JOHN DEERE
WORLDWIDE COMMERCIAL & CONSUMER
EQUIPMENT DIVISION

QuickTrak
647, 657 and 667

TM2042 June 2002

TECHNICAL MANUAL

JOHN DEERE

North American Version
Litho in U.S.A.

Manual Description

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

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

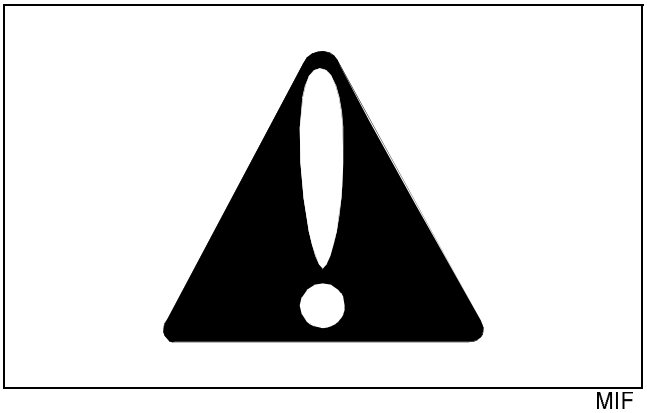
- Table of Contents
- Specifications
- General Information
- Identification Numbers
- Tools and Materials
- Component Location
- Schematics and Harnesses
- Theory of Operation
- Operation and Diagnostics
- Diagnostics
- Tests and Adjustments
- Repair
- Other

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

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

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

Recognize Safety Information



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.

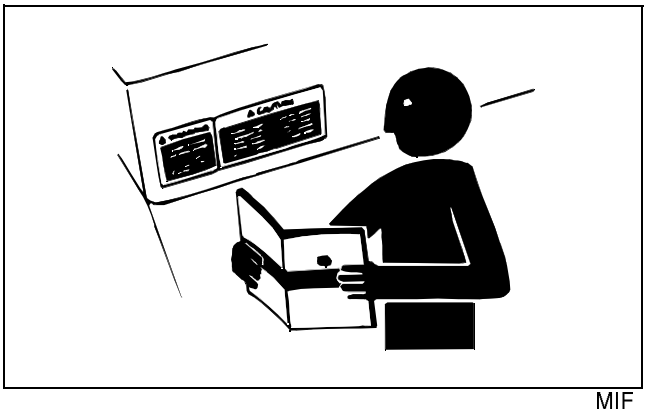
Follow recommended precautions and safe servicing practices.

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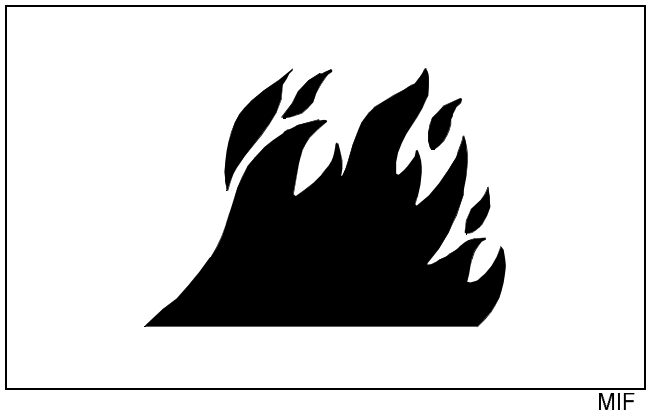
Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

Be Prepared for Emergencies



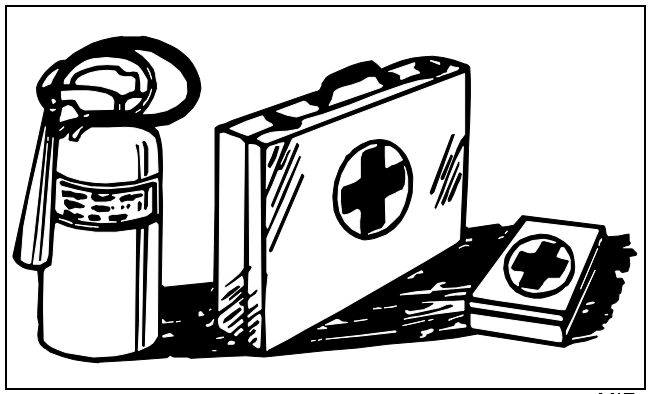
MIF

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

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

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

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



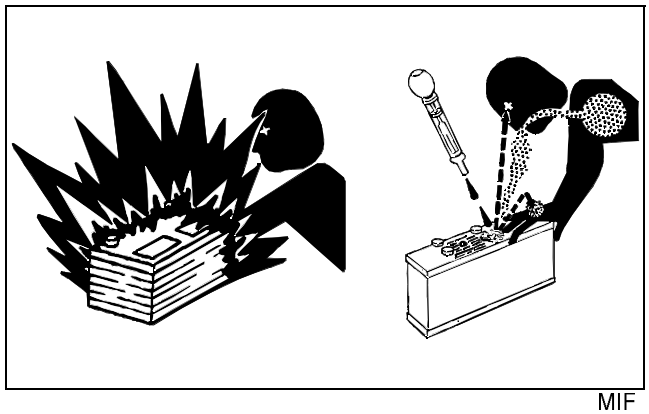
MIF

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.

Prevent Battery Explosions



MIF

- 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:**
  a. Filling batteries in a well-ventilated area.
  b. Wearing eye protection and rubber gloves.
  c. Avoiding breathing fumes when electrolyte is added.
  d. Avoiding spilling or dripping electrolyte.
  e. Using proper jump start procedure.
- **If you spill acid on yourself:**
  a. Flush your skin with water.
  b. Apply baking soda or lime to help neutralize the acid.
  c. Flush your eyes with water for 10-15 minutes.
  d. Get medical attention immediately.
- **If acid is swallowed:**
  a. Drink large amounts of water or milk.
  b. Then drink milk of magnesia, beaten eggs, or vegetable oil.
  c. Get medical attention immediately.

Avoid High-Pressure Fluids

MIF

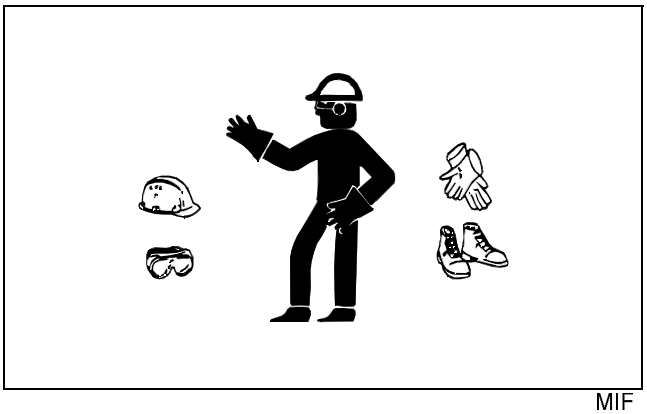
Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

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.

Avoid Heating Near Pressurized Fluid Lines

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.

Wear Protective Clothing



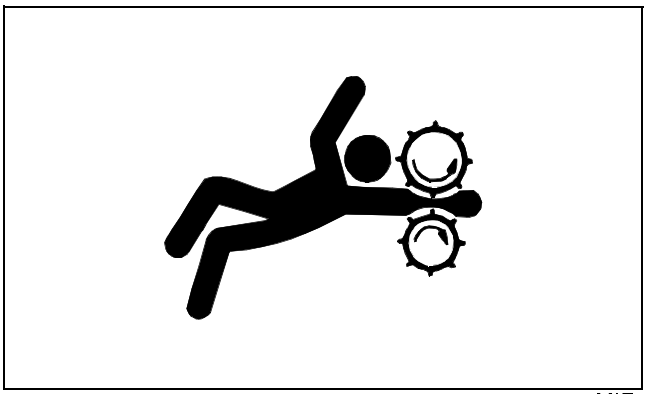
MIF

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

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

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

Service Machines Safely



MIF

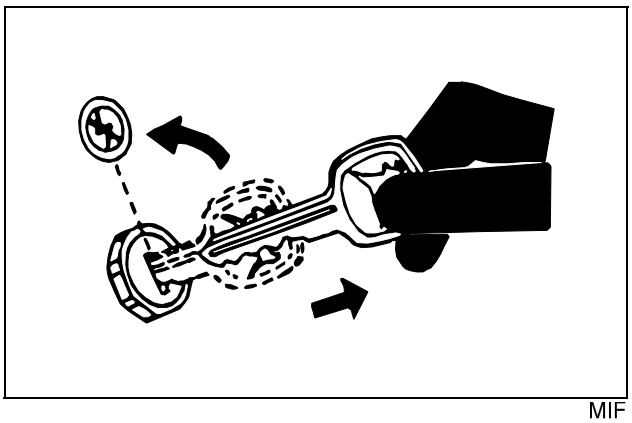
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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

Use Proper Tools

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

Park Machine Safely



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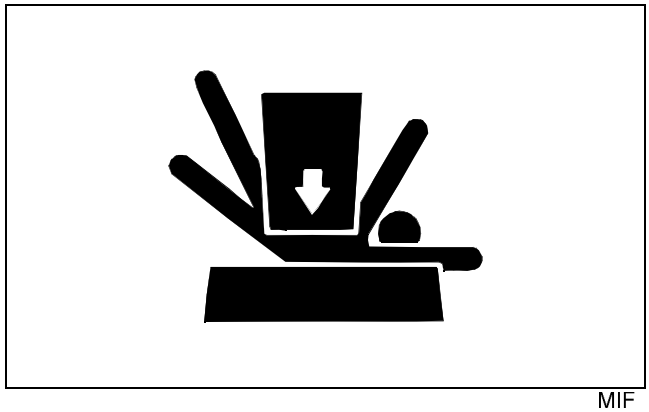
Before working on the machine:

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

Support Machine Properly and Use Proper Lifting Equipment



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

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

Follow recommended procedures in this manual.

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

Work in Clean Area

Before starting a job:

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

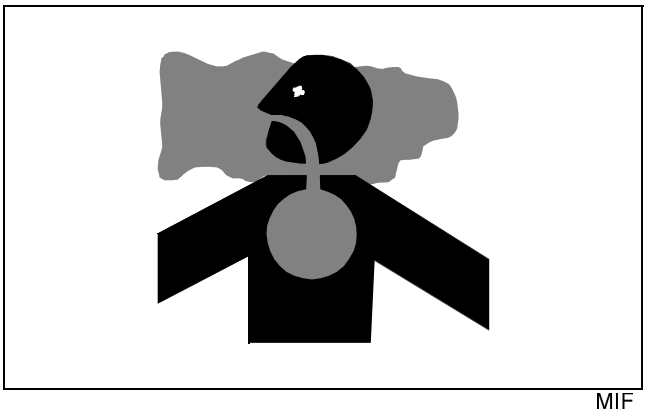
Using High Pressure Washers

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

Illuminate Work Area Safely

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

Work In Ventilated Area



MIF

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

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

WARNING: California Proposition 65 Warning

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

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.

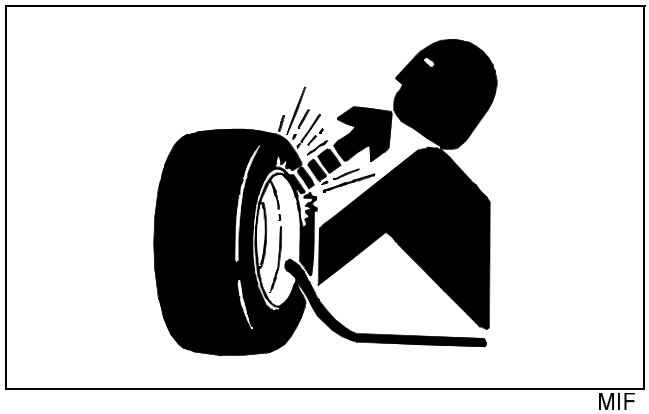
Avoid Harmful Asbestos Dust

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

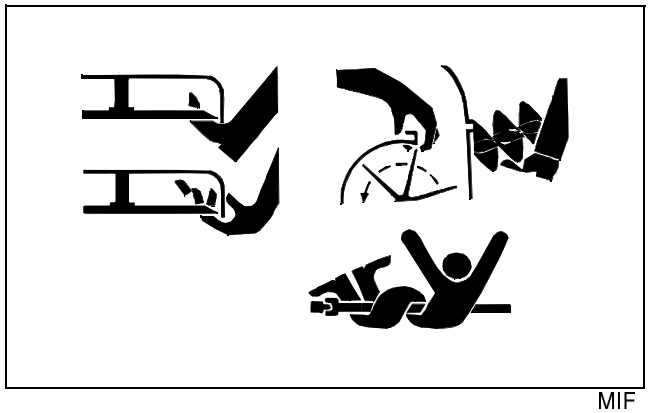


MIF

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, Augers and PTO Shafts



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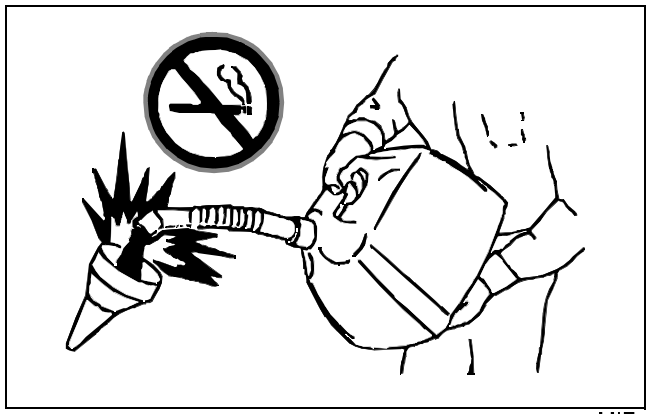
Keep hands and feet away while machine is running. Shut off power to service, lubricate or remove mower blades, augers or PTO shafts.

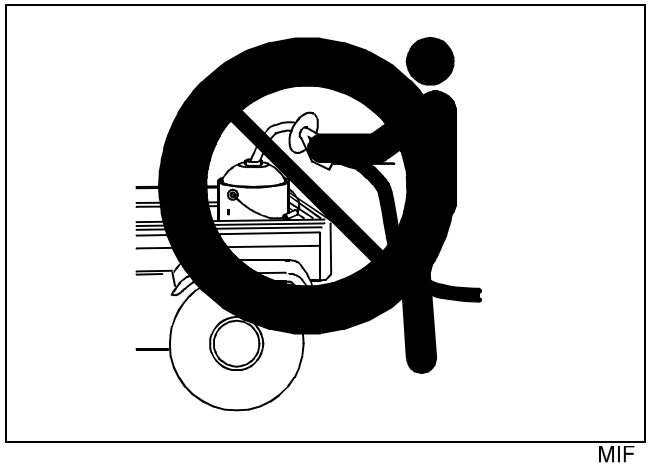
Handling Fuel Safely

Fuel and fuel vapors are highly flammable:



MIF

- Do not refuel machine while you smoke, when machine is near an open flame or sparks, or when engine is running. Stop engine and allow to cool before filling.
- Never remove the fuel cap or add fuel with the engine running.
- Never fill fuel tank or drain fuel from a machine in an enclosed area. Fill fuel tank outdoors.
- Prevent fires. Clean up spilled fuel immediately.
- Do not store machine with fuel in tank in a building where fumes may reach an open flame or spark.
- Prevent fire and explosion caused by static electric discharge. Use only non-metal, portable fuel containers approved by the Underwriter's Laboratory (U.L.) or the American Society for Testing & Materials (ASTM). If using a funnel, make sure it is plastic and has no screen or filter.

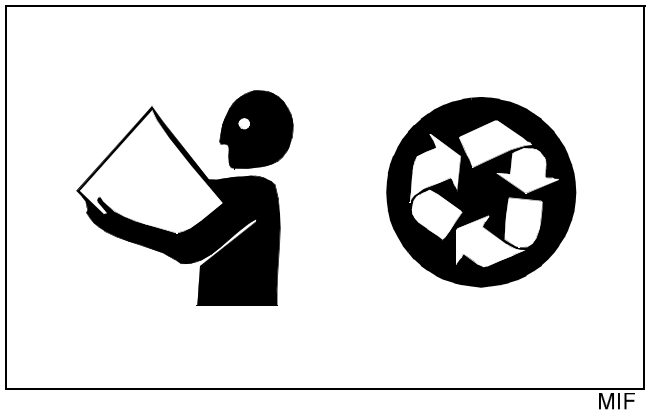


MIF

- Static electric discharge can ignite gasoline vapors in an ungrounded fuel container. Remove the fuel container from the bed of a vehicle or the trunk of a car and place on the ground away from the vehicle before filling. Keep nozzle in contact with container opening while filling.

- When practical, remove equipment from trailers or truck beds and refuel them on the ground. If this is not possible, use a portable, plastic fuel container to refuel equipment on a truck bed or trailer.
- For gasoline engines, do not use gas with methanol. Methanol is harmful to your health and to the environment.

Handle Chemical Products Safely



MIF

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

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

Dispose of Waste Properly

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

Live With Safety

MIF

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

Table of Contents

Specifications

Engine

Model 647

Make	Kawasaki
Type	Gasoline
Model	FH601V
Horsepower	14.2 kW (19 hp)
Displacement	675 cm^3 (41.2 cu in.)
Compression Ratio	8.1:1
Slow Idle Speed	1550 rpm
Fast Idle Speed	3600 rpm
Cylinders	2
Stroke/Cycle	4
Valves	Overhead Valves
Lubrication	Positive Displacement Pump
Oil Filter	Cartridge-Type, Full Flow
Crankcase Capacity (With Filter)	1.6 L (1.7 qt)
Cooling System	Air Cooled
Air Cleaner	Paper Element with Foam Precleaner
Muffler	Horizontal Discharge Below Frame
Spark Plug Gap	0.75 mm (0.030 in.)
Spark Plug Torque	22 N•m (16 lb-ft)

Models 657 and 667

Make	Kawasaki
Type	Gasoline
Model	FH680V
Horsepower	17.1 kW (23.0 hp)
Displacement	675 cm^3 (41.2 cu in.)
Compression Ratio	8.1:1
Slow Idle Speed	1550 rpm
Fast Idle Speed	3400 rpm
Cylinders	2
Stroke/Cycle	4
Valves	Overhead Valves
Lubrication	Positive Displacement Pump
Oil Filter	Cartridge-Type, Full Flow
Crankcase Capacity (with Filter)	1.6 L (1.7 qt)
Cooling System	Air Cooled
Air Cleaner	Paper Element with Foam Precleaner
Muffler	Horizontal Discharge Below Frame

Spark Plug Gap	0.75 mm (0.030 in.)
Spark Plug Torque	22 N•m (16 lb-ft)

Fuel System

Fuel Tank Location	Right Side of Operator
Fuel Tank Capacity	22.7 L (6 gal)
Fuel Type (Minimum Octane)	Unleaded, 87 Octane
Fuel Delivery	Float-Type Side Draft Carburetor
Fuel Pump	Vacuum Operated
Fuel Filter	Replaceable In-Line

Electrical

Ignition	Flywheel Magneto
Type of Starter	Electric, Solenoid Shift
Charging System	Flywheel Alternator

Battery

Voltage	12-volt
BCI group	UL1
CCA Rating	340 Amps at -18°C (0°F)
Reserve Capacity	67 Minutes at 25 Amps
Specific Gravity (Minimum)	1.230 points
Load Test (Minimum)	255 amps for 15 seconds

Power Train

Type	Hydrostatic Wheel Motor
Number of Speeds	Variable
Pump Drive	Belt
Controls	Hand Levers
Hydraulic Reservoir Capacity (with Filter)	1.9 L (2 qt)
Hydraulic System Capacity	3.1 L (3.3 qt)

Travel Speed:

Forward	0 - 13.7 km/h (0 - 8.5 mph)
Reverse	0 - 6.2 km/h (0 - 4 mph)

Hydraulic Pump:

Make	HydroGear
Model	BDP-10A

Wheel Motor:

Make	Parker
Model	MF-12

Attachment Drive

Type	V-Belt
Clutch Type	Electric
Control	Switch on Dash

Steering

Type	Hydrostatic
Turning Radius	Zero
Controls	Hand Levers

Brakes

Main	Hydraulic Resistance
Park Brake	Tire Contact

Attachment Lift

Lift System	Manual
Lift Lever Location	Each Side of Mower Deck
Number of Cutting Height Positions	7
Cutting Height Range	38 - 114 mm (1-1/2 - 4-1/2 in.)
Adjustment Increments	13 mm (1/2 in.)

Tires

Size-Front Caster Wheels	13 x 5-6
Size-Rear (Model 647)	20 x 8-8
Size-Rear (Models 657 and 667)	20 x 10-8
Pressure-Front	110 - 138 kPa (16 - 20 psi)
Pressure-Rear	69 - 97 kPa (10 - 14 psi)

Dimensions

Wheelbase	1.32 m (52 in.)
Overall Height	1.14 m (45 in.)
Overall Length (Model 647)	1.6 m (65.5 in.)
Overall Length (Models 657 and 667)	1.7 m (68.5 in.)

Overall Width:

48-Inch Deck with Chute Up	1.36 m (53.5 in.)
48-Inch Deck with Chute Down	1.57 m (62 in.)
54-Inch Deck with Chute Up	1.46 m (57.5 in.)
54-Inch Deck with Chute Down	1.73 m (68 in.)
60-Inch Deck with Chute Up	1.61 m (63.5 in.)
60-Inch Deck with Chute Down	1.88 m (74 in.)

Weight

Model 647 with 48-iInch 7-Iron Deck . . . . . 408 kg (899 lb)
Model 657 with 54-Inch 7-Iron Deck . . . . . 424 kg (934 lb)
Model 667 with 60-iInch 7-Iron Deck . . . . . 433 kg (955 lb)

Mower Decks

48-Inch 7-Iron Mower Deck

Type . . . . . Rotary, Side Discharge
Number of Cutting Blades 3
Overall Cutting Width . . . . . 1.2 m (48 in.)

54-Inch 7-Iron Mower Deck

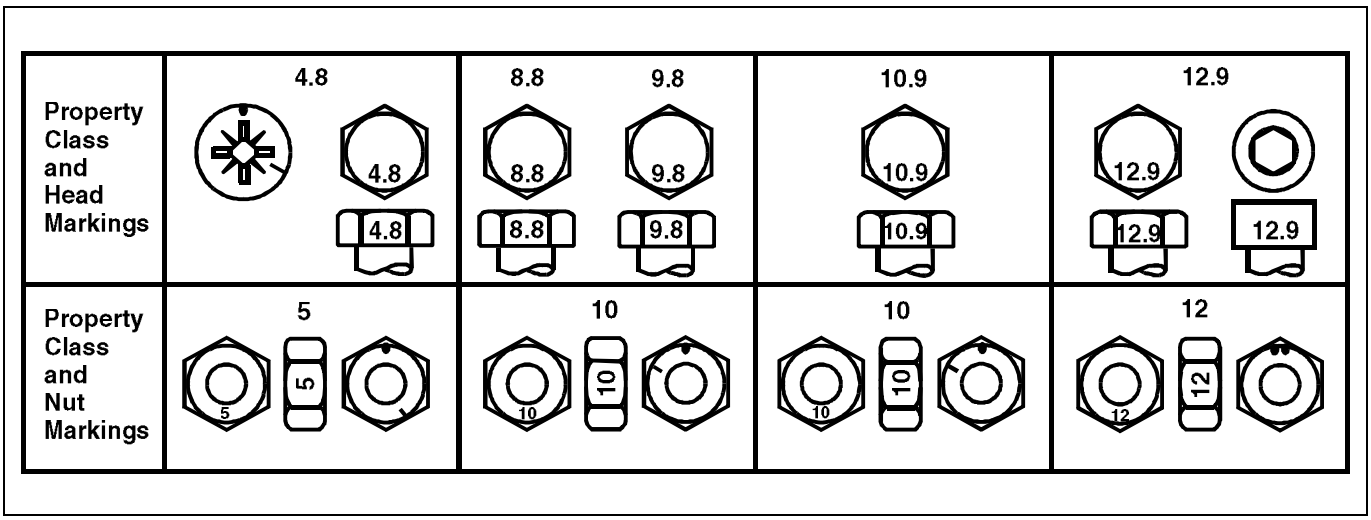
Type . . . . . Rotary, Side Discharge
Number of Cutting Blades 3
Overall Cutting Width . . . . . 1.4 m (54 in.)

60-Inch 7-Iron Mower Deck

Type . . . . . Rotary, Side Discharge
Number of Cutting Blades 3
Overall Cutting Width . . . . . 1.5 m (60 in.)

Fastener Torques

Metric Fastener Torque Values



MIF (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	109
M16	100	73	125	92	190	140	240	175	275	200	350	225	320	240	400	300
M18	135	100	175	125	260	195	330	250	375	275	475	350	440	325	560	410
M20	190	140	240	180	375	275	475	350	530	400	675	500	625	460	800	580
M22	260	190	330	250	510	375	650	475	725	540	925	675	850	625	1075	800
M24	330	250	425	310	650	475	825	600	925	675	1150	850	1075	800	1350	1000
M27	490	360	625	450	950	700	1200	875	1350	1000	1700	1250	1600	1150	2000	1500
M30	675	490	850	625	1300	950	1650	1200	1850	1350	2300	1700	2150	1600	2700	2000
M33	900	675	1150	850	1750	1300	2200	1650	2500	1850	3150	2350	2900	2150	3700	2750
M36	1150	850	1450	1075	2250	1650	2850	2100	3200	2350	4050	3000	3750	2750	4750	3500

DO NOT use these hand torque values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only and include a ±10% variance factor. Check tightness of

fasteners periodically. DO NOT use air powered wrenches.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Fasteners should be replaced with the same 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.

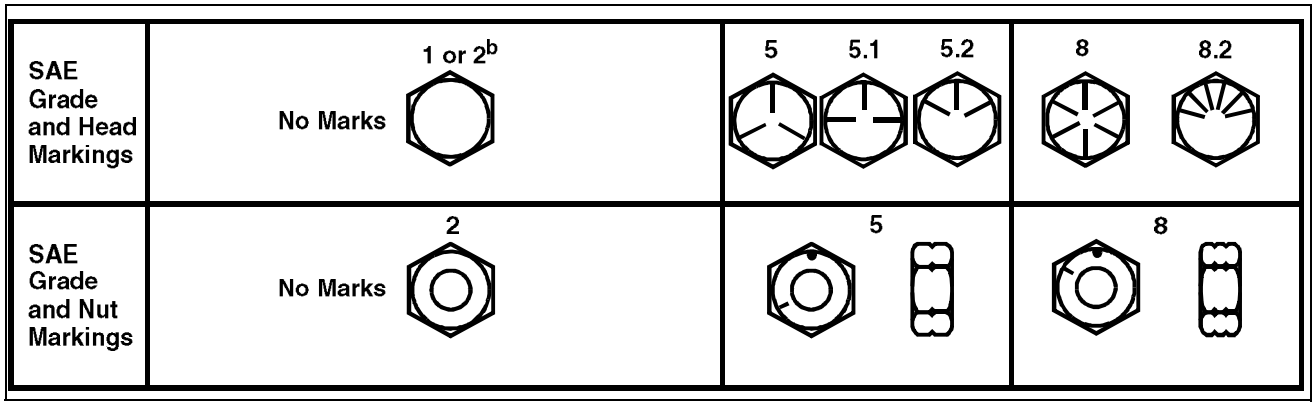
[a] *"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.*

Reference: JDS-G200.

Metric Fastener Torque Value—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



MIF (TS1162)

	Grade 1				Grade 2b				Grade 5, 5.1 or 5.2				Grade 8 or 8.2			
	Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]	
SIZE	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft
1/4	3.7	2.8	4.7	3.5	6	4.5	7.5	5.5	9.5	7	12	9	13.5	10	17	12.5
5/16	7.7	5.5	10	7	12	9	15	11	20	15	25	18	28	21	35	26
3/8	14	10	17	13	22	16	27	20	35	26	44	33	50	36	63	46
7/16	22	16	28	20	35	26	44	32	55	41	70	52	80	58	100	75
1/2	33	25	42	31	53	39	67	50	85	63	110	80	120	90	150	115
9/16	48	36	60	45	75	56	95	70	125	90	155	115	175	130	225	160
5/8	67	50	85	62	105	78	135	100	170	125	215	160	215	160	300	225
3/4	120	87	150	110	190	140	240	175	300	225	375	280	425	310	550	400
7/8	190	140	240	175	190	140	240	175	490	360	625	450	700	500	875	650
1	290	210	360	270	290	210	360	270	725	540	925	675	1050	750	1300	975

1-1/8	470	300	510	375	470	300	510	375	900	675	1150	850	1450	1075	1850	1350
1-1/4	570	425	725	530	570	425	725	530	1300	950	1650	1200	2050	1500	2600	1950
1-3/8	750	550	950	700	750	550	950	700	1700	1250	2150	1550	2700	2000	3400	2550
1-1/2	1000	725	1250	925	990	725	1250	930	2250	1650	2850	2100	3600	2650	4550	3350

DO NOT use these hand torque values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only and include a ±10% variance factor. Check tightness of fasteners periodically. DO NOT use air powered wrenches.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Fasteners should be replaced with the same grade. Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

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

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

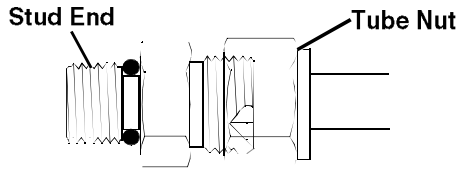
[a] *"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.*

[b] *"Grade 2" applies for hex cap screws (not hex bolts) up to 152 mm (6-in.) long. "Grade 1" applies for hex cap screws over 152 mm (6-in.) long, and for all other types of bolts and screws of any length.*

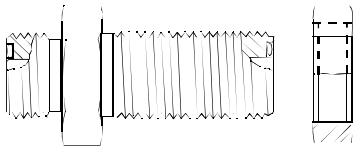
Reference: JDS-G200

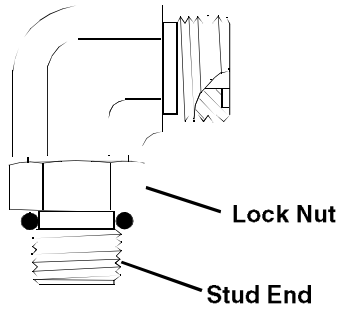
Hydraulic Fitting Service Recommendations

Face Seal Fittings with Inch Stud End Torques

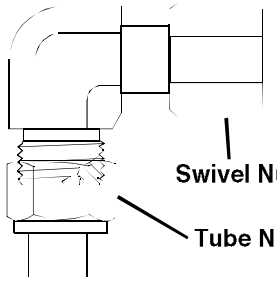


Stud Straight and Tube Nut


Bulkhead Union and Bulkhead Lock Nut



90° Adjustable Stud Elbow



90° Swivel Elbow and Tube Nut

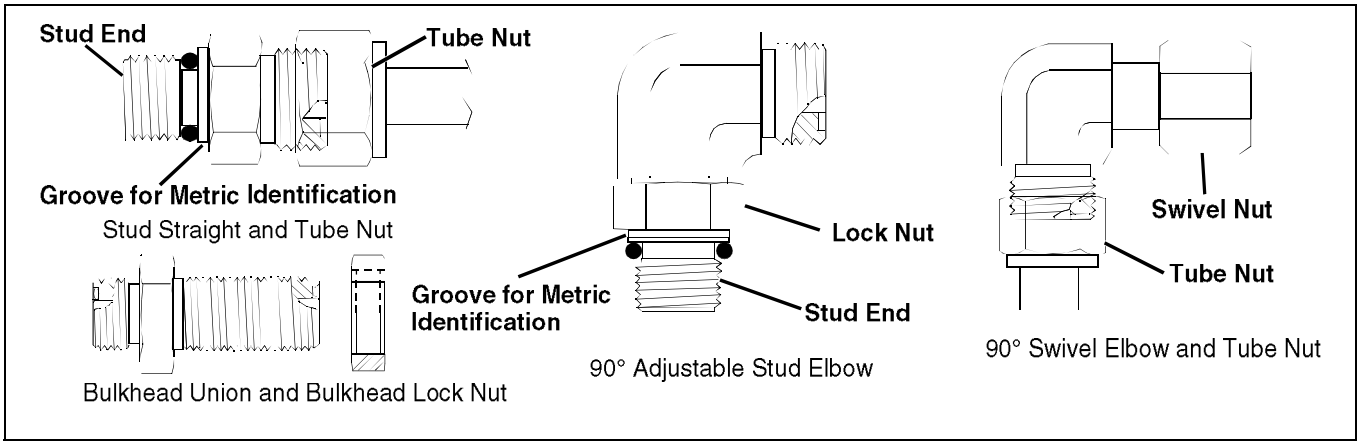
MIF

NOTE: Torque tolerance is + 15 - 20%.

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 of 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

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 of Lock Nut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
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	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

Face Seal Fittings with Metric Stud End Torques



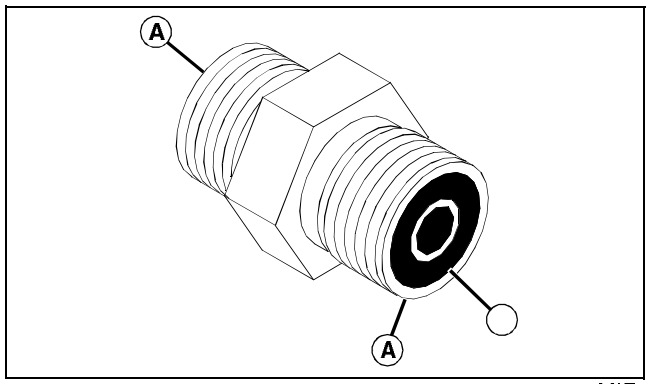
MIF

NOTE: Torque tolerance is + 15%.

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

O-Ring Seal Service Recommendations

O-Ring Face Seal Fittings



MIF

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

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

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

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

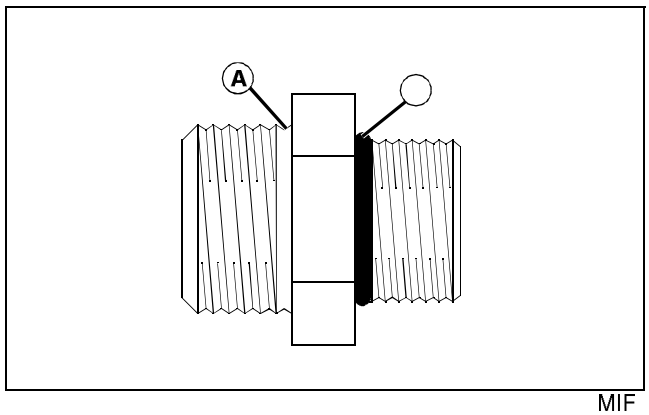
5. Index angle fittings and tighten by hand-pressing joint together to ensure O-ring remains in place.

IMPORTANT: Avoid damage! DO NOT allow hoses or lines 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. Do not allow hoses to twist when tightening fittings.

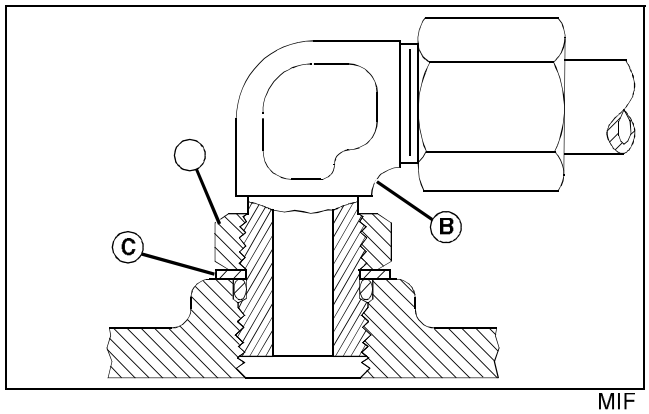
O-Ring Boss Fittings

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



MIF

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



MIF

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

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

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

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

Straight Fitting or Special Nut Torque

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.

Gasoline

4-Cycle Engines - North America

CAUTION: Avoid injury! Gasoline is HIGHLY FLAMMABLE, handle it with care.

DO NOT refuel machine while:

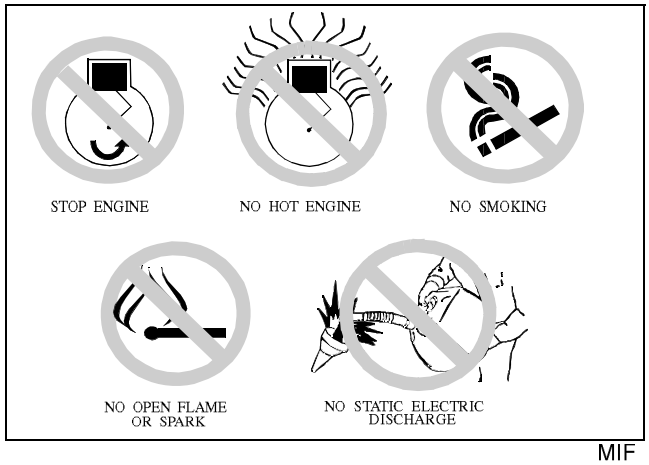
- **indoors, always fill gas tank outdoors;**
- **machine is near an open flame or sparks;**
- **engine is running, STOP engine;**
- **engine is hot, allow it to cool sufficiently first;**
- **smoking.**

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.**



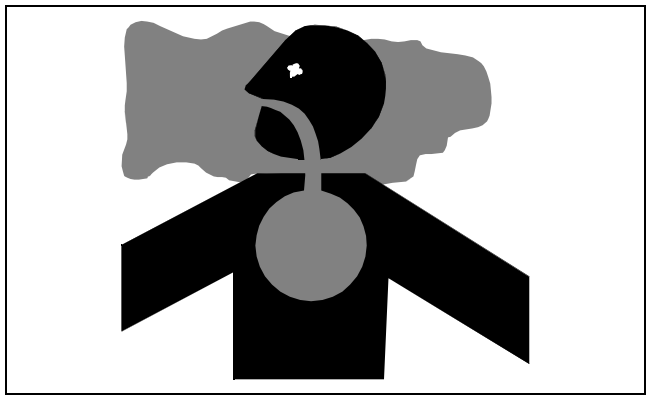
MIF

To avoid engine damage:

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

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

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



MIF

CAUTION: Avoid injury! DO NOT use METHANOL gasolines 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 unit or gasoline, it is recommended that you add John Deere Gasoline Conditioner and Stabilizer (TY15977) or an equivalent to the gasoline. BE SURE to follow directions on container and to properly discard empty container.

4-Cycle Engines - Europe

CAUTION: Avoid injury! Gasoline is HIGHLY FLAMMABLE, handle it with care.

DO NOT refuel machine while:

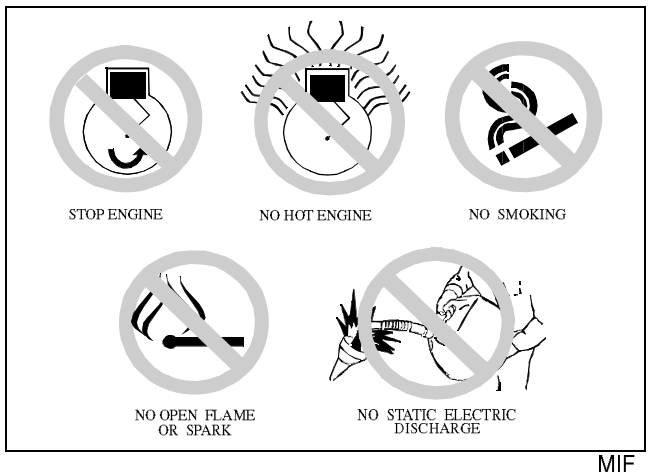
- **indoors, always fill gas tank outdoors;**
- **machine is near an open flame or sparks;**
- **engine is running, STOP engine;**
- **engine is hot, allow it to cool sufficiently first;**
- **smoking.**

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.**



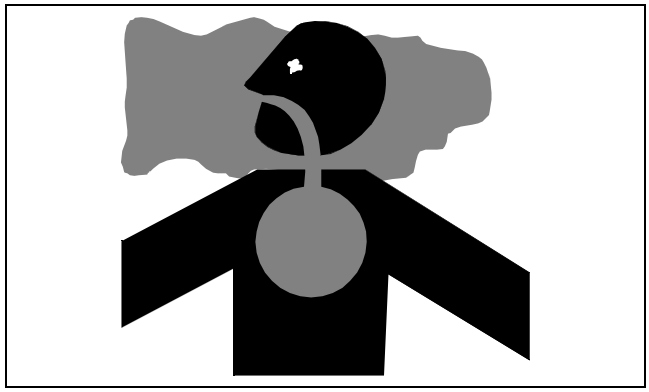
MIF

To avoid engine damage:

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

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

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



MIF

CAUTION: Avoid injury! DO NOT use METHANOL gasolines because METHANOL is harmful to the environment and to your health.

Gasoline Storage

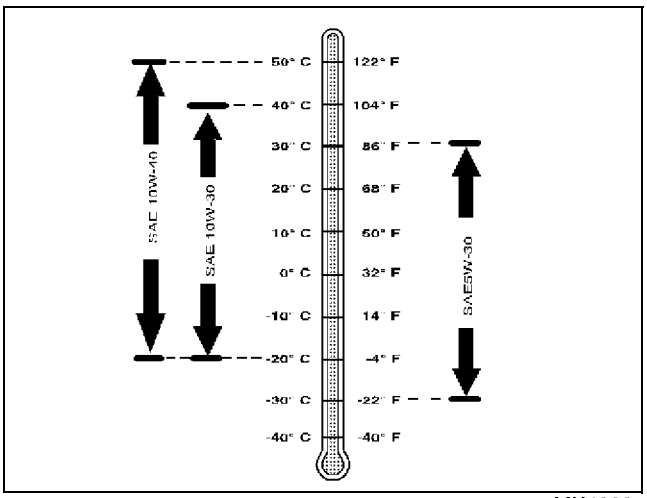
IMPORTANT: Avoid damage! Keep all dirt, scale, water or other foreign material out of gasoline.

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 unit 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.

Oils and Lubricants

Engine Oil

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



MX4888

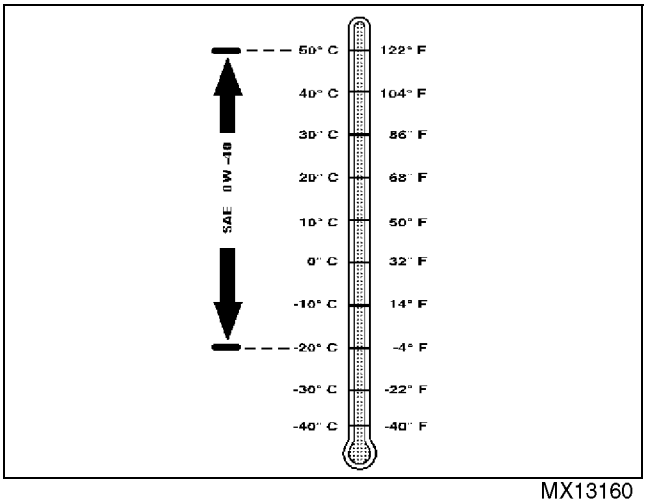
The following John Deere oils are preferred:

- John Deere TURF-GARD®
- John Deere PLUS-4®

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

- API Service Classification SG or higher

Hydrostatic Transmission and Hydraulic Oil



MX13160

Use the following oil viscosity based on the air temperature range. Operating outside of the recommended oil air temperature range may cause premature hydrostatic transmission failure.

IMPORTANT: Avoid damage! Only use a quality oil in this transmission. Do not mix any other oils in this transmission. Do not use BIO-HY-GARD® in this transmission. Do not use "Type F" (Red) Automatic Transmission Fluid in this transmission.

The following oil is preferred:

- JD Plus 50® - 0W-40 Synthetic Blend

Oil must meet the following:

- API Service Classification SG or higher

Grease

IMPORTANT: Avoid damage! Use recommended John Deere greases to avoid component failure and premature wear.

The recommended John Deere greases are effective within an average air temperature range of -29 to 135 degrees C (-20 to 275 degrees F).

If operating outside that temperature range, contact your Servicing dealer for a special-use grease.

The following greases are preferred:

- John Deere Multi-Purpose SD Polyurea Grease
- John Deere Multi-Purpose HD Lithium Complex Grease

If not using any of the preferred greases, be sure to use a general all-purpose grease with an NLGI grade No. 2 rating.

Wet or high-speed conditions may require use of a special-use grease. Contact your Servicing dealer for information.

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.

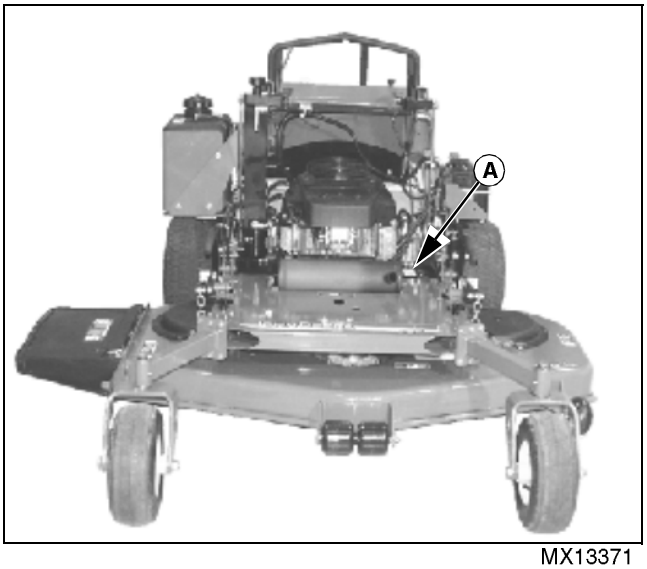
Mixing of Lubricants

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.

Serial Number Locations

Machine Product Identification Number

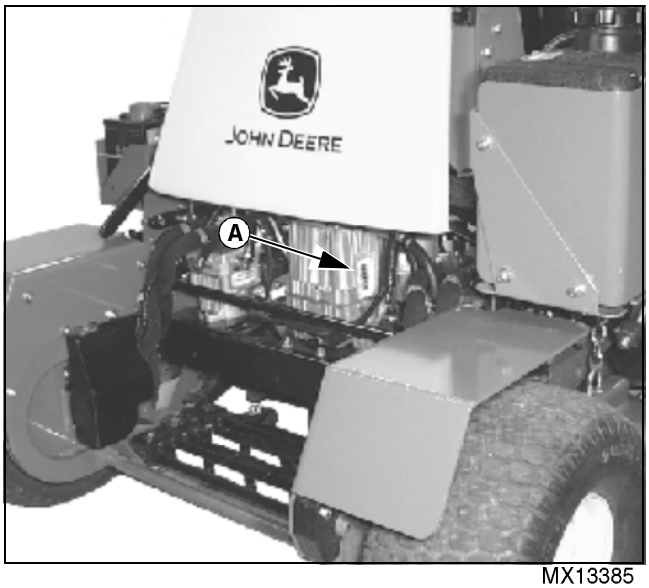
When ordering parts or submitting a warranty claim, it is IMPORTANT that the machine product identification number (PIN) and component serial numbers are included. The location of the PIN and component serial numbers are shown.



MX13371

The product identification number (PIN) (A) is located on the left side of frame near the engine.

Engine Serial Number

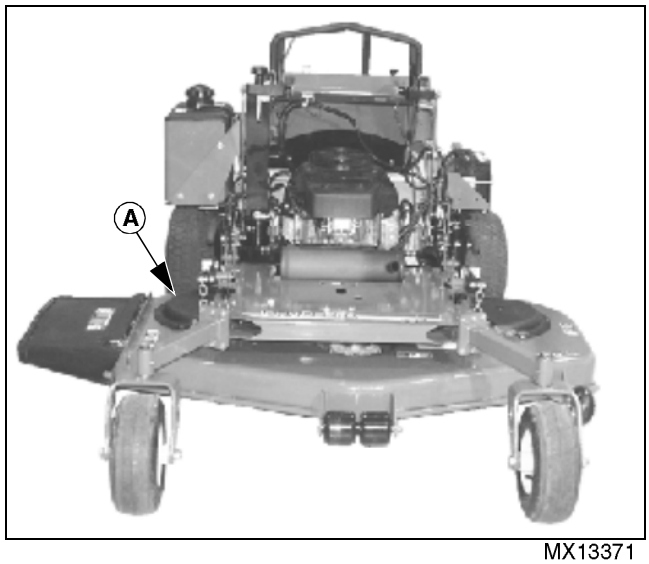


MX13385

Picture Note: Rear shield removed for photo clarity.

The engine serial number (A) is located on the engine crankcase on the right side of engine.

Mower Deck Serial Number



MX13371

The mower deck serial number (A) is located at the rear of the mower deck on the right side.

Table of Contents

Specifications

Engine Specifications

Make	Kawasaki
Type	OHV, Vertical Shaft, 90° V-Twin
Stroke/Cycle	4
Engine Model Number:	
Model 647	FH601V
Model 657 and 667	FH680V
Horsepower:	
Model 647	14.2 kW (19 hp)
Model 657 and 667	17.1 kW (23 hp)
Displacement:	
Model 647	675 cm^3 (41.2 cu in.)
Model 657 and 667	675 cm^3 (41.2 cu in.)
Bore:	
Model 647	75.2 mm (2.96 in.)
Model 657 and 667	75.2 mm (2.96 in.)
Stroke:	
Model 647	76 mm (2.99 in.)
Model 657 and 667	76 mm (2.99 in.)
Cooling Type	Air
Lubrication	Positive Displacement Pump
Oil Filter	Cartridge-Type Full Flow
Oil Capacity (with Filter)	1.7 L (1.8 qt)
Air Cleaner	Paper Element with Foam Precleaner
Muffler	Horizontal Discharge Below Frame
Fuel Filter	Replaceable (In-Line Type)
Aspiration	Normal
Compression Release	Automatic
Weight, Dry (without muffler)	40.5 kg (89.3 lb)

Test and Adjustment Specifications

Ungoverned Slow Idle Speed	1450 rpm
Governed Slow Idle Speed	1550 rpm
Governor Shaft Protrusion (Approx.)	7 mm (0.275 in.)
Fast Idle (FH601V)	3600 rpm
Fast Idle (FH680V)	3400 rpm
Minimum Fuel Flow in 10 Seconds	40 mL (1.3 oz)

Cylinder Compression Pressure	390 kPa (57 psi)
Intake Valve Clearance	0.075 - 0.125 mm (0.003 - 0.005 in.)
Exhaust Valve Clearance	0.075 - 0.125 mm (0.003 - 0.005 in.)
Valve Clearance Lock Screw Torque	7 N•m (61 lb-in.)
Fan Screen Clearance	1.0 - 3.0 mm (0.039 - 0.118 in.)
Fan Screen Screw Torque	6 N•m (52 lb-in.)
Spark Plug Gap	0.75 mm (0.030 in.)
Spark Plug Torque	22 N•m (16 lb-ft)
Oil Pump Operating Pressure	241 - 310 kPa (35 - 45 psi)
Oil Pressure Test Port Plug Torque	4 N•m (35 lb-in.)
Maximum Crankcase Vacuum	10.2 mm (4 in.)
Ignition Coil Air Gap	0.2 - 0.4 mm (0.008 - 0.016 in.)
Ignition Coil Capscrew Torque	6 N•m (52 lb-in.)

Repair Specifications

Fuel Pump Capscrew Torque	6 N•m (52 lb-in.)
Muffler Mounting Flange Nut Torque	15 N•m (132 lb-in.)
Engine Mounting Capscrew Torque	40 N•m (30 lb-ft)
PTO Clutch Capscrew Torque	68 N•m (50 lb-ft)
Oil Drain Fitting Torque	39 N•m (29 lb-ft)
Oil Filter Torque	3/4 Turn Past Contact
Crankcase Capacity (with Filter)	1.6 L (1.7 qt)
Throttle Plate Assembly:	
Mounting Capscrew Torque	6 N•m (52 lb-in.)
Carburetor:	
Main Jet Size (Left)	136
Main Jet Size (Right)	140
Pilot Jet Size (Left)	46
Pilot Jet Size (Right)	44
Float Height	Parallel with Carburetor Body
Fuel Shutoff Solenoid Torque	19 N•m (14 lb-ft)
Mounting Capscrew Torque	6 N•m (52 lb-in.)
Float Chamber Mounting Capscrew Torque	4 N•m (35 lb-in.)
Blower Housing and Shields:	
Mounting Capscrew Torque	6 N•m (52 lb-in.)
Fan Screen-to-Blower Housing Clearance	1.0 - 3.0 mm (0.039 - 0.118 in.)
Fan Screen Screw Torque	6 N•m (52 lb-ft)
Outer Intake Screen Nut Torque	6 N•m (52 lb-in.)
Voltage Regulator/Rectifier Capscrew Torque	3 N•m (30 lb-in.)

Intake Manifold:

Mounting Capscrew Torque . . . . . 6 N•m (52 lb-in.)

Crankcase Breather:

Breather Cover Capscrew Torque . . . . . 6 N•m (52 lb-in.)

Reed Valve Body Screw Torque . . . . . 2 N•m (18 lb-in.)

Ignition Coil:

Ignition Coil Air Gap . . . . . 0.2 - 0.4 mm (0.008 - 0.016 in.)

Mounting Capscrew Torque . . . . . 6 N•m (52 lb-in.)

Flywheel:

Retaining Capscrew Torque . . . . . 56 N•m (41 lb-ft)

Stator:

Mounting Capscrew Torque . . . . . 3 N•m (27 lb-in.)

Blower Housing Plate Capscrew Torque . . . . . 6 N•m (52 lb-in.)

Cylinder Head:

Rocker Arm Cover Capscrew Torque . . . . . 6 N•m (52 lb-in.)

Rocker Arm Adjuster Lock Screw Torque . . . . . 7 N•m (61 lb-in.)

Maximum Push Rod Bend . . . . . 0.50 mm (0.020 in.)

Cylinder Head Capscrew Final Torque . . . . . 25 N•m (18 lb-ft)

Rocker Arm Stud Torque . . . . . 28 N•m (21 lb-ft)

Cylinder Head Out-of-Flat (Max) . . . . . 0.05 mm (0.002 in.)

Valve Guide ID . . . . . 6.000 - 6.012 mm (0.2362 - 0.2367 in.)

Valve Guide ID (Wear Limit) . . . . . 6.08 mm (0.239 in.)

Valve Seat Angle (Intake and Exhaust) . . . . . 45°

Valve Seat Narrowing Angle . . . . . 30°

Valve Seat Width (Intake) . . . . . 0.8 - 1.4 mm (0.03 - 0.05 in.)

Valve Seat Width (Exhaust) . . . . . 1.1 - 1.6 mm (0.04 - 0.06 in.)

Valve Springs:

Free Length (Min) . . . . . 31 mm (1.22 in.)

Valves:

Valve Face Margin (Min) . . . . . 0.35 mm (0.014 in.)

Intake Valve Stem OD (Wear Limit) . . . . . 5.95 mm (0.233 in.)

Exhaust Valve Stem OD (Wear Limit) . . . . . 5.93 mm (0.233 in.)

Valve Stem Bend (Max) . . . . . 0.05 mm (0.002 in.)

Crankcase Cover:

Crankshaft Bore ID (Wear Limit) . . . . . 40.15 mm (1.581 in.)

Camshaft Bore ID (Wear Limit) . . . . . 16.136 mm (0.6352 in.)

Crankcase Cover Capscrew Torque . . . . . 25 N•m (18 lb-ft)

Governor Shaft:	
Plate Screw Torque	2.0 N•m (18 lb-in.)
Governor Shaft Seal Installation Depth	0 - 2 mm (0 - 080 in.)
Governor Shaft Protrusion (Approx.)	7 mm (0.275 in.)
Oil Pump:	
Cover Plate Capscrew Torque	6 N•m (52 lb-in.)
Rotor Shaft Diameter (Min)	10.923 mm (0.4300 in.)
Rotor Shaft Bearing ID (Max)	11.072 mm (0.4359 in.)
Outer Rotor Diameter (Min)	40.470 mm (1.5933 in.)
Outer Rotor Bore Diameter (Max)	40.801 mm (1.6063 in.)
Outer Rotor Thickness (Min)	9.83 mm (0.387 in.)
Outer Rotor Bore Depth (Max)	10.230 mm (0.4028 in.)
Inner Rotor-to-Outer Rotor Clearance	0.2 mm (0.008 in.)
Relief Valve Spring Free Length	19.5 mm (0.77 in.)
Camshaft:	
Bearing Journal OD (Wear Limit)	15.985 mm (0.6293 in.)
Cam Lobe Height (Wear Limit)	29.621 mm (1.166 in.)
Piston:	
Top Compression Ring-to-Groove Clearance (Max)	0.18 mm (0.007 in.)
Center Compression Ring-to-Groove Clearance (Max)	0.16 mm (0.006 in.)
Top Compression Ring Thickness (Min)	1.40 mm (0.055 in.)
Center Compression Ring Thickness (Min)	1.40 mm (0.055 in.)
Top Compression Ring End Gap (Wear Limit)	0.65 mm (0.026 in.)
Center Compression Ring End Gap (Wear Limit)	0.078 mm (0.031 in.)
Oil Ring End Gap (Wear Limit)	1.05 mm (0.041 in.)
Piston Thrust Face OD (Wear Limit) (Standard)	74.99 mm (2.952 in.)
Piston Thrust Face OD (Wear Limit) (0.30 mm [0.020 in.] Oversize Piston)	75.49 mm (2.972 in.)
Piston Pin Bore ID (Wear Limit)	16.08 mm (0.633 in.)
Piston Pin OD (Wear Limit)	15.96 mm (0.682 in.)
Connecting Rod:	
Crankshaft Bearing Bore ID (Wear Limit)	40.044 mm (1.577 in.)
Connecting Rod Width, Crankshaft End (Wear Limit)	20.45 mm (0.805 in.)
Piston Pin Bore ID (Wear Limit)	16.05 mm (0.632 in.)
Connecting Rod Bend (Max)	0.15/100 mm (0.006/3.94 in.)
Connecting Rod Twist (Max)	0.15/100 mm (0.006/3.94 in.)
Connecting Rod Cap Capscrew Torque	21 N•m (15 lb-ft)

ENGINE SPECIFICATIONS

Crankshaft:

Main Bearing Journal OD (Min)	39.896 mm (1.571 in.)
Connecting Rod Journal OD (Min)	39.940 mm (1.5724 in.)
Connecting Rod Journal Width (Max)	43.10 mm (1.697 in.)
Crankshaft Runout (TIR) (Max)	0.05 mm (0.002 in.)

Cylinder Block - Standard:

Cylinder Bore ID (New)	75.18 - 75.20 mm (2.960 - 2.961 in.)
Cylinder Bore ID (Wear Limit)	75.28 mm (2.964 in.)
Cylinder Bore Maximum Out-of-Round	0.056 mm (0.0022 in.)
Crankshaft Bore ID (Wear Limit)	40.15 mm (1.581 in.)

Cylinder Block - 0.050 mm (0.020 in.) Oversize:

Cylinder Bore ID (New)	75.68 - 75.70 mm (2.979 - 2.980 in.)
Cylinder Bore ID (Wear Limit)	75.78 mm (2.983 in.)
Cylinder Bore Maximum Out-of-Round	0.056 mm (0.0022 in.)
Crankshaft Bore ID (Wear Limit)	40.15 mm (1.581 in.)

Starting Motor:

Mounting Capscrew Torque	15 N•m (132 lb-in.)
Brush Length (Wear Limit)	6.4 mm (0.25 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
Digital Pulse Tachometer	JT07270	Used to check/ adjust engine slow and fast idle rpm.
Graduated Container	NA	Used to catch and measure fuel output of fuel pump.
178 mm (7 in.) Hose	NA	Used to connect to fuel pump, and pump fuel into container.
Cylinder Compression Tester	JDM59	Used to check engine compression.
Feeler Gauge (Blade Type)	N/A	Used to measure intake and exhaust valve clearance.
Adapter - 1/8 BSPT X 7/16-20 M 37°	JT03349	Used to connect to engine oil pressure switch port.
Hose with Quick Connect	JT03017	Connect between adapter and gauge.
Pressure Gauge - 0 - 414 kPa (0 - 60 psi)	JT03092	Used to measure engine oil pressure.

Other Materials

Other Material

Part No.	Part Name	Part Use
TY9370 (US) 242 (Loctite®) TY9477 (Canada)	Thread Lock and Sealer (Medium Strength)	Applied to threads of throttle and choke plate screws before installation.
M79292	MPG-2 Polymer Multipurpose Grease	Prevents parts from seizing. Apply to engine crankshaft.
NA	SCOTCH-BRITE™ Abrasive Sheet/Pad	Clean cylinder head.

Other Material

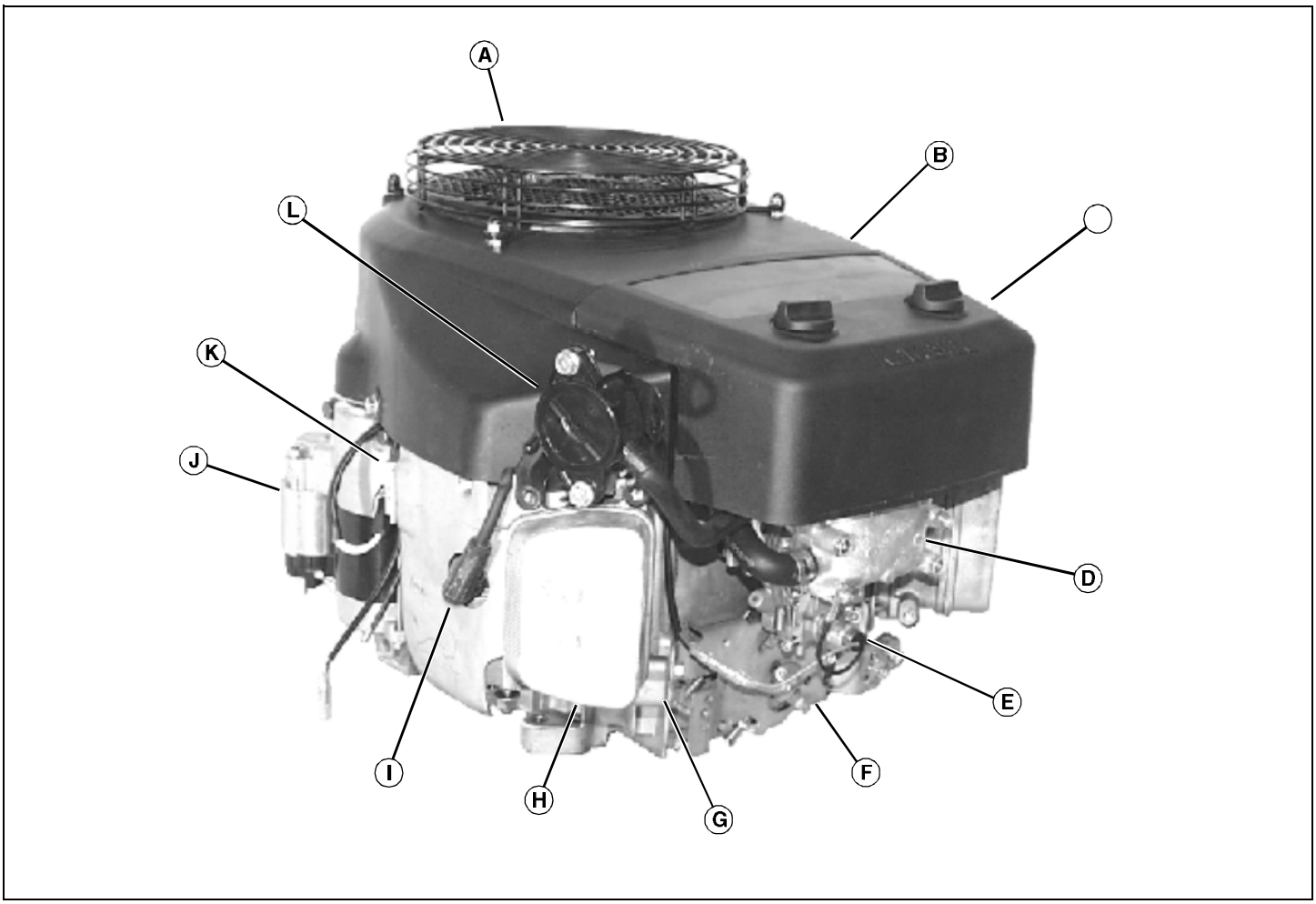
Part No.	Part Name	Part Use
NA	Prussian Blue Compound	Check valve seat contact.
NA	Lapping Compound	Lap valves into valve seats.
NA	Lithium-Based Grease	Pack oil seals.
NA	Zinc Oxide/Wood Alcohol	Check block for cracks.

Service Parts Kits

The following kits are available through your parts catalog:

- Carburetor Assembly
- Carburetor Float Chamber Kit
- Carburetor Gasket Kit
- Engine Gasket Kit
- Piston Ring Kit (Standard)
- Piston Ring Kit (0.50 mm [0.020 in. Oversize])
- Piston (Standard)
- Piston (0.50 mm [0.020 in. Oversize])
- Connecting Rod (Standard)
- Governor Control Plate Assembly
- Oil Pump Kit
- Cylinder Block

Component Location — External Engine Components

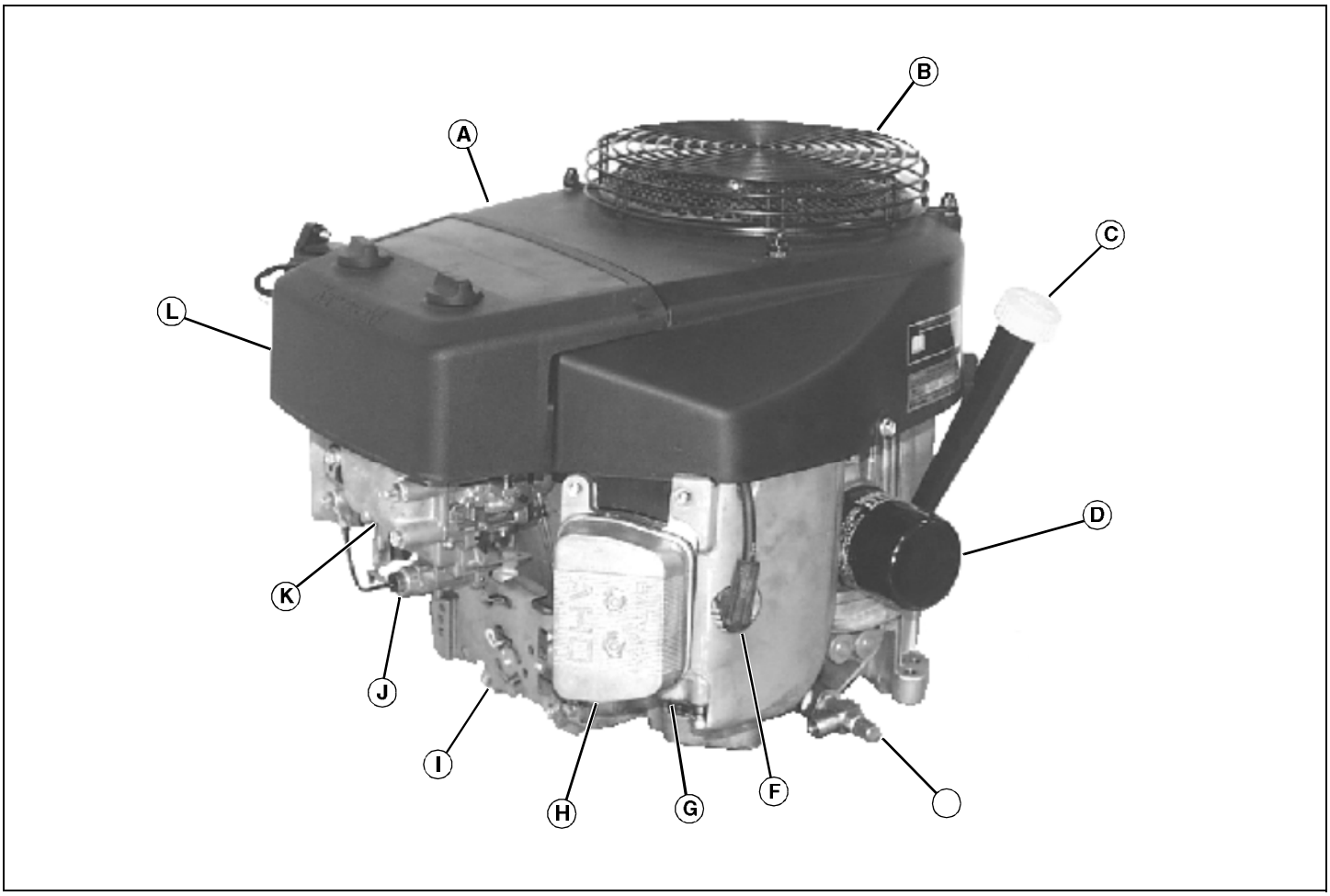


MX15113

Picture Note: Right side shown.

A - Outer Air Intake Screen
B - Blower Housing
C - Air Cleaner Cover
D - Carburetor
E - Fuel Shutoff Solenoid
F - Throttle Plate Assembly
G - No. 1 Cylinder Head
H - Rocker Arm Cover
I - Spark Plug
J - Starting Motor
K - Voltage Regulator/Rectifier
L - Fuel Pump

ENGINE COMPONENT LOCATION



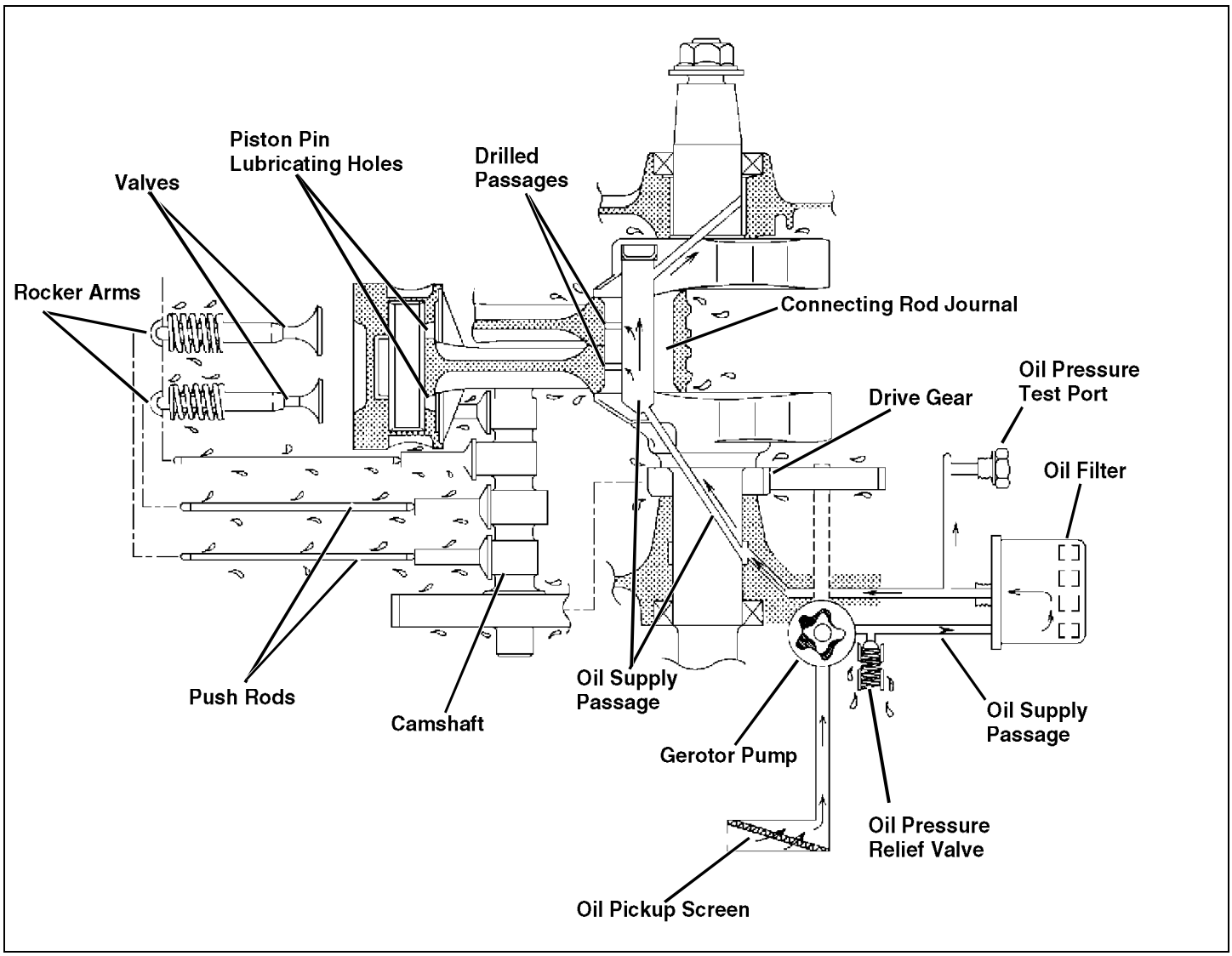
MX15114

Picture Note: Left side shown.

A - Blower Housing
B - Outer Air Intake Screen
C - Oil Dipstick/Fill Tube
D - Oil Filter
E - Oil Drain
F - Spark Plug
G - No. 2 Cylinder Head
H - Rocker Arm Cover
I - Throttle Plate Assembly
J - Fuel Shutoff Solenoid
K - Carburetor
L - Air Cleaner Cover

Theory of Operation

Lubrication System Operation



MX14485

Function

To provide oil to lubricate internal engine components.

Theory of Operation

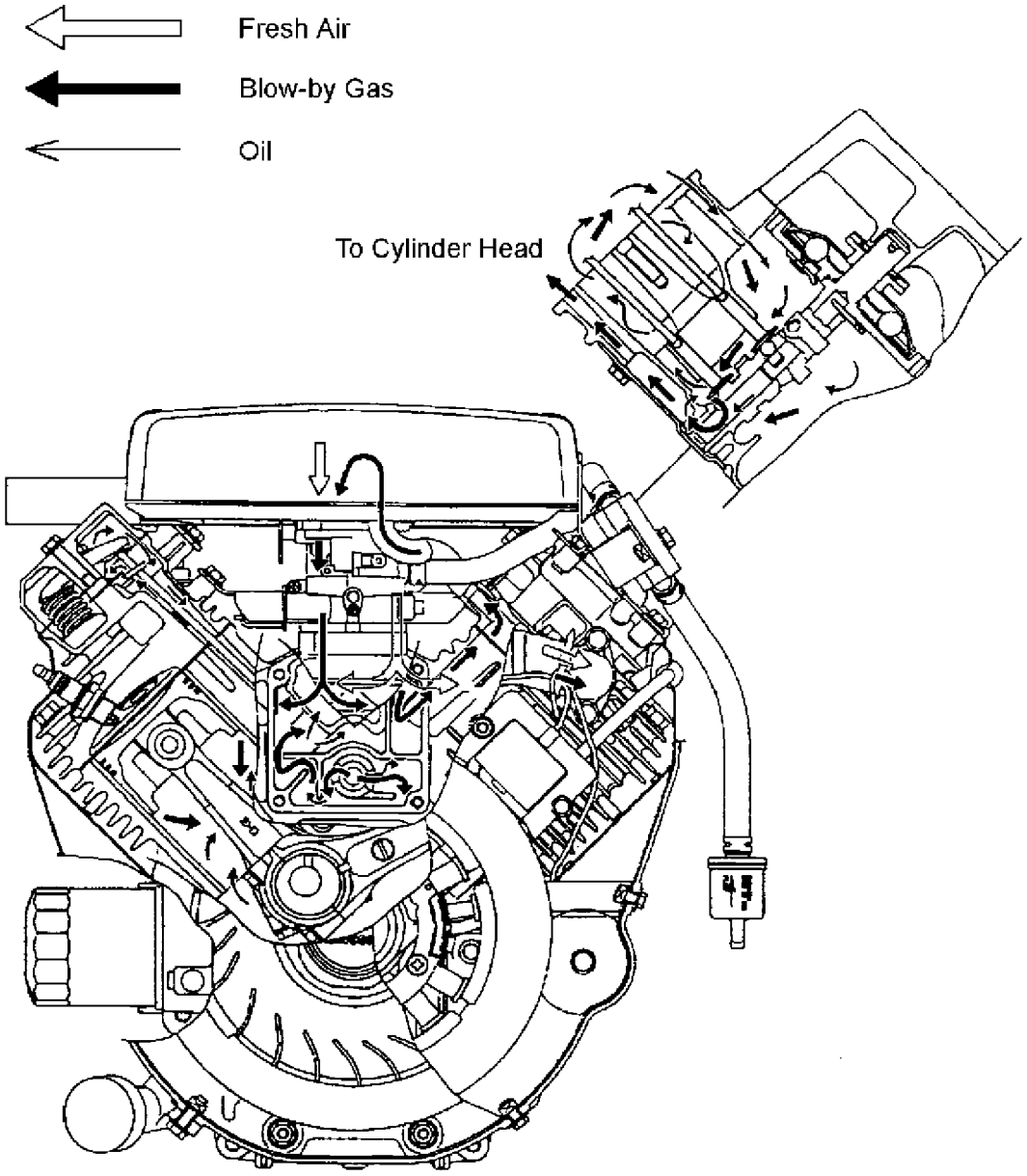
A positive displacement Gerotor pump is used to pressurize the lubrication system. The oil pump is driven directly off the crankshaft gear. The lubrication system is protected by an oil pressure relief valve, low oil pressure switch and an oil filter with bypass.

The oil pump draws oil from the sump through a pickup screen. Pressurized oil flows from the pump to a pressure relief valve that limits the oil pressure to approximately 241 - 310 kPa (35 - 45 psi). Relief oil is vented back to the sump.

The pressurized, non-relieved oil flows through a full flow spin-on oil filter. Filtered oil is then routed to the crankshaft and camshaft bearings. Drilled passages in the connecting rods allow for lubrication of the piston pin and pistons.

The rocker arms, valves and push rods are lubricated by an oil/air mixture carried to the head through the breather tube.

Crankcase Breather Operation



MX14496

Function

To remove blow-by gases and provide oil to lubricate valves and rocker arms.

Theory of Operation

The function of the breather is to create a vacuum in the crankcase, which prevents oil from being forced out of the engine through the piston rings, oil seals or gaskets. A sealed-type crankcase emission control system is used to eliminate blow-by gases. The blow-by gases are led to the breather chamber through the crankcase and the camshaft. Then it is drawn through the rocker arm covers and into the clean side of the air cleaner to be mixed with the clean air flow to be burned along with normal combustion.

Oil is primarily separated from the gases while passing through the inside of the rocker arm covers to provide lubrication for the rocker arms and valves. Oil is secondairly separated from the gases in the breather chamber and then returned back to the crankcase.

Cooling System Operation

Function

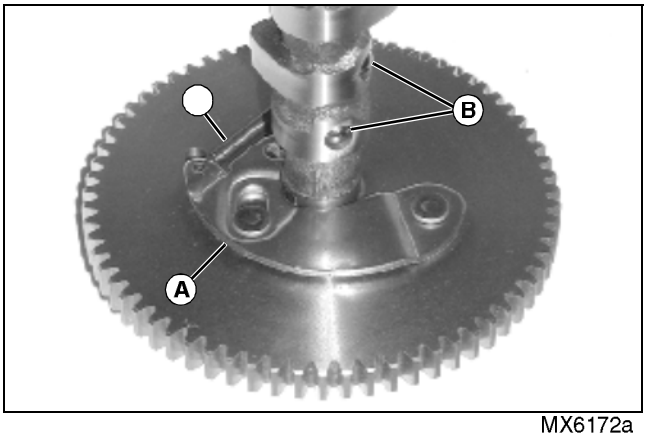
To remove heat from the engine.

Theory of Operation

The engine is air-cooled with air flow provided by a fan mounted on the flywheel. When the engine is running, the fan draws air through an opening in the fan housing. The engine covers then direct the air flow past the cooling fins on the cylinder head and block. Most of the cooling air flows directly over the valve area. This increased cooling capacity in the valve area helps to minimize valve sticking and seat wear due to overheating. The cooling fins are cast into the engine block and cylinder head to increase their surface area and allow better transfer of the heat generated by the engine into the air stream.

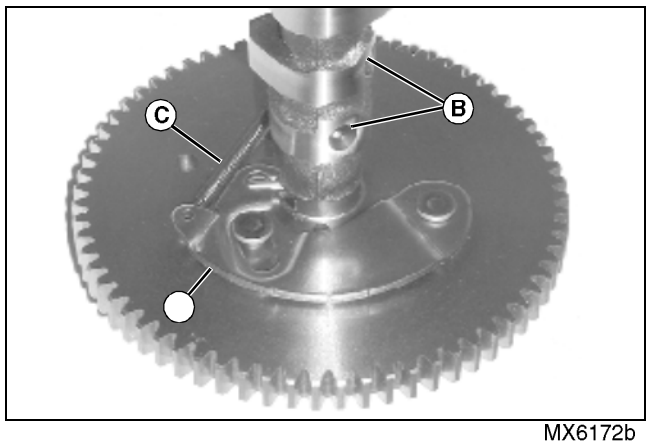
It is important that the cooling fan screen and the cooling fins on the cylinder block and cylinder head remain free of debris to ensure proper air flow. The engine covers should not be removed or altered, as cooling capacity will be reduced. Cylinder block and head cooling fins must remain clean to properly dissipate heat.

Automatic Compression Release (ACR) Operation



MX6172a

Picture Note: ACR in cranking position.



MX6172b

Picture Note: ACR in running position.

Function

The automatic compression release (ACR) relieves some of the compression created during starting of the engine. This is done by slightly raising the exhaust valve as the engine rotates through the compression stroke.

Theory of Operation

The ACR consists of a flyweight (A) that is attached to the cam gear, balls (B) and a return spring (C). The ACR is attached to the camshaft and has limited serviceability.

When the engine is cranked, the pins are held above the surface of the exhaust cam lobes, causing the exhaust valves to open slightly during the compression stroke. The result is a lowered cylinder pressure, allowing the engine to turn over more easily.

When the engine starts, the centrifugal force overcomes the force of the return spring and the flyweight moves away from its at-rest position. As the flyweight rotates, the compression release pins withdraw below the surface of the cam lobe, allowing normal valve timing and engine operation.

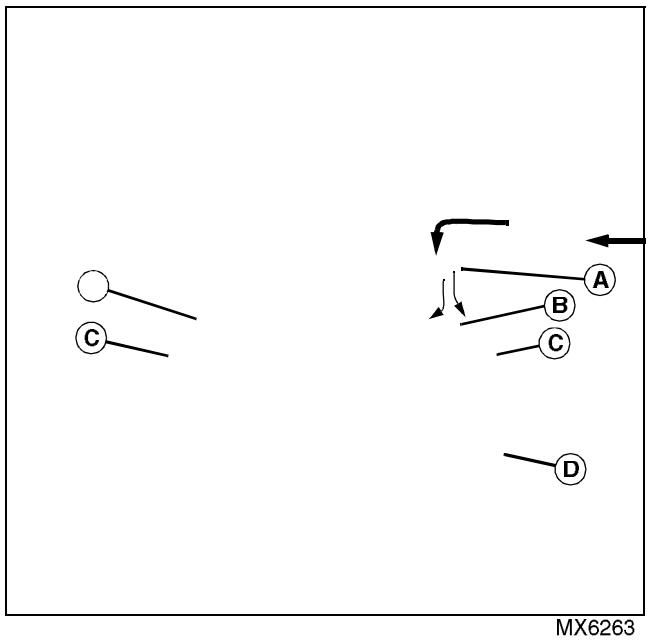
Carburetor Operation

Function

To control engine speed and to mix fuel and air in correct proportions for efficient engine operation at all speeds.

Theory of Operation

The carburetor consists of three circuits: Fuel Supply, Pilot Fuel and Main Fuel.

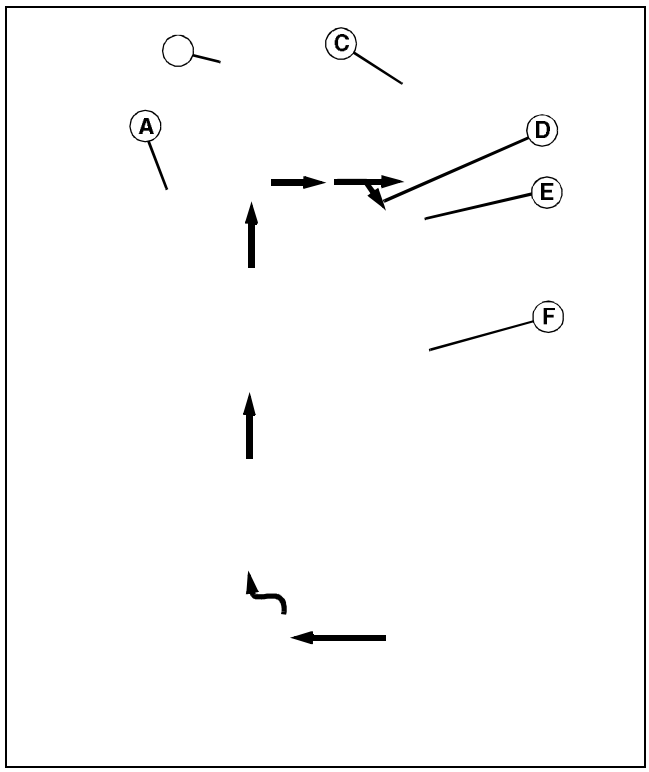


MX6263

Fuel Supply Circuit

The main components of the fuel supply circuit are float chamber (D), float valve (A) and float (B). The fuel supply circuit controls the fuel level (C) in the float chamber.

Fuel under light pressure from the fuel pump enters the carburetor and passes through the float valve (A). As fuel enters the float chamber (D), the float (B) begins to rise. The float valve (A) is located near the float pivot, and as the float rises, the float valve closes. When a predetermined position is reached (referred to as float level), the float completely stops the flow of fuel. Misadjustment of the float level can cause poor engine operation and even premature engine wear or damage. If the float level is high, the fuel/air mixture entering the engine will be rich (excessive fuel) and may cause black exhaust. If the float level is low, the fuel/air mixture will be lean (lack of fuel) and result in low engine power or stalling.



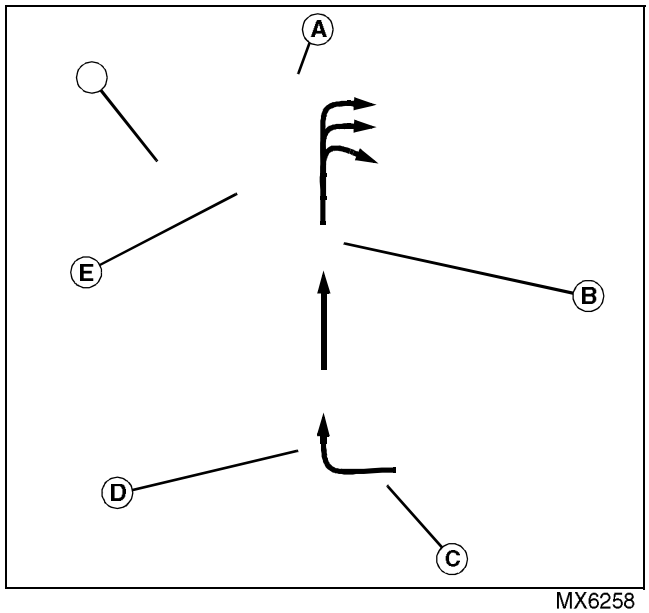
MX6257

Pilot Fuel Circuit

The pilot circuit includes a pilot air jet (A), pilot fuel jet (B), pilot mixture screw (idle mixture screw) (C), bypass holes (D) and pilot outlet (E). The pilot system meters the fuel/air mixture while the engine is idling and running under a light load. Under these conditions there is very little air flow through the carburetor bore, so little that it is not enough to draw fuel through the main system of the carburetor. Instead, the fuel is drawn from the main fuel circuit and through the pilot system. The nearly closed throttle valve (F) causes high speed air flow past the pilot outlet (E) and bypass holes (D), and creates a low pressure area that “pulls” fuel through the pilot circuit.

Fuel flow in the pilot system is metered by the pilot fuel jet (B). Air is admitted into the pilot fuel via the pilot air jet (A) located in the throat of the carburetor, creating an emulsion that results in better atomization of the fuel passing into the engine. The fuel/air emulsion passes into the bore of the carburetor, near the throttle valve, through the bypass holes (D) and pilot outlet (E). At slow idle, the bypass holes (D) are covered by the throttle valve (F), and all fuel/air emulsion is delivered through the pilot outlet (E). As the throttle valve begins to open, it uncovers the bypass holes (D), allowing more fuel/air emulsion to flow. The extra flow is needed due to the increased air passing through the carburetor as the throttle is opened. The pilot mixture screw (C) controls the amount of fuel/air emulsion allowed through the pilot outlet (E), but does not meter the bypass holes (D). A moderate amount of air comes in around the throttle valve at idle, so adjusting the pilot mixture screw (C)

changes the fuel/air ratio. Turning the pilot mixture screw (idle mixture screw) out (counterclockwise) enriches the mixture; turning it in (clockwise) leans the mixture.



MX6258

Main Fuel Circuit

The main fuel circuit consists of the main jet (C), valve seat (D), main nozzle (B), main air passage (E) and main air orifice (F). The main system meters fuel to the engine during moderate to heavy load conditions.

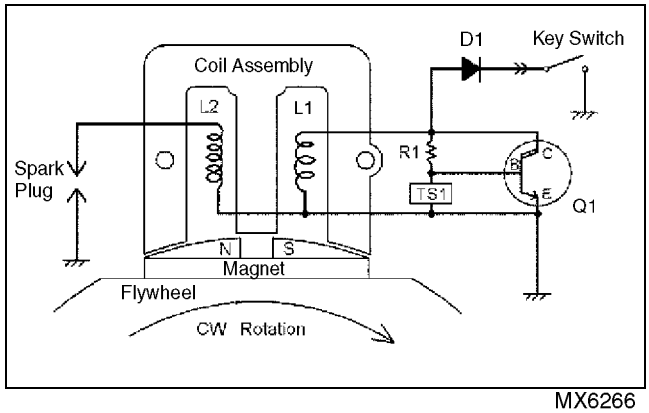
The throat of the carburetor incorporates an area having a reduced diameter called a venturi (A). As air passes through the venturi, it increases in speed resulting in a low pressure area. The main nozzle (B) is located in the venturi area. The pressure differential between the fuel in the float chamber and the venturi (A) causes the fuel to be “lifted” through the main nozzle (B).

The main jet (C) controls the amount of fuel that passes into the main nozzle (B). Fuel flows through the main jet (C) and into the main nozzle (B), where it is joined by air from the main air passage (E) to create an fuel/air emulsion that is easier to “lift”. The main air orifice (F) controls air flow through the main air passage (E). The resulting emulsion flows out the end of the main nozzle (B) into the carburetor bore, where it is atomized by the high speed air flow and carried into the engine.

Ignition System Operation

This engine ignition is controlled by two solid state ignition assemblies and requires no periodic maintenance except for the spark plugs.

- Inductive Ignition Assemblies
- Permanent Magnet Flywheel
- Spark Plugs
- Key Switch



MX6266

Mounted to the periphery of a flywheel are a pair of magnetic poles (south leading in clockwise rotation), generated by a permanent magnet.

By rotating the flywheel (magnetic poles) clockwise past the ignition coil on a laminated core, a voltage is generated in the primary winding (L1). This generates a small bias current to flow through the control resistor (R1) to the base of transistor (Q1). This base drive causes the transistor to conduct (turn on), completing the primary circuit. Current flows from the high side of the primary winding through the transistor (collector to emitter) to ground.

The trigger sensor (TS1) senses the optimum time (peak current) to remove the base drive from the transistor (Q1). This abrupt "turning off" of the transistor causes an interruption in current flow which allows its associated flux to collapse, and several hundred volts is induced through the primary winding (L1), inducing a very large voltage in the secondary winding (L2).

When the secondary voltage reaches several thousand volts, the spark plug gap is ionized and ignition occurs. The placement of the trigger sensor internal to the ignition ensures constant timing over speed and temperature, and prevents counterclockwise operation. The diode (D1) in the ignition shutoff circuit blocks inadvertent application of battery voltage, protecting the internal components of the ignition.

When the key switch is turned off, primary voltage is routed to ground, preventing ignition operation.

Diagnostics

Engine Hard to Start

Test Conditions:

- Machine parked on level surface.
- Park brake locked.
- Motion control levers in neutral position.
- Key switch in run position.

CAUTION: Avoid injury! To avoid electric shock, DO NOT hold spark plug. Instead, make sure to hold plug cap.

Symptom: Engine Hard to Start

(1) Is the fuel tank filled with fresh, clean fuel of the correct grade?

Yes - Go to step (2).

No - Fill the tank with fresh, clean fuel. (See "Gasoline" on page 19.) Go to step (2) if the problem continues.

(2) Is fuel shutoff valve in the open position?

Yes - Go to step (3).

No - Open fuel shutoff valve. Go to step (3) if the problem continues.

(3) Are the fuel hoses and fuel filter free of obstructions?

Yes - Go to step (4).

No - Clear fuel lines and/or replace fuel filter. (See "Remove and Install Fuel Filter" on page 55.) Go to step (4) if the problem continues.

(4) Is the fuel tank cap breather hole free of obstructions?

Yes - Go to step (5).

No - Clear obstructions from breather hole. Go to step (5) if the problem continues.

(5) Is choke adjusted properly?

Yes - Go to step (6).

No - Adjust choke cable. (See "Adjust Throttle and Choke Cable" on page 45.) Go to step (6) if the problem continues.

(6) Does the fuel pump operate within specifications? (Perform fuel pump flow rate test.)

Symptom: Engine Hard to Start

Yes - Go to step (7).

No - Replace the fuel pump. (See "Remove and Install Fuel Pump" on page 56.) Go to step (7) if the problem continues.

(7) Is fuel shutoff solenoid operating properly? (Perform fuel shutoff solenoid test.)

Yes - Go to step (8).

No - Replace fuel shutoff solenoid. Go to step (8) if the problem continues.

(8) Are air filter elements in good condition, not clogged?

Yes - Go to step (9).

No - Clean and/or replace air filter elements. (See "Service Air Cleaner" on page 61.) Go to step (9) if the problem continues.

(9) Is the carburetor operating and/or adjusted properly?

Yes - Go to step (10).

No - Overrich fuel in carburetor slow idle circuit. Adjust idle mixture screw to 1-5/8 turns from lightly seated. Go to step (10) if the problem continues.

No - Plugged air and/or fuel passages in carburetor. Clean the carburetor. (See "Clean and Inspect Carburetor" on page 65.) Go to step (10) if the problem continues.

No - Adjust carburetor float. (See "Check Carburetor Float Level" on page 65.) Go to step (10) if the problem continues.

No - Replace carburetor float valve if damaged. (See "Disassemble and Assemble Carburetor" on page 63.) Go to step (10) if the problem continues.

(10) Is adequate spark available at spark plug? (Perform spark output test.)

Yes - Go to step (11).

No - May be due to faulty spark plug insulation. Replace spark plug.

No - Spark plug electrodes may be fouled. Clean the spark plug.

No - High tension lead may be faulty. (See "Test Ignition Coil" on page 158.)

No - Ignition coil air gap may be incorrect. (See "Adjust Ignition Coil Air Gap" on page 53.) Go to step (11) if the problem continues.

Symptom: Engine Hard to Start

(11) Is engine compression within specifications? (Preform cylinder compression test.)

No - Proceed as directed in "Results".

Engine Malfunctions at Low Speed

Test Conditions:

- Machine parked on level surface.
- Park brake locked.
- Motion control levers in neutral position.
- Key switch in run position.

CAUTION: Avoid injury! To avoid electric shock, DO NOT hold spark plug. Instead, make sure to hold cap.

Symptom: Engine Malfunctions at Low Speed

(1) Is adequate spark available at spark plug? (Perform spark output test.)

Yes - Go to step (2).

No - May be due to faulty spark plug insulation. Replace spark plug. Go to step (2) if the problem continues.

No - Spark plug electrodes may be fouled. Clean the spark plug. Go to step (2) if the problem continues.

No - High tension lead may be faulty. (See "Test Ignition Coil" on page 158.) Go to step (2) if the problem continues.

No - Ignition coil air gap may be incorrect. (See "Adjust Ignition Coil Air Gap" on page 53.) Go to step (2) if the problem continues.

(2) Start engine and run it at slow idle. Is exhaust free of unusual black smoke?

Yes - Go to step (3).

No - Overrich fuel in carburetor slow idle circuit. Adjust idle mixture screw to 1-5/8 turns from lightly seated. Go to step (3) if the problem continues.

No - Choke not opening completely. (See "Adjust Throttle and Choke Cable" on page 45.) Go to step (3) if the problem continues.

(3) Gradually open throttle valve by hand. Does engine accelerate smoothly through all throttle positions?

Symptom: Engine Malfunctions at Low Speed

Yes - Go to step (4).

No - Passages in carburetor are plugged. Clean the carburetor. Go to step (4) if the problem continues.

(4) Are carburetor-to-intake manifold connections tight?

Yes - Go to step (5).

No - Flange nuts may be loose. Tighten flange nuts. Go to step (5) if the problem continues.

No - Gasket may be damaged. Replace gasket. (See "Remove and Install Carburetor" on page 61.) Go to step (5) if the problem continues.

(5) Stop engine and check valve clearance. Is clearance within specifications?

Yes - Go to step (6).

No - Adjust valve clearance. (See "Check and Adjust Valve Clearance" on page 49.) Go to step (6) if the problem continues.

(6) Is alignment of timing gears correct?

No - Align timing gears. (See "Remove and Install Camshaft and Tappets" on page 82.)

Engine Runs Erratically

Test Conditions:

- Machine parked on level surface.
- Park brake locked.
- Motion control levers in neutral position.
- Key switch in run position.

Symptom: Engine Runs Erratically

(1) Is adequate spark available at spark plug? (Perform spark output test.)

Yes - Go to step (2).

No - Spark plugs fouled or gapped incorrectly. Clean sparks plugs and adjust gap. (See "Adjust Spark Plug Gap" on page 51.) Go to step (2) if the problem continues.

No - Faulty or misadjusted ignition coils. Test and/or adjust as necessary. (See "Adjust Ignition Coil Air Gap" on page 53.) Go to step (2) if the problem continues.

(2) Is the fuel system operating and/or adjusted properly?

Symptom: Engine Runs Erratically

Yes - Go to step (3).

No - Dirt or water in fuel line or fuel filter. Replace fuel filter. (See "Remove and Install Fuel Filter" on page 55.) Go to step (3) if the problem continues.

No - Air or vapor lock in fuel line. Bleed the fuel line. Go to step (3) if the problem continues.

No - Plugged air vent in fuel tank cap. Clean the fuel tank cap air vent. Go to step (3) if the problem continues.

No - Fuel line is pinched or sucking air. Repair as necessary. Go to step (3) if the problem continues.

No - Loose carburetor or leaking flange gasket. Repair as necessary. Go to step (3) if the problem continues.

No - Carburetor fitted with high altitude jetting. Replace with correct main jets. Go to step (3) if the problem continues.

No - Plugged air and/or fuel passages in carburetor. Clean the carburetor. (See "Clean and Inspect Carburetor" on page 65.) Go to step (3) if the problem continues.

(3) Is the governor system operating properly?

No - Governor linkage may be incorrectly adjusted. (See "Adjust Slow Idle Speed" on page 45.)

No - Governor spring may be faulty. Replace spring.

No - Governor flyweight assembly may be faulty. (See "Inspect Camshaft and Tappets" on page 83.)

Oil Consumption Is Excessive

Test Conditions:

- Machine parked on level surface.
- Park brake locked.
- Motion control levers in neutral position.
- Key switch in run position.

Symptom: Oil Consumption Is Excessive

(1) Is engine compression within specifications? (Perform cylinder compression test.)

Yes - Go to step (2).

No - Proceed as directed in "Results". Go to step (2) if the problem continues.

(2) Is the engine oil level correct?

Symptom: Oil Consumption Is Excessive

Yes - Go to step (3).

No - Engine oil level may be too high. Drain engine oil and refill to proper level. Go to step (3) if the problem continues.

(3) Is the engine oil viscosity correct?

Yes - Go to step (4).

No - Drain engine oil and refill with proper viscosity. (See "Engine Oil" on page 22.) Go to step (4) if the problem continues.

(4) Is the engine oil drain plug properly tightened, free of leakage?

Yes - Go to step (5).

No - Tighten drain plug. Go to step (5) if the problem continues.

(5) Is the area around the governor shaft free of leakage?

Yes - Go to step (6).

No - Replace governor shaft seal. (See "Install Governor Shaft" on page 80.) Go to step (6) if the problem continues.

(6) Is the crankcase breather tube free of obstructions?

Yes - Go to step (7).

No - Clean breather tube. Go to step (7) if the problem continues.

(7) Are valve stems and/or valve guides in good condition, not worn?

Yes - Go to step (8).

No - Inspect valves and valve guides. Replace parts as needed. (See "Inspect Cylinder Head and Valves" on page 73.) Go to step (8) if the problem continues.

(8) Is drain-back hole in the tappet chamber free of obstructions?

Yes - Go to step (9).

No - Clear drain-back hole. Go to step (9) if the problem continues.

(9) Are areas around crankshaft oil seals free of leakage?

No - Replace oil seals. (See "Replace Oil Seal" on page 93 [engine block/crankcase], also See "Remove and Install Crankcase Cover" on page 78 [crankcase cover].)

Engine Has Low Power

Test Conditions:

- Machine parked on level surface.
- Park brake locked.
- Steering levers in neutral position.
- Key switch in run position.

Symptom: Engine Has Low Power

(1) Is adequate spark available at spark plug? (Perform spark output test.)

Yes - Go to step (2).

No - Spark plugs fouled or gapped incorrectly. Clean spark plugs and adjust gap. (See "Adjust Spark Plug Gap" on page 51.) Go to step (2) if the problem continues.

No - High tension lead may be faulty. (See "Test Ignition Coil" on page 158.) Go to step (2) if the problem continues.

(2) Does the engine run within normal operating temperature, does not overheat?

Yes - Go to step (3).

No - Engine load may be excessive. Reduce engine load. Go to step (3) if the problem continues.

No - Intake screens, shroud and/or engine fins may be clogged. Clean the intake screens, shroud and/or engine fins. Go to step (3) if the problem continues.

No - The spark plug may be incorrect. Replace spark plug. (See "Adjust Spark Plug Gap" on page 51.) Go to step (3) if the problem continues.

(3) Does the engine run smoothly, does not knock?

Yes - Go to step (4).

No - Fuel may be stale. Drain fuel tank and refill with fresh fuel. Go to step (4) if the problem continues.

No - Engine load may be excessive. Adjust load on engine. Go to step (4) if the problem continues.

No - Engine may have excessive carbon deposits. Remove carbon deposits. Go to step (4) if the problem continues.

(4) Is the lubrication system operating normally? (Perform engine oil pressure test.)

Yes - Go to step (5).

Symptom: Engine Has Low Power

No - There may be too much or too little engine oil in crankcase. Drain and fill engine oil to proper level. Go to step (5) if the problem continues.

No - Engine oil may have excessive contamination. Drain and fill engine oil to proper level. Go to step (5) if the problem continues.

No - Proceed as directed in "Results". Go to step (5) if the problem continues.

(5) Is engine exhaust free of any unusual smoke?

Yes - Go to step (6).

No - Crankcase may have too much engine oil. Drain/fill engine oil to proper level. Go to step (6) if the problem continues.

No - Air cleaner may be clogged. (See "Service Air Cleaner" on page 61.) Go to step (6) if the problem continues.

No - Carburetor float misadjusted. (See "Check Carburetor Float Level" on page 65.) Go to step (6) if the problem continues.

No - Carburetor float valve damaged. (See "Disassemble and Assemble Carburetor" on page 63.) Go to step (6) if the problem continues.

No - Carburetor may be fitted with high altitude jetting. Install correct main jets. Go to step (6) if the problem continues.

No - Carbon deposits may be present in exhaust port and muffler. Remove carbon deposits. Go to step (6) if the problem continues.

(6) Is engine compression within specifications? (Perform cylinder compression test.)

No - Proceed as directed in "Results".

Fuel Consumption Is Excessive

Test Conditions:

- Machine parked on level surface.
- Park brake locked.
- Motion control levers in neutral position.
- Key switch in run position.

Symptom: Fuel Consumption Is Excessive

(1) Is engine compression within specifications? (Perform cylinder compression test.)

Yes - Go to step (2).

No - Proceed as directed in "Results". Go to step (2) if the problem continues.

(2) Is the engine free of excessive loads?

Yes - Go to step (3).

No - Reduce engine load. Go to step (3) if the problem continues.

(3) Is choke fully open?

Yes - Go to step (4).

No - Open the choke. Go to step (4) if the problem continues.

(4) Are air filter elements in good condition, not clogged?

Yes - Go to step (5).

