circuit Diagnosis - Gas Engine: Test Procedure D

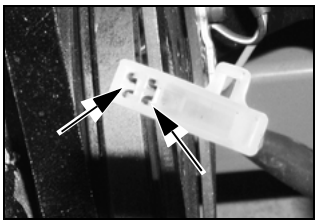


MX5675

(3) Is the resistance between primary coil winding's negative (-) terminal and coil casing infinite?

Yes - Go to next step.

No - Replace coil.



MX5677

(4) Disconnect the pulser coil connectors. Measure resistance between the pulser coil connector terminals. Is the resistance 15 - 25 ohms?

Yes - Test complete.

No - Replace pulser coil.

Fuel Shutoff Solenoid Circuit Operation - Gas Engine

Function:

To ensure engine shutdown and prevent backfire by stopping the flow of fuel from the carburetor float bowl to the main metering well. This is accomplished either manually using the key switch or automatically when the operator rises from the seat for more than one second while PTO is ENGAGED or park brake is UNLOCKED.

Operating Conditions:

- Key switch in RUN or START position.
- Operator on seat, or park brake LOCKED and PTO DISENGAGED.

Theory of Operation:

The fuel shutoff solenoid gets its power from the hold-in circuit. For information on how the hold-in circuit operates, see “Operator Presence and PTO Interlock Circuit Operation - Gas Engine” on page 372 in this group.

Protection for the fuel shutoff solenoid circuit is provided by fuse link (F2) and 15-amp switched power fuse (F3).

Turning key switch (S1) to the RUN or start position allows current from the positive (+) terminal of battery (G1) to flow through fuse link (F2), 240 Red wire, then to terminal B of the key switch.

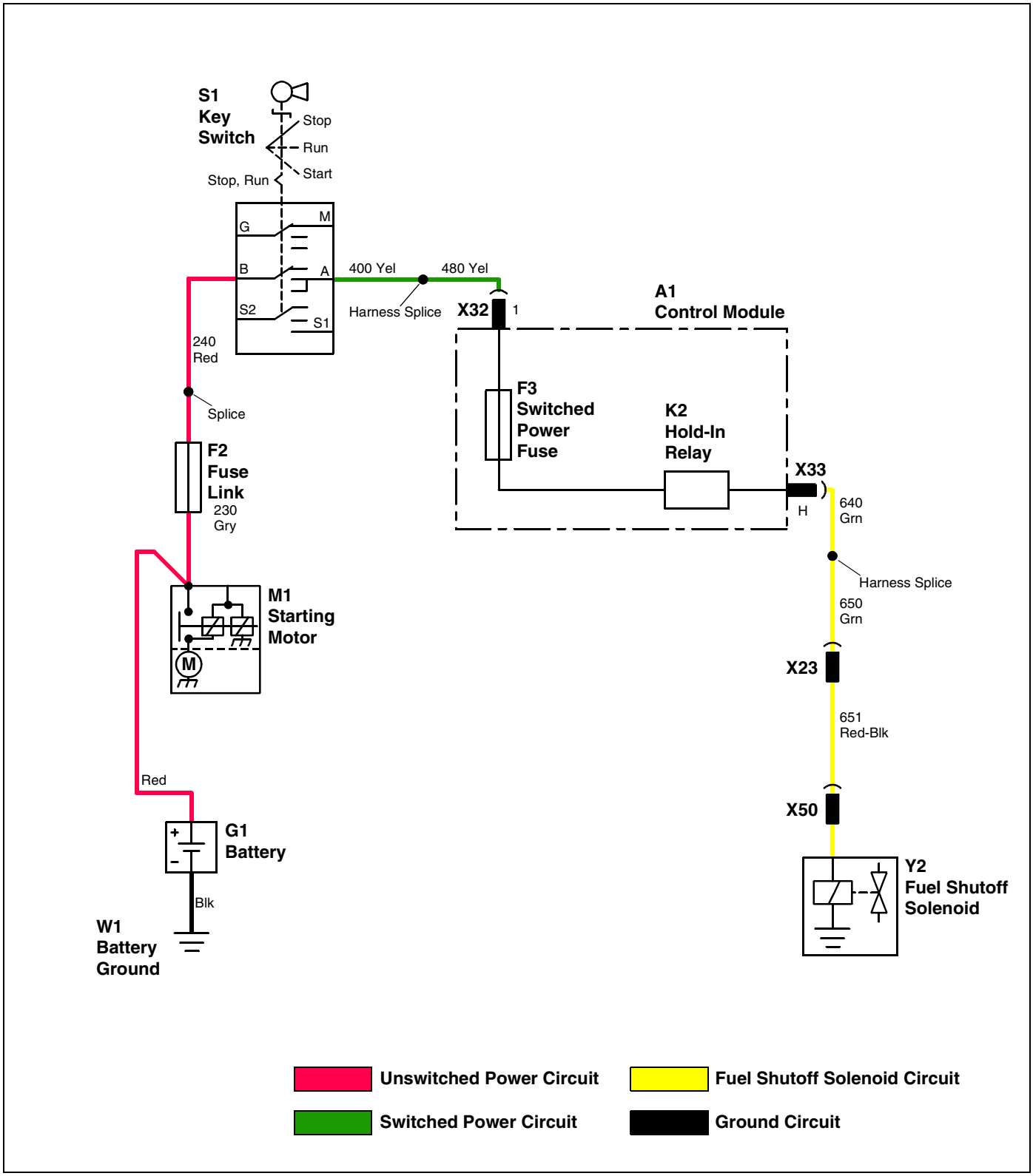
The current flows out terminal A of the key switch, through 400 Yel and 480 Yel wires, to switched power fuse (F3). As long as the hold-in relay (K2) is energized, current from fuse (F3) is allowed to flow across the contacts of hold-in relay (K2), through 640 Grn and 650 Grn wires, connector (X23), 651 Red-Blk wire, then to fuel shutoff solenoid (Y2), thus energizing the solenoid.

NOTE: When the fuel shutoff solenoid is energized, the solenoid allows fuel to flow from the float bowl to the main metering well. When de-energized, fuel flow is stopped.

Both fuse (F3) and hold-in relay (K2) are located on control module (A1).

Fuel Shutoff Solenoid Circuit Schematic - Gas Engine

Fuel Shutoff Solenoid Circuit Schematic - Gas Engine



MIF MX5536

Fuel Shutoff Solenoid Circuit Operation - Diesel Engine

Function:

To stop the engine by stopping fuel flow to the injection pump. This is accomplished either manually using the key switch or automatically when the operator rises from the seat for more than one second while PTO is ENGAGED or park brake is UNLOCKED.

Operating Conditions:

- Key switch in RUN or START position.
- Operator on seat, or park brake LOCKED and PTO DISENGAGED.

Theory of Operation:

Protection for the fuel shutoff solenoid circuit is provided by fuse link (F2) and 15-amp switched power fuse (F3).

Turning key switch (S1) to the RUN or START position allows current from the positive (+) terminal of battery (G1) to flow through fuse link (F2), 240 Red wire, then to terminal B of the key switch. The current flows out terminal A of the key switch, through 400 Yel and 480 Yel wires, to switched power fuse (F3).

As long as the hold-in relay (K2) is energized, current from fuse (F3) is allowed to flow through 640 Grn and 650 Grn wires, to the hold-in windings of fuel shutoff solenoid (Y2), thus energizing the hold-in windings. The magnetic field produced in the hold-in windings is not enough to move the solenoid armature by itself.

NOTE: For information on how the hold-in circuit operates, see “Operator Presence and PTO Interlock Circuit Operation - Diesel Engine” on page 376 or “Operator Presence and PTO Interlock Circuit Operation - Gas Engine” on page 372.

Both fuse (F3) and hold-in relay (K2) are located on control module (A1).

At the same time, current from fuse (F3) also flows through 402 Yel and 407 Yel wires, to coil of fuel shutoff solenoid relay (K5). The current flows through the relay coil, then through 751 Pur wire, to terminal B of diesel engine control module (A2). The control module allows the current to flow to ground, thus energizing the fuel shutoff solenoid relay.

With the fuel shutoff solenoid relay energized, unswitched battery current from fuse link (F2) is allowed to flow across the relay contacts to the pull-in windings of fuel shutoff solenoid (Y2), thus energizing the pull-in windings. The energized windings cause the solenoid armature and linkage to move to the on position.

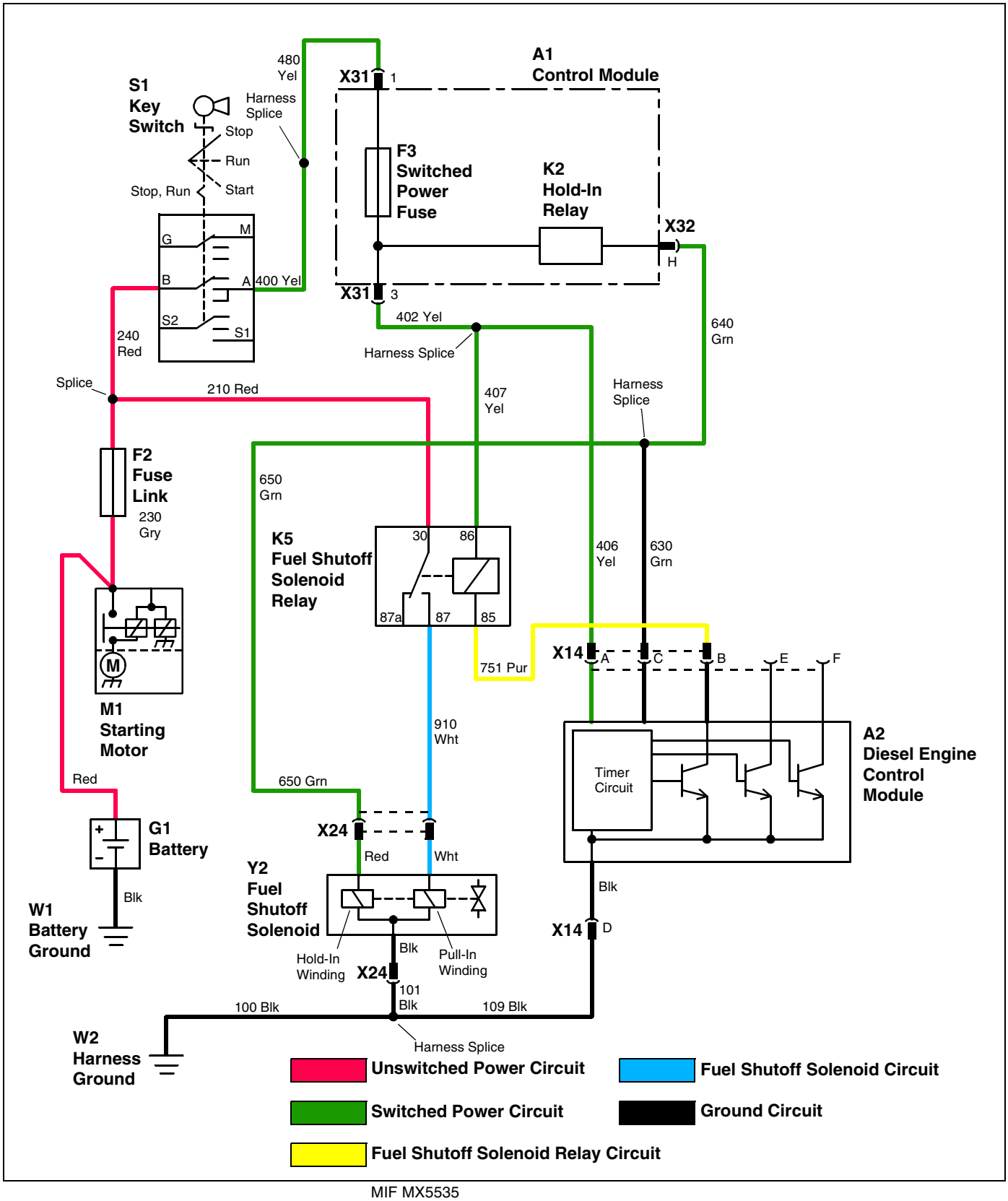
After approximately one second, the diesel engine control module breaks the fuel shutoff solenoid relay coil's path to ground, thus de-energizing the relay. The relay contacts open, causing the current to stop flowing to the solenoid's pull-in windings.

Current from the hold-in circuit continues to flow to the solenoid's hold-in windings. The magnetic field produced by this current is sufficient to hold the solenoid armature in, thus keeping the fuel shutoff linkage at the on position and allowing the engine to continue running.

During machine operation, the operator presence circuit controls the hold-in power circuit. The operator presence circuit contains a built-in delay [located on control module (A1)] so if the operator bounces on the seat during machine operation, the engine will continue to run.

Fuel Shutoff Solenoid Circuit Schematic - Diesel Engine

Fuel Shutoff Solenoid Circuit Schematic - Diesel Engine



MIF MX5535

Fuel Shutoff Solenoid Circuit Diagnosis - Gas Engine

Front Mower

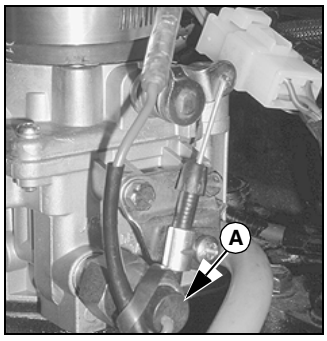
1420

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- Park brake LOCKED.
- PTO switch at the DISENGAGED position.
- Meter or test light negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Fuel Shutoff Solenoid Circuit Diagnosis - Gas Engine



MX5690

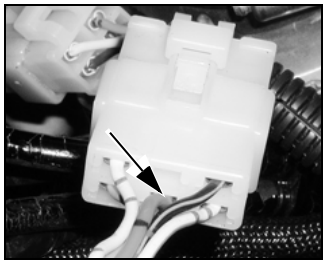
(1) Checking both sides of the connector, is the voltage measured between fuel shutoff solenoid connector (X50), 650 Grn wire and ground 11.8 - 13.2 VDC?

Yes - Check fuel shutoff solenoid (Y2).

No - If voltage is present on only one side of connector, repair or replace connector.

No - Go to next step.

System: Fuel Shutoff Solenoid Circuit Diagnosis - Gas Engine



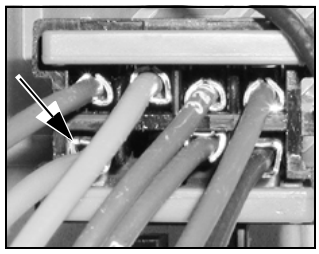
MX5671

(2) Checking both sides of connector, is voltage present at 651 Red-Blk wire of coil pack wiring harness connector (X23)?

No - Go to next step.

Yes - If voltage is present on only one side of connector, repair or replace connector.

Yes - Replace coil pack wiring harness (W6).

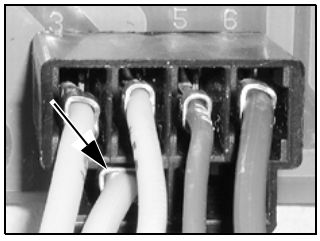


MX5651

(3) Is the voltage measured at terminal H, 640 Grn wire of the control module connector (X33) 11.8 - 13.2 VDC?

No - Go to next step.

Yes - Replace main wiring harness (W4).



MX5650

(4) Is the voltage measured at terminal 1,480 Yel wire of control module connector (X32) 11.8 - 13.2 VDC?

Yes - See “Operator Presence and PTO Interlock Circuit Diagnosis - Gas Engine” on page 380.

System: Fuel Shutoff Solenoid Circuit Diagnosis - Gas Engine

No - See “Power Circuit Diagnosis - Gas Engine” on page 347.

Fuel Shutoff Solenoid Circuit Diagnosis - Diesel Engine

Front Mower

1435

1445

1545

- If engine does not start: Go to step (1).
- If engine starts but stops after approximately one second: Go to step (14).

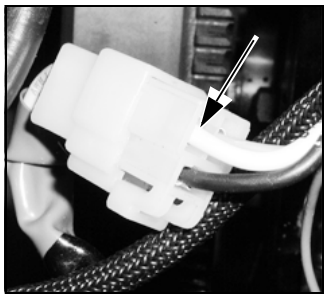
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- PTO switch at the DISENGAGED position.
- Meter or test light negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Fuel Shutoff Solenoid Circuit Diagnosis - Diesel Engine



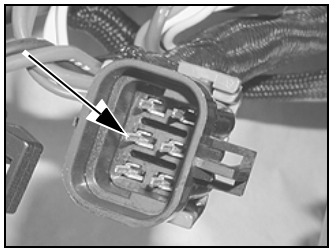
MX5688

(1) Is voltage present at 910 Wht wire on fuel shutoff solenoid connector (X24)? Voltage must only be present for approximately one second after the key switch is turned to the RUN position.

Yes - Go to step (15).

No - Go to next step.

System: Fuel Shutoff Solenoid Circuit Diagnosis - Diesel Engine

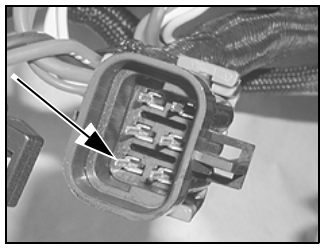


MX5683

(2) IMPORTANT: Do not connect jumper wire for more than 2 seconds at a time. Permanent damage to the fuel shutoff solenoid will result. Disconnect diesel engine control module connector (X14). Connect a jumper wire between terminal B and ground, then check again for voltage at 910 Wht wire on fuel shutoff solenoid connector (X24). Is battery voltage present?

Yes - Go to next step.

No - Go to step (6) to continue test.



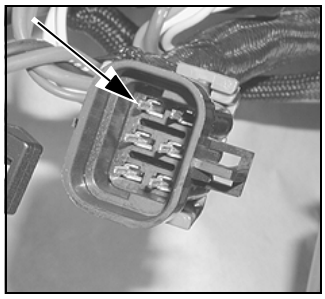
MX5683

(3) Is voltage present at terminal C, 630 Grn wire of diesel engine control module connector (X14)?

Yes - Go to next step.

No - Go to step (12) to continue test.

System: Fuel Shutoff Solenoid Circuit Diagnosis - Diesel Engine

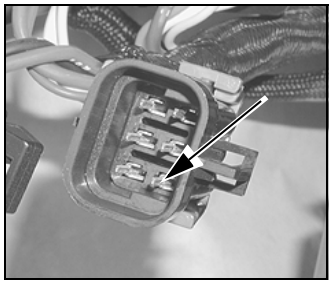


MX5683

(4) Is voltage present at terminal A, 406 Yel wire of diesel engine control module connector (X14)?

Yes - Go to next step.

No - Go to step (11) to continue test.

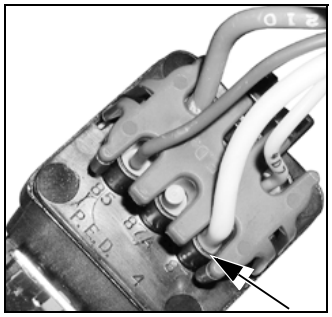


MX5683

(5) Is continuity present between terminal D, 109 Blk wire of diesel engine control module connector (X14) and ground?

Yes - Replace diesel engine control module (A2).

No - Replace main wiring harness (W4).



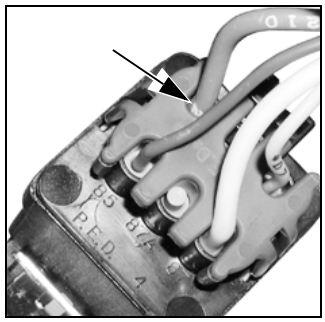
MX5689

(6) Using a small diameter probe between wire and relay socket seal, if voltage present at terminal 87, 910 Wht wire of fuel shutoff solenoid relay (K5)?

No - Go to next step.

Yes - Replace main wiring harness (W4).

System: Fuel Shutoff Solenoid Circuit Diagnosis - Diesel Engine

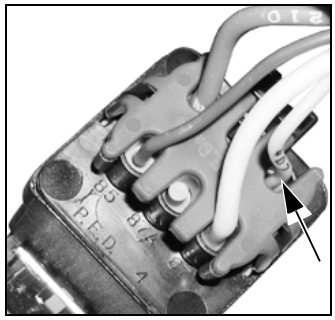


MX5689

(7) Using a small diameter probe between wire and relay socket seal, is voltage present at terminal 30, 210 Red wire of fuel shutoff solenoid relay (K5)?

Yes - Go to next step.

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.

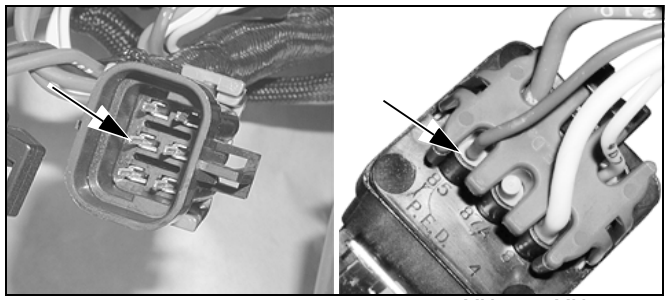


MX5689

(8) Using a small diameter probe between wire and relay socket seal, is voltage present at terminal 86, 407 Yel wire of fuel shutoff solenoid relay (K5)?

Yes - Go to next step.

No - Go to step (10) to continue test.



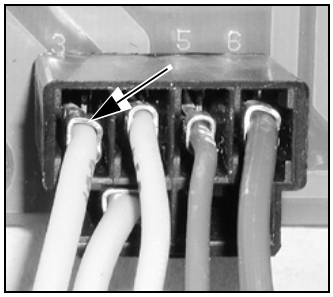
MX5689, MX5683

(9) Is continuity present between terminal 85, 751 Pur wire of fuel shutoff solenoid relay (K5) and terminal B of diesel engine control module connector (X14)?

Yes - Test fuel shutoff solenoid relay (K5).

System: Fuel Shutoff Solenoid Circuit Diagnosis - Diesel Engine

No - Replace main wiring harness (W4).

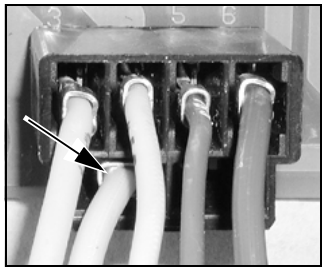


MX5650

(10) Is voltage present at terminal 3, 402 Yel wire of control module connector (X31)?

No - Go to next step.

Yes - Replace main wiring harness (W4).



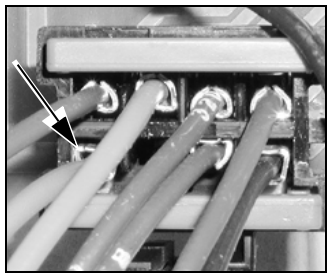
MX5650

(11) Is voltage present at terminal 1, 480 Yel wire of control module connector (X31)?

Yes - Check fuse (F3).

Yes - Replace control module (A1).

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.



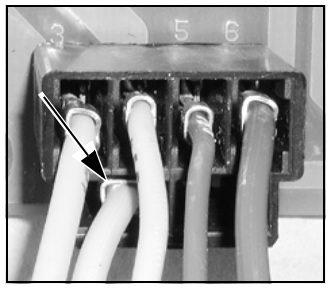
MX5651

(12) Is voltage present at terminal H, 640 Grn wire of control module connector (X32)?

No - Go to next step.

Yes - Replace main wiring harness (W4).

System: Fuel Shutoff Solenoid Circuit Diagnosis - Diesel Engine

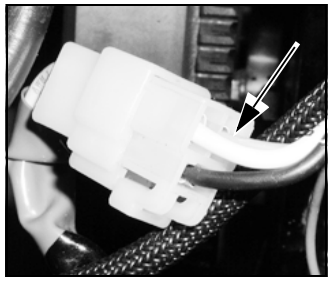


MX5650

(13) Is battery voltage present at terminal 1, 480 Yel wire of control module connector (X31)?

Yes - If fuse (F3) is good, “Operator Presence and PTO Interlock Circuit Diagnosis - Diesel Engine” on page 387.

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.

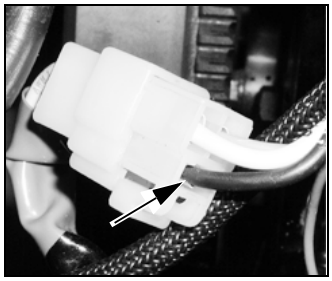


MX5688

(14) Is voltage present at 650 Grn wire on fuel shutoff solenoid connector (X24)?

Yes - Go to next step.

No - Go to step (12) to continue test.



MX5688

(15) Is there continuity between 101 Blk wire on fuel shutoff connector (X24) and ground?

Yes - Test fuel shutoff solenoid.

No - Replace main wiring harness (W4).

Cooling Fan Circuit Operation

Function:

To regulate the engine coolant temperature by starting and stopping the electric cooling fan at predetermined coolant temperature settings.

Operating Conditions:

- Key switch in RUN position.
- Engine operating.
- Operator on seat, or park brake LOCKED and PTO DISENGAGED.

Theory of Operation:

Protection for the cooling fan circuit is provided by fusible link [(F1 diesel) (F2 gas)], 15-amp switched power fuse (F3), and 30-amp fan fuse (F5).

With key switch (S1) in the RUN position, current flows from the positive (+) terminal of battery (G1), through fuse link (F2), then through the 240 Red wire to terminal B of the key switch.

The current flows out terminal A of the key switch, through 400 Yel and 480 Yel wires, to switched power fuse (F3). From fuse (F3), current flows through 402 Yel and 401 Yel wires, to dual temp coolant switch [(B4, gas) (B1, diesel)], thus providing power for the solid state switch.

When engine coolant temperature is less than 90°C (195°F), the dual temp coolant switch prevents current flow through the coil of cooling relay [(K5, gas) (K7, diesel)]. The relay contacts are open and no current flows to fan motor [(M3, gas) (M2, diesel)].

When engine coolant temperature exceeds 90°C (195°F), the dual temp coolant switch allows current from fuse (F3) to flow through 402 Yel and 420 Yel wires, through the coil of cooling fan relay, the 106 Blk wire, the dual temp coolant switch, then to ground through 108 and 100 Blk wires.

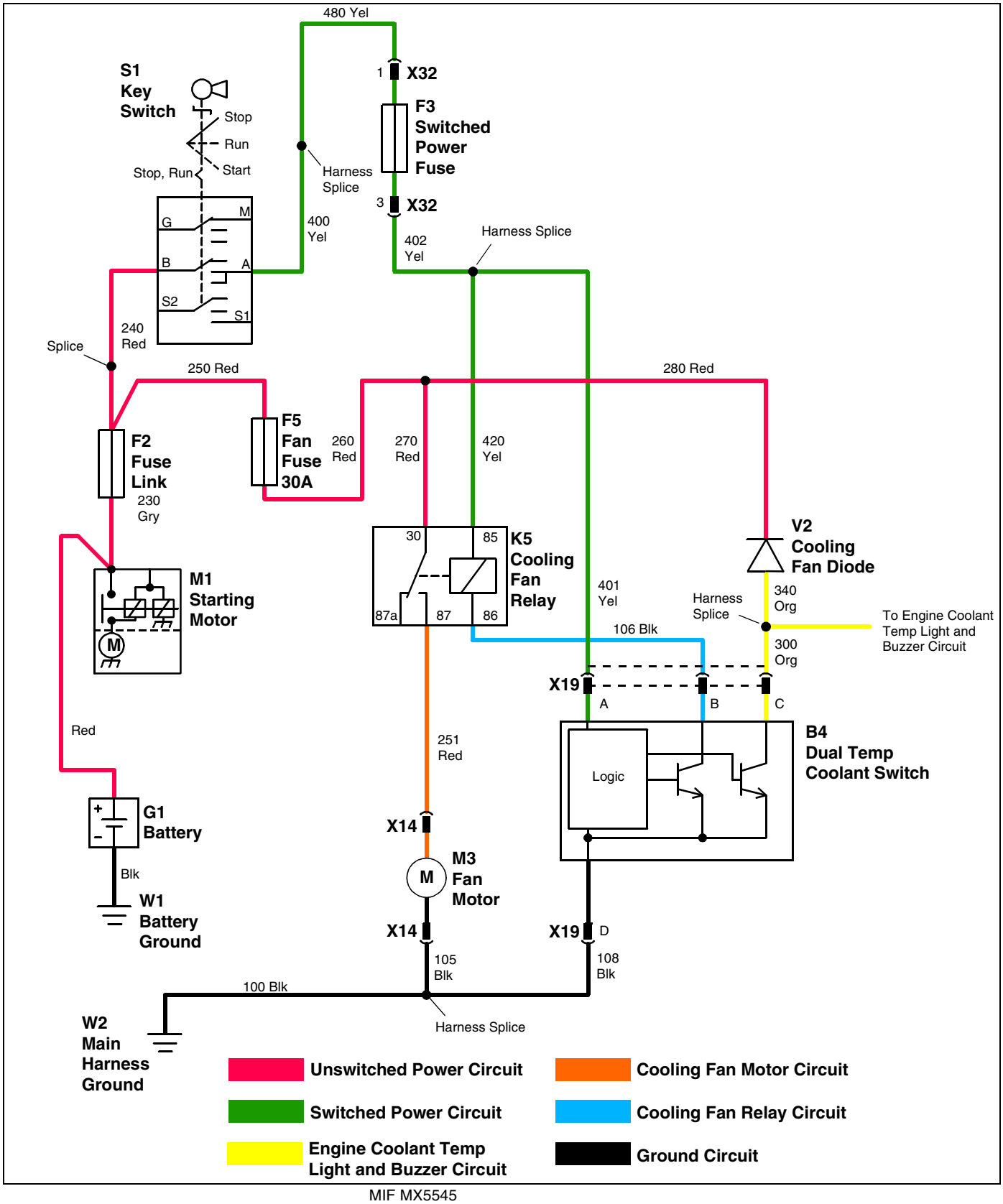
With the cooling fan relay energized, unswitched battery current from fuse link (F2) flows through 250 Red wire, fan fuse (F5), and 270 Red wire, to the contacts of the cooling fan relay. The current then flows across the relay contacts, through 251 Red wire, to the fan motor. From the fan motor, current flows through 105 Blk wire to ground, thus completing the circuit and energizing the fan motor.

When the engine coolant temperature decreases to 80° C (175°F), the dual temp coolant switch stops current flow through the coil of the cooling fan relay, thus de-energizing the relay. With the relay de-energized, current stops flowing to the fan motor, causing the fan motor to stop operating.

If the cooling fan relay is energized and cooling fan fuse (F5) blows, cooling fan diode (V2) will provide a path to ground for the buzzer and the engine coolant temperature light through the fan motor. When this occurs, the PTO will shut off, the engine coolant temperature light will come on, and the buzzer will activate.

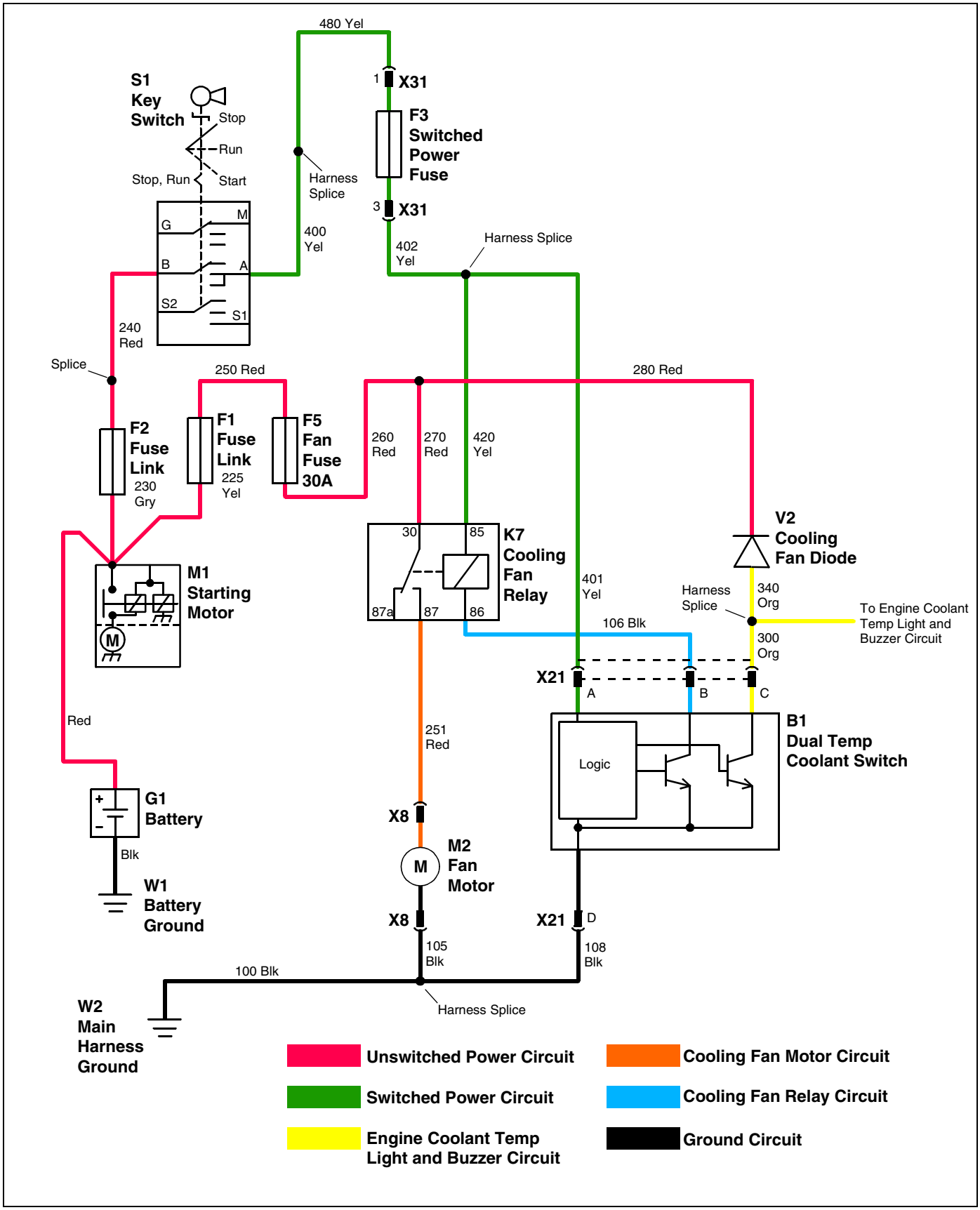
Cooling Fan Circuit Schematic

Cooling Fan Circuit Schematic - Gas Engine



MIF MX5545

Cooling Fan Circuit Schematic - Diesel Engine



MIF MX5546

Cooling Fan Circuit Diagnosis - Gas Engine

Front Mower

1420

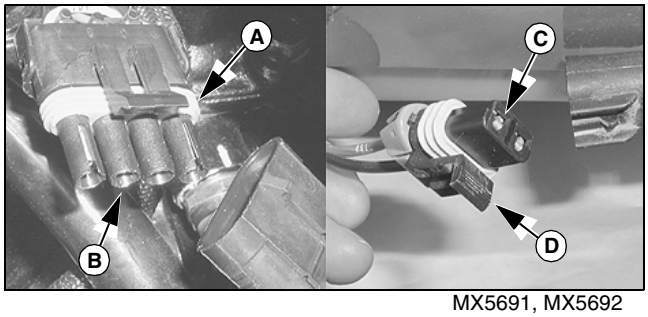
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine off.
- Park brake LOCKED.
- PTO switch at the DISENGAGED position.
- Meter or test light negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Cooling Fan Circuit Diagnosis - Gas Engine



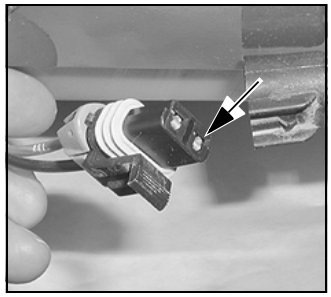
MX5691, MX5692

(1) Disconnect dual temp coolant switch connector (A). Connect a jumper wire between terminal B, 106 Blk (B), and ground. Check for voltage at 251 Red wire (C) on fan motor connector (D) (X13). Does the voltage measure 11.8 - 13.2 VDC?

Yes - Disconnect jumper wire and go to next step.

No - Go to step (5) to continue test.

System: Cooling Fan Circuit Diagnosis - Gas Engine

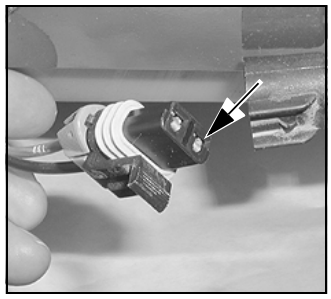


MX5692

(2) Is continuity present between 105 Blk wire on fan motor connector (X13) and ground?

Yes - Test fan motor (M2). If OK, go to next step.

No - Replace main wiring harness (W4).

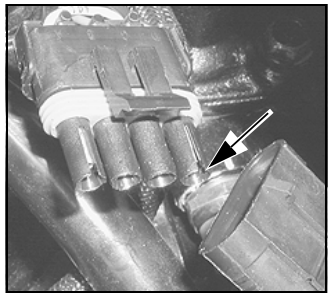


MX5692

(3) Is there voltage at terminal A, 401 Yel wire of dual temp coolant switch connector (X19)?

Yes - Go to next step.

No - Go to step (9) to continue test.



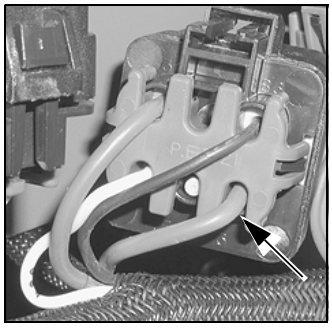
MX5691

(4) Does continuity exist between terminal D, 108 Blk wire of dual temp coolant switch connector (X19) and ground?

Yes - Test dual temp coolant switch (B4).

System: Cooling Fan Circuit Diagnosis - Gas Engine

No - Replace main wiring harness (W4).

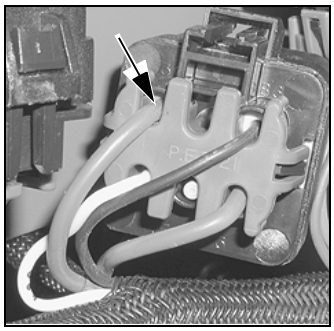


MX5693

(5) Using a small diameter probe between wire relay and socket seal, is voltage present at terminal 87, 251 Red wire of cooling fan relay (K5)?

No - Remove jumper wire installed in step 1 and go to next step.

Yes - replace main wiring harness (W4). Remove jumper wire installed in step 1.



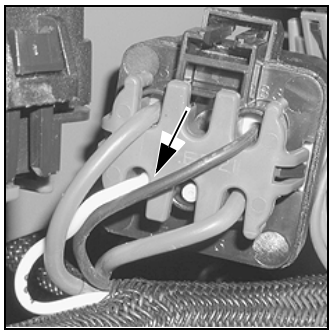
MX5693

(6) Using a small diameter probe between wire and socket seal, is there voltage present at terminal 30, 270 Red wire of cooling fan relay (K5)?

Yes - Go to next step.

No - Go to step (11) to continue test.

System: Cooling Fan Circuit Diagnosis - Gas Engine

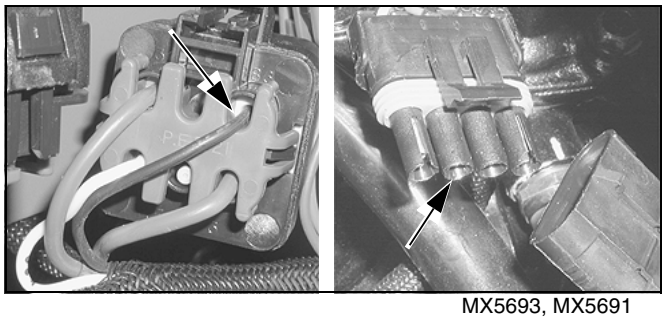


MX5693

(7) Using a small diameter probe between wire and relay socket seal, is voltage present at terminal 85, 420 Yel wire of cooling fan relay (K5)?

Yes - Go to next step.

No - Go to step (9) to continue test.

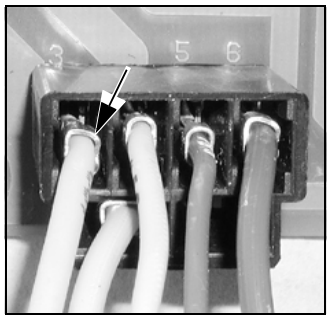


MX5693, MX5691

(8) Does continuity exist between terminal 86, 106 Blk wire of cooling fan relay (K5) and terminal B of dual temp coolant switch connector (X19)?

Yes - Test cooling fan relay (K5).

No - Replace main wiring harness (W4).



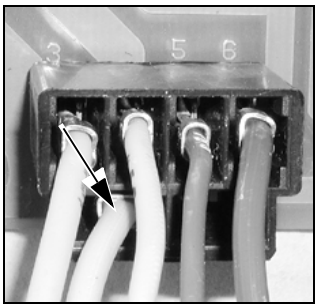
MX5650

(9) Does voltage exist at terminal 3, 402 Yel wire of control module connector (X32)?

No - Go to next step.

Yes - Replace main wiring harness (W4).

System: Cooling Fan Circuit Diagnosis - Gas Engine



MX5650

(10) Is voltage present at terminal 1, 480 Yel wire of control module conductor (X32)?

No - See “Power Circuit Diagnosis - Gas Engine” on page 347.

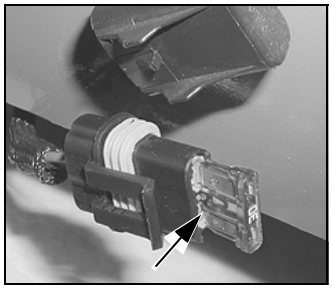
Yes - Check fuse (F3).

Yes - Replace control module (A1).

(11) Is voltage present at 260 Red wire on fan fuse (F5) holder?

No - Go to next step.

Yes - Replace main wiring harness (W4).



MX5694

(12) Is there voltage at 250 Red wire on fan fuse (F5) holder?

Yes - Replace fan fuse (F5).

No - See “Power Circuit Diagnosis - Gas Engine” on page 347.

Cooling Fan Circuit Diagnosis - Diesel Engine

Front Mower

1435

1445

1545

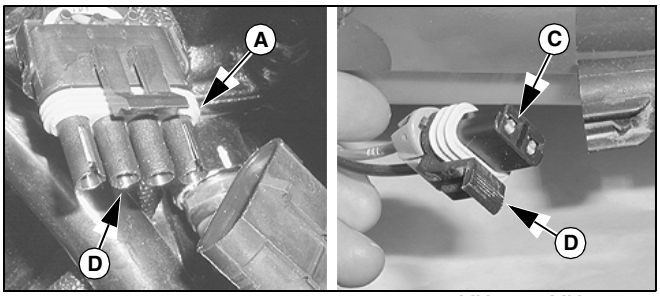
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- Park brake LOCKED.
- PTO switch at the DISENGAGED position.
- Meter or test light negative (BLACK) lead on battery negative (-) terminal or chassis ground.

System: Cooling Fan Circuit Diagnosis - Diesel Engine



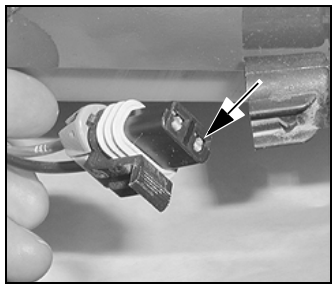
MX5691, MX5692

(1) Disconnect dual temp coolant switch connector (A) (X21). Connect a jumper wire between terminal B, 106 Blk (B), and ground. Check for voltage at 251 Red wire (C) on fan motor connector (D) (X8). Does the voltage measure 11.8 - 13.2 VDC?

Yes - Disconnect jumper wire and go to next step.

No - Go to step (5) to continue test.

System: Cooling Fan Circuit Diagnosis - Diesel Engine

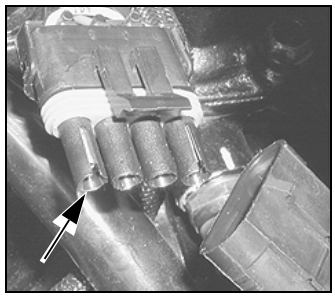


MX5692

(2) Is continuity present between 105 Blk wire on fan motor connector (X8) and ground?

Yes - Test fan motor (M2). If OK, go to next step.

No - Replace main wiring harness (W4).

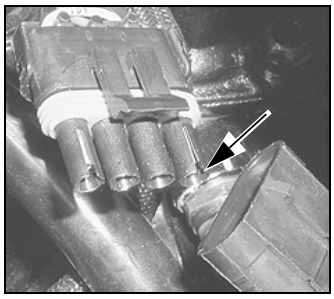


MX5691

(3) Is there voltage at terminal A, 401 Yel wire of dual temp coolant switch connector (X21)?

Yes - Go to next step.

No - Go to step (9) to continue test.

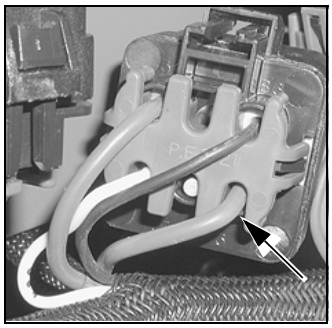


MX5691

(4) Does continuity exist between terminal D, 108 Blk wire of dual temp coolant switch connector (X21) and ground?

Yes - Test dual temp coolant switch (B1).

No - Replace main wiring harness (W4).

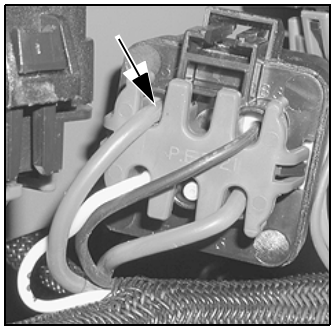


MX5693

(5) Using a small diameter probe between wire relay and socket seal, is voltage present at terminal 87, 251 Red wire of cooling fan relay (K7)?

No - Remove jumper wire installed in step 1 and go to next step.

Yes - Replace main wiring harness (W4). Remove jumper wire installed in step 1.



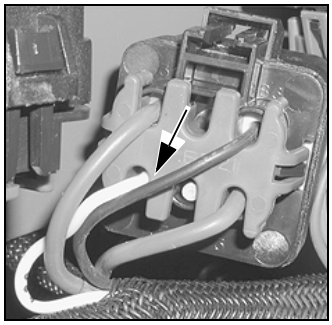
MX5693

(6) Using a small diameter probe between wire and socket seal, is there voltage present at terminal 30, 270 Red wire of cooling fan relay (K7)?

System: Cooling Fan Circuit Diagnosis - Diesel Engine

Yes - Go to next step.

No - Go to step (11) to continue test.

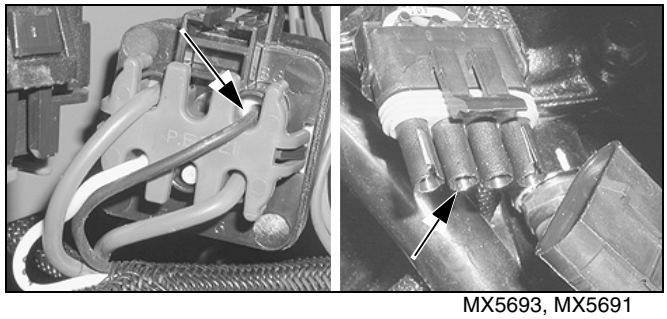


MX5693

(7) Using a small diameter probe between wire and relay socket seal, is voltage present at terminal 85, 420 Yel wire of cooling fan relay (K7)?

Yes - Go to next step.

No - Go to step (9) to continue test.

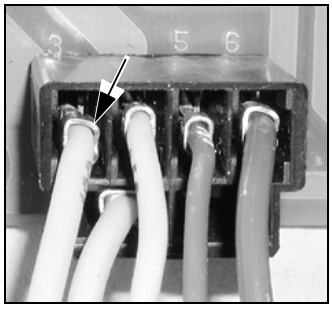


MX5693, MX5691

(8) Does continuity exist between terminal 86, 106 Blk wire of cooling fan relay (K7) and terminal B of dual temp coolant switch connector (X21)?

Yes - Test cooling fan relay (K7).

No - Replace main wiring harness (W4).



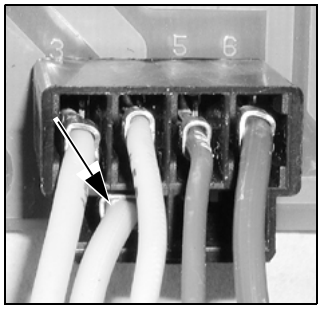
MX5650

(9) Does voltage exist at terminal 3, 402 Yel wire of control module connector (X31)?

No - Go to next step.

System: Cooling Fan Circuit Diagnosis - Diesel Engine

Yes - Replace main wiring harness (W4).



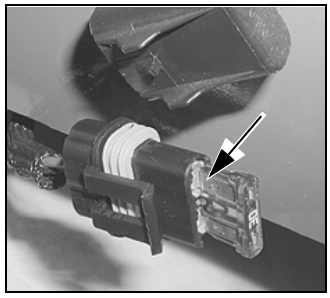
MX5650

(10) Is voltage present at terminal 1, 480 Yel wire of control module connector (X31)?

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.

Yes - Check fuse (F3).

Yes - Replace control module (A1).

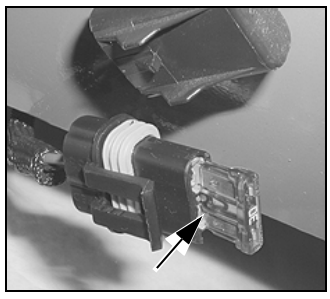


MX5694

(11) Is voltage present at 260 Red wire on fan fuse (F5) holder?

No - Go to next step.

Yes - Replace main wiring harness (W4).



MX5694

(12) Is there voltage at 250 Red wire on fan fuse (F5) holder?

Yes - Replace fan fuse (F5).

System: Cooling Fan Circuit Diagnosis - Diesel Engine

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.

Cruise Control Circuit Operation

Function:

To provide a means of keeping the speed of the machine constant without the need of having the operator's foot on the forward hydrostatic control pedal.

The circuit controls an electromagnet that when energized, holds the forward hydrostatic control pedal at the desired position as selected by the operator.

Operating Conditions:

- Key switch in RUN position.
- Operator on seat.
- Brakes UNLOCKED.
- Cruise control switch in the ENGAGE or ON positions.

Theory of Operation:

NOTE: To engage the cruise control, the cruise control switch must be first moved to the engage position to latch the circuit.

Protection for cruise control circuit is provided by fuse link (F2) and 15-amp switched power fuse (F3) located on control module (A1).

When key switch (S1) is in the RUN position, operator on the seat, brakes UNLOCKED, and cruise control switch (S6) moved to the ENGAGE position, current from the positive (+) terminal of battery (G1) is allowed to flow through fuse link (F2), then through 240 Red wire, to terminal B of the key switch.

The current flows out terminal A of the key switch, through 400 and 480 Yel wires, to switched power fuse (F3). From fuse (F3), current flows through 402 Yel and 411 Yel wires to seat switch (S2).

From the seat switch, current flows through 831 Pnk wire, across the contacts of cruise control brake switch (S5), then through 832 Pnk wire to cruise control switch (S6).

With the cruise control switch at the momentary engage position, current is allowed to flow through 837 and 836 Pnk wires, to cruise control electromagnet (Y3). The current flows through the electromagnet, then to ground through 135, 110, and 100 Blk wires, thus energizing the electromagnet.

The current also flows through 835 Pnk wire to the coil of cruise control relay [(K6, gas) (K8, diesel)]. The current flows through the relay coil, then to ground through 130 and 100 Blk wires, thus energizing the relay.

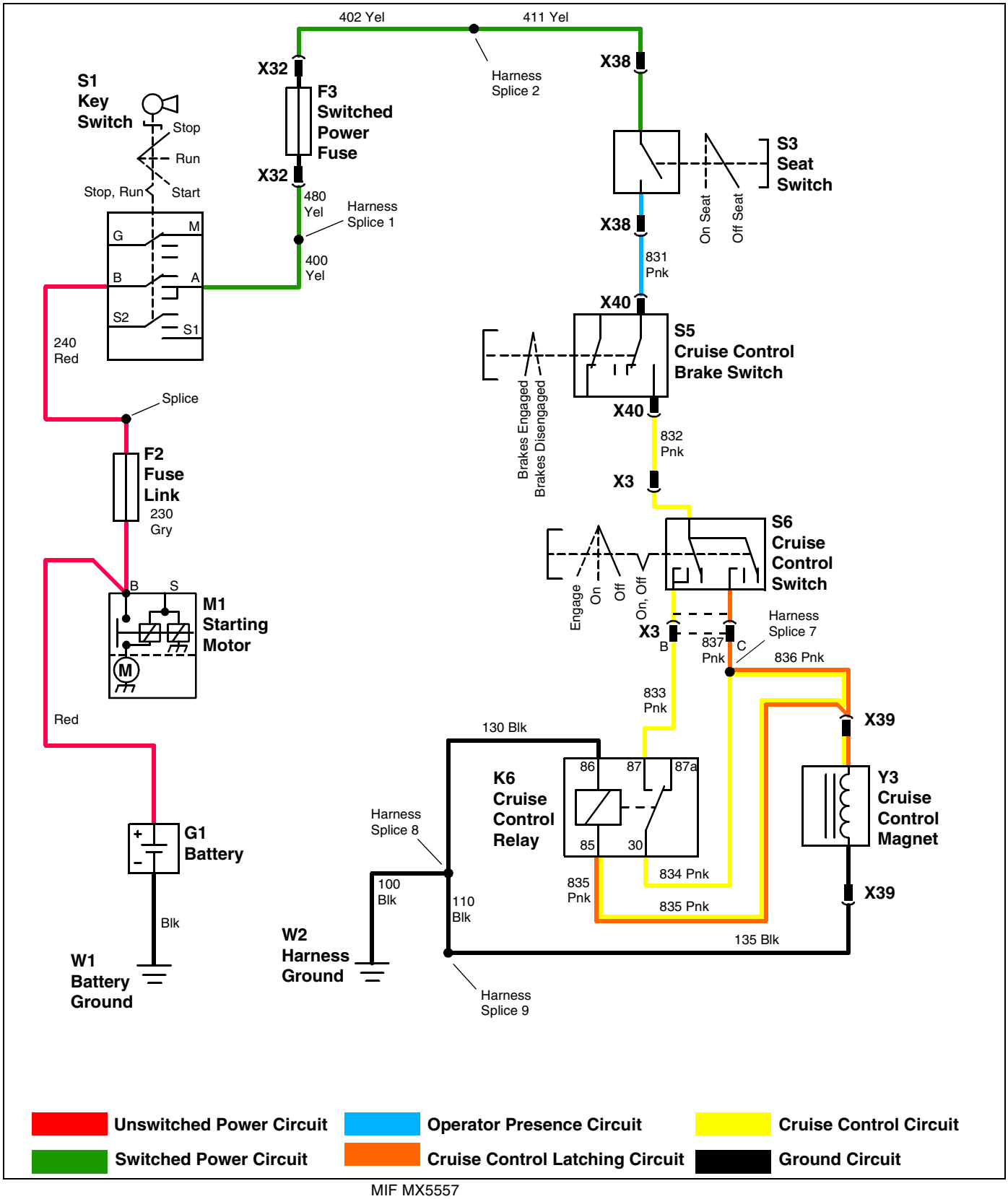
With the cruise control relay energized, the cruise control switch can now be moved to the on position. At this position, current is allowed to flow from cruise control switch, through 833 Pnk wire, and across the cruise control relay contacts. From the relay contacts current flows through 834 and 836 Pnk wires to the cruise control electromagnet. Current also flows from the relay contacts through 835 Pnk wire to the cruise control relay coil completing the circuit latch, thus keeping the electromagnet energized.

The cruise control will be de-activated should any of the following occur:

- Cruise control switch moved to the OFF position.
- Brakes are applied (cruise control brake switch moves to the brakes LOCKED position).
- Operator rises from the seat.

Cruise Control Circuit Schematic - Gas Engine

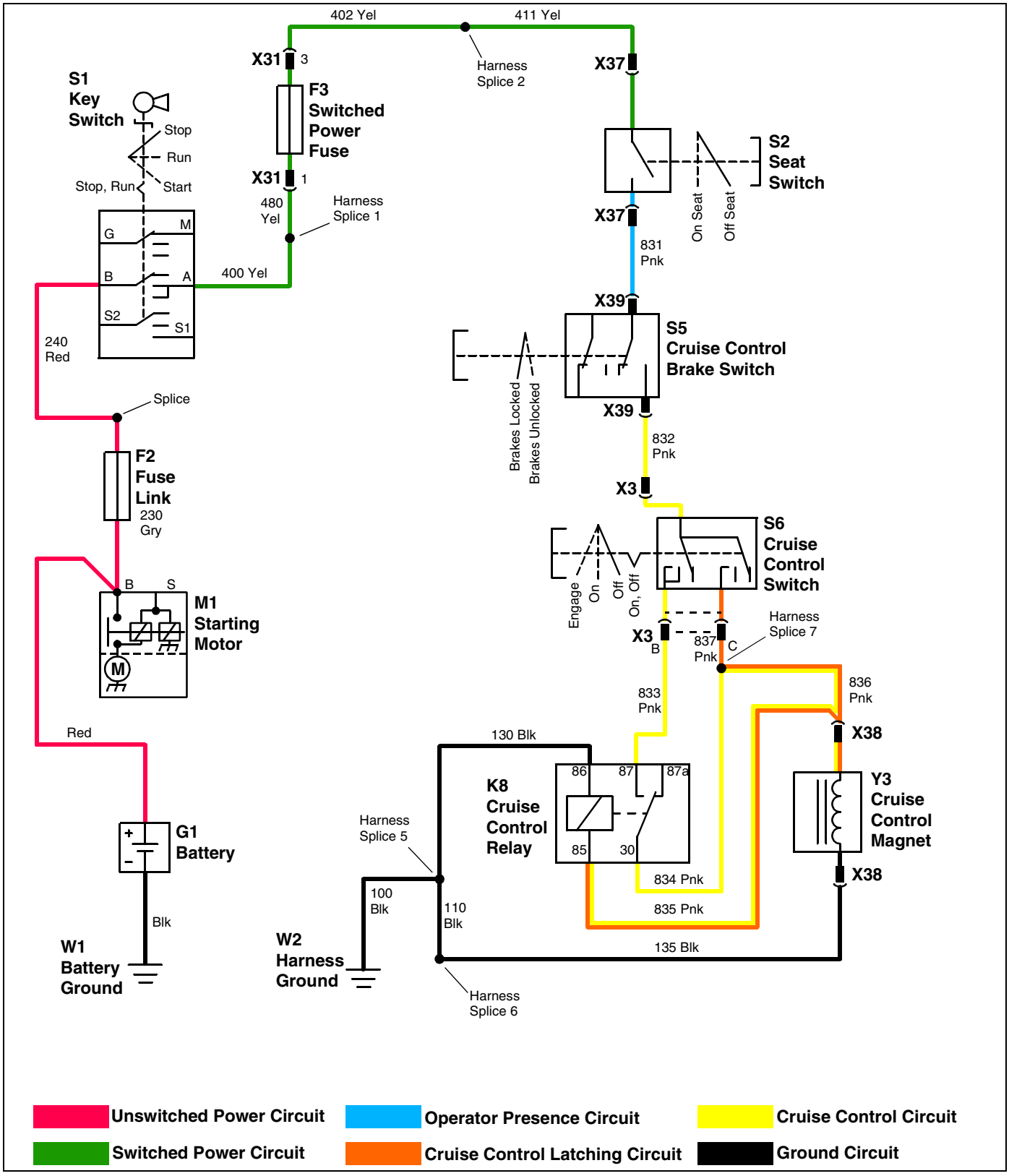
Cruise Control Circuit Schematic - Gas Engine



MIF MX5557

Cruise Control Circuit Schematic - Diesel Engine

Cruise Control Circuit Schematic - Diesel Engine



MIF MX5603

Cruise Control Circuit Diagnosis - Gas Engine

Front Mower

1420

- If cruise control does not engage: Go to step (1). (Test Procedure A)
- If cruise control engages when cruise control switch is held at the ENGAGED position but does not stay ENGAGED when switch moves to the on position: Go to step (1). (Test Procedure B)

Test Procedure A

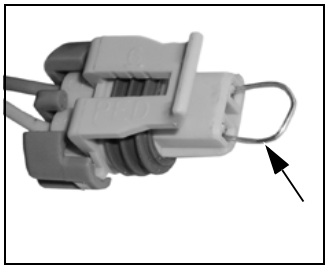
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- Park and service brakes UNLOCKED (cruise control brake switch at the brakes LOCKED position).
- Cruise control switch at the ENGAGE position.
- Meter or test negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Cruise Control Circuit Diagnosis - Gas Engine: Test Procedure A



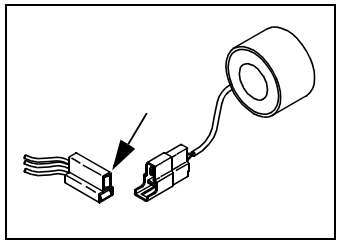
MX5654

(1) Install a jumper wire across terminals A and B on seat switch side of connector (X38). Does the cruise control magnet (Y3) produce a magnetic field?

System: Cruise Control Circuit Diagnosis - Gas Engine: Test Procedure A

Yes - If the cruise control magnet produces a strong magnetic field and the magnet clamps tightly against forward hydrostatic control pedal arm, test the seat switch (S2).

No - If the cruise control magnet does not produce a strong magnetic field and clamp tightly against forward hydrostatic control pedal arm, go to next step.

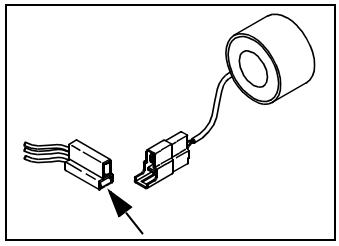


MIF MX5870

(2) Is voltage present at 835/836 Pnk wires on cruise control magnet connector (Y3).

Yes - Go to next step.

No - Go to step (4) to continue test.



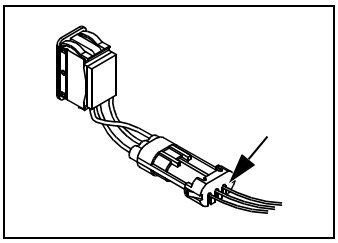
MIF MX5870

(3) Is there continuity between 135 Blk wire on cruise control magnet connector (X39) and ground?

Yes - Test the cruise control magnet (Y3).

No - Replace main wiring harness.

System: Cruise Control Circuit Diagnosis - Gas Engine: Test Procedure A



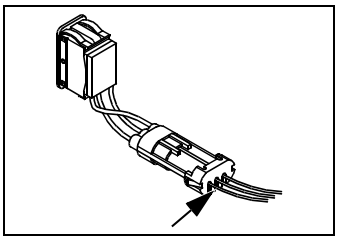
MIF MX5869

(4) Using a small diameter probe between wire and testing both sides of connector socket seal, is voltage present at terminal C, 837 Pnk wire of cruise control switch connector (X3)?

Yes - Replace main wiring harness (W4).

Yes - If voltage is not present at both sides of connector, repair or replace connector.

No - Go to next step.

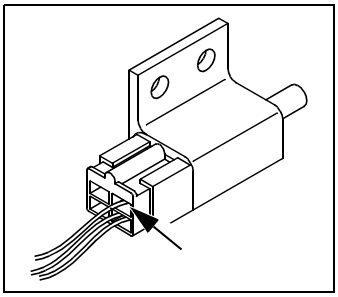


MIF MX5869

(5) Using a small diameter probe between wire and testing both sides of connector socket seal, is voltage present at terminal A, 832 Pnk wire of cruise control switch connector (X3)?

Yes - Replace cruise control switch (S6).

No - If battery voltage is not present at both sides of connector, repair or replace connector.



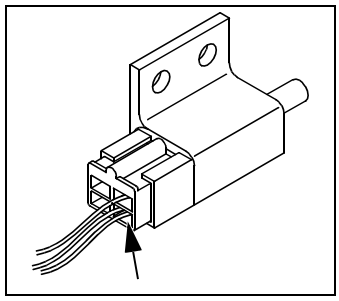
MIF MX5868

(6) Is voltage present at 832 Pnk wire of cruise control brake switch connector (X40)?

No - Go to next step.

Yes - replace main wiring harness (W4).

System: Cruise Control Circuit Diagnosis - Gas Engine: Test Procedure A

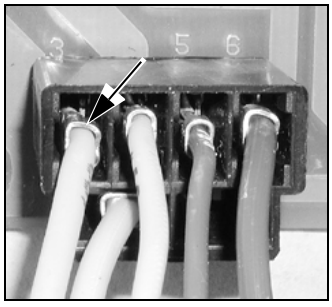


MIF MX5868

(7) Is voltage present at 830/831 Pnk wire of cruise control bake switch connector (X40)?

No - Go to next step.

Yes - Replace cruise control brake switch (S5).

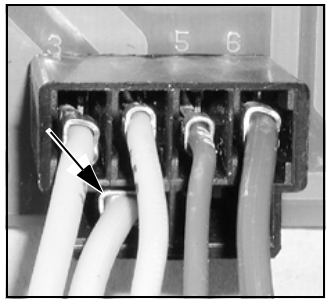


MX5650

(8) Is voltage present at terminal 3, 402 Yel wire of control module connector (X32)?

No - Go to next step.

Yes - Replace main wiring harness (W4).



MX5650

(9) Is voltage present at terminal 1, 480 Yel wire of control module connector (X32)?

Yes - If fuse (F3) is good, replace control module (A1).

No - See “Power Circuit Diagnosis - Gas Engine” on page 347.

Test Procedure B

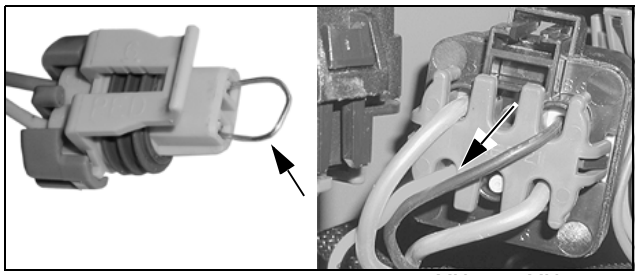
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- Park brake and service brakes UNLOCKED (cruise control brake switch at the brake in UNLOCKED position).
- Cruise control switch moved to the ENGAGE position, the allowed to go to the ON position.
- Meter or test light negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Cruise Control Circuit Diagnosis - Gas Engine: Test Procedure B



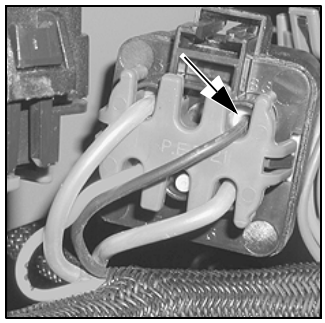
MX5654, MX58724

(1) Install a jumper wire across terminals A and B on seat switch side of connector (X38). Using a small diameter probe between wire and relay socket seal, is voltage present at terminal 85, 835 Pnk of cruise control relay (K6)?

Yes - Go to next step.

No - Replace main wiring harness (W4).

System: Cruise Control Circuit Diagnosis - Gas Engine: Test Procedure B

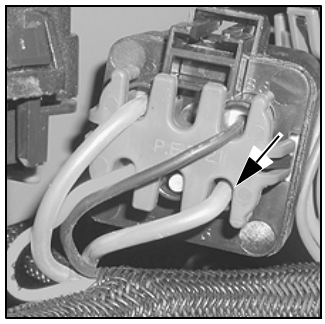


MX5872

(2) Is continuity present between terminal 86, 130 Blk wire of cruise control relay (K6) and ground?

Yes - Go to next step.

No - Replace main wiring harness (W4).

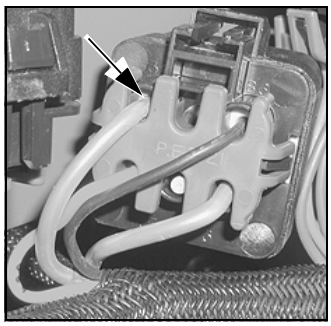


MX5872

(3) Is voltage present at terminal 87, 833 Pnk wire of cruise control relay (K6)?

Yes - Go to next step.

No - Go to step (5) to continue test.



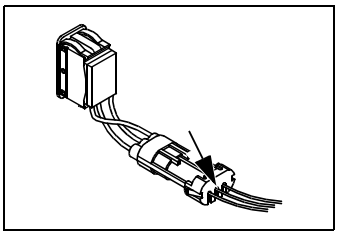
MX5872

(4) Using a small diameter probe between wire and relay socket, is there voltage present at terminal 30, 834 Pnk wire of cruise control relay (K6)?

Yes - Replace main wiring harness (W4).

No - Test cruise control relay (K6).

System: Cruise Control Circuit Diagnosis - Gas Engine: Test Procedure B



MIF MX5869

(5) Using a small diameter probe between wire and connector socket seal, is voltage present, on both sides of the connector, at terminal B, 833 Pnk wire of cruise control switch connector (X3)?

Yes - Replace main wiring harness (W4).

No - If voltage is present on only one side of connector, repair or replace connector.

No - Replace cruise control switch (S6).

Cruise Control Circuit Diagnosis - Diesel Engine

Front Mower

1435

1445

1545

IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

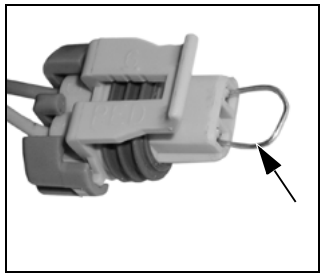
- If cruise control does not engage: Go to step (1). (Test Procedure A)
- If cruise control engages when cruise control switch is held at the ENGAGED position but does not stay ENGAGED when switch moves to the on position: Go to step (1). (Test Procedure B)

Test Procedure A

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- Park brake and service brakes UNLOCKED (cruise control brake switch at the UNLOCKED position).
- Cruise control at engage position.
- Meter or test light negative (BLACK) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.

System: Cruise Control Circuit Diagnosis - Diesel Engine: Test Procedure A

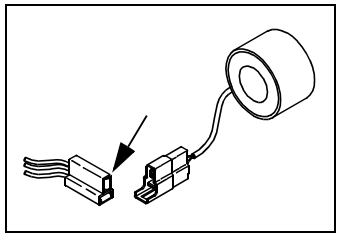


MX5654

(1) Install a jumper wire across terminals A and B on seat switch side of connector (X37). Does the cruise control magnet (Y3) produce a magnetic field?

Yes - If the cruise control magnet produces a strong magnetic field and the magnet clamps tightly against forward hydrostatic control pedal arm, test the seat switch (S2).

No - If the cruise control magnet does not produce a strong magnetic field and clamp tightly against forward hydrostatic control pedal arm, go to next step.



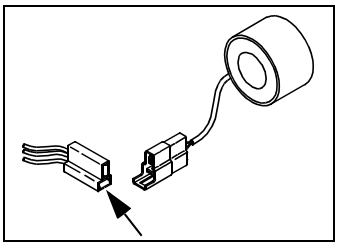
MIF MX5870

(2) Is voltage present at 835/836 Pnk wires on cruise control magnet connector (X38).

Yes - Go to next step.

No - Go to step (4) to continue test.

System: Cruise Control Circuit Diagnosis - Diesel Engine: Test Procedure A

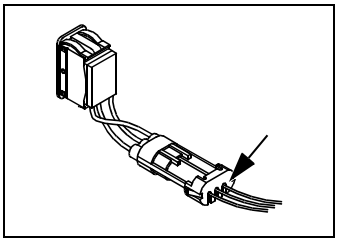


MIF MX5870

(3) Is there continuity between 135 Blk wire on cruise control magnet connector (X38) and ground?

Yes - Test the cruise control magnet (Y3).

No - Replace main wiring harness.



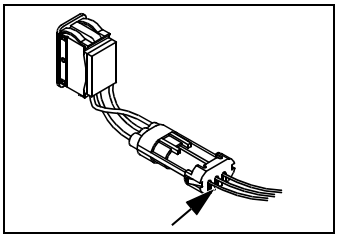
MIF MX5869

(4) Using a small diameter probe between wire and testing both sides of connector socket seal, is voltage present at terminal C, 837 Pnk wire of cruise control switch connector (X3)?

Yes - Replace main wiring harness (W4).

Yes - If voltage is not present at both sides of connector, repair or replace connector.

No - Go to next step.



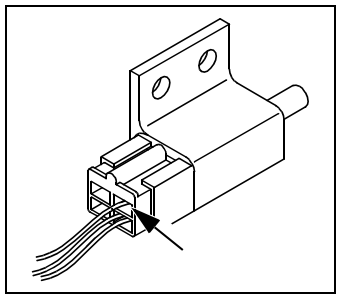
MIF MX5869

(5) Using a small diameter probe between wire and testing both sides of connector socket seal, is voltage present at terminal A, 832 Pnk wire of cruise control switch connector (X3)?

Yes - Replace cruise control switch (S6).

No - If battery voltage is not present at both sides of connector, repair or replace connector.

System: Cruise Control Circuit Diagnosis - Diesel Engine: Test Procedure A

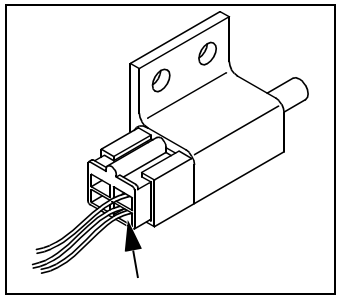


MIF MX5868

(6) Is voltage present at 832 Pnk wire of cruise control brake switch connector (X39)?

No - Go to next step.

Yes - replace main wiring harness (W4).

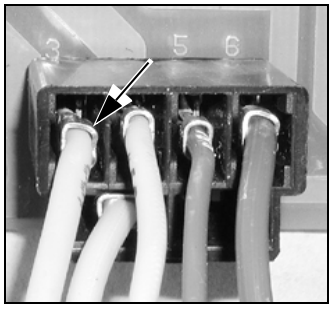


MIF MX5868

(7) Is voltage present at 830/831 Pnk wire of cruise control bake switch connector (X39)?

No - Go to next step.

Yes - Replace cruise control brake switch (S5).



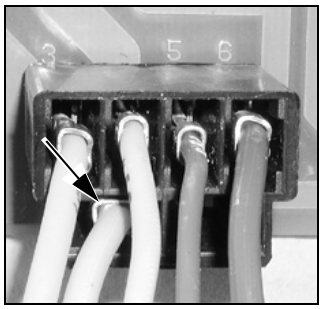
MX5650

(8) Is voltage present at terminal 3, 402 Yel wire of control module connector (X31)?

No - Go to next step.

Yes - Replace main wiring harness (W4).

System: Cruise Control Circuit Diagnosis - Diesel Engine: Test Procedure A



MX5650

(9) Is voltage present at terminal 1, 480 Yel wire of control module connector (X31)?

Yes - If fuse (F3) is good, replace control module (A1).

No - See “Power Circuit Diagnosis - Diesel Engine” on page 352.

Test Procedure B

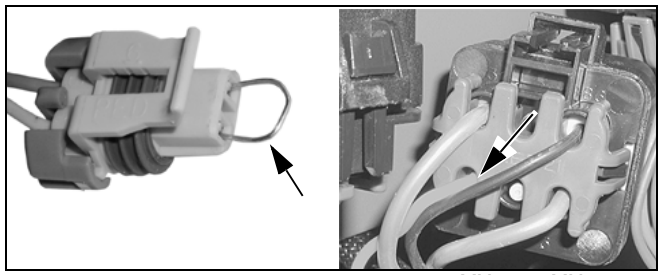
IMPORTANT: Avoid damage! Do not insert any test probes into female terminals of METRI-PACK™ connectors. Damage to terminals may occur. Touch terminals lightly with probes when testing.

NOTE: If a wire is determined to be faulty, the only recommended repair is to replace the entire wiring harness.

Test Conditions:

- Machine parked safely.
- Key switch in RUN position with engine OFF.
- Parked brake and engine brakes UNLOCKED (cruise control brake switch at the brakes UNLOCKED position).
- Cruise control switch moved to the engage position, then allowed to go to the ON position.
- Meter or test light negative (BLACK) lead on battery negative (-) terminal.
- Check connections for corrosion and looseness when testing.

System: Cruise Control Circuit Diagnosis - Diesel Engine: Test Procedure B

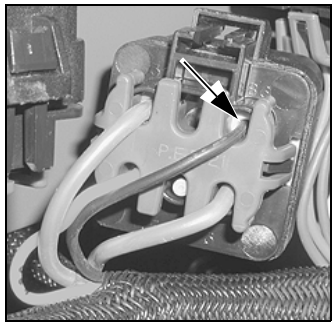


MX5654, MX5872

(1) Install a jumper wire across terminals A and B on seat switch side of connector (X37). Using a small diameter probe between wire and relay socket seal, is voltage present at terminal 85, 835 Pnk of cruise control relay (K8)?

Yes - Go to next step.

No - Replace main wiring harness (W4).

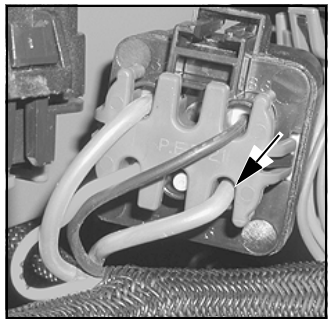


MX5872

(2) Is continuity present between terminal 86, 130 Blk wire of cruise control relay (K8) and ground?

Yes - Go to next step.

No - Replace main wiring harness (W4).



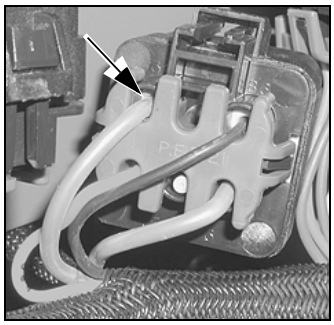
MX5872

(3) Is voltage present at terminal 87, 833 Pnk wire of cruise control relay (K8)?

Yes - Go to next step.

No - Go to step (5) to continue test.

System: Cruise Control Circuit Diagnosis - Diesel Engine: Test Procedure B

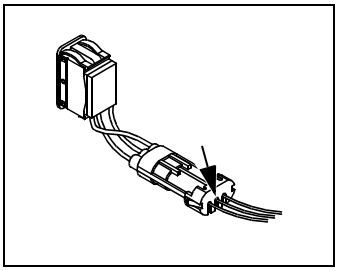


MX5872

(4) Using a small diameter probe between wire and relay socket, is there voltage present at terminal 30, 834 Pnk wire of cruise control relay (K8)?

Yes - Replace main wiring harness (W4).

No - Test cruise control relay (K8).



MIF MX5869

(5) Using a small diameter probe between wire and connector socket seal, is voltage present, on both sides of the connector, at terminal B, 833 Pnk wire of cruise control switch connector (X3)?

Yes - Replace main wiring harness (W4).

No - If voltage is present on only one side of connector, repair or replace connector.

No - Replace cruise control switch (S6).

Tests and Adjustments

Ground Circuit Test

Reason:

To check for open circuits, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

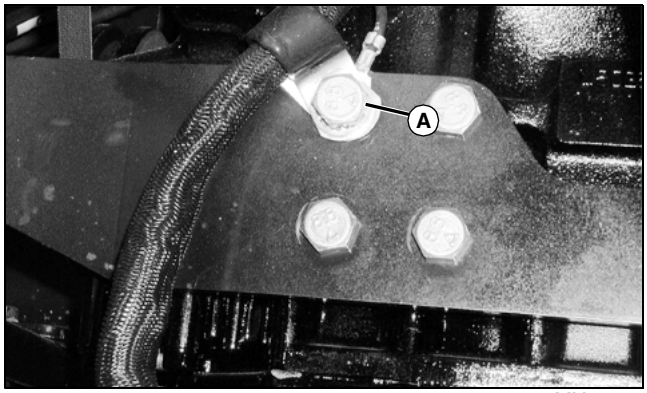
Equipment:

- Ohmmeter or voltmeter

NOTE: The voltmeter method checks ground connections under load.

Procedure - Ohmmeter Method:

1. Park machine on level surface.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Raise seat platform.
6. Connect ohmmeter negative (BLACK) lead to negative (-) terminal of battery. Connect meter positive (RED) lead to negative (-) terminal of battery and record reading.



MX5789

7. Connect ohmmeter RED lead to ground terminal of circuit (A) or component to be tested that is closest to the battery negative (-) terminal. **Resistance reading must be the same or very close to the battery negative (-) terminal reading. Work backward from the battery frame ground on the ground side of the problem circuit until the resistance reading increases above 0.1 ohm.** The problem is between the last two test points. If a problem is indicated, disconnect the wiring harness connector to isolate the wire or component and check resistance again. **Maximum allowable resistance in the circuit is 0.1 ohms.** Check both sides of the connectors closely, as disconnecting and connecting may **temporarily** solve the problem.

Procedure - Voltmeter Method:

1. Park machine on level surface.
2. Disengage PTO.
3. Turn key switch to ON position.
4. LOCK park brake.
5. Raise seat platform.
6. Connect voltmeter negative (BLACK) lead to negative (-) terminal of battery.
7. Connect voltmeter positive (RED) lead to ground terminal of circuit (1) or component to be tested. Be sure that component circuit is activated (see appropriate circuit operation description) so that voltage will be present at the component. Record voltage. **Voltage must be greater than 0, but less than 1.0 volt.** Some components will have a very small voltage reading on the ground side and still be operating correctly.

Results:

- If voltage is 0, the component is open.
- If voltage is greater than 1.0 volt, the ground circuit is bad. Check for open wiring, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

Battery Test

CAUTION: Avoid injury! Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into the eyes.

Avoid the hazard by:

1. Filling batteries in a well-ventilated area.

2. Wearing eye protection and rubber gloves.

3. Avoiding breathing fumes when electrolyte is added.

4. Avoiding spilling or dripping electrolyte.

5. Using proper jump start procedure.

If you spill acid on yourself:

1. Flush your skin with water.

2. Apply baking soda or lime to help neutralize the acid.

3. Flush your eyes with water for 15 - 30 minutes. Get medical attention immediately.

If acid is swallowed:

1. Do not induce vomiting.

2. Drink large amounts of water or milk, but do not exceed 1.9 L (2 qts).

3. Get medical attention immediately.

Reason:

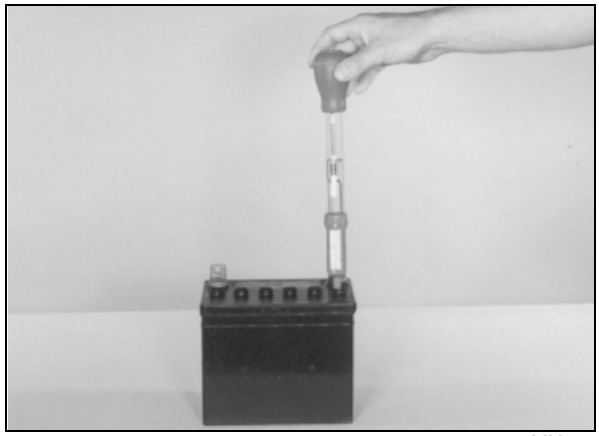
To check condition of battery and determine battery voltage.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Hydrometer	NA	Used to check specific gravity of electrolyte in battery cells.
Battery Tester (or Voltmeter)	JT05685	Used to measure battery voltage.

Procedure:

1. Park machine on level surface.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Raise seat platform.
6. Clean cable ends, battery terminals and top of battery.
7. Remove battery.
8. Inspect battery terminals and case for breakage or cracks.
9. Check electrolyte level in each battery cell. Add clean, soft water as needed. If water is added, charge battery for **20 minutes at 10 amps.**



MX5926

10. Remove surface charge by placing a small load on the battery for 15 seconds.
11. Use a hydrometer to check for a **minimum specific gravity of 1.225 with less than 50 point variation in each cell**.

Results:

- If all cells are less than 1.175, charge battery at 10 amp rate.
- If all cells are less than 1.225 with less than 50 point variation, charge battery at 10 amp rate.
- If all cells are more than 1.225 with less than 50 point variation, load test battery.

12. Use a voltmeter or JT05685 Battery Tester to check for a **minimum battery voltage of 12.4 VDC**.

Results:

- If battery voltage is less than 12.4 VDC, charge battery.
- If battery voltage is more than 12.4 VDC, test specific gravity. (See step 11.)

13. Install battery.

Charge Battery

Reason:

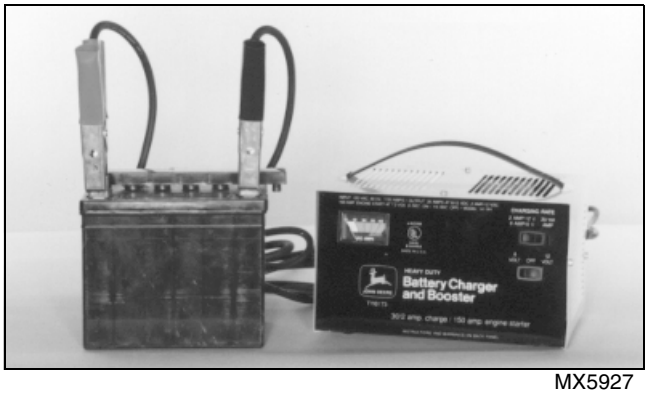
To increase battery charge after the battery has been discharged.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Charger	NA	Used to charge the battery.

Procedure:

1. Park machine on level surface.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Raise seat platform.
6. Clean cable ends, battery terminals and top of battery.
7. Remove battery and check water level.
8. Connect variable rate charger to battery.



MX5927

9. 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.

10.Check if battery is accepting 10 amp charge rate after 10 minutes at boost setting.

Results:

- If battery will not accept 10 amp charge after 10 minutes at boost setting, replace battery.
- If battery is accepting 10 amp charge after 10 minutes at boost setting, and battery did not need water, go to steps 11 and 12.
- If battery is accepting 10 amp charge after 10 minutes at boost setting, but battery DID need water or all cells were below 1.175, go to steps 9 and 10.

11.Set charger at 15 - 25 amps.

IMPORTANT: Avoid damage! Decrease charge rate if battery gases or bubbles excessively or becomes too warm to touch.

12.Check specific gravity after 30 minutes (60 minutes for maintenance-free battery).

Results:

- If more than 50 point variation between cells, replace battery.
- If less than 50 point variation between cells, go to step 13.

NOTE: If battery was discharged at slow or unknown rate, charge battery at 10 - 15 amps for 6 - 12 hours. (Maintenance-free battery: 4 - 8 hours).

13.Continue to charge battery until specific gravity is **1.230 - 1.265 points**.

14.Load test the battery (See “Battery Load Test” on page 468).

15.Install battery.

Battery Load Test

Reason:

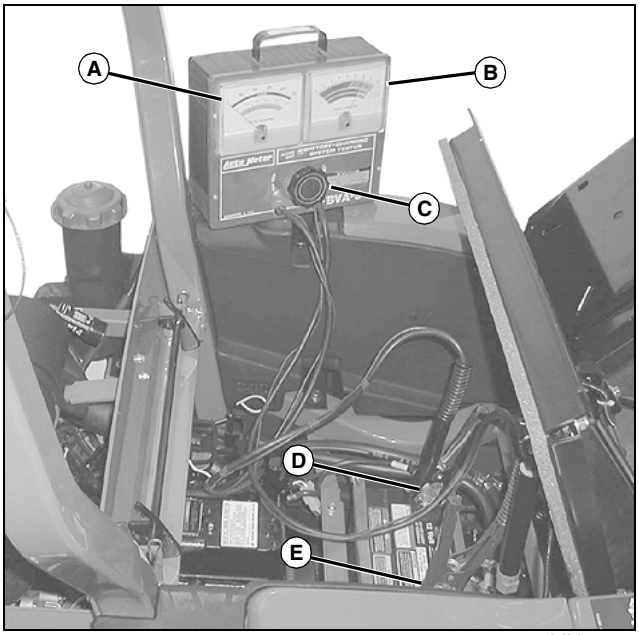
To check condition of battery under load.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Tester	JT05685	Used to provide a load for the battery and check battery condition while under load.

Procedure:

1. Park machine on level surface.
2. Disengage PTO.
3. Turn key switch to OFF position.
4. LOCK park brake.
5. Raise seat platform.
6. Clean cable ends, battery terminals and top of battery.
7. Remove battery.



MX5791

8. Turn load knob (C) counterclockwise to off position.

9. Connect tester positive (RED) cable to battery positive (+) terminal (E).

10.Connect tester negative (BLACK) cable to battery negative (-) terminal (D).

11.Turn load knob (C) of tester clockwise (in) until amperage reading (A) is equal to either of the following:

- cold cranking amperage rating of battery (use blue scale).
- three times ampere-hour rating (use black scale).

12.Hold for 15 seconds and turn load knob (C) of tester counterclockwise (out) to off position.

13.Repeat steps 8 and 9 and read condition of battery at DC volts scale (B).

Results:

- If battery does not pass test and has not been charged, charge battery and retest.
- If battery does not pass test and has been charged, replace battery.

Unregulated Amperage Test

55 Amp Alternator

Reason:

To determine the charging output of the alternator.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Current Gun	JT05712	Used to measure alternator output current.

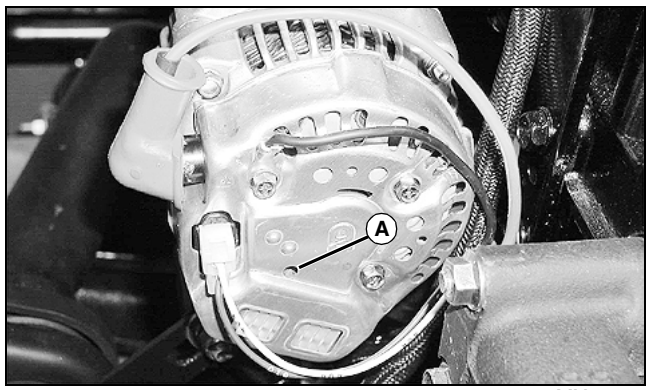
Connections:

1. Put JT05712 Current Gun over alternator Red wire.
2. Set current gun for DC current.

Procedure:

IMPORTANT: Avoid damage! Perform this test quickly to prevent damage to the battery. Do not apply full load to battery for more than 10 seconds.

1. Start engine and run at high idle.



MX5790

2. Insert a small Phillips screwdriver through the hole (A) in rear cover of alternator to ground the regulator to the rear cover. Read amperage on current gun.

Results:

- If reading does not meet specification, verify voltage at the alternator regulated terminal and good alternator ground. If voltage and ground are ok, replace the alternator.

Specifications:

Unregulated Amperage . . . . . 50 amps minimum

Regulated Voltage Output Test

Reason:

To check the regulated voltage (charging) output of the alternator.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Voltmeter	NA	Used to measure regulator output voltage.

Procedure:

1. Park machine safely.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Raise seat platform.
6. Remove surface charge from battery by cranking the engine for 15 seconds.
7. Set voltmeter for 25 - 50 VDC scale.
8. Connect meter RED lead to battery positive (+) terminal.
9. Connect meter BLACK lead to battery negative (-) terminal.
10. Start and run engine at fast idle.
11. Read meter several times during 5 minutes of running time. voltage should remain within specifications.

Results:

- If the DC voltage goes above the maximum specification, replace the alternator.

Specifications:

Regulated Voltage . . . . . .12.2 - 14.7 VDC

Starting Motor Loaded Amperage Draw Test

Reason:

To determine the amperage required to crank the engine and check starting motor operation under load.

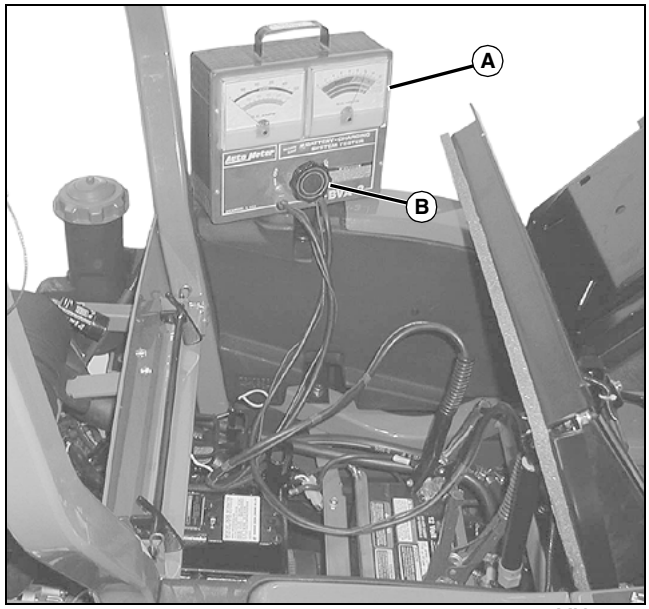
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Tester	JT05685	To simulate load of starting motor and measure the battery current under the simulated load.

Procedure:

1. Park machine safely.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Raise seat platform.
6. Test ground connections and battery.
7. Disconnect fuel shutoff solenoid connector.

IMPORTANT: Avoid damage! Turn load knob (B) fully counterclockwise before making any test connections.



MX5791

8. Connect JT05685 Battery Tester (A) to battery.
9. Crank engine and read voltage.
10. Turn key switch to the off position. Adjust load knob until battery voltage reads the same as when cranking.
11. Read amperage on meter.
12. Turn load knob fully counterclockwise.

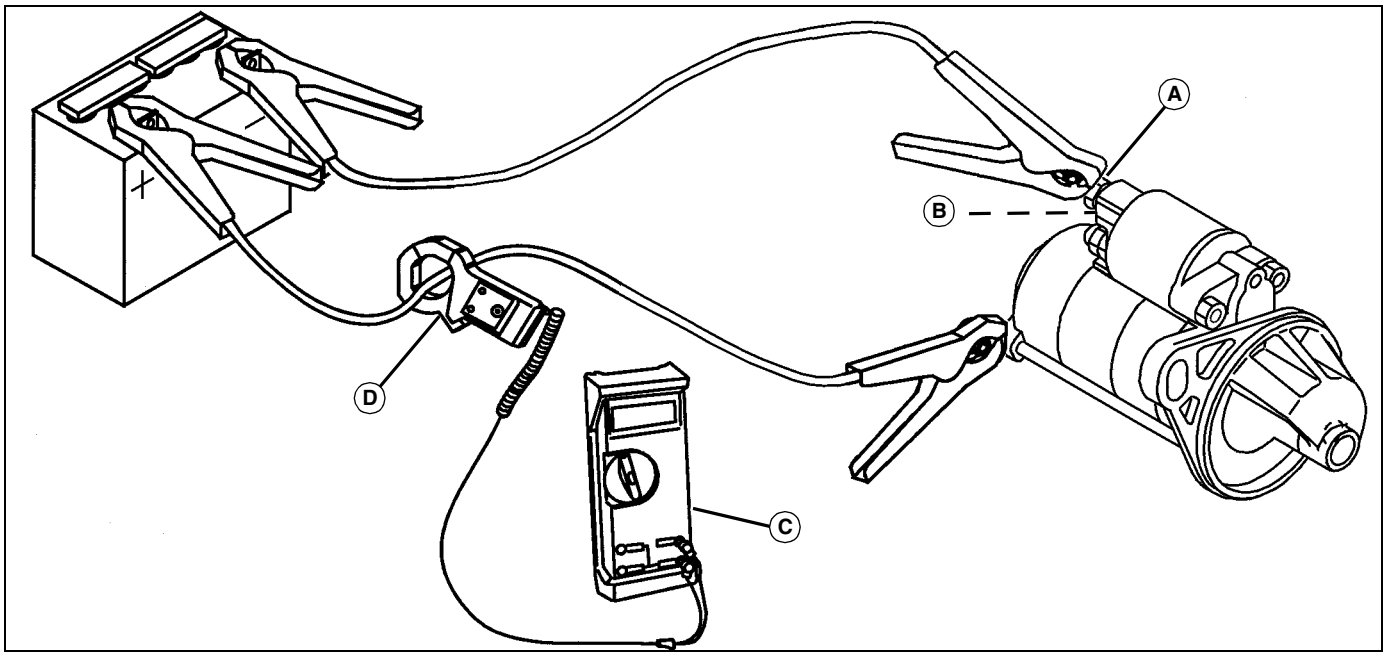
Results:

- If amperage is greater than specification, test starting motor no-load rpm and amperage (see “Starting Motor No-Load Amperage Draw and RPM Test” on page 471) to determine if the starting motor is binding or damaged.
- If the starting motor is good, check internal engine components for binding or damage.

Specifications:

Starting Motor Loaded Amperage . . . . . 230 amps

Starting Motor No-Load Amperage Draw and RPM Test



MX5796

Reason:

To determine if starter is binding ar has excessive amperage draw under no-load.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Current Clamp	JT02153	Used with Multitester to measure starting motor current draw.
Multitester	JT05791	Used with current clamp to measure starting motor current draw.
Digital Tachometer	Digital Tachometer	Used to measure speed of starting motor.
Jumper Cables	NA	Used to connect battery to starting motor.
Jumper Wire	NA	Used to energize starting motor solenoid to engage starting motor.

Procedure:

NOTE: Check battery is fully charged and of proper size to ensure accuracy of test.

1. Park machine safely.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Raise seat platform.
6. Remove starting motor assembly from machine and place starting motor in a vise.
7. Connect jumper cables to a 12-volt battery.
8. Connect positive (+) cable to solenoid battery terminal (1) on starting motor.
9. Connect negative (-) cable to starting motor body.
10. Attach current clamp (D) with multitester (C) to positive (+) cable.

IMPORTANT: Avoid damage! Complete this test in 20 seconds or less to prevent starting motor damage.

11. Use a jumper wire to briefly connect positive (+) starting motor terminal (A) to solenoid terminal pin (B). Starting motor should engage and run.
12. Read and record starting motor amperage and rpm.
13. Using JT05719 Digital Tachometer, read and record starting motor rpm.

Results:

- If solenoid clicks or chatters and starting motor does not turn, replace starting motor.
- If pinion gear engages and starting motor doesn't turn, replace starting motor.
- If starting motor engages and runs, but amperage is more than starting motor no-load amperage specification at no-load speed specification, repair or replace starting motor.
- If speed is less than specification, repair or replace starting motor.

Specifications:

Starting Motor No-Load Amperage . . . . . 90 amps

Starting Motor No-Load Speed . . . . . .3000 rpm

Air Preheater Test

Reason:

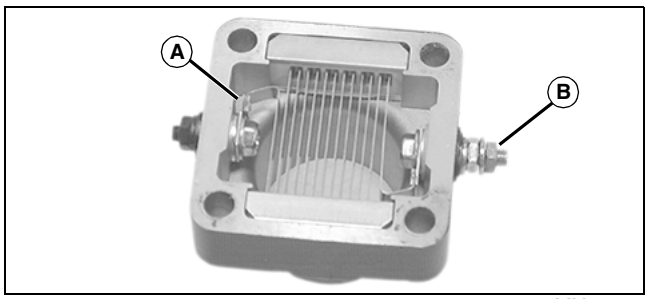
To test the condition of the engine air preheater.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to check continuity of air preheater.

Procedure:

1. Park machine safely.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Slide engine cover back.
6. Remove air preheater.



MX5805

7. Check continuity across terminal (B) and air preheater element (A).

Results:

- Resistance should be within specification.
- If resistance across the air preheater element is high, or completely open, replace the element.

Specifications:

Preheater Resistance . . . . . .0.3 - 0.5 ohms

Relay Test

Reason:

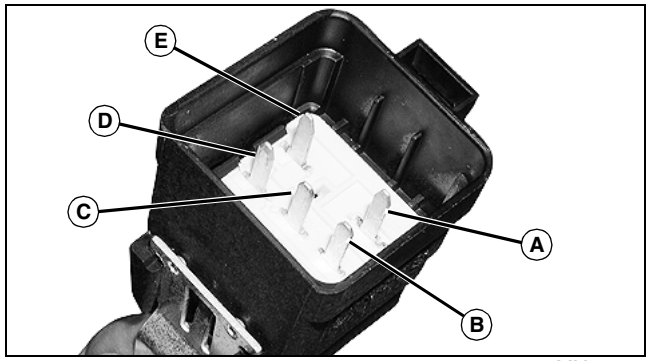
To check relay terminal continuity in the energized and de-energized condition.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to check continuity of relay contacts and resistance of relay coil.
12-V Battery	NA	Used to energize relay.

Procedure:

1. Park machine safely.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Slide engine cover back.
6. Remove relay from right side panel.
7. Check terminal continuity using an ohmmeter.



MX5788

8. **Results:**
   - There should be continuity between terminals 30 (E) and 87a (C).
   - There should be approximately 75 ohms resistance between terminals 85 (D) and 86 (A).
   - There should not be continuity between any other terminals.
   - If continuity is not correct, replace relay.

9. Connect a small jumper wire from battery positive (+) terminal to relay terminal 85 (D). Connect a small jumper wire from relay terminal 86 (A) to battery negative (-) terminal.

Results:

- There should be continuity between terminals 30 (E) and 87 (B).
- If continuity is not correct, replace relay.

Key Switch Test

Reason:

To verify that the key switch is operating properly.

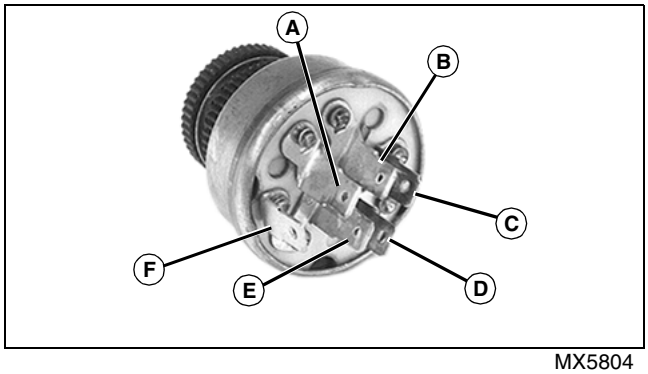
Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter or continuity tester	NA	Used to check continuity of key switch.

Procedure:

1. Park machine safely.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Remove upper steering column cover.
6. Disconnect key switch connector.
7. Use an ohmmeter or continuity tester to test switch continuity in STOP, run, and start positions.

NOTE: Do not refer to markings stamped on terminals. Identify by art keys only. Terminal combinations other than those listed should not have continuity.



MX5804

Results:

Key Switch Continuity	
Switch Position	**Terminal Continuity**
Stop	C and D
Run	E and F
Start	E and F A and B

- If any continuity is **not** correct, or continuity exists in any other combination than listed above, replace the switch.

Brake Switch Test

Reason:

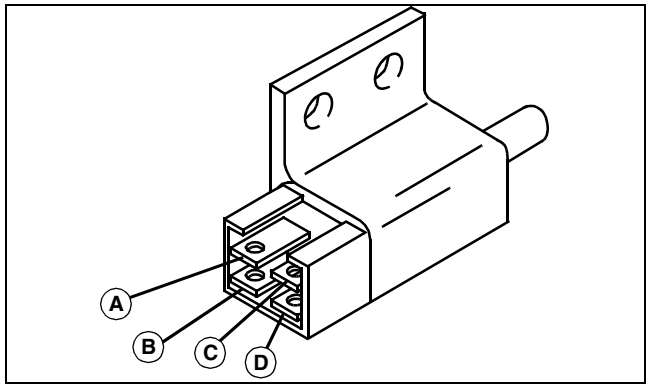
To verify that the brake switch functions properly.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Park machine safely.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. Raise seat platform.
5. Disconnect brake switch connector.
6. Use an ohmmeter or continuity tester to test switch continuity in both positions.



MX5798

Results:

Brake Switch Continuity	
Switch Position	**Terminal Continuity**
Released	A and B
Depressed	C and D

- If any continuity is **not** correct, or continuity exists in any other combination than listed above, replace the switch.

Adjustment Procedure:

1. LOCK parking brake.
2. Loosen switch bracket hardware.
3. Move switch body until there is approximately 3 mm (0.12 in.) between switch plunger and tab of mixer arm.
4. Check to ensure switch is not fully depressed when parking brake is fully released. Increase clearance if needed.
5. Tighten bracket hardware.
6. Check switch operation.

Seat Switch Test

Reason:

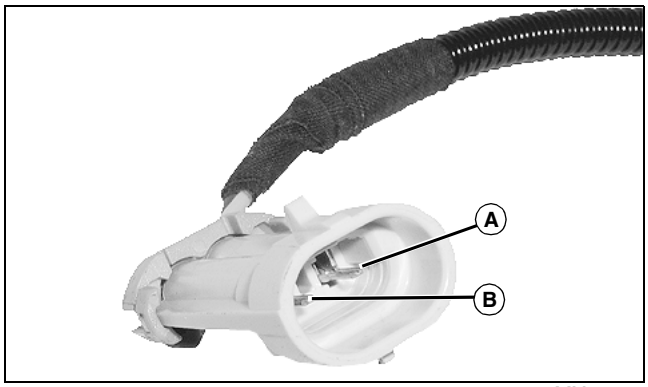
To verify that the seat switch functions properly.

Equipment:

- Ohmmeter or continuity tester

Procedure:

1. Park machine safely.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Raise seat platform and slide engine cover back.
6. Disconnect seat switch connector from wiring harness.
7. Use an ohmmeter or continuity tester to check continuity across connector terminals. There should be no continuity.



MX5793

8. Depress seat. Continuity should exist between terminals (A and B).

Results:

- If any continuity is **not** correct, replace seat switch.

Engine Oil Pressure Switch Test

Reason:

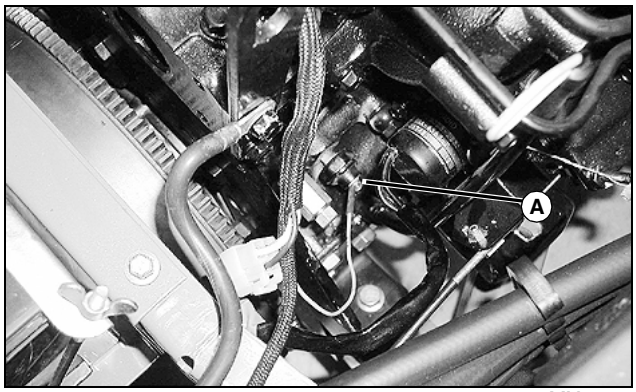
To determine if engine oil pressure switch is functioning properly.

Equipment:

- Ohmmeter

Procedure:

1. Park machine safely on a level surface.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. Slide engine cover back.



MX5794

5. Disconnect 620 Tan wire from oil pressure switch (A).
6. Connect BLACK lead of ohmmeter to engine block and RED lead of ohmmeter to terminal of switch.
7. Measure resistance between terminal and engine block.

Results:

- There should be continuity between terminal and ground.
- It 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 any time it is installed.

8. Start and run engine.
9. Check continuity 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 (see appropriate Engine section), replace the oil pressure switch.

Dual Temperature Coolant Switch Test

Reason:

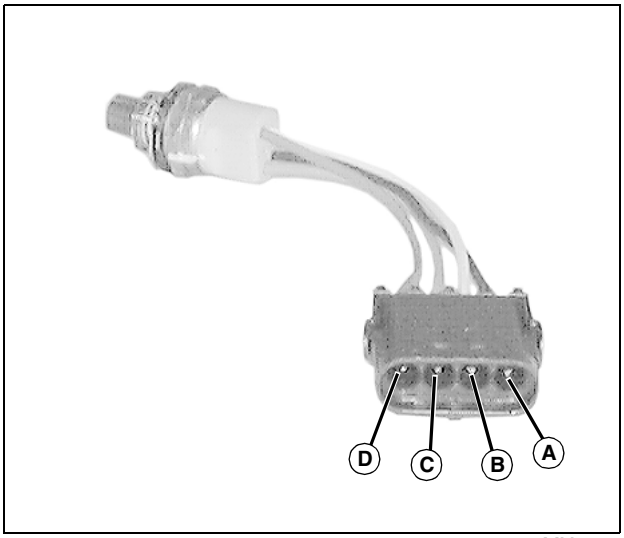
To determine if the dual temperature coolant switch is functioning properly.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Multimeter	NA	Used to check continuity and measure resistance.
Thermometer	NA	Used to measure temperature at which light bulbs illuminate.
Container	NA	Used to hold heated oil for test.
Heating Unit	NA	Used to heat oil for test.

Procedure:

1. Park machine safely on a level surface.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Slide engine cover back.
6. Disconnect the dual temperature coolant switch from the harness.



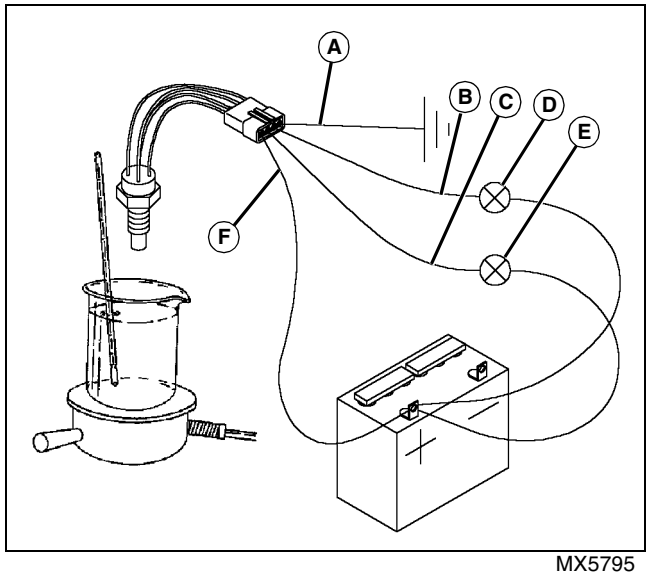
MX5809

7. Check continuity across all switch terminals with the engine cold.

Black / Red	A	B	C	D
A		4.91M	4.91M	1.48M
B	OL		OL	OL
C	OL	OL		OL
D	OL	2.72M	2.72M	

8. Set the multimeter to measure ohms; use the chart to sequentially test continuity across each terminal combination. The RED lead position of the meter is listed down the side and the BLACK lead position of the meter is listed across the top of the chart.

9. If the resistance readings are not correct, replace switch. If readings are correct, remove switch from the machine and proceed to next step.



MX5795

A - Terminal D (Logic Ground)
B - Terminal C (Light/Buzzer)
C - Terminal B (Fan)
D - Light Bulb (Light/Buzzer)
E - Light Bulb (Fan)
F - Terminal A (Logic Power)

10. Connect dual temperature coolant switch terminals to ground, light bulbs, and battery as shown.

11. Submerge end of switch in oil and secure harness to container.

CAUTION: Avoid injury! Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer and do not exceed 182°C (360°F). Do not allow a flame or heating element to be in direct contact with the oil. Heat the oil in a well ventilated area. Plan a safe handling procedure to avoid burns.

12.Heat oil and observe temperature and operation of switch.

- At 91°C (195°F), bulb (5) should illuminate (fan on).
- At 110°C (230°F), bulb (4) should illuminate (light/buzzer on).

13.Allow oil to cool and observe temperature and operation of switch.

- At 100°C (212°F), bulb (4) should go off (light/buzzer off).
- At 79°C (175°F), bulb (5) should go off (fan off).

Results:

- If light bulbs do not go on and off at specified temperatures, replace switch.

Specifications:

Dual Temperature Coolant Switch Closing Temperature (Fan On). . . . . 91°C (195°F)

Dual Temperature Coolant Switch Over Temperature (Light/Buzzer on) . . . . . 110°C (230°F)

Dual Temperature Coolant Switch Over Temperature (Light/Buzzer off) . . . . . 100°C (212°F)

Dual Temperature Coolant Switch Opening Temperature (Fan off). . . . . 79°C (175°F)

Glow Plug Test

Reason:

To check the condition of the glow plugs.

Equipment:

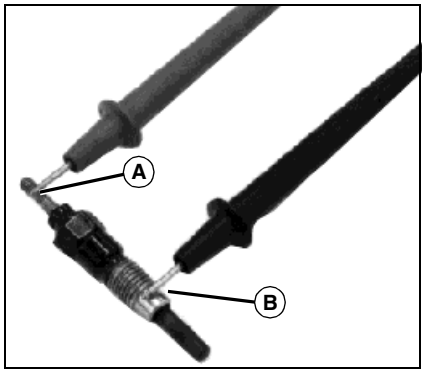
- Ohmmeter

Procedure:

1. Park machine safely on a level surface.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Slide engine cover back.

IMPORTANT: Avoid damage! Cover glow plug hole to prevent debris from entering cylinder when glow plug is removed.

6. Remove glow plug lead. Remove glow plug.



M46296

7. Check continuity across terminal (A) and glow plug body (B). The reading should be within specification.

Results:

- If glow plug does not have proper resistance, replace glow plug.

Specifications:

Glow Plug Resistance . . . . . .0.2 - 0.5 ohms

Diode Test

Reason:

To verify proper diode operation.

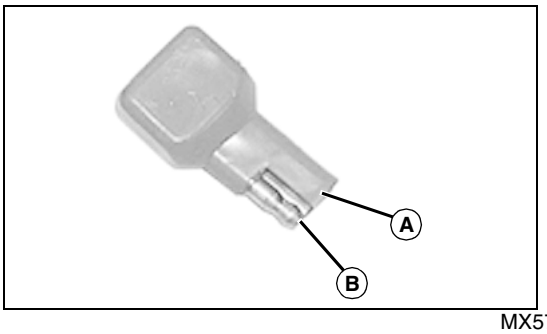
Equipment:

- Ohmmeter, continuity tester or multimeter

Procedure:

1. Park machine safely on a level surface.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Remove diode from wiring harness.
6. Set multimeter to diode test range.

NOTE: The multimeter will measure and display voltage drop across diode when set to diode test range.



MX5792

7. Connect multimeter leads across diode terminals (A and B). Check meter.
8. Reverse position of multimeter leads and retest.

NOTE: If using ohmmeter for test, diode should have continuity in one direction only. If a diode has continuity in both directions, or has no continuity, replace diode.

Results:

- Meter should beep once in one meter lead position only.
- Meter has continuous tone in either position. Diode is shorted; replace diode.
- Meter displays “OL” in both positions. Diode is “open”; replace diode.

PTO Switch Test

Reason:

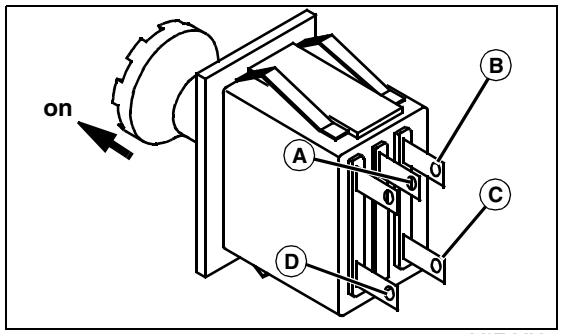
To verify proper PTO switch operation.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Ohmmeter or continuity	NA	Used to check continuity of PTO switch.

Procedure:

1. Park machine safely on a level surface.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Slide engine cover back.
6. Disconnect PTO switch connector from harness and remove switch.
7. Use an ohmmeter or continuity tester to test switch continuity.



MIF MX5801

PTO Switch Continuity	
Switch Position	**Terminal Continuity**
On	A and B
Off	C and D

Results:

- If continuity is not correct, replace the switch.

Light Switch Test

Reason:

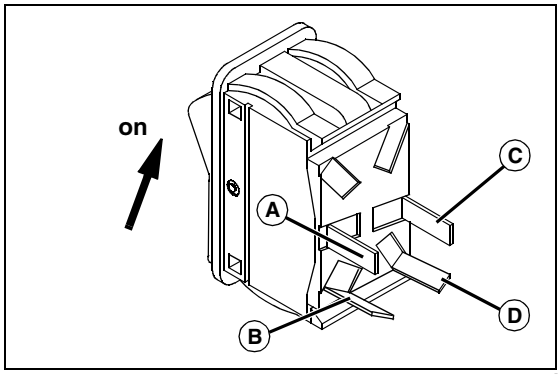
To verify proper switch operation.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Ohmmeter or continuity	NA	Used to check continuity of PTO switch.

Procedure:

1. Park machine safely on a level surface.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Remove steering column cover.
6. Disconnect light switch connector from harness.
7. Use an ohmmeter or continuity tester to test switch continuity.



MIF

Light Switch Continuity	
Switch Position	**Terminal Continuity**
On	A and B C and D

Results:

- If continuity is not correct, replace the switch.

Cruise Control Switch Test

Reason:

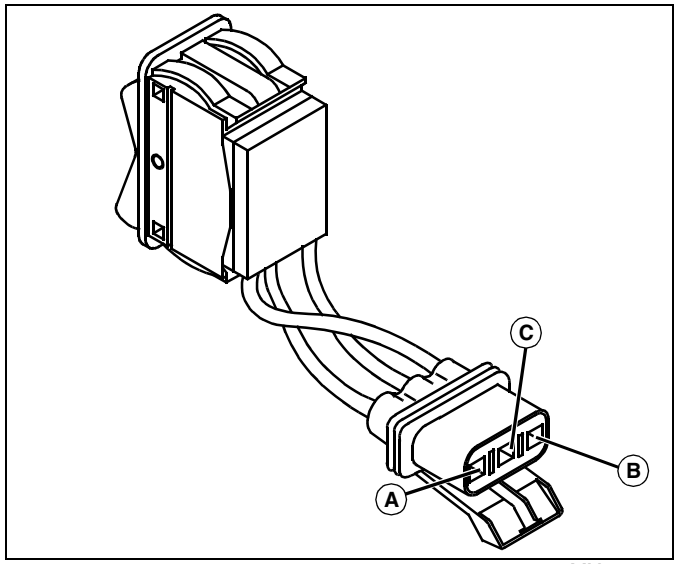
To verify proper cruise control switch operation.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Ohmmeter or continuity	NA	Used to check continuity of cruise control switch.

Procedure:

1. Park machine safely on a level surface.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Remove upper steering column cover.
6. Disconnect cruise control switch connector from harness.
7. Use an ohmmeter or continuity tester to test switch continuity.



MX5799

Cruise Control Switch Continuity	
Switch Position	**Terminal Continuity**
Off	None
On	A and C
Engage (momentary)	A, B and C

Results:

- If continuity is not correct or exists in any other combination than shown above, replace the switch.

Cruise Control Magnet Test

Reason:

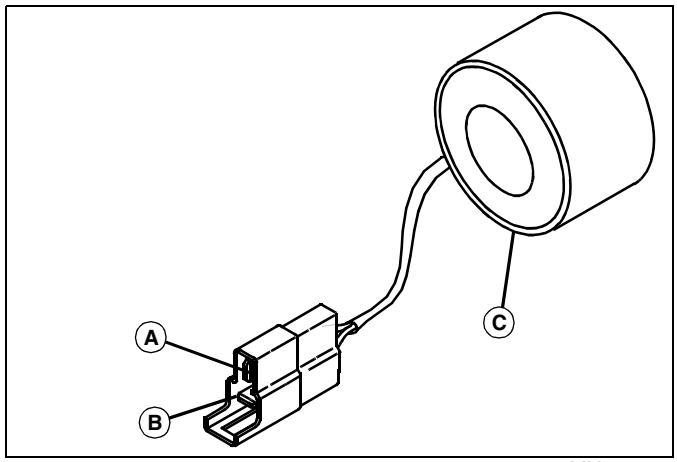
To verify proper cruise control magnet operation.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Ohmmeter or continuity tester	NA	Used to check continuity of cruise control magnet.

Procedure:

1. Park machine safely on a level surface.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. LOCK park brake.
5. Raise seat platform.
6. Disconnect cruise control magnet connector from harness.
7. Use an ohmmeter or continuity tester to test magnet and terminal-to-housing continuity.



MX5800

Cruise Control Magnet Continuity	
A to B	See Specification
A to Magnet Housing (C)	None
B to Magnet Housing (C)	None

Results:

- If continuity is not correct or resistance is not to specification, replace the magnet.

Specifications:

Cruise Control Magnet Resistance . . . . . Approximately 20 ohms

Fuel Shutoff Solenoid Test

Reason:

To verify proper fuel shutoff solenoid operation.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to measure resistance of fuel shutoff solenoid coils.

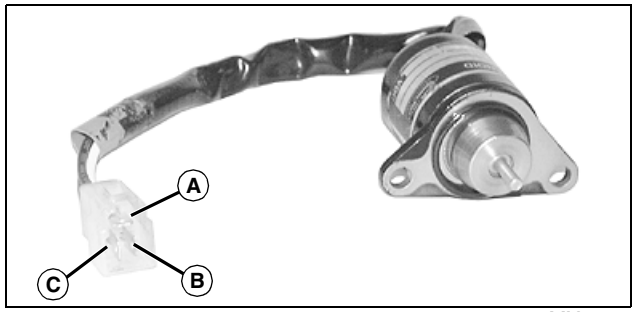
Procedure:

1. Park machine safely on a level surface.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. Move travel pedals to NEUTRAL position.
5. LOCK park brake.
6. Turn key switch to RUN position. A click should be heard as the solenoid engages.

Results:

- If a click is not heard, proceed to next step.

7. Slide engine cover back.
8. Disconnect the solenoid connector from the harness.



MX2492

9. Using an ohmmeter, check resistance across terminals (A) and (B). Resistance should be within specification for fuel shutoff solenoid hold-in coil.
10. Using an ohmmeter, check resistance across terminals (A) and (C). Resistance should be within specification for fuel shutoff solenoid pull-in coil.

Results:

- If resistance is not to specifications, replace fuel shutoff solenoid.

Specifications:

Fuel Shutoff Solenoid Resistance

Pull-In Coil . . . . . 0.4 ohms
Hold-In Coil . . . . . 12.0 ohms

Repair

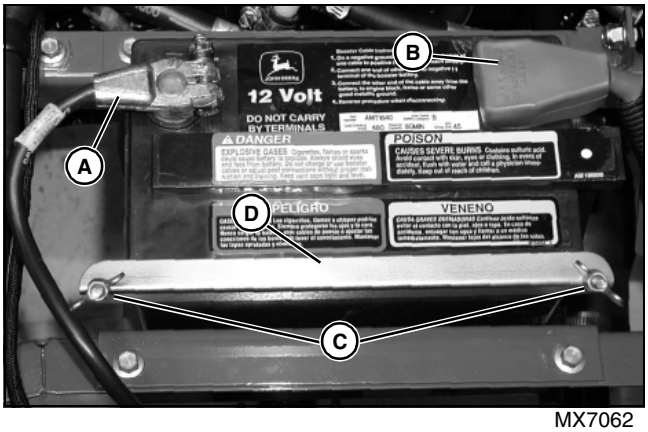
Battery Removal and Installation

CAUTION: Avoid injury! A battery explosion can be caused by sparks when removing or installing battery:

- **Do not smoke.**
- **Wear eye protection and gloves.**
- **Do not allow direct metal contact across battery posts.**
- **Disconnect negative (-) cable first when removing battery.**
- **Connect positive (+) cable to battery first when installing battery.**

Removal:

1. Park machine safely.
2. Raise operator's seat platform.



MX7062

3. Disconnect negative (-) battery cable (A).
4. Pull up red plastic cover (B) and disconnect positive (+) battery cable clamp from battery post.
5. Remove wing nuts (C) from left and right side of battery hold-down bracket (D).
6. Remove battery from machine.
7. Clean and inspect battery for damage. Replace battery if necessary.
8. Check battery electrolyte level. Add as needed.

Installation:

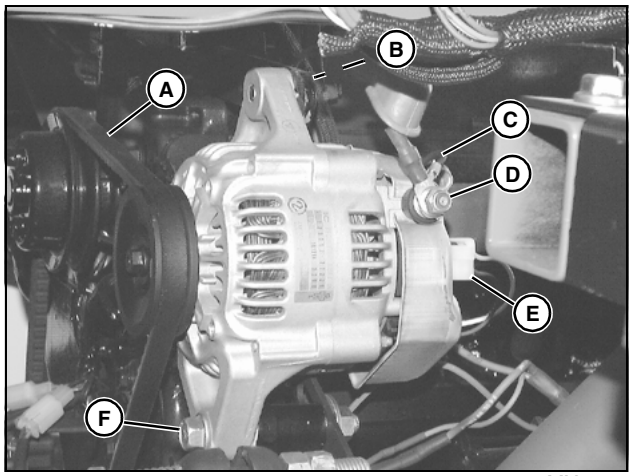
- Installation is done in the reverse order of removal.
- Install battery J-bolts, battery hold down bracket and wing nuts.
- Install positive (+) cable clamp onto positive (+) battery post. Replace plastic cover.
- Install negative (-) battery cable onto negative (-) battery post.
- Lower operator's seat platform.

Alternator Removal and Installation - 1420 and 1435

Removal:

IMPORTANT: Avoid damage! Always disconnect the negative (-) cable from the battery before working on any electrical components.

1. Disconnect the negative (-) cable from the battery.
2. Remove the engine cover.



MX5450

3. Disconnect ground lead (C).
4. Lift the red plastic protective cover from the positive (RED) lead (D). Remove the nut and washer, and remove the lead from the alternator stud.
5. Disconnect wire harness connector (E) from the alternator.
6. Remove the mounting cap screws (B and F), and belt (A).
7. Remove the alternator.

Installation:

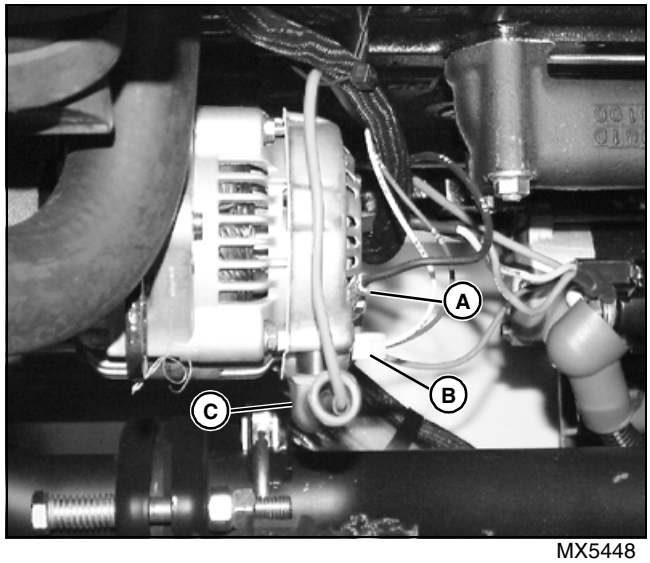
1. Install alternator. Installation is done in the reverse order of removal.
2. Tighten the alternator belt. (See Alternator Drive Belt Adjustment in the appropriate engine section.)

Alternator Removal and Installation - 1445/ 1545/1565

Removal:

IMPORTANT: Avoid damage! Always disconnect the negative (-) cable from the battery before working on any electrical components.

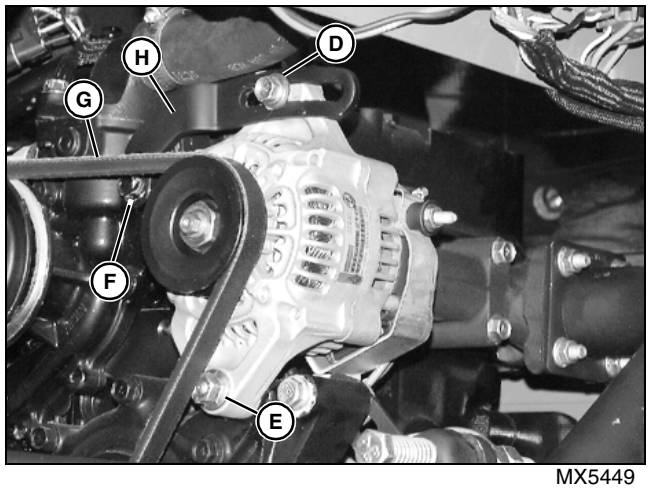
1. Disconnect the negative (-) cable from the battery.
2. Remove the engine cover.



MX5448

Picture Note: 1445 Model Shown

3. Disconnect ground lead (A).
4. Lift the plastic protective cover from the positive (RED) lead (B). Remove the nut and washer, and disconnect the lead from the alternator stud.
5. Disconnect the wire harness connector (C) from the alternator.



MX5449

Picture Note: 1565 Model Shown

6. Remove mounting cap screws (D and F). Remove bracket (H).
7. Remove lower nut (E) and belt (G) from alternator.
8. Remove alternator from stud.

Installation:

1. Install alternator. Installation is done in the reverse order of removal.
2. Tighten the drive belt. (See Alternator Drive Belt Adjustment in the appropriate engine section.)

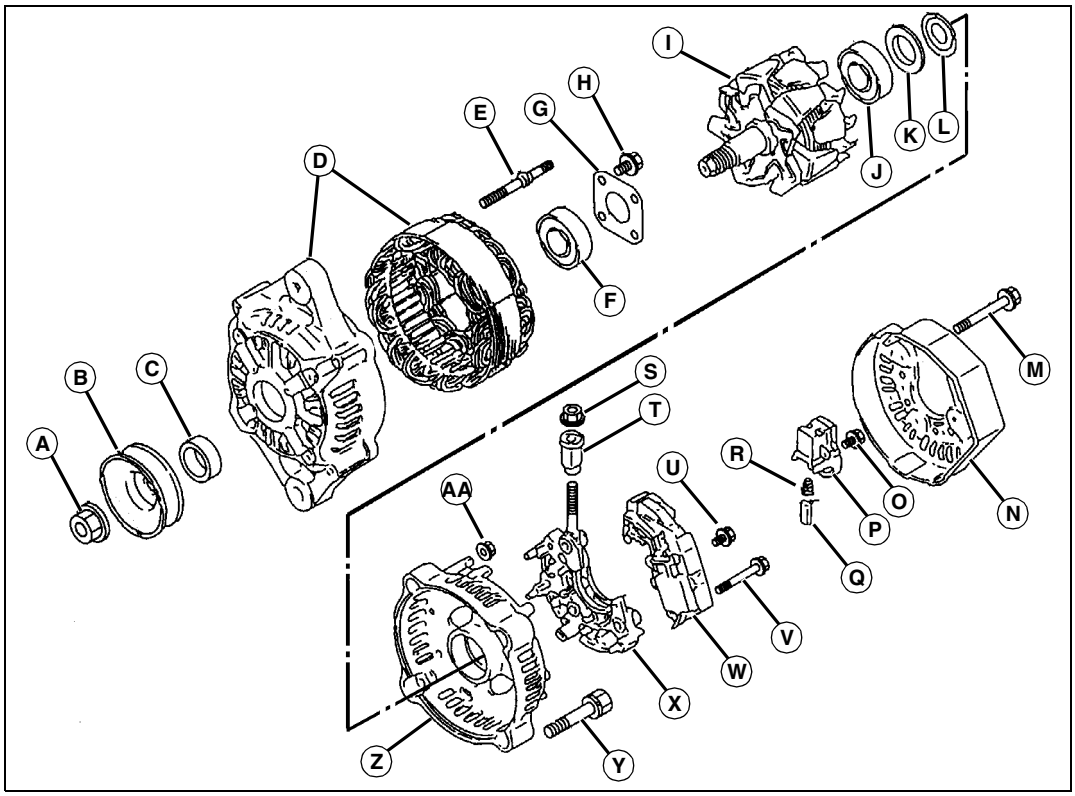
Alternator Repair

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Soft Jaw Vise	NA	Used to hold pulley while removing pulley nut.
Air Impact Wrench	NA	Used to remove pulley nut.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Bearing Puller Set	NA	Used to remove pulley from alternator.
Ohmmeter (Sensitive to 0 - 1 Ohm)	NA	Used during inspection to check for continuity.
400-grit Silicon Carbide Sandpaper	NA	Used to polish slip rings.



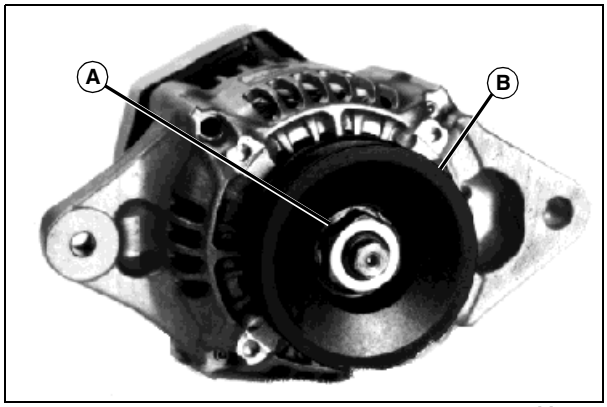
M91878

A - Nut
B - Pulley
C - Spacer
D - Frame Assembly
E - Stud
F - Bearing
G - Plate
H - Screw (4 used)
I - Rotor
J - Bearing
K - Bearing Cover
L - Thrust Washer
M - Cap Screw
N - Rear Cover
O - Screw (6 used)
P - Brush Holder
Q - Brush
R - Spring
S - Nut
T - Bushing
U - Screw
V - Cap Screw with Washer
W - Regulator
X - Rectifier
Y - Cap Screw
Z - Rear Frame
AA- Nut (2 used)

Disassembly:

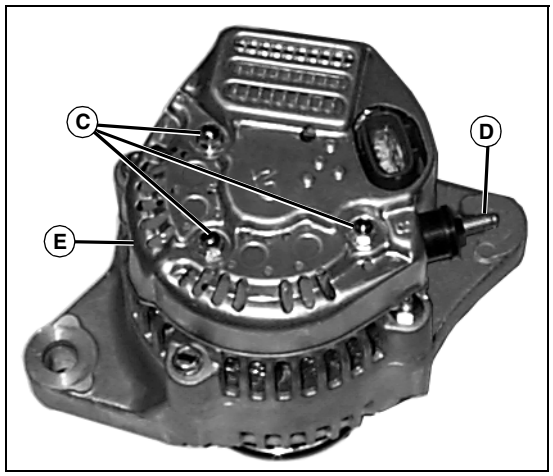
M91674

NOTE: Clamp pulley in a soft-jaw vise and use an air impact wrench to remove pulley nut.



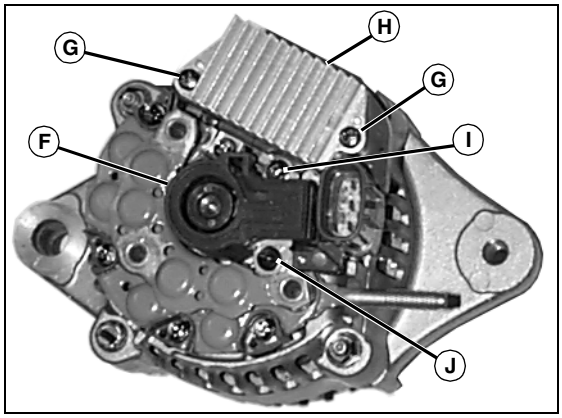
M52469

1. Remove pulley nut (A).
2. User a puller to remove pulley (B).



M91673

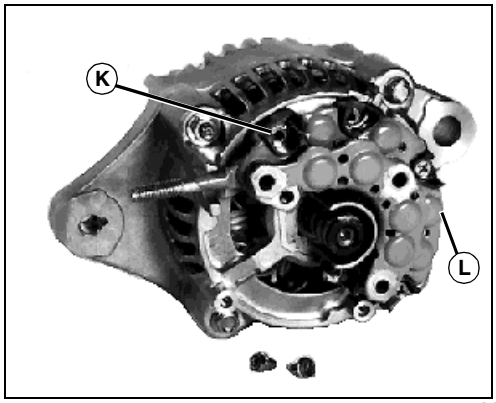
3. Remove nut, washer and insulator from battery terminal post (D).
4. Remove three screws (C) securing rear cover (E) to rear frame. Remove rear cover.



5. Remove the short screw (I) and the long screw (J) securing brush holder (F) to body. Remove brush holder.

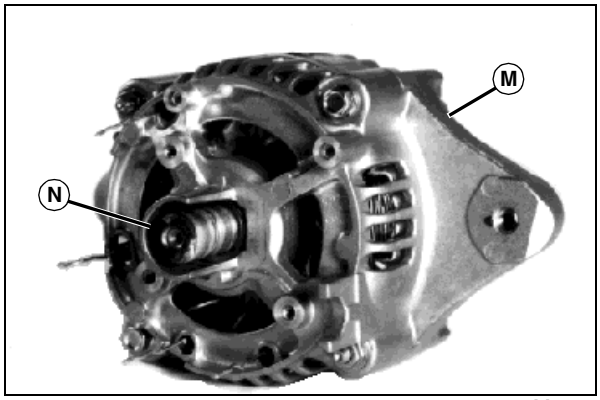
NOTE: Remember location of short screw on regulator tab.

6. Remove two screws (G) securing regulator to rear frame. Remove regulator (H).



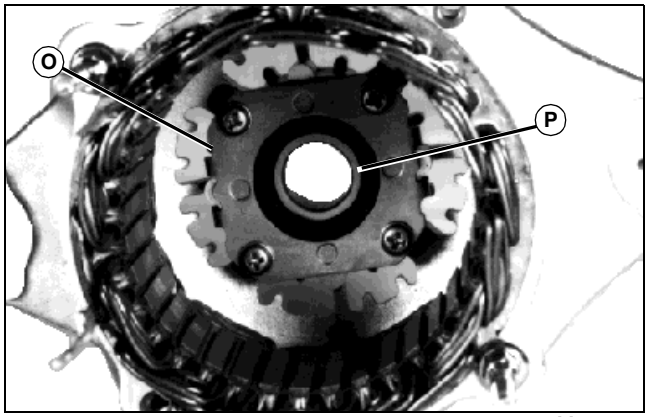
M52471

7. Remove screw and straighten wire leads (K).
8. Remove rectifier (L).



M52473

9. Remove rear frame (M).
10. Press rotor shaft (N) from frame assembly.

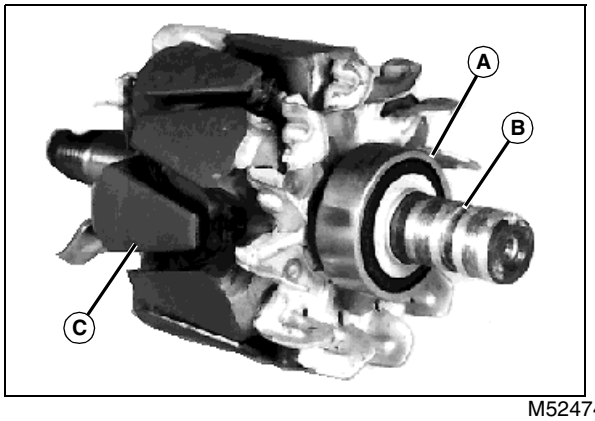


M52475

11.Remove retainer plate (O).

12.Press bearing (P) from frame assembly.

Inspection:



M52474

1. Inspect bearing (A) for smooth rotation. Replace if necessary.

2. Inspect slip rings (B) for dirt or rough spots. If necessary, use 400-grit silicon carbide paper to polish rings.

3. Measure outer diameter of slip rings. Replace rotor if less than specification.

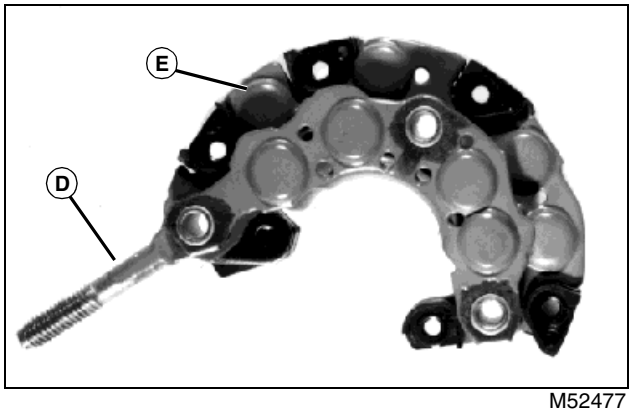
4. Check continuity between slip rings using ohmmeter. Replace rotor assembly if there is no continuity.

5. Check continuity between slip rings and rotor core (C). Replace rotor assembly if there is continuity.

6. Inspect stator for defective insulation, discoloration, or burned odor.

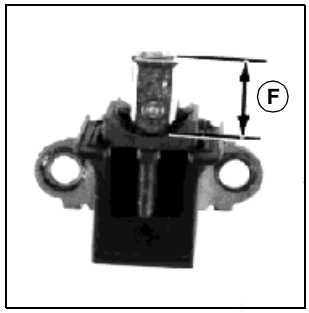
7. Check for continuity between each stator lead and body. Replace stator if there is continuity.

NOTE: Set ohmmeter range to k-ohm.



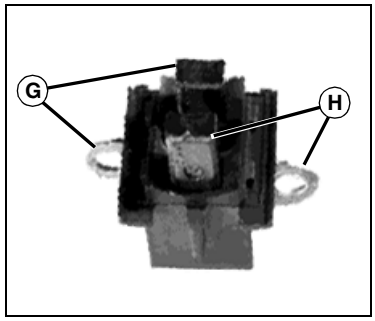
M52477

8. Check continuity between main lead (D) and each diode lead (E). Reverse the multimeter leads and check again. There should be continuity in only one direction when checking each diode lead. Replace diodes or rectifier plate if continuity is not correct.



M52478

9. Measure length of brush (F) protruding from brush holder. Replace brush if length is not within specification.



M52479

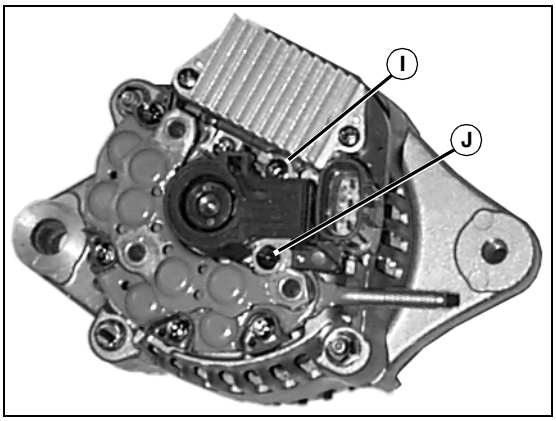
10.Check continuity between brush and terminal (G). Check continuity between brush and terminal (H). There should be continuity only at these points.

Assembly:

Assembly procedure is the reverse of disassembly.

IMPORTANT: Avoid damage! Check that rotor fan does not contact case and that rotor assembly turns smoothly in bearing.

If the short screw (I) and longer screw (J) are interchanged, the longer screw will contact the frame and damage the charging system.



M91674

- Install short screw (I) in regulator tab and longer screw (J) as shown.
- Clamp pulley in a soft-jaw vise. Install pulley nut and tighten to specification.

Specifications:

Exposed Brush Length . . 4.5 - 10.5 mm (0.17 - 0.41 in.)

Rotor Slip Ring Diameter (Minimum) . 14 mm (0.55 in.)

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

Starting Motor Removal and Installation

Front Mower

1420

1435

1445

1545

Special or Required Tools:

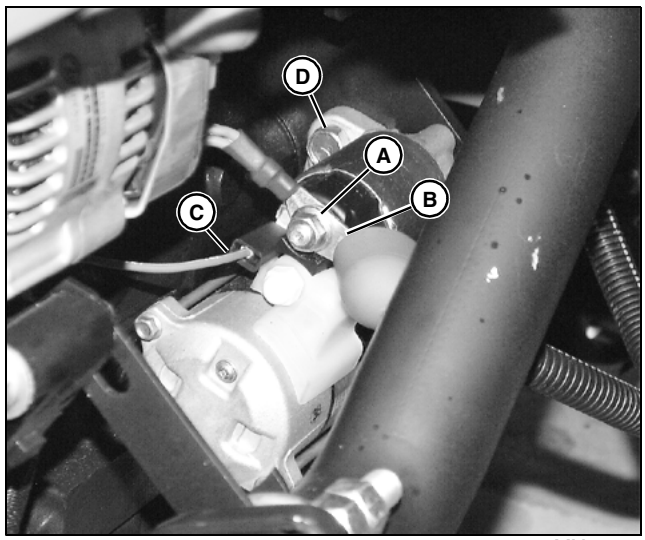
Tool Name	Tool No.	Tool Use
Ohmmeter		Used to check continuity.
Growler		Used to locate short circuits in armature.

Removal:

1. Park machine on a hard, level surface.
2. LOCK park brake.
3. Remove engine cover.

NOTE: Disconnect the negative (-) battery cable first.

4. Disconnect negative (-) battery cable.



MX5447

5. Remove nut (A) from starting motor solenoid battery terminal.
6. Remove positive (+) battery cable and wires (B) from solenoid terminal.
7. Disconnect purple wire (C) from solenoid signal terminal.
8. Remove two cap screws (D) and starter.
9. Inspect pinion gear for wear or damage. Replace as necessary.
10. Check solenoid for proper operation. Replace as necessary.

Installation:

NOTE: Connect negative (-) battery cable last.

1. Install starting motor. Installation is done in the reverse order of removal.
2. Tighten cap screws to specification.
3. Clean all battery cable connections before installing negative (-) battery cable.

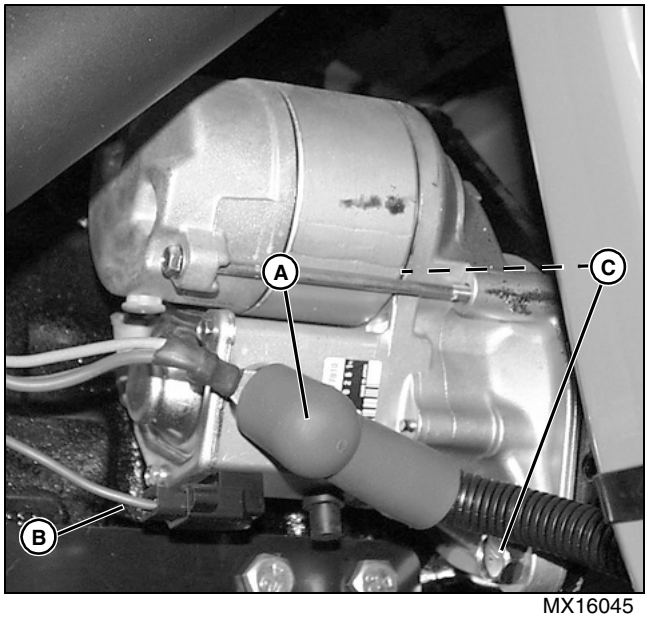
Specifications:

Cap Screw Torque . . . . . 24 N•m (212 lb-in.)

Starting Motor Removal and Installation - 1565

Removing:

IMPORTANT: Avoid damage! Always disconnect the negative (-) cable from the battery before working on any electrical components.



MX16045

1. Disconnect the negative (-) battery cable.

2. Slide back the protective boot (A) and remove the nut securing the battery cable and wires on the starting motor.

3. Disconnect the starting motor solenoid wire (B).

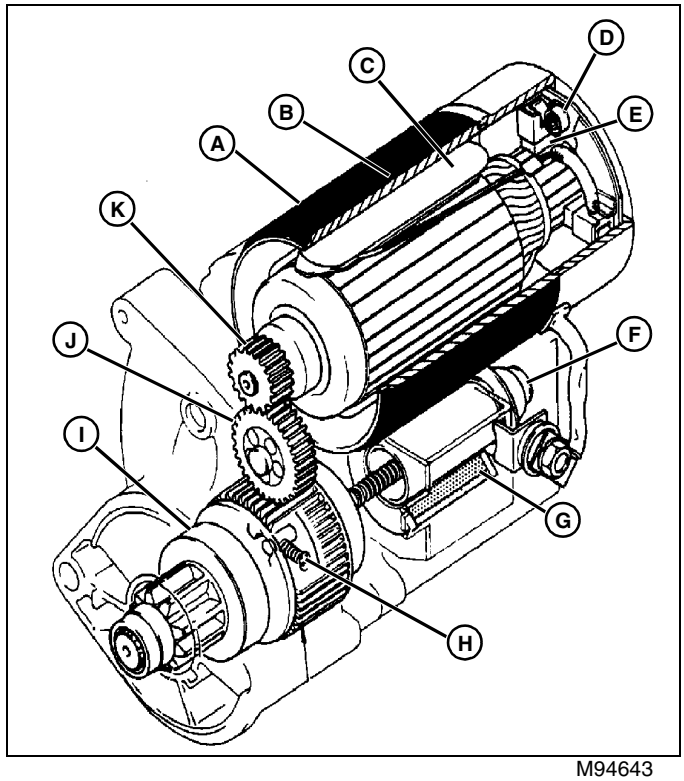
4. Remove the cap screws (C) securing the starting motor to the backplate. Remove the starting motor.

Installing:

Installation is done in the reverse order of removal.

- Do not overtighten the starting motor cap screws! Tighten the starting motor cap screws to **47 N•m (35 lb-ft)**.

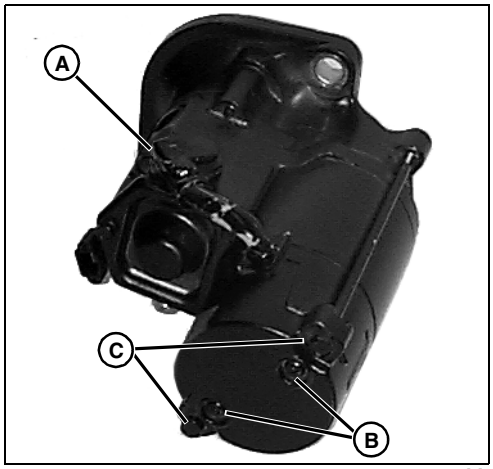
Starting Motor Component Location



M94643

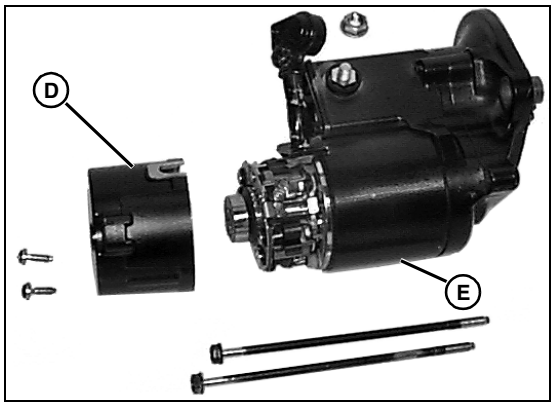
A - Motor
B - Field Coil
C - Armature
D - Brush Spring
E - Brush
F - Plunger
G - Solenoid
H - Overrunning Clutch
I - Pinion
J - Idler Gear
K - Drive Gear

Disassembly:



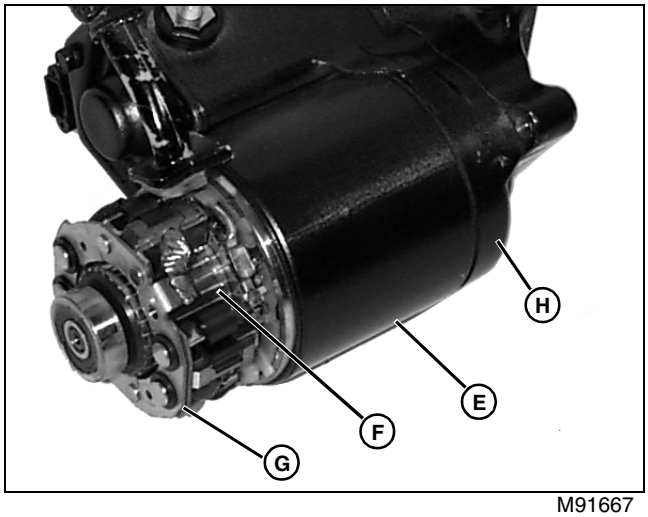
M82233A

1. Disconnect the field lead (A).
2. Remove the cover screws (B).
3. Remove the cap screws (C) that secure the motor to the clutch housing.



M91666

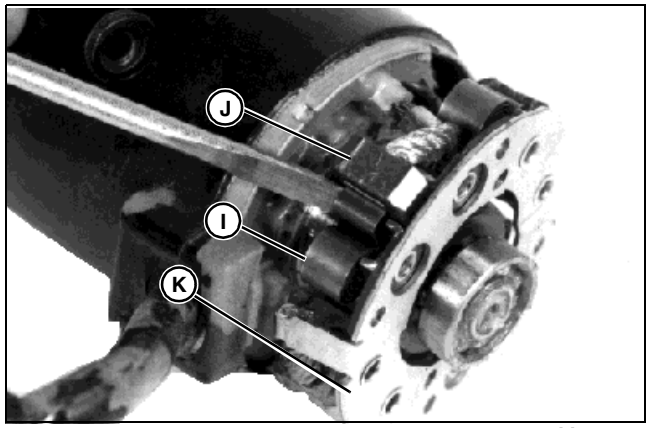
4. Separate the cover (D) from the motor (E).



M91667

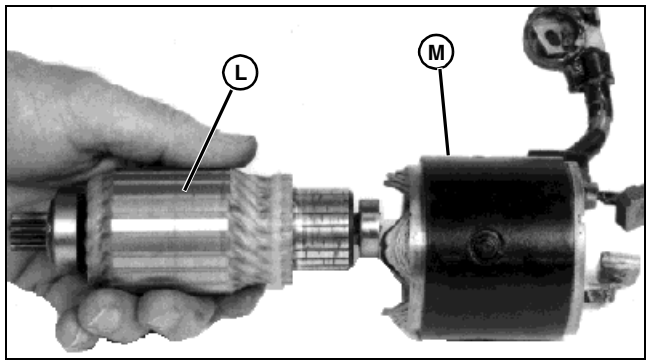
5. Remove motor (E), armature (F), and brush holder (G) as a unit from the clutch housing (H).

NOTE: Brushes are not serviceable separately. If the brushes require replacement, the entire brush holder, with brushes attached, must be replaced.



M36754

6. Pry the brush springs (I) away and pull the negative (-) brushes (J) up enough to allow the springs to hold the brushes in place.
7. Remove the brush holder (K).



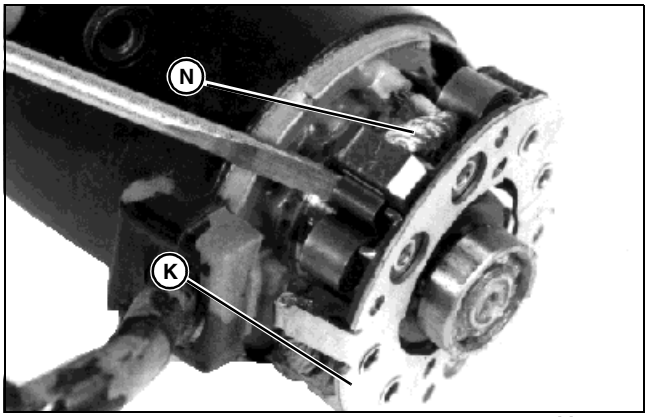
M36759

8. Remove the armature (L) from the field coil housing (M).
9. Inspect and test the brushes, holder, field coil and armature. (See “Starting Motor Inspection and Test:” on page 488).

Assembly:

Assembly is done in the reverse order of disassembly.

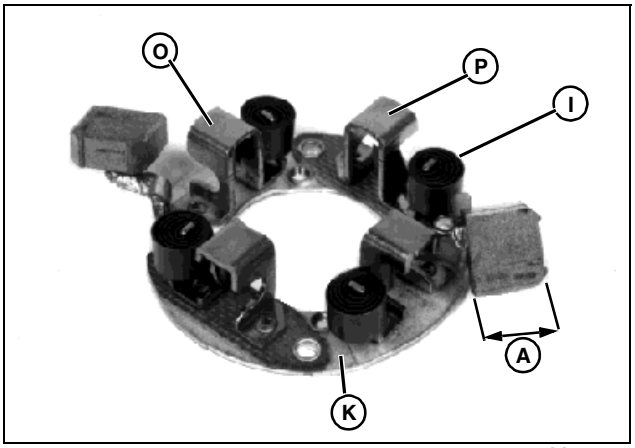
NOTE: Apply multipurpose grease to bearing cup inside rear cover.



M36754

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

Starting Motor Inspection and Test:



M82234

1. Measure brush lengths (A). Minimum brush length is **8.5 mm (0.335 in.)**. Replace brush if length is below minimum.

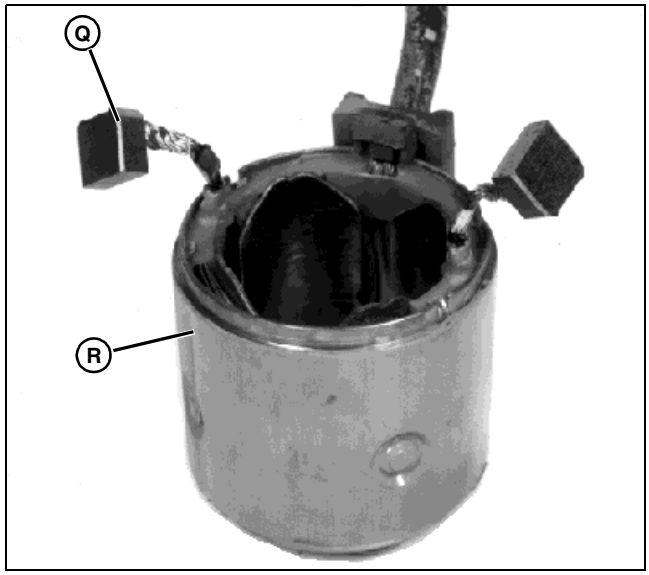
NOTE: Test brush holder using an ohmmeter or test light.

2. Test brush holder (K):

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

3. Inspect springs (I) for wear or damage. Replace if necessary.

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



M82235

4. Test for grounded field winding:

- Touch one probe of tester to field coil brush (Q) and other probe to field coil housing (R).
- Be sure the brush lead is not touching the frame. If there is continuity, the coil is grounded and the field coil housing assembly must be replaced.

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

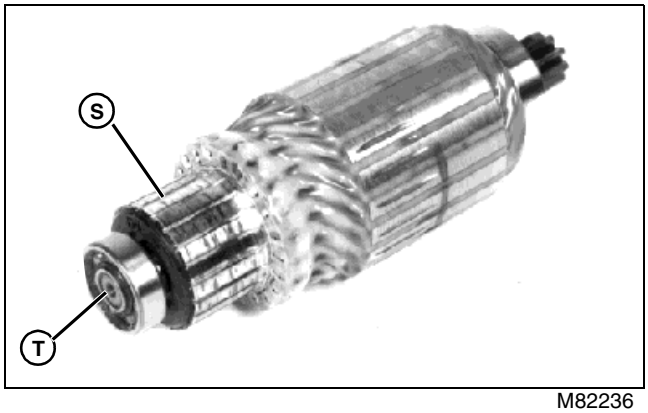
5. Test for open field coil:

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

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

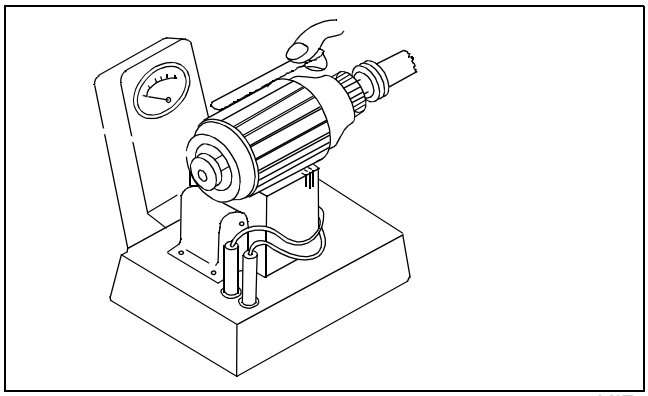
7. Inspect commutator. Look for roughness, burned bars, or any material which might cause short circuits between bars. If necessary, clean and touch up with 400 sandpaper. NEVER use emery cloth. Clean all dust from armature when finished.

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



M82236

8. Test for grounded windings:
   - Touch probes on one commutator bar (S) and armature shaft (T). Armature windings are connected in series, so only one commutator bar needs to be checked.
   - If test shows continuity, a winding is grounded and the armature must be replaced.
9. Test for open circuit windings:
   - Touch probes on two different commutator bars.
   - If test shows no continuity, there is an open circuit and the armature must be replaced.


MIF

10. Test for short circuit windings using a growler.
    - Put armature in a growler and hold a hacksaw blade above each slot while slowly rotating armature.
    - If coil is shorted, the blade will vibrate on the slot.

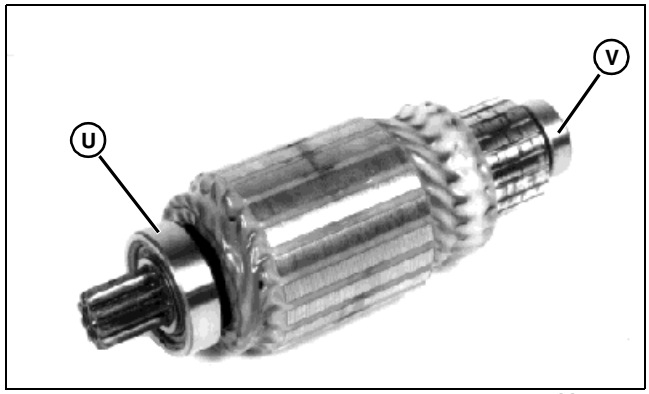
NOTE: A short circuit most often occurs because of copper dust or filings between two commutator segments.

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

12. Inspect armature cover and housing bearings for wear or damage. Replace if necessary.

To Replace Bearings:

NOTE: The bearings are press fit.



M82237

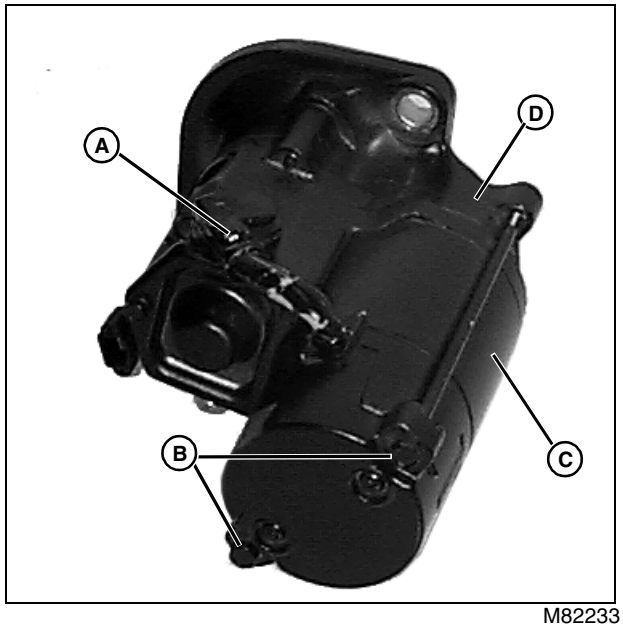
1. Remove the bearings using a knife-edge puller set.

IMPORTANT: Avoid damage! Install both bearings with the sealed side toward armature.

2. Install a new housing bearing (U) tight against the shoulder of the shaft using an appropriate size socket that only presses on the inner race of the bearing.

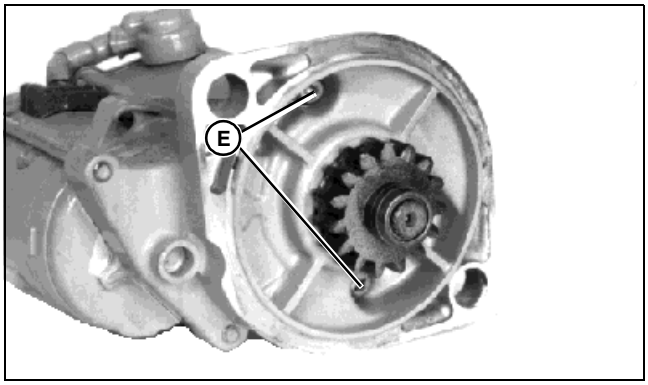
3. Install a new cover bearing (U) tight against the shoulder of the shaft using a driver set.

Starting Motor Gear Train Disassembly/Inspection:



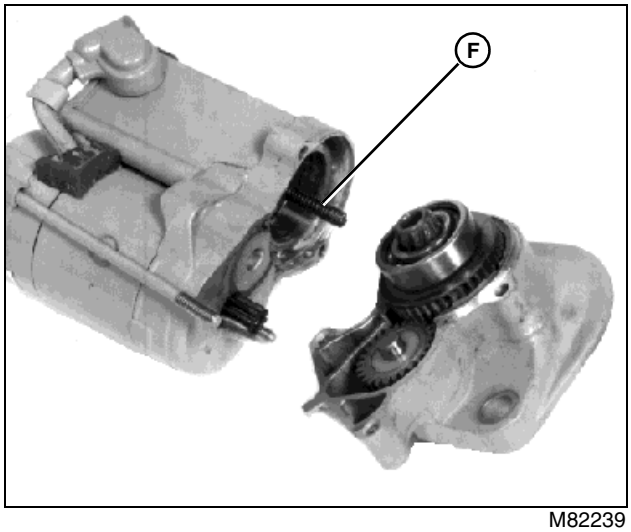
M82233

1. Remove the field wire (A) and two motor-to-clutch housing cap screws (B).
2. Remove the motor (C) from the clutch housing (D).



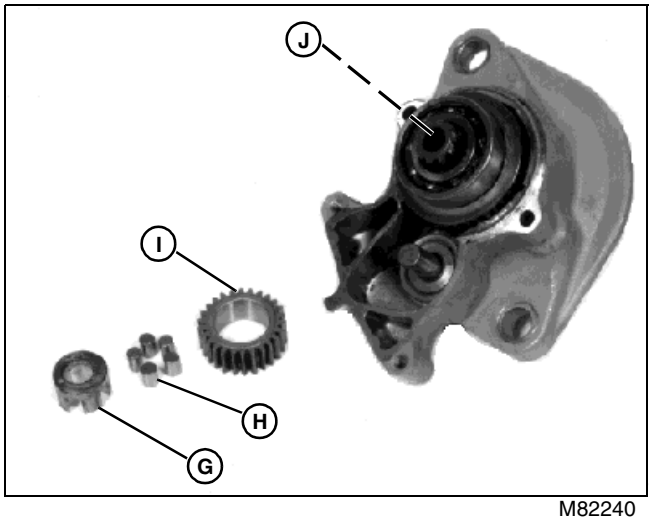
M82238

3. Remove two clutch housing-to-solenoid housing screws (E) to separate the clutch housing from the solenoid/motor assembly.



M82239

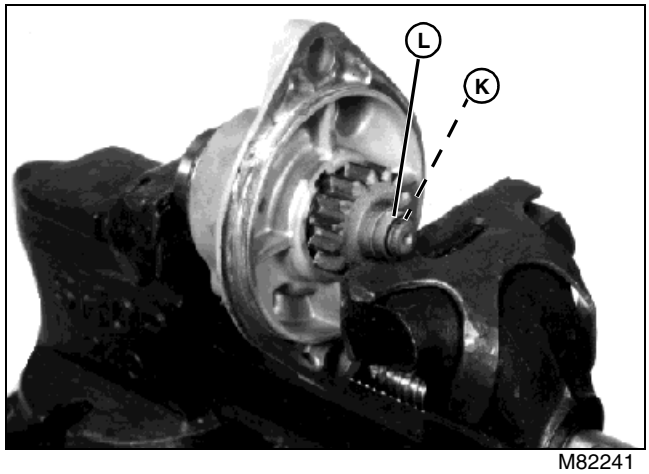
4. Remove the plunger spring (F).



M82240

5. Remove the retainer (G), five rollers (H), and pinion gear (I).

6. Remove the steel ball (J).



M82241

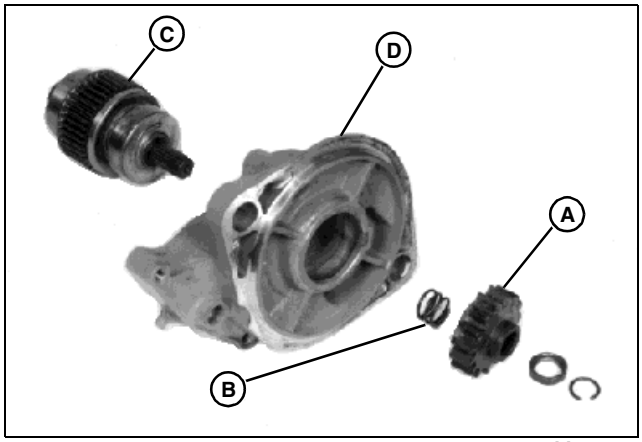
7. Put the clutch housing assembly into a soft-jawed vice, as shown.

8. Tighten the vise slowly, until the drive gear compresses.

9. While holding the clutch assembly, slowly open the vise until all spring compression is relieved.

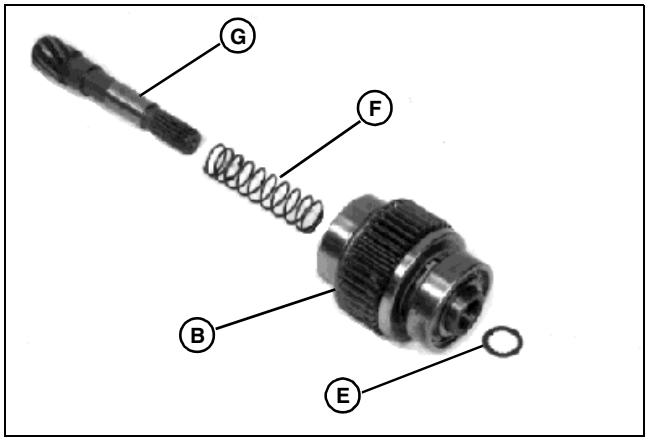
CAUTION: Avoid injury! The shaft could be propelled from the clutch unit with considerable force if the spring is not allowed to extend fully while in the vise!

10. Remove the circlip (K) and retainer (L).



M82242

11. Remove the drive gear (A), spring (B), and clutch (C) assembly from the housing (D).



M82243A

12.Remove the toothed washer (E), spring (F), and clutch shaft (G).

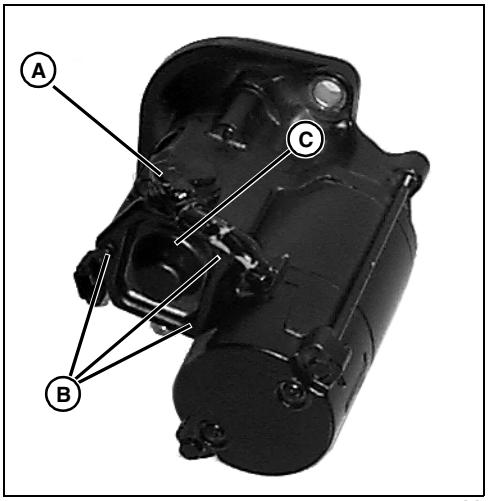
13.Inspect all parts for wear or damage.

Starting Motor Gear Train Assembly:

Assembly is done in the reverse order of disassembly.

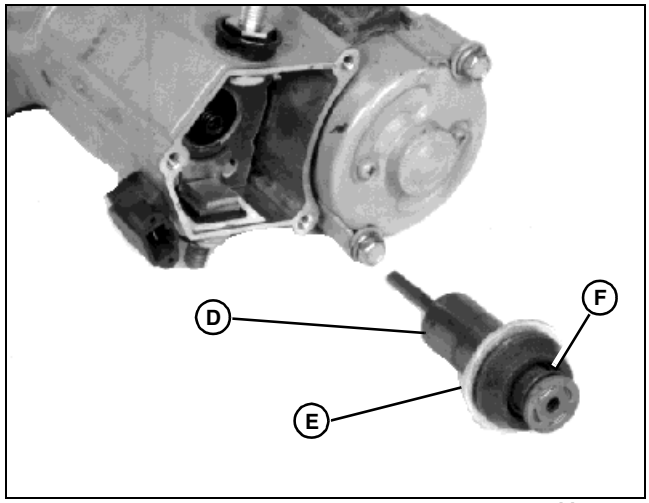
- Apply multipurpose grease to bearings, clutch shaft, springs, pinion gears, retainer, rollers and steel ball.
- Install the large washer with the flat side toward the clutch assembly.
- Install the retainer with the cupped side away from the clutch assembly.

Starting Motor Solenoid Disassembly/Inspection:



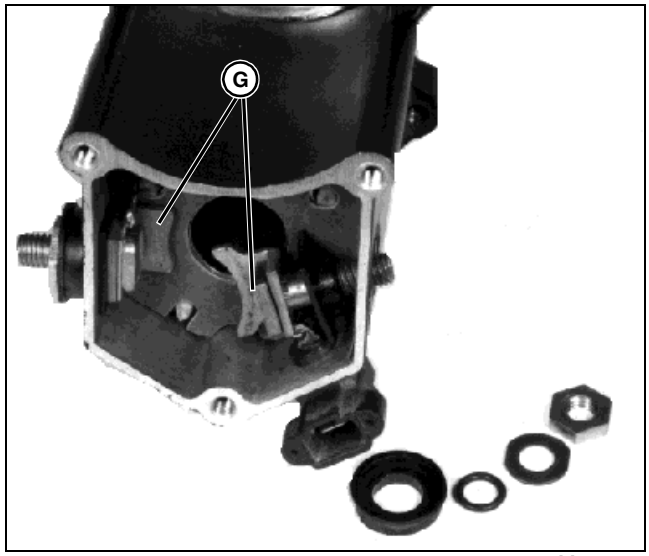
M82233A

1. Disconnect the field lead (A).
2. Remove three screws (B), the cover and gasket (C).



M82245

3. Remove the plunger (D).
4. Inspect the copper washer (E) and spring (F).

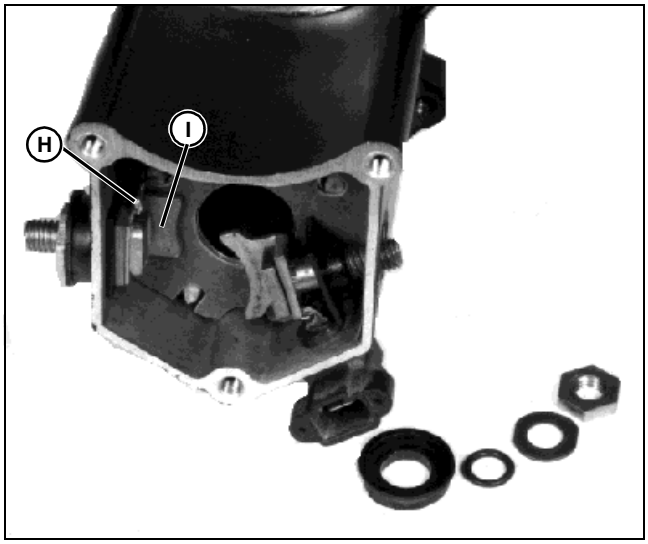


M36771

5. Inspect the contact plates (G) for excessive burning or pitting. Contacts and plunger come as a kit. If contacts or plunger are defective, replace all the parts with the kit.

Starting Motor Solenoid Assembly:

Assembly is done in the reverse order of disassembly.



M36771

NOTE: The assembly sequence of the left and right terminals is similar. Be sure solenoid terminal lead (H) is installed between terminal bolt and contact plate. Also, be sure smaller contact plate (I) is on the left side.

