MID-MOUNT ZTRAK M653/655/665

Serial No. (010001 -)

TECHNICAL MANUAL

John Deere
Worldwide Commercial and
Consumer Equipment Division

TM1778 (Sep99)

Litho in U.S.A

MX1835

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:

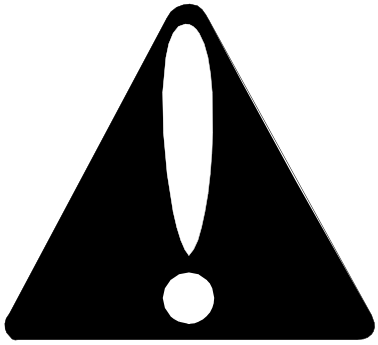
- Table of Contents
- General Diagnostic Information
- Specifications
- Electrical Wiring Harness Legend
- Component Location
- System Schematic
- Wiring Harness
- Troubleshooting Chart
- Theory of Operation
- Diagnostics
- Tests & Adjustments
- Repair

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

Each section will be identified with a symbol rather than a number. The groups and pages within a section will be consecutively numbered.

We appreciate your input on this manual. To help, there are postage paid post cards included at the back. If you find any errors or want to comment on the layout of the manual please fill out one of the cards and mail it back to us.

RECOGNIZE SAFETY INFORMATION



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.

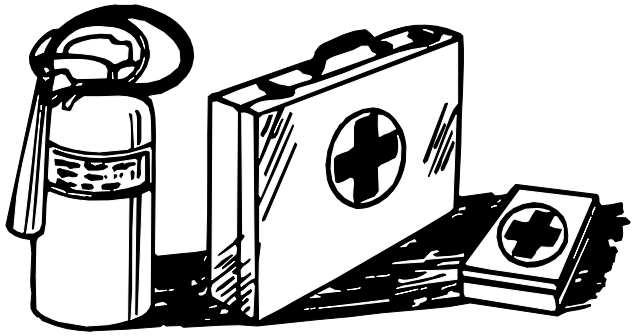
DANGER or WARNING safety signs are located near specific hazards. General precautions are listed on CAUTION safety signs. CAUTION also calls attention to safety messages in this manual.

REPLACE SAFETY SIGNS

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

HANDLE FLUIDS SAFELY-AVOID FIRES

Be Prepared For Emergencies



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

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

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

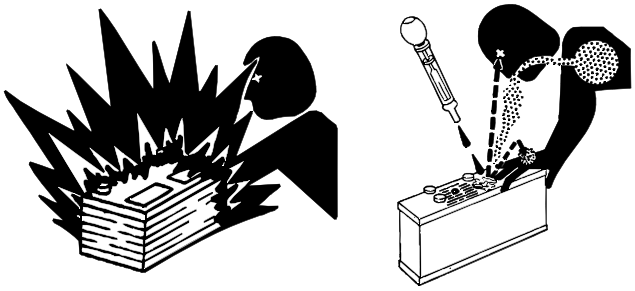
Do not store oily rags; they can ignite and burn spontaneously.

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

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

USE CARE IN HANDLING AND SERVICING BATTERIES



Prevent Battery Explosions

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

Prevent Acid Burns

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

- **Avoid acid burns by:**

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

- **If you spill acid on yourself:**

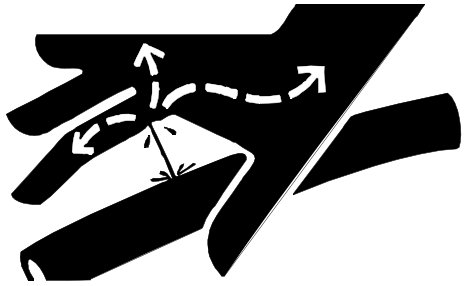
1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 10—15 minutes.
4. Get medical attention immediately.

- **If acid is swallowed:**

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

USE CARE AROUND HIGH-PRESSURE FLUID LINES

Avoid High-pressure Fluids



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

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

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

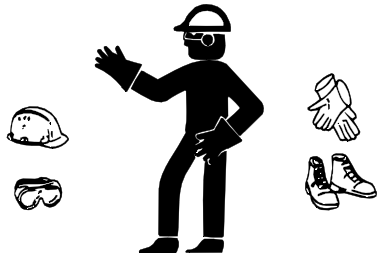
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical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

Avoid Heating Near Pressurized Fluid Lines

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

USE SAFE SERVICE PROCEDURES

Wear Protective Clothing

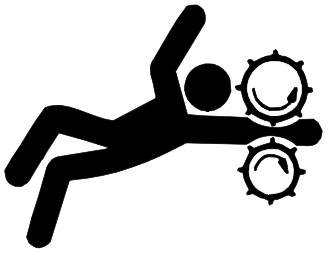


Wear close fitting clothing and safety equipment appropriate to the job.

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



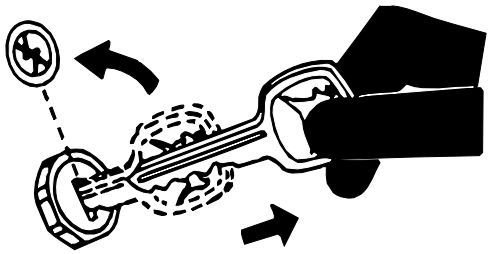
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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.

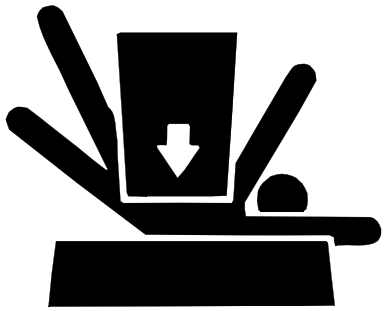
Park Machine Safely



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



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.

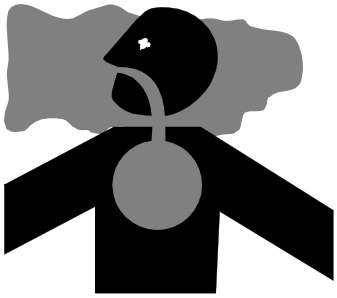
Using High Pressure Washers

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



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

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

WARNING: California Proposition 65 Warning

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

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

Remove Paint Before Welding Or Heating

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

Avoid Harmful Asbestos Dust

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

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

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

SERVICE TIRES SAFELY

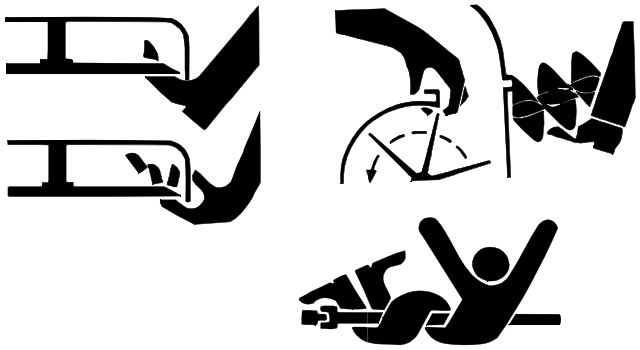
Explosive separation of a tire and rim parts can cause serious injury or death.

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.

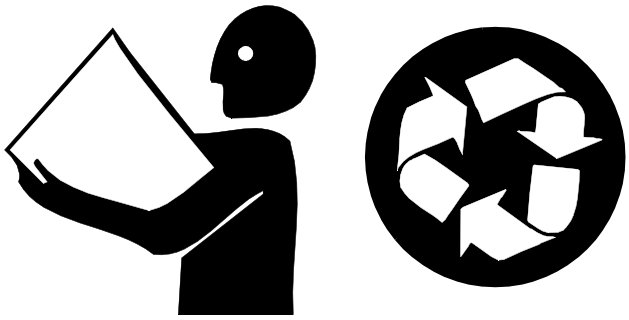
Check wheels for low pressure, cuts, bubbles, damaged rims or missing lug bolts and nuts.

AVOID INJURY FROM ROTATING BLADES, AUGERS AND PTO SHAFTS



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

HANDLE CHEMICAL PRODUCTS SAFELY



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

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

CONTENTS

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GENERAL VEHICLE SPECIFICATIONS

ENGINE—M653

Make	Kohler
Type	4 Cycle, V-Twin
Model	CH22S
Power Output	16.4 kW (22 hp)
Displacement	674 cm^3 (41.1 cu in.)
Aspiration	Natural
Cooling System	Air Cooled
Lubrication	Full Pressure
Engine Oil Capacity (with Filter)	1.9 L (2.0 qt)
Oil Filter	Replaceable, Full Flow
Valving	Overhead Valves
Air Cleaner	Heavy-Duty, Dry, Replaceable Filter Element with Cyclone Pre-Cleaner
Bore	80 mm (3.15 in.)
Stroke	67 mm (2.64 in.)
Compression Ratio	8.5:1
Slow Idle	1400 ±50 rpm
Fast Idle (No Load)	3600 +50/-0 rpm

ENGINE—M655 and 665

Make	Kohler
Type	4 Cycle, V-Twin
Model	CH25S
Power Output	18.6 kW (25 hp)
Displacement	725 cm^3 (44.2 cu in.)
Aspiration	Natural
Cooling System	Air Cooled
Lubrication	Full Pressure
Engine Oil Capacity (with Filter)	2.0 L (2.1 qt)
Oil Filter	Replaceable, Full Flow
Valving	Overhead Valves
Air Cleaner	Heavy-Duty, Dry, Replaceable Filter Element with Cyclone Pre-Cleaner
Bore	83 mm (3.27 in.)
Stroke	67 mm (2.64 in.)
Compression Ratio	9:1
Slow Idle	1400 ±50 rpm
Fast Idle (No Load)	3600 +50/-0 rpm

FUEL SYSTEM

Fuel Tank Location	On Each Side of the Operator
Fuel Tank Capacity (Total)	30.0 L (10.0 gal)
Fuel (Minimum Octane)	Unleaded Gasoline, 87 Octane
Fuel Delivery	Pulse
Carburetor	Externally Vented Downdraft
Fuel Filter	Replaceable In-Line
Gasoline/Alcohol Blends	Up to 10% Ethyl Alcohol/90% Unleaded (By Volume)
Gasoline/Ether Blends	Up to 15% MTBE/85% Unleaded (By Volume)
Fuel Shutoff Solenoid	Below Carburetor Float Bowl

DRIVE TRAIN

Hydraulic System Oil Capacity . . . . . 7.6 L (2.0 gal)
Type. . . . . Hydrostatic
Travel Speeds:
Forward. . . . . 0—14.4 km/h (0—9.0 mph)
Reverse. . . . . 0—6.4 km/h (0—4.0 mph)

STEERING

Type. . . . . Individual Wheel Motor Speed Control
Control. . . . . Twin Hand Control Lever

BRAKES

Main Breaking . . . . . Hydrostatic (Dynamic)
Park Brake. . . . . Dual Band
Park Brake Actuation. . . . . Hand Lever

MOWER DECK (54-INCH)

Number of Blades 3
Cutting Height . . . . . 38—127 mm (1.50—5.00 in.)
Cutting Width. . . . . 1372 mm (54 in.)
Drive . . . . . Belt

MOWER DECK (60-INCH)

Number of Blades 3
Cutting Height . . . . . 38—127 mm (1.50—5.00 in.)
Cutting Width. . . . . 1524 mm (60 in.)
Drive . . . . . Belt

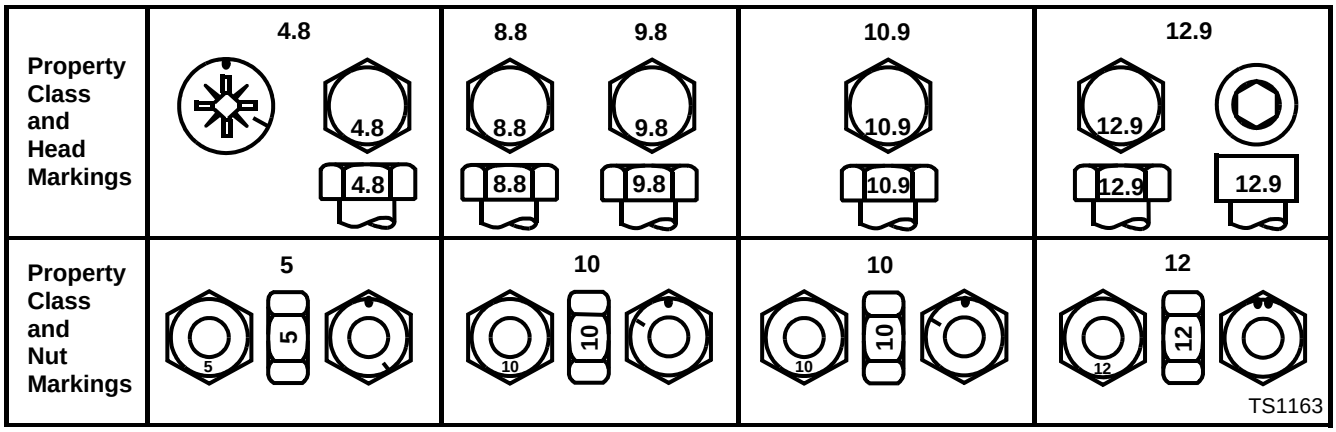
WHEELS AND TIRES

Front Wheels . . . . . 13 x 5.00-6 Pneumatic
Drive Wheels (Rear) . . . . . 23 x 10.5-12 Turf
Load Rating. 4-Ply

WEIGHTS AND DIMENSIONS

Weight . . . . . 476 kg (1050 lbs)
Overall Width - Discharge Chute Up (54-Inch Mower Deck) . . . . . 1460 mm (57 in.)
Overall Width - Discharge Chute Up (60-Inch Mower Deck) . . . . . 1613 mm (63.5 in.)
Overall Length. . . . . 2006 mm (79 in.)
Overall Height . . . . . 1940.3 mm (76.5 in.)

METRIC FASTENER TORQUE VALUES



	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
	Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]	
SIZE	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft
M6	4.8	3.5	6	4.5	9	6.5	11	8.5	13	9.5	17	12	15	11.5	19	14.5
M8	12	8.5	15	11	22	16	28	20	32	24	40	30	37	28	47	35
M10	23	17	29	21	43	32	55	40	63	47	80	60	75	55	95	70
M12	40	29	50	37	75	55	95	70	110	80	140	105	130	95	165	120
M14	63	47	80	60	120	88	150	110	175	130	225	165	205	150	260	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.

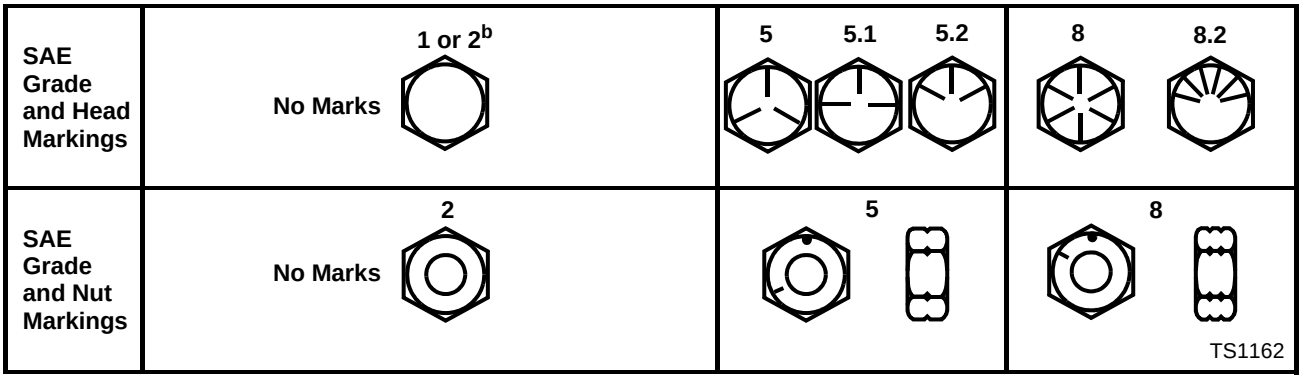
[a] *"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.*

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



	Grade 1				Grade 2[b]				Grade 5, 5.1 or 5.2				Grade 8 or 8.2			
	Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]	
SIZE	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft
1/4	3.7	2.8	4.7	3.5	6	4.5	7.5	5.5	9.5	7	12	9	13.5	10	17	12.5
5/16	7.7	5.5	10	7	12	9	15	11	20	15	25	18	28	21	35	26
3/8	14	10	17	13	22	16	27	20	35	26	44	33	50	36	63	46
7/16	22	16	28	20	35	26	44	32	55	41	70	52	80	58	100	75
1/2	33	25	42	31	53	39	67	50	85	63	110	80	120	90	150	115
9/16	48	36	60	45	75	56	95	70	125	90	155	115	175	130	225	160
5/8	67	50	85	62	105	78	135	100	170	125	215	160	215	160	300	225
3/4	120	87	150	110	190	140	240	175	300	225	375	280	425	310	550	400
7/8	190	140	240	175	190	140	240	175	490	360	625	450	700	500	875	650
1	290	210	360	270	290	210	360	270	725	540	925	675	1050	750	1300	975
1-1/8	470	300	510	375	470	300	510	375	900	675	1150	850	1450	1075	1850	1350
1-1/4	570	425	725	530	570	425	725	530	1300	950	1650	1200	2050	1500	2600	1950
1-3/8	750	550	950	700	750	550	950	700	1700	1250	2150	1550	2700	2000	3400	2550
1-1/2	1000	725	1250	925	990	725	1250	930	2250	1650	2850	2100	3600	2650	4550	3350

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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.*

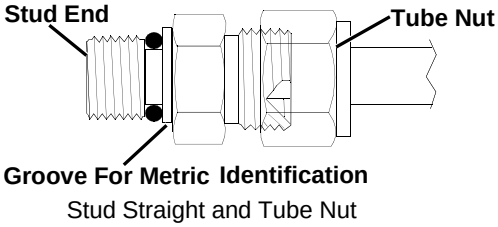
b *"Grade 2" applies for hex cap screws (not hex bolts) up to 152 mm (6-in.) long. "Grade 1" applies for hex cap screws over 152 mm (6-in.) long, and for all other types of bolts and screws of any length.*

Reference: JDS—G200.

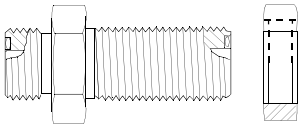
NOTE: Torque tolerance is + 15 minus 20%.

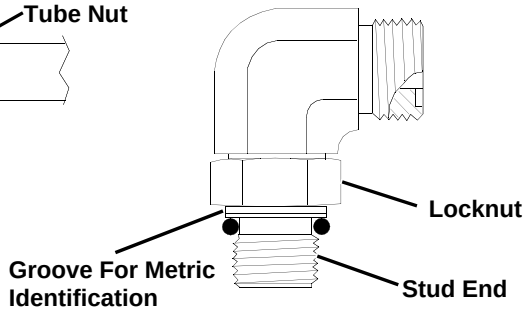
O-RING SEAL SERVICE RECOMMENDATIONS

FACE SEAL FITTINGS WITH METRIC STUD ENDS TORQUE

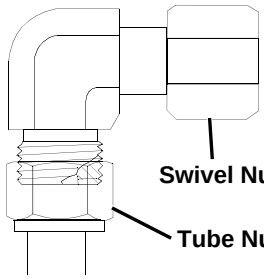


Stud Straight and Tube Nut


Bulkhead Union and Bulkhead Lucknut



90 Adjustable Stud Elbow

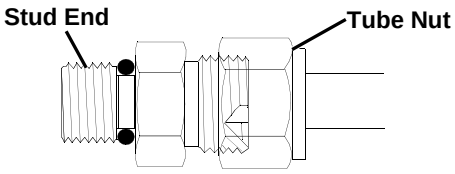


90 Swivel Elbow and Tube Nut

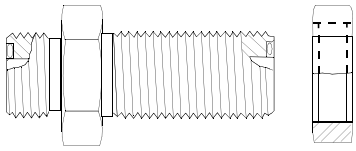
Nominal Tube O.D./Hose I.D.				Face Seal Tube/Hose End						O-ring Stud Ends, Straight Fitting or Locknut					
Metric Tube O.D.	Inch Tube O.D.			Thread Size	Hex Size	Tube Nut/ Swivel Nut Torque		Bulkhead Locknut Torque		Thread Size	Hex Size	Steel or Gray Iron Torque		Aluminum Torque	
mm	Dash Size	in.	mm	in.	mm	N•m	lb-ft	N•m	lb-ft	mm	mm	N•m	lb-ft	N•m	lb-ft
6	-4	0.250	6.35	9/16-18	17	16	12	12	9	M12X1.5	17	21	15.5	9	6.6
8	-5	0.312	7.94												
										M14X1.5	19	33	24	15	11
10	-6	0.375	9.52	11/16-16	22	24	18	24	18	M16X1.5	22	41	30	18	13
12	-8	0.500	12.70	13/16-16	24	50	37	46	34	M18X1.5	24	50	37	21	15
16	-10	0.625	15.88	1-14	30	69	51	62	46	M22X1.5	27	69	51	28	21
	-12	0.750	19.05	1-3/16-12	36	102	75	102	75	M27X2	32	102	75	46	34
22	-14	0.875	22.22	1-3/16-12	36	102	75	102	75	M30X2	36				
25	-16	1.000	25.40	1-7/16-12	41	142	105	142	105	M33X2	41	158	116	71	52
28										M38X2	46	176	130	79	58
32	-20	1.25	31.75	1-11/16-12	50	190	140	190	140	M42X2	50	190	140	85	63
38	-24	1.50	38.10	2-12	60	217	160	217	160	M48X2	55	217	160	98	72

NOTE: Torque tolerance is + 15 minus 20%.

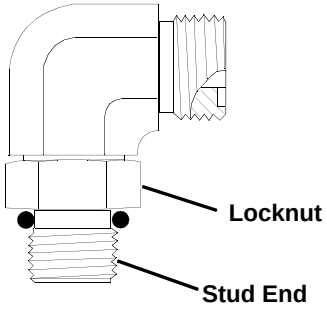
FACE SEAL FITTINGS WITH INCH STUD ENDS TORQUE



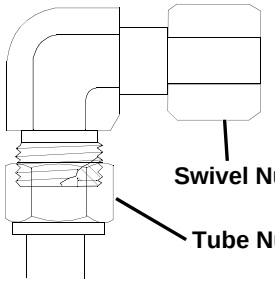
Stud Straight and Tube Nut



Bulkhead Union and Bulkhead Locknut



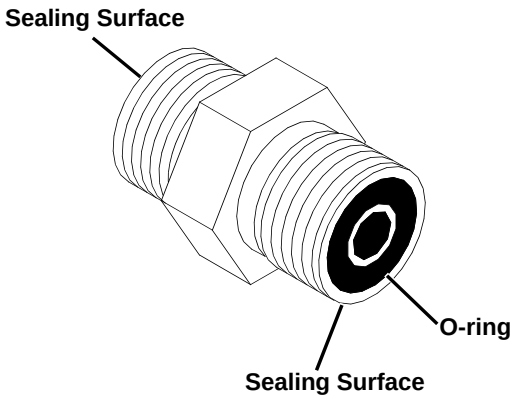
90 Adjustable Stud Elbow



90 Swivel Elbow and Tube Nut

Nominal Tube O.D./Hose I.D.				Face Seal Tube/Hose End					O-ring Stud Ends		
Metric Tube O.D.	Inch Tube O.D.			Thread Size	Tube Nut/ Swivel Nut Torque		Bulkhead Locknut Torque		Thread Size	Straight Fitting or Locknut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
	-3	0.188	4.76						3/8-24	8	6
6	-4	0.250	6.35	9/16-18	16	12	12	9	7/16-20	12	9
8	-5	0.312	7.94						1/2-20	16	12
10	-6	0.375	9.52	11/16-16	24	18	24	18	9/16-18	24	18
12	-8	0.500	12.70	13/16-16	50	37	46	34	3/4-16	46	34
16	-10	0.625	15.88	1-14	69	51	62	46	7/8-14	62	46
	-12	0.750	19.05	1-3/16-12	102	75	102	75	1-1/16-12	102	75
22	-14	0.875	22.22	1-3/16-12	102	75	102	75	1-3/16-12	122	90
25	-16	1.000	25.40	1-7/16-12	142	105	142	105	1-5/16-12	142	105
32	-20	1.25	31.75	1-11/16-12	190	140	190	140	1-5/8-12	190	140
38	-24	1.50	38.10	2-12	217	160	217	160	1-7/8-12	217	160

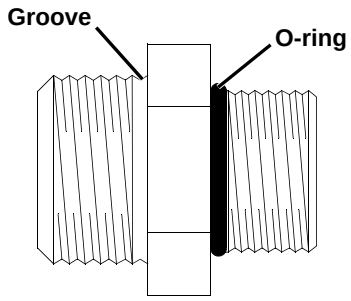
O-RING FACE SEAL FITTINGS



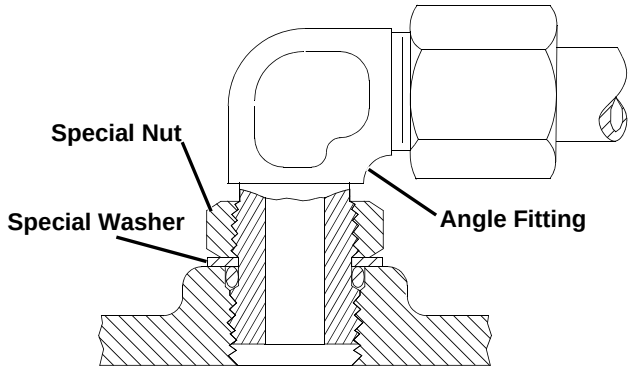
1. Inspect the fitting sealing surfaces. They must be free of dirt or defects.
2. Inspect the O-ring. It must be free of damage or defects.
3. Lubricate O-rings and install into groove using petroleum jelly to hold in place.
4. Push O-ring into the groove with plenty of petroleum jelly so O-ring is not displaced during assembly.
5. Index angle fittings and tighten by hand pressing joint together to insure O-ring remains in place.
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 boss O-ring boss seat. It must be free of dirt and defects. If repeated leaks occur, inspect for defects with a magnifying glass. Some raised defects can be removed with a slip stone.



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



3. For angle fittings, loosen special nut and push special washer 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 SPECIFICATIONS

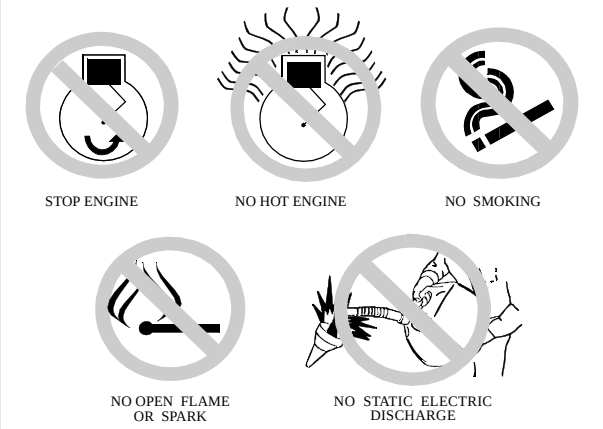
4-CYCLE ENGINES—NORTH AMERICA

⚠ CAUTION

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 no more than 1” below bottom of filler neck;**
- **be sure fill cap is tight after fueling;**
- **clean up any gas spills IMMEDIATELY;**
- **keep machine clean and in good repair—free of excess grease, oil, debris, and faulty or damaged parts;**
- **any storage of machines with gas left in tank should be in an area that is well ventilated to prevent possible igniting of fumes by an open flame or spark, this includes any appliance with a pilot light.**

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

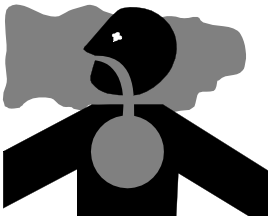
- **ONLY use a clean, approved POLYETHYLENE PLASTIC fuel container and funnel WITHOUT any metal screen or filter.**

To avoid engine damage:

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

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

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



IMPORTANT: DO NOT use METHANOL gasolines because METHANOL is harmful to the environment and to your health.

⚠ WARNING

<u>California Proposition 65 Warning:</u> 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: 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.

OIL AND LUBRICANT SPECIFICATIONS

4–CYCLE GASOLINE ENGINE OIL—NORTH AMERICA

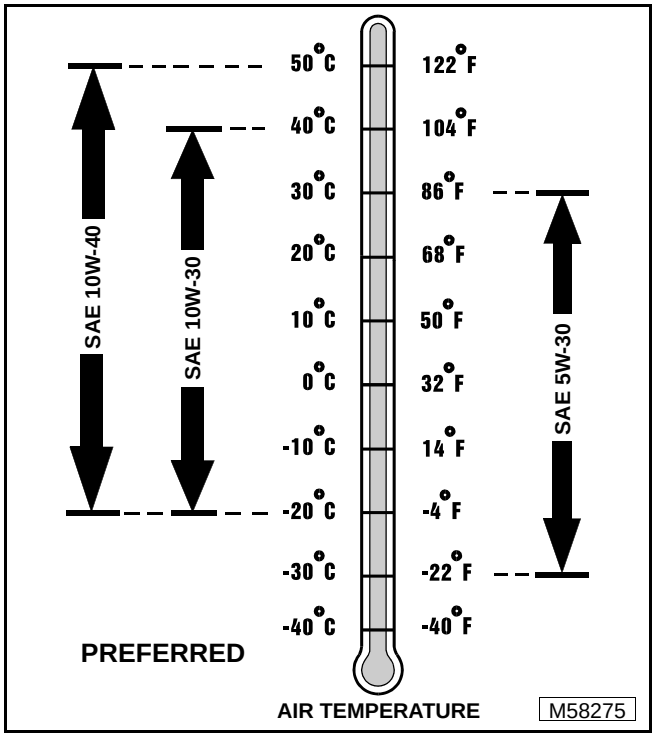
Use the appropriate oil viscosity based on the expected air temperature range during the period between recommended oil changes. Operating outside of these recommended oil air temperature ranges may cause premature engine failure.

The following John Deere oils are **PREFERRED**:

- **TURF–GARD®—SAE 10W-30;**
- **PLUS–4®—SAE 10W-30**;

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

- SAE 10W-30—API Service Classification SG or higher;



HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA

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 or hydraulic system failures.

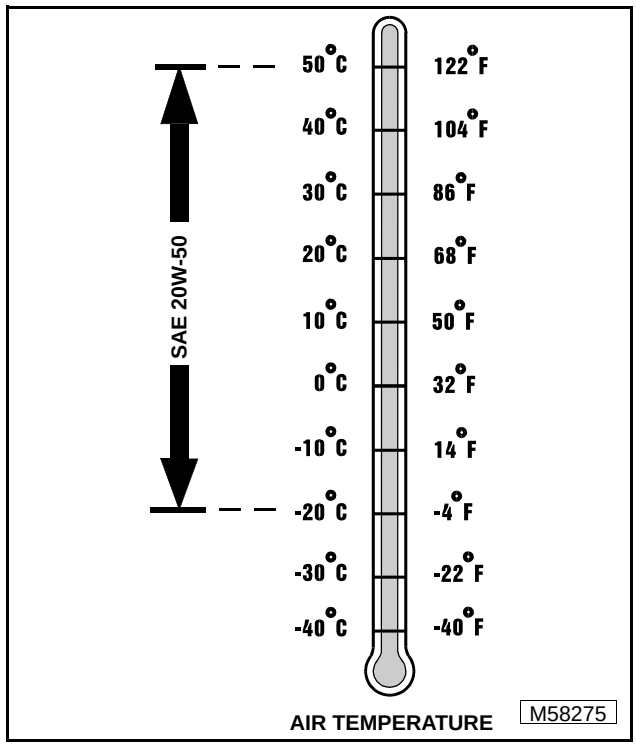
IMPORTANT: DO NOT use engine oil or "Type F" (Red) Automatic Transmission Fluid in this transmission. DO NOT mix any other oils in this transmission. DO NOT use BIO–HY–GARD® in this transmission.

The following oil is **REQUIRED**:

- **SAE 20W-50**.

Oils must meet the following specification:

- API Service Specification SG or higher.



ANTI-CORROSION GREASE SPECIFICATIONS

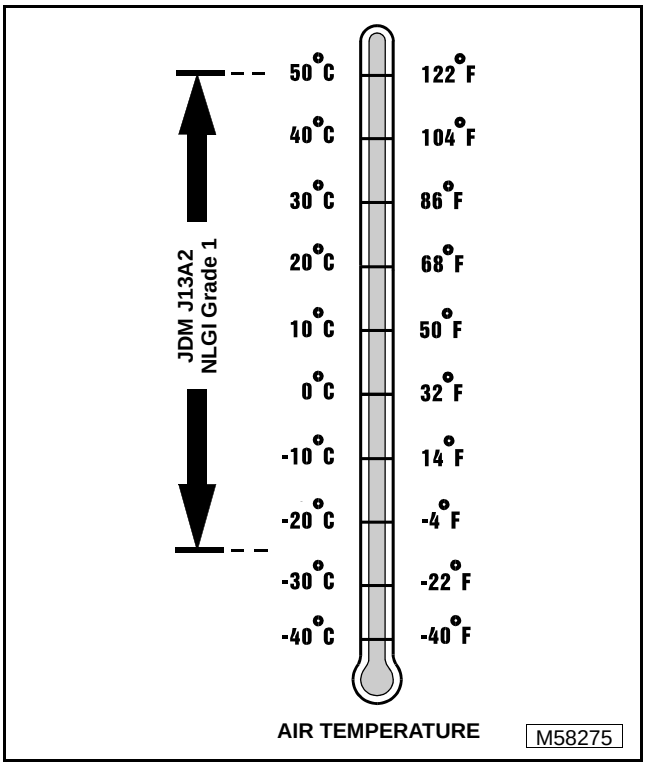
This anti-corrosion grease is formulated to provide the best protection against absorbing moisture, which is one of the major causes of corrosion. This grease is also superior in its resistance to separation and migration.