No - Clean and/or replace air filter elements. (See "Service Air Cleaner" on page 61.) Go to step (5) if the problem continues.

(5) Is the carburetor float properly adjusted, float valve not damaged?

Yes - Go to step (6).

No - Adjust carburetor float. (See "Check Carburetor Float Level" on page 65.) Go to step (6) if the problem continues.

No - Replace carburetor float valve if damaged. (See "Disassemble and Assemble Carburetor" on page 63.) Go to step (6) if the problem continues.

(6) Is adequate spark available at spark plug?

No - Spark plugs fouled or gapped incorrectly. Clean sparks plugs and adjust gap. (See "Adjust Spark Plug Gap" on page 51.)

No - High tension lead may be faulty. (See "Test Ignition Coil" on page 158.)

Tests and Adjustments

Adjust Throttle and Choke Cable

Reason:

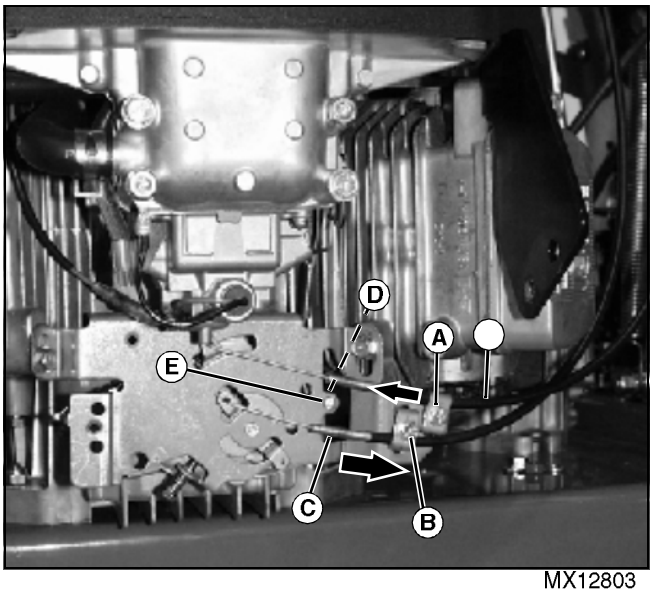
To make sure the throttle and choke operate through the full range of movement.

Procedure:

CAUTION: Avoid injury! Engine and muffler might be hot.

NOTE: Adjust throttle cable before adjusting choke.

1. Park machine safely and stop engine.
2. Move motion control levers to neutral position.
3. Move throttle control lever to fast idle position.



MX12803

Picture Note: Muffler removed for photo clarity.

4. Loosen capscrews (A and B) and pull throttle cable (C) to remove all slack. Be sure that inner throttle lever (D) is tight against stop screw (E). Tighten capscrew (B).
5. Push operator choke control in. Choke (butterfly) should be fully open.
6. Push choke cable housing (F) to remove all slack. Tighten capscrew (A).
7. Move operator throttle lever and choke knob through full range to be sure throttle or choke linkage is not binding.

Adjust Slow Idle Speed

IMPORTANT: Avoid damage! DO NOT attempt to adjust carburetors that meet California Air Resource Board/Environmental Protection Agency (CARB/EPA) restrictions unless you are a factory trained technician with authorization to service CARB/EPA Emissions Carburetors.

Reason:

To set engine slow idle mixture and rpm.

NOTE: Throttle cable should be properly adjusted prior to setting slow idle speed.

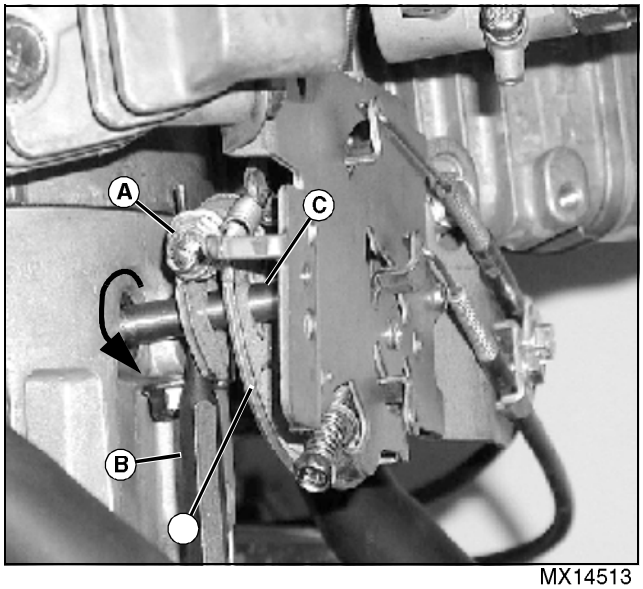
Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Pulse Tachometer	JT07270	Used to check/adjust engine slow and fast idle rpm.

Procedure:

1. Park machine safely.
2. Move motion control levers to neutral position.
3. Operate engine until it has reached normal operating temperature.
4. Stop engine.

CAUTION: Avoid injury! Engine and muffler will be hot.



MX14513

5. Verify that the governor arm and shaft are properly adjusted.

a. Loosen clamp screw nut (A).

b. Insert a punch (B) in hole of shaft (C) and rotate shaft counterclockwise while holding arm (D) up at WOT (Wide Open Throttle) position.

c. Verify that the governor shaft (C) protrudes above arm to specification.

d. Tighten clamp screw nut to specification.

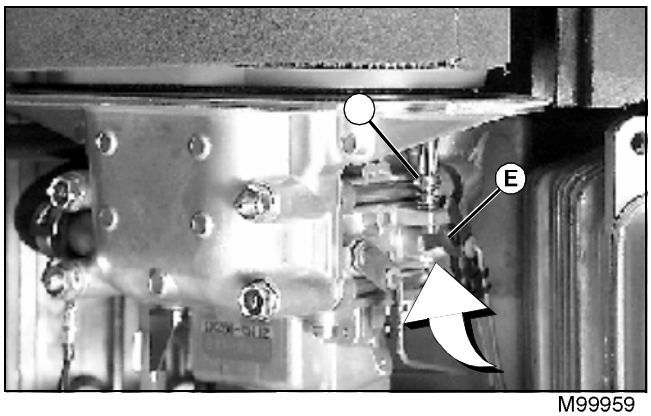
e. Verify that the throttle control arm and linkage move through the full range.

6. Start engine.

7. Move the throttle control to slow idle position.

8. Use JT07270 Digital Pulse Tachometer to check engine rpm.

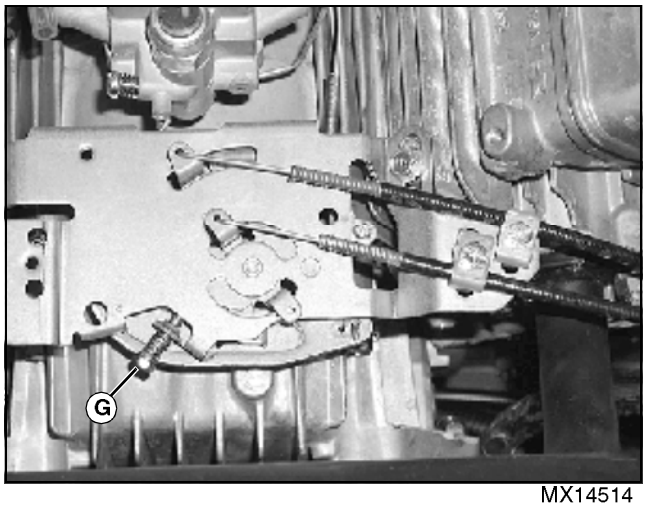
Ungoverned Slow Idle Speed Adjustment



M99959

9. Rotate and hold the throttle lever (E) clockwise while adjusting the carburetor idle speed screw (F) to obtain correct engine idle speed as specified.

Governed Slow Idle Speed Adjustment



MX14514

10.Release the throttle lever and adjust the governed slow idle speed screw (G) to obtain correct governed slow idle speed as specified.

Specifications:

Ungoverned Slow Idle Speed . . . . . .1450 rpm

Governed Slow Idle Speed . . . . . .1550 rpm

Governor Clamp Screw Nut Torque . . 8 N•m (69 lb-in.)

Governor Shaft Protrusion (Approx.) . 7 mm (0.275 in.)

Adjust Fast Idle Speed

IMPORTANT: Avoid damage! DO NOT attempt to adjust carburetors that meet California Air Resource Board/Environmental Protection Agency (CARB/EPA) restrictions unless you are a factory trained technician with authorization to service CARB/EPA Emissions Carburetors.

Reason:

To set engine fast idle rpm.

IMPORTANT: Avoid damage! 1000 and 2000 meter high altitude jet kits are available. These jets must be installed by an authorized repair facility.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Pulse Tachometer	JT07270	Used to check/adjust engine slow and fast idle rpm.

Procedure:

NOTE: Throttle cable must be properly adjusted and slow idle speed should be adjusted prior to adjusting fast idle speed.

1. Park machine safely.

2. Move motion control levers to neutral position.

3. Operate engine until it has reached normal operating temperature.

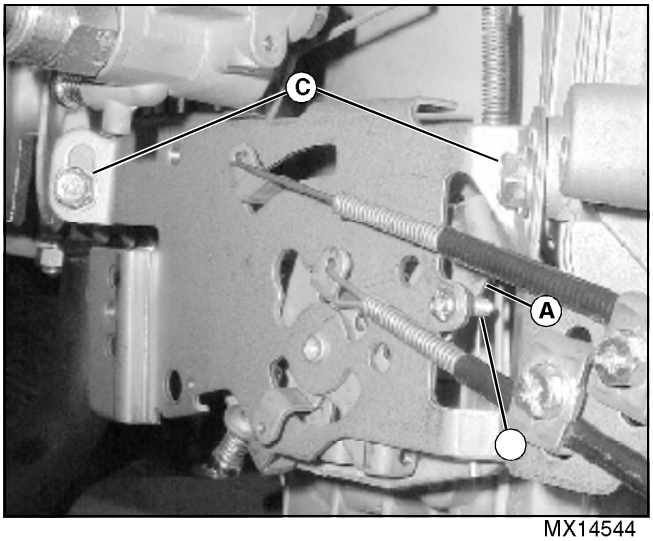
Stop engine.

CAUTION: Avoid injury! Engine and muffler will be hot.

4. Connect JT07270 Digital Pulse Tachometer.

NOTE: Do not adjust fast idle speed with air cleaner removed.

5. Move the throttle control to fast idle position.



MX14544

6. Be sure the inner throttle lever (A) remains tight against the stop screw (B).

7. Loosen two control plate mounting capscrews (C).

8. Move right side of control plate until fast idle speed specification is obtained.

9. Tighten control plate mounting capscrews (C) to specification.

10. Verify that the low speed idle is correct. Adjust as necessary.

11. Stop engine.

Specifications:

Fast Idle (FH601V) .....3600 rpm

Fast Idle (FH680V) .....3400 rpm

Control Plate Capscrew Torque ..... 6 N•m (52 lb-in.)

Test Fuel Shutoff Solenoid

Reason:

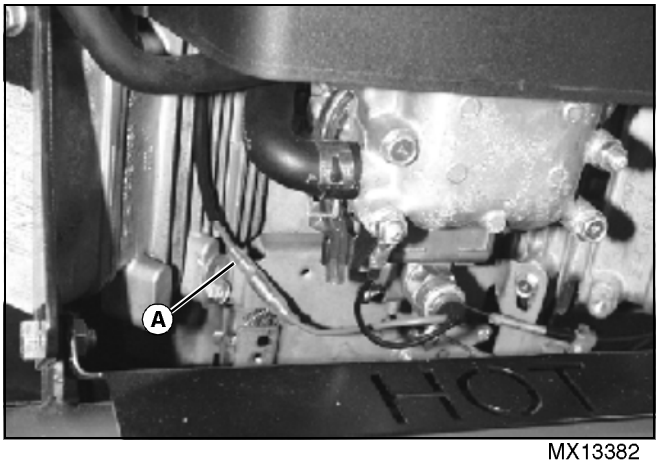
To test proper operation of fuel shutoff solenoid.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Jumper Wire	NA	Used to supply voltage to the fuel shutoff solenoid.

Procedure:

1. Listen for an audible click when key switch is turned from STOP to RUN.



MX13382

2. Disconnect wire (A) from solenoid.

3. Momentarily place a jumper wire from solenoid wire to battery positive terminal.

4. If solenoid now clicks, the solenoid is working properly.

NOTE: If battery voltage drops below 9 volts when cranking engine or while engine is running, the solenoid will not function.

Results:

- Solenoid is operating properly if a click is heard when key switch is moved from STOP to RUN position.
- If solenoid does not click, problem could be in equipment wiring. (See “Run Circuit Diagnostics” on page 128.)

Test Fuel Pump Flow Rate

Reason:

To determine if the fuel pump is performing properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Graduated Container	NA	Catch and measure fuel output of fuel pump.
178 mm (7 in.) Hose	NA	Connect to fuel pump, and pump fuel into container.

Procedure:

NOTE: Two persons will be required to perform this test.

1. Park machine on a level surface.

2. Move key switch to STOP position.

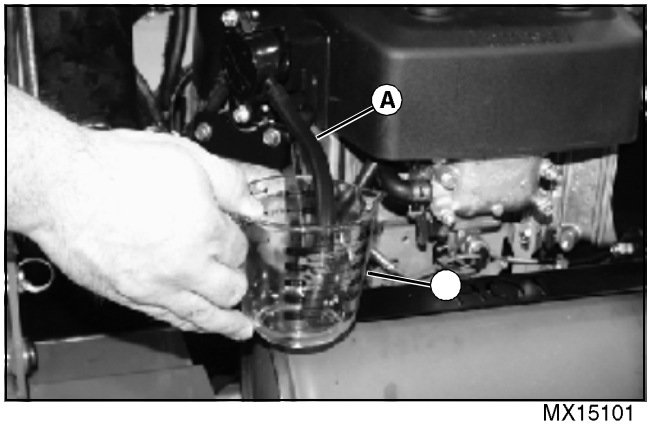
3. Move motion control levers to neutral position.

4. Lock park brake.

5. Disconnect both spark plug wires. Securely connect jumper wires between each spark plug lead and the engine block.

CAUTION: Avoid injury! Gasoline is present in the carburetor and fuel line. Gasoline is extremely flammable and its vapors can explode if ignited. Keep sparks and other sources of ignition away from the engine. BE SURE to connect spark plug leads to engine ground.

NOTE: Place a clean rag underneath line to catch fuel already in line.



MX15101

6. Remove fuel line from fuel pump outlet, and connect a 178 mm (7 in.) hose (A) to the fuel pump.

7. Place hose end in a graduated container (B).

IMPORTANT: Avoid damage! Do not crank more than 10 seconds continuously.

NOTE: Crank engine until fuel begins to flow. Empty container and begin test.

8. Crank engine for 10 seconds and catch fuel in container.

Results:

If fuel flow is below specifications, do the following:

- Check fuel lines, fuel filter, fuel tank pick-up and fuel tank cap for blockage, kinks or restrictions.
- Replace filter and/or fuel pump.

Specifications:

Minimum Fuel Flow in 10 Seconds . . . . . 40 mL (1.3 oz)

Test Cylinder Compression

Reason:

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

Special or Required Tools

Tool Name	Tool No.	Tool Use
Cylinder Compression Tester	JDM59	Used to test cylinder compression.

Procedure:

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

NOTE: Battery must be fully charged and in good condition. A weak battery could result in low cranking rpm and cause a low compression reading.

1. Run engine for five minutes to bring to operating temperature.

2. Park machine on a level surface.

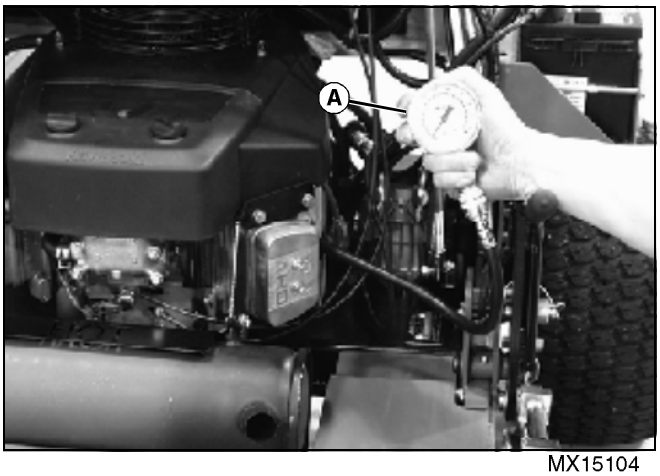
3. Move key switch to STOP position.

4. Move motion control levers to neutral position.

5. Lock park brake.

6. Remove spark plug from cylinder to be tested.

7. Connect high tension leads to ground.



MX15104

8. Install JDM59 Cylinder Compression Tester (A) in spark plug hole.

9. Move throttle control lever to fast idle position.

IMPORTANT: Avoid damage! Do not crank engine more than 15 seconds to prevent starter overheat and damage.

10.Crank engine until reading on gauge stops increasing. Compare compression pressure reading to specification.

Results:

NOTE: Specification listed is for an engine that has had sufficient time to allow rings to fully seat.

Compression that is lower than specifications on low-hour machines probably does not indicate a problem.

- If reading is at or slightly above specification, piston, piston rings, cylinder and valves are in good condition.
- If reading is considerably above specification, check the following:
  - Excessive carbon buildup in cylinder and cylinder head.
  - Incorrect cylinder head gasket.
  - Malfunctioning automatic compression relief (ACR).
- If below specifications, squirt clean engine oil into cylinder and repeat test (one spurt from oil can).
  - If compression pressure DOES NOT increase after retest, check for misadjusted valves, damaged intake or exhaust valves, valve seats or cylinder head gasket. Adjust or replace parts as necessary.
  - If compression pressure INCREASES after retest, check rings, piston and cylinder bore for broken rings, scoring, wear or damage. Replace parts as necessary.

Specifications:

Cylinder Compression Pressure. . . . . 390 kPa (57 psi)

Check and Adjust Valve Clearance

Reason:

To provide correct valve-to-rocker arm clearance for optimum engine performance.

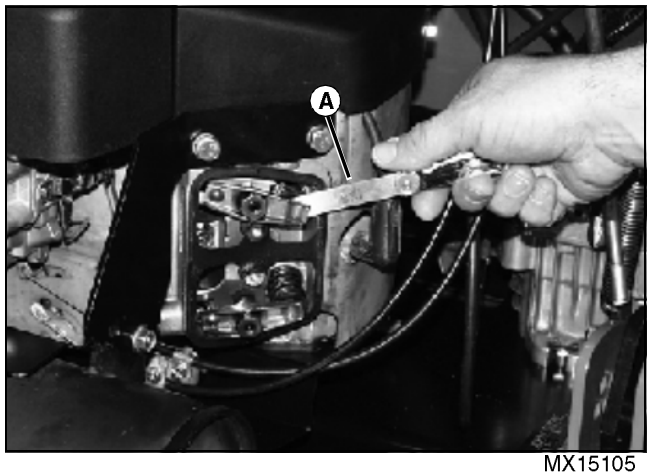
Special or Required Tools

Tool Name	Tool No.	Tool Use
Feeler Gauge (Blade Type)	N/A	Used to measure intake and exhaust valve clearance.

Check Procedure:

IMPORTANT: Avoid damage! Perform adjustment when engine is cold.

1. Park machine on a level surface.
2. Move key switch to STOP position. Allow engine to cool.
3. Move motion control levers to neutral position.
4. Lock park brake.
5. Remove both spark plugs to ease rotating the crankshaft.
6. Remove rocker arm covers. (See “Remove and Install Rocker Arm Cover” on page 70.)
7. Rotate crankshaft until cylinder to be checked is at top dead center (TDC) and both valves are closed.



MX15105

8. Measure clearance between valve stem and rocker arm using feeler gauge (A) as shown.

Results:

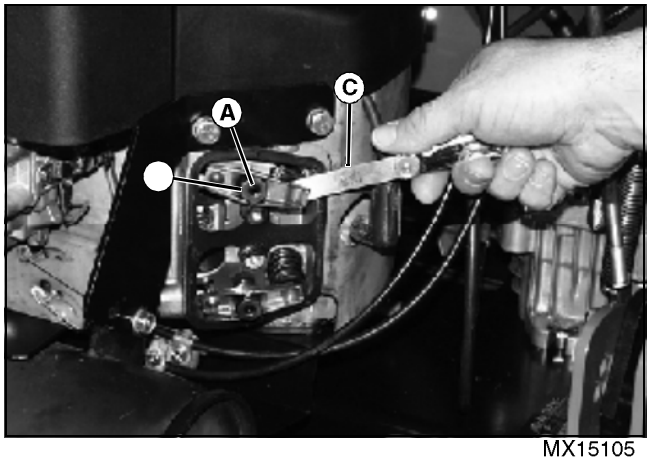
If valve clearance does not meet the specifications, proceed to adjustment procedure.

Specifications:

Intake Valve Clearance 0.075 - 0.125 mm (0.003 - 0.005 in.)

Exhaust Valve Clearance. . . . 0.075 - 0.125 mm (0.003 - 0.005 in.)

Adjustment Procedure:



MX15105

1. Loosen lock screw (A) and valve clearance adjusting nut (B).
2. Turn adjusting nut (B) until clearance is at specification (slight drag on feeler gauge [C]).
3. Hold the adjusting nut (B) and tighten the lock screw (A) to specification.
4. Repeat check procedure to verify adjustment.
5. Repeat steps 1 - 4 with remaining valves.
6. Install rocker arm covers. (See “Remove and Install Rocker Arm Cover” on page 70.)
7. Install spark plugs. Tighten to specification.

Specifications:

Valve Lock Screws . . . . . 7 N•m (61 lb-in.)

Spark Plug Torque . . . . . 22 N•m (16 lb-ft)

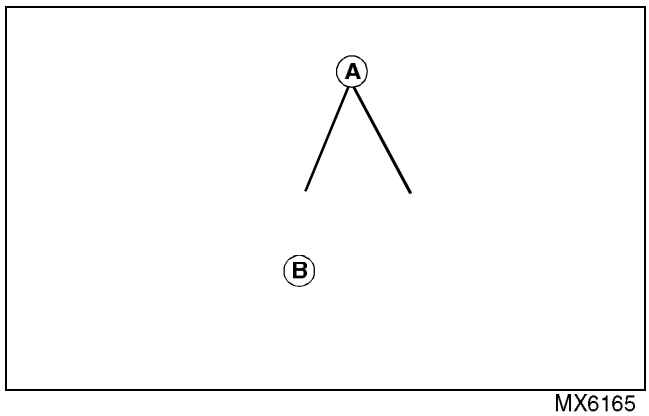
Check and Adjust Fan Screen Clearance

Reason:

To ensure the cooling fan screen does not rub on the blower housing.

Check Procedure:

1. Park machine on a level surface.
2. Move key switch to STOP position.
3. Move motion control levers to neutral position.
4. Lock park brake.
5. Disconnect negative battery cable at battery.



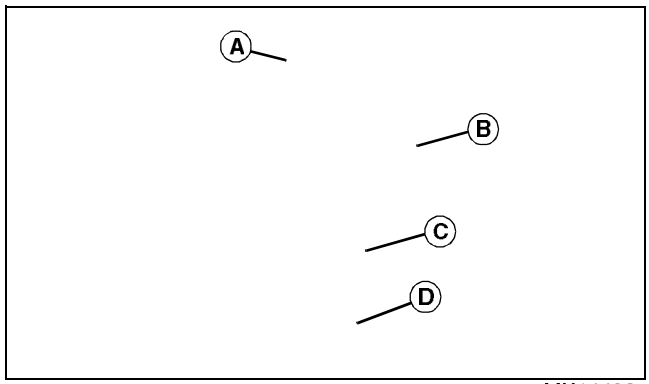
MX6165

6. Measure clearance between the tabs (A) on the screen and blower housing (B). If clearance is less than specifications, perform adjustment procedure.

Specifications:

Fan Screen-to-Blower Housing Clearance 1.0 - 3.0 mm (0.039 - 0.118 in.)

Adjustment Procedure:



MX14482

1. Remove three screws (A) retaining the fan screen (B).
2. Install additional shims (C) between fan screen (B) and bracket (D) to achieve proper clearance.
3. Install fan screen. Tighten screws to specification.
4. Repeat check procedure to verify clearance.

Specifications:

Fan Screen Screw Torque . . . . . 6 N•m (52 lb-in.)

Adjust Spark Plug Gap

Reason:

To ensure correct spark plug gap for maximum performance.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Feeler Gauge	NA	Used to measure spark plug gap.

Procedure:

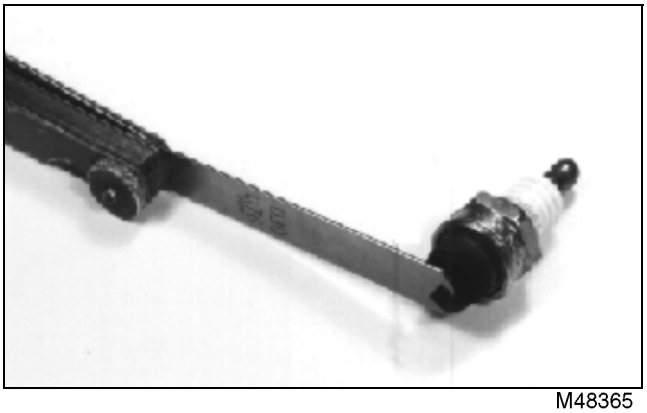
1. Park machine on a level surface.
2. Move key switch to STOP position. Allow engine to cool.
3. Move motion control levers to neutral position.
4. Lock park brake.

CAUTION: Avoid injury! Engine components are HOT. To prevent possible burns, allow the engine to cool before removing.

5. Remove spark plug.

IMPORTANT: Avoid damage! DO NOT clean spark plug with sandpaper or abrasives. Engine scoring can result.

6. Scrape or wire brush deposits from spark plug.
7. Inspect plug for:
   - Cracked porcelain
   - Pitted or damaged electrodes



M48365

8. Check spark plug gap using a feeler gauge. Set gap to specifications.
9. Inspect sealing washer. Replace spark plug if necessary.
10. Install plug and tighten to specifications.

Specifications:

Spark Plug Gap . . . . . 0.75 mm (0.030 in.)

Spark Plug Torque . . . . . 22 N•m (16 lb-ft)

Test Engine Oil Pressure

Reason:

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

Special or Required Tools

Tool Name	Tool No.	Tool Use
Adapter - 1/8 BSPT X 7/16-20 M 37°	JT03349	Connect to engine oil pressure switch port.
Hose with Quick Connect	JT03017	Connect between adapter and gauge.
Pressure Gauge - 0-414 kPa (0-60 psi)	JT03092	Used to measure engine oil pressure.

Procedure:

1. Park machine on a level surface.
2. Operate engine until it has reached normal operating temperature.
3. Move key switch to STOP position.
4. Move motion control handles to neutral position.
5. Lock park brake.
6. Raise and support thigh pad.

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

MX15107

7. Remove plug (A).

8. Apply Pipe Sealant with TEFLON® to pipe threads of adapter, and install JT03349 Adapter. Connect JT03017 Hose and JT03092 Pressure Gauge.

9. Start engine and run it at fast idle. Record gauge reading.

NOTE: The oil pressure might drop below specification at SLOW idle. If the pressure drops below 98 kPa (14.2 psi), excessive wear is likely and inspection of the internal engine components is needed.

10.Move throttle control to slow idle and stop engine.

11.Remove test equipment and install plug (A). Tighten plug to specification.

Results:

- If pressure is below specification, inspect the oil pump, relief valve and the condition of the crankshaft and rod bearings.
- If the pressure is above specification, the pressure relief valve is not operating correctly.

Specifications:

Slow Idle . . . . . .1550 rpm
Fast Idle (FH601V) . . . . . .3600 rpm
Fast Idle (FH680V) . . . . . .3400 rpm
Engine Oil Pressure . . . . . 241 - 310 kPa (35 - 45 psi)
Plug Torque. . . . . 4 N•m (35 lb-in.)

Test Crankcase Vacuum

Reason:

To measure the amount of crankcase vacuum. A pressurized crankcase will force oil leakage past the seals. A normal crankcase has negative pressure.

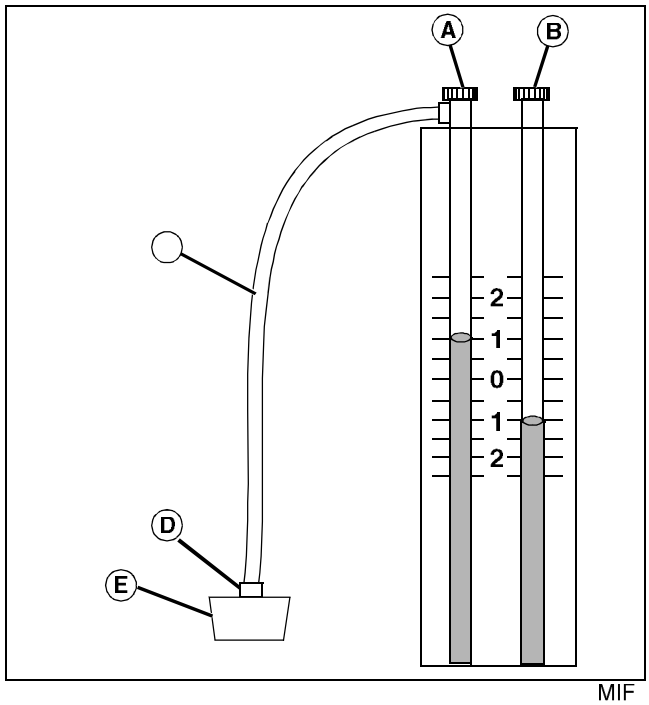
Special or Required Tools

Tool Name	Tool No.	Tool Use
U-Tube Manometer Kit	JT05697	Measure crankcase vacuum.

Procedure:

1. Park machine on a level surface.
2. Move key switch to STOP position.
3. Move motion control levers to neutral position.
4. Lock park brake.
5. Attach manometer magnets to a solid metal object.

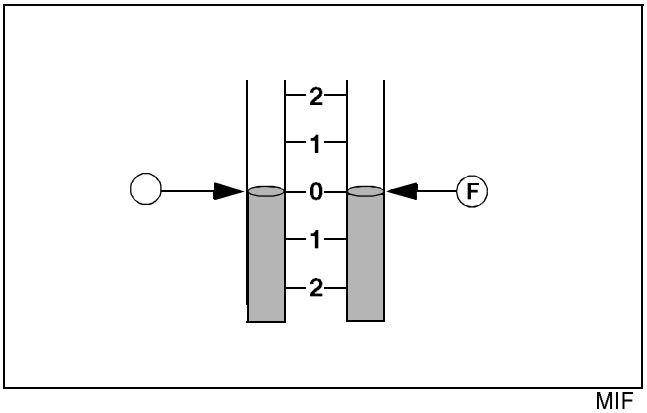
IMPORTANT: Avoid damage! Attaching manometer to engine before starting engine will cause all of the water in the manometer to be drawn into the engine crankcase. DO NOT use more than 914 mm (3 ft) of manometer tubing. If a longer hose is used, the manometer readings will be inaccurate. Some units require a rubber hose (adapter) using clamps to fit the dipstick opening.



MIF

A - Valve
B - Valve
C - Manometer Tube
D - Adapter
E - Plug with Hole

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



MIF

7. Set the manometer to zero by sliding the ruled scale up or down so “0” mark is located where water level (F) on both sides is even.

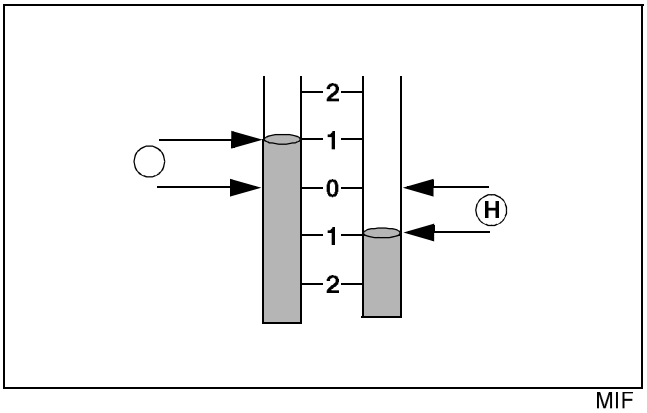
IMPORTANT: Avoid damage! Do not attach manometer tube (C) to manometer until engine is running.

8. Remove oil fill cap from engine and install appropriate plug (E), adapter (D) and tube (C) from JT05697 Manometer Kit into oil fill opening.

9. Start and run engine at fast idle.

10. Allow engine to reach operating temperature.

11. Attach manometer tube (C) to valve (A).



MIF

12. Record vacuum reading. The reading is obtained by adding water movement (G and H) from “0”. In this case, reading would be 2 inches of vacuum (1 inch + 1 inch). Reading from (G) should always be above the “0” mark. If reading from (G) (actual crankcase vacuum) is below the “0” mark, then crankcase is pressurized, causing seals to leak oil.

13. Repeat test at least three times for accuracy. DO NOT shut off engine. To repeat test, remove the manometer tube from top of manometer valve (A). DO NOT remove manometer tube from engine. Reset manometer at zero (see step 7). Reattach manometer tube (C) to valve (A) and record reading.

14. Remove tube (C) from manometer valve (A), before stopping engine. Then remove plug (E) from oil fill opening and install oil fill cap.

Results:

If crankcase vacuum reading is greater than specification, check the following:

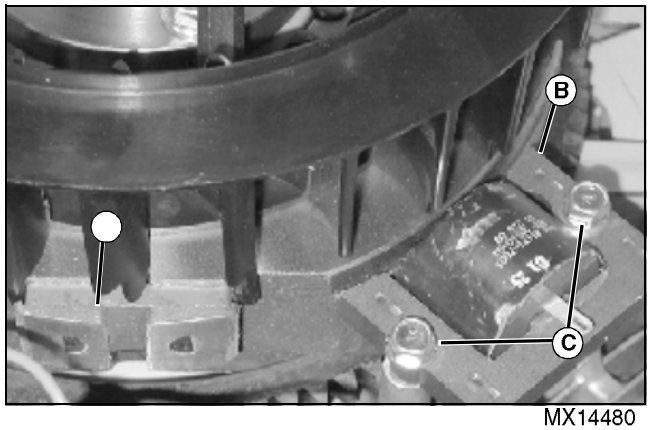
- Crankcase breather clogged or inoperative.
- Seals and gaskets for leakage, including rocker arm cover gasket (loose or improperly tightened fasteners).
- Valve and valve seats for wear or damage.
- Rings, piston and cylinder bore for wear or damage.

Specifications:

Crankcase Vacuum (Max, in Water Movement) . 10.2 cm (4 in.)

Adjust Ignition Coil Air Gap

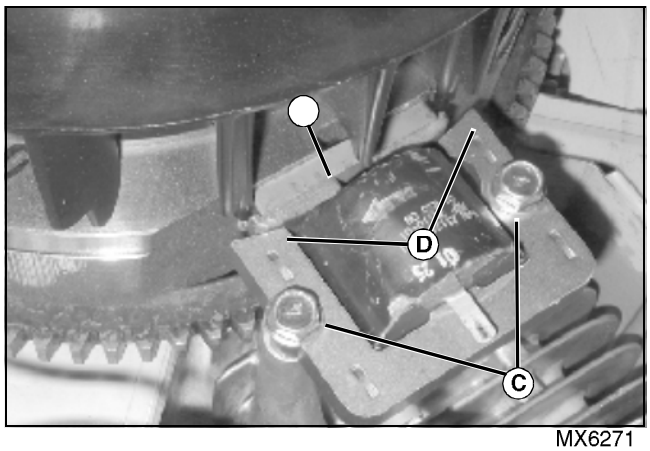
1. Remove blower housing. (See “Remove and Install Blower Housing Assembly” on page 66.)



MX14480

2. Turn flywheel to move magnetic pole plate (A) away from ignition coil (B).

3. Loosen ignition coil mounting capscrews (C). Move coil as far from flywheel as possible and hand tighten capscrews.



MX6271

4. Position and center the magnetic pole plate (A) under both legs (D) of the coil.

5. Insert a 0.3 mm (0.012 in.) feeler gauge between magnetic pole plate (A) and both ignition coil legs (D).

6. Loosen capscrews (C) and push ignition coil against feeler gauge.

7. Tighten capscrews to specification.

Specifications:

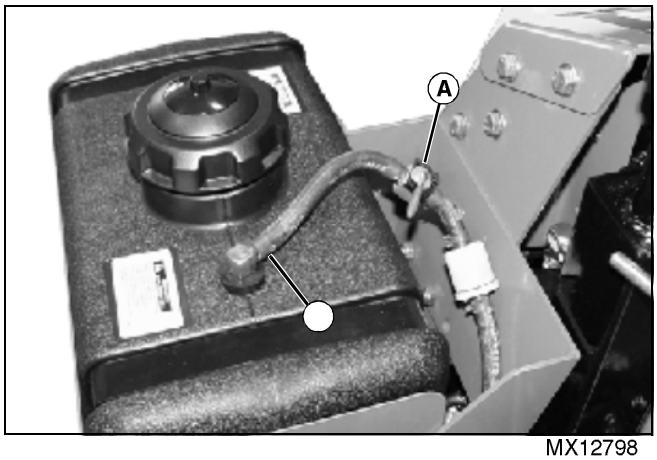
Ignition Coil Air Gap. . . . 0.2 - 0.4 mm (0.008 - 0.016 in.)

Ignition Coil Capscrew Torque . . . . . 6 N•m (52 lb-in.)

Repair

Remove and Install Fuel Tank

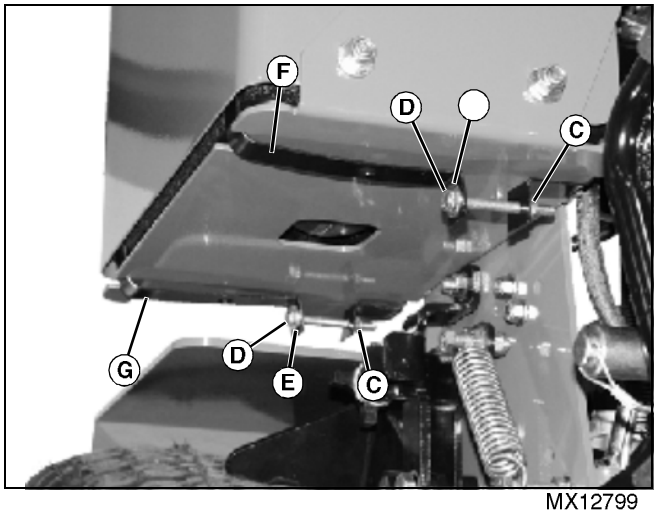
1. Park the machine safely.



MX12798

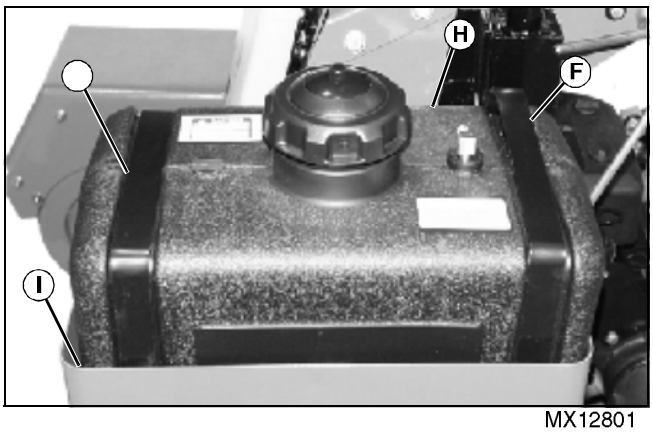
2. Move fuel shutoff valve (A) to the closed position.

3. Disconnect and plug the fuel line (B) at the fuel tank fitting.

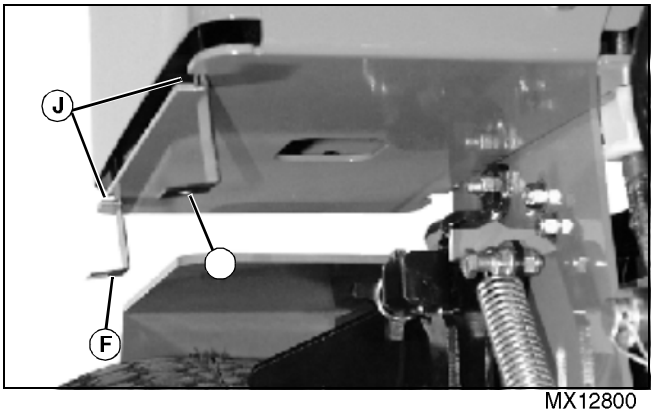


MX12799

4. Remove locknut (C), capscrew (D) and flat washer (E) from both tank straps (F and G).



MX12801



MX12800

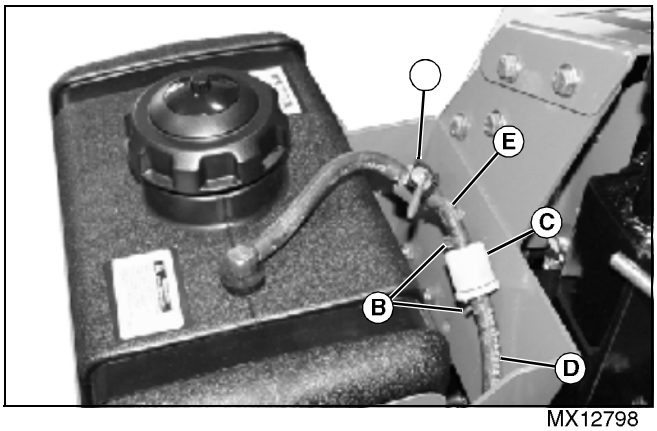
5. Lift tank (H) and straps (F and G) from bracket (I) while guiding the straps through the notches (J) at the bottom of the mounting bracket.

6. Fill tank and check for leaks. Replace the tank as needed.

Installation is done in the reverse order of removal.

Remove and Install Fuel Filter

1. Park the machine safely.



MX12798

2. Move fuel shutoff valve (A) to the closed position.

3. Compress spring clamps (B) and slide them away from the filter (C).

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

4. Disconnect lower fuel line (D) from fuel filter, and drain the fuel into a properly marked container.
5. Disconnect fuel filter from upper fuel line (E).

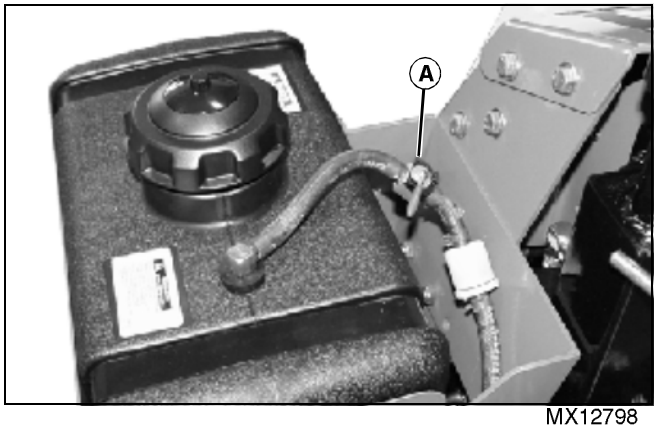
Installation is done in the reverse order of removal.

IMPORTANT: Avoid damage! When installing a new new fuel filter, the filter arrow must be pointing in the direction of the fuel flow.

- Install fuel filter with the arrow pointing in the direction of the fuel flow.

Remove and Install Fuel Pump

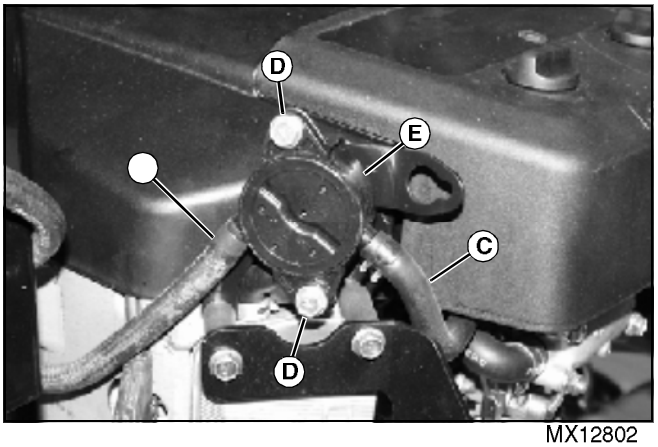
1. Park the machine safely.



MX12798

2. Move fuel shutoff valve (A) to the closed position.

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



MX12802

3. Disconnect fuel supply line (B) at fuel pump, and drain the fuel into a properly marked container.
4. Disconnect fuel line (C) at fuel pump.
5. Remove two capscrews (D).
6. Remove fuel pump (E).

Installation is done in the reverse order of removal.

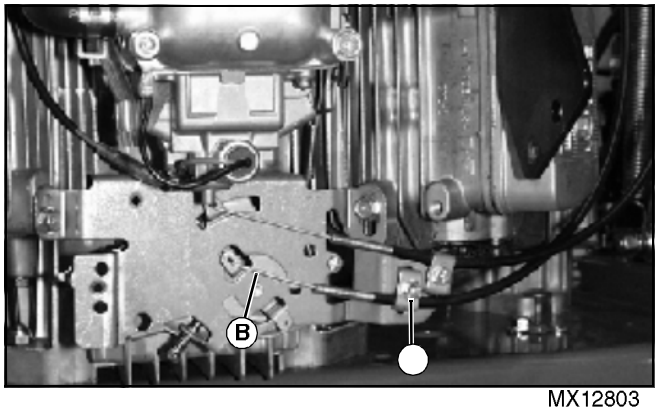
- Tighten capscrews (D) to specifications.

Specifications:

Fuel Pump Capscrew Torque . . . . . 6 N•m (52 lb-in.)

Remove and Install Throttle Cable

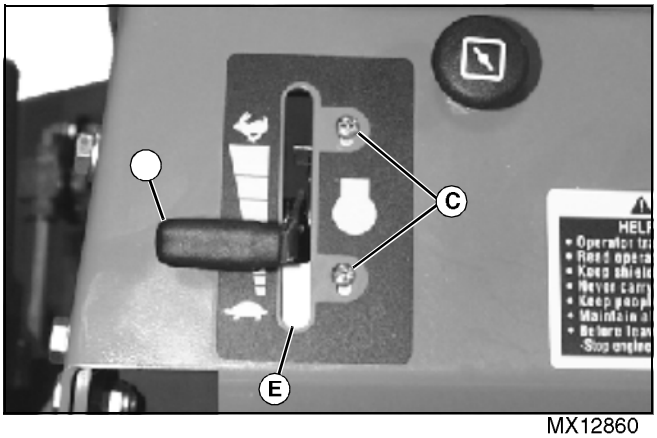
1. Park the machine safely.
2. Move throttle lever to the slow idle position.



MX12803

Picture Note: Muffler removed for photo clarity.

3. Loosen cable clamp screw (A) and disconnect throttle cable (B).



MX12860

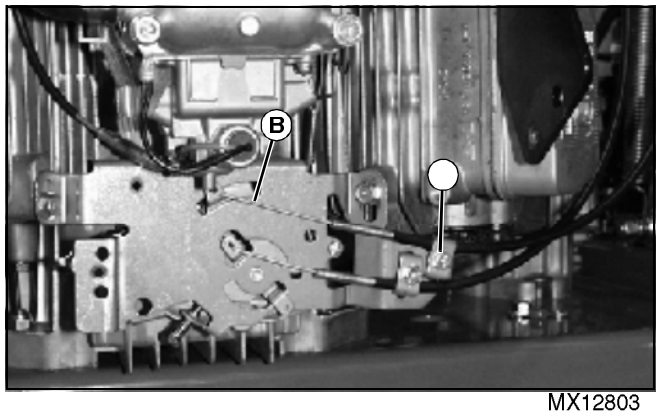
4. Remove two locknuts and screws (C).
5. Remove throttle lever/cable (D) and limiter plate (E).

Installation is done in the reverse order of removal.

- Adjust throttle cable. (See “Adjust Throttle and Choke Cable” on page 45.)

Remove and Install Choke Cable

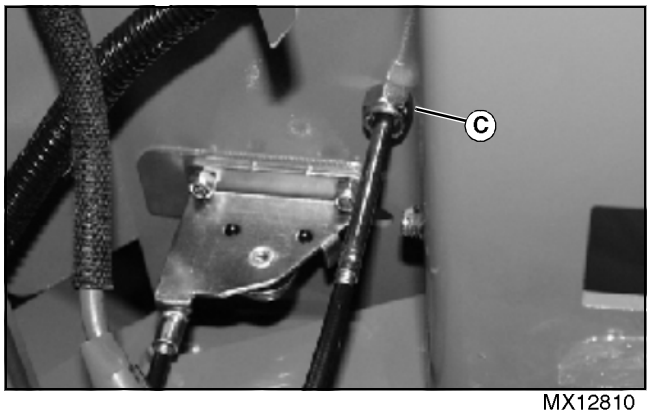
1. Park the machine safely.



MX12803

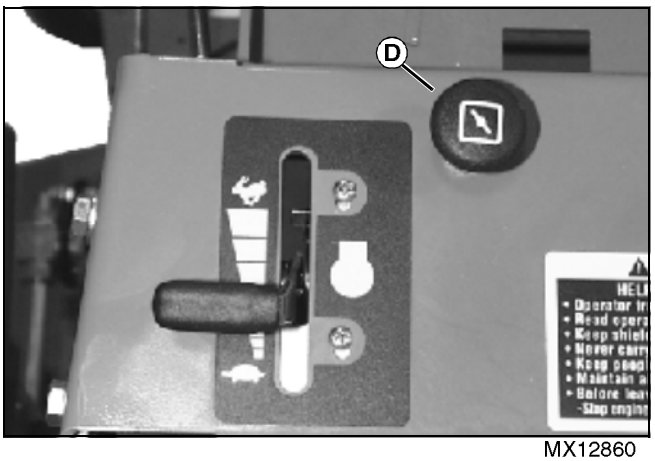
Picture Note: Muffler removed for photo clarity.

2. Loosen cable clamp screw (A) and disconnect choke cable (B).



MX12810

3. Remove nut (C) from the shank of the choke cable sheath.



MX12860

4. Remove choke cable (D) by pulling it through the console from the top.

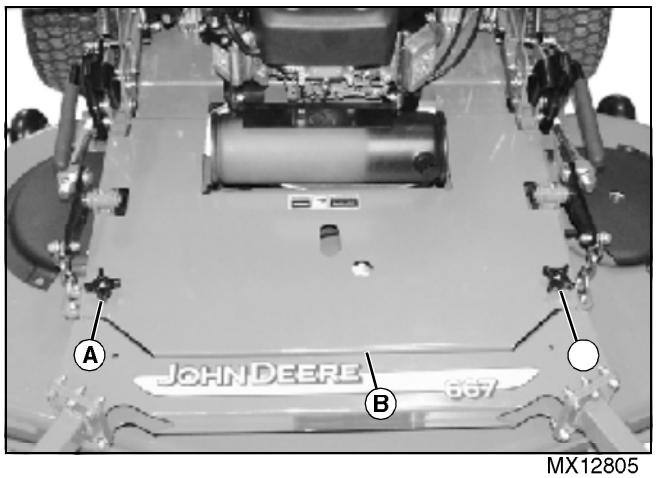
Installation is done in the reverse order of removal.

- Adjust choke cable. (See “Adjust Throttle and Choke Cable” on page 45.)

Remove and Install Muffler

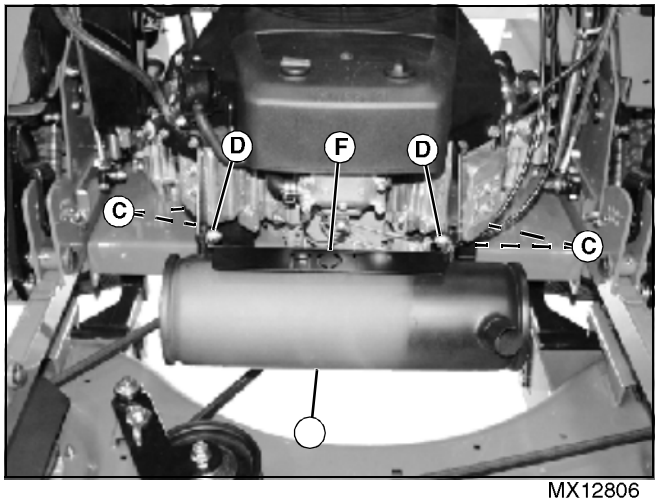
CAUTION: Avoid injury! Engine Components are HOT. To prevent possible burns, allow the muffler to cool before removing.

1. Park the machine safely.
2. Disconnect the negative battery cable at the battery.



MX12805

3. Remove two knobs (A).
4. Remove mower deck shield (B).



MX12806

5. Remove two hex nuts and lockwashers (C) from each muffler mounting flange.
6. Remove two nuts, lockwashers and capscrews (D).
7. Remove muffler (E), shield (F) and gaskets.
8. Remove gasket residue from the exhaust port and muffler mating surfaces.

Installation is done in the reverse order of removal.

- Install new gaskets when installing the muffler.
- Tighten muffler mounting flange nuts (C) to specifications.

Specifications:

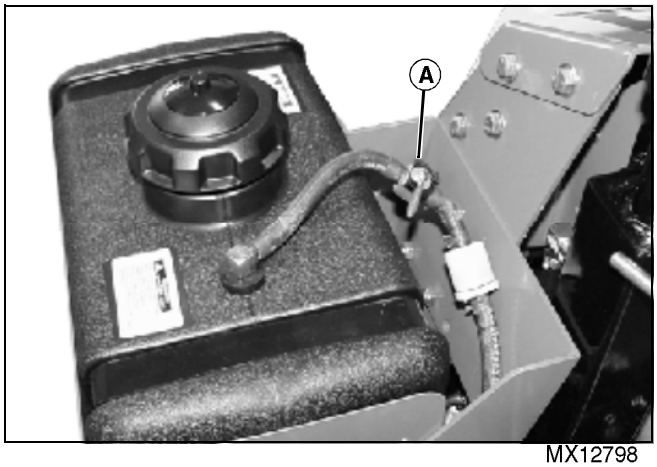
Muffler Mounting Flange Nut Torque . . 15 N•m (132 lb-in.)

Remove and Install Engine

1. Park the machine safely.

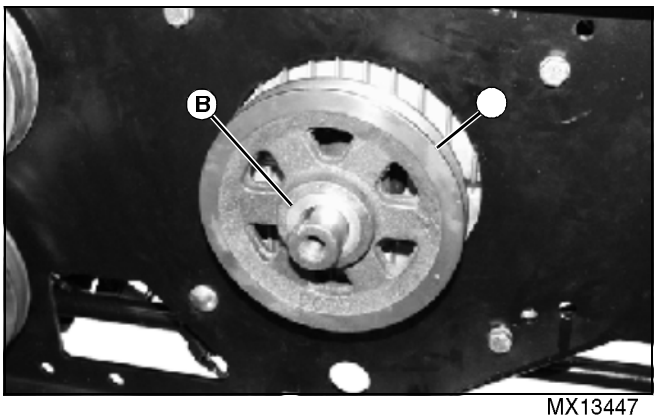
CAUTION: Avoid injury! Engine components are HOT. To prevent possible burns, allow the muffler to cool before removing.

2. Allow engine to cool before removing the engine.
3. Disconnect the negative battery cable at the battery.
4. Remove muffler. (See “Remove and Install Muffler” on page 57.)
5. Remove PTO clutch. (See “Remove and Install PTO Clutch” on page 162.)



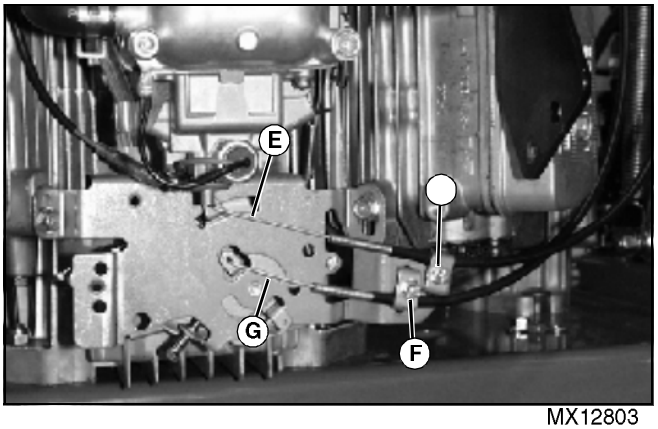
MX12798

6. Move fuel shutoff valve (A) to the closed position.
7. Drain engine oil.



MX13447

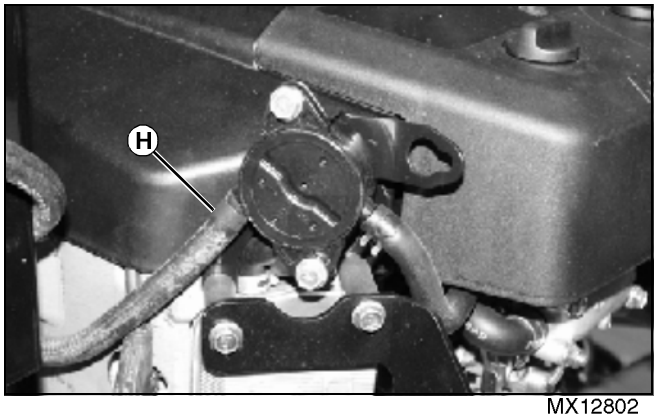
8. Remove washer (B), traction drive belt pulley (C) and key.



MX12803

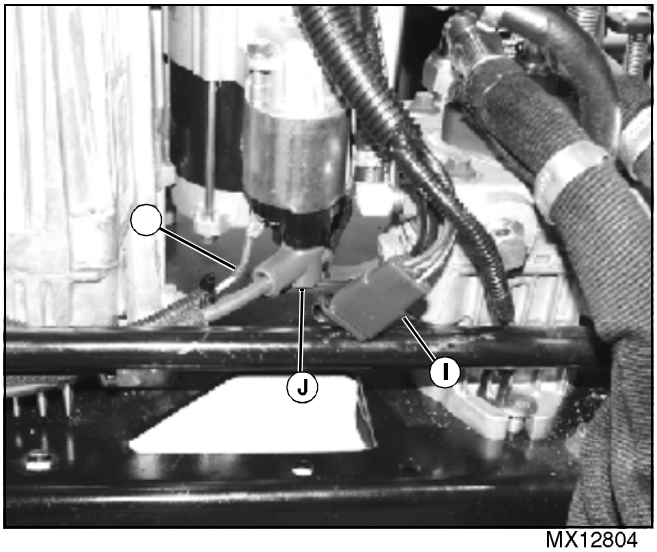
9. Loosen cable clamp screw (D) and disconnect choke cable (E).
10. Loosen cable clamp screw (F) and disconnect throttle cable (G).

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



MX12802

11. Disconnect fuel supply line (H) at fuel pump, and drain the fuel into a properly marked container.

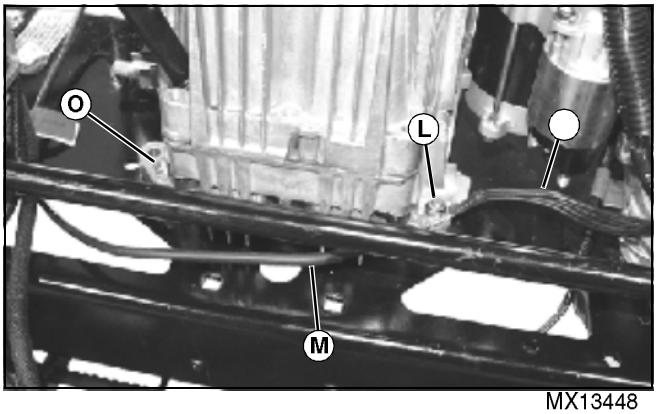


MX12804

12.Disconnect engine wiring connector (I).

13.Disconnect the positive battery cable (J) from the starter motor solenoid.

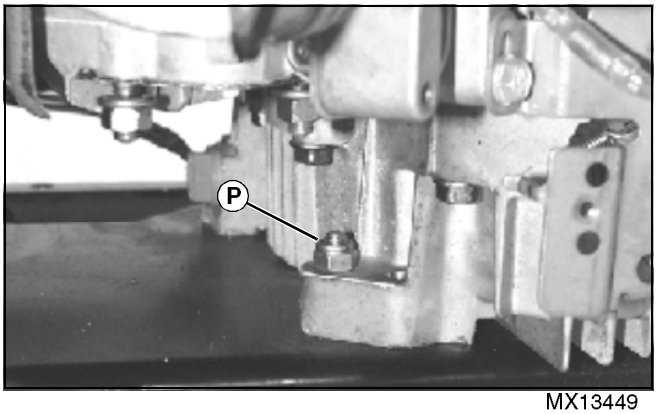
14.Disconnect gray wire (No. 600 [W1]) (K) from the starter motor solenoid.



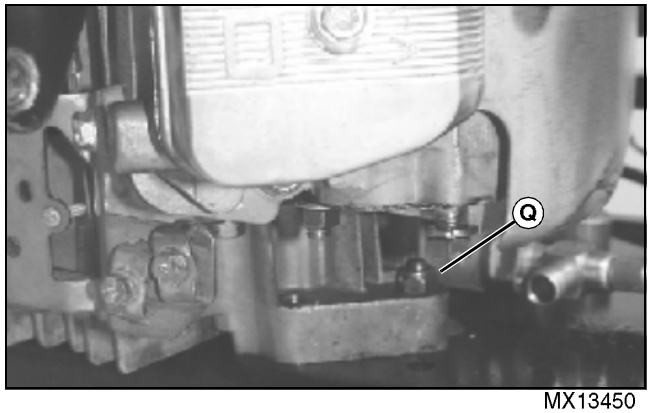
MX13448

15.Remove the locknut and carriage bolt (L), and disconnect the negative battery cable (M) and harness ground wires (N).

16.Remove locknut and capscrew (O).

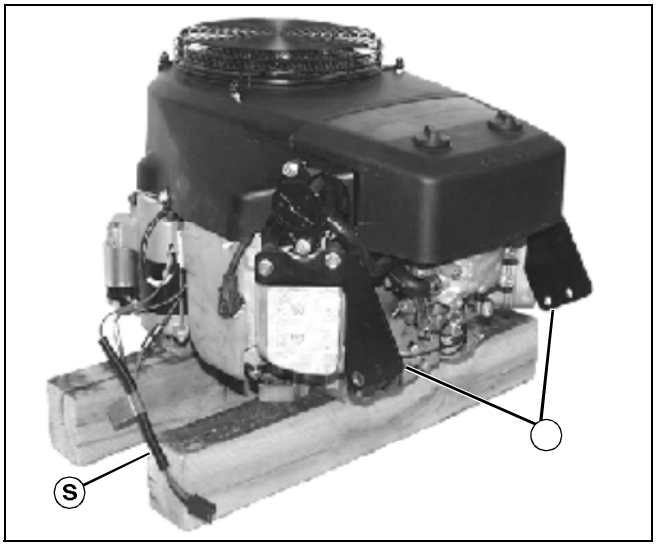


MX13449



MX13450

17.Remove the front capscrews (P and Q).



MX13451

18.If the engine is to be serviced or replaced, remove the muffler brackets (R) and engine extension harness (S).

Installation is done in the reverse order of removal.

- Tighten engine mounting capscrews and nuts (L, O, P and Q) to specifications.
- Tighten muffler mounting flange nuts to specifications.
- Apply grease to the engine output shaft before installing the traction drive pulley and PTO clutch. (See “Grease” on page 22.)
- Apply medium-strength threadlocker to PTO clutch capscrew.
- Tighten PTO clutch capscrew to specifications.

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

- Fill engine with clean engine oil and install a new oil filter. (See “Engine Oil” on page 22.)

- Adjust throttle and choke cables. (See “Adjust Throttle and Choke Cable” on page 45.)

Specifications:

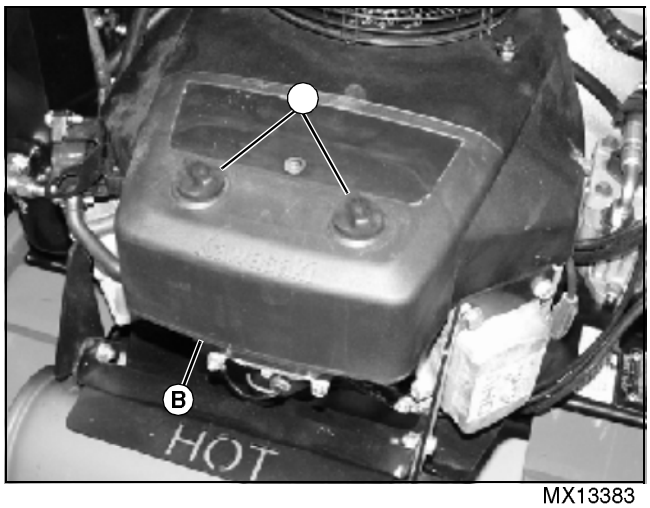
Engine Mounting Capscrew Torque . . 40 N•m (30 lb-ft)
Muffler Mounting Flange Nut Torque 15 N•m (132 lb-in.)
Oil Drain Fitting Torque . . . . . 39 N•m (29 lb-ft)
Oil Filter Torque . . . . . 3/4 Turn Past Contact
Crankcase Capacity (with Filter). . . . . 1.7 L (1.8 qt)
PTO Clutch Capscrew Torque . . . . . 68 N•m (50 lb-ft)

Remove and Install Air Cleaner

IMPORTANT: Avoid damage! Carefully remove air cleaner cover and elements. Inspect inside paper element and intake passage for signs of dust. If present, replace elements and test engine compression. Correct source of leakage.

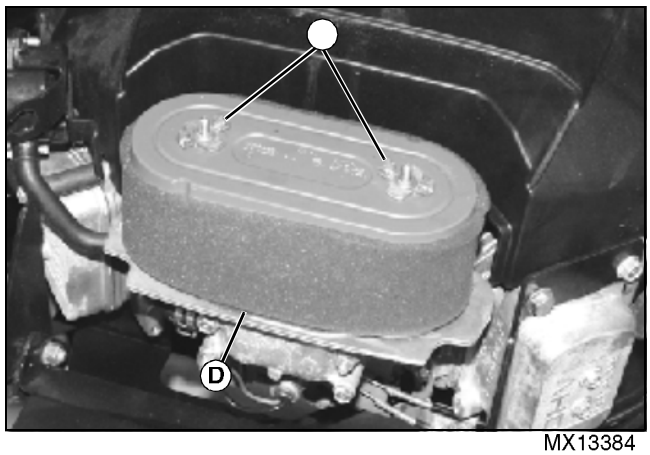
NOTE: Replace elements annually or every 25 hours of use.

1. Park the machine safely.



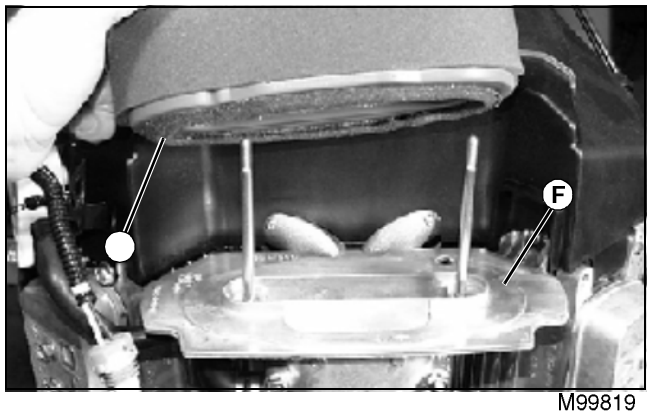
MX13383

2. Remove two special nuts (A).
3. Remove air cleaner cover (B).



MX13384

4. Remove two wingnuts (C).
5. Remove air filter assembly (D).



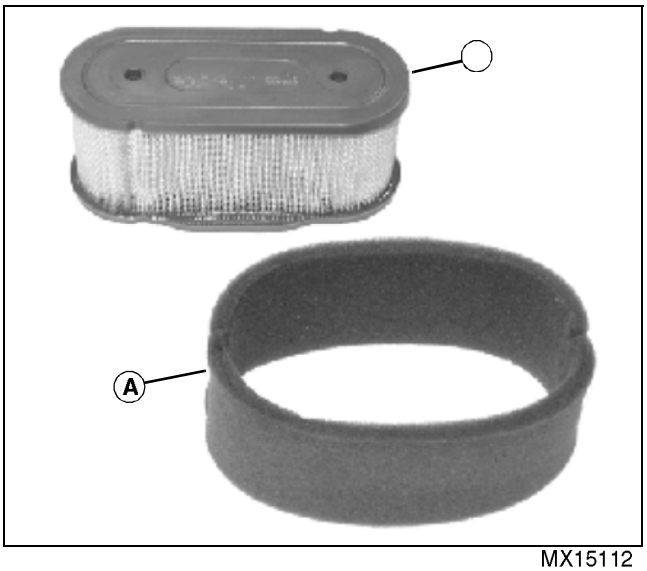
M99819

6. Inspect air cleaner cover, foam gasket (E) and air cleaner base (F) for damage. Replace parts as necessary.
7. Clean or replace filter elements. (See “Service Air Cleaner” on page 61.)

Installation is done in the reverse order of removal.

Service Air Cleaner

1. Remove air cleaner. (See “Remove and Install Air Cleaner” on page 60.)



MX15112

2. Remove foam precleaner (A) from paper element (B).

IMPORTANT: Avoid damage! DO NOT oil precleaner.

3. Wash foam precleaner (A) in warm water with liquid detergent. Rinse thoroughly and squeeze out excess water; do not wring. Allow to dry thoroughly.

IMPORTANT: Avoid damage! DO NOT clean paper element with solvent or compressed air.

4. Gently tap paper element (B) to remove dust.

5. Inspect paper element:

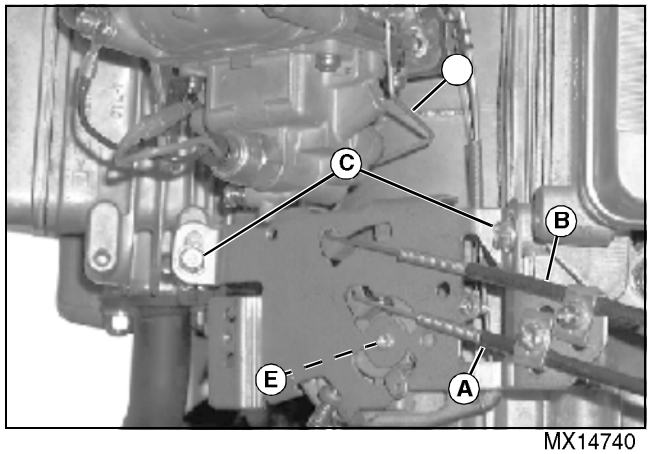
- Element is still usable if you can see light through it and element appears clean.
- Replace element if oily, dirty or damaged in any way.

6. Inspect cover and housing for damage. Replace parts as necessary.

7. Assemble and install air cleaner assembly. (See “Remove and Install Air Cleaner” on page 60.)

Remove and Install Throttle Plate Assembly

NOTE: Note location of springs for later installation.



MX14740

1. Disconnect throttle cable (A) and choke cable (B) from plate.

2. Remove throttle plate capscrews (C).

3. Disconnect choke linkage (D) and governor spring (E) as the plate is being removed.

Installation is done in the reverse order of removal.

- Tighten capscrews to specifications.
- Adjust throttle and choke cables. (See “Adjust Throttle and Choke Cable” on page 45.)
- Adjust engine slow idle speed. (See “Adjust Slow Idle Speed” on page 45.)
- Adjust engine fast idle speed. (See “Adjust Fast Idle Speed” on page 46.)

Specifications:

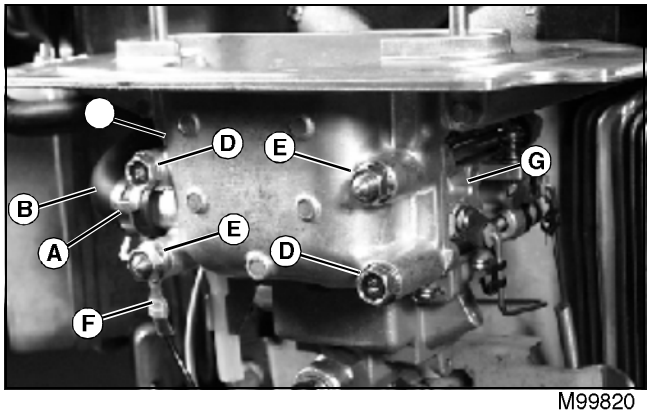
Throttle Plate Capscrew Torque . . . . . 6 N•m (52 lb-in.)

Remove and Install Carburetor

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. Remove air cleaner. (See “Remove and Install Air Cleaner” on page 60.)

2. Move fuel shutoff valve to closed position.

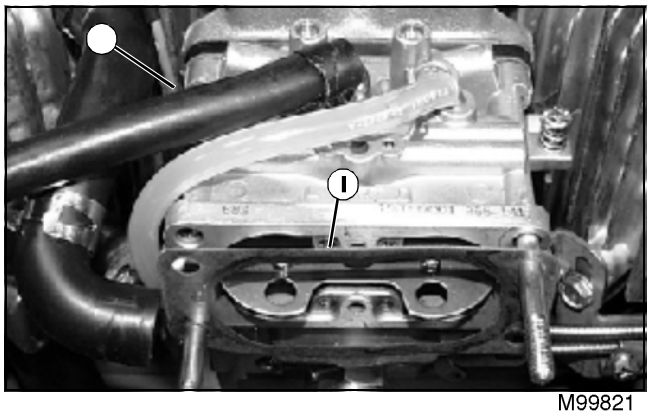


M99820

3. Loosen clamp (A) and disconnect breather hose (B) from the air cleaner base (C).

4. Remove two capscrews (D) and two nuts (E) and fuel shutoff solenoid ground wire (F) holding the carburetor (G) and air cleaner base (C) to the intake manifold.

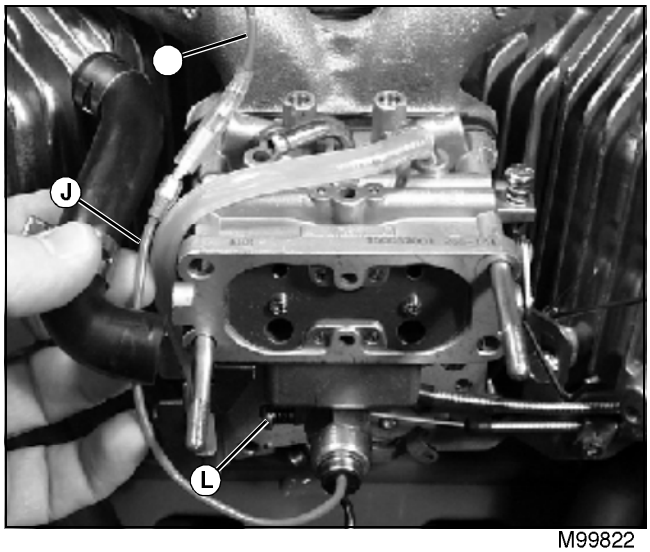
5. Carefully pull air cleaner base (C) away from carburetor (G).



M99821

6. Disconnect fuel inlet hose (H) from carburetor.

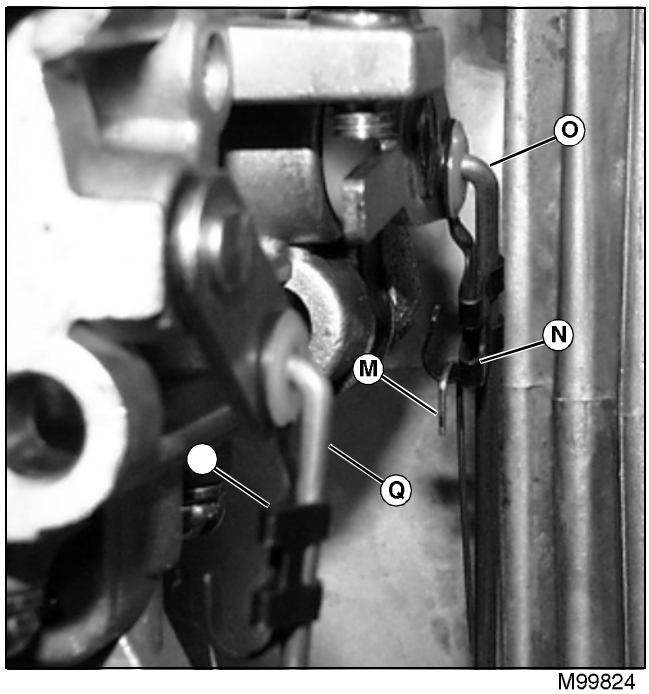
7. Remove gasket (I).



M99822

8. Disconnect the fuel shutoff solenoid wire (J) from the engine wiring harness wire (K).

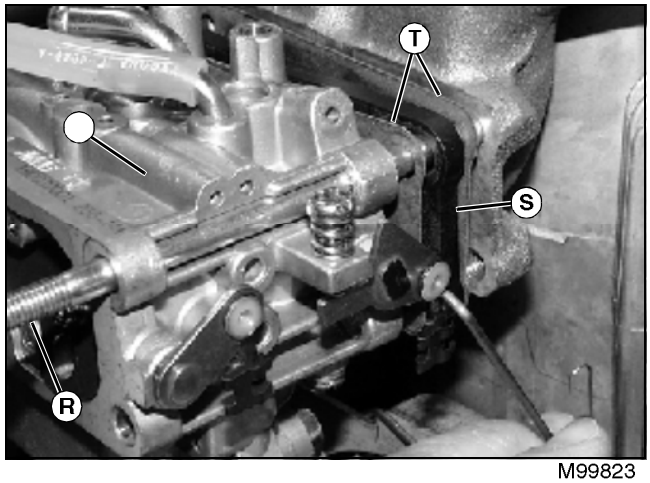
9. Place a suitable container under the carburetor drain port (hidden from view). Loosen the drain screw (L) and drain the fuel from the float bowl.



M99824

10.Remove the throttle spring (M) from the retaining clip (N). Unsnap the retaining clip (N) from around the throttle rod (O) and pull the throttle rod out of the carburetor.

11.Unsnap the retaining clip (P) from around the choke rod (Q) and pull the choke rod out of the carburetor.



M99823

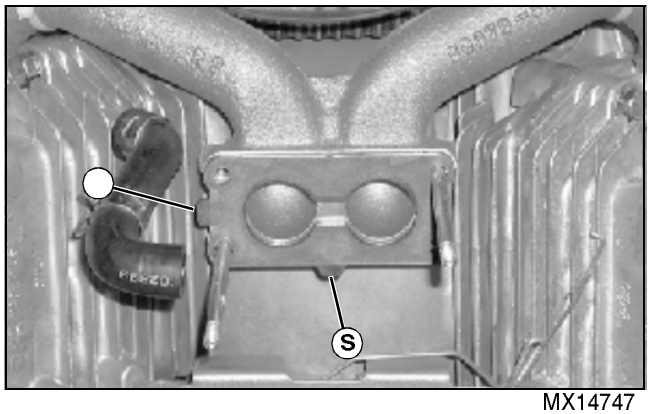
12.Slide the carburetor (G) forward and off the intake mounting studs (R).

13.Remove isolator (S) and gaskets (T).

14.Remove gasket material from intake manifold, isolator and carburetor mating surfaces.

Installation is done in the reverse order of removal.

- Use new gaskets for installation.
- Check insulator (S) for cracks or damage. Replace if needed.



MX14747

- Install insulator with tab (S) facing down and tab (T) facing toward number one cylinder.
- Tighten the carburetor mounting capscrews (D) and nuts (E) to specifications. Be sure fuel shutoff solenoid ground wire (F) is installed under nut.
- Adjust engine slow idle speed. (See “Adjust Slow Idle Speed” on page 45.)
- Adjust engine fast idle speed. (See “Adjust Fast Idle Speed” on page 46.)

Specifications:

Carburetor Mounting Capscrew and Nut Torque. 6 N•m (52 lb-in.)

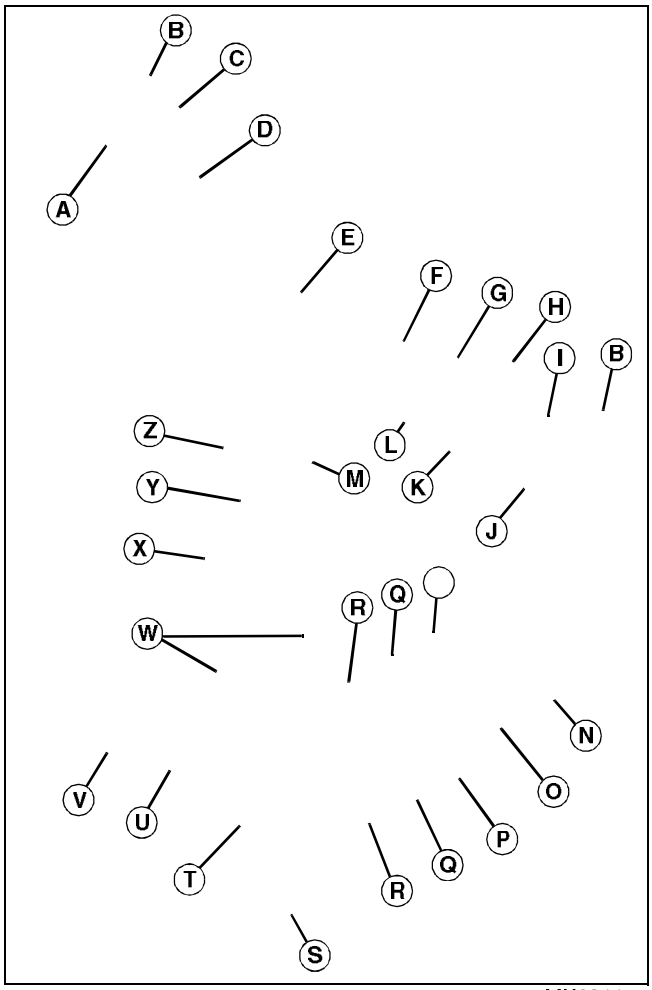
Disassemble and Assemble Carburetor

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.

IMPORTANT: Avoid damage! DO NOT attempt to repair, replace jets, or adjust the carburetor unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions Carburetors.

Other Material

Part No.	Part Name	Part Use
TY9370 (US) 242 (Loctite®) TY9477 (Canada)	Thread Lock and Sealer (Medium Strength)	Applied to threads of throttle and choke plate screws before installation.



MX6311a

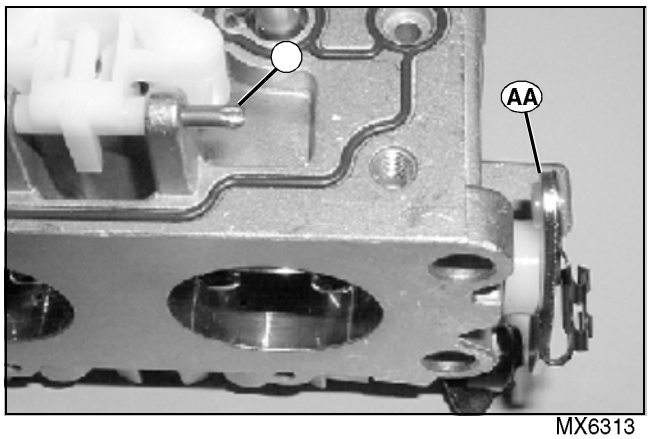
A - Choke Shaft
B - Screw (4 used)
C - Choke Plate
D - Seal
E - Carburetor Body
F - Spring
G - Pilot Screw (2 used)
H - Pilot Screw Limiter
I - Throttle Plate (2 used)
J - Throttle Shaft
K - Collar

L - Seal
M - Float Valve
N - Fuel Shutoff Solenoid
O - O-Ring
P - Plug (2 used)
Q - Gasket (2 used)
R - Main Jet (2 used)
S - Screw (4 used)
T - Float Bowl
U - Spring
V - Drain Valve
W - Pilot Jet (2 used)
X - Float Chamber Seal
Y - Float
Z - Float Pivot Pin

NOTE: There are several ball type passage plugs. DO NOT attempt to remove them.

1. Remove float bowl (T).

IMPORTANT: Avoid damage! The float pivot pin (Z) is knurled on the end nearest the throttle shaft lever (AA). Be sure to drive the pin out from the opposite end.



MX6313

2. Remove float pivot pin (Z), float valve (M) and float (Y).
3. Remove fuel shutoff solenoid (N).
4. Remove main jets (R) and pilot jets (W).

IMPORTANT: Avoid damage! Remove the pilot screws only if required for cleaning.

The pilot screw limiters will be destroyed when removed and must be replaced with new ones.

5. Remove pilot screws (G) as follows:
   a. Carefully mark location of pilot screw limiter tab (H) on carburetor body (E).
   b. Remove pilot screw limiter (H) without turning pilot screw (G).
   c. Turn the pilot screw (G) clockwise and count the number of turns required to lightly seat the pilot screw.
   d. Remove pilot screw (G) from carburetor.

IMPORTANT: Avoid damage! If the carburetor is to be soaked in cleaning solvent, the seals on the throttle and choke shafts will be damaged. Remove the shafts to install new seals.

6. Remove the throttle shaft (J) or choke (A) shaft as follows:
   a. Mark the outside of the throttle plates (I) or choke plate (C).
   b. Remove screws (B) and plate(s) (C or I).
   c. Remove shaft (A or J) from carburetor body (E).
7. Inspect components for damage and replace as required. (See “Clean and Inspect Carburetor” on page 65.)

IMPORTANT: Avoid damage! DO NOT clean holes or passages with small drill bits or wire.

NEVER use a rag or paper towel to dry carburetor parts. Lint can plug holes and passages.

NOTE: Always follow manufacturer’s instructions on carburetor cleaner container.

8. Clean carburetor using cleaning solvent, and dry using compressed air. (See “Clean and Inspect Carburetor” on page 65.)

Assembly is done in the reverse order of removal.

- Always use new gaskets and seals for assembly.
- Be sure float valve is installed in notch in float. Install the float pin from the side nearest the throttle shaft lever.
- Check float level. (See “Check Carburetor Float Level” on page 65.)
- Install main jets and pilot jets in correct location per specifications.
- Install pilot screws to original setting, and install limiter caps aligned with the marks made during disassembly.
- Apply a small amount of LOCTITE® 242 to threads of throttle and choke plate screws. Tighten screws with plates closed and in full contact with throttle bore.
- Adjust engine slow idle speed. (See “Adjust Slow Idle Speed” on page 45.)
- Adjust engine fast idle speed. (See “Adjust Fast Idle Speed” on page 46.)

Specifications:

Float Height. . . . . Parallel with Carburetor Body

Main Jet Size:
Left. 136
Right 140

Pilot Jet Size
Left. 46
Right 44

Carburetor Slow Idle Mixture Screw Initial Setting:
Left. . . . . 2-1/4 Turns Out from Lightly Seated
Right . . . . . 1-1/4 Turns Out from Lightly Seated

Fuel Shutoff Solenoid Valve Torque . . 19 N•m (14 lb-ft)

Float Chamber Mounting Screw Torque. . . . . 4 N•m (35 lb-in.)

Carburetor Mounting Fastener Torque 6 N•m (52 lb-in.)

Clean and Inspect Carburetor

IMPORTANT: Avoid damage! DO NOT clean holes or passages with small drill bits or wire.

NEVER use a rag or paper towel to dry carburetor parts. Lint can plug holes and passages.

NOTE: Always follow manufacturer's instructions on carburetor cleaner container.

1. Remove rubber and plastic parts from carburetor. Soak all carburetor metal parts in a carburetor cleaning solution per manufacturer's instructions.

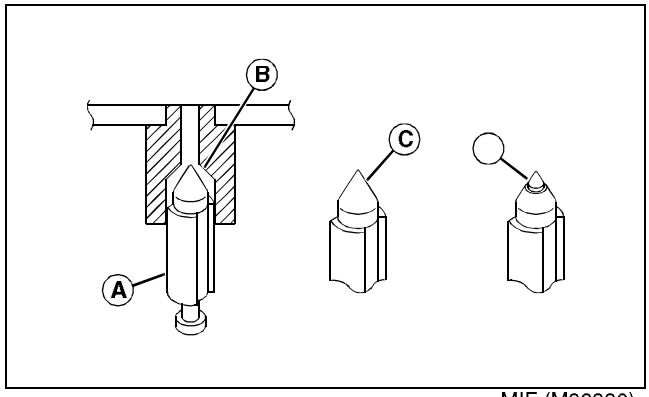
CAUTION: Avoid injury! Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment, including eye protection.

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

2. Rinse carburetor parts in warm water and dry with compressed air. DO NOT use rag or paper to dry parts; lint can plug holes and passages in carburetor.

3. Inspect all parts for wear or damage:

- Verify that the throttle and choke shafts rotate smoothly. Verify that there is not excessive wear between shaft and carburetor body.
- Inspect the carburetor body for wear or damage. Verify that all sealing surfaces and flanges are smooth and free of nicks and burrs. Replace as necessary.



MIF (M83880)

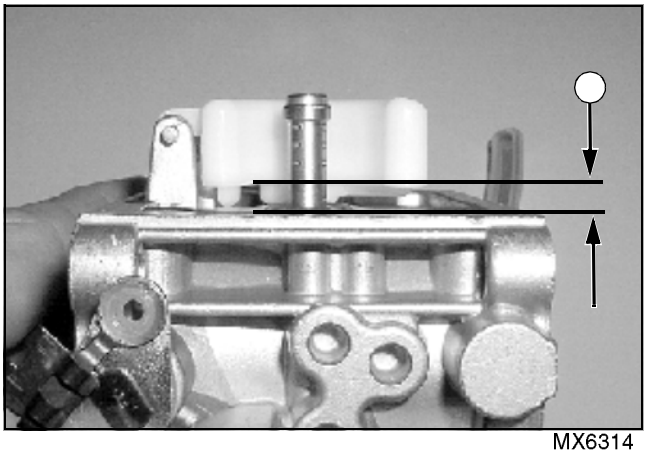
A - Float Valve
B - Valve Seat
C - Float Valve (Good)
D - Float Valve (Worn)

- Inspect float valve (D) and valve seat (A) for wear or damage. The tip should be smooth, without any grooves, scratches or tears. If seat is worn or damaged, replace the carburetor body.
- Inspect tapered portion of pilot screw for wear. Replace as required.

Check Carburetor Float Level

IMPORTANT: Avoid damage! DO NOT press on float during float level check.

1. Assemble carburetor (minus the float chamber).



MX6314

2. Hold the carburetor upsidedown and compare the position of the float to the carburetor body (A).

NOTE: The float setting is not adjustable.

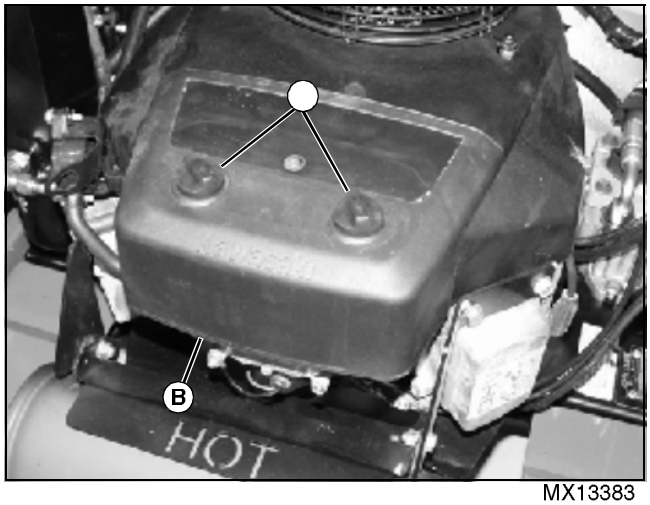
3. Replace the float and/or float valve if the measurement is out of specification.

Specifications:

Float Height. . . . . Parallel with Carburetor Body

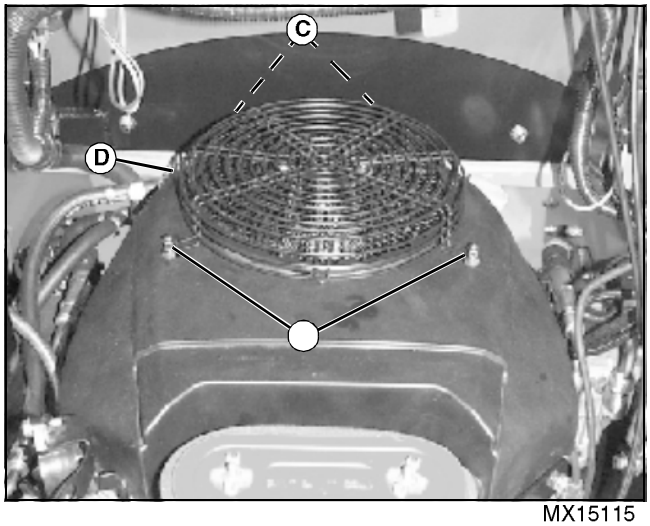
Remove and Install Blower Housing Assembly

1. Park the machine safely.



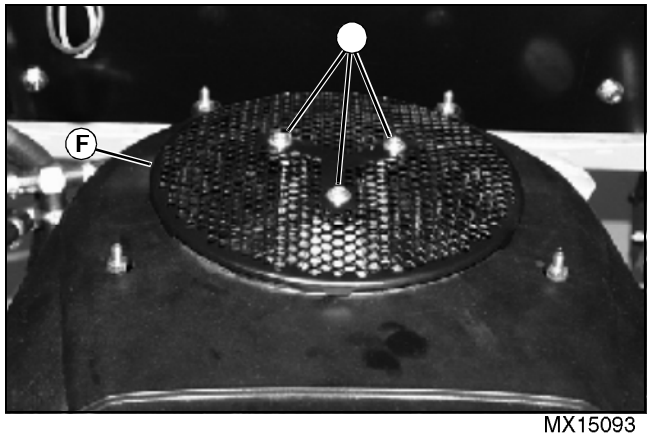
MX13383

2. Remove two special nuts (A).
3. Remove air cleaner cover (B).



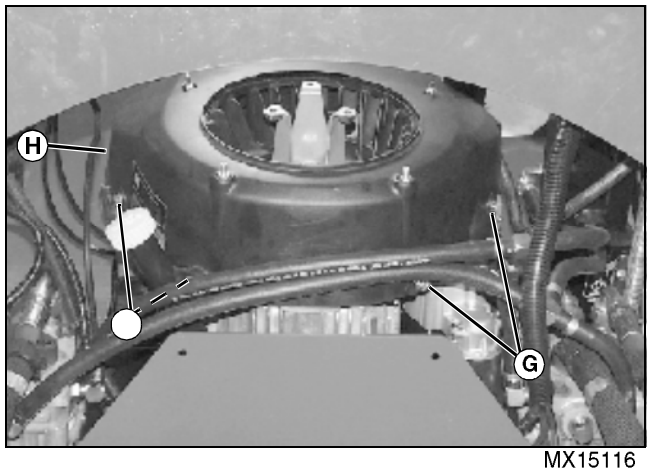
MX15115

4. Remove four nuts (C).
5. Remove outer intake screen (D).



MX15093

6. Remove three screws (E) and fan screen (F).



MX15116

7. Loosen four capscrews (G) 3 to 4 turns. Screws do not need to be removed.
8. Remove blower housing (H).

Installation is done in the reverse order of removal.

- Tighten mounting capscrews (G) to specifications.
- Adjust fan screen clearance before installing the outer intake screen. (See “Check and Adjust Fan Screen Clearance” on page 50.)
- Tighten fan screen screws (E) to specifications.
- Tighten outer intake screen nuts (C) to specifications.

Specifications:

Mounting Capscrew Torque . . . . . 6 N•m (52 lb-in.)

Fan Screen-to-Blower Housing Clearance 1.0 - 3.0 mm (0.039 - 0.118 in.)

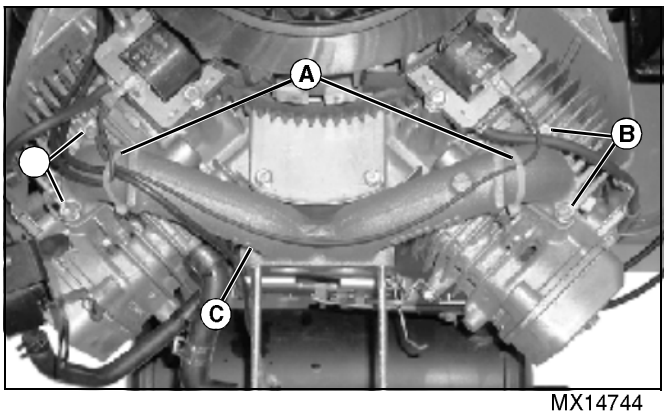
Fan Screen Screw Torque . . . . . 6 N•m (52 lb-in.)

Outer Intake Nut Torque . . . . . 6 N•m (52 lb-in.)

Remove and Install Intake Manifold

1. Remove blower housing. (See “Remove and Install Blower Housing Assembly” on page 66.)

2. Remove carburetor. (See “Remove and Install Carburetor” on page 61.)



MX14744

3. Remove tie straps (A) securing the ignition coil wires to the intake manifold.

4. Remove four capscrews (B).

5. Remove intake manifold (C).

6. Inspect intake manifold. (See “Inspect Intake Manifold” on page 67.)

Installation is done in the reverse order of removal.

NOTE: Screw holes in the gaskets are off center from the port. Make sure they are installed correctly.

- Always use new gaskets for installation.
- Tighten capscrews (B) to specifications.

Specifications:

Intake Manifold Capscrew Torque. . . . 6 N•m (52 lb-in.)

Inspect Intake Manifold

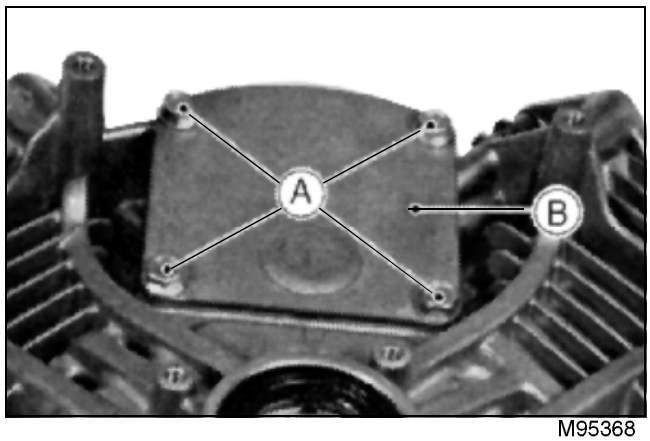
NOTE: Cracks not visible to the eye may be detected by coating the suspected area with a mixture of 25% kerosene and 75% light engine oil. Wipe area dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area.

Visually inspect manifold passages for corrosion, cracks, porous castings or deposits. Clean or replace as necessary.

Remove and Install Crankcase Breather

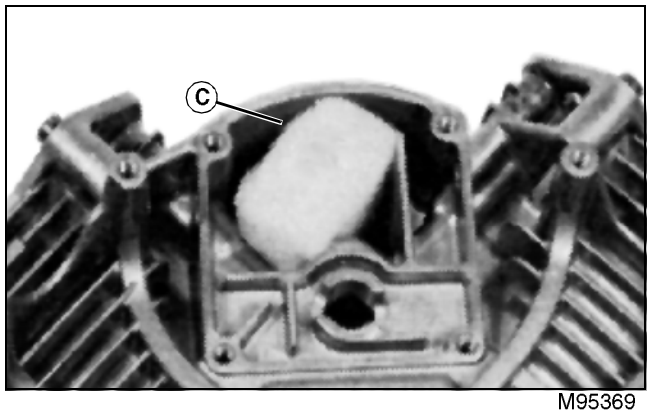
1. Remove flywheel. (See “Remove and Install Flywheel” on page 69.)

2. Remove intake manifold. (See “Remove and Install Intake Manifold” on page 67.)



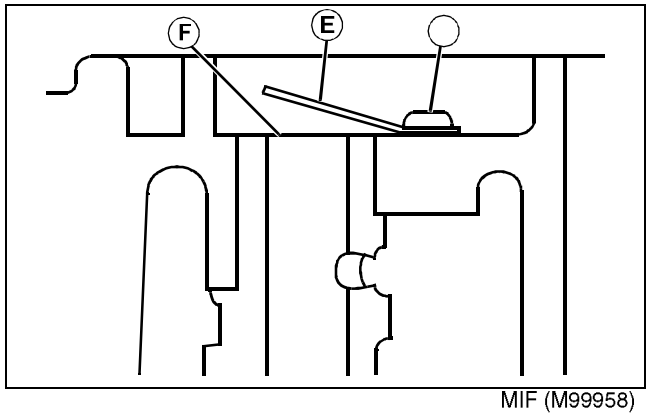
M95368

3. Remove four capscrews (A) securing the breather chamber cover (B) to the crankcase.



M95369

4. Remove and replace breather element (C), or clean with solvent and allow to dry.



MIF (M99958)

5. Remove mounting screw (D), reed plate (E) and breather valve (F).

6. Inspect breather valve (F) for breakage, hairline cracks and distortion. Replace as needed.

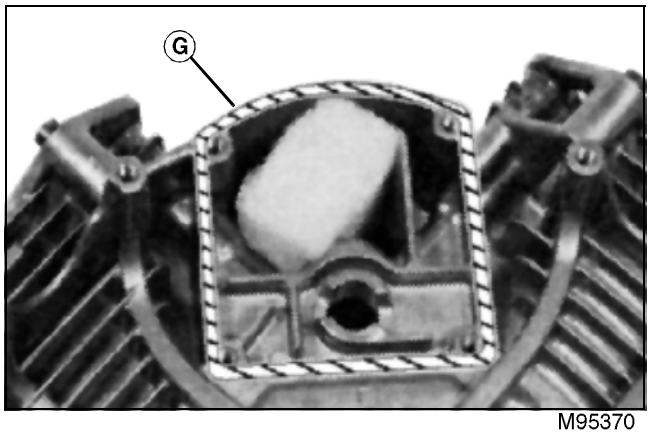
7. Inspect the reed plate (E) for damage and rough contact surface. Replace as needed.

8. Inspect the valve seating surface; it should be free of nicks and burrs. Replace as needed.

9. Check drain hole on breather chamber. Make sure no foreign material has accumulated, before installing breather valve.

Installation is done in the reverse order of removal.

- Align the center of the valve seat with the center of the breather valve and the plate, then tighten the mounting screw.



M95370

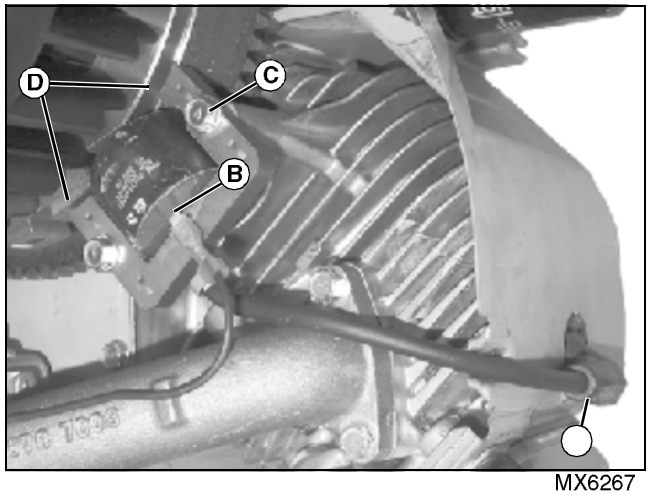
- Apply sealant to the mating surface of the crankcase and install a new gasket (G).
- Tighten breather chamber capscrews (A) to specifications.

Specifications:

Reed Valve Body Screw Torque . . . . . 2 N•m (18 lb-in.)
Breather Cover Capscrew Torque. . . . 6 N•m (52 lb-in.)
Intake Manifold Mounting Capscrews 6 N•m (52 lb-in.)
Flywheel Capscrew Torque. . . . . 56 N•m (41 lb-ft)

Remove and Install Ignition Coil

1. Remove blower housing. (See "Remove and Install Blower Housing Assembly" on page 66.)



MX6267

2. Disconnect spark plug lead (A) from spark plug.
3. Disconnect ignition wire (B) from ignition coil (C).
4. Remove capscrews (D).
5. Remove ignition coil (C).

Installation is done in the reverse order of removal.

- Stop switch connector must face blower housing when installed.
- Secure ignition wire to intake manifold using a tie strap.
- Adjust air gap. (See "Adjust Ignition Coil Air Gap" on page 53.)
- Tighten capscrews (D) to specifications.

Specifications:

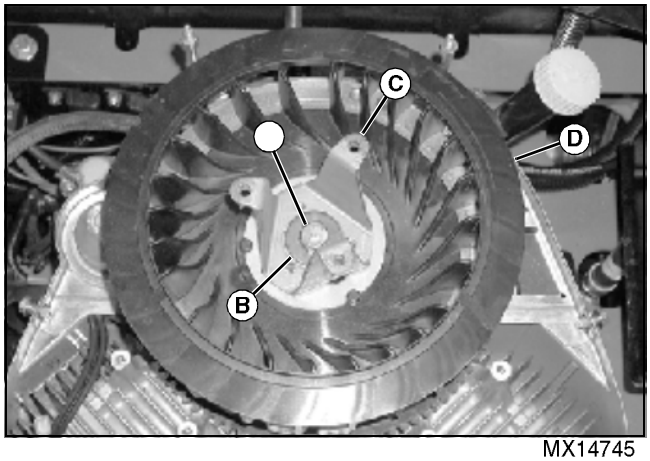
Ignition Coil Air Gap . . . 0.2 - 0.4 mm (0.008 - 0.016 in.)

