JOHN DEERE
WORLDWIDE COMMERCIAL & CONSUMER EQUIPMENT DIVISION

Bunker and Field Vehicle
1200A

TM1587 MAY 2009

TECHNICAL MANUAL

JOHN DEERE

North American Version
Litho In U.s.a.

INTRODUCTION

Manual Description

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

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

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

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

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

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

Safety

Specifications and Information

Engine

Electrical

Gear Power Train

Hydraulics/Power Train

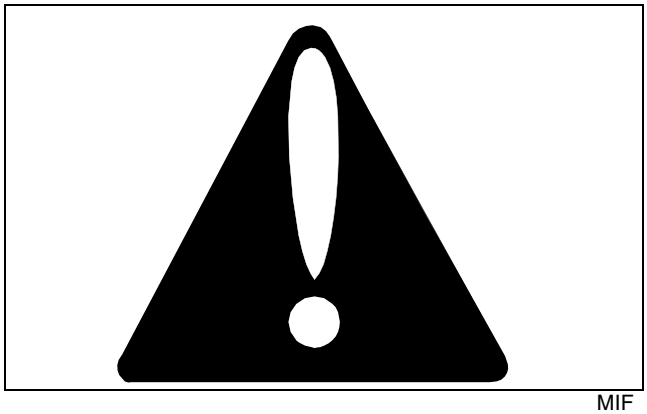
Steering

Brakes

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.

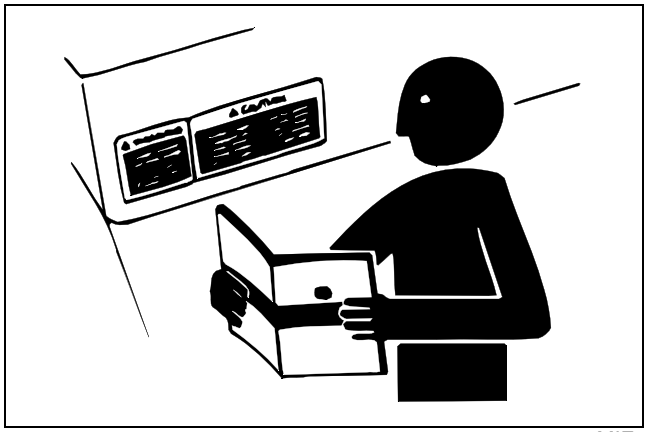
Follow recommended precautions and safe servicing practices.

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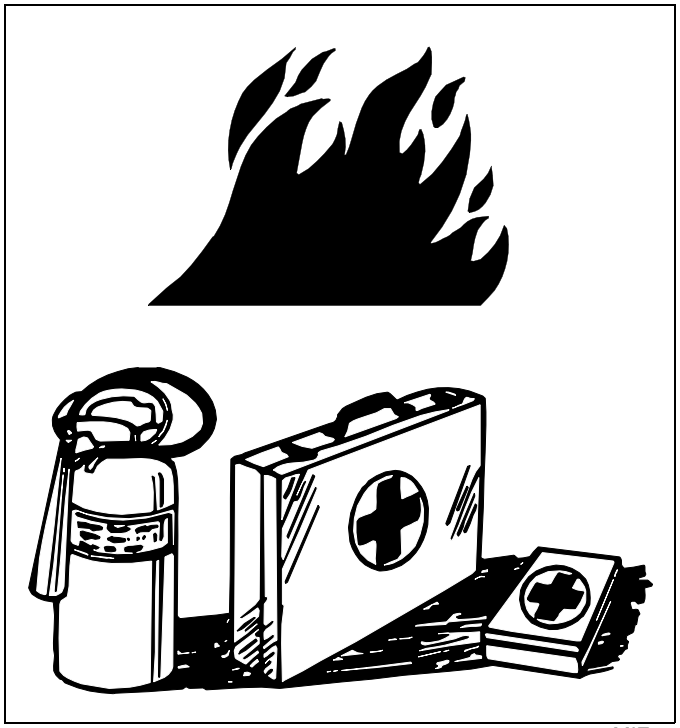
Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

Handle Fluids Safely - Avoid Fires

Be Prepared For Emergencies



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When you work around fuel, do not smoke or work near heaters or other fire hazards.

Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, and debris.

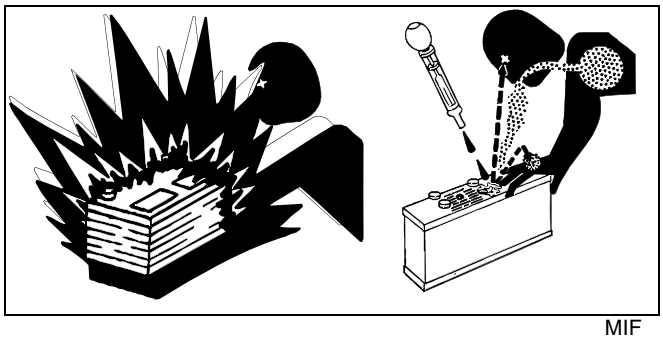
Do not store oily rags; they can ignite and burn spontaneously.

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.

Use Care in Handling and Servicing Batteries



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Prevent Battery Explosions

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

Prevent Acid Burns

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

Avoid acid burns by:

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

If you spill acid on yourself:

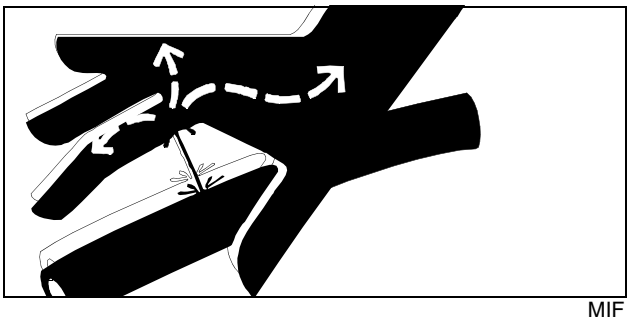
6. Flush your skin with water.
7. Apply baking soda or lime to help neutralize the acid.
8. Flush your eyes with water for 10-15 minutes.
9. Get medical attention immediately.

If acid is swallowed:

10. Drink large amounts of water or milk.
11. Then drink milk of magnesia, beaten eggs, or vegetable oil.
12. Get medical attention immediately.

Use Care Around High-Pressure Fluid Lines

Avoid High-Pressure Fluids



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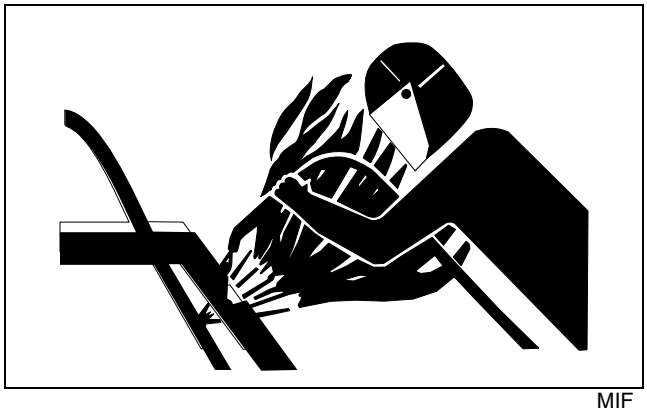
Escaping fluid under pressure can penetrate the skin causing serious injury.

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

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

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

Avoid Heating Near Pressurized Fluid Lines

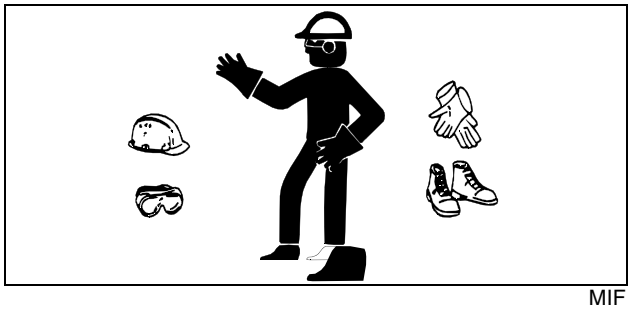


MIF

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

Use Safe Service Procedures

Wear Protective Clothing



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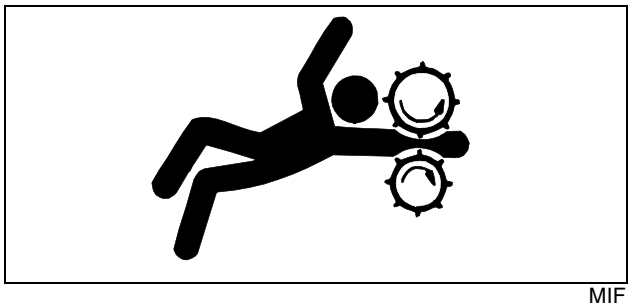
Wear close-fitting clothing and safety equipment appropriate to the job.

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.

Service Machines Safely



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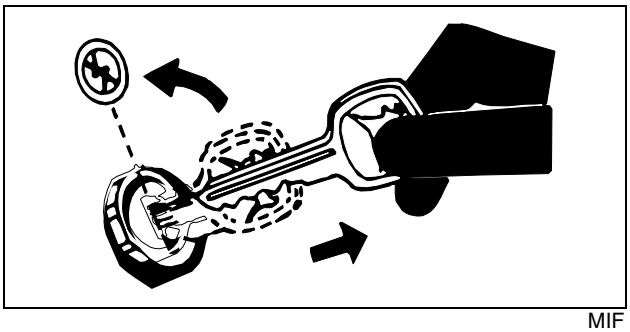
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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

Use Proper Tools

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

Park Machine Safely



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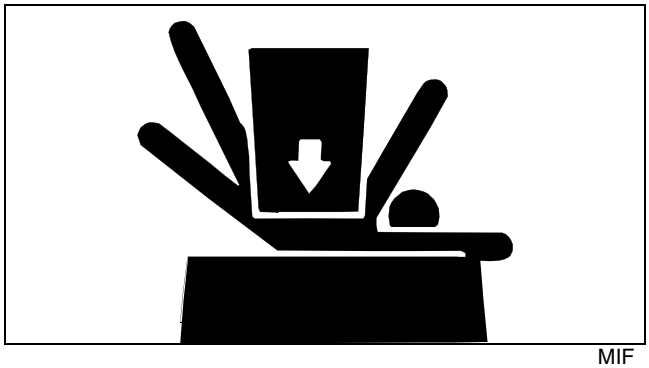
Before working on the machine:

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

Support Machine Properly and Use Proper Lifting Equipment



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

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

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

Work in Clean Area

Before starting a job:

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

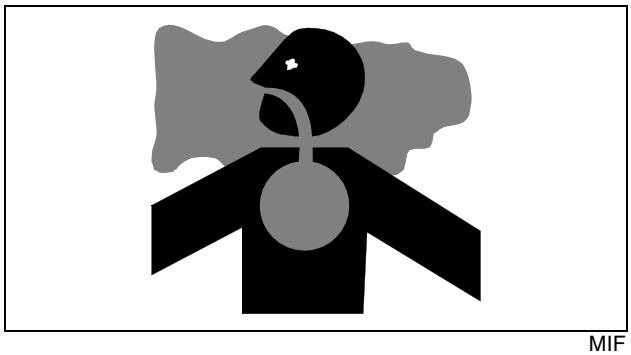
Using High-Pressure Washers

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

Illuminate Work Area Safely

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

Work in Ventilated Area



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

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

WARNING: California Proposition 65 Warning

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

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

Remove Paint Before Welding or Heating

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

Avoid Harmful Asbestos Dust

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

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

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

Service Tires Safely

MIF

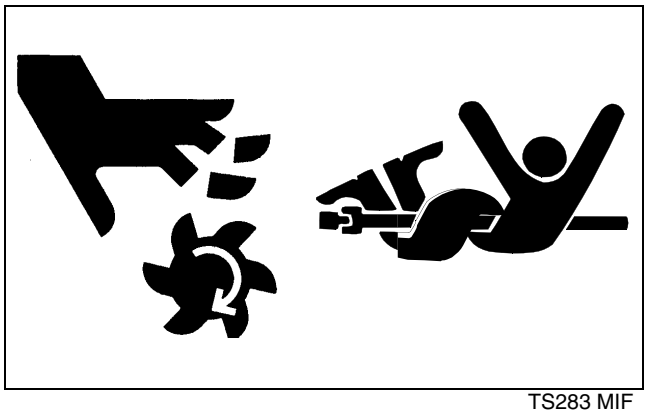
Explosive separation of a tire and rim parts can cause serious injury or death.

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

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

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

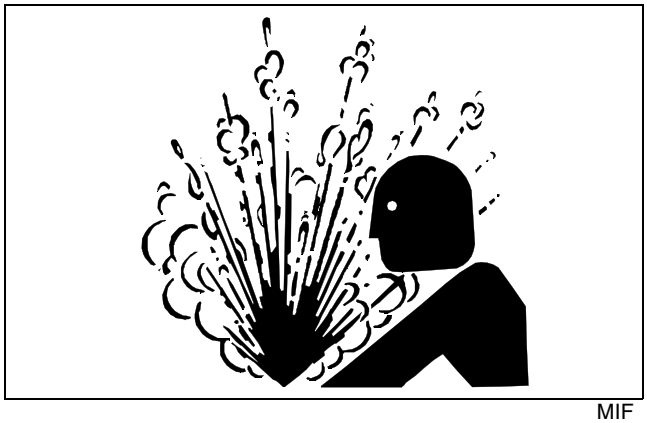
Avoid Injury from Rotating Blades and Drive Shafts



TS283 MIF

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

Service Cooling System Safely



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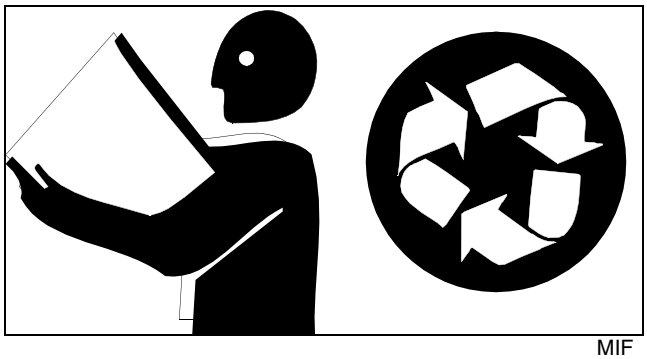
Explosive release of fluids from pressurized cooling system can cause serious burns.

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

Handle Chemical Products Safely



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

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

Dispose of Waste Properly

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

Live With Safety

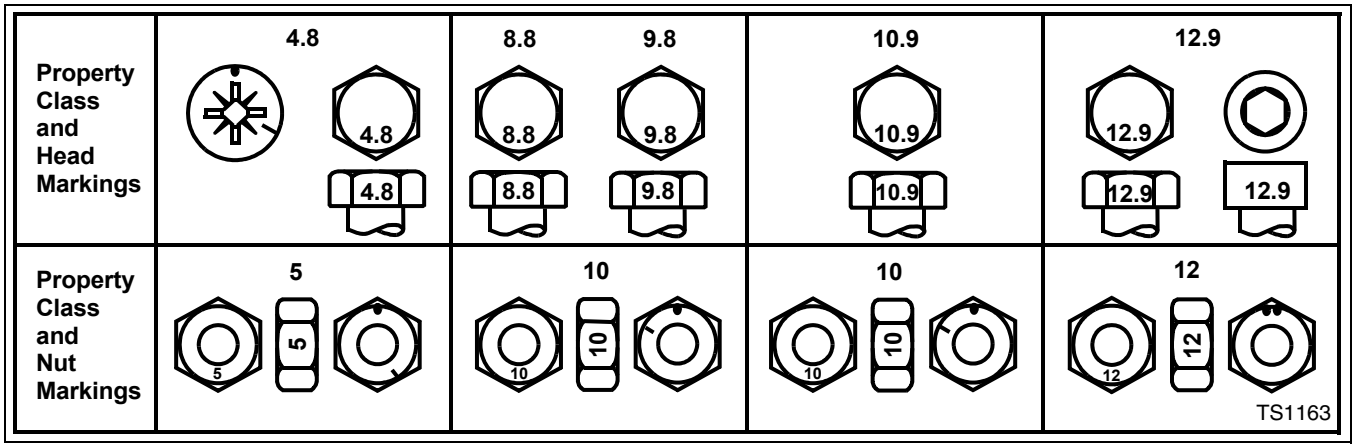
MIF

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

Table of Contents

General Specifications

Metric Fastener Torque Values



TS1163

	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.

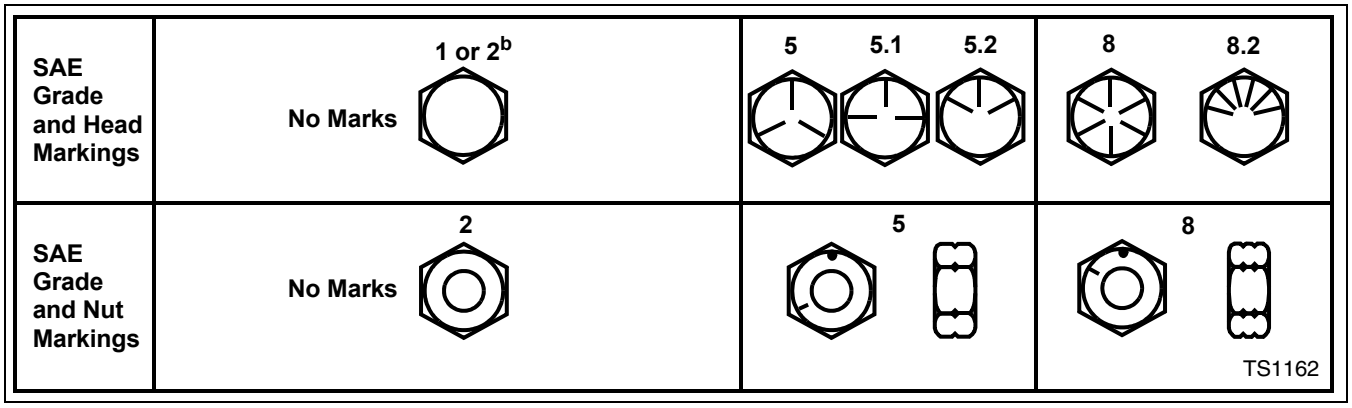
[a] **"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate—Specification JDS117) without any lubrication.**

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



TS1162

	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

Gasket Sealant Application

Cleaning:

Clean both surfaces that will be joined using 100% isopropyl alcohol. Wipe excess off with a clean cloth. Cleaner/degreaser can be substituted for isopropyl alcohol.

How to Dispense/Apply/Assemble Gasket Sealants:

Dispense approximately 1 to 2 ounces of flexible form-in-place gasket on a clean sheet or table top. Avoid using excess amounts that may be exposed for long periods of time. This will help prevent contamination from surrounding atmosphere such as dust with metal content.

Using an ink roller or similar devise, apply to one surface of the joint by loading the roller from a plastic sheet and transferring the material in a thin film to the joint. The application should be the thinnest film possible, but providing complete coverage. This can be judged by the appearance of the joint once it is put together. Excessive amounts of will cause incorrect bearing end play, extend cure time, and will cause runoff of the material. A small bead or buildup at the joint is permissible and indicates good dispersion through the joint. Excess can be wiped from the joint. Joining should take place within three minutes after sealant application.

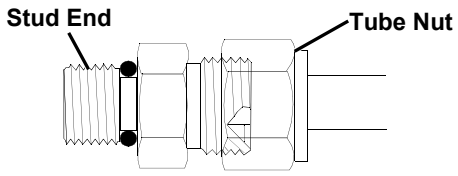
Apply proper cap screw torque and sequence as applicable. Allow a minimum of 30 minutes before air test or adding oil for test stand usage.

Disassembly:

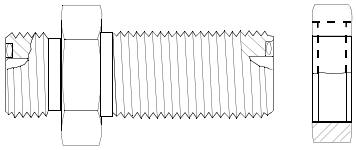
Cured material can be removed with a wire brush or scraper. Chemical cleaners are available for customer use, should they be deemed necessary.

O-Ring Seal Service Recommendations

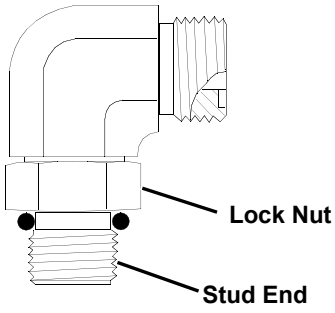
Face Seal Fittings - Inch Stud Ends Torque



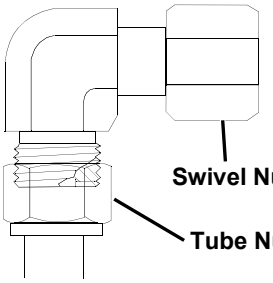
Straight Stud and Tube Nut



Bulkhead Union and Bulkhead Lock Nut



90° Adjustable Stud Elbow



90° Swivel Elbow and Tube Nut

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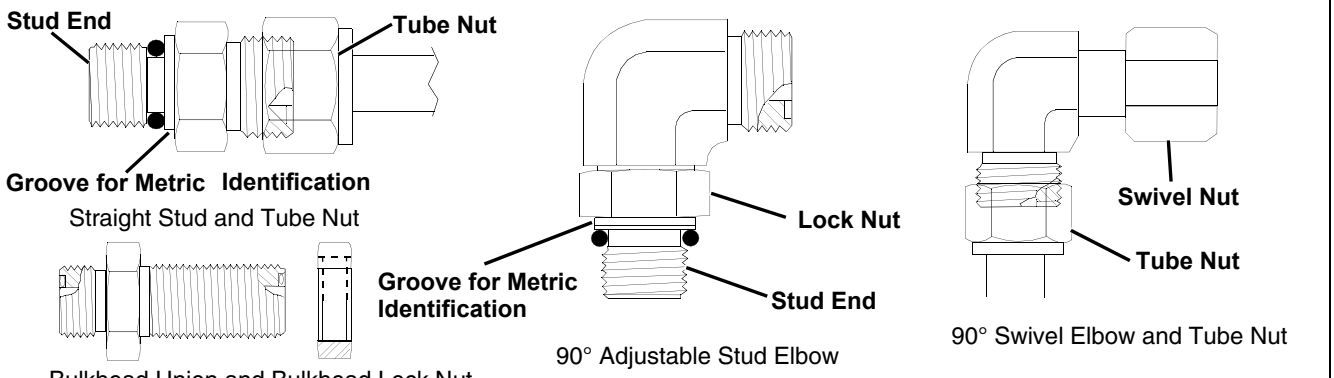
Nominal Tube OD/Hose ID				Face Seal Tube/Hose End					O-Ring Stud Ends		
Metric Tube OD	Inch Tube OD			Thread Size	Tube Nut/ Swivel Nut Torque		Bulkhead Lock Nut Torque		Thread Size	Straight Fitting or Lock Nut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
	-3	0.188	4.76						3/8-24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



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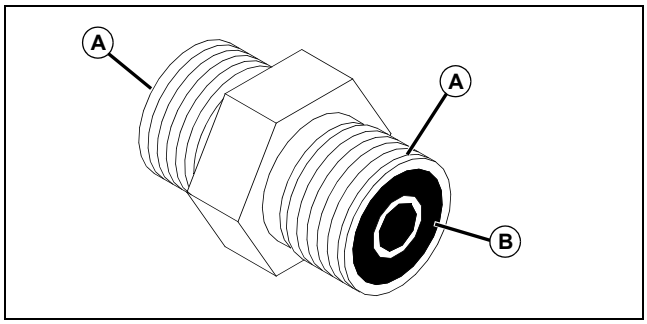
Nominal Tube OD/Hose ID				Face Seal Tube/Hose End						O-Ring Stud Ends, Straight Fitting or Lock Nut					
Metric Tube OD	Inch Tube OD			Thread Size	Hex Size	Tube Nut/ Swivel Nut Torque		Bulkhead Lock Nut Torque		Thread Size	Hex Size	Steel or Gray Iron Torque		Aluminum Torque	
mm	Dash Size	in.	mm	in.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

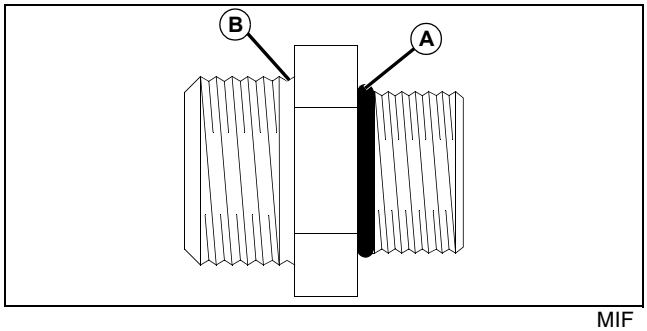
5. Index angle fittings and tighten by hand-pressing joint together to ensure O-ring remains in place.

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.



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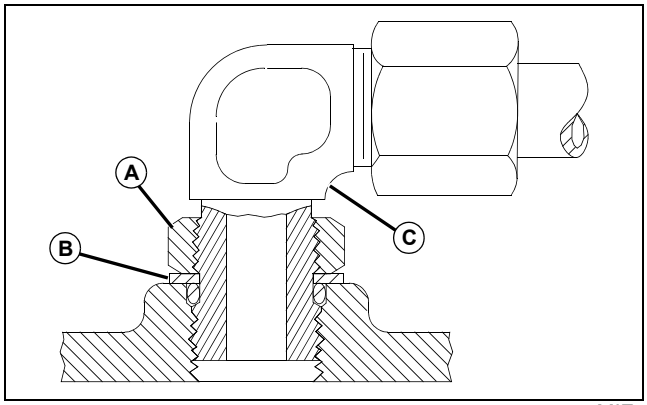
2. Put hydraulic oil or petroleum jelly on the O-ring (A). Place electrical tape over the threads to protect O-ring from nicks. Slide O-ring over the tape and into the groove (B) of fitting. Remove tape.



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3. For angle fittings, loosen special nut (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.

Fuels and Lubricants

Gasoline

Caution: Avoid Injury! Gasoline is HIGHLY FLAMMABLE, handle it with care.DO NOT refuel machine while:

indoors, always fill gas tank outdoors

machine is near an open flame or sparks

engine is running, STOP engine

engine is hot, allow it to cool sufficiently first

smoking

Help prevent fires:

fill gas tank to bottom of filler neck only

be sure fill cap is tight after fueling

clean up any gas spills IMMEDIATELY

keep machine clean and in good repair-free of excess grease, oil, debris, and faulty or damaged parts

any storage of machines with gas left in tank should be in an area that is well ventilated to prevent possible igniting of fumes by an open flame or spark, this includes any appliance with a pilot light

To prevent fire or explosion caused by STATIC ELECTRIC DISCHARGE during fueling:

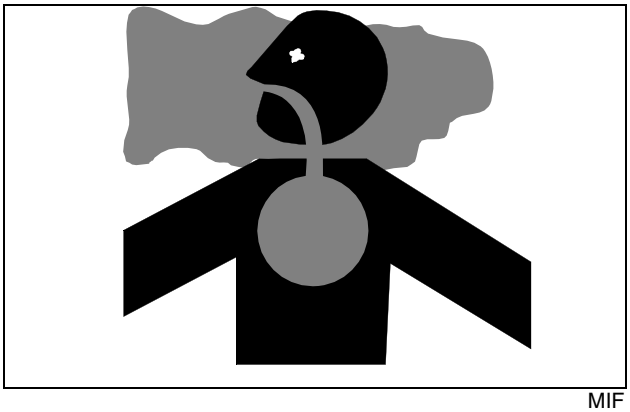
ONLY use a clean, approved POLYETHYLENE PLASTIC fuel container and funnel WITHOUT any metal screen or filter

To avoid engine damage:

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

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

- the ethyl or grain alcohol blends DO NOT exceed 10% by volume or



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- methyl tertiary butyl ether (MTBE) blends DO NOT exceed 15% by volume

Important: Avoid Damage! DO NOT use METHANOL gasoline because METHANOL is harmful to the environment and to your health.

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.

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.

Engine Oil

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

The following John Deere oils are PREFERRED:

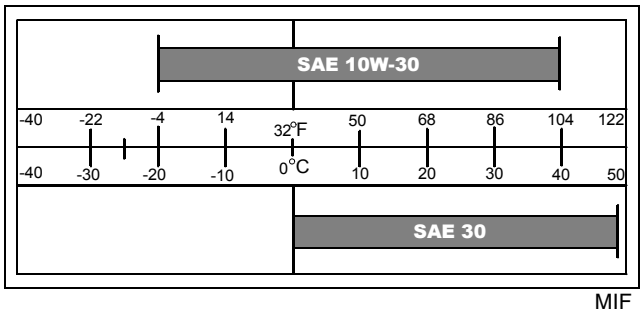
- **TURF-GARD™ - SAE 10W-30;**
- PLUS-4™ - SAE 10W-30;

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

- **TORQ-GARD SUPREME™ - SAE 30;**

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

- SAE 30 - API Service Classification SJ or higher;
- SAE 10W-30 - API Service Classification SJ or higher;



MIF

Engine Break–in Oil

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

The following John Deere oil is PREFERRED:

- **BREAK–IN ENGINE OIL**.

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

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

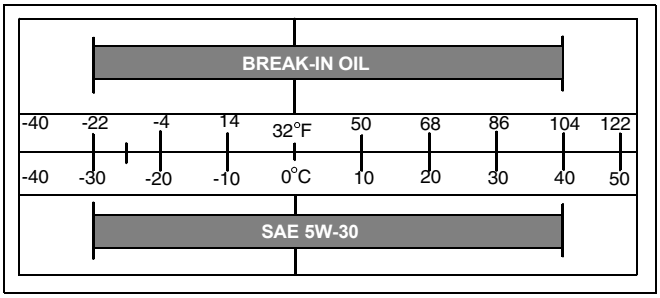
The following John Deere oil is **also recommended as a break-in engine oil**:

- **TORQ–GARD SUPREME®—SAE 5W-30.**

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

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

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



Alternative Lubricants

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

Important: Avoid Damage! Use of alternative lubricants could cause reduced life of the component.

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

Synthetic Lubricants

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

The recommended air temperature limits and service or lubricant change intervals should be maintained as shown in the operator’s manual.

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

these additives and degrade lubricant performance.

Lubricant Storage

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

Mixing Of Lubricants

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

Chassis Grease

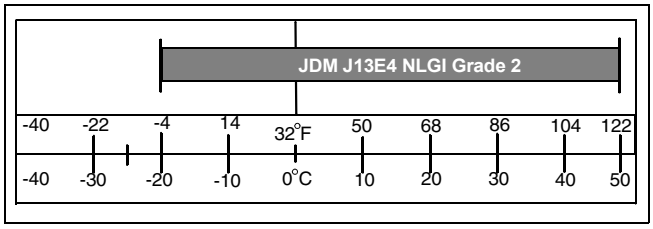
Use the following grease based on the air temperature range. Operating outside of the recommended grease air temperature range may cause premature failures.

The following John Deere grease is PREFERRED:

- **NON-CLAY HIGH-TEMPERATURE EP GREASE®—JDM J13E4, NLGI Grade 2.**
- Multi-Purpose SD Polyurea Grease
- Multi-Purpose HD Lithium Complex Grease

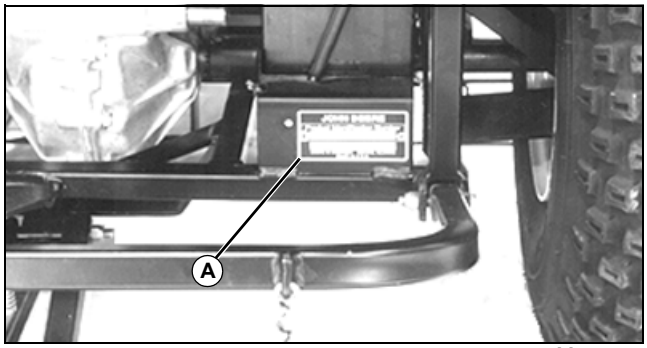
Other greases may be used if above preferred John Deere grease is not available, provided they meet the following specification:

- John Deere Standard JDM J13E4, NLGI Grade 2.



Serial Number Locations

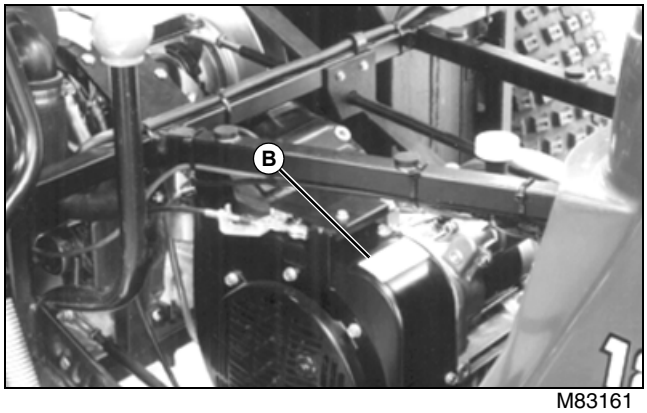
Product Serial Number



M83160

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

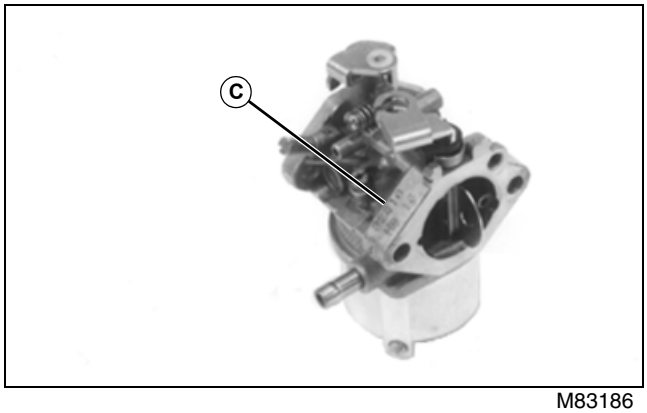
Engine Serial Number



M83161

Engine serial number (B) is located on the side of the engine housing.

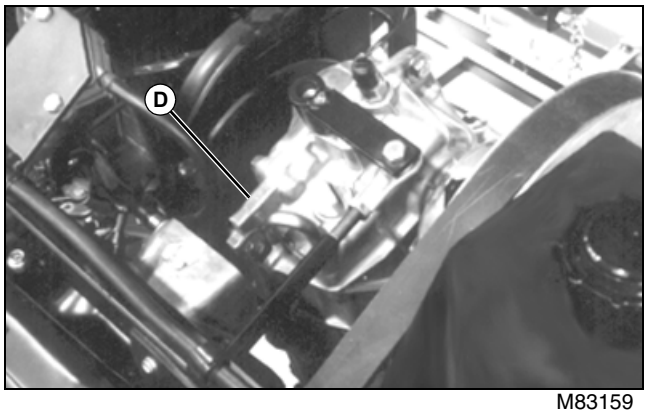
Carburetor Serial Number



M83186

Carburetor serial number (C) is located on the top of the carburetor, above the fuel inlet.

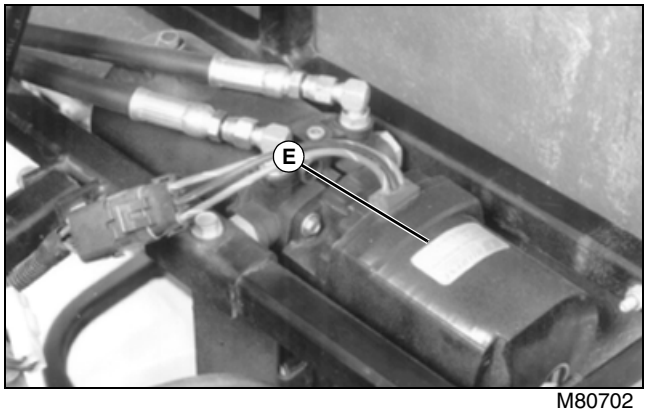
Transaxle Serial Number



M83159

Transaxle serial number (D) is located on the top of the transaxle.

Optional Hydraulic Pump Serial Number



M80702

Hydraulic pump product identification number (E) is located on the top of the pump.

ENGINE - GAS TABLE OF CONTENTS

Table of Contents

ENGINE - GAS SPECIFICATIONS

Specifications

General Specifications

Engine Specifications:

Make	Kawasaki
Model	FE290D
Model	FE350D
Type	4-cycle gas/Air cooled
Cylinders	1
Cycles	4
Bore (FE290D)	78 mm (3.070 in.)
Stroke (FE290D)	60 mm (2.360 in.)
Displacement (FE290D)	286 cm^3 (17.5 cu-in.)
Bore (FE350D)	83 mm (3.268 in.)
Stroke (FE350D)	65 mm (2.559 in.)
Displacement (FE350D)	351 cm^3 (21.4 cu-in.)
Crankcase Oil Capacity (without filter)	0.9 L (0.95 qt)
Crankcase Oil Capacity (with filter, if equipped)	1.2 L (1.26 qt)
Spark Plug	NGK BPR5ES
Compression Release	Automatic
Crankshaft Type	Horizontal, Counterbalanced
Lubrication	Pressurized, Positive Displacement Pump
Oil Pressure	314 kPa (46 psi)
Oil Filter	Full Flow, Spin-On Filter
Cooling System	Air Cooled
Air Cleaner	Single Element, Replaceable Paper
Muffler	45° Angled Down, Optional Spark Arrestor
Fuel Filter	Replaceable, In-Line Type
Fuel Pump	Engine Mounted Diaphragm-type Pulse Pump
Carburetor	Float type, Fixed Main Jet
Charging System	12 Volt, 3 - 13 Amps with Regulator

Fuel System Specifications

Fuel Tank Location	Behind driver, left side
Fuel Tank Capacity	13.25 L (3.5 gal)
Fuel	Unleaded gasoline (minimum 87 octane)
Fuel Pump Location	On right side of engine
Fuel Delivery	Side draft carburetor
Fuel Filter	Replaceable, in-line

Test and Adjustment Specifications

Engine:

Auto Compression Release Minimum Lift (FE290D)	0.6 mm (0.023 in.)
Auto Compression Release Minimum Lift (FE350D)	1.0 mm (0.039 in.)
Breather Valve Air Gap	0.20 mm (0.008 in.)
Compression Pressure At Operating Temperature (minimum)	390 kPa (57 psi)

Minimum Crankcase Vacuum	30 mm (1.2 in.) water movement at fast idle
Ignition Coil Air Gap	0.3 mm (0.012 in.)
Intake and Exhaust Valve Clearance (FE290D) (cold)	0.12 mm (0.047 in.)
Intake and Exhaust Valve Adjustment Interval (FE290D)	300 hrs
HLA Device Leak-Down Dimension, Intake and Exhaust (FE350D) (maximum)	0.5 mm (0.020 in.)
Oil Pressure At High Idle (minimum)	314 kPa (46 psi)
Spark Plug Gap	0.7 - 0.8 mm (0.028 - 0.031 in.)
Spark Plug Torque	23 N•m (204 lb-in.)
Starter Brush Length (Minimum)	6 mm (0.240 in.)
Valve Clearance Adjusting Nut Torque (FE290D)	8.8 N•m (78 lb-in.)
Valve Cover Cap Screw Torque	6 N•m (53 lb-in.)

Fuel/Air System:

Carburetor Butterfly Slow Idle Stop Screw Setting	200 rpm less than Governed Slow Idle Setting
Throttle Control Arm SLOW Idle Stop Screw Setting	1175 ± 75 rpm
Slow Idle, Governed Setting	1125 ± 75 rpm
Throttle Control Arm FAST Idle Stop Screw Setting	3100 ± 75 rpm
Fuel Pump Flow (minimum)	80 ml (2.7 oz) in 15 seconds
Fuel Pump Pressure (minimum)	6.12 kPa (0.9 psi)

Repair Specifications

Cylinder Head:

Cylinder Head Flatness	0.05 mm (0.002 in.)
Valve Seating Surface Width (standard)	0.8 mm (0.031 in.)
Valve Seating Surface Width (maximum)	1.9 mm (0.075 in.)
Valve Guide Bore ID (maximum)	7.06 mm (0.278 in.)
Valve Guide Finished (Reamed) ID	7.00 - 7.015 mm (0.2756 - 0.276 in.)
Rocker Arm Bearing Bore ID (FE290D) (maximum)	12.07 mm (0.475 in.)
Rocker Arm Bearing Bore ID (FE350D) (maximum)	12.30 mm (0.484 in.)

Rocker Arm:

Shaft OD (minimum)	11.95 mm (0.470 in.)
Push Rod Maximum Bend (FE290D) (maximum)	0.3 mm (0.012 in.)
Push Rod Maximum Bend (FE350D) (maximum)	0.5 mm (0.020 in.)

Valves:

Intake and Exhaust Valve Clearance (FE290D) (Cold)	0.12 mm (0.047 in.)
HLA Device Leak-Down Dimension, Intake and Exhaust (FE350D) (maximum)	0.5 mm (0.020 in.)
Valve Lift Height by ACR (FE290D) (minimum)	0.6 mm (0.024 in.)
Valve Lift Height by ACR (FE350D) (minimum)	1.0 mm (0.039 in.)
Valve Seat Width (maximum)	1.9 mm (0.075 in.)
Intake and Exhaust Valves Bend (maximum)	0.03 mm (0.0012 in.)
Intake and Exhaust Valves Face Margin (maximum)	0.060 mm (0.024 in.)
Valve Stem OD (Intake) (minimum)	6.930 mm (0.273 in.)
Valve Stem OD (Exhaust) (minimum)	6.915 mm (0.272 in.)
Valve Springs Free Length (FE290D) (minimum)	32.8 mm (1.291 in.)
Valve Springs Free Length (FE350D) (minimum)	38.1 mm (1.500 in.)

Valves - Recondition - FE290D:

Valve Face Angle	45°
Valve Narrowing Angle	30°
Valve Seat Angle	45°
Valve Seating Surface Width	0.50 - 1.10 mm (0.020 - 0.043 in.)

Valves - Recondition - FE350D:

Valve Face Angle (Intake)	30°
Valve Narrowing Angle (Intake)	15°
Valve Seat Angle (Intake)	30°
Valve Face Angle (Exhaust)	45°
Valve Narrowing Angle (Exhaust)	30°
Valve Seat Angle (Exhaust)	45°
Valve Seating Surface Width	0.50 - 1.10 mm (0.020 - 0.043 in.)

Crankcase:

Cover Mounting Cap Screw Torque	31 N•m (23 lb-ft)
Oil Drain Plug Torque (metal with sealing washer)	32 N•m (24 lb-ft)
Crankcase Main Bearing ID (FE290D) (maximum)	30.08 mm (1.184 in.)
Crankcase Main Bearing ID (FE350D) (maximum)	35.08 mm (1.381 in.)
End Play	0.09 - 0.22 mm (0.004 - 0.009 in.)
Crankshaft Oil Seal Depth (PTO End)	4 mm (0.158 in.)

Camshaft:

Cam Lobe Height (FE290D) (minimum)	32.70 mm (1.287 in.)
Cam Lobe Height (FE350D) (minimum)	33.24 mm (1.309 in.)
PTO and Flywheel Side Journal OD (minimum)	22.93 mm (0.903 in.)
Cylinder Block and Cover Bearing ID (maximum)	23.06 mm (0.908 in.)
Axial Play (FE350D) (maximum)	0.35 mm (0.013 in.)

Crankshaft - FE290D:

Total Indicated Runout (maximum)	0.05 mm (0.002 in.)
Main Bearing Journal OD (PTO and Flywheel) (minimum)	29.92 mm (1.178 in.)
Connecting Rod Journal OD Standard (minimum)	35.44 mm (1.395 in.)
Balancer Link Rod Journal (minimum)	46.92 mm (1.847 in.)
Axial Play (maximum)	0.35 mm (0.013 in.)

Crankshaft - FE350D:

Total Indicated Runout (maximum)	0.05 mm (0.002 in.)
Main Bearing Journal OD (PTO and Flywheel) (minimum)	34.93 mm (1.375 in.)
Connecting Rod Journal OD Standard (minimum)	37.44 mm (1.474 in.)
Balancer Link Rod Journal (minimum)	49.92 mm (1.965 in.)
Axial Play (maximum)	0.35 mm (0.013 in.)

Cylinder Bore ID - FE290D:

Standard Bore	77.98 - 78.00 mm (3.070 - 3.071 in.)
Wear Limit	78.07 mm (3.074 in.)
Out-of-Round (maximum)	0.056 mm (0.0022 in.)
Oversize Bore	0.50 mm (0.0197 in.)

ENGINE - GAS SPECIFICATIONS

Cylinder Bore ID - FE350D:

Standard Bore	**82.98 - 83.00 mm (3.267 - 3.268 in.)**
Wear Limit	**83.07 mm (3.270 in.)**
Out-of-Round (maximum)	**0.056 mm (0.0022 in.)**
Oversize Bore	**0.50 mm (0.0197 in.)**

Piston and Rings:

Ring Thickness (minimum) Top and Second Rings	**1.44 mm (0.057 in.)**
Ring Groove Clearance (maximum) Top Ring	**0.16 mm (0.006 in.)**
Ring Groove Clearance (maximum) Second Ring	**0.14 mm (0.005 in.)**
Oil Ring Assembly	**Not Measured**
End Gap (maximum) Top and Second Rings	**1.2 mm (0.047 in.)**
End Gap Oil Ring Assembly	**Not Measured**
Piston Pin Bore ID (FE290D) (maximum)	**19.03 mm (0.749 in.)**
Piston Pin Bore ID (FE350D) (maximum)	**20.03 mm (0.789 in.)**
Piston Pin OD (FE290D) (minimum)	**18.98 mm (0.747 in.)**
Piston Pin OD (FE350D) (minimum)	**19.98 mm (0.786 in.)**
Piston OD, Standard (FE290D) (minimum)	**77.85 - 77.87 mm (3.0649 - 3.0657 in.)**
Piston OD, Standard (FE350D) (minimum)	**82.85 - 82.87 mm (3.262 - 3.263 in.)**

Connecting Rod - FE290D:

Crankshaft Bearing ID (maximum)	**35.57 mm (1.400 in.)**
Piston Pin Bearing ID (maximum)	**19.05 mm (0.750 in.)**
End-Cap Screw Torque	**20 N•m (177 lb-in.)**

Connecting Rod - FE350D:

Crankshaft Bearing ID (maximum)	**37.57 mm (1.479 in.)**
Piston Pin Bearing ID (maximum)	**20.05 mm (0.789 in.)**
End-Cap Screw Torque	**23 N•m (204 lb-in.)**

Reciprocating Balancer:

Balancer Link Rod

Journal OD (minimum)	**46.86 mm (1.845 in.)**
Small End ID (maximum)	**12.06 mm (0.475 in.)**
Large End ID (FE290D) (maximum)	**47.12 mm (1.855 in.)**
Large End ID (FE350D) (maximum)	**50.11 mm (1.973 in.)**
Bushing Depth	**1.00 mm (0.040 in.)**

Balancer Support Guide

Weight Guide Bearing ID (maximum)	**26.10 mm (1.027 in.)**
Support Shaft Guide OD (minimum)	**25.93 mm (1.021 in.)**

Oil Pump:

Inner Rotor Shaft OD (minimum)	**12.63 mm (0.497 in.)**
Inner Rotor Shaft Bearing ID (maximum)	**12.77 mm (0.503 in.)**
Outer Rotor OD (minimum)	**40.47 mm (1.593 in.)**
Outer Rotor Thickness (minimum)	**9.92 mm (0.391 in.)**
Outer Rotor Bearing ID (maximum)	**40.77 mm (1.605 in.)**

Inner to Outer Rotor Clearance (maximum) . . . . . 0.3 mm (0.012 in.)
Relief Valve Spring Free Length (minimum) . . . . . 19 mm (0.748 in.)

Torque Specifications

Alphabetical:

Carburetor Mounting Nuts . . . . . 10 N•m (90 lb in.)
Connecting Rod Bolts (FE290D) . . . . . 20 N•m (177 lb-in.)
Connecting Rod Bolts (FE350D) . . . . . 23 N•m (204 lb-in.)
Control Plate Mounting Bolts . . . . . 6 N•m (53 lb-in.)
Crankcase Cover Bolts . . . . . 26 N•m (230 lb-in.)
Cylinder Head Cap Screw Torque:
First . . . . . 18 N•m (159 lb-in.)
Second . . . . . 21 N•m (186 lb-in.)
Final . . . . . 25 N•m (221 lb-in.)
Drain Screw (Carburetor) . . . . . 2 N•m (18 lb-in.)
Engine Mounting Cap Screws . . . . . 23 N•m (204 lb-in.)
Flywheel Nut (FE290D) . . . . . 86 N•m (63 lb-ft)
Flywheel Nut (FE350D) . . . . . 137 N•m (101 lb-ft)
Governor Arm Nut . . . . . 6.9 N•m (61 lb-in.)
Governor Shaft Plate Screws . . . . . 2 N•m (17 lb-in.)
Muffler Retaining Nut . . . . . 14 N•m (124 lb-in.)
Muffler Flange, Hex Nuts . . . . . 20 N•m (177 lb-in.)
Oil Drain Plug . . . . . 21 N•m (186 lb-in.)
Oil Drain Plug (metal with sealing washer) . . . . . 32 N•m (24 lb-ft)
Regulator Screws . . . . . 3.4 N•m (30 lb-in.)
Rocker Arm Bolts . . . . . 28 N•m (21 lb-ft)
Rocker Arm Lock Nut Torque (FE290D) . . . . . 9.8 N•m (87 lb-in.)
Spark Plug Torque . . . . . 23 N•m (204 lb-in.)
Starting Motor Retaining Bolt . . . . . 20 N•m (177 lb-in.)
Starting Motor Battery Cable Nut . . . . . 9.8 N•m (87 lb-in.)
Support to Engine Lock Nuts . . . . . 32 N•m (24 lb-in.)
Support to Transaxle Cap Screw . . . . . 37 N•m (27 lb-in.)
Throttle Valve Screws (use non-permanent thread locker) . . . . . 0.95 N•m (8.4 lb-in.)
Valve Clearance Adjustment Lock Nut (FE290D) . . . . . 8.8 N•m (78 lb-in.)
Valve Cover Bolt Torque . . . . . 6 N•m (53 lb-in.)

Special or Essential Tools

Note: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Tachometer	JT05719	Slow idle mixture screw and speed adjustments, and fast idle speed adjustment.
Fuel Pump Pressure Test Kit	JDG356	Fuel pump pressure test.
Carburetor Test Kit	JDZ25-2	Fuel tank check valve test.
Compression Gauge Spark Plug Test Tool	JDM59 JDM-74A-5	Cylinder compression test, and Valve clearance adjustment.
Dial Indicator		Automatic compression relief test, valve inspection, crankshaft end play
Pressure Gauge Assembly Hose Assembly Connector 1/8” BSP Thread	JT05577 JT03017 JT03349	Oil pressure test. (If oil filter option is installed)
Valve Spring Compressor	JDM70	Cylinder head disassembly and assembly.
Valve Guide Driver Tool	JDG504	Replace valve guides.
Spark Tester	D-05351ST	Used to check overall condition of ignition system.
Feeler Gage	N/A	Used to measure clearance.
Dial Indicator	N/A	Used to measure ACR movement and crankshaft end play.

Other Materials

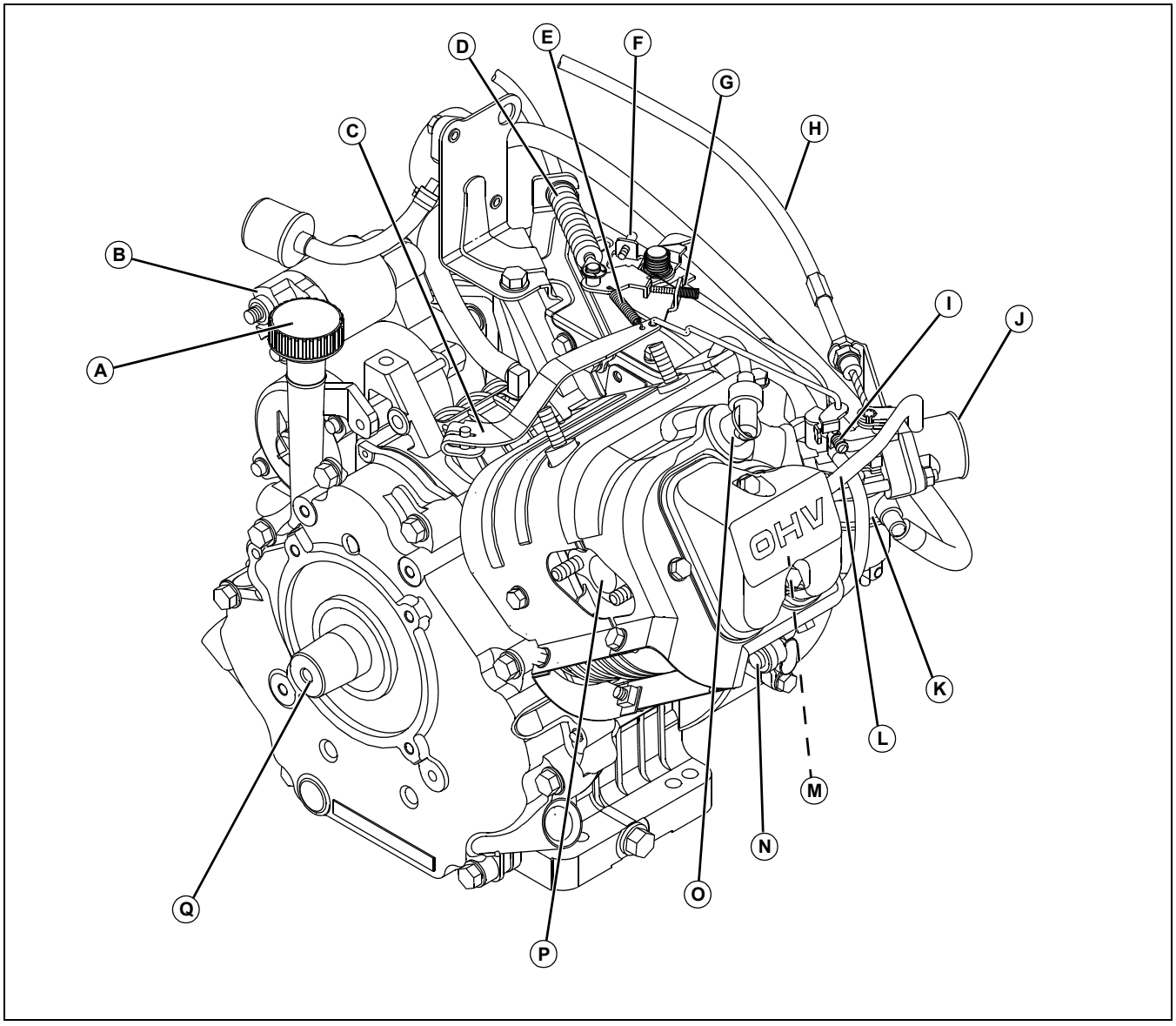
Other Material

Part No.	Part Name	Part Use
TY24416	Multipurpose Grease	Apply to engine crankshaft
PT569	John Deere NEVER-SEEZ® Lubricant	Apply to crankshaft end
TY9375/ TY9480/ 592	Pipe Sealant with TEFLON®[1]	Apply to threads of oil pressure plug.
	SCOTCH-BRIGHT® Abrasive Sheets/ Pads	Clean cylinder head.
	Valve Guide Cleaner	Clean valve guides.
	Stanisol or Kerosene	Finish ream valve guide.
	Prussian Blue Compound	Check valve seat contact.
	Lithium Base Grease	Pack oil seals.
	Zinc Oxide/Wood Alcohol	Check block for cracks.
	Mineral Spirits	Clean electric starter armature.

1. TEFLON is a registered trademark of Du Pont Co.

Component Location

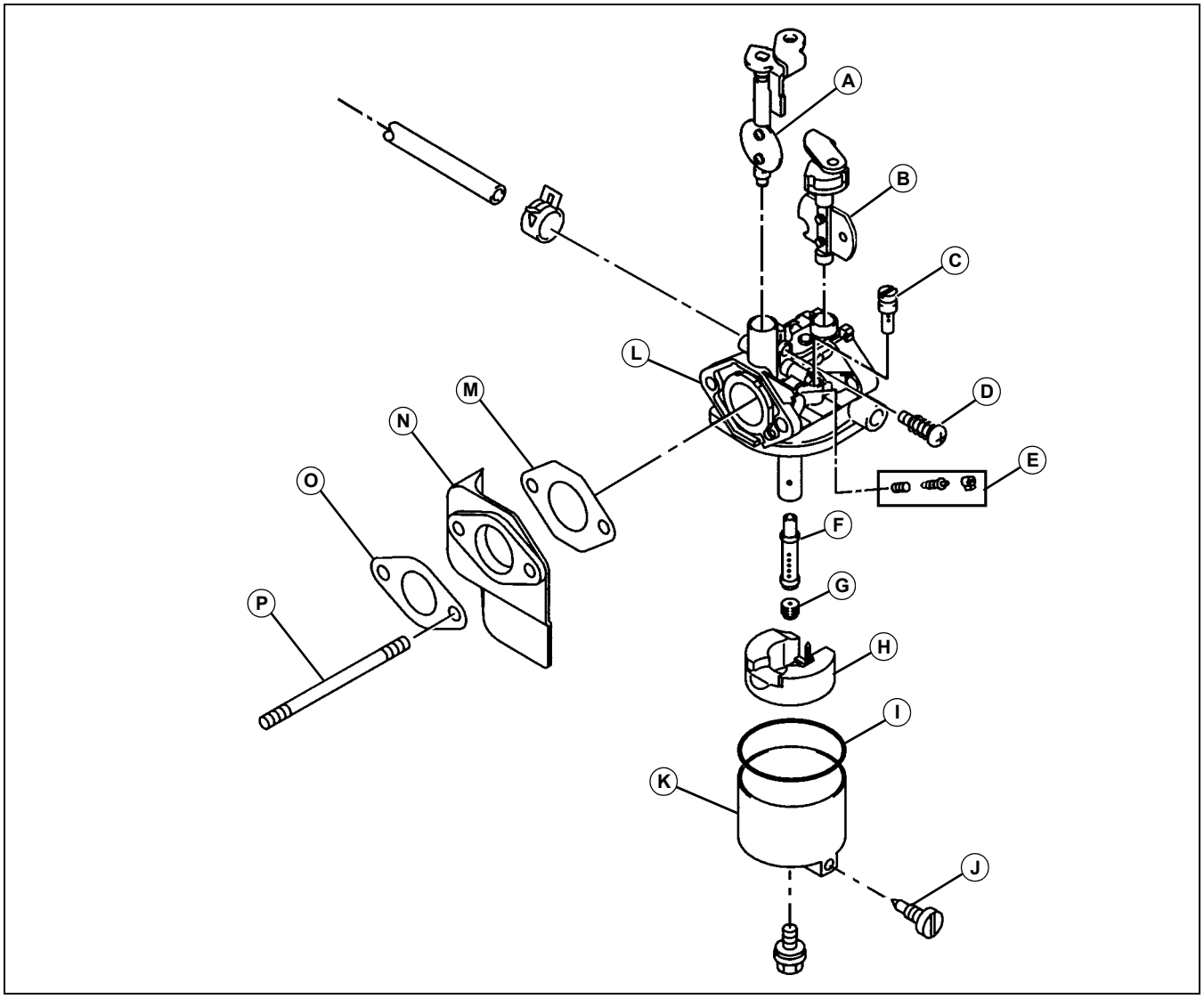
FE290D / FE350D Engine



MIF

A- Engine Oil Dipstick
B- Starting Motor Solenoid
C- Governor Arm Assembly
D- Throttle Cable Assembly
E- Governor Spring
F- Fast Idle Screw
G- Slow Idle Governor Screw
H- Choke Cable Assembly
I- Carburetor Butterfly Stop Screw
J- Carburetor Air Intake
K- Carburetor Assembly
L- Crankcase Vent Hose
M- Intake and Exhaust Valves
N- Oil Pressure Test Port
O- Spark Plug
P- Exhaust Port
Q- Crankshaft

Carburetor Components

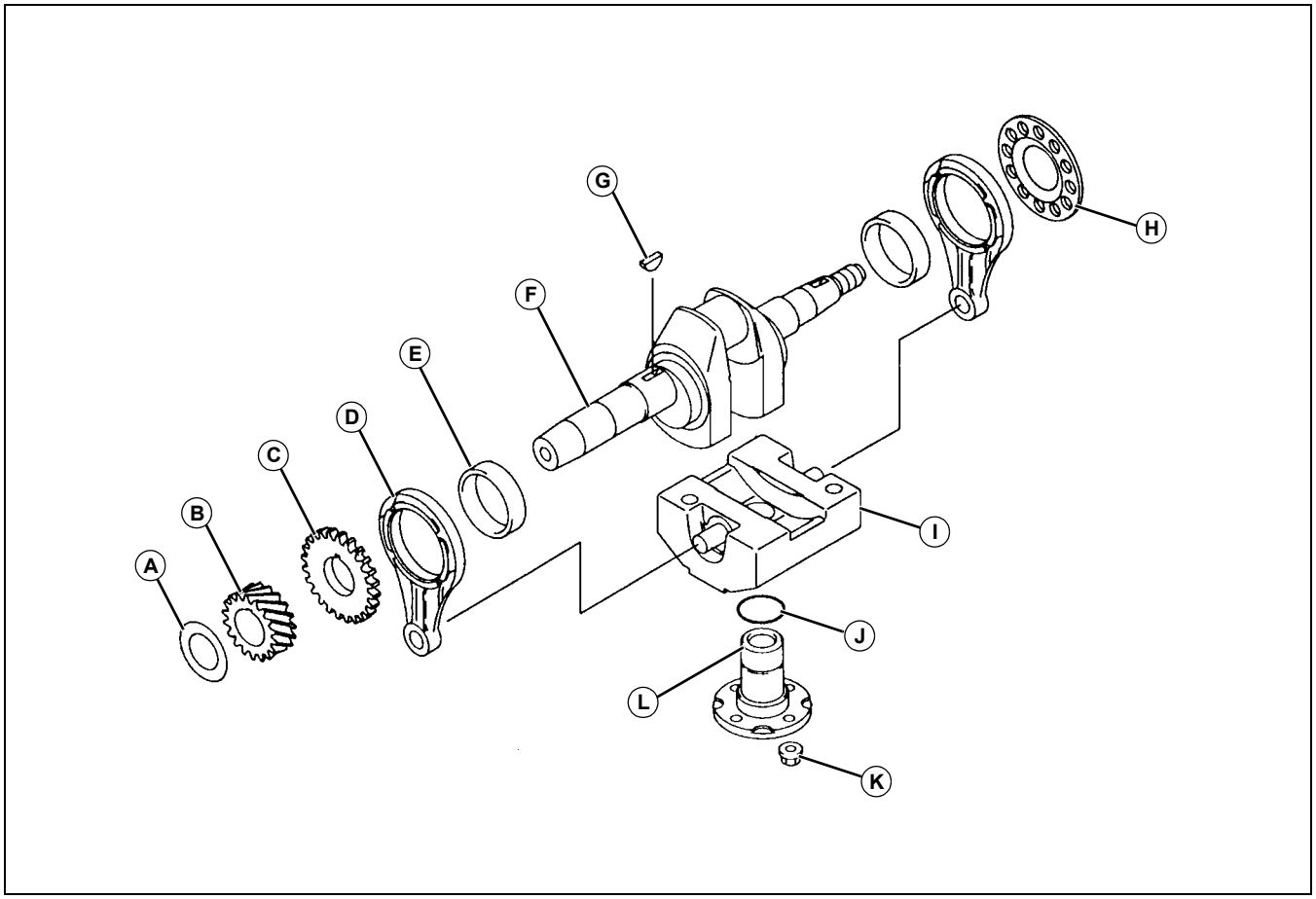


MX31242

1. For altitude changes, see Carburetor Jets in Specifications for selection.

A- Throttle Plate
B- Choke Plate
C- Pilot Jet
D- Idle Speed Screw
E- Idle Mixture Screw and Limiter
F- Main Nozzle
G- Main Jet[1]
H- Float
I- Gasket
J- Drain Screw
K- Float Chamber
L- Carburetor Body
M- Gasket
N- Insulator
O- Gasket
P- Stud (2 used)

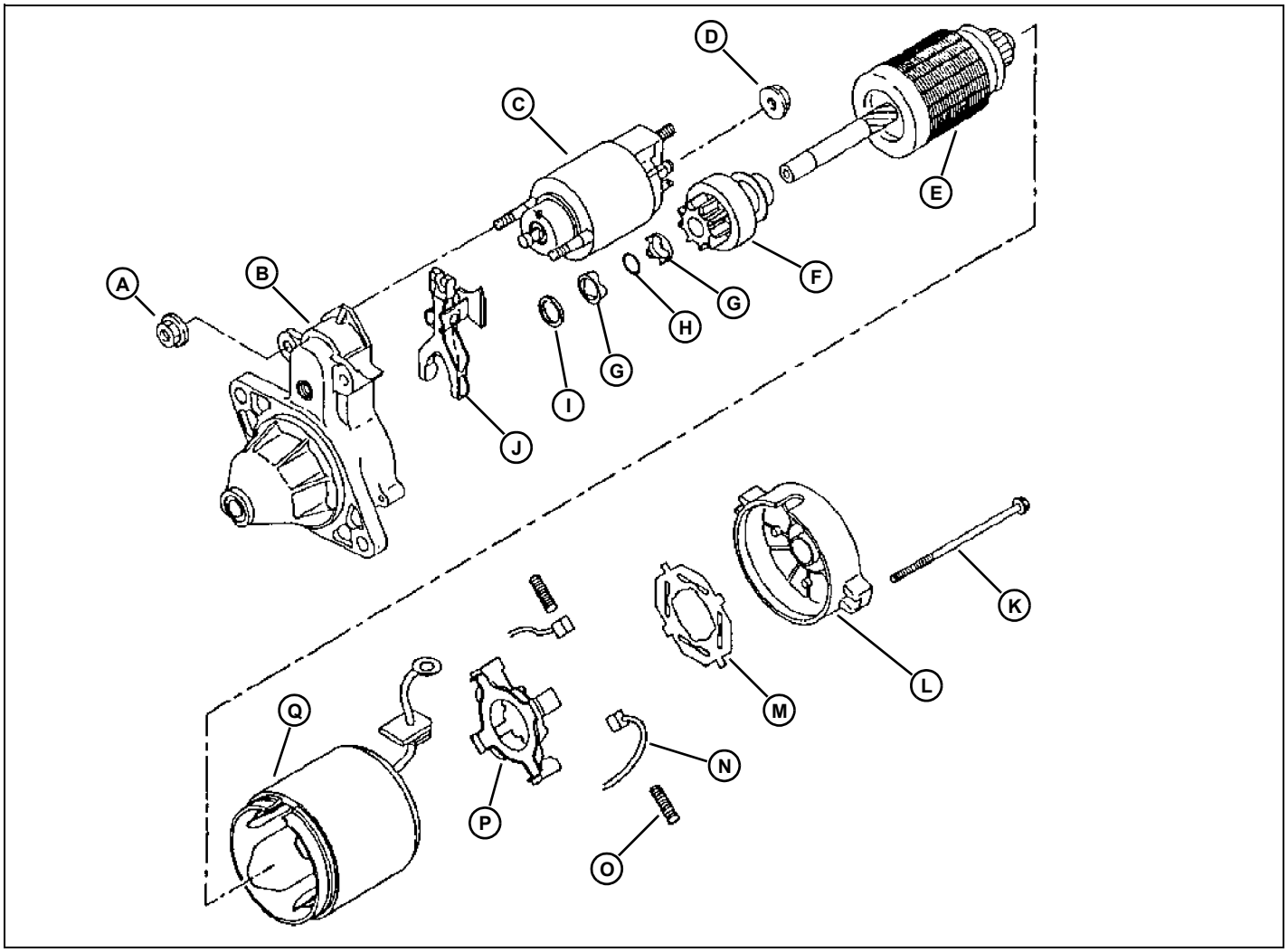
Balancer Components



M87730

A- Shim
B- Helical Gear
C- Spur Gear
D- Link Rod
E- Collar
F- Crankshaft
G- Key
H- Spacer
I- Balancer Assembly
J- O-Ring
K- Nut (4)
L- Support Shaft

Starting Motor Components



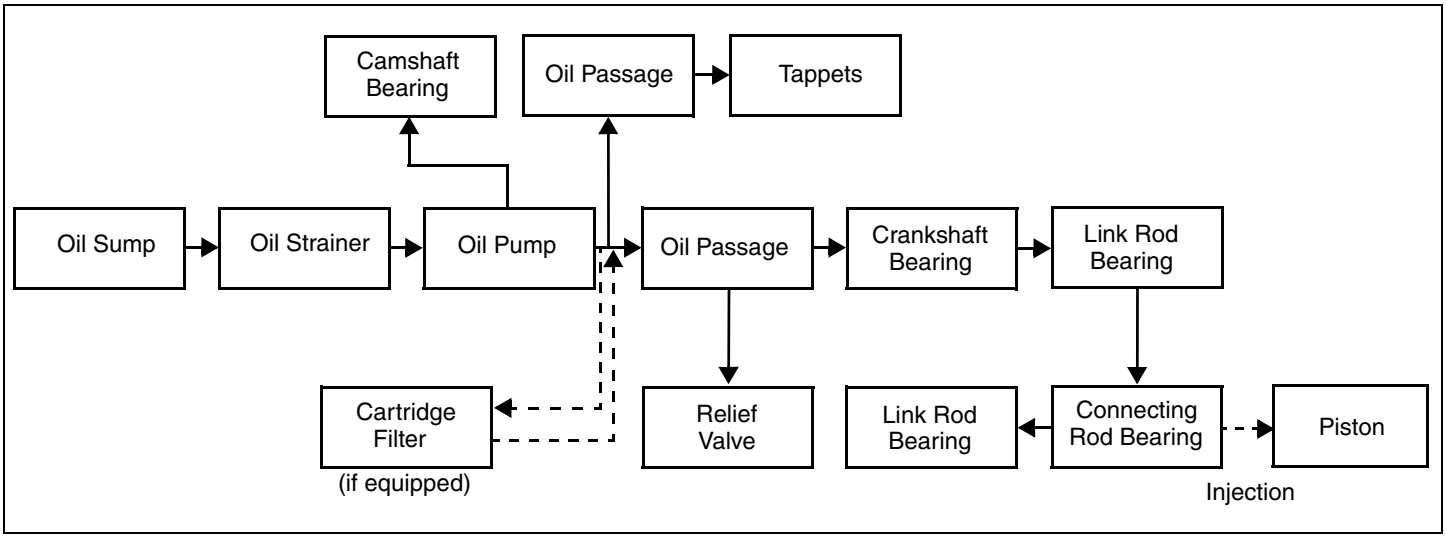
M82414A

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

Theory of Operation

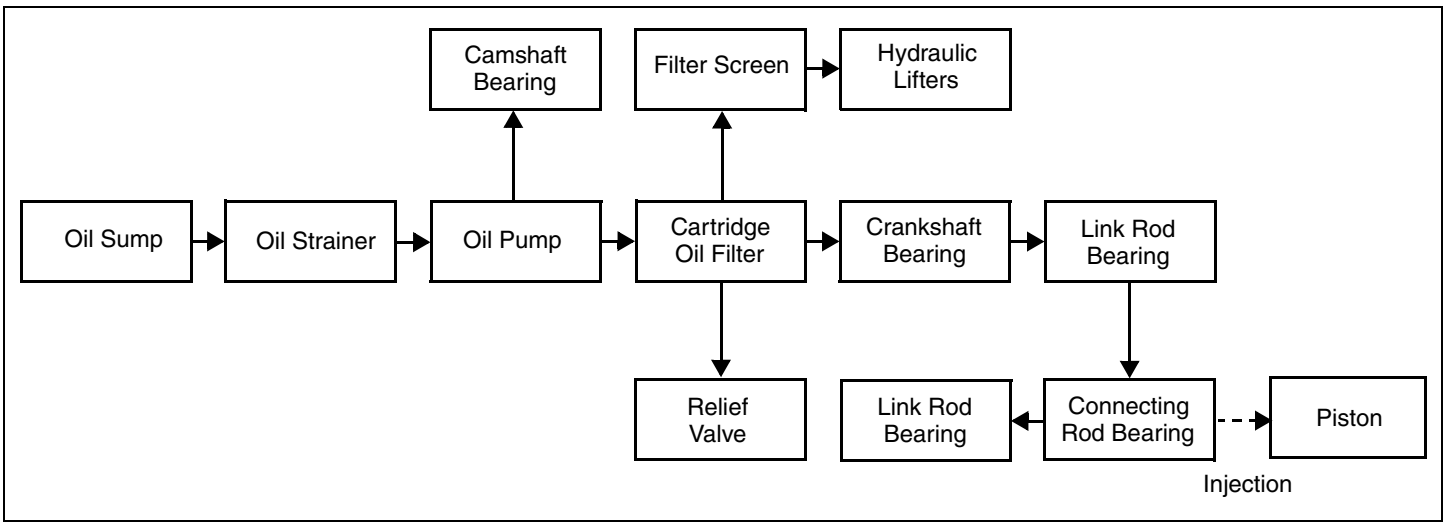
Lubrication System Operation

FE290D Engine Oil Flow Chart



MIF

FE350D Engine Oil Flow Chart



MIF

Function:

To provide pressurized oil to lubricate internal engine components.

Theory of Operation:

A positive displacement gerotor pump, located at the front side of the engine and driven by the camshaft, is used to pressurize the lubrication system.

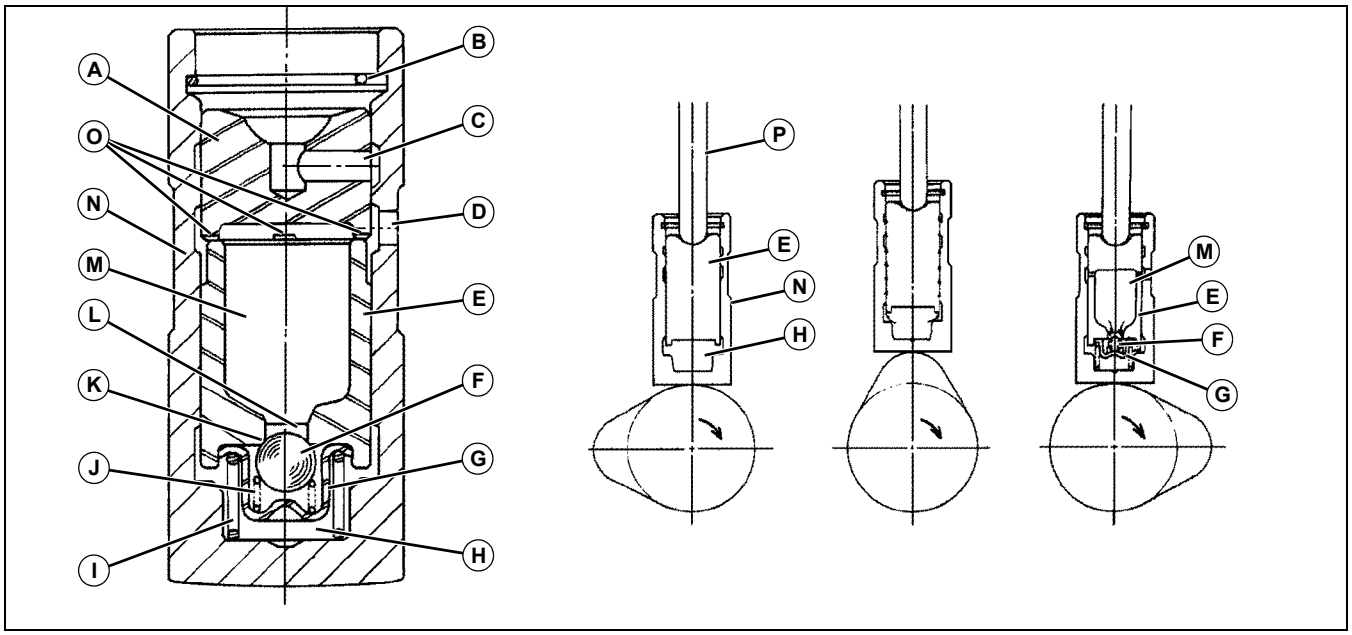
The pump draws oil from the oil sump through a strainer screen and pumps pressurized oil through the oil passages to engine components as indicated in the engine oil flow chart for each engine.

The lubrication system is protected by an oil intake strainer, oil pressure relief valve and a cartridge type oil filter with bypass valve (some FE290D models not equipped with cartridge filter). The FE350D also includes an additional filter screen at the oil pump.

The pressure relief valve is located at the outlet side of the oil pump. When the oil pressure is higher than the preset pressure of the relief valve, the relief valve opens to discharge oil into the crankcase and prevent damage. When the oil pressure is lower than the preset pressure, the relief valve closes.

The FE350D engine is supplied with hydraulic valve lifters to automatically adjust the valve train to zero clearance, eliminating the need for manually adjusting valve train clearance, reducing engine noise and optimizing performance. An additional filter screen on the FE350D is provided for added protection against contaminants affecting operation of the hydraulic valve lifters.

Hydraulic LIfter Operation



MX40354

A- Socket
B- Snap Ring
C- Oil Metering Hole
D- Oil Hole
E- Plunger
F- Check Ball
G- Lifter Cage
H- High Pressure Chamber
I- Plunger Spring
J- Check Valve Spring
K- Check Valve Seat
L- Passage
M- Oil Pool
N- Lifter Body
O- Oil Groove
P- Pushrod

Function:

Hydraulic valve lifters automatically adjust the valve train to zero clearance, eliminating the need for manually adjusting valve train clearance, reducing engine noise and optimizing performance.

Theory of Operation:

When the camshaft pushes the hydraulic lifter upward, the oil in the high-pressure chamber (H) tries to flow back to the oil pool (M) of plunger (E) through passage (L), but because the check ball (F) closes the passage (L), the oil cannot flow back, which causes hydraulic pressure in the high-pressure chamber (H) to rise.

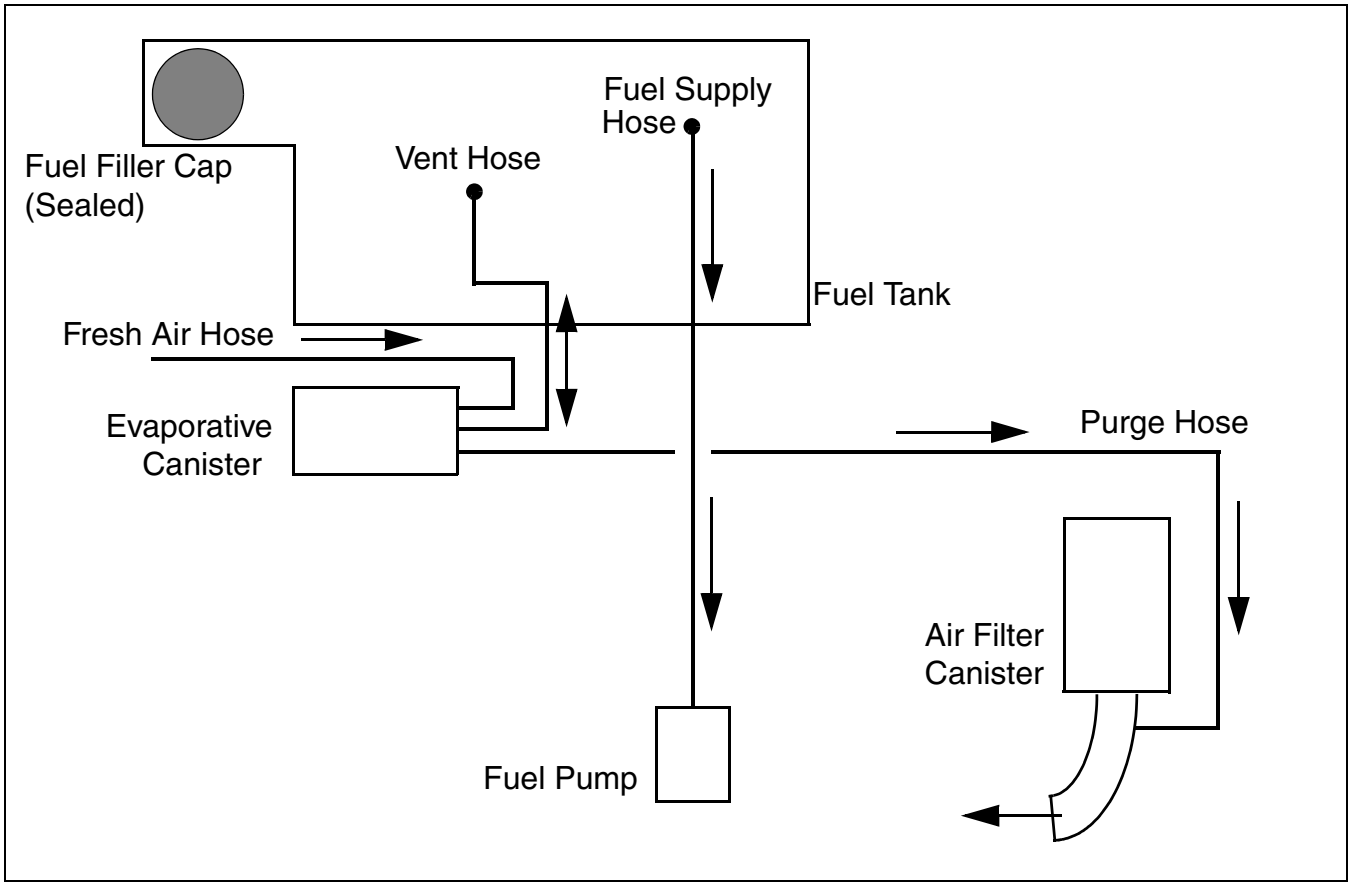
The oil of the high-pressure chamber (H), in which the hydraulic pressure has now risen, leaks at a very slow rate through the gap between the plunger (E) and the lifter body (N). As a result, the plunger compresses slightly and pushes the pushrod (P) upward.

When the rotation of the camshaft causes the hydraulic lifter to descend to the cam base circle, the pressurized oil from the oil pump passes through the oil hole (D) in the lifter body (N), travels through the oil groove (O) that is cut into the socket (A), and enters the oil pool (M) in the plunger (E).

After filling the oil pool (M), the oil pushes open the check ball (F), and flows into the lifter cage (G) and the high-pressure chamber (H), in order to correct the valve train to achieve zero clearance.

Evaporative Emissions System Operation

Note: This system is only installed with FE350D engine.



MIF

Function:

The evaporative emissions system reduces the amount of fuel vapors that are vented into the atmosphere. Utilizing a sealed fuel filler cap, an evaporative canister of activated charcoal and appropriate hoses, the vapors are captured and drawn into the engine to be burned normally, reducing evaporative emissions.

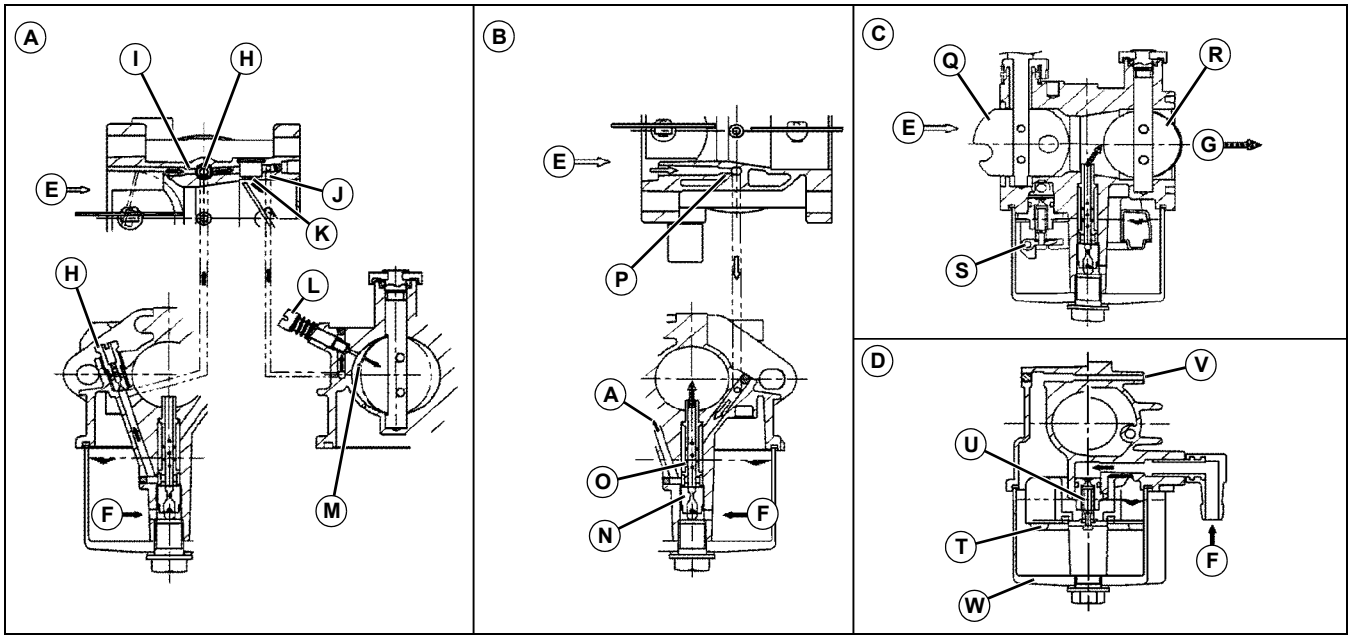
Theory of Operation:

The evaporative emissions system components consist of a sealed fuel filler cap, an evaporative canister with activated charcoal, and the following hoses:

- Fresh air supply hose, to the evaporative canister.
- Vent hose from the fuel tank to the evaporative canister.
- Fuel supply hose from the fuel tank to the fuel pump.
- Purge hose from the evaporative canister to the engine air intake.

Fuel vapors are vented to the evaporative canister, where they are captured by the activated charcoal in the canister. When the engine is running, vacuum in the purge hose pulls the captured fuel from the activated charcoal in the canister, and it is drawn into the engine and burned normally.

Carburetor Fuel/Air



MX40340

A- Pilot System
B- Main System
C- Choke System
D- Float System
E- Air
F- Fuel
G- Air-Fuel Mixture
H- Pilot Jet
I- Pilot Air Jet (Body Jet)
J- Pilot Port
K- Bypass Port
L- Pilot Screw
M- Pilot Port
N- Main Jet
O- Main Nozzle
P- Main Air Jet (Body jet)
Q- Choke Valve
R- Throttle Valve
S- Float Hinge Pin
T- Float
U- Float Valve
V- Air Vent
W- Float Chamber

Function:

The function of a carburetor is to mix fuel and air by atomization, creating an appropriate air-fuel mixture in accordance with load fluctuations for proper engine operation.

Theory of Operation:

The major carburetor functions consist of the pilot system, main system, choke system and float system.

- Pilot System - This system supplies fuel during idling, low speed and light load engine operation.

Fuel regulated by the pilot jet mixes with air regulated by the pilot air jet, and the resulting mixture flows through the pilot port and bypass port to the engine.

Fuel used during idling is primarily supplied to the engine through the pilot port.

- Main System - This system supplies fuel during medium to high speed, high-load operation. Fuel flows through the main nozzle and is regulated by the main jet.

Air regulated by the main air jet mixes with fuel via the main nozzle bleed hole, and is discharged into the venturi in an emulsion form (liquid fuel intermixed with air bubbles).

In the venturi, airflow from the air cleaner atomizes the fuel, and the resulting air-fuel mixture flows into the cylinder for combustion.

- Choke System - Closing the choke decreases the volume of air entering the carburetor and increases the intake vacuum during the intake stroke of the engine. As a result, more fuel than normal is discharged from the pilot and main systems to facilitate cold engine starting.

Note: The fuel level in the carburetors used on FE series engines cannot be adjusted. Replace the float if defective.

- Float System - The float maintains fuel in the float chamber of the carburetor at a constant level for delivery to

the engine.

As fuel is used by the engine, the float moves downward and opens the float valve, allowing fuel to enter the float chamber. When no fuel is being used, the float will raise, closing the float valve and stopping fuel entry into the float chamber. During normal operation, the float and float valve are constantly moving up or down to maintain the nominal fuel level in the float chamber, based on fuel demand by the engine.

Air pressure in the float chamber is constantly maintained at atmospheric pressure via the air vent.

Diagnostics

System: Engine Troubleshooting Guide

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

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

Engine Diagnostics

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 Load Test" in the Electrical section.

Yes: Go to next step.

No: Charge battery. See "Charge Battery" in the Electrical Section.

3. Is key switch working correctly?

Yes: Go to next step.

No: Test switch. Replace as needed.

4. Is starter motor defective? See "Starting Motor Troubleshooting Guide" on page 42.

Yes: Repair or replace.

No: Go to next step.

5. Is starting motor or solenoid defective?

Yes: Repair or replace.

No: Go to next step.

6. Are operating conditions met, or is there a open circuit in wiring?

Yes: Diagnose and repair as necessary.

No: Go to next step.

7. Are the valves adjusted properly?

Yes: Go to next step.

No: Adjust valve clearance.See "Valve Clearance Adjustment - FE290D" on page 47.

8. Is engine compression good? See "Cylinder Compression Test" on page 46.

Yes: Go to next step.

No: Check for seized or burned valves, broken piston

rings, or worn cylinder.

9. Has engine seized?

Yes: See engine Repair Section.

No: Go to next step.

Engine Hard To Start, Backfires or Misses

1. Are battery cables loose or dirty?

Yes: Repair.

No: Go to next step.

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

Yes: Go to next step.

No: Charge battery. See “Charge Battery” in the Electrical Section.

3. Is there a strong blue spark? See “Spark Test” in the Electrical section.

Yes: Go to next step.

No: Check spark plug wire(s) for proper seating and connections. Check ignition coil gap. See “Ignition Coil Air Gap Adjustment” on page 49. Adjust gap, or replace ignition module.

4. Are sparks jumping between high tension lead and ignition block. Check high tension lead and ignition coil air gap.

Yes: Repair or replace parts as needed.

No: Go to next step.

5. Is the fuel shutoff solenoid operating correctly?

Yes: Go to next step.

No: Repair or replace.

6. Is the fuel filter or fuel line clogged?

Yes: Clean or replace as necessary.

No: Go to next step.

7. Is the fuel pump operating correctly? See “Test Fuel Pump” on page 46.

Yes: Go to next step.

No: Clean or replace as necessary.

8. Is their water in the fuel?

Yes: Drain and replace fuel.

No: Go to next step.

9. Is air sucked through carburetor or intake manifold flanges?

Yes: Tighten manifold flange nuts or replace damaged gasket.

No: Go to next step.

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.

10. Make starting attempts a number of times, remove spark plug and observe electrodes. After starting attempts, are spark plug electrodes wet?

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

No: Go to next step.

11. Are the valves set correctly? See “Valve Clearance Adjustment - FE290D” on page 47.

Yes: Go to next step.

No: Check push rods and adjust valves. See “Valve Clearance Adjustment - FE290D” on page 47. Repair or replace parts as needed.

12. Is engine compression good? See “Cylinder Compression Test” on page 46.

Yes: Remove flywheel and inspect flywheel key. See “Flywheel Removal and Installation” on page 62.

No: Check piston rings and cylinder for wear. See “Piston and Connecting Rod” on page 70. Inspect Cylinder head. See “Cylinder Head Inspection and Replacement” on page 64.

Engine Runs Erratically or Surges

1. Does the engine smooth out if partial choke is applied?

Yes: Go to next step.

No: Check for proper governor adjustment. See “Adjust Governor” on page 44.

2. Is fuel delivery correct? See “Test Fuel Pump” on page 46.

Yes: Go to next step.

No: Check for defective fuel pump, plugged fuel lines, fuel filter, or fuel tank vent.

3. Is fuel present in carburetor?

Yes: Go to next step.

No: Check for plugged air/fuel passages in carburetor. See “Remove and Install Carburetor” on page 55.

4. Is the fuel stale or is there contamination in fuel lines, or fuel tank?

Yes: Replace fuel and clean or replace parts as needed.

No: Go to next step.

5. Is air leaking through carburetor connections or intake manifold flanges?

Yes: Tighten manifold flange nuts or replace damaged gasket.

No: Go to next step.

Engine Malfunctions at Low Speed

1. Is unusual smoke emitted out of muffler?

Yes: Check choke. See “Adjust Choke Cable” on page 43.

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: Check for obstruction or plugged passage in carburetor. See “Remove and Install Carburetor” on page 55.

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 - FE290D” on page 47.

Yes: Go to next step.

No: Adjust valves.

Engine Dies After Running

1. Does engine die after running 20 seconds or less?

Yes: Check choke. See “Adjust Choke Cable” on page 43.

Yes: Check for stale fuel or contamination. Replace fuel and clean or replace parts as needed.

No: Go to next step.

2. Does engine die after running 10 minutes ar more under load?

Yes: Check fuel lines for obstruction, plugged passage or collapsed fuel line. Test fuel pump. See “Test Fuel Pump” on page 46.

Yes: Check all shielding is in place and fuel line is run away from heat sources.

Oil Consumption Is Excessive

1. Check for oil leaks, high oil level, clogged breather valve, plugged drain back hole in breather. Is oil viscosity correct?

Yes: Repair as required.

No: Go to next step.

2. Is compression correct? See “Cylinder Compression Test” on page 46.

Yes: Go to next step.

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

Low Oil Pressure

1. Is oil level correct?

Yes: Go to next step.

No: Top off oil to correct level.

2. Is oil filter clogged?

Yes: Replace oil filter.

No: Go to next step.

3. Is oil of correct viscosity?

Yes: Go to next step.

No: Change engine oil.

4. Check for oil leaks, high oil level, clogged breather valve, plugged drain back hole in breather. Is oil viscosity correct?

Yes: Repair as required.

No: Go to next step.

5. Is oil relief valve worn?

Yes: Clean, adjust or replace relief valve.

No: Go to next step.

6. Is oil pump operating correctly? See “Oil Pressure Test” on page 51.

Yes: Go to next step.

No: Replace oil pump.

7. Is there fuel in the oil?

Yes: Check for broken or seized piston rings or worn cylinder.

No: Go to next step.

8. Is oil pump screen clogged or pick up tube cracked?

Yes: Clean screen and repair or replace pick up tube.

No: Go to next step.

9. Is there excessive crankshaft or rod bearing clearance? See “Crankshaft End Play Adjustment” on page 76.

Yes: Replace worn crankshaft and/or worn connecting rods.

No: Go to next step.

10. Intake/exhaust valves or guides worn?

Yes: Replace valves and head.

No: Go to next step.

Contamination in Crankcase

1. Is there fuel in the crankcase?

Yes: Check for broken or seized piston rings or worn cylinder. Check for worn or seized exhaust valve.

No: Go to next step.

2. Is there water in the crankcase?

Yes: Check to make sure that crankcase breather is working correctly. See “Crankcase Vacuum Test” on page 48. See “Crankcase Breather Inspection” on page 61.

System: Starting Motor Troubleshooting Guide

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

Important: Avoid Damage! If starting motor does not stop rotating by turning ignition switch OFF, 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.

Starting Motor Diagnostics

Starter Does Not Rotate

1. Is there a click sound from the starter solenoid?

Yes: Go to next step.

No: Repair starter motor.

2. Check that all starting conditions are met?

Yes: Go to next step.

No: Make sure all starting conditions are met.

3. Are battery cables loose or dirty?

Yes: Clean and tighten.

No: Go to next step.

4. Is battery fully charged? See “Charge Battery” in the Electrical Section.

Yes: Go to next step.

No: Charge battery. Check for charging voltage to battery.

5. Is key switch working correctly?

Yes: Go to next step.

No: Repair or replace key switch.

6. Is engine seized?

Yes: See Engine Repair Section.

No: Go to next step.

Starter Rotates Slowly

1. Are battery cables loose or dirty?

Yes: Clean and tighten.

No: Go to next step.

2. Is battery fully charged? See “Charge Battery” in the Electrical Section.

Yes: Go to next step.

No: Charge battery. Check for charging voltage to battery.

3. Is there a click sound from the starter solenoid?

Yes: Go to next step.

No: Repair starter motor.

4. Is engine seized?

Yes: See engine Repair section.

No: Go to next step.

5. Is starting motor or solenoid defective?

Yes: Repair or replace.