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

- **DuBois MPG-2® Multi-Purpose Polymer Grease—M79292.**

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

- John Deere Standard JDM J13A2, NLGI Grade 1.



CHASSIS AND MOWER SPINDLE GREASE

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

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

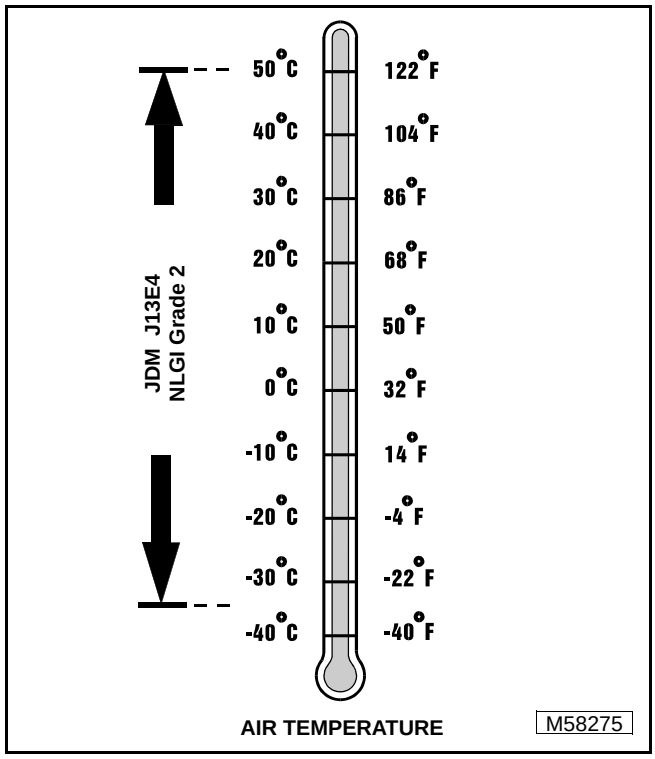
- **Multi-Purpose SD Polyurea Grease—TY6341.**

The following multi-purpose grease may also be used:

- **Multi-Purpose HD Lithium Complex Grease—TY24416.**

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

- John Deere Standard JDM J13E4, NLGI Grade 2.



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: 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.

OIL FILTERS

IMPORTANT: Filtration of oils is critical to proper lubrication performance. Always change filters regularly.

The following John Deere oil filters are PREFERRED:

- AUTOMOTIVE AND LIGHT TRUCK ENGINE OIL FILTERS.

Most John Deere filters contain pressure relief and anti-drainback valves for better engine protection.

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

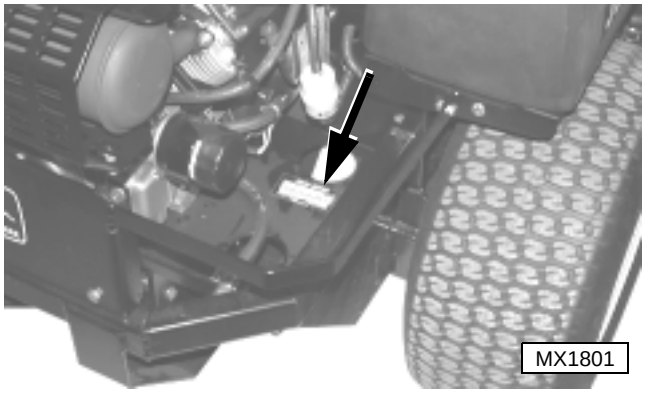
- ASTB Tested In Accordance With SAE J806.

SERIAL NUMBER LOCATIONS

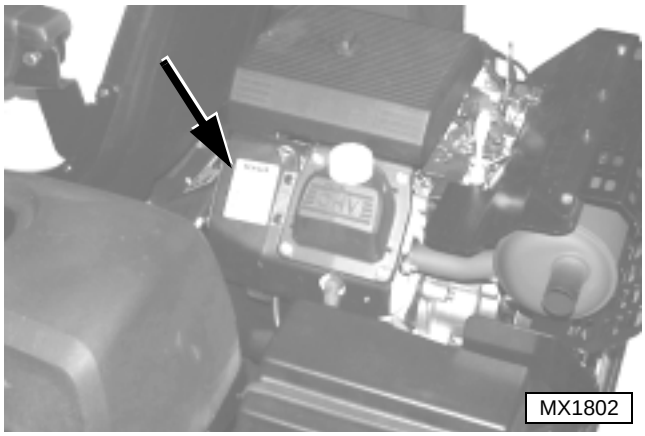
When ordering parts or submitting a warranty claim, it is IMPORTANT the machine product identification number and component serial number are included.

The location of the machine identification number and component numbers are shown.

MACHINE IDENTIFICATION NUMBER



ENGINE SERIAL NUMBER



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CONTENTS

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REPAIR (Continued)

Page

REPAIR (Continued)

SPECIFICATIONS

TEST AND ADJUSTMENT SPECIFICATIONS

Crankcase Vacuum (Minimum at Operating Temp.)	10.2 cm (4 in.) of Water Movement
Fuel Pump Minimum Fuel Flow	10.4 mL (0.35 oz.) in 10 seconds
Oil Pressure (Minimum at 1250 rpm)	124 kPa (18 psi)
Carburetor Slow Idle Mixture Screw Initial Setting	Lightly Seat, then 1 Turn Out
Slow Idle Speed	1400 ±50 rpm
Fast Idle Speed	3600 +50/-0 rpm
Spark Plug:	
Type	Champion® RC12YC (or Equivalent)
Gap	1.02 mm (0.040 in.)
Installation Torque	27 N•m (20 lb-ft)

REPAIR SPECIFICATIONS

Fuel Tank Capacity	30 L (10 gal)
Muffler Mounting Nut Torque	24.4 N•m (216 lb-in.)
PTO Drive Sheave Installation Distance (Rear of sheave flange to Blower Screen)	76 mm (3.0 in.)
Engine Oil Capacity (with Filter, Dry Engine):	
CH22S	1.9 L (2.0 qt)
CH25S	2.0 L (2.1 qt)
Oil Filter Torque	7.5 ±1.5 N•m (65 ±15 lb-in.)
Oil Drain Hose Fitting Torque	14 N•m (124 lb-in.)
Engine Mounting Cap Screw Torque	32 N•m (24 lb-ft)
PTO Clutch Retainer Screw Torque	136 N•m (100 lb-ft)
Air Cleaner Assembly Base Plate Mounting Cap Screw Torque	10 N•m (88 lb-in.)
Carburetor:	
Carburetor Air Horn Cap Screws	1.7 N•m (15 lb-in.)
Carburetor Mounting Fasteners Torque	10 N•m (88 lb-in.)
Float Height	22 mm (0.86 in.)
Throttle Plate Assembly Mounting Cap Screw Torque	10 N•m (88 lb-in.)
Intake Manifold Mounting Cap Screw Torque	10 N•m (88 lb-in.)
Fuel Pump Mounting Cap Screw Torque	2.3 N•m (20 lb-in.)
Oil Cooler Mounting Cap Screw Torque	4.7 N•m (35 lb-in.)
Voltage Regulator/Rectifier Mounting Cap Screw Torque	4.7 N•m (35 lb-in.)
Blower Housing and Shields:	
Mounting Cap Screw Torque (M5 Fasteners)	4.7 N•m (35 lb-in.)
Mounting Cap Screw Torque (M6 Fasteners)	8.6 N•m (65 lb-in.)
Flywheel Screen Cap Screw Torque	10 N•m (88 lb-in.)
Breather Mounting Cap Screw Torque	8.6 N•m (65 lb-in.)
Ignition Modules:	
Mounting Cap Screw Torque	4.0 N•m (35 lb-in.)
Resistance—Primary Side	5—1000 ohms
Resistance—Primary Side (Lead Reversed)	30 000 ohms (Minimum)
Resistance—Secondary Side	7.9—10.85 ohms.
Initial Air Gap	0.25 mm (0.010 in.)
Final Air Gap	0.203—0.305 mm (0.008—0.012 in.)
Flywheel Retaining Screw Torque	66.4 N•m (49 lb-ft)
Stator Mounting Cap Screw Torque	4.0 N•m (35 lb-in.)
Rocker Arm Cover Cap Screw Torque	8 N•m (70 lb-in.)

REPAIR SPECIFICATIONS (Continued)

- Rocker Arm Pivot Bolt Torque . . . . . 14 N•m (124 lb-in.)
- Push Rod —Maximum Bend . . . . . 0.76 mm (0.030 in.)
- Cylinder Head:
  - Spark Plug Installation Torque . . . . . 27.5 N•m (20 lb-ft)
  - Cylinder Head Cap Screw Torque . . . . . 40.7 N•m (30 lb-ft)
  - Cylinder Head Flatness (Maximum Warping) . . . . . 0.076 mm (0.003 in.)
  - Valve Seat Angle . . . . . 45°
  - Valve Seating Width . . . . . 0.50—1.10 mm (0.20—0.043 in.)
- Valve Guides:
  - Intake Valve Guide ID:
    - New . . . . . 7.038—7.058 mm (0.2771—0.2779 in.)
    - Maximum Wear Limit (Standard) . . . . . 7.134 mm (0.2809 in.)
    - Maximum Wear Limit (0.25 mm [0.010 in.] Reamed) . . . . 7.384 mm (0.2907 in.)
  - Exhaust Valve Guide ID:
    - New . . . . . 7.038—7.058 mm (0.2771—0.2779 in.)
    - Maximum Wear Limit (Standard) . . . . . 7.159 mm (0.2819 in.)
    - Maximum Wear Limit (0.25 mm [0.010 in.] Reamed) . . . . 7.409 mm (0.2917 in.)
  - Valve Guide Reamer:
    - Standard . . . . . 7.048 mm (0.2775 in.)
    - Oversize (0.25 mm) . . . . . 7.298 mm (0.2873 in.)
- Intake Valves:
  - Valve Stem-to-Valve Guide Running Clearance . . . . . 0.038—0.076 mm (0.0015—0.0030 in.)
  - Valve Lift (Minimum—Engine Cold) . . . . . 8.07 mm (0.3177 in.)
  - Maximum Valve Stem Bend . . . . . 0.076 mm (0.003 in.)
- Exhaust Valves:
  - Valve Stem-to-Valve Guide Running Clearance . . . . . 0.050—0.088 mm (0.0020—0.0035 in.)
  - Valve Lift (Minimum—Engine Cold) . . . . . 8.07 mm (0.3177 in.)
  - Maximum Valve Stem Bend . . . . . 0.076 mm (0.003 in.)
- Crankcase Cover:
  - Mounting Cap Screw Torque . . . . . 24.4 N•m (216 lb-in.)
  - Crankshaft Bore ID (Wear Limit) . . . . . 41.003 mm (1.6143 in.)
  - Oil Seal Installation Depth . . . . . 2.03 mm (0.08 in.)
- Governor:
  - Control Lever Cap Screw/Nut Torque . . . . . 10 N•m (88 lb-in.)
  - Cross Shaft OD:
    - New . . . . . 5.975—6.012 mm (0.2352—0.2367 in.)
    - Wear Limit . . . . . 5.962 mm (0.235 in.)
  - Crankcase-to-Cross Shaft Running Clearance . . . . . 0.013—0.075 mm (0.0005—0.0030 in.)
  - Gear Shaft OD:
    - New . . . . . 5.990—6.000 mm (0.2358—0.2362 in.)
    - Wear Limit . . . . . 5.977 mm (0.235 in.)
  - Gear Shaft-to-Governor Gear Running Clearance . . . . . 0.015—0.140 mm (0.0006—0.0055 in.)
  - Gear Shaft Installation Depth . . 34.0 mm (1.34 in.) above Flat on Crankcase Cover
- Oil Pump:
  - Relief Valve Spring Free Length . . . . . 47.4 mm (1.80 in.)
  - Oil Pump Screws:
    - First Time (Installation in a new cover) . . . . . 10.7 N•m (95 lb-in.)
    - Reinstallation . . . . . 6.7 N•m (60 lb-in.)

REPAIR SPECIFICATIONS, continued

Camshaft:
- Maximum End Play (with Shim) . . . . . 0.076—0.127 mm (0.003—0.005 in.)
- Bearing-to-Bore Clearance . . . . . 0.025—0.063 mm (0.0010—0.0025 in.)
- Bore ID:
  - New . . . . . 20.000—20.025 mm (0.7874—0.7884 in.)
  - Wear Limit . . . . . 20.038 mm (0.7889 in.)
- Bearing Surface OD:
  - New . . . . . 19.962—19.975 mm (0.7859—0.7864 in.)
  - Wear Limit . . . . . 19.959 mm (0.7858 in.)

Hydraulic Lifter-to-Crankcase
- Running Clearance . . . . . 0.0124—0.0501 mm (0.0005—0.0020 in.)

Pistons:
- Piston-to-Pin Clearance . . . . . 0.006—0.017 mm (0.0002—0.0007 in.)
- Piston Pin Bore ID:
  - New . . . . . 17.006—17.012 mm (0.6695—0.6698 in.)
  - Wear Limit . . . . . 17.025 mm (0.6703 in.)
- Piston Pin OD:
  - New . . . . . 16.995—17.000 mm (0.6691—0.6693 in.)
  - Wear Limit . . . . . 16.994 mm (0.6691 in.)
- Top Compression Ring-to-Groove Side Clearance
  - CH22S . . . . . 0.040—0.080 mm (0.0016—0.0031 in.)
  - CH25S . . . . . 0.025—0.048 mm (0.0010—0.0019 in.)
- Middle Compression Ring-to-Groove Side Clearance
  - CH22S . . . . . 0.040—0.072 mm (0.0016—0.0028 in.)
  - CH25S . . . . . 0.015—0.037 mm (0.0006—0.0015 in.)
- Oil Control Ring-To-Groove Side Clearance
  - CH22S . . . . . 0.060—0.202 mm (0.0024—0.0080 in.)
  - CH25S . . . . . 0.026—0.176 mm (0.0010—0.0070 in.)
- Top and Center Compression Ring End Gap—CH22S:
  - New Bore . . . . . 0.25—0.45 mm (0.0098—0.0177 in.)
  - Used Bore (Maximum Wear Limit) . . . . . 0.77 mm (0.030 in.)
- Top and Center Compression Ring End Gap—CH25S:
  - New Bore . . . . . 0.25—0.56 mm (0.0100—0.0224 in.)
  - Used Bore (Maximum Wear Limit) . . . . . 0.94 mm (0.037 in.)
- Piston Thrust Face OD—CH22S:
  - Standard:
    - New . . . . . 76.967—76.985 mm (3.0302—3.0309 in.)
    - Wear Limit . . . . . 76.840 mm (3.0252 in.)
  - 0.50 mm (0.020 in.) Oversize Piston:
    - New . . . . . 76.967—76.985 mm (3.0302—3.0309 in.)
    - Wear Limit . . . . . 77.34 mm (3.0452 in.)
- Piston Thrust Face OD—CH25S:
  - Standard:
    - New . . . . . 82.986 mm (3.3194 in.)
    - Wear Limit . . . . . 82.841 mm (3.3136 in.)
  - 0.50 mm (0.020 in.) Oversize Piston:
    - New . . . . . 83.486 mm (3.339 in.)
    - Wear Limit . . . . . 83.341 mm (3.336 in.)
- Piston Thrust Face-to-Cylinder Bore Clearance:
  - CH22S . . . . . 0.015—0.058 mm (0.0006—0.0023 in.)
  - CH25S . . . . . 0.002—0.045 mm (0.001—0.0018 in.)

REPAIR SPECIFICATIONS, continued

- Connecting Rod:
  - Connecting Rod Cap Screws Torque . . . . . 17.3 N•m (130 lb-in.)
  - Connecting Rod Journal OD:
    - New . . . . . 35.955—35.973 mm (1.4156—1.4163 in.)
    - Wear Limit . . . . . 35.94 mm (1.415 in.)
    - Maximum Taper . . . . . 0.018 mm (0.0007 in.)
    - Maximum Out-of-Round . . . . . 0.025 mm (0.0010 in.)
  - Connecting Rod-to-Crankpin Running Clearance:
    - New . . . . . 0.030—0.055 mm (0.0012—0.0022 in.)
    - Wear Limit . . . . . 0.07 mm (0.0028 in.)
  - Connecting Rod-to-Crankpin Side Clearance. 0.26—0.63 mm (0.0102—0.0248 in.)
  - Connecting Rod-to-Piston Pin Running Clearance. . . . . 0.015—0.028 mm (0.0006—0.0011 in.)
  - Piston Pin End ID:
    - New . . . . . 17.015—17.023 mm (0.6699—0.6702 in.)
    - Wear Limit . . . . . 17.036 mm (0.6707 in.)
- Cylinder Block:
  - Cylinder Bore ID—CH22S:
    - New . . . . . 77.000—77.025 mm (3.0315—3.0325 in.)
    - Wear Limit . . . . . 77.063 mm (3.0340 in.)
    - Maximum Out-of-Round . . . . . 0.12 mm (0.0047 in.)
    - Maximum Taper . . . . . 0.05 mm (0.0020 in.)
  - Cylinder Bore ID—CH25S:
    - New . . . . . 83.000—83.025 mm (3.367—3.268 in.)
    - Wear Limit . . . . . 83.063 mm (3.270 in.)
    - Maximum Out-of-Round . . . . . 0.12 mm (0.0047 in.)
    - Maximum Taper . . . . . 0.05 mm (0.0020 in.)
- Crankshaft:
  - End Play (Free). . . . . 0.070—0.480 mm (0.0028—0.0189 in.)
  - Crankshaft Sleeve Bearing (Crankcase) New 0.03—0.09 mm (0.0012—0.0035 in.)
  - Crankshaft Sleeve Bearing ID (Crankcase):
    - New . . . . . 40.965—41.003 mm (1.6128—1.6143 in.)
    - Wear Limit . . . . . 41.016 mm (1.6148 in.)
  - Crankshaft Bore (in Crankcase Cover)-to-Crankshaft Running Clearance—New . . . . . 0.039—0.074 mm (0.0015—0.0029 in.)
  - Main Bearing Journal OD (Flywheel End):
    - New . . . . . 40.913—40.935 mm (1.6107—1.6116 in.)
    - Wear Limit . . . . . 40.84 mm (1.608 in.)
    - Maximum Taper . . . . . 0.022 mm (0.0009 in.)
    - Maximum Out-of-Round . . . . . 0.025 mm (0.0010 in.)
  - Main Bearing Journal OD (Closure Plate End):
    - New . . . . . 40.913—40.935 mm (1.6107—1.6116 in.)
    - Wear Limit . . . . . 40.84 mm (1.608 in.)
    - Maximum Taper . . . . . 0.022 mm (0.0009 in.)
    - Maximum Out-of-Round . . . . . 0.025 mm (0.0010 in.)
  - Crankshaft Total Indicated Runout (TIR):
    - PTO End (Crankshaft in Engine) . . . . . 0.15 mm (0.0059 in.)
    - Entire Crankshaft (in Bench V-Blocks) . . . . . 0.10 mm (0.0039 in.)
  - Starting Motor Mounting Cap Screw Torque. . . . . 15.3 N•m (135 lb-in.)

SERVICE PARTS KITS

The following kits are available through your parts catalog:

- Gear Kit
- Governor Gear with Pin Kit
- Crankcase Cover Kit
- Oil Cooler Kit
- Breather Cover and Gasket Kit
- Rocker Arm Cover Kit (Right and Left)
- Rocker Arm and Push Rod Kit
- Oil Filler Cap and O-Ring Kit
- Piston Ring Kit—22 hp (Standard)
- Piston Ring Kit—22 hp (0.50 mm [0.020 in.] oversize)
- Piston Ring Kit—25 hp (Standard)
- Piston Ring Kit—25 hp (0.50 mm [0.020 in.] oversize)
- Extension Shaft Kit
- Engine Overhaul Gasket Kit
- Choke Repair Kit
- Float Repair Kit
- Fuel Shutoff Solenoid Kit
- Carburetor Repair Kit
- Air Cleaner Knob with Seal Kit
- Starting Motor Repair Kit
- Starting Motor Brush and Spring Kit

TROUBLESHOOTING

ENGINE AND FUEL SYSTEM TROUBLESHOOTING CHART

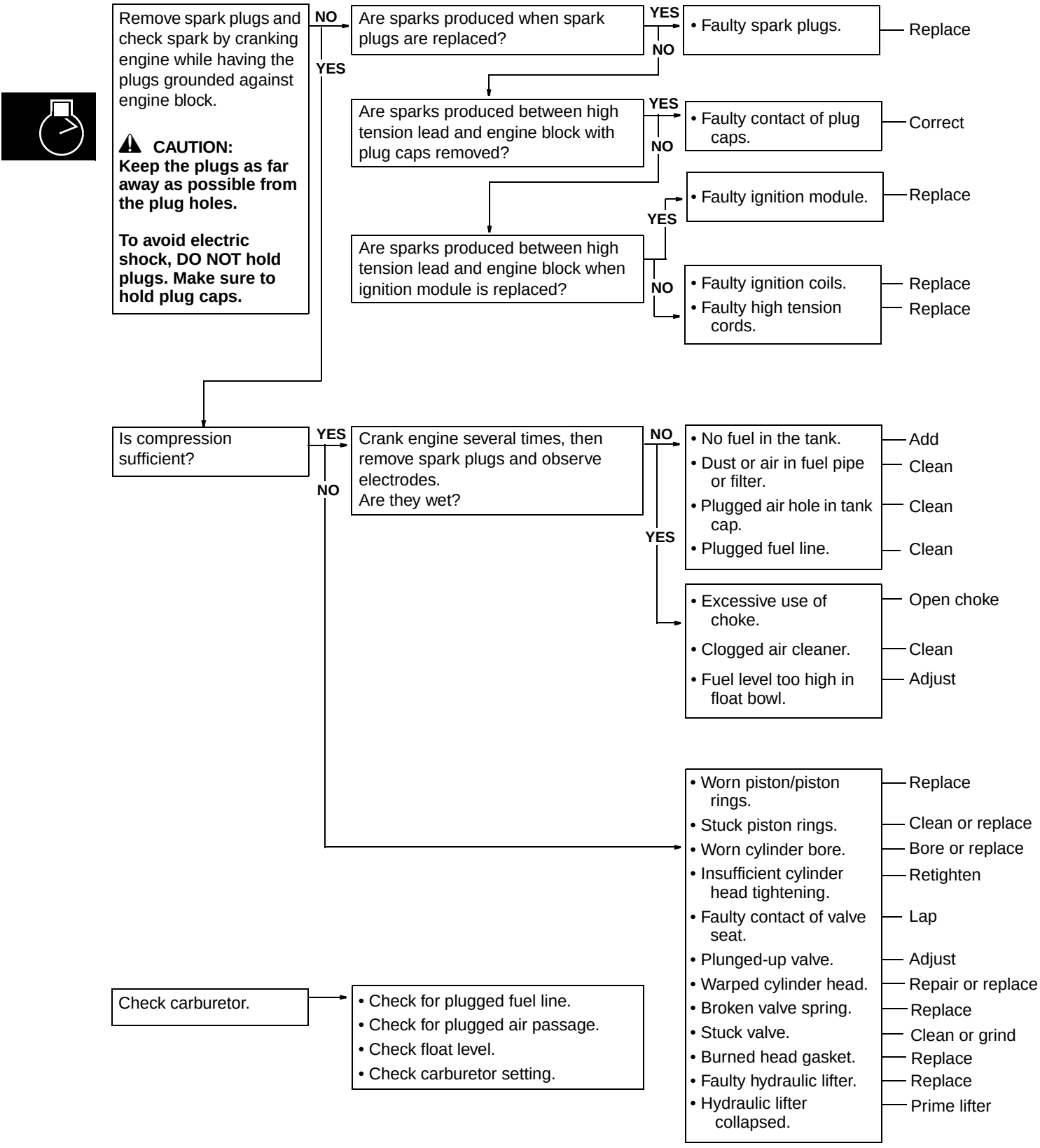
Problem or Symptom / Check or Solution	Engine cranks, but will not start, or starts hard.	Engine will not stay running, runs rough or irregularly.	Engine surges, or has uneven or uncontrolled rpm.	Hydraulic lifters are noisy.	Engine has low power under load.	White smoke on start-up.	Exhaust smoke blue or high oil consumption	Exhaust smoke black, engine floods or burns rich	Engine won't shut off.	Engine has low oil pressure	Engine overheats	Engine stalls frequently	Excessive engine noise or vibration.	Engine backfires	Fuel in oil
Carburetor worn, contaminated with debris or varnish. Passages plugged. Wrong jets.	●	●	●		●			●				●		●	
Carburetor float mis-adjusted or sticking.								●							●
Choke, throttle or governor linkage misadjusted. Carburetor misadjusted.	●	●	●		●			●						●	●
Air being drawn in through hole in fuel lines.	●	●	●		●									●	
Improper use of choke.	●	●			●			●				●			●
Spark plug fouled, faulty or gap not correct. Incorrect spark plug.	●	●			●			●			●				●
Carburetor, intake manifold, or cylinder head gaskets leaking or damaged.	●	●	●		●						●	●	●	●	
Faulty ignition components.	●	●	●		●			●				●		●	●
Faulty fuel shutoff solenoid. Fuel shutoff solenoid not activated. (See RUN CIRCUIT OPERATION in ELECTRICAL Section.)	●														
Fuel tank shutoff valve closed.	●	●													
Faulty fuel pump.	●														
Fuel filter or line restricted.	●	●	●		●							●			
Fuel stale, contains water, or wrong type	●	●	●		●	●						●			
Fuel tank cap vent blocked.	●	●	●		●							●			

Problem or Symptom / Check or Solution	Engine cranks, but will not start, or starts hard.	Engine will not stay running, runs rough or irregularly.	Engine surges, or has uneven or uncontrolled rpm.	Hydraulic lifters are noisy.	Engine has low power under load.	White smoke on start-up.	Exhaust smoke blue or high oil consumption	Exhaust smoke black, engine floods or burns rich	Engine won't shut off.	Engine has low oil pressure	Engine overheats	Engine stalls frequently	Excessive engine noise or vibration.	Engine backfires	Fuel in oil
Air filter element(s) plugged or oil soaked or restricted.	●	●	●		●			●				●			●
Low compression from worn pistons, rings, cylinders, valves or warped heads.	●	●	●		●		●						●		
Burned or warped valves and seats.	●	●	●		●							●		●	
Faulty/broken valve springs.	●	●	●		●							●	●	●	
Valve stems, guides or seals worn or leaking.	●	●	●		●		●					●		●	
Governor shaft binding.			●												
Faulty hydraulic lifter.															
Hydraulic lifter collapsed.				●	●										
Hydraulic lifter stuck in bore.				●	●										
Ignition switch faulty and/or not properly grounded. (See RUN CIRCUIT OPERATION in ELECTRICAL Section.)									●						
High carbon build-up on pistons, valves, cylinder heads and muffler.					●				●		●	●	●		
Prime hydraulic lifters.											●	●			
Bleed hydraulic lifters.	●				●						●	●			
Engine oil viscosity or level incorrect.	●				●		●			●	●		●		
Engine oil filter plugged.	●				●					●	●		●		
Cooling fan damaged.											●		●		
Engine cooling fins plugged with debris.											●				

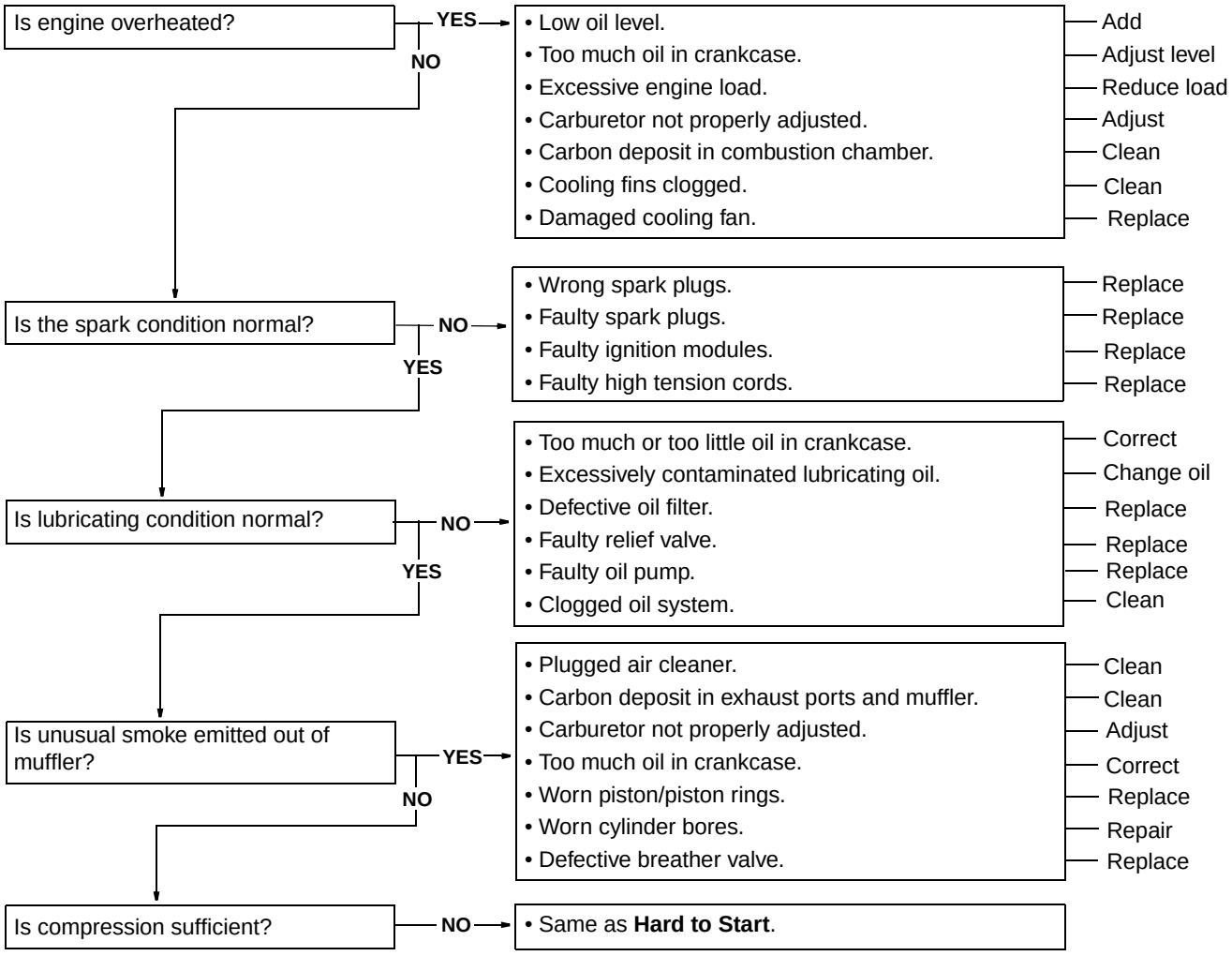
Problem or Symptom / Check or Solution	Engine cranks, but will not start, or starts hard.	Engine will not stay running, runs rough or irregularly.	Engine surges, or has uneven or uncontrolled rpm.	Hydraulic lifters are noisy.	Engine has low power under load.	White smoke on start-up.	Exhaust smoke blue or high oil consumption	Exhaust smoke black, engine floods or burns rich	Engine won't shut off.	Engine has low oil pressure	Engine overheats	Engine stalls frequently	Excessive engine noise or vibration.	Engine backfires	Fuel in oil
Blower screen plugged with debris.											●				
Excessive engine loading.											●		●		
Engine oil cooler fins clogged.											●				
Engine gaskets or seals leaking.	●	●	●		●							●		●	
Oil pump components worn or oil passages obstructed.							●								
Crankcase breather restricted, reed valve damaged, clearance incorrect, or drain hole plugged.	●	●	●		●		●			●	●	●			
Exhaust system (muffler) restricted.					●					●	●				
Connecting rod or crankshaft bearings worn.	●	●	●		●					●	●	●	●		
PTO clutch engaged (external load on engine).	●														
Engine mounting hardware loose or broken.			●		●								●		

ENGINE AND FUEL SYSTEM TROUBLESHOOTING GUIDE

Engine Hard to Start



Engine Has Low Power



Engine Runs Erratically

Problem in fuel system (lack of fuel).	• Dust or water in fuel pipe.	Clean
	• Vapor lock in fuel line.	Clean
	• Plugged air vent of fuel tank cap.	Clean
	• Plugged air/fuel passages in carburetor.	Clean
	• Carburetor not properly adjusted.	Adjust
Problem in fuel system (engine running lean).	• Carburetor flange leaking at gasket.	Replace
	• Carburetor body and throttle shaft worn.	Replace
	• Carburetor not properly adjusted.	Adjust
	• Air in fuel line.	Correct
Problem in ignition system.	• Spark plugs fouled, pitted, or gapped incorrectly.	Replace
	• Faulty ignition module(s).	Replace
Problem in governor system.	• Incorrect governor linkage adjustment.	Adjust
	• Faulty governor spring.	Replace
	• Governor gear assembly malfunction.	Correct

Engine Malfunctions at High Speed

Is revolution fluctuation of relatively large period produced when a load is applied.	YES	• Plugged air hole in tank cap.	Clean
		• Dust and air in fuel filter or fuel pipe.	Clean

Fuel Consumption Is Excessive

Is compression sufficient?	YES	• High fuel level in carburetor float chamber (including overflow).	Adjust
		• Faulty ignition module(s).	Replace
		• High idling rpm.	Adjust
		• Choke partially closed.	Open
		• Carburetor not adjusted properly.	Adjust
	NO	• Same as **Hard to Start**.	