Ignition Coil Capscrew Torque . . . . . 6 N•m (52 lb-in.)

Remove and Install Flywheel

1. Remove ignition coils. (See “Remove and Install Ignition Coil” on page 68.)

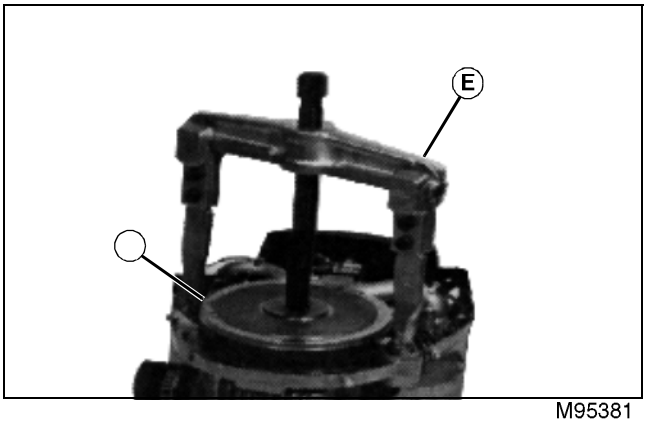
IMPORTANT: Avoid damage! When using strap wrench to hold flywheel, only wrap it around the metal flywheel. DO NOT wrap it around the plastic cooling fan.



MX14745

2. Hold flywheel with a suitable tool and remove flywheel retaining capscrew (A), washer (B), blower screen bracket (C) and cooling fan (D).

IMPORTANT: Avoid damage! Use a puller to remove flywheel. Avoid attaching puller to the magnet sections. To avoid possible damage, DO NOT hit the flywheel with a hammer to loosen.

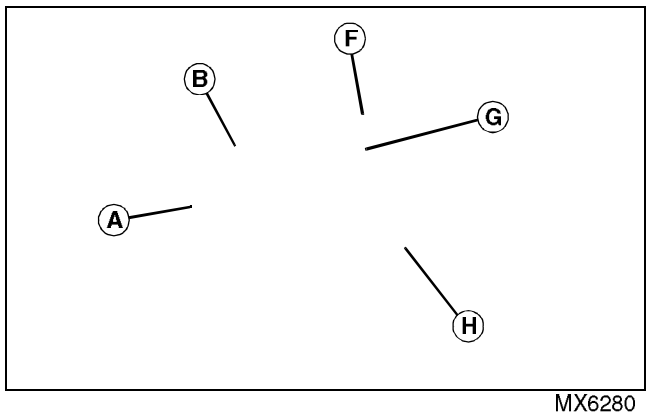


M95381

3. Using a suitable puller (E), remove flywheel (F) and key.

Installation is done in the reverse order of removal.

- Use a suitable cleaning fluid to clean all dirt or oil from the tapered contact area of both the flywheel and crankshaft.



MX6280

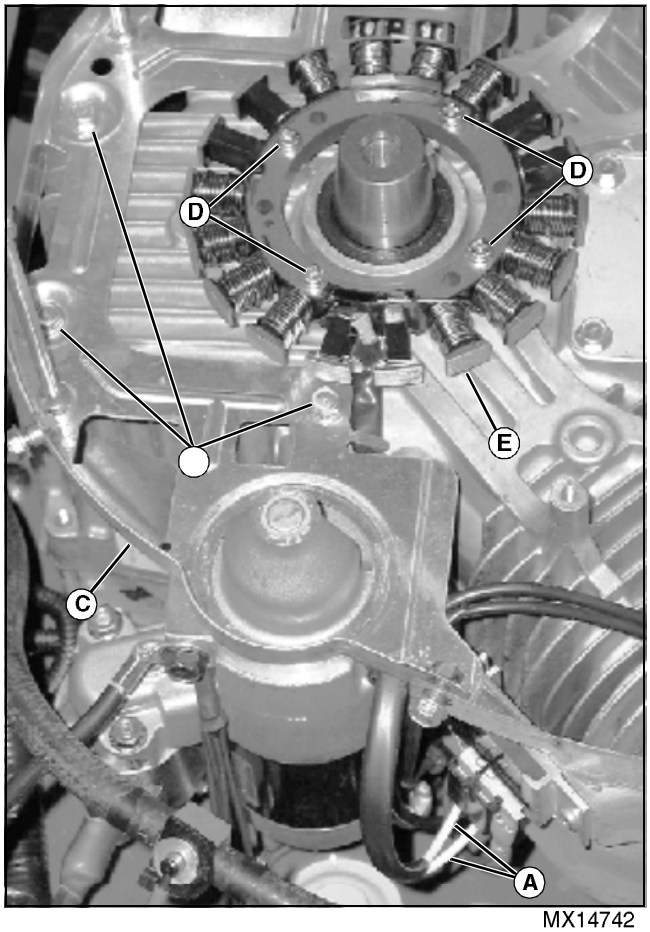
- Fit the key (G) securely in the slot of the crankshaft (H) before installing the flywheel (B).
- Be sure to align the pins on the bottom of the fan with the magnetic pole plate.
- Install the flywheel capscrew washer (B) with the concave side toward the crankshaft as shown.
- Tighten flywheel capscrew (A) to specifications.

Specifications:

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

Remove and Install Stator

1. Remove flywheel. (See "Remove and Install Flywheel" on page 69.)



MX14742

2. Disconnect stator leads (A) from voltage regulator/ rectifier.

3. Remove capscrews (B) securing the blower housing plate (C).

4. Remove four capscrews (D) from stator (E).

5. Remove stator (E) and blower housing plate (C) together.

Installation is done in the reverse order of removal.

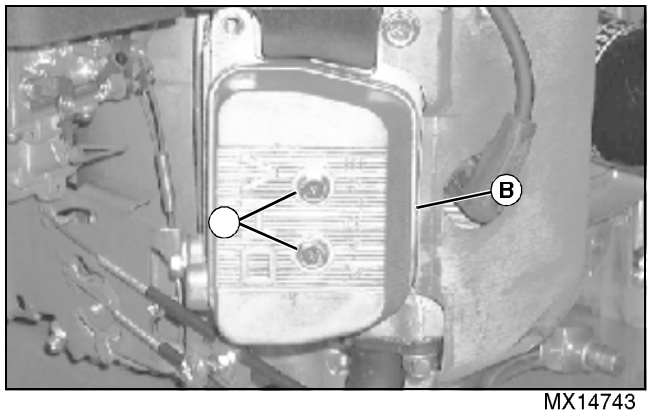
- Tighten stator mounting capscrews (D) and blower housing plate capscrews (C) to specifications.

Specifications:

Stator Capscrew Torque . . . . . 3 N•m (27 lb-in.)

Blower Housing Plate Capscrew Torque . 6 N•m (52 lb-in.)

Remove and Install Rocker Arm Cover



MX14743

1. Remove two capscrews (A).

2. Remove rocker arm cover (B) and gasket.

Installation is done in the reverse order of removal.

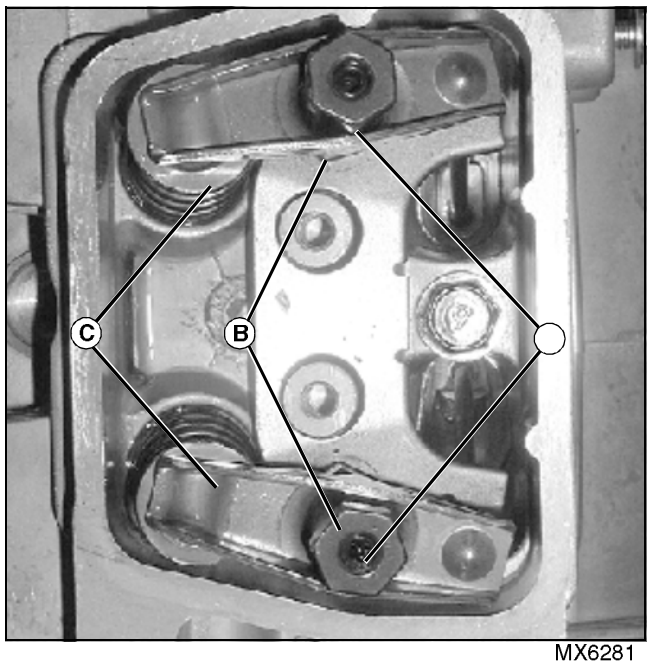
- Remove gasket material from mating surfaces of rocker arm cover and cylinder head before installation.
- Use a new gasket for installation.
- Tighten capscrews (A) to specifications.

Specifications:

Rocker Arm Cover Capscrew Torque . . 6 N•m (52 lb-in.)

Remove Rocker Arms and Push Rods

1. Remove rocker arm cover. (See "Remove and Install Rocker Arm Cover" on page 70.)



MX6281

2. Loosen rocker arm lock screws (A).

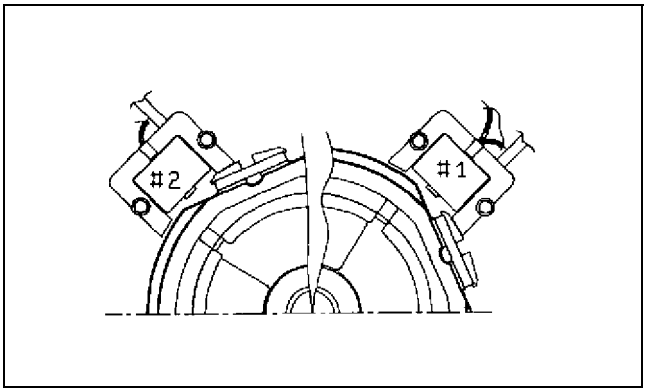
IMPORTANT: Avoid damage! Rocker arms and push rods must be installed in their original locations. Mark cylinder heads, rocker arms and push rods to aid in assembly.

3. Remove rocker arm adjuster screws (B).
4. Remove rocker arms (C).
5. Remove push rods.
6. Inspect and replace components as necessary. (See "Inspect Rocker Arms and Push Rods" on page 71.)

Install Rocker Arms and Push Rods

NOTE: Apply clean engine oil to contact surfaces of all components prior to installation.

1. Install push rods in their original location. Be sure push rods properly pass through slot in guide plate and are correctly seated in tappets.



MX6282

2. Set cylinder to TDC of power stroke (push rods at their lowest position and flywheel aligned as shown).
3. Install rocker arms, being sure to correctly engage the push rod.
4. Install adjuster nuts finger tight.
5. Adjust valve clearance to specification. (See "Check and Adjust Valve Clearance" on page 49.)
6. Tighten adjuster set screw to specification.

IMPORTANT: Avoid damage! If engine is started with valve spring completely compressed (no gap between coils), engine valve train will be damaged.

7. Rotate engine slowly by hand to check for free operation of the valve train. Check the clearance between valve spring coils at full camshaft lift. If valve spring is compressed to the point of binding (no free space between spring coils), valve adjustment is incorrect. Adjust as necessary.
8. Install rocker arm covers. (See "Remove and Install Rocker Arm Cover" on page 70.)

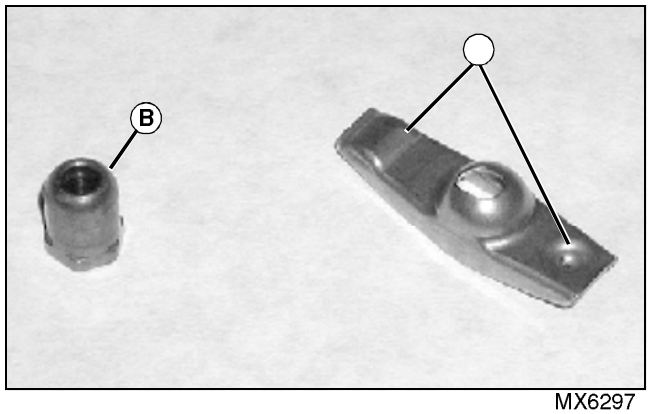
Specifications:

Rocker Arm Adjuster Lock Screw Torque . . . 7 N•m (61 lb-in.)

Intake Valve Clearance 0.102 - 0.152 mm (0.004 - 0.006 in.)

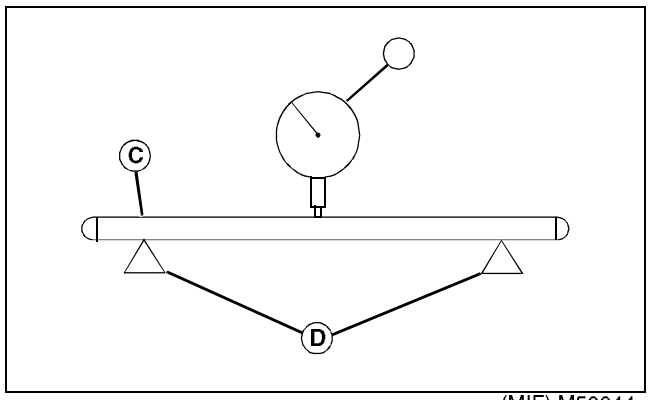
Exhaust Valve Clearance. . . . 0.102 - 0.152 mm (0.004 - 0.006 in.)

Inspect Rocker Arms and Push Rods



MX6297

1. Inspect the contact areas (A) of the rocker arms for excessive wear or damage.
2. Inspect pivot area of rocker arm adjuster (B) for wear. Replace parts as required.



(MIF) M50044

3. Inspect push rod (C) for bends using V-blocks (D) and a dial indicator (E). Turn rod slowly while reading variation on indicator. Replace push rod if variation is greater than specification.

Specifications:

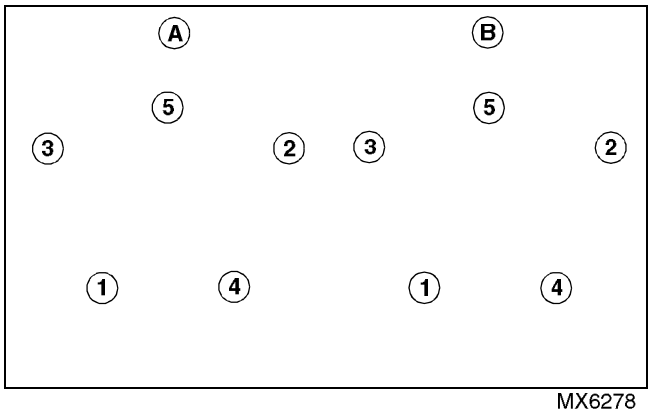
Maximum Push Rod Bend. . . . . 0.50 mm (0.020 in.)

Remove and Install Cylinder Head

IMPORTANT: Avoid damage! Engine must be cold before removing cylinder head capscrews, to avoid warping the cylinder head.

1. Remove rocker arm and push rods. (See "Remove Rocker Arms and Push Rods" on page 70.)
2. Remove intake manifold. (See "Remove and Install Intake Manifold" on page 67.)
3. Remove throttle plate assembly. (See "Remove and Install Throttle Plate Assembly" on page 61.)
4. Remove spark plug.

IMPORTANT: Avoid damage! Loosen cylinder head capscrews 1/4 turn at a time, in the sequence shown, to avoid warping the cylinder head.



MX6278

A - Cylinder Head Marked "1"
B - Cylinder Head Marked "2"

5. Loosen capscrews 1/4 turn at a time, in the sequence shown.
6. Remove capscrews, cylinder head and gasket.
7. Disassemble cylinder head. (See "Disassemble and Assemble Cylinder Head" on page 72.)
8. Inspect cylinder head and valve components. (See "Inspect Cylinder Head and Valves" on page 73.)
9. Remove all gasket material from the cylinder head and cylinder block mating surfaces.

Installation is done in the reverse order of removal.

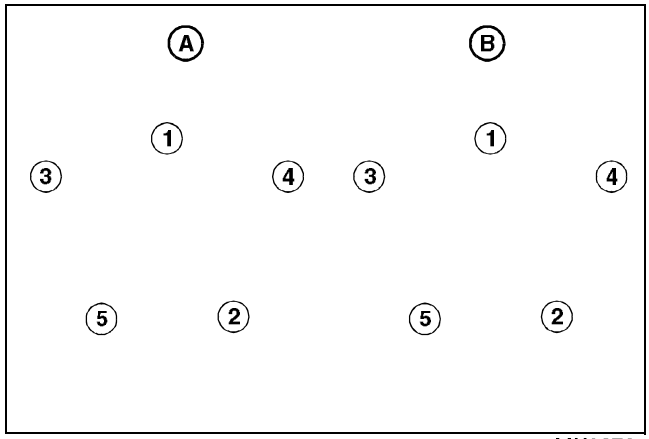
- Use new gaskets for installation. Gaskets are coated with a sealing agents. Use no additional sealant.
- Be sure alignment dowels are in place.

IMPORTANT: Avoid damage! Torque should be applied in the sequence shown, in three stages:

1/2 final torque specification

3/4 final torque specification

Final torque specification



MX6278

A - Cylinder Head Marked "1"
B - Cylinder Head Marked "2"

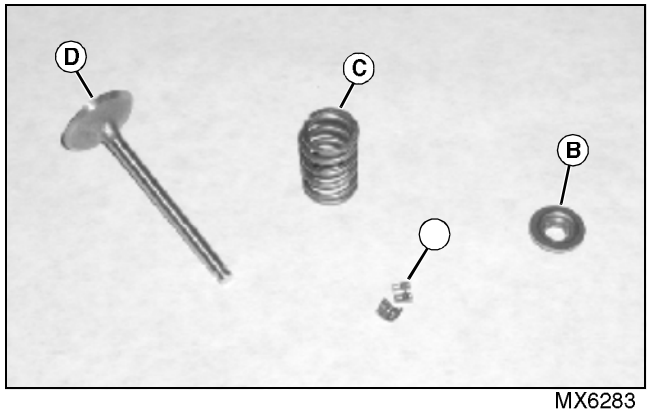
- Tighten capscrews in sequence shown to initial torque values. Finish tightening cylinder head to final torque.
- Adjust valve clearance. (See "Check and Adjust Valve Clearance" on page 49.)

Specifications:

Cylinder Head Capscrew Final Torque. 25 N•m (19 lb-ft)

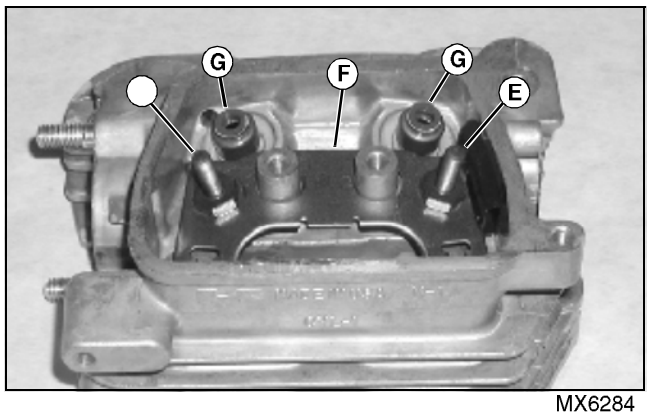
Disassemble and Assemble Cylinder Head

1. Compress valve springs using a suitable valve spring compressor.



MX6283

2. Remove keepers (A), retainers (B), springs (C) and valves (D).



MX6284

3. Remove rocker arm studs (E) only if damaged or if push rod guide plate (F) requires replacement.

4. Remove valve guide seals (G) only if they are to be replaced.

5. Inspect cylinder head. (See “Inspect Cylinder Head and Valves” on page 73.)

Assembly is done in the reverse order of disassembly.

- Apply a light film of clean engine oil to intake and exhaust valve stems during assembly.
- Tighten rocker arm studs to specifications.

Specifications:

Rocker Arm Stud Torque . . . . . 28 N•m (21 lb-ft)

Inspect Cylinder Head and Valves

Other Material

Part No.	Part Name	Part Use
NA	SCOTCH-BRITE™ Abrasive Sheet/Pad	Clean cylinder head.

Cylinder Head

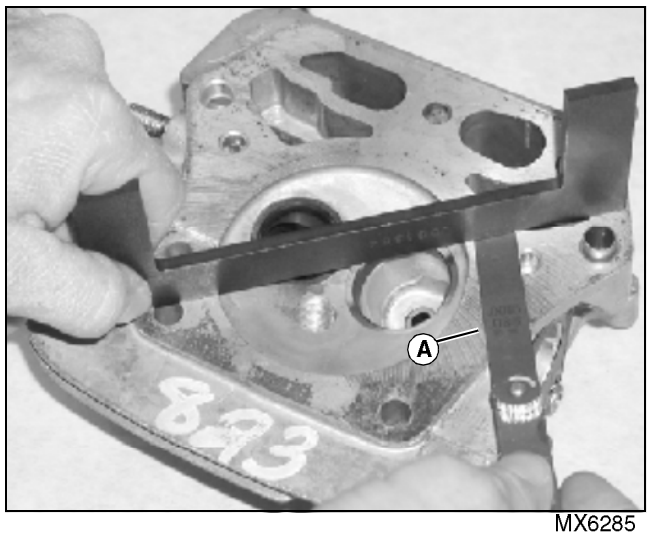
1. Remove carbon deposits from combustion chamber using SCOTCH-BRITE™ abrasive pads or an equivalent.

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.

2. Clean head with a suitable solvent and dry with compressed air.

3. Inspect head for cracks or broken cooling fins.

4. Inspect gasket surface for burrs and nicks.



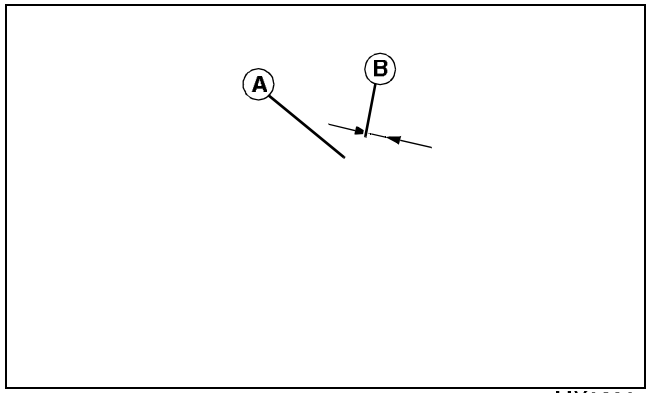
MX6285

5. Use a straightedge and feeler gauge (A) to check head for distortion at several points around head. Replace head if distortion is greater than specifications.

Valve Guides

1. Clean inside of valve guides with a valve guide cleaner.

NOTE: Valve guides are not replaceable and valves with oversize stems are not available. Cylinder head must be replaced if valve guides are beyond service limits.



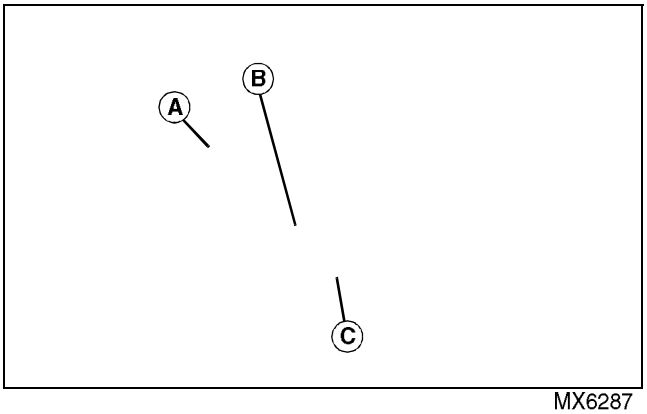
MX6286

2. Measure inside diameter (B) of valve guides (A) in three locations along length of guide. Replace cylinder head if inside diameter is greater than wear limit.

Valve Seats

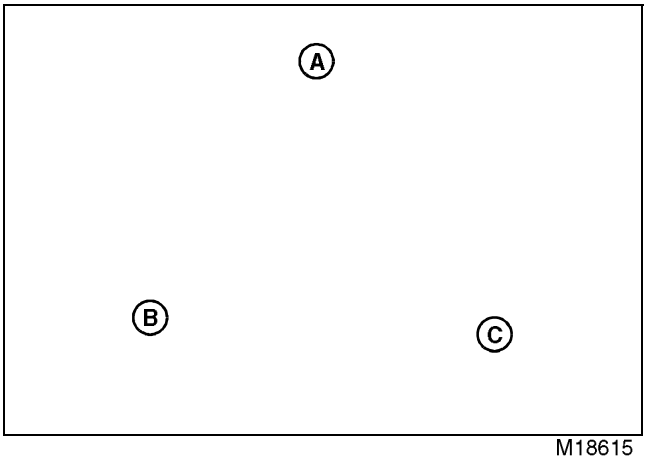
1. Remove carbon deposits from valve seat and port areas.

NOTE: If valve seats are loose, warped or distorted beyond reconditioning, replace the cylinder head. Pitted or worn seats can be reconditioned using a suitable valve seat cutter.



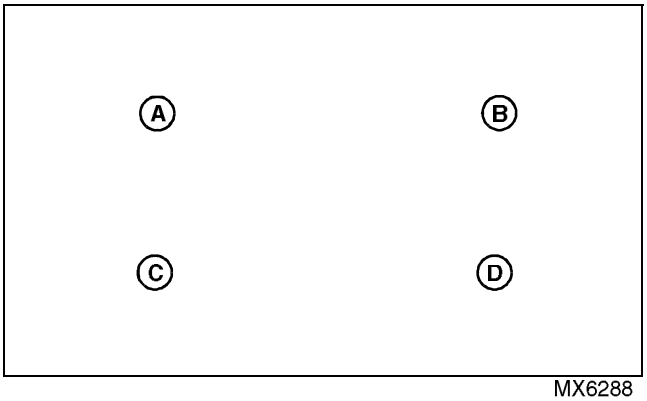
MX6287

A - Valve Seat Width
B - Valve Seat
C - Valve



M18615

A - Correct Seat Position
B - Valve Too High
C - Valve Too Deep



MX6288

Picture Note: Valve seat patterns.

A - Correct
B - Too Wide
C - Too Narrow
D - Uneven Wear

2. Check valve seating pattern for correct width, correct seat position and even contact all around. If not within specification, recondition seats and reface or replace valves. (See “Recondition Valve Seats” on page 76.)

   a. Coat the valve seat with machinist’s dye.

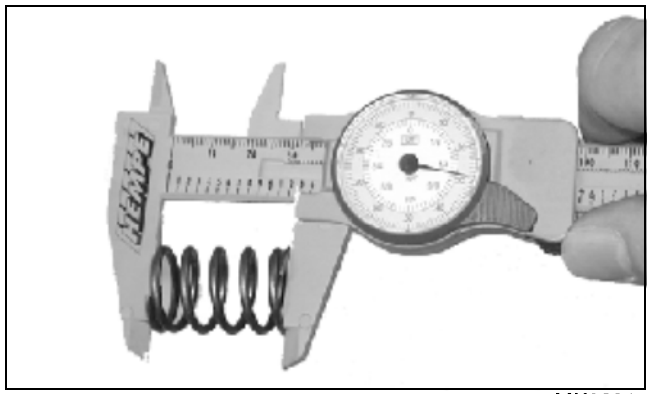
   b. Install valve and rotate against the seat using a lapping tool.

   c. Remove valve and inspect the contact area.

3. Lap valves prior to installation and recheck seat width and contact pattern. (See “Lap Valves” on page 77.)

Valve Springs

1. Inspect springs for pitting, rust, burrs and distortion. Replace if necessary.



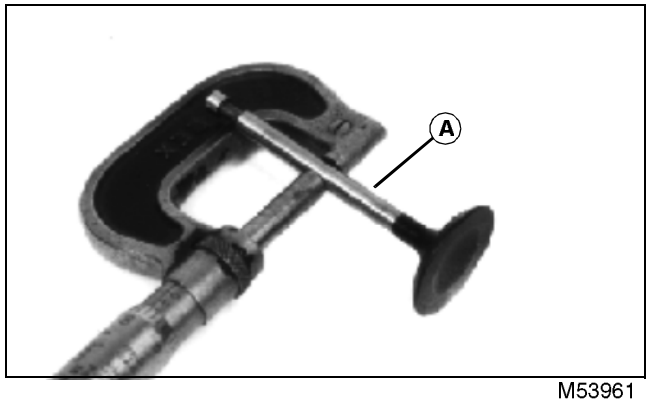
MX6291

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

Intake and Exhaust Valves

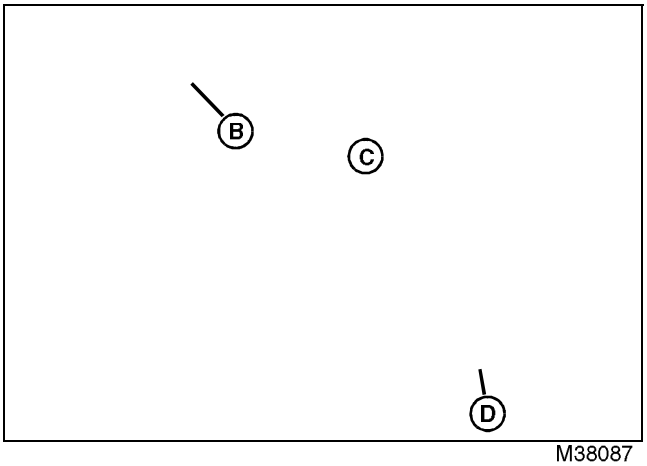
1. Remove carbon from valve head, face and stem with a power-operated wire brush. Be sure carbon is removed, not merely burnished.

2. Inspect valve head, face and stem for defects. Replace if necessary.



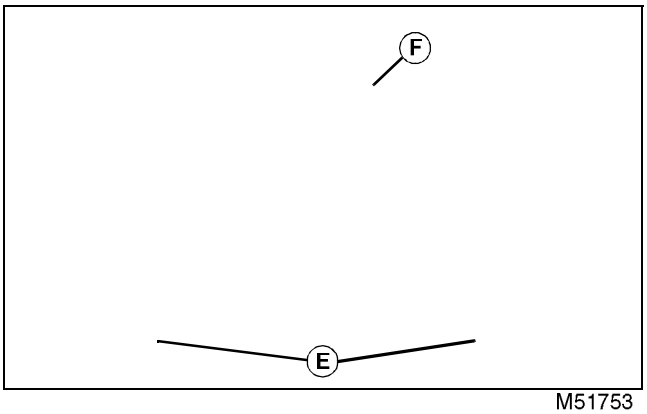
M53961

3. Measure the diameter of the valve stem (A) in two directions at right angles, at four different positions on the stem. Replace if diameter is less than specification.



M38087

4. Replace warped valves (B) or valves with a margin less than specification (C). Valve stem ends (D) should be ground square before checking valve-to-rocker arm clearance.



M51753

5. Check valve stem for bends using V-blocks (E) and a dial indicator (F). Turn valve slowly and read variation on indicator. Replace valve if variation is greater than specification.

Specifications:

Cylinder Head Out-of-Flat (Max) . . . 0.05 mm (0.002 in.)

Valve Guide ID. . . 6.000 - 6.012 mm (0.2362 - 0.2367 in.)

Valve Guide ID (Wear Limit). . . . . 6.08 mm (0.239 in.)

Valve Seat Angle (Intake and Exhaust). . . . . .45°

Valve Seat Width (Intake). . 0.8 - 1.4 mm (0.03 - 0.05 in.)

Valve Seat Width (Exhaust) 1.1 - 1.6 mm (0.04 - 0.06 in.)

Valve Face Margin (Min). . . . . 0.35 mm (0.014 in.)

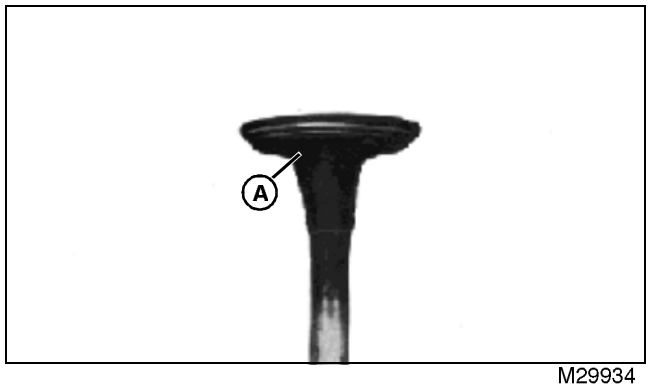
Valve Spring Free Length (Min). . . . . 31 mm (1.22 in.)

Intake Valve Stem OD (Wear Limit). 5.95 mm (0.234 in.)

Exhaust Valve Stem OD (Wear Limit) . . . . . 5.93 mm (0.233 in.)

Valve Stem Bend (Max) . . . . . 0.05 mm (0.002 in.)

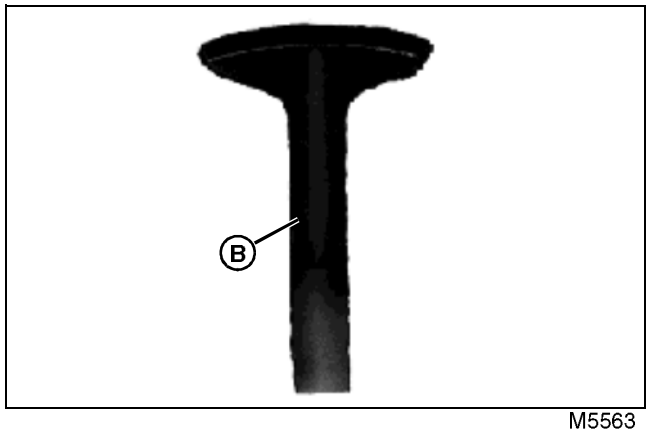
Analyze Valves



M29934

Lead deposits (A) on the intake valve are caused by exhaust gas leakage past the valve. This indicates that the valve is not seating properly.

Lap the valves after resurfacing the seat to correct this condition.

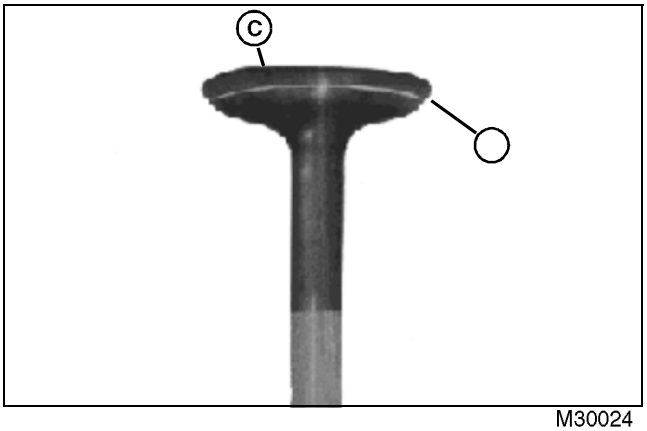


M5563

Valve stem corrosion (B) is caused by moisture in the engine. Moisture in the fuel/air mixture can condense inside the engine when the engine is stopped and cools down.

Valve corrosion can also occur during storage. Fogging or pouring oil in the combustion chamber before storing helps prevent valve corrosion.

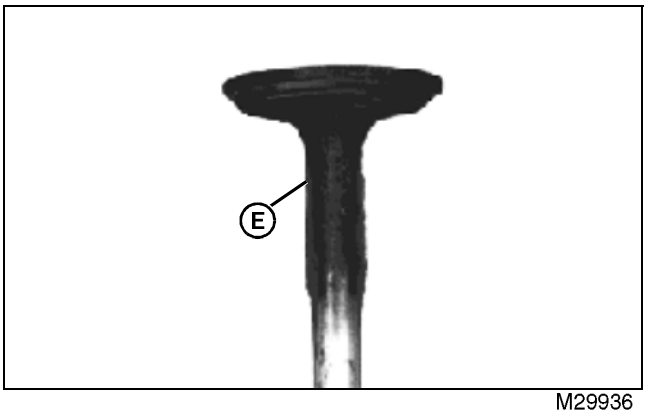
Corroded or pitted valves collect deposits and may cause sticking valves. Replace badly corroded or pitted valves.



M30024

Exhaust valves are designed to function in temperatures exceeding 2760°C (5000°F). However, when operating at high temperatures for long periods of time, valve burning may occur. Valves running too hot will show a dark discoloration of the valve stem into the area protected by the valve guide. Another indication is distortion of the valve margin (C) and valve face (D). Valve seat inserts may also begin to burn away.

Other causes for valves running hot are worn valve guides or valve springs, incorrect valve clearance, lean fuel/air mixture and incorrect or overheated spark plug.



M29936

Using old or stale gasoline is a common cause for sticky valves.

This gummy deposit (E) can be seen on the valve. When this condition exists, the carburetor may also contain gummy deposits and will require cleaning.

Always use fresh gasoline and drain fuel tank, lines and carburetor before storing machine.

Recondition Valve Seats

Other Material

Part No.	Part Name	Part Use
NA	Prussian Blue Compound	Check valve seat contact.
NA	Valve Lapping Compound	Lap valves to seats after reconditioning.

1. Thoroughly clean the combustion chamber and valve seats to remove carbon deposits.

NOTE: Hardened steel alloy intake and exhaust valve seat inserts are press fitted into the cylinder head. The inserts are not replaceable on the engine, but can be reconditioned if not too badly pitted or distorted. If the seat is cracked or badly warped, the cylinder head must be replaced.

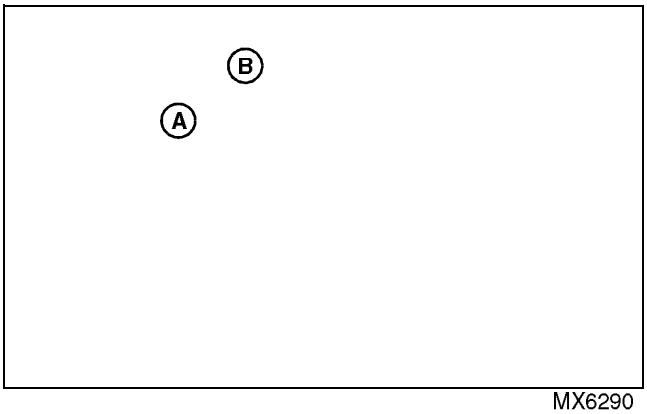
2. Inspect valve seats for damage. If seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be refaced using a seat cutter.

3. Inspect the valve seat contact pattern. (See “Inspect Cylinder Head and Valves” on page 73.)

4. Apply a light coat of machinist’s dye to the seat area to improve inspection as the seat is resurfaced.

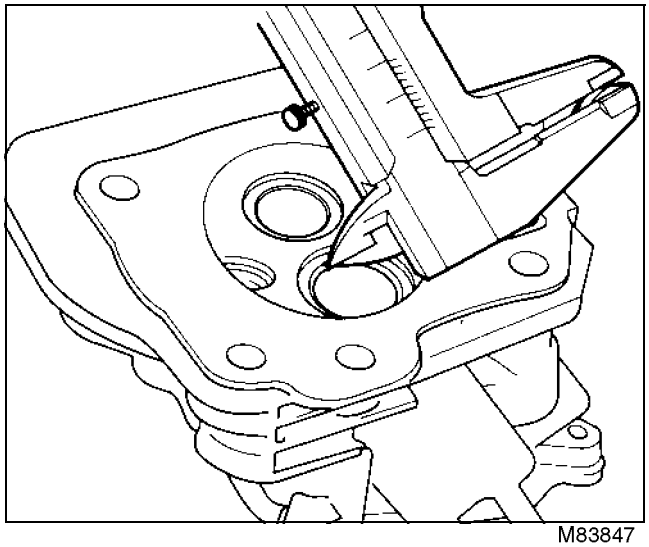
IMPORTANT: Avoid damage! ONLY turn cutter clockwise, DO NOT turn counterclockwise. Continue to turn cutter as you lift it off the valve seat.

NOTE: The valve guide must be in good condition to recondition seat properly.



MX6290

5. Resurface the seat using a 45° cutter (A) and driver (B). Remove only enough material to produce a fresh contact area all around the seat.

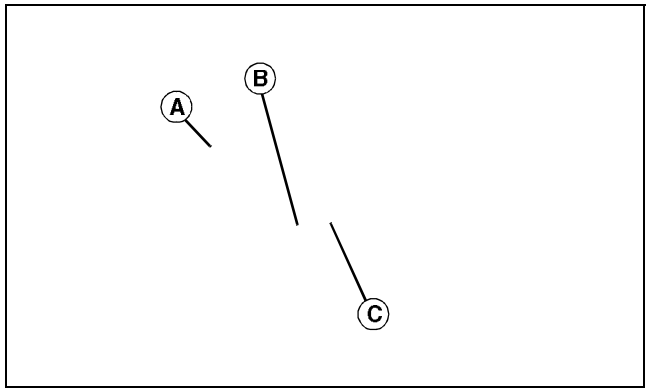


M83847

6. Measure seat width.

   • Use a 30° cutter to narrow a wide seat to specification.

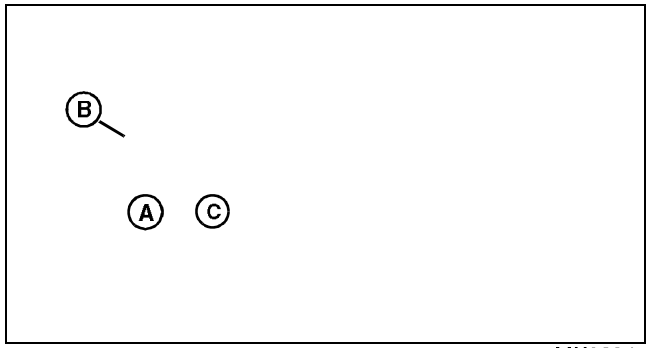
   • Continue to cut with a 45° cutter if the seat is still too narrow.



MX6287

A - Valve Seat Width
B - Valve Seat
C - Valve

7. Apply a light coating of machinist's dye to the seat. Install the valve and rotate against the seat using a valve lapping tool. Remove the valve and inspect the contact area.



MX6294

A - Valve Seat Angle (45°)
B - Narrowing Angle (30°)
C - Valve Seat Width

8. Use a 30° cutter to "top dress" and narrow the valve seat, if necessary, so that the valve makes contact near the middle of the valve face.

9. Recheck valve seat width and adjust if necessary.

10. Lap valves. (See "Lap Valves" on page 77.)

Specifications:

Valve Seat Angle (Intake and Exhaust) . . . . . 45°

Intake Valve Seat Width 0.8 - 1.40 mm (0.030 - 0.050 in.)

Exhaust Valve Seat Width . . . . . 1.10 - 1.60 mm (0.040 - 0.060 in.)

Valve Face Margin (Min) . . . . . 0.35 mm (0.014 in.)

Lap Valves

Other Material

Part No.	Part Name	Part Use
NA	Lapping Compound	Lap valves into valve seats.

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

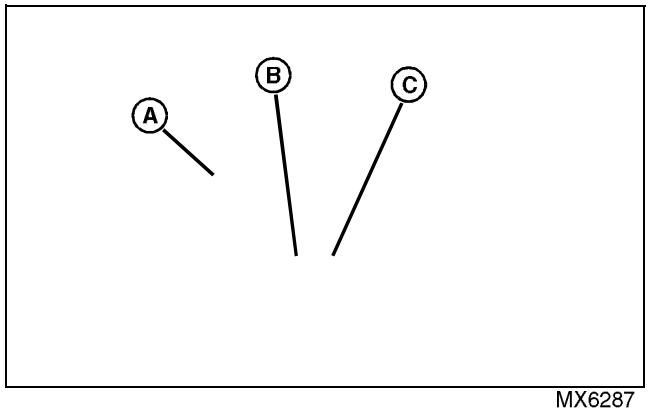
1. Apply a small amount of fine lapping compound to face of valve.

MX6302

2. Grip head of valve with a vacuum cup tool and turn valve to lap valve to seat.

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

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



MX6287

A - Valve Seat Width
B - Valve Seat
C - Contact Area

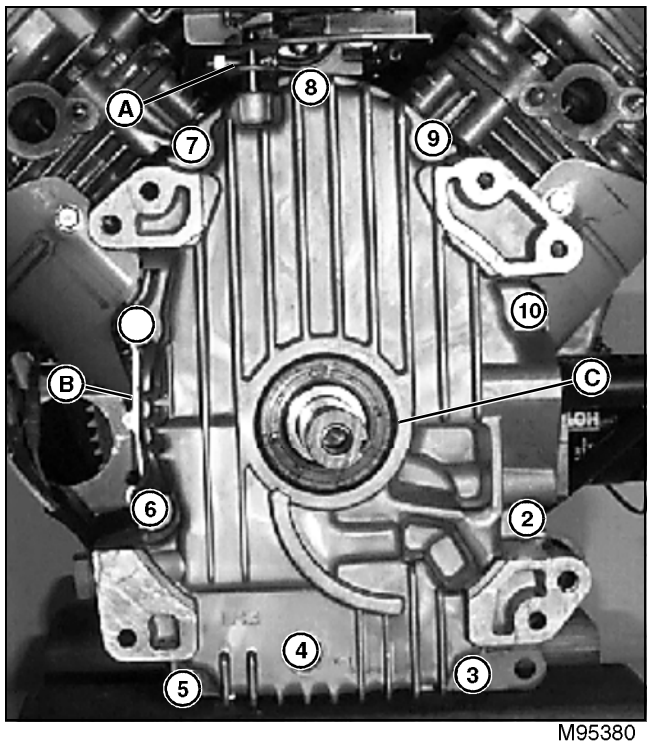
5. Check position of lap mark on valve face. Lap mark must be on or near the center of valve face.

Remove and Install Crankcase Cover

1. Remove engine from machine. (See “Remove and Install Engine” on page 58.)

2. Remove throttle control plate. (See “Remove and Install Throttle Plate Assembly” on page 61.)

3. Drain oil from crankcase.



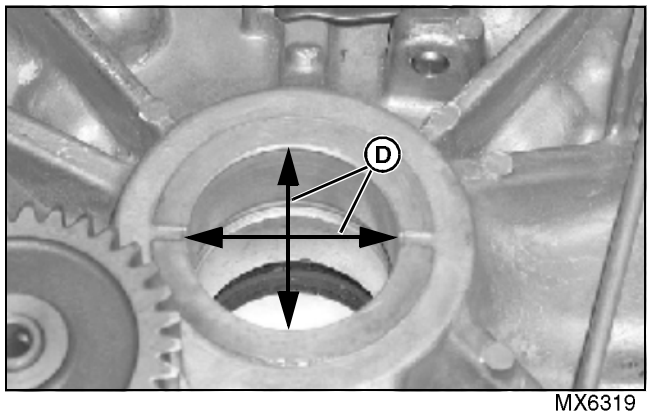
M95380

4. Remove governor arm (A) from shaft.

5. Remove ten capscrews and crankcase cover (B).

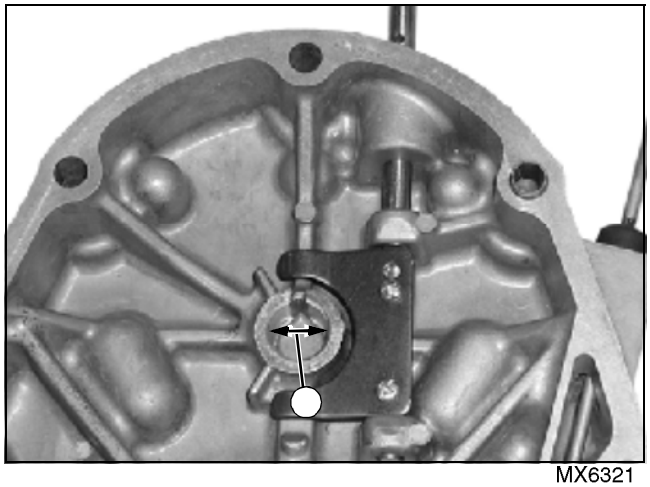
6. Remove crankshaft seal (C).

7. Remove gasket material from crankcase cover and crankcase mating surfaces.



MX6319

8. Measure the inside diameter of the crankshaft bore in two directions on both sides (D) of the oil groove. Replace crankcase cover if greater than specifications.


MX6321

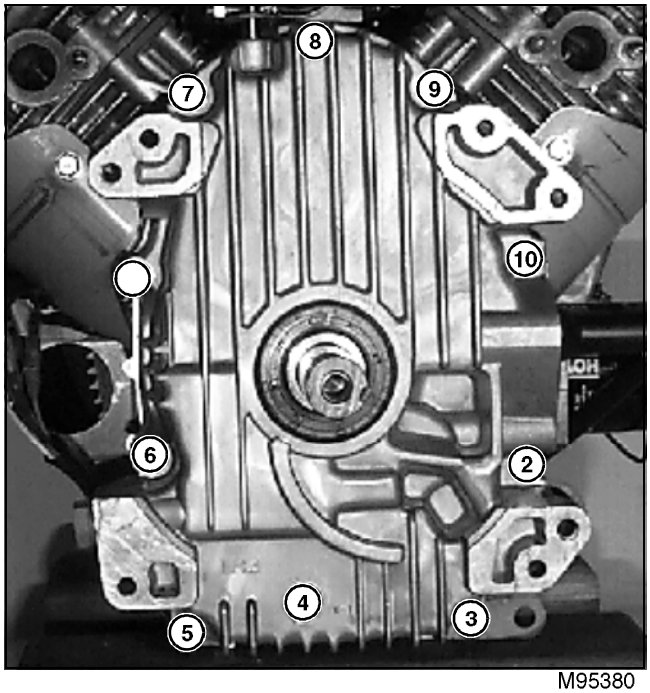
9. Measure the inside diameter of the camshaft bore (E). Replace crankcase cover if greater than specifications.

10. Inspect all parts for wear or damage. Replace parts as needed.

Installation is done in the reverse order of removal.

- Use a new gasket for installation.
- Make sure two alignment dowels are installed between engine and crankcase cover.

IMPORTANT: Avoid damage! Install crankshaft seal after cover is installed to prevent seal lip from rolling.



M95380

- Install cover and loosely install all capscrews. Once all capscrews are installed, tighten capscrews to specifications in the order shown.
- Apply grease to lips of crankshaft seal. Install crankshaft seal flush with housing after cover is installed.
- Install governor arm.
- Adjust engine slow idle speed. (See "Adjust Slow Idle Speed" on page 45.)
- Adjust engine fast idle speed. (See "Adjust Fast Idle Speed" on page 46.)

Specifications:

Crankshaft Bore ID (Wear Limit) . . 40.15 mm (1.581 in.)

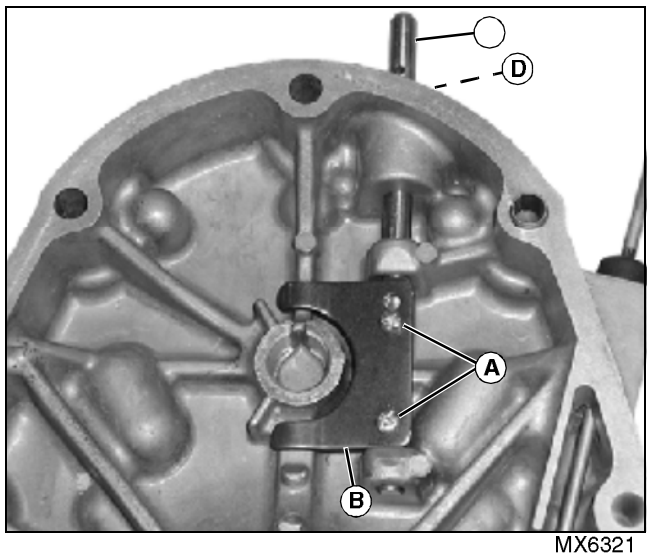
Camshaft Bore ID (Wear Limit) . 16.136 mm (0.6352 in.)

Crankcase Capacity (with Filter) . . . . . 1.7 L (1.8 qt)

Crankcase Cover Capscrew Torque . . . 25 N•m (18 lb-ft)

Remove Governor Shaft

1. Remove crankcase cover. (See "Remove and Install Crankcase Cover" on page 78.)



MX6321

2. Remove two screws (A) and remove the plate (B) from the governor shaft. Remove shaft.

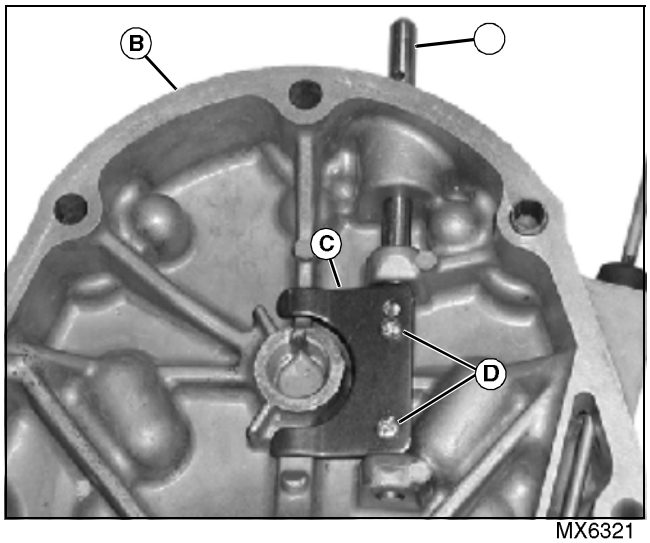
3. Remove governor shaft seal (D).

4. Inspect all parts for wear or damage. Replace parts as needed.

Install Governor Shaft

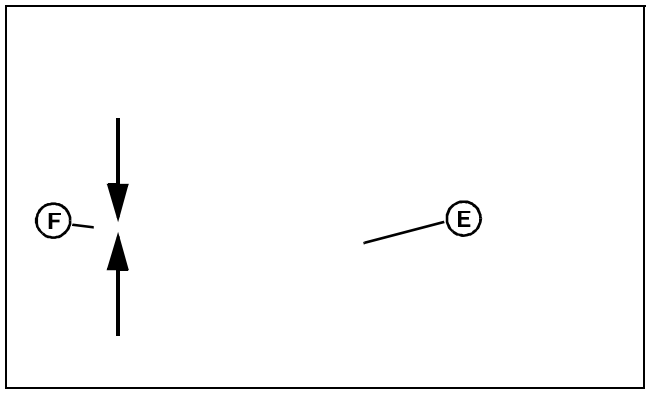
IMPORTANT: Avoid damage! Lubricate all components with engine oil during assembly.

NOTE: Seal is to be installed after shaft is in place.



MX6321

1. Install governor shaft (A) in crankcase cover (B).
2. Install plate (C) and tighten screws (D) to specifications.



MX6322B

3. Install seal (E) to depth (F) below surface as specified.
4. Install governor arm on shaft. Adjust position of governor arm after crankcase cover has been installed. (See “Remove and Install Crankcase Cover” on page 78.)

Specifications:

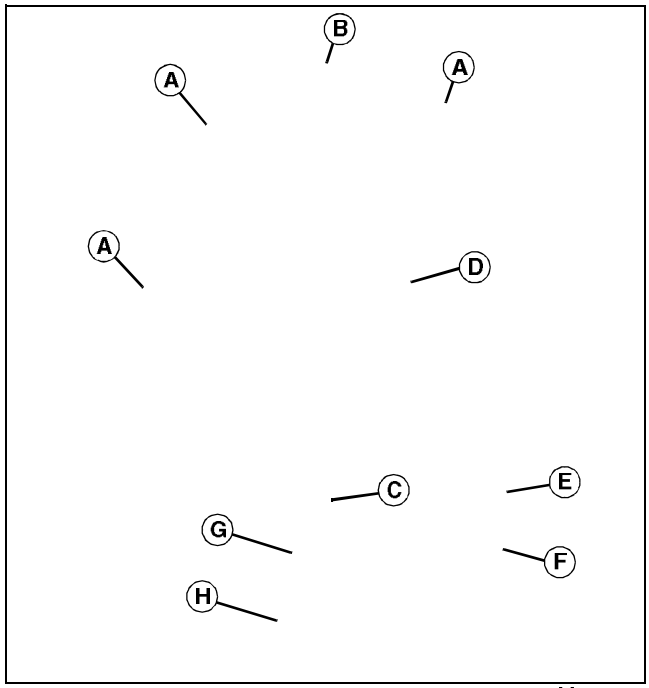
Shaft Plate Screw Torque. . . . . 2.0 N•m (18 lb-in.)

Governor Shaft Seal Installation Depth . . 0 - 2 mm (0 - 0.080 in.)

Governor Shaft Protrusion (Approx.) . 7 mm (0.275 in.)

Disassemble and Assemble Oil Pump

1. Remove crankcase cover. (See “Remove and Install Crankcase Cover” on page 78.)



M95415

2. Remove three mounting capscrews (A) and lift the oil pump gear (B), rotor shaft (C) and cover plate (D) out of the crankcase cover.
3. Remove relief valve spring (E) and ball (F).
4. Remove the inner (G) and outer (H) rotors.
5. Inspect all parts for wear and damage. (See “Inspect Oil Pump” on page 81.)

Assembly is done in the reverse order of disassembly.

- Fill rotor housing with clean engine oil for initial lubrication.
- Tighten capscrews (A) to specification.

Specifications:

Cover Plate Capscrew Torque. . . . . 6 N•m (52 lb-in.)

Inspect Oil Pump

1. Measure rotor shaft diameter. Replace shaft if less than specification.

M53969

2. Measure rotor shaft bearing inside diameter. Replace crankcase cover if greater than specification.

M53970

3. Measure outside diameter of outer rotor. Replace outer rotor if less than specification.

M53971

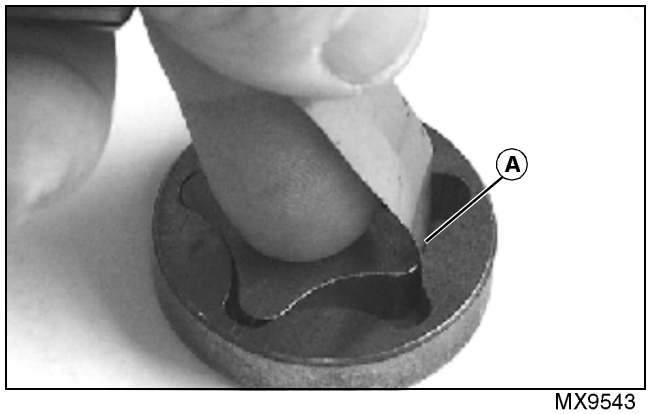
4. Measure inside diameter of rotor housing. Replace crankcase cover if greater than specification.

M80015

5. Measure thickness of outer rotor. Replace rotor if less than specification.

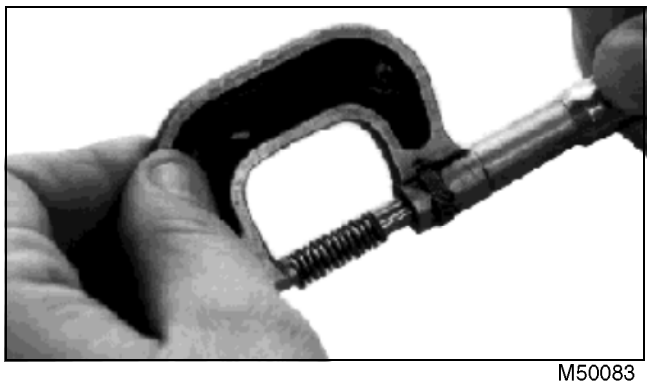
M82908

6. Measure outer rotor housing depth. Replace crankcase cover if greater than specification.



MX9543

7. Measure inner-to-outer rotor clearance (A) with a feeler gauge. Replace both rotors if clearance is greater than specification.


M50083

8. Measure relief valve spring free length. Replace spring if less than specification.

Specifications:

Rotor Shaft Diameter (Min) . . . . 10.923 mm (0.4300 in.)

Rotor Shaft Bearing ID (Max). . . 11.072 mm (0.4359 in.)

Outer Rotor Diameter (Min) . . . . 40.470 mm (1.5933 in.)

Outer Rotor Bore Diameter (Max) . . 40.801 mm (1.6063 in.)

Outer Rotor Thickness (Min) . . . . . 9.83 mm (0.387 in.)

Outer Rotor Bore Depth (Max). . 10.230 mm (0.4028 in.)

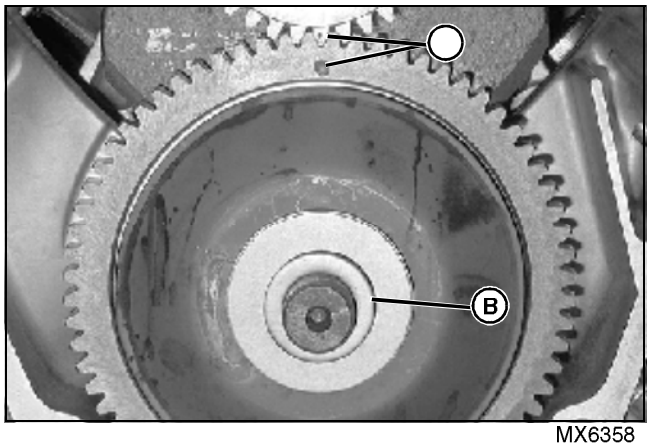
Inner Rotor-to-Outer Rotor Clearance (Wear Limit) 0.2 mm (0.008 in.)

Relief Valve Spring Free Length . . . . 19.5 mm (0.77 in.)

Remove and Install Camshaft and Tappets

1. Remove rocker arms and push rods. (See "Remove Rocker Arms and Push Rods" on page 70.)

2. Remove crankcase cover. (See "Remove and Install Crankcase Cover" on page 78.)



MX6358

3. Rotate camshaft and crankshaft until timing marks (A) align.

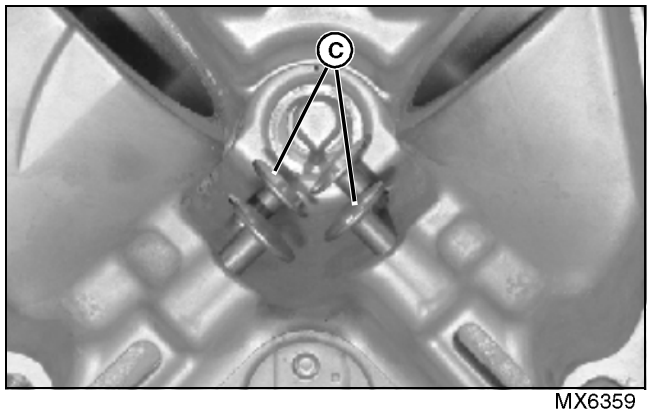
4. Turn engine with cylinders down to prevent tappets from falling out when camshaft is removed.

5. Remove camshaft and thrust washer (B). Remove thrust washer from camshaft.

6. Remove camshaft.

7. Inspect camshaft for wear or damage. (See "Inspect Camshaft and Tappets" on page 83.)

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



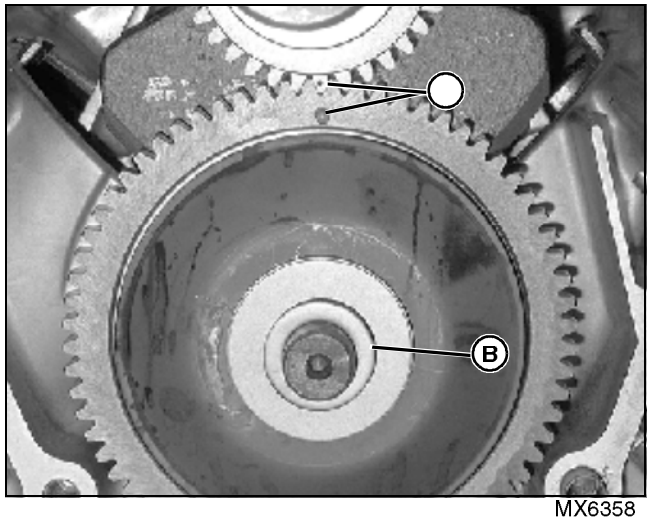
MX6359

8. Mark each tappet (C) as it is removed so it can be installed in its original location.

9. Remove and inspect tappets for wear or damage. (See "Inspect Camshaft and Tappets" on page 83.)

Installation is done in the reverse order of removal.

- Apply a thin film of clean engine oil to tappets and bores, and install tappets in original bores.
- Apply a thin film of clean engine oil to camshaft lobes and journals before installation.



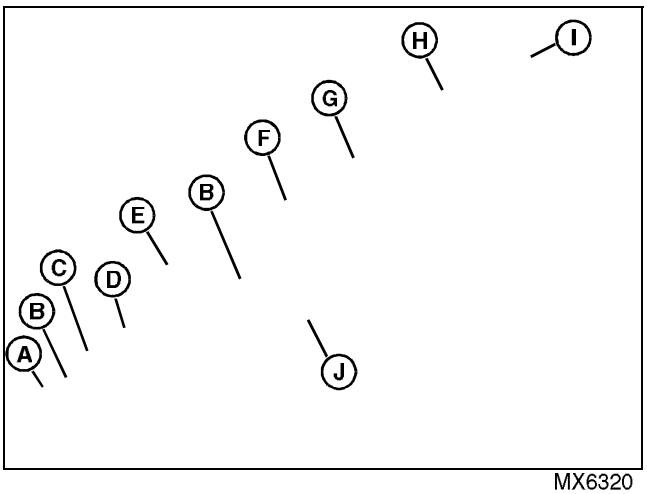
MX6358

- Align timing marks (A) when installing camshaft.
- Make sure thrust washer (B) is in place before installing crankcase cover.

Inspect Camshaft and Tappets

1. Measure camshaft bearing bore in cylinder block. (See "Inspect Cylinder Block" on page 92.)

2. Measure camshaft bearing bore in crankcase cover. (See "Remove and Install Crankcase Cover" on page 78.)

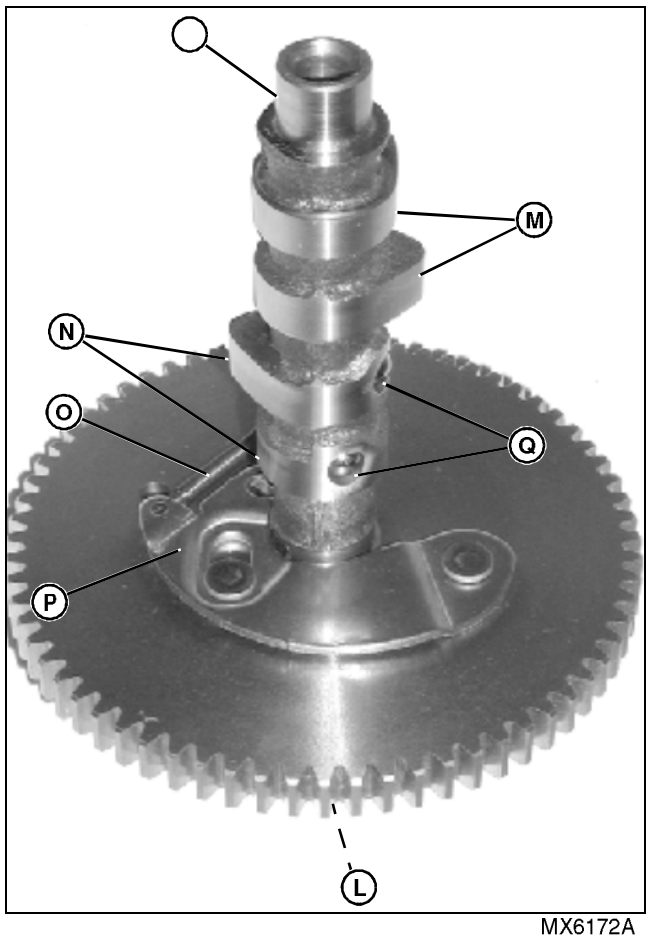


MX6320

A - Thrust Washer
B - Snap Ring (2 used)
C - Washer
D - Sleeve
E - Plate
F - Guide
G - Backing Plate
H - Camshaft
I - ACR Return Spring
J - Ball (6 used)

3. Disassemble governor flyweight components by removing snap rings (B).

4. Inspect balls (J), guide (F) and plates (E and G) for wear.



MX6172A

5. Measure bearing journals (K and L) on each end of the camshaft.

6. Inspect and measure intake (M) and exhaust (N) lobes at the point of greatest lift.

7. Inspect ACR return spring (O), arm (P) and balls (Q) for damage. Verify that all parts move freely.

8. Inspect tappets for abnormal wear.

Specifications:

Bore ID (Wear Limit). . . . . 16.136 mm (0.6352 in.)

Bearing Journal OD (Wear Limit) . . 15.985 mm (0.6293 in.)

Cam Lobe Height (Wear Limit) . . 29.621 mm (1.166 in.)

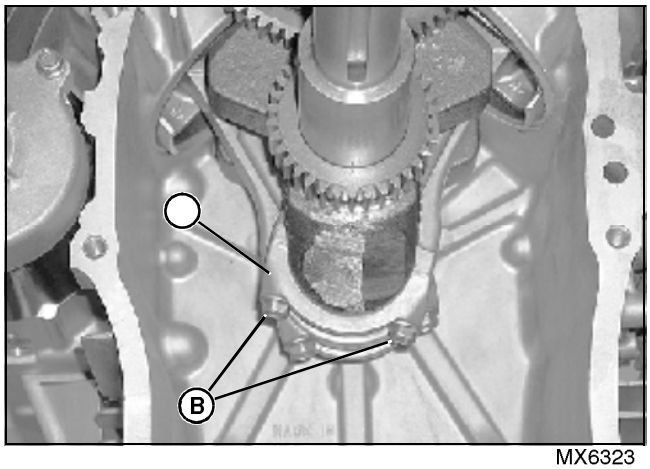
Remove Piston and Connecting Rod

1. Remove cylinder heads. (See “Remove and Install Cylinder Head” on page 72.)

2. Remove crankcase cover. (See “Remove and Install Crankcase Cover” on page 78.)

3. Check cylinder bore for carbon and varnish ridges. These ridges can cause piston damage if not removed.

4. If necessary, remove ridge from top of cylinder bore using a ridge reamer.



MX6323

5. Turn crankshaft to expose connecting rod end cap (A).

IMPORTANT: Avoid damage! No. 1 cylinder is the one closest to the flywheel. Mark each piston, end cap and connecting rod with the cylinder number it was removed from.

6. Mark pistons, end caps and connecting rods with cylinder number.

7. Remove capscrews (B) and connecting rod cap.

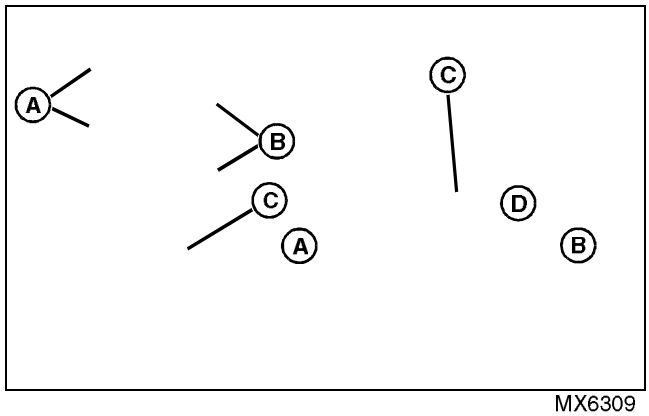
8. Push piston and connecting rod assemblies from cylinder bore.

9. Disassemble the piston and connecting rod. (See “Disassemble Piston and Connecting Rod” on page 85.)

10.Inspect all parts for wear or damage. (See “Inspect Piston and Connecting Rod” on page 86.)

Install Piston and Connecting Rod

1. Deglaze cylinder bore. (See “Deglaze Cylinder Bore” on page 93.)



MX6309

A - Top Compression Ring; Upper Oil Ring Rail End Gaps

B - Second Compression Ring; Lower Oil Ring Rail End Gaps

C - Arrow on Top of Piston

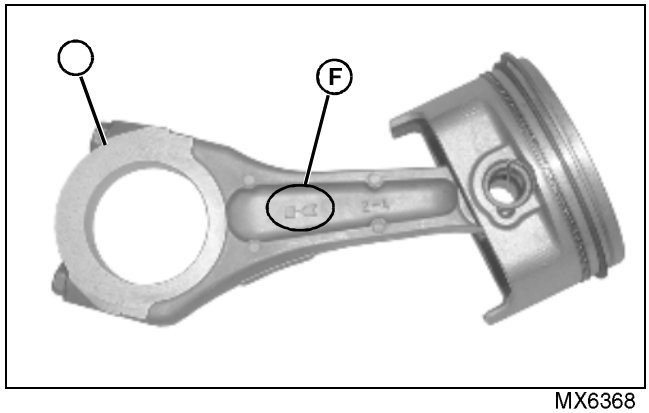
D - 30° - 45°

2. Stagger piston ring end gaps as shown.

3. Apply a thin film of clean engine oil to piston and rings. Compress rings with a ring compressor.

4. Apply a thin film of clean engine oil to cylinder bore, connecting rod bearing surface and ring compressor.

IMPORTANT: Avoid damage! Pistons and connecting rods MUST be assembled correctly and installed in the correct cylinder. (See “Assemble Piston and Connecting Rod” on page 88.)



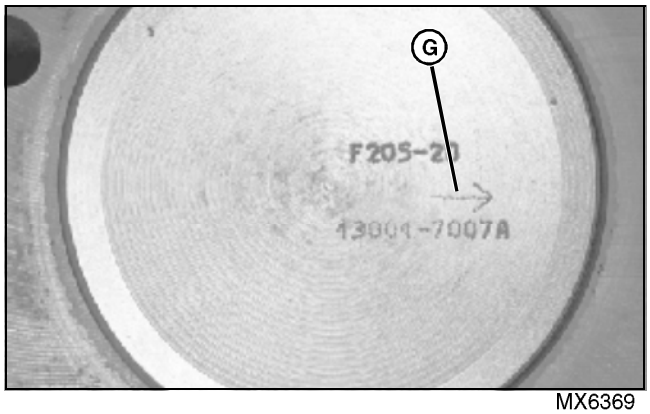
MX6368

5. Position the pistons as follows:

- No. 1 cylinder is closest to the flywheel.
- No. 1 cylinder: The “K” mark (F) must be opposite the arrow in the top of the piston.

- No. 2 cylinder: The “K” mark (F) must be on the same side as the arrow on the top of the piston.
- The machined surfaces (E) of the connecting rods must face each other when installed on the crankshaft.

6. Compress piston rings using a suitable ring compressor.



MX6369

7. Place piston in bore with arrow (G) pointing toward the flywheel. Tap into place using a wooden dowel.

8. Install connecting rod cap. Tighten capscrews to specification.

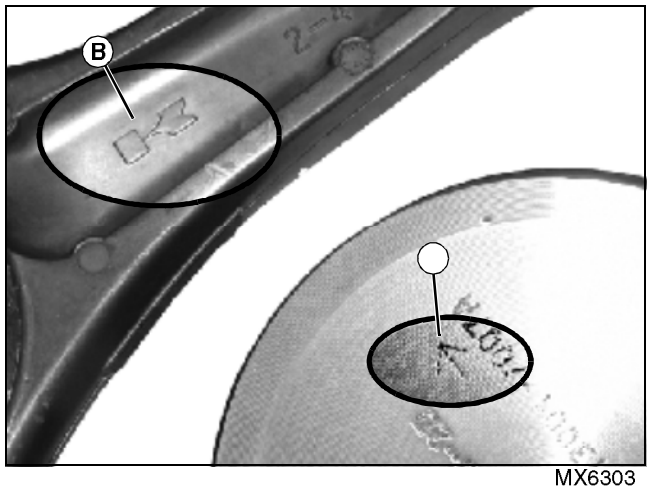
9. Install crankcase cover. (See “Remove and Install Crankcase Cover” on page 78.)

10. Install cylinder heads. (See “Remove and Install Cylinder Head” on page 72.)

Specifications

Connecting Rod Cap Capscrew Torque . . . . 21 N•m (15 lb-ft.)

Disassemble Piston and Connecting Rod



MX6303

IMPORTANT: Avoid damage! Note the location of the arrow match mark (A) on the piston in relation to the “K” mark (B) on the connecting rod.


MX6304

1. Remove piston pin retainers.

2. Push piston pin through piston and remove connecting rod from piston.

3. Use a piston ring expander to remove the top and second rings from the piston.

4. Remove the three-piece oil ring by carefully spiraling each component off from the piston using your thumbs.

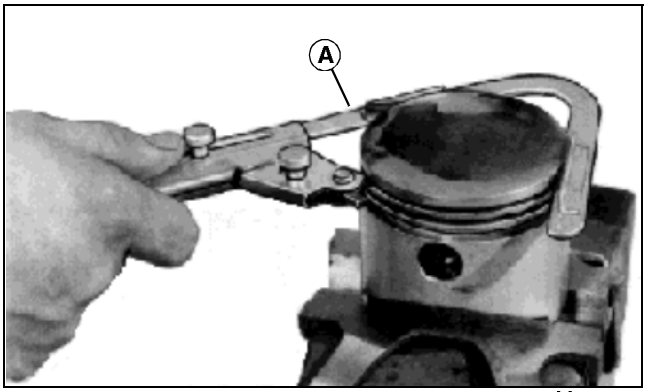
5. Inspect and measure parts to verify if they can be reused. (See “Inspect Piston and Connecting Rod” on page 86.)

Inspect Piston and Connecting Rod

Piston

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

1. Remove all deposits from piston.

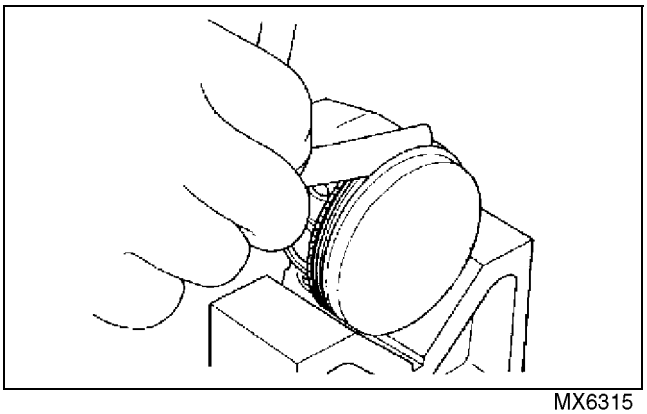


M29946

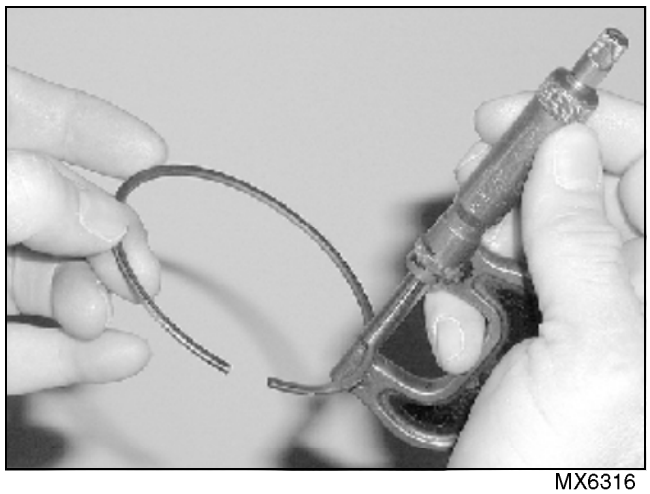
2. Clean carbon deposits from piston ring grooves with a ring groove cleaner (A). If cleaning tool is not available, break an old ring and use it to carefully clean groove.

3. Check that all oil return passages in grooves are open.

4. Inspect piston for scoring or fractures. Replace piston if damaged.


MX6315

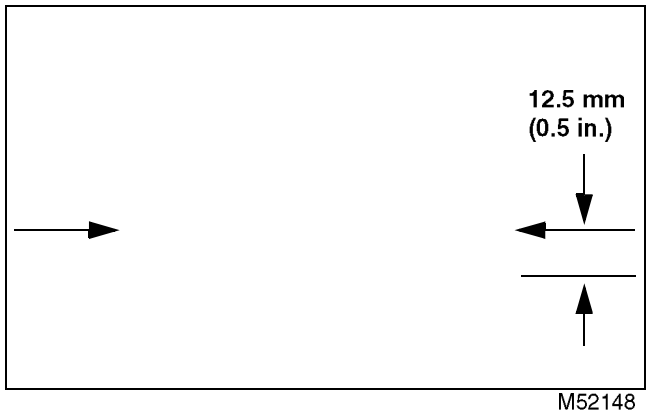
5. Measure piston compression ring side clearance (top and center rings) at several points around piston (use new rings). Replace piston if clearance is greater than specification.


MX6316

6. Measure the top and center piston ring thickness at several points around the ring. Replace all rings if any are less than specification.

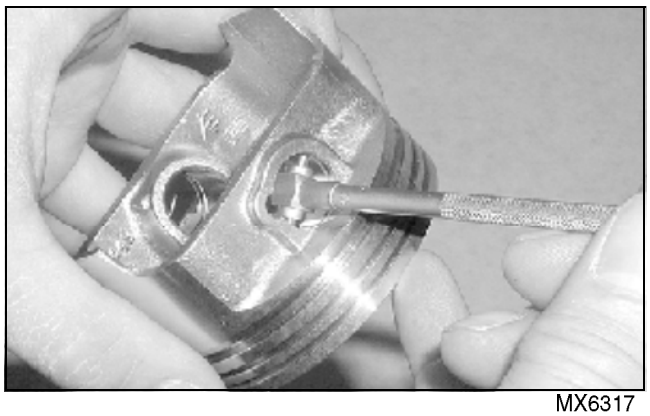
7. Measure piston ring end gap. (See “Check Piston Ring End Gap” on page 89.) Replace all piston rings if any measurement is greater than specification.

NOTE: If the engine has had a previous major overhaul, an oversized piston may have been installed. Pistons and rings are available in 0.50 mm (0.020 in.) oversize.



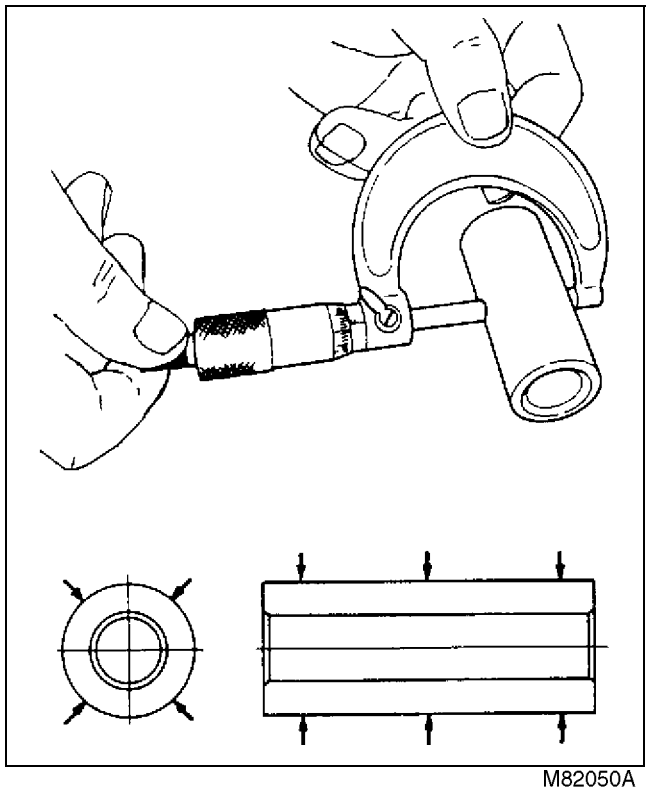
M52148

8. Measure piston outside diameter at a point 12.5 mm (0.5 in.) from the bottom of the skirt and 90° to the piston pin bore. Replace piston if outside diameter measures less than specification.



MX6317

9. Measure piston pin bore diameter in piston. Replace piston if measurement is greater than specification.



M82050A

Picture Note: Arrows indicate measuring positions.

10.Measure piston pin diameter at six places. Replace pin if any measurement is less than specification.

NOTE: If the engine has had a previous major overhaul, an oversized piston may have been installed. Pistons and rings are available in 0.50 mm (0.020 in.) oversize.

Specifications:

Piston Pin Bore ID (Wear Limit). . . 16.08 mm (0.633 in.)

Piston Pin OD (Wear Limit) . . . . . 15.96 mm (0.628 in.)

Top Compression Ring-to-Groove Side Clearance Limit 0.18 mm (0.007 in.)

Center Compression Ring-to-Groove Side Clearance Limit. . . . . 0.16 mm (0.006 in.)

Top Compression Ring End Gap (Wear Limit) 0.65 mm (0.026 in.)

Center Compression Ring End Gap (Wear Limit) . . . . . 0.078 mm (0.031 in.)

Oil Ring End Gap (Wear Limit) . . . . 1.05 mm (0.041 in.)

Top Compression Ring Thickness (Min) . . . . . 1.40 mm (0.055 in.)

Center Compression Ring Thickness (Min). . . 1.40 mm (0.055 in.)

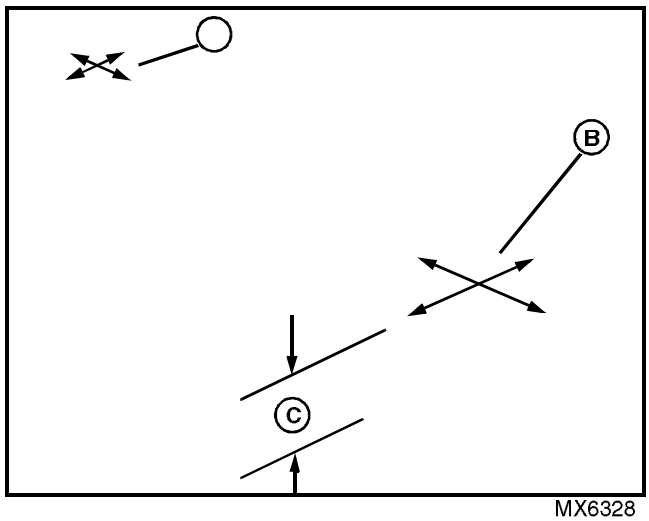
Piston Thrust Face OD Wear Limit (Standard) . . . . . 74.99 mm (2.952 in.)

Piston Thrust Face OD (Wear Limit) (0.50 mm [0.020 in.] Oversize Piston). . . . . 75.49 mm (2.972 in.)

Connecting Rod

1. Analyze crankshaft and connecting rod wear. (See “Analyze Crankshaft and Connecting Rod Wear” on page 92.)

2. Clean and inspect connecting rod. Replace the connecting rod if either bore is scored or damaged.



MX6328

3. Measure connecting rod piston pin bore (A). Replace connecting rod if measurement is greater than specification.

4. Lightly oil connecting rod capscrews and install connecting rod cap. Tighten capscrews to specification.

5. Measure connecting rod crankshaft bearing bore (B). Replace connecting rod if measurement is greater than specifications.

6. Measure connecting rod thickness (C). Replace connecting rod if measurement is less than specifications.

Specifications:

Connecting Rod ID, Crankshaft End (Wear Limit) . . . . . 40.044 mm (1.577 in.)

Connecting Rod Width, Crankshaft End (Wear Limit) . . 20.45 mm (0.805 in.)

Connecting Rod ID, Piston Pin End (Wear Limit) . . . . . 16.05 mm (0.632 in.)

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

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

Connecting Rod Capscrew Torque . . . 21 N•m (15 lb-ft)

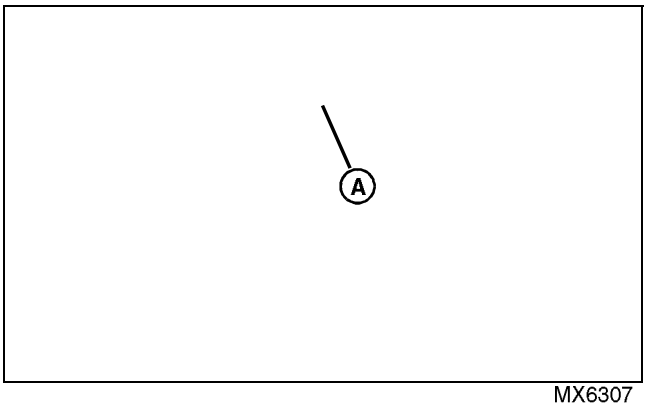
Assemble Piston and Connecting Rod

1. Before installing rings on piston, check ring end gap in cylinder bore. (See "Check Piston Ring End Gap" on page 89.)

IMPORTANT: Avoid damage! Be sure that top and second compression rings are not interchanged.

DO NOT align any piston ring end gaps with piston pin bore.

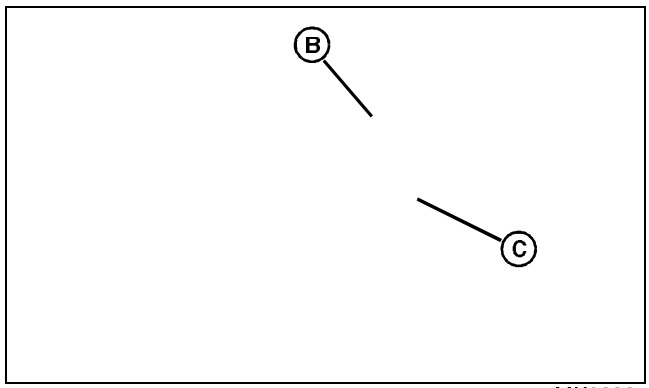
NOTE: Rings should rotate freely in grooves after installation.



MX6307

2. Install piston rings as follows:

   • Oil Control Ring (Bottom Groove): Install expander, then rails. Make sure the ends (A) of expander do not overlap. Carefully spiral oil rails in place and position gaps 180° apart.



MX6308

   • Compression Ring (Center Groove): Install the second ring as shown. Be sure the notch (C) is facing down.

   • Compression Ring (Top Groove): Install the top ring as shown. Be sure the chamfer (B) is facing up.

3. Apply a light coat of clean engine oil to piston pin, piston pin bore and connecting rod bearing.

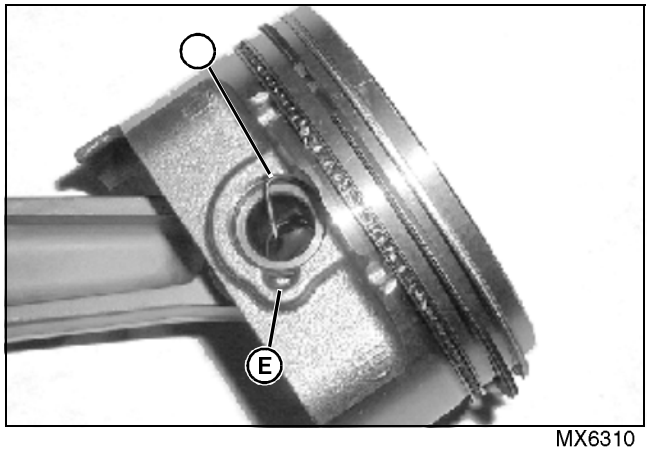
IMPORTANT: Avoid damage! The piston and connecting rods must be positioned as follows:

- **No.1 cylinder piston: Align the arrow on the top of the piston with the side of the connecting rod NOT having the "K" mark.**
- **No. 2 cylinder piston: Align the arrow on the top of the piston with the side of the connecting rod HAVING the "K" mark.**

4. Correctly position the connecting rod in the piston and install piston pin.

IMPORTANT: Avoid damage! DO NOT reuse piston pin retaining rings. ALWAYS install new ones.

DO NOT align retaining ring gap with cutout in piston pin bore.



MX6310

5. Install retaining ring (D) on each side by inserting one end in groove, and holding other end with a needle-nosed pliers, rotate the ring into place. Rotate retaining ring so the opening is away from notch (E) in the piston.

6. Correctly position the rings before installing piston in cylinder block. (See “Install Piston and Connecting Rod” on page 84.)

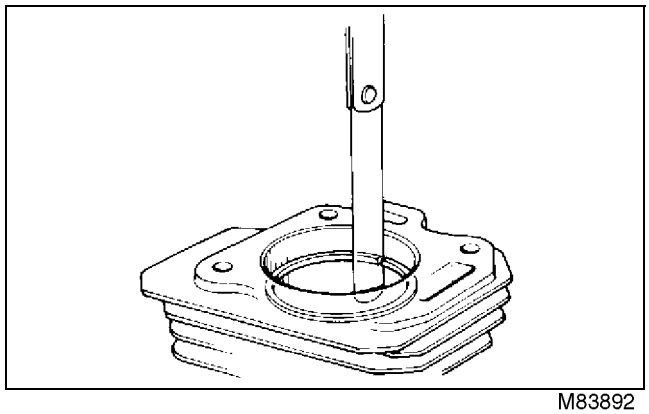
Check Connecting Rod-to-Crankshaft Clearance

There is no clearance specification for connecting rod-to-crankshaft. Perform the appropriate measurements on the connecting rods and crankshaft. (See “Inspect Crankshaft” on page 92, also See “Inspect Piston and Connecting Rod” on page 86.)

Replace any component that is not within specification.

Check Piston Ring End Gap

1. Use a clean or new piston to push piston compression ring squarely into bore, to a point where it normally runs.


M83892

2. Measure end gap using a feeler gauge.

3. Rings with too large a gap must be replaced. If one piston ring needs to be replaced, all must be replaced as a set.

If gap is too large with new rings, the cylinder is worn beyond limits and requires reboring to the next oversize.

Specifications:

Top Compression Ring End Gap (Wear Limit) 0.65 mm (0.026 in.)

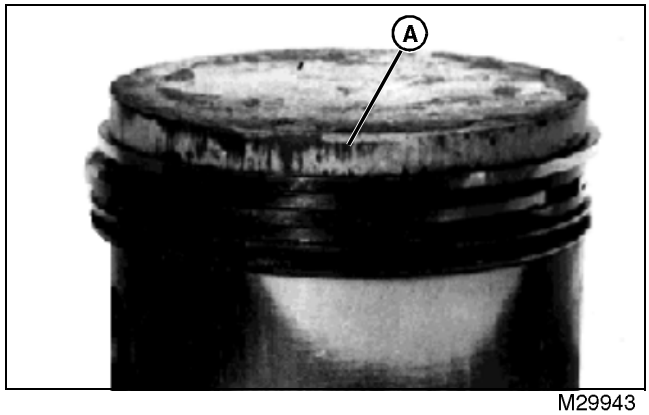
Center Compression Ring End Gap (Wear Limit) . . . . . 0.078 mm (0.031 in.)

Oil Ring End Gap (Wear Limit) . . . . 1.05 mm (0.041 in.)

Analyze Piston Ring Wear

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

Ring end gaps should be staggered on the piston during installation. (See “Assemble Piston and Connecting Rod” on page 88.) End gaps in alignment can also cause oil consumption and blow-by.

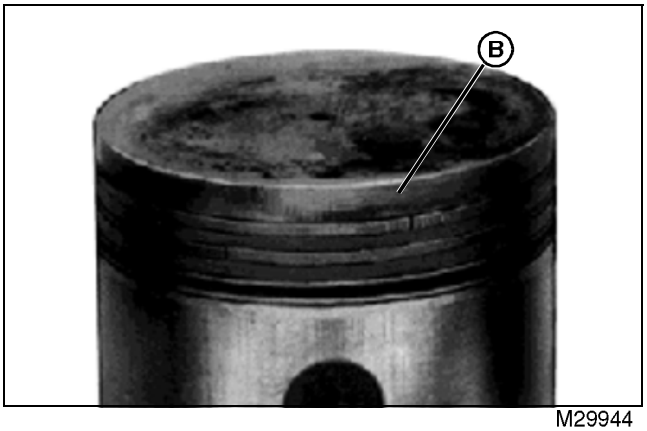


M29943

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

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

- Dirty cooling shroud and cylinder head.
- Lack of cylinder lubrication.
- Improper combustion.
- Wrong bearing or piston clearance.
- Too much oil in crankcase, causing fluid friction.

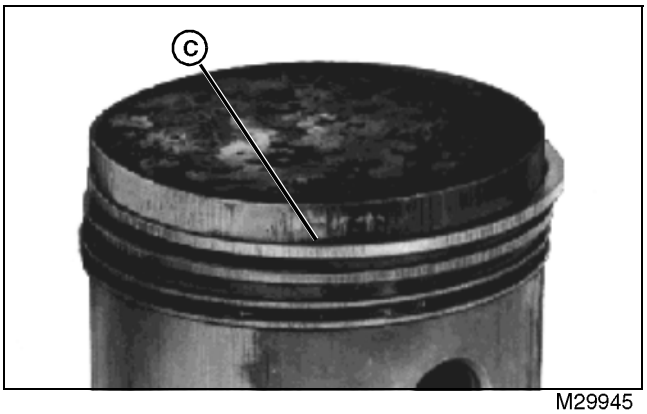


M29944

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

Engine overheating and ring sticking is usually caused by one or more of the following:

- Overloading.
- Incorrect ignition timing.
- Lean fuel mixture.
- Dirty cooling fins.
- Incorrect oil.
- Low oil supply.
- Stale fuel.

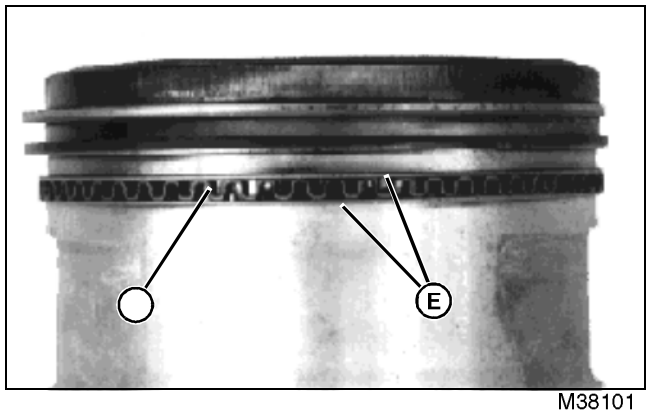


M29945

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

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

- Damaged, collapsed or improperly installed air filter.
- Loose connection or damaged basket between air cleaner and carburetor.
- Air leak around carburetor-to-cylinder head gasket.
- Air leak around throttle shaft.
- Failure to properly clean cylinder bore after reconditioning engine.



M38101

Abrasive particles in engine oil cause scratches on side rails (E) of oil control ring. Inner spacer (D) wear or distortion may cause:

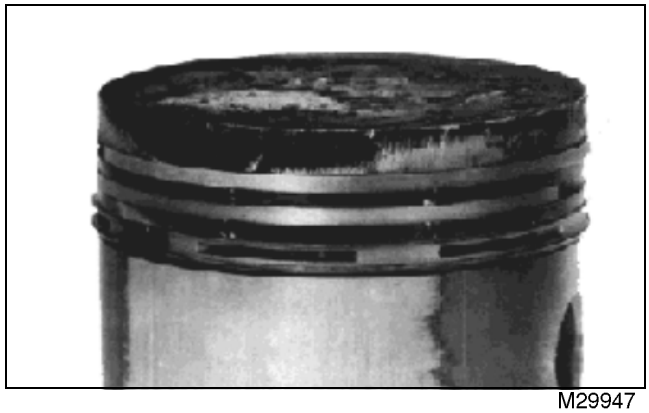
- High oil consumption.
- Increased deposits in combution chamber.
- Sticking compression rings.

Increased oil consumption may be caused by:

- Worn side rails with low tension.
- Worn or distorted inner spacer.

Analyze Piston Wear

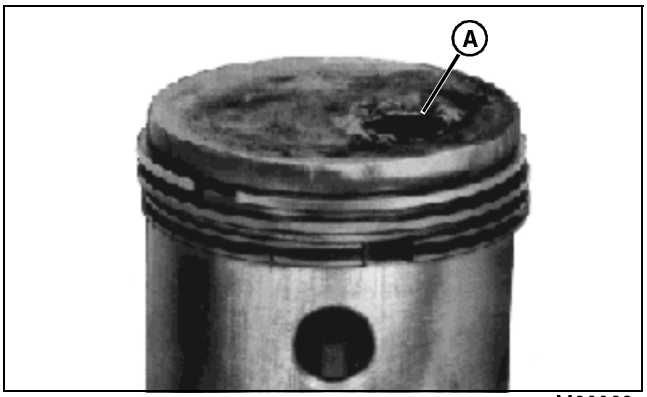
Detonation is abnormal combustion causing excessive temperature and pressure in the combustion chamber. Commonly called knock, spark knock or timing knock, detonation occurs as the compressed fuel/air mixture ignites spontaneously to interrupt the normal ignition.


M29947

The following is a list of possible causes for detonation:

- Pre-ignition.
- Lean fuel mixture.

- Low octane fuel.
- Advanced ignition timing.
- Engine lugging.
- Build-up of carbon deposits on piston or cylinder head, causing excessive compression.
- Wrong cylinder head or milling of head, increasing compression ratio.

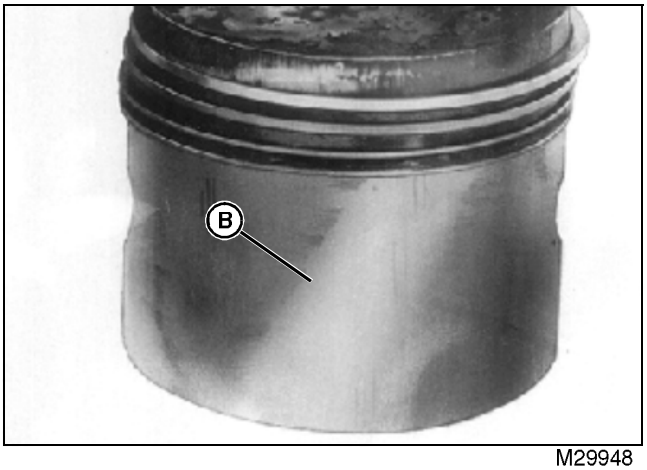


M30039

Pre-ignition is the igniting of the fuel/air mixture prior to regular ignition spark. Pre-ignition causes shock, resulting in pings, vibration, detonation and power loss. Severe damage (A) to piston, rings and valves results from pre-ignition.

Check the following for causes of pre-ignition:

- Internal carbon deposits.
- Incorrect spark plug (high heat range).
- Broken ceramic in spark plug.
- Sharp edges on valves.
- Sharp edges in combustion chamber.



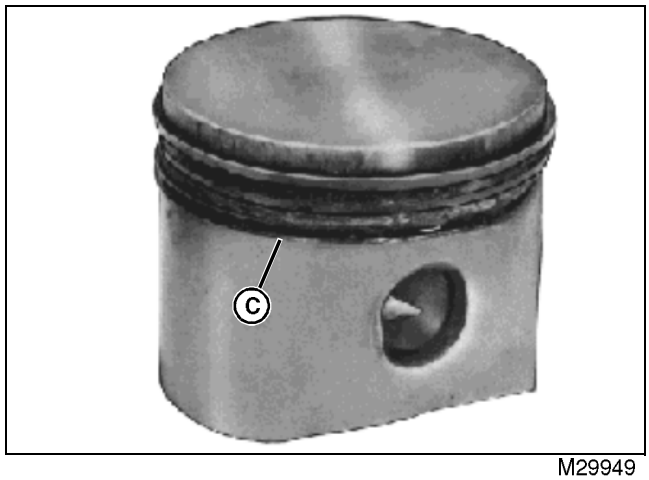
M29948

Check rod and piston alignment when piston shows a diagonal wear pattern (B) extending across the skirt of the piston. Contact with the cylinder wall shows on the bottom of the skirt at left and at the ring lands at the right.

A cylinder bored at an angle to the crankshaft can also cause improper ring contact with the cylinder.

This condition causes:

- Rapid piston wear.
- Uneven piston wear.
- Excess oil consumption.



M29949

A broken retaining ring caused the damage (C) shown.

Retaining rings loosen or break due to:

- Rod misalignment.
- Excessive crankshaft end play.
- Crankshaft journal taper.
- Weak retaining rings.
- Incorrectly installed retaining rings.

Inertia can cause a broken retaining ring to beat out the piston and cylinder, causing extensive damage.

Remove and Install Crankshaft

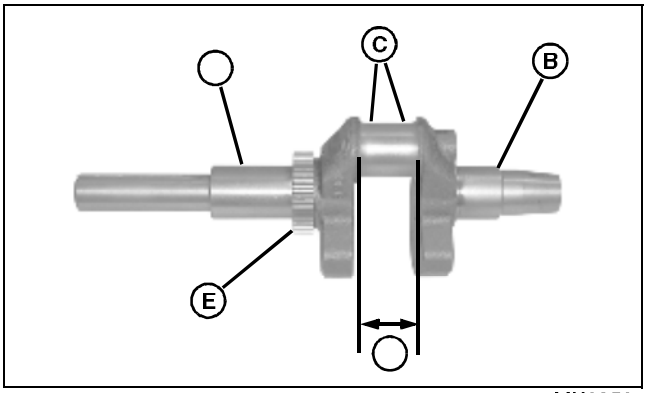
1. Remove flywheel. (See “Remove and Install Flywheel” on page 69.)
2. Remove camshaft. (See “Remove and Install Camshaft and Tappets” on page 82.)
3. Remove pistons and connecting rods. (See “Remove Piston and Connecting Rod” on page 84.)
4. Remove crankshaft.
5. Inspect crankshaft for wear or damage. (See “Inspect Crankshaft” on page 92.)
6. Measure crankshaft bore in cylinder block. (See “Inspect Cylinder Block” on page 92.)
7. Measure crankshaft bore in crankcase cover. (See “Remove and Install Crankcase Cover” on page 78.)