Tests and Adjustments

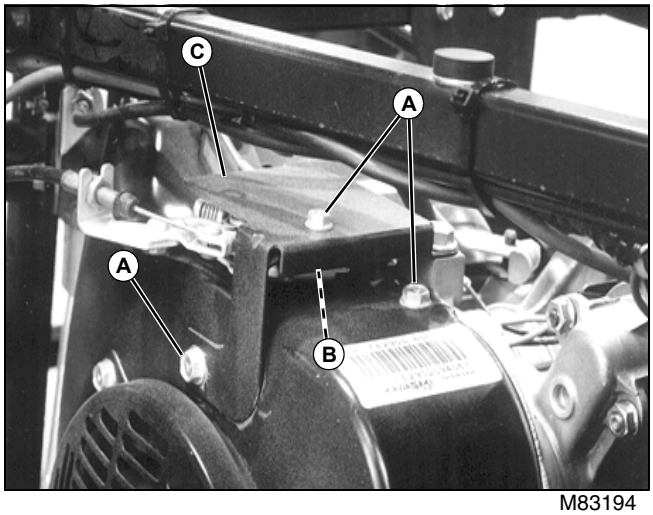
Adjust Throttle Cable

Reason

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

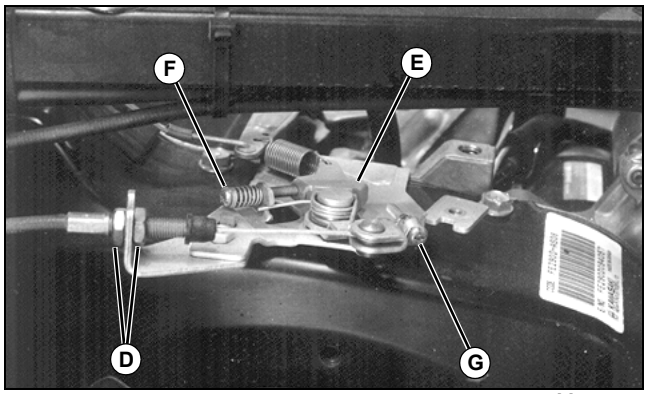
Procedure

1. Park machine safely. (See “Parking Safely” in the Safety section.)
2. Turn key switch OFF.
3. Move gearshift pedals to NEUTRAL position. Lock park brake.
4. Lower front blade (if equipped).
5. Raise rear body cowling.



M83194

6. Remove cap screws (A), spacer (B), and cover (C).



M83464

7. Loosen cable locknuts (D).
8. Adjust cable length so governor control lever (E):
   - Contacts slow idle stop screw (F) when accelerator pedal is NOT pressed.
   - Contacts fast idle stop screw (G) when accelerator pedal is fully pressed.
9. Tighten cable locknuts.
10. Move accelerator pedal through full range to be sure linkage is not binding.

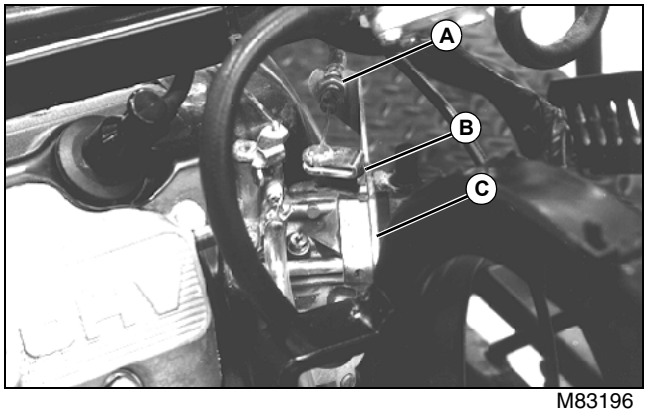
Adjust Choke Cable

Reason

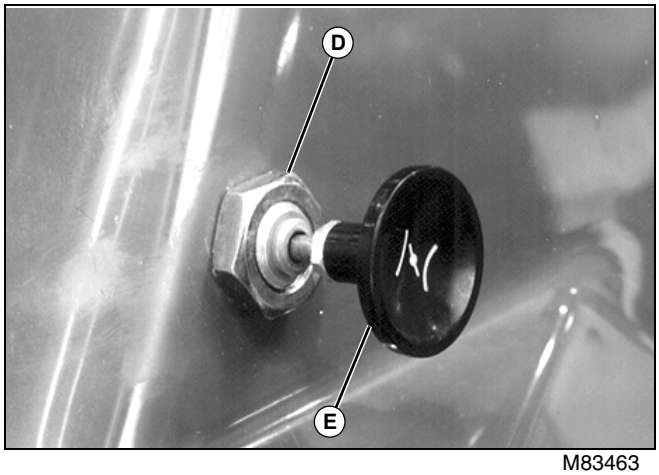
To make sure the choke cable moves the choke through its full range of movement.

Procedure

1. Park machine safely. (See “Parking Safely” in the Safety section.)
2. Turn key switch OFF.
3. Move gearshift pedals to NEUTRAL position. Lock park brake.
4. Lower front blade (if equipped).
5. Raise rear body cowling.



M83196



M83463

6. Loosen cable locknuts (A).
7. Adjust cable position so:

- There is 2-3 mm (0.08-0.12 in.) clearance between choke knob (E) and cable mount (D) when choke open stop (B) contacts block (C) on rear of air intake duct.
- Choke stop contacts block on front side of air intake duct when choke knob is pulled out.

8. Tighten cable locknuts.

Adjust Governor

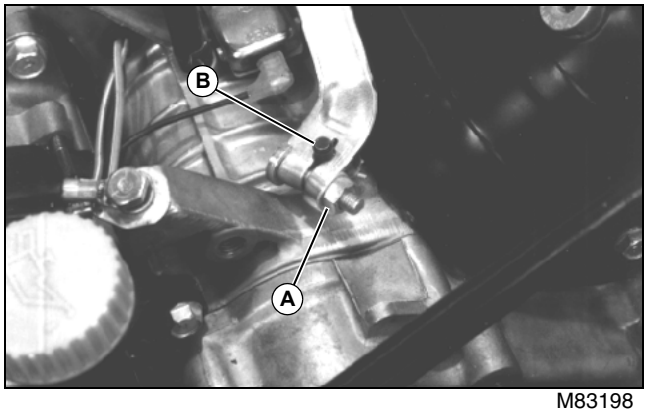
Reason

To make sure the governor shaft contacts the fly-weight plunger when the engine is stopped.

Procedure

Note: Adjust accelerator cable before adjusting governor linkage.

1. Park machine safely. (See “Parking Safely” on page 5.)
2. Turn key switch OFF.
3. Move gearshift pedals to NEUTRAL position. Lock park brake.
4. Lower front blade (if equipped).
5. Raise rear body cowling.
6. Move accelerator lever to FAST idle position.



M83198

7. Loosen nut (A).
8. Hold governor arm in the full right position. Turn governor shaft (B) clockwise until governor shaft stops. Hold governor shaft and tighten nut.
9. Move accelerator lever through full range to be sure linkage is not binding.

Adjust Fast Idle Speed

Reason

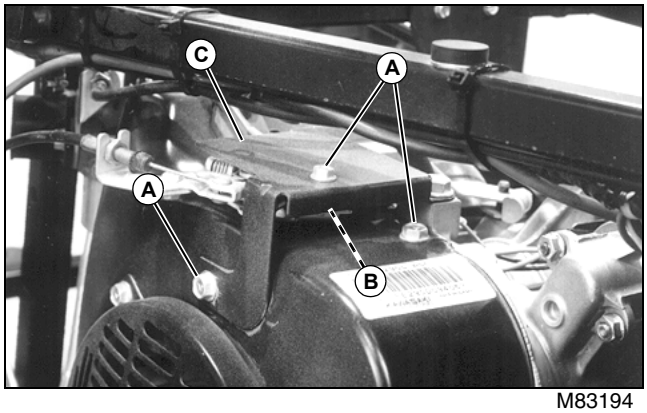
To set engine fast idle speed setting.

Special or Required Tools:

- Tachometer

Procedure

1. Park machine safely. (See “Parking Safely” on page 5.)
2. Turn key switch OFF.
3. Move gearshift pedals to NEUTRAL position. Lock park brake.
4. Lower front blade (if equipped).
5. Raise rear body cowling.

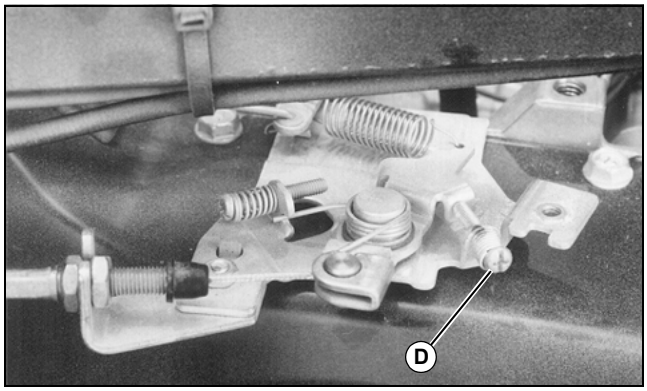


M83194

6. Remove cap screws (A), spacer (B), and cover (C).
7. Start and run engine at MEDIUM idle for 10 minutes.

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

8. Move accelerator lever to FAST idle position.
9. Check engine speed using a tachometer.



10. Adjust fast idle stop screw (D) until 3100 rpm (±75 rpm) is achieved.

Adjust Slow Idle Speed

Reason

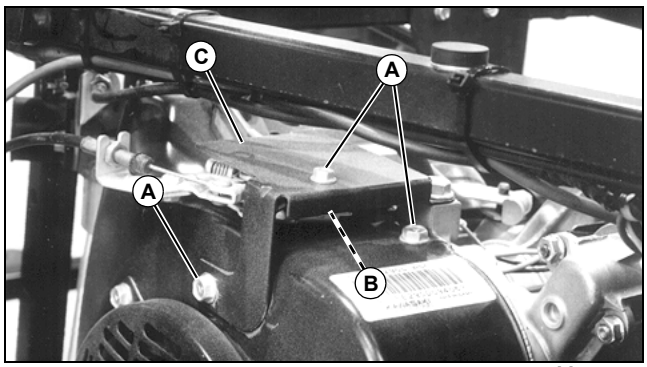
To ensure correct fuel/air mixture and to ensure that engine is running at proper SLOW idle rpm.

Special or Required Tools:

- Tachometer

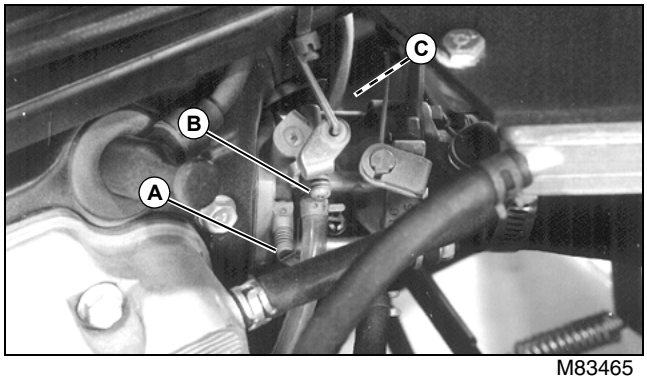
Procedure

1. Park machine safely. (See “Parking Safely” on page 5.)
2. Turn key switch OFF.
3. Move gearshift pedals to NEUTRAL position. Lock park brake.
4. Lower front blade (if equipped).
5. Raise rear body cowling.



M83194

6. Remove cap screws (A), spacer (B) and cover (C).



M83465

7. Turn SLOW idle mixture screw (A) clockwise until lightly seated, then turn counterclockwise 1-3/8 turns.

Important: Avoid Damage! DO NOT overtighten idle mixture screw; the needle and seat will be damaged.

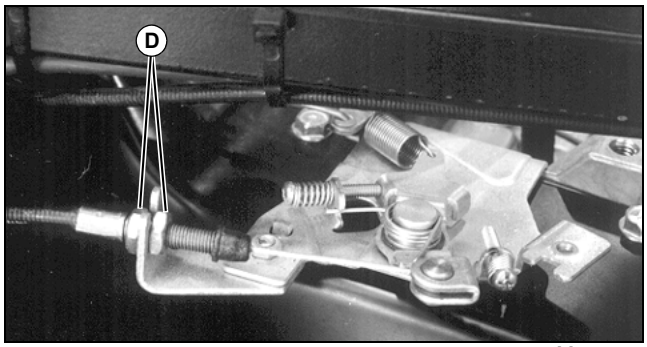
8. Start and run engine at MEDIUM idle for 5 minutes to bring engine to operating temperature.

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

9. Release accelerator pedal.

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

10. Turn slow idle stop screw (B) counterclockwise until screw does not touch throttle arm stop tab (C).



M83461

It may be necessary to loosen accelerator cable locknuts (D) and move cable slightly to obtain proper slow idle speed setting.

11. Turn slow idle mixture screw on carburetor clockwise until engine speed begins to drop off; note position. Turn it counterclockwise until engine speed increases and begins to drop off; note position.
12. Adjust screw halfway between positions. Turn screw counterclockwise an additional 1/4 turn.
13. Check engine speed using a tachometer.
14. Adjust throttle control arm slow idle stop screw to 1175 rpm (±75 rpm).
15. Turn slow idle stop screw clockwise until it touches stop tab.
16. Hold tab against stop screw; adjust screw until engine speed is 50 rpm less than throttle control arm slow idle.
17. Depress and slowly release accelerator pedal. Allow idle speed to stabilize. Recheck throttle slow idle speed.
18. Hold throttle arm against carburetor slow idle stop screw. Engine speed should be 50 rpm less than the throttle control arm slow idle. Readjust if necessary.

It may be necessary to readjust accelerator cable. (See “Adjust Throttle Cable” on page 43.)

Cylinder Compression Test

Reason:

To check that the automatic compression release is working and to help determine condition of piston, piston rings, cylinder wall, valves, valve guides, gaskets, and seals.

Equipment:

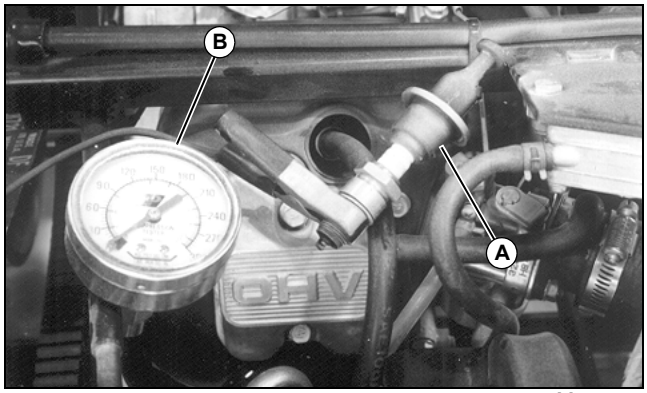
- JDM-59 Compression Gauge
- JDM-74A-5 Spark Plug Wire Test Tool or equivalent

Procedure

1. Park machine safely. (See “Parking Safely” on page 5.)
2. Turn key switch OFF.
3. Move gearshift pedals to NEUTRAL position. Lock park brake.
4. Lower front blade (if equipped).
5. Raise rear body cowling.
6. Start and run engine for 5 minutes to bring engine to operating temperature.
7. Turn key switch OFF.

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

Important: Avoid Damage! Spark plug wire must be grounded or electronic ignition could be damaged.



M83466

8. Disconnect and ground spark plug high tension lead (A).
9. Remove spark plug and install JDM-59 Compression Gage (B).
10. Move the accelerator lever to FAST idle position.
11. Crank engine for 5 seconds and record compression reading. Minimum compression should be to specification.

Specification

Minimum Compression . . . . . 393 kPa (57 psi)

Results:

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

Test Fuel Pump

Reason

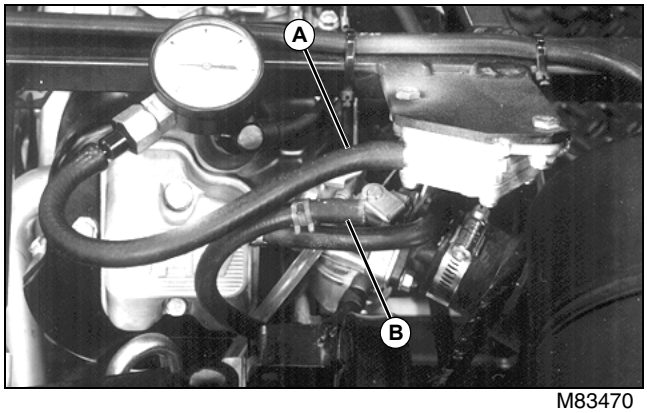
To check condition of fuel pump and determine fuel pressure.

Special or Required Tools

- JDG356 Pressure Gauge
- Graduated Container

Procedure

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move gearshift pedals to NEUTRAL position. Lock park brake.
4. Lower front blade (if equipped).
5. Raise rear body cowling.
6. Start and run engine at SLOW idle for 1 minute to fill carburetor with fuel.
7. Stop the engine.



M83470

8. Disconnect fuel pump outlet hose (B). Install plug in hose.

9. Connect JDG356 Pressure Gage (A) to fuel pump outlet.

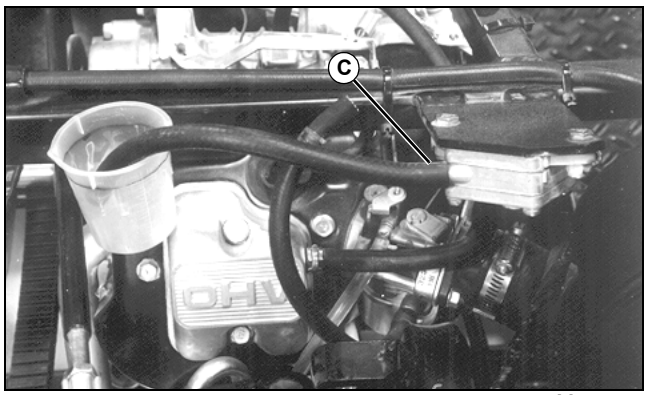
10. Start and run engine at FAST idle for 15 seconds. Record pressure reading. Gage should read a minimum pressure reading to specification.

11. Stop engine.

12. Remove pressure gage and connect fuel pump outlet hose.

13. Start and run engine at **SLOW idle** for 1 minute to fill carburetor with fuel.

14.Stop engine.



M83471

15. Disconnect fuel pump outlet hose (C) from carburetor and put it in a graduated container.

16. Start and run engine at FAST idle for 15 seconds, then stop the engine and record container measurement. Minimum flow should be to specifications.

Results

- If fuel pump pressure or flow does not meet the specifications, check the following:
  - Fuel lines, filter, shut-off valve, and fuel tank cap for restrictions.
  - Crankcase vacuum. (See “Test Crankcase Vacuum” on page 36.)
- If pressure or flow is still below specifications, replace fuel pump.

Specifications

Minimum Fuel Flow 80 mL/15 seconds . . . . . (2.7 oz/15 seconds)

Minimum Fuel Pressure at Fast Idle. 6.12 kPa (0.90 psi)

Valve Clearance Adjustment - FE290D

Reason:

To check and adjust valve clearance.

Equipment:

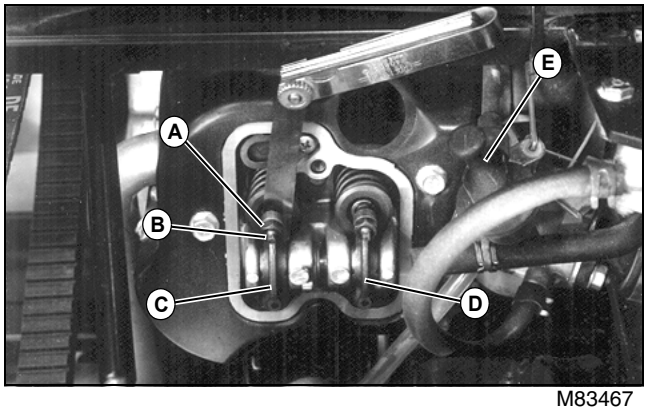
- JDM-74A-5 Spark Plug Wire Test Tool or equivalent
- Flat bladed feeler gauge

Note: Correct position of crankshaft is necessary to eliminate interference by the compression release mechanism on the cam gear when adjusting valve clearance.

Important: Avoid Damage! Perform valve clearance measurement or adjustment when engine is cold. Proper valve clearance is essential for the compression release system to operate correctly.

Procedure

1. Park machine safely. (See “Parking Safely” on page 5.)
2. Turn key switch OFF. Allow engine to cool.
3. Move gearshift pedals to NEUTRAL position. Lock park brake.
4. Lower front blade (if equipped).
5. Raise rear body cowling.
6. Remove and ground spark plug lead. Remove spark plug.
7. Remove valve cover.



M83467

A- Locknut
B- Adjustment Screw
C- Exhaust Rocker Arm
D- Intake Rocker Arm
E- High Tension Lead

8. Turn crankshaft until piston is at TDC (top dead center) of the compression stroke (both intake and exhaust valves will be closed).

9. Use a feeler gage to measure valve clearance. Valve clearance should be to specifications.

10. If clearance does meet specifications, loosen locknut and turn adjustment screw as necessary.

11. Tighten locknut.

Note: Before installing rocker cover and spark plug, perform Compression Release Check.

Specifications

Intake and Exhaust Valve Clearance (Cold) . . . 0.125 ± 0.025 mm (0.005 ± 0.001 in.)
Jam Nut Torque . . . . . 20 N•m (180 lb-in.)
Valve Cover Cap Screw Torque. . . . . 6 N•m (53 lb-in.)
Spark Plug Torque . . . . . 23 N•m (204 lb-in.)

Automatic Compression Release (ACR) Test

Reason:

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

Procedure:

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

Important: Avoid Damage! Exhaust valve clearance MUST BE set properly BEFORE this test is performed.

1. Park machine safely.

2. Use a dial indicator to measure exhaust valve ACR movement. Minimum exhaust valve ACR movement should be to specifications.

3. Rotate crankshaft counterclockwise slowly, watch intake valve. As soon as intake valve raises up to the closed position, exhaust valve should open slightly. Measure this movement with a dial indicator or calipers and record reading.

Results:

- Exhaust valve (B) must lift briefly, after intake valve (A) closes.
- If A.C.R. lift movement is not within specifications, See “Automatic Compression Release” on page 69.

A.C.R. lift Specifications

Minimum . . . . . 0.6 mm (0.024 in.)
Maximum. . . . . 1.65 mm (0.065 in.)

Crankcase Vacuum Test

Reason:

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

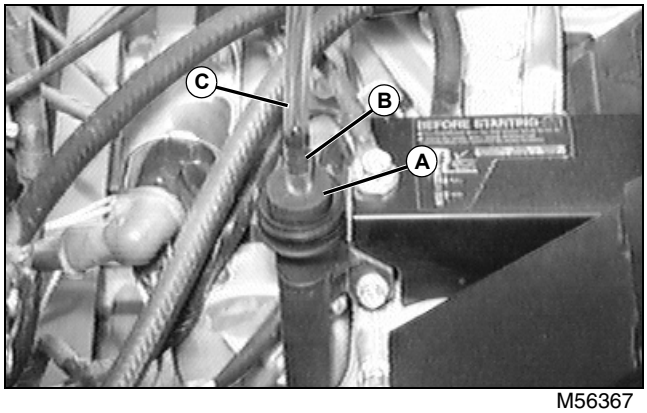
Equipment:

- JT03503 Vacuum Gauge
- JT05703 Barb Fitting
- JT05699 Line
- 8741-F66 Plug

Procedure:

1. Park machine safely.

2. Cargo box raised and locked.



M56367

3. Remove dipstick.

4. Push plug (A) and barbed fitting (B) in dipstick hole until tight.

5. Cover barbed fitting with a plug or finger and start engine.

6. Quickly remove finger or plug from barbed fitting and attach hose from gauge (C).

7. Run engine at FAST idle and record reading on gauge.

8. Manometer minimum vacuum **25 mm (1.0 in.) Hg**.

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

10.Disconnect hose and quickly place finger or plug over barbed fitting.

11.Turn engine OFF.

12.Remove plug and install dipstick.

Results:

If crankcase vacuum is LESS than specification, check:

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

Specification:

Minimum Crankcase Vacuum . . . . . 30 mm (1.18 in.)Hg

Ignition Coil Air Gap Adjustment

Reason:

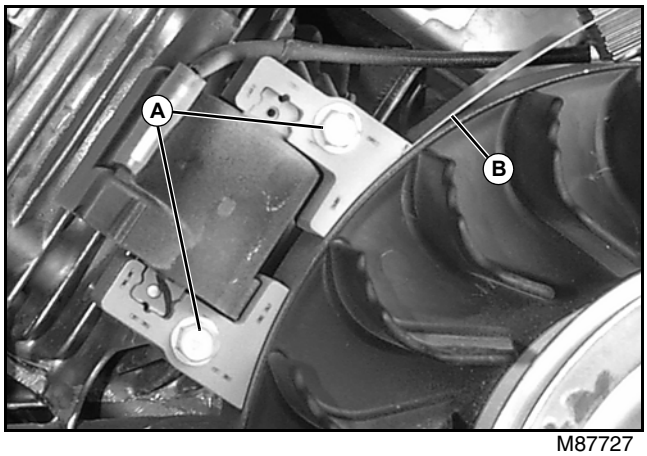
To adjust air gap between ignition coil and flywheel magnets to a specified dimension needed for proper ignition timing.

Equipment:

- Flat bladed feeler gauge.

Procedure:

1. Place engine switch in OFF position.
2. Cargo box raised and locked.
3. Remove flywheel housing.
4. Turn flywheel magnet away from coil.



M87727

5. Loosen ignition coil cap screws (A).

Important: Avoid Damage! The engine is very sensitive to this adjustment so both legs of coil must have the same air gap.

6. Select the 0.3 mm (0.012 in.) feeler gauge blade (B) and insert it between flywheel and coil legs.

Note: If a misfire condition exists, adjust air gap to a minimum of 0.25 mm (0.010 in.) to increase magnetic force.

7. Turn flywheel until magnet aligns with legs of ignition coil and feeler gauge spans both legs of coil and the flywheel magnet at the same time.

8. Hold coil in position and tighten cap screws (A). Turn flywheel to remove feeler gauge.

Specification:

Ignition Coil Air Gap . . . . 0.25 - 0.40 mm (0.010 - 0.016 in.)

Spark Test

Reason:

Check overall condition of ignition system.

Equipment:

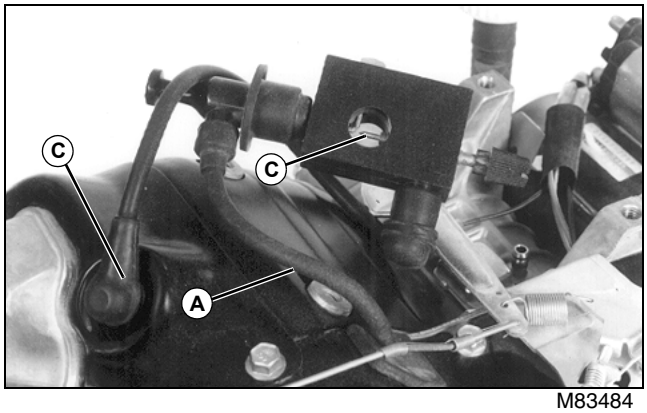
- D-05351ST Spark Tester

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

Important: Avoid Damage! Do not use an ohmmeter to test the ignition coil. Different ohmmeters will show different results. Ohmmeters with high capacity batteries will damage the ignition coil solid state components.

Procedure:

1. Park machine safely.
2. Cargo box raised and locked.



M83484

3. Remove high tension lead (A) from spark plug.
4. Connect D-05351ST Spark Tester (B) to spark plug.
5. Connect high tension lead to Spark Tester.

Important: Avoid Damage! Do not adjust spark tester gap beyond 5.0 mm (0.20 in.) (5 turns). Damage to ignition components could occur.

6. Adjust spark tester gap to **4.2 mm (0.166 in.)** (4 turns) with screw.
7. Turn key switch to start position and watch spark (C) at spark tester.

Results:

- If engine will start, watch spark with engine running. There should be a strong, steady, blue spark.
- If spark is weak, or if no spark, install new spark plug and test again.
- If spark is still weak, or still no spark, check armature air gap, adjust as needed.
- If spark is still weak, or still no spark, replace ignition module.

8. Remove spark tester.
9. Start and run engine at medium idle for ten minutes to reach operating temperature.

Caution: Avoid Injury! Engine components are HOT. Be careful not to touch, especially the exhaust pipe or muffler, while installing components. Wear protective eye glasses and clothing. Always keep hands clear of moving parts.

10. Stop engine and install spark tester while the engine is still at operating temperature.

Important: Avoid Damage! Do not adjust spark tester gap beyond 5.0 mm (0.20 in.) as damage to ignition system components could occur.

11. Adjust spark tester gap to 4.2 mm (0.166 in.) with screw.
12. Turn key switch to start position and watch spark at spark tester.

Results:

- If engine will start, watch spark with engine running. There should be a strong, steady, blue spark.
- If spark is still weak, or still no spark, replace ignition coil.

Oil Pressure Test

Reason:

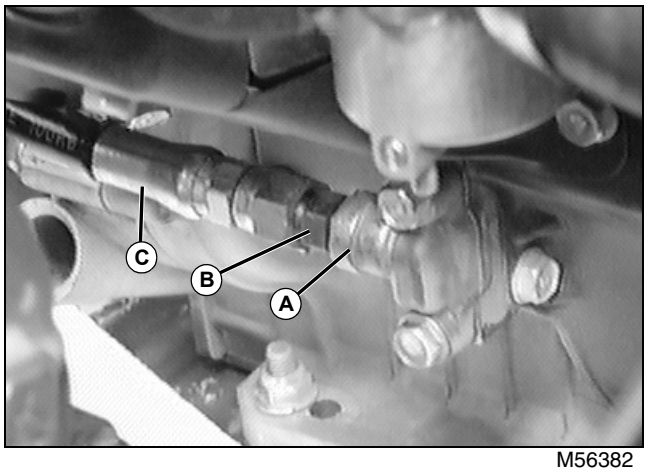
To verify that the engine has enough oil pressure to lubricate the internal engine components.

Equipment:

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

Procedure:

1. Park machine safely.
2. Cargo box raised and locked.
3. Check engine oil level, fill to full mark, if necessary.



M56382

4. Remove plug from housing (A).
5. Install JT03349 connector (B), JT03017 hose assembly (C), and JT05577 pressure gauge assembly.

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

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

6. Run engine at MEDIUM idle for five minutes to reach operating temperature.
7. Run at FAST idle. Oil pressure minimum **314 kPa (46 psi)**.
8. Remove hose, gauge, and straight fitting. Install plug using John Deere Pipe Sealant with TEFLON (medium strength), or equivalent, on plug threads.

Results:

- If oil pressure reading is BELOW specifications, inspect or replace the following:
  - Oil pressure relief valve for broken or weak spring, stuck or damaged valve
  - Oil pump suction screen or oil passages plugged
  - Oil pump worn or damaged
  - Excessive wear of connecting rod and main bearings

Repair

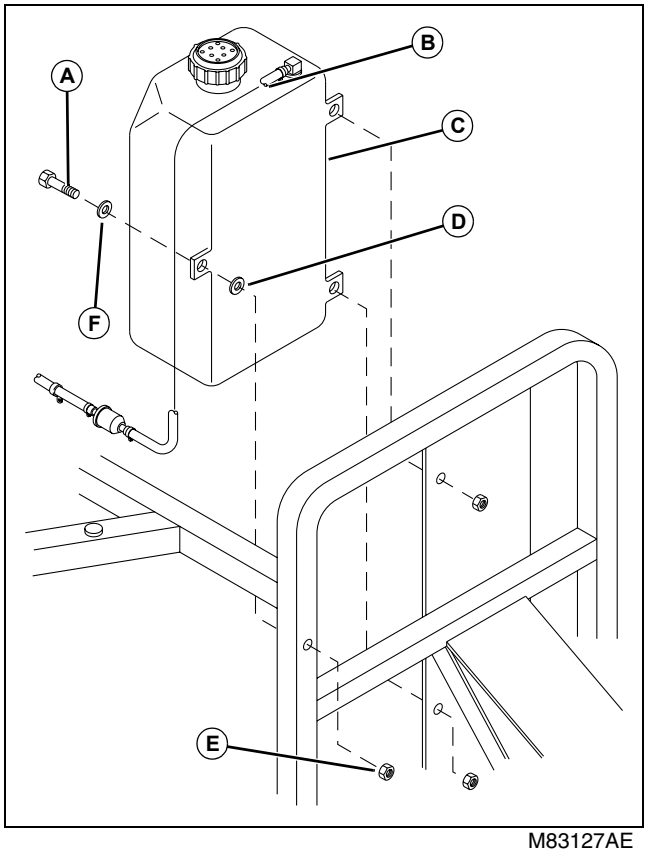
Remove and Install Fuel Tank

Removal

Caution: Avoid Injury! Fuel vapors are explosive and flammable:

- **Shut engine off before filling fuel tank.**
- **Do not smoke while handling fuel.**
- **Keep fuel away from flames or sparks.**
- **Fill fuel tank outdoors or in well ventilated area.**
- **Clean up spilled fuel immediately.**
- **Use clean approved non-metal container to prevent static electric discharge.**
- **Use clean approved plastic funnel without screen or filter to prevent static electric discharge.**

1. Lower front blade (if equipped).
2. Raise rear body cowling.



M83127AE

3. Disconnect fuel line from fuel tank fitting (B).

Note: Plastic spacer is located between fuel tank and frame on front mounting bracket only.

4. Remove three cap screws (A), washers (F), and nuts (E).
5. Remove spacer (D) (front mounting bracket only).
6. Remove fuel tank (C).
7. Inspect fuel tank for wear or damage. Replace if necessary.

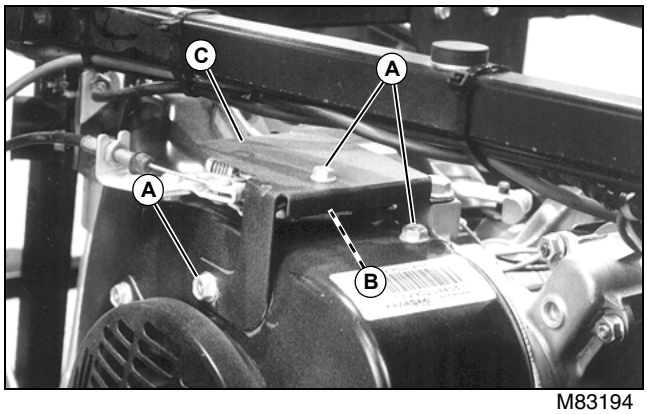
Installation

Installation is done in the reverse order of removal.

Remove and Install Accelerator Cable

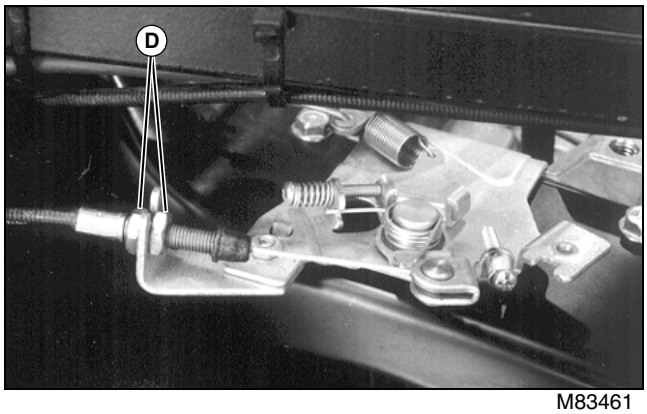
Procedure

1. Park machine safely. (See “Parking Safely” on page 5.)
2. Lower front blade (if equipped).
3. Raise rear body cowling.



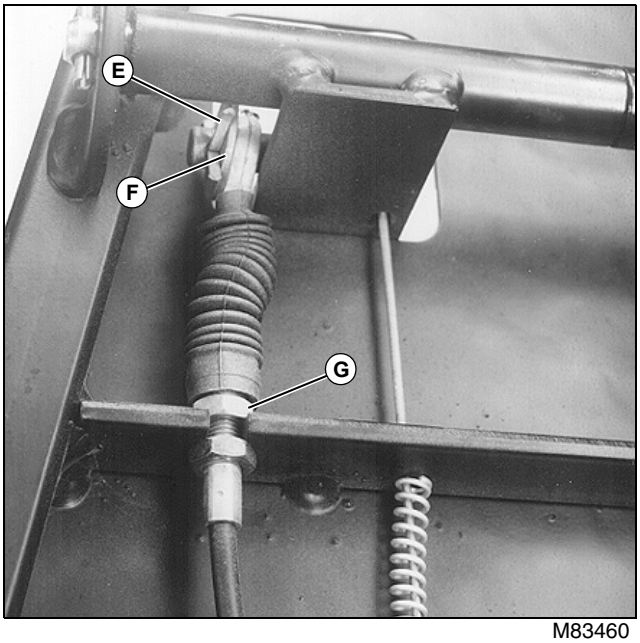
M83194

4. Remove cap screws (A), spacer (B) and cover (C).



M83461

5. Loosen locknuts (D) and remove cable from bracket.
6. Disconnect accelerator cable from throttle control lever.



M83460

7. Remove cotter pin (E) and washer (F).
8. Loosen locknut (G). Remove cable.
9. Cut tie straps as necessary.

Installation

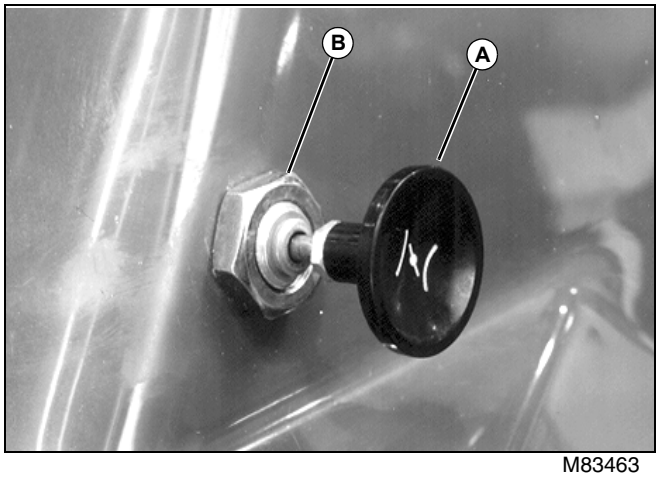
Installation is done in the reverse order of removal.

- Route new cable through loop under platform.
- Install tie straps as necessary.
- Adjust accelerator cable. (See “Adjust Throttle Cable” on page 43.)

Remove and Install Choke Cable

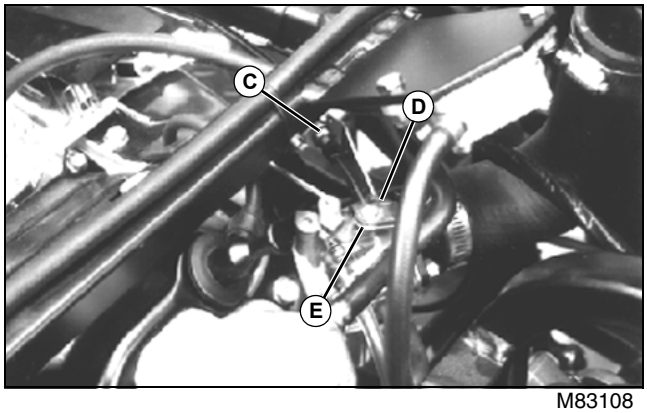
Procedure

1. Lower front blade (if equipped).
2. Raise rear body cowling.
3. Remove dash panel. (See “Remove and Install Dash Panel” on page 229.)



M83463

4. Remove choke knob (A) and retaining nut (B).
5. Cut tie straps as necessary to free cable.



M83108

6. Loosen nut (C).
7. Rotate choke arm (D) and remove cable through slot (E).

Installation

Installation is done in the reverse order of removal.

- Install tie straps as needed.
- Adjust choke. (See “Adjust Choke Cable” on page 43.)

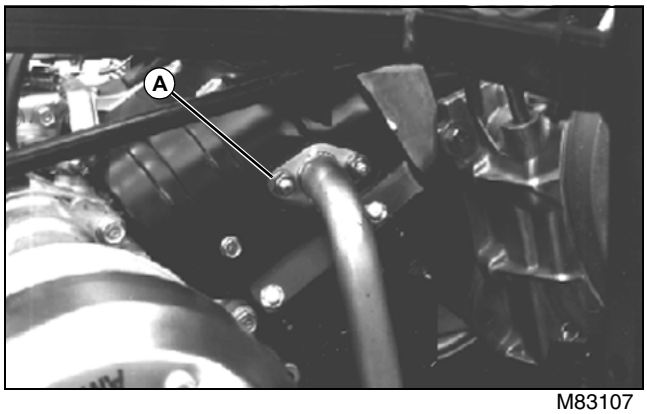
Remove and Install Muffler

Procedure

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

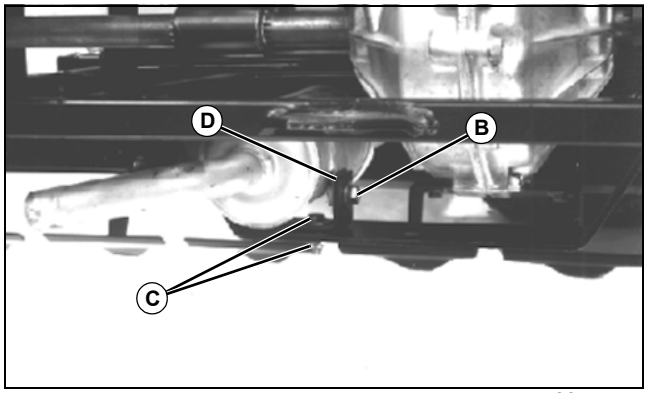
1. Remove:
   - Rake assembly. (See “Remove and Install Rake Assembly (Optional)” on page 226.)
   - Drive belt. (See “Remove and Install Drive Belt” on page 164.)

- Fuel tank. (See “Remove and Install Fuel Tank” on page 52.)



M83107

2. Remove nuts and lock washers (A).



M83139

3. Remove cap screw and washer (B).
4. Remove cap screw, washer and nut (C) and bracket (D).
5. Remove muffler.
6. Inspect muffler for wear or damage. Replace if necessary.

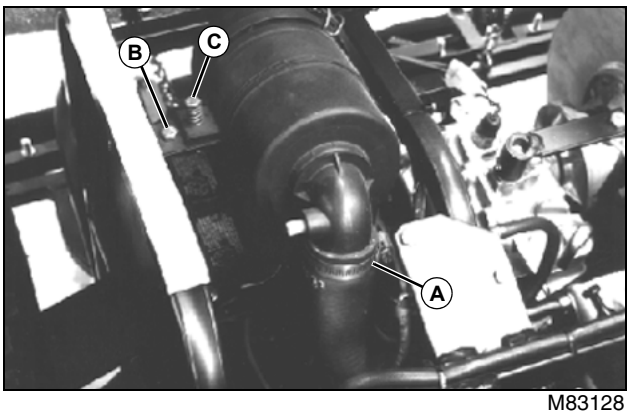
Installation

Installation is done in the reverse order of removal.

- Install new gasket.

Remove and Install Air Cleaner

1. Park machine safely. (See “Parking Safely” on page 5.)
2. Lower front blade (if equipped).
3. Raise rear cowling.



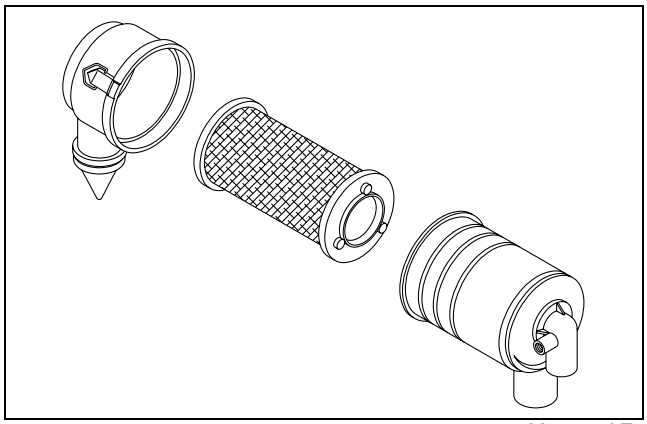
M83128

4. Loosen hose clamp (A).
5. Remove cap screws, nuts (B), and spring (C).
6. Remove air cleaner.

Installation

Installation is done in the reverse order of removal.

Inspection


M83180AE

Important: Avoid Damage! Carefully remove air cleaner cover and filter element. Inspect inside paper element and intake passage for signs of dust. If present, replace elements and test engine compression or inspect for damage.

Any time the air cleaner is removed, check for free choke operation during reassembly.

Note: Replace filter element yearly or every 300 hours.

1. Remove and disassemble air cleaner.

Important: Avoid Damage! Do not clean paper filter element with solvent or compressed air.

2. Inspect filter element.
   - Element is still usable if you can see light through it

and filter element appears clean.

- Replace if oily, dirty, or damaged in any way.

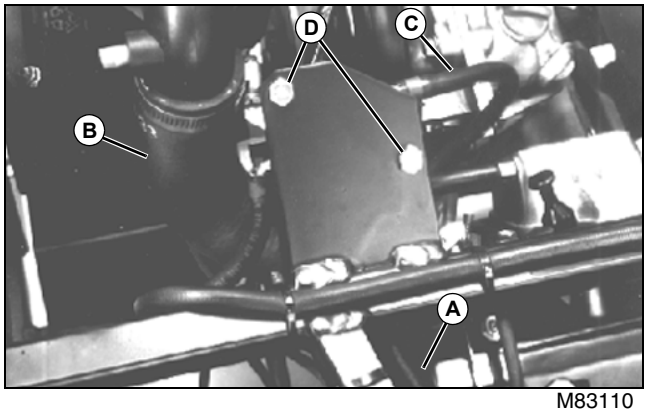
3. Inspect all parts for damage. Replace parts as necessary.

4. Assemble and install air cleaner.

Remove and Install Fuel Pump

Removal

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



M83110

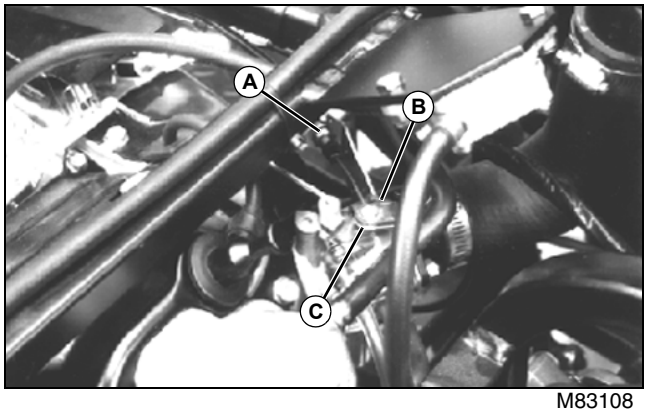
1. Disconnect vacuum hose (A).
2. Disconnect inlet (B) and outlet (C) fuel hoses.
3. Remove cap screws and nuts (D).
4. Remove fuel pump.

Remove and Install Carburetor

Procedure

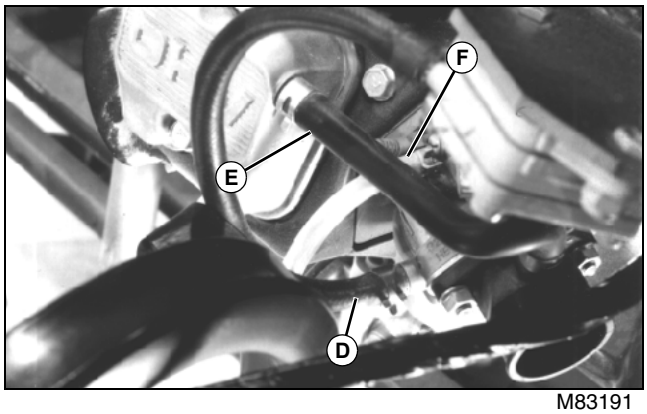
Caution: Avoid Injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; this includes equipment that utilizes pilot lights.

1. Park machine safely. (See “Parking Safely” on page 5.)
2. Drain fuel from carburetor.



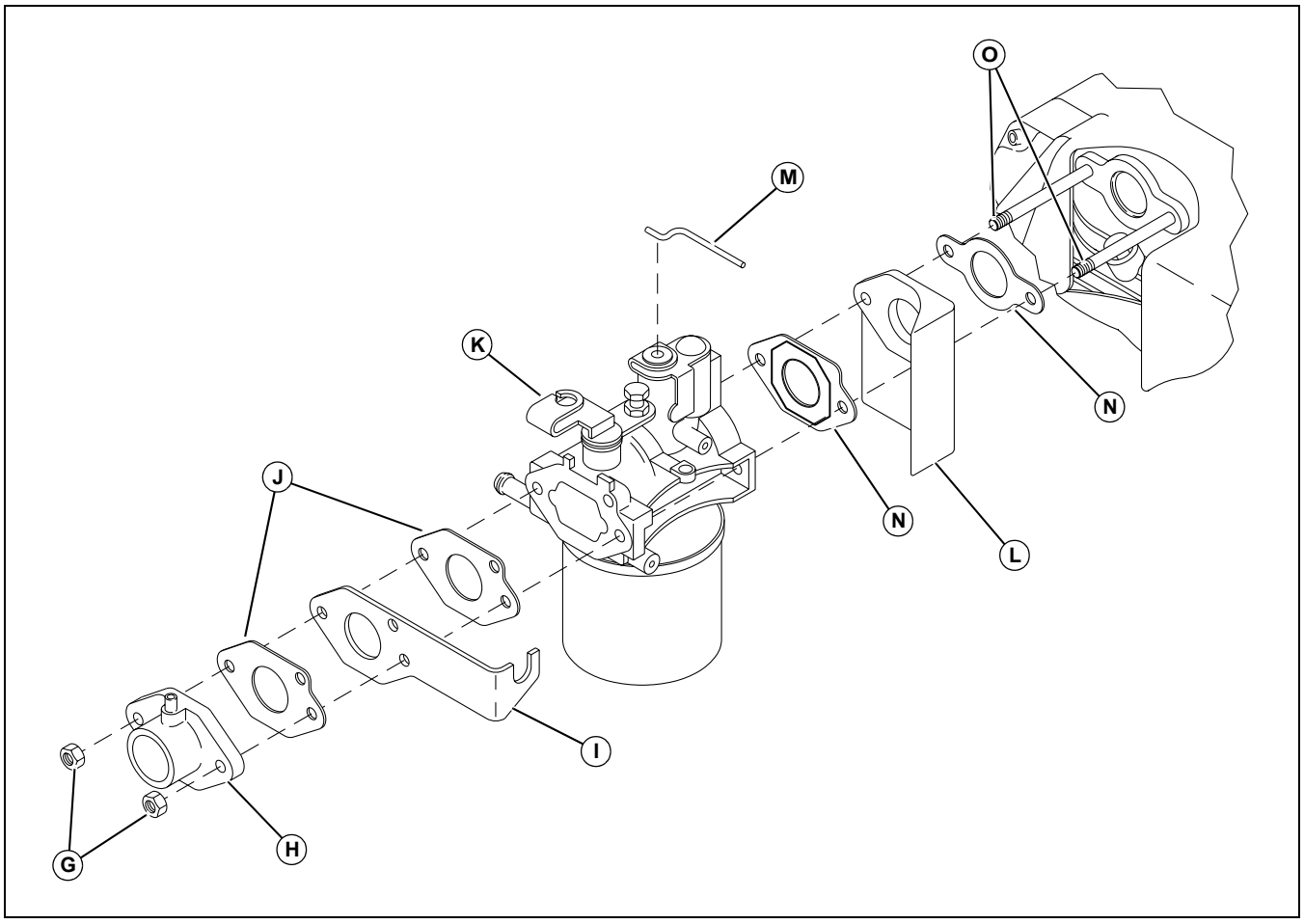
M83108

3. Loosen nut (A).
4. Rotate choke arm (B) and remove cable through slot (C).
5. Remove air cleaner assembly and hose.



M83191

6. Disconnect fuel supply (D) and breather hose (E).
7. Disconnect vent tube (F).



M83192AE

8. Remove nuts (G).

9. Remove air intake duct (H), cable bracket (I), and gaskets (J).

Important: Avoid Damage! When removing carburetor, be careful not to bend governor linkage.

10.Separate carburetor (K) from heat shield (L). Remove carburetor.

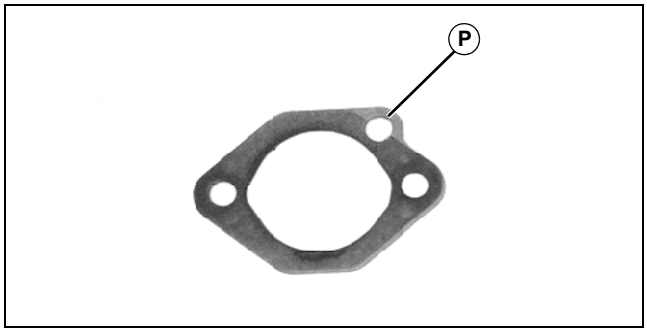
11.Disconnect governor linkage (M).

12.Remove heat shield and gaskets (N) from studs (O).

Installation

Installation is done in the reverse order of removal.

- Install heat shield-to-carburetor gasket with tab pointing up on fuel inlet side of carburetor.



M83193

- Install carburetor-to-cable bracket and cable bracket-to-air intake duct gaskets with hole (P) pointing away from fuel inlet side of carburetor.
- Adjust choke linkage. (See “Adjust Choke Cable” on page 43.)

Caution: Avoid Injury! Static governor adjustment must be made whenever carburetor or manifold has been removed from engine. Failure to make static adjustments first could result in engine overspeeding and may result in engine or equipment damage causing personal injury or property damage.

Specifications

Air Cleaner Bracket Torque . . . . . 7 N•m (65 lb-in.)
Carburetor Screw Torque . . . . . 7 N•m (65 lb-in.)

Carburetor Disassembly and Assembly

Important: Avoid Damage! DO NOT attempt to disassemble or adjust the engine CARB/EPA Certified Emissions Carburetor unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions Carburetors.

Important: Avoid Damage! Do not clean holes or passages with drill bits or wire.

Procedure:

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

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

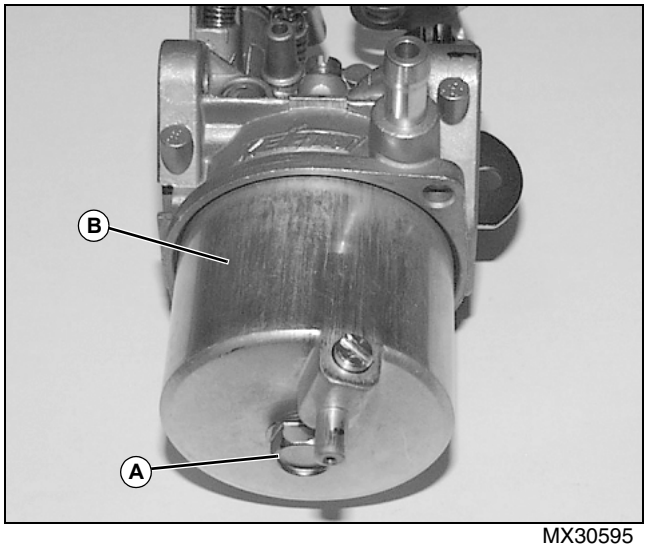
2. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

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! Rinse carburetor body in warm water to neutralize corrosive action of cleaner on aluminum.

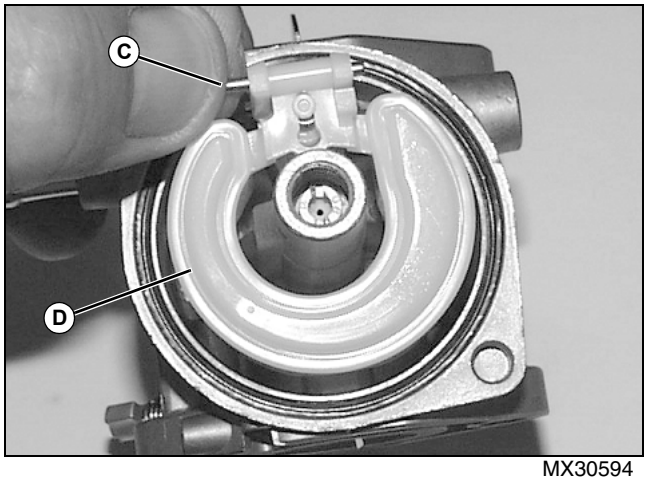
3. Rinse carburetor with warm water and dry with compressed air. Do not use rags or paper to dry parts; lint may plug holes or passages.

- Inspect all parts for wear or damage; replace as necessary.



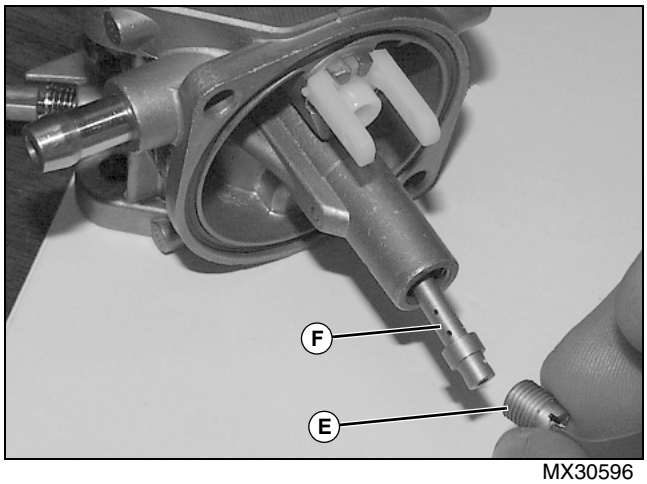
MX30595

4. Remove cap screw (A) and float bowl (B).



MX30594

5. Remove float hinge pin (C) and float (D).



MX30596

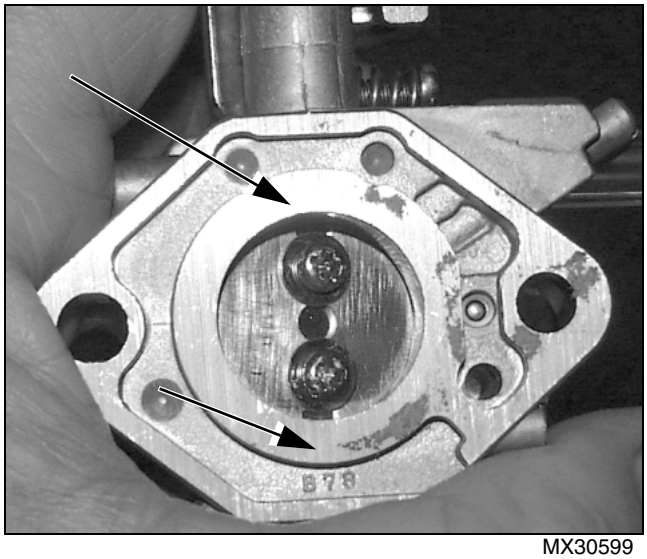
6. Remove main jet (E) and nozzle (F).

MX30598

7. Remove pilot jet (G).

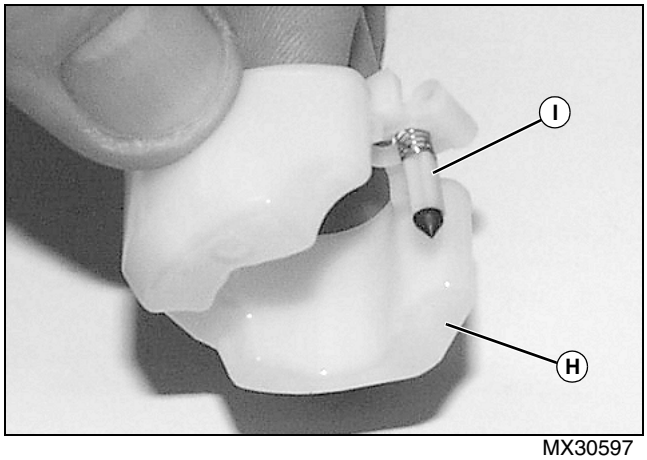
Important: Avoid Damage! Rinse carburetor body in warm water to neutralize corrosive action of cleaner.

8. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.



MX30599

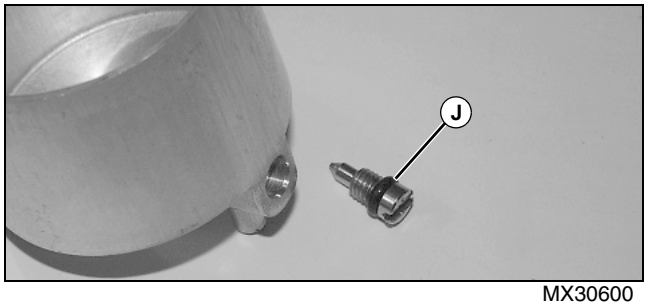
9. Check throttle shaft for wear (arrows). If worn replace shaft assembly.



MX30597

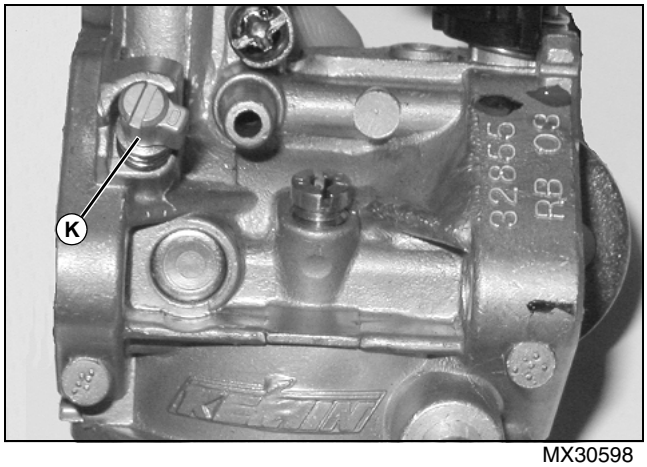
10. Inspect float (H) for cracks or leaks. Replace float if damaged.

11. Replace needle (I).



MX30600

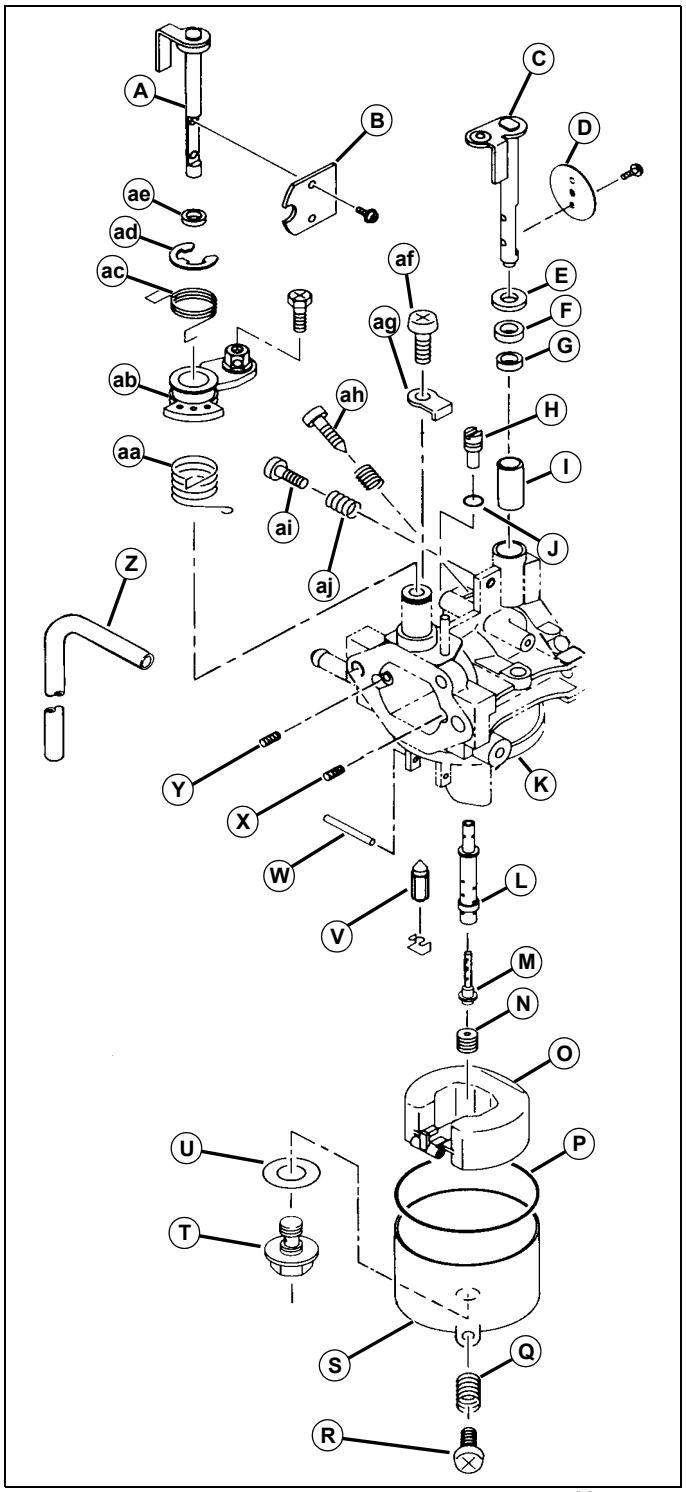
12. Remove bowl drain screw and clean drain passage. Replace o-ring on screw (J).



MX30598

13. If the idle circuit was malfunctioning and needs servicing, idle mixture screw is manufactured with a weak spot so limiter cap (K) must be broken off with a pliers to remove idle mixture screw. After cleaning out idle circuit and installing new adjustment screw, do not install limiter cap until idle adjustment has been made with engine running. Adjust mixture screw until smoothest idle is obtained, and then install limiter cap with pointer midway between stops.

Components:



M80402

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

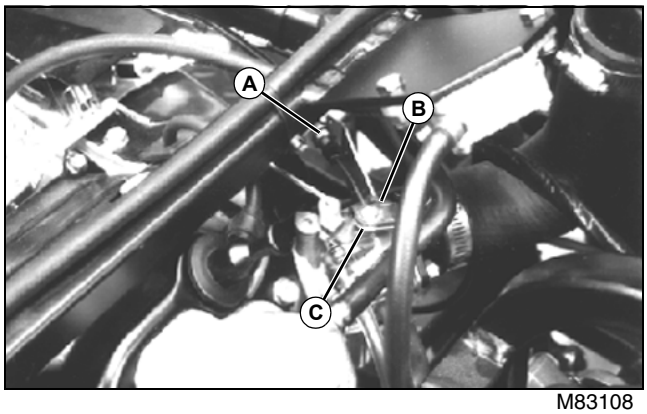
Assembly:

- Replace all gaskets and o-rings.
- Assemble in the reverse order of disassembly.
- For main jet changes due to high altitude use, refer to parts catalog.

Remove and Install Engine

Removal

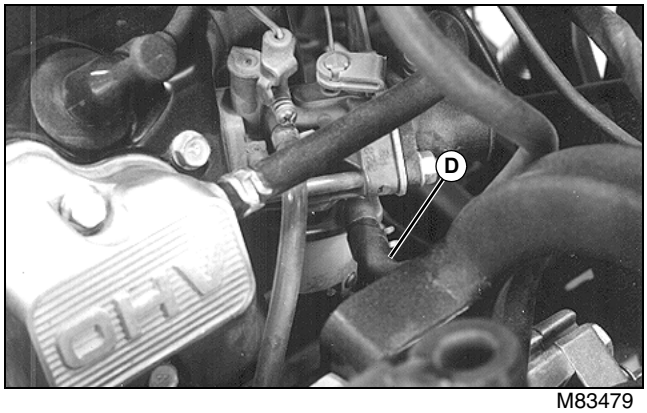
1. Park machine safely. (See “Parking Safely” on page 5.)
2. Allow engine to cool before removing the engine.
3. Remove:
   - Mid-mount implement or rear implement (if equipped). (See “Removal and Installation” on page 224.)
   - Gearshift linkage. (See “Gearshift Pedals and Linkage” on page 163.)
   - Rear cowling. (See “Remove and Install Rear Body Cowling” on page 230.)
   - Muffler. (See “Remove and Install Muffler” on page 53.)
   - Air cleaner. (See “Remove and Install Air Cleaner” on page 54.)
   - Drive clutch. (See “Remove and Install Drive (Primary) Clutch” on page 165.)
   - Differential lock pedal. (See “Differential Lock Pedal and Linkage” on page 163.)
4. Remove battery cover and disconnect negative (-) cable at battery.
5. Drain engine oil.



M83108

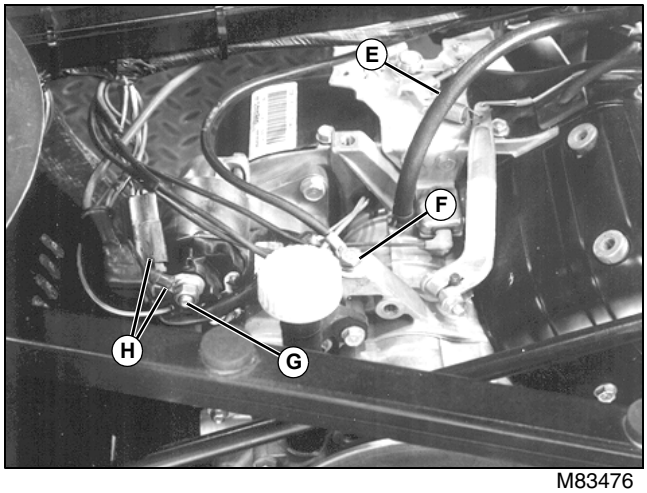
6. Loosen nut (A).
7. Rotate choke arm (B) and remove cable through slot (C).

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



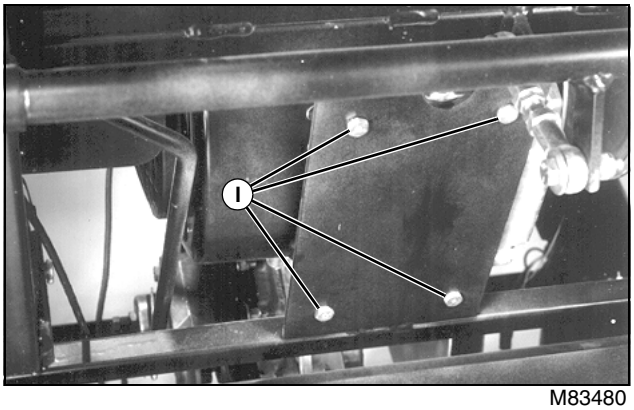
M83479

8. Disconnect fuel inlet hose (D).



M83476

9. Disconnect fuel pump vacuum hose (E).
10. Disconnect engine ground connections (F).
11. Disconnect leads from starter battery terminal (G).
12. Disconnect wiring connectors (H).



M83480

13. Remove four engine mounting cap screws and nuts (I).

Note: Remove engine from left side of machine.

14. Remove engine.

Installation

Installation is done in the reverse order of removal.

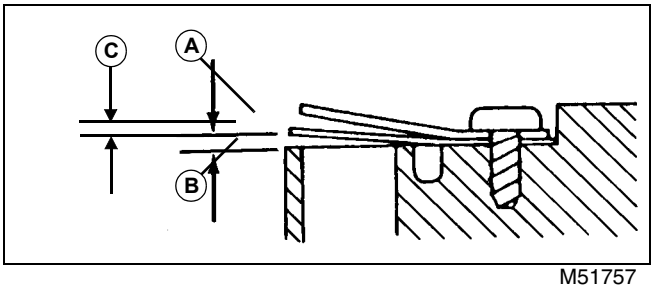
- Apply MPG-2® Polymer Multipurpose Grease to engine crankshaft.
- Fill engine to proper level with oil of correct specifications. (See “4-Cycle Gasoline Engine Oil” on page 8.)
- Adjust accelerator cable. (See “Adjust Throttle Cable” on page 43.)
- Adjust choke. (See “Adjust Choke Cable” on page 43.)
- Adjust gearshift linkage. (See “Adjust Gearshift Linkage” on page 160.)

Specifications

Engine Mounting Bolt Torque . . . . . 23 N•m (204 lb-in.)
Clutch Mounting Bolt Torque . . . . . 75 N•m (55 lb-ft)
Exhaust Manifold Bolt . . . . . 20 N•m (180 lb-in.)
Oil Capacity With Filter . . . . . 1.3 L (2.7 U.S. pt)

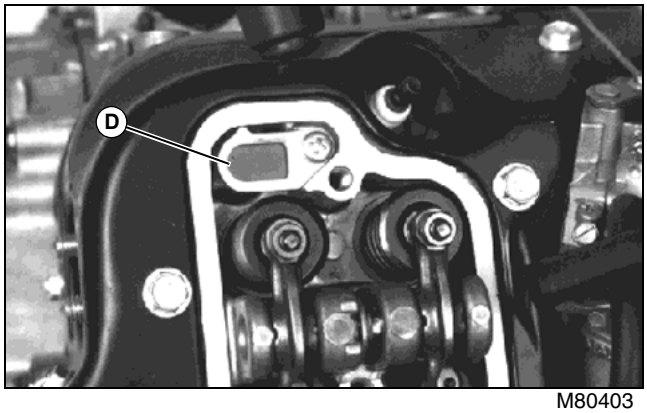
Crankcase Breather Inspection

1. Remove rocker arm cover and gasket.



M51757

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



M80403

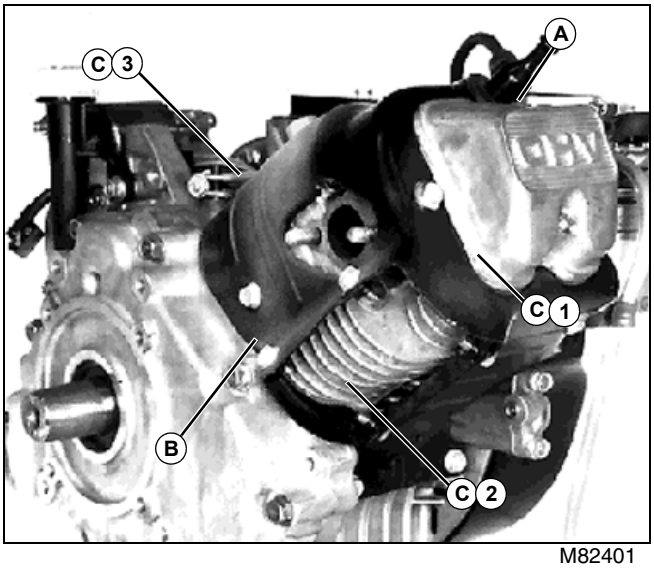
FE290D engine shown.

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

Specifications

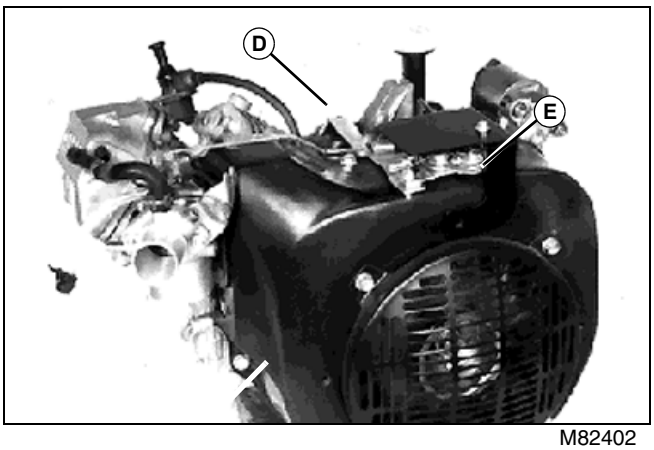
Breather Cover Screw Torque. . . . . 3 N•m (30 lb-in.)
Breather Valve Air Gap . . . . . 0.20 mm (0.008 in.)

Blower Housing Removal and Installation



M82401

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



M82402

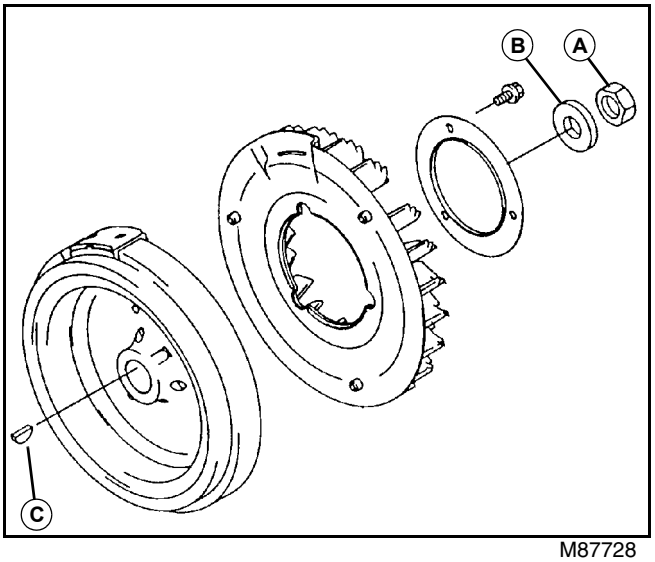
3. Remove bracket cover (D) and blower housing (E).

Installation:

Installation is done in reverse order of removal.

Flywheel Removal and Installation

1. Remove blower housing.



M87728

2. Hold flywheel and remove nut (A) and washer (B).
3. Remove flywheel using a puller set.
4. Remove shaft key (C).

Installation:

Installation is done in reverse order of removal.

- Install washer with concave side toward flywheel.
- Tighten flywheel nut to **86 N•m (63 lb-ft)**.

Specifications:

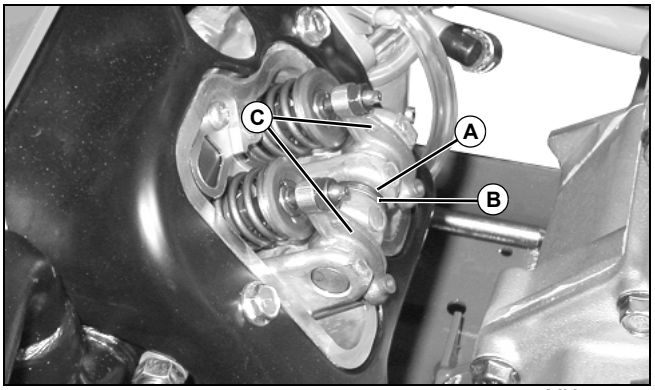
Flywheel Nut (FE290D). . . . . 86 N•m (63 lb-ft)
Flywheel Nut (FE350D). . . . . 137 N•m (101 lb-ft)

Rocker Arm Removal and Installation

Removal:

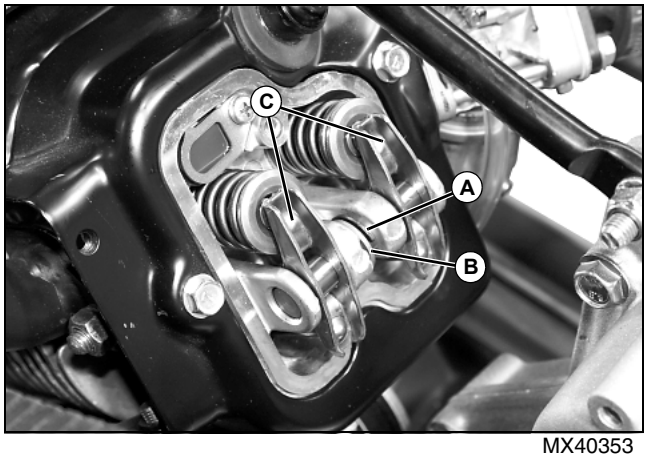
1. Remove rocker arm cover and gasket.

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



MX33402

FE290D engine shown



MX40353

FE350D engine shown

3. Remove E-clip (A) from rocker shaft.
4. Remove rocker shaft, washer (B) and rocker arms (C).

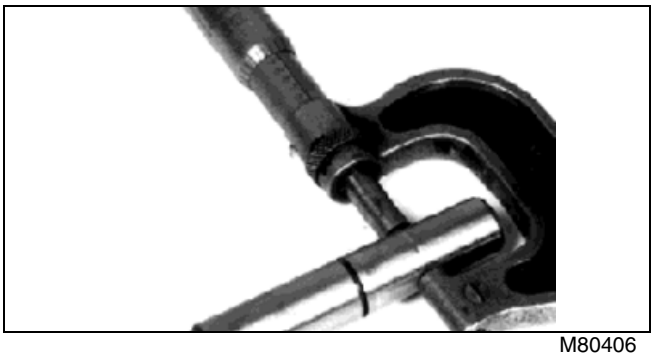
Important: Avoid Damage! Push rods must be installed in the same locations from which they were removed.

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

Installation is done in reverse order of removal.

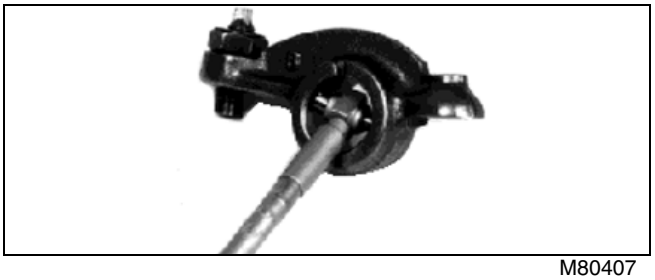
- FE290D engine only - Check valve clearance when complete and adjust as needed. See “Valve Clearance Adjustment - FE290D” on page 47.

Rocker Arm Inspection



M80406

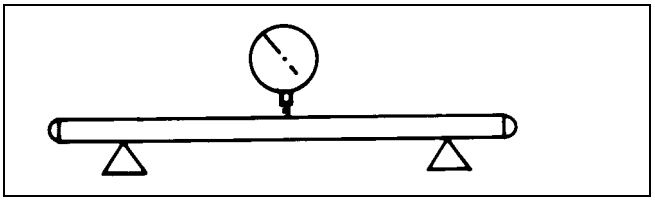
1. Measure outside diameter of rocker shaft. Replace shaft if OD is less than specification.



M80407

FE290D engine shown.

2. Measure inside diameter of rocker arms. Replace arms if ID is greater than specification. FE350D engine rocker arms are made of sheet metal, measure ID with vernier caliper instead of inside micrometer.



M50044

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

Specifications:

Rocker Shaft OD (minimum) . . . . . 11.95 mm (0.470 in.)
Rocker Arm ID (FE290D) (maximum) . 12.07 mm (0.475 in.)
Rocker Arm ID (FE350D) (maximum) . . 12.3 mm (0.484 in.)
Push Rod Bend (FE290D) (maximum) . 0.30 mm (0.012 in.)
Push Rod Bend (FE350D) (maximum) . 0.50 mm (0.020 in.)

Cylinder Head Removal and Installation

Removal:

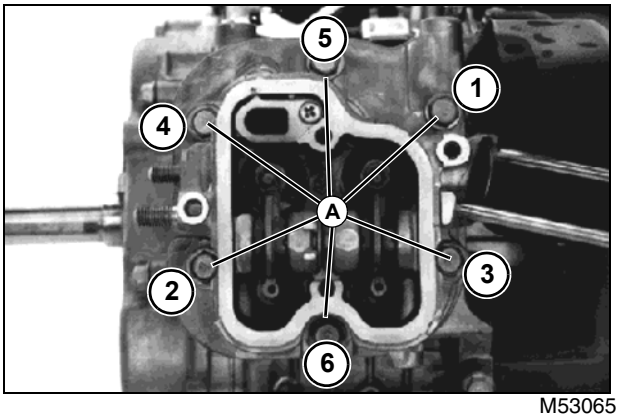
1. Remove blower housing, carburetor, rocker arm assembly, and spark plug.

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

3. Disassemble and inspect cylinder head and valves.

Installation:

1. Install a new gasket and cylinder head assembly.



M53065

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

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

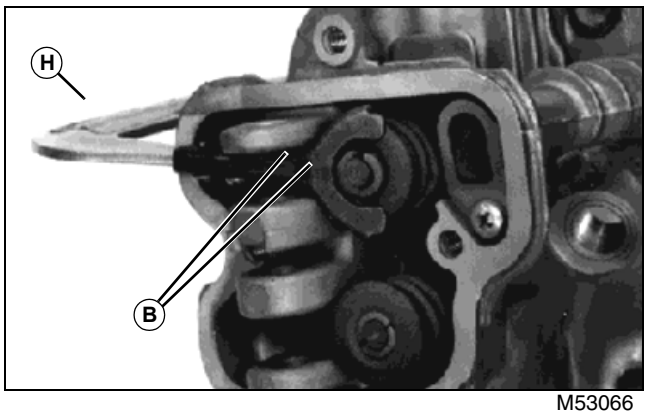
4. Install spark plug and tighten to **27 N•m (239 lb-in.)**.

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

Torque Specifications:

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

Cylinder Head Disassembly and Assembly

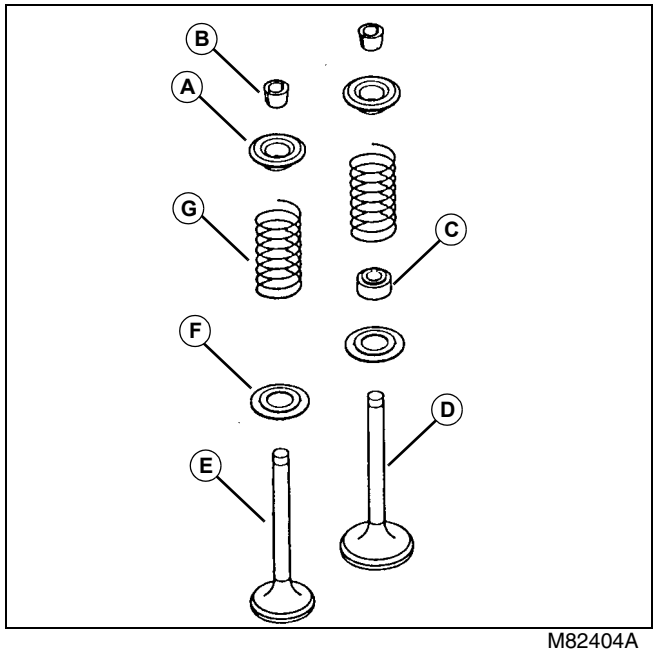


M53066

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

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

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



M82404A

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

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

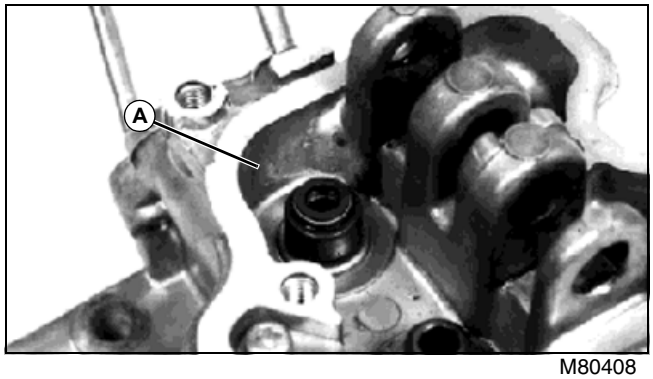
4. Install springs with smaller pitch end toward cylinder head.

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

Cylinder Head Inspection and Replacement

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

Intake Valve Stem Seal:

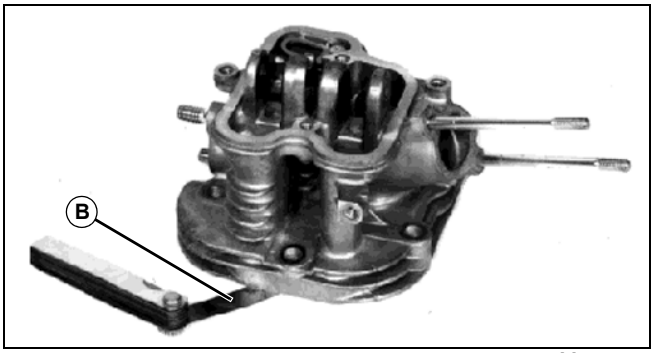


M80408

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

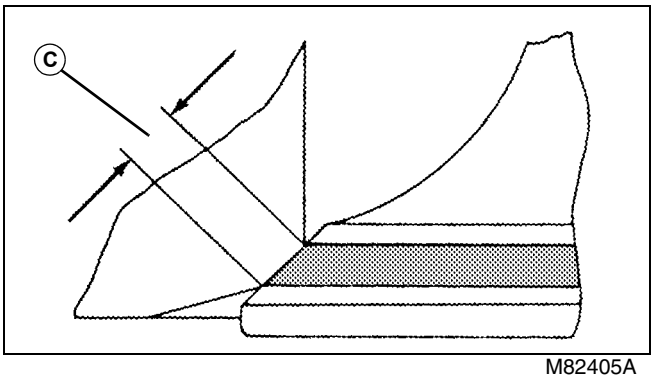
Cylinder Head:

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



M80409

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



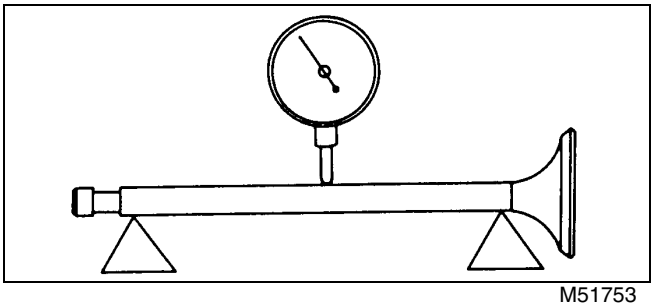
M82405A

4. Measure valve seat width. Inspect valve seat for wear or

damage. If valve seat width is not within **0.50 - 1.10 mm (0.020 - 0.043 in.)** (C), recondition valve seats.

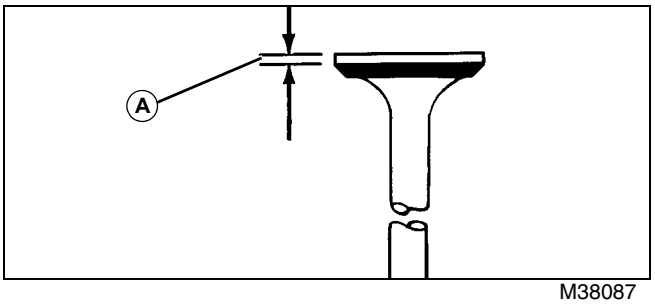
Intake and Exhaust Valves:

1. Analyze valves.



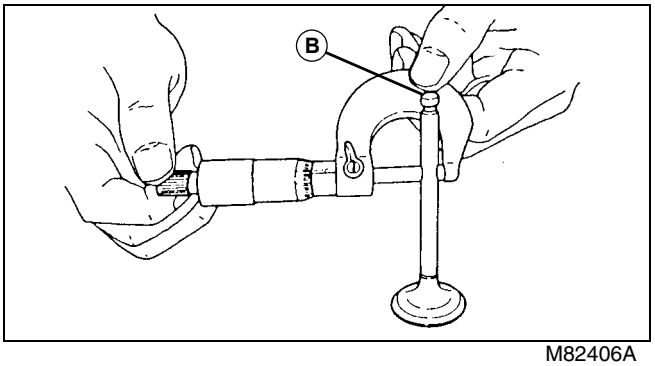
M51753

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



M38087

3. Remove carbon from valve head, face and stem. Check for defects. Measure face margin. If margin **less than 0.60 mm (0.024 in.)** (A), replace.



M82406A

4. Check valve stem end (B) for uneven wear. If stem ends are uneven, grind ends square.

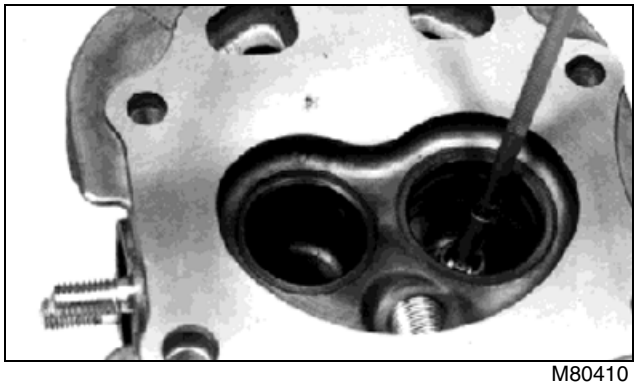
5. Measure valve stem diameter in two directions at right angles, at four different positions. Replace if measurement is less than specifications.

Valve Stem OD (Wear Limit):

Intake Valve . . . . . 6.930 mm (0.2728 in.)
Exhaust Valve . . . . . 6.915 mm (0.2722 in.)

Valve Guides:

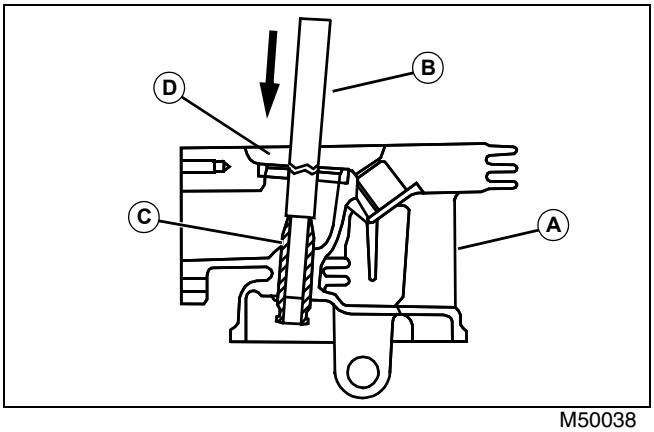
1. Clean valve guides using a valve guide brush and cleaner.



M80410

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

To Replace Bushings:



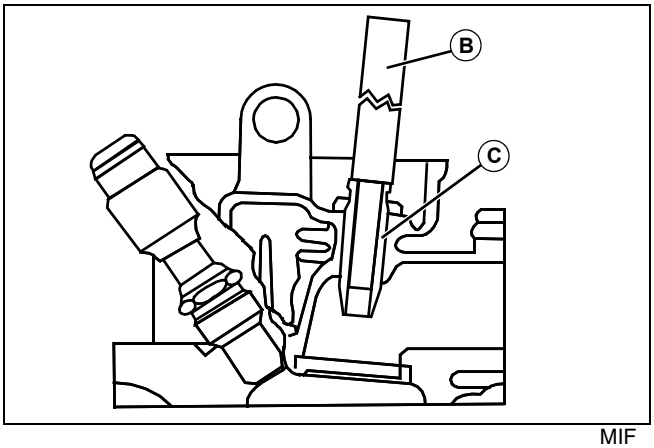
M50038

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

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

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

Note: Place valve guide in dry ice before installation.



MIF

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

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

Valve Springs:

1. Measure spring free length. Replace spring if measurement is **less than specification**.

Note: The spring pitch is smaller at the valve seat side of the intake and exhaust valve springs. Be sure to orient springs correctly during assembly.

Valve Spring Free Length (minimum):

FE290D . . . . . 32.8 mm (1.291 in.)
FE350D . . . . . 38.1 mm (1.500 in.)

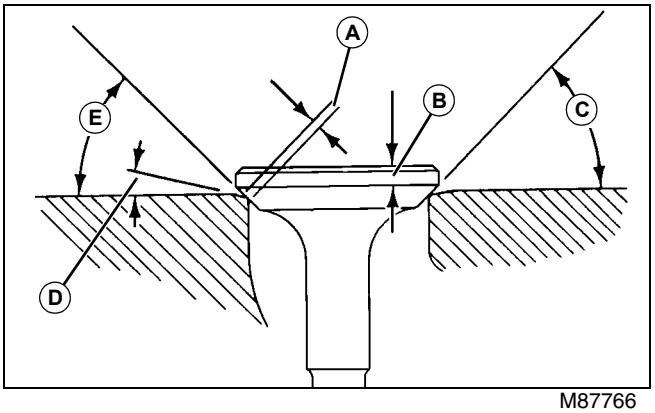
Recondition Valve Seats

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

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

- FE350D Intake Valve Only: cut at 30° angle to clean up seat. Cut narrowing angle at 15°. Finish cut at 30° to establish seating surface width.

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



M87766

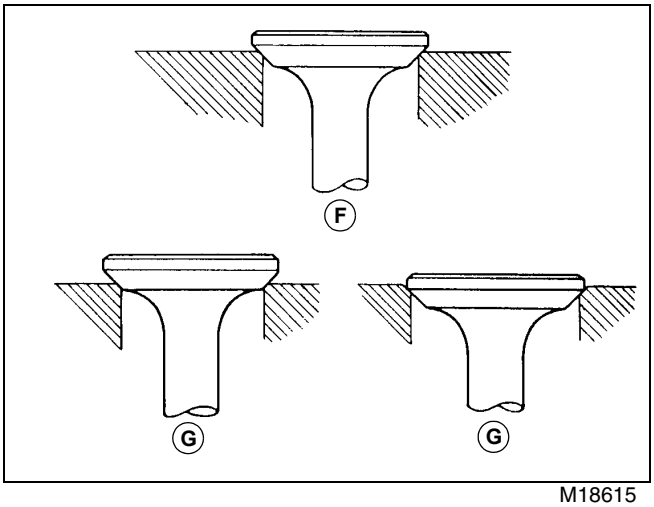
A- Valve Seating Surface Width
B- Valve Margin
C- Valve Face Angle
D- Valve Narrowing Angle
E- Valve Seat Angle

4. Lap valves to seats after refacing.

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

6. Check seat for good contact:

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



M18615

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

Specifications - FE290D:

Valve Seating Surface Contact Width 0.8 mm (0.031 in.)
Contact Width Service Limit . . . . . 1.9 mm (0.075 in.)
Valve Seat Angle . . . . . 45°
Valve Face Angle . . . . . 45°
Valve Narrowing Angle . . . . . 30°
Valve Margin . . . . . 0.60 mm (0.020 in.)

Specifications - FE350D:

Valve Seating Surface Contact Width 0.8 mm (0.031 in.)
Contact Width Service Limit . . . . . 1.9 mm (0.075 in.)
Intake Valve Seat Angle . . . . . 30°
Intake Valve Face Angle . . . . . 30°
Intake Valve Narrowing Angle . . . . . 15°
Exhaust Valve Seat Angle . . . . . 45°
Exhaust Valve Face Angle . . . . . 45°
Exhaust Valve Narrowing Angle . . . . . 30°
Valve Margin . . . . . 0.60 mm (0.020 in.)