Cab

Schematic and Wiring Harness Legend - Gas Engine

Component

B1 - Horn (SE2, W2)

E1 - License Plate Light (SE1, W8)

E2 - Beacon (SE1, W1)

E3 - Work Light (SE1, W1)

E4 - Work Light (SE1, W1)

E5 - RH Headlight (SE2, W2)

E6 - Not Used

E7 - Not Used

E8 - RH Front Position Light (SE2, W2)

E9 - RH Front Turn Light (SE2, W2)

E10 - LH Headlight (SE2, W2)

E11 - Not Used

E12 - Not Used

E13 - LH Front Position Light (SE2, W2)

E14 - LH Front Turn Light (SE2, W2)

F1 - Fuse 15A (SE1, W1)

F2 - Fuse 25A (SE1, W1)

F3 - Fuse-10A (SE1, W1)

F4 - Fuse-10A (SE1, W1)

F5 - Fuse 15A (SE1, W1)

F6 - Not Used

F7 - Fuse-10A (SE1, W1)

F8 - Fuse-10A (SE1, W1)

H1 - Position Lights Indicator (SE1, W1)

H2 - Blinker Lights Indicator (SE1, W1)

H3 - Trailer Lights Indicator (SE1, W1)

K1 - Sealed Relay (SE1, W1)

K2 - Flasher (SE1, W1)

M1 - Wiper Motor (SE1, W1)

R1 - Resistor at K2 (SE1, W1)

S1 - Headlight Switch (SE1, W1)

S2 - Turn Signal Switch (SE1, W1)

S3 - Horn Switch (SE1, W1)

S4 - Wiper Switch (SE1, W1)

S5 - Hazard Switch (SE1, W1)

S6 - Beacon Switch (SE1, W1)

S7 - Work Light Switch (SE1, W1)

S8 - Brake Switch (SE2, W2)

W1 - Cab Harness Ground (SE1, W1)

Main Wiring Harness Connectors

X1 - W1 to W2 Connector (W1, W2)

X2 - W1 to W2 Connector (W1, W2)

X3 - Fuse Block Connector (W1)

X4 - Fuse Block Connector (W1)

X5 - W1 to W8 Connector (W1, W8)

X6 - Cab Power Connector (W1)

X7 - K2 Flasher Connector (W1)

X8 - W1 to E3 Work Light Connector (W1)

X9 - W1 to E4 Work Light Connector (W1)

Auxiliary Wiring Harness Connectors

X1a - W2 to W1 Connector (W2, W1)

X2a - W2 to W1 Connector (W2, W1)

X3a - Brake Switch Connector (W2)

X4a - W2 to RH Headlight Connector (W2)

X5a - W2 to LH Headlight Connector (W2)

X6a - W2 to LH Front Position/Turn Lights (W2)

X7a - W2 to RH Front Position/Turn Lights (W2)

X1b - W2 to W7 Rear Position/Turn Lights Connector (W3)

X2b - W2 to W9 Trailer Wiring Harness (W3)

X3b - W2 to W9 Trailer Wiring Harness (W3)

X4b - W2 to W9 Trailer Wiring Harness (W3)

X5b - W2 to W6 Rear Position/Turn Lights Connector (W3)

X12b - W3 to W1 Connector (W3, W1)

Harnesses

W1 - Cab Main Wiring Harness

W2 - Front Road Lights Wiring Harness

W3 - Rear Road Lights Wiring Harness

W4 - RH Front Position/Turn Lights Wiring Harness

W5 - LH Front Position/Turn Lights Wiring Harness

W6 - Rear Position/Turn Lights Wiring Harness

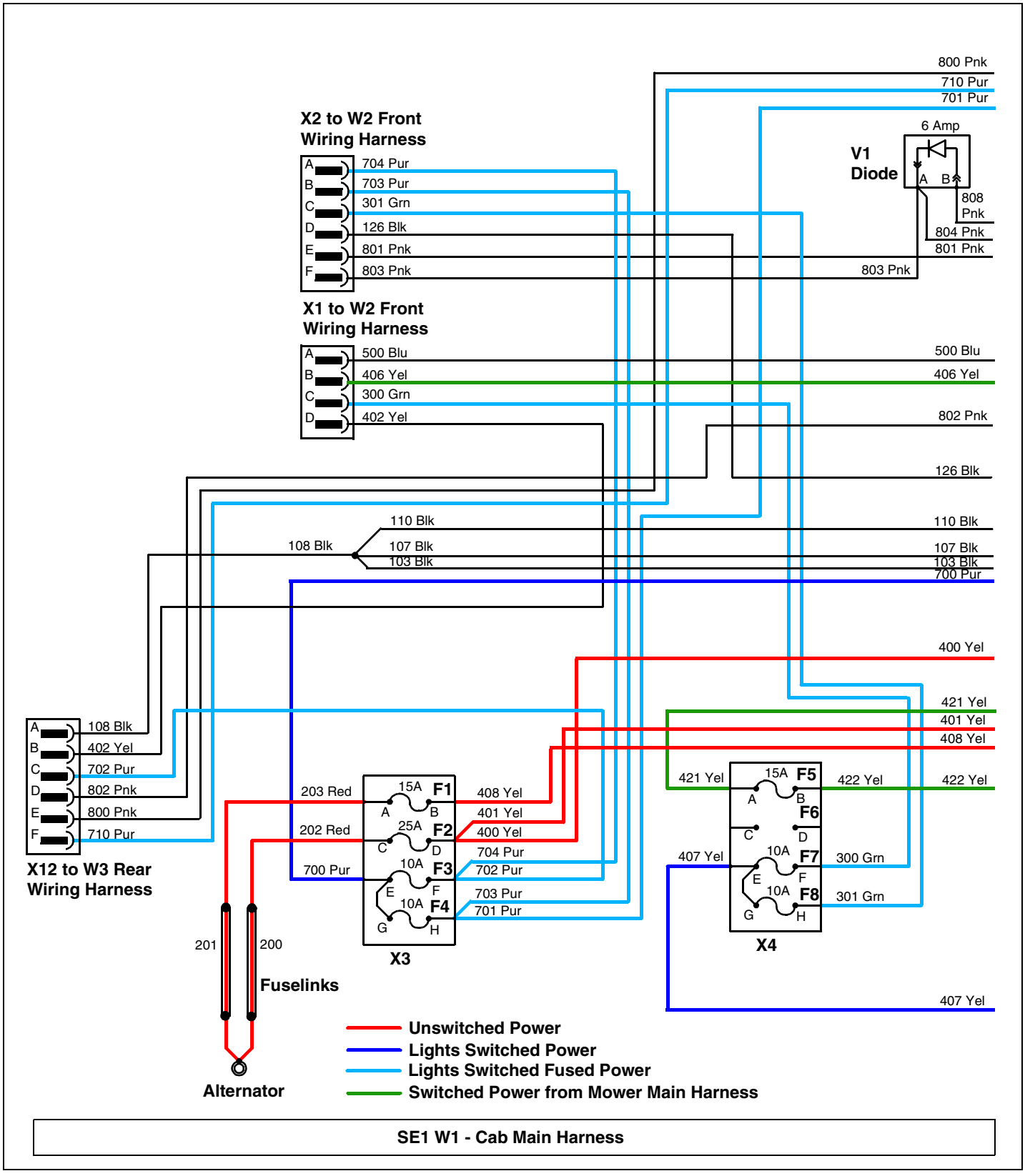
W7 - Rear Position/Turn Lights Wiring Harness

W8 - License Plate Lights Wiring Harness

W9 - Trailer Connector Wiring Harness

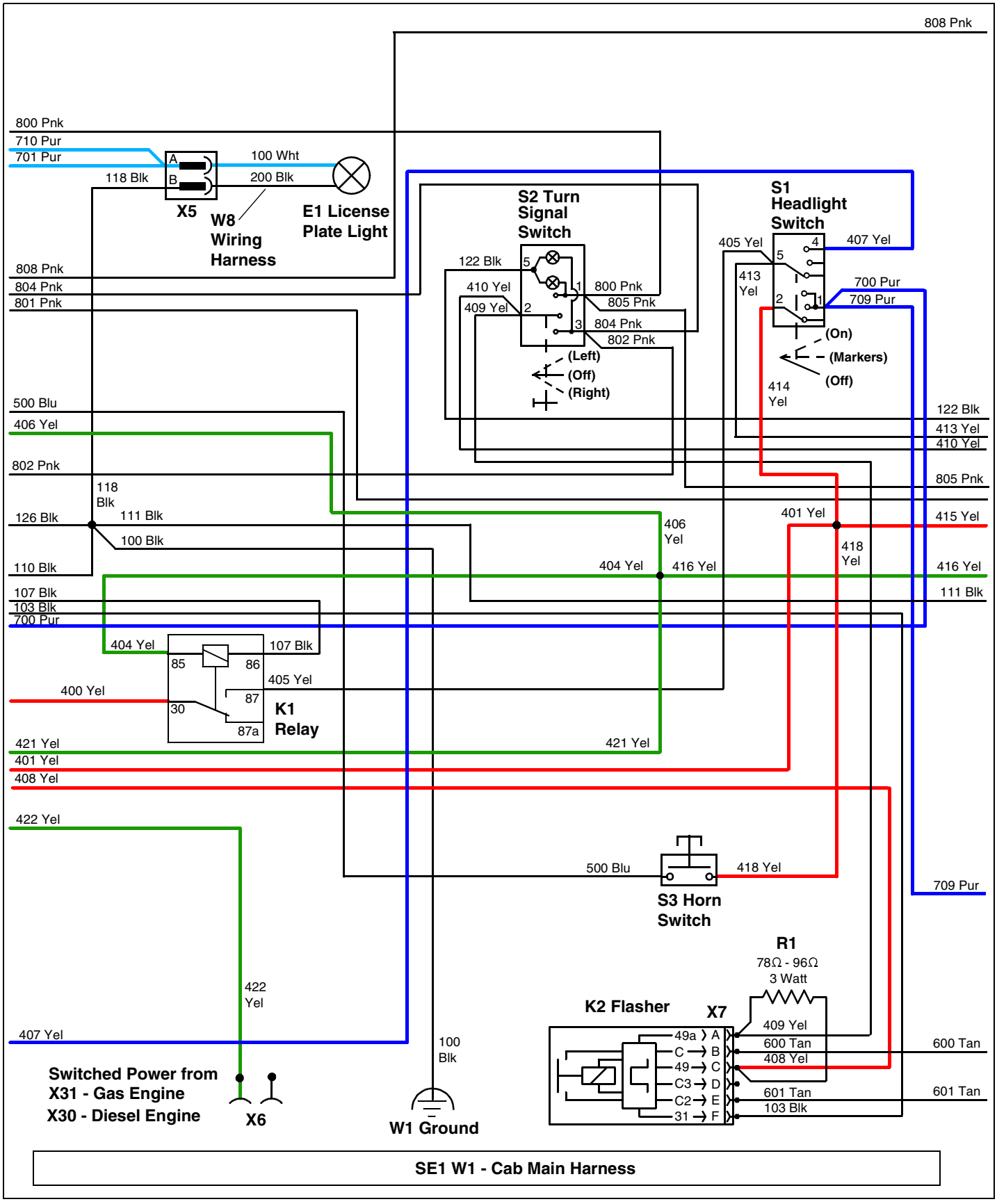
Main Electrical Schematic

W1 Cab Main Schematic (1 of 3)

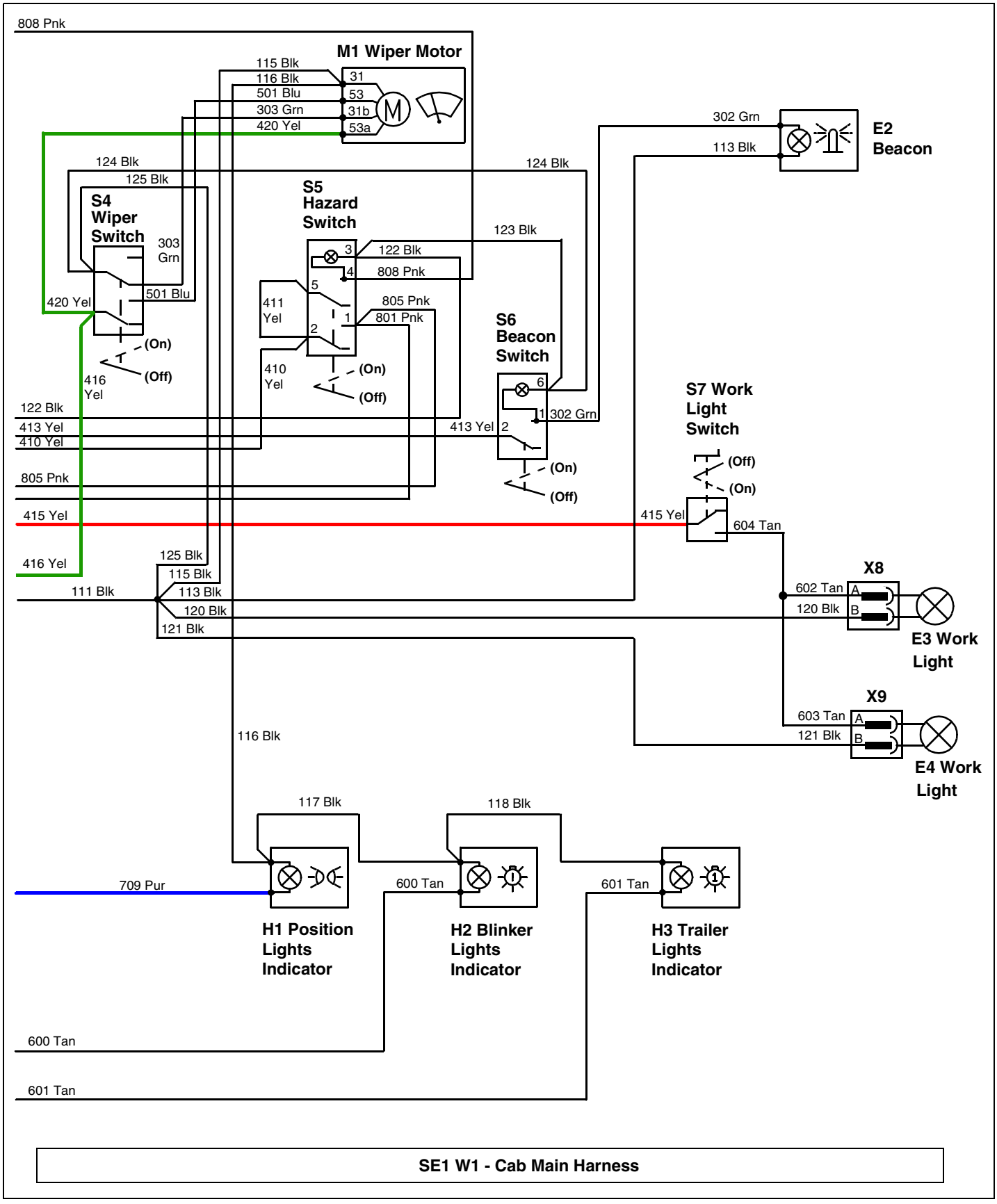


SE1 W1 - Cab Main Harness

W1 Cab Main Schematic (2 of 3)

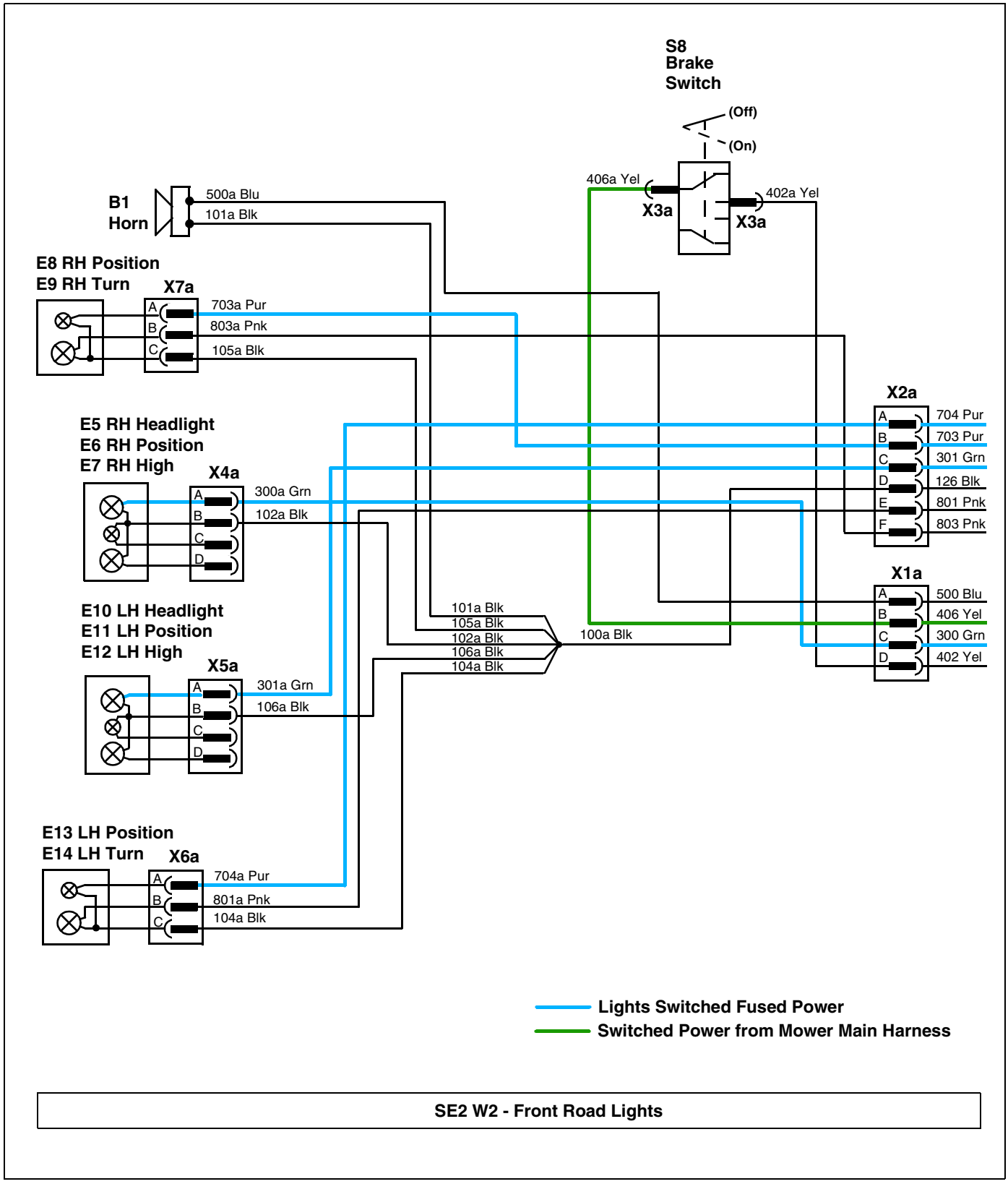


W1 Cab Main Schematic (3 of 3)



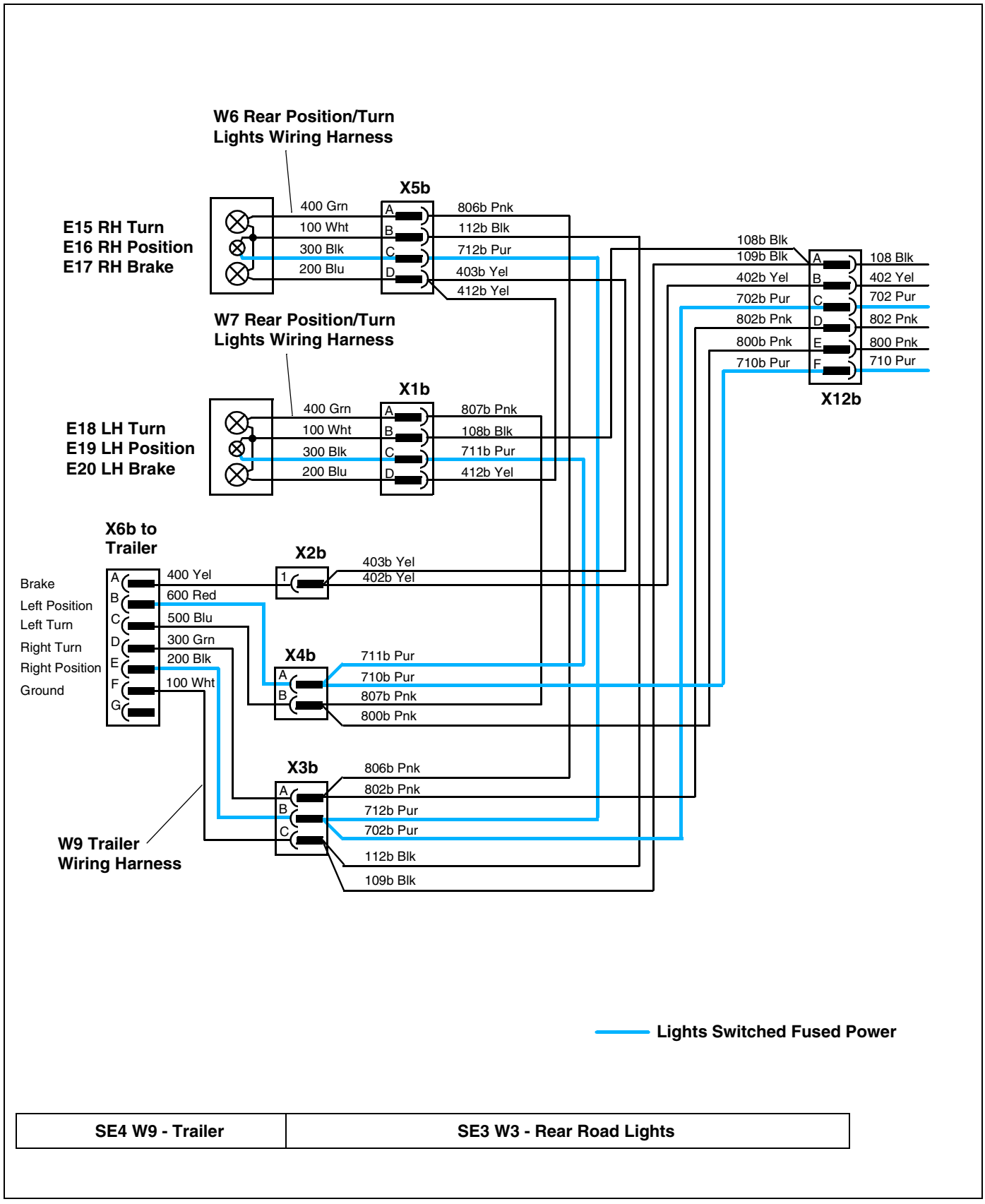
Cab Road Lights Schematics

Front Road Lights Schematic



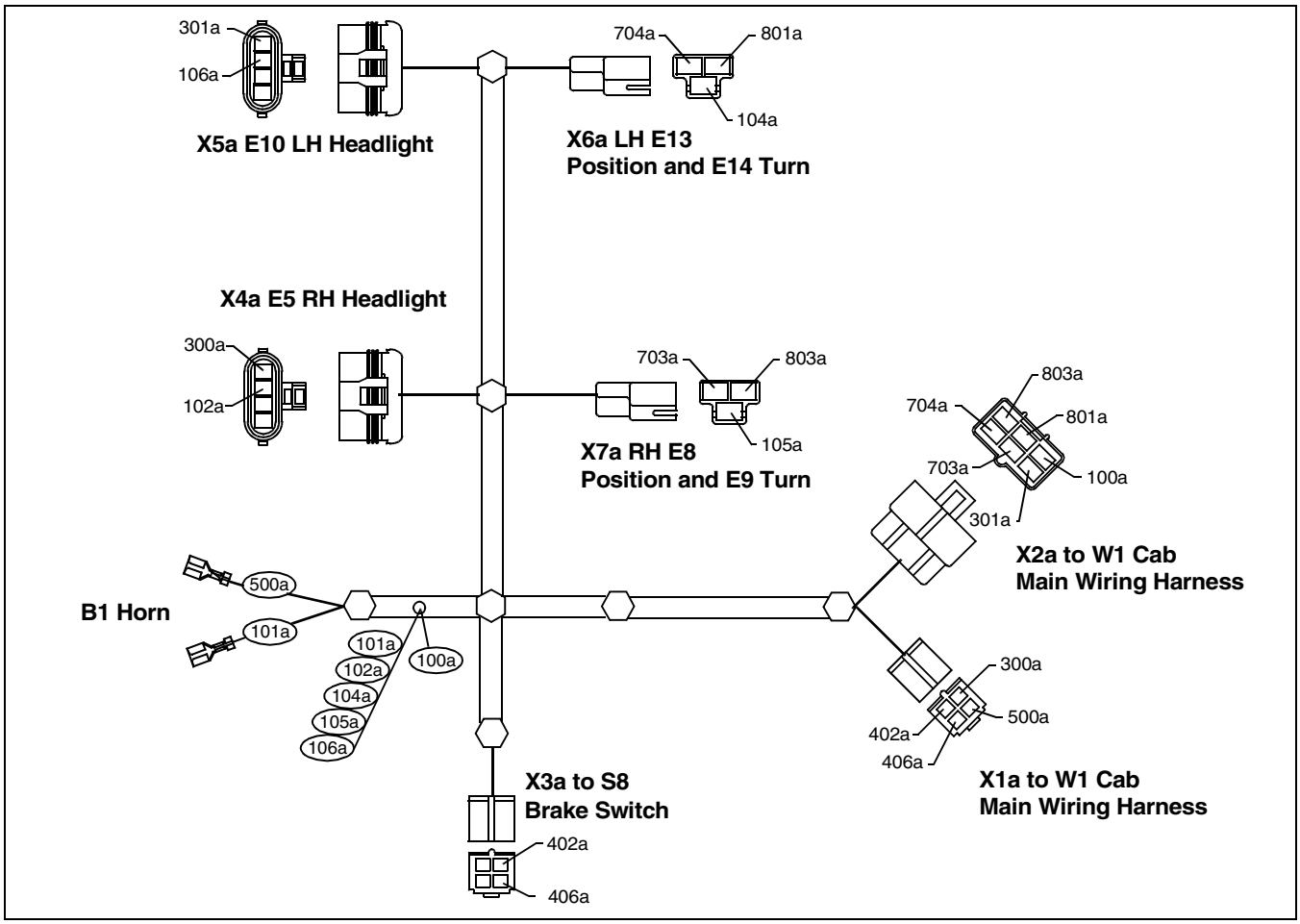
SE2 W2 - Front Road Lights

Rear Road Lights Schematic

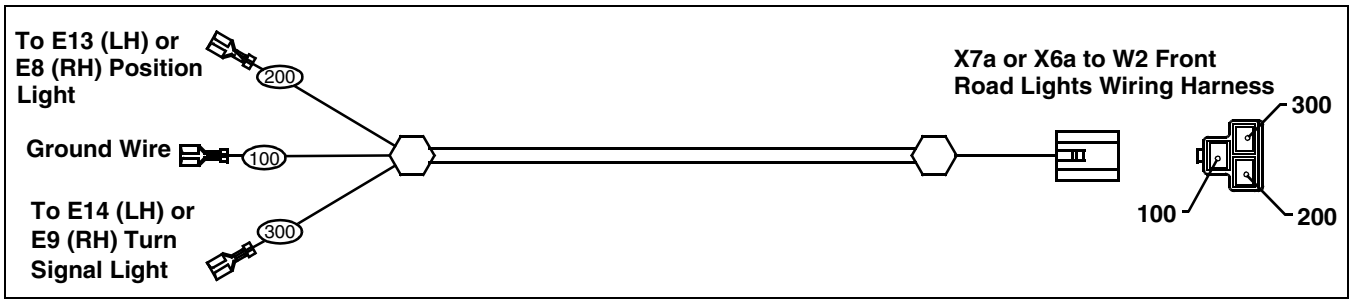


SE4 W9 - Trailer	SE3 W3 - Rear Road Lights

W2 Front Road Lights Wiring Harness



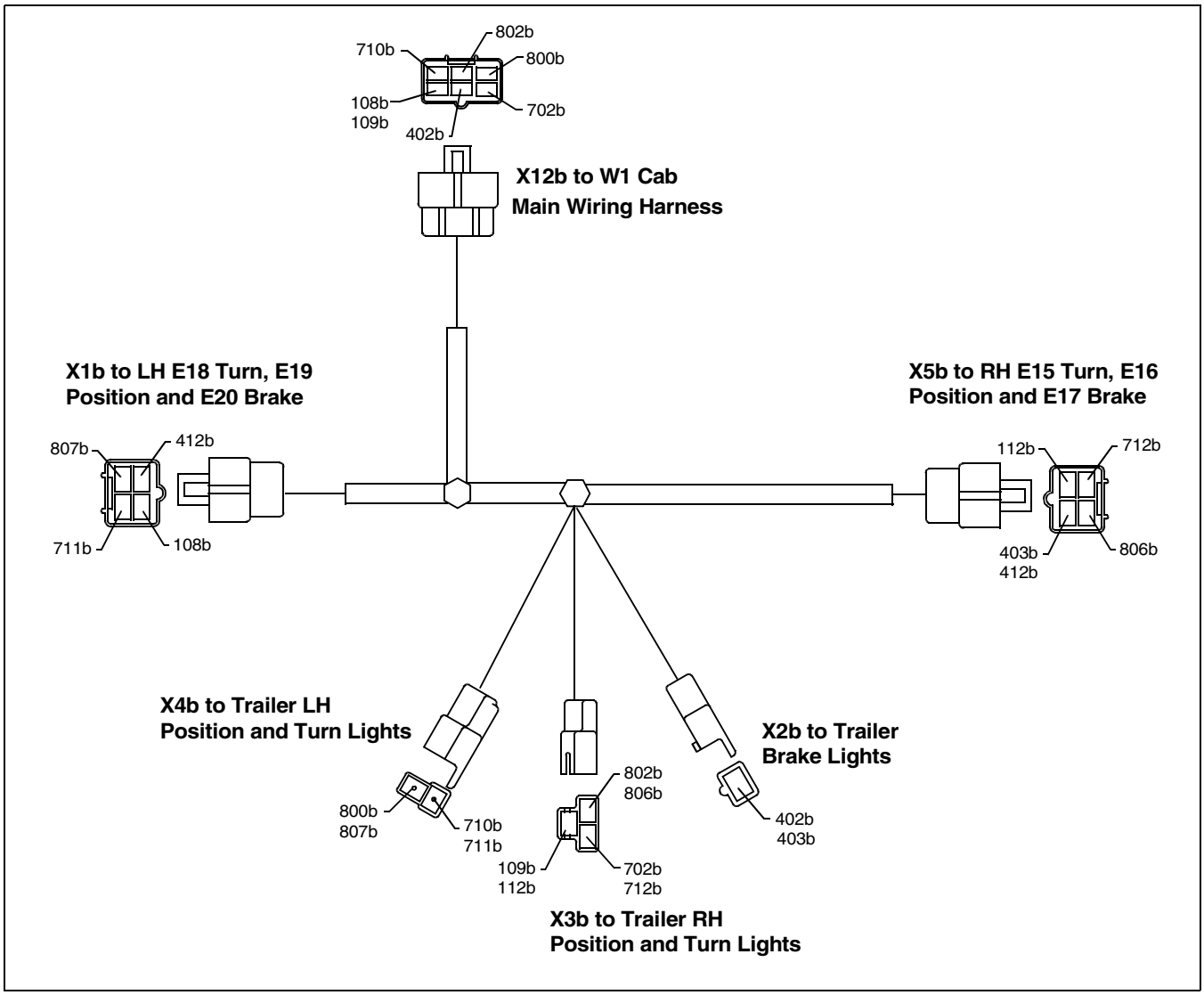
W4 and W5 Front Position/Turn Lights Harness (LH and RH)



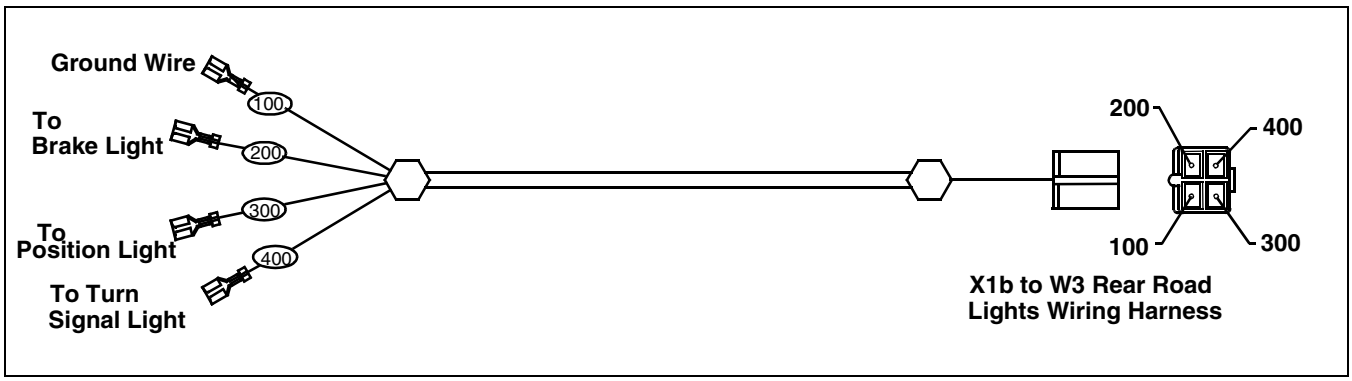
W4 and W5 Front Position/Turn Wiring Harness Wire Code Table

Size/No./Color	Wire Connection Points
1.0 100 Wht	X7a to Ground
1.0 200 Blk	X7a to E8 or X6a to E13
1.0 300 Lt Grn	X7a to E9 or X6a to E14

W3 Rear Road Lights Wiring Harness



W6 and W7 Rear Position/Turn Lights Harness (LH and RH)



NOTE: The W5 and W6 rear position/turn lights wiring harnesses are separate part numbers. They have the same wire numbers and colors but are not interchangeable.

W6 and W7 Rear Position/Turn Lights Harness Wire Code Table

Size/No./Color	Wire Connection Points	Size/No./Color	Wire Connection Points
1.0 100 Wht	X7a to Ground	1.0 300 Blk	X7a to E16 or E19
1.0 200 Blu	X7a to E17 or E20	1.0 400 Grn	X7a to E15 or E18

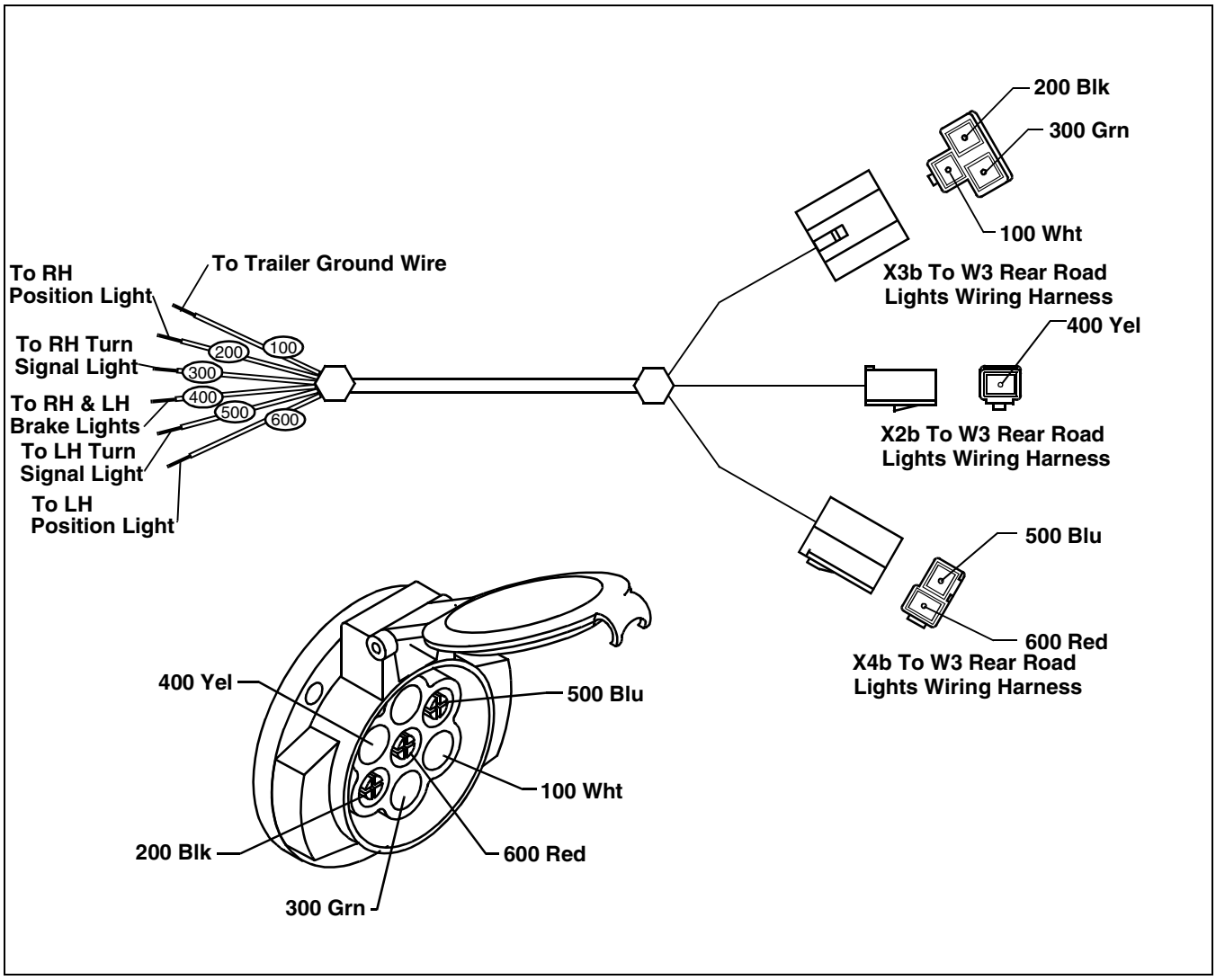
W8 License Plate Light Wiring Harness



W8 License Plate Wiring Harness Wire Code Table

Size/No./Color	Wire Connection Points
1.0 100 Wht	X5 to E1
1.0 200 Blk	X5 to Ground

W9 Trailer Wiring Harness



W9 Trailer Wiring Harness Wire Code Table

Size/No./Color	Wire Connection Points
1.0 100 Wht	X3b to Ground
1.0 200 Blk	X3b to RH Position Light
1.0 300 Grn	X3b to RH Turn Light
1.0 400 Yel	X2b to Brake Lights
1.0 500 Blu	X4b to LH Turn Light
1.0 600 Red	X4b to LH Position Light

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4WD Gear Case Disassembly, Inspection, and Assembly 557
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4WD Axle Disassembly, Inspection, and Assembly 564

Specifications

Test and Adjustment Specifications

4WD Axle End Play	0.127 - 1.016 mm (0.005 - 0.040 in.)
4WD Axle Flanged Cap Screw and Lock Nut Torque	88 N•m (65 lb-ft)
Forward and Reverse Pedal-to-Floor Clearance	3 mm (0.1 in.)
Neutral Safety Link Ball Joint Thread Engagement (Minimum)	8 mm (0.3 in.)
Differential Lock Pedal-to-Floor Clearance	3 mm (0.1 in.)

Repair Specifications

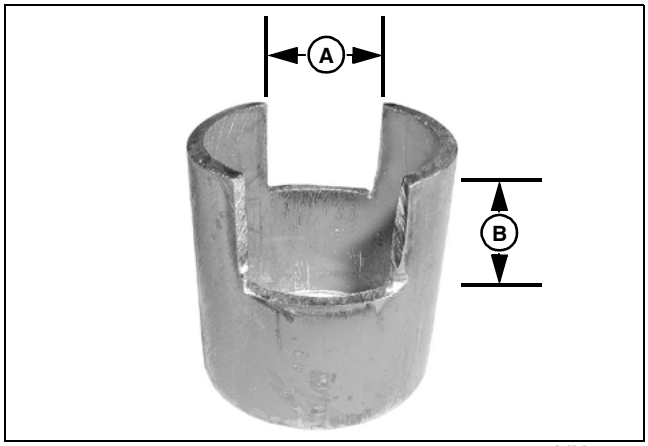
Transaxle Mounting Cap Screw Torque	142 N•m (105 lb-ft)
Front Drive Wheel Mounting Cap Screw Torque	225 N•m (165 lb-ft)
Charge Pump Relief Valve Torque	22 - 27 N•m (195 - 240 lb-in.)
Lube Reduction Valve Torque	27 - 32 N•m (240 - 284 lb-in.)
Tow Valve Torque	34 N•m (25 lb-ft)
Forward and Reverse Check Valve Torque	34 N•m (25 lb-ft)
Implement Relief Valve Torque	24 N•m (212 lb-in.)
Swashplate End Play	0.20 - 0.50 mm (0.007 - 0.0019 in.)
Center Section-to-Housing Hex Socket and Cap Screw Torque	34 - 49 N•m (25 - 36 lb-ft)
Bottom Separator Plate-to-PTO Gap (Maximum)	9.1 mm (0.36 in.)
Clutch Top Plate Thickness (Minimum)	3.03 mm (0.119 in.)
Clutch Disk Thickness (Minimum)	2.0 mm (0.08 in.)
Clutch Separator Plate Thickness (Minimum)	1.0 mm (0.04 in.)
Piston Return Spring Free Length (Minimum)	75 mm (2.95 in.)
Piston Return Spring Test Length @ 499 N (112 lb-force)	28.6 mm (1.13 in.)
Solenoid Stud Torque	23 N•m (203 lb-in.)
Solenoid Coil Nut Torque	5 N•m (44 lb-in.)
Axle Housing-to-Differential Cap Screw (M10 x 60) Torque	69 N•m (51 lb-ft)
Axle Housing-to-Differential Cap Screw (M10 x 45) Torque	69 N•m (51 lb-ft)
Differential Ring Gear-to-Housing Cap Screw Torque	69 N•m (51 lb-ft)
Axle Seal Housing-to-Axle Housing Cap Screw Torque	27 N•m (20 lb-ft)
Differential Side Cover-to-Differential Case (M8 x 35) Cap Screw Torque	27 N•m (20 lb-ft)
4WD Axle Weight (Approximately)	68 kg (150 lb)
4WD Axle Oil Capacity (Approximately)	2.1 L (2.25 qt)
Differential Input Cover Cap Screw Torque	26 N•m (19 lb-ft)
Final Drive Cover Cap Screw Torque	52 N•m (38 lb-ft)
Final Drive Drain Plug Torque	39 ± 10 N•m (29 ± 10 lb-ft)
Tie Rod Castellated Nut Torque	53 N•m (39 lb-ft)

Fabricated Tools

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Clutch Piston Compression Tool	NA	Used in a vise to compress the PTO clutch piston spring so the snap ring can be removed or installed.
Snap Ring Removal Tool	NA	Used to compress the spring to remove the snap ring on the differential lock shaft.
Snap Ring Installation Tool	NA	Used to install the snap ring on the differential lock shaft.

Clutch Piston Compression Tool Fabrication:



MX5887

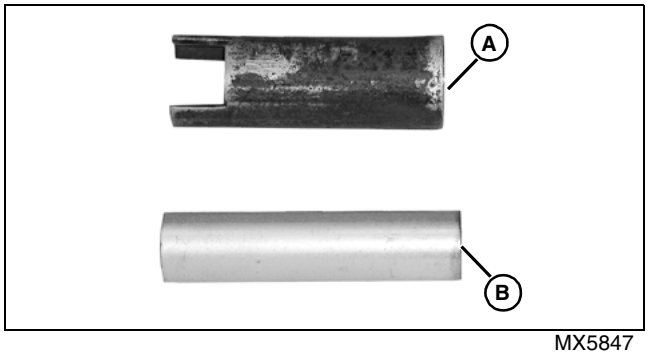
Make the clutch piston compression tool from pipe with an inside diameter of 43 mm (1-11/16 in.) and approximately 50 mm (2 in.) long.

Clutch Piston Compression Tool Specifications:

Dimension A 32 mm (1-1/4 in.)

Dimension B 25 mm (1 in.)

Snap Ring Removal and Installation Tool Fabrication:



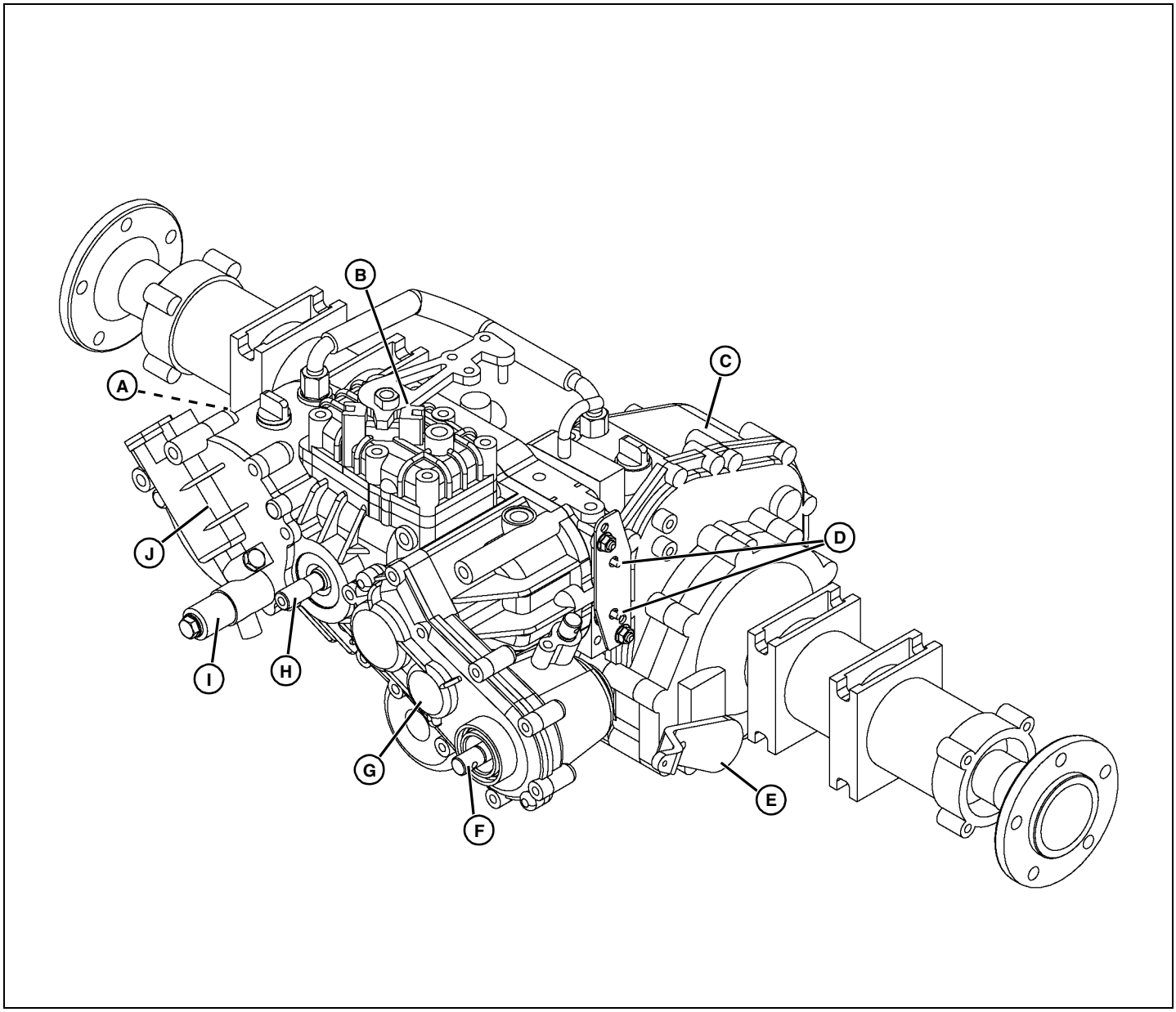
MX5847

Snap ring removal tool (A) inside pipe diameter is 25 mm (1 in.). Make a 19 mm (3/4 in.) notch in the end of the pipe. Pipe length should be five inches.

Snap ring installation tool (B) inside pipe diameter is 19 mm (3/4 in.). Pipe length should be five inches.

Component Location

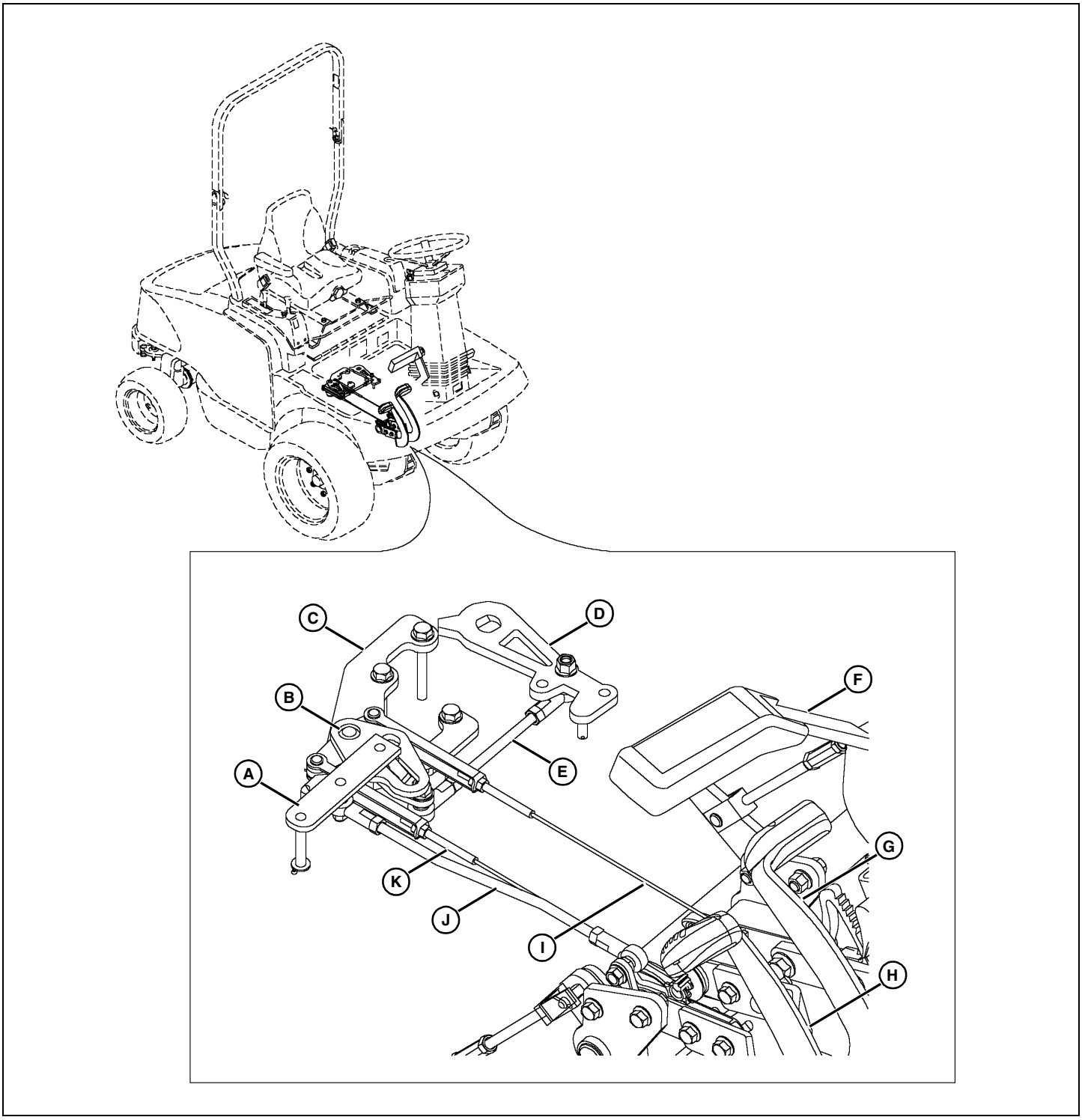
Transaxle Component Location (Single Speed Range)



MX5541

- **A - Left Brake Arm**
- **B - Hydrostatic Assembly**
- **C - Differential Assembly**
- **D - Tow Valves**
- **E - Right Brake Arm**
- **F - 4WD Output Shaft**
- **G - 4WD Gear Case**
- **H - Input Shaft**
- **I - PTO Solenoid**
- **J - PTO Assembly**

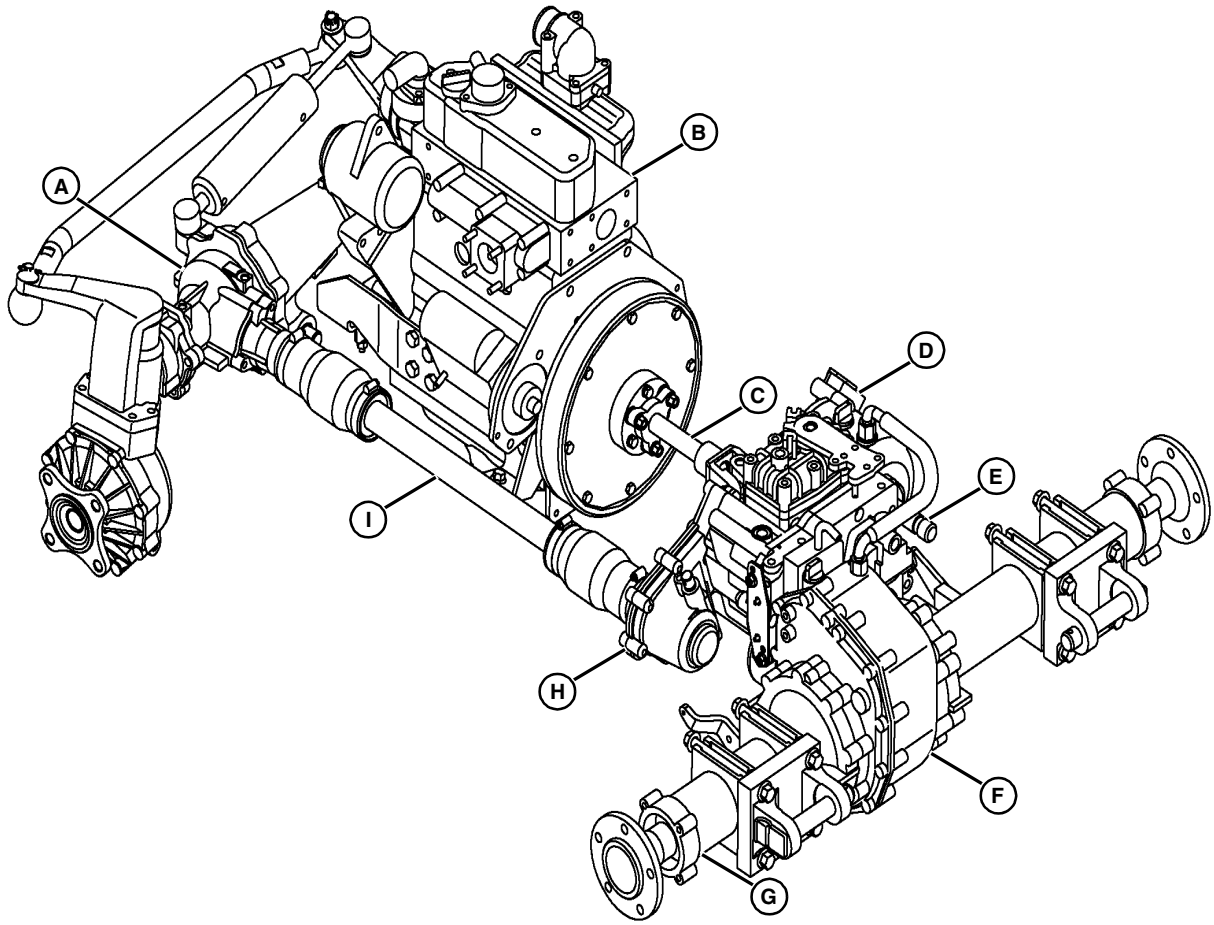
Hydrostatic Pedal and Neutral Safety Linkage Component Location



MX5806

A - Neutral Safety Arm
B - F-N-R Bellcrank
C - Linkage Support Bracket
D - Hydrostatic Control Arm
E - Hydrostatic Control Link
F - Brake Pedal
G - Forward Pedal
H - Reverse Pedal
I - Forward Cable
J - Neutral Safety Link
K - Reverse Cable

4WD Component Location



MX5543

A - 4WD Axle
B - Engine
C - Drive Shaft
D - Hydrostatic Assembly
E - PTO Shaft
F - Differential Assembly
G - Front Axle Housing
H - 4WD Gear Case
I - 4WD Drive Shaft

Diagnostics

Differential Will Not Lock Up when Differential Lock Pedal Is Depressed

Test Conditions:

- Machine parked safely.

Check differential lock linkage for wear or damage.	**Linkage not worn or damaged. See next step.** • Linkage is worn or damaged. Replace as necessary.
Check differential lock linkage adjustment.	**Linkage is correctly adjusted. See next step.** • Linkage needs adjustment. (See “Differential Lock Adjustment” on page 517.)
Check differential lock assembly for wear or damage. (See “Differential Disassembly, Inspection, and Assembly” on page 536.)	**Differential lock assembly is not worn or damaged.** • Assembly is worn or damaged. Repair or replace as necessary.

Machine Moves with Travel Pedals in Neutral Position

Test Procedure A

Test Conditions:

- Machine supported safely on jack stands with all four wheels off ground.
- Engine running at slow idle.

Check neutral adjustment. (See “Transaxle Neutral Creep Test and Adjustment” on page 515.)	**Neutral adjustment is correct.** • If condition resumes after adjustment, refer to Test Procedure B

Test Procedure B

Test Conditions:

- Machine parked safely.
- Park brake released.

Check hydrostatic pedal linkage and cable for wear and damage. Check linkage and cable adjustment. (See “F-N-R Linkage Adjustment” on page 516, and/or “Transaxle Neutral Creep Test and Adjustment” on page 515.)	**Linkage and cable are not worn or damaged and are adjusted properly.** • Linkage and/or cable are worn or damaged. Replace parts as necessary. • Linkage and/or cable cannot be properly adjusted. Replace parts as necessary.

Machine Will Not Move when Travel Pedals Are Engaged

NOTE: This condition may be caused by systems other than power train. Check the brake system if the following procedures do not correct the problem.

Test Procedure A

Test Conditions:

- Machine parked safely.
- Park brake released.

Check free-wheel valve plate position.	**Plate in run position. See next step.** • Plate in free-wheel position. Move to run position.
Check hydraulic reservoir (transaxle) oil level. Check oil for contamination. Check oil for foaming.	**Hydraulic reservoir filled to correct level with clean oil of correct specification. See next step.** • Oil is contaminated. Drain system, replace oil filter, and fill with specified oil. • Oil is foamy. (See “Hydraulic Oil Foams” on page 668 in Steering section.)
Check hydrostatic pedal linkage and cable for wear and damage. Check linkage and cable adjustment. (See “F-N-R Linkage Adjustment” on page 516, and/or “Transaxle Neutral Creep Test and Adjustment” on page 515.)	**Linkage and cable are not worn or damaged and are adjusted properly.** • Linkage and/or cable are worn or damaged. Replace parts as necessary. • Linkage and/or cable cannot be properly adjusted. Replace parts as necessary.

Test Procedure B

Test Conditions:

- Engine running at fast idle.
- Park brake locked.

Check system charge pressure. (See Charge Pressure Relief Valve Test in Hydraulics section.)	**Charge pressure is within specification.** • If charge pressure is not within specification, replace charge pressure relief valve.

Machine Will Not Reach Full Speed

NOTE: This condition may be caused by systems other than power train. Check the brake system if the following procedures do not correct the problem.

Test Procedure A

Test Conditions:

- Machine parked safely.
- Park brake released.

Check hydraulic reservoir (transaxle) oil level. Check oil for contamination. Check oil for foaming.	**Hydraulic reservoir filled to correct level with clean oil of correct specification. See next step.** • Oil is contaminated. Drain system, replace oil filter, and fill with specified oil. • Oil is foamy. (See “Hydraulic Oil Foams” on page 668 in Steering section.)
Check hydrostatic pedal linkage and cable for wear and damage. Check linkage and cable adjustment. (See “F-N-R Linkage Adjustment” on page 516, and/or “Transaxle Neutral Creep Test and Adjustment” on page 515.)	**Linkage and cable are not worn or damaged and are adjusted properly.** • Linkage and/or cable are worn or damaged. Replace parts as necessary. • Linkage and/or cable cannot be properly adjusted. Replace parts as necessary. • Check for debris in the hydrostatic control arm stop area.

Test Procedure B

Test Conditions:

- Engine running at fast idle.
- Park brake locked.

Check system charge pressure. (See “Charge Pressure Relief Valve Test 1400 Series” on page 728 in Hydraulics section.)	**Charge pressure is within specification. See next step.** • If charge pressure is not within specification, replace charge pressure relief valve.
Check hydrostatic motor leakage.	**Leakage is within specification.** • If leakage exceeds specification, repair or replace hydrostatic motor as necessary.

PTO Shaft Turns with PTO Switch OFF

Test Conditions:

- Machine parked safely.

Check PTO switch. (See “PTO Switch Test” on page 477 in Electrical section.)	**PTO switch good. See next step.** • Switch is bad. Replace.
Check PTO solenoid. (See “PTO Solenoid Valve Check” on page 735 in Hydraulics section.)	**PTO solenoid good. See next step.** • Solenoid is bad. Repair or replace.
Check PTO brake for wear or damage. (See “PTO Disassembly, Inspection, and Assembly” on page 546.)	**PTO brake is not worn or damaged.** • PTO brake is worn or damaged. Replace brake parts as necessary. • Check PTO solenoid valve. Spool should move freely inside sleeve.

PTO Shaft Will Not Turn with PTO Switch ON

Test Conditions:

- Machine parked safely.

Check hydraulic reservoir (transaxle) oil level. Check oil for contamination. Check oil for foaming.	**Hydraulic reservoir filled to correct level with clean oil of correct specification. See next step.** • Oil is contaminated. Drain system, replace oil filter, and fill with specified oil. • Oil is foamy. (See “Hydraulic Oil Foams” on page 668 in Steering section.)
Check PTO switch. (See “PTO Switch Test” on page 477 in Electrical section.)	**PTO switch good. See next step.** • Switch is bad. Replace.
Check PTO solenoid. (See “PTO Solenoid Valve Check” on page 735 in Hydraulics section.)	**PTO solenoid good. See next step.** • Solenoid is bad. Repair or replace.
Check PTO brake for wear or damage. (See “PTO Disassembly, Inspection, and Assembly” on page 546.)	**PTO brake is not worn or damaged.** • PTO brake is worn or damaged. Replace brake parts as necessary. • Check PTO piston seal for damage. If seal is torn, excessive heat will be generated in PTO housing.

Rear Wheels Do Not Drive

Test Conditions:

- Machine parked safely.

Check 4WD lever linkage for wear or damage.	**Lever linkage is not worn or damaged. See next step.** • Linkage is worn or damaged. Repair or replace as necessary.
Check 4WD drive shaft for wear or damage.	**Drive shaft is in place and not damaged. See next step.** • Drive shaft is missing or damaged. Repair or replace as necessary.
Check transaxle 4WD gear case assembly for wear or damage. (See “4WD Gear Case Disassembly, Inspection, and Assembly” on page 557.)	**Gear case is not worn or damaged. See next step.** • Gear case worn or damaged. Repair or replace as necessary.
Check 4WD axle assembly for wear or damage. (See “4WD Axle Disassembly, Inspection, and Assembly” on page 564.)	**4WD axle is not worn or damaged. See next step.** • 4WD axle is worn or damaged. Repair or replace as necessary.

Tests and Adjustments

Transaxle Neutral Creep Test and Adjustment

Reason:

To ensure that machine does not creep when pedals are in neutral.

Special or Required Tools:

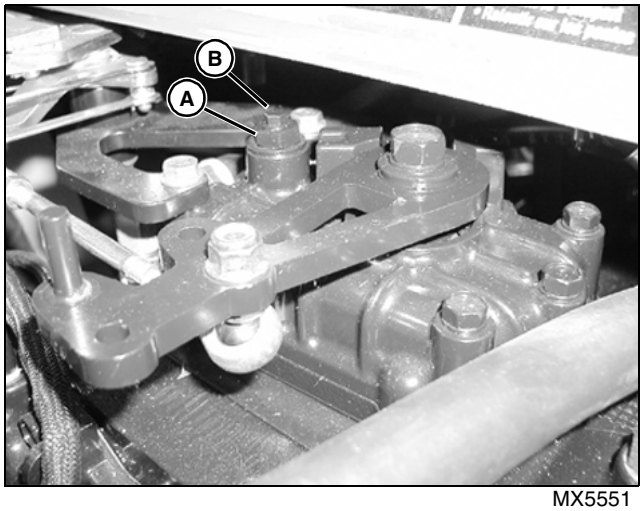
Tool Name	Tool No.	Tool Use
Hoist	NA	Used to lift machine.
Jack Stand (4 used)	NA	Used under frame to support machine.

NOTE: If creep is intermittent, inspect hydrostatic pedal linkage for wear, damage, or binding before adjusting transaxle neutral.

Procedure:

CAUTION: Avoid injury! When servicing a 4WD equipped machine with front wheels supported off ground and engine running, always support rear wheels in a similar manner. The 4WD is always engaged and will push machine off supports if wheels are not raised.

1. Lift machine with a hoist and support both front and rear wheels off the ground.
2. Put jack stands under frame.



MX5551

3. Loosen lock nut (A).

CAUTION: Avoid injury! Use extreme caution when doing this adjustment. Drive wheels are free to spin.

4. Have someone push down center of seat cushion to activate seat safety switch, or use a jumper wire to bypass the seat switch.
5. Start engine and run at slow idle.
6. With brakes unlocked, turn eccentric nut (B) left or right until drive wheels stop turning.
7. Hold adjustment and tighten lock nut. Make sure adjustment did not change.
8. Depress both forward and reverse speed pedals, then release.
9. Check neutral adjustment. Repeat adjustment as necessary.

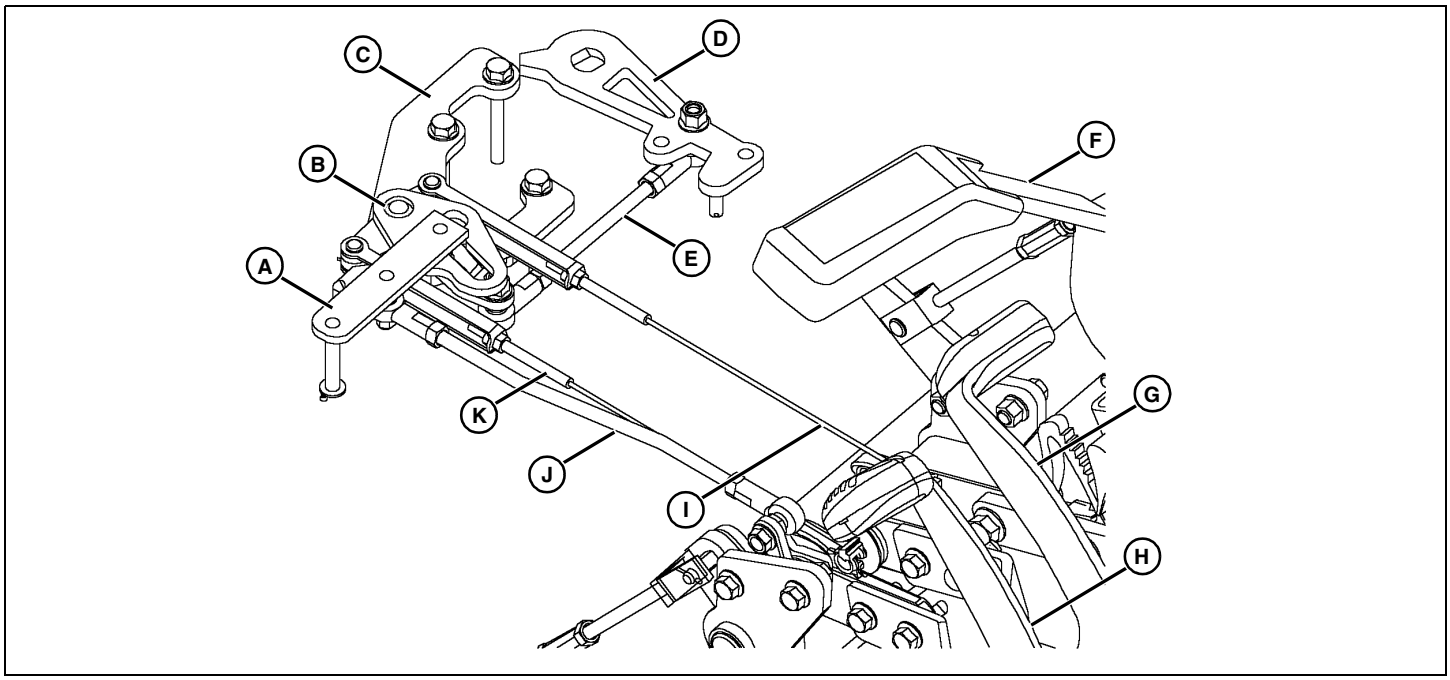
CAUTION: Avoid injury! Remove jumper wire from seat switch if installed.

10. Lower machine to the ground. Remove seat switch jumper wire if used.

Results:

- If drive wheels continue to turn, check for worn or binding hydrostatic pedal linkage or internal transaxle problems.

F-N-R Linkage Adjustment



MX5807

- **A - Neutral Safety Arm**
- **B - F-N-R Bellcrank**
- **C - Linkage Support Bracket**
- **D - Hydrostatic Control Arm**
- **E - Hydrostatic Control Link**
- **F - Brake Pedal**
- **G - Forward Pedal**
- **H - Reverse Pedal**
- **I - Forward Cable**
- **J - Neutral Safety Link**
- **K - Reverse Cable**

Cable Installation and Adjustment:

1. Park machine safely on level surface.

2. Disengage PTO.

3. With machine running, release brake and check for creep. If machine creeps, adjust neutral creep before continuing with linkage adjustment. (See “Transaxle Neutral Creep Test and Adjustment” on page 515.)

4. Turn key switch off.

5. Open floor access panel.

6. Loosen lock nuts on ball joint ends of hydrostatic control link (E). Disconnect link from hydrostatic control arm (D). Adjust length of control link to 179 mm (7 in.), measuring from center-to-center of ball joint studs. Ensure sufficient thread engagement in both ball joint ends. Install link and tighten ball joint nuts, but do not tighten jam nuts at this time.

7. Loosen nuts on clevis of forward (I) and reverse (K) cables.

8. Adjust jam nut on forward cable until threaded end of cable extends approximately 20 mm (0.8 in.) beyond nut. Adjust rear cable until end extends approximately 12 mm (0.5 in.) beyond jam nut. Do not tighten nuts at this time.

9. Adjust hydrostatic control link (E) until the roller of the neutral safety arm (A) is centered in the forward cam slot of F-N-R bellcrank (B) as the safety arm and roller swing forward. Tighten control link jam nuts.

10. Adjust forward and reverse cables until pedal pad distance from floor is to specification and the hydrostatic control arm (D) hits the hard stops on the transaxle.

11. Tighten jam nuts on forward and reverse cables.

12. Recheck pedal travel and operation of park brake.

13. Operate machine and check for neutral creep. (See “Transaxle Neutral Creep Test and Adjustment” on page 515.)

Link Installation and Adjustment:

NOTE: If installing neutral safety link, make sure the thread engagement in both front and rear ball joints is to specification.

1. Loosen lock nut on rear ball joint of neutral safety link (J). Disconnect link from neutral safety arm (A) and adjust length of link to approximately 305 mm (12 in.), measuring from center-to-center of ball joint studs.

2. Install link on safety arm (A) and adjust the length of the safety link (J), as necessary, until the roller of the neutral safety arm (A) is about 2 - 4 mm (0.08 - 0.16 in.) from the rear surface of F-N-R bellcrank cam slot. Tighten lock nut attaching link to arm and jam nut on rod.

3. With the brakes off, operate the forward (G) and reverse (H) pedals. Make sure that the neutral safety arm does not impede forward and reverse pedal strokes.

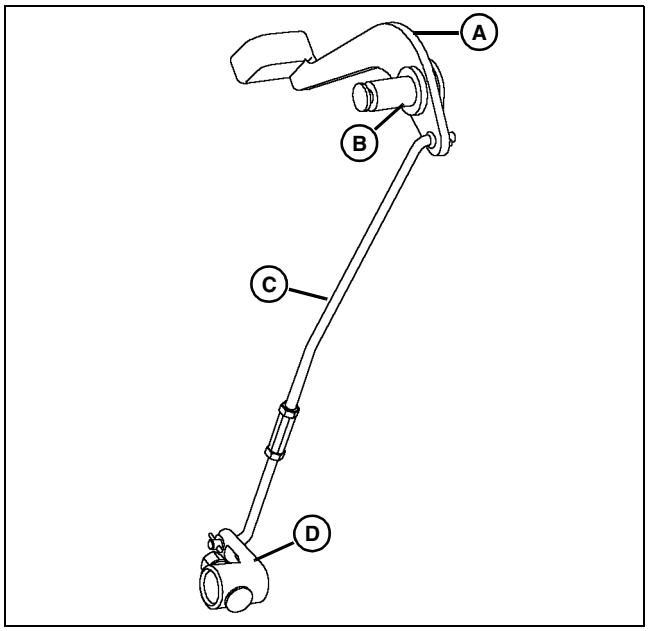
4. Check operation of park brake (F) and park brake switch.

Specifications:

Forward and Reverse
Pedal-to-Floor Clearance . . . . . 3 mm (0.1 in.)

Neutral Safety Link Ball Joint Thread Engagement
(Minimum) . . . . . 8 mm (0.3 in.)

Differential Lock Adjustment



MX5808

A - Differential Lock Pedal
B - Differential Lock Pivot
C - Differential Lock Link Assembly
D - Differential Lock Arm

Adjustment:

1. Park machine on level ground.

2. With at least one wheel off the ground, turn the tire and depress the differential lock pedal until it locks into position.

   - If pedal hits floor and will not lock into position, shorten the differential lock link until it locks.

3. Adjust the length of the differential lock link so that a 1 - 3 mm gap exists between the pedal and floor.

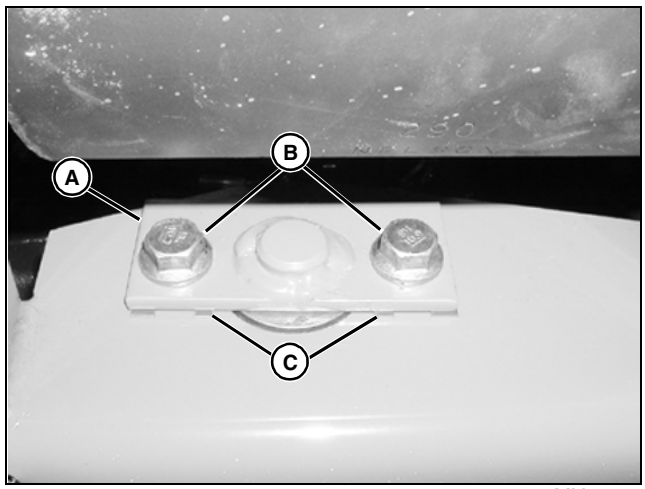
4. Tighten jam nuts.

4WD Axle Pivot Pin Clearance Adjustment

Procedure:

1. Safely raise rear frame so axle is free to pivot.

2. With feeler gauge, measure gap between rear edge of axle housing and front edge of frame bushing.



MX5552

3. Loosen flanged cap screws and lock nuts (B) to add or deduct shims (C) between pin flange (A) and machine frame until you gain a dimension within the specification.

4. Tighten flanged cap screws and lock nuts to specification.

5. Re-check gap to ensure proper specified end play has been obtained.

Specifications:

4WD Axle
End Play . . . . . 0.127 - 1.016 mm (0.005 - 0.040 in.)

4WD Axle Flanged Cap Screw
and Lock Nut Torque . . . . . 88 N•m (65 lb-ft)

Repair

Engine Drive Shaft Removal and Installation

Special or Required Tools:

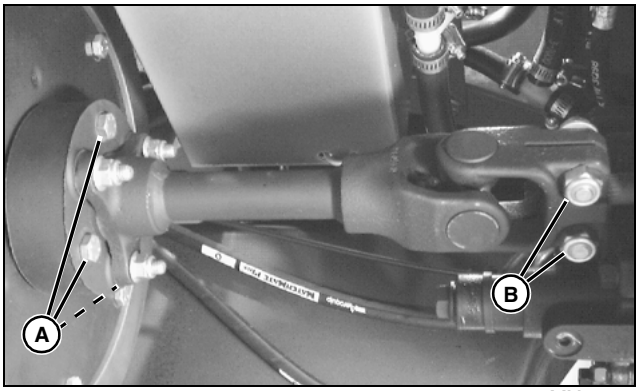
Tool Name	Tool No.	Tool Use
Long Pointer (1400's)	JDG-1389-2	Used to check and set engine-to-transaxle alignment.
Short Pointer (1565)	JDG-1389-3	Used to check and set engine-to-transaxle alignment.
Engine Alignment Tool Base	JDG-1389-1	Used to check and set engine-to-transaxle alignment.

Procedure:

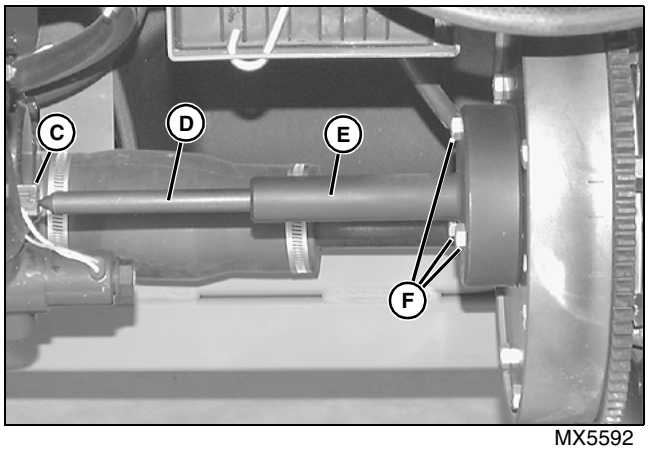
1. Remove front attachment.

2. Place wedge blocks in front of and behind both rear wheels.

3. Raise front of machine. Support both sides of frame just behind transaxle with 2-ton jackstands or wooden block for safety reasons.



MX5442



MX5592

4. Remove two cap screws and nuts (B).

5. Remove three drive shaft mounting cap screws (A).

IMPORTANT: Avoid damage! Drive shaft alignment should be checked any time drive shaft is removed.

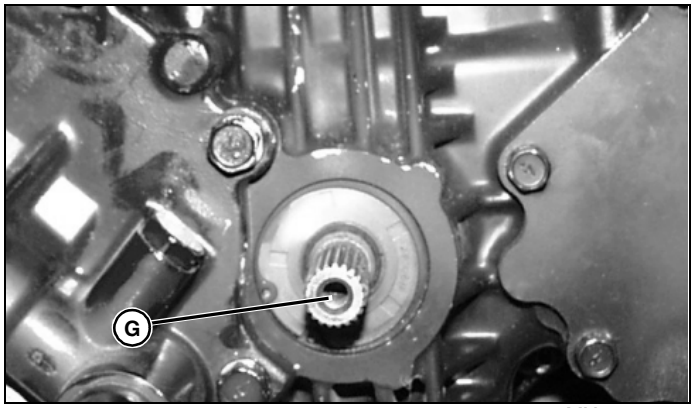
6. Slide drive shaft forward, then tip rear of drive shaft down and slide to rear to remove.

IMPORTANT: Avoid damage! When installing the transaxle, the John Deere Engine Alignment Tool must be used to properly align the engine and the transaxle.

7. Install JDG-1389-2 Long Pointer (D) for 1400 series, or JDG-1389-3 Short Pointer for 1565 into JDG-1389-1 Engine Alignment Tool Base (E).

8. Install engine alignment tool base to engine flywheel using three drive shaft mounting cap screws (F).

9. Slide pointer out until it contacts transaxle input shaft (C).



MX14377

10.Pointer (D) should be centered in the end (G) of the input shaft.

11.If pointer will not center, engine must be realigned.

12.Loosen engine mounting cap screws.

13.Grasp the alignment tool pointer (D) and move engine as necessary to center pointer in transaxle input shaft (C). If pointer will not center in transaxle input shaft, replace engine isolators and realign engine.

14.When engine and transaxle are correctly aligned, tighten engine mount cap screws to specification.

15.Remove alignment tool (E).

16.Install drive shaft.

17.Install three drive shaft mounting cap screws (A).

18.Install two cap screws and nuts (B).

19.Lower machine to ground.

Transaxle Removal and Installation

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Lifting Bracket	JT01748	Used with hoist to remove and install transaxle.

Procedure:

1. Remove front attachment.

2. Put wedge blocks in front of and behind both rear drive wheels.

3. Loosen front drive wheel lug nuts.

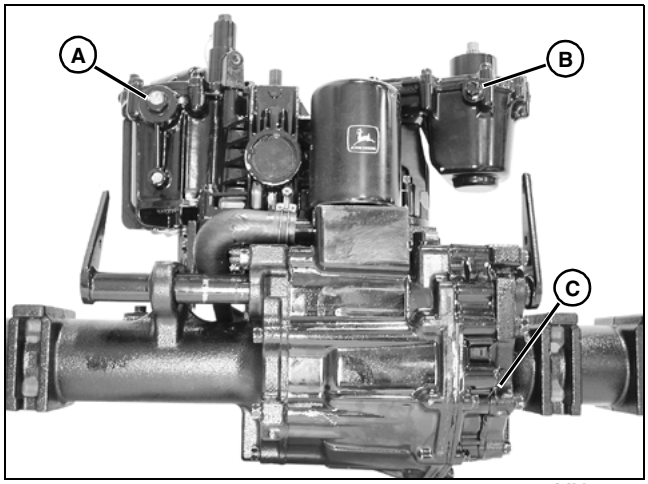
4. Raise front of machine. Support both sides of frame just behind transaxle with 2-ton jackstands or wooden blocks for safety reasons.

5. Remove front drive wheels.

6. Remove engine drive shaft. (See “Engine Drive Shaft Removal and Installation” on page 518.)

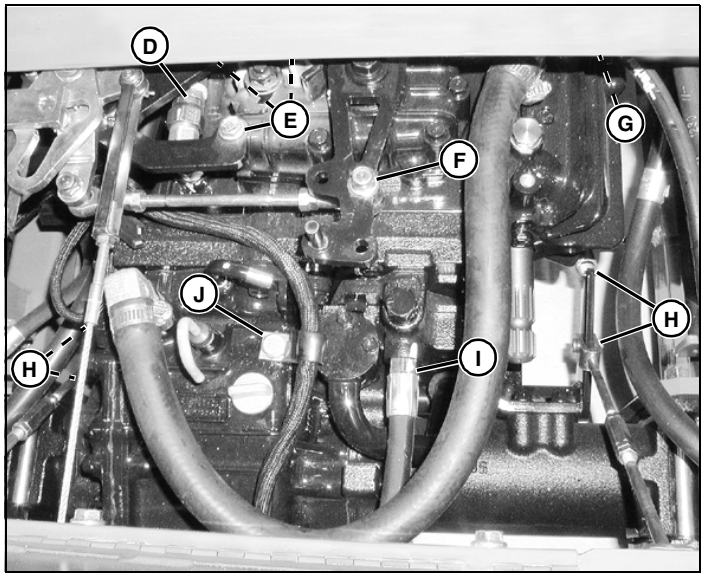
7. Remove 4WD drive shaft, if equipped. (See “4WD Drive Shaft Removal and Installation” on page 556.)

NOTE: Use shop cloths or paper towels to catch and clean up any spilled oil immediately. Close all ports and lines using caps or plugs.



MX5553

8. Remove drain plugs at PTO/hydrostatic housing (A), 4WD housing (B), and differential housing (C).



MX5554

9. Disconnect pedal linkage (F).

10. Remove three mounting cap screws (E) for linkage pivot. Move pedal linkage aside.

11. Disconnect hydraulic hose (D).

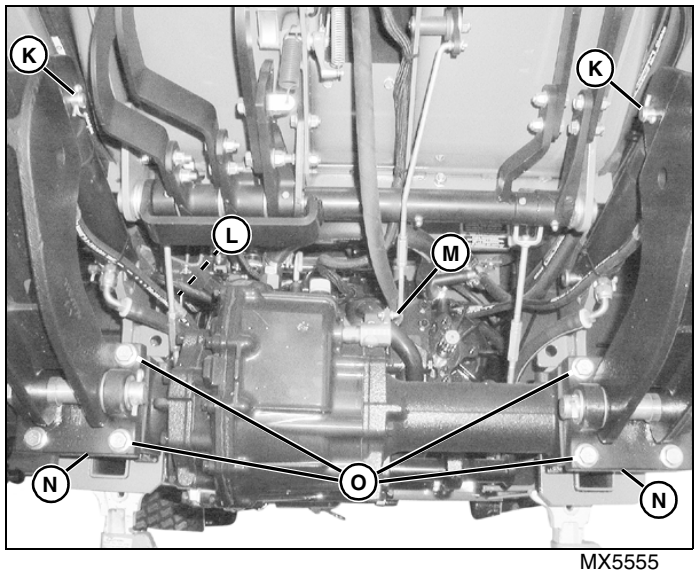
12. Disconnect PTO solenoid harness (G).

13. Disconnect right and left brake links and springs (H).

NOTE: Power steering hose (I) will rotate at power steering valve.

14. Disconnect power steering hose (I).

15. Remove cap screw (J) and move wire harness aside. Attach JT01748 Lifting Bracket in place of cap screw.



MX5555

16. Disconnect implement lift cylinders (K).

17. Disconnect differential lock linkage (M).

18.Disconnect 4WD linkage (L), if equipped.

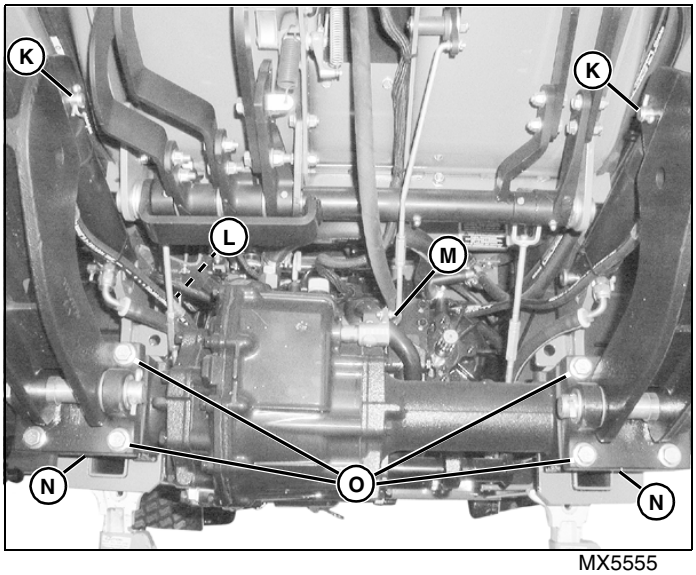
19.Connect an overhead hoist to lifting bracket on transaxle.

20.Remove eight transaxle mounting cap screws (O) and implement lift arm mounts (N).

21.Remove transaxle.

22.Raise transaxle to frame.

IMPORTANT: Avoid damage! Locating pins on rear side of transaxle must be positioned in frame locating holes before tightening of transaxle mounting cap screws.



MX5555

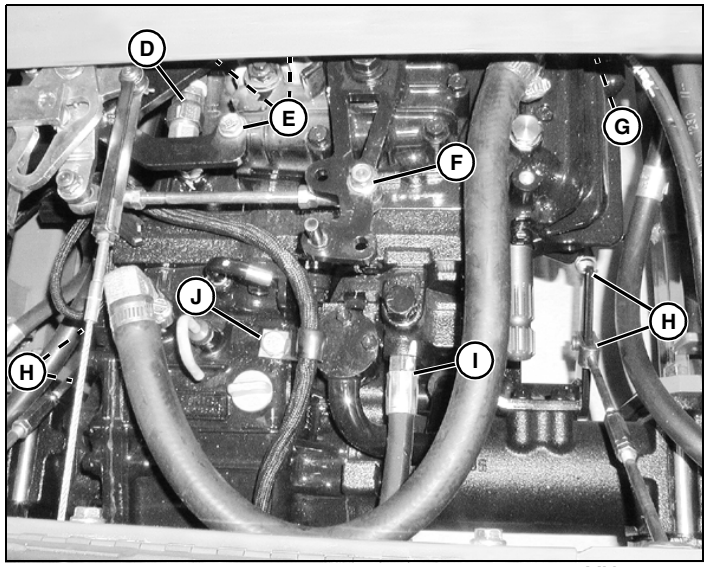
23.Install eight mounting cap screws (O) and implement lift arm mounts (N). Position locating pins on transaxle into locating holes of frame and tighten mounting cap screws to specification.

24.Remove overhead hoist.

25.Connect 4WD linkage (L), if equipped.

26.Connect differential lock linkage (M).

27.Connect implement lift cylinders (K).



MX5554

28.Remove lifting bracket and install cap screw (J) and wiring harness.

29.Connect power steering hose (I).

30.Connect right and left brake links and springs (H).

31.Connect PTO solenoid harness (G).

32.Connect hydraulic hose (D).

33.Install pedal linkage pivot using three mounting cap screws (E).

34.Connect pedal linkage (F). Check that all pedals operate properly.

35.Install 4WD drive shaft, if equipped. (See “4WD Drive Shaft Removal and Installation” on page 556.)

36.Install engine drive shaft. (See “Engine Drive Shaft Removal and Installation” on page 518.)

37.Install front drive wheels. Tighten mounting cap screws to specification.

38.Lower machine to ground.

39.Fill transaxle with proper fluid. (See “Oil and Lubricant Specifications” on page 18 in Section 2, Specifications and General Information.)

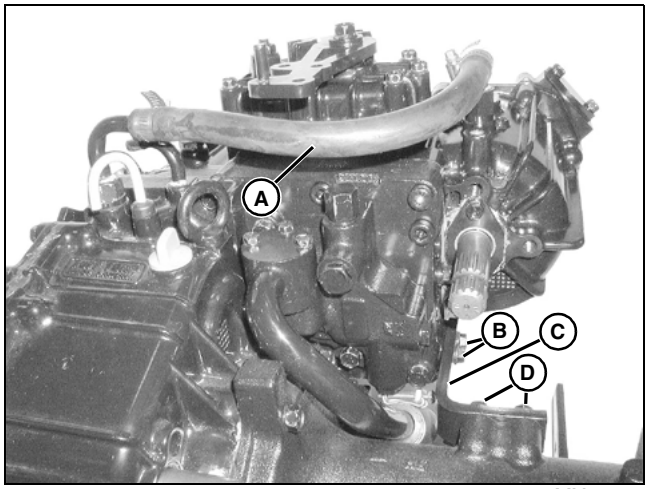
Specifications:

Transaxle Mounting
Cap Screw Torque . . . . . 142 N•m (105 lb-ft)

Front Drive Wheel Mounting
Cap Screw Torque . . . . . 225 N•m (165 lb-ft)

Hydrostatic Assembly-to-Differential Assembly Separation and Installation

1. Remove transaxle. (See “Transaxle Removal and Installation” on page 519.)

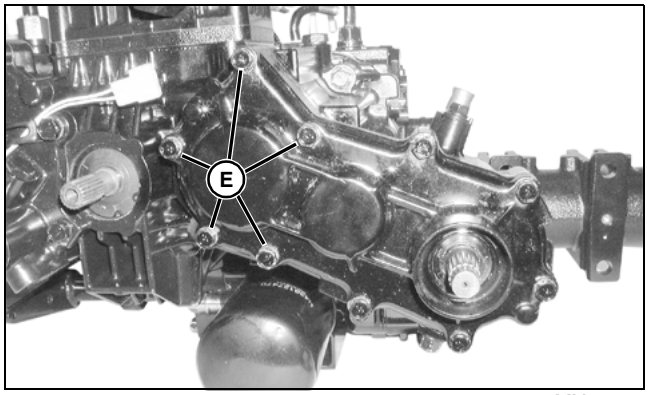


MX5660

2. Disconnect return hose (A).

3. Remove two cap screws (B), two cap screws (D), and L-bracket (C).

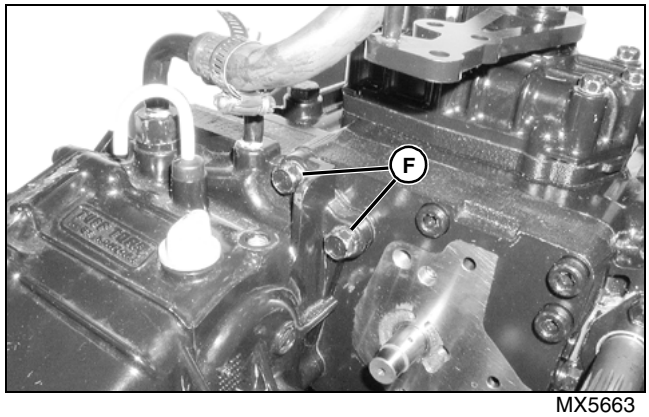
4. Remove charge pump. (See “Charge Pump Disassembly, Inspection, and Assembly” on page 522.)



MX5662

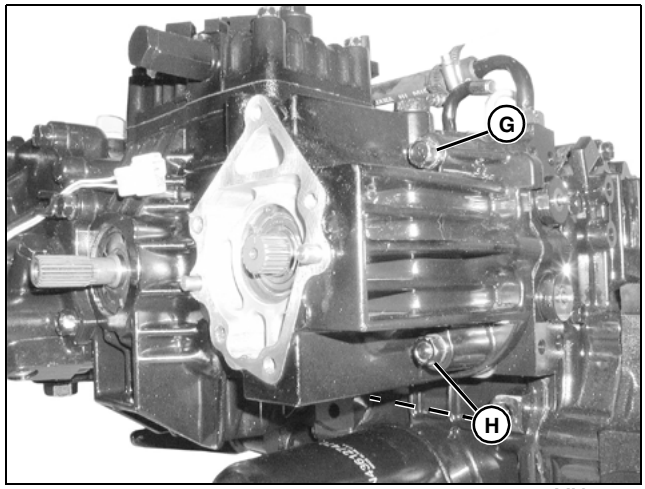
Picture Note: 4WD Gearbox Shown

5. Remove five cap screws (E) and cover plate or 4WD gearbox, if equipped.



MX5663

6. Remove two front cap screws (F).



MX5664

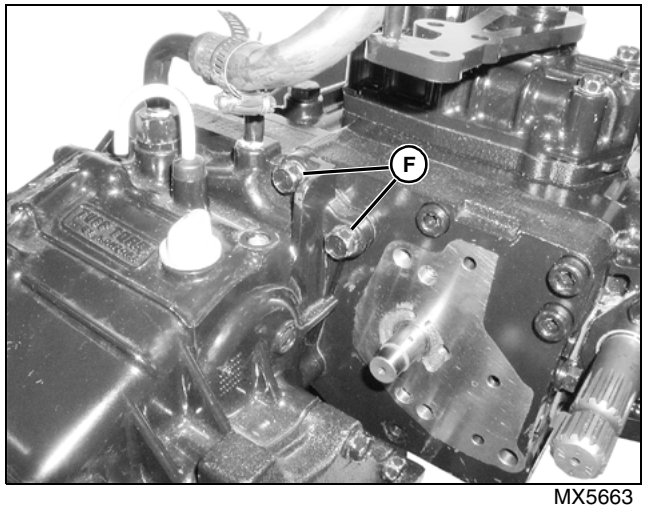
7. Remove rear cap screw (G) and two nuts (H).

8. Separate hydrostatic assembly from differential assembly.

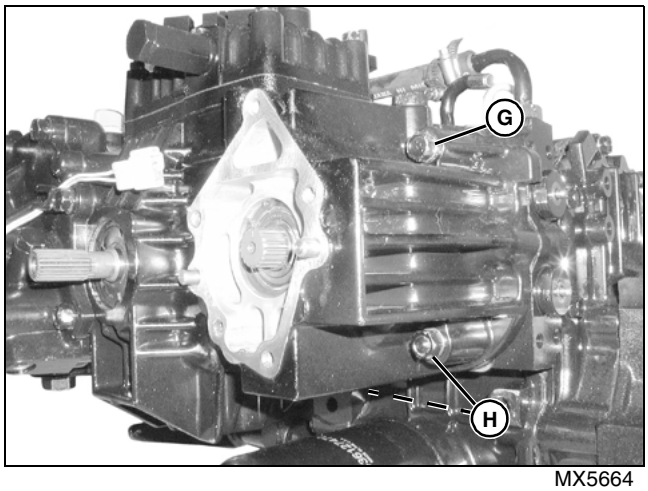
9. Repair assemblies as necessary.

10. Clean gasket surfaces.

11. Replace gaskets.



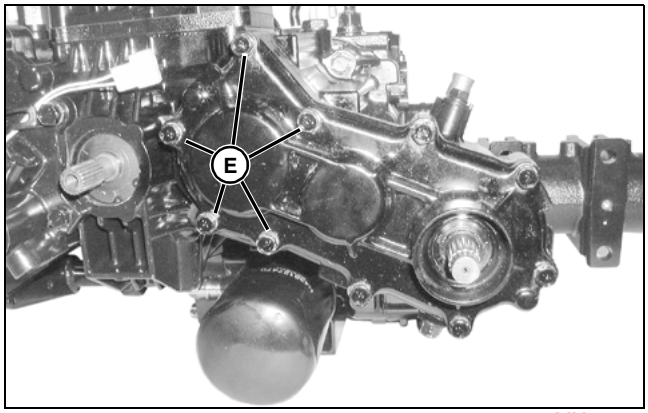
MX5663



MX5664

12.Install hydrostatic assembly to differential assembly.

13.Install cap screws (F and G) and nuts (H).

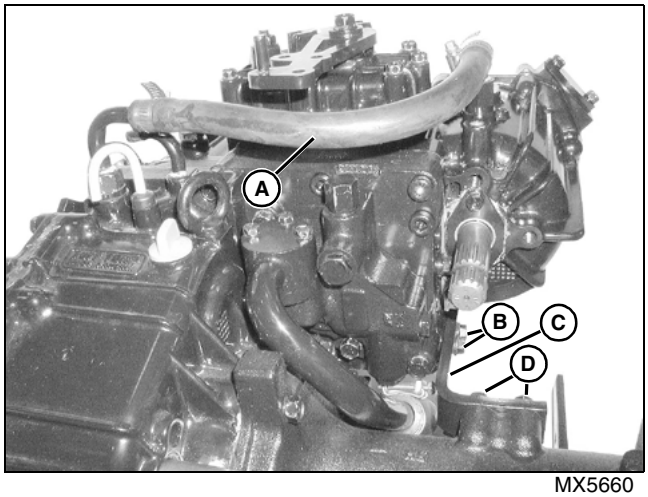


MX5662

Picture Note: 4WD Gearbox Shown

14.Install cover plate or 4WD gearbox using cap screws (E).

15.Install charge pump. (See “Charge Pump Disassembly, Inspection, and Assembly” on page 522.)



MX5660

16.Install L-bracket (C) using cap screws (B and D).

17.Connect return hose (A).

18.Install transaxle. (See “Transaxle Removal and Installation” on page 519.)

Charge Pump Disassembly, Inspection, and Assembly

Disassembly/Inspection:

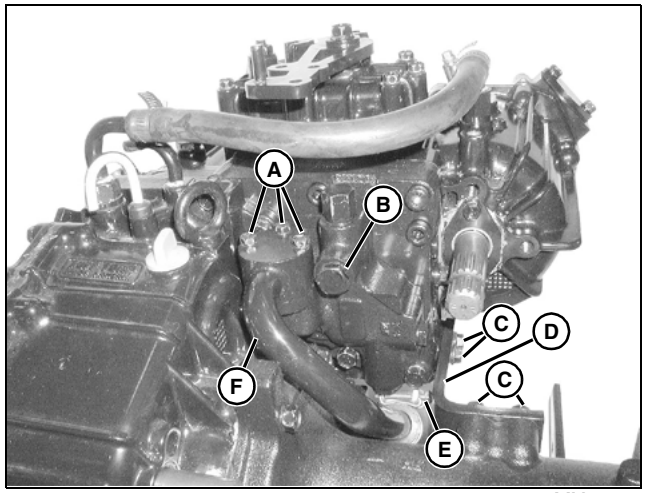
NOTE: You do not need to remove transaxle to repair charge pump only. Charge pump can be removed without disassembly of transaxle.

Transaxle is shown removed for clarity.

Use shop cloths or paper towels to catch and clean up any spilled oil immediately. Close all ports and lines using caps or plugs.

1. If transaxle is in machine, drain transaxle. (See Changing the Transaxle Oil and Filter in the operator’s manual.)

NOTE: Power steering hose will rotate at power steering valve.



MX5660

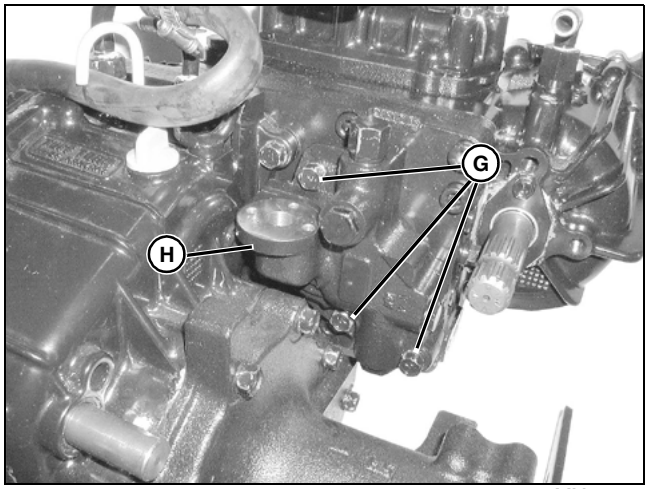
2. If transaxle is in machine, disconnect and plug power steering at port (B).

3. Remove four cap screws (C) and L-bracket (D).

4. Loosen hose clamp (E).

5. Remove three cap screws (A) and remove suction tube (F).

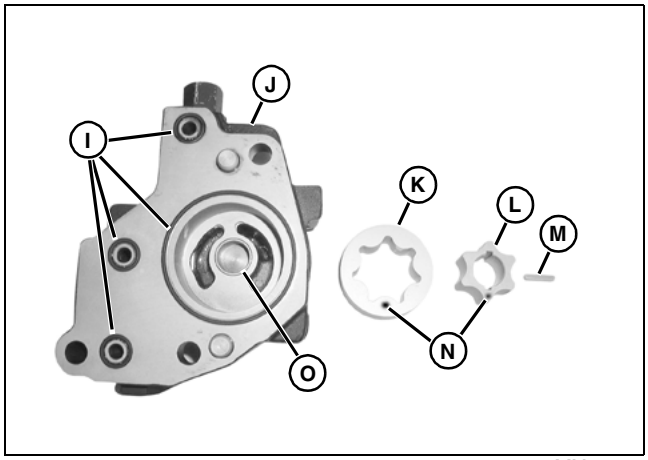
NOTE: Charge pump gears may fall out when removing charge pump. Do not allow gears to fall and be damaged.



MX5661

6. Remove three cap screws (G).

7. Remove charge pump (H). Do not drop charge pump gears.



MX5668

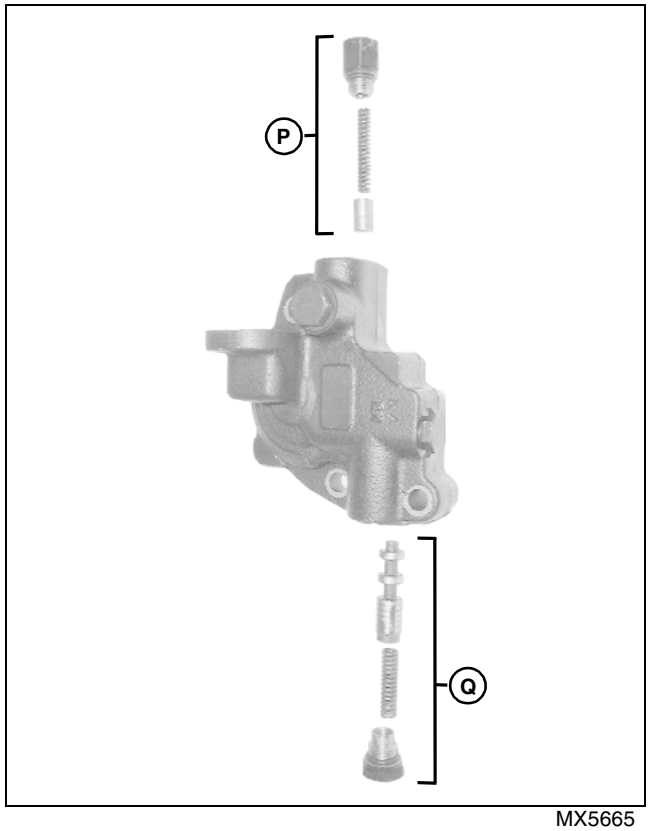
8. Remove outer gear (K) from pump housing (J).

9. Remove O-rings (I) from pump housing.

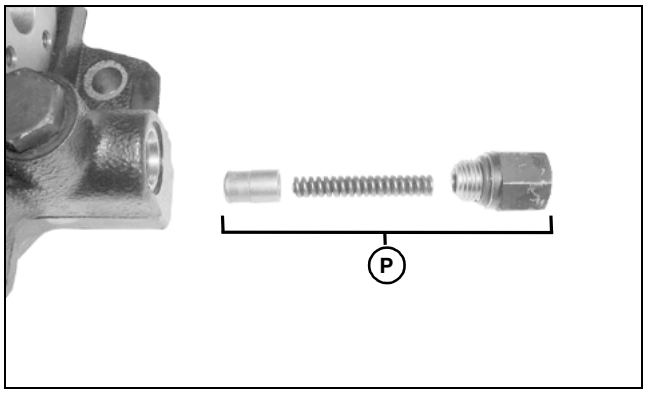
10. Remove inner gear (L) and key (M) from pump shaft.

11. Inspect pump shaft bushing (O) for wear. If bushing shows excessive wear, replace charge pump.

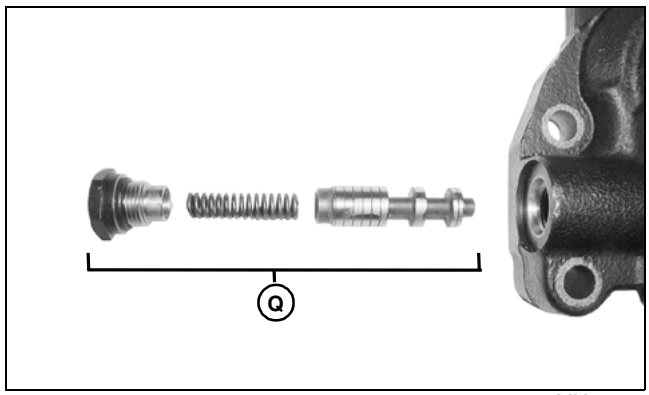
12. Inspect machined surfaces of charge pump and hydrostatic center section for severe scoring. If scoring is noted, replace charge pump and center section.



MX5665



MX5667



MX5666

13.Remove charge pump relief valve (P) and lube reduction valve (Q).

14.Inspect valve spools and bores for severe scoring or damage. If scoring or damage is noted, replace charge pump and valves.

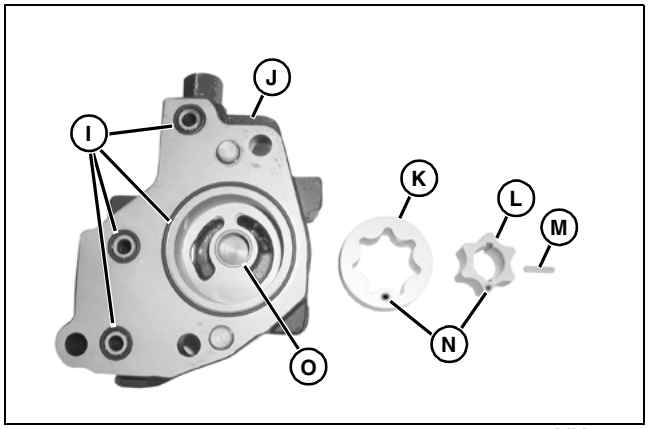
15.Clean and dry all parts.

Assembly:

1. Apply clean transmission oil on all internal parts.

NOTE: Always replace O-rings. Old O-rings may be worn or damaged and will result in leaks.

2. Replace O-rings and install charge pump relief (P) and lube reduction (Q) valves. Tighten valves to specification.



MX5668

3. Install key (M) on pump shaft.

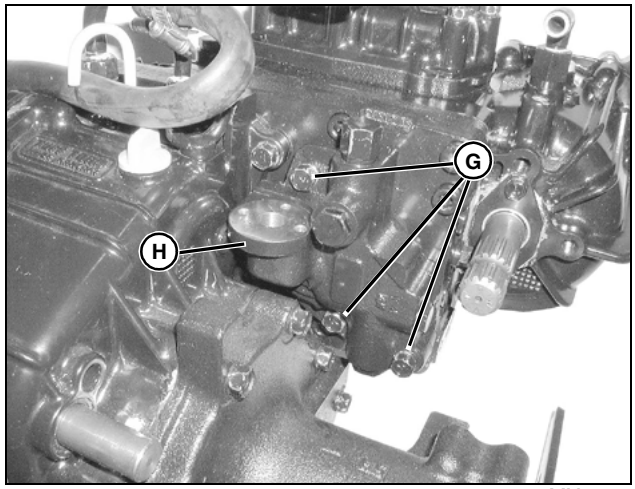
NOTE: Dimples on inner and outer gear of charge pump must face in same direction. If gears are installed incorrectly, damage to pump will occur.

4. With dimple (N) facing front of transaxle, install inner gear (L) on pump shaft.

5. With dimple facing front of pump housing (J), install outer gear (K) into pump housing.

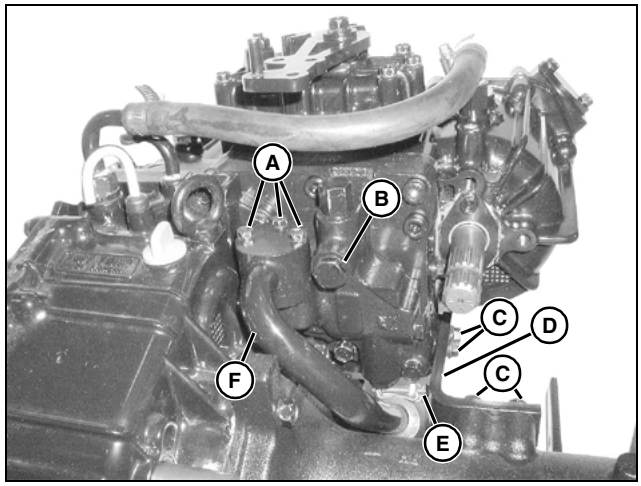
NOTE: Always replace O-rings. Old O-rings may be worn or damaged and will result in leaks.

6. Replace O-rings (I).



MX5661

7. Install charge pump (H) using three cap screws (G).



MX5660

8. Install suction tube (F) using three cap screws (A).

9. Tighten hose clamp (E).

10.Install L-bracket (D) using four cap screws (C).

11.If transaxle is in machine, connect power steering hose to port (2).

12.If transaxle is in machine, fill transaxle. (See Changing the Transaxle Oil and Filter in the operator's manual.)

Specifications:

Charge Pump
Relief Valve Torque . . . . . 22 - 27 N•m (195 - 240 lb-in.)

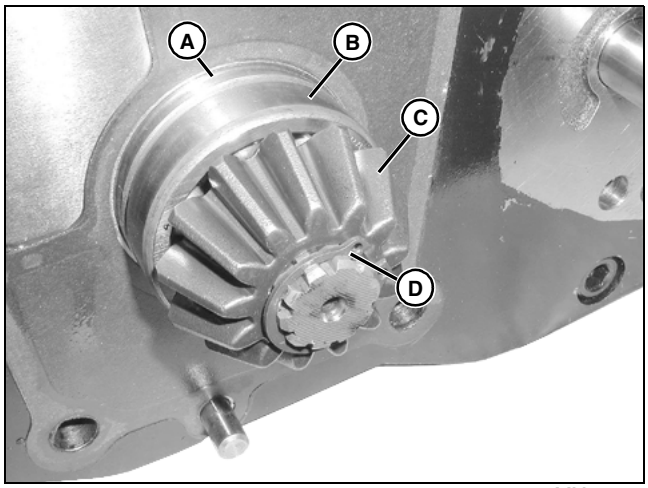
Lube Reduction Valve
Torque . . . . . 27 - 32 N•m (240 - 284 lb-in.)

Hydrostatic Assembly - Disassembly, Inspection, and Assembly

Disassembly/Inspection:

1. Remove transaxle. (See “Transaxle Removal and Installation” on page 519.)

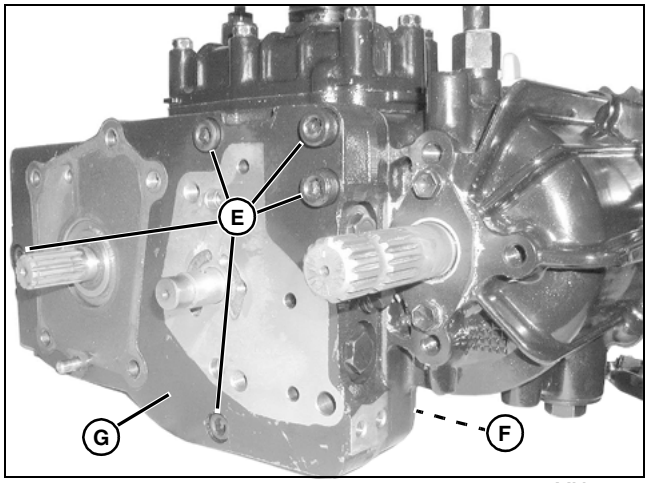
2. Separate hydrostatic assembly. (See “Hydrostatic Assembly-to-Differential Assembly Separation and Installation” on page 521.)



MX5742

3. Remove snap ring (D), gear (C), bearing (B), and spacer (A).

NOTE: Use shop cloths or paper towels to catch and clean up any spilled oil immediately. Close all ports and lines using caps or plugs.



MX5743

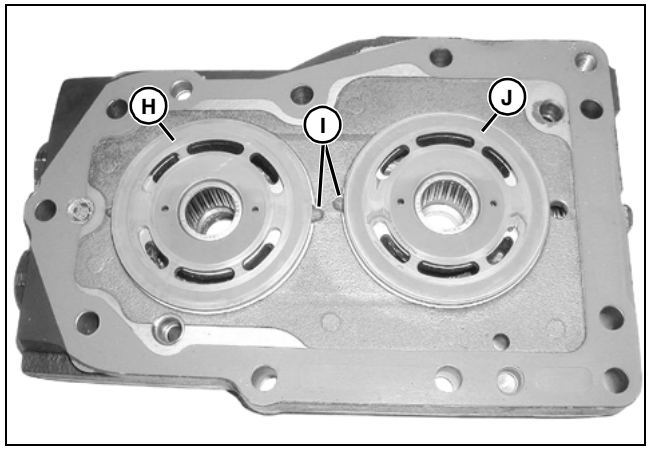
4. Remove five hex socket screws (E) and one cap screw (F).

IMPORTANT: Avoid damage! Do not allow internal parts to fall free when removing center section.

Do not nick or scratch lapped or machined surfaces of the center section, valve plates, or cylinder blocks and pistons.

5. Carefully separate center section (G) from housing. Take care not to let the gasket get hung up on the guide pins. You may have to gently pry it off.

NOTE: If valve plates Do not come off with center section, remove valve plates from cylinder block assemblies. It may be necessary to apply diesel fuel between valve plates and cylinder blocks to cut oil film.

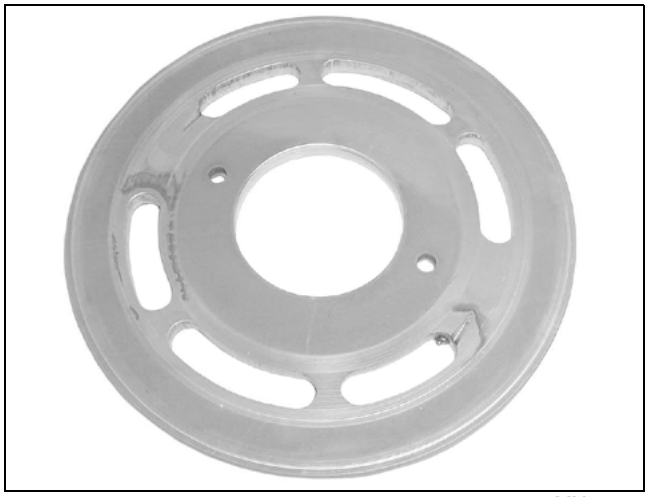


MX5744

6. Remove motor valve plate (H) and pump valve plate (J). If valve plates stick to the center section, it may be necessary to pry valve plates loose from the center section. Use a wooden dowel and pry only at dowel pin grooves (I).

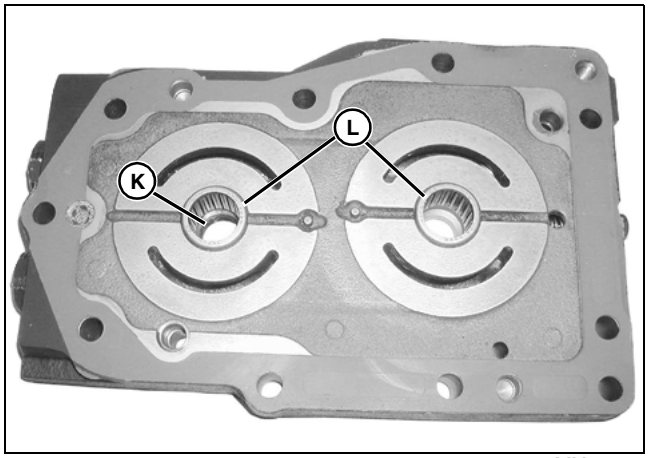
NOTE: Scoring is indicated by fine scratches or grooves cut into the smooth plated surface of the valve plate. Use a close visual inspection with a magnifying glass or feel with your fingertips, fingernail, or a sharpened lead pencil.

If scratches or grooves are detected, the plate must be replaced.



MX5745

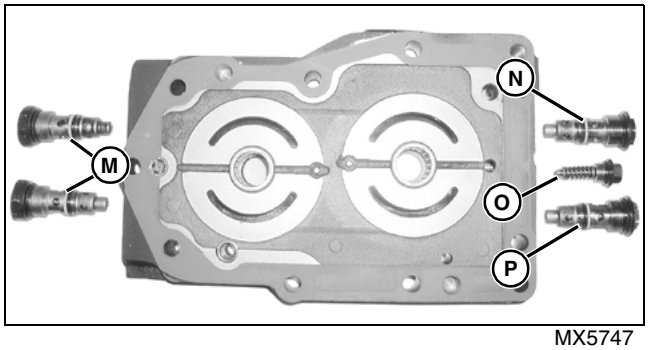
7. Inspect valve plates. Valve plates should be flat, free of all nicks, burrs, scratches, and erosion around the ports. The plated side should show no scoring, smearing, or discoloration (a sign of overheating).



MX5746

8. Inspect motor shaft seal (K). Replace if necessary.

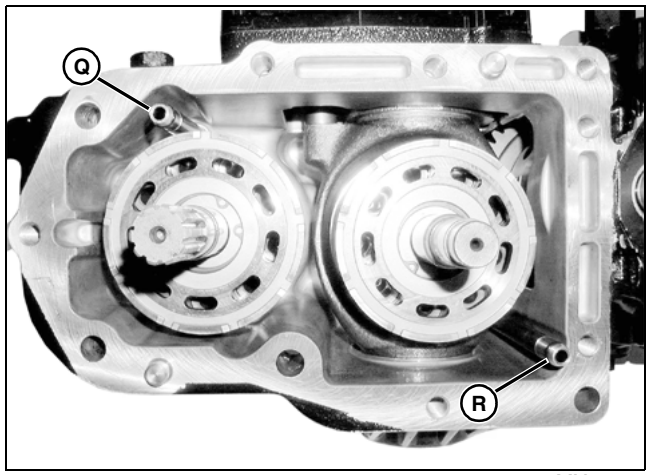
9. Inspect both bearings (L) in the center section. Replace if necessary. Remove bearing using a two-jaw, slide-hammer puller.



MX5747

10.Remove tow valves (M), forward check valve (N), implement relief valve (O), and reverse check valve (P) as required.

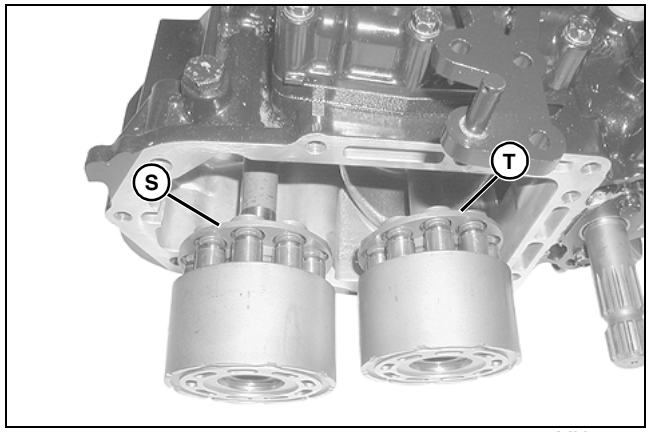
11.Inspect valves and seats for damage. Valves must slide freely in their bores. Valve seals must not be cut or damaged. Replace valves as necessary. Tighten valves to specification.



MX5748

12.Remove drain tube (Q) and PTO supply tube (R).

IMPORTANT: Avoid damage! Do not nick or scratch lapped surface of cylinder blocks.



MX5749

13.Reach in to grab pump assembly piston retainer rim (T) to ensure none of the pistons slip out of the cylinder block as you remove assembly from the pump shaft.

14.In the same manner, reach in to grab motor assembly piston retainer rim (S) and remove assembly from the motor shaft.

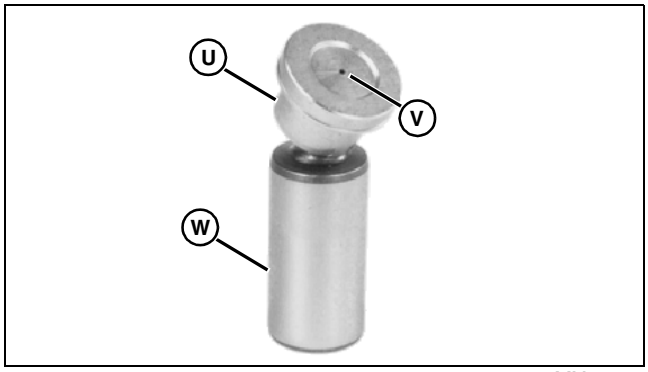
NOTE: Piston-to-bore relationship need not be maintained. Pistons and cylinder blocks are not matched sets.



MX5750

15.Inspect cylinder block assemblies.

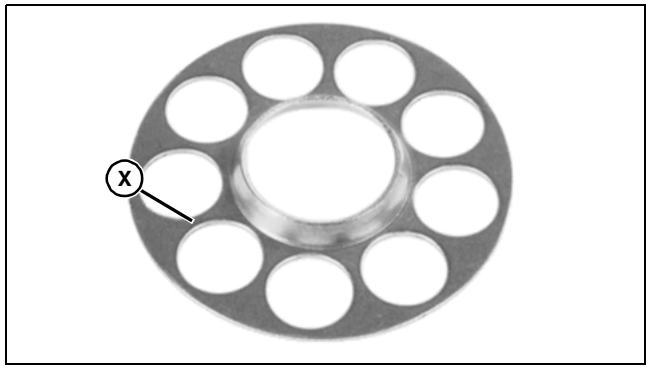
- Lift piston retainer and pistons from cylinder block.
- Check for free movement of pistons in cylinder bores as you remove them.
- If any dragging is detected, replace entire cylinder block assembly.



MX5679

16.Remove and inspect all pistons:

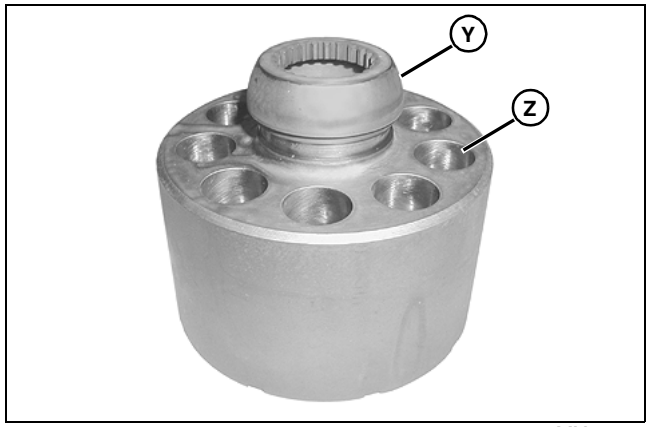
- Check barrel (W) for scoring, discoloration, or any signs of separation of slippers.
- Check slipper (U) for scoring, smearing, rolled edges, and a full 360° free rotation on barrel.
- Check lubrication hole (V) for blockage. Clean with compressed air.
- If any component of the piston is damaged, replace the entire cylinder block assembly.



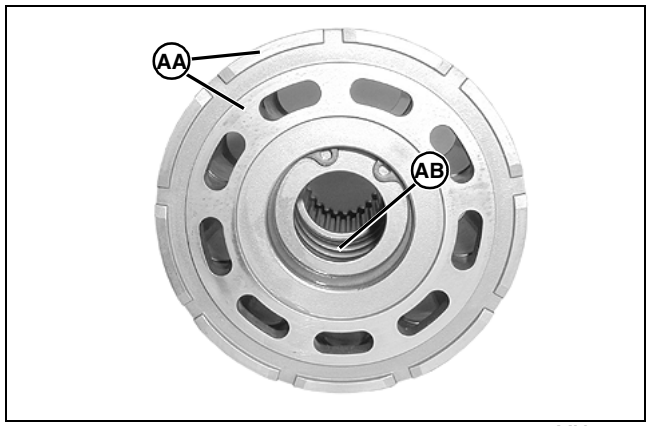
MX5680

17.Remove and inspect both piston retainers:

- Check retainer for flatness, nicks, burrs, and discoloration.
- Check area around piston slipper (X) for scoring.
- If any part of the piston retainer is damaged, replace the entire cylinder block assembly.



MX5751

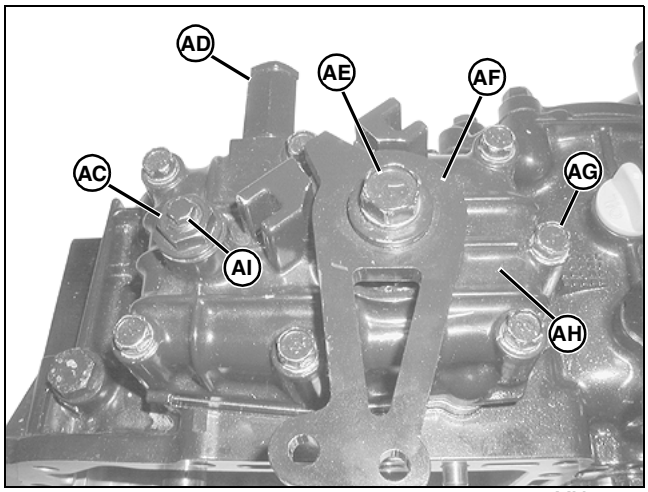


MX5752

18.Inspect both cylinder blocks:

- Check ball guide area (Y) for scoring, wear, and damage.
- Check nine cylinder bores (Z) for burns and scoring.

- Check lapped surface (AA) for wear and damage.
- Check spring assembly (AB) for damage and free axle movement.
- If any part of the cylinder block is damaged, replace the entire cylinder block assembly.



MX5753

19.Remove return spring assembly (AD). Inspect plunger for excessive tip wear and that plunger does not bind. If plunger binds or has excessive tip wear, replace return spring assembly.

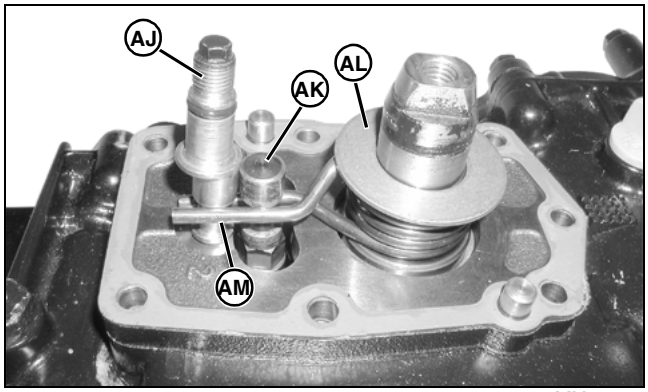
20.Remove lock nut and washer (AC).

21.Remove cap screw and washer (AE) and arm (AF).

22.Remove seven cap screws (AG).

IMPORTANT: Avoid damage! Control cover has centering pins and may stick to them. If gentle prying of cover is required, pry under cover, not under plate below cover.

23.Carefully remove control cover (AH) while pushing neutral adjust screw (AI) down through cover.

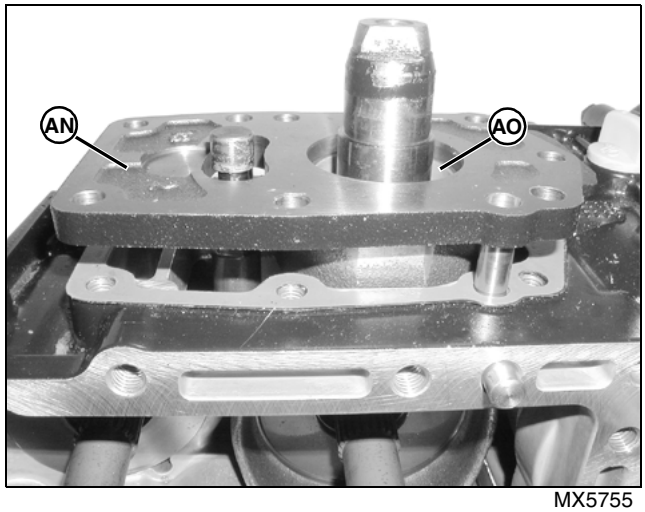


MX5754

24.Remove neutral adjust screw (AJ) and washer (AL).

CAUTION: Avoid injury! Neutral centering spring is under tension. Use caution when removing to prevent bodily injury.

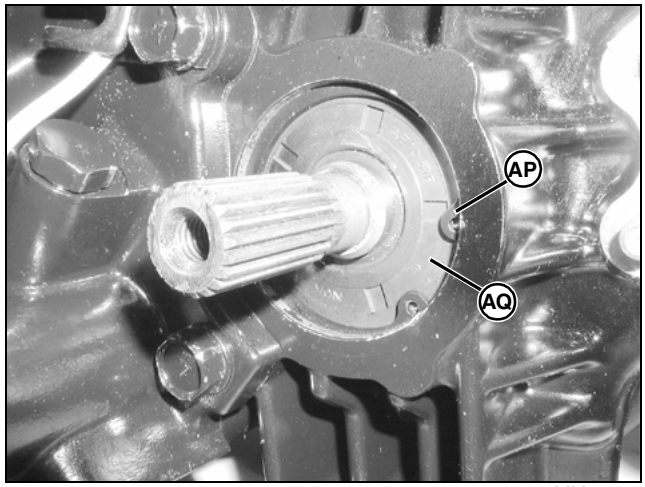
25.Carefully pry neutral centering spring (AM) over top of centering pin (AK). Remove spring.



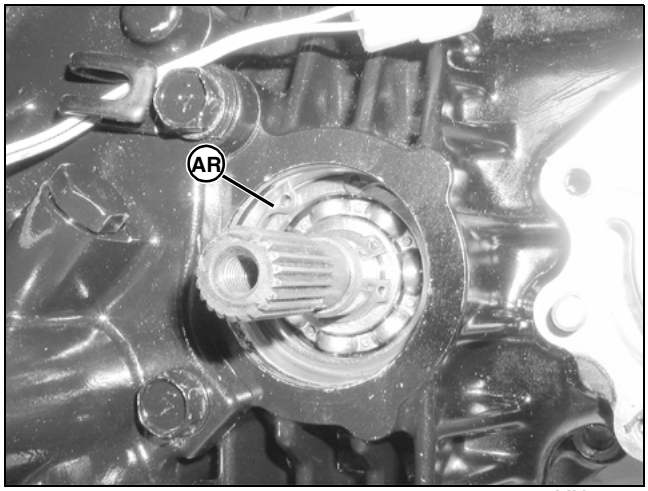
MX5755

26.Remove upper support plate (AN).

27.Inspect swash plate bearing (AO) for excessive wear or scoring. Replace if necessary.



MX5756



MX5757

28.Remove snap ring (AP).

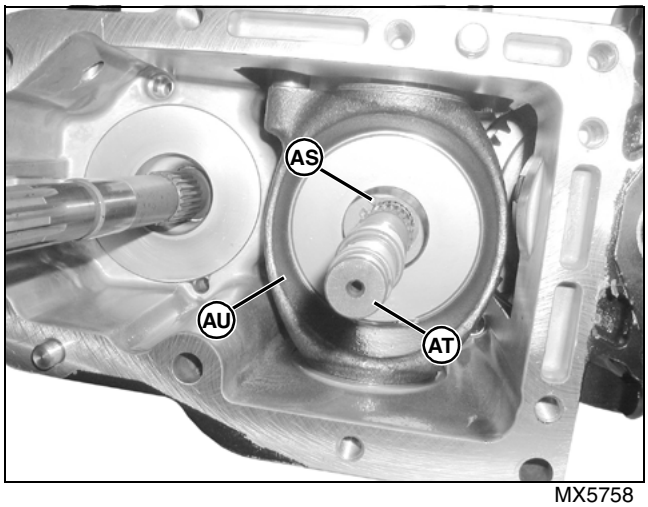
29.Remove seal (AQ) by prying out. Remove seal spacer.

30.Remove snap ring (AR).

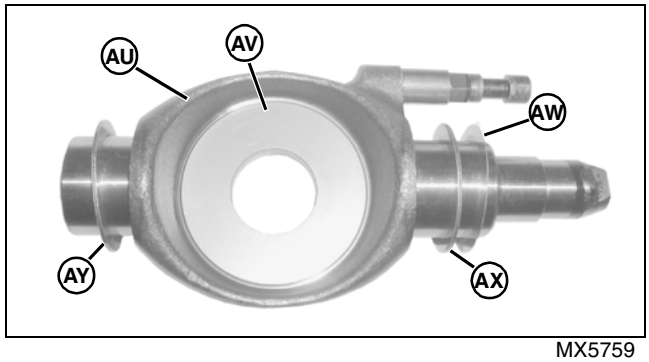
NOTE: Pump shaft rear bearing will be removed with shaft.

PTO drive gear will remain in housing until swash plate is removed.

Swashplate thrust washer and shim location and direction must be noted for reassembly.



MX5758



MX5759

31.Remove snap ring (AS).

32.Using a plastic hammer, gently tap pump shaft (AT) out rear of housing and PTO drive gear.

33.Carefully lift swash plate (AU) while retaining lower thrust washer (AY) to bottom of swash plate. Remove swash plate from housing.

34.Remove PTO drive gear from housing.

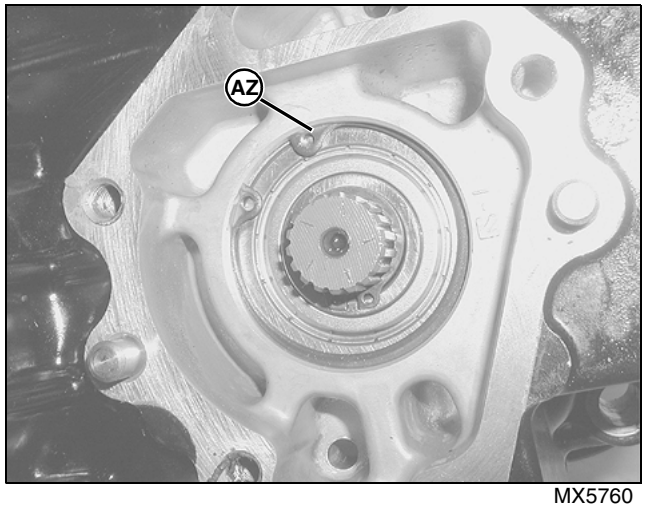
35.Note direction and location of upper shim (AW), upper thrust washer (AX), and lower thrust washer (AY) and remove from swash plate.

36.Inspect thrust washers and shim for scoring or damage. If scoring or damage is detected, replace thrust washers and shim.

37.Remove thrust plate (AV) from swash plate using a brass O-ring pick.

38.Inspect thrust plate for scoring or smeared plated material. If scoring or smearing is detected, replace thrust plate.

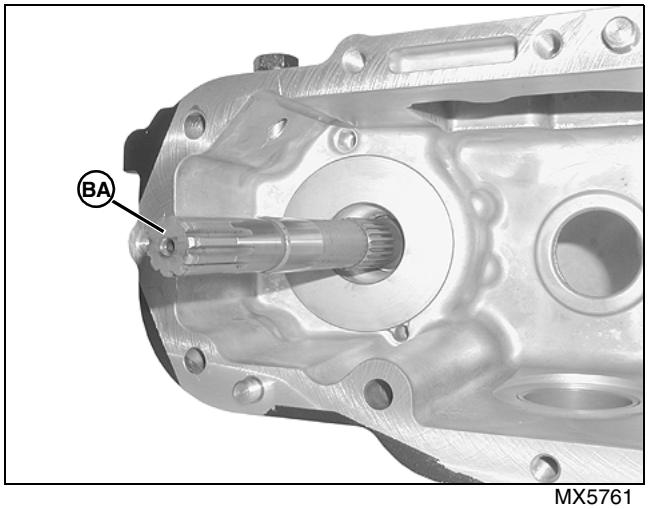
39.Inspect all machined surfaces of swash plate for scoring or damage. If scoring or damage is detected, replace swash plate.



MX5760

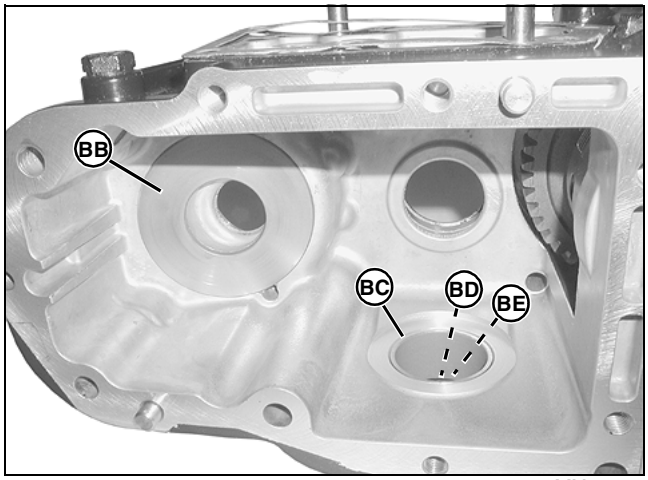
40.Remove motor shaft rear bearing retaining snap ring (AZ).

NOTE: Motor shaft rear bearing will be removed with motor shaft.



MX5761

41.Using a plastic hammer, gently tap motor shaft and bearing (BA) out rear of housing.

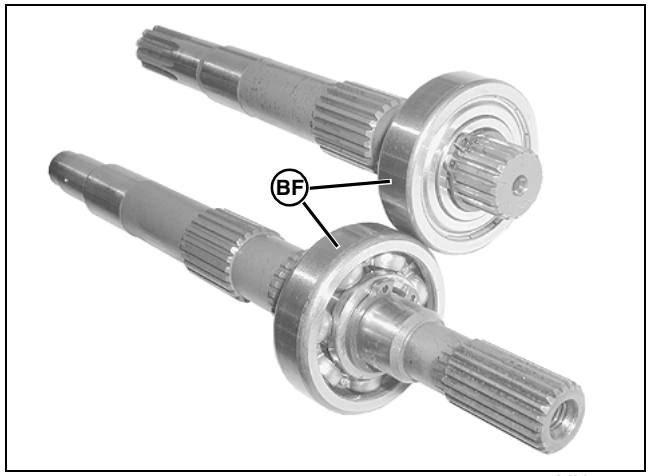


MX5762

42.Remove motor thrust plate (BB) using a brass O-ring pick.

43.Inspect lower swash plate bearing (BC) for excessive wear or scoring.

44.If excessive wear or scoring is detected, remove snap ring (BD) and cap seal (BE) and replace lower swash plate bearing.



MX5763

45.Inspect input shaft and motor shaft bearings (BF). Replace as necessary.

46.If repairing or inspecting PTO, see “PTO Disassembly, Inspection, and Assembly” on page 546.

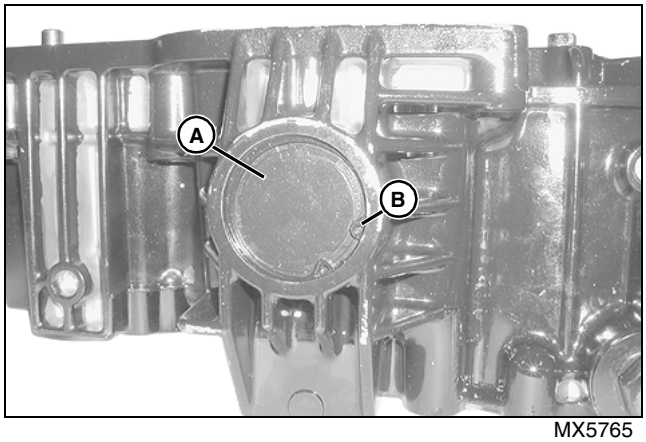
47.If repairing or inspecting 4WD gear case, see “4WD Gear Case Disassembly, Inspection, and Assembly” on page 557.

48.Remove all gaskets and clean all gasket surfaces.

Assembly:

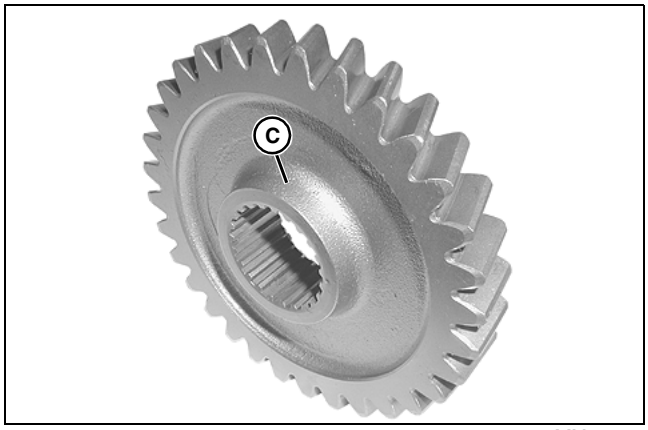
1. Clean and dry all parts.

NOTE: Apply clean hydrostatic oil to all parts when assembling.

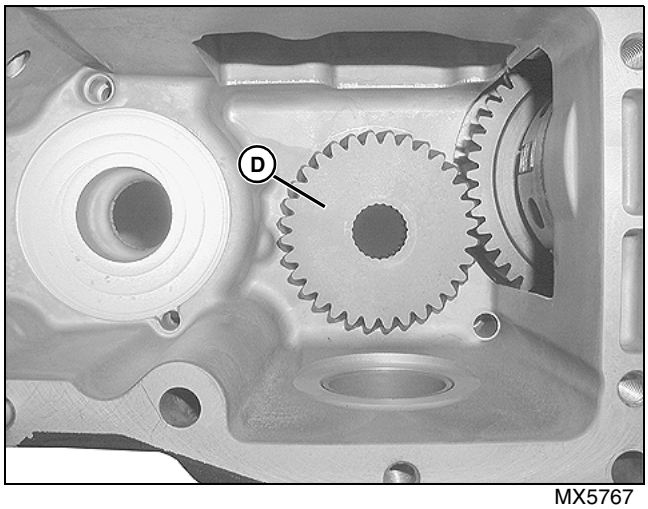


MX5765

2. If lower swash plate bearing was replaced, install new cap seal (A) and install snap ring (B).



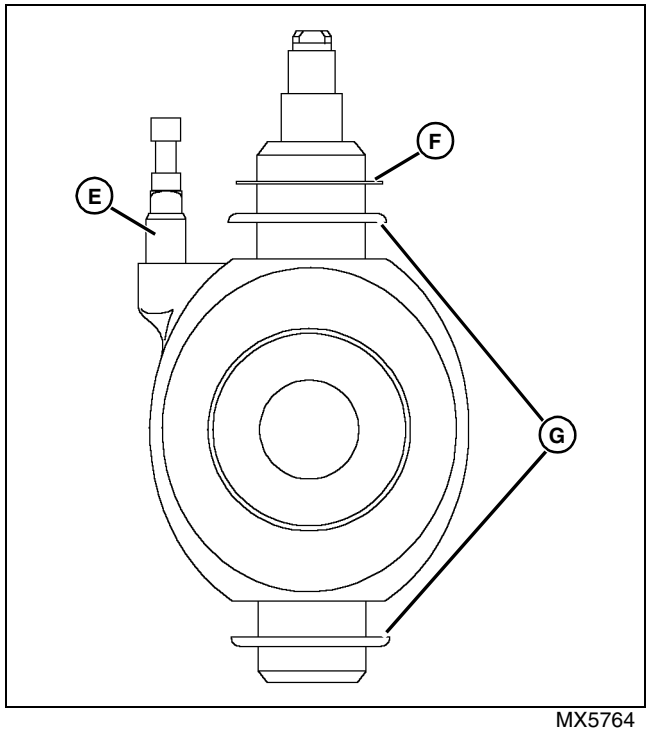
MX5766



MX5767

3. Install PTO drive gear (D) into housing with shoulder (C) facing rear of housing.

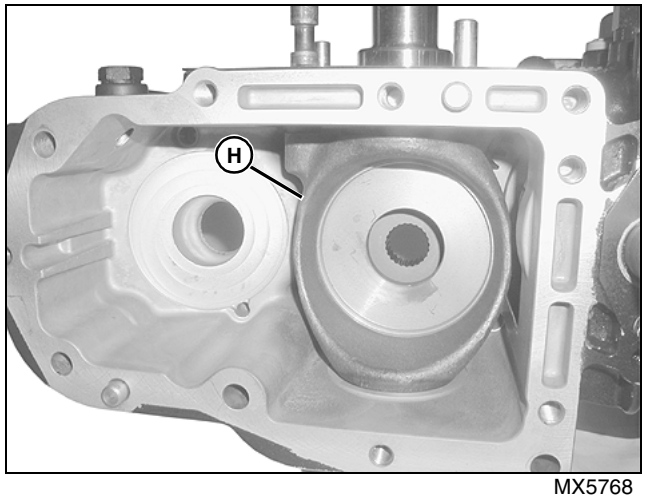
NOTE: Swashplate thrust washers must be installed with flat edge facing center of swash plate.



MX5764

4. Install thrust washers (G) onto swash plate (E) with flat edge facing center of swash plate.

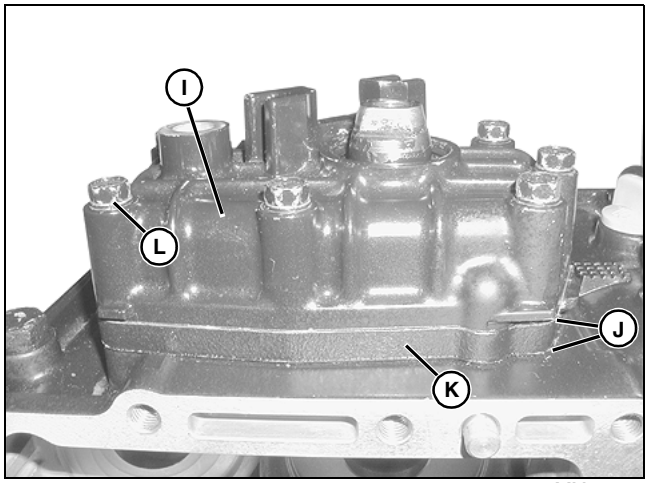
5. Install shims (F) onto swash plate.



MX5768

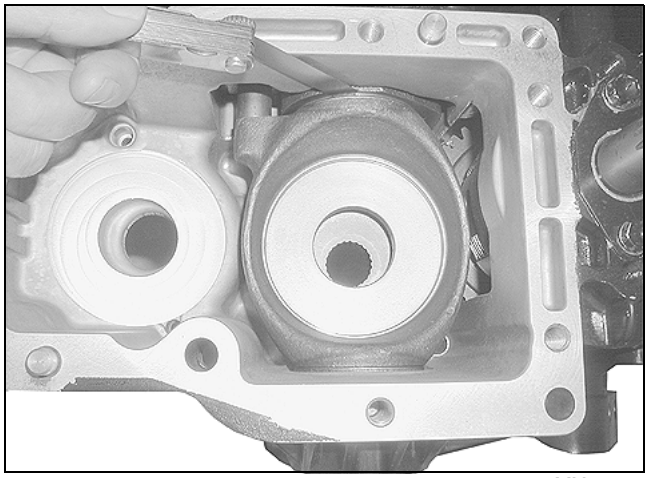
6. Install swash plate (H) with thrust washers and shims into housing.

NOTE: Top cover is being temporarily installed to set swash plate end play. Parts normally contained inside of top cover need not be installed at this point.



MX5769

7. Install upper support plate (K) and top cover (I) with gaskets (J) using seven cap screws (L).


MX5770

8. Check swash plate end play between bottom of support plate and top of shim. End play must be within specification.

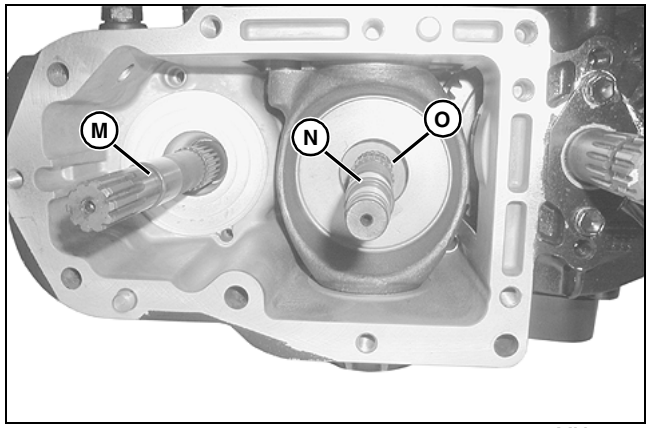
9. If end play is not within specification, remove top cover, support plate, and gaskets.

10.Add or subtract shims from top of swash plate to obtain specification.

11.Reinstall support plate, top cover, and gaskets. Check end play again.

12.Repeat steps 9 - 11 until correct specification is obtained.

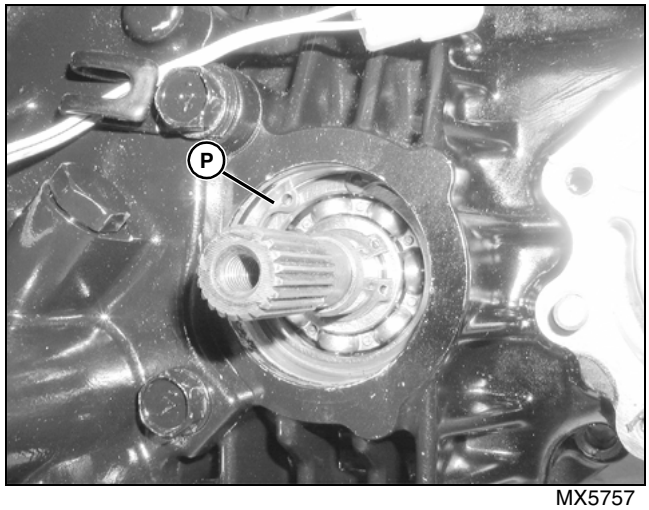
13.Remove top cover and gasket only.



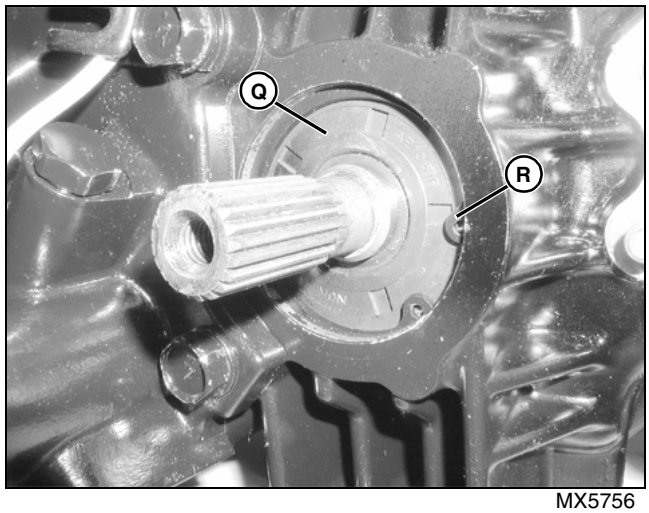
MX5771

14.Install motor shaft (M) into housing.

15.Carefully install pump shaft (O) through PTO drive gear (P) and into housing.



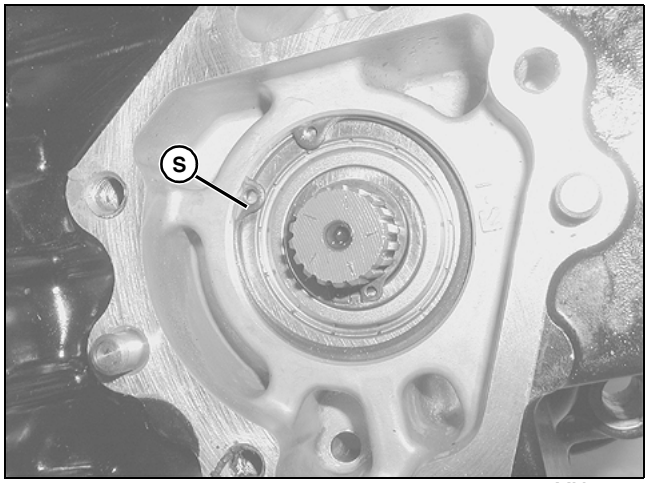
MX5757



MX5756

16.Install pump shaft bearing snap ring (P).

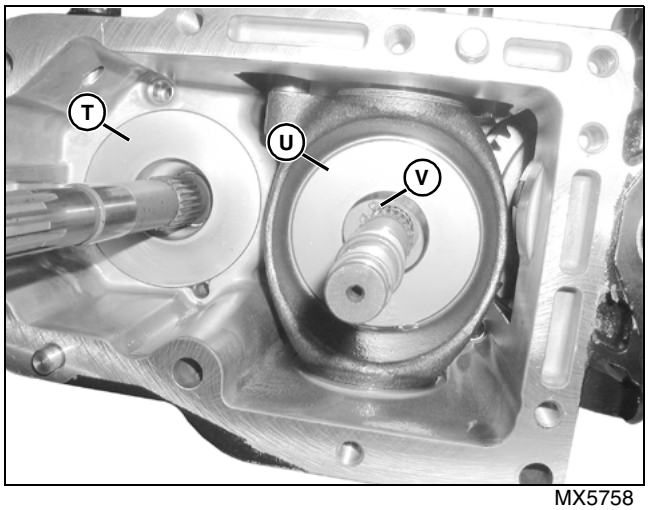
17.Install seal spacer and new pump shaft seal (Q) using snap ring (R).



MX5760

18.Install motor shaft bearing snap ring (S).

NOTE: Do not scratch machined surfaces of thrust plates or swashplate.

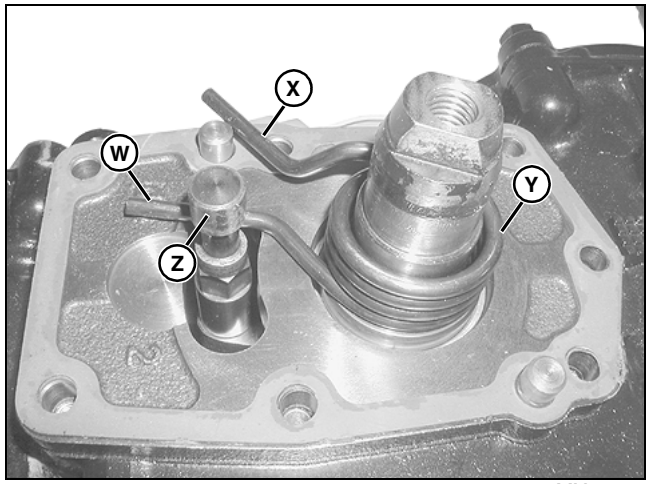


MX5758

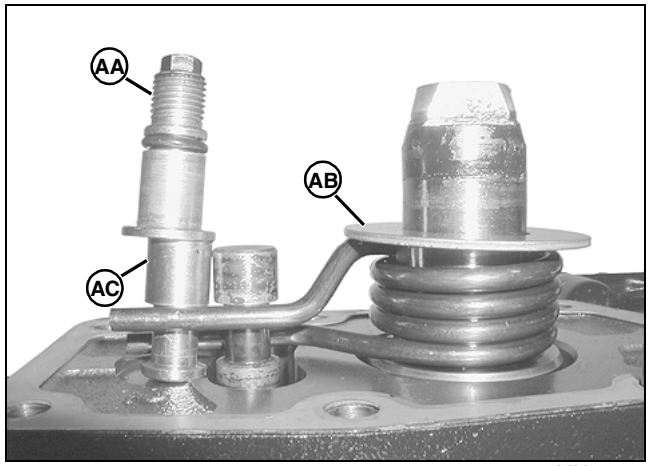
19.Install PTO drive gear snap ring (V).

20.Install motor thrust plate (T) and pump thrust plate (U).

CAUTION: Avoid injury! Installing centering spring will put it under tension. Use caution when installing to prevent bodily injury.



MX5772



MX5773

21.Install neutral centering spring (Y) with flat arm (W) down and to the rear of centering pin (Z).

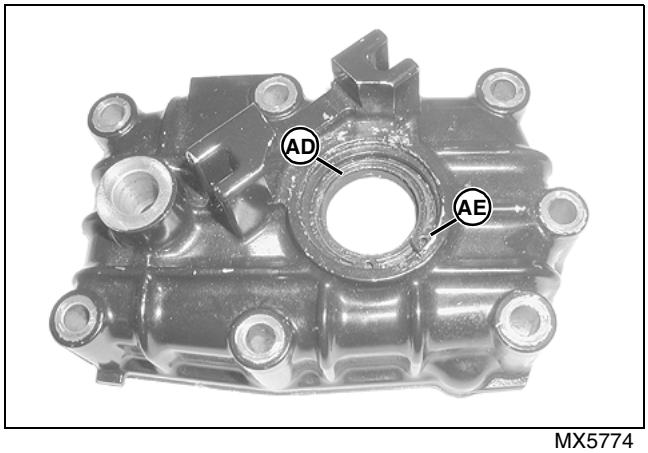
22.Carefully pry bent arm (X) up and forward over the top of centering pin.

23.Install washer (AB).

24.Replace O-ring on neutral adjust screw (AA).

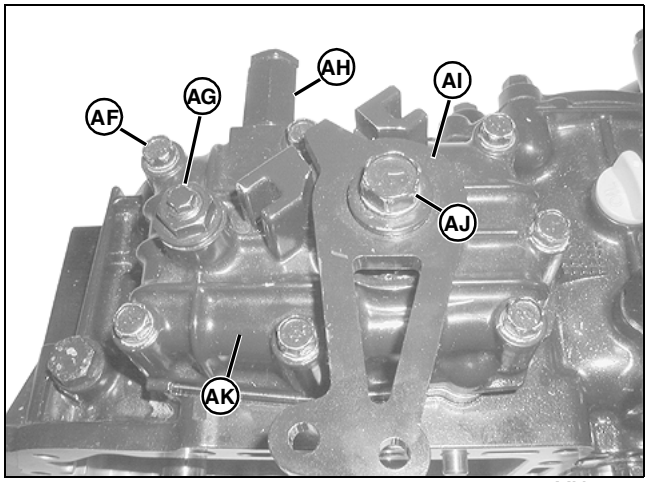
25.Install neutral adjust screw between arms of neutral centering spring.

26.Rotate neutral adjust screw until adjusting cam (AC) faces centering pin.



MX5774

27.Replace upper swash plate seal (AD). Install with top of seal against snap ring (AE).



MX5753

28.Install cover (AK) using seven cap screws (AF).

29.Install washer and nut (AG).

30.Install return spring assembly (AH).

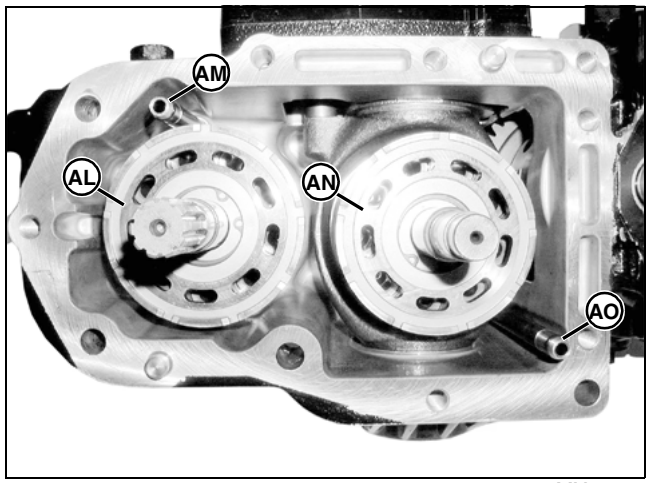
31.Install arm (AI) using cap screw and washer (AJ).

IMPORTANT: Avoid damage! Do not nick or scratch lapped surface of cylinder blocks. Piston-to-bore relationship need not be maintained.


MX5750

32.Install pistons into piston retainer, then into cylinder block.

33.Lift piston retainer and pistons from cylinder block two or three times to check for free movement of pistons in cylinder block before you install the assembly into the housing.



MX5748

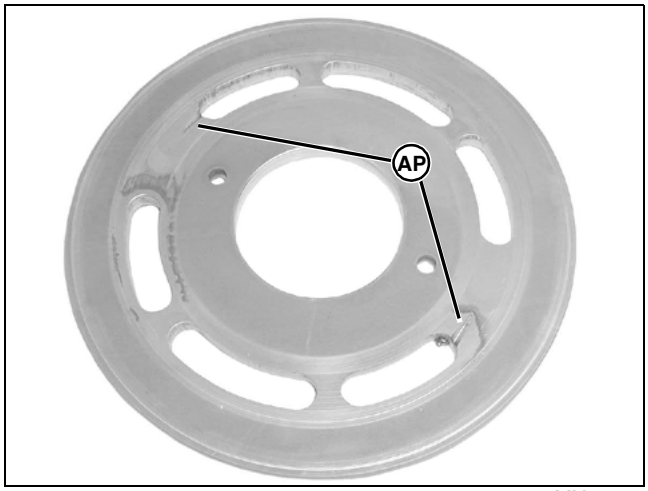
34.Install pump (AN) and motor (AL) cylinder blocks. Hold onto the retainer rim to ensure pistons remain in their bores.

35.Install new O-rings on drain tube (AM) and PTO supply tube (AO) and install tubes into housing.

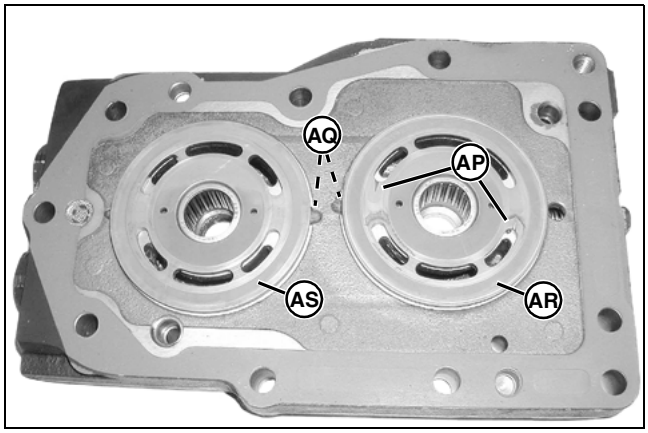
IMPORTANT: Avoid damage! Use extreme care when assembling the center section, valve plates, and cylinder blocks to avoid dropping, nicking, or scratching lapped surfaces.

Pump valve plate has two slotted ports (AP).

Motor valve plate (AS) has no slotted ports.



MX5745

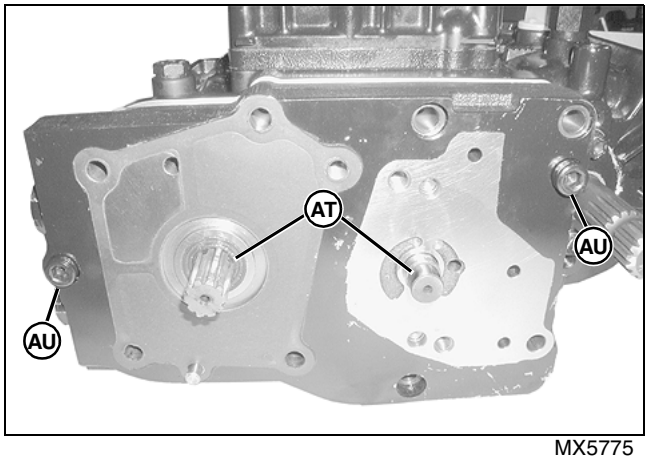


MX5744

36.Put clean hydrostatic oil on valve plates and housing surfaces.

37.Align slots on back sides of plates with pins (AQ) in center section and install pump valve plate (AR), with slotted ports (AP), and motor valve plate (AS) over their respective protruding bearings.

38.Install new center section to housing gasket onto housing.



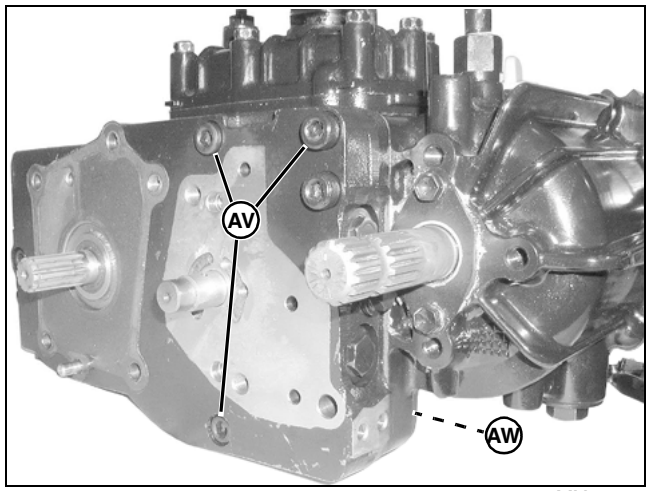
MX5775

39.Align bearings of center section with pump and motor shafts (AT). Slide center section on shafts until valve plates contact cylinder blocks.

40.Apply pressure to center section and install two socket head screws (AU) to hold center section in place.

IMPORTANT: Avoid damage! Check for proper internal assembly by slowly rotating pump and motor shafts while tightening cap screws.

NOTE: Center section will seem springy. This is because the springs inside the cylinder blocks are being compressed.

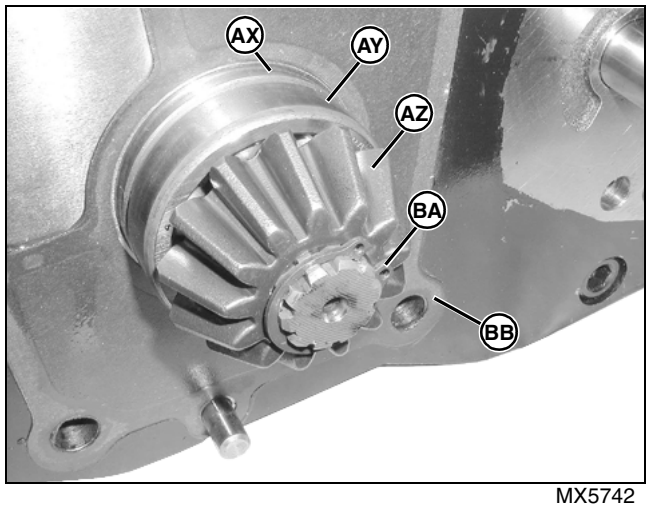


MX5743

41.Install three remaining hex socket screws (AV) and one cap screw (AW). Tighten cap screws evenly in a crossing pattern until they are snug - Do not tighten to specification at this time.

42.Check that both pump and motor shafts turn without any binding or roughness.

43.Tighten five hex socket screws and one cap screw to specification.



MX5742

44.Install spacer (AX), bearing (AY), gear (AZ), and snap ring (BA).

45.Install new gasket (BB) to hydrostatic assembly.

46.Install hydrostatic assembly to differential assembly. (See “Hydrostatic Assembly-to-Differential Assembly Separation and Installation” on page 521.)

Specifications:

Tow Valve Torque . . . . . 34 N•m (25 lb-ft)

Forward and Reverse Check Valve Torque . . . . . 34 N•m (25 lb-ft)

Implement Relief Valve Torque . . . . 24 N•m (212 lb-in.)

Swashplate End Play . . . . . 0.20 - 0.50 mm (0.007 - 0.0019 in.)

Center Section-to-Housing Hex Socket and Cap Screw Torque . . . . . 34 - 49 N•m (25 - 36 lb-ft)

Differential Disassembly, Inspection, and Assembly

Special or Required Tools:

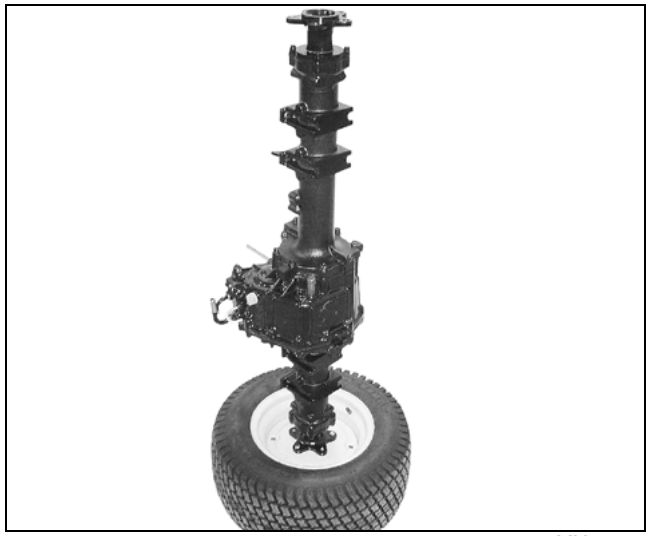
Tool Name	Tool No.	Tool Use
Hoist	NA	Used to remove and install axle shaft housing.
Knife-Edge Puller	NA	Used to remove bearings and axle seal.
50.8 mm (2 in.) ID Pipe	NA	Used to install bearings and axle shaft sleeve.
Punch	NA	Used to drive spring pin from pinion cross shaft.
Snap Ring Removal Tool[a]	NA	Used to compress the spring to remove the snap ring on the differential lock shaft.
Snap Ring Installation Tool[a]	NA	Used to install the snap ring on the differential lock shaft.
Press	NA	Used to install bearing.

a. For instructions on making tool, see Fabricated Tools in this section.

Other Material:

Part No.	Part Name	Part Use
TY16021 (U.S.)/ LOCTITE ® 17430/ TY9484 (Canada)	John Deere High Flex Form-in-Place Gasket	Applied to differential-to-axle housing and side cover-to-differential housing mating surfaces.
TY16285 (U.S.)/ LOCTITE ® 17649/ CXTY16285 (Canada)	Cure Primer	Applied to threads of cap screws and gear.
T43512 (U.S.)/ LOCTITE ® 242/TY9473 (Canada)	Thread Lock and Sealer (Medium Strength)	Applied to threads of cap screws before installation.

Axle Shaft Housing Disassembly:



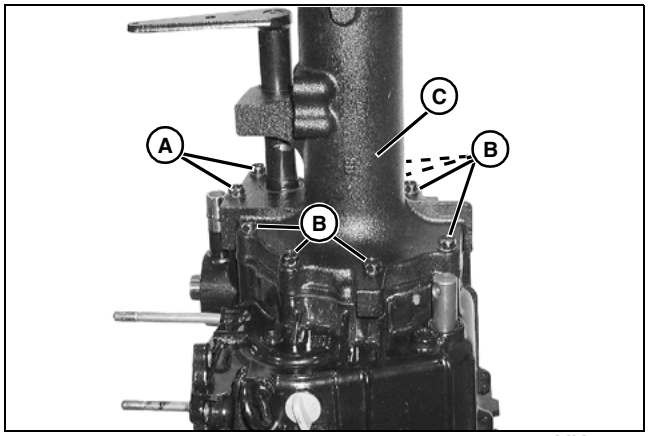
MX5811

1. Separate hydrostatic assembly from differential assembly. (See “Hydrostatic Assembly-to-Differential Assembly Separation and Installation” on page 521.)

2. Remove oil filter and hose.

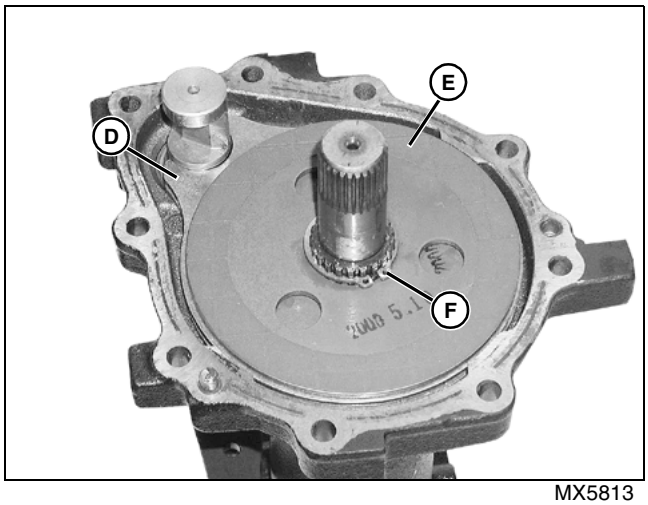
3. Mount one wheel to axle flange. Lift axle using a hoist and support axle on wheel.

NOTE: This disassembly procedure is for the left axle shaft housing. The procedure for the right side is similar, but some parts are not interchangeable, left to right. Do not mix right and left side parts.



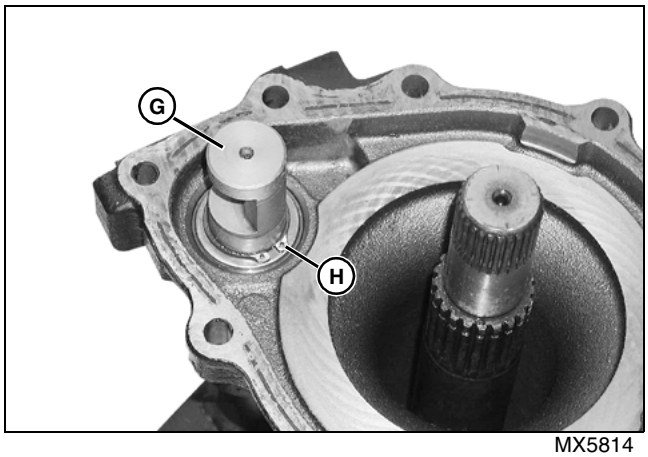
MX5812

4. Remove two M10 x 60 cap screws (A).
5. Remove seven M10 x 45 cap screws (B).
6. Remove axle shaft housing (C) using a hoist.



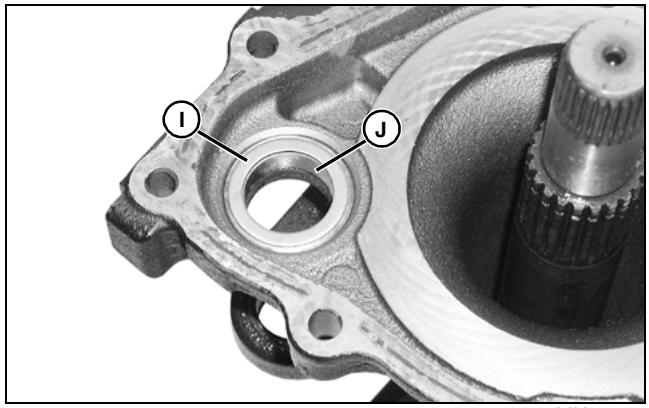
MX5813

7. Remove snap ring (F).
8. Remove brake disks (E) and brake separator plates (D).



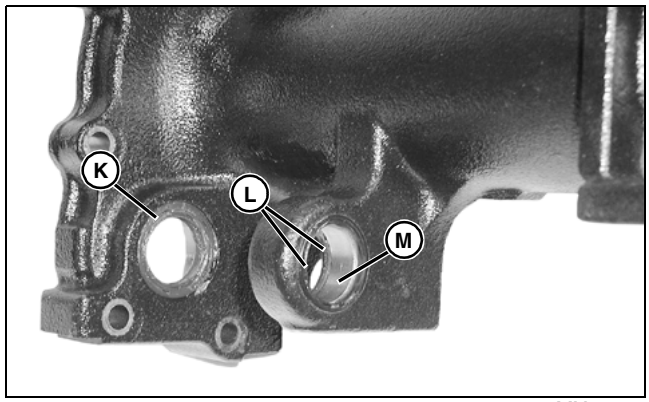
MX5814

9. Remove snap ring (H).
10. Remove brake camshaft (G).



MX5815

11. Remove flat washer (I) and bushing (J).
12. Turn axle shaft housing over and allow it to rest on the mounting flange.

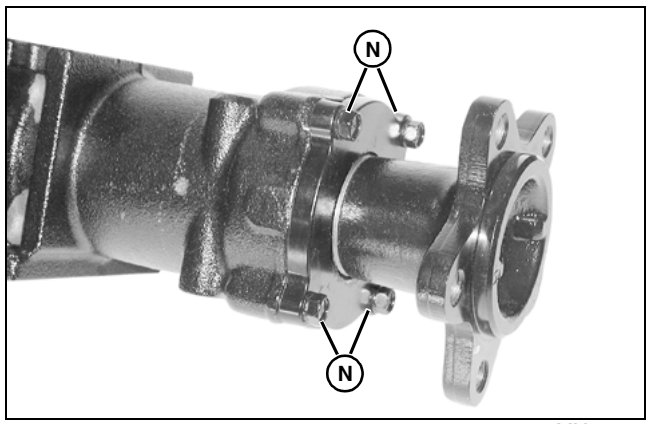


MX5816

13. Remove oil seal (K).

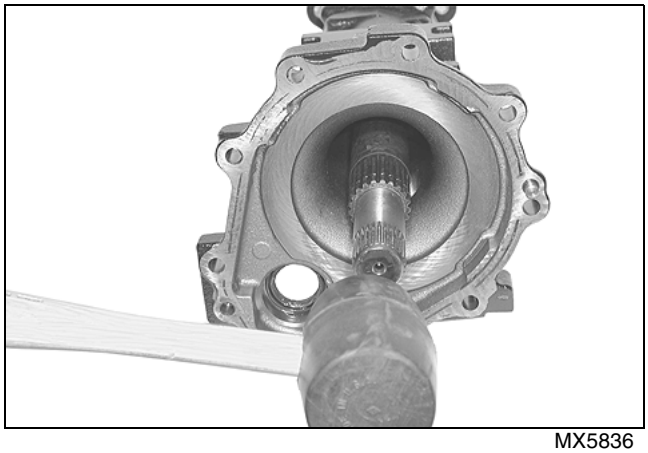
NOTE: Oil seals (L) and bushing (M) are located only on left axle shaft housing.

14. Remove oil seals (L) and bushing (M).



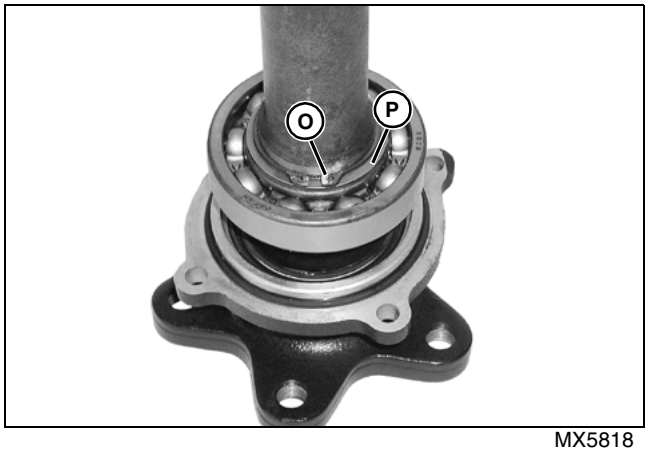
MX5817

15. Remove four cap screws (N).



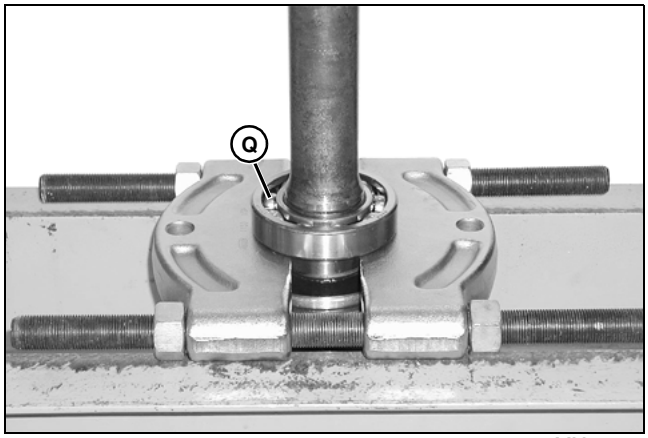
MX5836

16.Drive the axle out of the housing using a soft-faced hammer.



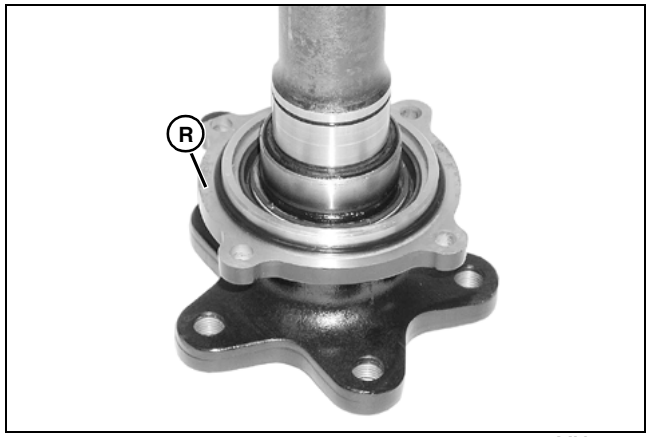
MX5818

17.Remove snap ring (O) and spacer (P).



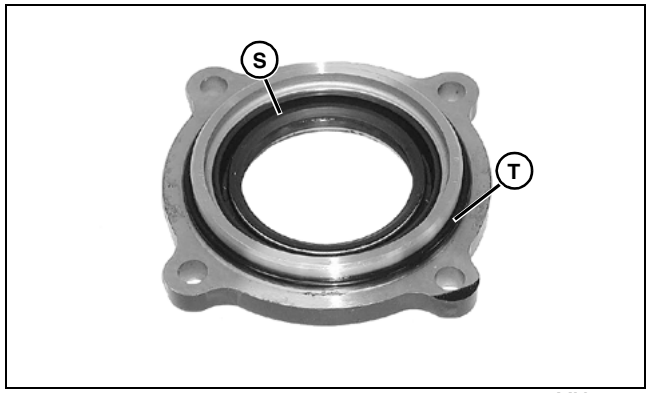
MX5819

18.Remove bearing (Q) from axle using a knife-edge puller.



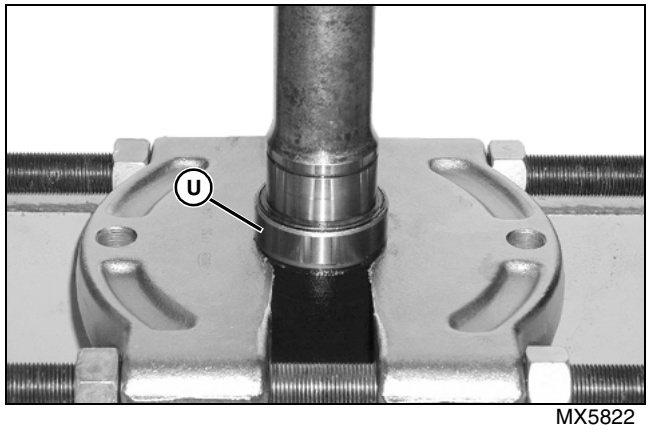
MX5820

19.Remove axle seal housing (R) from axle shaft.



MX5821

20.Remove oil seal (S) and O-ring (T).

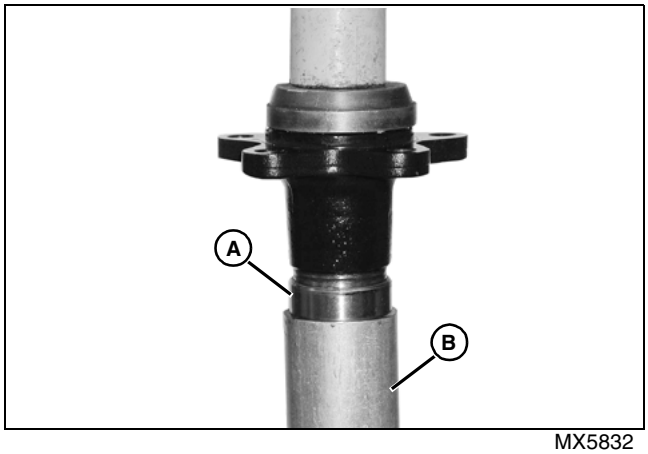


MX5822

21.Inspect sleeve (U) for wear or damage. Remove the sleeve using a knife-edge puller if replacement is required.

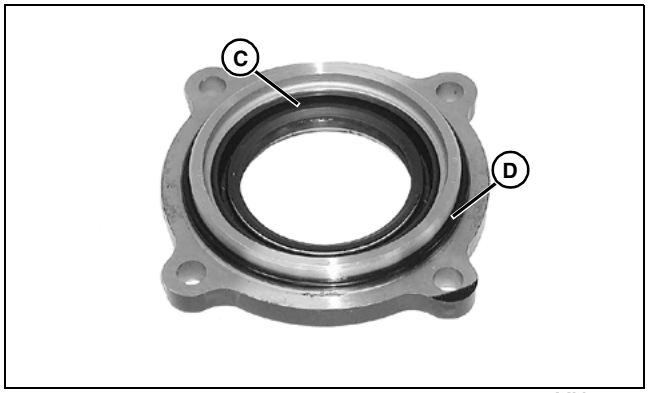
22.Inspect all parts for wear or damage. Replace parts as needed.

Axle Shaft Housing Assembly:



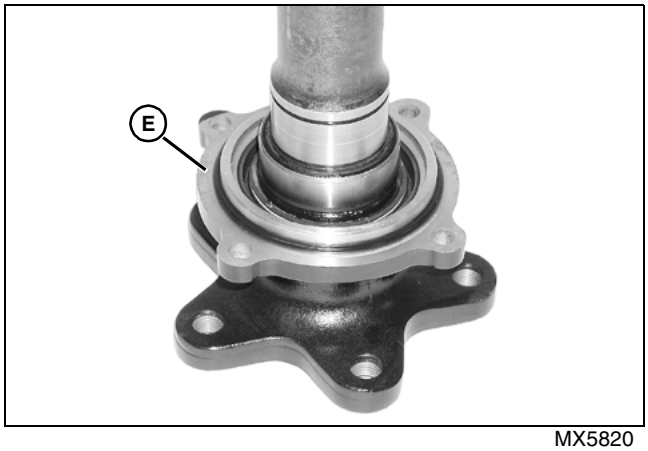
MX5832

1. Install new sleeve (A) on axle shaft (if needed). Press sleeve into place using a length of pipe (B) with an inside diameter of 50.8 mm (2 in.).



MX5821

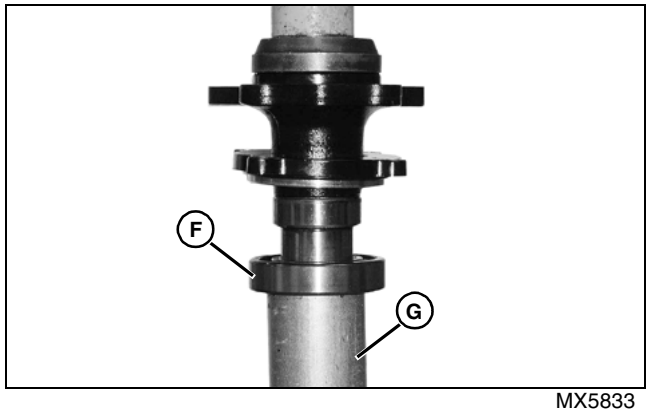
2. Install new axle oil seal (C) and O-ring (D).



MX5820

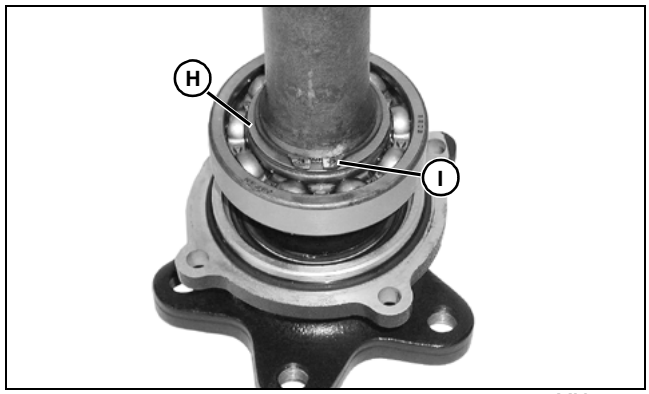
3. Install axle seal housing (E) onto axle.

IMPORTANT: Avoid damage! Press on inner race only to avoid damaging bearing.



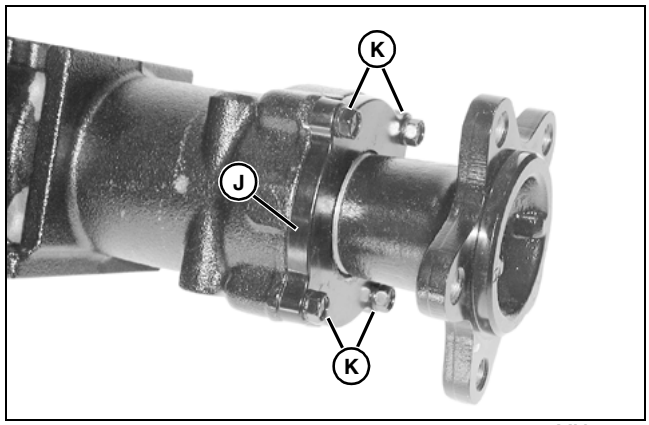
MX5833

4. Install bearing (F) into axle. Press the bearing into place using a length of pipe (G) with an inside diameter of 50.8 mm (2 in.).



MX5818

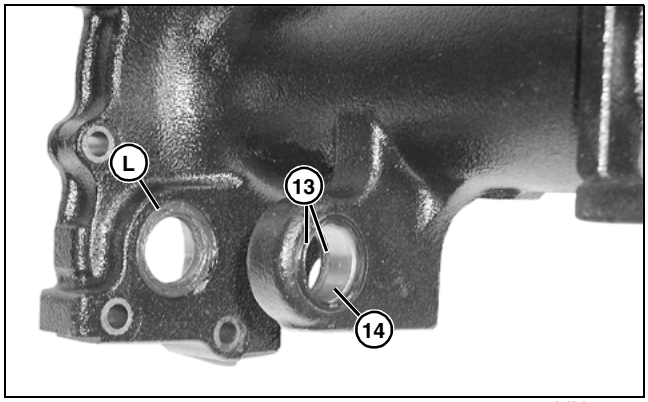
5. Install spacer (H) and snap ring (I).



MX5817

6. Install axle into housing until bearing bottoms against axle housing.

7. Install seal housing (J) into axle housing. Install four cap screws (K). Tighten to specification.

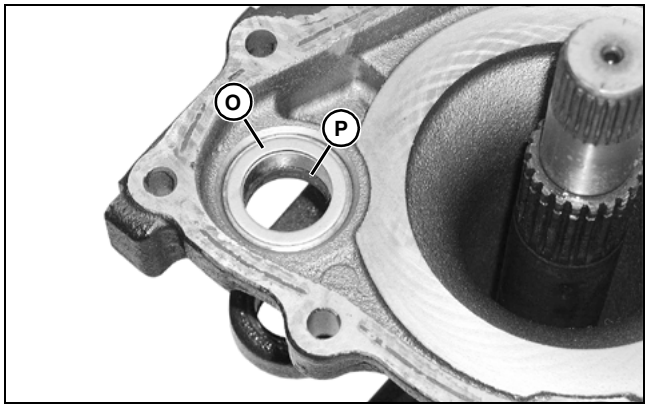


MX5816

8. Install new brake camshaft oil seal (L).

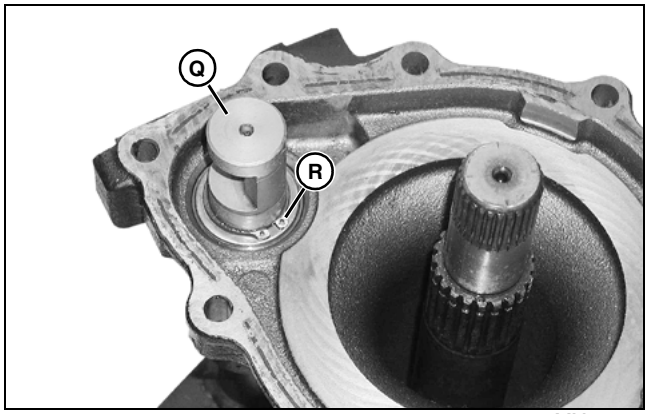
NOTE: Oil seals (M) and bushing (N) are located only on left axle shaft housing.

9. Install bushing (N) and oil seals (M).



MX5815

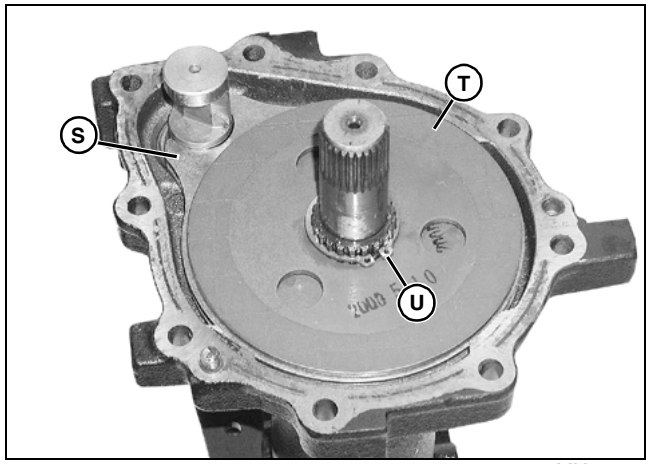
10.Install bushing (P) and flat washer (O).



MX5814

11.Install brake camshaft (Q).

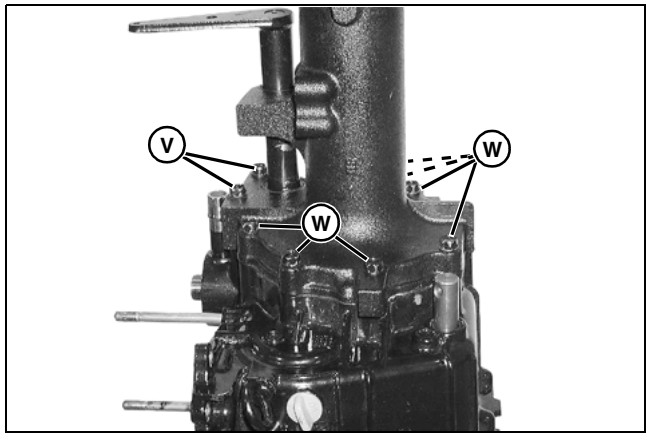
12.Install snap ring (R).



MX5813

13.Install two brake separator plates (S) and brake disks (T).

14.Install snap ring (U).

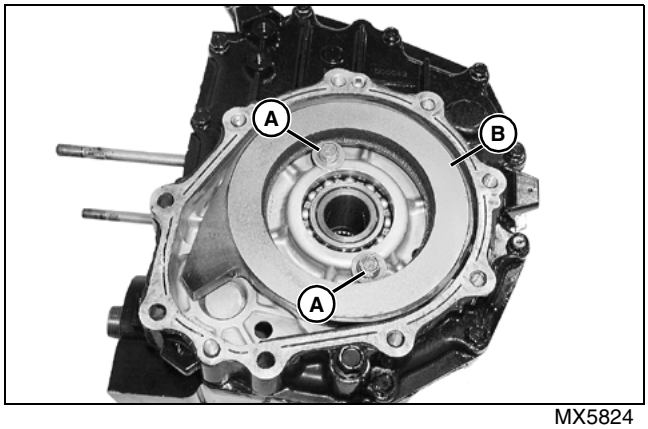


MX5812

15.Apply TY16021 John Deere High Flex Form-in-Place Gasket on differential-to-axle housing mating surfaces.