Installation is done in the reverse order of removal.

Inspect Crankshaft

1. Analyze crankshaft and connecting rod wear. (See "Analyze Crankshaft and Connecting Rod Wear" on page 92.)

2. Measure crankshaft bearing bore in cylinder block. (See "Inspect Cylinder Block" on page 92.)



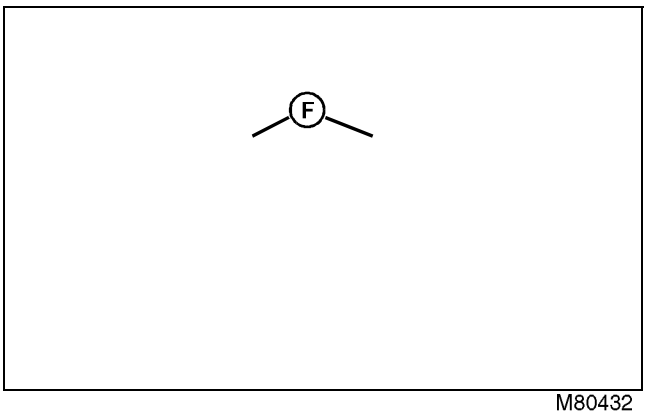
MX6356

3. Measure the diameter of main bearing journals (B).

4. Measure the diameter of connecting rod journals (C).

5. Measure the connecting rod journal width (D).

6. Inspect camshaft drive gear (E) for wear or damage. Replace crankshaft as required.



M80432

7. Place crankshaft into an alignment jig and slowly rotate crankshaft. Use dial indicators (F) to measure maximum Total Indicated Runout (TIR). Replace crankshaft if runout exceeds specification.

Specifications:

Main Bearing Journals OD (Min). 39.896 mm (1.571 in.)

Connecting Rod Journal OD (Min) . . . . . 39.940 mm (1.5724 in.)

Connecting Rod Journal Width (Max) . . . . . 43.10 mm (1.697 in.)

Crankshaft Runout (TIR) (Max) . . . . 0.05 mm (0.002 in.)

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 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 also result from:

- Engine run low on oil or without oil.
- Oil not changed regularly.
- Connecting rod cap installed incorrectly.

Inspect Cylinder Block

Other Material

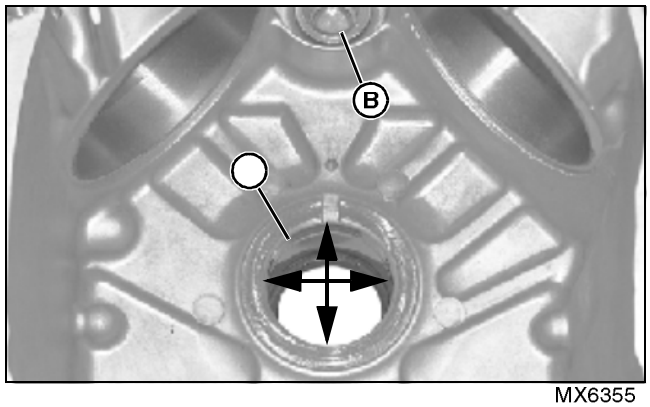
Part No.	Part Name	Part Use
NA	Zinc Oxide/Wood Alcohol	Check block for cracks.

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

A bare block is available for service.

1. Clean block and check for cracks.

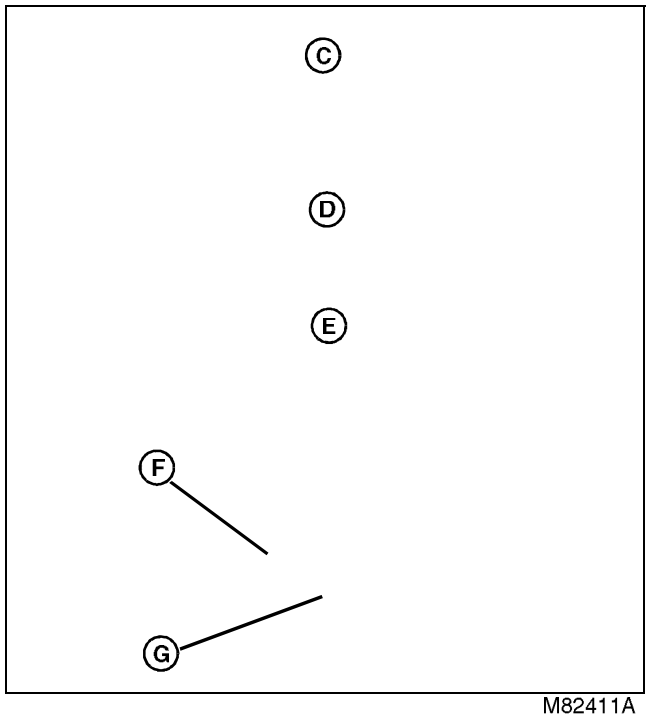
NOTE: Measurements should be made at several points and at 90° to one another.



MX6355

2. Measure crankshaft bore (A). Replace the engine block if the bore is greater than specifications. Check bore for wear or scoring.

3. Measure the inside diameter of the camshaft bore (B). Replace engine block if bore is greater than specifications.



M82411A

4. Measure cylinder bore diameter at three positions: top (C), middle (D) and bottom (E). At these three positions, measure in both directions: along the crankshaft centerline (G) and in the direction of crankshaft rotation (F).

Specifications:

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

Cylinder Bore ID New (Standard) . . . 75.18 - 75.20 mm (2.960 - 2.961 in.)

Cylinder Bore ID Wear Limit (Standard) . . . . . 75.28 mm (2.964 in.)

Cylinder Bore ID Maximum Out-of-Round (Standard). . 0.056 mm (0.0022 in.)

Cylinder Bore ID New (0.5 mm Oversize) . . . . . 75.68 - 75.70 mm (2.979 - 2.980 in.)

Cylinder Bore ID Wear Limit (0.5 mm Oversize) . . . . . 75.78 mm (2.983 in.)

Cylinder Bore ID Maximum Out-of-Round (0.5 mm Oversize). . . . . 0.056 mm (0.0022 in.)

Crankshaft Bore ID Wear Limit . . . 40.15 mm (1.581 in.)

Camshaft Bore ID (Wear Limit) . 16.136 mm (0.6352 in.)

Replace Oil Seal

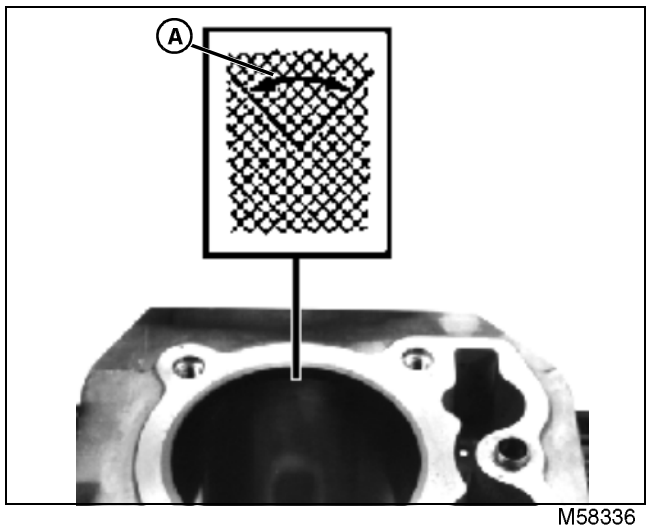
Other Material

Part No.	Part Name	Part Use
NA	Lithium-Based Grease	Pack oil seals.

1. Remove old seal using a seal remover.
2. Pack lithium-based grease inside lips of seal.
3. Install seal with lip toward inside of crankcase using a seal driver set. Install seal flush with housing.

Deglaze Cylinder Bore

1. Deglaze cylinder bore using a rigid hone with a 220 - 300 grit stone.



M58336

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

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

3. Clean cylinder walls using clean white rags and warm soapy water. Continue to clean cylinder until white rags show no discoloration.
4. Dry cylinder and apply a light coat of clean engine oil.

Rebore Cylinder Block

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

NOTE: The cylinder can be rebored to use 0.50 mm (0.020 in.) oversize piston and rings. Have a reliable repair shop rebore the block, or use a drill press and honing tool.

Rebore cylinder with a honing tool to initial and final bore specifications.

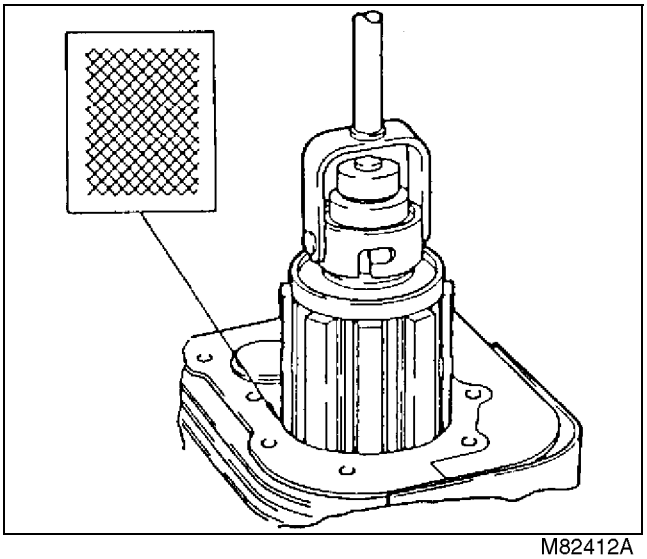
1. Align center of bore to drill press center.
2. Lower and raise hone until end extends 20 - 25 mm (0.75 - 1.0 in.) past end of cylinder.
3. Adjust hone stones until they contact the narrowest point of the cylinder walls.
4. Coat the inside of cylinder with honing oil. Turn hone by hand. Adjust if too tight.
5. Run drill press at 200 - 250 rpm. Move hone up and down in cylinder approximately 20 times per minute.

NOTE: Measure bore when cylinder is cool.

6. Stop press and check cylinder diameter.

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

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



M82412A

8. If cylinder bore exceeds wear limit, rebore cylinder or replace block.
9. Hone the cylinder an additional 0.007 - 0.009 mm (0.0003 - 0.0004 in.) for final bore specifications. This allows for 0.020 mm (0.0008 in.) shrinkage when cylinder cools.

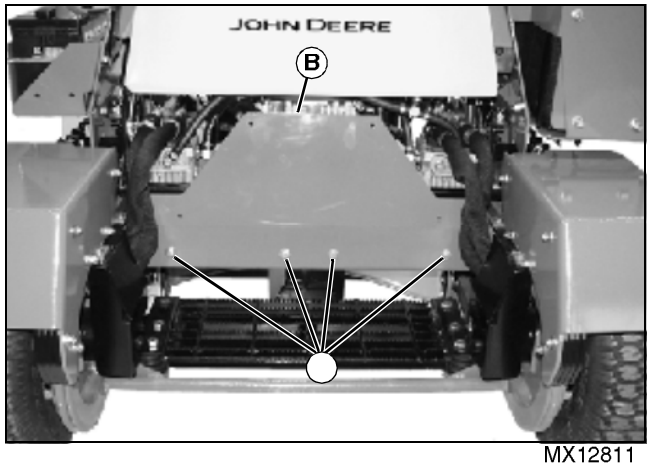
IMPORTANT: Avoid damage! DO NOT use gasoline, kerosene or commercial solvents to clean cylinder bore. Solvents will not remove all abrasives from cylinder walls.

10. Clean cylinder walls using clean white rags and warm soapy water. Continue to clean cylinder until white rags show no discoloration.
11. Dry cylinder and apply a light film of clean engine oil.

Remove and Install Starting Motor

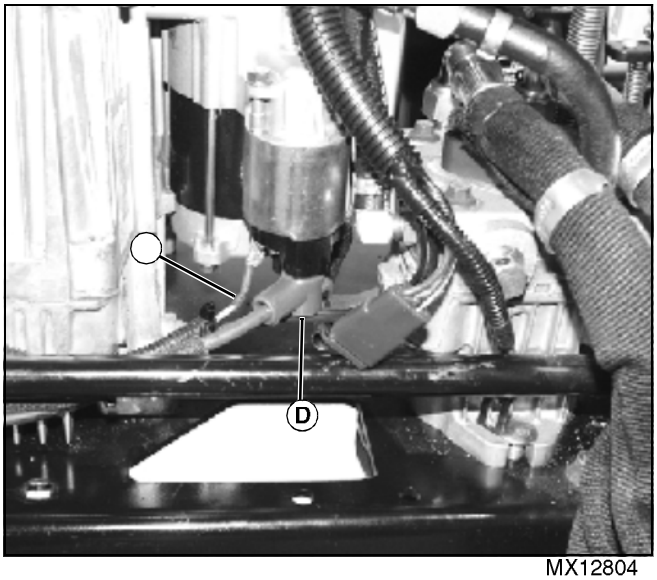
CAUTION: Avoid injury! Engine components are HOT. To prevent possible burns, allow the engine to cool before removing.

1. Allow engine to cool before removing the engine.
2. Disconnect the negative battery cable at the battery.



MX12811

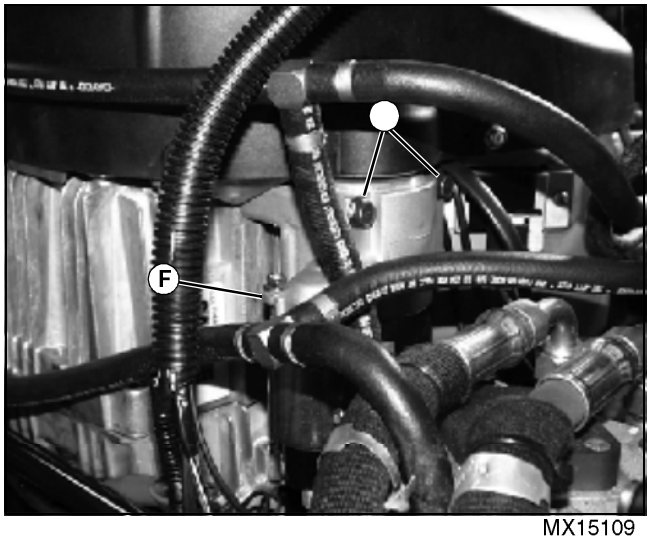
3. Remove four capscrews and washers (A).
4. Remove rear shield (B).



MX12804

5. Disconnect the positive battery cable (C) from starter motor solenoid.

6. Disconnect gray wire (No. 600 [W1]) (D) from starter motor solenoid.



MX15109

7. Remove two capscrews (E).

8. Remove starting motor (F).

Installation is done in the reverse order of removal.

- Tighten starting motor mounting capscrews (E) to specifications.

Specifications:

Mounting Capscrew Torque. . . . . 15 N•m (132 lb-in.)

Analyze Starting Motor Condition

The starting motor overheats because of:

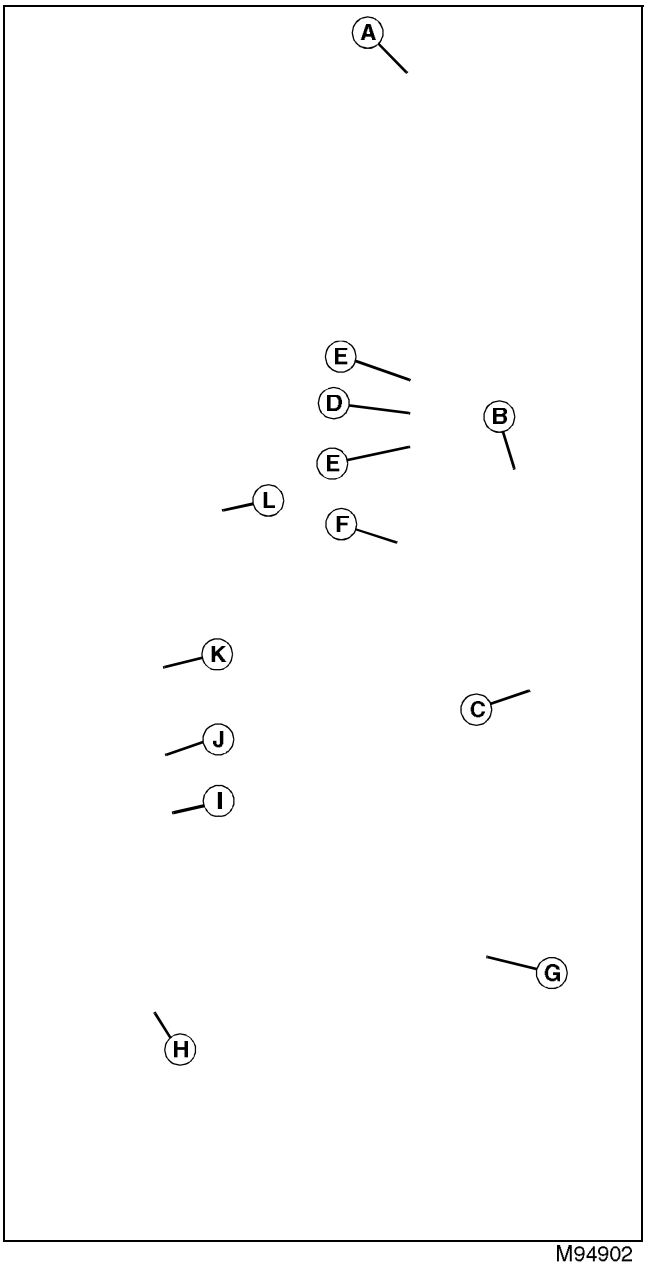
- Long cranking.
- Armature binding.

The starting motor operates poorly because of:

- Armature binding.
- Dirty or damaged starting motor 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: Starting motor repair is limited to brushes, end caps and starting motor drive. Fields in starting motor are permanent magnets and are not serviceable. If housing or armature is damaged, replace starting motor.

Disassemble and Assemble Starting Motor



M94902

A - Front Cover
B - Shift Lever
C - Solenoid
D - Retaining Clip
E - Pinion Stopper
F - Pinion
G - Armature
H - End Cover
I - Insulator
J - Brush Springs
K - Brush Holder
L - Brush

Disassembly

1. Mark body and covers for correct alignment during reassembly.

2. Push pinion stopper (E) toward pinion (F) to remove retaining clip (D).

3. Inspect parts for wear and damage.

4. Test solenoid (C), starting motor armature (G) and brushes (L). (See “Inspect Starting Motor Components” on page 96.)

Assembly is done in the reverse order of disassembly.

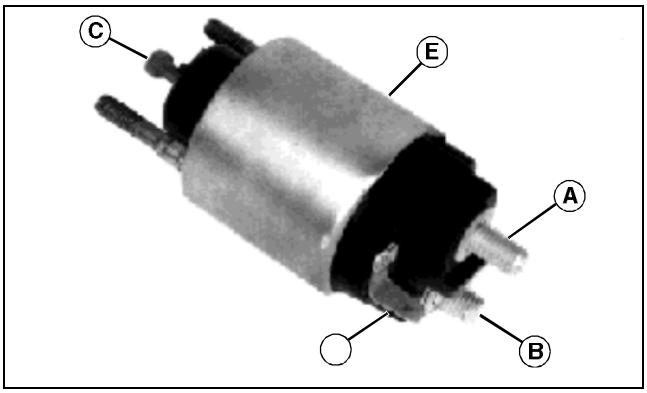
Apply a thin film of multipurpose grease to:

- Sliding surfaces of armature and solenoid shift lever.
- Armature shaft spline.
- Points where shaft contacts cover.

Inspect Starting Motor Components

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

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



M51705

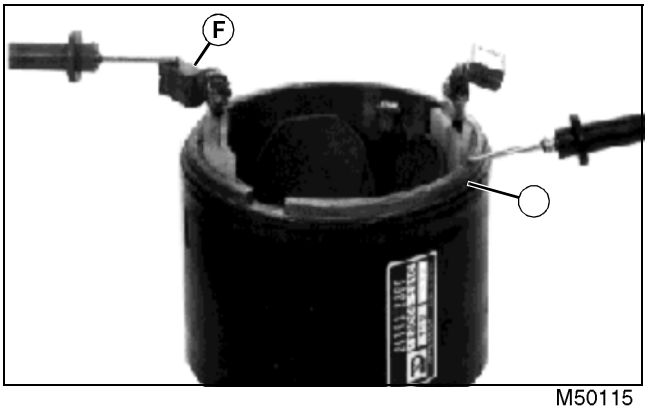
3. Test solenoid terminals (A and B) for continuity. There should be no continuity.

4. Depress switch arm (C). There should be continuity when arm is fully depressed.

5. Test for open circuits between terminal (B) and tang (D). There should be continuity.

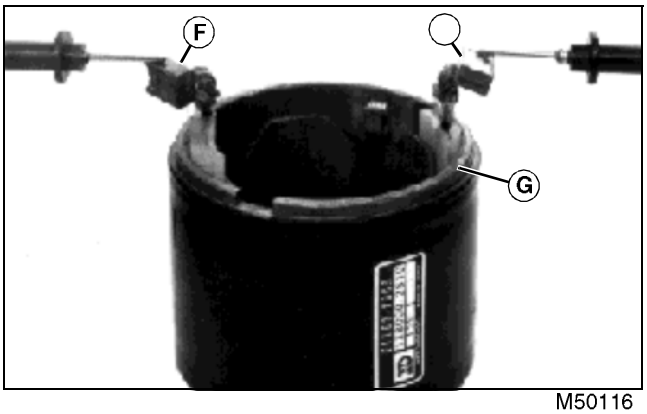
6. Test for open circuits between tang (D) and body (E). There should be continuity.

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



M50115

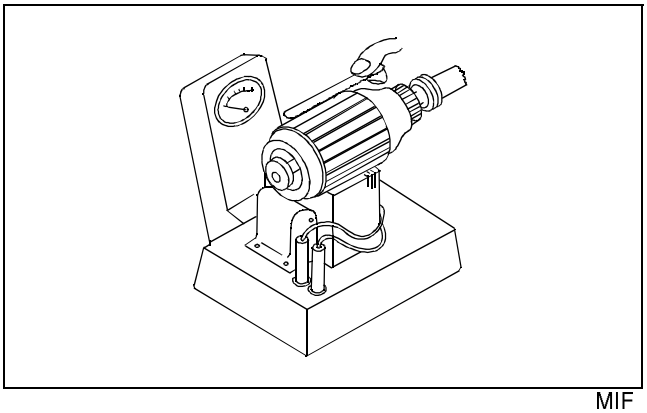
8. Test for grounded field winding. Touch one probe of tester fo field coil brush (F) and the other probe to the field coil housing (G). Be sure the brush lead is not touching the frame. If there is continuity, the coil is grounded and the field coil housing must be replaced.



M50116

9. Test for open field coil. Touch one probe of tester to each field coil brush (F). If there is no continuity, the field coil is open and the field coil housing assembly (G) must be replaced.

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

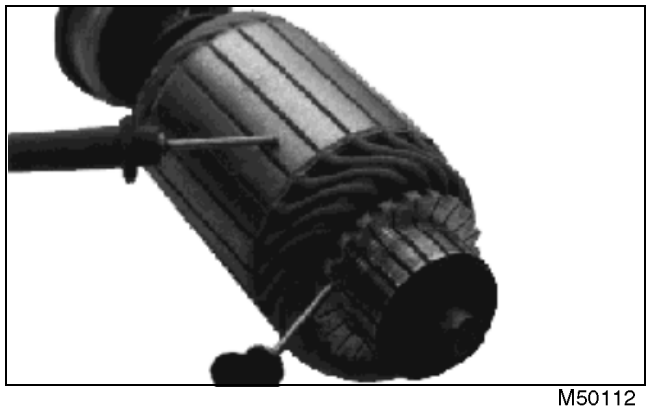


MIF

10.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.

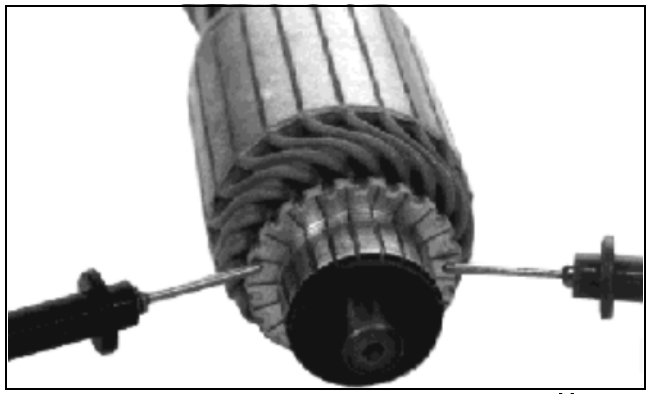
IMPORTANT: Avoid damage! Do not clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.

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



M50112

12.Test for grounded windings using an ohmmeter. 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

13.Test for open circuited windings using an ohmmeter. Touch probes on each commutator bar. If test shows no continuity, there is an open circuit and armature must be replaced.

Specifications:

Starting Motor Brush Minimum Length . . 6.4 mm (0.25 in.)

Table of Contents

ELECTRICAL TABLE OF CONTENTS

General Information

Reading Electrical Schematics

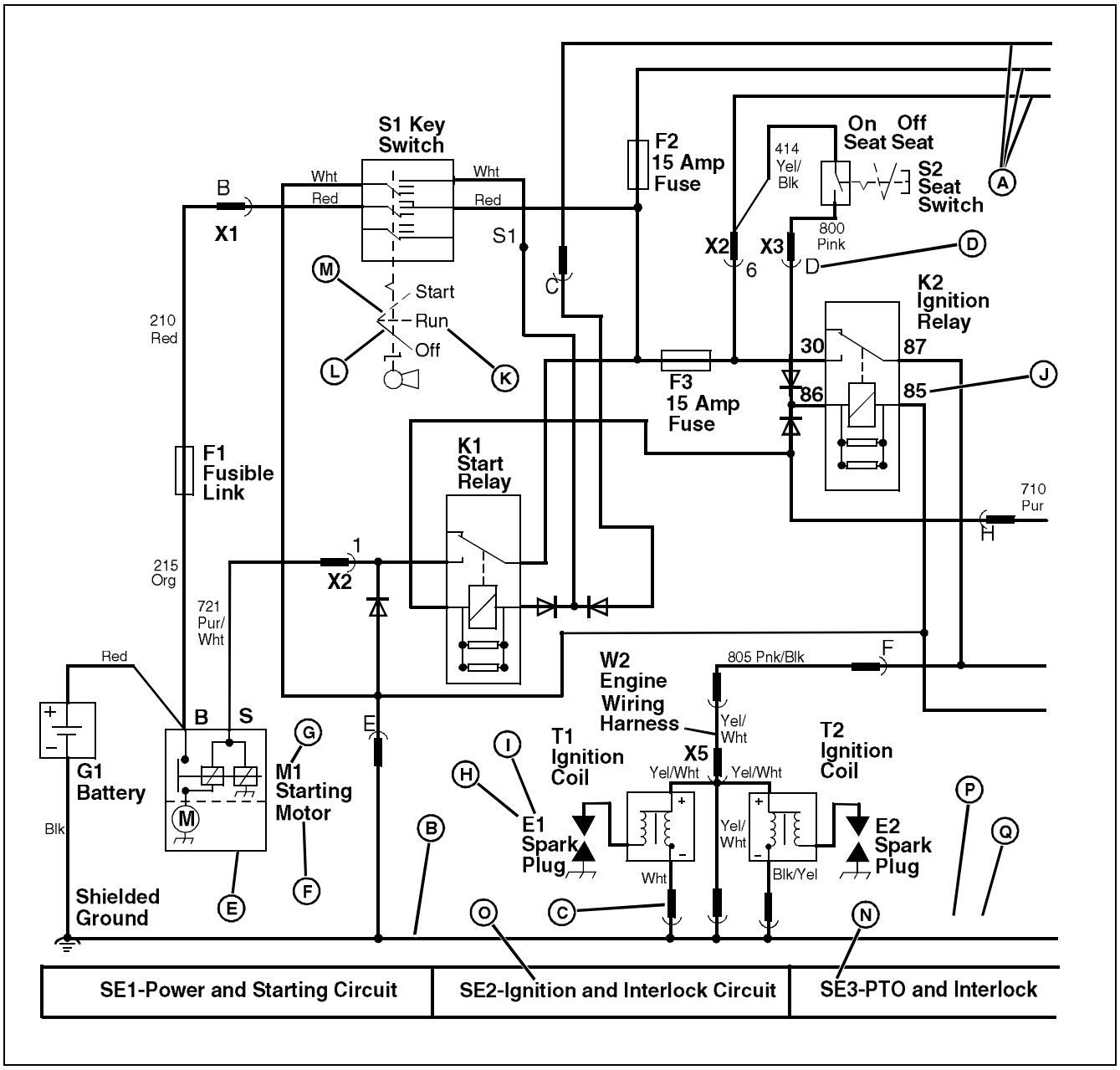
The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all ground wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in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

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

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

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

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



MIF

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

Theory of Operation Information

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

Diagnostic Information

The diagnostic procedures are used to test the complete circuit regardless of the problem or complaint. Select a symptom or system from the quick check or troubleshooting chart and follow the test procedures under that heading.

The diagnostic procedure lists:

- Test conditions
- Test sequence
- Test location
- Normal reading
- Check or test to perform if reading is not normal

When performing the test or check, be sure to set your machine up to the TEST POINT/PROCEDURES listed in the first column and follow the sequence carefully. The middle RESULTS column gives the reading or condition that should be obtained in **BOLD** print. If the results of the test or check are not normal, perform the test, check or adjustment listed below the **BOLD** print. The system diagram that accompanies each test procedure is drawn to resemble machine components. The leader line points to the exact point the test is to be made.

Wire Color Abbreviation Chart

Blk	**Black**
Blu	**Blue**
Brn	**Brown**
Grn	**Green**
Gry	**Gray**
Org	**Orange**
Pnk	**Pink**
Pur	**Purple**
Red	**Red**
Tan	**Tan**
Wht	**White**
Yel	**Yellow**
Blk/Wht	**Black/White**
Blu/Wht	**Blue/White**
Brn/Wht	**Brown/White**
Brn/Yel	**Brown/Yellow**
Dk Blu	**Dark Blue**
Dk Brn/Lt Grn	**Dark Brown/Light Green**
Dk Brn/Red	**Dark Brown/Red**
Dk Brn/Yel	**Dark Brown/Yellow**
Dk Grn	**Dark Green**
Lt Blue	**Light Blue**
Lt Grn	**Light Green**
Org/Wht	**Orange/White**
Pnk/Blk	**Pink/Black**
Pur/Wht	**Purple/White**
Red/Blk	**Red/Black**
Red/Wht	**Red/White**
Wht/Blk	**White/Black**
Wht/Red	**White/Red**
Yel/Blk	**Yellow/Black**
Yel/Red	**Yellow/Red**
Yel/Wht	**Yellow/White**

Conductors for 12-Volt Circuits

STRANDED CONDUCTORS FOR 12-VOLT CIRCUITS						
SAE WIRE SIZE (GAUGE)	20	18	16	14	12	10
METRIC WIRE SIZE (MM)	0.5	0.8	1.0	2.0	3.0	5.0
TYPICAL STRANDING	7 x 28	16 x 30	19 x 29	19 x 27	19 x 25	19 x 23
MINIMUM CONDUCTOR AREA IN CIRCULAR MILS	1072	1537	2336	3702	5833	9343

SPECIFICATIONS

General Specifications

Battery:

Voltage	12-volt DC
Cold Cranking Amps	340 amps
Reserve Capacity	67 minutes
BCI Group Size	U1L

Ignition:

Type	Solid-State Inductive
Ignition Coil Air Gap	0.2 – 0.4 mm (0.008 – 0.016 in.)

Spark Plug:

Gap	0.75 mm (0.030 in.)
Torque	22 N•m (16 lb-ft)

Starting Motor:

Type	Solenoid Shift

Test Specifications

Battery Specific Gravity	1.230 - 1.265 points
Regulated Voltage Output	13.8 - 15-volts DC
Unregulated Voltage Output	26-volts AC
Maximum Stator Coil Resistance	0.1 ohms
Maximum Loaded Starting Motor Amperage Draw	(Loaded)100 amps
Maximum No Load Starting Motor Amperage Draw	35 amps

Repair Specifications

PTO Clutch Capscrew Torque	68 N•m (50 lb-ft)

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
Hydrometer	NA	Used to check battery for a minimum specific gravity.
Voltmeter	NA	Used to check for a minimum battery voltage.
Battery Tester	JT05685	Used to measure battery voltage.
Battery Charger (Variable Rate)	NA	Used to charge battery.
Pulse Tachometer	JT07270	Used to read engine rpm.
Digital Multimeter	JT05791	Used to check voltages and amperages of various circuits.
Jumper Wire	NA	Used to test starting motor.
Ohmmeter	NA	Used to read stator resistance.
Current Clamp	JT02153	Used to check the current draw of the starting motor.
Spark Tester	D-05351st	Used to check the operation of the ignition system.
Diode Tester, Ohmmeter or Continuity Tester	NA	Used to check continuity of various components.

System Schematics

Schematic and Wiring Harness Legend

E1—Spark Plug (SE3)

E2—Spark Plug (SE3)

E3—Left Headlight (SE5, W7)

E4—Right Headlight (SE5, W17)

F1—Fusible Link (SE1, W7)

F2—20-Amp Fuse (SE1, W1)

F3—Fusible Link (SE2, W3)

G1—Battery (SE1, W1)

G2—Stator (SE2)

K1—Start Relay (SE1, W1)

K2—Operator Presence Relay (SE3, W1)

M1—Starting Motor (SE1, W1)

N1—Voltage Regulator/Rectifier (SE2, W3)

P1—Hourmeter (SE4, W1)

S1—Key Switch (SE1, W1)

S2—Left Neutral Switch (SE2, W1)

S3—Right Neutral Switch (SE2, W1)

S4—Park Brake Switch (SE3, W1)

S5—PTO Switch (SE3, W1)

S6—Operator Presence Switch (SE3, W1)

S7—Headlight Switch (SE2, W1)

T1—Ignition Coil (SE3, W5)

T2—Ignition Coil (SE3, W5)

V1—Diode (SE1, W1)

V2—Diode (SE2, W1)

V3—Diode (SE3, W5)

V4—Diode (SE3, W5)

V5—Diode (SE3, W1)

V6—Diode (SE3, W1)

W1—Shielded Ground (SE1, W1)

Y1—Fuel Shutoff Solenoid (SE3, W4)

Y2—PTO Clutch

Connectors:

X1—W1 Main Wiring Harness to S3 Right Neutral Switch (SE2, W1)

X2—W1 Main Wiring Harness to S1 Key Switch (SE1, W1)

X3—W1 Main Wiring Harness to S1 Key Switch (SE1, W1)

X4—W1 Main Wiring Harness to K2 Operator Presence Relay (SE3, W1)

X5—W1 Main Wiring Harness to F2 20-Amp Fuse (SE1, W1)

X6—W1 Main Wiring Harness to M1 Starter Motor Solenoid (SE1, W1)

X7—W1 Main Wiring Harness to M1 Starter Motor Solenoid (SE1, W1)

X8—W1 Main Wiring Harness to Chassis Ground (SE1, W1)

X9—W1 Main Wiring Harness to W2 Engine Extension Wiring Harness (SE2, W1)

X10—W1 Main Wiring Harness to W6 PTO Wiring Harness (SE4, W1)

X11—W1 Main Wiring Harness to S2 Left Neutral Switch (SE2, W1)

X12—W1 Main Wiring Harness to K1 Start Relay (SE1, W1)

X13—W1 Main Wiring Harness to P1 Hourmeter (SE4, W1)

X14—W1 Main Wiring Harness to S5 PTO Switch (SE3, W1)

X15—W1 Main Wiring Harness to S4 Park Brake Switch (SE3, W1)

X16—W1 Main Wiring Harness to S6 Operator Presence Switch (SE3, W1)

X17—W2 Engine Extension Harness to W5 Engine Wiring Harness (SE3)

X18—W2 Engine Extension Harness to W4 Fuel Shutoff Solenoid Harness (SE3)

X19—W3 Fusible Link Harness to G1 Battery (SE1)

X20—W3 Fusible Link Harness to N1 Voltage Regulator/ Rectifier (SE3)

X21—W4 Fuel Shutoff Solenoid Harness to Y1 Fuel Shutoff Solenoid (SE3)

X22—W5 Engine Harness to T1 Ignition Coil (SE3)

X23—W5 Engine Harness to T2 Ignition Coil (SE3)

X24—W6 PTO Clutch Harness to Y2 PTO Clutch (SE4)

X25—W7 Optional Headlight Harness to S7 Headlight Switch (SE5)

X26—W7 Optional Headlight Harness to E2 Left Headlight (SE5)

X27—W7 Optional Headlight Harness to G1 Battery Positive Terminal (SE1)

X28—W7 Optional Headlight Harness to G2 Battery Negative Terminal (SE1)

X29—W7 Optional Headlight Harness to E2 Right Headlight (SE5)

Wiring Harnesses:

W1—Main Wiring Harness

W2—Engine Extension Wiring Harness

W3—Fusible Link Wiring Harness

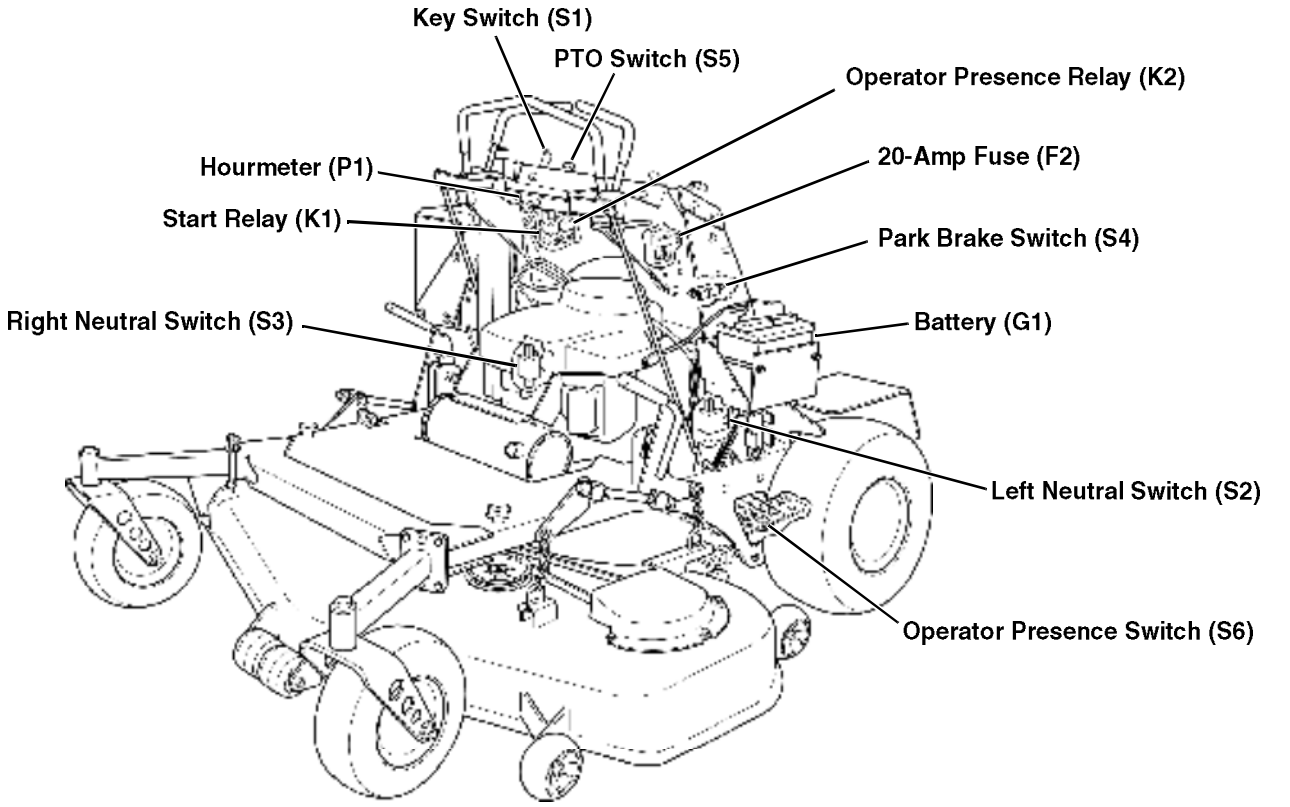
W4—Fuel Shutoff Solenoid Wiring Harness

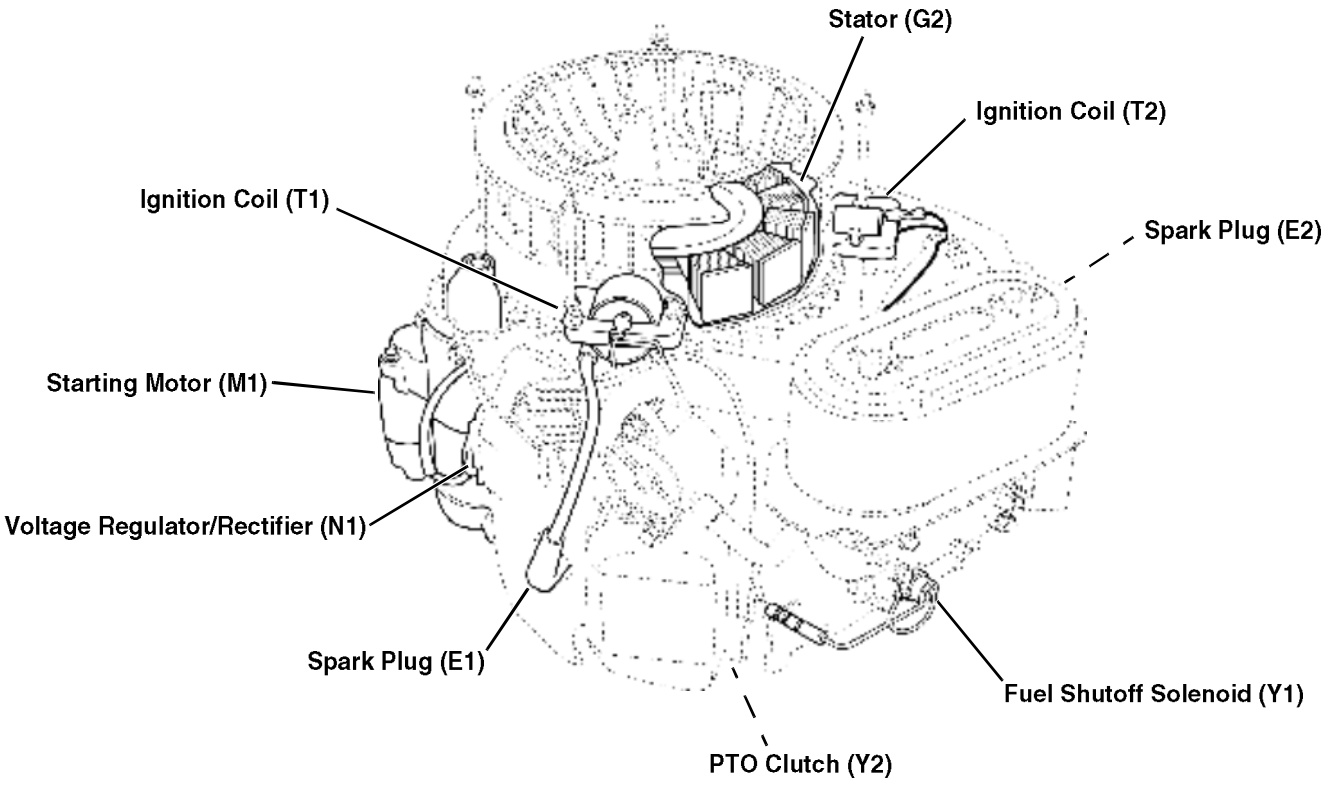
W5—Engine Wiring Harness

W6—PTO Wiring Harness

W7—Optional Headlight Wiring Harness

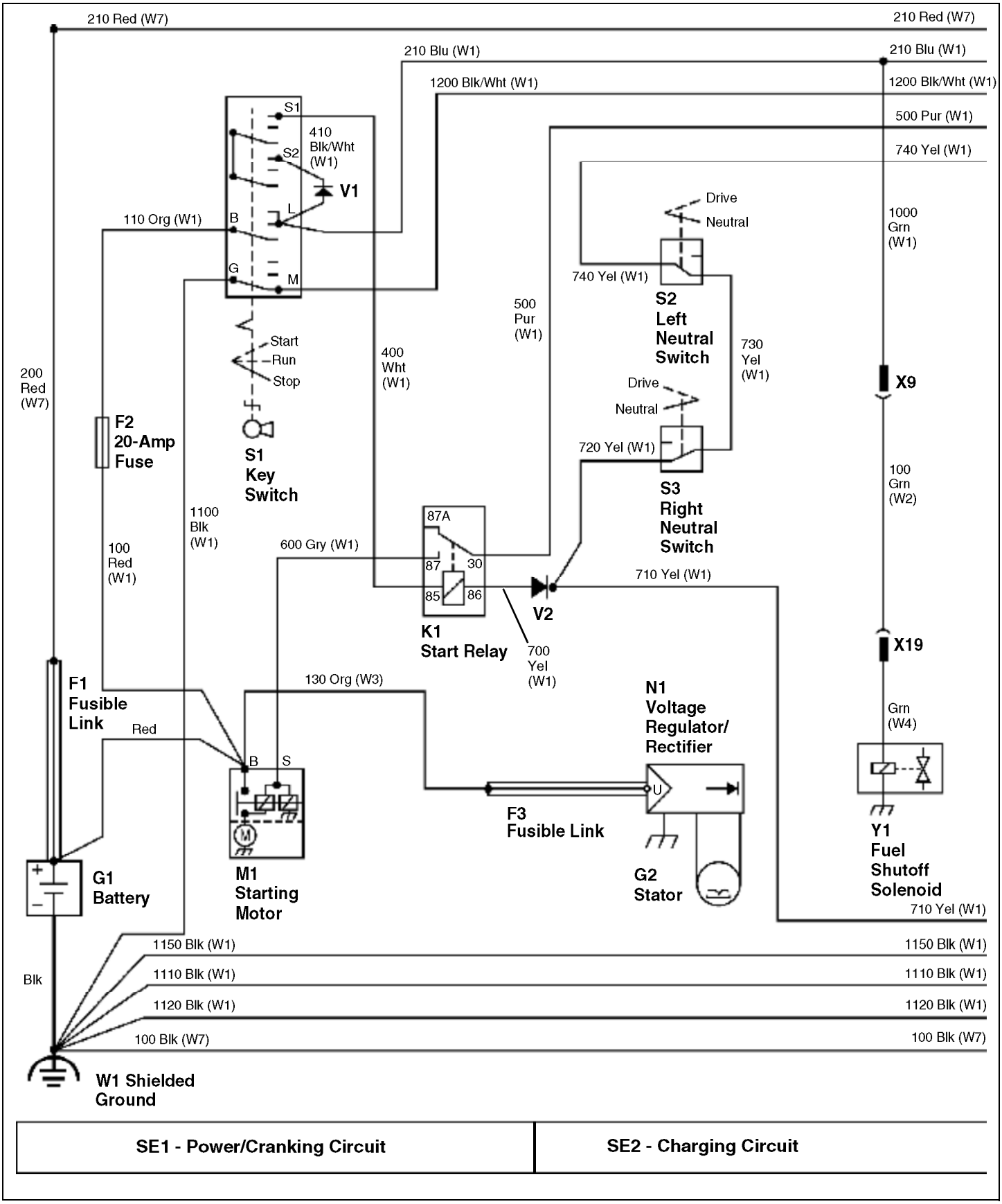
Component Location



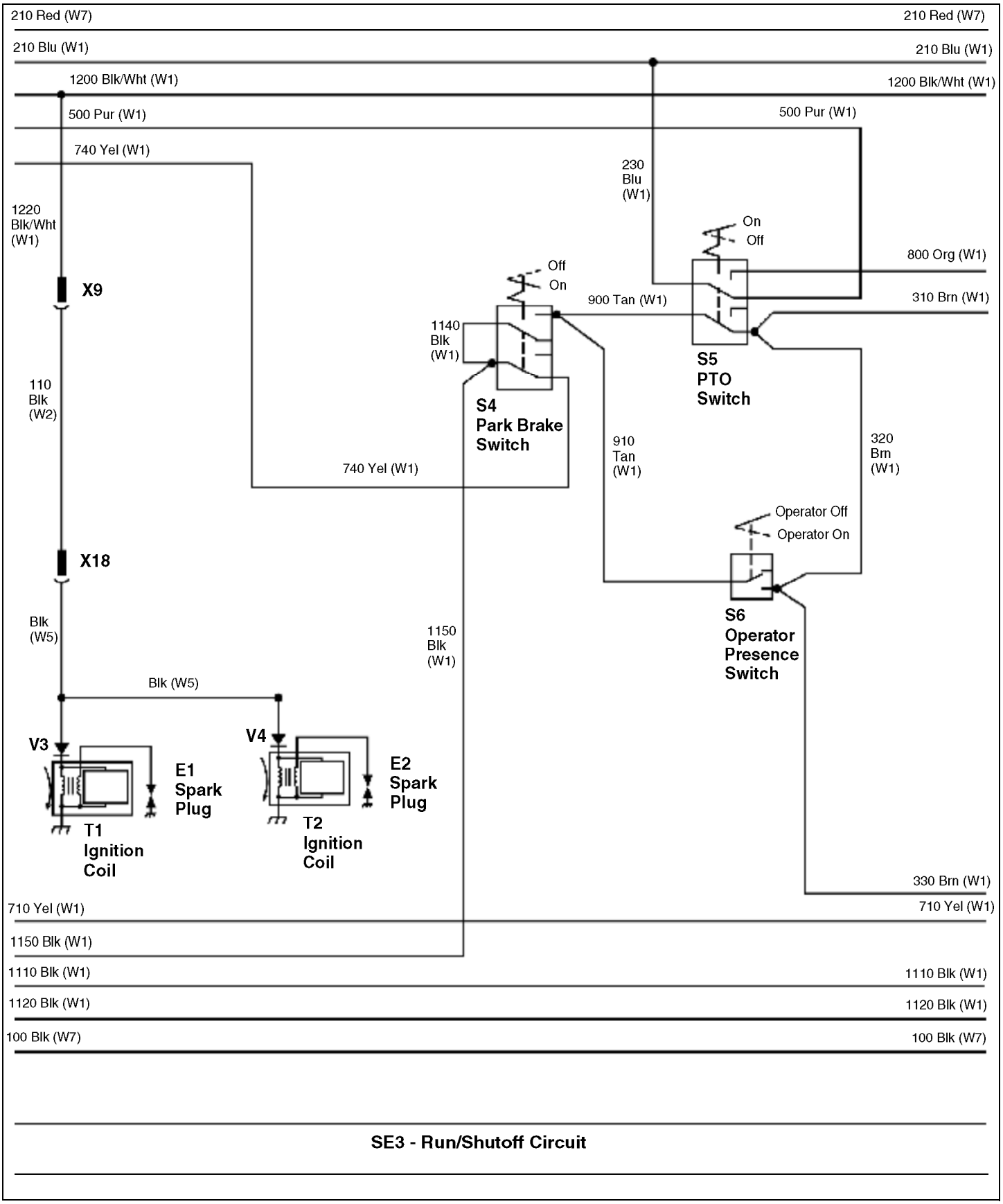


MX15088a, MX15088b

Main Electrical Schematic

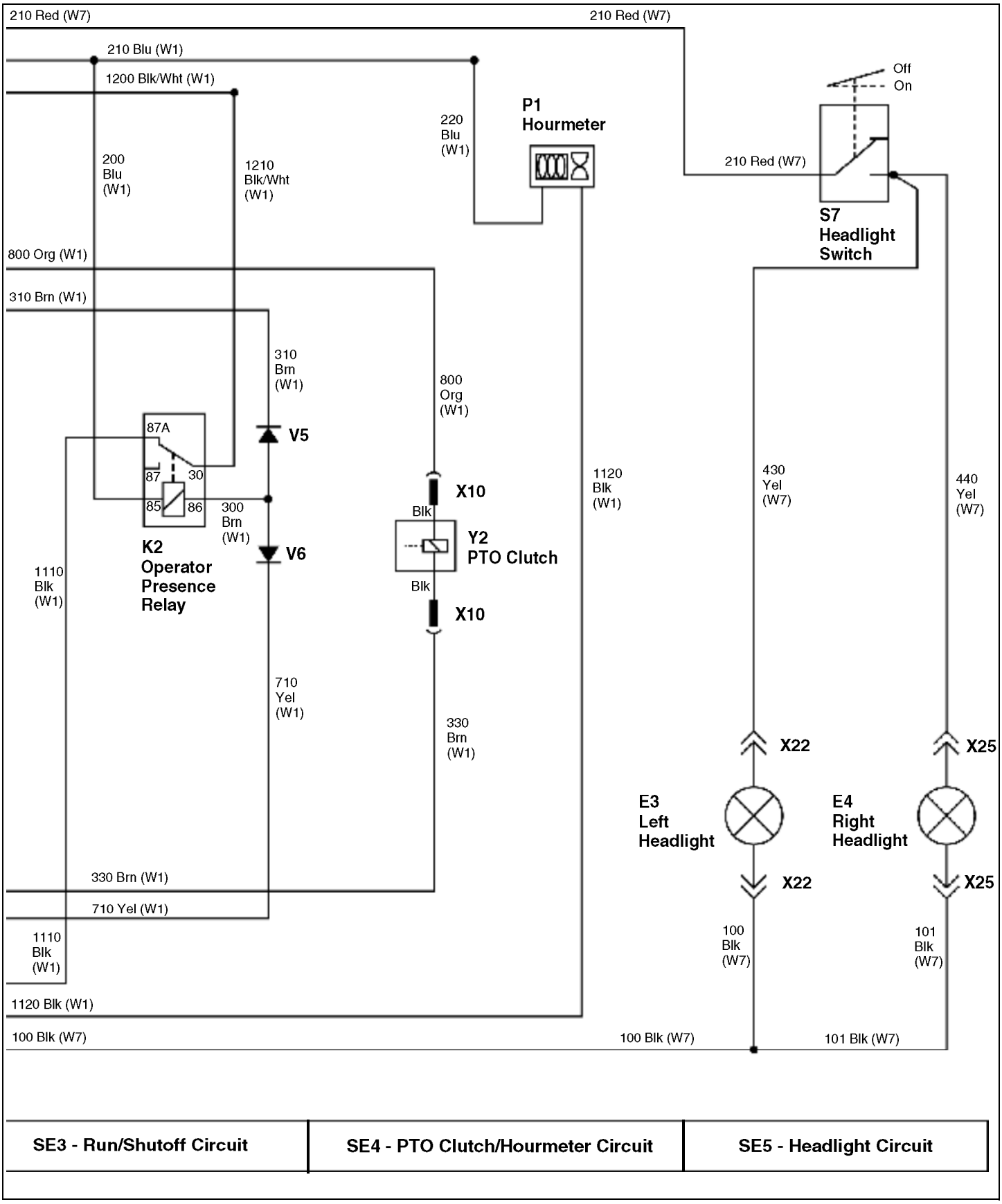


MX13433a



SE3 - Run/Shutoff Circuit

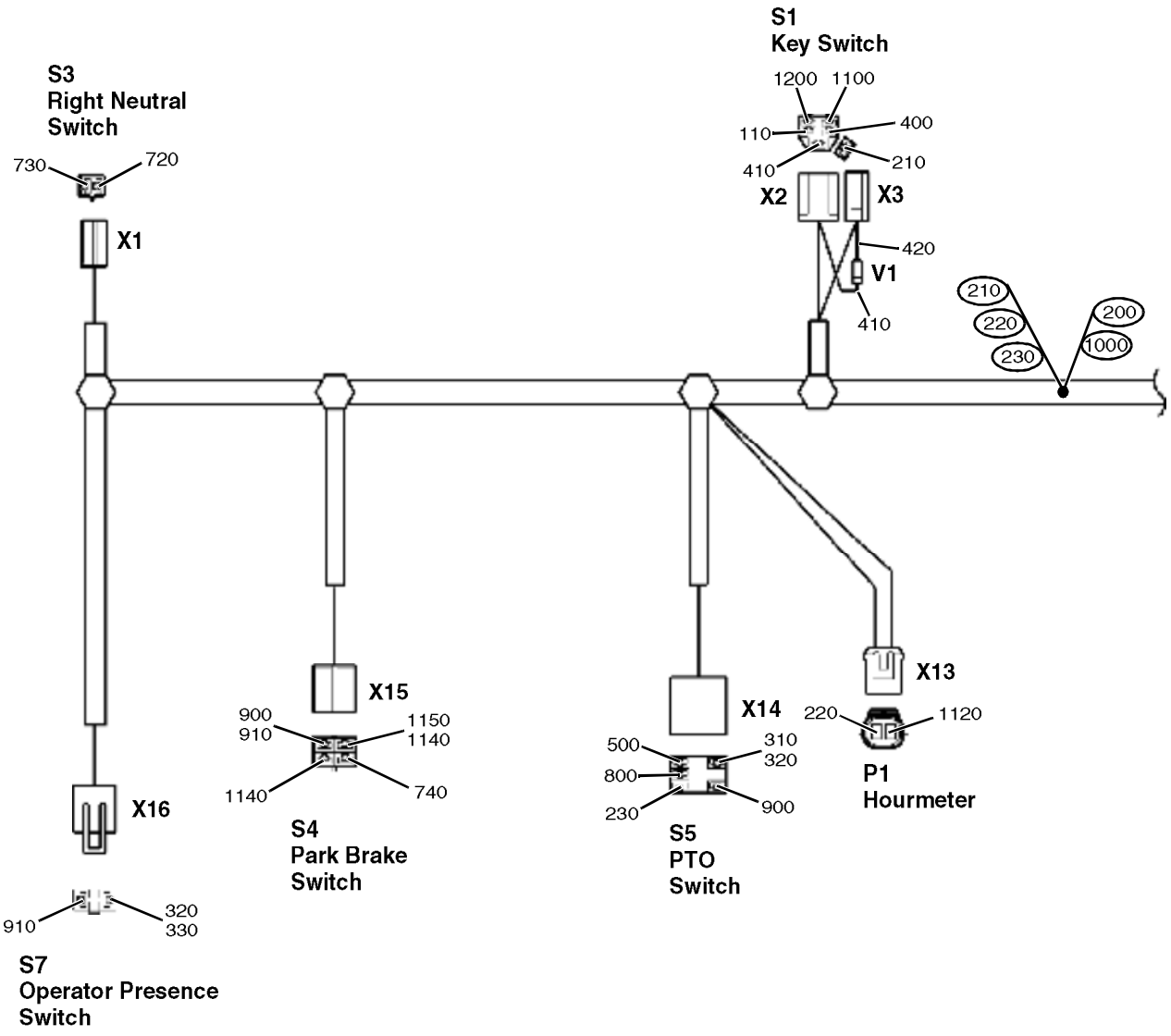
MX13433b



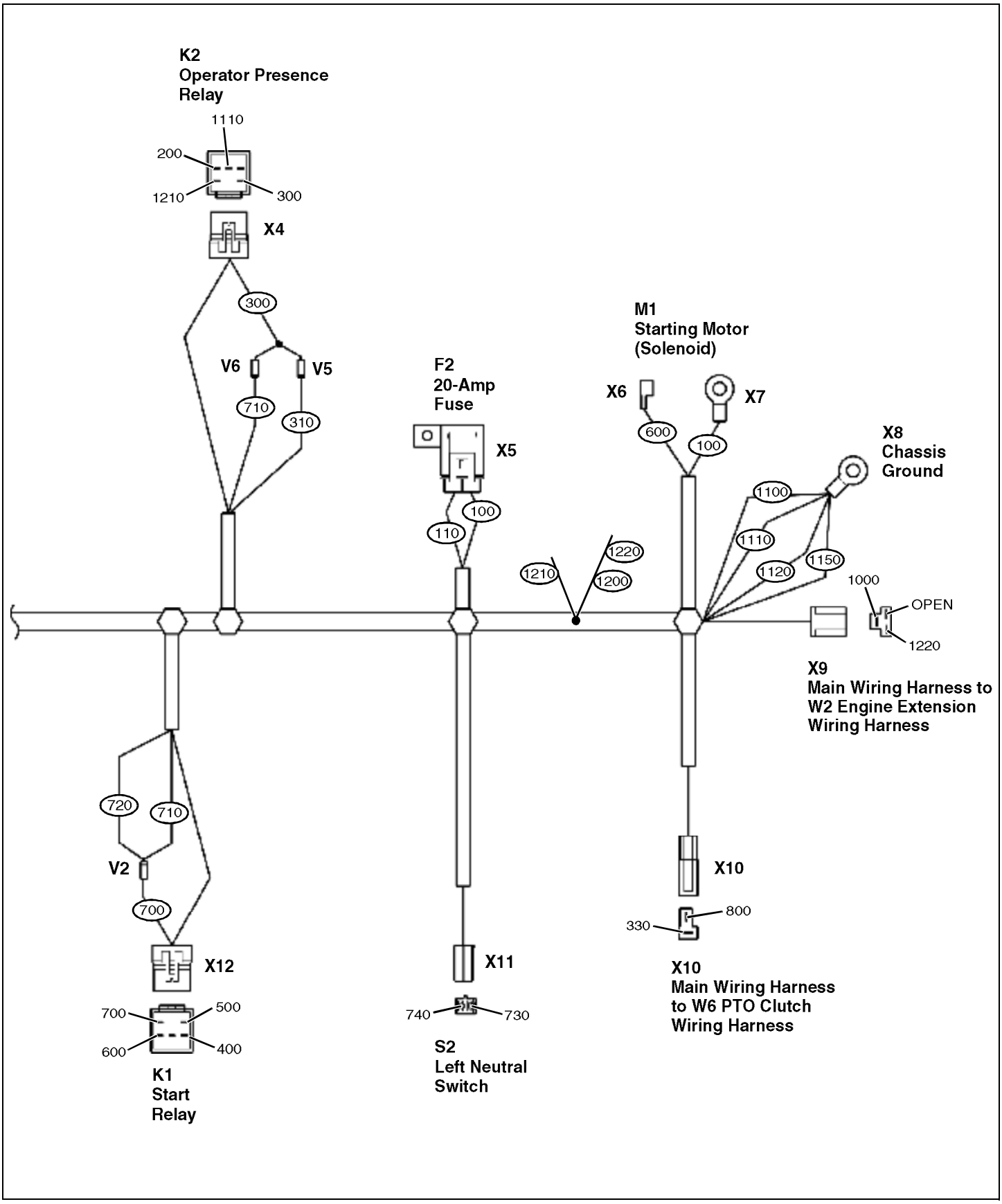
SE3 - Run/Shutoff Circuit	SE4 - PTO Clutch/Hourmeter Circuit	SE5 - Headlight Circuit

MX13433c

W1 Main Wiring Harness



MX13446a

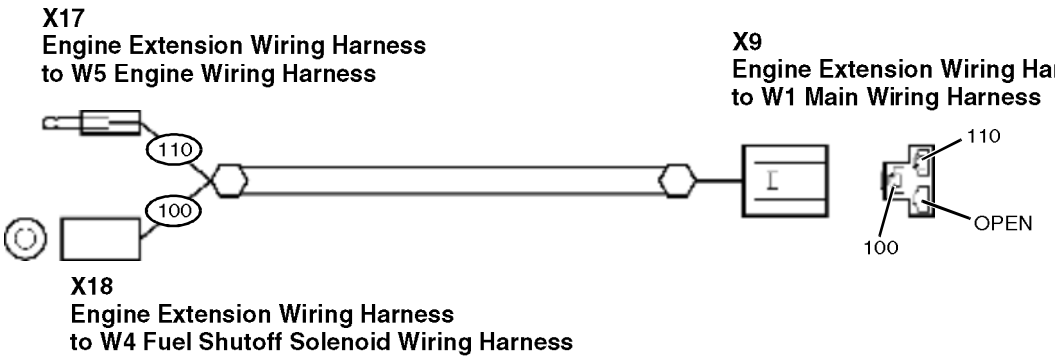

K2
Operator Presence
Relay
1110
200
1210
300
X4
300
V6
V5
710
310
F2
20-Amp
Fuse
X5
100
110
M1
Starting Motor
(Solenoid)
X6
X7
600
100
X8
Chassis
Ground
1100
1110
1120
1150
1000
OPEN
1220
1210
1220
1200
X9
Main Wiring Harness to
W2 Engine Extension
Wiring Harness
720
710
V2
700
X12
700
500
600
400
K1
Start
Relay
X11
740
730
S2
Left Neutral
Switch
X10
800
330
X10
Main Wiring Harness
to W6 PTO Clutch
Wiring Harness

MX13446b

W1 Main Wiring Harness Wire Color Codes

Size/No./Color	Wire Connection Points
2.0 100 Red	X7, F2
2.0 110 Org	F2, S2
1.0 200 Blu	K2, Splice 210
1.0 210 Blu	S1, Splice 1000/200/220/230
1.0 220 Blu	P1, Splice 1000/200/210/230
1.0 230 Blk	S5, Splice 1000/200/210/220
1.0 300 Brn	K2 (86), Splice V5 (310)/V6 (710)
1.0 310 Brn	S4, V5
1.0 320 Brn	S5, S6
1.0 330 Brn	X10, S6
1.0 400 Wht	S1, K1 (85)
NA 410 Blk/Wht	V1 (X2, X3)
NA 420 Blk/Wht	V1 (X2, X3)
1.0 500 Pur	K1 (30), S5
1.0 600 Gry	X6, K1 (87)
1.0 700 Yel	K1 (86), V2
1.0 710 Yel	V2, V6
1.0 720 Yel	V2, S3
1.0 730 Yel	S2, S3
1.0 740 Yel	S2, S4
1.0 800 Org	X10, S5
1.0 900 Tan	S4, S5
1.0 910 Tan	S4, S6
1.0 1000 Grn	X9, Splice 200/210/220/230
1.0 1100 Blk	X8, S1
1.0 1110 Blk	X8, K2 (87A)
1.0 1120 Blk	X8, P1
1.0 1140 Blk	S4
1.0 1150 Blk	X8, S4
1.0 1200 Blk/ Wht	S1, Splice 1210/1220
1.0 1210 Blk/ Wht	K2 (30), Splice 1200/1220
1.0 1220 Blk/ Wht	X9, Splice 1200/1210

W2 Engine Extension Wiring Harness

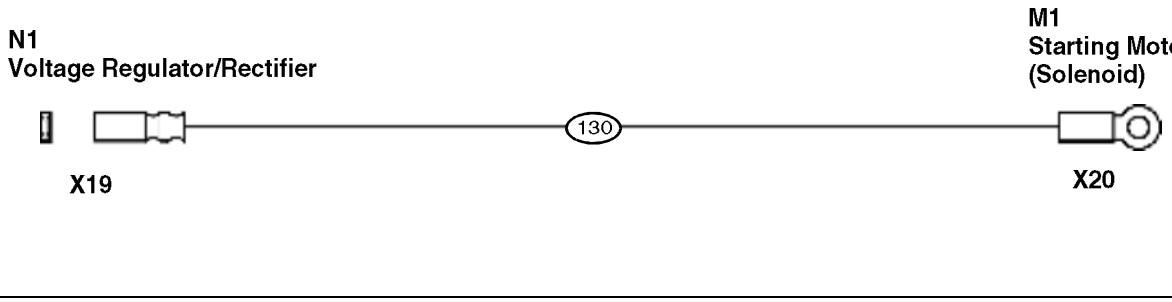


MX13445

W2 Engine Extension Wiring Harness Wire Color Codes

Size/No./Color	Wire Connection Points
1.0 110 Blk	X9, X17
1.0 100 Grn	X9, X18

W3 Fusible Link Wiring Harness

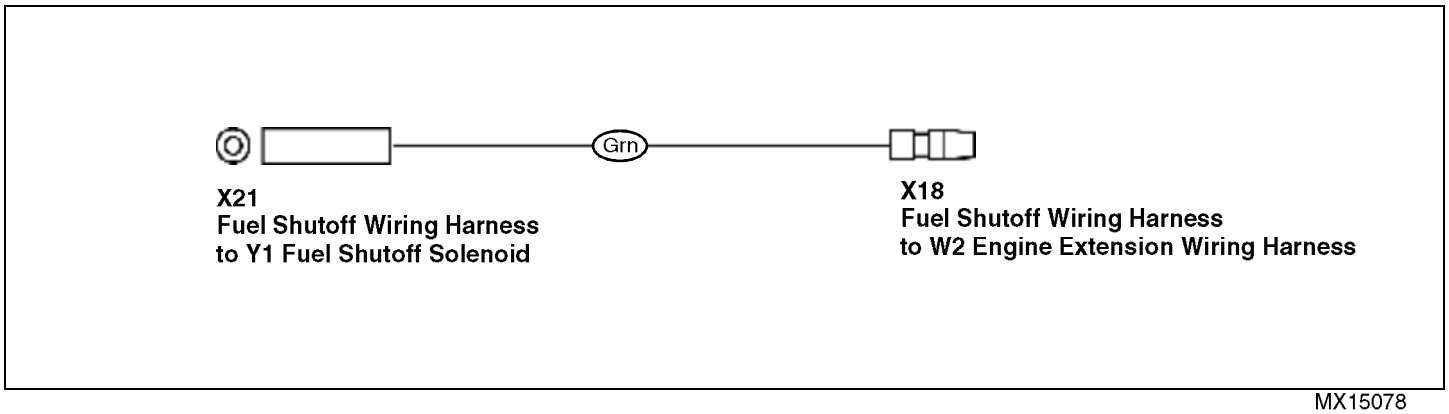


MX15074

W3 Fusible Link Wiring Harness Wire Color Codes

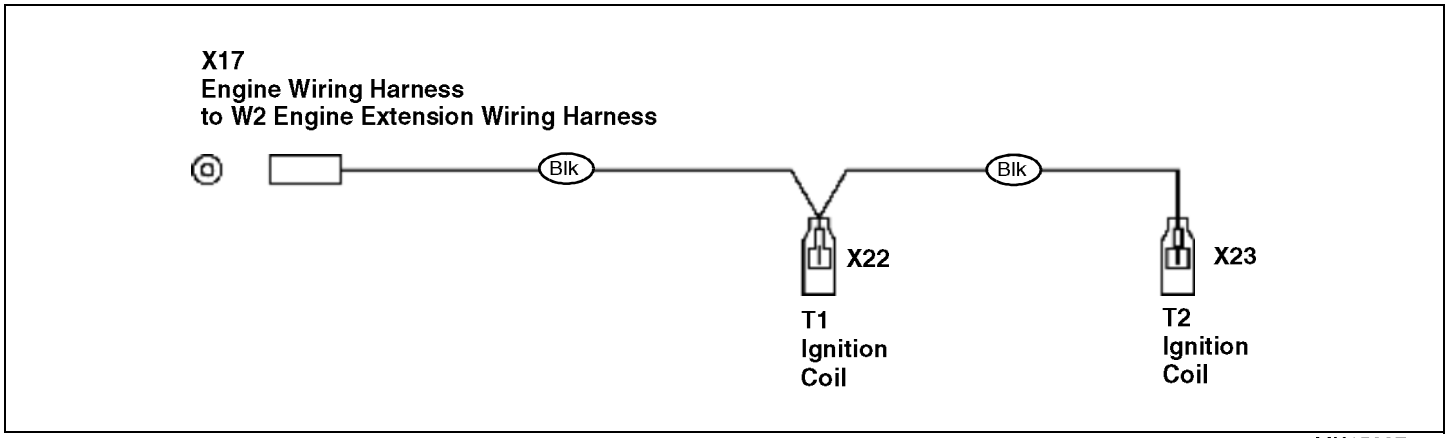
Size/No./Color	Wire Connection Points
2.0 130 Org/ Fusible Link	X19, X20

W4 Fuel Shutoff Solenoid Wiring Harness



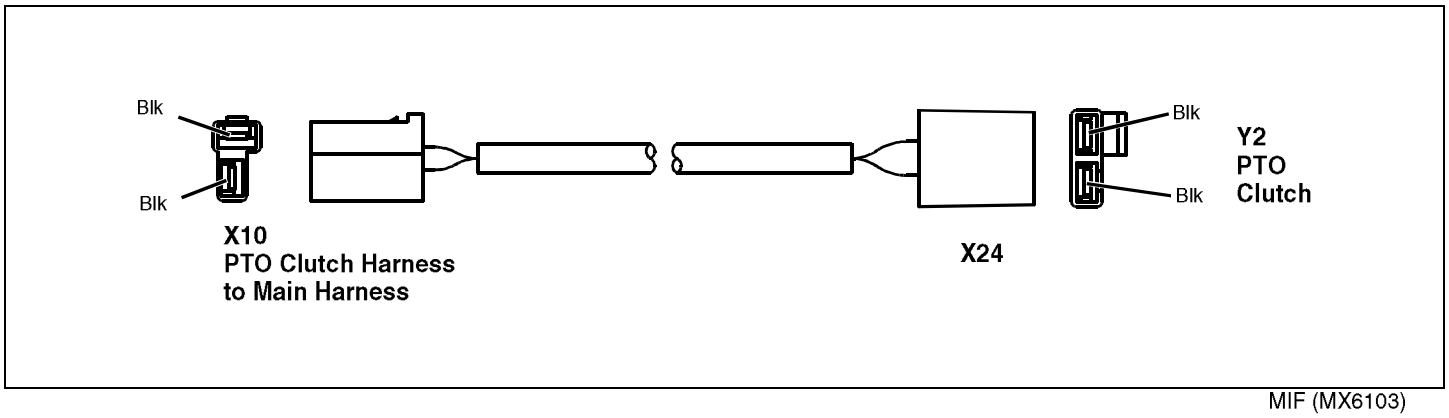
MX15078

W5 - Engine Wiring Harness



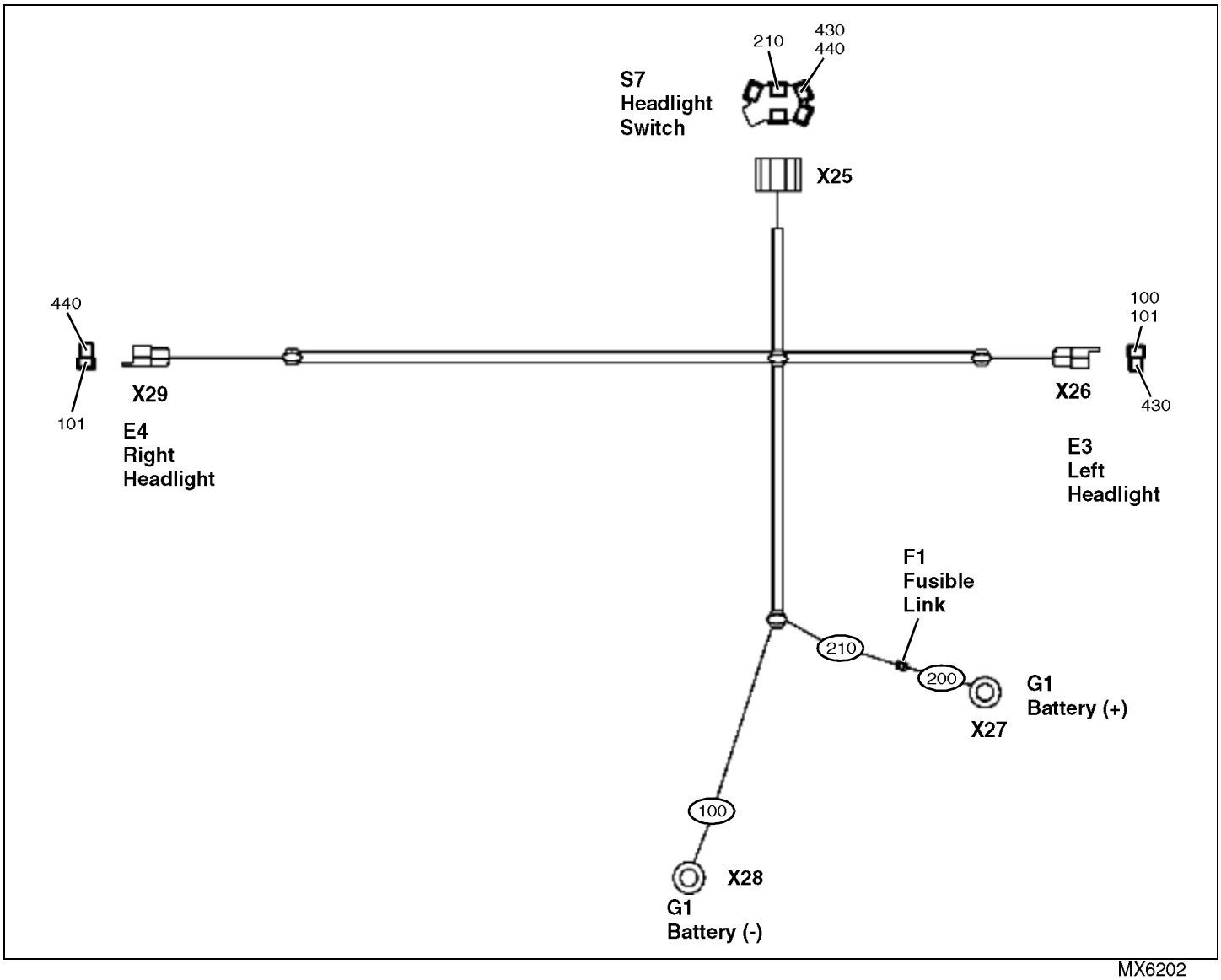
MX15087

W6 - PTO Clutch Wiring Harness



MIF (MX6103)

W7 Optional Headlight Wiring Harness



MX6202

W7 Optional Headlight Wiring Harness Wire Color Codes

Size/No./Color	Wire Connection Points
1.0 100 Blk	E3, Chassis Ground
1.0 101 Blk	E3, E4
1.0 200 Red	G1, F1
1.0 210 Red	F1, S7
1.0 430 Yel	S7, E3
1.0 440 Yel	S7, E4

Y1 Fuel Shutoff Solenoid

MIF

Diagnostics and Operation

Power Circuit Operation - Unswitched Power

Function:

To provide unswitched power to primary components whenever the battery is connected.

Operating Conditions, Unswitched Circuits:

Voltage must be present at the following components with the key switch in the STOP position:

- Battery positive terminal
- Starting motor solenoid positive contact stud
- Terminal “B” of key switch (S1)
- Orange wire/fusible link (F3) (No. 130 [W3]) at voltage regulator/rectifier, connector (X19)

System Operation

The positive battery cable connects the battery to the starting motor solenoid stud.

The ground cable connection is as important as the positive cable. Proper starting operation depends on these cables and connections to carry the high current for its operation.

The red wire (No. 100 [W1]) and orange wire (No. 110 [W1]) provide unswitched power to the key switch (S1). This circuit is protected by a 20-amp fuse (F2).

The orange wire/fusible link (F3) (No. 130 [W3]) provide unswitched power to the voltage regulator/rectifier (N1).

The fusible link is a short length of wire designed to protect the circuit, and will fail if the current load becomes excessive or if a short occurs.

Power Circuit Operation - Switched Power

Function:

Provides switched power to secondary components whenever the battery is connected, and the key switch is in the run or start position.

Operating Conditions, Switched Circuits:

Voltage must be present at the following components with the key switch in the run or start positions:

- All unswitched locations
- Terminal “L” of key switch (S1)
- Terminal “S2” of key switch (S1)
- Terminal “S1” of key switch (S1) (start position only)
- Terminal “85” of start relay (K1) (start position only)
- Fuel shutoff solenoid (Y1)
- PTO switch (S5)
- Terminal “85” of operator presence relay (K2)
- Hourmeter (P1)

System Operation

Placing the key switch (S1) in the run or start position, routes current through the key switch to terminal “L”, providing current to blue wire (No. 210 [W1]).

Diode (V1) is connected across key switch terminals “L” and “S2”. When the key switch is in the start position, current flows from key switch terminals “S2” to “S1”. Current is then routed through white wire (No. 400 [W1]) to provide current to terminal “85” of the start relay (K1).

Current is supplied to the fuel shutoff solenoid (Y1) by blue wire (No. 210 [W1]) and green wires (No. 1000 [W1], 100 [W2] and Grn [W4]).

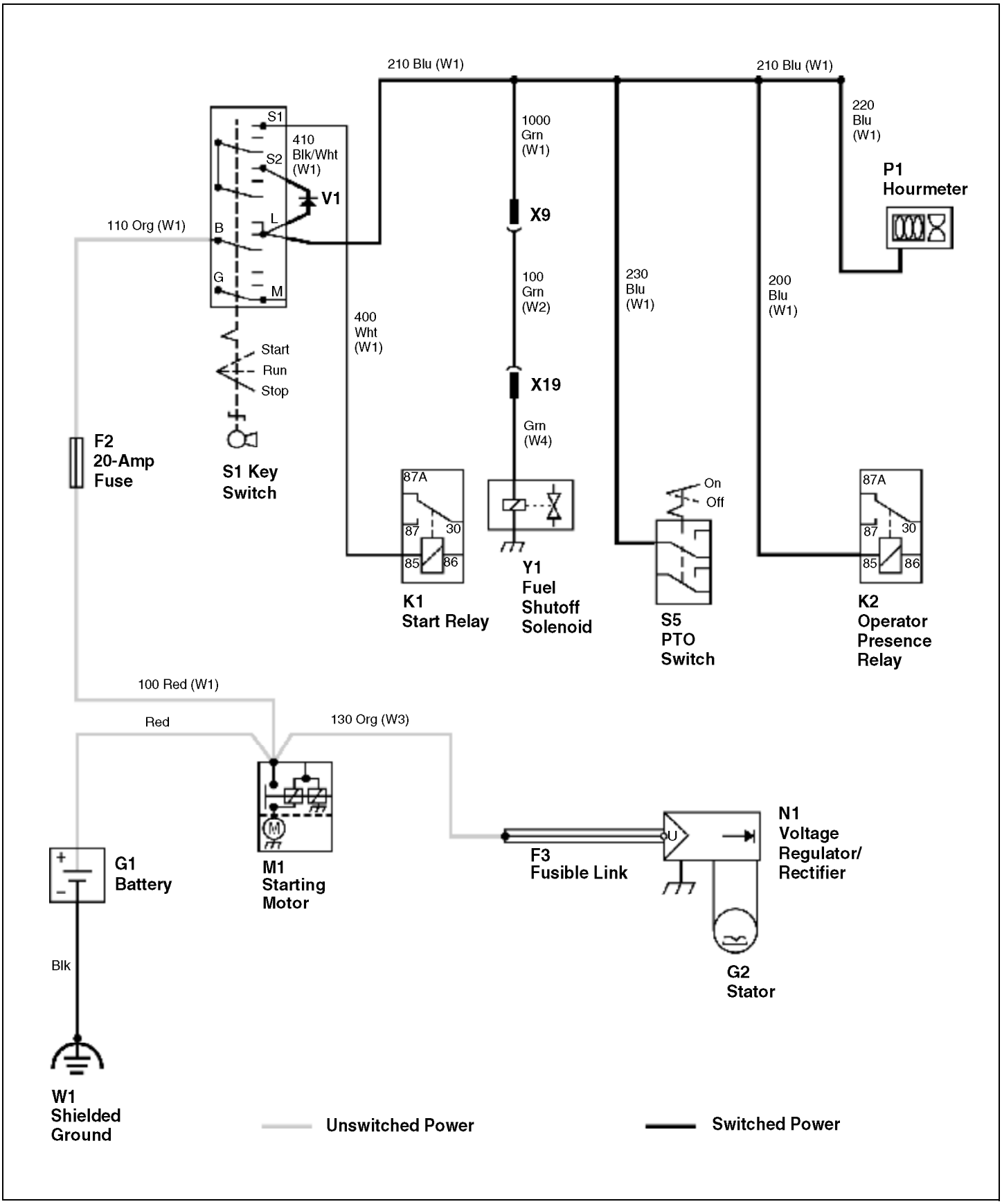
Current is supplied to the PTO switch (S5) through blue wires (No. 210 [W1] and 230 [W1]).

Current is supplied to the operator presence relay (K2), terminal 85, through blue wires (No. 210 [W1] and 200 [W1]).

Current is supplied to the hourmeter (P1) through blue wires (No. 210 [W1] and 220 [W1]).

These circuits are controlled by the key switch and are protected by the 20-amp fuse (F2).

Power Circuit Electrical Schematic



MX13434

Power Circuit Diagnosis

Unswitched Power

Test Conditions:

- Machine parked on a level surface.
- Key switch (S1) in STOP position.
- Meter negative lead on battery negative terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Power Circuit - Unswitched Power

(1) Measure voltage at battery positive post. Is voltage within 11.8 - 13.2 volts?

Yes - Go to step (2).

No - Check battery condition. (See "Test Battery" on page 146.)

(2) Measure voltage at starting motor solenoid, battery terminal. Is battery voltage present?

Yes - Go to step (3).

No - Check battery positive cable and clamps. Clean and tighten connections.

(3) Measure voltage at voltage regulator/rectifier (N1), terminal "1", orange wire/fusible link (F3) (No. 130 [W3]). Is battery voltage present?

Yes - Go to step (4).

No - Check orange wire/fusible link (F3) (No. 130 [W3]) between starting motor (M1) solenoid and voltage regulator/rectifier (N1) and connections.

(4) Measure voltage at key switch (S1), battery terminal, orange wire (No. 110 [W1]). Is battery voltage present?

No - Check red wire (No. 100 [W1]), orange wire (No. 110 [W1]) and connections.

No - Test fuse (F2). (See "Test Fuse" on page 153.)

Switched Power - Run Position

Test Conditions:

- Machine parked on a level surface.
- Key switch (S1) in run position.
- Meter negative lead on battery negative terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Power Circuit - Switched Power (Run Position)

(1) Measure voltage at key switch (S1), terminal "L", blue wire (No. 210 [W1]). Is battery voltage present?

Yes - Go to step (2).

No - Test key switch. (See "Test Key Switch" on page 155.)

(2) Measure voltage at fuel shutoff solenoid (Y1), green wire (W4). Is battery voltage present?

Yes - Go to step (3).

No - Check blue wire (No. 210 [W1]), green wires (No. 1000 [W1], 100 [W2] and Grn [W4]) and connections.

(3) Measure voltage at PTO switch (S5), blue wire (No. 230 [W1]). Is battery voltage present?

Yes - Go to step (4).

No - Check blue wires (No. 210 [W1] and 230 [W1]) and connections.

(4) Measure voltage at operator presence relay (K2), terminal "85", blue wire (No. 200 [W1]). Is battery voltage present?

Yes - Go to step (5).

No - Check blue wires (No. 210 [W1] and 200 [W1]) and connections.

(5) Measure voltage at hourmeter (P1), blue wire (No. 220 [W1]). Is battery voltage present?

No - Check blue wires (No. 210 [W1] and 220 [W1]) and connections.

Switched Power - Start Position

Test Conditions:

- Machine parked on a level surface.
- Key switch (S1) in start position.
- Meter negative lead on battery negative terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Power Circuit - Switched Power

(1) Measure voltage at key switch (S1), terminal "S1", white wire (No. 400 [W1]). Is battery voltage present?

Yes - Go to step (2).

No - Check black/white wire (No. 410 [W1]) and connections.

No - Test diode (V1). (See "Test Diode" on page 154.)

No - Test key switch. (See "Test Key Switch" on page 155.)

(2) Measure voltage at start relay (K1), terminal "85", white wire (No. 400 [W1]). Is battery voltage present?

No - Check white wire (No. 400 [W1]) and connections.

Cranking Circuit Operation

Function:

To energize the start relay and engage the starting motor, which cranks the engine.

Operating Conditions:

To crank the engine the key switch must be in the start position, the park brake must be locked, the motion control levers must be in the neutral position and the PTO switch must be in the off (disengaged) position. The operator does not have to stand on the operator platform to crank the engine with the park brake locked.

Theory of Operation:

Current flows from the battery positive terminal, to the starter motor solenoid through the positive battery cable. Current then flows through red wire (No. 100 [W1]) to the 20-amp fuse (F2) and through the orange wire (No. 110 [W1]) to the key switch terminal “B”.

Diode (V1) is connected across key switch terminals “L” and “S2”. When the key switch is in the start position, current flows from key switch terminals “S2” to “S1”. Current is then routed through white wire (No. 400 [W1]) to provide current to terminal “85” of the start relay (K1).

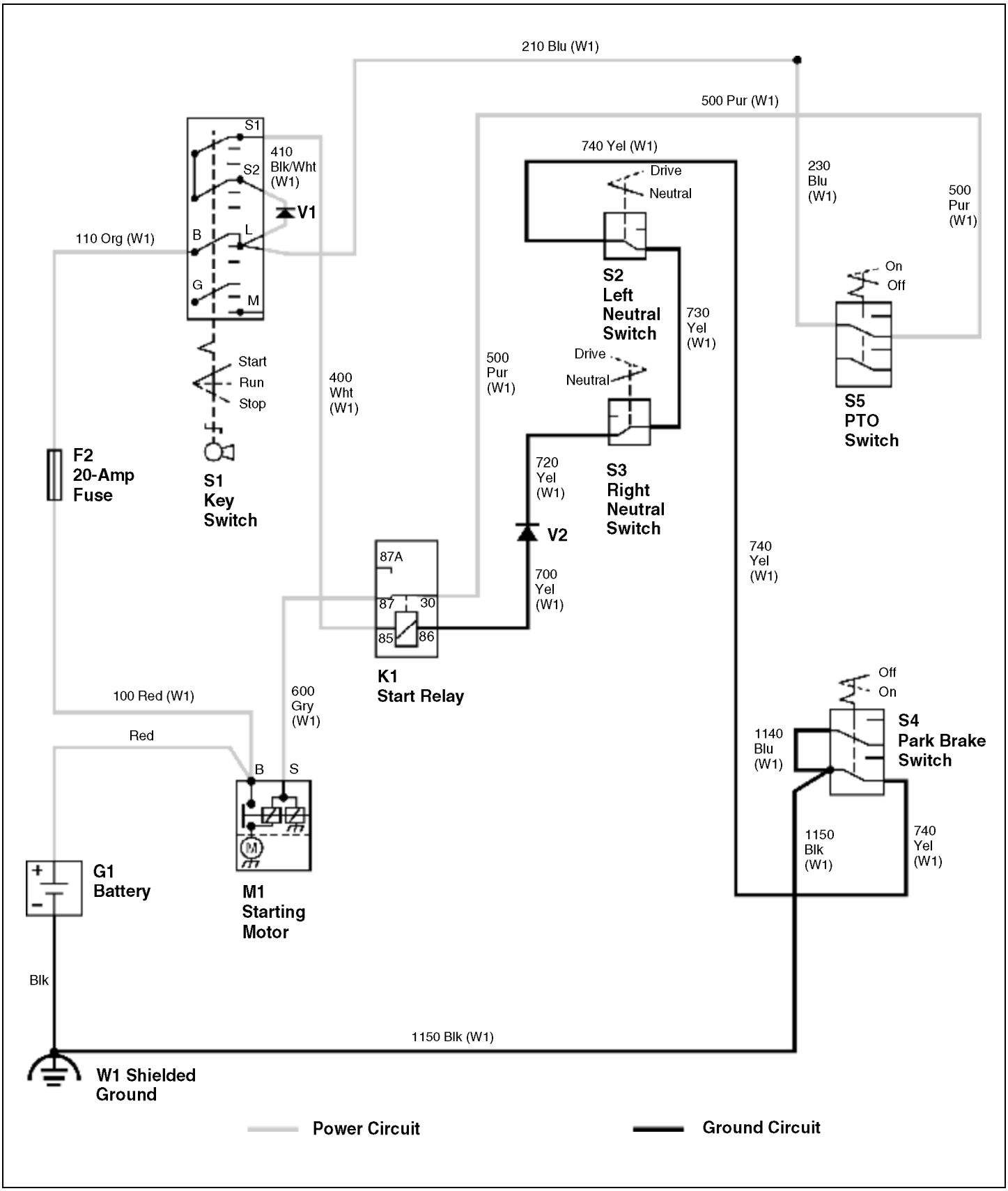
From the key switch terminal “L”, current flows through blue wires (No. 210 [W1] and 230 [W1]) to the PTO switch (S5).

With the PTO switch in the off (disengaged) position, current flows through the switch and purple wire (No. 500 [W1]) to terminal “30” of the start relay (K1).

From the start relay terminal “86”, a path to ground is created through yellow wires (No. 700 [W1], 730 [W1], 740 [W1]), right (S3) and left (S2) neutral switches, park brake switch (S4) and black wire (No. 1150 [W1]) to the battery negative terminal.

With the start relay energized, current flows from relay terminal “30” to “87”, through gray wire (No. 600 [W1]) to the starting motor solenoid. This energizes the solenoid, and engages the starting motor, cranking the engine.

Cranking Circuit Electrical Schematic



MX13435

Cranking Circuit Diagnosis

Test Conditions:

- Machine parked on level surface.
- Key switch (S1) in STOP position.
- Motion control levers in neutral position (right [S3] and left [S2] neutral switches engaged).
- Park brake locked (park brake switch [S4] engaged).
- Meter negative lead on battery negative terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Cranking Circuit

(1) Measure voltage at battery positive post. Is voltage within 11.8 - 13.2 volts?

Yes - Go to step (2).

No - Check battery condition. (See "Test Battery" on page 146.)

(2) Measure voltage at starting motor solenoid - battery terminal. Is battery voltage present?

Yes - Go to step (3).

No - Check battery positive cable and clamp. Clean and tighten connections.

(3) Measure voltage at key switch (S1), terminal "B", orange wire (No. 110 [W1]). Is battery voltage present?

Yes - Go to step (4).

No - Test red wire (No. 100 [W1]) and orange wire (No. 110, W1) and connections.

No - Test 20-amp fuse (F2). (See "Test Fuse" on page 153.)

(4) Measure resistance from ground terminal to park brake switch (S4), black wire (No. 1150 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (5).

No - Check black wire (No. 1150 [W1]) and connections.

(5) Measure resistance from ground terminal to park brake switch (S4), yellow wire (No. 740 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (6).

No - Test park brake switch. (See "Test Park Brake Switch" on page 157.)

System: Cranking Circuit

(6) Measure resistance from ground terminal to left neutral switch (S2), yellow wire (No. 740 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (7).

No - Check yellow wire (No. 740 [W1]) and connections.

(7) Measure resistance from ground terminal to left neutral switch (S2), yellow wire (No. 730 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (8).

No - Check motion control linkage adjustment. (See "Check and Adjust Motion Control Linkage" on page 180.)

No - Test left neutral switch. (See "Test Neutral Switch" on page 156.)

(8) Measure resistance from ground terminal to right neutral switch (S3), yellow wire (No. 730 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (9).

No - Check yellow wire (No. 630 [W1]) and connections.

(9) Measure resistance from ground terminal to right neutral switch (S3), yellow wire (No. 720 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (10).

No - Check motion control linkage adjustment. (See "Check and Adjust Motion Control Linkage" on page 180.)

No - Test right neutral switch. (See "Test Neutral Switch" on page 156.)

(10) Measure resistance from ground terminal to start relay (K1), terminal "85", white wire (No. 400 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (11).

No - Check yellow wires (No. 720 [W1] and 700 [W1]) and connections.

No - Test diode (V2). (See "Test Diode" on page 154.)

(11) Move key switch (S1) to run position and measure voltage at key switch, terminal "L", blue wire (No. 210 [W1]). Is battery voltage present?

Yes - Go to step (12).

No - Test key switch. (See "Test Key Switch" on page 155.)

System: Cranking Circuit

(12) Measure voltage at PTO switch (S5), blue wire (No. 230 [W1]). Is battery voltage present?

Yes - Go to step (13).

No - Check blue wires (No. 210 [W1] and 230 [W1]) and connections.

(13) Measure voltage at PTO switch (S5), purple wire (No. 500 [W1]). Is battery voltage present?

Yes - Go to step (14).

No - Test PTO switch. (See "Test PTO Switch" on page 155.)

(14) Measure voltage at start relay (K1), terminal "30", purple wire (No. 500 [W1]). Is battery voltage present?

Yes - Go to step (15).

No - Check purple wire (No. 500 [W1]) and connections.

(15) Move key switch (S1) to start position and measure voltage at key switch, terminal "S1", white wire (No. 400 [W1]). Is battery voltage present?

Yes - Go to step (16).

No - Test diode (V1). (See "Test Diode" on page 154.)

No - Test key switch. (See "Test Key Switch" on page 155.)

(16) Move key switch (S1) to start position and measure voltage at start relay (K1), terminal "85", white wire (No. 400 [W1]). Is battery voltage present?

Yes - Go to step (17).

No - Check white wire (No. 400 [W1]) and connections.

(17) Move key switch (S1) to start position and measure voltage at start relay (K1), terminal "87", gray wire (No. 600 [W1]). Is battery voltage present?

Yes - Go to step (18).

No - Test relay. (See "Test Relay" on page 154.)

(18) Move key switch (S1) to start position and measure voltage at starting motor solenoid, gray wire (No. 600 [W1]). Is battery voltage present?

No - Check gray wire (No. 600 [W1]) and connections.

Run Circuit Operation

Function:

To create a spark at the correct time that ignites the fuel/air mixture in the cylinder. To keep the engine running by eliminating ground paths to both sides of the ignition primary coil.

Also, to provide current to the fuel shutoff solenoid, to allow fuel to flow to the carburetor.

Operating Conditions:

To produce a spark, the key switch must be in the start or run position. The operator can be on or off the operator platform; however, the PTO must be disengaged, motion control levers must be in the neutral position, and the brake switch must be engaged (park brake locked) to start the engine.

Once the engine is running, the operator must stand on the operator platform to disengage the brake or engage the PTO.

System Operation:

The ignition system is a transistor-controlled magneto design. Ignition timing is controlled by the transistor and is not adjustable. The engine is shut off by grounding both sides of the ignition primary coil. With the ignition primary coil grounded, a spark cannot be produced.

When the engine is rotating, the flywheel magnet induces current into the magneto ignition coil, which in turn produces current high enough to jump the spark plug gap, creating a spark to ignite the engine fuel/air mixture.

By placing the key switch (S1) in the start or run position, one possible path to ground for the ignition primary coil through black/white wires (No. 1200 [W1], 1220 [W1]), black wires (No. 110 [W2] and Blk [W5]) to key switch, terminal “M” is eliminated.

Current flows from the battery positive terminal, to the starter motor solenoid through the positive battery cable. Current then flows through red wire (No. 100 [W1]) to the 20-amp fuse (F2) and through the orange wire (No. 110 [W1]) to the key switch, terminal “B”.

When the key switch is in the start or run position, current flows from the key switch, terminal “B” to terminal “L”, providing current to blue wire (No. 210 [W1]).

Current is supplied to the fuel shutoff solenoid (Y1) through blue wire (No. 210, W1) and green wires (No. 1000 [W1], 100 [W2] and Grn [W4]), allowing fuel to flow to the carburetor.

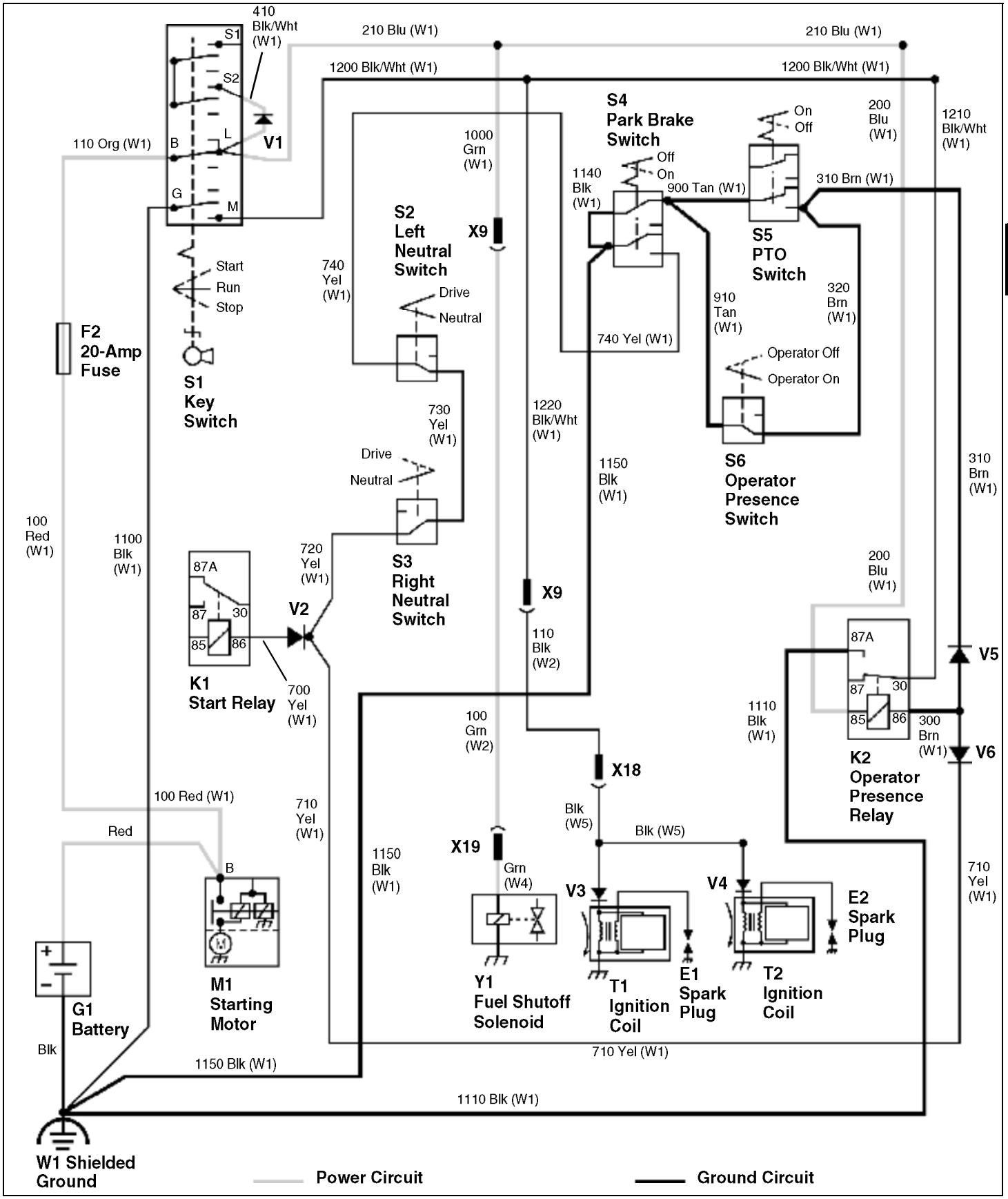
Current is supplied to the operator presence relay (K2), terminal “85”, through blue wires (No. 210 [W1] and 200 [W1]).

In order for the engine to run, the operator presence relay must remain energized (ground circuit completed) to break the path to ground for the ignition primary coil through black wires (No. 110 [W2] and Blk [W5]) and black/white wires (No. 1200 [W1] and 1220 [W1]), through the operator presence relay terminals “30” and “87A”, and black wire (No. 1110 [W1]). This ground circuit can be maintained through several combinations of the PTO (S5), operator presence (S6), park brake (S4) and right (S3) and left (S2) neutral switches.

With the park brake unlocked (park brake switch disengaged) and the operator presence switch in the on position (operator standing on the platform), a path to ground for the operator presence relay is created through brown wires (No. 300 [W1], 310 [W1] and 320 [W1]), operator presence switch, tan wire (No. 910 [W1]), park brake switch and black wires (No. 1140 [W1] and 1150 [W1]) to the battery negative terminal. In this case, the PTO switch can be in the on or off position.

The second path to ground for the operator presence relay is created when the park brake is locked (park brake switch engaged), and the right and left neutral switches are in the neutral position. This ground circuit is created through brown wire (No. 300 [W1]), yellow wires (No. 710 [W1], 720 [W1]), right neutral switch, yellow wire (No. 730 [W1]), left neutral switch, yellow wire (No. 740 [W1]), park brake switch and black wire (No. 1150 [W1]) to the battery negative terminal. In this case, the PTO and operator presence switches can be in the on or off position.

Run Circuit Electrical Schematic



MX13436

Run Circuit Diagnostics

Test Conditions:

- Machine parked on a level surface.
- Key switch (S1) in STOP position.
- Operator standing on platform (operator presence switch [S6] engaged).
- PTO switch (S5) in off position.
- Park brake locked (park brake switch [S4] engaged).
- Motion control levers in neutral position (right [S3] and left [S2] neutral switches engaged).
- Meter negative lead on battery negative terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Run Circuit

(1) Measure voltage at battery positive post. Is voltage within 11.8 - 13.2 volts?

Yes - Go to step (2).

No - Check battery condition. (See "Test Battery" on page 146.)

(2) Measure voltage at starting motor solenoid - battery terminal. Is battery voltage present?