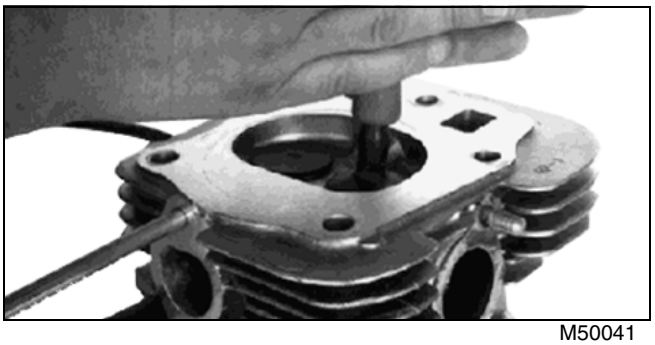
Lap Valves

1. If seat does not make proper contact, lap valve in seat.

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

3. Grip top of valve with a vacuum cup tool. Turn valve to lap valve to seat.

4. Lift valve from seat every eight to ten strokes. Lap until uniform ring appears around surface of valve face.



M50041

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

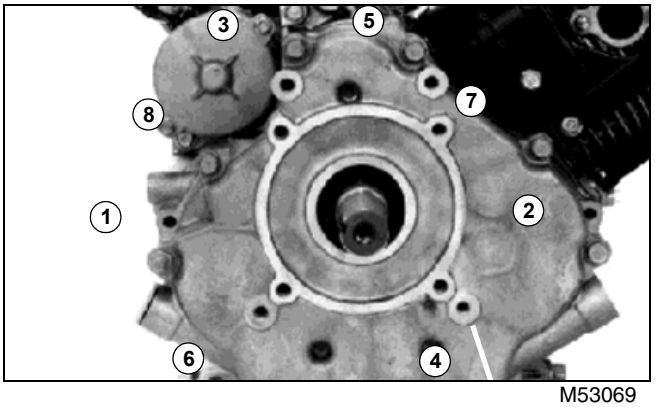
6. Check position of lap mark on valve face. Lap mark must be on or near center of valve face.

Crankcase Cover Removal and Installation

1. Remove drain plug and drain crankcase.

2. Remove crankcase cover and gasket.

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



M53069

3. Install short end of mounting stud into block.

4. Tighten cap screws to specification using sequence shown.

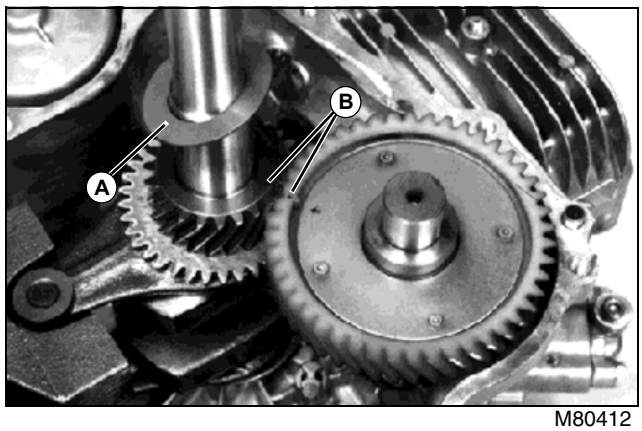
Crankcase capacity (approximate):

Without filter . . . . . 0.9 L (0.95 qt)
With filter (if equipped) . . . . . 1.2 L (1.26 qt)

Torque Specifications:

Mounting Stud . . . . . 26 N•m (230 lb-in.)
Mounting Cap Screws . . . . . 26 N•m (230 lb-in.)
Oil Drain Plug . . . . . 21 N•m (186 lb-in.)
Oil Drain Plug (metal w/washer) . . . . . 32 N•m (24 lb-ft)

Camshaft Removal and Installation



M80412

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

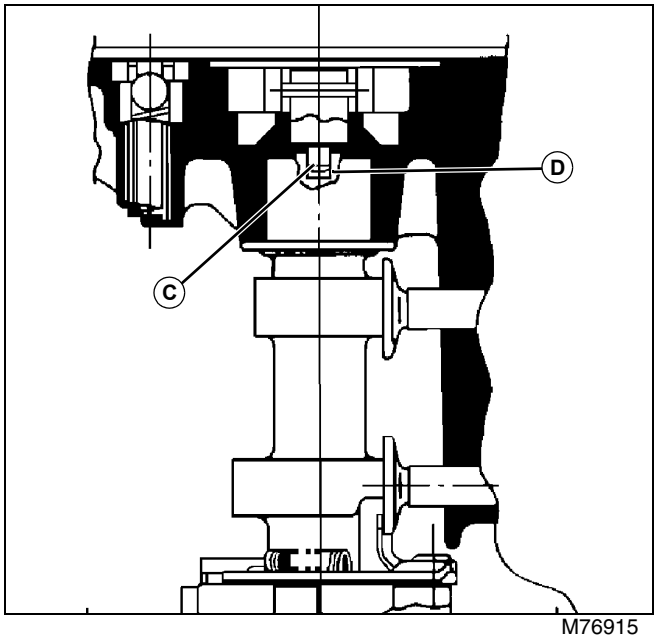
Important: Avoid Damage! Turn engine upside down and align timing marks to prevent damage to tappets when removing camshaft.

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

3. Remove camshaft.

Installation is done in reverse order of removal.

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



M76915

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

Camshaft Inspection

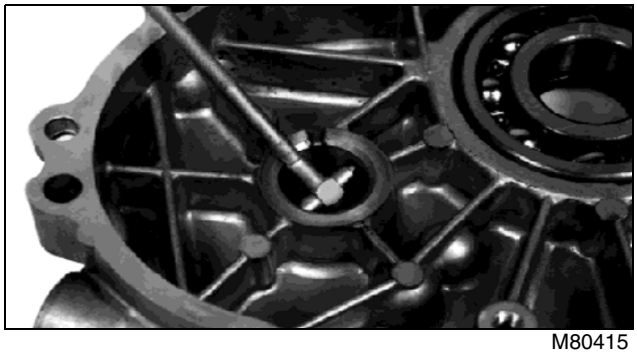
1. Inspect camshaft for worn or broken teeth.


M80413

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


M80414

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


M80415

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

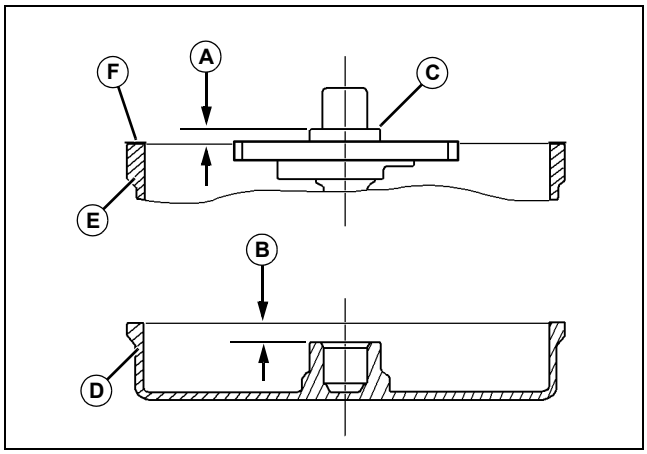
Camshaft Specifications (Wear Limit):

PTO and Flywheel Side:

Journal OD . . . . . 22.93 mm (0.903 in.)
Cam Lobe Height - FE290D . . . . . 32.70 mm (1.287 in.)
Cam Lobe Height - FE350D . . . . . 33.24 mm (1.308 in.)

Camshaft Axial Play Adjustment (FE350D)

If a part that affects the axial play of the camshaft has been replaced (FE350D only), the axial play must be adjusted.



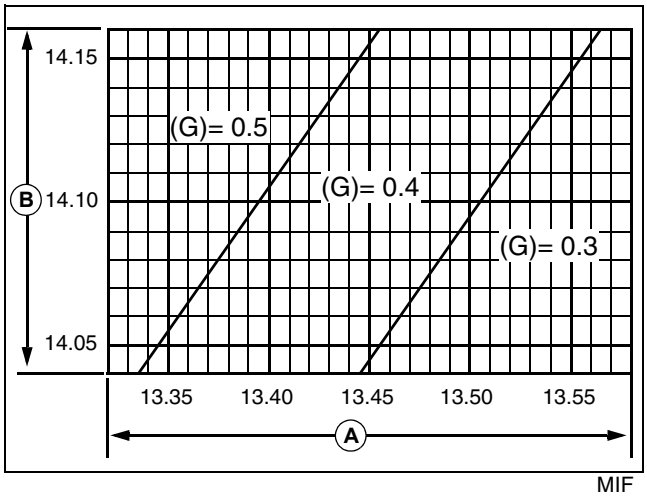
MX40347

A- Measurement A
B- Measurement B
C- Camshaft Gear
D- Crankcase Cover
E- Crankcase
F- Gasket

1. Place a gasket (F) on the crankcase (E). Measure and record the distance from the gasket surface to the camshaft gear (C) surface (Measurement A).

2. Measure and record the distance from the crankcase cover (D) mating surface to the end face of the camshaft

bearing inner race (Measurement B).



MIF

Camshaft shim selection table (FE350D). Measurements (A) (B) and shim thickness (G) in millimeters.

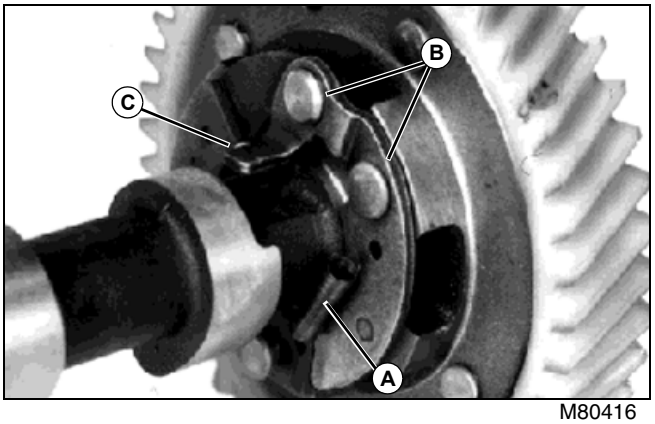
3. Locate measurements on shim selection table. Follow lines to where recorded measurements intersect. Choose the next thinner shim (G) from the table.

Automatic Compression Release

Inspection/Replacement:

1. Remove camshaft. See “Camshaft Removal and Installation” on page 67.

2. Inspect A.C.R. mechanism for wear or damage.



M80416

3. Inspect spring (A) for wear or damage. Replace if necessary.

4. Move weights (B) by hand to check for proper operation. Check that top of tab (C) is slightly above cam lobe when weights are pulled fully outward. Tab should drop below cam lobe when weights are fully retracted.

Caution: Avoid Injury! Be sure to remove the oil pump before camshaft installation. If the oil pump tang does not fit into the slot in the end of the camshaft, serious engine damage will result. See “Camshaft Removal and Installation” on page 67.

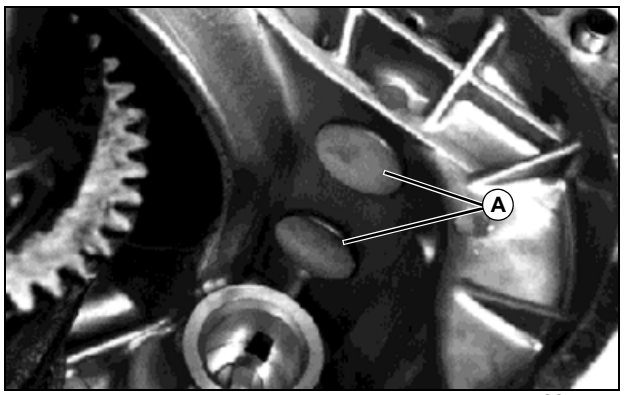
5. Replace camshaft assembly if A.C.R. does not operate properly.

Tappets Inspection and Replacement (FE290D)

1. Remove camshaft. See “Camshaft Removal and Installation” on page 67.

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

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



M80417

3. Remove tappets (A). Inspect tappets for wear or damage.

4. Apply clean engine oil to tappets and bores.

Hydraulic Lifter Replacement (FE350D)

Removal:

1. Rotate the crankshaft in the normal direction to bring the piston to the top-dead-center of the compression stroke to remove pressure on the valve train.

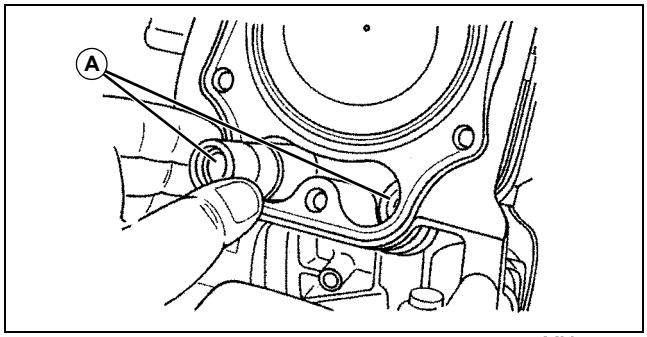
2. Remove the rocker cover and breather pipe.

3. Remove the rocker arms and shaft. See “Rocker Arm Removal and Installation” on page 62.

4. Remove cylinder head. See “Cylinder Head Removal and Installation” on page 63. Do not disassemble valves.

Note: When hydraulic lifters are removed from engine, keep the lifters upright, with the end of the lifter with

the snap ring facing upward. This will prevent oil from leaking out of the high-pressure chamber of the lifter.



MX40355

5. Pull the hydraulic lifters (A) out of the lifter bores with the aid of a magnet.

Inspection:

Note: Do not disassemble the hydraulic lifters. If debris is lodged in the lifter, replace the lifter.

Perform a leak-down test on each lifter:

1. Place a lifter, with the snap ring facing upwards, on a surface plate.

2. Using a rod with a rounded tip, firmly press the socket downward. The distance that the socket moves downward is the leak-down dimension. If the leak-down dimension is greater than the service limit, replace the lifter.

The leak-down dimension service limit (maximum) is 0.5 mm (0.020 in.).

Installation:

1. Apply engine oil to all friction areas of the hydraulic lifters, pushrods, rocker arms, rocker arm shaft and valve before installation.

2. Install hydraulic lifters into the lifter bores in the engine block. The end of the lifters with the snap ring must be facing upward.

3. Install cylinder head. See “Cylinder Head Removal and Installation” on page 63.

4. Install rocker arms and shaft.See “Rocker Arm Removal and Installation” on page 62.

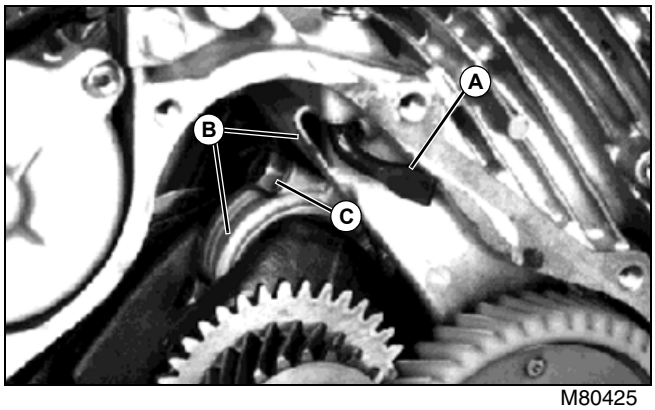
5. Install the rocker cover and breather pipe. Tighten bolts to 6 N•m (53 lb-in.).

Piston and Connecting Rod

Removal and Installation:

1. Remove cylinder head.

2. Remove crankcase cover.



M80425

3. Loosen governor arm nut and rotate governor shaft (A) 180°.

4. Remove carbon and varnish from top of cylinder bore with a ridge reamer, if necessary.

5. Remove cap screws (B) and connecting rod cap (C).

6. Push piston and connecting rod from cylinder bore.

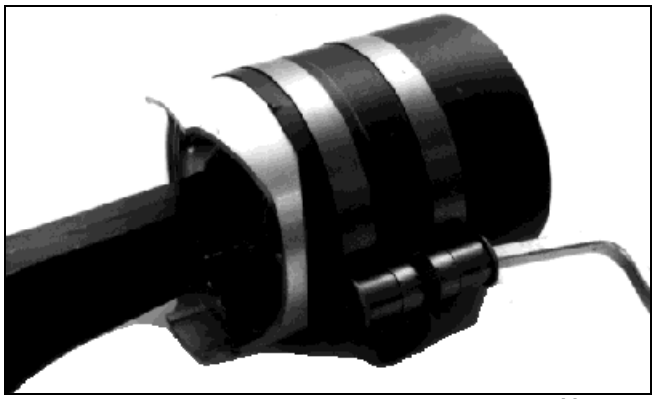
7. Disassemble and inspect all parts for wear or damage.

   - Apply clean engine oil on all parts during installation.

8. If new piston rings installed, deglaze cylinder.

9. Stagger piston rings 180° apart, but do not align with oil ring side rail end gaps.

10.Compress piston rings with a ring compressor.



M50074

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

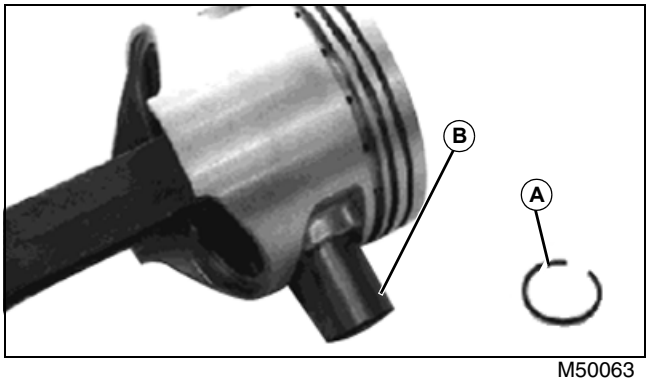
12.Install connecting rod cap and cap screws. Tighten cap screws to **20 N•m (177 lb-in.)**.

13.Rotate governor shaft 180° and tighten nut.

14.Install crankcase cover and cylinder head.

Disassembly:

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

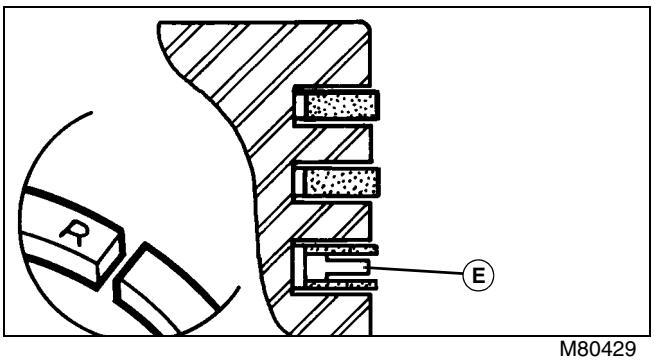


M50063

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

Assembly:

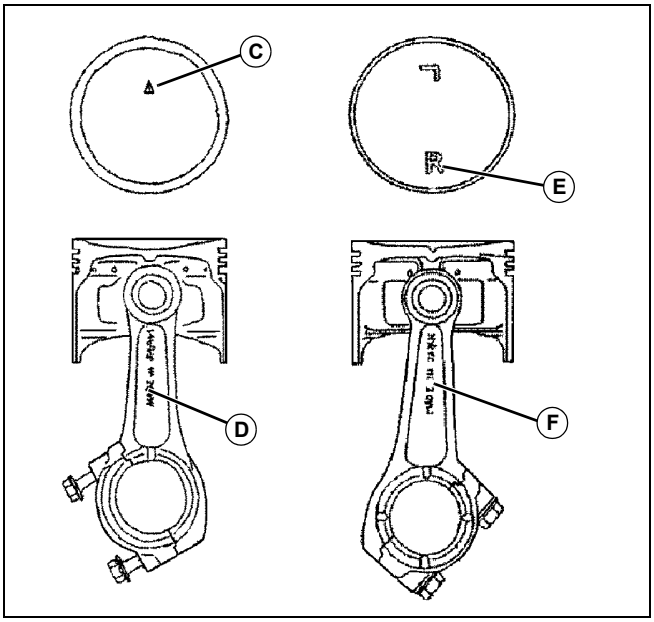
1. Apply clean engine oil to all parts during assembly.



M80429

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

Important: Avoid Damage! Note direction markings during assembly.

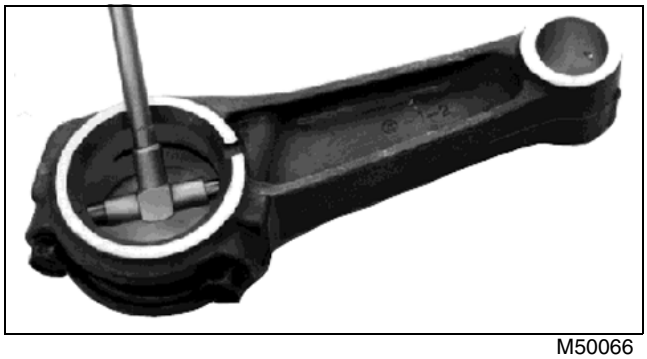


MX40274

5. For FE290D Assembly:
   - Assemble piston to rod with arrow mark (C) on piston opposite “MADE IN JAPAN” (D) on rod.
   - The “MADE IN JAPAN” side of the connecting rod MUST face the output shaft side of the crankshaft.
6. For FE350D Assembly:
   - Assemble piston to rod with “R” mark (E) on piston toward “MADE IN JAPAN” (F) on rod.
   - The “MADE IN JAPAN” side of the connecting rod MUST face the magneto side of the crankshaft.
7. Install piston pin and circlip.

Inspection:

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



M50066

5. Measure connecting rod crankshaft bearing and piston

pin bearing diameters.

Connecting Rod - FE290D:

Crankshaft Bearing ID (maximum) 35.57 mm (1.400 in.)

Piston Pin Bearing ID (maximum). 19.05 mm (0.750 in.)

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

Connecting Rod - FE350D:

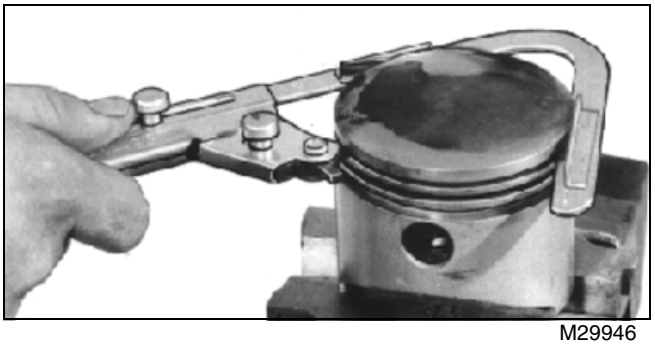
Crankshaft Bearing ID (maximum) 37.57 mm (1.479 in.)

Piston Pin Bearing ID (maximum). 20.05 mm (0.789 in.)

End-Cap Screw Torque . . . . . 23 N•m (204 lb-in.)

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

6. Remove all deposits from the piston.



M29946

7. Clean carbon from piston ring grooves with a ring groove cleaner. If a cleaning tool is not available, break an old ring and use it carefully to clean groove.

8. Check that oil return passages in the grooves are open.

Note: Replace piston if clearance is greater than specification.

M38102

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

Piston Ring Groove Clearance (Wear Limit):

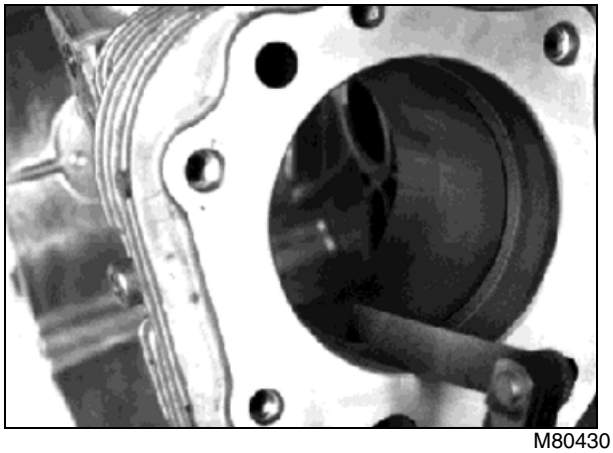
First Compression Ring . . . . . 0.16 mm (0.006 in.)

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

Oil Ring Assembly . . . . . .Not Measured

Ring Thickness (minimum) Top and Second Rings 1.44 mm (0.057 in.)

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



M80430

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

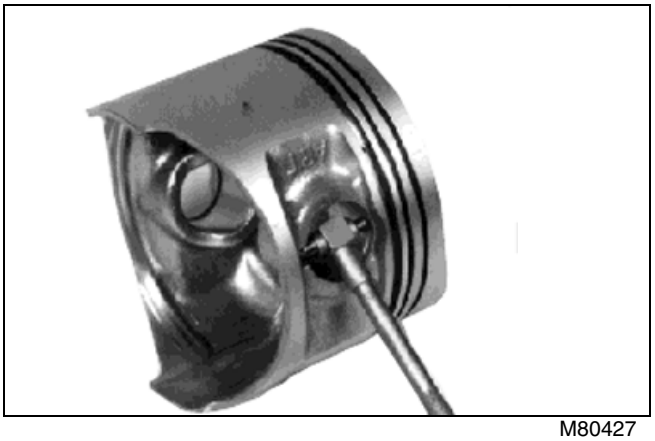
Piston Ring End Gap (Wear Limit):

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

Oil Ring Assembly . . . . . .Not Measured

M50064

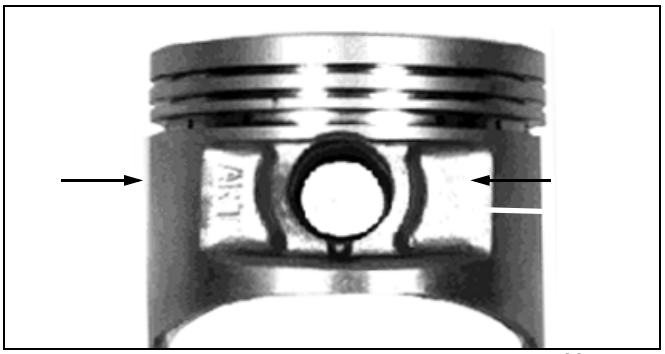
11.Measure piston pin diameter. Replace pin if diameter is less than specification.



M80427

12.Measure piston pin bore diameter. Replace piston if diameter is greater than specification.

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



M80428

13.Measure piston diameter perpendicular to piston pin bore.

Piston and Rings - FE290D:

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

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

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

Piston and Rings - FE350D:

Piston Pin OD (minimum) . . . . . 19.98 mm (0.786 in.)

Piston Pin Bore ID (maximum) . . . 20.03 mm (0.789 in.)

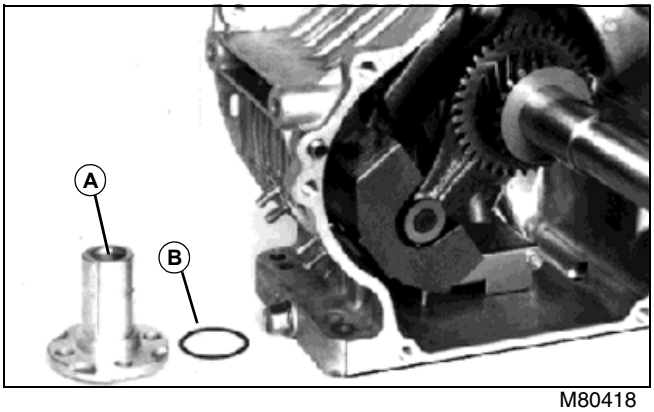
Piston OD, Standard (minimum) . . . . . 82.85 - 82.87 mm (3.262 - 3.263 in.)

14.Measure cylinder bore diameter. See “Cylinder Bore ID - FE290D:” on page 78.

Reciprocating Balancer

Removal and Installation:

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



M80418

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

Installation is done in reverse order of removal.

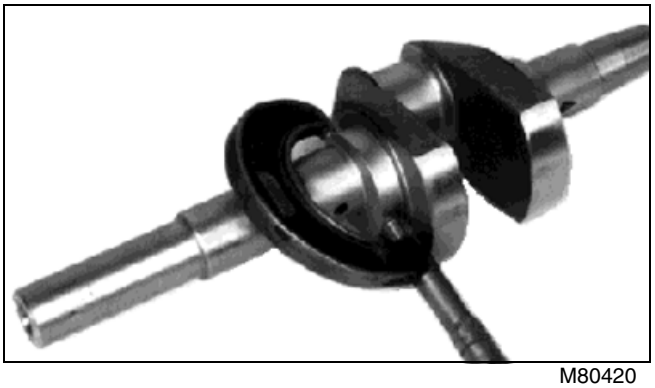
1. Cover keyway on flywheel end of crankshaft with tape to prevent damage to oil seal when installing assembly.
2. Apply clean engine oil to crankshaft bearing surfaces and all components during assembly.
3. Check and adjust crankshaft end play.

Disassembly/Assembly:

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

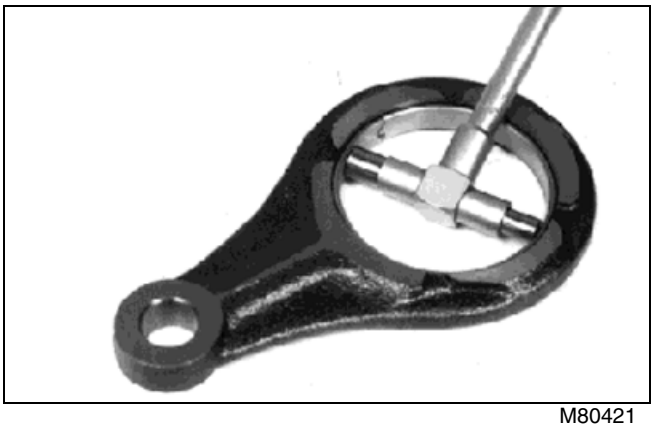
Inspection/Replacement:

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



M80420

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

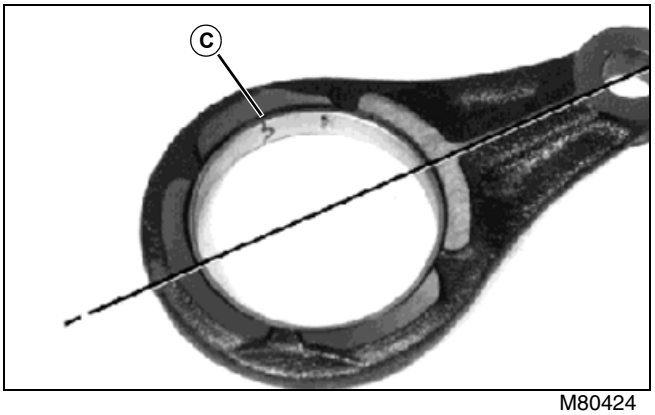


M80421

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

To replace link rod bushing:

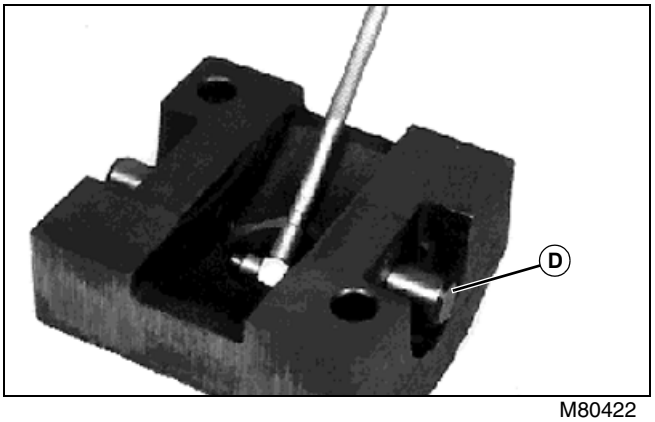
1. Replace bushing using a driver set and a press.



M80424

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

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



M80422

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

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

M80423

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

Crankshaft Removal and Installation

Removal:

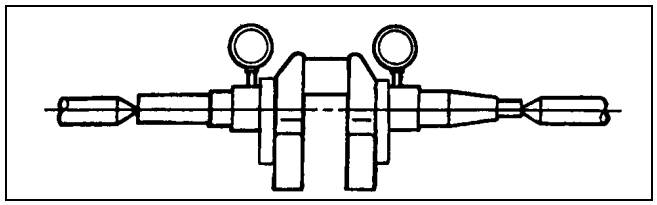
1. Check crankshaft end play. See “Crankshaft End Play Check” on page 76.
2. Remove balancer.
3. Remove balancer assembly from crankshaft.
4. Inspect crankshaft for wear or damage.

Installation:

Installation is done in reverse order of removal.

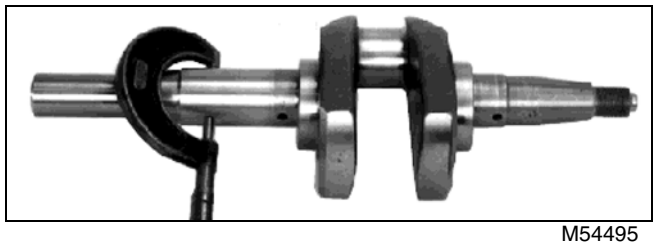
Crankshaft Inspection

1. Analyze crankshaft and connecting rod wear.



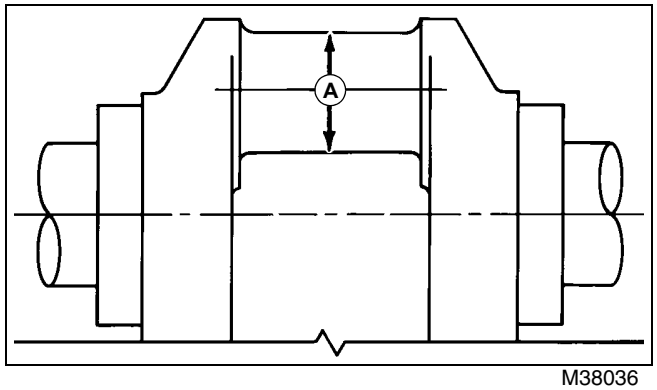
M80432

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



M54495

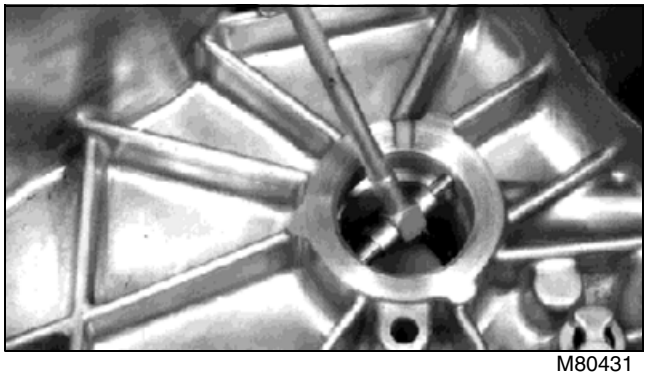
3. Measure crankshaft main bearing journal diameters. If either journal OD is less than **29.93 mm (1.178 in.) - FE290D**, or **34.93 mm (1.375 in.) - FE350D,** replace crankshaft.



M38036

4. Measure connecting rod journal diameter (A).

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



M80431

5. Measure crankshaft main bearing diameter in crankcase. Replace crankcase if diameter is greater than **30.08 mm (1.184 in.) - FE290D,** or **35.08 mm (1.381 in.) - FE350D**.

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

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

Results:

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

Connecting Rod Journal OD (Wear Limit):

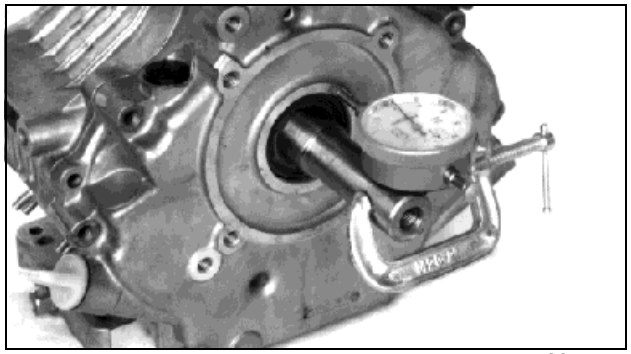
Standard - FE290D . . . . . 35.44 mm (1.395 in.)
Undersized - FE290D . . . . . 34.94 mm (1.375 in.)
Standard - FE350D . . . . . 37.44 mm (1.474 in.)
Undersized - FE350D . . . . . 36.94 mm (1.454 in.)

Crankshaft End Play Check

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

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

3. Zero the dial indicator.



M80433

4. Push crankshaft in as far as possible. If end play is not within **0.09 - 0.20 mm (0.004 - 0.008 in.) - FE290D** or **0.08 - 0.22 mm (0.003 - 0.009 in.) - FE350D**, adjust end play.

Analyze Crankshaft and Connecting Rod Wear

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

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

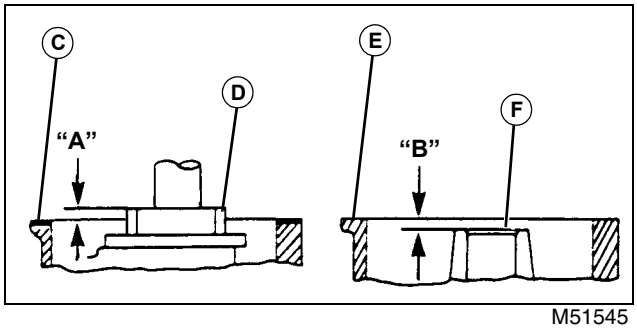
When the rod and cap seize to the crankshaft, the connecting rod and piston may both break causing other internal damage. Inspect block carefully before rebuilding engine.

Crankshaft and connecting rod damage can result from:

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

Crankshaft End Play Adjustment

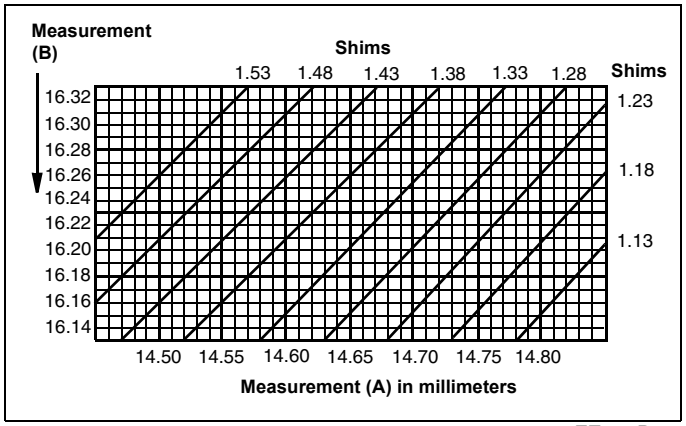
1. Remove crankcase cover.



M51545

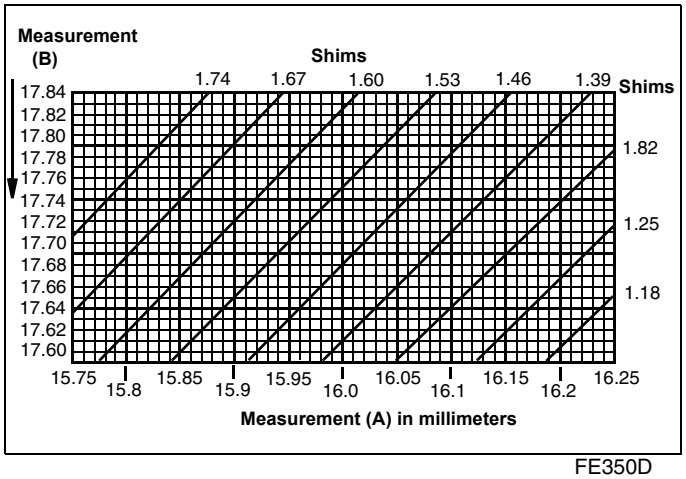
2. With gasket (C) installed on crankcase, measure from gasket surface to crankshaft gear surface (D). Record this measurement as "A".

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



FE290D

FE290D Engines



FE350D

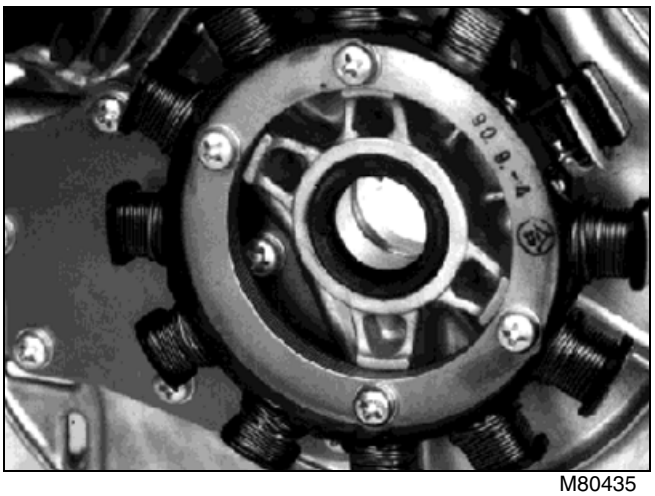
FE350D Engines

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

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

Crankshaft Oil Seal - Flywheel End Replacement

1. Remove crankshaft.



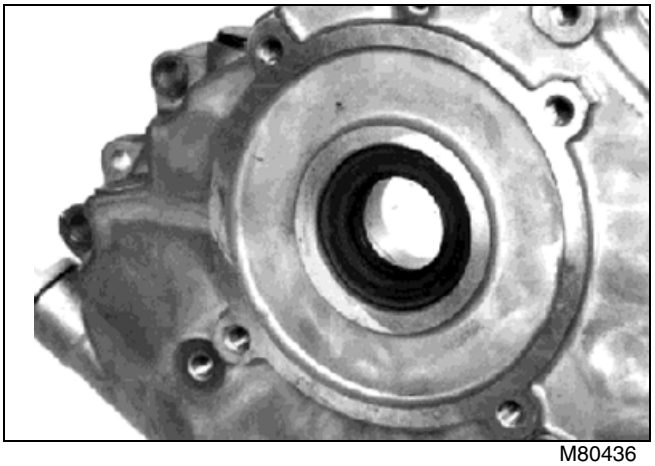
M80435

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

3. Pack lithium base grease inside lips of seal.

Crankshaft Oil Seal - PTO End Replacement

1. Remove crankcase cover.



M80436

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

3. Pack lithium base grease inside lips of seal.

Cylinder Block Inspection

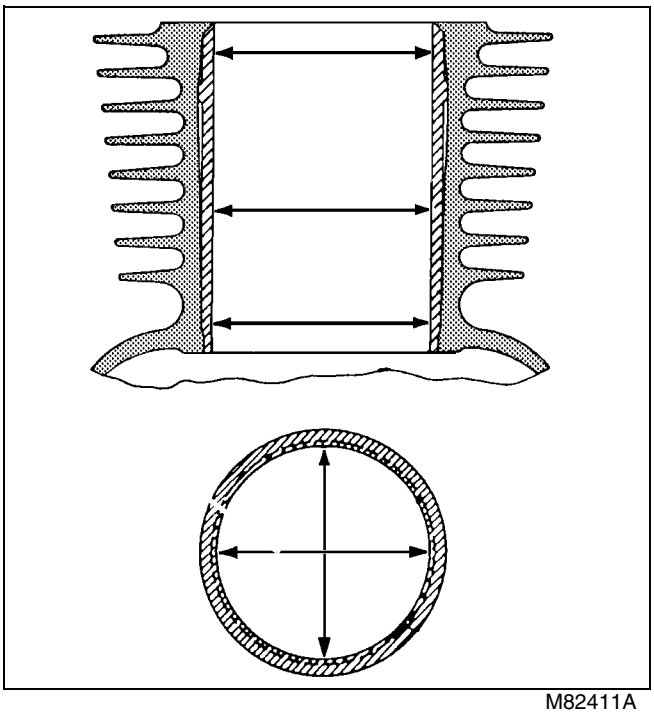
1. Remove crankshaft.

2. Clean and check block for cracks.

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

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

Note: A bare block is available for service.



M82411A

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

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

Results:

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

Cylinder Bore ID - FE290D:

Standard Size Bore:
Standard . . . . . 77.98 - 78.00 mm (3.070 - 3.071 in.)
Wear Limit . . . . . 78.07 mm (3.074 in.)
Out-of-Round (Maximum) . . . . . 0.056 mm (0.0022 in.)
0.50 mm (0.020 in.) Oversize Bore:
Standard . . . . . 78.46 - 78.48 mm (3.089 - 3.090 in.)
Wear Limit . . . . . 78.55 mm (3.093 in.)

Cylinder Bore ID - FE350D:

Standard Size Bore:
Standard . . . . . 82.98 - 83.00 mm (3.267 - 3.268 in.)
Wear Limit . . . . . 83.07 mm (3.270 in.)
Out-of-Round (Maximum) . . . . . 0.056 mm (0.0022 in.)
0.50 mm (0.020 in.) Oversize Bore:
Standard . . . . . 83.48 - 83.50 mm (3.287 - 3.288 in.)
Wear Limit . . . . . 83.57 mm (3.290 in.)

Cylinder Deglazing

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

1. Deglaze cylinder bores using a rigid hone with 220 to 300 grit stone.

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

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

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

Cylinder Reboring

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

1. Align center of bore to drill press center.

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

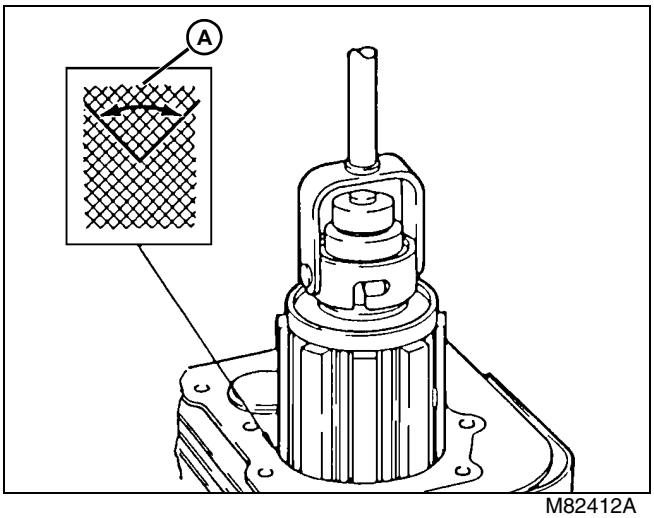
2. Adjust hone so lower end is even with lower end of cylinder bore.

3. Adjust rigid hone stones until they contact narrowest point of cylinder.

4. Coat cylinder with honing oil. Hone should turn by hand. Adjust if too tight.

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

Note: Measure bore when cylinder is cool.



M82412A

6. Stop press and check cylinder diameter.

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

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

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

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

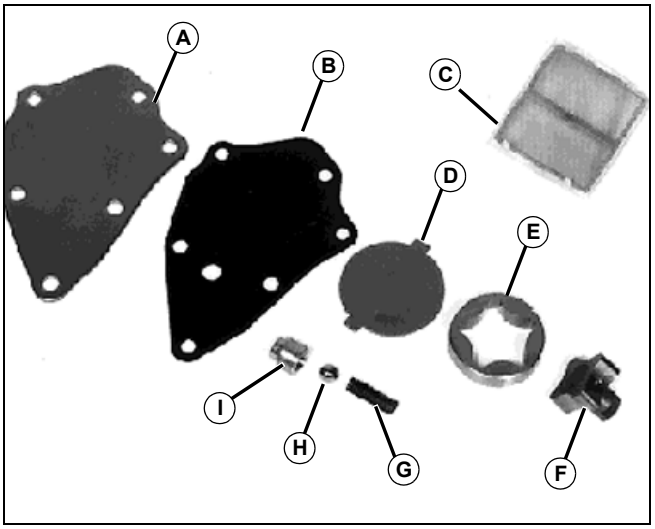
9. Clean cylinder thoroughly using warm soapy water until clean white rags show no discoloration.

10. Dry cylinder and apply engine oil.

Oil Pump Disassembly and Assembly

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

Note: To inspect or clean oil screen, remove crankcase cover. See "Crankcase Cover Removal and Installation" on page 67.



M80438

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

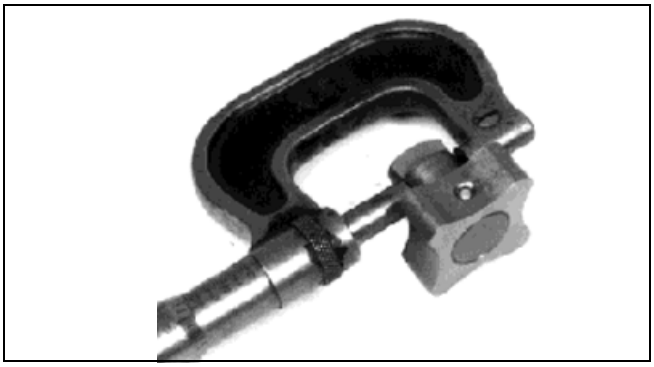
2. Inspect all parts for wear or damage.

Assembly is done in reverse order of disassembly.

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

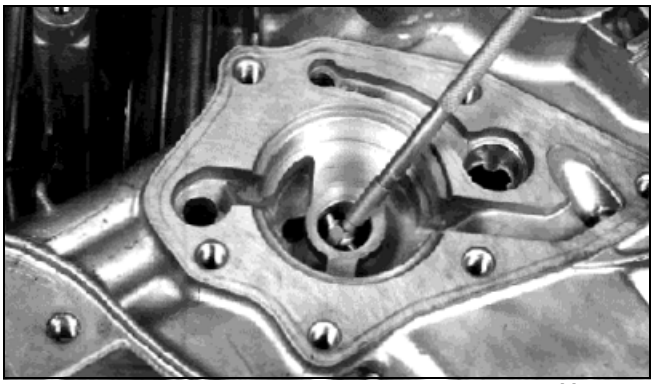
Oil Pump Inspection

Clean and inspect all parts for wear or damage.



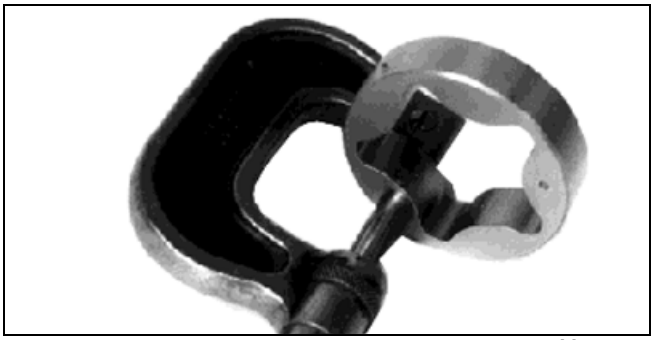
m80439

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



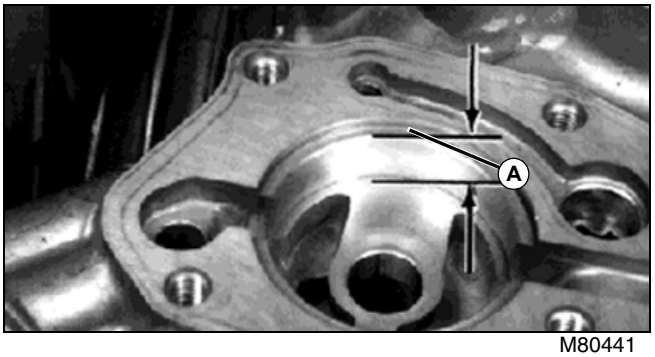
M80440

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



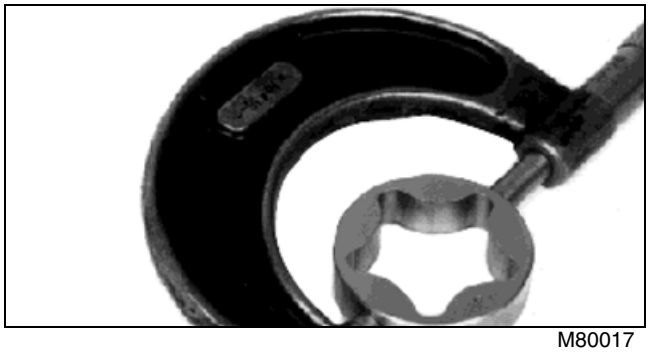
M80015

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

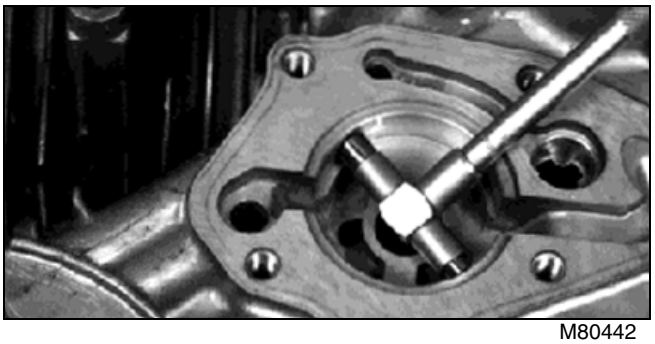


M80441

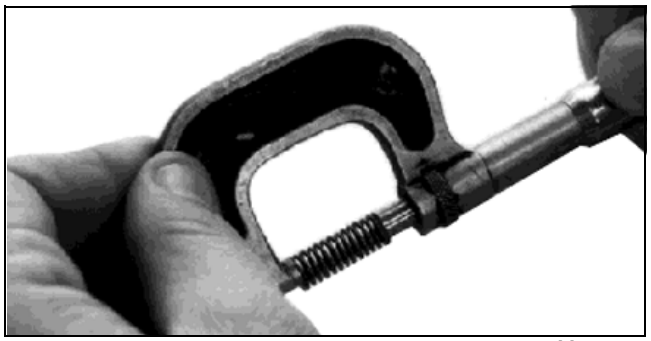
• Measure outer rotor bearing depth. If depth is greater than **10.17 mm (0.400 in.)** (A), replace cylinder block.


M80017

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

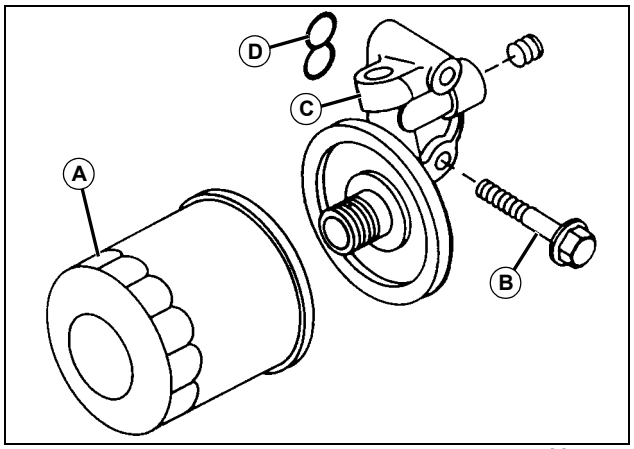

M80442

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


M50083

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

Remove and Install Oil Filter Manifold



M80443

1. Remove oil filter (A).
2. Remove two cap screws (B).
3. Remove oil filter manifold (C) and gasket (D).

Installation

Installation is done in reverse order of removal.

• Install new gasket.

Governor Inspection and Replacement

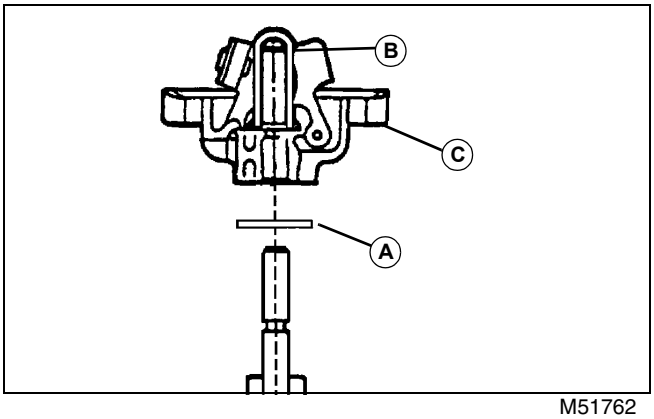
1. Remove crankcase cover.

Important: Avoid Damage! Removal damages governor. If not damaged, do not remove.

2. Inspect governor for wear or damage.

To replace governor:

• Remove governor with a screwdriver.



M51762

• Install washer (A) and sleeve (B) onto governor gear.

• Install governor gear (C) onto shaft. Push down on governor assembly until it snaps into place.

Governor Shaft Inspection and Replacement

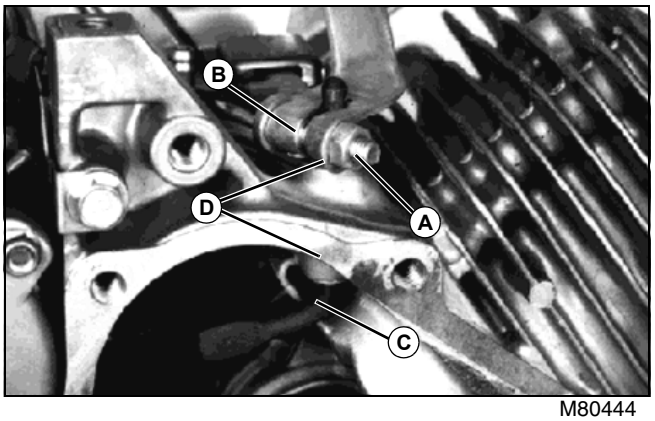
Note: It is not necessary to remove governor shaft unless seal is leaking or shaft is damaged.

1. Remove crankcase cover.

2. Inspect governor shaft for wear or damage. Replace if necessary.

To replace governor shaft:

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

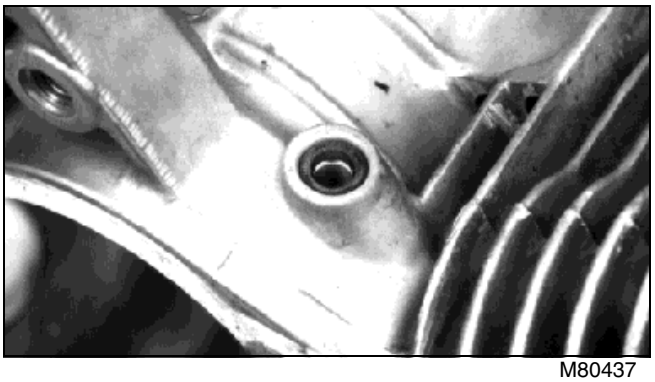


M80444

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

Governor Shaft Oil Seal Replacement

1. Remove governor shaft.


M80437

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

3. Pack lithium base grease inside lips of seal.

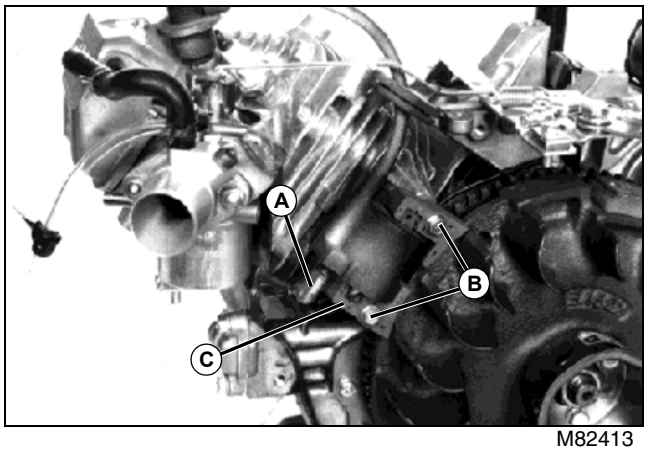
Armature With Coil

Special or Required Tools

- Digital Ohmmeter

Removal

1. Remove blower housing.



M82413

2. Disconnect wiring lead (A).

3. Remove cap screws (B) and armature with coil (C).

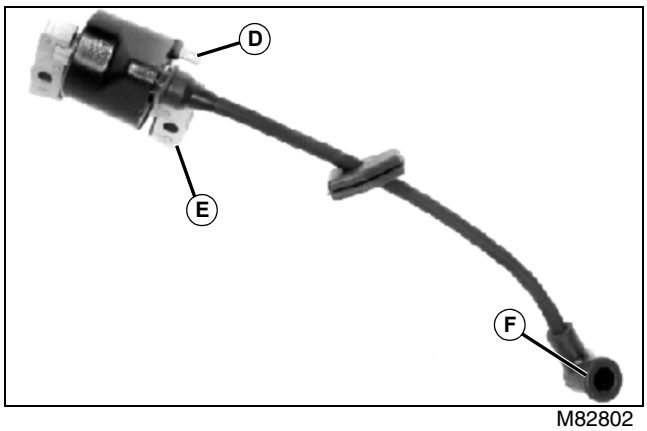
4. Test armature with coil. (See “Armature With Coil Test” on page 81.)

Installation

Installation is done in reverse order of removal.

- Adjust armature air gap. Tighten cap screws.

Armature With Coil Test



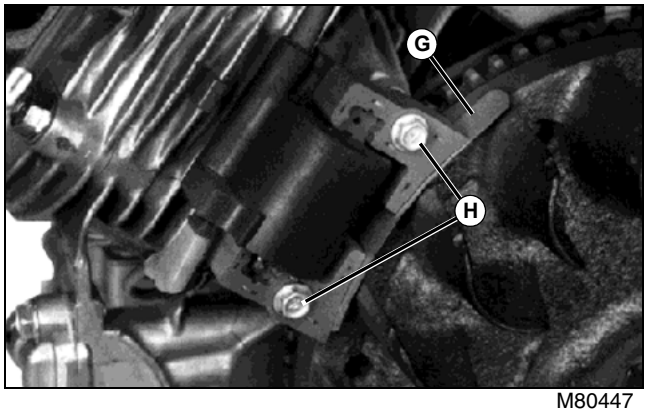
M82802

1. Measure resistance between primary lead (D) and core (E). If resistance is not within specifications, replace the ignition coil.

2. Measure resistance between spark plug cap (F) and core (E). If resistance is not within specifications, replace the ignition coil.

Air Gap Adjustment

1. Turn flywheel magnet away from armature.



M80447

2. Insert a 0.30 mm (0.012 in.) feeler gage (G) between flywheel and armature.

3. Push armature against flywheel and tighten mounting cap screws (H).

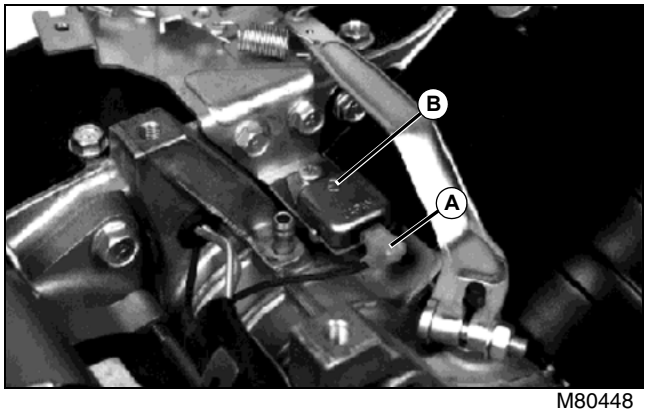
4. Turn flywheel to remove feeler gage.

Specifications

Coil Resistance Specifications

Primary Lead to Core . . . . . .0.67-1.10 ohms
Spark Plug Cap to Core . . . . . .6-10 ohms

Replace Ignition Module



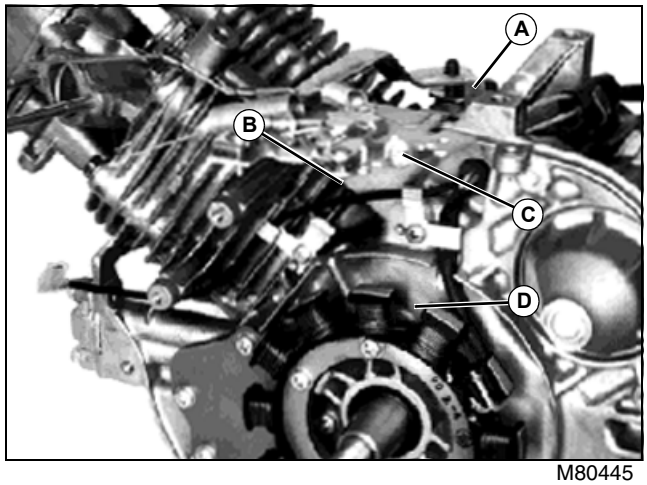
M80448

1. Disconnect wiring lead (A).

2. Remove mounting screw and replace ignition module (B).

Stator Removal and Installation

1. Remove flywheel. See “Flywheel Removal and Installation” on page 62.



M80445

2. Disconnect wiring leads (A).

3. Remove clamp (B), rubber grommet (C), screws and stator (D).

Installation:

Installation is done in reverse order of removal.

Analyze Starting Motor

Analyze Condition

The starter overheats because of:

- Long cranking.
- Armature binding.

The starter operates poorly because of:

- Armature binding.
- Dirty or damaged starter drive.
- Badly worn brushes or weak brush springs.
- Excessive voltage drop in cranking system.
- Defective battery or wiring.
- Shorts, opens, or grounds in armature.

Note: Starter repair is limited to brushes, end caps, and starter drive. Fields in starter are permanent magnets and are not serviceable. If housing or armature is damaged, replace starter.

Test No-Load Amperage

Special or Required Tools

Tool Name	Tool No.	Tool Use
Current Clamp	JT02153	Used to measure current.
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.
Jumper Cables	N/A	Used to connect staring motor to battery.

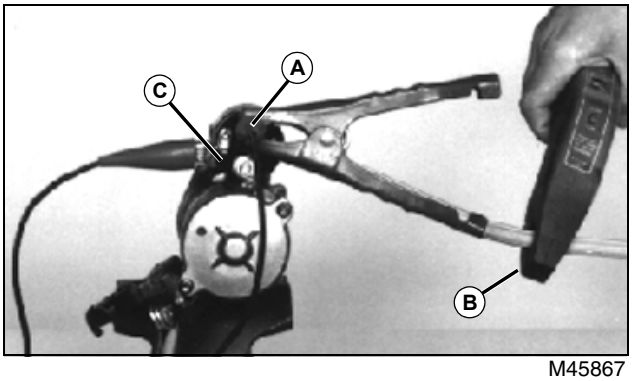
Reason

To determine if starter is binding or has excessive amperage draw under no-load.

Procedure

Important: Avoid Damage! Complete this test in 20 seconds or less to prevent starter damage. Allow at least two minutes for cooling and battery recovery before operating again. Overheating caused by excessive operation will seriously damage starting motor.

Note: Check that battery is fully charged and of proper size to ensure accuracy of test.



M45867

1. Connect jumper cables to battery.

2. Connect negative (-) cable to starter body. Connect positive (+) cable to solenoid battery terminal (A).

3. Connect ammeter in series with jumper wire, or place current gun (B) over positive (+) jumper cable.

4. Use jumper wire to briefly connect solenoid battery terminal and “Start” terminal (C). Measure starter amperage. Maximum starter amperage should be within specifications.

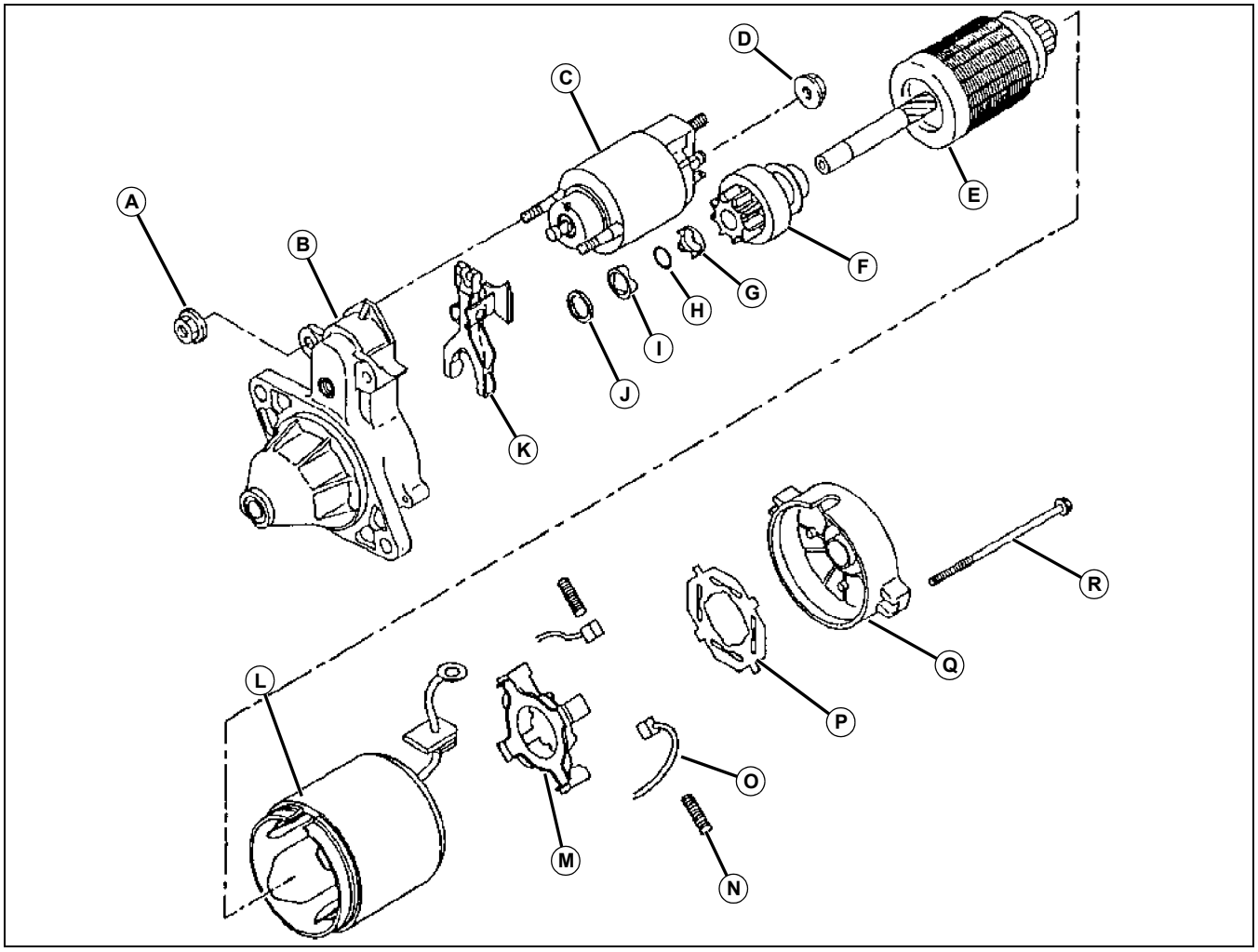
Results

- If amperage is out of specification, check for binding or seizing bearings, sticking brushes, dirty or worn commutator. Repair or replace starter.

Specifications

Starter Amperage (No-Load) (Maximum) . . . . . .50 amps

Disassemble and Assemble Starting Motor



M82414A

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

1. Mark body and covers for correct alignment during reassembly.
2. Remove two long cap screws and end cover.
3. Remove insulator, springs and brush holder.
4. Remove flange nut.
5. Remove field coil housing from armature assembly.
6. Remove two solenoid mounting nuts.
7. Remove solenoid, shift lever and armature assembly.
8. Remove washer and separate stopper halves to remove retaining clip.
9. Remove pinion from armature.
10. Inspect and test solenoid, starter armature and brushes. (See “Inspect and Test Starting Motor” on page 85.)

Assembly

Assembly is done in reverse order of disassembly.

Apply a thin coat of multipurpose grease to:

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

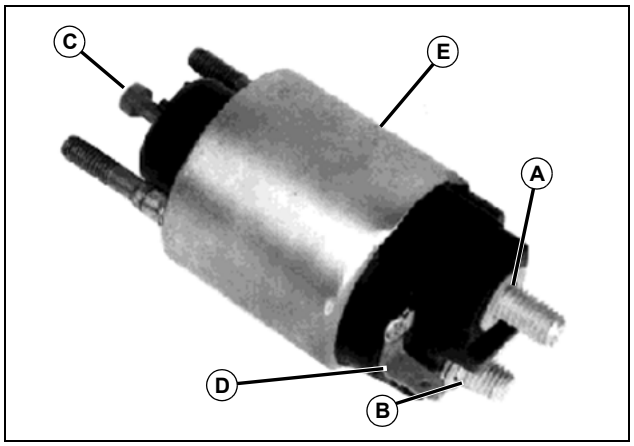
Inspect and Test Starting Motor

Special or Required Tools

- Digital Multimeter

1. Measure field coil brush lengths. If any one brush length is less than specifications, replace all four brushes.

2. Inspect brush springs for wear or damage. Replace if necessary.

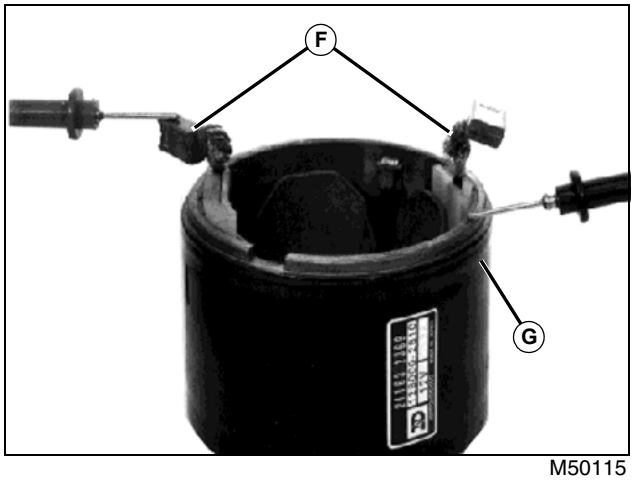


M51705

3. Test solenoid:

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

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



M50115

4. Test for grounded field winding:

Touch one probe of tester to field coil brush (F) and the other probe to the field coil housing (G). Be sure the brush lead is not touching the field coil housing. If there is continuity, the coil is grounded and the field coil housing must be replaced.

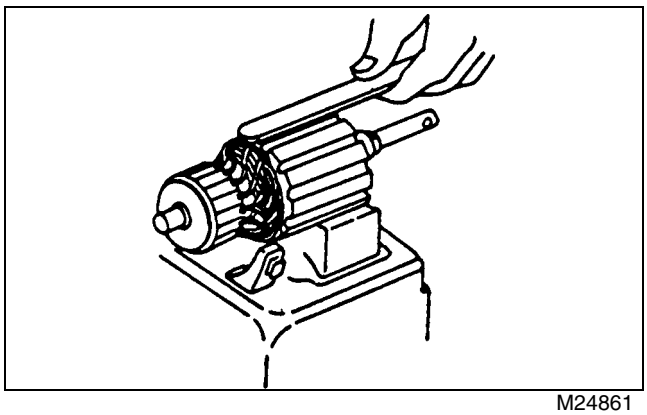

M50116

5. Test for open field coil:

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

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

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



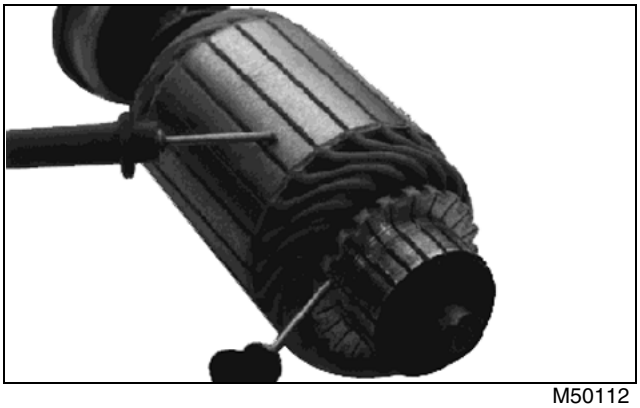
M24861

7. Locate short circuits by rotating armature on a growler while holding a hacksaw blade or steel strip on armature. The hacksaw blade will vibrate in area of short circuit.

Note: Shorts between bars are sometimes caused by dirt or copper between bars. Inspect for this condition.

8. If test indicates short circuited windings, 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 grit sandpaper. NEVER use emery cloth. Clean all dust from armature when finished.

9. Check armature again. If test still indicates short circuit, replace armature.

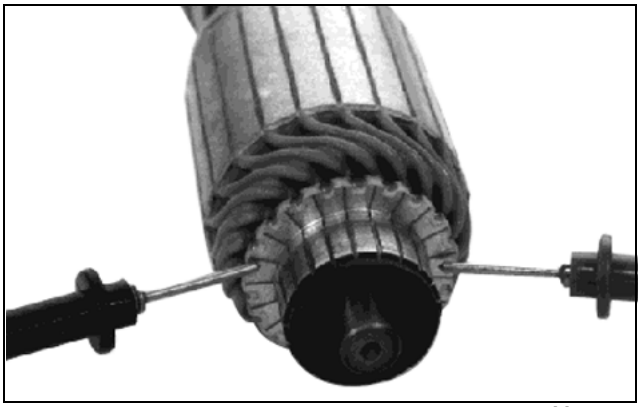


M50112

10.Test for grounded windings using an ohmmeter or test light.

Touch probes on each commutator bar. Armature windings are connected in parallel, so each commutator bar needs to be checked.

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



M50113

11.Test for open circuited windings using an ohmmeter or test light.

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

Specifications

Starting Motor Brush Length . . . . . 6 mm (0.240 in.)

ELECTRICAL TABLE OF CONTENTS

Table of Contents

Specifications

Test and Adjustment Specifications

Battery

Specific Gravity (Minimum) . . . . . 1.225 with less than 50 point variation between cells
Voltage (Minimum) . . . . . 12.4 volts
Cold Cranking Amps . . . . . .295 amps at -18°C (0°F)

Starting Motor

Maximum Amperage (No Load). . . . . .50 amps at 6000 rpm
Maximum Amperage (Load) . . . . . .51 amps at 750 rpm

Stator

Voltage Output (Minimum - Unregulated at Fast Idle) . . . . . .34 volts AC
Voltage Output (Regulated at Fast Idle) . . . . . 12.2-14.7 volts DC
Amperage (Minimum - Regulated at Fast Idle) . . . . . 13 amps

Lift Motor

Raise Amperage Draw (No Load) . . . . . 3-6 amps
Lower Amperage Draw (No Load). . . . . 3-4 amps
Raise Amperage Draw (Maximum Load) . . . . . 3-6 amps

Repair Specifications

Lift Actuator

Retaining Plate-to-Lower Housing Cap Screw Torque . . . . . 8 N•m (70 lb-in.)
Lower Housing-to-Upper Housing Cap Screw Torque . . . . . 2.3 N•m (20 lb-in.)
Motor Nut Torque . . . . . 8 N•m (70 lb-in.)

Special or Essential Tools

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

Special or Required Tools

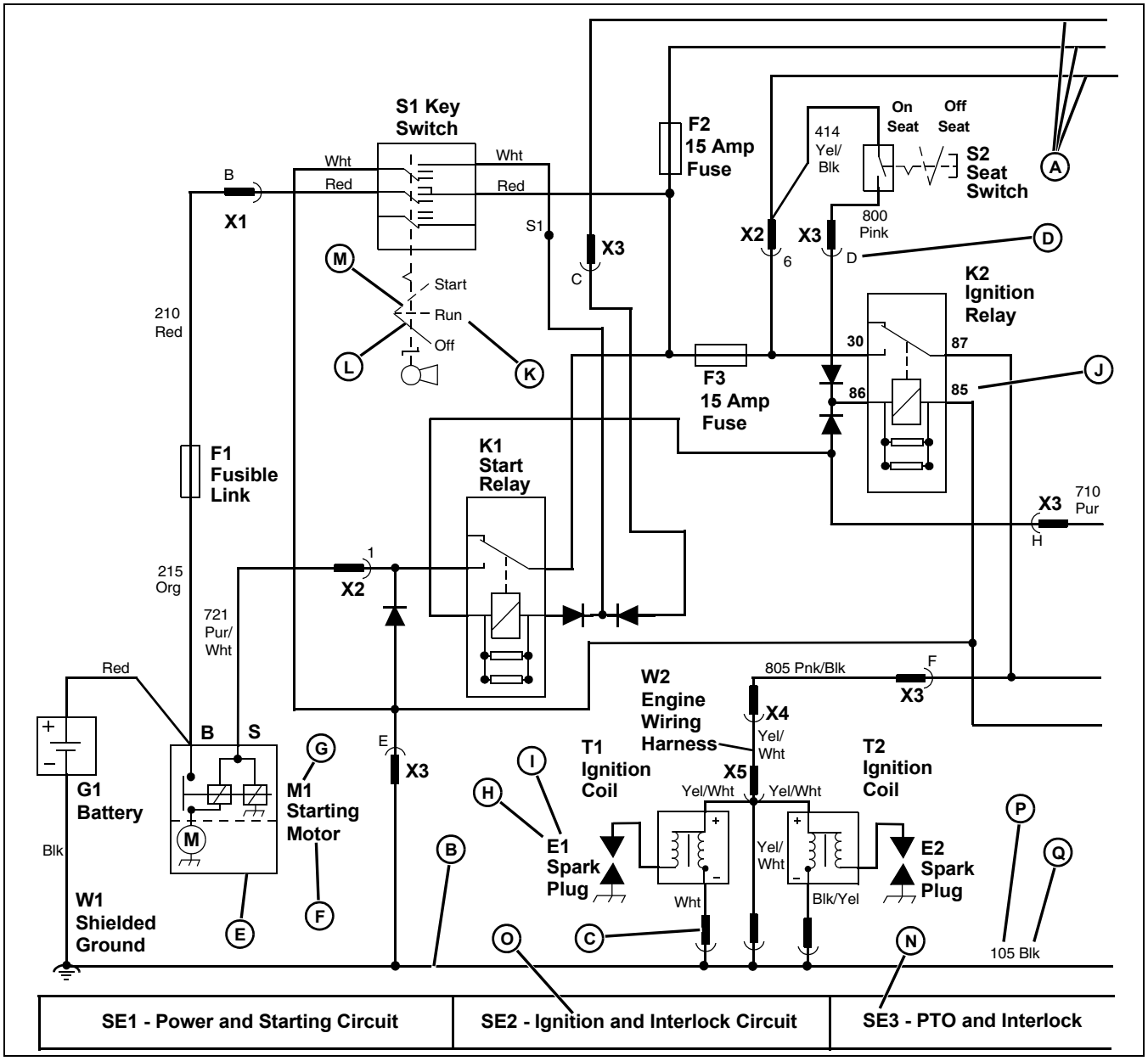
Tool Name	Tool No.	Tool Use
Battery Tester	JT05685	Used to test battery performance.
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.
Current Clamp	JT02153	Used to measure current.
Spark Tester	D05351ST	Used to test ignition system.
Universal Electrical Pliers	JDG145	Used to cut wires and strip insulation.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Terminal Removal Tool	JDG777	Used to remove contacts from connector body.
Crimper	JDG865	Used to attach contacts and seals.
12-Volt Battery	N/A	Used to provide power.
Jumper Cables	N/A	Used to connect staring motor to battery.
Hydrometer	N/A	Used to check specific gravity.
Battery Charger (Variable Rate)	N/A	Used to charge battery.

General Information

Reading Electrical Schematics



MIF

The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all ground wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in the OFF position. The diagram does not list connector (C) information unless needed to avoid confusion. If the connector is shown, the number next to it is the terminal pin location (D) in the connector.

Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

The identifying letter is always the same for a specific component, but the identifying numbers are numbered consecutively from upper left to lower right. The terminal designation (J) is placed directly outside the symbol next to the connecting wire path. Switch positions (K) are also placed directly outside the symbol. The solid line (L) shows the position the switch is currently in, and dash lines (M) represent other switch positions.

Each circuit is identified at the bottom of the drawing by a section number (N) and section name (O).

The circuit number (P) and wire color (Q) are shown directly next to the wire path.

The same component name and identification code are used consistently on all diagrams in this section. Components can be easily cross-referenced.

Theory of Operation Information

The theory of operation stories divide the electrical system into individual circuits by function. Each circuit is isolated from the main wiring schematic and shows only the components that are used in it. The story contains information on function, operating conditions, and theory of operation. The circuit schematics are drawn with the components in the operating position, with the power, or battery positive, into them across the top and the ground, or battery negative, across the bottom.

Diagnostic Information

The diagnostic procedures are used to test the complete circuit regardless of the problem or complaint. Select a circuit or symptom from Circuit Operation and Diagnosis and follow the test procedures under that heading.

The diagnostic procedure provides:

- Test conditions
- Test location
- A question regarding the normal reading
- A yes or no answer based on the test results

When performing the test or check, be sure to set your machine up to the test conditions listed and follow the sequence carefully.

Common Circuit Tests

Shorted Circuit

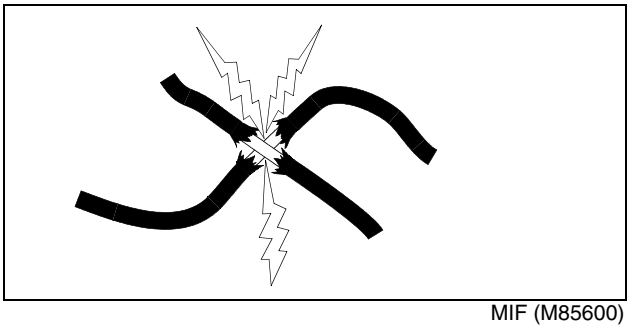
A shorted circuit may result in the wrong component operating (i.e., improper wire-to-wire contact). To test for a shorted or improperly wired circuit:

1. Turn component switch ON.

2. Start at the controlling switch of the component that should not be operating.

3. Follow the circuit and disconnect wires at connectors until component stops operating.

4. Shorted or improper connections will be the last two wires disconnected.



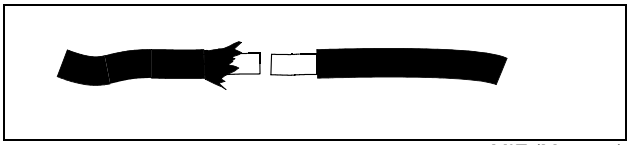
MIF (M85600)

High Resistance or Open Circuit

High resistance or open circuits usually result in slow, dim, or no component operation (i.e., poor, corroded, or disconnected connections). Voltage at the component will be low when the component is in operation. To test for high resistance and open circuits:

1. Check all terminals and grounds of the circuit for corrosion.

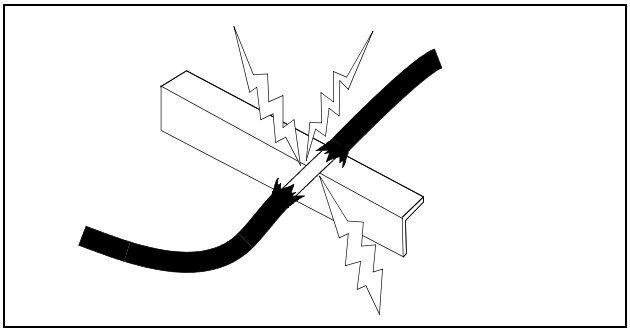
2. If terminals are not corroded or loose, the problem is in the component or wiring.



MIF (M85601)

Grounded Circuit

Grounded circuits usually result in no component operation or a blown fuse.