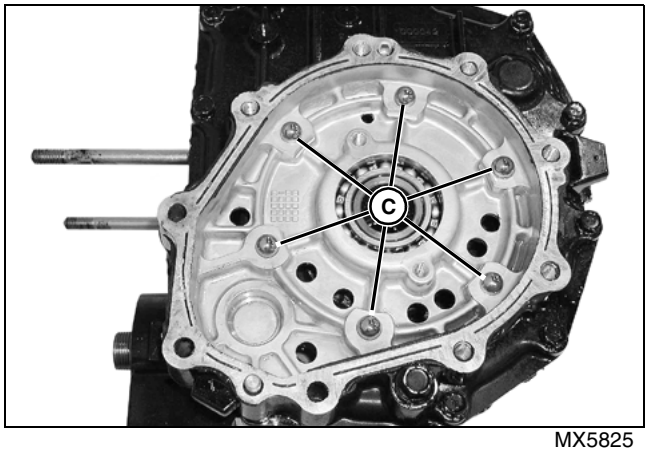
16.Using a hoist, install axle housing. Install two M10 x 60 cap screws (V) and seven M10 x 45 cap screws (W). Tighten to specification.

Differential Disassembly/Inspection:



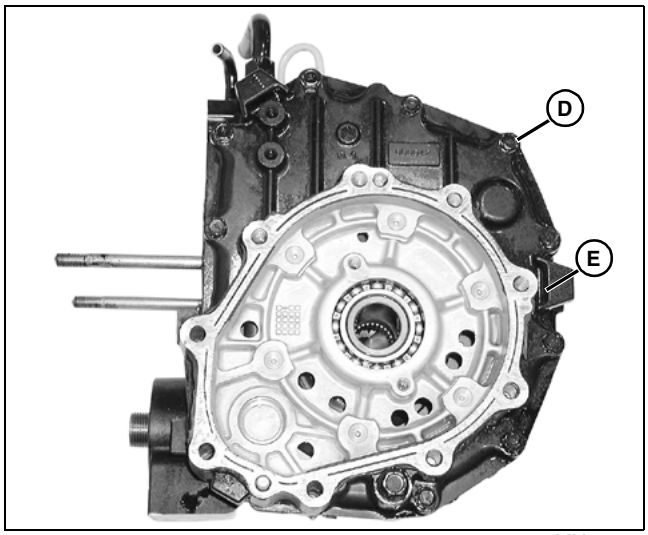
MX5824

1. Remove both axle shaft housings. (See “Axle Shaft Housing Disassembly:” on page 536.)
2. Remove cap screws and washers (A).
3. Remove brake actuator disk (B).



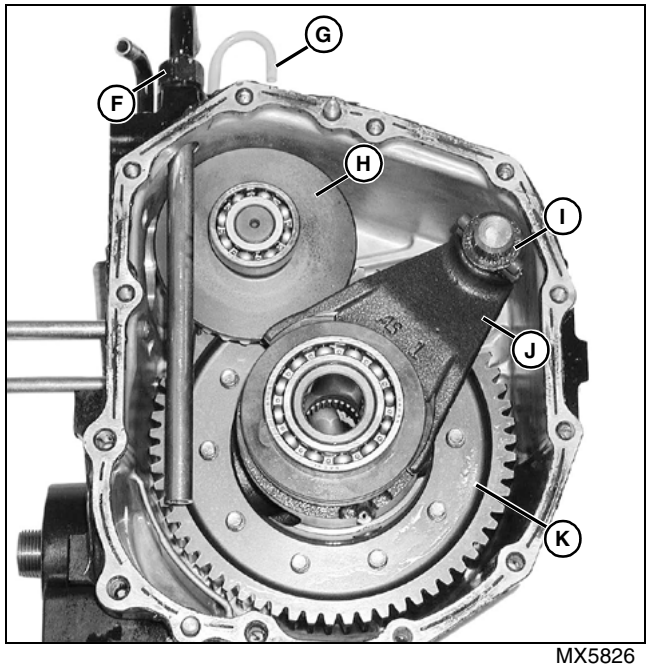
MX5825

4. Remove six brake actuator balls (C).
5. Repeat steps 2 - 4 on opposite side.



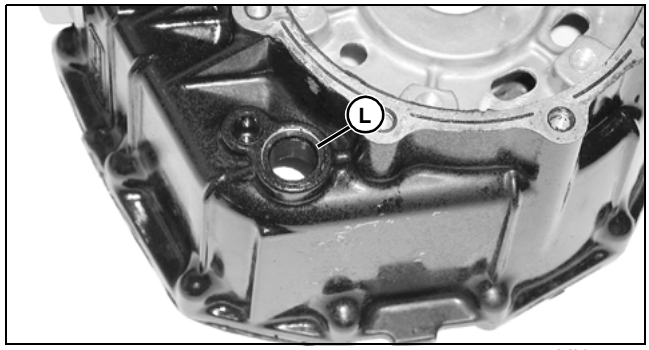
MX5823

6. Remove nine M8 x 35 cap screws (D).
7. Remove differential side cover (E).



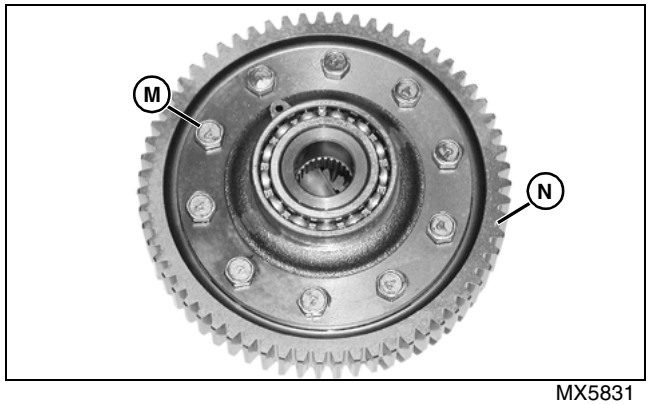
MX5826

8. Remove oil return tube (F), dipstick (G), and washer (I).
9. Lift out idler gear shaft (H).
10. Lift out differential lock fork (J) and differential assembly (K) as one assembly.



MX5827

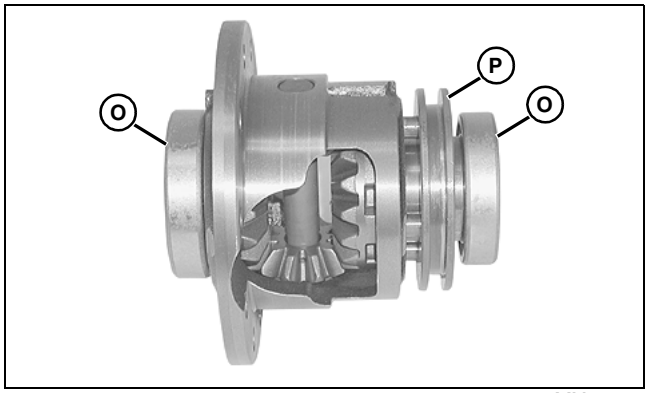
11. Remove differential lock shaft seal (L).



MX5831

12.Remove ten cap screws (13).

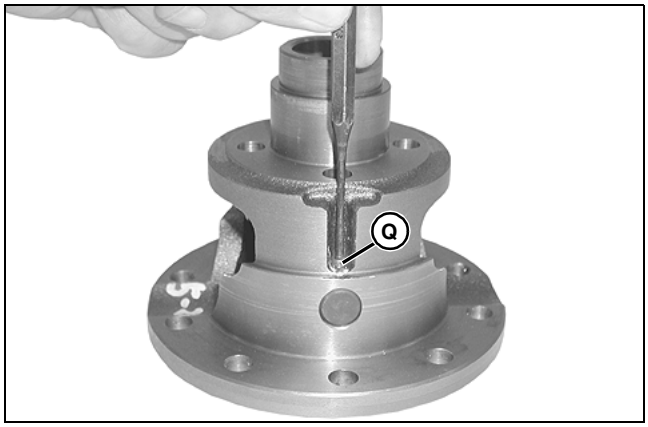
13.Remove ring gear (14).



MX5837

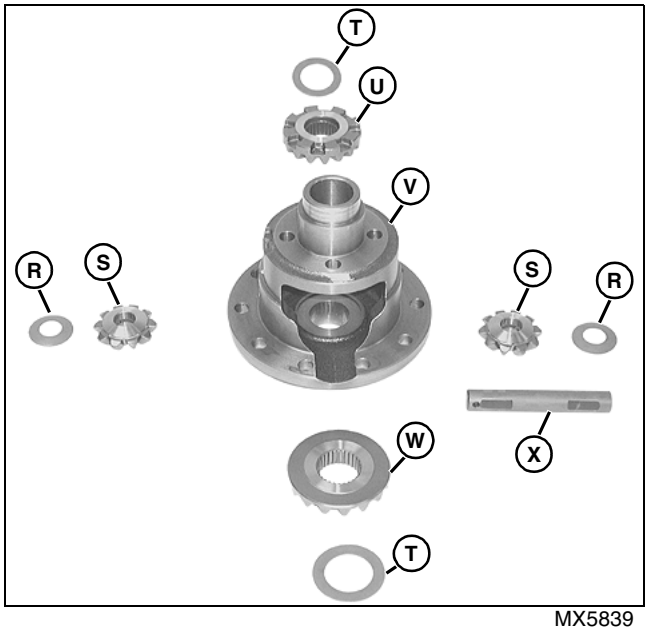
14.Using a knife-edge puller, remove bearings (O).

15.Remove shift collar (P).



MX5838

16.Using a punch, drive spring pin (Q) from the pinion cross shaft.

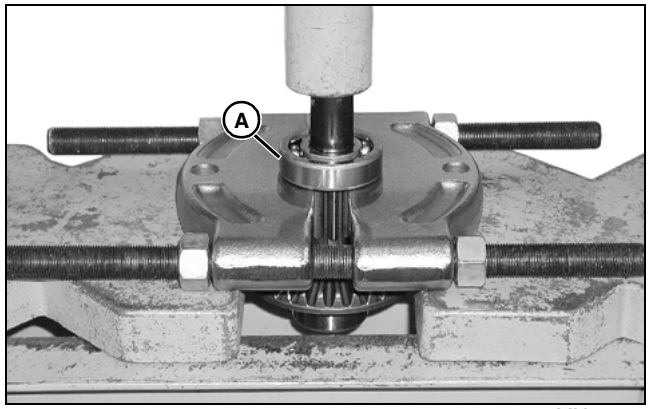


MX5839

17.Remove pinion cross shaft (X), bevel washers (R), pinion gears (S), right side gear (U), left side gear (W), and flat thrust washers (T) from differential housing (V).

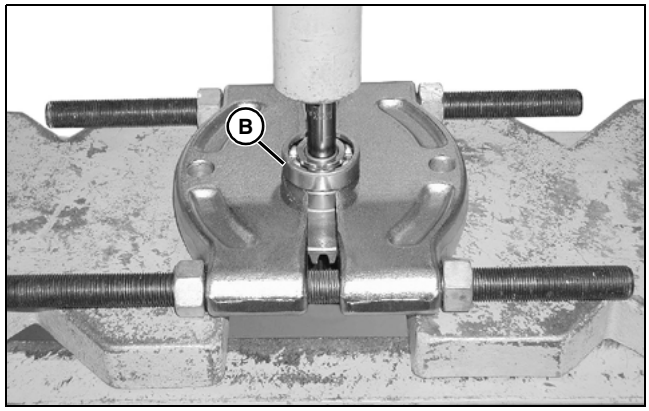
18.Inspect all parts for wear or damage. Replace parts as needed.

Idler Shaft Disassembly/Inspection:



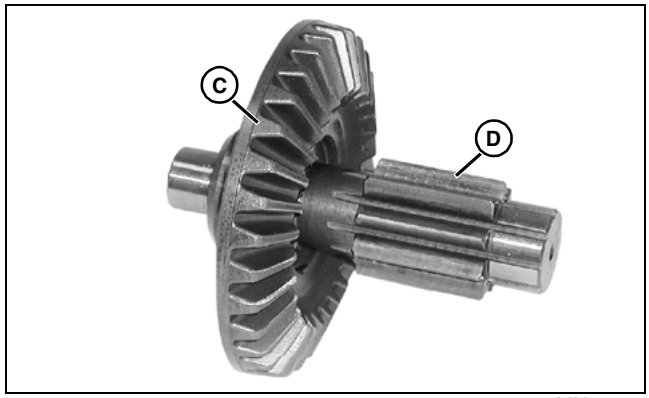
MX5828

1. Remove bearing (A) using a knife-edge puller.



MX5829

2. Remove bearing (B) using a knife-edge puller.

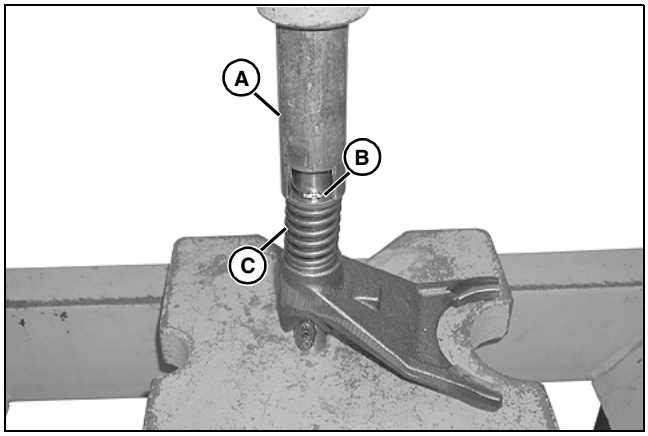


MX5830

3. Remove ring gear (C) from idler shaft (D).

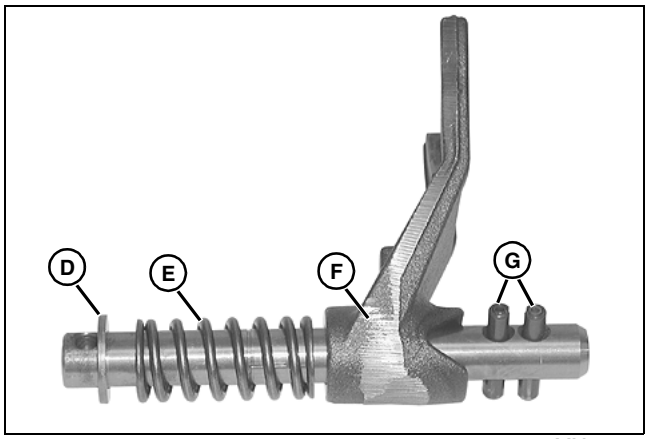
Differential Lock Lever Disassembly/Assembly:

NOTE: The differential lock lever assembly does not have to be disassembled unless repair is required. Inspect components for wear or damage.



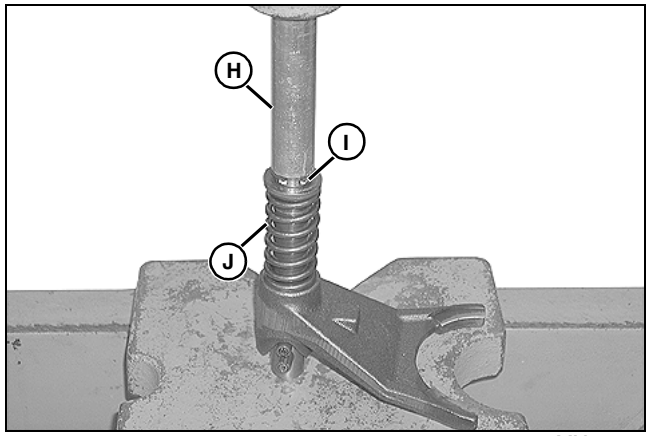
MX5846

1. Compress spring (C) using snap ring removal tool[1] (A).
2. Remove snap ring (B) from its groove while spring is compressed.



MX5845

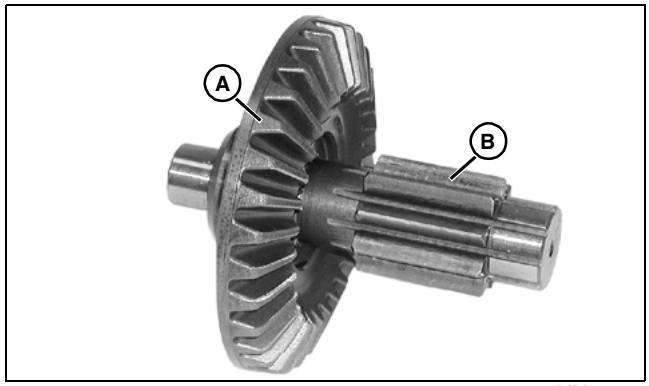
3. Remove washer (D), spring (E), fork (F), and spring pins (G) if replacement is required.



MX5844

4. Slide snap ring (I) on shaft.
5. Using snap ring installation tool[2] (H), compress spring (J) until snap ring locks in its groove.

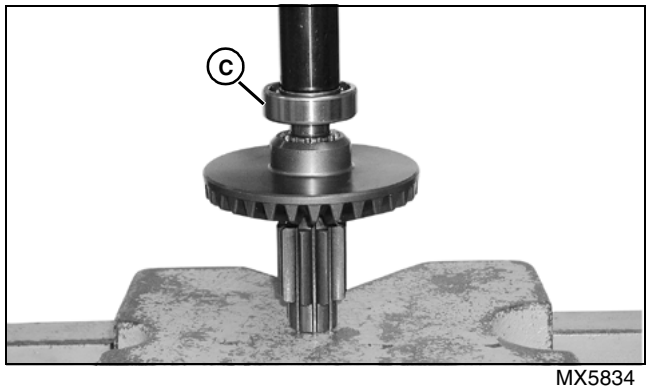
Idler Shaft Assembly:



MX5830

1. Install ring gear (A) onto idler shaft (B).

IMPORTANT: Avoid damage! Press on inner race only to avoid damaging bearing.



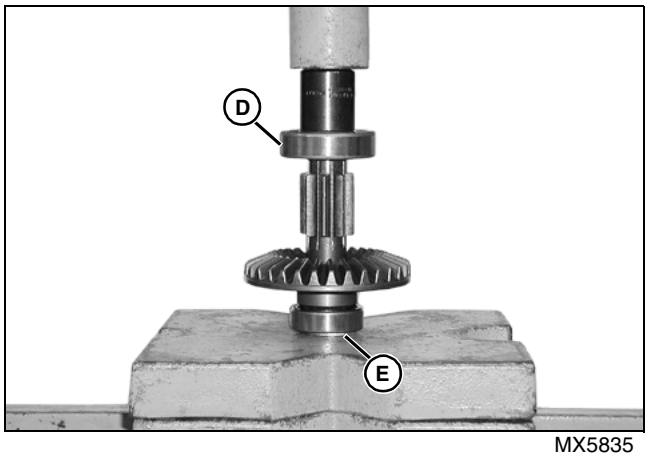
MX5834

2. Install bearing (C) using a press.

1. Snap ring removal tool is a fabricated tool. For instructions to make tool, see Fabricated Tools in this section.

2. Snap ring installation tool is a fabricated tool. For instructions to make tool, see Fabricated Tools in this section.

IMPORTANT: Avoid damage! Press on inner race only to avoid damaging bearing.

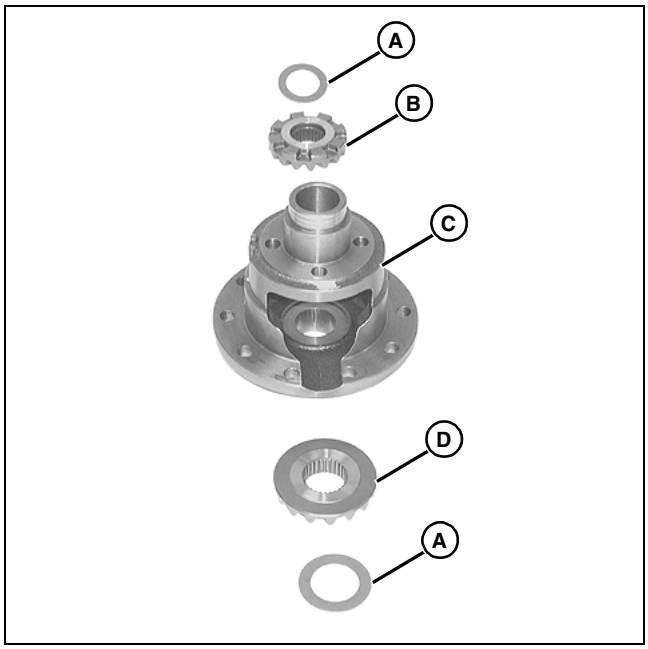


MX5835

3. Place a washer (E) to contact bearing inner race to prevent bearing damage while applying pressure.

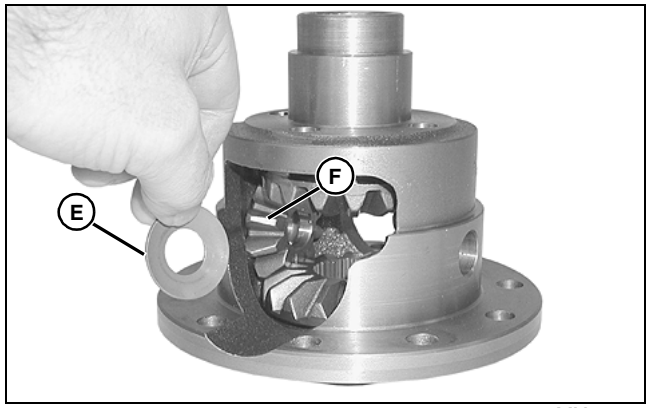
4. Install bearing (D) using a press.

Differential Assembly:



MX5840

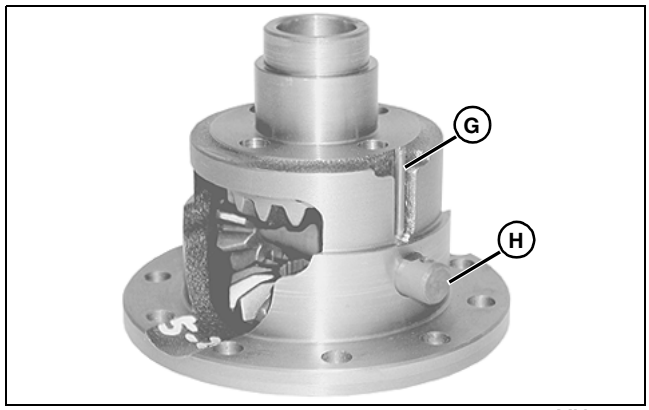
1. Install side gears (B and D) with flat thrust washers (A) inside housing (C).



MX5841

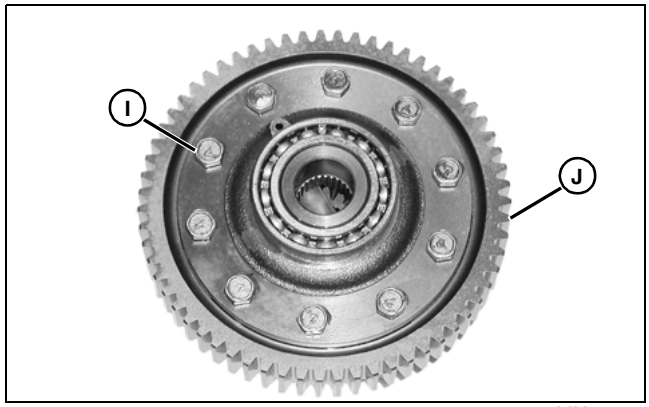
2. Install pinion gears (F) between side gears.

3. Slide the bevel thrust washers (E) between pinion gears and differential housing.



MX5842

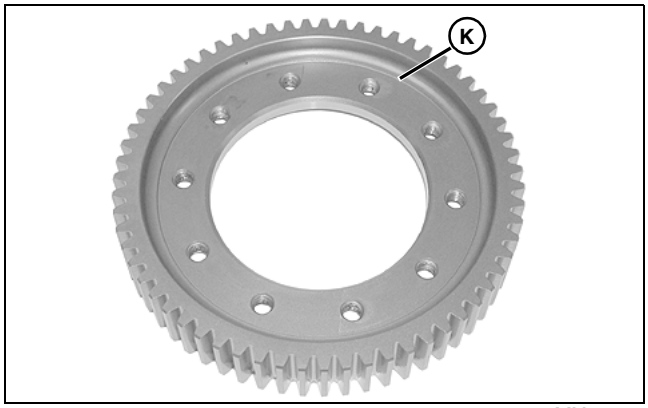
4. Install pinion shaft (H) and secure it with spring pin (G).



MX5831

5. Clean threads of cap screws (I) and threads of gear (J) with TY16285 Cure Primer.

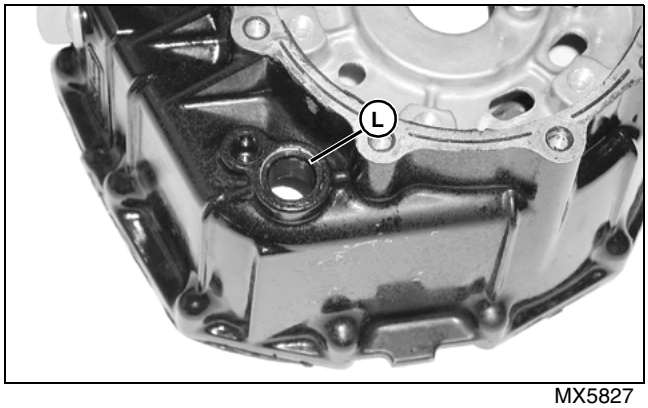
6. Apply T43512 Thread Lock and Sealer (Medium Strength) to threads of cap screws.



MX5843

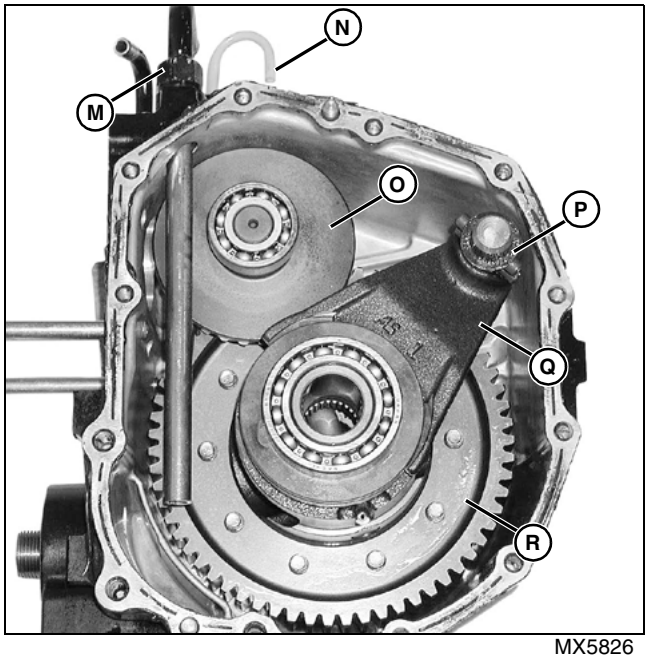
7. Install gear with ridge side (K) facing differential housing.

8. Install ten cap screws and tighten to specification.



MX5827

9. Install differential lock shaft seal (L).



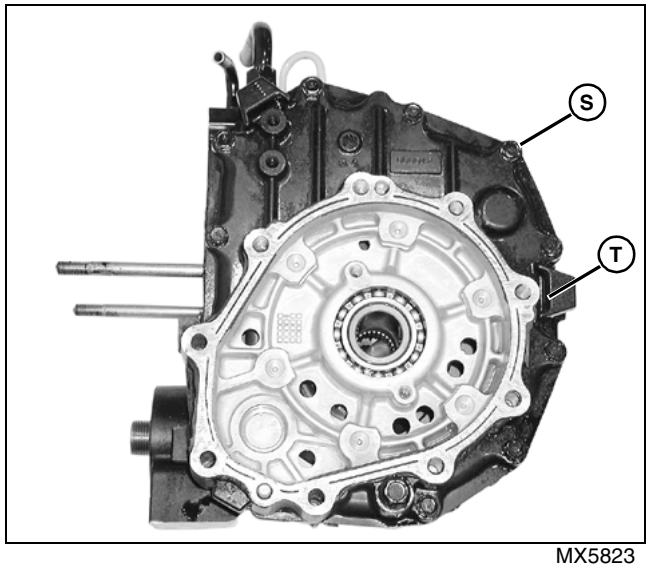
MX5826

10.Install differential lock shaft (Q) and differential assembly (R) into case as an assembly.

11.Install washer (P) on differential lock shaft.

12.Install idler shaft assembly (O).

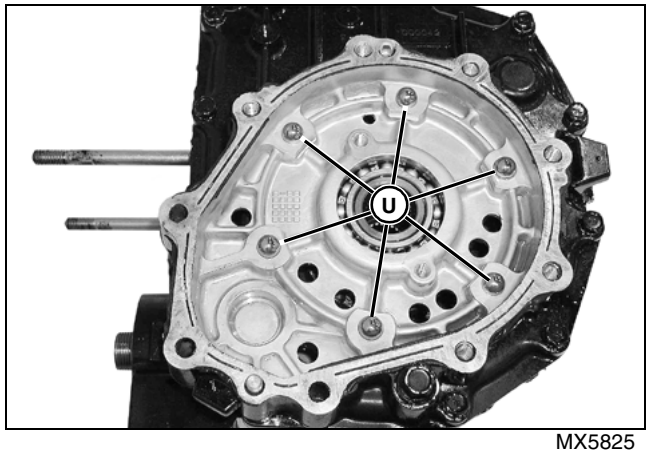
13.Install oil return tube (M) and dipstick (N).



MX5823

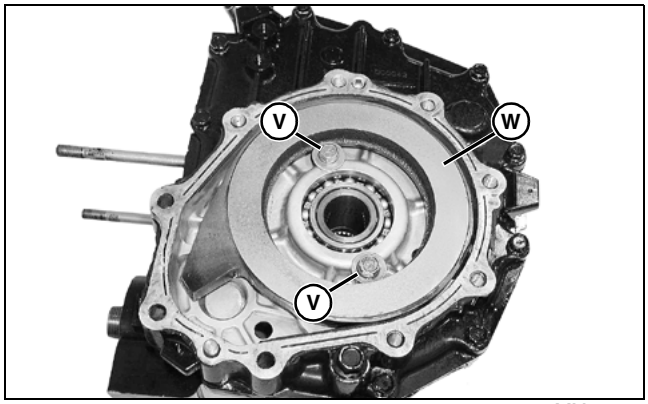
14.Apply TY16021 John Deere High Flex Form-in-Place Gasket on side cover (T) and differential housing mating surfaces.

15.Install side cover and nine M8 x 35 cap screws (S). Tighten cap screws to specification.



MX5825

16.Install six brake actuator balls (U).



MX5824

17.Install brake actuator disk (W).

18.Install cap screws and washers (V).

19.Repeat steps 16 - 18 on opposite side.

20.Install both axle housings. (See “Axle Shaft Housing Assembly:” on page 539.)

Specifications:

Axle Housing-to-Differential Cap Screw (M10 x 60) Torque . . . . . 52 N•m (38 lb-ft)

Axle Housing-to-Differential Cap Screw (M10 x 45) Torque . . . . . 52 N•m (38 lb-ft)

Differential Ring Gear-to-Housing Cap Screw Torque . . . . . 52 N•m (38 lb-ft)

Axle Seal Housing-to-Axle Housing Cap Screw Torque . . . . . 27 N•m (20 lb-ft)

Differential Side Cover-to-Differential Case Cap Screw (M8 x 35) Torque . . . . . 27 N•m (20 lb-ft)

PTO Disassembly, Inspection, and Assembly

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Clutch Piston Compression Tool[a]	NA	Used in a vise to compress the PTO clutch piston spring so the snap ring can be removed or installed.
M8 x 30 Cap Screw (2 used)	NA	Used to relieve spring pressure when removing accumulator cover.
Knife-Edge Puller	NA	Used to remove bearings.

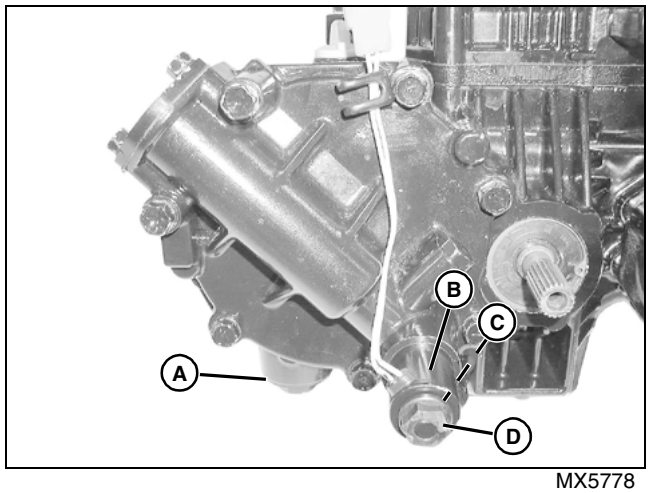
a. For instructions on making tool, see Fabricated Tools in this section.

Disassembly/Inspection:

NOTE: You do not need to remove transaxle to repair PTO only. PTO can be removed without disassembly of transaxle.

Transaxle is shown removed for clarity.

Use shop cloths or paper towels to catch and clean up any spilled oil immediately.

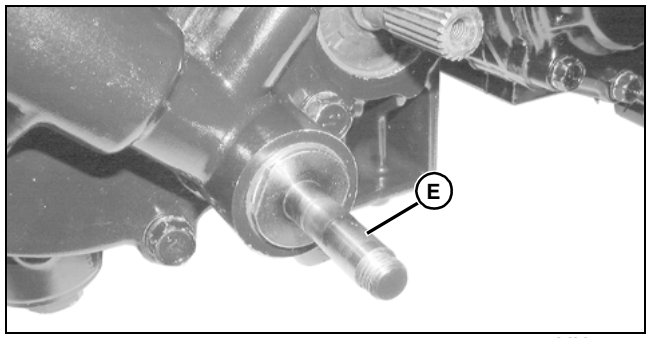


MX5778

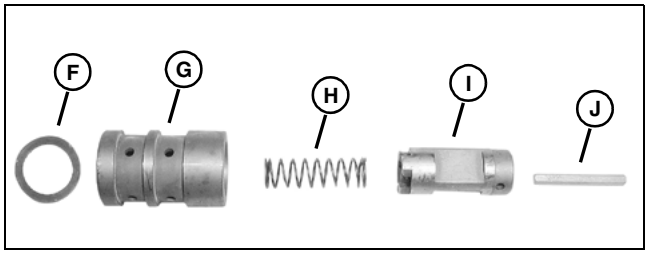
1. Drain PTO housing at drain plug (A).
2. Remove solenoid nut (D).
3. Remove O-ring (C) and solenoid coil (B).

NOTE: PTO solenoid valve, relief valve, and accumulator may be repaired without complete disassembly of PTO.

All valves have small parts; take note of order and direction of disassembly. Use caution not to drop or lose small parts.



MX5779



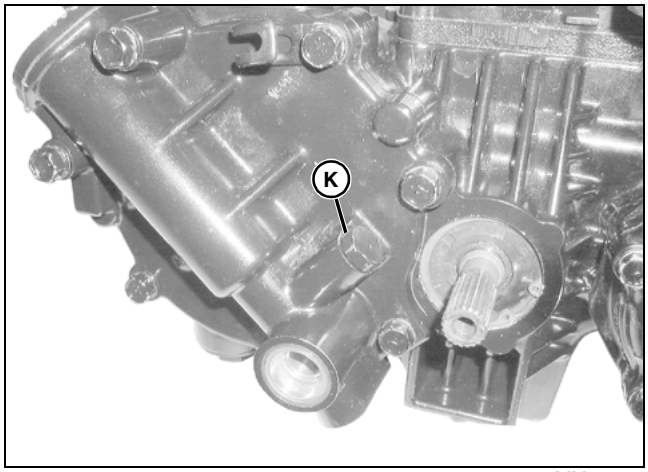
MX5786

4. Remove solenoid stud (E).

5. Remove solenoid valve parts (F - J).

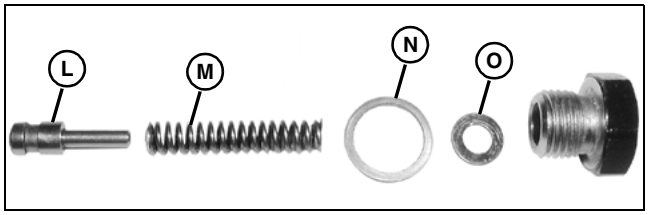
6. Inspect parts for scoring or damage. Replace as necessary.

NOTE: Valve adjustment shims may stick inside of valve cap and fall out when removing cap. Remove cap slowly to prevent loss of shims.



MX5780

7. Remove relief valve cap (K).

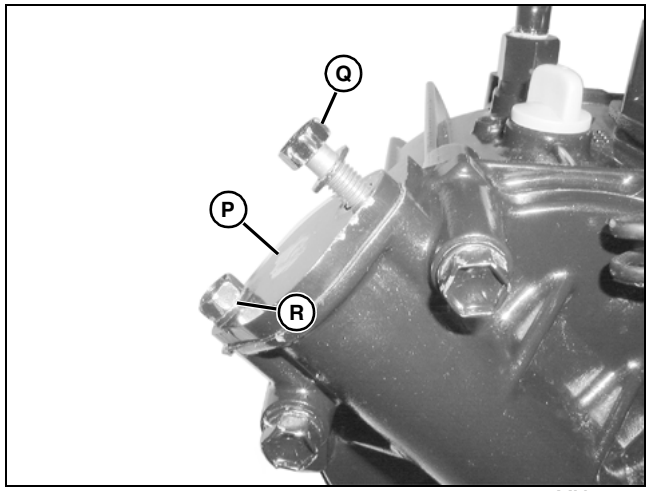


MX5787

8. Remove relief valve parts (L - O).

9. Inspect parts for scoring or damage. Replace as necessary.

CAUTION: Avoid injury! Accumulator spring is compressed. Do not remove cover without properly relieving spring pressure.



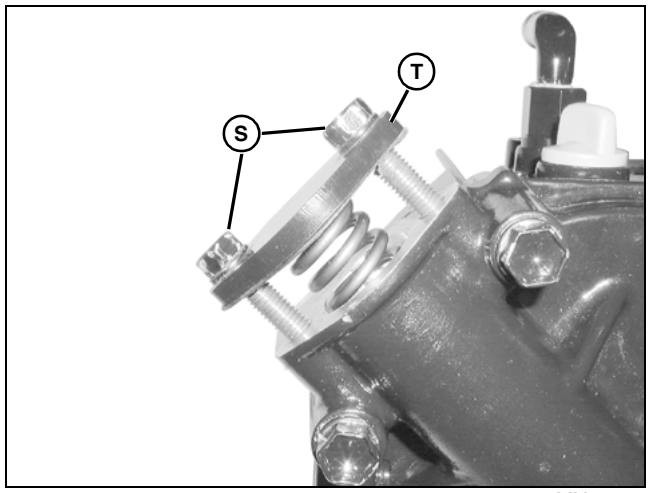
MX5782

10.Remove ONE cap screw from accumulator cover (P).

NOTE: M8 x 30 cap screw will bottom in thread hole. Do not overtighten.

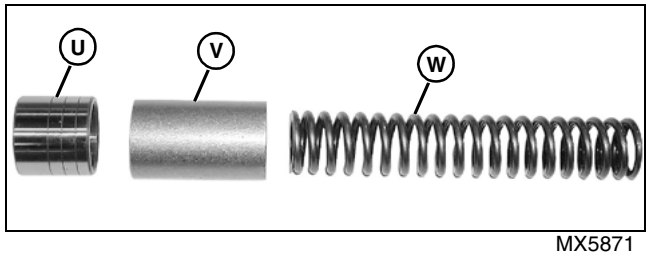
11.Install an M8 x 30 cap screw (Q) and tighten until snug.

12.Carefully remove remaining original cap screw (R) and replace with an M8 x 30 cap screw. Tighten until snug.



MX5783

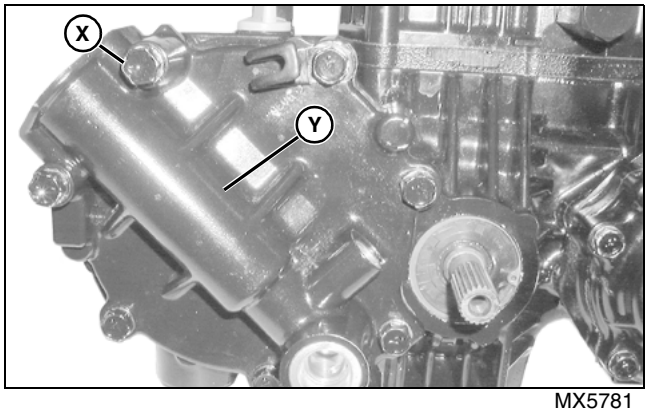
13.Slowly loosen both cap screws (S) evenly until spring pressure is relieved. Remove cover (T).



MX5871

14.Remove accumulator parts (U - W).

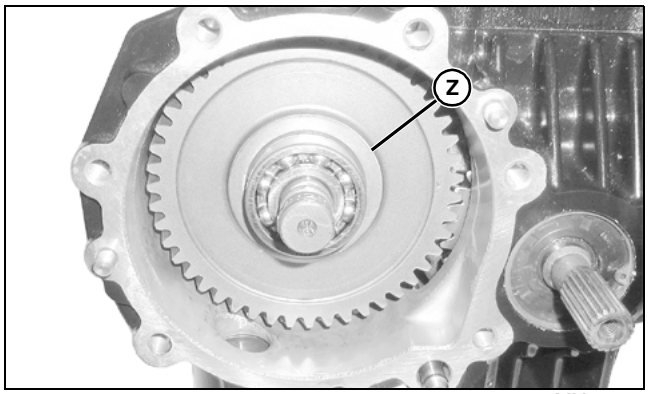
15.Inspect parts for scoring or damage. Replace as necessary.



MX5781

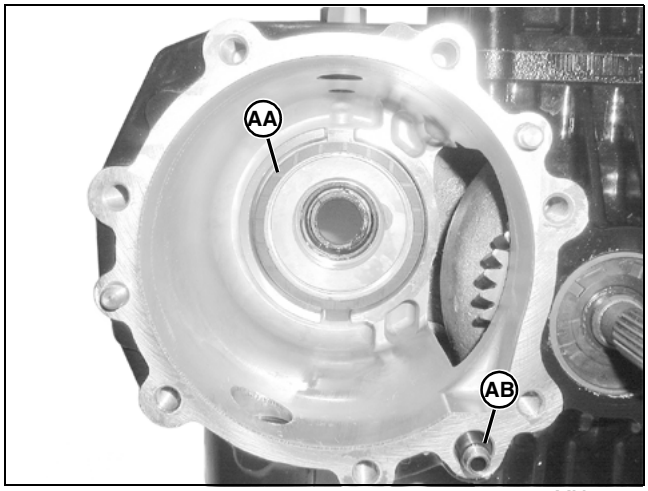
16.Remove seven cap screws (X).

17.Remove PTO cover (Y).



MX5784

18.Remove PTO assembly (Z).



MX5785

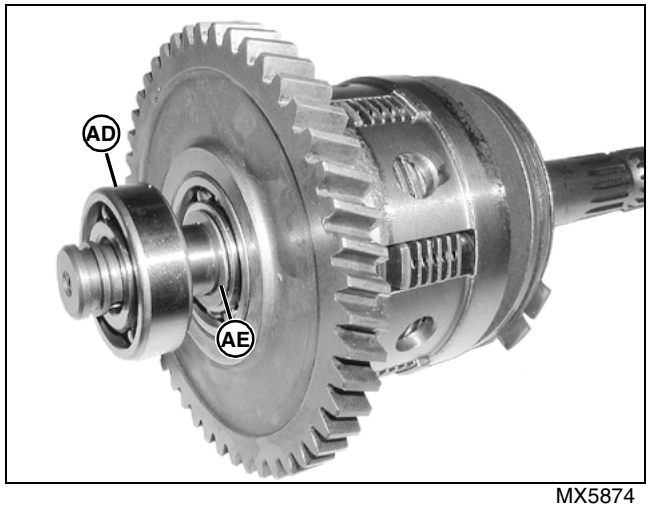
19.Remove brake disk and spacer ring (AA).

20.Remove PTO supply tube (AB).



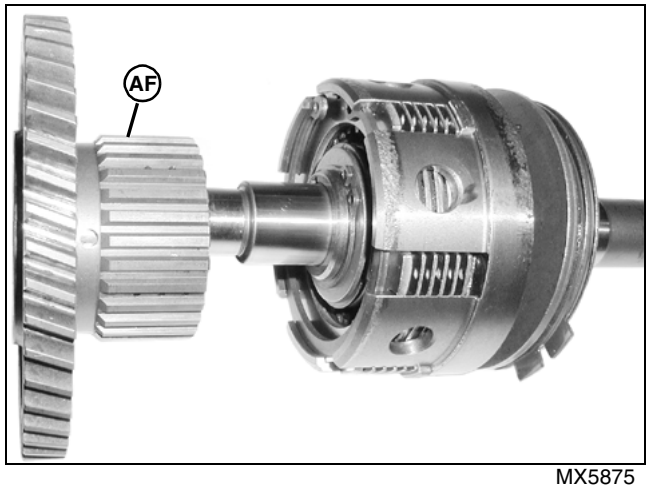
MX5873

21.Remove fiber seals (AC).



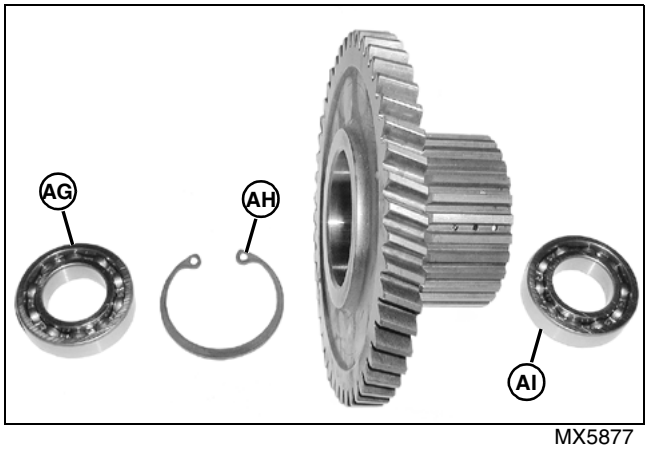
MX5874

22.Remove bearing (AD) using a knife-edge puller. Remove spacer (AE).



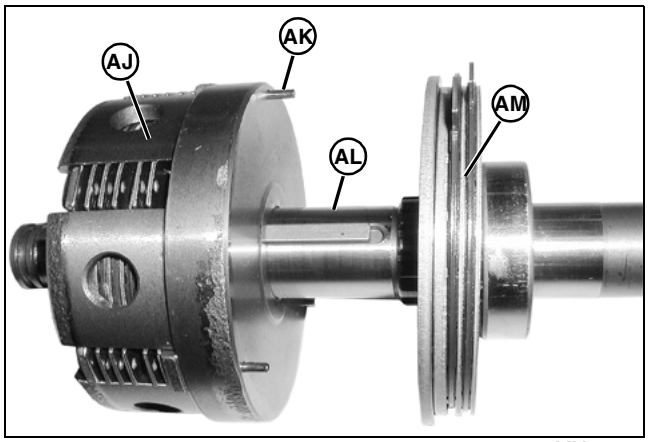
MX5875

23.Remove clutch gear (AF).



MX5877

24.Inspect bearings (AG and AI) and snap ring (AH). Remove and replace as necessary.

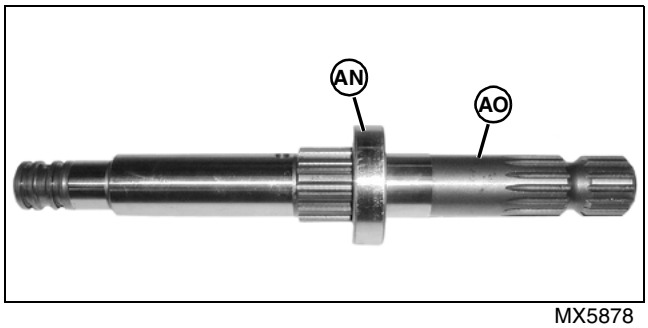


MX5876

25.Slide clutch assembly (AJ) partway off shaft and remove three brake pins (AK). Remove clutch assembly.

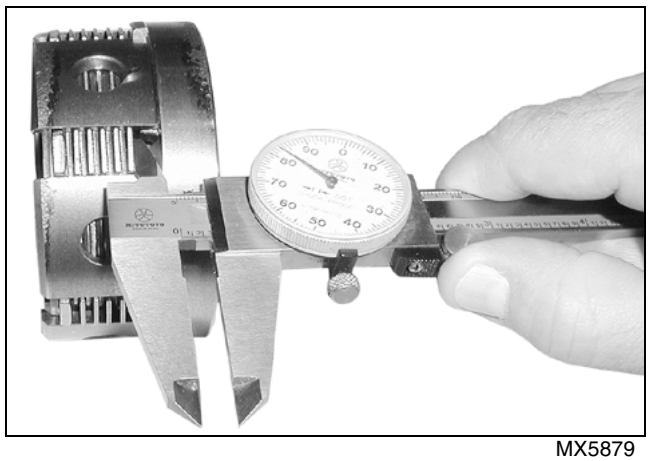
26.Remove key (AL).

27.Remove brake pack (AM).



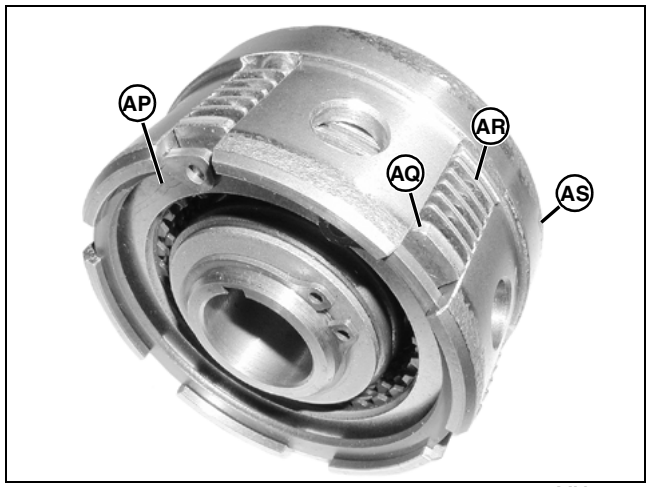
MX5878

28.Inspect bearing (AN) and shaft (AO). Use knife-edge puller if replacement is necessary.

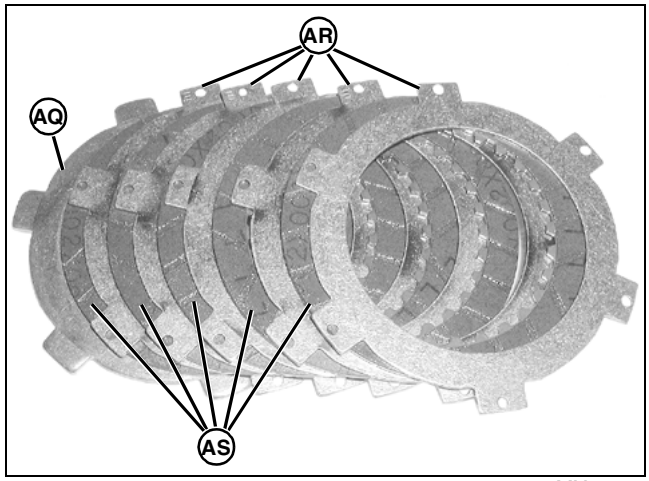


MX5879

29.Holding all the clutch disks together, measure the space between the bottom separator plate and the PTO cylinder. If space measured exceeds specification, replace all the clutch disks.



MX5880

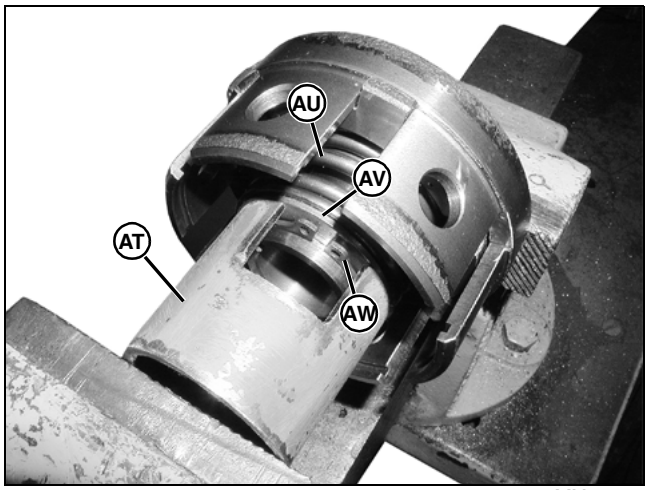


MX5881

30.Disassemble clutch if required. Remove large snap ring (AP). Lift top plate (AQ) off clutch assembly. Measure thickness of the top plate. A minimum thickness

specification is required and the plate must be flat; replace plate if necessary.

31.Remove five clutch disks (AS) and five separator plates (AR). Measure clutch disks (five used) and separator plates (five used) for minimum thickness requirement. The separator plates must be flat; replace plates if necessary.

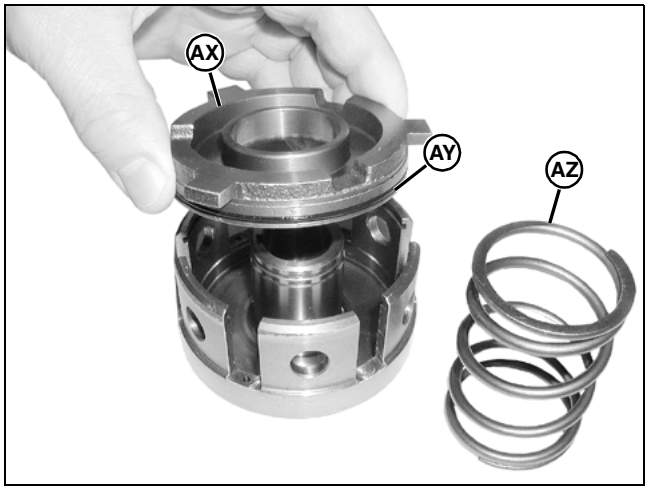


MX5882

32.Disassemble clutch piston by placing piston and clutch piston compression tool[1] (AT) in a vise.

33.Tighten vise to compress spring (AU) and flat washer (AV) to remove snap ring (AW).

34.Slowly back off on vise to remove spring (AU).

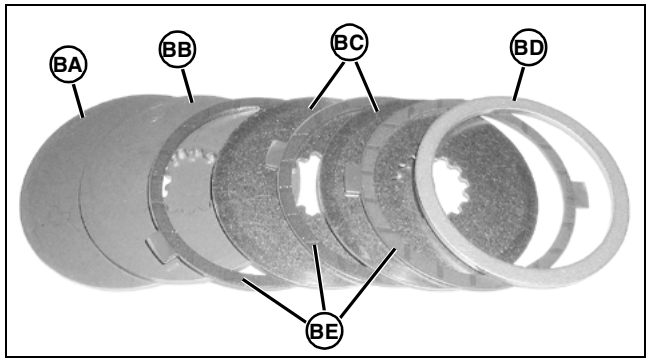


MX5886

35.Remove piston (AX). Remove O-ring (AY) and discard. Piston must be free of nicks and scratches; if not, replace it.

36.Check free length of piston return spring (AZ). Replace if required.

1. Clutch piston compression tool is a fabricated tool. For instructions to make tool, see Fabricated Tools in this section.



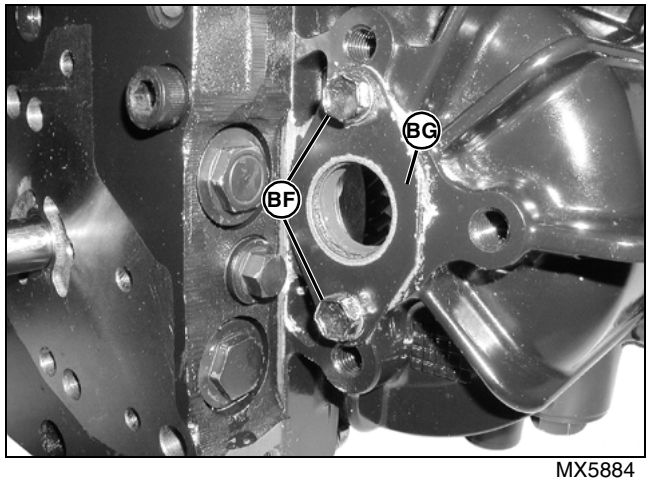
MX5883

37.Inspect brake pressure plate (BA). Plate must be flat and not damaged.

38.The top plate (BB) must be flat; replace if necessary.

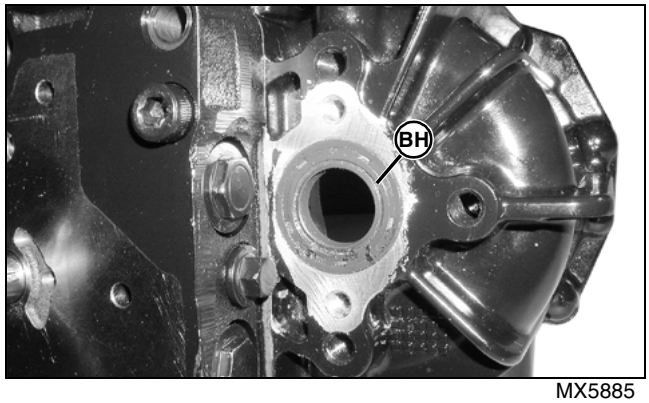
39.Inspect brake disks (BE) (three used) and brake separator plates (BC) (two used). The separator plates must be flat; replace if necessary. If oil grooves of brake disks are worn down, replace disks. If oil grooves have disappeared, replace all plates and disks.

40.Inspect brake spacer ring (BD). Spacer ring must be flat and not damaged.



MX5884

41.Remove two cap screws (BF) and plate (BG).

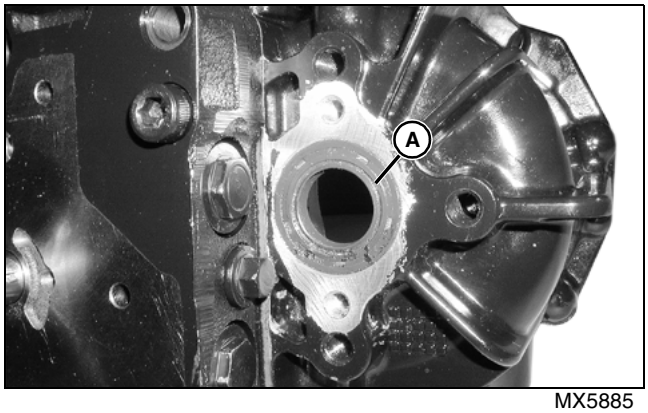


MX5885

42.Remove shaft seal (BH).

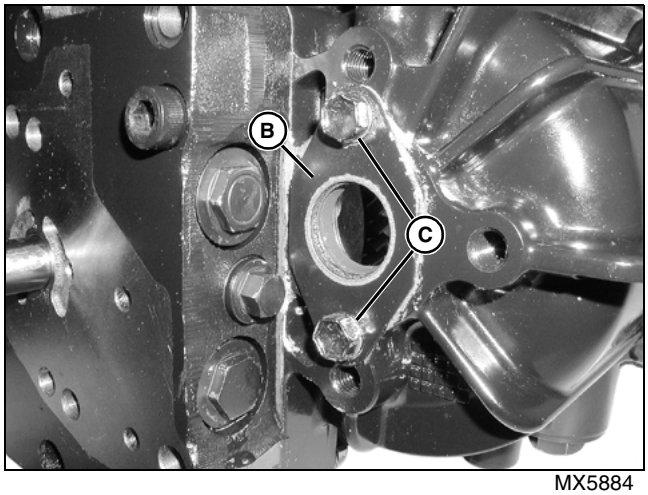
Assembly:

NOTE: Clean, dry, and lubricate all parts with clean hydrostatic fluid before assembly.



MX5885

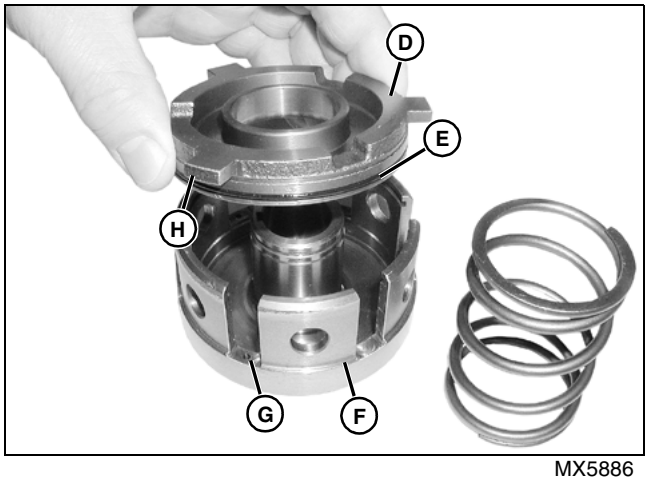
1. Install new seal (A) flush with surface of housing.



MX5884

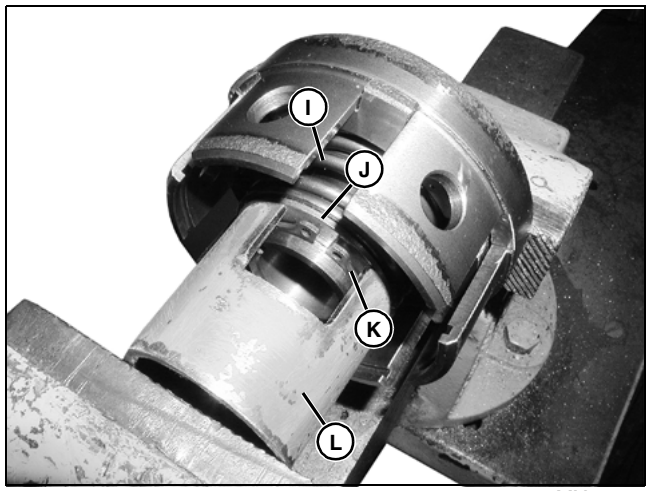
2. Install plate (B) and cap screws (C).

NOTE: Clutch piston must be positioned so that three spokes cover three pin holes in drum. If improperly installed, PTO brake will not work.



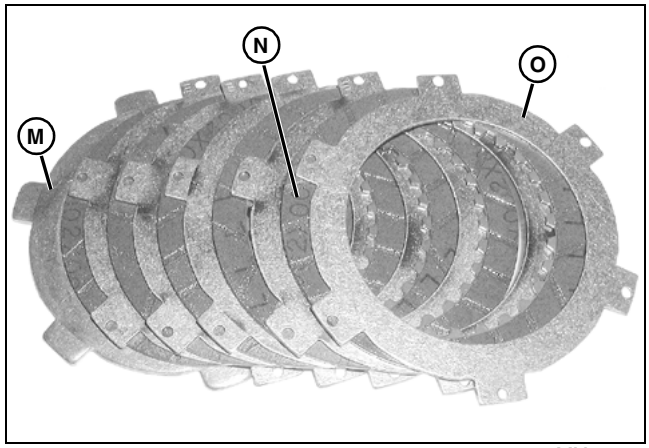
MX5886

3. Replace O-ring (E) and install piston (D) into drum (F). Three piston spokes (H) must cover three pin holes (G) in drum.



MX5882

4. Install piston spring (I), washer (J), and snap ring (K) using clutch piston compression tool[1] (L).



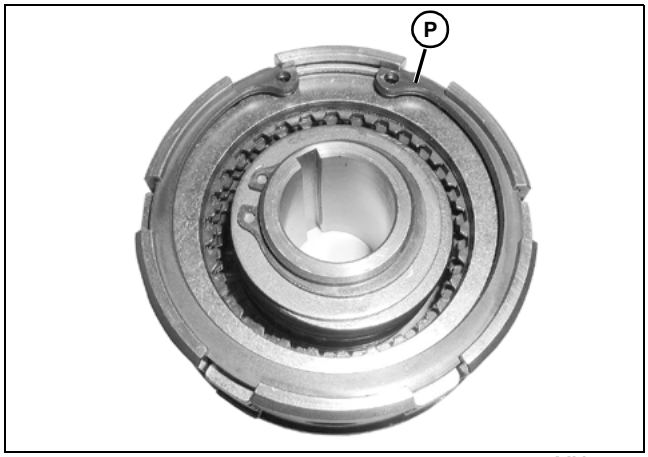
MX5881

5. Install one separator plate (O) in clutch, then one disk (N). Repeat until all five separator plates and five disks are alternately installed in clutch.

6. Install top plate (M) in clutch.

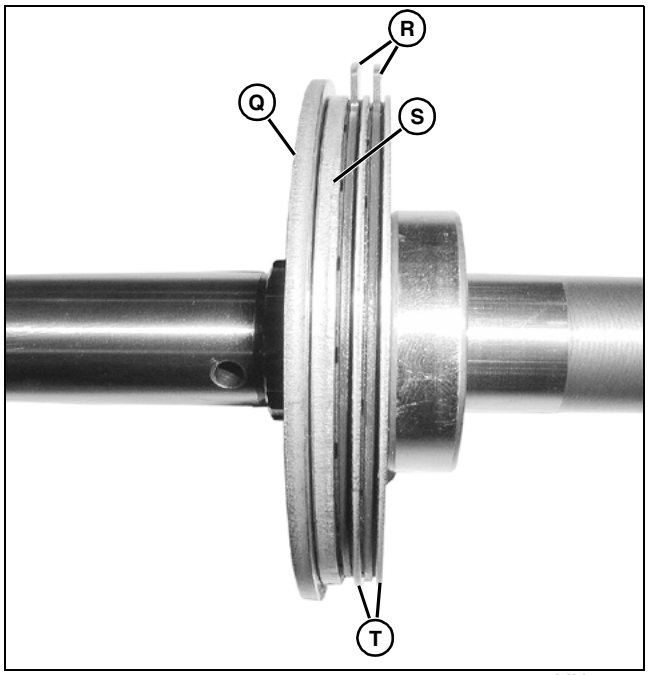
IMPORTANT: Avoid damage! Position the snap ring (P) so that the open portion is against one of the sides of the cylinder wall.

1. Clutch piston compression tool is a fabricated tool. For instructions to make tool, see Fabricated Tools in this section.



MX5889

7. Install snap ring (P) with open end facing drum wall.

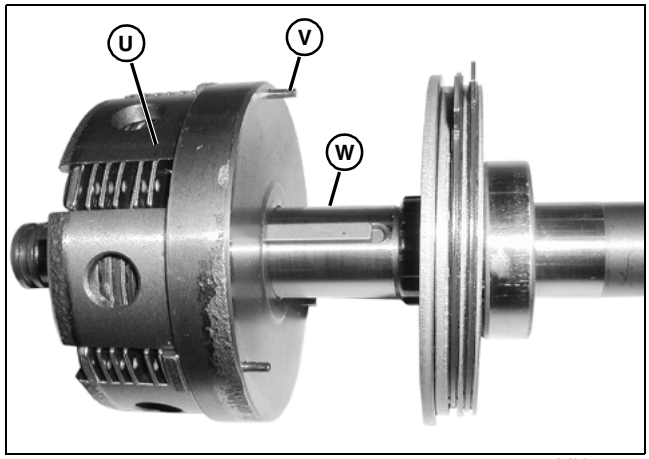


MX5890

8. Alternately install two brake separator plates (T) and two brake disks (R).

9. Install brake top plate (S).

10. Install brake pressure plate (Q).



MX5876

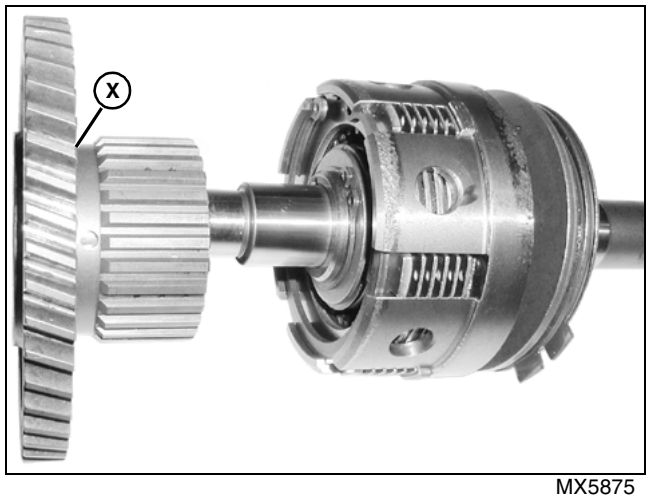
11. Install key (W) into shaft.

12. Slide clutch (U) partially onto shaft.

13. Install three pins (V) into clutch.

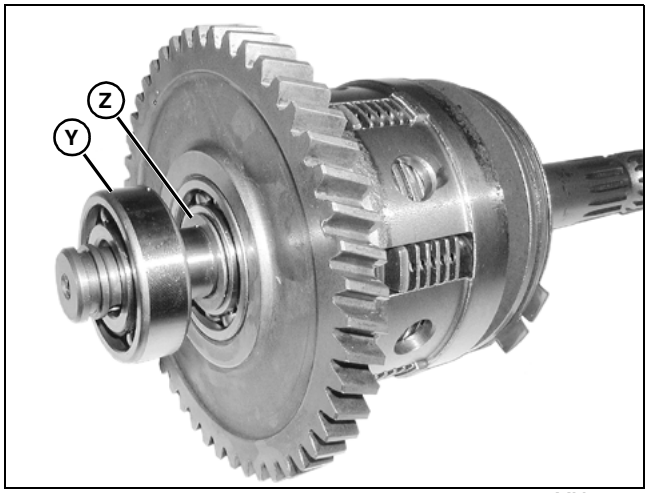
14. Install clutch fully onto shaft.

NOTE: Aligning clutch disks with a small O-ring pick and rotating gear and hub will aid in installation.



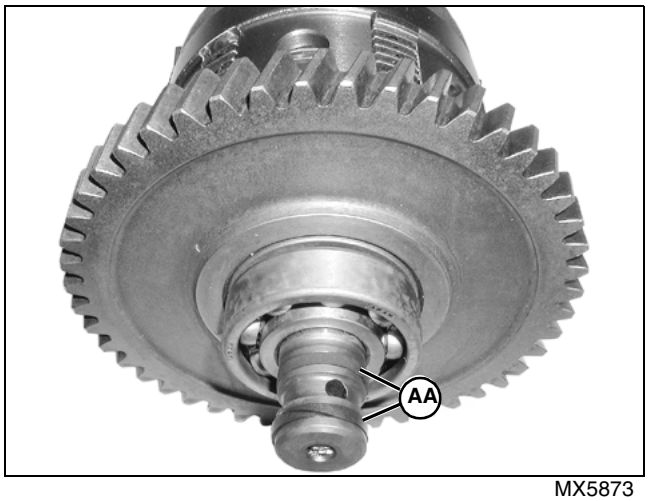
MX5875

15. Install PTO gear and hub (X) to clutch.



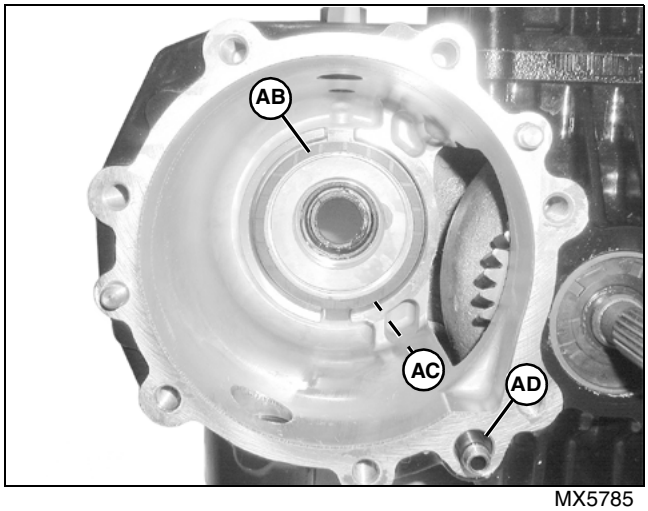
MX5874

16.Install spacer (Z) and bearing (Y) onto shaft.



MX5873

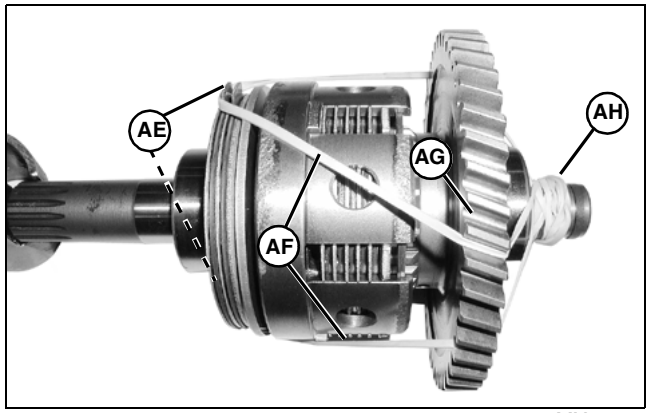
17.Install two fiber seals (AA).



MX5785

18.Install brake spacer ring (AC) and then brake disk (AB) into housing.

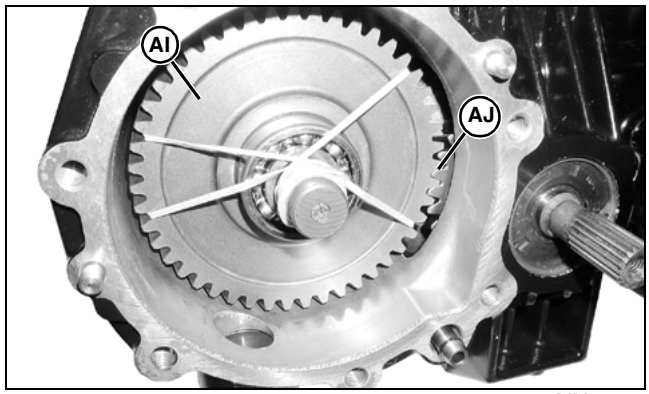
19.Replace O-rings and install PTO supply tube (AD).



MX5891

20.Install two medium rubber bands (AF) behind brake disk tab (AE). Spread legs of rubber band and pull them over gear (AG). Wrap ends of rubber bands around shaft end (AH).

21.Check that brake disk tabs and brake separator plate are all in alignment.



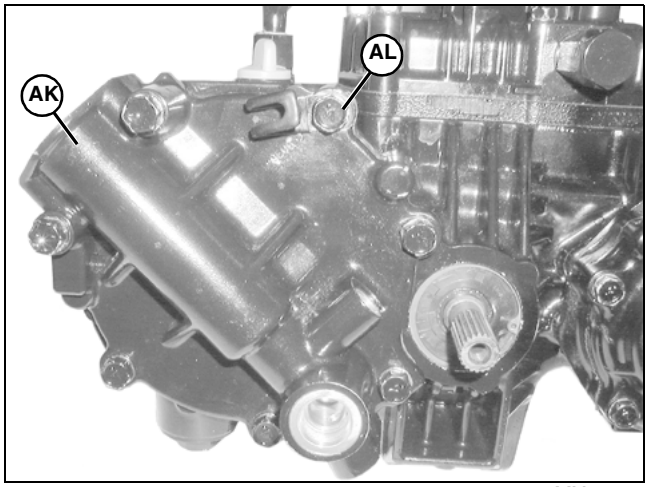
MX5892

22.Position PTO assembly so that brake disk tabs align with previously installed brake disk in housing.

23.Carefully guide PTO assembly (AI) into housing until PTO gears (AJ) are even.

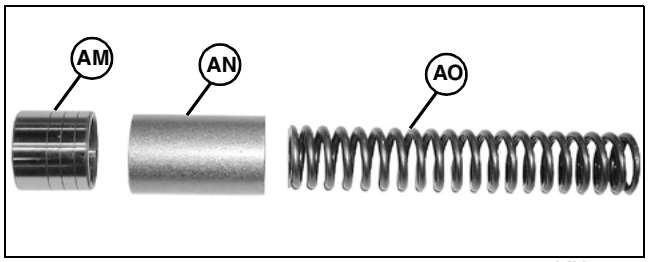
24.Cut rubber bands and gently wiggle PTO assembly while pulling on rubber bands to remove rubber bands.

25.Install new PTO cover-to-PTO housing gasket to PTO housing.



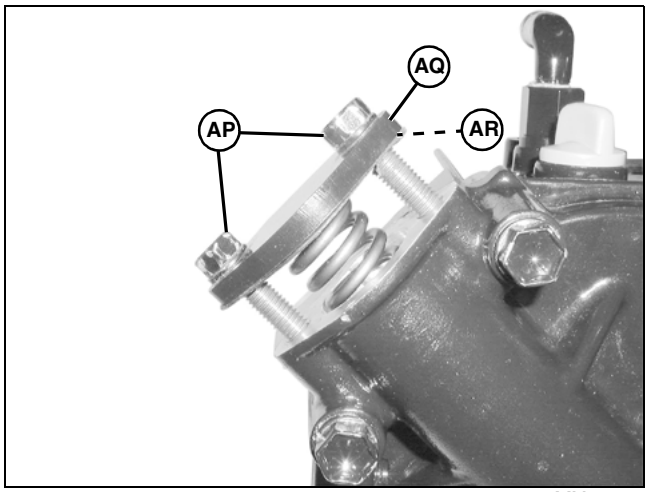
MX5781

26.Install PTO cover (AK) using seven cap screws (AL).



MX5871

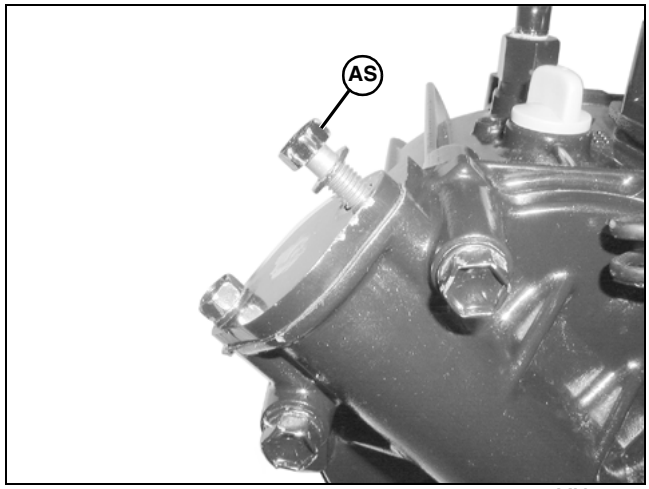
27.Install piston (AM), then sleeve (AN), and then spring (AO) into PTO cover.



MX5783

28.Install cover gasket (AR) to cover (AQ).

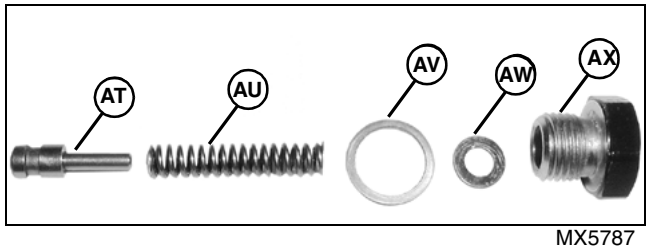
29.Install cover using two M8 x 30 (AP) cap screws. Tighten cap screws evenly until snug.



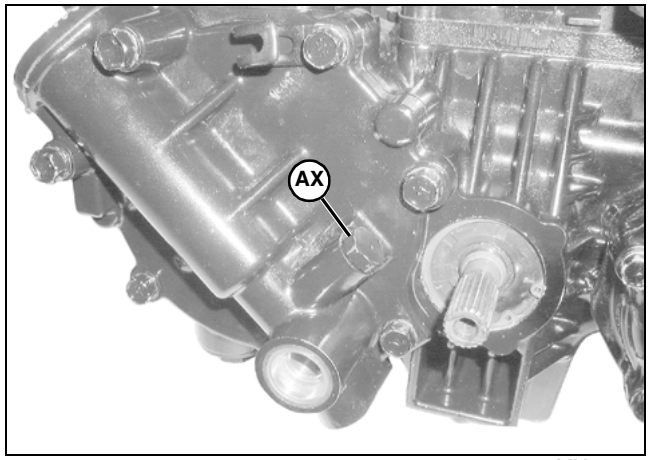
MX5782

30.Remove one M8 x 30 cap screw (AS) and replace it with an original cover cap screw. Tighten cap screw.

31.Repeat for other M8 x 30 cap screw.



MX5787

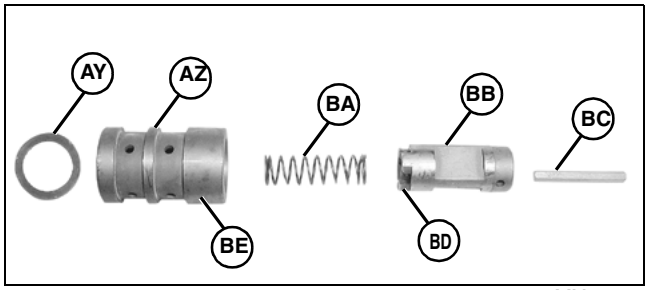


MX5780

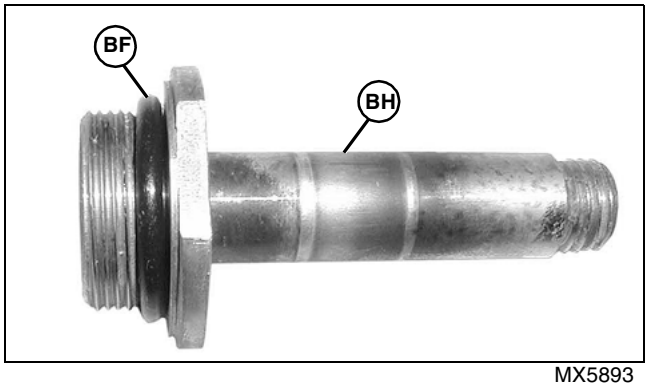
32.Install PTO relief piston (AT) and then spring (AU) into PTO cover.

33.Install shims (AW) and new seal (AV) into relief cap (AX).

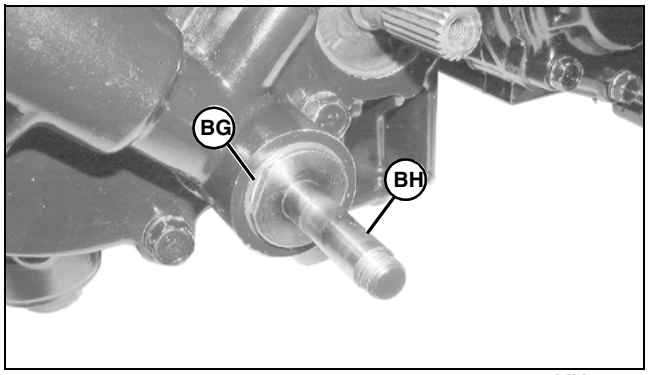
34.Carefully install cap into PTO cover, taking care not to drop shims out of cap.



MX5786



MX5893



MX5779

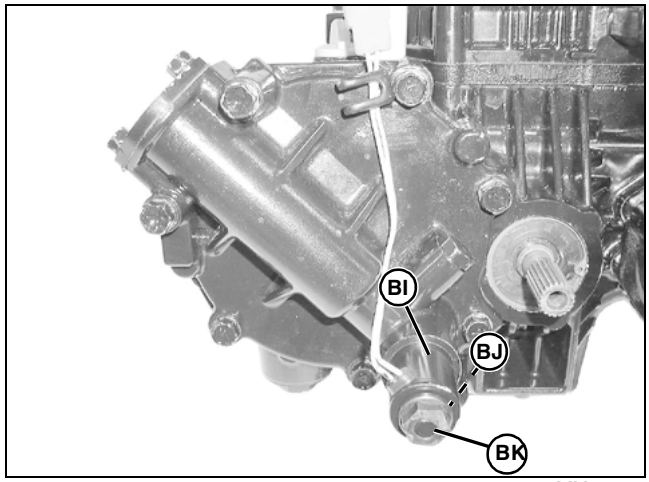
35.Install washer (AY) and then outer spool (AZ), with large boss (BE) up, into PTO cover.

36.Install spring (BA) and then inner spool (BB), with fingers (BD) down, into PTO

37.Install new O-ring (BF).

38.Install pin (BC) into solenoid stud (BH).

39.Install new seal (BG) and install solenoid stud. Tighten to specification.



MX5778

40.Install solenoid coil (BI) with wires toward threaded end of solenoid stud, and then new O-ring (BJ) and nut (BK). Tighten nut to specification.

41.Fill transaxle. (See Checking the Transaxle Oil Level in operator's manual.)

Specifications:

Bottom Separator Plate-to-PTO Gap (Maximum) . . . . . 9.1 mm (0.36 in.)

Clutch Top Plate Thickness (Minimum) . . . . . 3.03 mm (0.119 in.)

Clutch Disk Thickness (Minimum) . . . 2.0 mm (0.08 in.)

Clutch Separator Plate Thickness (Minimum) . . . . . 1.0 mm (0.04 in.)

Piston Return Spring Free Length (Minimum) . . . . . 75 mm (2.95 in.)

Piston Return Spring Test Length @ 499 N (112 lb-force) . . . . . 28.6 mm (1.13 in.)

Solenoid Stud Torque . . . . . 23 N•m (203 lb-in.)

Solenoid Coil Nut Torque . . . . . 5 N•m (44 lb-in.)

4WD Drive Shaft Removal and Installation

Special or Required Tools:

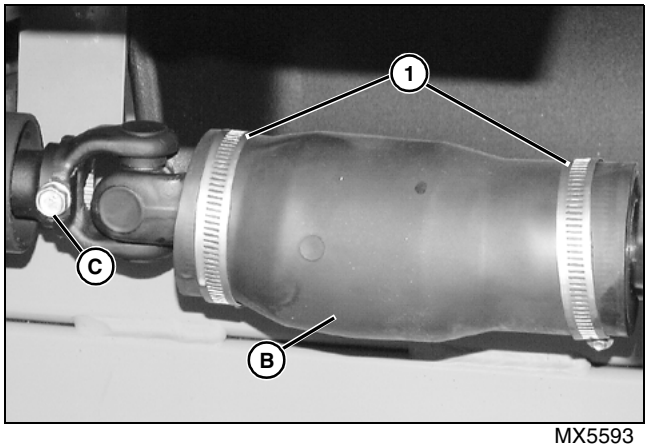
Tool Name	Tool No.	Tool Use
Floor Jack	NA	Used to raise front of machine.
Jackstand (2 used)	NA	Used to support machine.

Removal:

1. Park machine safely.
2. Stop engine.
3. Remove engine cover.
4. Disconnect battery (-) negative cable.
5. Block rear tires to prevent machine from rolling.

CAUTION: Avoid injury! Support machine properly.

6. Raise front of machine using a floor jack and support with jackstands.



MX5593

7. Loosen band clamps (A) on front and rear universal joint boots (B).
8. Slide boots away from front and rear universal joints.
9. Remove cap screw and washer (C) from front universal joint connection.
10. Slide drive shaft rearward to remove universal joint from transaxle output shaft.
11. Lower and slide drive shaft forward to remove drive shaft from 4WD axle input shaft.
12. Inspect the splines of the universal joints and drive shafts for wear or damage. Replace parts as needed.

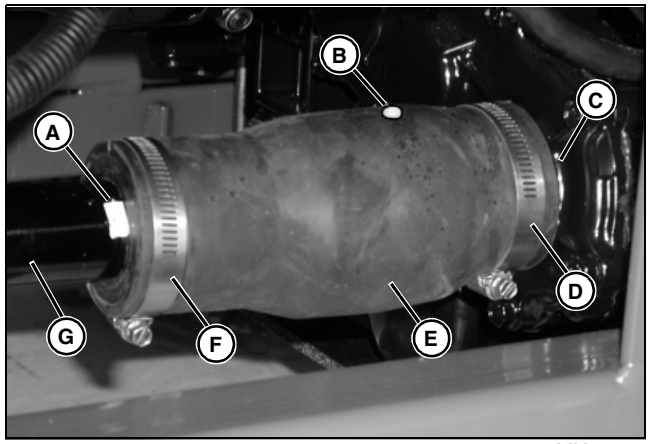
Installation:

IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.

1. Slide rear universal joint of drive shaft onto 4WD axle input shaft.

NOTE: Holes for cap screw and washer in front universal joint and transaxle 4WD output shaft must be aligned when installing drive shaft.

2. Align hole in front universal joint with hole in transaxle 4WD output shaft.
3. Slide universal joint onto spline until the holes are aligned.
4. Install washer and cap screw in front universal joint. Tighten cap screw.



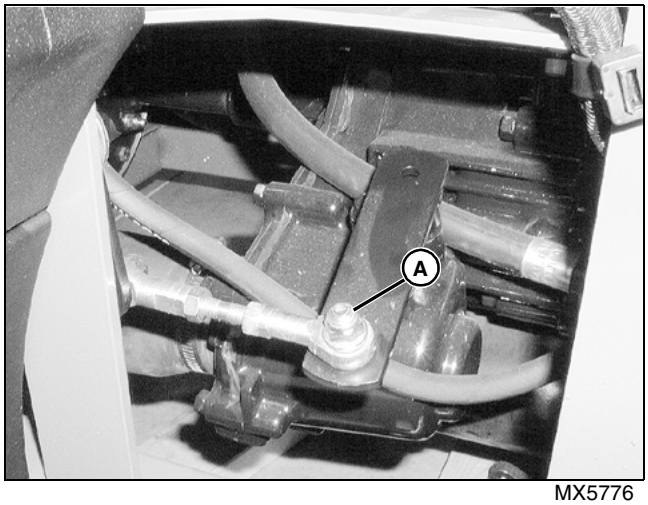
MX8940

5. Slide the front rubber boot (E) forward over the output shaft (C) on the gearbox.
6. Turn the rubber boot so that the white painted dot (B) is on top of the rubber boot. Tighten the front hose clamp (D) on the rubber boot.
7. Slide the shield tube (G) in the rubber boot until the white line (A) is showing at the edge of the rubber boot.
8. Tighten the rear hose clamp (F).
9. Slide the rear rubber boot rearward over the rear axle input shaft, rotate boot until white dot is on top, and tighten both hose clamps.
10. Remove jackstands and lower machine.
11. Connect battery negative (-) cable.
12. Install engine cover.

4WD Gear Case Removal and Installation

NOTE: You do not need to remove transaxle to repair 4WD gear case only.

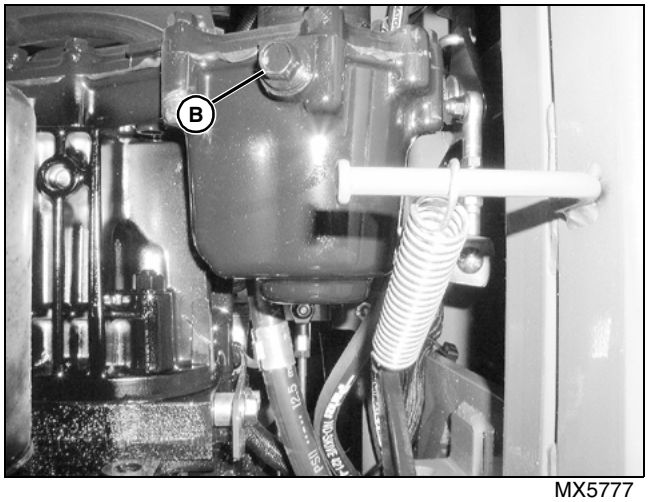
1. Remove 4WD drive shaft. (See “4WD Drive Shaft Removal and Installation” on page 556.)



MX5776

2. Remove carriage bolt and lock nut (A) to disconnect 4WD linkage.

NOTE: Use shop cloths or paper towels to catch and clean up any spilled oil immediately.

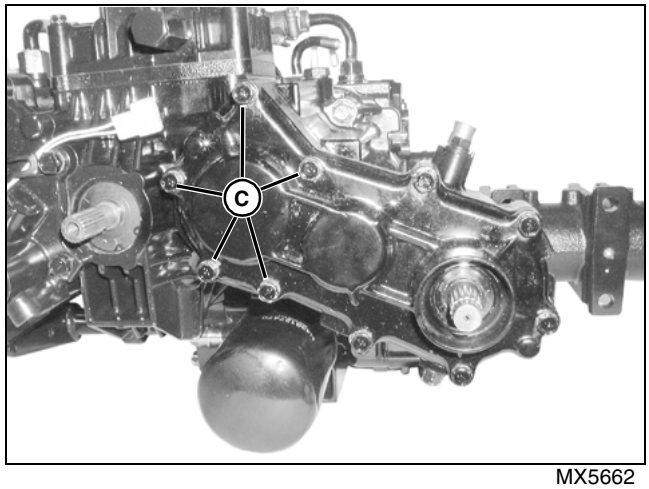


MX5777

3. Place drain pan below 4WD gear case, remove drain plug (B), and drain gear case.

4. Install drain plug.

NOTE: Transaxle is shown removed for clarity.



MX5662

5. Remove five cap screws (C).

6. Remove 4WD gear case; repair as necessary.

7. Replace 4WD gear case-to-hydrostatic assembly gasket.

NOTE: Turning 4WD gear case output shaft will aid in installation.

8. Install 4WD gear case.

9. Install five cap screws.

10. Connect 4WD linkage.

11. Install 4WD drive shaft. (See “4WD Drive Shaft Removal and Installation” on page 556.)

12. Fill transaxle. (See Checking the Transaxle Oil Level in operator’s manual.)

4WD Gear Case Disassembly, Inspection, and Assembly

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Snap Ring Pliers Set	NA	Used to remove and install snap rings.
Hydraulic Press	NA	Used to remove and install bearings.

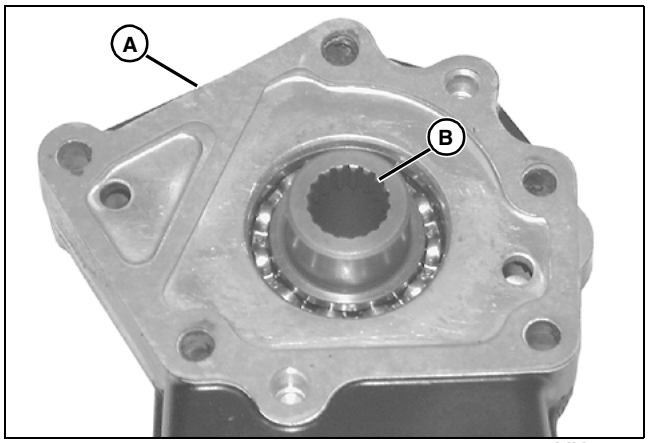
Other Material:

Part No.	Part Name	Part Use
TY16021 (U.S.)/ LOCTITE ® 17430/ TY9484 (Canada)	John Deere High Flex Form-in-Place Gasket	Used to make gaskets.

Other Material:

Part No.	Part Name	Part Use
TY16285 (U.S.)/ LOCTITE ® 17649/ CXTY16285 (Canada)	John Deere Cure Primer	Used to clean parts and speed cure of sealant.

Disassembly/Inspection:

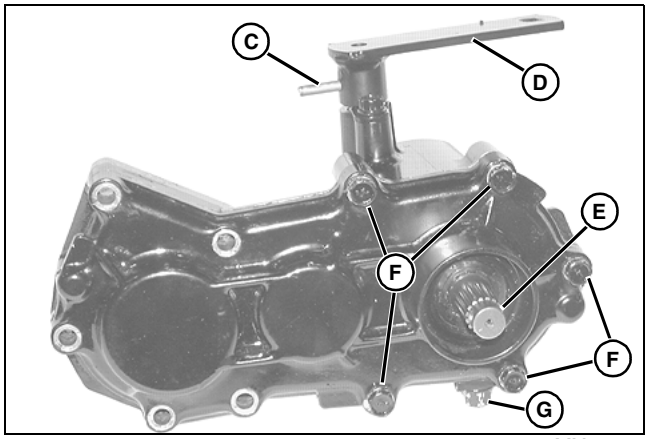


MX5645

1. Remove 4WD gear case from transaxle case. (See “4WD Gear Case Removal and Installation” on page 557.)

2. Remove gasket (A) and clean gasket mating surfaces.

3. Inspect splines (B). If splines are worn or damaged, replace gear.



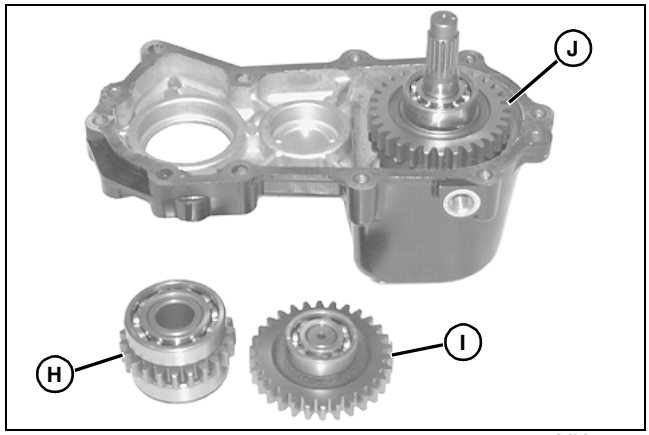
MX5648

4. Remove spring pin (C) to remove arm (D).

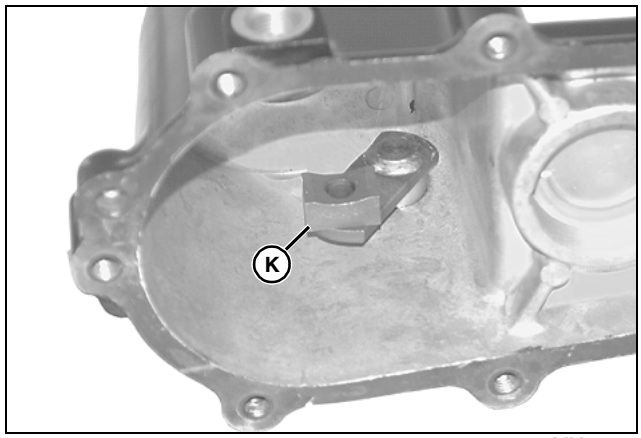
5. Inspect splines (E) on clutch shaft.

6. Remove drain plug and washer (G). Drain any remaining oil into a properly marked container.

7. Remove five cap screws (F) and washers to remove cover. It may be necessary to tap on case cover to remove it.



MX5713

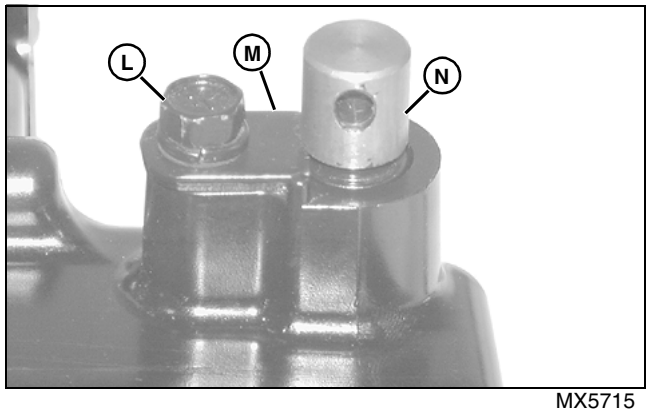


MX5714

8. Remove idler gear (I) and drive gear (H).

NOTE: When removing 4WD clutch assembly, do not lose the shift collar located inside clutch housing.

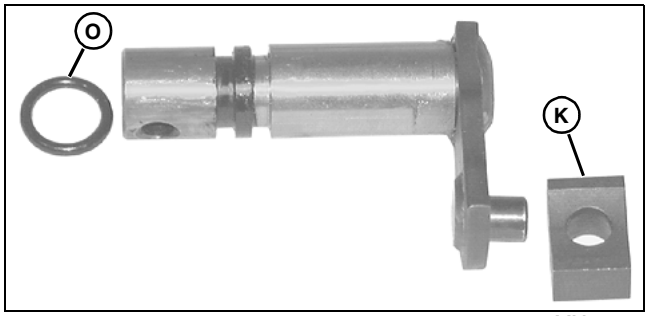
9. Remove clutch assembly (J). Do not lose shift collar (K) located inside case when removing clutch assembly.



MX5715

10.Remove cap screw and lock washer (L) to remove strap (M) securing shift arm (N).

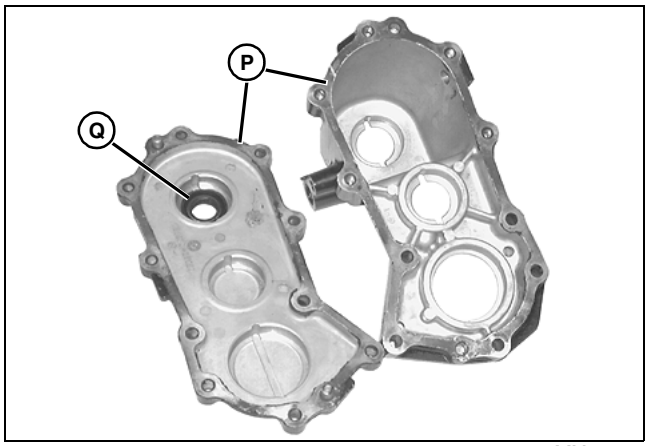
11.Remove shift arm.



MX5716

12.Remove and discard O-ring (O).

13.Inspect shift arm and collar for wear or damage. replace as necessary.



MX5717

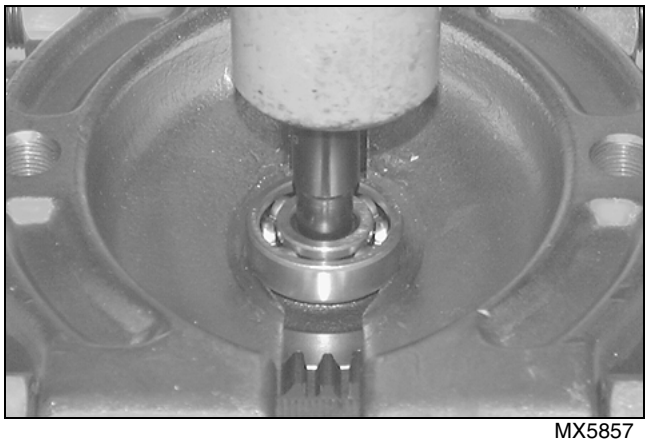
14.Remove gasket material from mating surfaces (P).

15.Clean inside of case and cover.

16.Remove and discard oil seal (Q).

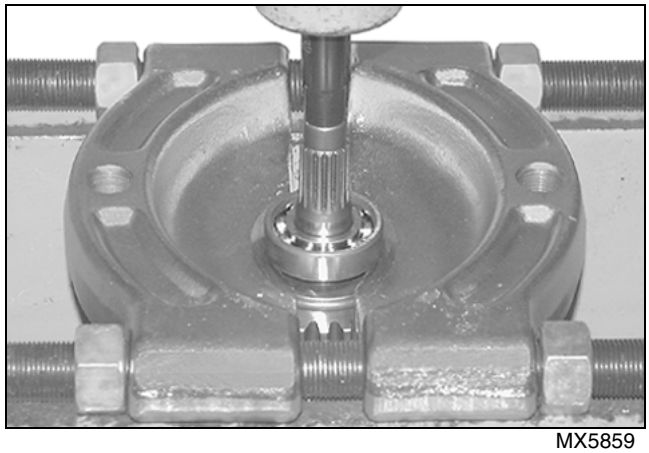
17.Inspect idler and drive gears and bearings for wear, damage, or rough movement. Replace parts as needed.

NOTE: Steps for removing bearings from idler and drive gears are the same.

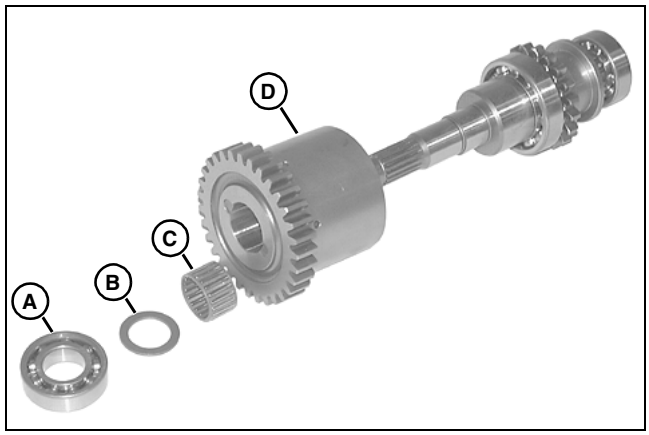

MX5857

18.If bearings require replacement, remove bearings using a knife-edge puller and press.

4WD Clutch Disassembly and Inspection:


MX5859

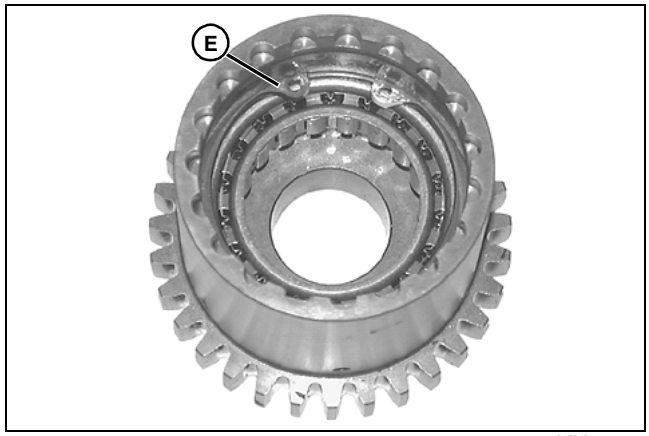
1. Put clutch assembly in a press and remove bearing on drive shaft end.



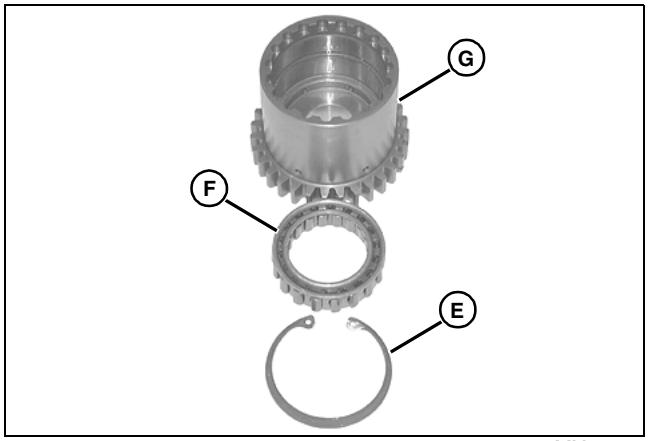
MX5860

2. Remove roller bearing (A), washer (B), and needle bearing (C). Inspect for damage, wear, or rough movement. Replace as needed.

3. Remove clutch assembly (D) from shaft.



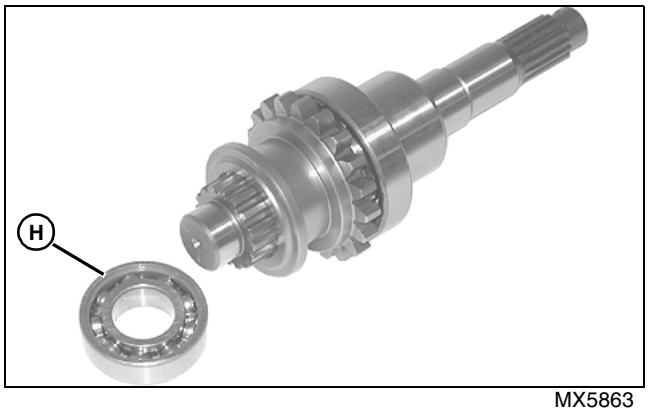
MX5861



MX5862

4. Remove snap ring (E) to remove clutch (F) from housing (G). Inspect clutch for wear, damage, or rough movement. Replace as needed.

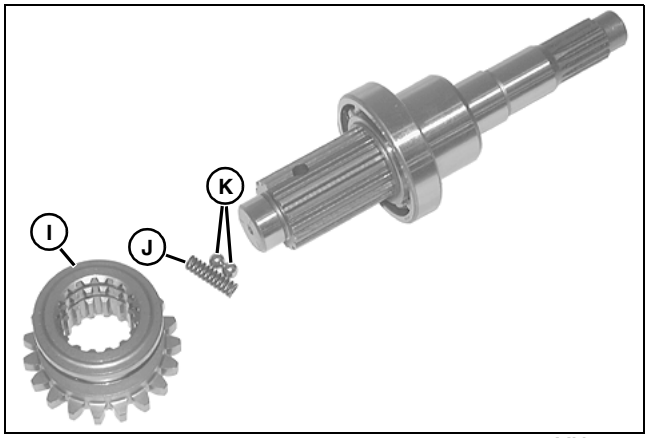
5. Inspect clutch housing for wear or damage. Replace as needed.



MX5863

6. Remove opposite bearing (H) from clutch shaft. Inspect bearing for wear, damage, or rough movement. Replace bearing as needed.

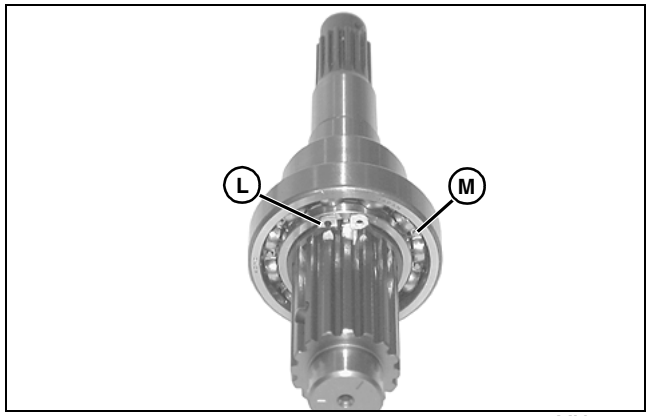
NOTE: When removing the shifter (I) from the clutch shaft, do not lose the detent balls (K) and spring (J) located internally in the shaft.



MX5864

7. Remove shifter (I) from clutch shaft. Use care not to lose spring (J) and detent balls (K) when removing shifter.

8. Inspect shifter, spring, and detent balls for wear or damage. Replace parts as needed.



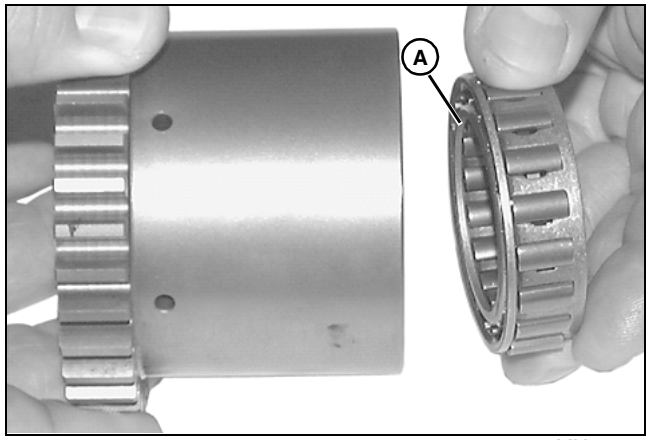
MX5865

9. Remove snap ring (L) to remove bearing (M). Inspect for wear, damage, or rough movement. Replace as needed.

4WD Clutch Assembly:

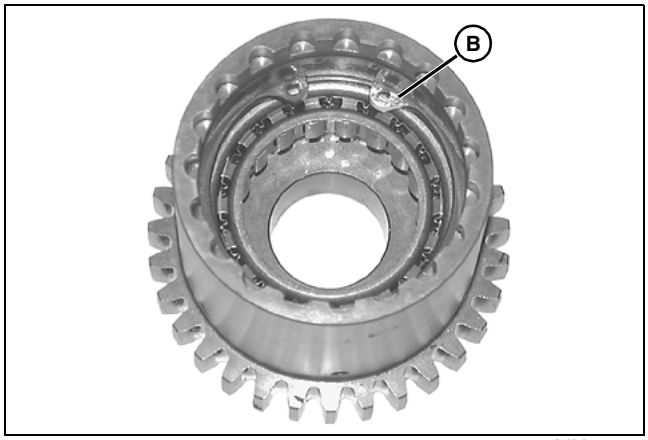
IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.

NOTE: When installed correctly, clutch should turn clockwise only. Verify clutch is installed correctly.



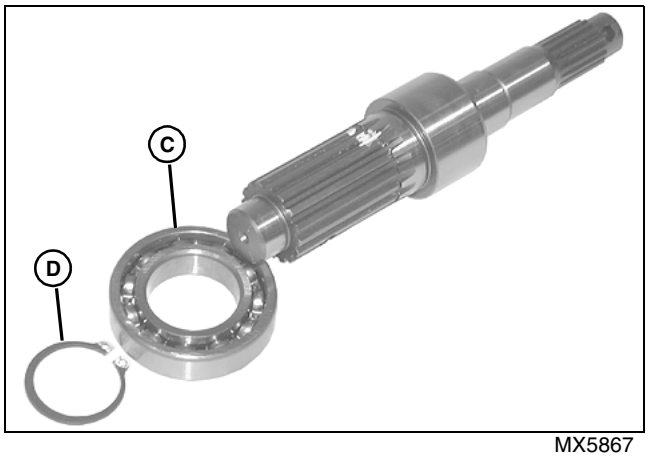
MX5866

1. Install clutch in housing with flange (A) toward housing. Rotate clutch inside housing. Clutch should turn clockwise. If clutch rotates counterclockwise, remove clutch and reinstall with flange inward.



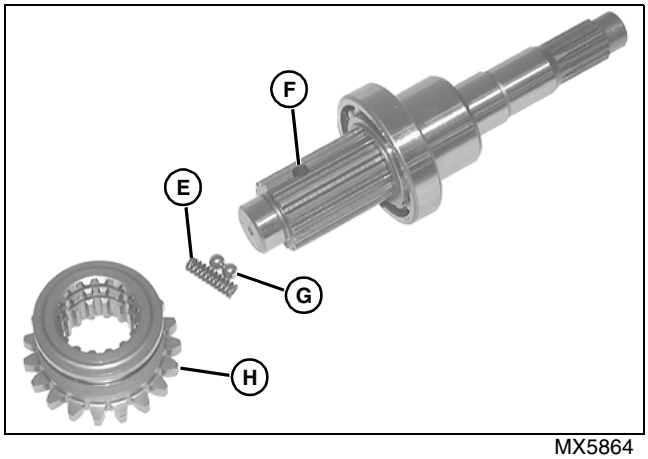
MX5861

2. Install snap ring (B).



MX5867

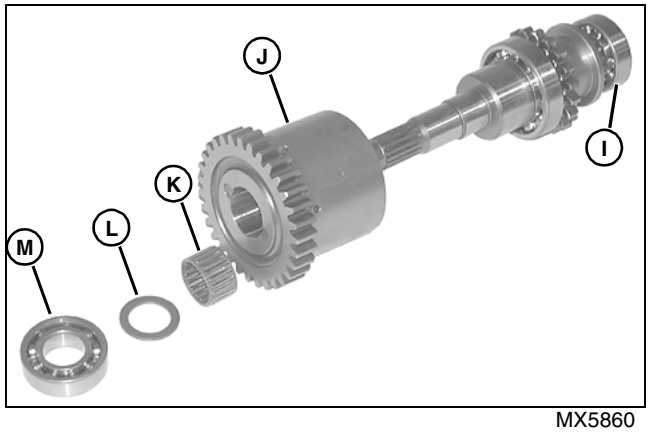
3. Install bearing (C) and snap ring (D) on shaft.



MX5864

4. Install spring (E) in hole (F) of shaft. Put a ball (G) on each end of spring.

5. While compressing balls and spring, install shifter (H) on shaft with teeth of shifter toward bearing.



MX5860

6. Install bearing (I) on shifter end of shaft.

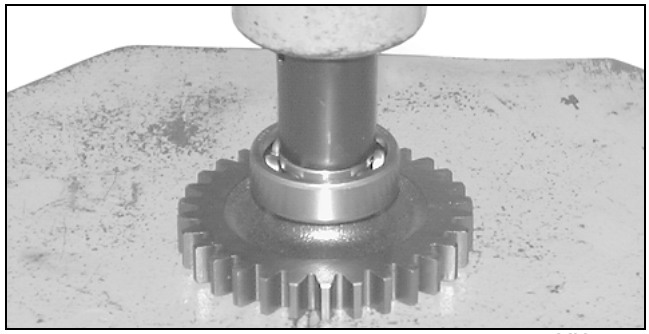
7. Install clutch assembly (J) on shaft.

8. Install needle bearing (K), washer (L) and bearing (M).

4WD Gear Case Assembly:

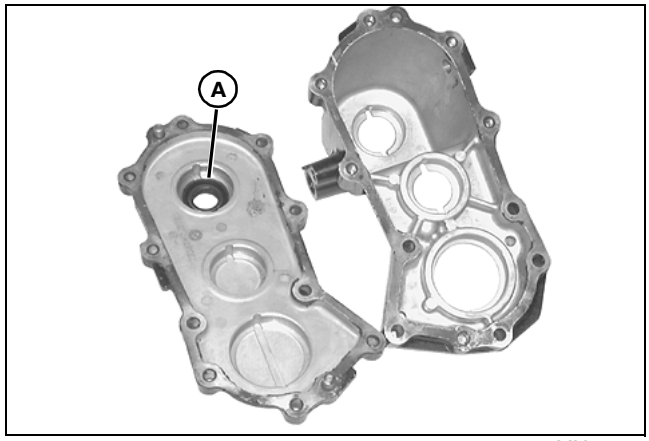
IMPORTANT: Avoid damage! Press on inner race only to avoid damaging bearing.

NOTE: Steps for installing bearings on idler gear and drive gear are the same.



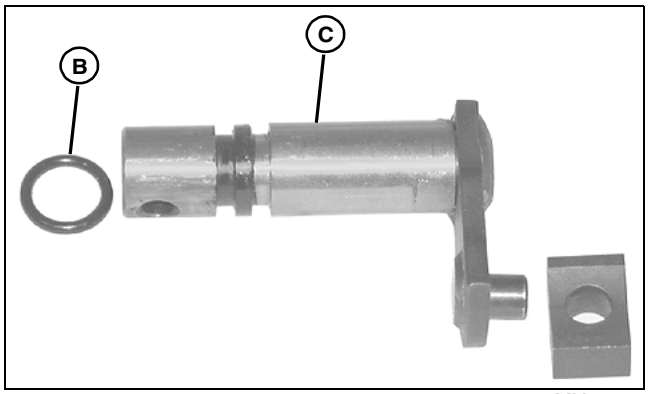
MX5858

1. Install bearings by pressing on inner race until tight against shoulder of gear.



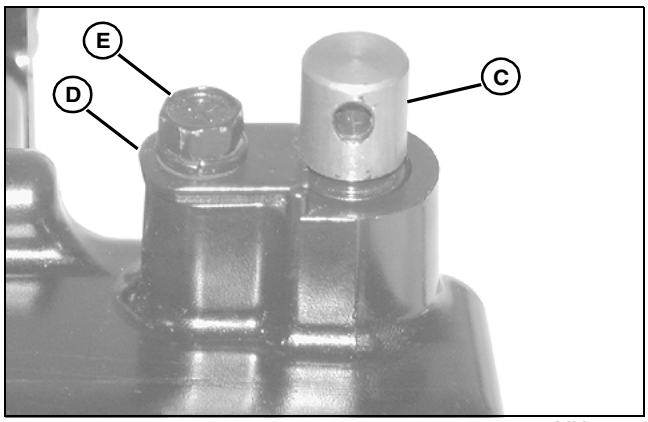
MX5717

2. Install new oil seal (A) in cover. Be sure spring side of seal is toward inside of case. Push seal into bore approximately **3mm (0.12 in.)** below top surface of bore.



MX5716

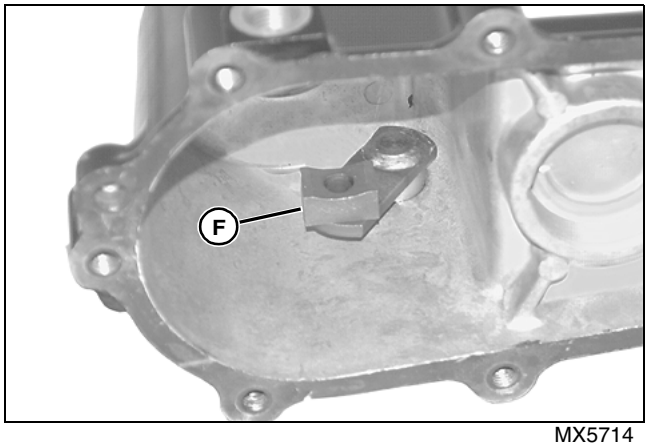
3. Install new O-ring (B) on shift arm (C).



MX5715

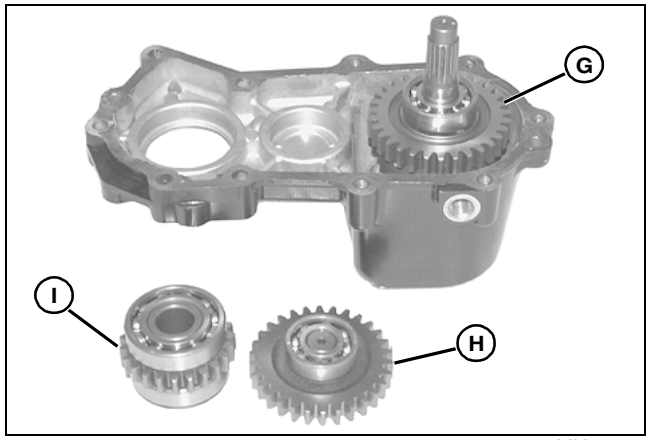
4. Install shift arm (C) in case.

5. Install strap (D), cap screw and washer (E) to secure shift arm.



MX5714

6. Install shift collar (F) on arm.



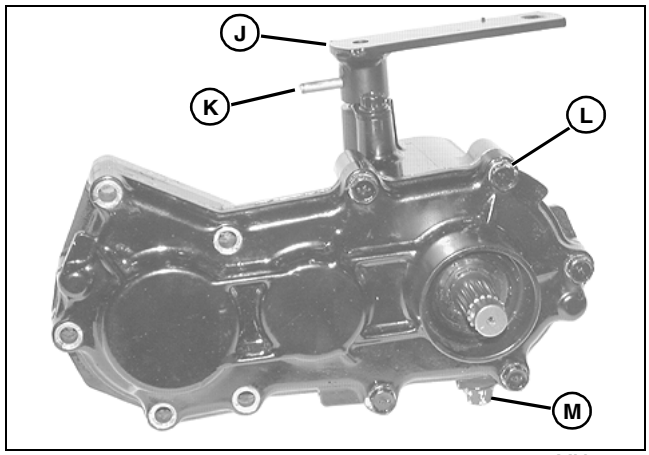
MX5713

7. Install clutch assembly (G). Shift collar must fit inside groove of shifter.

8. Install idler gear (H) and drive gear (I).

9. Clean all cover cap screws and housing threads with TY16285 John Deere Cure Primer.

10. Apply a bead of TY16021 John Deere High Flex Form-in-Place Gasket to mating surface of case toward the inside of all cap screw holes.



MX5648

11. Install cover and five cap screws and lock washers (L). Tighten cap screws.

12. Install washer and drain plug (M).

13. Install clutch arm (J) and spring pin (K).

14. Install gear case on transaxle. (See “4WD Gear Case Removal and Installation” on page 557.)

4WD Axle Removal and Installation

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Floor Jack	NA	Used to raise rear of machine.
Jackstand (2 used)	NA	Used to support machine.
Hoist	NA	Used to remove and install axle.

Removal:

CAUTION: Avoid injury! 4WD axle is heavy. An additional person is required when removing 4WD axle from machine.

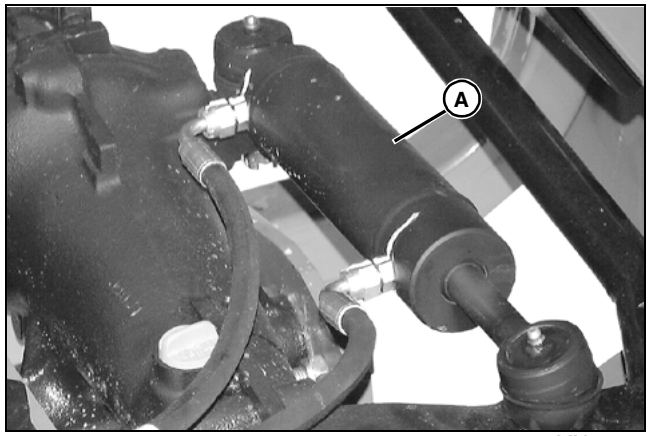
1. Park machine safely.
2. Stop engine.
3. Remove engine cover.
4. Disconnect battery negative (-) cable.

NOTE: Muffler and exhaust pipes must be removed to remove and install 4WD axle.

5. Remove muffler and exhaust pipes. (See “Muffler Removal and Installation” and “Exhaust Pipe Removal and Installation” in appropriate engine section.)
6. Block front wheels.

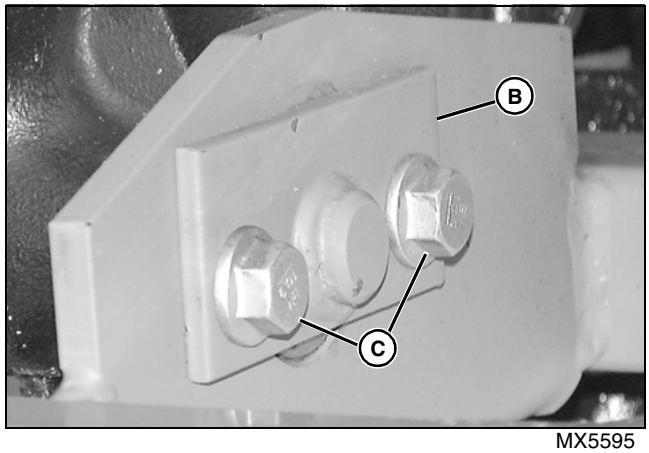
CAUTION: Avoid injury! Support machine properly.

7. Raise rear of machine with floor jack and support frame with jackstands.
8. Remove rear wheels. (See “Rear Wheel Removal and Installation” on page 809 in the Miscellaneous Section.)



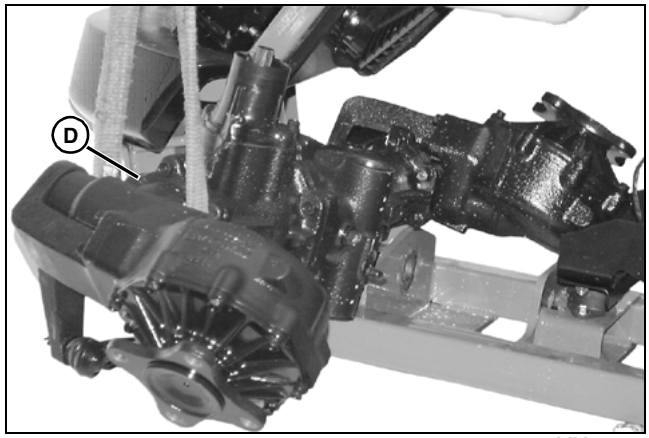
MX5594

9. Remove steering cylinder (A). (See “Steering Cylinder Removal and Installation” on page 680 in Steering section.)



MX5595

10. Support axle to relieve weight of axle on axle pin (B).
11. Remove two cap screws (C).
12. Remove axle pin.



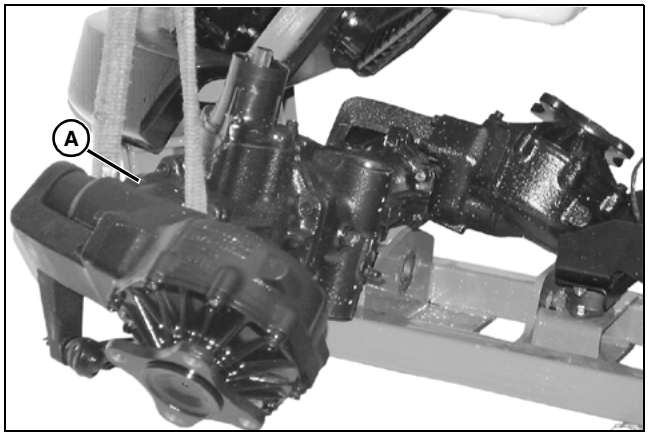
MX5596

13. Use a hoist and lift sling to raise right side of axle (D).
14. With an assistant, lift axle, rotate clockwise, and remove axle out right side of machine.

Installation:

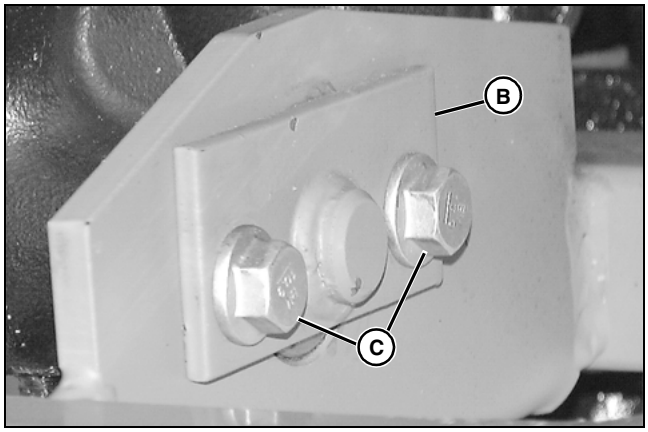
CAUTION: Avoid injury! 4WD axle is heavy. An additional person is required when installing 4WD axle in machine.

IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.



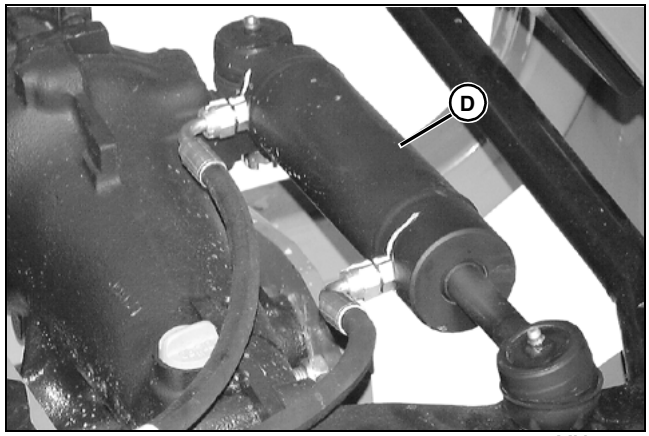
MX5596

1. Use a hoist and lift sling to lift the right side of 4WD axle (A).
2. With an assistant, install 4WD axle into right side of machine.
3. Support axle in position.
4. Align axle pin pivot point with axle pin flange.



MX5595

5. Install 4WD axle pin (B).
6. Install and tighten two cap screws (C).
7. Remove support from axle.



MX5594

8. Install steering cylinder (D). (See “Steering Cylinder Removal and Installation” on page 680 in the Steering section.)
9. Install rear wheels. (See “Rear Wheel Removal and Installation” on page 809 in the Miscellaneous section.)
10. Remove jackstands and use floor jack to lower machine.
11. Install muffler and exhaust pipes. (See “Muffler Removal and Installation and “Exhaust Pipe Removal and Installation” in the appropriate engine section.)
12. Connect battery negative (-) cable.
13. Install engine cover and remove wheel blocks.

Specifications:

4WD Axle Weight (Approximately) . . . . . 68 kg (150 lb)

4WD Axle Disassembly, Inspection, and Assembly

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Floor Jack	NA	Used to raise machine.
Jackstand (2 used)	NA	Used to support frame.
Hoist	NA	Used to remove and install 4WD axle.
Snap Ring Pliers Set	NA	Used to remove and install snap rings.
Hydraulic Press	NA	Used to remove and install bearings.
Bushing, Bearing, and Seal Driver Set	NA	Used to install bearings and seals.

Special or Required Tools:

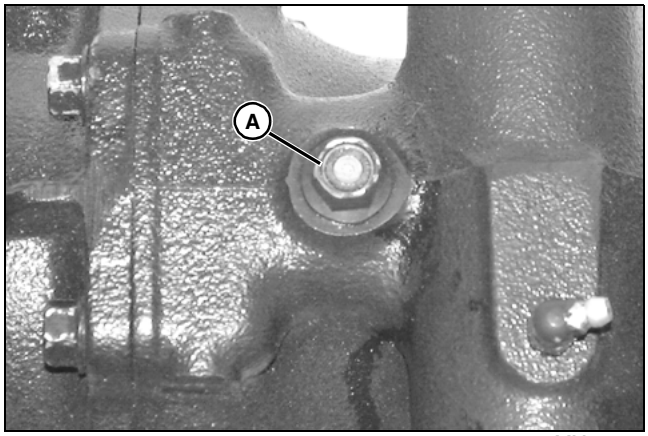
Tool Name	Tool No.	Tool Use
3-Jaw Puller	NA	Used to remove bearings.
Knife-Edge Puller	NA	Used to remove bearings.

Other Material:

Part No.	Part Name	Part Use
TY16021 (U.S.)/ LOCTITE ® 17430/ TY9484 (Canada)	John Deere High Flex Form-in-Place Gasket	Used to make gaskets.
TY16285 (U.S.)/ LOCTITE ® 17649/ CXTY16285 (Canada)	Cure Primer	Used to clean parts and speed cure of sealant.

Procedure:

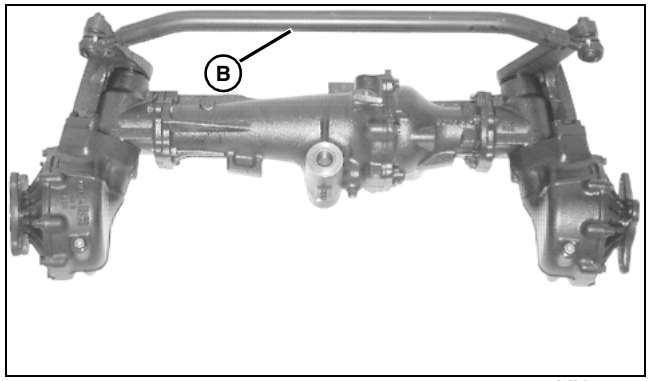
1. Remove axle from machine. (See “4WD Axle Removal and Installation” on page 563.)



MX5598

2. Remove drain plug (A) at differential housing. Drain oil into a properly marked container of sufficient size to hold oil from axle.

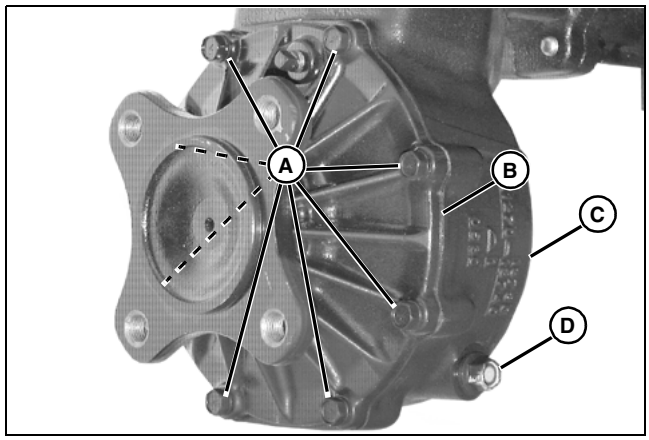
IMPORTANT: Avoid damage! When removing tie rod (B), keep ball joints clean. Dirt and contaminants can damage ball joint seals and shorten service life.



MX5597

3. Remove cotter pin and nut from each end of tie rod (B). Tie rod ends have a tapered joint. Remove tie rod.

Final Drive Hub Disassembly:



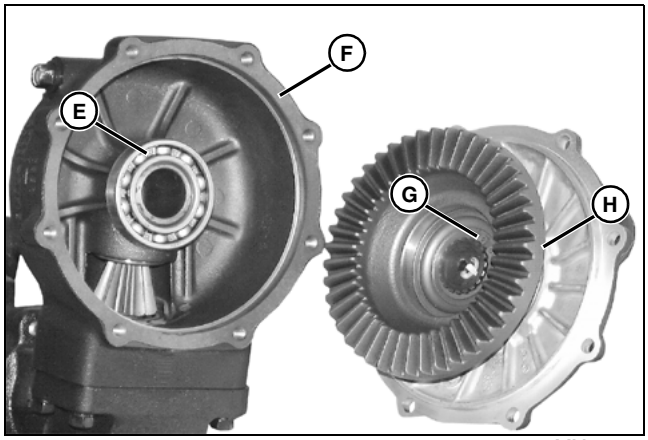
MX5599

1. Remove drain plug (D) from lower gear case. Drain oil into a properly marked container.

2. Remove eight cap screws and lock washers (A) from lower gear case cover (B).

3. Remove cover assembly. It may be necessary to tap on cover with a soft-faced hammer to separate it from the lower gear case (C).

NOTE: Remove bearing (E) with a bearing puller only if bearing requires replacement.



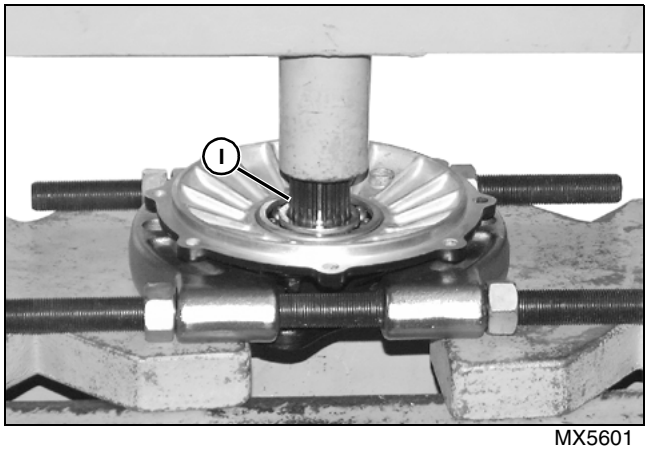
MX5600

4. Inspect bearing (E) for wear, damage, or rough movement. Replace bearing as needed.

5. Remove gasket (F) and clean gasket mating surfaces.

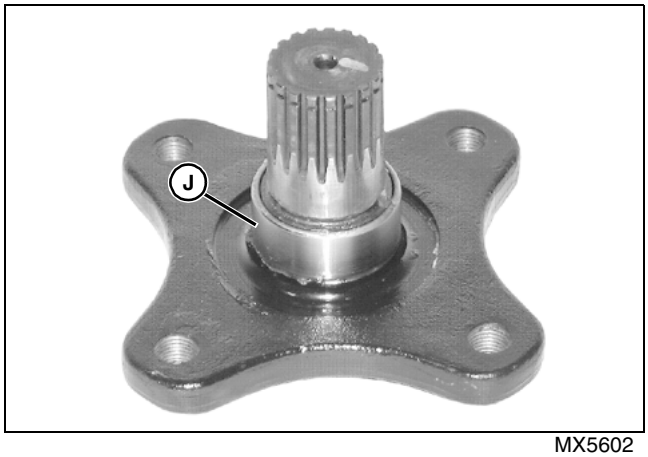
6. Remove snap ring (G) to remove ring gear (H).

7. Inspect ring gear for wear or damage. Replace as needed.



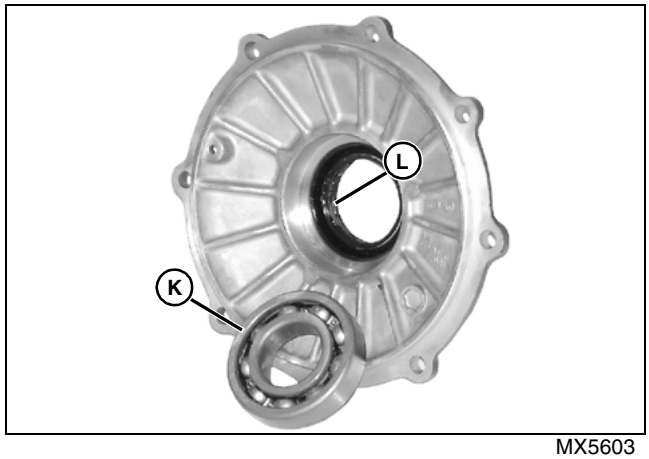
MX5601

8. Use a press to remove hub shaft (I) from cover.



MX5602

9. Inspect oil seal wear sleeve (J) for wear or damage. Replace as needed.

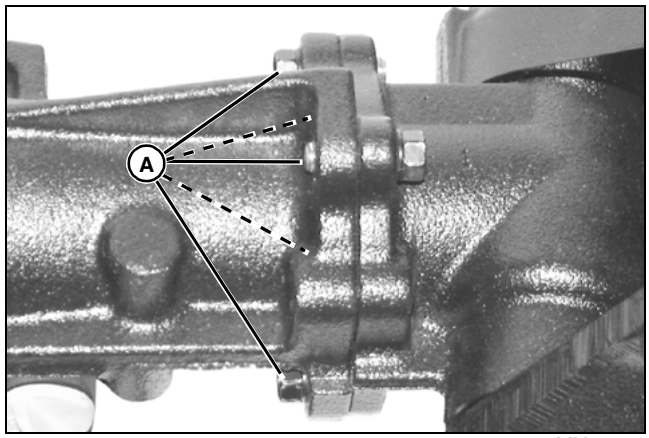


MX5603

10.Remove bearing (K). Inspect for wear, damage, or rough movement. Replace as needed.

11.Remove oil seal (L).

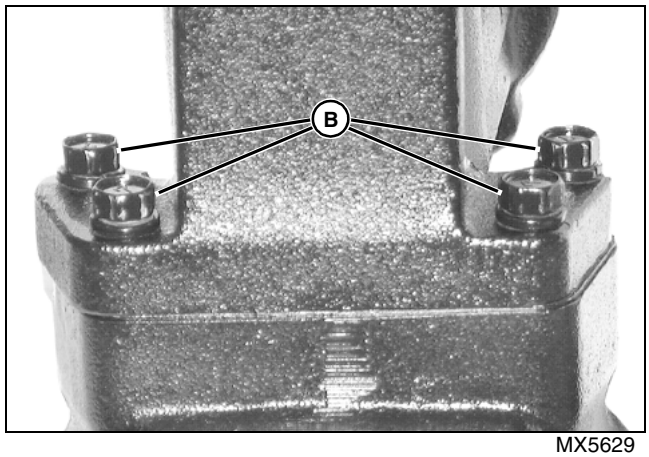
Final Drive Disassembly:



MX5628

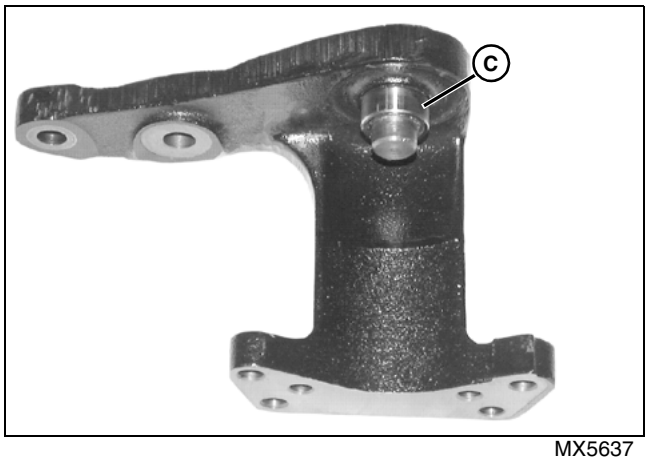
1. Remove five axle housing-to-final drive cap screws and lock washers (A).

2. Remove final drive assembly. It may be necessary to tap on spindle gear case with a soft-faced hammer to separate final drive assembly from axle housing.



MX5629

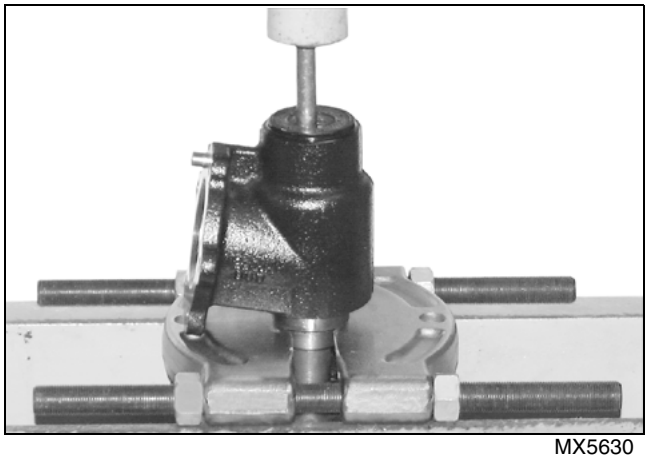
3. Remove four cap screws and lock washers (B) to remove steering arm. It may be necessary to use a soft-faced hammer to separate steering arm from spindle gear case.



MX5637

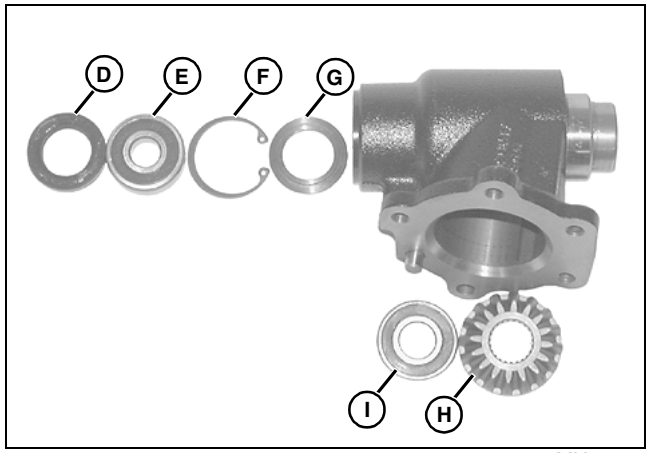
4. Inspect oil seal wear sleeve (C) on steering arm for wear or damage. Replace as needed.

NOTE: When spindle and lower gear cases are separated, a spacer, gear, and bearing from the spindle shaft will be loose in the spindle gear case.



MX5630

5. Put final drive assembly in a press. Press on spindle shaft in spindle gear case to separate spindle and lower gear cases. Support lower gear case so it does not fall and cause injury or damage.

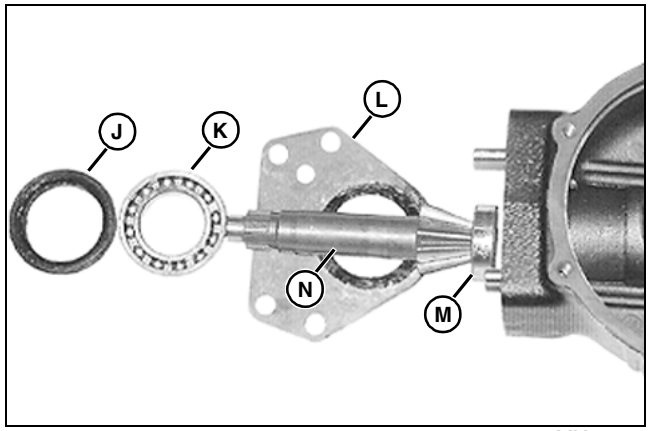


MX5631

6. Remove spacer (G), bearing (I), and gear (H) from spindle gear case.

7. Remove upper oil seal (D), bearing (E), and snap ring (F) from top of spindle gear case.

8. Inspect parts for wear or damage. Inspect bearings for wear, damage, or rough movement. Replace parts as needed.



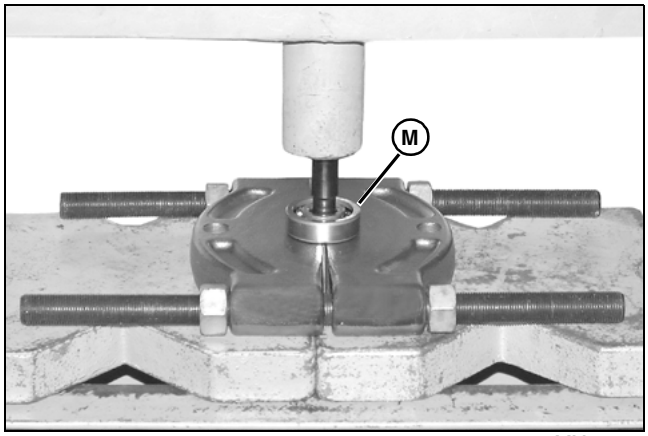
MX5632

9. Remove shim (L), lower oil seal (J), and bearing (K) from lower gear case. Discard oil seal.

10. Inspect bearing for wear, damage, or rough movement. Replace as needed.

11. Remove spindle shaft (N) from lower gear case.

12. Inspect spindle shaft and splines on shaft for wear or damage. Replace as needed.



MX5699

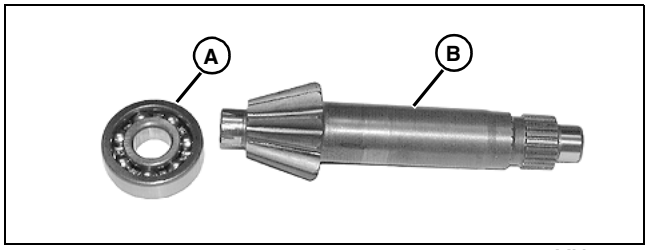
13.Inspect bearing (M) on spindle shaft for wear, damage, or rough movement. Replace as needed. Remove bearing from spindle shaft only if it requires replacement.

Final Drive Assembly:

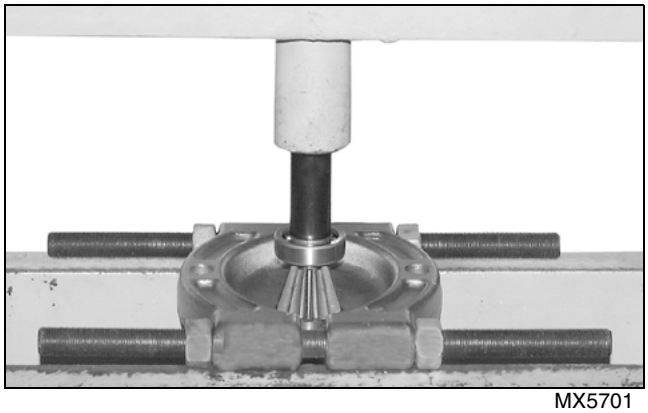
IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.

Press on inner bearing race only to avoid damaging bearing.

NOTE: Steps for assembly of left and right final drives are same.

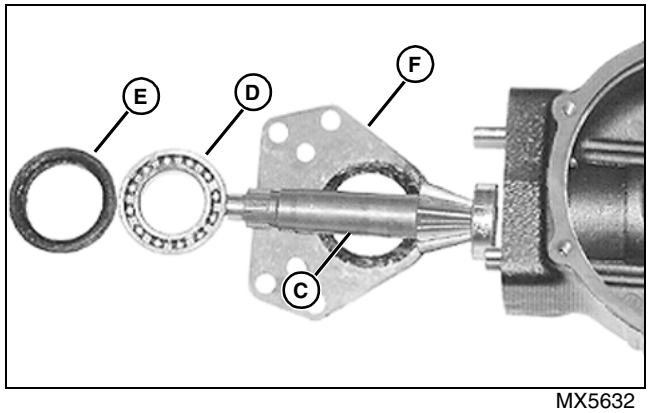


MX5700



MX5701

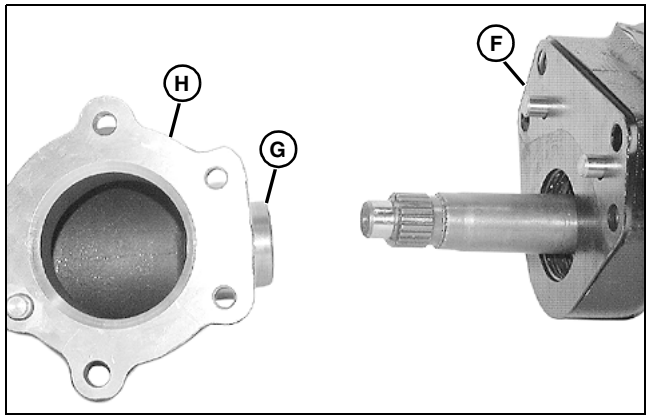
1. Press on inner race of bearing (A) to install new bearing on spindle shaft (B).



MX5632

2. Install spindle shaft (C) in lower gear case. It may be necessary to tap shaft to seat bearing to bottom of bore.

3. Install bearing (D) and seal (E). Install seal with spring side into bore first and flush with mounting surface.

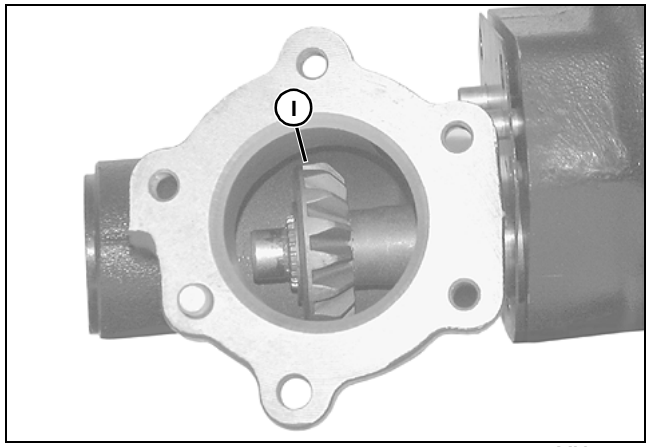


MX5706

4. Install shim (F) on lower gear case.

5. If removed, press new sleeve (G) onto spindle gear case (H).

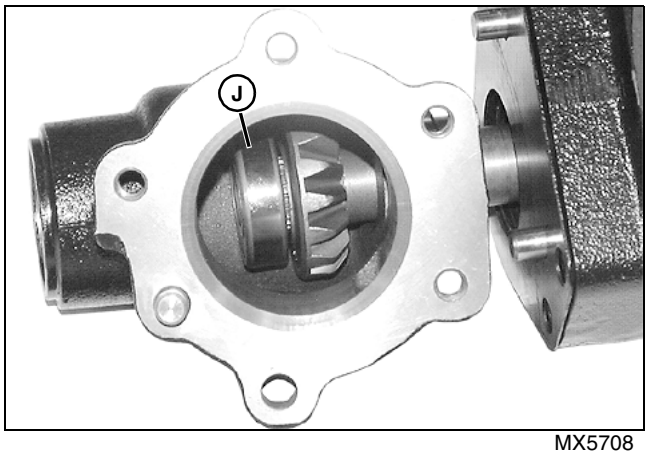
6. Put spindle gear case (H) over spindle shaft. Do not install into lower gear case at this time.



MX5707

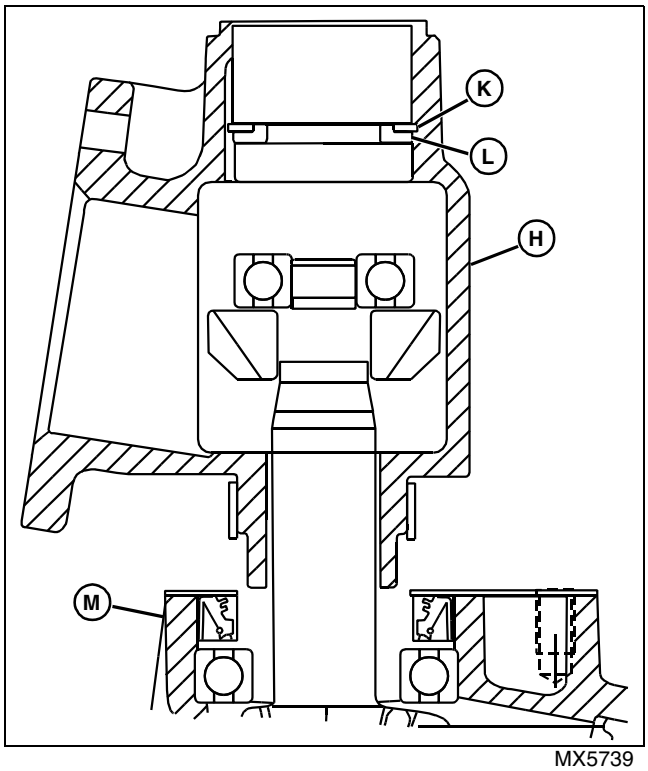
7. Install gear (I) on spindle shaft with gear teeth toward lower gear case.

IMPORTANT: Avoid damage! Push on inner race only to avoid damaging bearing.



MX5708

8. Install bearing (J) on spindle shaft. Tap on inner race of bearing to install bearing onto spindle shaft.

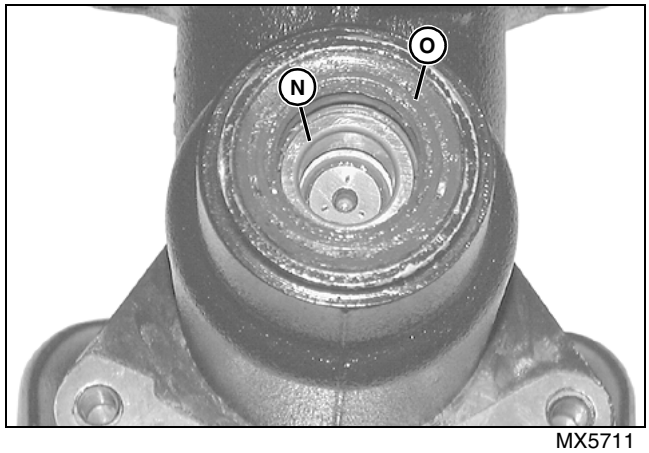


MX5739

9. Install snap ring (K).

10.Install spacer (L) with stepped side against snap ring. Keep spacer against snap ring while holding spindle (H) and lower (M) gear cases upright. Tap on spindle gear case with a soft-face hammer to install into lower gear case. use care not to damage seal in lower gear case.

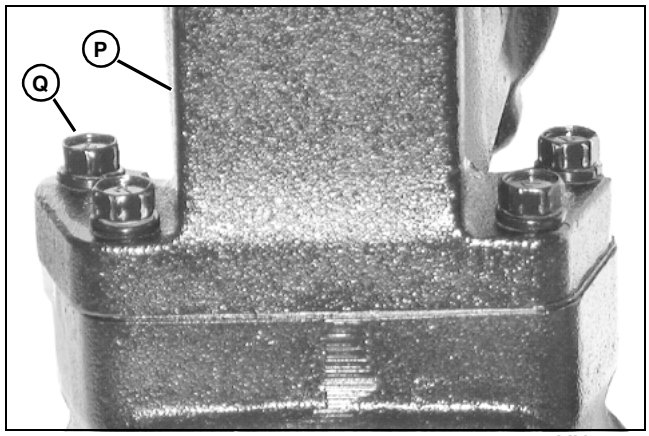
11.Hold upper (H) and lower (M) gear cases upright. Install upper gear case in lower gear case by tapping on upper case with a soft-faced hammer. Use care not to damage seal in lower gear case.



MX5711

12.Install bearing (N) in upper gear case tight against snap ring. It may be necessary to tap on inner race to install bearing.

13.Install new oil seal (O) with spring side toward bearing.



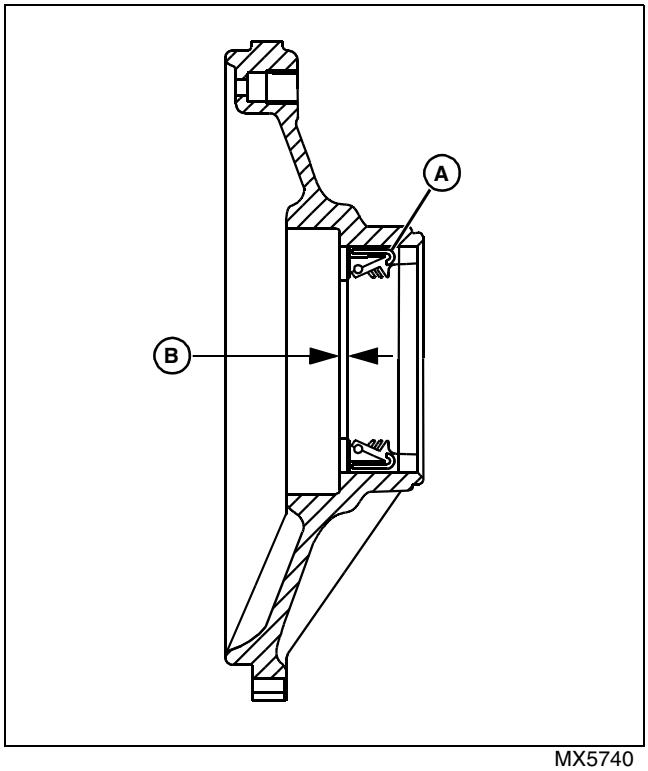
MX5629

14.Hold final drive assembly upright and install steering arm (P). Tap on steering arm with a soft-faced hammer to install steering arm on final drive assembly. Use care not to damage seal.

15.Install and tighten four cap screws and washers (Q).

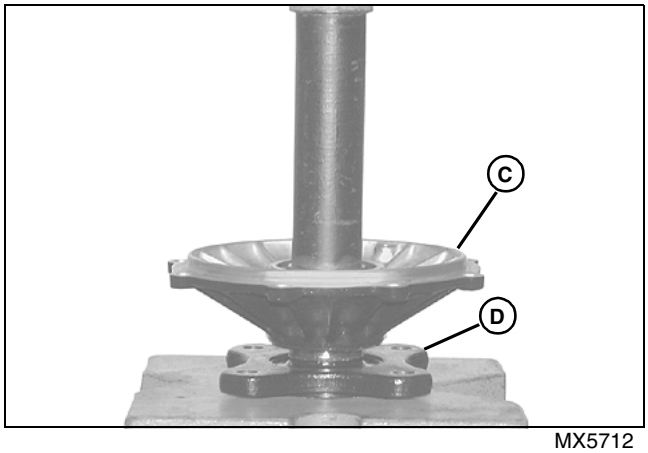
Final Drive Hub Assembly:

IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.



MX5740

1. Install new hub shaft seal (A) with seal spring into bore first. Push seal to a depth (B) of 6.5 mm (0.25 in.) below top of bore.

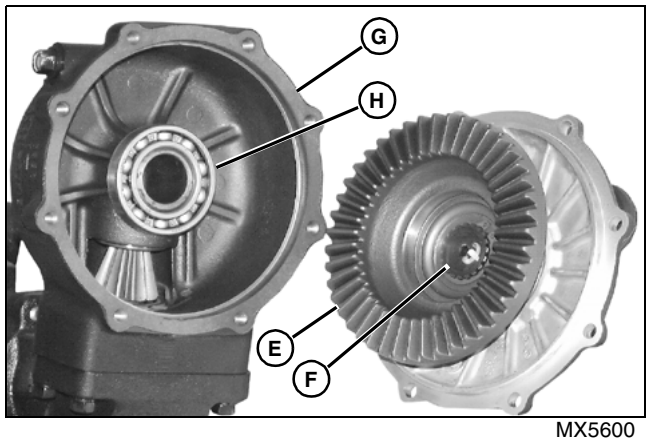


MX5712

2. Carefully put lower gear case cover (C) over hub shaft (D) so as not to damage seal.

IMPORTANT: Avoid damage! Press on inner race only to avoid damaging bearing.

3. Press on inner race of bearing to install bearing on hub shaft in lower gear case cover. Push bearing tight against shoulder of hub shaft.

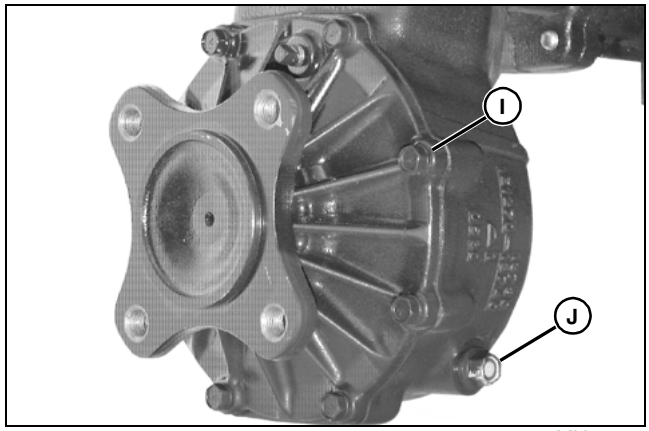


MX5600

4. Install ring gear (E) and snap ring (F) on hub shaft.

5. Install new gasket (G).

6. Install bearing (H).

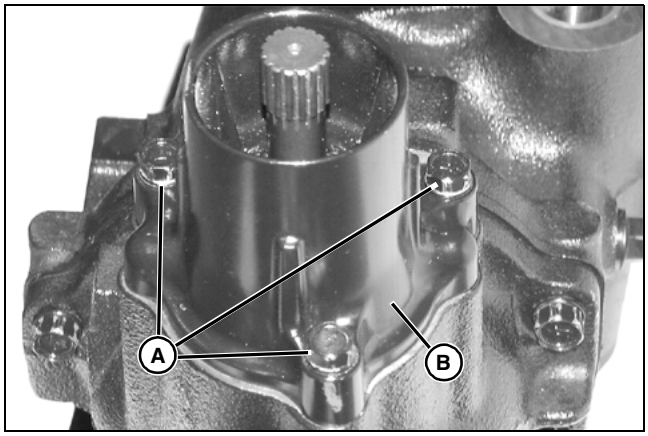


MX5599

7. Install cover assembly on lower gear case. Install and tighten eight cap screws and lock washers (I).

8. Install drain plug (J) in final drive and tighten to specification.

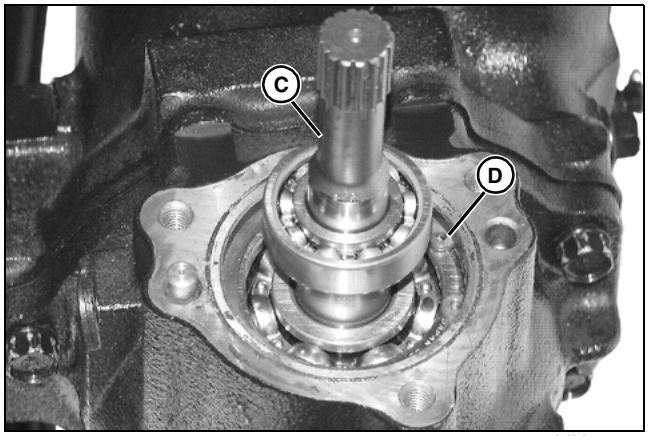
Differential Input Shaft and Cover Disassembly:



MX5633

1. Remove three cap screws and lock washers (A).

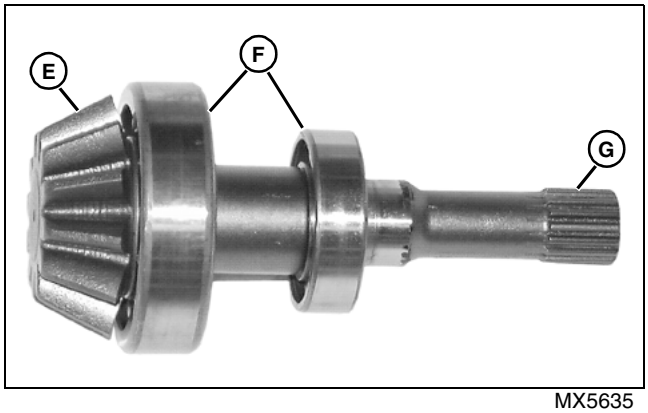
2. Remove differential input cover (B). Remove gasket material from mating surfaces.



MX5634

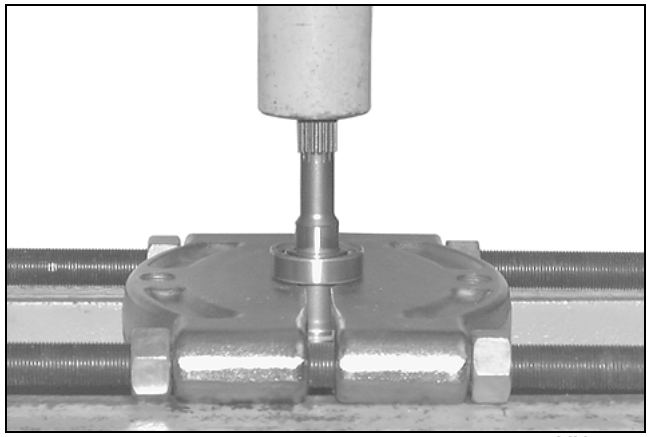
3. Remove snap ring (4).

4. Remove input shaft assembly (C) from differential housing.



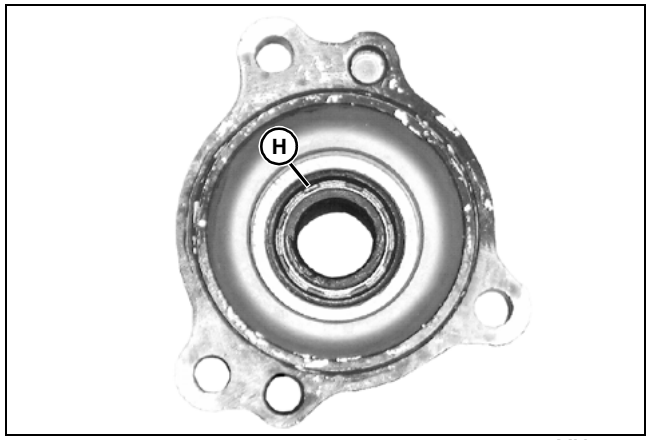
MX5635

5. Inspect gear (E), inner and outer bearings (F), and spline (G) of input shaft for wear, damage, or rough movement. Replace parts as needed.



MX5642

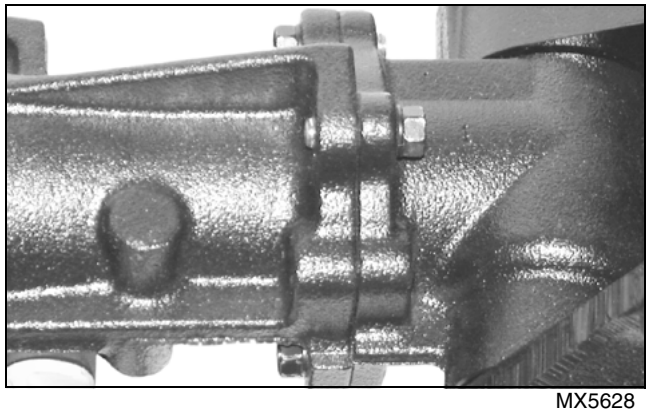
6. Remove bearings from input shaft only if they require replacement.



MX5636

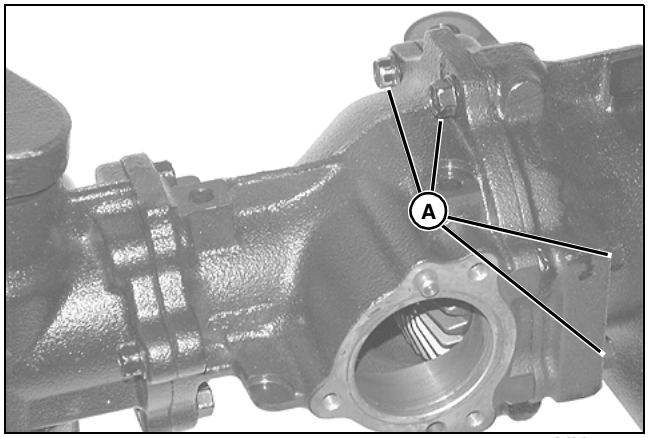
7. Remove and discard oil seal (H) from input housing cover.

Differential and 4WD Axle Housing Disassembly/ Inspection:

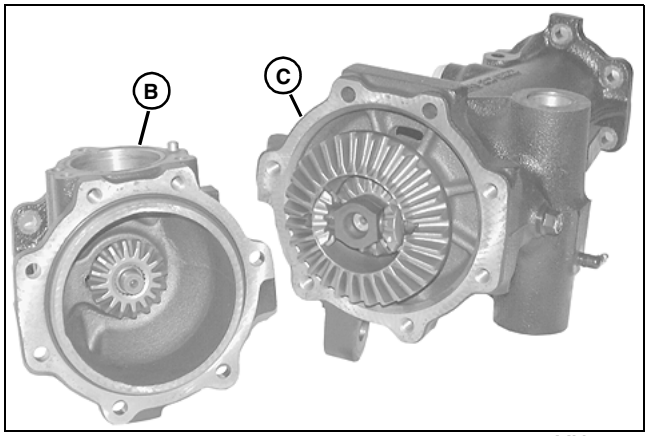


MX5628

1. Remove left and right final drive assemblies from axle. For final drive disassembly, see “Final Drive Disassembly:” on page 566.

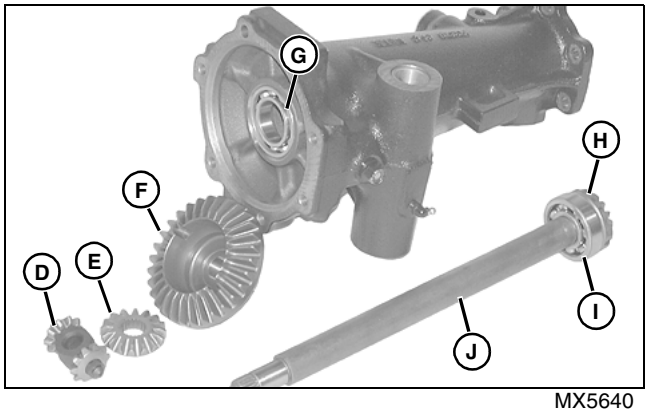


MX5638



MX5639

2. Remove seven cap screws (A) to separate right axle/ differential case (B) and left axle case (C).



MX5640

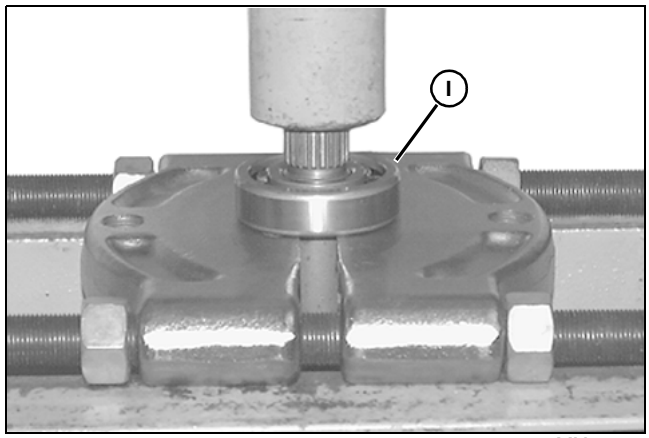
3. Remove pinion shaft with pinion gears (D), axle inner gear (E) and ring gear (F). Inspect for wear or damage. Replace parts as needed.

4. Remove left axle shaft (J) from axle case.

NOTE: Remove bearing (G) with a bearing puller only if bearing needs to be replaced.

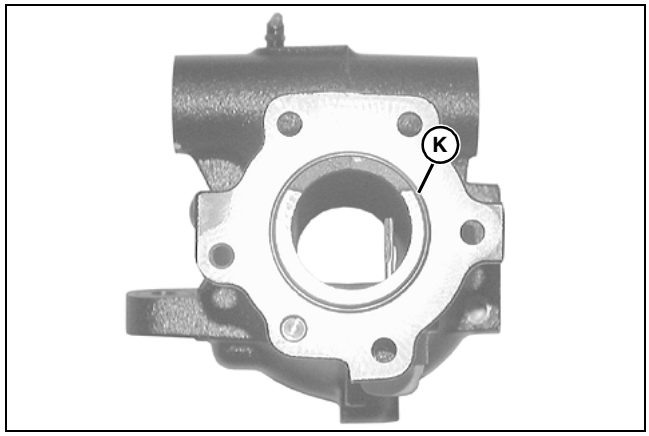
5. Inspect inner bearing (G) for wear, damage, or rough movement. Replace bearing as needed.

6. Remove axle outer gear (H) from left axle. Inspect splines in gear and axle. Replace gear or axle as needed.

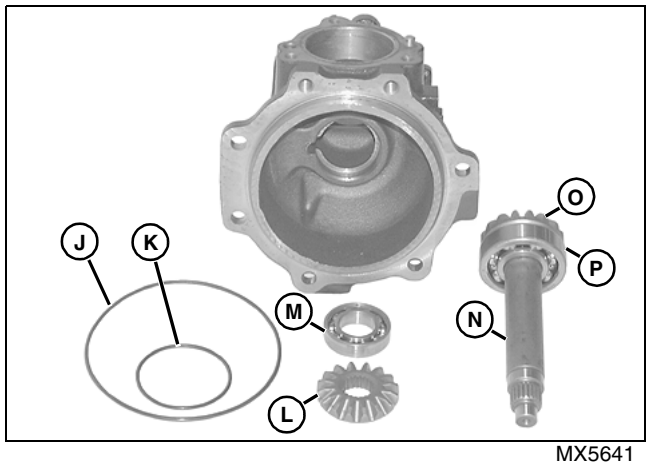


MX5644

7. Check outer bearing (I) on left axle for wear, damage, or rough movement. Replace bearing if necessary using a press.



MX5643

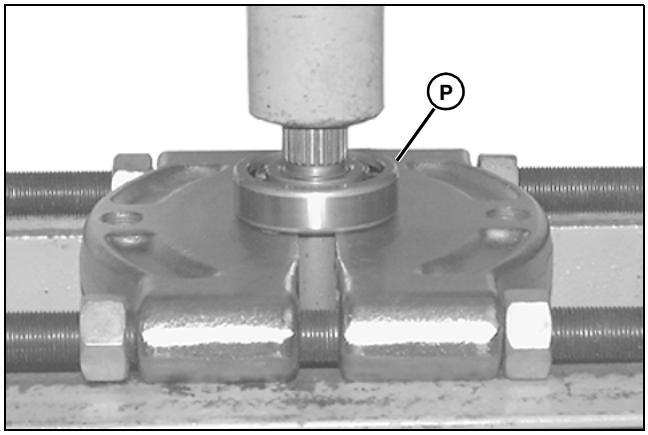


MX5641

8. Remove large (J) and small (K) O-rings, axle gear (L), and bearing (M). Inspect gear and splines of gear for wear or damage. Inspect bearing for wear, damage, or rough movement. Replace parts as needed.

9. Remove right axle shaft (N) from axle case.

10.Remove axle outer gear (O) on right axle. Inspect gear and splines of gear for wear or damage. Replace gear or axle as needed.



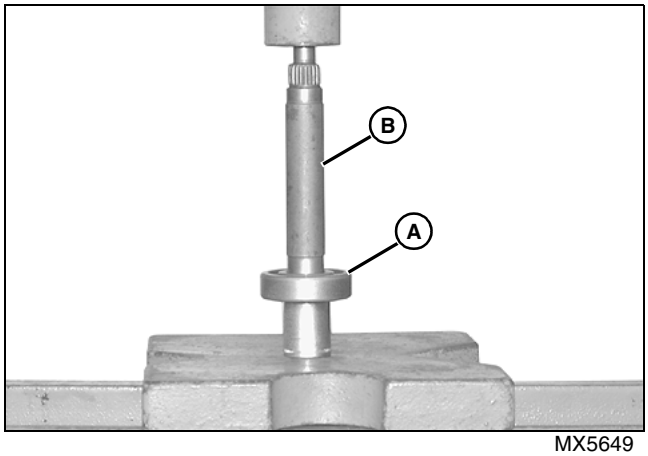
MX5644

11.Inspect outer bearing (P) on right axle for wear, damage, or rough movement. Replace bearing if necessary, using a press.

Right Axle Housing Assembly:

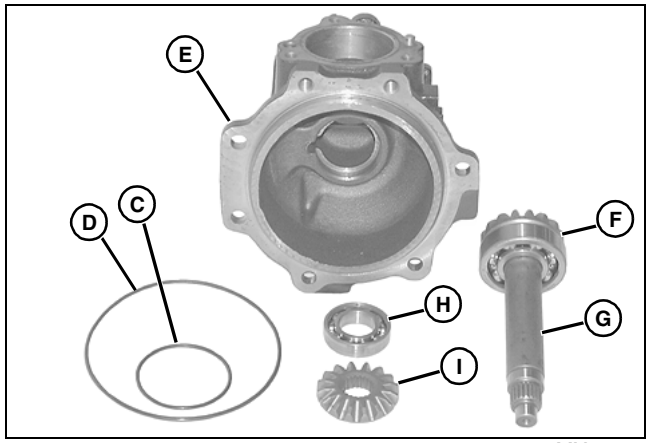
IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.

Push on inner race only to avoid damaging bearing.

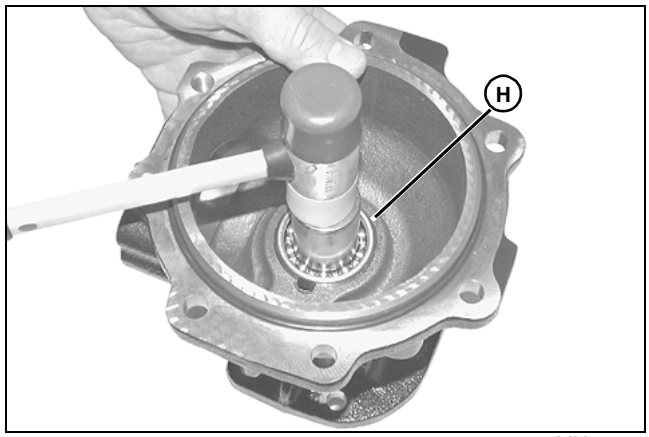


MX5649

1. Install new outer bearing (A) on right axle (B) if removed. Support inner race of bearing and press axle into bearing until tight against shoulder.



MX5641



MX5646

2. Install small (C) and large (D) O-rings on right axle case (E).

3. Install outer axle gear (F) on axle assembly (G).

4. Install axle assembly in axle case.

IMPORTANT: Avoid damage! Push on inner race only to avoid damaging bearing.

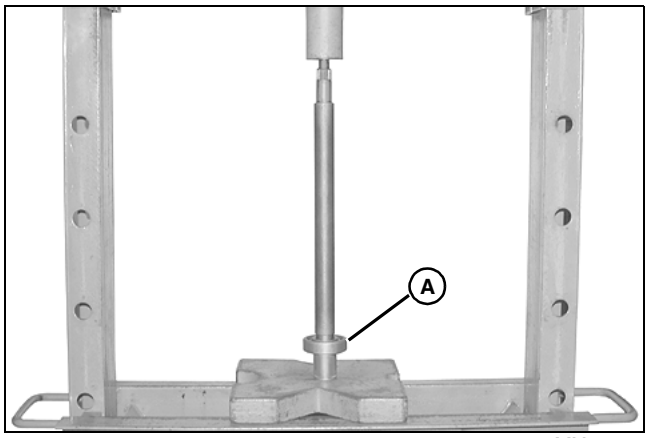
5. Stand axle case on end and install bearing (H). It may be necessary to tap on inner race of bearing to install tight against bottom of bore in case.

6. Install axle gear (I) on axle shaft.

Left Axle and Differential Housing Assembly:

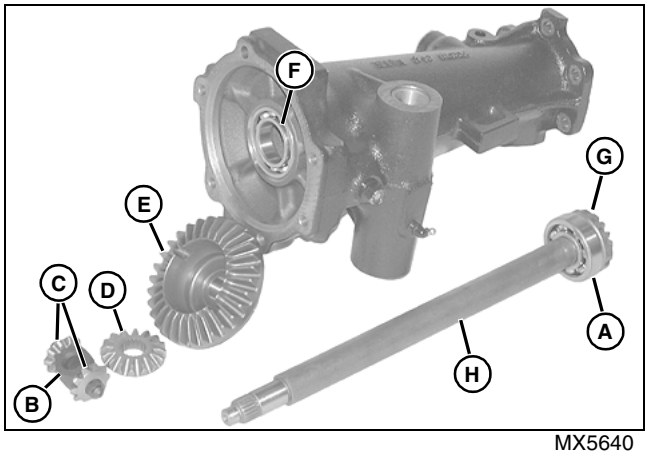
IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.

Push on inner race only to avoid damaging bearing.



MX5697

1. Install new outer bearing (A) on left axle, if removed. Support inner race of bearing and press axle into bearing until tight against axle shoulder.



MX5640

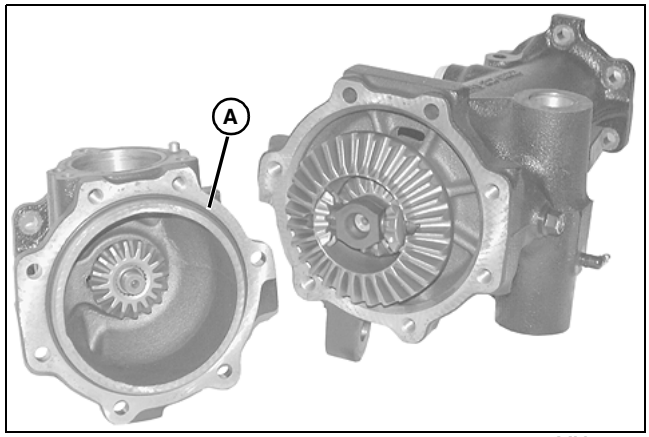
2. Install axle outer gear (G).

3. Install bearing (F) and ring gear (E) in axle housing.

4. Install left axle assembly (H) in housing.

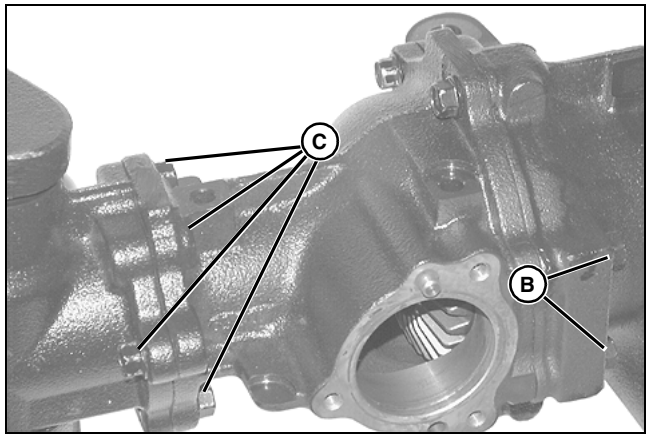
5. Install axle inner gear (D), pinion gears (C) and pinion shaft (B).