Yes - Go to step (3).

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

(3) Measure voltage at key switch (S1), terminal "B", orange wire (No. 110 [W1]). Is battery voltage present?

Yes - Go to step (4).

No - Check red wire (No. 100 [W1]), and orange wire (No. 110, W1) and connections.

No - Test 20-amp fuse (F2). (See "Test Fuse" on page 153.)

(4) Measure resistance from ground terminal to park brake switch (S4), black wire (No. 1140 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (5).

No - Check black wires (No. 1140 [W1] and 1150 [W1]) and connections.

System: Run Circuit

(5) Measure resistance from ground terminal to park brake switch (S4), tan wires (No. 900 [W1] and 910 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (6).

No - Test park brake switch. (See "Test Park Brake Switch" on page 157.)

(6) Measure resistance from ground terminal to operator presence switch (S6), tan wire (No. 910 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (7).

No - Check tan wire (No. 910 [W1]) and connections.

(7) Measure resistance from ground terminal to operator presence switch (S6), brown wires (No. 320 [W1] and 310 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (8).

No - Test operator presence switch. (See "Test Operator Presence Switch" on page 156.)

(8) Measure resistance from ground terminal to operator presence relay (K2), terminal "86", brown wire (No. 300 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (10).

No - Check brown wires (No. 320 [W1], 310 [W1] and 300 [W1]) and connections.

No - Test diode (V5). (See "Test Diode" on page 154.)

(9) Measure resistance from park brake switch (S4) (yellow wire No. 740 [W1]) to operator presence relay (K2), terminal "86", brown wire (No. 300 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (10).

No - Check yellow wires (No. 740 [W1], 730 [W1], 720 [W1] and 710 [W1]), brown wire (No. 300 [W1]) and connections.

No - Test diodes (V6 and V2). (See "Test Diode" on page 154.)

No - Check motion control linkage adjustment. (See "Check and Adjust Motion Control Linkage" on page 180.)

No - Test neutral switches (S2 and S3). (See "Test Neutral Switch" on page 156.)

System: Run Circuit

(10) Move key switch (S1) to run position and measure voltage at key switch, terminal "L", blue wire (No. 210 [W1]). Is battery voltage present?

Yes - Go to step (11).

No - Test key switch. (See "Test Key Switch" on page 155.)

(11) Move key switch (S1) to run position and measure voltage at fuel shutoff solenoid (Y1), connector X19, green wire (No. 100 [W2]). Is battery voltage present?

Yes - Go to step (12).

No - Check blue wire (No. 210 [W1]), green wires (No. 1000 [W1] and 100 [W2]) and connections.

(12) Move key switch (S1) to run position and measure voltage at operator presence relay (K2), terminal "85", blue wire (No. 200 [W1]). Is battery voltage present?

Yes - Test relay. (See "Test Relay" on page 154.)

No - Check blue wires (No. 210 [W1] and 200 [W1]) and connections.

Shutoff Circuit Operation

Function:

To ground the ignition system in order to keep the engine from starting or to shut off the engine.

Also to stop current flow to the fuel shutoff solenoid, to stop fuel to flow to the carburetor.

Operating Conditions:

To produce a spark, the key switch (S1) must be in the start or run position. The operator can be on or off the operator platform; however, the PTO must be disengaged and the park brake switch (S4) must be engaged (park brake locked) to start the engine.

Once the engine is running, the operator must stand on the operator platform to release the brake or engage the PTO.

The engine will shut off when the key switch is turned to the STOP position, or the operator leaves the operator platform without locking the park brake and disengaging the PTO.

System Operation

The engine is shut off by grounding both sides of the ignition primary coil. With the ignition primary coil grounded, a spark cannot be produced.

The primary path to ground, with the key switch in the STOP position, is created through black/white wires (No. 1200 [W1], 1220 [W1]) and black wires (No.110 [W2] and Blk [W5]), through the key switch, terminal “M” to terminal “G”, and black wire (No. 1100 [W1]) to the W1 frame ground. Placing the key switch in the start or run position eliminates that path to ground.

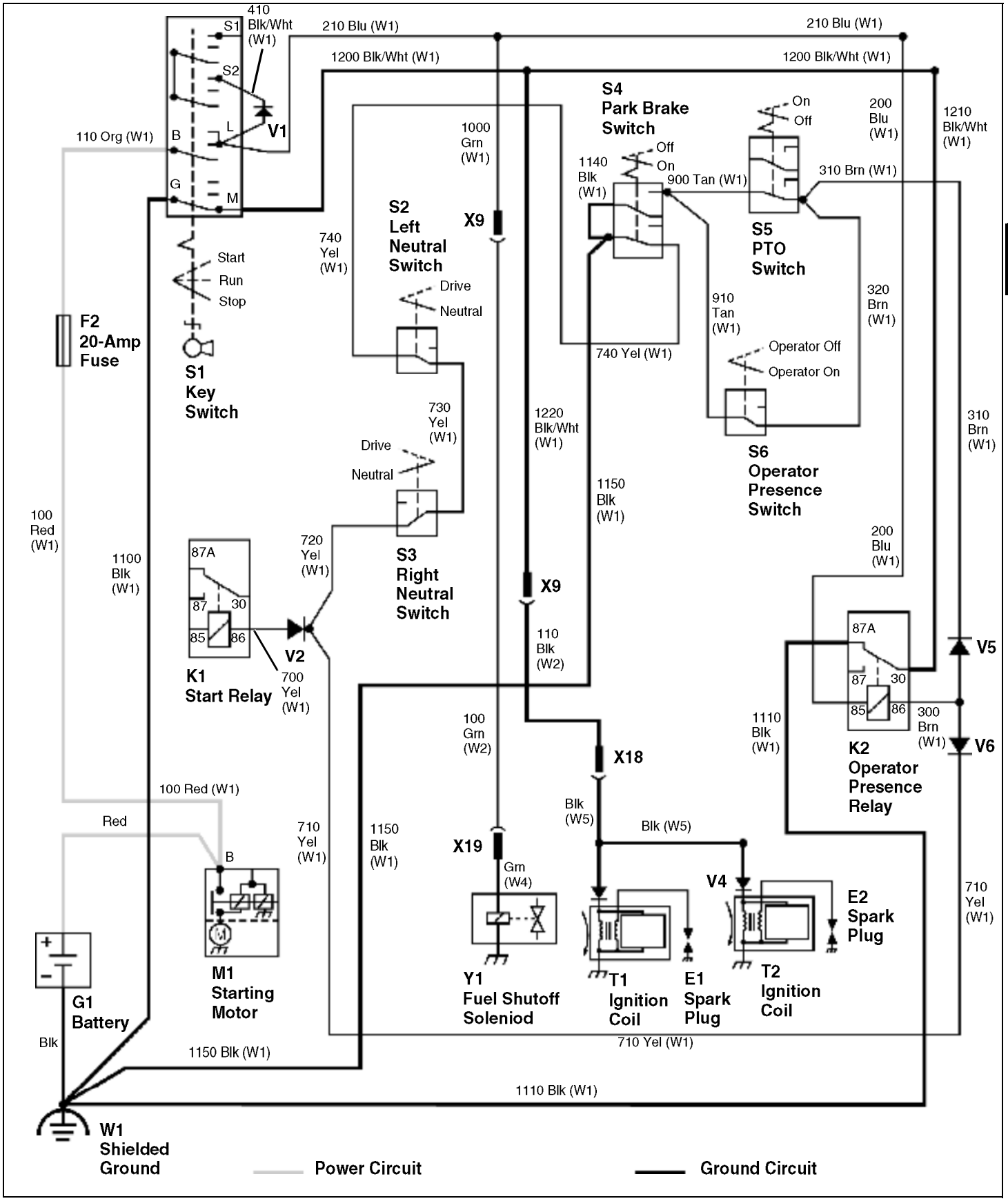
With the engine running, a second path to ground is created if the operator steps off the operator platform (opening the operator presence switch [S6]) with the park brake unlocked (park brake switch disengaged). This interrupts the path to ground for the operator presence relay (K2), causing it to de-energize.

A third path to ground will be created, with the engine running and the park brake locked, if one of the motion control levers is moved out the neutral position, opening neutral switch(es) (S2 and/or S3). This interrupts the path to ground for the operator presence relay (K2), causing it to de-energize.

With the operator presence relay de-energized, a path to ground is created through black/white wires (No. 1200 [W1], 1220 [W1]), black wires (No. 110 [W2] and Blk [W5]), through operator presence relay terminals “30” and 87A”, and through black wire (No. 1110 [W1]) to the W1 frame ground.

When the key switch is moved to the STOP position, current flow is interrupted to the fuel shutoff solenoid (Y1), causing it to de-energize, stopping fuel flow to the carburetor.

Shutoff Circuit Electrical Schematic



MX13437

Shutoff Circuit Diagnosis

Test Conditions:

- Machine parked on a level surface.
- Key switch (S1) in STOP position.
- Operator standing on platform (operator presence switch [S6] engaged).
- PTO switch (S5) in off position.
- Park brake locked (park brake switch (S4) engaged).
- Motion control levers in neutral position (right [S3] and left [S2] neutral switches engaged).
- Meter negative lead on battery negative terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Shutoff Circuit

(1) Measure resistance from ground terminal to key switch (S1), terminal "G", black wire (No. 1100 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (2).

No - Check black wire (No. 1100 [W1]) and connections.

(2) Measure resistance from ground terminal to key switch (S1), terminal "M", black/white wire (No. 1200 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (3).

No - Test key switch. (See "Test Key Switch" on page 155.)

(3) Measure resistance from ground terminal to ignition coil (T1 and T2) primary wires (black wires [W5]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (4).

No - Check black/white wires (No. 1200 [W1] and 1220 [W1]), black wires (No. 110 [W2] and Blk [W5]) and connections.

(4) Measure resistance from ground terminal to operator presence relay (K2), terminal "87A", black wire (No. 1110 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (5).

No - Check black wire (No. 1110 [W1]) and connections.

System: Shutoff Circuit

(5) Measure resistance from ground terminal to operator presence relay (K2), terminal "30", black/white wire (No. 1210 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (6).

No - Test relay. (See "Test Relay" on page 154.)

(6) Measure resistance from ground terminal to main harness-to-engine extension harness connector X9, black/white wire (No. 1220 [W1]). Is there less than 0.1 ohms of resistance?

No - Check black/white wires (No. 1220 [W1], 1200 [W1] and 1210 [W1]) and connections.

Charging Circuit Operation

Function:

To maintain battery voltage at 12.4 volts or higher.

Operating Conditions:

The engine must be running for the charging system to operate.

System Operation:

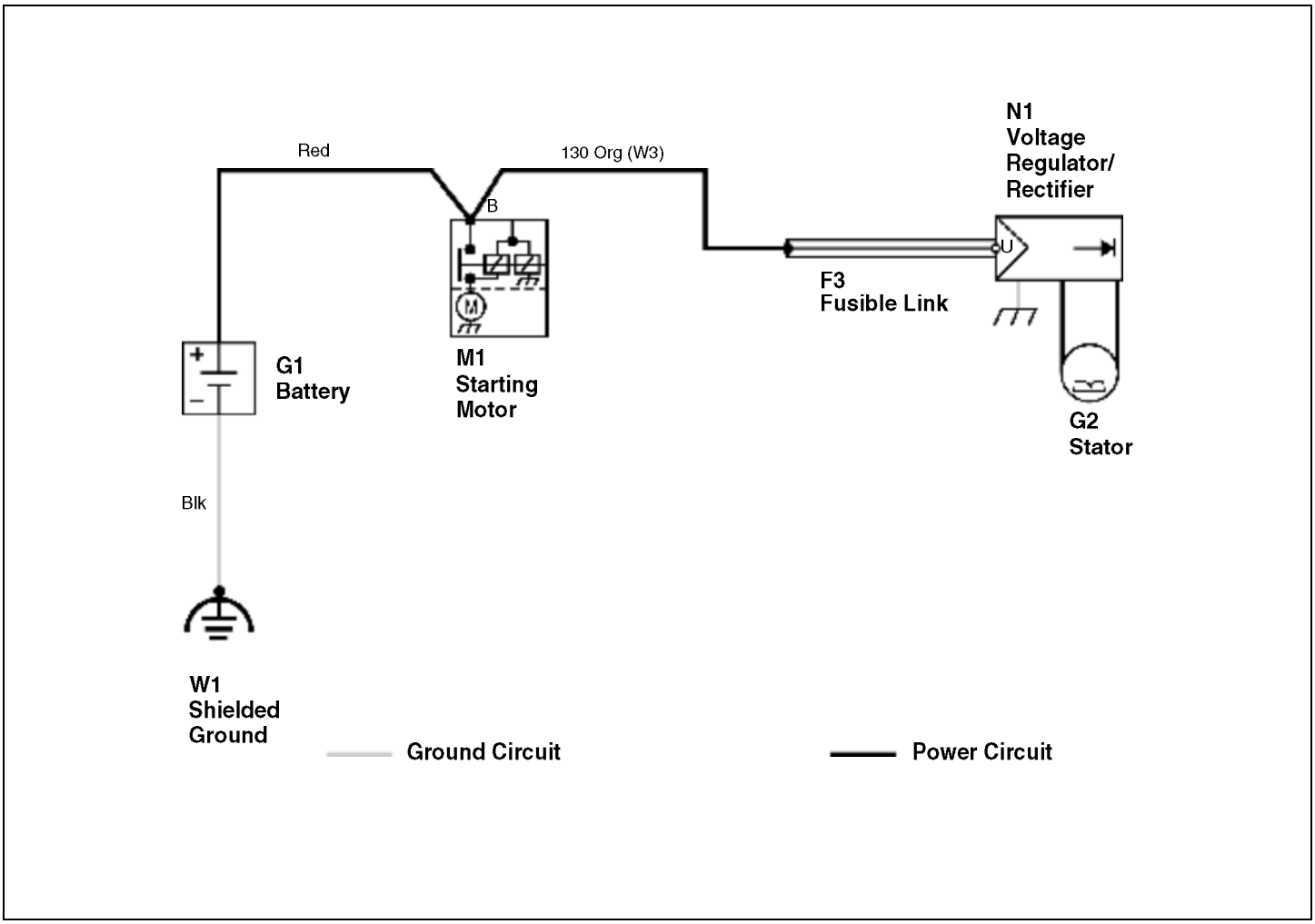
The single circuit stator and regulator/rectifier provide DC current for charging the battery (G1). Magnets mounted to the flywheel rotate around a coil of wire, (stator [G2]), mounted underneath the flywheel.

As the magnets rotate, AC current is generated in the coiled wire. The AC current is converted to DC by the regulator/rectifier (N1).

The regulated DC output from the regulator/rectifier charges the battery through the orange wire/fusible link (F3) (No. 130 [W3]), to the starter motor solenoid and through the battery positive cable to the battery positive terminal.

The circuit is protected by a fusible link (F3) (W3). The fusible link is a short length of wire designed to protect the circuit, and will fail if the current load becomes excessive or if a short occurs.

Charging Circuit Electrical Schematic



MX13438

Charging Circuit Diagnosis

Test Conditions:

- Machine parked on a level surface.
- Key switch (S1) in STOP position.
- Meter negative lead on battery negative terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Charging Circuit

(1) Measure battery voltage at battery positive post. Is voltage within 11.9 - 13.2 volts?

Yes - Go to step (2).

No - Test battery. (See "Test Battery" on page 146.)

(2) Measure voltage at starting motor solenoid battery terminal. Is battery voltage present?

Yes - Go to step (3).

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

(3) Measure voltage at voltage regulator/rectifier (N1) at battery terminal, orange wire/fusible link (F3) (No. 130 [W3]). Is battery voltage present?

Yes - Go to step (4).

No - Check orange wire/fusible link (F3) (No. 130 [W3]) and connections.

(4) Check regulated voltage output at voltage regulator/rectifier (N1). (See "Test Regulated Voltage Output".) Is voltage within specifications?

Yes - Go to step (5).

No - Proceed as specified in "Results".

(5) Check unregulated voltage output at voltage regulator/rectifier (N1). Is voltage within specifications? (See "Test Unregulated Voltage Output".)

No - If voltage reading was less than specifications, test stator. (See "Test Stator" on page 150.) If stator tests OK, replace flywheel. (See "Remove and Install Flywheel" on page 69.)

PTO Clutch Circuit Operation

Function:

To provide a method to engage and disengage the mower deck drive belt.

Operating Conditions:

The key switch in the run position, engine running, operator on the operator platform, park brake unlocked, and the PTO switch in the on position.

System Operation:

Current flows from the battery positive terminal, to the starter motor solenoid through the positive battery cable. Current then flows through red wire (No. 100 [W1]) to the 20-amp fuse (F2) and through the orange wire (No. 110 [W1]) to the key switch (S1), terminal “B”.

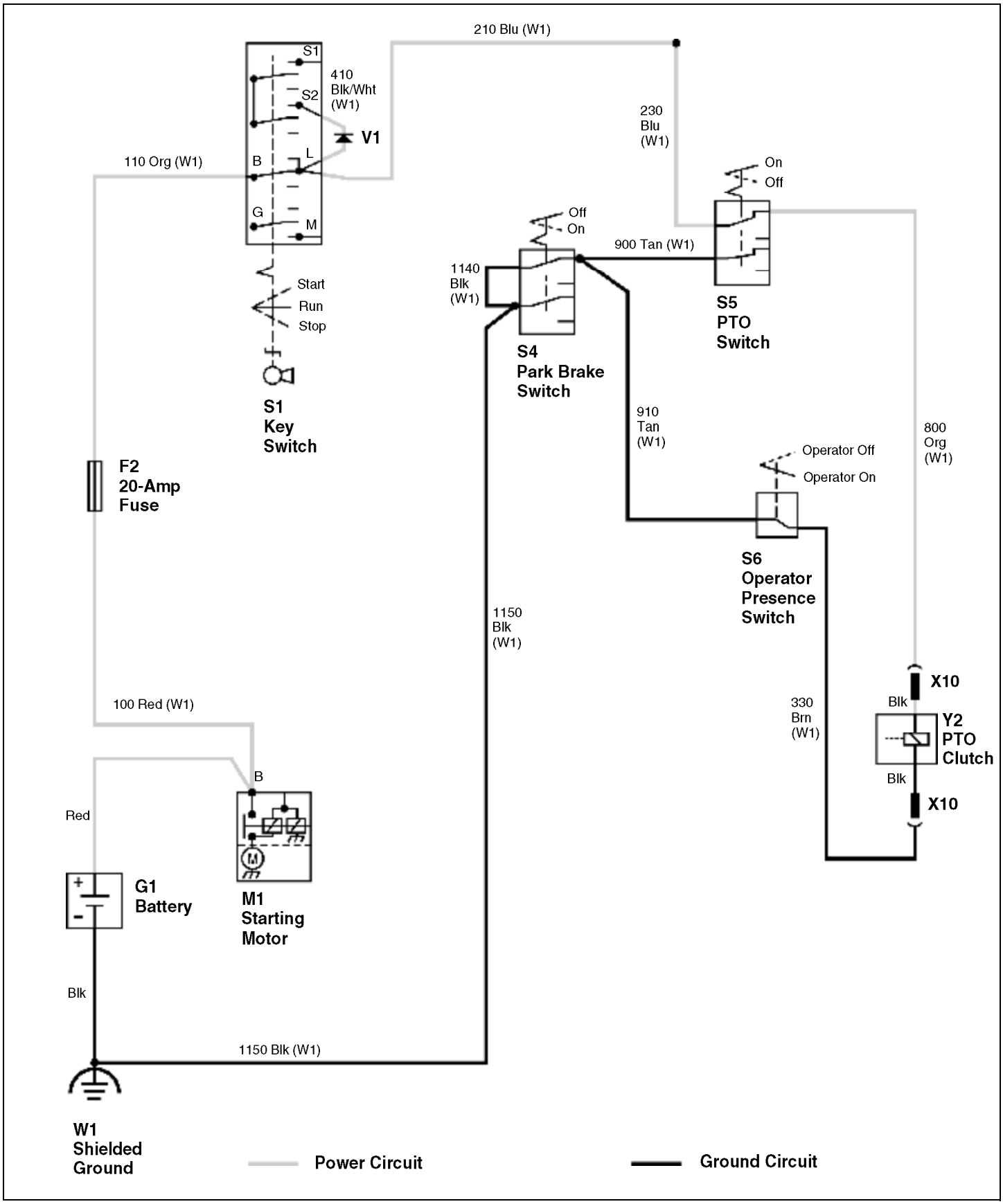
When the key switch is in the start or run position, current flows from the key switch terminal “B” to terminal “L”, through blue wires (No. 210 [W1] and 230 [W1]) to the PTO switch (S5).

With the PTO switch in the on (engaged) position, current flows through the switch, through orange wire (No. 800) to connector (X10) and PTO clutch (Y2).

With the operator presence switch (S6) engaged, and the park brake switch (S4) in the off position, the ground circuit is completed through brown wire (No. 330 [W1]), tan wire (No. 910 [W1]) and black wires (No. 1140 [W1] and 1150 [W1]) to the battery negative terminal.

When the circuit is completed, the clutch energizes, coupling the PTO pulley to the engine crankshaft, driving the mower deck drive belt.

PTO Clutch Circuit Electrical Schematic



MX13439

PTO Clutch Circuit Diagnosis

Test Conditions:

- Machine parked on a level surface.
- Key switch (S1) in STOP position.
- Park brake unlocked.
- Operator standing on platform (operator presence switch [S6] engaged).
- Meter negative lead on battery negative terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: PTO Clutch Circuit

(1) Measure battery voltage at battery positive post. Is voltage within 11.9 - 13.2 volts?

Yes - Go to step (2).

No - Test battery. (See "Test Battery" on page 146.)

(2) Measure voltage at starting motor solenoid - battery terminal. Is battery voltage present?

Yes - Go to step (3).

No - Check battery positive cable and clamps. Clean and tighten connections.

(3) Measure voltage at key switch (S1) - battery terminal, orange wire (No. 110 [W1]). Is battery voltage present?

Yes - Go to step (4).

No - Check red wire (No. 100 [W1]) and orange wire (No. 110, W1) and connections.

No - Test 20-amp fuse (F2). (See "Test Fuse" on page 153.)

(4) Measure resistance from ground terminal to park brake switch (S4), black wire (No. 1140 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (5).

No - Check black wires (No. 1140 [W1] and 1150 [W1]) and connections.

(5) Measure resistance from ground terminal to park brake switch (S4), tan wire (No. 900 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (6).

No - Test park brake switch. (See "Test Park Brake Switch" on page 157.)

System: PTO Clutch Circuit

(6) Measure resistance from ground terminal to operator presence switch (S6), tan wire (No. 910 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (7).

No - Check tan wire (No. 910 [W1]) and connections.

(7) Measure resistance from ground terminal to operator presence switch (S6), brown wire (No. 330 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (8).

No - Test operator presence switch. (See "Test Operator Presence Switch" on page 156.)

(8) Measure resistance from ground terminal to PTO clutch (Y2) connector (X10), brown wire (No. 330 [W1]). Is there less than 0.1 ohms of resistance?

Yes - Go to step (9).

No - Check brown wire (No. 330 [W1]) and connections.

(9) Move key switch (S1) to run position and measure voltage at terminal "L", blue wire (No. 210 [W1]). Is battery voltage present?

Yes - Go to step (10).

No - Test key switch. (See "Test Key Switch" on page 155.)

(10) Measure voltage at PTO switch (S5), blue wire (No. 230 [W1]). Is battery voltage present?

Yes - Go to step (11).

No - Check blue wires (No. 210 [W1] and 230 [W1]) and connections.

(11) Measure voltage at PTO switch (S5), orange wire (No. 800 [W1]). Is battery voltage present?

Yes - Go to step (12).

No - Test PTO switch. (See "Test PTO Switch" on page 155.)

(12) Measure voltage at PTO clutch (Y2), connector X10, orange wire (No. 800 [W1]). Is battery voltage present?

No - Check orange wire (No. 800 [W1]) and connections.

Hourmeter Circuit Operation

Function:

To provide power to the hourmeter.

Operating Conditions:

Key switch (S1) in the run position.

System Operation:

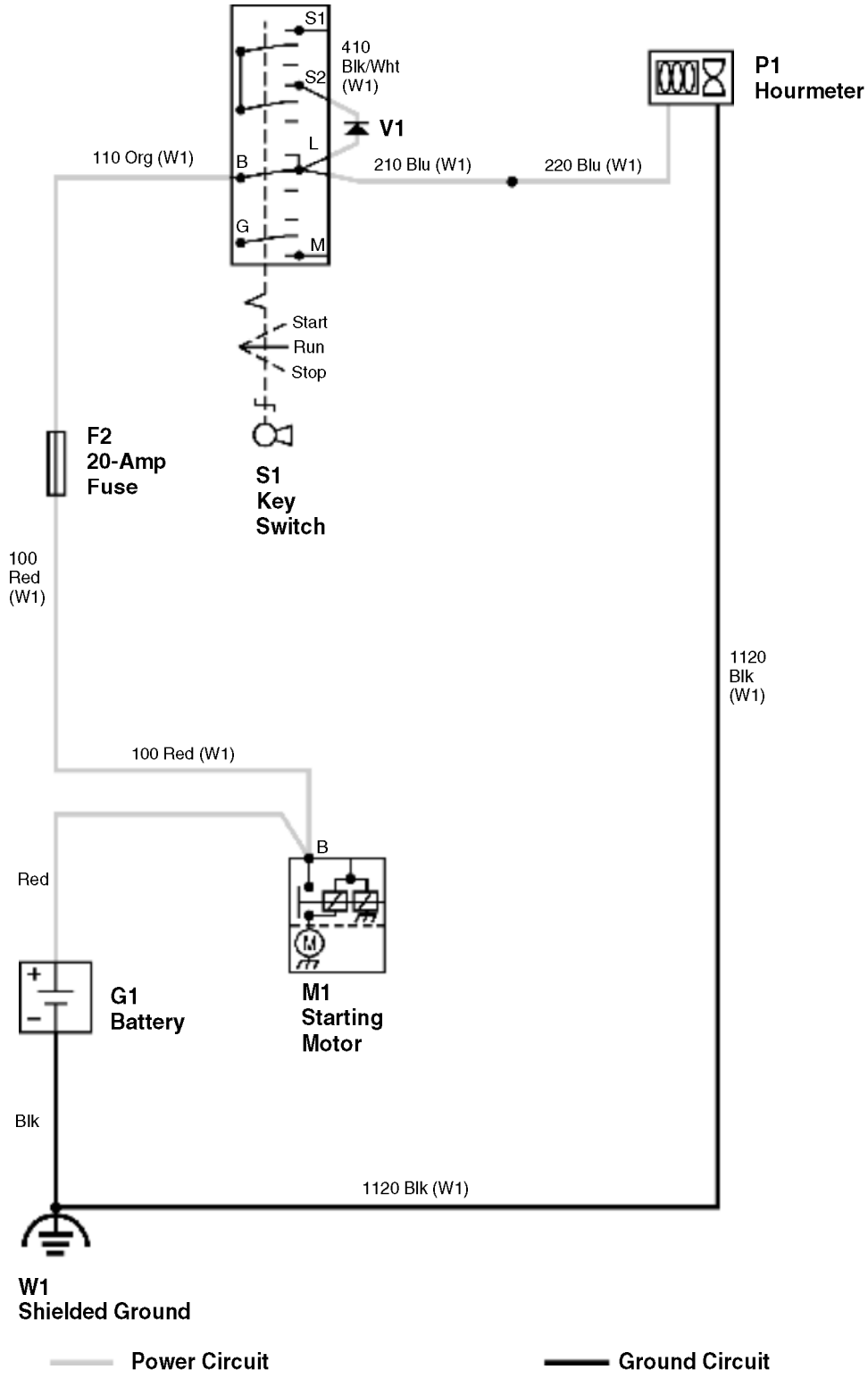
The hourmeter (P1) will operate any time a charged battery is correctly installed and the key switch (S1) is in the run or start position, with or without the engine running.

Current flows from the battery positive terminal, to the starter motor solenoid through the positive battery cable. Current then flows through red wire (No. 100 [W1]) to the 20-amp fuse (F2) and through the orange wire (No. 110 [W1]) to the key switch terminal “B”.

When the key switch is in the start or run position, current flows from the key switch terminal “B” to terminal “L”, through blue wires (No. 210 [W1] and 200 [W1]) to the hourmeter.

The ground circuit is completed through black wire (No. 1120 [W1]) to the battery negative terminal.

Hourmeter Circuit Electrical Schematic



MX13440

Hourmeter Circuit Diagnosis

Test Conditions:

- Machine parked on a level surface.
- Key switch (S1) in STOP position.
- Meter negative lead on battery negative terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Hourmeter Circuit

(1) Measure battery voltage at battery positive post. Is voltage within 11.9 - 13.2 volts?

Yes - Go to step (2).

No - Test battery. (See "Test Battery" on page 146.)

(2) Measure voltage at starting motor solenoid (M1) - battery terminal. Is battery voltage present?

Yes - Go to step (3).

No - Check battery positive cable and clamps. Clean and tighten connections.

(3) Measure voltage at key switch (S1) - battery terminal, orange wire (No. 110 [W1]). Is battery voltage present?

Yes - Go to step (4).

No - Check red wire (No. 100 [W1]), orange wire (No. 110 [W1]) and connections.

No - Test 20-amp fuse (F2). (See "Test Fuse" on page 153.)

(4) Check hourmeter (P1) ground circuit at black wire (No. 1120 [W1]) for resistance. Is there less than 0.1 ohms of resistance?

Yes - Go to step (5).

No - Check black wire (No. 1120 [W1]) and connections.

(5) Move key switch (S1) to run position, and measure voltage at key switch, terminal "L", blue wire (No. 210 [W1]). Is battery voltage present?

Yes - Go to step (6).

No - Test key switch. (See "Test Key Switch" on page 155.)

(6) Measure voltage at hourmeter (P1) at blue wire (No. 220 [W1]). Is battery voltage present?

Yes - Replace hourmeter.

System: Hourmeter Circuit

No - Check blue wires (No. 220 [W1] and 210 [W1]) and connections.

Optional Headlight Circuit Operation

Function:

To provide power to the headlights.

Operating Conditions:

Headlight switch (S7) in the on position.

System Operation:

The headlights (E3 and E4) will operate any time a charged battery is correctly installed and the headlight switch (S7) is in the on position, with or without the engine running.

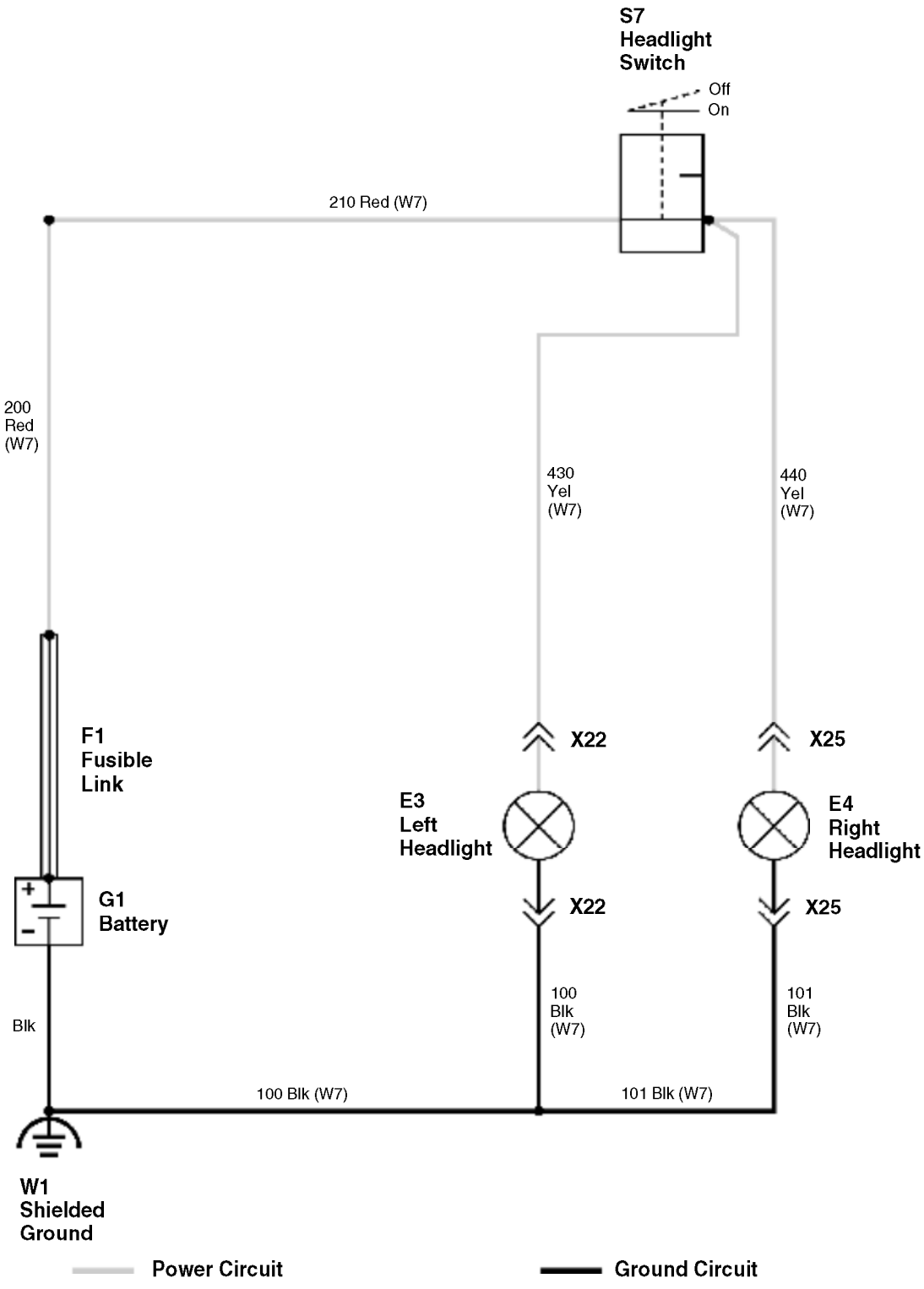
Current from the battery (G1) flows through red wires (No. 200 [W7] and 210 [W7]) to the headlight switch. This circuit is protected by a fusible link (F1).

The fusible link is a short length of wire designed to protect the circuit, and will fail if the current load becomes excessive or if a short occurs.

With the headlight switch in the on position, current flows through yellow wires (No. 430, W7) to the left headlight, and (No. 440, W7) to the right headlight.

The ground circuit is completed through black wires (No. 101 [W7] and 100 [W7]) to the battery negative terminal.

Optional Headlight Circuit Schematic



MX15079

Optional Headlight Circuit Diagnosis

Test Conditions:

- Machine parked on a level surface.
- Headlight switch (S7) in off position.
- Meter negative lead on battery negative terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

System: Headlight Circuit

(1) Measure battery voltage at battery positive post. Is voltage within 11.9-13.2 volts?

Yes - Go to step (2).

No - Test battery. (See "Test Battery" on page 146.)

(2) Measure voltage at headlight switch (S7) at red wire (No. 210, W7). Is battery voltage present?

Yes - Go to step (3).

No - Check red wires (No. 210 [W7] and 200 [W7]), fusible link (F1) and connections.

(3) Check left headlight (E3) ground circuit at black wire (No. 100 [W7]) for resistance. Is there less than 0.1 ohms of resistance?

Yes - Go to step (4).

No - Check black wire (No. 100 [W7]) and connections.

(4) Check right headlight (E4) ground circuit at black wire (No. 100, [W7]) for resistance. Is there less than 0.1 ohms of resistance?

Yes - Go to step (5).

No - Check black wires (No. 101 [W7] and 100 [W7]) and connections.

(5) Move headlight switch (S7) to on position, and measure voltage at yellow wires (No. 430 [W7] and 440 [W7]). Is battery voltage present?

Yes - Go to step (6).

No - Test headlight switch. (See "Test Headlight Switch" on page 158.)

(6) Measure voltage at left headlight (E3) at yellow wire (No. 430 [W7]). Is battery voltage present?

Yes - Go to step (7).

No - Check yellow wire (No. 430 [W7]) and connections.

System: Headlight Circuit

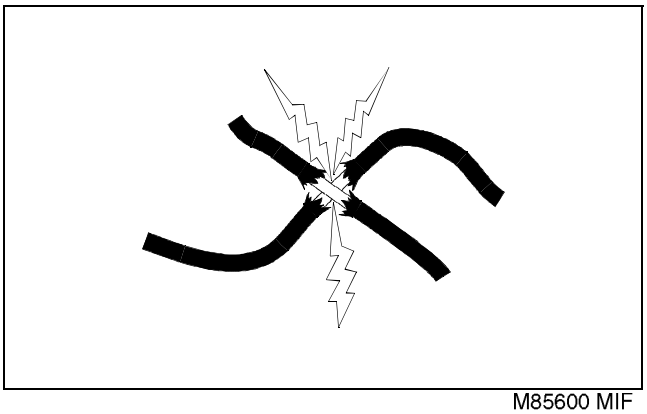
(7) Measure voltage at right headlight (E4) at yellow wire (No. 440 [W7]). Is battery voltage present?

No - Check yellow wire (No. 440 [W7]) and connections.

Tests and Adjustments

Test Common Circuit

Shorted Circuit:

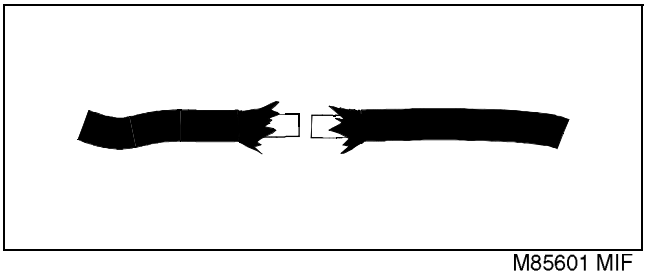


M85600 MIF

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

1. Turn component switch ON.
2. Start at the controlling switch of the component that should not be operating.
3. Follow the circuit and disconnect wires at connectors until component stops operating.
4. Shorted or improper connections will be the last two wires disconnected.

High Resistance or Open Circuit:

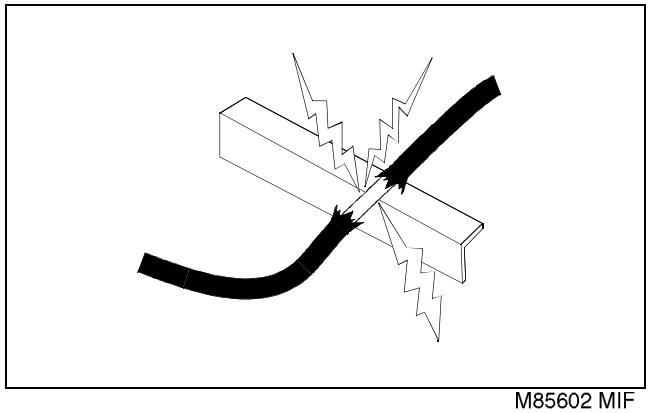


M85601 MIF

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

1. Check all terminals and grounds of the circuit for corrosion.
2. If terminals are not corroded or loose, the problem is in the component or wiring.

Grounded Circuit:



M85602 MIF

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

Test Ground Circuit

Reason:

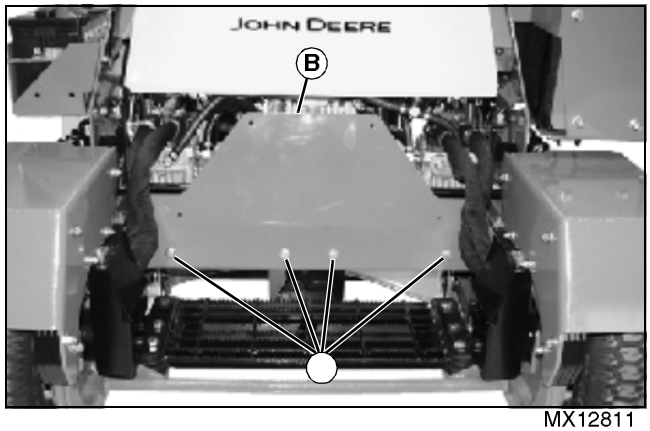
To check for open circuits, loose terminal wire crimps, poor connections or corrosion in the ground circuit.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to read the resistance from battery terminals.
Voltmeter	NA	Used to check ground connections under load.

NOTE: The voltmeter method checks ground connections under load.

1. Park machine on level surface.
2. Move motion control levers to neutral position.
3. Turn key switch to STOP position.
4. Lock park brake.



MX12811

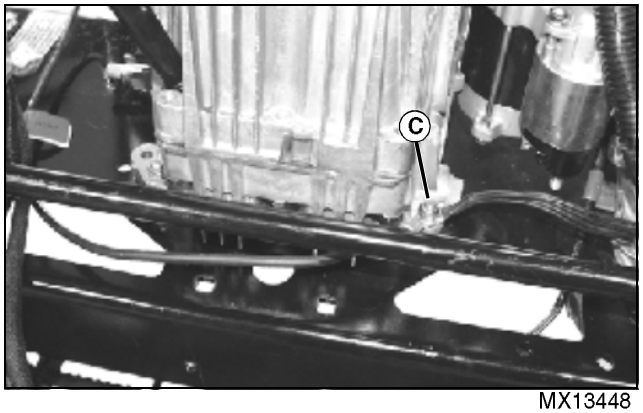
5. Remove four capscrews and washers (A) from rear shield (B).

6. Remove rear shield (B).

7. Proceed to Ohmmeter Method or Voltmeter Method.

Procedure - Ohmmeter Method:

1. Connect both ohmmeter negative (black) lead and positive (red) lead to the negative (-) terminal of battery. Record reading.



MX13448

2. Connect ohmmeter red lead to ground terminal (C) 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, as disconnecting and connecting may temporarily solve problem.

Procedure - Voltmeter Method:

1. Connect voltmeter negative (black) lead to negative terminal of battery.

2. 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: Mower comes with sealed battery and is not serviceable. This procedure is for a serviceable battery that has replaced the original sealed battery.

Reason:

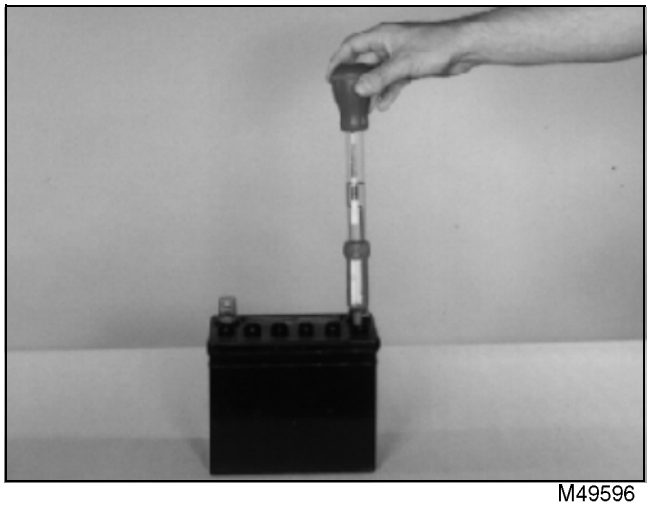
To check condition of battery and determine battery voltage.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hydrometer	NA	Used to check battery for a minimum specific gravity.
Voltmeter	NA	Used to check for a minimum battery voltage.
Battery Tester	JT05685	Used to check for a minimum battery voltage.

Procedure:

1. Park machine on level surface.
2. Move motion control levers to neutral position.
3. Turn key switch to STOP position.
4. Lock park brake.
5. Clean cable ends, battery terminals and top of battery. (See "Clean Battery" on page 162.)
6. Remove battery. (See "Remove and Install Battery" on page 161.)
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 amp rate.
    - 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 voltmeter 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. (See step 10.)
12. Install battery. (See "Remove and Install Battery" on page 161.)

Charge Battery

Reason:

To increase battery charge after the battery has been discharged.

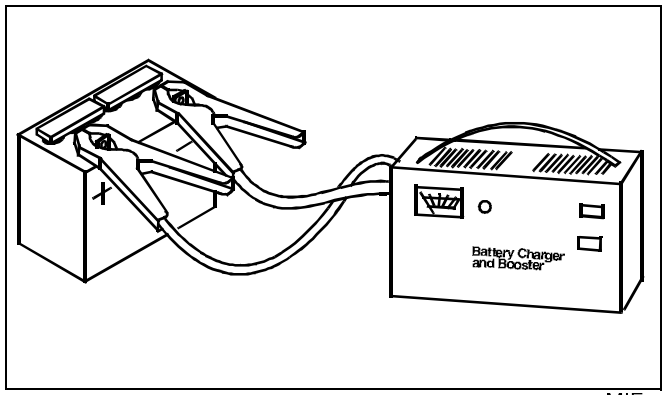
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Charger (Variable Rate)	NA	Used to charge battery.

Procedure:

NOTE: Before charging serviceable battery, check electrolyte level. (See "Test Battery" on page 146.)

1. Park machine on level surface.
2. Move motion control levers to neutral position.
3. Turn key switch to STOP position.
4. Lock park brake.
5. Clean cable ends, battery terminals and top of battery. (See "Clean Battery" on page 162.)
6. Remove battery. (See "Remove and Install Battery" on page 161.)



MIF

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.
- **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 11 and 12.
- **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 13 and 14.

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. (See "Load Test Battery" on page 148.)

13.Install battery. (See "Remove and Install Battery" on page 161.)

Specifications:

Battery Specific Gravity . . . . . 1.230 - 1.265 points

Load Test Battery

Reason:

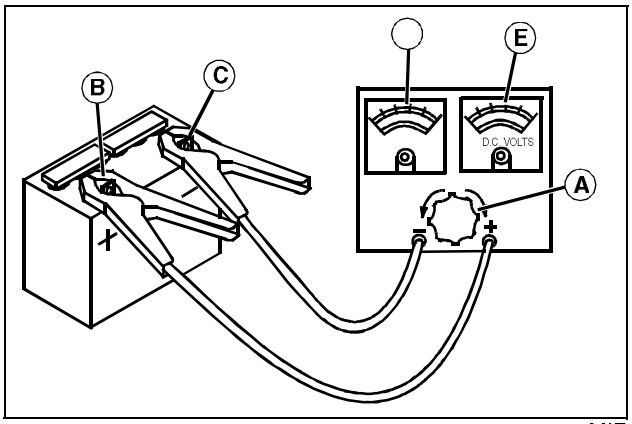
To check condition of battery under load.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Tester	JT05685	Used to test battery load.

Procedure:

1. Park machine on level surface.
2. Move motion control levers to neutral position.
3. Turn key switch to STOP position.
4. Lock park brake.
5. Clean cable ends, battery terminals and top of battery. (See "Clean Battery" on page 162.)
6. Remove battery. (See "Remove and Install Battery" on page 161.)



7. Turn load knob (A) counterclockwise to OFF position.
8. Connect tester positive (red) cable to battery positive terminal (B).
9. Connect tester negative (black) cable to battery negative terminal (C).
10.Turn load knob (A) of tester clockwise (in) until amperage scale (D) 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 7 and 8 above and read condition of battery on DC volts scale (E).

Results:

- If battery DOES NOT pass test and has NOT been charged, charge battery and retest.
- If battery DOES NOT pass test and HAS BEEN charged, replace battery.

Test Regulated Voltage Output

Reason:

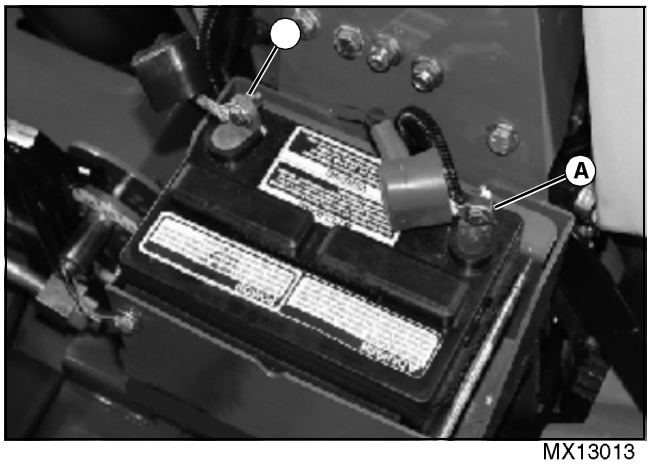
To check the regulated voltage (charging) output of the voltage regulator/rectifier.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Voltmeter	NA	Used to read battery voltage.

Procedure:

1. Park machine on level surface.
2. Move motion control levers to neutral position.
3. Turn key switch to STOP position.
4. Lock park brake.
5. Disconnect spark plug wires from engine.
6. Remove surface charge from battery by cranking the engine for 15 seconds.
7. Reconnect spark plug wires.
8. **Serviceable batteries only:** Verify battery electrolyte is at proper level.



MX13013

9. Connect meter red lead to battery positive terminal (A).
10. Connect meter black lead to battery negative terminal (B).
11. Record the battery voltage with engine off.
12. Start and run engine at fast idle.

NOTE: Regulated output voltage will vary with engine rpm.

13. Read meter several times during 5 minutes of running time. Voltage should read above battery voltage with the engine off, but below maximum voltage specification with engine at fast idle.

Results:

- If the DC voltage remains below the minimum specification, check unregulated voltage output. (See "Test Unregulated Voltage Output" on page 149.)
- If the DC voltage goes above the maximum specification, check regulator leads for loose or open connection. If connection is OK, replace the voltage regulator/rectifier.

Specifications:

Fast Idle (Model 647) . . . . . .3600 rpm

Fast Idle (Models 657 and 667) . . . . . .3400 rpm

Regulated Voltage . . . . . .13.8-15 volts DC

Test Unregulated Voltage Output

Reason:

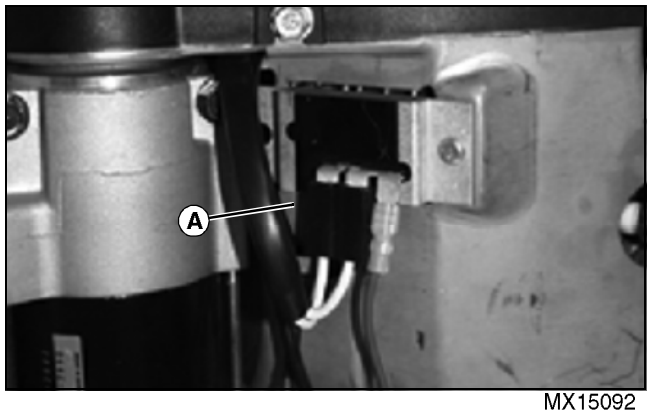
To check the stator output voltage to determine the stator condition.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Voltmeter	NA	Used to read output voltage.
Pulse Tachometer	JT07270	Used to read engine rpm.

Procedure:

1. Park machine on level surface.
2. Move motion control levers to neutral position.
3. Turn key switch to STOP position.
4. Lock park brake.



MX15092

5. Disconnect the stator wire connector (A) at voltage regulator/rectifier.

6. Connect voltmeter leads across stator leads (connector with white wires).

7. Connect pulse tachometer.

8. Start and run engine at 3000 rpm.

9. Read and record stator output voltage. Voltage should be to specification.

Results

If reading is less than specifications, test stator. (See "Test Stator" on page 150.)

If stator tests OK, replace flywheel. (See "Remove and Install Flywheel" on page 69.)

Specifications

Minimum Unregulated Output Voltage . . . . . 26 volts AC

Test Stator

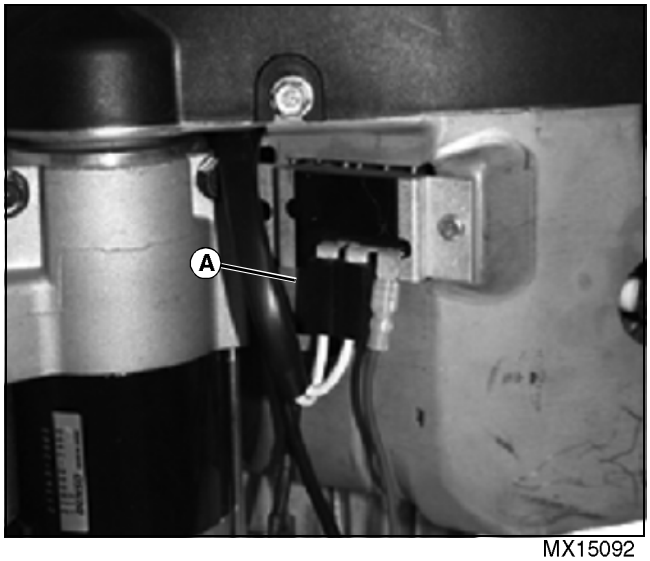
Reason:

To check stator coil resistance to determine the stator condition.

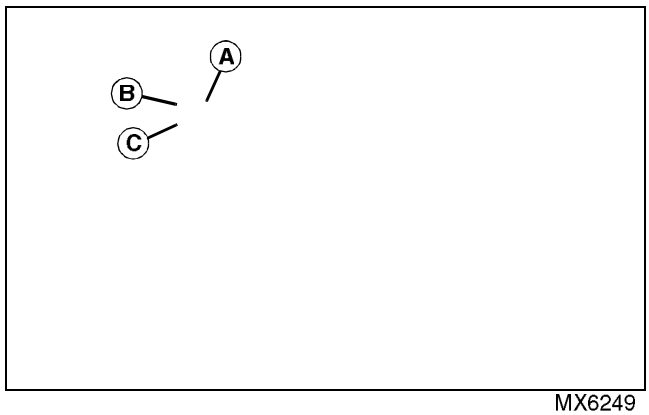
Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to read stator resistance.

Procedure:



MX15092



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:

Maximum Stator Coil Resistance . . . . . 0.1 ohms

Test Starting Motor Solenoid

Reason:

To determine if the starter solenoid or starting motor is defective.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Jumper Wire	NA	Used to test starting motor.

Procedure:

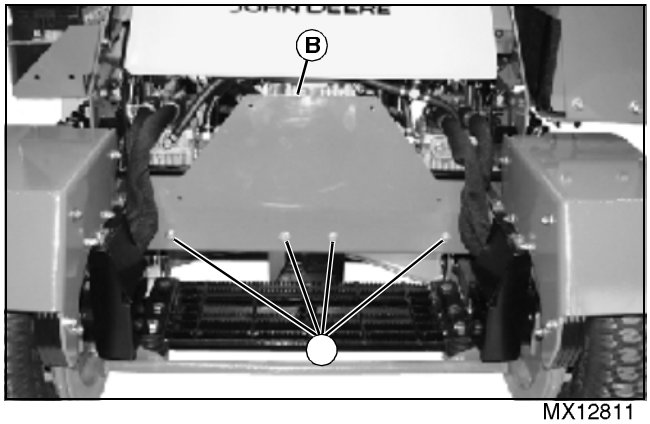
1. Park machine on level surface.

2. Move motion control levers to neutral position.

3. Turn key switch to STOP position.

4. Lock park brake.

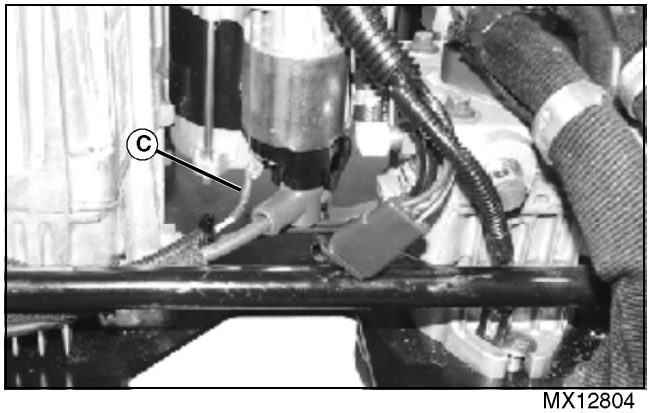
5. Remove spark plug high-tension leads and connect to engine ground.



MX12811

6. Remove four capscrews and washers (A) from the rear shield (B).

7. Remove rear shield (B).



MX12804

8. Disconnect gray wire (No. 600 [W1]) (C) from starter solenoid.

9. Connect jumper wire to positive battery terminal and briefly jump to gray wire terminal on starter solenoid. One of the following should result:

- Starter runs: Solenoid is good; check circuit wiring. (See “Cranking Circuit Diagnosis” on page 124.)
- Solenoid clicks but starting motor does not run: Go to step 10.
- Solenoid does not click: Replace solenoid.

10.Briefly connect jumper wire between starter solenoid large terminals. One of the following should result:

- Starting motor runs: Replace solenoid.
- Starting motor does not run: Check battery cables; replace starter.

Test Loaded Starting Motor Amperage Draw

Reason:

To determine amperage needed to crank the engine.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used with the Current Clamp to check the current draw of the starting motor.
Current Clamp	JT02153	Used to check the current draw of the starting motor.

Procedure:

1. Park machine on level surface.
2. Move motion control levers to neutral position.
3. Turn key switch to STOP position.
4. Lock park brake.
5. Remove spark plug high-tension leads and connect to engine ground.
6. 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.
7. Clamp jaws of current clamp around the positive battery cable.
8. Set the current clamp to 2000A and the multimeter to 300mV.

NOTE: The core of the jaws may hold some magnetic force after the current clamp has been used for measurement. If you can not zero adjust the display, open the jaws and snap them closed several times.

9. Adjust the DCA ZERO ADJUST dial on the current clamp for a zero reading on the multimeter.

NOTE: If using a multimeter other than JT05791, use a meter that will read millivolts. Millivolts = current in amps; 1mV= 1 amp.

10.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 Amp Draw . . . . . 100 amps

Test No-Load Starting Motor Amperage Draw

Reason:

To determine starting motor condition under no-load conditions.

Special or Required Tools

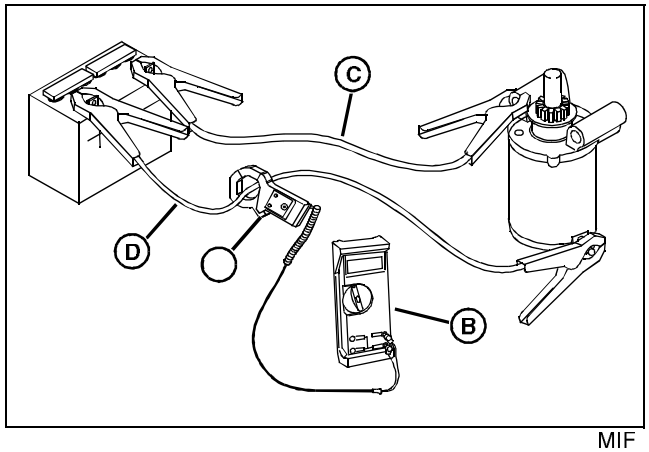
Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used with the Current Clamp to check the current draw of the starting motor.
Current Clamp	JT02153	Used to check the current draw of the starting motor.
12-Volt Battery	NA	Used to supply power to the starting motor.
Jumper Cables	NA	Used to connect the starting motor to the battery.

Procedure:

1. Remove starting motor. (See “Remove and Install Starting Motor” on page 94.)

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.

2. Clamp the starting motor mounting bracket in a vise.



MIF

3. Connect current clamp (A) RED lead to the VOLTS jack of the multimeter (B) and current clamp BLACK lead to the COM jack on the multimeter.

4. Connect the NEG jumper cable (C) to the battery NEG post and the frame of the starting motor.

5. Connect one end of the POS jumper cable (D) to the POS post of the battery.

6. Clamp jaws of current clamp around the positive jumper cable (D).

7. 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 can not zero adjust the display, open the jaws and snap them closed several times.

8. Adjust the DCA ZERO ADJUST dial on the current clamp for a zero reading on the multimeter.

NOTE: If using a multimeter other than JT05791, use a meter that will read millivolts. Millivolts = current in amps; 1mV= 1 amp.

9. Momentarily touch the POS jumper cable lead to the starting motor POS post and read the starting motor amperage draw.

Result:

- If amperage is above specification, check starting motor for binding or damage.

Specifications:

Maximum Starting Motor Amp Draw . . . . . 35 amps

Test Spark Output

Reason:

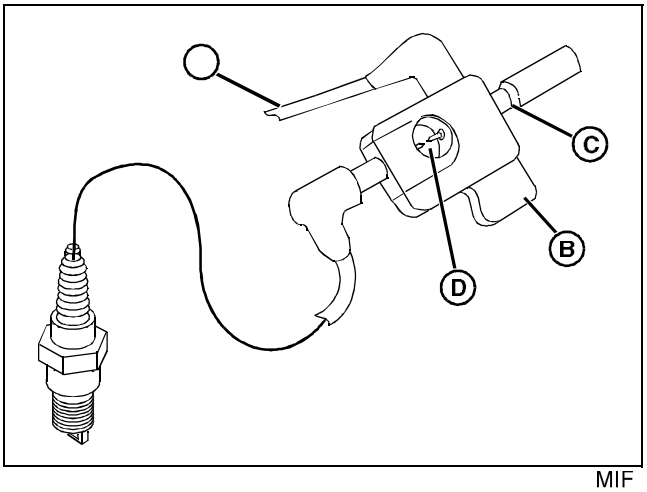
To determine condition of the ignition system.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Spark Tester	D-05351st	Used to check the operation of the ignition system.

Procedure:

1. Park machine on level surface.
2. Turn key switch to STOP position.
3. Move control levers to neutral position.
4. Lock park brake.



MIF

5. Remove high tension lead (A) from spark plug and connect to spark tester (B).

6. Connect spark tester lead to spark plug.

7. 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.) as damage to ignition system components could occur.

8. Start engine and watch spark (D) at 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. (See “Adjust Ignition Coil Air Gap” on page 53.)
- If spark is still weak, or still no spark, check run circuit. (See “Run Circuit Diagnostics” on page 128.) Replace coils as needed. (See “Remove and Install Ignition Coil” on page 68.)

Test Fuse

Reason:

To verify that the fuse has continuity.

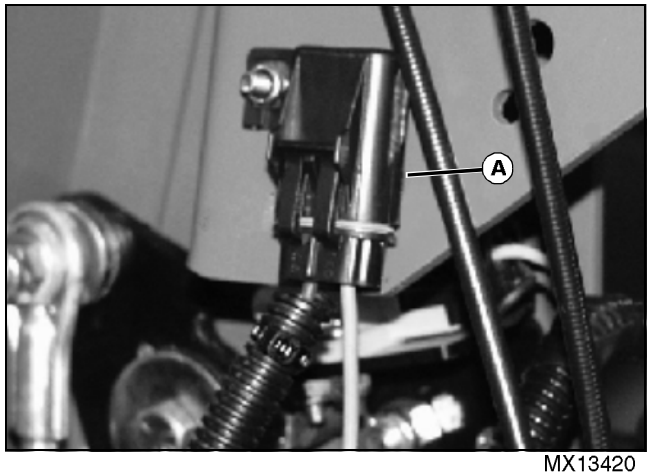
Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter or Continuity Tester	NA	Used to check continuity of fuses.

Procedure:

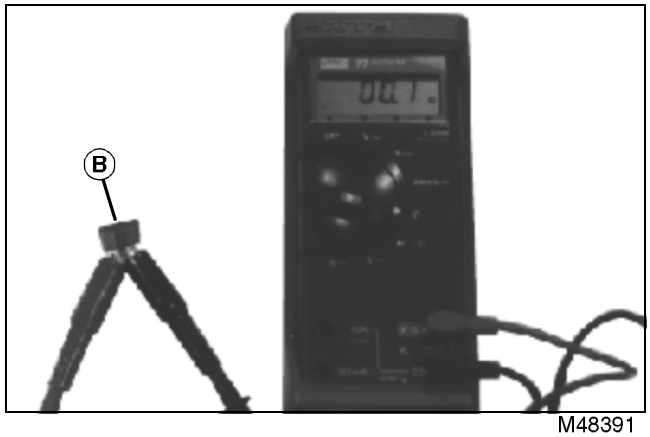
1. Park machine on a level surface.
2. Move key switch to STOP position.
3. Lock park brake.

NOTE: Fuse is located under the control panel, on the left support.



MX13420

4. Remove fuse from fuse block (A).
5. Check visually for broken filament.



M48391

6. Connect ohmmeter or continuity tester to each end of fuse (B).
7. Check for continuity.

Results:

- If continuity is not indicated, replace fuse.

Test Diode

Reason:

To verify that the diode has proper continuity.

Special or Required Tools

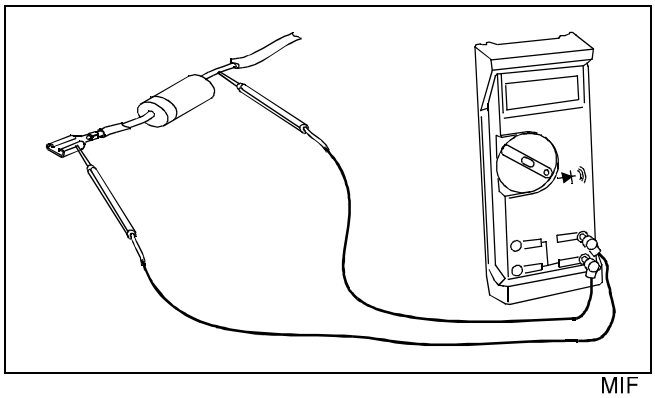
Tool Name	Tool No.	Tool Use
Diode Tester, Ohmmeter or Continuity Tester	NA	Used to check continuity of diodes.

Procedure:

1. Park machine on level surface.
2. Turn key switch to STOP position.
3. Move motion control levers to neutral position.
4. Lock park brake.

NOTE: The meter will measure and display voltage drop across diode when set to diode test range.

5. Set meter to diode test range.



MIF

6. Place one meter lead on connector and second meter lead on opposite side of diode.
7. Reverse meter leads. Check for continuity.

NOTE: If using ohmmeter for test, resistance in one direction will be approximately 80,000 ohms, and reading will "fall" during testing. Ohmmeter reading in opposite direction will be between 4 and 5 mega-ohms and "rise" during testing.

Results:

- Meter should "beep" once in one meter lead position only.
- Meter has continuous tone in either position, diode is shorted; replace diode.
- Meter displays "OL" in both positions, diode is "open"; replace diode.

Test Relay

Reason:

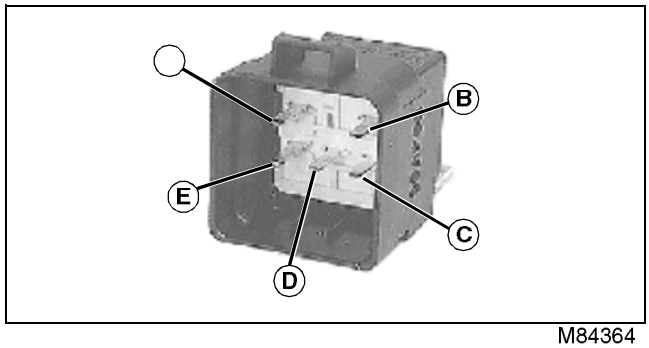
To check relay terminal continuity in the energized and de-energized condition.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter or Continuity Tester	NA	Used to check continuity between terminals.

Procedure:

1. Park machine on level surface.
2. Lock park brake.
3. Turn key switch to STOP position.
4. Disconnect relay(s) from harness.



M84364

5. Using an ohmmeter or continuity tester, check for continuity between terminals 87A (D) and 30 (A). There should be continuity between terminals 87A and 30.
6. Using an ohmmeter or continuity tester, check for continuity between terminals 87 (C) and 30 (A). There should NOT be continuity between terminals 87 and 30.
7. Using an ohmmeter or continuity tester, check for continuity between terminals 85 (E) and 86 (B). There should be continuity between terminals 85 and 86.
8. 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.
9. Using an ohmmeter or continuity tester, 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 Key Switch

Reason:

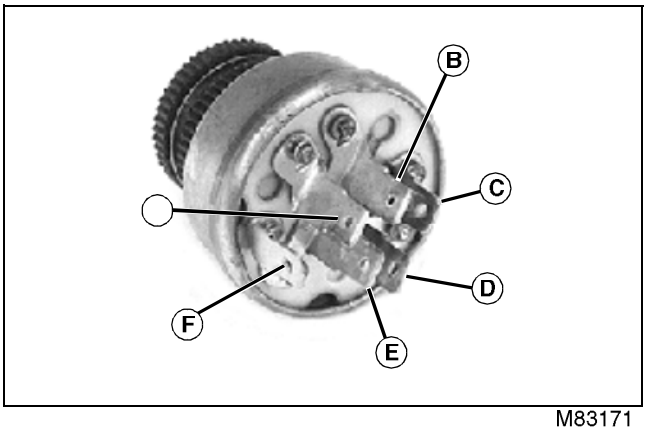
To verify that the key switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter or Continuity Tester	NA	Used to test switch continuity.

Procedure:

1. Park machine on level surface.
2. Move motion control levers to neutral position.
3. Turn key switch to STOP position.
4. Lock park brake.
5. Disconnect key switch connector.



M83171

6. Using an ohmmeter or continuity tester, check switch continuity in STOP, RUN, and START positions.

NOTE: DO NOT refer to markings if stamped on terminals. Identify by art keys ONLY. Terminal combinations other than those listed should not have continuity.

Key Switch Continuity:

Switch Position	Terminal Continuity
STOP	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 PTO Switch

Reason:

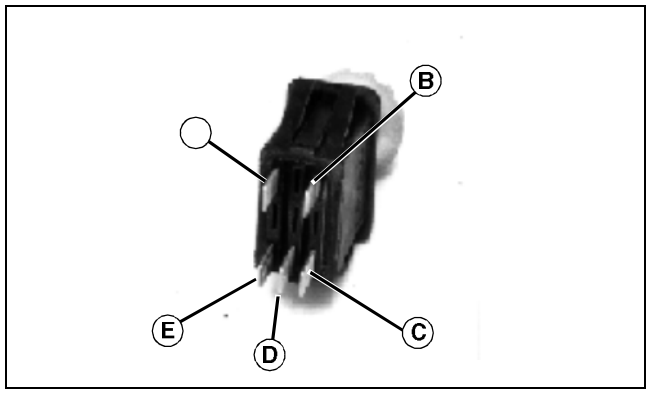
To verify that the continuity between terminals is correct when the switch is in the on and off positions.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter or Continuity Tester	NA	Used to test continuity between terminals.

Procedure:

1. Park machine on level surface.
2. Turn key switch to STOP position.
3. Lock park brake.
4. Disconnect PTO switch connector.
5. Move PTO switch to off position.



M47616

6. Using an ohmmeter or continuity tester, check continuity across terminals (A and B). Record reading.
7. Check continuity across terminals (C and E). Record reading.
8. Move PTO switch to ON position.
9. Using an ohmmeter or continuity tester, check continuity across terminals (D and E). Record reading.

PTO Switch Continuity:

Switch Position	Terminal Continuity
OFF	Continuity - A and B
	No Continuity - C and E
ON	Continuity - D and E

Results:

- If continuity is not correct, replace switch.

Test Operator Presence Switch

Reason:

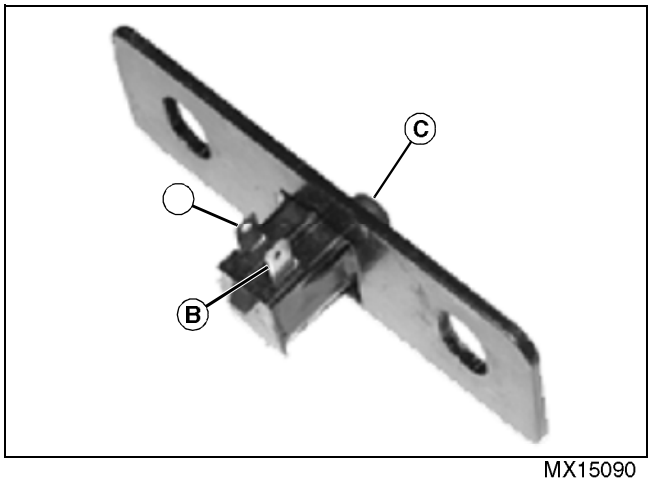
To determine if the operator presence switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter or Continuity Tester	NA	Used to check continuity across terminals.

Procedure:

1. Park machine on level surface.
2. Move motion control levers to neutral position.
3. Turn key switch to STOP position.
4. Lock park brake.
5. Remove operator presence switch bracket. (See “Remove and Install Operator Platform” on page 261, steps 1-7.)



MX15090

6. Connect one meter lead to terminal (A).
7. Connect the other meter lead to terminal (B).
8. Press and release switch plunger (C) and check continuity.
9. Install operator presence switch bracket. (See “Remove and Install Operator Platform” on page 261, steps 7-1.)
10. Adjust the operator presence switch actuator bracket. (See “Check and Adjust Operator Presence Switch” on page 258.)

Operator Presence Switch Continuity:

Switch Position	Continuity
Plunger Not Pressed	No Continuity
Plunger Pressed	Continuity

Results:

- If continuity is not correct, replace switch.

Test Neutral Switch

Reason:

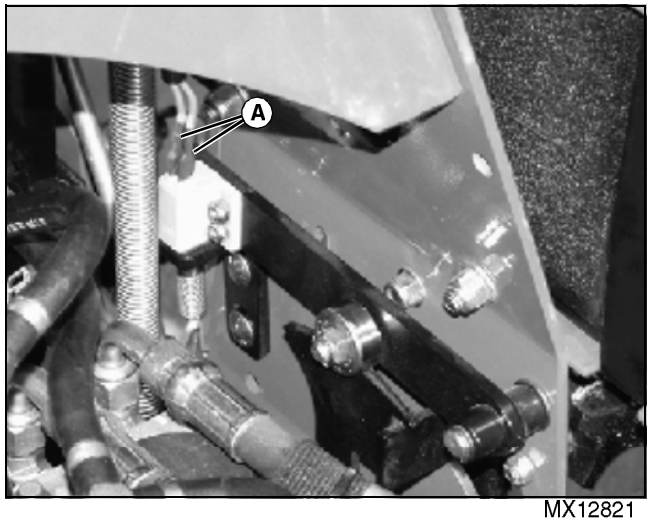
To determine if the neutral switches are operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter or Continuity Tester	NA	Used to check continuity across terminals.

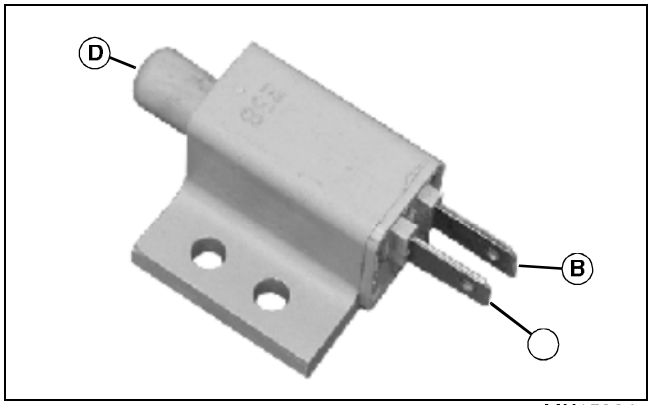
Procedure:

1. Park machine on level surface.
2. Move motion control levers to neutral position.
3. Turn key switch to STOP position.
4. Lock park brake.



MX12821

5. Disconnect wires (A) from the neutral switch.



MX15094

6. Connect one meter lead to post (B).
7. Connect other meter lead to post (C).
8. Press and release switch plunger (D).

Neutral Switch Continuity:

Switch Position	Continuity
Plunger Not Pressed	No Continuity
Plunger Pressed	Continuity

Results:

- If the continuity is not correct, replace switch.

Test Park Brake Switch

Reason:

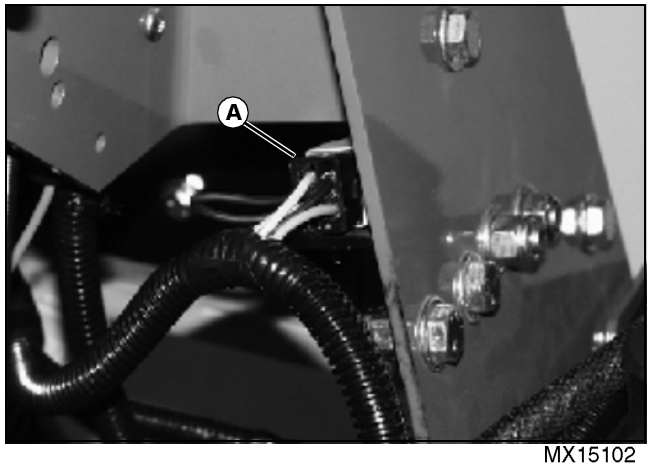
To determine if the park brake switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter or Continuity Tester	NA	Used to check continuity across terminals.

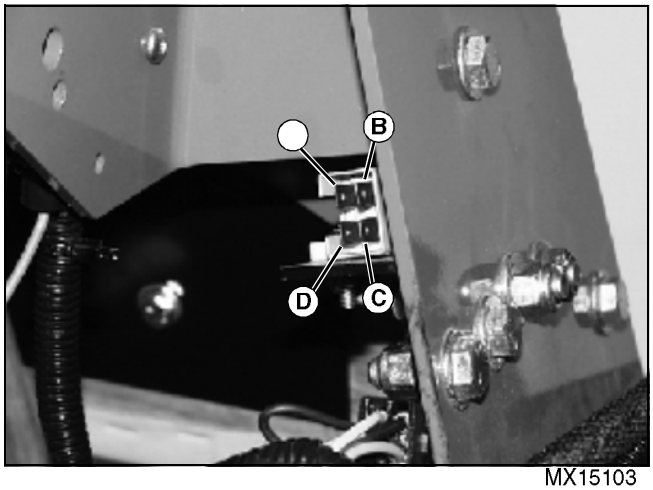
Procedure:

1. Park machine on level surface.
2. Move motion control levers to neutral position.
3. Turn key switch to STOP position.
4. Move park brake lever to unlocked position (park brake switch plunger not pressed).



MX15102

5. Disconnect connector (A) from park brake switch.



MX15103

6. Using an ohmmeter or continuity tester, check continuity across terminals (A and B). Record reading.
7. Check continuity across terminals (C and D). Record reading.
8. Move park brake lever to locked position (park brake switch plunger pressed).
9. Using an ohmmeter or continuity tester, check continuity across terminals (A and B). Record reading.
10. Check continuity across terminals (C and D). Record reading.

Park Brake Switch Continuity:

Switch Position	Continuity
Plunger Not Pressed (Park Brake Unlocked)	Continuity Across Terminals A and B. No Continuity Across Terminals C and D.

Switch Position	Continuity
Plunger Pressed (Park Brake Locked)	No Continuity Across Terminals A and B. Continuity Across Terminals C and D.

Results:

- If the continuity is not correct, replace switch.

Test Headlight Switch

Reason:

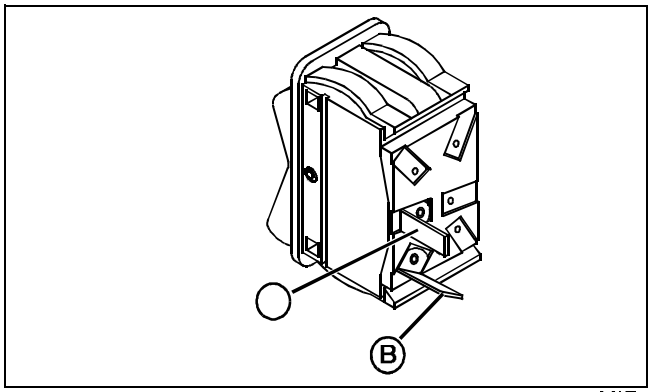
To determine if the headlight switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter or Continuity Tester	NA	Used to check continuity across terminals.

Procedure:

1. Park machine on level surface.
2. Move motion control levers to neutral position.
3. Turn key switch to STOP position.
4. Lock park brake.
5. Disconnect connector from headlight switch.



MIF

6. Connect one meter lead to terminal (A).
7. Connect other meter lead to terminal (B).
8. Move the switch to ON and then OFF position and check continuity.

Headlight Switch Continuity:

Switch Position	Continuity
Switch ON	Continuity between posts A and B.
Switch OFF	No continuity

Results:

- If continuity is not correct, replace switch.

Test Ignition Coil

Reason:

To check the condition of the ignition coils.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure ignition coil resistance.

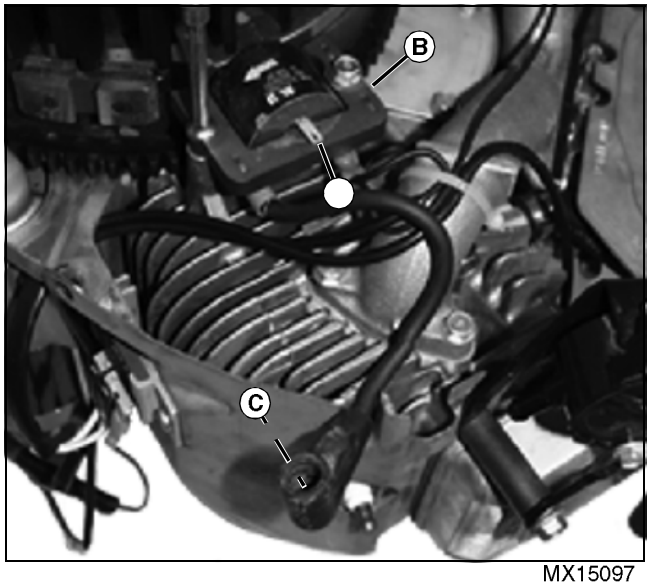
IMPORTANT: Avoid damage! If a meter other than specified is used, your readings may be different. If a meter having a large capacity battery is used, the ignition coil will be damaged.

Procedure:

1. Park machine on level surface.
2. Turn key switch to STOP position.
3. Move motion control levers to neutral position.
4. Lock park brake.
5. Remove flywheel blower housing from engine. (See “Remove and Install Blower Housing Assembly” on page 66.)

Primary Side

NOTE: A false reading will be obtained if the spark plug cap is not removed from spark plug.



MX15097

1. Measure resistance between ignition coil primary terminal (A) and iron core (B).
2. Reverse ohmmeter leads and again measure resistance.
3. Readings should be infinity (•) one way and 2k-18k ohms the other way.
4. Move the lead from the iron core (B) to the spark plug terminal (C). Record the meter reading.
5. Reverse leads and record meter reading.
6. Readings should be infinity (•) one way and 10k-30k ohms the other way.
7. Replace ignition coil if readings are not within specification.

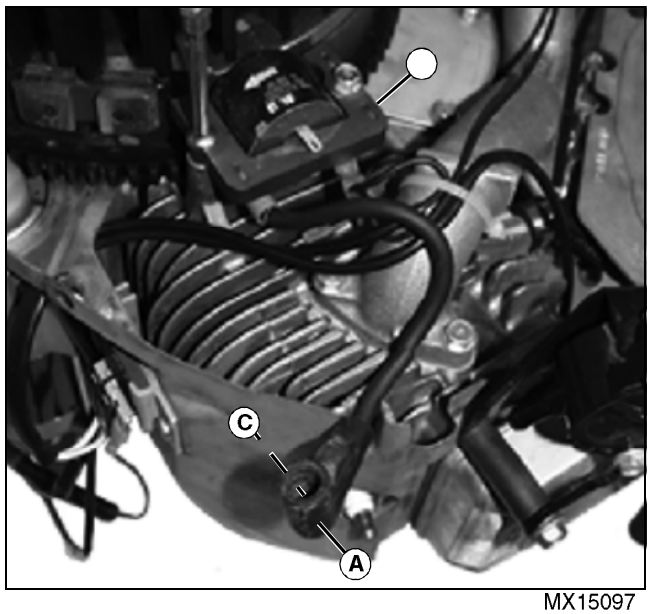
Specifications:

Primary Resistance . . . . . .Infinity (•) or 2k-18k ohms (depending on polarity)

Primary-to-Secondary Resistance . . . . . Infinity (•) or 10k-30k ohms (depending on polarity)

Secondary Side

NOTE: A false reading will be obtained if the spark plug cap is not removed from spark plug.



MX15097

1. Remove spark plug cap (A).
2. Measure resistance between the end of the spark plug terminal (C) and iron core (B). Replace ignition coil if resistance is not within specification. (See “Remove and Install Ignition Coil” on page 68.)

Specification

Ignition Coil Secondary Resistance. . . . . 8k - 11k ohms

Test Flywheel Magnet

Reason:

To make sure flywheel magnet(s) have enough force to induce current into ignition coil.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Screwdriver	NA	Used to check the condition of the flywheel magnet.

Procedure:

1. Park machine on level surface.
2. Turn key switch to STOP position.
3. Move motion control levers to neutral position.
4. Lock park brake.
5. Remove flywheel blower housing from engine. (See “Remove and Install Blower Housing Assembly” on page 66.)
6. Loosely hold screwdriver blade 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. (See “Remove and Install Flywheel” on page 69.)

Test Fuel Shutoff Solenoid

Reason:

To determine if the fuel shutoff solenoid is operating properly.

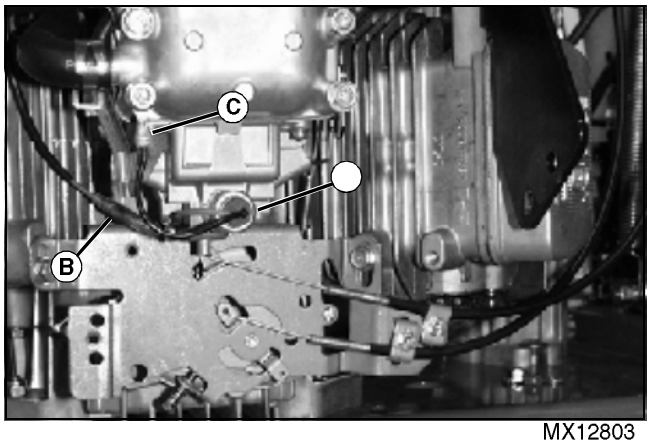
Special or Required Tools

Tool Name	Tool No.	Tool Use
Jumper Wire	NA	Used to test solenoid.

Procedure:

CAUTION: Avoid injury! Gasoline is present in the carburetor and fuel line. Gasoline is extremely flammable and its vapors can explode if ignited. Keep sparks and other sources of ignition away from the engine.

1. Park machine on level surface.
2. Move motion control levers to neutral position.
3. Turn key switch to STOP position.
4. Lock park brake.



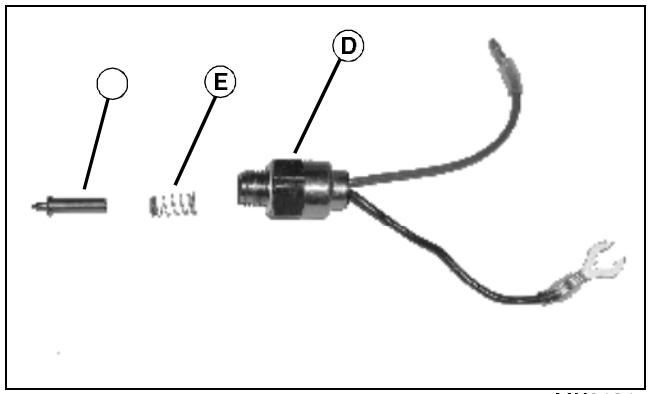
MX12803

Picture Note: Muffler removed for photo clarity.

5. Turn key switch to the run position. Listen for a “click” sound from fuel shutoff solenoid (A).
   - If “click” sounds, solenoid is good.
   - If no “click” sounds, proceed to next step.
6. Disconnect solenoid leads (B and C).
7. Remove carburetor. (See “Remove and Install Carburetor” on page 61.)

NOTE: Make sure needle valve and spring do not fall from fuel shutoff solenoid while removing solenoid.

Gas will leak out of the carburetor when the fuel shutoff solenoid is removed. Use a rag to catch fuel already in the carburetor.



MX6191

8. Remove fuel shutoff solenoid body (D) with spring (E) and needle valve (F).
9. Connect a jumper wire between the battery negative terminal and the negative wire of the solenoid.
10. Briefly touch male terminal of the solenoid lead to the battery positive terminal.

Results:

- If the pin retracts, the solenoid is good.
- If the pin fails to retract, replace the solenoid.

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:

Filling batteries in a well-ventilated area

Wearing eye protection and rubber gloves

Avoiding breathing fumes when electrolyte is added

Avoid spilling or dripping electrolyte

Use proper jumpstart procedure

If you spill acid on yourself:

Flush your skin with water

Apply baking soda or lime to help neutralize the acid

Flush your eyes with water for 10—15 minutes. Get medical attention immediately.

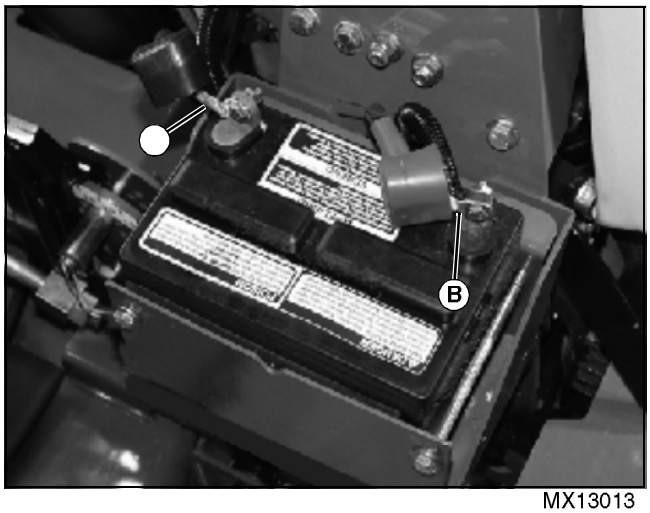
If acid is swallowed:

Drink large amounts of water or milk

Then drink milk of magnesia, beaten eggs, or vegetable oil

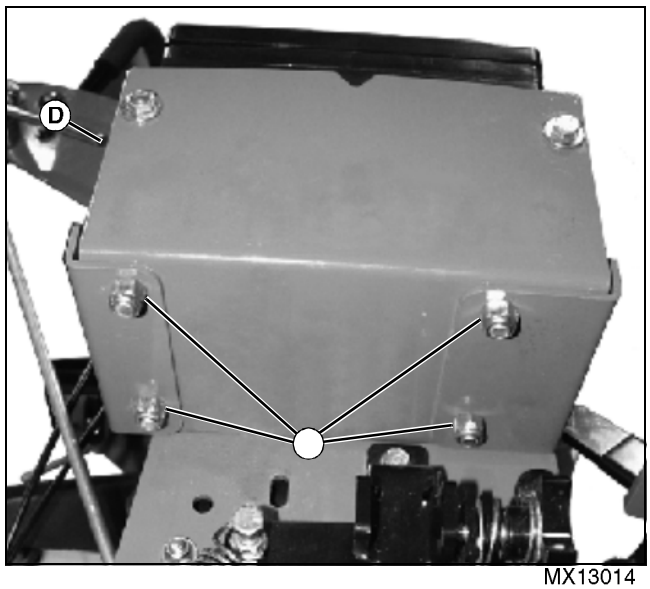
Get medical attention immediately

1. Park the machine safely.



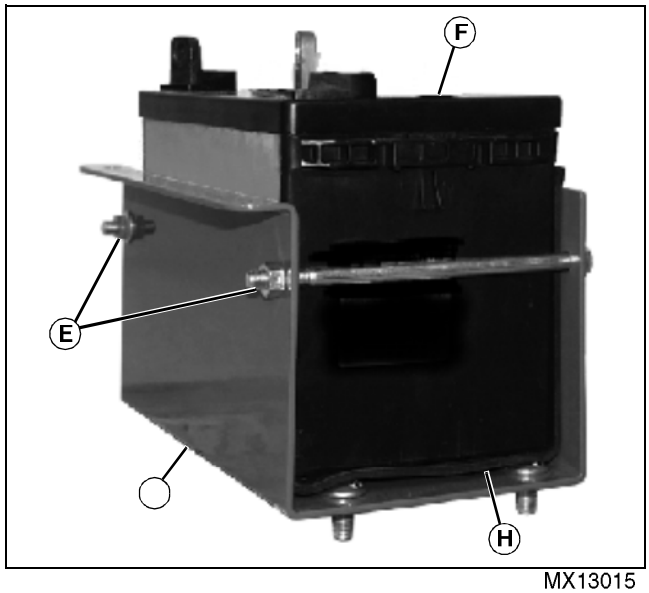
MX13013

2. Disconnect negative battery cable (A).
3. Disconnect positive battery cable (B).



MX13014

4. Remove four locknuts (C) at the bottom of the mounting bracket.
5. Lift battery and tray (D) from the machine.



MX13015

6. Loosen nuts (E).
7. Remove battery (F) from tray (G).
8. Inspect isolator pad (H). Replace as needed.

Installation is done in the reverse order of removal.

Clean Battery

1. Remove battery from machine. (See “Remove and Install Battery” on page 161.)

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.

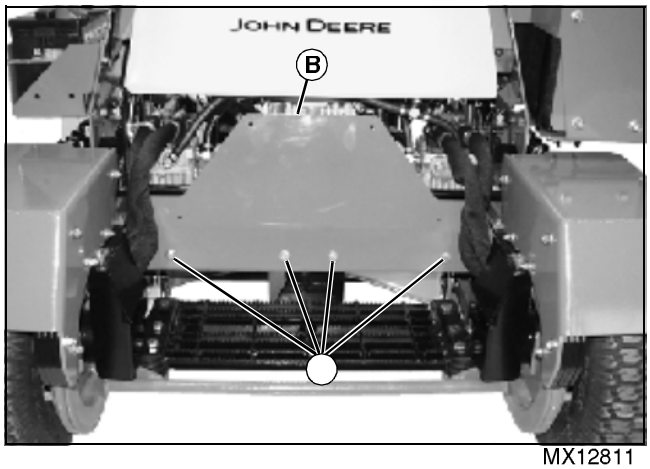
3. Rinse all parts with clean water. Let dry thoroughly.

4. Apply petroleum jelly to battery terminals to prevent corrosion.

Remove and Install PTO Clutch

1. Remove mower deck. (See “Remove and Install Mower Deck” on page 244.)

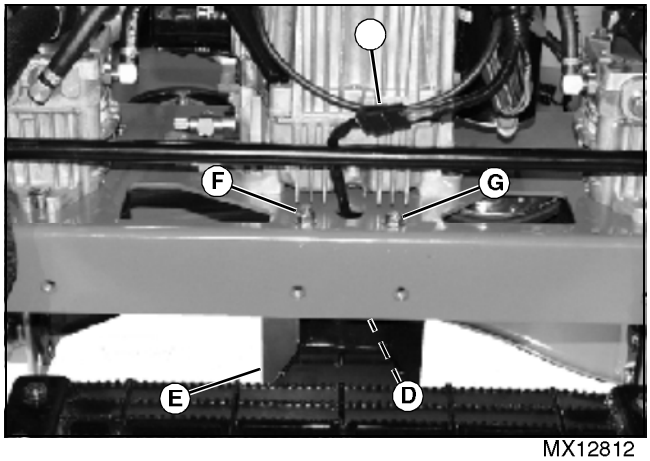
2. Remove traction drive belt. (See “Remove and Install Traction Drive Belt” on page 185.)



MX12811

3. Remove four capscrews and washers (A) from the rear shield (B).

4. Remove rear shield (B).



MX12812

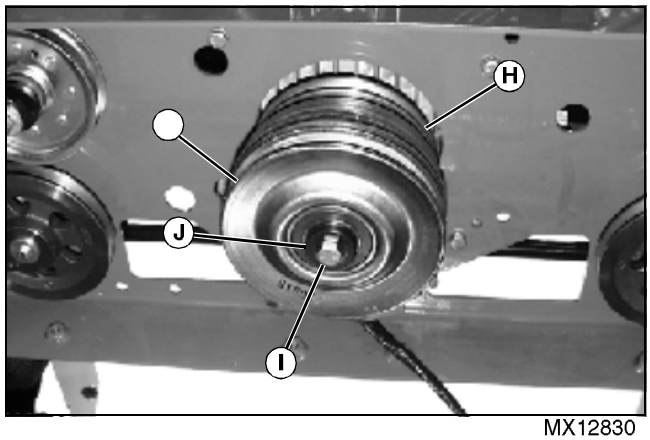
5. Disconnect PTO clutch wiring connector (C).

6. Cut the tie wrap (D) securing the PTO clutch wiring harness to the belt guard (E).

7. Remove locknut (F), flat washer and carriage bolt.

8. Remove locknut (G), flat washer and anchor capscrew.

9. Remove mower drive belt guard (E).



MX12830

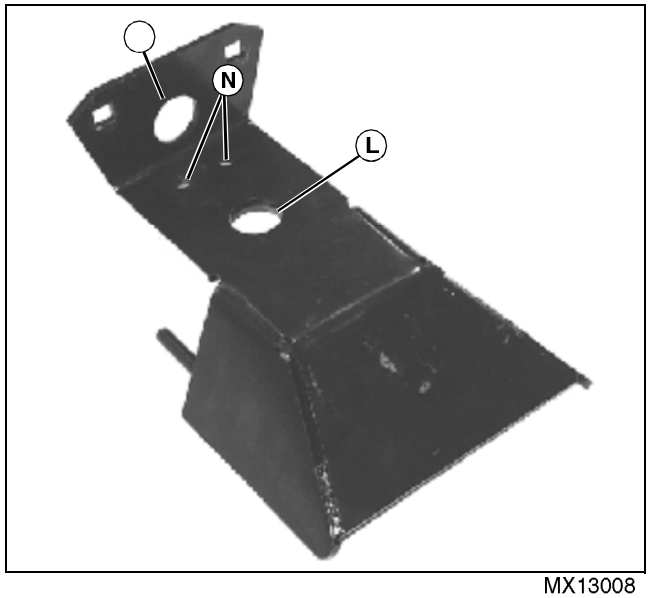
10.Hold the traction drive belt pulley (H) using a strap wrench.

11.Remove capscrew (I) and special washer (J).

12.Remove PTO clutch (K) and key.

Installation is done in the reverse order of removal.

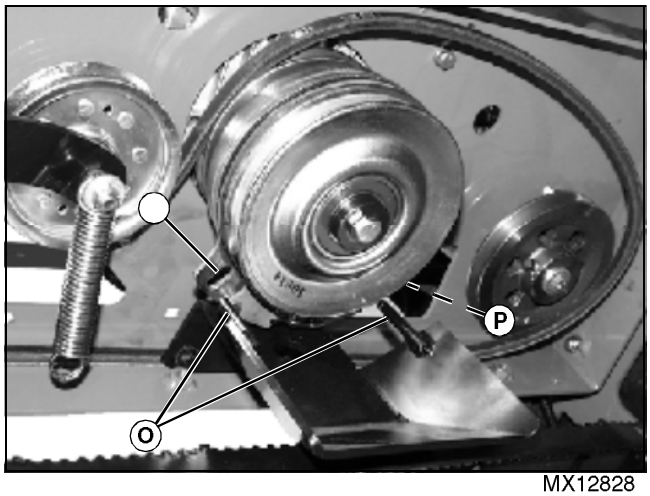
- Apply grease to the engine output shaft before installing the traction drive pulley and PTO clutch. (See “Grease” on page 22.)
- Apply medium-strength threadlocker to PTO clutch capscrew.
- Tighten PTO clutch capscrew to specifications.



MX13008

- Route PTO wiring harness through both holes (L and M) in the mower drive belt guard.

- Secure wiring harness to belt guard using a tie strap through the two holes (N).



MX12828

- Align anti-rotation pins (O) on the mower drive belt guard with the holes (P) in the PTO clutch.

Specifications:

PTO Clutch Capscrew Torque . . . . . 68 N•m (50 lb-ft)

Table of Contents

POWER TRAIN TABLE OF CONTENTS

Specifications

Power Train Specifications

Type	Hydrostatic Wheel Motor
Travel Speed (Forward)	0 - 13.7 km/h (0 - 8.5 mph)
Travel Speed (Reverse)	0 - 6.2 km/h (0 - 4 mph)
Hydraulic System Capacity	3.1 L (3.3 qt)
Hydraulic Pump:	
Make	HydroGear
Model	BDP-10A
Wheel Motor:	
Make	Parker
Model	MF12

Test Specifications

Hydraulic Pump:	
Maximum Drop Under Heavy Load	5.6 L (1.5 gpm)

Repair Specifications

Hydraulic Oil Reservoir Capacity (with Filter)	1.9 L (2 qt)
Hydraulic System Capacity	3.1 L (3.3 qt)
Hydraulic Pump:	
Charge Pump Cover Capscrew Torque	12 N•m (102 lb-in.)
Bypass Valve Torque	12 N•m (102 lb-in.)
Check Valve Torque	23 N•m (204 lb-in.)
End Cover Capscrew Torque	22 N•m (191 lb-in.)
Sheave Retaining Capscrew Torque	68 N•m (50 lb-ft)
Wheel Motor:	
Hub Retaining Nut Torque	203 N•m (150 lb-ft)
Rotor Lobe-to-Roller Vane Maximum Clearance	0.13 mm (0.005 in.)
Retaining Capscrew Torque	68 N•m (50 lb-ft)

Other Materials

Other Material

Part No.	Part Name	Part Use
NA	Mobilith SHC® 460 Grease	Applied to wheel motor seals and seal rings.
NA	Multi-Purpose SD Polyurea Grease	Applied to wheel motor and pump input and output shafts and keys.

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
Bi-Directional Pressure Flow Meter	Hydro Gear 70661[a]	Used to measure hydraulic pump flow and pressure.

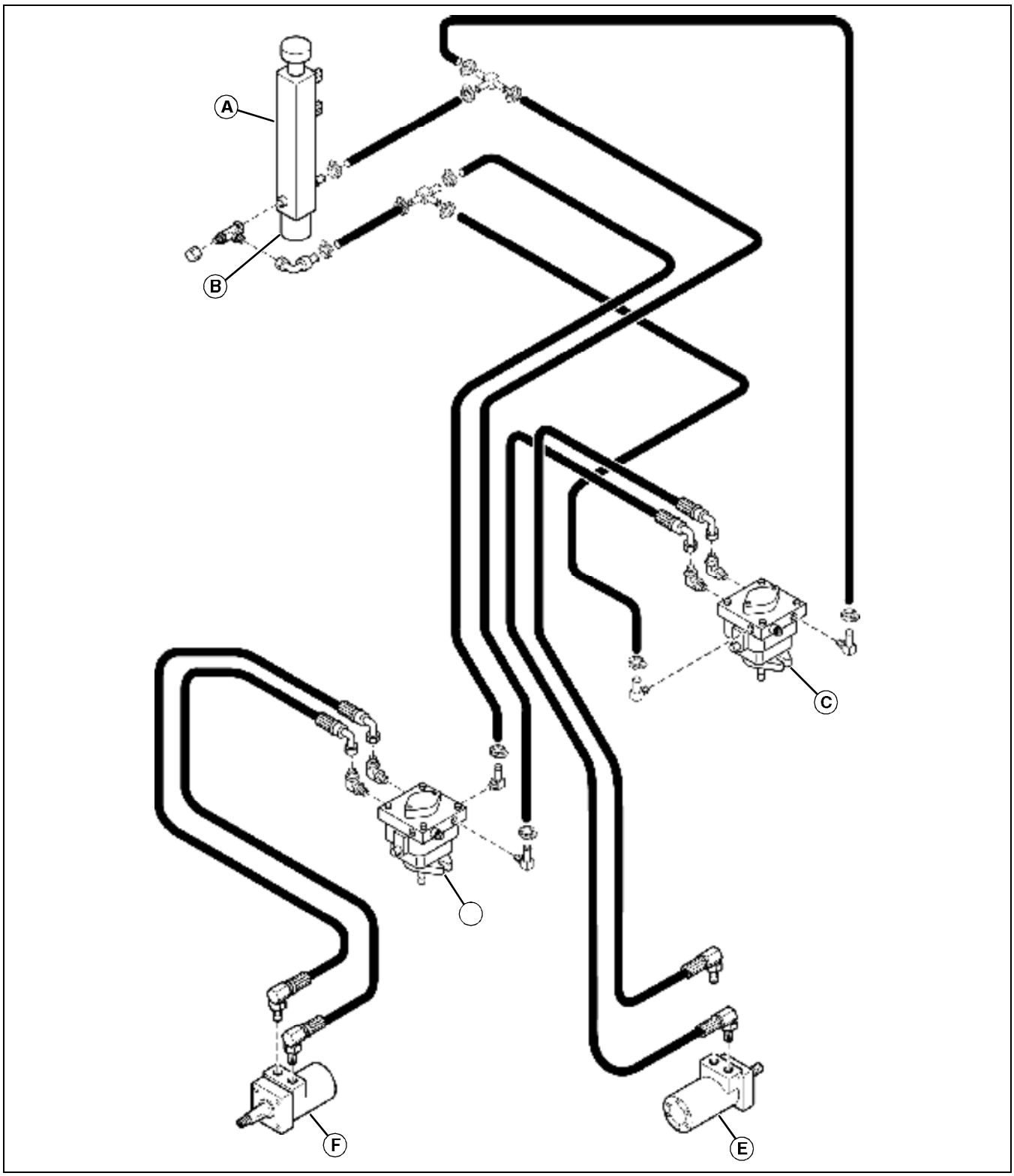
a. Tool is available from an authorized Hydro Gear distributor. See Service Bulletin 02-11-65-02 for additional information.