MIF (M85602)

Conductors for 12-Volt Circuits

Stranded Conductors for 12-Volt Circuits									
SAE Wire Size (Gauge)	20	18	16	14	12	10	8	6	4
Metric Wire Size (mm)	0.5	0.8	1.0	2.0	3.0	5.0	8.0	15.0	20.0
Typical Stranding	7 x 28	16 x 30	19 x 29	19 x 27	19 x 25	19 x 23	19 x 21	37 x 21	61 x 22
Minimum Conductor Area in Circular Mils	1072	1537	2336	3702	5833	9343	14,810	25,910	37,360

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**

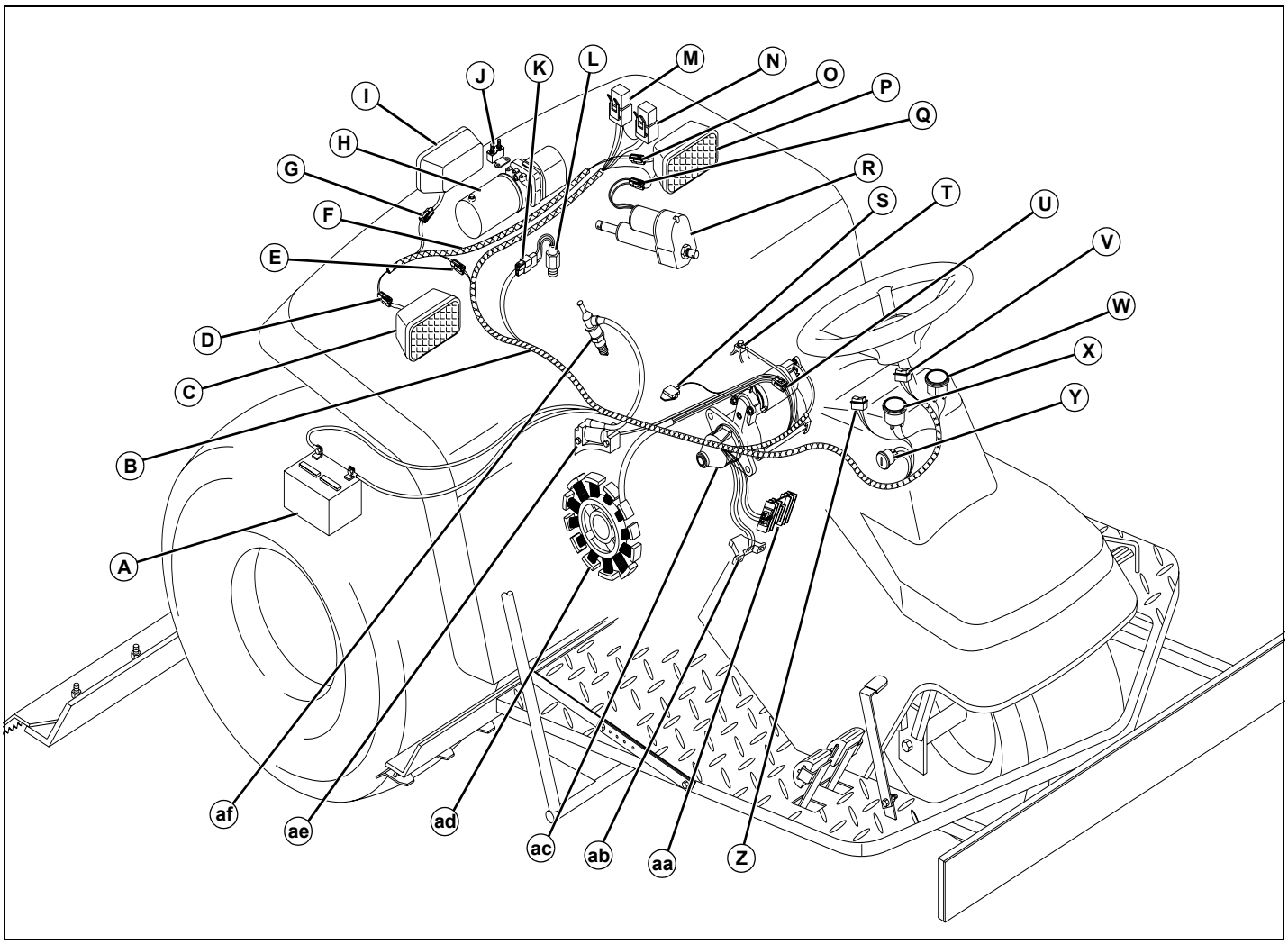
Schematic and Harness Legend

Component Identification Legend

A1	Ignition Module (SE2)
E1	Spark Plug (SE2)
E2	Rear Work Light (SE5, W2)
E3	Left Work Light (SE5, W2)
E4	Right Work Light (SE5, W2)
F1	Main Power 20 Amp Fuse (SE1, W1)
F2	Voltage Regulator/Rectifier 20 Amp Fuse (SE1, W1)
F3	Fusible Link (SE1, W1)
F4	30 Amp Circuit Breaker - Optional (W3)
G1	Battery (SE1)
G2	Stator (SE3)
K1	Lift Relay (SE6, W1)
K 2	Lower Relay (SE6, W1)
M1	Starting Motor (SE1, W1)
M2	Lift Motor (SE6)
M3	Hydraulic Pump Motor - Optional (W3)
N1	Voltage Regulator/Rectifier (SE3, W1)
P1	Hour Meter (SE4, W1)
P2	Voltmeter (SE4, W1)
S1	Neutral Start Switch (SE1, W1)
S2	Key Switch (SE2, W1)
S3	Work Lights Switch (SE5, W1)
S4	Lift Switch (SE6, W1)
T1	Magneto Ignition Coil (SE2)
W1	Main Harness
W2	Work Lights Harness - Optional
W3	Hydraulic Pump Harness - Optional
X1	Work Lights Switch Connector (switched power) (W1)
X2	Work Lights Switch Connector (to work lights harness) (W1)
X3	Hour Meter Positive (+) Connector (W1)
X4	Hour Meter Negative (-) Connector (W1)
X5	Voltmeter Positive (+) Connector (W1)
X6	Voltmeter Negative (-) Connector (W1)
X7	Lift Switch Connector (W1)
X8	Key Switch Connector (W1)
X9	Main Harness-to-Work Lights Harness Connector (W1)
X10	Main Harness-to-Lift Motor Connector (W1)
X11	Lower Relay Connector (W1)
X12	Lift Relay Connector (W1)
X13	Neutral Start Switch Connector (W1)
X14	Starting Motor Connector (from neutral start switch) (W1)
X15	Main Harness-to-Ground Connector (from Splice 3) (W1)
X16	Main Harness-to-Ground Connector (W1)
X17	Starting Motor Connector (from battery) (W1)
X18	Main Harness-to-Engine Harness Connector (W1)
X19	Fuse Load Center Connector (W1)
X20	Voltage Regulator/Rectifier Connector (W1)
X21	Work Lights Harness-to-Main Harness Connector (W2)
X22	Rear Work Light Connector (W2)
X23	Left Work Light Connector (W2)
X24	Right Work Light Connector (W2)
X25	Hydraulic Pump Motor Connector (W3)
X26	Circuit Breaker Connector (from main harness) (W3)
X27	Circuit Breaker Connector (to hydraulic pump motor) (W3)
X28	Hydraulic Pump Harness-to-Main Harness Connector (W3)
X29	Hydraulic Pump Harness-to-Ground Connector (W3)

ELECTRICAL COMPONENT LOCATION

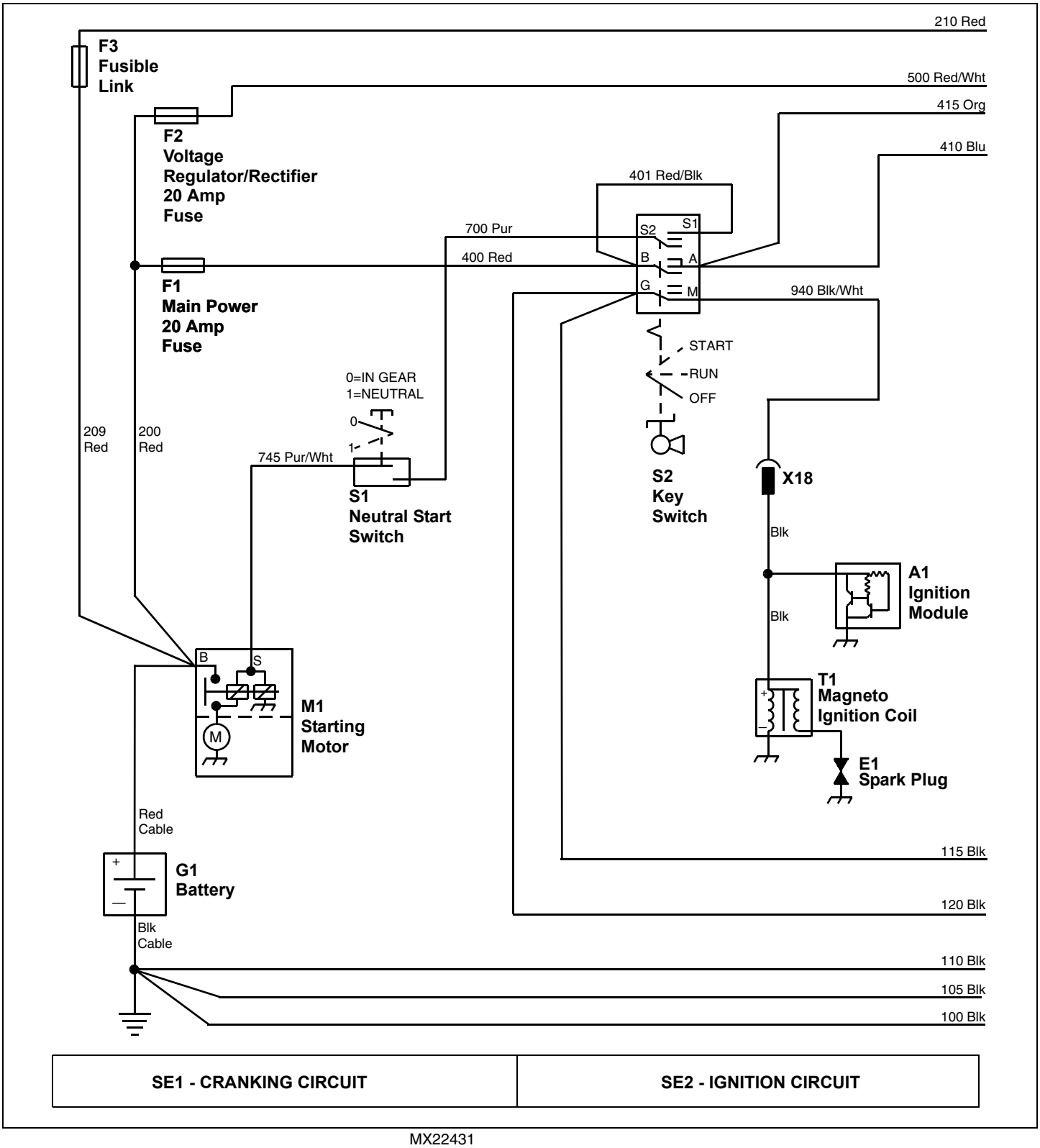
Component Location — Machine Electrical Component Location



M83101AE

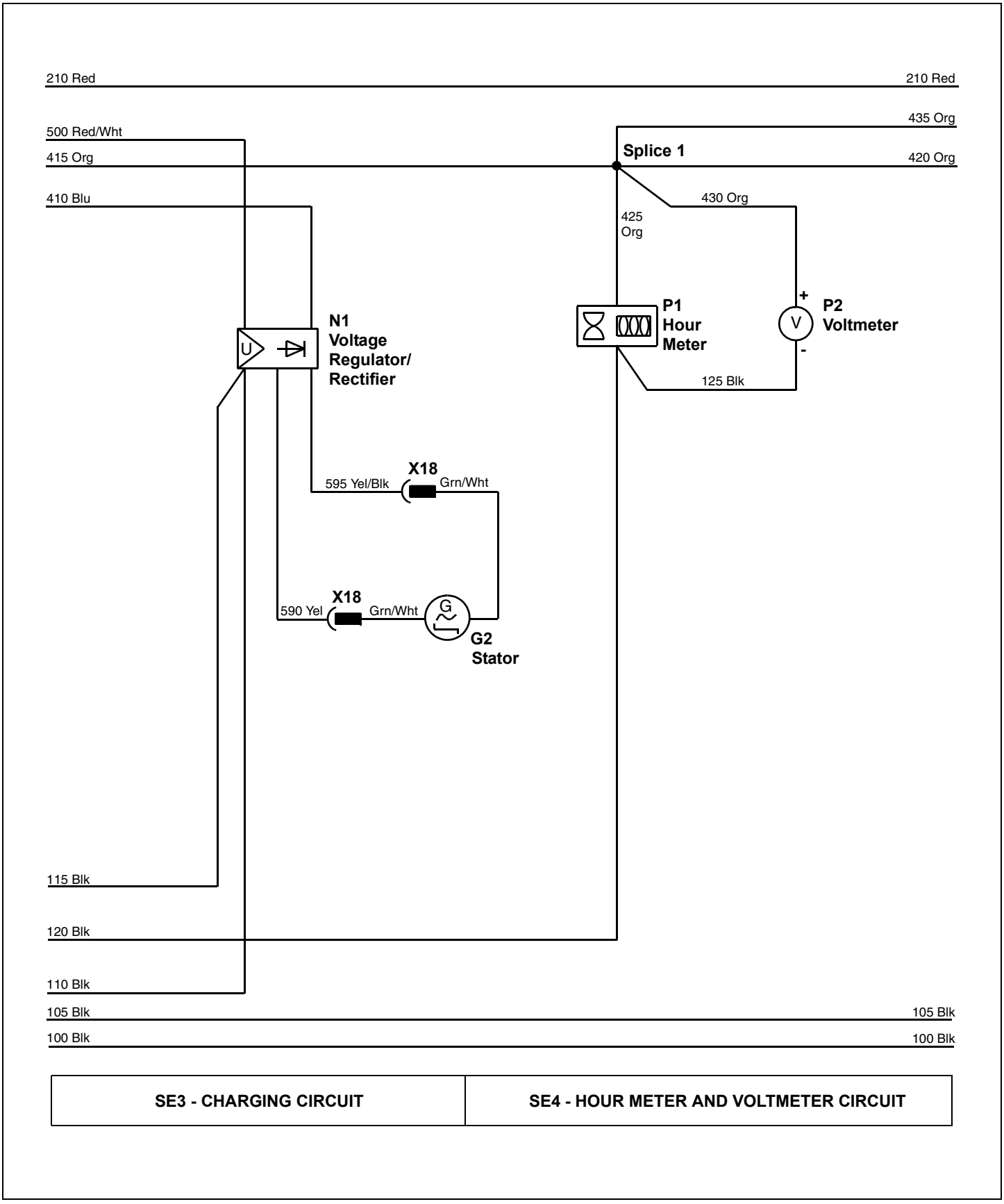
A- Battery (G1)
B- Main Harness (W1)
C- Right Work Light (E4)
D- Right Work Light Connector (X24)
E- Main Harness-to-Work Lights Harness Connector (X9)
F- Work Lights Harness (W2)
G- Rear Work Light Connector (X22)
H- Hydraulic Pump Motor (M3)
I- Rear Work Light (E2)
J- Circuit Breaker (F4)
K- Neutral Start Switch Connector (X13)
L- Neutral Start Switch
M- Lift Relay (K1)
N- Lower Relay (K2)
O- Left Work Light Connector (X23)
P- Left Work Light (E3)
Q- Main Harness-to-Lift Motor Connector (X10)
R- Lift Motor (M2)
S- Ignition Module (A1)
T- Engine Harness Grounds
U- Main Harness-to-Engine Harness Connector (X18)
V- Lift Switch (S4)
W- Hour Meter (P1)
X- Voltmeter (P2)
Y- Key Switch (S2)
Z- Work Lights Switch (S3)
AA- Voltage Regulator/Rectifier (N1)
AB- Fuse Load Center Connector (X19)
AC- Starting Motor (M1)
AD- Stator (G2)
AE- Magneto Ignition Coil (T1)
AF- Spark Plug (E1)

Main Schematic - Standard



MX22431

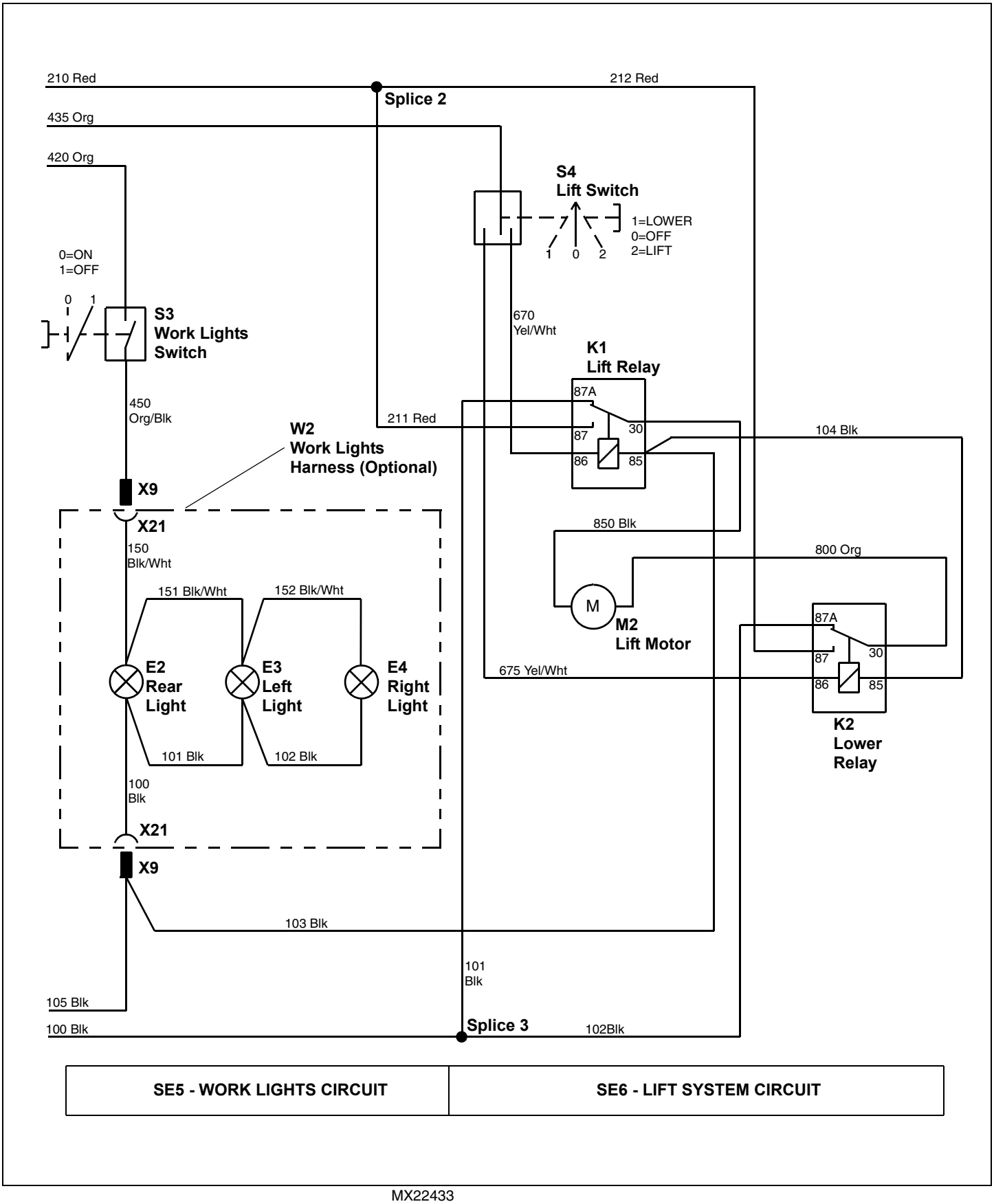
Main Schematic - Standard (2 of 3)



SE3 - CHARGING CIRCUIT	SE4 - HOUR METER AND VOLTMETER CIRCUIT

MX22432

Main Schematic - Standard (3 of 3)

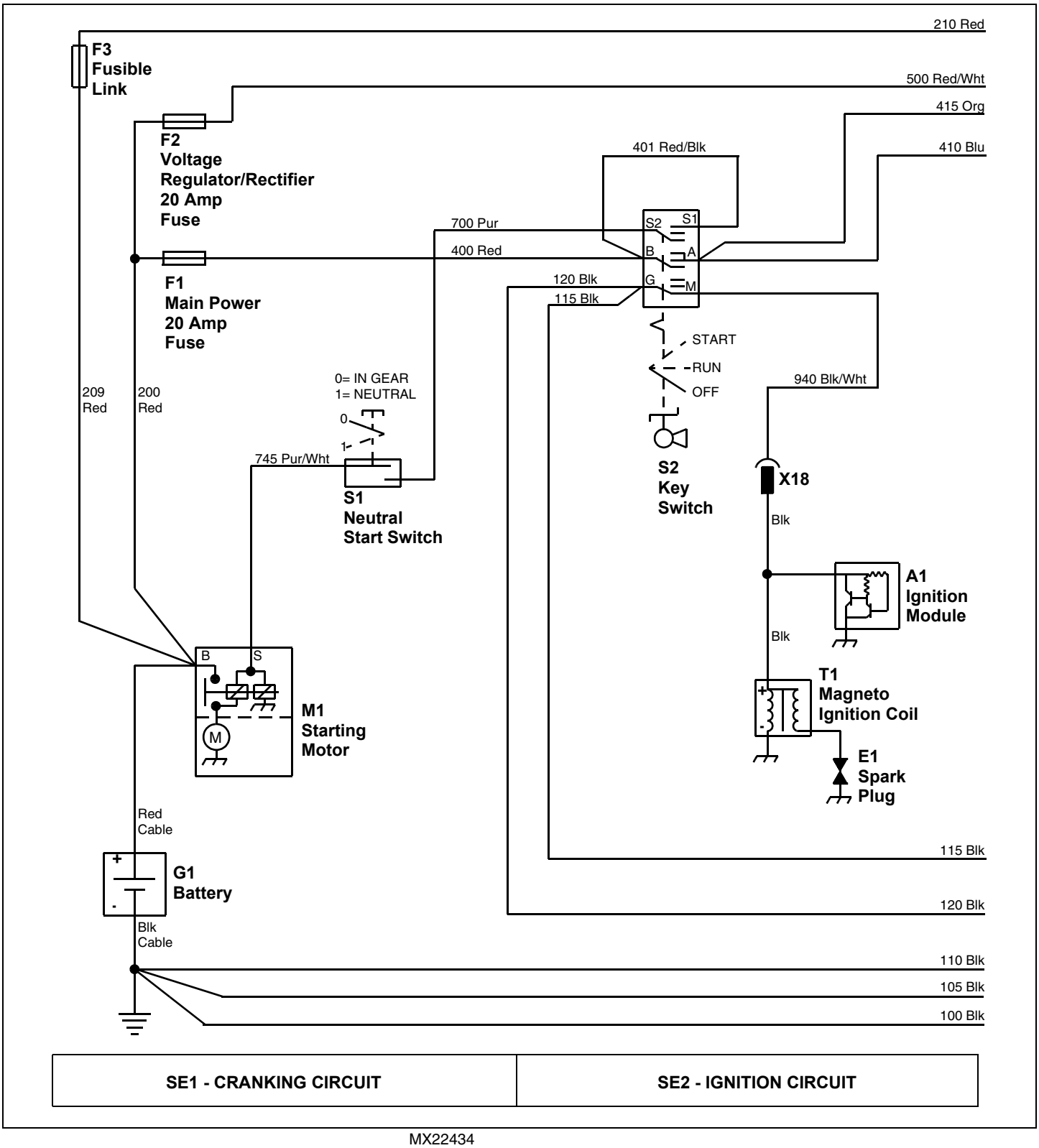


SE5 - WORK LIGHTS CIRCUIT	SE6 - LIFT SYSTEM CIRCUIT

MX22433

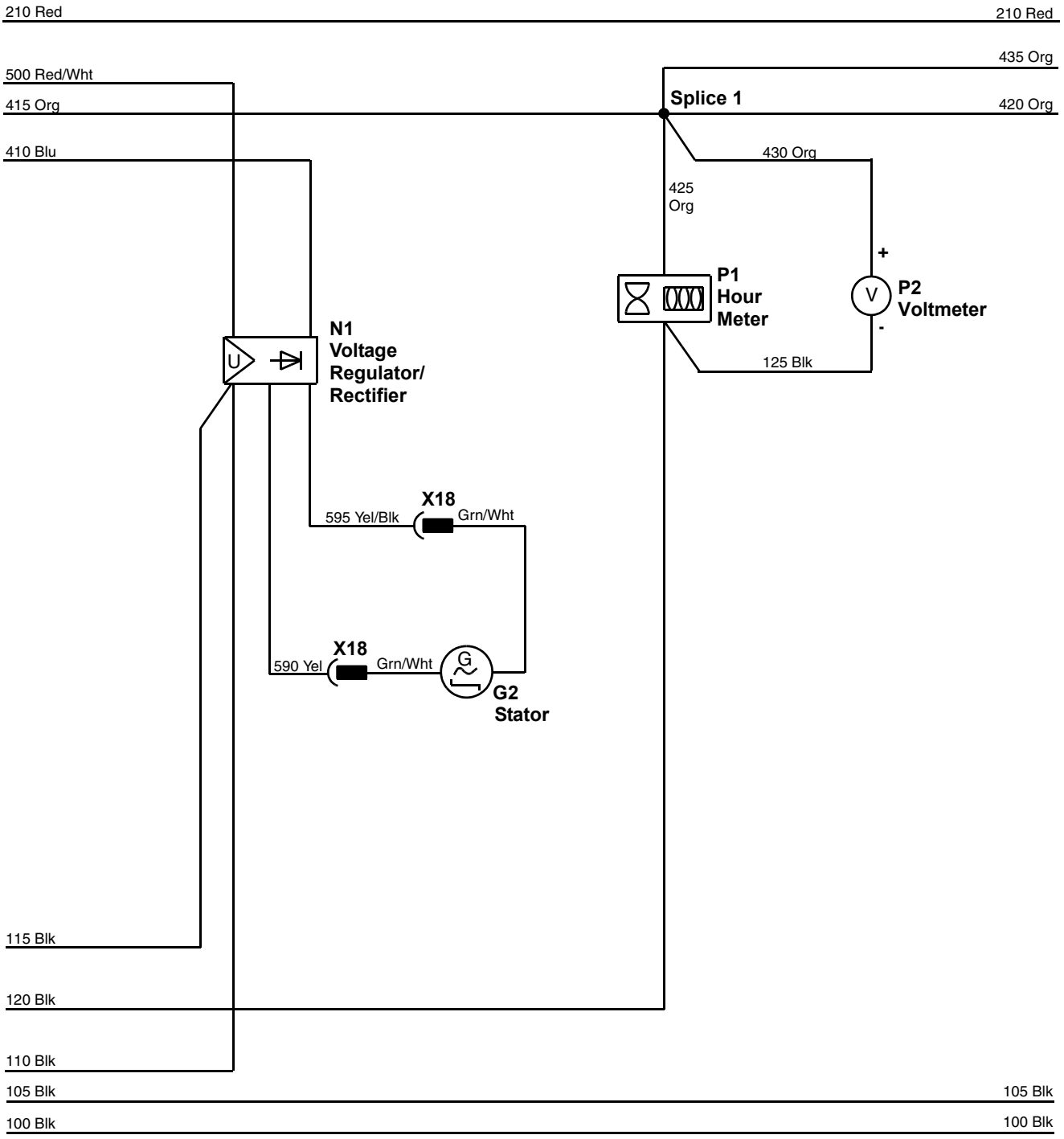
Main Schematic - Options

Main Schematic - Options (1 of 3)



MX22434

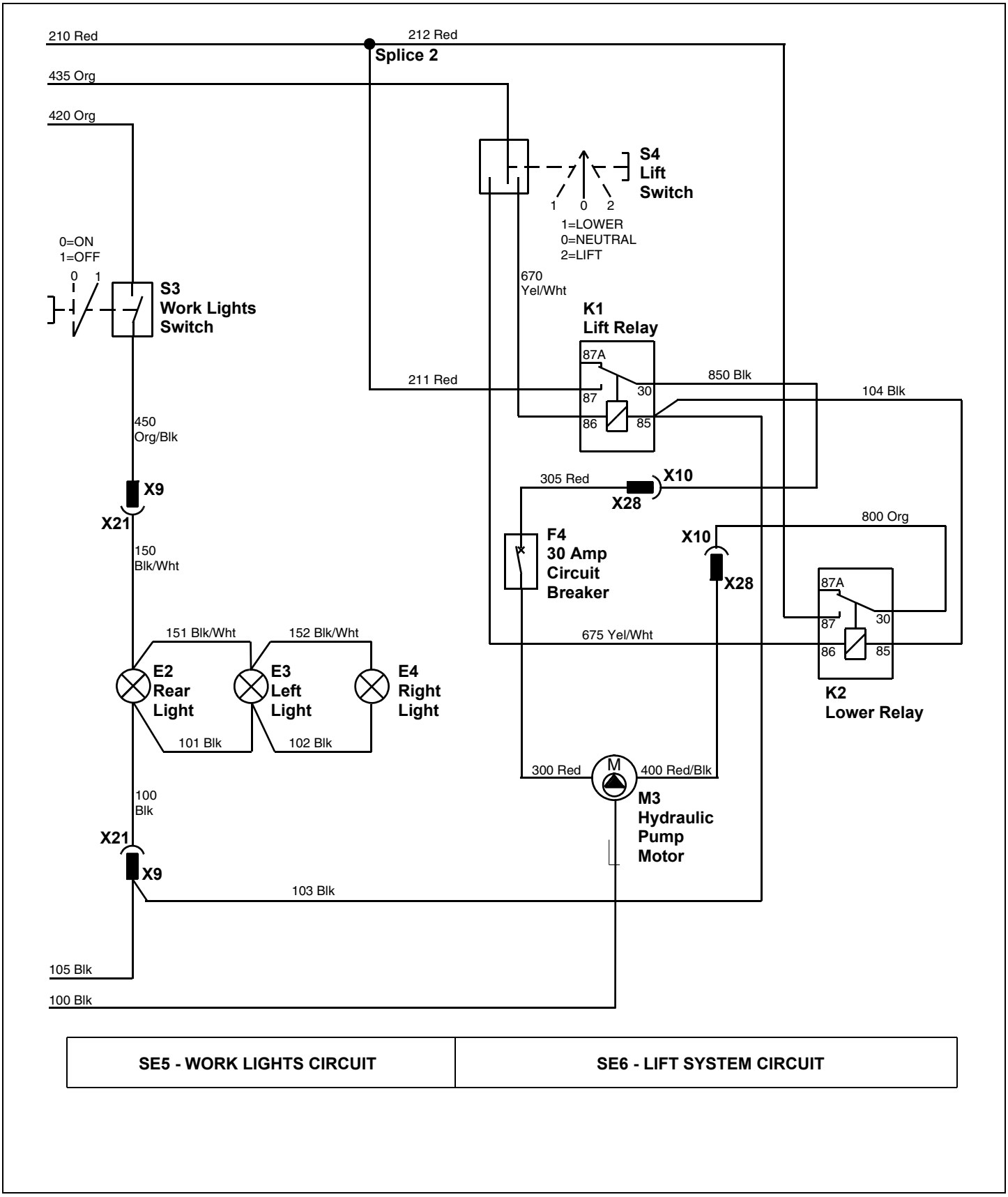
Main Schematic - Options (2 of 3)



SE3 - CHARGING CIRCUIT	SE4 - HOUR METER AND VOLTMETER CIRCUIT

MX22435

Main Schematic - Options (3 of 3)

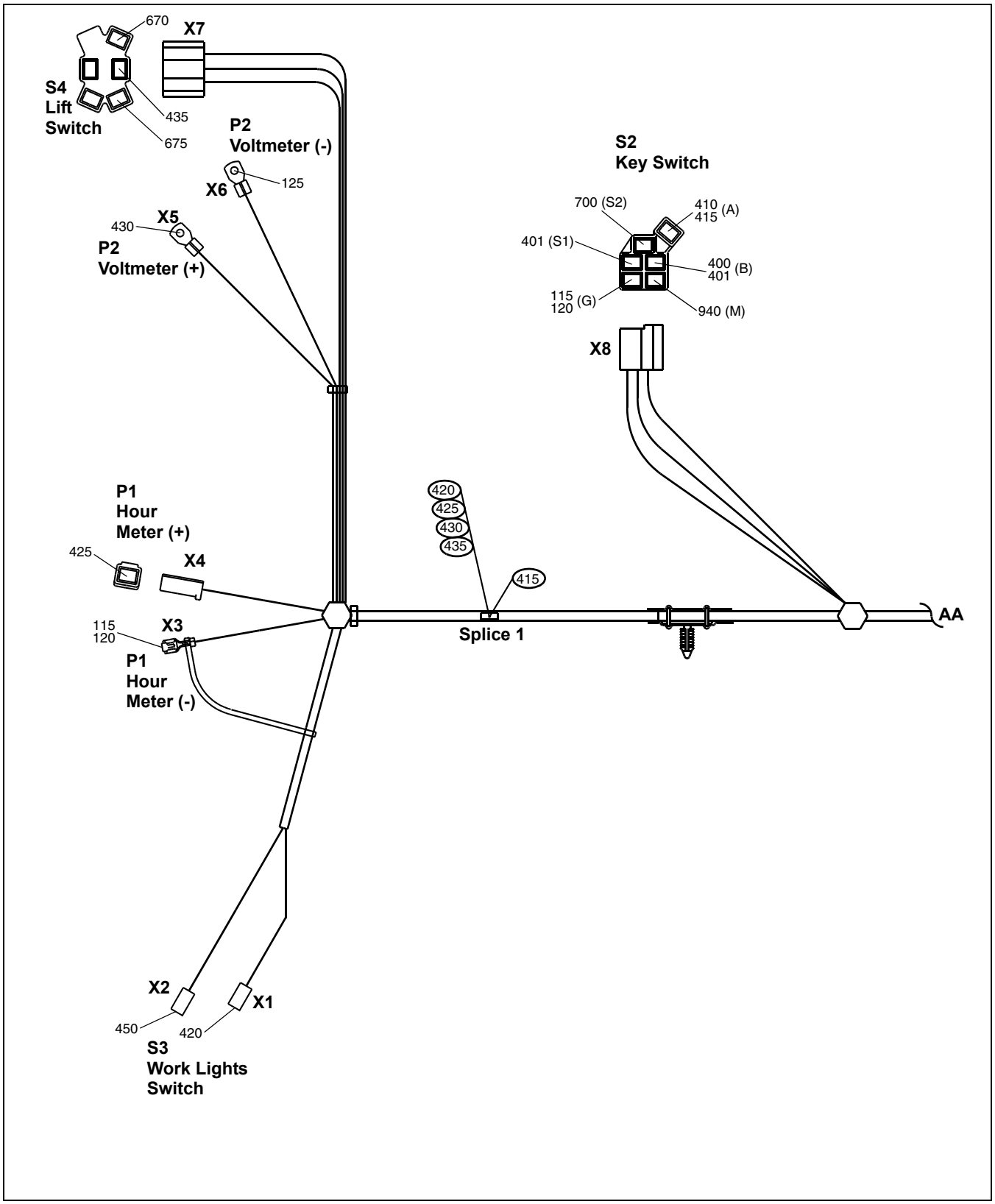


SE5 - WORK LIGHTS CIRCUIT	SE6 - LIFT SYSTEM CIRCUIT

MX22436

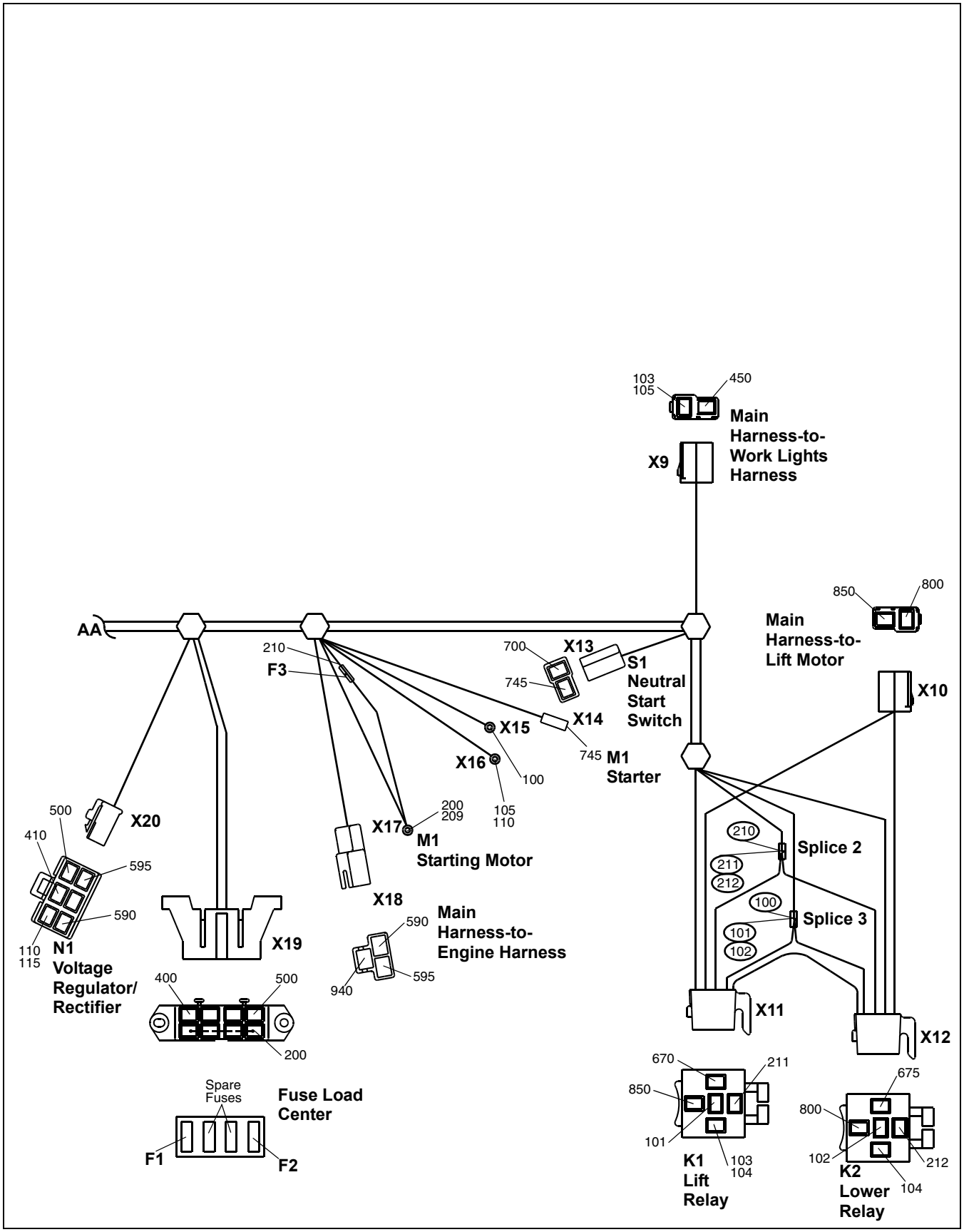
W1 Main Harness

W1 Main Harness (1 of 2)



MX22427

W1 Main Harness (2 of 2)

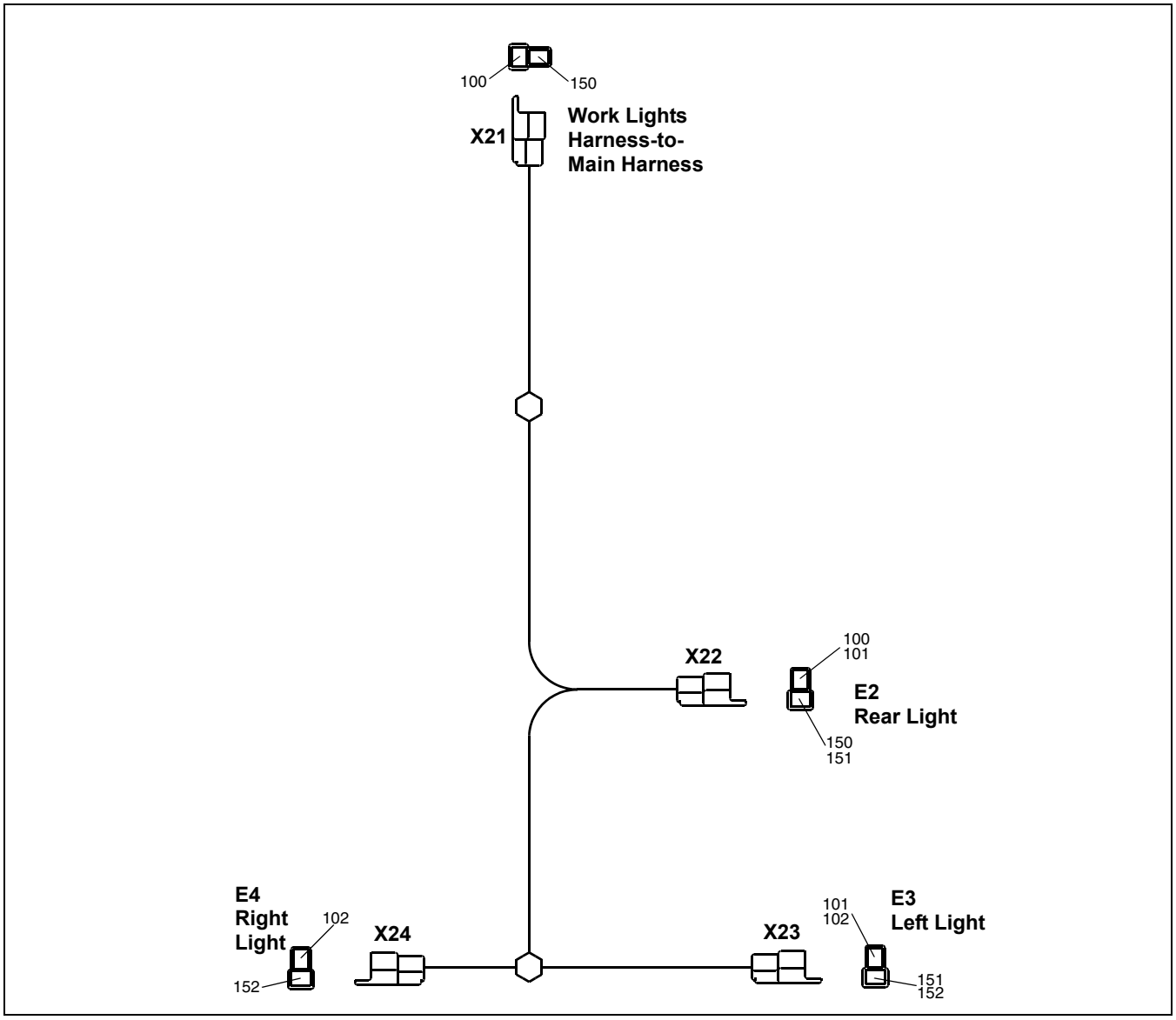


MX22428

W1 Main Harness Color Codes

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
100	3.0	Blk	X15, Splice 3
101	2.0	Blk	Splice 3, X12 (K1)
102	2.0	Blk	Splice 3, X11 (K2)
103	0.8	Blk	X12 (K1), X9 (W2)
104	0.8	Blk	X12 (K1), X11 (K2)
105	2.0	Blk	X16, X9 (W2)
110	2.0	Blk	X16, X20 (N1)
115	0.8	Blk	X20 (N1), X8 (S2)
120	0.8	Blk	X8 (S2), X3 (P1)
125	0.8	Blk	X3 (P1), X6 (P2)
200	2.0	Red	X17 (M1), X19 (F1 and F2)
209	1.0	Red	X17 (M1), X19 (F3)
210	3.0	Red	X19 (F3), Splice 2
211	2.0	Red	Splice 2, X12 (K1)
212	2.0	Red	Splice 2, X11 (K2)
400	2.0	Red	X19 (F1), X8 (S2)
401	0.8	Red/Blk	X8 (S2), X8 (S2)
410	2.0	Blu	X8 (S2), X20 (N1)
415	2.0	Org	X8 (S2), Splice 1
420	2.0	Org	Splice 1, X1 (S3)
425	0.8	Org	Splice 1, X4 (P1)
430	0.8	Org	Splice 1, X5 (P2)
435	0.8	Org	Splice 1, X7 (S4)
450	2.0	Org/Blk	X2 (S3), X9 (W2)
500	1.0	Yel	X20 (N1), X19 (F2)
590	1.0	Yel	X20 (N1), X18
595	1.0	Yel/Blk	X20 (N1), X18
670	0.8	Yel/Wht	X7 (S4), X12 (K1)
675	0.8	Yel/Blk	X7 (S4), X11 (K2)
700	0.8	Pur	X8 (S2), X13 (S1)
745	0.8	Pur/Wht	X13 (S1), X14 (M1)
800	2.0	Org	X11 (K2), X10
850	2.0	Blk	X12 (K1), X10
940	0.8	Blk/Wht	X8 (S2), X18

W2 Work Lights Harness - Optional

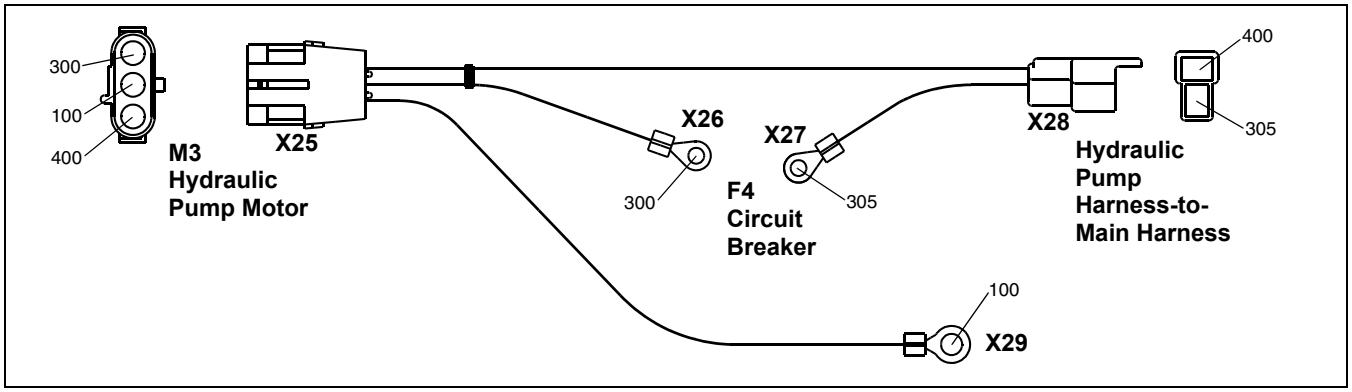


MX22429

W2 Work Lights Harness Color Codes

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
100	1.0	Blk	X21 (W1), X22 (E2)
101	1.0	Blk	X22 (E2), X23 (E3)
102	1.0	Blk	X23 (E3), X24 (E4)
150	1.0	Blk/Wht	X21 (W1), X22 (E2)
151	1.0	Blk/Wht	X22 (E2), X23 (E3)
152	1.0	Blk/Wht	X23 (E3), X24 (E4)

W3 Hydraulic Pump Harness - Optional



MX22430

W3 Hydraulic Pump Harness Color Codes

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
100	3.0	Blk	X29, X25 (M3)
300	3.0	Red	X26 (F4), X25 (M3)
305	3.0	Red	X28 (W1), X27 (F4)
400	3.0	Red/Blk	X28 (W1), X25 (M3)

Operation and Diagnostics

Use of Dielectric Grease

Whenever non-sealed harness connectors on the machine are disconnected, apply dielectric grease to the ends before reassembling. Clean excess grease from the connector. Do not use grease on sealed connectors.

Power Circuit Operation - Unswitched

Function

Provides power to the primary circuit whenever the battery is properly connected.

Operating Conditions

- Key switch in OFF position.

Theory of Operation

When key switch (S2) is in the OFF position, power is available at the following locations:

- Battery (G1), positive (+) terminal.
- Starting motor (M1), terminal B.
- Voltage regulator/rectifier (N1), wire 500 Red/Wht.
- Key switch (S2), terminals B and S1.
- Main power 20 amp fuse (F1).
- Voltage regulator/rectifier 20 amp fuse (F2).
- Lift relay (K1), terminal 87.
- Lower relay (K2), terminal 87.

The positive (+) battery cable connects the battery to terminal B of starting motor (M1). This connection is used as a tie point for the rest of the electrical system.

The ground cable connects the negative (-) battery terminal to the machine frame ground. 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.

Note: The battery cables and the starting motor connections must be in good condition for the electrical system to function properly.

The connection between the starting motor and key switch (S2) is protected by main power 20 amp fuse (F1). The connection between the starting motor and voltage regulator/rectifier (N1) is protected by voltage regulator/ rectifier 20 amp fuse (F2). The connections between the starting motor and lift relay (K1) and lower relay (K2), are protected by fusible link (F3). These devices are designed to fail (open) if current draw is excessive or a short circuit occurs, protecting the components from damage.

Power Circuit Operation - Switched

Function

Provides power to components by means of a key switch.

Operating Conditions

- Key switch in RUN position.

Theory of Operation

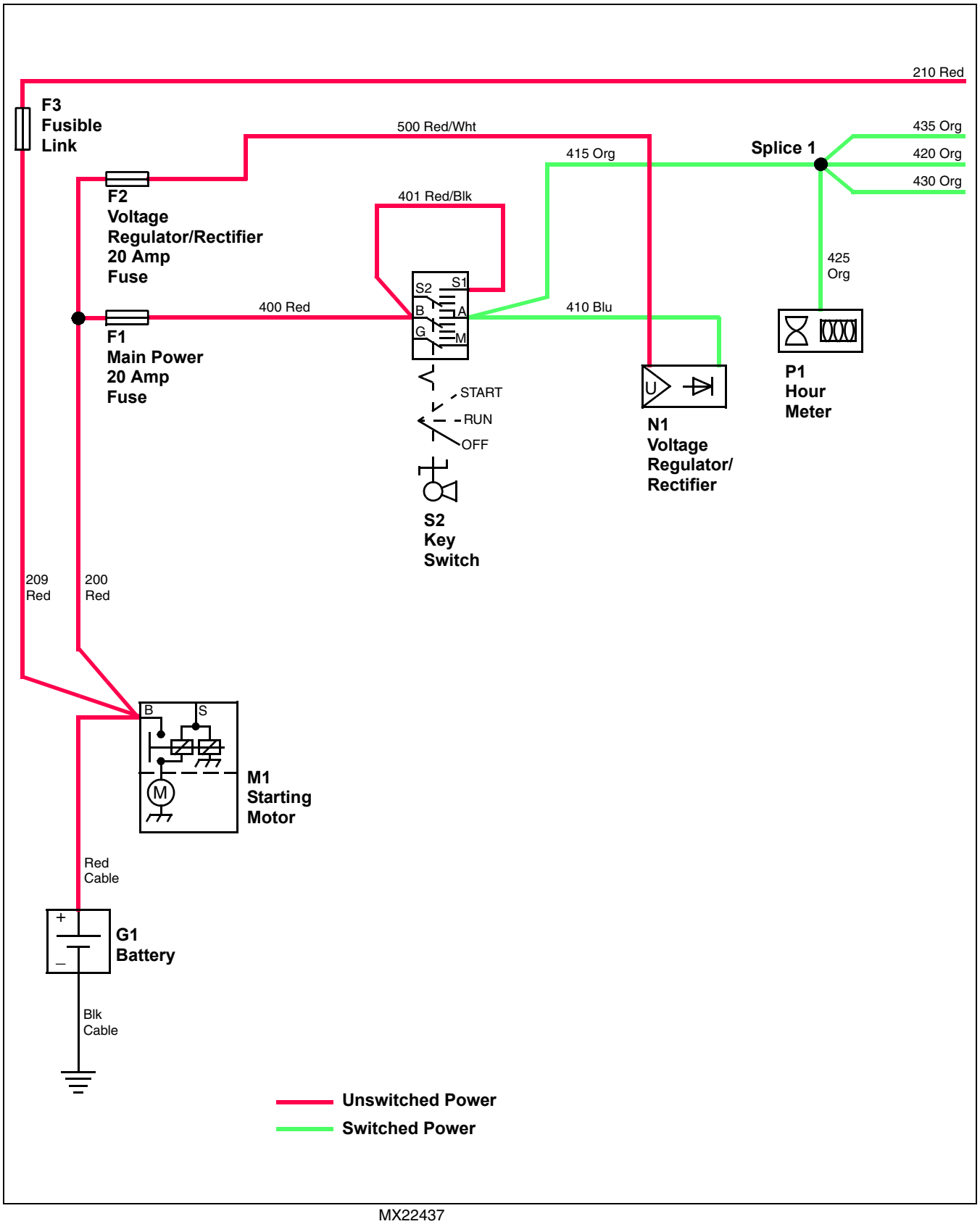
When key switch (S2) is in the RUN position, power is available at the following locations:

- Key switch (S2), terminal A.
- Voltage regulator/rectifier (N1), wire 410 Blu.
- Hour meter (P1), positive (+) terminal.
- Lift switch (S4).
- Work light switch (S3).
- Voltmeter (P2), positive (+) terminal.

These components are protected by main power 20 amp fuse (F1).

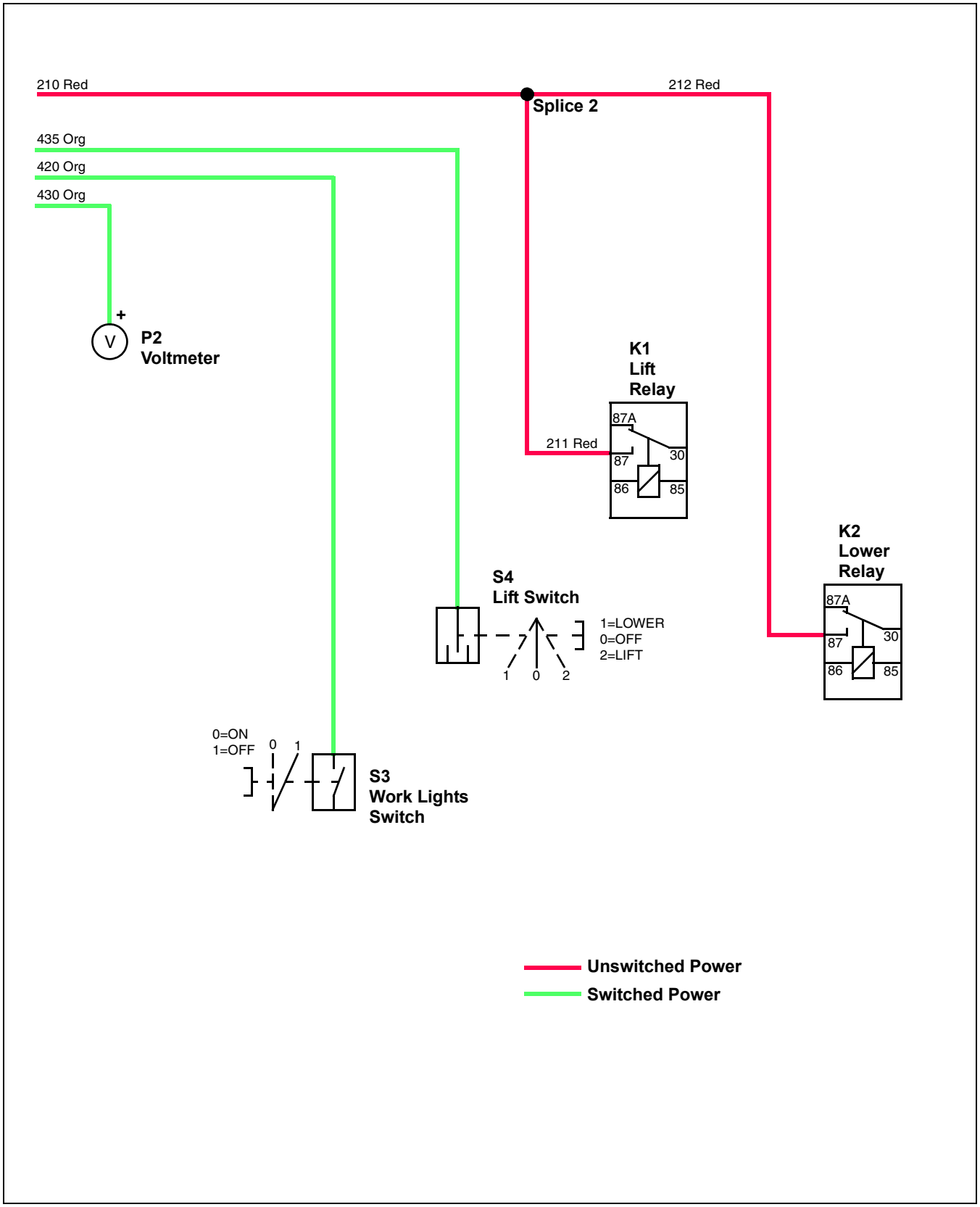
Power Circuit Schematic

Power Circuit Schematic (1 of 2)



MX22437

Power Circuit Schematic (2 of 2)



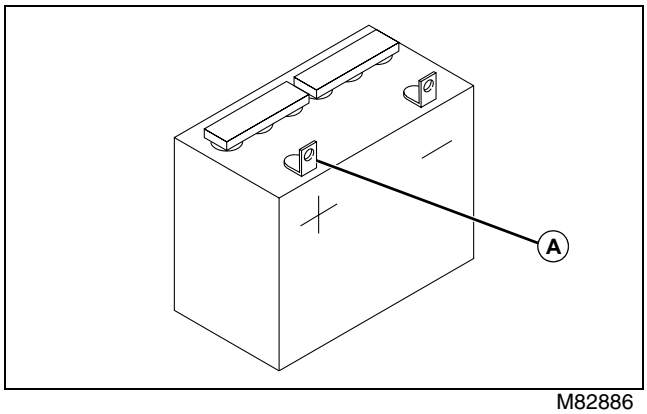
MX22438

System: Unswitched Power Diagnostics

Test Conditions

- Machine parked safely.
- Park brake LOCKED.
- Key switch in OFF position.

Power Circuit

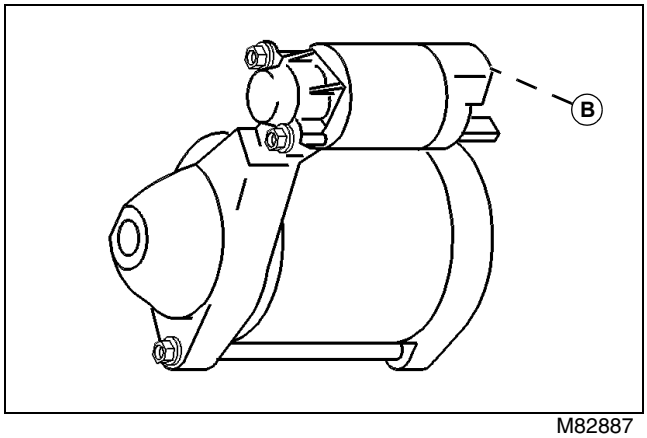


M82886

1. Is there 11.8-13.2 volts at battery positive (+) terminal (A)?

Yes: Go to next step.

No: Test battery. (See “Test Battery” on page 137.)

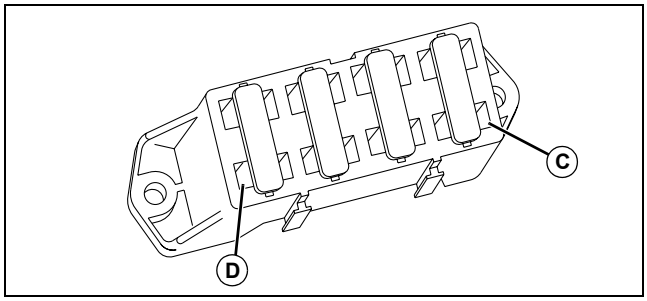


M82887

2. Is there battery voltage at starting motor terminal B (B)?

Yes: Go to next step.

No: Check battery cables and clamps. Clean and tighten connections.



M83142AE

3. Is there battery voltage at fuse load center (C)?

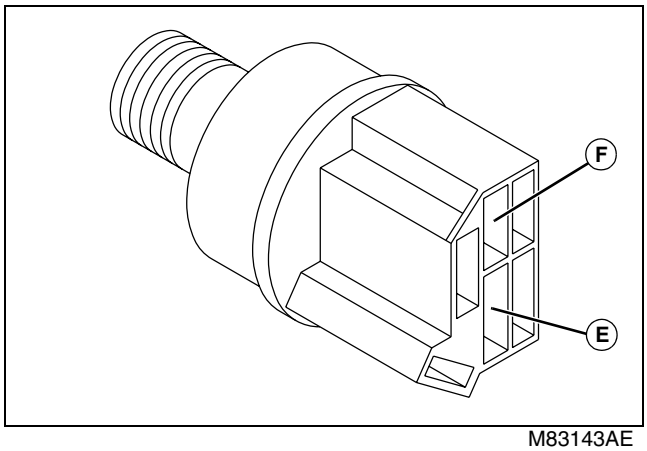
Yes: Go to next step.

No: Check main power 20 amp fuse (F1), wire 200 Red, and connections.

4. Is there battery voltage at fuse load center (D)?

Yes: Go to next step.

No: Check voltage regulator/rectifier 20 amp fuse (F2), wire 200 Red, and connections.



M83143AE

5. Is there battery voltage at the key switch 400 Red wire (E)?

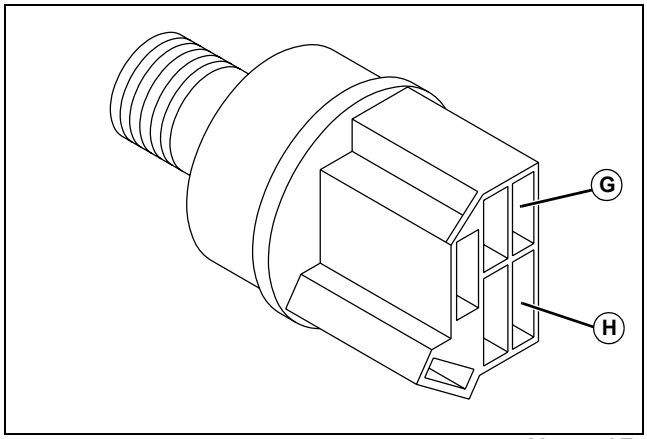
Yes: Go to next step.

No: Check wire 400 Red and connections.

6. Is there battery voltage at the key switch 401 Red/Blk wire (F)?

Yes: Go to next step.

No: Check wire 401 Red/Blk and connections.



M83143AE

7. Is there continuity to ground at the key switch 115 Blk wire (G) and all ground connections?

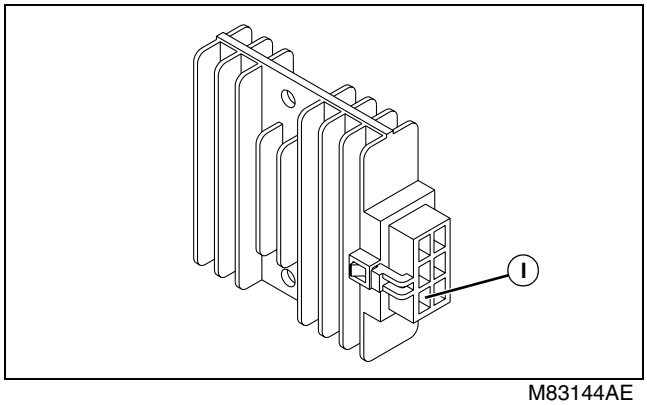
Yes: Go to next step.

No: Check 115 Blk wire and connections.

8. Is there continuity to ground at the key switch 940 Blk/Wht wire (H)?

Yes: Go to next step.

No: Test key switch. (See “Test Key Switch” on page 146.)

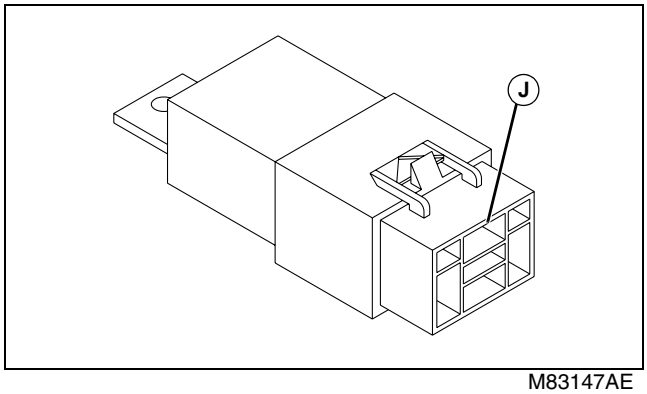


M83144AE

9. Is there battery voltage at the voltage regulator/ rectifier 500 Red/Wht wire (I)?

Yes: Go to next step.

No: Check wire 500 Red/Wht and connections.

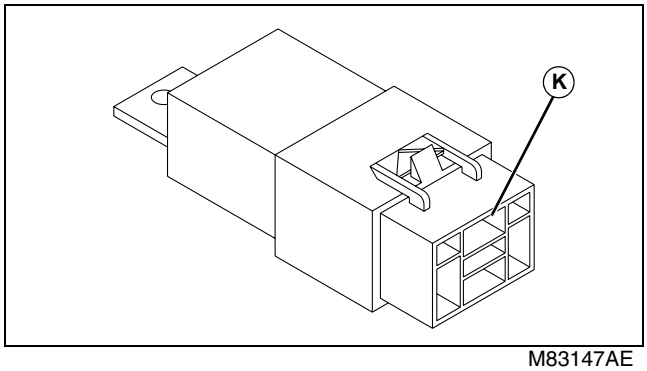


M83147AE

10. Is there battery voltage at the lift relay terminal 87 (J)?

Yes: Go to next step.

No: Check fusible link (F3), wire 209 Red, wire 210 Red, wire 211 Red, and connections.



M83147AE

11. Is there battery voltage at the lower relay terminal 87 (K)?

Yes: Test complete.

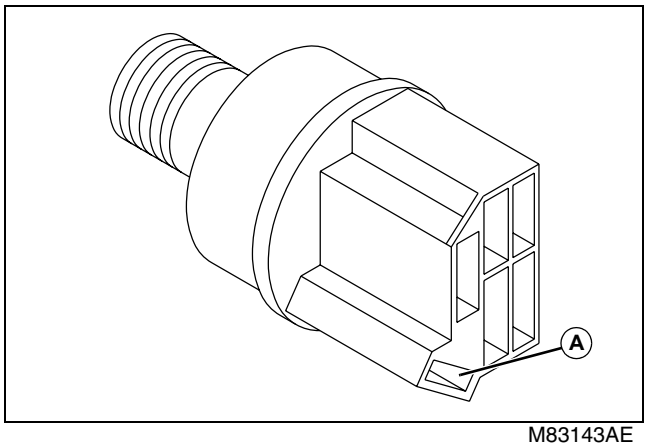
No: Check fusible link (F3), wire 209 Red, wire 210 Red, wire 212 Red, and connections.

System: Switched Power Diagnostics

Test Conditions

- Machine parked safely.
- Park brake LOCKED.
- Key switch in RUN position.

Power Circuit

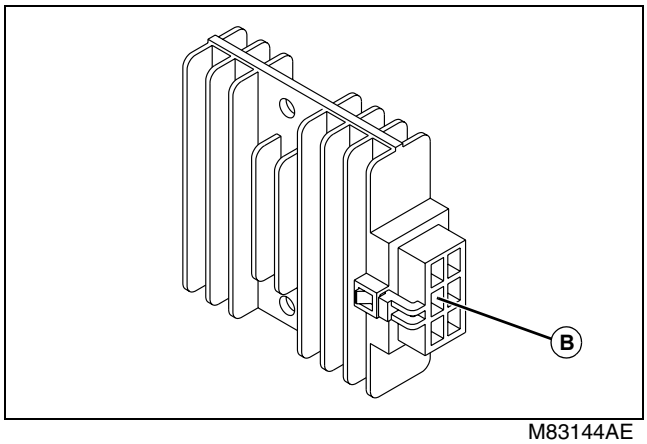


M83143AE

1. Is there battery voltage at the key switch wires 410 Blu and 415 Org (A)?

Yes: Go to next step.

No: Test key switch. (See “Test Key Switch” on page 146.)

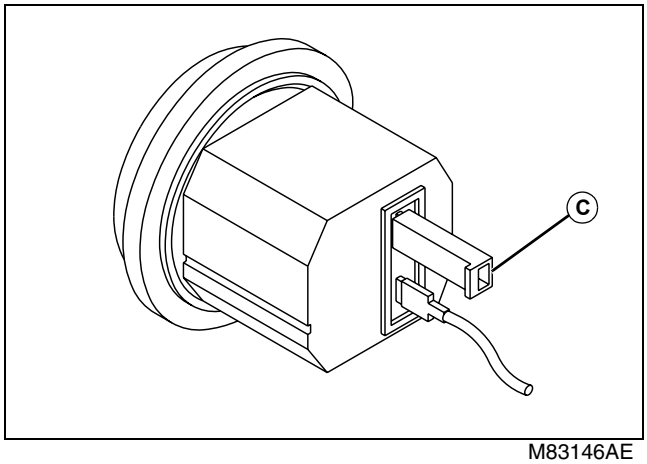


M83144AE

2. Is there battery voltage at the voltage regulator/ rectifier 410 Blu wire (B)?

Yes: Go to next step.

No: Check wire 410 Blu and connections.

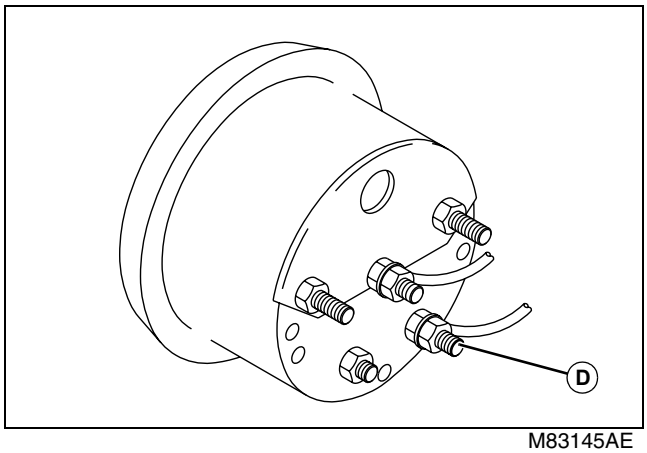


M83146AE

3. Is there battery voltage at the hour meter positive (+) terminal (C)?

Yes: Go to next step.

No: Check wire 415 Org, wire 425 Org, and connections.

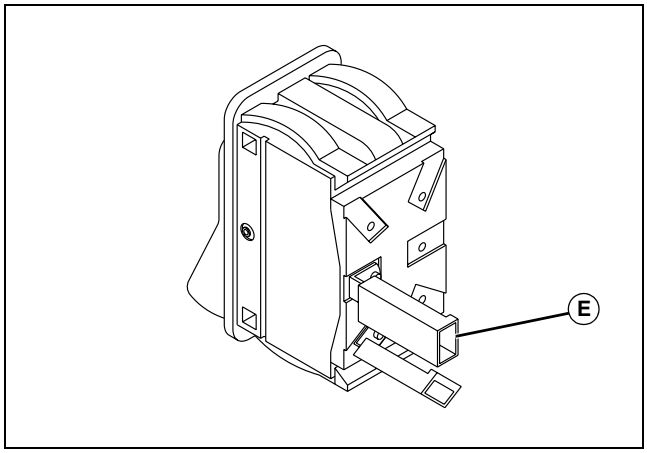


M83145AE

4. Is there battery voltage at the voltmeter positive (+) terminal (D)?

Yes: Go to next step.

No: Check wire 415 Org, wire 430 Org, and connections.



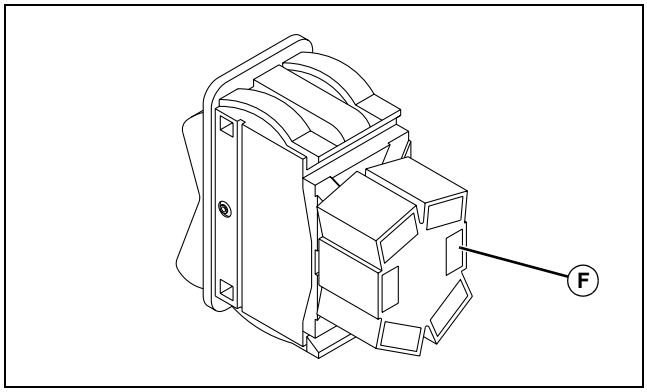
M83148AE

Wire 420 Org can be connected to either terminal of the work light switch.

5. Is there battery voltage at the work light switch wire 420 Org (E)?

Yes: Go to next step.

No: Check wire 415 Org, wire 420 Org, and connections.



M83149AE

6. Is there battery voltage at the lift switch wire 425 Org (F)?

Yes: Test complete.

No: Check wire 415 Org, wire 435 Org, and connections.

Cranking Circuit Operation

Function

Provides switched power to starting motor solenoid when the key switch is in the START position.

Operating Conditions

Key switch in START position.

Gearshift pedals in NEUTRAL position (neutral start switch CLOSED).

System Operation

Starting motor (M1) is a solenoid shift design. The power circuit provides current to key switch (S2) and protects the cranking circuit with main power 20 amp fuse (F1).

Unswitched power from battery (G1) is available at the following components:

Starting motor (M1), terminal B.

Main power 20 amp fuse (F1).

Key switch (S2), terminals B and S1.

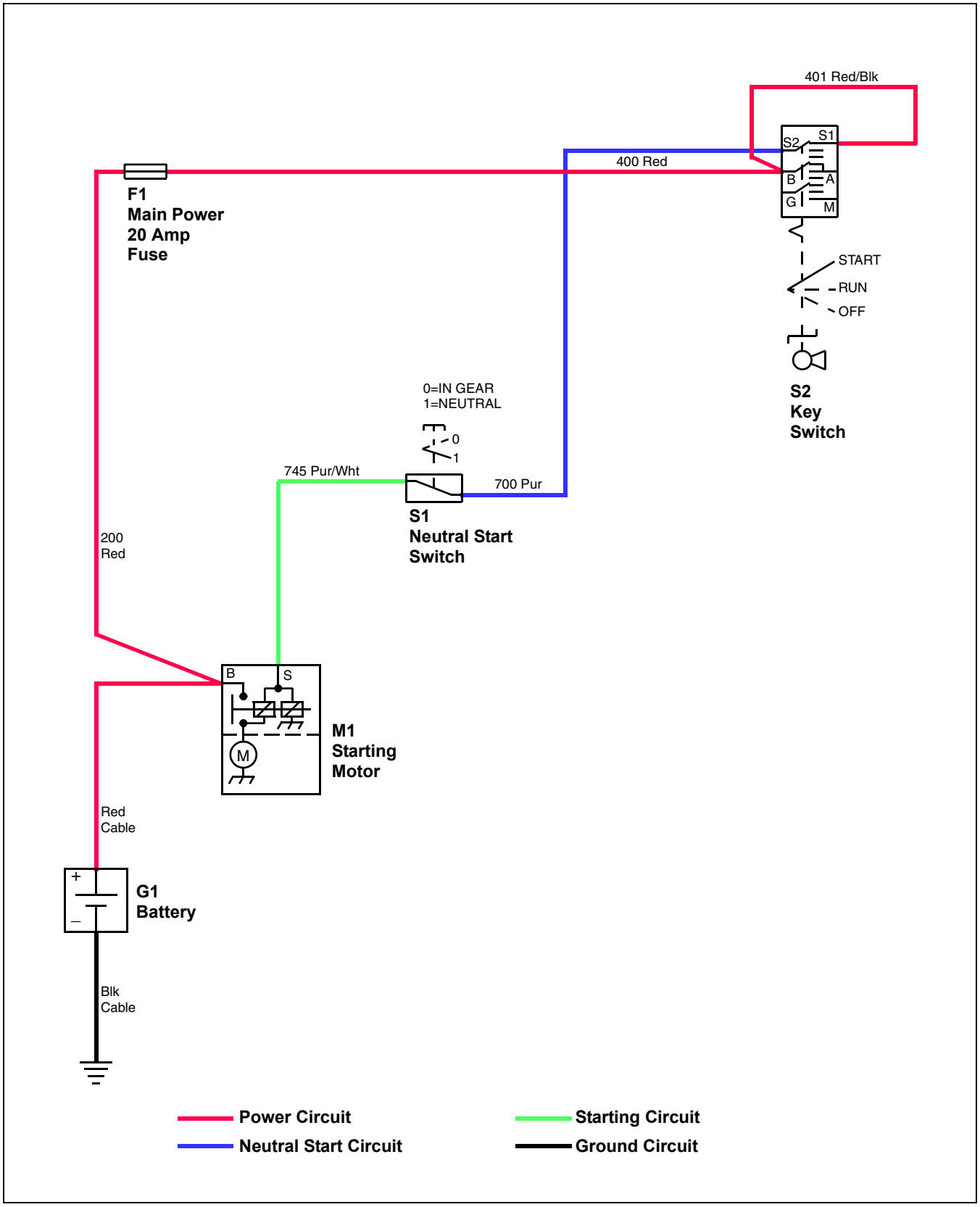
Turning the key switch to the START position allows current to flow from the key switch (terminals S1 and S2) to neutral start switch (S1) (wire 700 Pur).

The neutral start switch is used in the neutral start circuit to prevent the engine from cranking if the transaxle is in gear. With the neutral start switch closed (transaxle in neutral), current flows to terminal S of the starting motor (wire 745 Pur/Wht).

The solenoid is engaged by current flowing through both pull-in and hold-in windings, pulling the plunger inward. The plunger closes the solenoid main contacts. When the main contacts are closed, both ends of the pull-in windings have the same voltage, so current through the pull-in windings stops. Current continues flowing through the hold-in windings, keeping the solenoid engaged.

With the solenoid engaged, the main contacts are closed. This allows current from the battery to flow across the main contacts to starting motor, activating the motor.

Cranking Circuit Schematic

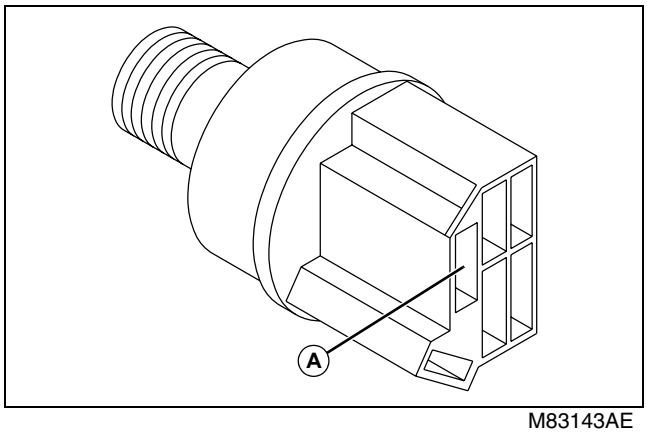


MX22439

System: Cranking Circuit Diagnosis

Test Conditions

- Machine parked safely.
- Park brake UNLOCKED.
- Key switch in START position.

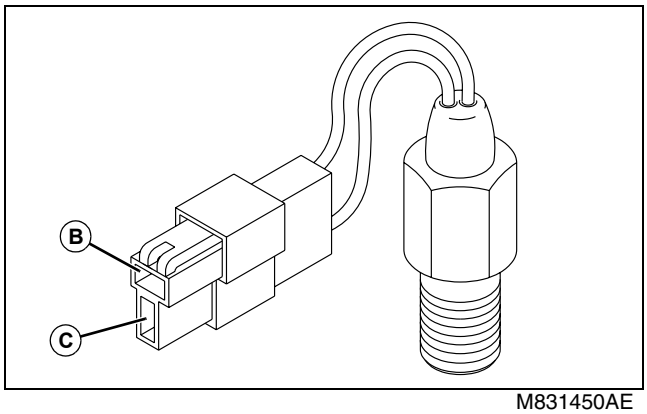


M83143AE

1. Is there battery voltage at terminal S2 of the key switch (A)?

Yes: Go to next step.

No: Test key switch. (See “Test Key Switch” on page 146.)



M831450AE

2. Is there battery voltage at wire 700 Pur (B) of the neutral start switch?

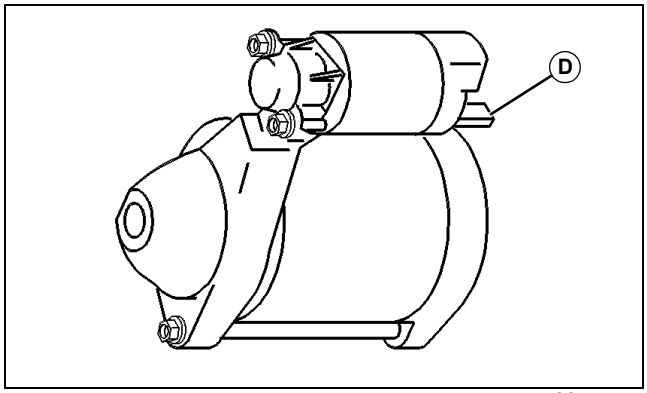
Yes: Go to next step.

No: Check wire 700 Pur and connections.

3. Is there battery voltage at wire 745 Pur/Wht (C) of the neutral start switch?

Yes: Go to next step.

No: Test neutral start switch. (See “Test Neutral Start Switch” on page 146.)



M82887

4. Is there battery voltage at wire 745 Pur/Wht (D) of the starting motor solenoid?

Yes: Test starting solenoid. (See “Test Starting Solenoid” on page 141.)

No: Check wire 745 Pur/Wht and connections.

Ignition Circuit Operation

Function

To create a spark that ignites the fuel/air mixture in the engine.

Operating Conditions

- Key switch in START or RUN position.
- Gearshift pedals in NEUTRAL position (neutral start switch CLOSED).

System Operation

The ignition system is a transistor-controlled magneto design. Ignition timing is controlled by ignition module (A1) and is not adjustable.

With the key switch in the START or RUN position, the positive (+) terminal of the magneto ignition coil is not grounded from terminal (M) of the key switch, so a spark can be produced.

As the flywheel turns, a magnet in the flywheel starts to align with magneto ignition coil (T1) and produces a low voltage current in the primary coil by electromagnetic induction.

This small initial current flows to a low ohm resistor (A) and a high ohm resistor (B) in ignition module (A1). With resistor (A) having a lower resistance than resistor (B), most of the current flows through resistor (A) to the base of transistor (C), activating the transistor. With the transistor activated, part of the low voltage current flows through resistor (B), through the collector and emitter of transistor (C), and to ground. Transistor (D) is not activated at this time.

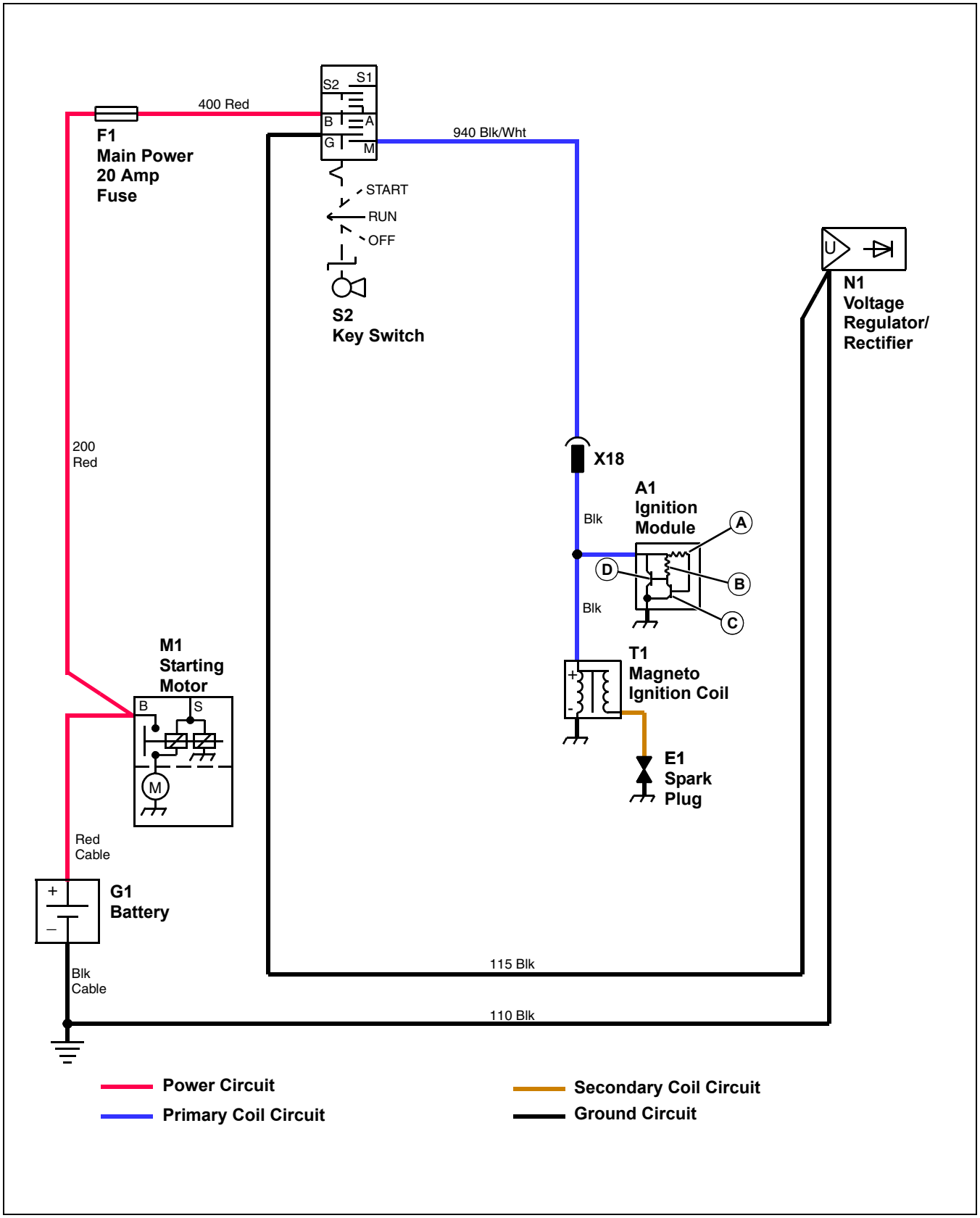
As the flywheel continues to turn, the magnet in the flywheel aligns with the ignition coil. At this point, the initial low current is increased to its maximum.

With this maximum current at the base of transistor (D), the transistor is now activated. This allows current to flow from the collector to the emitter of transistor (D), and then to ground. This deactivates transistor (C), causing all the current to flow through transistor (D).

The sudden flow of current to ground through transistor (D) collapses the electromagnetic field in the primary coil of the magneto ignition coil. This induces a high voltage current in the secondary coil.

The high voltage current flows through the coil wire to spark plug (E1). The voltage is now high enough to jump the spark plug gap and a spark is produced, igniting the fuel/air mixture in the cylinder.

Ignition Circuit Schematic



MX22440

Ignition Circuit Operation - Shutting Off

Function

To shut off the engine by grounding the ignition coil through the key switch.

Operating Conditions

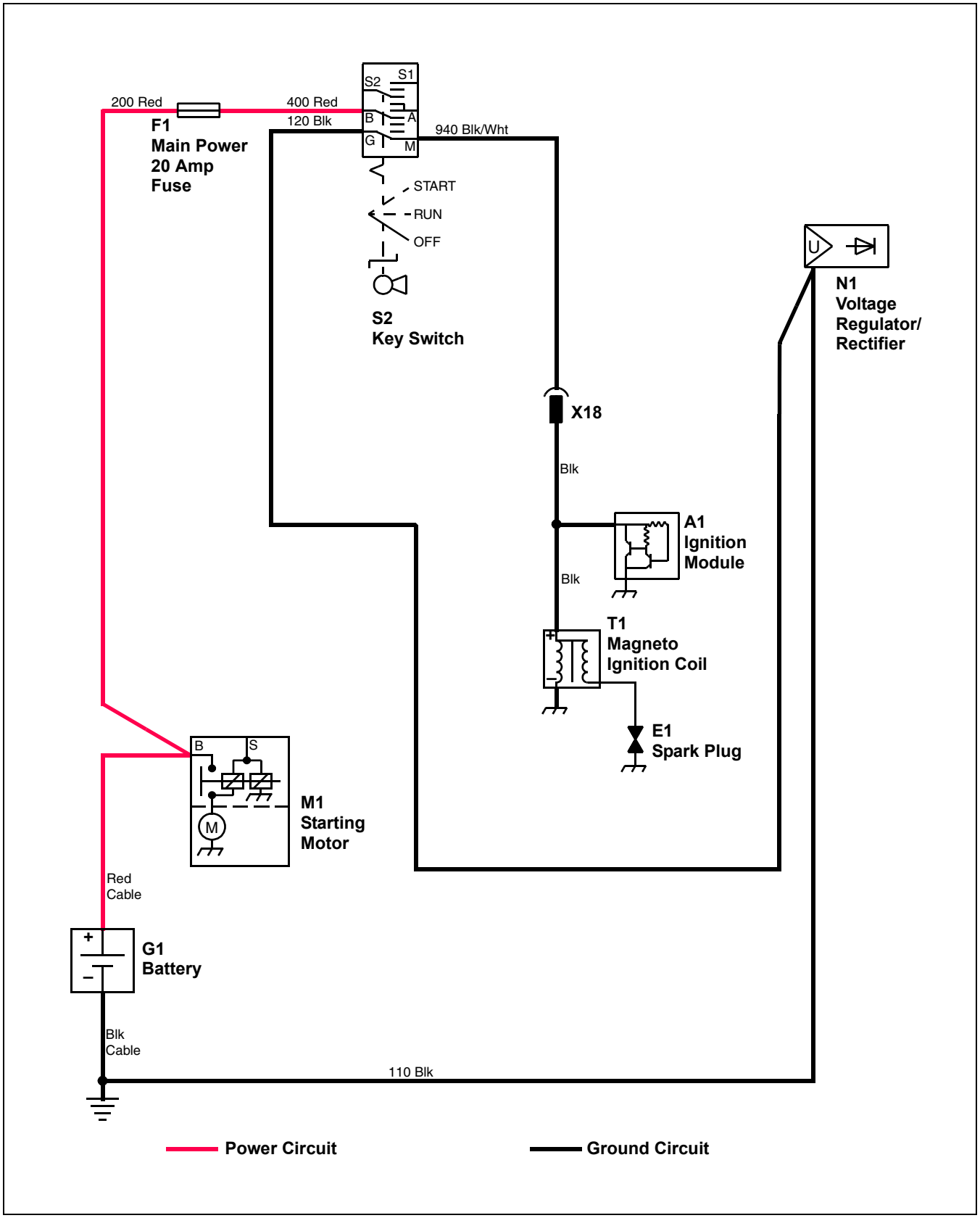
Key switch in OFF position.

System Operation

When key switch (S2) is turned to the OFF position, the positive (+) terminal of magneto ignition coil (T1) is connected to ground.

The low voltage current produced in the primary coil of the magneto ignition coil (T1) flows to the ignition module (A1) and to terminal M of the key switch, grounding the ignition coil current.

Ignition Circuit Schematic - Shutting Off



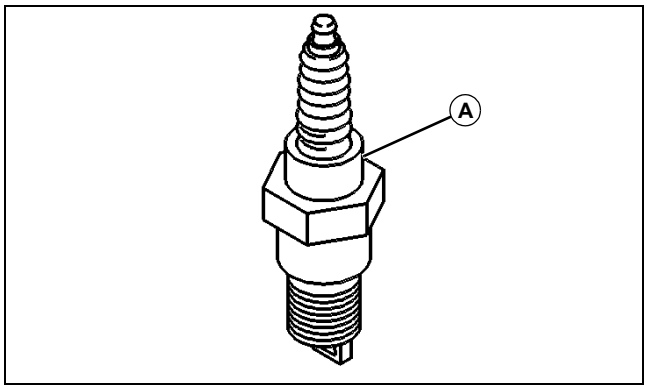
MX22441

System: Ignition Circuit Diagnosis

Test Conditions

- Machine parked safely.
- Key switch in START position.
- Main harness-to-engine harness connector DISCONNECTED.

Ignition Circuit Diagnosis - Spark



M82882

1. Is there a hot blue spark at spark plug (A)? (See "Test Spark" on page 145.)

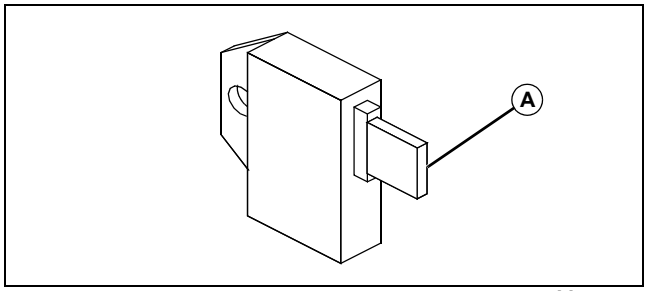
   Yes: Check spark plug gap and condition of spark plug. If plug is good, test ground circuit.

   No: Check ignition coil air gap, flywheel magnets, and test ignition module.

Test Conditions

- Machine parked safely.
- Key switch in OFF position.
- Main harness-to-engine harness connector CONNECTED.

Ignition Circuit Diagnosis - Shutting Off



M83153

1. Is there less than 0.1 ohm resistance from the ignition module (A) to the negative (-) terminal on the battery?

   Yes: Perform ignition module test. (See "Test Ignition Module" on page 144.)

   No: Check battery negative (-) cable ground, wire 110 Blk, wire 115 Blk, wire 940 Blk/Wht, and connections. Test key switch. (See "Test Key Switch" on page 146.)

Charging Circuit Operation

Function

To maintain battery voltage between 11.6 and 14.5 volts DC.

Operating Conditions

- Key switch in RUN position.
- Engine running.

System Operation

The charging circuit is protected with voltage regulator/ rectifier 20 amp fuse (F2). The power circuit provides unswitched power to terminal B of key switch (S2).

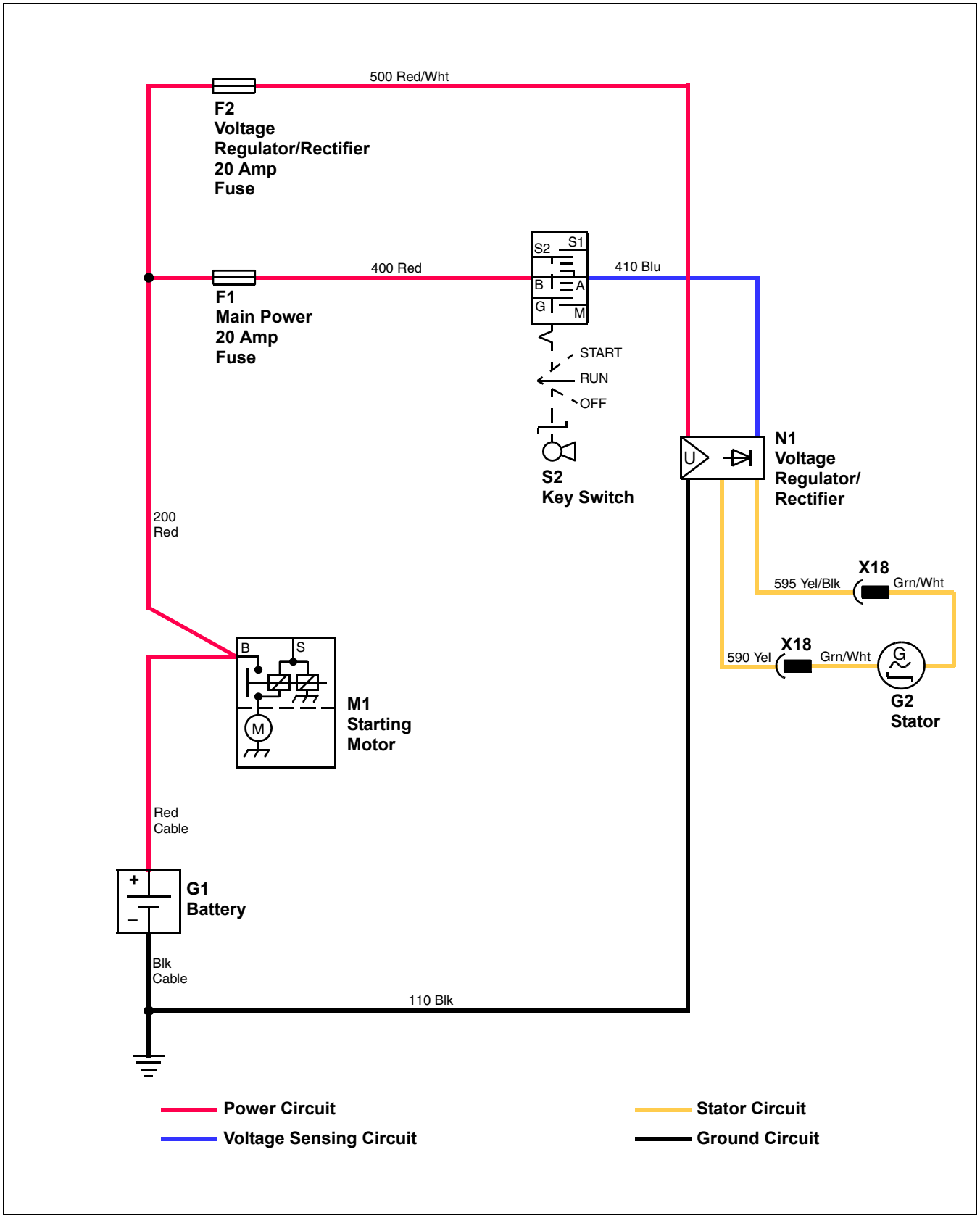
With the key switch in the RUN position, power is provided to voltage regulator/rectifier (N1) from the key switch (wire 410 Blu).

As the flywheel turns, a permanent magnet located in the flywheel induces alternating current (AC) in stator (G2) windings. The AC from the stator flows to the voltage regulator/rectifier (wires 590 Yel and 595 Yel/Blk). The voltage regulator/rectifier converts the AC to the direct current (DC) needed to charge the battery.

If the battery voltage is low, the voltage regulator/rectifier allows DC to flow to the battery (wire 500 Red/Wht), charging the battery. When the battery is fully charged, the regulator stops current flow to the battery.

A path to ground for the regulator/rectifier is provided by wire 110 Blk.

Charging Circuit Schematic



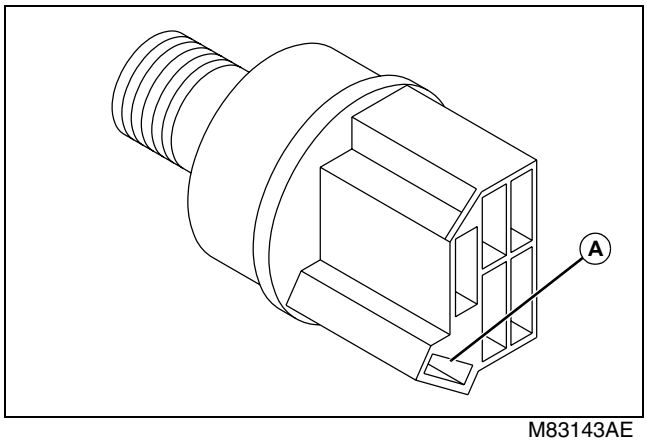
MX22442

System: Charging Circuit Diagnosis

Test Conditions

- Machine parked safely.
- Key switch in RUN position.
- Engine running.

Charging Circuit

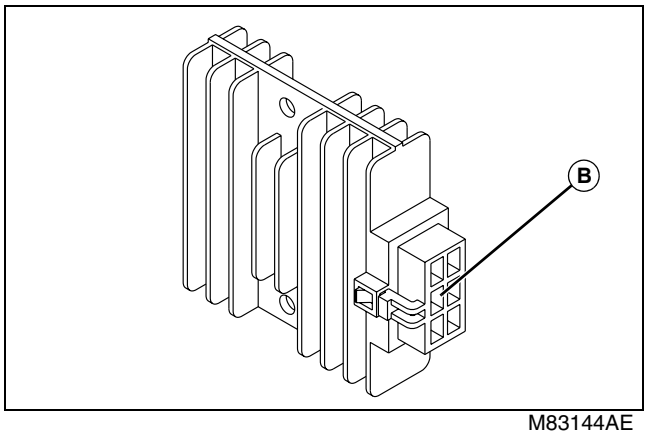


M83143AE

1. Is there battery voltage at terminal A of the key switch (A)?

Yes: Go to next step.

No: Test key switch. (See “Test Key Switch” on page 146.)

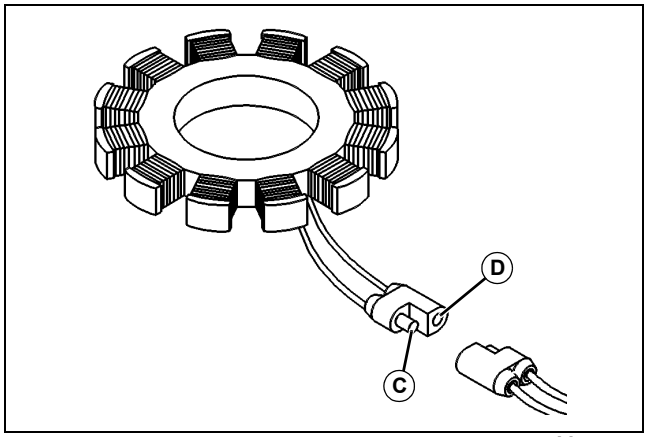


M83144AE

2. Is there battery voltage at wire 410 Blu (B) of the voltage regulator/rectifier?

Yes: Go to next step.

No: Check wire 410 Blu and connections.

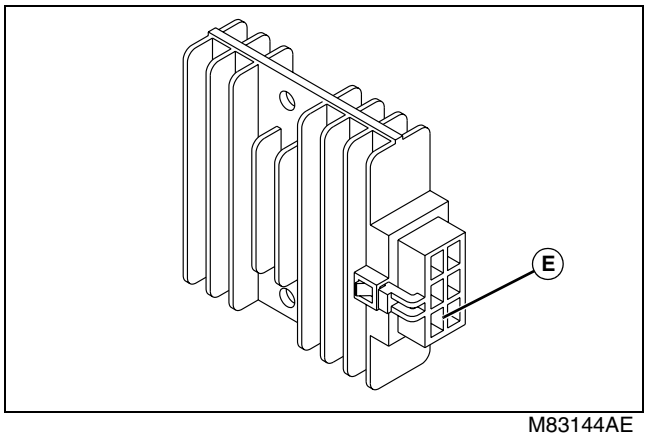


M82883

3. Is voltage across stator terminals (C and D) a minimum of 34 volts AC?

Yes: Go to next step.

No: Perform unregulated voltage output test. (See “Test Unregulated Voltage” on page 140.)



M83144AE

4. Is there a minimum of 13 amps output from the voltage regulator/rectifier at wire 500 Red/Wht (E)? (See “Test Regulated Amperage Output” on page 139.)

Yes: Test complete.

No: Check wire 595 Yel/Blk, wire 590 Yel, and ground connections. If OK, replace voltage regulator/rectifier.

Lift Circuit Operation - Raise

Function

To control the direction of current applied to the lift motor to raise the rake assembly.

Operating Conditions

- Key switch in RUN position.
- Lift switch in RAISE position.

System Operation

The lift circuit is protected with main power 20 amp fuse (F1) and fusible link (F3). The power circuit provides unswitched power to the following components:

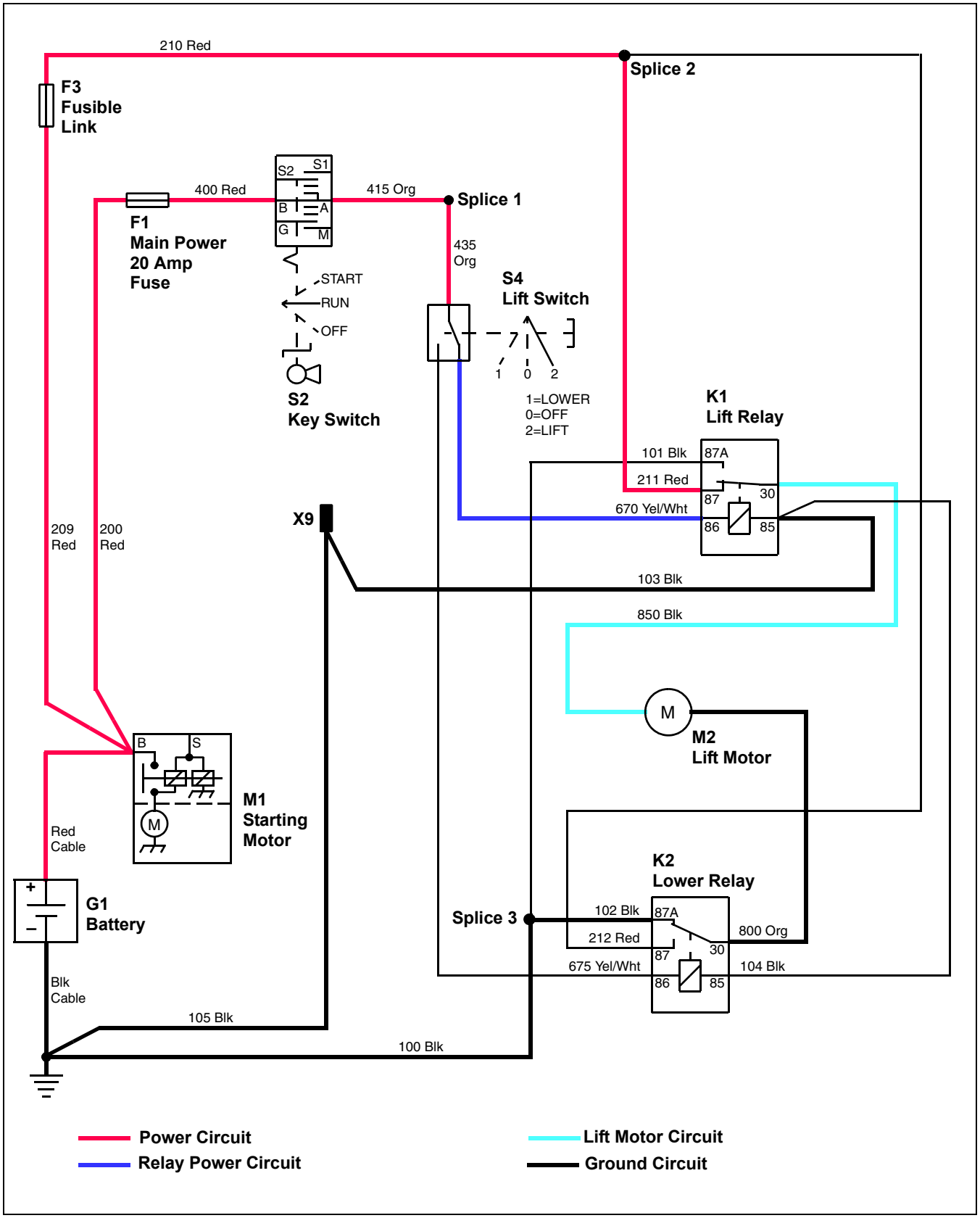
- Key switch (S2), terminal B.
- Lift relay (K1), terminal 87.
- Lower relay (K2), terminal 87.