Differential and 4WD Axle Housing Assembly:



MX5639

1. Be sure O-ring (A) is on axle housing.



MX5638

2. Align gears and housings. Put housings together. Install cap screws and lock washers between axle housings. Be sure to install two longer cap screws (B) in holes adjacent to input shaft. Tighten all cap screws.

3. Be sure O-ring is on end of axle housing.

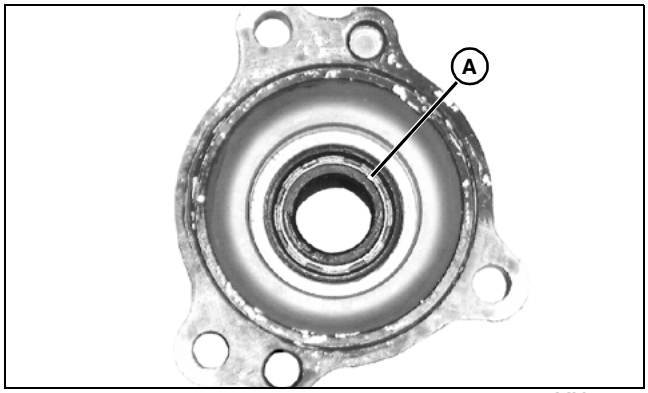
4. Align final drive with axle housing.

5. Install five cap screws and lock washers (C) housing between final drive assembly and axle housing. Tighten cap screws to specification.

6. Repeat steps 3 - 5 for opposite end of axle housing.

Differential Input Shaft and Cover Assembly:

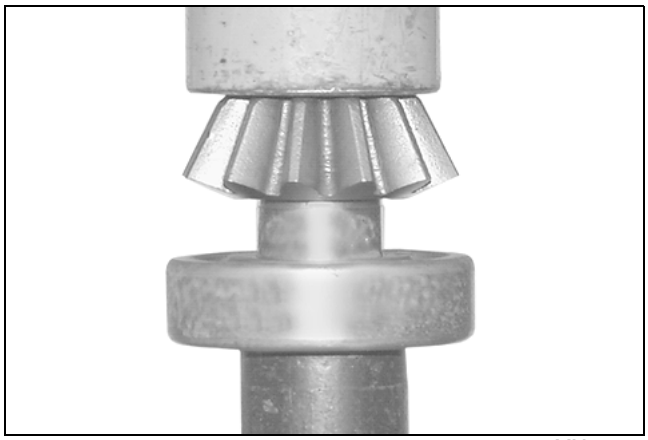
IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.



MX5636

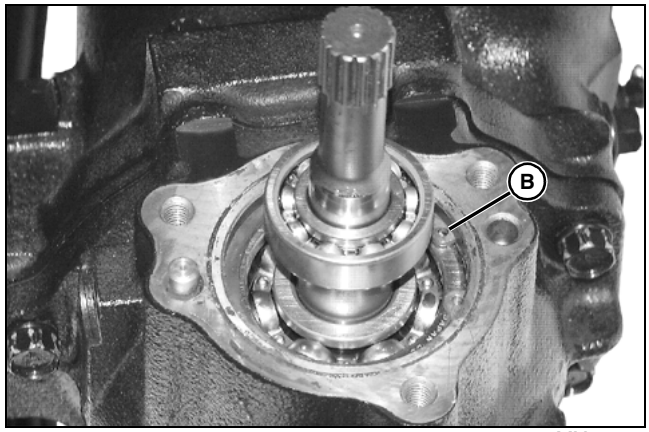
1. Install new seal (A) in input shaft cover. Install seal with seal spring toward inside of cover. Push seal to bottom of bore.

IMPORTANT: Avoid damage! Push on inner race only to avoid damaging bearing.



MX5647

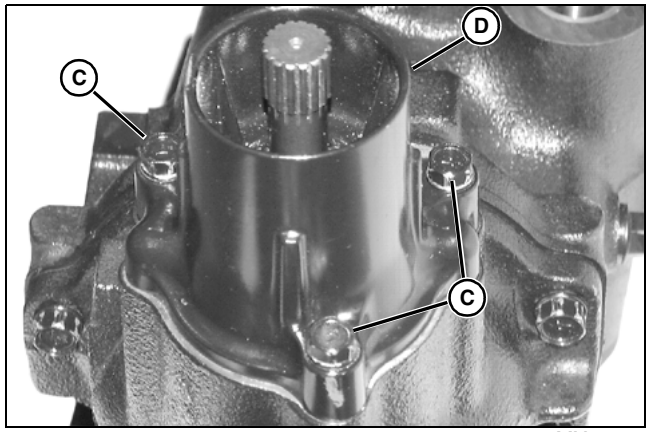
2. Install new bearings on input shaft by pressing on inner race of bearing. Install inner bearing first, then outer bearing. Push bearings tight against shoulder of shaft.



MX5634

3. Install input shaft in differential case.

4. Install snap ring (B).



MX5633

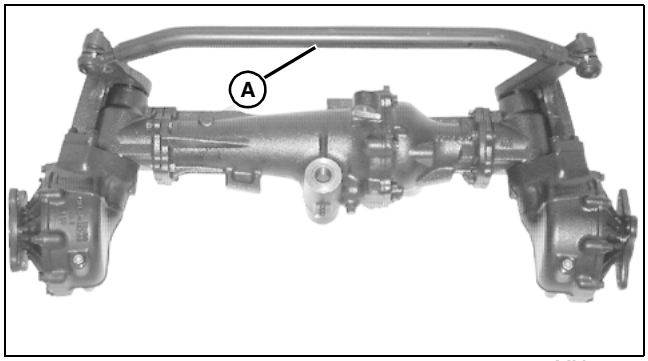
5. Ensure the mating surfaces between the differential input cover (D) and housing are clean.

6. Clean the differential input cover cap screws (C) with TY16285 John Deere Cure Primer.

7. Apply TY16021 John Deere High Flex Form-in-Place Gasket to mating surface of cover.

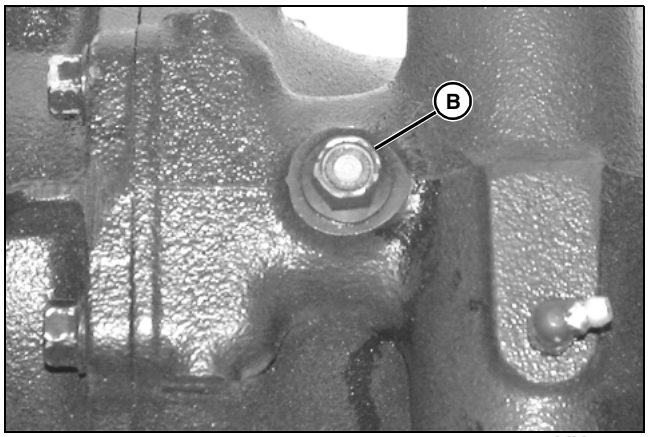
8. Install differential input shaft cover. Install and tighten three cap screws.

Final Assembly:



MX5597

1. Install tie rod (A). Install and tighten tie rod castellated nuts to specification. Continue to turn nut clockwise to align with drilled hole and install cotter pin.



MX5598

2. Install differential housing drain plug (B) and tighten to specification.

3. Remove oil filler cap and fill 4WD axle with oil to proper level.

4. Install filler cap.

5. Install 4WD axle assembly in machine. (See “4WD Axle Removal and Installation” on page 563.)

Specifications:

4WD Axle Weight (Approximately) . . . . . 68 kg (150 lb)

4WD Axle Oil Capacity (Approximately). 2.1 L (2.25 qt)

4WD Axle
Drain Plugs Torque. . . . . 39 ± 10 N•m (29 ± 10 lb-ft)

Tie Rod Castellated Nut Torque . . . . . 53 N•m (39 lb-ft)

Axle Housing-to-Final Drive Assembly
Cap Screw Torque . . . . . 68 N•m (39 lb-ft)

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POWER TRAIN (2 SPEED) - HYDRO TABLE OF CONTENTS

POWER TRAIN (2 SPEED) - HYDRO SPECIFICATIONS

Specifications

Test and Adjustment Specifications

4WD Axle End Play	0.127 - 1.016 mm (0.005 - 0.040 in.)
4WD Axle Flanged Cap Screw and Lock Nut Torque	88 N•m (65 lb-ft)
Forward and Reverse Pedal-to-Floor Clearance	3 mm (0.1 in.)
Neutral Safety Link Ball Joint Thread Engagement (Minimum)	8 mm (0.3 in.)
Differential Lock Pedal-to-Floor Clearance	3 mm (0.1 in.)

Repair Specifications

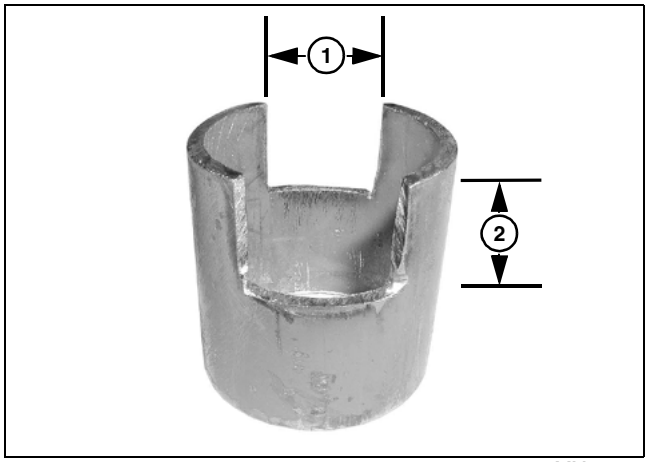
Transaxle Oil Capacity	9.5L (10 qt)
Transaxle Mounting Cap Screw Torque	142 N•m (105 lb-ft)
Front Drive Wheel Mounting Cap Screw Torque	225 N•m (165 lb-ft)
Priority Valve Torque	29 N•m (257 lb-in.)
Make Up Oil Check Valve Torque	34 N•m (25 lb-ft)
Charge Pump Relief Valve Torque	24 N•m (212 lb-in.)
Forward and Reverse Relief Valve Torque	34 N•m (25 lb-ft)
Swashplate End Play	0.20 - 0.50 mm (0.007 - 0.0019 in.)
Center Section-to-Housing Hex Socket and Cap Screw Torque	42 N•m (31 lb-ft)
Bottom Separator Plate-to-PTO Gap (Maximum)	9.1 mm (0.36 in.)
Clutch Top Plate Thickness (Minimum)	3.03 mm (0.119 in.)
Clutch Disk Thickness (Minimum)	2.0 mm (0.08 in.)
Clutch Separator Plate Thickness (Minimum)	1.0 mm (0.04 in.)
Piston Return Spring Free Length (Minimum)	75 mm (2.95 in.)
Piston Return Spring Test Length @ 499 N (112 lb-force)	28.6 mm (1.13 in.)
Solenoid Stud Torque	23 N•m (203 lb-in.)
Solenoid Coil Nut Torque	5 N•m (44 lb-in.)
Axle Housing-to-Differential Cap Screw (M10 x 60) Torque	52 N•m (38 lb-ft)
Axle Housing-to-Differential Cap Screw (M10 x 45) Torque	52 N•m (38 lb-ft)
Differential Ring Gear-to-Housing Cap Screw Torque	155 N•m (114 lb-ft)
Axle Seal Housing-to-Axle Housing Cap Screw Torque	27 N•m (20 lb-ft)
Differential Side Cover-to-Differential Case (M8 x 35) Cap Screw Torque	27 N•m (20 lb-ft)
4WD Axle Weight (Approximately)	68 kg (150 lb)
4WD Axle Oil Capacity (Approximately)	2.1 L (2.25 qt)
Differential Input Cover Cap Screw Torque	26 N•m (19 lb-ft)
Final Drive Cover Cap Screw Torque	52 N•m (38 lb-ft)
Final Drive Drain Plug Torque	39 ± 10 N•m (29 ± 10 lb-ft)
Tie Rod Castellated Nut Torque	53 N•m (39 lb-ft)

Fabricated Tools

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Clutch Piston Compression Tool	NA	Used in a vise to compress the PTO clutch piston spring so the snap ring can be removed or installed.
Snap Ring Removal Tool	NA	Used to compress the spring to remove the snap ring on the differential lock shaft.
Snap Ring Installation Tool	NA	Used to install the snap ring on the differential lock shaft.

Clutch Piston Compression Tool Fabrication:



MX5887

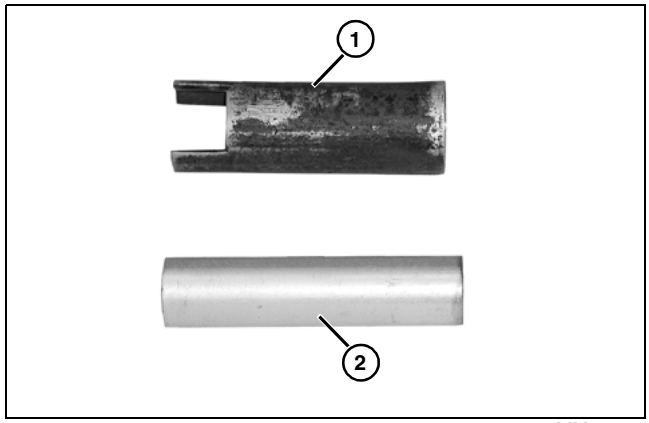
Make the clutch piston compression tool from pipe with an inside diameter of 43 mm (1-11/16 in.) and approximately 50 mm (2 in.) long.

Clutch Piston Compression Tool Specifications:

Dimension 1 . . . . . 32 mm (1-1/4 in.)

Dimension 2 . . . . . 25 mm (1 in.)

Snap Ring Removal and Installation Tool Fabrication:



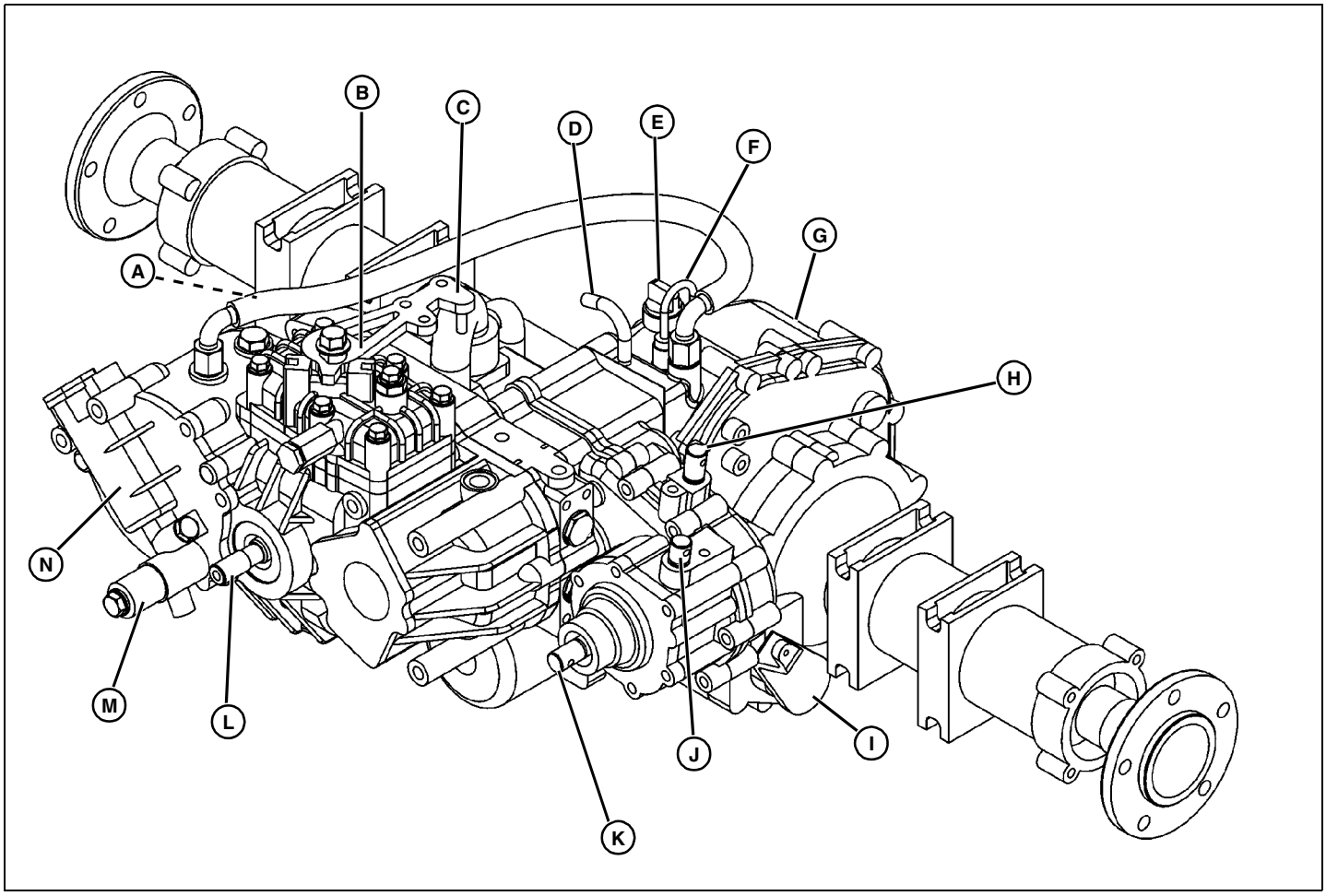
MX5847

Snap ring removal tool (1) inside pipe diameter is 25 mm (1 in.). Make a 19 mm (3/4 in.) notch in the end of the pipe. Pipe length should be five inches.

Snap ring installation tool (2) inside pipe diameter is 19 mm (3/4 in.). Pipe length should be five inches.

Component Location

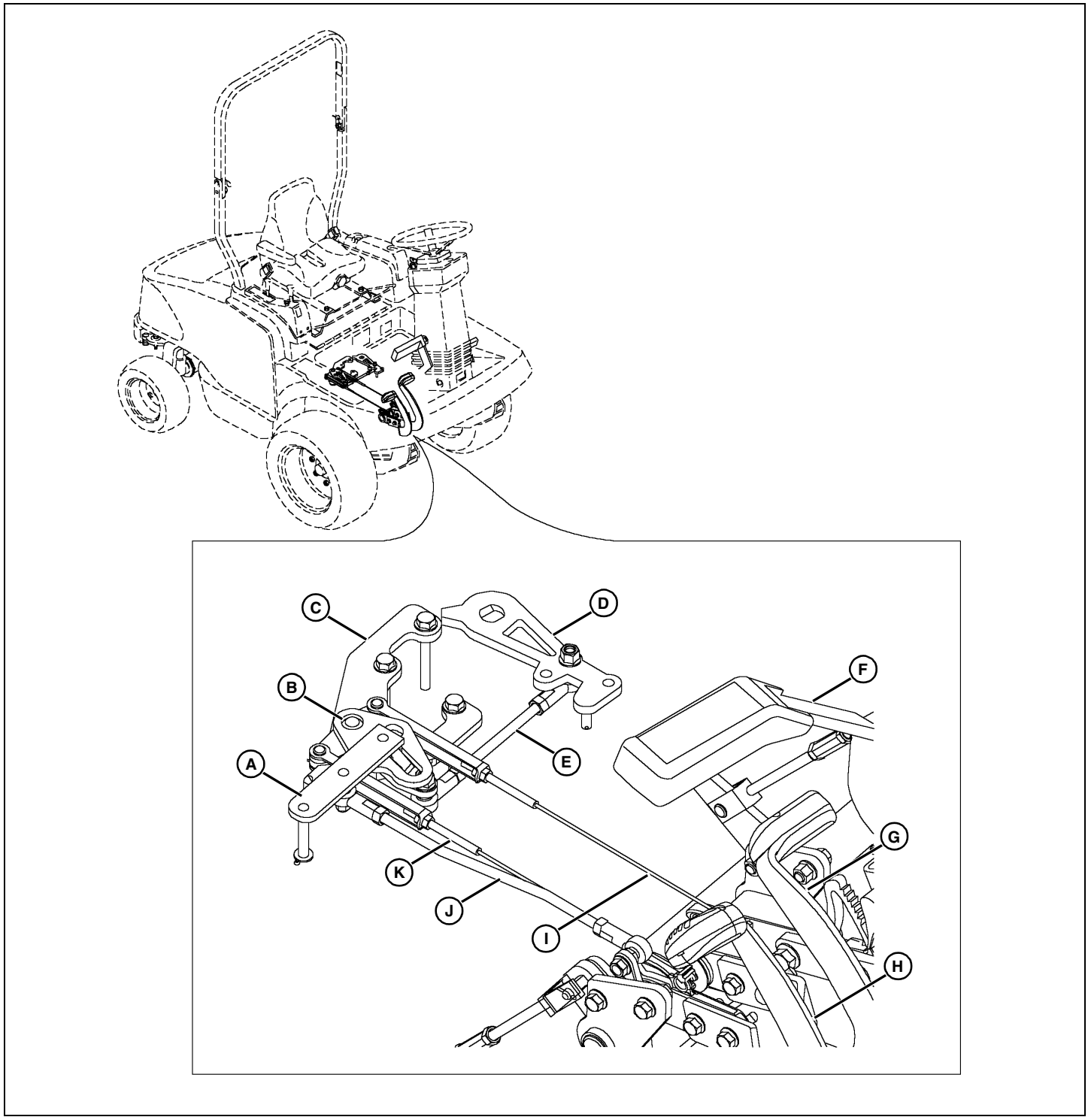
Transaxle Component Location (1545 and 1565 2-Speed Range)



MX16014

- **A - Left Brake Arm**
- **B - Hydrostatic Assembly**
- **C - Forward/Reverse Lever**
- **D - Vent**
- **E - Oil Fill Cap**
- **F - Dipstick**
- **G - Differential Assembly**
- **H - Two Speed Selector Shaft**
- **I - Right Brake Arm**
- **J - 4WD Selector Shaft**
- **K - 4WD Output Shaft**
- **L - Input Shaft**
- **M - PTO Solenoid**
- **N - PTO Assembly**

Hydrostatic Pedal and Neutral Safety Linkage Component Location



MX5806

A - Neutral Safety Arm
B - F-N-R Bellcrank
C - Linkage Support Bracket
D - Hydrostatic Control Arm
E - Hydrostatic Control Link
F - Brake Pedal
G - Forward Pedal
H - Reverse Pedal
I - Forward Cable
J - Neutral Safety Link
K - Reverse Cable

Diagnostics

Travel Symptom Diagnosis

Test Conditions:

- Machine Parked Safely

Symptom: Differential Will Not Lock When Lock Pedal Is Pressed

(1) Differential linkage is worn or damaged?

Yes - Replace as necessary.

No - Go to next step.

(2) Differential lock linkage is adjusted correctly?

Yes - Go to next step.

No - Adjust linkage. (See "Differential Lock Adjustment" on page 587.)

(3) Differential lock assembly is worn or damaged?

Yes - Repair or replace as necessary. (See "Differential Disassembly, Inspection, and Assembly" on page 624.)

Test Conditions:

- Machine supported safely on jackstands with all four wheels off ground.
- Engine running at slow idle.

Symptom: Machine Moves With Travel Pedals In Neutral

(1) Neutral adjustment is set properly? (See "Transaxle Neutral Creep Test and Adjustment" on page 585.)

Yes - Go to next step.

No - Adjust neutral creep.

Test Conditions:

- Machine parked safely.
- Park brake released.

Symptom: Machine Moves With Travel Pedals In Neutral

(1) Hydrostatic pedal linkage and cable are worn or damaged? (See "Hydrostatic Pedal and Neutral Safety Linkage Component Location" on page 582, or "F-N-R Linkage Adjustment" on page 586.)

Yes - Replace parts as necessary.

No - Go to next step.

(2) Hydrostatic pedal linkage and cable are adjusted properly? (See "Hydrostatic Pedal and Neutral Safety Linkage Component Location" on page 582.)

No - Adjust as necessary.

NOTE: The following condition may be caused by systems other than power train. Check the brake system if the following procedures do not correct the problem.

Test Conditions:

- Machine parked safely.
- Park brake released.

Symptom: Machine Will Not Move When Travel Pedals Are Pressed

(1) Is range transmission engaged?

Yes - Go to next step.

No - Engage range transmission.

(2) Is transmission fluid level to correct level, not contaminated or foamy?

Yes - Go to next step.

No - Low: Fill to proper level.

No - Contaminated: Drain system, replace oil filter, and fill with specified oil.

No - Foamy: (See "Hydraulic Oil Foams" on page 668 in Steering section.)

Test Conditions:

- Engine at fast idle.
- Park brake locked.

Symptom: Machine Will Not Move When Travel Pedals Are Pressed

(1) System charge pressure is correct? (See "Charge Pressure Relief Valve Test 1400 Series" on page 728 in Hydraulics section.)

No - Replace charge pressure relief valve.

NOTE: This condition may be caused by systems other than power train. Check the brake system if the following procedures do not correct the problem.

Test Conditions:

- Machine parked safely.
- Park brake released.

Symptom: Machine Will Not Reach Full Speed

(1) Is transmission fluid level to correct level, not contaminated or foamy?

Yes - Go to next step.

No - Low: Fill to proper level.

No - Contaminated: Drain system, replace oil filter, and fill with specified oil.

No - Foamy: (See “Hydraulic Oil Foams” on page 668 in Steering section.)

(2) Hydrostatic pedal linkage and cable are worn or damaged? (See “Hydrostatic Pedal and Neutral Safety Linkage Component Location” on page 582, or “F-N-R Linkage Adjustment” on page 586.)

Yes - Replace parts as necessary.

No - Go to next step.

Test Conditions:

- Engine at fast idle.
- Park brake locked.

Symptom: Machine Will Not Reach Full Speed

(1) System charge pressure is correct? (See “Charge Pressure Relief Valve Test 1400 Series” on page 728 in Hydraulics section.)

Yes - Go to next step.

No - Replace charge pressure relief valve.

(2) Hydrostatic motor is leaking?

Yes - Repair or replace hydrostatic motor.

PTO Symptom Diagnosis

Test Conditions:

- Machine parked safely.

Symptom: PTO Shaft Turns With PTO Switch off

(1) PTO switch is good? (See “PTO Switch Test” on page 477 in Electrical section.)

Yes - Go to next step.

No - Replace switch.

(2) Check PTO solenoid. (See “PTO Solenoid Valve Check” on page 735 in Hydraulics section.) Is solenoid good?

Yes - Go to next step.

No - Repair or replace solenoid.

(3) Check PTO brake for wear or damage. (See “PTO Disassembly, Inspection, and Assembly” on page 636.) Is brake worn or damaged?

Yes - Replace brake parts as necessary.

Symptom: PTO Shaft Will Not Turn

(1) Is transmission fluid level to correct level, not contaminated or foamy?

Yes - Go to next step.

No - Low: Fill to proper level.

No - Contaminated: Drain system, replace oil filter, and fill with specified oil.

No - Foamy: Go to Hydraulic Oil Foams in Steering section.

(2) PTO switch is good? (See “PTO Switch Test” on page 477 in Electrical section.)

Yes - Go to next step.

No - Replace switch.

(3) Check PTO solenoid. (See “PTO Solenoid Valve Check” on page 735 in Hydraulics section.) Is solenoid good?

Yes - Go to next step.

No - Repair or replace solenoid.

(4) Check PTO brake for wear or damage. (See “PTO Disassembly, Inspection, and Assembly” on page 636.) Is brake worn or damaged?

Yes - Replace brake parts as necessary.

MFWD Symptom Flow

Test Conditions:

- Machine parked safely.

Symptom: Rear Wheels Do Not Drive

(1) Check MFWD lever linkage for wear or damage. Is lever worn or damaged?

Yes - Repair or replace as necessary.

No - Go to next step.

(2) Check MFWD drive shaft for wear or damage. Is drive shaft in place and not damaged?

Yes - Go to next step.

No - Repair or replace as necessary.

(3) Check transaxle MFWD gear case assembly for wear or damage. Is case damaged?

Yes - Repair or replace as necessary.

No - Go to next step.

(4) Check MFWD axle assembly for wear or damage. (See "4WD Axle Disassembly, Inspection, and Assembly" on page 648.) Is axle worn or damaged?

Yes - Repair or replace as necessary.

Tests and Adjustments

Transaxle Neutral Creep Test and Adjustment

Reason:

To ensure that machine does not creep when pedals are in neutral.

Special or Required Tools:

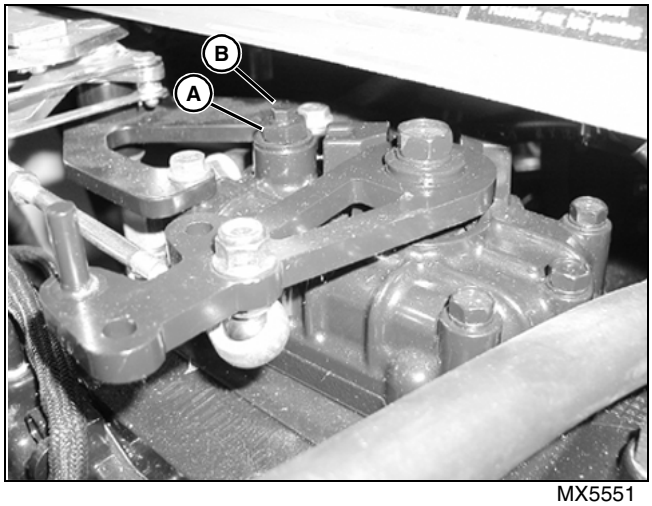
Tool Name	Tool No.	Tool Use
Hoist	NA	Used to lift machine.
Jackstand (4 used)	NA	Used under frame to support machine.

NOTE: If creep is intermittent, inspect hydrostatic pedal linkage for wear, damage, or binding before adjusting transaxle neutral.

Procedure:

CAUTION: Avoid injury! When servicing a 4WD equipped machine with front wheels supported off ground and engine running, always support rear wheels in a similar manner. The 4WD is always engaged and will push machine off supports if wheels are not raised.

1. Lift machine with a hoist and support both front and rear wheels off the ground.
2. Put jackstands under frame.



MX5551

3. Loosen lock nut (A).

CAUTION: Avoid injury! Use extreme caution when doing this adjustment. Drive wheels are free to spin.

4. Have someone push down center of seat cushion to activate seat safety switch, or use a jumper wire to bypass the seat switch.

5. Start engine and run at slow idle.

6. With brakes unlocked, turn eccentric nut (B) left or right until drive wheels stop turning.

7. Hold adjustment and tighten lock nut. Make sure adjustment did not change.

8. Depress forward and reverse pedals, then release.

9. Check neutral adjustment. Repeat adjustment as necessary.

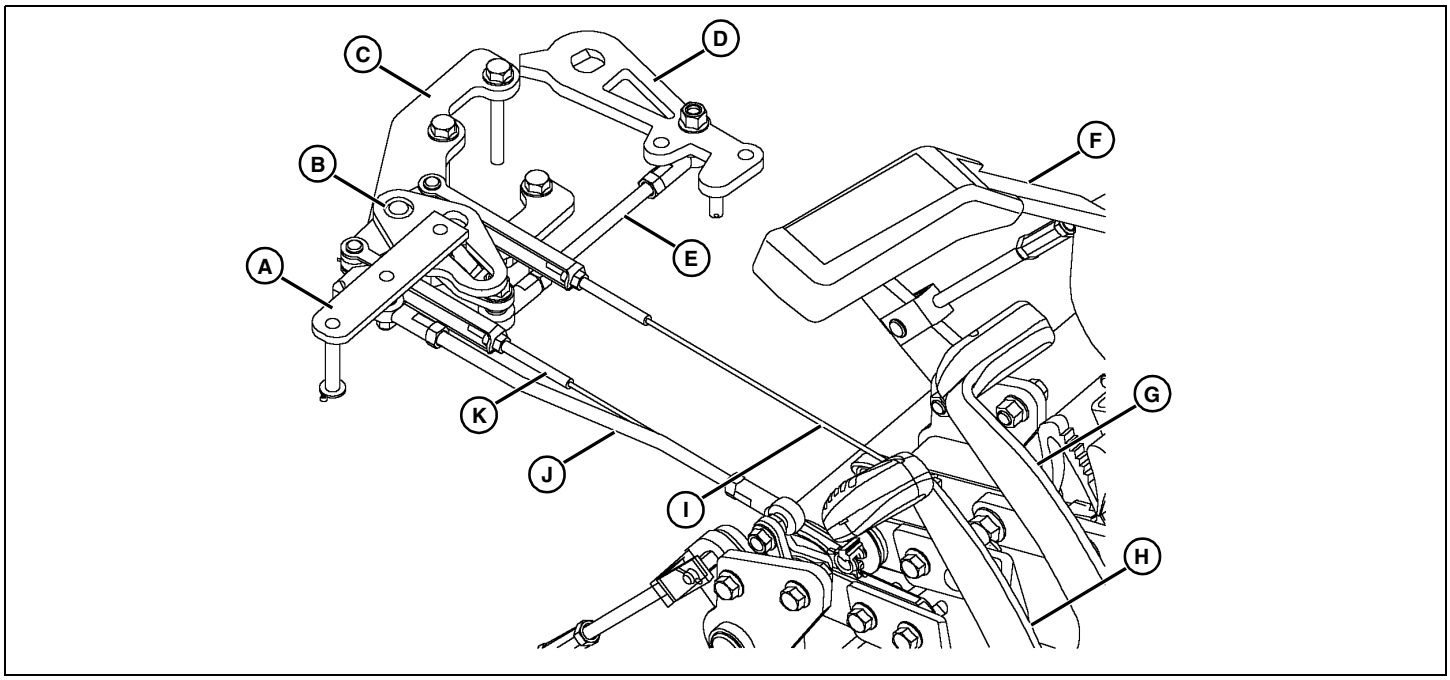
CAUTION: Avoid injury! Remove jumper wire from seat switch if installed.

10.Lower machine to the ground. Remove seat switch jumper wire if used.

Results:

- If drive wheels continue to turn, check for worn or binding hydrostatic pedal linkage or internal transaxle problems.

F-N-R Linkage Adjustment



MX5807

A - Neutral Safety Arm
B - F-N-R Bellcrank
C - Linkage Support Bracket
D - Hydrostatic Control Arm
E - Hydrostatic Control Link
F - Brake Pedal
G - Forward Pedal
H - Reverse Pedal
I - Forward Cable
J - Neutral Safety Link
K - Reverse Cable

Cable Installation and Adjustment:

1. Park machine safely on level surface.

2. Disengage PTO.

3. With machine running, release brake and check for creep. If machine creeps, adjust neutral creep before continuing with linkage adjustment. (See “Transaxle Neutral Creep Test and Adjustment” on page 585.)

4. Turn key switch off.

5. Open floor access panel.

6. Loosen lock nuts on ball joint ends of hydrostatic control link (E). Disconnect link from hydrostatic control arm (D). Adjust length of control link to **179 mm (7 in.)**, measuring from center-to-center of ball joint studs. Ensure sufficient thread engagement in both ball joint ends. Install link and tighten ball joint nuts, but do not tighten jam nuts at this time.

7. Loosen nuts on clevis of forward (I) and reverse (K) cables.

8. Adjust jam nut on forward cable until threaded end of cable extends approximately 20 mm (0.8 in.) beyond nut. Adjust rear cable until end extends approximately 12 mm (0.5 in.) beyond jam nut. Do not tighten nuts at this time.

9. Adjust hydrostatic control link (E) until the roller of the neutral safety arm (A) is centered in the forward cam slot of F-N-R bellcrank (B) as the safety arm and roller swing forward. Tighten control link jam nuts.

10. Adjust forward and reverse cables until pedal pad distance from floor is to specification and the hydrostatic control arm (D) hits the hard stops on the transaxle.

11. Tighten jam nuts on forward and reverse cables.

12. Recheck pedal travel and operation of park brake.

13. Operate machine and check for neutral creep. (See "Transaxle Neutral Creep Test and Adjustment" on page 585.)

Link Installation and Adjustment:

NOTE: If installing neutral safety link, make sure the thread engagement in both front and rear ball joints is to specification.

1. Loosen lock nut on rear ball joint of neutral safety link (J). Disconnect link from neutral safety arm (A) and adjust length of link to approximately 305 mm (12 in.), measuring from center-to-center of ball joint studs.

2. Install link on safety arm (A) and adjust the length of the safety link (J), as necessary, until the roller of the neutral safety arm (A) is about 2 - 4 mm (0.08 - 0.16 in.) from the rear surface of F-N-R bellcrank cam slot. Tighten lock nut attaching link to arm and jam nut on rod.

3. With the brakes off, operate the forward (G) and reverse (H) pedals. Make sure that the neutral safety arm does not impede forward and reverse pedal strokes.

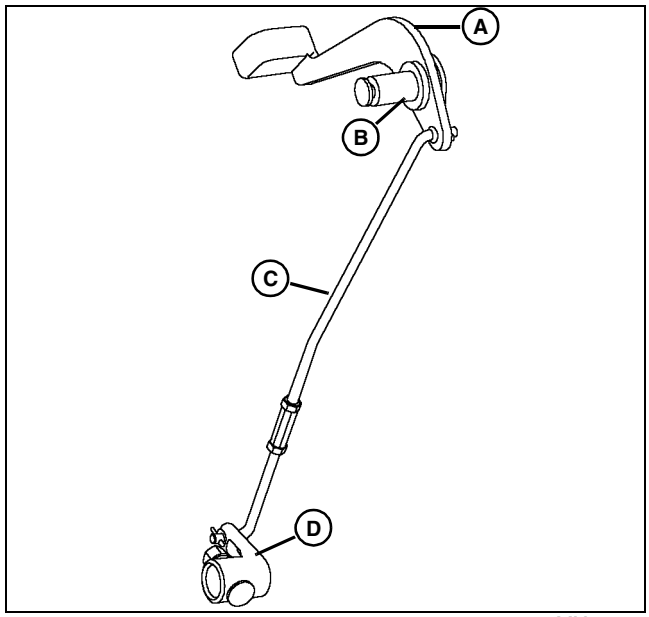
4. Check operation of park brake (F) and park brake switch.

Specifications:

Forward and Reverse
Pedal-to-Floor Clearance . . . . . 3 mm (0.1 in.)

Neutral Safety Link Ball Joint Thread Engagement
(Minimum) . . . . . 8 mm (0.3 in.)

Differential Lock Adjustment



MX5808

A - Differential Lock Pedal
B - Differential Lock Pivot
C - Differential Lock Link Assembly
D - Differential Lock Arm

Adjustment:

1. Park machine on level ground.

2. With at least one wheel off the ground, turn the tire and depress the differential lock pedal until it locks into position.

   - If pedal hits floor and will not lock into position, shorten the differential lock link until it locks.

3. Adjust the length of the differential lock link so that a 1-3 mm gap exists between the pedal and floor.

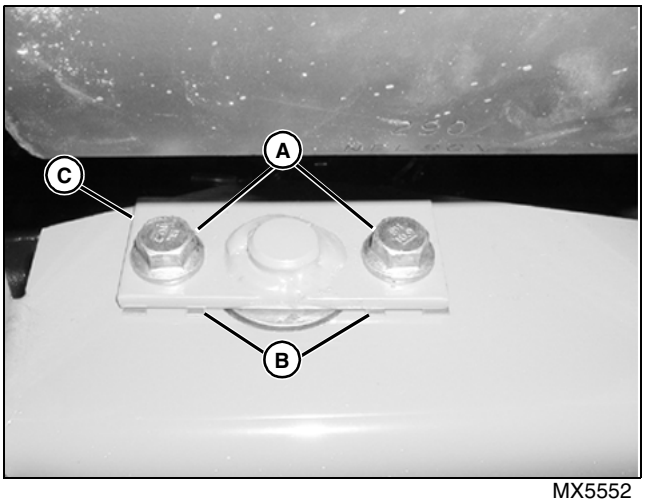
4. Tighten jam nuts.

4WD Axle Pivot Pin Clearance Adjustment

Procedure:

1. Safely raise rear frame so axle is free to pivot.

2. With feeler gauge, measure gap between rear edge of axle housing and front edge of frame bushing.



MX5552

3. Loosen flanged cap screws and lock nuts (A) to add or deduct shims (B) between pin flange (C) and machine frame until you gain a dimension within the specification.

4. Tighten flanged cap screws and lock nuts to specification.

5. Re-check gap to ensure proper specified end play has been obtained.

Specifications:

4WD Axle
End Play . . . . . 0.127 - 1.016 mm (0.005 - 0.040 in.)

4WD Axle Flanged Cap Screw
and Lock Nut Torque . . . . . 88 N•m (65 lb-ft)

Repair

Engine Drive Shaft Removal and Installation

Special or Required Tools:

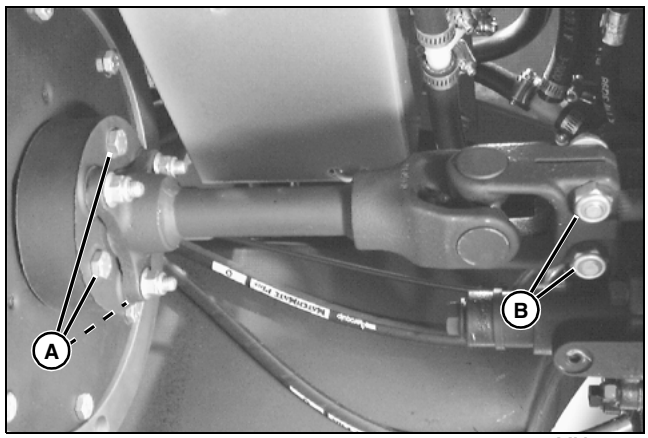
Tool Name	Tool No.	Tool Use
Long Pointer (1400's)	JDG-1389-2	Used to check and set engine-to-transaxle alignment.
Short Pointer (1545 and 1565)	JDG-1389-3	Used to check and set engine-to-transaxle alignment.
Engine Alignment Tool Base	JDG-1389-1	Used to check and set engine-to-transaxle alignment.

Procedure:

1. Remove front attachment.

2. Place wedge blocks in front of and behind both rear wheels.

3. Raise front of machine. Support both sides of frame just behind transaxle with 2-ton jackstands or wooden block for safety reasons.



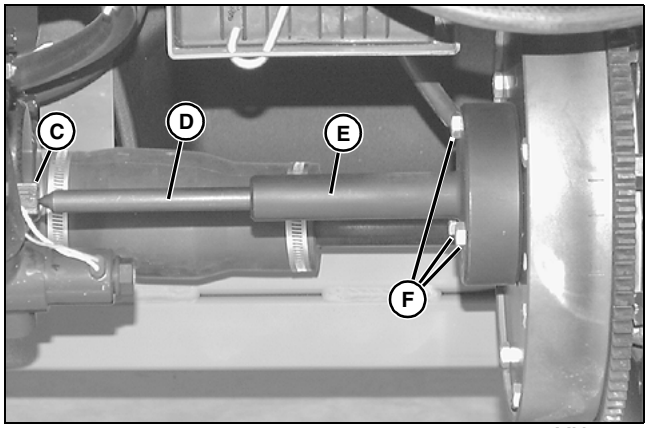
MX5442

4. Remove two cap screws and nuts (B).

5. Remove three drive shaft mounting cap screws (A).

6. Slide drive shaft forward, then tip rear of drive shaft down and slide to rear to remove.

IMPORTANT: Avoid damage! Drive shaft alignment should be checked any time drive shaft is removed. When installing the transaxle, the John Deere Engine Alignment Tool must be used to properly align the engine and the transaxle.

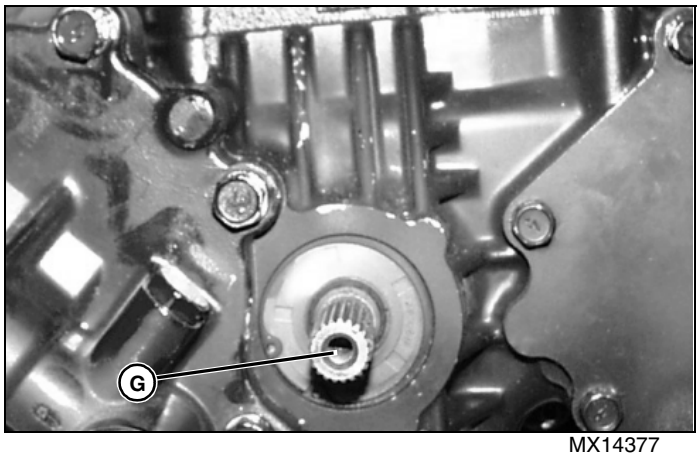


MX5592

7. Install JDG-1389-2 Long Pointer (D) for 1400 series, or JDG-1389-3 Short Pointer for 1545 and 1565 into JDG-1389-1 Engine Alignment Tool Base (E).

8. Install engine alignment tool base to engine flywheel using three drive shaft mounting cap screws (F).

9. Slide pointer out until it contacts transaxle input shaft (C).



MX14377

10.Pointer (D) should be centered in the end (G) of the input shaft.

11.If pointer will not center, engine must be realigned.

NOTE: Shims are available for aligning engine to transaxle.

12.Loosen engine mounting cap screws.

13.Grasp the alignment tool pointer (D) and move engine as necessary to center pointer in transaxle input shaft (C). If pointer will not center in transaxle input shaft, add shims between isolators engine brackets as required to achieve centering.

14.When engine and transaxle are correctly aligned, tighten engine mount cap screws to specification.

15.Remove alignment tool (E).

16.Install drive shaft.

17.Install three drive shaft mounting cap screws (A).

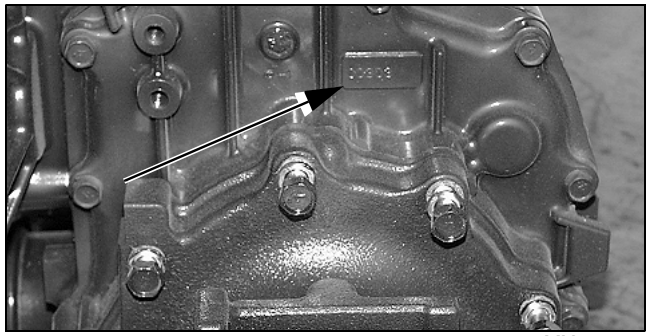
18.Install two cap screws and nuts (B).

19.Lower machine to ground.

Transaxle Removal and Installation

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Lifting Bracket	JT01748	Used with hoist to remove and install transaxle.


MX16091

NOTE: Record transaxle serial number (above right axle housing) for obtaining correct parts. Some early models are slightly different.

Procedure:

1. Remove front attachment.

2. Put wedge blocks in front of and behind both rear drive wheels.

3. Loosen front drive wheel lug nuts.

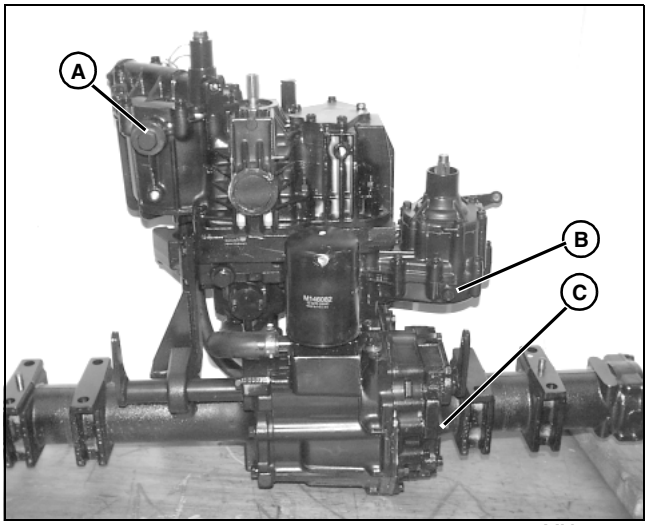
4. Raise front of machine. Support both sides of frame just behind transaxle with 2-ton jackstands or wooden blocks for safety reasons.

5. Remove front drive wheels.

6. Remove engine drive shaft. (See “Engine Drive Shaft Removal and Installation” on page 588.)

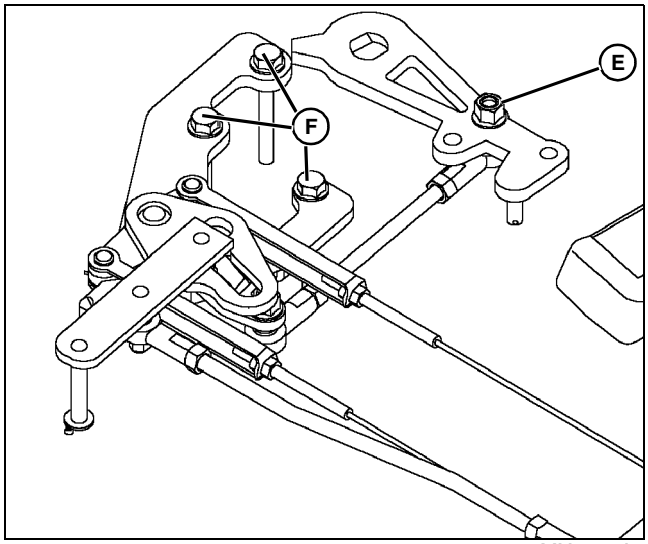
7. Remove 4WD drive shaft, if equipped. (See “4WD Drive Shaft Removal and Installation” on page 645.)

NOTE: Use shop cloths or paper towels to catch and clean up any spilled oil immediately. Close all ports and lines using caps or plugs.



MX16093

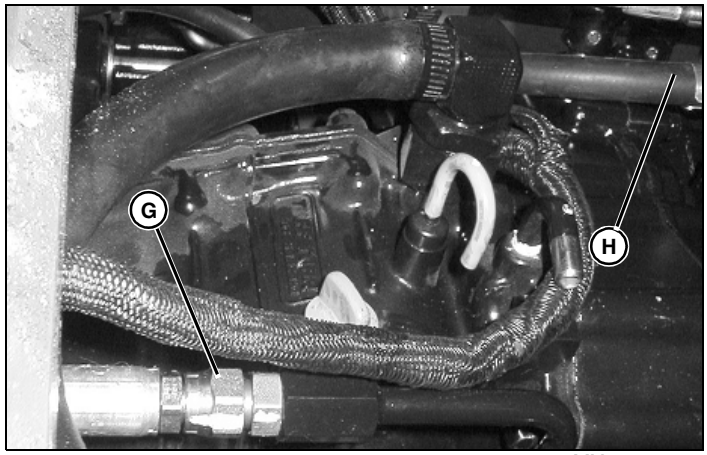
8. Remove drain plugs at PTO/hydrostatic housing (A), 4WD housing (B), and differential housing (C).



MX5807A

9. Remove nut (E) from pedal linkage ball joint and disconnect pedal linkage.

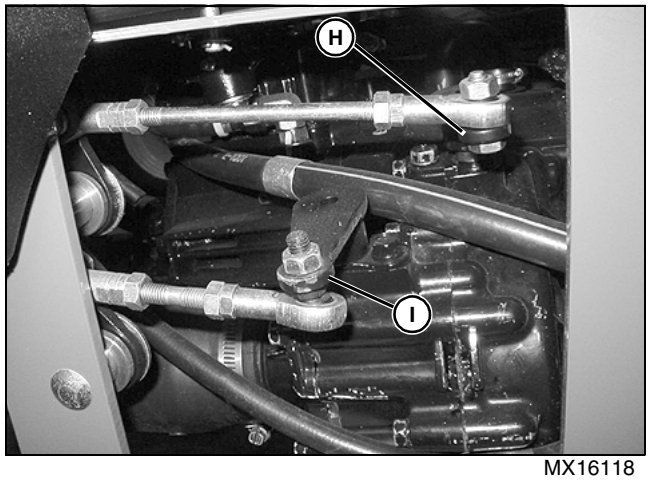
10. Remove three mounting cap screws (F) for linkage pivot. Move pedal linkage aside.



MX16399

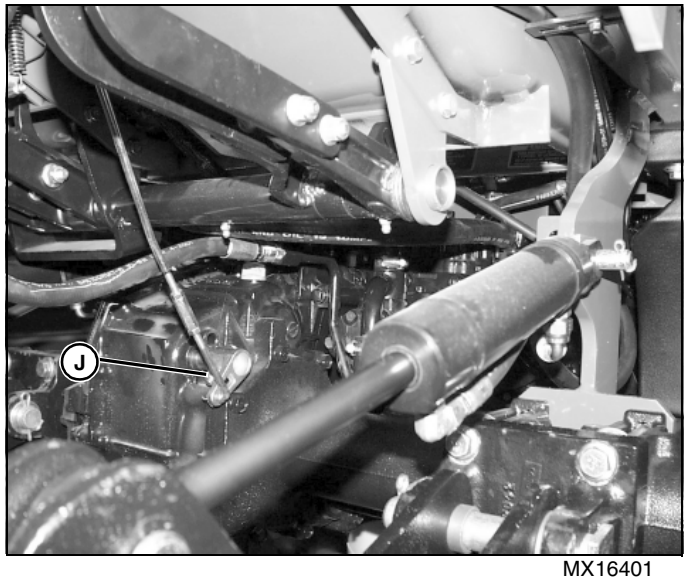
11. Disconnect hydraulic hose (G) and (H).

12. Disconnect PTO solenoid harness.



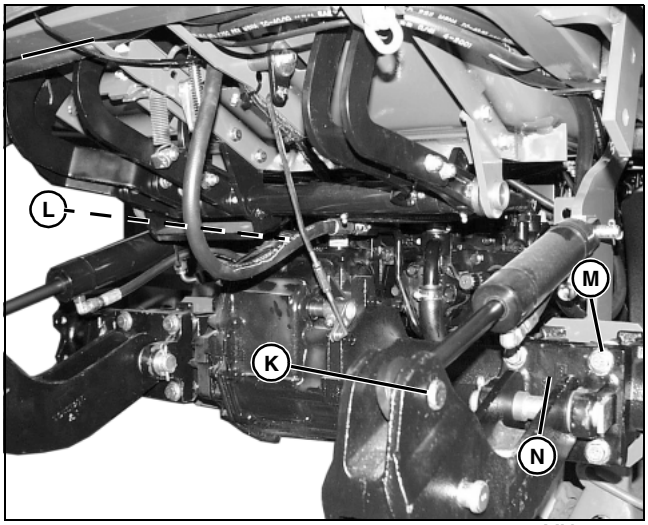
MX16118

13. Disconnect linkage from Hi-Lo lever (H) and 4WD lever (I).



MX16401

14. Disconnect differential lock linkage (J).



MX16402

15.Remove each lift cylinder pin (K) and secure lift cylinders up out of the way.

16.Remove wire clamp (L) and move wire harness aside.

17.Support transaxle with a transmission jack or rolling transmission stand

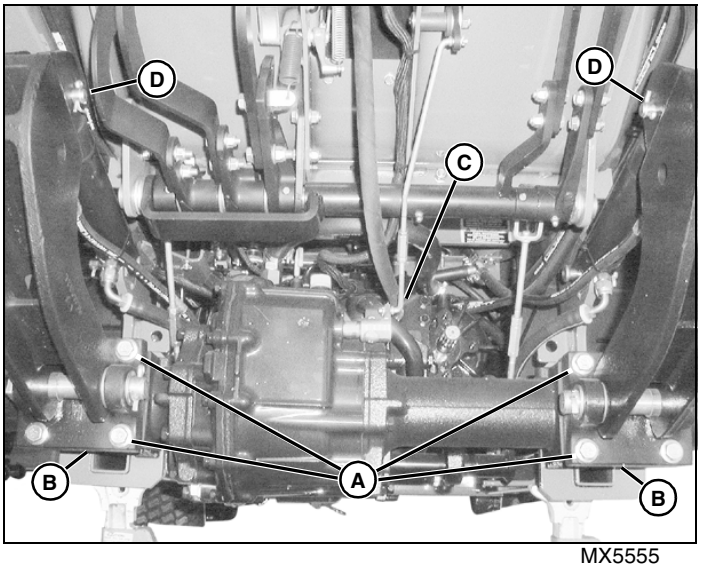
18.Remove eight transaxle mounting cap screws (M) and implement lift arm mounts (N).

19.Remove transaxle.

Installation:

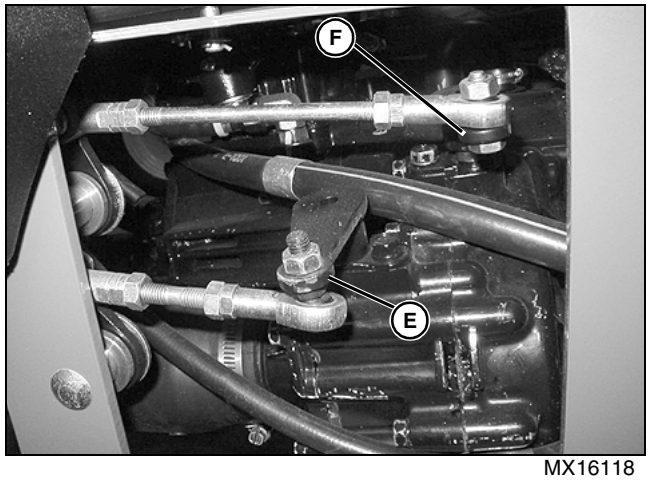
1. Raise transaxle to frame.

IMPORTANT: Avoid damage! Locating pins on rear side of transaxle must be positioned in frame locating holes before tightening of transaxle mounting cap screws.



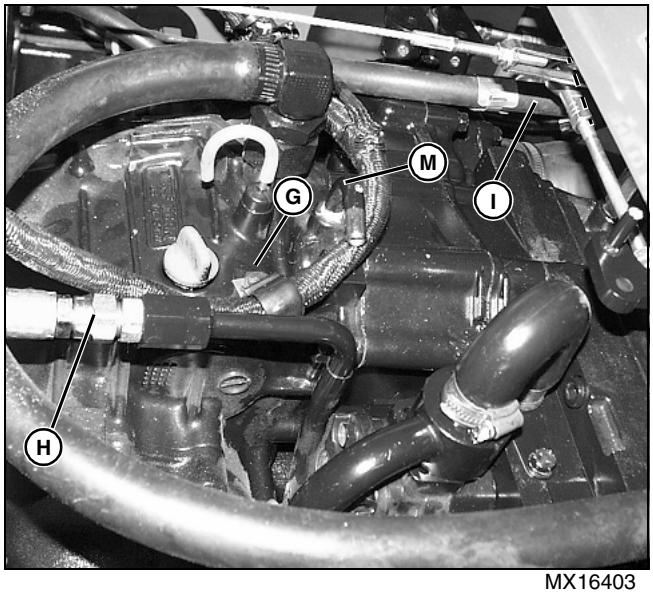
MX5555

2. Install eight mounting cap screws (A) and implement lift arm mounts (B). Position locating pins on transaxle into locating holes of frame and tighten mounting cap screws to specification.
3. Remove transmission jack.
4. Connect differential lock linkage (C).
5. Connect implement lift cylinders (D).



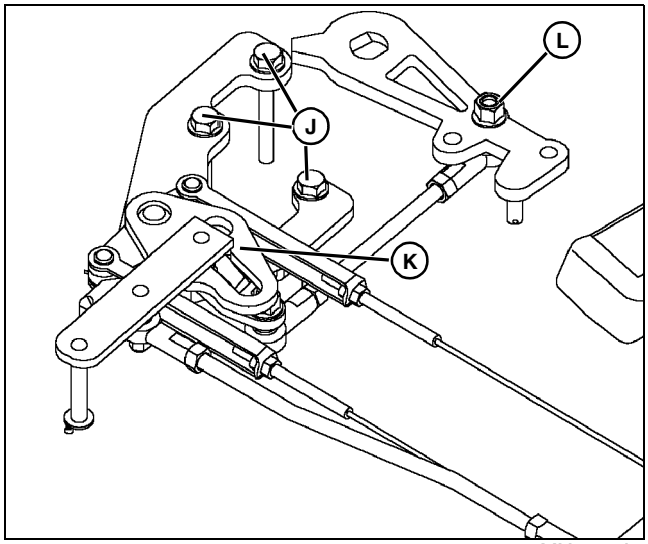
MX16118

6. Connect 4WD linkage (E) and Hi-Lo Lever linkage (F).



MX16403

7. Install cap screw and wiring harness clamp (G).
8. Connect power steering hose (H).
9. Connect right and left brake links and springs.
10.Connect PTO solenoid harness.
11.Connect hydraulic hose (I).



MX5807A

12.Install pedal linkage pivot using three mounting cap screws (J). Make sure brake/neutral return linkage is properly engaged in cam slot (K) before tightening cap screws (J).

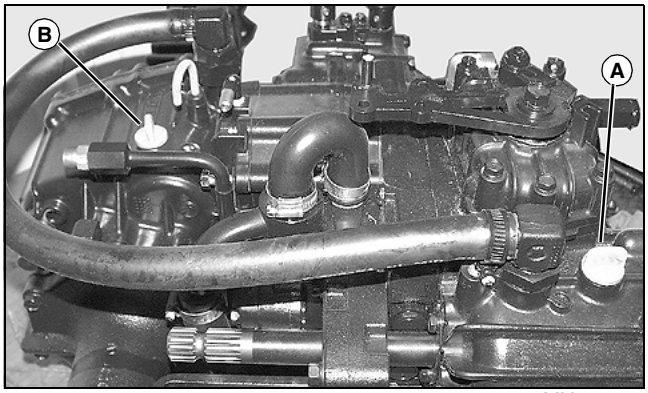
13.Connect pedal linkage (L). Check that all pedals operate properly.

14.Install 4WD drive shaft. (See “4WD Drive Shaft Removal and Installation” on page 645.)

15.Install engine drive shaft. (See “Engine Drive Shaft Removal and Installation” on page 588.)

16.Install front drive wheels. Tighten mounting cap screws to specification.

17.Lower machine to ground.



MX16102

18.Fill transaxle with proper fluid. (See “Oil and Lubricant Specifications” on page 18 in Specifications and General Information section). Remove fill plug (A) from hydro/pto section and fill with **3.4L (3.6 qt)** of oil. Remove fill plug (B) from differential section and fill with **6.2L (6.6 qt)** of oil. After running unit recheck oil with dipstick and add oil if necessary

Specifications:

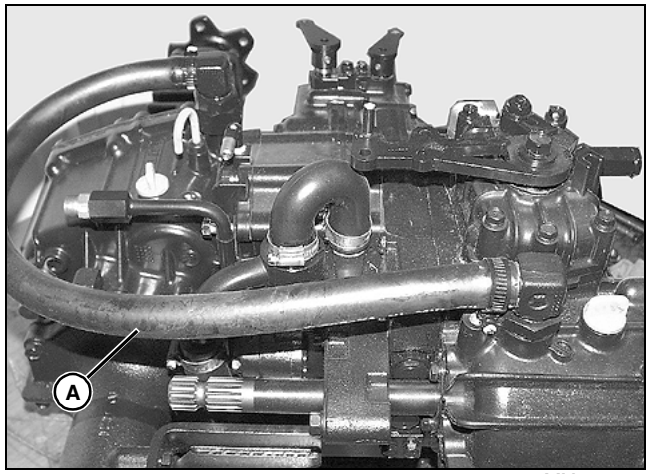
Transaxle Mounting
Cap Screw Torque . . . . . 142 N•m (105 lb-ft)

Front Drive Wheel Mounting
Cap Screw Torque . . . . . 225 N•m (165 lb-ft)

Hydrostatic Assembly-to-Differential Assembly Separation and Installation

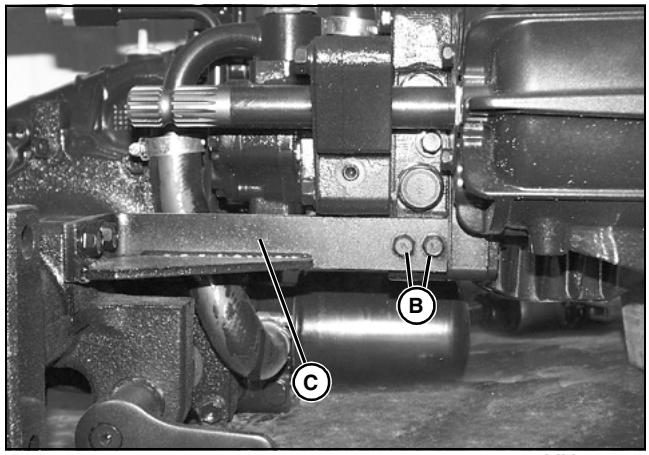
Separation

1. Remove transaxle. (See “Transaxle Removal and Installation” on page 589.)



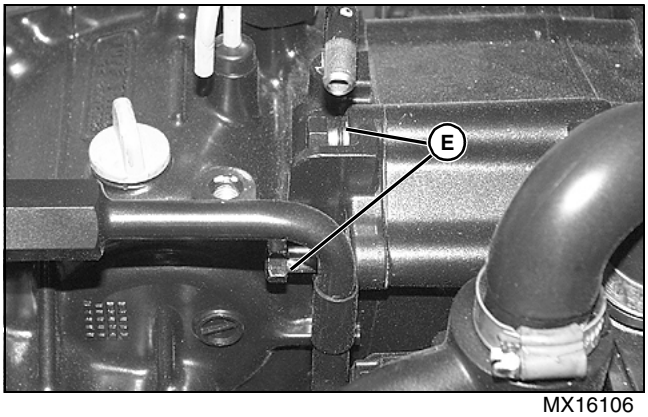
MX16102

2. Disconnect return hose (A).



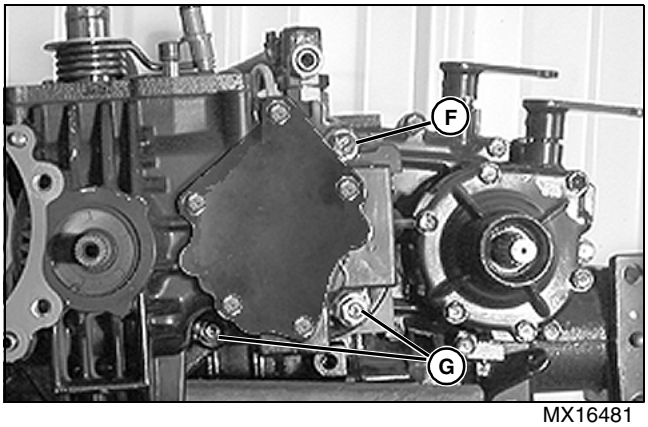
MX16103

3. Remove two cap screws (B) from L-bracket (C).



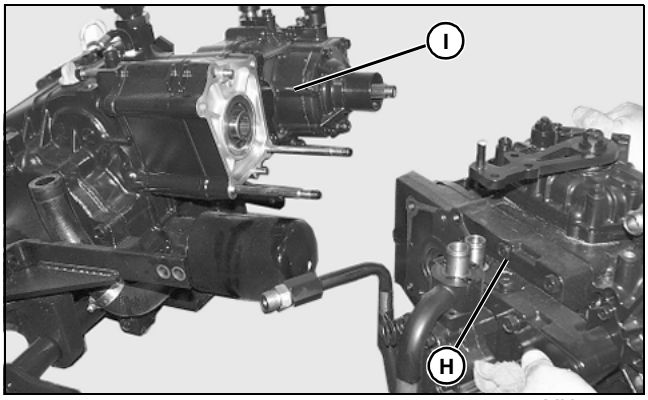
MX16106

4. Remove two front cap screws (E).



MX16481

5. Remove rear cap screw (F) and two nuts (G).



MX16108

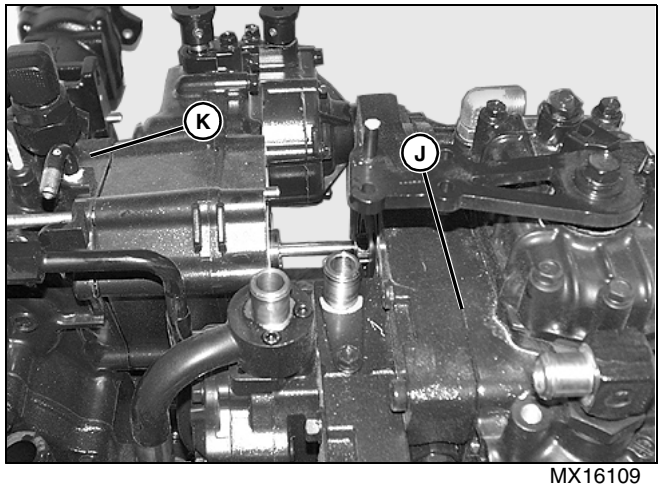
6. Separate hydrostatic assembly (H) from differential assembly (I).

7. Repair assemblies as necessary.

8. Clean gasket surfaces.

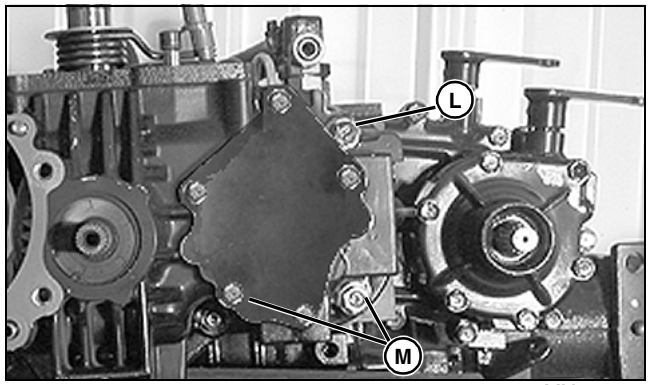
Installation:

1. Replace gaskets.



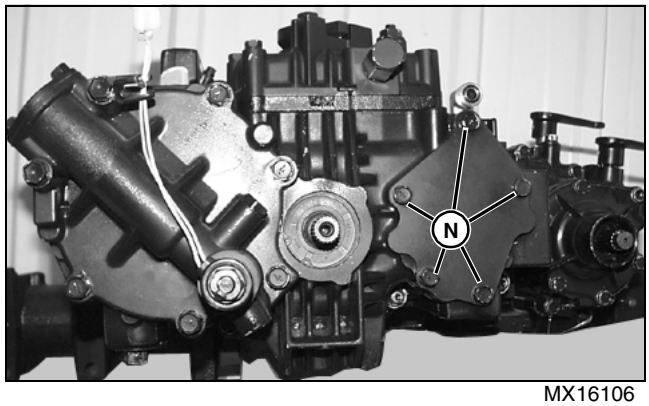
MX16109

2. Install hydrostatic assembly (J) to differential assembly (K).



MX16481

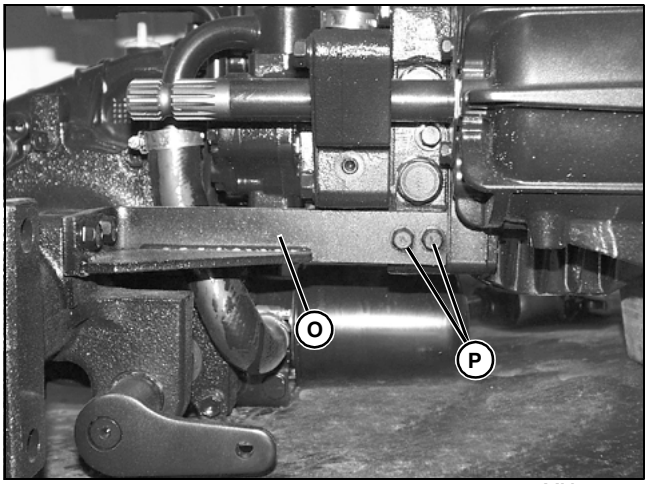
3. Install cap screw (L) and nuts (M).



MX16106

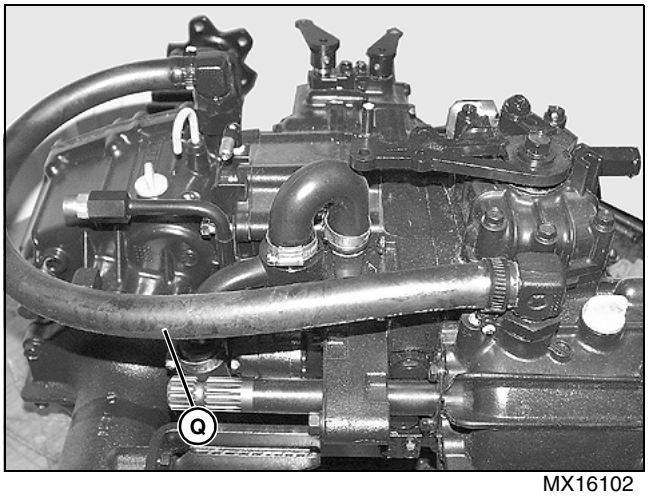
4. If removed, install cover plate using cap screws (N).

5. Install Hydraulic pump. (See “Hydraulic Pump Removal, Disassembly, Inspection, and Assembly” on page 594.)



MX16103

6. Install L-bracket (O) using two cap screws (P).



MX16102

7. Install and connect return hose (Q).

8. Install transaxle. (See “Transaxle Removal and Installation” on page 589.)

Hydraulic Pump Removal, Disassembly, Inspection, and Assembly

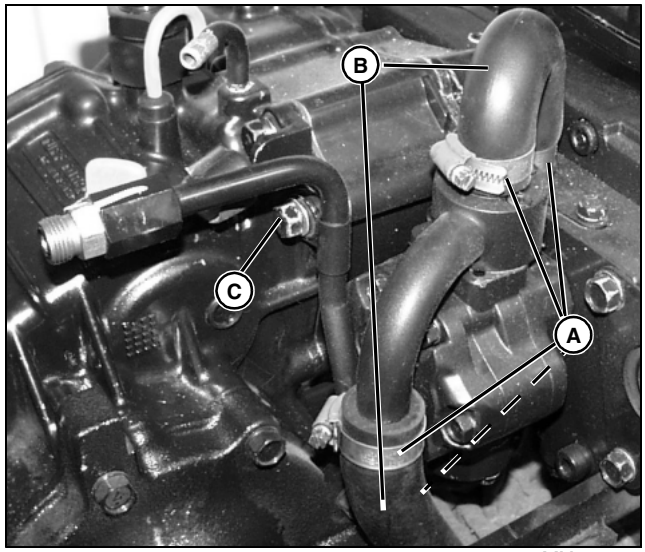
Removal:

NOTE: You do not need to remove transaxle to repair hydraulic pump only. Hydraulic pump can be removed without disassembly of transaxle.

Transaxle is shown removed for clarity.

Use shop cloths or paper towels to catch and clean up any spilled oil immediately. Close all ports and lines using caps or plugs.

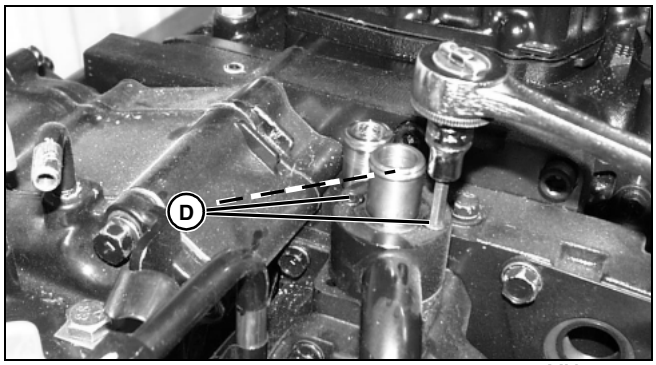
1. If transaxle is in machine, drain transaxle. (See Changing the Transaxle Oil and Filter in the operator’s manual.)



MX16039

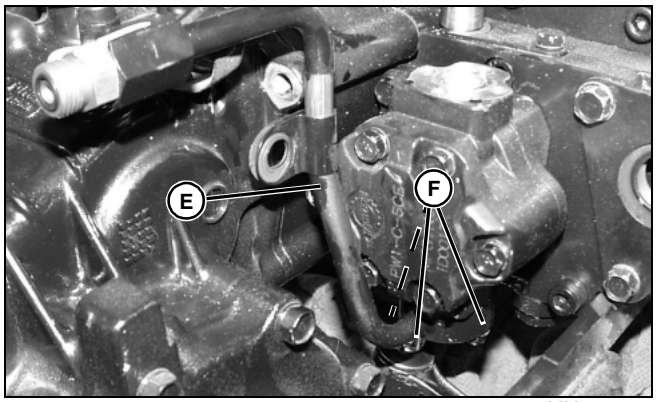
2. Loosen the four hose clamps (A) and remove the two hoses (B) from the intake manifold.

3. Remove bolt (C) holding the hydraulic line support bracket.



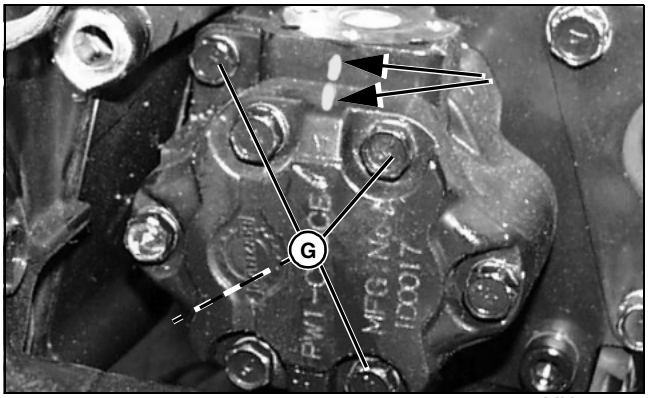
MX16040

4. Remove the three hex head screws (D) holding the intake manifold to the top of the hydraulic pump. Remove the manifold assembly.



MX16041

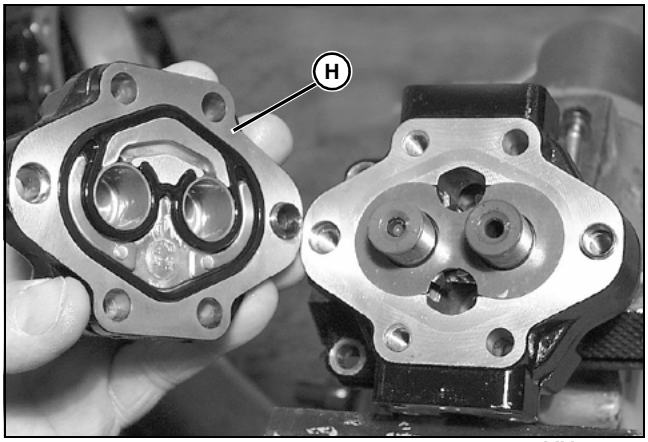
5. Remove the hydraulic line and pressure fitting (E) from the bottom of the hydraulic pump by removing the three capscrews (F).



MX16042

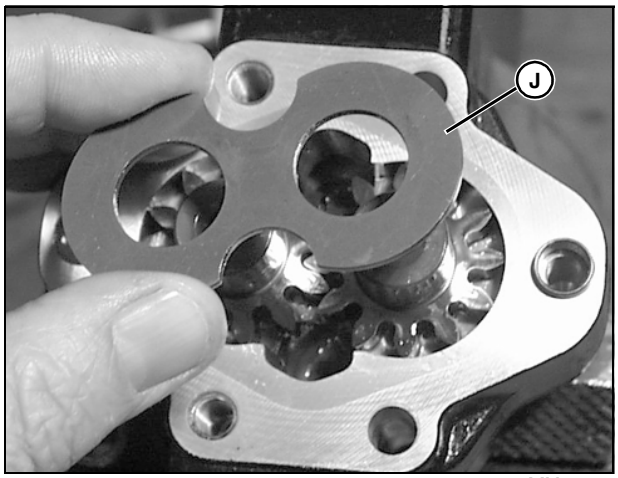
6. Mark cover and pump (arrows) for reassembly purposes. Remove four cap screws (G) that are marked in the photo, and remove the hydraulic pump. Do not remove the remaining four capscrews at this time, as the pump components could separate during removal.

Disassembly:



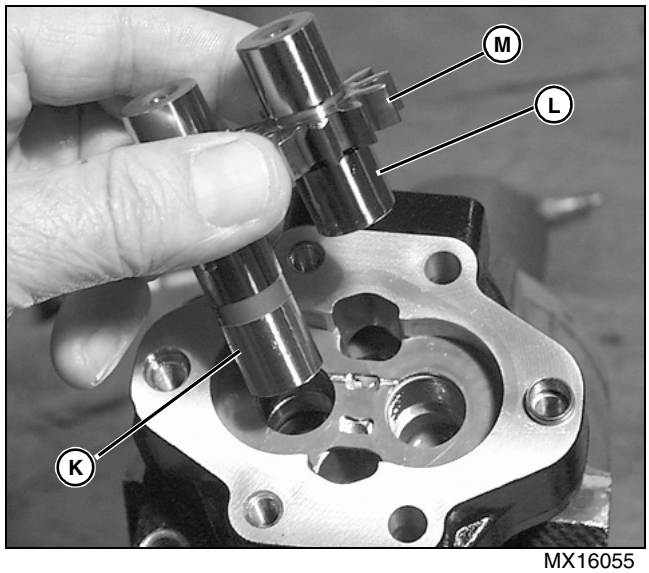
MX16053

1. Remove the four remaining pump body cap screws and separate the cover (H) from the body of the pump.



MX16054

2. Remove the front thrust plate (J) from the gears. Check the brass side (inside) for signs of damage such as gouging, scoring or pitting. Replace pump if damage or wear is evident.

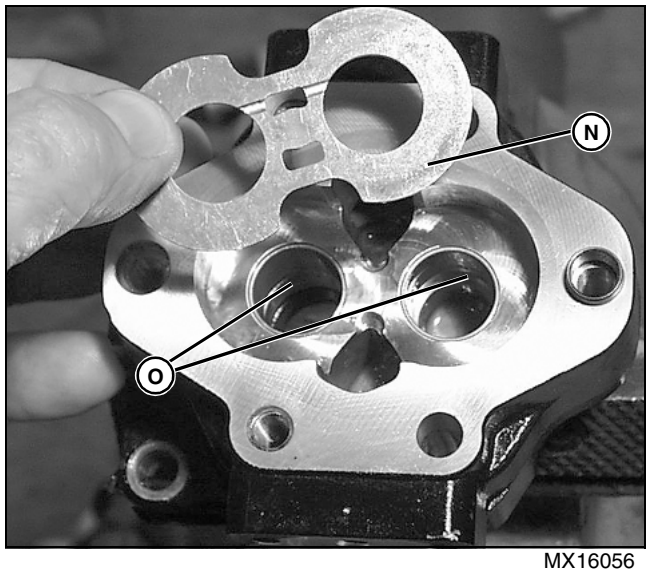


MX16055

3. Remove the pump drive gear (K) and idler gear (L) assemblies from the pump body noting the location of the gears.

4. Inspect gear faces (M) for wear such as chipping, pitting or spalling of the gear faces. Replace pump as required.

5. Inspect internal shaft splines on the drive gear. Replace pump if gear is worn or damaged.

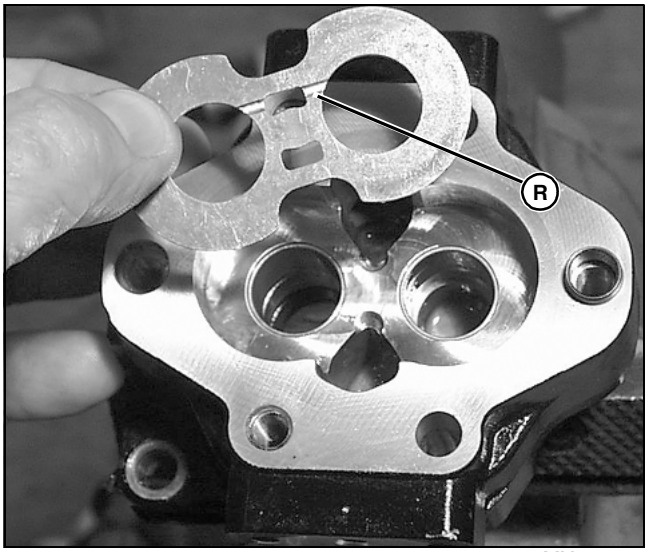


MX16056

6. Remove the rear thrust plate (N) from the pump body. Check the brass side for wear or damage. Replace pump as required.

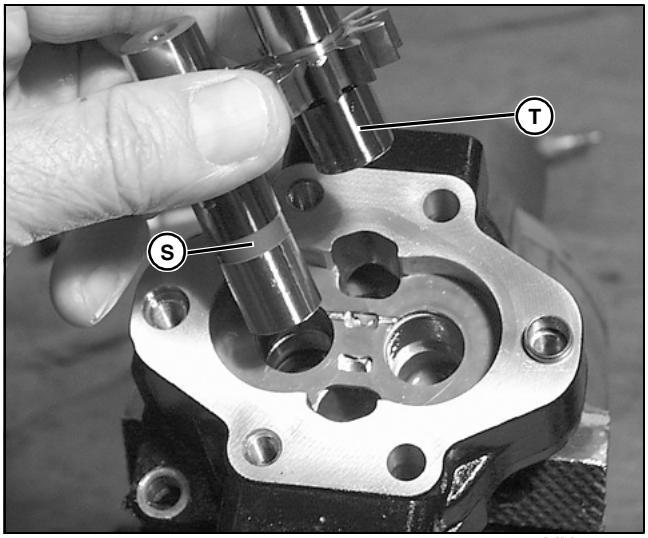
7. Inspect the bushing surfaces (O) in the pump body for wear or damage. Inspect the pump body internal surfaces for scoring, scratching or excessive wear. Replace pump if damaged.

Assembly:



MX16056

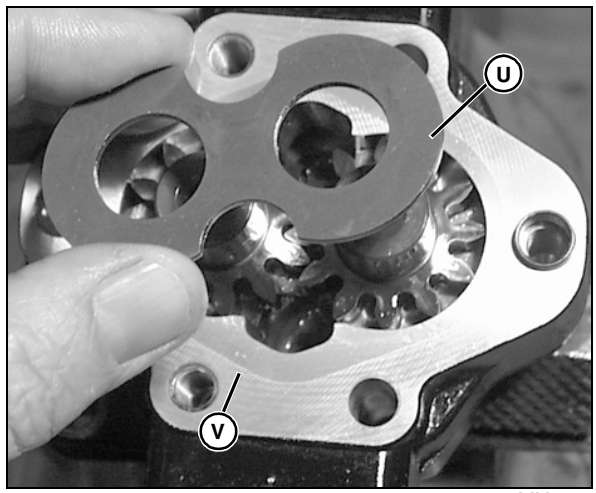
1. Install the rear thrust plate in the pump body with the brass side facing out (towards gear). Note that the lubrication groove (R) goes toward the top (intake side) of pump.



MX16055

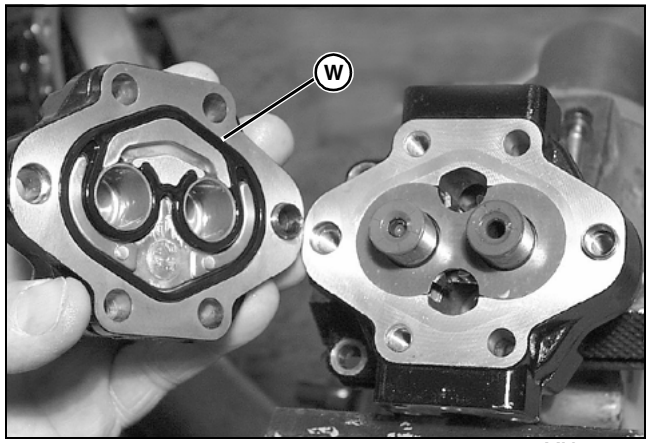
Picture Note: Idler gear (T) is symmetrical and can be placed in body either end first.

2. Install the pump drive gear (S) and idler gear (T) in the pump body.



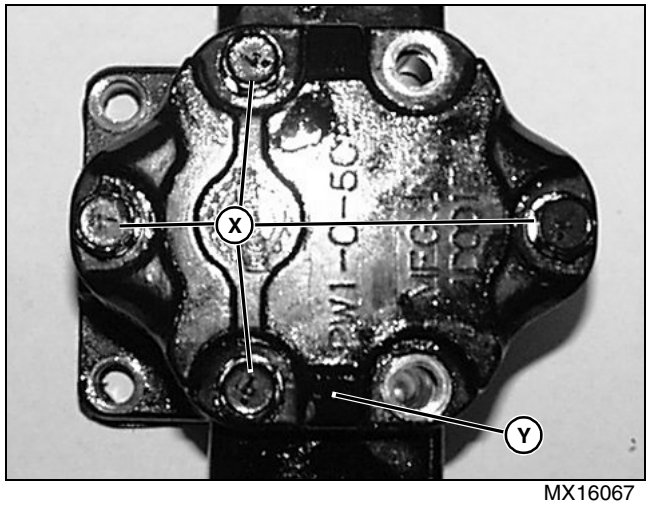
MX16054

3. Place front thrust plate (U) over shaft ends with the brass surface to the inside. Thrust plate should be flush with pump body gasket surface (V) when all components are installed correctly.



MX16053

4. If removed, install formed o-ring gasket (W) in the grooves on the front cover.

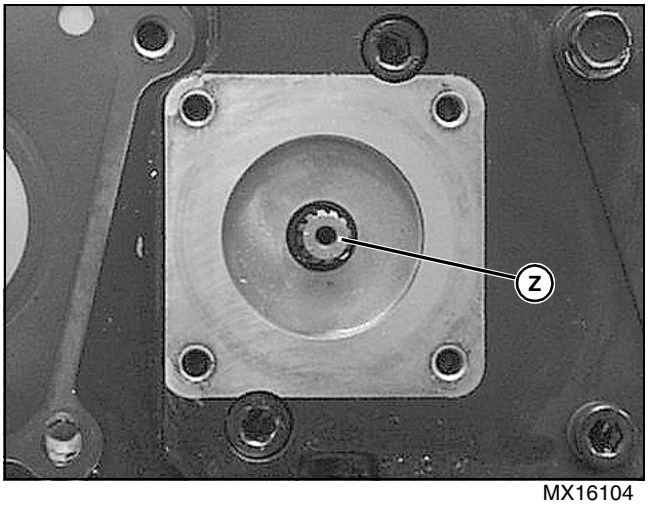


MX16067

5. Install the front cover using four cap screws (X). Note

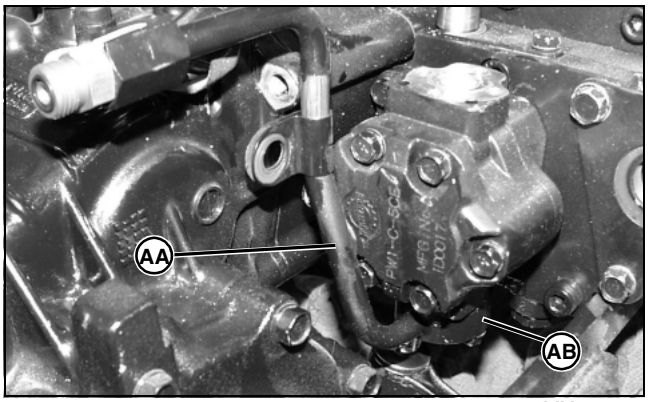
that the cover has an OUT (Y) marking that must be oriented on the bottom (outlet side) of pump. Tighten cap screws to **15 N•m (113 lb-in.)**.

6. Install a new gasket on the hydraulic pump.



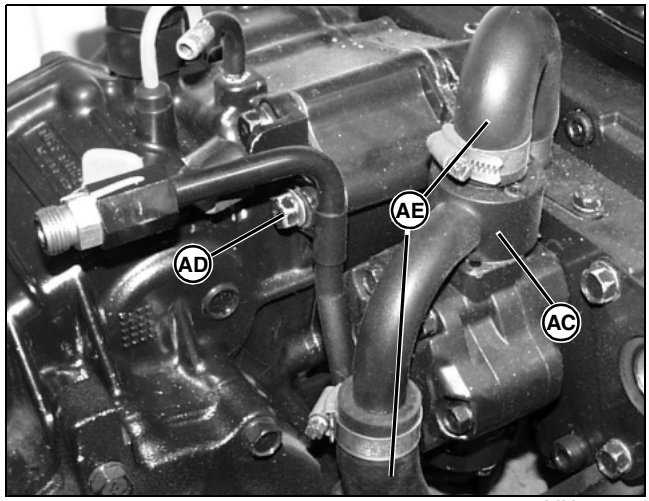
MX16104

7. Align the pump drive gear shaft internal splines with the splined shaft (Z) on the transaxle and install the hydraulic pump with the remaining four cap screws.



MX16041

8. Replace o-ring and install the hydraulic line (AA) and pressure fitting (AB) to the bottom of the hydraulic pump with three capscrews.



MX16039

9. Install the intake manifold (AC) to the top of the pump with three hex head screws. Install the bolt (AD) that holds the hydraulic line support bracket and the two rubber hoses (AE). Secure hoses with screw clamps.)

10.If transaxle is mounted in the machine refill with oil. See operators manual.)

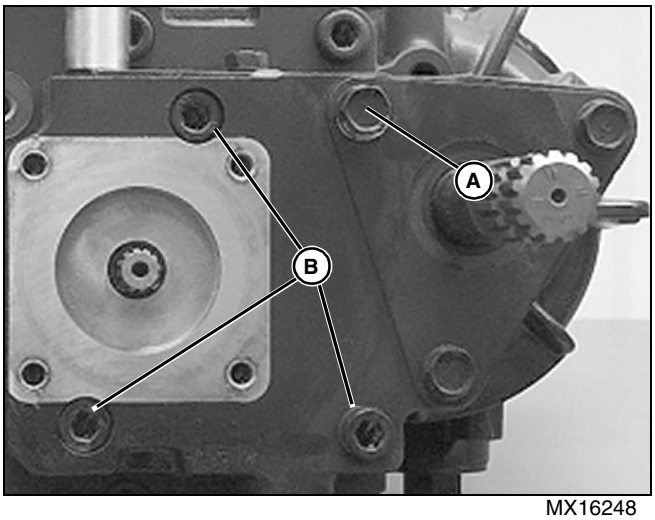
Charge Pump Disassembly, Inspection, and Assembly

Disassembly/Inspection:

1. Remove transaxle. (See “Transaxle Removal and Installation” on page 589.)

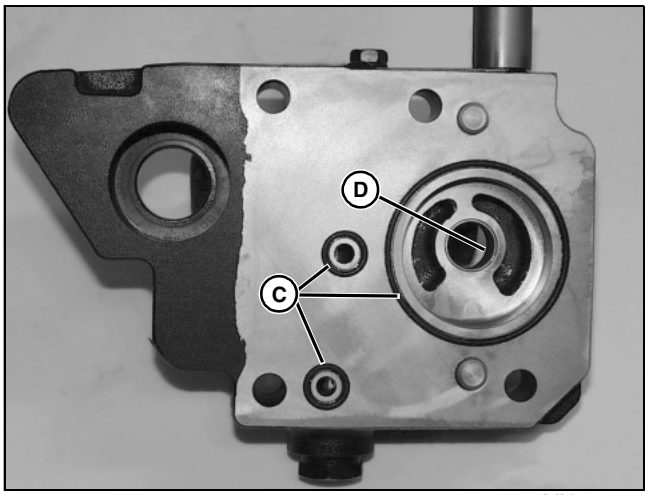
2. Remove Hydrostatic Assembly from Differential Assembly. (See “Hydrostatic Assembly-to-Differential Assembly Separation and Installation” on page 592.)

3. Remove Hydraulic Pump from the Hydrostatic Sub Plate. (See “Hydraulic Pump Removal, Disassembly, Inspection, and Assembly” on page 594.)



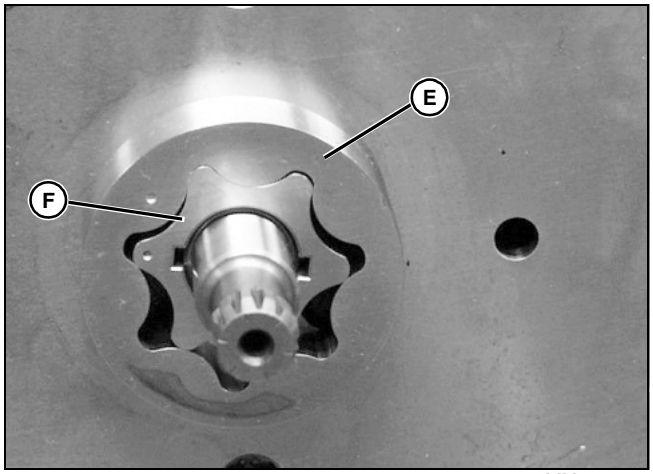
MX16248

4. Remove one cap screw (A) and three hex socket head screws (B) from the Hydrostatic Sub Plate. Separate Hydrostatic Sub Plate from Hydrostatic Center Plate.



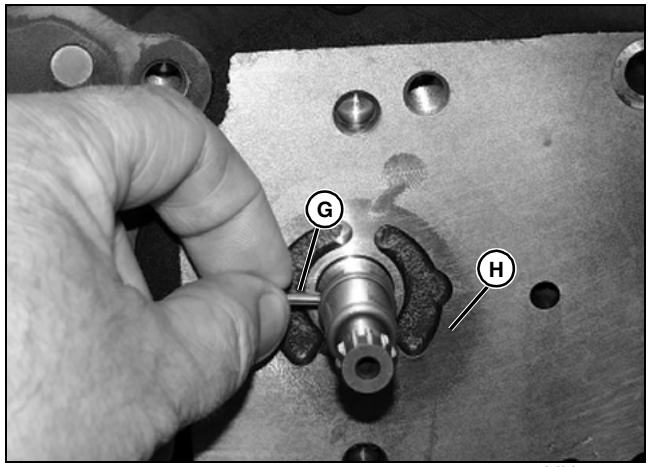
MX16234

5. Remove O-rings (C) from hydrostatic sub plate. Inspect pump shaft bushing (D). If bushing shows signs of excessive wear or damage, replace the hydrostatic sub plate assembly.



MX16240

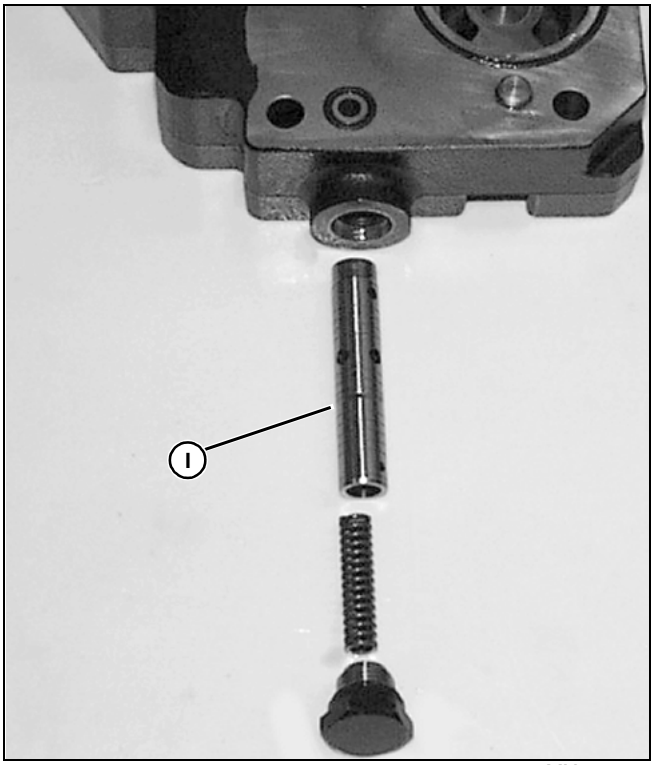
6. Remove the outer gear (E) and inner gear (F) from the drive pin on the pump shaft. Inspect both gears for damage or excessive wear. If any sign of grooving, scoring, bluing or surface flaking is evident, replace the pump gears as a set.



MX16241

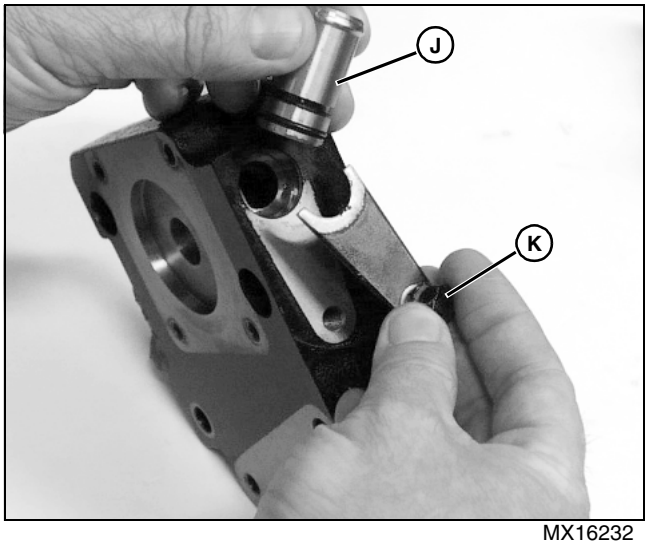
7. Remove gear drive pin (G) from pump shaft. Inspect the condition of the pin, if it is a loose fit in the bore, is deformed or bent or shows signs of surface damage replace the pin.

8. Inspect the pump wear surface (H) on the machined face of the hydrostatic center plate. If any scoring or damage is visible, replace the center plate.



MX16235

9. Remove the priority valve assembly (I) from the hydrostatic sub plate. Check the valve bores for signs of clogging or damage. If any sign of damage or scoring is evident replace the priority valve.



MX16232

10.Check the suction hose fitting (J) on the hydrostatic sub plate. If the fitting is deformed or damaged, or shows sign of leakage remove the location strap (K) and pull the fitting from the bore. Remove the O-Rings from the fitting.

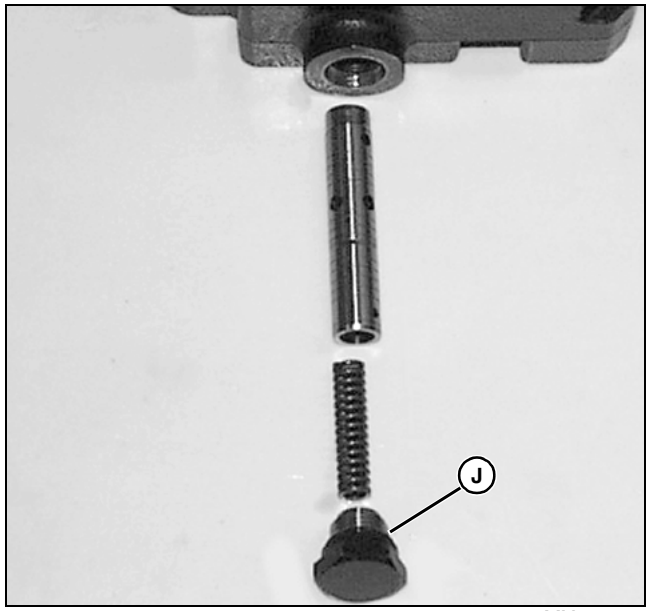
11.Clean and dry all parts.

Assembly:

1. Apply clean transmission oil to all internal parts.

2. Install new O-rings on the suction hose fitting and reinstall in the sub plate.

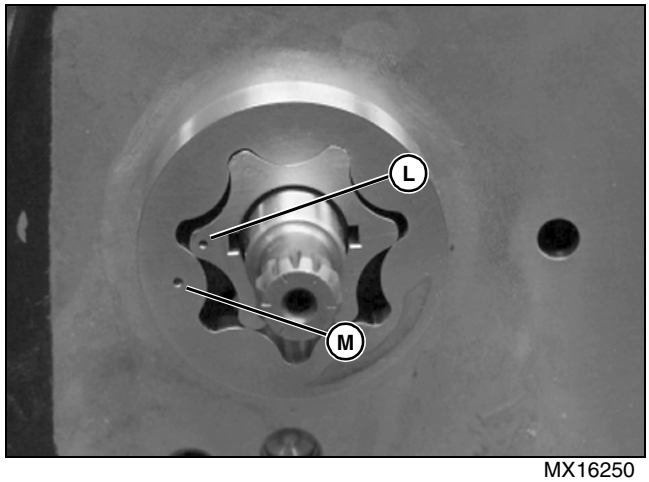
NOTE: Always replace O-rings. Old O-rings may be worn or damaged and will result in leaks.



MX16235

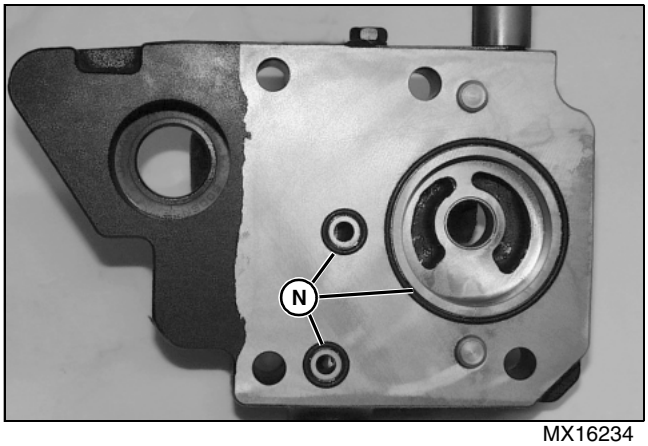
3. Replace the O-Ring on the valve bore plug (J) and install the spring and the priority valve in hydrostatic sub plate. Tighten plug to specification.

4. Install the gear drive pin in the pump shaft.



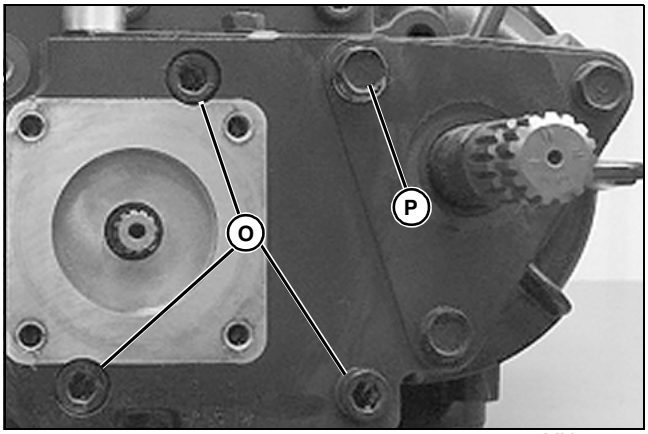
MX16250

5. Install the inner gear on the pin and pump shaft with the identification dimple (L) facing out. Install the outer gear over the inner, with the identification dimple (M) in the position shown.



MX16234

6. Replace the O-Rings (N) in the face of the hydrostatic sub plate.



MX16248

7. Install hydrostatic sub plate on hydrostatic center plate with 1 cap screw (P) and three hex socket head screws (O). Tighten fasteners to specification.

Two Speed Range Transaxle - Removal, Inspection, and Installation

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Snap Ring Pliers Set	NA	Used to remove and install snap rings.
Hydraulic Press	NA	Used to remove and install bearings.

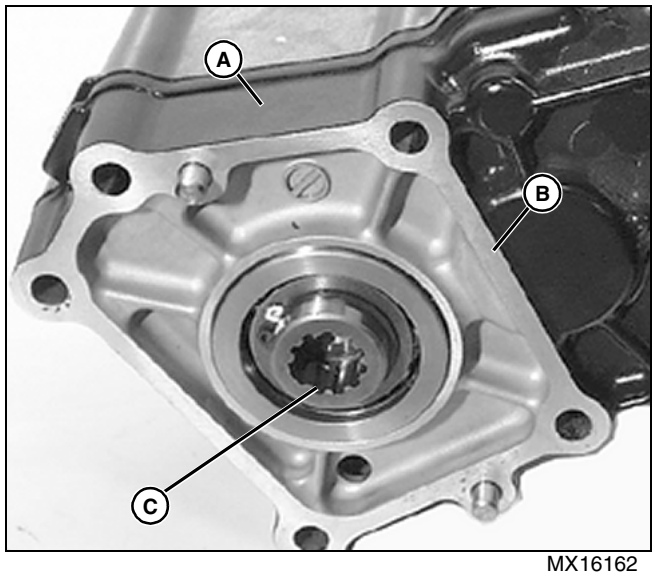
Other Material:

Part No.	Part Name	Part Use
TY16021 (U.S.)/ LOCTITE ® 17430/ TY9484 (Canada)	John Deere High Flex Form in-Place Gasket	Used to make gaskets.
TY16285 (U.S.)/ LOCTITE ® 17649/ CXTY16285 (Canada)	John Deere Cure Primer	Used to clean parts and speed cure of sealant.

Disassembly/Inspection:

1. Remove transaxle. (See “Transaxle Removal and Installation” on page 589.)

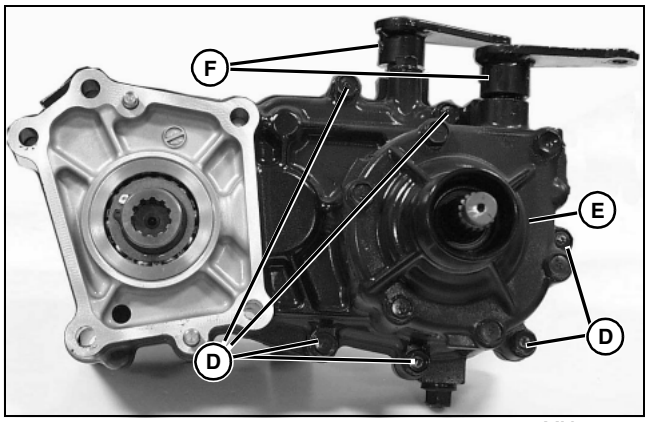
2. Separate hydrostatic assembly. (See “Hydrostatic Assembly-to-Differential Assembly Separation and Installation” on page 592.)



MX16162

3. Remove two speed range case (A) from the transaxle case. Remove any gasket material and clean the mating surface (B).

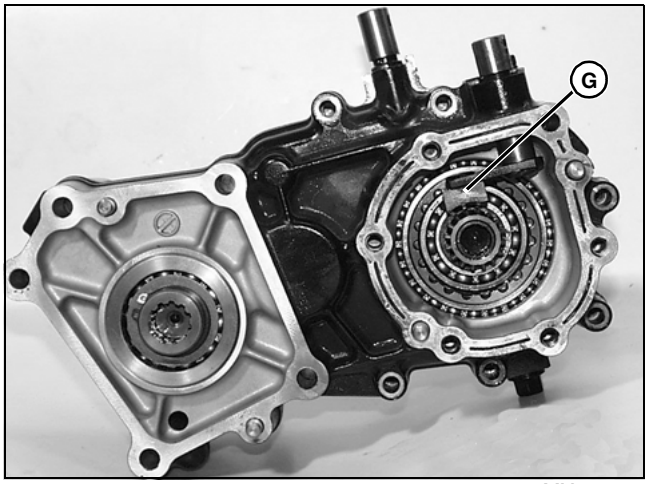
4. Inspect splines (C). If splines are worn or damaged, replace gear.



MX16164

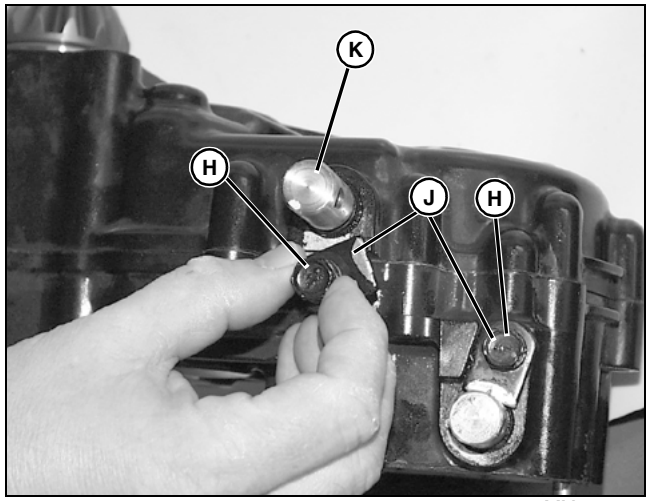
5. Remove the four wheel drive output unit (E). (See “Four Wheel Drive Output Unit - Removal, Inspection, and Assembly” on page 610). Remove six cap screws (D) from the front case half of the two speed range transaxle.

6. Drive the roll pins (F) from the High-Low and Four Wheel Drive actuator arm levers and remove the levers from the shafts.



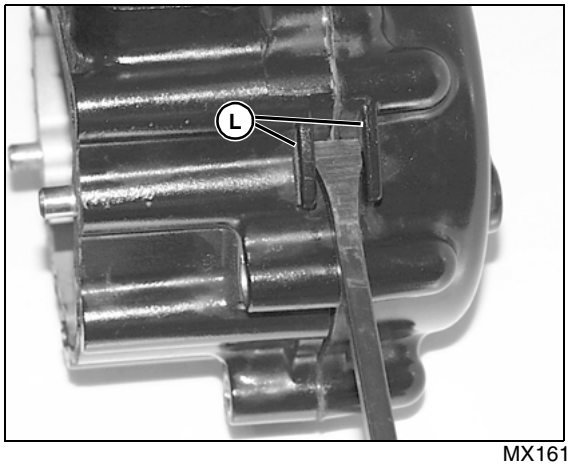
MX16166

7. Slide the clutch shoe (G) down off the pin on the actuator lever.



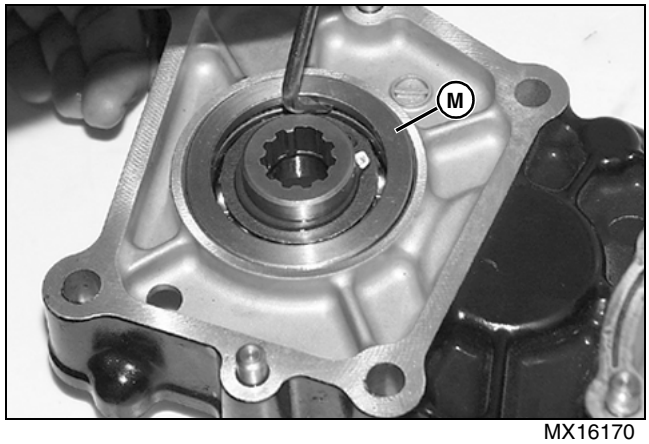
MX16169

8. Remove the cap screws (H) lock washers and straps (J) securing the actuator shaft to the cases. Remove the Four Wheel Drive actuator shaft (K) and the O-ring from the front case half. Discard O-ring



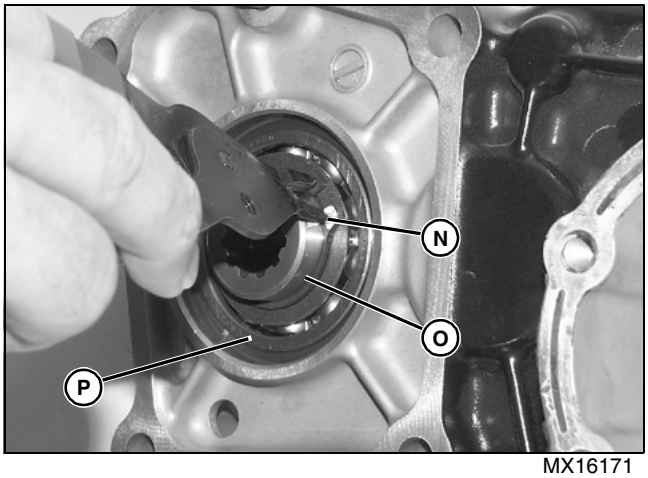
MX16167

9. Separate the two speed range unit cases by using an appropriate tool at the pry points (L) on the cases.



MX16170

10.Remove the spacer collar (M) from the high-low output shaft bearing in the front case half to access snap ring.



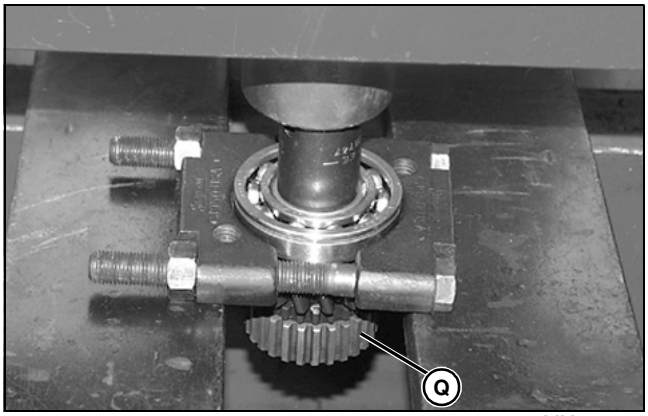
MX16171

11.Remove the snap ring (N) and washer from the output shaft.

12.Press the output shaft (O) down through the bearing (P), until the shaft end is flush with the bearing.

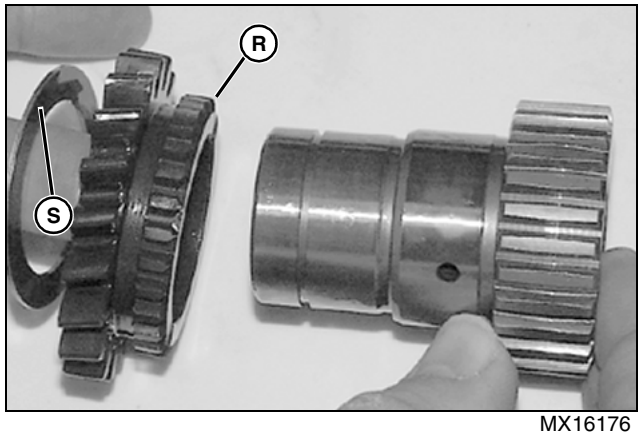
13.Turn the case over and drive the bearing and shaft assembly up, until the locator ring on the outside of the bearing is accessible. Remove the locator ring from the groove in the outer bearing race.

14.Turn the case back over and press the complete bearing/gear/shaft assembly down out of the case.



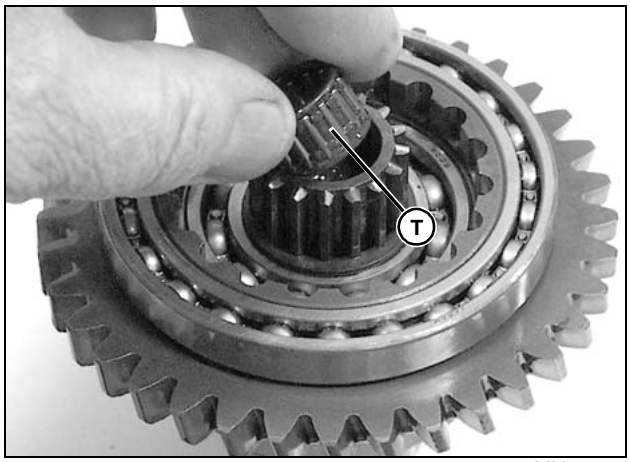
MX16174

15. Press the shaft and gear assembly (Q) completely out of the bearing using a hydraulic press.



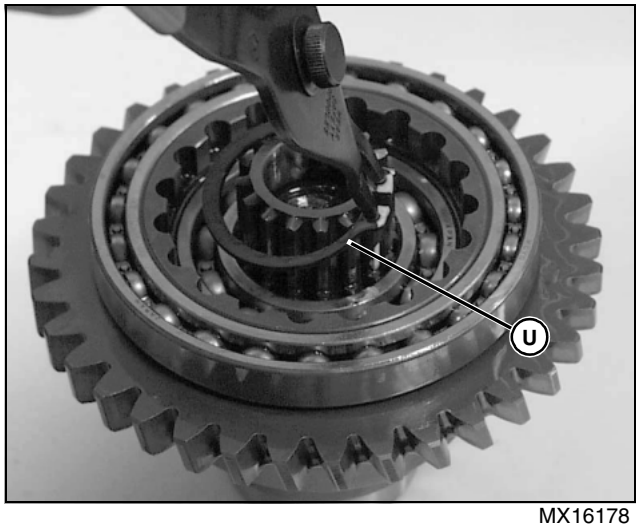
MX16176

16.Remove the shifter gear (R) and spacer (S) from the output shaft. Check gears on shifter gear and output shaft for signs of wear or damage, replace if necessary.



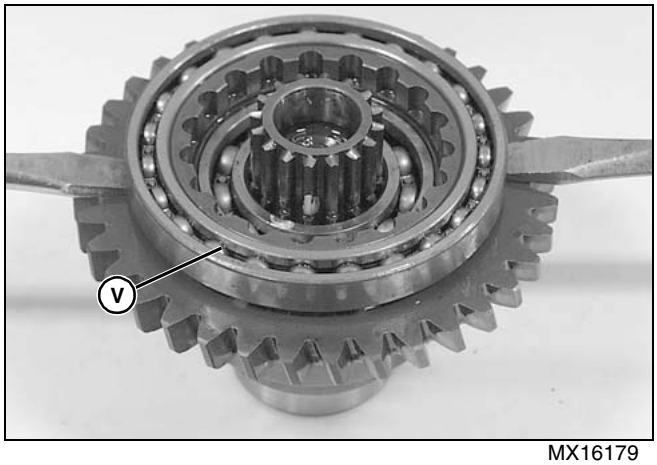
MX16177

17.Remove the needle bearing (T) from the output clutch shaft.



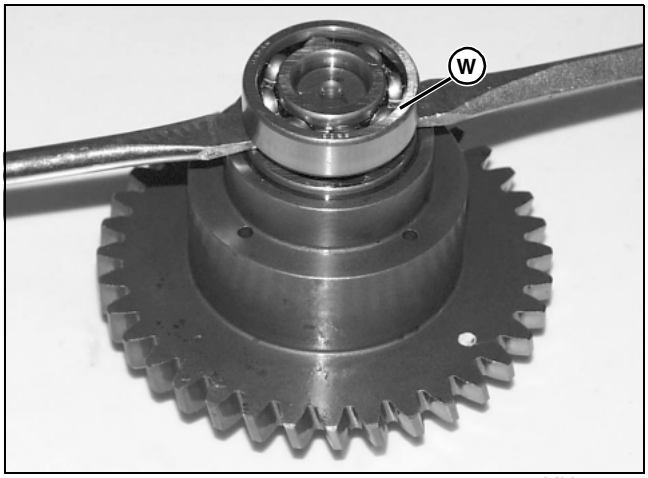
MX16178

18.Remove the inner bearing locator snap ring (U) from the output clutch shaft.



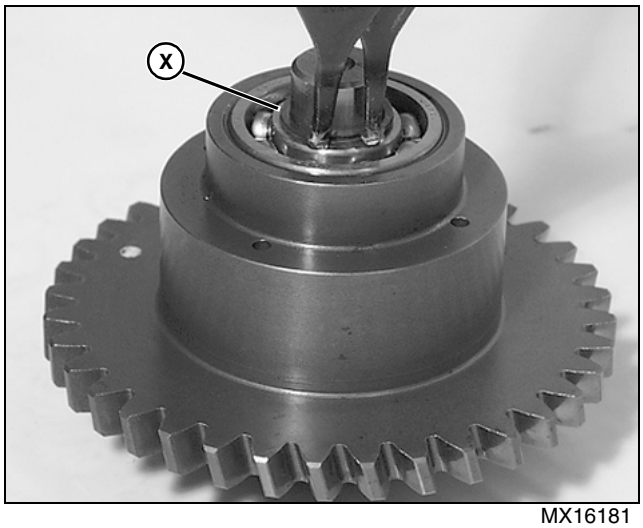
MX16179

19.Remove the outer bearing (V) from the output clutch gear hub.



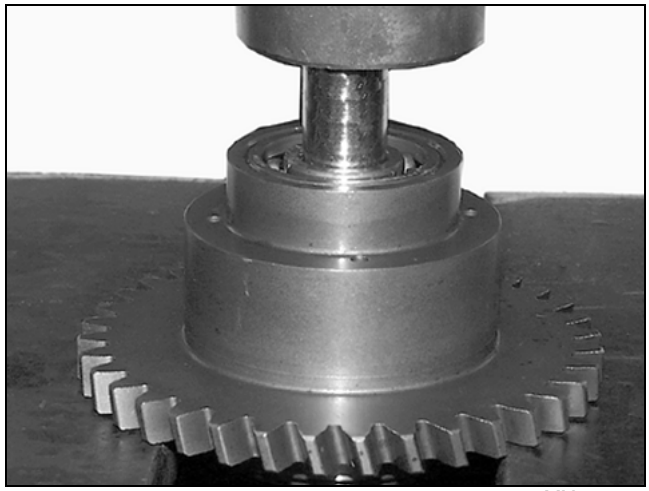
MX16180

20.Turn the output clutch gear hub over and remove the bearing (W) from the clutch shaft.



MX16181

21.Remove the snap ring (X) from the inner bearing



MX16182

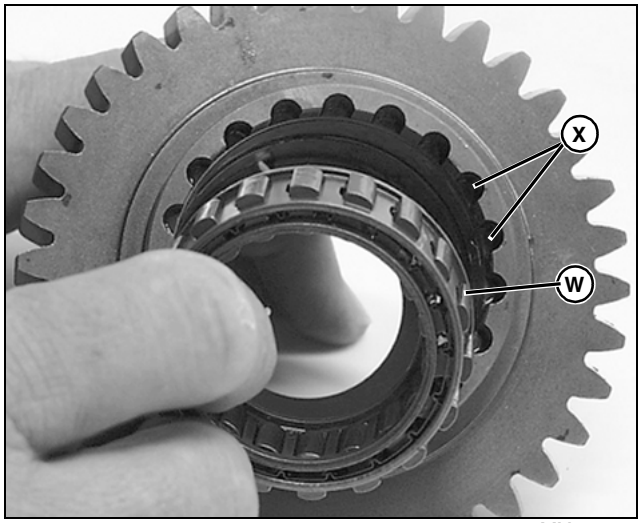
22.Put the clutch hub assembly in a press, and press the inner bearing from the shaft

23.Check all four output clutch bearings that were removed for damage, wear or rough movement. Replace if necessary.



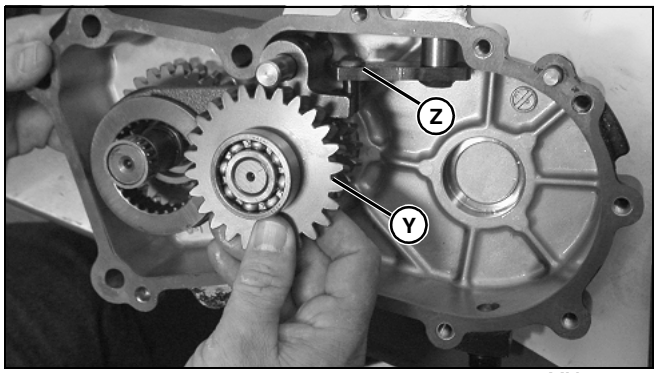
MX16183

24.Remove the snap ring from the clutch in the clutch hub.



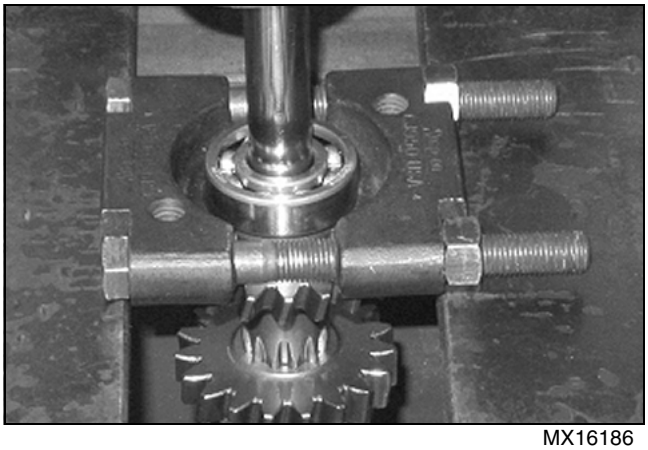
MX16184

25.Lift the clutch (W) out of the clutch housing. Inspect clutch cage and engagement rollers for wear or damage. Inspect the clutch housing for wear or damage. Note particularly the condition of the clutch housing ears (X). Replace as needed.



MX16185

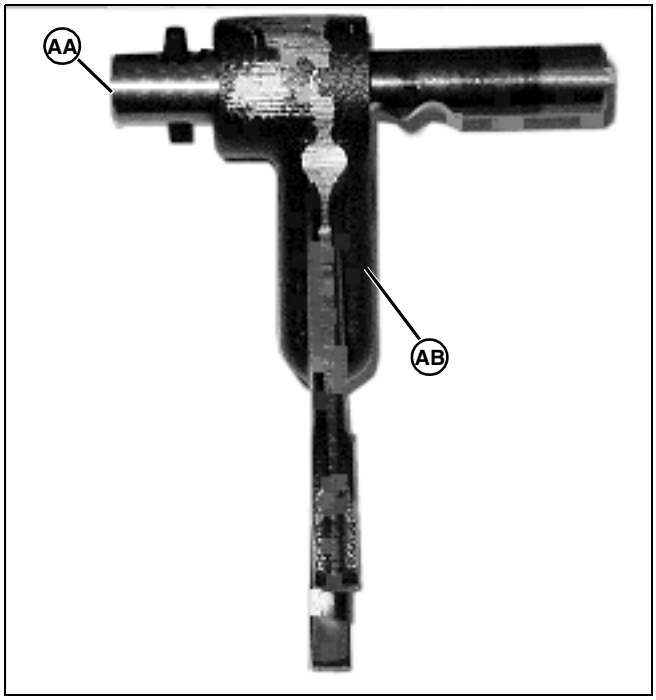
26.Remove the Idler gear assembly (Y) by disengaging the actuator arm pin from the shifter fork (Z) as the gear assembly is lifted out of the case.



MX16186

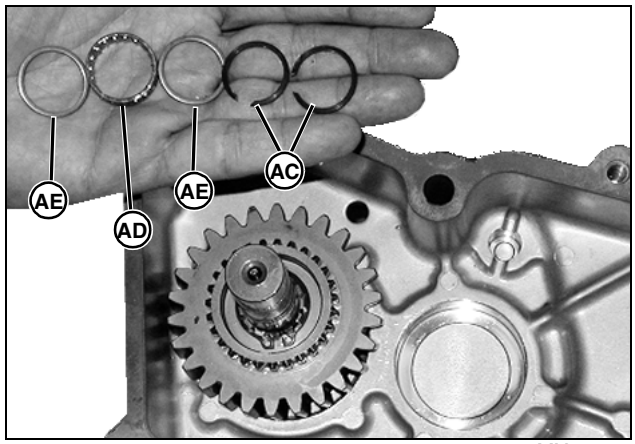
27.Press bearing off both ends of the idler shaft to remove the idler gears.

CAUTION: Avoid injury! Detent ball is under tension. Use caution when removing actuator arm to prevent bodily injury.



MX16187

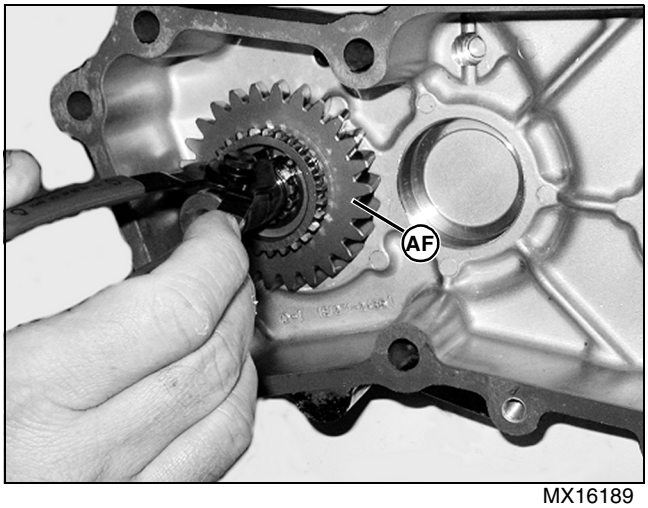
28.Disassemble shifter fork assembly, by pulling the actuator arm (AA) out of the fork (AB). Take care not to lose either the detent ball or spring that will be released when the actuator arm is pulled out of the fork.



MX16188

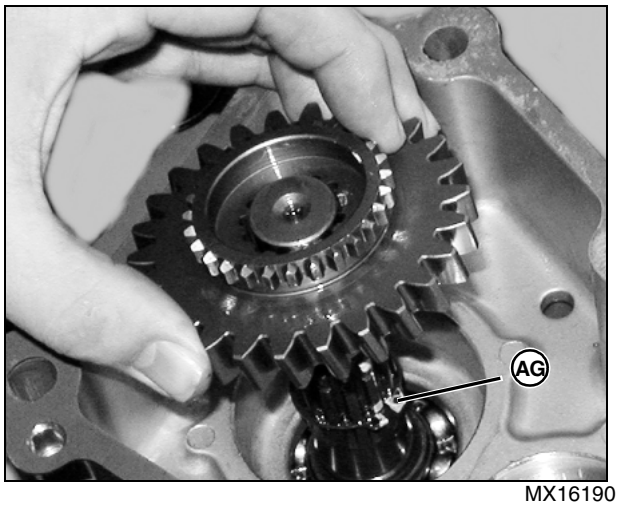
29.Slide the upper needle bearing and two bushings off the end of the reduction shaft.

30.Remove the two C rings (AC) from the reduction shaft and slide the second needle bearing (AD) and bushings (AE) off the shaft.



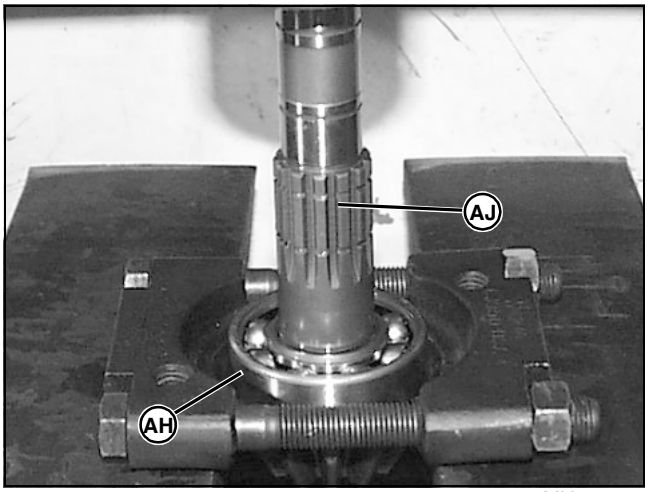
MX16189

31.Remove the snap ring located above the reduction gear (AF) on the reduction shaft.



MX16190

32.Slide the reduction gear off the shaft. Remove the second snap ring (AG) located beneath reduction gear.

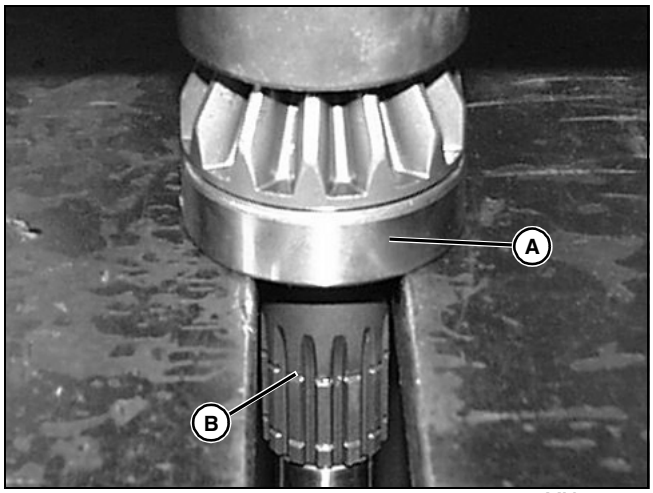


MX16195

33.Remove the reduction shaft and bearing from the case. Press the bearing (AH) off the reduction shaft (AJ) using a knife edge bearing separator to support the bearing.

34.Inspect the gear teeth on the bevel gear. If teeth are worn, chipped or damaged, replace the reduction shaft. Inspect the splines on the reduction shaft and the reduction gear. If splines are worn or damaged on either component, replace the gear and shaft as a set. Inspect the bearing for wear, damage, or rough movement, replace as needed.

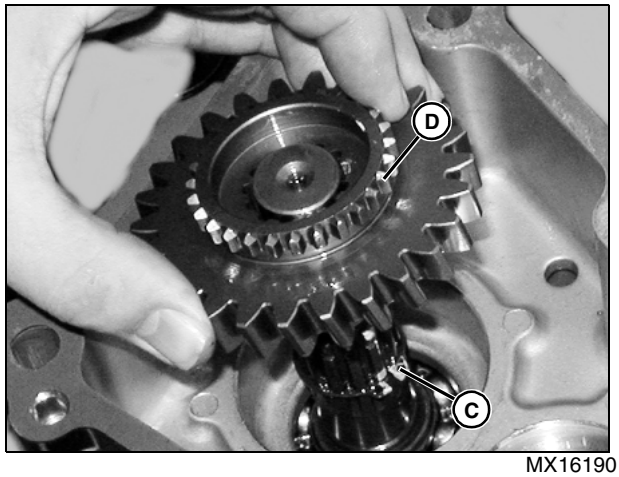
Reassembly:



MX16202

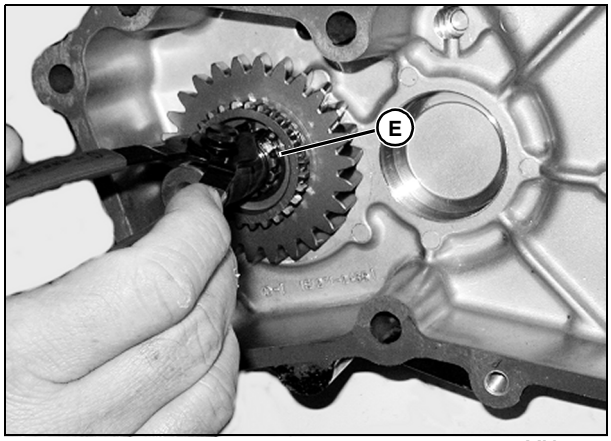
1. Install bearing (A) on reduction shaft (B) using a hydraulic press. Press the bearing races tight against the reduction shaft gear shoulder.

2. Install the reduction shaft and bearing into the case from the front.



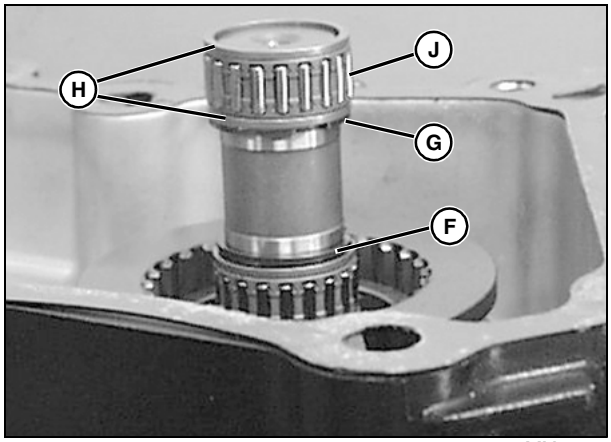
MX16190

3. Install the bottom snap ring (C) on the reduction shaft from inside the cases. Slide the reduction gear down into position with the toothed collar (D) pointing up.



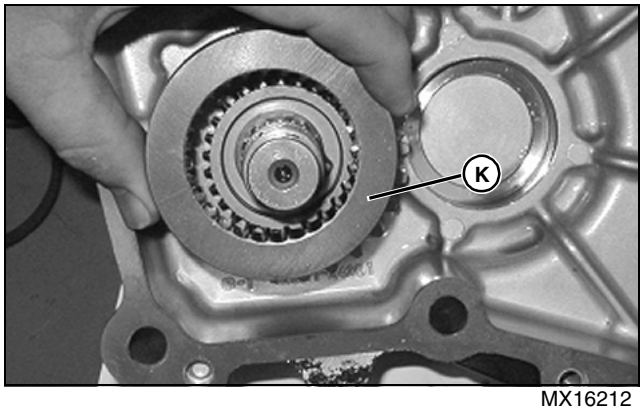
MX16190

4. Install the upper snap ring (E) above the reduction gear.



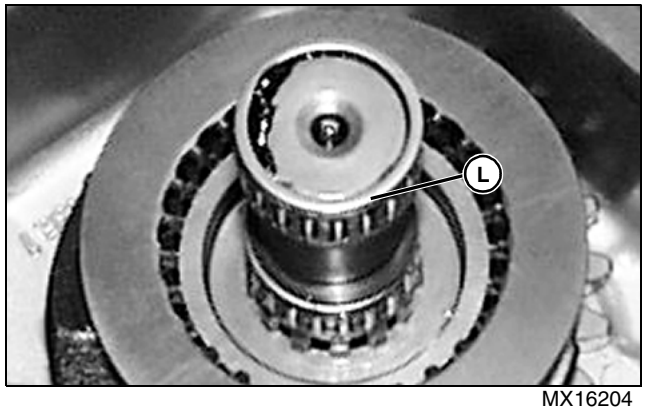
MX16203

5. Slide a bushing, a roller bearing and then a bushing down on the shaft. Secure the first roller bearing set with a C ring (F). Install the second C ring (G), bushings (H) and roller bearing (J) on shaft.



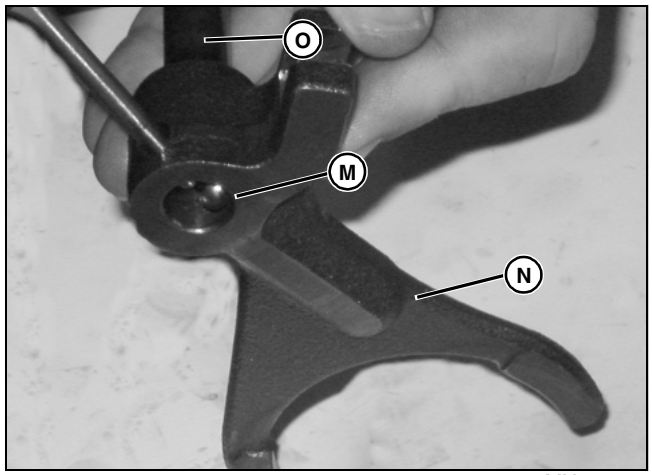
MX16212

6. Install the shift collar (K) with recess to the bottom, meshing it with the reduction gear.



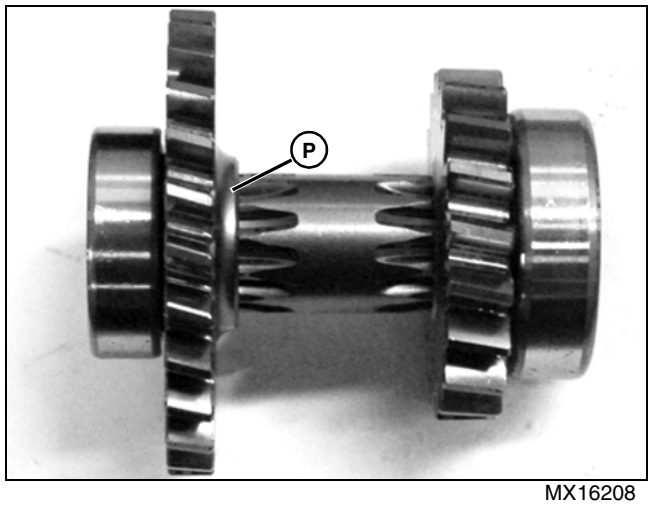
MX16204

7. When installing the top bushing (L) on the reduction shaft, use heavy grease to hold it in position. This is necessary to prevent dislodging the bushing during case assembly.



MX16205

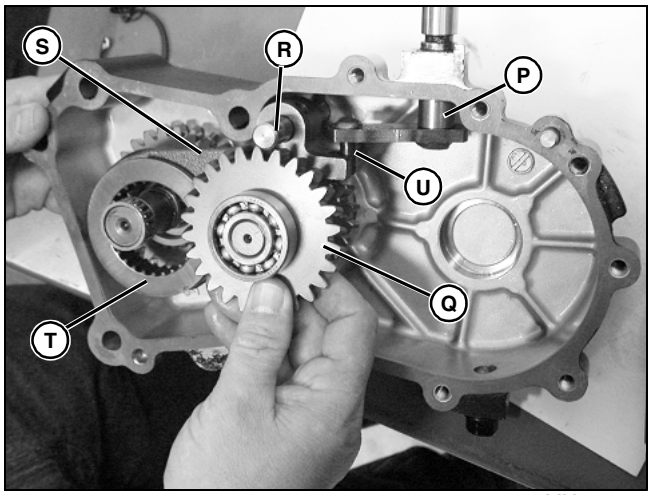
8. Install the detent spring and ball (M) in the shift fork (N). Assemble the shift fork, by pressing down on the detent ball with a flat end punch while sliding the actuator arm (O) into the fork.



MX16208

9. Install the idler gears on the idler shaft. Note that the

shoulder (P) on the upper gear is mounted down (away from bearing). Press bearing on both ends, so that races are flush with the gear faces.



MX16209

10.Install a new o-ring in the cover and install the 4-wheel drive actuator shaft (P) in the case.

11.Lower the idler gear assembly (Q) and the shift fork assembly (R) down into the case simultaneously. The ears on the shift fork (S) must be meshed with the shift collar (T) and the shift pin (U) must be fitted into the actuator arm as the idler gear is positioned in the case bore.



MX16213

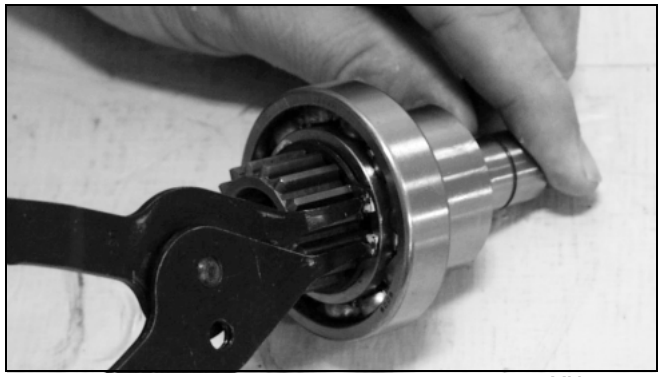
12.Install the outer bearing (V) on the output clutch gear hub.

13.Install the clutch into the clutch housing with the flange on the clutch (W) to the inside. Clutch should free-wheel when rotated clockwise and lock when rotated counter-clockwise.



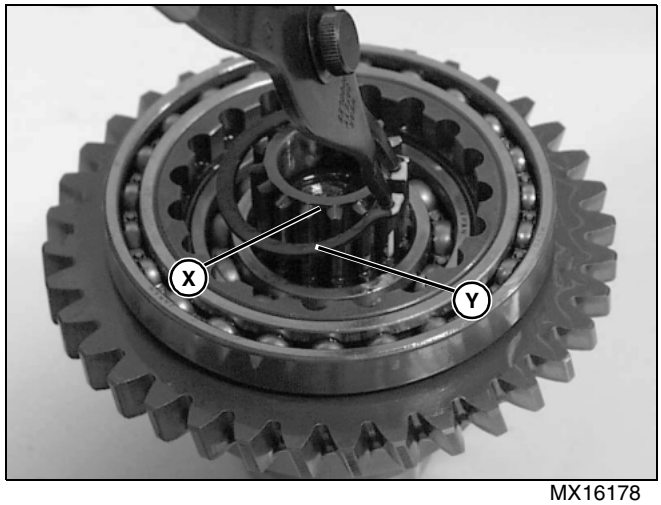
MX16214

14.Install the clutch retention snap ring in the clutch hub.



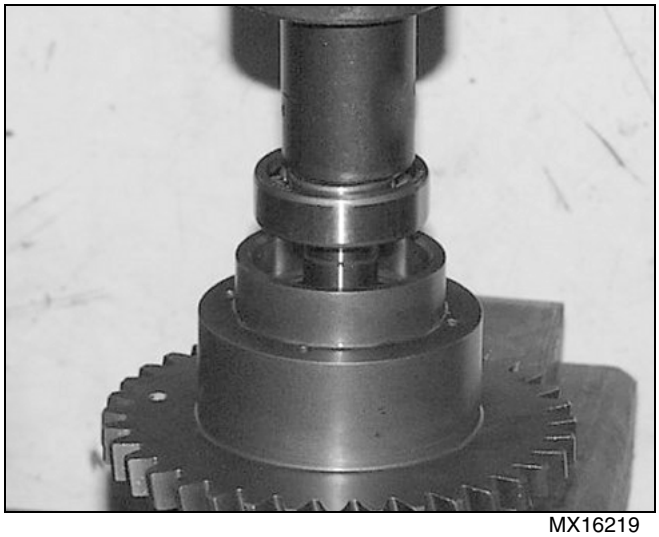
MX16218

15.Install bearing on output clutch shaft assembly and secure with snap ring.

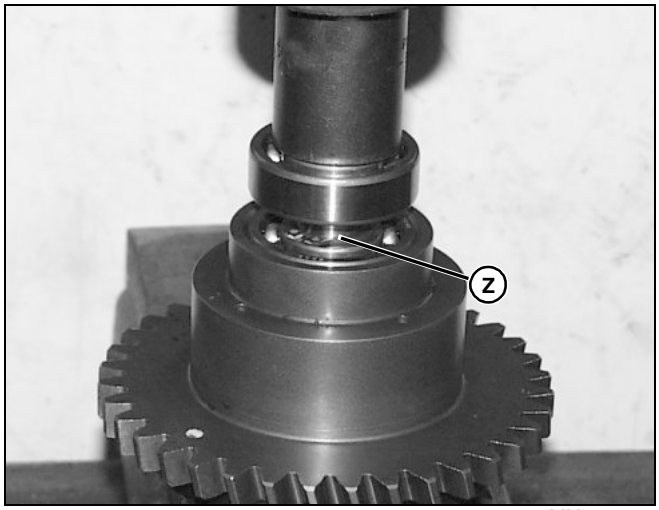


MX16178

16.Insert the output clutch shaft assembly (X) into the clutch hub, meshing with the clutch. Install the inner bearing locator snap ring (Y).


MX16219

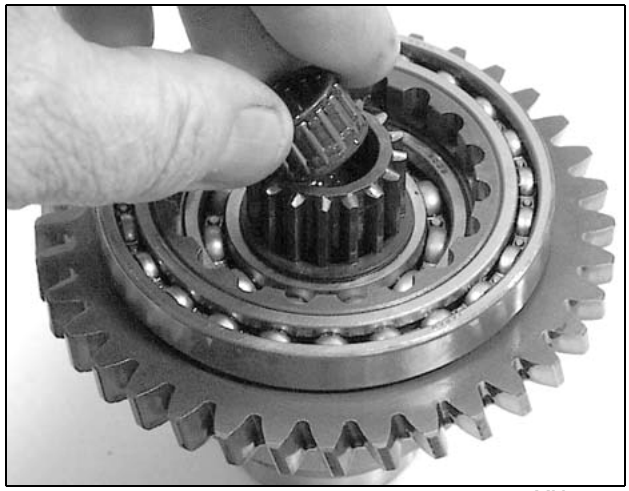
17.Turn the clutch hub over and install the inner bearing with a press. Press the bearing into the hub until the outer race is flush with the top of the hub.



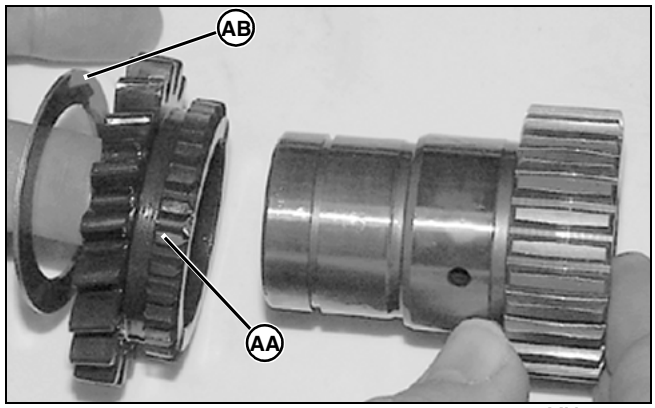
MX16220

18.Install snap ring (Z).

19.Press the outer bearing onto the output shaft until it is flush with the inner clutch hub bearing.

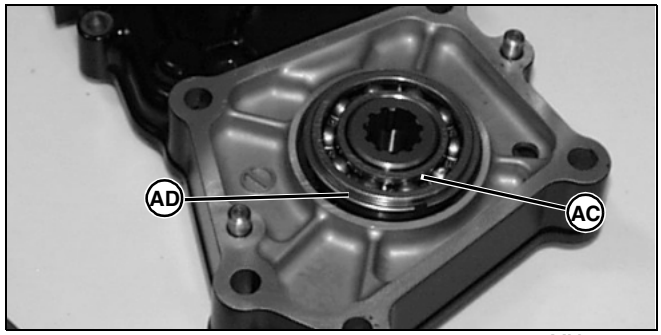

MX16177

20.Turn the clutch hub over and install the needle bearing into the output clutch shaft.



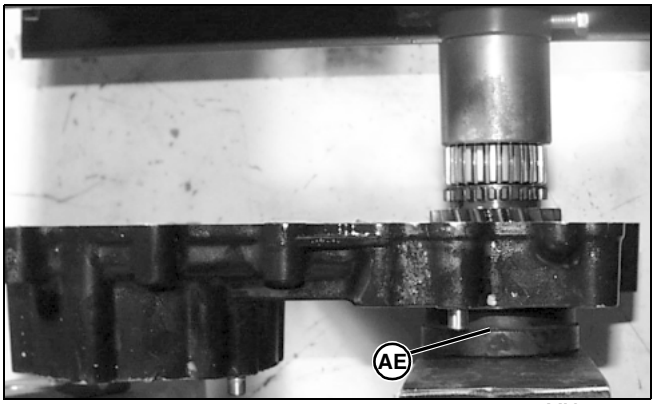
MX16176

21.Install the shifter gear (AA) and spacer (AB) on the high-low output shaft.



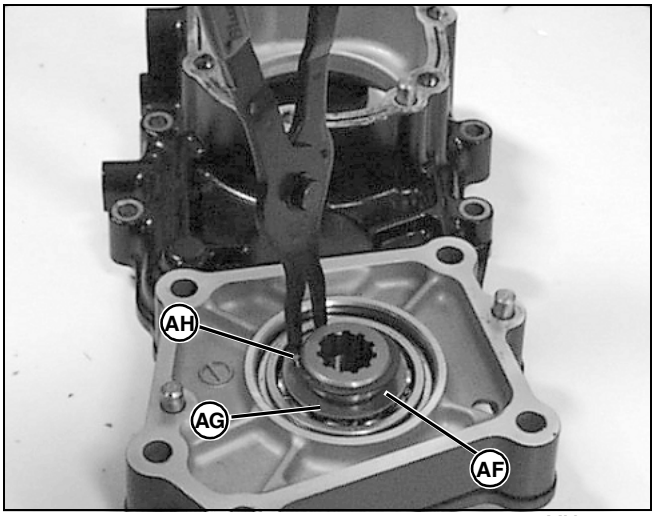
MX16222

22.Install the high low shaft assembly in the case from the back. Install the locator ring on the outside of the bearing. Turn the case over and press the bearing (AC) and locator ring (AD) assembly onto the high-low shaft until the bearing is flush with the end of the shaft.



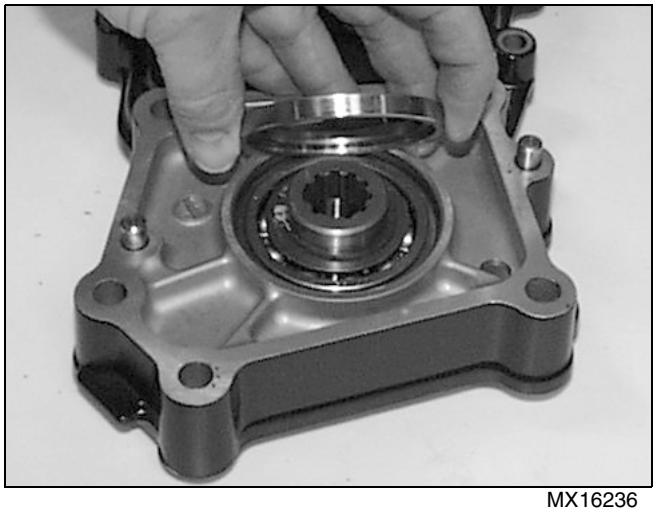
MX16223

23.Turn over the case and block up securely in a press. Support the inner bearing race with an appropriate bearing collar (AE) and press the high-low input shaft through the bearing until the bearing locator ring is seated on the cases.



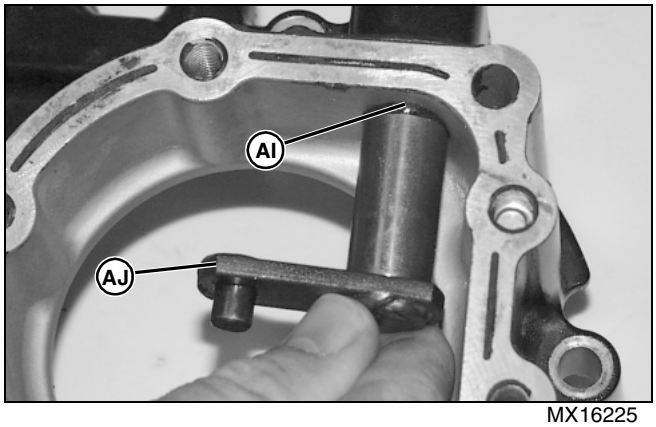
MX16224

24.Turn the case back over. Check that the snap ring groove (AF) is fully accessible when the bushing (AG) is installed on the high-low input shaft. Install the snap ring (AH).


MX16236

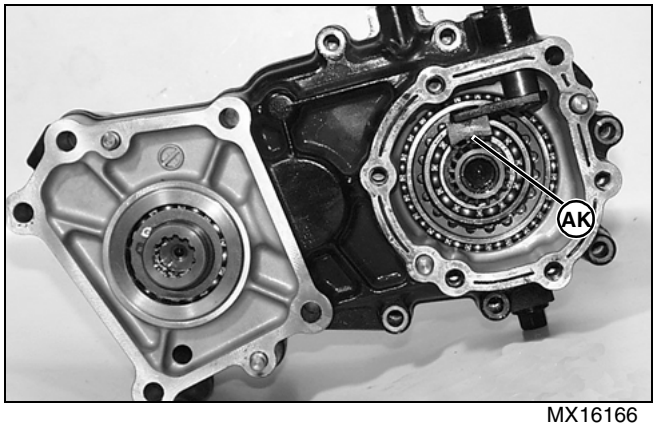
25.Install the spacer collar over the high-low output shaft with the recess facing down.

26.Rotate the input gear assembly to check that the shifter gear does not contact the cases. If the gear binds on the cases, the input shaft has been pressed too deep into the bearing.



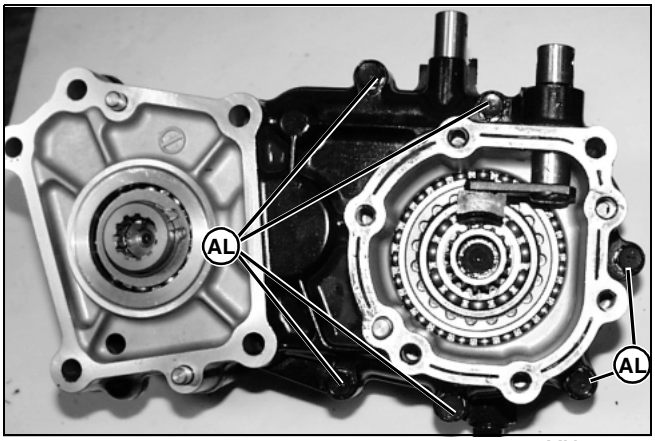
MX16225

27.Install a new o-ring (AI) on the four wheel drive actuator arm (AJ) and reinstall the arm in the front case half.



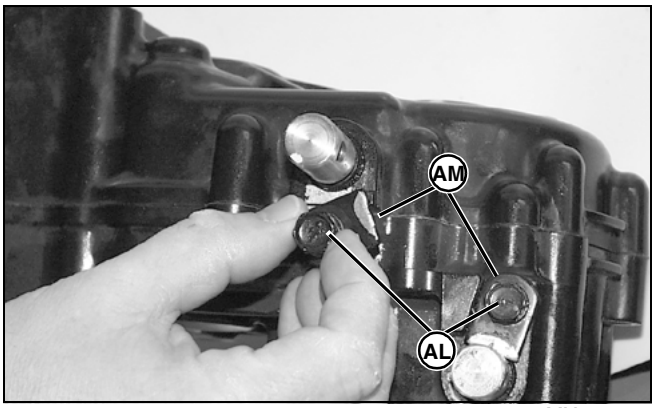
MX16166

28.Apply grease to the clutch shoe and install it on the actuator arm pin with the curve (AK) facing down.



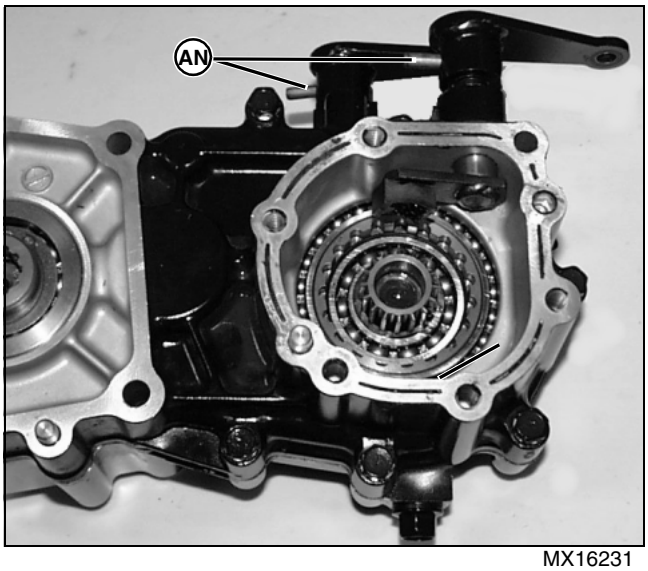
MX16230

29.Install a new gasket on the front case half and reassemble the range unit cases. Turning the high- low output shaft may help in meshing the splines as the cases are reassembled. Fasten the cases together with the six cap screws (AL) and tighten to specifications.



MX16169

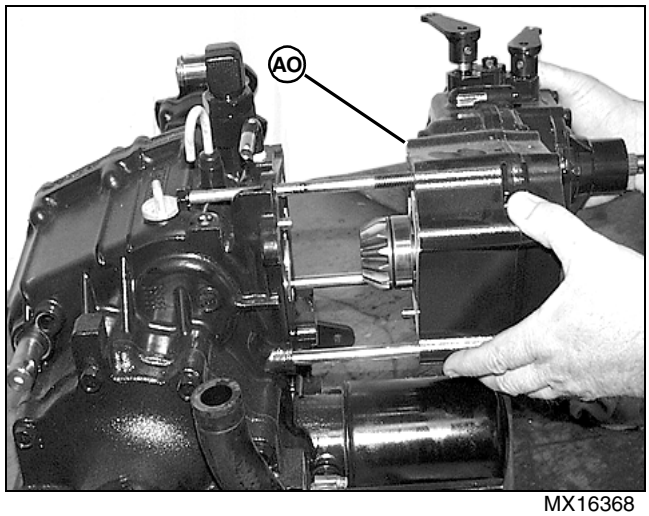
30.Secure the actuator shafts to the cases with cap screws (AL), lock washers and straps (AM).



MX16231

31.Install the High-Low and Four Wheel Drive actuator levers on the range unit with the levers positioned to the outside. Secure with roll pins (AN).

32.Install the Four Wheel Drive Output unit. (See “Four Wheel Drive Output Unit - Removal, Inspection, and Assembly” on page 610.)



MX16368

33.Install a new gasket on the mating surface (AO) of the two speed range case. Slide the range case onto the mounting studs until against transaxle.

Specifications:

Make Up Oil Check Valve Torque . . . . . 34 N•m (25 lb-ft)

Charge Relief Valve Torque . . . . . 24 N•m (212 lb-in.)

Swashplate End Play . . 0.20-0.50 mm (0.007-0.0019 in.)

Center Section-to-Housing Hex Socket and Cap Screw Torque . . . . . 42 N•m (31 lb-ft)

Four Wheel Drive Output Unit - Removal, Inspection, and Assembly

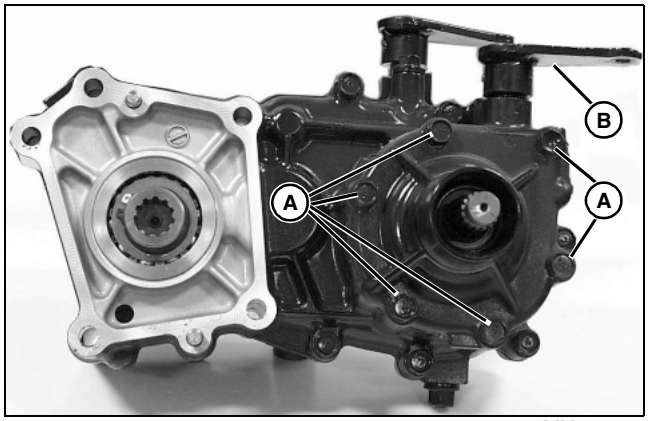
Disassembly/Inspection:

1. Remove transaxle. (See “Transaxle Removal and Installation” on page 589.)

2. Separate hydrostatic assembly. (See “Hydrostatic Assembly-to-Differential Assembly Separation and Installation” on page 592.)

3. Remove Two Speed Range Transaxle. (See “Two Speed Range Transaxle - Removal, Inspection, and Installation” on page 600.)

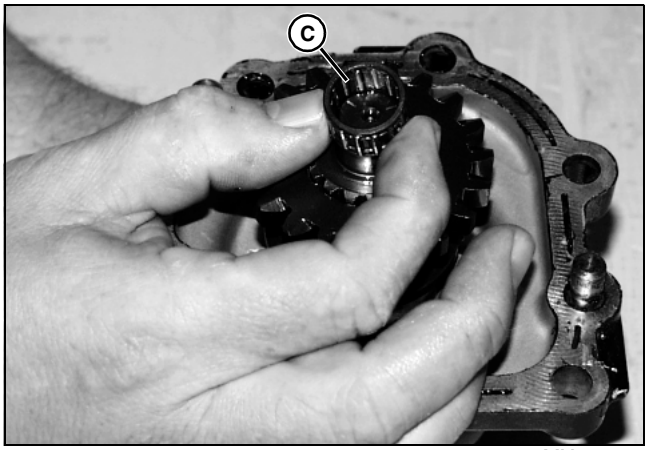
NOTE: Use shop cloths or paper towels to catch and clean up any spilled oil immediately. Close all ports and lines using caps or plugs.



MX16237

4. Remove six cap screws (A) holding the Four Wheel Drive Output Unit to the Transaxle and pull off cover.

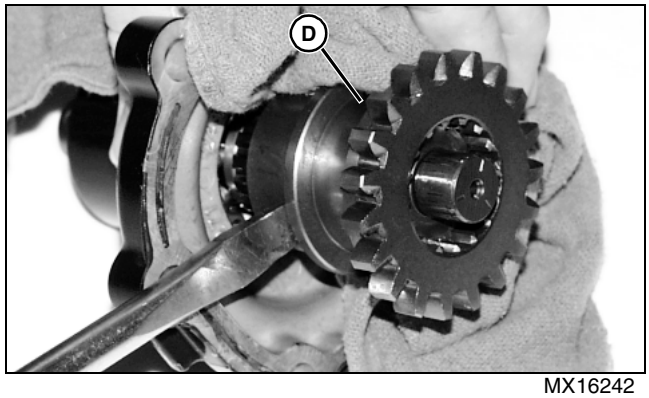
NOTE: Rotating the Four Wheel Drive Actuator arm (B) forward will help in breaking the cover seal.



MX16239

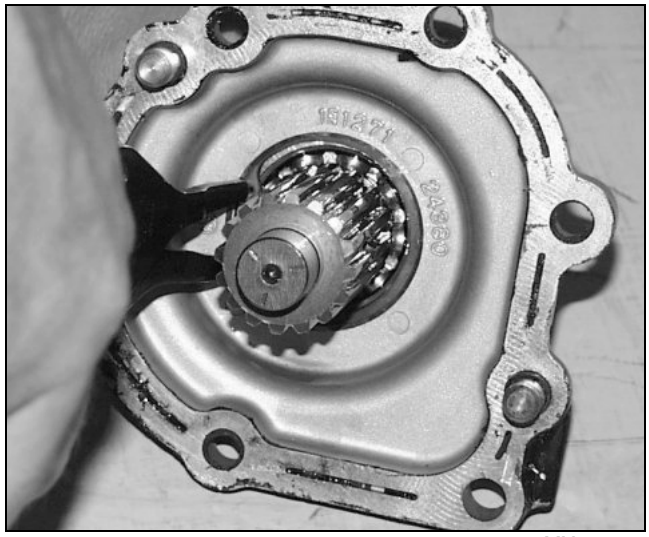
5. Remove the needle bearing (C) from the end of the output shaft.

CAUTION: Avoid injury! Detent balls are under tension. Use caution when removing to prevent bodily injury. Removing the clutch shifter gear will release the detent balls and spring. Cover the unit with a rag or perform this operation in a closed box to prevent loss of components.

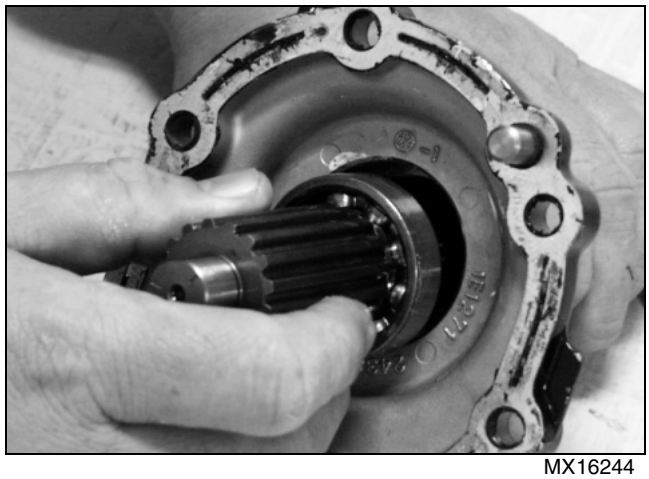


MX16242

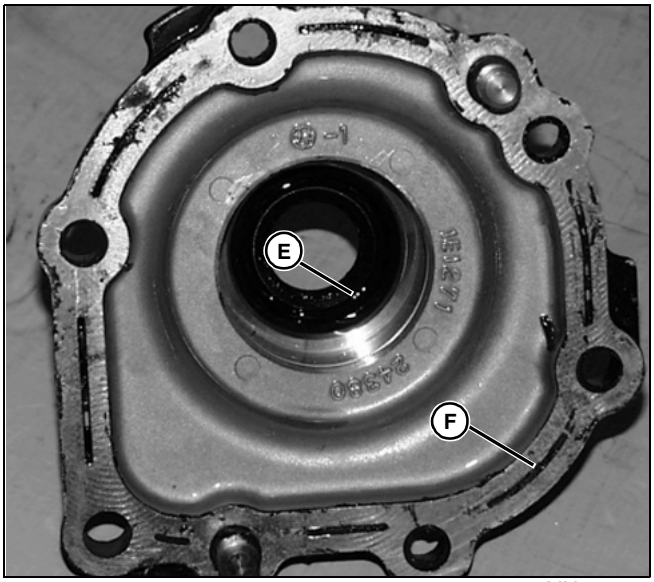
6. Lever the clutch shifter gear (D) off the output shaft.


MX16243

7. Remove the bearing location snap ring from the cover.


MX16244

8. Remove the output shaft and bearing from the cover as a unit. Take care not to damage the cover seal while removing the output shaft.



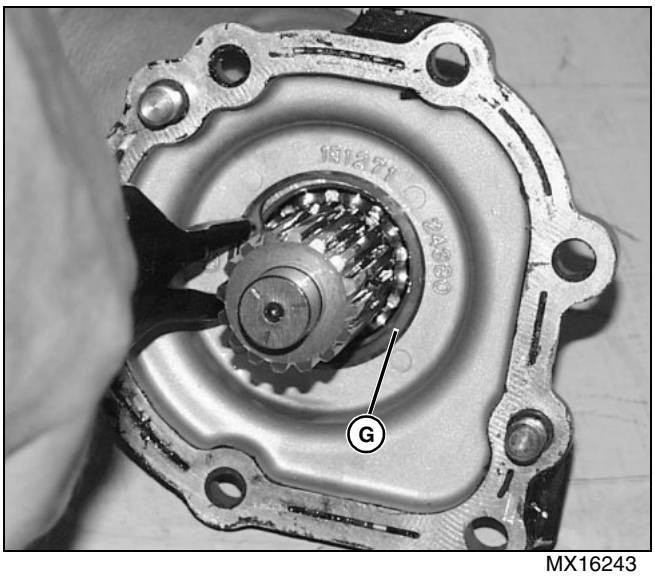
MX16245

9. Inspect the seal (E) in the nose of the cover for signs of damage or leakage. Press seal out of cover and replace if necessary. Remove old sealing compound from the cover and case including the grooves (F) in the cover. Prepare cover and case surface by cleaning with John Deere Cure Primer.

10.Inspect the bearing on the output shaft for signs of damage, wear or rough movement, replace bearing as necessary. Inspect the output shaft and clutch shifter gear splines and gear teeth. If damaged or worn, replace unit as a set.

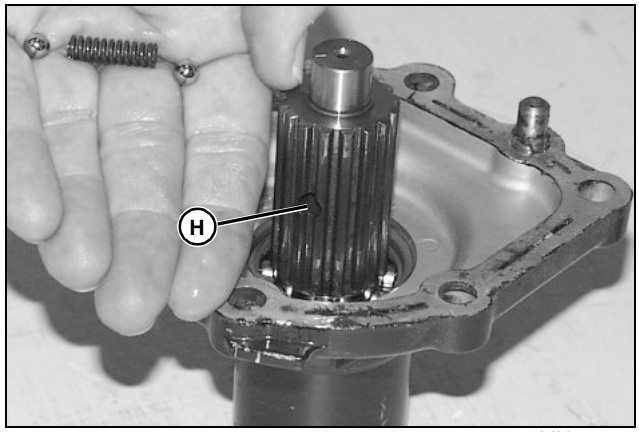
Assembly:

1. Apply grease to the lips of the cover seal and insert the output shaft and bearing assembly through the seal, seating the bearing in the cover.



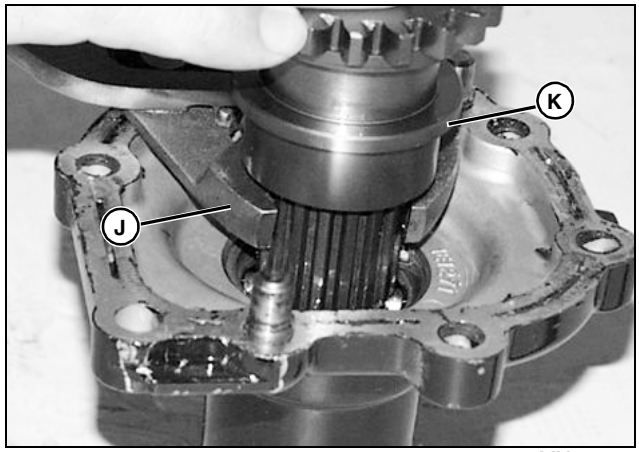
MX16243

2. Install the bearing location snap ring (G) in the cover.



MX16246

3. Grease the components thoroughly and insert the detent spring with one ball on each side of the spring into the bore (H) in the output shaft.

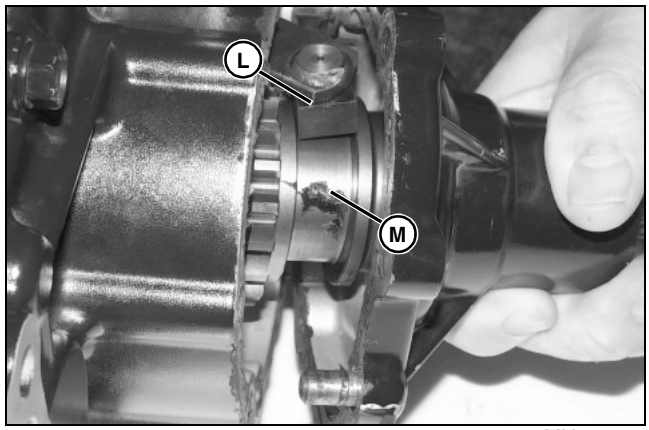


MX16247

4. Squeeze the detent balls into the bore with large pliers (J) while lowering the clutch shifter gear (K) down to the detent recess.

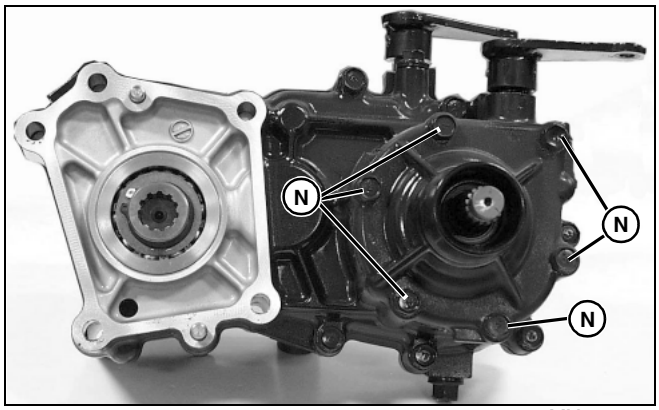
5. Install the needle bearing on the output shaft.

6. Apply a bead of John Deere High Flex Form-in-Place Gasket to the cover sealing surface.



MX16238

7. Position the Four Wheel Drive Actuator arm shift collar (L) in a forward position. Position the shift collar in the clutch shifter gear channel (M) as the output shaft is meshed with the clutch shaft on the range transaxle.



MX16237

8. When the Four Wheel Drive Unit has meshed correctly with the range transaxle, install the six capscrews (N) and tighten to specifications.

Hydrostatic Assembly - Disassembly, Inspection, and Assembly

Disassembly/Inspection:

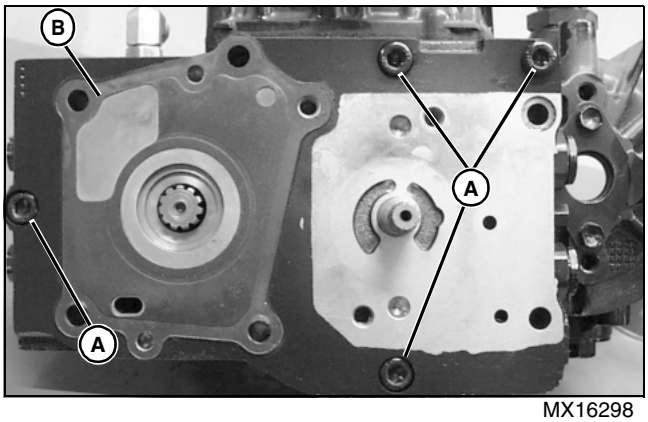
1. Remove transaxle. (See “Transaxle Removal and Installation” on page 589.)

2. Separate hydrostatic assembly. (See “Hydrostatic Assembly-to-Differential Assembly Separation and Installation” on page 592.)

3. Remove Hydraulic Pump. (See “Hydraulic Pump Removal, Disassembly, Inspection, and Assembly” on page 594.)

NOTE: Use shop cloths or paper towels to catch and clean up any spilled oil immediately. Close all ports and lines using caps or plugs.

4. Remove Hydrostatic Sub Plate. (See “Charge Pump Disassembly, Inspection, and Assembly” on page 598.)



MX16298

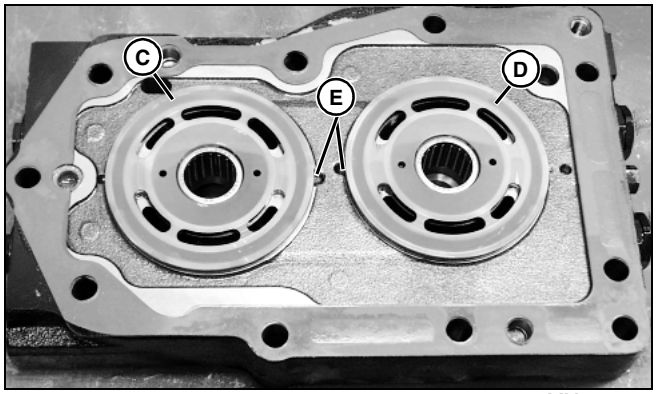
5. Remove four hex socket screws (A) holding the transmission center plate (B) to the transmission center housing.

IMPORTANT: Avoid damage! Do not allow internal parts to fall free when removing center section.

Do not nick or scratch lapped or machined surfaces of the center section, valve plates, or cylinder blocks and pistons.

6. Carefully separate center section (B) from housing. Take care not to let the gasket get hung up on the guide pins. You may have to gently pry it off.

NOTE: If valve plates Do not come off with center section, remove valve plates from cylinder block assemblies. It may be necessary to apply diesel fuel between valve plates and cylinder blocks to cut oil film.



MX16228

7. Remove motor valve plate (C) and pump valve plate (D). If valve plates stick to the center section, it may be necessary to pry valve plates loose from the center section. Use a wooden dowel and pry only at dowel pin grooves (E).

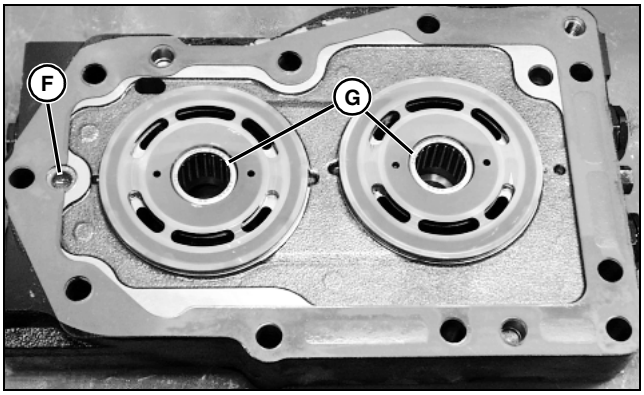
NOTE: Scoring is indicated by fine scratches or grooves cut into the smooth plated surface of the valve plate. Use a close visual inspection with a magnifying glass or feel with your fingertips, fingernail, or a sharpened lead pencil.

If scratches or grooves are detected, the plate must be replaced.



MX5745

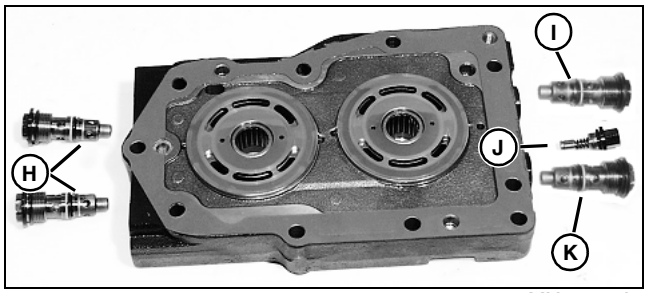
8. Inspect valve plates. Valve plates should be flat, free of all nicks, burrs, scratches, and erosion around the ports. The plated side should show no scoring, smearing, or discoloration (a sign of overheating).



MX16228

9. Inspect strainer screen (F). Clean screen or replace if damaged.

10.Inspect both bearings (G) in the center section. Replace if necessary. Remove bearing using a two-jaw, slide-hammer puller.

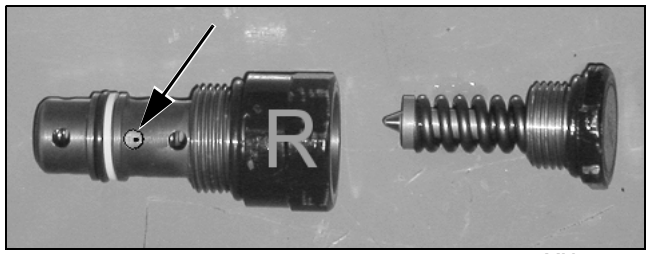


MX16278A

11. Remove make up oil valves (H) and charge pressure relief valve (J).

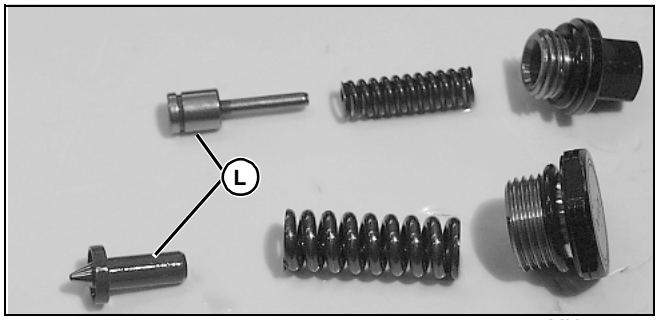
NOTE: Forward and reverse valves are different and cannot be interchanged.

12. Mark forward valve (I) and reverse valve (K) for proper placement during reassembly. Remove forward and reverse relief valves.



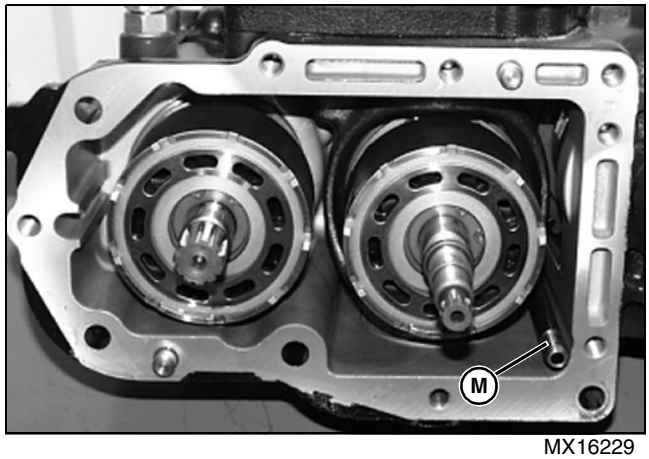
MX16362

13.The reverse valve can be identified by a small orifice in internal part of valve (arrow). Internal valve may have to be rotated with a soft piece of wire to observe orifice.