Service Parts Kits

- Hydraulic Pump Bypass Valve Kit
- Hydraulic Pump RH Check Valve Kit
- Hydraulic Pump LH Check Valve Kit

Component Location

Hydraulic System Hose Routing



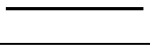
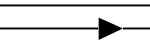
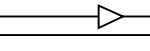
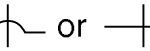
MX13386

A - Hydraulic Reservoir
B - Hydraulic Oil Filter
C - Right Hydraulic Pump
D - Left Hydraulic Pump
E - Right Wheel Motor
F - Left Wheel Motor

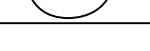
Theory of Operation

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

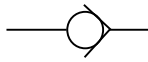
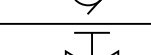
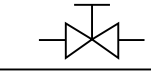
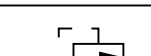
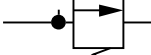
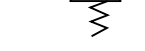
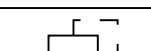
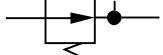
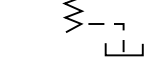
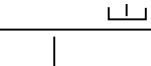
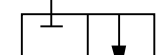
MOTORS

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

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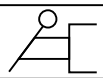
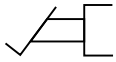
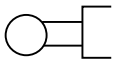
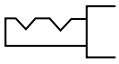
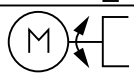
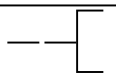
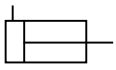
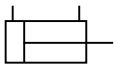
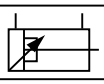
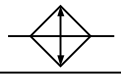
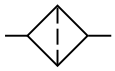
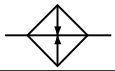
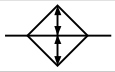
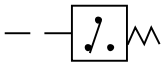
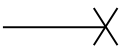
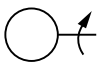
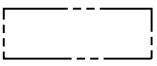
VALVE OPERATORS

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

Power Train Operation

Function

To drive the machine using hydraulic wheel motors.

Theory of Operation

The hydrostatic pumps are engine driven by a common drive belt. As the pump input shafts turn, the charge pump draws oil from the reservoir, through the oil filter and supplies oil to the pump block.

Neutral

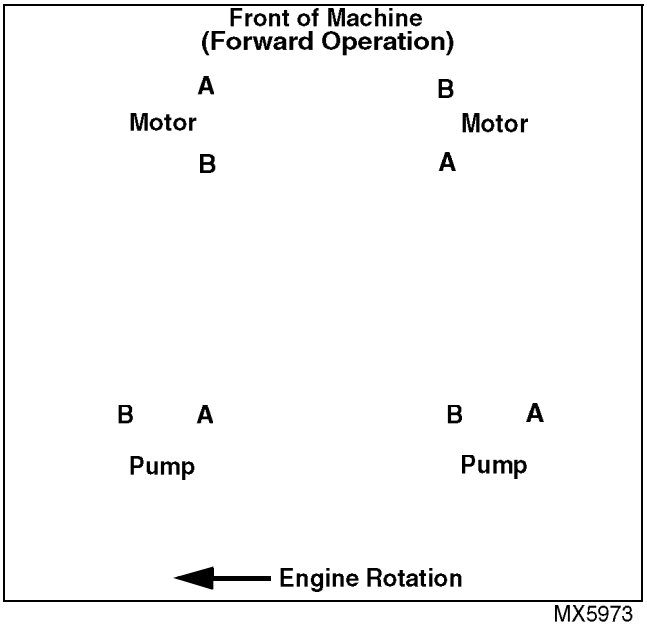
With the control levers in the neutral position, the piston springs in the cylinder blocks of the hydraulic pumps force the swashplates to a position that is parallel to the pump body. With the swashplates parallel to the pump body, the pistons do not reciprocate in the cylinder blocks, they merely rotate, and no oil is being drawn in or discharged from the pumps. The pumps are in a zero displacement position and the machine remains stationary.

Forward

As the control levers are pushed forward, the swashplates in the hydraulic pumps move from the neutral position (parallel to the pump body) to a forward angle position. Springs inside the cylinder bores force the pistons against the swashplates.

As the cylinder block rotates, the pistons follow the contour of the swashplate, moving outward, drawing oil into their bores. As the cylinder block continues to rotate, the pistons are forced into their bores, discharging oil under pressure.

High-pressure oil from the hydraulic pumps is routed to the wheel motors, driving the machine forward. Figure shows direction of oil flow during forward operation.



MX5973

Reverse

Reverse operation is accomplished by reversing the angle applied to the hydraulic pump swashplates, reversing the flow of high-pressure oil to the wheel motors.

The direction of oil flow is opposite of what is shown in figure above.

Steering

The QUIKTRAK® does not have a separate steering system. Steering is accomplished by varying the wheel motor speeds. This gives the machine a zero-turn capability.

As the control levers are moved to a full left turn position, the right hydraulic pump is moved to the full-speed forward position and the left pump is moved to the full-speed reverse position. This will allow the machine to pivot around its center.

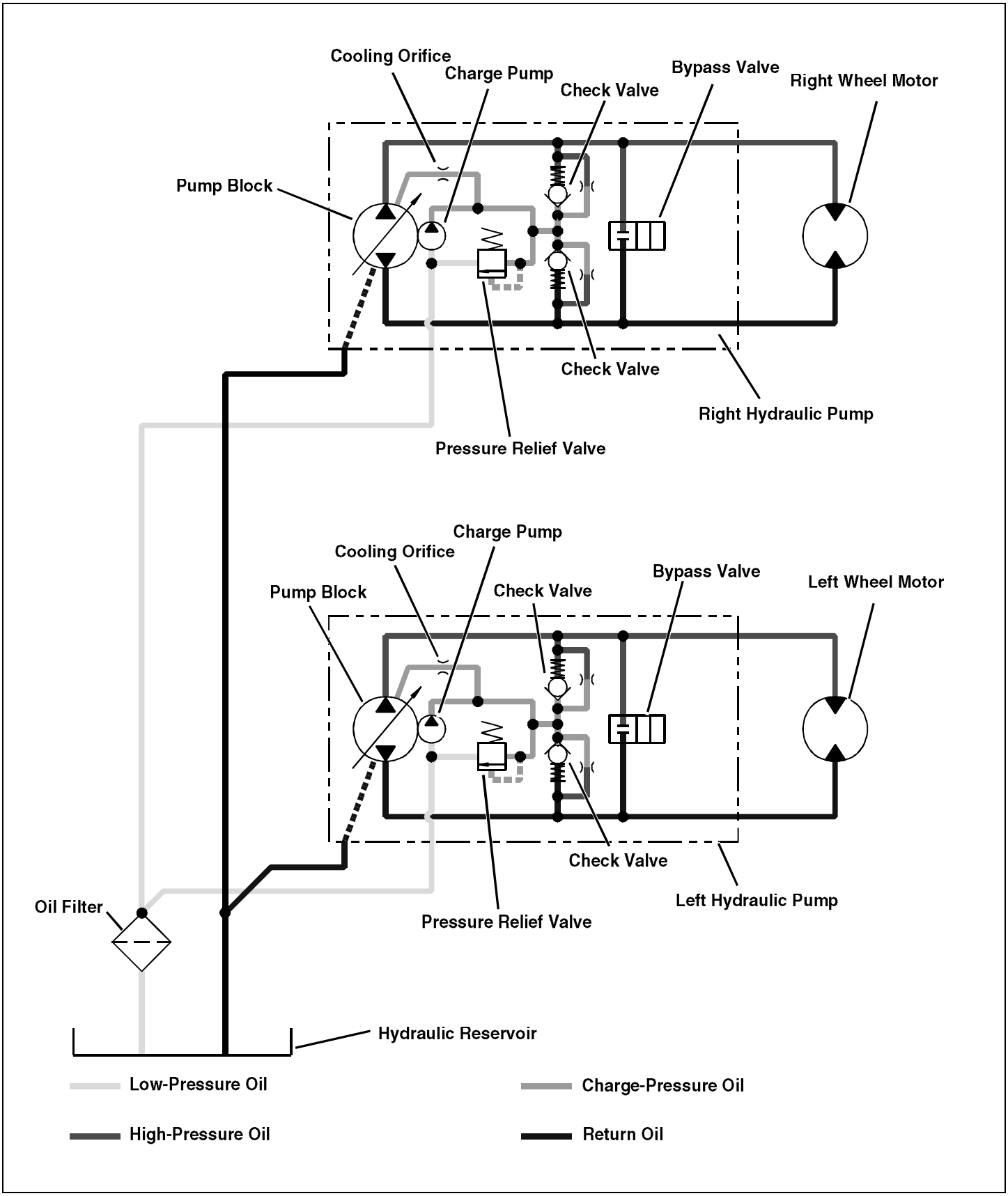
Pump Bypass Mode

CAUTION: Avoid injury! DO NOT open freewheel valves with engine running, or damage to hydrostatic transmission can occur.

In the event the machine must be moved with the engine off, bypass valve on each pump can be opened to relieve pressure.

As the machine is moved, the wheel motors act as pumps, forcing hydraulic oil back to the pumps. The pump blocks cannot turn with the engine off, so oil pressure will build up. When the bypass valves are open, the oil is allowed to bypass the pump body and freely flow back to the hydraulic reservoir.

Hydrostatic Power Train Schematic



MX6385

Diagnostics

System Fails to Build Pressure

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake locked.
- Control levers in neutral position.

Symptom: System Fails to Build Pressure

(1) Is reservoir filled to correct level with clean oil of correct specifications?

Yes - Go to step (2).

No - Fill reservoir to correct level with proper oil. (See "Hydrostatic Transmission and Hydraulic Oil" on page 22.) Go to step (2) if the problem continues.

(2) Is reservoir outlet free of obstructions or restrictions?

Yes - Go to step (3).

No - Clean reservoir outlet. Go to step (3) if the problem continues.

(3) Are hydraulic hoses free of any sharp bends or restrictions?

Yes - Go to step (4).

No - Replace hose(s). Go to step (4) if the problem continues.

(4) Are all hydraulic fittings tight?

Yes - Go to step (5).

No - Tighten fitting(s). Go to step (5) if the problem continues.

(5) Is the hydraulic oil filter free of restrictions?

Yes - Go to step (6).

No - Replace filter. Go to step (6) if the problem continues.

(6) Is the traction drive belt free of wear and/or damage, not frayed, glazed or stretched?

Yes - Go to step (7).

No - Replace drive belt. (See "Remove and Install Traction Drive Belt" on page 185.) Go to step (7) if the problem continues.

(7) Does the traction drive belt tension arm pivot freely, not binding or damaged?

Symptom: System Fails to Build Pressure

Yes - Go to step (8).

No - Repair or replace tension arm. (See "Disassemble and Assemble Traction Drive Belt Tension Arm" on page 186.) Go to step (8) if the problem continues.

(8) Are the hydraulic pump bypass valves closed completely?

Yes - Go to step (9).

No - Close bypass valve(s). Go to step (9) if the problem continues.

(9) Are hydraulic pumps operating properly, with no internal damage or leakage?

No - Repair or replace pump(s). (See "Disassemble and Inspect Hydraulic Pump" on page 189.)

Machine Will Not Drive Straight

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake locked.
- Control levers in neutral position.

Symptom: Machine Will Not Drive Straight

(1) Is park brake unlocked?

Yes - Go to step (2).

No - Unlock park brake. Go to step (3) if the problem continues.

(2) Is the park brake linkage adjusted correctly?

Yes - Go to step (3).

No - Adjust brake linkage. (See "Check and Adjust Park Brake" on page 218.) Go to step (3) if the problem continues.

(3) Are hydraulic hoses free of any sharp bends or restrictions?

Yes - Go to step (4).

No - Replace hose(s). Go to step (4) if the problem continues.

(4) Are all hydraulic fittings tight?

Yes - Go to step (5).

No - Tighten fitting(s). Go to step (5) if the problem continues.

Symptom: Machine Will Not Drive Straight

(5) Is the motion control linkage properly adjusted?

Yes - Go to step (6).

No - Adjust motion control linkages. (See "Check and Adjust Motion Control Linkage" on page 180.) Go to step (6) if the problem continues.

(6) Is the motion control linkage and hydraulic pump linkage free of damage?

Yes - Go to step (7).

No - Repair control linkages. (See "Motion Control Levers" on page 207 and/or See "Hydraulic Pump Control Linkage" on page 209.) Go to step (7) if the problem continues.

(7) Are the hydraulic pump bypass valves closed completely?

Yes - Go to step (8).

No - Close bypass valve(s). Go to step (8) if the problem continues.

(8) Are pumps operating properly, with no internal damage or leakage? (Perform Hydraulic Pump Flow Test.)

Yes - Go to step (9).

No - Repair or replace pump(s). (See "Disassemble and Inspect Hydraulic Pump" on page 189.) Go to step (9) if the problem continues.

(9) Are wheel motors operating properly, with no internal damage or leakage?

No - Repair or replace wheel motor(s). (See "Disassemble and Inspect Wheel Motor" on page 199.)

Machine Will Not Reach Maximum Speed

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake locked.
- Control levers in neutral position.

Symptom: Machine Will Not Reach Maximum Speed

(1) Is the park brake unlocked?

Yes - Go to step (2).

Symptom: Machine Will Not Reach Maximum Speed

No - Make sure the park brake is unlocked when operating the machine. Go to step (2) if the problem continues.

(2) Is the park brake linkage adjusted correctly?

Yes - Go to step (3).

No - Adjust brake linkage. (See "Check and Adjust Park Brake" on page 218.) Go to step (3) if the problem continues.

(3) Is reservoir filled to correct level with clean oil of correct specifications?

Yes - Go to step (4).

No - Fill reservoir to correct level with proper oil. (See "Hydrostatic Transmission and Hydraulic Oil" on page 22.) Go to step (4) if the problem continues.

(4) Is reservoir outlet free of obstructions or restrictions?

Yes - Go to step (5).

No - Clean reservoir outlet. Go to step (5) if the problem continues.

(5) Are hydraulic hoses free of any sharp bends or restrictions?

Yes - Go to step (6).

No - Replace hose(s). Go to step (6) if the problem continues.

(6) Are all hydraulic fittings tight?

Yes - Go to step (7).

No - Tighten fitting(s). Go to step (7) if the problem continues.

(7) Is the hydraulic oil filter free of restrictions?

Yes - Go to step (8).

No - Replace filter. Go to step (8) if the problem continues.

(8) Is the traction drive belt free of wear and/or damage, not frayed, glazed or stretched?

Yes - Go to step (9).

No - Replace traction drive belt. (See "Remove and Install Traction Drive Belt" on page 185.) Go to step (9) if the problem continues.

(9) Does the traction drive belt tension arm pivot freely, not binding or damaged?

Yes - Go to step (10).

Symptom: Machine Will Not Reach Maximum Speed

No - Repair or replace tension arm. (See "Disassemble and Assemble Traction Drive Belt Tension Arm" on page 186.) Go to step (10) if the problem continues.

(10) Is the motion control linkage properly adjusted?

Yes - Go to step (11).

No - Adjust motion control linkages. (See "Check and Adjust Motion Control Linkage" on page 180.) Go to step (11) if the problem continues.

(11) Is the motion control linkage free of damage?

Yes - Go to step (12).

No - Repair control linkages. (See "Motion Control Levers" on page 207 and/or See "Hydraulic Pump Control Linkage" on page 209.) Go to step (12) if the problem continues.

(12) Are the hydraulic pump bypass valves closed completely?

Yes - Go to step (13).

No - Close bypass valve(s). Go to step (13) if the problem continues.

(13) Are pumps operating properly, with no internal damage or leakage? (Perform Hydraulic Pump Flow Test.)

Yes - Go to step (14).

No - Repair or replace pump(s). (See "Disassemble and Inspect Hydraulic Pump" on page 189.) Go to step (14) if the problem continues.

(14) Are wheel motors operating properly, with no internal damage or leakage?

No - Repair or replace wheel motor(s). (See "Disassemble and Inspect Wheel Motor" on page 199.)

Machine Will Not Move When Controls Are Engaged

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake locked.
- Control levers in neutral position.

Symptom: Machine Will Not Move When Controls Are Engaged

(1) Is the park brake unlocked?

Yes - Go to step (2).

No - Unlock the park brake. Go to step (2) if the problem continues.

(2) Is reservoir filled to correct level with clean oil of correct specifications?

Yes - Go to step (3).

No - Fill reservoir to correct level with proper oil. (See "Hydrostatic Transmission and Hydraulic Oil" on page 22.) Go to step (3) if the problem continues.

(3) Is reservoir outlet free of obstructions or restrictions?

Yes - Go to step (4).

No - Clean reservoir outlet. Go to step (4) if the problem continues.

(4) Are hydraulic hoses free of any sharp bends or restrictions?

Yes - Go to step (5).

No - Replace hose(s). Go to step (5) if the problem continues.

(5) Are all hydraulic fittings tight?

Yes - Go to step (6).

No - Tighten fitting(s). Go to step (6) if the problem continues.

(6) Is the hydraulic oil filter free of restrictions?

Yes - Go to step (7).

No - Replace filter. Go to step (7) if the problem continues.

(7) Is the traction drive belt free of wear and/or damage, not frayed, glazed or stretched?

Yes - Go to step (8).

Symptom: Machine Will Not Move When Controls Are Engaged

No - Replace traction drive belt. (See "Remove and Install Traction Drive Belt" on page 185.) Go to step (8) if the problem continues.

(8) Does the traction drive belt tension arm pivot freely, not binding or damaged?

Yes - Go to step (9).

No - Repair or replace tension arm. (See "Disassemble and Assemble Traction Drive Belt Tension Arm" on page 186.) Go to step (9) if the problem continues.

(9) Is the motion control linkage properly adjusted?

Yes - Go to step (10).

No - Adjust motion control linkages. (See "Check and Adjust Motion Control Linkage" on page 180.) Go to step (10) if the problem continues.

(10) Is the motion control linkage free of damage?

Yes - Go to step (11).

No - Repair motion control linkages. (See "Motion Control Levers" on page 207 and/or See "Hydraulic Pump Control Linkage" on page 209.) Go to step (11) if the problem continues.

(11) Are the hydraulic pump bypass valves closed completely?

Yes - Go to step (12).

No - Close bypass valve(s). Go to step (12) if the problem continues.

(12) Are pumps operating properly, with no internal damage or leakage? (Perform Hydraulic Pump Flow Test.)

Yes - Go to step (13).

No - Repair or replace pump(s). (See "Disassemble and Inspect Hydraulic Pump" on page 189.) Go to step (13) if the problem continues.

(13) Are wheel motors operating properly, with no internal damage or leakage?

No - Repair or replace wheel motor(s). (See "Disassemble and Inspect Wheel Motor" on page 199.)

Jerky or Erratic Operation

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake locked.
- Control levers in neutral position.

Symptom: Jerky or Erratic Operation

(1) Is the park brake unlocked?

Yes - Go to step (2).

No - Unlock the park brake. Go to step (2) if the problem continues.

(2) Is the park brake linkage adjusted correctly?

Yes - Go to step (3).

No - Adjust brake linkage. (See "Check and Adjust Park Brake" on page 218.) Go to step (3) if the problem continues.

(3) Is reservoir filled to correct level with clean oil of correct specifications?

Yes - Go to step (4).

No - Fill reservoir to correct level with proper oil. (See "Hydrostatic Transmission and Hydraulic Oil" on page 22.) Go to step (4) if the problem continues.

(4) Is reservoir outlet free of obstructions or restrictions?

Yes - Go to step (5).

No - Clean reservoir outlet. Go to step (5) if the problem continues.

(5) Are hydraulic hoses free of any sharp bends or restrictions?

Yes - Go to step (6).

No - Replace hose(s). Go to step (6) if the problem continues.

(6) Are all hydraulic fittings tight?

Yes - Go to step (7).

No - Tighten fitting(s). Go to step (7) if the problem continues.

(7) Is the hydraulic oil filter free of restrictions?

Yes - Go to step (8).

No - Replace filter. Go to step (8) if the problem continues.

Symptom: Jerky or Erratic Operation

(8) Is the traction drive belt free of wear and/or damaged, not frayed, glazed or stretched?

Yes - Go to step (9).

No - Replace traction drive belt. (See "Remove and Install Traction Drive Belt" on page 185.) Go to step (9) if the problem continues.

(9) Does the traction drive belt tension arm pivot freely, not binding or damaged?

Yes - Go to step (10).

No - Repair or replace tension arm. (See "Disassemble and Assemble Traction Drive Belt Tension Arm" on page 186.) Go to step (10) if the problem continues.

(10) Are the hydraulic pump bypass valves closed completely?

Yes - Go to step (11).

No - Close bypass valve(s). Go to step (11) if the problem continues.

(11) Are hydraulic pumps operating properly, with no internal damage or leakage? (Perform Hydraulic Pump Flow Test.)

Yes - Go to step (12).

No - Repair or replace hydraulic pump(s). (See "Disassemble and Inspect Hydraulic Pump" on page 189.) Go to step (12) if the problem continues.

(12) Are wheel motors operating properly, with no internal damage or leakage?

No - Repair or replace wheel motor(s). (See "Disassemble and Inspect Wheel Motor" on page 199.)

Sluggish Operation Under Load

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake locked.
- Control levers in neutral position.

Symptom: Sluggish Operation Under Load

(1) Is the park brake locked?

Yes - Go to step (2).

Symptom: Sluggish Operation Under Load

No - Unlock the park brake. Go to step (2) if the problem continues.

(2) Is reservoir filled to correct level with clean oil of correct specifications?

Yes - Go to step (3).

No - Fill reservoir to correct level with proper oil. (See "Hydrostatic Transmission and Hydraulic Oil" on page 22.) Go to step (3) if the problem continues.

(3) Is reservoir outlet free of obstructions or restrictions?

Yes - Go to step (4).

No - Clean reservoir outlet. Go to step (4) if the problem continues.

(4) Are hydraulic hoses free of any sharp bends or restrictions?

Yes - Go to step (5).

No - Replace hose(s). Go to step (5) if the problem continues.

(5) Are all hydraulic fittings tight?

Yes - Go to step (6).

No - Tighten fitting(s). Go to step (6) if the problem continues.

(6) Is the hydraulic oil filter free of restrictions?

Yes - Go to step (7).

No - Replace filter. Go to step (7) if the problem continues.

(7) Is the traction drive belt free of wear and/or damage, not frayed, glazed or stretched?

Yes - Go to step (8).

No - Replace traction drive belt. (See "Remove and Install Traction Drive Belt" on page 185.) Go to step (8) if the problem continues.

(8) Does the traction drive belt tension arm pivot freely, not binding or damaged?

Yes - Go to step (9).

No - Repair or replace tension arm. (See "Disassemble and Assemble Traction Drive Belt Tension Arm" on page 186.) Go to step (9) if the problem continues.

(9) Are the hydraulic pump bypass valves closed completely?

Yes - Go to step (10).

Symptom: Sluggish Operation Under Load

No - Close bypass valve(s). Go to step (10) if the problem continues.

(10) Are hydraulic pumps operating properly, with no internal damage or leakage? (Perform Hydraulic Pump Flow Test.)

Yes - Go to step (11).

No - Repair or replace hydraulic pump(s). (See "Disassemble and Inspect Hydraulic Pump" on page 189.) Go to step (11) if the problem continues.

(11) Are wheel motors operating properly, with no internal damage or leakage.

No - Repair or replace wheel motor(s). (See "Disassemble and Inspect Wheel Motor" on page 199.)

Excessive Noise

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake locked.
- Control levers in neutral position.

Symptom: Excessive Noise

(1) Is the park brake unlocked?

Yes - Go to step (2).

No - Unlock the park brake. Go to step (2) if the problem continues.

(2) Is the park brake linkage adjusted correctly?

Yes - Go to step (3).

No - Adjust park brake linkage. (See "Check and Adjust Park Brake" on page 218.) Go to step (3) if the problem continues.

(3) Is reservoir filled to correct level with clean oil of correct specifications?

Yes - Go to step (4).

No - Fill reservoir to correct level with proper oil. (See "Hydrostatic Transmission and Hydraulic Oil" on page 22.) Go to step (4) if the problem continues.

(4) Is reservoir outlet free of obstructions or restrictions?

Yes - Go to step (5).

Symptom: Excessive Noise

No - Clean reservoir outlet. Go to step (5) if the problem continues.

(5) Are hydraulic hoses free of any sharp bends or restrictions?

Yes - Go to step (6).

No - Replace hydraulic hose(s). Go to step (6) if the problem continues.

(6) Are all hydraulic fittings tight?

Yes - Go to step (7).

No - Tighten hydraulic fitting(s). Go to step (7) if the problem continues.

(7) Is the hydraulic oil filter free of restrictions?

Yes - Go to step (8).

No - Replace hydraulic oil filter. Go to step (8) if the problem continues.

(8) Are the hydraulic pump bypass valves closed completely?

Yes - Go to step (9).

No - Close hydraulic pump bypass valve(s). Go to step (9) if the problem continues.

(9) Are hydraulic pumps operating properly, with no internal damage or leakage? (Perform Hydraulic Pump Flow Test.)

Yes - Go to step (10).

No - Repair or replace hydraulic pump(s). (See "Disassemble and Inspect Hydraulic Pump" on page 189.) Go to step (10) if the problem continues.

(10) Are wheel motors operating properly, with no internal damage or leakage?

No - Repair or replace wheel motor(s). (See "Disassemble and Inspect Wheel Motor" on page 199.)

Tests and Adjustments

Bleed Air from Hydraulic System

Reason:

To ensure that air is purged from the hydraulic system after the hydraulic hoses have been disconnected.

Procedure:

1. Park the machine safely.

2. Check hydraulic oil level. Add oil as needed. (See “Hydrostatic Transmission and Hydraulic Oil” on page 22.)

CAUTION: Avoid injury! Engine exhaust fumes can cause sickness or death:

- **If it is necessary to run an engine in an enclosed area, use an exhaust pipe extension to remove the fumes.**
- **Always try to work in a well ventilated area.**

3. Start the engine and run at slow idle.

4. Drive the machine forward approximately 6 m (20 ft), then make two hard left turns, and then two hard right turns.

5. Drive the machine in reverse approximately 3 m (10 ft).

6. Turn key switch to the STOP position.

7. Check all hoses and connections for leaks. Tighten connections and/or replace hoses as needed.

8. Check oil level at hydraulic oil reservoir. Add oil as needed. (See “Hydrostatic Transmission and Hydraulic Oil” on page 22.)

Check and Adjust Motion Control Linkage

Reason:

To ensure that the motion control linkages return to the neutral position, and that the neutral switches are engaged when the motion control levers are in the neutral position.

Check Procedure:

CAUTION: Avoid injury! Engine exhaust fumes can cause sickness or death:

- **If it is necessary to run an engine in an enclosed area, use an exhaust pipe extension to remove the fumes.**
- **Always try to work in a well ventilated area.**

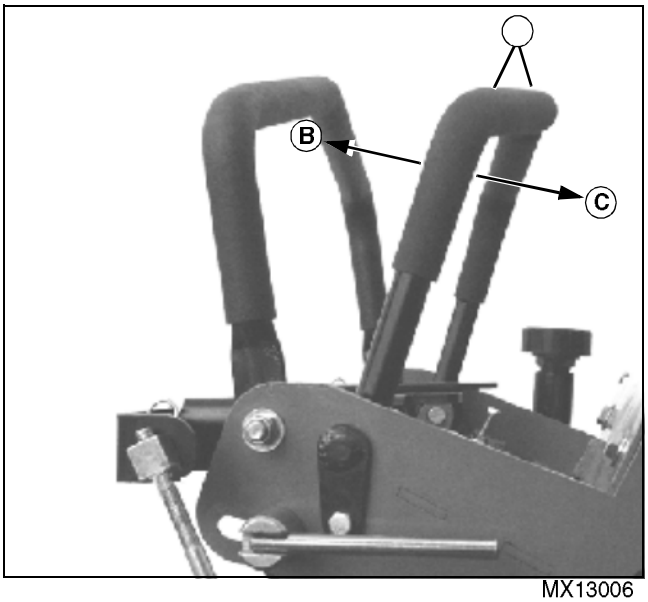
NOTE: Check and adjust the motion control linkages with the machine parked on a hard, level surface.

1. Park the machine safely.

2. Move the machine to an open, level area.

3. Start the engine and run at slow idle until it reaches normal operating temperature.

4. Stand on the operator platform, and release the park brake.



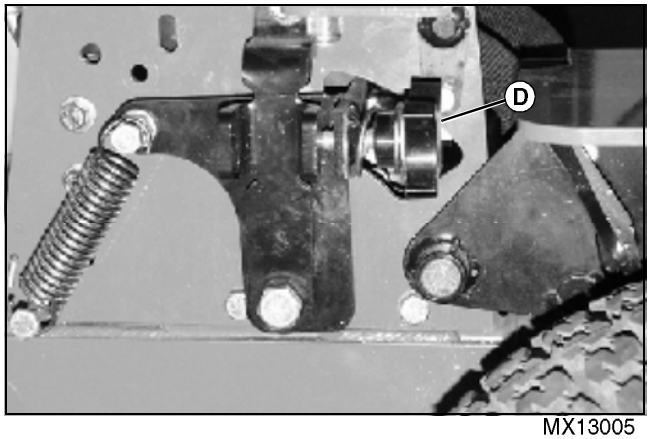
MX13006

5. Move the control levers (A) to the forward (B) and reverse (C) positions while observing the wheel movement. The wheels should move in the same direction the levers are moved.

6. Release the control levers and allow them to return to the neutral position. Both wheels should stop rotating. If the wheel(s) continue to rotate, proceed to adjustment procedure.

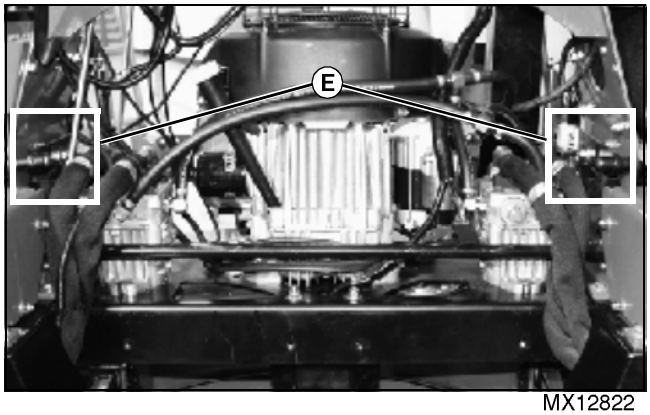
Adjustment Procedure:

1. Stop the engine.
2. Lock the park brake.

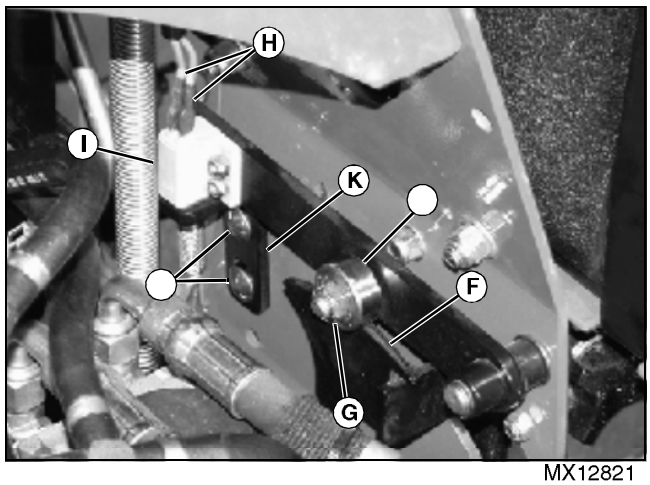


MX13005

3. Adjust the neutral adjustment knob(s) (D), located on both sides of the machine.
   - Turn the adjustment knob(s) counterclockwise to stop reverse rotation.
   - Turn the adjustment knob(s) clockwise to stop forward rotation.
4. Repeat check procedure to verify adjustment. Repeat adjustment procedure as needed until there is no rotating of the rear wheels when the motion control levers are in the neutral position.



MX12822



MX12821

5. Check the neutral positioning roller bearings (E). When the motion control levers are in the neutral position, the bearings should be seated in the detent in the pump control arm (F).

If the bearing is not seated in the detent, loosen the nut (G) and slide the bearing (E) forward or backward until it rests in the detent. Tighten the nut.

6. Start the engine and operate the motion control levers.
   - If the machine will not crank after adjustments are made, adjust the neutral switch (I) by loosening the carriage bolts and nuts (J), and sliding the contact bracket (K) up.
   - If the neutral switch sensitivity needs to be increased, loosen the carriage bolts and nuts (J), and slide the contact bracket (K) down.
7. Tighten the carriage bolts and nuts (J).

Check and Adjust Transmission Tracking

Reason:

To ensure that the machine travels straight when the control levers are moved evenly.

Check Procedure:

1. Park the machine safely.
2. Inflate tires to correct pressure. (See “Tire Pressure Adjustment” on page 258.)

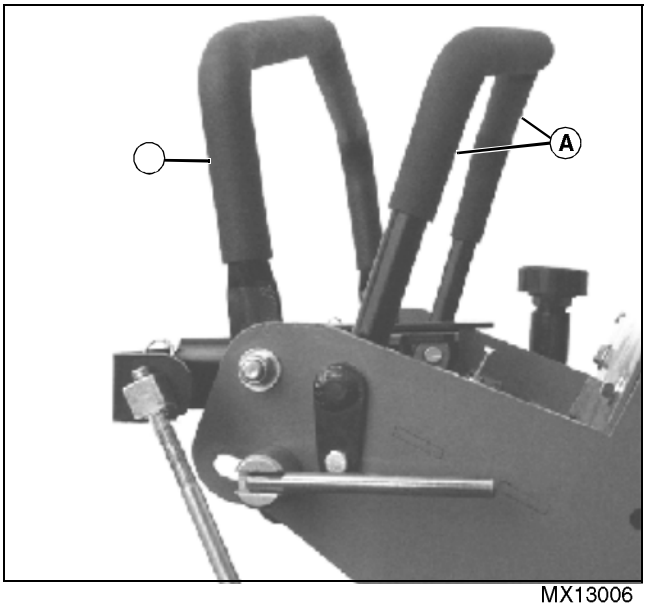
CAUTION: Avoid injury! Engine exhaust fumes can cause sickness or death:

- **If it is necessary to run an engine in an enclosed area, use an exhaust pipe extension to remove the fumes.**
- **Always try to work in a well ventilated area.**

NOTE: Check the tracking adjustment with the machine parked on a hard, level surface.

3. Start the engine and run at slow idle until it reaches normal operating temperature.

4. Move the machine to an open, level area.



MX13006

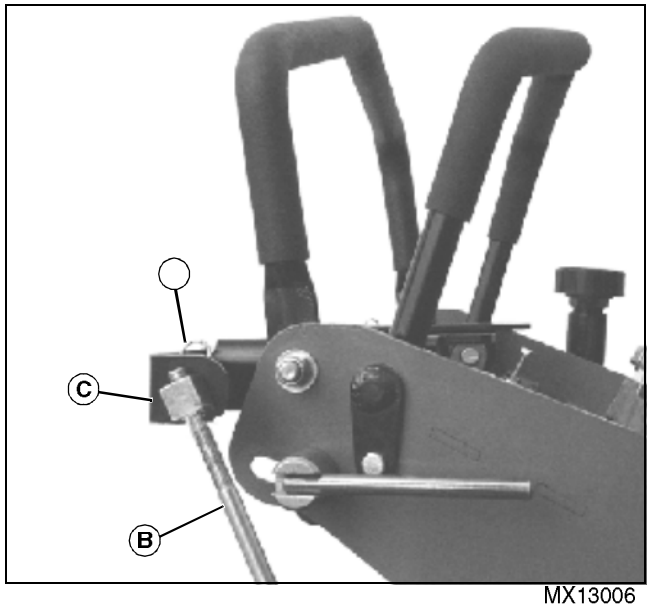
5. Drive the machine forward by pushing both control levers (A) against the speed control bar (B).

6. Drive the machine forward 3-5 m (10-15 ft), and observe the machine travel compared to a stationary reference point straight ahead of the starting point.

7. If the machine does not travel in a straight line, note the direction the machine pulls toward. Proceed to the adjustment procedure.

Adjustment Procedure:

1. Park the machine safely.



MX13006

2. Remove spring locking pin (A) and disconnect control rod (B) from the appropriate control lever. Adjust swivel nut (C) as needed.

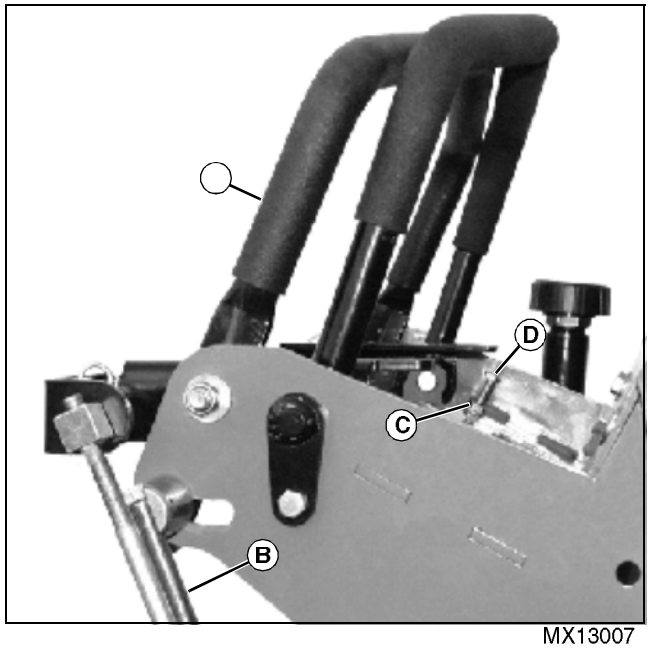
- If the machine tracks to the right, rotate left control rod swivel nut (C) one turn clockwise.
- If the machine tracks to the left, rotate right control rod swivel nut (C) one turn clockwise.

3. Connect control linkage rod (B) to the control lever and secure with a spring locking pin (A).

4. Repeat the check procedure to verify adjustment. Repeat adjustment procedure as needed.

Adjust Forward and Reverse Speed

1. Park the machine safely.



MX13007

2. Adjust forward speed by releasing lock lever (B) on the speed control bar (A) on each side of the machine.
   - To decrease forward speed, pull speed control bar (A) toward the operator's station.
   - To increase forward speed, push speed control bar (A) forward (away from the operator's station).
3. Tighten lock lever (B) on each side of the machine.
4. Adjust reverse speed by loosening jam nut (C) and adjusting the capscrew (D) on each side of the machine.
   - To decrease reverse speed, turn capscrew (D) counterclockwise.
   - To increase reverse speed, turn capscrew (D) clockwise.
5. Hold capscrew (D) and tighten jam nut (C) on each side of the machine.

Test Hydraulic Pump Flow

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.

NOTE: Two persons may be required to perform this test.

Reason

To determine if a hydraulic pump or wheel motor is faulty. Proper operation of the hydraulic pump indicates a faulty wheel motor.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Bi-Directional Pressure Flow Test Kit	Hydro Gear 70661[a]	Used to measure hydraulic pump flow and pressure.

a. See Service Bulletin 02-11-65-02 for additional information.

Test Conditions:

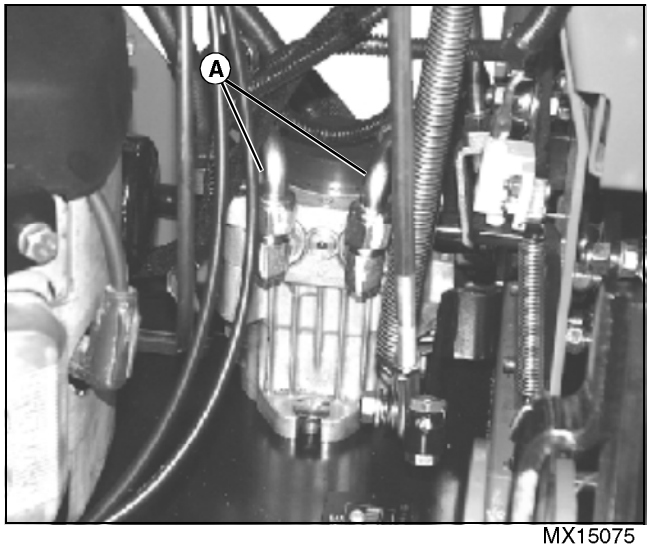
- Drive wheels raised off the ground.
- Caster wheels blocked.
- Park brake unlocked.
- Hydraulic pump bypass valves fully closed.
- Engine at fast idle.
- Motion control lever in forward position.

Procedure:

1. Park machine safely.
2. Block caster wheels to prevent machine from moving.
3. Raise the rear of the machine until the rear wheels clear the ground. Securely support the machine.

IMPORTANT: Avoid damage! Plug hose end fittings when removed to prevent system contamination.

NOTE: Label all hoses before removing to ensure correct installation.

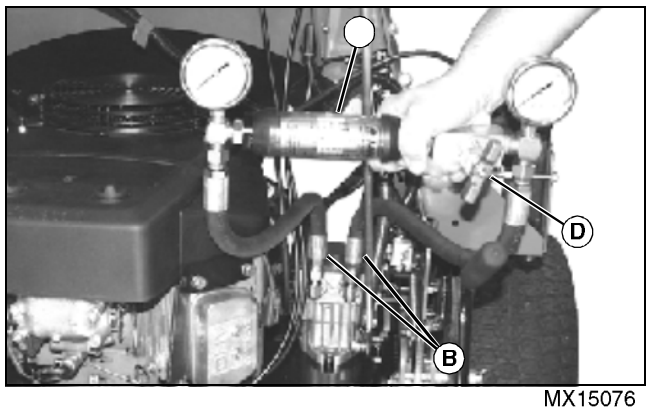


MX15075

4. Disconnect and move the hoses (A) away from the pump. Plug the hose end fittings. DO NOT remove fittings from pump.

CAUTION: Avoid injury! Ensure all fittings and hoses are attached securely. This test is being performed on the machines high pressure system.

NOTE: Hydro Gear 70661 Bi-Directional Pressure Flow Meter can be connected to the pump for use in either direction.



MX15076

5. Connect hoses (B) of Hydro Gear 70661 Bi-Directional Pressure Flow Meter (C) to the pump adapter fittings using the adapters provided with the test kit.
6. Tighten all fittings.
7. Turn load knob (D) on tester fully counterclockwise.

CAUTION: Avoid injury! Engine exhaust fumes can cause sickness or death. If it is necessary to run machine in an enclosed area, use an exhaust pipe extension to remove the fumes.

8. Start the engine and bring engine speed to fast idle.
9. Operate the motion control levers until the hydraulic oil is at normal operating temperature.
10. Move the motion control lever for the pump being tested to the full forward position.
11. Turn the load knob (D) on the tester clockwise to increase operating pressure to 2068 kPa (300 psi). Record the flowmeter reading.
12. Continue to turn load knob clockwise until operating pressure reading is at 7584 kPa (1100 psi). Record flowmeter reading.
13. Move the motion control lever to neutral, stop engine, and turn load knob on tester fully counterclockwise.
14. Subtract the first reading from the second and record the difference. Compare your value to the specification.

Results

- If pump flow is above specifications, repair or replace hydraulic pump. (See “Remove and Install Hydraulic Pump” on page 187.)
- If pump flow is at or below specifications, repair or replace wheel motor. (See “Remove and Install Wheel Motor” on page 197.)

Specifications

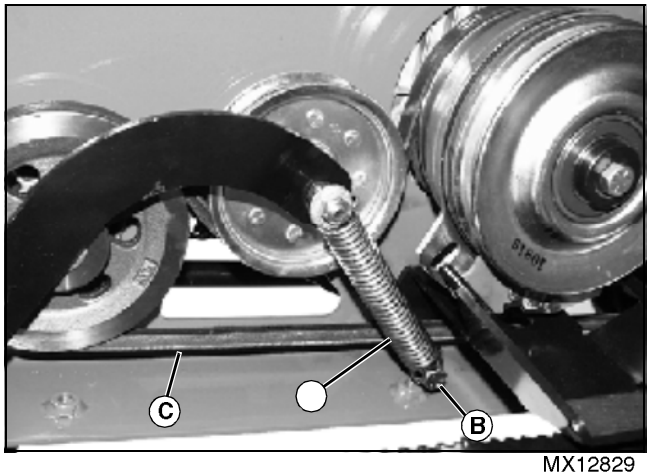
Hydraulic Pump Flow Differential (Max) 5.6 L (1.5 gpm)

Repair

Remove and Install Traction Drive Belt

1. Park the machine safely.
2. Disconnect negative battery cable at the battery.
3. Remove mower deck drive belt. (See “Remove and Install Mower Deck Drive Belt” on page 242.)

CAUTION: Avoid injury! Tensioning spring is under high tension. Wear gloves and use a firm grip when stretching spring.

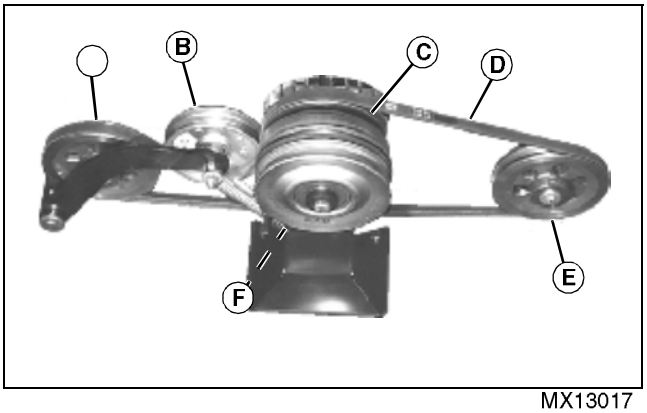


MX12829

Picture Note: Belt shown from the bottom of the machine.

4. Disconnect drive belt tension spring (A) from the anchor capscrew (B).
5. Remove drive belt (C).
6. Inspect belt for signs of stretching, glazing, wear or cracking. Replace belt as needed.

Installation is done in the reverse order of removal.



MX13017

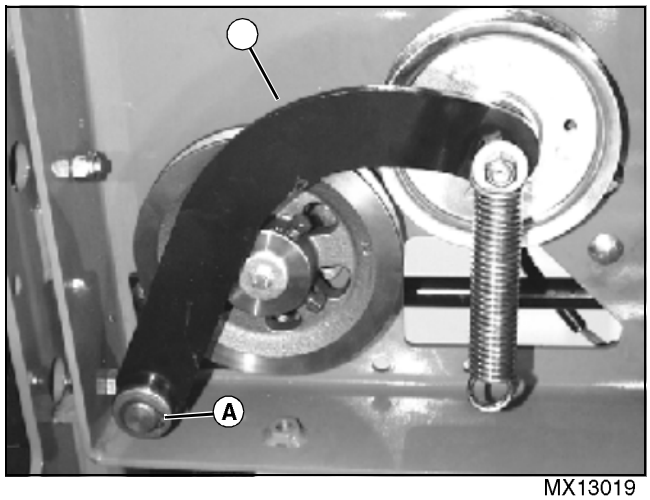
Picture Note: Belt shown from the bottom of the machine.

A - Left Hydraulic Pump Sheave
B - Tension Idler Sheave
C - PTO Clutch
D - Drive Belt
E - Right Hydraulic Pump Sheave
F - Tension Spring Anchor Capscrew

- Route the drive belt (D) as shown. Verify that the drive belt (D) is positioned in front of the tension spring anchor capscrew (F).

Remove and Install Traction Drive Belt Tension Arm

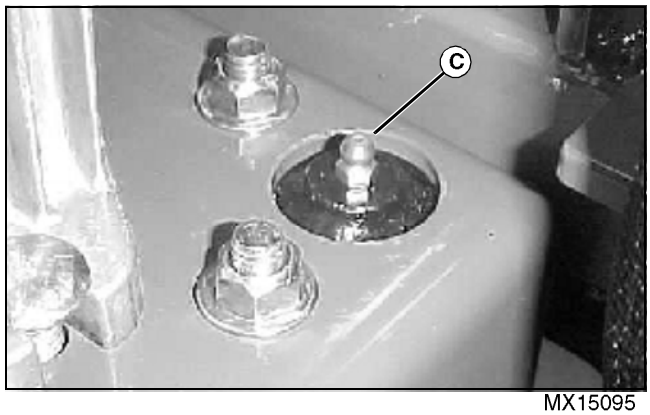
1. Park the machine safely.
2. Disconnect negative battery cable at the battery.
3. Remove traction drive belt. (See “Remove and Install Traction Drive Belt” on page 185.)



MX13019

4. Remove retaining ring (A).
5. Remove tension arm assembly (B).

Installation is done in the reverse order of removal.

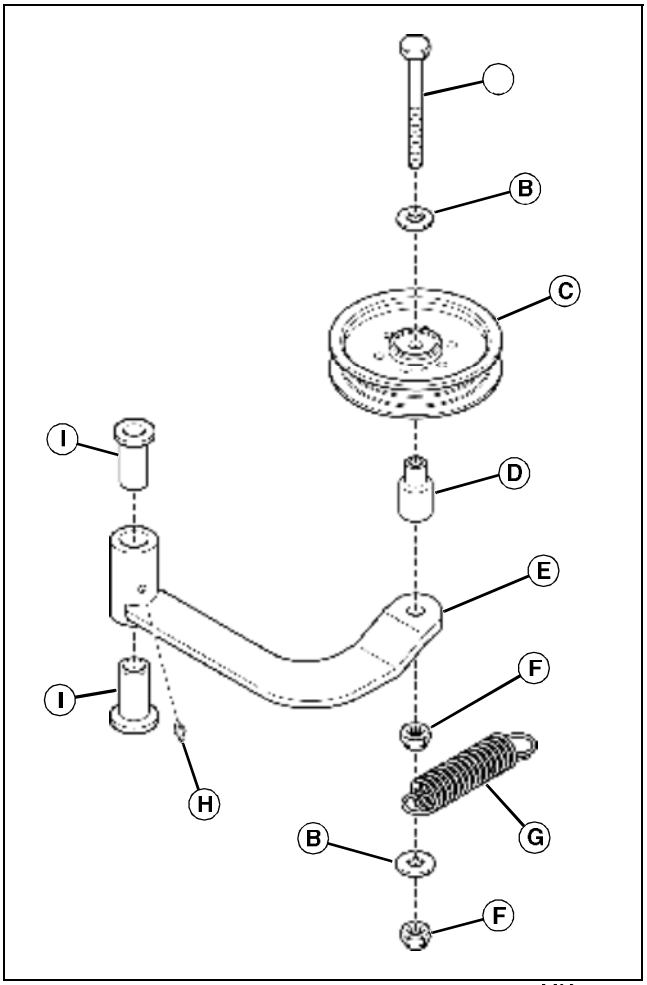


MX15095

- Apply grease to the lubrication fitting (C). (See “Grease” on page 22.)

Disassemble and Assemble Traction Drive Belt Tension Arm

NOTE: Spacer (D) and bushings (I) are pressed in place. Remove only if replacement is required.



MX15098

A - Capscrew
B - Washer (2 used)
C - Idler Sheave
D - Spacer
E - Tension Arm
F - Locknut (2 used)
G - Return Spring
H - Lubrication Fitting
I - Bushing (2 used)

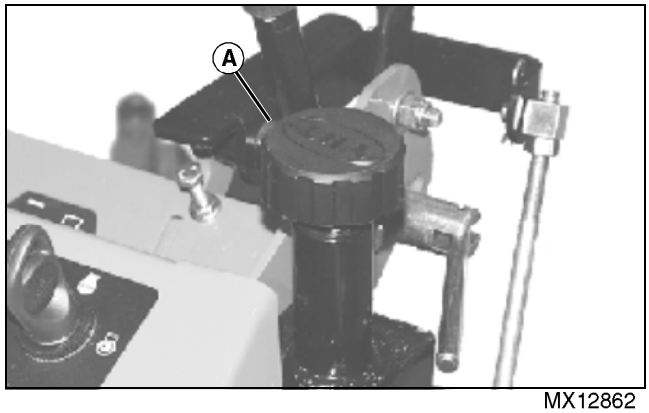
- Inspect all parts for wear or damage.
- Apply grease to lubrication fitting (H). (See “Grease” on page 22.)

Remove and Install Hydraulic Oil Reservoir

CAUTION: Avoid injury! Hydraulic fluid is under pressure. Escaping fluid can penetrate the skin and cause serious injury. Protect hands and body.

- **Relieve all pressure before checking hydraulic hoses.**
- **Search for leaks with a piece of cardboard. Do not use hands to check hoses.**
- **Tighten all connections before applying pressure.**

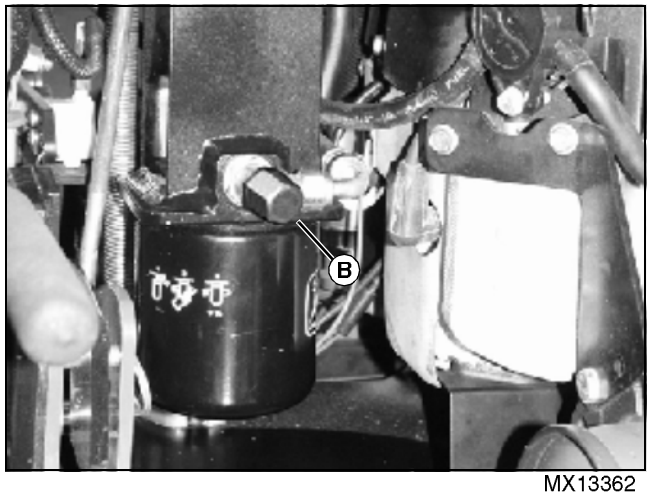
1. Park the machine safely.
2. Disconnect negative battery cable at the battery.
3. Unlatch, raise and support the thigh pad.



MX12862

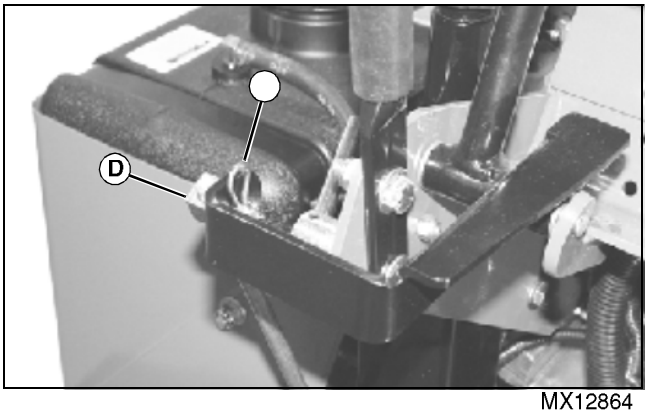
4. Loosen hydraulic oil reservoir filler cap (A).

NOTE: The capacity of the hydraulic oil reservoir is approximately 1.9 L (2 qt).



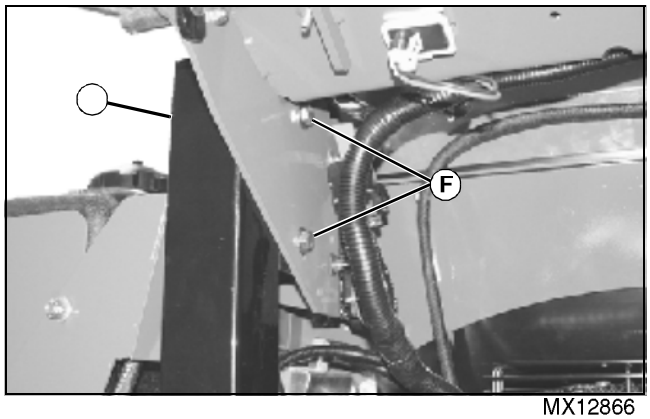
MX13362

5. Remove metal cap (B) at the bottom of the hydraulic reservoir, and drain oil into a properly marked container.



MX12864

6. Remove spring locking pin (C) and disconnect the control lever linkage (D) from the control lever.

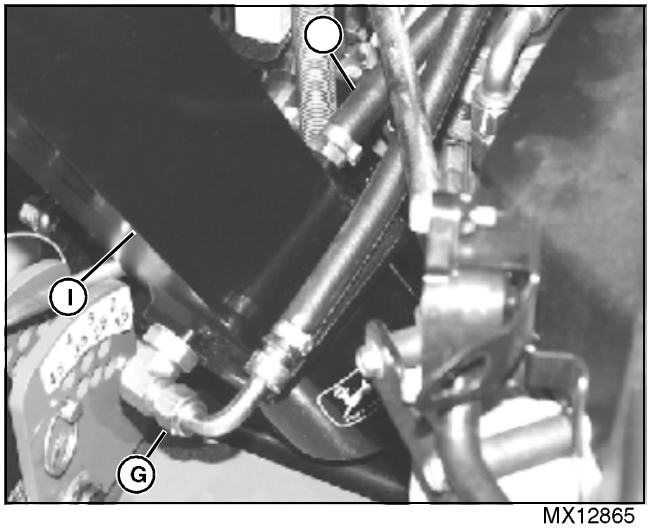


MX12866

7. Support hydraulic reservoir (E).

8. Remove two capscrews (F) and pull the reservoir forward.

NOTE: Label all hoses before removing to ensure correct installation.



MX12865

9. Disconnect and plug the supply hose (G) at the bottom of the hydraulic oil reservoir.

10. Disconnect and plug the return hose (H) at the bottom of the hydraulic oil reservoir.

11. Remove reservoir (I).

Installation is done in the reverse order of removal.

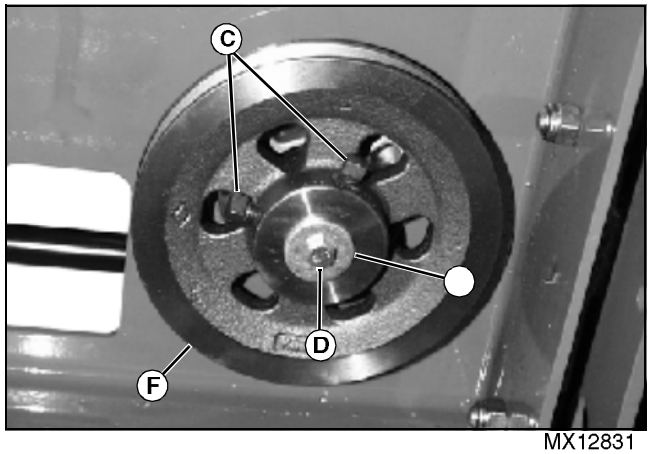
- Install new clamps when installing return hose (H).
- Install a new oil filter.
- Check hydraulic oil level. Add oil as needed. (See “Hydrostatic Transmission and Hydraulic Oil” on page 22.)
- Bleed air from the hydraulic system. (See “Bleed Air from Hydraulic System” on page 180.)

Remove and Install Hydraulic Pump

CAUTION: Avoid injury! Hydraulic fluid is under pressure. Escaping fluid can penetrate the skin and cause serious injury. Protect hands and body.

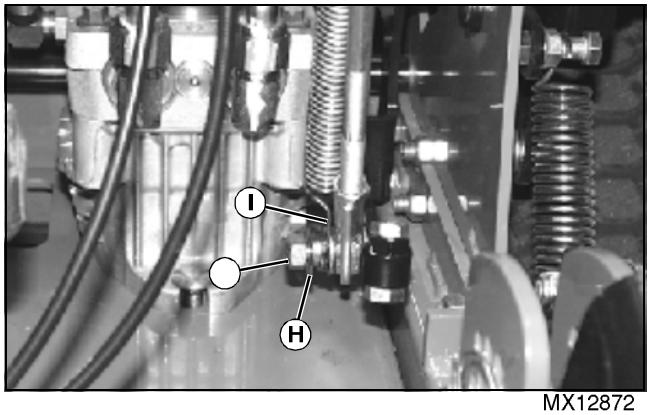
- **Relieve all pressure before checking hydraulic hoses.**
- **Search for leaks with a piece of cardboard. Do not use hands to check hoses.**
- **Tighten all connections before applying pressure.**

1. Park the machine safely.
2. Disconnect negative battery cable at the battery.
3. Remove traction drive belt. (See “Remove and Install Traction Drive Belt” on page 185.)
4. Remove traction drive belt tension arm. (See “Remove and Install Traction Drive Belt Tension Arm” on page 185.)



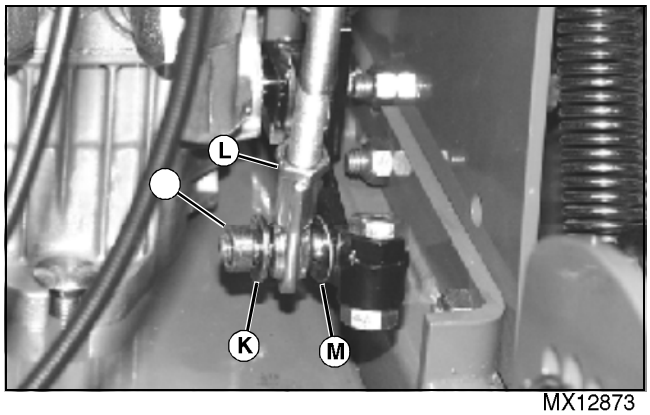
MX12831

5. Loosen two locking screws (C).
6. Remove capscrew (D) and washer (E).
7. Remove drive sheave (F) and key.



MX12872

8. Remove locknut (G) and thin flat washer (H).
9. Disconnect spring (I) from anchor capscrew.



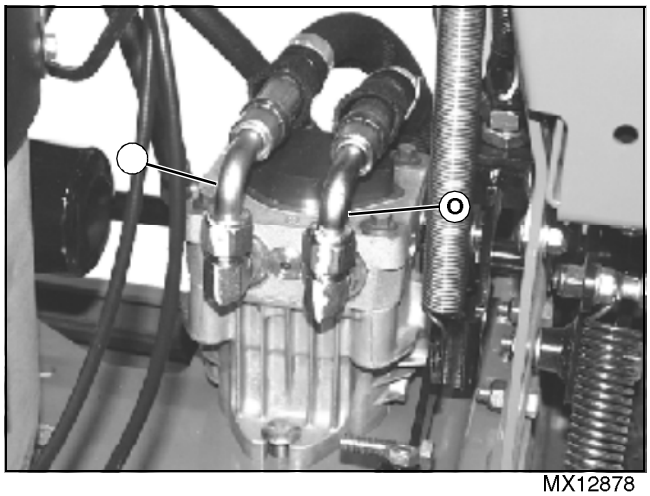
MX12873

10.Remove spacer (J) and flat washer (K).

11.Disconnect control linkage rod (L) from anchor capscrew.

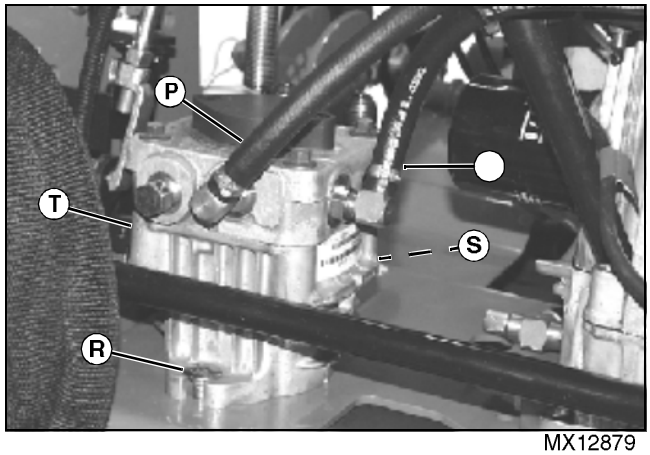
12.Remove thin flat washer (M).

NOTE: Label all hoses before removing to ensure correct installation.



MX12878

13.Disconnect and plug the output hydraulic hoses (N and O). Cap the fittings.

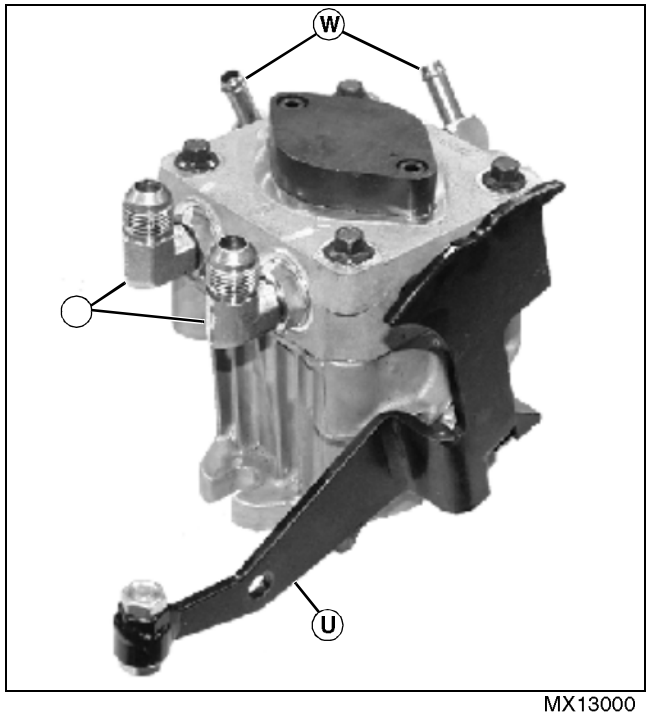


MX12879

14.Disconnect and plug the supply (P) and return (Q) hydraulic hoses. Cap the fittings.

15.Remove two carriage bolts and nuts (R and S).

16.Remove pump (T).



MX13000

17.Remove the control arm (U) and fittings (V and W).

Installation is done in the reverse order of removal.

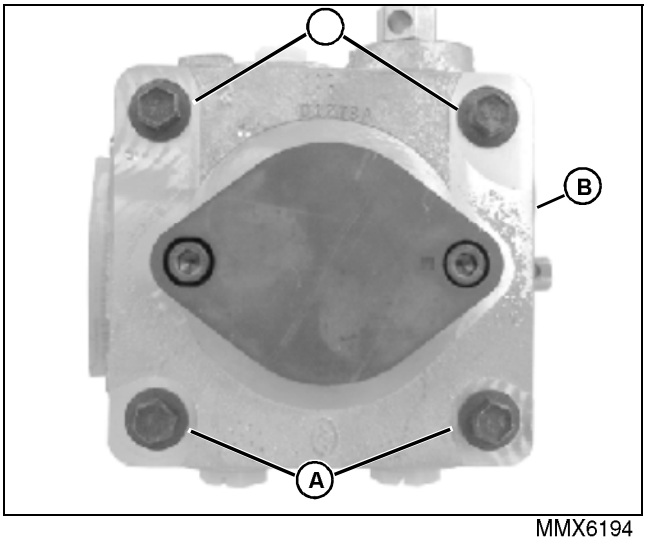
- Before connecting hydraulic hoses, fill the pump with clean hydraulic oil. (See “Hydrostatic Transmission and Hydraulic Oil” on page 22.)
- Apply grease to the pump input shaft before installing the drive sheave (F). (See “Grease” on page 22.)
- Install new clamps when connecting the supply and return hoses (P and Q).
- Apply medium-strength threadlocker to the threads of the drive sheave capscrew (D).

- Tighten the drive sheave capscrew (D) to specifications.
- Check hydraulic oil level. Add oil as needed. (See “Hydrostatic Transmission and Hydraulic Oil” on page 22.)
- Bleed air from the hydraulic system. (See “Bleed Air from Hydraulic System” on page 180.)
- Check neutral position and tracking adjustments. Adjust as needed. (See “Check and Adjust Motion Control Linkage” on page 180.)

Specifications:

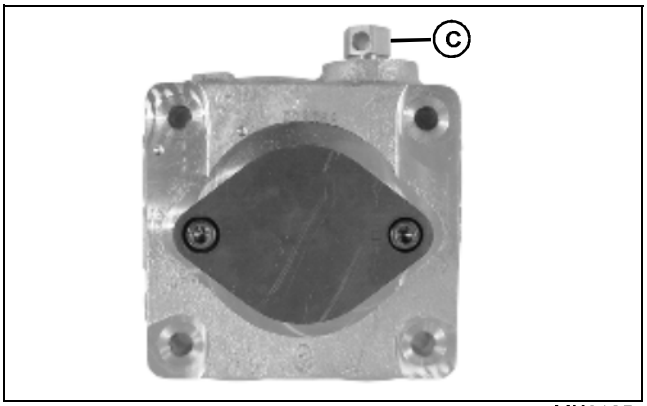
Drive Sheave Capscrew Torque . . . . . 68 N•m (50 lb-ft)

Disassemble and Inspect Hydraulic Pump



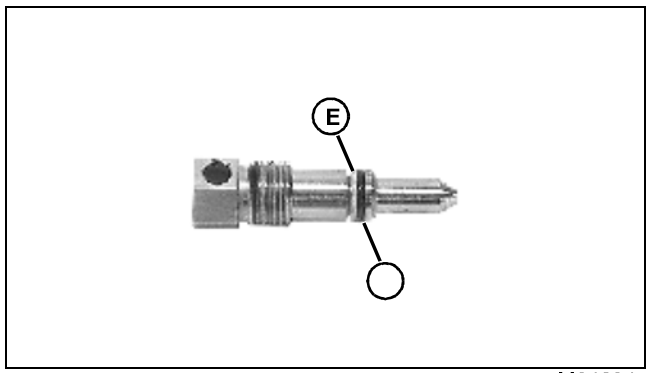
MMX6194

1. Remove four end cover capscrews (A).
2. Remove end cover (B).



MX6195

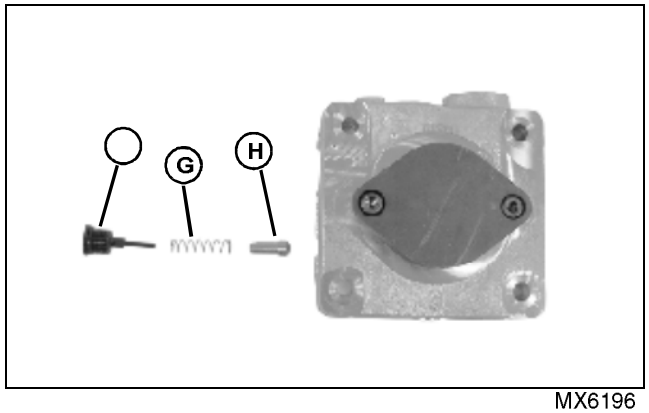
3. Remove the bypass valve (C) from end cover.



M84294

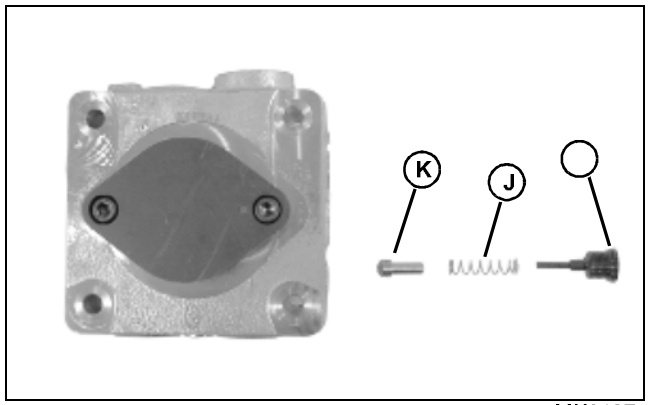
4. Remove O-ring (D) and backup ring (E).
5. Inspect bypass valve for damage. Replace if necessary.

IMPORTANT: Avoid damage! Note location of check valve poppets for installation. Each poppet must be installed in the same check valve from which it was removed.



MX6196

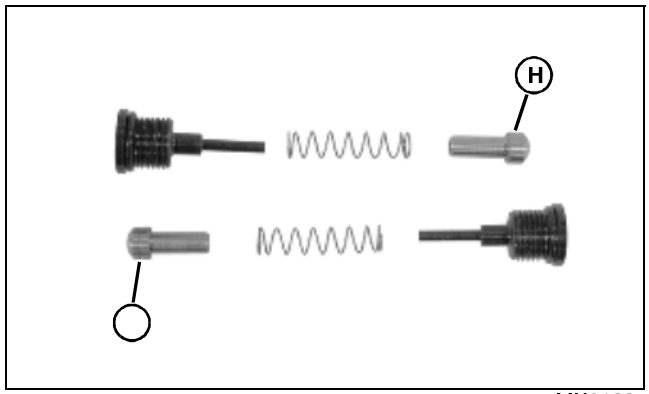
6. Remove left-hand charge check valve plug (F), spring (G) and poppet (H) from end cover.



MX6197

7. Remove right-hand charge check valve plug (I), spring (J) and poppet (K) from end cover.

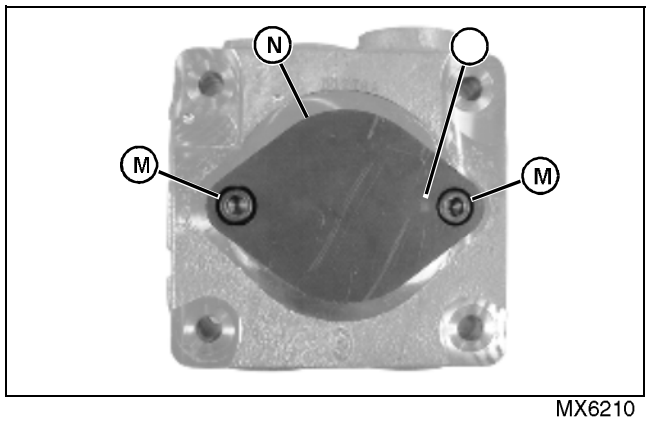
IMPORTANT: Avoid damage! Poppets must be replaced with the same type as removed.



MX6198

8. Inspect check valve poppets (H and K) and mating seats in the end cover for damage. Replace if necessary.

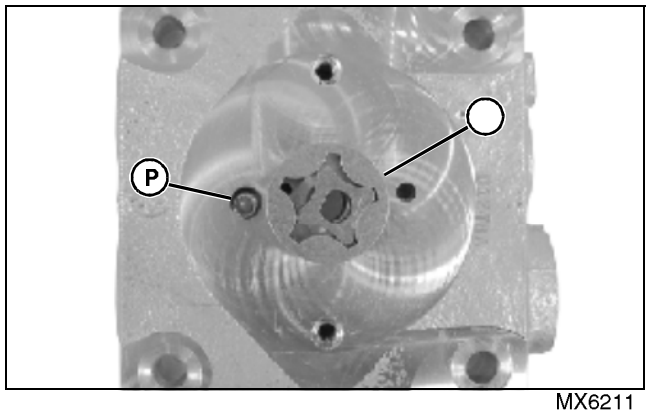
NOTE: Note the orientation of the mark (L) on the charge pump cover before removing to ensure correct installation. Incorrect installation will cause the charge pump to rotate in the opposite direction.



MX6210

9. Remove charge pump cover screws (M).

10.Remove charge pump cover (N).

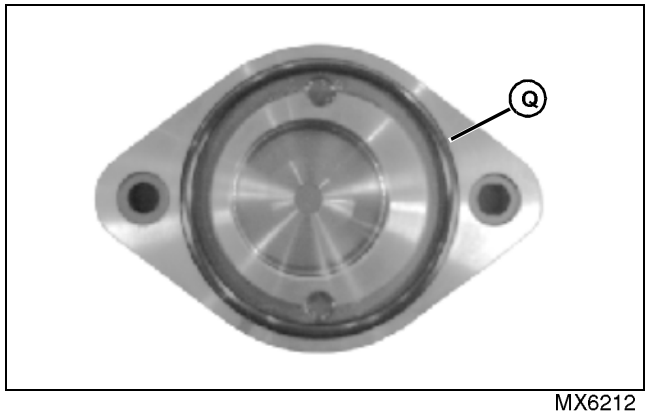


MX6211

11.Remove gerotor set (O).

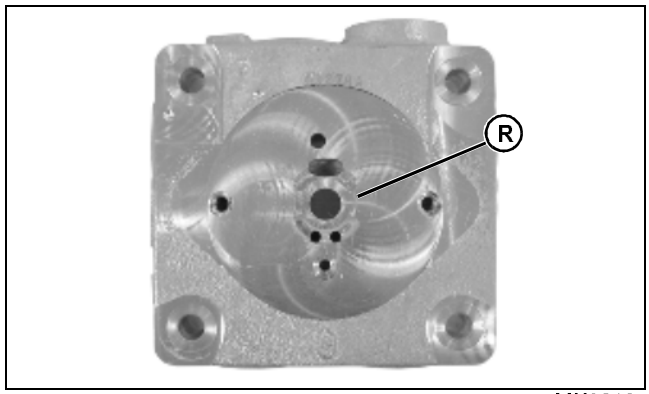
12.Remove the charge pump relief valve ball and spring (P).

13.Inspect charge pump components for wear or damage. Replace if necessary.



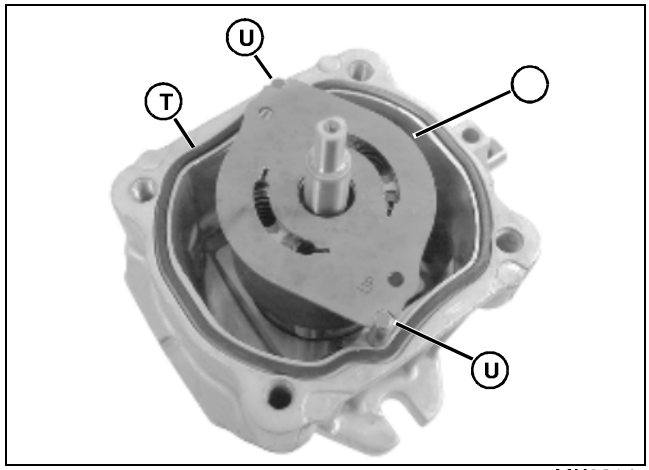
MX6212

14.Remove O-ring (Q).



MX6213

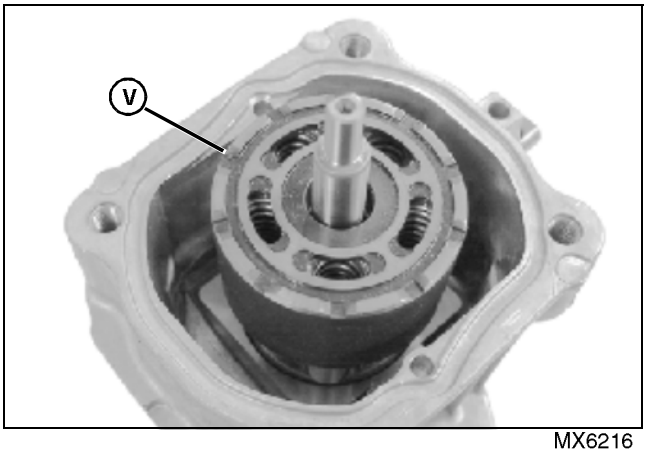
15.Inspect the running surface (R) for excessive wear and/ or damage. Replace the entire pump if damaged.



MX6214

16.Remove valve plate (S).

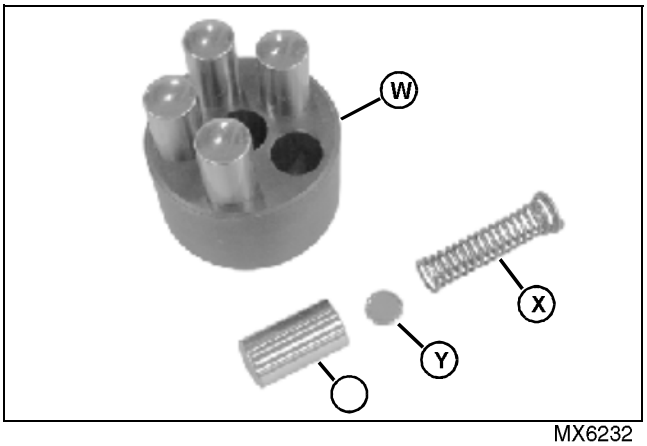
17.Remove seal (T) and locator pins (U).



MX6216

18.Remove pump cylinder block assembly (V) from pump shaft.

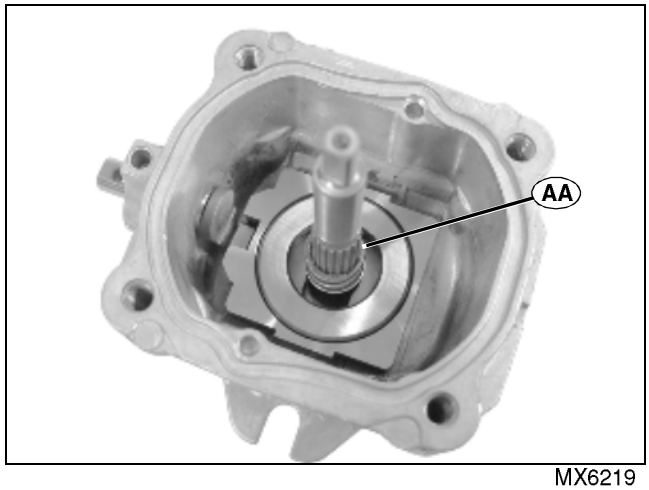
IMPORTANT: Avoid damage! Note location of pistons for installation. Each piston must be installed in the same cylinder from which it was removed.



MX6232

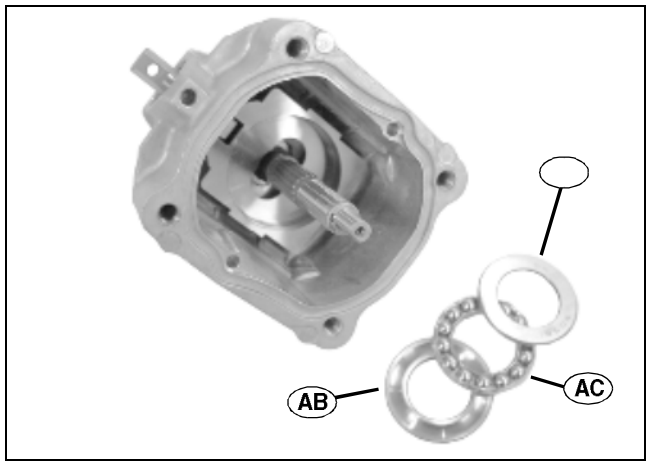
19.Remove pistons (Z), disks (Y) and springs (X) from cylinder block (W).

20.Inspect cylinder block components for damage, nicks, discoloration or unusual wear patterns. Replace pump if damage, discoloration or unusual wear is noted.



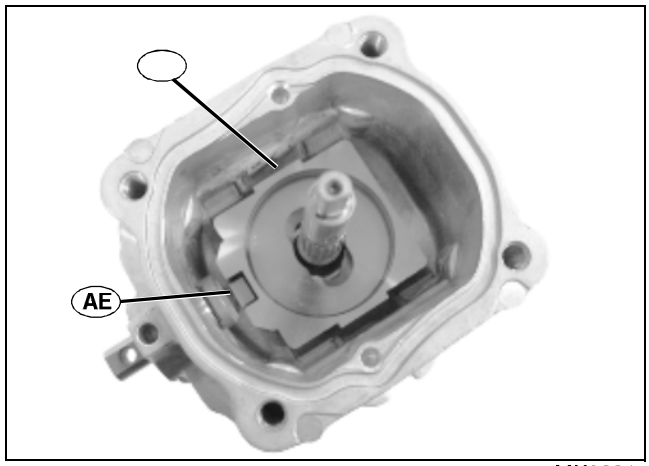
MX6219

21.Remove spring (AA) and washer from pump shaft.



MX6220

22.Remove thrust plates (AB) and thrust bearing (AC) from swash plate.

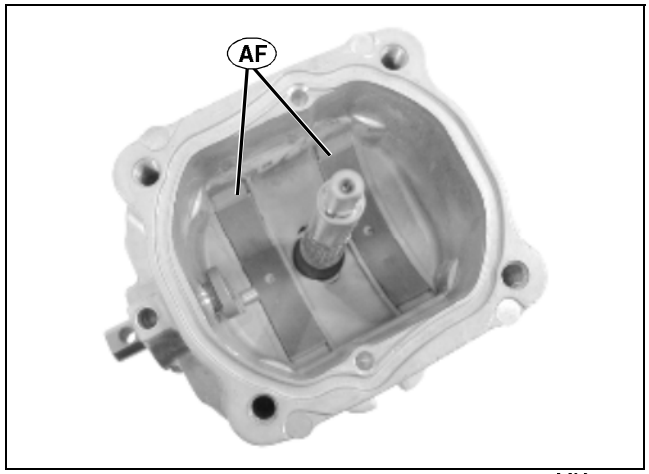


MX6221

23.Remove swash plate (AD) from housing.

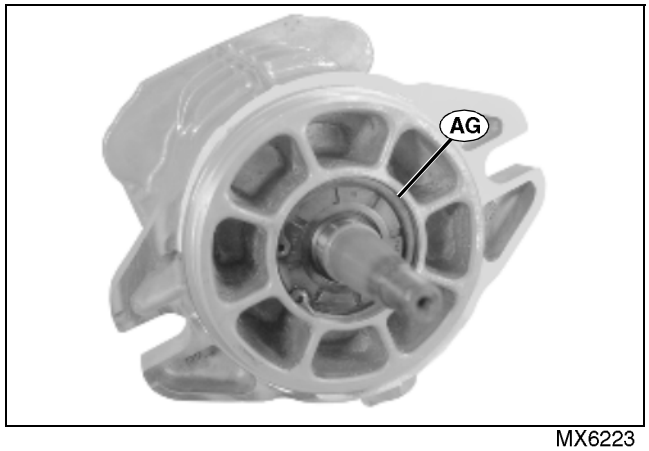
24.Remove guide block (AE) from the displacement control shaft.

NOTE: Cradle bearings are not replaceable. Replace pump if cradle bearings are worn or damaged.



MX6222

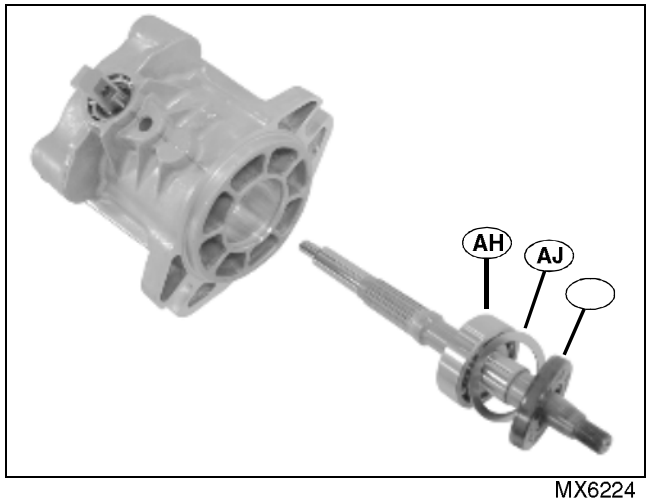
25.Inspect swash plate cradle bearings (AF). Replace pump if bearings are damaged.



MX6223

26.Remove input shaft seal retaining ring (AG).

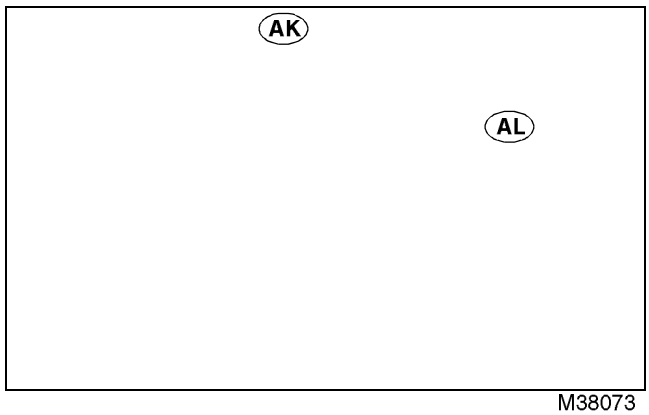
IMPORTANT: Avoid damage! Use caution when removing the input shaft seal. DO NOT damage the seal bore.



MX6224

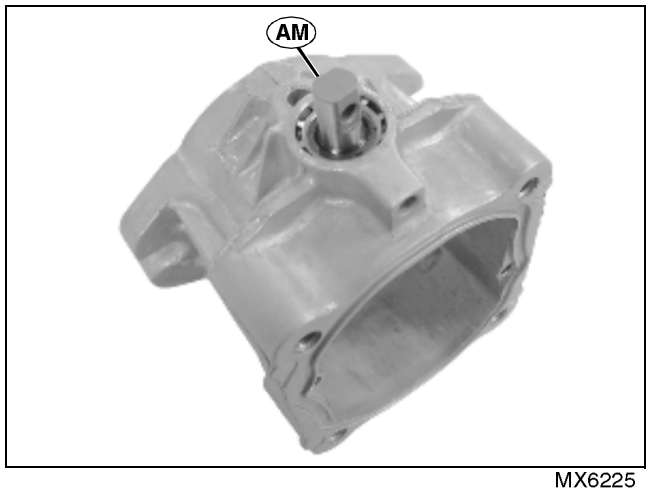
27.Drive the input shaft seal (AI) and shaft/bearing assembly (AH) out of the housing.

28.Remove input shaft seal (AI) and bearing spacer washer (AJ).



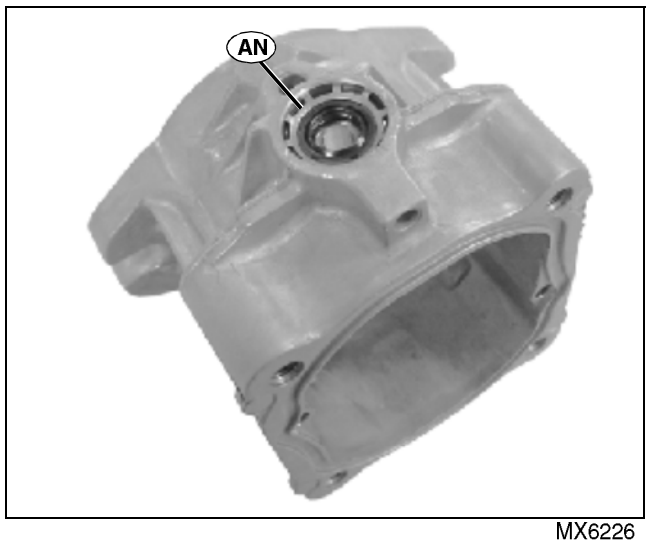
M38073

29.Inspect the bearing for axial free play (AK) and/or radial free play (AL) and/or rough movement. Replace the pump if bearing is damaged.



MX6225

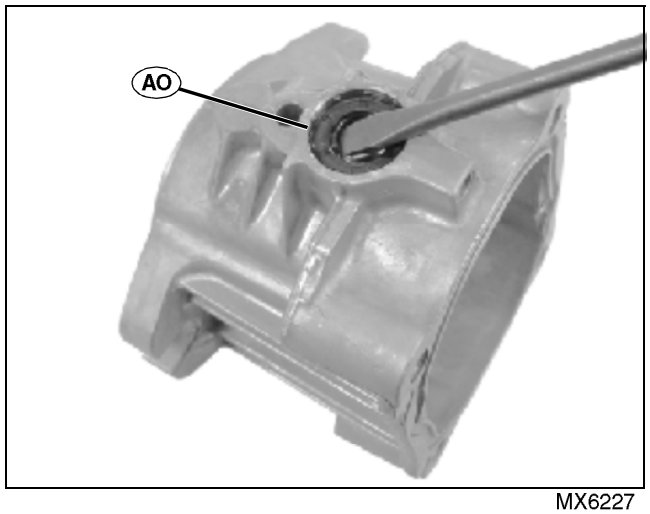
30.Remove the displacement control shaft (AM) from the housing.



MX6226

31.Remove seal retainer (AN).

IMPORTANT: Avoid damage! Use caution when removing the input displacement shaft seal. DO NOT damage the seal bore.



MX6227

32.Carefully pry the displacement shaft seal (AO) from the housing bore.

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.

33.Clean all metal parts with solvent and blow dry with compressed air.

34.Inspect all parts for damage, nicks or unusual wear. Replace parts if necessary.

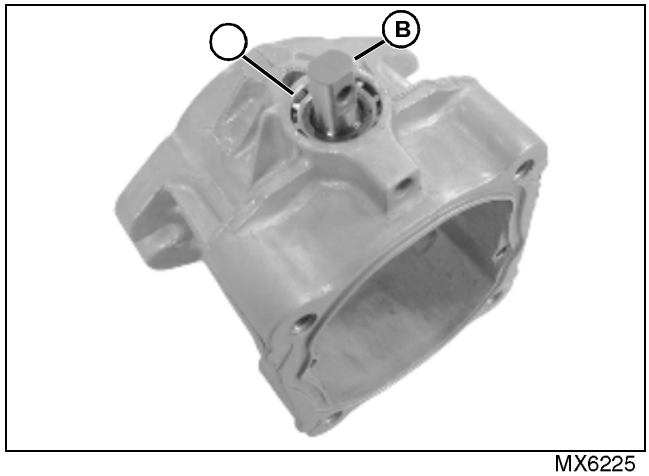
Assemble Hydraulic Pump

Other Material

Part No.	Part Name	Part Use
NA	Multi-Purpose SD Polyurea Grease	Applied to wheel motor and pump input and output shafts and keys.

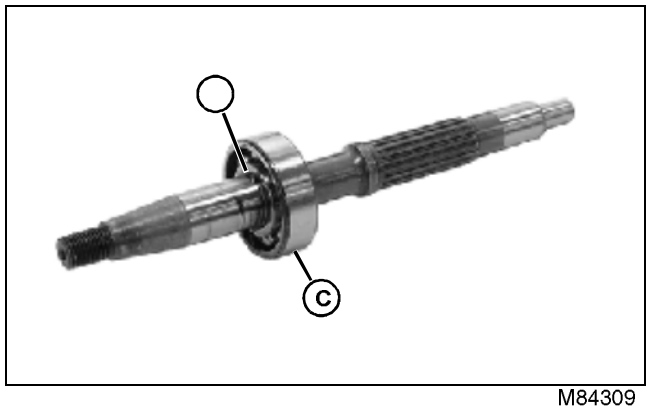
IMPORTANT: Avoid damage! Always use new O-rings. Damaged or used parts will leak.

NOTE: Lubricate all O-rings, connector threads and moving parts (as indicated) with a light coat of clean hydraulic oil during assembly.



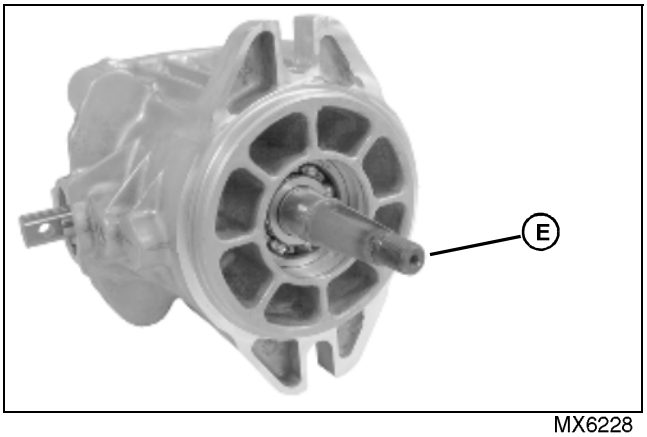
MX6225

1. Install the displacement shaft seal and retainer (A) in the housing.
2. Apply multipurpose grease to seal lips.
3. Install displacement shaft (B).



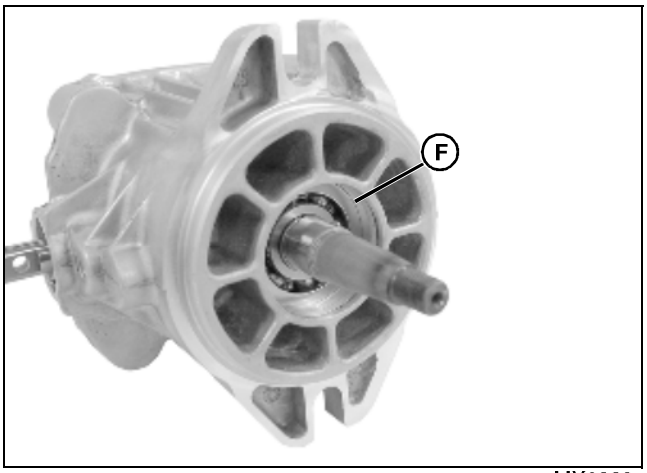
M84309

4. Press a new bearing (C) onto the input shaft.
5. Install a new bearing retaining ring (D) on the shaft.



MX6228

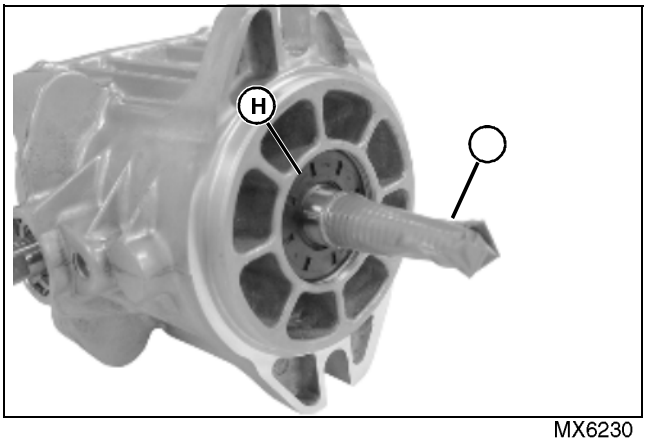
6. Install the input shaft (E) in the housing.



MX6229

7. Install bearing spacer washer (F).

IMPORTANT: Avoid damage! Apply multipurpose grease to the seal lips and tape to the threads and keyway of the pump shaft to prevent damage to the seal during installation.

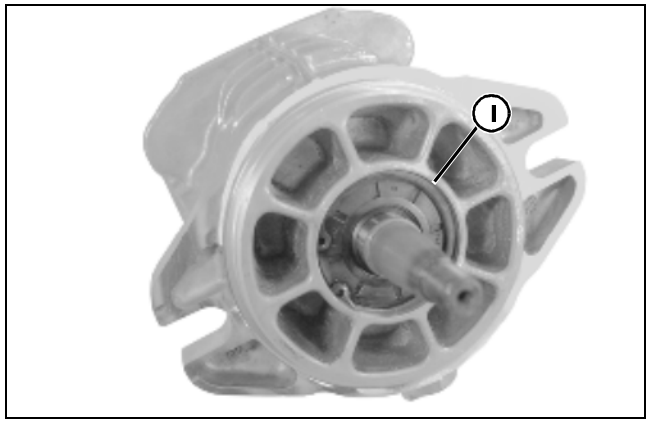


MX6230

8. Apply tape (G) to the threads and keyway of the pump shaft to prevent damage to the seal (H) during installation.

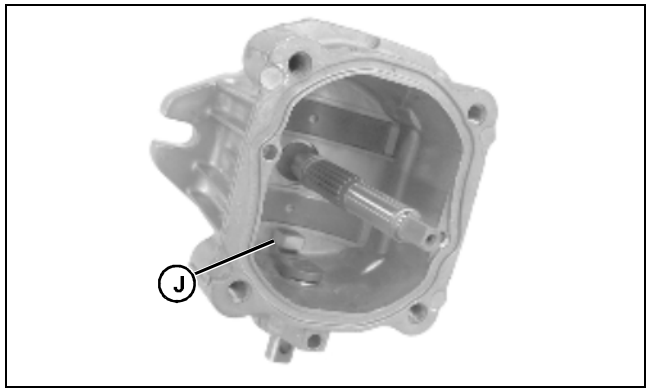
9. Apply multipurpose grease to seal lips.

10. Slide the seal over pump shaft, and press the seal into the housing.



MX6223

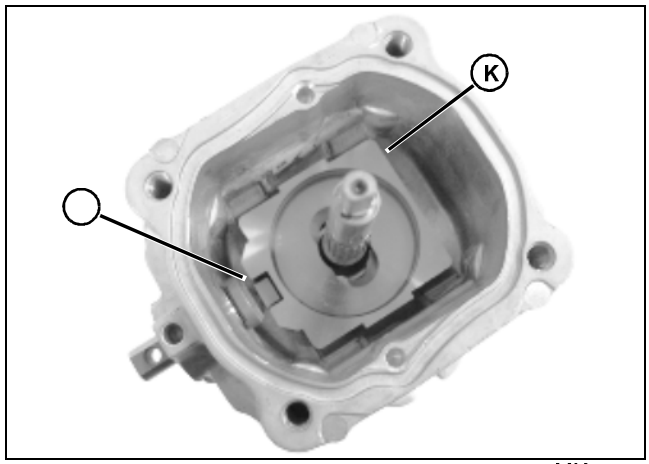
11. Install the seal retaining ring (I).



MX6231

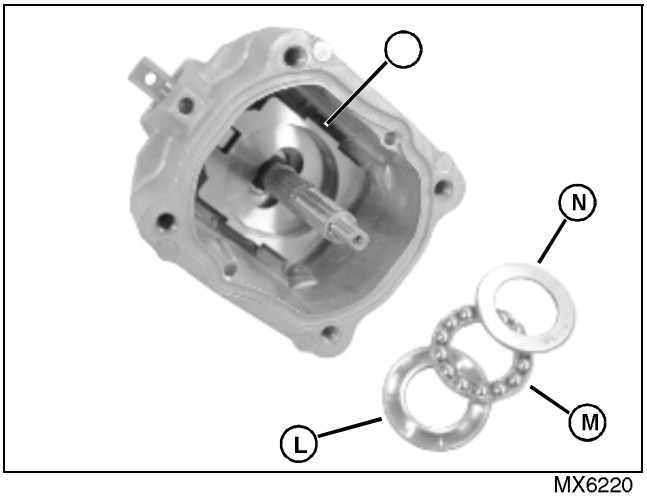
12. Apply a small amount of petroleum jelly to the guide block (J) and install the guide block on the displacement control shaft.

NOTE: Hold the guide block (J) in position while installing the swash plate assembly.



MX6221

13. Install swash plate assembly (K) in housing.

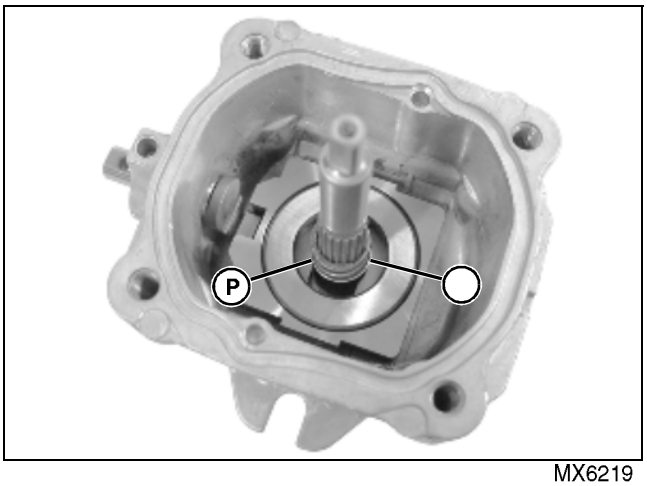


MX6220

14.Install thrust plate (L) on swash plate (K) with dished side out.

15.Install thrust bearing (M) on thrust plate (N).

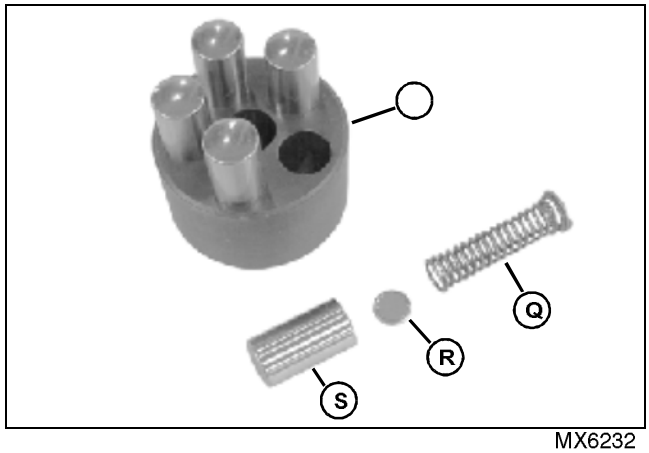
16.Install thrust plate (N) on bearing (M) with dished side toward bearing.



MX6219

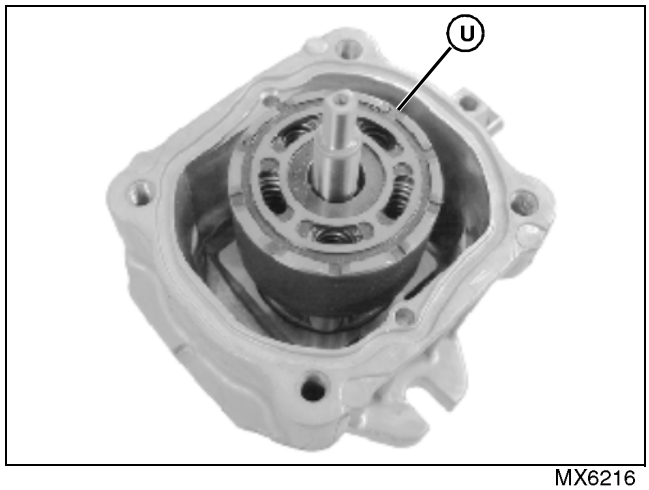
17.Install washer (O) and spring (P) on pump shaft.