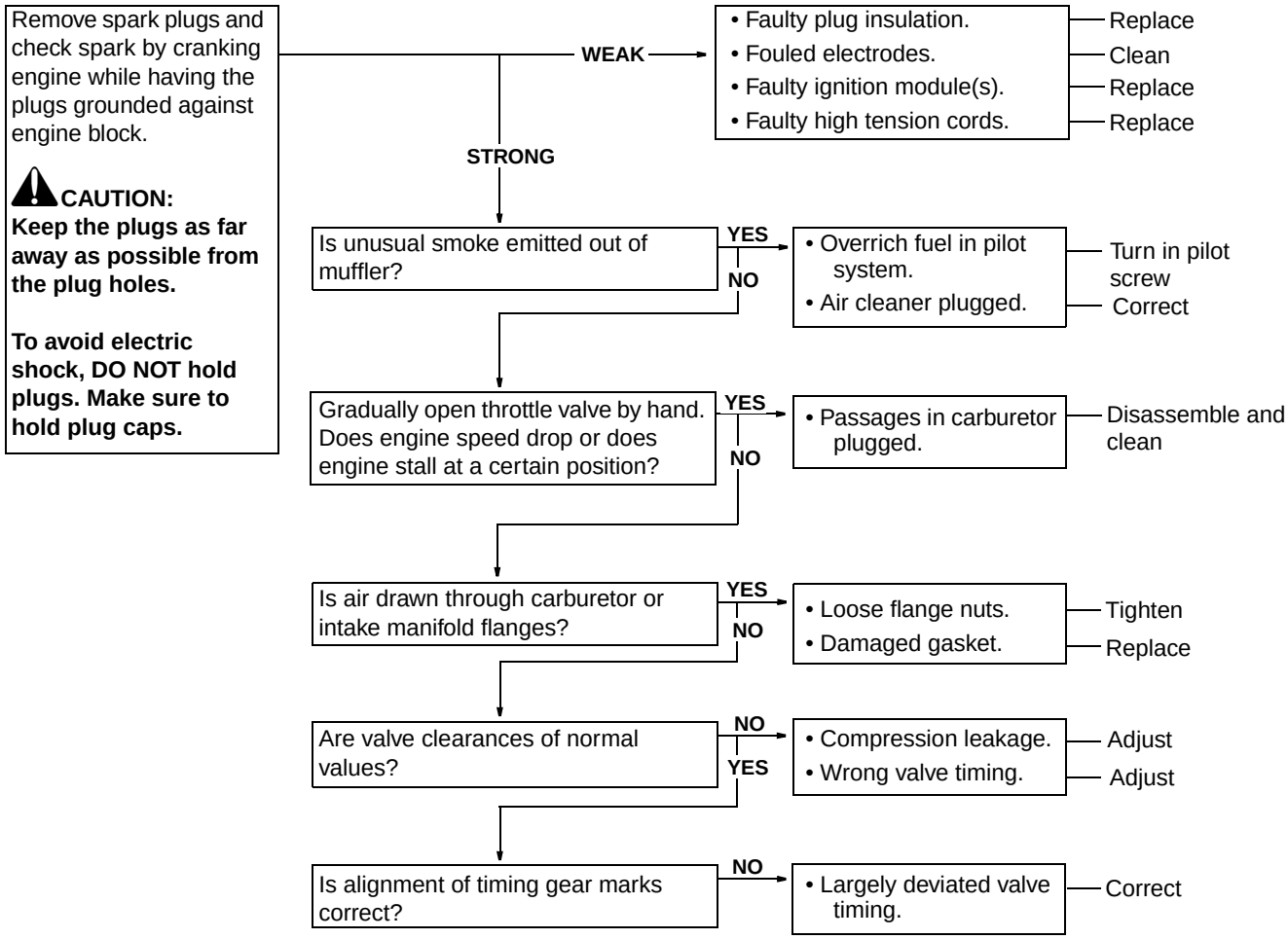
Engine Backfire

• Loose carburetor or intake manifold.	Tighten
• Loose cylinder head or leaking head gasket.	Tighten
• Burned or sticking intake valves.	Replace
• Faulty pulser coils.	Replace
• Carburetor not properly adjusted.	Adjust

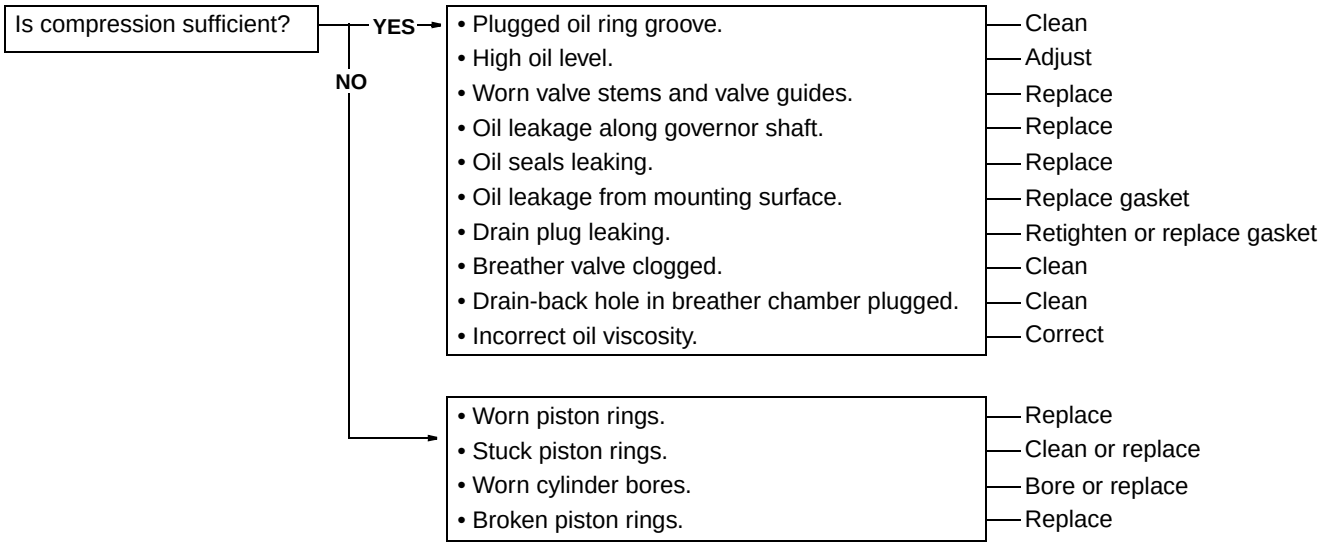
Engine Knocks

• Stale fuel.	Change
• Excessive carbon deposit in engine.	Clean
• Excessive engine load.	Adjust
• Engine overheating.	See **Engine Has Low Power**
• Faulty igniter.	Replace

Engine Malfunctions at Low Speed



Oil Consumption Is Excessive



STARTING MOTOR TROUBLESHOOTING GUIDE

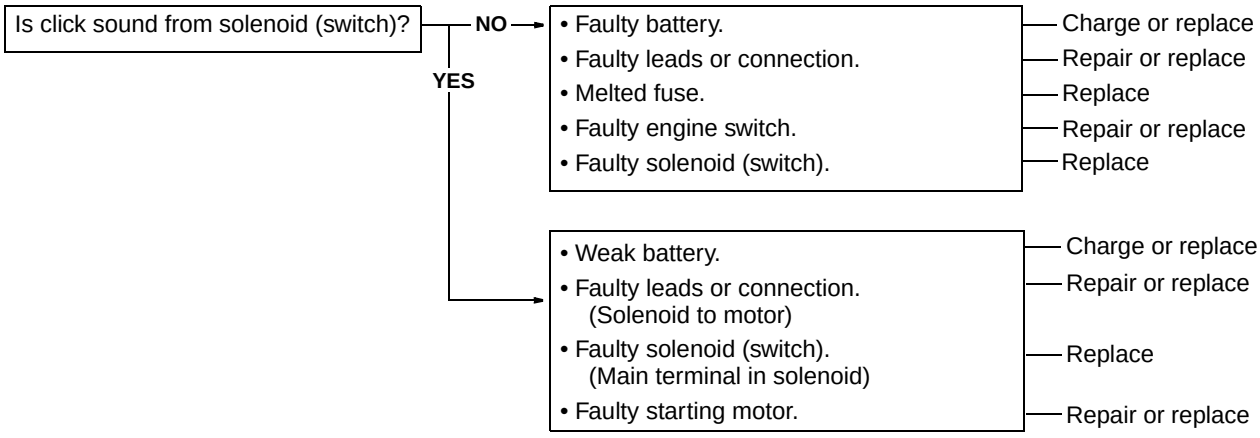
1. Disconnect spark plug caps and ground the cap terminals.
2. Turn engine switch to START position and check condition.

⚠ CAUTION

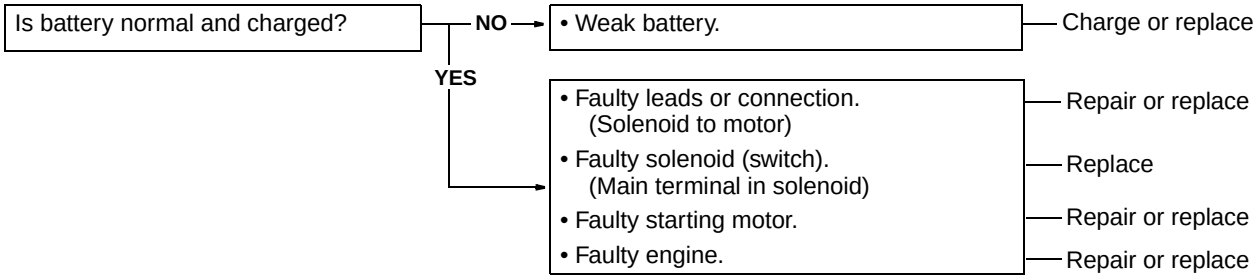
Engine may be cranked in this test. DO NOT touch any rotating parts of engine and equipment during test.

IMPORTANT: If starter does not stop by moving ignition switch to OFF position, disconnect negative (-) lead from battery as soon as possible.

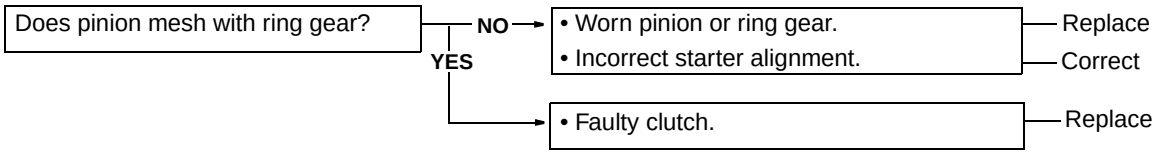
Starting Motor Does Not Rotate



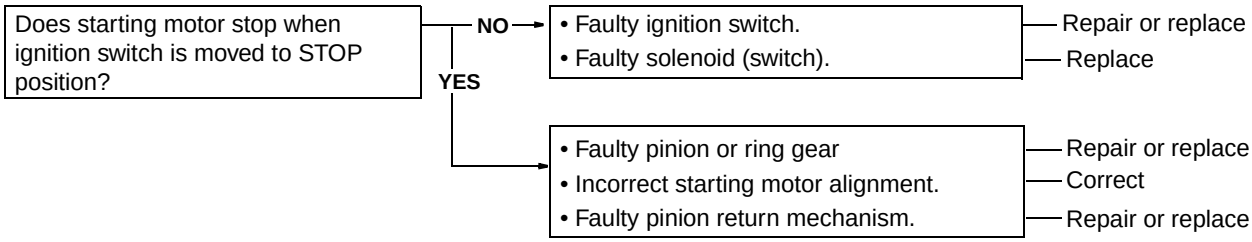
Starting Motor Rotates Slow



Starting Motor Rotates Slowly but Cannot Crank Engine



Starting Motor Does Not Stop If Ignition Switch is Moved to STOP Position



TESTS AND ADJUSTMENTS

CYLINDER LEAKDOWN TEST

Reason:

To determine if compression is leaking from the cylinder due to component wear or damage.

Test Equipment:

- JT-03502 Cylinder Leakdown Test Kit

Procedure:

⚠ CAUTION

Engine components are HOT. DO NOT touch with bare skin, especially the exhaust pipe or muffler while making test. Wear protective eye glasses and clothing.

1. Park machine safely.
2. Move control levers to NEUTRAL position.
3. Run engine for approximately five minutes to bring the engine to normal operating temperature.
4. Turn key switch to OFF position.
5. Remove spark plugs from engine.
6. Remove air cleaner assembly. (See AIR CLEANER ASSEMBLY—REMOVAL/INSTALLATION.)
7. Rotate crankshaft until piston (of cylinder being tested) is at top dead center of compression stroke. This position must be maintained while testing.
8. Remove spark plug and install JT-03502 Cylinder Leakdown test fitting.
9. Connect air source of at least 345 kPa (50 psi) to the tester.
10. Turn the regulator knob in the increase (clockwise) direction until the gauge needle is in the yellow “set” area at the low end of the scale.
11. Connect tester quick-disconnect to the adapter hose while firmly holding the engine at TDC. Record the gauge reading and listen for escaping air at the carburetor intake, exhaust outlet, and crankcase breather.

Results:

NOTE: All engines will leak air past the piston rings to some extent. Rings are worn if leakage is excessive.

- Air escaping from crankcase breather—Check for worn rings and/or worn cylinder walls
- Air escaping from exhaust system—Check for worn or damaged exhaust valves and/or valve seats.
- Air escaping from carburetor—Check for worn or damaged intake valves and/or valve seats.
- Gauge reading in “low” (green) zone—Piston rings and cylinder in good condition
- Gauge reading in “moderate” (yellow) zone—Engine is still usable, but there is some wear present. Customer should start planning for overhaul or replacement.
- Gauge reading in “high” (red) zone—Rings and/or cylinder have considerable wear. Engine should be reconditioned or replaced.

CRANKCASE VACUUM TEST

Reason:

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

Test Equipment:

- JT05697 U-Tube Manometer Kit

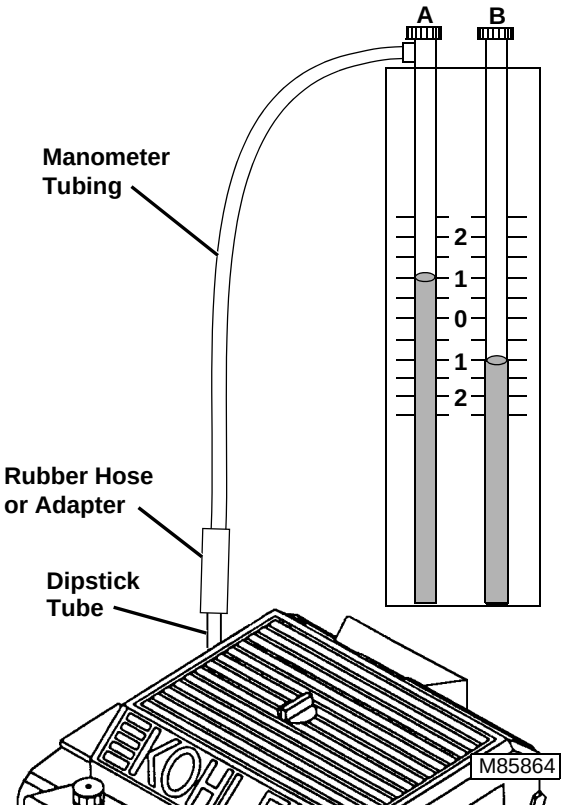
Procedure:

⚠ CAUTION

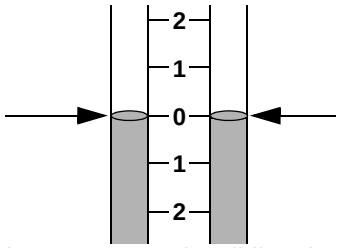
Engine components are HOT. DO NOT touch with bare skin, especially the exhaust pipe or muffler while making test. Wear protective eye glasses and clothing.

1. Park machine safely.
2. Move control levers to NEUTRAL position.
3. Run engine for approximately five minutes to bring the engine to normal operating temperature.
4. Turn key switch to OFF position.
5. Attach manometer magnets to solid metal surface.

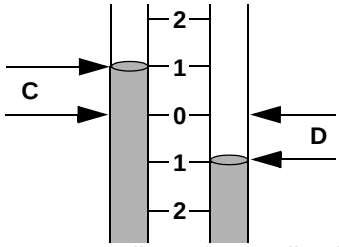
IMPORTANT: Attaching manometer to engine before starting engine will cause all of the water in the manometer to be drawn into the engine crankcase. DO NOT use more than 3 feet of manometer tubing. If a longer hose is used the manometer readings will be inaccurate. Some units require a rubber hose (adapter)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



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



7. Zero out the manometer by sliding the ruled scale up or down so “0” mark is located where water level on both sides is even.
8. Start and run engine at FAST idle **(3600 +50/-0 rpm)**.
9. Allow engine to reach operating temperature.
10. Quickly remove engine dipstick and attach hose from manometer to dipstick opening.



11. Record vacuum reading. The reading is obtained by adding (C) and (D) water movement from “0”. In this case reading should be 2 inches of vacuum (1 inches + 1 inch—C + D). Reading from (C) should always be above the “0” mark. If reading from (C) (actual crankcase vacuum) is below the “0” mark then crankcase is pressurized causing seals to leak oil.
12. Repeat test at least three times for accuracy. DO NOT shut off engine. To repeat test, remove the manometer tube from top of manometer at valve (A). DO NOT remove manometer tube from engine. Reset manometer at zero—see step 3. Reattach manometer tube to valve (A) and record reading.
13. Remove line from manometer (valve “A”) before stopping engine. Then remove dipstick hose connection and install dipstick.

Results:

If crankcase vacuum reading is greater than **10.2 cm (4 in.) of water movement** 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

FUEL FLOW TEST

Reason:

To determine fuel availability to the carburetor.

Test Equipment:

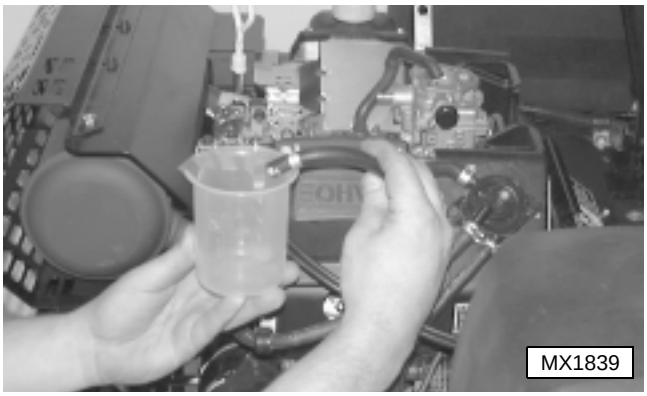
- Graduated Container

Procedure:

⚠ CAUTION

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 safely.
2. Remove air cleaner assembly. (See AIR CLEANER ASSEMBLY—REMOVAL/INSTALLATION.)



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

3. Disconnect fuel line from carburetor and place in measured container.
4. Disconnect both spark plug wires from spark plugs. Place the ends of the wires away from the container.

*NOTE: Crank engine 5 seconds at a time. Vacuum needs to build before fuel will flow. When fuel starts to flow, stop cranking, empty container, then time test for **10 seconds**. DO NOT crank more than 10 seconds continuously.*

5. Crank engine (it should not start) and catch fuel in measured container. Measure amount of fuel. Minimum fuel delivery rate must be **10.4 mL (0.35 oz.) in 10 seconds**.

Results:

If fuel flow is below specifications, check the following:

- Check fuel lines, shut-off valve, fuel tank outlet, and fuel tank cap for restrictions
- Replace fuel filter and/or fuel pump

OIL PRESSURE TEST

Reason:

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

Test Equipment:

- JT07262 Oil Pressure Test Kit
- JT05487 Fitting
- JT07034 Gauge
- JT03262 Coupler
- JT03017 Hose

Procedure:

⚠ CAUTION

Engine components are HOT. DO NOT touch with bare skin, especially the exhaust pipe or muffler while making test. Wear protective eye glasses and clothing.

1. Park machine safely.
2. Remove oil filter. (Plastic bag may be used to protect paint and channel oil to drain pan).
3. Install pressure tester to oil filter flange.
4. Check engine oil level, bring level to full mark.
5. Check oil pressure when oil is both cold and hot, and at both idle and full throttle.
6. Start engine and run until hot. (Be sure to maintain full crankcase oil level during testing).

Results:

- Oil pressure on a **cold** engine at start-up, as a minimum **414 kPa (60 psi)** (pressure relief valve will open beyond this pressure).
- Oil pressure at operating temperature **(warm engine** at idle) may be as low as **124 kPa (18 psi)**.

SPARK TEST

Reason:

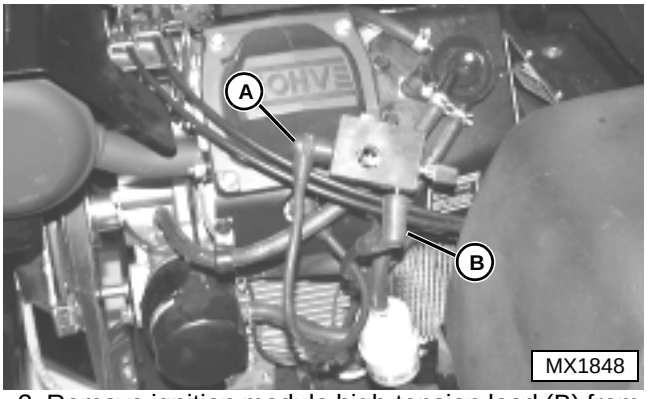
To check the overall condition of the ignition system.

Test Equipment:

- D-05351ST Spark Tester

Procedure:

1. Park machine safely.



2. Remove ignition module high-tension lead (B) from spark plug.
3. Connect D-05351ST Spark Tester lead (B) to spark plug.
4. Connect high-tension lead to tester.

IMPORTANT: DO NOT adjust spark tester gap beyond 5.0 mm (0.200 in.), as damage to ignition components could occur.

5. Adjust spark tester to **4.2 mm (0.166 in.)** with screw.
6. Move key switch to START position. Spin engine with starter and watch spark at spark tester.

Results:

- Steady, strong spark: Ignition is good. If engine will not start, check fuel supply and engine compression.
- If spark is weak or no spark, install new spark plug(s).
- If spark is still weak or no spark after replacing spark plug(s), test ignition module air gap. (See IGNITION MODULES—TEST in ELECTRICAL section.)

THROTTLE AND CHOKE CABLE ADJUSTMENT

Reason:

To make sure the throttle and choke cables are able to move through the full range of movement.

Equipment:

- 5 mm (15/64 in.) Drill Bit

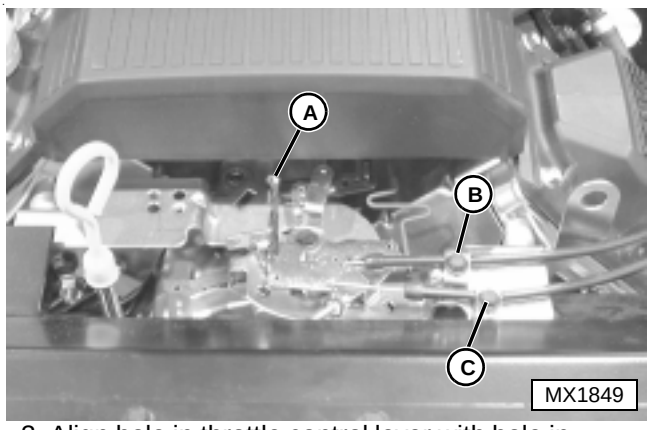
Procedure:

CAUTION

Avoid bodily injury. Engine and muffler shield may be hot. Wear gloves to avoid burning hands or wait for engine to cool.

NOTE: Adjust throttle cable before adjusting choke.

1. Park machine safely.
2. Move throttle lever to FULL throttle position.



3. Align hole in throttle control lever with hole in throttle control plate. Insert a **5 mm (15/64 in.)** drill bit (A) through holes to keep the throttle control lever from moving. Be sure drill bit is perpendicular to the throttle control plate.
4. Loosen cap screw (B) and pull throttle cable housing tight. Tighten cap screw.
5. Pull operator choke control out. Choke (butterfly) should be fully closed.
6. Loosen cap screw (C) and pull choke cable housing tight. Tighten cap screw.
7. Remove drill bit.
8. Move operator throttle lever and choke knob through full range to be sure throttle or choke linkage is not binding.

SLOW IDLE SPEED ADJUSTMENT

ATTENTION

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. These carburetors have no fast idle adjustment—the main jet is set at the factory.

Reason:

To set engine slow idle mixture and rpm.

IMPORTANT: 1500 and 3000 meter high altitude jet kits are available. These jets must be installed by an authorized repair facility.

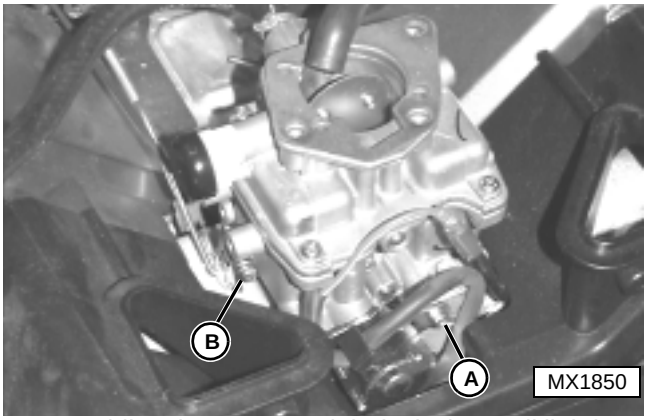
Equipment:

- JT07270 Pulse Tachometer

Procedure:

1. Park machine safely.
2. Remove air cleaner assembly. (See AIR CLEANER ASSEMBLY—REMOVAL/INSTALLATION.)
3. Connect pulse tachometer.

IMPORTANT: DO NOT force the SLOW idle mixture screw tight; this will damage the needle and seat. Air cleaner removed for photo; DO NOT remove for adjustment.



4. Turn idle mixture screw (A) clockwise until lightly seated, then turn counterclockwise 1 turn.
5. Start and run engine at MEDIUM idle for 5 minutes to obtain operating temperature. The carburetor has a self-relieving choke. Choke plate and shaft assembly is spring loaded. Check to make sure plate moves freely and is not binding and affecting idle fuel delivery.
6. Move throttle lever to SLOW idle position.
7. Use a pulse tachometer to check engine rpm.
8. Turn SLOW idle stop screw (B) in either direction until specified **SLOW idle speed of 1400 ± 50 rpm** is reached.
9. Turn idle mixture screw in (slowly) until engine speed drops. Note the position of screw when rpm drops. Back out screw **approximately 3/4 turn**.
10. Recheck slow idle and adjust slow idle stop screw again if necessary.

SPARK PLUG GAP ADJUSTMENT

Test Equipment:

- Feeler Gauge

Procedure:

1. Park machine safely.

CAUTION

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

2. Remove spark plugs.

IMPORTANT: Do not clean spark plug with sandpaper or abrasives. Engine scoring can result.

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

5. Check spark plug gap using a feeler gauge. Set gap to **1.02 mm (0.040 in.)**.
6. Install and tighten spark plug to **27 N•m (20 lb-ft)**.

REPAIR

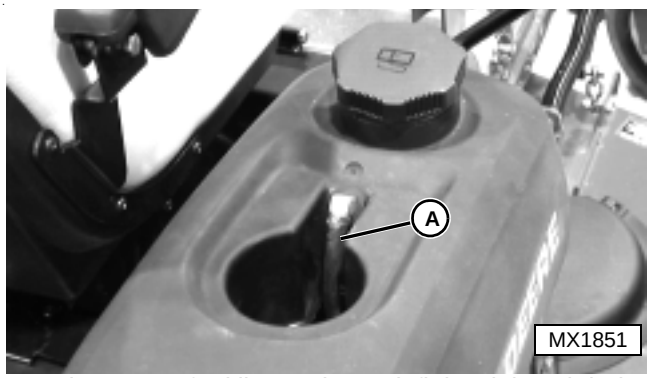
FUEL TANKS—REMOVAL/INSTALLATION

NOTE: The procedure is the same to remove and install the right or left fuel tank.

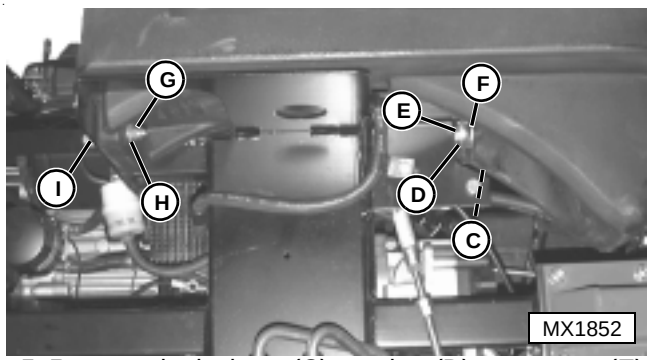
⚠ CAUTION

Gasoline is explosive. Do not expose to flame or spark. Serious injury can result. Catch or wipe up any spilled fuel immediately.

1. Park machine safely.
2. Remove rear wheel. (See REAR (DRIVE) WHEELS—REMOVAL/INSTALLATION.)
3. Turn fuel shut-off valve to OFF position.



4. Disconnect fuel line at the tank fitting (A) and drain fuel into a properly marked container.



5. Remove the lock nut (C), washer (D), cap screw (E) and spacer washers (F) from the front of the fuel tank.
6. Remove lock nut (G), washer (H) and round-head cap screw (I) from the front of the fuel tank.
7. Remove fuel tank.

Installation is done in the reverse order of removal.

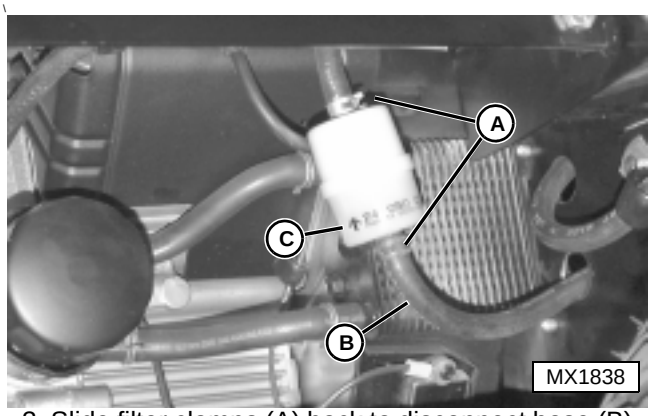
- Fill tanks. Check for and fix any leaks. Replace tanks as needed.

FUEL FILTER—REMOVAL/INSTALLATION

1. Park machine safely.
2. Turn fuel shut-off valve to OFF position.

⚠ CAUTION

Keep cigarettes, sparks, and flames away from fuel system. Make sure engine is cool to touch.



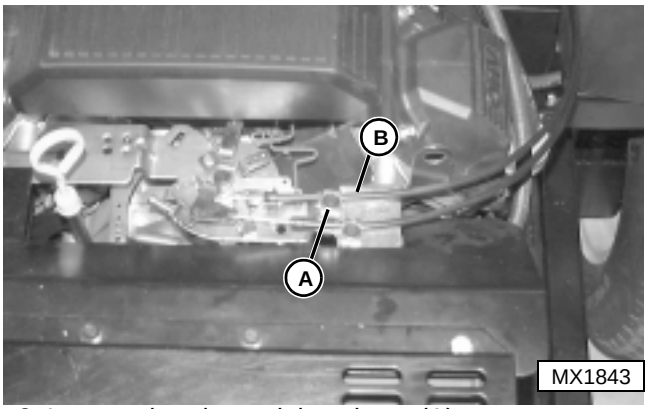
3. Slide filter clamps (A) back to disconnect hose (B) from filter (C).
4. Disconnect fuel line to fuel pump and drain fuel into a properly marked container.
5. Remove fuel filter.