MX16279

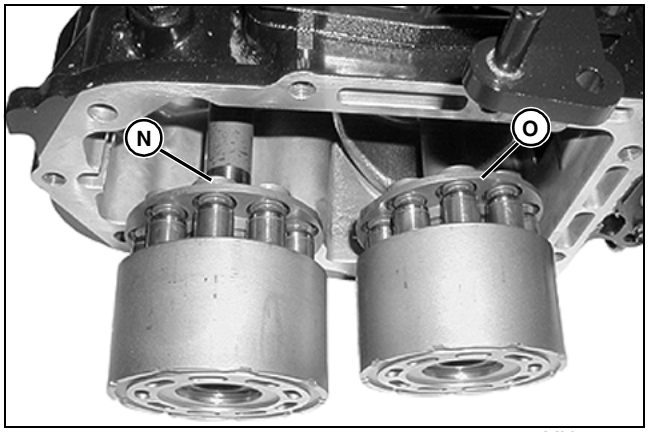
14.Inspect valves (L) and seats for damage. Valves must slide freely in their bores. Valve seals must not be cut or damaged. Replace valves as necessary. Tighten valves to specification.



MX16229

15.Remove PTO supply tube (M).

IMPORTANT: Avoid damage! Do not nick or scratch lapped surface of cylinder blocks.



MX16280

16.Reach in to grab pump assembly piston retainer rim (O) to ensure none of the pistons slip out of the cylinder block as you remove assembly from the pump shaft.

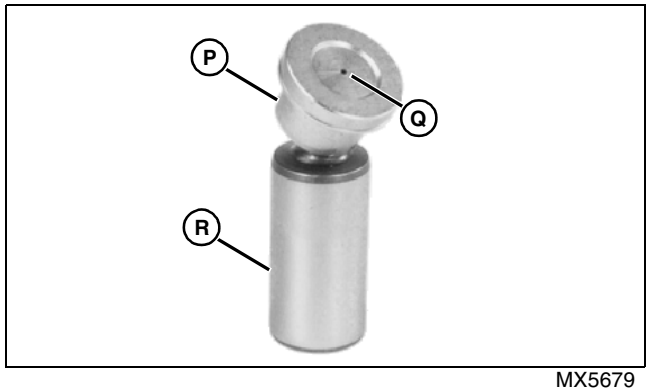
17.In the same manner, reach in to grab motor assembly piston retainer rim (N) and remove assembly from the motor shaft.

NOTE: Piston-to-bore relationship need not be maintained. Pistons and cylinder blocks are not matched sets.


MX5750

18.Inspect cylinder block assemblies.

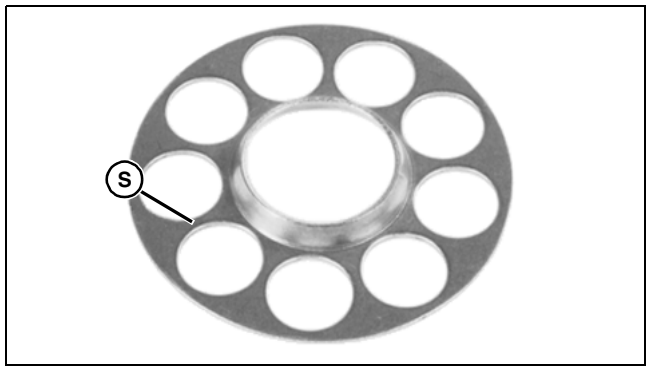
- Lift piston retainer and pistons from cylinder block.
- Check for free movement of pistons in cylinder bores as you remove them.
- If any dragging is detected, replace entire cylinder block assembly.



MX5679

19.Remove and inspect all pistons:

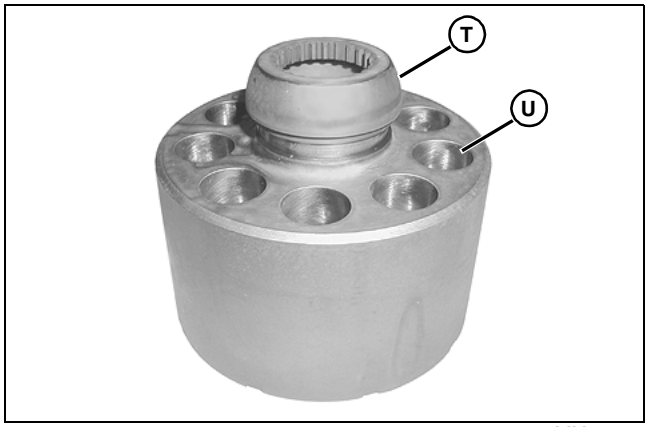
- Check barrel (R) for scoring, discoloration, or any signs of separation of slippers.
- Check slipper (P) for scoring, smearing, rolled edges, and a full 360° free rotation on barrel.
- Check lubrication hole (Q) for blockage. Clean with compressed air.
- If any component of the piston is damaged, replace the entire cylinder block assembly.



MX5680

20.Remove and inspect both piston retainers:

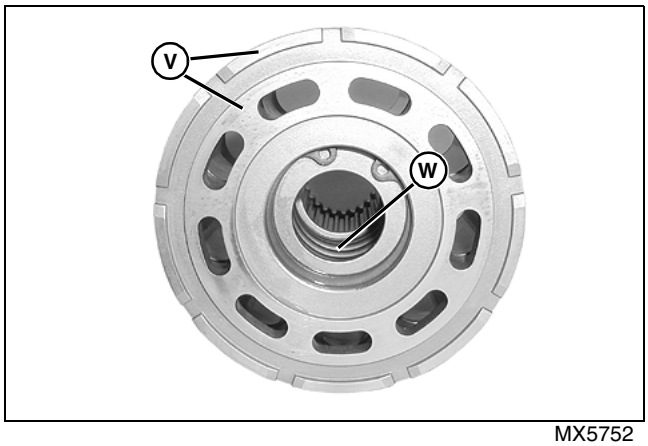
- Check retainer (S) for flatness, nicks, burrs, and discoloration or scoring.
- If any part of the piston retainer is damaged, replace the entire cylinder block assembly.



MX5751

21.Check cylinder blocks:

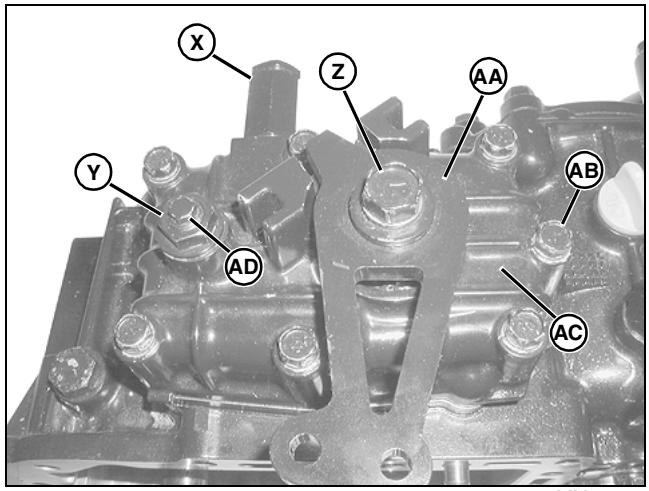
- Check ball guide area (T) for scoring, wear, and damage.
- Check nine cylinder bores (U) for burns and scoring.



MX5752

22.Inspect both cylinder blocks:

- Check lapped surface (V) for wear and damage.
- Check spring assembly (W) for damage and free axle movement.
- If any part of the cylinder block is damaged, replace the entire cylinder block assembly.



MX5753

23.Remove return spring assembly (X). Inspect plunger for excessive tip wear and that plunger does not bind. If plunger binds or has excessive tip wear, replace return spring assembly.

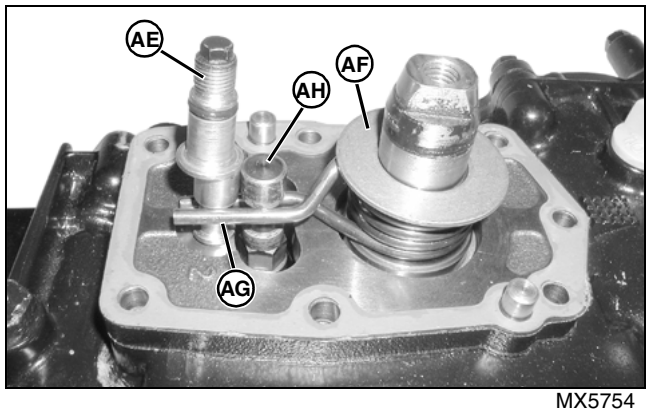
24.Remove lock nut and washer (Y).

25.Remove cap screw and washer (Z) and arm (AA).

26.Remove seven cap screws (AB).

IMPORTANT: Avoid damage! Control cover has centering pins and may stick to them. If gentle prying of cover is required, pry under cover, not under plate below cover.

27.Carefully remove control cover (AC) while pushing neutral adjust screw (AD) down through cover.

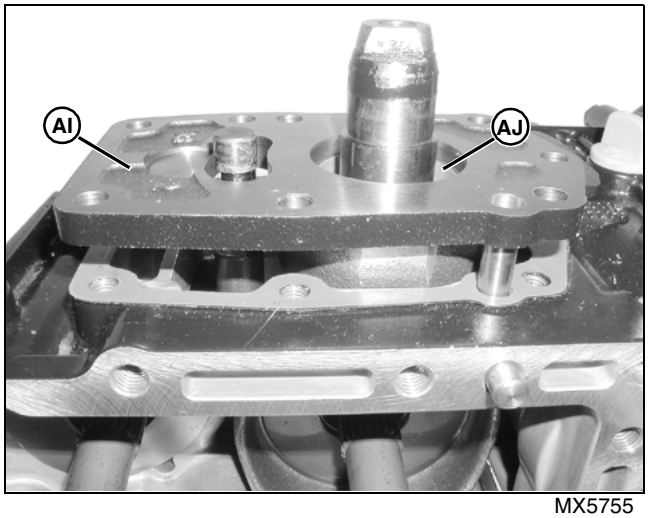


MX5754

28.Remove neutral adjust screw (AE) and washer (AF).

CAUTION: Avoid injury! Neutral centering spring is under tension. Use caution when removing to prevent bodily injury.

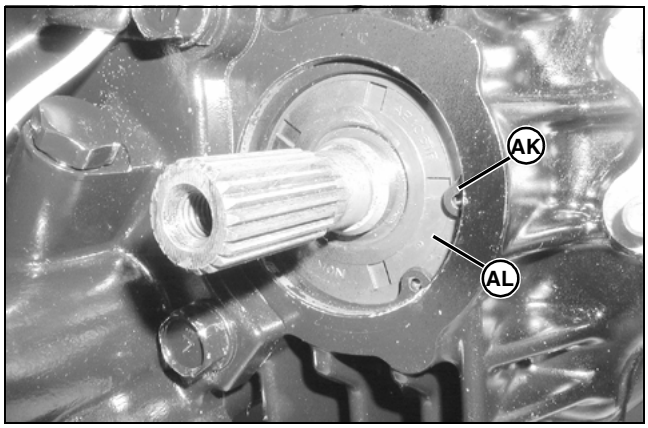
29.Carefully pry neutral centering spring (AG) over top of centering pin (AH). Remove spring.



MX5755

30.Remove upper support plate (AI).

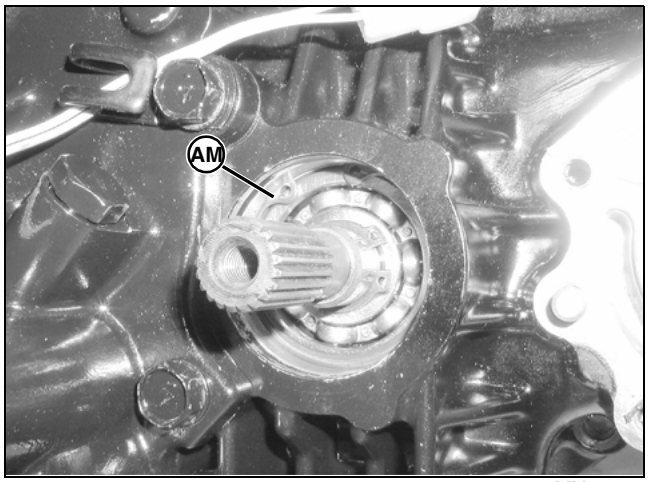
31.Inspect swashplate bearing (AJ) for excessive wear or scoring. Replace if necessary.



MX5756

32.Remove snap ring (AK).

33.Remove seal (AL) by prying out. Remove seal spacer.



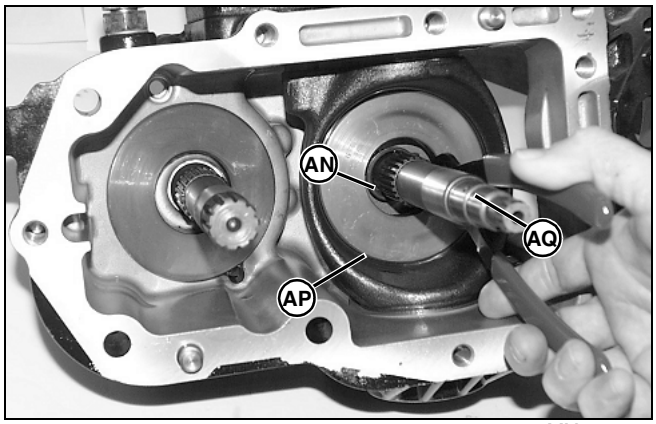
MX5757

34.Remove snap ring (AM).

NOTE: Pump shaft rear bearing will be removed with shaft.

PTO drive gear will remain in housing until swashplate is removed.

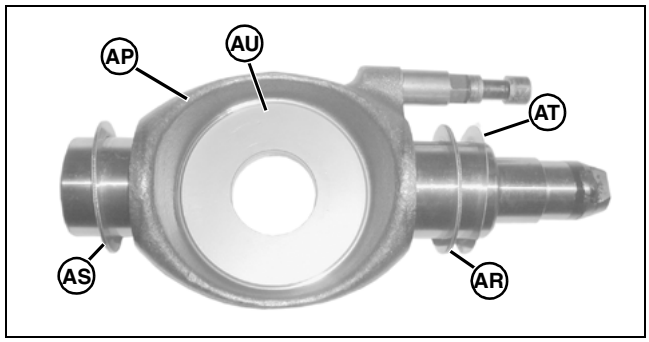
Swashplate thrust washer and shim location and direction must be noted for reassembly.



MX16284

35.Remove snap ring (AN).

36.Using a plastic hammer, gently tap pump shaft (AQ) out rear of housing and PTO drive gear.



MX5759

37.Carefully lift swashplate (AP) while retaining lower thrust washer (AS) to bottom of swashplate. Remove swashplate from housing.

38.Remove PTO drive gear from housing.

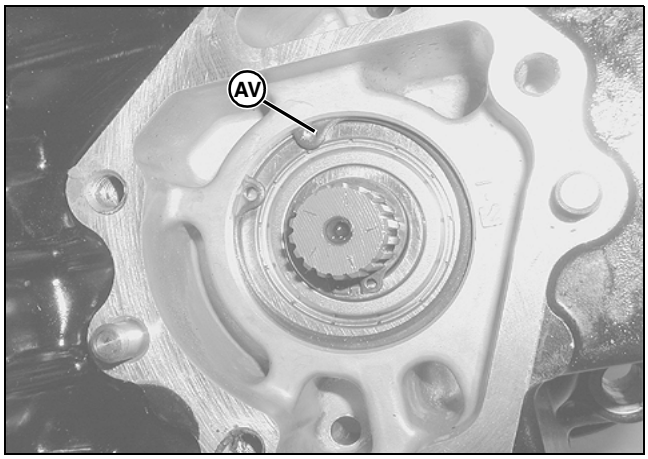
39.Note direction and location of upper shim (AT), upper thrust washer (AR), and lower thrust washer (AS) and remove from swashplate.

40.Inspect thrust washers and shim for scoring or damage. If scoring or damage is detected, replace thrust washers and shim.

41.Remove thrust plate (AU) from swashplate using a brass O-ring pick.

42.Inspect thrust plate for scoring or smeared plated material. If scoring or smearing is detected, replace thrust plate.

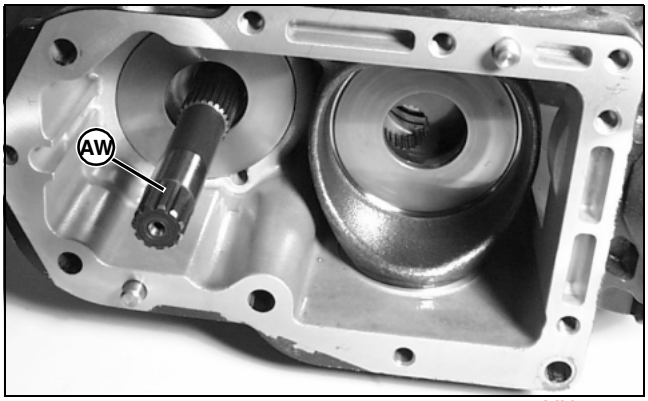
43.Inspect all machined surfaces of swashplate for scoring or damage. If scoring or damage is detected, replace swashplate.



MX5760

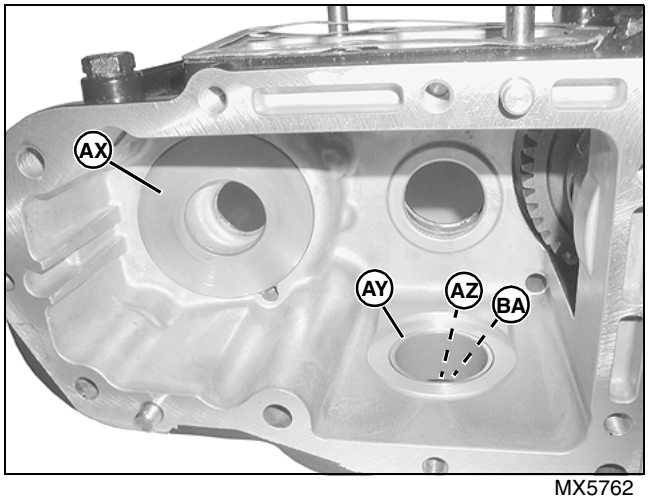
44.Remove motor shaft rear bearing retaining snap ring (AV).

NOTE: Motor shaft rear bearing will be removed with motor shaft.



MX16282

45.Using a plastic hammer, gently tap motor shaft and bearing (AW) out rear of housing.

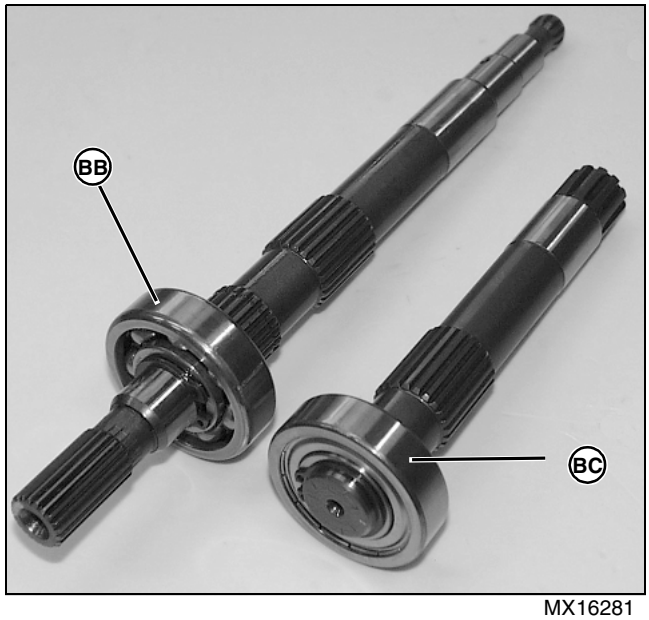


MX5762

46.Remove motor thrust plate (AX) using a brass O-ring pick.

47.Inspect lower swashplate bearing (AY) for excessive wear or scoring.

48.If excessive wear or scoring is detected, remove snap ring (AZ) and cap seal (BA) and replace lower swashplate bearing.



MX16281

49.Inspect input shaft (BB) and motor shaft (BC) bearings. Replace as necessary.

50.If repairing or inspecting PTO, see “PTO Disassembly, Inspection, and Assembly” on page 636.

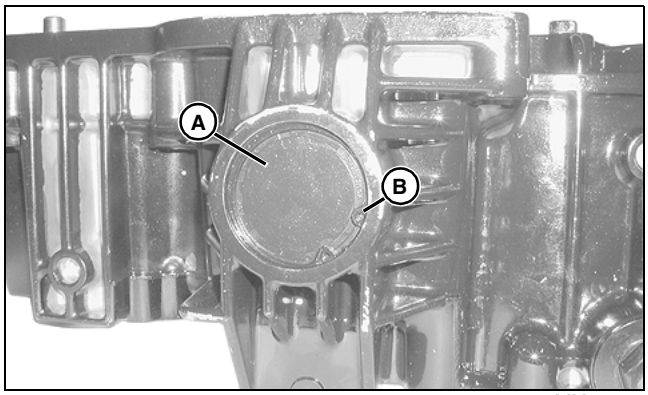
51.If repairing or inspecting 4WD gear case, see “4WD Axle Disassembly, Inspection, and Assembly” on page 648.

52.Remove all gaskets and clean all gasket surfaces.

Assembly:

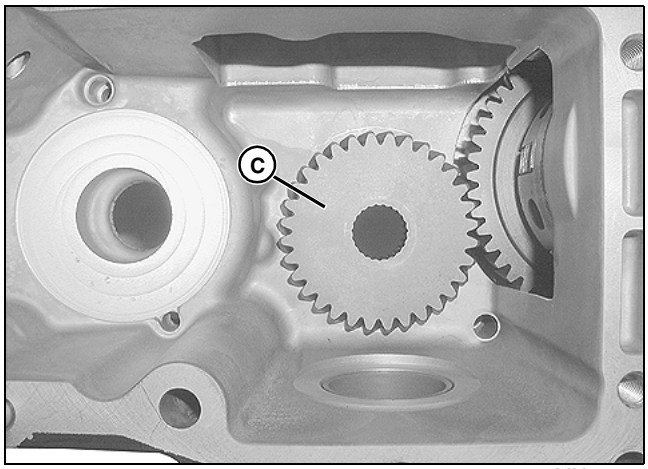
1. Clean and dry all parts.

NOTE: Apply clean hydrostatic oil to all parts when assembling.

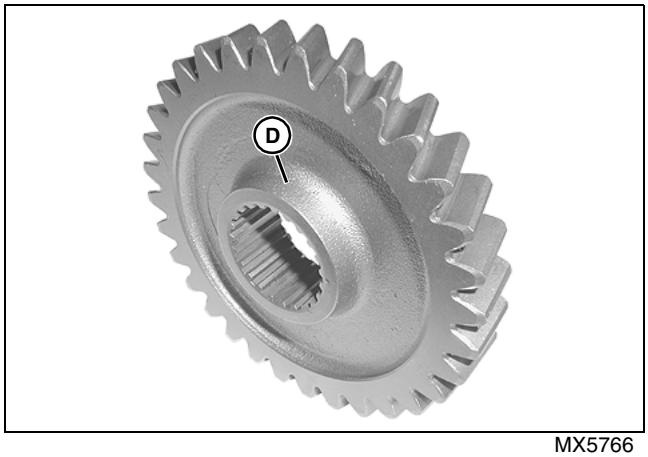


MX5765

2. If lower swashplate bearing was replaced, install new cap seal (A) and install snap ring (B).



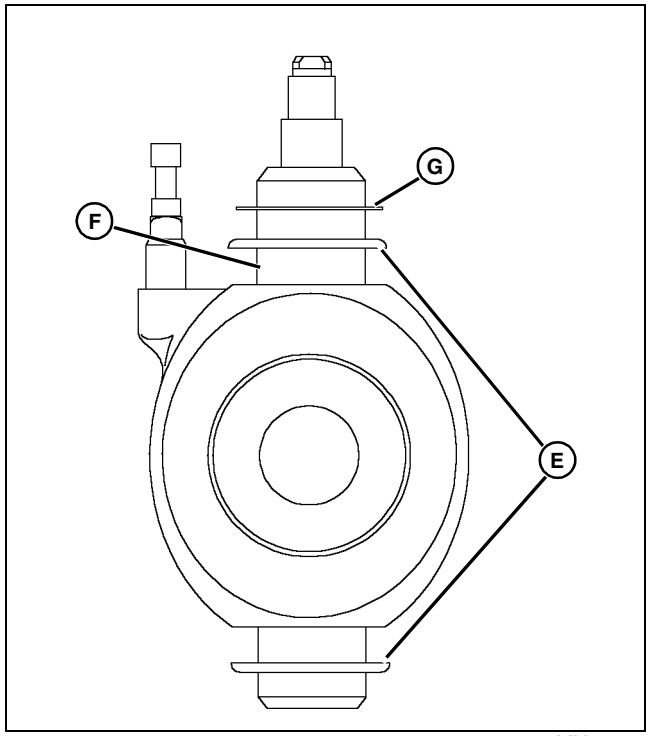
MX5767



MX5766

3. Install PTO drive gear (C) into housing with shoulder (D) facing rear of housing.

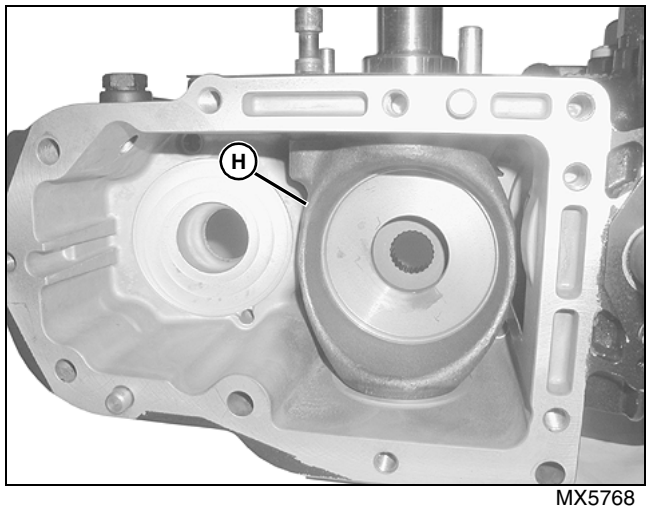
NOTE: Swashplate thrust washers must be installed with flat edge facing center of swashplate.



MX5764

4. Install thrust washers (E) onto swashplate (F) with flat edge facing center of swashplate.

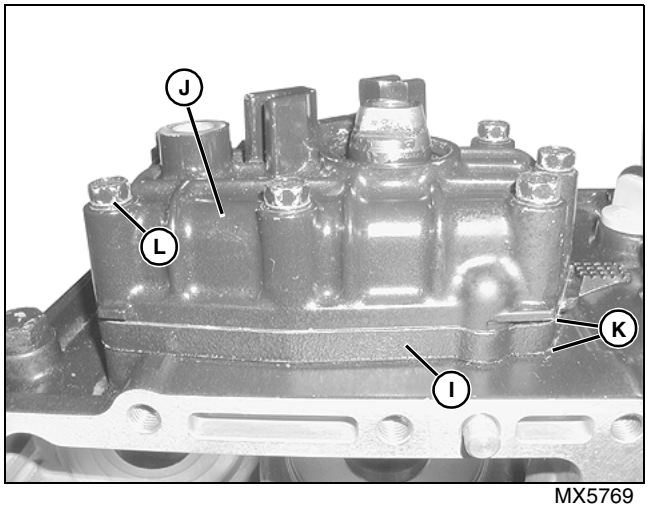
5. Install shims (G) onto swashplate.



MX5768

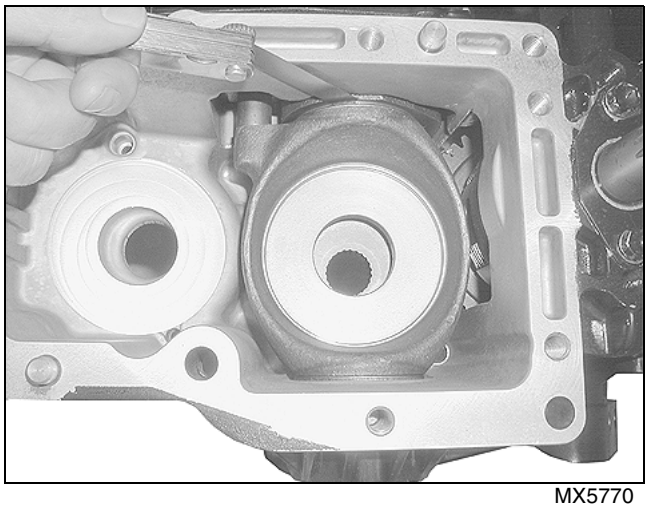
6. Install swashplate (H) with thrust washers and shims into housing.

NOTE: Top cover is being temporarily installed to set swashplate end play. Parts normally contained inside of top cover need not be installed at this point.



MX5769

7. Install upper support plate (I) and top cover (J) with gaskets (K) using seven cap screws (L).


MX5770

8. Check swashplate end play between bottom of support plate and top of shim. End play must be within specification.

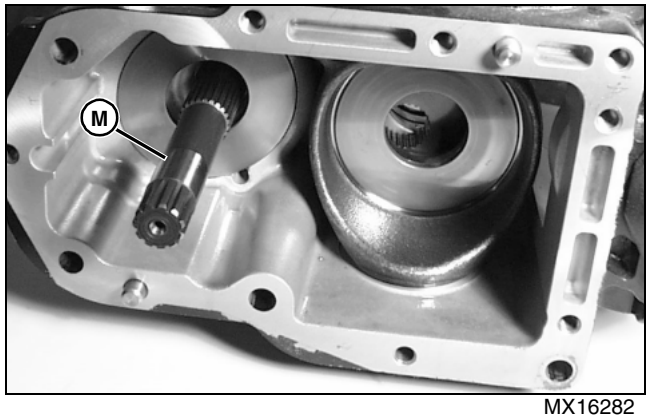
9. If end play is not within specification, remove top cover, support plate, and gaskets.

10. Add or subtract shims from top of swashplate to obtain specification.

11. Reinstall support plate, top cover, and gaskets. Check end play again.

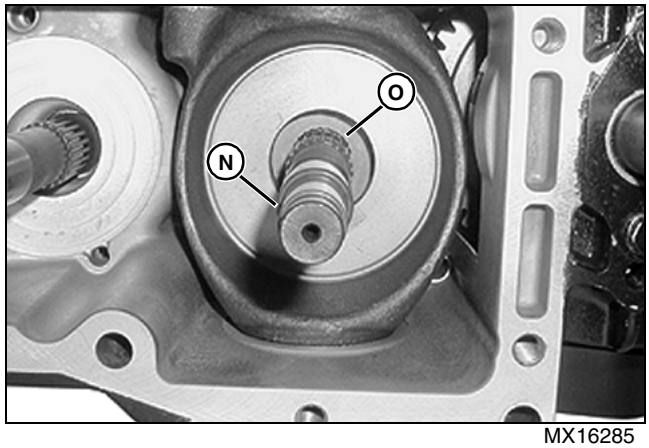
12. Repeat steps 9 - 11 until correct specification is obtained.

13. Temporarily, remove top cover and gasket only.



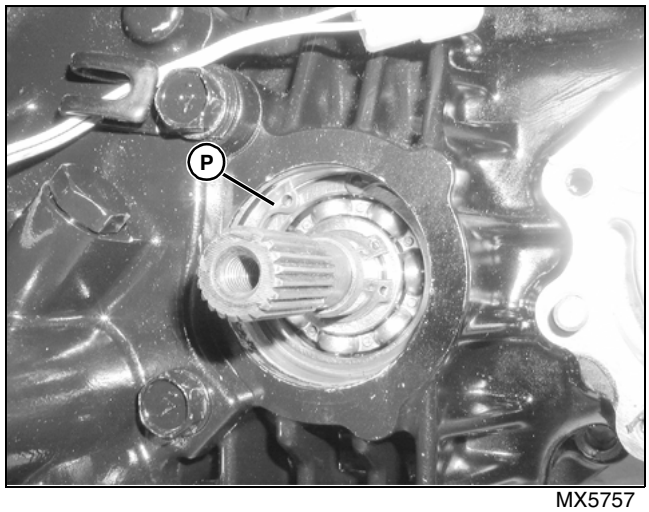
MX16282

14. Install motor shaft (M) into housing.



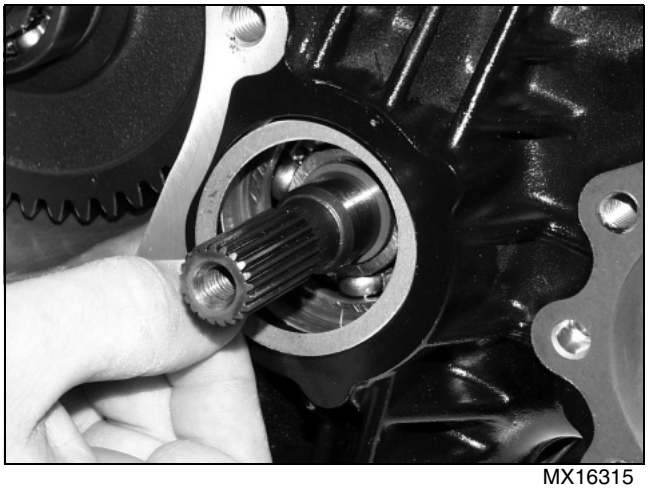
MX16285

15. Carefully install pump shaft (N) through PTO drive gear (O) and into housing.



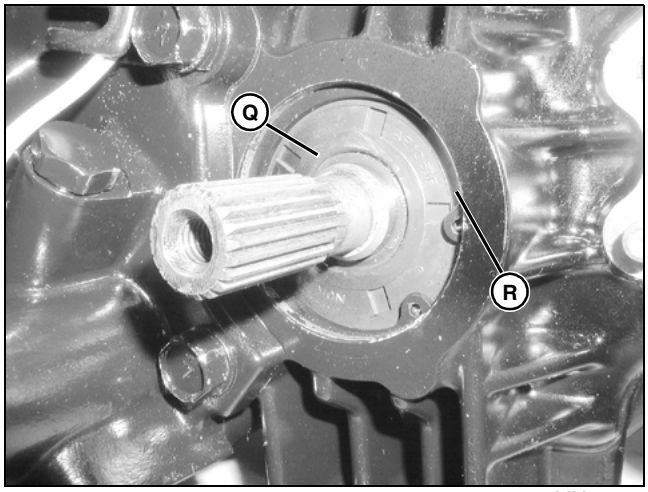
MX5757

16. Install pump shaft bearing snap ring (P).



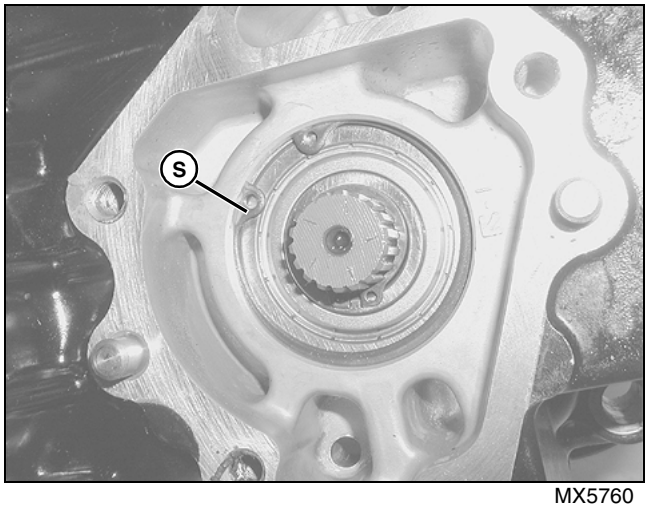
MX16315

17.Install seal spacer.



MX5756

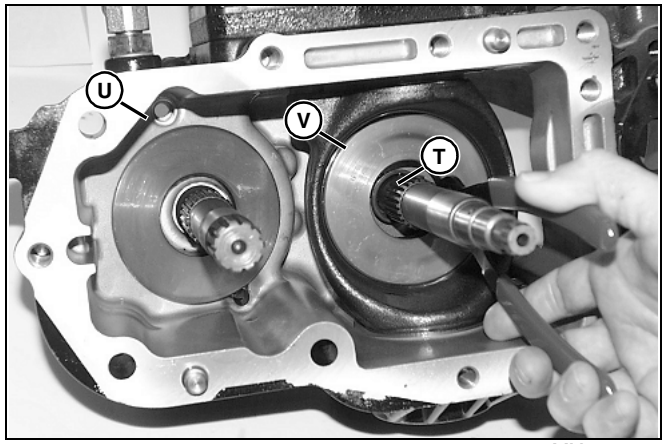
18.Install new pump shaft seal (Q) flush against spacer. Secure using snap ring (R).



MX5760

19.Install motor shaft bearing snap ring (S).

NOTE: Do not scratch machined surfaces of thrust plates or swashplates when installing components.

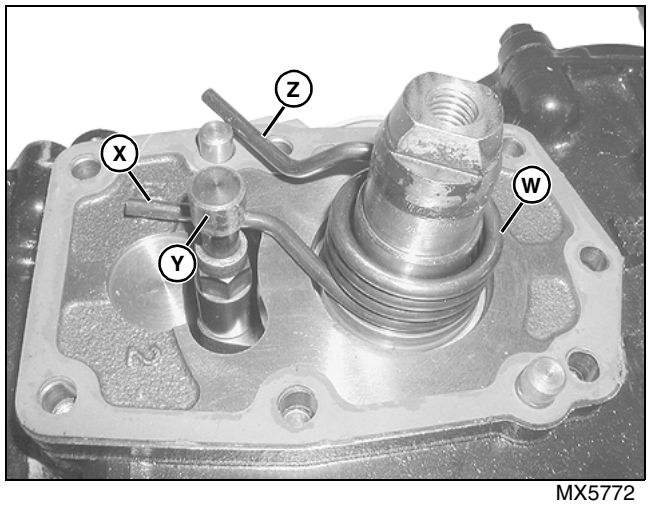


MX16284

20.Install PTO drive gear snap ring (T).

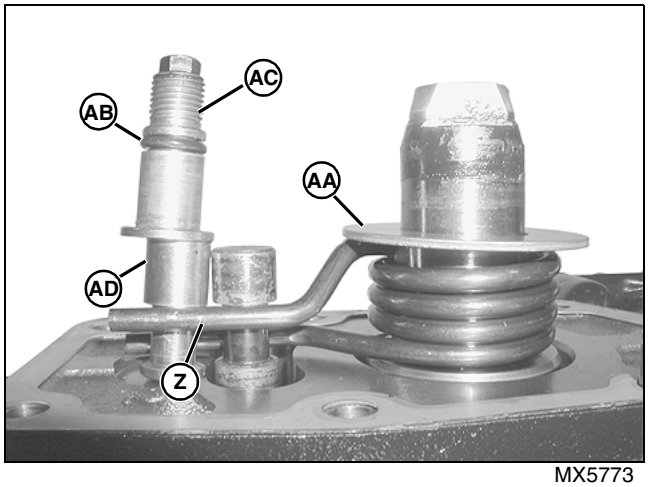
21.Install motor thrust plate (U) and pump thrust plate (V).

CAUTION: Avoid injury! Installing centering spring will put it under tension. Use caution when installing to prevent bodily injury.



MX5772

22.Install neutral centering spring (W) with flat arm (X) down and to the rear of centering pin (Y).



MX5773

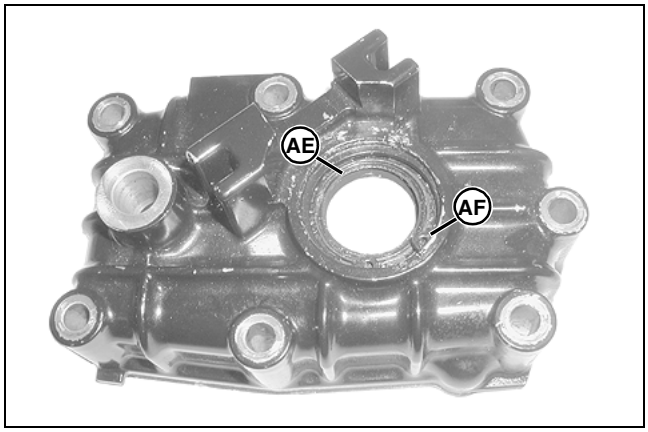
23.Carefully pry bent arm (Z) up and forward over the top of centering pin.

24.Install washer (AA).

25.Replace O-ring (AB) on neutral adjust screw (AC).

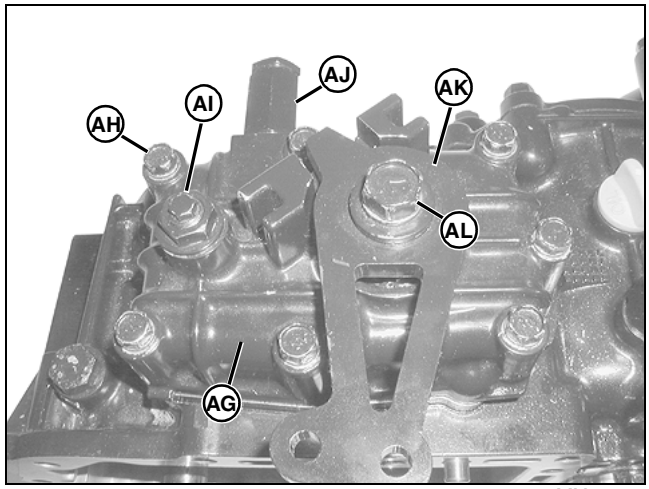
26.Install neutral adjust screw between arms of neutral centering spring.

27.Rotate neutral adjust screw until adjusting cam (AD) faces centering pin.



MX5774

28.Replace upper swashplate seal (AE). Install with face of seal against snap ring (AF).



MX5753

29.Install cover (AG) using seven cap screws (AH).

30.Install washer and nut (AI).

31.Install return spring assembly (AJ).

32.Install arm (AK) using cap screw and washer (AL).

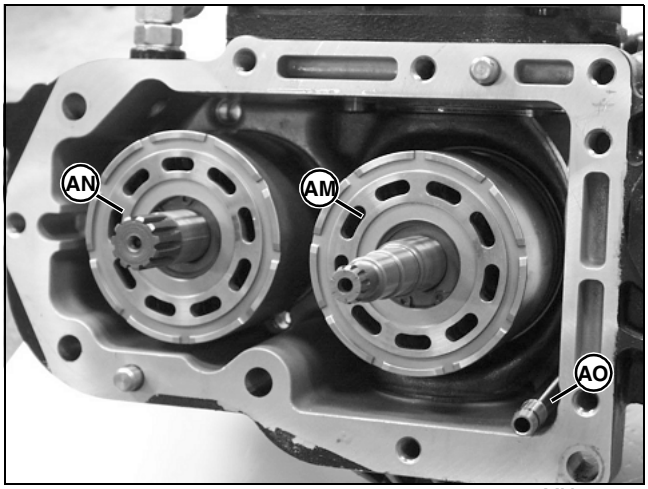
IMPORTANT: Avoid damage! Do not nick or scratch lapped surface of cylinder blocks.

Piston to cylinder block relationship is not unit specific. A matched piston-to-bore relationship need not be maintained.


MX5750

33.Install pistons into piston retainer, then into cylinder block.

34.Lift piston retainer and pistons from cylinder block two or three times to check for free movement of pistons in cylinder block before you install the assembly into the housing.



MX16283

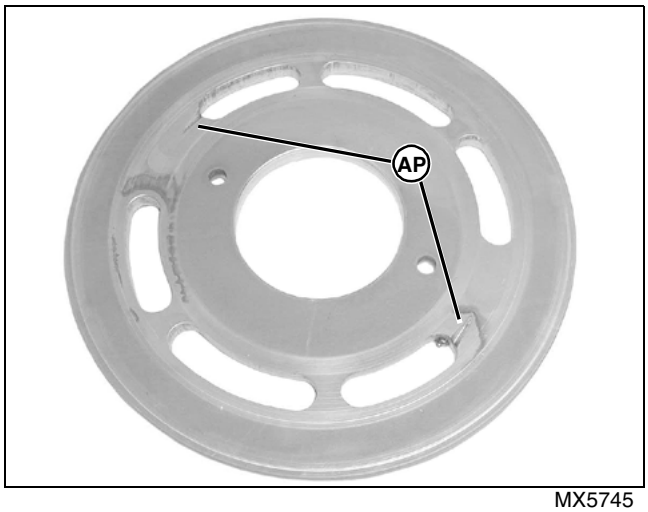
35.Install pump (AM) and motor (AN) cylinder blocks. Hold onto the retainer rim to ensure pistons remain in their bores.

36.Install new O-rings on PTO supply tube (AO) and install tube into housing.

IMPORTANT: Avoid damage! Use extreme care when assembling the center section, valve plates, and cylinder blocks to avoid dropping, nicking, or scratching lapped surfaces.

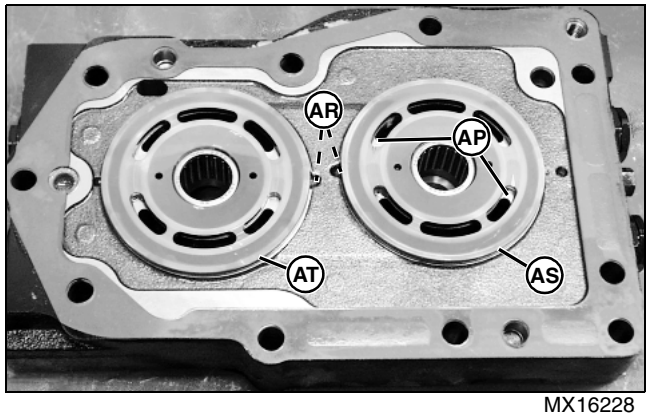
Pump valve plate has two slotted ports (AP).

Motor valve plate (AT) has no slotted ports.



MX5745

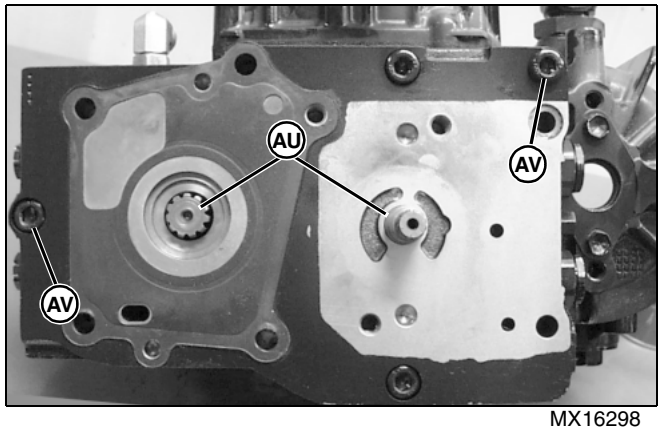
37.Put clean hydrostatic oil on valve plates and housing surfaces.



MX16228

38.Align slots on back sides of plates with pins (AR) in center section and install pump valve plate (AS), with slotted ports (AP), and motor valve plate (AT) over their respective protruding bearings.

39.Install new center section to housing gasket onto housing.



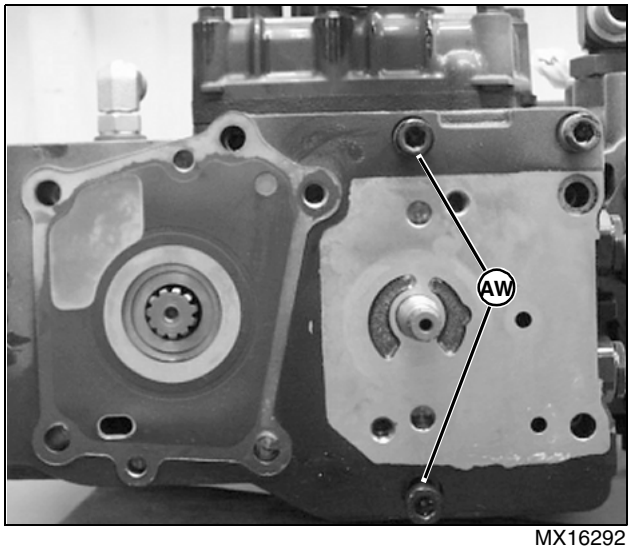
MX16298

40.Align bearings of center section with pump and motor shafts (AU). Slide center section on shafts until valve plates contact cylinder blocks.

41.Apply pressure to center section and install two socket head screws (AV) to hold center section in place.

IMPORTANT: Avoid damage! Check for proper internal assembly by slowly rotating pump and motor shafts while tightening cap screws.

NOTE: Center section will seem springy. This is because the springs inside the cylinder blocks are being compressed.



MX16292

42.Install two remaining hex socket screws (AW). Tighten all four hex socket screws evenly in a crossing pattern until they are snug - Do not tighten to specification at this time.

43.Check that both pump and motor shafts turn without any binding or roughness.

44.Tighten four hex socket screws to specification.

45.Install new gasket to hydrostatic assembly.

46.Install hydrostatic assembly to differential assembly. (See “Hydrostatic Assembly-to-Differential Assembly Separation and Installation” on page 592.)

Specifications:

Make Up Oil Check Valve Torque . . . . 34 N•m (25 lb-ft)

Forward and Reverse Check Valve Torque . . . . . 34 N•m (25 lb-ft)

Charge Relief Valve Torque . . . . . 24 N•m (212 lb-in.)

Swashplate End Play . . . . . 0.20 - 0.50 mm (0.007 - 0.0019 in.)

Center Section-to-Housing Hex Socket Torque . . . . . 42 N•m (31 lb-ft)

Differential Disassembly, Inspection, and Assembly

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Hoist	NA	Used to remove and install axle shaft housing.
Knife-Edge Puller	NA	Used to remove bearings and axle seal.

Special or Required Tools:

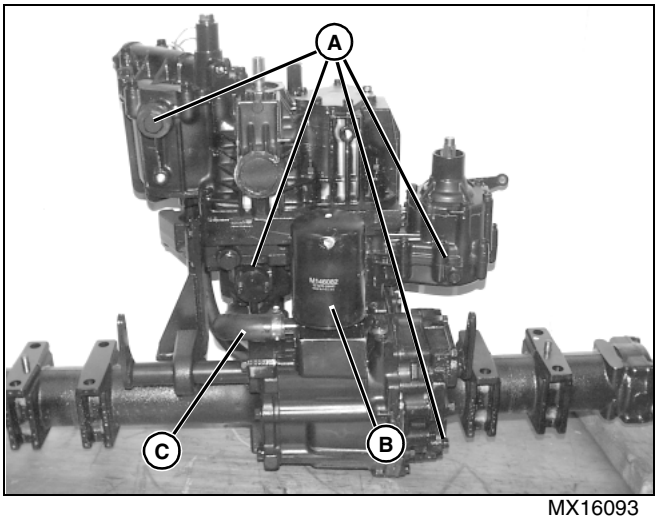
Tool Name	Tool No.	Tool Use
50.8 mm (2 in.) ID Pipe	NA	Used to install bearings and axle shaft sleeve.
Punch	NA	Used to drive spring pin from pinion cross shaft.
Snap Ring Removal Tool[1]	NA	Used to compress the spring to remove the snap ring on the differential lock shaft.
Snap Ring Installation Tool[a]	NA	Used to install the snap ring on the differential lock shaft.
Press	NA	Used to install bearing.

1. For instructions on making tool, see Fabricated Tools in this section.

Other Material:

Part No.	Part Name	Part Use
TY16021 (U.S.)/ LOCTITE 17430/ TY9484 (Canada)	John Deere High Flex Form-in-Place Gasket	Applied to differential-to-axle housing and side cover-to-differential housing mating surfaces.
TY16285 (U.S.)/ LOCTITE 17649/ CXTY16285 (Canada)	Cure Primer	Applied to threads of cap screws and gear.
T43512 (U.S.)/ LOCTITE 242/TY9473 (Canada)	Thread Lock and Sealer (Medium Strength)	Applied to threads of cap screws before installation.

Axle Shaft Housing Disassembly:



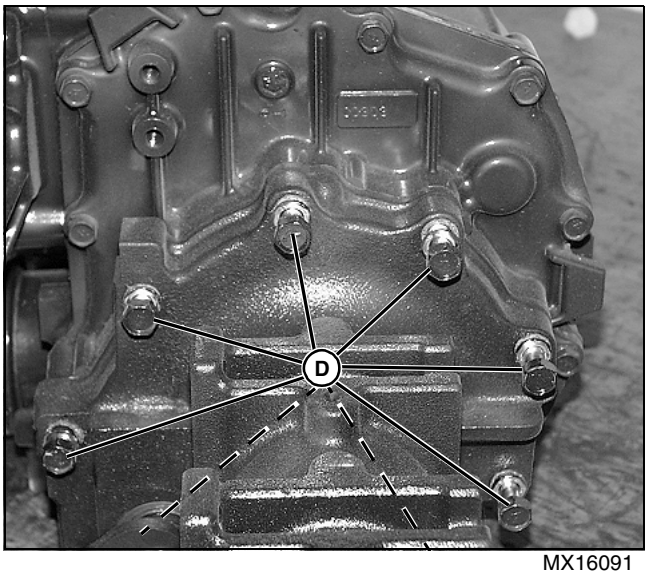
MX16093

1. Separate hydrostatic assembly from differential assembly. (See “Hydrostatic Assembly-to-Differential Assembly Separation and Installation” on page 592.)

2. Remove four drain plugs (A) and drain all oil from Hydrostatic unit.

3. Remove oil filter (B) and hose (C).

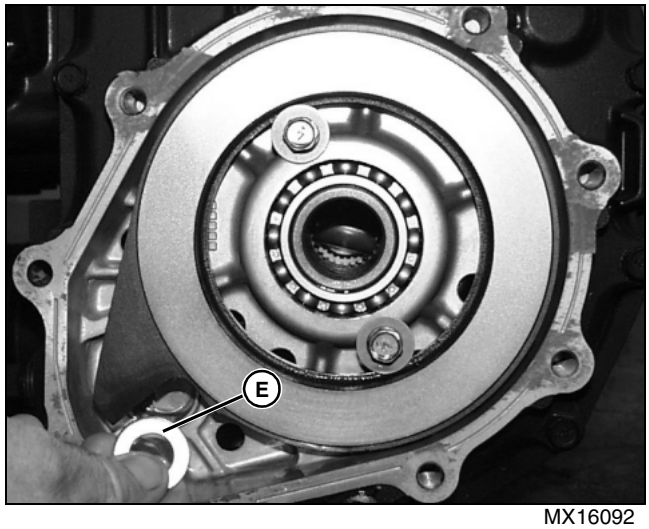
NOTE: This disassembly procedure is for the right axle shaft housing. The procedure for the left side is similar, but some parts are not interchangeable, left to right. Do not mix right and left side parts.



MX16091

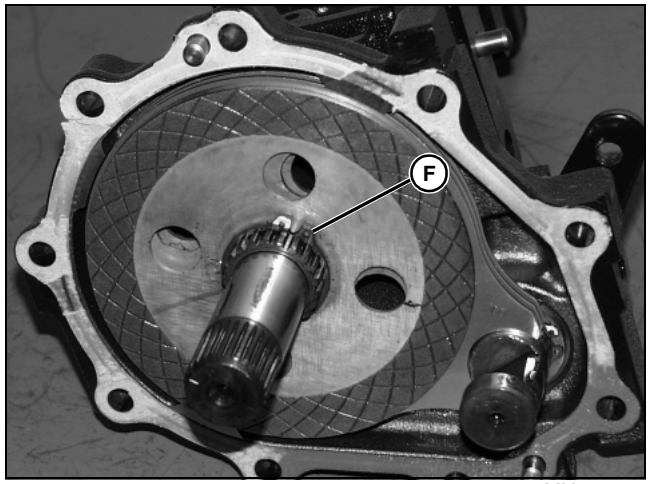
4. Remove the nine capscrews (D) holding the right axle shaft housing to the differential.

5. Remove the axle shaft housing using a hoist.



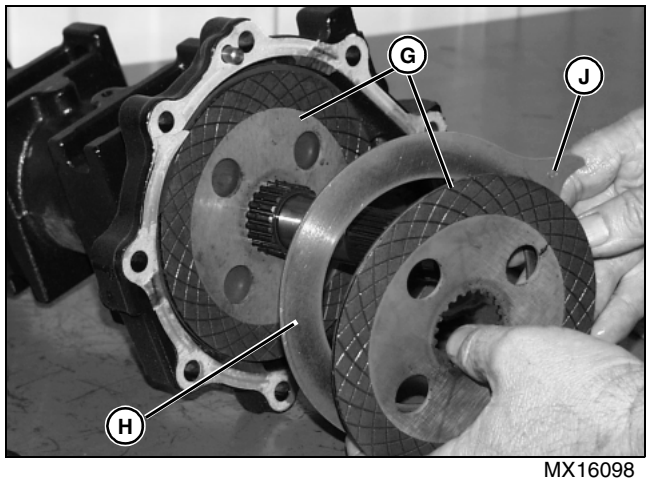
MX16092

6. Note the location of the thrust washer (E) that fits in the cam bearing bore in the axle case.



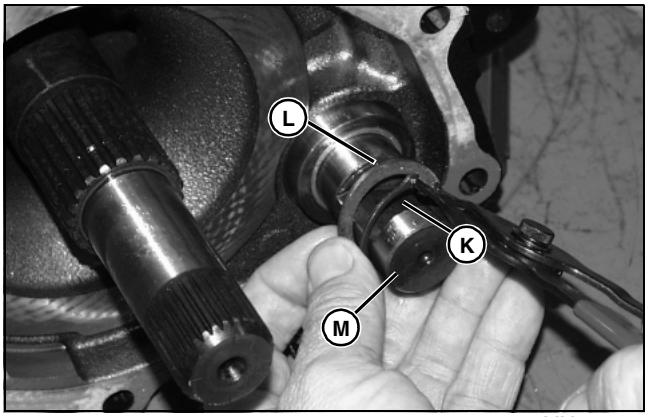
MX16097

7. Remove snap ring (F).



MX16098

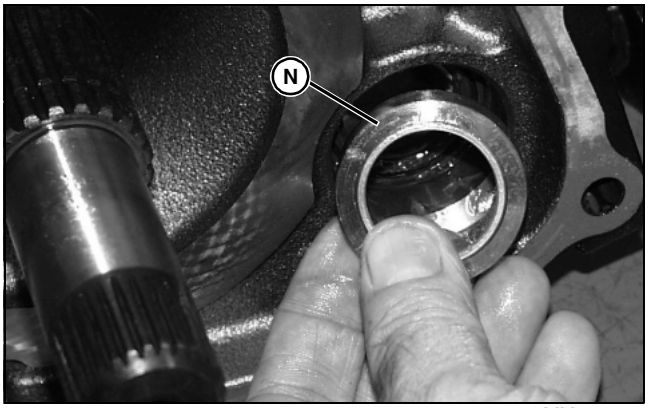
8. Remove the three brake disks (G) and three brake separator plates (H). Note the ‘S’ mark (J) on the separator plates that designates the outside of the plate.



MX16099

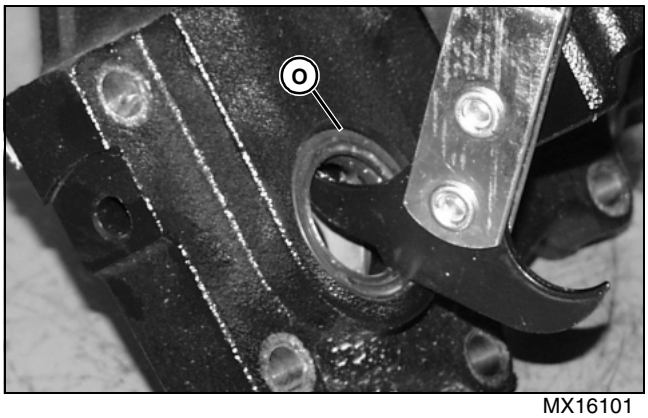
9. Remove snap ring (K) and flat washer (L) from brake camshaft (M).

10.Remove brake camshaft (M.



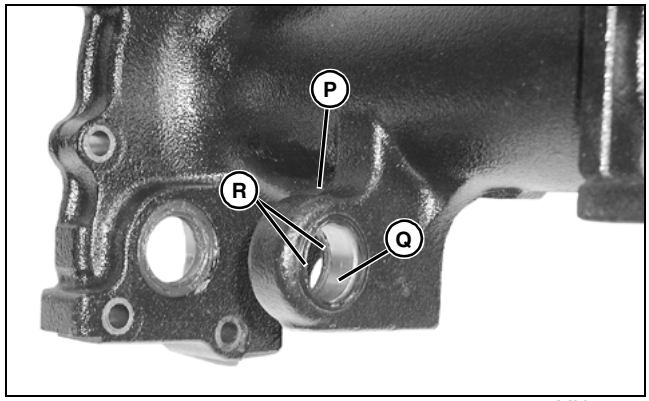
MX16100

11.Remove bushing (N).



MX16101

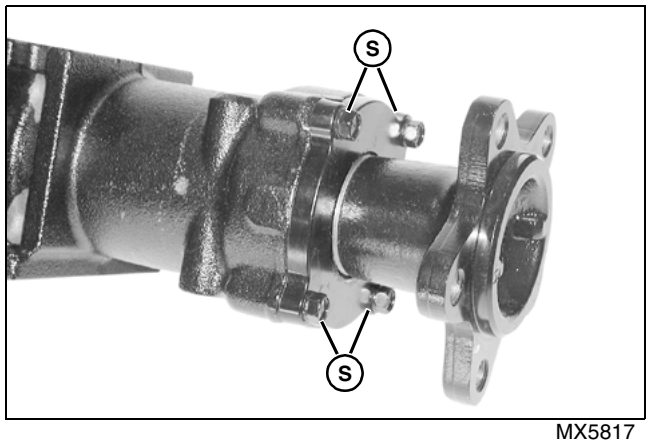
12.Turn axle shaft housing over and remove oil seal (O).



MX5816

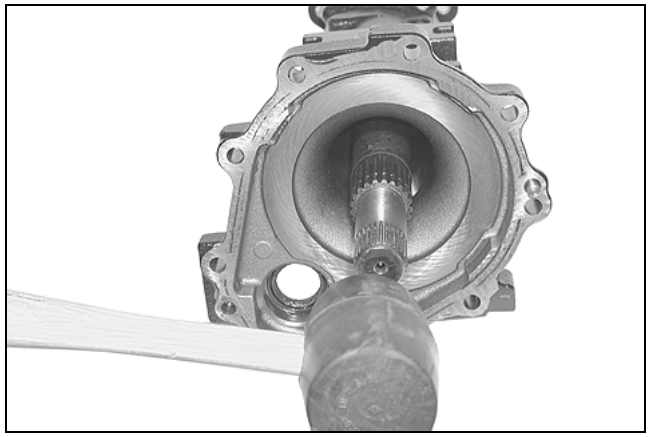
13.The left axle housing has an extra support hanger (P) for the camshaft arm with a bushing (Q) and seals (R). If the bushing requires replacement, remove the seals to access the bushing.

14.Remove oil seals (12) and bushing (13).



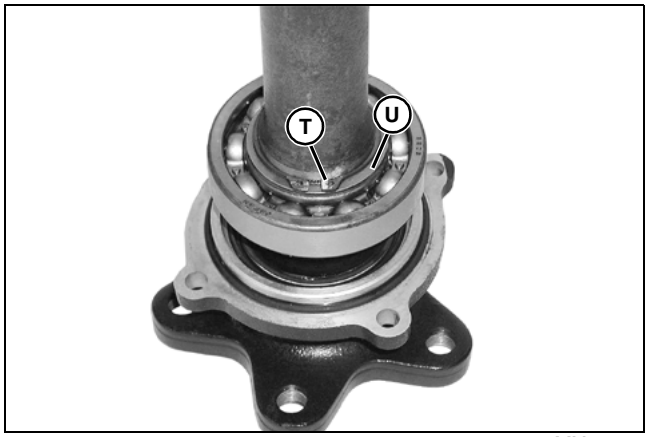
MX5817

15.Remove four cap screws (S).



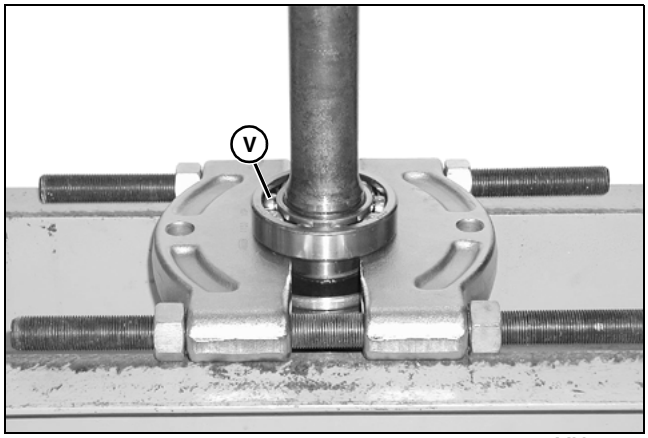
MX5836

16.Drive the axle out of the housing using a soft-faced hammer.



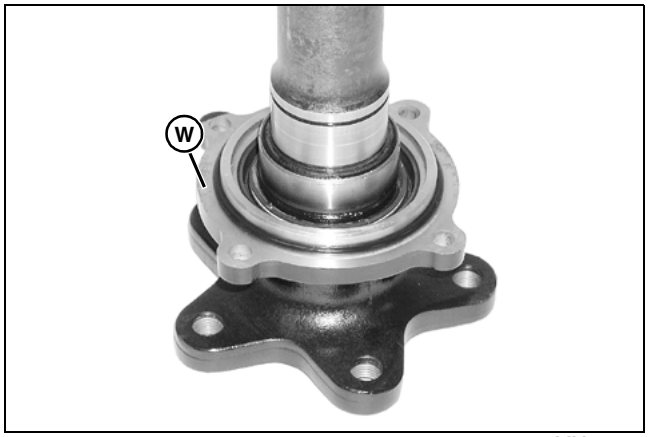
MX5818

17.Remove snap ring (T) and spacer (U).



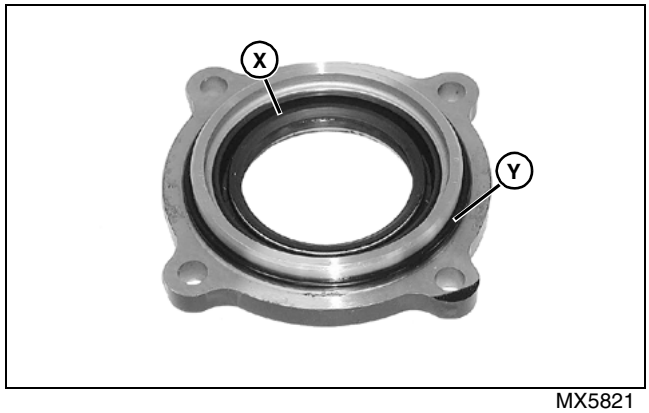
MX5819

18.Remove bearing (V) from axle using a knife-edge puller.



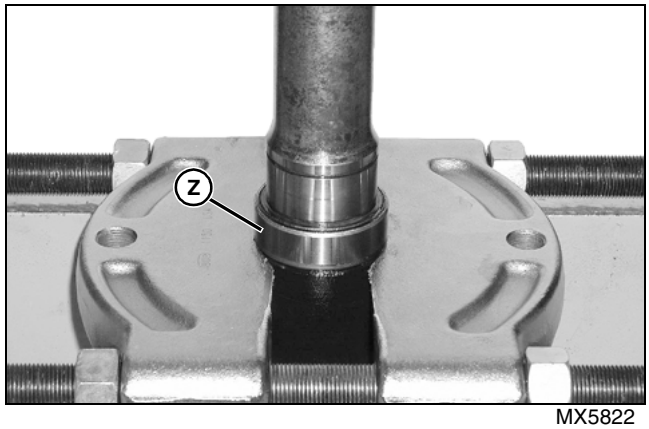
MX5820

19.Remove axle seal housing (W) from axle shaft.



MX5821

20.Remove oil seal (X) and O-ring (Y).

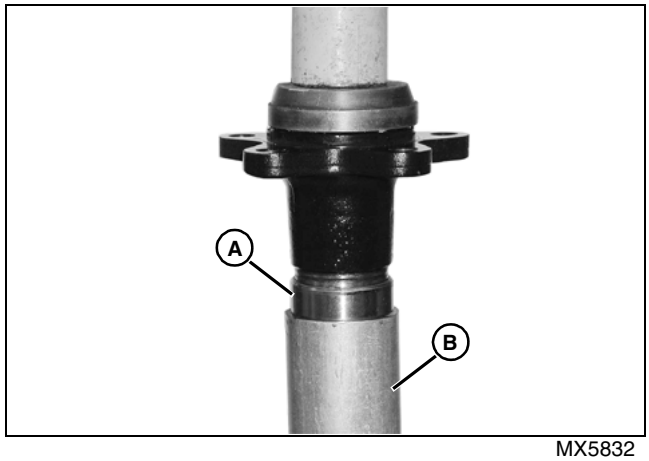


MX5822

21.Inspect sleeve (Z) for wear or damage. Remove the sleeve using a knife-edge puller if replacement is required.

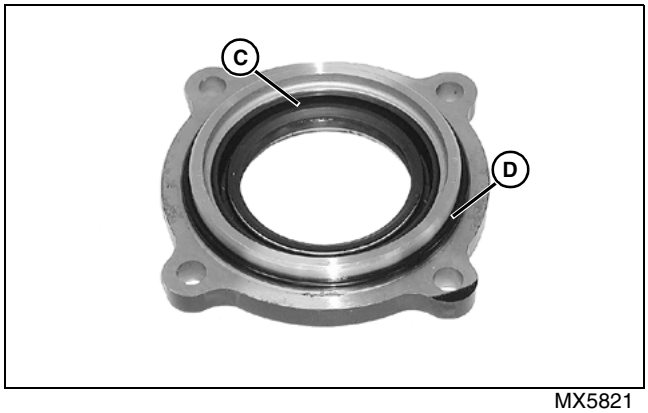
22.Inspect all parts for wear or damage. Replace parts as needed.

Axle Shaft Housing Assembly:



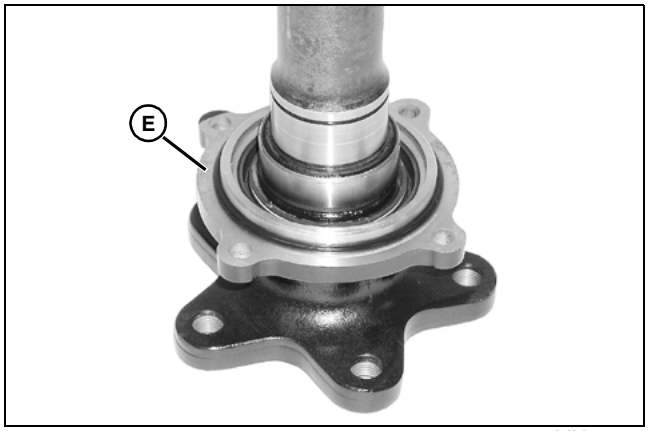
MX5832

1. Install new sleeve (A) on axle shaft (if needed). Press sleeve into place using a length of pipe (B) with an inside diameter of **50.8 mm (2 in.)**.



MX5821

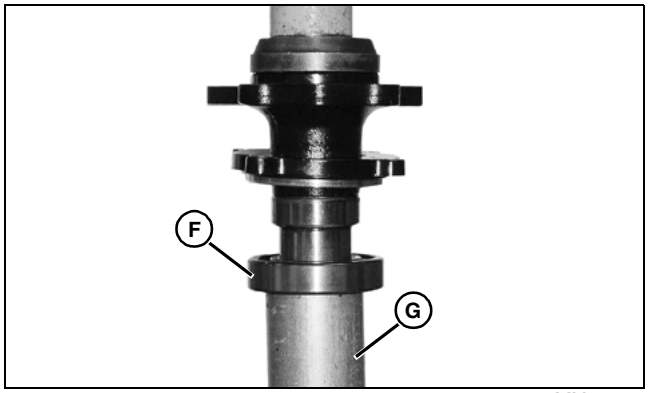
2. Install new axle oil seal (C) and O-ring (D).



MX5820

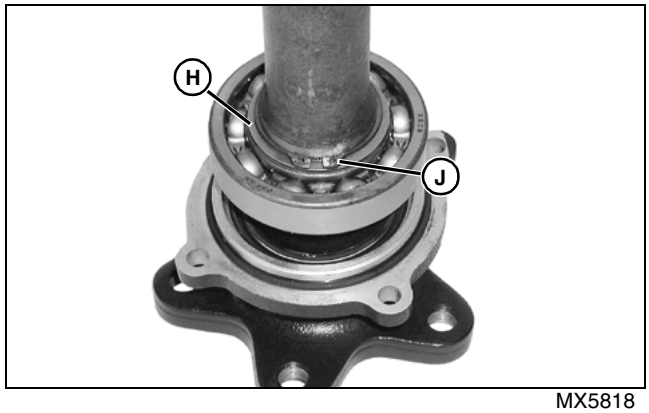
3. Install axle seal housing (E) onto axle.

IMPORTANT: Avoid damage! Press on inner race only to avoid damaging bearing.



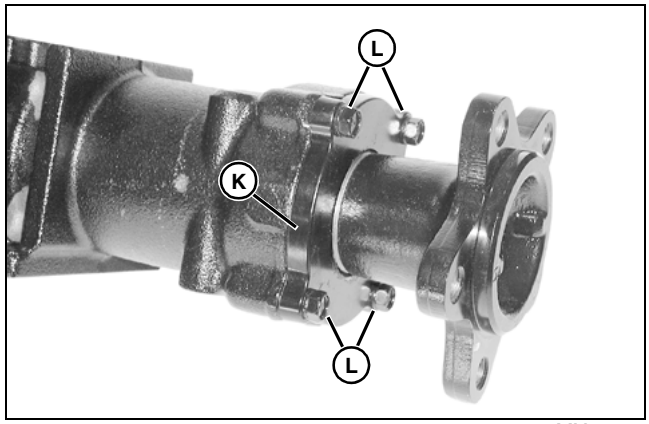
MX5833

4. Install bearing (F) into axle. Press the bearing into place using a length of pipe (G) with an inside diameter of **50.8 mm (2 in.)**.



MX5818

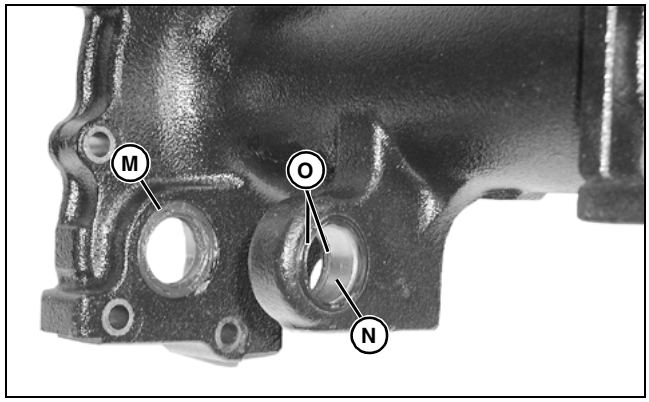
5. Install spacer (H) and snap ring (J).



MX5817

6. Install axle into housing until bearing bottoms against axle housing.

7. Install seal housing (K) into axle housing. Install four cap screws (L). Tighten to specification.

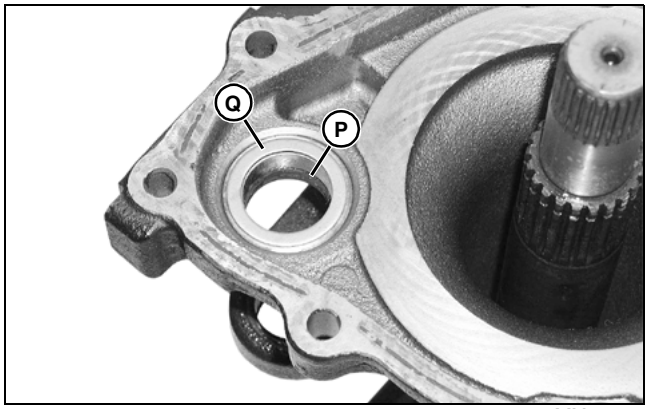


MX5816

8. Install new brake camshaft oil seal (M) using appropriate seal driver.

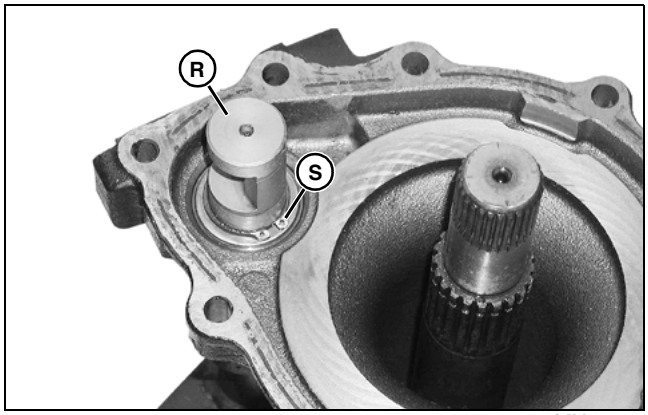
NOTE: Note left axle shaft housing with extra cam shaft support hanger is shown.

9. If bushing and seals were removed from cam shaft support hanger, install new bushing (N) and oil seals (O).



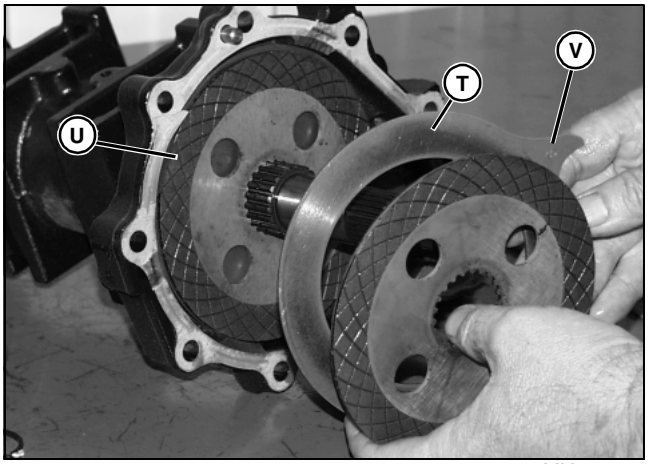
MX5815

10.Install bushing (P) and flat washer (Q).



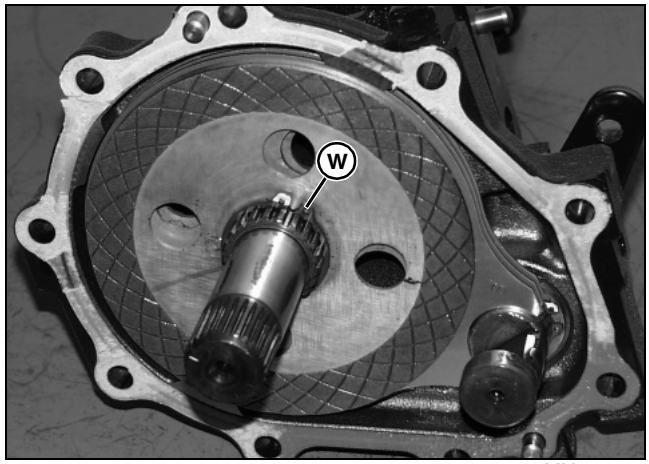
MX5814

11.Install brake camshaft (R) and snap ring (S).



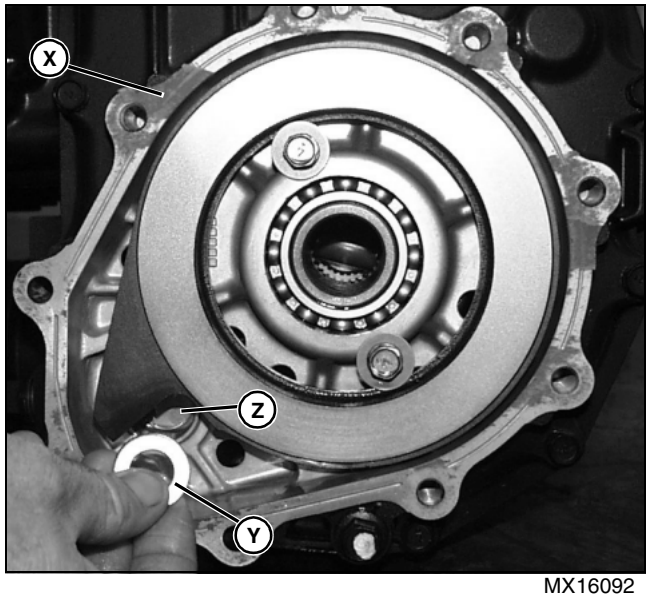
MX16098

12.Install three brake separator plates (T) and brake disks (U). Note that the 'S' marking (V) on the separator plates should face out.



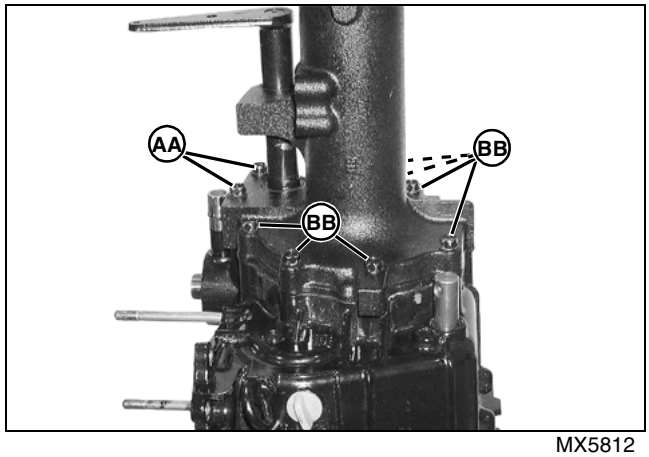
MX16097

13.Install snap ring (W).



MX16092

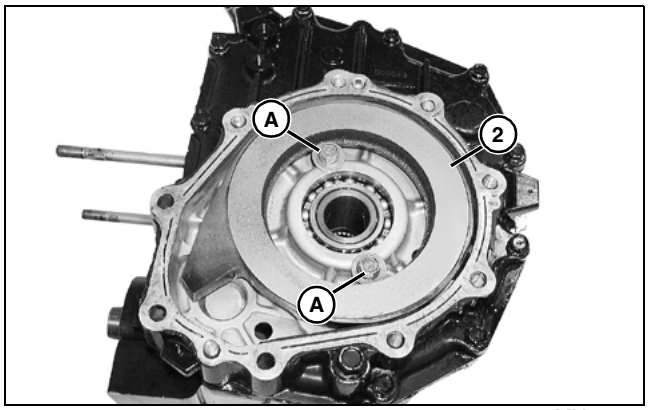
14.Apply TY16021 John Deere High Flex Form-in-Place Gasket on differential-to-axle housing mating surfaces (X). Apply sufficient grease to hold the cam shaft thrust washer (Y) in place and position it in the case bore (Z).



MX5812

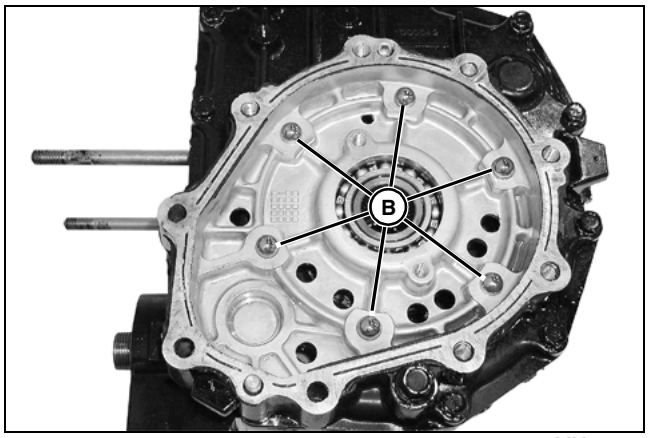
15.Using a hoist, position axle housing on differential. Install two M10 x 60 cap screws (AA) and seven M10 x 45 cap screws (BB). Tighten to specification.

Differential Disassembly/Inspection:



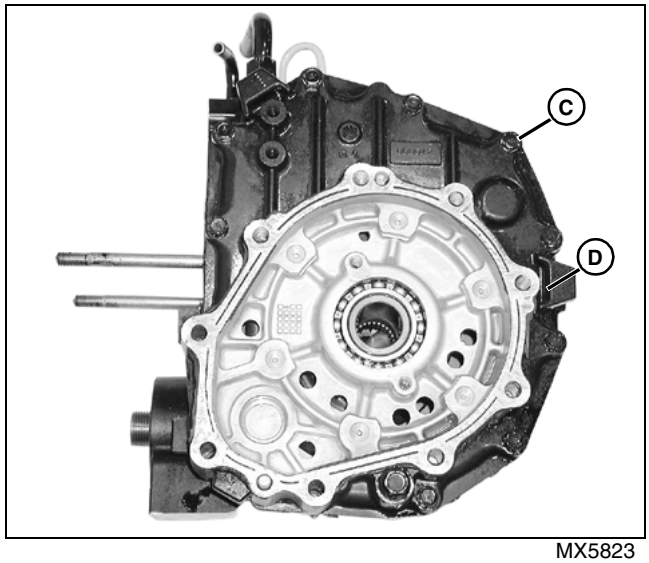
MX5824

1. Remove both axle shaft housings. (See “Axle Shaft Housing Disassembly:” on page 625.)
2. Remove cap screws and washers (A).
3. Remove brake actuator disk (2).



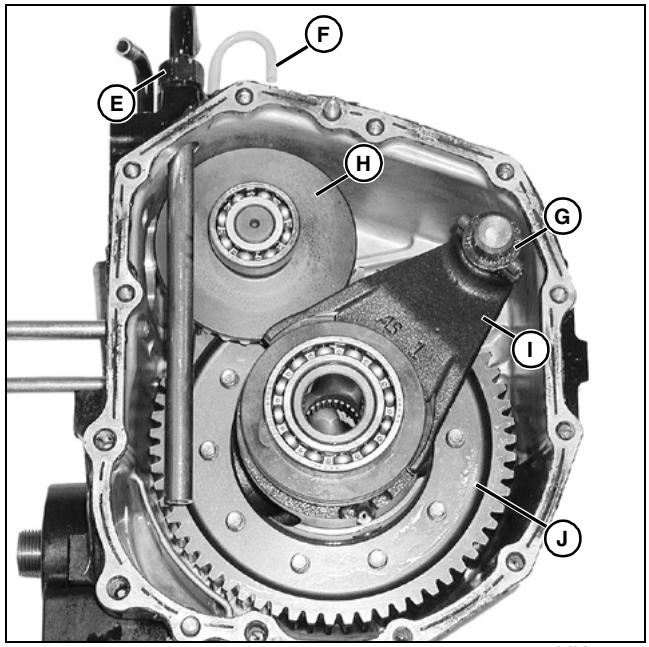
MX5825

4. Remove six brake actuator balls (B).
5. Repeat steps 2 - 4 on opposite side.



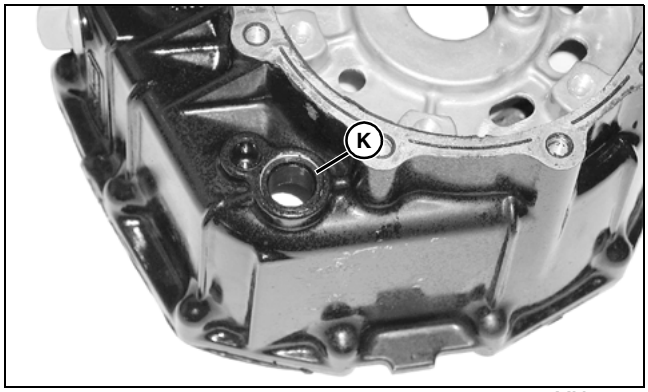
MX5823

6. Remove nine M8 x 35 cap screws (C).
7. Remove differential side cover (D).



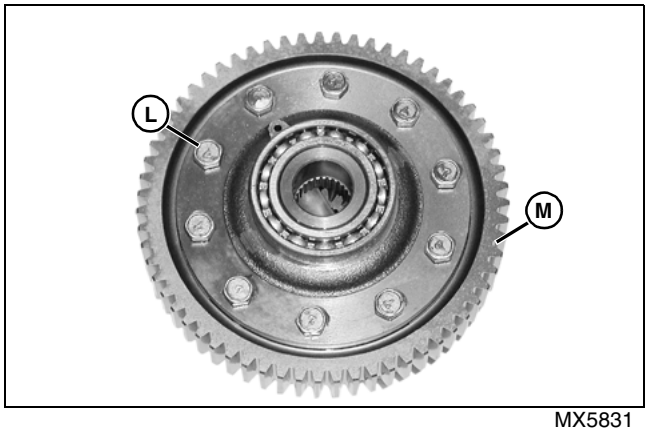
MX5826

8. Remove oil return tube (E), dipstick (F), and washer (G).
9. Lift out idler gear shaft (H).
10. Lift out differential lock fork (I) and differential assembly (J) as one assembly.



MX5827

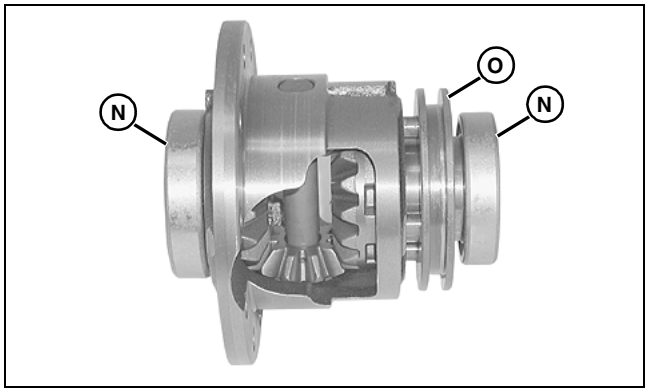
11.Remove differential lock shaft seal (K).



MX5831

12.Remove ten cap screws (L).

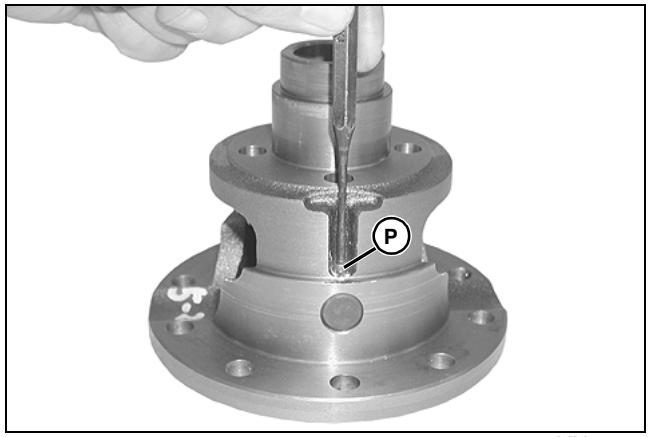
13.Remove ring gear (M).



MX5837

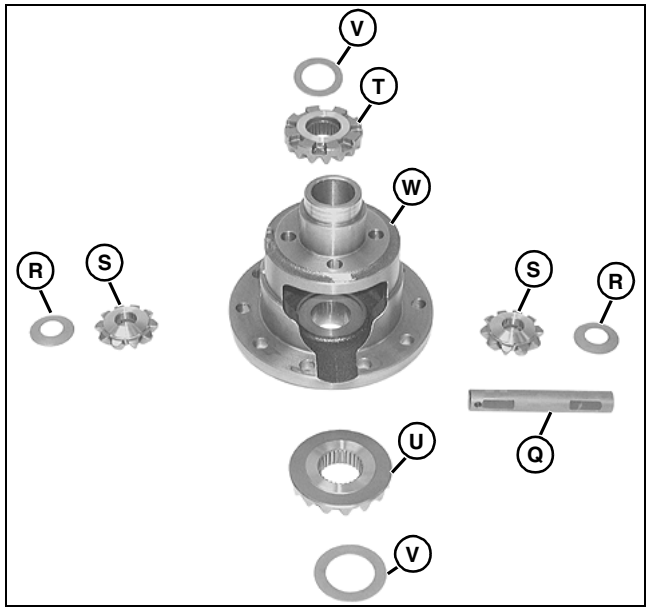
14.Using a knife-edge puller, remove bearings (N).

15.Remove shift collar (O).



MX5838

16.Using a punch, drive spring pin (P) from the pinion cross shaft.



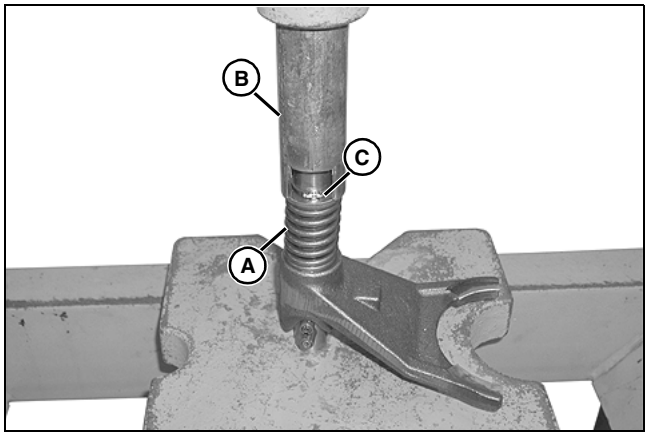
MX5839

17.Remove pinion cross shaft (Q), bevel washers (R), pinion gears (S), right side gear (T), left side gear (U), and flat thrust washers (V) from differential housing (W).

18.Inspect all parts for wear or damage. Replace parts as needed.

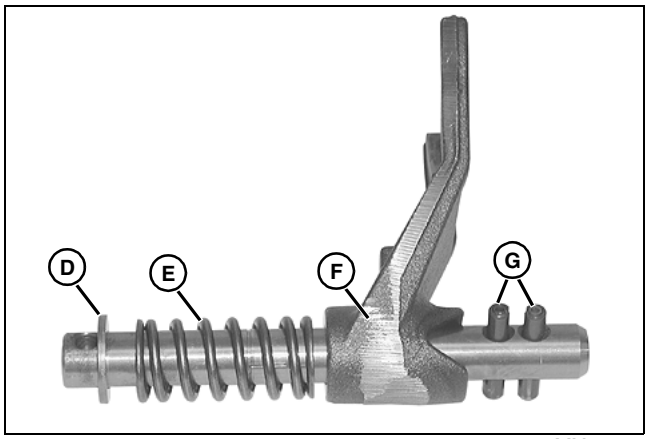
Differential Lock Lever Disassembly/Assembly:

NOTE: The differential lock lever assembly does not have to be disassembled unless repair is required. Inspect components for wear or damage.



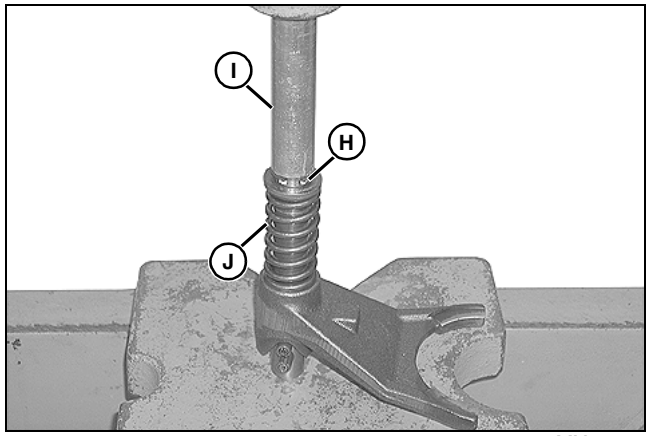
MX5846

1. Compress spring (A) using snap ring removal tool[1] (B).
2. Remove snap ring (C) from its groove while spring is compressed.



MX5845

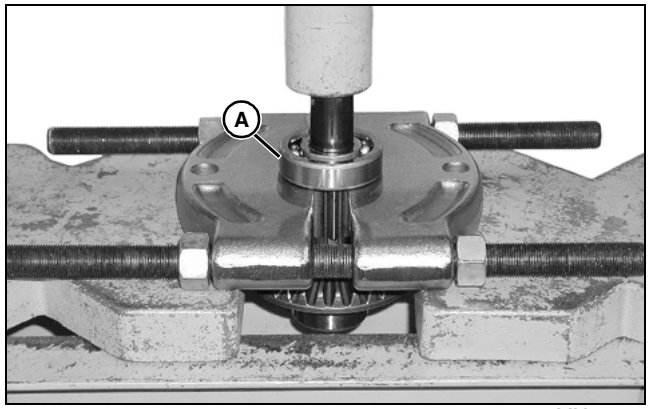
3. Remove washer (D), spring (E), fork (F), and spring pins (G) if replacement is required.



MX5844

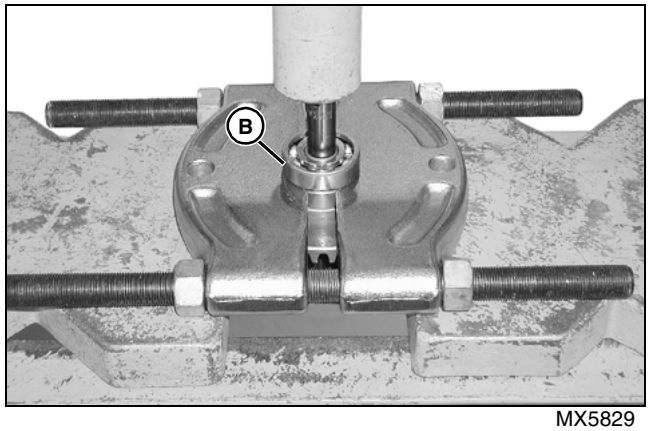
4. Slide snap ring (H) on shaft.
5. Using snap ring installation tool[2] (I), compress spring (J) until snap ring locks in its groove.

Idler Shaft Disassembly/Inspection:



MX5828

1. Remove bearing (A) using a knife-edge puller.

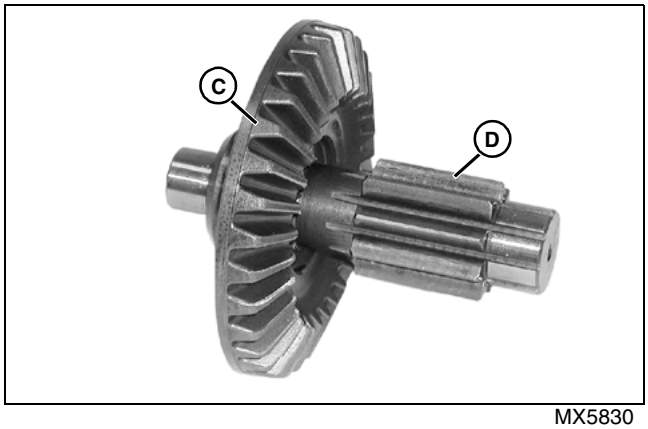


MX5829

2. Remove bearing (B) using a knife-edge puller.

1. Snap ring removal tool is a fabricated tool. For instructions to make tool, see Fabricated Tools in this section.

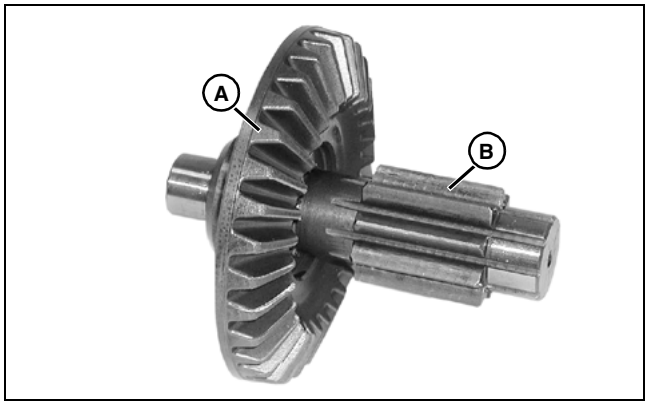
2. Snap ring installation tool is a fabricated tool. For instructions to make tool, see Fabricated Tools in this section.



MX5830

3. Remove ring gear (C) from idler shaft (D).

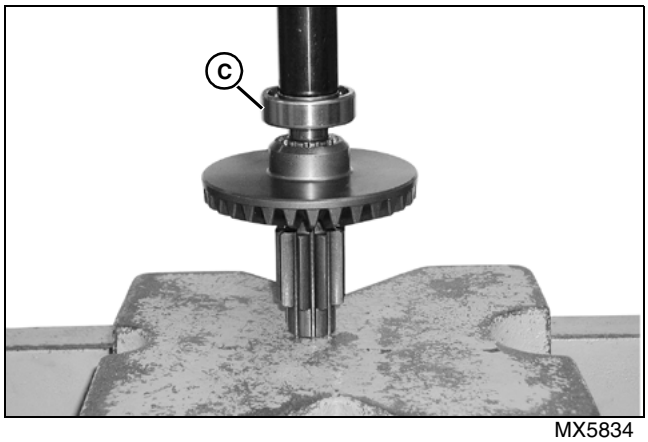
Idler Shaft Assembly:



MX5830

1. Install ring gear (A) onto idler shaft (B).

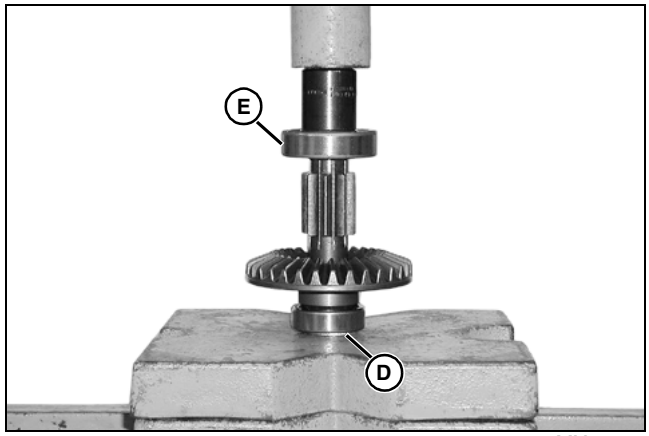
IMPORTANT: Avoid damage! Press on inner race only to avoid damaging bearing.



MX5834

2. Install bearing (C) using a press.

IMPORTANT: Avoid damage! Press on inner race only to avoid damaging bearing.

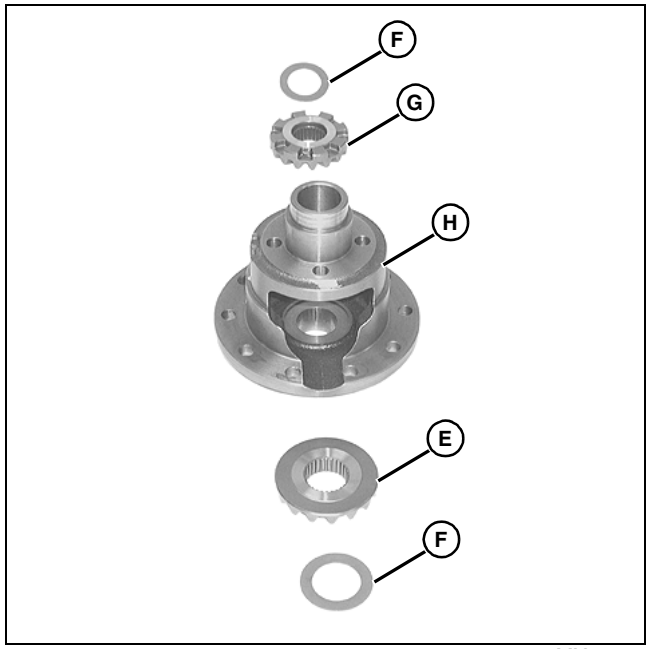


MX5835

3. Position a washer (D) to contact bearing inner race to prevent bearing damage while applying pressure.

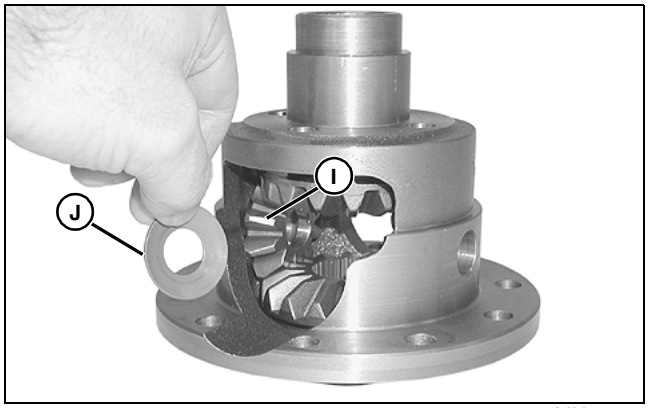
4. Install bearing (E) using a press.

Differential Assembly:



MX5840

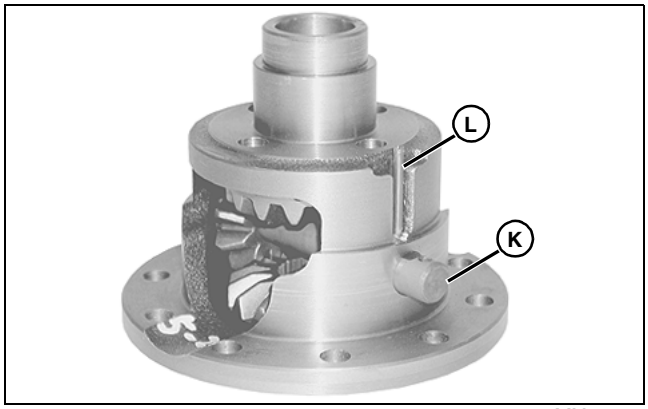
1. Install side gears (G and E) with flat thrust washers (F) inside housing (H).



MX5841

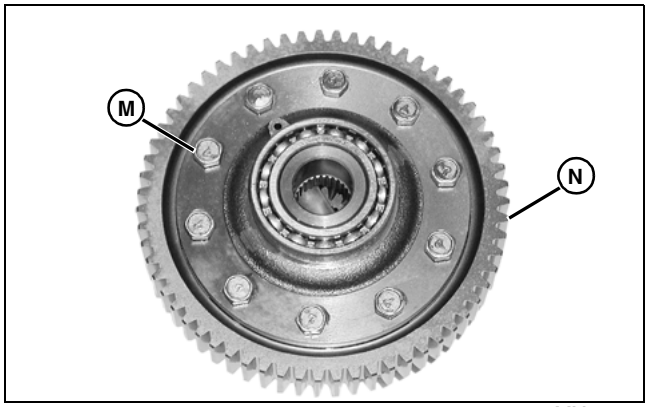
2. Install pinion gears (I) between side gears.

3. Slide the bevel thrust washers (J) between pinion gears and differential housing.



MX5842

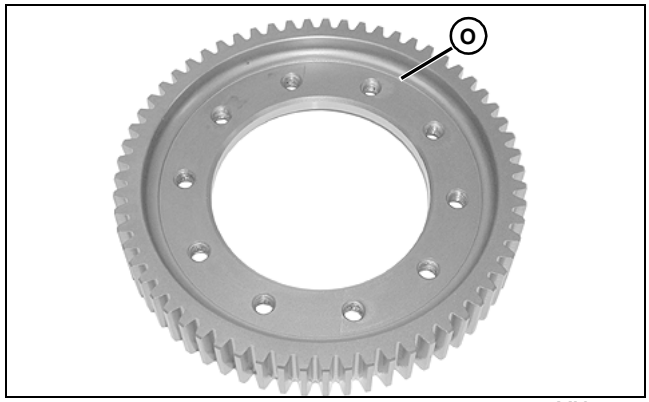
4. Install pinion shaft (K) and secure it with spring pin (L).



MX5831

5. Clean threads of cap screws (M) and threads of gear (N) with TY16285 Cure Primer.

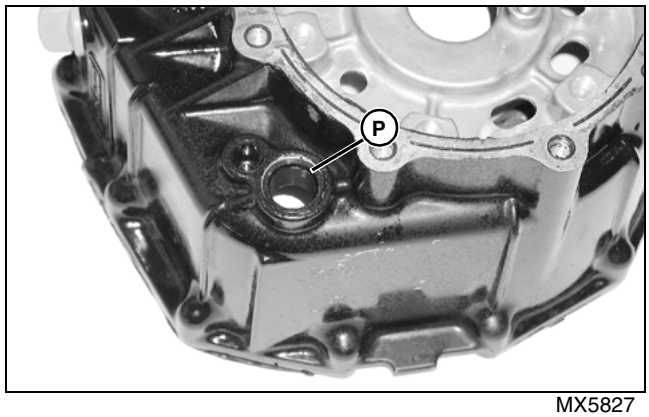
6. Apply T43512 Thread Lock and Sealer (Medium Strength) to threads of cap screws.



MX5843

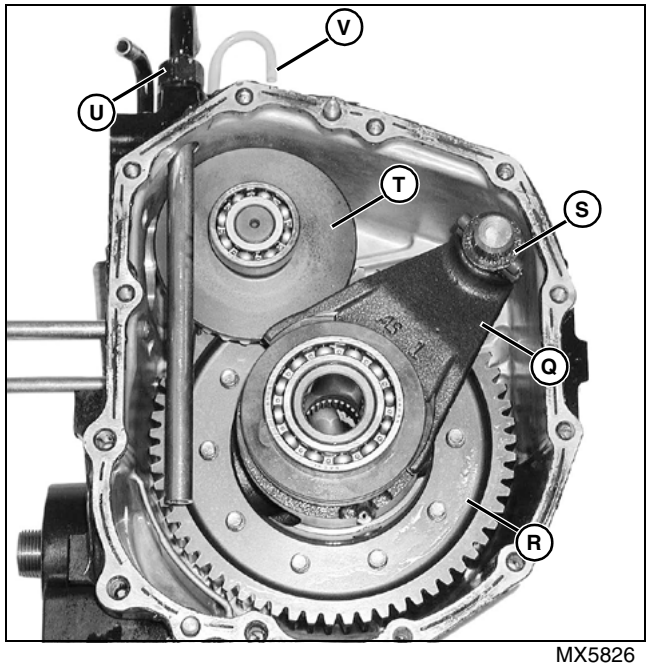
7. Install gear with ridge side (O) facing differential housing.

8. Install ten cap screws and tighten to specification.



MX5827

9. Install differential lock shaft seal (P).



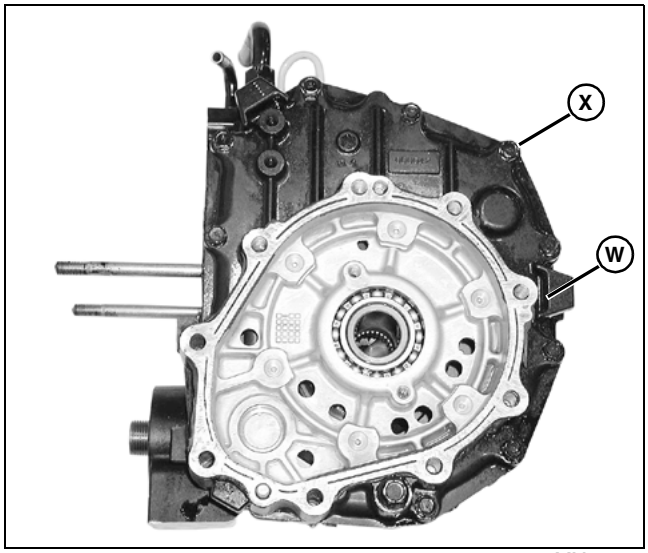
MX5826

10.Install differential lock shaft (Q) and differential assembly (R) into case as an assembly.

11.Install washer (S) on differential lock shaft.

12.Install idler shaft assembly (T).

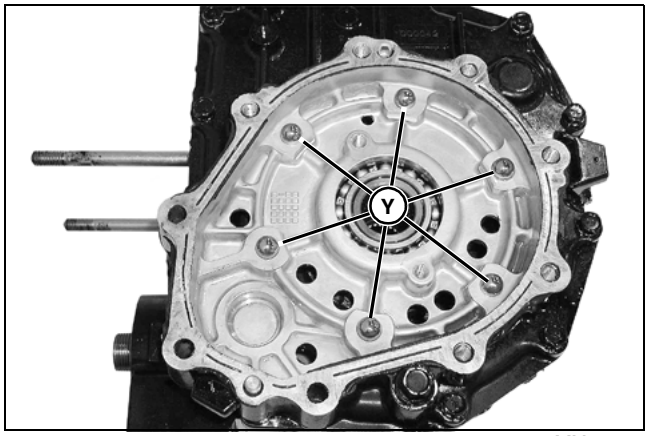
13.Install oil return tube (U) and dipstick (V).



MX5823

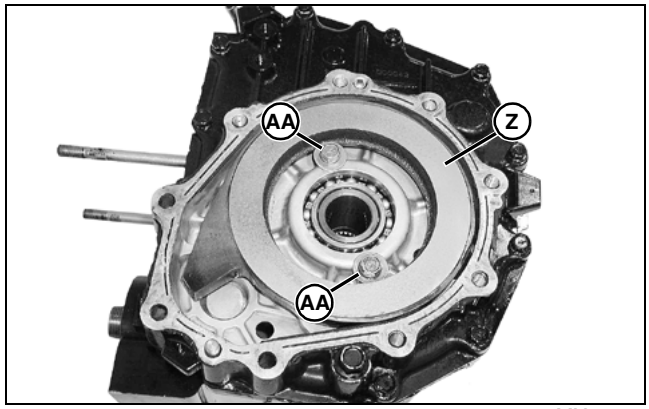
14.Apply TY16021 John Deere High Flex Form-in-Place Gasket on side cover (W) and differential housing mating surfaces.

15.Install side cover and nine M8 x 35 cap screws (X). Tighten cap screws to specification.



MX5825

16.Install six brake actuator balls (Y).



MX5824

17.Install brake actuator disk (Z).

18.Install cap screws and washers (AA).

19.Repeat steps 16 - 18 on opposite side.

20.Install both axle housings. (See “Axle Shaft Housing Assembly:” on page 627.)

Specifications:

Axle Housing-to-Differential
Cap Screw (M10 x 60) Torque . . . . . 52 N•m (38 lb-ft)

Axle Housing-to-Differential
Cap Screw (M10 x 45) Torque . . . . . 52 N•m (38 lb-ft)

Differential Ring Gear-to-Housing
Cap Screw Torque . . . . . 155 N•m (114 lb-ft)

Axle Seal Housing-to-Axle Housing
Cap Screw Torque . . . . . 26 N•m (19 lb-ft)

Differential Side Cover-to-Differential Case
Cap Screw (M8 x 35) Torque . . . . . 26 N•m (19 lb-ft)

PTO Disassembly, Inspection, and Assembly

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Clutch Piston Compression Tool[1]	NA	Used in a vise to compress the PTO clutch piston spring so the snap ring can be removed or installed.
M8 x 30 Cap Screw (2 used)	NA	Used to relieve spring pressure when removing accumulator cover.
Knife-Edge Puller	NA	Used to remove bearings.

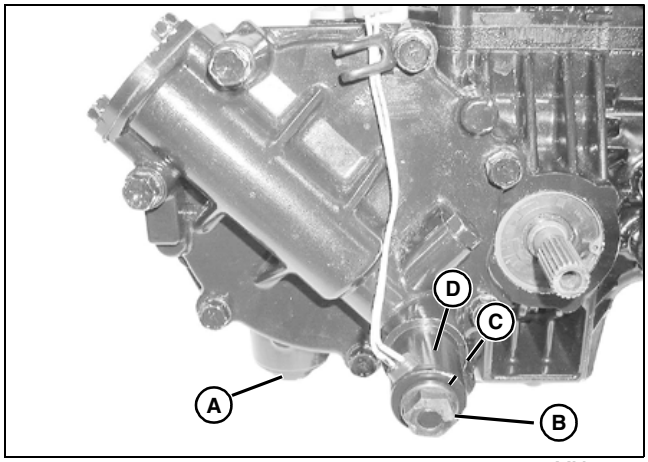
1. For instructions on making tool, see Fabricated Tools in this section.

Disassembly/Inspection:

NOTE: You do not need to remove transaxle to repair PTO only. PTO can be removed without disassembly of transaxle.

Transaxle is shown removed for clarity.

Use shop cloths or paper towels to catch and clean up any spilled oil immediately.

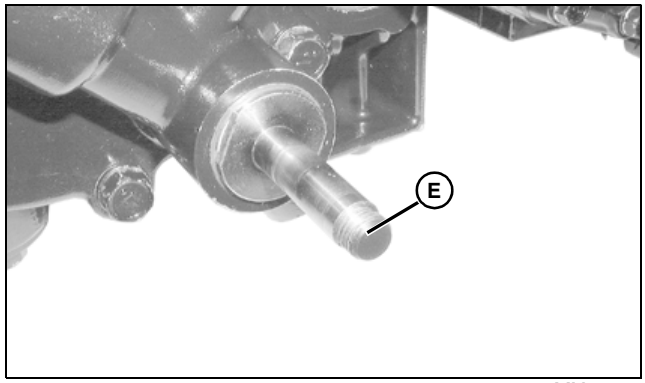


MX5778

1. Drain PTO housing at drain plug (A).
2. Remove solenoid nut (B).
3. Remove O-ring (C) and solenoid coil (D).

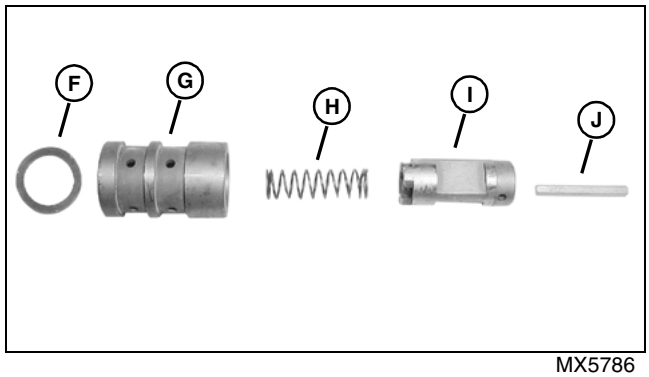
NOTE: PTO solenoid valve, relief valve, and accumulator may be repaired without complete disassembly of PTO.

All valves have small parts; take note of order and direction of disassembly. Use caution not to drop or lose small parts.



MX5779

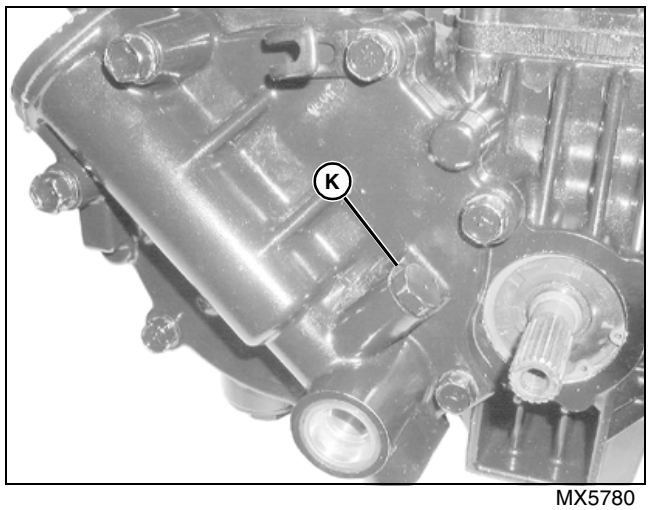
4. Remove solenoid stud (E).



MX5786

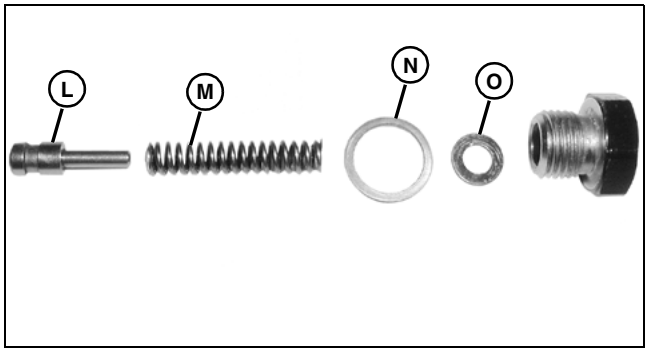
5. Remove solenoid valve parts (F - J).
6. Inspect parts for scoring or damage. Replace as necessary.

NOTE: Valve adjustment shims may stick inside of valve cap and fall out when removing cap. Remove cap slowly to prevent loss of shims.



MX5780

7. Remove relief valve cap (K).

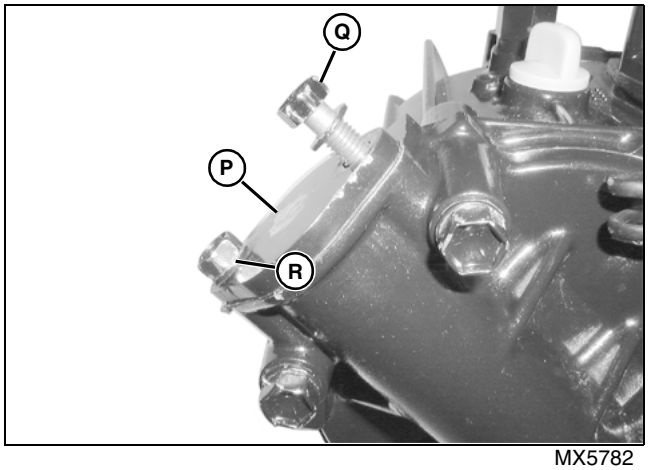


MX5787

8. Remove relief valve parts (L - O).

9. Inspect parts for scoring or damage. Replace as necessary.

CAUTION: Avoid injury! Accumulator spring is compressed. Do not remove cover without properly relieving spring pressure.



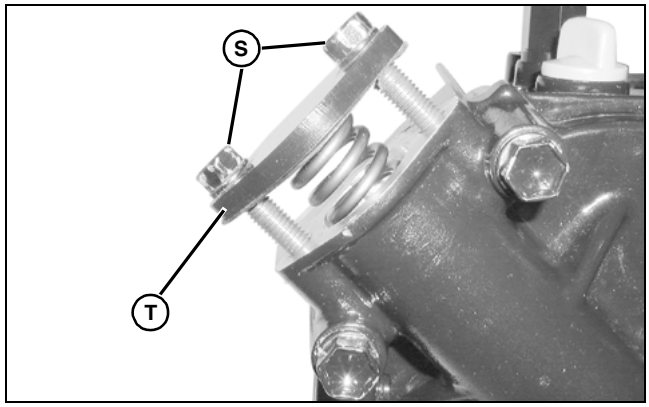
MX5782

10.Remove onE cap screw from accumulator cover (P).

NOTE: M8 x 30 cap screw will bottom in thread hole. Do not overtighten.

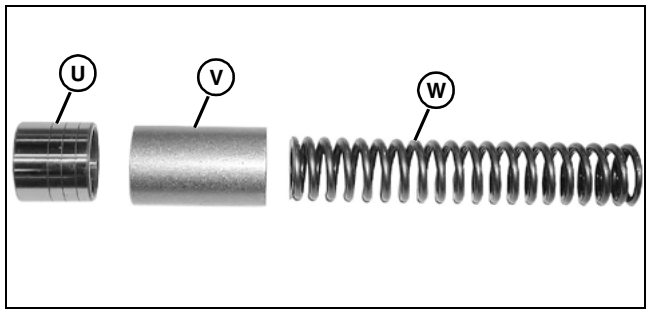
11.Install an M8 x 30 cap screw (Q) and tighten until snug.

12.Carefully remove remaining original cap screw (R) and replace with an M8 x 30 cap screw. Tighten until snug.



MX5783

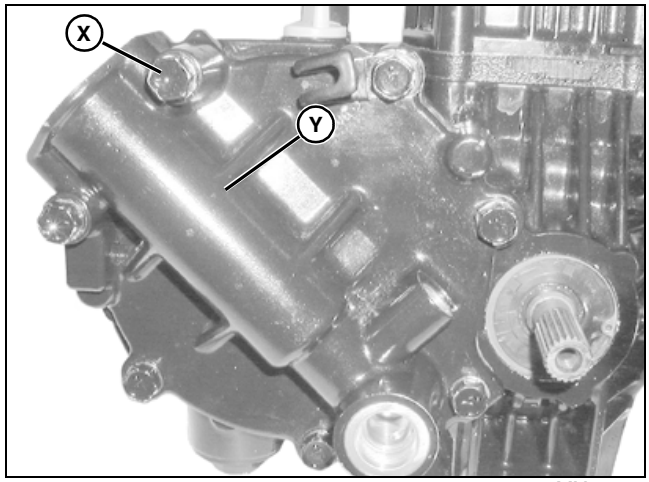
13.Slowly loosen both cap screws (S) evenly until spring pressure is relieved. Remove cover (T).



MX5871

14.Remove accumulator parts (U - W).

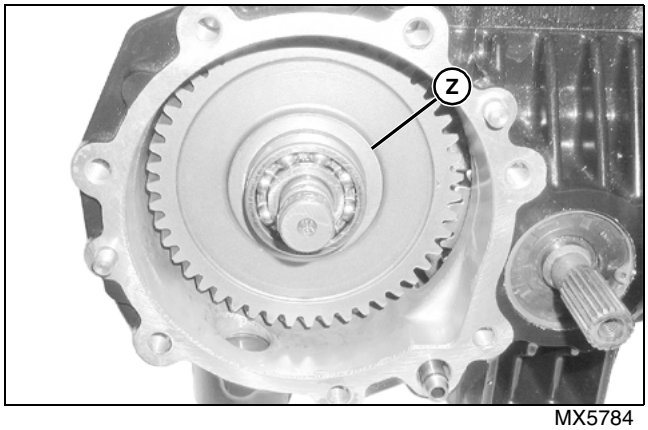
15.Inspect parts for scoring or damage. Replace as necessary.



MX5781

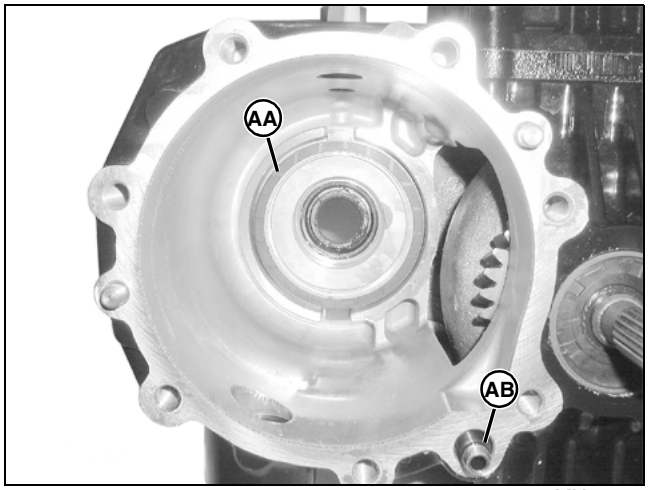
16.Remove seven cap screws (X).

17.Remove PTO cover (Y).



MX5784

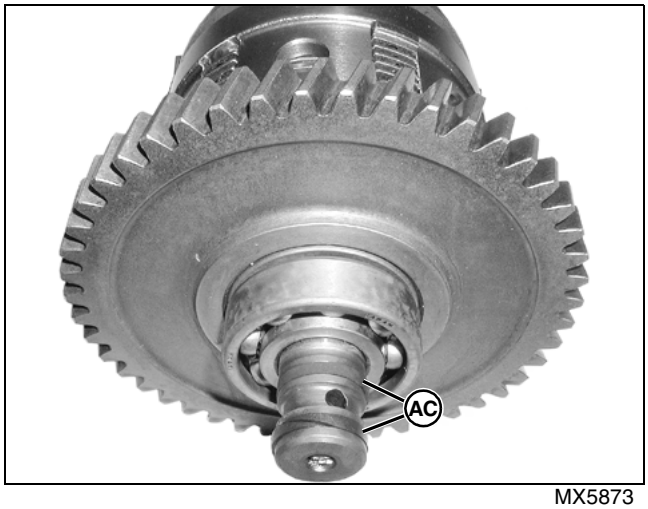
18.Remove PTO assembly (Z).



MX5785

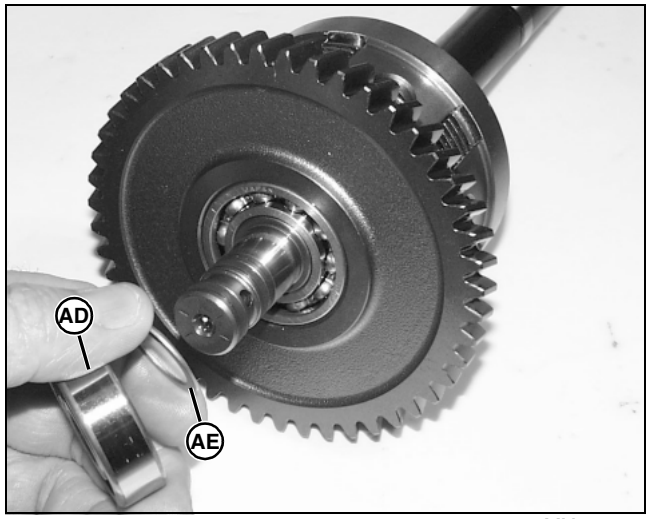
19.Remove brake disk (AA).

20.Remove PTO oil supply tube (AB).



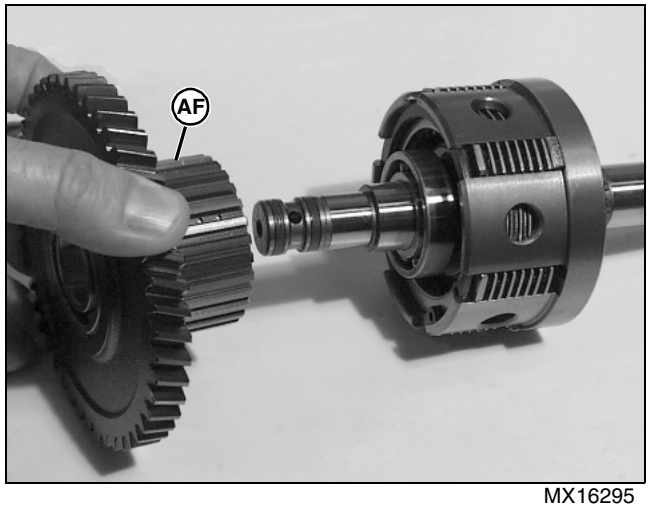
MX5873

21.Remove fiber seals (AC).



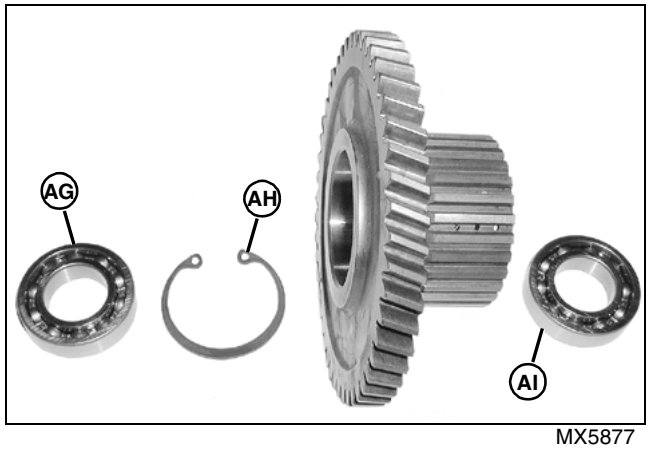
MX16294

22.Remove bearing (AD) using a knife-edge puller. Remove spacer (AE).



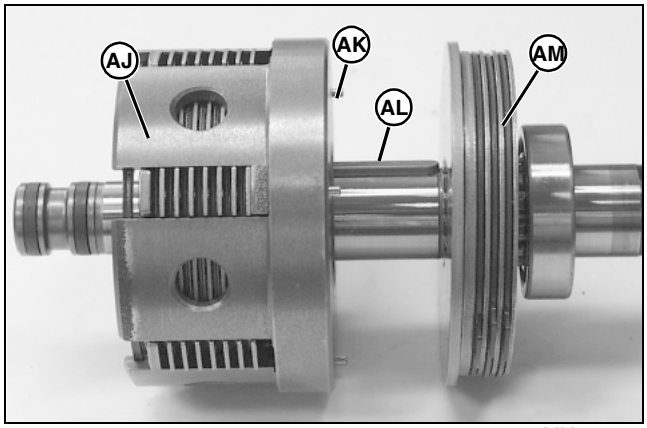
MX16295

23.Remove clutch gear (AF).



MX5877

24.Inspect bearings (AG and AI) and snap ring (AH). Remove and replace as necessary.

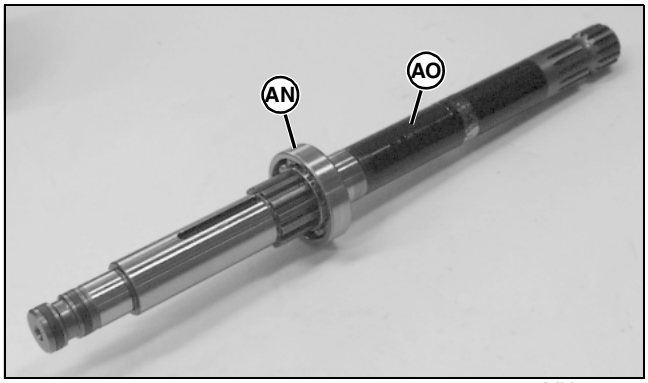


MX16305

25.Slide clutch assembly (AJ) partway off shaft and remove three brake pins (AK). Remove clutch assembly.

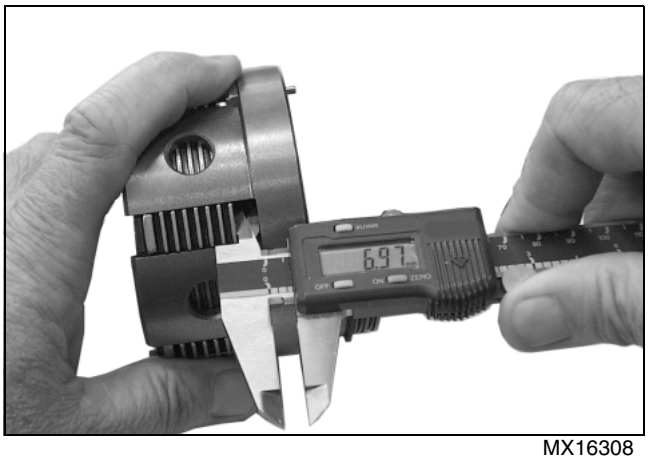
26.Remove key (AL).

27.Remove brake pack (AM).

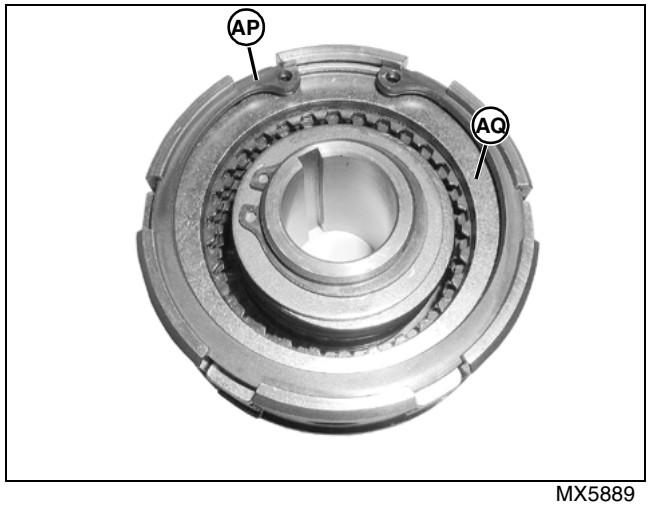


MX16306

28.Inspect bearing (AN) and shaft (AO). Use knife-edge puller if bearing replacement is necessary.

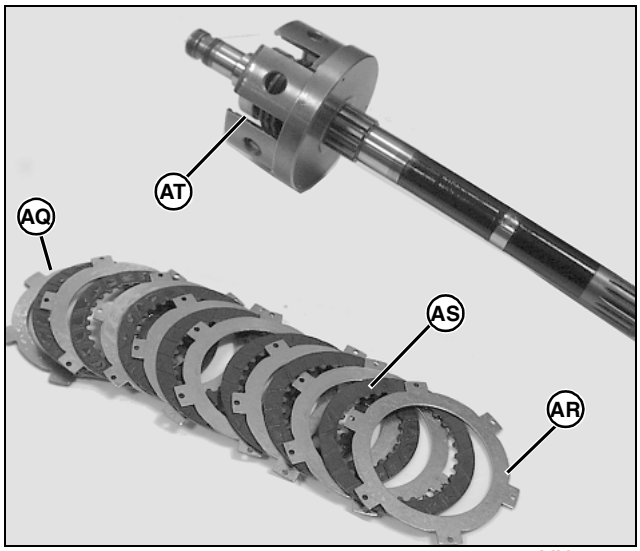

MX16308

29.Holding all the clutch disks together, measure the space between the bottom separator plate and the PTO cylinder. If space measured exceeds specification, replace all the clutch disks.



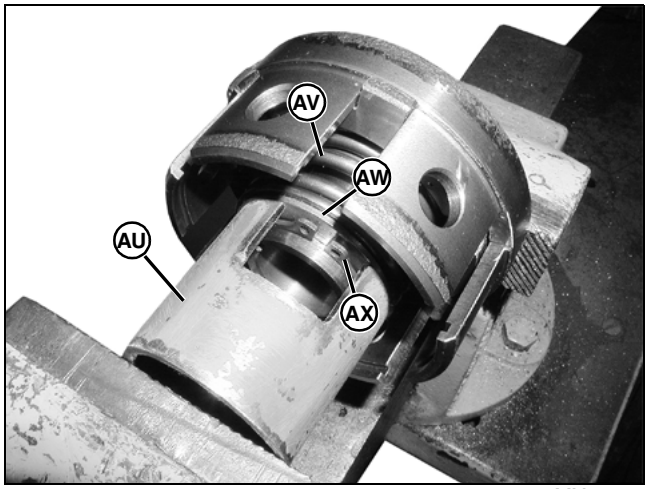
MX5889

30.Disassemble clutch if required. Remove large snap ring (AP). Lift top plate (AQ) off clutch assembly. Measure thickness of the top plate. A minimum thickness specification is required and the plate must be flat; replace plate if necessary.



MX16290

31.Remove seven clutch disks (AR) and seven separator plates (AS). Measure clutch disks (seven used) and separator plates (seven used) for minimum thickness requirement. The separator plates must be flat; replace plates if necessary. Check clutch basket fingers (AT) for notching or other damage. Replace clutch basket if necessary.

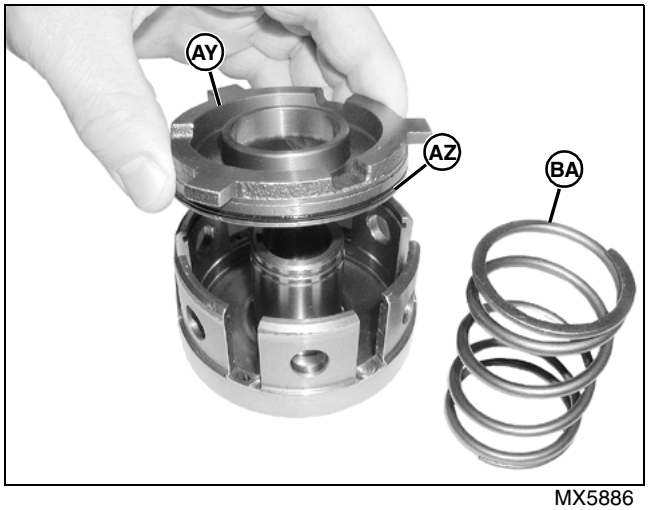


MX5882

32.Disassemble clutch piston by placing piston and clutch piston compression tool[1] (AU) in a vise.

33.Tighten vise to compress spring (AV) and flat washer (AW) to remove snap ring (AX).

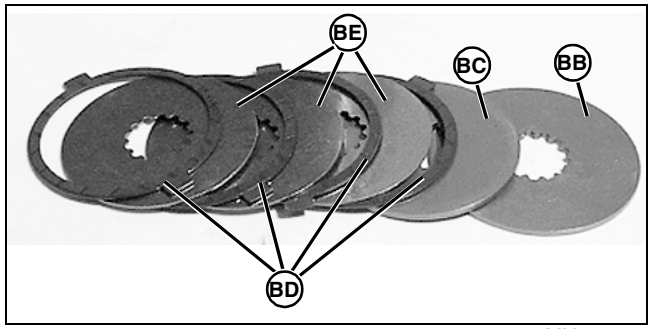
34.Slowly back off on vise to remove spring (AU).



MX5886

35.Remove piston (AY). Remove O-ring (AZ) and discard. Piston must be free of nicks and scratches; if not, replace it.

36.Check free length of piston return spring (BA). Replace if required.

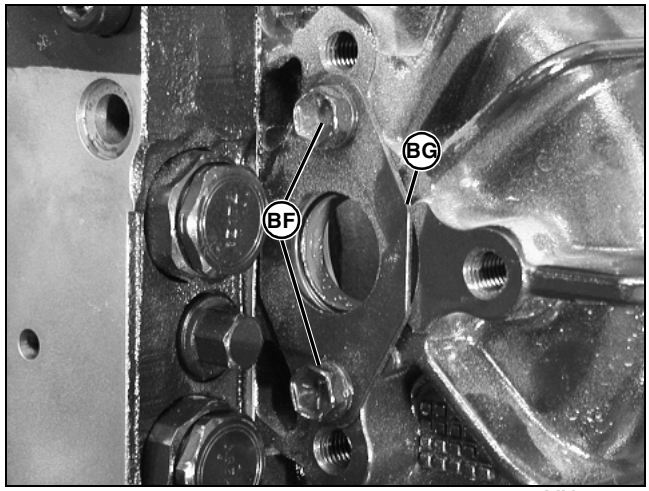


MX16296

37.Inspect brake pressure plate (BB). Plate must be flat and not damaged.

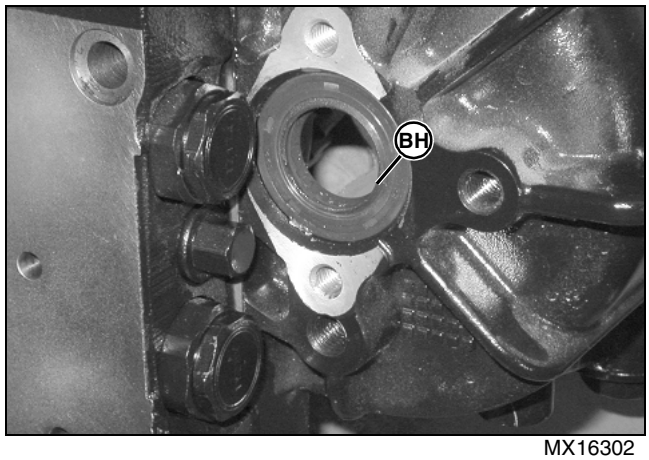
38.The top plate (BC) must be flat; replace if necessary.

39.Inspect brake disks (BD) (four used) and brake separator plates (BE) (three used). The separator plates must be flat; replace if necessary. If oil grooves of brake disks are worn down, replace disks. If oil grooves have disappeared, replace all plates and disks.



MX16301

40.Remove two cap screws (BF) and plate (BG).



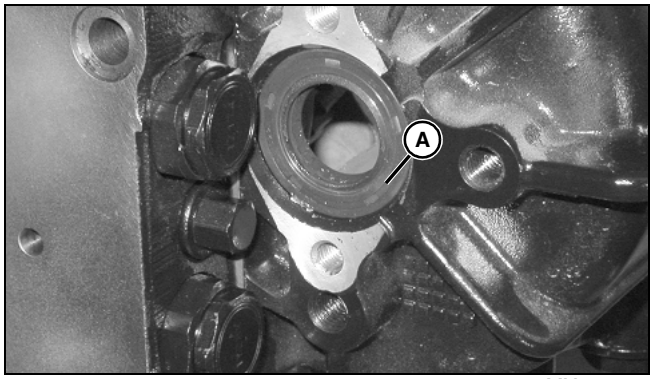
MX16302

41.Remove shaft seal (BH).

1. Clutch piston compression tool is a fabricated tool. For instructions to make tool, see Fabricated Tools in this section.

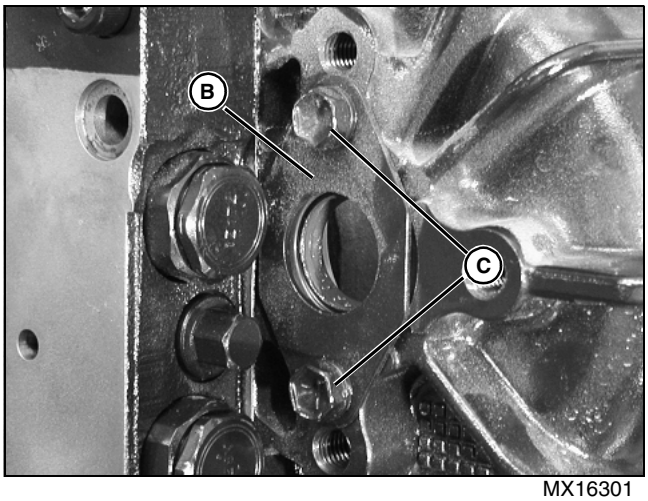
Assembly:

NOTE: Clean, dry, and lubricate all parts with clean hydrostatic fluid before assembly.



MX16302

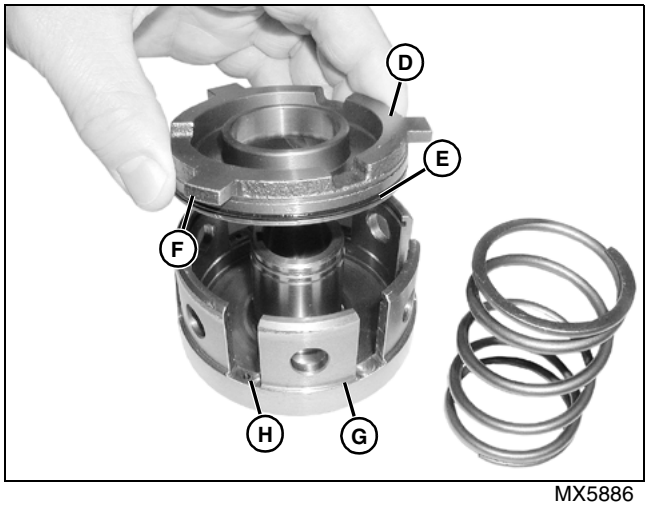
1. Install new seal (A) flush with surface of housing.



MX16301

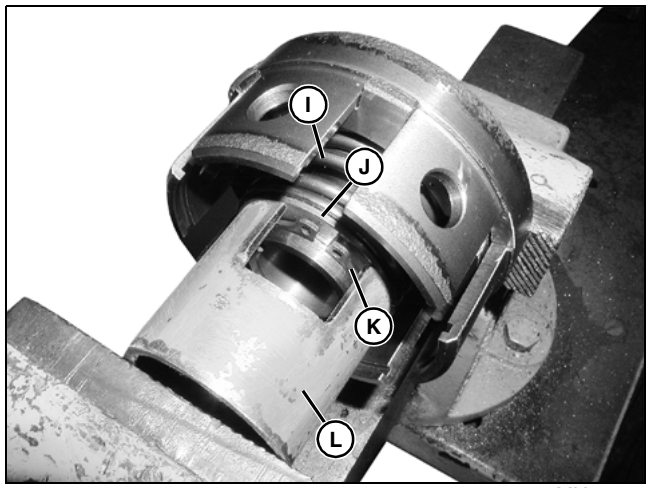
2. Install plate (B) and cap screws (C).

NOTE: Clutch piston must be positioned so that three spokes cover three pin holes in drum. If improperly installed, PTO brake will not work.



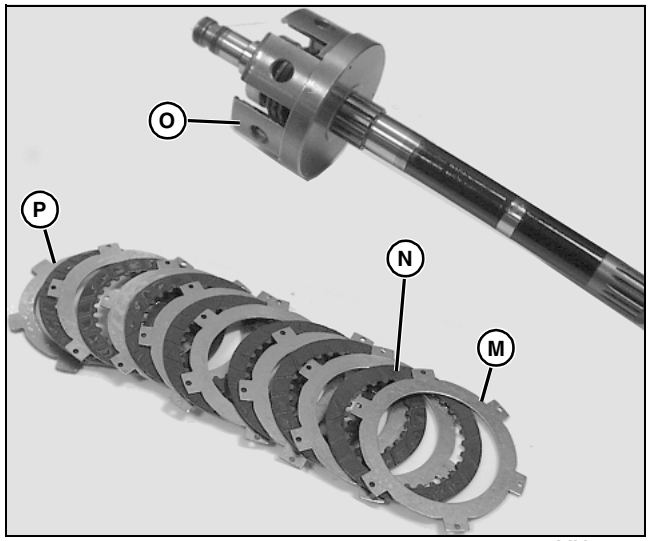
MX5886

3. Replace O-ring (E) and install piston (D) into drum (G). Three piston spokes (F) must cover three pin holes (H) in drum.



MX5882

4. Install piston spring (I), washer (J), and snap ring (K) using clutch piston compression tool[1] (L).



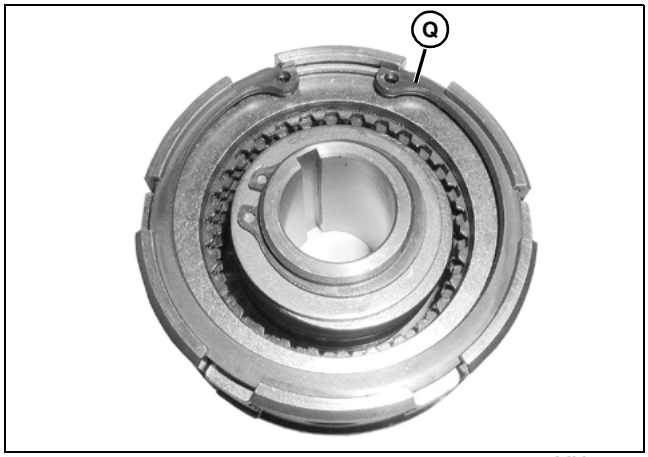
MX5889

5. Install one separator plate (M) in clutch basket (O), then one disk (N). Repeat until all seven separator plates and seven disks are alternately installed in clutch.

6. Install top plate (P) in clutch basket.

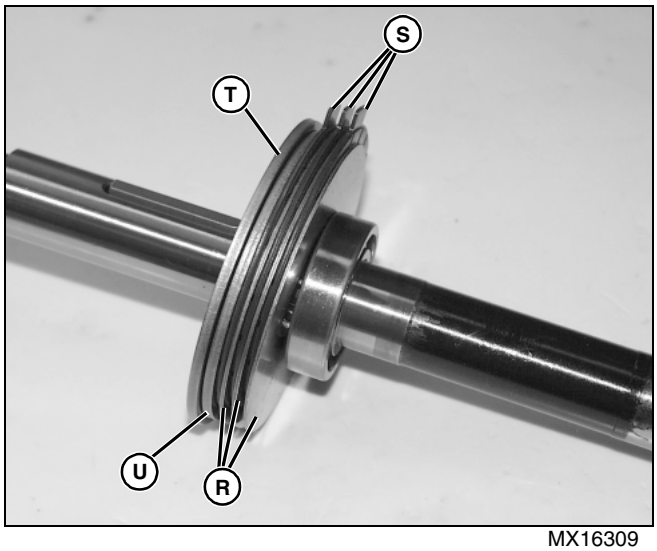
IMPORTANT: Avoid damage! Position the snap ring (Q) so that the open portion is against one of the sides of the cylinder wall.

1. Clutch piston compression tool is a fabricated tool. For instructions to make tool, see Fabricated Tools in this section.



MX5889

7. Install snap ring (Q) with open end facing drum wall.

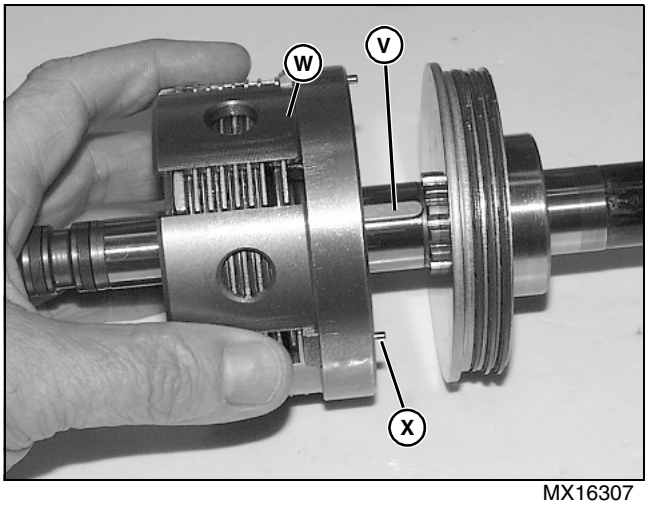


MX16309

8. Alternately install three brake separator plates (R) and three brake disks (S).

9. Install brake top plate (U).

10. Install brake pressure plate (T).



MX16307

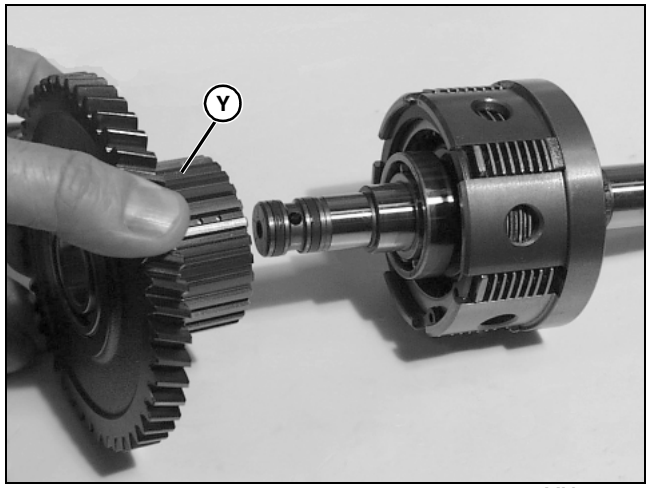
11. Install key (V) into shaft.

12. Slide clutch (W) partially onto shaft.

13. Install three pins (X) into clutch.

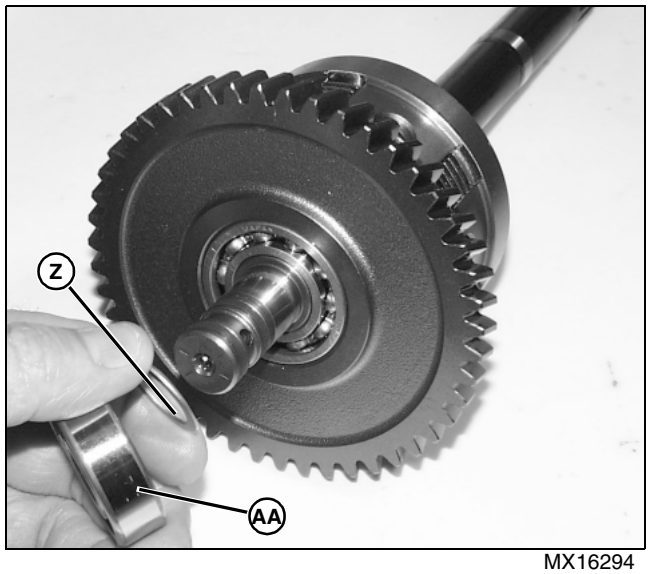
14. Install clutch fully onto shaft.

NOTE: Aligning clutch disks with a small O-ring pick and rotating gear and hub will aid in installation.



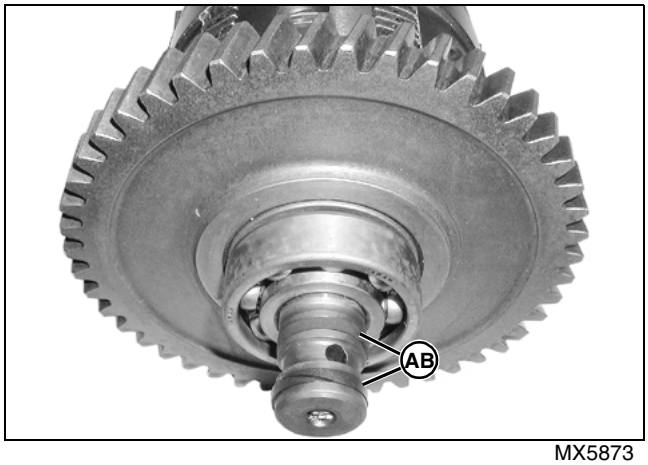
MX16295

15. Install PTO gear and hub (Y) to clutch.



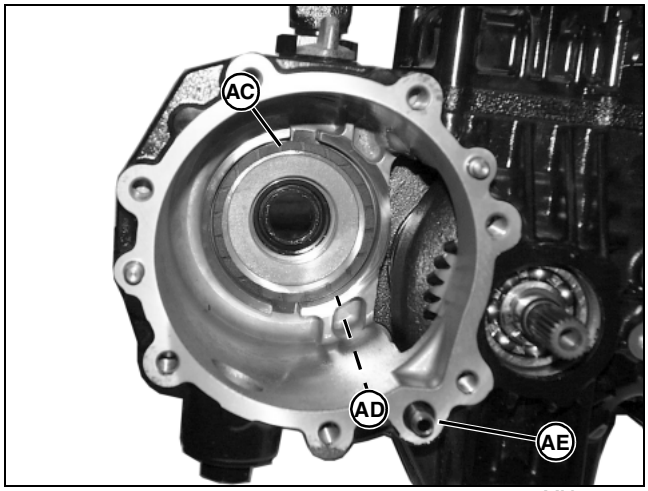
MX16294

16. Install spacer (Z) and bearing (AA) onto shaft.



MX5873

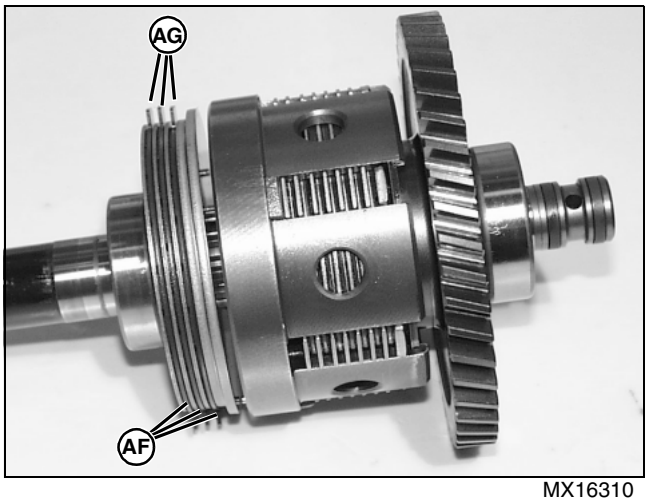
17.Install two fiber seals (AB).



MX16311

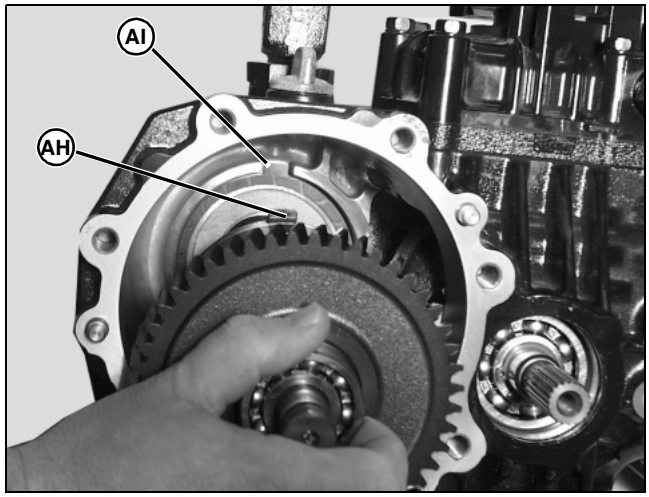
18.Install brake spacer ring (AD) and then brake disk (AC) into housing.

19.Replace O-rings and install PTO supply tube (AE).



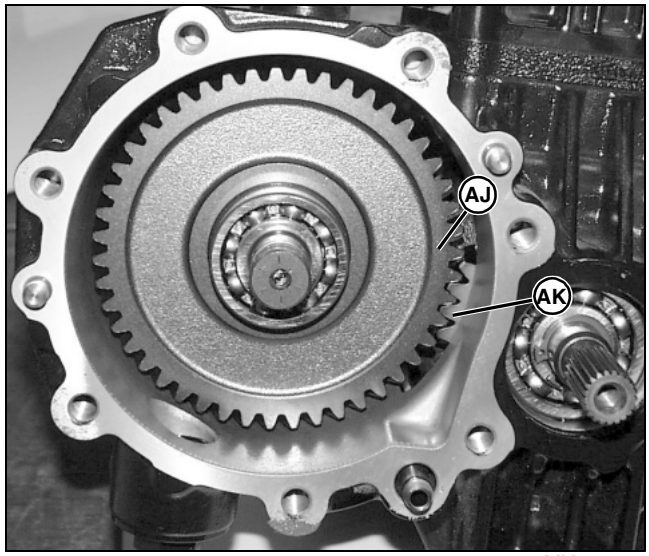
MX16310

20.Apply J-20D hydraulic fluid liberally to the brake disks (AF). Align the brake disc tabs (AG).



MX16312

21.Check that brake disk tabs (AH) align with the cutouts (AI) in the housing as you begin to insert the PTO assembly.

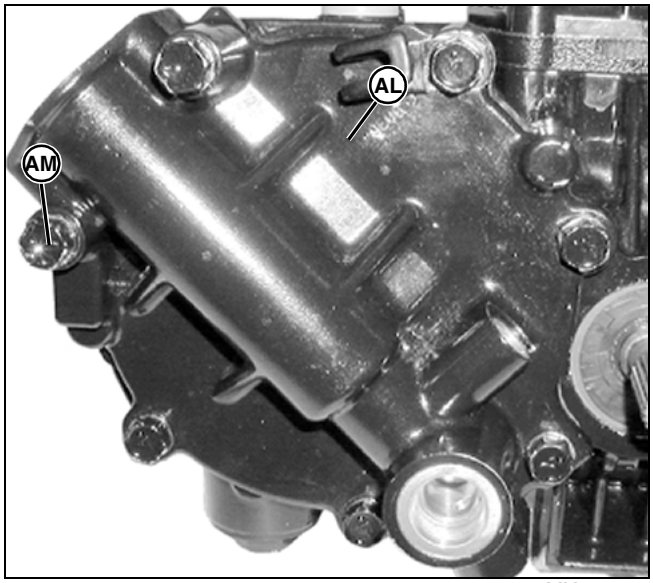


MX16313

22.Align the PTO clutch gear (AJ) with the PTO gear teeth (AK) as the unit is inserted in the housing.

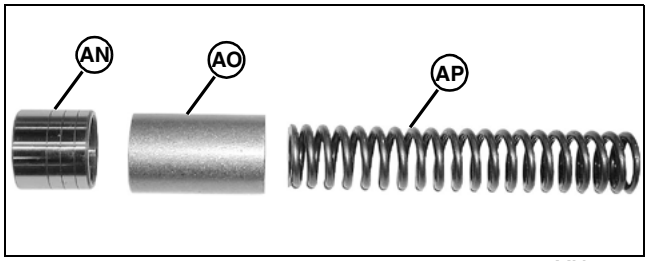
23.Carefully guide PTO assembly into housing until clutch gear and PTO gear faces are flush.

24.Install new PTO cover-to-PTO housing gasket to PTO housing.



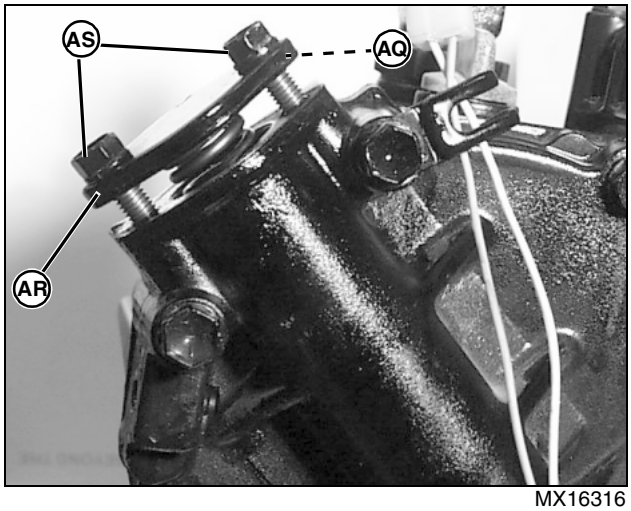
MX16314

25.Install PTO cover (AL) using seven cap screws (AM).



MX5871

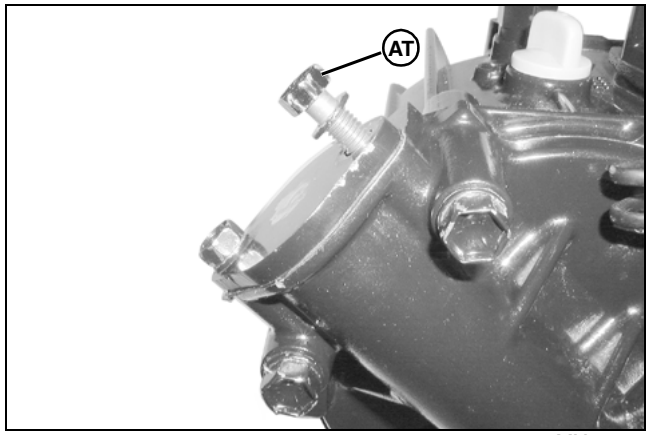
26.Install piston (AN), then sleeve (AO), and then spring (AP) into PTO cover.



MX16316

27.Install cover gasket (AQ) to cover (AR).

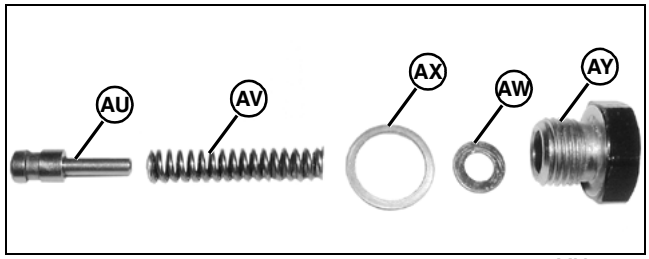
28.Install cover using two M8 x 30 (AS) cap screws. Tighten cap screws evenly until snug.



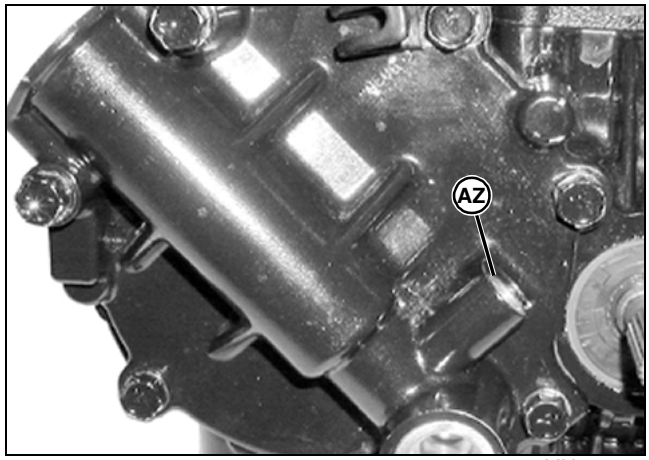
MX5782

29.Remove one M8 x 30 cap screw (AT) and replace it with an original cover cap screw. Tighten cap screw.

30.Repeat for other M8 x 30 cap screw.



MX5787

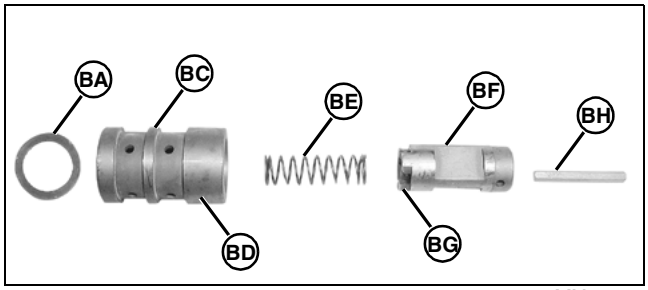


MX16314

31.Install PTO relief valve (AU) and then spring (AV) into PTO cover.

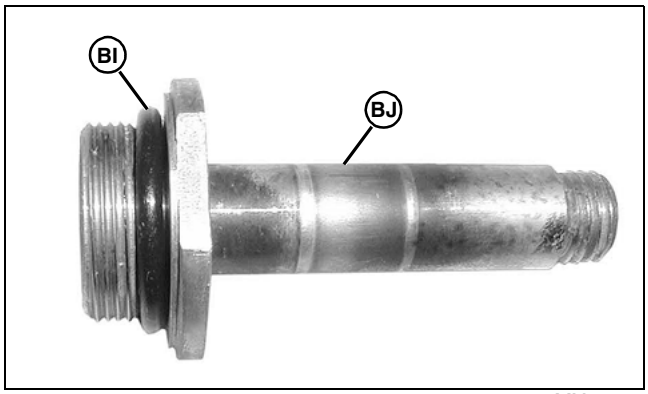
32.Install shims (AW) and new seal (AX) into relief cap (AY).

33.Carefully install cap into threaded hole (AZ) in PTO cover, taking care not to drop shims out of cap.

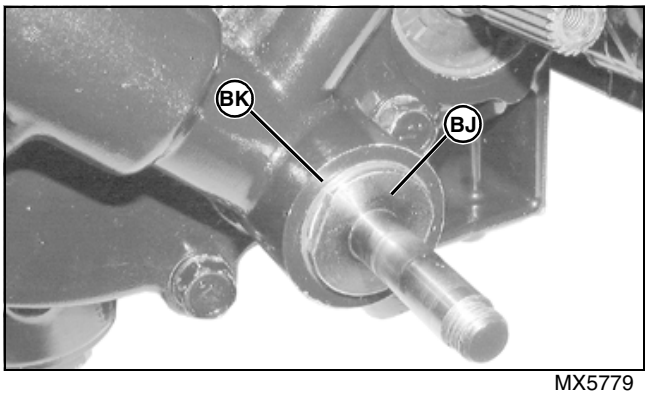


MX5786

34.Install washer (BA) and then outer spool (BC), with large boss (BD) up, into PTO cover.



MX5893



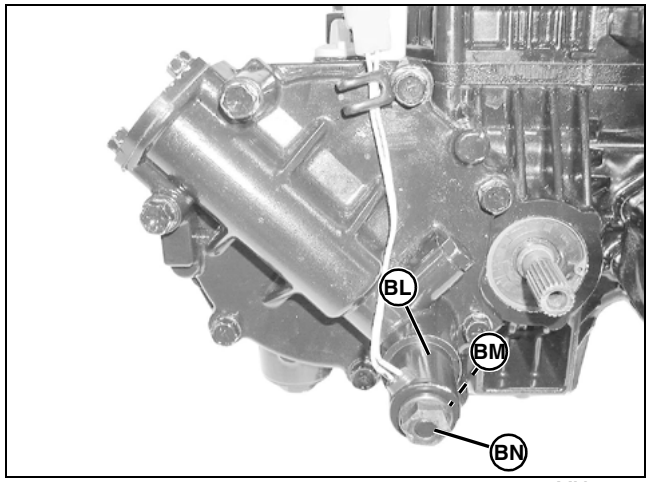
MX5779

35.Install spring (BE) and then inner spool (BF), with fingers (BG) down, into PTO

36.Install new O-ring (BI).

37.Install pin (BH) into solenoid stud (BJ).

38.Install new seal (BK) and install solenoid stud. Tighten to specification.



MX5778

39.Install solenoid coil (BL) with wires toward threaded end of solenoid stud, and then new O-ring (BM) and nut (BN). Tighten nut to specification.

40.Fill transaxle. (See Checking the Transaxle Oil Level in operator's manual.)

Specifications:

Bottom Separator Plate-to-PTO Gap (Maximum) . . . . . 9.1 mm (0.36 in.)

Clutch Top Plate Thickness (Minimum) . . . . . 3.03 mm (0.119 in.)

Clutch Disk Thickness (Minimum) . . . 2.0 mm (0.08 in.)

Clutch Separator Plate Thickness (Minimum) . . . . . 1.0 mm (0.04 in.)

Piston Return Spring Free Length (Minimum) . . . . . 75 mm (2.95 in.)

Piston Return Spring Test Length @ 499 N (112 lb-force) . . . . . 28.6 mm (1.13 in.)

Solenoid Stud Torque . . . . . 23 N•m (203 lb-in.)

Solenoid Coil Nut Torque . . . . . 5 N•m (44 lb-in.)

4WD Drive Shaft Removal and Installation

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Floor Jack	NA	Used to raise front of machine.
Jackstand (2 used)	NA	Used to support machine.

Removal:

1. Park machine safely.
2. Stop engine.

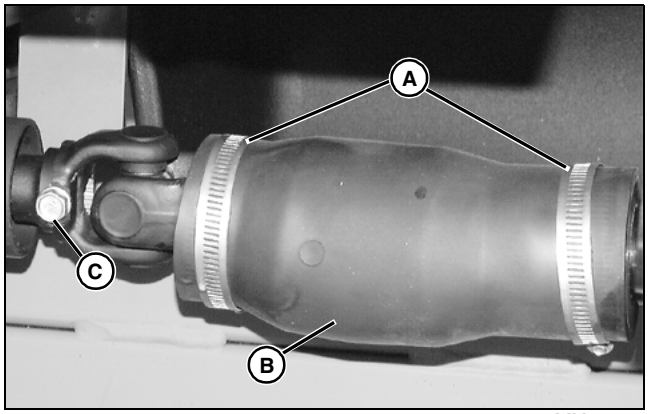
3. Remove engine cover.

4. Disconnect battery (-) negative cable.

5. Block rear tires to prevent machine from rolling.

CAUTION: Avoid injury! Support machine properly.

6. Raise front of machine using a floor jack and support with jackstands.



MX5593

7. Loosen band clamps (A) on front and rear universal joint boots (B).

8. Slide boots away from front and rear universal joints.

9. Remove cap screw and washer (C) from front universal joint connection.

10.Slide drive shaft rearward to remove universal joint from transaxle output shaft.

11.Lower and slide drive shaft forward to remove drive shaft from 4WD axle input shaft.

12.Inspect the splines of the universal joints and drive shafts for wear or damage. Replace parts as needed.

Installation:

IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.

1. Slide rear universal joint of drive shaft onto 4WD axle input shaft.

NOTE: Holes for cap screw and washer in front universal joint and transaxle 4WD output shaft must be aligned when installing drive shaft.

2. Align hole in front universal joint with hole in transaxle 4WD output shaft.

3. Slide universal joint onto spline until the holes are aligned.

4. Install washer and cap screw in front universal joint. Tighten cap screw.

5. Slide boots over front and rear universal joints.

6. Tighten band clamps.

7. Remove jackstands and lower machine.

8. Connect battery negative (-) cable.

9. Install engine cover.

4WD Axle Removal and Installation

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Floor Jack	NA	Used to raise rear of machine.
Jackstand (2 used)	NA	Used to support machine.
Hoist	NA	Used to remove and install axle.

Removal:

CAUTION: Avoid injury! 4WD axle is heavy. An additional person is required when removing 4WD axle from machine.

1. Park machine safely.

2. Stop engine.

3. Remove engine cover.

4. Disconnect battery negative (-) cable.

NOTE: Muffler and exhaust pipes must be removed to remove and install 4WD axle.

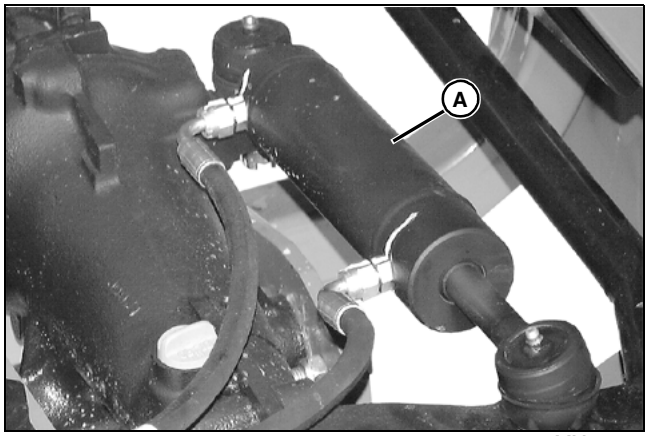
5. Remove muffler and exhaust pipes. (See Muffler Removal/Installation and Exhaust Pipe Removal/ Installation in appropriate engine section.)

6. Block front wheels.

CAUTION: Avoid injury! Support machine properly.

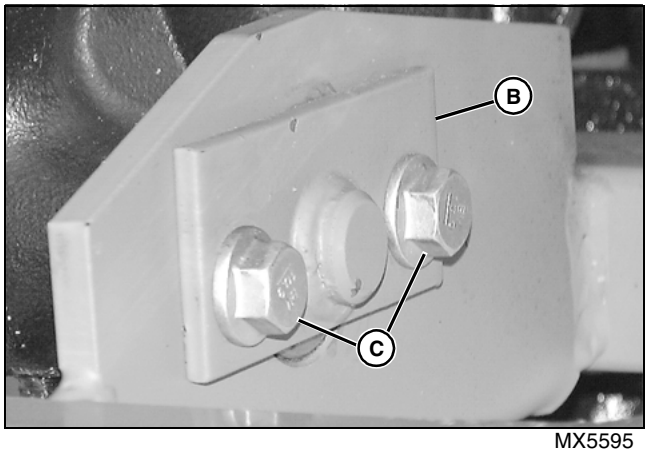
7. Raise rear of machine with floor jack and support frame with jackstands.

8. Remove rear wheels. (See “Rear Wheel Removal and Installation” on page 809 in the Miscellaneous section.)



MX5594

9. Remove steering cylinder (A). (See “Steering Cylinder Removal and Installation” on page 680 in Steering section.)

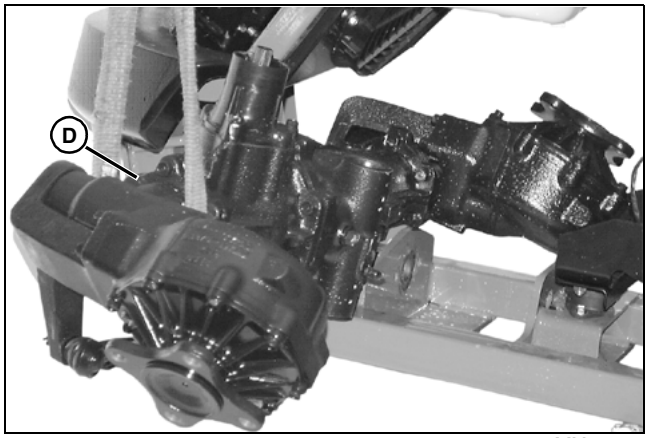


MX5595

10.Support axle to relieve weight of axle on axle pin (B).

11.Remove two cap screws (C).

12.Remove axle pin.



MX5596

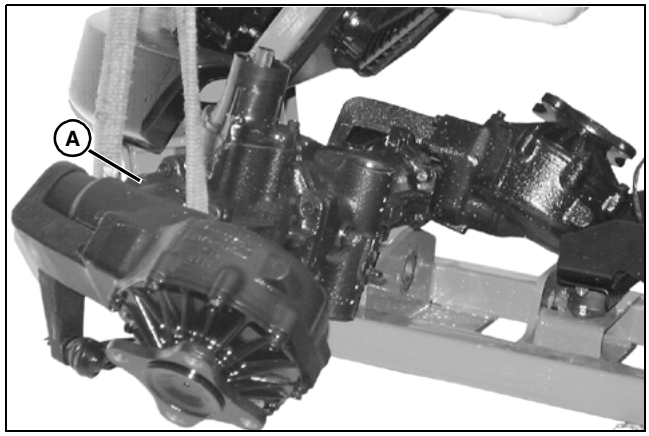
13.Use a hoist and lift sling to raise right side of axle (D).

14.With an assistant, lift axle, rotate clockwise, and remove axle out right side of machine.

Installation:

CAUTION: Avoid injury! 4WD axle is heavy. An additional person is required when installing 4WD axle in machine.

IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.



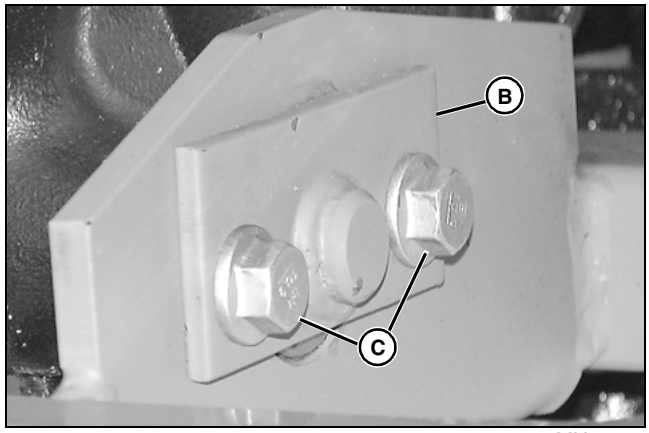
MX5596

1. Use a hoist and lift sling to lift the right side of 4WD axle (A).

2. With an assistant, install 4WD axle into right side of machine.

3. Support axle in position.

4. Align axle pin pivot point with axle pin flange.

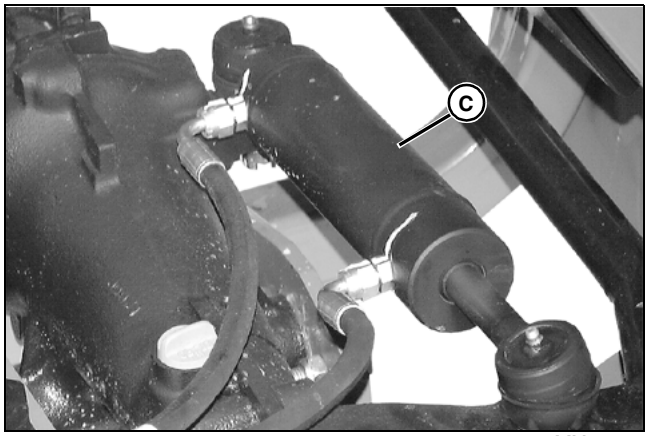


MX5595

5. Install 4WD axle pin (B).

6. Install and tighten two cap screws (C).

7. Remove support from axle.



MX5594

8. Install steering cylinder (C). (See “Steering Cylinder Removal and Installation” on page 680 in the Steering section.)

9. Install rear wheels. (See “Rear Wheel Removal and Installation” on page 809 in the Miscellaneous section.)

10.Remove jackstands and use floor jack to lower machine.

11.Install muffler and exhaust pipes. (See Muffler Removal and Installation and Exhaust Pipe Removal and Installation in the appropriate engine section.)

12.Connect battery negative (-) cable.

13.Install engine cover and remove wheel blocks.

Specifications:

4WD Axle Weight (Approximately) . . . . . 68 kg (150 lb)

4WD Axle Disassembly, Inspection, and Assembly

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Floor Jack	NA	Used to raise machine.
Jackstand (2 used)	NA	Used to support frame.
Hoist	NA	Used to remove and install 4WD axle.
Snap Ring Pliers Set	NA	Used to remove and install snap rings.
Hydraulic Press	NA	Used to remove and install bearings.
Bushing, Bearing, and Seal Driver Set	NA	Used to install bearings and seals.

Special or Required Tools:

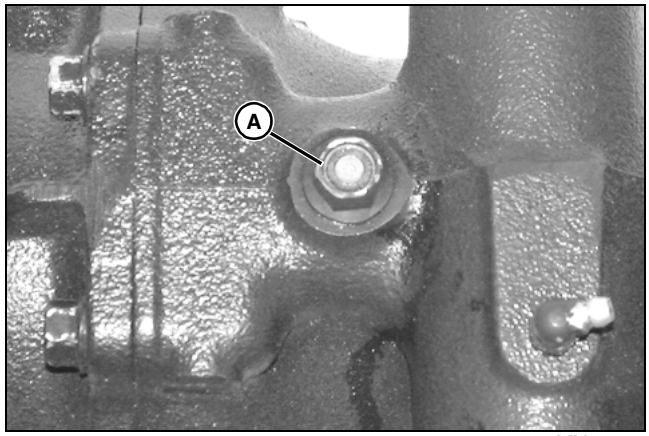
Tool Name	Tool No.	Tool Use
3-Jaw Puller	NA	Used to remove bearings.
Knife-Edge Puller	NA	Used to remove bearings.

Other Material:

Part No.	Part Name	Part Use
TY16021 (U.S.)/ LOCTITE 17430/ TY9484 (Canada)	John Deere High Flex Form-in-Place Gasket	Used to make gaskets.
TY16285 (U.S.)/ LOCTITE 17649/ CXTY16285 (Canada)	Cure Primer	Used to clean parts and speed cure of sealant.

Procedure:

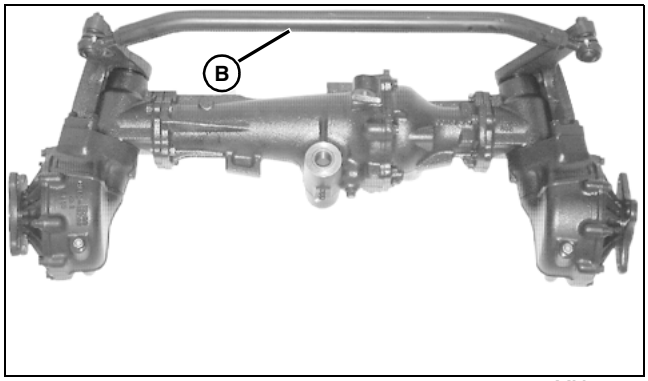
1. Remove axle from machine. (See “4WD Axle Removal and Installation” on page 646.)



MX5598

2. Remove drain plug (A) at differential housing. Drain oil into a properly marked container of sufficient size to hold oil from axle.