IMPORTANT: Avoid damage! Install pistons into the same bores from which it was removed.



MX6232

18.Install springs (Q), disks (R) and pistons (S) in their original bores in the cylinder block (T). The pistons must move freely in the bores.



MX6216

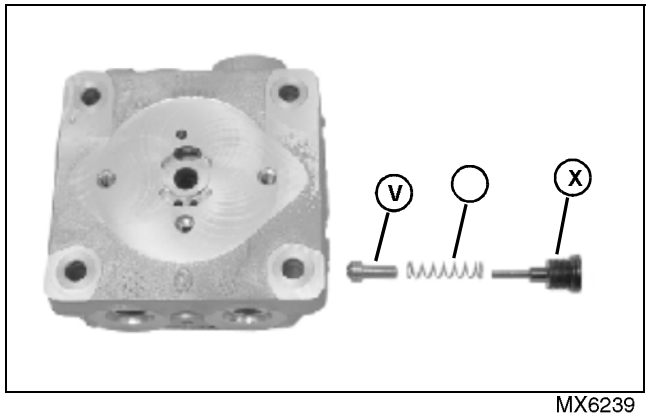
19.Position the pump housing on its side and move the swash plate to the 0° (neutral) position. Install the cylinder block assembly (U) on the pump shaft.

20.Check the piston springs to make sure they are centered in the cylinder block bores. Carefully reposition if necessary.

21.Reposition the housing with cylinder block/opening facing up.

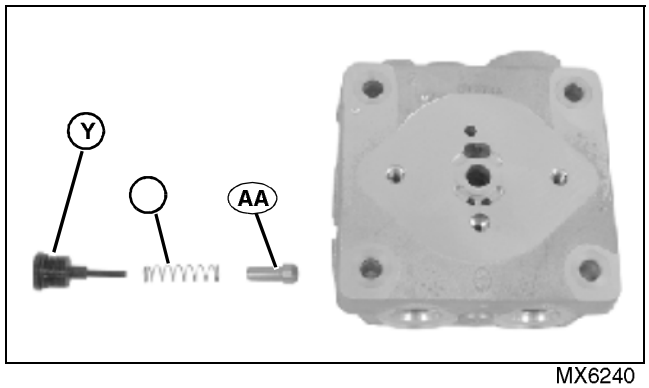
End Cover Assembly

IMPORTANT: Avoid damage! Right-hand poppet has center orifice and must be installed in right-hand check valve.



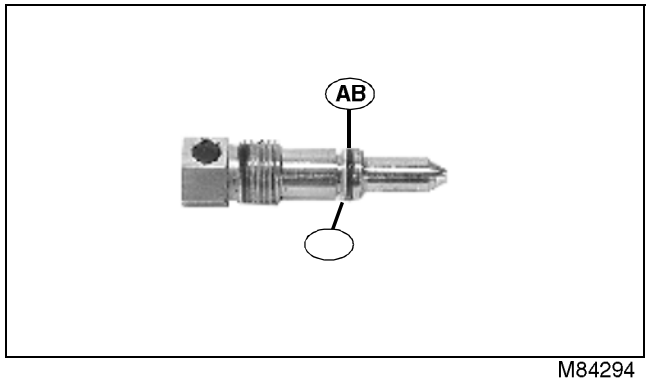
MX6239

1. Install the right-hand check valve poppet (V), spring (W) and plug (X) in the end cap. Tighten check valve to specification.



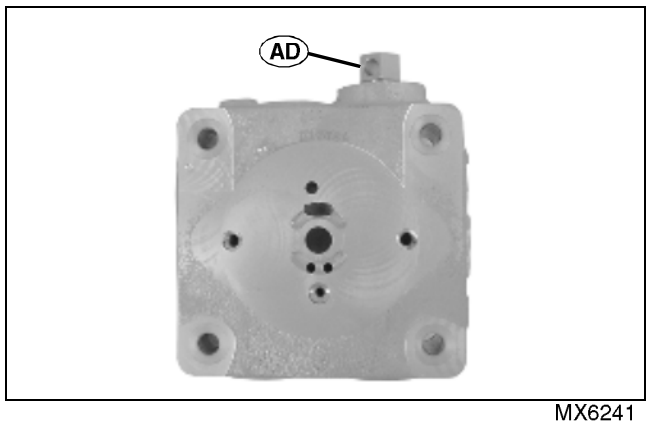
MX6240

2. Install the left-hand check valve poppet (AA), spring (Z) and plug (Y) in the end cap. Tighten check valve to specification.



M84294

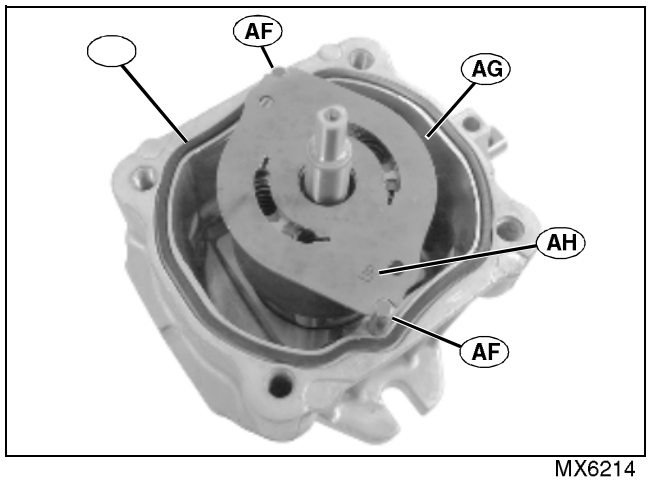
3. Install new O-ring (AC) and backup ring (AB) on bypass valve.



MX6241

4. Install bypass valve (AD) in end cap. Tighten bypass valve to specification.

5. Position and support the pump housing with the opening facing up.



MX6214

6. Install alignment pins (AF) and a new seal (AE).

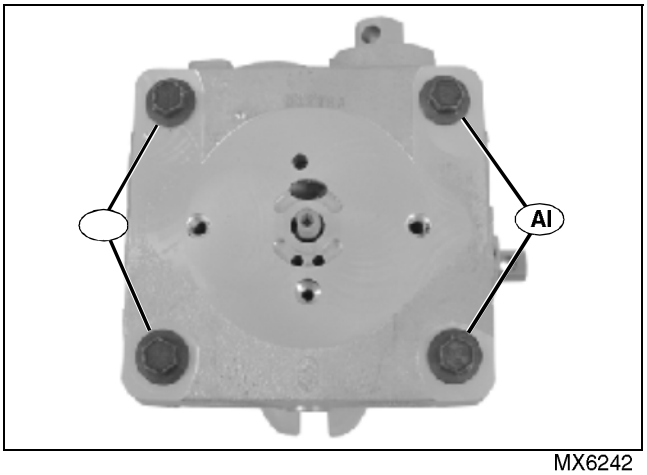
7. Apply a light coat of clean hydraulic oil to the running surfaces of cylinder block and valve plate.

IMPORTANT: Avoid damage! Valve plate (AG) must be installed with "UP" mark facing away from cylinder block.

8. Install valve plate (AG) with stamped "UP" (AH) facing up, away from cylinder block.

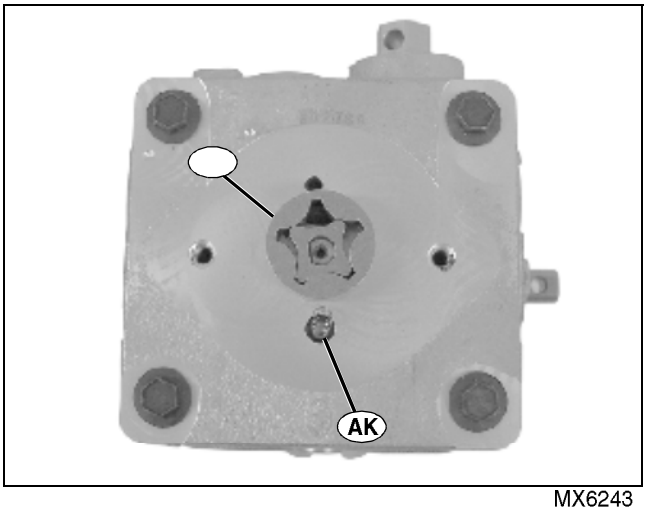
IMPORTANT: Avoid damage! Make sure that all parts are properly aligned before tightening the end cover. DO NOT force the end cap! Damage to the end cap and cylinder block sealing surfaces will result.

NOTE: When properly installed, the cylinder block springs will hold the end cover approximately 13 mm (1/2 in.) away from the housing.



MX6242

9. Install end cover assembly. Tighten end capscrews (AI) in small increments, in an alternating pattern, to specification.

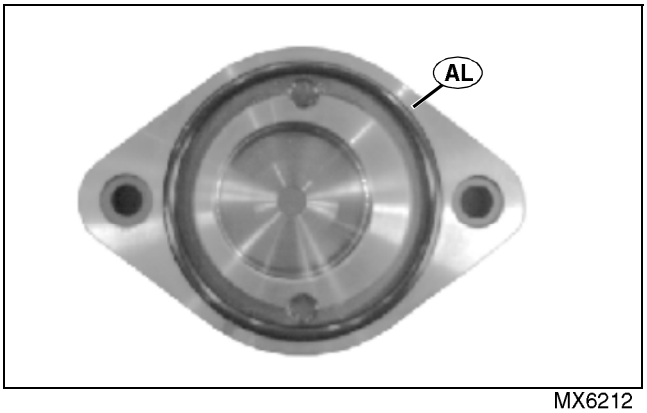


MX6243

10.Install charge relief valve ball and spring (AK).

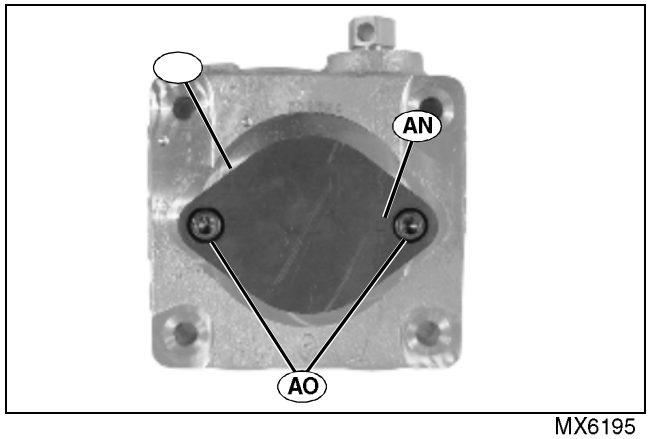
11.Apply a light coat of petroleum jelly to the gerotor stator and rotor (AJ).

12.Install gerotor stator and rotor.



MX6212

13.Install a new O-ring (AL) in the charge pump cover.



MX6195

14.Install charge pump cover (AM), aligning the relief valve spring with the recess in the cover, and positioning cover according to the orientation mark (AN) noted earlier.

15.Tighten charge pump cover screws (AO) to specification.

Specifications:

Check Valve Torque . . . . . 23 N•m (204 lb-in.)

Bypass Valve Torque . . . . . 12 N•m (102 lb-in.)

End Cover Capscrew Torque . . . . . 22 N•m (191 lb-in.)

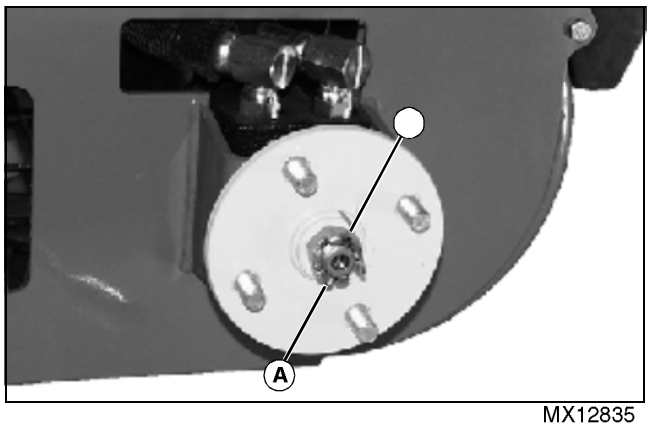
Charge Pump Cover Screw Torque . 12 N•m (102 lb-in.)

Remove and Install Wheel Motor

CAUTION: Avoid injury! Hydraulic fluid is under pressure. Escaping fluid can penetrate the skin and cause serious injury. Protect hands and body.

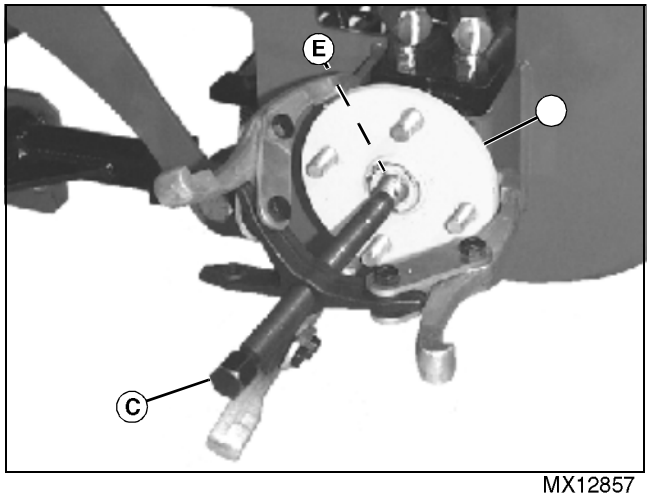
- **Relieve all pressure before checking hydraulic hoses.**
- **Search for leaks with a piece of cardboard. Do not use hands to check hoses.**
- **Tighten all connections before applying pressure.**

1. Park the machine safely.
2. Disconnect negative battery cable at the battery.
3. Remove rear tire. (See “Remove and Install Rear (Drive) Wheel” on page 259.)



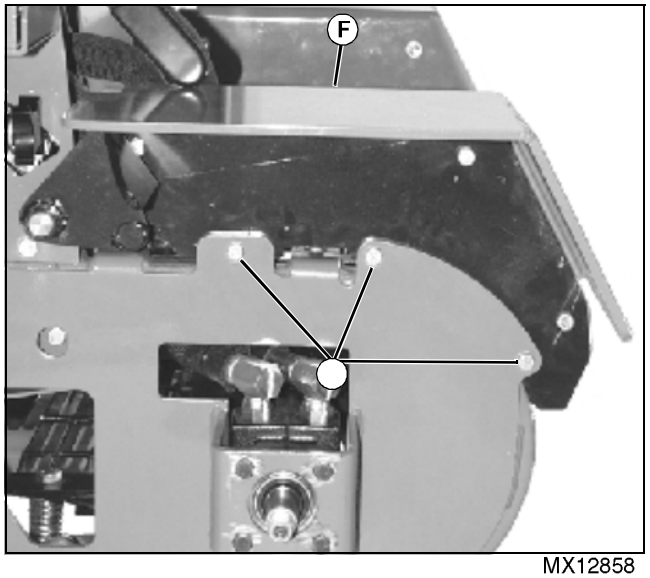
MX12835

4. Remove cotter pin (A) and castle nut (B).



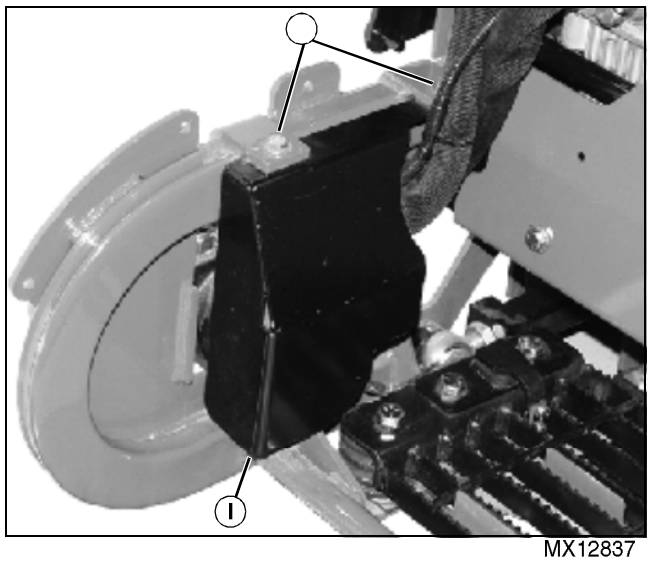
MX12857

5. Using puller (C), remove the hub (D) and key (E).



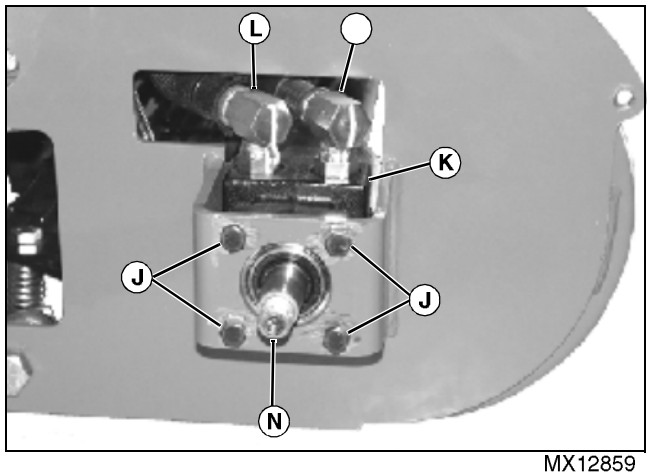
MX12858

6. Support fender/weight assembly (F).
7. Remove three capscrews and washers (G).
8. Remove fender/weight assembly (F).



MX12837

9. Remove two capscrews and washers (H).
10. Remove hose guard (I).



MX12859

11. Remove four capscrews (J).
12. Slide the wheel motor (K) through the mounting bracket.

NOTE: Label all hoses before removing to ensure correct installation.

13. Disconnect and plug hydraulic hoses (L and M).

Installation is done in the reverse order of removal.

- Before connecting hydraulic hoses, fill the wheel motor with clean hydraulic oil. (See “Hydrostatic Transmission and Hydraulic Oil” on page 22.)
- Apply grease to the traction motor output shaft (N) before installing the hub. (See “Grease” on page 22.)
- Tighten hub castle nut (B) to specifications.
- Check hydraulic oil level. Add oil as needed. (See “Hydrostatic Transmission and Hydraulic Oil” on page 22.)

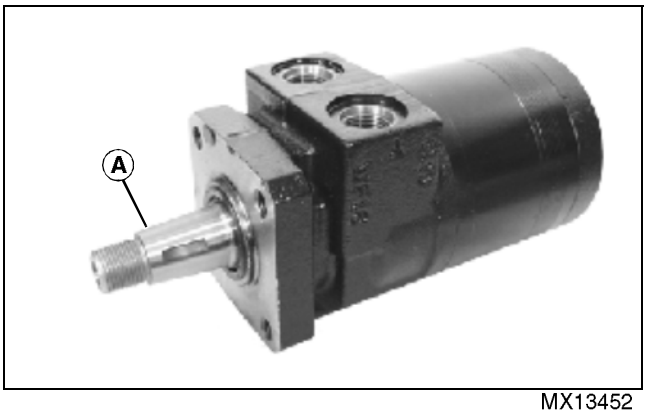
- Bleed air from the hydraulic system. (See "Bleed Air from Hydraulic System" on page 180.)

Specifications:

Hub Nut Torque. . . . . 203 N•m (150 lb-ft)

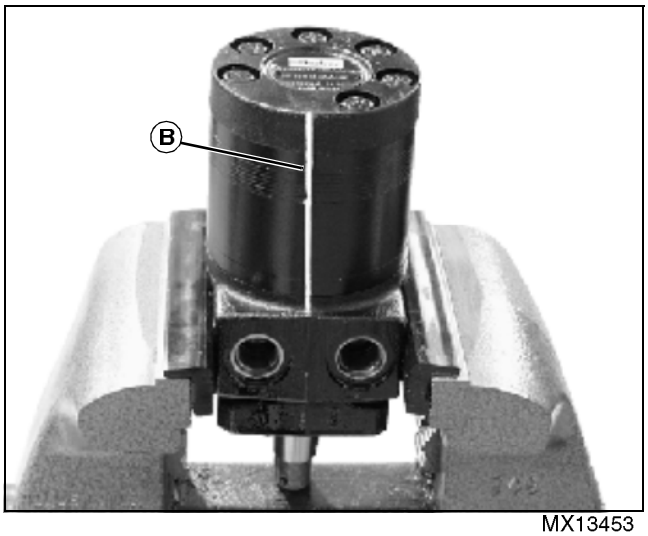
Disassemble and Inspect Wheel Motor

NOTE: Thoroughly clean the outside of the motor and port areas to eliminate the possibility of contamination of internal parts during disassembly.



MX13452

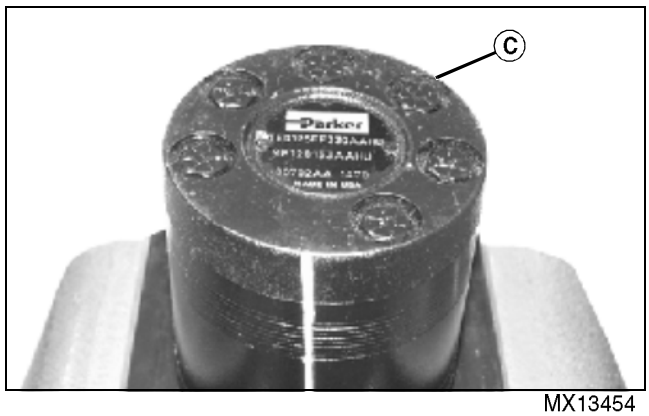
1. Clean rust, dirt and corrosion from coupling shaft (A).



MX13453

2. Place wheel motor in a soft-jawed vise with the output shaft down, clamping firmly on side of the housing, mounting flange or port bosses.

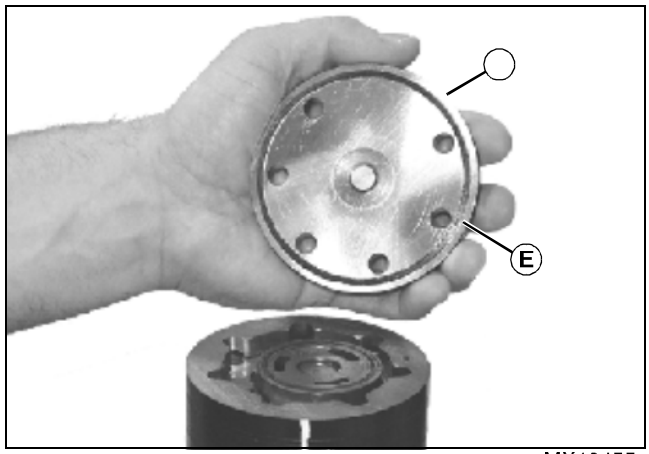
3. Scribe (or paint) an alignment mark (B) across the motor housing.



MX13454

4. Remove six retaining bolts (C).

5. Inspect bolts for damaged threads and damage to sealing ring under the bolt head.



MX13455

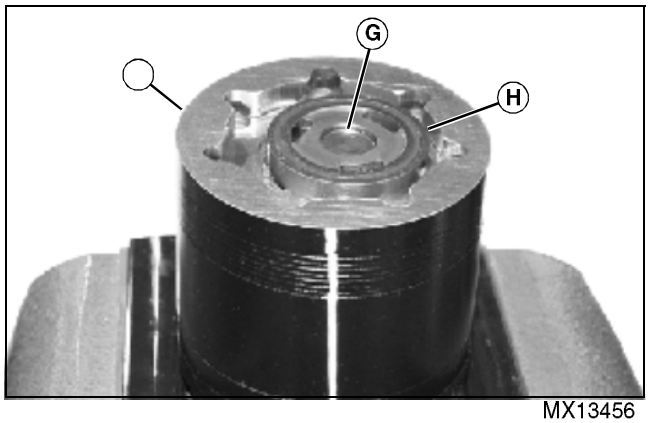
6. Remove end cover assembly (D) and sealing ring (E). Discard sealing ring.

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.

7. Thoroughly clean the end cover with solvent and blow dry with compressed air.

NOTE: A polished pattern on the face of the cover caused by rotation of the commutator is normal; however, the face should be free of scratches. Discoloration of the face surface may be caused by excessive fluid temperature, thermal shock or excessive speed. If discoloration is noted, thoroughly inspect all motor components for further damage. Inspect the entire drive/hydraulic system and correct any problems to prevent any possible further damage.

8. Inspect end cover for cracks, damage, discoloration or unusual wear.



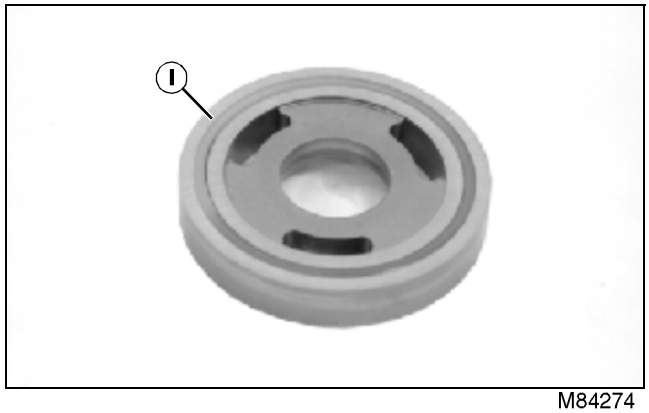
MX13456

9. Remove commutator ring (F).

10.Inspect commutator ring for cracks or burrs.

NOTE: Drive link (G) may stick to the commutator. Hold drive link in place while removing commutator.

11.Remove commutator (H).

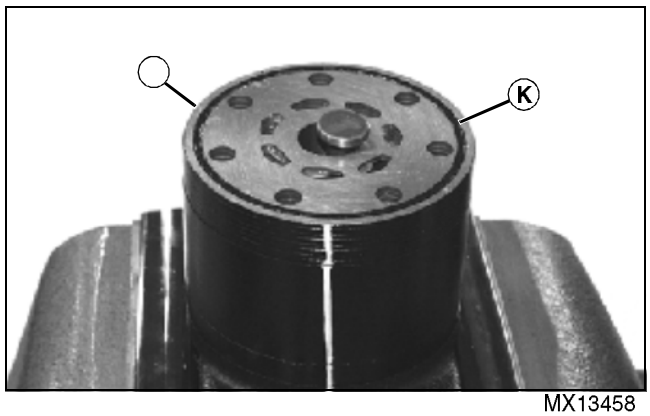


M84274

12.Remove seal ring (I) from commutator by blowing compressed air into the ring groove until the seal ring is lifted out of the groove. Discard the seal ring.

13.Inspect commutator for cracks, burrs, scoring, spalling, brinelling or unusual wear.

NOTE: Note the orientation of the manifold to ensure correct installation.



MX13458

14.Remove manifold (J).

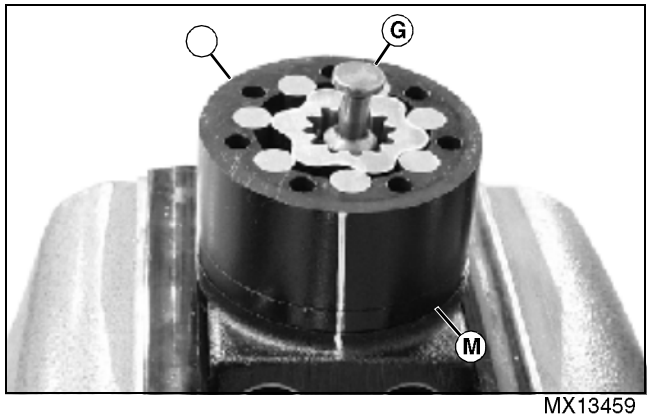
15.Remove seal rings (K) from both sides of the manifold. Discard seals.

NOTE: A polished pattern on the machined surface of the manifold caused by rotation of the commutator is normal.

16.Inspect manifold for cracks, surface scoring, spalling or brinelling.

NOTE: Hold rotor set (L) and wear plate (M) together while removing to maintain rotor vane-to-stator contact surfaces.

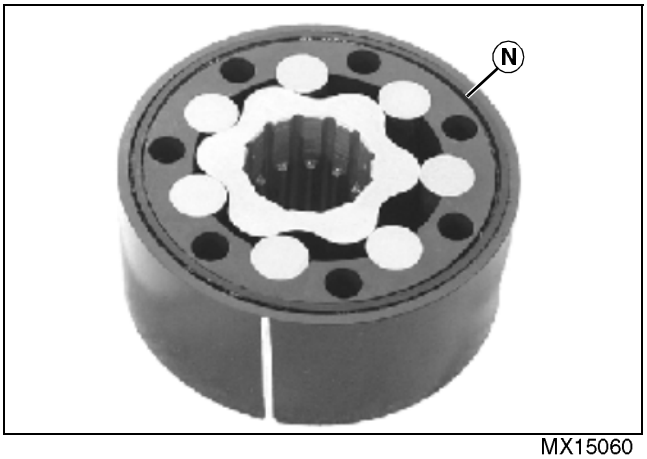
The drive link (G) may come out with the rotor set. If it does, hold the drive link while removing the rotor set/ wear plate.



MX13459

17.Remove rotor set and wear plate as a set.

NOTE: Maintain rotor set components in their original positions. DO NOT disassemble.

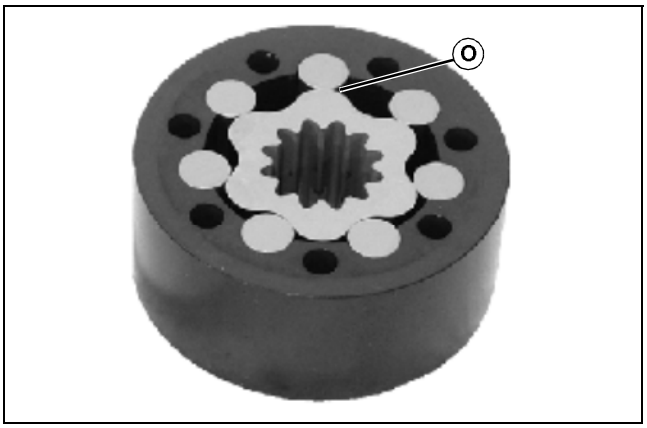


MX15060

Picture Note: Bottom of Rotor Set Shown.

18.Separate the rotor set from the wear plate. Discard seal ring (N).

19.Inspect rotor set for nicks, scoring or spalling on any surface, and for broken or worn splines.



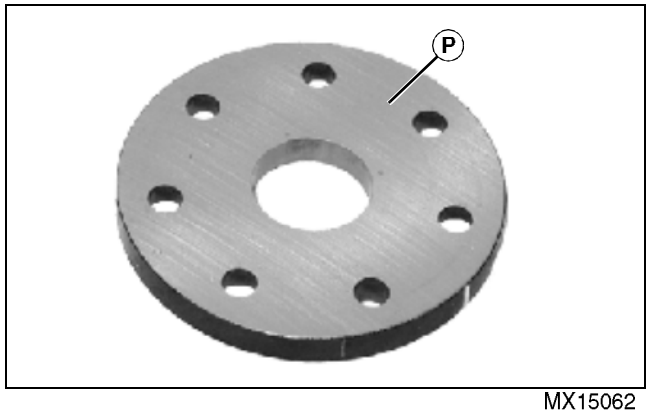
MX15061

20.Place rotor set on a surface plate.

21.Position the rotor in the stator so that two rotor lobes (180° apart) and roller vane centerline are on the same stator centering.

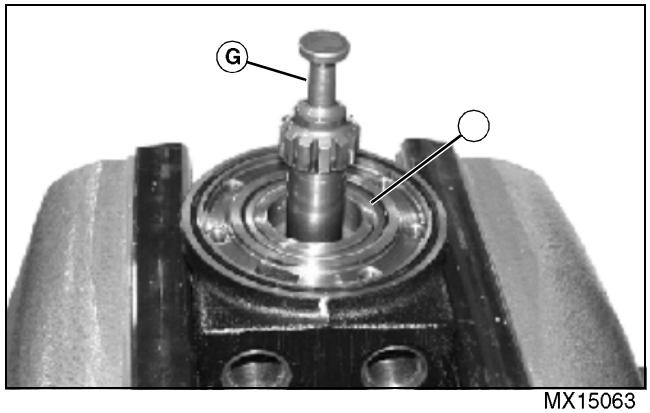
22.Check the rotor lobe-to-roller vane clearance (O) at the common centerline using a feeler gauge. Clearance should not be greater than specifications.

NOTE: A polished pattern on the machined surface of the wear plate (P) caused by rotation of the rotor is normal.



MX15062

23.Inspect wear plate for cracks, brinelling or scoring.

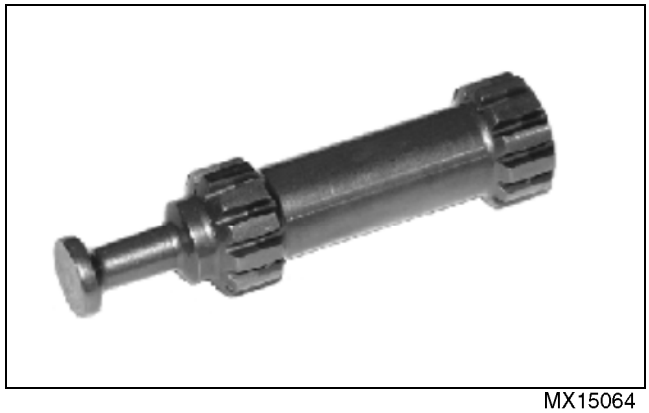


MX15063

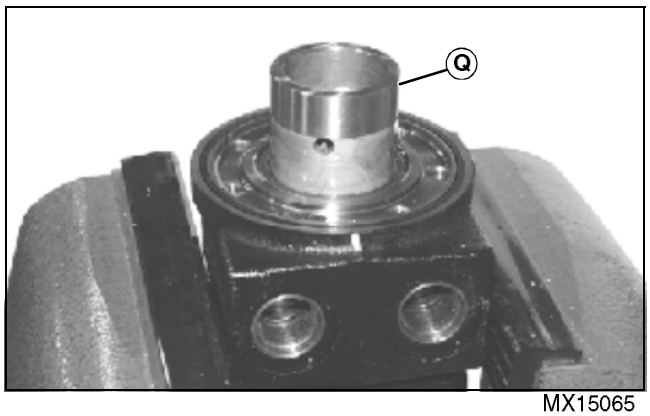
24.Inspect for play between drive link (G) and coupling shaft (Q). There should be no noticeable play.

25.Mark drive link and coupling shaft splines to ensure assembly in the original positions.

26.Remove drive link from the coupling shaft.

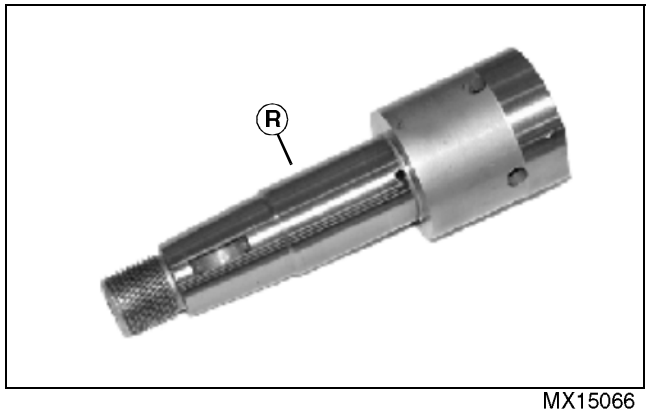

MX15064

27.Inspect the drive link for cracks and worn or damaged splines.



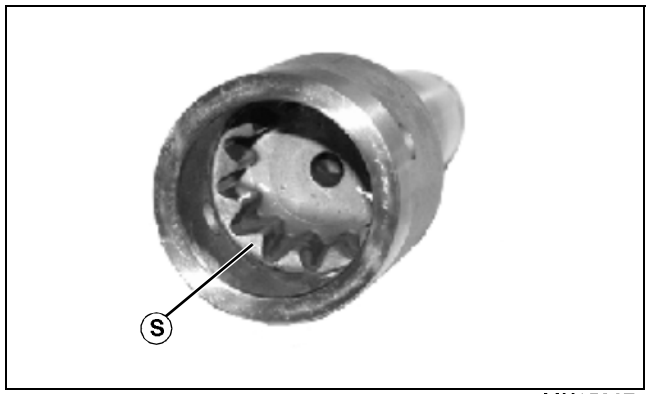
MX15065

28.Remove coupling shaft (Q).



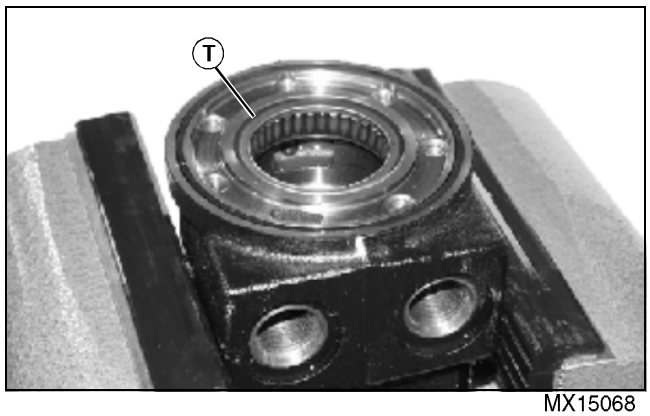
MX15066

29.Inspect coupling shaft bearing and seal surfaces (R) for spalling, nicks, excessive wear or corrosion.



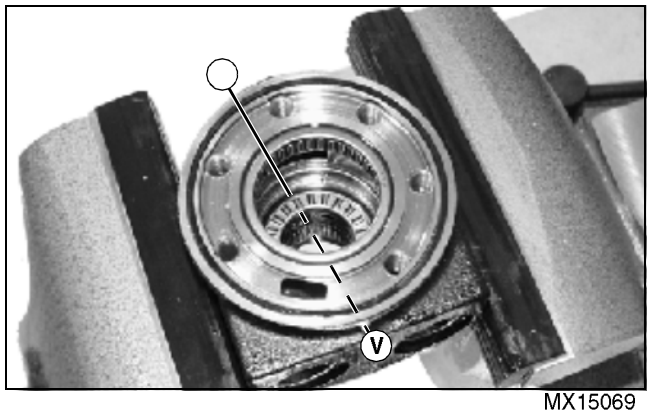
MX15067

30.Inspect coupling shaft splines (S) for wear or damage.



MX15068

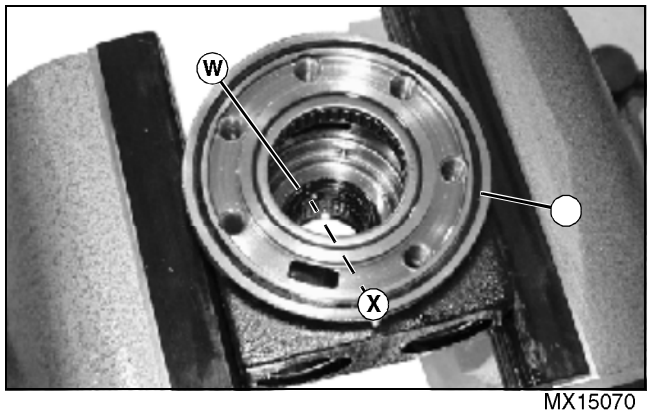
31.Inspect inner bearing (T) for free rotation and excessive play in bearing cage. Also inspect bearing for brinelling or corrosion.



MX15069

32.Remove thrust bearing (U) and thrust washer (V).

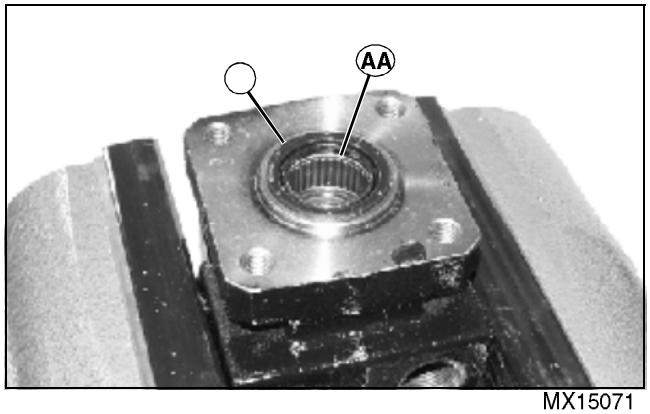
NOTE: A dental pick or similar device can be used to remove the seal.



MX15070

33.Remove the seal (W) and backup washer (X).

34.Remove seal ring (Y) from housing. Discard seal.



MX15071

35.Remove wheel motor from the vise, invert it and reinstall it in the vise.

36.Remove seal (Z) using a blind-hole bearing or seal puller.

37.Inspect the housing for cracks, excessive wear or damage. Inspect machine surfaces for nicks, burrs, brinelling or corrosion. Inspect tapped holes for thread damage.

38.Inspect bearing (AA) for free rotation and excessive play in bearing cage. Also inspect bearing for brinelling or corrosion. Remove bearing only if replacement is required.

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.

39.Clean all metal parts with solvent and blow dry with compressed air.

40.Inspect all parts for damage, nicks or unusual wear. Replace entire wheel motor assembly if any parts other than seal rings, seals or outer bearing are worn or damaged.

Specifications:

Rotor Lobe-to-Rotor Vane Clearance (Max.) . . 0.13 mm (0.005 in.)

Assemble Wheel Motor

Other Material

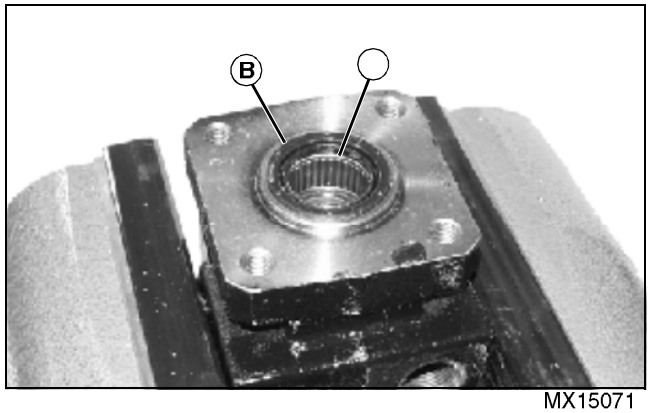
Part No.	Part Name	Part Use
NA	Mobilith SHC® 460 Grease	Applied to wheel motor seals and seal rings. (Supplied with wheel motor gasket kit.)

IMPORTANT: Avoid damage! Always use new O-rings. Damage or used parts will leak.

NOTE: Alignment studs screwed finger tight into the bolts holes 180° apart can be used to assist alignment during assembly. Alignment studs can be made by cutting the heads off 3/8-24 UNF 2A x 5 in. capscrews.

Lubricate all seals and seal rings with Mobilith SHC® 460 grease (supplied with seal kit) during assembly.

IMPORTANT: Avoid damage! The outer bearing is not lubricated by the system's hydraulic oil. Thoroughly pack the bearing with grease before installation.



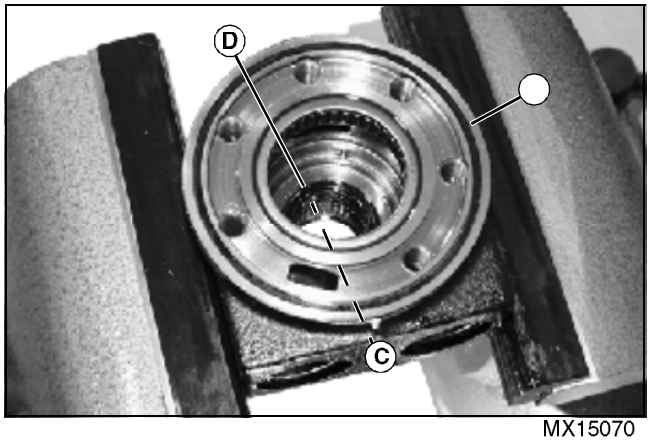
MX15071

1. Pack and coat the new outer bearing (A) with anti-corrosion grease.

2. Install a new outer bearing seal (B) with the lip facing out. Press seal into housing until the seal is flush with the end of the housing.

3. Apply grease to the seal.

4. Remove wheel motor from vise, invert it and install it in vise.



MX15070

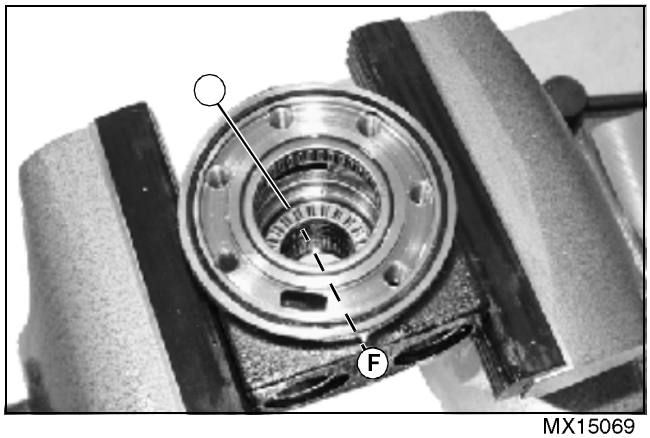
5. Install backup ring (C).

IMPORTANT: Avoid damage! Make sure that the seal is completely seated in bore. Improper seating may result in seal damage when installing coupling shaft, resulting in leakage.

6. Install a new seal (D) with lip facing toward the inside of the rotor.

7. Apply a thin film of grease to the seal ring (E).

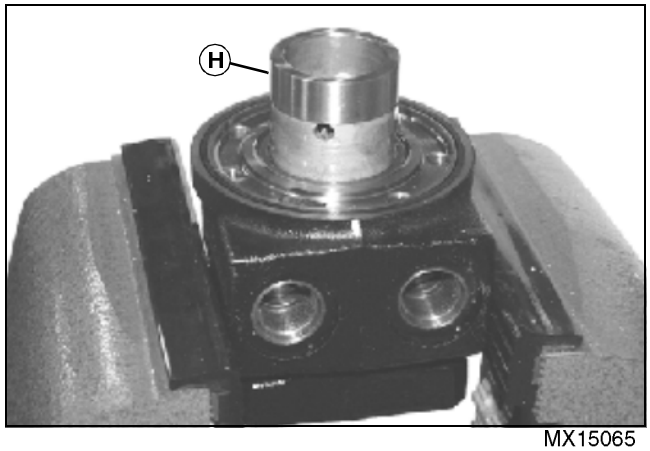
8. Install seal ring (E) in the groove in the housing.



MX15069

9. Seat thrust washer (F) and thrust bearing (G).

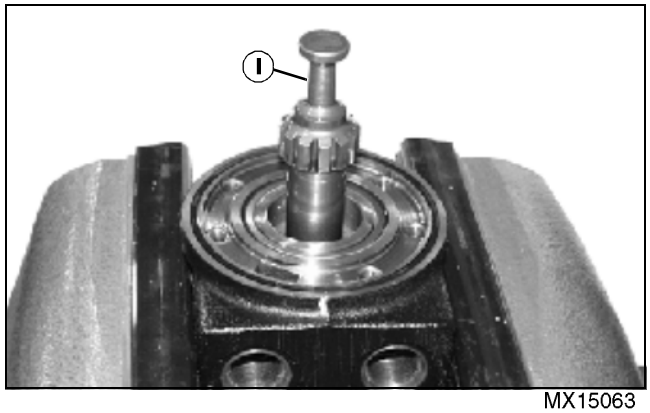
IMPORTANT: Avoid damage! Apply anti-corrosion grease to the outer bearing/bushing and tape to the threads and keyway of the coupling shaft to prevent damage to the seal during installation.



MX15065

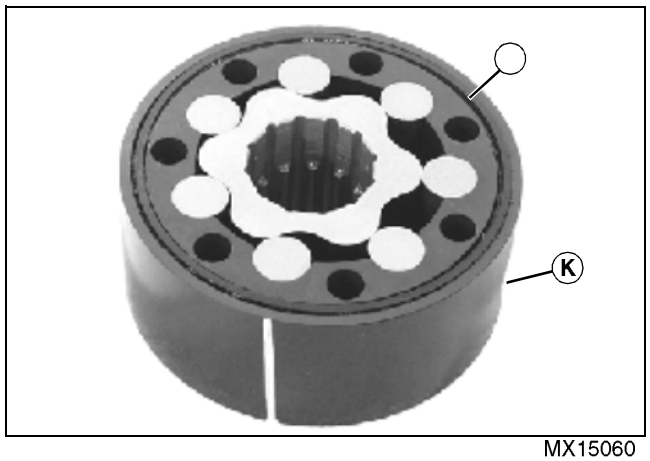
10. Apply tape to the threads and keyway of the coupling shaft (H) to prevent damage to the seal during installation.

11. Install the coupling shaft in the housing until it rests against the thrust washer.



MX15063

12. Install drive link (I) with the splined end toward the coupling shaft. Align marked splines on drive link and coupling shaft.

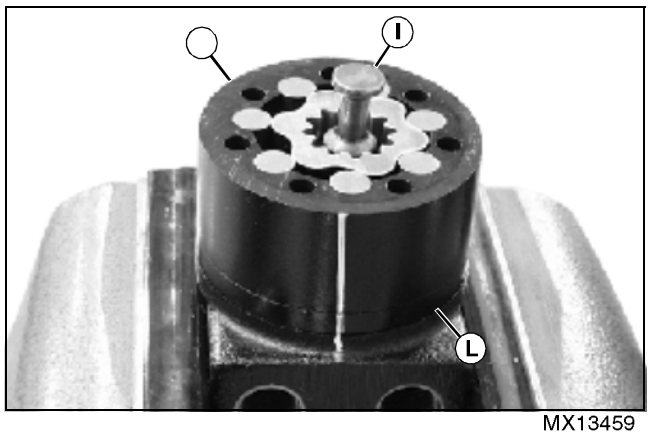


MX15060

Picture Note: Bottom of rotor set shown.

13. Apply a light coat of grease to seal ring (J).

14. Install seal ring (J) in the groove in the rotor set (K).

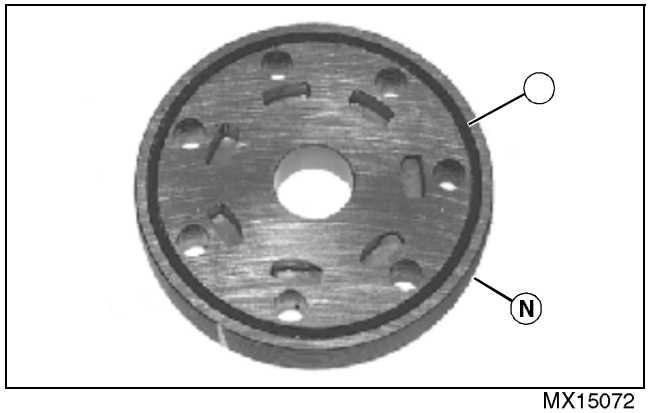


MX13459

15.Install wear plate (L) on rotor set (K).

16.Carefully flip rotor set/wear plate assembly over while holding the rotor set components in place.

17.Install rotor set (K) and wear plate (L) over the drive link (I).



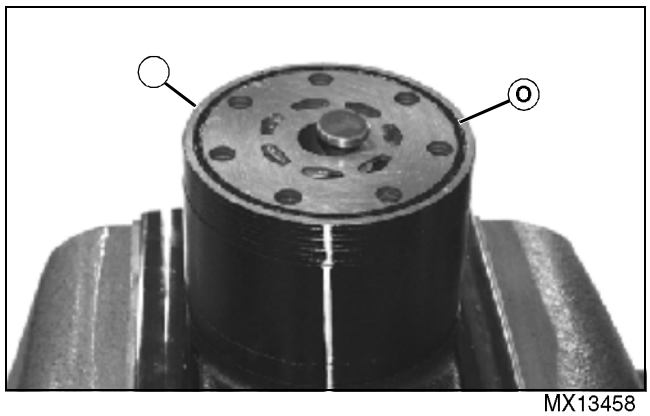
MX15072

Picture Note: Bottom of manifold shown.

18.Apply a light coat of grease to seal ring (M).

19.Install seal ring (M) in the groove in the bottom of the manifold (N).

NOTE: Correct installation of the manifold is important for proper operation. The manifold should be installed with the surface with the irregular shaped cavities on the largest circumference toward the rotor set.

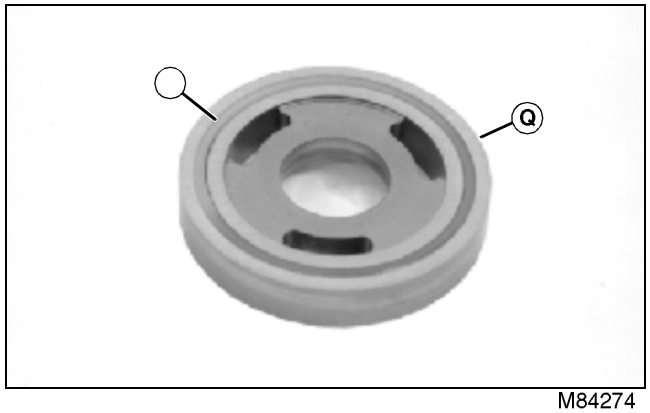


MX13458

20.Install manifold (N).

21.Apply a light coat of grease to the seal ring (O).

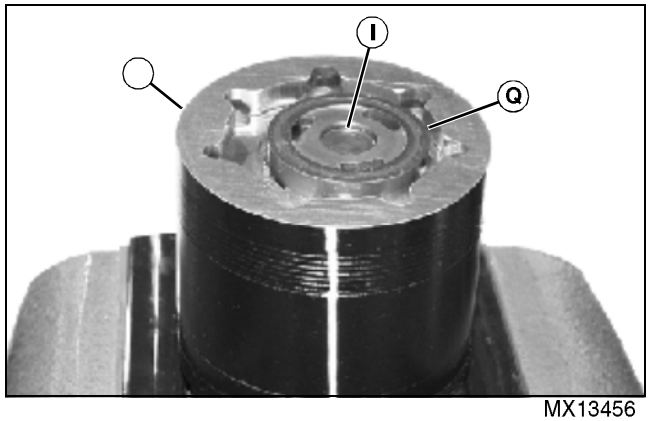
22.Install seal ring (O) in the groove in the manifold.



M84274

23.Apply a light coat of grease to the seal ring (P).

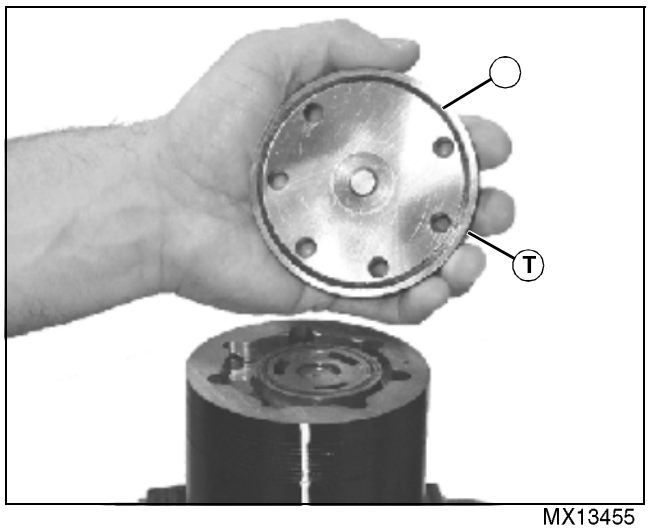
24.Install seal ring (P) in the groove in the commutator (Q).



MX13456

25.Install commutator (Q) on drive link (I).

26.Install commutator ring (R).

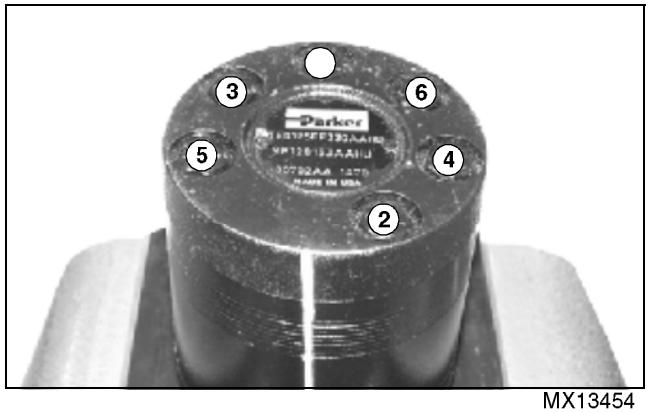


MX13455

27.Apply a light coat of grease to seal ring (S).

28.Install seal ring (S) in the groove in the end cover (T).

29.Install end cover (T).



MX13454

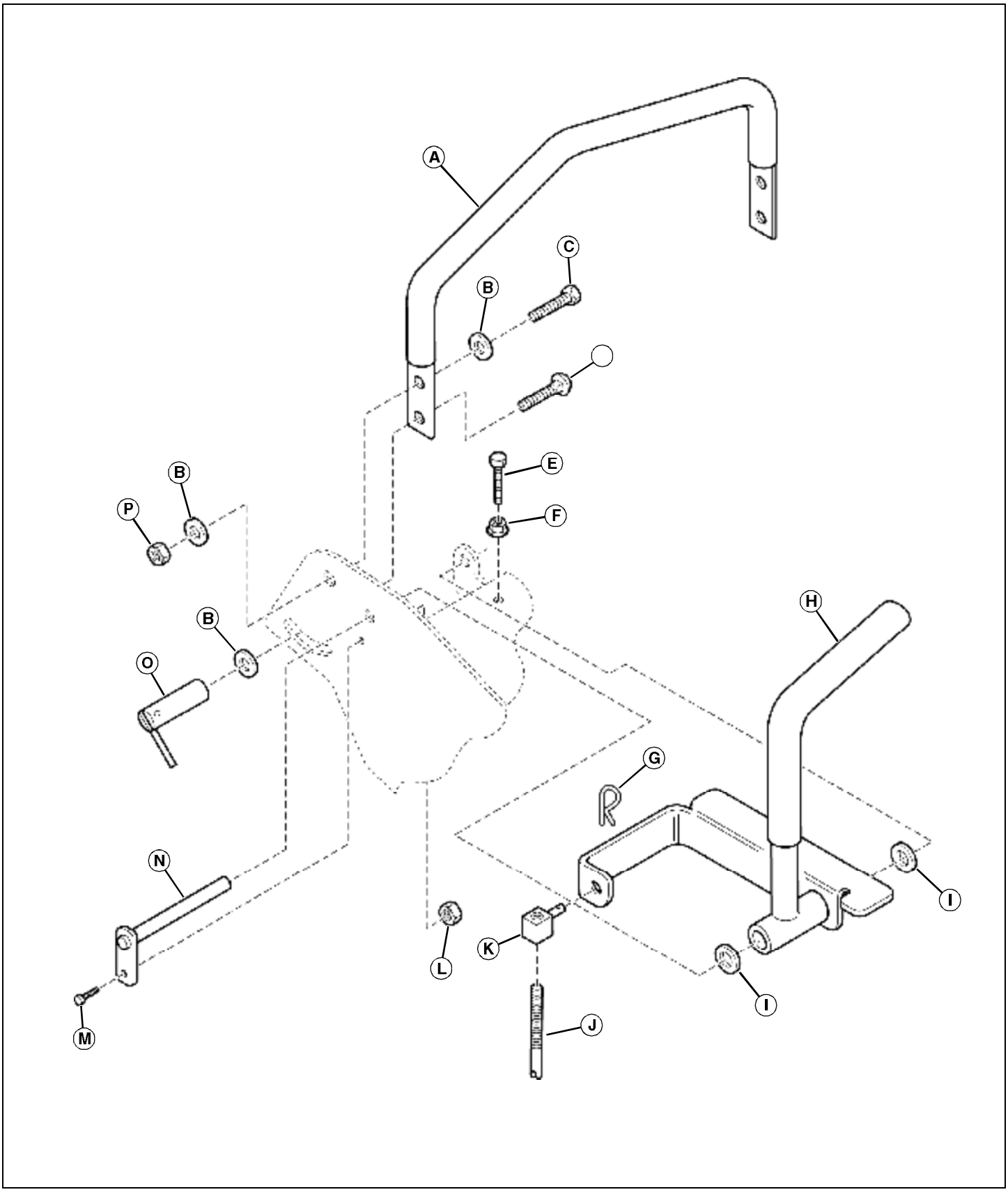
30.Install retaining capscrews.

31.Tighten capscrews evenly, in the sequence shown, to specifications.

Specifications:

End Cover Capscrew Torque. . . . . 68 N•m (50 lb-ft)

Motion Control Levers

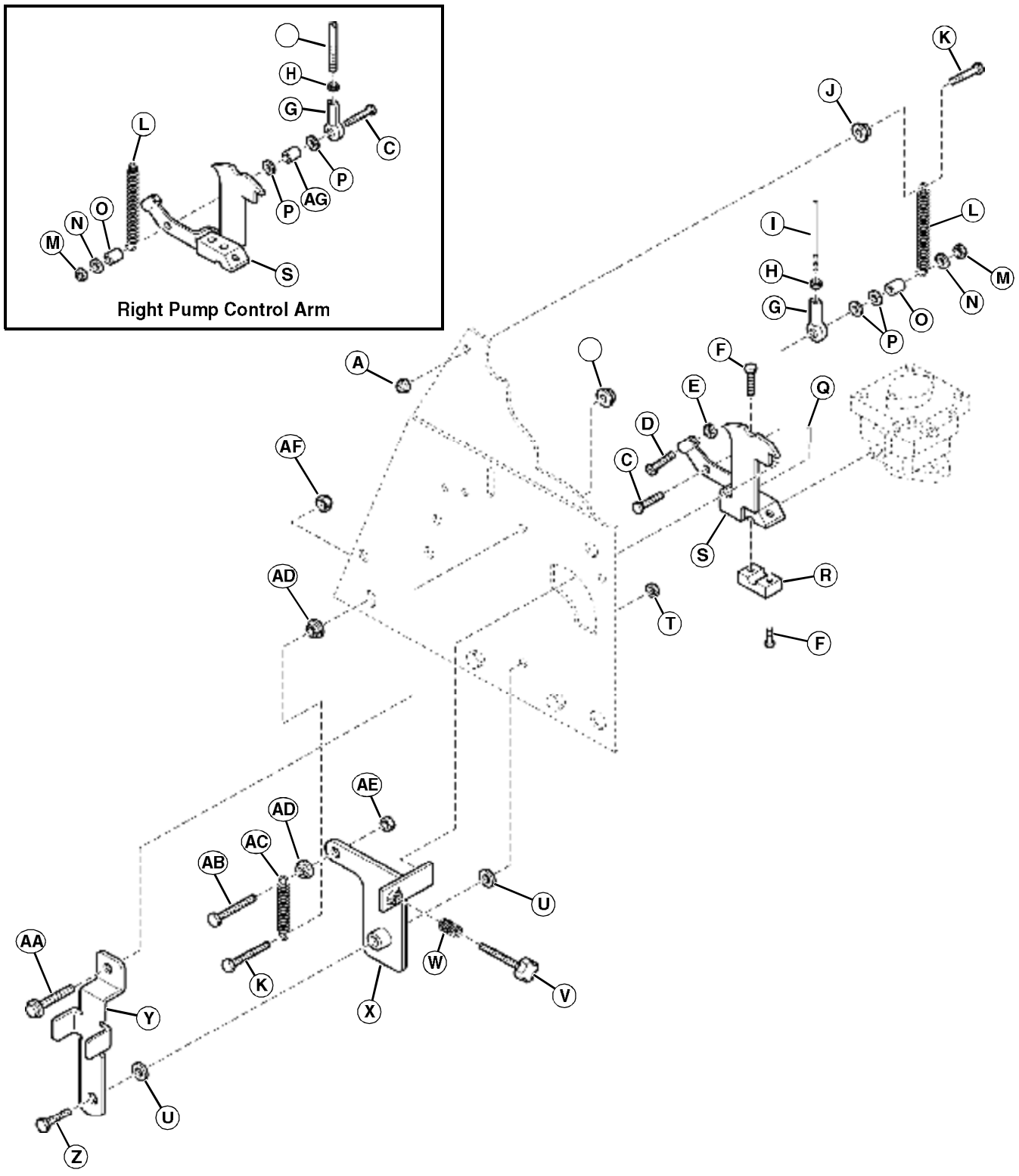


MX13422 **Picture Note: Left side shown.**

A - Speed Control Bar
B - Flat Washer (2 used per side)
C - Capscrew
D - Carriage Bolt
E - Capscrew
F - Flanged Nut
G - Spring Locking Pin
H - Control Lever
I - Flat Washer (2 used per side)
J - Control Rod
K - Pivot
L - Locknut
M - Capscrew
N - Pivot Shaft
O - Adjuster Handle
P - Locknut

- Inspect all parts for wear or damage. Replace parts as needed.
- Apply a thin film of grease to pivot pin before installation. (See “Grease” on page 22.)
- Check neutral position and tracking adjustments. Adjust as needed. (See “Check and Adjust Motion Control Linkage” on page 180.)

Hydraulic Pump Control Linkage

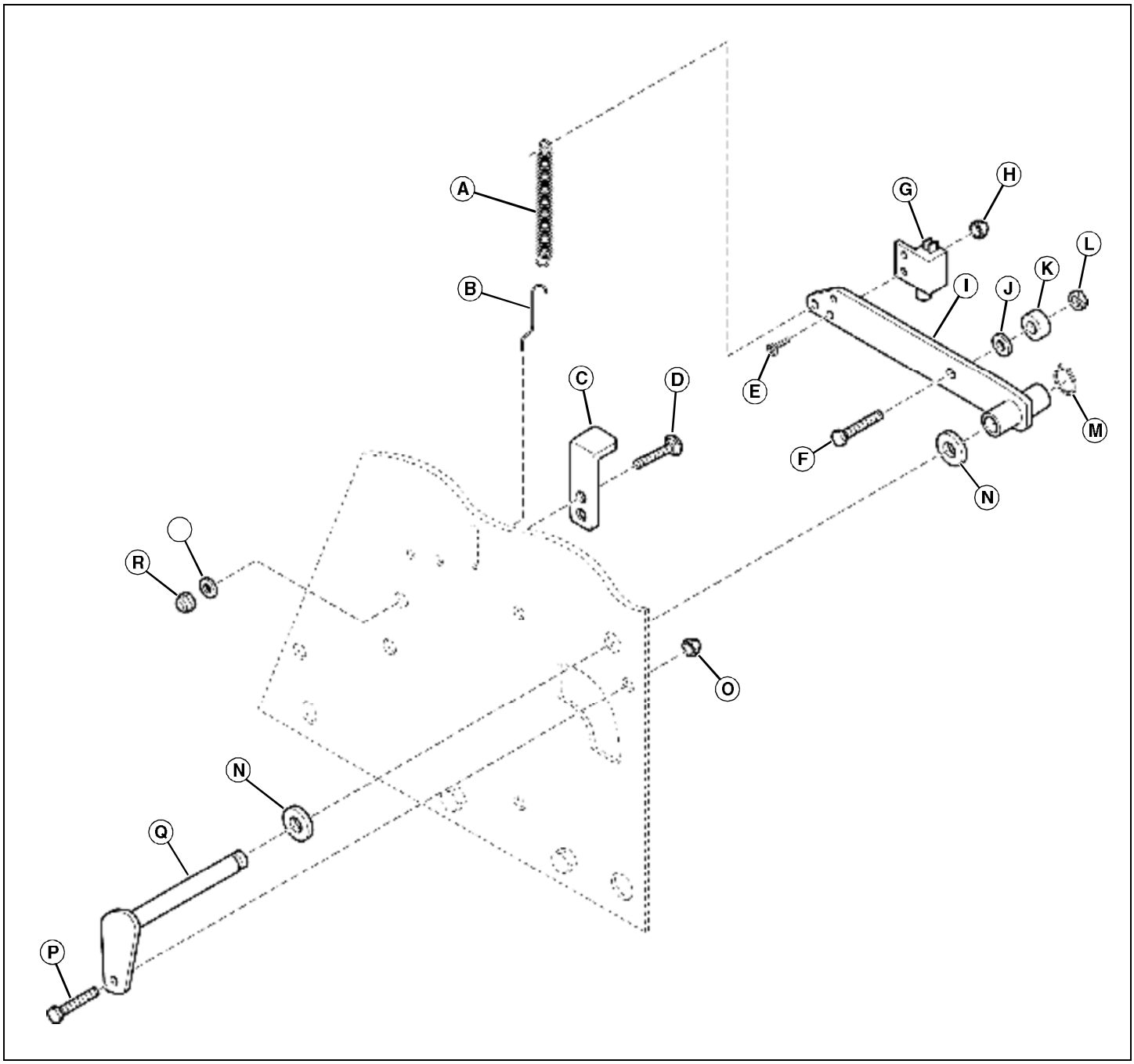


MX13423

A - Locknut
B - Flanged Nut (2 used per side)
C - Capscrew
D - Capscrew
E - Nut
F - Capscrew (2 used per side)
G - Spherical Bearing
H - Nut
I - Control Rod
J - Flanged Nut
K - Capscrew
L - Spring
M - Nut
N - Flat Washer
O - Spacer
P - Flat Washer (2 used per side)
Q - Roll Pin
R - End Cap
S - Control Arm
T - Jam Nut
U - Flat Washer (2 used per side)
V - Adjustment Knob
W - Spring
X - Adjustment Bracket
Y - Bracket
Z - Capscrew
AA- Flange Capscrew
AB- Capscrew
AC- Spring
AD- Flange Nut (2 used per side)
AE- Nut
AF- Locknut
AG- Spacer (right side only)

- Inspect all parts for wear or damage. Replace parts as needed.
- Check neutral position and tracking adjustments. Adjust as needed. (See “Check and Adjust Motion Control Linkage” on page 180.)

Neutral Switch Bracket



MX13429

Picture Note: Left side shown.

A - Spring
B - Spring Anchor
C - Bracket
D - Carriage Bolt (2 used)
E - Cross-Blade Screw (2 used)
F - Capscrew
G - Neutral Switch
H - Locknut (2 used)
I - Bracket
J - Flat Washer
K - Bearing
L - Nut
M - Retaining Ring
N - Washer (2 used per side)
O - Locknut
P - Capscrew
Q - Pivot Shaft
R - Locknut (2 used per side)
S - Flat Washer (2 used per side)

- Inspect all parts for wear or damage. Replace parts as needed.
- Apply grease to the pivot shaft (Q) before assembly.
- Check neutral position and tracking adjustments. Adjust as needed. (See “Check and Adjust Motion Control Linkage” on page 180.)
- Adjust forward and reverse speeds. (See “Adjust Forward and Reverse Speed” on page 183.)

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BRAKES TABLE OF CONTENTS

Specifications

General Specifications

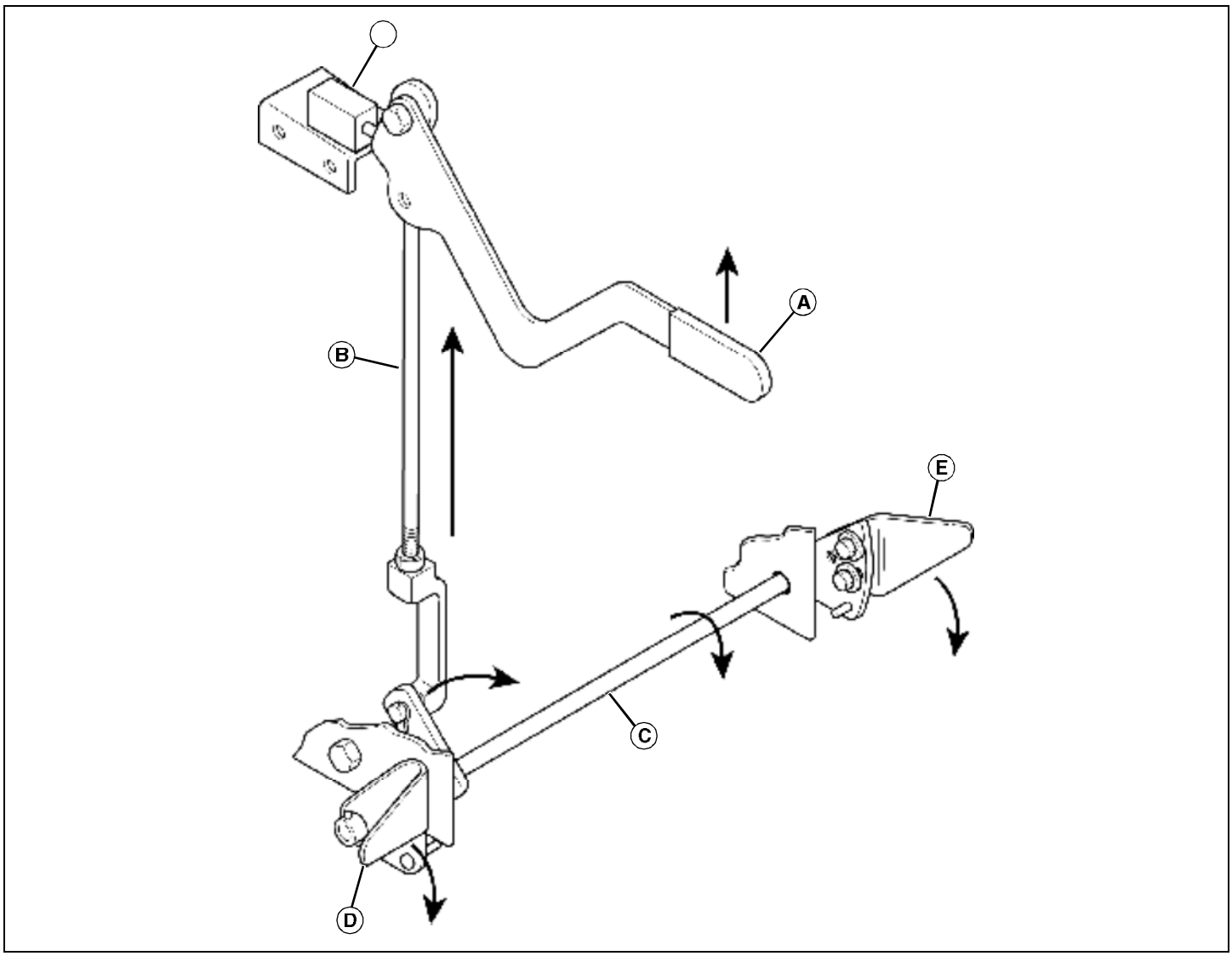
Normal Braking	Hydraulic Resistance
Park Brake	Tire Contact

Adjustment Specifications

Brake Pawl-to-Tire Gap	5 - 6 mm (3/16 - 1/4 in.)

Theory of Operation

Brake Operation



MX15089

- **A - Park Brake Lever**
- **B - Brake Rod**
- **C - Pivot Shaft**
- **D - Left Brake Pawl**
- **E - Right Brake Pawl**
- **F - Park Brake Switch**

Function

To provide a means of preventing the machine from moving when parked.

Theory of Operation - Normal Braking

During normal operation, braking is done by internal (hydraulic) resistance in the wheel motors. (See “Power Train Operation” on page 172.)

Theory of Operation - Park Brake

The park brake consists of lever-operated “pawls” that engage with the treads of the rear (drive) wheels.

When the park brake lever (A) is moved to the locked position, the brake rod (B) is pulled up, causing the pivot shaft (C) to rotate, bringing the brake pawls (D and E) into the tread of the rear (drive) tires.

When the lever is in the locked position, the park brake switch (F) is engaged. This prevents the engine from being started unless the park brake switch is engaged. (See “Cranking Circuit Operation” on page 122.)

Diagnostics

Machine Will Not Move

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake unlocked.
- Control levers in neutral position.

Symptom: Machine Will Not Move

(1) Is park brake unlocked?

Yes - Go to step (2).

No - Release park brake. Go to step (2) if the problem continues.

(2) Is the brake linkage adjusted properly?

Yes - Go to step (3).

No - Adjust brake linkage. (See "Check and Adjust Park Brake" on page 218.) Go to step (3) if the problem continues.

(3) Does the brake linkage move freely, not jammed or binding?

No - Repair brake linkage. (See "Park Brake Lever and Linkage" on page 220.)

Park Brake Will Not Engage

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake unlocked.
- Control levers in neutral position.

Symptom: Park Brake Will Not Engage

(1) Is the brake linkage adjusted properly?

Yes - Go to step (2).

No - Adjust brake linkage. (See "Check and Adjust Park Brake" on page 218.) Go to step (2) if the problem continues.

(2) Is the brake linkage free of wear or damage?

No - Repair brake linkage. (See "Park Brake Lever and Linkage" on page 220.)

Park Brake Will Not Hold Machine

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake unlocked.
- Control levers in neutral position.

Symptom: Park Brake Will Not Hold Machine

(1) Are rear (drive) tires inflated to correct pressure?

Yes - Go to step (2).

No - Inflate rear (drive) tires to correct pressure. (See "Tire Pressure Adjustment" on page 258.) Go to step (2) if the problem continues.

(2) Is the brake linkage adjusted properly?

Yes - Go to step (3).

No - Adjust brake linkage. (See "Check and Adjust Park Brake" on page 218.) Go to step (3) if the problem continues.

(3) Is the brake linkage free of wear or damage?

No - Repair brake linkage. (See "Park Brake Lever and Linkage" on page 220.)

Tests and Adjustments

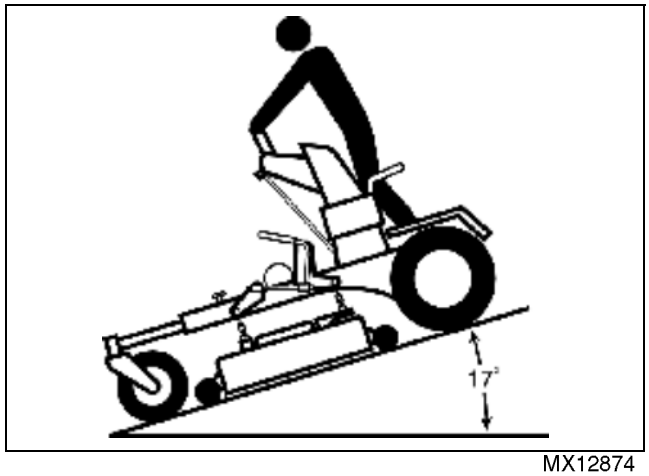
Check and Adjust Park Brake

Reason:

To ensure park brake functions properly.

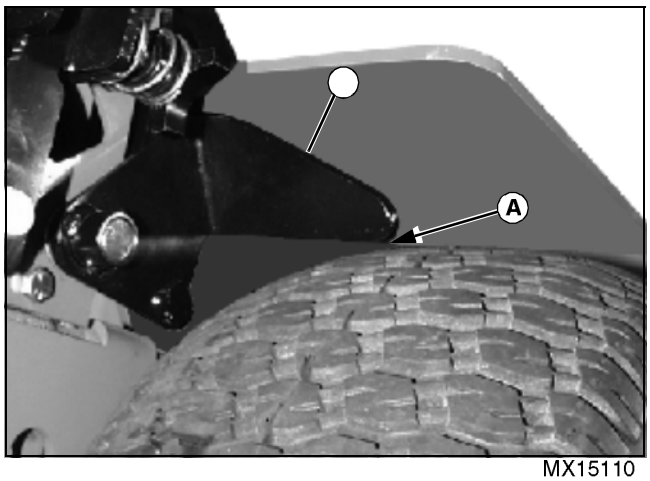
Check Procedure:

1. Inflate tires to correct pressure. (See “Tire Pressure Adjustment” on page 258.)



MX12874

2. Drive the machine onto a 17° slope and lock park brake. Check that park brake holds the machine stationary on slope and that the machine does not creep downward once park brake is set.
3. Unlock park brake.
4. Move the machine to a level surface.



MX15110

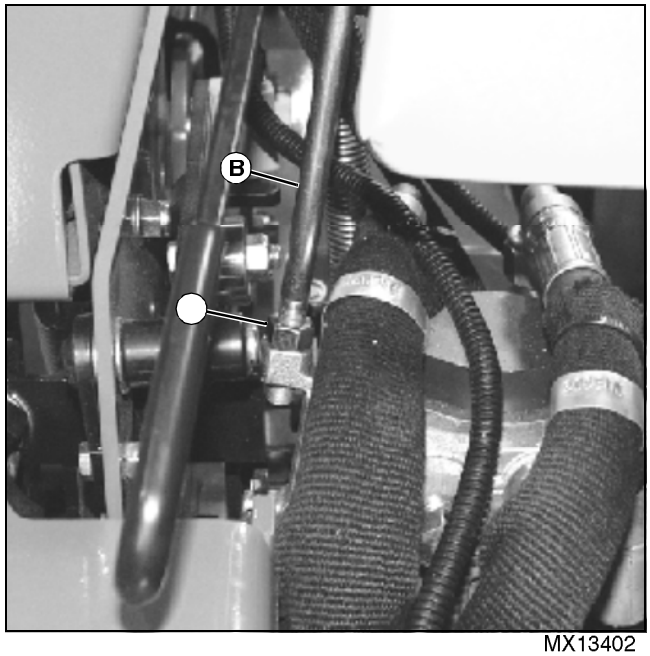
5. Measure the gap (A) between the brake pawl (B) and the tire on both sides of the machine.
6. If park brake does not hold machine, or if the gap does not meet specifications, inspect brake linkage components and adjust brake.

Specifications:

Brake Pawl-to-Tire Gap . . . . . 5 - 6 mm (3/16 - 1/4 in.)

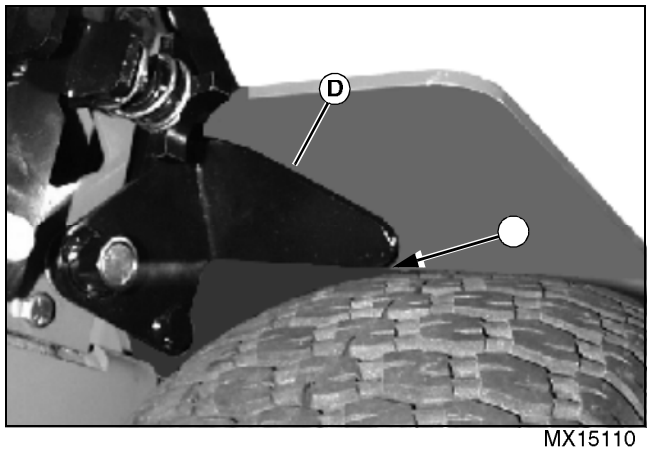
Adjustment Procedure:

1. Park the machine safely.
2. Inflate tires to correct pressure. (See “Tire Pressure Adjustment” on page 258.)
3. Unlock park brake.



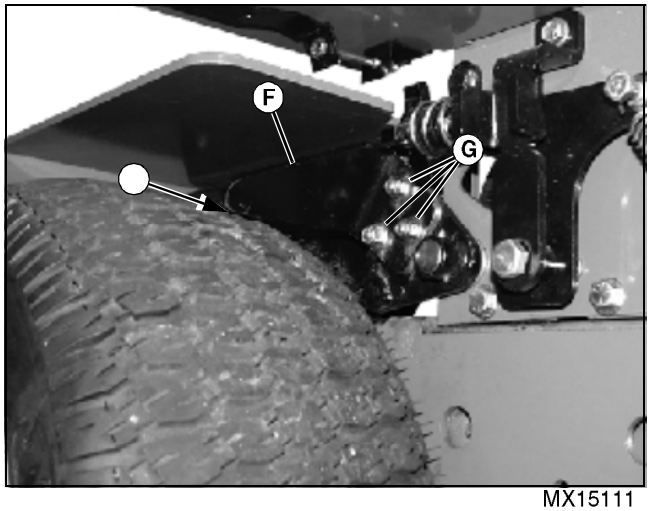
MX13402

4. Loosen jam nut (A) at the lower end of the brake linkage rod (B).



MX15110

5. Turn the brake linkage rod (B) until the gap (C) between the left brake pawl (D) and tire meets specifications:
   - To decrease gap, turn brake linkage rod clockwise.
   - To increase gap, turn brake linkage rod counterclockwise.
6. Tighten jam nut (A).



MX15111

7. Measure the gap (E) between the right brake pawl (F) and the tire. If the gap does not meet specifications, adjust as follows:

   a. Loosen the three capscrews and nuts (G).

   b. Adjust the brake pawl (F) until the gap (E) meets specifications.

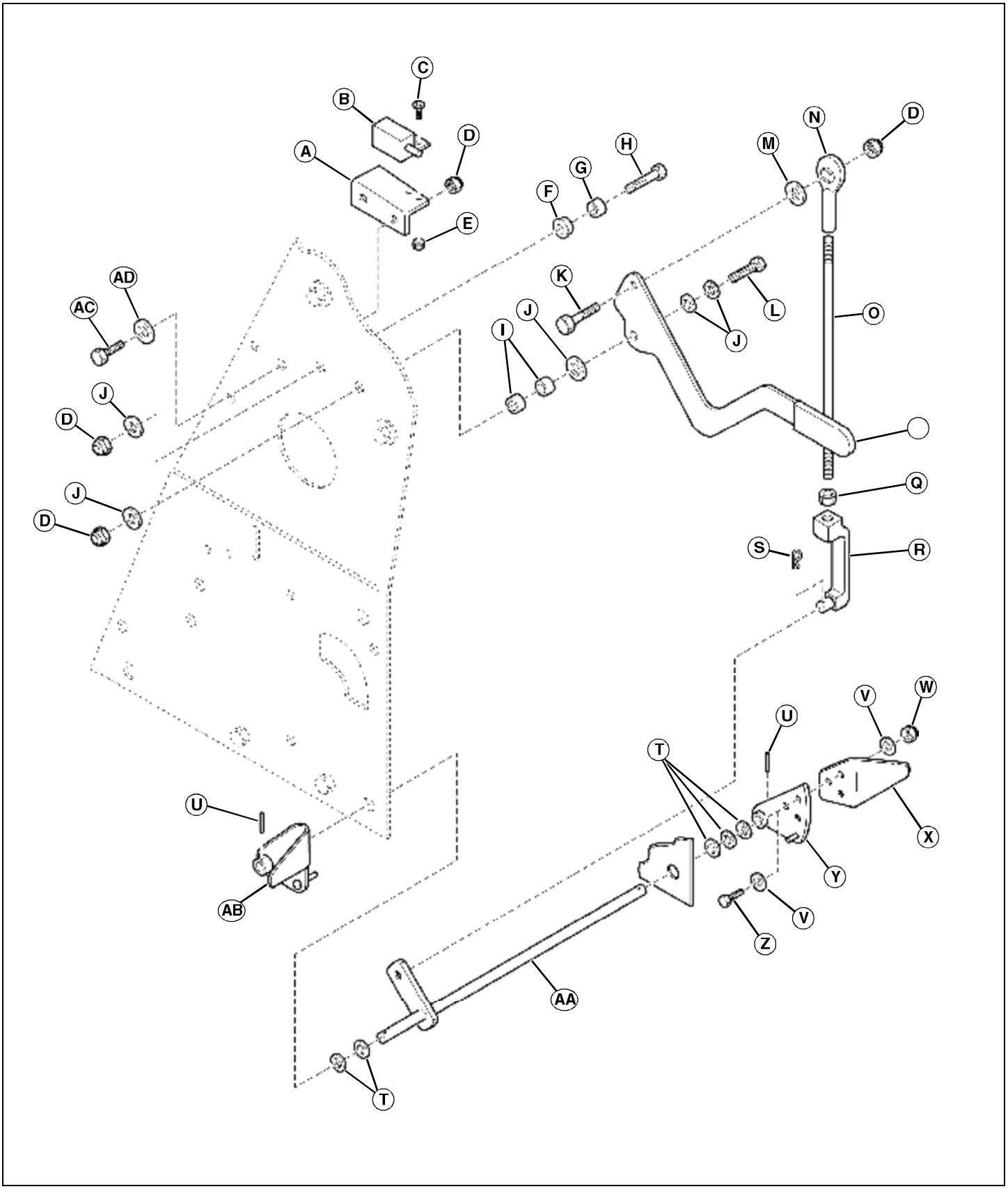
   c. Tighten the capscrews and nuts (G).

8. Check brake operation. Repeat adjustment procedure as needed.

Specifications:

Brake Pawl-to-Tire Gap . . . . . 5 - 6 mm (3/16 - 1/4 in.)

Repair **Park Brake Lever and Linkage**



MX13417

A - Bracket
B - Park Brake Switch
C - Cross-Blade Screw (2 used)
D - Locknut (5 used)
E - Locknut (2 used)
F - Flanged Nut
G - Sleeve
H - Capscrew
I - Spacer (2 used)
J - Special Washer (3 used)
K - Capscrew
L - Capscrew
M - Washer
N - Spherical Bearing
O - Brake Rod
P - Park Brake Lever
Q - Nut
R - Rod End
S - Spring Locking Pin
T - Shim Washers (A/R)
U - Roll Pin (2 used)
V - Flat Washer (6 used)
W - Locknut (3 used)
X - Right Brake Pawl
Y - Right Pivot Plate
Z - Capscrew (3 used)
AA- Pivot Shaft
AB- Left Brake Pawl
AC- Capscrew (2 used)
AD- Washer (2 used)

- Inspect all parts for wear or damage. Replace parts as needed.

NOTE: The use of too many shim washers could cause the pivot shaft to bind.

- Install enough shim washers (T) to eliminate pivot shaft (AA) side-to-side play.
- Apply a thin film of grease to capscrew (L) before installing spacers (I). (See “Grease” on page 22.)
- Adjust park brake. (See “Check and Adjust Park Brake” on page 218.)

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ATTACHMENTS TABLE OF CONTENTS

Specifications

PTO Clutch Specifications

Make	Warner
Model	MSS-125
Type	Electric
Minimum Operating Voltage	12 - 14 volts DC
Clutch Coil Resistance	1.7 - 1.9 ohms
Minimum Current Draw at 12 volts	7 amps
Maximum Rotor-to-Armature Air Gap	3 mm (1/8 in.)

Test and Adjustment Specifications

Drive Belt Tension Spring Length	225 - 235 mm (8-7/8 - 9-1/4 in.)
Side-to-Side Blade Height Difference (Maximum)	3 mm (1/8 in.)
Front-to-Rear Blade Height Difference (Maximum)	3 - 6 mm (1/8 - 1/4 in.)
Blade Height (Measured with Cutting Height Set at 76 mm [3 in.])	73 - 76 mm (2-7/8 - 3-1/8 in.)
Anti-Scalp Wheel Clearance	6 - 13 mm (1/4 - 1/2 in.)
Anti-Scalp Wheel Nut Torque	34 N•m (25 lb-ft)

Repair Specifications

Blade Capscrew Torque	122 N•m (90 lb-ft)
Blade Cutting Edge Width (Maximum)	0.40 mm (0.016 in.)
Spindle Mounting Locknut Torque	37 N•m (27 lb-ft)
Spindle Sheave Flange Nut Torque	255 N•m (188 lb-ft)
PTO Clutch Capscrew Torque	68 N•m (50 lb-ft)
Lower Spindle Seal Installation Depth	2.57 mm (0.10 in.)
Anti-Scalp Wheel Nut Torque	34 N•m (25 lb-ft)

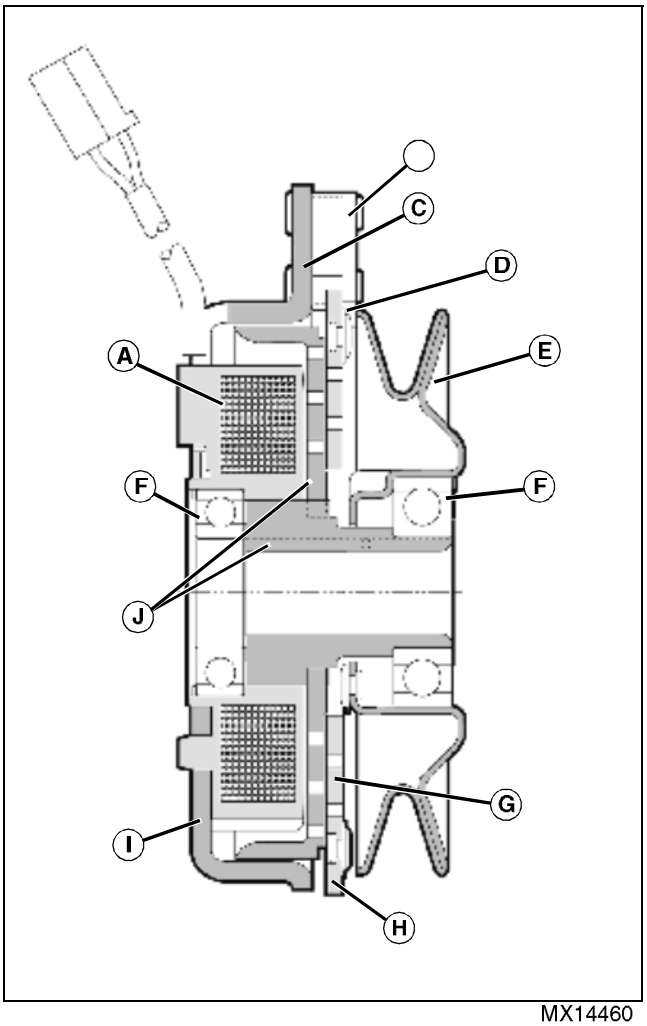
Special or Essential Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Blade Height Gage	TY15272	Used to measure height of cutting blades.

Theory of Operation

PTO Clutch Operation



MX14460

A - Field Coil
B - Brake Poles
C - Field Assembly
D - Armature Springs
E - Drive Pulley
F - Bearings
G - Armature Disk
H - Armature Assembly
I - Field Housing
J - Rotor Assembly

Four main components make up the PTO clutch:

- Rotor Assembly
- Armature Assembly
- Field Assembly
- Brake Poles

The rotor assembly (J) is keyed to the crankshaft and rotates whenever the engine is running. The rotor transmits the torque from the crankshaft to the armature assembly (H).

The armature assembly (H) consists of a disk (G), springs (D) and pulley (E) and turns when the clutch is engaged. The pulley drives the belt to the accessory (i.e., mower deck).

The field assembly (C) is stationary and consists of a housing (I) and coil (A), which generates a magnetic field when energized.

The brake poles (B) are permanent magnets and plates affixed to the outside of the field assembly. They provide braking when the clutch is disengaged.

When electrical power is applied to the field coil, magnetic force flexes the springs, causing the armature to contact the rotating rotor assembly. Friction between the armature disk and rotor causes the armature to turn, transmitting power to the PTO drive pulley.

When electrical power is removed from the field coil, the armature disk is released from the rotor and the permanent magnets of the brake poles contact the armature. The contact creates enough friction to stop the rotating armature, stopping the rotating accessory (i.e., mower deck).

Diagnostics

Mower Drive Checks

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Key switch in STOP position.

System: Mower Deck Drive Checks

(1) Are drive belt and sheaves free of debris?

Yes - Go to step (2).

No - Remove belt shields and remove debris.

(2) Is mower deck lift/adjustment mounting hardware tight?

Yes - Go to step (3).

No - Tighten hardware.

(3) Is mower deck lift/adjustment linkage free of wear or damage?

Yes - Go to step (4).

No - Repair as needed. (See "Mower Deck Lift Linkage" on page 251.)

(4) Is mower deck level side-to-side?

Yes - Go to step (5).

No - Level mower deck. (See "Level Mower Deck" on page 237.)

(5) Is mower deck level front-to-back?

Yes - Go to step (6).

No - Level mower deck. (See "Level Mower Deck" on page 237.)

(6) Is the PTO clutch tight on engine crankshaft, and the key present and free of damage?

Yes - Go to step (7).

No - Tighten PTO clutch capscrew to specifications and/or replace key.

(7) Is the correct drive belt installed?

Yes - Go to step (8).

No - Install correct drive belt. (See "Remove and Install Mower Deck Drive Belt" on page 242.)

(8) Is the drive belt free of wear, stretching and/or damage?

System: Mower Deck Drive Checks

Yes - Go to step (9).

No - Replace drive belt. (See "Remove and Install Mower Deck Drive Belt" on page 242.)

(9) Is the drive belt tension spring properly adjusted?

Yes - Go to step (10).

No - Adjust spring tension. (See "Check and Adjust Mower Deck Drive Belt Tension" on page 237.)

(10) Is the drive belt tension spring free of wear and/or damage?

Yes - Go to step (11).

No - Replace spring.

(11) Is the drive belt tension idler arm pivoting freely?

Yes - Go to step (12).

No - Apply grease to lubrication fitting.

(12) Is the drive belt tension idler arm free of damage?

Yes - Go to step (13).

No - Repair as needed. (See "Disassemble and Assemble Mower Drive Belt Tension Idler Arm" on page 243.)

(13) Are the spindle sheaves tight on spindles?

Yes - Go to step (14).

No - Tighten spindle nut to specifications.

(14) Are the spindle sheaves free of damage?

Yes - Go to step (15).

No - Replace spindle sheave(s) as needed. (See "Disassemble and Inspect Spindle" on page 246.)

(15) Is the drive belt properly installed on the spindle sheaves?

Yes - Go to step (16).

No - Install drive belt properly. (See "Remove and Install Mower Deck Drive Belt" on page 242.)

(16) Is the spindle properly lubricated?

Yes - Go to step (17).

No - Fill with grease.

(17) Is the spindle mounting hardware tight?

Yes - Go to step (18).

No - Tighten mounting hardware.

System: Mower Deck Drive Checks

(18) Are spindle bearings free of wear and/or damage?

Yes - Go to step (19).

No - Repair or replace spindles as needed. (See "Disassemble and Inspect Spindle" on page 246.)

(19) Are blades tight on the spindles?

Yes - Go to step (20).

No - Tighten blade capscrews to specifications.

(20) Are blades free of wear and/or damage, not bent?

Yes - Go to step (21).

No - Replace blade(s). (See "Remove and Install Mower Blades" on page 245.)

(21) Is the idler sheave mounting nut tight?

Yes - Go to step (22).

No - Tighten mounting nut.

(22) Does the idler sheave rotate freely?

Yes - Go to step (23).

No - Replace idler sheave. (See "Remove and Install Idler Sheave" on page 244.)

(23) Is the idler sheave free of damage?

Yes - Go to step (24).

No - Replace idler sheave. (See "Remove and Install Idler Sheave" on page 244.)

(24) Are blades properly sharpened and balanced?

Yes - Go to step (25).

No - Sharpen and balance blades. (See "Sharpen and Balance Mower Blades" on page 245.)

(25) Are the caster wheel tires inflated properly?

Yes - Go to step (26).

No - Inflate tires to specifications. (See "Tire Pressure Adjustment" on page 258.)

(26) Are the caster wheel yoke assemblies properly lubricated?

Yes - Go to step (27).

No - Apply grease to lubrication fittings.

(27) Do the caster wheel yoke assemblies rotate freely, and are the bushings free of damage or excessive wear?

System: Mower Deck Drive Checks

No - Replace bushings as needed. (See "Remove and Install Caster Wheel Yoke Assembly" on page 260.)

Specifications:

Drive Belt Tension Spring Length 225 - 235 mm (8-7/8 - 9-1/4 in.)

PTO Clutch Capscrew Torque . . . . . 68 N•m (50 lb-ft)

Spindle Sheave Flanged Nut Torque 255 N•m (188 lb-ft)

Mower Blade Capscrew Torque . . . . . 122 N•m (90 lb-ft)

Caster Wheel Tire Pressure . 110 - 138 kPa (16 - 20 psi)

Mower Drive Checks (Engine Running)

Test Conditions:

- Machine parked on a clean, level surface, away from people and objects.
- Engine running at fast idle.
- Engine at operating temperature.
- PTO engaged.

System: Mower Drive Checks (Engine Running)

(1) Is engine running at correct rpm?

Yes - Go to step (2).

No - Check engine operation. (See "Diagnostics" on page 40.)

(2) Is the PTO clutch circuit functioning properly?

Yes - Go to step (3).

No - Check PTO clutch circuit. (See "PTO Clutch Circuit Diagnosis" on page 138.)

No - Check PTO clutch. (See "PTO Clutch Diagnostics" on page 233.)

(3) Is the mower deck operating smoothly without any unusual noises, and does it stop quickly when shut down?

No - Slowly reduce the engine rpm, and listen for problem area. Disengage PTO and stop engine. Repair or replace faulty or damaged components.

Mower Deck Will Not Run

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Key switch in STOP position.

Symptom: Mower Deck Will Not Run

(1) Is the PTO circuit operating properly?

Yes - Go to step (2).

No - Test PTO clutch circuit. (See "PTO Clutch Circuit Diagnosis" on page 138.) Go to step (2) if the problem continues.

(2) Is the PTO clutch tight on the engine crankshaft, and is the key present and free of damage?

Yes - Go to step (3).

No - Tighten PTO clutch capscrew to specifications and/or replace key. (See "Remove and Install PTO Clutch" on page 162.) Go to step (3) if the problem continues.

(3) Is the PTO clutch operating properly?

Yes - Go to step (4).

No - Check PTO clutch. (See "PTO Clutch Diagnostics" on page 233.) Go to step (4) if the problem continues.

(4) Is the drive belt tension spring properly adjusted?

Yes - Go to step (5).

No - Adjust spring tension. (See "Check and Adjust Mower Deck Drive Belt Tension" on page 237.) Go to step (5) if the problem continues.

(5) Is the drive belt tension spring free of damage and/or wear?

Yes - Go to step (6).

No - Replace spring. Go to step (6) if the problem continues.

(6) Is the drive belt tension idler arm pivoting freely?

Yes - Go to step (7).

No - Apply grease to lubrication fitting. Go to step (7) if the problem continues.

(7) Is the tension idler arm moving freely, not binding or damaged?

Symptom: Mower Deck Will Not Run

Yes - Go to step (8).

No - Repair as needed. (See "Disassemble and Assemble Mower Drive Belt Tension Idler Arm" on page 243.) Go to step (8) if the problem continues.

(8) Is the correct drive belt installed?

Yes - Go to step (9).

No - Install correct drive belt. (See "Remove and Install Mower Deck Drive Belt" on page 242.) Go to step (9) if the problem continues.

(9) Is the drive belt free of wear and/or damage, not stretched?

No - Replace drive belt. (See "Remove and Install Mower Deck Drive Belt" on page 242.)

Specifications:

PTO Clutch Capscrew Torque . . . . . 68 N•m (50 lb-ft)

Drive Belt Tension Spring Length 225 - 235 mm (8-7/8 - 9-1/4 in.)

Mower Deck Vibrates

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Key switch in STOP position.

Symptom: Mower Deck Vibrates

(1) Is the deck free of debris and obstructions?

Yes - Go to step (2).

No - Remove debris and/or obstructions from deck. Go to step (2) if the problem continues.

(2) Is the PTO clutch circuit operating properly?

Yes - Go to step (3).

No - Check PTO clutch circuit. (See "PTO Clutch Circuit Diagnosis" on page 138.) Go to step (3) if the problem continues.

No - Check PTO clutch. (See "PTO Clutch Diagnostics" on page 233.) Go to step (3) if the problem continues.

(3) Is the correct belt installed?

Yes - Go to step (4).

Symptom: Mower Deck Vibrates

No - Install correct drive belt. (See "Remove and Install Mower Deck Drive Belt" on page 242.) Go to step (4) if the problem continues.

(4) Is the drive belt free of damage, not stretched, worn or broken?

Yes - Go to step (5).

No - Replace drive belt. (See "Remove and Install Mower Deck Drive Belt" on page 242.) Go to step (5) if the problem continues.

(5) Is the drive belt tension spring properly adjusted?

Yes - Go to step (6).

No - Adjust spring tension. (See "Check and Adjust Mower Deck Drive Belt Tension" on page 237.) Go to step (6) if the problem continues.

(6) Is the drive belt tension spring free of damage, not worn or weak?

Yes - Go to step (7).

No - Replace spring. Go to step (7) if the problem continues.

(7) Is the idler sheave mounting hardware tight?

Yes - Go to step (8).

No - Tighten mounting hardware. Go to step (8) if the problem continues.

(8) Does the idler sheave rotate freely?

Yes - Go to step (9).

No - Replace idler sheave. (See "Remove and Install Idler Sheave" on page 244.) Go to step (9) if the problem continues.

(9) Does the idler sheave rotate smoothly, not damaged or bent?

Yes - Go to step (10).

No - Replace idler sheave. (See "Remove and Install Idler Sheave" on page 244.) Go to step (10) if the problem continues.

(10) Are the blades free of damage, not worn, bent or loose?

Yes - Go to step (11).

No - Replace blades and tighten to specifications. (See "Remove and Install Mower Blades" on page 245.) Go to step (11) if the problem continues.

(11) Are blades properly sharpened and balanced?

Symptom: Mower Deck Vibrates

Yes - Go to step (12).

No - Sharpen and balance blades. (See "Sharpen and Balance Mower Blades" on page 245.) Go to step (12) if the problem continues.

(12) Are spindle sheaves free of debris?

Yes - Go to step (13).

No - Remove shields and remove debris. Go to step (13) if the problem continues.

(13) Are the spindle sheaves free of damage?

Yes - Go to step (14).

No - Replace spindle sheave(s) as needed. (See "Disassemble and Inspect Spindle" on page 246.) Go to step (14) if the problem continues.