Installation is done in the reverse order of removal.

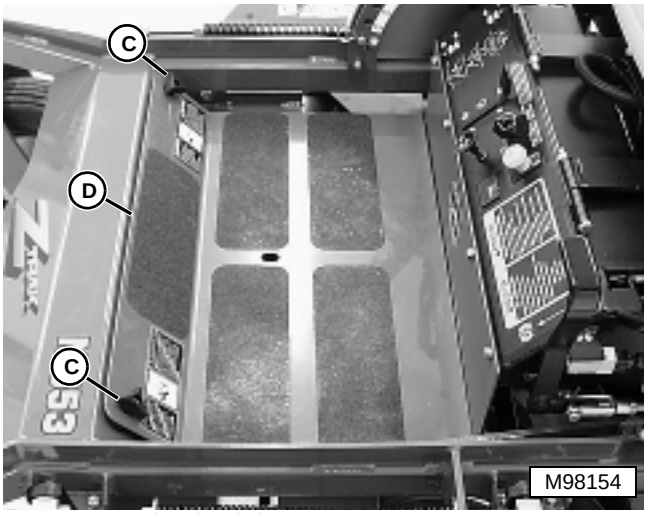
- Inspect fuel hoses for signs of cracks, wear or damage. Replace hoses if needed.
- Install new filter with arrow (C) pointing towards carburetor.

THROTTLE LEVER/CABLE—REMOVAL/INSTALLATION

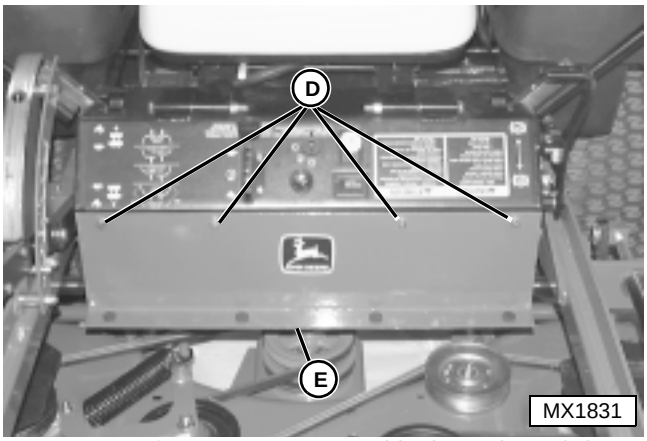
1. Park machine safely.
2. Move throttle lever to SLOW idle position.



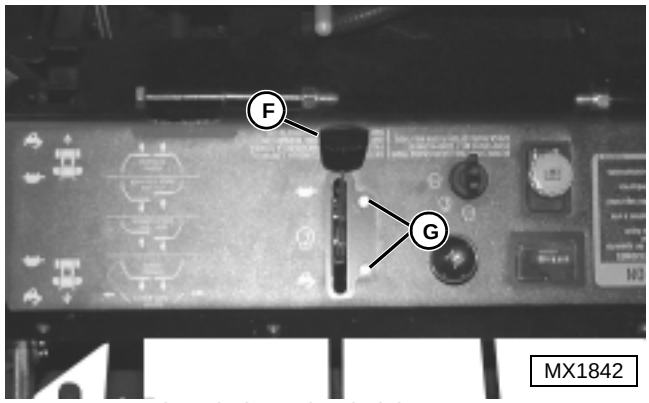
3. Loosen throttle retaining clamp (A).
4. Disconnect throttle cable (B) at throttle plate assembly.



5. Remove knobs (C).
6. Remove foot plate (D).



7. Remove four cap screws and lock washers (D).
8. Remove kick plate (E).



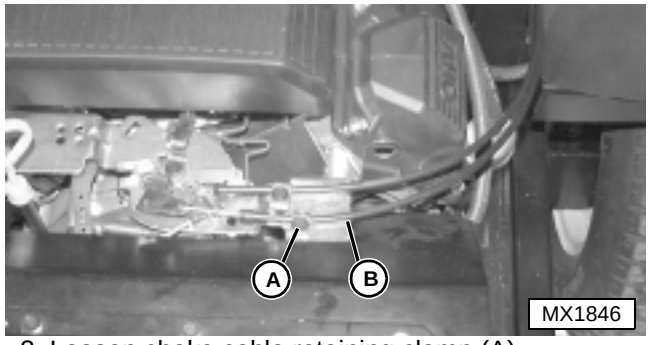
9. Remove throttle lever knob (F).
10. Remove screws (G).
11. Remove throttle lever/cable assembly.

Installation is done in the reverse order of removal.

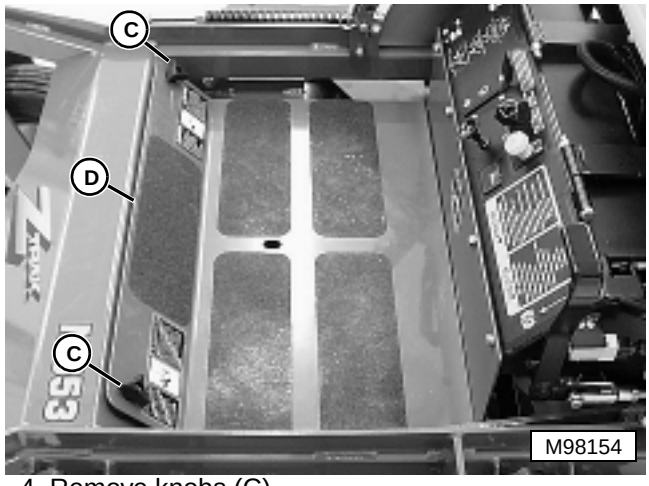
- Adjust throttle cable. (See THROTTLE AND CHOKE CABLE ADJUSTMENT.)

CHOKE CABLE—REMOVAL/INSTALLATION

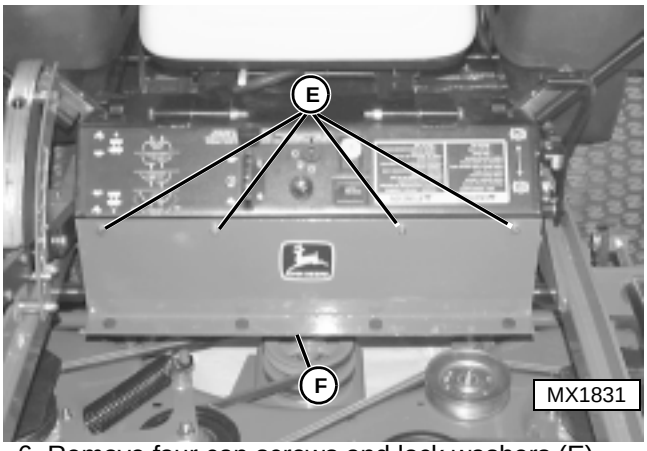
1. Park machine safely.



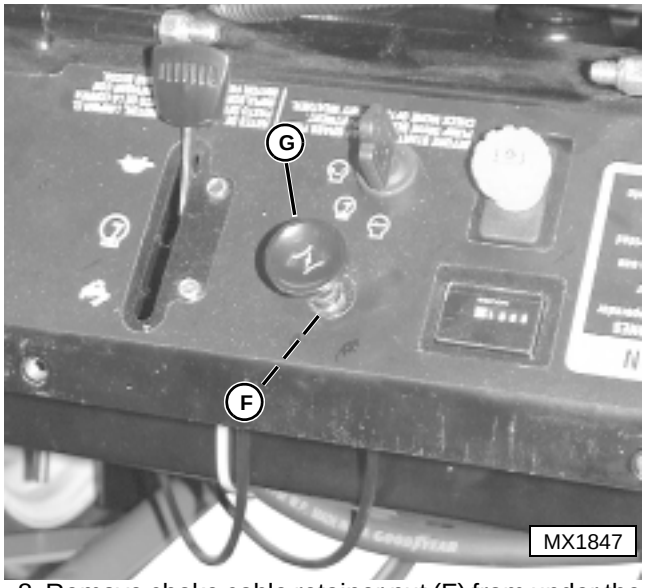
2. Loosen choke cable retaining clamp (A).
3. Disconnect choke cable (B) at throttle plate assembly.



4. Remove knobs (C).
5. Remove foot plate (D).



6. Remove four cap screws and lock washers (E).
7. Remove kick plate (F).



8. Remove choke cable retainer nut (F) from under the panel.
9. Remove choke cable (G).

Installation is done in the reverse order of removal.

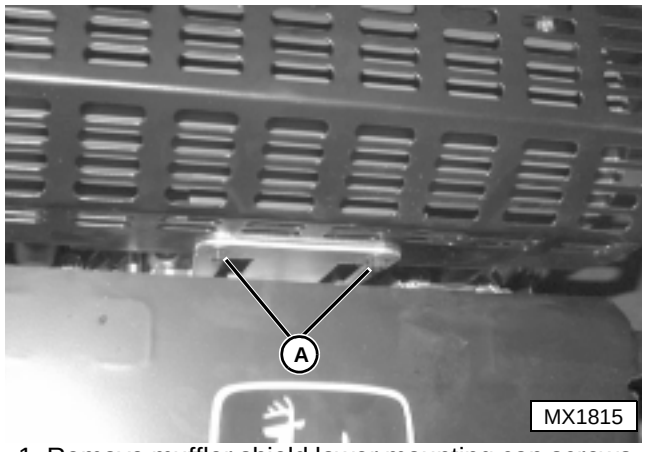
- Adjust choke cable. (See THROTTLE AND CHOKE CABLE ADJUSTMENT.)

MUFFLER— REMOVAL/INSTALLATION

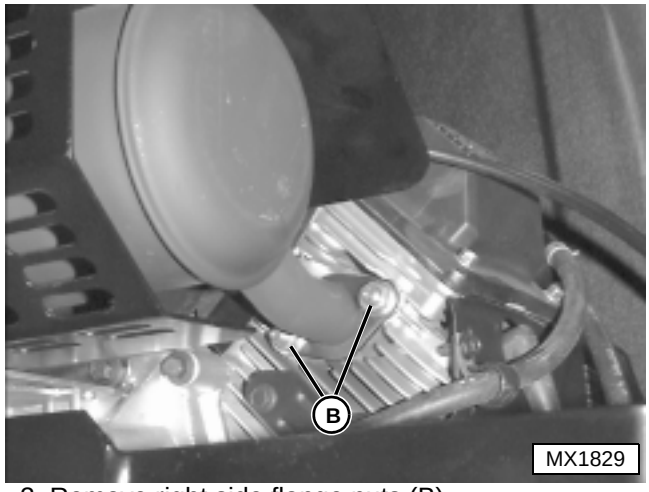
CAUTION

To prevent possible burns, allow engine to cool before removing muffler.

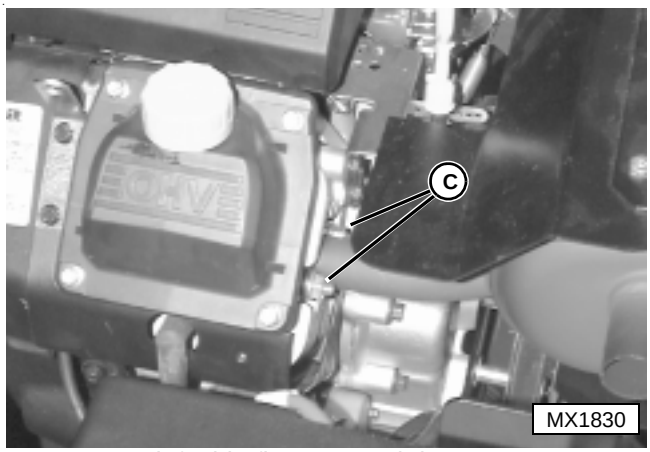
1. Park machine safely.



1. Remove muffler shield lower mounting cap screws (A).



2. Remove right side flange nuts (B).

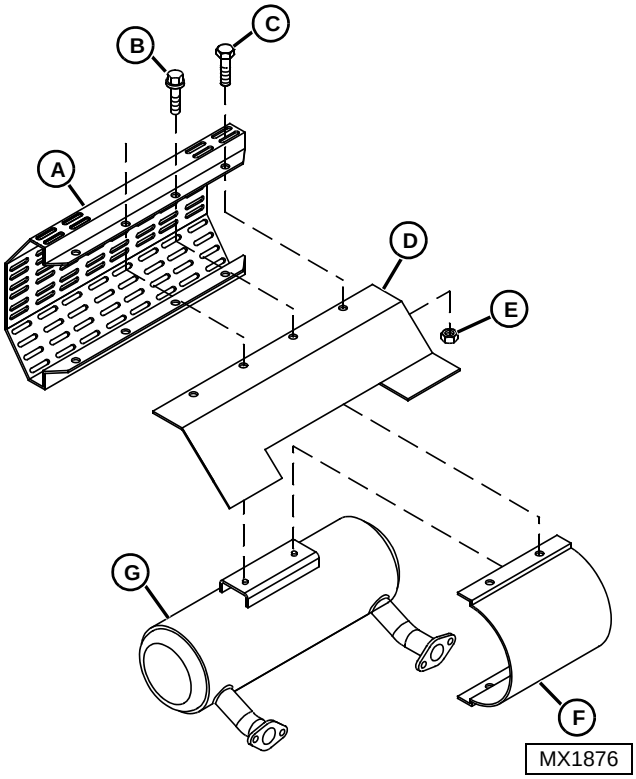


3. Remove left side flange nuts (C).
4. Remove muffler and gaskets.

Installation is done in the reverse order of removal.

- Use new gaskets for installation.
- Tighten muffler mounting nuts to **24.4 N•m (216 lb-in.)**.

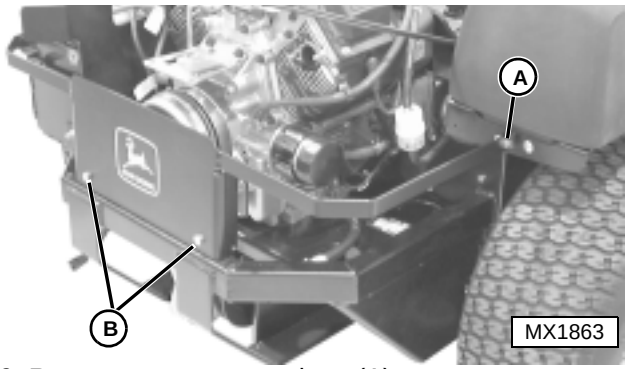
MUFFLER—REMOVE/INSTALL SHIELDS



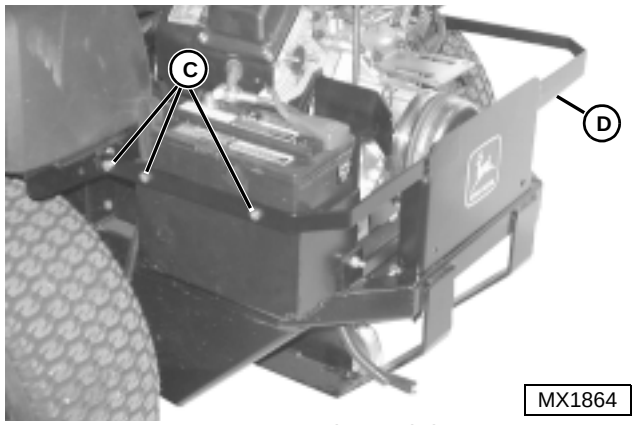
A—Shield
B—Cap Screw (2 used)
C—Cap Screw (2 used)
D—Shield
E—Nut (2 Used)
F—Muffler
G—Shield

ENGINE—REMOVAL/INSTALLATION

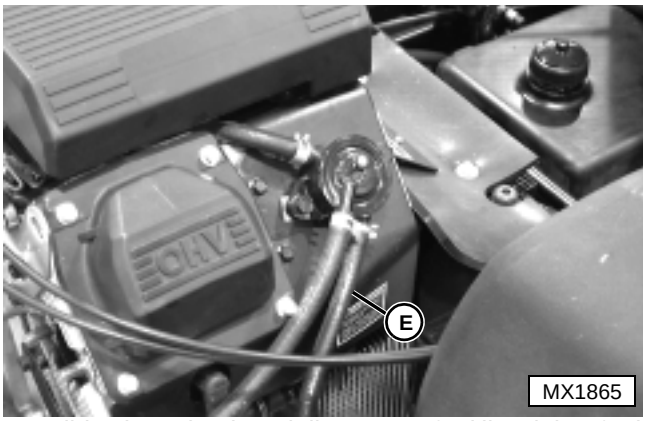
1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Raise and latch seat platform.
4. Disconnect battery negative (–) cable.
5. Turn fuel shut-off valve to OFF position.
6. Remove muffler. (See MUFFLER—REMOVAL/INSTALLATION.)
7. Remove hydraulic pump drive belt. (See HYDRAULIC PUMP DRIVE BELT—REMOVAL/INSTALLATION in HYDRAULIC POWER TRAIN section.)
8. Remove mower deck mule drive belt. (See MULE DRIVE BELT—REMOVAL/INSTALLATION in ATTACHMENTS section.)



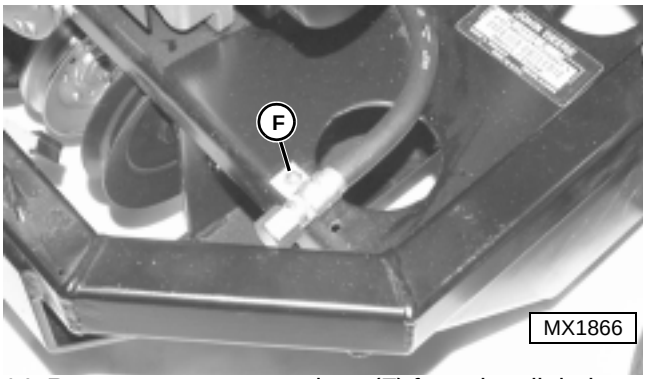
9. Remove cap screw and nut (A).
10. Remove rear cap screws and nuts (B).



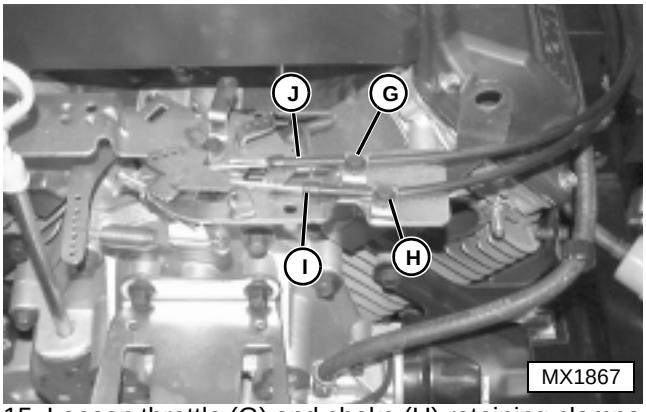
11. Remove cap screws and nuts (C).
12. Remove rear guard (D).



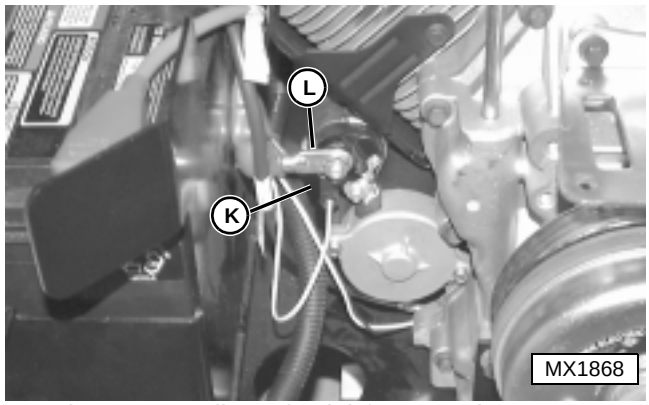
13. Slide clamp back and disconnect fuel line (E) at fuel pump. Drain fuel into a suitable container.



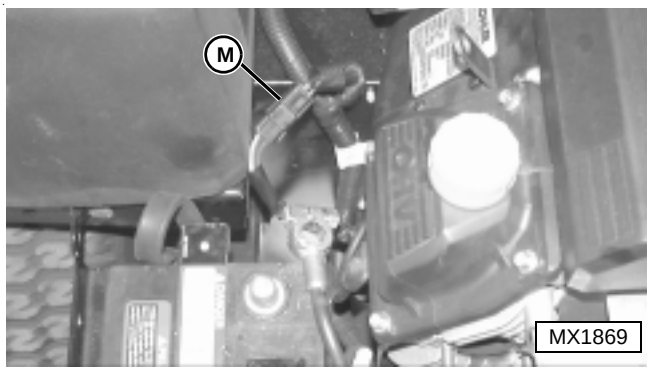
14. Remove cap screw and nut (F) from the oil drain hose retainer.



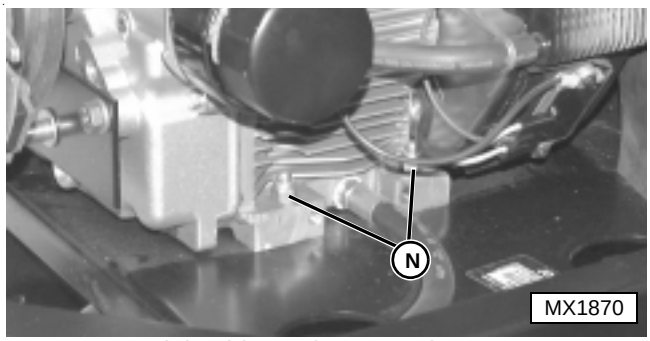
15. Loosen throttle (G) and choke (H) retaining clamps.
16. Disconnect choke cable (I) at throttle plate assembly.
17. Disconnect throttle cable (J) at throttle plate assembly.



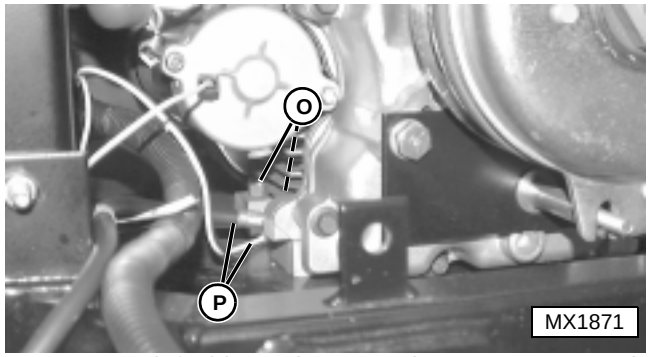
18. Disconnect yellow wire (K) from starting motor solenoid.
19. Disconnect red wires (L) from starting motor solenoid.



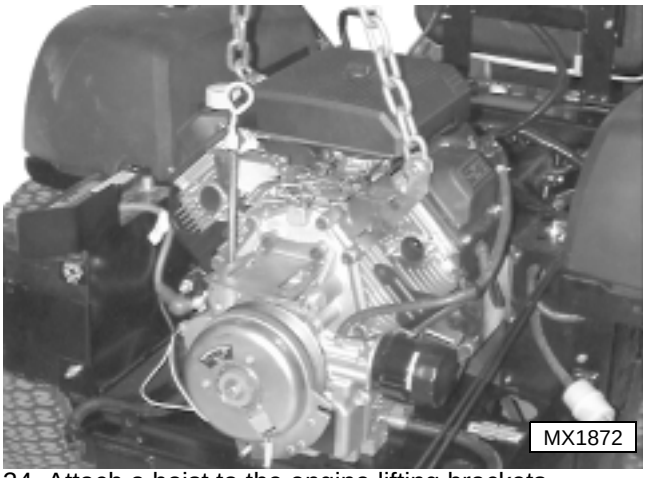
20. Disconnect wiring harness connector (M).



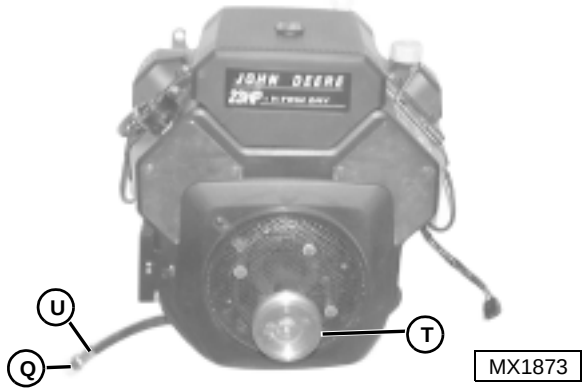
21. Remove right side engine mounting cap screws and nuts (N).



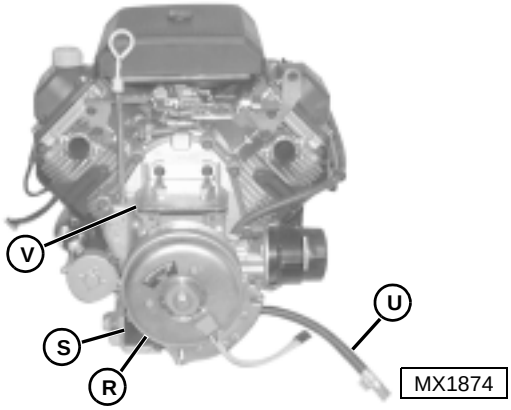
22. Remove left side engine mounting cap screws and nuts (O).
23. Remove ground leads (P).


MX1872

24. Attach a hoist to the engine lifting brackets.
25. Remove engine.



MX1873

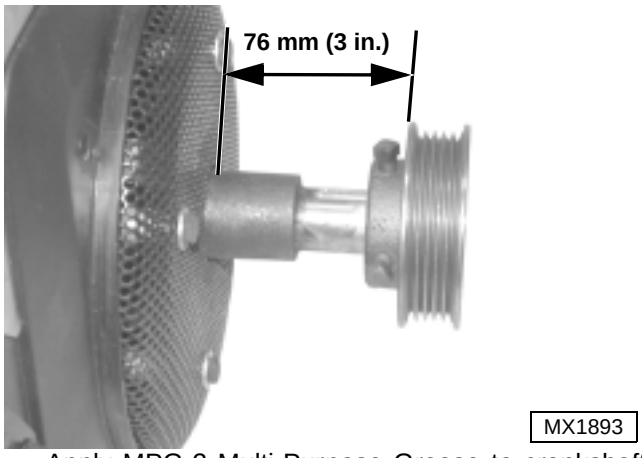


MX1874

*NOTE: Crankcase capacity (with filter) is approximately **1.9 L (2.0 qt)—CH22 or 2.0 L (2.1 qt)—CH25**.*

26. If engine is to be repaired remove:
    - Drain plug (Q) and drain crankcase.
    - PTO clutch (R), key and spacer.
    - Clutch anchor bracket (S).
    - PTO drive sheave (T).
    - Oil drain hose (U).
    - Muffler support bracket (V).

Installation is done in the reverse order of removal.



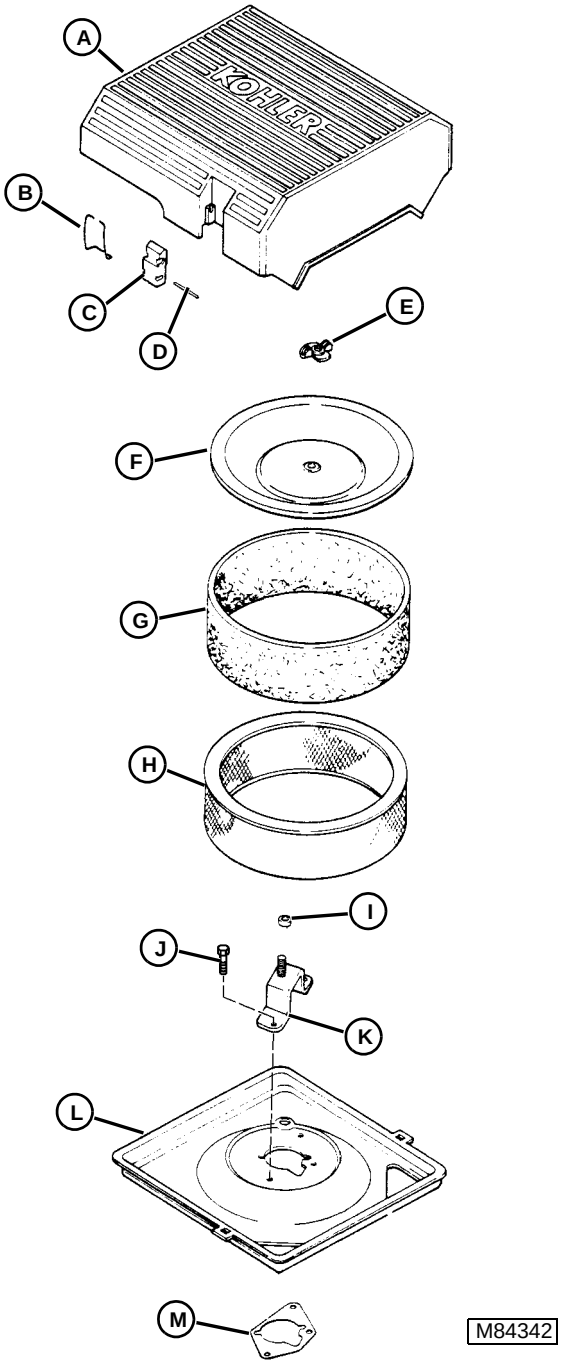
MX1893

- Apply MPG-2 Multi-Purpose Grease to crankshaft before installing PTO clutch and PTO drive sheave. (See ANTI-CORROSION GREASE in SPECIFICATIONS AND INFORMATION section.)
- Install PTO drive sheave with the rear flange of the sheave **76 mm (3 in.)** from the blower screen.
- Tighten engine-to-frame cap screws to **32 N•m (24 lb-ft)**.
- Tighten PTO clutch cap screw to **136 N•m (100 lb-ft)**.
- Tighten oil drain hose fitting to **14 N•m (124 lb-in.)**.

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

- Fill engine to proper level with oil of correct specifications. (See 4-CYCLE GASOLINE ENGINE OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
- Adjust drive belt tension. (See DRIVE BELT TENSION CHECK AND ADJUSTMENT in HYDRAULIC POWER TRAIN section.)
- Adjust throttle and choke cables. (See THROTTLE AND CHOKE CABLE ADJUSTMENT.)

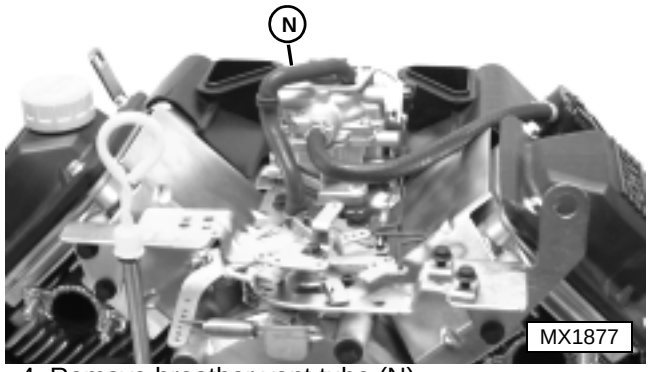
AIR CLEANER ASSEMBLY—REMOVAL/INSTALLATION



A—Cover
B—Latch Spring
C—Lever Latch
D—Lever Latch Pin
E—Wing Nut
F—Inside Air Cleaner Cover
G—Foam Precleaner
H—Paper Element
I—Seal
J—Screw
K—Air Cleaner Bracket
L—Air Cleaner Base
M—Gasket

IMPORTANT: Replace element when dirty.

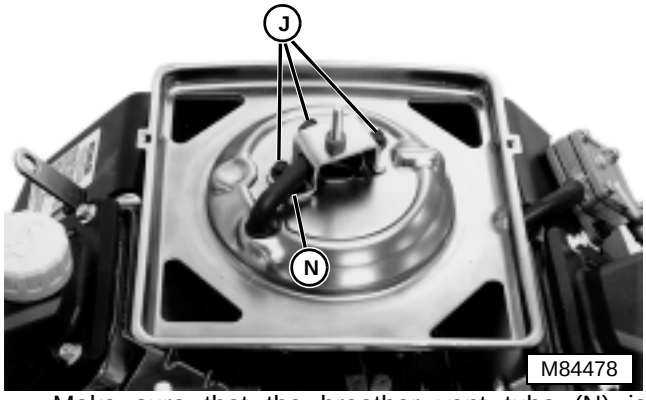
1. Remove cover (A).
2. Remove wing nut (B) and inner air cleaner cover (C).
3. Inspect and clean precleaner element (D).



4. Remove breather vent tube (N).

Installation is done in the reverse order of removal.

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



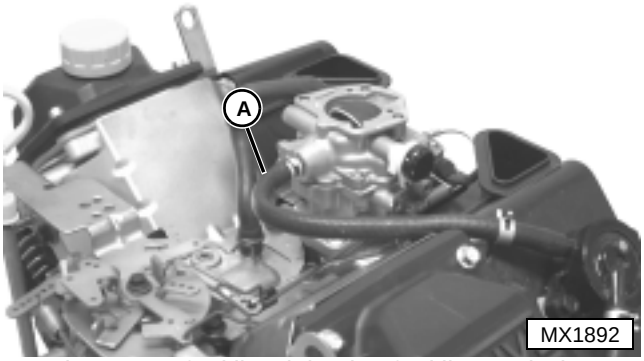
- Make sure that the breather vent tube (N) is properly seated in air cleaner base.
- Tighten air cleaner bracket screws (J) to **10 N•m (88 lb-in.)**.