With the key switch in the RUN position, current flows from the key switch (terminals B and A) to lift switch (S4) (wires 415 Org and 435 Org).

When the lift switch is moved to the RAISE position, current flows to terminal 86 of the lift relay (wire 670 Yel/Wht), energizing the relay. With the lift relay energized, current flows to lift motor (M2) (wire 850 Blk), activating the motor. The motor will remain activated until the lift switch is released.

A path to ground for the lift motor is provided through the normally closed contacts of the lower relay (wires 800 Org, 102 Blk, and 100 Blk).

Lift Circuit Schematic - Raise



MX22443

Lift Circuit Operation - Lower

Function

To control the direction of current applied to the lift motor to lower the rake assembly.

Operating Conditions

- Key switch in RUN position.
- Lift switch in LOWER position.

System Operation

The lift circuit is protected with main power 20 amp fuse (F1) and fusible link (F3). The power circuit provides unswitched power to the following components:

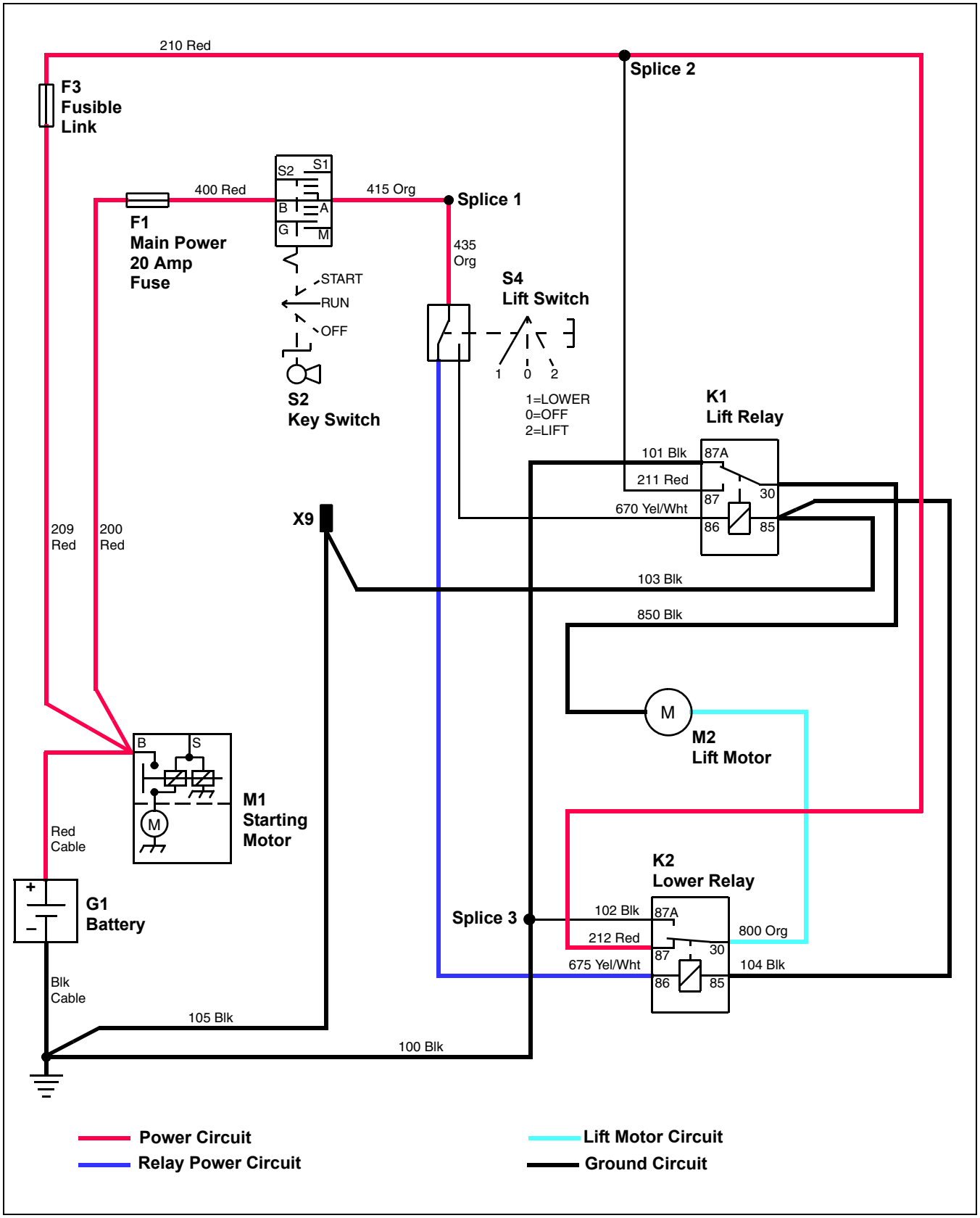
- Key switch (S2), terminal B.
- Lift relay (K1), terminal 87.
- Lower relay (K2), terminal 87.

With the key switch in the RUN position, current flows from the key switch (terminals B and A) to lift switch (S4) (wires 415 Org and 435 Org).

When the lift switch is moved to the LOWER position, current flows to terminal 86 of the lower relay (wire 675 Yel/Wht), energizing the relay. With the lower relay energized, current flows to lift motor (M2) (wire 800 Org), activating the motor. The motor will remain activated until the lift switch is released.

A path to ground for the lift motor is provided through the normally closed contacts of the lift relay (wires 850 Blk, 101 Blk, and 100 Blk).

Lift Circuit Schematic - Lower



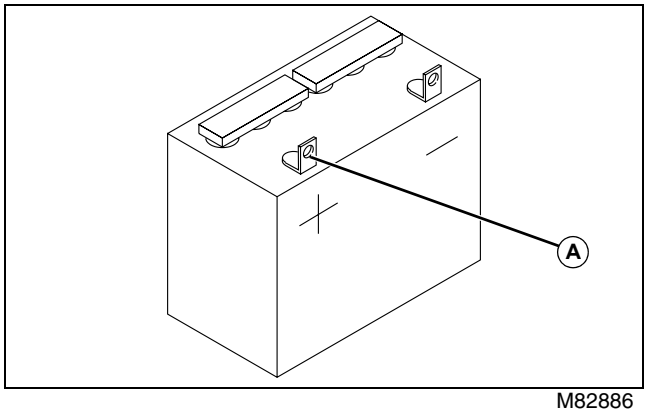
MX22444

System: Lift Circuit Diagnosis

Test Conditions

- Machine parked safely.
- Key switch in OFF position.

Lift Circuit

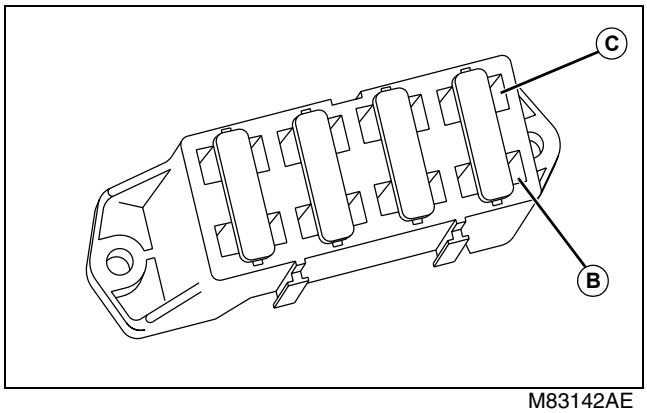


M82886

1. Is there 11.8-13.2 volts at positive (+) terminal (A) of the battery?

Yes: Go to next step.

No: Test battery. (See “Test Battery” on page 137.)



M83142AE

2. Is there battery voltage at main power 20 amp fuse (B)?

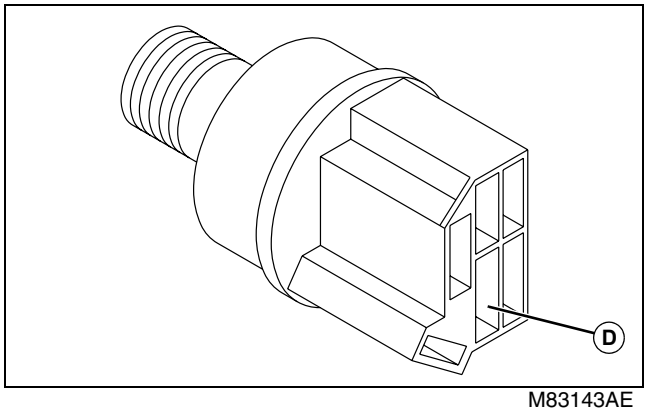
Yes: Go to next step.

No: Check wire 200 Red and connections.

3. Is there battery voltage at main power 20 amp fuse (C)?

Yes: Go to next step.

No: Replace fuse.

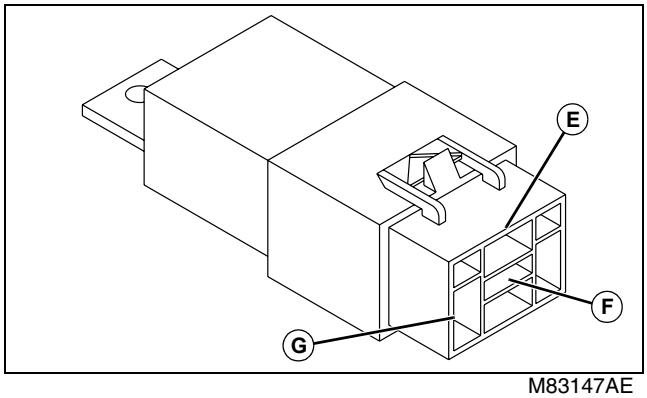


M83143AE

4. Is there battery voltage at terminal B (D) of the key switch?

Yes: Go to next step.

No: Check wire 400 Red and connections.



M83147AE

5. Is there battery voltage at terminal 87 (E) of the lift relay?

Yes: Go to next step.

No: Check fusible link (F3), wire 209 Red, wire 210 Red, wire 212 Red, and connections.

6. Is there less than 0.1 ohm of resistance between the negative (-) terminal of the battery and terminal 87A (F) of the lift relay?

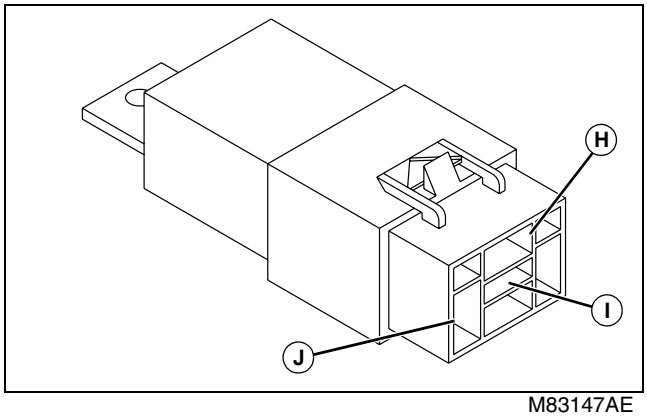
Yes: Go to next step.

No: Check battery negative (-) cable, wire 100 Blk, and wire 101 Blk.

7. Is there less than 0.1 ohm of resistance between the negative (-) terminal of the battery and terminal 85 (G) of the lift relay?

Yes: Go to next step.

No: Check battery negative (-) cable, wire 103 Blk, and wire 105 Blk.



M83147AE

8. Is there battery voltage at terminal 87 (H) of the lower relay?

Yes: Go to next step.

No: Check fusible link (F3), wire 209 Red, wire 210 Red, wire 212 Red, and connections.

9. Is there less than 0.1 ohm of resistance between the negative (-) terminal of the battery and terminal 87A (I) of the lower relay?

Yes: Go to next step.

No: Check battery negative (-) cable, wire 100 Blk, and wire 102 Blk.

10. Is there less than 0.1 ohm of resistance between the negative (-) terminal of the battery and terminal 85 (J) of the lower relay?

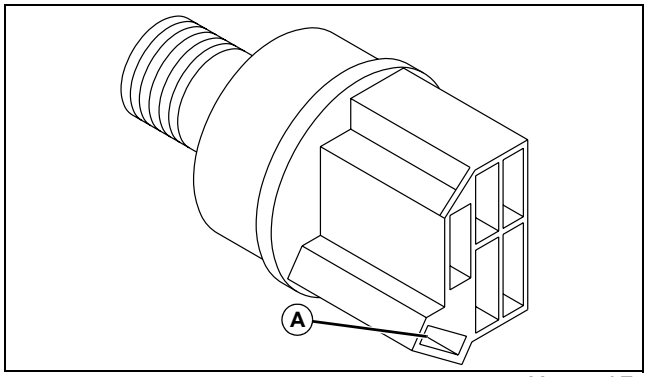
Yes: Test complete.

No: Check battery negative (-) cable, wire 103 Blk, wire 104 Blk, and wire 105 Blk.

Test Conditions

- Machine parked safely.
- Key switch in RUN position.
- Lift switch in RAISE position.

Lift System Circuit - Raise

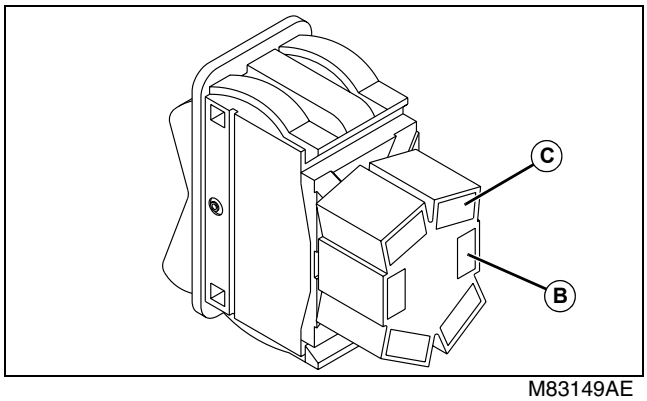


M83143AE

1. Is there battery voltage at terminal A (A) of the key switch?

Yes: Go to next step.

No: Test key switch. (See “Test Key Switch” on page 146.)



M83149AE

2. Is there battery voltage at wire 435 Org (B) of the lift switch?

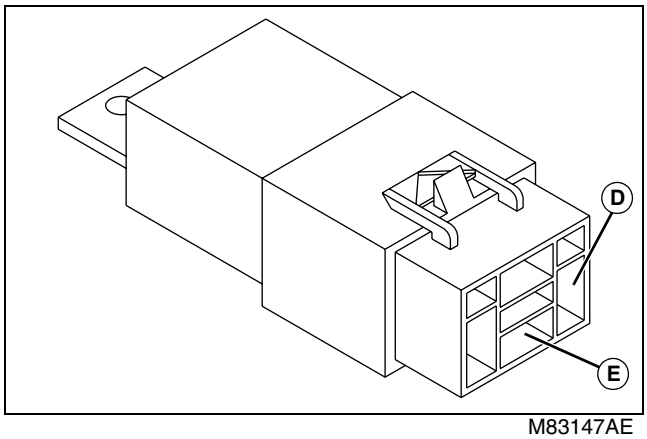
Yes: Go to next step.

No: Check wire 415 Org, wire 435 Org, and connections.

3. Is there battery voltage at lift switch terminal (C)?

Yes: Go to next step.

No: Test lift switch. (See “Test Lift Switch” on page 147.)



M83147AE

4. Is there battery voltage at terminal 86 (D) of the lift relay?

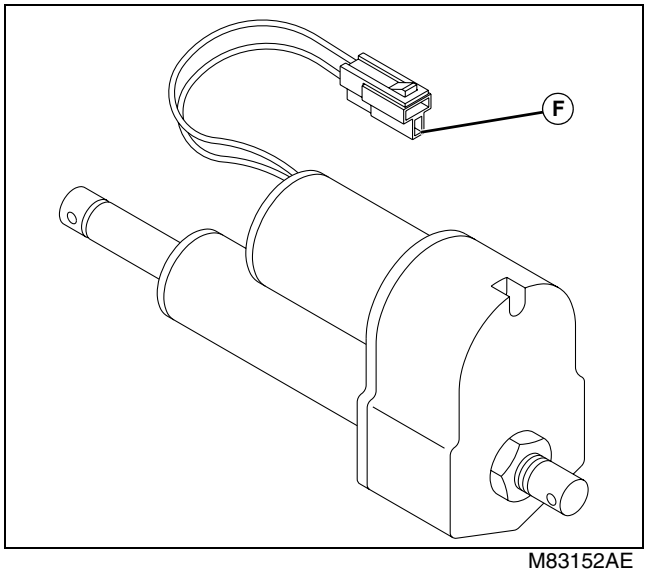
Yes: Go to next step.

No: Check wire 670 Yel/Wht and connections.

5. Is there battery voltage at terminal 30 (E) of the lift relay?

Yes: Go to next step.

No: Test lift relay. (See “Test Relay” on page 147.)



M83152AE

6. Is there battery voltage at wire 850 Blk (F) of the lift actuator motor?

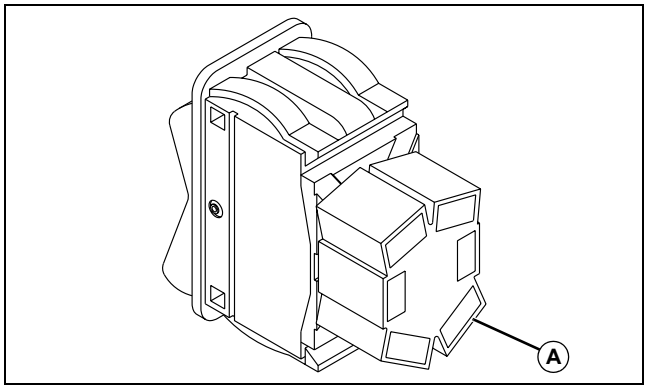
Yes: Test complete.

No: Check wire 850 Blk and connections.

Test Conditions

- Machine parked safely.
- Key switch in RUN position.
- Lift switch in LOWER position.

Lift Circuit - Lower

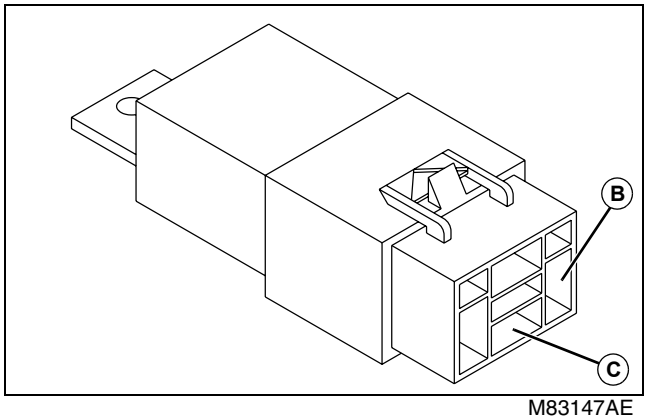


M83149AE

1. Is there battery voltage at lift switch terminal (A)?

Yes: Go to next step.

No: Test lift switch. (See “Test Lift Switch” on page 147.)



M83147AE

2. Is there battery voltage at terminal 86 (B) of the lower relay?

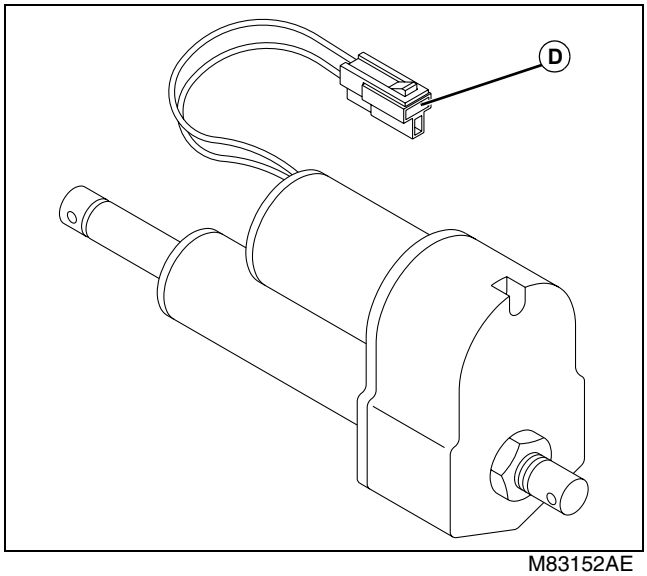
Yes: Go to next step.

No: Check wire 675 Yel/Blk and connections.

3. Is there battery voltage at terminal 30 (C) of the lower relay?

Yes: Go to next step.

No: Test lower relay. (See “Test Relay” on page 147.)



M83152AE

4. Is there battery voltage at wire 800 Org (D) of the lift actuator motor?

Yes: Test complete.

No: Check wire 800 Org and connections.

No: Test lift relay. (See “Test Relay” on page 147.)

Pump Circuit Operation - Raise

Function

To provide power to a hydraulic pump used for lifting rear rake or pulled implement.

Operating Conditions

- Key switch in RUN position.
- Lift switch in RAISE position.

System Operation

Important: Avoid Damage! When the hydraulic pump is used, the lift motor ground wire must be disconnected from ground and isolated with tape. The hydraulic pump motor harness ground is attached to frame ground. Failure to disconnect the lift motor ground wire will result in slow hydraulic pump operation, high current draw, and possible tripping of the circuit breaker.

The lift circuit is protected with main power 20 amp fuse (F1) and fusible link (F3). The power circuit provides unswitched power to the following components:

- Key switch (S2), terminal B.
- Lift relay (K1), terminal 87.
- Lower relay (K2), terminal 87.

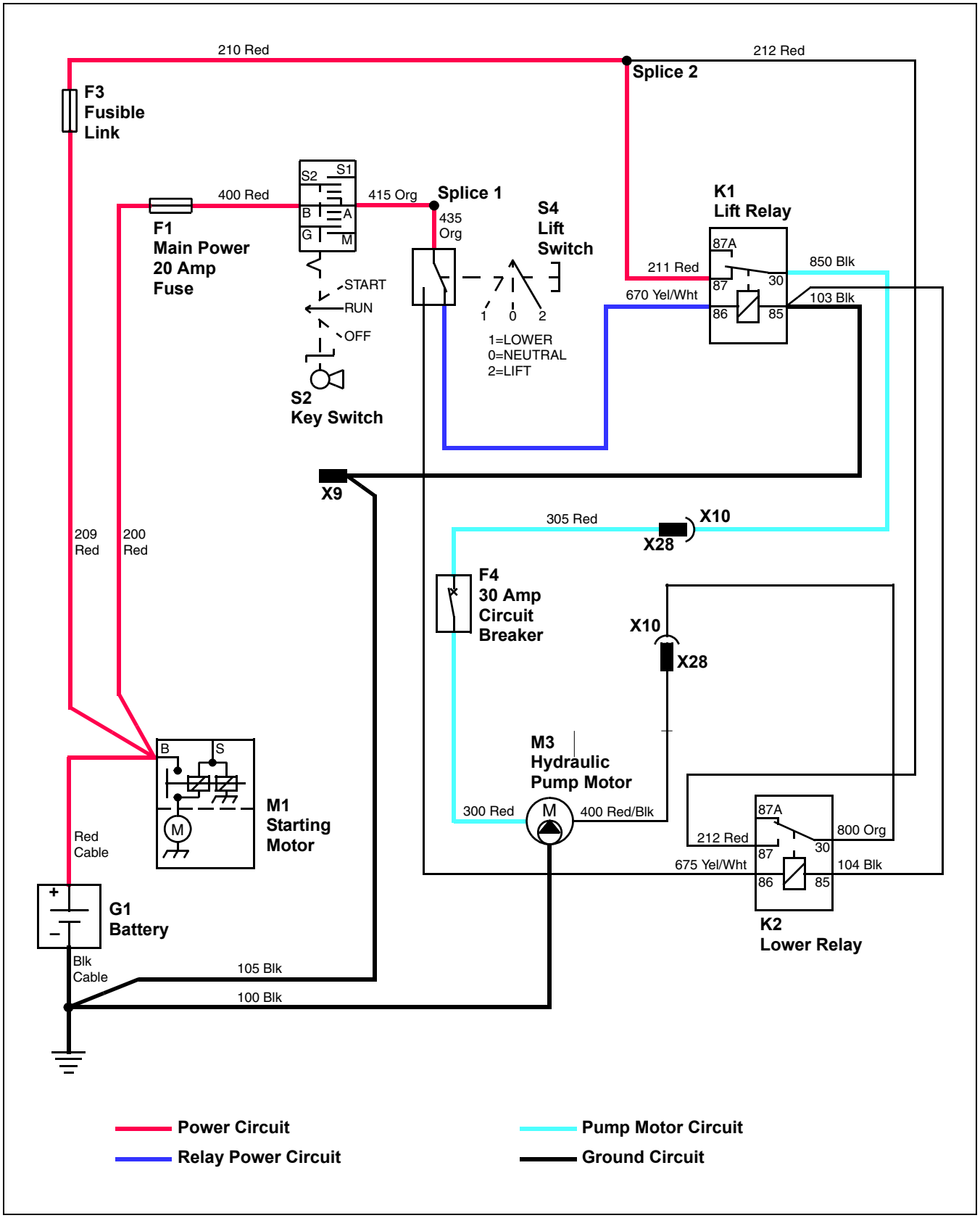
With the key switch in the RUN position, current flows from the key switch (terminals B and A) to lift switch (S4) (wires 415 Org and 435 Org).

When the lift switch is moved to the RAISE position, current flows to terminal 86 of the lift relay (wire 670 Yel/Wht), energizing the relay.

With the lower relay energized, current flows to 30 amp circuit breaker (F4) (wires 850 Blk and 305 Red) and to hydraulic pump motor (M3) (wire 300 Red). This activates the motor. The motor will remain activated until the lift switch is released.

A path to ground for the hydraulic pump motor is provided by wire 100 Blk. Wires 103 Blk and 104 Blk provide a path to ground for the lift relay.

Pump Circuit Schematic - Raise



MX2245

Pump Circuit Operation - Lower

Function

To provide power to a hydraulic pump used for lifting rear rake or pulled implement.

Operating Conditions

- Key switch in RUN position.
- Lift switch in LOWER position.

System Operation

Important: Avoid Damage! When the hydraulic pump is used, the lift motor ground wire must be disconnected from ground and isolated with tape. The hydraulic pump motor harness ground is attached to frame ground. Failure to disconnect the lift motor ground wire will result in slow hydraulic pump operation, high current draw, and possible tripping of the circuit breaker.

The lift circuit is protected with main power 20 amp fuse (F1) and fusible link (F3). The power circuit provides unswitched power to the following components:

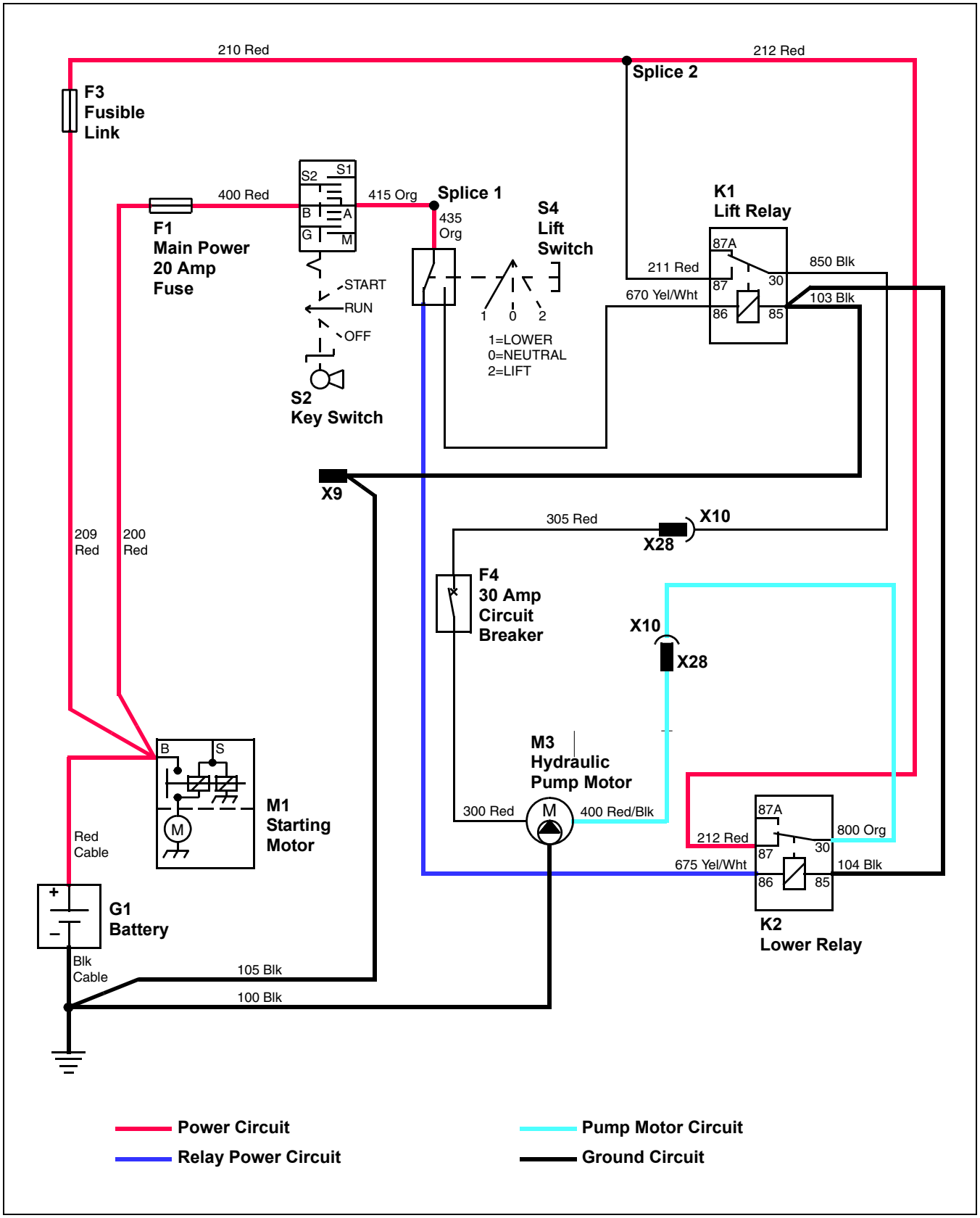
- Key switch (S2), terminal B.
- Lift relay (K1), terminal 87.
- Lower relay (K2), terminal 87.

With the key switch in the RUN position, current flows from the key switch (terminals B and A) to lift switch (S4) (wires 415 Org and 435 Org).

When the lift switch is moved to the LOWER position current flows to terminal 86 of the lower relay (wire 675 Yel/Wht), energizing the relay. With the lower relay energized, current flows to hydraulic pump motor (M3) (wires 800 Org and 400 Red/Blk), activating the motor. The motor will remain activated until the lift switch is released.

A path to ground for the hydraulic pump motor is provided by wire 100 Blk. Wires 103 Blk, 104 Blk, and 105 Blk provide a path to ground for the lower relay.

Pump Circuit Schematic - Lower



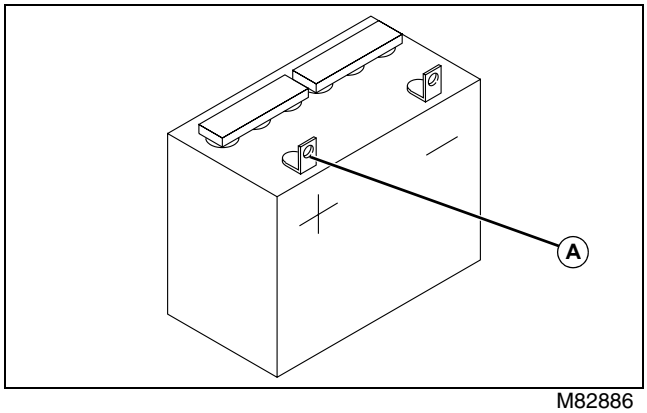
MX2246

System: Pump Circuit Diagnosis

Test Conditions

- Machine parked safely.
- Key switch in OFF position.

Pump Circuit

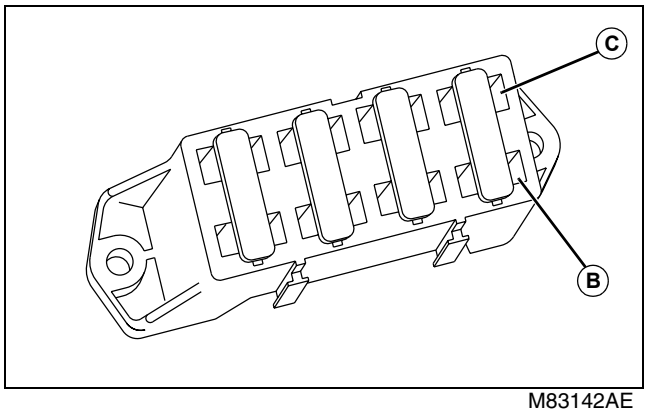


M82886

1. Is there 11.8-13.2 volts at positive (+) terminal (A) of the battery?

Yes: Go to next step.

No: Test battery. (See “Test Battery” on page 137.)



M83142AE

2. Is there battery voltage at main power 20 amp fuse (B)?

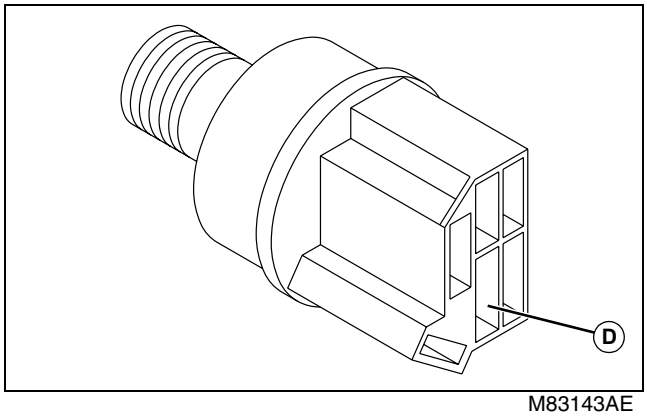
Yes: Go to next step.

No: Check wire 200 Red and connections.

3. Is there battery voltage at main power 20 amp fuse (C)?

Yes: Go to next step.

No: Replace fuse.

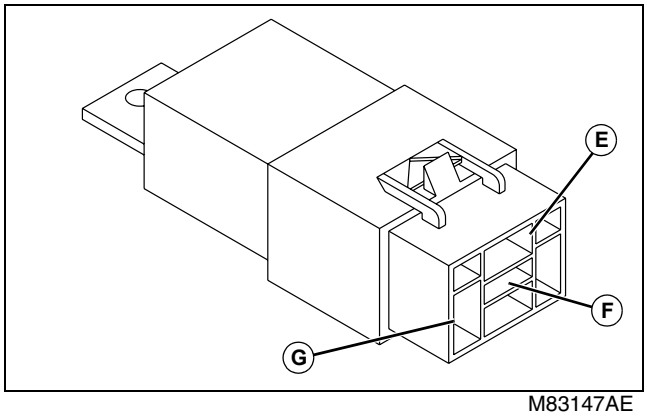


M83143AE

4. Is there battery voltage at terminal B (D) of the key switch?

Yes: Go to next step.

No: Check wire 400 Red and connections.



M83147AE

5. Is there battery voltage at terminal 87 (E) of the lift relay?

Yes: Go to next step.

No: Check fusible link (F3), wire 209 Red, wire 210 Red, wire 212 Red, and connections.

6. Is there an open circuit between the negative (-) terminal of the battery and terminal 87A (F) of the lift relay?

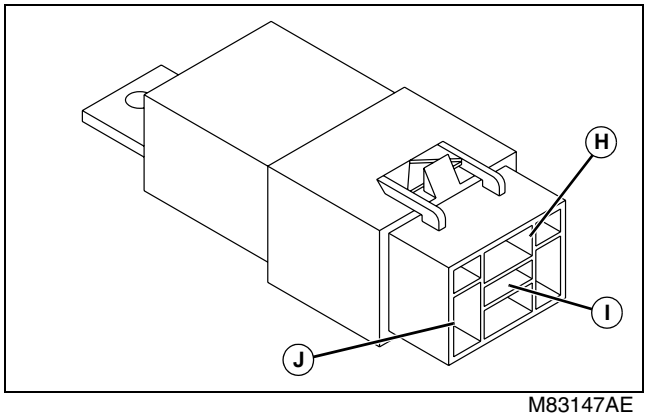
Yes: Go to next step.

No: Disconnect wire 100 Blk from ground.

7. Is there less than 0.1 ohm of resistance between the negative (-) terminal of the battery and terminal 85 (G) of the lift relay?

Yes: Go to next step.

No: Check battery negative (-) cable, wire 103 Blk, and wire 105 Blk.



M83147AE

8. Is there battery voltage at terminal 87 (H) of the lower relay?

Yes: Go to next step.

No: Check fusible link (F3), wire 209 Red, wire 210 Red, wire 212 Red, and connections.

9. Is there an open circuit between the negative (-) terminal of the battery and terminal 87A (I) of the lower relay?

Yes: Go to next step.

No: Disconnect wire 100 Blk from ground.

10. Is there less than 0.1 ohm of resistance between the negative (-) terminal of the battery and terminal 85 (J) of the lower relay?

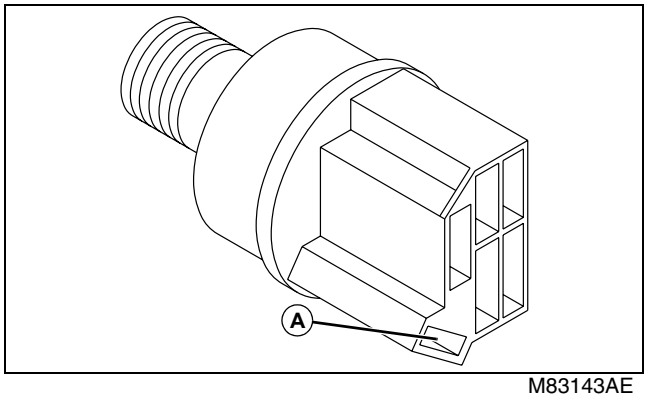
Yes: Test complete.

No: Check battery negative (-) cable, wire 103 Blk, wire 104 Blk, and wire 105 Blk.

Test Conditions

- Machine parked safely.
- Key switch in RUN position.
- Lift switch in RAISE position.

Hydraulic Pump Circuit - Raise

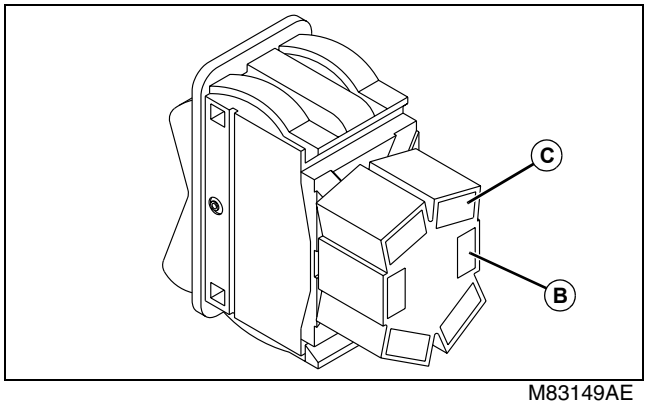


M83143AE

1. Is there battery voltage at terminal A (A) of the key switch?

Yes: Go to next step.

No: Test key switch. (See “Test Key Switch” on page 146.)



M83149AE

2. Is there battery voltage at wire 435 Org (B) of the lift switch?

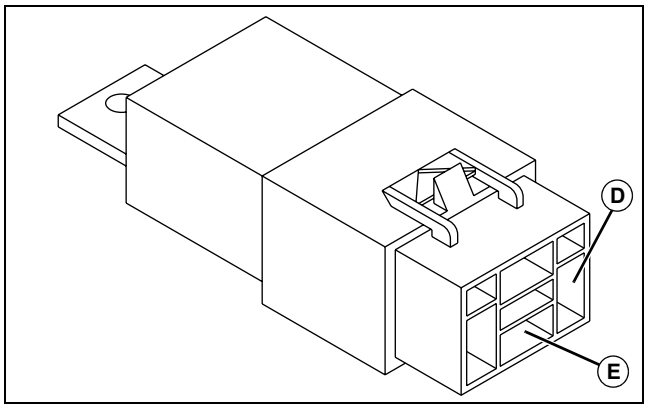
Yes: Go to next step.

No: Check wire 415 Org, wire 435 Org, and connections.

3. Is there battery voltage at lift switch terminal (C)?

Yes: Go to next step.

No: est lift switch. (See “Test Lift Switch” on page 147.)



M83147AE

4. Is there battery voltage at terminal 86 (D) of the lift relay?

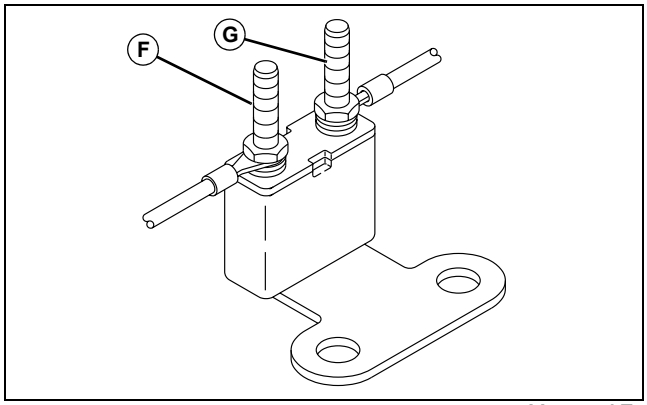
Yes: Go to next step.

No: Check wire 670 Yel/Wht and connections.

5. Is there battery voltage at terminal 30 (E) of the lift relay?

Yes: Go to next step.

No: Test lift relay. (See “Test Relay” on page 147.)



M83187AE

6. Is there battery voltage at terminal (F) of the circuit breaker?

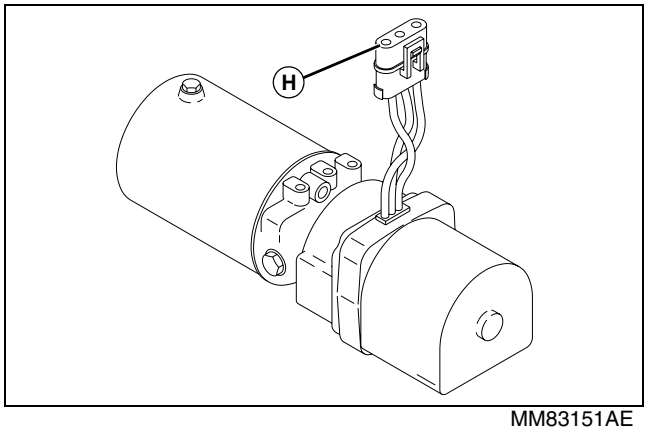
Yes: Go to next step.

No: Check wire 850 Blk, wire 305 Red, and connections.

7. Is there battery voltage at terminal (G) of the circuit breaker?

Yes: Go to next step.

No: Replace circuit breaker.



MM83151AE

8. Is there battery voltage at terminal (H) of the hydraulic pump motor?

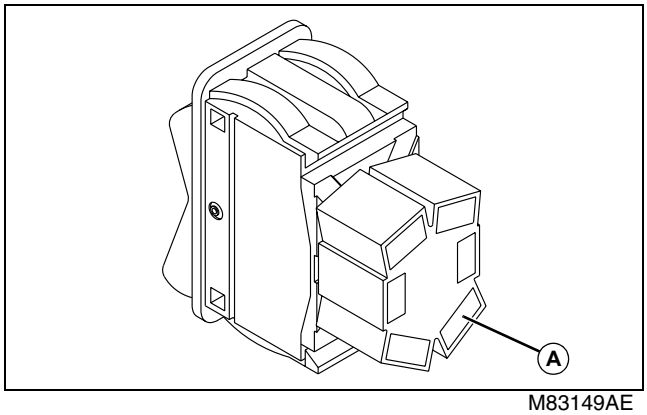
Yes: Test complete.

No: Check wire 300 Red and connections.

Test Conditions

- Machine parked safely.
- Key switch in RUN position.
- Lift switch in LOWER position.

Pump Circuit - Lower

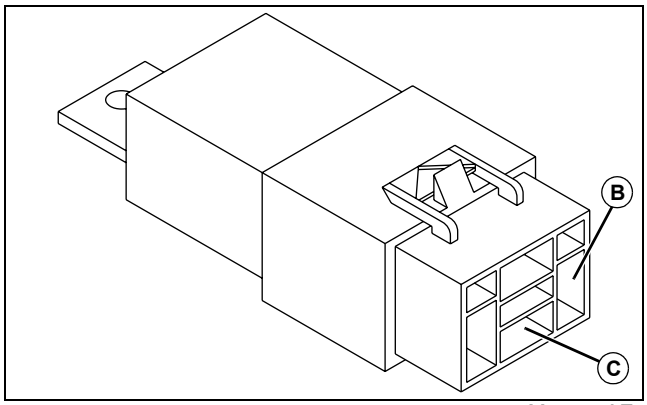


M83149AE

1. Is there battery voltage at lift switch terminal (A)?

Yes: Go to next step.

No: Test lift switch. (See “Test Lift Switch” on page 147.)



M83147AE

2. Is there battery voltage at terminal 86 (B) of the lower relay?

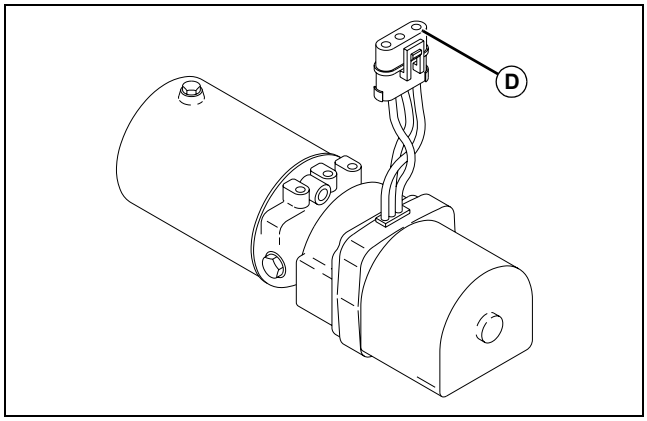
Yes: Go to next step.

No: Check wire 675 Yel/Blk and connections.

3. Is there battery voltage at terminal 30 (C) of the lower relay?

Yes: Go to next step.

No: Test lower relay. (See “Test Relay” on page 147.)



MM83151AE

4. Is there battery voltage at terminal (D) of the hydraulic pump motor?

Yes: Test complete.

No: Check wire 800 Org, wire 400 Red/Blk, and connections.

Tests and Adjustments

Test Ground Circuit

Reason

To check for open circuits, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

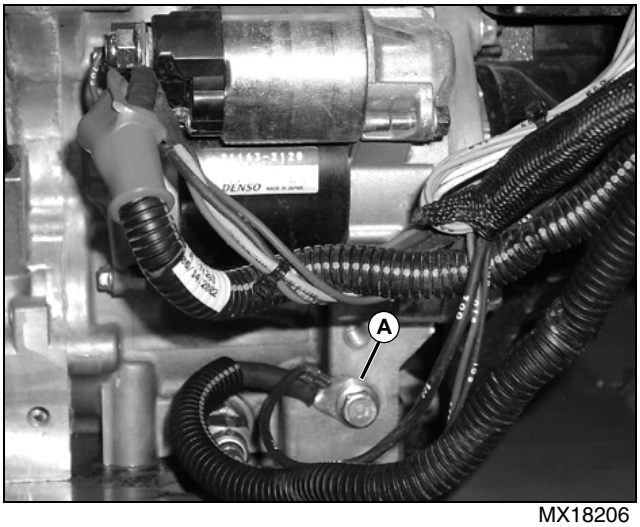
Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to read the resistance from battery terminals and check ground connections under load.

Note: The voltmeter method checks ground connections under load.

Procedure - Ohmmeter Method

1. Park machine on level surface.
2. Move control levers to NEUTRAL position.
3. Turn key switch to OFF position.
4. Lock park brake.
5. Raise and latch seat platform.
6. Connect both ohmmeter negative (black) lead and positive (red) lead to the negative (-) terminal of battery. Record reading.



MX18206

7. Connect ohmmeter red lead to ground terminal (A) while leaving black lead on battery. Resistance reading must be the same or very close to the battery negative terminal reading. Work backward from the battery on the ground side of the problem circuit until the resistance reading increases above 0.1 ohm. The problem is between the last two test points. If a problem is indicated, disconnect the wiring harness connector to isolate the wire or component and check resistance again. Maximum allowable resistance in the circuit is 0.1 ohm. Check both sides of the connectors closely, because disconnecting and connecting may temporarily solve problem.

Procedure - Voltmeter Method

1. Park machine on level surface.
2. Move control levers to NEUTRAL position.
3. Turn key switch to OFF position.
4. Lock park brake.
5. Raise and latch seat platform.
6. Connect voltmeter negative (black) lead to negative terminal of battery.
7. Connect voltmeter positive (red) lead to ground terminal of circuit or component to be tested. Be sure that component circuit is activated (key ON, switches CLOSED) so that voltage will be present at the component. Record voltage. Voltage must be greater than 0, but less than 1 volt. Some components will have a very small voltage reading on the ground side and still be operating correctly.

Results

- If voltage is 0, the component is open.
- If voltage is greater than 1 volt, the ground circuit is bad. Check for open wiring, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

Test Battery

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.

Note: Machine comes with sealed battery and is not serviceable. This procedure is for a serviceable battery that has replaced the original sealed battery.

Reason

To check condition of battery and determine battery voltage.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hydrometer	N/A	Used to check specific gravity.
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.
Battery Tester	JT05685	Used to test battery performance.

Procedure

1. Park machine on level surface.

2. Move control levers to NEUTRAL position.

3. Turn key switch to OFF position.

4. Lock park brake.

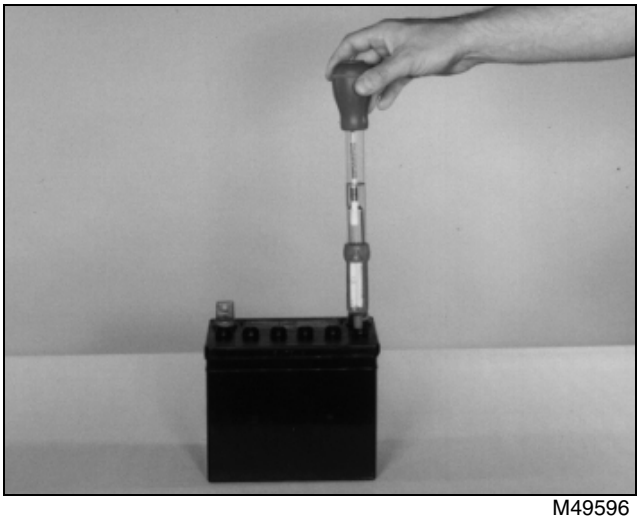
5. Clean cable ends, battery terminals, and top of battery. (See “Clean Battery” on page 149.)

6. Remove battery. (See “Remove and Install Battery” on page 149.)

7. Inspect battery terminals and case for breakage or cracks.

8. Check electrolyte level in each battery cell. Add clean, distilled water as needed. If water is added, charge battery for 20 minutes at 10 amps.

9. Remove surface charge by placing a small load on the battery for 15 seconds.



M49596

10.Use a hydrometer to check for a minimum specific gravity of 1.225 with less than a 50-point variation in each cell. If specific gravity is not within range, perform one of the following:

- 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 amps.
- If all cells are more than 1.225 with less than 50-point variation, load test battery.
- If more than 50-point variation, replace battery.

11.Use a multimeter or JT05685 Battery Tester to check for a minimum battery voltage of 12.4 volts. One of the following may result:

- If battery voltage is less than 12.4 VDC, charge battery.
- If battery voltage is more than 12.4 VDC, test specific gravity.

12.Install battery. (See “Remove and Install Battery” on page 149.)

Charge Battery

Reason

To increase battery charge after the battery has been discharged.

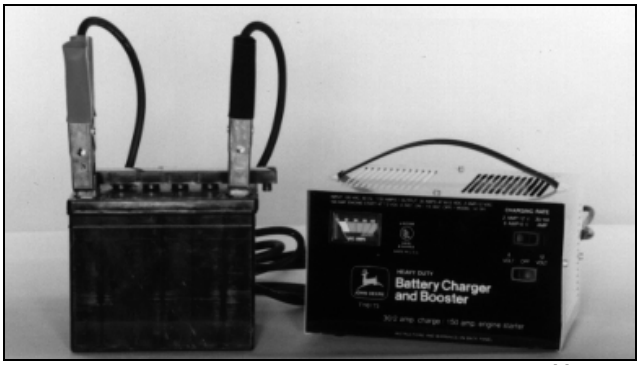
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Charger (Variable Rate)	N/A	Used to charge battery.

Procedure

Note: Before charging serviceable battery, check electrolyte level. (See “Test Battery” on page 137.)

1. Park machine on level surface.
2. Move control levers to NEUTRAL position.
3. Turn key switch to OFF position.
4. Lock park brake.
5. Clean cable ends, battery terminals, and top of battery.
6. Remove battery. (See “Remove and Install Battery” on page 149.)



M49598

7. Connect variable rate charger to battery.
8. 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.
9. Check if battery is accepting 10-amp charge rate after 10 minutes at boost setting. One of the following may result:
   - If battery WILL NOT accept 10-amp charge after 10 minutes at boost setting, replace battery.
   - If battery WILL accept 10-amp charge after 10 minutes at boost setting, go to step 10.
   - **Serviceable batteries only:** If battery is accepting 10-amp charge after 10 minutes at boost setting, and battery did NOT need water, go to steps 12 and 13.
   - **Serviceable batteries only:** 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 11 and 12.
10. Set charger at 15-25 amps.

Important: Avoid Damage! Decrease charge rate if battery gases or bubbles excessively or becomes too warm to touch.

11. **Serviceable batteries only:** Check specific gravity after 30 minutes. One of the following problems may result:
   - If MORE THAN 50-point variation between cells, replace battery.
   - If LESS THAN 50-point variation between cells, go to steps 12 and 13.

Note: Serviceable batteries: If battery was discharged at slow or unknown rate, charge battery at 10-15 amps for 6-12 hours.

Maintenance-free batteries: Follow battery charger manufacturer’s recommendations.

12. Load test battery.
13. Install battery. (See “Remove and Install Battery” on page 149.)

Specifications

Battery Specific Gravity1.230-1.265 points

Test Battery Load

Reason

To check condition of battery under load.

Special or Required Tools

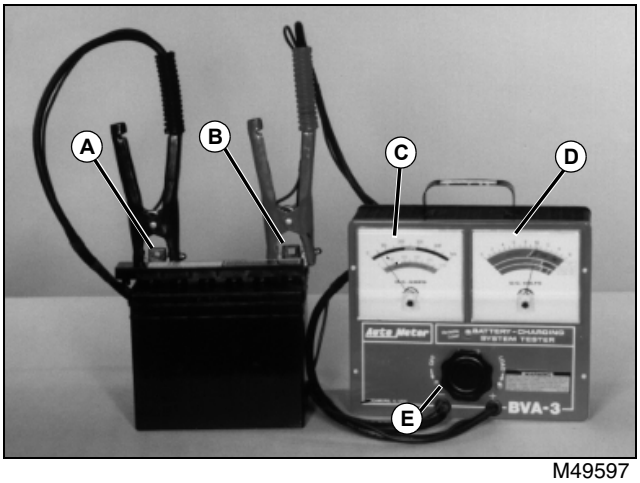
Tool Name	Tool No.	Tool Use
Battery Tester	JT05685	Used to test performance of battery.

Procedure

1. Park machine on level surface.
2. Move control levers to NEUTRAL position.
3. Turn key switch to OFF position.
4. Lock park brake.

5. Clean cable ends, battery terminals, and top of battery. (See “Clean Battery” on page 149.)

6. Remove battery. (See “Remove and Install Battery” on page 149.)



M49597

7. Turn load knob (E) counterclockwise to OFF position.

8. Connect tester positive (red) cable to battery positive (+) terminal (B).

9. Connect tester negative (black) cable to battery negative (-) terminal (A).

10.Turn load knob of tester clockwise (in) until amperage scale (C) reading is equal to:

- Cold cranking amperage rating of battery (use blue scale).

or

- Three times ampere hour rating (use black scale).

11.Hold for 15 seconds and turn load knob of tester counterclockwise (out) to OFF position.

12.Repeat steps 8 and 9 above and read condition of battery on DC volts scale (D).

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.

Test Regulated Amperage Output

Reason

To determine the amperage output of the charging system.

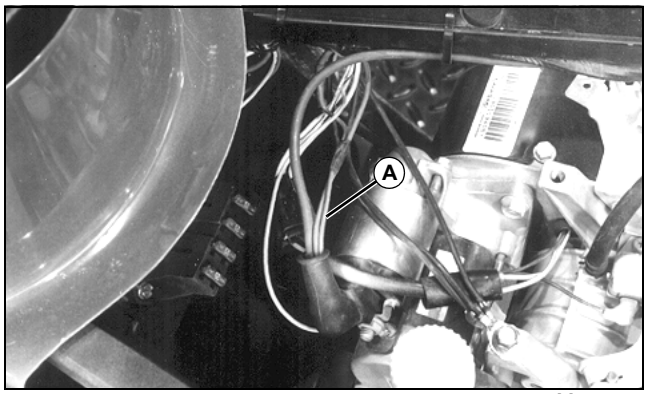
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Tester	JT05685	Used to load-test battery.
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.
Current Clamp (or Ammeter)	JT02153	Used to measure current.

Procedure

Note: The battery should be in good condition and fully charged before performing test. (See “Test Battery” on page 137.)

1. Park machine safely on level surface. (See “Park Machine Safely” on page 3.)
2. Move gearshift pedals to NEUTRAL position.
3. Lock park brake.
4. Turn key switch to OFF position.
5. Lower front blade (if equipped).
6. Raise rear body cowling.



M83494

7. Connect ammeter in series with wire 200 Red (A), or clamp jaws of current clamp around wire. When using a current clamp:

   a. Connect current clamp RED lead to the VOLTS jack of the multimeter and the BLACK lead of the current clamp to the COM jack on the multimeter.

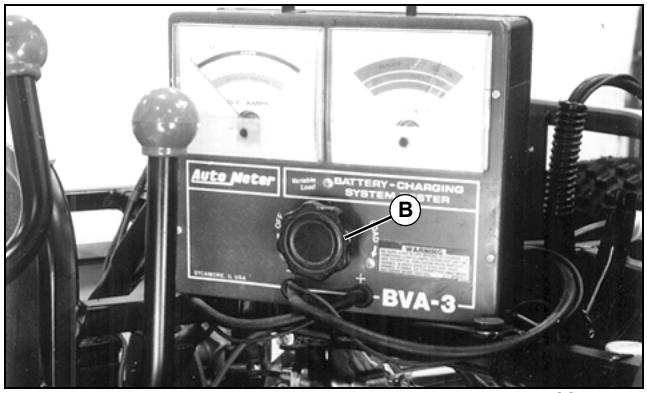
Note: If using a multimeter other than JT05791A, use a meter that will read millivolts. Millivolts = current in amps; 1 mV = 1 amp.

   b. Set the current clamp to 2000 A and the multimeter to 300 mV.

Note: The core of the jaws may hold some magnetic

force after the current clamp has been used for measurement. If you cannot zero adjust the display, open the jaws and snap them closed several times.

c. Adjust the DCA ZERO ADJUST dial on the current clamp for a zero reading on the multimeter.



M83495

8. Turn knob (B) of battery tester to OFF position (fully counterclockwise).

9. Connect red clamp of JT05685 Battery Tester to positive (+) terminal of battery and black clamp to frame.

Important: Avoid Damage! Perform this test as quickly as possible to prevent damage to electrical system components. DO NOT apply a full load to the battery for more than 10 seconds.

10.Start and run engine at fast idle.

11.Turn load knob until voltage reads 11 VDC.

12.Read and record amperage reading. Amperage should read a minimum of 13 amps at fast idle.

13.Turn load knob OFF (fully counterclockwise).

Results

- If the amperage output is below minimum specification, perform unregulated voltage test. (See “Test Unregulated Voltage” on page 140.)

Test Regulated Voltage

Reason

To determine regulated voltage output of the regulator/ rectifier.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.

Procedure

1. Park machine safely on level surface. (See “Park Machine Safely” on page 3.)

2. Turn key switch OFF.

3. Move gearshift pedals to NEUTRAL position.

4. Lock park brake.

5. Raise rear body cowling.

6. Remove surface charge from battery by placing a small load on the battery for 15 seconds.

7. Set multimeter to 50 DC volt scale.

8. Connect multimeter positive (red) lead to battery positive (+) terminal.

9. Connect multimeter negative (black) lead to battery negative (-) terminal.

10.Start and run engine at fast idle. Read multimeter several times during 5 minutes of running time.

11.Voltage should remain between 12.2 and 14.7 volts DC.

Results

- If the DC voltage remains below the minimum specification, test stator voltage output.
- If the DC voltage goes above the maximum specification, replace the regulator/rectifier.

Test Unregulated Voltage

Reason

To measure stator voltage output to determine stator condition.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.

Procedure

1. Park machine safely on level surface. (See “Park Machine Safely” on page 3.)

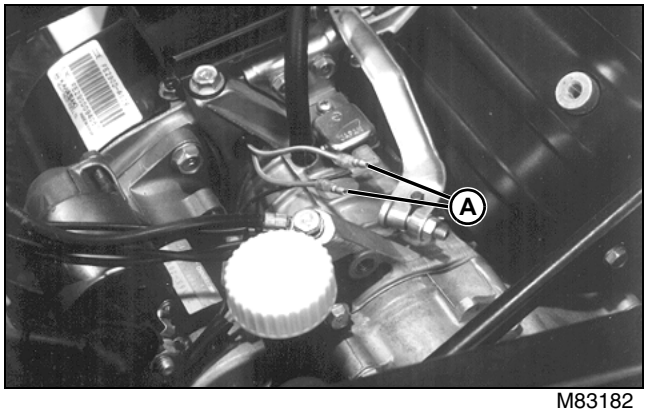
2. Turn key switch OFF.

3. Move gearshift pedals to NEUTRAL position.

4. Lock park brake.

5. Lower front blade (if equipped).

6. Raise rear body cowling.



M83182

7. Disconnect stator wire leads (A).

8. Set multimeter to 50 AC volt scale.

9. Connect multimeter leads to engine side of stator wire leads.

10.Start and run engine at fast idle. Read voltmeter several times during 5 minutes of running time.

11.Voltage should be a minimum of 34 volts AC.

Results

- If the voltage is less than specifications, test flywheel magnet and then replace stator. (See “Test Flywheel Magnet” on page 145.)

Test Starting Solenoid

Reason

To determine if starting solenoid is defective.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.

Procedure

1. Park machine safely on level surface. (See “Park Machine Safely” on page 3.)

2. Turn key switch to OFF position.

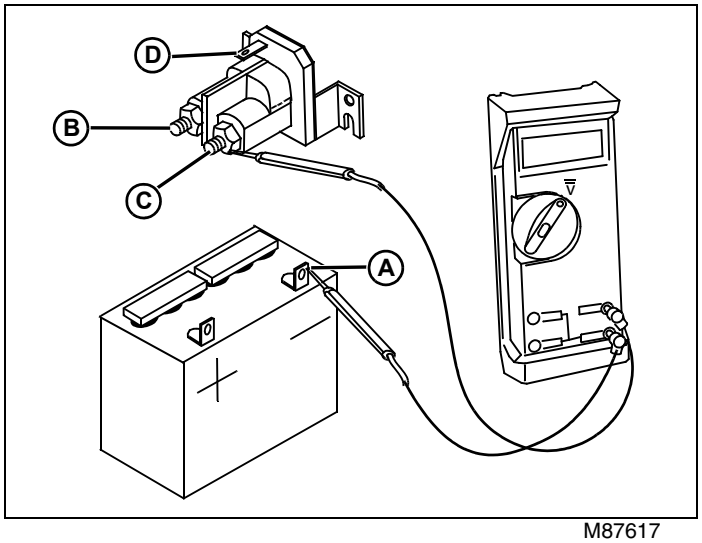
3. Move gearshift pedals to NEUTRAL position.

4. Lock park brake.

5. Lower front blade (if equipped).

6. Raise rear body cowling.

7. Disconnect and ground spark plug leads.



M87617

8. Connect multimeter to negative (-) battery terminal (A) and positive battery cable terminal (B) of solenoid. Check for battery voltage.

- No battery voltage - Check battery positive (+) terminal and starting motor solenoid terminal (B) for loose connections. Clean any corrosion.
- Battery voltage - Go to step 9.

9. Connect multimeter to negative (-) battery terminal (A) and starting motor cable terminal (C) of solenoid.

10.Momentarily turn ignition key to START position and check for battery voltage.

- Battery voltage - Starting motor solenoid is not defective.
- No battery voltage - Go to step 11.

11.Connect multimeter to negative (-) battery terminal (A) and terminal (D) (Blk wire) of starting motor solenoid.

12.Momentarily turn ignition key to START position and check for battery voltage.

- No battery voltage - Check Blk wire and connections.
- Battery voltage - Check Blk wire and connections between starting motor solenoid and frame ground. If OK, starting motor solenoid is defective. Replace solenoid.

Starting Motor Amperage Draw - Loaded

Reason

To determine amperage needed to crank the engine.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.
Current Clamp	JT02153	Used to measure current.

Procedure

1. Move gearshift pedals to NEUTRAL position.

2. Lock park brake.

Remove spark plug lead and ground to engine.

3. Connect current clamp RED lead to the VOLTS jack of the multimeter and the BLACK lead of the current clamp to the COM jack on the multimeter.

4. Clamp jaws of current clamp around the positive battery cable.

5. Set the current clamp to 2000 A and the multimeter to 300 mV.

Note: The core of the jaws may hold some magnetic force after the current clamp has been used for measurement. If you cannot zero adjust the display, open the jaws and snap them closed several times.

6. Adjust the DCA ZERO ADJUST dial on the current clamp for a zero reading on the multimeter.

Note: If using a multimeter other than JT05791A, use a meter that will read millivolts. Millivolts = current in amps; 1 mV = 1 amp.

7. Crank the engine and read the starting motor amperage draw.

Result

- If amperage is above specification, check starting motor for binding or damaged wires or windings.
- If starting motor is good, check internal engine, traction or PTO drive for binding or damage.

Specifications

Maximum Starting Motor Draw51 amps at 750 rpm

Starting Motor Amperage Draw - No Load

Reason

To determine starting motor condition under no-load conditions.

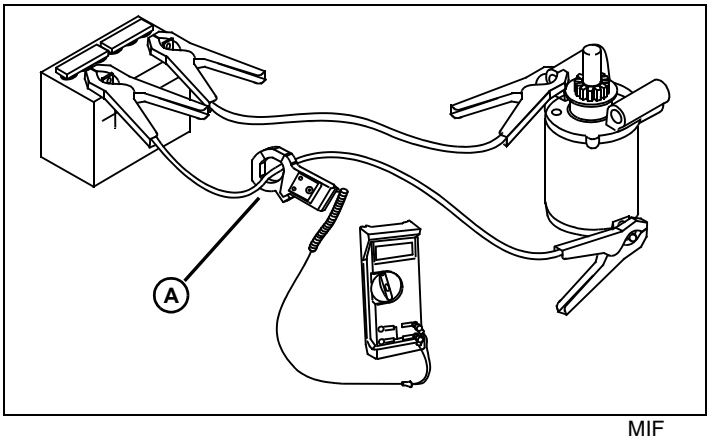
Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.
Current Clamp	JT02153	Used to measure current.
12-Volt Battery	N/A	Used to provide power.
Jumper Cables	N/A	Used to connect staring motor to battery.

Procedure

Caution: Avoid Injury! Do not clamp starting motor housing in vise or strike with a hammer. Clamp only on the mounting bracket. Starting motors contain two ceramic magnets that can be broken or cracked if the motor housing is hit, deformed or dented.

1. Clamp the starting motor mounting bracket in a vise.



MIF

2. Connect current clamp (A) RED lead to the VOLTS jack of the multimeter and the BLACK lead of the current clamp to the COM jack on the multimeter.

3. Connect the negative jumper cable to the battery negative post and the frame of the starting motor.

4. Connect the positive jumper cable to the positive post of the battery.

5. Clamp jaws of current clamp around the positive jumper cable.

6. Set the current clamp to 2000 A and the multimeter to 300 mV.

Note: The core of the jaws may hold some magnetic force after the current clamp has been used for measurement. If you cannot zero adjust the display, open the jaws and snap them closed several times.

7. Adjust the DCA ZERO ADJUST dial on the current clamp for a zero reading on the multimeter.

Note: If using a multimeter other than JT05791A, use a meter that will read millivolts. Millivolts = current in amps; 1 mV = 1 amp.

8. Momentarily touch the positive jumper cable lead to the starting motor positive post and read the starting motor amperage draw.

Result

- If amperage is above specification, check starting motor for binding or damaged wires or windings.

Specifications

Maximum Starting Motor Draw50 amps at 6000 rpm

Test Lift Motor Amperage Draw

Reason

To determine the condition of the lift motor and actuator assembly.

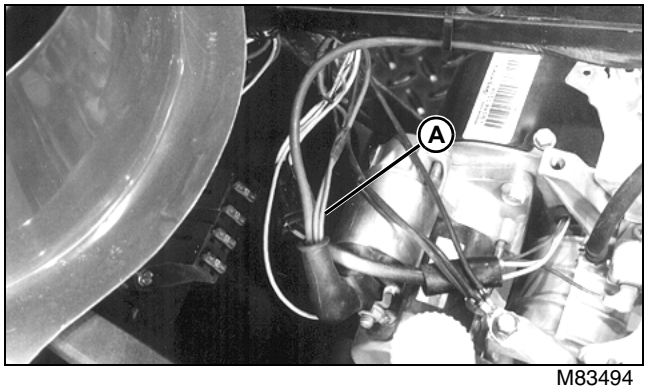
Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.
Current Clamp	JT02153	Used to measure current.

Procedure

Note: The battery should be in good condition and fully charged before performing test. (See "Test Battery" on page 137.)

1. Park machine safely on level surface. (See "Park Machine Safely" on page 3.)
2. Move gearshift pedals to NEUTRAL position.
3. Lock park brake.
4. Lower rear implement to the ground.
5. Turn the key switch to the OFF position.
6. Lower front blade (if equipped).
7. Raise rear body cowling.



M83494

8. Connect multimeter in series with lift circuit power lead (A), or clamp jaws of current clamp around wire. When using a current clamp:

   a. Connect current clamp RED lead to the VOLTS jack of the multimeter and the BLACK lead of the current clamp to the COM jack on the multimeter.

Note: If using a multimeter other than JT05791A, use a meter that will read millivolts. Millivolts = current in amps; 1 mV = 1 amp.

   b. Set the current clamp to 2000 A and the multimeter to 300 mV.

Note: The core of the jaws may hold some magnetic force after the current clamp has been used for measurement. If you cannot zero adjust the display, open the jaws and snap them closed several times.

   c. Adjust the DCA ZERO ADJUST dial on the current clamp for a zero reading on the multimeter.

9. Turn key switch to the RUN position.
10. Raise rear implement and record amperage reading.
11. Lower rear implement and record amperage reading.

Results

- If amperage is below specifications and unit does not lift, check for stripped gears or worn clutch.
- If amperage is zero, check control circuit or fusible link. If control circuit and fusible link are OK and motor will not run, thermal protector or motor may be defective. Replace motor.

If amperage is above specification, check lift actuator gears, worn gears or bearings for binding, causing excessive load.

Repair or replace lift actuator.

Specifications

Raise (No Load) . . . . . 3-6 amps
Lower (No Load). . . . . 3-4 amps
Raise (Maximum Load) . . . . . 28 amps

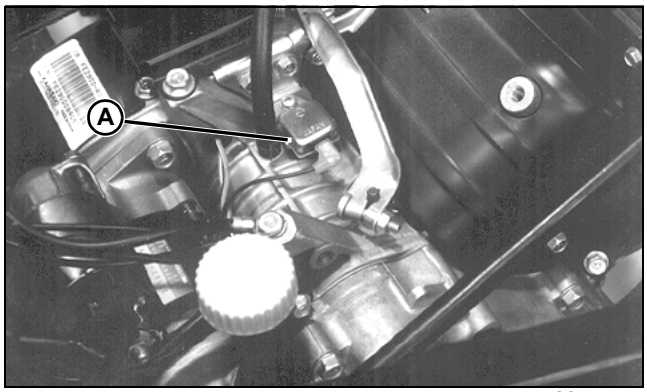
Test Ignition Module

Reason

To determine if the ignition module is defective.

Procedure

1. Park machine safely on level surface. (See “Park Machine Safely” on page 3.)
2. Turn key switch to OFF position.
3. Move gearshift pedals to NEUTRAL position.
4. Lock park brake.
5. Lower front blade (if equipped).
6. Raise rear body cowling.



M83183

7. The ignition module (A) is very sensitive to the type of meter used to check resistance. Due to variations in meters, the best way to determine if the ignition module is good is to replace the questionable ignition module with a known good module.

Results

- If the new ignition module does not solve the problem, check other ignition components.

Test Stator

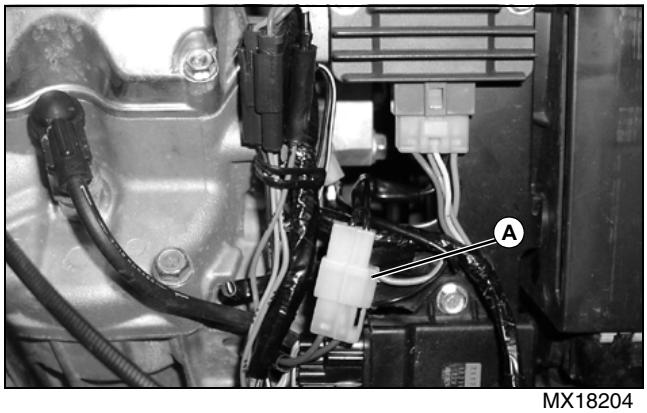
Reason

To check stator coil resistance to determine the stator condition.

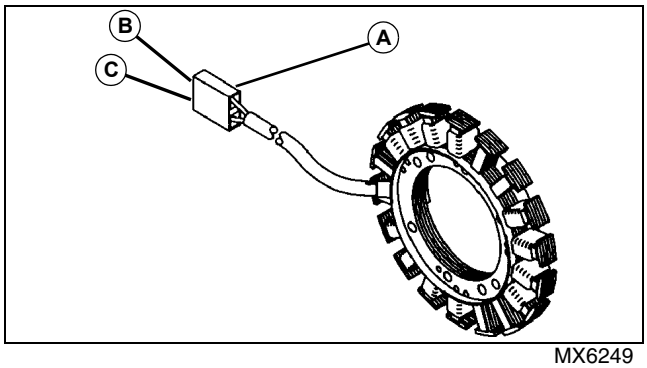
Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.

Procedure



MX18204



MX6249

1. Disconnect the stator wire connector (A) at voltage regulator/rectifier.
2. Test stator between connector pins (B and C) for resistance. Stator coil resistance should meet specifications.
3. Test stator for continuity between each connector pin and ground. There should be no continuity (infinite resistance).

Results

If readings do not meet specifications, replace stator.

Specifications

Stator Coil Resistance (Maximum) 0.1 ohm

Test Spark

Reason

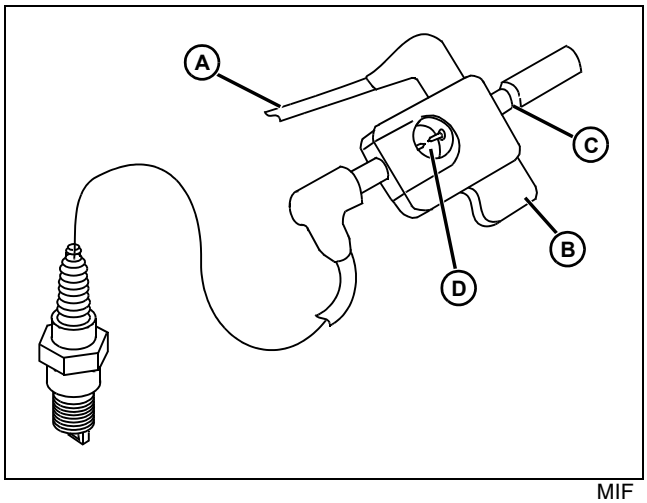
To determine condition of the ignition system.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Spark Tester	D05351ST	Used to test ignition system.

Procedure

1. Park machine safely on level surface. (See “Park Machine Safely” on page 3.)
2. Turn key switch to the OFF position.
3. Move gearshift pedals to NEUTRAL position.
4. Lock park brake.
5. Raise rear body cowling.



MIF

6. Remove high tension lead (A) from spark plug and connect to spark tester (B).
7. Connect spark tester lead to spark plug.
8. Adjust spark tester gap to 4.2 mm (0.166 in.) with screw (C).

Note: Do not adjust spark tester gap beyond 5.0 mm (0.200 in.) because damage to ignition system components could occur.

9. Start engine and watch spark (D) at tester.
10. If there is no spark:
    - Check for proper safety interlock setup.
    - Check for shorted stop switch.
    - Check for closed engine diodes.
    - Check for armature failure.

Results

- If engine will start, watch spark with engine running. There should be a strong, steady, blue spark.
- If spark is weak, or if no spark, install new spark plug and test again.
- If spark is still weak, or still no spark, check armature air gap and adjust as needed.
- If spark is still weak, or still no spark, perform ignition system diagnosis. (See “System: Ignition Circuit Diagnosis” on page 117.)
- Replace coils as needed.

Test Flywheel Magnet

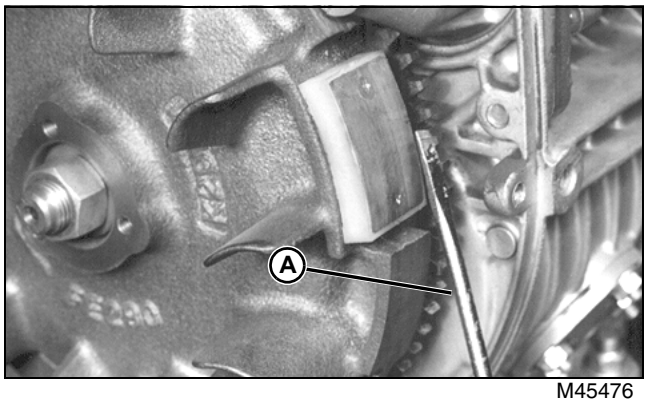
Reason

To make sure flywheel magnet(s) has enough force to induce current into ignition coil.

Procedure

Note: This is a rough test and should be used to determine flywheel magnet strength only if no other cause for weak or no spark is found.

1. Park machine safely on level surface. (See “Park Machine Safely” on page 3.)
2. Turn key switch to OFF position.
3. Move gearshift pedals to NEUTRAL position.
4. Lock park brake.
5. Raise rear body cowling.
6. Remove flywheel blower housing from engine. (See “Blower Housing Removal and Installation” on page 57.)
7. Rotate flywheel so magnet is away from coil.



M45476

8. Loosely hold screwdriver blade (A) about 25 mm (1.0 in.) away from magnet.

Results

- Magnet should attract blade to it.

• If blade is NOT attracted to magnet, flywheel must be replaced.

Test Key Switch

Reason

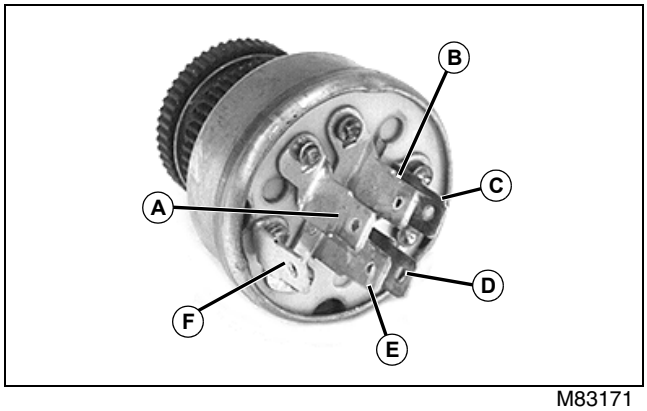
To verify that the key switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.

Procedure

1. Park machine safely on level surface. (See “Park Machine Safely” on page 3.)
2. Move control levers to NEUTRAL position.
3. Turn key switch to OFF position.
4. Lock park brake.
5. Remove right-side control console cover.
6. Disconnect key switch connector.



M83171

7. Use a multimeter to test switch continuity in OFF, RUN, and START positions.

Note: DO NOT refer to markings if stamped on terminals. Identify by callouts on art above ONLY. Terminal combinations other than those listed should not have continuity.

Key Switch Continuity

Switch Position	Terminal Continuity
OFF	C and D
RUN	E and F
START	E and F; A and B

Results

• If any continuity is NOT correct, replace the switch.

Test Neutral Start Switch

Reason

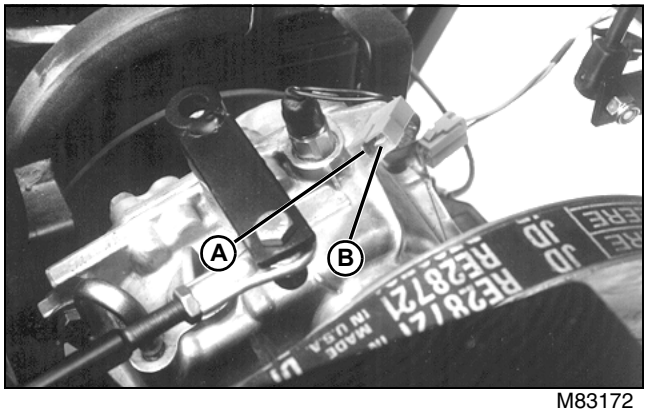
To verify that the neutral start switch has continuity when the transaxle is in neutral.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.

Procedure

1. Park machine safely on level surface. (See “Park Machine Safely” on page 3.)
2. Turn key switch to OFF position.
3. Move gearshift pedals to NEUTREAL position.
4. Lock park brake.
5. Lower front blade (if equipped).
6. Raise rear body cowling.
7. Disconnect neutral start switch wiring connector.



M83172

8. Check continuity across terminals (A and B). There should be continuity.
9. Depress and hold forward or reverse pedal to engage transaxle.
10. Check continuity across terminals (A and B). There should be no continuity.

Results

• If continuity is not correct, replace switch and retest.

• If after replacing switch, there is still no continuity when the transaxle is in the NEUTRAL position, inspect transaxle linkage.

Test Lift Switch

Reason

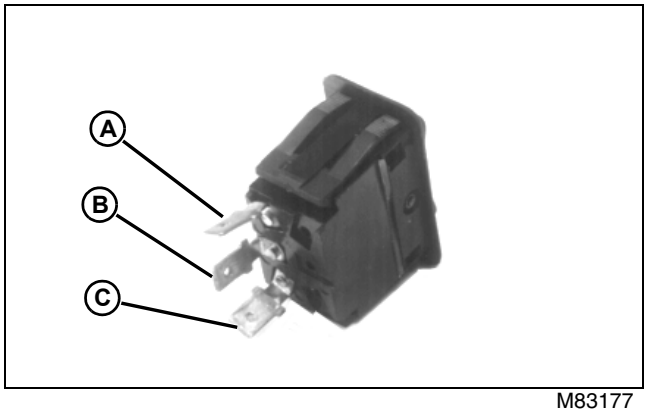
To verify that the lift switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.

Procedure

1. Park machine safely on level surface. (See “Park Machine Safely” on page 3.)
2. Turn key switch to OFF position.
3. Move gearshift pedals to NEUTRAL position.
4. Lock park brake.
5. Remove dash panel. (See “Remove and Install Dash Panel” on page 243.)
6. Disconnect lift switch wiring connector.



M83177

7. With switch in LIFT position, use a multimeter to check for the following:
   a. Continuity exists between terminals (B and C).
   b. No continuity exists between terminals (A and B).
8. With switch in LOWER position, use an ohmmeter or continuity tester to check for the following:
   - Continuity exists between terminals (A and B).
   - No continuity exists between terminals (B and C).

Results

If switch fails any continuity tests, replace switch.

Test Relay

Reason

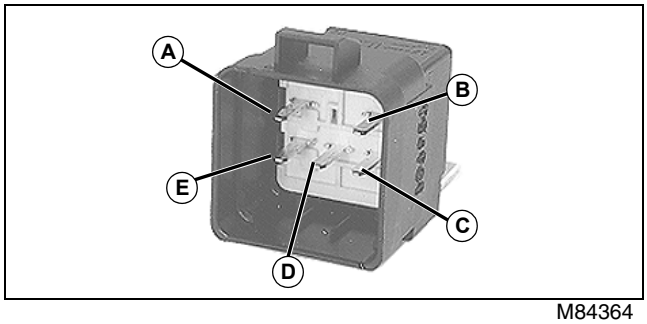
To check relay terminal continuity in the energized and de-energized conditions.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.

Procedure

1. Park machine safely on a level surface. (See “Park Machine Safely” on page 3.)
2. Move key switch to OFF position.
3. Lock park brake.
4. Remove right-side control console cover.
5. Raise and latch seat platform.
6. Disconnect relay(s) from harness.



M84364

7. Using a multimeter, check for continuity between terminals 87A (D) and 30 (A). There should be continuity between terminals 87A and 30.
8. Using a multimeter, check for continuity between terminals 87 (C) and 30 (A). There should NOT be continuity between terminals 87 and 30.
9. Using a multimeter, check for continuity between terminals 85 (E) and 86 (B). There should be continuity between terminals 85 and 86.
10. Connect a jumper wire from battery positive (+) to relay terminal 85 (E). Connect a jumper wire from battery negative (-) to relay terminal 86 (B). The relay should energize with an audible click.
11. Using a multimeter, check for continuity between terminals 87 (C) and 30 (A). There should be continuity between terminals 87 and 30.

Results

- If continuity is not correct, replace relay.

Test Fuse

Reason

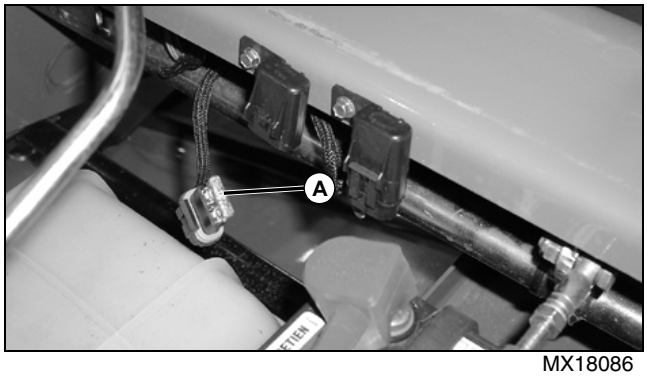
To verify that the fuse has continuity.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.

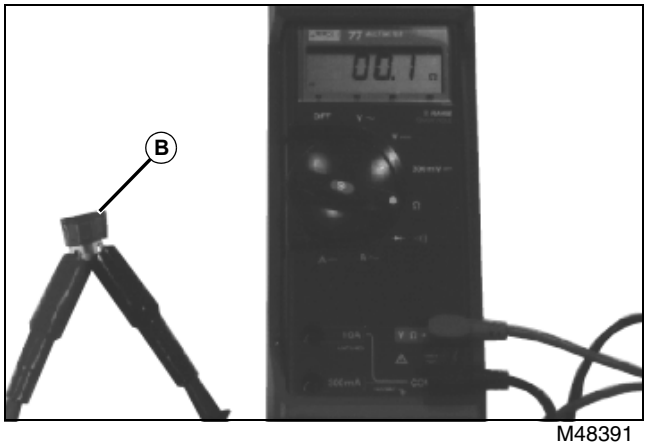
Procedure

1. Park machine safely on a level surface. (See “Park Machine Safely” on page 3.)
2. Move key switch to OFF position.
3. Lock park brake.
4. Raise and latch seat platform.



MX18086

5. Remove fuse (A) from fuse harness connector.



M48391

6. Check visually for broken filament.
7. Connect multimeter to each end of fuse (B).
8. Check for continuity.

Results

- If continuity is not indicated, replace fuse.

Test Circuit Breaker

Reason

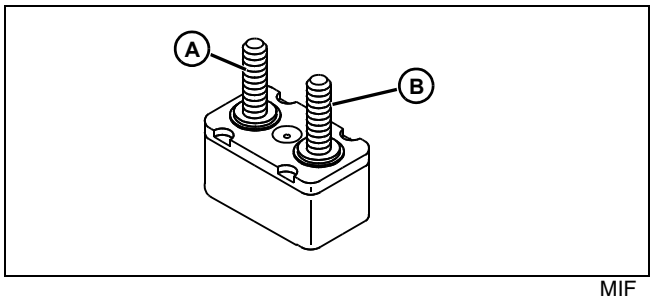
To check circuit breaker condition.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance, current, and voltage.

Procedure

1. Park machine safely on level surface. (See “Park Machine Safely” on page 3.)
2. Turn key switch to OFF position.
3. Disconnect one wire from the circuit breaker.



MIF

4. Check terminal continuity using a multimeter.
   - There should be continuity between terminals (A and B).

Note: This is a thermal circuit breaker. If continuity is not present, allow circuit breaker to cool and reset.

Results

If continuity is NOT present, replace circuit breaker.

Repair

Remove and Install Battery

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.

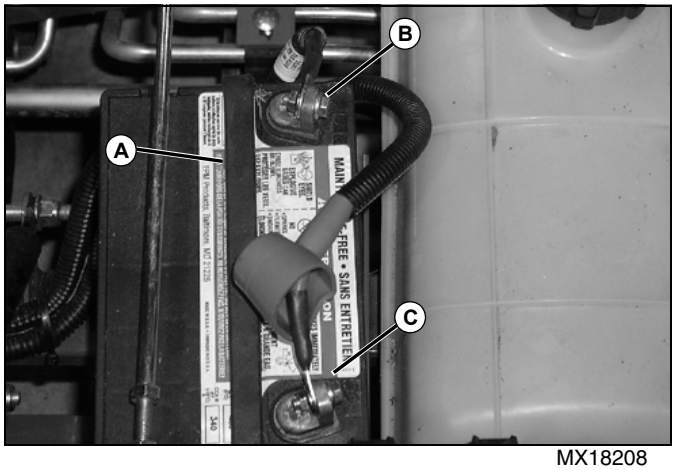
3. Flush your eyes with water for 15-30 minutes. Get medical attention immediately.

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 qt).

3. Get medical attention immediately.



MX18208

1. Disconnect negative (-) cable (B) first, then positive (+) cable (C).

2. Remove strap (A).

3. Remove battery.

Installation

Installation is done in the reverse order of removal.

- Clean battery if dirty. (See “Clean Battery” on page 149.)
- Inspect battery terminals and case for breakage or cracks. Replace if needed.
- Test battery condition. (See “Test Battery” on page 137.)
- Connect negative (-) cable last.

Clean Battery

1. Remove battery from machine. (See “Remove and Install Battery” on page 149.)

Note: Keep cleaning solution out of battery cells.

2. Clean battery, battery terminals, cable ends, bracket and battery box with a solution of one part baking soda and four parts water.

3. Rinse all parts with clean water. Let dry thoroughly.

4. Apply petroleum jelly to battery terminals to prevent corrosion.

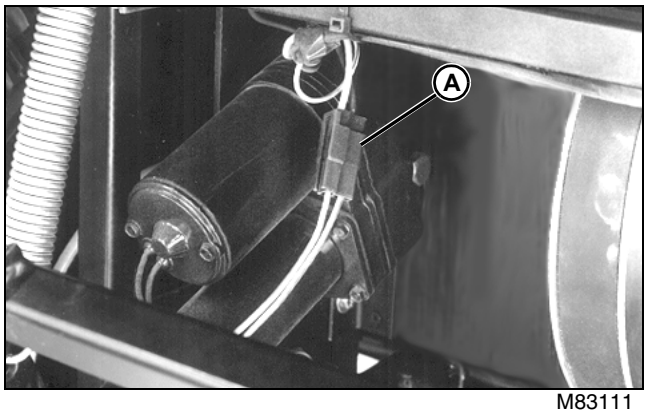
Remove and Install Lift Actuator

Removal

Note: Lift actuator mounting position and orientation may vary depending on the implement being used. (See “Attachments” on page 227.)

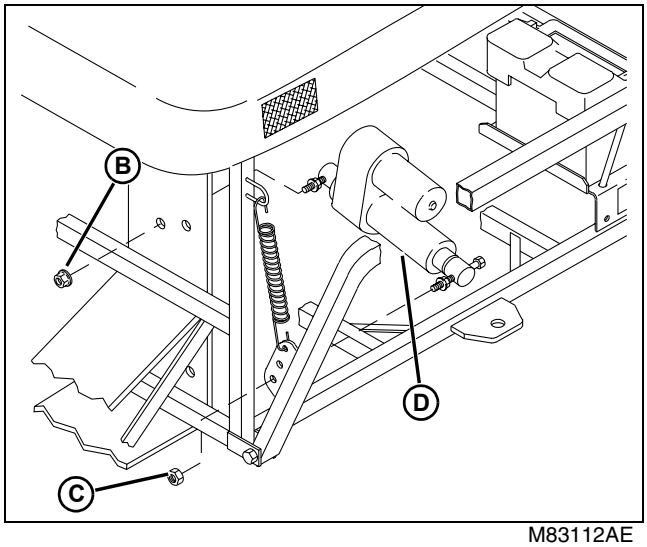
1. Remove rear implement. (See “Attachments” on page 227.)

2. Raise lift bar to full UP position.



M83111

3. Disconnect wiring connector (A).



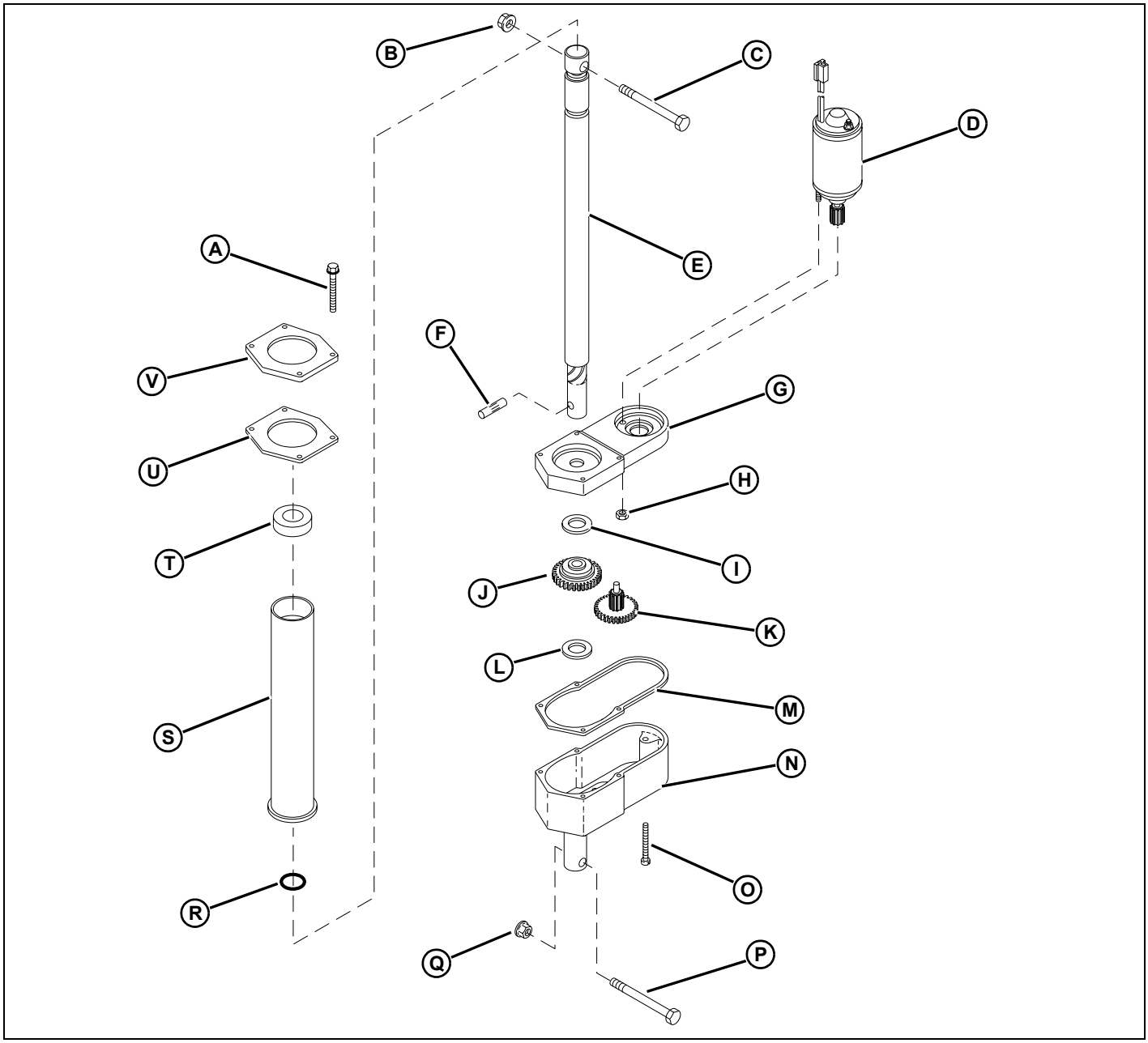
M83112AE

4. Remove nuts (B and C).
5. Remove lift motor (D).

Installation

Installation is done in the reverse order of removal.