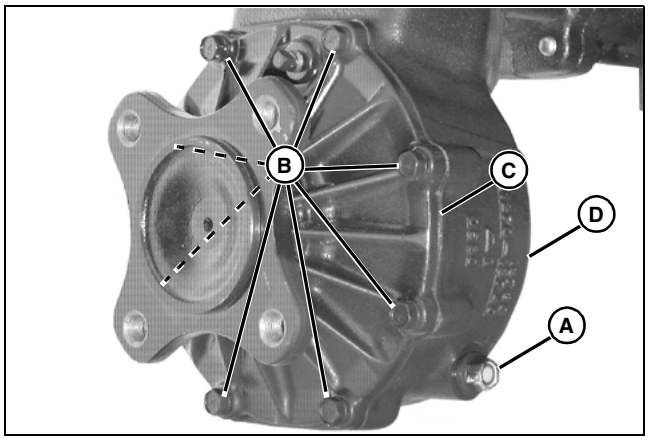
IMPORTANT: Avoid damage! When removing tie rod (2), keep ball joints clean. Dirt and contaminants can damage ball joint seals and shorten service life.



MX5597

3. Remove cotter pin and nut from each end of tie rod (B). Tie rod ends have a tapered joint. Remove tie rod.

Final Drive Hub Disassembly:



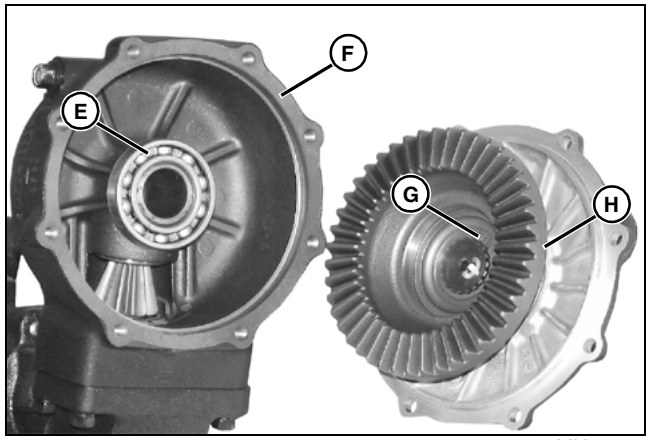
MX5599

1. Remove drain plug (A) from lower gear case. Drain oil into a properly marked container.

2. Remove eight cap screws and lock washers (B) from lower gear case cover (C).

3. Remove cover assembly. It may be necessary to tap on cover with a soft-faced hammer to separate it from the lower gear case (D).

NOTE: Remove bearing (E) with a bearing puller only if bearing requires replacement.



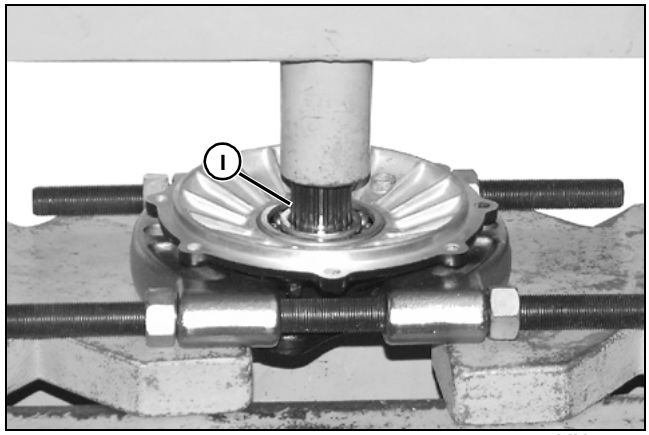
MX5600

4. Inspect bearing (E) for wear, damage, or rough movement. Replace bearing as needed.

5. Remove gasket (F) and clean gasket mating surfaces.

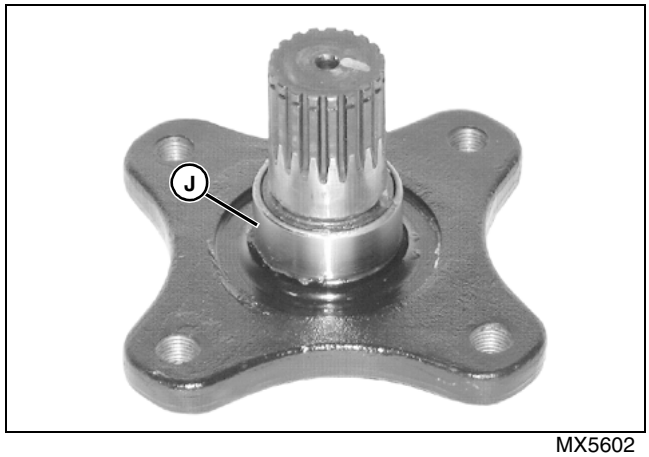
6. Remove snap ring (G) to remove ring gear (H).

7. Inspect ring gear for wear or damage. Replace as needed.



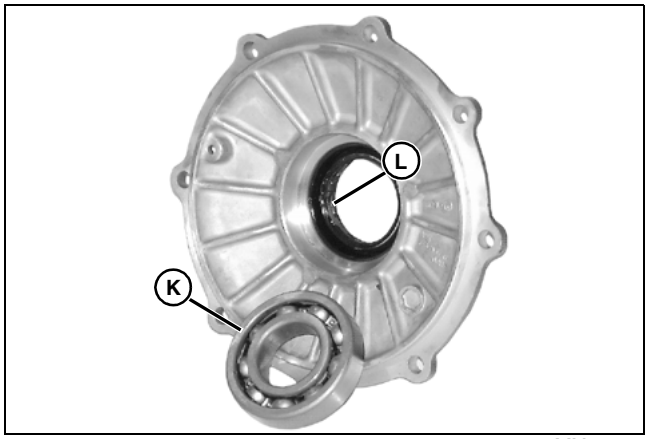
MX5601

8. Use a press to remove hub shaft (I) from cover.



MX5602

9. Inspect oil seal wear sleeve (J) for wear or damage. Replace as needed.

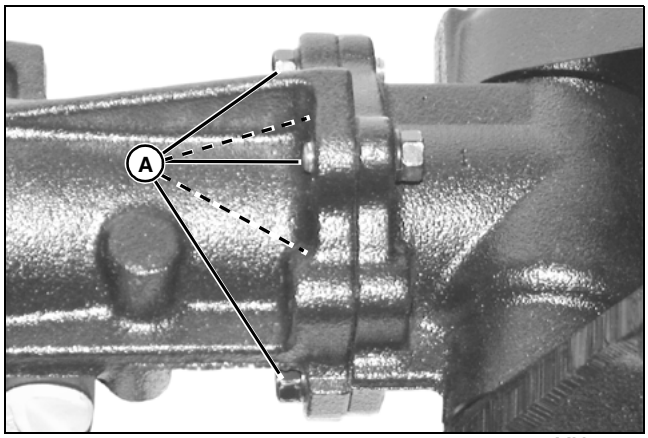


MX5603

10.Remove bearing (K). Inspect for wear, damage, or rough movement. Replace as needed.

11.Remove oil seal (L).

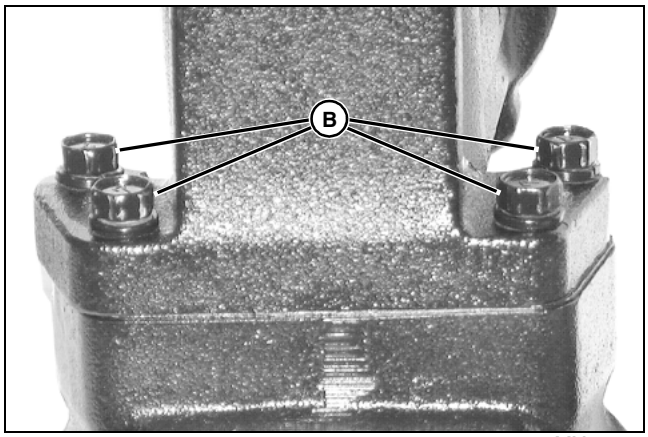
Final Drive Disassembly:



MX5628

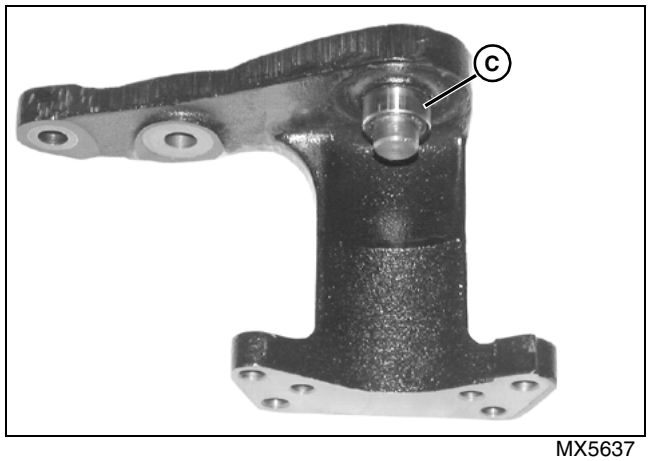
1. Remove five axle housing-to-final drive cap screws and lock washers (A).

2. Remove final drive assembly. It may be necessary to tap on spindle gear case with a soft-faced hammer to separate final drive assembly from axle housing.



MX5629

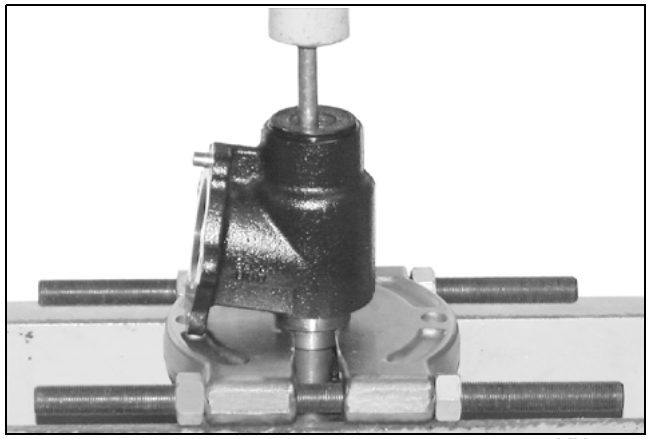
3. Remove four cap screws and lock washers (B) to remove steering arm. It may be necessary to use a soft-faced hammer to separate steering arm from spindle gear case.



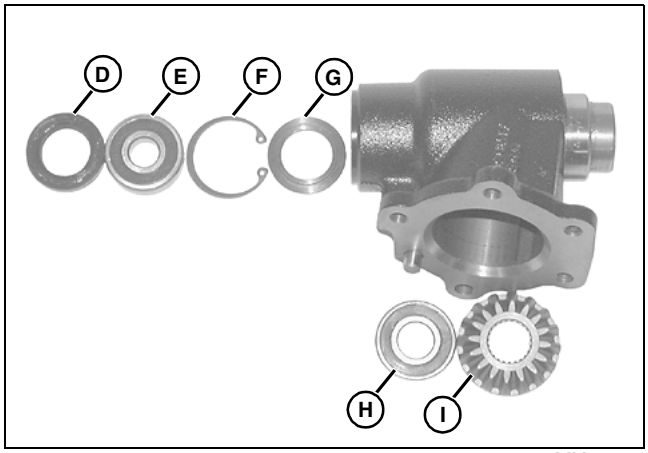
MX5637

4. Inspect oil seal wear sleeve (C) on steering arm for wear or damage. Replace as needed.

NOTE: When spindle and lower gear cases are separated, a spacer, gear, and bearing from the spindle shaft will be loose in the spindle gear case.


MX5630

5. Put final drive assembly in a press. Press on spindle shaft in spindle gear case to separate spindle and lower gear cases. Support lower gear case so it does not fall and cause injury or damage.

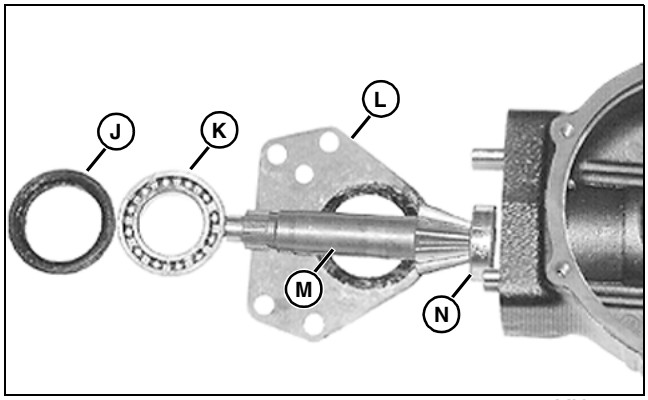


MX5631

6. Remove spacer (G), bearing (H), and gear (I) from spindle gear case.

7. Remove upper oil seal (D), bearing (E), and snap ring (F) from top of spindle gear case.

8. Inspect parts for wear or damage. Inspect bearings for wear, damage, or rough movement. Replace parts as needed.



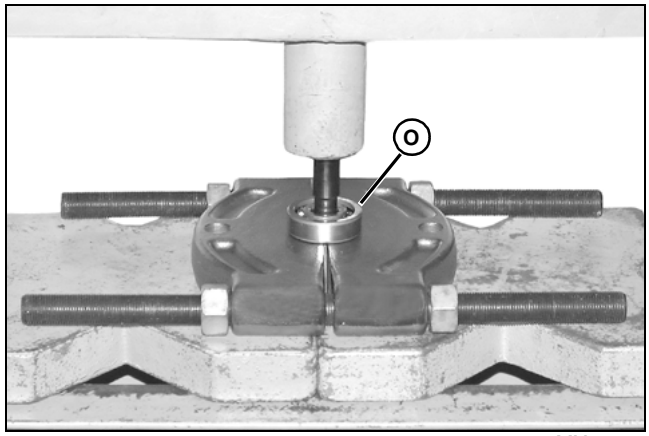
MX5632

9. Remove shim (L), lower oil seal (J), and bearing (K) from lower gear case. Discard oil seal.

10.Inspect bearing for wear, damage, or rough movement. Replace as needed.

11.Remove spindle shaft (M) from lower gear case.

12.Inspect spindle shaft and splines on shaft for wear or damage. Replace as needed.



MX5699

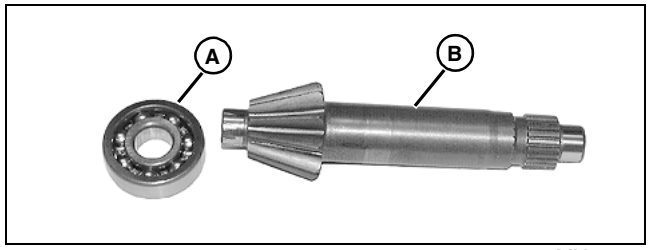
13.Inspect bearing (O) on spindle shaft for wear, damage, or rough movement. Replace as needed. Remove bearing from spindle shaft only if it requires replacement.

Final Drive Assembly:

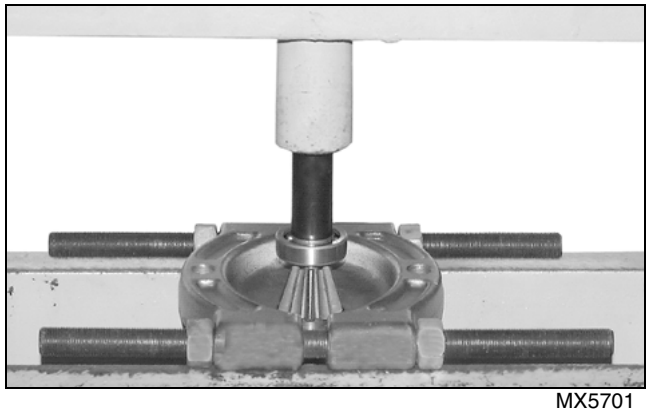
IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.

Press on inner bearing race only to avoid damaging bearing.

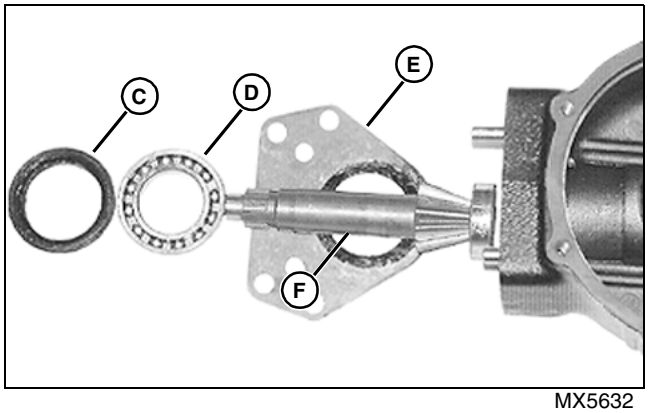
NOTE: Steps for assembly of left and right final drives are same.



MX5700


MX5701

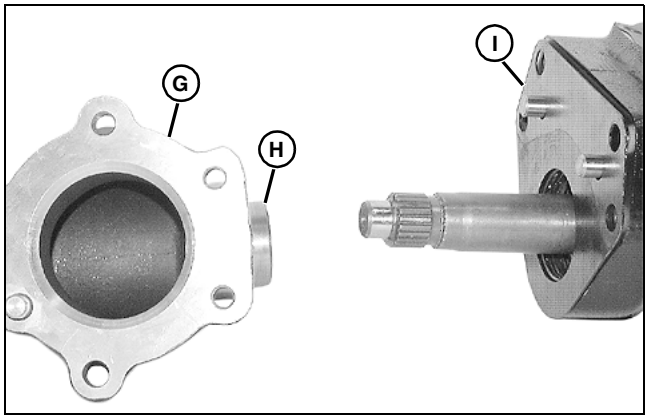
1. Press on inner race of bearing (A) to install new bearing on spindle shaft (B).



MX5632

2. Install spindle shaft (F) in lower gear case. It may be necessary to tap shaft to seat bearing to bottom of bore.

3. Install bearing (D) and seal (C). Install seal with spring side into bore first and flush with mounting surface.

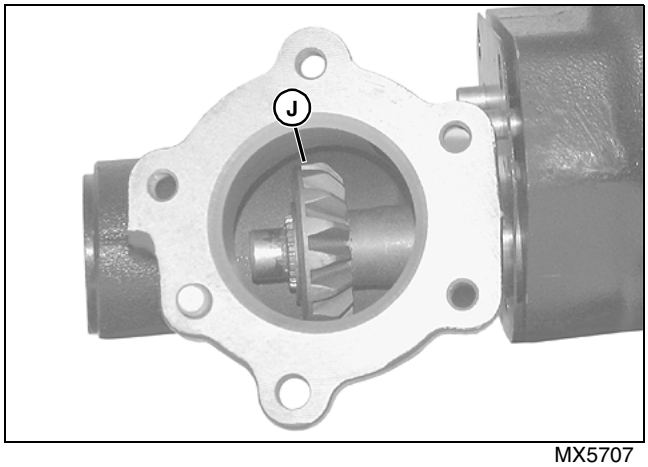


MX5706

4. Install shim (I) on lower gear case.

5. If removed, press new sleeve (H) onto spindle gear case (G).

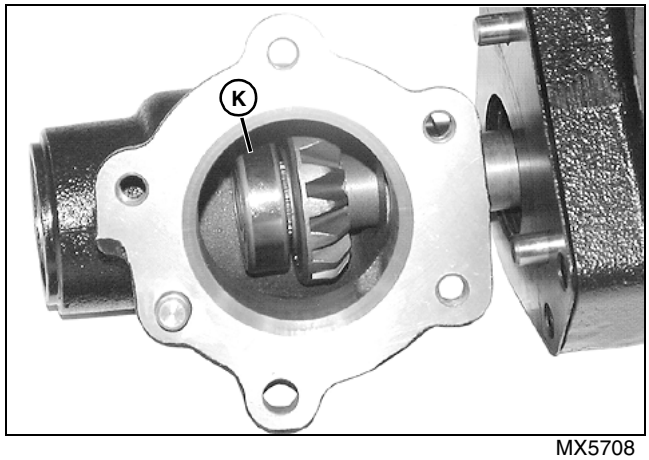
6. Put spindle gear case (G) over spindle shaft. Do not install into lower gear case at this time.



MX5707

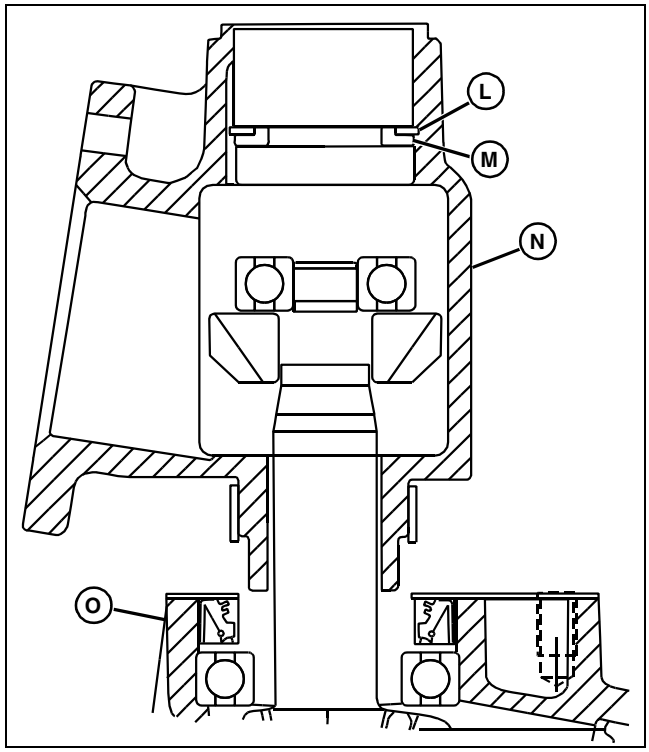
7. Install gear (J) on spindle shaft with gear teeth toward lower gear case.

IMPORTANT: Avoid damage! Push on inner race only to avoid damaging bearing.



MX5708

8. Install bearing (K) on spindle shaft. Tap on inner race of bearing to install bearing onto spindle shaft.

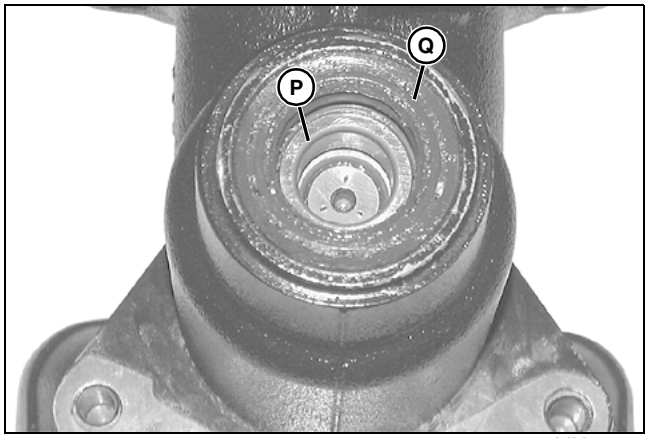


MX5739

9. Install snap ring (L).

10. Install spacer (M) with stepped side against snap ring. Keep spacer against snap ring while holding spindle (N) and lower (O) gear cases upright. Tap on spindle gear case with a soft-face hammer to install into lower gear case. use care not to damage seal in lower gear case.

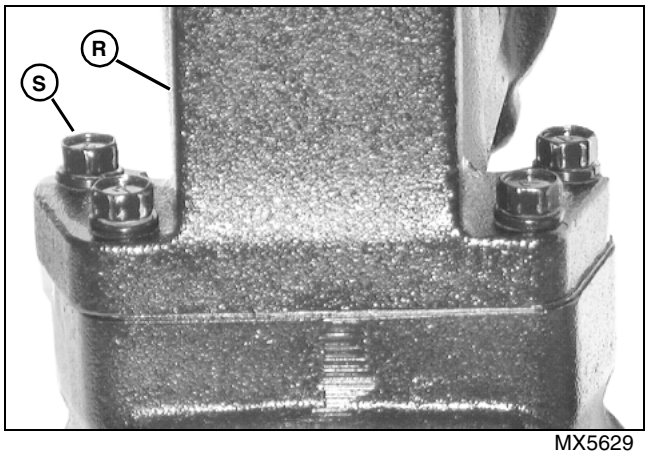
11. Hold upper (N) and lower (O) gear cases upright. Install upper gear case in lower gear case by tapping on upper case with a soft-faced hammer. Use care not to damage seal in lower gear case.



MX5711

12.Install bearing (P) in upper gear case tight against snap ring. It may be necessary to tap on inner race to install bearing.

13.Install new oil seal (Q) with spring side toward bearing.



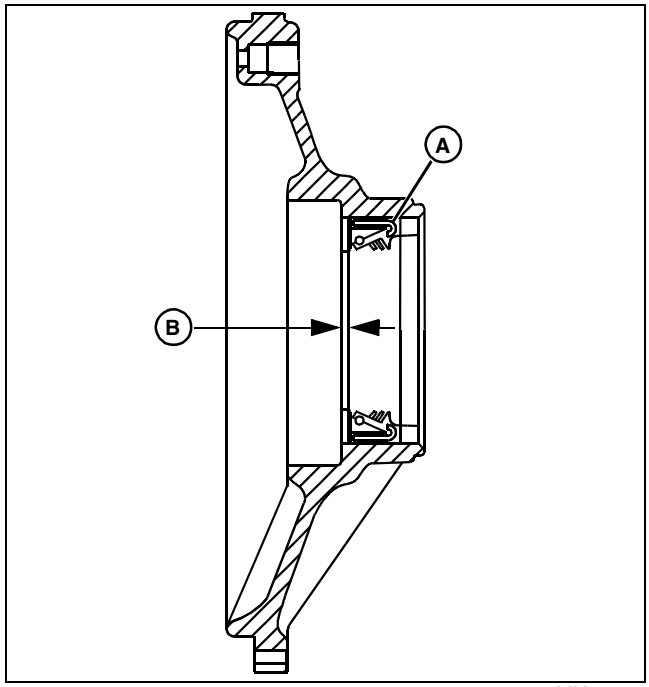
MX5629

14.Hold final drive assembly upright and install steering arm (R). Tap on steering arm with a soft-faced hammer to install steering arm on final drive assembly. Use care not to damage seal.

15.Install and tighten four cap screws and washers (S).

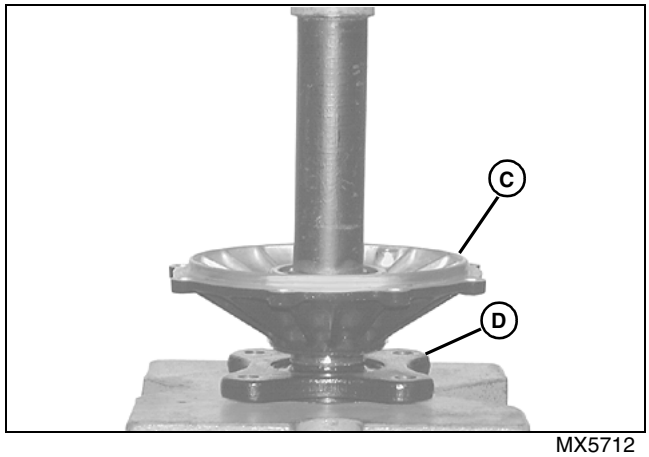
Final Drive Hub Assembly:

IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.



MX5740

1. Install new hub shaft seal (A) with seal spring into bore first. Push seal to a depth (B) of 6.5 mm (0.25 in.) below top of bore.

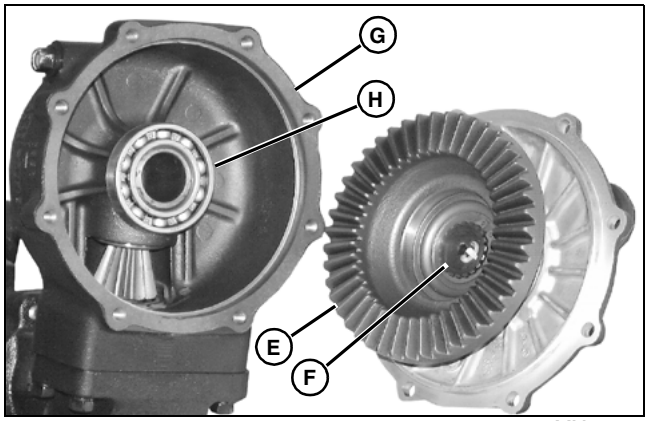


MX5712

2. Carefully put lower gear case cover (C) over hub shaft (D) so as not to damage seal.

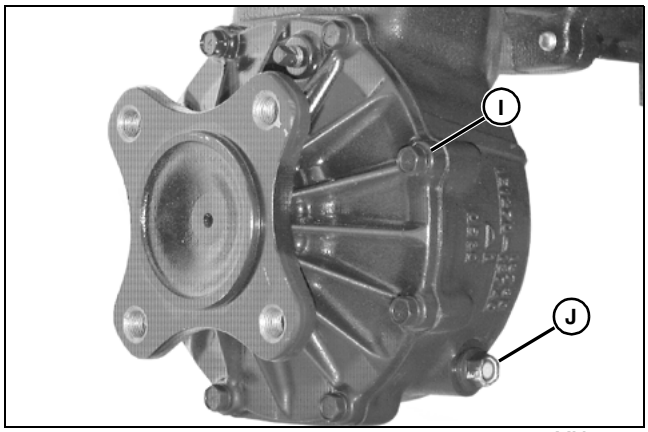
IMPORTANT: Avoid damage! Press on inner race only to avoid damaging bearing.

3. Press on inner race of bearing to install bearing on hub shaft in lower gear case cover. Push bearing tight against shoulder of hub shaft.



MX5600

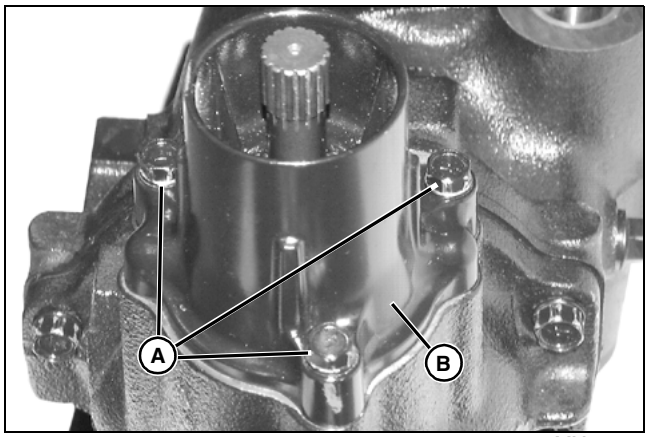
4. Install ring gear (E) and snap ring (F) on hub shaft.
5. Install new gasket (G).
6. Install bearing (H).



MX5599

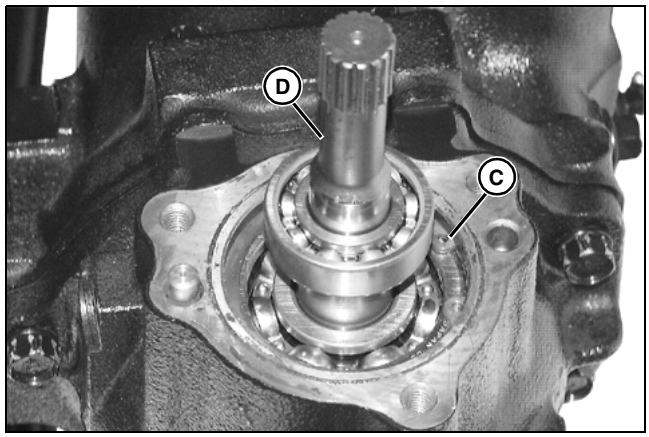
7. Install cover assembly on lower gear case. Install and tighten eight cap screws and lock washers (I).
8. Install drain plug (J) in final drive and tighten to specification.

Differential Input Shaft and Cover Disassembly:



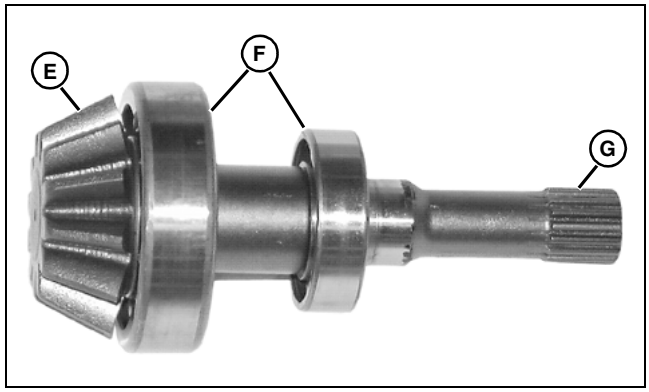
MX5633

1. Remove three cap screws and lock washers (A).
2. Remove differential input cover (B). Remove gasket material from mating surfaces.



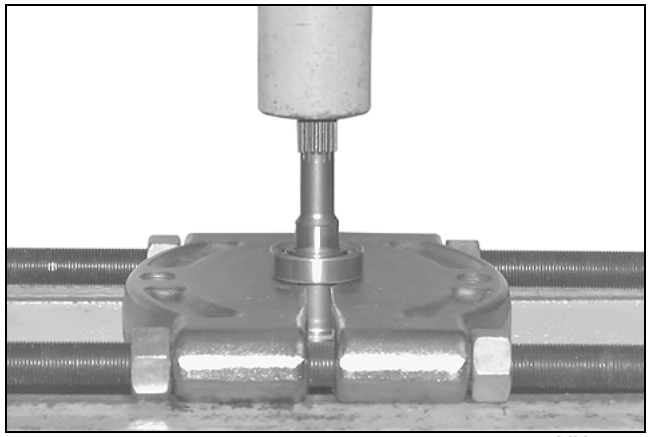
MX5634

3. Remove snap ring (C).
4. Remove input shaft assembly (D) from differential housing.

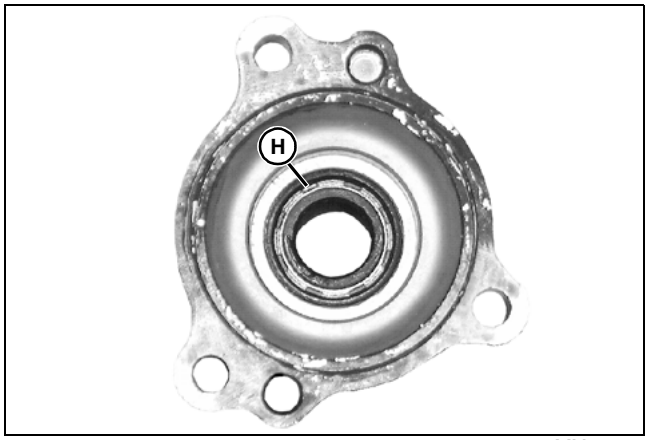


MX5635

5. Inspect gear (E), inner and outer bearings (F), and spline (G) of input shaft for wear, damage, or rough movement. Replace parts as needed.


MX5642

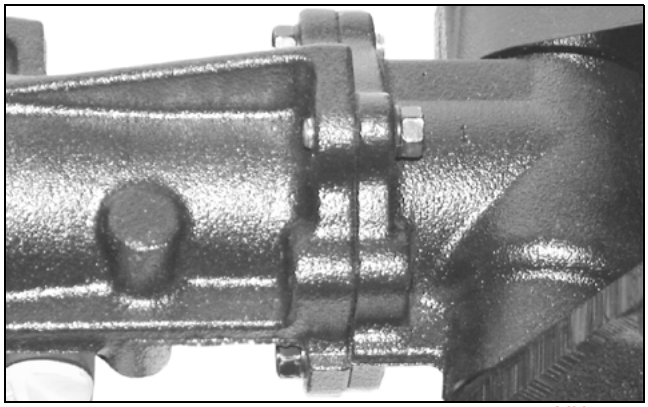
6. Remove bearings from input shaft only if they require replacement.



MX5636

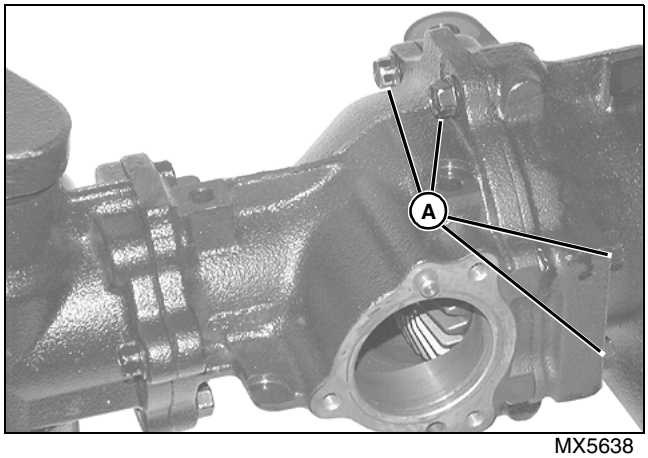
7. Remove and discard oil seal (H) from input housing cover.

Differential and 4WD Axle Housing Disassembly/ Inspection:

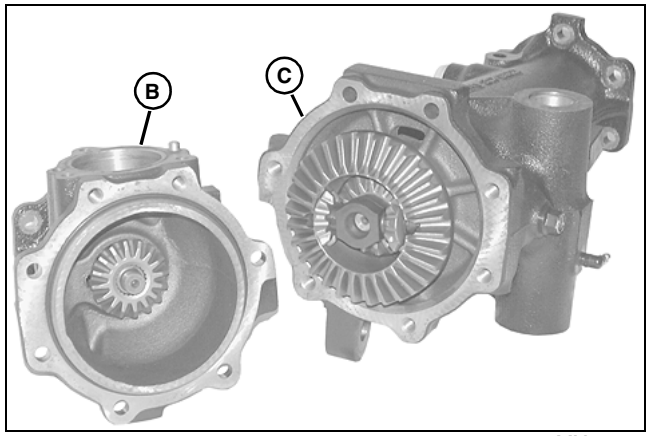


MX5628

1. Remove left and right final drive assemblies from axle. (For final drive disassembly, see “Final Drive Disassembly:” on page 650.)

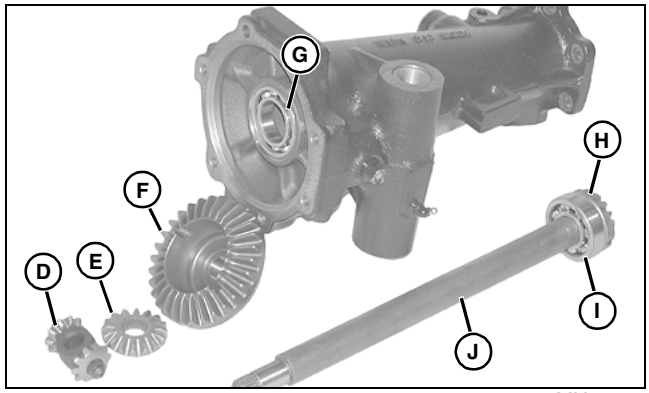


MX5638



MX5639

2. Remove seven cap screws (A) to separate right axle/ differential case (B) and left axle case (C).



MX5640

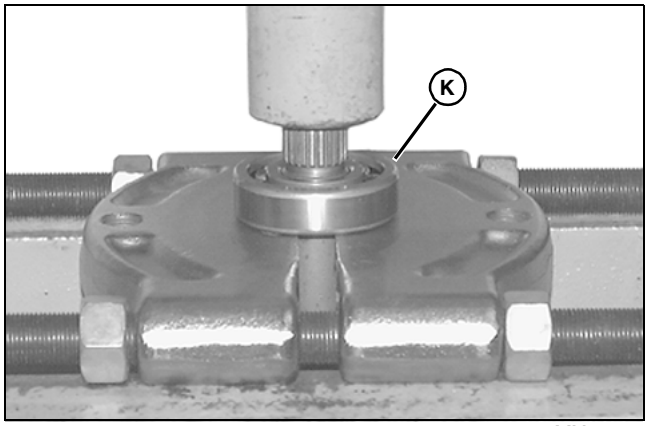
3. Remove pinion shaft with pinion gears (D), axle inner gear (E) and ring gear (F). Inspect for wear or damage. Replace parts as needed.

4. Remove left axle shaft (J) from axle case.

NOTE: Remove bearing (G) with a bearing puller only if bearing needs to be replaced.

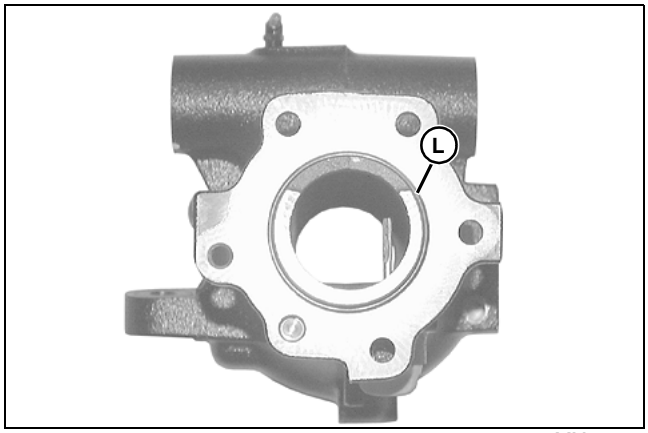
5. Inspect inner bearing (G) for wear, damage, or rough movement. Replace bearing as needed.

6. Remove axle outer gear (H) from left axle. Inspect splines in gear and axle. Replace gear or axle as needed.

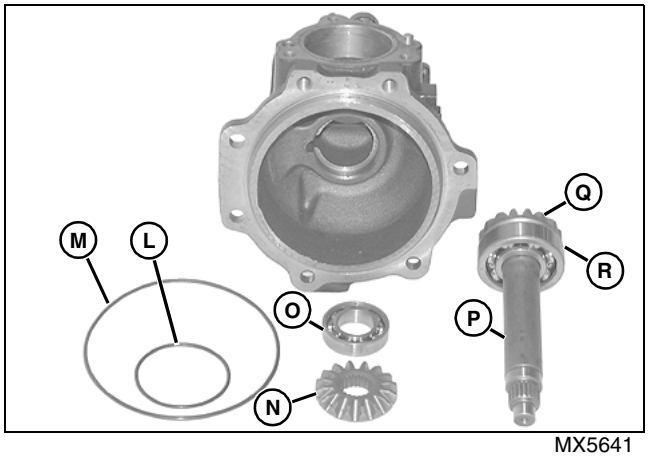


MX5644

7. Check outer bearing (K) on left axle for wear, damage, or rough movement. Replace bearing if necessary using a press.



MX5643

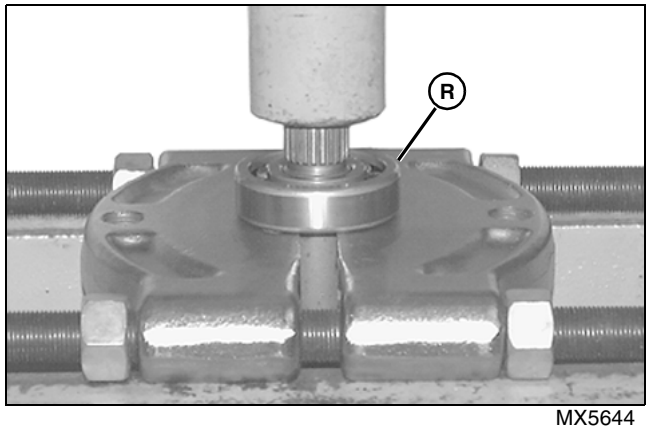


MX5641

8. Remove large (M) and small (L) O-rings, axle gear (N), and bearing (O). Inspect gear and splines of gear for wear or damage. Inspect bearing for wear, damage, or rough movement. Replace parts as needed.

9. Remove right axle shaft (P) from axle case.

10. Remove axle outer gear (Q) on right axle. Inspect gear and splines of gear for wear or damage. Replace gear or axle as needed.



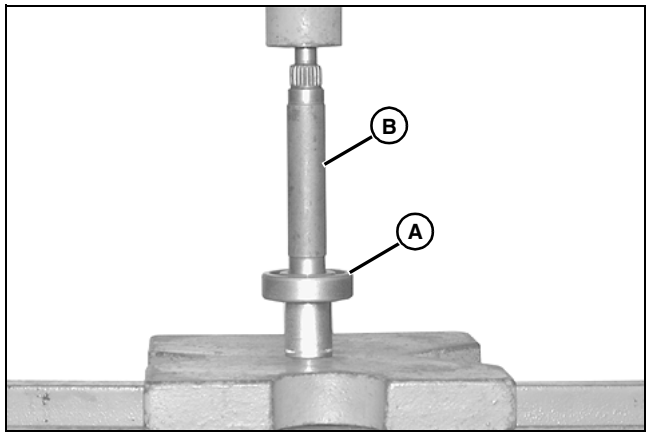
MX5644

11. Inspect outer bearing (R) on right axle for wear, damage, or rough movement. Replace bearing if necessary, using a press.

Right Axle Housing Assembly:

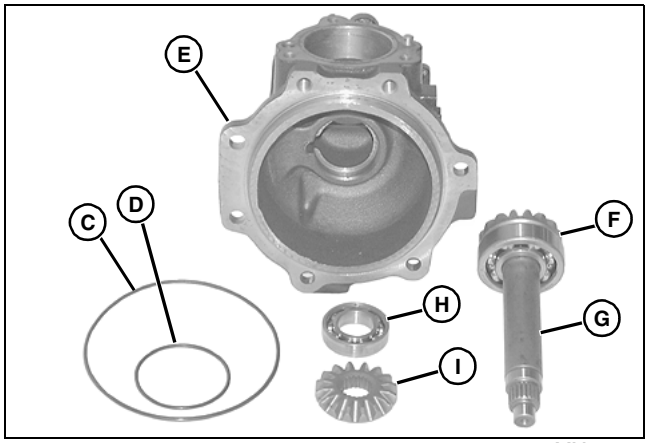
IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.

Push on inner race only to avoid damaging bearing.

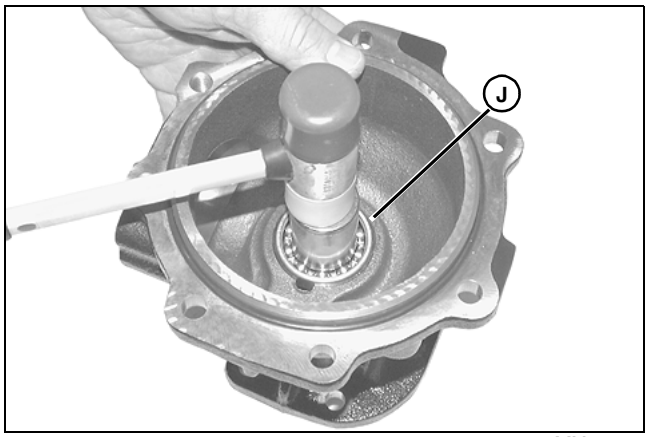


MX5649

1. Install new outer bearing (A) on right axle (B) if removed. Support inner race of bearing and press axle into bearing until tight against shoulder.



MX5641



MX5646

2. Install small (C) and large (D) O-rings on right axle case (E).

3. Install outer axle gear (F) on axle assembly (G).

4. Install axle assembly in axle case.

IMPORTANT: Avoid damage! Push on inner race only to avoid damaging bearing.

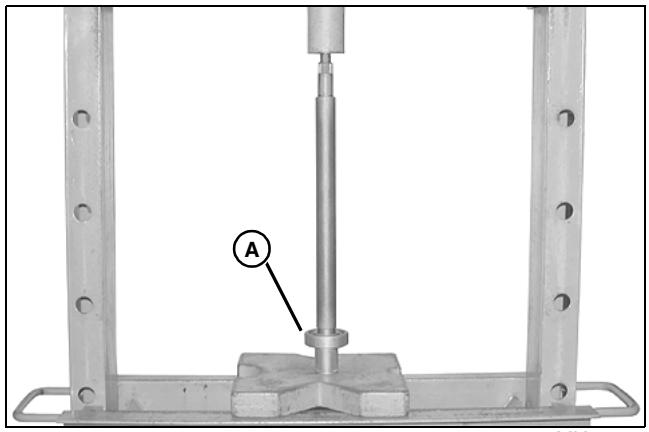
5. Stand axle case on end and install bearing (J). It may be necessary to tap on inner race of bearing to install tight against bottom of bore in case.

6. Install axle gear on axle shaft.

Left Axle and Differential Housing Assembly:

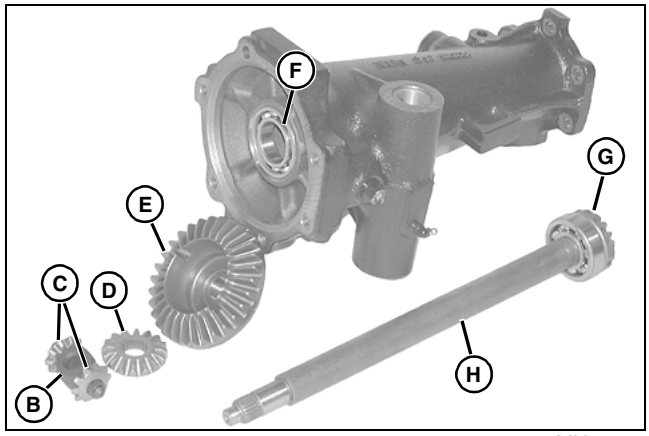
IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.

Push on inner race only to avoid damaging bearing.



MX5697

1. Install new outer bearing (A) on left axle, if removed. Support inner race of bearing and press axle into bearing until tight against axle shoulder.



MX5640

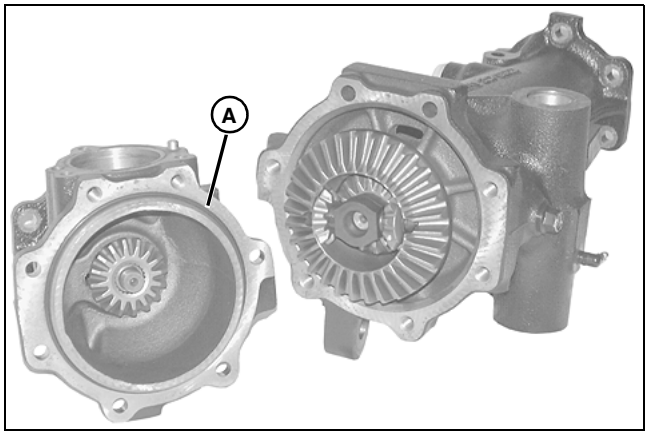
2. Install axle outer gear (G).

3. Install bearing (F) and ring gear (E) in axle housing.

4. Install left axle assembly (H) in housing.

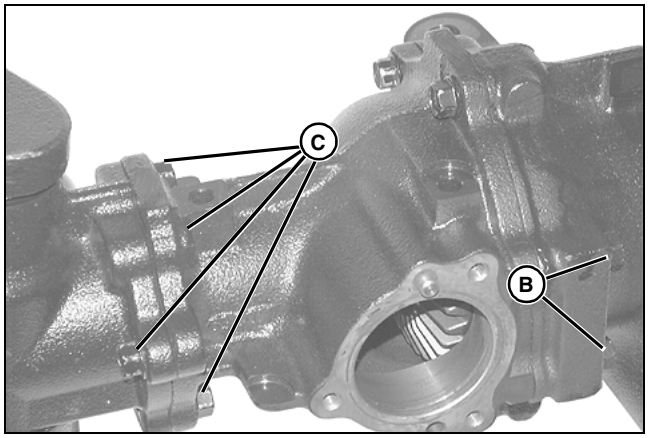
5. Install axle inner gear (D), pinion gears (C) and pinion shaft (B).

Differential and 4WD Axle Housing Assembly:



MX5639

1. Be sure O-ring (A) is on axle housing.



MX5638

2. Align gears and housings. Put housings together. Install cap screws and lock washers between axle housings. Be sure to install two longer cap screws (B) in holes adjacent to input shaft. Tighten all cap screws.

3. Be sure O-ring is on end of axle housing.

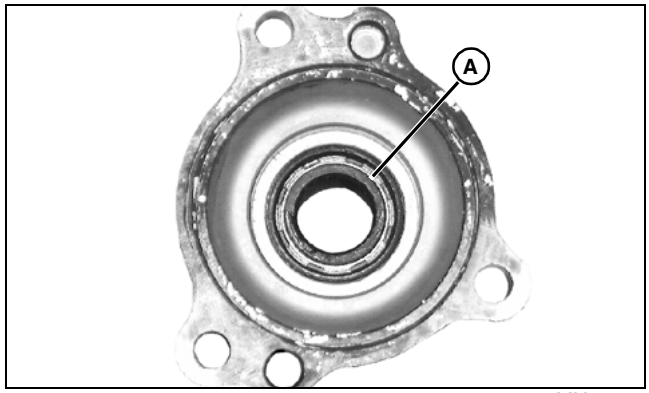
4. Align final drive with axle housing.

5. Install five cap screws and lock washers (C) to housing between final drive assembly and axle housing. Tighten cap screws to specification.

6. Repeat steps 3 - 5 for opposite end of axle housing.

Differential Input Shaft and Cover Assembly:

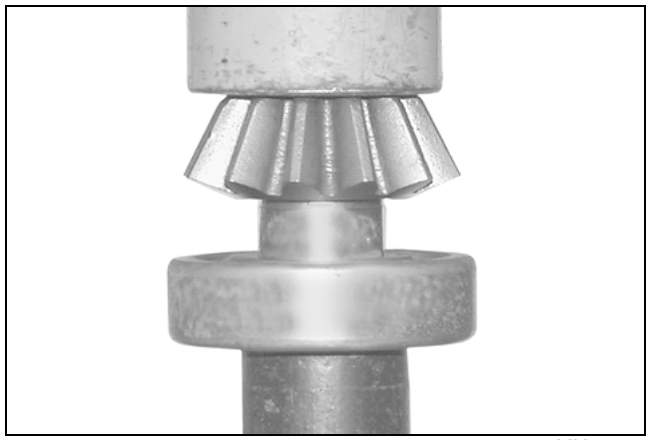
IMPORTANT: Avoid damage! Always install new gaskets, O-rings, and seals. Replace all damaged or rough moving parts. Damaged or worn parts will leak.



MX5636

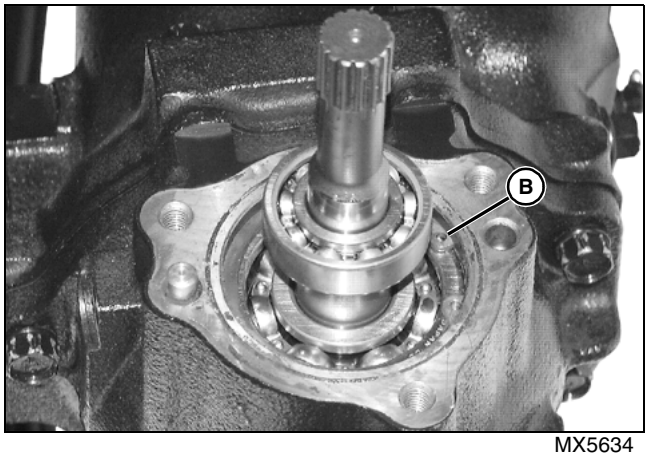
1. Install new seal (A) in input shaft cover. Install seal with seal spring toward inside of cover. Push seal to bottom of bore.

IMPORTANT: Avoid damage! Push on inner race only to avoid damaging bearing.



MX5647

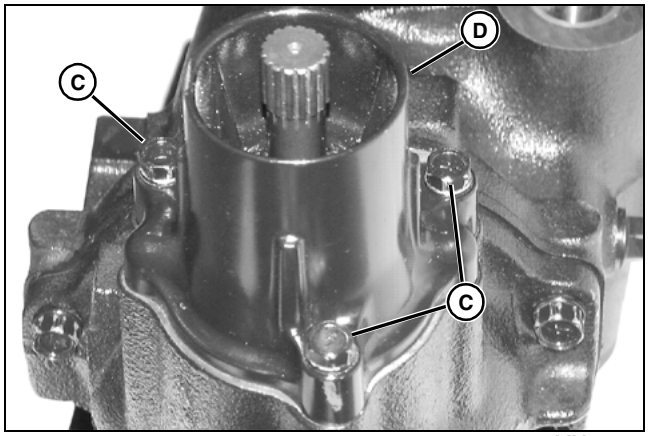
2. Install new bearings on input shaft by pressing on inner race of bearing. Install inner bearing first, then outer bearing. Push bearings tight against shoulder of shaft.



MX5634

3. Install input shaft in differential case.

4. Install snap ring (B).



MX5633

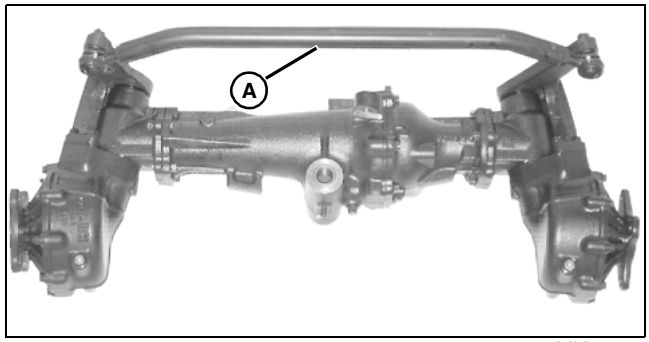
5. Ensure the mating surfaces between the differential input cover (D) and housing are clean.

6. Clean the differential input cover cap screws (C) with TY16285 John Deere Cure Primer.

7. Apply TY16021 John Deere High Flex Form-in-Place Gasket to mating surface of cover.

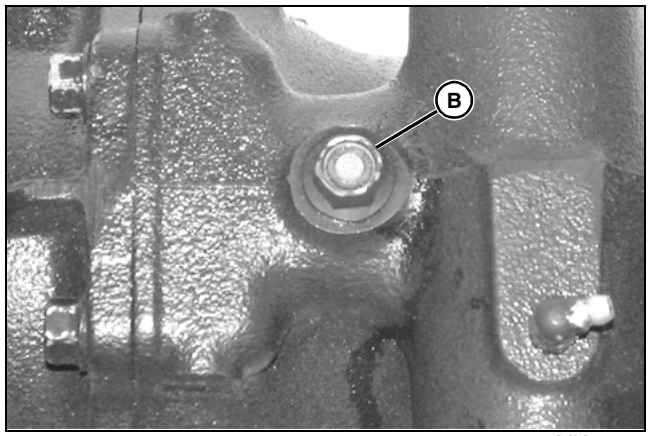
8. Install differential input shaft cover. Install and tighten three cap screws.

Final Assembly:



MX5597

1. Install tie rod (A). Install and tighten tie rod castellated nuts to specification. Continue to turn nut clockwise to align with drilled hole and install cotter pin.



MX5598

2. Install differential housing drain plug (B) and tighten to specification.

3. Remove oil filler cap and fill 4WD axle with oil to proper level.

4. Install filler cap.

5. Install 4WD axle assembly in machine. (See “4WD Axle Removal and Installation” on page 646.)

Specifications:

4WD Axle Weight (Approximately) . . . . . 68 kg (150 lb)

4WD Axle Oil Capacity (Approximately). . 2.1 L (2.25 qt)

4WD Axle Drain Plugs
Torque . . . . . 39 ± 10 N•m (29 ± 10 lb-ft)

Tie Rod Castellated Nut Torque . . . . . 53 N•m (39 lb-ft)

Axle Housing-to-Final Drive Assembly
Cap Screw Torque . . . . . 68 N•m (39 lb-ft)

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STEERING TABLE OF CONTENTS

STEERING SPECIFICATIONS

Specifications

Test and Adjustment Specifications

Steering Wheel Turns per Minute @ 6.8 N•m (72 lb-in.) Constant Torque . . . . . .6 (maximum)
Steering Toe-In Measurement (Less in Front than in Rear) . . . . . 3 - 9 mm (0.12 - 0.35 in.)

Repair Specifications

Steering Wheel Nut Torque . . . . . 38 N•m (28 lb-ft)
Steering Cylinder Castle Nut Torque . . . . . 75 N•m (55 lb-ft)

Special or Required Tools

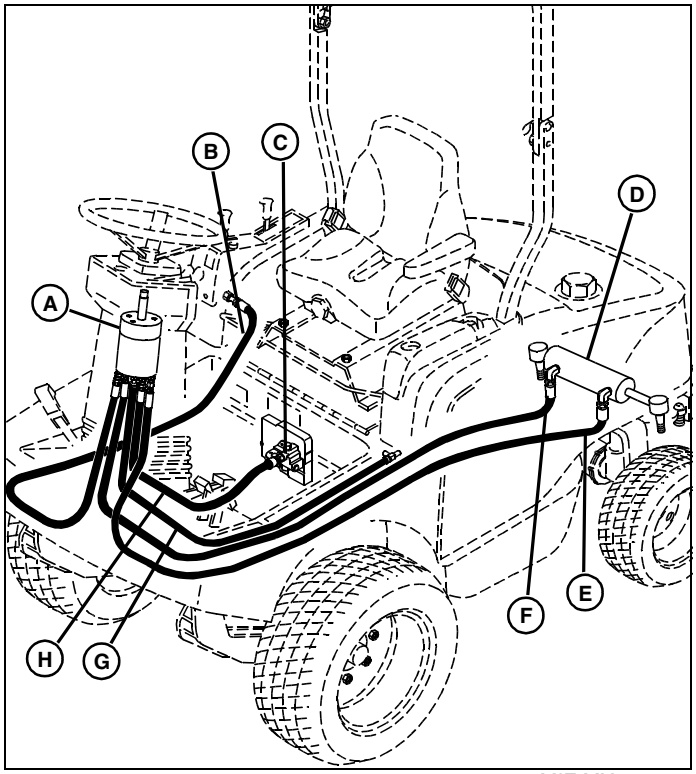
Special or Required Tools:

Tool Name	Tool No.	Tool Use
Hose Removal Tool	JDG1386	Used to disconnect hoses from steering valve.

STEERING COMPONENT LOCATION

Component Location

Steering System Component Location

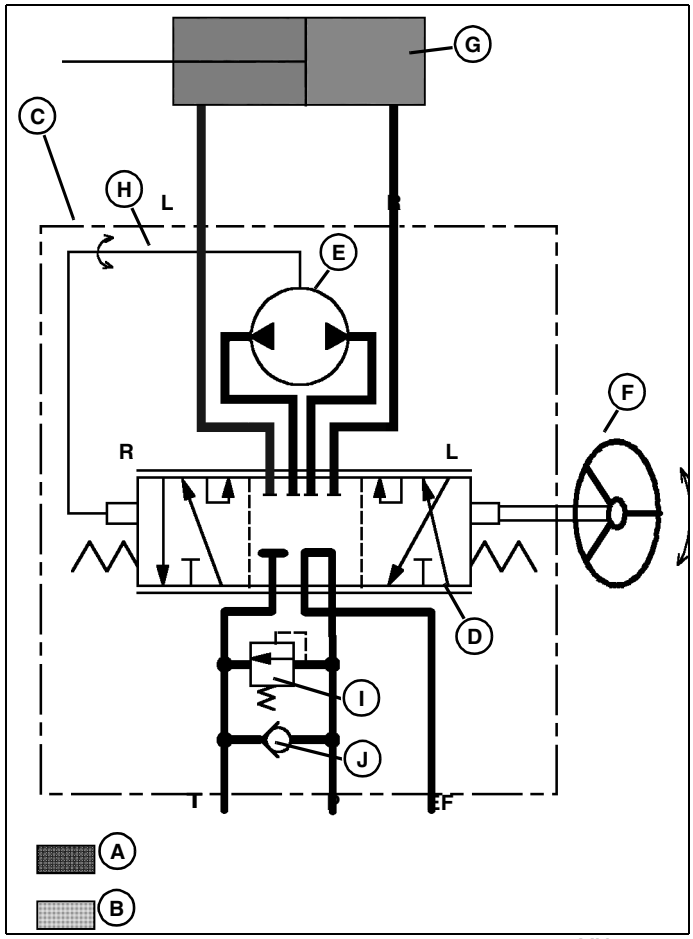


MIF MX5493

- **A - Steering Valve**
- **B - Hydraulic Hose, Steering Valve to Lift Valve**
- **C - Charge Pump**
- **D - Steering Cylinder**
- **E - Hydraulic Hose, Steering Valve to Steering Cylinder (right turn)**
- **F - Hydraulic Hose, Steering Valve to Steering Cylinder (left turn)**
- **G - Hydraulic Hose, Steering Valve to Reservoir**
- **H - Hydraulic Hose, Charge Pump to Steering Valve**

Theory of Operation

Steering System Operation - Neutral



MX5494

- **A - High-Pressure Oil**
- **B - Trapped Oil**
- **C - Steering Valve Assembly**
- **D - Control Valve Section**
- **E - Gerotor**
- **F - Steering Wheel**
- **G - Steering Cylinder**
- **H - Mechanical Link**
- **I - Relief Valve [10411 kPa (1510 psi)]**
- **J - Check Valve**

Function:

To block the flow of pressurized oil to the steering cylinder when no turning action is desired.

Theory of Operation:

The steering valve assembly (C) consists of a self-centering fluid control valve section (D) and a gerotor (E). These are hydraulically and mechanically interconnected inside the unit.

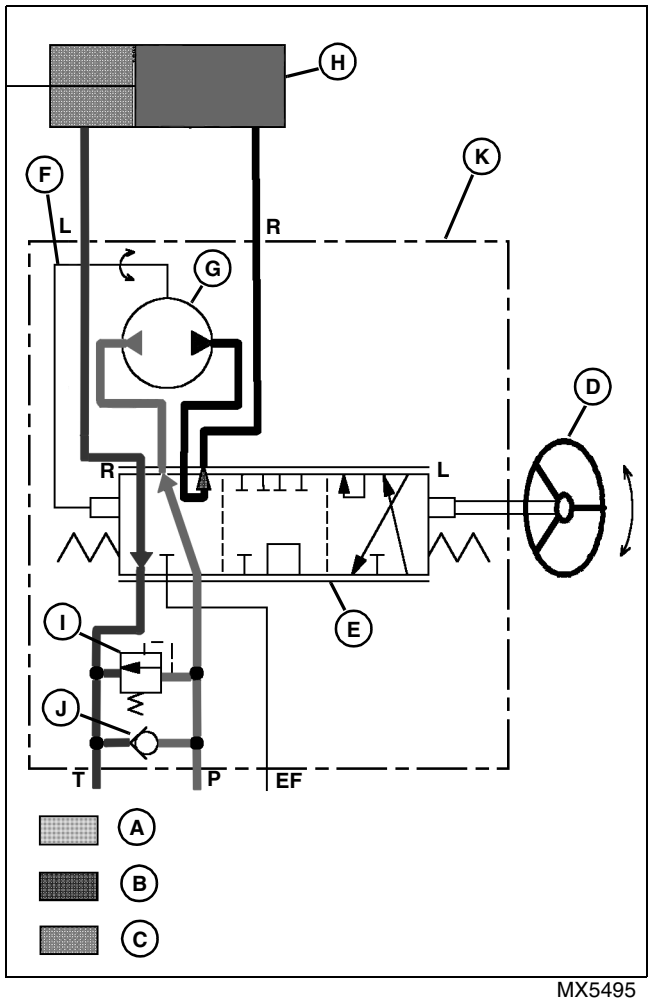
Pressurized oil (A) is supplied to the steering valve P port by the charge pump.

Whenever the steering wheel (F) is released, spring pressure moves the control valve section to the neutral position. In this position, pressurized oil from the charge pump enters the steering valve at the P port. It is then allowed to flow through the control valve section and flows out through the EF port. In this position, the control valve prevents pressurized oil from reaching the gerotor, and stops the flow of pressurized oil to the steering cylinder (G).

As the oil exits the EF port of the steering valve, the oil is used as a charge flow for the implement lift valve.

While the steering valve is in the neutral position, trapped oil (B) in the steering cylinder is allowed to flow into the control valve section. This slight flow will give the operator a feel of any change in the direction of the rear wheel, through the steering system, because of the mechanical link (H) between the gerotor and steering wheel.

Steering System Operation - Power Turn



MX5495

A - High-Pressure Oil
B - Metered Oil
C - Return (Charge Pressure) Oil
D - Steering Wheel
E - Control Valve Section
F - Mechanical Link
G - Gerotor
H - Steering Cylinder
I - Relief Valve [10 411 kPa (1510 psi)]
J - Check Valve
K - Steering Valve Assembly

Function:

To supply pressurized oil to the proper side of the steering cylinder to turn the rear wheels.

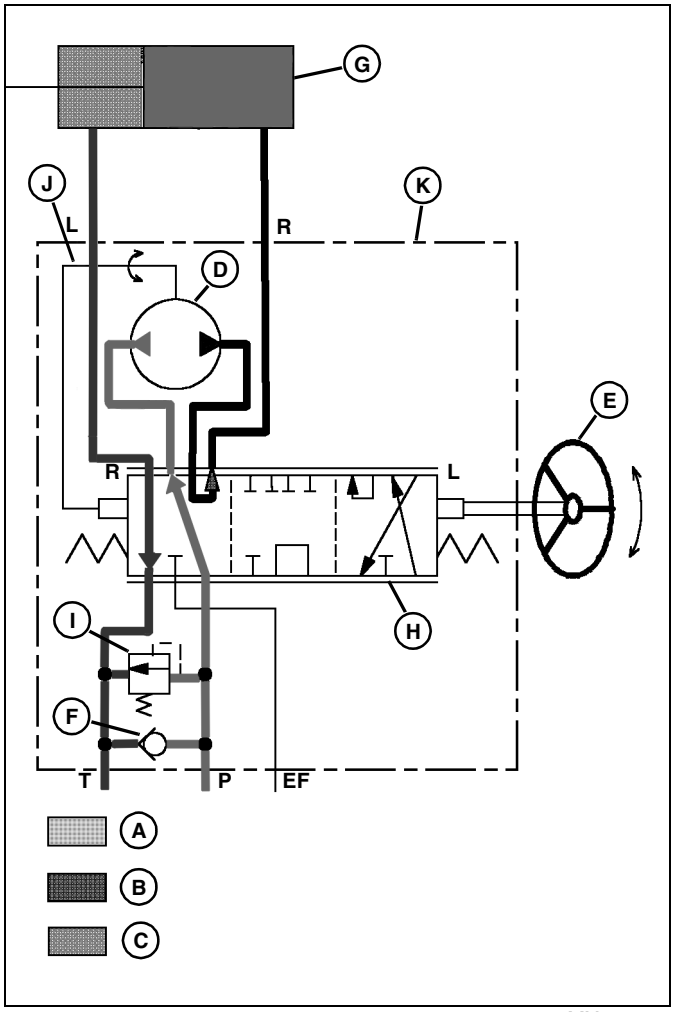
Theory of Operation:

NOTE: Right turn shown.

When the steering wheel (D) is turned to the right, the control valve section (E) is shifted by the mechanical link (F). This allows pressurized oil to flow through the control valve section to the inlet of the gerotor (G). As the steering wheel continues to turn, system oil flows through the gerotor and control valve section. Metered oil (B) is directed to the right side of the steering cylinder (K), forcing the piston to the left. Oil is forced out the other side of the cylinder and flows back to the reservoir. In this position, no oil is allowed to flow out of the EF port to the implement lift valve.

If the steering wheel is held against the stop, the implement relief valve 6895 kPa (1000 psi) would open before the steering relief valve (I) at 10411 kPa (1510 psi) differential, allowing the high-pressure oil to bypass the control valve and exit the steering valve assembly.

Steering System Operation - Manual Turn



MX5495

A - Low-Pressure Oil
B - Metered Oil
C - Return (Charge Pressure) Oil
D - Gerotor
E - Steering Wheel
F - Check Valve
G - Steering Cylinder
H - Control Valve Section
I - Relief Valve [10411 kPa (1510 psi)]
J - Mechanical Link
K - Steering Valve Assembly

Function:

To allow manual steering if hydraulic pressure is not available.

Theory of Operation:

NOTE: Right turn shown.

If hydraulic pressure is lost, the machine can still be steered without hydraulic assistance. All components still function the same, with the exception of the gerotor and check valve.

The gerotor (D) now acts as a pump, moving oil from one side of the gerotor to the other as the steering wheel (E) is turned. The check valve (F) opens, allowing oil to be drawn from the return side of the steering cylinder (G). Hydraulic oil is forced by the gerotor to either end of the steering cylinder, depending on which way the steering wheel is turned.

When the steering wheel is released, the centering springs move the control valve section (H) to the center (neutral) position, and will remain there until the steering wheel is turned again.

Diagnostics

High Steering Effort in Both Directions

Test Procedure A

Test Conditions:

- Key switch in stop position.
- Park brake locked.

Check rear tire air pressure. Check mounting hardware.	**Pressure is 138 kPa (20 psi). Mounting hardware is in place and tightened. Go To Next Step.** • Pressure is higher or lower. Correct pressure. • Mounting hardware is missing or loose. Replace or tighten hardware.
Check rear wheel toe-in alignment. (See “Steering Toe-in Check and Adjustment” on page 674 in this section.)	**Rear wheels have correct toe-in alignment. Go To Next Step.** • Rear wheel toe-in alignment incorrect. Adjust alignment.
Check hydraulic reservoir (transaxle) oil level. Check oil for contamination. Check oil for foaming.	**Hydraulic reservoir filled to correct level with clean oil of correct specification. Go To Next Step.** • Oil is contaminated. Drain system, replace oil filter, and fill with specified oil. • Oil is foamy. Go to Hydraulic Oil Foams in this group.
Check spindle bearings for wear.	**Bearings are not worn. Go To Next Step.** • Bearings are worn. Replace bearings.
Check steering system hoses for sharp bends or restrictions.	**Hoses do not have sharp bends or restrictions. Go To Next Step.** • Hoses bent or restricted. Reroute hoses or replace as needed.
Check steering cylinder swivel ends for wear. Check mounting hardware.	**Swivel ends must not be worn. Mounting hardware must be in place and tightened.** • Swivel ends are worn. Replace steering cylinder. • Mounting hardware is missing or loose. Replace or tighten hardware.

Test Procedure B

Test Conditions:

- Engine running at fast idle.
- Forward/reverse travel pedals in neutral position.

Check charge pump charge pressure. Check charge flow. (See “Charge Pressure Relief Valve Test 1400 Series” on page 728 and “Charge Pump Flow Test (1400 Series Only)” on page 731 in Hydraulics section.)	**Charge pressure and flow are within specification. Go To Next Step.** • Charge pressure is not within specification, replace charge pump pressure relief valve. • Charge flow is not within specification. Replace charge pump.
Test steering valve for leakage. (See “Steering Valve Leakage Test” on page 675 in this section.)	**Steering valve leakage is within specification. Go To Next Step.** • Steering valve leakage is beyond specification. Replace steering valve.
Test steering cylinder for leakage. (See “Steering System Leakage Test” on page 674 in this section.)	**Steering cylinder leakage must be within specification.** • Leakage is beyond specification. Replace steering cylinder.

Hydraulic Oil Foams

Test Conditions:

- Key switch in stop position.
- Machine parked safely.

Check hydraulic reservoir (transaxle) oil level. Check oil for contamination.	**Hydraulic reservoir filled to correct level with clean oil of correct specification. Go To Next Step.** • Oil is contaminated. Drain system, replace oil filter, and fill with specified oil.
Check steering system hoses for sharp bends or restrictions.	**Steering system hoses are not bent or restricted. Go To Next Step.** • Hoses are bent or restricted. Reroute hoses or replace as needed.
Check hydraulic suction hoses for cracks, cuts, and loose connections.	**Suction hoses must not have cracks, cuts, or loose connections.** • Tighten loose connections and/or replace hoses as necessary.

Lost Motion at Steering Wheel

Test Procedure A

Test Conditions:

- Key switch in stop position.
- Park brake locked.

Check hydraulic reservoir (transaxle) oil level. Check oil for contamination. Check oil for foaming.	**Hydraulic reservoir filled to correct level with clean oil of correct specification. Go To Next Step.** • Oil is contaminated. Drain system, replace oil filter, and fill with specified oil. • Oil is foamy. Go to “Hydraulic Oil Foams” on page 668 in this group.
Check steering valve mounting hardware.	**Mounting hardware must be in place and tightened.** • Mounting hardware is missing or loose. Replace or tighten hardware.

Test Procedure B

Test Conditions:

- Engine running at fast idle.
- Forward/reverse travel pedals in neutral position.

Test steering valve for leakage. (See “Steering Valve Leakage Test” on page 675 in this section.)	**Steering valve leakage is within specification. Go To Next Step.** • Leakage is beyond specification. Replace steering valve.
Test steering cylinder for leakage. (See “Steering System Leakage Test” on page 674 in this section.)	**Steering cylinder leakage must be within specification.** • Leakage is beyond specification. Replace steering cylinder.

Machine Continues to Turn after Steering Wheel Has Returned to Center Position

Test Procedure A

Test Conditions:

- Park brake locked.
- Engine running at fast idle.
- Forward/reverse pedals in neutral position.

Check for sticking steering valve.	**Steering valve must not stick.** • Steering valve sticking. Replace valve.

Test Procedure B

Test Conditions:

- Key switch in stop position.
- Park brake locked.

Check hydraulic reservoir (transaxle) oil level. Check oil for contamination. Check oil for foaming.	**Hydraulic reservoir must be filled to correct level with clean oil of correct specification.** • Oil is contaminated. Drain system, replace oil filter, and fill with specified oil. • Oil is foamy. Go to “Hydraulic Oil Foams” on page 668 in this group.

Sluggish Steering Response

Test Procedure A

Test Conditions:

- Key switch in stop position.
- Park brake locked.

Check oil viscosity rating of hydraulic reservoir (transaxle). (See “Hydrostatic Transaxle Oil” on page 18 in Specifications and Information section.)	**Proper viscosity rating within specification for the operating air temperature. Go To Next Step.** • Improper viscosity. Drain system, replace oil filter, and fill with specified oil.
Check hydraulic reservoir (transaxle) oil level. Check oil for contamination. Check oil for foaming.	**Hydraulic reservoir filled to correct level with clean oil of correct specification. Go To Next Step.** • Oil is contaminated. Drain system, replace oil filter, and fill with specified oil. • Oil is foamy. Go to “Hydraulic Oil Foams” on page 668 in this group.
Check steering system hoses for sharp bends or restrictions.	**Hoses must not have sharp bends or restrictions.** • Hoses bent or restricted. Reroute hoses or replace as needed.

Test Procedure B

Test Conditions:

- Engine running at fast idle.
- Forward/reverse pedals in neutral position.

Check for sticking steering valve.	**Steering valve does not stick. Go To Next Step.** • Steering valve sticking. Replace valve.
Test steering valve for leakage. (See “Steering Valve Leakage Test” on page 675 in this section.)	**Steering valve leakage is within specification. Go To Next Step.** • Leakage is beyond specification. Replace steering valve.
Test steering cylinder for leakage. (See “Steering System Leakage Test” on page 674 in this section.)	**Steering cylinder leakage is within specification. Go To Next Step.** • Leakage is beyond specification. Replace steering cylinder.
Check charge pump charge pressure. Check charge flow. (See “Charge Pressure Relief Valve Test 1400 Series” on page 728 and “Charge Pump Flow Test (1400 Series Only)” on page 731 in Hydraulics section.)	**Charge pressure and flow must be within specification.** • Charge pressure is not within specification. Replace charge pump pressure relief valve. • Charge flow is not within specification. Replace charge pump.

Steering Not Driving Straight

Test Procedure A

Test Conditions:

- Key switch in stop position.
- Park brake locked.

Check rear tire air pressure. Check mounting hardware.	**Pressure is 138 kPa (20 psi). Mounting hardware is in place and tightened. Go To Next Step.** • Pressure is higher or lower. Correct pressure. • Mounting hardware is missing or loose. Replace or tighten hardware. • Problem still exists. Go To Next Step.
Check hydraulic reservoir (transaxle) oil level. Check oil for contamination. Check oil for foaming.	**Hydraulic reservoir filled to correct level with clean oil of correct specification. Go To Next Step.** • Oil is contaminated. Drain system, replace oil filter, and fill with specified oil. • Oil is foamy. Go to “Hydraulic Oil Foams” on page 668 in this group.

Check rear wheel bearings for wear.	**Bearings are not worn. Go To Next Step.** • Bearings are worn. Replace bearings.
Check spindle bearings for wear.	**Bearings are not worn. Go To Next Step.** • Bearings are worn. Replace bearings.
Check steering cylinder swivel ends for wear. Check mounting hardware.	**Swivel ends must not be worn. Mounting hardware must be in place and tightened.** • Swivel ends are worn. Replace steering cylinder. • Mounting hardware is missing or loose. Replace or tighten hardware.

Test Procedure B

Test Conditions:

- Engine running at fast idle.
- Forward/reverse pedals in neutral position.
- Park brake locked.

Check for sticking steering valve.	**Steering valve does not stick. Go To Next Step.** • Steering valve sticking. Replace valve.
Test steering valve for leakage. (See “Steering Valve Leakage Test” on page 675 in this section.)	**Steering valve leakage is within specification. Go To Next Step.** • Leakage is beyond specification. Replace steering valve.
Test steering cylinder for leakage. (See “Steering System Leakage Test” on page 674 in this section.)	**Steering cylinder leakage is within specification. Go To Next Step.** • Leakage is beyond specification. Replace steering cylinder.
Check steering system hoses and fittings for leakage.	**Steering system hoses and fittings must not leak.** • Steering system hoses and fittings leak. Tighten connections and/or replace hoses.

Steering Operation Reversed

Test Conditions:

- Key switch in stop position.
- Park brake locked.

Check for proper installation of steering cylinder hoses.	**Steering cylinder hoses must be properly installed, not reversed.** • Hoses not properly installed, or reversed. Correct installation.

Steering Wheel Vibration

Test Conditions:

- Key switch in stop position.
- Park brake locked.

Check rear tire air pressure. Check mounting hardware.	**Pressure is 138 kPa (20 psi). Mounting hardware is in place and tightened. Go To Next Step.** • Pressure is higher or lower. Correct pressure. • Mounting hardware is missing or loose. Replace or tighten hardware. • Problem still exists. Go To Next Step.
Check hydraulic reservoir (transaxle) oil level. Check oil for contamination. Check oil for foaming.	**Hydraulic reservoir filled to correct level with clean oil of correct specification. Go To Next Step.** • Oil is contaminated. Drain system, replace oil filter, and fill with specified oil. • Oil is foamy. Go to “Hydraulic Oil Foams” on page 668 in this group.
Check rear wheel bearings for wear.	**Bearings are not worn. Go To Next Step.** • Bearings are worn. Replace bearings.
Check spindle bearings for wear.	**Bearings are not worn. Go To Next Step.** • Bearings are worn. Replace bearings.
Check steering cylinder swivel ends for wear. Check mounting hardware.	**Swivel ends must not be worn. Mounting hardware must be in place and tightened.** • Swivel ends are worn. Replace steering cylinder. • Mounting hardware is missing or loose. Replace or tighten hardware.

Tests and Adjustments

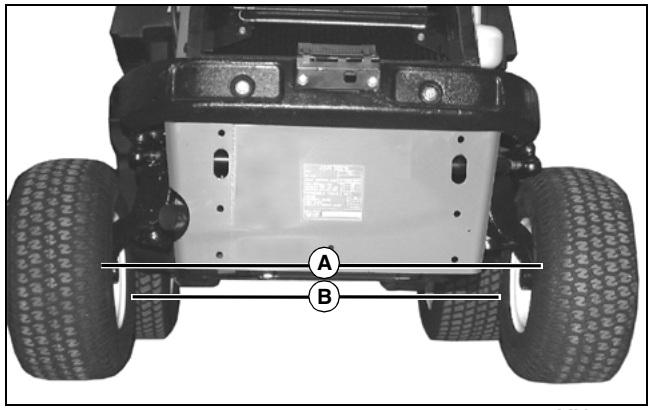
Steering Toe-in Check and Adjustment

Reason:

Correct toe-in prevents excessive tire wear and steering wander.

Check Procedure:

1. Park machine safely.

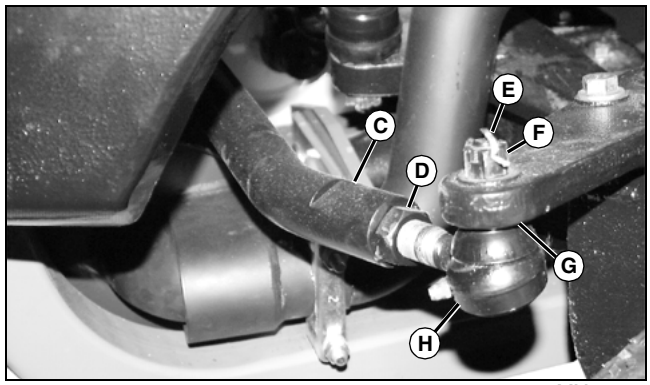


MX5498

2. Measure the distance between the rear tires at the rear of the tires (A).

3. Measure the distance between the rear tires at the front of the tires (B). The distance between tires (toe-in) should be within specification. If adjustment is required, perform adjustment procedure.

Adjustment Procedure:



MX5499

1. Remove cotter pin (E) and castle nut (F) from tie rod end (H).

2. Remove tie rod end from steering arm (G).

3. Loosen jam nuts (D) on both sides of tie rod (C).

4. With one tie rod end free, turn tie rod one or more full turns to adjust toe-in.

NOTE: Tie rod must be turned complete full turns so bend in tie rod is always toward the rear of machine.

If tie rod is turned, then tie rod end that is free must also be turned the same amount and in the same direction.

5. Turn the free tie rod end into or out of the tie rod the same direction as the tie rod was turned.

6. Install tie rod end in steering arm. Tighten castle nut.

7. Measure toe-in. If within specification, install cotter pin and tighten jam nuts.

Specification:

Distance Between Tires (Toe-In). . 3 - 9 mm less in the front than the rear (0.12 - 0.35 in. less in the front than the rear)

Steering System Leakage Test

Reason:

To check the steering system for internal leakage.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Torque Wrench	NA	Used to apply torque to steering wheel.

Procedure:

1. Park machine on level surface.

2. Lower all implements to the ground.

3. Lock park brake.

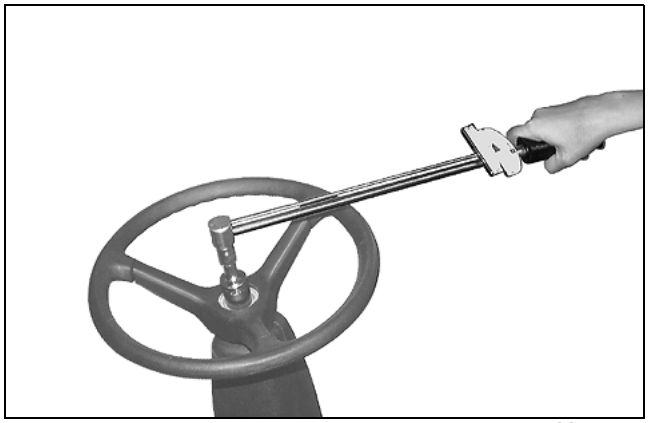
CAUTION: Avoid injury! Engine exhaust fumes can cause sickness or death.

If it is necessary to run an engine in an enclosed area, use an exhaust pipe extension to remove the fumes.

Always try to work in a well-ventilated area.

4. Start engine and bring hydraulic system oil to operating temperature.

5. Set throttle to slow idle.



M98614

6. With steering wheel at the maximum right turn position, apply a constant torque of **6.8 N•m (72 lb-in.)**. Count the number of rotations occurring in one minute.

7. Repeat the previous step with the steering wheel at the maximum left turn position.

Results:

If the number of rotations exceeds the specification, perform “Steering Valve Leakage Test” on page 675.

Specifications:

Steering Wheel Turns Per Minute at 6.8 N•m (72 lb-in.) 6

Steering Valve Leakage Test

Reason:

To determine if leakage is in steering valve or in steering cylinder.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Torque Wrench	NA	Used to apply torque to steering wheel.
Plugs	NA	Used to cap lines at steering cylinder.

Procedure:

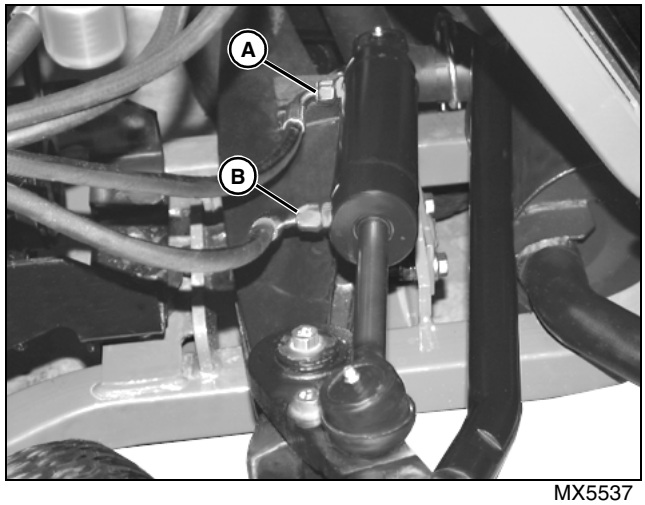
CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body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

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

1. Park machine on level surface.
2. Lower all implements to the ground.
3. Lock park brake.
4. Move key switch to stop position.

CAUTION: Avoid injury! To avoid injury from escaping hydraulic oil under pressure, relieve the pressure in the system by operating all the hydraulic controls.

NOTE: Mark all hydraulic hoses before removing to ensure correct installation.



MX5537

5. Disconnect and cap steering cylinder hoses (A and B).

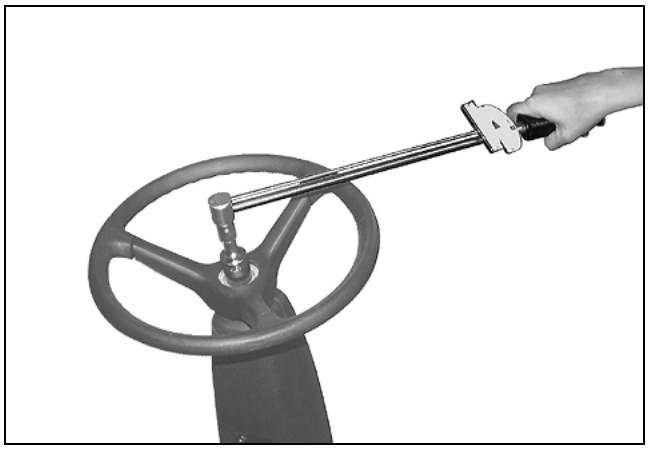
CAUTION: Avoid injury! Engine exhaust fumes can cause sickness or death.

If it is necessary to run an engine in an enclosed area, use an exhaust pipe extension to remove the fumes.

Always try to work in a well-ventilated area.

6. Start engine and bring hydraulic system oil to operating temperature.

7. Set throttle to slow idle.



M98614

8. With steering wheel at the maximum right turn position, apply a constant torque of **6.8 N•m (72 lb-in.)**, and count the number of rotations occurring in one minute.

9. Repeat the previous step with the steering wheel at the maximum left turn position.

Results:

- If the number of rotations exceeds the specification, replace steering valve.
- If the number of rotations is less than the specification, replace steering cylinder.

Specifications:

Steering Wheel
Turns Per Minute at 6.8 N•m (72 lb-in.) 6

Repair

Steering Console Cover Removal and Installation (1400 Series, S/N -20000)

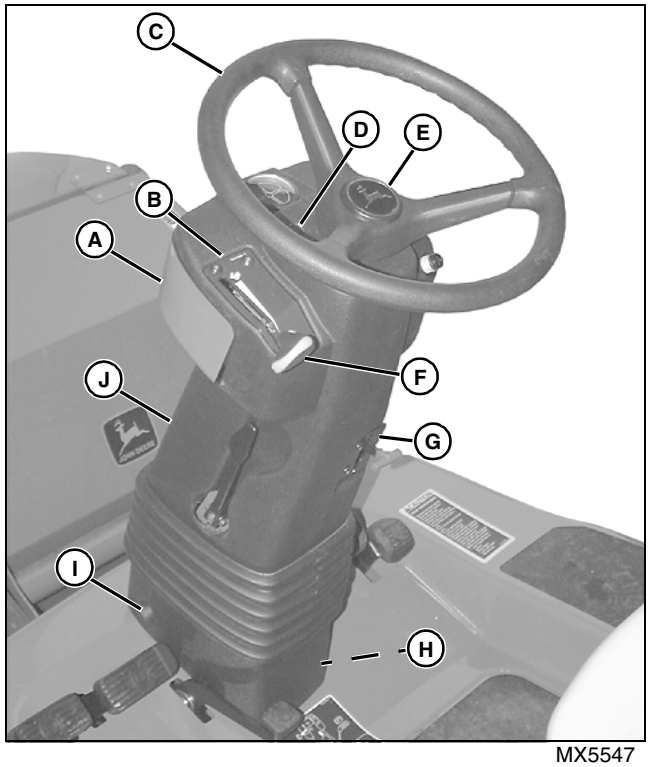
Specifications:

Steering Wheel Nut Torque . . . . . 38 N·m (28 lb-ft)

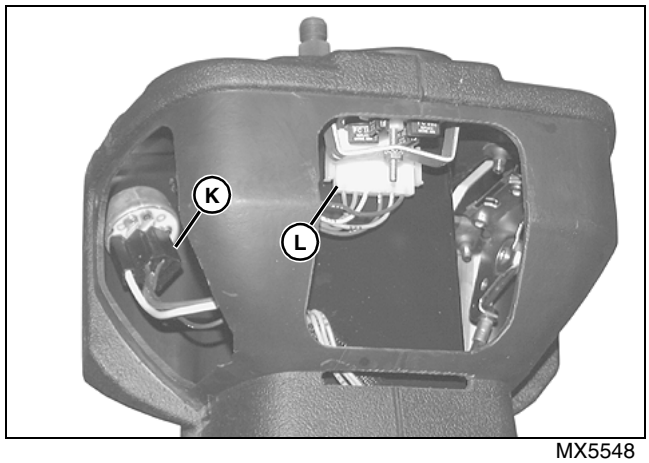
Removal:

IMPORTANT: Avoid damage! Do not use a hammer on end of steering shaft. Damage can occur to steering valve or shaft.

NOTE: If steering wheel cannot be pulled off shaft easily, use a knife-edge puller to remove.



MX5547



MX5548

1. Remove steering wheel cap (E), nut, and steering wheel (C).

2. Remove cover (A) and disconnect connectors (K and L).

NOTE: Do not disconnect cable from linkage.

3. Remove knob (F) and speed control linkage plate (B).

4. Remove park brake lock plate (G).

5. Remove two shoulder screws (D), two screws with washers and nuts (I), and two cap screws (H).

6. Remove console cover (J).

Installation:

Installation is done in the reverse order of removal.

- Tighten steering wheel nut to specification.

Steering Console Cover Removal and Installation (1400 Series, S/N 20001-; 1500 Series, S/N 10001-)

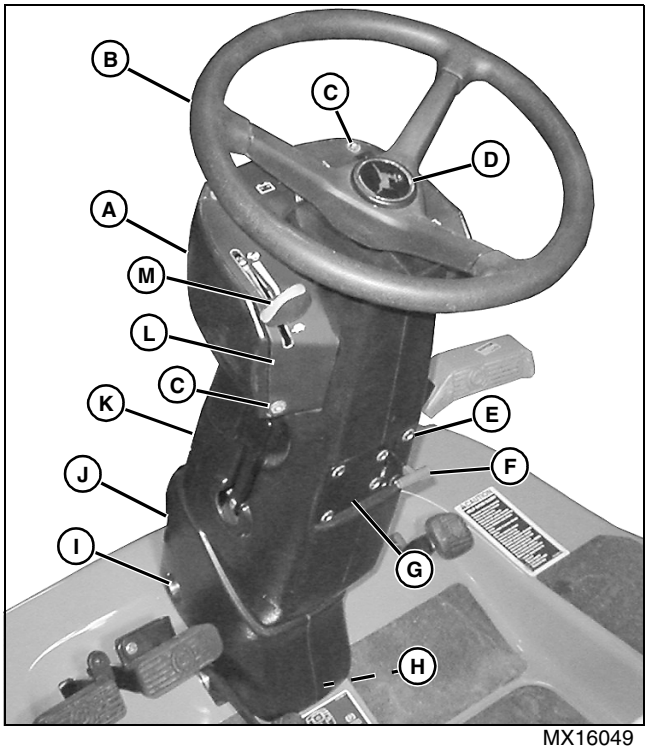
Specifications:

Steering Wheel Nut Torque . . . . . 38 N·m (28 lb-ft)

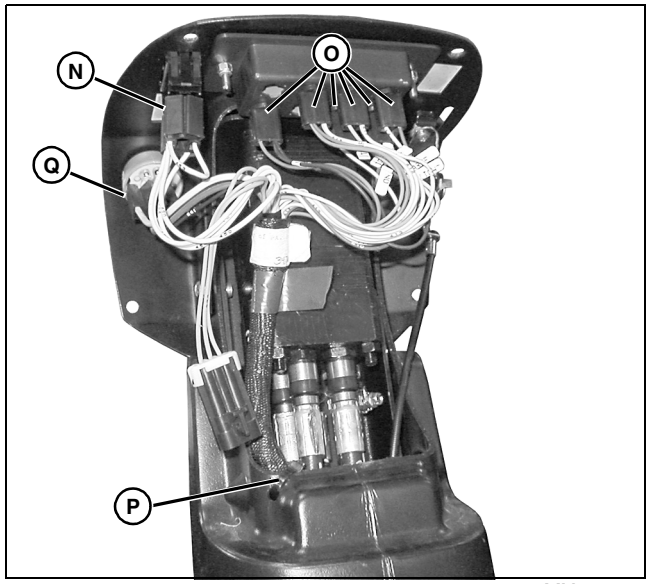
Removal:

IMPORTANT: Avoid damage! Do not use a hammer on end of steering shaft. Damage can occur to steering valve or shaft.

NOTE: If steering wheel cannot be pulled off shaft easily, use a knife-edge puller to remove.



MX16049



MX16050

1. Remove steering wheel cap (D), nut, and steering wheel (B).

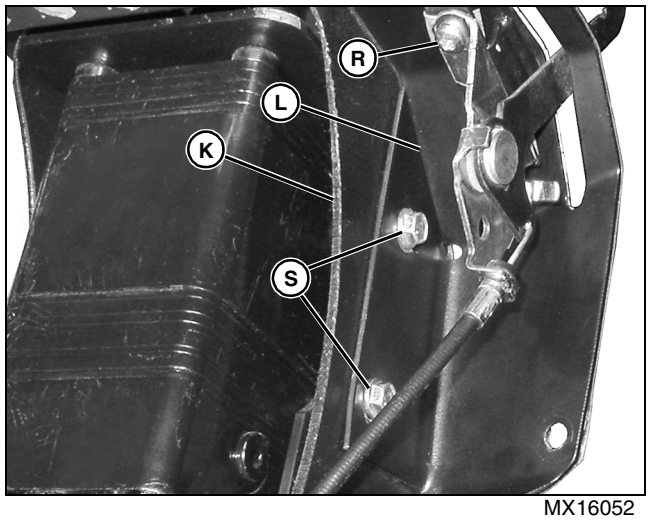
2. Remove four screws (C) and remove front cover (A).

3. Unplug connectors (N), (Q) and detach indicator lamps (15). (Note indicator lamp wire colors/locations for correct installation.)

4. Remove tie strap (P).

5. Remove park brake lock knob (F), six screws (E), and remove park brake lock plate (G).

NOTE: Do not disconnect cable from linkage.



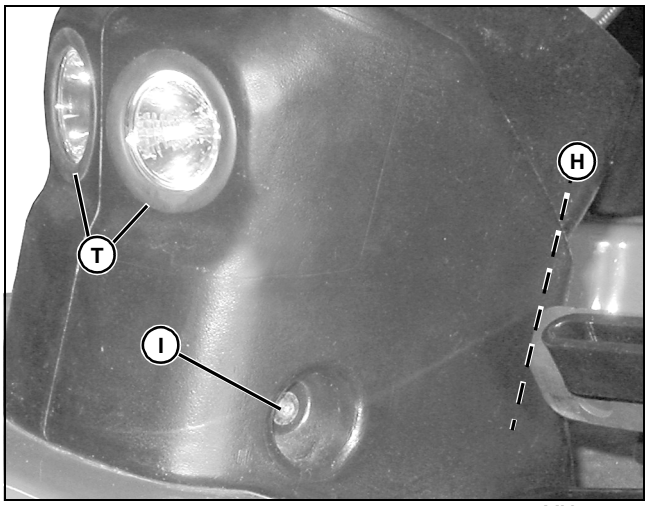
MX16052

6. Remove knob (M) and two screws (R) retaining speed control linkage.

7. Remove four cap screws (S).

8. Remove indicator panel (L) and upper console cover (K).

NOTE: Most service can be performed without removing lower console cover. To remove the lower console cover, perform the following steps:



MX16058

9. Remove two screws (I).

10.Remove two cap screws (H) from under the foot deck that retain the rear of the lower console.

11.Unplug the harness for the head lamps (T).

12.Remove the lower console cover.

Installation:

Installation is done in the reverse order of removal.

- Tighten steering wheel nut to specification.

Steering Valve Removal and Installation (1400 Series, S/N -20000)

NOTE: Service kits are available for this steering valve. See your John Deere parts supplier for more information.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hose Removal Tool	JDG1386	Used to disconnect hoses from steering valve.

Removal:

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

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

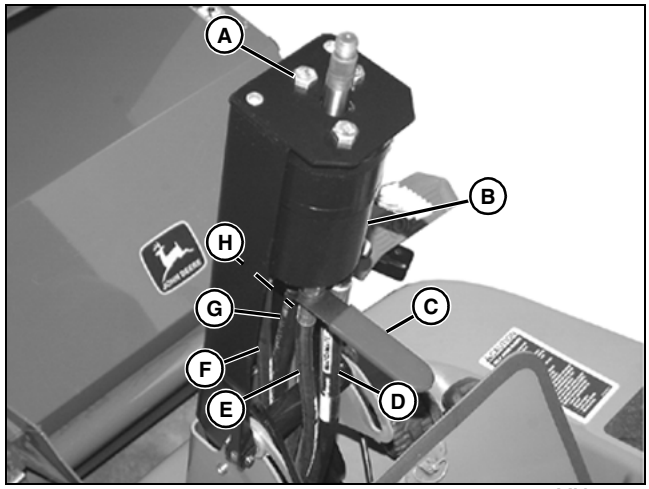
1. Park machine safely. Turn key switch to stop position.

2. Turn steering wheel back and forth several times to relieve hydraulic pressure from system.

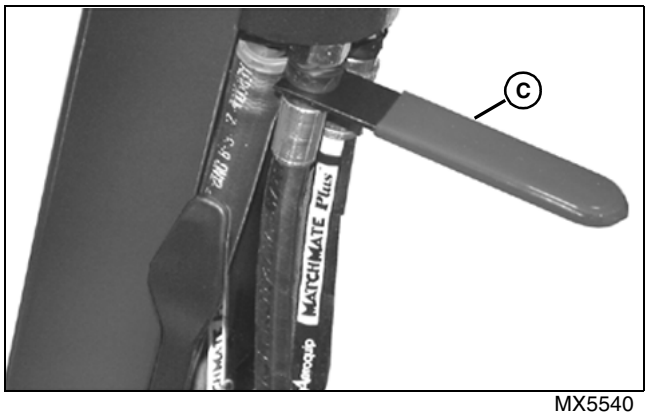
3. Remove steering column cover.

IMPORTANT: Avoid damage! JDG1386 Hose Removal Tool must be installed under plastic collar as shown. Insert tool until it stops. Do not pry or twist tool. Once tool is inserted, pull hose out of connector. Prying on connector with tool will damage collar, making connector separation impossible.

NOTE: Mark valve and all hydraulic hoses before removing to ensure correct installation.



MX5544



MX5540

4. Disconnect hoses (D - H) using JDG1386 Hose Removal Tool (C).

5. Remove three cap screws (A) and steering valve (B).

Installation:

Installation is done in reverse order of removal.

- Fill hydraulic reservoir (transaxle) to correct level with oil meeting specifications.
- Bleed air from hydraulic system.
- Check all connections for leaks. Repair as needed.

Steering Valve Removal and Installation (1400 Series, S/N 20001-; 1500 Series, S/N 10001-)

NOTE: A seal kit is available for this steering valve. See your John Deere parts supplier for more information.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hose Removal Tool	JDG1386	Used to disconnect hoses from steering valve.

Removal:

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

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

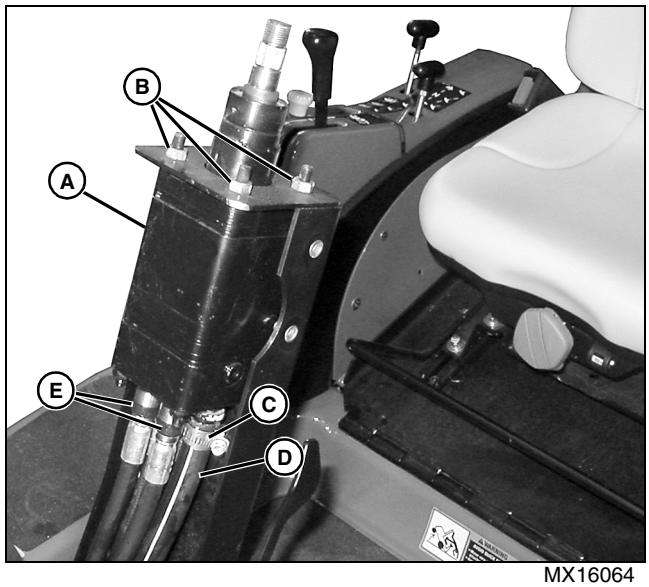
1. Park machine safely. Turn key switch to stop position.

2. Turn steering wheel back and forth several times to relieve hydraulic pressure from system.

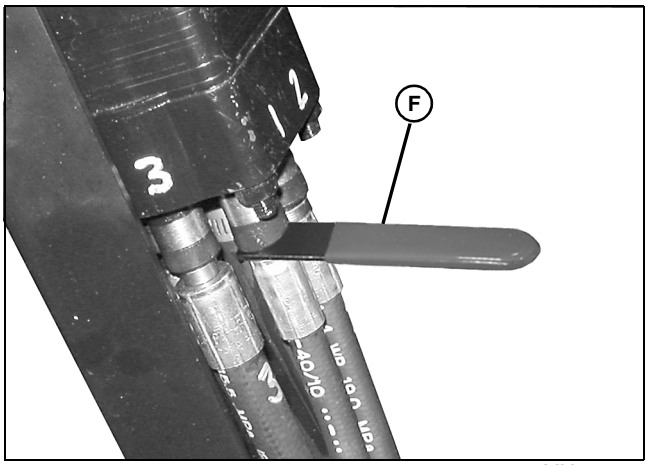
3. Remove upper steering column cover.

IMPORTANT: Avoid damage! JDG1386 Hose Removal Tool must be installed under plastic collar as shown. Insert tool until it stops. Do not pry or twist tool. Once tool is inserted, pull hose out of connector. Prying on connector with tool will damage collar, making connector separation impossible.

NOTE: Mark valve and all hydraulic hoses before removing to ensure correct installation.



MX16064



MX16065

4. Disconnect four hoses (E) using JDG1386 Hose Removal Tool (F).

5. Loosen clamp (C) and remove remaining hose (D).

6. Remove four nuts (B) and steering valve (A).

Installation:

Installation is done in reverse order of removal.

- Fill hydraulic reservoir (transaxle) to correct level with oil meeting specifications.
- Bleed air from hydraulic system.
- Check all connections for leaks. Repair as needed.

Steering Cylinder Removal and Installation

Removal:

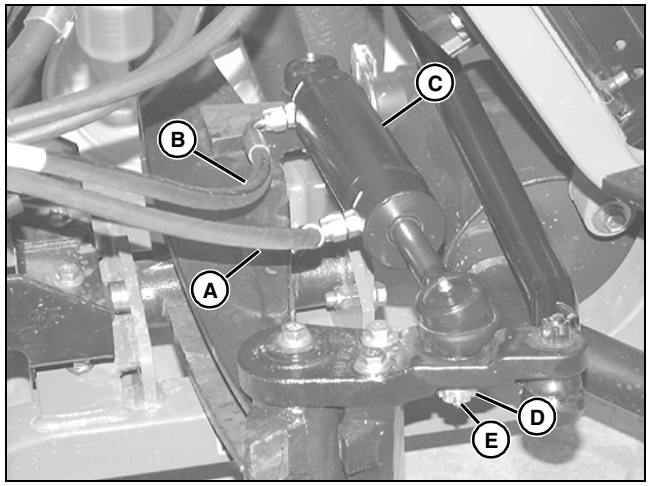
CAUTION: Avoid injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body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

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

1. Park machine safely and turn key switch to stop position.

2. Turn wheel back and forth several times to relieve hydraulic pressure from system.

NOTE: Mark hoses before removing to ensure correct installation.



MX5549

3. Disconnect and plug hydraulic hoses (A and B).

4. Remove cotter pin (E) and castle nut (D) from both sides of steering cylinder (C).

5. Separate steering cylinder from mounting using a wedge-fork driver.

6. Remove steering cylinder.

Installation:

Installation is done in the reverse order of removal.

- Tighten castle nuts to specification before installing cotter pins.
- Fill hydraulic reservoir (transaxle) to correct level with oil meeting specifications.
- Bleed air from hydraulic system.
- Check all connections for leaks. Repair as needed.

Specifications:

Steering Cylinder Castle Nut Torque . . 75 N·m (55 lb-ft)

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BRAKES TABLE OF CONTENTS

Specifications

Repair Specifications

Turn Brakes:

Brake Pedal Free Play . . . . . 25 - 30 mm (0.98 - 1.18 in.)

Brake Disk Wear Specifications:

Normal . . . . . 2.2 ± 0.1 mm (0.087 ± 0.004 in.)

Replace if Less Than . . . . . 2.0 mm (0.08 in.)

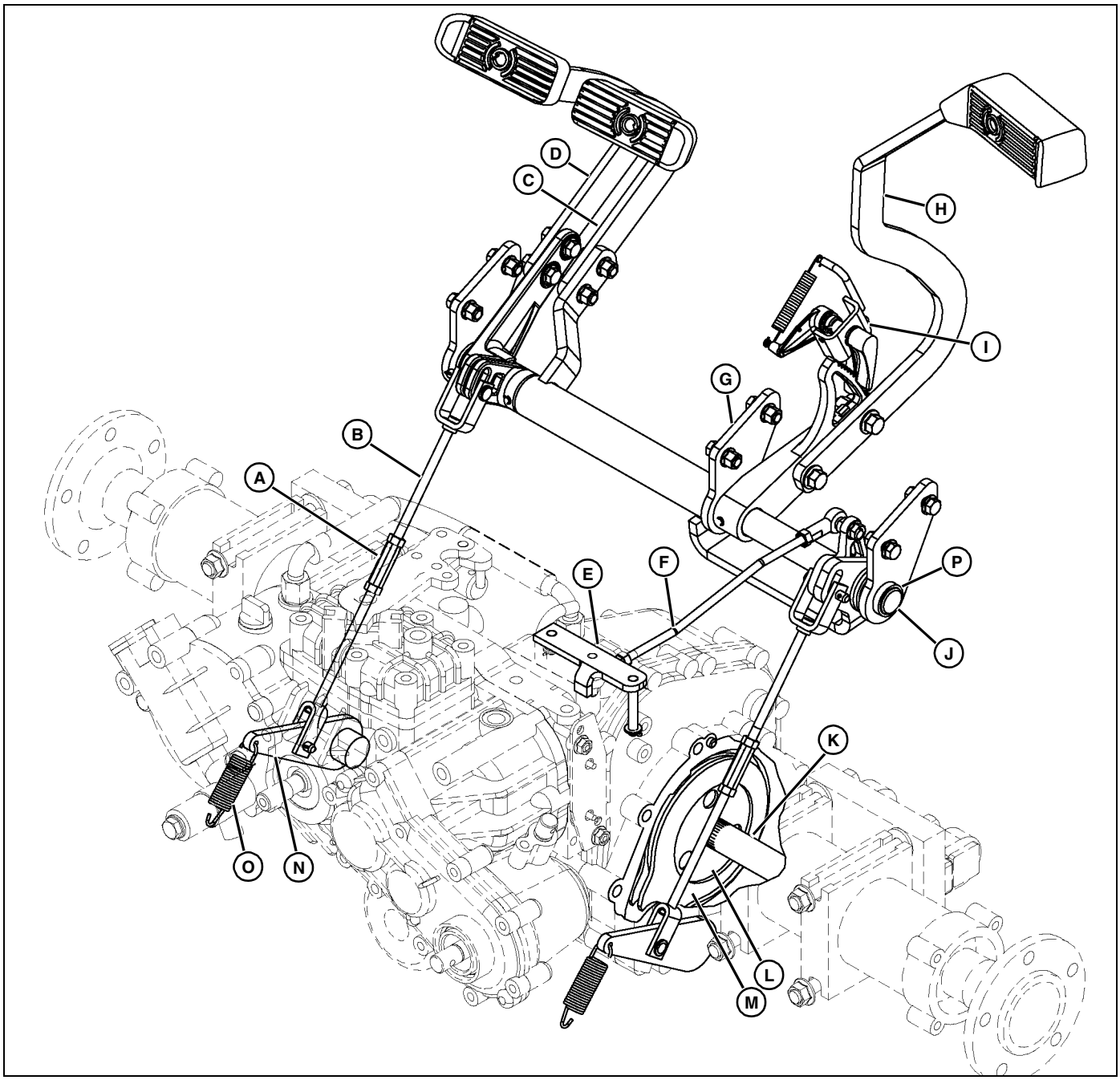
Brake Plate Wear Specifications:

Normal . . . . . 4.7 ± 0.1 mm (0.18 in.)

Replace if Less Than . . . . . 4.5 mm (0.17 in.)

Component Location

Brake System Component Location



MX5550

A - Turnbuckle
B - Brake Link Assembly
C - Right Turn Brake Pedal
D - Left Turn Brake Pedal
E - Neutral Safety Arm
F - Neutral Safety Link
G - Support Bracket
H - Master Brake Pedal
I - Park Lock Assembly
J - Brake Pedal Shaft
K - Axle Shaft
L - Friction Disk (2 used)
M - Separator Plate (2 used)
N - Actuator Lever
O - Return Spring
P - Brake Pedal Shaft Bushing (2 used)

Theory of Operation

Brake System Operation

Function:

To provide a means of stopping the machine and to prevent the machine from moving when not in use.

Theory of Operation:

The brake system consists of plates and disks located inside the axle housing on each side of the transaxle assembly.

The brakes are activated by a common pedal hooked to linkage connected to the individual brake assemblies located in each of the axle shaft housings. The brakes may be activated individually by depressing either the left turn brake pedal or the right turn brake pedal.

Inside each axle shaft housing, the brake components consist of a brake actuator lever/cam, actuator plate, and pairs of alternating friction disks and separator plates.

The brake actuator plate is mounted on six steel balls, which ride inside pockets with ramps on the actuator plate.

The brake friction disks are splined to the axle shafts. The separator plates are keyed to the brake actuator lever/cam shaft and cannot move.

When the brake pedal is depressed, the brake actuator lever/cams rotate, forcing the brake actuator plate to rotate.

As the actuator plate rotates, the ramps on the plate will allow the plate to ride up, forcing the plate against the friction disks and separator plates, causing drag and slowing the machine.

When the pedal is released, the return springs return the brake actuator lever/cams to the rest position, allowing the actuator plates to release the pressure on the friction disks and separator plates.

The machine is equipped with a park brake lock. When the brake pedal is depressed and held, and the park brake lock lever is pulled up, a pawl engages with the teeth on the pivot shaft, locking the brake linkage.

Diagnostics

Machine Will Not Move

NOTE: This condition may be caused by systems other than brakes. Check the power train system if the following conditions do not correct the problem.

Test Conditions:

- Machine parked safely.
- Park brake released.

Check park brake lock lever assembly for wear or damage.	**Lever moves freely. Go To Next Step.** • Park brake lock lever assembly is worn or damaged. Repair or replace as necessary.
Check brake linkage adjustment. (See “Adjusting Brakes:” on page 688 in this section.)	**Linkage is properly adjusted. Go To Next Step.** • Linkage needs adjustment. (See “Adjusting Brakes:” on page 688 in this section.)
Check condition of brake return springs.	**Springs must not be stretched, broken, or missing.** • Springs are damaged or missing. Replace springs as necessary.

Brake Will Not Engage or Hold Machine

Test Conditions:

- Machine parked safely.

Check brake linkage adjustment. (See “Adjusting Brakes:” on page 688 in this section.)	**Linkage is properly adjusted. Go To Next Step.** • Linkage needs adjustment. (See “Adjusting Brakes:” on page 688 in this section.)
Check brake friction disks for wear or damage.	**Friction disks are not worn or damaged. Go To Next Step.** • Friction disks are worn or damaged. Replace as necessary.
Check brake separator plates for wear or damage.	**Separator plates must not be worn or damaged.** • Separator plates are worn or damaged. Replace as necessary.

Excessive Brake Wear

Test Conditions:

- Machine parked safely.

Check brake pedal shaft and bushings for wear or damage.	**Shaft moves freely. Go To Next Step.** • Shaft is worn or damaged. Repair or replace as necessary.
Check park brake lock lever assembly for wear or damage.	**Lever moves freely. Go To Next Step.** • Park brake lock lever assembly is worn or damaged. Repair or replace as necessary.
Check condition of brake return springs.	**Springs are not stretched, broken, or missing. Go To Next Step.** • Springs are damaged or missing. Replace springs as necessary.
Check brake separator plates for wear or damage.	**Plates must not be worn or damaged.** • Plates are worn or damaged. Replace as necessary.

Machine Pulls to One Side

NOTE: This condition may be caused by systems other than brakes. Check the power train system if the following conditions do not correct the problem.

Test Conditions:

- Machine parked safely.
- Park brake released.

Check brake linkage adjustment. (See “Adjusting Brakes:” on page 688 in this section.)	**Linkage is properly adjusted. Go To Next Step.** • Linkage needs adjustment. (See “Adjusting Brakes:” on page 688 in this section.)
Check park brake lock lever assembly for wear or damage.	**Lever moves freely. Go To Next Step.** • Park brake lock lever assembly is worn or damaged. Repair or replace as necessary.
Check condition of brake return springs.	**Springs are not stretched, broken, or missing. Go To Next Step.** • Springs are damaged or missing. Replace springs as necessary.
Check brake friction disks for wear or damage.	**Friction disks are not worn or damaged. Go To Next Step.** • Disks are worn or damaged. Replace as necessary.
Check brake separator plates for wear or damage.	**Separator plates must not be worn or damaged.** • Plates are worn or damaged. Replace as necessary.

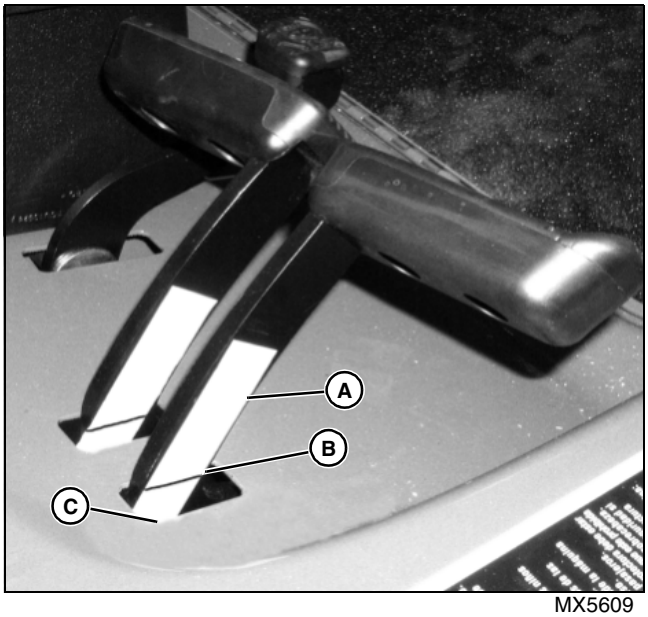
Tests and Adjustments

Turn Brake Adjustment

Checking Turn Brake Pedal Free Play:

1. Park machine on level ground.

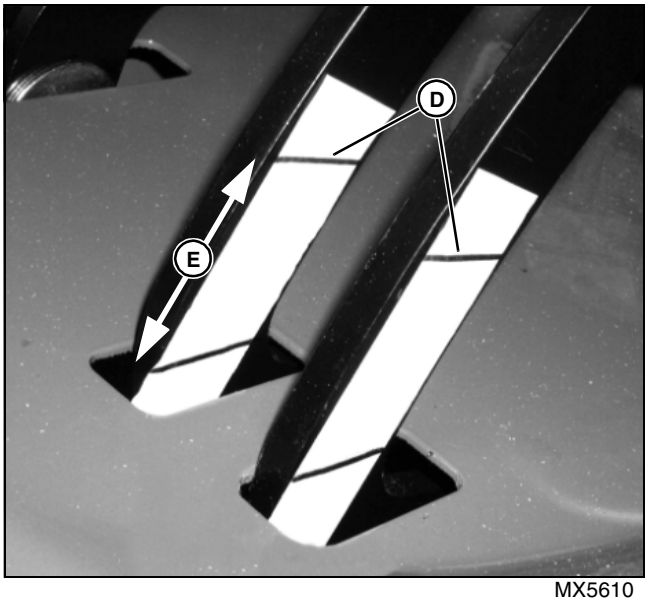
2. Unlock park brake.



MX5609

3. Place a piece of tape (A) on the front surface of each turn brake pedal and extending below the floor (C).

4. Make a mark (B) at the same height of the floor on the tape.



MX5610

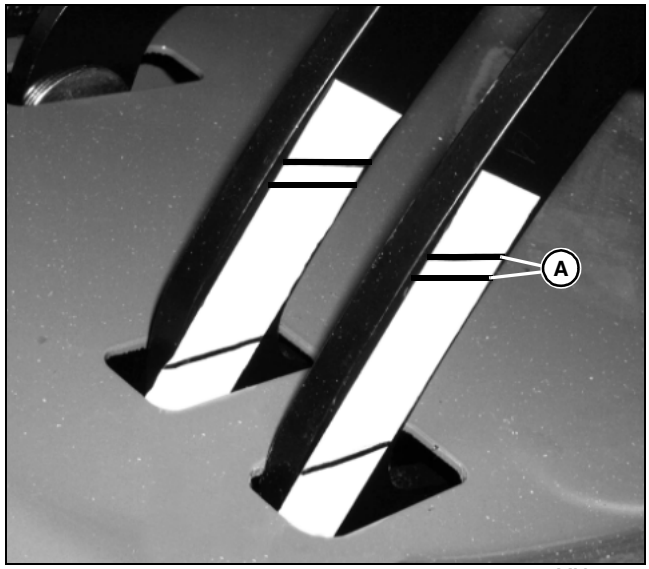
5. Press turn brake pedal until brake engages. Mark position of floor (D) on tape.

6. Release brake pedal and measure the distance (E) between the front edge of the marks on the tape to determine pedal travel.

7. Repeat steps 3 - 6 for the other turn brake pedal.

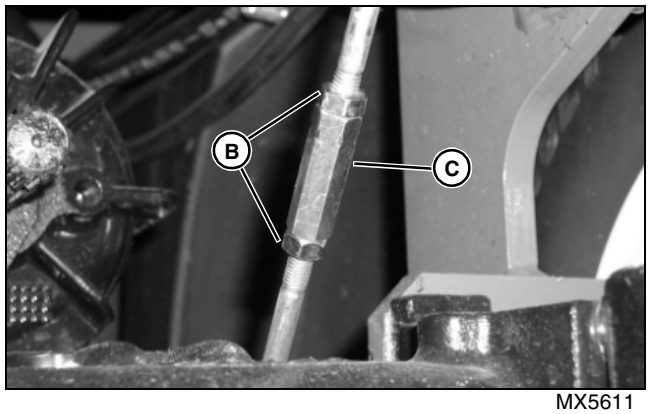
8. If brake pedal travel is greater than 30 mm, the brakes require adjustment.

Adjusting Brakes:



MX5610

1. Using tape installed earlier, make two marks (A) at 25 mm and 30 mm above the floor.



MX5611

2. Loosen lock nuts (B), and adjust turnbuckle (C) until brake begins to engage when the pedal is between the 25 mm and 30 mm marks on the tape.

3. Repeat for other pedal, keeping left and right side pedals adjusted evenly.

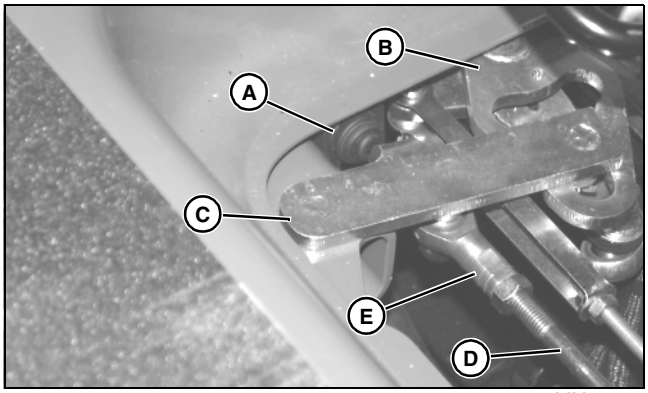
4. Tighten turnbuckle lock nuts.

5. If brakes cannot be adjusted within the range of the turnbuckles, check the transaxle brake plates and disks.

Brake Switch Adjustment

Inspection:

1. Park machine on level surface.
2. Unlock park brake.
3. Disconnect battery negative (-) cable.
4. Open service hatch.
5. Inspect brake switch. If boot, plunger and brake switch are worn or damaged, replace brake switch.

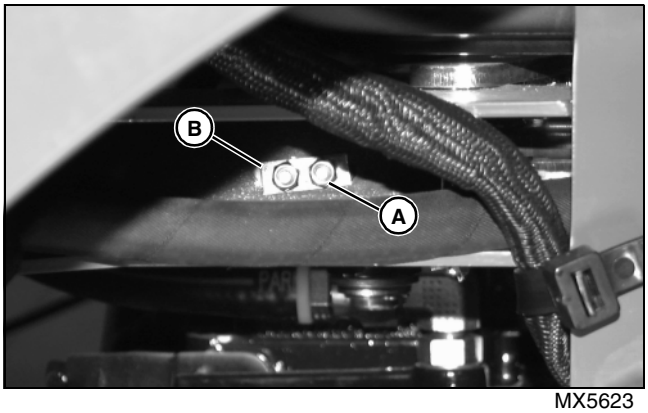


MX5622

6. Depress master brake pedal. Plunger on brake switch (A) should extend when mixer (B) and neutral safety arm (C) are activated.
7. Release master brake pedal. Plunger on brake switch should retract completely when neutral safety arm is activated by neutral safety link (D) and ball joint (E).

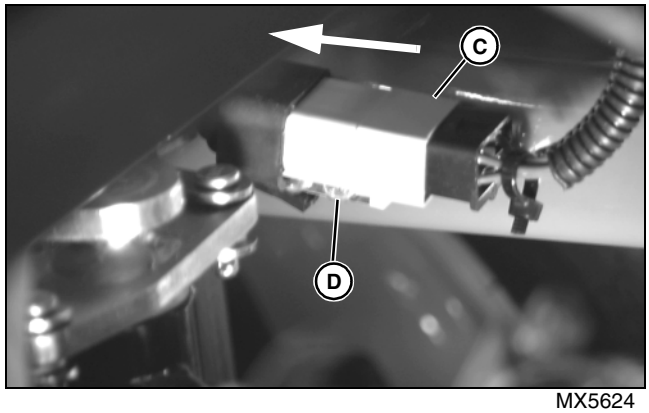
Adjustment:

IMPORTANT: Avoid damage! Improper adjustment may cause damage to plunger and brake switch. Adjust brake switch with park brake lock lever in unlocked position and brakes disengaged.



MX5623

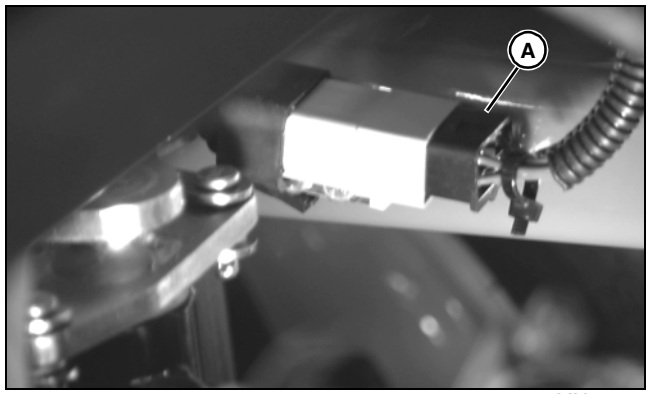
1. Loosen lock nut (A) and washer (B) on inside of frame rail.



MX5624

2. Move brake switch (C) toward front of machine until plunger is fully retracted when contacting neutral safety arm.
3. Tighten screw (D) and lock nut.
4. Depress master brake pedal and release. Ensure that neutral safety arm properly contacts plunger. Adjust if necessary.
5. Check brake switch for proper operation:
   a. Operate machine with PTO switch in on position.
   b. While depressing master brake pedal, ensure PTO disengages.
   c. Adjust or replace brake switch if necessary.

Removal:



MX5624

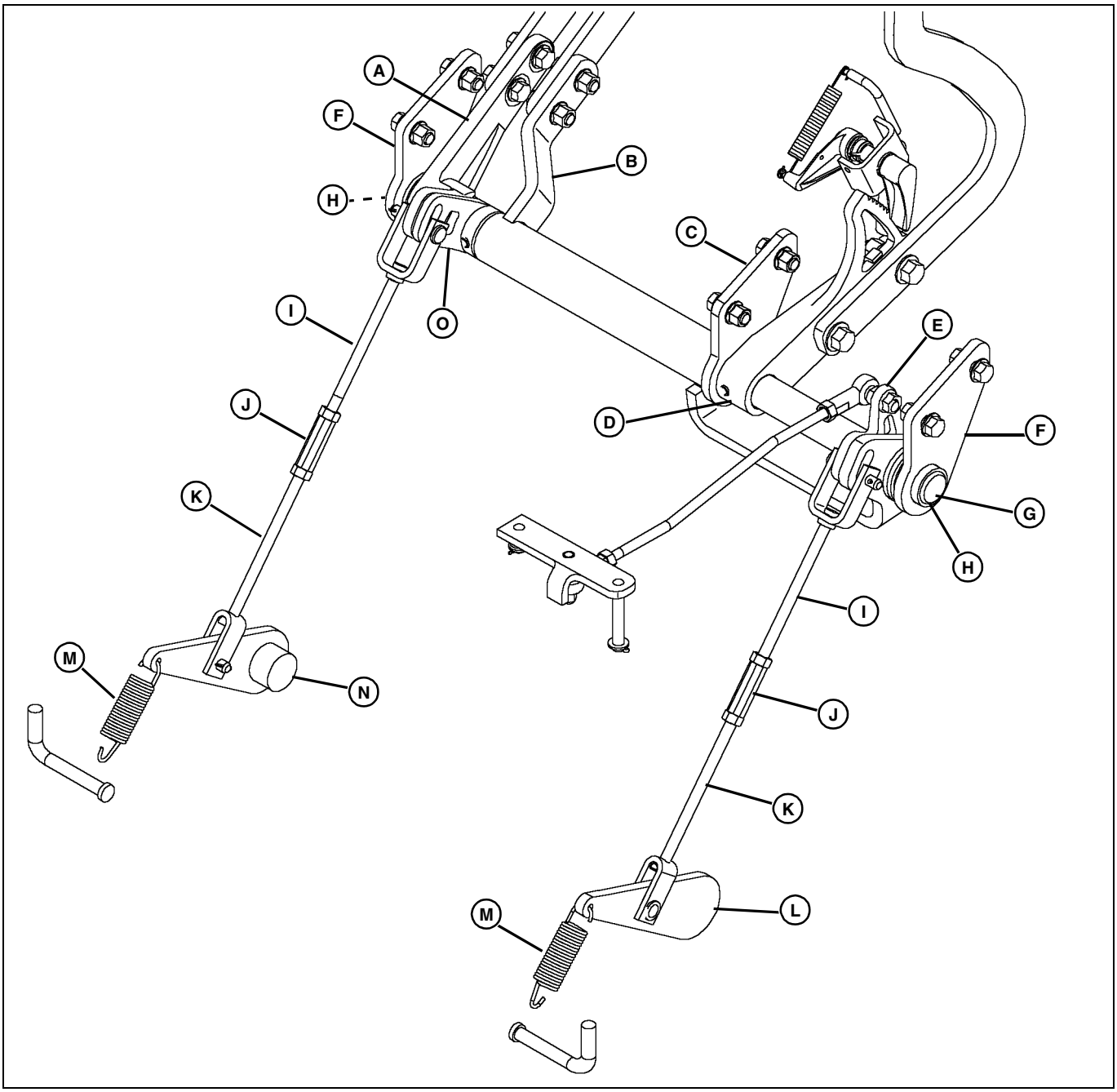
1. Disconnect connector (A) on back of brake switch.
2. Remove screw, lock nut and brake switch from machine.
3. Replace brake switch.

Installation:

- Installation is done in the reverse order of removal.
- Perform steps 2 - 5 in Adjustment section.
- Check brake switch for proper operation.

Repair

Brake Linkage Removal and Installation



MX5607

A - Left Turn Brake Arm
B - Right Turn Brake Arm
C - Center Support
D - Master Brake Pedal Support
E - Right Master Brake Arm
F - Support (2 used)
G - Pedal Shaft
H - Bushing (2 used)
I - Upper Brake Link Assembly (2 used)
J - Turnbuckle (2 used)
K - Lower Brake Link Assembly (2 used)
L - Right Brake Cam Arm
M - Brake Return Spring (2 used)
N - Left Brake Cam Arm
O - Left Master Brake Arm

Removal:

1. Park machine on level ground.

2. Raise machine and remove front wheels.

3. Remove left brake return spring (M) from latch hook.

4. Remove cotter pin and clevis pin holding upper left brake link assembly (I) to left master brake arm (O) and left turn brake arm (A).

5. Remove cotter pin and clevis pin holding left lower brake link assembly (K) to left brake cam arm (N) and remove assembly (I, J, and K).

6. Remove right brake return spring (M) from latch hook.

7. Remove cotter pin and clevis pin holding upper right brake link assembly (I) to right master brake arm (E) and right turn brake arm (B).

8. Remove cotter pin and clevis pin holding right lower brake link assembly (K) to right brake cam arm (N) and remove assembly (I, J, and K).

9. Inspect brake link assemblies and turnbuckles for wear and damage. Replace as necessary.

Installation:

1. Install lock nuts on upper and lower brake link rods and connect with turnbuckle. Adjust assembled linkage to a preset length of **34.3 cm (13.5 in.)**.

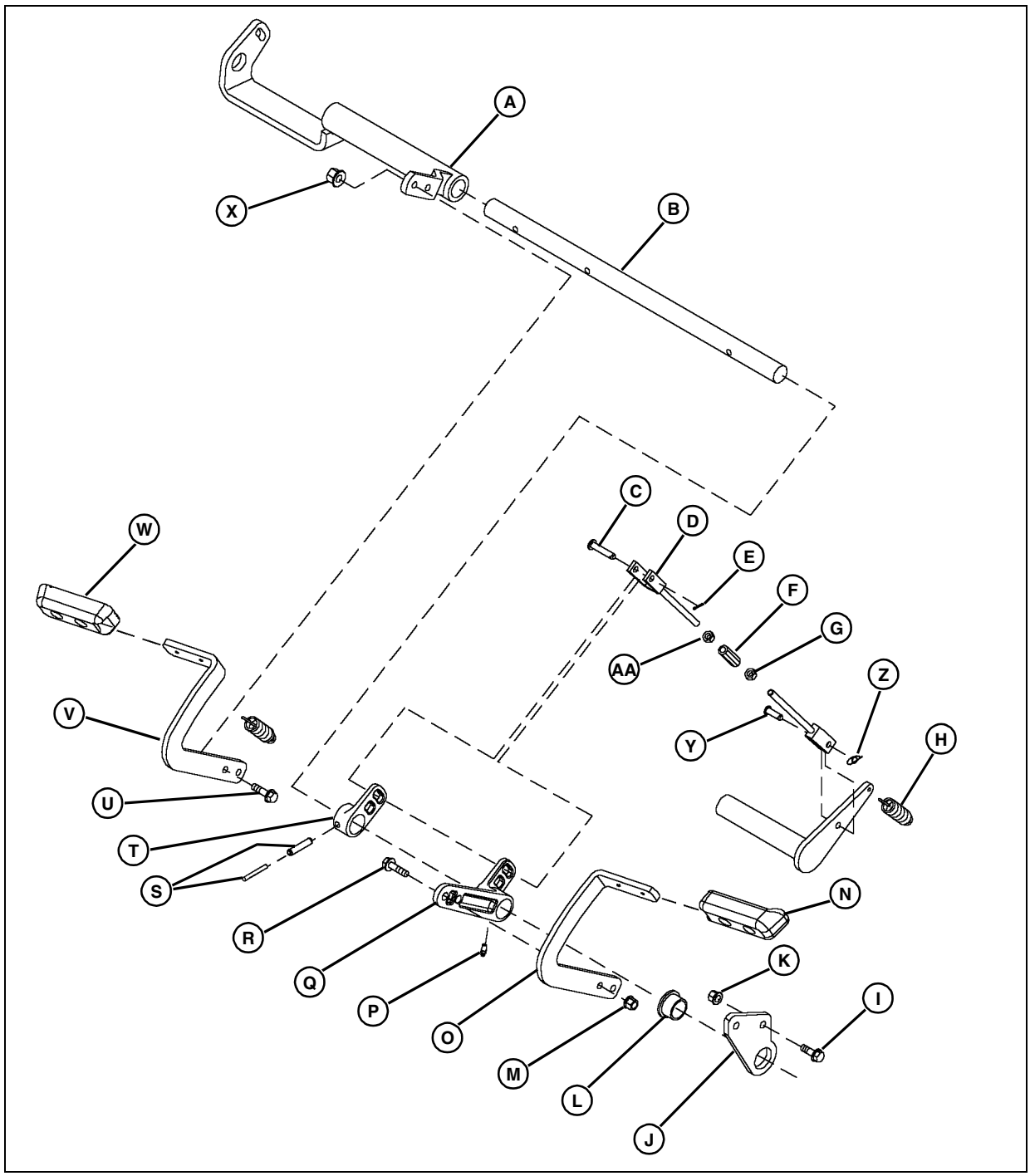
NOTE: The lower right side clevis pin should be installed with its head facing outward. Place a washer between the clevis and rue pin.

2. Install brake link assembly on machine starting with lower clevis first, then upper clevis.

3. Install the brake return springs.

4. Check the left and right turn pedal free play and adjust turn brake linkage. (See “Turn Brake Adjustment” on page 688 in this section.)

Turn Brake Pedals Removal and Installation

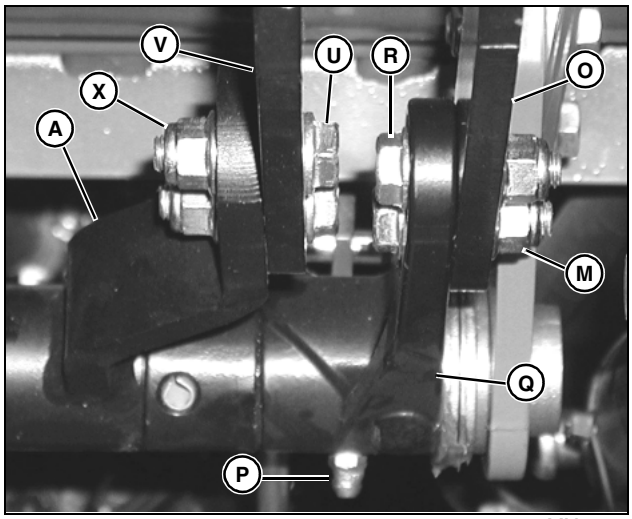


MX5614

A - Right Turn Brake Arm
B - Pedal Shaft
C - Drilled Clevis Pin (2 used)
D - Clevis (2 used)
E - Cotter Pin (2 used)
F - Turnbuckle (2 used)
G - Jam Nut, M8 (2 used)
H - Brake Return Spring (2 used)
I - Screw, M8 x 25 (2 used)
J - Support
K - Lock Nut, M8 (2 used)
L - Pivot Bushing
M - Lock Nut, M8 (4 used)
N - Left Turn Brake Pedal Pad
O - Left Turn Brake Pedal
P - Lubrication Fitting
Q - Left Turn Brake Arm
R - Screw, M8 x 30 (2 used)
S - Spring Pin Set
T - Left Master Brake Arm
U - Screw, M8 x 30 (2 used)
V - Right Turn Brake Pedal
W - Right Turn Brake Pedal Pad
X - Lock Nut, M8 (2 used)
Y - Clevis Pin (2 used)
Z - Rue Pin (2 used)
AA- Jam Nut M8 (left-hand thread)

Removal:

1. Park machine on level ground.
2. Lower lift arms or attachment.
3. Open service hatch on operator's platform.
4. Remove brake return spring (H) from hook on frame.



MX5615

5. Remove screws (R) and lock nuts (M) securing left turn brake pedal (O) to left turn brake arm (Q).
6. Remove left turn brake pedal.

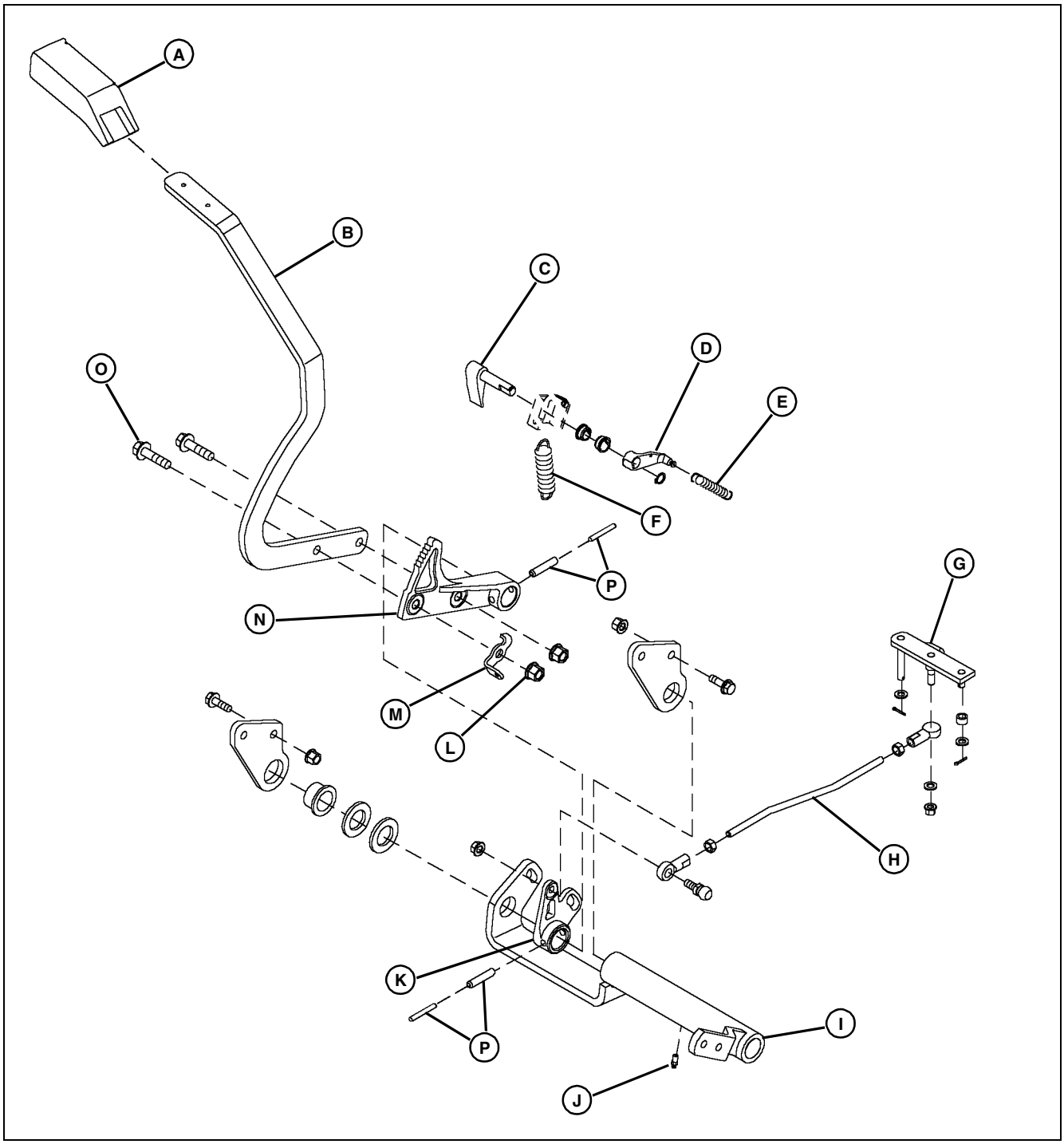
NOTE: Lower left turn brake arm to gain access and remove screws on right turn brake pedal.

7. Remove screws (U) and lock nuts (X) securing right turn brake pedal (V) and right master brake arm (A).
8. Remove right turn brake pedal.
9. Inspect all parts for wear or damage. Replace as necessary.

Installation:

- Installation is done in the reverse order of removal.
- Make sure slots of inner and outer spring pins for spring pin set (S) are 180° apart.
- Lubricate left turn brake arm and pedal shaft using lubrication fitting (P).
- Check turn brake pedal free play and adjust. (See "Turn Brake Adjustment" on page 688.)

Master Brake Pedal Removal and Installation

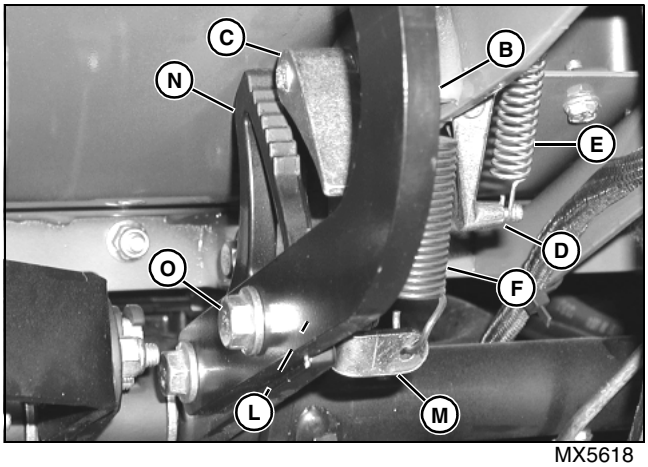


MX5617

A - Pad
B - Master Brake Pedal
C - Pawl
D - Arm
E - Spring
F - Spring (Master Brake Pedal)
G - Neutral Safety Arm
H - Neutral Safety Link
I - Right Turn Brake Arm
J - Lubrication Fitting
K - Right Master Brake Arm
L - Lock Nut, M8 (2 used)
M - Bracket
N - Support
O - Screw, M10 x 40 (2 used)
P - Spring Pins

Removal:

1. Park machine on level ground.
2. Unlock park brake.



MX5618

3. Disconnect spring (F) from bracket (M) to release support (N).

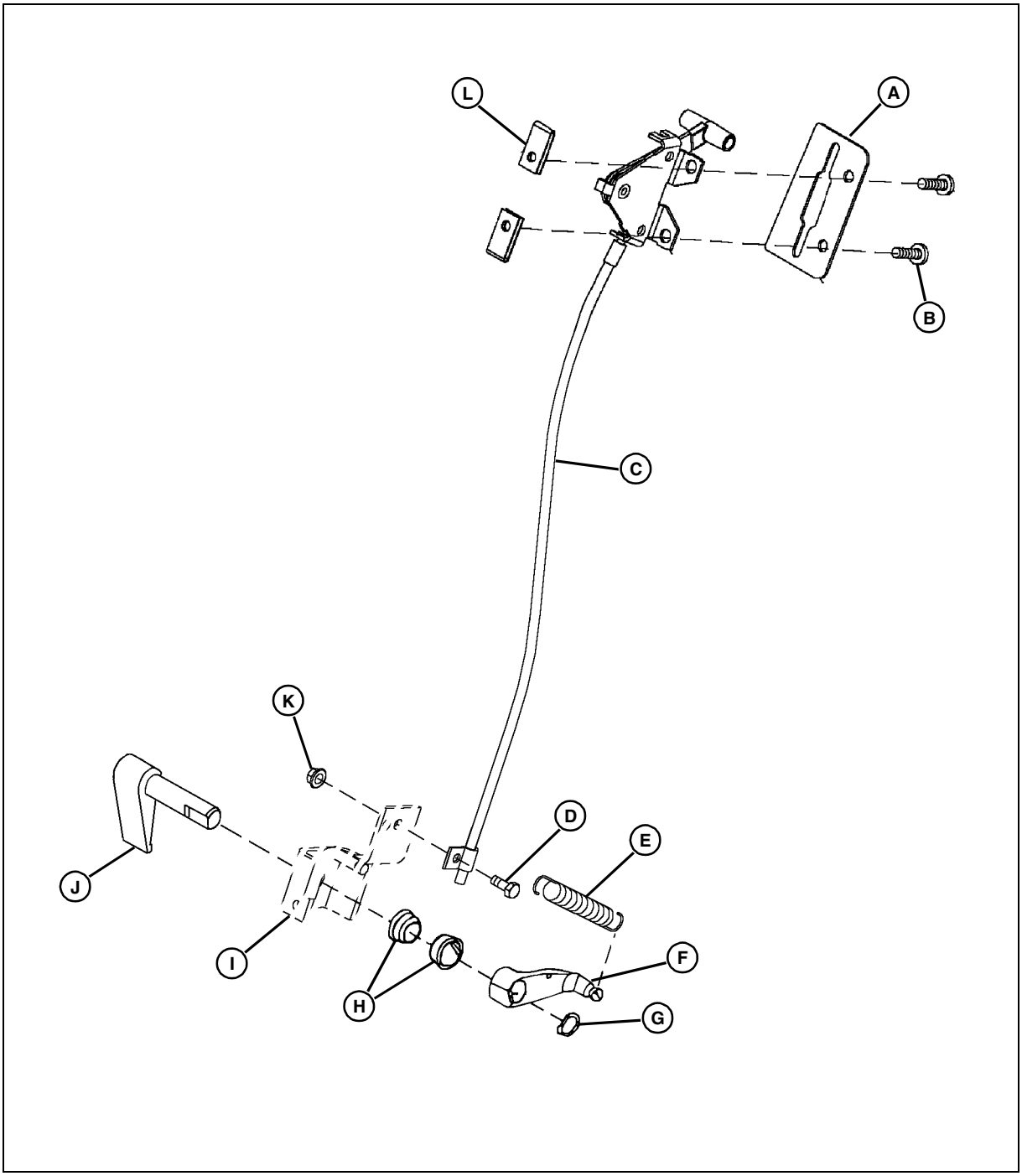
NOTE: Lift up on forward motion pedal to remove rear screw on master brake pedal.

4. Remove lock nut (L) and screw (O).
5. Remove master brake pedal (B) and bracket.
6. Inspect master brake pedal and pad (A) for wear or damage. Replace as necessary.

Installation:

- Installation is done in the reverse order of removal.
- Make sure slots of inner and outer spring pins for spring pin sets (P) are 180° apart.
- Apply grease to lubrication fitting (J) to lubricate right turn brake arm (I), right master brake arm (K), and pedal shaft.
- Check master brake pedal free play and adjust. (See “Turn Brake Adjustment” on page 688.)
- Move park brake lever to lock position. Park brake arm (D) should activate pawl (C), and lock the support. Adjust if necessary. (See “Park Brake Lock Lever Assembly Removal and Installation” on page 696 for repair procedure.)
- Check neutral safety arm (G) and neutral safety link (H) for proper operation, and adjust if necessary. (See “F-N-R Linkage Adjustment” in the Power Train section.)
- Check brake switch for proper operation and adjust. (See “Brake Switch Adjustment” on page 689.)

Park Brake Lock Lever Assembly Removal and Installation

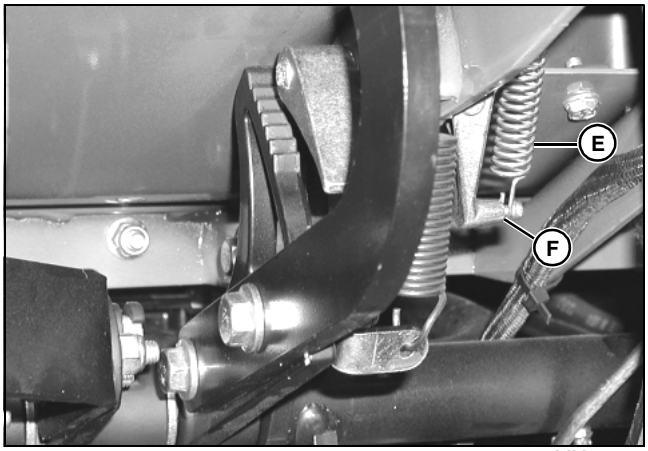


MX5620

A - Plate
B - Screw
C - Park Brake Lock Lever Assembly
D - Cap Screw
E - Spring
F - Arm
G - Snap Ring
H - Bushing (2 used)
I - Bracket
J - Pawl
K - Flange Nut
L - Lock Nut

Removal:

1. Park machine on level surface.
2. Unlock park brake.



MX5618

3. Remove spring (E) from arm (F).
4. Remove cap screw (D) and nut (K) to disconnect park brake cable from bracket (I).
5. Remove screws (B) securing park brake lock lever assembly (C) to steering column cover.
6. Remove park brake Lock lever assembly and cable from steering column cover.
7. Inspect park brake lock lever assembly and cable for wear or damage. Replace as necessary.

Installation:

- Installation is done in the reverse order of removal.
- Move park brake lock lever to lock position.
- Depress master brake pedal. Pawl (O) should mesh with tooth on master brake pedal support (Q) and lock master brake pedal.
- Test park brake:
  - Stop machine on 17° slope (30% grade). Stop the engine and lock park brake.

    Result: Park brake must hold the machine stationary. (ANSI standards permit movement of no more than 61cm (24in.) in one hour.) If machine moves more than that, brakes need to be adjusted.
- Adjust brakes if necessary. (See “Turn Brake Adjustment” on page 688.)

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Specifications

Test and Adjustment Specifications

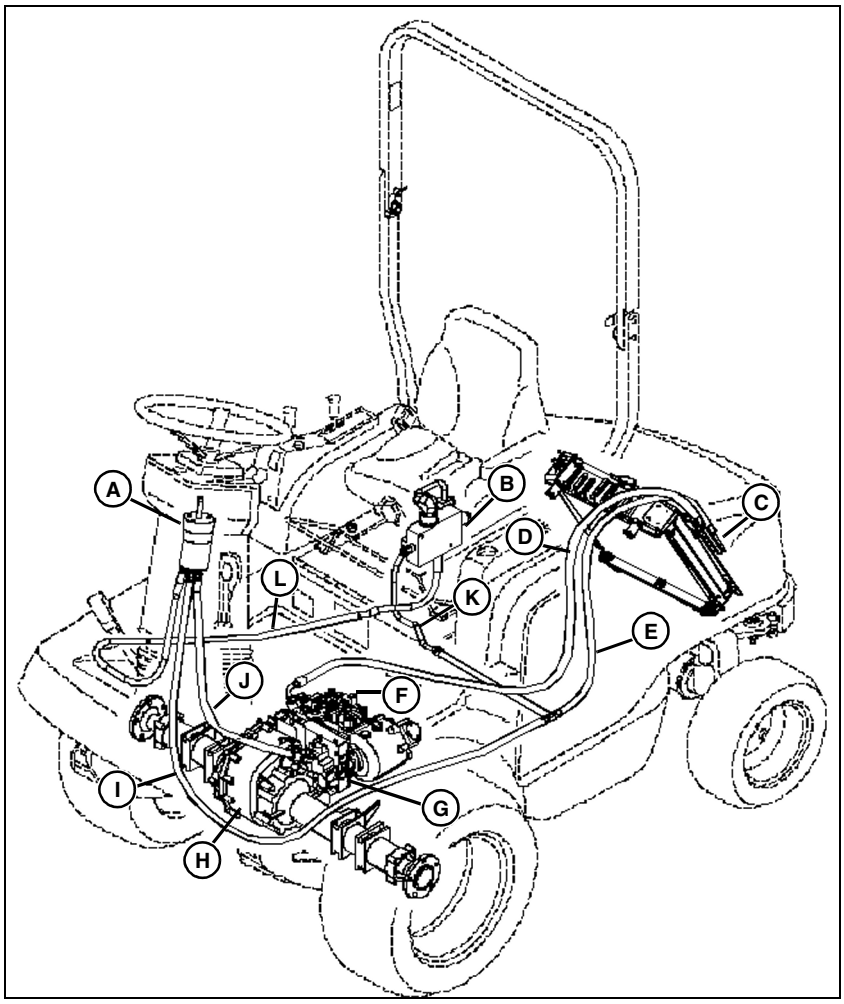
Hydraulic Oil Operating Temperature	**49°C (120°F)**
Charge Pressure Relief Valve (1400 Series):	
At SLOW idle	**2068 ± 206 kPa (300 ± 30 psi)**
At FAST idle	**2344 ± 206 kPa (340 ± 30 psi)**
Charge Pressure Relief Valve (1500 Series):	
At SLOW idle	**1500 ± 150 kPa (218 ± 22 psi)**
At FAST idle	**1850 ± 150 kPa (268 ± 22 psi)**
Charge Pump Flow (1400 Series Only):	
New charge pump flow	**21.0 L/min at 1517 kPa (5.6 gpm at 220 psi)**
Used charge pump flow	**15.1 L/min at 1517 kPa (4.0 gpm at 220 psi)**
PTO Relief Valve:	
At SLOW idle	**1724 ± 206 kPa (250 ± 30 psi)**
At FAST idle	**1930 ± 206 kPa (280 ± 30 psi)**
Implement Relief Valve (1400 Series Only):	
At SLOW idle	**5515 ± 500 kPa (800 ± 73 psi)**
At FAST idle	**6895 ± 500 kPa (1000 ± 73 psi)**
Implement Relief Valve (1500 Series)	
At Slow idle	**9307 kPa (1350 psi)**
At Fast idle	**11031 kPa (1600 psi)**
Hydraulic Pump Flow (1500 Series)	
At Fast idle	**16.5 L/min @ 2950 kPa (4.3 gpm @ 428 psi)**

Repair Specifications

Implement Lift Valve Torque Specifications:	
Plugs (small) and all screws	**3.5 N•m (30 lb-in.)**
Plugs (large)	**24 N•m (215 lb-in.)**
Optional Auxiliary Hydraulic Valve Torque Specifications:	
Plugs (small) and screws	**3.5 N•m (30 lb-in.)**
Plugs (large)	**24 N•m (215 lb-in.)**
PTO Solenoid Valve Torque Specifications:	
Solenoid stud	**20.5 - 22.5 N•m (184.5 - 202.5 lb-in.)**
Fastening nut	**3.9 - 5.9 N•m (35.1 - 53.1 lb-in.)**

Component Location

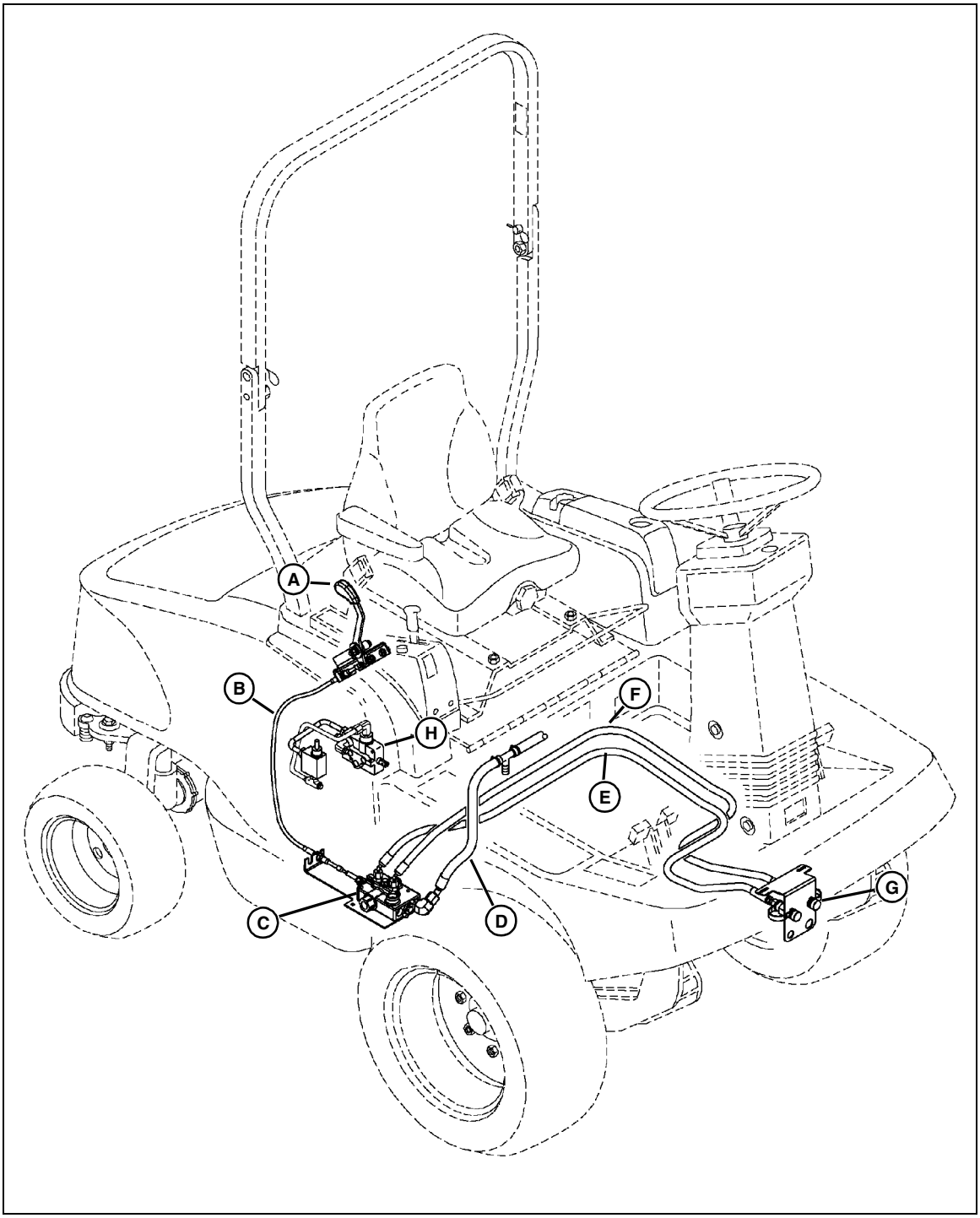
Hydraulic System Component Location



MX5488

A - Steering Valve
B - Implement Lift Valve
C - Oil Cooler
D - Hydraulic Hose, Oil Cooler to Hydro Pump
E - Hydraulic Hose, Steering and Implement Lift Valve to Oil Cooler
F - Hydro Pump
G - Charge Pump (1400 Series) Charge and Hydraulic Pump (1500 Series)
H - Transaxle
I - Hydraulic Hose, Steering Cylinder to Oil Cooler
J - Hydraulic Hose, Charge Pump to Steering Valve (1400 Series), Hydraulic Pump to Steering (1500 Series)
K - Tube and Hydraulic Hose, Implement Lift Valve to Oil Cooler
L - Hydraulic Hose, Steering Valve to Implement Lift Valve

Auxiliary Hydraulic Kit Component Location



MX5475

A - Auxiliary Control Lever (2 used with double spool valve)

B - Auxiliary Control Cable (2 used with double spool valve)

C - Auxiliary Lift Valve (single or double spool)

D - Hydraulic Hose, Auxiliary Lift Valve to Oil Cooler

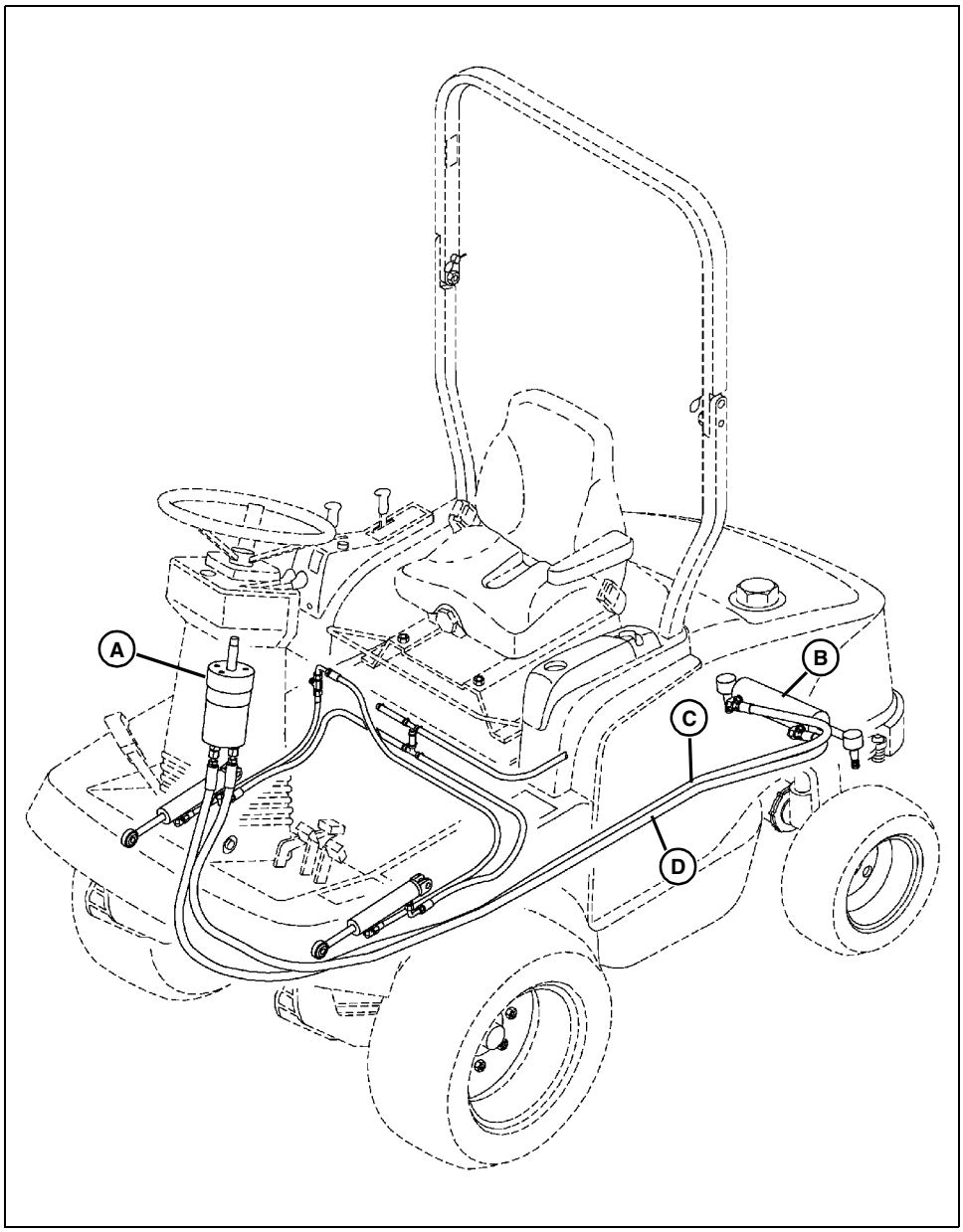
E - Hydraulic Hose (2 used for double spool valve)

F - Hydraulic Hose (2 used for double spool valve)

G - Quick Couplers (4 used for double spool valve)

H - Implement Lift Valve

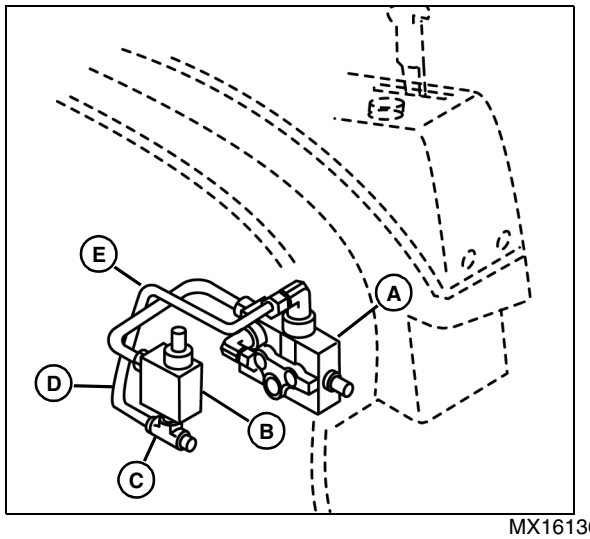
Steering System Hydraulic Hose Routing



MX5474

A - Steering Valve
B - Steering Cylinder
C - Left Turn Steering Hose
D - Right Turn Steering Hose

Weight Transfer System Component Location



MX16136

A - Implement Lift Valve

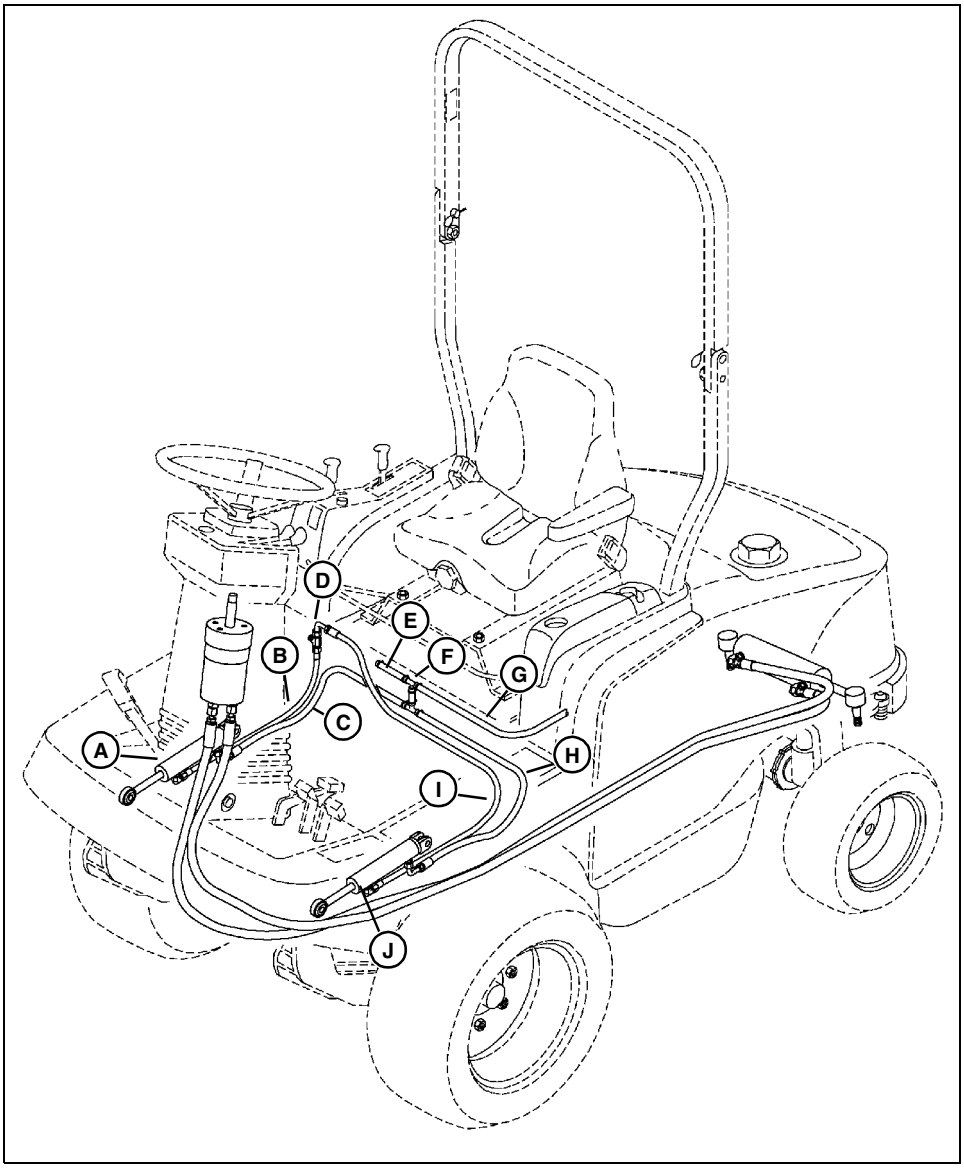
B - Weight Transfer Valve

C - Tee, Implement Lift Valve and Weight Transfer Valve to Lift Cylinders

D - Tube, Implement Lift Valve to Tee

E - Tube, Weight Transfer Valve to Implement Lift Valve

Lift System Hydraulic Hose Routing

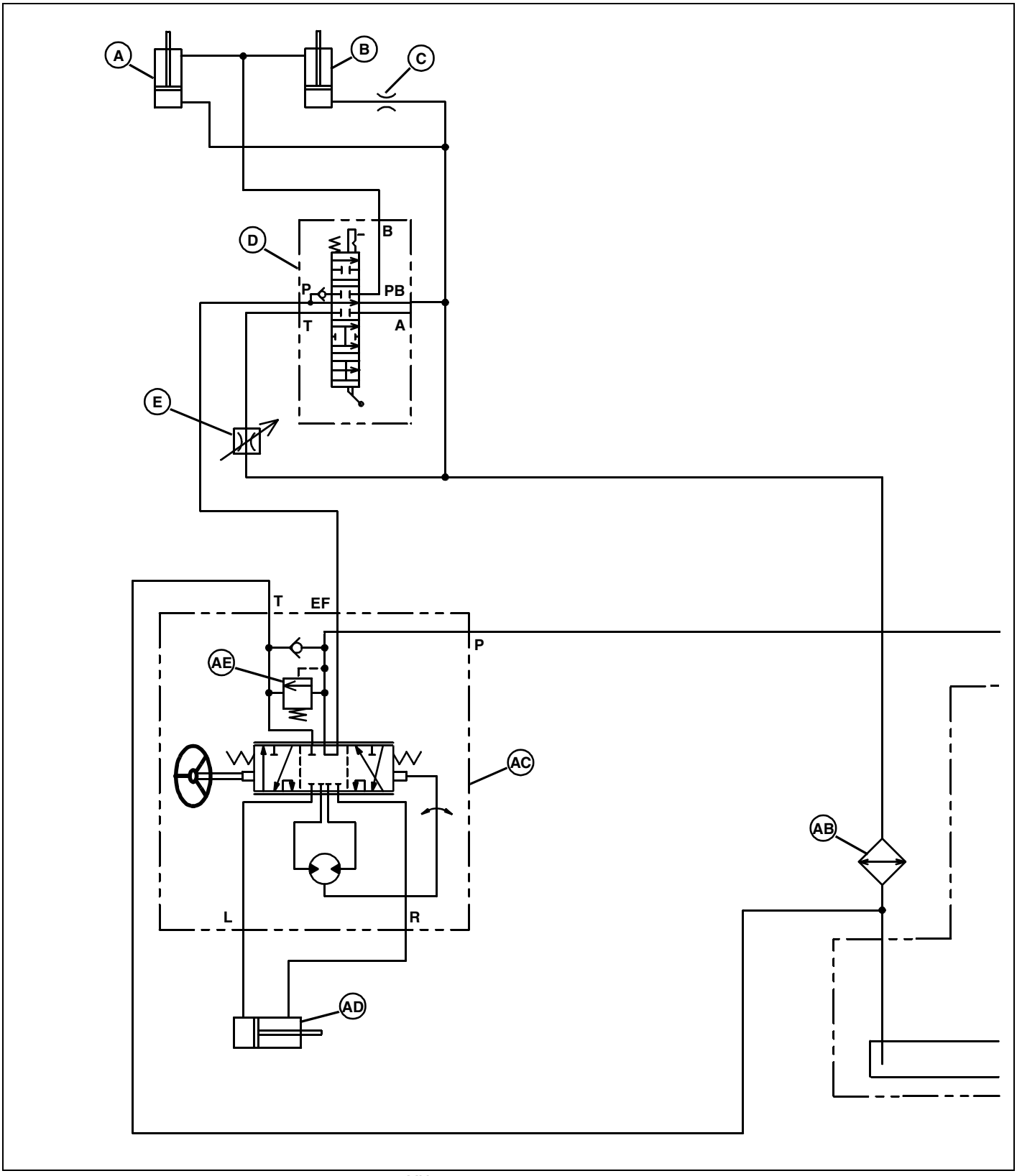


MX5474

A - Right Lift Cylinder
B - Right Hydraulic Hose (retract)
C - Right Hydraulic Hose (extend)
D - Tee Fitting, Implement Lift Valve to Lift Cylinder Hoses
E - Hydraulic Hose, Implement Lift Valve to Oil Cooler
F - Tee Fitting, Lift Cylinder Hoses to Oil Cooler Hose
G - Hydraulic Hose, Implement Lift Valve and Lift Cylinders to Oil Cooler
H - Left Hydraulic Hose (extend)
I - Left Hydraulic Hose (retract)
J - Left Lift Cylinder

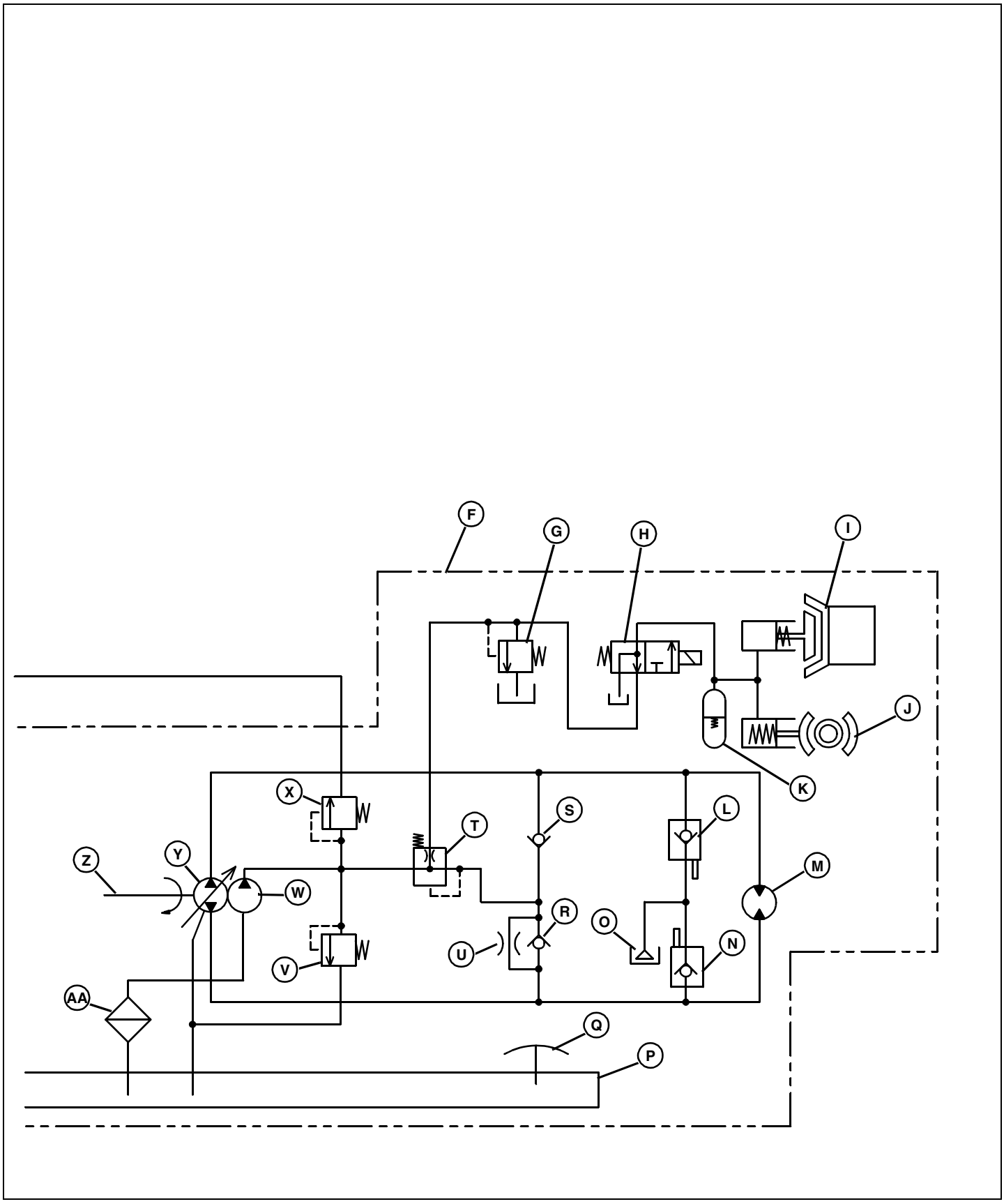
Schematics and Harnesses

Main Hydraulic Schematic Without Optional Auxiliary Valve (1400 Series)



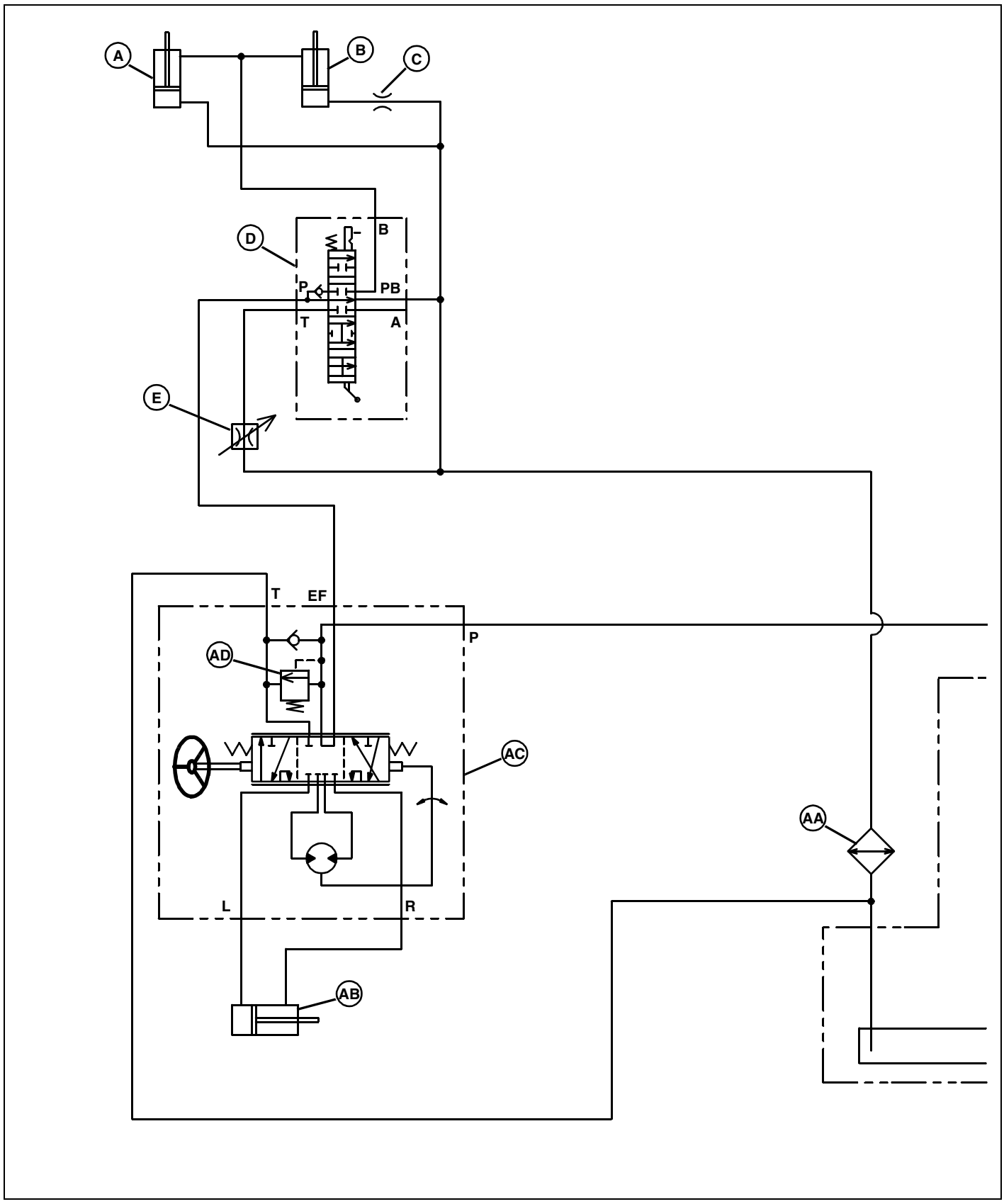
MX5410

Main Hydraulic Schematic Without Optional Auxiliary Valve - 1400 Series (2 of 2)