(14) Are spindle assemblies and bearings free from excessive wear or damage?

Yes - Go to step (15).

No - Repair or replace spindles as needed. (See "Disassemble and Inspect Spindle" on page 246.) Go to step (15) if the problem continues.

(15) Is the spindle mounting hardware tight?

No - Tighten mounting hardware.

Specifications:

Drive Belt Tension Spring Length 225 - 235 mm (8-7/8 - 9-1/4 in.)

Mower Cuts Unevenly

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Key switch in STOP position.

Symptom: Mower Cuts Unevenly

(1) Are all tires properly inflated?

Yes - Go to step (2).

No - Inflate tires to correct pressure. (See "Tire Pressure Adjustment" on page 258.) Go to step (2) if the problem continues.

(2) Are blades properly sharpened and balanced?

Yes - Go to step (3).

No - Sharpen and balance blades. (See "Sharpen and Balance Mower Blades" on page 245.) Go to step (3) if the problem continues.

(3) Is mower deck level side-to-side?

Yes - Go to step (4).

No - Level mower deck. (See "Level Mower Deck" on page 237.) Go to step (4) if the problem continues.

(4) Is mower deck level front-to-rear?

Yes - Go to step (5).

No - Level mower deck. (See "Level Mower Deck" on page 237.) Go to step (5) if the problem continues.

(5) Is lift/adjustment linkage and mounting hardware tight and free of excessive wear?

Yes - Go to step (6).

No - Repair mower deck lift linkage. (See "Mower Deck Lift Linkage" on page 251.) Go to step (6) if the problem continues.

(6) Are lift chains installed properly?

Yes - Go to step (7).

No - Reposition lift chains. Go to step (7) if the problem continues.

(7) Are spindle assemblies and bearings free from excessive wear or damage?

Yes - Go to step (8).

No - Repair or replace spindles as needed. (See "Disassemble and Inspect Spindle" on page 246.) Go to step (8) if the problem continues.

Symptom: Mower Cuts Unevenly

(8) Are all anti-scalp wheels installed in the same hole location?

No - Adjust location of anti-scalp wheels. (See "Check and Adjust Anti-Scalp Wheel Clearance" on page 240.)

Excessive Noise

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Key switch in STOP position.

Symptom: Excessive Noise

(1) Is the PTO circuit operating properly?

Yes - Go to step (2).

No - Test PTO circuit. (See "PTO Clutch Circuit Diagnosis" on page 138.) Go to step (2) if the problem continues.

No - Check PTO clutch. (See "PTO Clutch Diagnostics" on page 233.) Go to step (2) if the problem continues.

(2) Is the idler sheave mounting hardware tight?

Yes - Go to step (3).

No - Tighten mounting hardware. Go to step (3) if the problem continues.

(3) Does the idler sheave rotate freely?

Yes - Go to step (4).

No - Replace idler sheave. (See "Remove and Install Idler Sheave" on page 244.) Go to step (4) if the problem continues.

(4) Is the idler sheave free of damage?

Yes - Go to step (5).

No - Replace idler sheave. (See "Remove and Install Idler Sheave" on page 244.) Go to step (5) if the problem continues.

(5) Are spindle assemblies and bearings free from excessive wear or damage?

Yes - Go to step (6).

No - Repair or replace spindles as needed. (See "Disassemble and Inspect Spindle" on page 246.) Go to step (6) if the problem continues.

Symptom: Excessive Noise

(6) Are the blades free of damage, not worn, bent or loose?

Yes - Go to step (7).

No - Replace blades and tighten to specifications. (See "Remove and Install Mower Blades" on page 245.) Go to step (7) if the problem continues.

(7) Are blades properly sharpened and balanced?

No - Sharpen and balance blades. (See "Sharpen and Balance Mower Blades" on page 245.)

Specifications:

Mower Blade Capscrew Torque. . . . . 122 N•m (90 lb-ft)

PTO Clutch Diagnostics

Symptom: Clutch Will Not Engage

(1) Is 20-amp fuse (F2) in good condition, not blown?

Yes - Go to step (2).

No - Clutch coil resistance could be low. Go to step (2) if the problem continues.

No - Battery may be defective. Check battery condition. (See "Test Battery" on page 146.) Go to step (2) if the problem continues.

No - Charging system may be faulty. (See "Charging Circuit Diagnosis" on page 135.) Go to step (2) if the problem continues.

No - PTO clutch circuit may be faulty. See "PTO Clutch Circuit Diagnosis" on page 138.) Go to step (2) if the problem continues.

(2) Measure voltage at orange wire (No. 800 [W1]) at PTO clutch (Y1). Does voltage read at least 12 volts?

Yes - Go to step (3).

No - Battery may be defective. Check battery condition. (See "Test Battery" on page 146.) Go to step (3) if the problem continues.

No - Charging system may be faulty. (See "Charging Circuit Diagnosis" on page 135.) Go to step (3) if the problem continues.

No - PTO clutch circuit may be faulty. (See "PTO Clutch Circuit Diagnosis" on page 138.) Go to step (3) if the problem continues.

(3) Measure resistance of PTO clutch coil. Is resistance within specifications?

Symptom: Clutch Will Not Engage

Yes - Go to step (4).

No - Damaged coil. Replace PTO clutch. (See "Remove and Install PTO Clutch" on page 162.)

(4) Measure current in orange wire (No. 800 [W1]). Does current draw meet minimum specifications?

No - Clutch wires may be broken. Repair as needed.

No - Clutch-to-harness connection may be faulty. Repair or replace connections/connectors if damaged.

No - Replace PTO clutch if the problem continues. (See "Remove and Install PTO Clutch" on page 162.)

Specifications:

Clutch Coil Resistance. . . . . .1.7 - 1.9 ohms

Minimum Clutch Coil Current Draw at 12 volts DC . . . 7 amps

Symptom: Clutch Brake Will Not Engage

(1) Are friction surfaces free of engine or hydraulic oil contamination?

Yes - Go to step (2).

No - If engine is leaking oil, repair engine oil leaks. Clean PTO clutch. Go to step (2) if the problem continues.

No - If hydraulic system is leaking oil, repair oil leaks. Clean PTO clutch. Go to step (2) if the problem continues.

(2) Are armature/brake poles in good condition, not worn out?

No - Replace PTO clutch. (See "Remove and Install PTO Clutch" on page 162.)

Clutch Slips

Symptom: Clutch Slips

(1) Measure voltage at orange wire (No. 800 [W1]) at PTO clutch (Y2). Does voltage read at least 12 volts?

Yes - Go to step (2).

No - Battery may be defective. Check battery condition. (See "Test Battery" on page 146.) Go to step (2) if the problem continues.

No - Charging system may be faulty. (See "Charging Circuit Diagnosis" on page 135.) Go to step (2) if the problem continues.

No - PTO clutch circuit may be faulty. See "PTO Clutch Circuit Diagnosis" on page 138.) Go to step (2) if the problem continues.

(2) Measure current in orange wire (No. 800 [W1]). Does current draw meet minimum specifications?

Yes - Go to step (3).

No - Clutch wires may be broken. Repair as needed. Go to step (3) if the problem continues.

No - Clutch-to-harness connection may be faulty. Repair or replace connections/connectors if damaged. Go to step (3) if the problem continues.

No - Replace PTO clutch. (See "Remove and Install PTO Clutch" on page 162.) Go to step (3) if the problem continues.

Symptom: Clutch Slips

(3) Are deck, spindles or other moving parts free of debris?

Yes - Go to step (4).

No - Clutch is overloaded. Remove debris from deck, spindles and/or other moving parts. Go to step (4) if the problem continues.

(4) Are friction surfaces free of engine or hydraulic oil contamination?

No - If engine is leaking oil, repair engine oil leaks. Clean PTO clutch.

No - If hydraulic system is leaking oil, repair oil leaks. Clean PTO clutch.

No - Replace PTO clutch if the problem continues. (See "Remove and Install PTO Clutch" on page 162.)

Specifications:

Minimum Clutch Coil Current Draw at 12 volts DC . . . .7 amps

Noisy Clutch/Vibration

CAUTION: Avoid injury! A clutch with broken rivets or springs may separate from the shaft and cause injury.

Symptom: Noisy Clutch/Vibration

(1) Is the clutch bearing in good condition, free of wear and/or damage?

Yes - Go to step (2).

No - Damage/wear may have been caused by loose mounting screws. Replace PTO clutch. (See "Remove and Install PTO Clutch" on page 162.) Go to step (2) if the problem continues.

No - Damage/wear may have been caused by restricted field assembly movement. Replace PTO clutch. (See "Remove and Install PTO Clutch" on page 162.) Go to step (2) if the problem continues.

(2) Is PTO clutch adapter plate secure against anti-rotation pins, no excessive play or rattling?

Yes - Go to step (3).

No - Replace mower drive belt guard. Go to step (3) if the problem continues.

(3) Is PTO clutch fastened securely on the engine output shaft?

Yes - Go to step (4).

Symptom: Noisy Clutch/Vibration

No - Loose mounting capscrew. Tighten capscrew to specifications. Go to step (4) if the problem continues.

No - Mounting capscrew may be too long and bottoms before securing the clutch. Replace capscrew with correct capscrew. (See Parts Catalog.) Go to step (4) if the problem continues.

(4) Is PTO clutch squarely mounted on engine output shaft?

Yes - Go to step (5).

No - Mounting hardware (capscrew, washer, spacer and/or key) is damaged. Replace damaged hardware. (See "Remove and Install PTO Clutch" on page 162.) Go to step (5) if the problem continues.

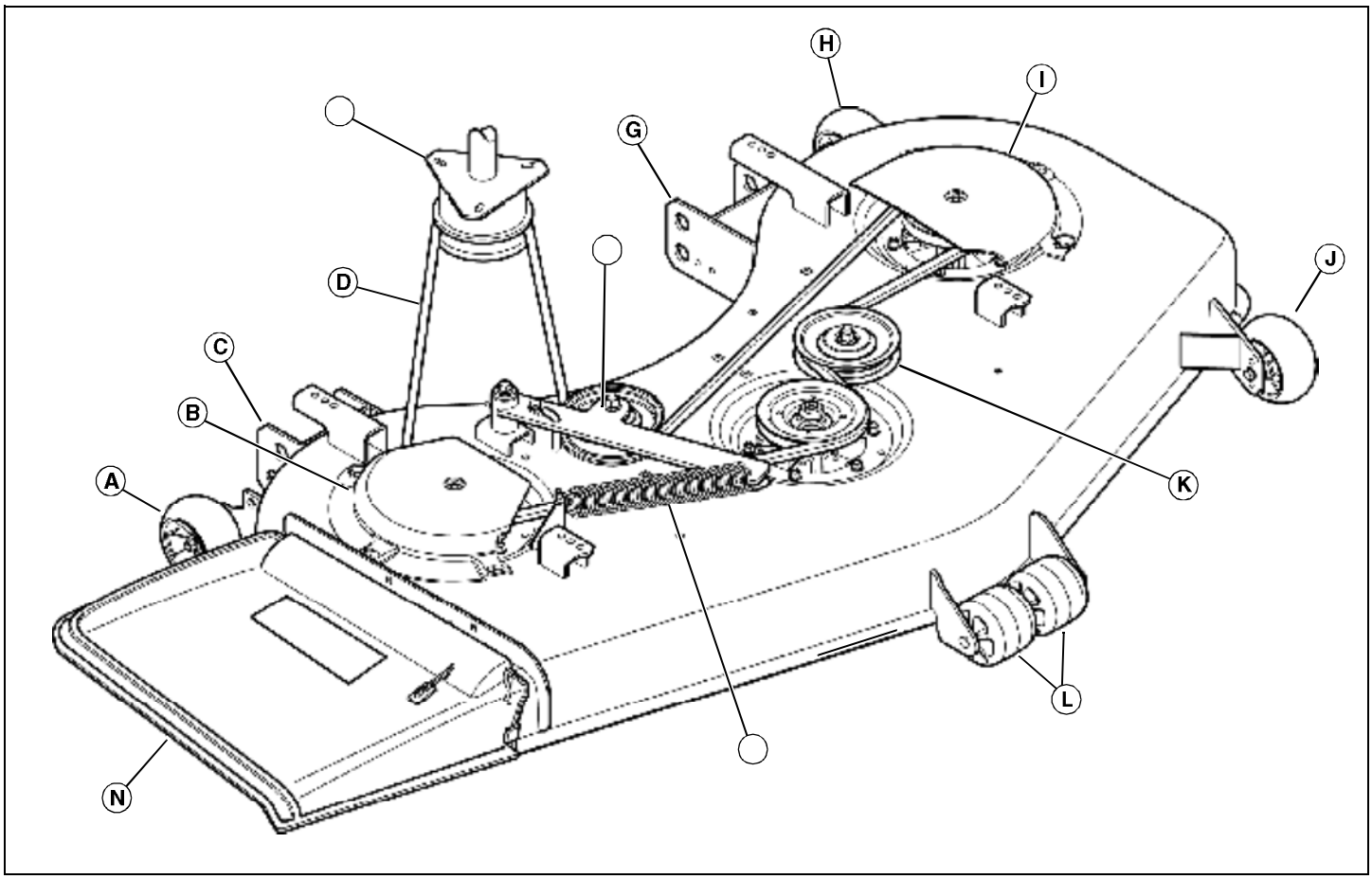
(5) Is PTO clutch spring in good condition, not damaged or broken?

No - Replace PTO clutch. (See "Remove and Install PTO Clutch" on page 162.)

Specifications:

PTO Clutch Capscrew Torque . . . . . 68 N•m (50 lb-ft)

Component Location — Mower Deck



MX13399

A - Anti-Scalp Wheel (Right Rear)
B - Belt Shield (Right)
C - Right Push Arm Attaching Bracket
D - Mower Deck Drive Belt
E - PTO Clutch
F - Tension Idler Arm
G - Left Push Arm Attaching Bracket
H - Anti-Scalp Wheel (Left Rear)
I - Belt Shield (Left)
J - Anti-Scalp Wheel (Left Front)
K - Idler Sheave
L - Roller (2 used)
M - Tension Spring
N - Discharge Chute

Tests and Adjustments

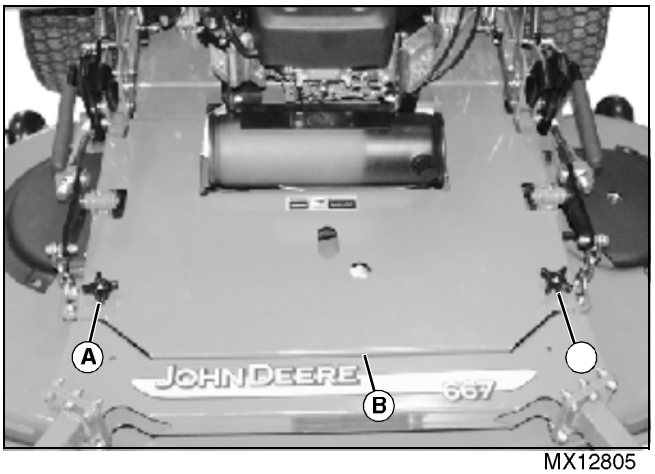
Check and Adjust Mower Deck Drive Belt Tension

Reason:

To make sure that the mower deck drive belt is properly tensioned.

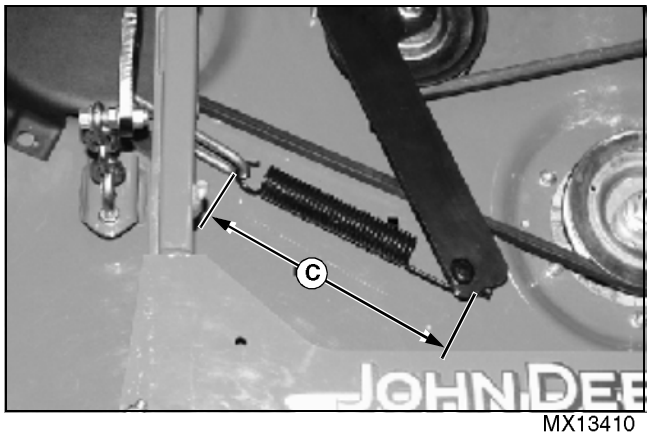
Check Procedure:

1. Park the machine safely.
2. Set mower deck to 76 mm (3 in.) cutting height position.



MX12805

3. Remove two knobs (A).
4. Remove mower deck shield (B).



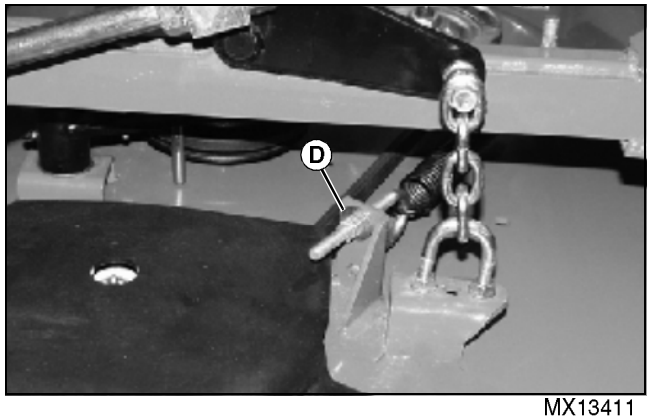
MX13410

5. Measure the length of the tension spring from inside of hook to inside of hook (C). The spring length should meet specifications.
6. If the spring does not meet specifications, proceed to adjustment procedure.

Specifications:

Tension Spring Length. 225 - 235 mm (8-7/8 - 9-1/4 in.)

Adjustment Procedure:



MX13411

1. Adjust spring tension as needed, by loosening or tightening the spring anchor nut (D).
   - To add tension: Turn anchor nut clockwise.
   - To release tension: Turn anchor nut counterclockwise.
2. Repeat check procedure to verify adjustment.

Level Mower Deck

Reason:

To make sure the mower deck is level.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Mower Deck Leveling Gage	AM130907	Used to check the mower deck cutting height.

Procedure:

CAUTION: Avoid injury! Rotating blades are dangerous. Before adjusting or servicing mower:

- **Disconnect spark plug wire(s) to prevent engine from starting accidentally.**
- **Always wear gloves when handling mower blades or working near blades.**

NOTE: Mower deck anti-scalp wheels should not contact the ground when leveling the deck.

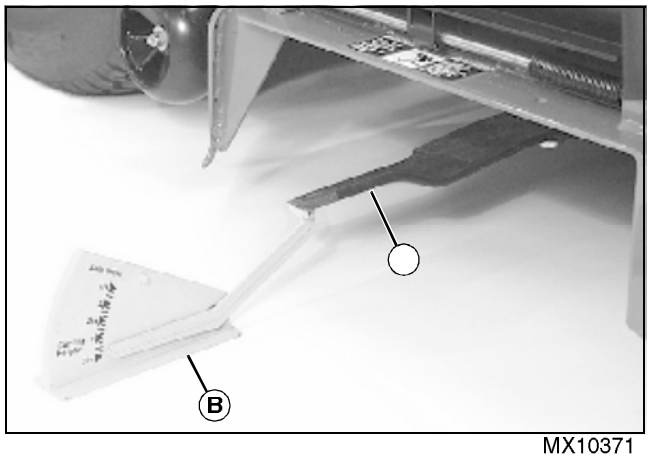
1. Park the machine safely.
2. Stop engine.
3. Lock park brake.
4. Inflate tires to the correct pressure.

5. Inspect mower blades for:
   - Sharpness.
   - Damage.
   - Bent blades.

Check Mower Deck Level (Side-to-Side)

NOTE: Mower deck anti-scalp wheels should not contact the ground.

1. Set mower deck to 76 mm (3 in.) cutting height position.



MX10371

Picture Note: Discharge chute raised for photo clarity.

2. Position the right mower blade (A) (discharge side) perpendicular to the direction of travel.

NOTE: Use a short ruler or leveling gage (B) to check the mower blade level.

3. Measure from the outside blade tip to the ground. Record measurement.

4. Position the left mower blade perpendicular to the direction of travel.

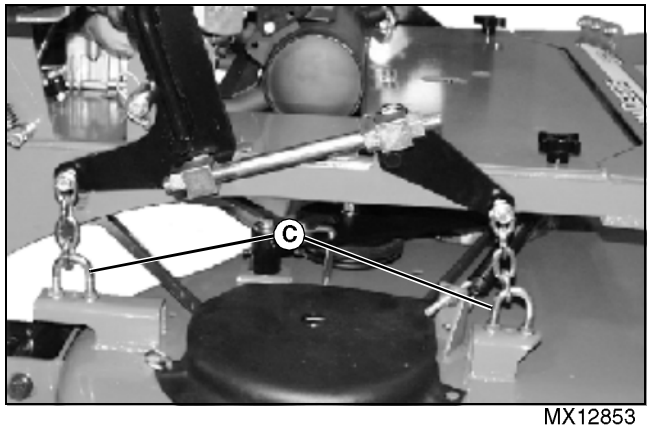
5. Measure from the outside blade tip to the ground. Record measurement.

6. Subtract the lesser measurement from the greater measurement to determine the height difference (side-to-side):
   - If the height difference is within specifications, check mower deck level (front-to-rear). (See "Check Mower Deck Level (Front-to-Rear)" on page 239.)
   - If the difference between both measurements is greater than specifications, adjust the mower deck. (See "Adjust Mower Deck Level (Side-to-Side)" on page 238.)

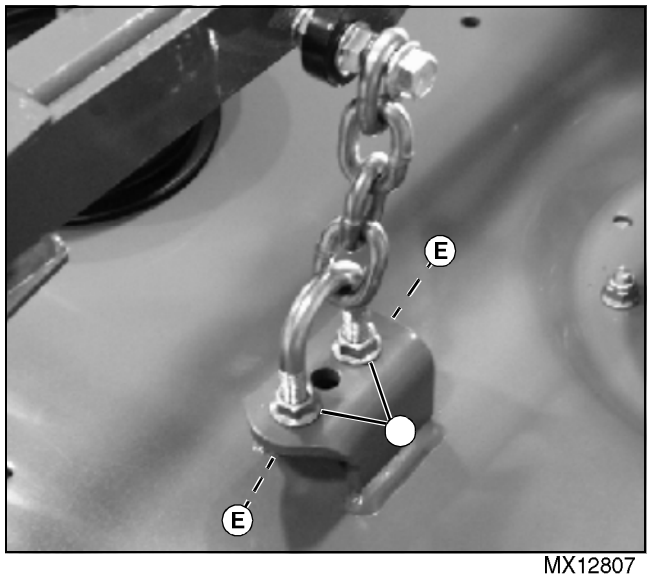
Specifications:

Maximum Difference in Blade Tip Height 3 mm (1/8 in.)

Adjust Mower Deck Level (Side-to-Side)



MX12853



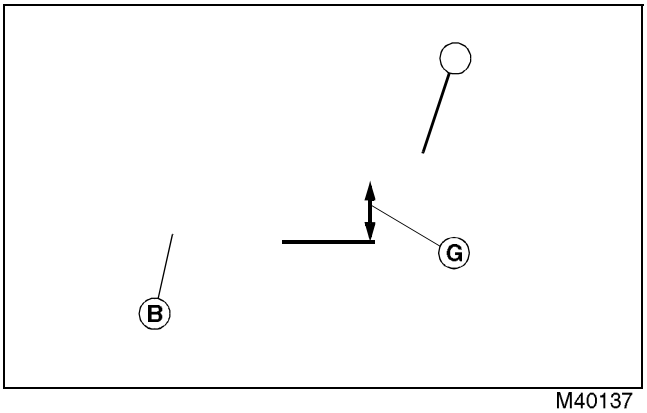
MX12807

1. Adjust the four U-bolts (C) (two on each side of the mower deck) until the deck level is within specifications.
   - Loosen jam nuts (D).
   - Adjust the nuts (E) on each U-bolt until the deck is level side-to-side.
   - Tighten jam nuts (D).

2. Repeat check procedure to verify adjustment. Repeat the adjustment as needed.

Check Mower Deck Level (Front-to-Rear)

1. Set mower deck to 76 mm (3 in.) cutting height position.



M40137

2. Position the right mower blade (F) (discharge side) parallel to the direction of travel.

NOTE: Use a short ruler or leveling gage (B) to check the mower blade level.

3. Measure from the front blade tip to the ground (G). Record measurement.

4. Turn blade 180° and measure from the rear blade tip to the ground. Record measurement. The height of the rear blade tip should be higher than the front blade tip by the amount specified.

5. Adjust the mower deck level (front-to-rear) if the difference in the front-to-rear blade height is not within specifications. (See “Adjust Mower Deck Level (Front-to-Rear)” on page 239.)

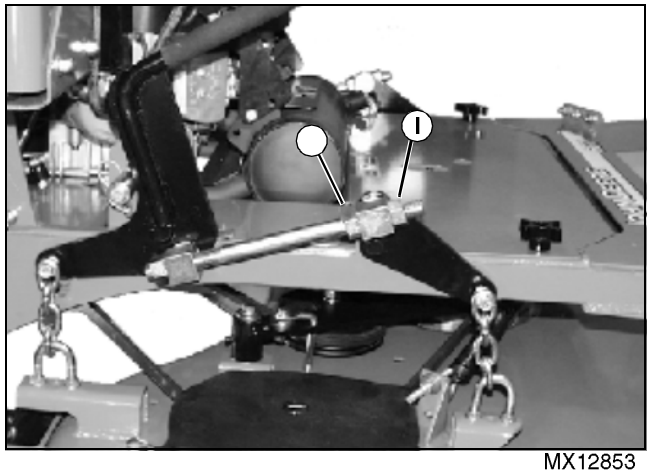
Specifications:

Front-to-Rear Blade Height Difference 3 - 6 mm (1/8 - 1/4 in.)

Adjust Mower Deck Level (Front-to-Rear)

IMPORTANT: Avoid damage! Adjust the right and left deck lift rods equally.

NOTE: Adjust the side-to-side mower deck level before adjusting the front-to-rear level.



MX12853

1. Loosen jam nut (H).
2. Adjust front-to-rear mower deck level:
   - Turn nut (I) clockwise to raise the front of the mower deck.
   - Turn nut (I) counterclockwise to lower the front of the mower deck.
3. Tighten jam nut (H).
4. Repeat check procedure to verify adjustment. Repeat the adjustment as needed.

Check and Adjust Cutting Height

Reason:

To adjust the mower deck cutting height to match the cut height positions on the lift levers.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Mower Deck Leveling Gage	AM130907	Used to check the height of cutting blades.

Check Procedure:

CAUTION: Avoid injury! Rotating blades are dangerous. Before adjusting or servicing mower:

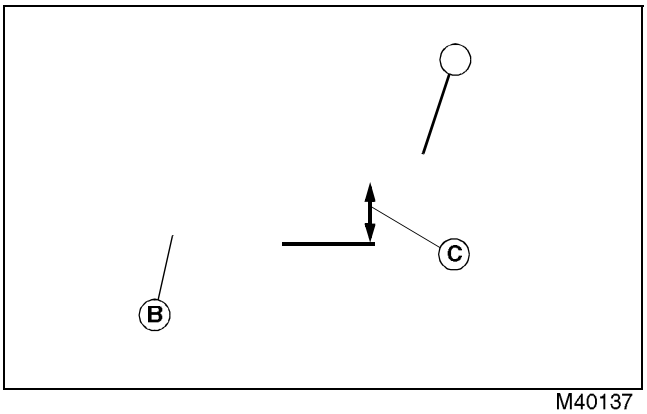
- **Disconnect spark plug wire(s) to prevent engine from starting accidentally.**
- **Always wear gloves when handling mower blades or working near blades.**

1. Park the machine safely.
2. Stop engine.

3. Lock park brake.

4. Inflate tires to the correct pressure. (See “Tire Pressure Adjustment” on page 258.)

5. Set mower deck to 76 mm (3 in.) cutting height position.



M40137

6. Position the right mower blade (A) (discharge side) parallel to the direction of travel.

NOTE: Use a short ruler or leveling gage (B) to check the mower blade level.

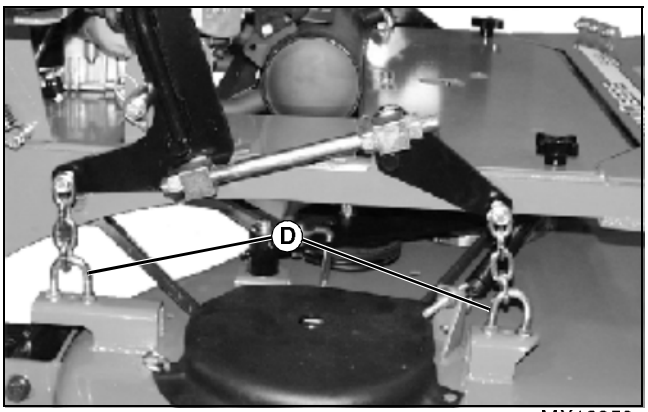
7. Measure from the front blade tip to the ground (C). If the blade height is not within specifications, proceed to adjustment procedure.

Specifications:

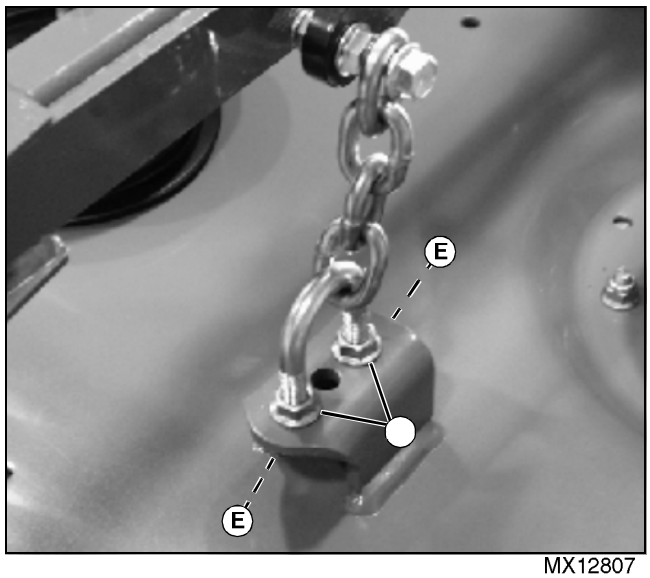
Blade Height . . . . . 73 - 79 mm (2-7/8 - 3-1/8 in.)

Adjustment Procedure

NOTE: Adjust all four U-bolts equally. All four chains should be tight. Tighten the U-bolts of the loose chain to correct.



MX12853



MX12807

1. Adjust the four U-bolts (D) (two on each side of the mower deck) until the blade height is within specifications.

- Loosen jam nuts (D).
- Adjust the nuts (E) on each U-bolt until the blade height is within specifications.
- Tighten jam nuts (D).

2. Repeat check procedure to verify adjustment. Repeat the adjustment as needed.

Check and Adjust Anti-Scalp Wheel Clearance

CAUTION: Avoid injury! Rotating blades are dangerous. Before adjusting or servicing mower:

- **Disconnect spark plug wire(s) to prevent engine from starting accidentally.**
- **Always wear gloves when handling mower blades or working near blades.**

IMPORTANT: Avoid damage! The mower deck can be damaged if mower wheels are adjusted wrong:

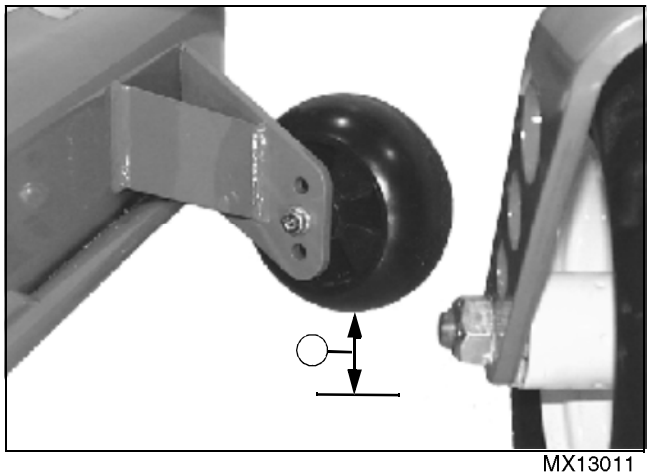
- **Wheels must not ride on ground, supporting mower weight.**
- **Check wheel adjustment each time cutting height is changed.**

NOTE: The flattest cut can be achieved by having all three anti-scalp wheels adjusted off the ground.

Check Procedure:

1. Park the machine safely.
2. Stop engine.
3. Lock park brake.
4. Inflate tires to the correct pressure. (See "Tire Pressure Adjustment" on page 258.)
5. Adjust mower deck to desired cutting height.

NOTE: The bottom of the wheels should be approximately 6 - 13 mm (1/4 - 1/2 in.) above mowing surface.



MX13011

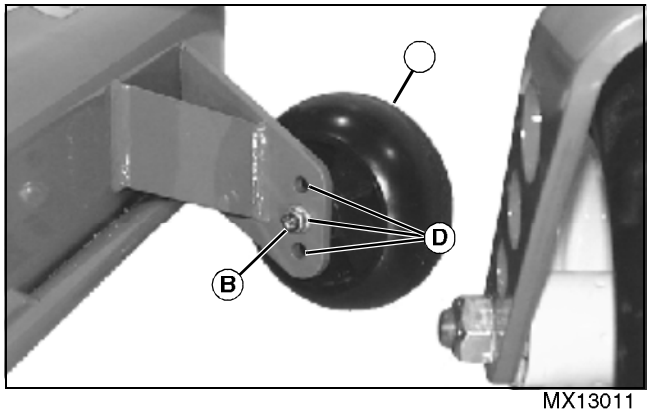
6. Check anti-scalp wheel height (A). The clearance between the bottom of anti-scalp wheel and ground should meet specifications.

If clearance does not meet specifications, proceed to adjustment procedure.

Specifications:

Anti-Scalp Wheel Clearance . . 6 - 13 mm (1/4 - 1/2 in.)

Adjustment Procedure:



MX13011

1. Remove capscrew, washer and locknut (B).
2. Remove anti-scalp wheel (C).
3. Install the wheel (C), capscrew, washer and locknut (B) in the appropriate hole (D) to obtain the correct ground clearance. Tighten nuts to specifications.
4. Repeat the adjustment procedure for all remaining anti-scalp wheels.
5. Repeat check procedure to verify adjustment.

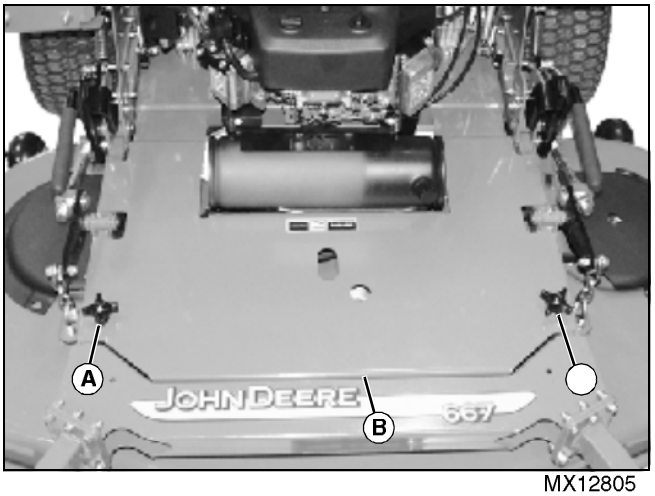
Specifications:

Anti-Scalp Wheel Nut Torque . . . . . 34 N•m (25 lb-ft)

Repair

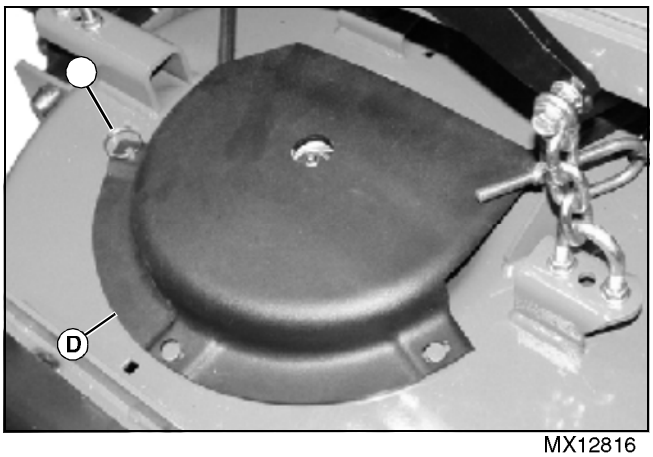
Remove and Install Mower Deck Drive Belt

1. Park the machine safely.
2. Raise mower deck to the transport position.



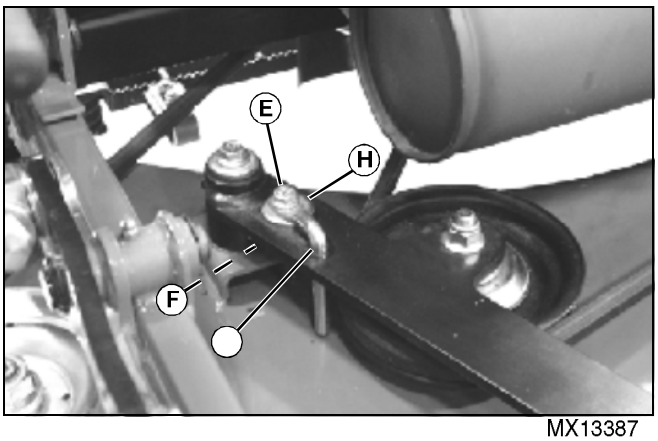
MX12805

3. Remove two knobs (A).
4. Remove mower deck shield (B).



MX12816

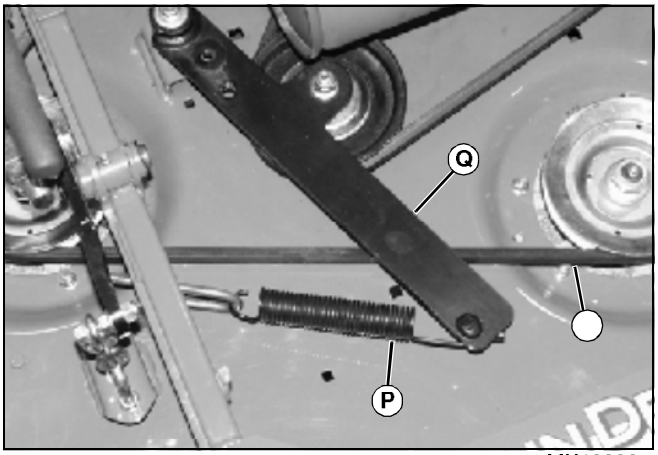
5. Remove retaining ring (C) and belt shield (D) from both sides of the mower deck.



MX13387

6. Remove capscrew (E), nut (F), belt guide (G) and special washer (H).

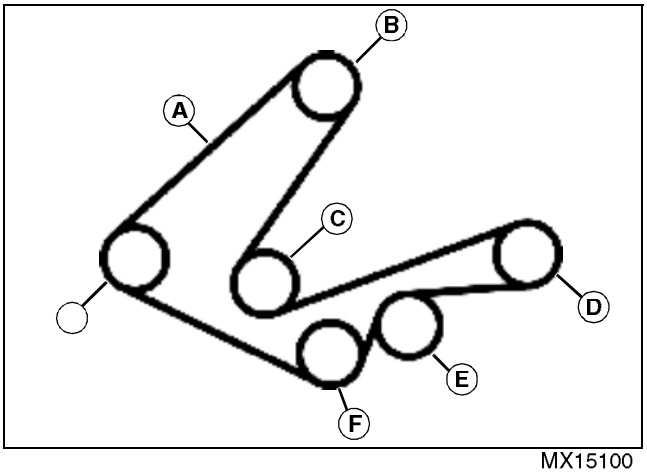
CAUTION: Avoid injury! Tensioning spring is under high tension. Wear gloves and use a firm grip when stretching spring.



MX13388

7. Disconnect tension spring (P) from tension arm (Q).
8. Remove drive belt (R).
9. Inspect belt for signs of stretching, glazing, wear or cracking. Replace belt as needed.

Installation is done in the reverse order of removal.



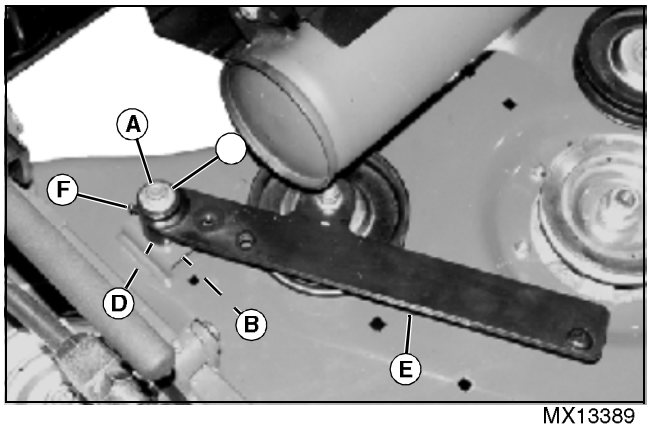
MX15100

A - Drive Belt
B - PTO Clutch Sheave
C - Tension Idler Sheave
D - Left Spindle Sheave
E - Idler Sheave
F - Center Spindle Sheave
G - Right Spindle Sheave

- Route drive belt (A) as shown.
- Check belt tension. Adjust as needed. (See "Check and Adjust Mower Deck Drive Belt Tension" on page 237.)

Remove and Install Mower Deck Drive Belt Tension Idler Arm

1. Remove mower deck drive belt. (See "Remove and Install Mower Deck Drive Belt" on page 242.)



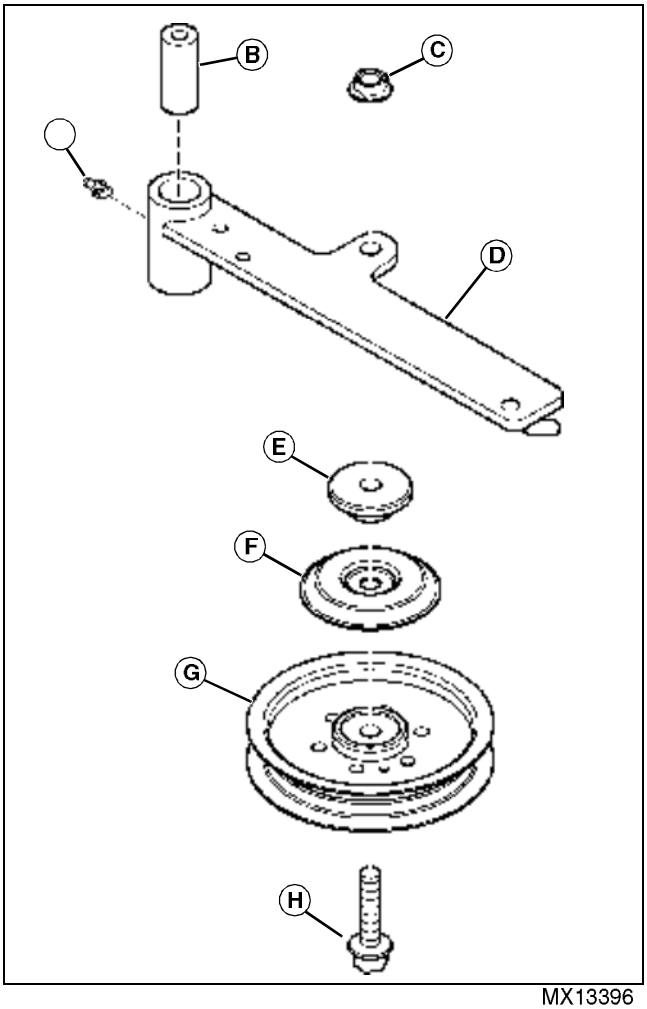
MX13389

2. Remove capscrew (A), nut (B), special washer (C) and flat washer (shim) (D).
3. Remove tension idler arm assembly (E).

Installation is done in the reverse order of removal.

- Apply grease to lubrication fitting (F). (See "Grease" on page 22.)

Disassemble and Assemble Mower Drive Belt Tension Idler Arm



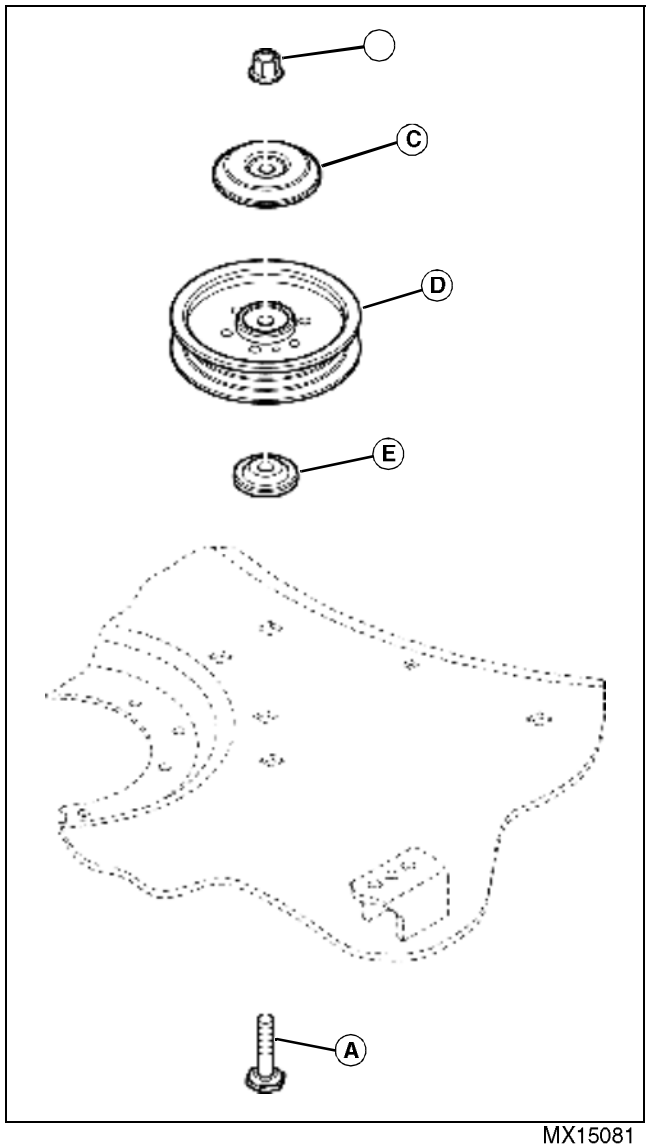
MX13396

A - Lubrication Fitting
B - Bushing
C - Flanged Nut
D - Tension Idler Arm
E - Special Washer
F - Shield
G - Sheave
H - Capscrew

- Inspect all parts for wear or damage. Replace parts as needed.
- Install special washer (E) with the raised area toward the shield (F).
- Apply grease to lubrication fitting (A). (See "Grease" on page 22.)

Remove and Install Idler Sheave

1. Remove mower deck drive belt. (See “Remove and Install Mower Deck Drive Belt” on page 242.)



MX15081

2. Hold special bolt (A) and remove locknut (B).

3. Remove shield (C), idler sheave (D) and special washer (E).

NOTE: The idler sheave contains a non-serviceable bearing. If bearing replacement is needed, replace entire idler sheave.

4. Inspect all parts for wear or damage. Replace parts as needed.

Installation is done in the reverse order of removal.

- Install special washer (E) with the raised area toward the idler sheave (D).

Remove and Install Mower Deck

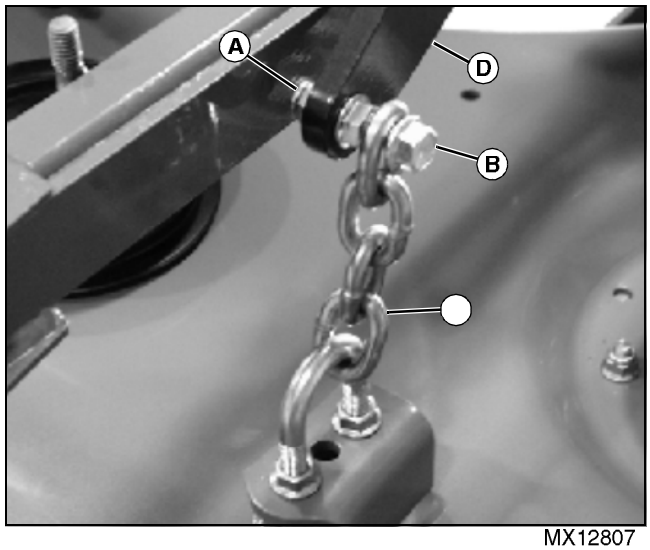
CAUTION: Avoid injury! Rotating blades are dangerous. Before adjusting or servicing mower:

- **Disconnect spark plug wire(s) to prevent engine from starting accidentally.**
- **Always wear gloves when handling mower blades or working near blades.**

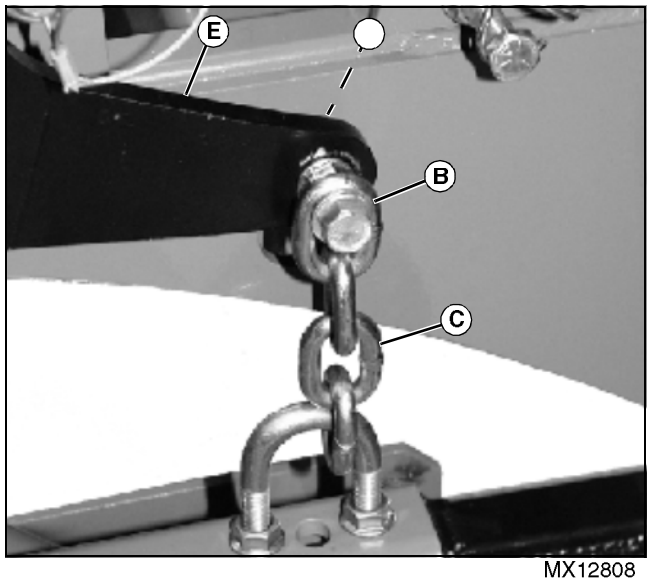
1. Park the machine safely.

2. Remove mower deck drive belt. (See “Remove and Install Mower Deck Drive Belt” on page 242.)

3. Lower mower deck to the lowest cutting position.

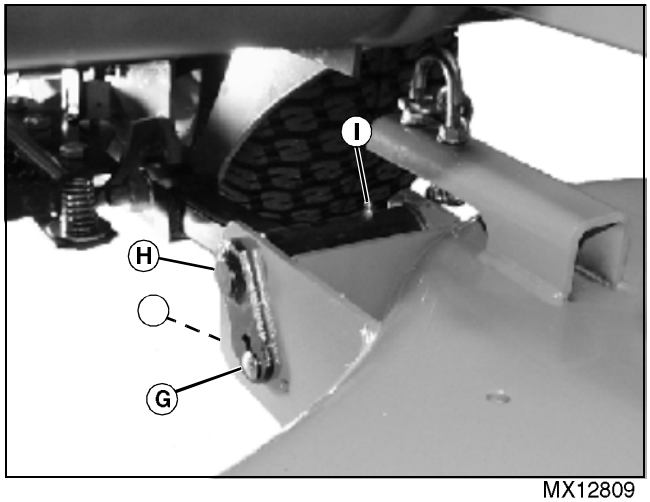


MX12807



MX12808

4. Remove locknuts (A) and capscrews (B), and disconnect lift chains (C) from the front (D) and rear (E) lift arms on both sides of mower deck.



MX12809

5. Remove locknut (F), carriage bolt (G) and pivot pin (H) from each side of the mower deck.

6. Slide mower deck out from the side of the machine.

Installation is done in the reverse order of removal.

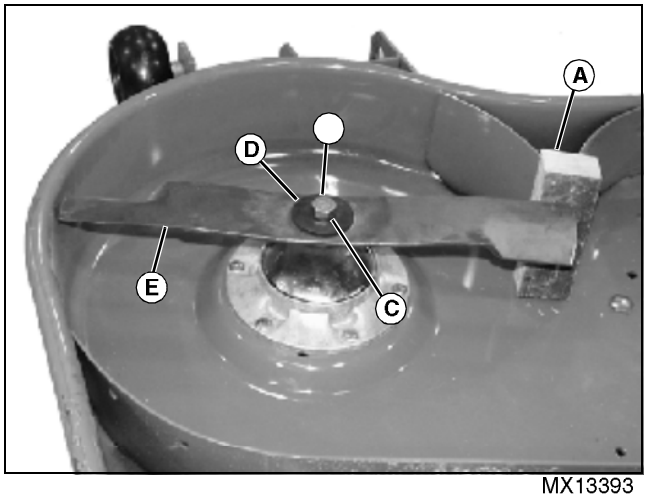
- Apply grease to the lubrication fitting (I) on push arm. (See “Grease” on page 22.)
- Level mower deck. (See “Level Mower Deck” on page 237.)
- Adjust cutting height. (See “Check and Adjust Cutting Height” on page 239.)
- Adjust anti-scalp wheel height. (See “Check and Adjust Anti-Scalp Wheel Clearance” on page 240.)
- Check mower deck drive belt tension. Adjust as needed. (See “Check and Adjust Mower Deck Drive Belt Tension” on page 237.)

Remove and Install Mower Blades

1. Park the machine safely.

2. Remove mower deck. (See “Remove and Install Mower Deck” on page 244.)

CAUTION: Avoid injury! Blades are sharp and could cause personal injury. Wear gloves or wrap blade with rag to remove or install blades. DO NOT hold blades with bare hand. Use a block of wood wedged between deck and blade to keep spindle from turning.



MX13393

3. Using a block of wood (A) wedged between the deck and the blade, remove capscrew (B), flat washer (C), concave washer (D) and blade (E).

4. Inspect blades; sharpen/balance or replace as necessary.

Installation is done in the reverse order of removal.

- Install cupped washer (C) with dished side toward the blade.
- Tighten blade capscrew (B) to specifications.

Specifications:

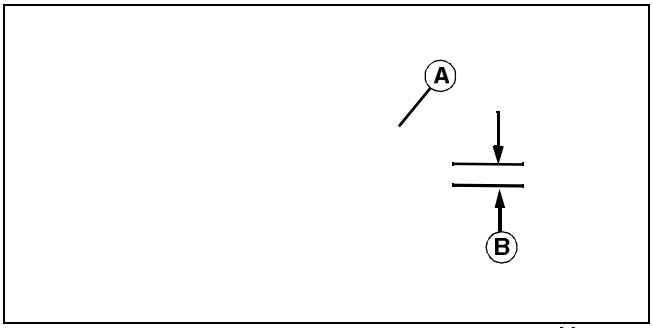
Blade Capscrew Torque. . . . . 122 N•m (90 lb-ft)

Sharpen and Balance Mower Blades

Sharpen Blade

CAUTION: Avoid injury! Wear goggles and gloves when sharpening blades.

1. Sharpen blade using grinder, file or power sharpener.



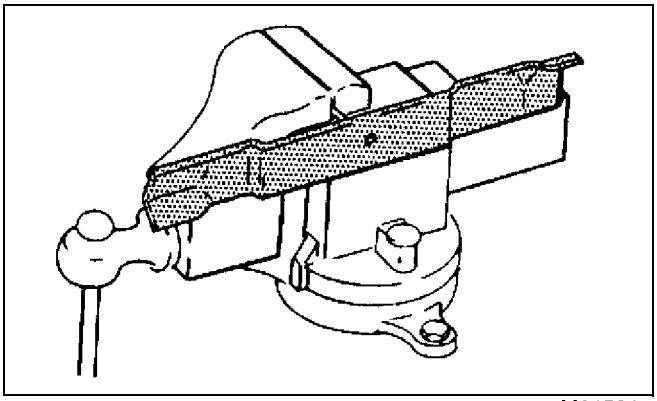
M61830

2. Do not alter original bevel (A). Blade should have a 0.40 mm (0.016 in.) cutting edge (B) rather than a razor-type edge.

Balance Blade

CAUTION: Avoid injury! Wear gloves when handling blade.

1. Clean blade.

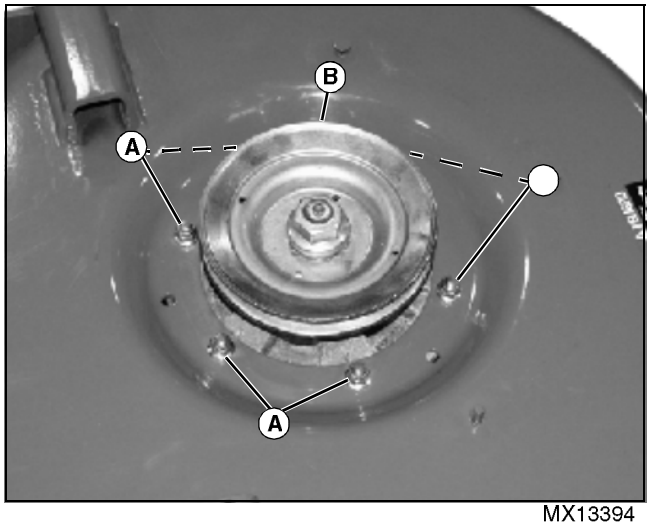


M61524

2. Put blade on nail in a vise or vertical wall stud.
3. Turn blade to HORIZONTAL position. If the blade is not balanced, the heavy end will drop.
4. Grind bevel of heavy end. Do not change blade bevel angle.

Remove and Install Spindle

1. Remove mower deck. (See “Remove and Install Mower Deck” on page 244.)
2. Remove mower blade(s). (See “Remove and Install Mower Blades” on page 245.)



MX13394

3. Remove six locknuts (A) and carriage bolts.
4. Remove spindle assembly (B).

Installation is done in the reverse order of removal.

- Tighten spindle mounting locknuts (A) to specifications.
- Tighten blade capscrew to specifications.

Specifications:

Blade Capscrew Torque. . . . . 122 N•m (90 lb-ft)

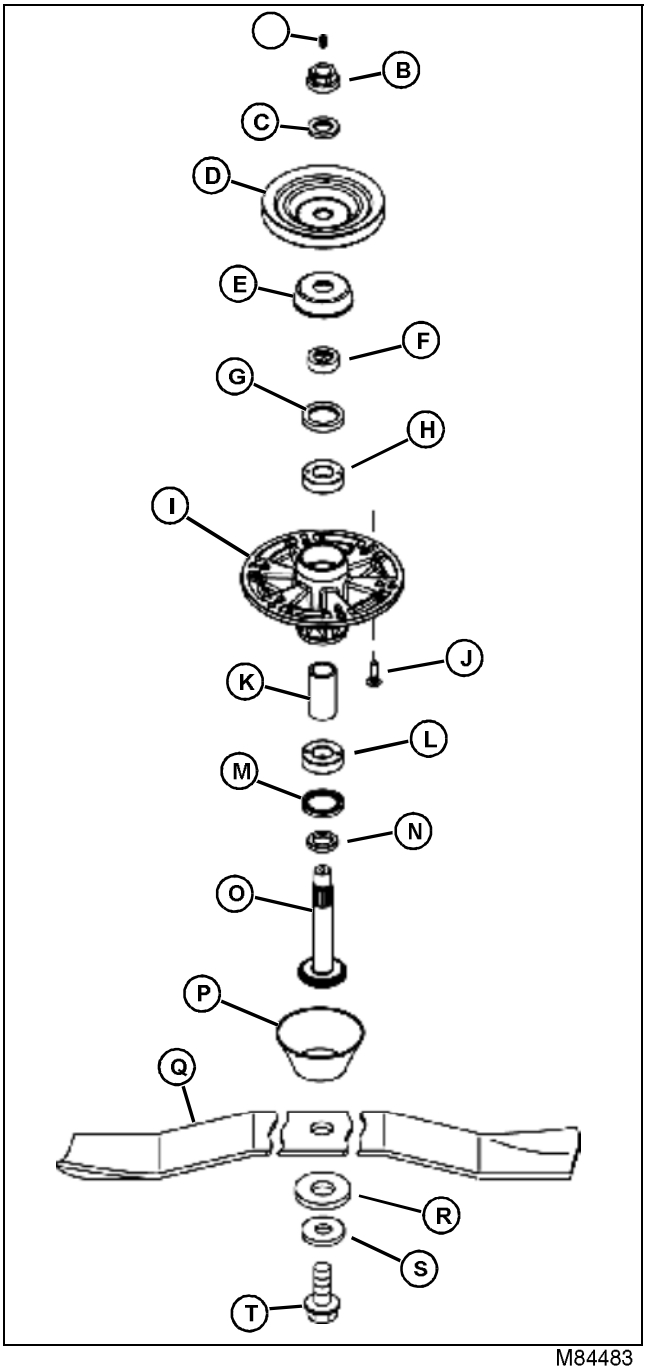
Spindle Mounting Locknut Torque . . . . 37 N•m (27 lb-ft)

Disassemble and Inspect Spindle

CAUTION: Avoid injury! Blades are sharp and could cause personal injury. Wear gloves or wrap blade with rag to remove or install blades. DO NOT hold blades with bare hand. Use a block of wood wedged between deck and blade to keep spindle from turning.

NOTE: If spindle sheave flanged nut needs to be removed for any reason, loosen nut while the spindle is still installed on the machine. Use a block of wood to prevent the blade from turning.

1. Remove spindle assembly from deck. (See “Remove and Install Spindle” on page 246.)



M84483

A - Lubrication Fitting
B - Flanged Nut
C - Splined Bushing
D - Sheave
E - Upper Deflector
F - Upper Seal Ring
G - Upper Seal
H - Upper Bearing
I - Housing
J - Carriage Bolt (6 used)
K - Bushing
L - Lower Bearing
M - Lower Seal
N - Lower Seal Ring
O - Spindle Shaft
P - Lower Deflector
Q - Blade
R - Cupped Washer
S - Washer
T - Capscrew

IMPORTANT: Avoid damage! DO NOT install round end (blade end) of spindle shaft in a vise to remove spindle sheave nut. The surface of the spindle shaft will be damaged, resulting in improper blade operation.

NOTE: The blade capscrew must be temporarily overtightened to prevent blade from slipping while loosening the spindle sheave flanged nut.

2. If the flanged nut and blade capscrew were not loosened prior to spindle removal, install blade, washers and capscrew on spindle. Place blade in a soft-jawed vise. Tighten blade capscrew to **320 N•m (236 lb-ft)** to prevent blade from slipping while loosening spindle sheave flanged nut.

3. Remove flanged nut (B), splined bushing (C), sheave (D), upper deflector (E) and upper seal ring (F).

4. Remove blade capscrew (T), washers (R and S) and blade (Q).

5. Remove spindle shaft (O) and lower deflector (P) as an assembly from spindle housing.

6. Remove lower seal ring (N).

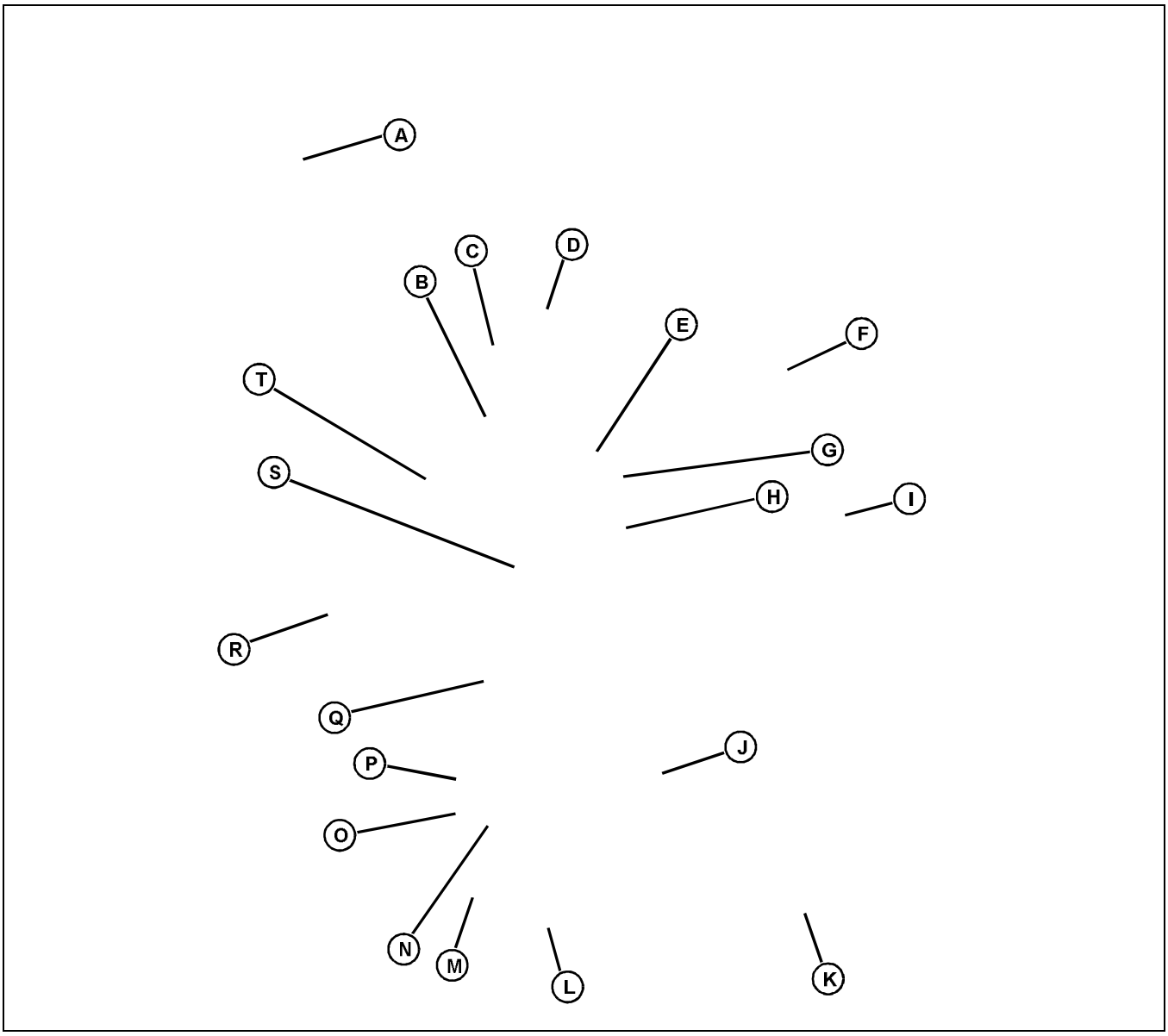
NOTE: Remove bearings (H and L) only if replacement is necessary.

7. Bearings (H and L) are seated against spindle hub shoulder and cannot be removed with a press. Remove seals (G and M) and bearings (H and L) using a punch.

8. Remove bushing (K).

9. Inspect all parts for wear or damage. Replace parts as needed.

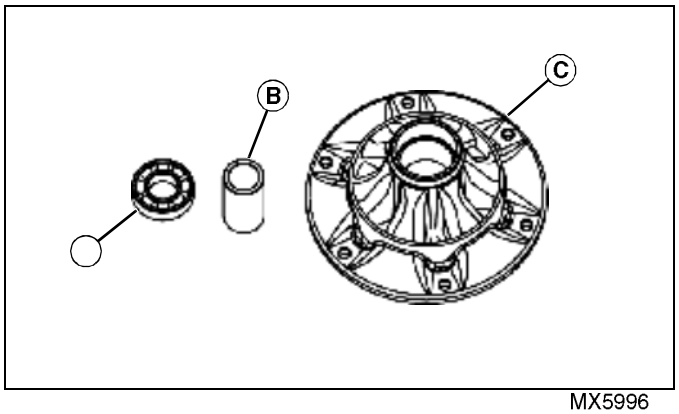
Spindle Cross Section



MX5937

A - Grease Notch
B - Splined Bushing
C - Flanged Nut
D - Lubrication Fitting
E - Upper Seal Ring
F - Spindle Sheave
G - Upper Seal
H - Upper Bearing
I - Carriage Bolt (6 used)
J - Lower Deflector
K - Blade
L - Capscrew
M - Cupped Washer
N - Lower Seal Ring
O - Lower Seal
P - Lower Bearing
Q - Spacer
R - Housing
S - Spindle Shaft
T - Upper Deflector

Assemble Spindle



MX5996

1. Using a 2 in. disk and press, install lower bearing (A) until it is seated against spindle housing (C) shoulder.

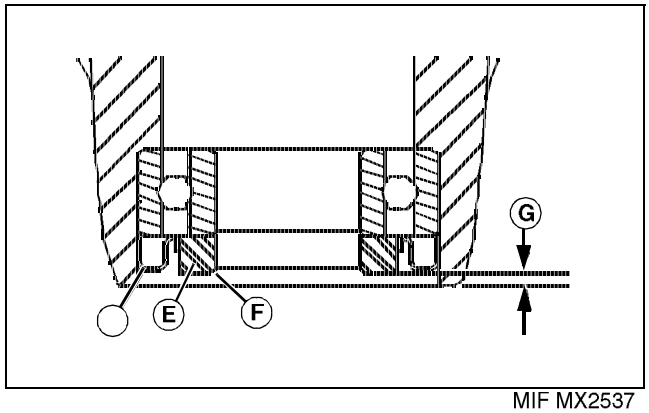
IMPORTANT: Avoid damage! Using disk drivers, support both the inner and outer races of the upper and lower bearings when installing the upper bearing. DO NOT support the housing by allowing it to rest on its end.

2. Turn housing over. Support the assembly using a 2 in. disk against the lower bearing and a pipe, approximately the same diameter, against the disk. Pipe must extend beyond housing so that assembly is supported by the pipe and not by the spindle housing.

3. Place spacer (B) into housing.

4. Using a 2 in. disk and press, install upper bearing until it is seated against the spacer.

5. Using a disk and press, install upper seal with lip against bearing. Press until the face of the seal is flush ±0.5 mm (±0.020 in.) with the top of the housing. Refer to cross section on previous page for correct installation.



MIF MX2537

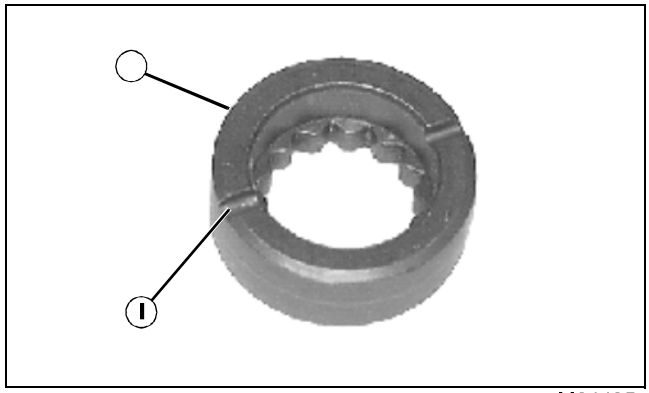
6. Using a 2 in. disk and press, install lower seal (D) with lip against bearing. Press to depth of specifications (G).

NOTE: The inner diameter chamfer of the seal ring is away from the bearing.

7. Install lower seal ring (E) with inner chamfer (F) facing away from bearing. Be careful not to turn lip of seal inside out when installing seal ring.

8. Install spindle shaft in spindle housing.

NOTE: Upper seal ring is installed with grease notch facing toward upper bearing.



M84485

9. Install upper seal ring (H) with grease notch (I) toward bearing.

10. Install upper deflector, sheave, splined bushing and flanged nut, making sure to index all components to spindle shaft.

IMPORTANT: Avoid damage! DO NOT install round end (blade end) of spindle shaft in a vise to install spindle sheave flanged nut. Tighten nut after the spindle assembly is installed in the mower deck. If this is not possible, place blade in a vise and attach spindle assembly. Temporarily tighten blade capscrew to 320 N•m (236 lb-ft) first, then tighten spindle sheave flanged nut. Loosen and retighten blade capscrew to specification.

11. Tighten sheave flanged nut securely, but do not torque to specifications at this time.

12. Install spindle assembly in mower deck. (See “Remove and Install Spindle” on page 246.)

13. Install lower deflector.

14. Install blade with blade wing toward top of mower deck.

IMPORTANT: Avoid damage! Blade MUST be properly seated on the spindle, and concave side of large cupped washer MUST face toward blade.

15. Install large cupped washer, washer and capscrew.

NOTE: The blade capscrew must be temporarily overtightened to prevent blade from slipping while loosening the spindle sheave flanged nut.

16.Use a block of wood to prevent blade from turning. Tighten blade capscrew to **320 N•m (236 lb-ft)** to prevent blade from slipping while loosening the spindle sheave flanged nut.

17.Tighten spindle sheave flanged nut to specifications.

18.Loosen blade capscrew and retighten to specifications.

19.Lubricate spindle with multipurpose grease at lubrication fitting. (See “Grease” on page 22.)

Specifications:

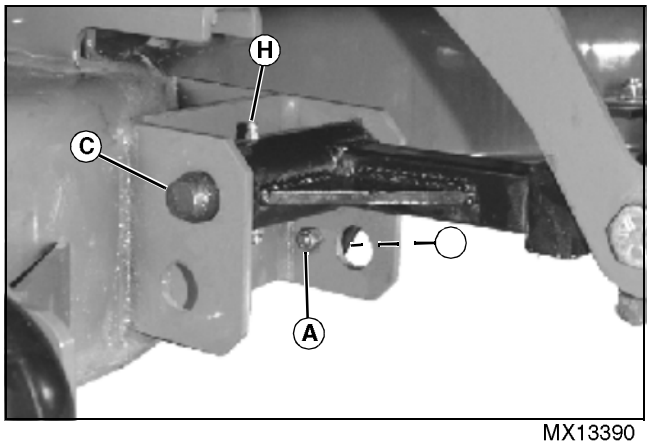
Lower Seal Installation Depth . . . . . 2.57 mm (0.10 in.)

Spindle Sheave Flanged Nut Torque 255 N•m (188 lb-ft)

Blade Capscrew Torque . . . . . 122 N•m (90 lb-ft)

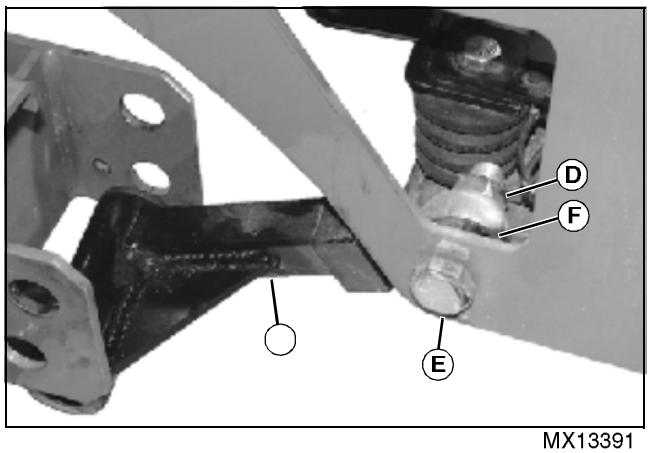
Remove and Install Push Arm

1. Park the machine safely.
2. Lower mower deck to the lowest mowing position.
3. Remove rear wheel. (See “Remove and Install Rear (Drive) Wheel” on page 259.)



MX13390

4. Remove locknut (A), carriage bolt (B) and pivot pin (C).



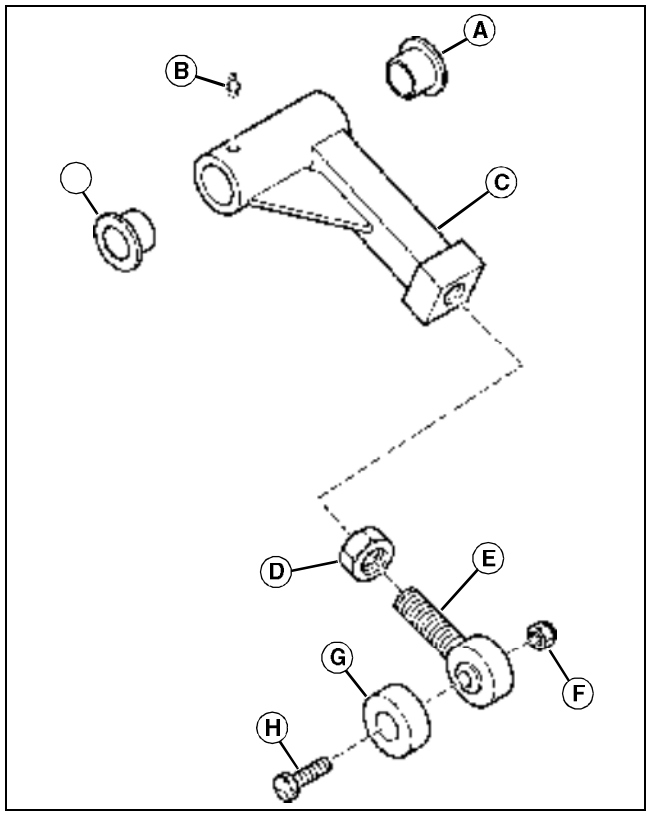
MX13391

5. Remove locknut (D), capscrew (E) and spacer (F).
6. Remove push arm (G).

Installation is done in the reverse order of removal.

- Apply grease to lubrication fitting (H). (See “Grease” on page 22.)

Repair Push Arm

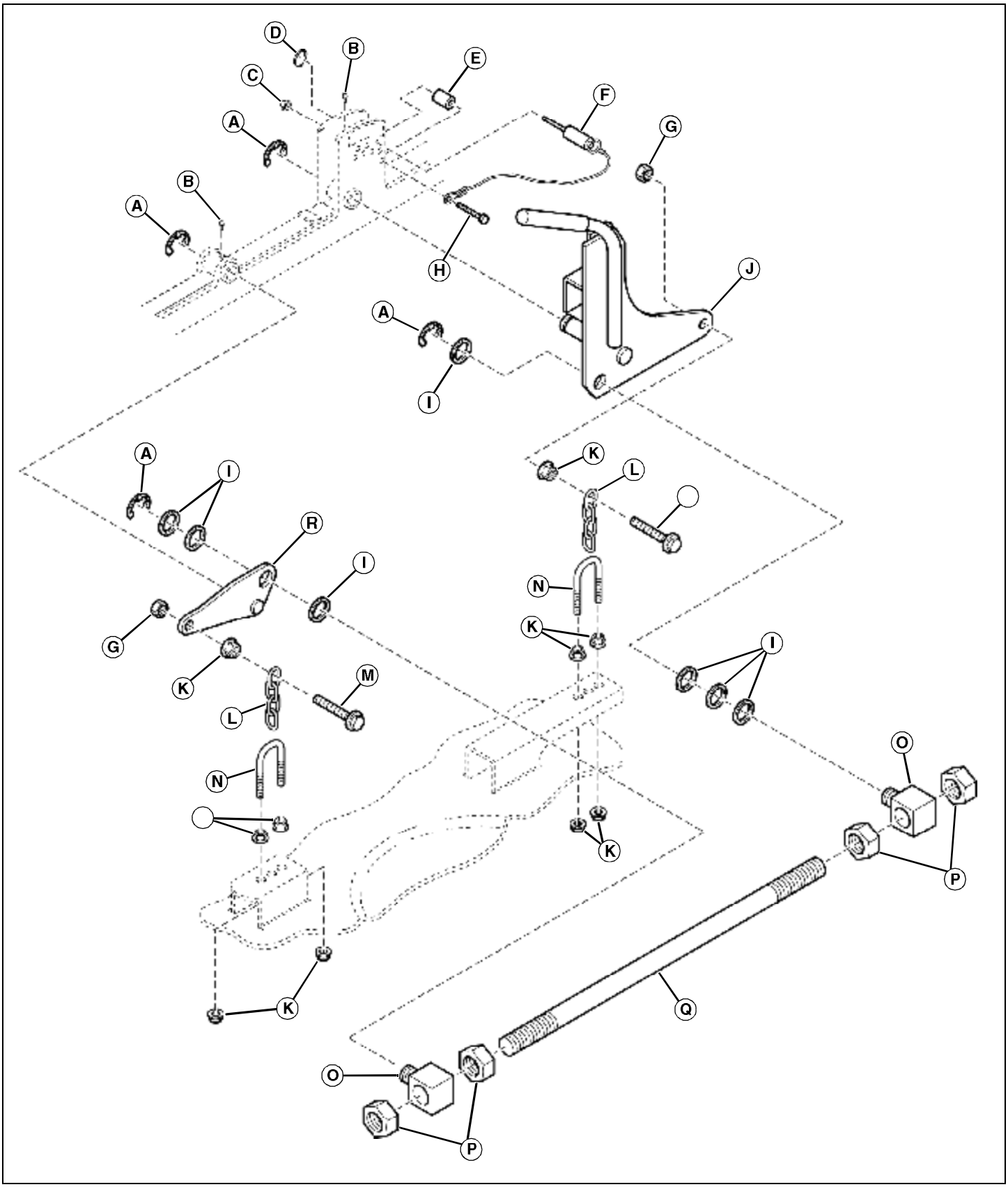


MX13397

A - Bushing (2 used)
B - Lubrication Fitting
C - Push Arm
D - Jam Nut
E - Spherical Bearing
F - Locknut
G - Spacer
H - Capscrew

- Inspect all parts for wear or damage. Replace parts as needed.
- Apply grease to lubrication fitting (B). (See “Grease” on page 22.)

Mower Deck Lift Linkage

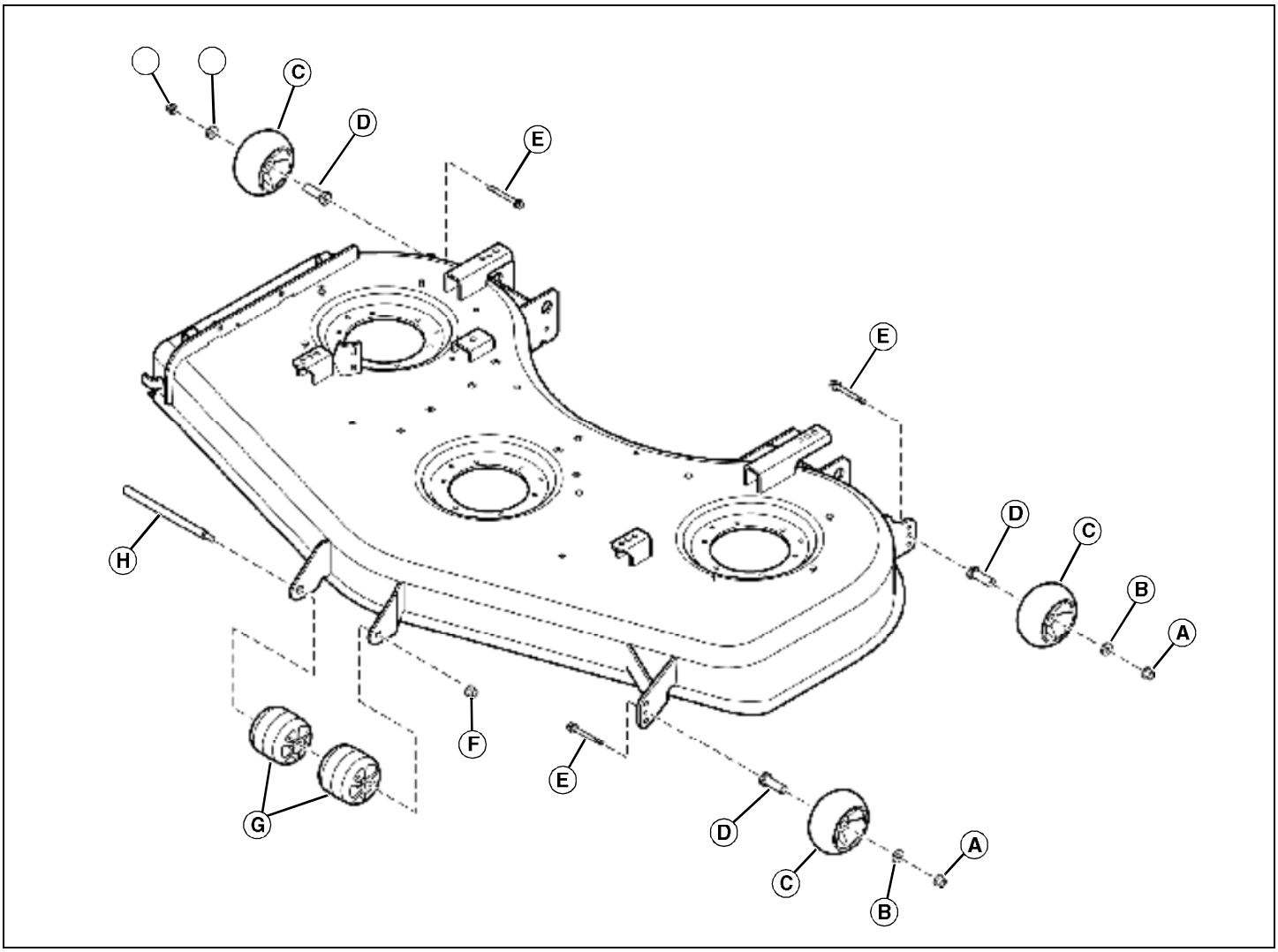


MX13412 **Picture Note: Left side shown.**

A - Retaining Ring (4 used per side)
B - Lubrication Fitting (2 used per side)
C - Nut
D - Retaining Ring
E - Spacer
F - Height-of-Cut Pin
G - Nut (2 used per side)
H - Capscrew
I - Shim Washer (7 used per side)
J - Deck Lift Lever Assembly
K - Flanged Nut (10 used per side)
L - Lift Chain (2 used per side)
M - Flanged Capscrew (2 used per side)
N - U-Bolt (2 used per side)
O - Swivel Nut (2 used per side)
P - Nut (4 used per side)
Q - Adjustment Rod
R - Front Pivot Bracket

- Inspect all parts for wear or damage. Replace as needed.
- Level mower deck. (See “Level Mower Deck” on page 237.)
- Adjust cutting height. (See “Check and Adjust Cutting Height” on page 239.)
- Apply grease to lubrication fittings (B). (See “Grease” on page 22.)

Anti-Scalp Wheels and Rollers



MX15080

A - Locknut (3 used)
B - Washer (3 used)
C - Anti-Scalp Wheel (3 used)
D - Bushing (3 used)
E - Capscrew (3 used)
F - Locknut
G - Roller (2 used)
H - Pivot Pin

- Adjust anti-scalp wheel height. (See “Check and Adjust Anti-Scalp Wheel Clearance” on page 240.)
- Tighten anti-scalp wheel nut to specifications.

Specifications:

Anti-Scalp Wheel Nut Torque . . . . . 34 N•m (25 lb-ft)

Table of Contents

MISCELLANEOUS TABLE OF CONTENTS

Specifications

Repair Specifications

Model 647

Front Tire Size	13 x 5-6
Front Tire Pressure	110 - 138 kPa (16 - 20 psi)
Rear (Drive) Tire Size	20 x 8-8
Rear (Drive) Tire Pressure	69 - 97 kPa (10 - 14 psi)

Models 657 and 667

Front Tire Size	13 x 5-6
Front Tire Pressure	110 - 138 kPa (16 - 20 psi)
Rear (Drive) Tire Size	20 x 10-8
Rear (Drive) Tire Pressure	69 - 97 kPa (10 - 14 psi)

Torque Specifications

Rear (Drive) Wheel Lug Nut	108 N•m (80 lb-ft)
Actuator Platform Locknut Torque	47 N•m (35 lb-ft)
Operator Platform Jam Nut Torque	68 N•m (50 lb-ft)

Tests and Adjustments

Tire Pressure Adjustment

CAUTION: Avoid injury! Explosive separation of a tire and rim parts can cause serious injury or death:

- **Do not attempt to mount a tire without 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.**
- **Check tires for low pressure, cuts or missing lug bolts and nuts.**

NOTE: Tire pressure can affect steering tracking. Always check tire pressure before making steering adjustments.

Procedure:

1. Check tire and rim for damage.
2. Check air pressure using an air pressure gauge.
3. Add or remove air as needed.

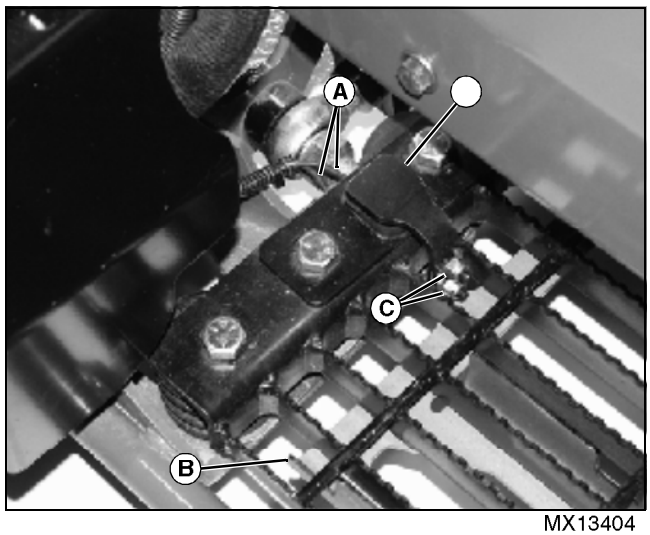
Specifications:

Front . . . . . 13 x 5-6
Rear (647) . . . . . 20 x 8-8
Rear (657 and 667) . . . . . 20 x 10-8
Inflation Front . . . . . 110 - 138 kPa (16 - 20 psi)
Inflation Rear . . . . . 69 - 97 kPa (10 - 14 psi)

Check and Adjust Operator Presence Switch

Check Procedure:

1. Park the machine safely.



MX13404

2. Disconnect operator presence switch wires (A).
3. Connect an ohmmeter to the terminals of the operator presence switch and check for continuity. With no pressure on the actuator platform (B), there should be no continuity across the operator presence switch.
4. Depress actuator platform (B) until it is flush with the operator platform. Check the operation of the operator presence switch. There should be continuity across the switch.
5. If the switch does not have continuity, proceed to adjustment procedure.
6. Connect wires (A).

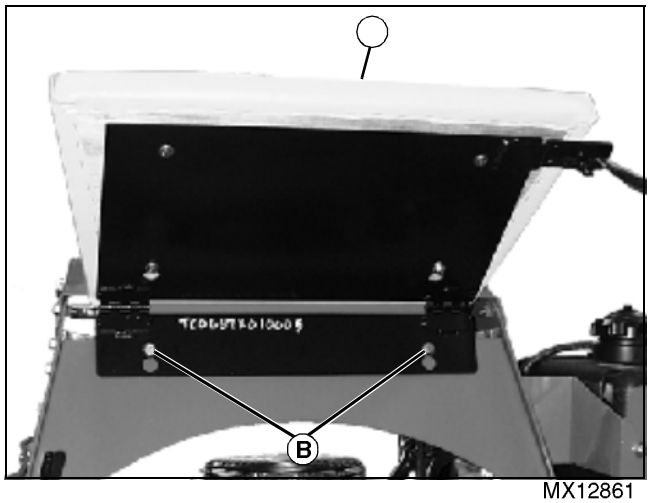
Adjustment Procedure:

1. Loosen two locknuts (C).
2. With no pressure on the actuator platform (B), connect an ohmmeter to the terminals of the operator presence switch.
3. Move operator presence switch actuator bracket (D) until there is no continuity across the operator presence switch.
4. Tighten locknuts (C).
5. Repeat check procedure to verify adjustment.

Repair

Remove and Install Thigh Pad

1. Park the machine safely.



MX12861

2. Unlatch, raise and support the thigh pad (A).
3. Remove two capscrews (B).
4. Remove thigh pad (A).

Installation is done in the reverse order of removal.

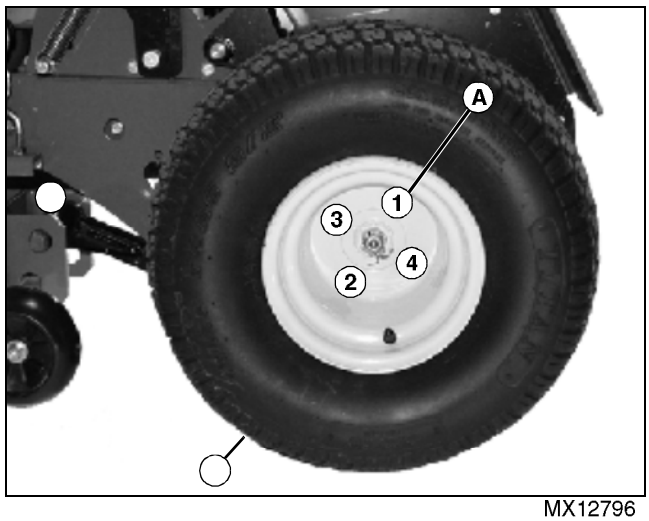
Remove and Install Rear (Drive) Wheel

1. Park the machine safely.
2. Release park brake.
3. Block the front caster wheels.

CAUTION: Avoid injury! The machine may fall or slip from an unsafe lifting device:

- **Use a device rated for the load to be lifted.**
- **Secure the machine properly to the lift.**

4. Raise and securely support the rear of the machine.



MX12796

5. Remove four nuts (A).
6. Remove wheel (B).

Installation is done in the reverse order of removal.

- Tighten nuts (A) to specifications, in the sequence shown.

Specifications:

Wheel Nut Torque. . . . . 108 N•m (80 lb-ft)

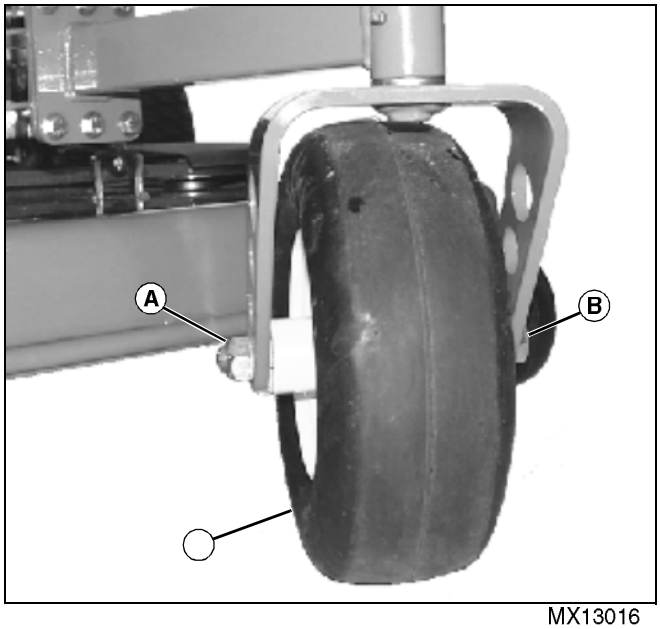
Remove and Install Caster Wheel Assembly

1. Park the machine safely.

CAUTION: Avoid injury! The machine may fall or slip from an unsafe lifting device:

- **Use a device rated for the load to be lifted.**
- **Secure the machine properly to the lift.**

2. Raise and securely support the front of the machine.



MX13016

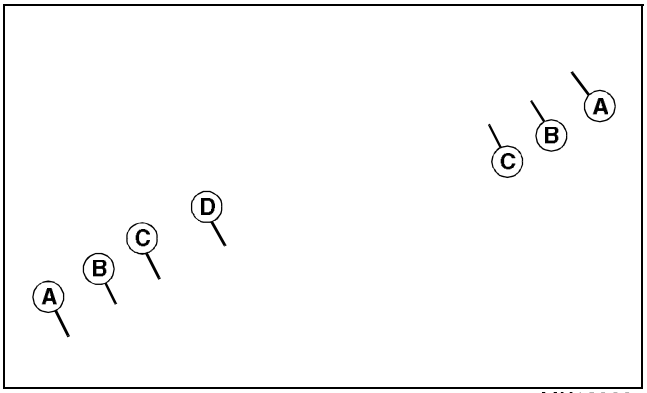
3. Remove locknut (A) and capscrew (B).

4. Remove wheel assembly (C).

Installation is done in the reverse order of removal.

Replace Caster Wheel Bearings

1. Remove caster wheel assembly. (See “Remove and Install Caster Wheel Assembly” on page 259.)



MX12838

2. Remove spacers (A), seals (B), bearings (C) and spacer tube (D).

3. Clean and inspect the bearings (C). Replace bearings as needed.

4. Pack bearings (C) with John Deere Multi-Purpose SD Polyurea Grease.

NOTE: Always install new seals.

5. Install spacer tube (D), bearings (C), new seals (B) and spacers (A).

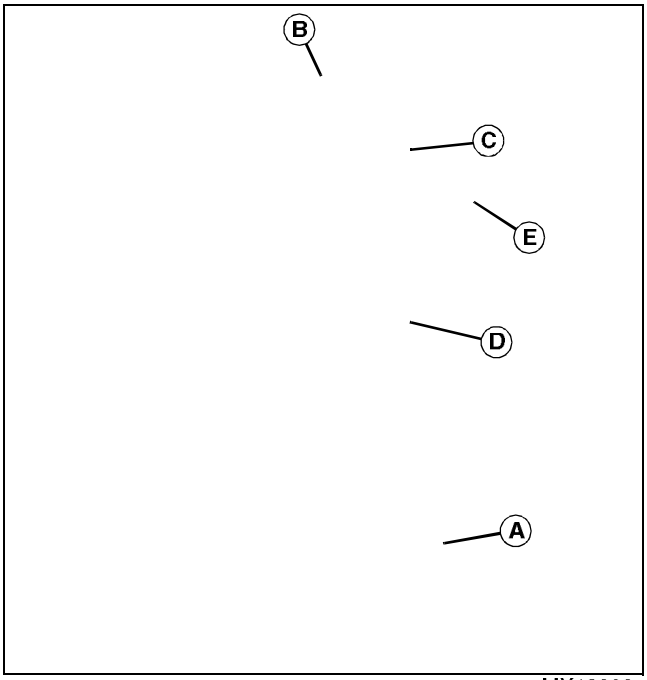
Remove and Install Caster Wheel Yoke Assembly

1. Park the machine safely.

CAUTION: Avoid injury! The machine may fall or slip from an unsafe lifting device:

- **Use a device rated for the load to be lifted.**
- **Secure the machine properly to the lift.**

2. Raise and securely support the front of the machine.



MX12868

3. Support the bottom of the caster wheel and yoke assembly (A).

4. Remove and discard cotter pin (B).

5. Remove caster wheel and yoke assembly (A).

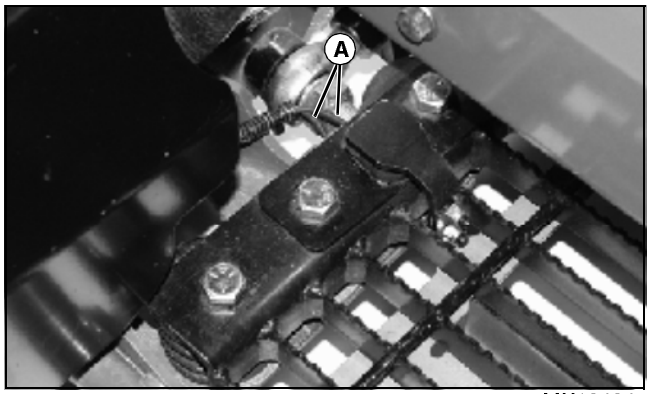
6. Inspect the upper (C) and lower (D) bushings. Replace as needed.

Installation is done in the reverse order of removal.

- Install a new cotter pin (B).
- Apply grease to lubrication fitting (E). (See “Grease” on page 22.)

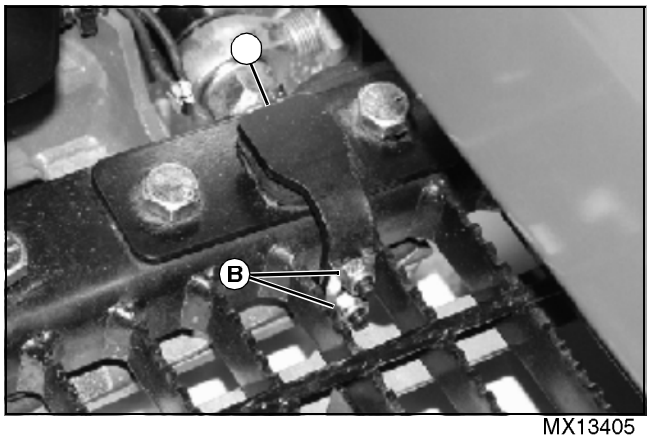
Remove and Install Operator Platform

1. Park the machine safely.
2. Lock park brake.



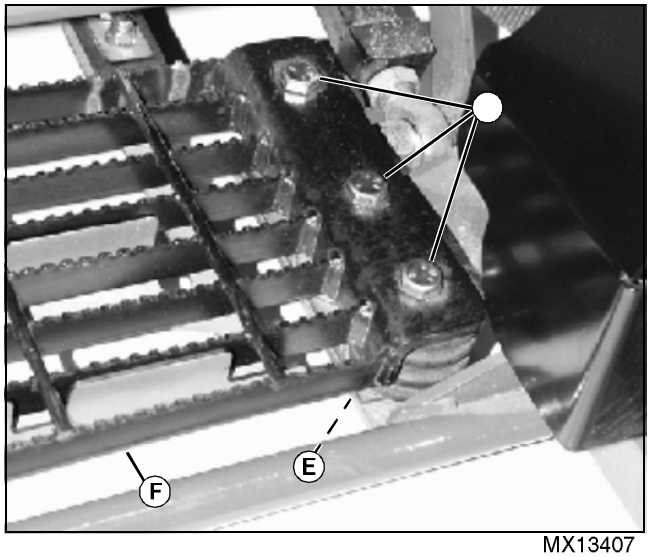
MX13404

3. Disconnect operator presence switch wires (A).

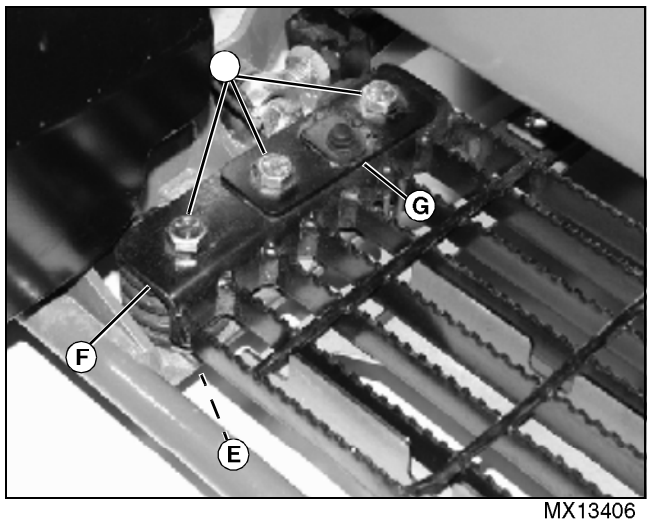


MX13405

4. Loosen two locknuts (B).
5. Remove operator presence switch actuator bracket (C).

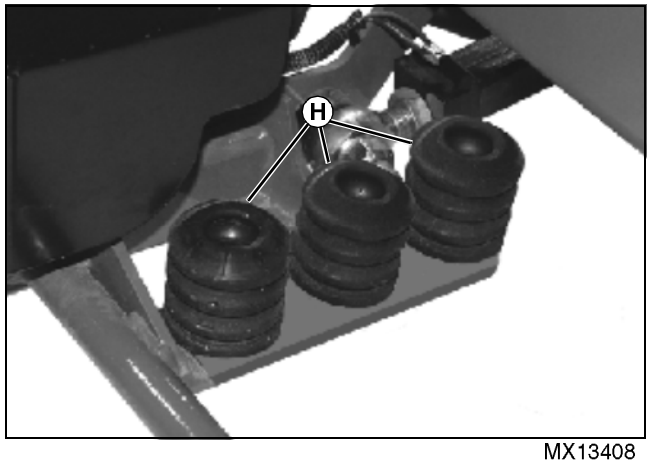


MX13407



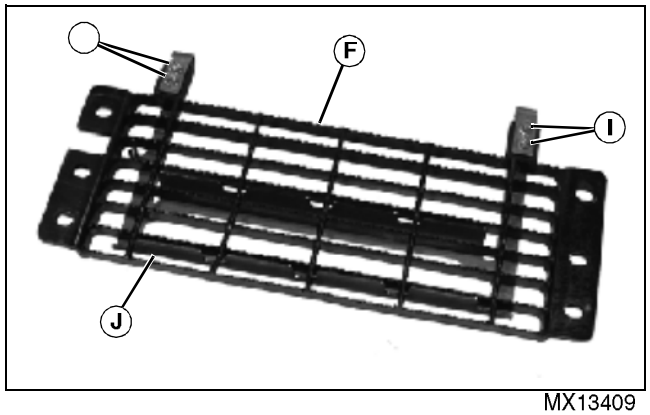
MX13406

6. Remove three capscrews (D) and jam nuts (E) from each side of the operator platform (F).
7. Remove operator presence switch assembly (G) and operator platform (F).



MX13408

8. Remove and inspect rubber cushions (H).



MX13409

9. Remove the two locknuts (I) on each side of the operator platform (F).
10. Remove the actuator platform (J).

11.Inspect all parts for wear or damage. Replace parts as needed.

Installation is done in the reverse order of removal.

- Tighten actuator platform locknuts (I) to specifications.
- Tighten three operator platform jam nuts (E) to specifications.
- Adjust the operator presence switch actuator bracket (C). (See “Check and Adjust Operator Presence Switch” on page 258.)

Specifications:

Actuator Platform Locknut Torque . . . 47 N•m (35 lb-ft)

Operator Platform Jam Nut Torque. . . 68 N•m (50 lb-ft)

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