Disassembly



M83131AE

A- Retaining Plate-to-Lower Gear Housing Cap Screw (4 used)
B- Flange Nut
C- Cap Screw
D- Lift Motor
E- Actuator Screw Assembly
F- Pin
G- Upper Gear Housing
H- Motor Nut (2 used)
I- Thrust Washer
J- Clutch
K- Intermediate Gear
L- Thrust Washer
M- Gasket
N- Lower Gear Housing
O- Lower Gear Housing-to-Upper Gear Housing Cap Screw
P- Cap Screw
Q- Flange Nut
R- O-Ring
S- Cover Tube
T- Seal
U- Gasket
V- Retaining Plate

Note: Remove seal only if replacement is necessary.

1. Inspect all parts for wear or damage.

Important: Avoid Damage! When replacing motor, note direction that the motor is installed. Intermediate gear should ride close to the center of motor gear.

2. Replace parts as necessary.
3. Install new gaskets.

Assembly

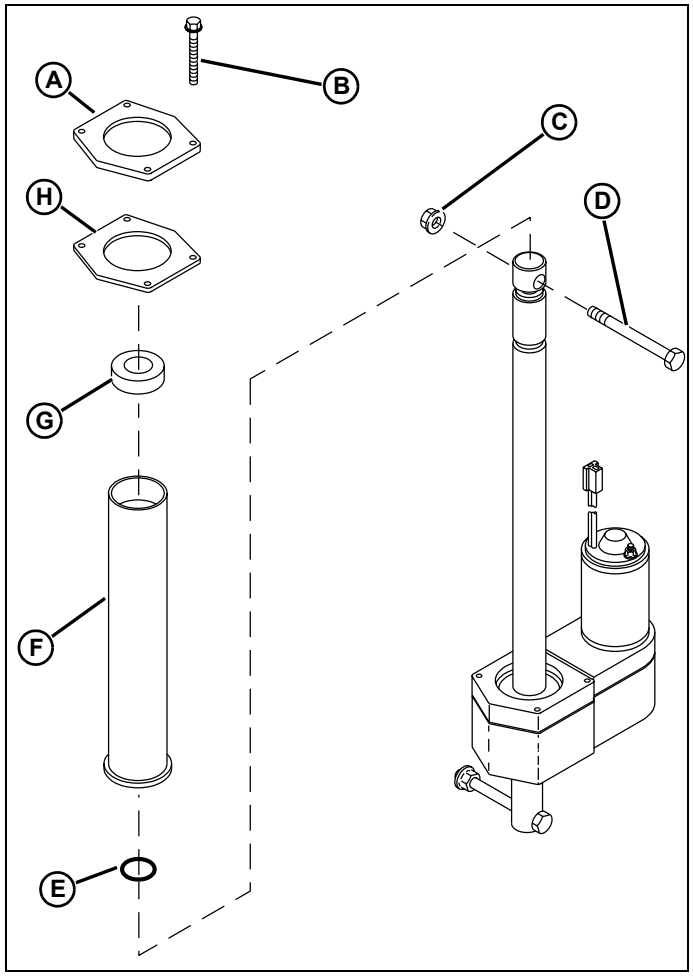
Assembly is done in the reverse order of disassembly.

Specifications

Lift Actuator

Retaining Plate Cap Screw Torque . . . 8 N•m (70 lb-in.)
Lower Housing Cap Screw Torque . 2.3 N•m (20 lb-in.)
Motor Nut Torque . . . . . 8 N•m (70 lb-in.)

Replace Cover Tube Seal



M83134AE

A- Retaining Plate
B- Retaining Plate-to-Lower Gear Housing Cap Screw (4 used)
C- Flange Nut
D- Cap Screw
E- O-Ring
F- Cover Tube
G- Seal
H- Gasket

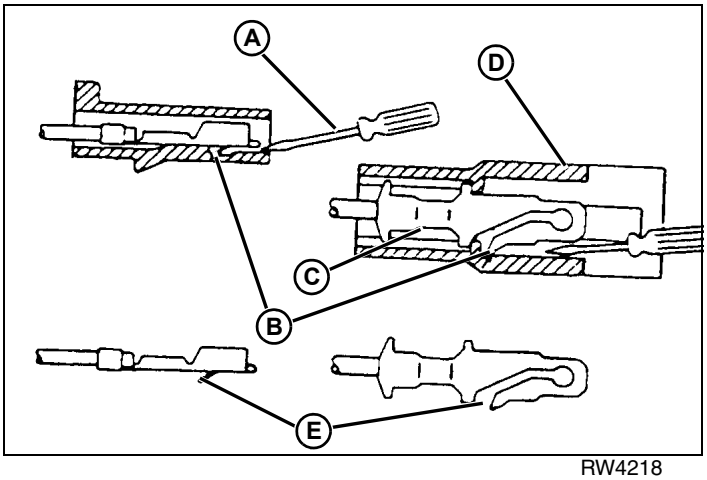
1. Remove cover tube (F).
2. Remove seal (G) from cover tube using a disk and driver set.
3. Install seal and O-ring (E) until flush with end of tube.
4. Install cover tube using new gasket (H).

Specifications

Lift Actuator

Retaining Plate Cap Screw Torque . . . 8 N•m (70 lb-in.)

Connector Body - Blade Terminals



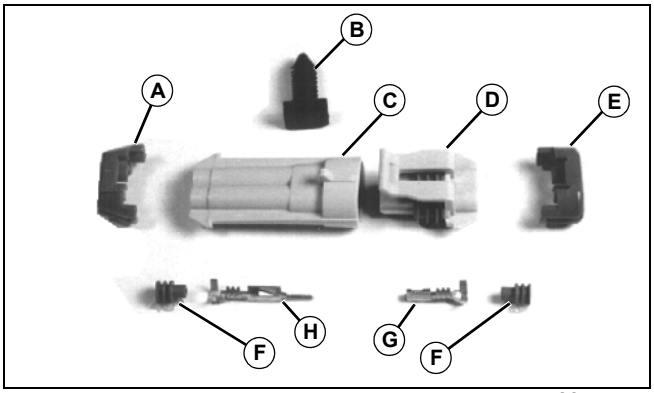
RW4218

1. Use a small screwdriver (A) to depress locking tang (B).
2. Slide terminal (C) from connector body (D).
3. Be sure to bend locking tang back to original position (E) before installing connector body.

METRI-PACK™ Connector Removal

Special or Required Tools

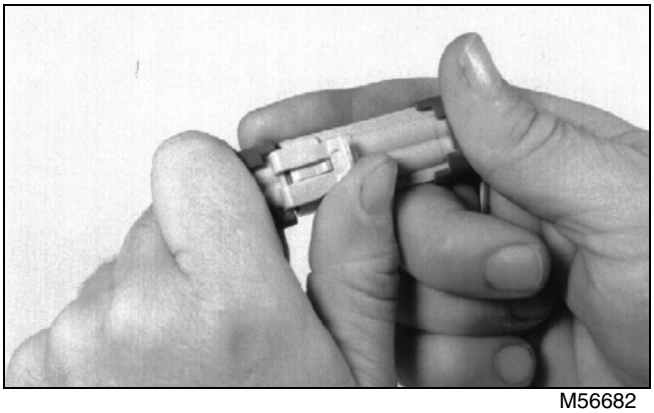
Tool Name	Tool No.	Tool Use
Extractor Weatherpack, Narrow	JDG777	Used to depress locking tang and remove contact.



M56685

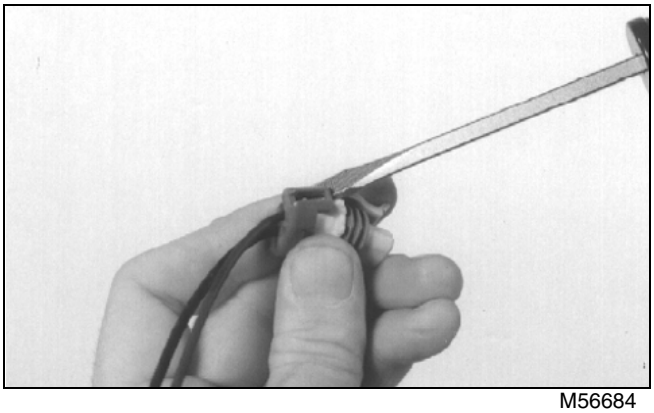
A- Wire Retainer
B- Mounting Post
C- Pin Body
D- Sleeve Body
E- Wire Retainer
F- SHURE-Seal
G- Sleeve
H- Pin

Important: Avoid Damage! Identify wire number/ color locations with connector terminal letters.



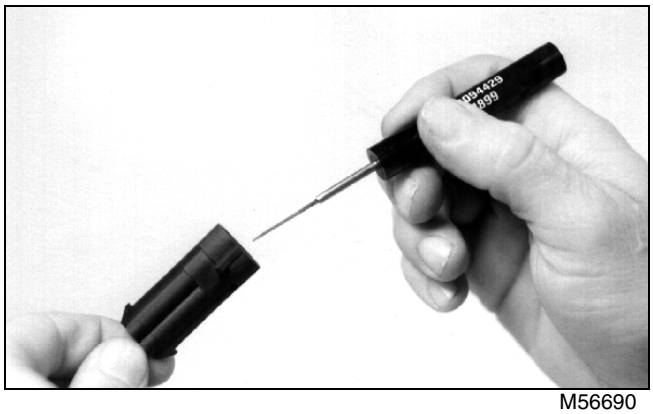
M56682

1. Open connector body.

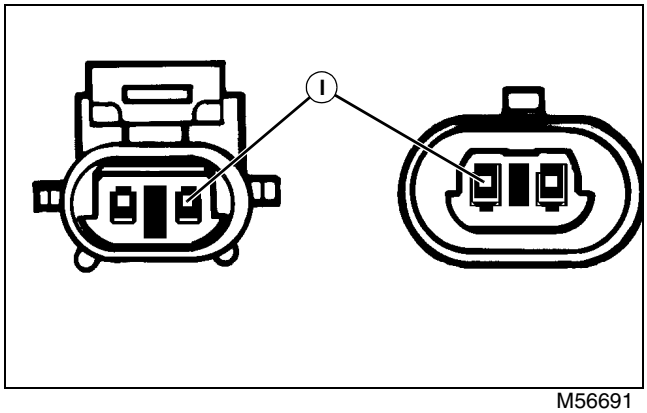


M56684

2. Remove retainer on wire end of connector with a screwdriver.



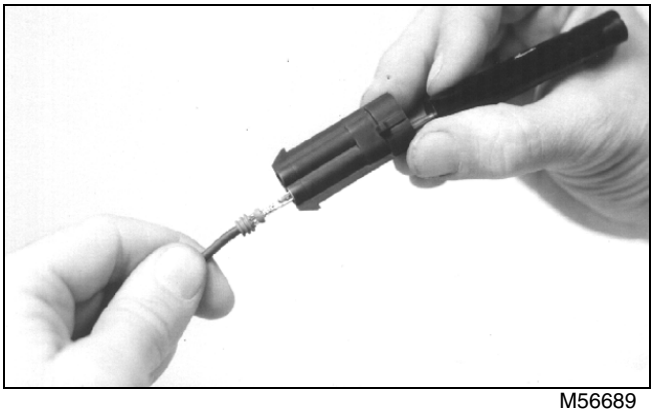
M56690



M56691

3. Use JDG777 Weatherpack, narrow extractor to remove contact from connector body at position (I).

Note: To remove sleeve connector from sleeve body (short connector half), insert tool in slot between terminal contact and connector body. To remove pin connector from pin body (long connector half), insert tool in center of contact.



M56689

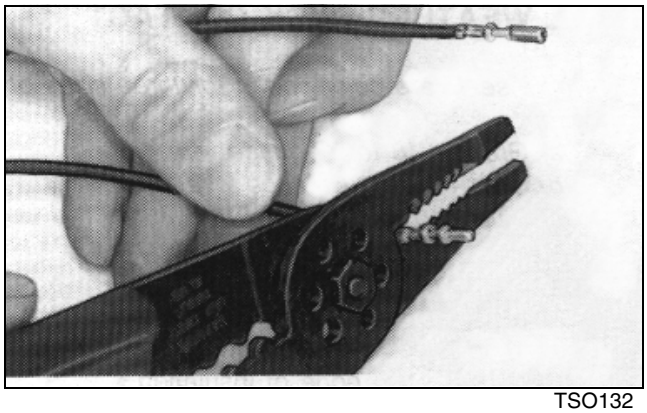
4. Hold the removal tool fully seated and pull wire from connector body.

METRI-PACK™ Connector Replacement

Special or Required Tools

Tool Name	Tool No.	Tool Use
Electrician's Pliers	JDG145	Used to cut and strip wire.
Crimper	JDG360	Used to crimp contact in place on wire. Used to secure cable seal to contact.

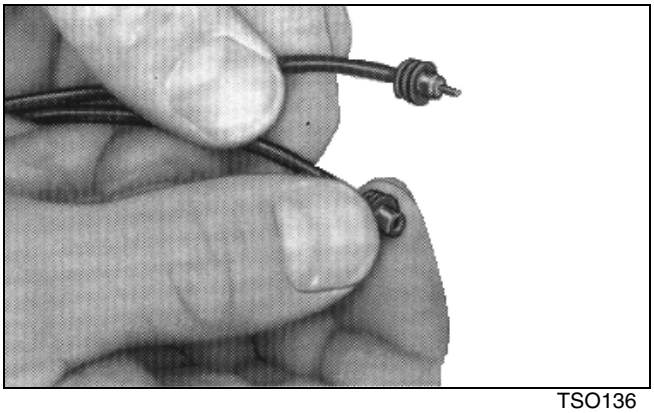
1. Remove wire from connector body as described above.



TSO132

2. Use JDG145 Electrician's Pliers to remove wire as close as possible to old contact.

Important: Avoid Damage! METRI-PACK connectors are keyed A, B, C, etc., for proper contact mating. Be sure contacts and wire colors/numbers match and are in proper alignment.

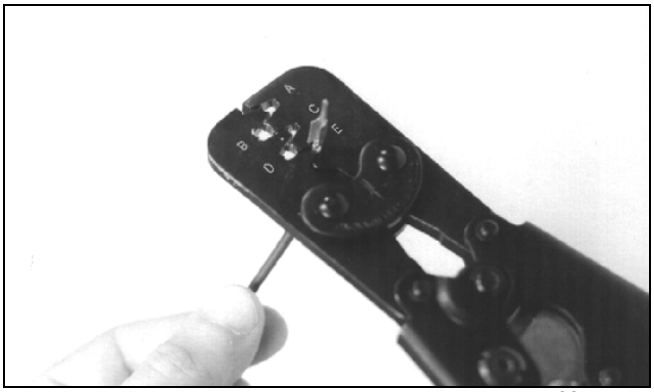


TSO136

3. Install correct size cable seal on wire.

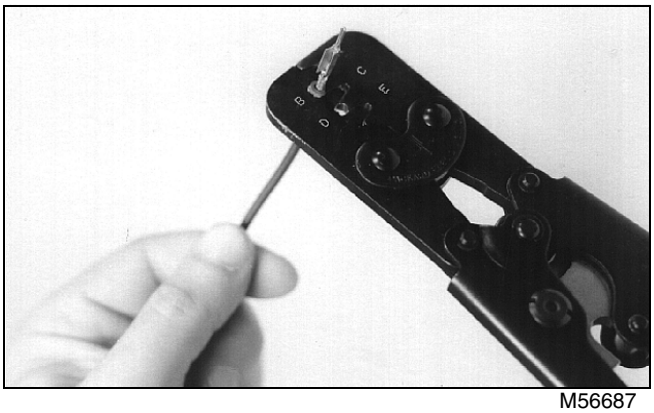
Note: Cable seals are available for three sizes of wire:
- ***Large - 1.0 mm (16 gauge) wire***
- ***Medium - 0.8 mm (18 gauge) wire***
- ***Small - 0.5 mm (20 gauge) wire***

4. Strip insulation from wire to expose 6 mm (1/4 in.) and align cable seal with edge of insulation.



M56686

5. Place proper size contact on wire and use crimper to crimp contact in place with a "W" type crimp.

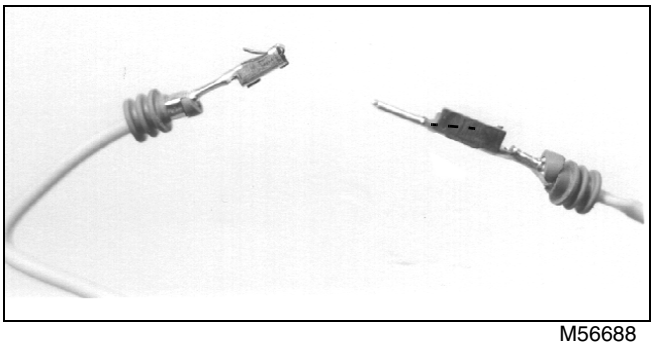


M56687

6. Use crimper to secure cable seal to contact as shown.

Important: Avoid Damage! Proper barb location and orientation for installation of sleeve and pin are shown.

Note: Connector bodies are keyed for proper contact mating. Be sure contacts are in proper alignment.



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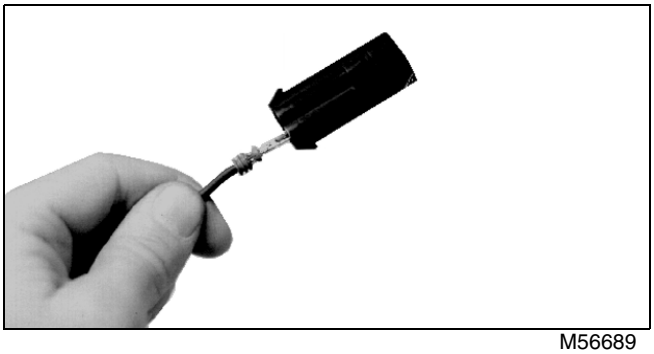
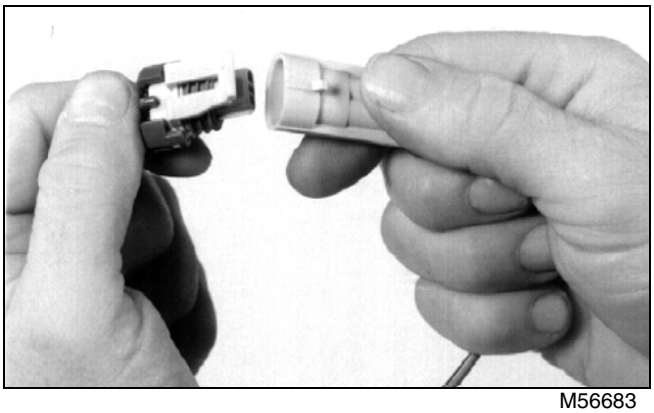


M56689

7. Push contact into new connector body until fully seated.

8. Pull on wire slightly to be certain terminal is locked in place.

9. Install wire retainer.



M56683

10.Transfer remaining wires to correct terminal in new connector.

11.Place retainer on wire end of connector and snap in place.

12.Close connector body.

Table of Contents

POWER TRAIN - GEAR SPECIFICATIONS

Specifications

Test and Adjustment Specifications

Specifications

Drive Belt Width (Minimum)	27 mm (1.0625 in.)
Drive (Primary) Clutch Engagement Speed	1550 rpm

Vehicle Driving Check

Standing Start Through 15.2 m (50 ft) Time	7.0 seconds
Standing Start Through 30.5 m (100 ft) Time	10.0 seconds
Travel Time Through 30.5 m (100 ft) (at Full Throttle)	6.0 seconds

Repair Specifications

Drive (Primary) Clutch

Mounting Cap Screw Torque	50 N•m (37 lb-ft)
Spider Torque	135 N•m (100 lb-ft)

Driven (Secondary) Clutch

Mounting Cap Screw Torque	24 N•m (18 lb-ft)
Driven (Secondary) Clutch Spring Torsion Standard Wrap	22-40 N (5-9 lb)

Transaxle

Oil Capacity	2.3 L (2.5 qt)
Axle Shaft Bearing Carriage Screw Torque	25 N•m (216 lb-in.)
Transaxle-to-Frame Cap Screw Torque	50 N•m (37 lb-ft)
Transaxle Case Cap Screw Torque	
(Same Case)	25 N•m (228 lb-in.)
(New Case)	29 N•m (21 lb-ft)
Neutral Start Switch Torque	39 N•m (29 lb-ft)
Breather Torque	10 N•m (90 lb-in.)
Shift Shaft	
Cap Screw	(25 N•m (228 lb-in.)
Shift Shaft OD	16.96-17.00 mm (0.668-0.669 in.)
Shift Shaft Bore ID	17.02-17.04 (0.670-0.671 in.)
Shift Shaft-to-Bore Clearance (Maximum)	0.2 mm (0.01 in.)
Shift Block Width	13.7-13.9 mm (0.054-0.055 in.)
Shift Block-to-Collar Clearance (Maximum)	2.0 mm (0.08 in.)
Input Shaft Assembly	
Drive Gear Washer Thickness	1.45-1.55 mm (0.057-0.061 in.)
Reverse Sprocket Washer Thickness	1.55-1.65 mm (0.061-0.064 in.)
Drive Gear ID	24.01-24.02 (0.945-0.946 in.)
Input shaft OD (Reverse Gear)	19.987-20.00 mm (0.7868-0.7874 in.)
Input shaft OD (Driver Gear)	19.99-20.01 mm (0.787-0.788 in.)
Reverse Sprocket ID	24.01-24.02 mm (0.945-0.946 in.)
Shift Collar Groove Width	14.1-14.3 mm (0.55-0.56 in.)
Detent Spring Free Length	24.2 mm (0.95 in.)
Free Length (Minimum)	20.0 mm (0.79 in.)

Working Load Length . . . . . 15.8 mm@ 53 N (0.62 in. @ 12 lb)
Differential Assembly Differential Nut Torque . . . . . 27 N•m (19 lb-ft)
Differential Lock Collar Groove Width . . . . . 7.1-7.3 mm (0.28-0.29 in.)
Washer Thickness . . . . . 0.74-0.86 mm (0.28-0.29 in.)
Bevel Pinion ID . . . . . 0.93-1.04 mm (0.631-0.632 in.)
Pinion Shaft OD . . . . . 15.95-15.97 mm (0.628-0.629 in.)
Pinion Shaft-to-Bevel Pinion Clearance . . . . . 0.2 mm (0.01 in.)
Differential Lock Shaft Lock Fork Finger thickness . . . . . 6.7-6.9 mm (0.26-0.27 in.)
Lock Fork-to-Shift Lock Collar Groove Clearance (Maximum) . . . . . 2.0 mm (0.08 in.)
Lock Fork ID . . . . . 20.05-20.10 mm (0.789-0.791 in.)
Differential Lock Shaft OD (at Fork Seating Area) . . . . . 0.5 mm (0.02 in.)
Differential Lock Spring
Free Length . . . . . 77.6 mm (3.06 in.)
Working Length . . . . . 52 mm@ 511 N•m (2.07 in. @ 15 lb)

Drive Clutch

Transmission Output Sheave Setscrew Torque . . . . . 24 N•m (18 lb-ft)

Driven Clutch

Spring Force . . . . . 22-40 N (5-9 lb)

Axle Bearing Flange

Axle Bearing Flange Carriage Bolt Torque . . . . . 25 N•m (216 lb-in.)
Transaxle Cap Screw Torque . . . . . 50 N•m (37 lb-ft)

Transaxle Specifications

Shift Shaft

Shift Shaft OD . . . . . 16.96-17.00 mm (0.668-0.669 in.)
Shift Shaft Bore ID . . . . . 17.02-17.04 mm (0.670-0.671 in.)
Shift Shaft-to-Bore Clearance (Maximum) . . . . . 0.2 mm (0.01 in.)

Shift Block

Shift Block Width . . . . . 13.7-13.9 mm (0.08 in.)
Shift Block-to-Collar Clearance (Maximum) . . . . . 2.0 mm (0.08 in.)

Drive

Drive Gear Washer Thickness . . . . . 1.45-1.55 mm (0.057-0.061 in.)
Reverse Sprocket Washer Thickness . . . . . 0.65-0.75 mm (0.026-0.029 in.)
Drive Gear ID . . . . . 24.01-24.02 mm (0.945-0.946 in.)
Input Shaft OD (Diameter “B”) . . . . . 19.987-20.000 mm (0.7868-0.7874 in.)
Input Shaft OD (Diameter “A”) . . . . . 19.99-20.01 mm (0.787-0.788 in.)
Reverse Sprocket ID . . . . . 24.01-24.02 mm (0.945-0.946 in.)
Shift Grove Width . . . . . 14.1-14.3 mm (0.55-0.56 in.)

Detent Spring

Free Length . . . . . 24.2 mm (0.95 in.)
Free Length (Minimum) . . . . . 20.0 mm (0.79 in.)
Working Load Length . . . . . 15.8 mm @ 53 N (0.62 in. @ 12 lb)

POWER TRAIN - GEAR SPECIFICATIONS

Differential Specifications

Differential Lock Collar Groove Width	**7.1-7.3 mm (0.28-0.29 in.)**
Washer Thickness	**0.74-0.86 mm (0.029-0.034 in.)**
Bevel Pinion Washer Thickness	**0.96-1.04 mm (0.038-0.041 in.)**
Bevel Pinion ID	**16.03-16.05 mm (0.631-0.632 in.)**
Pinion Shaft OD	**15.95-15.97 mm (0.628-0.629 in.)**
Pinion Shaft-to-Bevel Pinion Clearance (Maximum)	**0.2 mm (0.01 in.)**

Lock specifications

Lock Fork Finger Thickness	**6.7-6.9 mm (0.26-0.27 in.)**
Lock Fork Finger-to-Lock Collar Groove Width Clearance	**2.0 mm (0.08 in.)**
Lock Fork ID	**20.05-20.10 mm (0.789-0.791 in.)**
Lock Shaft OD	**19.95-20.00 mm (0.785-0.787 in.)**
Lock Shaft OD to Lock Fork ID Clearance	**0.5 mm (0.02 in.)**
Lock Spring Free Length	**77.6 mm (3.06 in.)**
Lock Spring Working Length	**52 mm @ 511 N•m (2.07 in. @ 115 lb)**

Torque Specifications

Shift Shaft Cap Screw	**25 N•m (228 lb-in.)**
Neutral Start Switch	**39 N•m (29 lb-ft)**
Differential Halves to Differential Gear Nuts	**27 N•m (19 lb-ft)**

Case Assembly Cap Screw Torque

Same Case	**25 N•m (228 lb-in.)**
New Case	**29 N•m (21 lb-ft)**
Breather	**10 N•m (90 lb-in.)**

Special or Essential Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Clutch Removal Tool	JDG813-1	Used to remove primary clutch.
Spanner Wrench	JDG813-2	Used to disassemble primary clutch.
Tapered Holding Tool	JDG813-3	Used to hold primary clutch while performing service.
Hand-Held Digital Tachometer	N/A	Used to measure engine rpm.
Tapered Holding Tool	N/A	Used to measure spring tension.

Other Materials

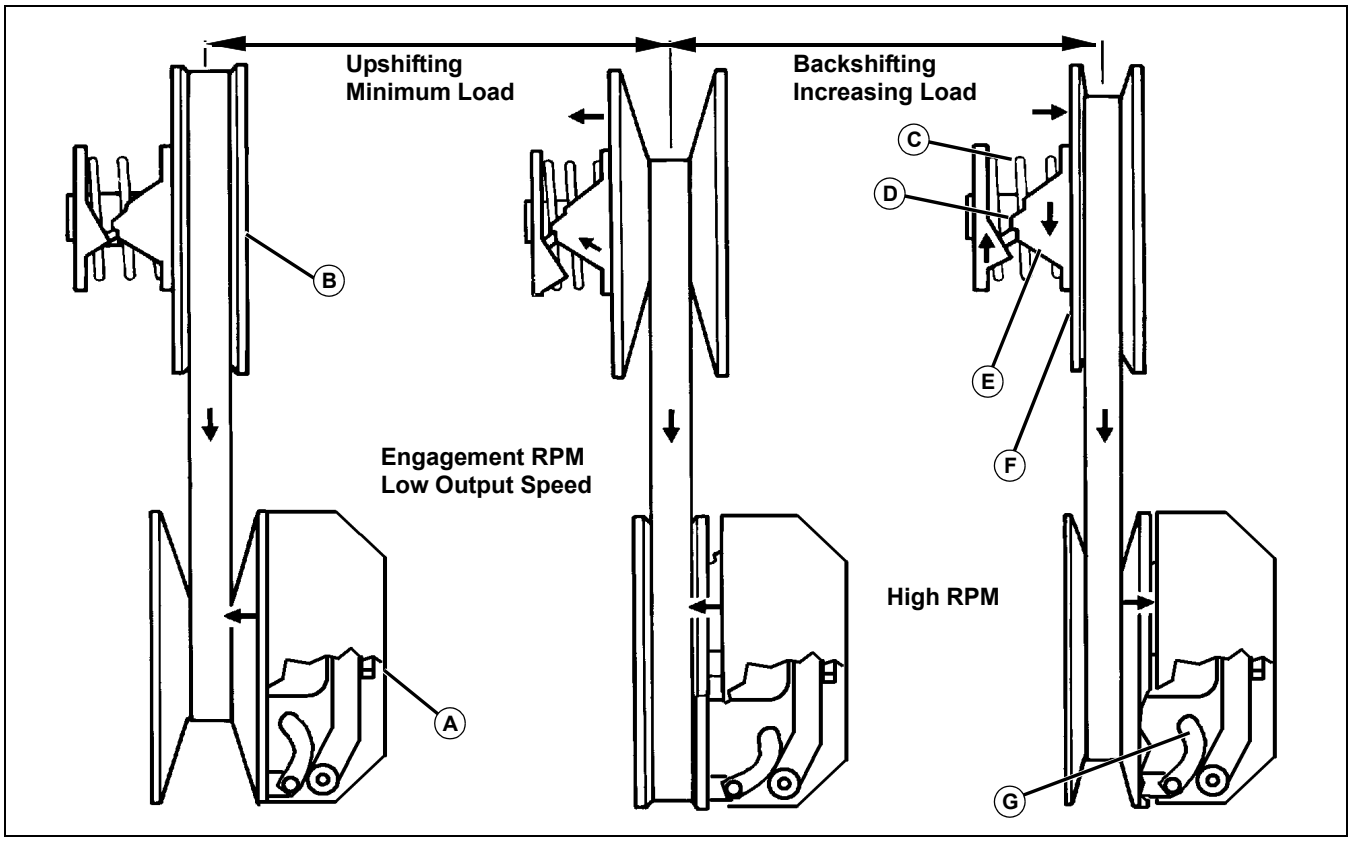
Other Material

Part No.	Part Name	Part Use
M79292	MPG-2®[1] Polymer Multipurpose Grease	Prevents parts from seizing. Apply to transaxle axles shafts.
TY22034	John Deere SUPERLUBE®	Apply to rollers and cam weight pivots of drive clutch.
T43512	Thread Lock and Sealer (Medium Strength)	Apply to various fasteners.
TY6305/ TY9485/ 764	Clean and Cure Primer	Clean transmission case mating surfaces.
TY6304/ TY94854/ 518	Flexible Sealant	Seal transmission case.

1. MPG-2 is a registered trademark of DuBois USA.

Component Location and Operation

Clutch System Component Location and Operation



M56089

A- Drive (Primary) Clutch
B- Drive (Secondary) Clutch
C- Spring
D- Wear Buttons
E- Ramp
F- Movable Sheave
G- Flyweights

Function

To transmit engine power to the transaxle.

Theory of Operation

The variable clutch system is speed and load sensitive. The primary and secondary clutches work together, automatically upshift and backshift. This shifting changes the ratio between the clutches, allowing the engine to operate at optimum efficiently, at the peak of its power curve.

The primary drive clutch is mounted on the engine crankshaft and operates on the principle of centrifugal force, and is sensitive to engine speed. The secondary clutch, mounted on the transaxle input shaft, is load sensitive.

Engagement RPM, Minimum Load, Low Output Speed

Primary clutch sheaves are moving closer together, just starting to move the drive belt. Belt is running at the top of the secondary clutch. A high ratio between the clutches exists, similar to a low gear as long as there is a minimum load.

High Engine RPM, Light Load, High Output Speed

As engine speed increases, centrifugal force acting on the flyweights forces the primary clutch to upshift, moving the belt to the outer pulley diameter, overcoming secondary clutch spring. The belt is then pulled deep into the secondary clutch, resulting in a low ratio, similar to a high gear.

High Engine RPM, Increasing Load, Lower Output Speed

Backshifting occurs as a load such as a hill or soft terrain is encountered. The stationary side of the secondary clutch resists forward movement of the wheels; at the same time, torque from the belt moves the movable sheave up the ramp. The ramp and spring force the belt to the outside diameter of the secondary clutch and overcome centrifugal forces of the primary, clutch causing backshifting.

Transaxle Component Location and Operation

Function

The transaxle provides:

- A means for shifting into forward, neutral and reverse.
- Differential action between axles for turning.
- Differential lock, allowing axles to be locked together for better traction.

Neutral Power Flow

In neutral the shift levers center the shift collar between the forward and reverse gears so that neither is engaged. The input shaft rotates freely and no power is transferred to the intermediate shaft.

In this position, the shift fork engages the neutral start switch. The switch will allow the engine to be started only when the transaxle is in neutral.

Forward Power Flow

Power to the transaxle is supplied by the clutch system. The driven clutch and the shift collar are splined to the transaxle input shaft. When the transaxle is shifted to the forward position, the shift collar engages the forward gear. Power is transmitted from the input shaft through the shift collar, the forward drive gear, and the forward driven gear to the intermediate shaft. A gear on the intermediate shaft is in constant mesh with the differential gear. The differential gear and housing rotate together transmitting power through the bevel and pinion gears to the axles.

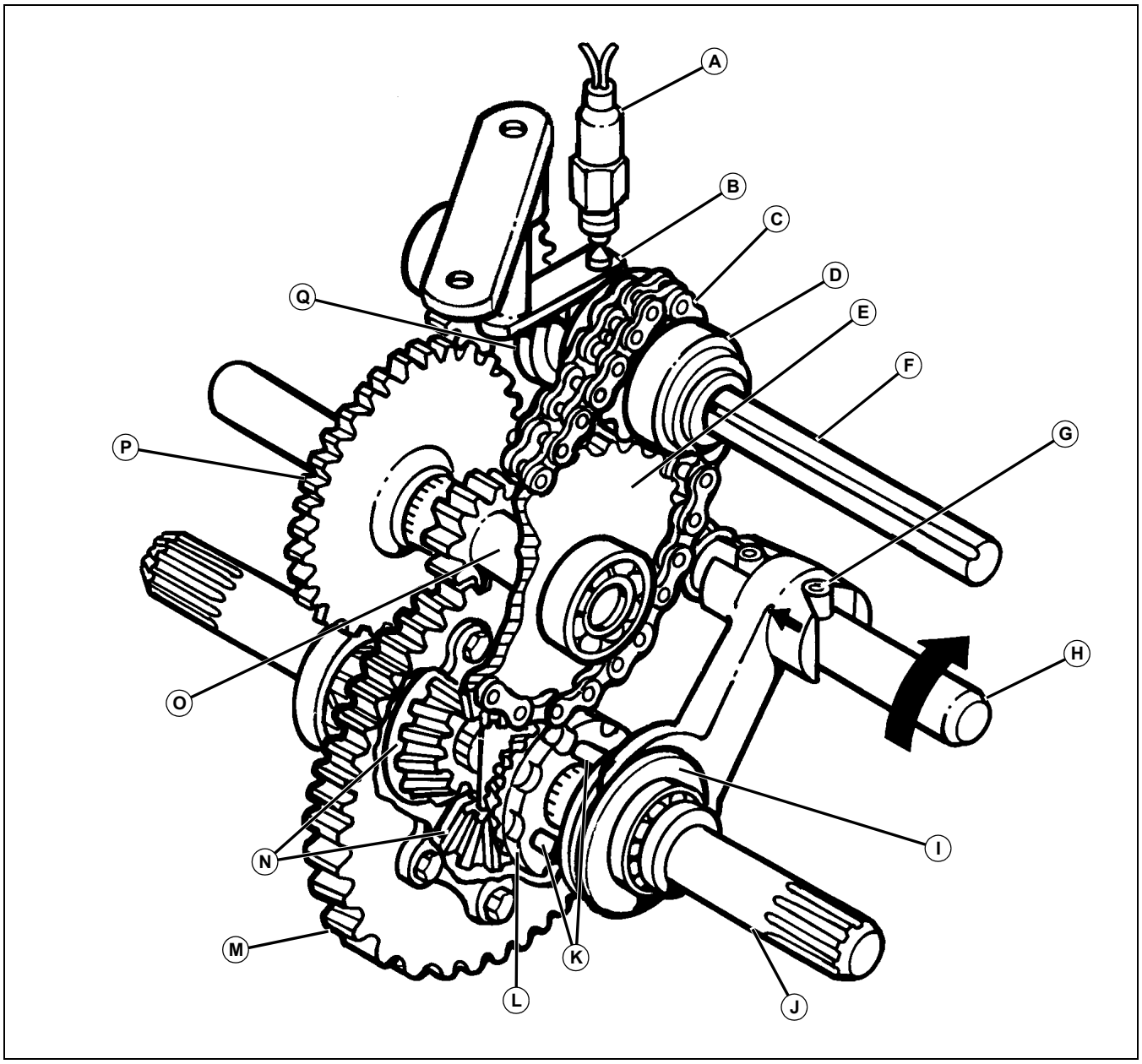
Reverse Power Flow

When shifted into reverse, the shift collar engages the reverse sprocket and transmits power through the reverse chain and driven sprocket to the intermediate shaft. The chain drives the intermediate shaft in the opposite direction from the forward gear, rotating the differential gear in the reverse direction. Power is transmitted through the differential to the axle.

Differential Lock

The differential lock is engaged by depressing the pedal at the operator station. As the pedal is depressed, the differential lock shaft turns. As the shaft turns, the shaft pins ride against the locking fork cam and push the locking collar and pins inward.

The locking pins slide into the bevel gear. This locks the differential gears to the housing, resulting in both axles turning at the same speed. As the pedal is released, the pedal return spring disengages the locking collar by pushing the fork outward.



M83135A

A- Neutral Start Switch
B- Shift Fork
C- Reverse Drive Chain
D- Reverse Drive Sprocket
E- Reverse Driven Sprocket
F- Transaxle Input Shaft
G- Shaft Pin
H- Differential Lock Shaft
I- Locking Collar
J- Output Shaft
K- Locking Collar Pins
L- Differential Housing
M- Differential Drive Gear
N- Bevel Gears
O- Intermediate Shaft
P- Forward Driven Gear
Q- Shift Collar

Diagnostics

Symptom: Machine Will Not Drive Straight

Test Conditions

- Machine parked on a level surface.
- Key switch in OFF position.
- Park brake unlocked.
- Control lever in NEUTRAL position.

Machine Will Not Drive Straight

1. Are both drive tires inflated to proper psi?

Yes: Go to next step.

No: Inflate evenly to proper pressure.

2. Is park brake unlocked?

Yes: Go to next step.

No: Unlock park brake.

3. Is drive belt free from damage (broken, worn, frayed, glazed, or stretched)?

Yes: Go to next step.

No: Replace drive belt. (See “Remove and Install Drive Belt” on page 174.)

4. Is drive clutch operating properly?

Yes: Go to next step.

No: Check for debris or binding. (See “Remove and Install Drive (Primary) Clutch” on page 174.)

5. Are transmission output sheaves secure?

No: Check setscrews and keyway. (See “Remove and Install Driven Pulley” on page 175.)

Symptom: Machine Will Not Move in Reverse

Test Conditions

- Machine parked on a level surface.
- Key switch in OFF position.
- Park brake unlocked.
- Control lever in forward NEUTRAL position.

Machine Will Not Move In Reverse

1. Is park brakes unlocked?

Yes: Go to next step.

No: Unlock park brake.

2. Is the park brake adjusted properly?

Yes: Go to next step.

No: Adjust park brake. (See “Adjust Brake Linkage” on page 221.)

3. Is gearshift selector lever in reverse?

Yes: Go to next step.

No: Move gearshift selector lever into reverse.

4. Is gearshift linkage adjusted properly?

No: See “Adjust Gearshift Linkage” on page 169.)

Symptom: Machine Will Not Reach Maximum Speed

Test Conditions

- Machine parked on a level surface.
- Key switch in OFF position.
- Park brake unlocked.
- Control levers in NEUTRAL position.

Machine Will Not Reach Maximum Speed

1. Is park brakes unlocked?

Yes: Go to next step.

No: Unlock park brake.

2. Is drive belt free from damage (broken, worn, frayed, glazed, or stretched)?

Yes: Go to next step.

No: Replace drive belt. (See “Remove and Install Drive Belt” on page 174.)

3. Is drive clutch operating properly?

No: Check for debris or binding. (See “Remove and Install Drive (Primary) Clutch” on page 174.)

Symptom: Machine Will Not Move When Controls Are Engaged

Test Conditions

- Machine parked on a level surface.
- Key switch in OFF position.
- Park brake unlocked.
- Control levers in NEUTRAL position.

Machine Will Not Move When Controls Are Engaged

1. Is park brakes unlocked?

Yes: Go to next step.

No: Unlock park brake.

2. Is engine to transmission drive belt free from damage (broken, worn, frayed, glazed, or stretched)?

Yes: Go to next step.

No: Replace engine-to-transmission drive belt. (See “Remove and Install Drive Belt” on page 174.)

3. Are engine output sheave and keyway free of damage?

Yes: Go to next step.

No: Replace sheave and/or key

4. Are transmission input sheave and keyway free of damage?

Yes: Go to next step.

No: Replace sheave and/or key.

5. Is transmission working properly?

No: Check transmission housing for cracks or damage.

Symptom: Jerky or Erratic Operation

Test Conditions

- Machine parked on a level surface.
- Key switch in OFF position.
- Park brake unlocked.
- Control levers in NEUTRAL position.

Jerky Or Erratic Operation

1. Is park brakes unlocked?

Yes: Go to next step.

No: Unlock park brake.

2. Is brake assembly free of debris?

Yes: Go to next step.

No: Clear debris from brake assembly.

3. Is brake caliper in working order?

Yes: Go to next step.

No: Check that brake caliper is free of any debris.

4. Is engine-to-transmission drive belt free from damage (broken, frayed, glazed, or stretched)?

Yes: Go to next step.

No: Replace belt. (See “Remove and Install Drive Belt” on page 174.)

5. Is transmission shift lever adjusted correctly?

Yes: Go to next step.

No: Adjust transmission shift lever. (See “Check Drive Belt” on page 168.)

6. Is motor running properly?

No: See “System: Engine Troubleshooting Guide” on page 35.

Symptom: Sluggish Operation Under Load

Test Conditions

- Machine parked on a level surface.
- Key switch in OFF position.
- Park brake unlocked.
- Control levers in NEUTRAL position.

Sluggish Operation Under Load

1. Is park brakes unlocked?

Yes: Go to next step.

No: Unlock park brake.

2. Is park brake adjusted properly?

Yes: Go to next step.

No: Adjust brake. (See “Adjust Brake Linkage” on page 221.)

3. Are tires and axles free of debris?

Yes: Go to next step.

No: Remove any foreign objects from wheel area and axle. (See “Remove and Install Rear Wheel” on page 246.)

4. Is transmission running properly?

No: Check external housing for cracks or damage. (See “Remove and Install Transaxle” on page 178.)

Symptom: Excessive Noise

Test Conditions

- Machine parked on a level surface.
- Key switch in OFF position.
- Park brake unlocked.
- Control levers in NEUTRAL position.

Excessive Noise

1. Is park brakes unlocked?

Yes: Go to next step.

No: Unlock park brake.

2. Is park brake linkage adjusted properly?

Yes: Go to next step.

No: Adjust brake linkage. (See “Adjust Brake Linkage” on page 221.)

3. Is brake assembly free of damage?

Yes: Go to next step.

No: Check for damaged or missing components.

4. Are axles lubricated?

Yes: Go to next step.

No: Grease axles.

5. Are transmission output bearings in good operating condition?

Yes: Go to next step.

No: Replace transmission. (See “Remove and Install Transaxle” on page 178.)

6. Is transmission the source of the noise?

No: Replace transmission assembly.

Tests and Adjustments

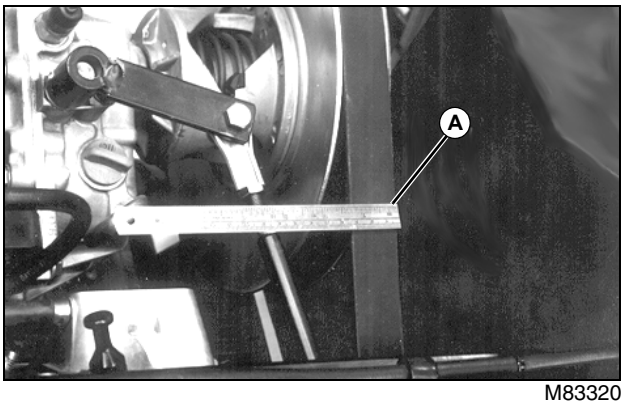
Check Drive Belt

Reason

To check belt wear and condition of belt.

Procedure

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move gearshift pedals to NEUTRAL position.
4. Lock park brake.
5. Lower front blade (if equipped).
6. Raise rear body cowling.



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7. Measure belt width (A). Belt must not be less than specifications.
8. Check drive belt condition. Belt must not be glazed or cracked.

Results

- If belt is less than specification, replace.
- If belt is within specifications and there is a performance complaint, check clutches and perform POWER TRAIN PERFORMANCE TESTS.

Specifications

Drive Belt Width . . . . . 27 mm (1.0625 in.)

Adjust Gearshift Linkage

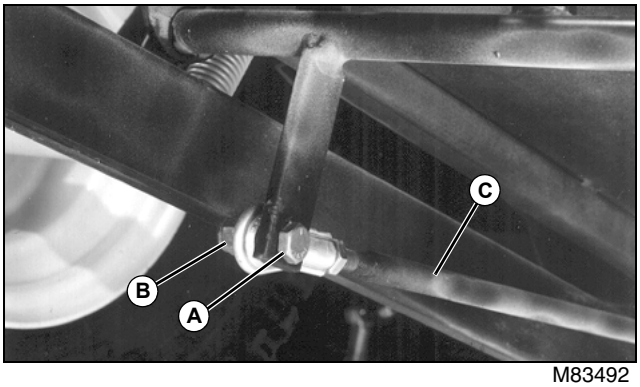
Reason

To ensure gearshift pedals are at the proper height when transaxle is in neutral.

To ensure both forward and reverse gears will be completely engaged.

Procedure

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move gearshift pedals to NEUTRAL position.



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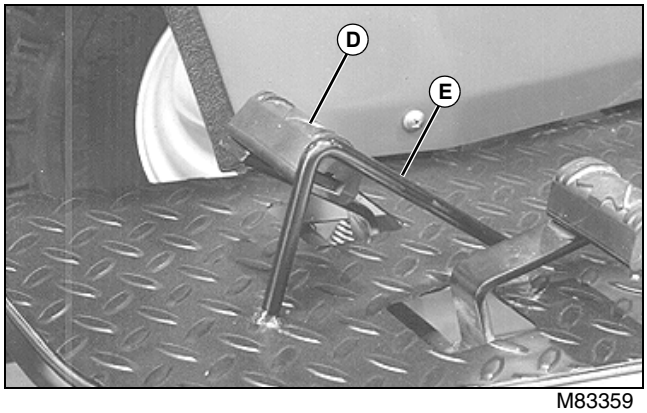
4. Lock park brake.
5. Remove cap screw (A) and nut (B) to disconnect shift rod (C) at pedal assembly.
6. Lower front blade (if equipped).
7. Raise rear body cowling.
8. Verify that the transaxle is in NEUTRAL position.



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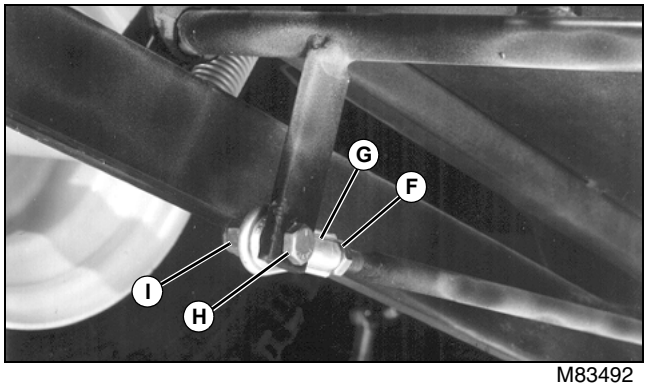
9. Align forward pedal (D) even with guide (E).



M83492

10. Loosen jam nut (F).
11. Rotate tie rod end (G) until it aligns with hole in pedal assembly.
12. Install and tighten cap screw (H) and nut (I).
13. Tighten jam nut.

Check Engagement and Full Upshift

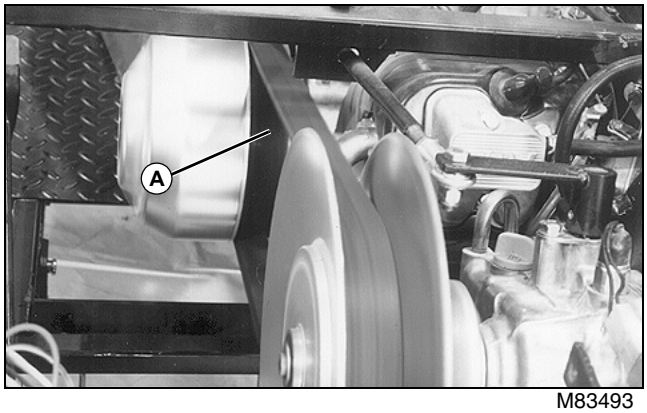
Reason

To determine if the engine and drive train are operating at peak performance.

Procedure

Note: Engine slow and fast idle speeds must be set to specifications before performing tests. (See "Adjust Fast Idle Speed" on page 40. See "Adjust Slow Idle Speed" on page 41.)

1. Park machine on level surface.
2. Move gearshift pedals to NEUTRAL position.
3. Lock park brake.
4. Inspect drive belt. Belt should be in good condition and within specification.
5. Lower front blade (if equipped).
6. Raise rear body cowling.
7. Start and run engine at MEDIUM idle for 5 minutes to heat engine oil to normal operating temperature.



M83493

8. Slowly increase engine rpm. Observe engine rpm when clutch starts to grab and move belt (engagement).

9. Accelerate from idle to wide-open throttle and back to idle several times. Watch belt for smooth transition from bottom to top of primary clutch. Watch closely for any hesitation or engine surging. Observe gap between drive (primary) clutch movable sheave and stationary sheave. Gap (A) should close completely.

10.When approaching idle, watch for a positive disengagement from belt.

Note: On clutches with some hours of use, system may not disengage smoothly due to drive clutch spring taking a set and other wear in the drive components.

11.Turn off engine.

Results

- Clutch should slowly start to engage and move primary belt at 1550 rpm. Belt should be riding high in the primary clutch and low in the secondary clutch.
- Clutch has harsh engagement, erratic transition or hesitation or clutch noise (chirping), perform primary clutch lubrication. Check primary clutch for flyweights binding, pivot pins worn, flat spots on roller or rollers sticking. No groove in sheave. Repair or replace primary clutch as necessary.
- Engine surging, check engine and governor performance.
- Smooth engagement and transition (upshift). Drive clutch is good. Perform DRIVEN (SECONDARY) CLUTCH BACKSHIFTING CHECK.

Check Driven (Secondary) Clutch Backshifting

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hand-Held Digital Tachometer	JT05719	Measures engine rpm.

Reason

To determine condition of driven clutch and backshifting performance.

Procedure

Caution: Avoid Injury! Rear wheels will rotate during test. Keep clear.

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move gearshift pedals to NEUTRAL position.
4. Lift machine high enough to raise rear wheels off the floor. Support with jackstands.
5. Lower front blade (if equipped).
6. Raise rear body cowling.
7. Engage differential lock.
8. Start and run engine at full throttle.
9. Read engine rpm using JT05719 Hand-Held Digital Tachometer.

Results

- Engine and wheel speed should remain at constant speed. Belt should be riding high in the drive (primary) clutch and low in the driven (secondary) clutch.
- Momentarily load power train by slowly applying brake until downshift is made.
- Quickly observe engine speed and release the brake.
- Drive belt should not squeal or slip.
- If engine speed drops below 3000 rpm or if clutches do not backshift, perform DRIVEN CLUTCH SPRING TORSION CHECK.

Check Driving

Reason

To determine operating performance of vehicle.

Procedure

Caution: Avoid Injury! When operating vehicle to observe any clutch problems, find and operate vehicle in an area flat and free of obstacles so that you can concentrate on observing performance safely.

1. Park machine on level surface.
2. Move gearshift pedals to NEUTRAL position.
3. Lock park brake.
4. Start and run engine at MEDIUM idle for 5 minutes to heat engine oil to normal operating temperature.
5. Move gearshift pedals to FORWARD position. Unlock park brake.
6. From a standing start, accelerate through 15.2 m (50 ft.). This should take approximately 7 seconds.
7. Stop vehicle.
8. From a standing start, accelerate through 30.5 m (100 ft.). This should take approximately 10 seconds.
9. Once at maximum speed, travel time through 30.5 m (100 ft) should be approximately 6 seconds.

Results

- If performance is not to specifications, check engine performance: engine rpm, governor, compression and valve clearance. (See “Tests and Adjustments” on page 39 in the Engine section.)
- Check driven clutch for correct spring tension and that all ramp shoes are in place and against ramp. Repair driven clutch.

Check Driven Clutch Spring Torsion

Special or Required Tools

Tool Name	Tool No.	Tool Use
Spring Scale	N/A	Used to measure spring tension.

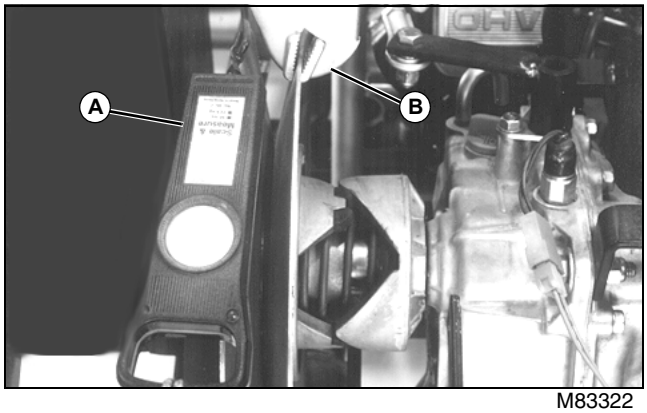
Reason

To verify condition and spring adjustment of driven clutch.

Procedure

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Move gearshift pedals to FORWARD position.
4. Lock park brake.
5. Lower front blade (if equipped).
6. Raise rear body cowling.
7. Remove belt.

Important: Avoid Damage! Do not damage sheave when clamping pliers. Use protective strips of brass or aluminum.



M83322

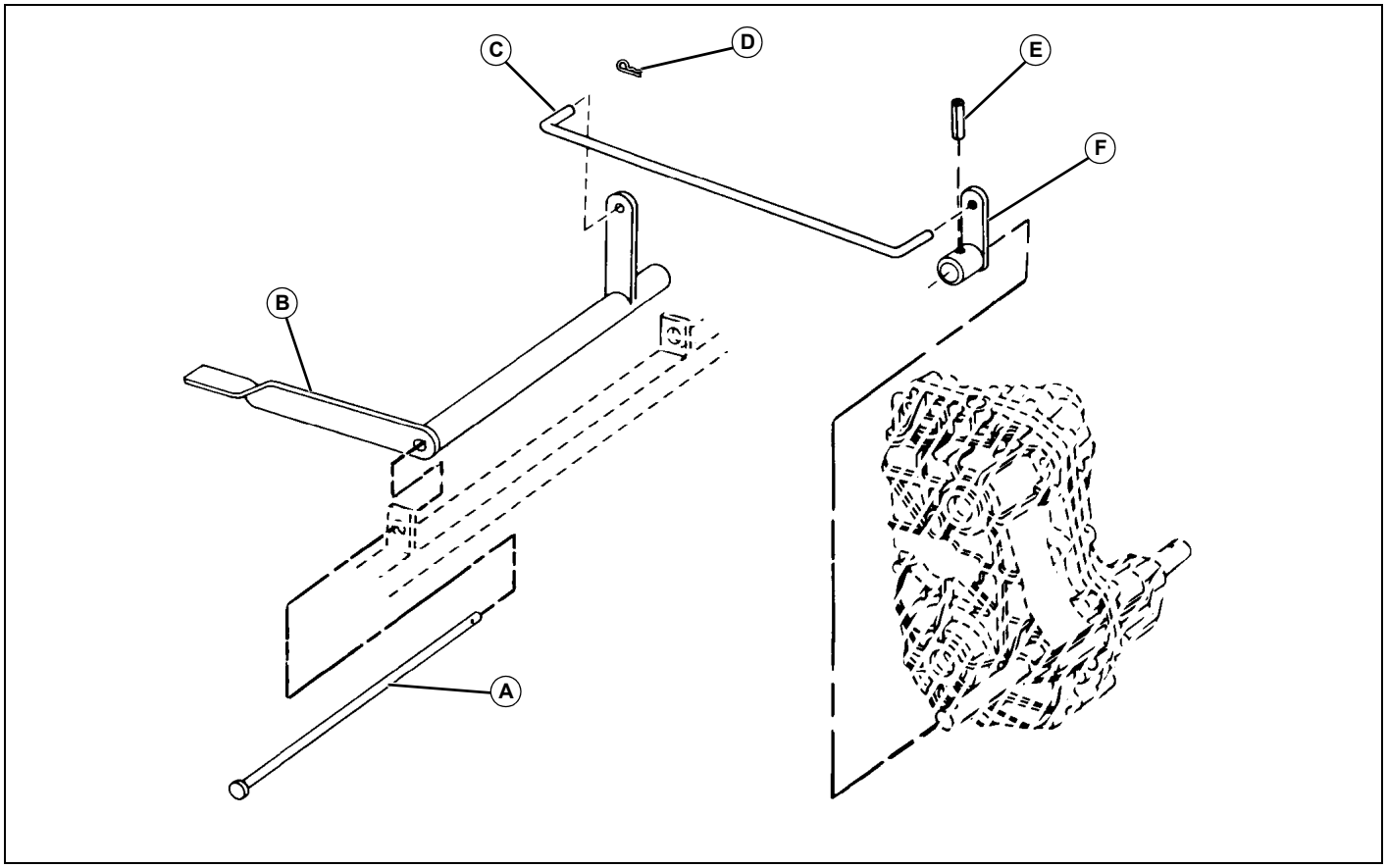
8. Clamp locking-type pliers (B) to movable sheave.
9. Use a spring scale (A) to measure force at the point sheave is returning and almost contacting ramp. Standard wrap should be within specifications.

Results

- If spring force is within specifications, secondary or driven clutch is operating normally. Check engine rpm and performance.
- Spring force is less than specification, upshift will be faster and engine load greater, reducing engine rpm and response time. Check spring position or replace.
- Spring force higher than specification, upshift or acceleration will be slower, reducing engine load, increasing engine rpm and response time. Check spring position or replace spring. Spring position is hole 2.

Repair

Differential Lock Pedal and Linkage

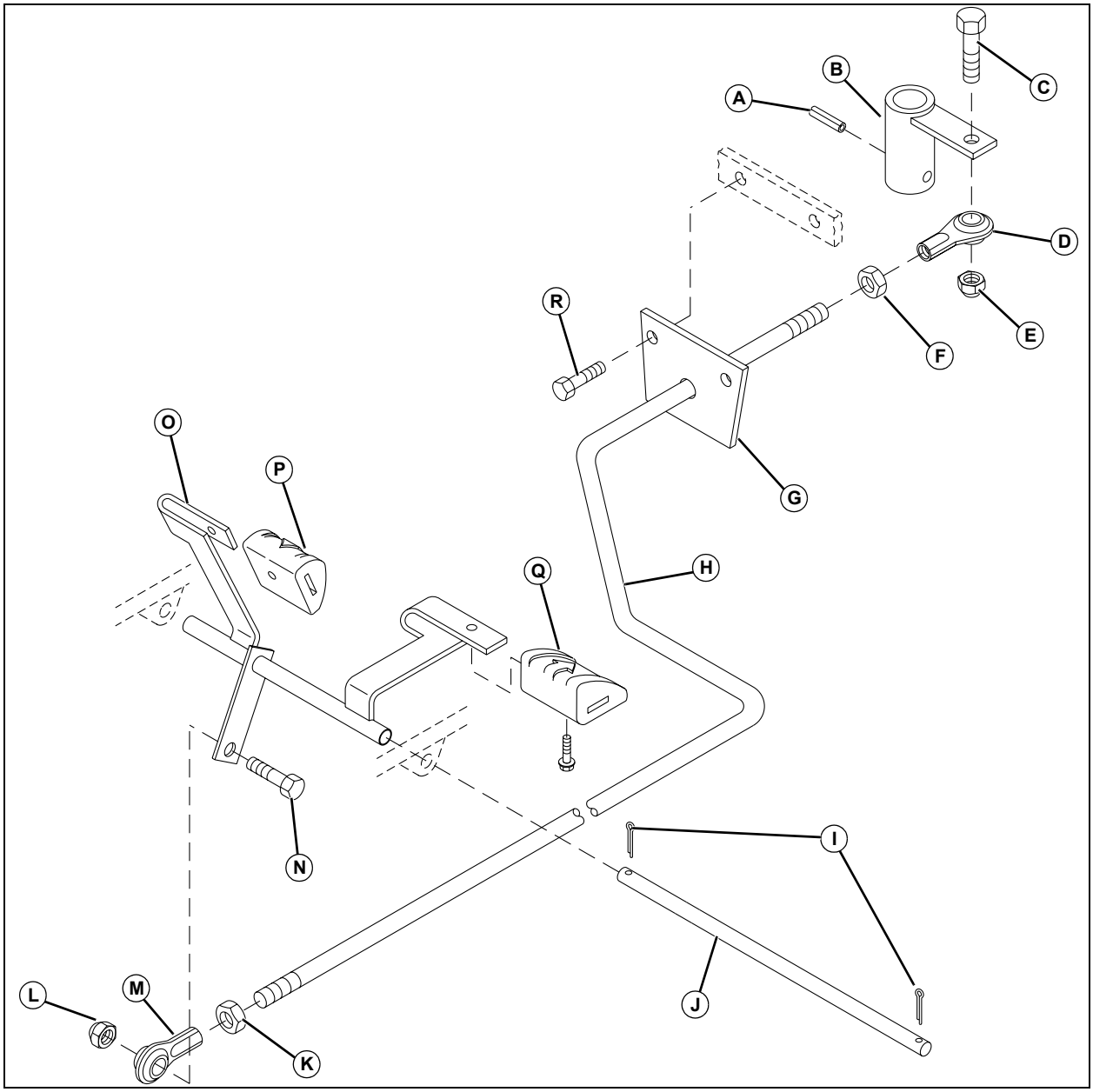


M80771

A- Rod
B- Differential Lock Pedal
C- Link Rod
D- Spring Locking Rod (2 used)
E- Spring Pin
F- Lever

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

Gearshift Pedals and Linkage



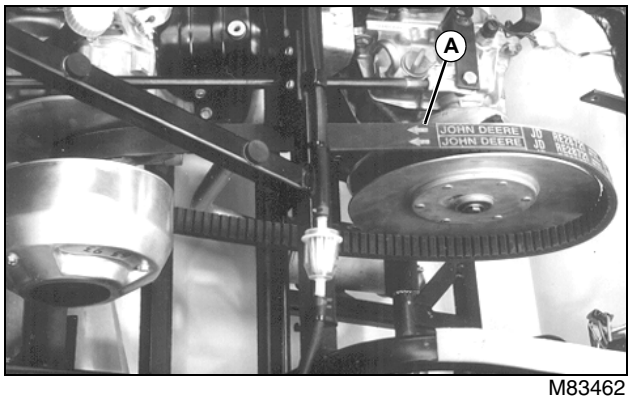
M83219AE

A- Spring Pin
B- Control Arm
C- Cap Screw
D- Tie Rod End
E- Locknut
F- Jam Nut
G- Bracket
H- Shift Rod
I- Spring Pin (2 used)
J- Pivot Rod
K- Jam Nut
L- Locknut
M- Tie Rod End
N- Cap Screw
O- Gearshift Pedal Assembly
P- Forward Pedal Pad
Q- Reverse Pedal Pad
R- Cap Screw

- Inspect all parts for wear or damage. Replace parts as necessary.
- Adjust linkage. (See “Adjust Gearshift Linkage” on page 169.)

Remove and Install Drive Belt

1. Lower front blade (if equipped).
2. Raise rear cowling.



M83462

Picture Note: Fuel tank removed for photo clarity.

3. Loop slack in belt over driven pulley.
4. Rotate driven pulley to remove drive belt.

Installation

Installation is done in the reverse order of removal.

- Install belt with arrows (A) pointing forward.

Remove and Install Drive (Primary) Clutch

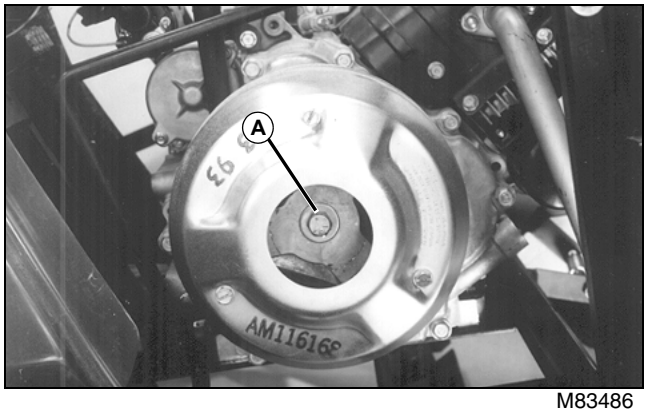
Special or Required Tools

Tool Name	Tool No.	Tool Use
Clutch Removal Tool	JDG813-1	Used to pull clutch from crankshaft.
Spanner Wrench	JDG813-2	Used to remove spider from clutch housing.
Tapered Holding Tool	JDG813-3	Used to hold clutch assembly in place for disassembly.

Other Material

Part No.	Part Name	Part Use
TY22034	John Deere SUPERLUBE®	Apply to rollers and cam weight pivots of drive clutch.
T43512 (US)	Thread Lock and Sealer (Medium Strength)	Applied to spider threads.

1. Remove drive belt. (See “Remove and Install Drive Belt” on page 174.)
2. Remove drive (primary) clutch center cover.

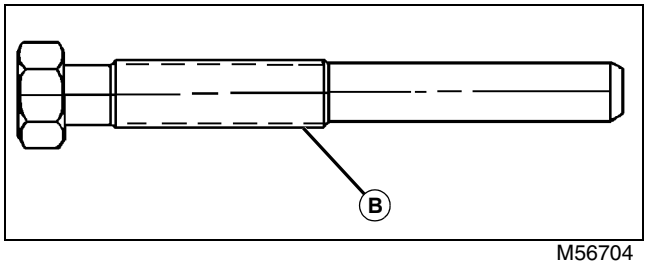


M83486

3. Remove cap screw (A).

Important: Avoid Damage! Lightly grease end of puller to prevent puller wear. To prevent clutch thread damage, DO NOT thread bolt in any farther than necessary to remove clutch.

Note: An air impact wrench works well to remove the drive clutch.



M56704

4. Remove cap and install JDG813-1 Clutch Removal Tool (B). Thread puller into clutch and against crankshaft until clutch loosens. Leave puller in clutch to remove cover.

Installation

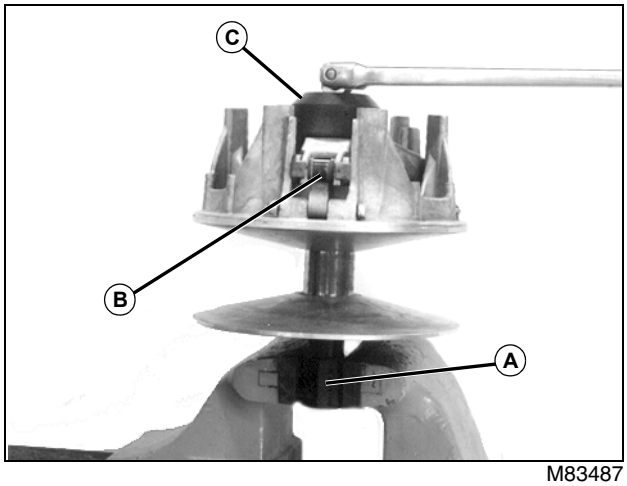
Installation is done in the reverse order of removal.

Specifications

Drive (Primary) Clutch Cap Screw Torque . . . . . 50 N•m (37 lb-ft)

Disassemble and Assemble Drive (Primary) Clutch

1. Remove clutch cover bolts. Rap end of puller bolt sharply; cover should pop off. Do not pry on the cover.

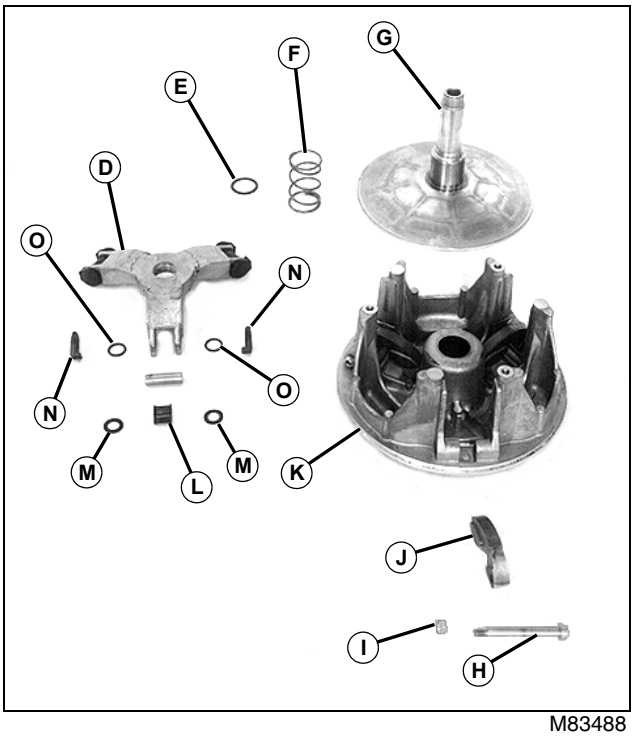


M83487

2. Install JDG813-3 Tapered Holding Tool (A) and retain it with M10x1.5x150 mm hex head bolt.

Important: Avoid Damage! Always use a spanner wrench to remove spider. Unequal pressure on clutch towers could cause stress fractures or break them off. A medium strength thread locking compound is used on spider threads.

3. Use JDG813-2 Spanner Wrench (C) to remove spider (B).



M83488

D- Spider
E- Washer
F- Spring
G- Stationary Sheave
H- Pivot Bolt
I- Nut
J- Flyweight
K- Clutch Sheave
L- Roller
M- O-Ring (2 used)
N- Button
O- O-Ring (2 used)

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

Assembly

Assembly is done in the reverse order of disassembly.

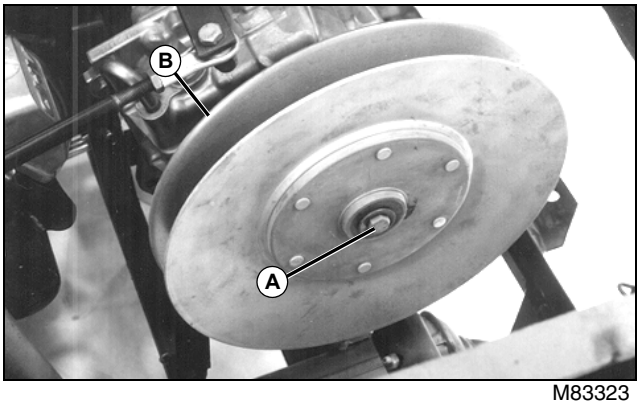
- Lubricate cam weight pivot area using SUPERLUBE® spray or equivalent. Slide bolts to side to allow lubricant to penetrate pivot area. Bolt may need to be removed to lubricate properly. Replace bolt if worn through plating. Check flyweight for binding.
- Apply T43512 Thread Lock and Sealer (Medium Strength) to spider threads.

Remove and Install Driven Pulley

Other Material

Part No.	Part Name	Part Use
T43512 (US)	Medium Strength Thread Lock and Sealer	Applied to threads of drive pulley cap screw and ramp shoe tabs.

1. Remove:
   - Drive belt. (See “Remove and Install Drive Belt” on page 174.)
   - Fuel tank. (See “Remove and Install Fuel Tank” on page 48.)



M83323

2. Hold clutch with a strap wrench and remove cap screw (A).

3. Tap on inside of driven clutch (B) with a rubber mallet.

4. Remove driven clutch.

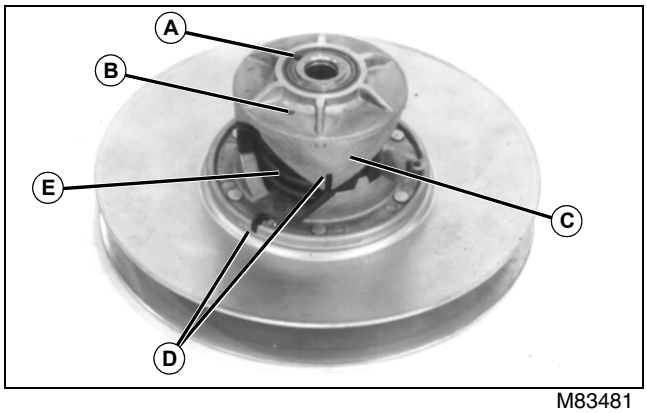
Installation

Installation is done in the reverse order of removal.

Important: Avoid Damage! Do not tighten cap screw beyond 24 N•m (18 lb-ft). Damage to transaxle will result if over-tightened.

- Install new mounting cap screw or apply J43512 Thread Lock and Sealer to original cap screw. New cap screw will have Thread Lock and Sealer applied.

Disassemble and Assemble Driven Pulley



M83481

1. Release tension on spring using a punch in hole (A) of cam (C).

2. Remove set screw (B). Clean bore of sheave with a non-oily cleaner and dry thoroughly.

3. Put alignment marks (D) on cam and movable sheave half to aid in assembly.

Caution: Avoid Injury! Hold cam securely to prevent sudden spring release.

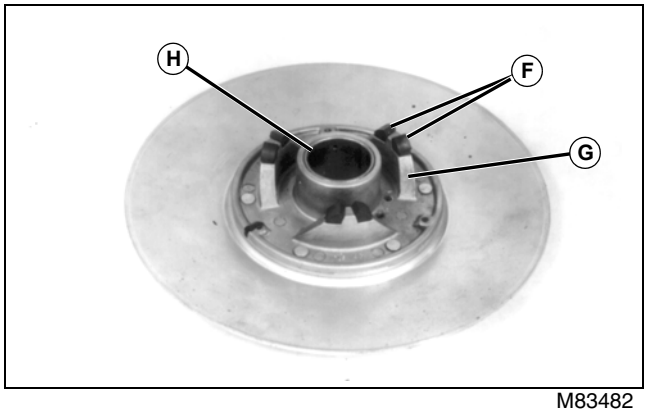
4. Cam is press-fit on shaft. Use a three-jaw puller and an impact wrench at low speed to remove.

5. Remove spring (E), movable sheave half and spacer.

Note: Ramp shoes are interference-fit. Remove shoes only if replacement is necessary.

6. Inspect ramp shoes for wear or cracks. Replace if necessary. (See “Ramp Shoe Replacement” on page 176.)

Ramp Shoe Replacement



M83482

1. Inspect ramp shoes (F) for wear or cracks.

2. Apply heat to movable sheave ramp (G) and pull off shoes. If shoe mounting tabs break off inside sheave ramp, remove tabs using a drill bit.

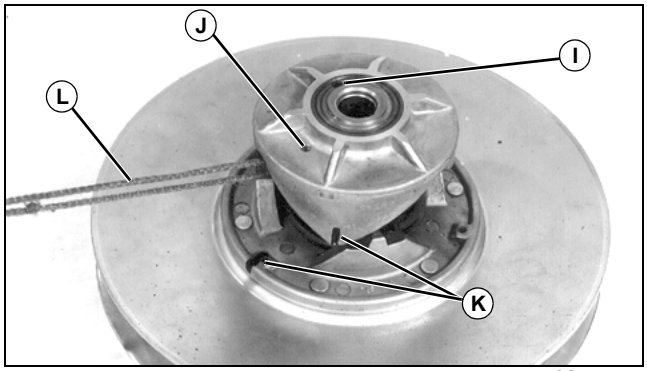
3. Install ramp shoe tabs into ramp holes.

   - If shoes are too difficult to install, sand tabs as necessary.
   - If tabs are loose, apply T43512 Thread Lock and Sealer (Medium Strength) on tabs.

4. Inspect bushing (H) for wear or damage. Replace movable sheave if necessary.

Assembly

1. Install spacer and movable sheave on fixed sheave.



M83483

2. Install spring. Insert spring tab in hole (I) marked “2” in movable sheave half. Place cam on spring.

3. Align setscrew (J) bores and alignment marks (K). Press cam on shaft until it stops.

4. Apply Thread Lock and Sealant (Medium Strength) to threads of setscrew and install until flush with surface.

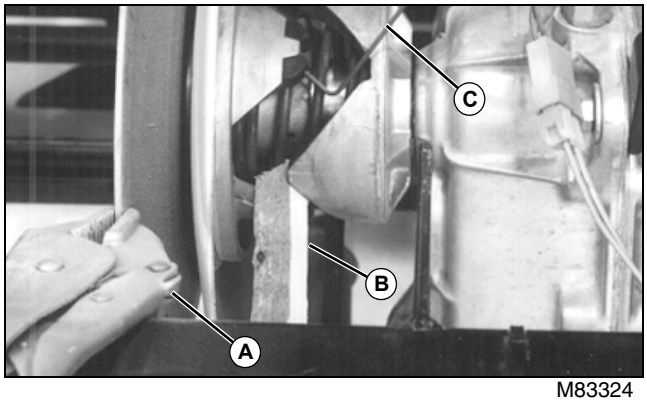
5. Pry spring away from cam and loop a piece of string (L) around top spring tab. Pull on string until tab seats in hole in cam.

Replace Ramp Shoes (Clutch Mounted on Machine)

Other Material

Part No.	Part Name	Part Use
T43512 (US)	Medium Strength Thread Lock and Sealer	Applied to threads of drive pulley cap screw and ramp shoe tabs.

1. Remove drive belt. (See “Remove and Install Drive Belt” on page 174.)



M83324

2. Install locking pliers (A) on outer edge of fixed sheave half. Move pliers against frame.

3. Turn movable sheave half until shoes are away from ramps. Install a small block of wood (B) between other ramps and shoes to hold sheave half in position.

Caution: Avoid Injury! Prevent burns. Hold allen wrench with locking pliers.

4. Heat short end of a 2 mm (0.078 in.) hex key wrench (C) until red. Insert wrench into center of ramp shoe as plastic melts. Hold wrench in place until plastic hardens.

5. Twist and pull on hex key wrench to remove ramp shoe.

6. Install ramp shoe tabs into ramp holes.

   • If shoes are too difficult to install, sand tabs as necessary.

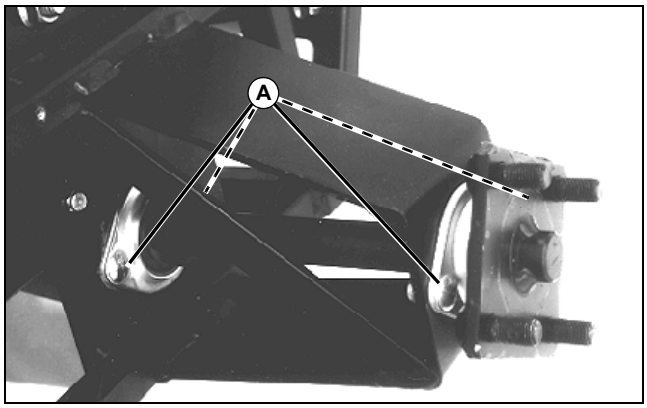
   • If tabs are loose, apply Thread Lock and Sealant (Medium Strength) on tabs.

Remove and Install Transaxle

Other Material

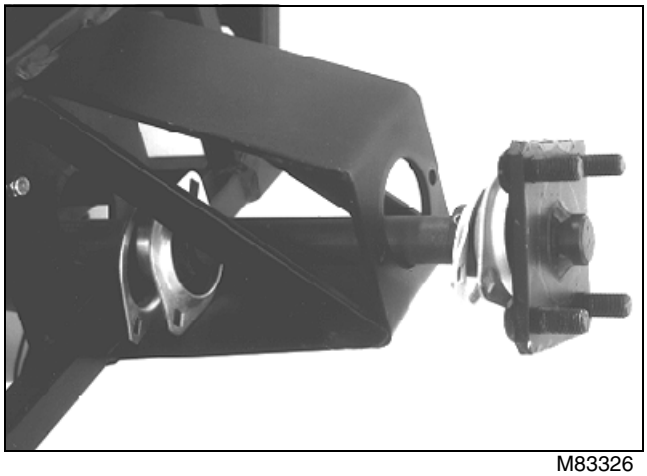
Part No.	Part Name	Part Use
M79292	MPG-2®Polymer Multipurpose Grease	Applied to axle shafts.

1. Remove:
   - Rear body cowling. (See “Remove and Install Rear Body Cowling” on page 244.)
   - Rear wheels. (See “Remove and Install Rear Wheel” on page 246.)
   - Driven pulley. (See “Remove and Install Driven Pulley” on page 175.)
   - Brake disk. (See “Remove and Install Brake Disk” on page 224.)



M83325

2. Remove four carriage bolts and nuts (A) from axle bearing flanges.

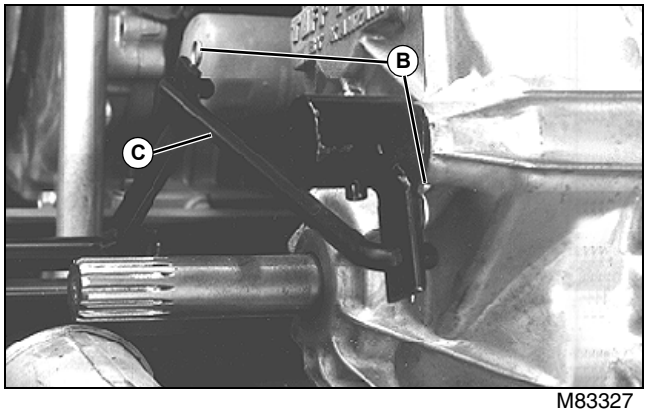


M83326

3. Pull axle shaft out of coupler, both sides.

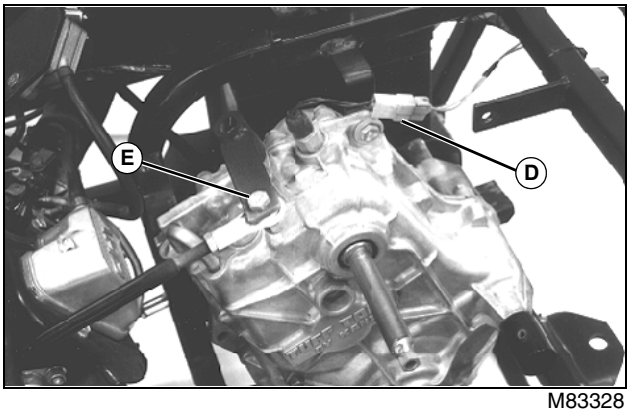
Note: Transaxle oil capacity is approximately 2.3 L (2.5 qt).

4. Drain transaxle.



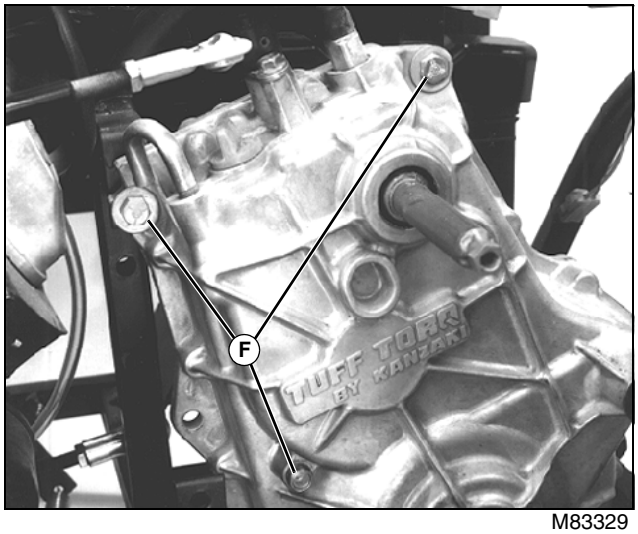
M83327

5. Remove both locking pins (B). Remove rod (C).



M83328

6. Disconnect neutral start switch wire connector (D).
7. Remove shift rod and cap screw (E).



M83329

8. Remove cap screws, washers and nuts (F). Remove transaxle.

Installation

Installation is done in the reverse order of removal.

- Fill transaxle to proper level with clean John Deere

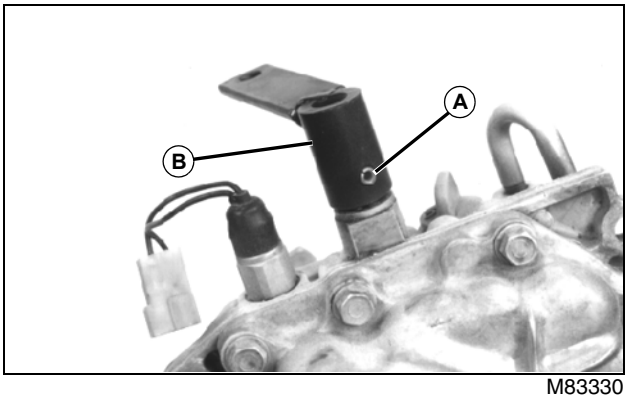
85W140 API GL-5 gear oil.

- Apply M79292 MPG-2® multipurpose polymer grease to axle shafts.

Disassemble and Inspect Transaxle

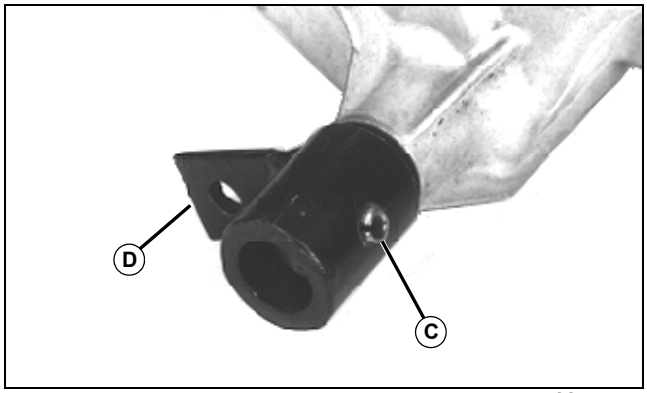
Transaxle Case Disassembly

1. Thoroughly clean the outside of the transaxle.



M83330

2. Drive spring pin (A) from shift arm (B). Remove shift arm.

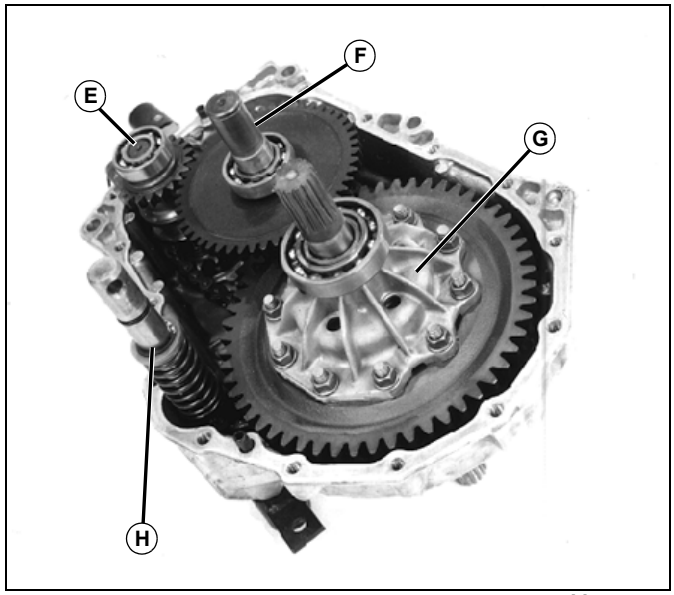


M83331

3. Remove spring pin (C) and differential arm (D).

Important: Avoid Damage! Grease shafts to avoid tearing seals and O-rings when separating case.

4. Remove cap screws from housings and separate using a screwdriver and rubber hammer.

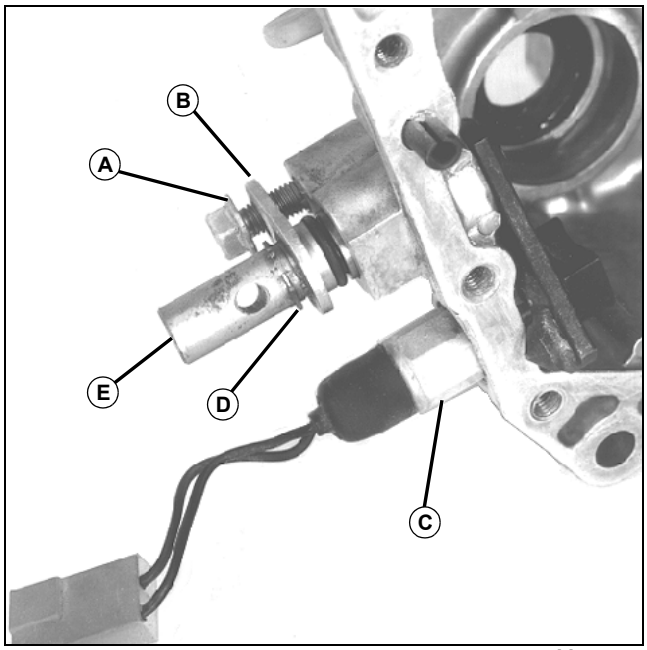


M83332

5. Tap on end of input shaft (E) and pry gear of intermediate shaft (F) out to remove as one unit.

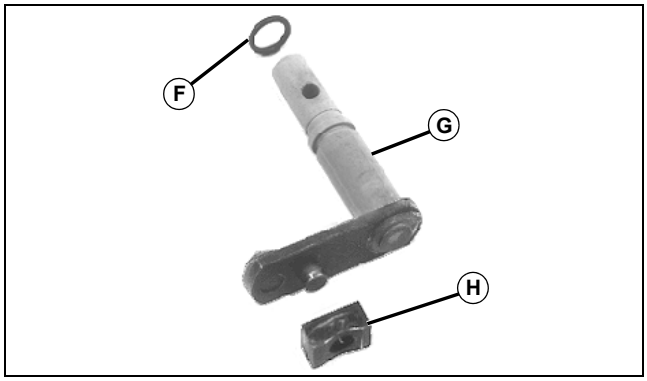
6. Remove differential (G) and differential lock assembly (H) together.

Shift Shaft



M83337

1. Remove cap screw (A), snap ring (D) and retainer (B).
2. Remove shifter shaft (E).
3. Remove neutral start switch (C) (if necessary).



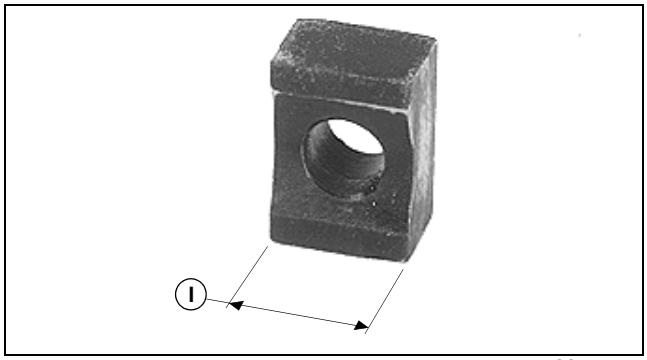
M83335

4. Clean and inspect shift shaft (G), shifter block (H), and O-ring (F) for wear or damage.

5. Measure OD of shift shaft. Replace if measurement is less than specifications.

6. Measure ID of shift shaft bore in case. Replace if measurement is greater than specifications.

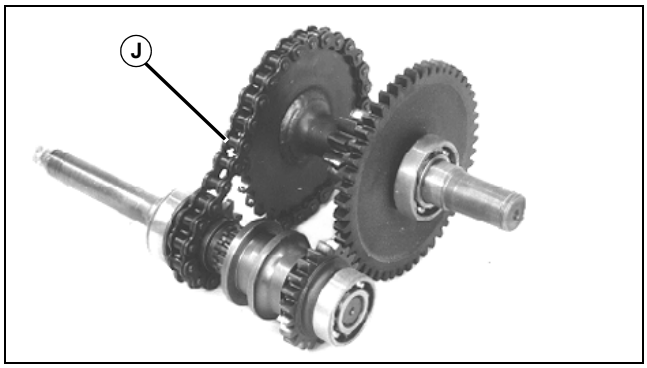
7. Subtract shift shaft OD from ID of shaft bore in case to find clearance. Replace shift shaft and case if clearance is greater than specifications.



M83347

8. Measure shift block width (I). Replace if measurement is less than specifications.

9. Subtract block width from shift collar groove width to find clearance. Replace shift block and collar if clearance is greater than specifications.

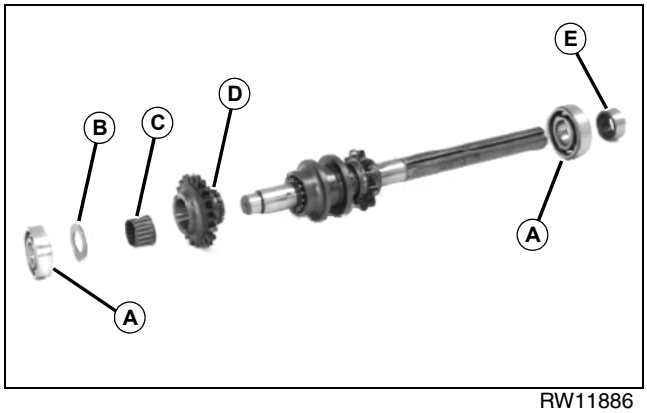


M83334

10.Remove reverse drive chain (J).

11.Inspect chain for worn or loose links.

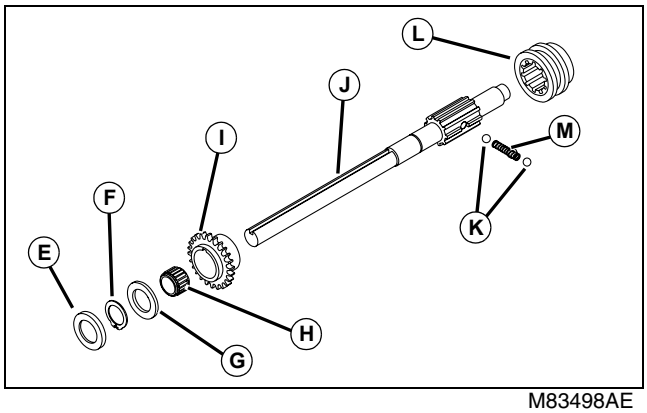
Input Shaft



RW11886

1. Remove sleeve (E) and bearings (A) using a knife-edge puller.

2. Remove washer (B), needle bearing (C) and drive gear (D).

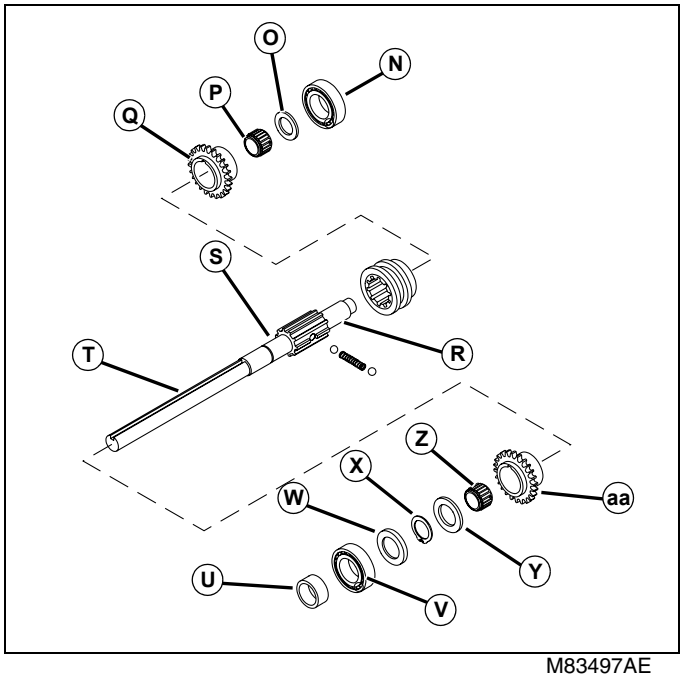


M83498AE

3. Remove step washer (E), sprocket retaining snap ring (F), washer (G), needle bearing (H), and reverse chain sprocket (I).