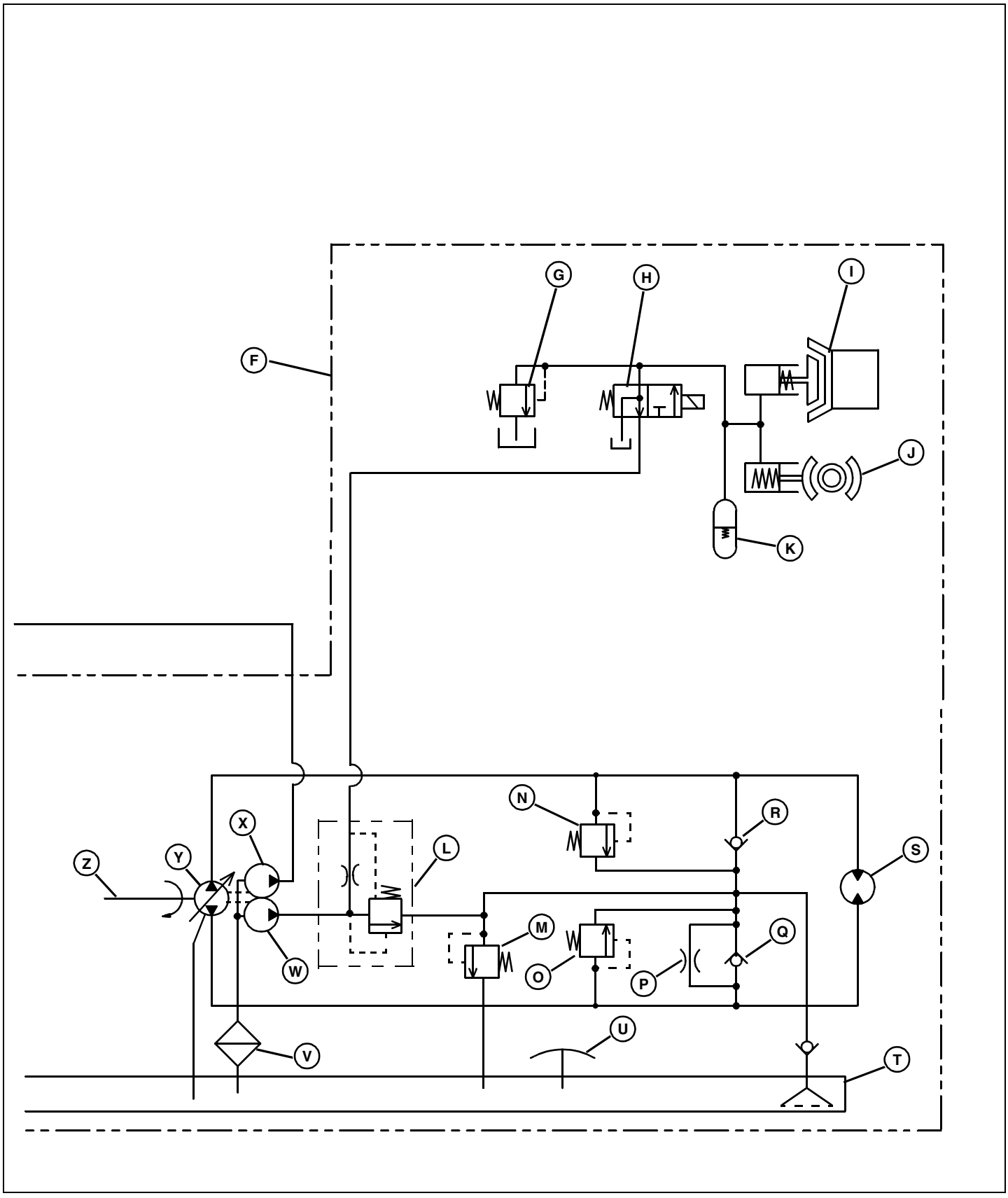
A - Left Lift Cylinder
B - Right Lift Cylinder
C - Orifice (Use N220668 for 72-in. Decks; Use T121143 for 60-in. and 62-in. Decks)
D - Implement Lift Valve
E - Weight Transfer Valve (Optional)
F - Transaxle
G - PTO Relief Valve
H - PTO Solenoid Valve
I - PTO Clutch
J - PTO Brake
K - Accumulator
L - TOW Valve (Forward)
M - Hydrostatic Motor
N - TOW Valve (Reverse)
O - Sump Screen
P - Hydraulic Oil Reservoir (8.5 L [2.25 gal] 2WD; 8.7 L (2.3 gal) 4WD)
Q - Vented Reservoir Cap
R - Check Valve (Reverse)
S - Check Valve (Forward)
T - Lube Reduction Valve
U - Orifice
V - Implement Pressure Relief Valve
W - Charge Pump (8 cc/rev [0.50 in./rev])
X - Charge Pressure Relief Valve
Y - Hydrostatic Pump
Z - Input Shaft
AA- Hydraulic Oil Filter
AB- Oil Cooler
AC- Steering Control Valve
AD- Steering Cylinder
AE- Relief Valve

Main Hydraulic Schematic Without Optional Auxiliary Valve (1500 Series)



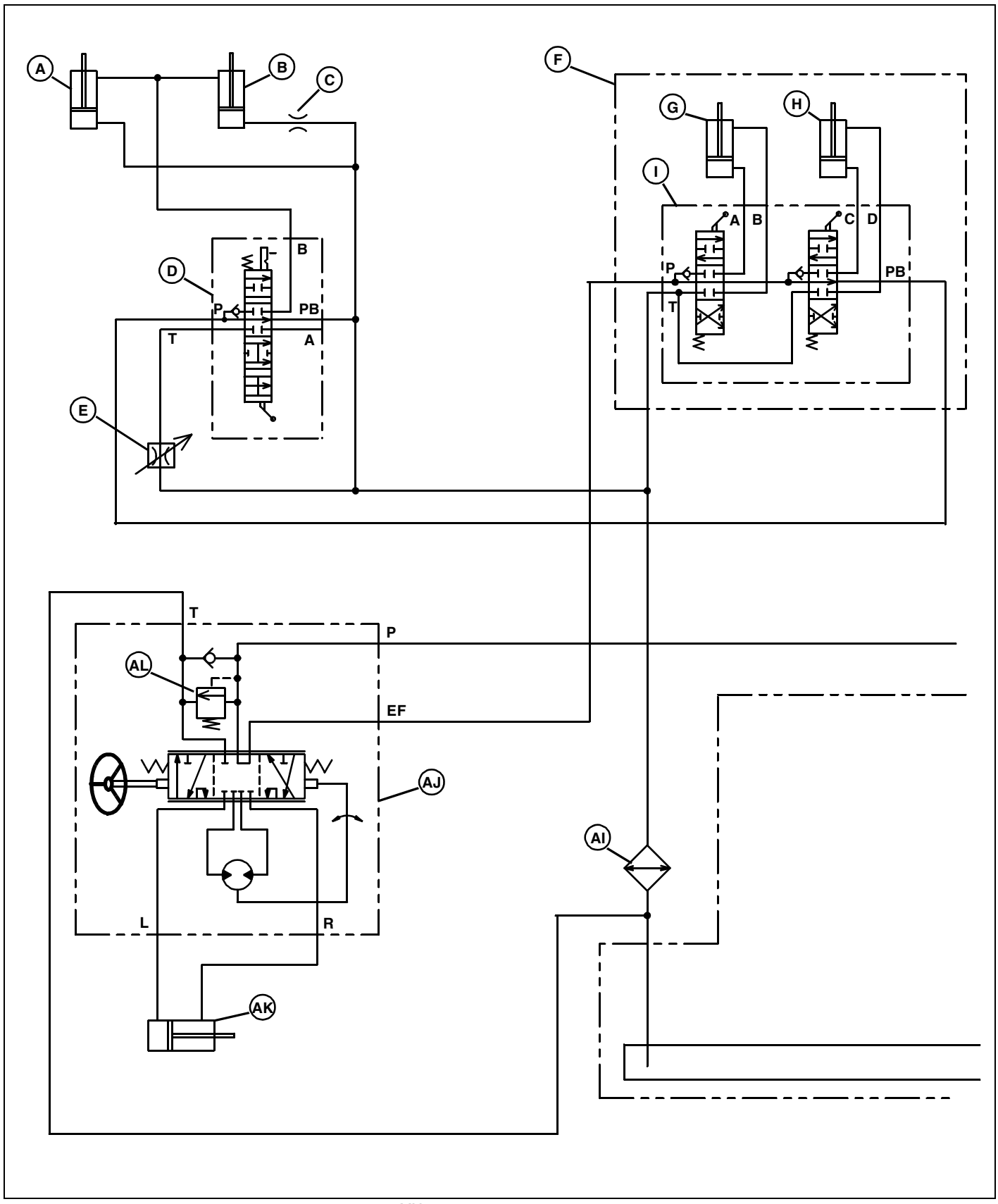
MX5410

Main Hydraulic Schematic Without Optional Auxiliary Valve - 1500 Series (2 of 2)



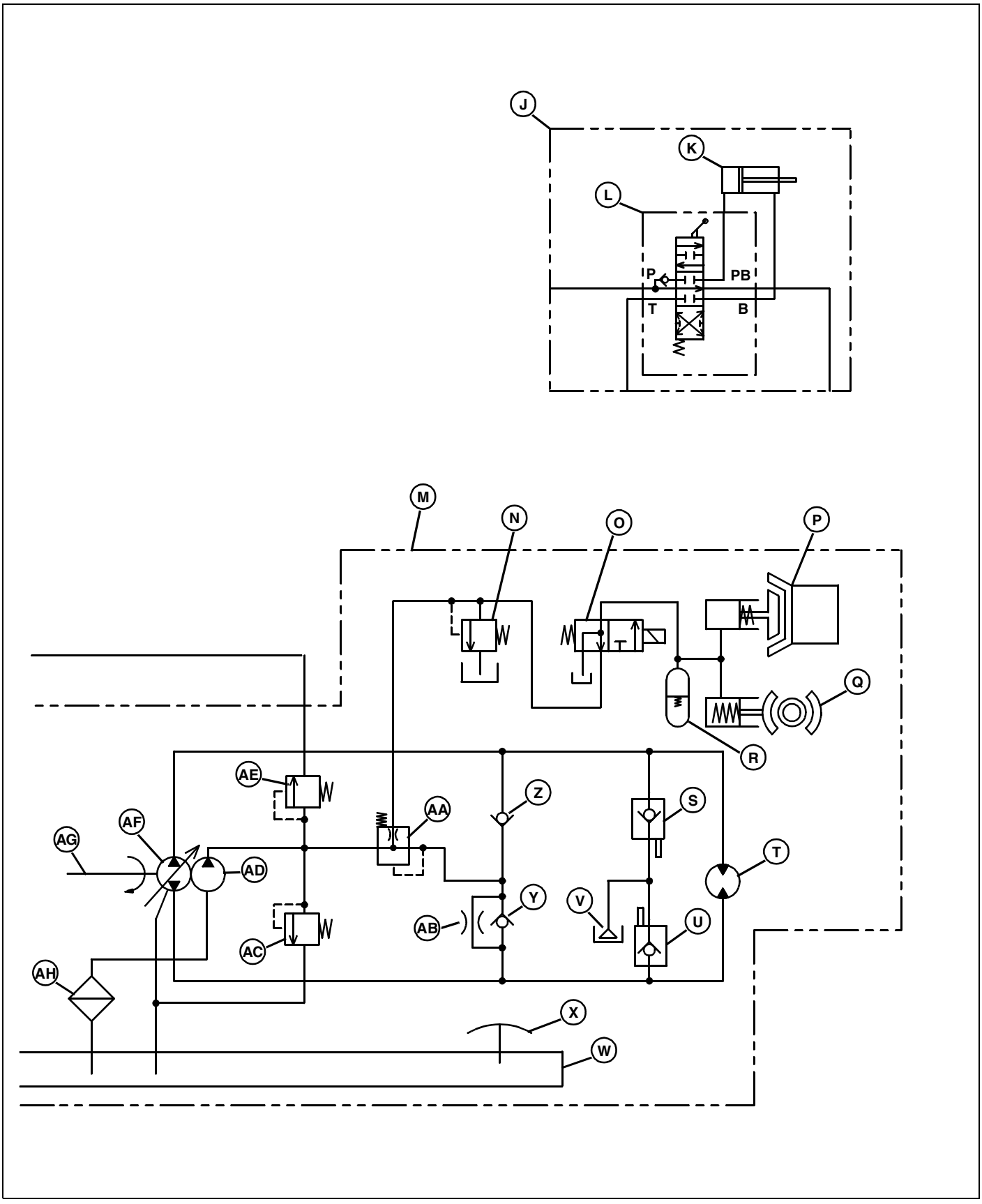
A - Left Lift Cylinder
B - Right Lift Cylinder
C - Orifice (Use N220668 for 72-in. Decks; Use T121143 for 60-in. and 62-in. Decks)
D - Implement Lift Valve
E - Weight Transfer Valve (Optional)
F - Transaxle
G - PTO Relief Valve
H - PTO Solenoid Valve
I - PTO Clutch
J - PTO Brake
K - Accumulator
L - Priority Valve
M - Charge Pressure Relief Valve
N - Relief Valve (Forward)
O - Relief Valve (Reverse)
P - Orifice
Q - Check Valve (Reverse)
R - Check Valve (Forward)
S - Hydrostatic Motor
T - Hydraulic Oil Reservoir (8.7 L (2.3 gal) 4WD)
U - Vented Reservoir Cap
V - Hydraulic Oil Filter
W - Charge Pump (Trochoid 5 cc/rev)
X - Hydraulic Pump (Gear 5 cc/rev)
Y - Hydrostatic Pump
Z - Input Shaft
AA- Oil Cooler
AB- Steering Cylinder
AC- Steering Control Valve
AD- Implement Pressure Relief Valve

Main Hydraulic Schematic With Optional Auxiliary Valve (1400 Series)



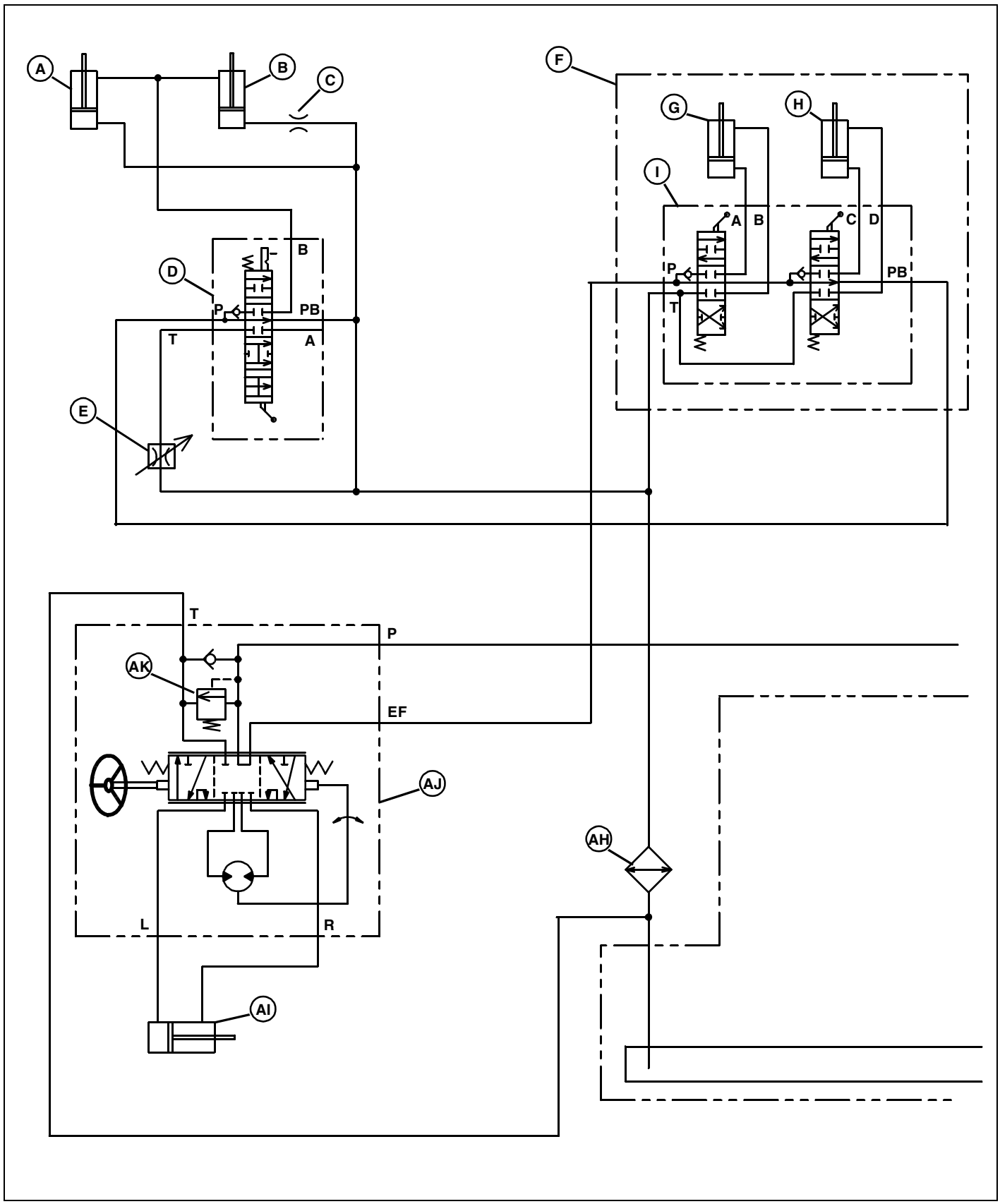
MX5410

Main Hydraulic Schematic With Optional Auxiliary Valve - 1400 Series (2 of 2)



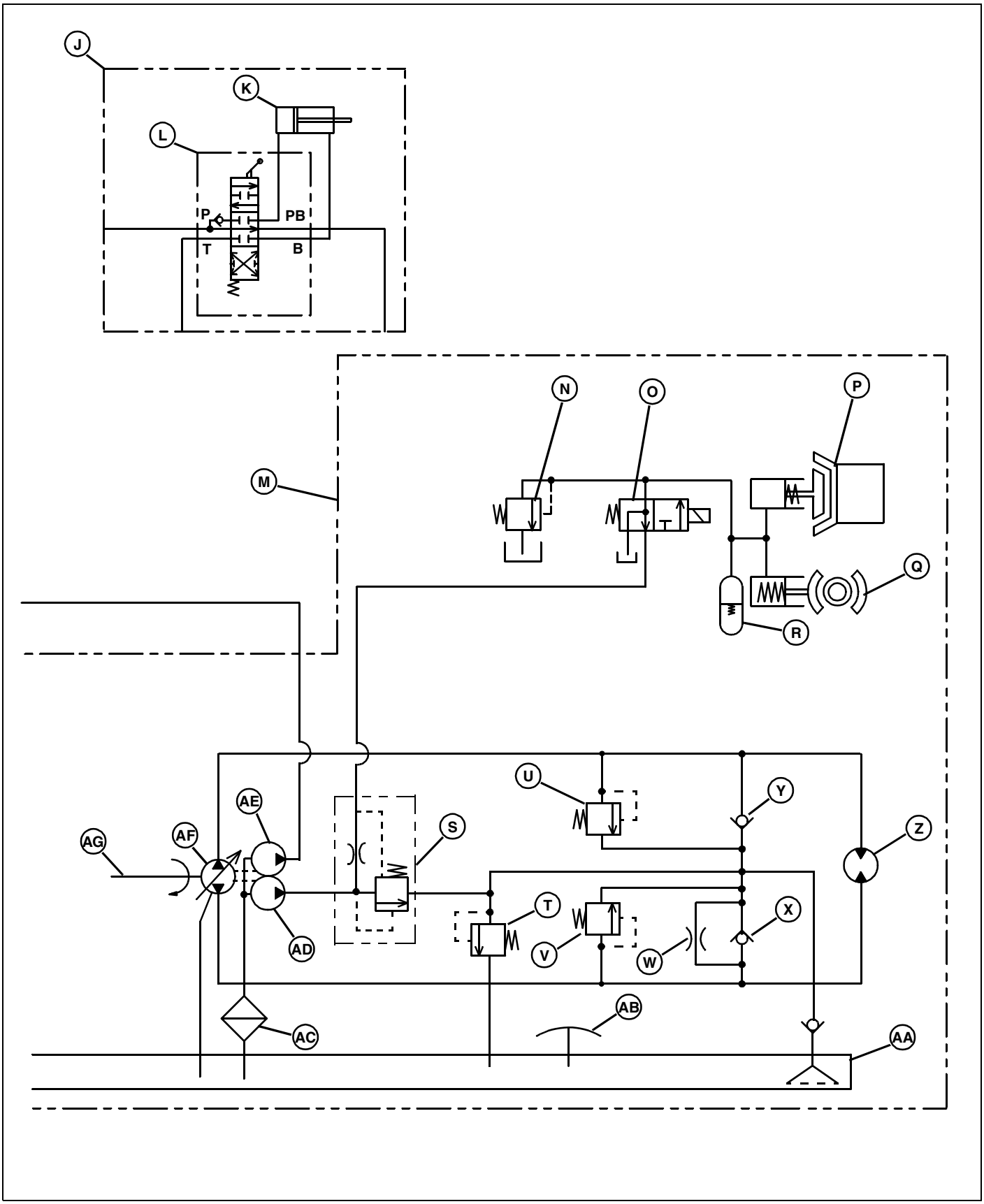
A - Left Lift Cylinder
B - Right Lift Cylinder
C - Orifice (Use N220668 for 72-in. Decks; Use T121143 for 60-in. and 62-in. Decks)
D - Implement Lift Valve
E - Weight Transfer Valve (Optional)
F - Double Spool Auxiliary Hydraulics Valve (Optional)
G - Auxiliary Cylinder
H - Auxiliary Cylinder
I - Spool Valve Assembly
J - Single Spool Auxiliary Hydraulics Valve (Optional)
K - Auxiliary Cylinder
L - Single Spool Valve Assembly
M - Transaxle
N - PTO Relief Valve
O - PTO Solenoid Valve
P - PTO Clutch
Q - PTO Brake
R - Accumulator
S - TOW Valve (Forward)
T - Hydrostatic Motor (30 cc/rev [2.2 in./rev])
U - TOW Valve (Reverse)
V - Sump Screen
W - Hydraulic Oil Reservoir (8.5 L [2.25 gal] 2WD; 8.7 L [2.3 gal] 4WD)
X - Vented Reservoir Cap
Y - Check Valve (Reverse)
Z - Check Valve (Forward)
AA- Lube Reduction Valve
AB- Orifice
AC- Implement Pressure Relief Valve
AD- Charge Pump (8 cc/rev (0.50 in./rev])
AE- Charge Pressure Relief Valve
AF- Hydrostatic Pump
AG- Input shaft
AH- Hydraulic Oil Filter
AI - Oil Cooler
AJ- Steering Control Valve
AK- Steering Cylinder
AL- Relief Valve

Main Hydraulic Schematic With Optional Auxiliary Valve (1500 Series)



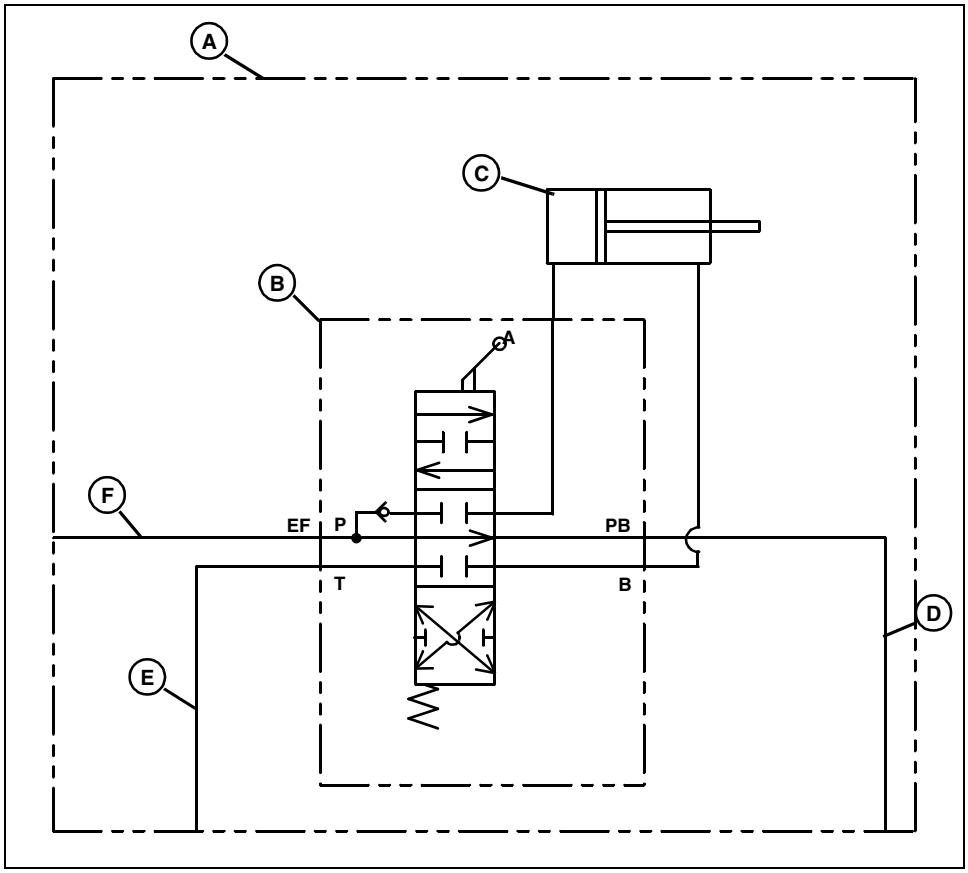
MX5410

Main Hydraulic Schematic With Optional Auxiliary Valve - 1500 Series (2 of 2)



A - Left Lift Cylinder
B - Right Lift Cylinder
C - Orifice (Use N220668 for 72-in. Decks; Use T121143 for 60-in. and 62-in. Decks)
D - Implement Lift Valve
E - Weight Transfer Valve (Optional)
F - Double Spool Auxiliary Hydraulics Valve (Optional)
G - Auxiliary Cylinder
H - Auxiliary Cylinder
I - Spool Valve Assembly
J - Single Spool Auxiliary Hydraulics Valve (Optional)
K - Auxiliary Cylinder
L - Single Spool Valve Assembly
M - Transaxle
N - PTO Relief Valve
O - PTO Solenoid Valve
P - PTO Clutch
Q - PTO Brake
R - Accumulator
S - Priority Valve
T - Charge Relief Valve
U - Relief Valve (Forward)
V - Relief Valve (Reverse)
W - Orifice
X - Check Valve (Reverse)
Y - Check Valve (Forward)
Z - Hydrostatic Motor
AA- Hydraulic Oil Reservoir (8.7 L (2.3 gal) 4WD)
AB- Vented Reservoir Cap
AC- Hydraulic Oil Filter
AD- Charge Pump (Trochoid 5 cc/rev)
AE- Hydraulic Pump (Gear 5 cc/rev)
AF- Hydrostatic Pump
AG- Input Shaft
AH- Oil Cooler
AI - Steering Cylinder
AJ- Steering Control Valve
AK- Implement Pressure Relief Valve

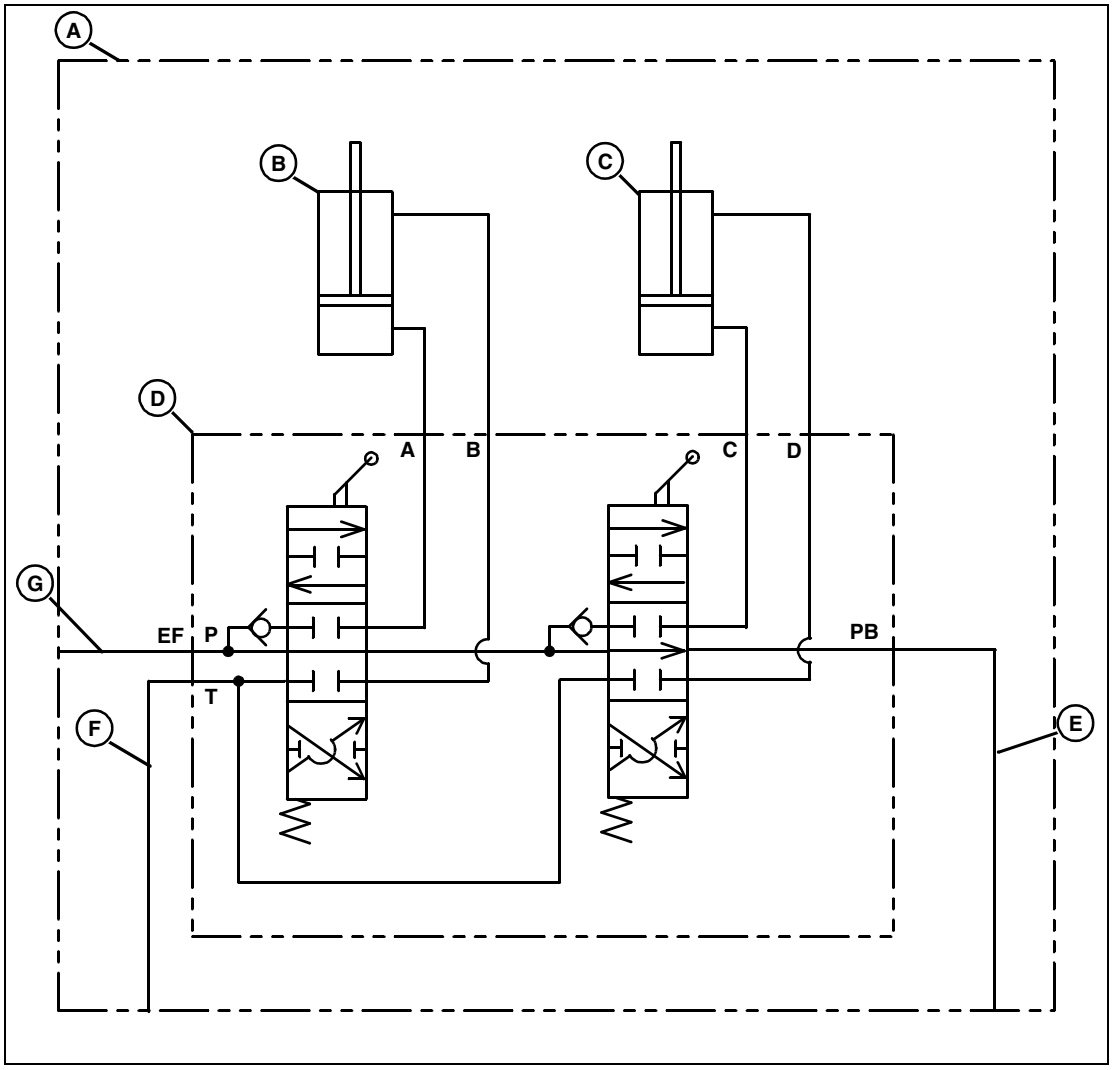
Single Spool Auxiliary Hydraulic Kit Schematic



MIF MX5527

A - Single Spool Hydraulics Valve (Optional)
B - Spool Valve Assembly
C - Auxiliary Lift Cylinder
D - Line to Lift Valve
E - Line to Oil Cooler
F - Line from Steering Valve

Double Spool Auxiliary Hydraulic Kit Schematic



MIF MX5528

A - Double Spool Hydraulics Valve (Optional)
B - Auxiliary Lift Cylinder
C - Auxiliary Lift Cylinder
D - Spool Valve Assembly
E - Line to Implement Lift Valve
F - Line to Oil Cooler
G - Line from Steering Valve

Operation and Diagnostics

Hydraulic System Operation

Function:

To provide hydraulic fluid to the hydraulic pump and motor, PTO system, steering valve, lift control valve, auxiliary control valves and lift cylinders.

Theory of Operation (1400 Series):

The hydraulic system consists of hydrostatic charge pump, hydro pump and motor, charge pump relief valve, implement relief valve, lube reduction valve, forward and reverse check ball, forward and reverse tow valves, steering valve, single lift spool valve, oil cooler and oil filter. The system can also include an optional auxiliary single or double spool valve.

Oil flow starts at the reservoir and is drawn through the oil filter to the charge pump. From the charge pump, oil is routed to three valves in the hydro center section (charge pump relief valve, implement relief valve, lube reduction valve which supplies priority oil to PTO clutch circuit and the makeup oil for the closed hydrostatic loop), to the forward and reverse check ball (reverse has 1.4 mm orifice which gives a wider neutral band and less jerky feel in reverse), and to the forward and reverse tow valves.

After the oil requirements are met in the hydro, the oil is routed to the steering valve and then is passed on to the implement lift valve. When an optional auxiliary lift valve is installed, oil is routed from the steering valve to the auxiliary lift valve then the implement control valves then the implement lift valve. From the implement lift valves, oil is sent to the auxiliary lift cylinders and returned to the oil cooler and sump. When there is no optional equipment installed, the oil is returned from the implement lift valves back to the oil cooler and sump.

Theory of Operation (1500 Series):

The hydraulic system consists of hydrostatic charge pump, hydraulic pump, hydro pump and motor, priority valve, charge pump relief valve, implement relief valve, forward and reverse check ball, forward and reverse relief valves, steering valve, single lift spool valve, oil cooler and oil filter. The system can also include an optional auxiliary single or double spool valve.

Oil flow starts at the reservoir and is drawn through the oil filter to the charge pump and hydraulic pump. From the charge pump, oil is routed to the priority valve in the hydro center section.

The priority valve and integral PTO orifice supply priority oil to the PTO clutch circuit. The priority valve is controlled by oil pressure on each side of the PTO orifice.

The remaining oil flow through the priority valve is used as make up oil for the hydrostatic pump and motor. The charge relief valve limits the maximum make up oil pressure. Forward and reverse check balls prevent oil back flow in the make up oil circuit. The reverse ball check includes an orifice which gives a wider neutral band and less jerky feel in reverse. The forward and reverse relief valves limit the maximum oil pressure in the hydrostatic loop circuit.

The hydraulic pump sends oil to the steering valve and then to the auxiliary valves if installed, and then to the implement lift valve. Oil from these valves is used to operate auxiliary and lift cylinders respectively. Return oil from the cylinders and excess oil not used for cylinder operation flows through the oil cooler and back to the transaxle sump. Located in the steering valve is an implement relief valve that limits the output pressure from the hydraulic pump.

Lift Circuit Operation

Function:

To lift front mounted equipment.

Theory of Operation:

The lift circuit is a hydraulic circuit and consists of hydrostatic charge pump (1400 Series), hydraulic pump (1500 Series), steering valve, implement lift valve, optional weight transfer valve, front lift cylinders, and optional auxiliary control valves.

From the steering valve, oil is routed to the implement lift valve and passes through the optional weight transfer valve. The optional weight transfer valve operates when the lift valve is in float and return oil passes through a variable orifice, causing a restriction in the return circuit which increases lift pressure to the lift cylinders. The lift cylinders try to partially raise the implement transferring weight to the drive tires. When no optional equipment is installed, oil is returned to the oil cooler and sump.

When the optional auxiliary control valves are installed, the oil is routed from the steering valve to the optional auxiliary control valves and implement lift valve. From the optional auxiliary control valves, oil is then routed to the implement lift cylinders and is passed on to the oil cooler and sump.

Auxiliary Hydraulic Operation

Function:

To provide hydraulic fluid to optional equipment.

Theory of Operation:

There are two optional auxiliary valves added to the system in series before the implement lift valve (the last valve in the circuit):

- An optional single spool valve used for extra cylinder control.
- An optional double spool valve used with the MCS system to control both the dump and lift cylinders.

Oil from the steering valve is routed to the optional auxiliary valve and passed on to the implement lift valve. When the optional auxiliary control levers activate the auxiliary valves, oil from the auxiliary valves is passed to the auxiliary lift cylinders. From the auxiliary lift cylinders, returned oil is sent back to the oil cooler and sump.

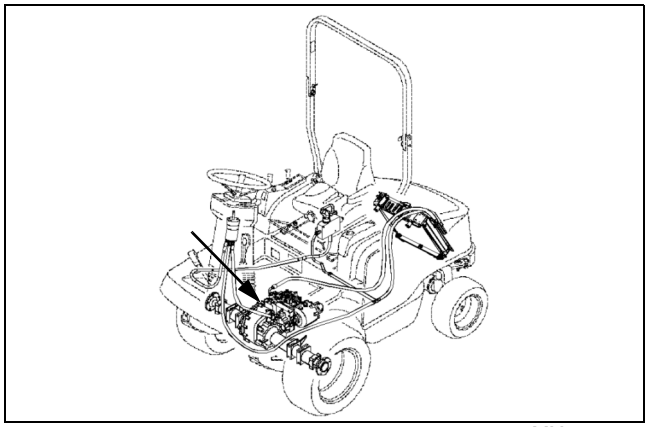
Lift System Diagnosis

Lift System Diagnosis: Test Procedure A

Test Conditions:

- Machine parked safely.
- Key switch to off position.
- Park brake locked.

System: Transaxle Oil

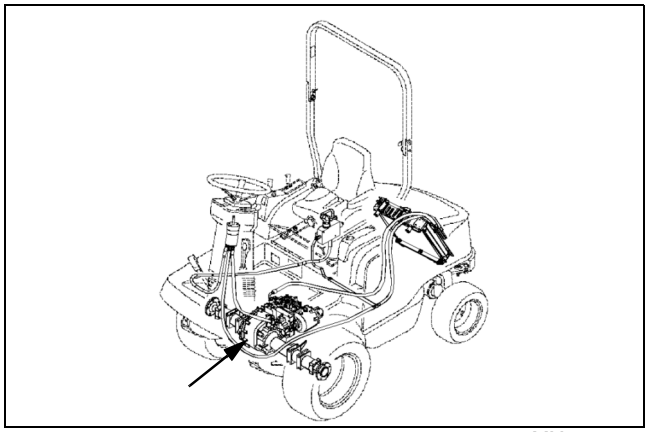


MX5488a

(1) Check hydraulic oil level in transaxle. Normal oil level?

Yes - Go to next step.

No - Fill transaxle to normal level with clean oil of correct specification.



MX5488a

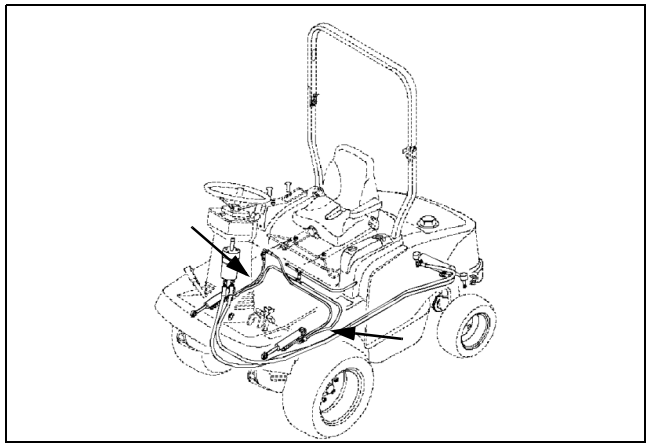
(2) Check hydraulic oil and system for air or contamination. Oil not contaminated?

Yes - Go to next step.

No - If air in hydraulic system, bleed hydraulic system.

System: Transaxle Oil

No - If contaminated, drain system and fill transaxle to proper level with oil meeting specifications. Replace oil filter.



MX5474a

(3) Check hydraulic hoses. Hoses have no sharp bends or restrictions?

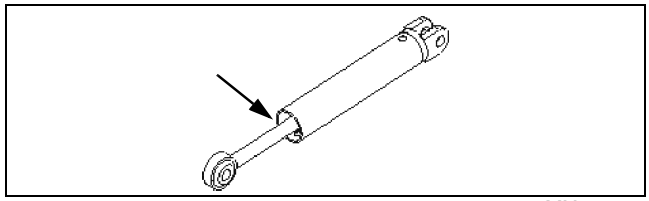
Yes - Go to next step.

No - If hoses have bends or restrictions, replace hose(s) with hoses of proper size.

No - If hoses are cracked or cut, replace hoses as needed with hoses of proper size.

No - If hoses are loose/leaking, tighten connections and/or replace O-rings as needed.

No - If hoses are chafed, pinched or damaged, replace hoses as needed. Route hoses in a manner to prevent rubbing, and/or away from moving parts or heat sources.



MX5529

(4) Check lift cylinder(s) condition. Lift cylinders not damaged or leaking?

Yes - Go to Test Procedure B.

No - Lift cylinders damaged or leaking. Replace lift cylinder(s) as needed.

NOTE: In order to properly diagnose the hydraulic system, it is important to verify that the hydraulic components and control function inputs and outputs

related to the hydraulic system are working properly before diagnosing hydraulic components.

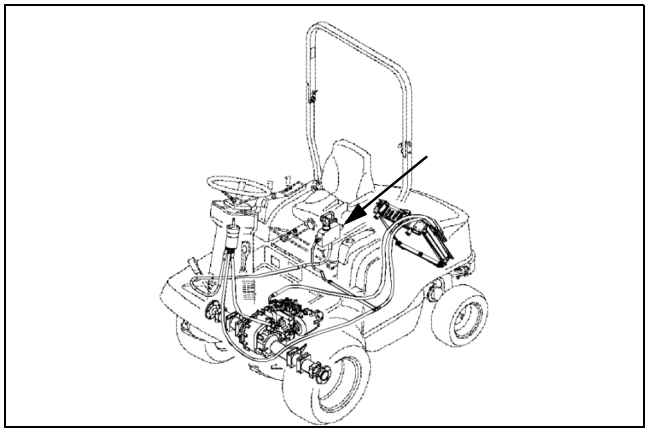
In many cases, the combination and sequences of activation of controls are critical to successful lift system activation. Follow the sequence listed in the test conditions to ensure correct activation.

Lift System Diagnosis: Test Procedure B

Test Conditions:

- Operator on seat.
- Engine running.
- Park brake locked.

System: Lift Cylinders

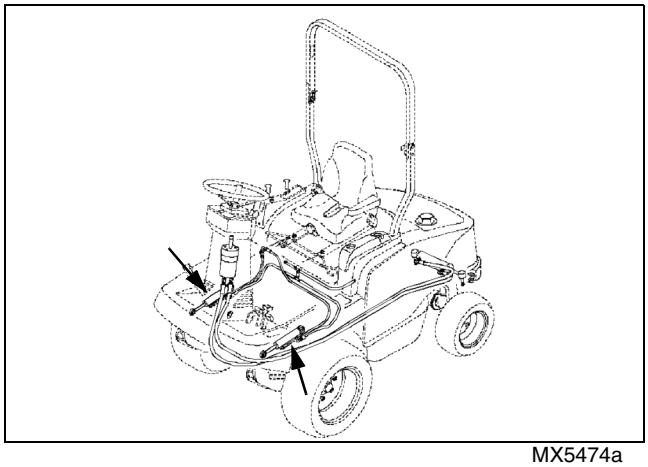


MX5488a

(1) Implement lift valve operates properly?

Yes - Go to next step.

No - Implement lift valve not operating properly. Replace implement lift valve.



MX5474a

(2) Lift cylinder(s) operate properly?

Yes - End test.

System: Lift Cylinders

No - Lift cylinder(s) not operating properly. Replace lift cylinder(s).

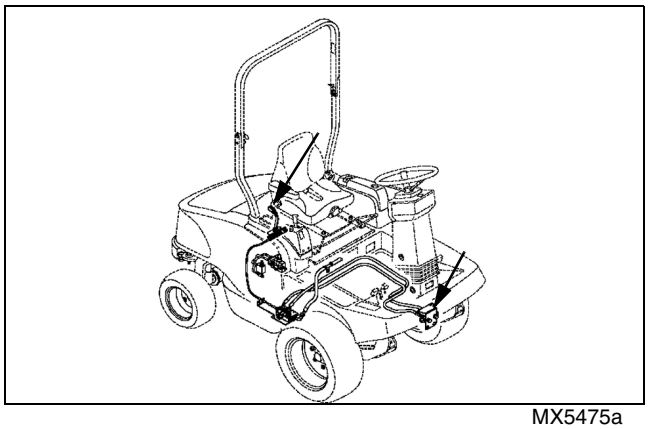
Auxiliary Hydraulic Diagnosis

Auxiliary Hydraulic Diagnosis: Test Procedure A

Test Conditions:

- Operator on seat.
- Engine running at high idle.
- Park brake unlocked.
- PTO switch in off position.
- Place control lever in raise position, then release lever.

System: Auxiliary Hydraulic Controls



MX5475a

(1) Control lever returns to neutral, and attachment raises and holds position without settling?

Yes - Go to Test Procedure B.

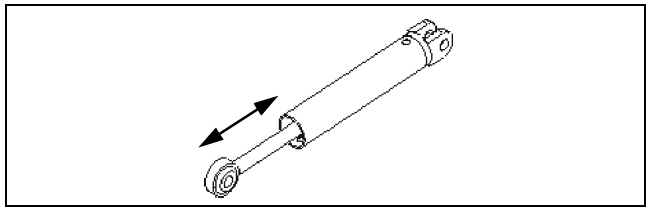
No - Lever does not return to neutral, or attachment does not raise and/or hold position without settling. Repair or replace auxiliary control valve.

Auxiliary Hydraulic Diagnosis: Test Procedure B

Test Conditions:

- Operator on seat.
- Engine running at high idle.
- Park brake unlocked.
- PTO switch in off position.
- Lower attachment to ground.
- Place control lever in float position, then release lever.

System: Auxiliary Hydraulic Controls



MX5529

(1) Auxiliary lift cylinders retract and extend freely?

Yes - Go to Test Procedure C.

No - Auxiliary lift cylinders do not retrace and extend freely. Repair or replace auxiliary control valve.

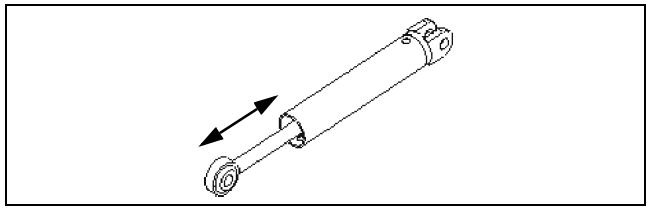
No - Auxiliary lift lever does not stay in float position. Repair or replace auxiliary control valve.

Auxiliary Hydraulic Diagnosis: Test Procedure C

Test Conditions:

- Operator on seat.
- Engine running at high idle.
- Park brake unlocked.
- PTO switch in off position.
- Lower attachment to ground.
- Pull and push auxiliary control lever (raise/lower) to cycle auxiliary lift cylinders.

System: Auxiliary Hydraulic Controls



MX5529

(1) Auxiliary lift cylinders retract and extend freely?

Yes - End test.

No - Auxiliary Lift Cylinders do not operate properly. Replace auxiliary lift cylinders.

Weight Transfer System Diagnosis

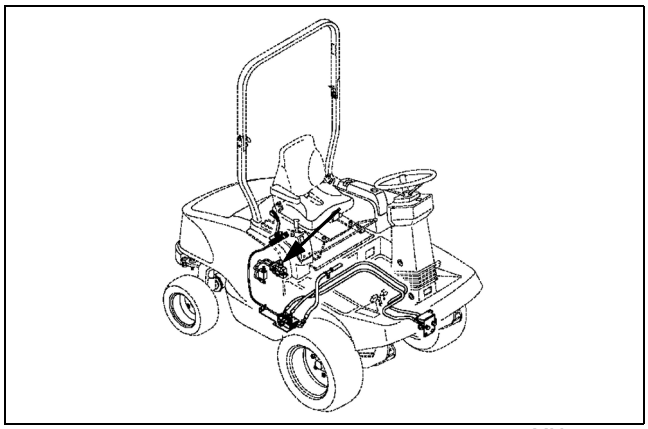
NOTE: Weight transfer valve is optional.

Weight Transfer System Diagnosis: Test Procedure A

Test Conditions:

- Operator on seat.
- Engine running.
- Park brake unlocked.
- PTO switch in off position.

System: Weight Transfer System



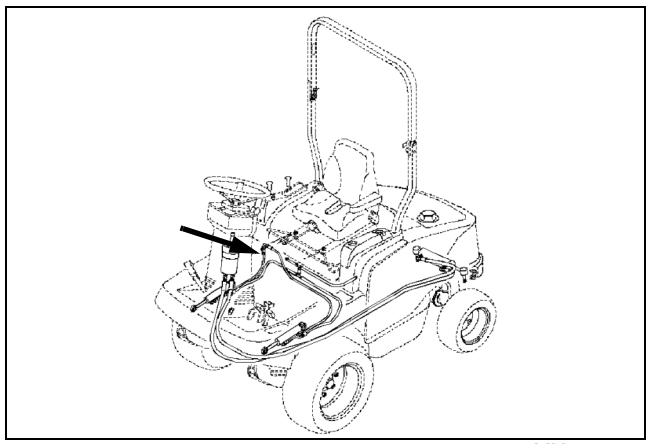
MX5475a

(1) Check hydraulic tubes and connections from implement lift valve to weight transfer valve. Tubes and connections not leaking or damaged?

Yes - Go to next step.

No - Tubes or connections leak or are damaged. Replace tubes and connections as needed.

System: Weight Transfer System



MX5474a

(2) Check hydraulic hoses from lift cylinders to weight transfer valve for leaks or damage. Hydraulic hoses not leaking or damaged?

Yes - Go to Test Procedure B.

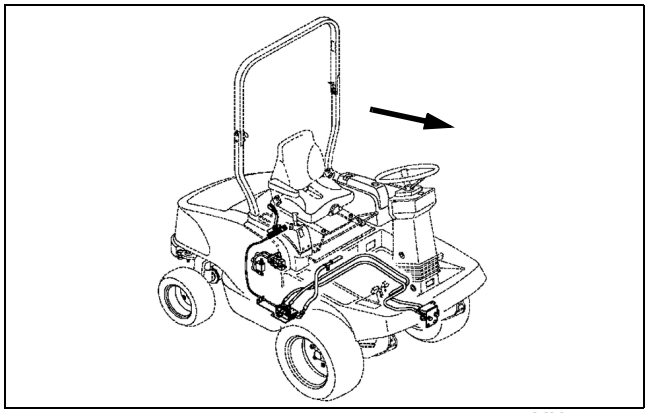
No - Hydraulic hoses leaking or damaged. Replace hoses as needed.

Weight Transfer System Diagnosis: Test Procedure B

Test Conditions:

- Operator on seat.
- Engine running.
- Park brake unlocked.
- PTO switch in off position.

System: Weight Transfer System



MX5475a

(1) Operate machine and attachments a short distance with implement lift valve in float position. Machine and attachment operating properly with no jerking motion or feel?

Yes - End test.

No - Machine and attachment has a jerking motion or feel. Replace weight transfer valve.

Tests and Adjustments

Hydraulic Oil Warm-Up Procedure

CAUTION: Avoid injury! Engine exhaust fumes can cause sickness or death.

If it is necessary to run an engine in an enclosed area, use an exhaust pipe extension to remove the fumes.

Reason:

To ensure that the hydraulic oil is at operating temperature, **49°C (120°F)**.

Equipment:

- JDG282 - Temperature Gauge.

Procedure:

1. Park machine safely.
2. **1400 Series:** Install JDG282 Temperature Gauge on charge pump-to-steering valve hose fitting.
3. **1500 Series:** Install JDG282 Temperature Gauge on hydraulic pump outlet.
4. Start and run engine at fast idle.

NOTE: Periodically cycle all hydraulic functions to distribute heated oil.

5. Run engine until oil temperature reaches **49°C (120°F)**.

Hydraulic System Bleeding Procedure

CAUTION: Avoid injury! Engine exhaust fumes can cause sickness or death.

If it is necessary to run an engine in an enclosed area, use an exhaust pipe extension to remove the fumes.

Reason:

To ensure that air is purged from the hydraulic system after the hydraulic hoses/lines have been disconnected.

Procedure:

1. Park machine safely.
2. Check level of hydraulic oil. Fill as needed.
3. Start engine and run at slow idle.
4. Turn steering wheel full left and hold for five seconds.
5. Turn steering wheel full right and hold for five seconds.
6. Cycle the implement lift cylinders up and down ten times.
7. Return steering wheel to the straight forward position.
8. Drive machine forward approximately 20 feet.
9. Drive machine in reverse approximately 10 feet.
10. Turn key switch to stop position.
11. Check all hoses and connections for leaks. Tighten connections and/or replace hoses as needed.
12. Check transaxle oil level. Add oil as needed.

Charge Pressure Relief Valve Test 1400 Series

CAUTION: Avoid injury! Engine exhaust fumes can cause sickness or death.

If it is necessary to run an engine in an enclosed area, use an exhaust pipe extension to remove the fumes.

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 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.

Reason:

To verify proper function of the charge pressure relief valve.

Special or Required Tools-1400 Series:

Tool Name	Tool No.	Tool Use
Hydraulic Test Hose	TCA13057	To connect to charge pump outlet.
Fitting	61H1161	To connect test hose to transaxle vent cap port.
Fitting w/ Male Quick Connect	JTO5479	To connect gauge to charge pump test port.
Gauge with Female Quick Coupler 0 - 7000 kPa (0 - 1000 psi)	JT05471	To obtain charge pump relieve pressure readings.

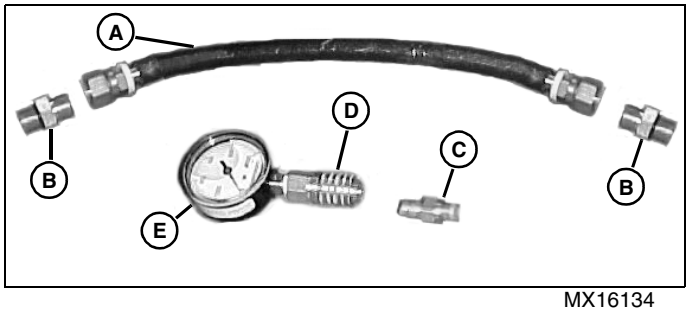
Test Conditions:

- Operator on seat.
- Hydraulic oil at operating temperature.
- Implements lowered to ground.
- Engine at slow idle.
- PTO switch off.

Procedure:

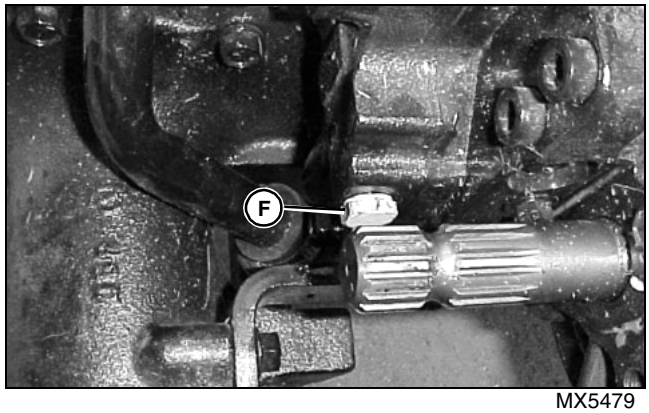
1. Park machine safely.
2. Turn key switch to off position.

NOTE: Thoroughly clean area around all hydraulic test connection points to eliminate possibility of contaminating internal parts during disassembly.



MX16134

3. Assemble fittings 61H1161 (B) to hydraulic test hose TCA13057 (A). Assemble fitting JTO5479 (C) to quick connect (D) on test gauge JT05471 (E).



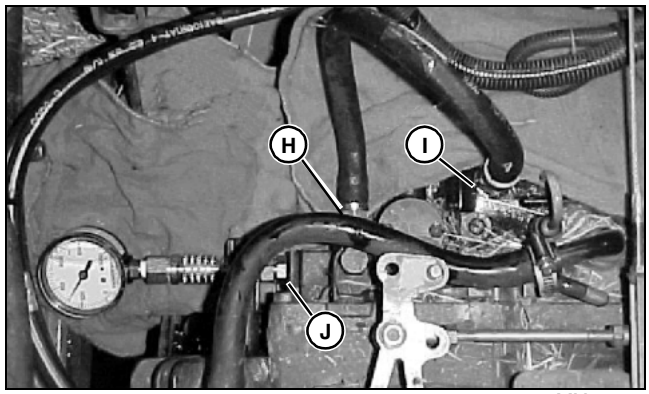
MX5479

4. **1400 Series:** Remove plug (F) on test port located on left side of charge pump.



MX5605

5. **1400 Series Only:** Disconnect steering valve hose (G) from charge pump outlet and place in oil pan.



MX5480

6. Connect test hose to charge pump outlet (H) and transaxle vented cap port (I).
7. **1400 Series:** Connect test gauge assembly to charge pump test port (J).
8. Tighten all fittings.
9. Start engine and run at fast idle.
10. Bring hydraulic oil to operating temperature.
11. Check gauge reading and record results.

12. Reduce engine to slow idle.

13. Check gauge reading and record results.

Results:

Charge Pressure
at Slow Idle . . . . . 2068 ± 206 kPa (300 ± 30 psi)

Charge Pressure
at Fast Idle. . . . . 2344 ± 206 kPa (340 ± 30 psi)

- If specifications are not met, replace charge pressure relief valve.

Charge Pressure Relief Valve Test 1500 Series

CAUTION: Avoid injury! Engine exhaust fumes can cause sickness or death.

If it is necessary to run an engine in an enclosed area, use an exhaust pipe extension to remove the fumes.

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 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.

Reason:

To verify proper function of the charge pressure relief valve.

Special or Required Tools-1500 Series:

Tool Name	Tool No.	Tool Use
Hydraulic Test Hose	JTO3017	To connect to charge pump outlet.
Fitting	JTO3349	To connect test hose to transaxle test port.
Gauge with Quick Coupler 0 - 2800 kPa (0 - 400 psi)	JT05584	To obtain charge pump relieve pressure readings.

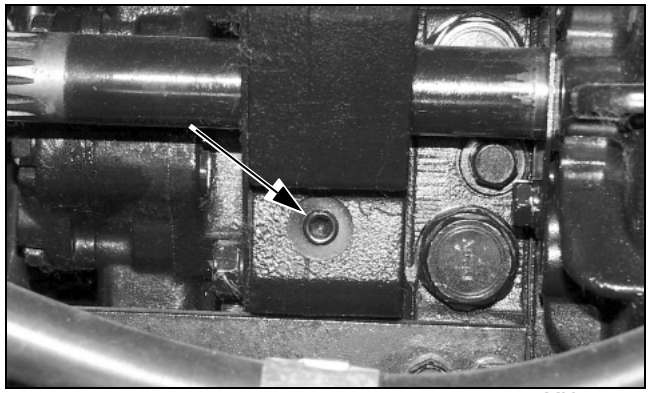
Test Conditions:

- Hydraulic oil at operating temperature.
- Implements lowered to ground.
- Engine at slow idle.
- PTO switch off.

Procedure:

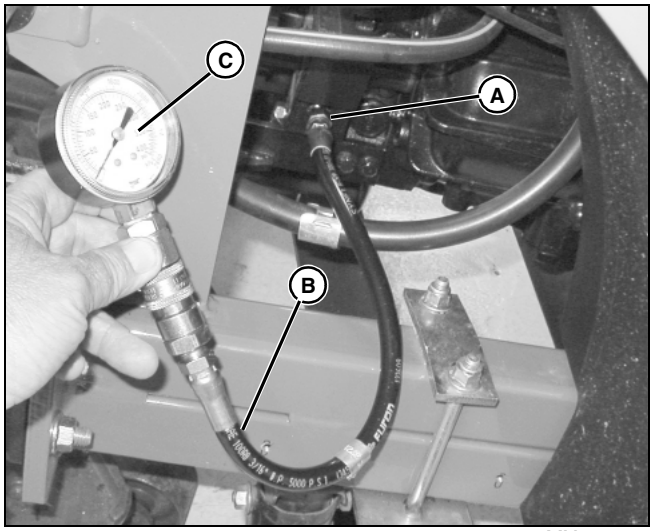
1. Park machine safely.
2. Turn key switch to off position.

NOTE: Thoroughly clean area around all hydraulic test connection points to eliminate possibility of contaminating internal parts during disassembly.



MX17163

3. Locate charge pressure test port plug on left side of transaxle just below PTO shaft. Remove plug.



MX17161

4. Install fitting JTO3349 (A) into transmission test port. Attach hydraulic test hose JTO3017 (B) and gauge (C).
5. Tighten all fittings.
6. Start engine and run at fast idle.
7. Bring hydraulic oil to operating temperature.
8. Check gauge reading and record results.
9. Reduce engine to slow idle.
10. Check gauge reading and record results.

Results:

Charge Pressure
at SLOW Idle . . . . . 1500 ± 150 kPa (218 ± 22 psi)

Charge Pressure
at FAST Idle . . . . . 1850 ± 150 kPa (268 ± 22 psi)

- If specifications are not met, replace charge pressure relief valve.

Charge Pump Flow Test (1400 Series Only)

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

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

CAUTION: Avoid injury! Engine exhaust fumes can cause sickness or death.

If it is necessary to run an engine in an enclosed area, use an exhaust pipe extension to remove the fumes.

CAUTION: Avoid injury! Help prevent serious injury. Use caution when performing this service procedure. Keep hands, feet and clothing away from rotating blades, pulleys and other components.

NOTE: Two persons are required to perform this test.

Reason:

To verify proper flow from the charge pump.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
In-Line Hydraulic Tester	D01169AA	Used to measure flow and pressure.
9/16-18 M 37° x 9/16-18 M ORB Fitting	JT03216	Used to connect hydraulic tester to machine.
9/16-18 M 37° x 9/16-18 F 37° SW 90° Elbow	JTO3341	Used to connect hydraulic tester to machine.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
9/16-18 F 37° x 3/4 F NPT Coupler	JT03342	Used to connect hydraulic tester to machine.
7/8-14 M 37° x 9/16-18 F ORB Adapter	JT03056	Used to connect hydraulic tester to machine.
7/8-14 F 37° x 3/4 F NPT Coupler	JT03385	Used to connect hydraulic tester to machine.

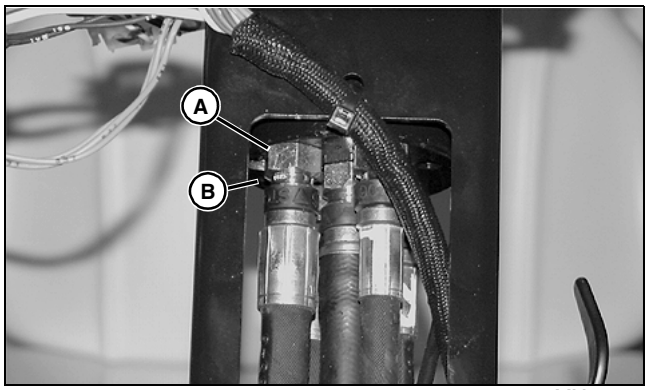
Test Conditions:

- Operator on seat
- Second person to operate in-line hydraulic tester
- Hydraulic oil at operating temperature
- Mower decks lowered to ground
- Engine at fast idle

Procedure:

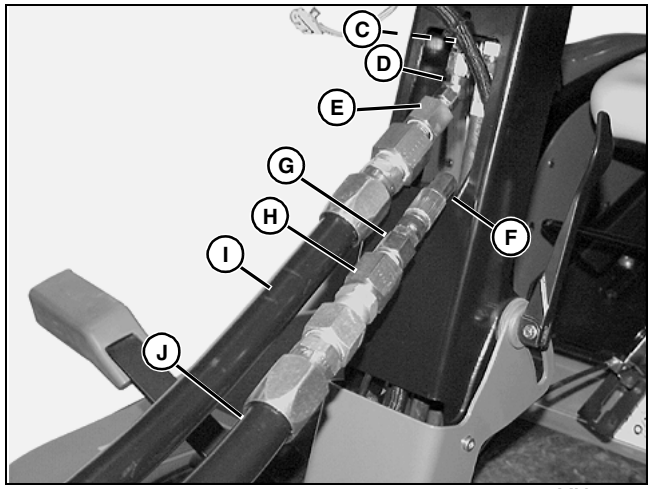
1. Park machine safely.
2. Lower mower decks to ground.
3. Turn key switch to stop position.
4. Remove steering wheel.
5. Remove steering column cover.

NOTE: Thoroughly clean area around all hydraulic test connection points to eliminate possibility of contaminating internal parts during disassembly.

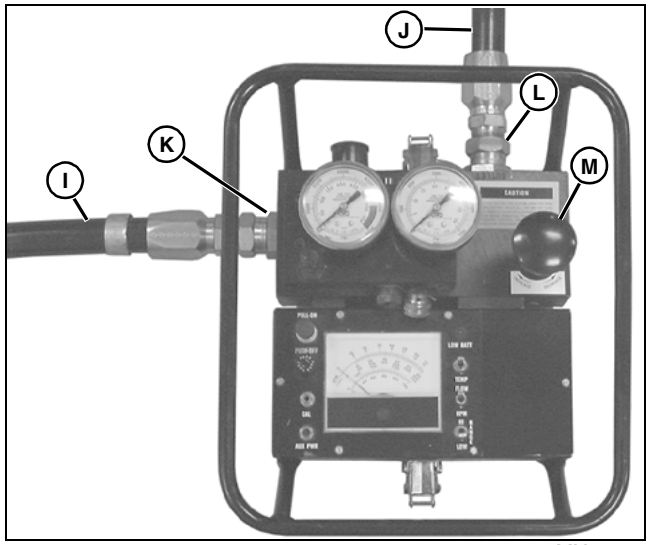


MX5497

6. Disconnect pressure hose (A) from steering valve (B).



MX5496



MX2645

7. Connect hydraulic test hose (I), JT03216 Fitting (C), JTO3341 90° elbow (D), and JT03342 Coupler (E) to EF port of steering valve.

8. Connect hydraulic test hose (J), JT03056 Adapter (G), and JT03385 Coupler (H) to steering valve-to-lift control valve hose (F).

9. Connect hydraulic test hose (I) to inlet (K) of D01169AA In-Line Hydraulic Tester.

10.Connect hydraulic test hose (J) to outlet (L) of in-line hydraulic tester.

11.Tighten all fittings.

NOTE: Make sure there is no load set on in-line hydraulic tester during warm-up procedure. Set load knob (13) all the way to decrease.

12.Start engine and bring hydraulic oil to operating temperature.

13.Perform bleed procedures to remove air from hydraulic system.

NOTE: Do not turn steering wheel during testing.

14.Run engine at fast idle.

15.Increase load by turning knob on in-line hydraulic tester clockwise to 1517 kPa (220 psi) and record test results.

16.Decrease load completely on in-line hydraulic tester.

Results:

New Charge Pump
Flow . . . . . 21.0 L/min@ 1517 kPa (5.6 gpm @ 220 psi)

Used Charge Pump
Flow . . . . . 19.0 L/min @ 1517 kPa (5.1 gpm @ 220 psi)

Minimum Charge Pump
Flow . . . . . 15.1 L/min @ 1517 Kpa (4.0 gpm @ 220 psi)

- If test is not within specification, rebuild or replace charge pump.

Hydraulic Pump Flow and Implement Relief Valve Test (1500 Series Only)

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

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

CAUTION: Avoid injury! Engine exhaust fumes can cause sickness or death.

If it is necessary to run an engine in an enclosed area, use an exhaust pipe extension to remove the fumes.

CAUTION: Avoid injury! Help prevent serious injury. Use caution when performing this service procedure. Keep hands, feet and clothing away from rotating blades, pulleys and other components.

Reason:

To verify proper flow from the hydraulic pump.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
In-Line Hydraulic Tester	D01169AA	Used to measure flow and pressure.
9/16-18 M 37° x 9/16-18 M ORB Fitting	JT03216	Used to connect hydraulic tester to machine.
9/16-18 M 37° x 9/16-18 F 37° SW 90° Elbow	JTO3341	Used to connect hydraulic tester to machine.
9/16-18 F 37° x 3/4 F NPT Coupler	JT03342	Used to connect hydraulic tester to machine.
7/8-14 M 37° x 9/16-18 F ORB Adapter	JT03056	Used to connect hydraulic tester to machine.
7/8-14 F 37° x 3/4 F NPT Coupler	JT03385	Used to connect hydraulic tester to machine.

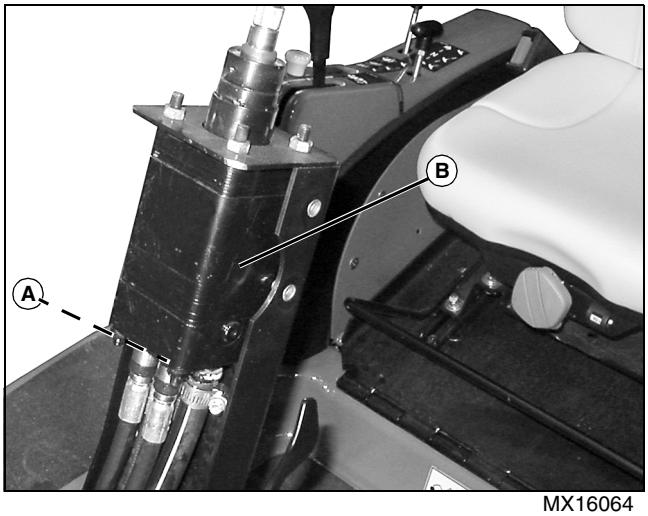
Test Conditions:

- Hydraulic oil at operating temperature
- High/low range selector in neutral position
- 4WD selector in 2WD position
- Mower decks lowered to ground
- Engine at fast idle

Procedure:

1. Park machine safely.
2. Lower mower decks to ground.
3. Turn key switch to stop position.
4. Remove steering wheel.
5. Remove steering column cover.

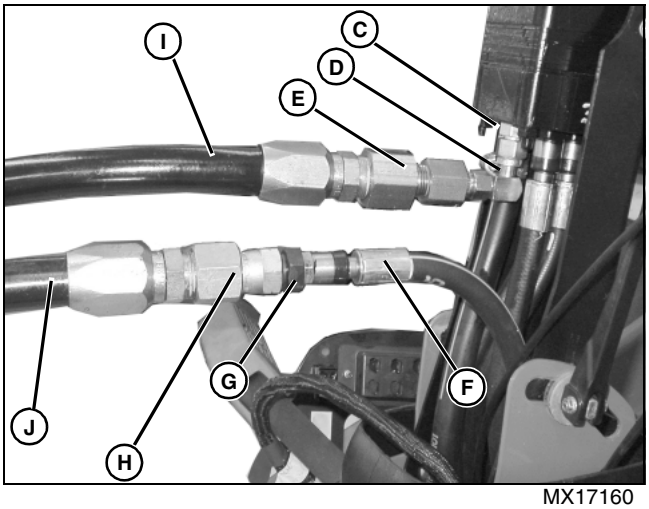
NOTE: Thoroughly clean area around all hydraulic test connection points to eliminate possibility of contaminating internal parts during disassembly.



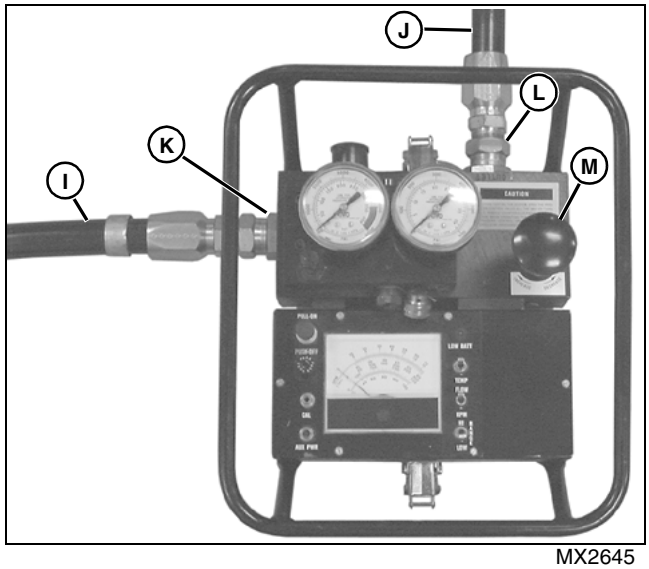
MX16064

Picture Note: Auxiliary port is marked AUX on fitting end of valve. There are two different positions in which the steering valve may have been installed. The nuts holding the valve may have to be removed and the valve rotated to access the AUX port.

6. Disconnect pressure hose (A) from auxiliary (aux) port of steering valve (B).



MX17160



MX2645

7. Connect hydraulic test hose (I), JT03216 Fitting (C), JTO 3341 90° fitting (D), and JT03342 Coupler (E) to AUX port of steering valve.

8. Connect hydraulic test hose (J), JT03056 Adapter (G), and JT03385 Coupler (H) to hose disconnected from AUX port (F).

9. Connect hydraulic test hose (I) to inlet (K) of D01169AA In-Line Hydraulic Tester.

10.Connect hydraulic test hose (J) to outlet (L) of in-line hydraulic tester.

11.Tighten all fittings.

NOTE: Make sure there is no load set on in-line hydraulic tester during warm-up procedure. Set load knob (13) all the way to decrease.

12.Start engine and bring hydraulic oil to operating temperature.

13.Perform bleed procedures to remove air from hydraulic system.

NOTE: Do not turn steering wheel during testing.

14.Run engine at fast idle.

15.Increase load by turning knob on in-line hydraulic tester clockwise to 2950 kPa (428 psi) and record test results.

16.Continue to increase load by turning knob on in-line hydraulic tester clockwise until flow stops. Record pressure reading.

17.Decrease load completely on in-line hydraulic tester.

Results:

Hydraulic Pump
Flow . . . . . 16.5 L/min@ 2950 kPa (4.3 gpm @ 428 psi)

Minimum Hydraulic Pump

Flow . . . . . 12.6 L/min @ 2950 kPa (3.3 gpm @ 428 psi)

Pressure at Zero Flow:

High idle . . . . . 11031 kPa (1600 psi)

Low idle . . . . . 9307 kPa (1350 psi)

- If test is not within specification, replace hydraulic pump.

PTO Solenoid Valve Check

Reason:

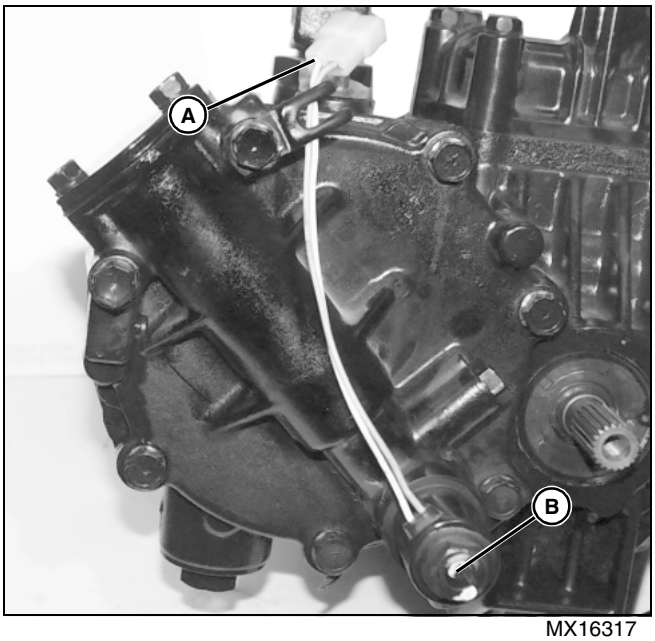
To determine if the PTO solenoid valve is mechanically functional.

Special or Required Tools

Tool Name	Tool No.	Tool Use
12-volt Power Supply or 12-volt Battery	NA	To check PTO solenoid valve engagement.
17 mm Wrench	NA	To remove end cap.
25 mm Wrench	NA	To remove solenoid stud.

Procedure:

1. Park machine safely.



MX16317

2. Disconnect PTO solenoid connector (A) from wiring harness.

3. Remove fastening nut (B) from solenoid stud.

4. Remove O-ring and magnet from solenoid stud.

NOTE: Rolled pin is inside solenoid stud.

5. Remove solenoid stud, inner spool, outer spool and spring from PTO housing.

6. Inspect parts for wear and damage. Replace as needed.

IMPORTANT: Avoid damage! Do not over-tighten solenoid stud or fastening nut or damage to the assembly may result. Tighten to specified torque only.

NOTE: Inner spool slides into slot of outer spool. Ensure there is tension between spring and inner spool after installing spool assembly into PTO housing.

7. Install spring, inner spool and outer spool in PTO housing.

8. Install new O-ring on solenoid stud.

9. Screw in solenoid stud and tighten to specifications. Do not over-tighten or stud threads may become stripped.

10. Install magnet and new O-ring onto solenoid stud.

11. Screw on fastening nut and tighten to specifications.

Torque Specifications:

Solenoid Stud . . . . 20.5 - 22.5 N•m (184.5 - 202.5 lb-in.)

Fastening Nut . . . . . 3.9 - 5.9 N•m (35.1 - 53.1 lb-in.)

PTO Relief Valve Test

CAUTION: Avoid injury! Engine exhaust fumes can cause sickness or death.

If it is necessary to run an engine in an enclosed area, use an exhaust pipe extension to remove the fumes.

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.

Reason:

To verify the proper function of PTO relief valve.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Fitting 1/8 Male NPT x 7/16-20 M 37°	JT05487	Used to connect test hose and gauge to test port.
Fitting 90° 7/16-20 F 37° Sw x 7/16-20 M 37°	JT05483	Used to connect JT05487 to test hose.
Hose with Male Quick Coupler	JT03017	Used to connect gauge to test port.
Gauge with Male Quick Coupler	JT05471	Used to obtain PTO relief valve pressure.

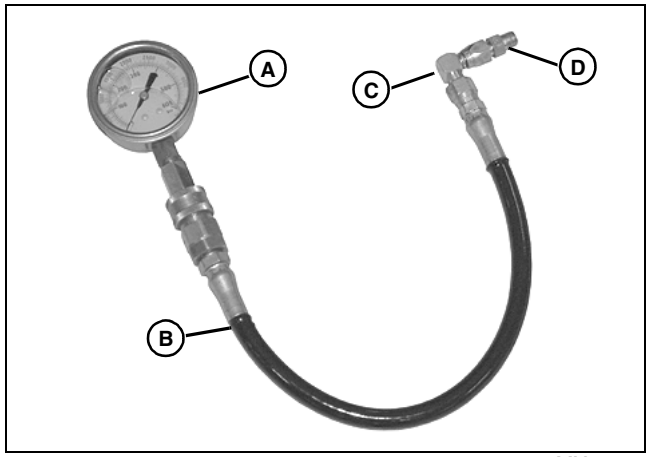
Test Conditions:

- Operator on seat.
- Park brake off.
- Implements lowered to ground.
- Engine at slow idle.
- PTO switch on.

Procedure:

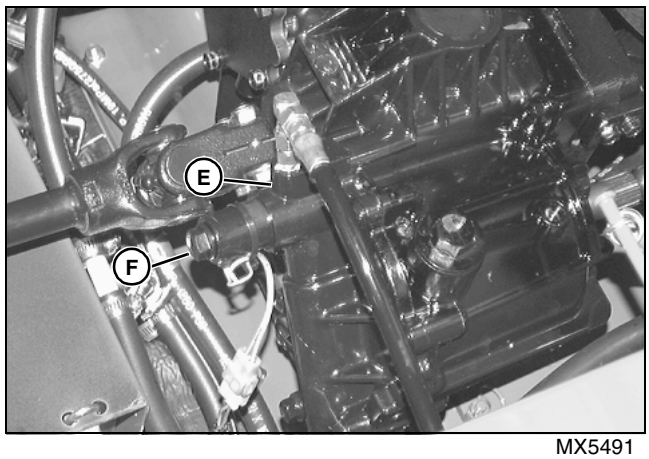
1. Park machine safely.
2. Turn key to off position.

NOTE: Thoroughly clean area around all hydraulic test connection points to eliminate possibility of contaminating internal parts during disassembly.



MX5492

3. Assemble fittings JT05483 (C) and JT05487 (D), hydraulic test hose JT03017 (B) and gauge JT05471 (A).



MX5491

4. Connect test gauge assembly to test port (E), located below PTO solenoid (F).
5. Tighten all fittings.
6. Start engine and run at fast idle.
7. Bring hydraulic oil to operating temperature.
8. Turn PTO on.
9. Check gauge reading and record results.
10. Reduce engine to slow idle.
11. Check gauge and record results.

Results:

PTO Relief Pressure
at Slow Idle . . . . . 1724 ± 206 kPa (250 ± 30 psi)

PTO Relief Pressure
at Fast Idle. . . . . 1930 ± 206 kPa (280 ± 30 psi)

- If specifications are not met, replace PTO relief valve.

Implement Relief Valve Test (1400 Series Only)

CAUTION: Avoid injury! Engine exhaust fumes can cause sickness or death.

If it is necessary to run an engine in an enclosed area, use an exhaust pipe extension to remove the fumes.

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

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

Reason:

To verify proper function of the implement relief valve.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Hydraulic Test Hose	TCA13057	To connect to charge pump outlet.
Fitting	61H1161	To connect test hose to transaxle vent cap port.
Fitting w/ Male Quick Connect	JTO5479	To connect gauge to charge pump test port.

Special or Required Tools:

Tool Name	Tool No.	Tool Use
Gauge with Female Quick Coupler 0 - 7000 kPa (0 - 1000 psi)	JT05471	To obtain implement relief valve pressure readings.

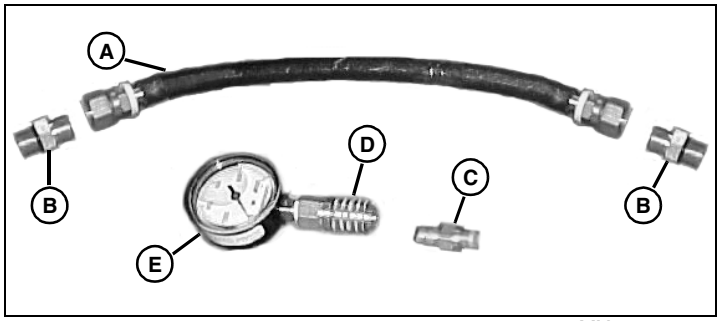
Test Conditions:

- Operator on seat.
- Hydraulic oil at operating temperature.
- Implements lowered to ground.
- Engine at slow idle.
- PTO switch off.

Procedure:

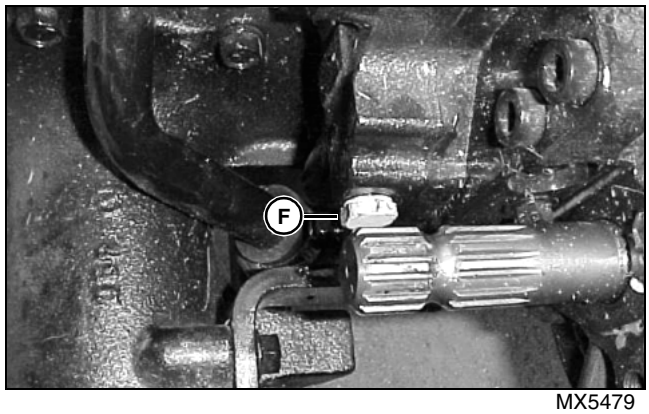
1. Park machine safely.
2. Turn key switch to off position.

NOTE: Thoroughly clean area around all hydraulic test connection points to eliminate possibility of contaminating internal parts during disassembly.



MX16134

3. Assemble fittings 61H1161 (B) to hydraulic test hose TCA13057 (A). Assemble fitting JTO5479 (C) to quick connect (D) on test gauge JT05471 (E).



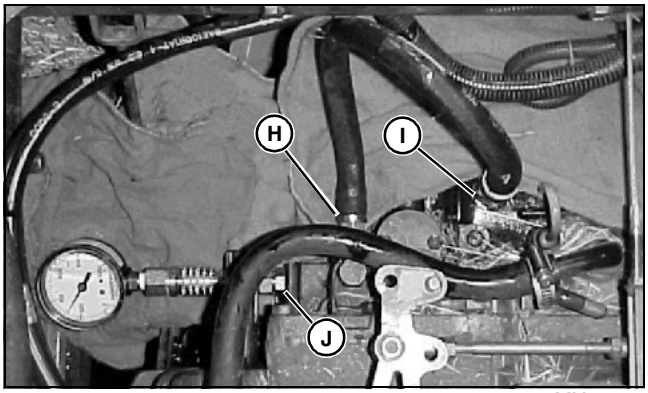
MX5479

4. Remove plug (F) from test port located on left side of charge pump.



MX5605

5. Disconnect steering valve hose (G) from charge pump outlet and place in oil pan.



MX5480

6. Connect test hose to charge pump outlet (H) and transaxle vented cap port (I).

7. Connect test gauge assembly to charge pump test port (J).

8. Tighten all fittings.

9. Start engine and run at fast idle.

10. Bring hydraulic oil to operating temperature.

11. Pull lift control lever back and hold.

12. Check gauge reading and record results.

13. Reduce engine to slow idle.

14. Check gauge reading and record results.

Results:

Implement Relief Pressure at Slow Idle . . . . . 5515 ± 500 kPa (800 ± 73 psi)

Implement Relief Pressure at Fast Idle. . . . . 6895 ± 500 kPa (1000 ± 73 psi)

- If specifications are not met, replace implement relief valve.

Repair

Oil Cooler Removal and Installation

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

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

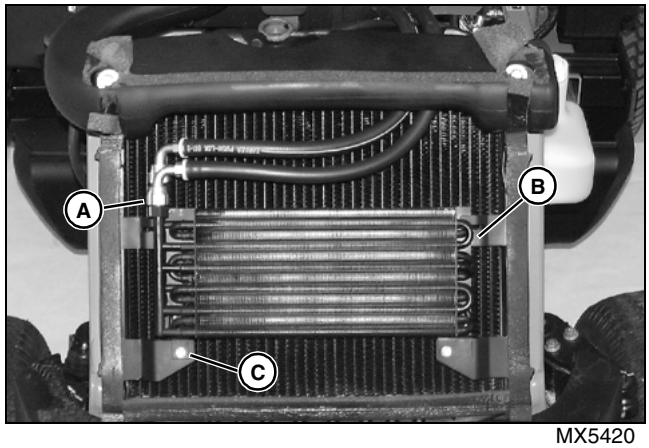
Removal:

1. Park machine safely.

2. Turn key switch to off position and allow machine to cool.

3. Slide hood back and remove from machine.

NOTE: Mark hose connections to ensure correct installation.



MX5420

4. Disconnect and cap hydraulic hoses (A).

5. Remove two cap screws and flange lock nuts (C).

6. Lift bottom of cooler (B) out and slide cooler from upper mounting tabs.

Installation:

- Installation is done in reverse order of removal.
- Fill transaxle to correct oil level.
- Check all connections for leaks. Repair or replace as needed.
- Bleed hydraulic system. (See “Hydraulic System Bleeding Procedure” on page 728)

Oil Cooler Inspection

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

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

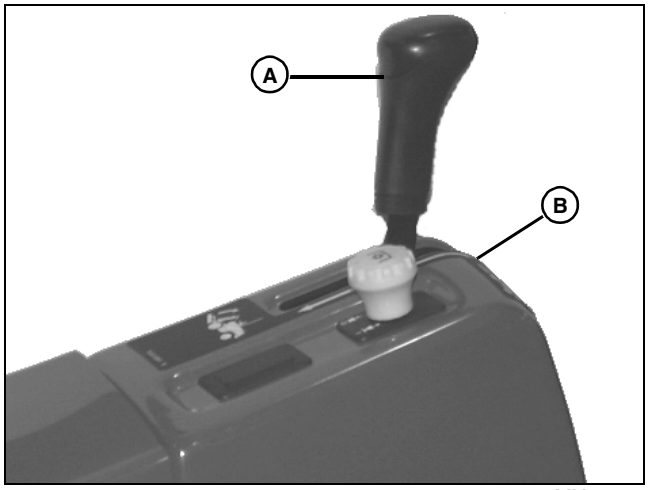
Inspection:

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

Lift Lever Removal and Installation

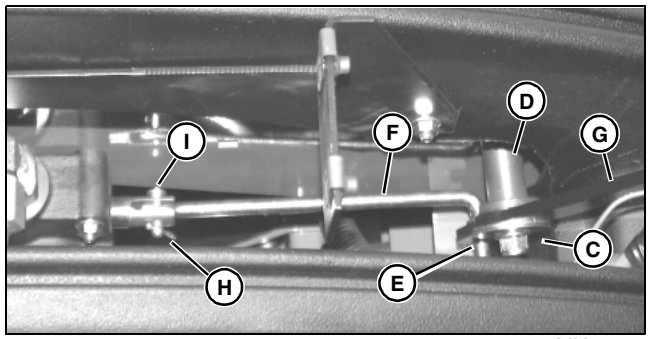
Removal:

1. Park machine safely.
2. Turn key switch to off position.



MX5476

3. Remove plastic cap, nut and knob (A) from lever.
4. Remove four screws from implement lift lever and PTO switch cover (B). Lift cover and disconnect PTO switch connector. Remove cover.



MX5487

5. Remove flange lock nut and flat washer (C), pivot and washer and carriage bolt (D) securing lever to bracket.
6. Remove cotter pin and washer (E) securing link (F) to lever.
7. Remove lever (G).
8. Remove cotter pin (H) on link end. Turn link and valve control to remove pin (I).
9. Remove link.
10. Inspect parts for wear or damage. Replace as needed.

Installation:

- Installation is done in the reverse order of removal.
- Lift lever and link should move freely.

Implement Lift Valve Removal and Installation

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

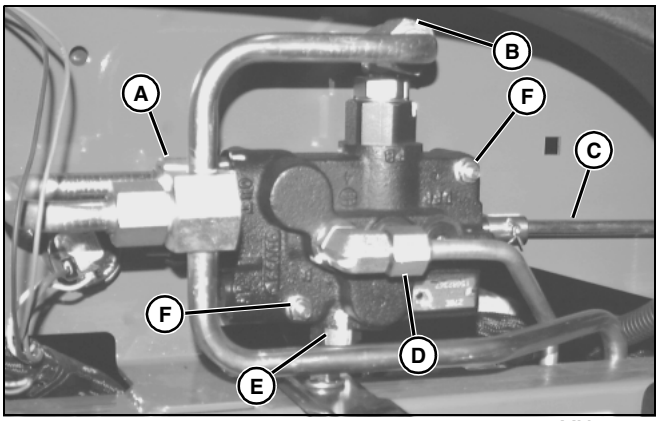
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical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

NOTE: This procedure is for machines without optional weight transfer valve. If the optional weight transfer valve is installed, removal and installation procedure is similar. Remove the control cable from weight control valve shaft and disconnect hydraulic lines.

Removal:

1. Disconnect battery negative (-) cable.
2. Remove engine cover.

NOTE: Mark all hydraulic lines and connection points before removing to ensure correct installation.



MX5484

Picture Note: Implement Lift Valve Without Optional Weight Transfer Valve

3. Disconnect link (C) from lift lever (see Implement Lift Lever Removal and Installation).
4. Disconnect lines (A - E). Close all openings using caps and plugs. Wipe up spills immediately.
5. Remove bolt and flange nuts (F) securing implement lift valve.
6. Remove implement lift valve from machine.
7. Inspect valve for leakage, wear, and damage.

Installation:

- Lubricate O-rings on fittings and adapters before installing.
- Connect all lines. Tighten fittings to specifications.
- Connect link.
- Install engine cover.
- Connect battery cable.
- Bleed hydraulic system. (See “Hydraulic System Bleeding Procedure” on page 728)
- Check hydraulic oil level. Add oil if necessary.

Specifications:

Implement Lift Valve
Fittings Torque . . . . . 47 N•m (416 lb-in.)

Implement Lift Valve Repair

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

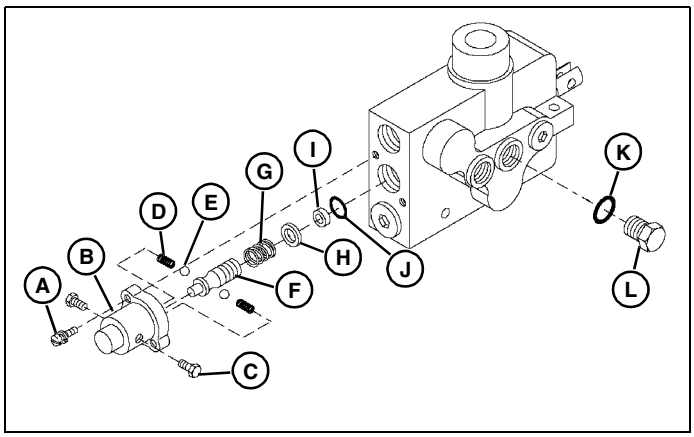
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical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

IMPORTANT: Avoid damage! Spools and housing are matched and must be replaced as a unit.

NOTE: Medium strength thread lock and sealer has been applied to threads of spool end screws.

Removal:

1. Disconnect battery negative (-) cable.
2. Remove implement lift valve. (See “Implement Lift Valve Removal and Installation” on page 739)



MX5534

A - Screw with Washer (2 used)
B - Cap
C - Detent Plug (2 used)
D - Spring (2 used)
E - Ball (2 used)

F - Detent Screw
G - Spring
H - Spacer
I - Washer
J - O-Ring
K - O-Ring
L - Plug

3. Remove parts (A - L).
4. Inspect parts for wear and damage.

Installation:

- Installation is done in the reverse order of removal.
- Lubricate and install new O-rings and seals.
- Apply grease to all springs.
- Apply thread lock and sealer to threads of all plugs and screws.
- Tighten all plugs and screws to specifications.
- Install implement lift valve, and connect all hoses and fittings.
- Connect lift lever link.
- Connect battery negative (-) cable.
- Bleed hydraulic system. (See “Hydraulic System Bleeding Procedure” on page 728)
- Check hydraulic oil level. Add oil if necessary.

Repair:

- Install new spool and housing assembly.
- Install new detent assembly.
- Install new check valve assembly.

Torque Specifications

Plugs (3) and screws	**3.5 N•m (30 lb-in.)**
Plug (12)	**24 N•m (215 lb-in.)**

Lift Cylinder Removal and Installation

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 using a piece of cardboard. Protect hands and body from high-pressure fluids.

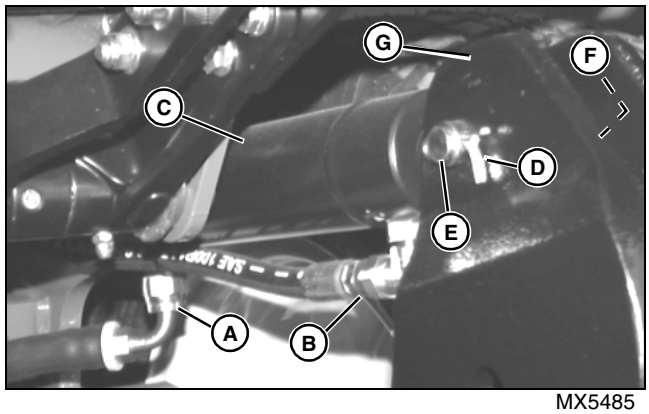
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical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

NOTE: Lift cylinders are not serviceable. A new cylinder must be installed.

Removal:

1. Park machine safely.
2. Turn key to off position.
3. Remove attachment.

NOTE: Removing drive wheel provides better access to lift cylinder.

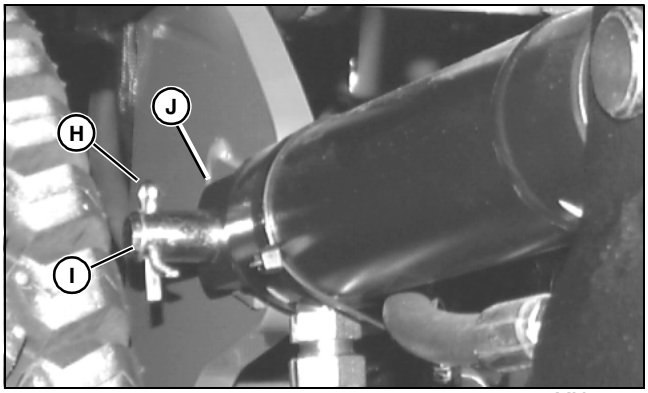


MX5485

4. Disconnect lift cylinder hoses (A - B) from lift cylinder (C). Close all openings using caps or plugs.

CAUTION: Avoid injury! Injury to hands and feet can occur when lift arm is released from lift cylinder ball joint. Avoid the hazard by supporting lift arm before releasing lift cylinder ball joint from lift arm.

5. Remove cotter pin (D) and pin (E) to separate lift cylinder ball joint (F) from lift arm (G).



MX5530

6. Remove cotter pin (H) and pin (I) securing lift cylinder base (J) to frame.

7. Remove lift cylinder from machine.

8. Inspect lift cylinder for leakage, wear or damage.

9. Replace lift cylinder as needed.

Installation:

NOTE: Raise and support lift arm before installing lift cylinder ball joint.

- Installation is done in the reverse order of removal.
- Lubricate O-rings on fittings and adapters before installing.
- Bleed hydraulic system. (See “Hydraulic System Bleeding Procedure” on page 728)
- Check hydraulic oil level. Add oil if needed.

Auxiliary Hydraulic Valve Repair

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

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

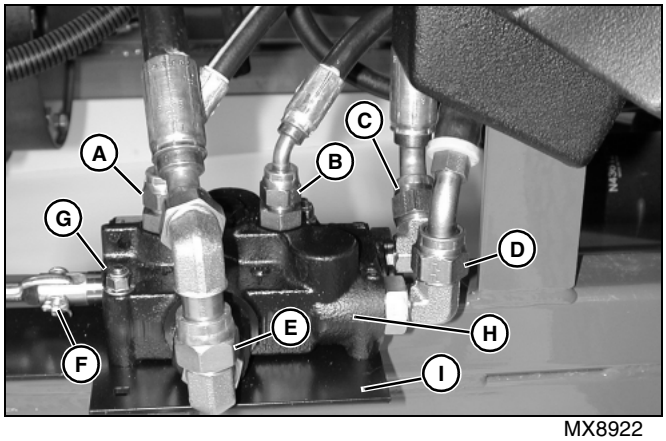
NOTE: Auxiliary hydraulic spool valves and housings are matched and must be replaced as a unit.

Medium strength thread lock and sealer has been applied to threads of spool end screws.

Removal:

1. Disconnect battery negative (-) cable.

NOTE: Optional double spool auxiliary hydraulic valve has two valve controls and four auxiliary inlet/outlet ports.



MX8922

2. Disconnect hydraulic hose connections (A - E). Close all openings using caps and plugs. Wipe up any spills immediately.

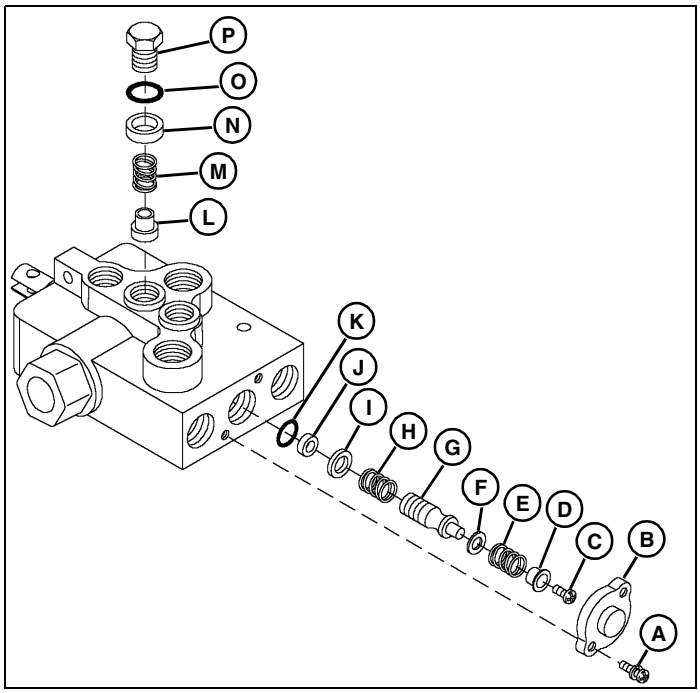
3. Remove cotter pin and pin from valve control (F).

4. Remove bolts and flange nuts (G).

5. Remove auxiliary hydraulic valve (H) from mounting bracket (I).

6. Inspect threads in ports for damage or wear.

Control Valve:



MX5606

A - Screw with Washer (2 used)
B - Cap
C - Screw
D - Bushing
E - Spring
F - Washer
G - Spool
H - Spring
I - Spacer
J - Washer
K - O-Ring
L - Poppet
M - Spring
N - Spacer
O - O-Ring
P - Plug

1. Remove parts (A - P).

2. Inspect parts for wear or damage.

Installation:

- Lubricate and install new O-rings on fittings and adapters.
- Apply thread lock and sealer to threads of all screws and plugs.
- Tighten all plugs and screws to specifications.
- Install auxiliary lift valve onto mounting bracket.
- Connect all hoses and tighten fittings.
- Connect lift lever link(s).
- Connect battery negative (-) cable.
- Bleed hydraulic system. (See “Hydraulic System Bleeding Procedure” on page 728)
- Check hydraulic oil level. Add oil if necessary.

Repair:

- If port threads are worn or damaged. Install new optional auxiliary valve assembly.
- If screw (C), bushing (D), spring (E) and washer (F) are worn or damaged. Replace as necessary.

Steering Cylinder

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 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.

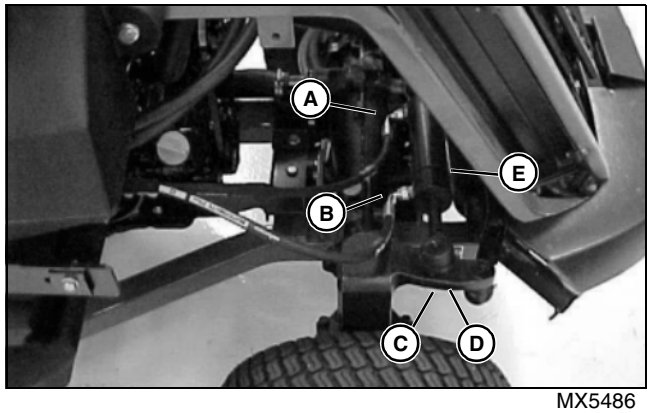
Removal:

1. Park machine safely.

2. Turn key switch to off position.

3. Turn steering wheel back and forth several times to relief hydraulic pressure from system.

NOTE: Mark hoses before removing to ensure correct installation.



MX5486

4. Disconnect and plug hoses (A) and (B).

5. Remove cotter pin (C) and castle nut (D) from steering cylinder.

6. Remove cotter pin and castle nut from other side of steering cylinder.

7. Separate steering cylinder from steering arm using a wedge-fork driver.

8. Remove steering cylinder (E).

Installation:

- Installation is done in the reverse order of removal.
- Tighten castle nuts to specifications.
- Check hydraulic oil level. Add oil as needed.
- Bleed air from hydraulic system.
- Check all connections for leaks. Replace as needed.

Specifications:

Steering Cylinder Castle Nuts Torque 75 N•m (55 lb-ft)

Hydraulic Pump

Removal:

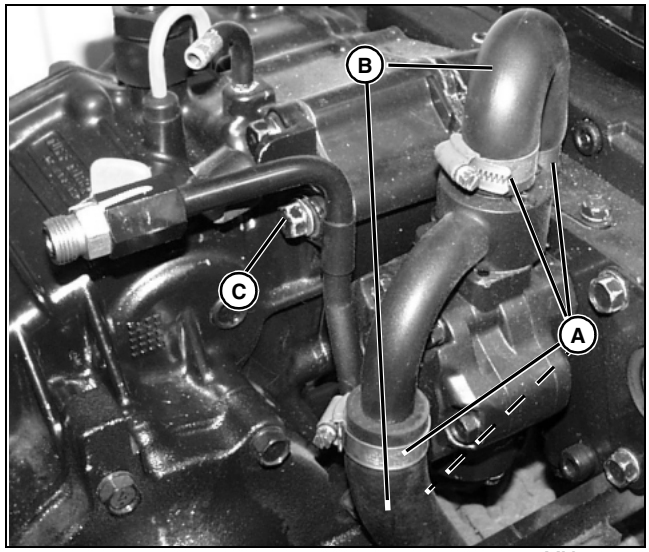
NOTE: You do not need to remove transaxle to repair hydraulic pump only. Hydraulic pump can be removed without disassembly of transaxle.

Transaxle is shown removed for clarity.

Use shop cloths or paper towels to catch and clean up any spilled oil immediately. Close all ports and lines using caps or plugs.

1. If transaxle is in unit, drain transaxle. (See Changing the Transaxle Oil and Filter in the operator's manual.)

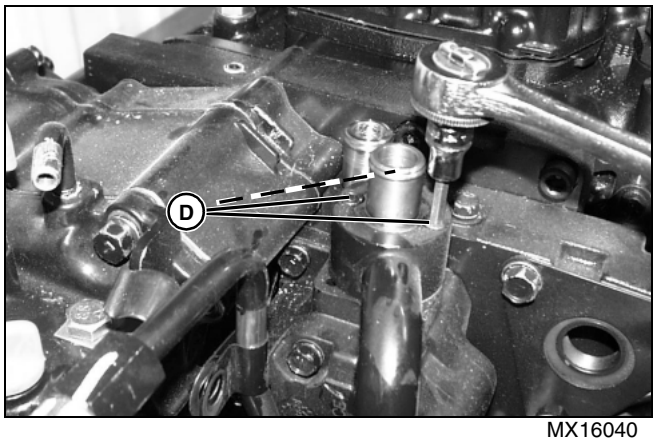
NOTE: Power steering hose will rotate at power steering valve.



MX16039

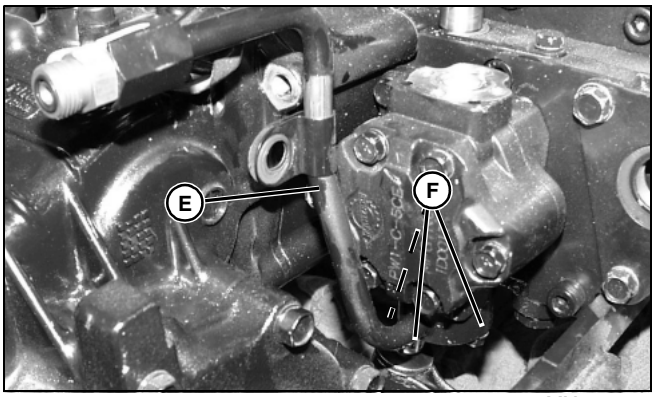
2. Loosen the four hose clamps (A) and remove the two hoses (B) from the intake manifold.

3. Remove bolt (C) holding the hydraulic line support bracket.



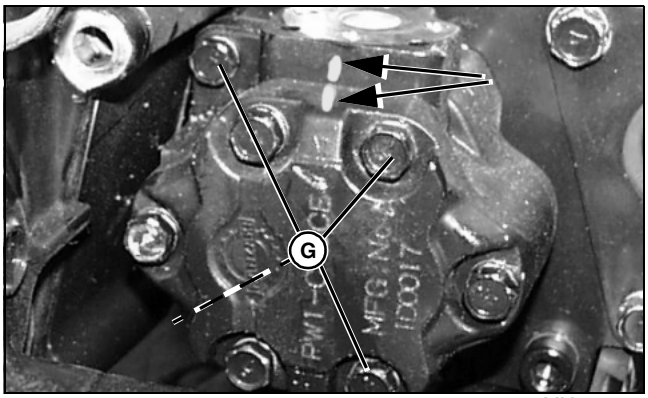
MX16040

4. Remove the three hex head screws (D) holding the intake manifold to the top of the hydraulic pump. Remove the manifold assembly.



MX16041

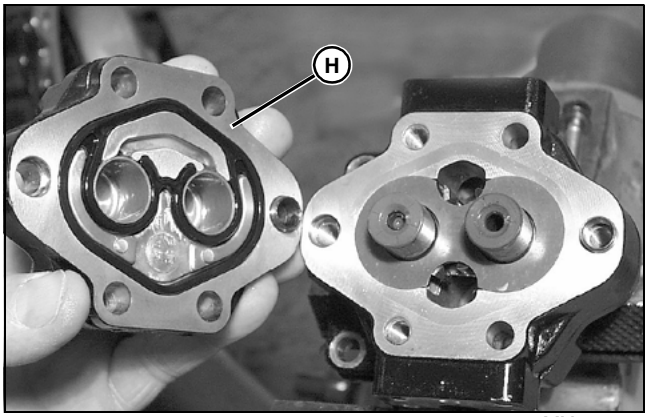
5. Remove the hydraulic line and pressure fitting (E) from the bottom of the hydraulic pump by removing the three capscrews (F).



MX16042

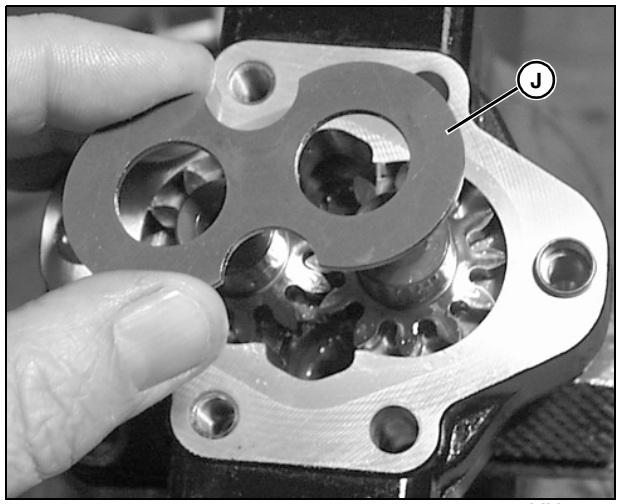
6. Mark cover and pump (arrows) for reassembly purposes. Remove four cap screws (G) that are marked in the photo, and remove the hydraulic pump. Do not remove the remaining four capscrews at this time, as the pump components could separate during removal.

Disassembly:



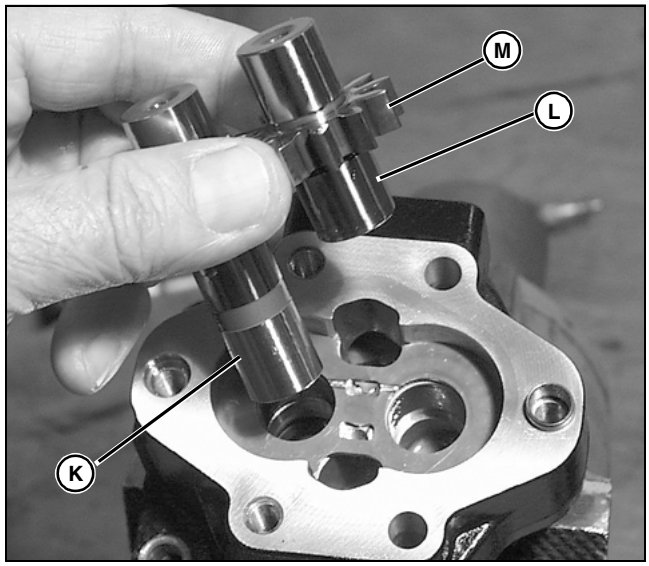
MX16053

1. Remove the four remaining pump body cap screws and separate the cover (H) from the body of the pump.



MX16054

2. Remove the front thrust plate (J) from the gears. Check the brass side (inside) for signs of damage such as gouging, scoring or pitting. Replace pump if damage or wear is evident.



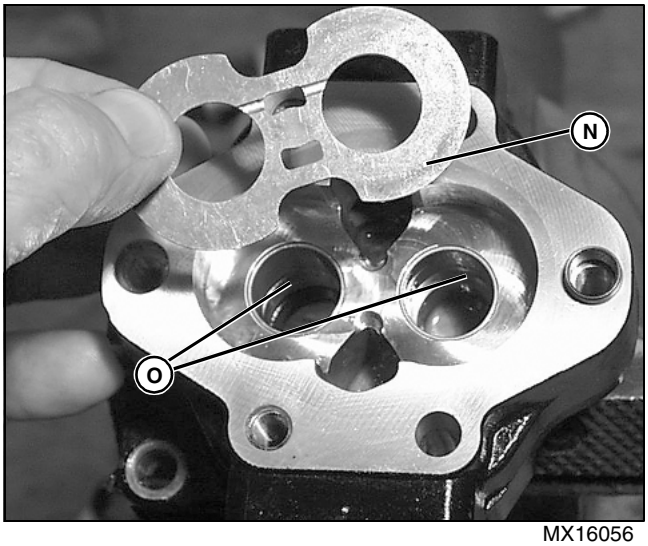
MX16055

3. Remove the pump drive gear (K) and idler gear (L) assemblies from the pump body noting the location of the gears.

4. Inspect gear faces (M) for wear such as chipping, pitting or spalling of the gear faces. Replace pump as required.

5. Inspect internal shaft splines on the drive gear. Replace pump if gear is worn or damaged.

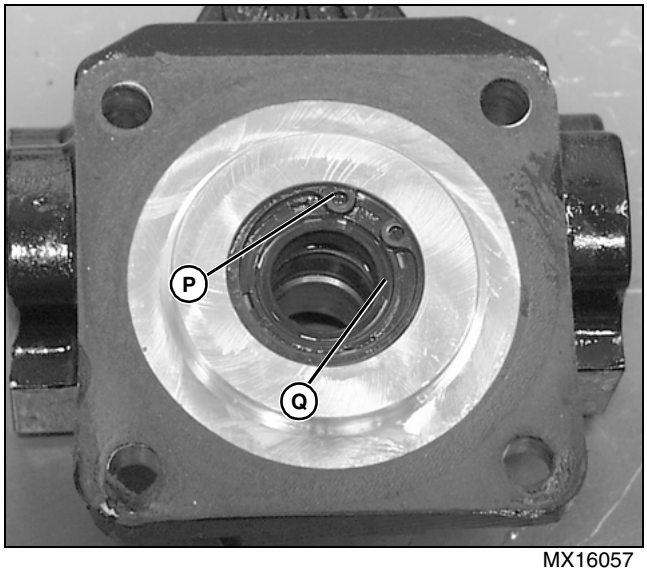
6. Measure the bearing surfaces on both the idler gear and drive gear. Replace pump if gears are worn below minimum specification.



MX16056

7. Remove the rear thrust plate (N) from the pump body. Check the brass side for wear or damage. Replace pump as required.

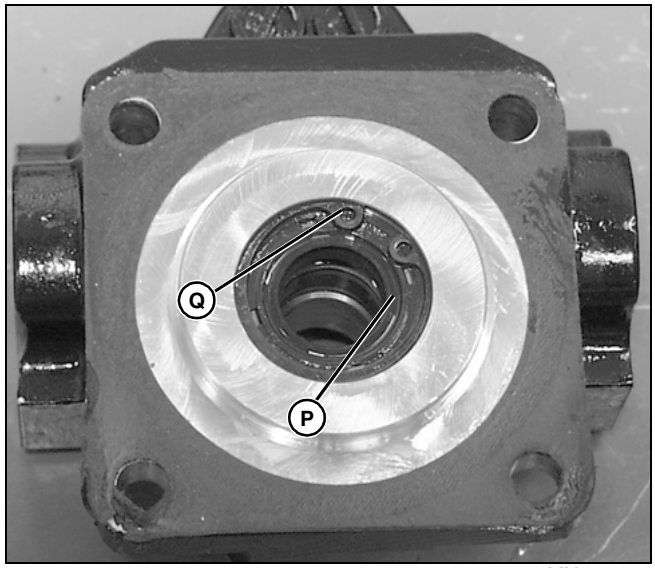
8. Inspect the bushing surfaces (O) in the pump body for wear or damage. Inspect the pump body internal surfaces for scoring, scratching or excessive wear. Replace pump if damaged.



MX16057

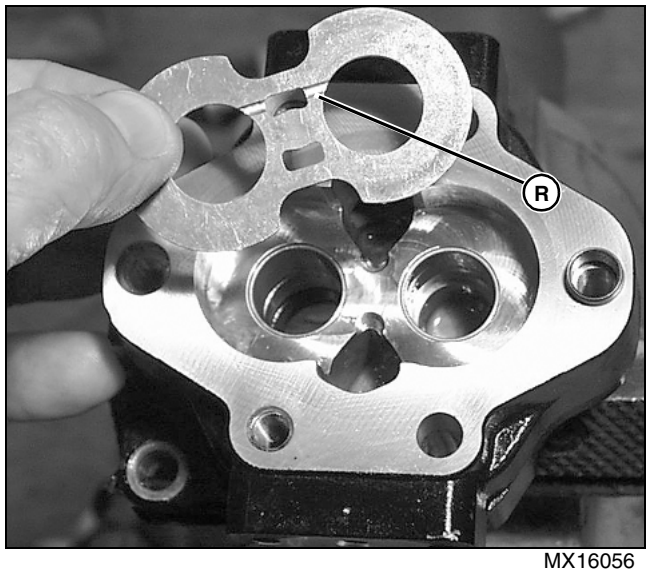
9. Remove the internal snap ring (P) and the seal (Q) from the pump body.

Assembly:



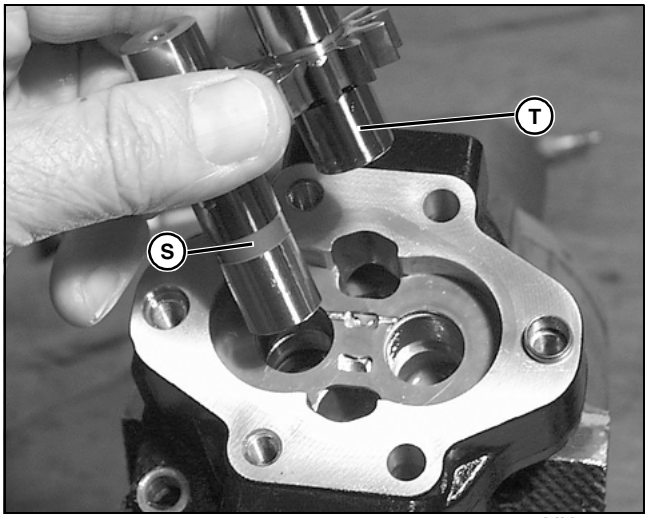
MX16057

1. Install a new seal (P) in the pump body and secure with internal snap ring (Q).



MX16056

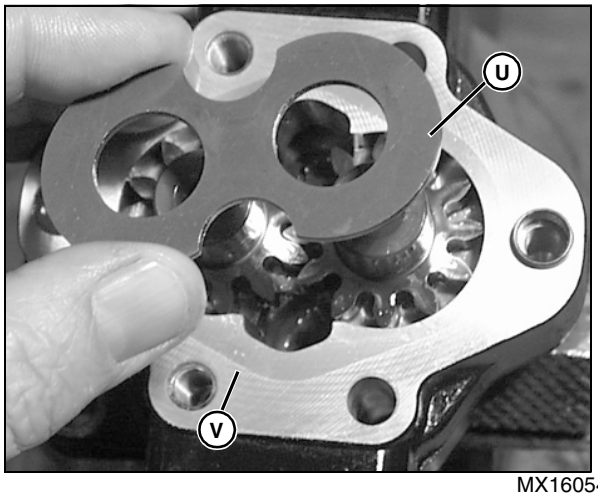
2. Install the rear thrust plate in the pump body with the brass side facing out (towards gear). Note that the lubrication groove (R) goes toward the top (intake side) of pump.



MX16055

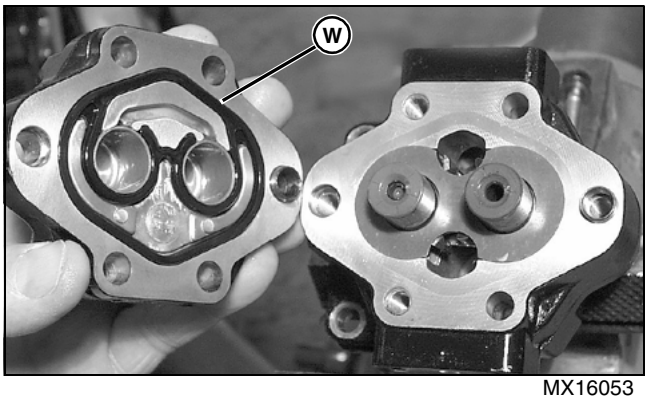
Picture Note: Idler gear (T) is symmetrical and can be placed in body either end first.

3. Install the pump drive gear (S) and idler gear (T) in the pump body.



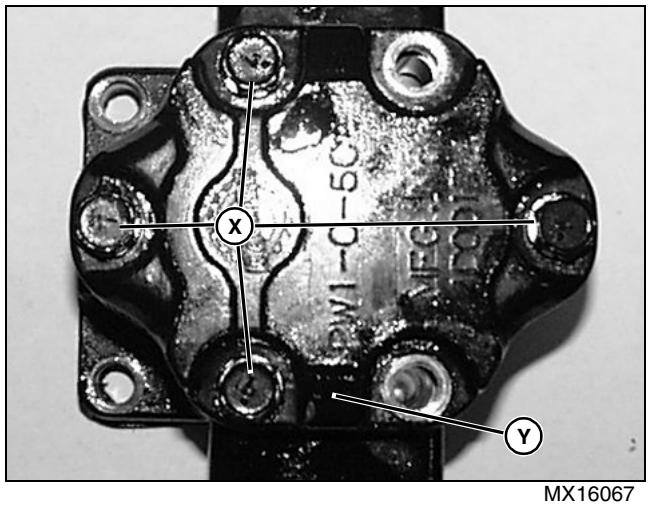
MX16054

4. Place front thrust plate (U) over shaft ends with the brass surface to the inside. Thrust plate should be flush with pump body gasket surface (V) when all components are installed correctly.



MX16053

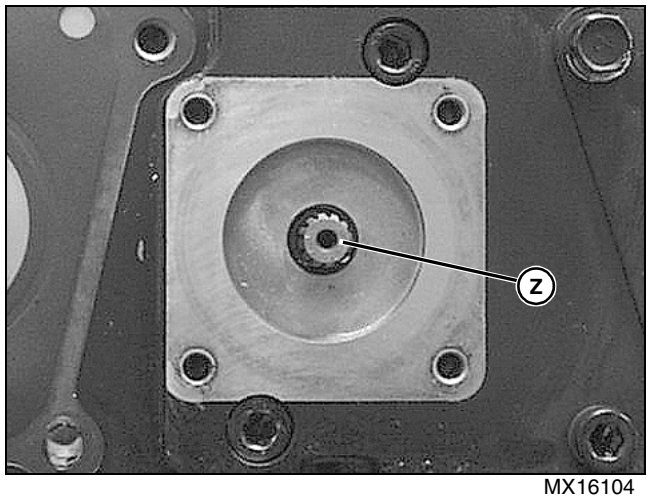
5. If removed, clean and install formed o-ring gasket (W) in the grooves on the front cover.



MX16067

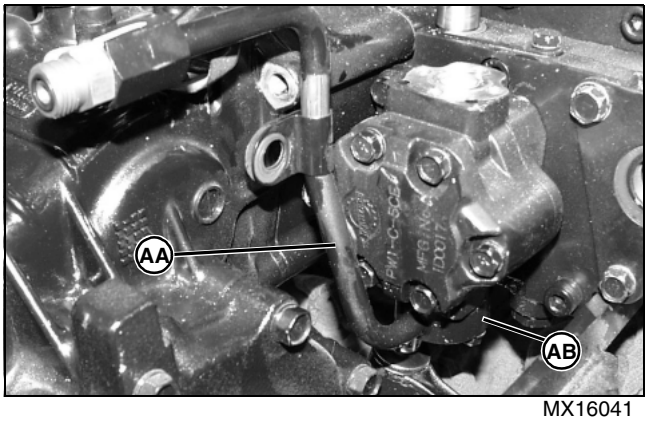
6. Install the front cover using four cap screws (X). Note that the cover has an out (Y) marking that must be oriented on the bottom (outlet side) of pump. Tighten cap screws to **15 N•m (113 lb-in.)**.

7. Install a new gasket on the hydraulic pump.



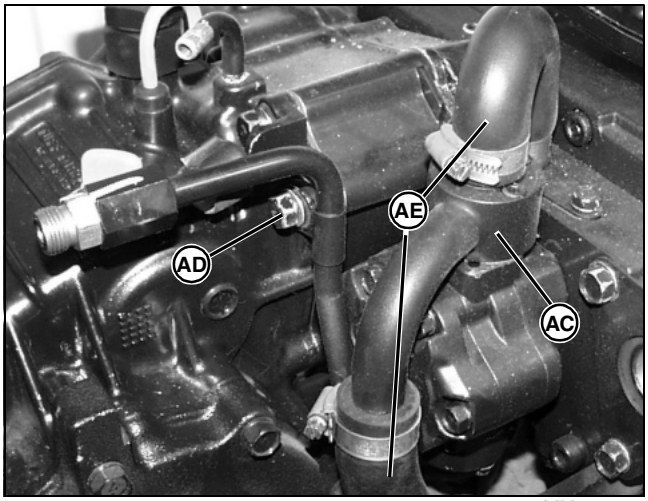
MX16104

8. Align the pump drive gear shaft internal splines with the splined shaft (Z) on the transaxle and install the hydraulic pump with the remaining four cap screws.



MX16041

9. Install the hydraulic line (AA) and pressure fitting (AB) to the bottom of the hydraulic pump with three capscrews.



MX16039

10.Install the intake manifold (AC) to the top of the pump with three hex head screws. Install the bolt (AD) that holds the hydraulic line support bracket and the two rubber hoses (AE). Secure hoses with screw clamps.)

11.If transaxle is mounted in the unit refill with oil. (See operator's manual.)

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Specifications

Test and Adjustment Specifications

60-Inch Mower Deck:

Discharge Type	Side
Cutting Height Range	25 - 152 mm (1 - 6 in.)
Weight	171.9 kg (379 lb)
Cutting Width	152.4 cm (60 in.)
Overall Width	186.7 cm (73.5 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	Rear
Cutting Height Range	25 - 152 mm (1 - 6 in.)
Weight	200 kg (442 lb)
Cutting Width	157.5 cm (62 in.)
Overall 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

72-Inch Mower Deck:

Discharge Type	Side
Cutting Height Range	25 - 152 mm (1 - 6 in.)
Weight	205 kg (452 lb)
Cutting Width	182.9 cm (72 in.)
Overall Width	218.4 cm (86 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.)

7-Iron V-Flex Deck:

Discharge Type	Side
Cutting Height Range With Rear Roller Kit	25 - 102 mm (1 - 4 in.)
Cutting Height Range With Rear Wheel Kit	25 - 127 mm (1 - 5 in.)
Weight With Rear Rollers	371 kg (820 lb)
Weight With Rear Wheels	317 kg (700 lb)
Cutting Width	182.9 cm (72 in.)

ATTACHMENTS SPECIFICATIONS

Overall Width	**218.4 cm (86 in.)**
Wing Flex Angle	**(±20 degrees)**
PTO Gearbox Capacity	**0.4 L (13.5 oz)**
Belt Tension Spring Length	**120 mm (4.75 in.)**
Blade Height	**6 mm (0.25 in.) Higher in Rear**

Tire Dimensions:

Caster Tires	**11 x 4-5**

Tire Inflation Pressures:

Machine Front Tires	**140 kPa (20 psi)**
Machine Rear Tires	**140 kPa (20 psi)**
Mower Deck Caster Tires	**152 kPa (22 psi)**

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.

Tightening Torques:

Front Caster Wheel Axles	**80 N•m (60 lb-ft)**
Blade Mounting Bolts	**122 N•m (90 lb-ft)**

60-Inch Heavy Duty Snowblower

Approximate Weight	**220.0 kg (480 lb)**
Width	**152.4 cm (60 in.)**
Height of Opening	**58.4 cm (23 in.)**
Auger Diameter	**40.6 cm (16 in.)**
Blower Diameter	**40.6 cm (16 in.)**
Auger Speed	**160 rpm**
Blower Speed	**800 rpm**
Lift System	**Two-Way Hydraulic Cylinder with Float and Lock-Up**

Chute Control	Hydraulic-Powered
Chute Rotation	200°

Repair Specifications

60-Inch Side Discharge Mower Decks:

Blade Edge	0.40 mm (0.016 in.)
Blade Cap Screw	122 N•m (90 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)
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)

62-Inch Rear Discharge Mower Decks:

Blade Edge	0.40 mm (0.016 in.)
Blade Cap Screw	122 N•m (90 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)

72-Inch Side Discharge Mower Decks:

Blade Edge	0.40 mm (0.016 in.)
Blade Cap Screw	122 N•m (90 lb-ft)
Sheave Lock Nut (4 used)	24 ± 4 N•m (18 ± 4 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)
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)
PTO Gear Box to Frame Support Bushing Lock Nut and Cap Screw	70 ± 17.5 N•m (52 ± 17.5 lb-ft)

7-Iron V-Flex Side Discharge Mower Decks:

Blade Edge	0.40 mm (0.016 in.)
Blade Cap Screw	122 N•m (90 lb-ft)
Sheave Lock Nut (4 used)	24 ± 4 N•m (18 ± 4 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)
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)
PTO Gear Box to Frame Support Bushing Lock Nut and Cap Screw	70 ± 17.5 N•m (52 ± 17.5 lb-ft)

Diagnostics

60, 62 and 72-Inch Mower Deck Diagnosis

Special or Required Tools:

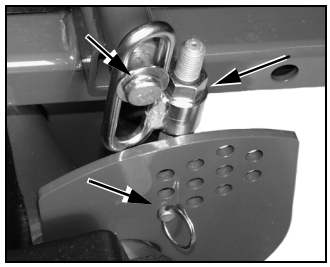
Tool Name	Tool No.	Tool Use
Leveling Gauge	AM130907	To check blade level.

Test Procedure A

Test Conditions:

- Machine parked safely.
- PTO disengaged.

System: Mower Deck Linkage



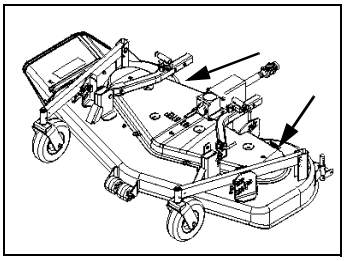
MX7027

(1) Is the mounting hardware in place and secure?

Yes - Go to the next step.

No - Tighten or replace hardware.

System: Mower Deck Level



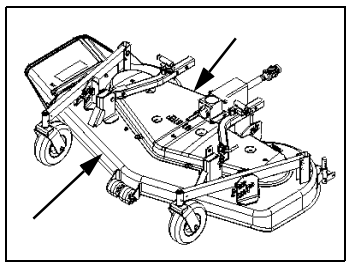
MX5729

(1) Is mower deck level side-to-side?

Yes - Go to step.

No - Adjust as needed. (See “Mower Deck Level Check and Adjustment”.)

System: Mower Deck Level



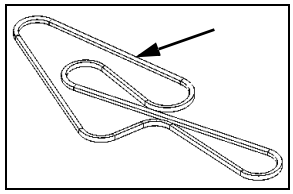
MX5729

(2) Is mower deck level front-to-back?

Yes - Go to next step.

No - Adjust as needed. (See “Mower Deck Level Check and Adjustment”.)

System: Mower Deck Drive Belt

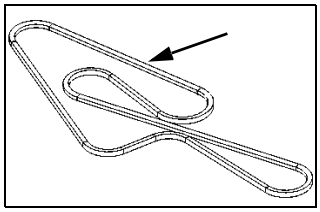


MX5727

(1) Is the drive belt and sheaves free of debris?

Yes - Go to next step.

No - Remove belt shields and remove debris.

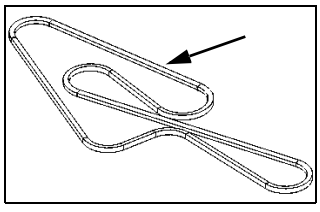


MX5727

(2) Is the correct belt installed?

Yes - Go to the next step.

No - Replace belt.



MX5727

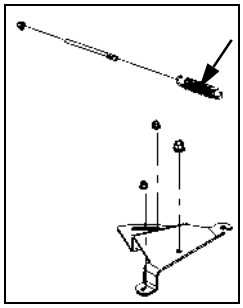
(3) Is the drive belt damaged, worn, stretched or broken?

Yes - Replace belt if necessary.

System: Mower Deck Drive Belt

No - Go to the next step.

System: Mower Drive Belt Tension Spring



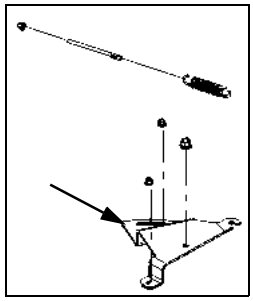
MX5728

(1) Is the tension spring damaged, worn or weak?

Yes - Replace spring.

No - Go to the next step.

System: Drive Belt Adjustment Arm



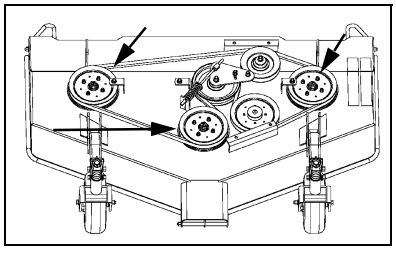
MX5728

(1) Is the adjustment arm binding or damaged?

Yes - Repair as needed.

No - Go to the next step.

System: Spindle Sheave



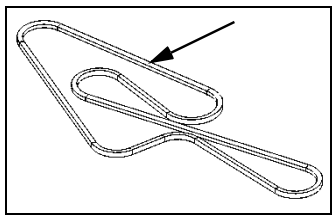
MX2425

(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.

System: Spindle Sheave



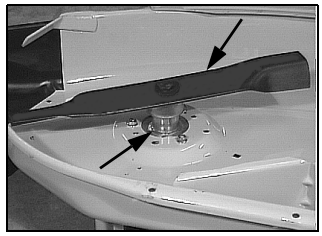
MX5727

(2) Is the belt off sheave?

Yes - Install or replace belt.

No - Go to the next step.

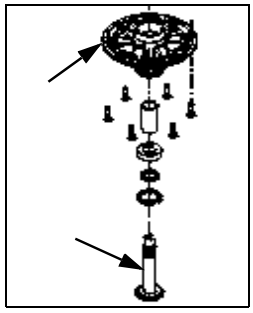
System: Spindle and Housing



(1) Is there material wrapped around spindle or blade?

Yes - Remove material.

No - Go to the next step.



MX5730

(2) Is the spindle and housing properly lubricated?

Yes - Go to the next step.

No - Apply specific grease to lube fittings at top of spindle.

System: Spindle and Housing



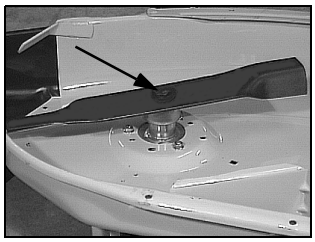
MX2380

(3) Do bearings not rotate freely or are worn or damaged?

Yes - Repair or replace spindles as needed.

No - Go to the next step.

System: Mower Blades

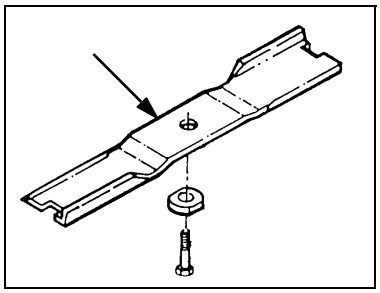


M89081

(1) Are blades tight on spindle?

Yes - Go to the next step.

No - Tighten blade cap screw.



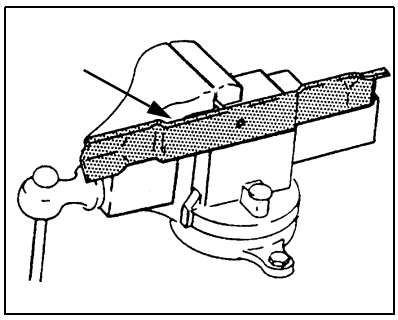
M82898A

(2) Are the blades bent, worn or damaged?

Yes - Replace blades.

No - Go to the next step.

System: Mower Blades



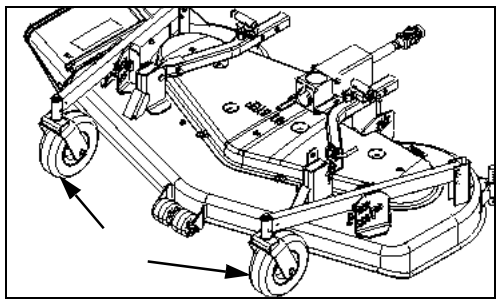
M61524

(3) Are the blades properly sharpened and balanced?

Yes - Go to the next step.

No - Sharpen and balance blades.

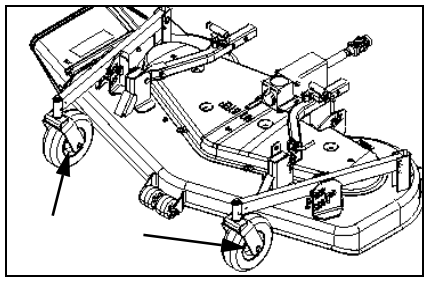
System: Caster Wheels



(1) Are the tires properly inflated?

Yes - Go to the next step.

No - Inflate tires to specification.



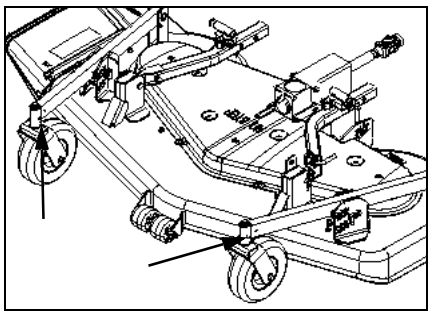
MX5729

(2) Are the wheels properly lubricated?

Yes - Go to the next step.

No - Apply specific grease to wheel lubrication fitting.

System: Caster Wheel Yoke Assemblies

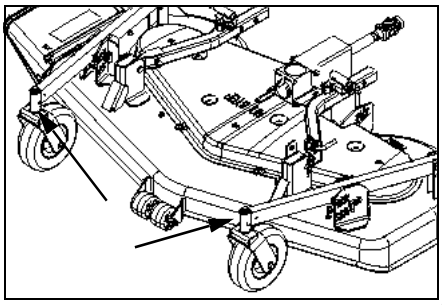


MX5729

(1) Are the caster wheel yoke assemblies properly lubricated?

Yes - Go to the next step.

No - Apply specified grease to pivot lubrication fittings



MX5729

(2) Do the assemblies rotate freely and are the bearings not worn or damaged?

Yes - Done

No - Replace bearings as needed.

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.

System: Engine



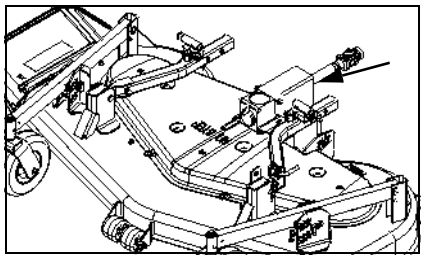
MX5446

(1) Is the engine running at the correct RPM.

Yes - Go to the next step.

No - Check engine operation.

System: Mower Deck PTO Shaft

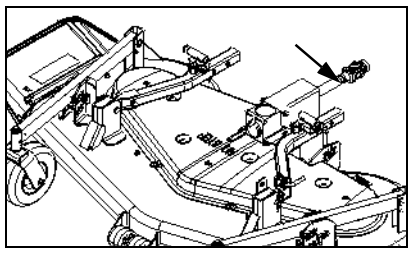


MX5729

(1) Is the PTO shaft 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.



MX5729

(2) Does PTO stop quickly?

Yes - End test.

No - Inspect and repair PTO brake (See “PTO Disassembly, Inspection and Assembly”.)

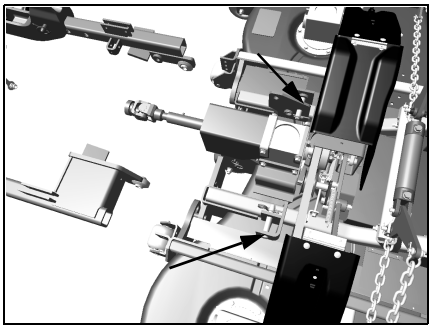
7-Iron V-Flex Deck

Test Procedure A

Test Conditions:

- Machine parked safely.
- PTO disengaged.

System: Mower Deck Linkage

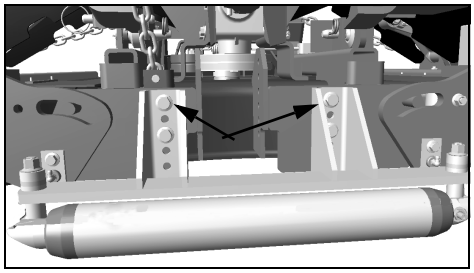


(1) Is the mounting hardware in place and secure?

Yes - Go to the next step.

No - Tighten or replace hardware.

System: Mower Deck Level

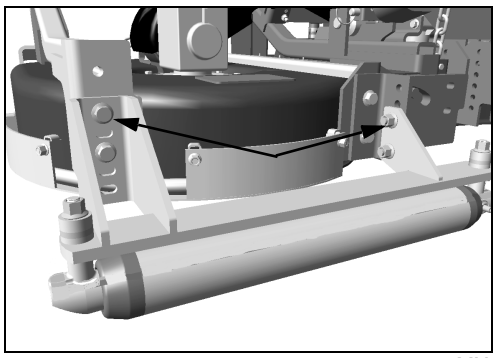


(1) Is there uneven cut?

Yes - Go to step.

No - Adjust level or Height Of Cut as needed. (See “Mower Deck Level Check and Adjustment”.)

System: Mower Deck Level



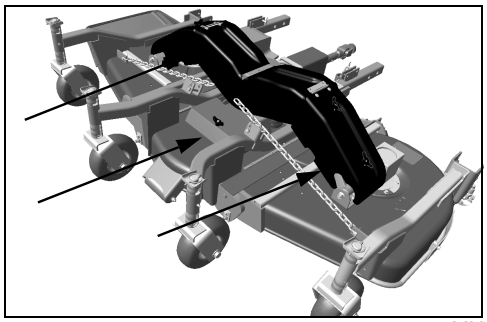
MX17309

(2) Does mower deck load down machine?

Yes - Cutting height set too low, adjust as needed.

No - Go to the next step.

System: Mower Deck Drive Belt

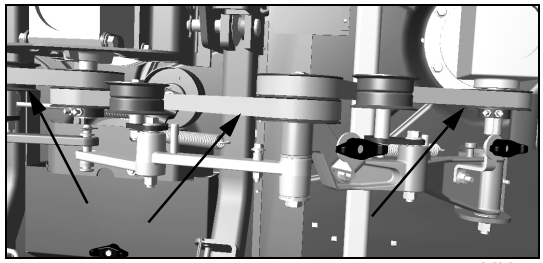


MX17287

(1) Is the drive belt and sheaves free of debris?

Yes - Go to next step.

No - Remove belt shields and remove debris.



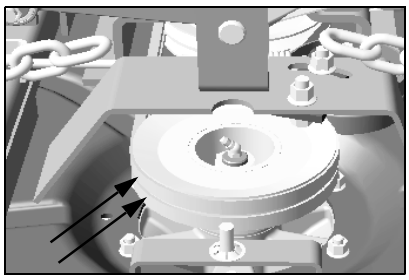
MX19103

(2) Is the correct belt installed?

Yes - Go to the next step.

No - Replace belt.

System: Mower Deck Drive Belt

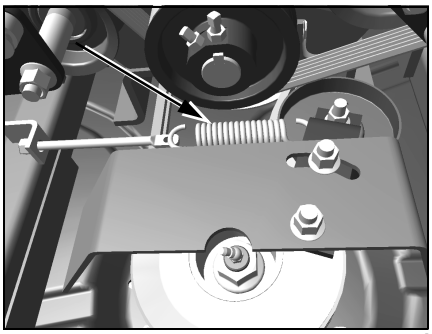


MX17292

(3) Is the drive belt damaged, worn, stretched or broken?

Yes - Replace belt if necessary.

No - Go to the next step.



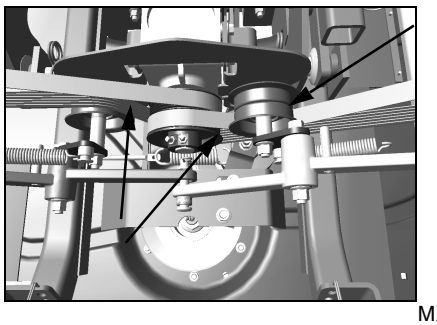
MX17294

(4) Does the belt slip?

Yes - Check belt tension, debris in sheaves or worn belt.

No - Go to the next step.

System: Vertical Drive Belts



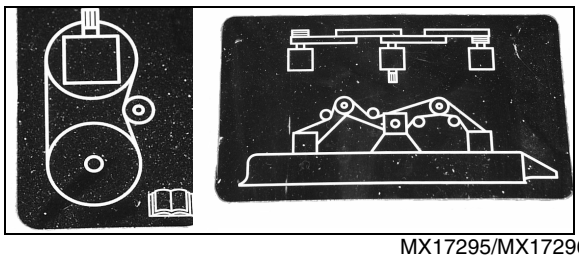
MX19105

(1) Are the sheaves and belts free of debris?

Yes - Go to the next step.

No - Remove belt shields and remove debris.

System: Vertical Drive Belts

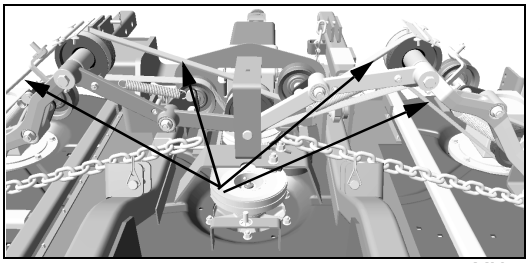


MX17295/MX17296

(2) Are the belts installed correctly?

Yes - Go to the next step.

No - Install belts according to procedures.



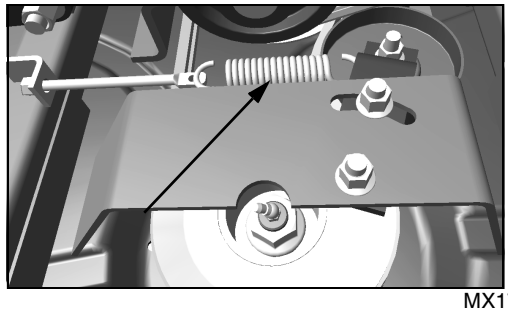
MX17292

(3) Are the vertical drive belts damaged, worn, stretched or broken?

Yes - Replace belts.

No - Go to the next step

System: Mower Drive Belt Tension Spring



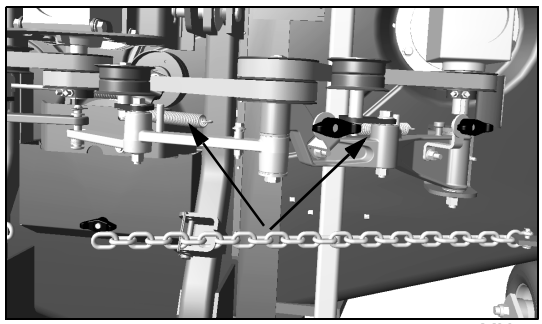
MX17294

(1) Is the tension spring damaged, worn or weak?

Yes - Replace spring.

No - Go to the next step.

System: Vertical Drive Belt Tension Springs



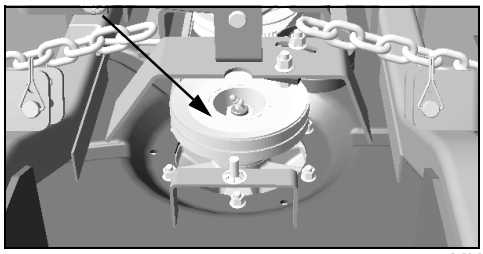
MX19103

(1) Is the tension spring damaged, worn or weak?

Yes - Replace spring.

No - Go to the next step.

System: Spindle Sheave

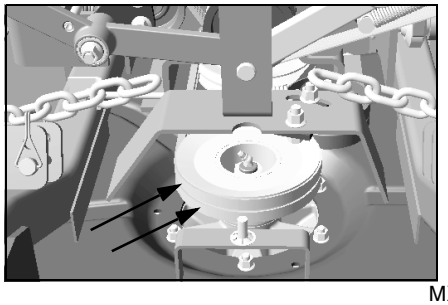


MX17292

(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.



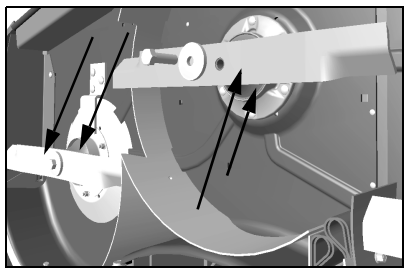
MX17292

(2) Is a belt off sheave?

Yes - Install or replace belt.

No - Go to the next step.

System: Spindle and Housing

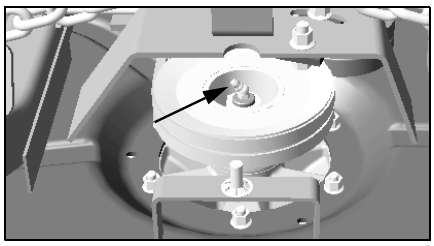


MX17288

(1) Is there material wrapped around spindle or blade?

Yes - Remove material.

No - Go to the next step.

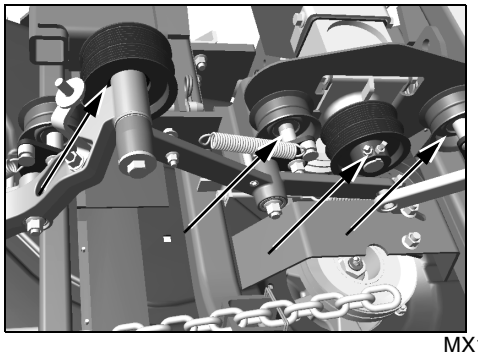


MX17292

(2) Is the spindle and housing properly lubricated?

Yes - Go to the next step.

No - Apply specific grease to lube fittings at top of spindle.



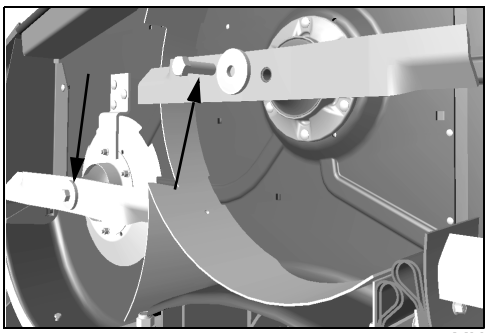
MX19106

(3) Do bearings not rotate freely or are worn or damaged?

Yes - Repair or replace spindles as needed.

No - Go to the next step.

System: Mower Blades

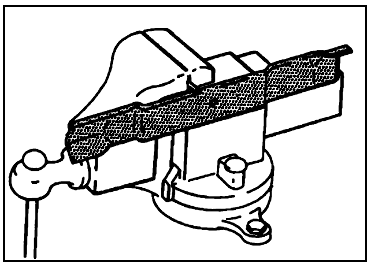


MX17288

(1) Are blades tight on spindle?

Yes - Go to the next step.

No - Tighten blade cap screw.

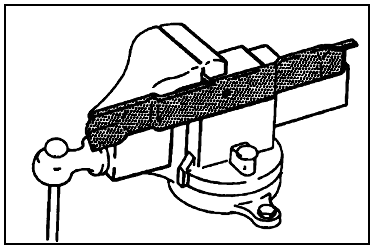


MIF

(2) Are the blades bent, worn or damaged?

Yes - Replace blades.

No - Go to the next step.



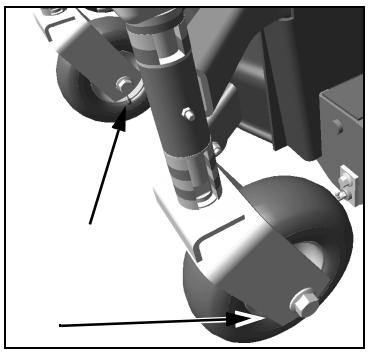
MIF

(3) Are the blades properly sharpened and balanced?

Yes - Go to the next step.

No - Sharpen and balance blades.

System: Caster Wheels

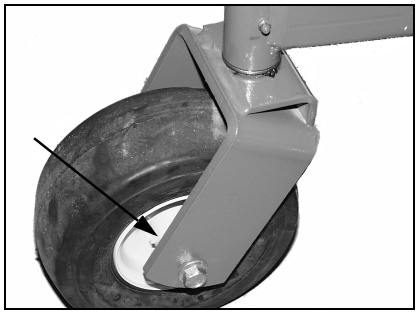


MX17290

(1) Are the tires properly inflated?

Yes - Go to the next step.

No - Inflate tires to specification.



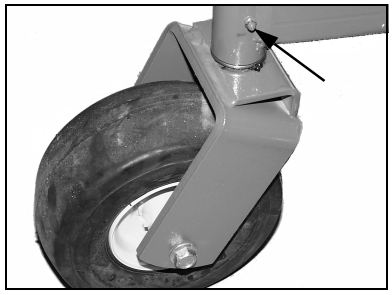
MX17293

(2) Are the wheels properly lubricated?

Yes - Go to the next step.

No - Apply specific grease to wheel lubrication fitting.

System: Caster Wheel Yoke Assemblies



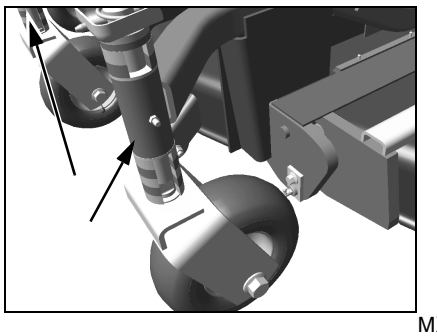
MX17293

(1) Are the caster wheel yoke assemblies properly lubricated?

Yes - Go to the next step.

No - Apply specified grease to pivot lubrication fittings

System: Caster Wheel Yoke Assemblies



MX17290

(2) Do the assemblies rotate freely and are the bearings not worn or damaged?

Yes - Done

No - Replace bearings as needed.

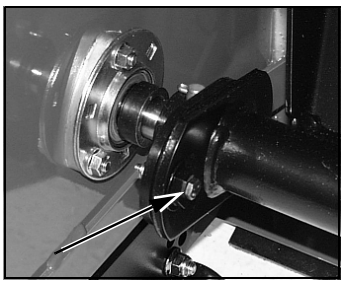
60 Heavy Duty Snowblower

Test Procedure A

Test Conditions:

- Machine parked safely.

System: Auger Drive System

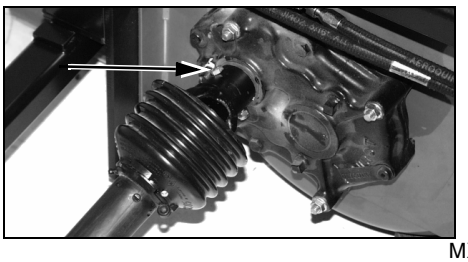


MX6972

(1) Does the auger engage and disengage?

Yes - Go to the next step.

No - Check or replace shear bolts.



MX6980

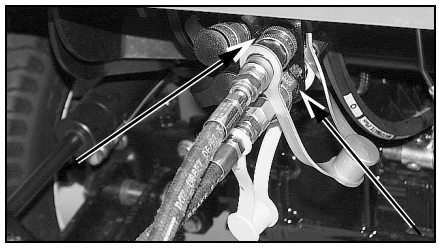
(2) Does the auger engage and disengage?

Yes - Go to the next step.

System: Auger Drive System

No - Check if auger bolt is missing or sheared and replace.

System: Spout Control System

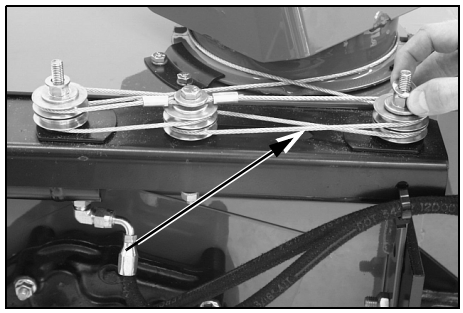


MX7221

(1) Does the spout rotate freely?

Yes - Go to the next step.

No - Check if hydraulic hoses connected.



(2) Does the spout rotate freely?

Yes - Done.

No - Check if cables are installed and operating.

Tests and Adjustments

Mower Deck Level Check and Adjustment

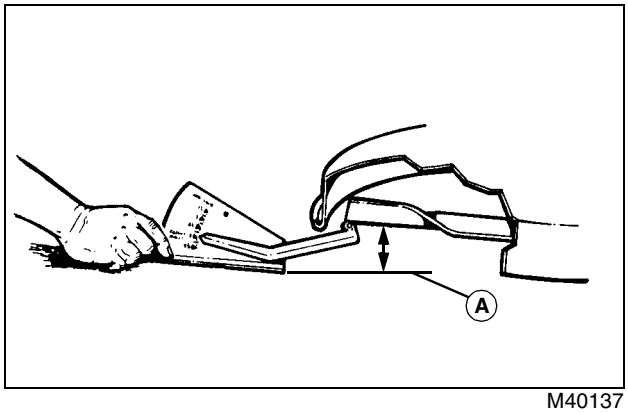
Checking Mower Deck Level: 60-Inch and 72-Inch Side Discharge Mower Decks

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 on level surface.
2. Lower mower deck to the ground.
3. Check tire pressures on all machine tires and deck caster wheels. Adjust pressure to specification.
4. Set mower deck to desired cutting height.
5. Make sure that mower deck caster 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.
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.

Specifications:

Tire Pressures

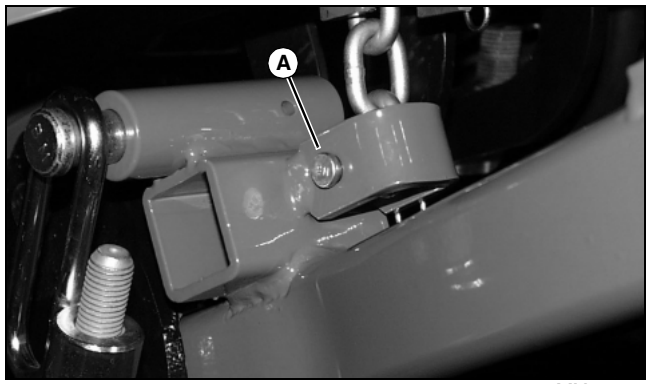
Machine Front Tires . . . . . 140 kPa (20 psi)
Machine Rear Tires . . . . . 140 kPa (20 psi)
Mower Deck Caster Wheels . . . . . 152 kPa (22 psi)

Mower Blade and Anti-Scalp Wheel Heights

Anti-Scalp Wheel . . . . . 6 mm (0.25 in.)

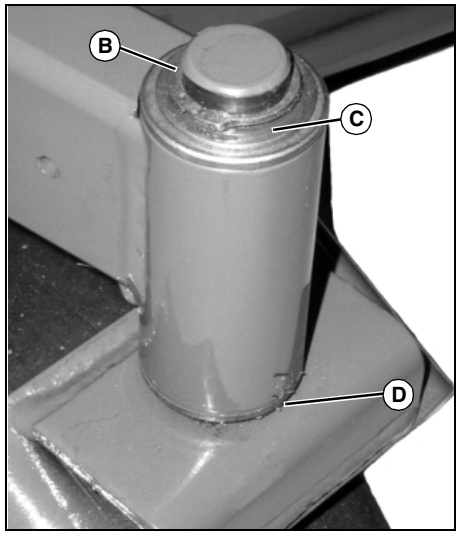
Rear Blade Tip
Higher Than Front Blade Tip . . . . . 6 mm (0.25 in.)

Adjust Deck Level Side-to-Side: 60-Inch and 72-Inch Side Discharge Mower Decks



MX7024

1. Raise mower deck and lock lift arm service latches (A).



MX8834

2. Support bottom of caster wheel with one hand while removing snap ring (B).
3. Lower caster wheel and yoke from support arm.
4. Adjust height of caster wheel:

- To raise deck, move one flat washer (C) from top of support arm to bottom position (D).
- To lower deck, move one flat washer from bottom of support arm to top position. (Leave one flat washer at bottom position at all times.)

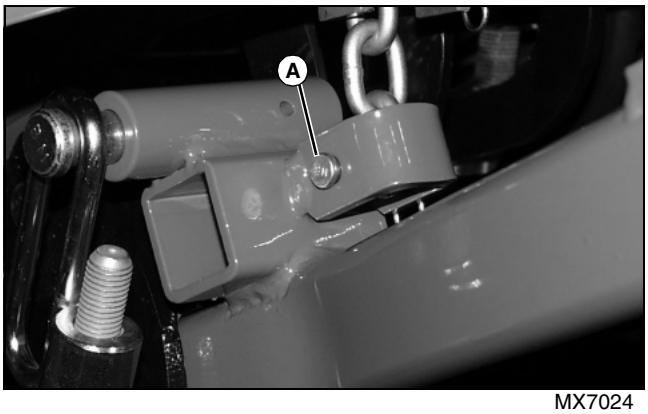
5. Install caster wheel and yoke into support arm. Install snap ring.

6. Lower mower deck and check side-to-side level. The blades should be at the same height.

NOTE: If the blades are still not at equal height, the air pressure in the caster wheel on the side which is high can be reduced.

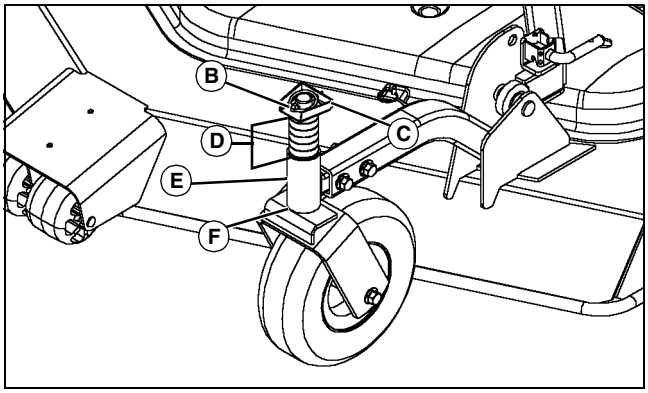
7. Adjust deck level front-to-rear.

Adjust Deck Level Side-to-Side: 62-Inch Rear Discharge Mower Decks



MX7024

1. Raise mower deck and lock lift arm service latches (A).



MX5725

2. Support bottom of caster wheel with one hand while removing quick lock pin (B) and guard (C).

3. Lower caster wheel and yoke from pivot (E).

4. Adjust height of caster wheel:

- To raise deck, move one or more of the spacers (D) from top of pivot to bottom position (F).
- To lower deck, move one or more spacers from the bottom of pivot to top position. (Leave the flat washer at bottom position of yoke on at all times.)

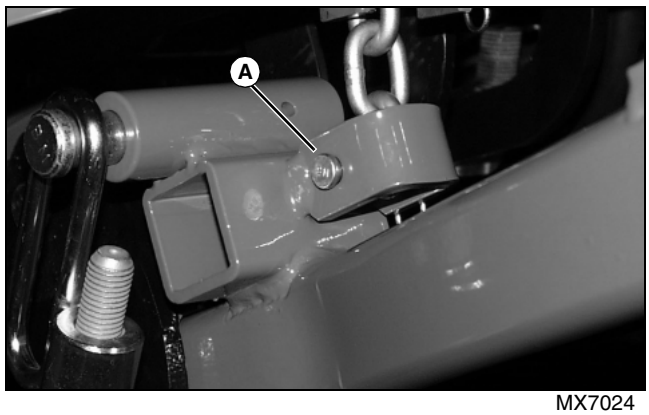
5. Install caster wheel and yoke into pivot. Install guard and quick lock pin.

6. Lower mower deck and check side-to-side level. The blades should be at the same height.

NOTE: If the blades are still not at the same height, the air pressure in the caster wheel on the side which is high can be reduced.

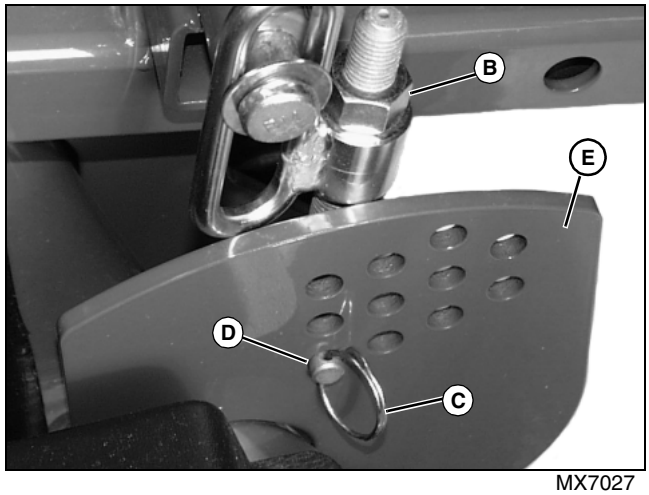
7. Adjust deck level front-to-rear.

Adjust Deck Level Front-to-Rear - All Decks



MX7024

1. Raise mower deck and lock lift arm service latches (A).



MX7027

2. Loosen nut (B) on rear hanger.

3. Remove retainer ring (C) on hanger pin (D).

4. Remove hanger pin from adjustment plate (E).

5. While counting the number of turns, adjust the rear hanger up or down to adjust deck height.

6. Insert hanger pin back into proper hole in adjustment plate, and secure with retainer ring.

7. Tighten lock nut.

8. Repeat steps 2 - 7 for rear hanger on opposite side of mower deck with equal number of turns of hanger.

9. Lower mower deck and check front-to-rear blade height. The blade height should be to specification. Repeat adjustment if necessary.

Specifications:

Rear Blade Tip
Higher Than Front Blade Tip . . . . . 6 mm (0.25 in.)

Checking V-Flex Deck Level

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

2. Check tire pressures on all machine tires, and deck caster wheels.

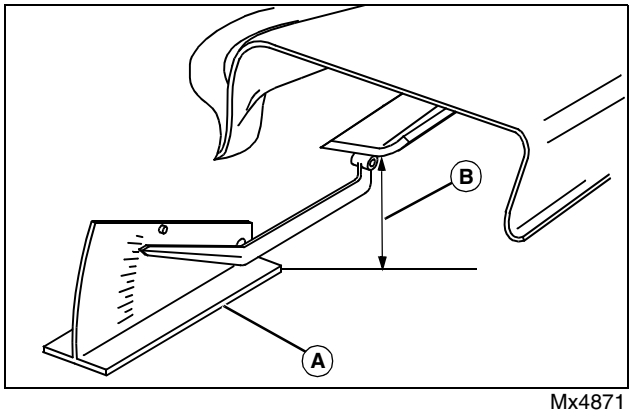
- Machine front tires: 140 kPa (20 psi)
- Machine rear tires: 140 kPa (20 psi)
- Mower deck caster wheels: 152 kPa (22 psi)

3. Set the mower decks at the desired cutting height.

4. Check that the front mower deck caster wheels and rear wheels or rollers are all set to the same 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.

5. Turn the blades until parallel to the front axle.



Mx4871

Picture Note: A convenient leveling gauge (A), AM130907, is available from your John Deere dealer.

6. Measure distance from tip of outside blade (B), to the ground. Repeat for outer blade on other side of deck.

7. Turn outer mower blades to face front-to-rear.

8. Measure height of front and rear of blades to ground. Repeat for outer blade on other side of deck.

Results:

NOTE: The V-Flex Deck is design for both the front and rear wheels to run on the ground. The rake of 1/4 inch is designed into the deck. If more or less rake is required adjust the rear wheel height of cut.

- The blade cutting heights should be level side-to-side.
- The blade height should be 6 mm (0.25 in.) higher in the rear.

Specifications:

Tire Pressures

Machine Front Tires . . . . . 140 kPa (20 psi)

Mower Deck Caster Wheels . . . . . 152 kPa (22 psi)

Mower Blade and Anti-Scalp Wheel Heights

Anti-Scalp Wheel . . . . . 6 mm (0.25 in.)

Rear Blade Tip
Higher Than Front Blade Tip . . . . . 6 mm (0.25 in.)

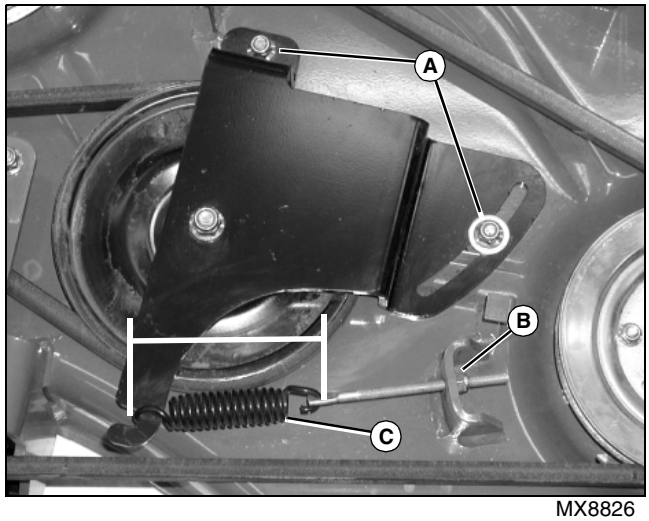
60, 62 and 72-inch Mower Drive Belt Tension Check and Adjustment

Procedure:

1. Park machine on level surface.

2. Lower mower deck to the ground.

3. Remove mower deck belt shields. (See “Mower Deck Belt Shield Removal and Installation” on page 768)



MX8826

4. Loosen nuts (A).

5. Measure length of belt tension spring (C) from hook to hook. Spring length should be to specification.

6. Adjust nut (B) until length of spring is at specified length.

7. Tighten nuts.

8. Install mower deck belt shield.

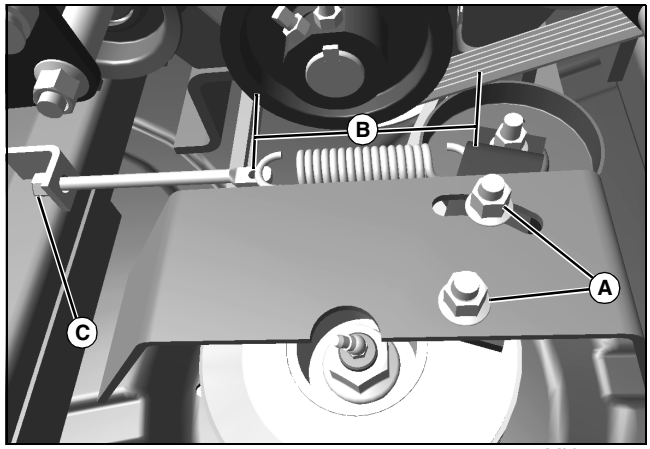
Specifications:

Drive Belt Tension Spring Length. . 138 mm (5-7/16 in.)

Adjusting V-Flex Deck Drive Belt Tension

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

2. Remove the mower deck belt shield.



MX17294

Picture Note: Some parts removed for clarity.

3. Loosen nuts (A).

4. Measure length of belt tension spring (B) from hook to hook. Spring length should be to specification.

5. Adjust nut (C) until length of belt tension spring is correct.

6. Tighten nuts (A).

7. Install belt shields.

Specifications:

Drive Belt Tension Spring Length. . . 120 mm (4-3/4 in.)

Repair

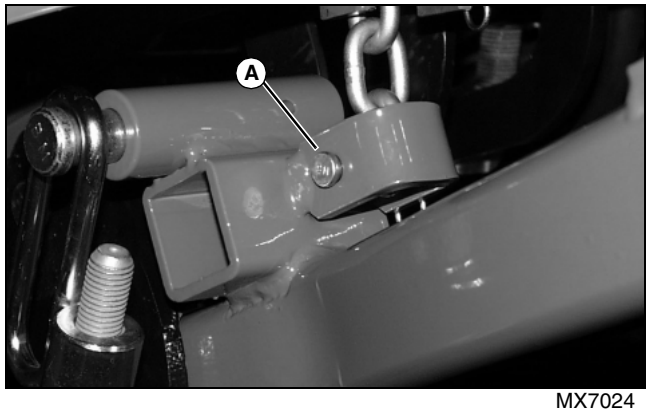
Rotate Mower Deck for Service

Procedure:

1. Park machine on level surface.

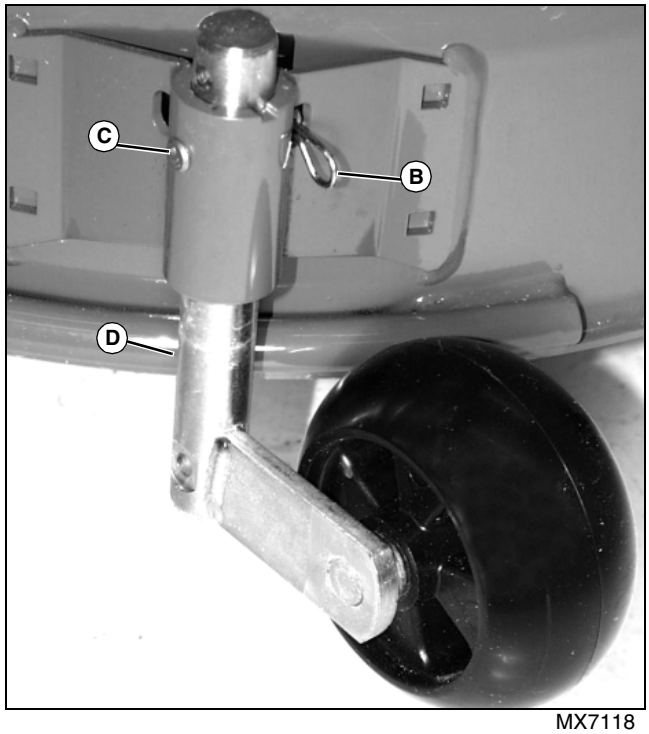
2. Move mower deck to fully raised position.

CAUTION: Avoid injury! Failure to engage service latches can result in mower deck dropping to ground if hydraulic system pressure is lost.



MX7024

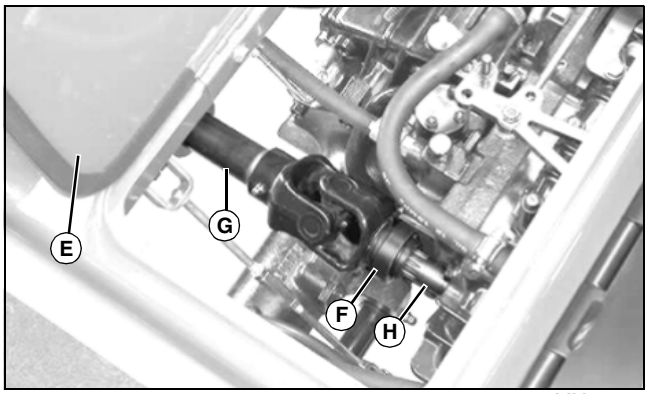
3. Engage the service latches (A) on left and right hand lift arms.



MX7118

4. For side discharge decks only, remove spring pin (B)

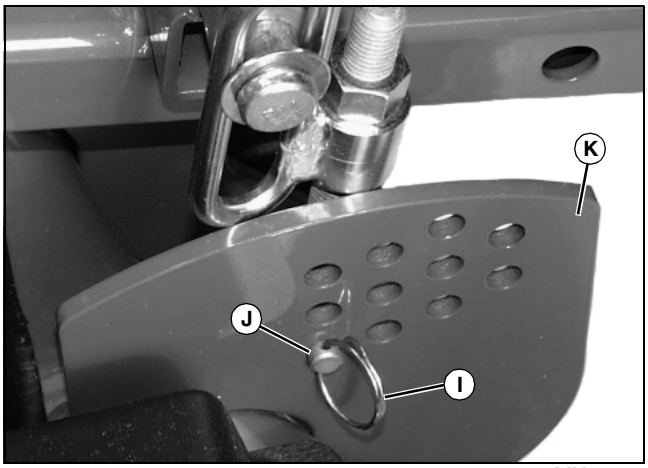
from drilled pin (C) holding anti-scalp wheel bracket (D) onto left side of mower deck. Remove anti-scalp wheel from mower deck.



MX7093

5. Unlock and open service hatch (E) on machine.

6. Pull forward on coupler ring (F) of PTO drive shaft (G). Pull PTO drive shaft off of the PTO output shaft (H).

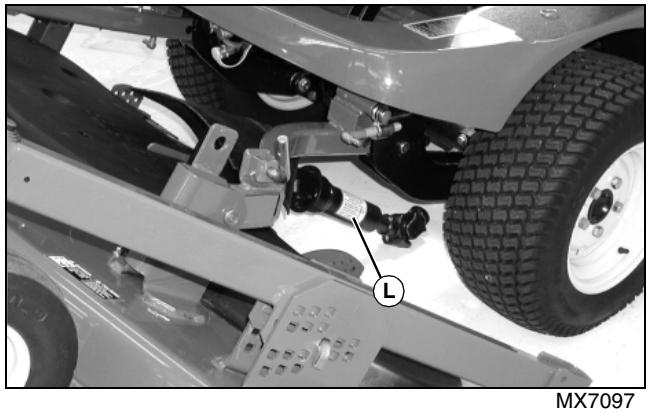


MX7027

7. Remove retaining ring (I) from hanger pin (J).

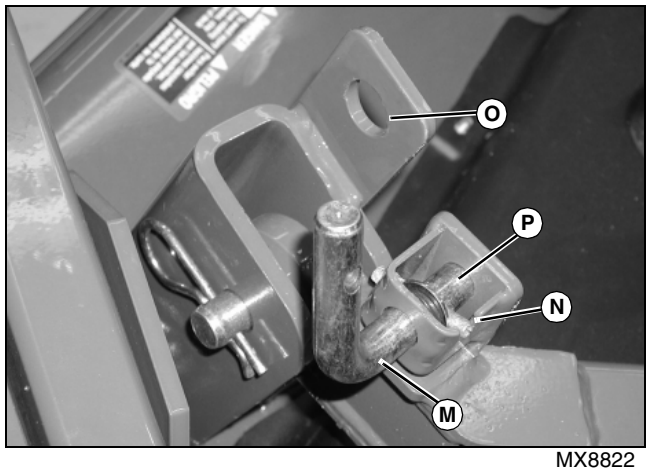
NOTE: To return the mower deck to its original cutting height, mark the hole location where the hanger pin was installed before removing the pin.

8. Carefully remove hanger pin from adjustment plate (K). Deck will drop. Repeat for other side of mower deck.



MX7097

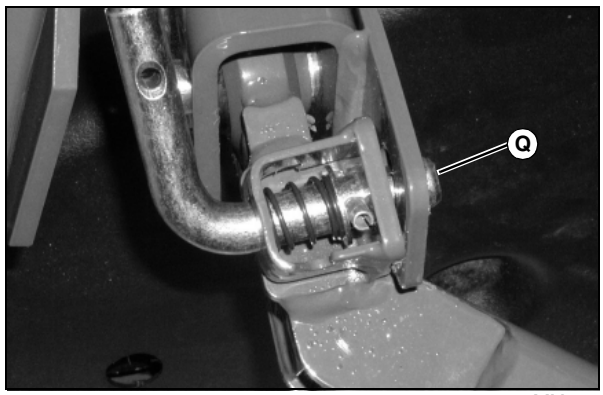
9. Lower rear of mower deck down to the ground. PTO drive shaft (K) will drop clear of front axle.



MX8822

10. Pull service lock handle (M) out and rotate back until spring is compressed and pin (N) is locked into slot.

11. Continue to rotate the mower deck back until hole (O) in deck bracket is aligned with service lock (P).



MX8824

12. Rotate service lock handle forward to extend pin (Q) into deck bracket.

Rotate Mower Deck for Operation

Procedure:

1. Pull mower deck service lock out of mower deck bracket.
2. Rotate deck forward while keeping PTO shaft from wedging into ground or machine.
3. Connect PTO drive shaft to PTO output shaft of transaxle.
4. Rotate mower deck to level position. Install rear hanger pins into hole marked or to desired cutting height holes on rear adjustment plates.
5. Install retaining rings on left and right side hanger pins.
6. For side discharge decks only, install anti-scalp wheel on mower deck.
7. Unlock service latches.
8. Lower mower deck to ground.

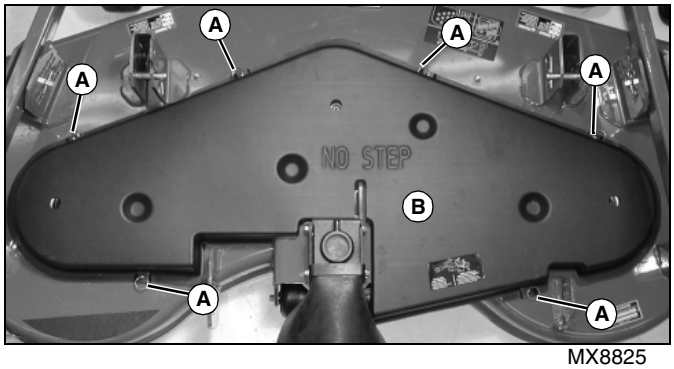
Mower Deck Belt Shield Removal and Installation

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. Rotate mower deck for service, or remove mower deck from machine. (See “Rotate Mower Deck for Service” on page 766)

NOTE: The belt shield for the 60-inch mower deck consists of two pieces. The belt shield for the 62-inch and 72-inch mower deck consists of one piece.



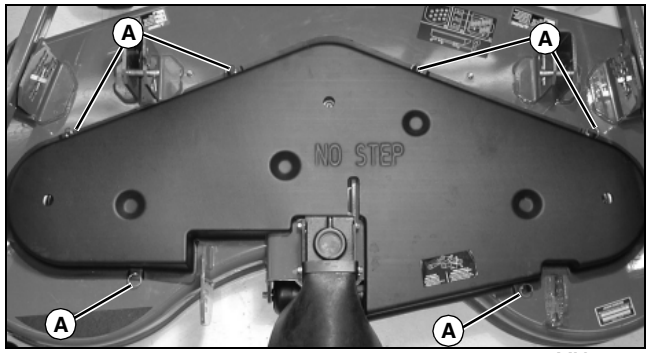
MX8825

Picture Note: 72-Inch Mower Deck Shown

3. Remove six retaining rings (A) securing belt shield (B) to mower deck.
4. Lift belt shield up off of the attaching bolts.
5. Inspect belt shield for cracks, wear or damage. Replace if necessary.
6. Installation is done in the reverse order of removal.
7. Rotate mower deck for operation.

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.



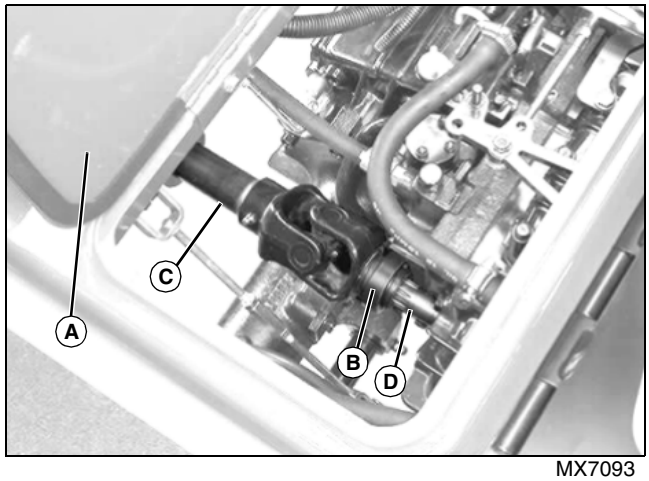
MX8825

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.

Rotating the V-Flex Mower Deck for Service

Rotating Mower Deck for Service

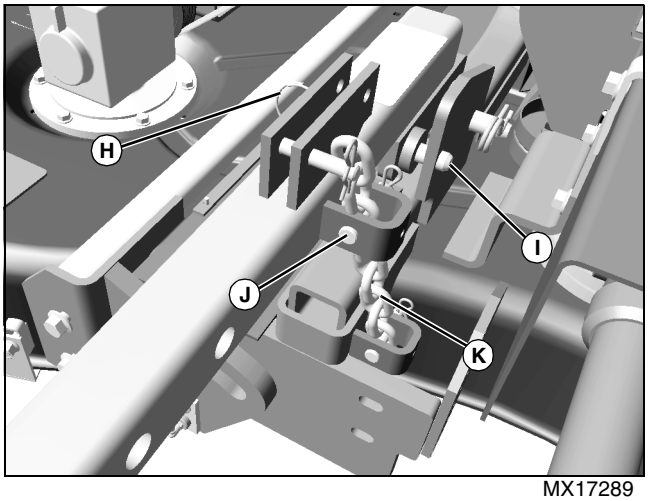
1. Park machine safely. (See Parking Safely in the Safety section.)



MX7093

2. Unlock and open service hatch (A) on machine.

3. Pull forward on the coupler ring (B) located on the mower deck PTO drive shaft (C). Pull the drive shaft off of machine PTO output shaft (D).

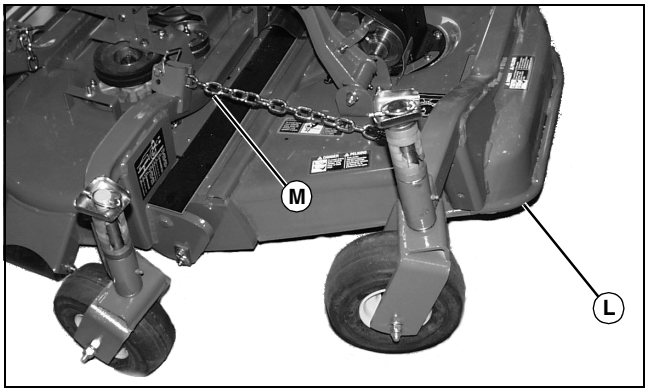


MX17289

4. Pull out turn and release the retaining ring (H) to release the hanger pin (I) so the pin rides on the deck bracket.

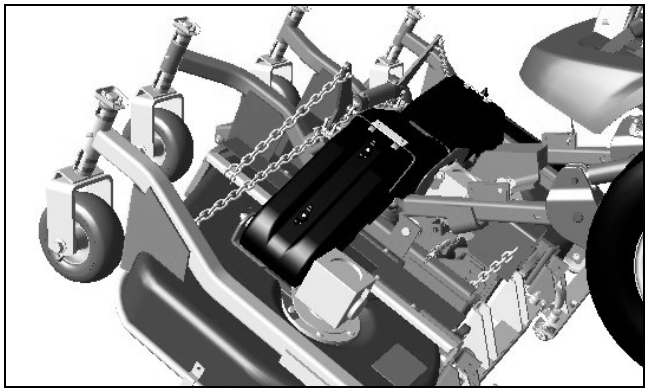
5. Remove quick pull pin from drilled pin (J) and remove float chain (K)

NOTE: A second person may be needed to help lift wing while latching wing chain.



MX17312

6. Lift wing deck (L) and latch chain (M).

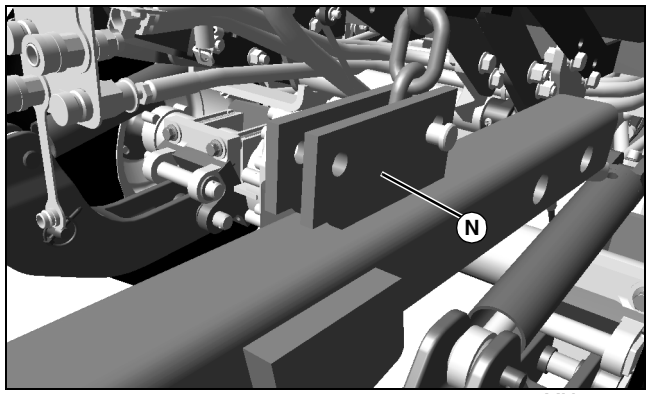


MX17307

7. Start machine and raise mower deck to top of travel. Stop engine. Mower deck should rotate.

8. Lift up on the front of deck until hanger pins snaps into hole of deck bracket.

CAUTION: Avoid injury! Failure to engage service latches can result in mower deck dropping to ground if hydraulic system pressure is lost.