CARBURETOR—REMOVAL/INSTALLATION

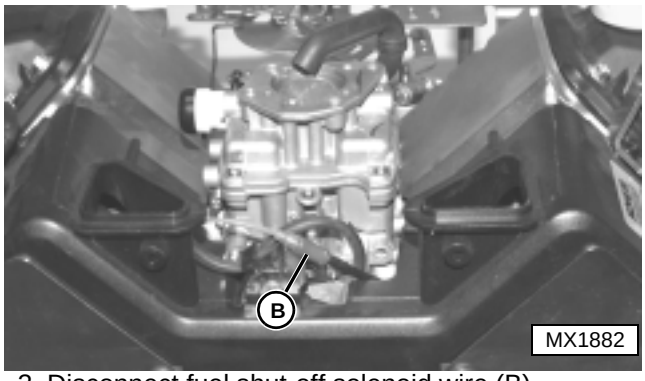
⚠ CAUTION

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.

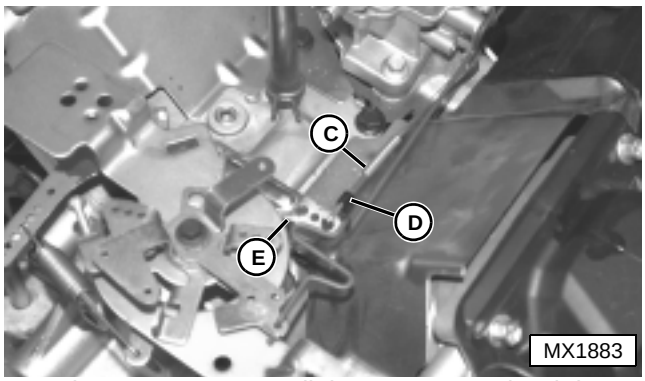
1. Remove air cleaner assembly. (See AIR CLEANER ASSEMBLY—REMOVAL/INSTALLATION.)



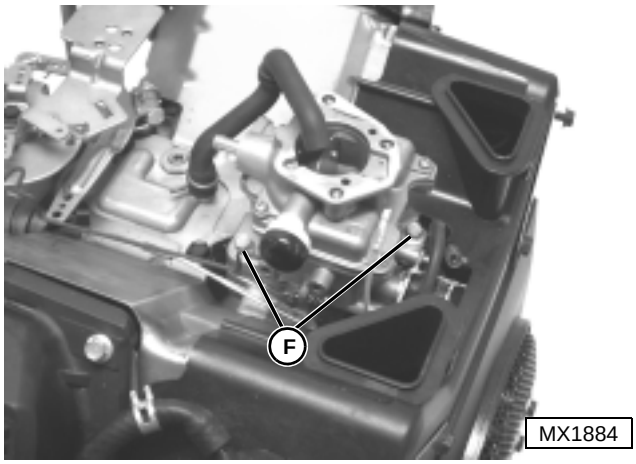
2. Disconnect fuel line (A). Plug fuel line and wipe up spilled fuel IMMEDIATELY.



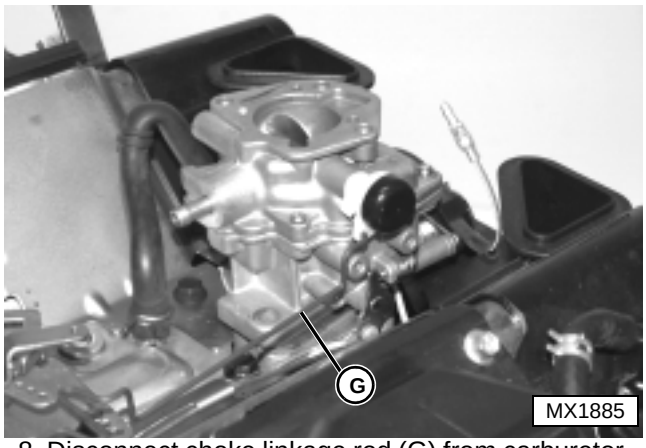
3. Disconnect fuel shut-off solenoid wire (B).



4. Disconnect governor linkage return spring (C) at governor arm.
5. Disconnect retainer (D) from governor linkage.
6. Disconnect governor linkage from governor arm (E).



7. Remove carburetor mounting cap screws (F).



8. Disconnect choke linkage rod (G) from carburetor levers.

Installation is done in the reverse order of removal.

- Use a new gasket for installation.
- Tighten air cleaner bracket cap screws to **10 N•m (88 lb-in.)**.
- Tighten carburetor cap screws (F) to **10 N•m (88 lb-in.)**.
- Adjust carburetor. (See SLOW IDLE SPEED ADJUSTMENT.)

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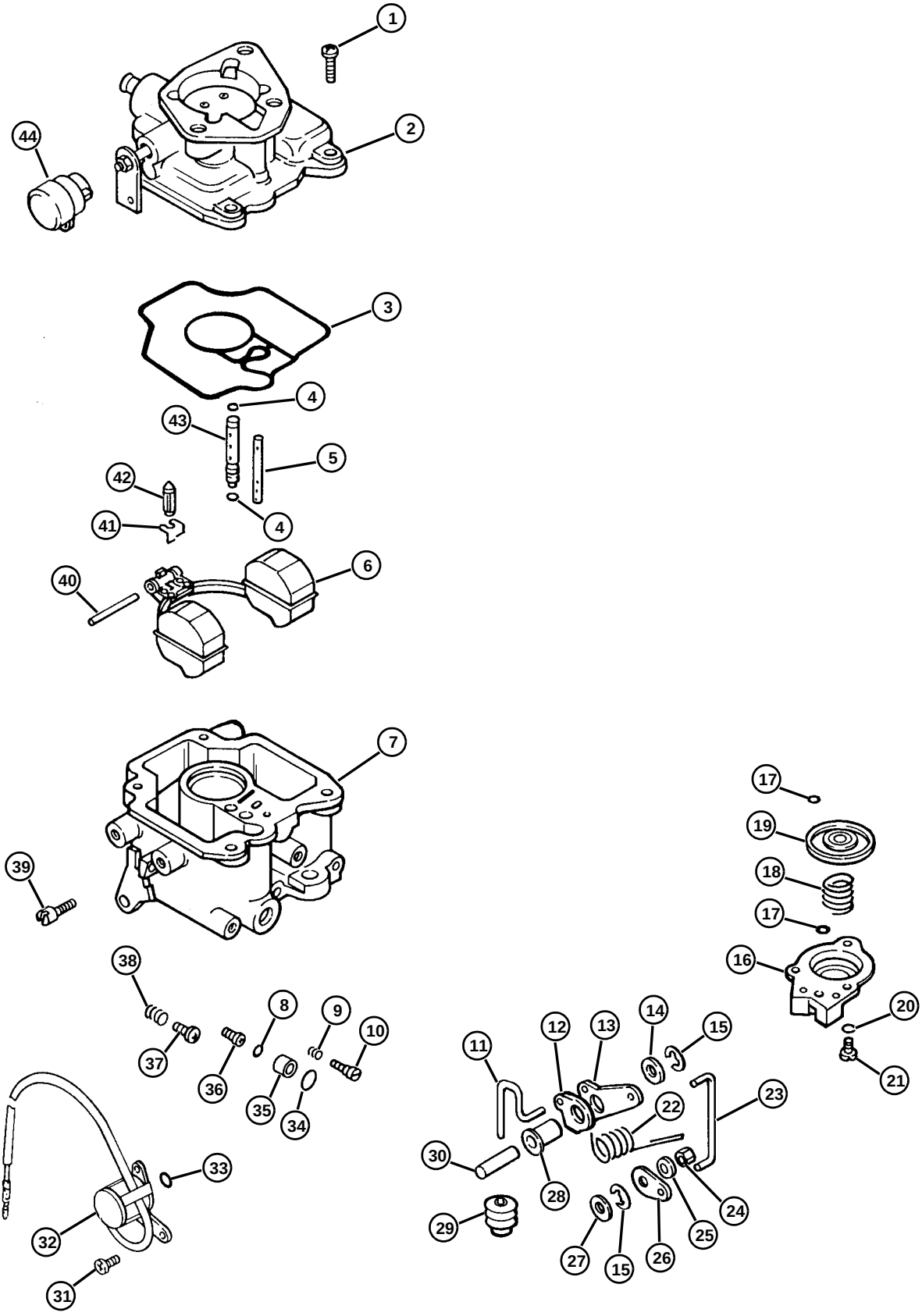
CARBURETOR—DISASSEMBLY/INSPECTION/ASSEMBLY



MX1862

1—Screw (4 Used)

2—Air Horn Assembly

3—Gasket

4—O-Ring (2 Used)

5—Accelerator Pump Jet
(25 HP Engine Only)

6—Float Assembly

7—Body

8—O-Ring

9—Spring

10—Main Idle Adjustment Needle

11—Link
(25 HP Engine Only)

12—Spacer
(25 HP Engine Only)

13—Link
(25 HP Engine Only)

14—Washer
(25 HP Engine Only)

15—Retaining Clip
(2 Used)
(25 HP Engine Only)

16—Accelerator Pump Cover
(25 HP Engine Only)

17—O-Ring (2 Used)
(25 HP Engine Only)

18—Diaphragm Spring
(25 HP Engine Only)

19—Diaphragm
(25 HP Engine Only)

20—O-Ring
(25 HP Engine Only)

21—Screw
(25 HP Engine Only)

22—Return Spring
(25 HP Engine Only)

23—Link
(25 HP Engine Only)

24—Nut
(25 HP Engine Only)

25—Washer
(25 HP Engine Only)

26—Link
(25 HP Engine Only)

27—Washer
(25 HP Engine Only)

28—Bushing
(25 HP Engine Only)

29—Rubber Boot
(25 HP Engine Only)

30—Shaft
(25 HP Engine Only)

31—Screw

32—Fuel Shutoff Solenoid

33—O-Ring

34—O-Ring

35—Solenoid Seat

36—Main Jet

37—Screw

38—Spring

39—Screw

40—Float Pin

41—Clip

42—Inlet Needle Valve

43—Slow Speed Jet

44—Automatic Choke

⚠ CAUTION

Gasoline and carburetor cleaners are extremely flammable. DO NOT expose them to flame or spark. Follow the cleaner manufacture's warning and instructions on their proper and safe use. Never use gasoline as a cleaning agent.

⚠ ATTENTION

DO NOT attempt to adjust the main jet (fast idle) on 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. These carburetors have no fast idle adjustment—the main jet is set at the factory.

IMPORTANT: 1500 and 3000 meter high altitude jet kits are available. These must be installed by an authorized repair facility.

Procedure:

1. Remove air horn assembly.
2. Remove float pin, float, inlet needle, slow speed jet and spring from carburetor air horn.
3. Remove fuel shut-off solenoid, O-rings, solenoid seat and main jet from carburetor lower body.

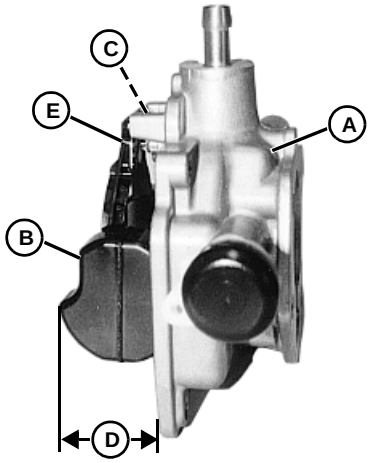
NOTE: Do not soak carburetor in cleaning solvent with gaskets or O-rings installed. Cleaning solvent may damage these components. Always install new O-rings and gaskets.

4. Clean carburetor using cleaning solvent and compressed air.
5. Install fuel inlet needle in float tab. Install float, float pin and inlet needle in air horn assembly. Tighten screw. Check float height. (See CARBURETOR—FLOAT LEVEL ADJUSTMENT.)
6. Install slow speed jet with stepped end facing out. Make sure jet is fully seated.
7. Install slow idle mixture screw and spring in carburetor lower body. Set preliminary adjustment for mixture screw. Turn clockwise until LIGHTLY seated and back out one turn.
8. Install air horn on lower body with four screws. Tighten four screws to **1.7 N•m (15 lb-in.)**.
9. Install throttle control bracket screws and air cleaner assembly. (See SLOW IDLE SPEED ADJUSTMENT.)

CARBURETOR—FLOAT LEVEL ADJUSTMENT

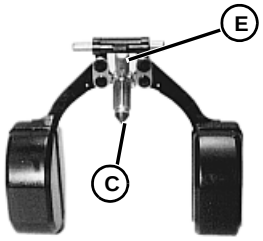
1. Assemble carburetor air horn (A).

NOTE: The fuel inlet needle tip is spring loaded. Make sure float assembly rests against the fuel inlet needle without depressing the tip.



M85856

2. Hold the carburetor air horn so that the float assembly (B) hangs vertically and rests lightly against the fuel inlet needle (C). The fuel inlet needle should be fully seated but the needle tip should not be depressed.
3. The correct float height adjustment is **22 mm (0.86 in.)** (D) measured from the float bottom to the air horn casting. Be sure to measure from the casting surface, not the rubber gasket surface. Adjust the float height by carefully bending the tab (E).

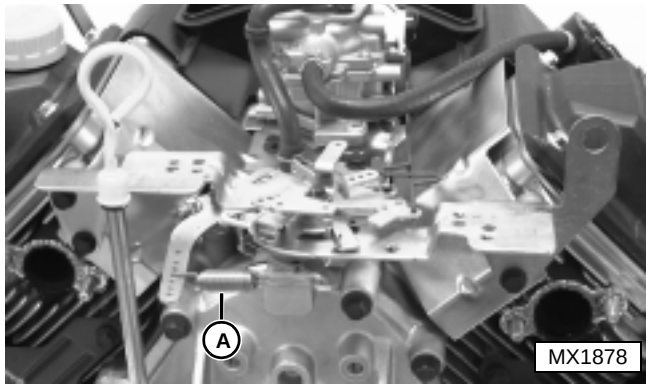


M85863

4. If proper float height adjustment cannot be achieved, check to see if the fuel inlet needle (C) is dirty, obstructed or worn. Remove the brass screw and float assembly to remove the fuel inlet needle.
5. Once proper float height is obtained, carefully lower the carburetor air horn assembly onto the carburetor body connecting choke linkage. Install the four screws. Tighten screws to **1.7 N•m (15 lb-in.)**.

THROTTLE PLATE ASSEMBLY—REMOVAL/INSTALLATION

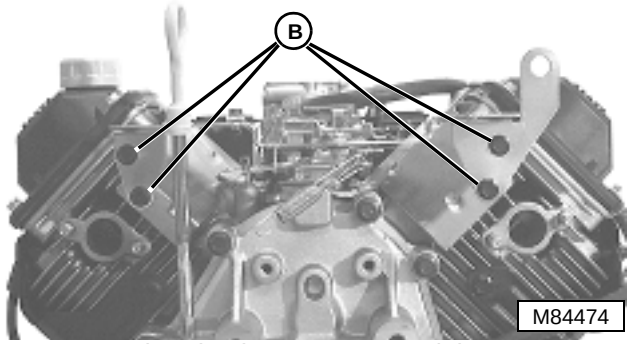
1. Remove air cleaner assembly. (See AIR CLEANER ASSEMBLY—REMOVAL/INSTALLATION.)



MX1878

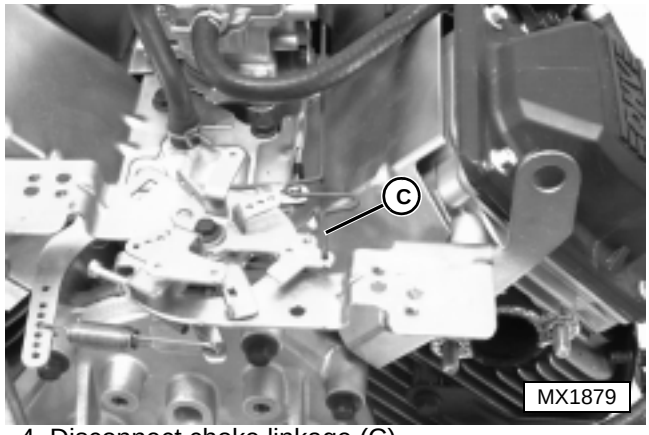
NOTE: Note location of springs for later installation.

2. Disconnect springs (A) at governor linkage arm.



M84474

3. Remove throttle plate cap screws (B).



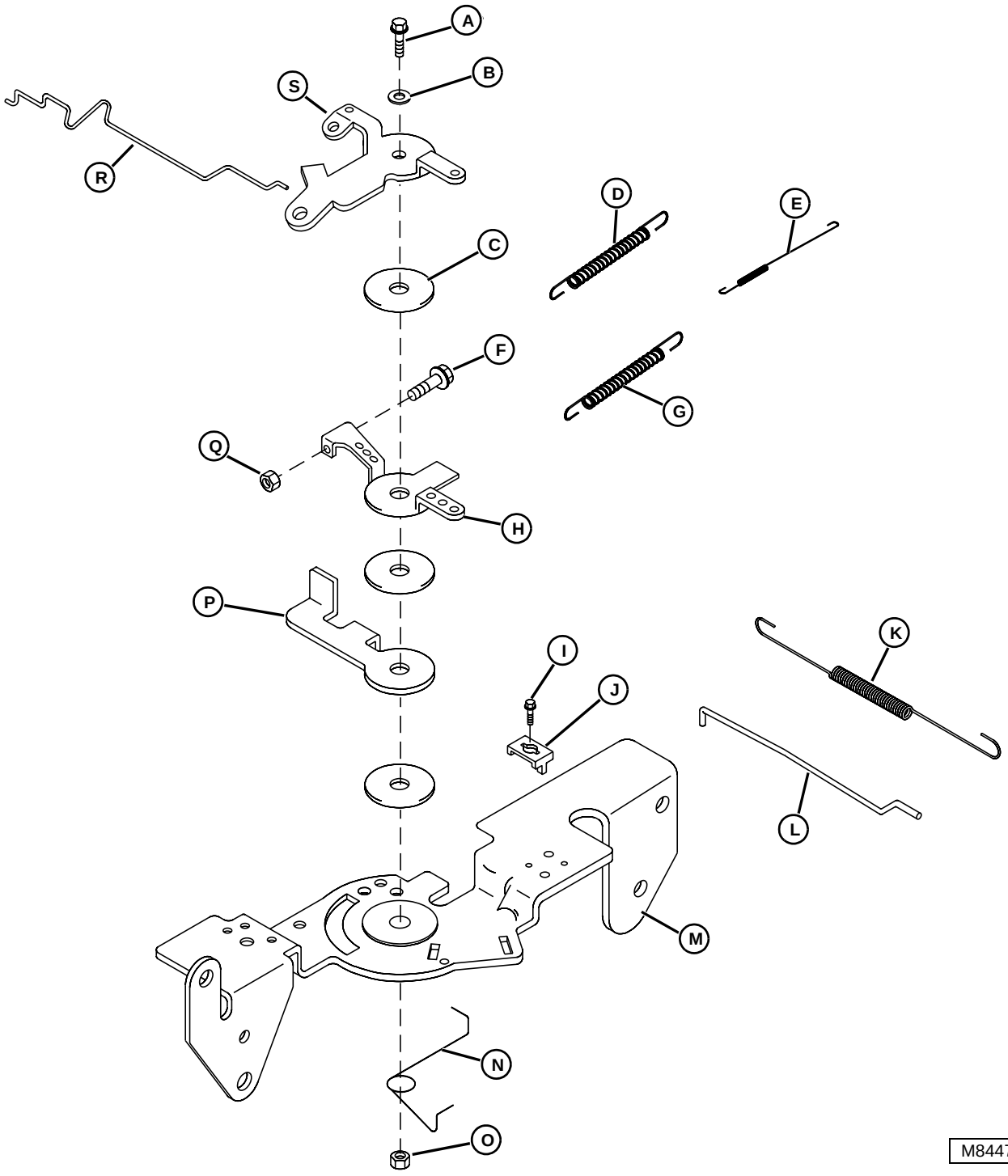
MX1879

4. Disconnect choke linkage (C).
5. Remove throttle plate assembly.

Installation is done in the reverse order of removal.

- Tighten cap screws to **10 N•m (88 lb-in.)**.

THROTTLE PLATE ASSEMBLY—REPAIR

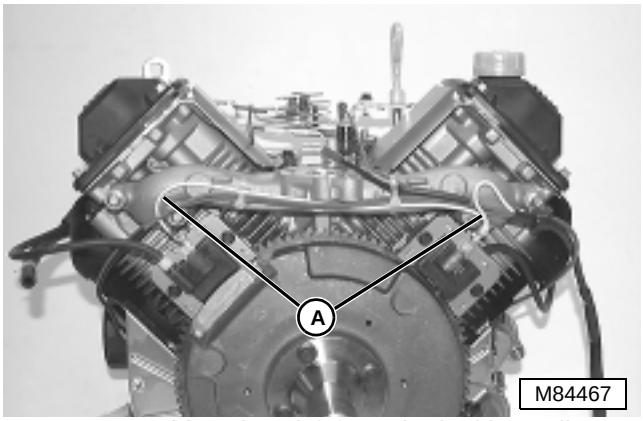


A—Cap Screw	**F—Cap Screw**	**K—Spring**	**P—Throttle Actuator Lever**
B—Washer	**G—Spring**	**L—Throttle Linkage**	**Q—Nut**
C—Washer (3 Used)	**H—Throttle Control Lever**	**M—Bracket**	**R—Linkage**
D—Spring	**I—Screw** (3 Used)	**N—Spring**	**S—Linkage**
E—Spring	**J—Clamp** (2 Used)	**O—Nut**	

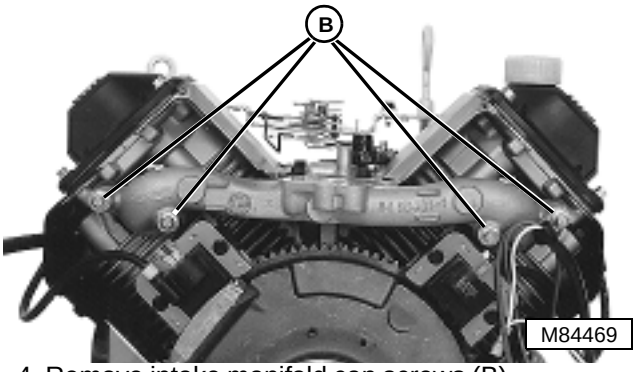
- Inspect all parts for wear or damage. Replace parts as needed.

INTAKE MANIFOLD—REMOVAL/INSTALLATION

1. Remove carburetor. (See CARBURETOR—Removal/Installation.)



2. Remove white wires (A) from the ignition coils.
3. Remove tie wraps securing wiring harness to manifold.



4. Remove intake manifold cap screws (B).

Installation is done in the reverse order of removal.

- Use new gaskets for installation.
- Tighten intake mounting cap screws (B) to **10 N•m (88 lb-in.)**.

INTAKE MANIFOLD—INSPECTION

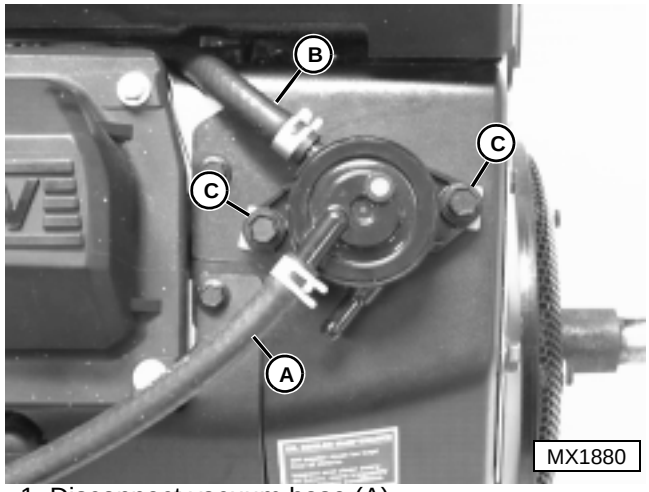
- Visually inspect manifold passages for corrosion, cracks, porous castings, or deposits. Clean or replace as necessary.

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 manifold if any cracks are found.

FUEL PUMP—REMOVAL/INSTALLATION

⚠ CAUTION

Gasoline is explosive. Do not expose to flame or spark. Serious injury can result. Store in a properly marked, safe container. Wipe up any spills IMMEDIATELY.

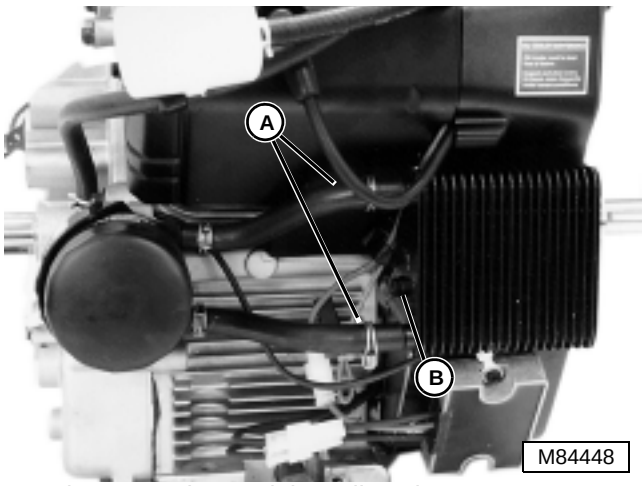


1. Disconnect vacuum hose (A).
2. Disconnect fuel outlet hose (B).
3. Remove cap screws (C).
4. Remove fuel pump.

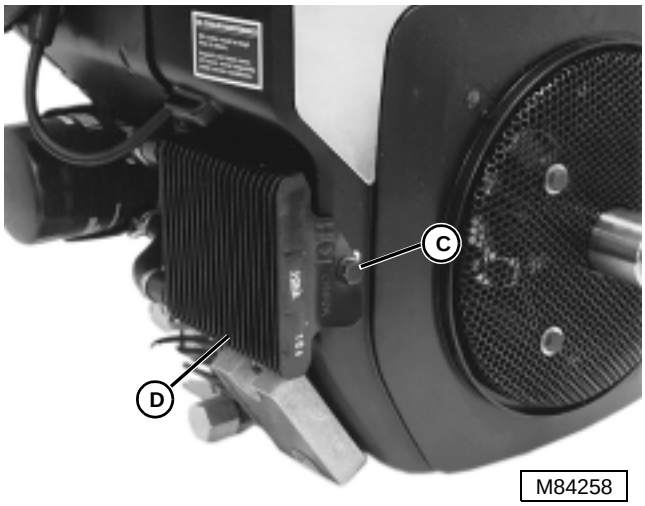
Installation is done in the reverse order of removal.

- Tighten fuel pump mounting cap screws to **2.3 N•m (20 lb-in.)**.

OIL COOLER—REMOVAL/INSTALLATION



1. Disconnect hoses (A) at oil cooler.
2. Remove cap screw (B).

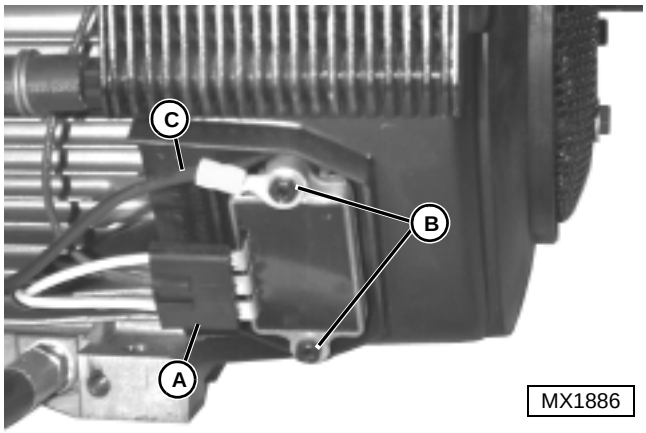


3. Remove cap screw (C).
4. Remove oil cooler (D).

Installation is done in the reverse order of removal.

- Inspect oil cooler for bent or damaged fins. Replace oil cooler as needed.
- Inspect hoses for signs of cracking. Replace hoses as needed.
- Tighten mounting cap screws (B and C) to **4.7 N•m (35 lb-in.).**
- Check oil level, add oil as needed. (See 4-CYCLE GASOLINE ENGINE OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)

VOLTAGE REGULATOR/RECTIFIER—REMOVAL/INSTALLATION



1. Disconnect connector (A).
2. Remove cap screws (B).
3. Disconnect black wire (C).
4. Remove voltage regulator/rectifier.

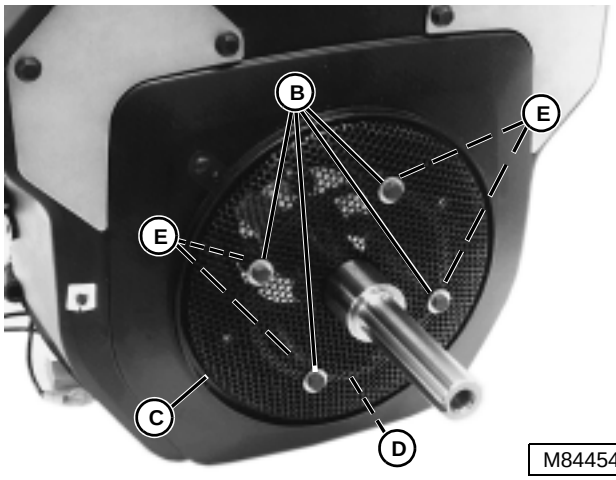
Installation is done in the reverse order of removal.

- Tighten voltage regulator/rectifier cap screws (B) to **4.7 N•m (35 lb-in.).**

BLOWER HOUSING AND SHIELDS—REMOVAL/INSTALLATION

1. Remove oil cooler. (See OIL COOLER—REMOVAL/INSTALLATION.)
2. Remove voltage regulator/rectifier. (See VOLTAGE REGULATOR/RECTIFIER—REMOVAL/INSTALLATION.)
3. Remove fuel pump. (See FUEL PUMP—REMOVAL/INSTALLATION.)

4. Remove air cleaner cover (A).

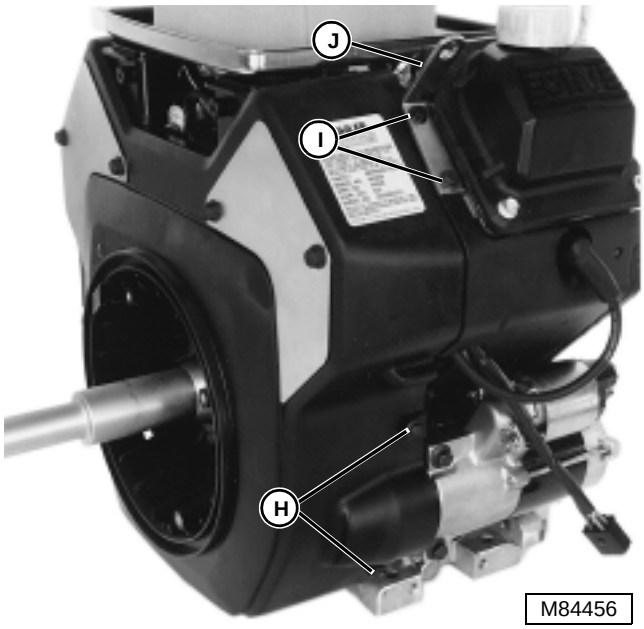


M84454

5. Remove four cap screws and washers (B).
6. Remove blower screen (C), inner ring (D) and spacers (E).

M84455

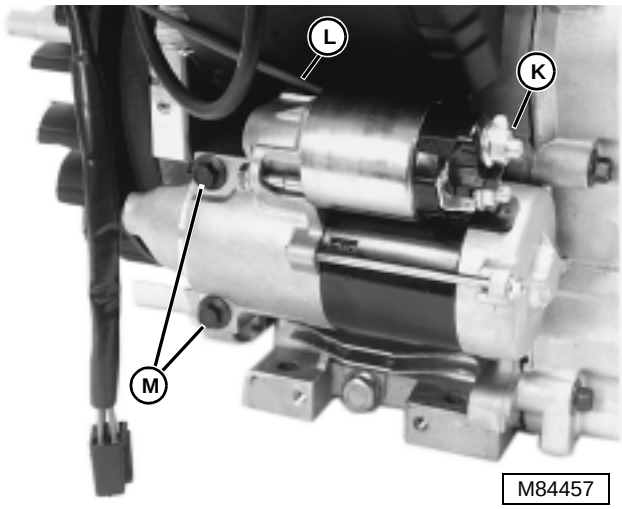
7. Remove lower cap screw (F).
8. Remove upper cap screws (G).