Note: Detent spring (M) and balls (K) will fly out from holes in shaft when shift collar is removed.

4. Remove shift collar (L) carefully to avoid losing detent spring (M) and balls (K).



M83497AE

N- Ball Bearing
O- Drive Gear Washer
P- Needle Bearing
Q- Drive Gear
R- Diameter “B”
S- Diameter “A”
T- Input Shaft
U- Wear Sleeve
V- Bearing
W- Step Washer
X- Snap Ring
Y- Reverse Sprocket Washer
Z- Needle Bearing
aa-Reverse Sprocket

5. Inspect bearings (N and V) for scoring or pitting. Replace if necessary.

6. Inspect drive gear washer (O) for scoring. Replace if necessary.

7. Measure drive gear washer thickness. Replace if measurement is less than specifications.

8. Inspect needle bearings (P and Z) for wear or pitting. Replace if necessary.

9. Measure reverse sprocket washer (Y) thickness. Replace if measurement is less than specifications.

10.Inspect drive gear (Q) teeth and chamfer of splines for wear or damage.

11.Measure ID of drive gear. Replace if measurement is greater than specifications.

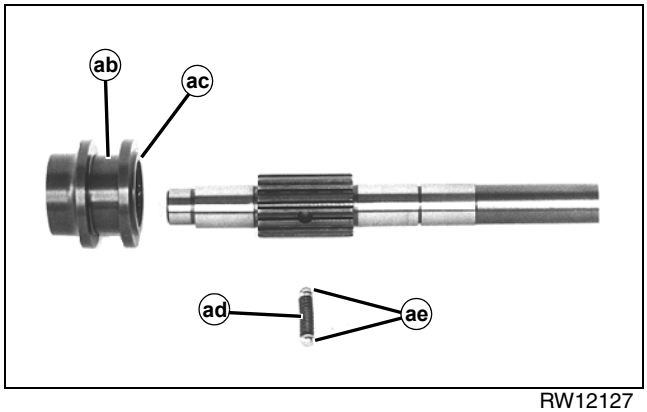
12.Measure diameter “B” (R) of input shaft (T). Replace if measurement is less than specifications.

13.Measure diameter “A” (S) of input shaft. Replace if measurement is less than specifications.

14.Inspect reverse sprocket (aa) teeth and chamfer of splines for wear or damage.

15.Measure ID of reverse sprocket. Replace if measurement is greater than specifications.

16.Inspect input shaft for wear or scoring. Replace if necessary.



RW12127

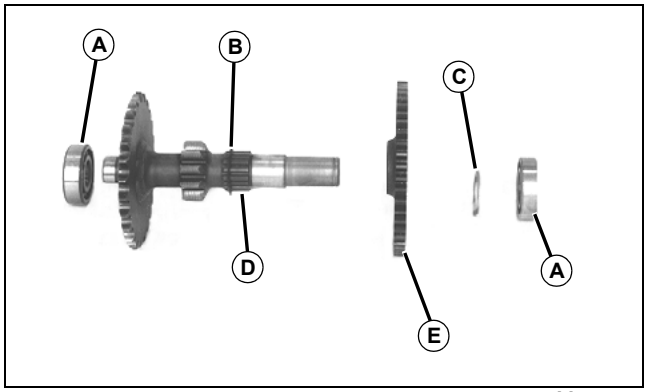
17.Inspect chamfered spline of shift collar (ac) for wear.

18.Measure width of shift groove (ab). Replace if measurement is greater than specifications.

19.Inspect detent spring (ad) and balls (ae) for nicks or cracks.

20.Measure detent spring length. Replace if measurement is not within specifications.

Intermediate Shaft



M83336

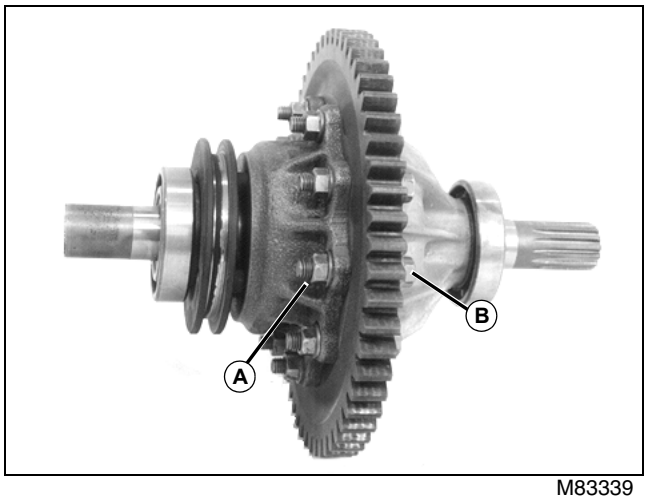
A- Bearing
B- Snap Ring
C- Washer
D- Reduction Gear Splines
E- Intermediate Drive Gear

1. Remove bearings (A) from intermediate shaft using a knife-edge puller.

2. Remove washer (C), intermediate drive gear (E) and snap ring (B).

3. Inspect all parts for wear or pitting. Replace parts if necessary.

Differential

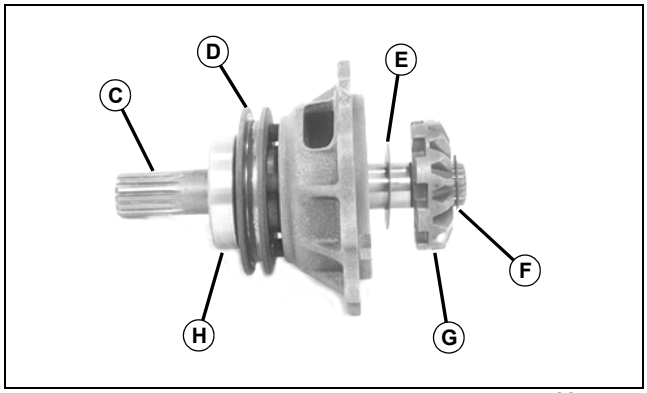


M83339

Note: New nuts and bolts will be used when assembling differential.

1. Remove nuts (A) and bolts (B) from differential housing. Discard nuts and bolts.

2. Separate housings. Note position of bevel pinion for reassembly.

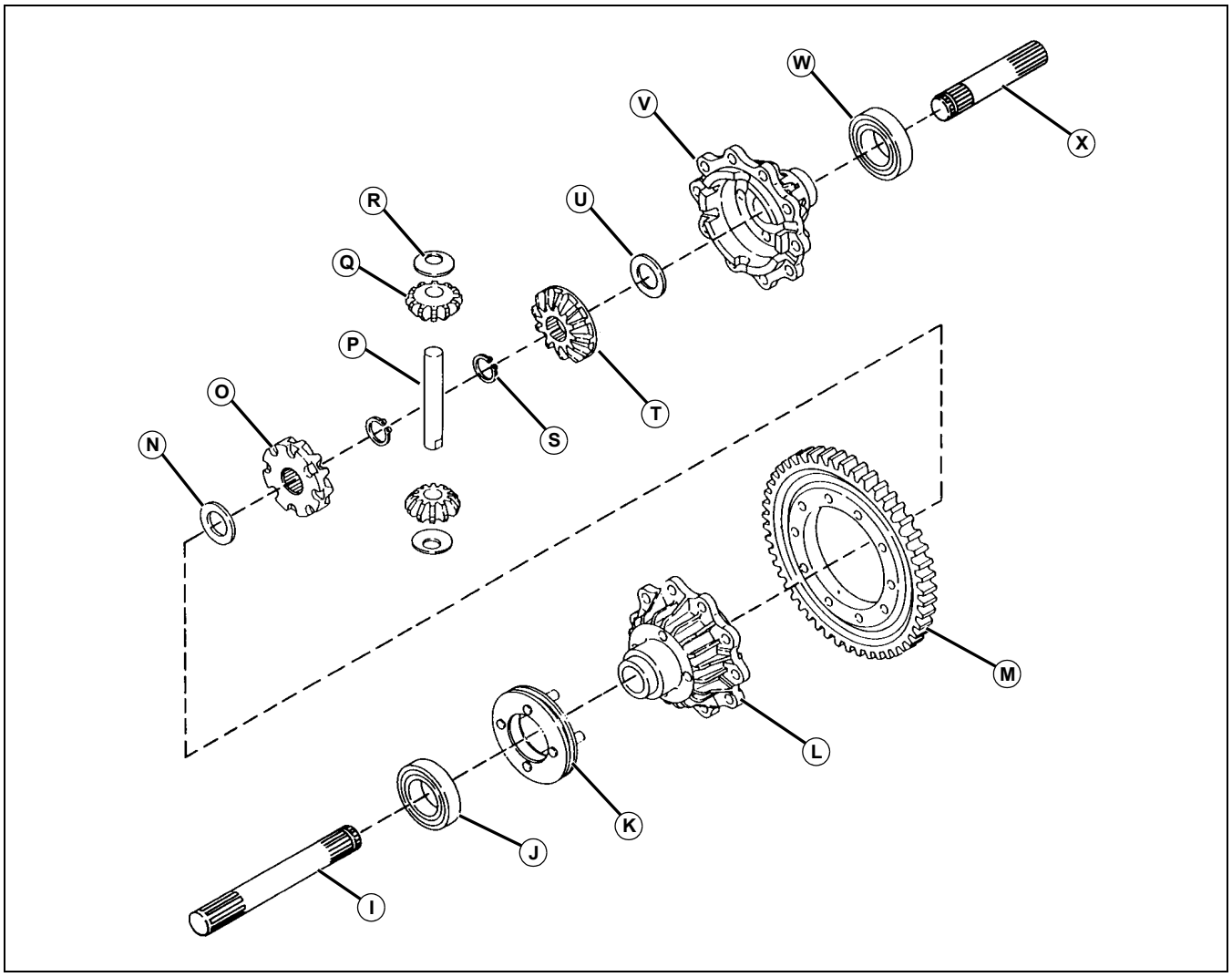


M83340

3. Remove output shaft (C) from both carriers.

4. Remove washer (E), snap ring (F), and gear (G) from output shaft.

5. Press bearings (H) from both carrier housings and remove differential lock collar (D) from left carrier.



M83197

I- Left Axle Shaft
J- Bearing
K- Differential Lock Collar
L- Left Differential Housing
M- Differential Gear
N- Washer
0- Left Bevel Gear
P- Pinion Shaft
Q- Bevel Pinion Gear (2 used)
R- Bevel Pinion Washer (2 used)
S- Snap Ring (2 used)
T- Right Bevel Gear
U- Washer
V- Right Differential Housing
W- Bearing
X- Right Axle Shaft

6. Clean differential parts and inspect for wear or scoring.

7. Measure differential lock collar groove width. Replace if measurement is not within specifications.

8. Measure washer thickness. Replace if measurement is not within specifications.

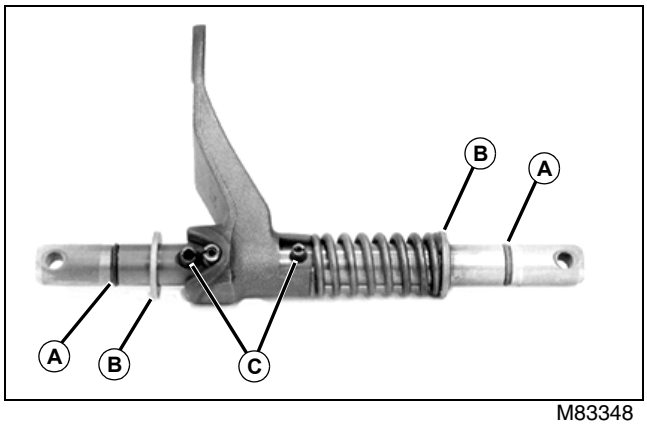
9. Measure bevel pinion washer thickness. Replace if measurement is not within specifications.

10.Measure bevel pinion ID Replace if measurement is not within specifications.

11.Measure pinion shaft OD Replace if measurement is not within specifications.

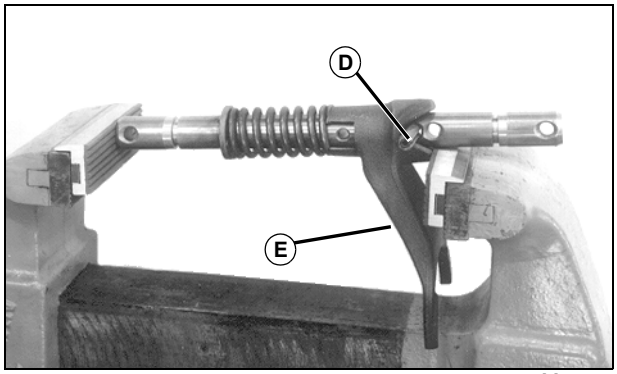
12.Subtract pinion shaft OD from bevel pinion ID to find clearance. Replace bevel pinion and pinion shaft if clearance is greater than specifications.

Differential Lock Shaft



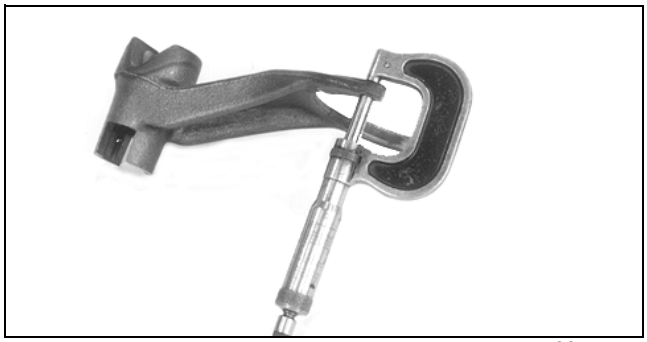
M83348

1. Remove O-rings (A) and washers (B).
2. Drive out outer spring pins (C).



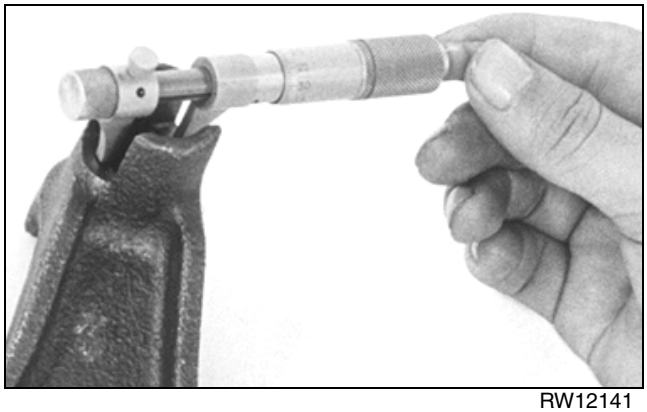
M83346

3. Mount lock shaft in vice to compress spring.
4. Drive out inner spring pin (D).
5. Release pressure. Remove lock fork (E).



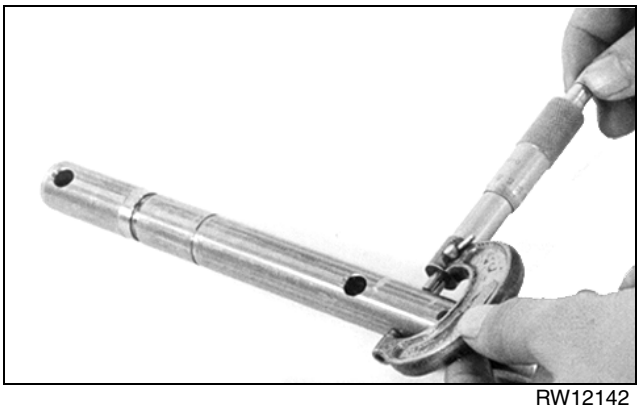
M83344

6. Inspect lock fork fingers for scoring or wear.
7. Measure thickness of lock fork fingers. Replace if measurement is not within specifications.
8. Subtract lock fork finger thickness from lock collar groove width to find clearance. Replace lock fork and lock collar if clearance is greater than specifications.



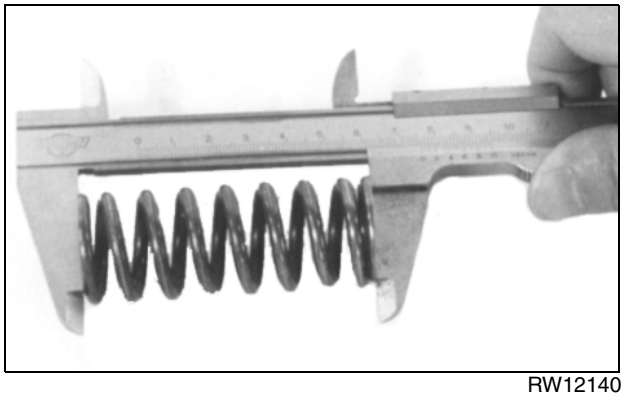
RW12141

9. Measure ID of lock fork. Replace if measurement is greater than specifications.



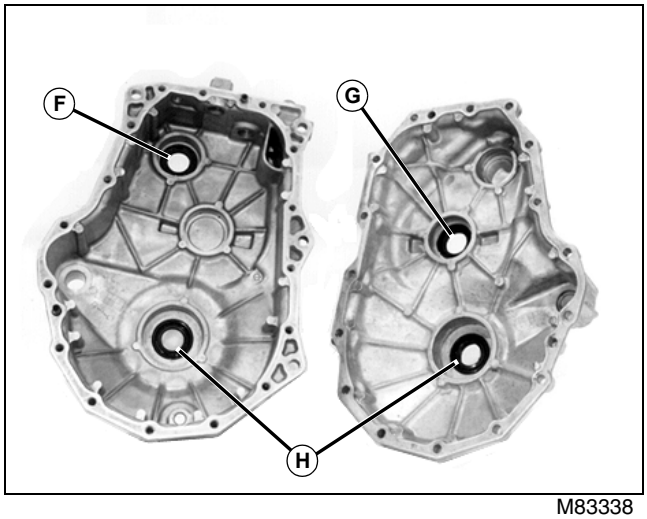
RW12142

10. Inspect lock shaft for scoring or wear. Replace if necessary.
11. Measure OD of shaft at fork seating area. Replace if measurement is less than specifications.
12. Subtract shaft OD from lock fork ID to find clearance. Replace shaft and lock fork if clearance is greater than specifications.



RW12140

13. Measure free length of lock spring. Replace if measurement is less than specification.
14. Measure working length of lock spring. Replace if measurement is less than specifications.



M83338

15.Clean sealant from case mounting surfaces.

Caution: Avoid Injury! Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

16.Clean all metal parts with solvent and blow dry with compressed air.

17.Inspect input shaft seal (F), output shaft seals (H) and intermediate shaft seal (G). Replace if necessary.

18.Inspect case halves for wear or damage. Replace as necessary.

Assemble Transaxle

Other Material

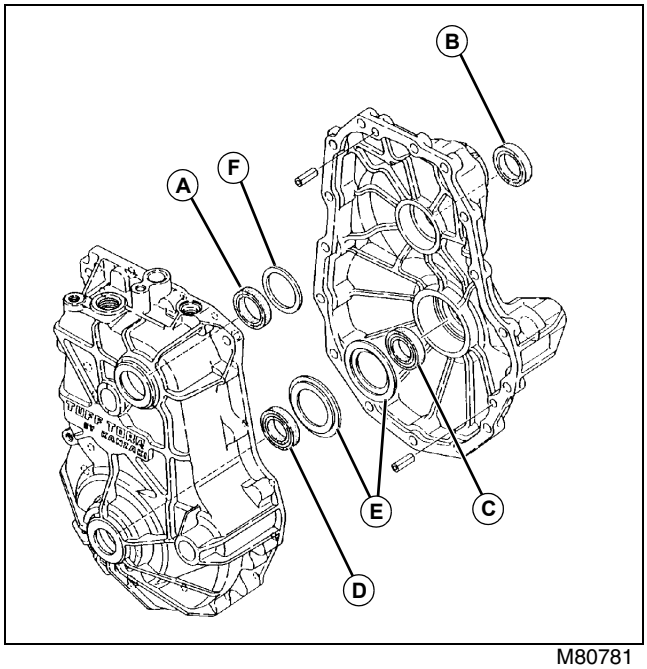
Part No.	Part Name	Part Use
T43512 (US)	Medium Strength Thread Lock and Sealer	Applied to fastener threads.
M79292	MPG-2® Polymer Multipurpose Grease	Lubricates seals and transaxle parts.

Case Assembly

Important: Avoid Damage! Always use new seals and O-rings. Damaged or used parts will leak.

Note: Lubricate all seals and O-rings with petroleum jelly during assembly.

Apply clean John Deere 85W140 API GL-5 gear oil to all internal parts during assembly.



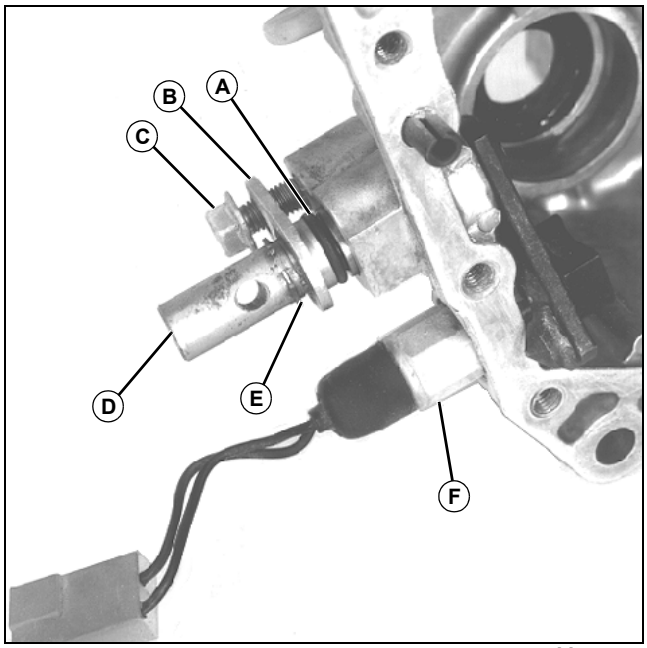
M80781

1. Apply MPG-2® multipurpose grease to inside lips of seals (A-D).

Important: Avoid Damage! Install output shaft spacers (E) as shown.

2. Apply MPG-2® multipurpose grease to spacers (F) to hold in place. Install spacers.

Shift Shaft

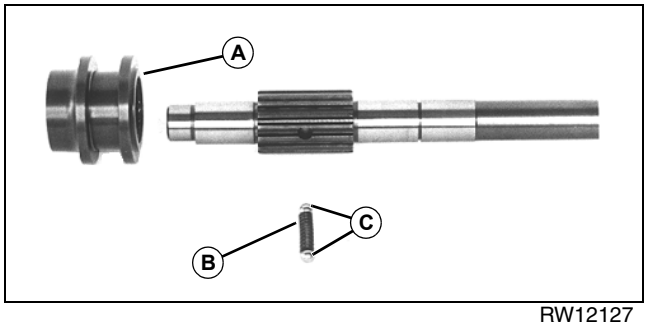


M83337

Note: Coat shift shaft and bore in case half with MPG-2® multipurpose grease before assembly.

1. Install shifter shaft (D) in bore in case.
2. Install O-ring (A).
3. Install retaining plate (B), snap ring (E) and cap screw (C).
4. Install neutral start switch (F).

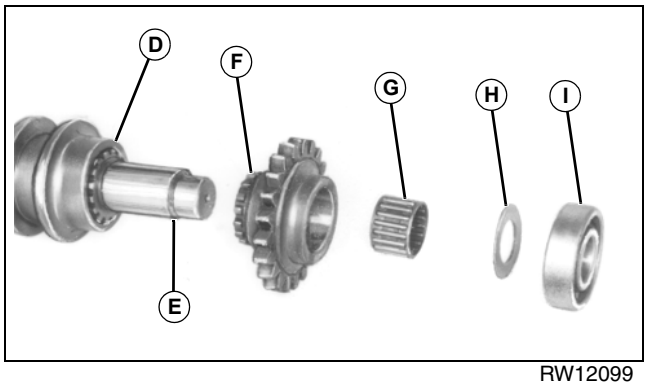
Input Shaft



RW12127

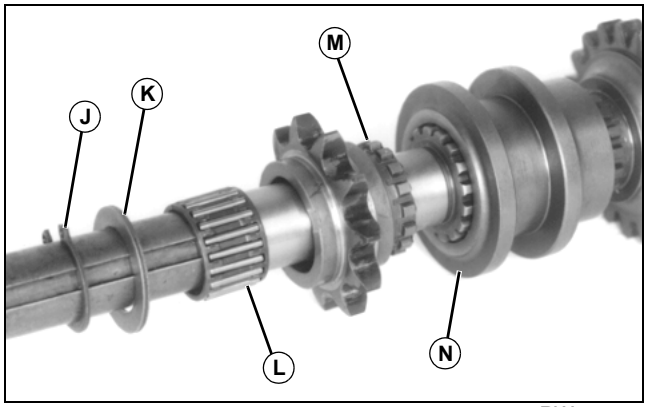
Note: Apply a light coat of MPG-2® multipurpose grease to detent balls to hold in place.

1. Position detent spring (B) and balls (C) through input shaft.
2. Install shift collar (A) to neutral position with shoulder toward short end of input shaft.



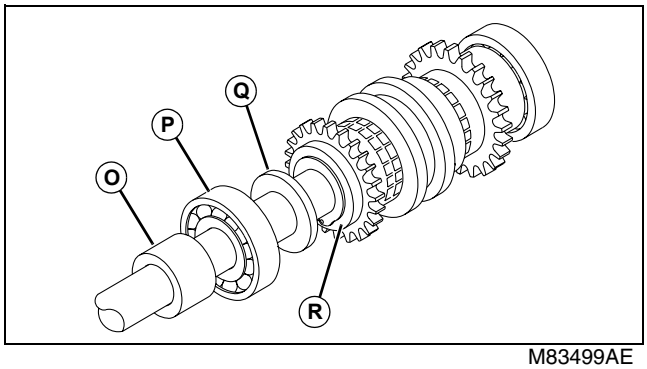
RW12099

3. Install drive gear onto short end of input shaft with shift splines (F) facing shift collar (D).
4. Install needle bearing (G) and washer (H). Press bearing (I) tight against shoulder (E) of input shaft.



RW12100

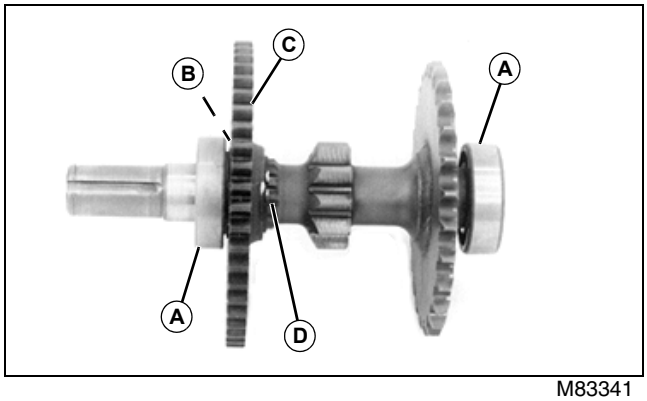
5. Install sprocket to keyed end of input shaft with shift splines (M) facing shift collar (N).
6. Install needle bearing (L), washer (K) and snap ring (J).



M83499AE

7. Press bearing (P) onto shaft against step washer (Q) and snap ring (R).
8. Apply a light coat of MPG-2® multipurpose grease to shaft and wear sleeve (O).
9. Press wear sleeve (O) onto shaft against bearing (P).

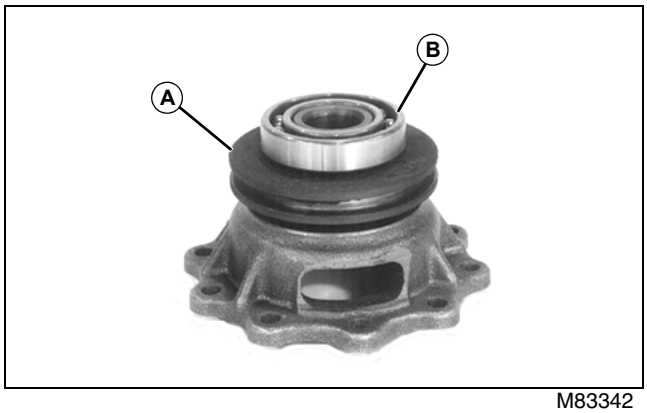
Intermediate Shaft



M83341

1. Install snap ring (D) and gear (C) with gear shoulder facing snap ring (D).
2. Press bearings (A) onto intermediate shaft with washer (B) between bearing and gear.

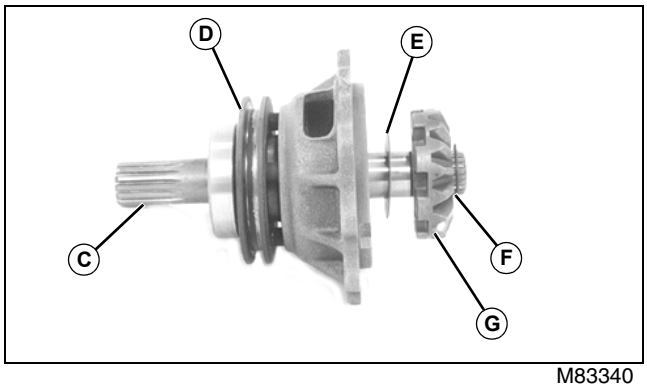
Differential



M83342

1. Assemble differential lock collar (A) onto left differential housing half.

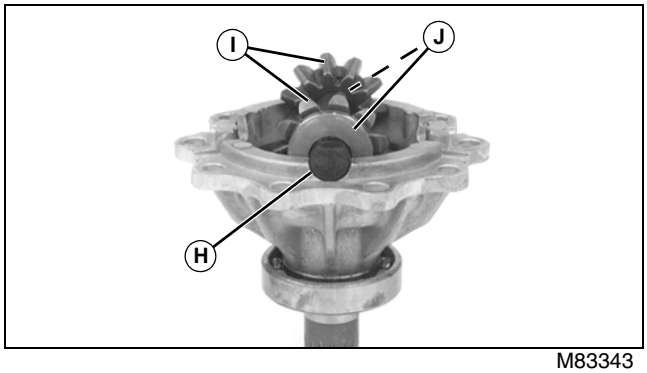
2. Press carrier bearings (B) onto both differential housing halves.



M83340

3. Install long input shaft (C), washer (E), and notched differential gear (G) with snap ring (F), into left housing half with lock collar (D).

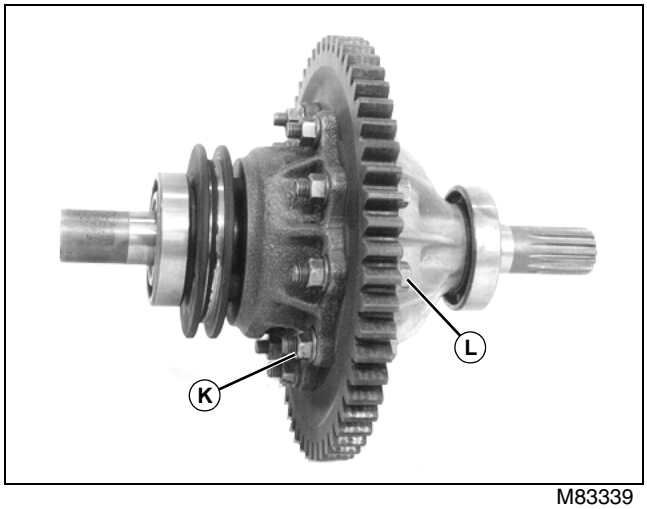
4. Install short output shaft, gear, and snap ring assembly in right housing half.



M83343

Note: Be sure bevel pinion is seated into correct housing notch.

5. Install pinion shaft (H) with gears (I) and washers (J) into right differential carrier half.



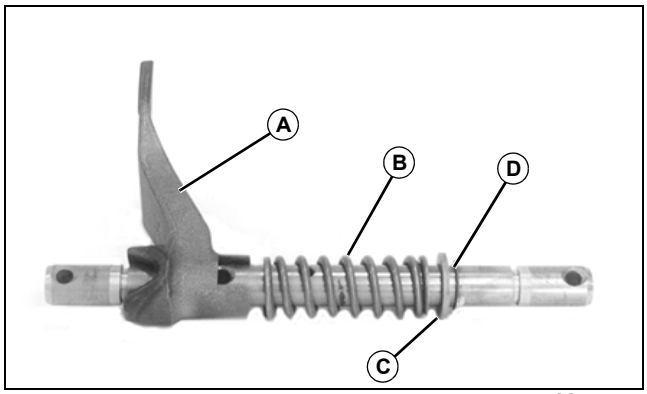
M83339

6. Assemble two differential halves to differential gear.

Note: Use new bolts (L) and nuts (K) to secure differential halves.

7. Apply T43512 Thread Lock and Sealer (Medium Strength) to bolts. Tighten nuts.

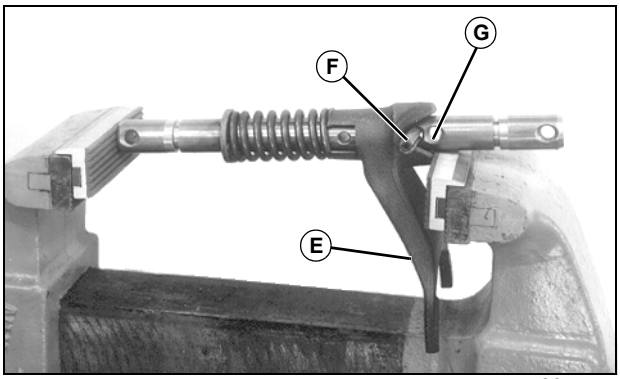
Differential Lock Shaft



M83345

1. Install snap ring (D), washer (C) and spring (B).

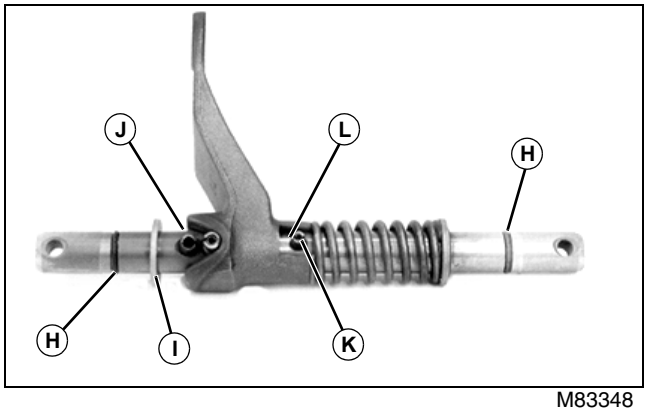
2. Install fork (A) on shaft.



M83346

3. Compress spring in vice.

4. Install double spring pin (F) with split (G) facing away from lock fork (E).



M83348

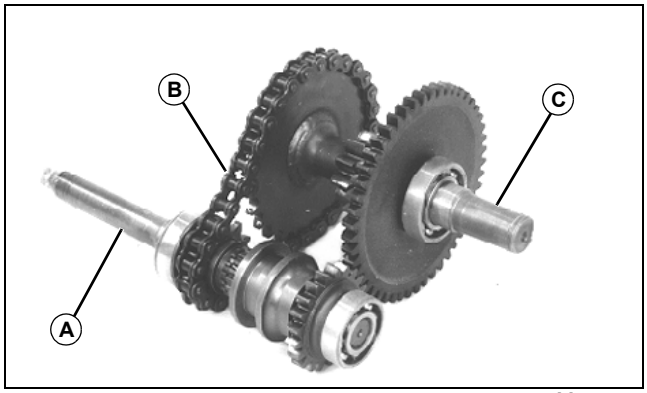
5. Install double spring pins (K) with split (L) facing spring.

6. Install single spring pin (J) with slit facing toward fork.

7. Install washer (I) onto shaft until seated against spring pin.

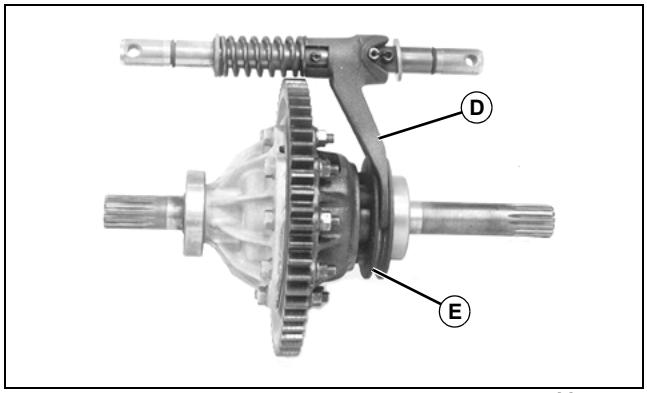
8. Install O-rings (H).

Final Assembly



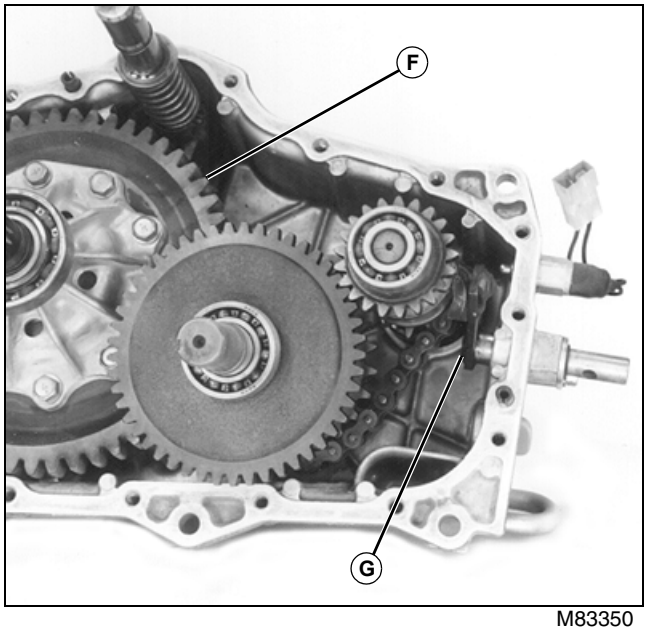
M83334

1. Assemble input shaft (A) and intermediate shaft (C) with reverse drive chain (B).



M83349

2. Assemble differential lock shaft fork (D) into collar (E).



M83350

Note: Apply MPG-2® multipurpose grease to input and output shafts and seals before assembly.

3. Install differential (F) and differential lock shaft into left case half.

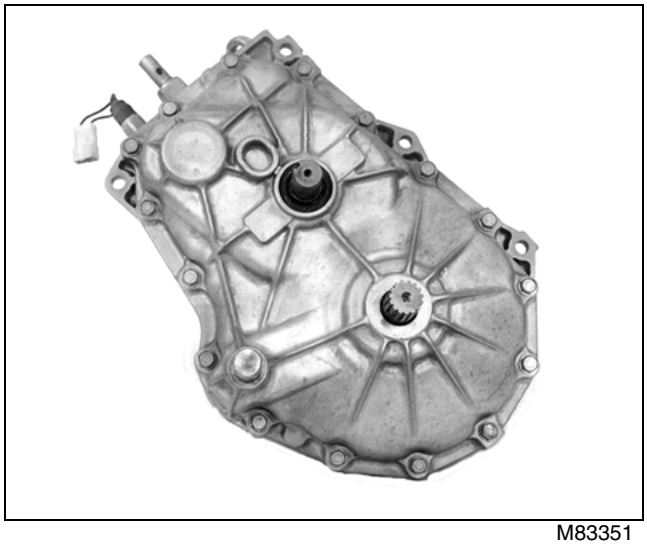
4. Start input shaft through case while working sprocket and chain behind differential gear.

5. Align shift block (G) with shift collar.

6. Align intermediate shaft with case bore.

7. Tap intermediate and input shafts with a rubber mallet to seat bearings.

8. Clean case mating surfaces using Clean and Cure Primer. Apply a coat of TY6304 Flexible Sealant or equivalent to mating surfaces of case halves.

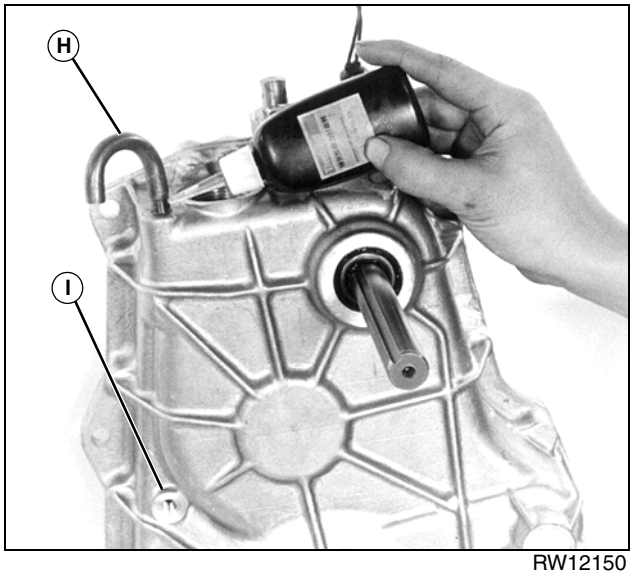


M83351

9. Assemble right case half to left case half carefully to

avoid tearing seals and O-rings.

10.Install cap screws. Tighten to specifications.



RW12150

11.If breather (H) has been removed, apply T43512 Thread Lock and Sealant (Medium Strength) to threads.

12.Install drain plug.

13.Install check plug (I) and oil fill cap.

Table of Contents

Specifications

Test Specifications

Raise Relief Valve Pressure. . . . . 4826-5516 kPa (700-800 psi)
Lower Relief Valve Pressure . . . . . 2413-3103 kPa (350-450 psi)

Repair Specifications

Hydraulic Pump

Reservoir Oil Capacity . . . . . 367 mL (12.4 oz)
Reservoir Breather/Plug Torque . . . . . 5 N•m (45 lb-in.)
Gear Pump Screw Torque . . . . . 8 N•m (70 lb-in.)
Hex Plug Torque . . . . . 59 N•m (44 lb-ft)
Lower Relief Valve Nut Torque . . . . . 2 N•m (20 lb-in.)
Raise Relief Valve Nut Torque . . . . . 2 N•m (20 lb-in.)
Thermal Relief Valve Torque . . . . . 7 N•m (60 lb-in.)

Special or Essential Tools

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

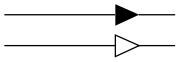
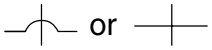
Special or Required Tools

Tool Name	Tool No.	Tool Use
0-6900 kPa (0-1000 psi) Gage	JT05471	Measure hydraulic pressure.

Hydraulic Schematics

JIC Hydraulic Circuit Symbols

LINES

1		Working (Main) Lines
2		Pilot Control Lines
3		Drain Line
4		Hydraulic / Pneumatic } Flow Direction
5		Crossing Lines
6		Joining Lines
7		Flexible Line

PUMPS

8		Fixed Displacement
9		Variable Displacement

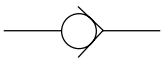
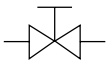
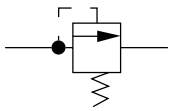
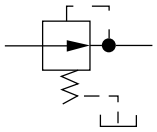
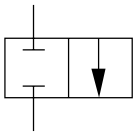
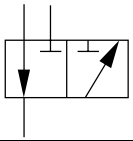
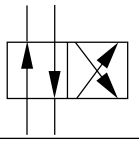
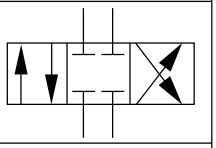
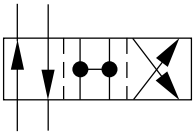
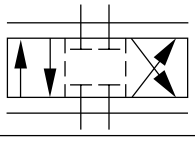
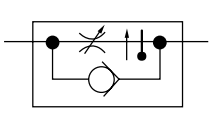
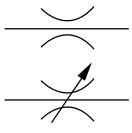
MOTORS

10		Fixed Displacement
11		Variable Displacement

RESERVOIR

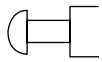
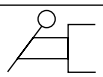
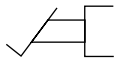
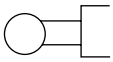
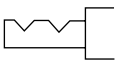
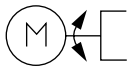
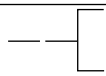
12		Vented Reservoir
13		Pressurized Reservoir
14		Reservoir Return -Above Fluid Level
15		Reservoir Return -Below Fluid Level

VALVES

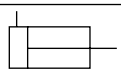
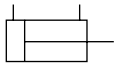
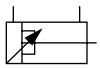
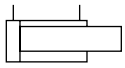
16		Check Valve
17		Manual On/Off Valve
19		Pressure Relief Valve
20		Pressure Reduction Valve
21		Two Position, Two Connection Valve
22		Two Position, Three Connection Valve
23		Two Position, Four Connection Valve
24		Three Position, Four Connection Valve
25		Two Position, Four Connection Valve with Transmission
26		Three Position, Four Connection Valve with Infinite Positioning
27		Adjustable Flow Control Valve (Temperature and Pressure Compensated)
18		Fixed / Variable } Orifice

M82612AE

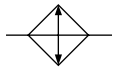
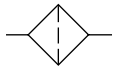
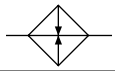
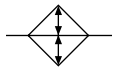
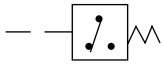
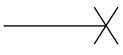
VALVE OPERATORS

28		Spring
29		Manual
30		Push Button
31		Push/Pull Lever
32		Pedal or Treadle
33		Mechanical
34		Detents
35		Pressure Compensated
36		Solenoid-Single Winding
37		Reversing Motor
38		Pilot Pressure -Remote Supply
39		Pilot Pressure -Internal Supply

CYLINDERS

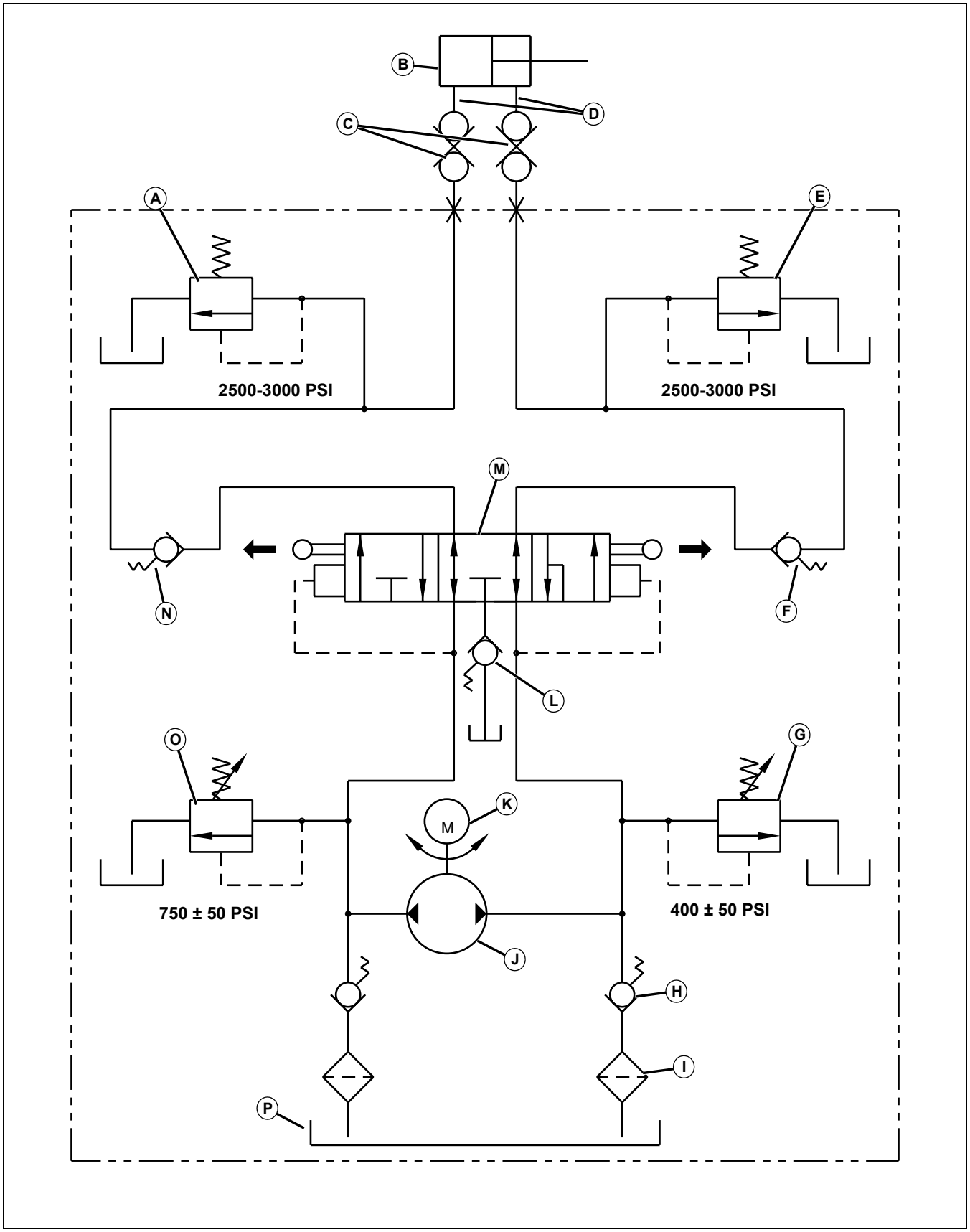
40		Single Acting
41		Double Acting, Single Rod
42		Double Acting, Double Rod
43		Double Acting, Adj. Cushion, Extend Only
44		Double Acting, Differential Piston

MISCELLANEOUS

45		Cooler
46		Filter, Strainer
47		Heater
48		Temperature Controller
49		Pressure Switch
50		Pressure Indicator
51		Temperature Indicator
52		Pressure Compensated
53		Variable Component (Symbol Thru Component)
54		Plug, Test Port, Pressure Supply Test
55		Gas Charged Accumulator
56		Spring Loaded Accumulator
57		Electric Motor
58		Shaft Rotation (Arrow on Near Side of Shaft)
59		Component Outline

M82613AE

Hydraulic Schematic



M83358AE

A- Thermal Relief Valve
B- Lift Cylinder (Customer-supplied)
C- Quick Disconnect Couplers
D- Lift Cylinder Hoses (Customer-supplied)
E- Thermal Relief Valve
F- Lower Check
G- Lower Relief Valve
H- Inlet Check
I- Suction Screen
J- Gear Pump
K- Motor
L- Added Flow Lower Check
M- Shuttle
N- Raise Check
O- Raise Relief Valve
P- Reservoir

Component Operation

Optional Hydraulic Pump Operation

Function

The hydraulic pump supplies hydraulic pressure to raise or lower the implement. The hydraulic pump is a dealer-installed option.

Theory of Operation

Raise

When the lift switch is in the RAISE position and the motor is operating, the gear pump draws oil from the reservoir through the suction screen. The inlet check valve opens, allowing oil to flow to the inlet side of the gear pump.

The gear pump produces high pressure on the outlet side of the gear pump. This high-pressure oil closes the inlet check valve so oil can not flow back to the reservoir. High pressure acts against the shuttle, moving the shuttle toward the down port check valve, opening the down port check valve.

As pressure increases, the UP check valve opens by overcoming the spring force. This allows high-pressure oil to flow to the lift cylinder (customer-supplied) to extend the cylinder. The raise relief valve prevents the pressure from exceeding 5271 ± 345 kPa (750 ± 50 psi).

Oil from the head of the cylinder flows back to the pump, through the open DOWN port check valve, and to the suction side of the pump.

Neutral

Note: The following operation describes lift-to-neutral operation. Lower-to-neutral operation is similar with oil flow reversed.

When the lift switch is released, the motor and gear pump stop operating. The oil pressure at the outlet side of the gear pump decreases. As oil pressure decreases, spring tension closes the UP check valve. Oil returning from the cylinder overcomes the DOWN check valve spring pressure, closing the down check valve. As the DOWN check valve closes, it pushes the shuttle to the NEUTRAL position.

Oil in the lift cylinder is now trapped, maintaining the implement in its desired position. Oil remaining in the shuttle and gear pump overcome inlet check valve spring pressure, closing the inlet check valves.

Lower

When the lift switch is moved to the LOWER position, the motor and gear pump rotate in the opposite direction as in the raise operation. The gear pump draws oil from the reservoir through the suction screen and inlet check valve.

The gear pump produces high-pressure oil on the outlet side of the gear pump. The high-pressure oil closes the inlet check valve, preventing oil flow back to the reservoir. High-pressure oil acts on the shuttle, moving the shuttle toward the UP port check valve. The shuttle contacts the UP port check valve, opening the check valve.

As oil pressure increases, the DOWN check valve spring pressure is overcome, opening the check valve. This allows high-pressure oil to flow to the rod end of the lift cylinder. The lower relief valve prevents the lower pressure from exceeding 2758 ± 345 kPa (400 ± 50 psi).

Oil from the lift cylinder flows through the UP port check valve, past the shuttle, and to the inlet side of the gear pump. More oil is present in the head end of the cylinder than in the rod end, so to allow the greater volume of oil to return to the pump, the return oil unseats the added flow check valve, allowing a portion of the oil to return directly to the reservoir.

Relief Valve Operation

If the load being raised is too heavy or if an oil passage becomes blocked, oil pressure will increase at the outlet side of the gear pump. When oil pressure overcomes the raise relief valve spring, the relief valve opens, allowing high-pressure oil to relieve directly to the reservoir. This protects the gear pump from damage. The raise relief valve is set at approximately 5171 kPa (750 psi). The raise relief valve is adjustable by turning the relief valve body.

When the lift cylinder is lowered and the implement contacts the ground, cylinder bottoms or an oil passage becomes blocked, oil pressure will increase on the down side of the gear pump. When oil pressure overcomes the lower relief valve spring, the relief valve opens, allowing high-pressure oil to relieve directly to the reservoir. The lower relief valve is set at approximately 2758 kPa (400 psi). The lower relief valve is also adjustable.

With the lift system in the neutral position, the check valves are closed. If the cylinder encounters a shock load, oil pressure in the cylinder will increase because it is blocked by the lift check. When oil pressure overcomes the thermal relief valve spring, the relief valve opens, allowing high-pressure oil to relieve to the reservoir. This protect the lift cylinder from damage. The thermal valve is set at approximately 17237-20684 kPa (2500-3000 psi). The thermal relief valve is not adjustable.

Diagnostics

System: Hydraulic Diagnosis

Hydraulic System

1. Does implement raise?

Yes: Go to next step.

No: Check to see if maximum load is being exceeded.

No: Check to see if oil is low.

No: Check for correct oil viscosity.

No: Check relief valve for damage.

No: Check shuttle valve for binding or O-ring damage.

No: Check suction filter.

No: Check gear pump for wear or damage.

2. Does implement raise slowly?

No: Go to next step.

Yes: Check to see if oil is low.

Yes: Check shuttle valve for binding or O-ring damage.

3. Does implement lower?

Yes: Go to next step.

No: Check to see if oil level is low.

No: Check for correct oil viscosity.

No: Check shuttle valve for binding or O-ring damage.

No: Check suction filter.

No: Check gear pump for wear or damage.

4. Noisy operation?

Yes: Check to see if oil level is low.

Yes: Check for correct oil viscosity.

Yes: Check shuttle valve for binding or O-ring damage.

5. Implement lowers/leaks down during operation?

Yes: Check to see if oil level is low.

Yes: Check shuttle valve for O-ring damage.

Yes: Actuator/housing worn or damaged.

Tests and Adjustments

Test Raise Relief Valve Pressure

Reason

To check raise relief valve pressure setting.

Test Equipment

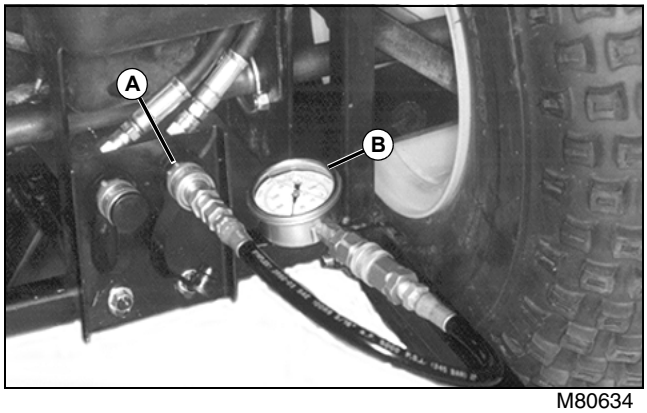
Special or Required Tools

Tool Name	Tool No.	Tool Use
0-6900 kPa (0-1000 psi) Gage	JT05471	Measure hydraulic pressure.

Procedure

Note: Hydraulic oil should be at room temperature when performing test.

1. Park machine safely. (See “Park Machine Safely” on page 3.)
2. Turn key switch to OFF position.
3. Move gearshift pedals to NEUTRAL position.
4. Lock park brake.
5. Lower rear implement.



M80634

6. Connect JT054710 0-6900 kPa (0-1000 psi) Gage (B) to quick coupler - UP port (A).
7. Turn key switch to RUN position.
8. Move lift switch to LIFT position. Record raise relief valve pressure. Release switch.

Results

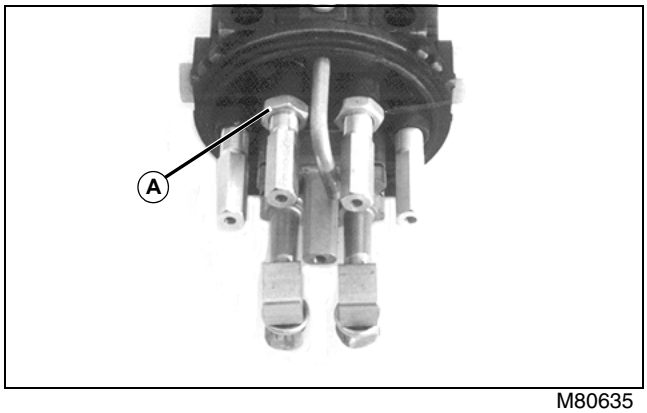
- If pressure is not within specifications, adjust raise relief valve.

Specifications

Raise Relief Valve Pressure . . . . . 4826-5516 kPa . . . . . (700-800 psi)

Adjust Raise Relief Valve Pressure

Drain and remove reservoir.



M80635

Loosen nut. Turn relief valve body:

- Clockwise to increase pressure.
- Counterclockwise to decrease pressure.

Hold relief body and tighten nut.

Install reservoir and fill with John Deere Low Viscosity HY-GARD® (J20D) transmission/hydraulic oil.

Test Lower Relief Valve Pressure

Reason

To check lower relief valve pressure setting.

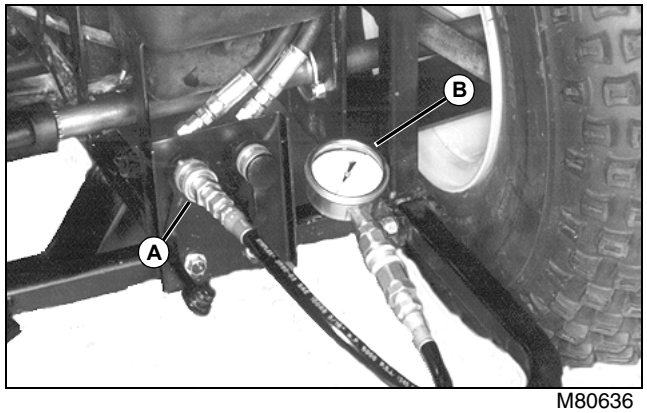
Special or Required Tools

Tool Name	Tool No.	Tool Use
0-6900 kPa (0-1000 psi) Gage	JT05471	Measure hydraulic pressure.

Procedure

Note: Hydraulic oil should be at room temperature when performing test.

1. Park machine safely. (See “Park Machine Safely” on page 3.)
2. Turn key switch to OFF position.
3. Move gearshift pedals to NEUTRAL position.
4. Lock park brake.
5. Lower rear implement.



M80636

6. Connect JT05471 0-6900 kPa (0-1000 psi) Gage (B) to quick coupler-DOWN port (A).
7. Turn key switch to RUN position.
8. Move lift switch to LOWER position. Record raise relief valve pressure. Release switch.

Results

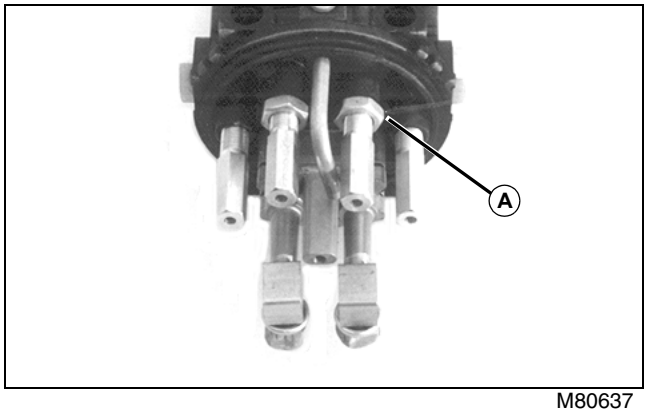
- If pressure is not within specifications, adjust lower relief valve.

Specifications

Lower Relief Valve Pressure . . . . . 2413-3103 kPa . . . . . (350-450 psi)

Adjust Lower Relief Valve Pressure

Drain and remove reservoir.



M80637

Loosen nut. Turn relief valve body:

- Clockwise to increase pressure.
- Counterclockwise to decrease pressure.

Hold relief body and tighten nut.

Install reservoir and fill with John Deere Low Viscosity HY-GARD® (J20D) transmission/hydraulic oil.

Repair

Remove and Install Hydraulic Pump (Optional)

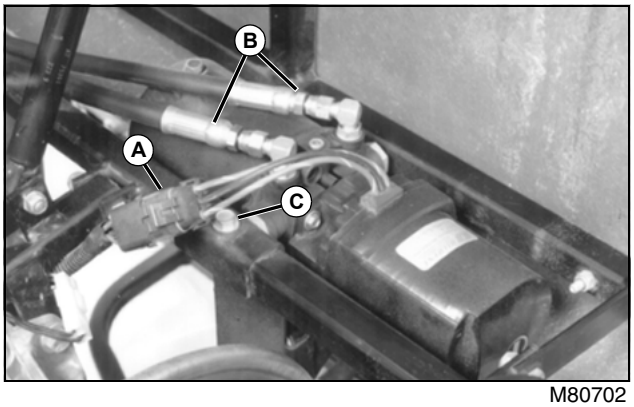
Removal

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 removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury may call Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

Always lower all attachments to the ground before you work on the machine. If must work on a lifted machine or attachment, securely support the machine or attachment. Failure to do so may result in serious injury.

1. Park machine safely. (See “Park Machine Safely” on page 3.)
2. Lower all implements (if equipped).
3. Raise rear body cowling.



M80702

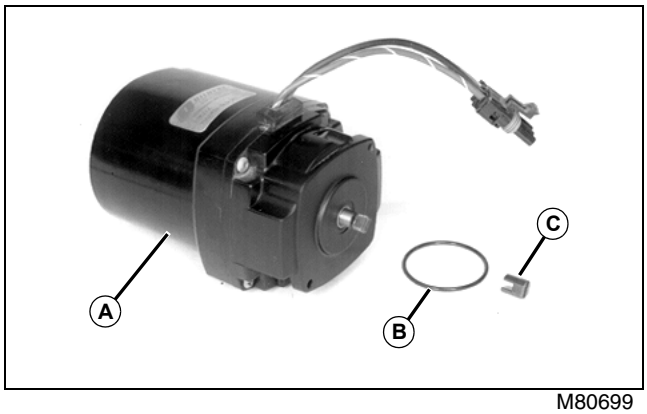
4. Disconnect wiring connector (A).
5. Disconnect hoses (B).
6. Remove two cap screws and washers (C) and remove pump.

Installation

Installation is done in the reverse order of removal.

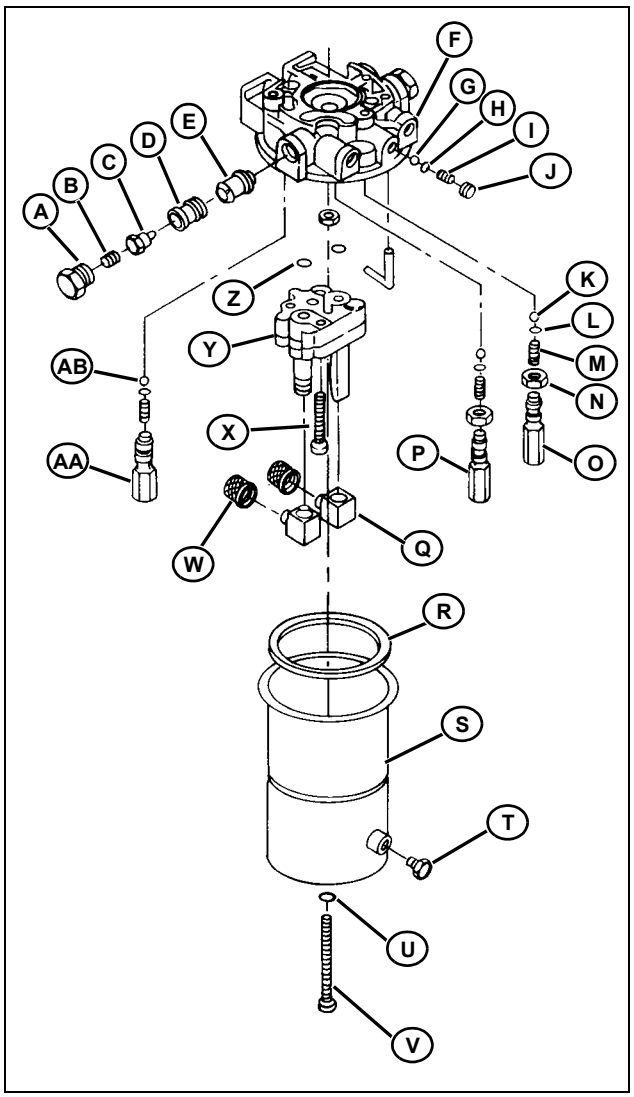
Repair Hydraulic Pump

Disassembly, Inspection, and Assembly



M80699

1. Remove two cap screws.
2. Remove pump motor (A), O-ring (B), and coupler (C).



M80705

A- Hex Plug
B- Spring
C- Lift Check Assembly
D- Lift Check Body
E- Shuttle Valve
F- Adapter
G- Ball
H- Eyelet
I- Spring
J- Setscrew
K- Steel Ball (2 used)
L- Eyelet (3 used)
M- Spring (3 used
N- Nut (2 used)
O- Lower Relief Valve
P- Raise Relief Valve
Q- Fitting
R- Seal
S- Reservoir
T- Breather/Plug
U- O-Ring
V- Screw
W- Suction Screen (2 used)
X- Screw
Y- Gear Pump
Z- O-Ring (2 used)
AA- Thermal Relief Valve (2 used)
AB- Plastic Ball (2 used)

3. Remove breather/plug (T) and drain reservoir.

Note: Reservoir oil capacity is 367 mL (12.4 oz).

4. Remove parts (R-V).

Note: Gear pump (Y), relief valves (O, P and AA) and adapter assembly (F) are serviced as assemblies.

5. Mark relief valves (O, P and AA), nuts (N) and adaptor (F) for each relief valve assembly prior to removal to aid in assembly. Also measure the length of each relief valve from the adapter to the end of the relief in case the relief valve must be replaced.

Important: Avoid Damage! Mark the position of the relief valves before removal. Failure to install the relief valves in their original position will change the relief pressures, which may damage components.

6. Inspect relief valve springs (M), balls (K and AB), and seat for debris, cracks, wear or damage. Replace parts as necessary.

7. Inspect gear pump (Y) teeth for nicks or burrs. Inspect pump housing for wear or damage. Replace parts as necessary.

8. Check shuttle valve (E) for free movement in bore and O-ring for damage. Replace parts as necessary.

9. Inspect passages for plugged conditions.

Important: Avoid Damage! Absolute cleanliness is essential when working on pump. Contamination can result in serious damage or inadequate operation.

DO NOT use shop towels or rags to dry clean parts. Lint will clog passages in hydrostatic system and cause damage.

10.Clean components in solvent and dry with compressed air. Be sure all passages are clear.

Caution: Avoid Injury! Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

Assembly

Assembly is done in the reverse order of disassembly.

Important: Avoid Damage! Always use new O-rings. Damaged or used parts will leak.

- Lubricate O-rings with petroleum jelly during assembly.
- Apply a light coating of clean hydraulic oil to all internal parts before assembly.

Note: Install fittings (Q) and screens (W) pointing 180× to set screw (J).

Install reservoir (S) with breather/plug (T) in alignment with setscrew (J).

- Tighten components to specifications.
- Fill reservoir with John Deere Low Viscosity HY-GARD® (J20D) transmission/hydraulic oil.

Specifications

Reservoir Breather/Plug Torque	**5 N•m (45 lb-in.)**
Gear Pump Screw Torque	**8 N•m (70 lb-in.)**
Hex Plug Torque	**59 N•m (44 lb-in.)**
Lower Relief Valve Nut Torque	**2 N•m (20 lb-in.)**
Raise Relief Valve Nut Torque	**2 N•m (20 lb-in.)**
Thermal Relief Valve Torque	**7 N•m (60 lb-in.)**

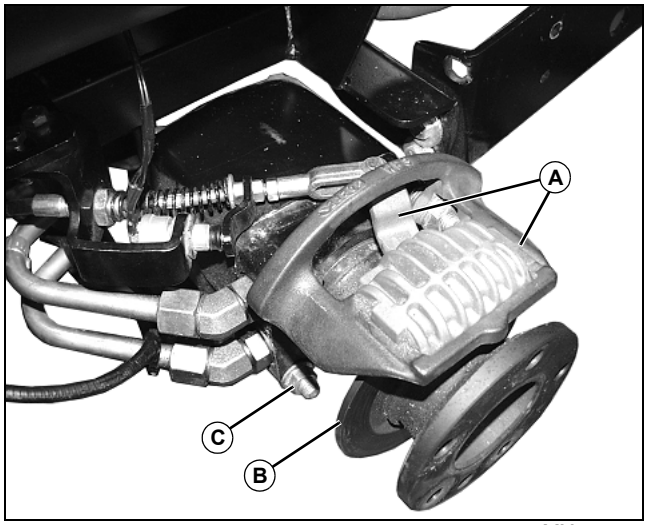
Remove and Install Rear Wheel Motor

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. (See “Park Machine Safely” on page 3.)



MX32679

2. Remove park brake assembly (A) and rotor (B). (See “Remove and Install Brake Disk” on page 224.)
3. Disconnect hydraulic hoses.
4. Remove mounting cap screws and nuts (C).
5. Inspect parts for wear or damage. Replace seals as necessary.

Installation

Installation is done in the reverse order of removal.

- Apply MPG-2® Multi-Purpose Grease to wheel motor shaft and key.
- Tighten the nut securing the rotor to the wheel to specifications.
- Tighten hydraulic line nuts to specifications.
- Check oil reservoir before operating machine.

Specifications

Rotor Nut Torque . . . . . 407 N•m (300 lb-ft)
Hydraulic Line Nut Torque. . . . . 50 N•m (37 lb-ft)

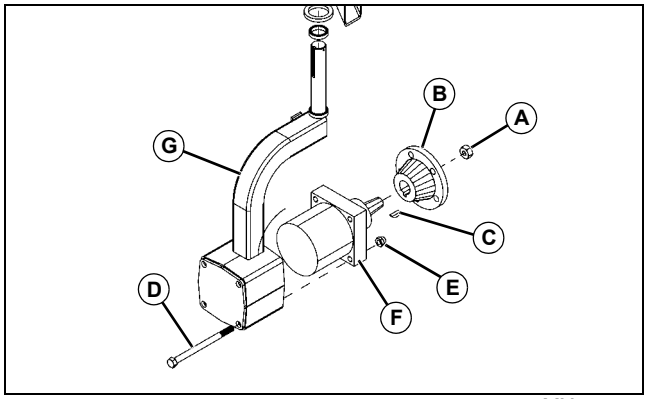
Remove and Install Front Wheel Motor

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. (See “Park Machine Safely” on page 3.)
2. Remove front wheel.



MX32923

3. Remove nut (A) to remove front hub (B), being sure to retain key (C).
4. If necessary, remove bolts (D) and nuts (E) and remove front wheel motor (F) from front steering fork (G).
5. Inspect all parts for wear or damage. Replace seals as necessary.

Installation

Installation is done in the reverse order of removal.

- Apply MPG-2® Multi-Purpose Grease to wheel motor shaft and key.
- Tighten the nut securing the front hub to the wheel to specifications.
- Tighten hydraulic line nuts to specifications.
- Check oil reservoir before operating machine.

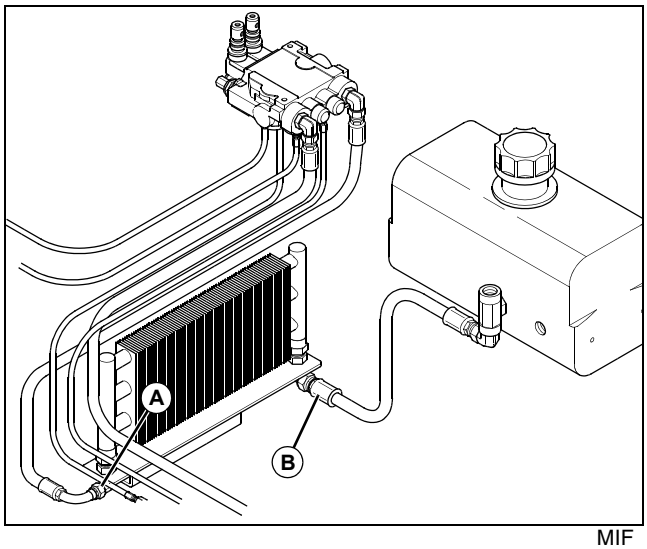
Specifications

Rotor Nut Torque . . . . . 407 N•m (300 lb-ft)
Hydraulic Line Nuts Torque. . . . . 50 N•m (37 lb-ft)

Remove and Install Oil Cooler

Removal

1. Park machine safely. (See “Park Machine Safely” on page 3.)
2. Raise rear body cowling.



MIF

3. Remove lower left line (A) from oil cooler (line connected to control valve).
4. Remove lower right line (B) from oil cooler (line connected to oil reservoir).
5. Remove hardware securing oil cooler to machine frame, and raise oil cooler from machine.

Installation

Installation is done in the reverse order of removal.

- Tighten line nuts (A and B) to specifications.
- Check oil reservoir before operating machine.

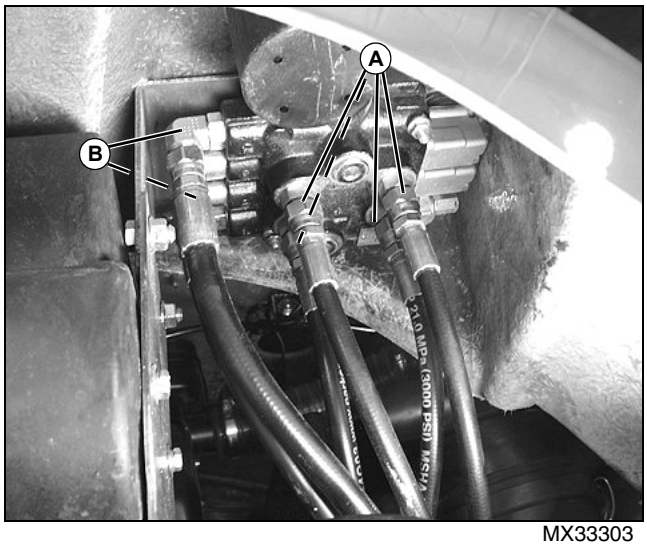
Specifications

Hydraulic Line Nut Torque . . . . . 50 N•m (37 lb-ft)

Remove and Install Lower/Lift Levers

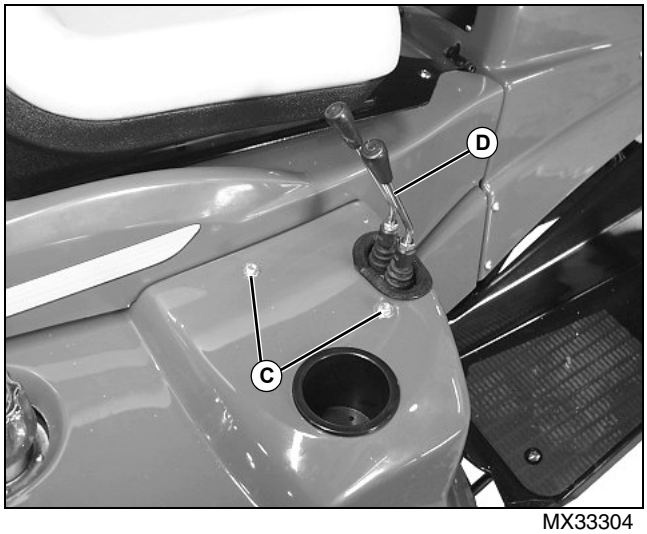
Removal

1. Park machine safely. (See “Park Machine Safely” on page 3.)



MX33303

2. Disconnect four lines (A).
3. Disconnect two lines (B).



MX33304

4. Remove two bolts (C) holding valve in position.
5. Lower valve assembly (D) from bottom of right fender.

Installation

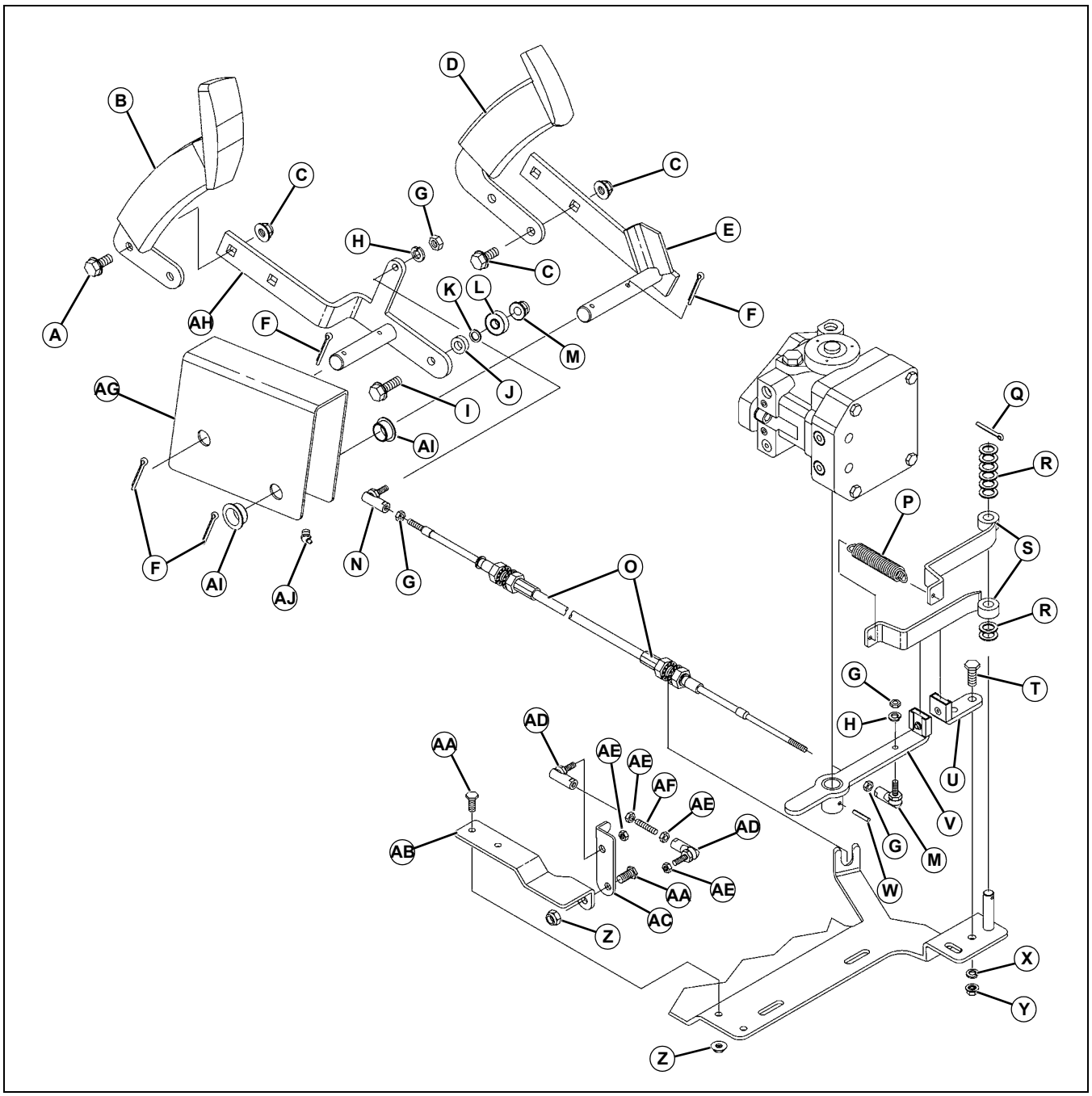
Installation is done in the reverse order of removal.

- Tighten all line connections to specifications.
- Check oil reservoir before operating machine.

Specifications

Hydraulic Line Nut Torque . . . . . 50 N•m (37 lb-ft)

Remove and Install Forward and Reverse Pedals and Linkage



MX32928

A- Screw (M8x25)
B- Pedal, Forward
C- Locknut (M8)
D- Pedal, Reverse
E- Shaft, Reverse
F- Cotter Pin (4 x 25 mm)
G- Nut, 1/4 in.
H- Lock washer, 1/4 in.
I- Bolt
J- Bushing
K- Washer
L- Bearing
M- Nut
N- Tie Rod End
O- Cable
P- Spring
Q- Cotter Pin (1/8 x 1 in.)
R- Washer
S- Arm, Centering

T- Cap Screw (3/8 x 1 in.)
U- Stop
V- Control Arm
W- Spring Pin
X- Washer
Y- Nut
Z- Locknut
AA- Cap Screw (5/16 x 1 in.)
AB- Bracket
AC- Arm
AD- Tie Rod End
AE- Nut
AF- Linkage
AG- Pivot (Part of floorboard assembly)
AH- Shaft, Forward
AI- Bushing
AJ- Lubrication Fitting

- Inspect all parts for wear or damage. Replace parts as necessary.
- Adjust linkage. (See “Test Raise Relief Valve Pressure” on page 199.)

Table of Contents

STEERING TABLE OF CONTENTS

Specifications

General Specifications

Steering Specifications

Type . . . . . Mechanical, roller-chain and sprocket
Ratio. 8:1
Steering Wheel Diameter . . . . . 355 mm (14 in.)
Turns (Lock to Lock) 3.0
Maximum Torque Required to Turn . . . . . 14 N•m (10 lb-ft)
Expected Operating Grade . . . . . 20% (11.3 degrees)

Repair Specifications

Torque Specifications

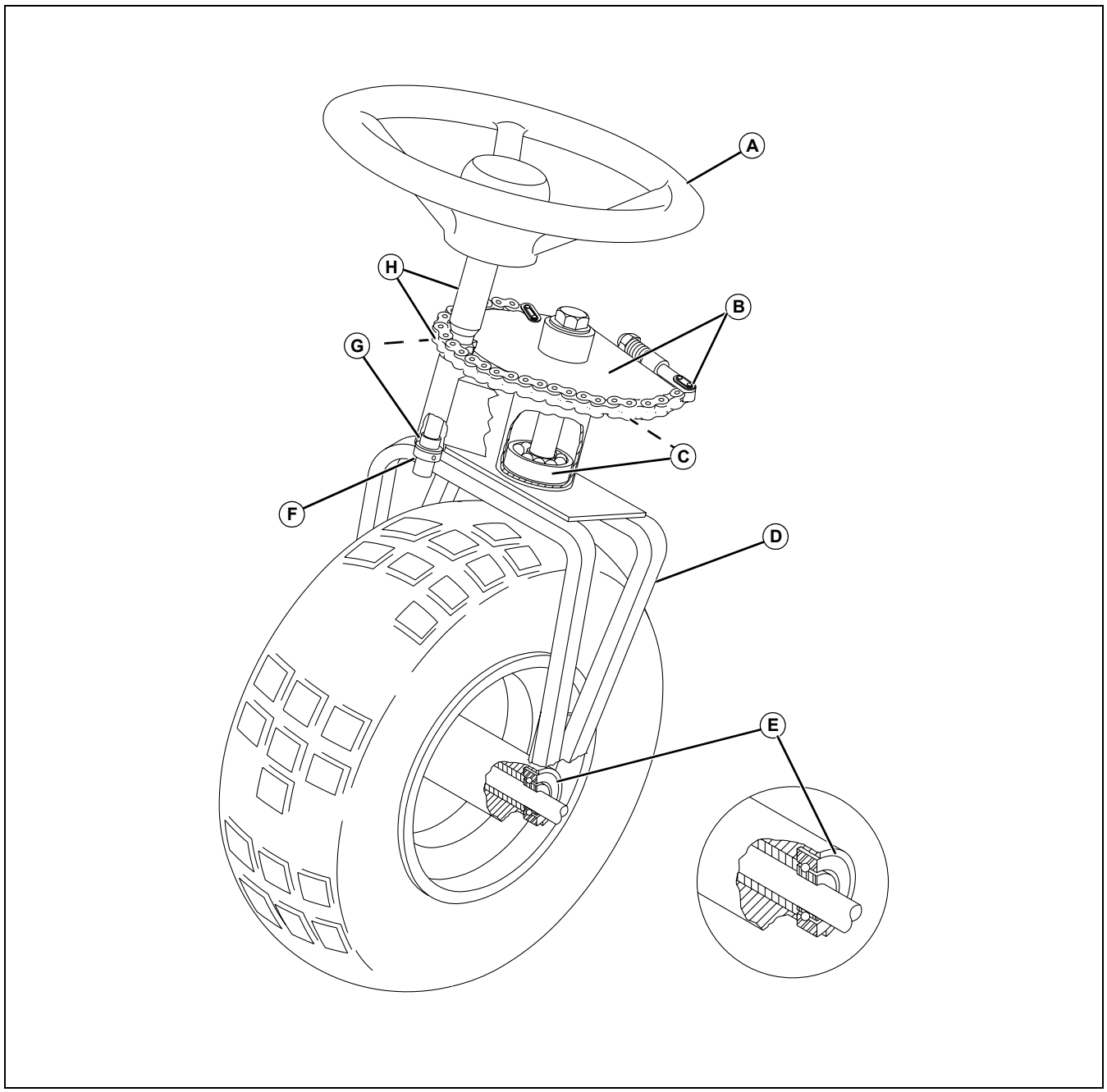
Locking Collar Setscrew . . . . . 8 N•m (64 lb-in.)
Steering Disk Cap Screw . . . . . 33 N•m (24 lb-ft)
Steering Wheel-to-Shaft Nut . . . . . 33 N•m (24 lb-ft)

Other Materials

Other Material

Part No.	Part Name	Part Use
M79292	MPG-2™ Multipurpose Polymer Grease	Apply to steering shaft and steering fork shaft.

MPG-2®is a registered trademark of DuBois USA.



M83178AE

A- Steering Wheel
B- Steering Disk and Chain
C- Bearing
D- Steering Fork
E- Wheel Bearing
F- Locking Collar
G- Bushing
H- Steering Shaft and Sprocket

Theory of Operation

Steering System Operation

Function

To direct movement of the machine in forward or reverse.

Theory of Operation

When the steering wheel is turned, the steering shaft and sprocket rotate. The sprocket is connected to the steering disk by a chain. The steering disk is splined to the steering fork. As the sprocket turns, the chain causes the steering disk/steering fork to rotate, turning the front wheels.

Steering effort is quite low due to the 8:1 reduction between the steering shaft and the fork shaft. There are two mechanical stops between the fork and frame, which limits the steering angle of the front wheel.

Diagnostics

System: Steering Diagnosis

Steering System Checks

1. Does steering wander?

Yes: Check to see if steering chain is loose or worn.

Yes: Check sprocket teeth for wear or damage.

Yes: Check wheel bearings for wear or damage.

Yes: Check for a bent rim.

Yes: Check to make sure tire is mounted correctly on rim.

2. Does steering feel loose or unresponsive?

Yes: Check to see if steering wheel is loose on column.

Yes: Check to see if steering chain is loose or worn.

Yes: Check sprocket teeth for wear or damage.

3. Is there vibration at steering wheel?

Yes: Check wheel bearings for wear or damage.

Yes: Check fork shaft bearings for wear or damage.

Yes: Check wheel motor components for wear or damage.

Yes: Check for a bent rim.

Yes: Check to make sure tire is mounted correctly on rim.

4. Does the steering wheel turn hard?

Yes: Check fork shaft bearings for wear or damage.

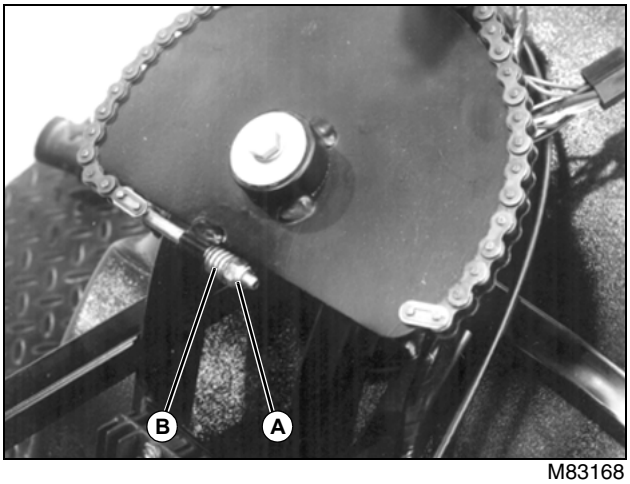
Yes: Check wheel motor components for wear or damage and that hoses are correctly installed.

Adjustments

Adjust Steering Chain Tension

Procedure

1. Park machine on level surface.
2. Move forward/reverse pedals to NEUTRAL position.
3. Turn key switch to OFF position.
4. Remove front cowling. (See “Remove and Install Front Cowling” on page 244.)



M83168

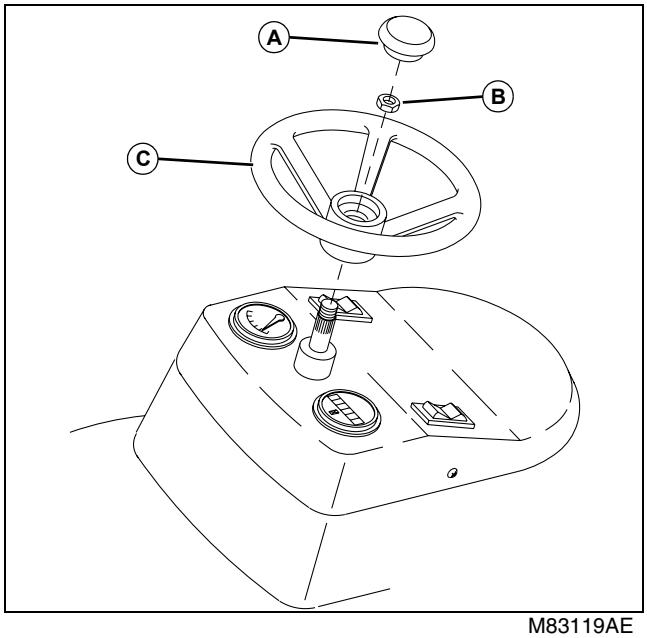
5. Tighten locknut (A) until spring (B) is fully compressed. Loosen locknut (A) 1/2 turn.

Repair

Remove and Install Steering Wheel

Removal

1. Park machine safely. (See “Park Machine Safely” on page 3.)



M83119AE

2. Remove cap (A).
3. Remove locknut (B).
4. Remove steering wheel (C).

Installation

Installation is done in the reverse order of removal.

Specifications

Steering Wheel Locknut Torque . . . . . 33 N•m (24 lb-ft)

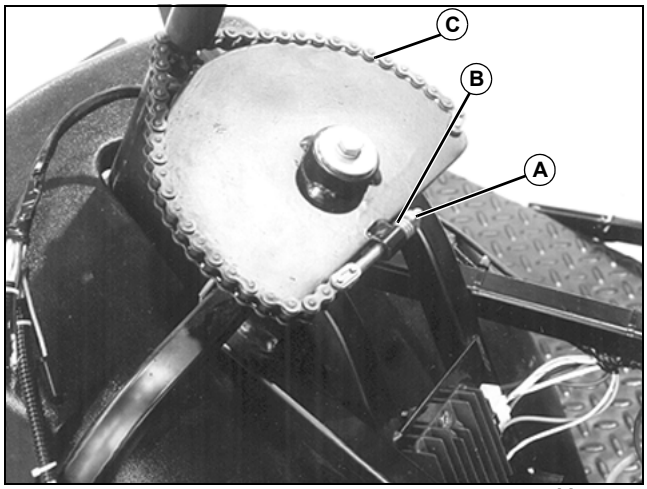
Remove and Install Steering Shaft

Other Material

Part No.	Part Name	Part Use
M79292	MPG-2™ Multipurpose Polymer Grease	Apply to steering shaft and steering fork shaft.

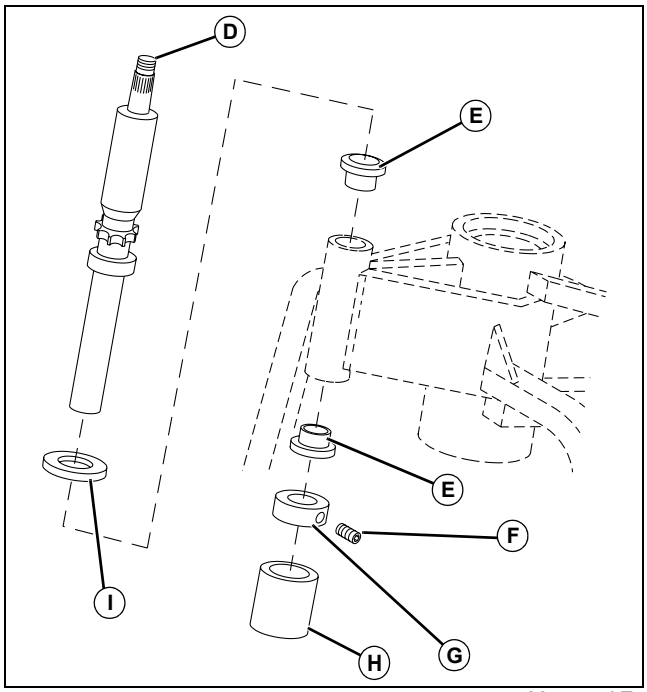
Removal

1. Park machine safely.
2. Remove steering wheel. (See “Remove and Install Steering Wheel” on page 214.)
3. Remove front cowling. (See “Remove and Install Front Cowling” on page 244.)



M83121

4. Remove locknut (A) and spring (B).
5. Disconnect chain (C).



M83136AE

6. Remove cap (H).
7. Loosen setscrew (F) and remove locking collar (G).
8. Remove shaft (D) and washer (I).
9. Inspect all parts for wear or damage. Replace parts as necessary.

Note: Remove bushings only if replacement is necessary.

10. Inspect bushings (E) for wear or damage. Replace if necessary.

11.Remove bushings using a blind hole puller set.

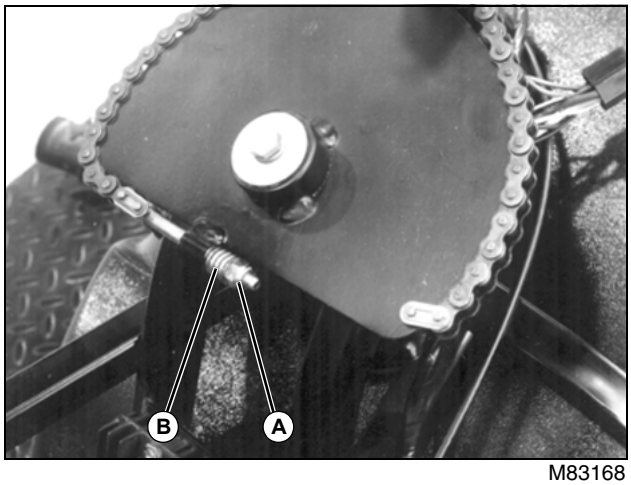
Installation

Installation is done in the reverse order of removal.

1. Apply MPG-2® Polymer Multipurpose Grease to lower half of steering shaft.

2. Install bushings using a driver set.

3. Install locking collar with recessed side facing down. Do not install locking collar tight against frame.



M83168

4. Tighten locknut (A) until spring (B) is fully compressed. Loosen locknut 1/2 turn.

Specifications

Locking Collar Setscrew Torque . . . . . 8 N•m (64 lb-in.)