MX17304

9. Lock service chain to latch brackets (N) on left and right side mower deck lift arms.

Rotating Mower Deck for Operation

1. Start machine and raise mower deck to top of travel and stop engine.

2. Remove service chain latches.

3. While one person lifts up on front of deck a second person pulls mower deck service lock out of deck bracket.

4. Allow deck to rotate forward carefully.

5. Latch service latch in retracted position.

6. Install pin and service chain.

7. Lower mower deck to ground.

8. Lift up on deck wings and release chains.

9. Install chain safety pins.

10. Install driveshaft.

60, 62 and 72-Inch Mower Deck Drive Belt Removal

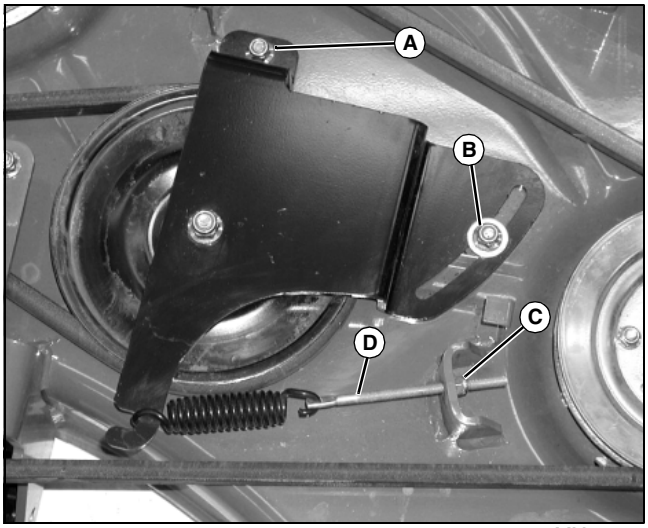
Procedure:

1. Park machine on level surface.

2. Lower attachment.

3. Remove belt shield. (See “Mower Deck Belt Shield

Removal and Installation" on page 768)

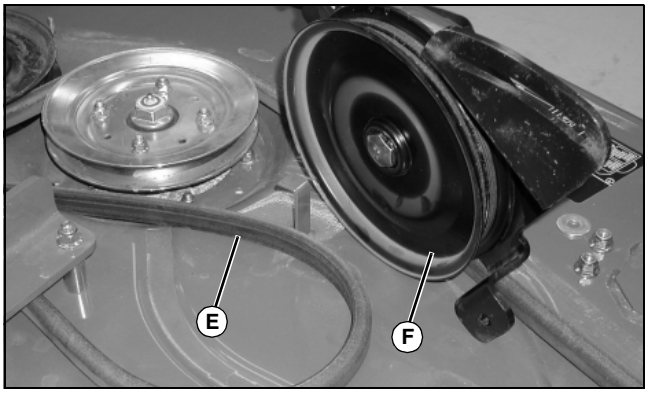


MX8826

4. Loosen lock nuts (A) and (B).

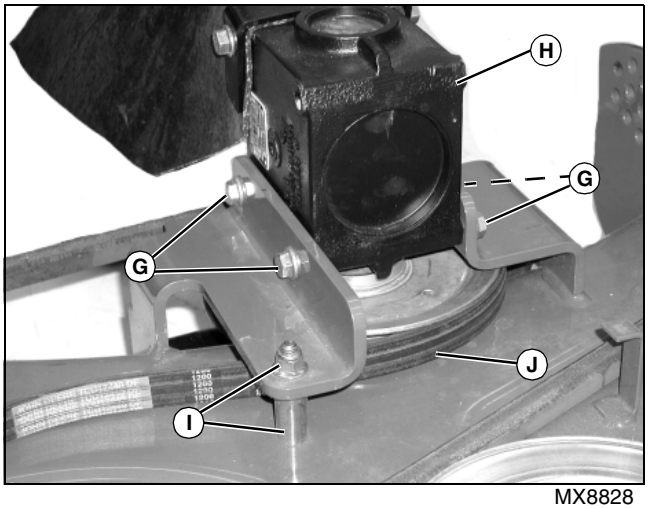
5. Remove nut (C), and remove tension spring and rod (D) from mower deck.

6. Remove nuts and washers from (A) and (B).



MX8827

7. Remove drive belt (E) from belt tensioning sheave (F).



MX8828

8. Remove four cap screws (G) holding mower deck PTO gear box (H) to frame.

- 72-inch deck only: remove support bushing (I).

9. Slide gear box out from mounting brackets, and remove drive belt (J) from sheave.

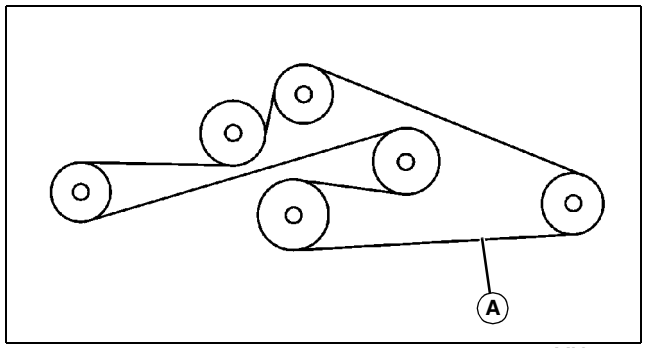
10. Inspect drive belt for cracks, wear or damage. Replace if necessary.

60, 62 and 72-Inch Mower Deck Drive Belt Installation

Procedure:

CAUTION: Avoid injury! BE CAREFUL when removing drive belt from sheaves; your fingers may be pinched and injury may result.

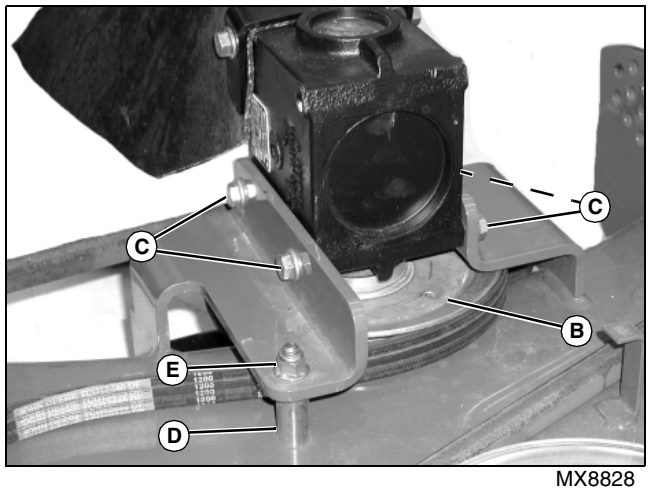
NOTE: For correct drive belt routing, refer to drive belt routing diagram or drive belt tension label on mower deck.



MX5737

Picture Note: Drive Belt Routing (Shown from Rear of Deck)

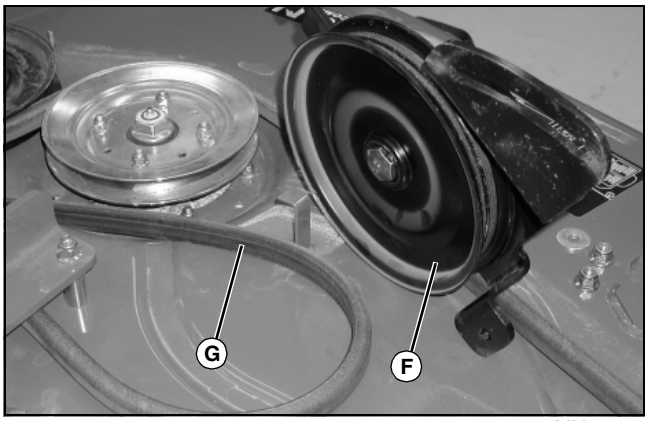
1. Route drive belt (A) around mower deck as shown on drive belt tension label on mower deck.



MX8828

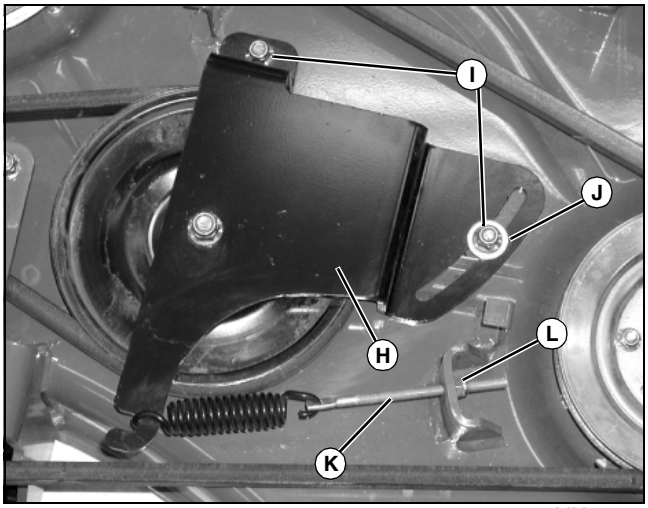
2. Wrap the drive belt around the PTO gearbox drive sheave (B) and install PTO gearbox onto mower deck frame. Secure PTO gearbox with cap screws and washers (C). Tighten cap screws to specification.

3. 72-inch mower deck only: install the support bushing (D), cap screw and nut (E).



MX8827

4. Install the tensioning sheave (6) onto the drive belt (7).



MX8826

5. Install the tensioning bracket (H) to the mower deck using two carriage head cap screws and nylock nuts (I), and a flat washer (J). Do not tighten hardware at this time.

6. Install tension spring, rod (K), and secure nut (L).

7. Adjust spring tension for mower deck drive belt to specification. (See “60, 62 and 72-inch Mower Drive Belt Tension Check and Adjustment” on page 765) Tighten tensioning bracket mounting cap screws.

8. Install belt shield.

Specifications:

Gearbox-to-Deck Frame Cap Screws . 99 N•m (73 lb-ft)

Drive Belt Tension Spring Length. . 138 mm (5-7/16 in.)

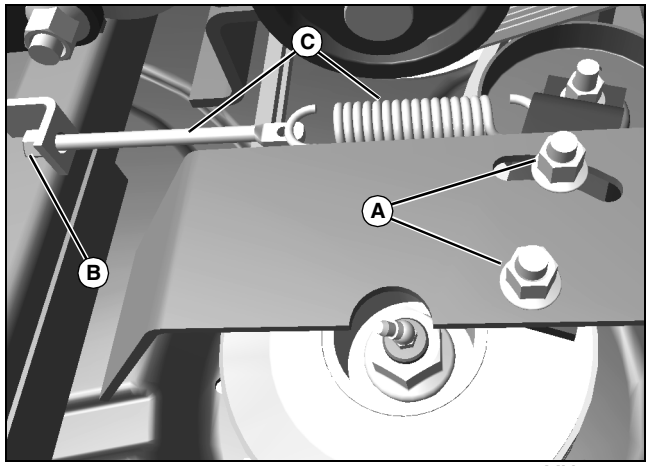
Removing and Installing V-Flex Mower Deck Drive Belts

Removing Gearbox Belt

CAUTION: Avoid injury! To avoid injury to hands or fingers because of pinch areas, use care when removing belt from sheave.

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

2. Remove the mower deck belt shield.



MX17294

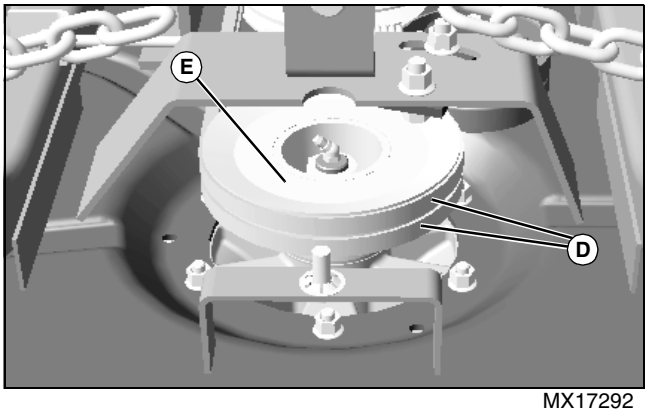
Picture Note: Parts removed for clarity.

3. Loosen nuts (A).

CAUTION: Avoid injury! Spring is under tension and can cause injury. Use care when pulling back on spring off idler arm. Use eye protection.

4. Remove nut (B), and tension spring and rod (C) from mower deck.

IMPORTANT: Avoid damage! Do not clean mower belts using a parts cleaning solvent or belt dressing. They soften belts and shorten belt life.



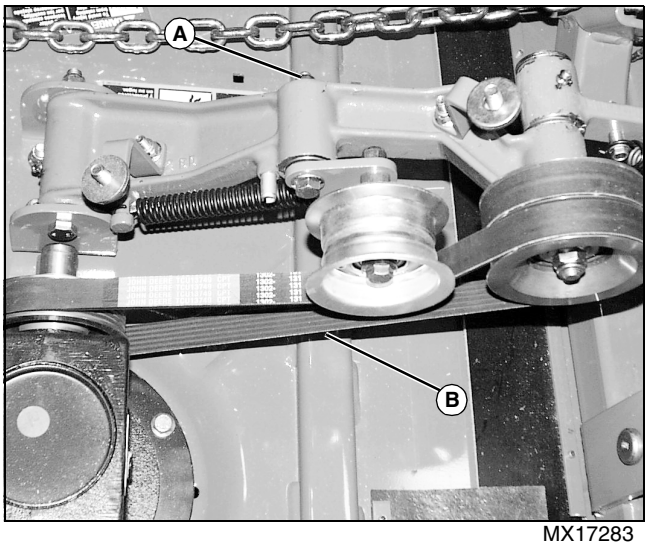
MX17292

5. Remove drive belts (D) from drive sheave (E).

Removing Vertical Drive Belt

1. Remove belt shields.
2. Remove left belt.

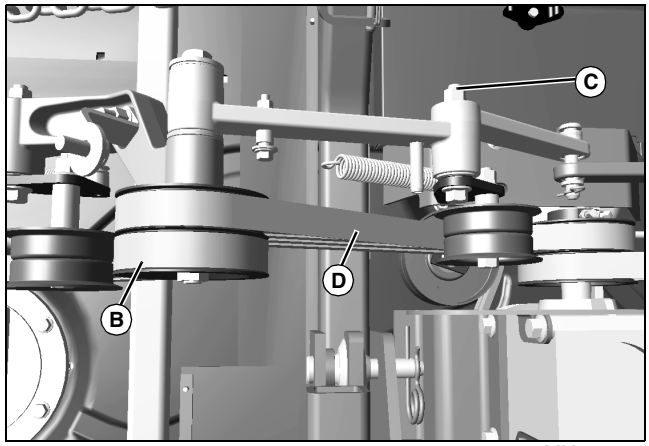
CAUTION: Avoid injury! Spring is under tension and can cause injury. Use care when pulling back on spring off idler arm. Use eye protection.



MX17283

a. Loosen nut (A), using a 15mm wrench, on idler pivot and rotate idler and remove belt (B) by hand.

3. Remove left center belt.

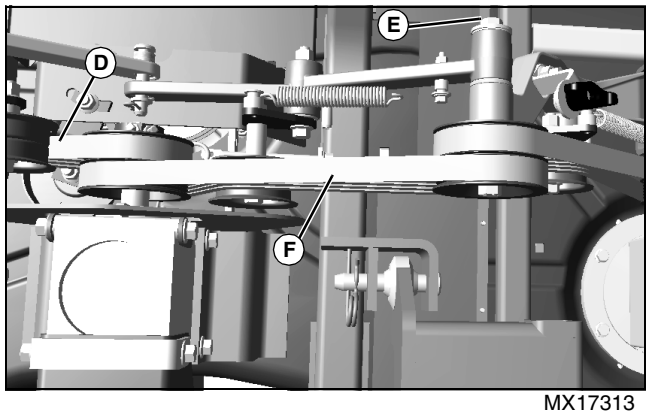


MX17315

a. Partially remove left belt (B) by loosening nut from previous steps.

b. Loosen nut (C), using a 15mm wrench, from left center idler pivot to rotate idler and remove belt (D) by hand.

4. Remove right center belt.

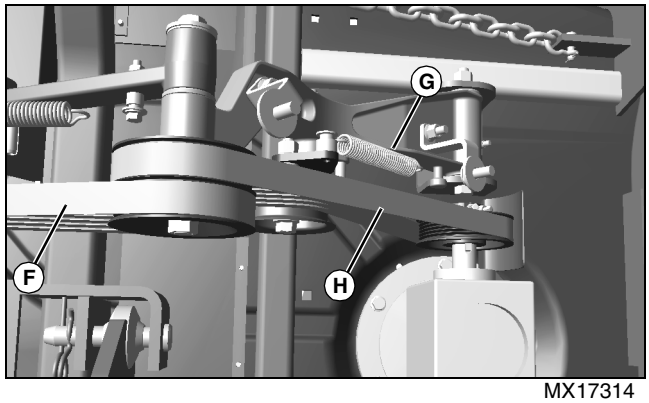


MX17313

a. Partially remove left center belt (D) by loosening nut from previous steps.

b. Loosen nut (E), using a 15mm wrench, from right center idler pivot to rotate idler and remove belt (F) by hand.

5. Remove right belt.



MX17314

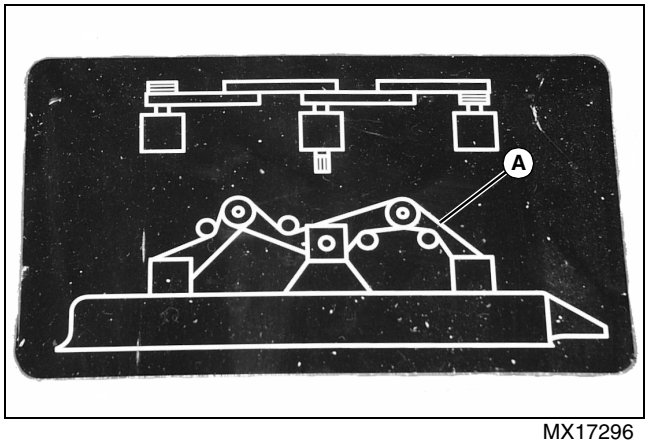
a. Partially remove right center belt (F) by loosening nut from previous steps.

b. Loosen nut (G), using a 15mm wrench, from right idler pivot to rotate idler and remove belt (H) by hand.

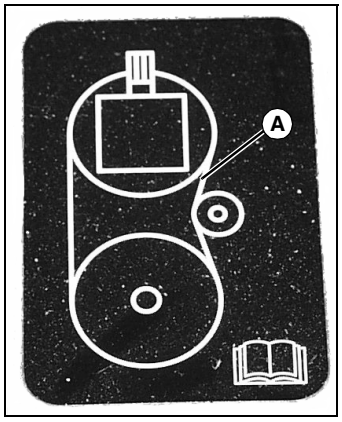
Installing Belt

1. Belt installation in opposite order of removal.

NOTE: Belt routing diagram is affixed to mower deck belt shield and to the deck.



MX17296

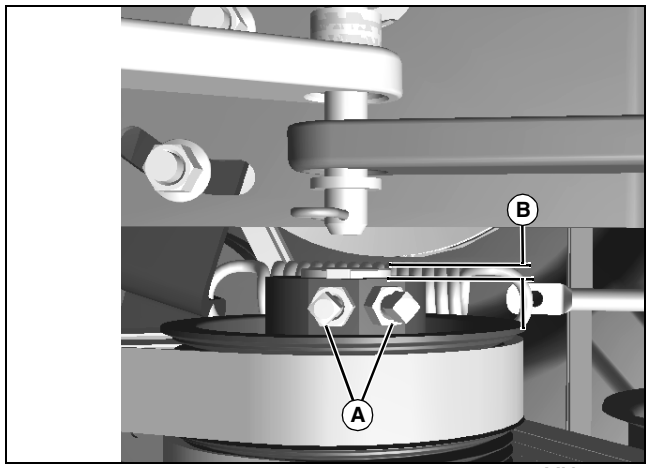


MX17296

2. Route drive belt (A) around mower deck sheaves as shown. (Shown from rear of deck.)

3. Install belt shields.

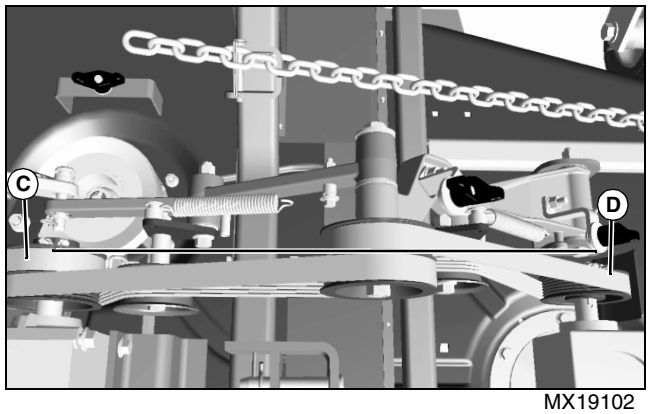
Aligning Vertical Belt Drive



MX19101

Picture Note: Some parts removed for clarity.

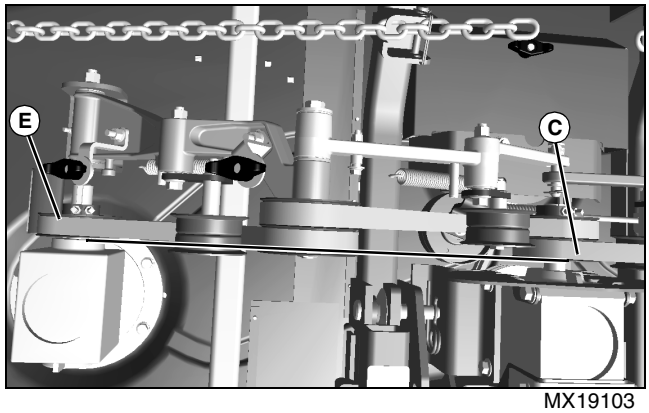
1. Loosen jam nuts and set screws (A) to adjust center pulley on gear box 4 mm (B) from end. Tighten hardware.



MX19102

2. Use a straight edge on front of center pulley (C) to locate pulley (D) on right side gearbox. If pulley is located off shaft go to step 1 and adjust 4 mm dimension.

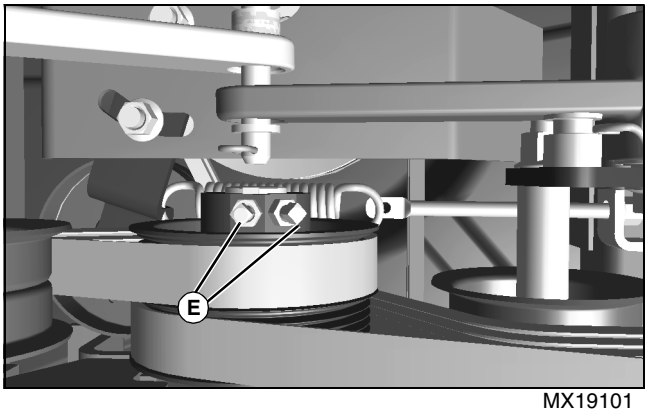
3. Use straight edge on right side gearbox back to center pulley to verify right side pulley and gearbox location. Rotate gearbox to get alignment. Work between step 2 and 3 to get alignment within 2 mm.



MX19103

4. Use straight edge on rear of center pulley (C) to locate pulley (E) of left side gearbox. If pulley interferes with gearbox go back to step 1 and adjust 4 mm dimension accordingly.

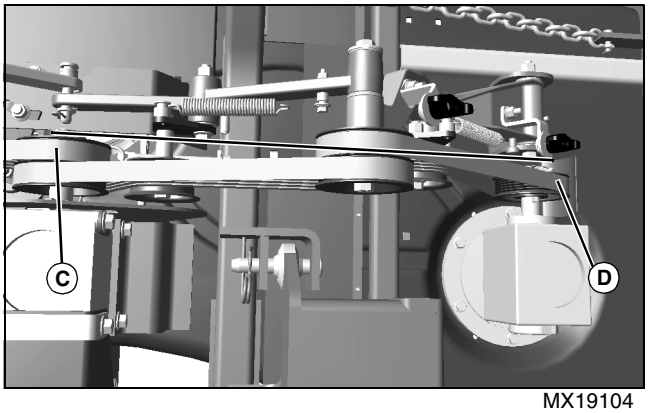
5. Use straight edge on left side gearbox back to center pulley to verify left side pulley and gearbox location. Rotate gearbox to get alignment. Work between steps 4 and 5 to get alignment within 2 mm.



MX19101

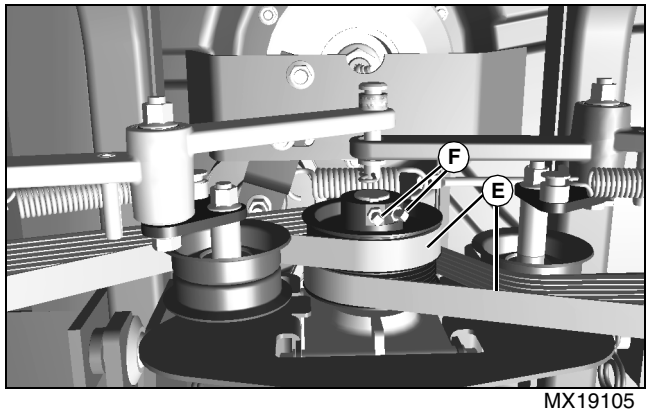
6. Assemble jam nut to set screws (A) (if not already done).

7. Apply thread lock to set screws of each of the gearbox pulleys and tighten between 6 and 10 ± 2 N•m (53 and 88 ± 12 lb-in.)



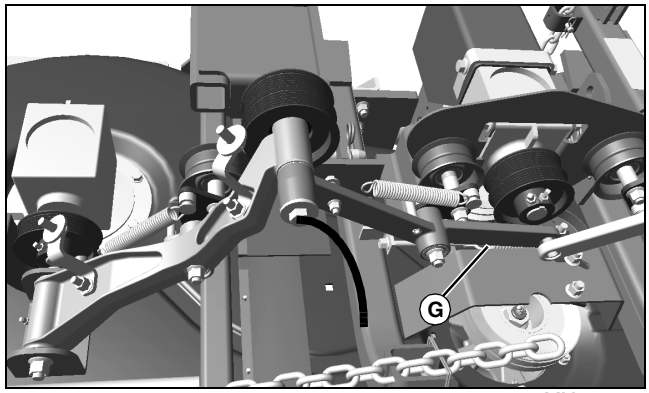
MX19104

8. Use straight edge between front of center pulley (C) to right side pulley (D).



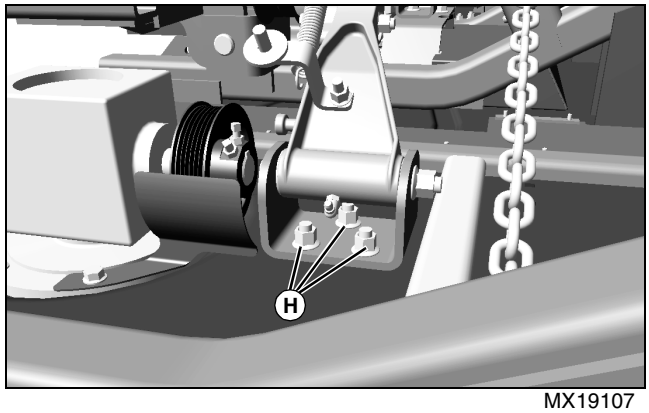
MX19105

9. Remove belts (E) and center pivot pin and spacers (F).



MX19106

10. Rotate right arm assembly down (G) to deck and locate front of transfer pulley to straight edge.

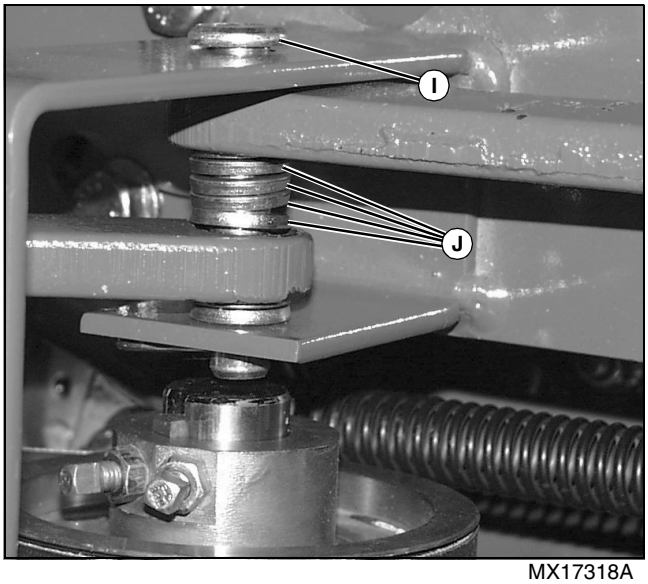


MX19107

11. Adjust three mounting bolts by loosening the three nuts (H) near outer gearbox to locate pulley.

12. Rotate arm up and install center pin.

13. Repeat steps 10 through 12 and on other side, except with straight edge on the back of center pulley.



MX17318A

14. Remove center pin (I) and install spacers (J) between brackets and drive arms to limit movement of arm to less then 2 mm.

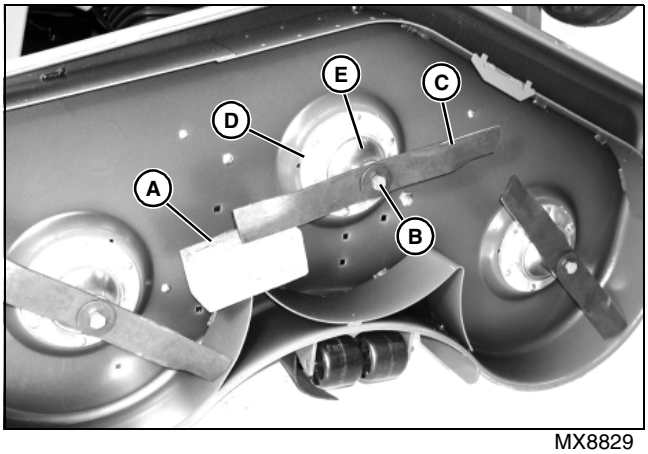
15. Install drive belts.

Mower Deck Blade Removal and Installation

Removal:

1. Park machine on level surface.
2. Lock park brake.
3. Raise mower deck completely.
4. Lock lift arm service latches.
5. Rotate mower deck for service. (See “Rotate Mower Deck for Service” on page 766)

CAUTION: Avoid injury! The blades are sharp. To help prevent personal injury, wear heavy gloves or wrap the end of the blade with a rag.



MX8829

6. Place a wooden block (A) between end of blade and edge of mower deck.
7. Remove cap screw and blade washer (B) and blade (C) from spindle (D). Deflector cup (E) may or may not come off when removing blade. Repeat for all blades requiring service.
8. Inspect blade for cracks, wear or damage. Replace blade if damaged.
9. Sharpen and balance blade as needed.

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.
- Install blade with bent tip up.
- Install blade hole over shaft pilot and flat against deflector cup surface.
- Make sure to install blade washer with concave side toward blade.
- Tighten blade cap screw to specification.

Specifications:

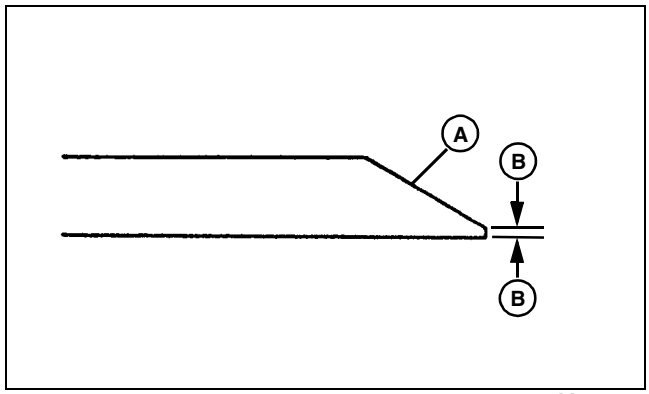
Blade Cap Screw Torque . . . . . 122 N•m (90 lb-ft)

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

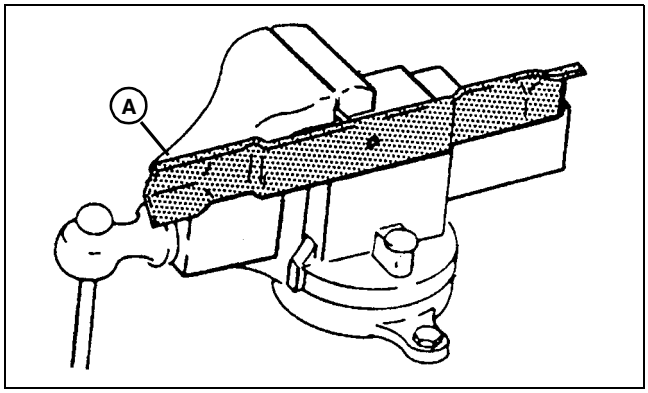
Procedure:

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 775)



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.

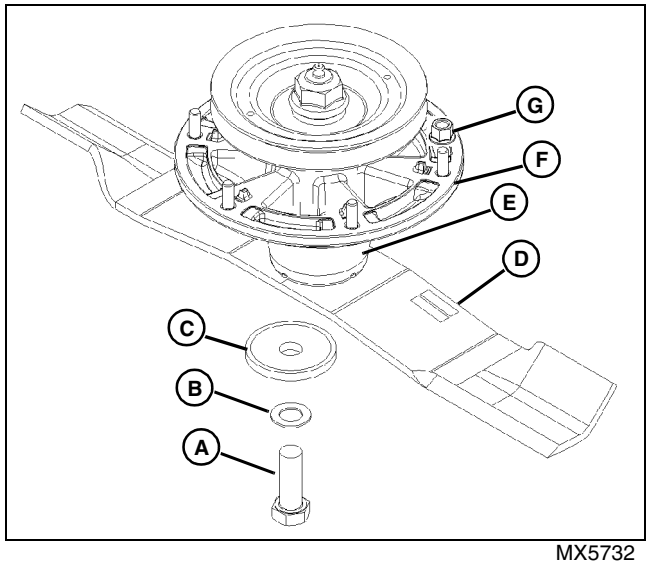
5. Grind blade edge of heavy end. Do not alter original blade bevel angle of 30°.

Mower Deck Spindle Removal and Installation

Removal: 60-Inch Side Discharge and 62-Inch Rear Discharge Mower Decks

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 Drive Belt Removal”.)



MX5732

2. Remove blade cap screw (A), flat washer (B), blade washer (C), blade (D) and deflector (E).

3. Remove mounting lock nuts (G).

4. Remove spindle assembly (F) from mower deck.

5. Inspect spindle assembly for wear or damage. Replace components as necessary.

Installation: 60-Inch Side Discharge and 62-Inch Rear Discharge Mower Decks

- Installation is done in the reverse order of removal.
- Tighten spindle mounting lock nuts to specification.

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 specification.
- Install drive belt. (See” Mower Deck Drive Belt Removal”.)

Specification:

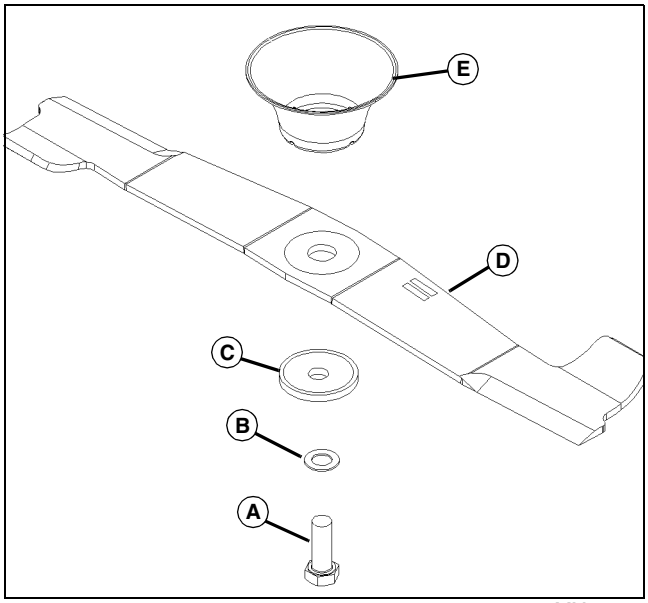
Blade Cap Screw Torque . . . . . 122 N•m (90 lb-ft)

Spindle Mounting Lock Nut Torque . . . . . 24 ± 4 N•m (18 ± 4 lb-ft)

Removal: 72-Inch Side Discharge Mower Deck

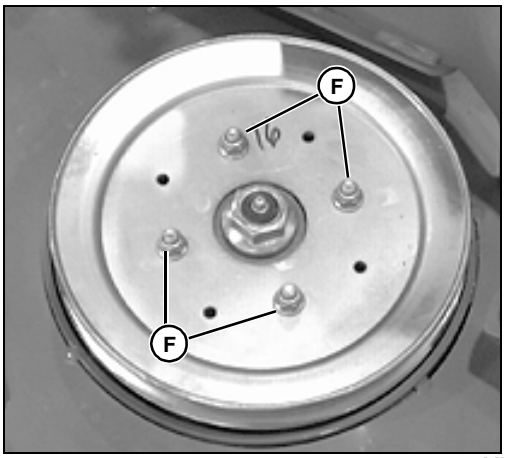
CAUTION: Avoid injury! To help prevent personal injury, wear heavy gloves or wrap the end of the blade with a rag.

1. Remove drive belt. (See” Mower Deck Drive Belt Removal”.)



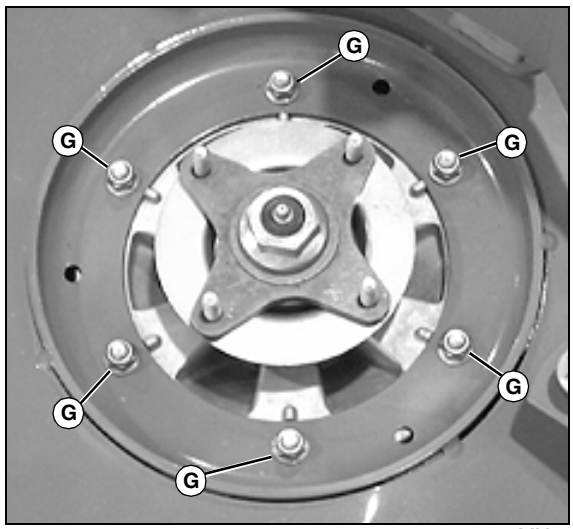
MX5731

2. Remove blade cap screw (A), flat washer (B), blade washer (C), blade (D) and deflector (E).



MX2380

3. Remove four sheave-to-hub lock nuts and bolts (F), on spindle.



MX2381

4. Remove six mounting lock nuts (G) securing spindle housing to mower deck.

5. Remove spindle from mower deck.

6. Inspect spindle assembly for wear or damage. Replace components as necessary.

Installation: 72-Inch Side Discharge Mower Deck

- Installation is done in the reverse order of removal.
- Tighten spindle mounting lock nuts to specification.
- Tighten sheave-to-hub lock nuts to specification.

IMPORTANT: Avoid damage! Install blade with bent tips up. Install blade washer with cusp side to blade.

- Install blade and tighten cap screw to specification.
- Install drive belt. (See “60, 62 and 72-Inch Mower Deck Drive Belt Installation” on page 770)

Specification:

Blade Cap Screw Torque . . . . . 122 N•m (90 lb-ft)

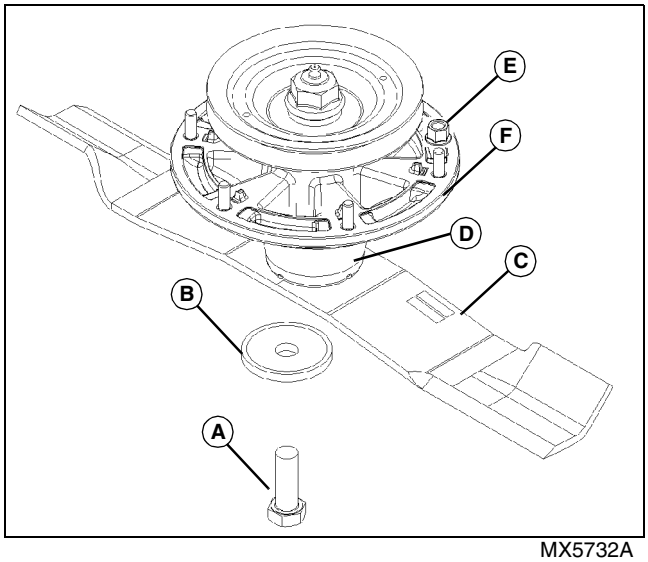
Spindle Mounting
Lock Nut Torque . . . . . 24 ± 4 N•m (18 ± 4 lb-ft)

Sheave-to-Hub
Lock Nut Torque . . . . . 24 ± 4 N•m (18 ± 4 lb-ft)

Removal: 7-Iron V-Flex Side Discharge Mower Decks

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 Drive Belt Removal”.)



MX5732A

2. Remove blade cap screw (A), blade washer (B), blade (C) and deflector (D).

3. Remove mounting lock nuts (E).

4. Remove spindle assembly (F) from mower deck.

5. Inspect spindle assembly for wear or damage. Replace components as necessary.

Installation: 7-Iron V-Flex Side Discharge Mower Decks

IMPORTANT: Avoid damage! Install blade with bent tips up. Install blade washer with concave side to blade.

1. Installation is done in reverse order of removal.

2. Tighten spindle mounting lock nuts to specifications.

3. Install blade and tighten blade cap screw to specifications.

4. Install drive belt. (See “Mower Drive Belt Removal”.)

Specification:

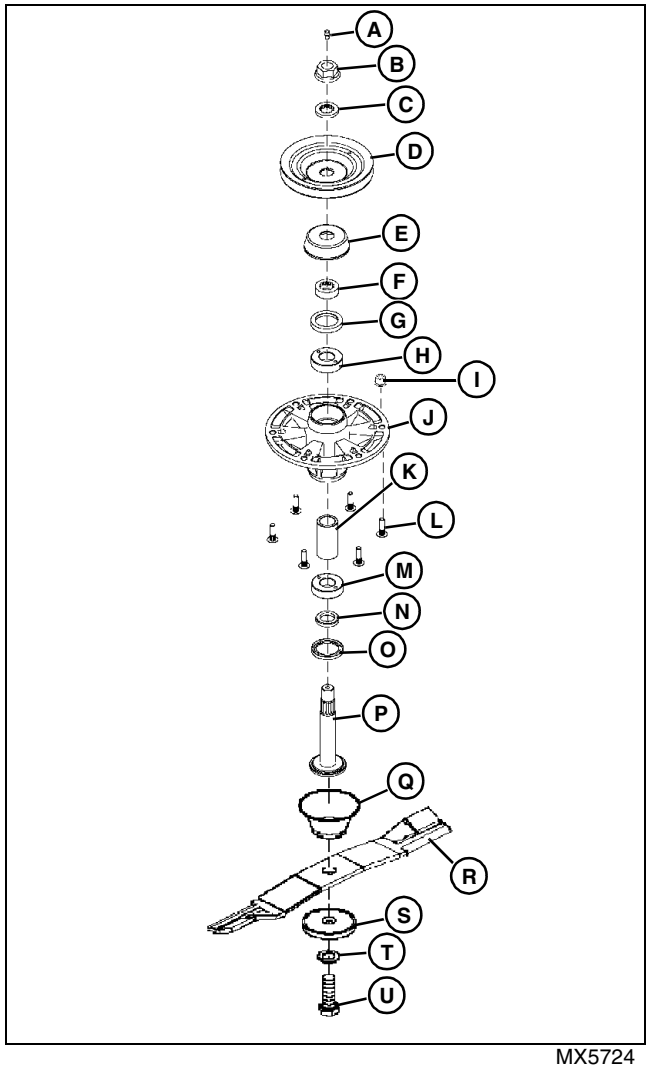
Blade Cap Screw Torque . . . . . 122 N•m (90 lb-ft)

Spindle Mounting
Lock Nut Torque . . . . . 24 ± 4 N•m (18 ± 4 lb-ft)

Mower Deck Spindle Disassembly and Inspection

Disassembly and Inspection: 60-Inch Side Discharge Mower Decks and 62-Inch Rear Discharge Mower Decks

IMPORTANT: Avoid damage! Always install new bearings and seals when servicing spindles.



MX5724

A - Lubrication Fitting (apply grease)
B - Flanged Nut
C - Bushing
D - Sheave
E - Upper Deflector
F - Bushing
G - Upper Seal
H - Upper Bearing
I - Flanged Lock Nut
J - Housing
K - Spacer
L - Mounting Bolt (6 used)
M - Lower Bearing
N - Lower Seal Ring
O - Lower Seal
P - Spindle Shaft
Q - Lower Deflector
R - Blade
S - Blade Washer

T - Washer

U - Cap Screw

1. Install blade (R), blade washer (S), washer (T) and cap screw (U) on spindle shaft (P). Tighten to **320 N•m (236 lb-ft)**.

2. Place blade in a soft-jawed vise.

3. Remove flanged nut (B).

4. Remove bushing (C), sheave (D), deflector (E), and bushing (F).

5. Remove cap screw, washer, blade washer and blade.

6. Remove spindle shaft from housing (J).

7. Remove lower seal ring (N) and lower seal (O).

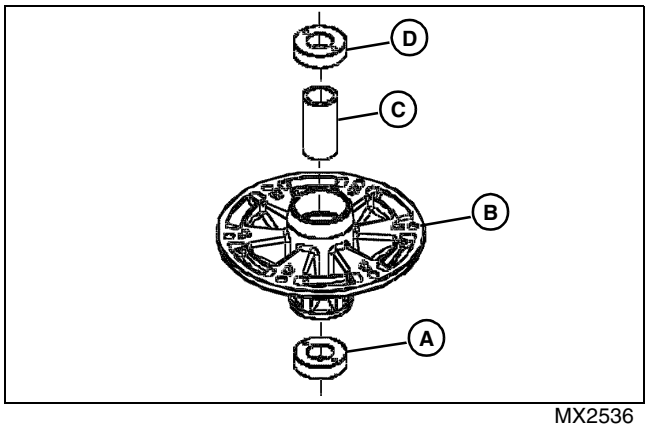
NOTE: Remove upper bearing (H) and lower bearing (N) only if replacement is necessary.

8. Upper and lower bearings are seated against spindle hub shoulder and cannot be removed with a press. Remove upper seal (G) and bearings using a punch.

9. Remove spacer (K).

10. Inspect all parts for wear or damage. Replace parts as needed.

Assembly: 60-Inch Side Discharge Mower Decks and 62-Inch Rear Discharge Mower Decks



MX2536

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).

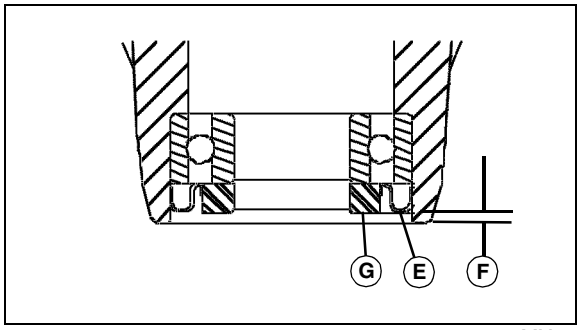
2. Turn the housing over.

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.

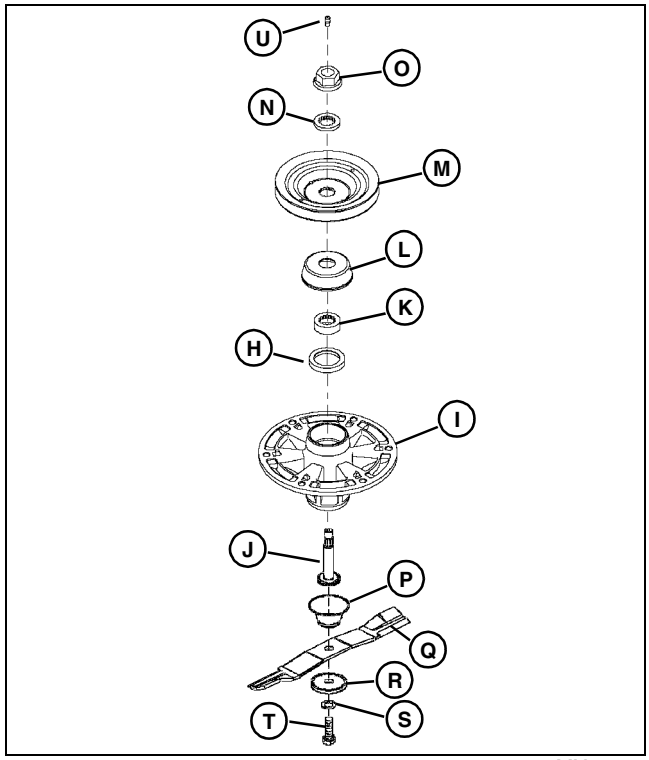
NOTE: The inner diameter chamfer of the seal ring is away from the bearing.



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.



MX2539

7. Using a press and disk, install upper seal (H) with open side toward bearing until the face of the seal is flush with the end of the housing (I).

8. Install spindle shaft (J) into housing.

9. Install bushing (K), upper deflector (L), sheave (M) and bushing (N).

10. 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.

11. Install lower deflector (P), blade (Q), washers (R) and (S) and cap screw (T).

12. Tighten blade cap screw to **320 N•m (236 lb-ft)**.

13. Place blade in a soft-jawed vise.

14. Tighten flange nut to specification.

15.Loosen blade cap screw and retighten to specification.

16. Apply specified grease to lubrication fitting (U).

Specifications:

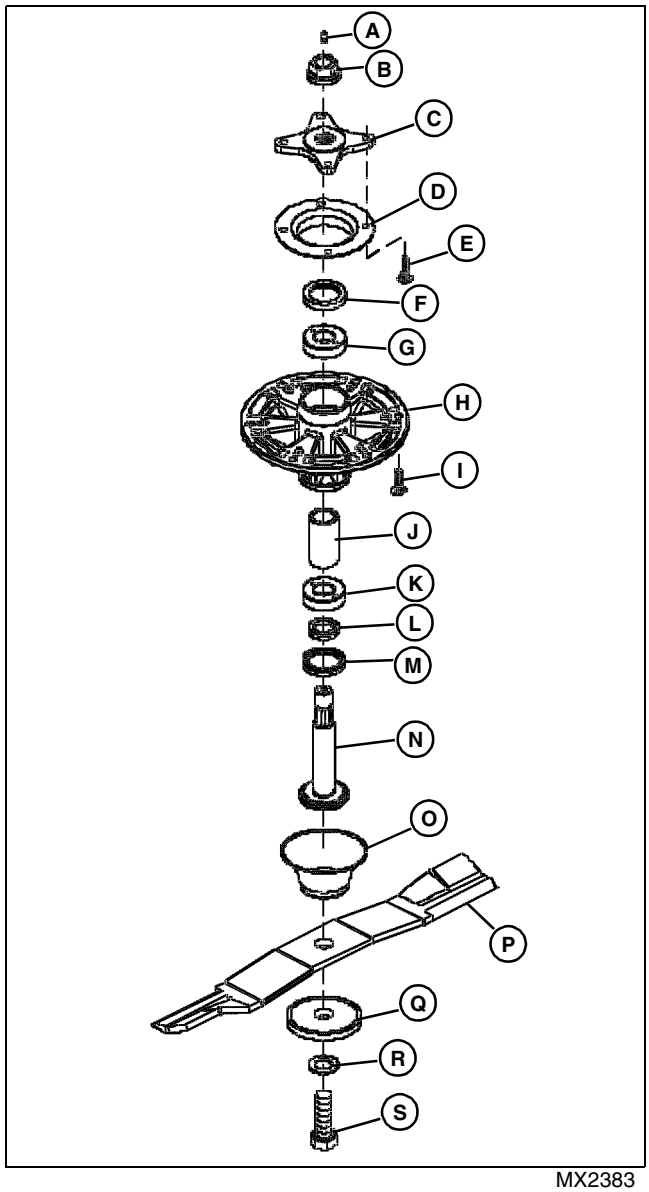
Seal Face Distance
from Lower End of Housing. . . . . 2.57 mm (0.10 in.)

Blade Cap Screw Torque . . . . . 122 N•m (90 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

Disassembly and Inspection: 72-Inch Side Discharge Mower Decks



MX2383

A - Lubrication Fitting (apply grease)
B - Flanged Nut
C - Hub
D - Upper Deflector
E - Bolt (4 used)
F - Upper Seal
G - Upper Bearing
H - Housing
I - Bolt (6 used)
J - Spacer
K - Lower Bearing
L - Lower Seal Ring
M - Lower Seal

N - Spindle Shaft
O - Lower Deflector
P - Blade
Q - Blade Washer
R - Washer
S - Cap Screw

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.

1. Install blade (P), blade washer (Q), washer (R) and cap screw (S) on spindle shaft (N). Tighten cap screw to **320 N•m (236 lb-ft)**.
2. Place blade in a soft-jawed vise.
3. Remove flanged nut (B).

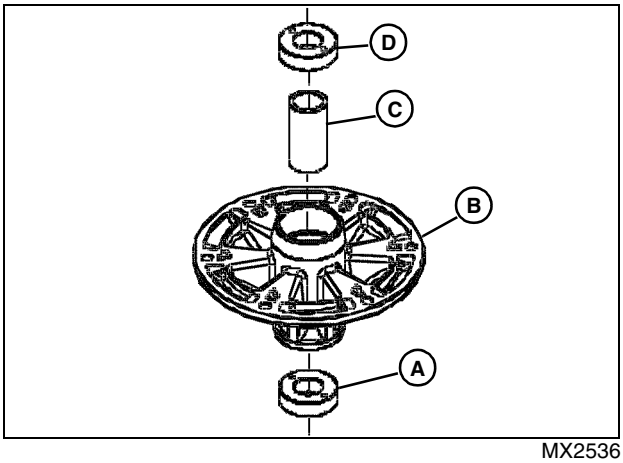
NOTE: Remove bolts (E) from hub (C) only if replacement of parts is necessary. If required, press bolts from hub to remove upper deflector (D).

4. Remove hub, upper deflector, and bolts as an assembly.
5. Remove cap screw, washer, blade washer and blade.
6. Remove spindle shaft (N) from housing (H).
7. Remove lower seal ring (L) and lower seal (M).

NOTE: Remove upper bearing (G) and lower bearing (K) only if replacement is necessary.

8. The upper bearing and lower bearing are seated against the spindle hub shoulders and cannot be removed with a press. Remove upper seal (F) and bearings using a punch.
9. Remove spacer (J).
10. Inspect all parts for wear or damage. Replace parts as needed.

Assembly: 72-Inch Side Discharge Mower Decks



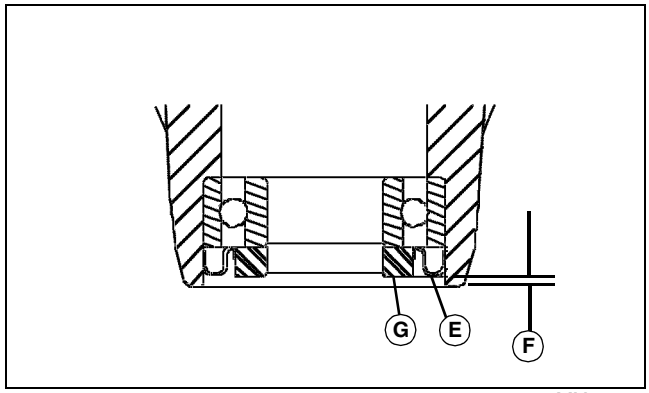
MX2536

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 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.

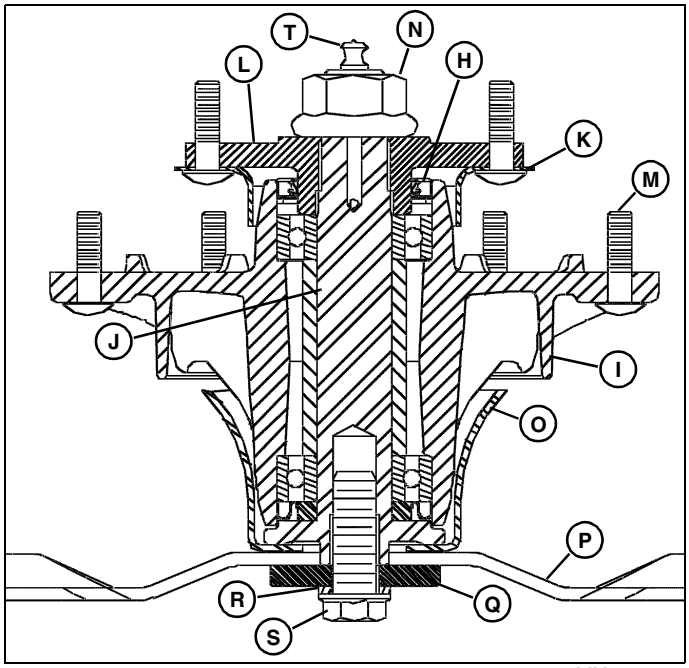
4. Using a press and disk driver, install upper bearing (D) until it rests against the bottom of the housing shoulder.

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 the specified distance (F) from the lower end of the housing.
6. Install lower seal ring (G) with the outer diameter chamfered edge toward bearing.



MX2489

7. Using a press and disk, install upper seal (H) with open side toward bearing until the face of the seal is flush with the end of the housing (I).

8. Install spindle shaft (J) into housing.

9. If disassembled, assemble the upper deflector (K), hub (L) and new bolts (M). Align holes of deflector and hub. Press bolts into hub until tight against deflector.

10. Install upper deflector, hub, and bolts as an assembly.

11. Install flanged nut (N).

IMPORTANT: Avoid damage! Blade (P) must be properly seated on the spindle, and concave side of blade washer (Q) must face toward blade.

12. Install lower deflector (O), blade, blade washer, washer (R) and cap screw (S). Tighten blade cap screw to **320 N•m (236 lb-ft)**.

13. Place blade in a soft-jawed vise.

14. Tighten flanged nut to specification.

15.Loosen blade cap screw and retighten to specification.

16. Apply specified grease to lubrication fitting (T).

Specifications:

Seal Face Distance from Lower End of Housing. . . . . 2.57 mm (0.10 in.)

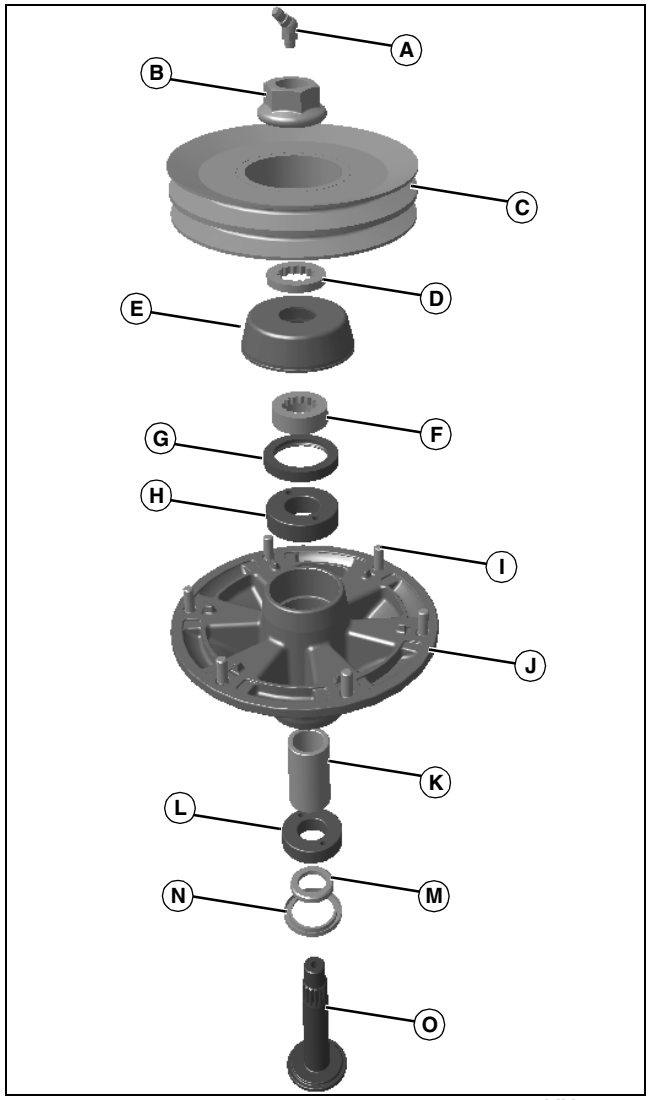
Blade Cap Screw Torque . . . . . 122 N•m (90 lb-ft)

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

Disassembly and Inspection: V-Flex Deck

IMPORTANT: Avoid damage! Always install new bearings and seals when servicing spindles.



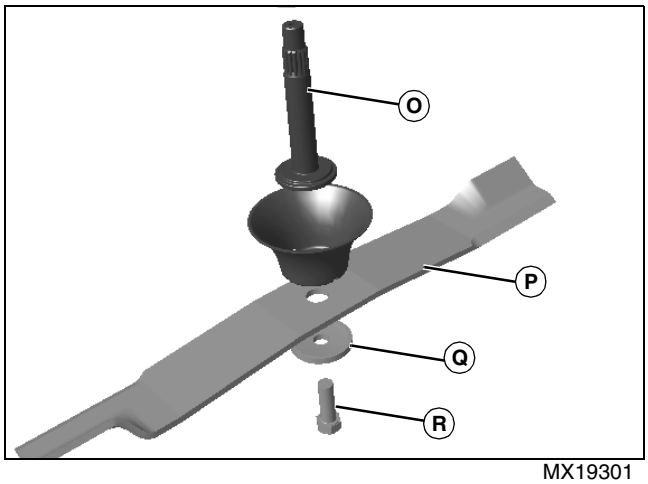
MX19302

A - Lubrication Fitting
B - Flanged Nut
C - Dual Sheave
D - Bushing
E - Upper Deflector
F - Seal
G - Oil Seal
H - Upper Bearing
I - Mounting Bolt and Flanged Lock Nut (6 used)
J - Housing
K - Spacer
L - Lower Bearing

M - Lower Seal Bushing

N - Seal

O - Spindle Shaft



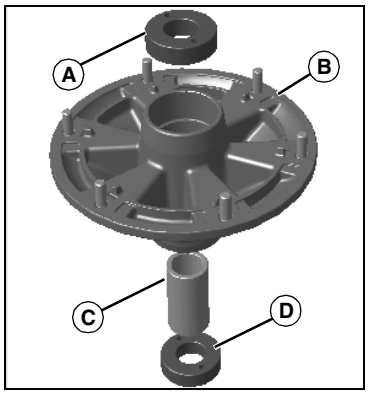
MX19301

1. Install blade (P), blade washer (Q) and cap screw (R) on spindle shaft (O).
2. Place blade in soft jawed vise.
3. Remove flanged nut (B).
4. Remove bushing (D), sheave (C), and deflector (E).
5. Remove cap screw, blade washer and blade.
6. Remove spindle shaft from housing (J).
7. Remove Lower seal (N) and lower seal bushing (M).

NOTE: Remove upper and lower bearing s (H) and (L) only if replacement is necessary.

8. Upper and lower bearing (H) and (L) are seated against spindle hub shoulder and can not be removed with a press. Remove upper and lower bearings with a punch.
9. Remove spacer (K).
10. Inspect all parts for wear or damage. Replace parts as needed.

Assembly: V-Flex Deck

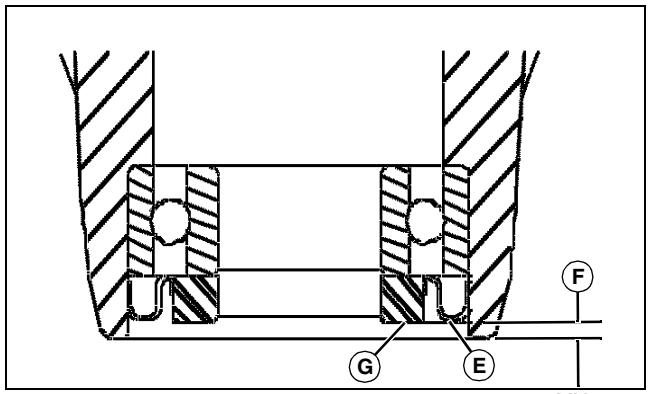


MX19302A

1. Using a press and a disk drive large enough to contact the bearing outer race, install upper bearing (A) until it is seated against the shoulder of the housing (B).
2. Turn housing over.
3. Install spacer (C). Center the spacer over upper bearing.

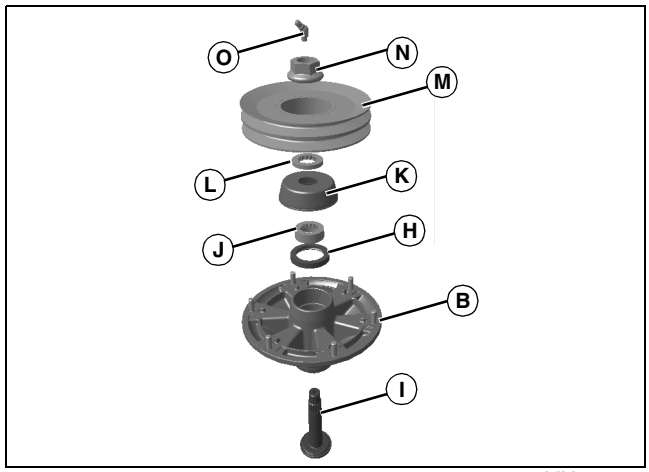
IMPORTANT: Avoid damage! Using disk drivers, support both the inner and outer races of the upper and lower bearings when installing the upper bearing. Do not support the housing by allowing it to rest on its end.

4. Using press and disk driver, install lower bearing (D) until it rest against the housing shoulder.



MX2537

5. Using a press and disk, install lower seal (E) with open side towards bearing until the face of the seal is at the specified height (F) from the lower end of the housing.
6. Install lower seal bushing (G) with the outer diameter chamfered edge toward bearing.



MX19303

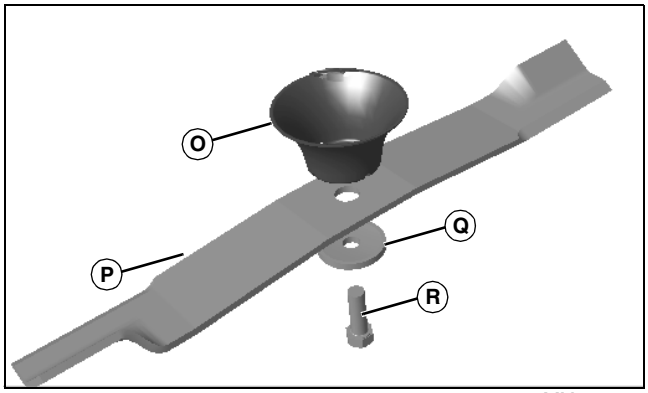
7. Using a press and disk, install upper oil seal (H) with open side toward bearing until the face of the seal is flush with end of housing (B)
8. Install spindle shaft (I) into housing.

9. Install upper seal ring (J) into housing.

10. Install bushing (L) into sheave (M) and install sheave.

11.Install flanged nut (N).

IMPORTANT: Avoid damage! Blade () must be properly seated on the spindle, and concave side of blade washer () must face toward blade.



MX19301

12.Install lower deflector (O), blade (P), washer (Q) and cap screw (R).

13.Tighten blade cap screw to 320 N•m (236 lb-ft).

14.Place blade in a soft vise jawed vice.

15.Tighten flanged nut to specification.

16.Loosen blade cap screw and tighten to specification.

17.Apply specified grease to lubrication fitting.

Specifications:

Seal Face Distance from Lower End of Housing. . . . . 2.57 mm (0.10 in.)

Blade Cap Screw Torque . . . . . 122 N•m (90 lb-ft)

Flanged Nut Torque . . . . . 255 N•m (188 lb-ft)

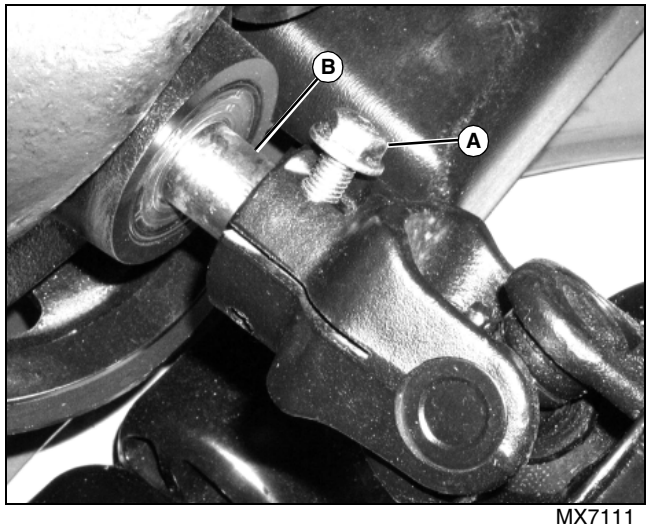
Recommended Grease. . John Deere Multi-Purpose SD Polyurea Grease or John Deere Multi-Purpose Lithium Complex Grease

Mower Deck Drive Shaft Removal and Installation

Removal:

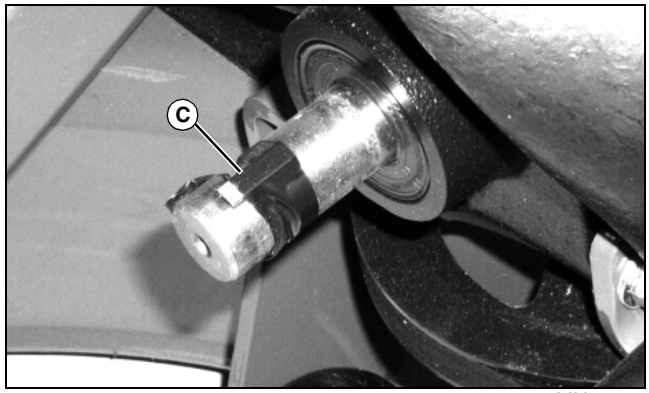
IMPORTANT: Avoid damage! Use of incorrect greases can result in premature wear of parts and component failures.

1. Lift up PTO drive shaft cover to gain access to the front PTO drive shaft universal joint.



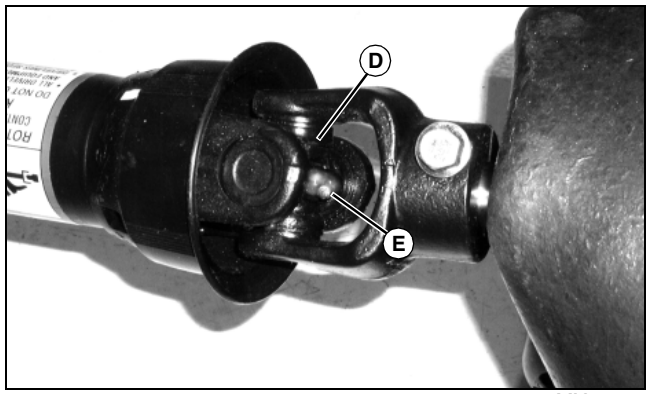
MX7111

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

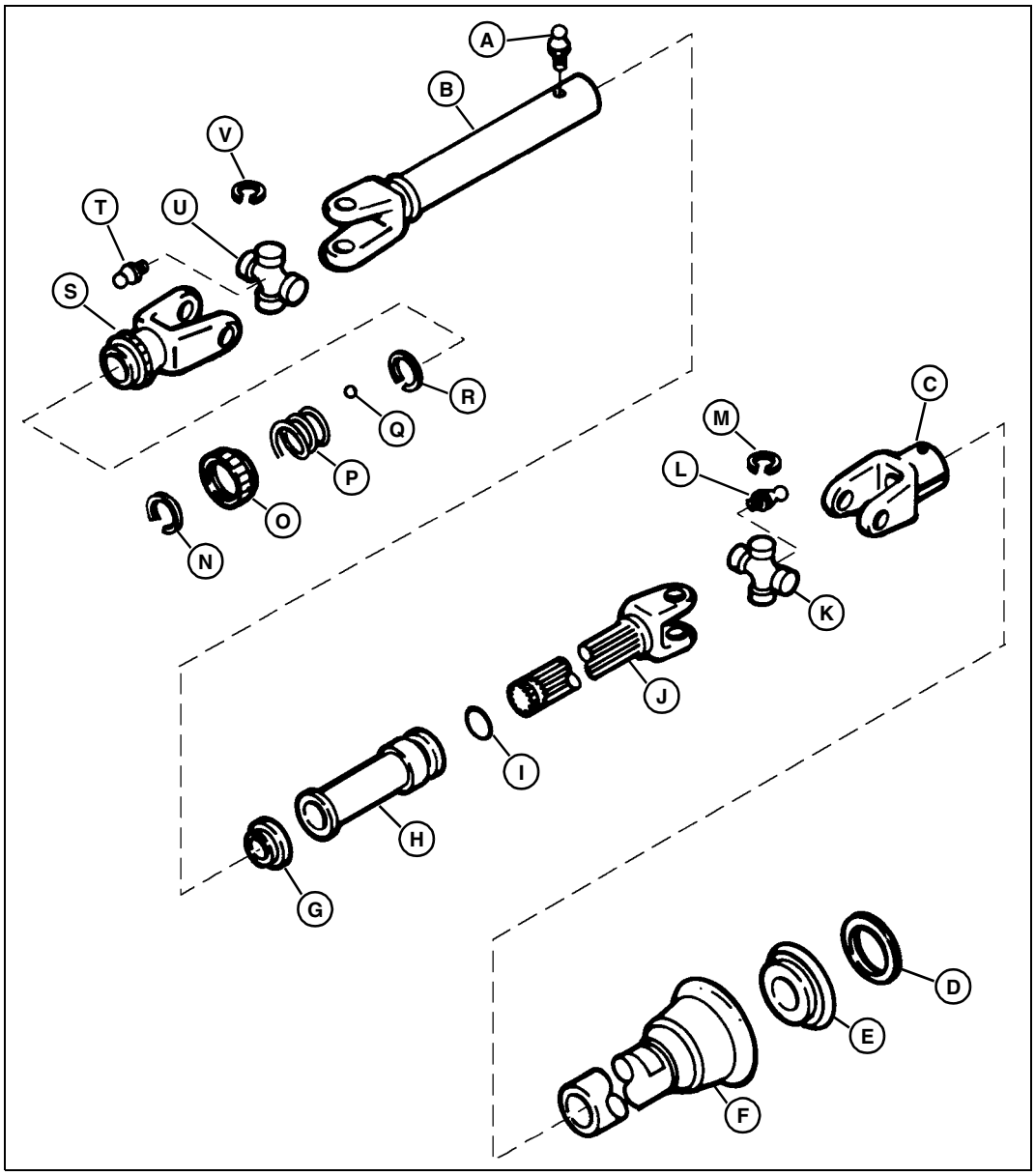
not to misplace shaft key.

- Apply a light coat of MPG-2 Multi-Purpose Grease to splines of drive shaft. (See “Anti-Corrosion Grease” on page 19 in Specifications and General Information section.)
- 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” on page 20 in Specifications and General Information section.)

Specifications:

Drive Shaft Flanged Head
Cap Screw Torque . . . . . 81 N•m (60 lb-ft)

Mower Deck Drive Shaft Repair



MX5733

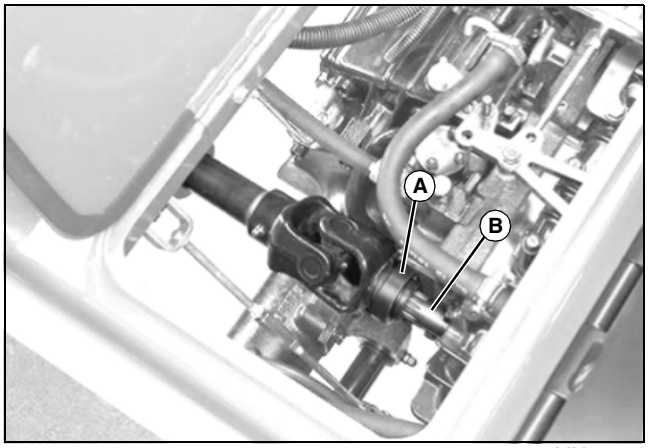
A - Lubrication Fitting
B - Yoke, with Tube
C - Yoke
D - Snap Ring
E - Bearing
F - Guard
G - Spring Pin
H - Shaft
I - Snap Ring
J - Universal Joint Yoke
K - Universal Joint
L - Lubrication Fitting
M - Snap Ring
N - Snap Ring
O - Locking Collar
P - Compression Spring
Q - Ball
R - Snap Ring
S - Universal 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” on page 19 in Specifications and General Information section.)

Mower Deck Gearbox Removal and Installation

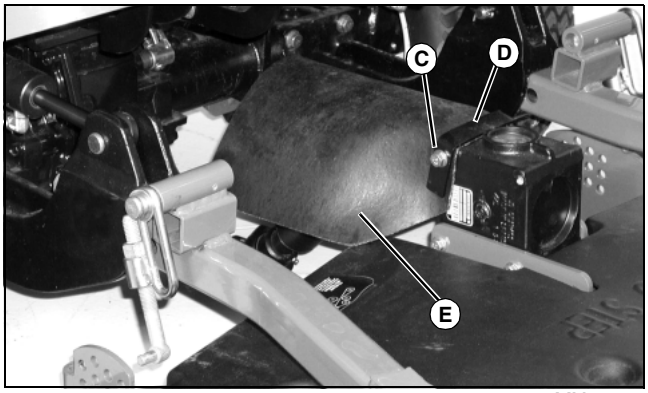
Removal:

1. Lower attachment to the ground.



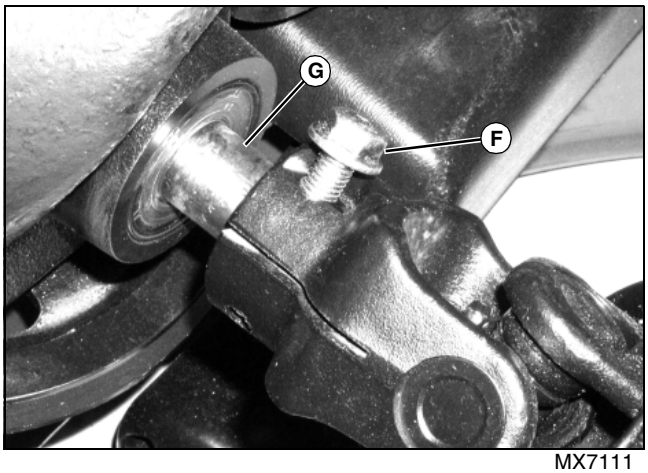
MX7093

2. Open hatch and pull collar (A) forward to remove drive shaft from PTO output shaft (B).



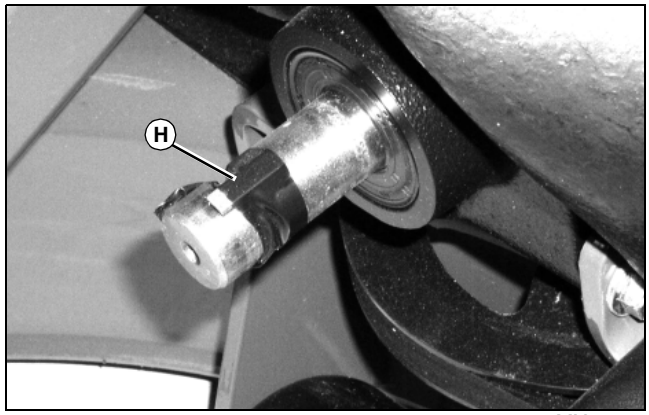
MX7028

3. Remove two cap screws (C) to remove bracket (D) and rubber shield (E).



MX7111

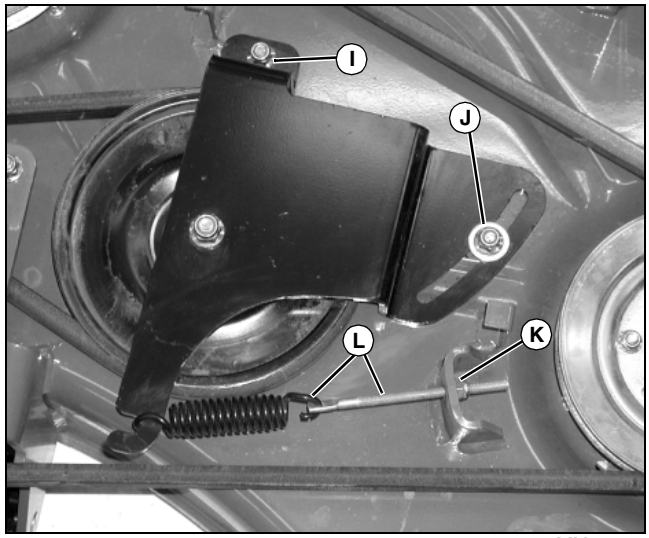
4. Remove cap screw (F) to remove drive shaft from PTO gearbox input shaft (G).



MX7109

5. Using care not to misplace shaft key (H), wrap a piece of tape around shaft key and input shaft.

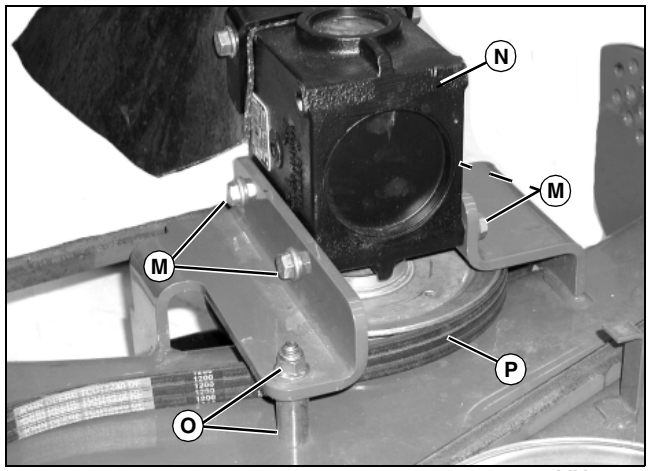
6. Remove the belt shield.



MX8826

7. Loosen nuts (I) and (J) on belt tensioning bracket.

8. Remove nut (K), tension spring and rod (L).



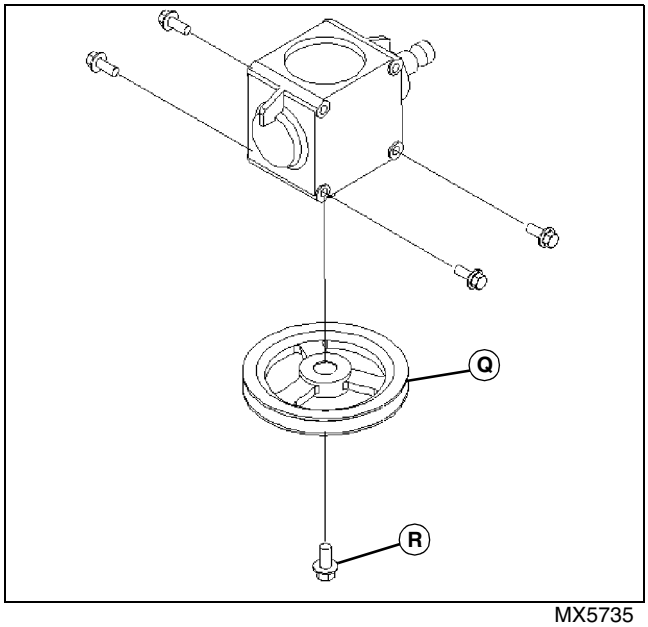
MX8828

9. Remove four cap screws (M) holding mower deck gearbox (N) to frame.

- 72-inch deck only: remove support bushing (O).

10. Slide gearbox out from mounting brackets, and remove drive belt (P) from gearbox sheave.

NOTE: Gearbox sheave-to-shaft is a tapered joint and may require a puller.



MX5735

11. Remove cap screw (R) to remove drive sheave (Q) from gearbox.

12. 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.
- 72-inch deck only: install the support bushing, cap screw and nut.
- Install tension spring, rod and adjusting nut. Adjust belt tension to specification. (See “60, 62 and 72-inch Mower Drive Belt Tension Check and Adjustment” on page 765)
- 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. (See “Mower Deck Drive Shaft Removal and Installation” on page 784)

Specifications:

Tightening Torques:

Drive Sheave Cap Screw . 129 ± 9.5 N•m (95 ± 9.5 lb-ft)

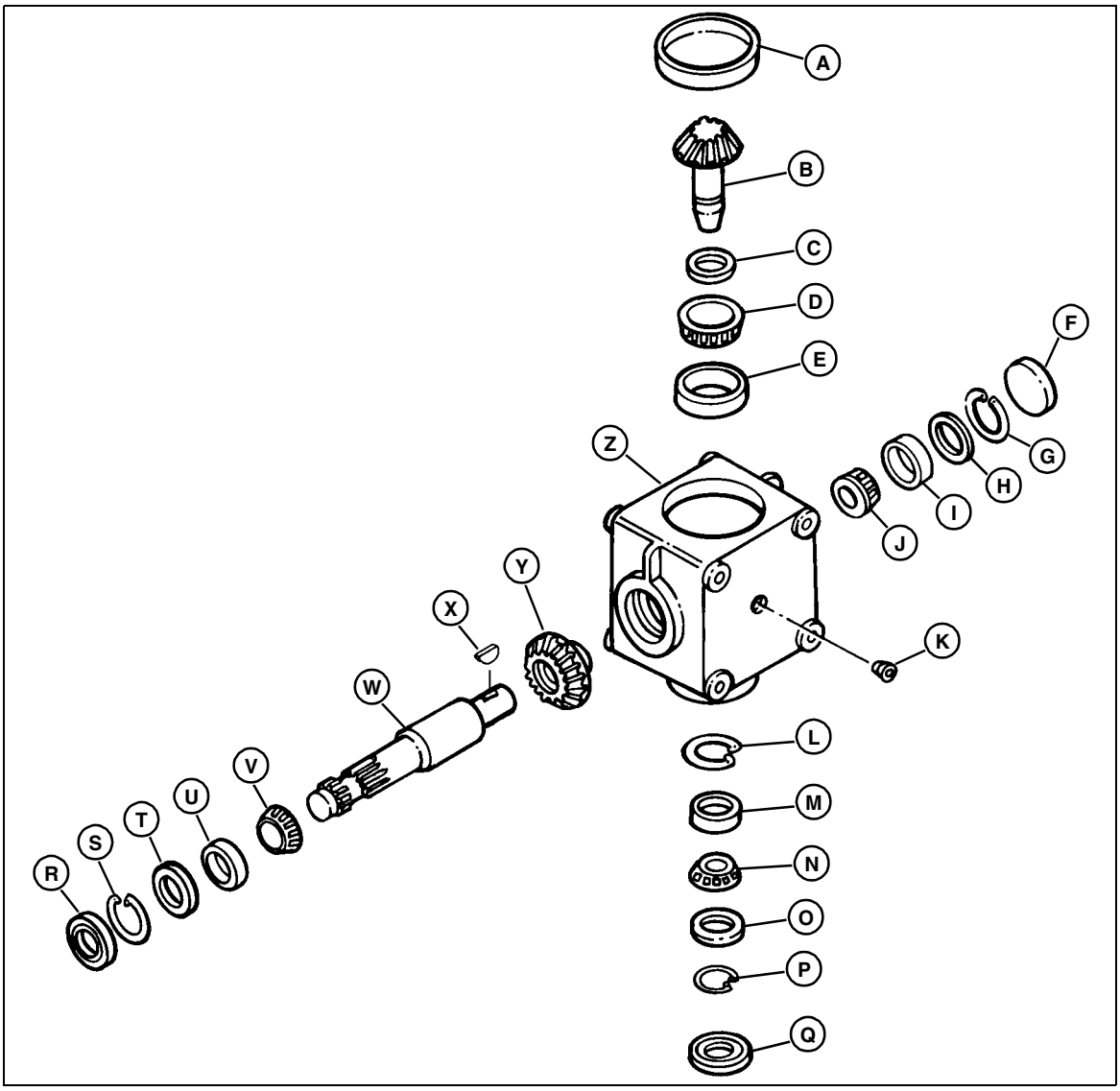
Gearbox-to-Frame Cap Screw. . . . . 99 N•m (73 lb-ft)

Drive Shaft Cap Screw. . . . . 81 N•m (60 lb-ft)

Drive Belt Tension Adjustment:

Drive Belt Tension Spring Length . 138 mm (5-7/16 In.)

Mower Deck Gearbox Repair



MX5738

A - Plug
B - Output Shaft with Gear (26 teeth - 60-inch and 72-inch deck, 24 teeth - 62-inch deck)
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 (23 teeth - 60-inch and 72-inch deck, 24 teeth - 62-inch deck)
Z - Housing

- Inspect all parts for wear or damage. Replace seals or plugs as needed. If gears are worn or damaged, replace gearbox assembly.

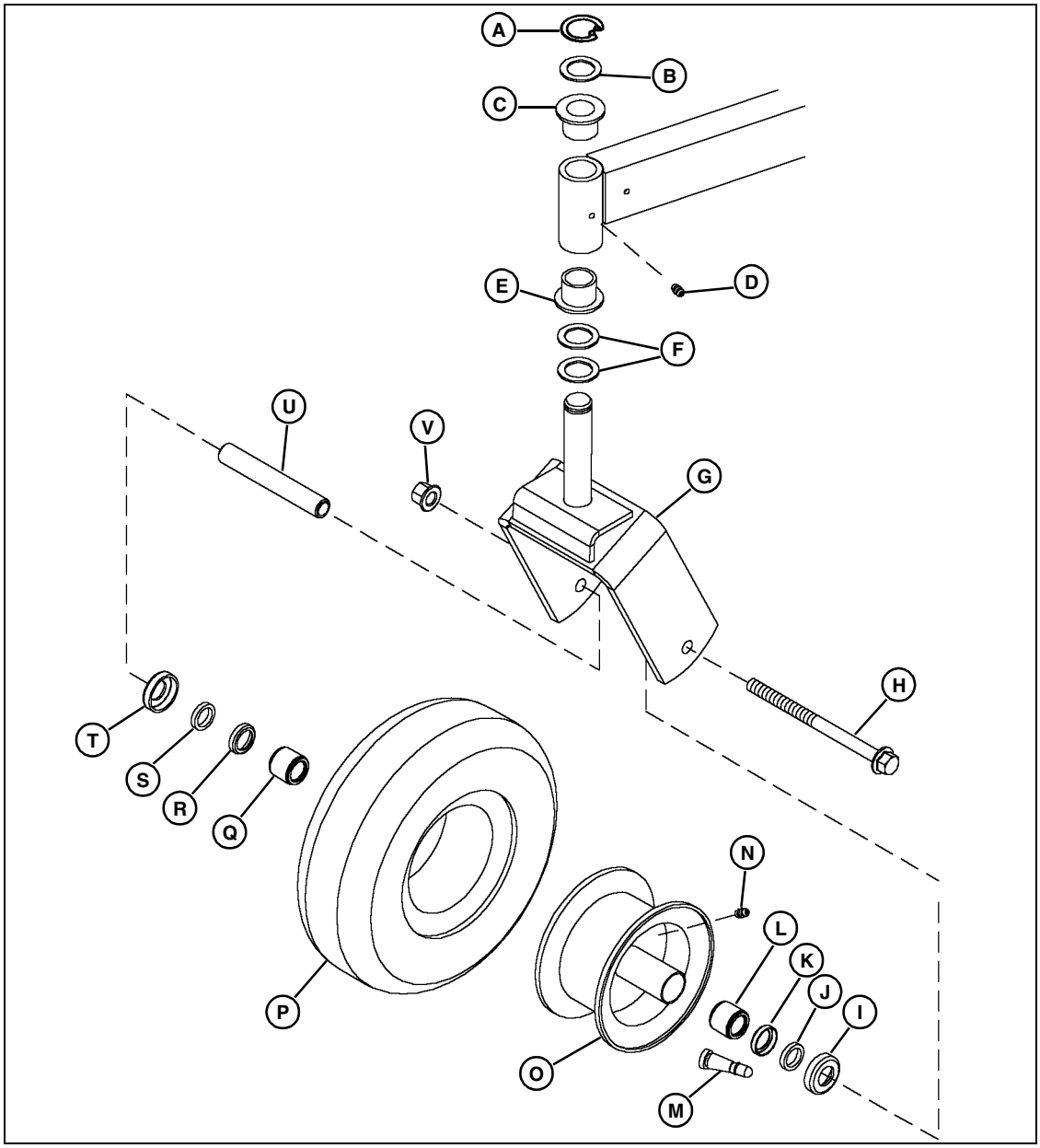
IMPORTANT: Avoid damage! Do not overfill the gearbox with oil. Damage to internal gearbox seal will result.

NOTE: Gearbox oil capacity is approximately 0.4 L (13.5 oz).

- Fill gearbox to proper level with approved gear oil. (See "Oil and Lubricant Specifications" on page 18 in Specifications and General Information section.)

Caster Wheels, Yoke and Bearings

Repair:

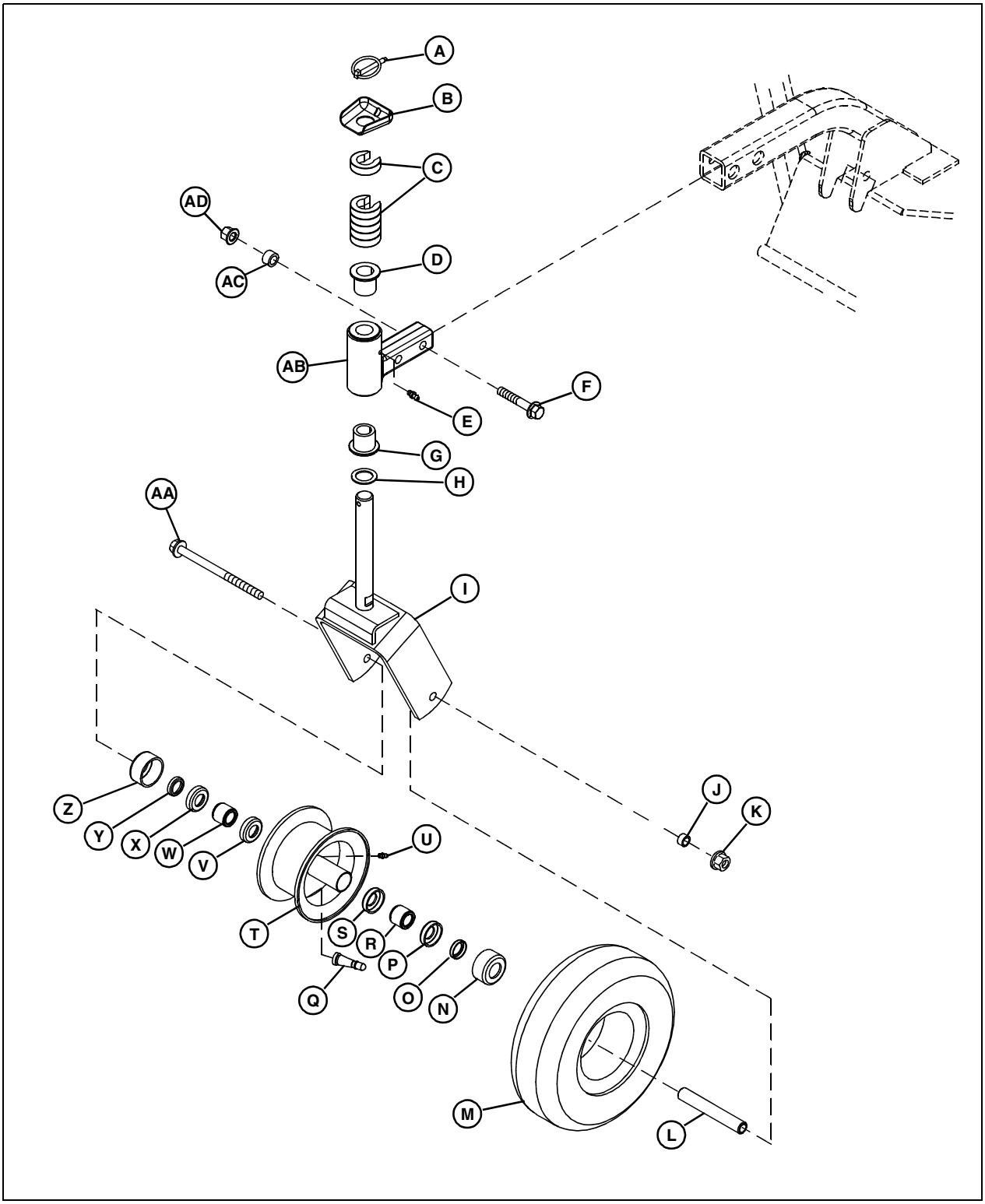


MX16133

Picture Note: 60-Inch and 72-Inch Mower Decks

A - Snap Ring
B - Washer
C - Bushing
D - Lubrication Fitting
E - Bushing
F - Washer (2 used)
G - Yoke
H - Cap Screw
I - Cap
J - Washer
K - Cap
L - Roller Bearing
M - Valve Stem

N - Lubrication Fitting
O - Rim
P - Tire
Q - Roller Bearing
R - Cap
S - Washer
T - Cap
U - Bushing
V - Lock Nut



MIF MX2363

Picture Note: 62-Inch Mower Deck

A - Quick Lock Pin
B - Pin Guard

C - Spacer (6 used)
D - Bushing
E - Lubrication Fitting
F - Cap Screw (2 used)
G - Bushing
H - Washer (2 used)
I - Yoke
J - Spacer
K - Lock Nut
L - Bushing
M - Tire
N - Cap
O - Washer
P - Cap
Q - Valve Stem
R - Roller Bearing
S - Cap
T - Rim
U - Lubrication Fitting
V - Cap
W - Roller Bearing
X - Cap
Y - Washer
Z - Cap
AA- Cap Screw
AB- Removable Pivot
AC- Bushing (2 used)
AD- Lock Nut (2 used)

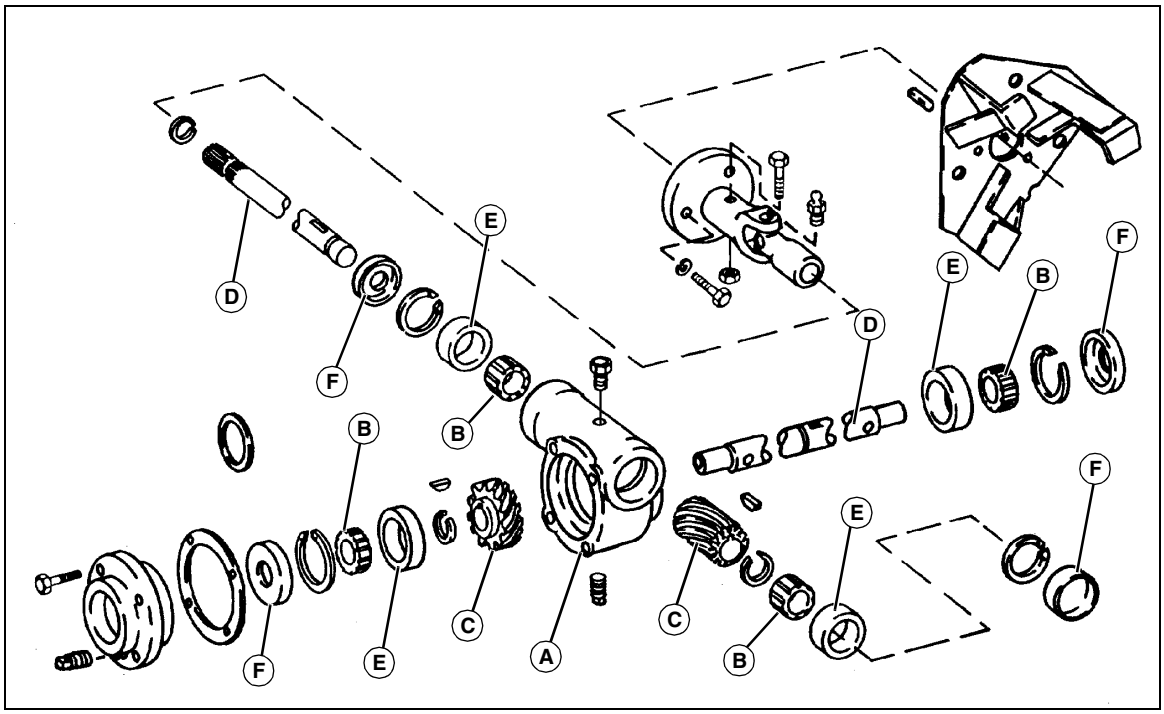
- Inspect all parts for wear or damage. Replace parts as needed.
- Apply multi-purpose grease to lubrication fittings (D, N for 60-inch and 72-inch mower decks) and (E, U for 62-inch mower deck).
- Tighten caster wheel axles to specification.
- If tire is replaced, inflate tire to specified inflation pressure.

Specifications:

Caster Wheel Axle
Tightening Torque . . . . . 80 N•m (60 lb-ft)

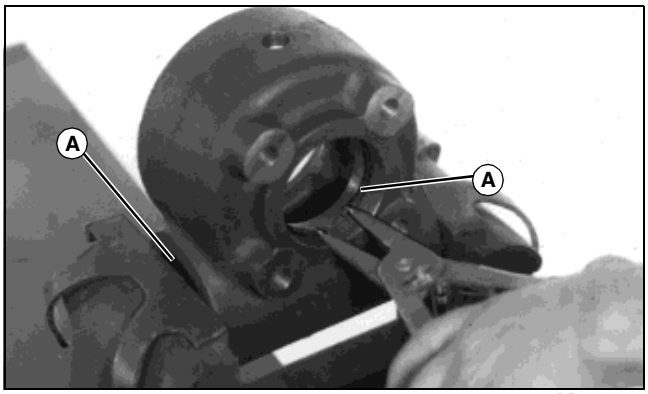
Caster Tire Inflation Pressure. . . . . 152 kPa (22 psi)

60 Snowblower Gear Case Inspection



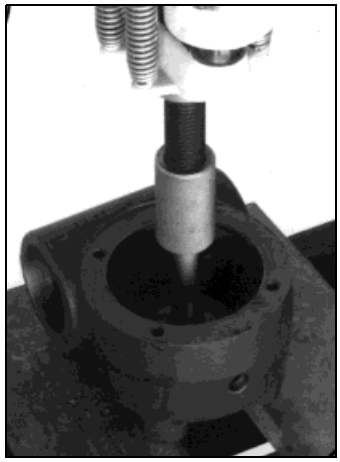
1. Inspect housing (A) for cracks.
2. Inspect bearings (B) for wear.
3. Inspect gears (C) for chipped, worn or broken teeth.
4. Inspect shafts (D) for wear and straightness.
5. Inspect bearing caps (E) for wear and galling.
6. Inspect end caps (F) for cracks or distortion.
7. Replace parts as required when assembling gear case.

Snowblower Gear Assembly



M77731

1. Install snap rings (A).



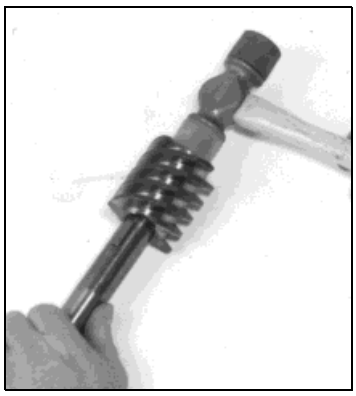
M77732

2. Press bearing cups into case until they bottom out against snap rings.



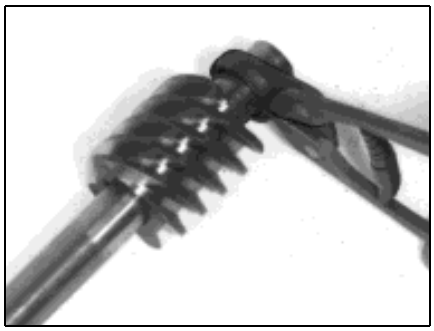
M77733

3. Press oil seals into case until they are flush with flat surface of case.



M77735

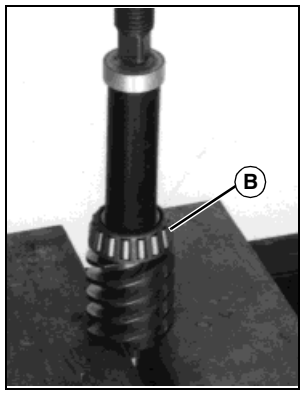
4. Place key in input shaft. Align slot in worm gear with key and tap into place with soft faced hammer.



M77734

5. Install retaining ring with D-05327ST retaining ring pliers.

IMPORTANT: Avoid damage! Do not press on bearing cage.



M77736

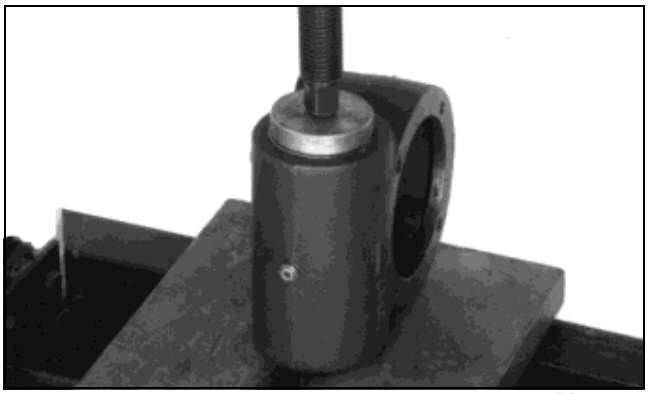
6. Press bearing (B) on plain end of input shaft until bottomed on retaining ring.

7. Clean burrs off shaft and install bearing.



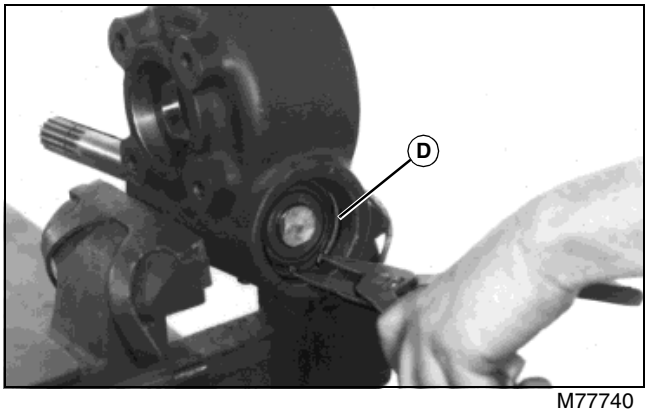
M77737

8. Put bearing cup (C) over bearing (plain end).



M77738

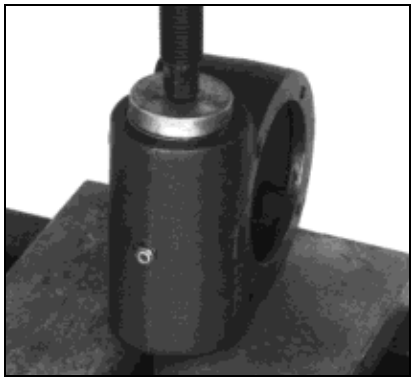
9. Press bearing cup into case until press plate bottoms against input shaft. Remove press plate and use thin wall pipe with large enough diameter to clear bearing. Press bearing cup until below snap ring groove.



M77740

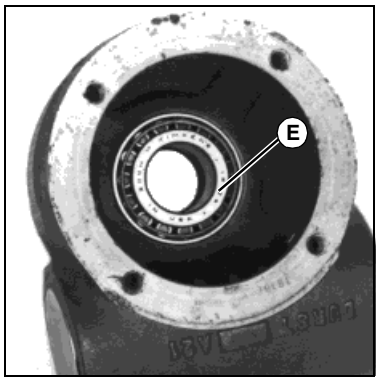
10.Install snap ring (D) with snap ring pliers.

11.Turn input shaft to seat bearings in cups. Push and pull input shaft to check for excessive end play. Use a dial indicator to measure end play. Maximum end play is 0.076 mm (0.003 in.). If end play exceeds this tolerance remove snap ring and install shim under snap rings.



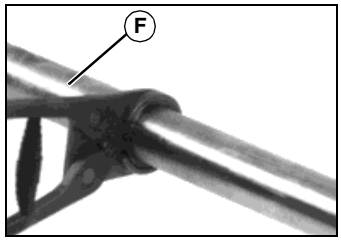
M77741

12.Press cap in case until flush with surface.



M77742

13.Put bearing cup (E) in case.

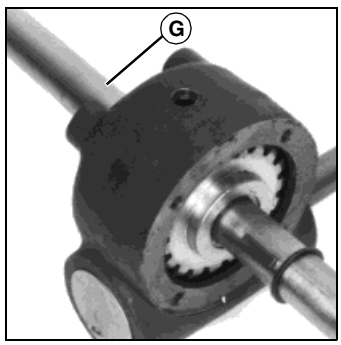


M77743

14.Install retaining ring in groove on output shaft (F) with JDT-1 retaining ring pliers.

15.Put key in shaft and slide gear over key.

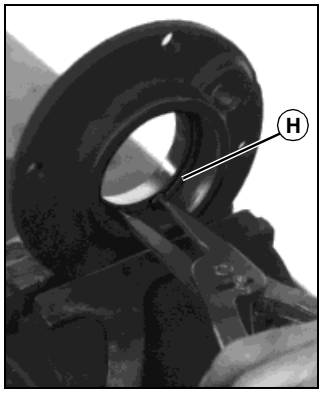
16.Grease an oil seal and insert shaft through case and oil seal.



M77744

17.Turn input shaft (G) and set gear teeth in worm gear.

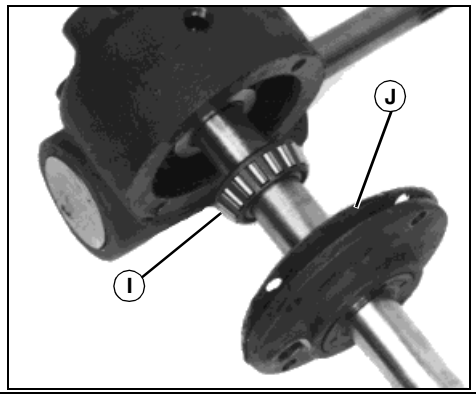
18.Press bearing cup into cover far enough to install retaining ring.



M77745

19.Install snap ring (H).

20.Press new seal into cover until flush with end cap.

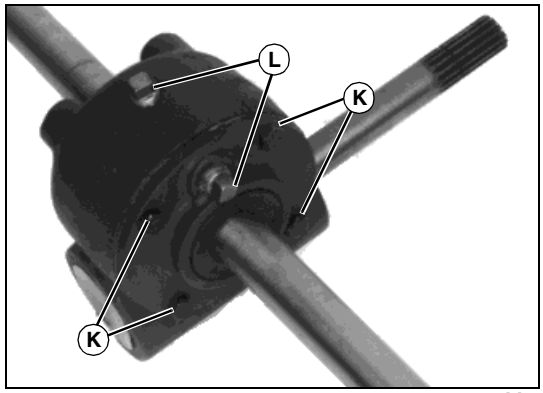


M77746

21.Install bearing (I) on shaft.

22.Install new gasket (J).

23.Slip cover over shaft.



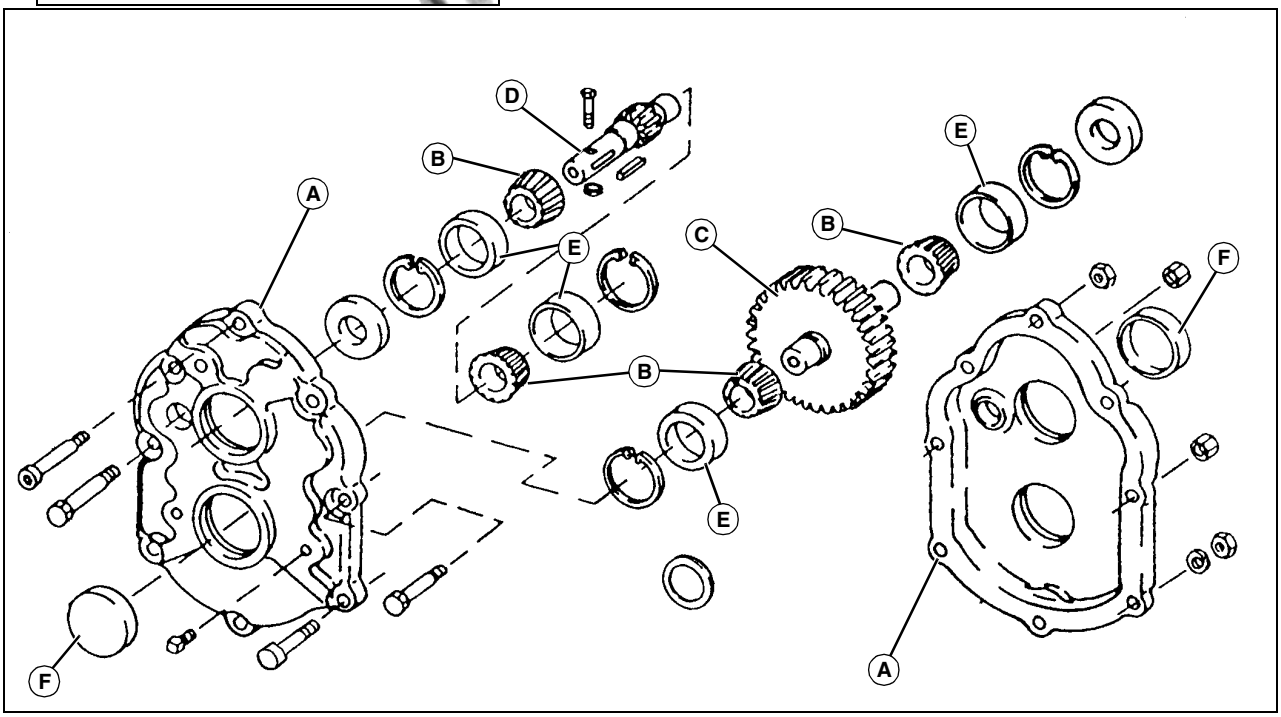
M77747

24.Secure cover with four cap screws (K). Tighten to 20-24 N•m (180-216 lb-in.).

25.Add 0.4 L (13.5 oz) of John Deere GL-5® Gear Oil-SAE 80W-90.

26.Apply loctite 592 pipe sealant with teflon to pipe plugs (L). Tighten pipe plugs to 18 N•m (160 lb-in.).

Snowblower Main Case Inspection



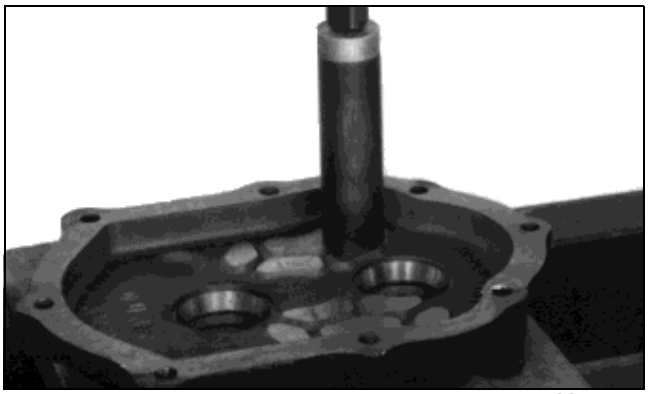
M78268

1. Inspect housing (A) for cracks.

2. Inspect bearings (B) for wear.
3. Inspect gear (C) for chipped, worn or broken teeth.
4. Inspect shaft (D) for wear and straightness.
5. Inspect bearing caps (E) for wear or galling.
6. Inspect end caps (F) for cracks or distortion.
7. Replace parts as required when assembling gear case.

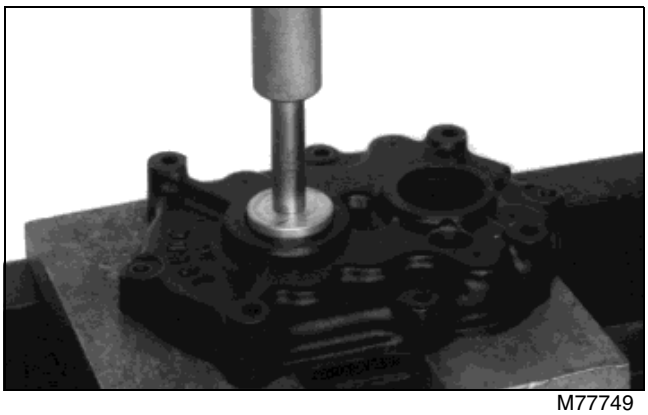
Snowblower Main Case Assembly

1. Clean sealing adhesive off both gear case halves before assembly. Wash parts in cleaning solvent and dry them.



M77748

2. Press bearing cups far enough into each case half so snap rings can be installed.



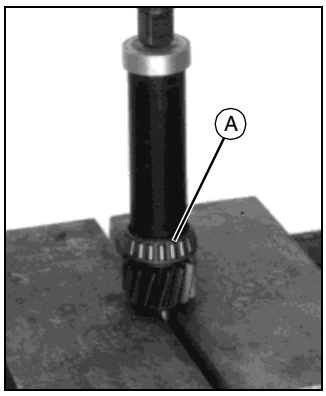
M77749

3. Install snap rings in slot behind cups in each case half. Invert case half and press bearing cup tight against snap ring.

NOTE: Some gear cases may have a shim under snap ring. If a shim was removed on disassembly, install it to maintain correct end play.

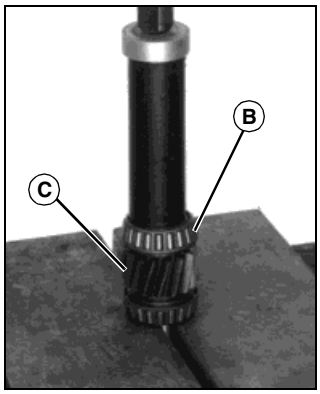
4. Press oil seals into each case half.

5. Apply RTV sealant around outside edge of each cap. Press cap into each case half.



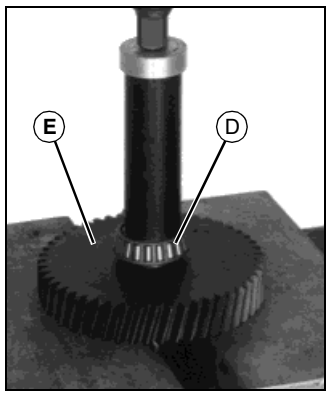
M77750

6. Press bearing (A) on short end of small gear input shaft until bearing bottoms against gear shoulder. Do not press against bearing cage.



M77751

7. Press bearing (B) on long end of small gear (C) input shaft.

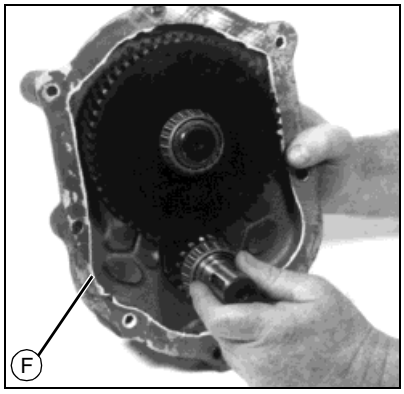


M77752

8. Press bearing (D) on short end of large gear shaft until bottomed against gear (E).

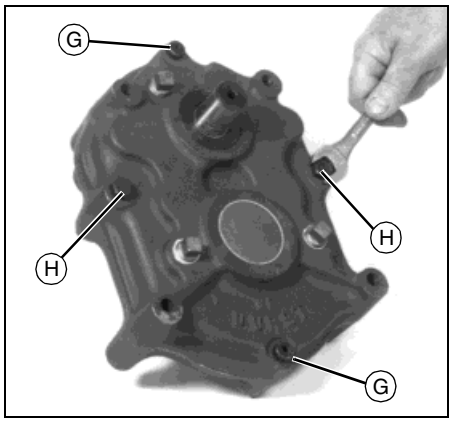
9. Press bearing on long end of large gear shaft until bottomed against gear.

10. Put gear shaft and bearing assemblies in case half.



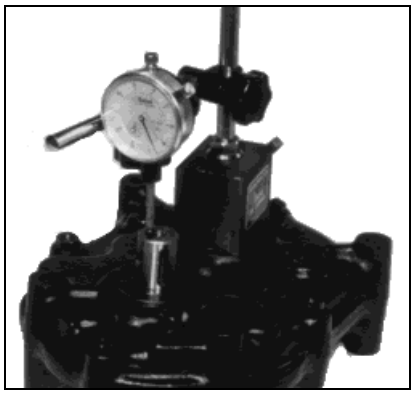
M77753

11.Apply RTV sealant (F) evenly around sealing surface of each case half.



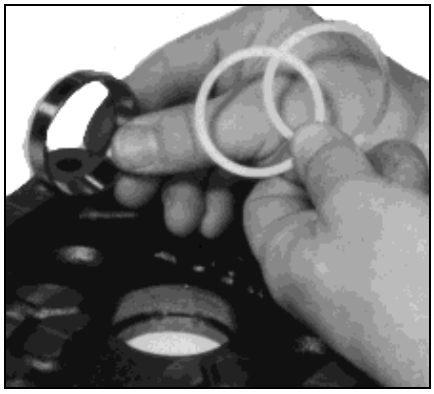
M77754

12.Put gear case halves together and install two socket head screws (G) and cap screws (H). Tighten socket head screws to 26 N•m (228 lb-in.). Tighten cap screws to 41 N•m (34 lb-ft).



M77756

13.Check input and output shaft end play. End play should be 0.025 - 0.15 mm (0.001 - 0.006 in.).



M77755

14.If necessary disassemble gear case and add or remove shims to get correct end play.

IMPORTANT: Avoid damage! Backlash is 0.15 - 0.4 mm (0.006 - 0.016 in.), rolling drag torque 1.736 - 8.68 lb-in. Backlash is adjusted by added or removing shims.

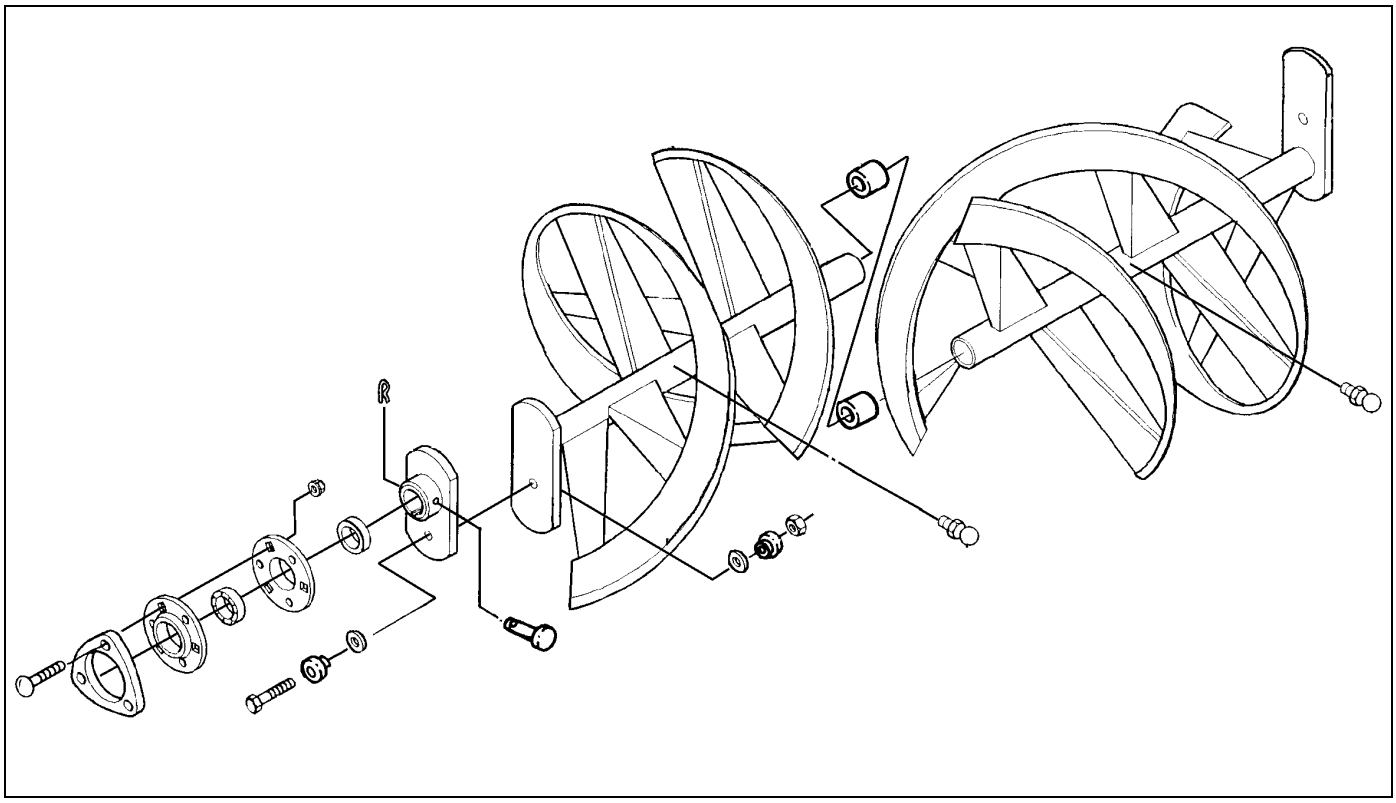
15.When end play and backlash are within limits, fill gear case with 0.4 L (13.5 oz) of John Deere GL-5® Gear Oil.

16.Apply loctite 592 pipe sealant with teflon to pipe plugs. Torque pipe plugs to 18 N•m (160 lb-in.).

17.Reinstall gear case and power shaft (make sure key is installed in gear case shaft). Install cap screw and elastic lock nut (no specified torque)

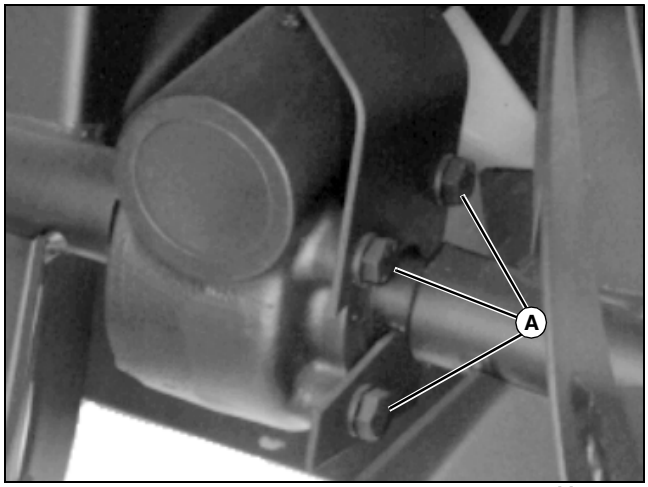
18.Tighten main gear case to snowblower housing bolts to 47.5 N•m (35 lb-ft).

Installing Snowblower Rotor and Fan



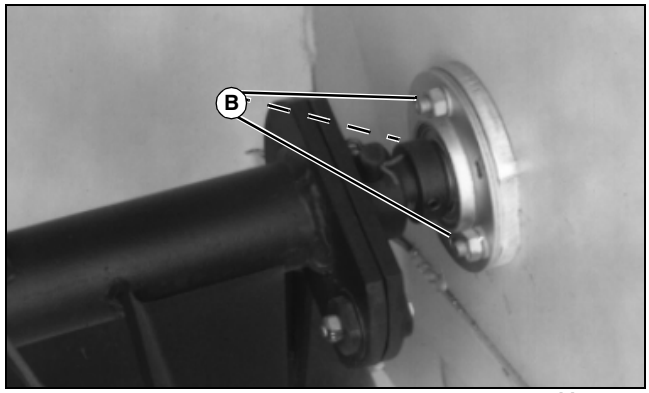
MP16933

1. Remove rotor assembly.



M85003

2. Remove cap screws and lock washers (A) securing support to worm gear case.

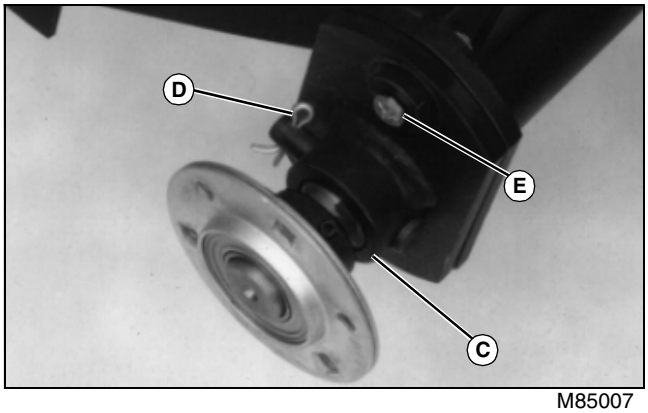


M85006

3. Remove three flanged bolts (B) securing rotor to each side of housing.

4. Remove rotor by pulling and lifting it forward out of housing.

5. Remove bearings, shear coupling and flighting.

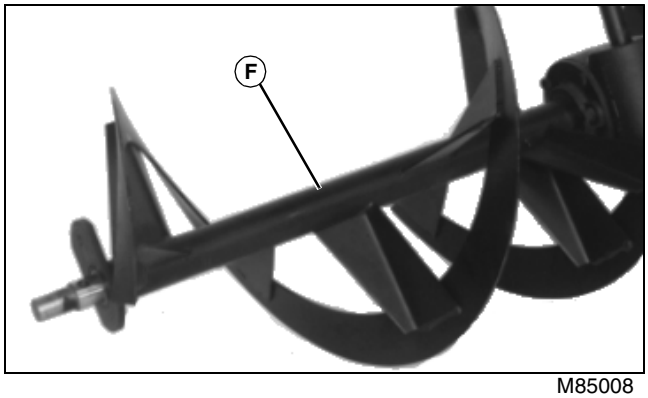


M85007

6. Loosen locking collar set screw. Loosen locking collar (C) from bearing by tapping it counterclockwise with a punch and hammer. Remove flanged and bearing and locking collar.

7. Remove cotter pin (D) and drilled pin.

8. Remove shear bolt (E) and coupling.



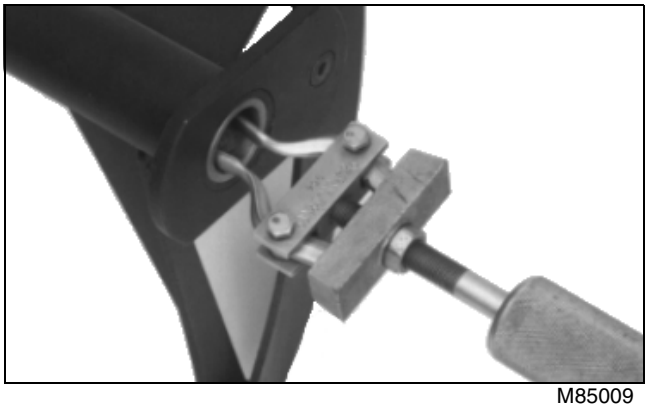
M85008

9. Slide or pull flighting (F) off drive shaft.

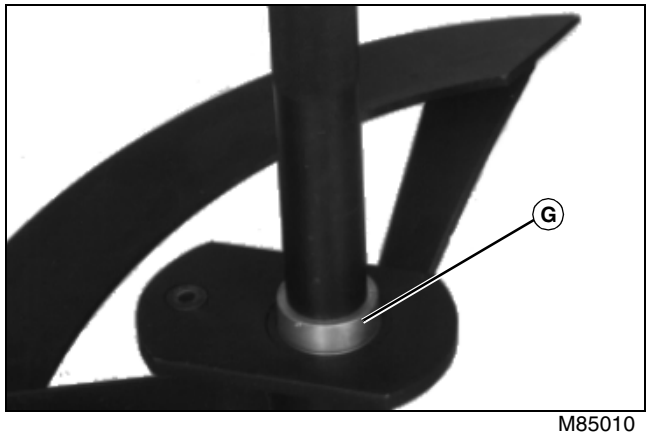
10.Replace fan or coupling plate and reinstall assembly.

11.Tighten nut on cap screw securing fan coupling to gear case shaft.

12.Replace flighting bearings.


M85009

13.Remove bearing with a slide hammer puller on each end of flighting.

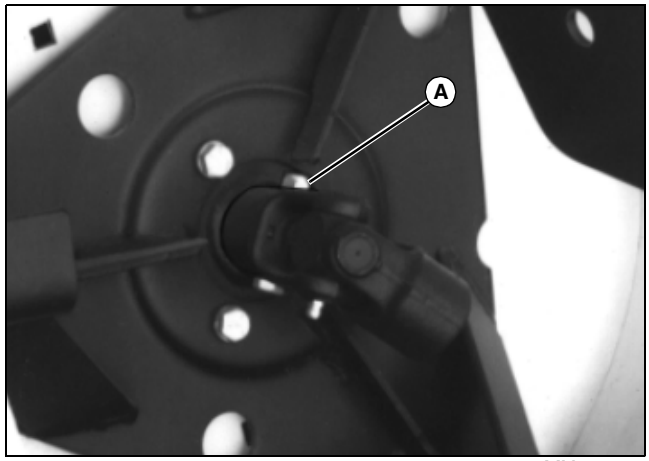


M85010

14.Press new bearing (G) flush to end of flighting shaft.

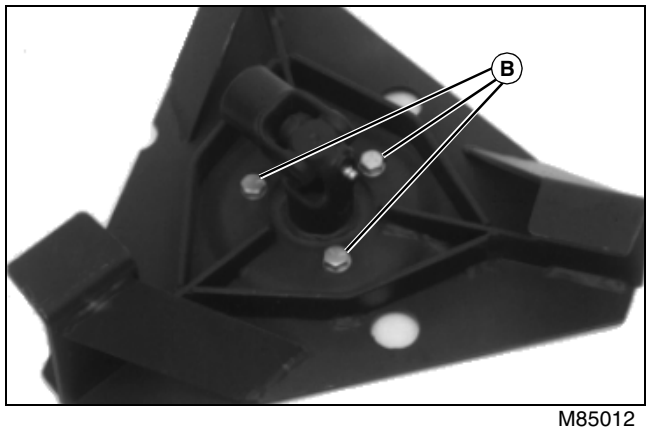
Replacing Fan or Coupler

1. Remove rotor from housing. (See Remove Rotor Assembly).



MX85011

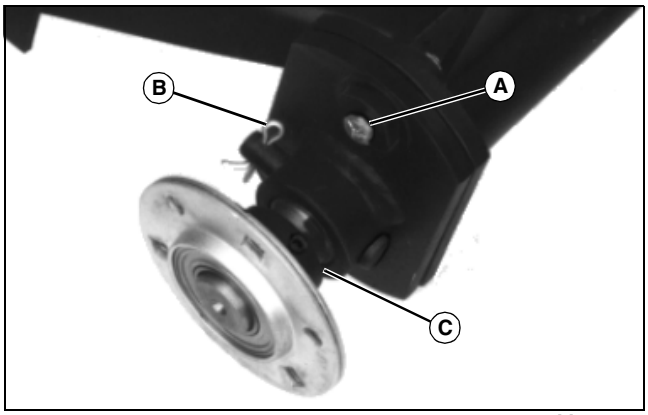
2. Remove cap screw (A) and pull fan assembly off gear case shaft. Be careful not to lose key in shaft.



M85012

3. Remove three cap screws (B) and lock washers securing fan to coupling plate. Remove fan from coupling plate.

Installing Rotor Assembly

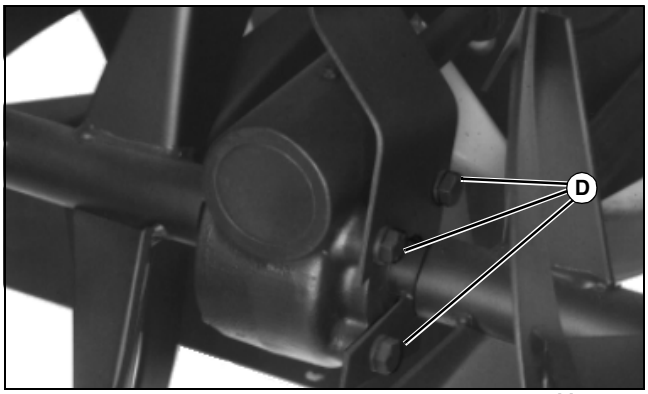


M85013

1. Install shear coupling and shear bolt (A). Tighten nut on shear bolt only enough to draw couplings together. Do not overtighten nut.

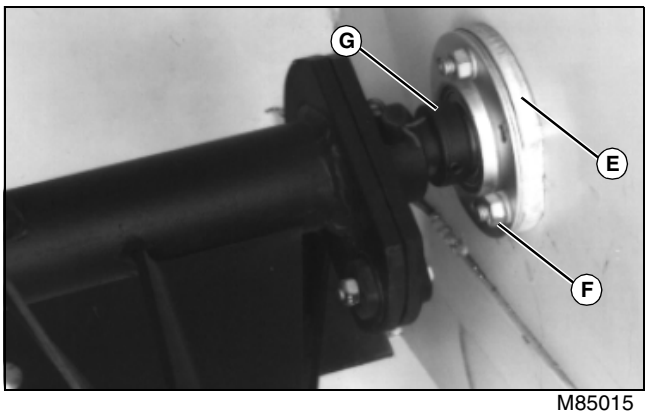
2. Install drilled pin and cotter pin (B). Spread ends of cotter pin.

3. Install locking collar (C) and bearing and flange assembly.



M85014

4. Install rotor assembly in support slot. Install cap screws and lock washers (D). Leave cap screws loose until final assembly.



M85015

5. Install spacer (E) between housing and flange assembly.

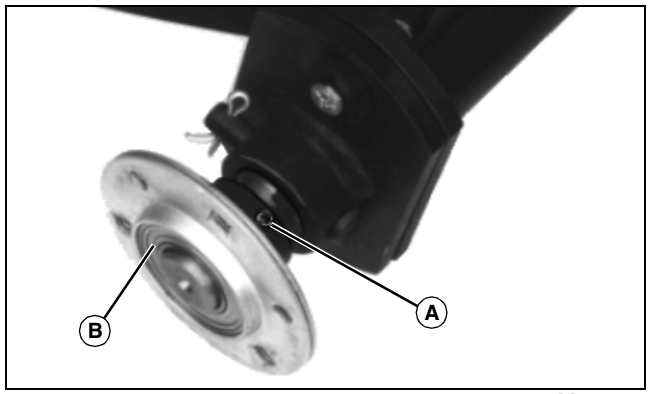
6. Install three carriage bolts, lock washers and nuts (F). Leave nuts loose on bolts on one end of rotor until other assembly is installed on other end of rotor. Then tighten nuts on bolts on both assemblies.

7. Tighten locking collar (G) onto bearing. Then tighten set screw in locking collar.

8. Tighten cap screws installed in Step 4.

Replacing Rotor Bearing

1. Remove rotor from housing.



M85005

2. Loosen set screw (A) in locking collar. Loosen locking collar by tapping it counterclockwise with a punch and hammer.

3. Remove old bearing (B) from shaft with flanges. Separate flanges and install new bearing. Slide bearing and flange assembly back on shaft. Reinstall rotor assembly in housing.

4. Turn locking collar on bearing. Tighten locking collar by tapping it clockwise with a hammer and punch.

5. Tighten set screw in locking collar.

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Rear Wheel Removal and Installation 809
Fuel Tank Removal and Installation 811
Fuel Tank Removal and Installation - 1500 Series 812

MISCELLANEOUS TABLE OF CONTENTS

MISCELLANEOUS SPECIFICATIONS

Specifications

Repair Specifications

Tire Inflation Pressures:

Front Tires	**140 kPa (20 psi)**
Rear Tires	**140 kPa (20 psi)**

Tightening Torques:

Front Wheel Bolt Torque	**225 N•m (165 lb-ft)**
Rear Wheel Bolt Torque - 2WD	**82 N•m (60 lb-ft)**
Rear Wheel Bolt Torque - 4WD	**225 N•m (165 lb-ft)**

Traveling Speeds:

Forward	**0 - 7.5 km/h (0 - 12 mph)**
Reverse	**0 - 3.1 km/h (0 - 5 mph)**

Tire Dimensions:

Front Drive Tires - Standard	**23 x 10.50 - 12**
Front Drive Tires - Optional	**23 x 8.50 - 12**
Front Drive Tires - Dual	**23 x 8.50 - 12**
Rear Tires - 2WD	**18 x 8.50 - 8**
Rear Tires - 4WD	**18 x 8.50 - 10**

Repair

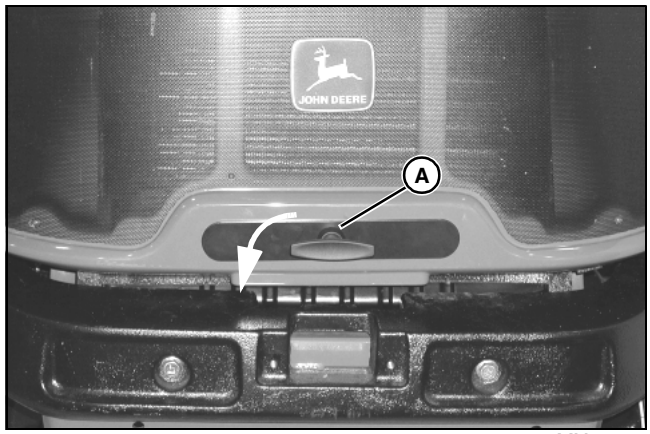
Engine Cover Removal and Installation

CAUTION: Avoid injury! To avoid pinched fingers, carefully open and close the engine cover by using the handle provided on the rear of the machine.

IMPORTANT: Avoid damage! Do not operate the machine with the engine cover in the opened position.

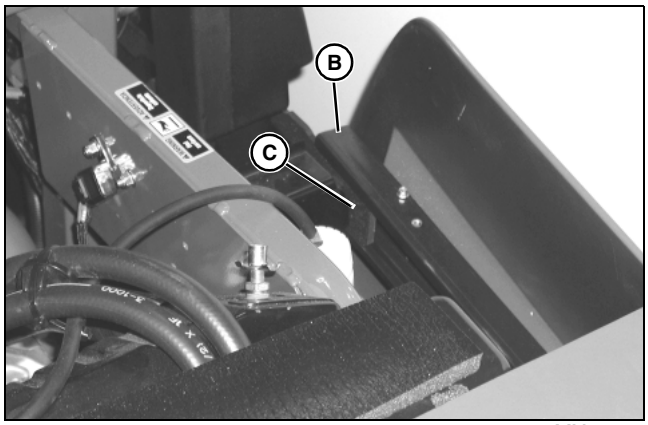
NOTE: Some later models have tee-handle-type latches. Prior to removal, check machine to determine which latch type is installed.

Removal: Tee-Handle-Type (Later Models)



MX5720

1. Turn tee handle (A) counterclockwise to unlock engine cover. Lift and pull rearward on handle.

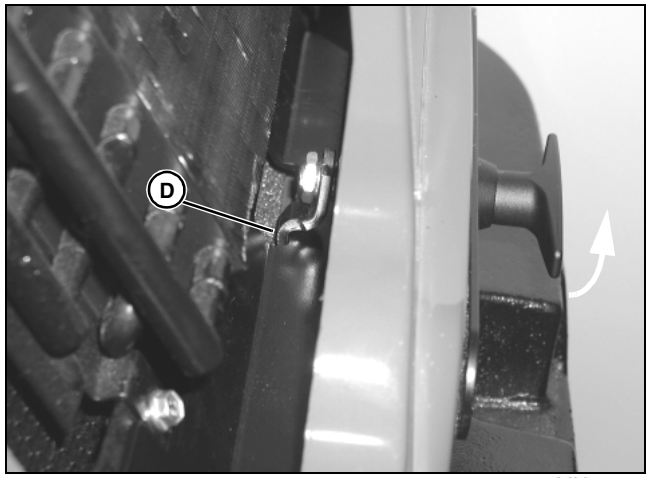


MX5723

2. Pull engine cover rearward until guides (B) are released from left and right side slide track (C). Remove engine cover from machine.

Installation: Tee-Handle-Type (Later Models)

1. Line up guides on left and right side slide tracks. Push on engine cover until guides slide completely onto slide tracks.



MX5722

Picture Note: Grille Removed for Picture Clarity.

2. Push on engine cover until it stops. Turn tee handle clockwise to lock position. Adjust pawl (D) on handle assembly if necessary. (See “Engine Cover Latch Removal and Installation” on page 805.)

3. Make sure latch and engine cover is secure before operating machine.

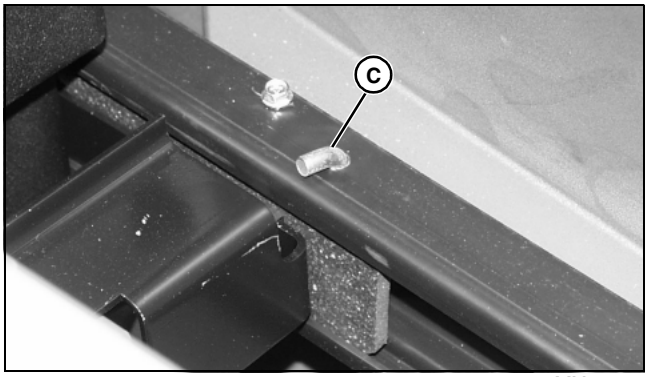
Removal: Pull Handle Type (Early Models)

1. Park machine on level surface.



MX7008

2. Push down on top of engine cover latch (A), then pull rearward on handle (B).



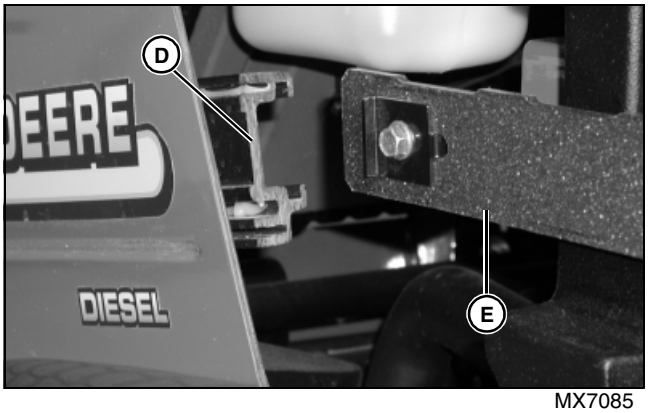
MX7041

3. Pull engine cover rearward until pin (C) is visible. Remove the pin from left and right side of engine cover slides.

4. Pull engine cover rearward until it can be removed from machine.

5. Inspect engine cover for wear or damage. Replace as necessary.

Installation: Pull Handle Type (Early Models)

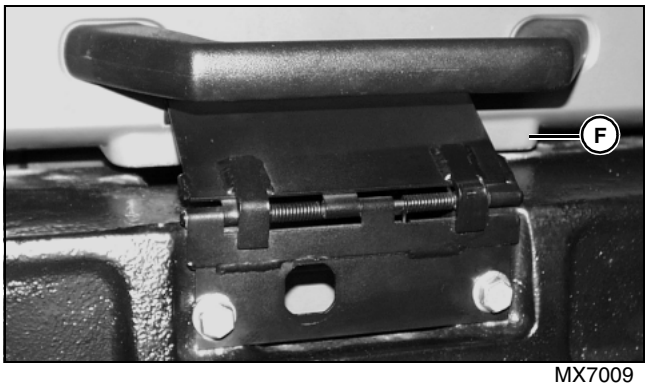


MX7085

1. Line up slides (D) on inside of engine cover with rails (E) on left and right side of machine.

2. Push the engine cover onto the rails until top edge of engine cover is over radiator cap.

3. Install stop pins into holes on left and right side of engine cover slides.



MX7009

4. Push on engine cover until latch pops up and catches tab (F) on engine cover.

5. Make sure engine cover is secure before operating machine.

Engine Cover Latch Removal and Installation

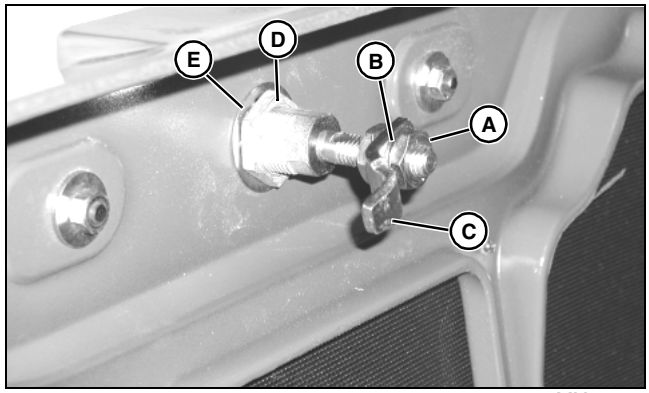
CAUTION: Avoid injury! To avoid pinched fingers, carefully open and close the engine cover by using the handle provided on the rear of the machine.

IMPORTANT: Avoid damage! Do not operate the machine with the engine cover in the opened position.

NOTE: Some later models have tee-handle-type latches. Prior to disassembly, check the machine to determine which latch type is installed.

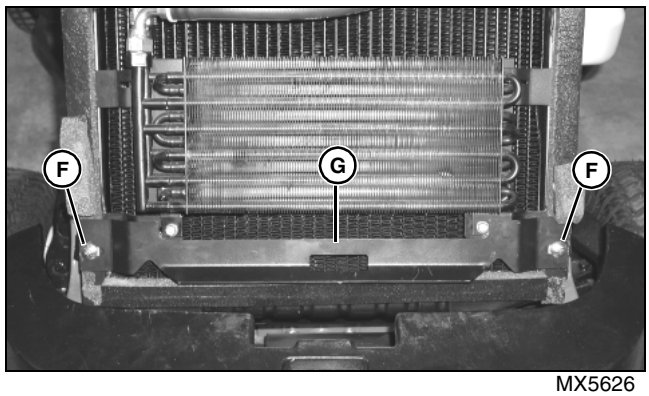
Removal: Tee-Handle-Type (Later Models)

1. Remove engine cover from machine. (See “Engine Cover Removal and Installation” on page 804.)



MX5625

2. Remove nut (A) and star washer (B). Remove pawl (C). Remove nut (D) and star washer (E). Remove latch handle assembly from latch handle bracket and engine cover. Inspect latch assembly and replace if worn or damaged.



MX5626

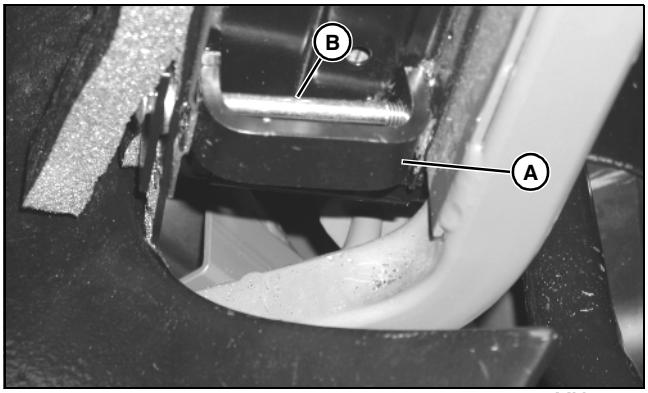
3. Remove flange lock nuts, flat washers, and carriage bolts (F). Remove lock bracket (G). Inspect lock bracket for wear or damage. Replace as necessary.

Installation: Tee-Handle-Type (Later Models)

1. Install tee handle into engine cover and install star washer and nut on inside of engine cover.

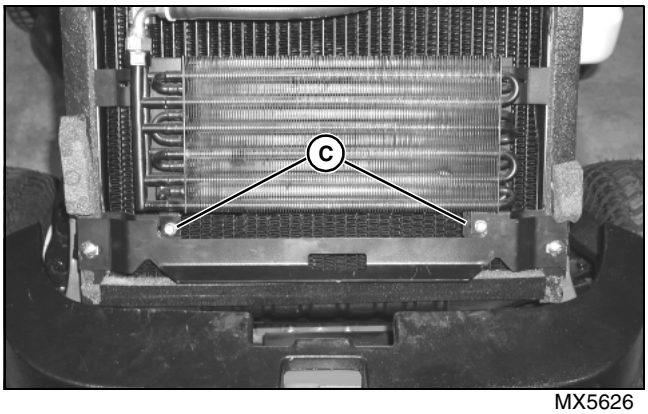
2. Properly orient pawl (unlock position) on handle shaft.

3. Install star washer and nut onto latch handle shaft.



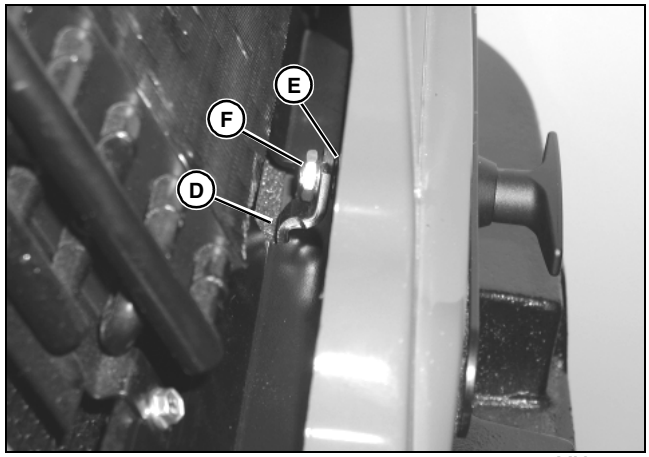
MX5721

4. If removed, install L-bracket (A) on each side of radiator. Install carriage bolts, lock bracket, flat washers, and flange lock nuts (B).



MX5626

5. When installing lock bracket, ensure that slot and angled lip are facing the ground. Center lock bracket using oil cooler mounting tabs (C).



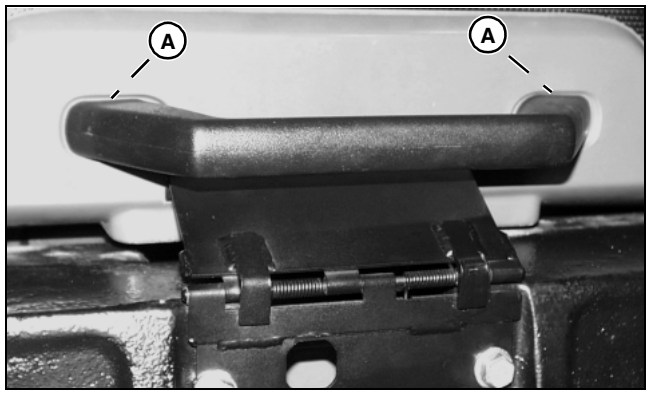
MX5722

Picture Note: Grille Removed for Picture Clarity.

6. Install engine cover onto machine and turn tee handle clockwise to lock, counterclockwise to unlock. Adjust pawl (D) by turning nut (E). Ensure that pawl completely latches onto lock bracket and tighten nut (F).

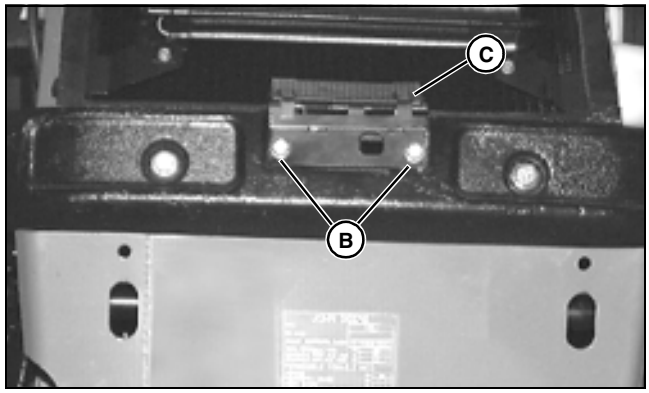
Removal: Pull Handle Type (Early Models)

1. Remove engine cover from machine. (See “Engine Cover Removal and Installation” on page 804.)



MX7009

2. Remove handle by removing nut and flat washer on handle mounting stud (A) and pull handle from engine cover. Inspect handle and replace if needed.



MX5498

3. Remove screw (B) and latch assembly (C). Inspect latch assembly for wear or damage. Replace as necessary.

Installation: Pull Handle Type (Early Models)

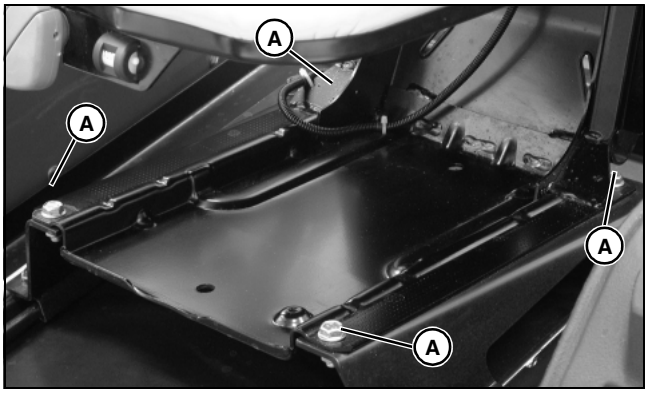
- Installation is done in the reverse order of removal.
- Check to ensure that engine cover is closed and latched securely before operating machine.

Operator's Seat Platform Removal and Installation

Removal:

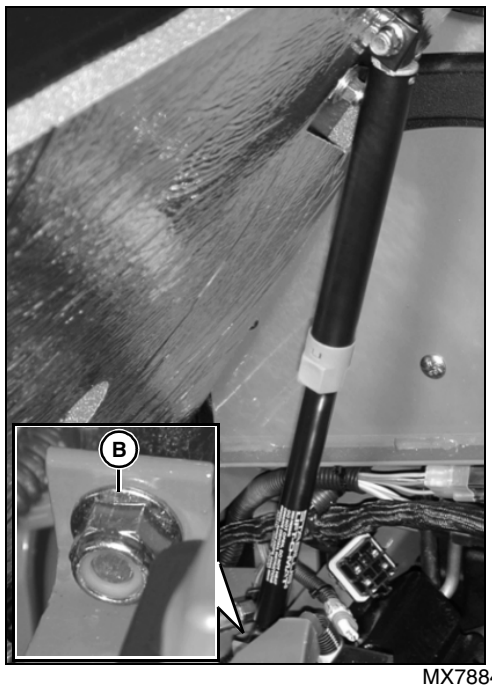
CAUTION: Avoid injury! Keep fingers away from pinch points when raising or lowering seat platform.

1. Raise seat platform until gas strut latches in open position.
2. Disconnect seat wire harness.
3. Lower seat platform completely.



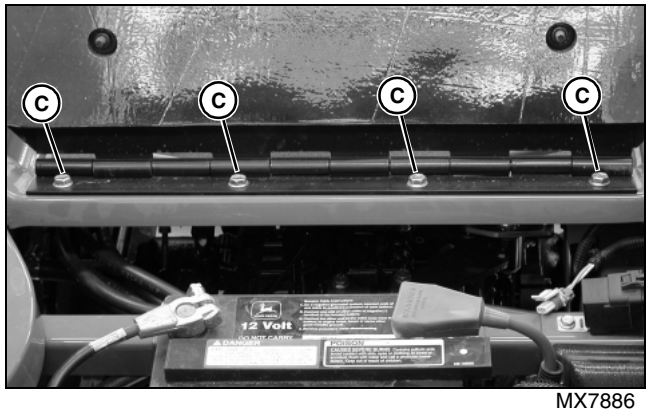
MX7887

4. Remove four bolts (A) from seat housing. Remove seat.
5. Raise seat platform until gas strut latches in open position.



MX7884/7885

6. Remove nut (B) attaching gas strut to frame mount.

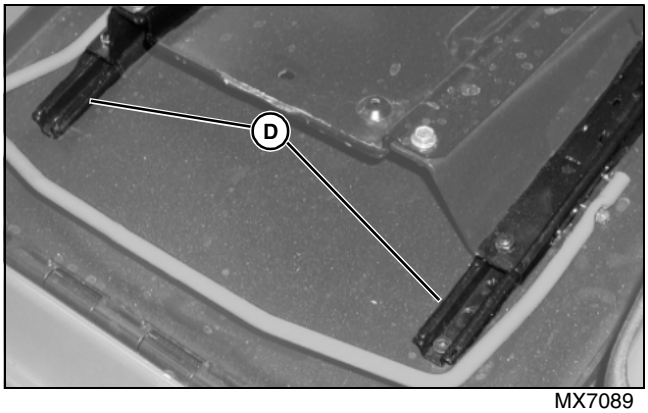


MX7886

7. Remove four bolts (C) attaching seat platform to frame. Remove seat platform.
8. Inspect seat cushion, seat adjustment lever, seat height adjustment assembly, seat belt and platform for wear or damage. Replace as necessary.

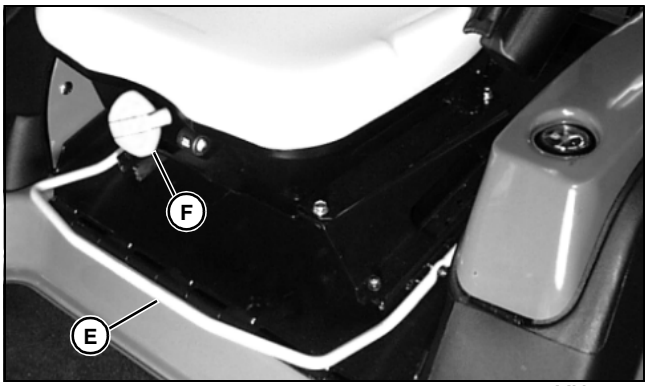
Installation:

- Installation is done in the reverse order of removal.
- Check to be sure that seat latch properly locks operator's seat platform. Adjust if necessary.



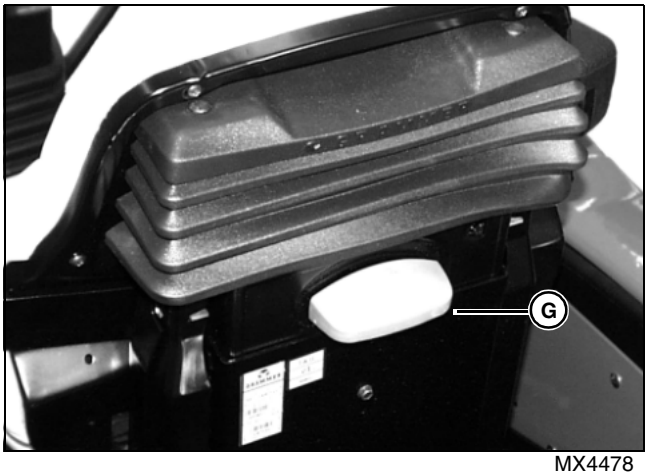
MX7089

• Lubricate operator seat slides (D) using a dry, Teflon® lubricant, such as John Deere Super Lube®.



MX4477

• Check seat adjustment lever (E) and seat spring adjustment (F) for proper operation.



MX4478

• Check seat height adjustment lever (G) for proper operation.

• Check operation of seat safety switch. (See “Seat Switch Test” on page 474 in the Electrical section.)

Front Wheel Removal and Installation

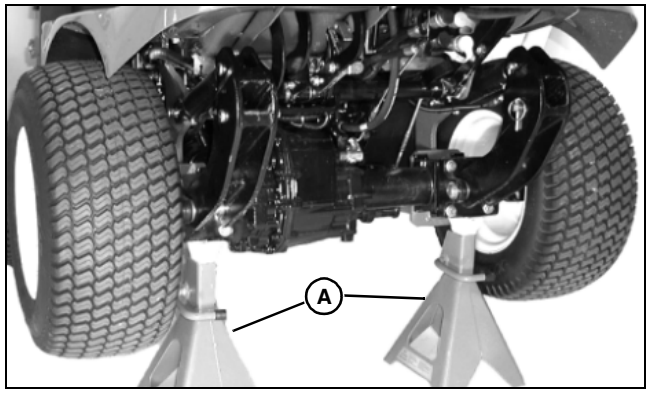
CAUTION: Avoid injury! Use only a safe lifting device for raising machine.

- **Ensure that machine is stable on floor jack before lifting machine.**
- **Lower machine unto blocks or jack stands before loosening wheel bolts.**

Removal:

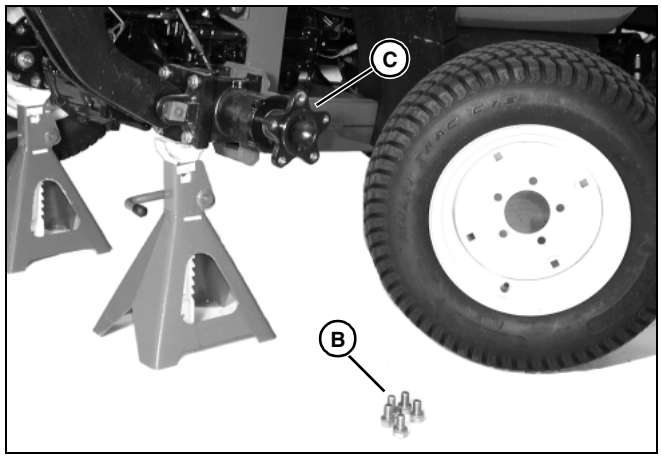
1. Park machine on level surface.
2. Remove attachment from machine.
3. Block rear tires.

IMPORTANT: Avoid damage! Do not use jack on transaxle or oil filter may be damaged.



MX7071

4. Raise machine and install jack stands (A) under left and right sides of front axle.



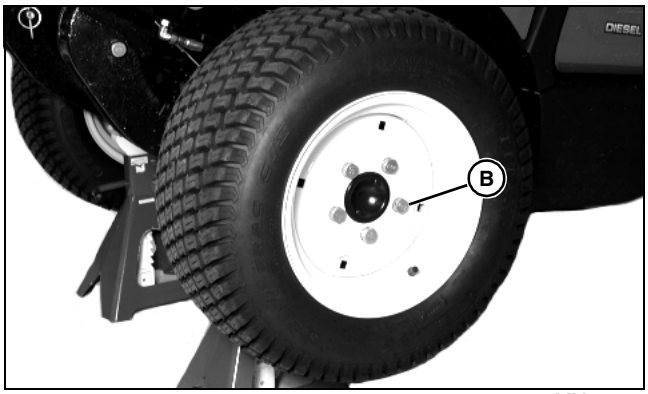
MX7073

5. Remove the five wheel bolts and lock washers (B).
6. Remove front wheel from axle hub (C).
7. Inspect wheel and tire. Replace as needed.

Installation:

CAUTION: Avoid injury! Machine must be safely supported on jack stands before installing wheels. Do not use floor jack to support machine.

1. Install wheel onto axle hub with valve stem facing outward.



MX7072

2. Install five wheel bolts and lock washers (B) into wheel and axle hub.
3. Tighten wheel bolts to specification.
4. Lower machine.
5. Remove wheel blocks from rear tires.
6. Check wheel bolt torque:
   - After traveling 30 m (100 ft) while changing direction.
   - After 3 to 10 hours of use.
   - Often during the next 100 hours of operation.

Specifications:

Wheel Bolts Torque . . . . . 225 N•m (165 lb-ft)

Rear Wheel Removal and Installation

CAUTION: Avoid injury! Use only a safe lifting device for jacking machine.

- **Ensure that machine is stable on floor jack before lifting.**
- **Lower machine onto jack stands before loosening wheel bolts.**

Removal: 2WD Models

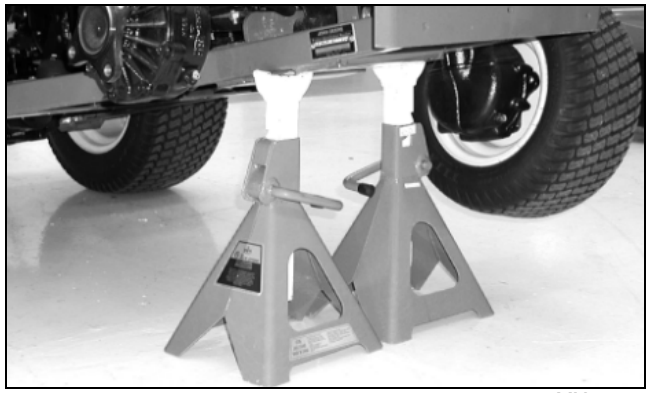
1. Park machine on level surface.
2. Lock park brake.

IMPORTANT: Avoid damage! When using rear frame plate as a lifting point care should be taken not to damage the muffler.



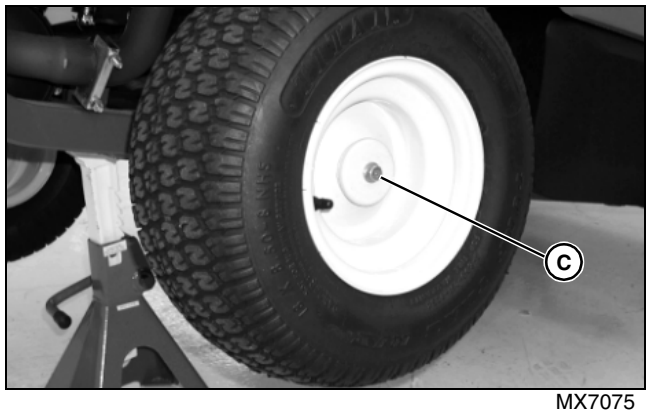
MX7069

3. Lift rear of machine with floor jack at center of rear frame (A) or rear frame plate (B).



MX7074

4. Install jack stands under left and right side of rear frame.

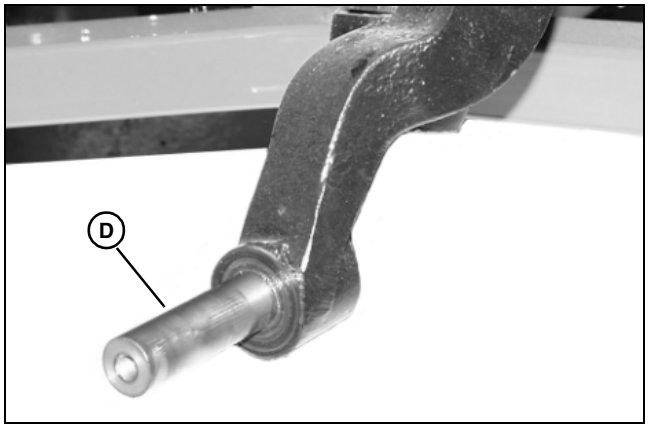


MX7075

5. Remove rear wheel bolt and washer (C) from center of rear wheel.
6. Pull wheel and tire straight off of rear axle.

Installation: 2WD Models

CAUTION: Avoid injury! Machine must be safely supported on jack stands before installing wheels. Do not use floor jack to support machine.



MX7092

1. Apply recommended grease to rear axle shaft (D).
2. Install rear wheel onto axle shaft with valve stem facing outward.
3. Install washer and wheel bolt. Tighten wheel bolt to specification.
4. Lower machine.

Specifications:

Wheel Bolt Torque . . . . . 82 N•m (60 lb-ft)

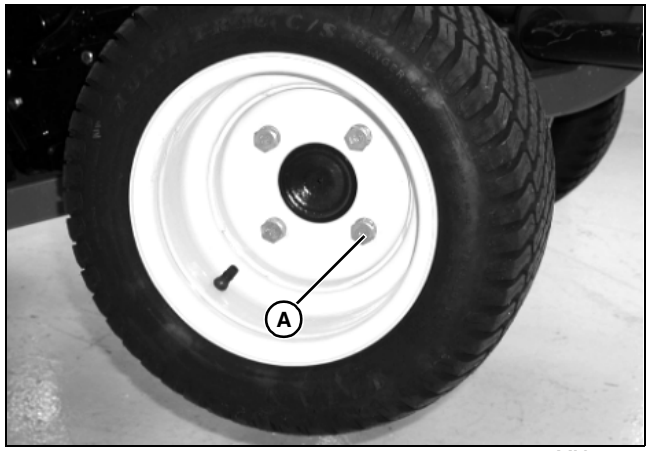
Removal: 4WD Models

CAUTION: Avoid injury! Use only a safe lifting device for raising machine.

- **Ensure that machine is stable on floor jack before lifting.**
- **Lower machine onto blocks or jack stands before loosening wheel bolts.**

IMPORTANT: Avoid damage! When using rear frame plate as a lifting point, care should be taken not to damage the muffler.

1. Raise machine and support on jack stands.



MX7076

2. Remove four wheel bolts and washers (A).
3. Remove wheel from rear axle hub.
4. Inspect wheel and tire for wear or damage. Replace as necessary.

Installation: 4WD Models

CAUTION: Avoid injury! Machine must be safely supported by jack stands before installing wheel. Do not use floor jack to support machine.

1. Install rear wheel onto axle hub with valve stem facing outward.
2. Install wheel bolts and washers. Tighten bolts to specification.
3. Lower machine.

Specifications:

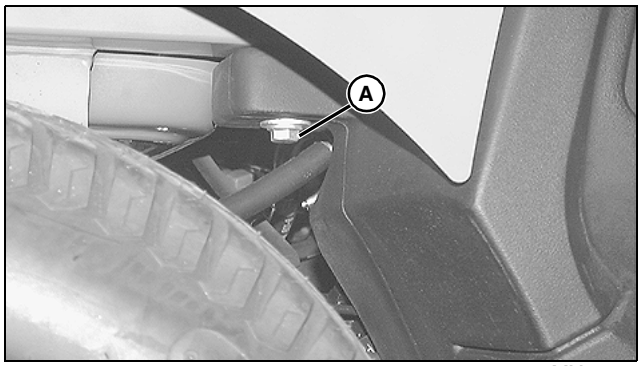
Wheel Bolt Torque . . . . . 225 N•m (165 lb-ft)

Fuel Tank Removal and Installation

Front Mower
1420
1435
1445

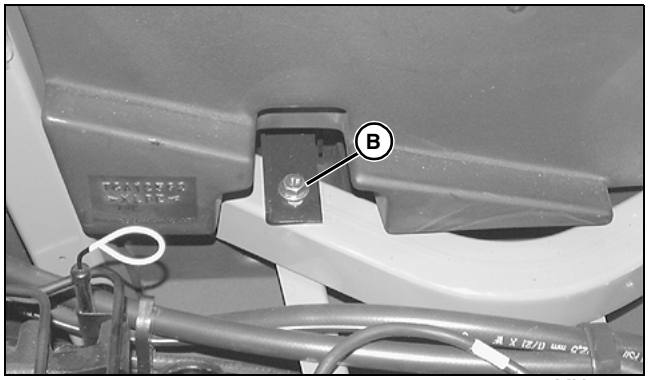
Removal:

1. Remove engine cover.
2. Tilt seat forward.



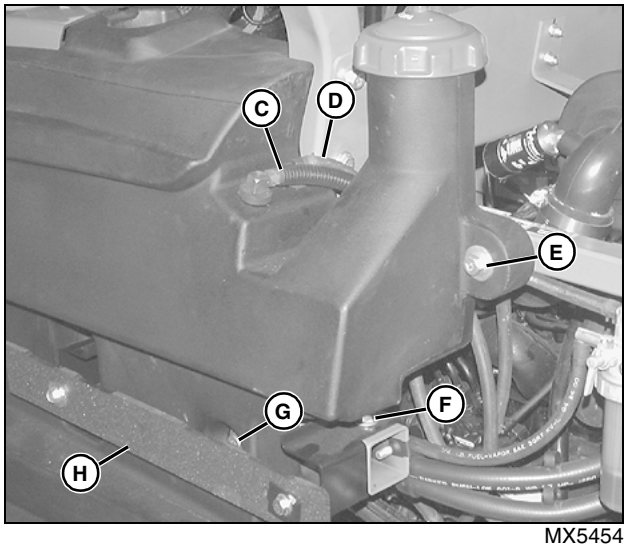
MX5455

3. Remove cap screw (A) in front wheel area.



MX5453

4. Remove cap screw (B) from engine cover slide bracket.

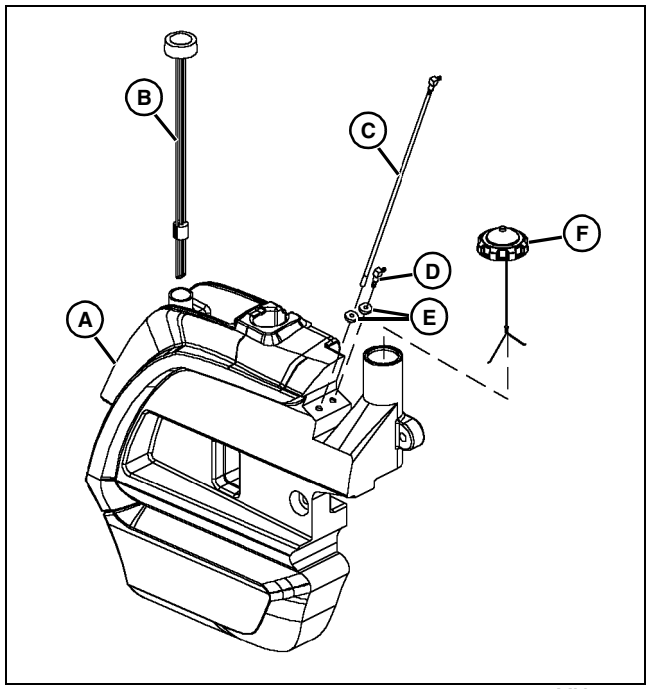


MX5454

5. Remove cap screw (F) from engine cover slide bracket (H).
6. Remove engine cover slide bracket.
7. Disconnect fuel lines (C and D).
8. Remove cap screw (G).
9. Remove cap screw (E), spacers, and nut.
10. Remove fuel tank.

Installation:

NOTE: Inspect all parts for wear or damage. Replace as needed.



MX5457

A - Fuel Tank
B - Gauge
C - Pick-Up Tube
D - Fitting
E - Grommet (2 used)
F - Cap

1. Install fuel tank. Installation is done in reverse order of removal.
2. Fill tank and check for leaks. Replace tank as needed.

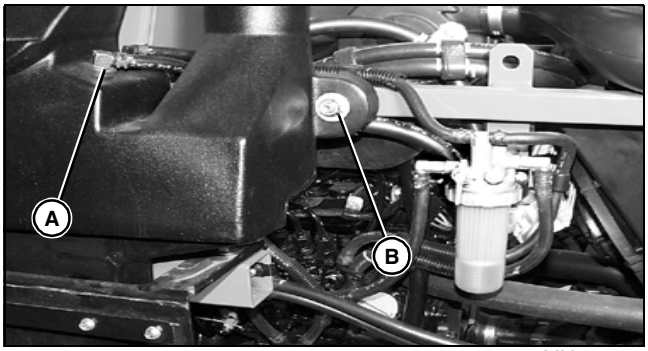
Fuel Tank Removal and Installation - 1500 Series

Removal:

1. Park machine on level surface.

2. Lock park brake.

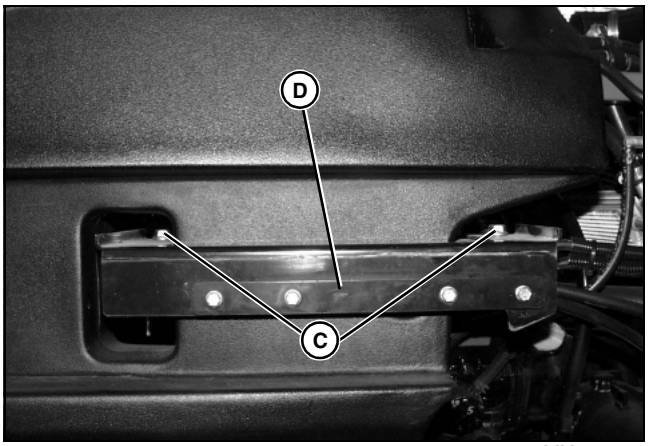
3. Siphon diesel fuel into an approved container, so that fuel level in tank is half full or less.



MX16011

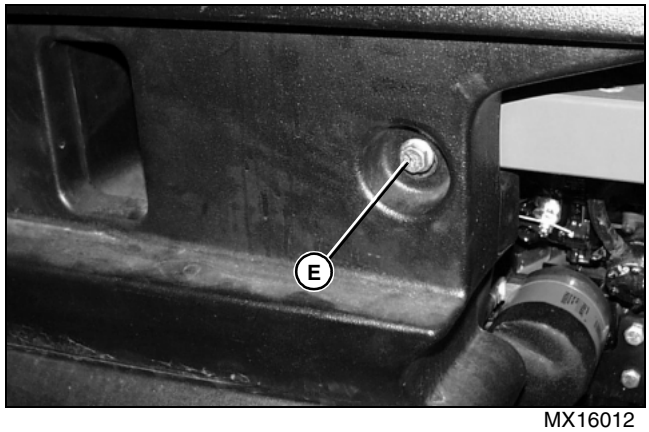
4. Remove the fuel lines at the upper fuel fittings (A).

5. Remove the upper tank mounting capscrew and washer (B).



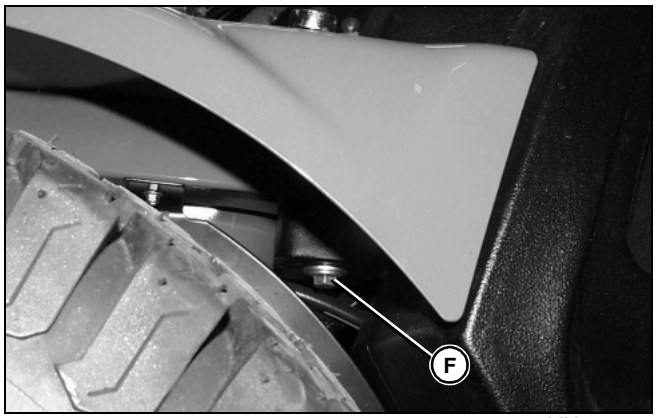
MX16010

6. Remove the two capscrews (C) holding the gas tank mounting strap (D) to the frame, and slide the strap out of the pockets in the tank.



MX16012

7. Remove the center tank mounting capscrew and washer (E) located beneath the mounting strap.

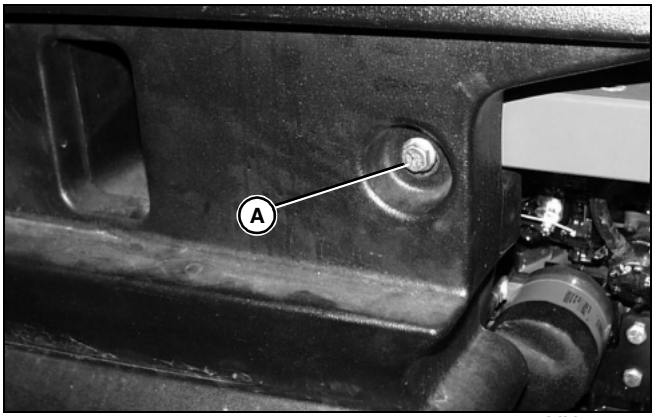


MX16013

8. Remove the capscrew (F) holding the front inside mounting bracket to the bottom of the step platform.

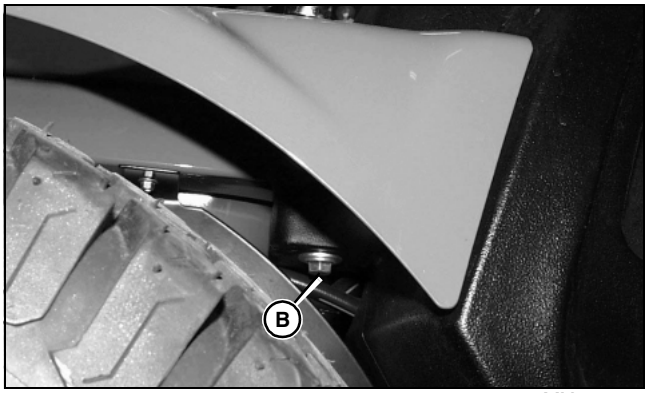
9. Lift tank up slightly, and pull outward to remove from machine.

Installation:



MX16012

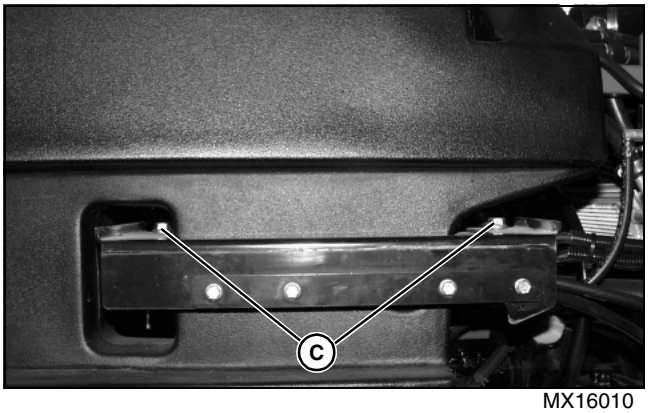
1. Lift the gas tank up into position on the frame and loosely install the center mount capscrew (A).



MX16013

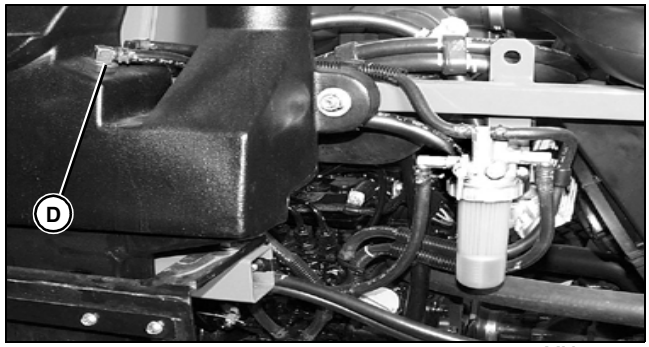
2. Align the inner front (B) and upper rear mounting brackets and install mounting hardware.

3. Return to the center mount cap screw (A) and final tighten to specification.



MX16010

4. Position the gas tank mounting strap in the tank pockets and install the two capscrews (C) holding it to the frame.



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5. Install the fuel lines, noting that the fuel line from the fuel pump to the tank is mounted on the outside (metal) fitting (D) and the line from the fuel filter mounts to the inside (plastic) fitting.

6. Refill the fuel tank, and run the mower engine to check for fuel leaks.

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