M84456

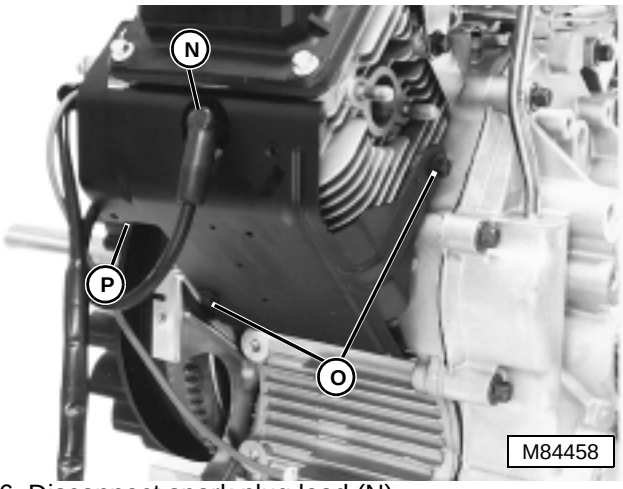
9. Remove lower cap screws (H).
10. Remove upper cap screws (I) and bracket (J).
11. Remove blower housing.

Side Shield—Starter Side



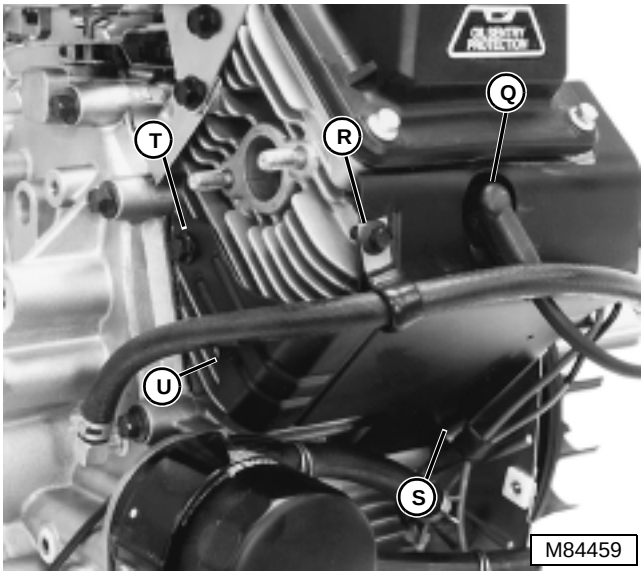
M84457

12. Remove nut (K).
13. Disconnect purple wire (L) from starter terminal.
14. Remove two cap screws (M).
15. Remove starter.



16. Disconnect spark plug lead (N).
17. Remove two caps screws (O).
18. Remove shield (P).

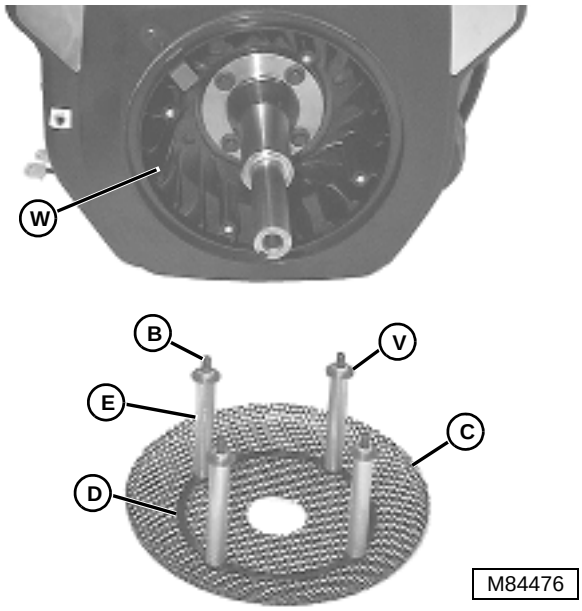
Side Shield—Voltage Regulator Side



19. Disconnect spark plug lead (Q).
20. Remove M6 cap screw (R) and vacuum hose clamp.
21. Remove M5 cap screw (S) and wire clamp.
22. Remove M6 cap screw (T).
23. Remove shield (U).

Installation is done in the reverse order of removal.

- When installing cap screws always tighten evenly to prevent pinching shields or blower housing.
- Tighten longer (M6) blower housing cap screws (R and T) to **8.6 N•m (65 lb-in.**).
- Tighten shorter (M5) blower housing cap screws (S) to **4.7 N•m (35 lb-in.**).

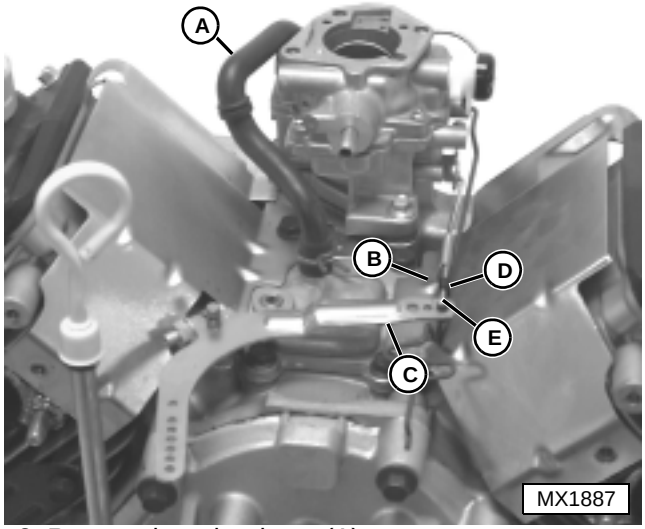


IMPORTANT: Make sure cooling fan is properly seated on flywheel before tightening cap screws.

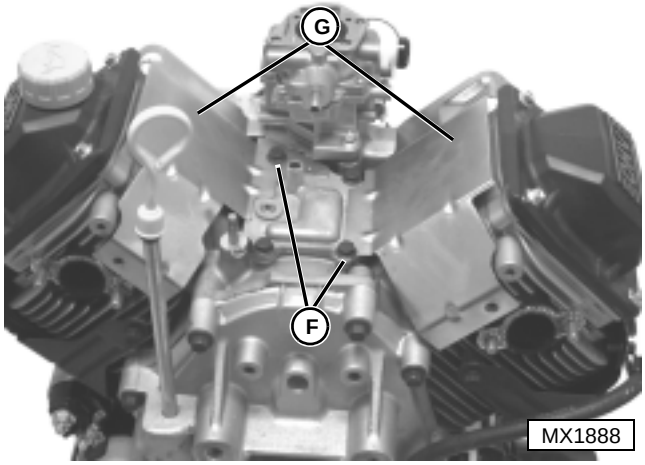
- Install blower screen (C) with dished side of concave washers (V) facing toward fan (W).
- Tighten blower screen cap screws (B) to **10 N•m (88 lb-in).**
- Tighten starting motor mounting cap screws (M) to **15 N•m (135 lb-in).**

BREATHER—REMOVAL/INSPECTION

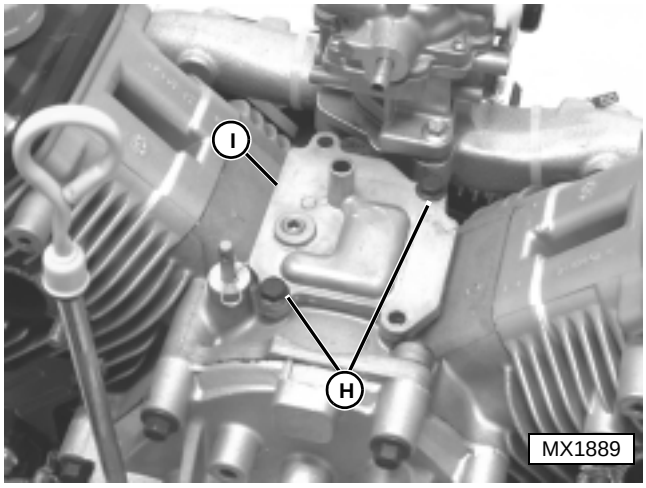
1. Remove blower housing. (See BLOWER HOUSING AND SHIELDS—REMOVAL/INSTALLATION.)
2. Remove throttle plate assembly. (See THROTTLE PLATE ASSEMBLY—REMOVAL/INSTALLATION.)



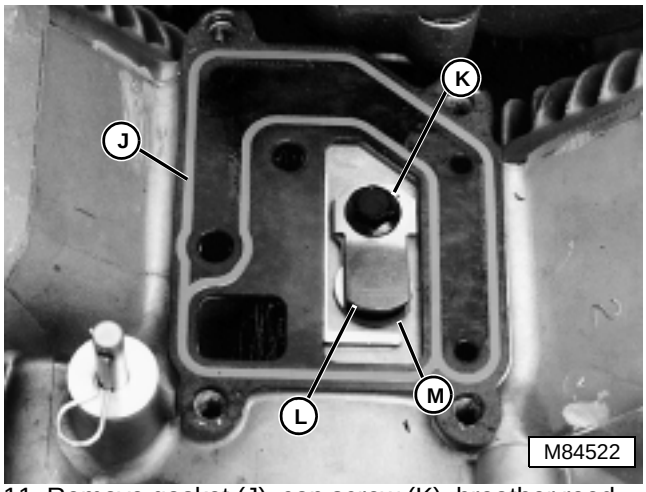
3. Remove breather hose (A).
4. Disconnect governor linkage return spring (B) at governor arm (C).
5. Disconnect retainer (D) from governor linkage (E).
6. Disconnect governor linkage from governor arm.
7. Remove governor arm (C) from end of governor cross shaft.



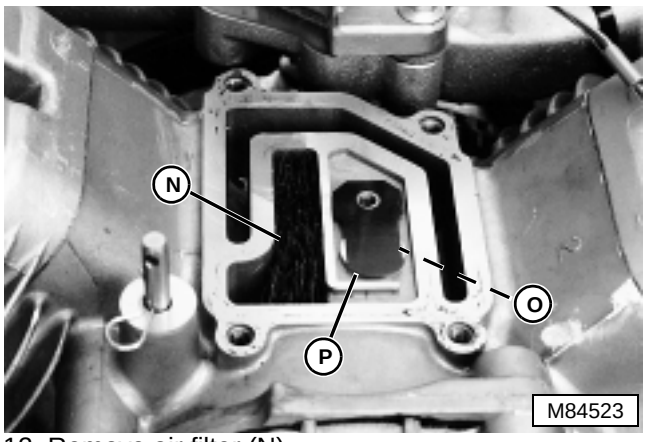
8. Remove two cap screws (F) and inner baffles (G).



9. Remove breather cover cap screws (H).
10. Remove breather cover. (I)



11. Remove gasket (J), cap screw (K), breather reed retainer (L), and breather reed (M).

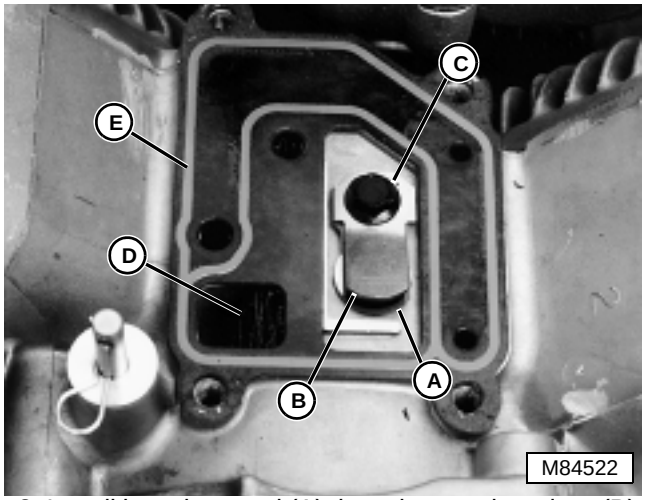


12. Remove air filter (N).
13. Check that breather opening (O) is clear.
14. Replace breather reed (P) if it does not lie flat on casting.

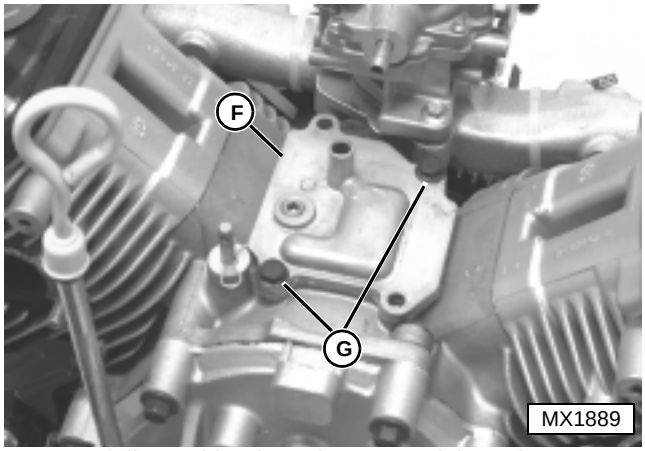
BREATHER—INSTALLATION

IMPORTANT: Clean mating surfaces of any sealant residue. Prepare the sealing surfaces of the crankcase and breather cover by using gasket removing solvent. DO NOT scrape surfaces as this could result in leakage.

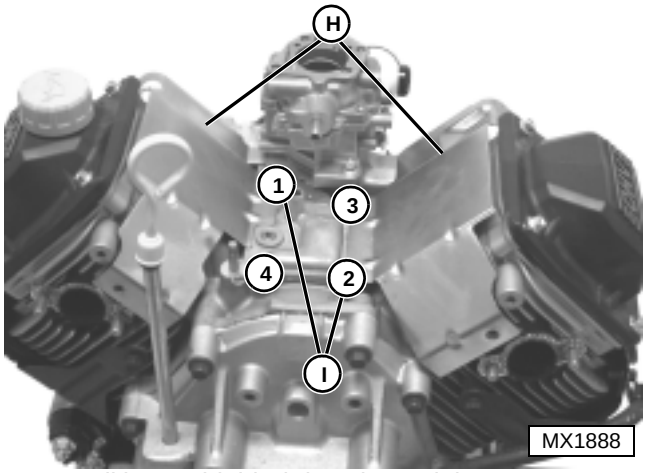
1. Check to make sure there are no nicks or burrs on sealing surfaces.



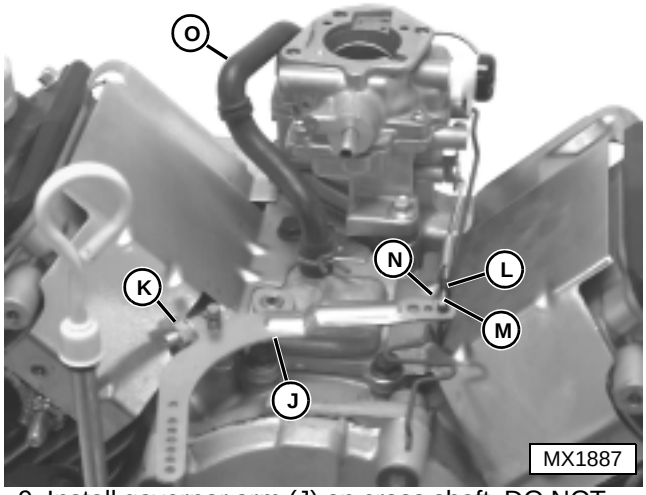
2. Install breather reed (A), breather reed retainer (B) and cap screw (C).
3. Insert new air breather filter (D).
4. Install new gasket (E).



5. Carefully position breather cover (F). Make sure filter hairs are not on cover seating surface.
6. Install two cap screws (G) as shown—finger tight.



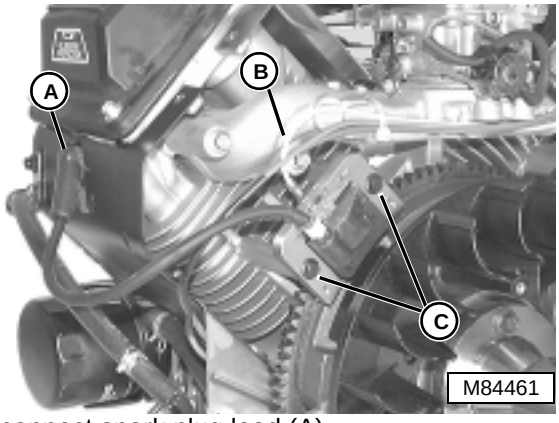
7. Install inner shields (H) and remaining two cap screws (I) finger tight.
8. After blower housing and remaining shields are installed, tighten four breather cap screws in sequence shown to **8.6 N•m (65 lb-in.)**.



9. Install governor arm (J) on cross shaft. DO NOT tighten cap screw/nut (K).
10. Install retainer (L) on governor arm.
11. Connect governor linkage (M) in retainer. Snap retainer over linkage.
12. Connect governor linkage return spring (N) to governor arm.
13. Rotate governor arm toward carburetor (WIDE OPEN THROTTLE) and hold in position.
14. Rotate cross shaft counterclockwise as far as it will go and tighten cap screw/nut (K).
15. Install breather hose (O).
16. Adjust governor. (See GOVERNOR—SENSITIVITY ADJUSTMENT.)
17. Install blower housing. (See BLOWER HOUSING AND SHIELDS—REMOVAL/INSTALLATION.)
18. Install throttle plate assembly. (See THROTTLE PLATE ASSEMBLY—REMOVAL/INSTALLATION.)

IGNITION MODULES—REMOVAL/INSTALLATION

1. Remove blower housing. (See BLOWER HOUSING AND SHIELDS—REMOVAL/INSTALLATION.)

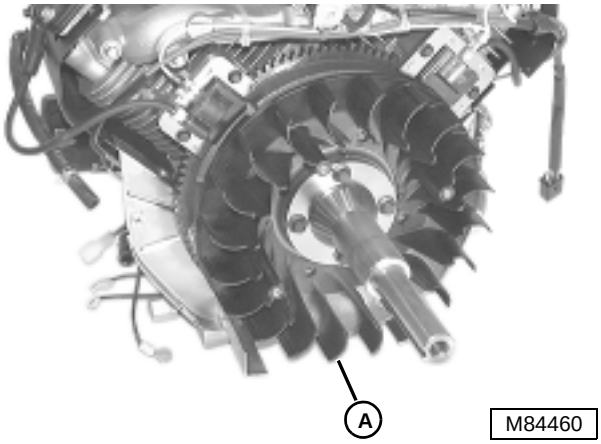


2. Disconnect spark plug lead (A).
3. Disconnect white wire (B).
4. Remove cap screws (C).
5. Remove ignition module.

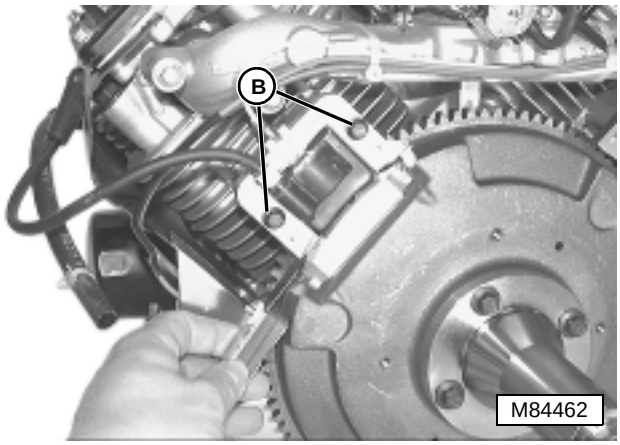
Installation is done in the reverse order of removal.

- Install ignition module loosely. Rotate magnet away from module mount.
- Adjust ignition module air gap. (See IGNITION MODULES—AIR GAP ADJUSTMENT.)

IGNITION MODULES—AIR GAP ADJUSTMENT



1. Remove cooling fan (A).



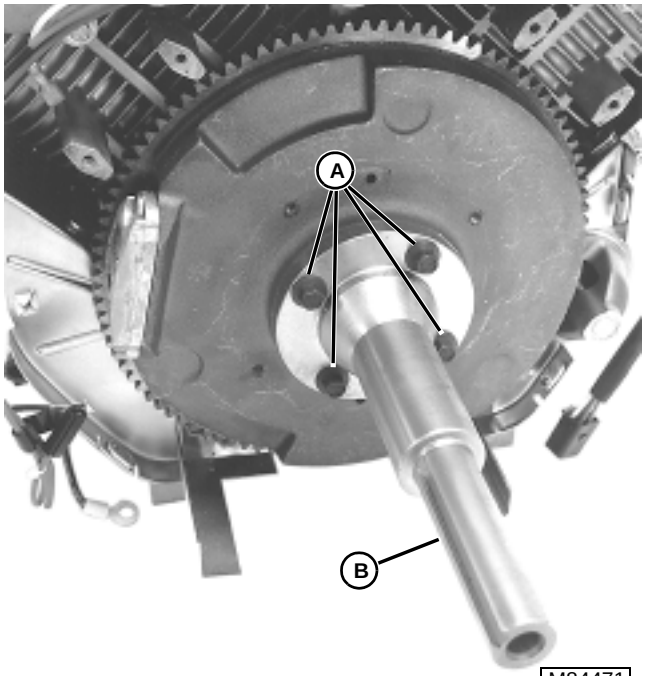
2. Rotate the flywheel to position the magnet directly under the ignition module.
3. Insert a **0.25 mm (0.010 in.)** feeler gauge or shim stock between the magnet and ignition module.
4. Loosen the ignition module mounting screws (B) and allow the magnet to pull the ignition module against the magnet.
5. Tighten the mounting screws (B) to **4.0 N•m (35 lb-in.)**.
6. Repeat steps 1—4 for the other ignition module.
7. Rotate the flywheel back and forth to check clearance between the ignition modules and magnet.
8. Recheck the gap, the final gap should be **0.203—0.305 mm (0.008—0.012 in)**. Repeat adjustment procedure as needed.

FLYWHEEL—REMOVAL/INSTALLATION

CAUTION

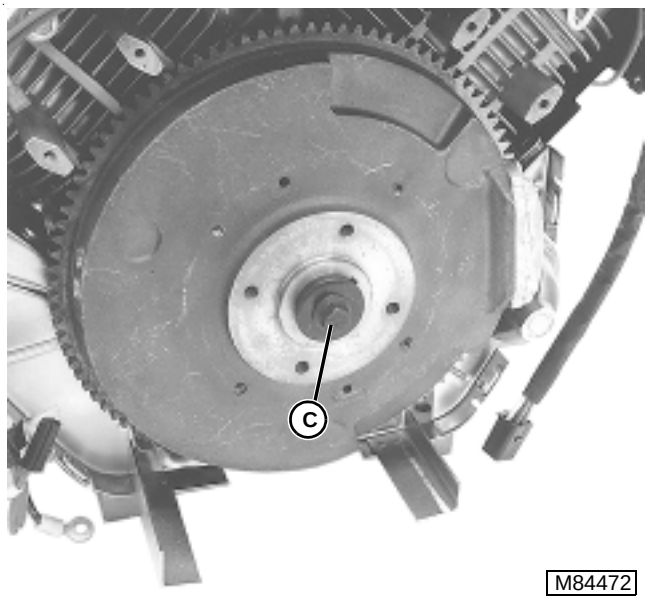
Wear gloves to protect hands. Flywheel could rotate during disassembly and assembly.

1. Remove ignition modules. (See IGNITION MODULES—REMOVAL/INSTALLATION.)



M84471

2. Remove four extension shaft cap screws (A).
3. Remove extension shaft (B).



M84472

IMPORTANT: Always use a strap wrench to hold the flywheel when loosening or tightening the flywheel or flywheel fasteners. DO NOT use any type of bar or wedge between the cooling fins.

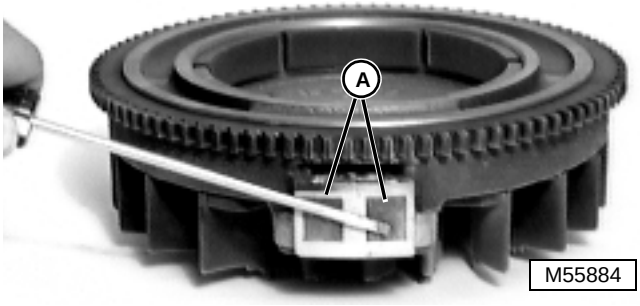
4. Hold flywheel with a strap wrench. Remove crankshaft cap screw (C).
5. Remove flywheel using a puller.
6. Inspect flywheel for cracks, chips, and broken teeth. Replace as necessary.
7. Inspect for sheared or partially sheared key, replace as needed.
8. Test magnets. (See FLYWHEEL—INSPECT MAGNETS.)

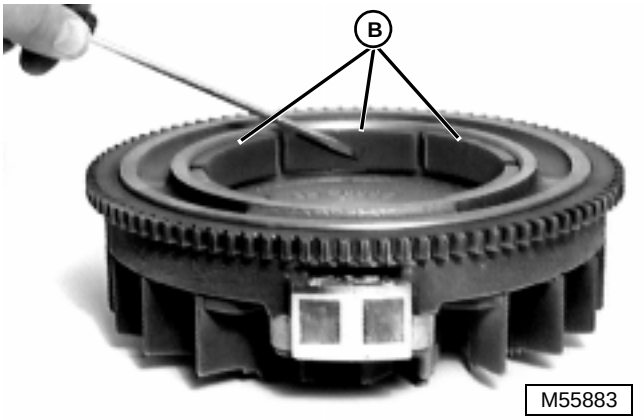
Installation is done in the reverse order of removal.

IMPORTANT: Check that crankshaft end and flywheel hub are clean and free of lubricant, and flywheel key is installed properly in keyway. Improperly installed flywheel can cause machine damage and serious personal injury.

- Apply MPG-2 Multi-Purpose Grease to pump output shaft and key. (See ANTI-CORROSION GREASE in SPECIFICATIONS AND INFORMATION section.)
- Hold flywheel with a strap wrench. Tighten crankshaft cap screw (C) to **66.4 N•m (49 lb-ft)**.
- Tighten the extension shaft cap screws to **24 N•m (210 lb-in.)**.
- Tighten blower screen cap screws to **10 N•m (88 lb-in)**.
- Adjust ignition module air gap. (See IGNITION MODULES—AIR GAP ADJUSTMENT.)

FLYWHEEL—INSPECT MAGNETS

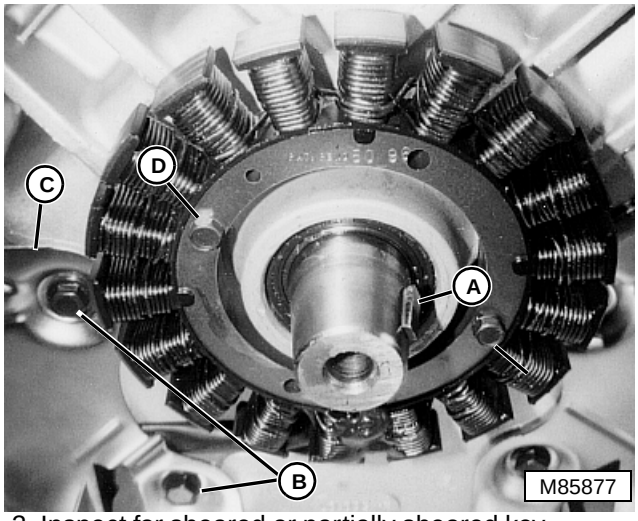




Hold a steel tool about 25 mm (1.0 in.) from the ignition coil magnets (A) and stator magnets (B). The tool should be attracted to the magnets. Replace the flywheel if the tool is not attracted to the magnets.

STATOR—REMOVAL/INSTALLATION

1. Remove flywheel. (See FLYWHEEL—REMOVAL/INSTALLATION.)



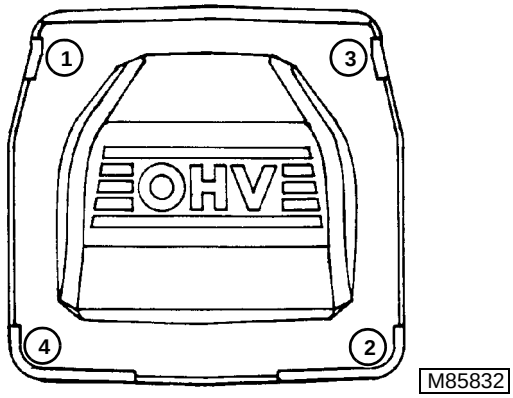
2. Inspect for sheared or partially sheared key. Remove key (A).
3. Remove two cap screws (B).
4. Remove left side bracket (C) (right side optional).
5. Remove stator cap screws (D).
6. Remove stator.

Installation is done in the reverse order of removal.

- Adjust ignition module air gap. (See IGNITION MODULES—AIR GAP ADJUSTMENT.)
- Tighten stator cap screws (D) to **4.0 N•m (35 lb-in.)**.

ROCKER ARM COVERS—REMOVAL/INSTALLATION

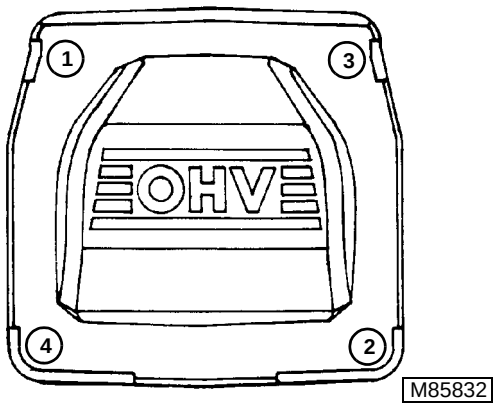
NOTE: Make note of location of lifting bracket and oil filler for correct reassembly.



1. Remove four cap screws in sequence shown.
2. Remove the rocker arm cover and lifting bracket.

Installation is done in the reverse order of removal.

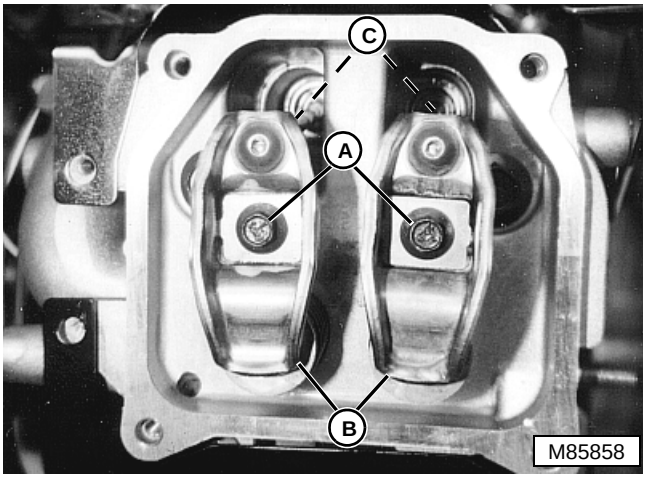
- Clean mating surfaces of rocker arm cover and head before installation.
- Install new rocker arm cover O-ring gasket for installation.



- Tighten rocker arm cover cap screws, in sequence shown to **8 N•m (70 lb-in.)**.

ROCKER ARMS AND PUSH RODS—REMOVAL/INSTALLATION

1. Remove rocker arm cover. (See ROCKER ARM COVER—REMOVAL/INSTALLATION.)



2. Remove rocker arm pivot bolts (A).
3. Remove rocker arms (B).
4. Remove push rods (C). Push rods must go in exact location as removed. Mark cylinder head and push rods to aid in reassembly.
5. Inspect and replace components as necessary.

Assembly is done in the reverse order of removal.

IMPORTANT: DO NOT interchange parts from one cylinder head with parts from the other cylinder head.

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

- Rotate engine 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), lifter is overextended. Allow 10—15 minutes for lifter to bleed down, and recheck clearance. If there still is no clearance between spring coils, repair or replace overextended lifter.
- Tighten rocker arm pivot bolts (A) to **14 N•m (124 lb-in.)**.

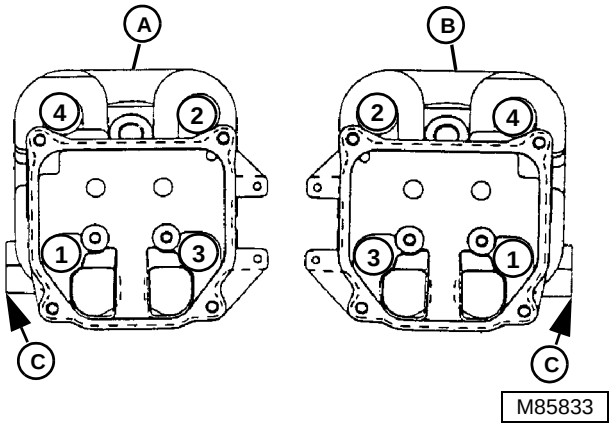
PUSH ROD INSPECTION

Inspect push rods for bend using V-blocks and a dial indicator. Turn rod slowly and read variation on indicator. Replace rod if variation is **greater than 0.76 mm (0.030 in.)**.

CYLINDER HEADS AND VALVES—REMOVAL/INSTALLATION

IMPORTANT: Engine must be cold before removing cylinder head bolts to avoid warping aluminum cylinder head.

1. Remove intake manifold. (See INTAKE MANIFOLD—REMOVAL/INSTALLATION.)
2. Remove muffler. (See MUFFLER—REMOVAL/INSTALLATION.)
3. Remove blower housing and side shields. (See BLOWER HOUSING AND SHIELDS—REMOVAL/INSTALLATION.)
4. Remove rocker arms and push rods. (See ROCKER ARMS AND PUSH RODS—REMOVAL/INSTALLATION.)
5. Remove throttle plate assembly. (See THROTTLE PLATE ASSEMBLY—REMOVAL/INSTALLATION.)