Remove and Install Steering Fork

Other Material

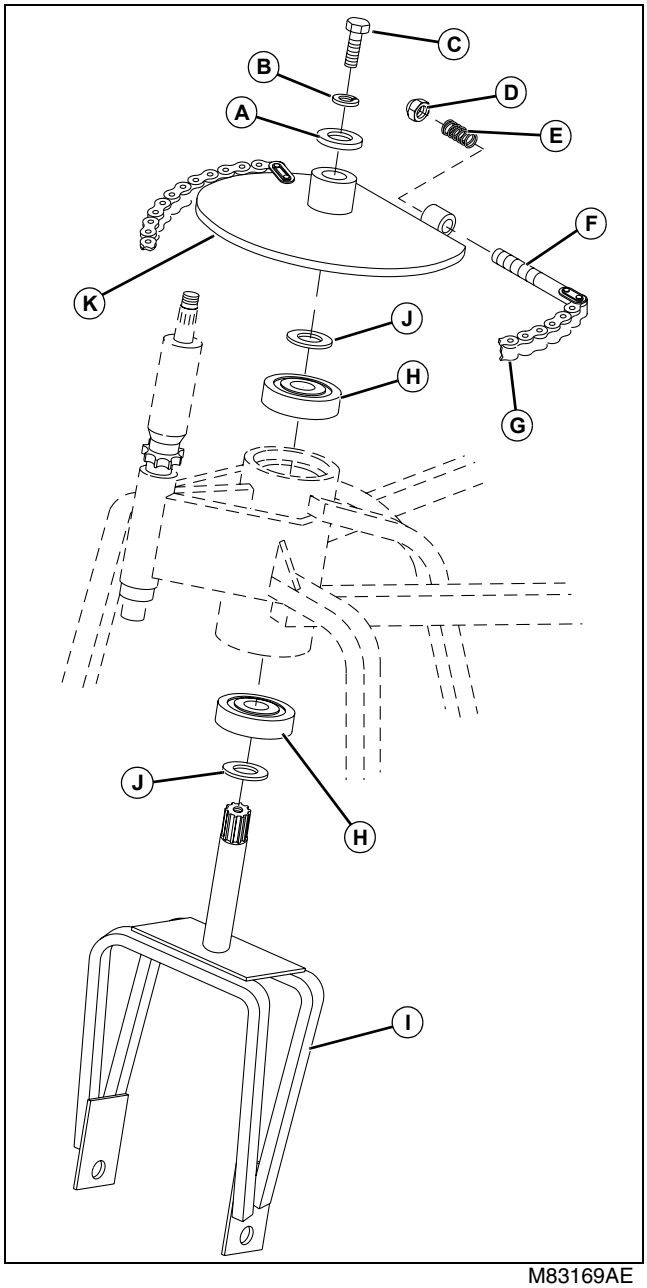
Part No.	Part Name	Part Use
M79292	MPG-2™ Multipurpose Polymer Grease	Apply to steering shaft and steering fork shaft.

Removal

1. Park machine safely. (See “Park Machine Safely” on page 3.)

2. Remove front cowling. (See “Remove and Install Front Cowling” on page 244.)

3. Remove front wheel. (See “Remove and Install Front Wheel” on page 245.)



M83169AE

4. Remove locknut (D), spring (E), and disconnect stud (F) and chain (G).

5. Support steering fork (I).

6. Remove cap screw (C), lock washer (B), washer (A), steering disk (K), and thrust washer (J).

7. Remove steering fork (I).

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

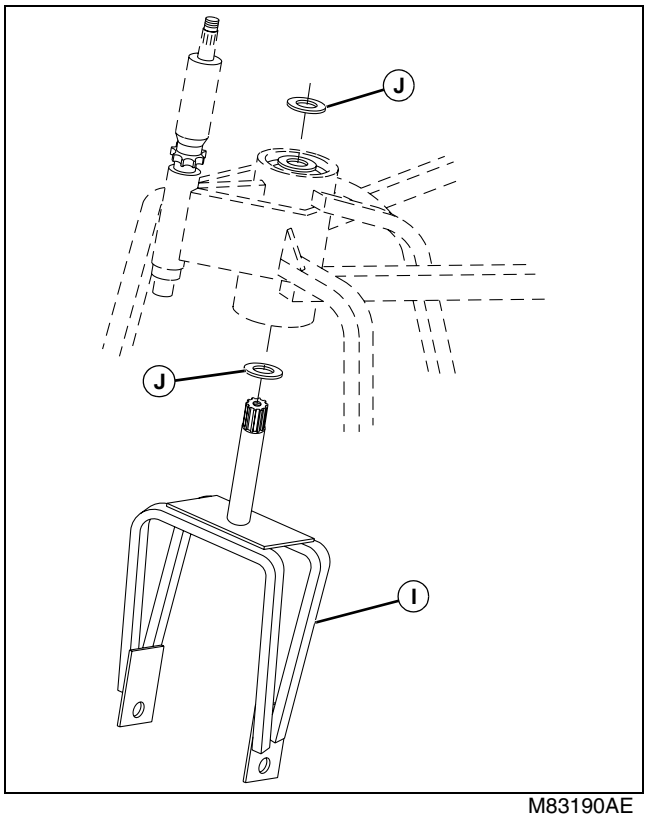
Note: Bearings (H) are press-fit. Remove only if replacement is necessary.

9. Inspect bearings (H) for wear or damage. Replace if necessary.

Installation

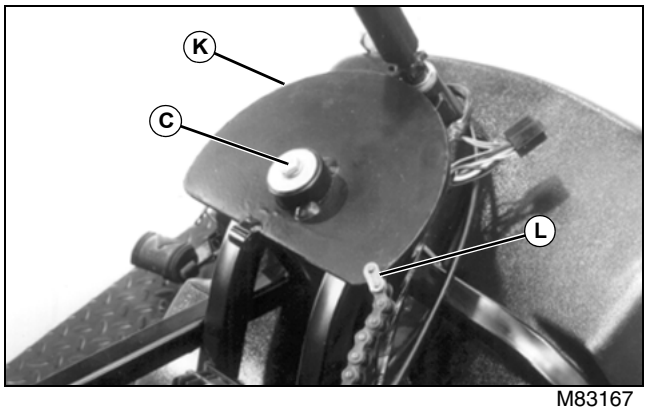
Installation is done in the reverse order of removal.

- Apply MPG-2® Polymer Multipurpose Grease to steering fork shaft.



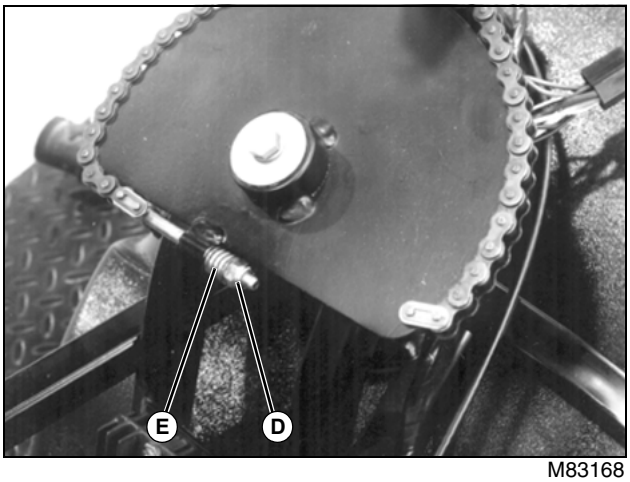
M83190AE

1. Install thrust washer (J) on steering fork shaft and install steering fork (I).
2. Support steering fork.
3. Install thrust washer (J).
4. Rotate steering fork until parallel to frame.



M83167

5. Position disk with chain end (L) in 4 o'clock position as shown.
6. Align disk (K) ID splines with steering fork shaft and install.
7. Install flat washer, lock washer and cap screw (C).



M83168

8. Tighten locknut (D) until spring (E) is fully compressed. Loosen locknut 1/2 turn.

Specifications

Steering Fork Cap Screw Torque . . . . . 33 N•m (24 lb-ft)

Table of Contents

BRAKES TABLE OF CONTENTS

Specifications

General Specifications

Brake Specifications

Brake Location/Type . . . . . Transaxle, internal
Park Brake. . . . . Brake locking lever

Adjustment Specifications

Brake Specifications

Brake Pad Contact Adjustment Screw . . . . . Tighten, then turn counterclockwise 1/2 turn
Brake Pedal Lock Tab-to-Lock Lever Notch Gap . . . . . 3.2 mm (0.125 in.)

Repair Specifications

Brake Specifications

Brake Caliper-to-Frame Nut Torque . . . . . 33 N•m (24 lb-ft)
Axle Shaft Bearing Carriage Bolt Torque . . . . . 25 N•m (216 lb-in.)

Other Materials

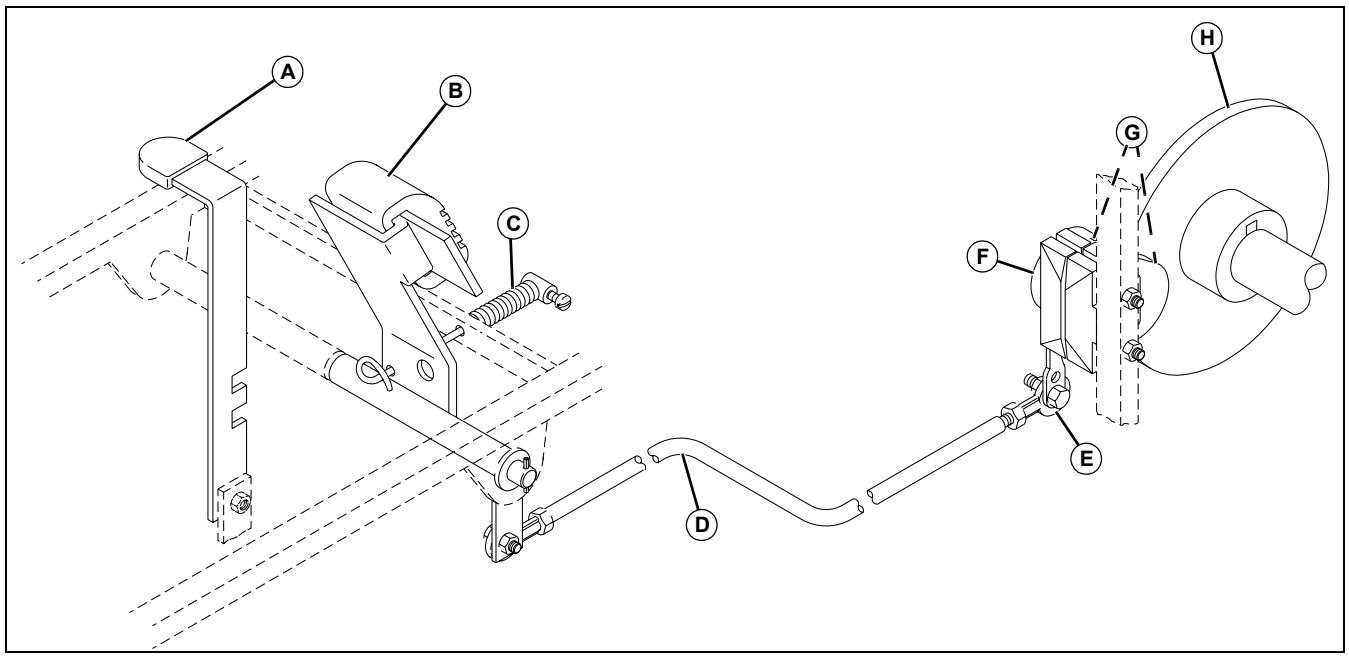
Other Material

Part No.	Part Name	Part Use
M79292	MPG-2® Polymer Multipurpose Grease	Prevents parts from seizing. Apply to transaxle axle shaft splines and brake actuator pin.
AR31790	Adhesive	Attaches brake lining to caliper housing.

MPG-2® is a registered trademark of DuBois USA.

Component Location

Brake System Components and Operation



M83179AE

A- Park Brake Lock Lever
B- Pedal Assembly
C- Return Spring
D- Brake Rod
E- Brake Actuator Arm
F- Caliper Assembly
G- Brake Linings
H- Disk

Function

To provide a means of stopping the machine and also prevent movement when machine is not in use.

Theory of Operation

The brakes are a mechanical disk type mounted on the intermediate shaft of the transaxle.

When the brake pedal is pressed, the brake rod moves to the rear, pushing the brake actuator arm to the rear. As the actuator arm moves, it forces a pin within the caliper assembly against the brake linings, pushing the linings against the brake disk, slowing vehicle motion.

As the brake lever is released, the return spring pulls the pedal assembly back, releasing pressure on the brake linings, allowing the transaxle gears to rotate freely.

The brake can be locked for parking by depressing the pedal and locking the park brake locking lever.

Diagnostics

System: Brakes

Brakes Diagnosis

1. Steering pulls in one direction?

Yes: Brakes improperly adjusted.

Yes: Brakes worn or no longer serviceable.

Yes: Brake friction/stationary plates worn or damaged.

Yes: Brake linkage damaged/binding.

2. Brakes drag or slow to release?

Yes: Brakes improperly adjusted.

Yes: Brake return spring weak/damaged/missing.

Yes: Brake linkage damaged/binding.

3. Brakes not effective?

Yes: Brakes improperly adjusted.

Yes: Brakes worn or no longer serviceable.

Yes: Brake friction/stationary plates worn or damaged.

Yes: Brake linkage damaged/binding.

Yes: Brake lever cam and/or actuator worn.

Yes: Actuator/housing worn or damaged.

4. Excessive brake lever travel?

Yes: Brakes improperly adjusted.

Yes: Brakes worn or no longer serviceable.

Yes: Brake friction/stationary plates worn or damaged.

Yes: Brake lever cam and/or actuator worn.

Yes: Actuator/housing worn or damaged.

5. Noise during braking?

Yes: Brakes worn or no longer serviceable.

Yes: Brake friction/stationary plates worn or damaged.

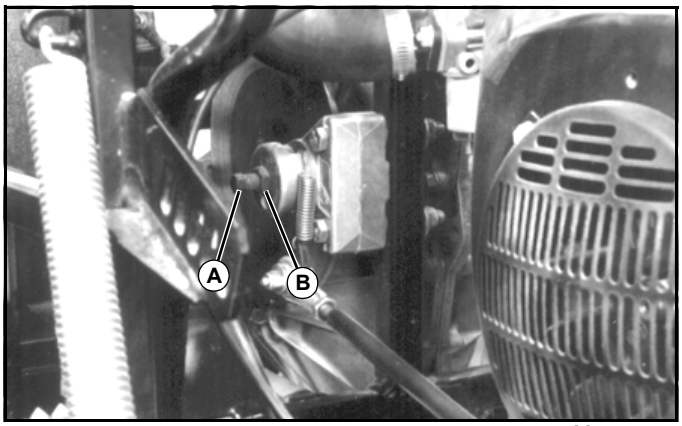
Yes: Brake lever cam and/or actuator worn.

Yes: Actuator/housing worn or damaged.

Adjustments

Adjust Brake Lining Contact

1. Park machine safely. (See “Park Machine Safely” on page 3.)
2. Move gearshift pedals to NEUTRAL position.
3. Turn key switch to OFF position.
4. Lower front blade (if equipped).
5. Raise rear body cowling.



M83154

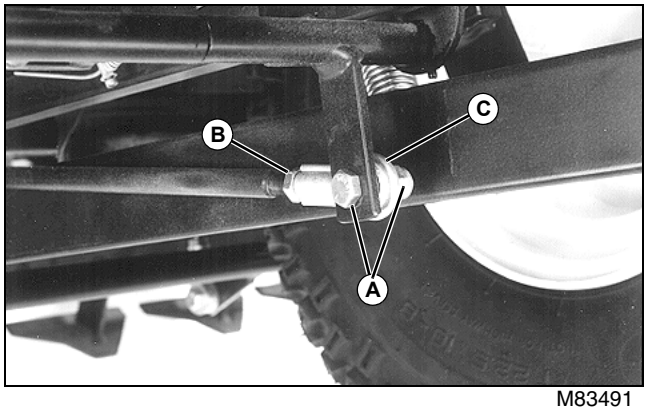
6. Loosen jam nut (B).
7. Turn screw (A) clockwise until tight.
8. Turn screw counterclockwise 1/2 turn.
9. Tighten jam nut.
10. Adjust brake linkage.

Adjust Brake Linkage

Procedure

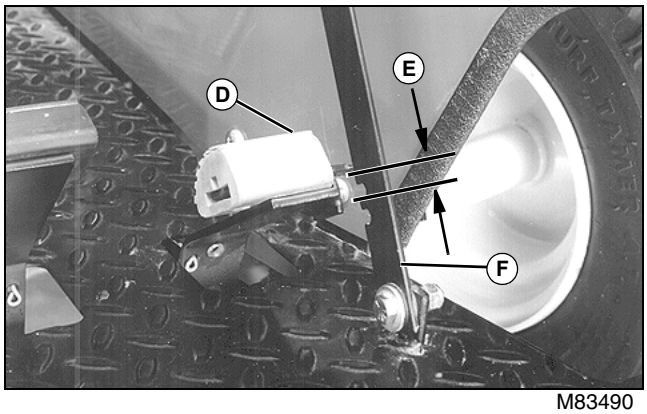
Note: Perform brake lining contact adjustment before adjusting brake linkage.

1. Park machine safely. (See “Park Machine Safely” on page 3.)
2. Move gearshift pedals to NEUTRAL position.
3. Turn key switch to OFF position.



M83491

4. Remove cap screw and nut (A) to disconnect brake rod at pedal assembly.



M83490

5. Rotate park brake lock lever against brake pedal.

6. Depress brake pedal (D) until there is a gap (E) between the bottom of the brake lock tab and the first notch on the park brake lock lever (F).

7. Loosen jam nut (B).

8. Hold brake rod in the fully actuated position.

9. Rotate tie rod end (C) until it aligns with hole in pedal assembly.

10. Install and tighten cap screw and nut.

11. Tighten jam nut.

Specifications

Gap (E). . . . . 3.2 mm (0.125 in.)

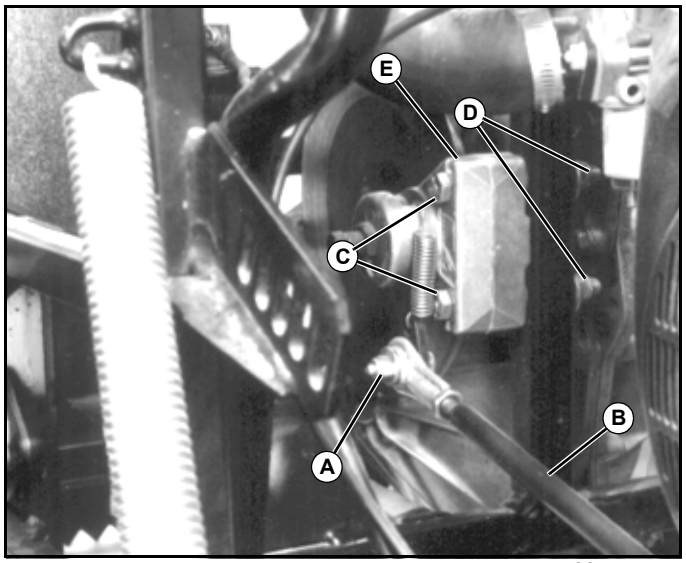
Repair

Remove and Install Brake Caliper

Removal

1. Park machine safely. (See “Park Machine Safely” on page 3.)

2. Raise rear body cowling.



M83154

3. Remove cap screw, washer, and nut (A).

4. Remove brake rod (B).

5. Remove cap screws (C), nuts (D), and brake caliper (E).

Installation

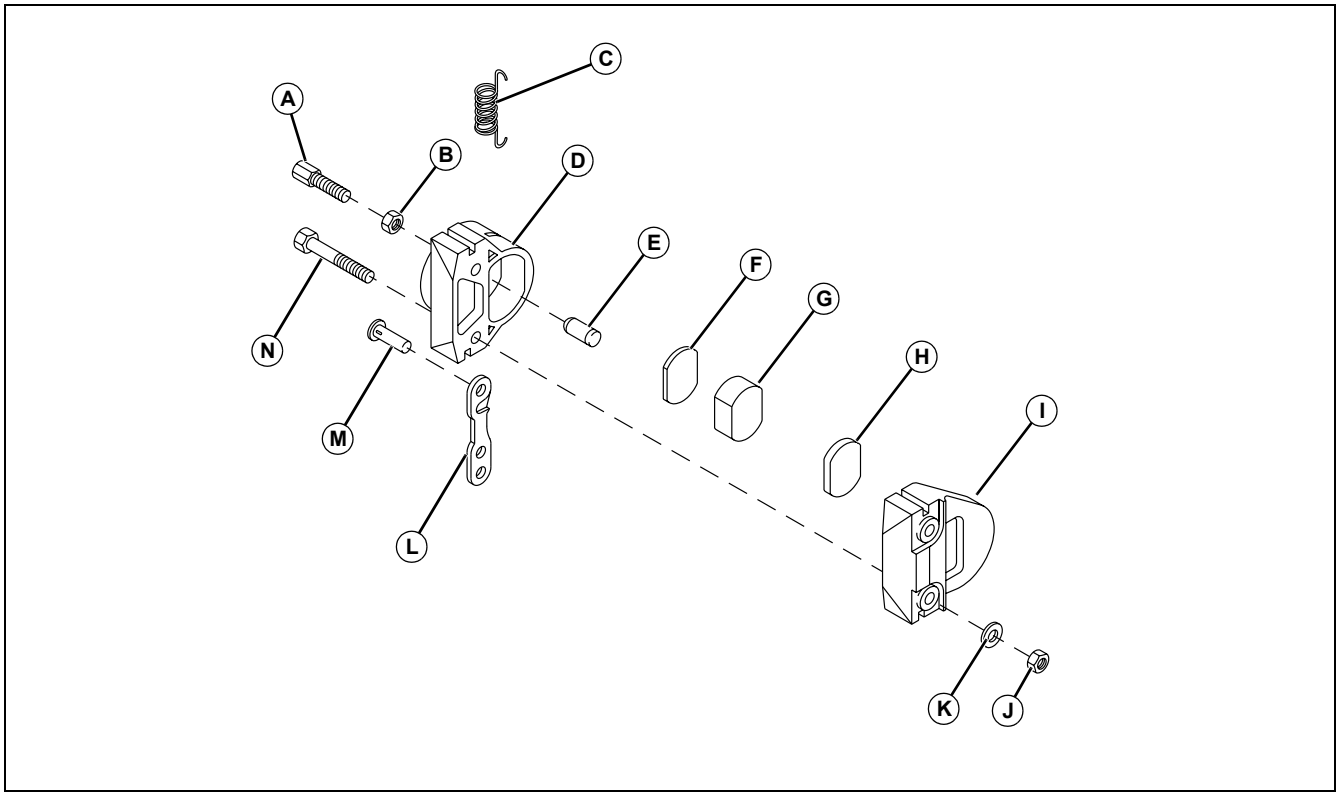
Adjust brake pad contact. (See “Adjustments” on page 221.)

Specifications

Brake Caliper Cap Screw and Nut Torque. . . . . 33 N•m (24 lb-ft)

Disassemble, Inspect, and Assemble

Brake Caliper

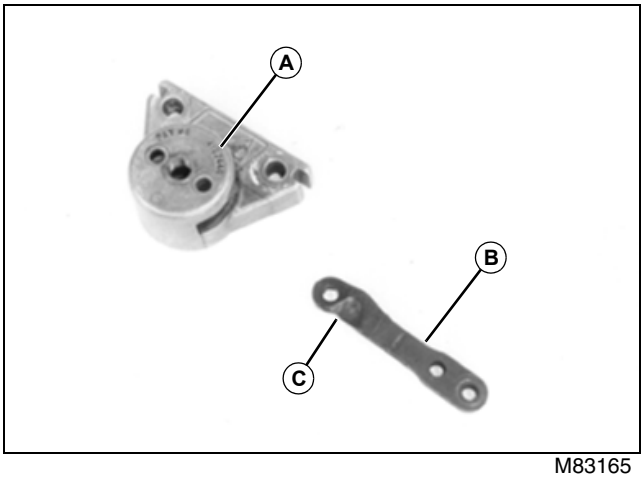


M83156AE

A- Adjustment Screw
B- Jam Nut
C- Spring
D- Housing Half
E- Actuator Pin
F- Wear Plate
G- Lining
H- Lining (Glued to housing half)
I- Housing Half
J- Nut (2 used)
K- Washer (2 used)
L- Lever
M- Pin
N- Cap Screw (2 used)

Note: Lining is glued to housing half. Replace only if necessary.

Remove pin using a hammer and a punch.



M83165

A- PAT No. Characters
B- Lever
C- Thin Area

Other Material

Part No.	Part Name	Part Use
M79292	MPG-2® Polymer Multipurpose Grease	Prevents parts from seizing. Apply to transaxle axle shaft splines and brake actuator pin.
AR31790	Adhesive	Attaches brake lining to caliper housing.

Removal

- Disassemble parts.
- Inspect all parts for wear or damage. Replace parts if necessary.
- Inspect linings for excessive wear. Replace if necessary.

Installation

Installation is done in the reverse order of removal.

- Apply AR31790 Adhesive, or an equivalent to lining.
- Apply M79292 MPG-2® Multipurpose Polymer Grease to spherical end of actuator pin.

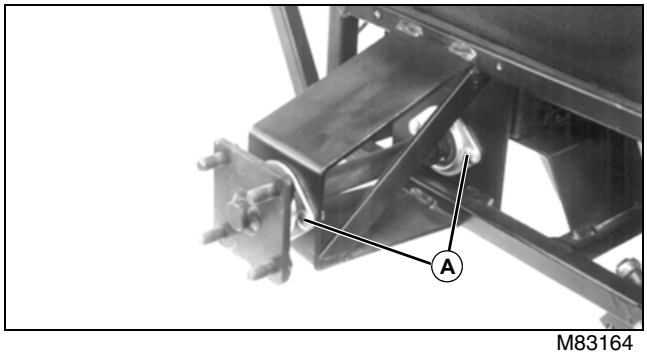
Note: Install lever with thin part away from PATENT No. characters.

- Do not tighten adjustment screw. Adjust brake pad contact. (See “Adjustments” on page 221.)

Remove and Install Brake Disk

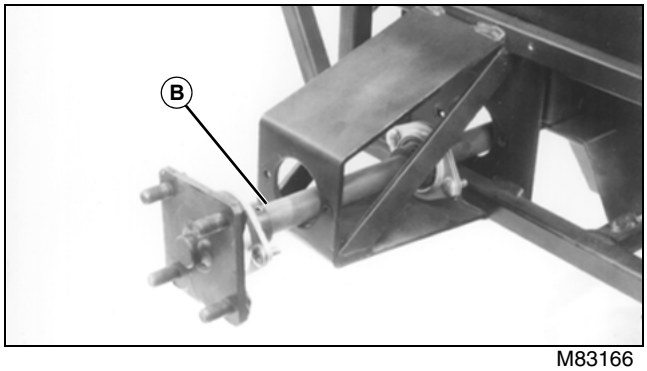
Removal

1. Remove battery.
2. Remove rake attachment. (See “Remove and Install Rake Assembly (Optional)” on page 238.)
3. Remove brake caliper. (See “Remove and Install Brake Caliper” on page 222.)
4. Remove right side rear wheel. (See Miscellaneous section.)



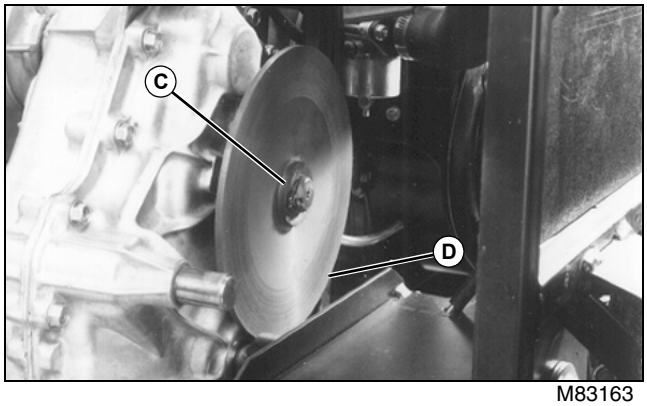
M83164

5. Remove four carriage bolts and locknuts (A).



M83166

6. Pull axle shaft (B) out of coupler. Remove coupler.



M83163

7. Remove snap ring (C).
8. Remove disk (D) and key.

Installation

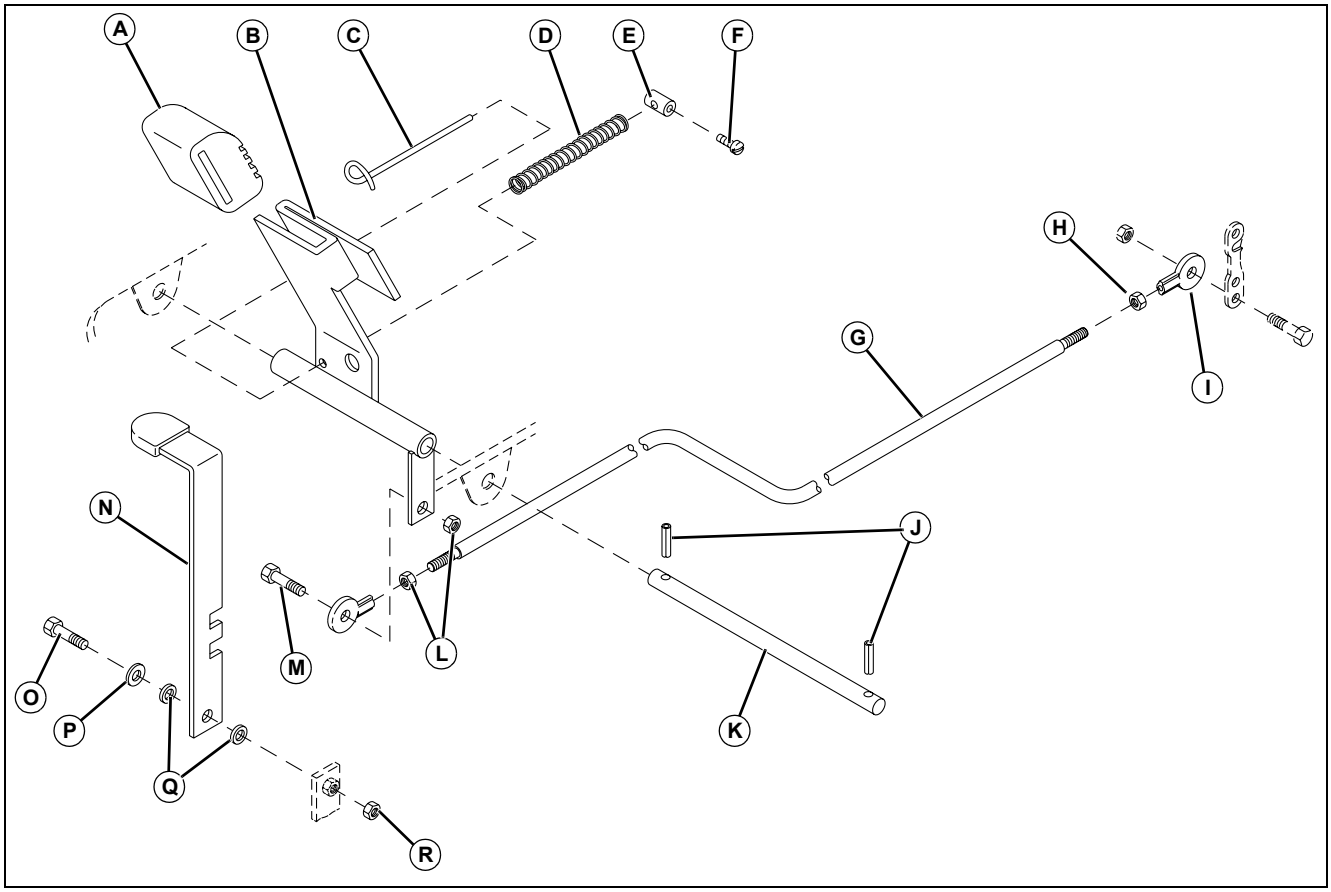
Installation is done in the reverse order of removal.

- Inspect all parts for wear or damage. Replace parts as necessary.
- Apply MPG-2® Multipurpose Polymer Grease or an equivalent to transaxle shaft and axle splines.

Specifications

Carriage Bolt Torque . . . . . 25 N•m (216 lb-in.)

Brake Pedal and Linkage



M83155AE

A- Pedal Pad
B- Brake Pedal
C- Pin
D- Return Spring
E- Clamp
F- Screw
G- Brake Rod
H- Nut
I- Tie Rod End (2 used)
J- Spring Pin
K- Pivot Rod
L- Nut
M- Cap Screw
N- Park Brake Locking Lever
O- Cap Screw
P- Washer
Q- Washer (2 used)
R- Nut

Note: Spring pins may be replaced with cotter pins.

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

Installation

Installation is done in the reverse order of removal.

- Apply multipurpose grease to pivot rod.
- Adjust brake linkage. (See “Adjustments” on page 221.)

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Specifications

Repair Specifications

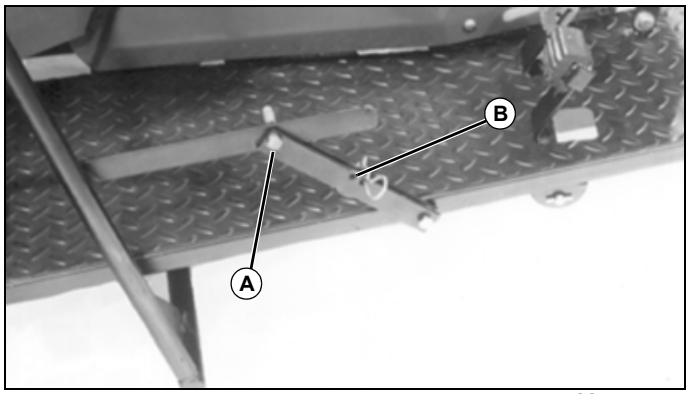
Mid-Mounted Lift Handle

Return Spring Length. . . . . 89 mm (3.50 in.)

Repair

Remove and Install 40-Inch Front Blade Assembly (Optional)

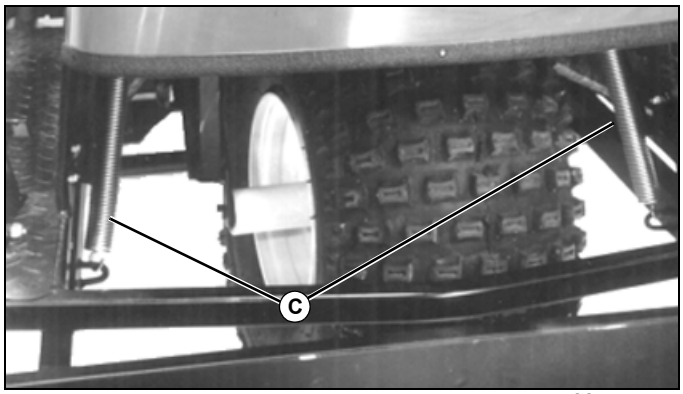
Removal



M83162

Note: Storage hole (B) is used to store spring lock pin during blade operation.

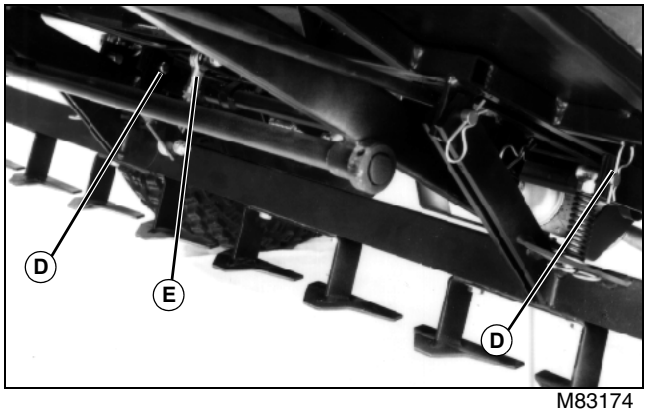
1. Remove cap screws, washers and locknut (A).



M83173

Caution: Avoid Injury! Front blade will drop when springs (C) are removed. Support blade before removing springs.

2. Support front blade.
3. Disconnect springs (C) from blade frame.



M83174

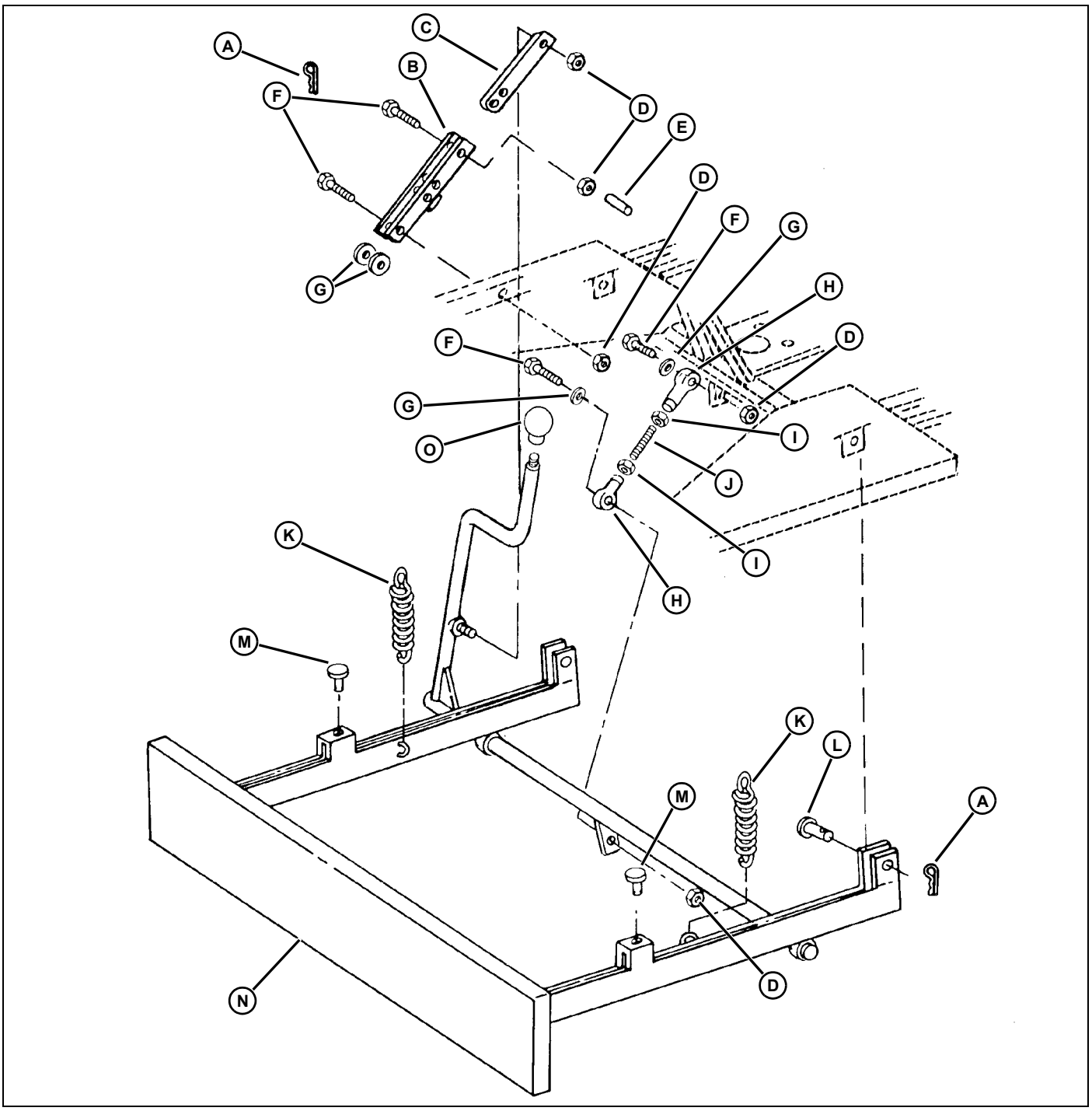
4. Disconnect turnbuckle (E) from frame.
5. Remove pins (D).
6. Raise handle above platform.
7. Remove front blade and framework from under machine.

Installation

Installation is done in the reverse order of removal.

- Connect springs to blade frame last.

Disassemble, Inspect, and Assemble 40-Inch Front Blade Assembly (Optional)

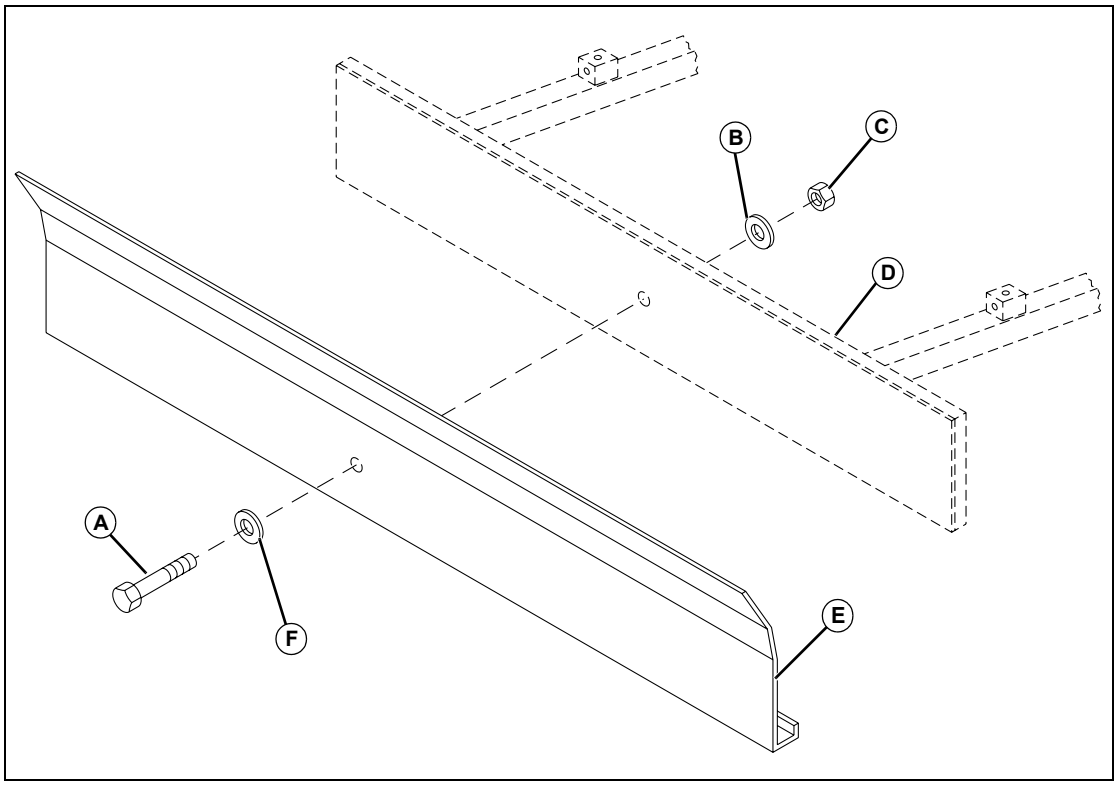


M83199

A- Spring Locking Pin
B- Bracket
C- Strap
D- Locknut
E- Cover
F- Cap Screw
G- Flat Washer
H- Ball Joint
I- Nut
J- Stud
K- Spring
L- Stud
M- Bumper
N- Front Blade
O- Knob

- Inspect all parts for wear or damage. Replace parts as necessary.
- Do not overtighten locknuts. Parts must be free to pivot.
- Adjust ball joints as necessary.

Disassemble, Inspect, and Assemble 60-Inch Front Aluminum Blade (Optional)



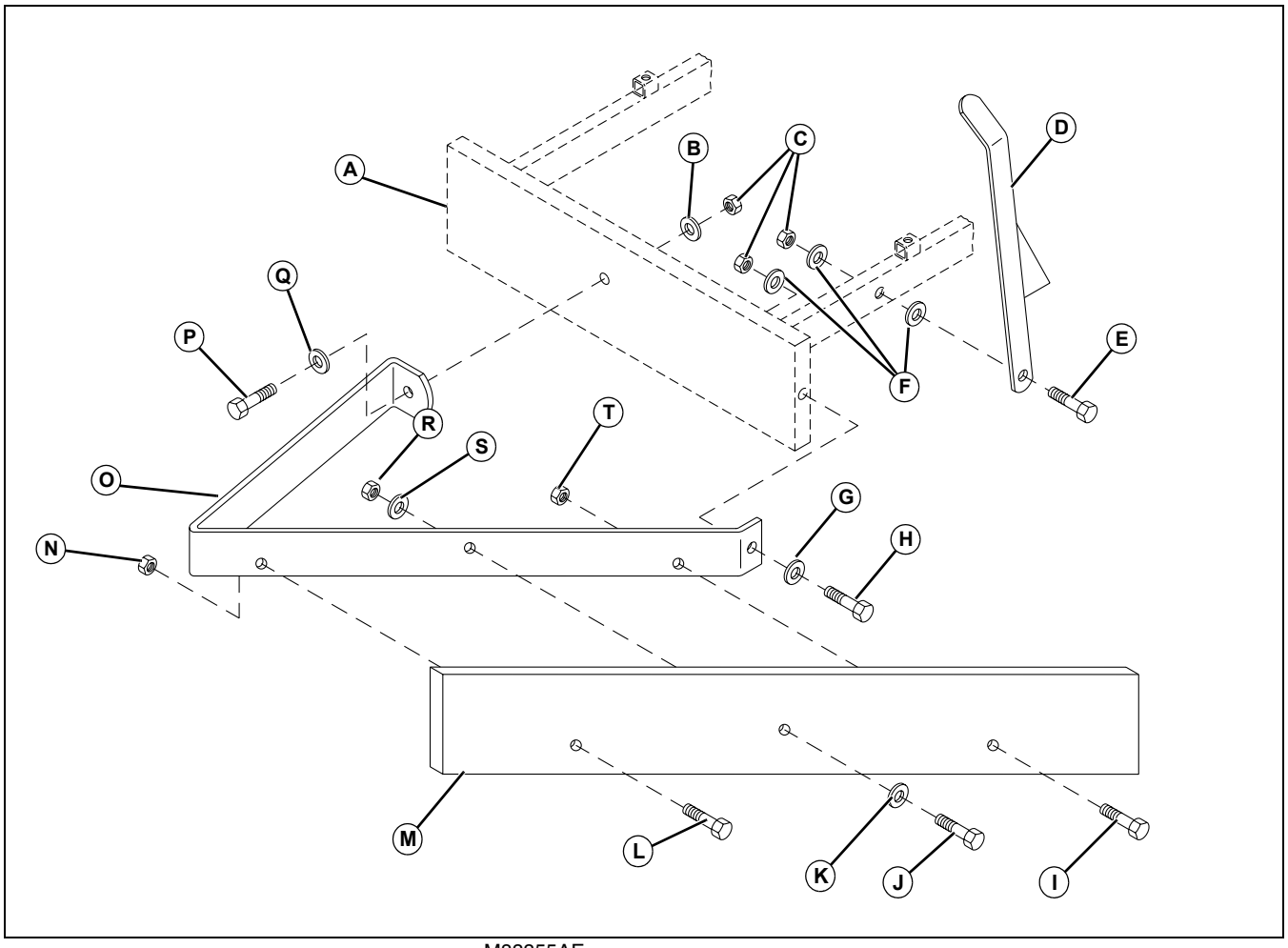
M83353AE

A- Cap Screw
B- Washer
C- Locknut
D- 40-Inch Blade
E- 60-Inch Blade
F- Washer

Note: 60-inch front aluminum blade attaches to optional 40-inch front blade assembly.

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

Disassemble, Inspect, and Assemble Front Core Removal Blade (Optional)



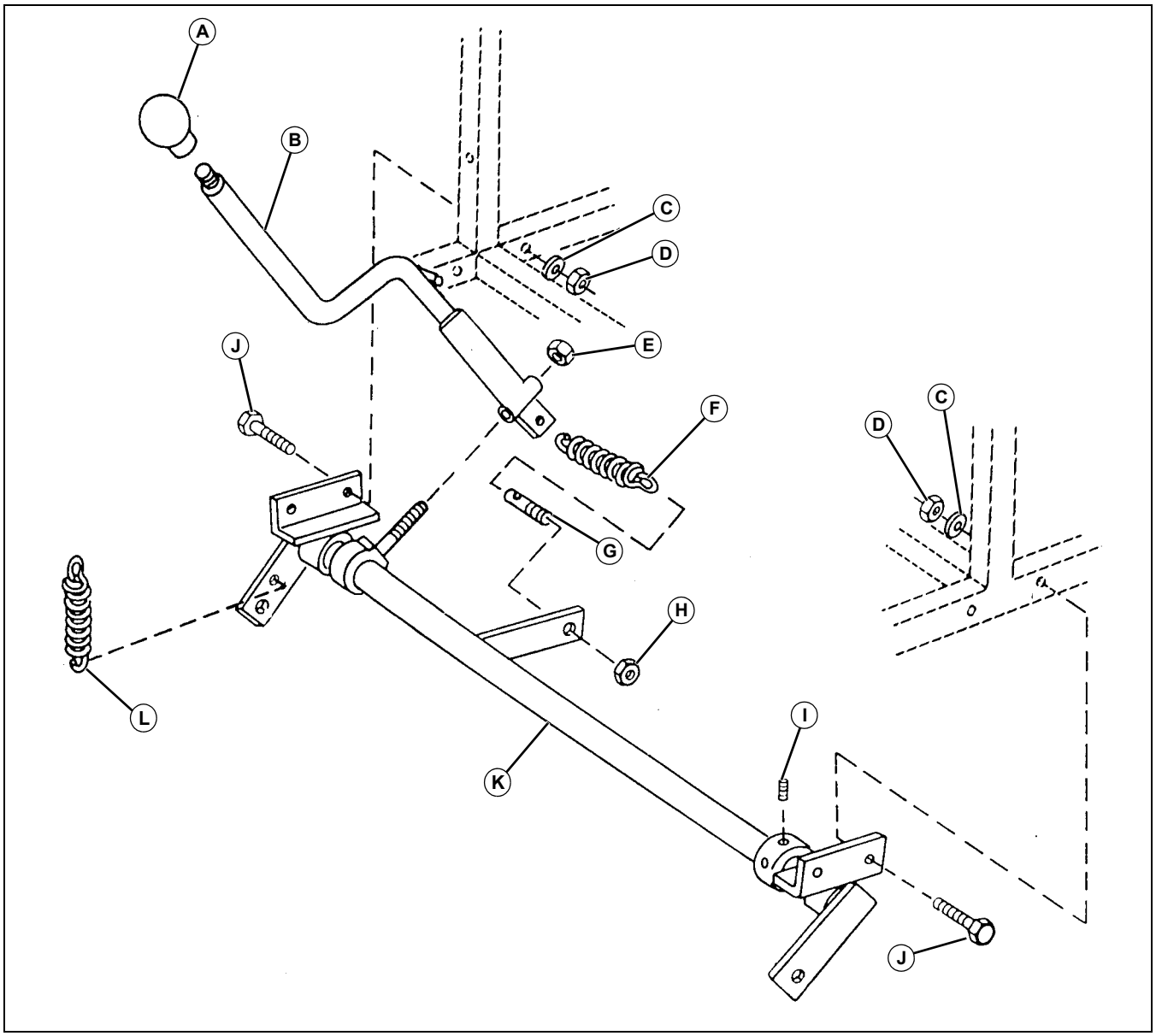
M83355AE

A- 40-Inch Blade
B- Washer
C- Locknut
D- Lock Lever
E- Cap Screw (3/8 in. x 2 in.)
F- Washer
G- Washer
H- Cap Screw (3/8 in. x 1-1/4 in.)
I- Cap Screw (1/4 in. x 2 in.)
J- Cap Screw (3/8 in. x 2-1/2 in.)
K- Washer
L- Cap Screw (1/4 in. x 2 in.)
M- Core Removal Blade
N- Locknut
O- Frame
P- Cap Screw (3/8 in. x 2-3/4 in.)
Q- Washer
R- Locknut
S- Washer
T- Locknut

Note: Front core removal blade attaches to optional 40-inch front blade assembly.

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

Disassemble, Inspect, and Assemble Mid-Mounted Lift Linkage



M83353AE

A- Knob
B- Lift Handle
C- Washer
D- Locknut
E- Locknut
F- Return Spring
G- Stud
H- Locknut
I- Setscrew
J- Cap Screw
K- Support
L- Lift Spring

- Inspect all parts for wear or damage. Replace parts as necessary.
- Install right rear cap screw with head to inside of frame.
- Adjust handle locknut until length of return spring is to specifications.
- Do not overtighten handle locknut. Handle must be free to pivot.

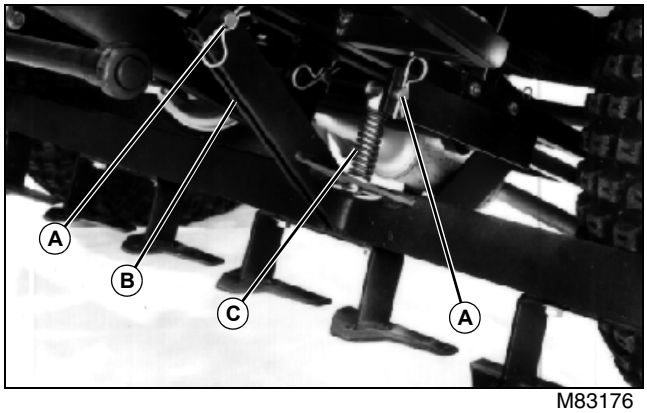
Specifications

Mid-Mount Lift Handle Return Spring Length
. . . . . 89 mm (3.50 in.)

Remove and Install Cultivator Assembly (Optional)

Removal

1. Lower cultivator to the ground.



M83176

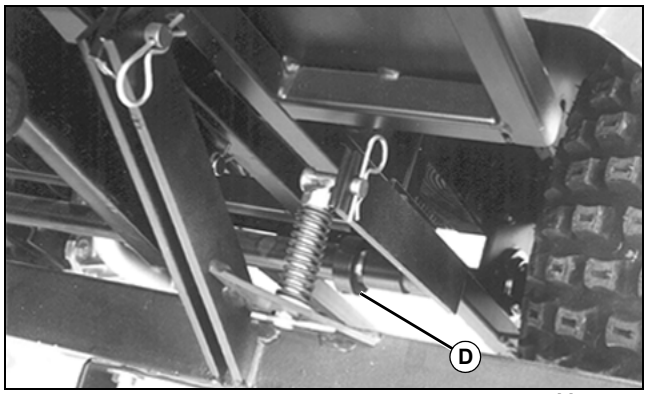
2. Remove spring locking pin (A) and disconnect hook bolt (C) from pivot strap (B). Repeat on opposite side.

3. Remove spring locking pin (A) and drilled pin from strap (B). Repeat on opposite side.

4. Remove cultivator from under machine.

Installation

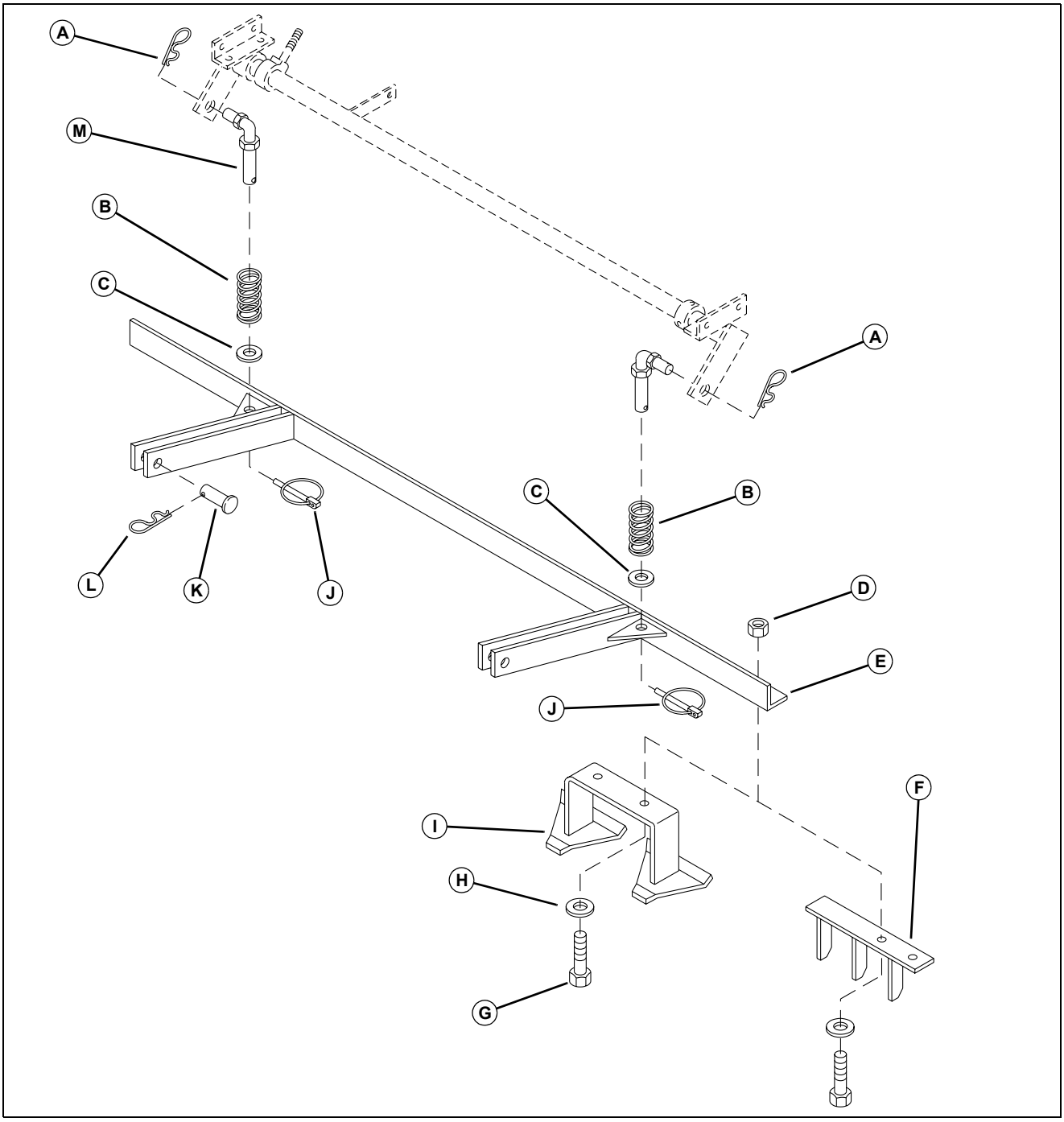
Installation is done in the reverse order of removal.



M83175

Note: If hook bolt does not line up with pivot strap, move left collar (D) to adjust pivot shaft.

Disassembly, Inspection, and Assembly

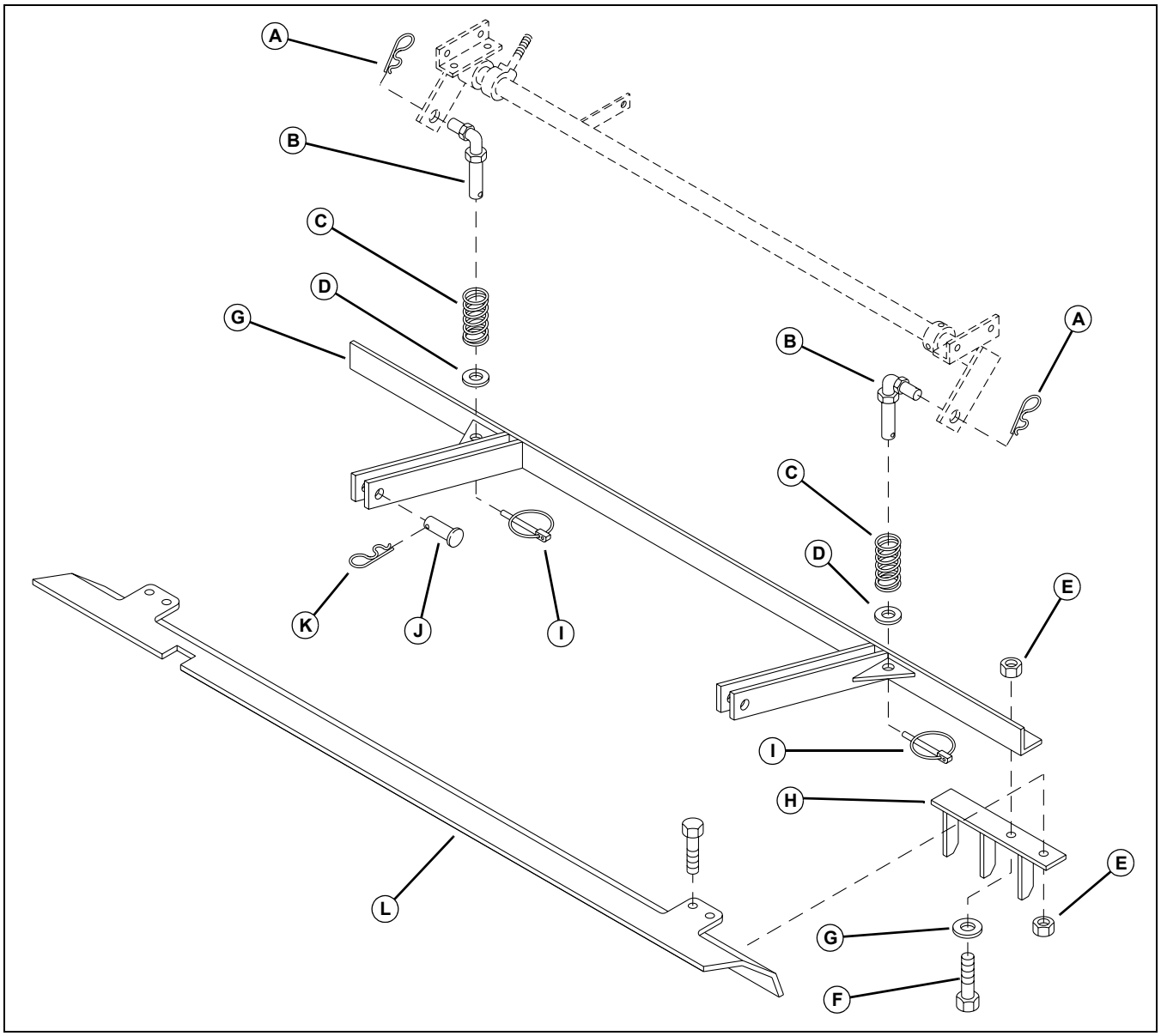


M83333AE

A- Spring Locking Pin
B- Spring
C- Washer
D- Locknut (10 used)
E- Angle
F- Scarifier Tines, Wide or Narrow (5 used)
G- Cap Screw (10 used)
H- Washer (10 used)
I- Blade (5 used)
J- Quick Locking Pin
K- Pin (2 used)
L- Spring Locking Pin (2 used)

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

Disassemble, Inspect, and Assemble Scraper Blade (Optional)



M83356AE

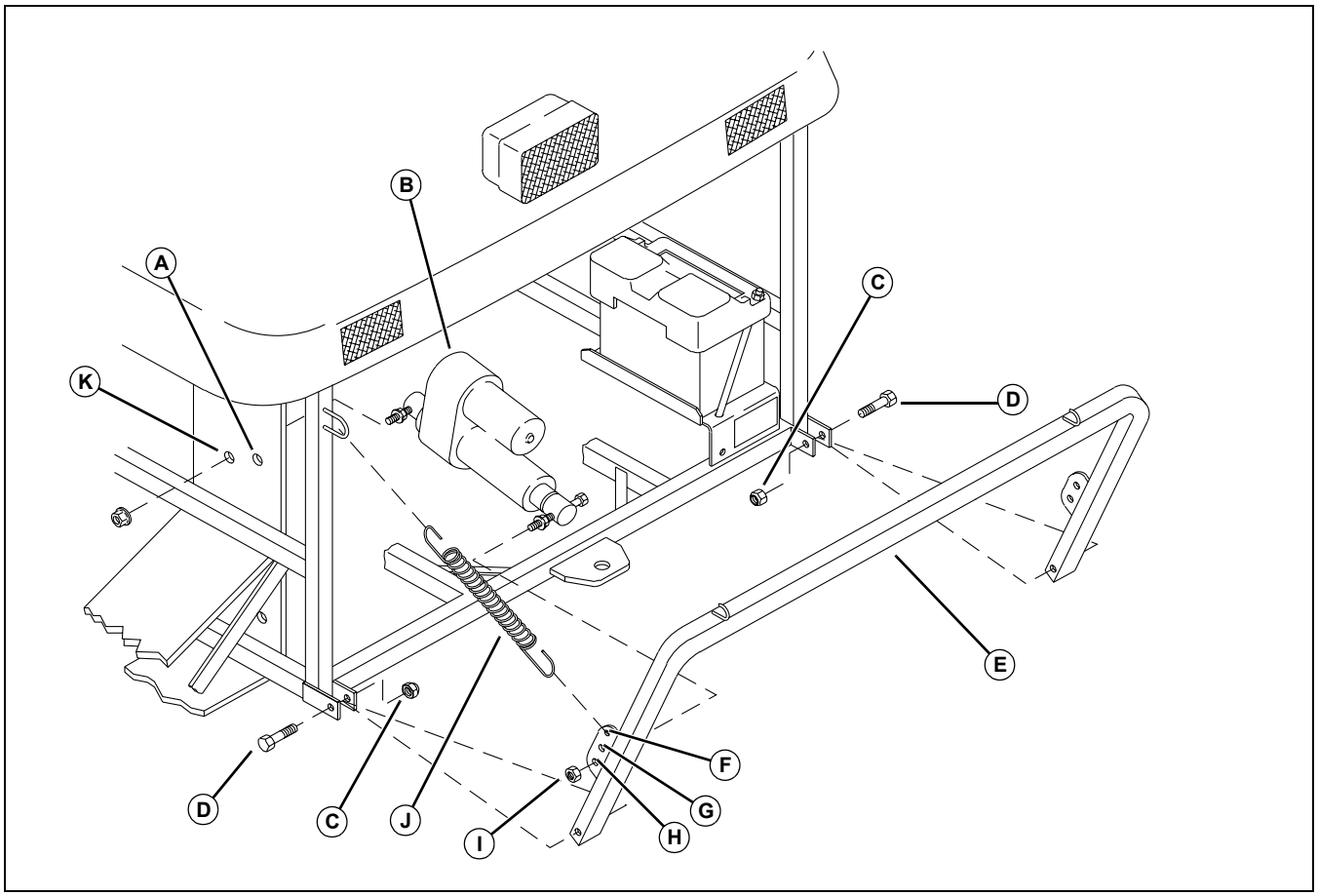
A- Spring Locking Pin
B- Hook Bolt
C- Spring
D- Washer
E- Locknut (12 used)
F- Cap Screw (12 used)
G- Angle
H- Scarifier Tines, Wide or Narrow (5 used)
I- Quick Locking Pin
J- Pin (2 used)
K- Spring Locking Pin (2 used)
L- Scraper Blade

Note: Scraper blade is removed and installed in the same manner as cultivator. (See "Remove and Install Cultivator Assembly (Optional)" on page 234.)

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

Remove and Install Rear Implement Lift Linkage

Removal and Installation



M83185AE

A- Field Finisher Hole
B- Lift Actuator
C- Locknut
D- Cap Screw
E- Lift Bar
F- Spring Hole
G- Field Finisher Hole
H- Rear Rake Hole
I- Locknut (Actuator-to-bar)
J- Spring
K- Rear Rake Hole

Note: When using field finisher attachment, lift actuator must be repositioned. (See "Reposition Lift Actuator" on page 237.)

1. Remove rear implement.
2. Raise lift bar (E) to UP position.
3. Remove lift actuator-to-lift bar locknut (I).
4. Disconnect spring (J) from lift bar (E).
5. Remove cap screws (C), locknuts (D) and lift bar (E).
6. Inspect all parts for wear or damage. Replace parts as necessary.

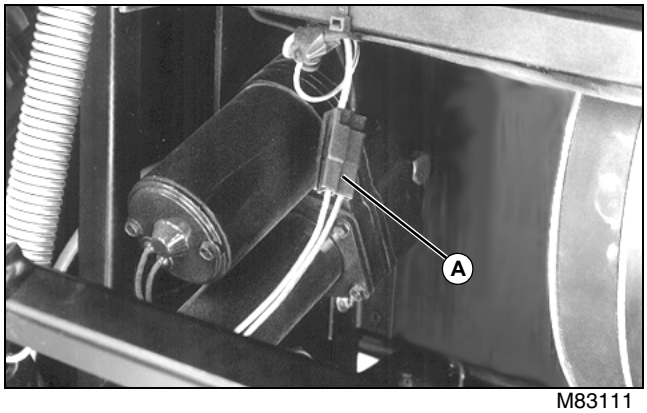
Installation

- Do not overtighten locknuts. Handle must be free to pivot.

Reposition Lift Actuator

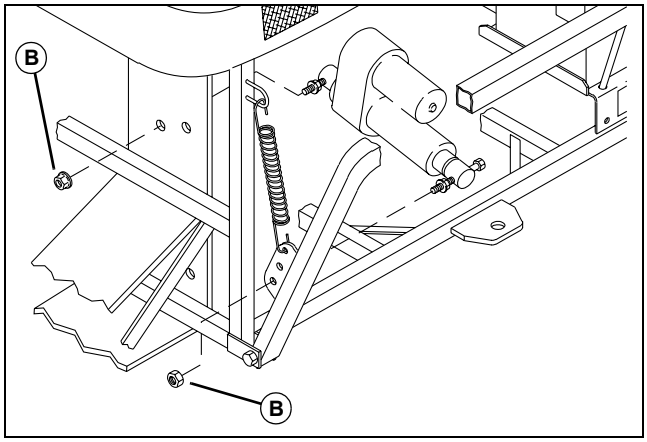
Note: Lift actuator is positioned at the factory for bunker and field rake operation. In this position, the actuator motor is located above the cylinder. When using the field finisher, the actuator MUST be repositioned with the motor below the cylinder to prevent interference with electrical relay mounted on side frame.

1. Remove rear implement.
2. Raise lift bar to full UP position.



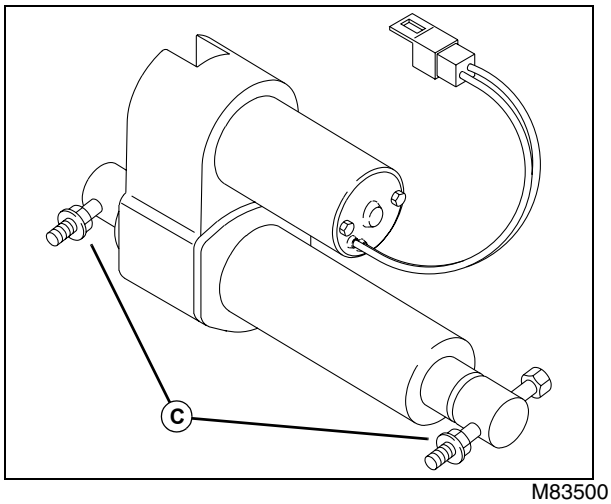
M83111

3. Disconnect wiring connector (A).



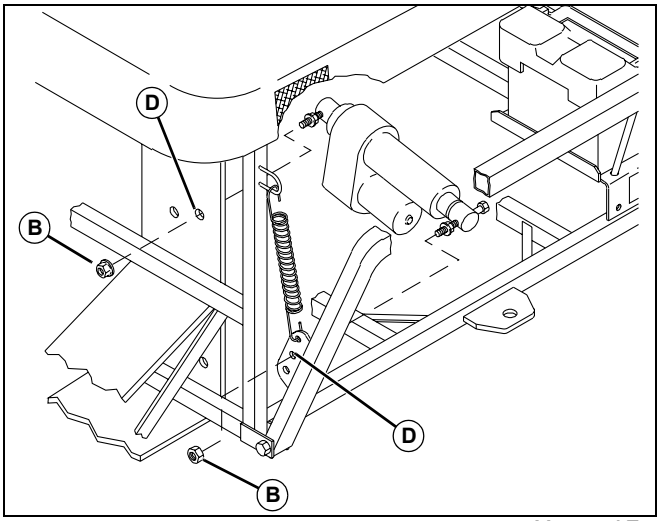
M83112AE

4. Remove nuts (B).
5. Remove lift actuator.



M83500

6. Remove nut (C) from bolt at each end of the cylinder. Remove bolts and install from opposite side into cylinder shaft holes. Install nuts (C) on bolts.



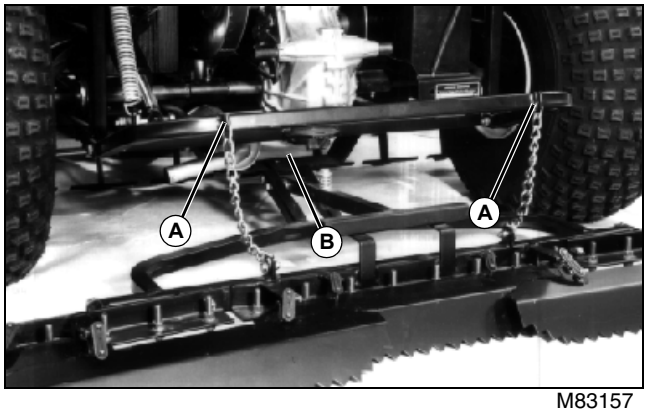
M83477AE

7. Rotate actuator so that the motor is below the cylinder.
8. Install bolts in field finisher holes (D) in frame and lift bar. Secure with nuts (B).
9. Connect wiring connector (A).

Remove and Install Rake Assembly (Optional)

Removal

1. Lower rake assembly to the ground.

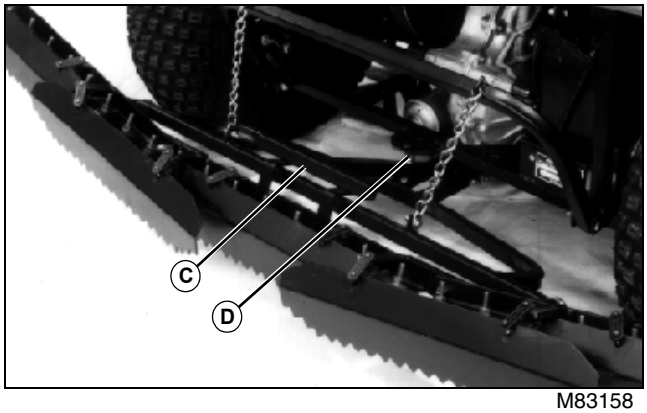


M83157

2. Remove chains from lift hooks (A).
3. Remove pin (B). Remove rake hitch from frame.

Installation

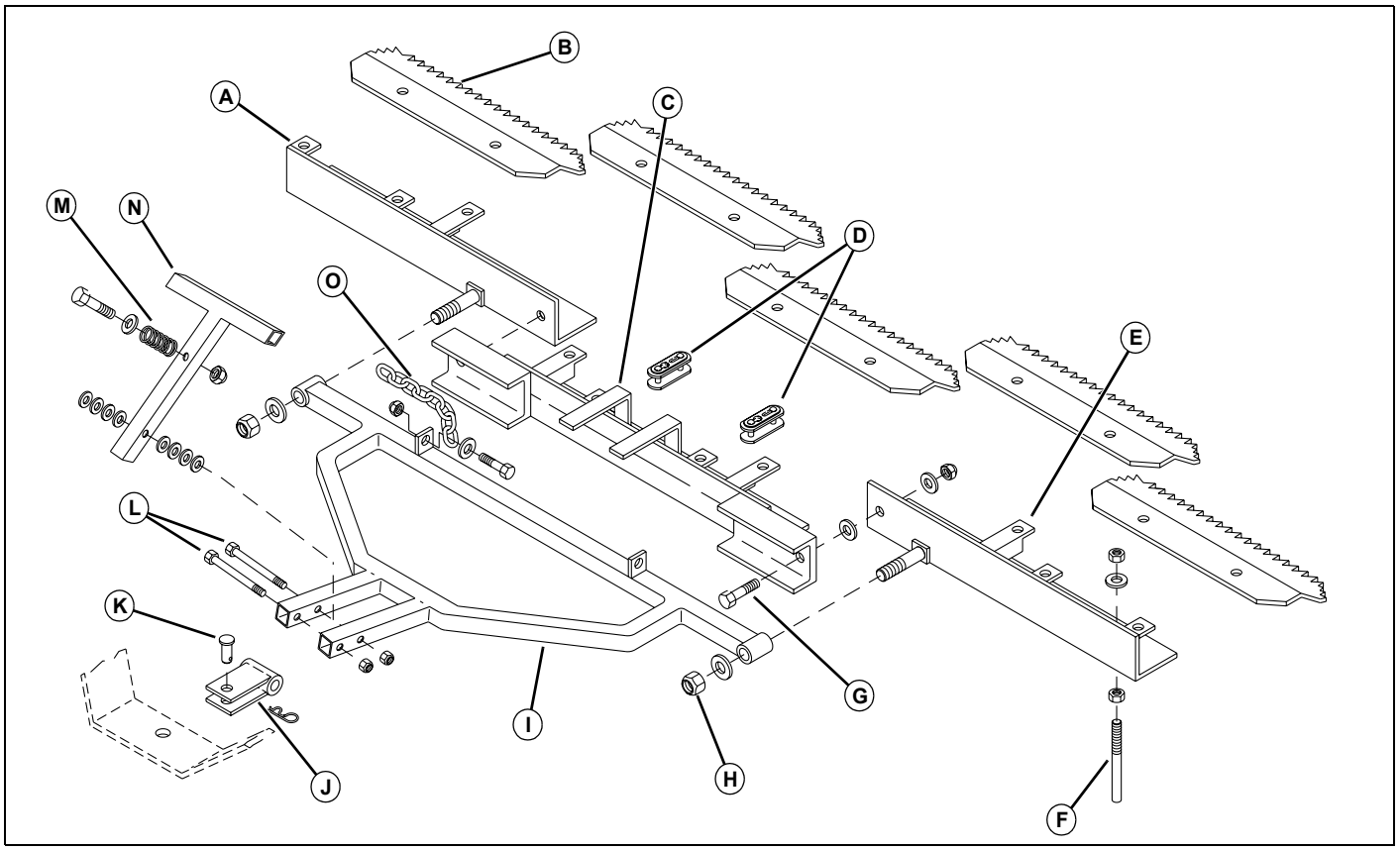
Installation is done in the reverse order of removal.



M83158

- Raise rake. Guide (C) must have spring (D) compressed and touching frame. Adjust chain length if necessary.

Disassembly, Inspection, and Assembly

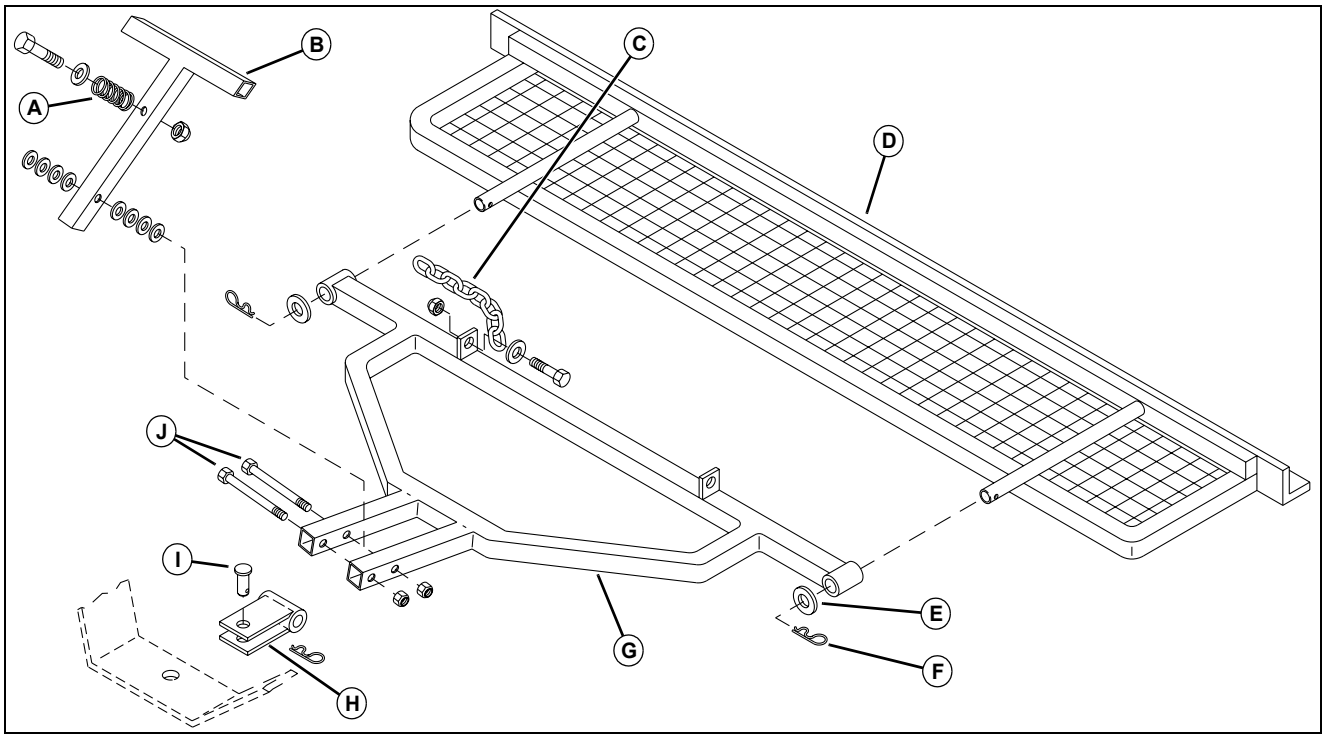


M83357AE

A- Right Angle
B- Rake Blade (5 used)
C- Center Angle
D- Chain Link
E- Left Angle
F- Prong Rake Bolt (24 used)
G- Cap Screw (2 used)
H- Locknut (2 used)
I- Frame
J- Hitch
K- Pin
L- Cap Screw (2 used)
M- Compression Spring
N- Guide
O- Chain (2 used)

- Inspect all parts for wear or damage. Replace parts as necessary.
- Do not overtighten hitch cap screws. Hitch must be free to pivot.
- Do not overtighten right and left angle cap screws and locknuts. Angles must be free to pivot.

Disassemble, Inspect, and Assemble Field Finisher (Optional)



M83354AE

A- Compression Spring
B- Guide
C- Chain (2 used)
D- Field Finisher
E- Washer (2 used)
F- Spring Locking Pin (2 used)
G- Frame
H- Hitch
I- Pin
J- Cap Screw (2 used)

Important: Avoid Damage! Correct machine setup is critical for optimum field finisher performance.

(See “Field Finisher Setup” on page 240.)

Note: Field finisher is removed and installed in the same manner as rake assembly. (See “Remove and Install Rake Assembly (Optional)” on page 238).

- Inspect all parts for wear or damage. Replace parts as necessary.
- Do not overtighten hitch cap screws. Hitch must be free to pivot.

Field Finisher Setup

Important: Avoid Damage! Correct air pressure is necessary to ensure proper field finishing performance. Tire pressure is 27.6-41.4 kPa (4-6 psi). Rear tire pressure MUST be equal for finisher to provide optimum performance.

For most field conditions:

- Lower field finisher to the ground and make sure frame is in lowest position.
- Make sure field finisher is squared with vehicle.
- Pull chains tight without lifting the field finisher and fasten chains to the frame hooks.
- If chain has clack when connected to the frame, twist chain one revolution and reattach to frame.

Note: To prevent dirt buildup on the finisher screen in muddy soil or other conditions, shorten both chains equally to raise the front of the screen attachment slightly.

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Specifications

General Specifications

Tire Specifications

Tire Size (All)	**22 x 11 x 8**
Tire Operating Pressure	**34.5 kPa (5 psi)**

Repair Specifications

Torque Specification

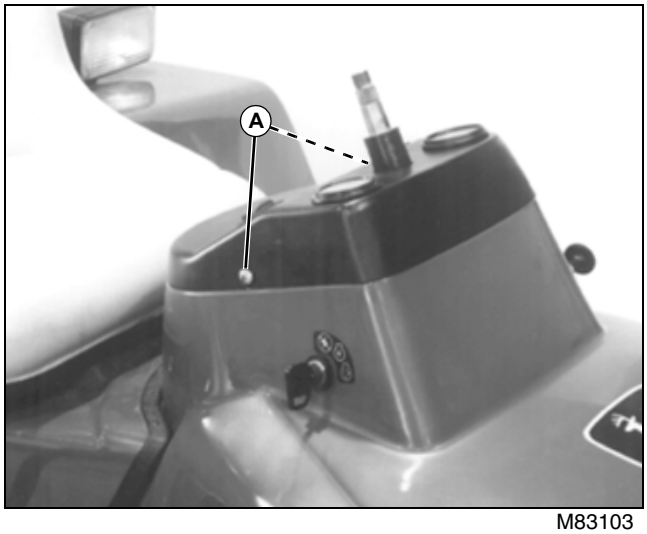
Front and Rear Wheel Cap Screw	**80 N•m (60 lb-ft)**

Repair

Remove and Install Dash Panel

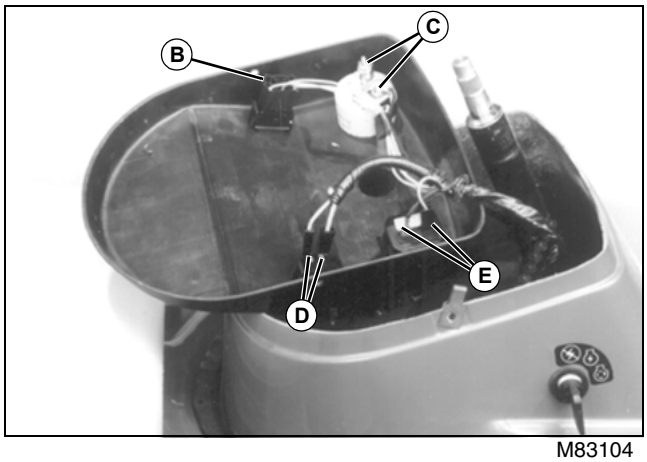
Removal

1. Park machine safely. (See “Park Machine Safely” on page 3.)
2. Remove steering wheel. (See “Remove and Install Steering Wheel” on page 214.)



M83103

3. Remove cap screws (A) from both sides of panel.



M83104

4. Disconnect lift switch wiring connector (B).
5. Disconnect voltmeter leads (C).
6. Disconnect light switch connectors (D).
7. Disconnect hour meter wiring connectors (E).

Installation

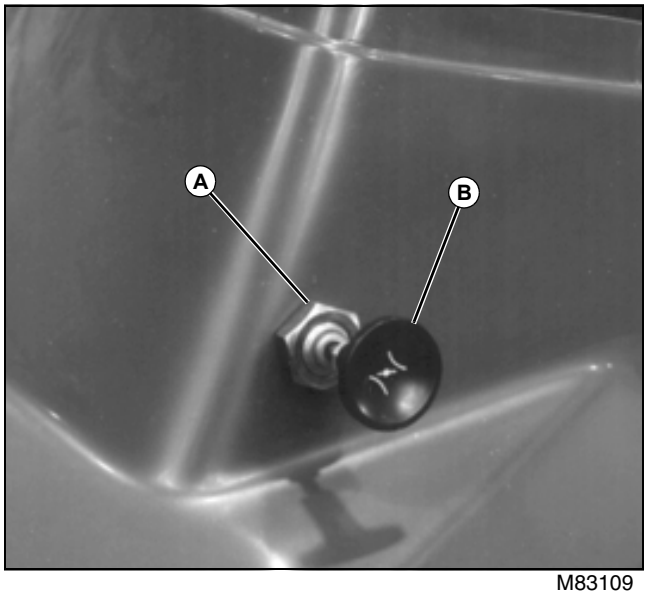
Installation is done in the reverse order of removal.

- Install steering wheel as marked during removal.
- Ensure that all electrical lights and components work correctly.

Remove and Install Front Cowling

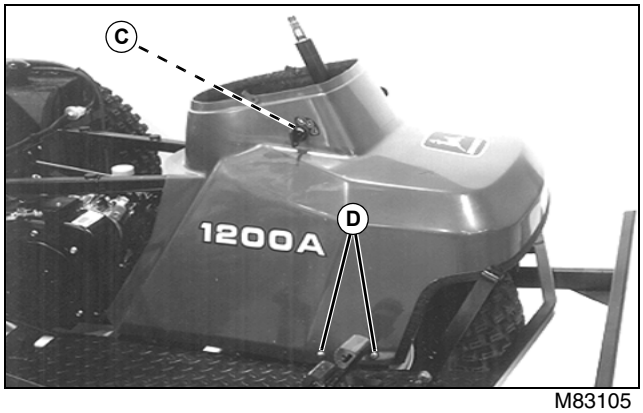
Removal

1. Park machine safely. (See “Park Machine Safely” on page 3.)
2. Lower front blade (if equipped).
3. Raise rear body cowling.



M83109

4. Remove dash panel. (See “Remove and Install Dash Panel” on page 243.)
5. Remove retaining nut (A) and choke knob (B).



M83105

6. Disconnect wiring connector (C) from key switch.
7. Remove screws, washers, and nuts (D) from both sides of hood.
8. Remove front hood.

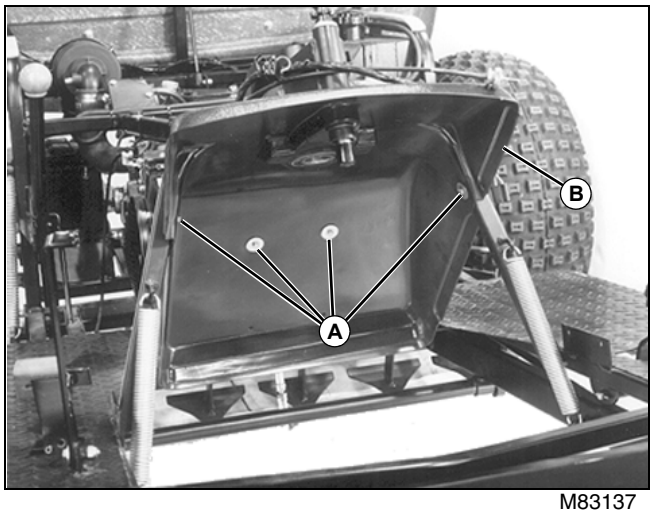
Installation

Installation is done in the reverse order of removal.

Remove and Install Splash Guard

Removal

1. Remove steering fork. (See “Remove and Install Steering Fork” on page 215.)



M83137

2. Remove four screws and washers (A).
3. Remove splash guard (B).

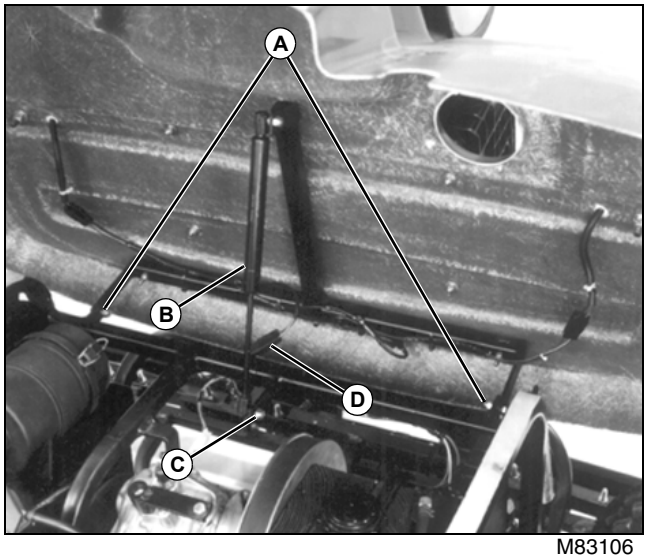
Installation

Installation is done in the reverse order of removal.

Remove and Install Rear Body Cowling

Removal

1. Park machine safely. (See “Park Machine Safely” on page 3.)



M83106

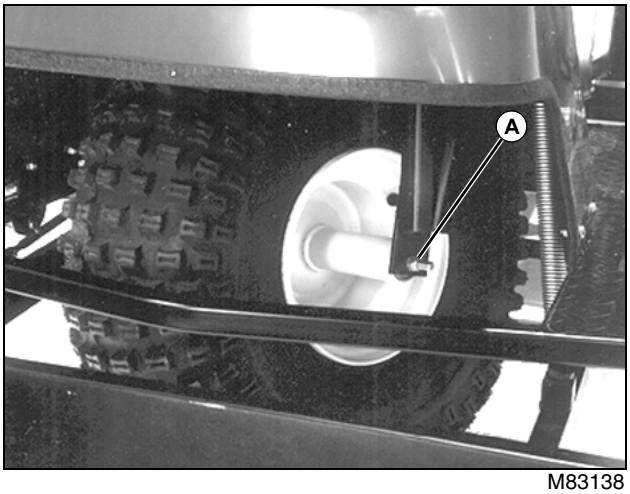
2. Lower front blade (if equipped).
3. Raise rear body cowling. Attach a lifting strap to support cowling.
4. Disconnect lighting harness (D), if equipped.
5. Remove locknut (C) and disconnect support cylinder (B).
6. Remove cap screws and locknuts (A).
7. Remove rear body cowling.

Installation

Installation is done in the reverse order of removal.

Remove and Install Front Wheel

1. Park machine safely. (See “Park Machine Safely” on page 3.)
2. Raise vehicle with a safe lifting device. Place support stands under vehicle.



M83138

3. Remove locknut (A), cap screw, and wheel.
4. Inspect wheel bearings for wear or damage. Replace if necessary. (See “Inspect and Replace Wheel Bearings” on page 245.)

Installation

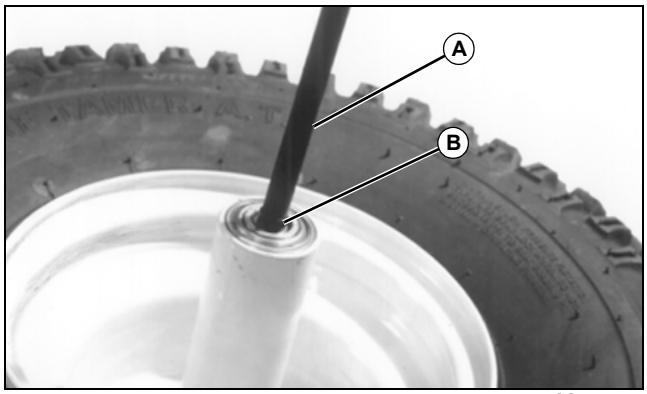
Installation is done in the reverse order of removal.

Inspect and Replace Wheel Bearings

Note: Remove bearings only if replacement is necessary.

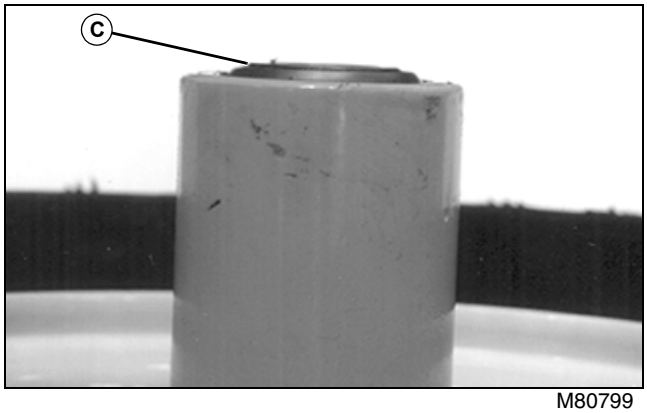
Note: Bearings are press-fit in wheel and slip-fit on axle tube.

1. Inspect bearings for wear or damage. Replace if necessary.



M80798

2. Remove wheel bearing from wheel by driving axle tube (A) from opposite side using a driver set (B). Turn wheel over and repeat process for remaining bearing.



M80799

Note: Install bearings with raised side (C) facing away from wheel. Press on outer race only.

3. Install one bearing in wheel until seated using a driver set. Turn wheel over and repeat process for remaining bearing.

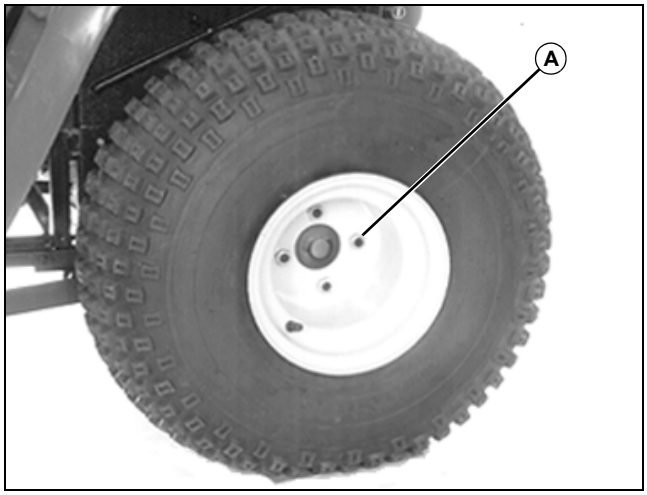
4. Install front wheel.

Remove and Install Rear Wheel

Removal

1. Park machine safely. (See “Park Machine Safely” on page 3.)

2. Raise vehicle with a safe lifting device. Place support stands under vehicle.



M80861

3. Remove cap screws (A) and rear wheels.

Installation

- Installation is done in the reverse order of removal.
- Install wheels with valve stems facing away from machine.
- Tighten cap screws to specification.

Specification

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

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