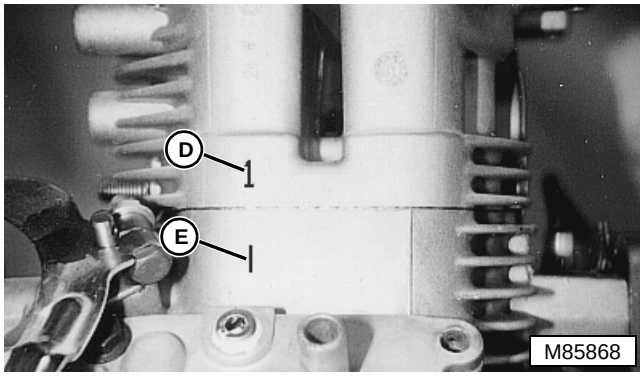
A—Cylinder Head Marked "1"
B—Cylinder Head Marked "2"
C—Exhaust Port Side

IMPORTANT: Loosen cylinder head bolts 1/4 turn at a time in the sequence shown to avoid warping the cylinder head.

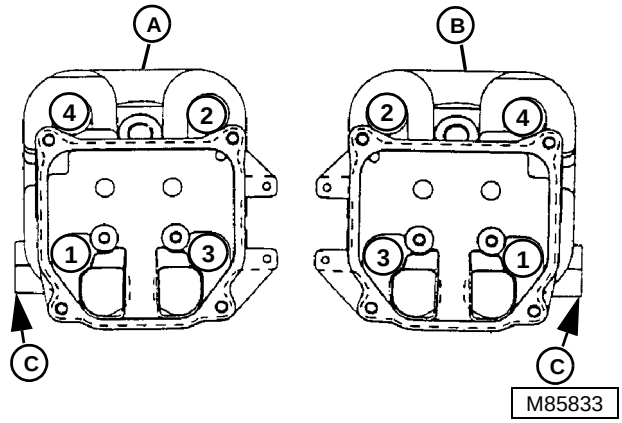
6. Loosen head bolts in the sequence shown.
7. Remove head bolts, cylinder heads and gasket. Discard head gaskets.
8. Disassemble and inspect cylinder head and valves. (See CYLINDER HEADS AND VALVES—DISASSEMBLY/ASSEMBLY and CYLINDER HEADS AND VALVES—INSPECTION.)
9. Clean cylinder head and engine block surface. Check to make sure there are no nicks or burrs on the sealing surfaces of the cylinder head or crankcase.

Installation is done in the reverse order of removal.

- Install new cylinder head gasket.



- Align cylinder head mark (D) with crankcase mark (E). Both cylinder heads and crankcase are marked (1 or 2).

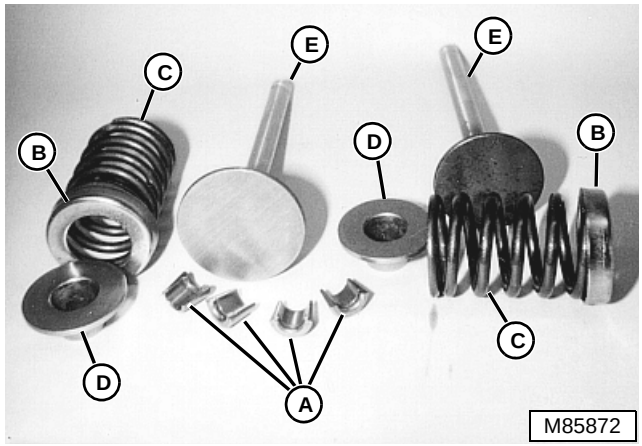


A—Cylinder Head Marked "1"
B—Cylinder Head Marked "2"
C—Exhaust Port Side

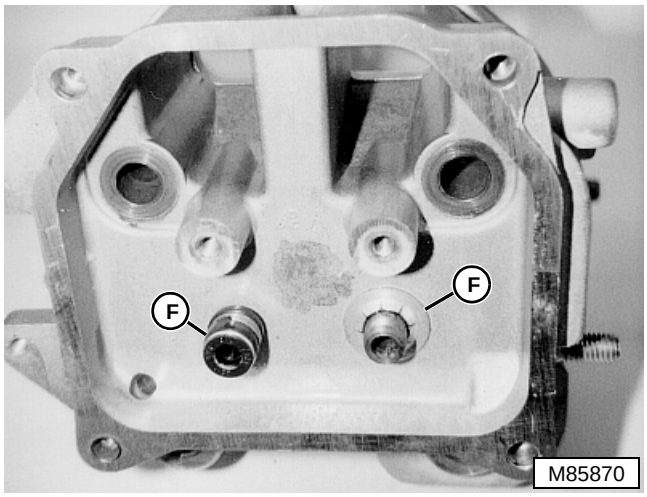
- Tighten cylinder head bolts in **20 N•m (15 lb-ft)** increments in sequence illustrated. Repeat procedure, tightening cylinder head bolts to a final value of **40.7 N•m (30 lb-ft)**.
- Install push rods (reinstall push rods in same position as before disassembly) and rocker arms (See ROCKER ARMS AND PUSH RODS—REMOVAL/INSTALLATION.)

CYLINDER HEADS AND VALVES—DISASSEMBLY/ASSEMBLY

1. Compress intake and exhaust springs using valve spring compressor.



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



3. Remove valve stem seals (F).
4. Inspect all parts for wear or damage. (See CYLINDER HEADS AND VALVES—INSPECTION.)

Assembly is done in the reverse order of disassembly.

IMPORTANT: Always use a new seal when valves are installed in the cylinder head. Also, replace the seals if they are deteriorated or damaged in any way. Never reuse an old seal.

- Replace valve stem seals

CYLINDER HEADS AND VALVES—INSPECTION

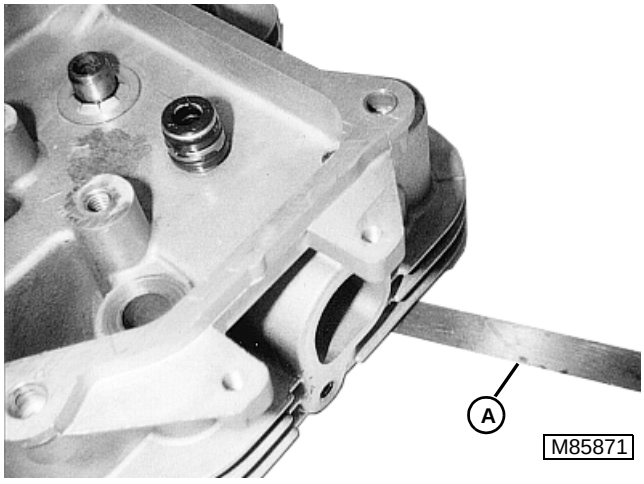
Cylinder Head:

1. Remove carbon deposits and clean gasket surface with SCOTCH-BRITE® abrasive or equivalent.

⚠ CAUTION

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.

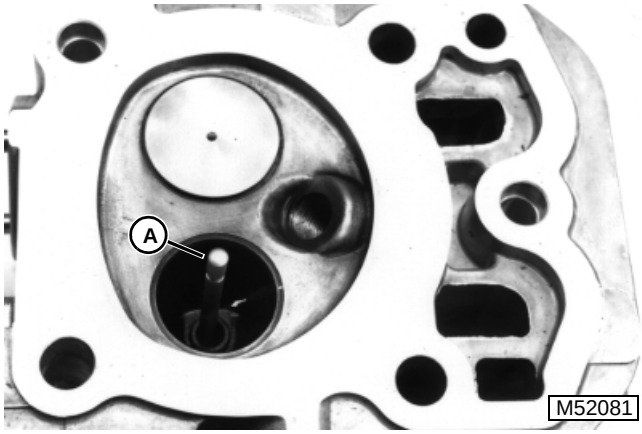
2. Clean head with a suitable solvent and dry with compressed air.
3. Inspect head for cracks, damage or broken cooling fins.
4. Inspect gasket surface for burrs and nicks.
5. Make sure oil drain port is open.



6. Place head on a flat surface plate. Check for distortion at several points with a feeler gauge (A). Replace head if distortion is greater than **0.076 mm (0.003 in.)**.

Valve Guides:

1. Clean inside of valve guide using a D20020WI standard valve guide reamer.



NOTE: Valve guides can be reamed 0.25 mm (0.010 in.) oversized. A 0.25 mm (0.010 in.) oversize valve must be installed.

2. Measure inside diameter of guide with gauge (A).

   If valve guides exceeds the standard wear limit; Ream guide using JDG705 Oversize Reaming Tool, and install an oversized valve(s).

   If valve guides exceeds the reamed wear limit; Replace the cylinder head.

Intake Valve Guide Inside Diameter (Wear Limit)

Standard . . . . . 7.134 mm (0.2809 in.)
0.25 mm (0.010 in.) Reamed . 7.384 mm (0.2907 in.)

Intake Valve Guide Inside Diameter (Wear Limit)

Standard . . . . . 7.159 mm (0.2819 in.)
0.25 mm (0.010 in.) Reamed . 7.409 mm (0.2917 in.)

3. Measure outside diameter of valve stem.
4. Subtract outside diameter of valve from the inside diameter of valve guide to determine valve stem-to guide clearance.
5. Replace valve and/or cylinder head if valve stem-to-guide clearance exceeds wear limits

Valve Stem-to-Guide Clearance (Wear Limit)

Intake. . . . . 7.134 mm (0.2809 in.)
Exhaust . . . . . 7.159 mm (0.2819 in.)

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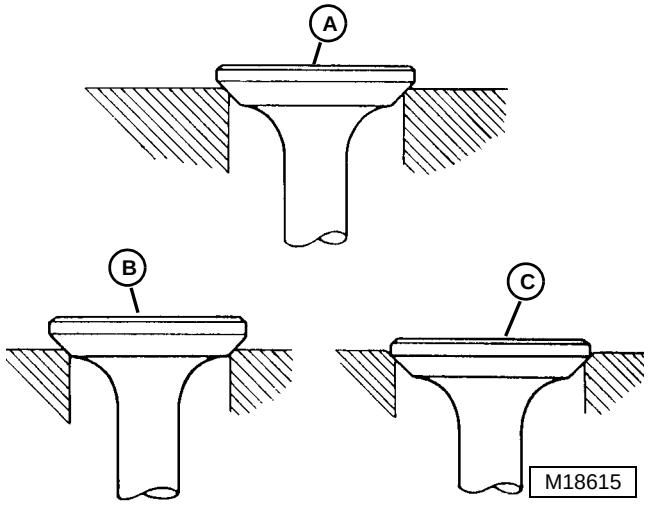
Valve Seats:

1. If valve seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be re-faced using a seat cutter.

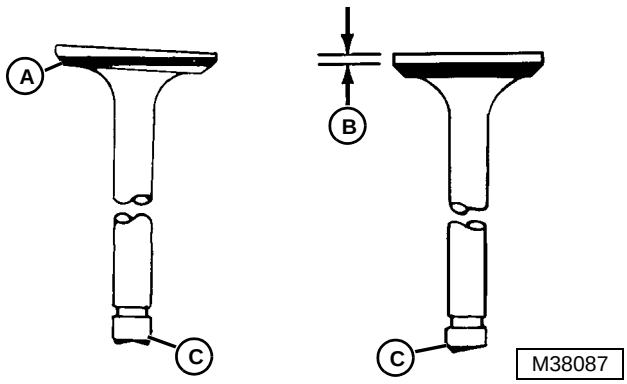


A—Correct Seat Position
B—Seat Too High
C—Seat Too Deep

2. Check valve seating pattern for correct width and evenness all around. If valve seat width is not within **0.50—1.10 mm (0.020—0.043 in.)**, recondition valve seat. (See RECONDITION VALVE SEATS.)
3. Lap valve after reconditioning with lapping compound and recheck valve seating surface for proper width and evenness of seating pattern. (See LAP VALVES.)

Intake and Exhaust Valves:

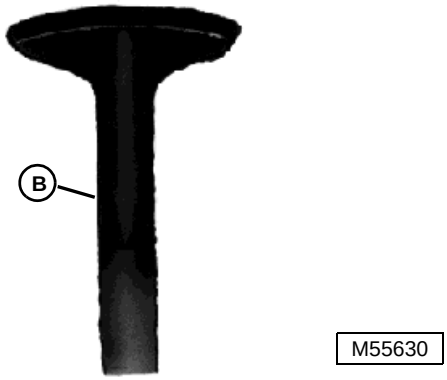
1. Remove carbon from valve head, face, and stem with a power-operated wire brush. Be sure carbon is removed, not merely burninshed.
2. Check valve for cracks or damage.



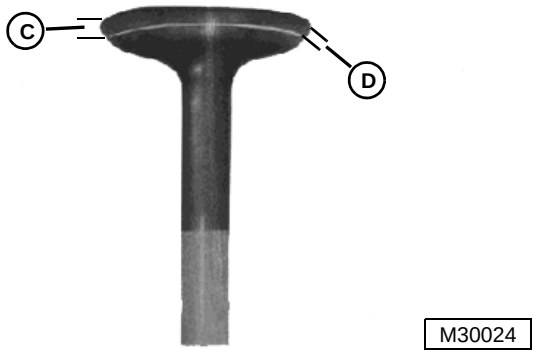
3. Replace warped valves (A) or valves with less than serviceable margin (B). Valve stem ends (C) should be square, not worn uneven as shown.
4. Inspect valve stems for bends using V-blocks and dial indicator. Turn valve slowly and read variation. Replace if variation is greater than **0.076 mm (0.003 in.)**.

ANALYZE VALVES

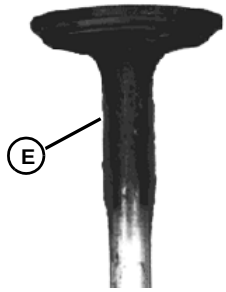
Lead deposits (A) on the intake valve are caused by exhaust gas leakage past the valve when using leaded gasoline. Grind intake valve and reface valve seat to correct this condition.
Use unleaded fuel to prevent lead deposits.



Valve stem corrosion (B) is caused by moisture in the engine which occurs during hot engine cool-down periods or during storage.
Fogging of combustion chamber with oil before storage helps prevent corrosion. Replace badly corroded valves.



Operating at high temperatures for long periods of time can cause exhaust valve burning. Burned valve will show dark discoloration into the area protected by the valve guide. Another indication is distortion of the margin (C) and face angle (D). The valve seat may also show erosion.
An overheated engine can also cause valve burning. Check for clogged engine cooling fins. DO NOT run engine with blower housing removed. Also check for worn valve guides, springs or hydraulic lifters, lean fuel-air mixture, or incorrect spark plug.



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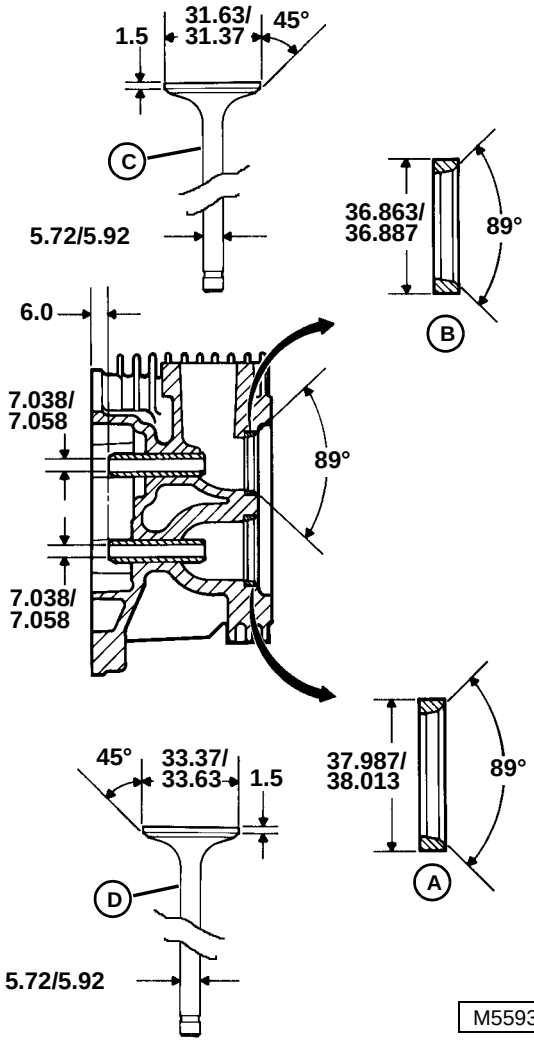
Use of old or stale gasoline is a common cause for sticky valves.

Gummy deposits (E) can build up on valve and can also gum carburetor, requiring cleaning. Always use fresh gasoline of 87 octane rating or higher. Drain fuel tank, lines, and carburetor before storage.

RECONDITION VALVE SEATS



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A—Intake Valve Seat Insert
B—Exhaust Valve Seat Insert
C—Exhaust Valve
D—Intake Valve

IMPORTANT: Hardened steel alloy intake (A) and exhaust (B) valve seat inserts are press fitted into the cylinder head. The inserts are not replaceable on the engines but can be reconditioned if not too badly pitted or distorted. If cracked or badly warped, the cylinder head should be replaced. With the proper 45° valve face angle and valve seat cut properly (44.5° as measured from centerline when cut 89°) the result would be an 0.5° (1.0° full cut) interference angle where the maximum pressure occurs on the outside diameters of valve face and seat.

1. Inspect valve seats (A and B).
2. Replace cylinder head if seats are warped or distorted beyond reconditioning.
3. Reface pitted or worn seats as shown in drawing.
4. Lap valves after refacing.
5. Check seat for good contact using Prussian Blue Compound.

LAP VALVES

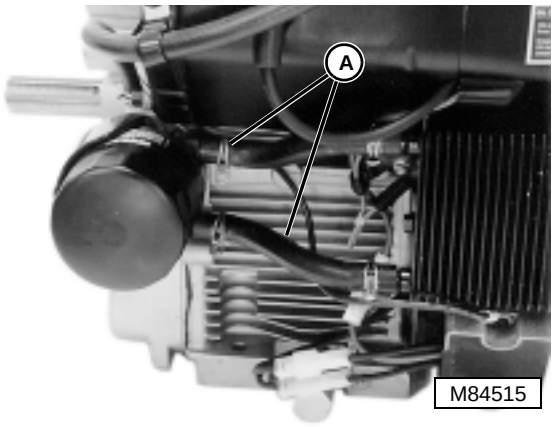
If the valves do not make proper contact with the valve seat, lap the valves into the seats.

1. Apply light coat of lapping compound to valve face.
2. Grip the head of the valve with a vacuum cup tool and turn valve to lap to seat.
3. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around surface of valve face.
4. Wash parts in solvent to remove lapping compound. Dry parts.
5. Check position of lap mark on face. Lap mark must be on or near center of valve face.

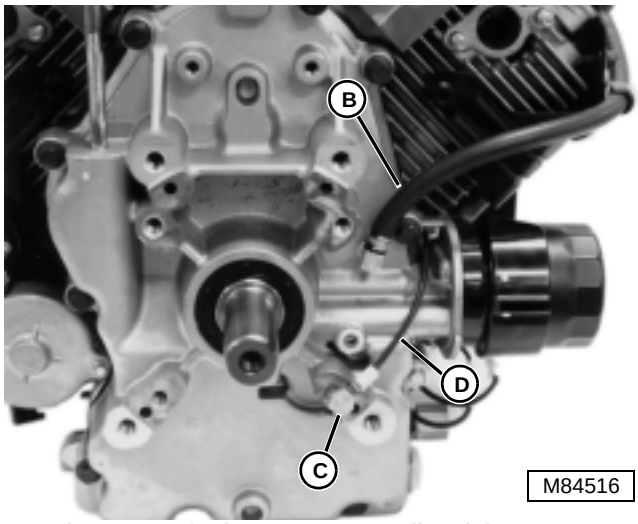
CRANKCASE COVER—REMOVAL

*NOTE: Crankcase capacity (with filter) is approximately **1.9 L (2.0 qt)—CH22 or 2.0 L (2.1 qt)—CH25**.*

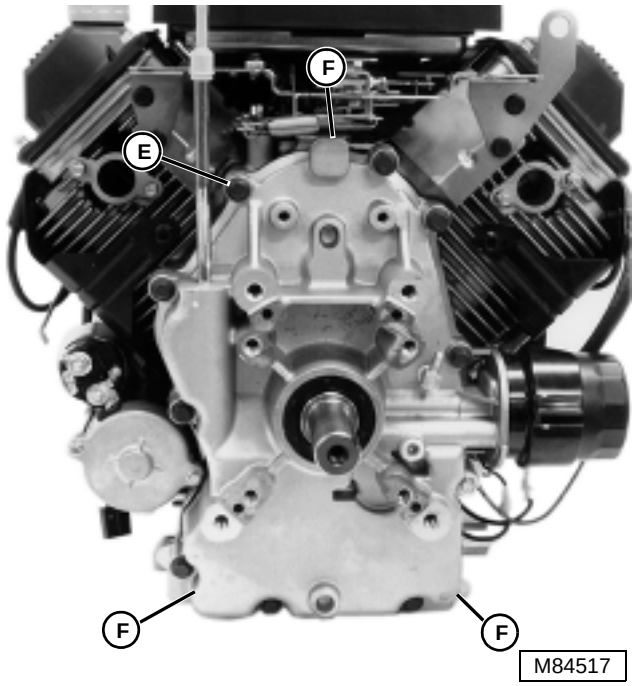
1. Remove drain plug and drain crankcase.



2. Disconnect oil cooler hoses (A) at oil filter base.

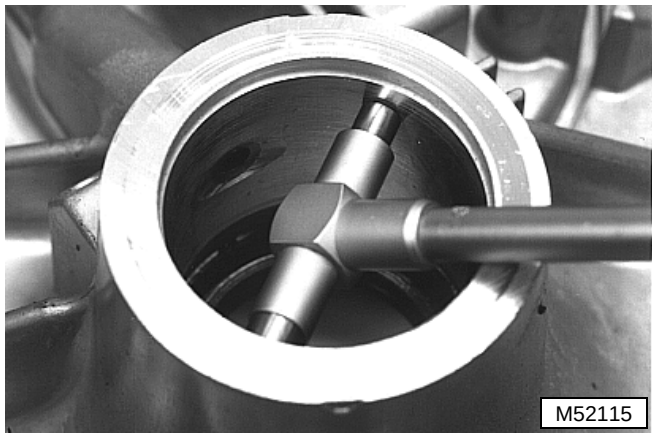


3. Disconnect fuel pump vacuum line (B).
4. Remove cap screw (C) and ground wire (D).



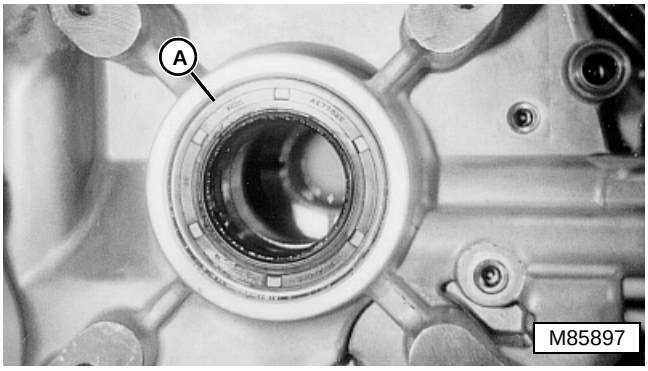
5. Remove ten cap screws (E).
6. Pry crankcase cover from crankcase using flat blade screwdriver on splitting tabs (F).
7. Clean mating surfaces of crankcase and crankcase cover.
8. Replace crankcase cover seal. (See CRANKCASE COVER—OIL SEAL REPLACEMENT.)

CRANKCASE COVER—INSPECTION



1. Measure crankshaft bore inside diameter in crankcase cover. Replace crankcase cover if bore exceeds **41.003 mm (1.6143 in.)**.
2. Check bore for nicks or cracks. Replace crankcase cover if bore is damaged.
3. Inspect crankcase cover for nicks or damage. Replace crankcase cover if needed.

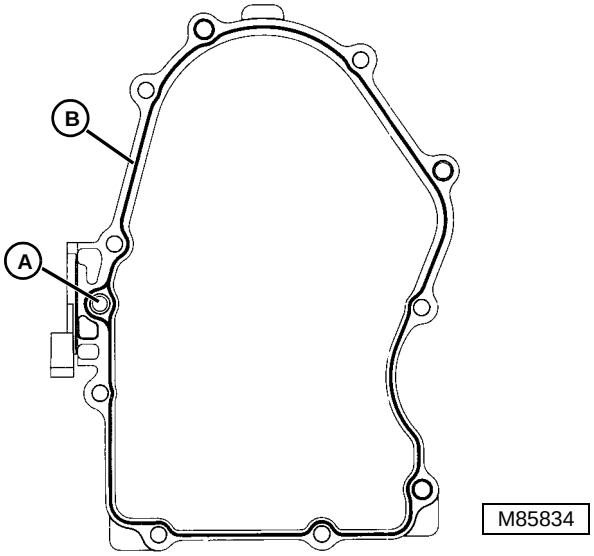
CRANKCASE COVER— OIL SEAL REPLACEMENT



IMPORTANT: DO NOT damage seal bore when removing seal.

1. Remove worn or damaged oil seal (A) using a screwdriver.
2. Apply light coat of oil to outside diameter of oil seal.
3. Drive oil seal into crankcase to a depth of **2.03 mm (0.08 in.)** using appropriate driver.

CRANKCASE COVER— INSTALLATION



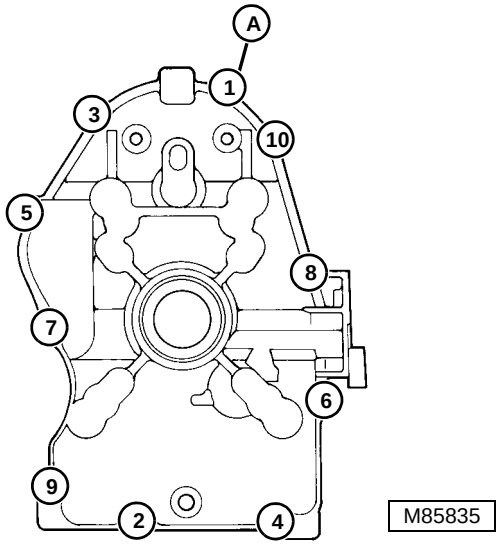
IMPORTANT: DO NOT get sealant in oil passage. Apply just enough to seal both sides of oil passage when case halves are fastened together.

1. Install new O-ring in oil passage (A).
2. Apply 1.6 mm (1/16 in.) bead of RTV silicone sealant (B) to crankcase cover flange. DO NOT block oil passage.
3. Apply grease to inside lip of crankcase cover seal.

IMPORTANT: Be sure to align flats of governor cross shaft before installing crankcase cover.

NOTE: Install closure plate over crankshaft carefully to avoid damaging crankcase cover seal.

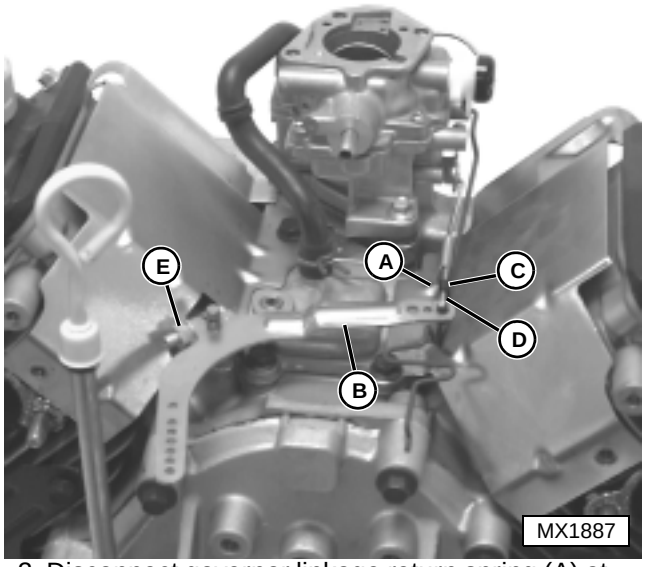
4. Install cover onto crankcase.



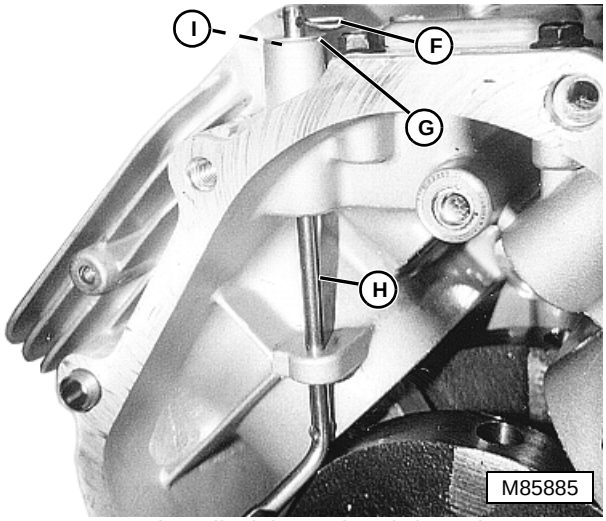
5. Tighten crankcase cover cap screws (A) in sequence shown to **24.4 N•m (216 lb-in.)**.

GOVERNOR—REMOVAL/INSPECTION

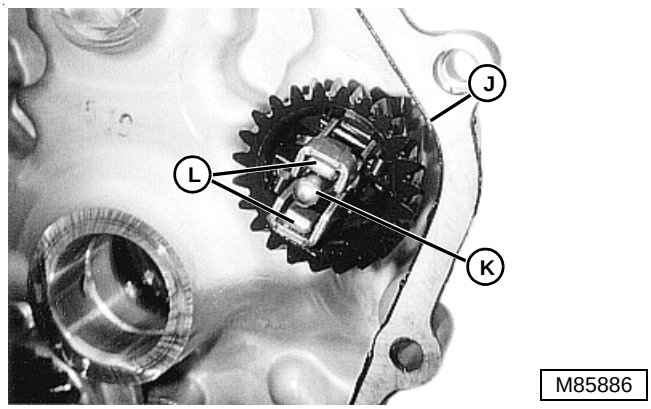
1. Remove throttle plate assembly. (See THROTTLE PLATE ASSEMBLY—REMOVAL/INSTALLATION.)



2. Disconnect governor linkage return spring (A) at governor arm (B).
3. Disconnect retainer (C) from governor linkage.
4. Disconnect governor linkage (D) from governor arm.
5. Remove cap screw and nut (E).
6. Remove crankcase cover. (See CRANKCASE COVER—REMOVAL.)
7. Remove governor arm from cross shaft.

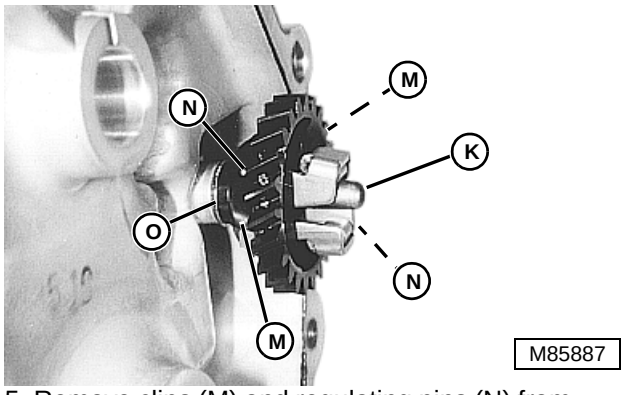


8. Remove spring clip (F), washer (G), and governor cross shaft (H) from inside of crankcase.
9. Measure outside diameter of cross shaft. Replace cross shaft if outside diameter is less than **5.962 mm (0.235 in.)**.
10. Measure inside diameter of cross shaft bore in the block. Subtract the outside diameter of the cross shaft from the cross shaft bore inside diameter to determine clearance. Replace shaft and/or engine block if the clearance exceeds **0.075 mm (0.0030 in.)**.
11. Inspect cross shaft for damage. Replace if needed.
12. Inspect governor cross shaft seal (I) for damage or leakage. Replace as needed.



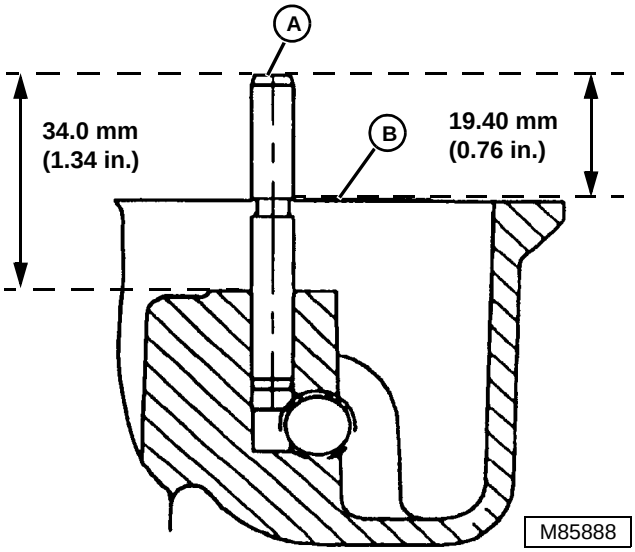
IMPORTANT: The governor gear (J) is held onto the shaft by small molded tabs in the gear. When the gear is removed from the shaft (K), these tabs are destroyed and the gear must be replaced. Therefore, remove the gear only if absolutely necessary.

13. Inspect the governor gear teeth. Replace the gear if worn, chipped, or if any teeth are missing.
14. Inspect the governor flyweights (L) for proper operation and movement. The flyweights should move freely in the governor gear.

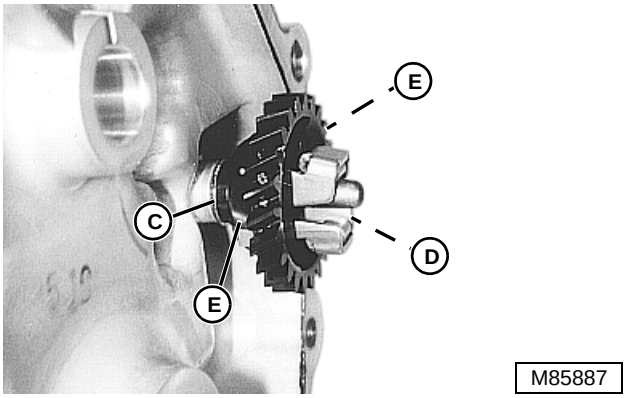


15. Remove clips (M) and regulating pins (N) from governor gear assembly.
16. Remove thrust washer (O) located under gear assembly.
17. Measure outside diameter of gear shaft (K). Replace gear shaft if outside diameter is less than **5.977 mm (0.235 in.)** or damaged.

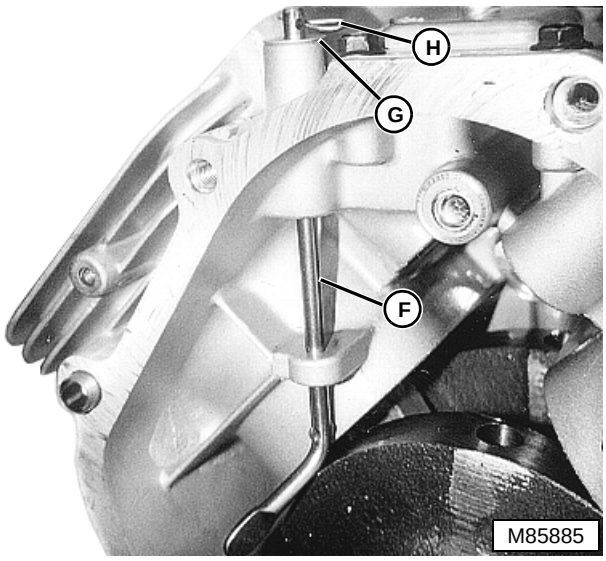
GOVERNOR—INSTALLATION



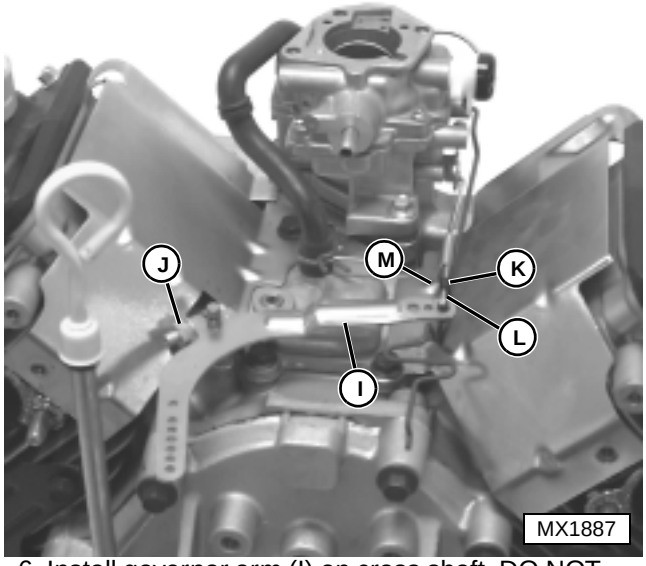
1. Press new governor gear shaft (A) into crankcase cover until the end of the shaft is **34.0 mm (1.34 in.)** from the flat on the crankcase cover (B), or **19.40 mm (0.76 in.)** from the mating surface of the crankcase cover.



2. Install thrust washer (C) and governor gear assembly.
3. Install regulating pin (B) and clips (C).

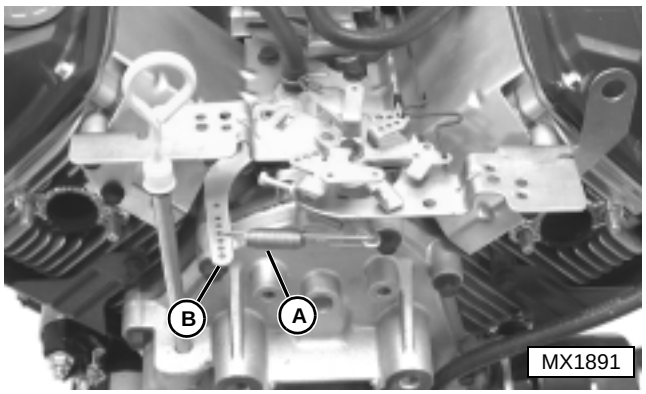


4. Install cross shaft (F), washer (G), and clip (H).
5. Install crankcase cover. (See CRANKCASE COVER—INSTALLATION.)



6. Install governor arm (I) on cross shaft. DO NOT tighten cap screw/nut (J).
7. Install retainer (K) on governor arm.
8. Connect governor linkage (L) in retainer, snap retainer over linkage.
9. Connect governor linkage return spring (M) to governor arm.
10. Rotate governor arm toward carburetor (WIDE OPEN THROTTLE) and hold in position.
11. Rotate cross shaft counterclockwise as far as it will go and tighten cap screw/nut to **10 N•m (88 lb-in.)**.
12. Install throttle plate assembly. (See THROTTLE PLATE ASSEMBLY—REMOVAL/INSTALLATION.)
13. Adjust governor sensitivity if needed. (See GOVERNOR—SENSITIVITY ADJUSTMENT.)

GOVERNOR—SENSITIVITY ADJUSTMENT

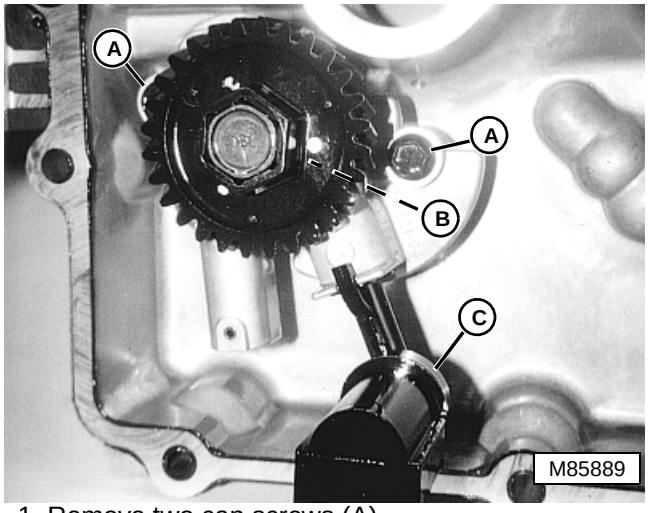


NOTE: Governor sensitivity is adjusted by repositioning the governor spring (A) in the holes on the governor arm (B). If speed surging occurs with a change in engine load, the governor is set too sensitive. If a big drop in speed occurs when normal load is applied, the governor should be set for greater sensitivity.

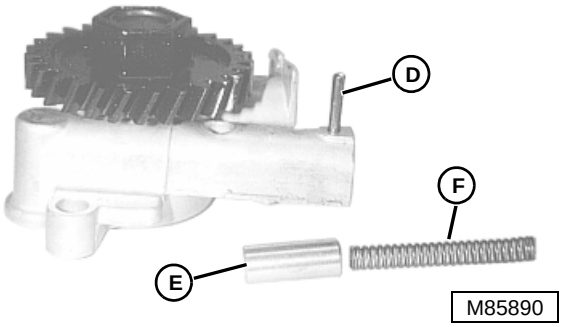
1. To increase the sensitivity, move the spring (A) closer to the governor lever pivot point.
2. To decrease the sensitivity, move the spring away from the governor lever pivot point.

OIL PUMP—REMOVAL/INSPECTION/INSTALLATION

1. Remove crankcase cover. (See CRANKCASE COVER—REMOVAL.)



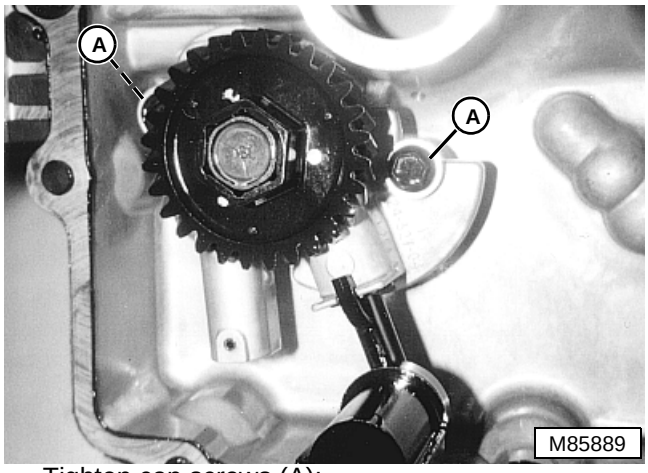
1. Remove two cap screws (A).
2. Remove the oil pump assembly from the crankcase cover.
3. Remove oil pump rotors (B).
4. Remove oil pickup (C) by pulling it free from oil pump body.



5. Gently drive out pin (D) to remove oil pressure relief valve piston (E) and spring (F).
6. Inspect oil pressure relief valve piston. It should be free of nicks or burrs.
7. Check spring for wear or distortion. Replace spring if it is distorted or worn.
8. Measure spring free length. Spring should measure **47.4 mm (1.8 in.)**. Replace spring if needed.
9. Inspect oil pickup screen. It should be free of debris.

Installation is done in the reverse order of removal.

- Reassemble oil pump. Turn rotors to align marks. Install oil pump on crankcase cover.



- Tighten cap screws (A):

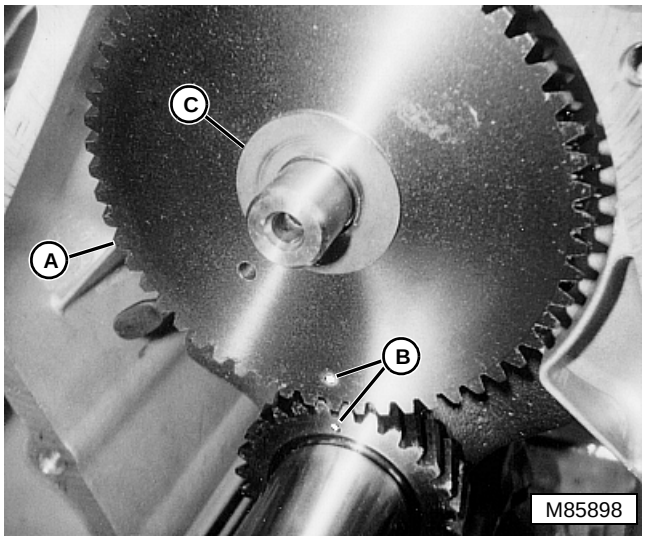
  If installing oil pump on a new cover, tighten cap screws to **10.7 N•m (95 lb-in.)**.

  If reinstalling oil pump, tighten cap screws to **6.7 N•m (60 lb-in.)**

- Rotate oil pump gear. Make sure there is no binding of pump. If binding occurs, loosen cap screws, reposition pump, retighten, and recheck movement.

CAMSHAFT—REMOVAL/INSTALLATION

1. Remove crankcase cover. (See CRANKCASE COVER—Removal.)
2. Remove push rods. (See ROCKER ARMS AND PUSH RODS—Removal/Installation.)

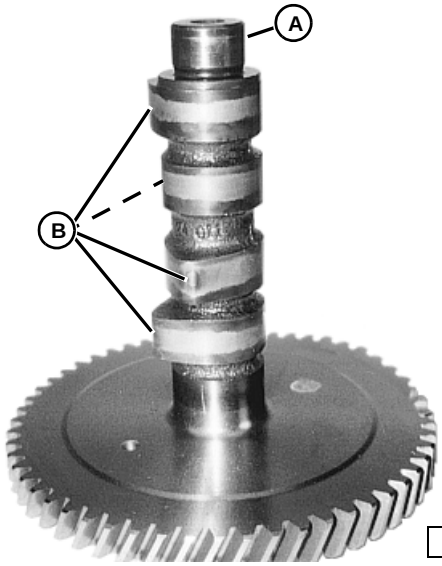


1. Rotate crankshaft (A) to align camshaft and crankshaft alignment marks (B).
2. Remove camshaft and shim (C).
3. Inspect camshaft. (See CAMSHAFT—INSPECTION.)

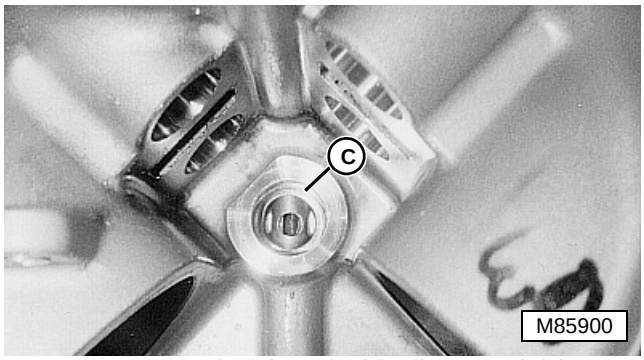
Installation is done in the reverse order of removal.

- Apply a light coat of clean engine oil to camshaft lobes and journals.
- Align timing marks when installing camshaft.
- Check camshaft end play. (See CAMSHAFT—CHECK END PLAY). Make sure shim is in place. If not within specifications, add, remove or replace shims as necessary. Reinstall camshaft.

CAMSHAFT—INSPECTION



1. Inspect camshaft for worn or broken teeth.
2. Measure camshaft journal outside diameter (A). Journal diameter should measure **19.962—19.975 mm (0.7859—0.7864 in.)**. Replace camshaft if journal is less than **19.959 mm (0.7858 in.)**.
3. Inspect lobes (B). Replace camshaft if lobes show excessive wear.

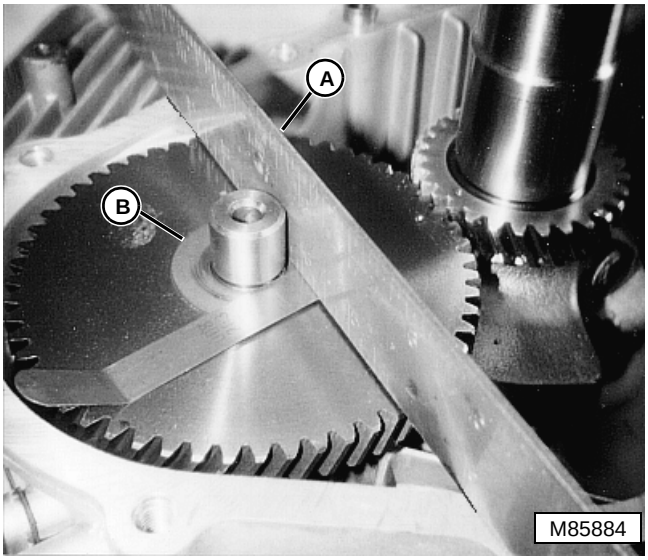


4. Measure camshaft bore inside diameter (C) in engine block. Bore should measure **20.000—20.025 mm (0.7874—0.7844 in.)**. Replace cylinder block if bore is greater than **20.038 mm (0.7889 in.)**.
5. Subtract journal outside diameter from crankcase bore inside diameter to determine clearance. Replace both the cylinder block and camshaft if clearance is greater than **0.025—0.063 mm (0.0010—0.0025 in.)**.

CAMSHAFT—CHECK END PLAY

NOTE: Make sure all gasket material is removed from the crankcase mating surface to ensure accuracy

1. Check that camshaft is seated in crankcase bore.



2. Place straight edge (A) across crankcase gasket mating surface. Make sure straight edge is flush on crankcase mating surface.
3. Measure end play between camshaft and straight edge (spanning crankcase) using flat feeler gauge.
4. If the camshaft end play is not snug within **0.076—0.127 mm (0.003—0.005 in.)**, add or remove shims (B) from Shim Kit as necessary until end play is within specification.

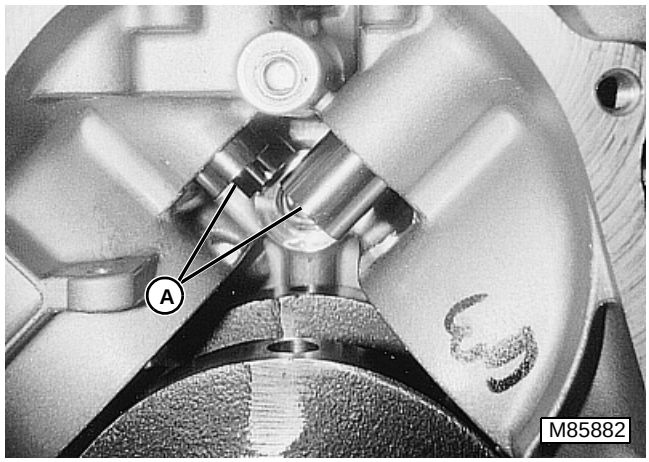
Camshaft Shims:

White . . . . 0.69215/0.73025mm (0.02725/0.02875 in.)
Blue . . . . . 0.74295/0.78105mm (0.02925/0.03075 in.)
Red . . . . . 0.79375/0.83185mm (0.03125/0.03275 in.)
Yellow . . . 0.84455/0.88265mm (0.03325/0.03475 in.)
Green. . . . 0.89535/0.99345mm (0.03525/0.03675 in.)
Gray. . . . . 0.94615/0.98425mm (0.03725/0.03875 in.)
Black . . . . 0.99695/1.03505mm (0.03925/0.04075 in.)

HYDRAULIC LIFTERS—REMOVAL/INSTALLATION

1. Remove camshaft. (See CAMSHAFT—REMOVAL/INSTALLATION.)

IMPORTANT: Used lifters are mated to their camshaft lobes. Mark them for installation in the correct bore if they are not already marked. The exhaust lifters are located on the output shaft side of the engine while the intake lifters are located on the fan side of the engine. The cylinder head number is bossed on the outside of each cylinder head.



2. Remove lifters (A). Lifters must be installed in same bore as removed.
3. Inspect lifters for wear. Replace as necessary. (See HYDRAULIC LIFTERS—INSPECTION.)

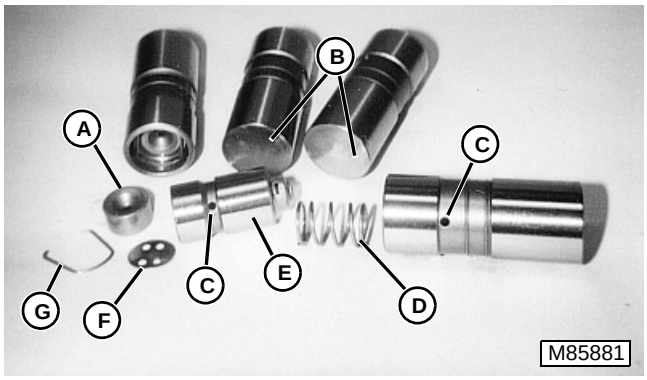
Installation is done in the reverse order of removal.

- Coat lifters with a light coat of clean engine oil and install in correct bore.

HYDRAULIC LIFTERS—INSPECTION

Reasons:

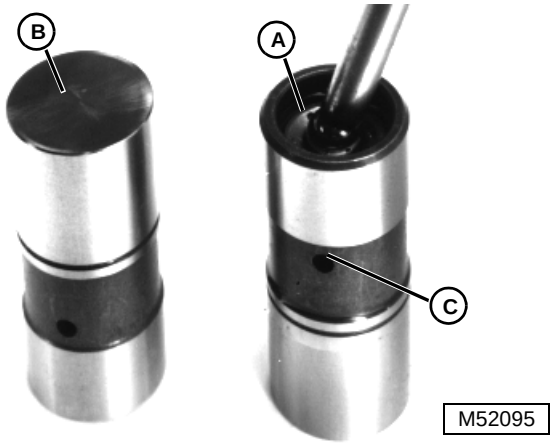
- If lifter noise continues after 20 minutes of running, it is probably an indication of contamination or dirt in the lifter preventing the inner piston from seating. Replace lifter.
- A lifter which suddenly gets noisy while engine is running would probably be caused by trapped air. If noise is caused by contamination, replace lifter. If noise is caused by trapped air, see BLEED HYDRAULIC LIFTERS and PRIME HYDRAULIC LIFTERS.
- Lifter noise which appears or worsens as the engine heats up is usually due to wear in the lifters and other engine components, especially if engine has considerable running hours or has not had regular oil changes. Replaces lifters and other internal engine components that do not meet wear limit specifications.
- A situation where the lifter seems to pump up too much, holds a valve open, causes loss of compression or hard starting, indicates insufficient clearance between the plunger and body. Replace lifter.



A—Plunger
B—Lifter Face
C—Oil Hole
D—Spring
E—Inner Piston
F—Seal
G—Clip

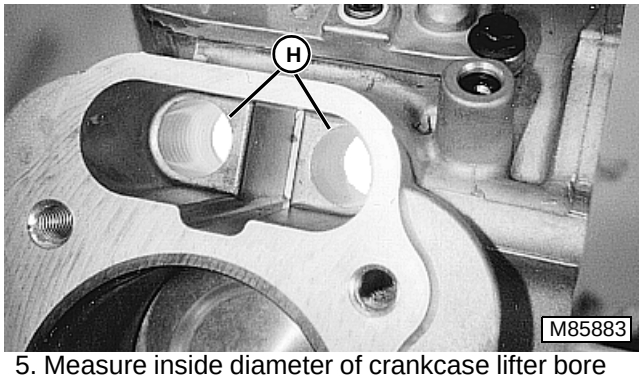
NOTE: Damaged or worn lifters usually indicate a damaged camshaft. Check camshaft before replacing lifters.

1. Inspect lifter face (B) for wear. Face should be flat and smooth.



2. Use push rod to depress plunger (A). Plunger should offer resistance but move smoothly.
3. Check that oil hole (C) is clear to inner piston.
4. Measure outside diameter of lifter.

IMPORTANT: Make sure lifters are "PRIMED" before installation and "BLED" before start-up to prevent damage to push rods or rocker arms. (See PRIME HYDRAULIC LIFTERS and BLED HYDRAULIC LIFTERS procedures.



5. Measure inside diameter of crankcase lifter bore (H).
6. Subtract lifter outside diameter from bore inside diameter to determine lifter-to-bore clearance. Replace lifter and/or block if clearance is greater than **0.0501 mm (0.0020 in.**).

PRIME HYDRAULIC LIFTERS

1. Place lifter in small container.
2. Pour 10W30 oil into container until oil is level with top of lifter.
3. Place the end of one of the push rods into the socket on top of the lifter and "pump" the lifter with push rod until it feels solid.
4. Remove lifter from oil, let it drip off for a moment, and install into appropriate bore in engine.

BLEED HYDRAULIC LIFTERS

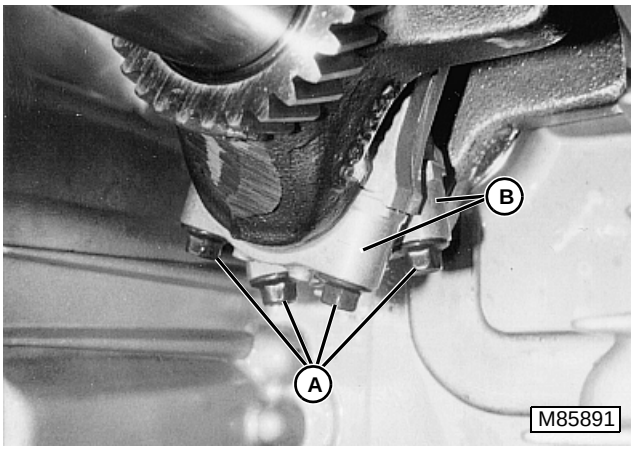
1. After installing cylinder head, rotate flywheel so the rocker arms will move alternately if the flywheel is rocked. This allows for maximum pressure on the lifters.
2. Leave engine in this position and reassemble remaining engine parts.
3. After engine has been in this position for 10 minutes (can include assembly time) turn engine over slowly by hand.
4. If engine turns over completely, fill the crankcase to proper level with recommended oil and test run.
5. If engine does not turn over completely (locks up at some point), stop turning at the point of lockup and allow 10 more minutes for the lifters to bleed down. Then try rotating by hand again.

Results:

- Lifter noise immediately after start-up is usually due to contraction and/or leakdown. There will be some noise when engine is first started but should last only a few seconds, but no more than a few minutes.
- If lifter is still noisy after 5 minutes of running, air could be trapped in the lifter. Stop engine and check oil level. Adjust as necessary and run engine for an additional 20 minutes at half throttle.

PISTONS AND CONNECTING RODS—REMOVAL

1. Remove cylinder heads. (See CYLINDER HEAD AND VALVES—REMOVAL/INSTALLATION.)
2. Remove camshaft and hydraulic lifters. (See CAMSHAFT—REMOVAL/INSTALLATION.)
3. Inspect top of cylinder for carbon and/or 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 before removing piston.



5. Remove connecting rod bolts (A) to remove rod caps (B) from connecting rods.

IMPORTANT: The cylinders are numbered on the crankcase. Use the numbers to mark each end cap, connecting rod and piston for installation. DO NOT mix end caps, connecting rods and pistons.

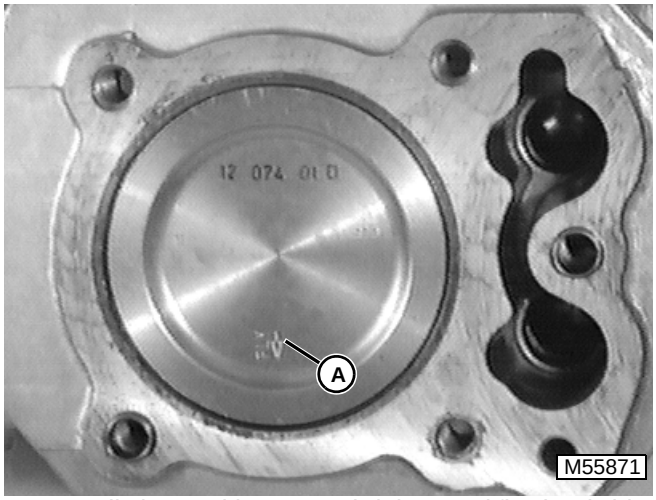
6. Remove piston assemblies through top of cylinder.
7. Disassemble and inspect all parts for wear or damage. (See PISTON AND CONNECTING RODS—DISASSEMBLY and PISTON AND CONNECTING RODS—INSPECTION.)

PISTONS AND CONNECTING RODS—INSTALLATION

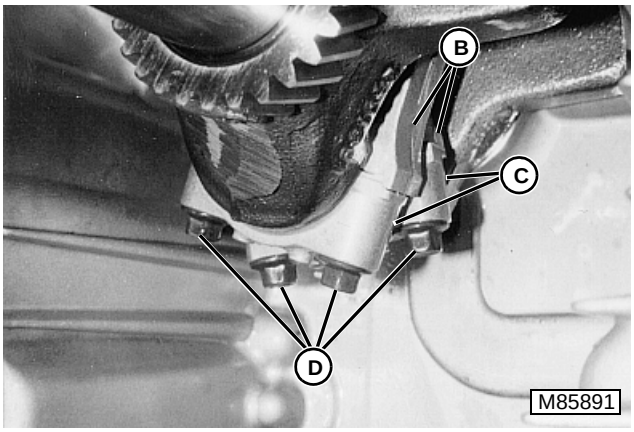
1. Deglaze cylinder bore. (See CYLINDER BLOCK—DEGLAZE CYLINDER BORE.)
2. Stagger piston ring end gaps 120° apart, but DO NOT align with oil ring side rail end gaps.
3. Apply a light coat of clean engine oil to piston and rings. Compress rings with a ring compressor.
4. Apply a light coat of clean engine oil to cylinder bore, connecting rod bearing surface and ring compressor.

IMPORTANT: The cylinders are numbered on the crankcase. Use the numbers to mark each end cap, connecting rod and piston for installation. DO NOT mix end caps, connecting rods and pistons.

NOTE: Gently tap piston with wood dowel—DO NOT force.



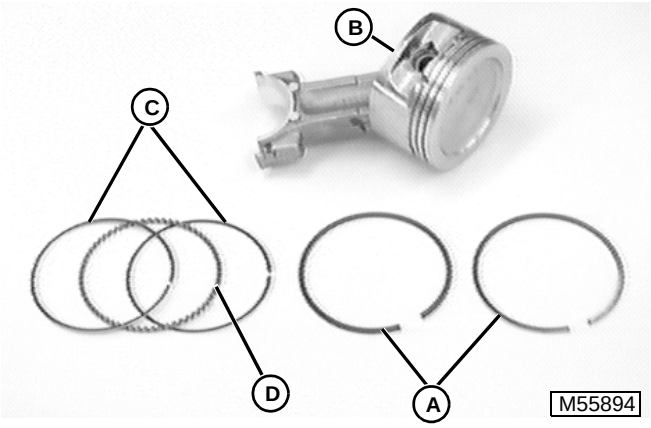
5. Install piston with FLY mark (A) toward flywheel side of crankcase. Use wooden dowel to push piston into bore.



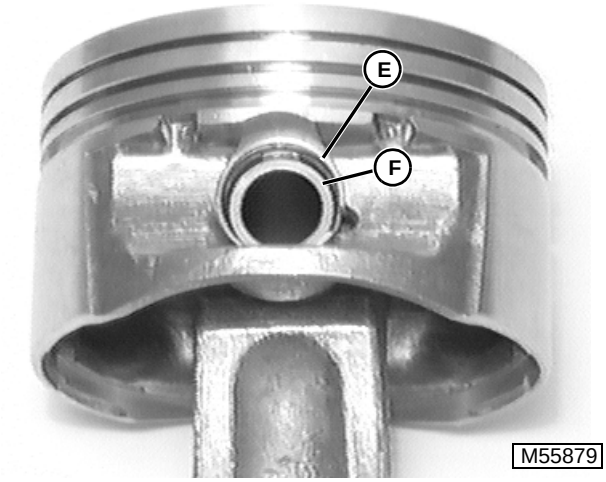
6. Fasten connecting rod (B) and cap (C) to crankshaft. Make sure to align chamfer of connecting rod with chamfer of mating end cap. When installed, flat faces of connecting rods should face each other. Faces with raised rib should be toward the outside.
7. Tighten connecting rod bolts (D) to **17.3 N•m (130 lb-in.)**.
8. Install camshaft. (See CAMSHAFT—REMOVAL/INSTALLATION.)
9. Install cylinder heads. (See CYLINDER HEAD AND VALVES—REMOVAL/INSTALLATION.)

PISTONS AND CONNECTING RODS—DISASSEMBLY

1. Analyze piston and piston ring wear. (See ANALYZE PISTON RING WEAR and ANALYZE PISTON WEAR.)

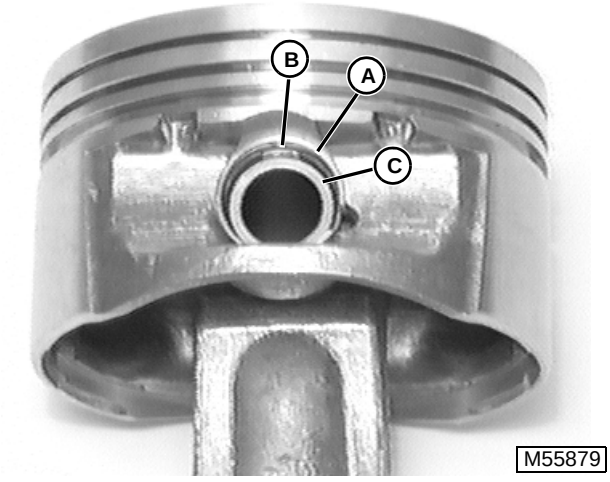


2. Remove compression rings (A) from piston (B) using ring expander.
3. Remove rails (C).
4. Remove oil control ring (D).



5. Remove retaining rings (E) by prying at indent.
6. Use wooden dowel to remove pin (F) from piston and connecting rod.
7. Inspect all parts for wear or damage. (See PISTON AND CONNECTING RODS—INSPECTION.)

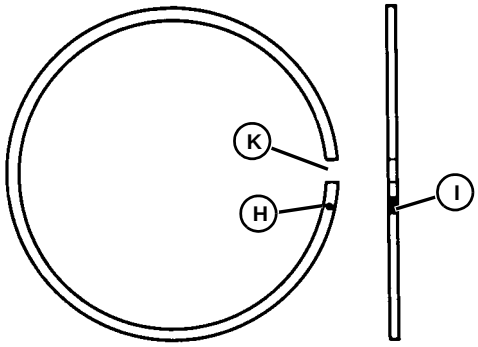
PISTONS AND CONNECTING RODS—ASSEMBLY

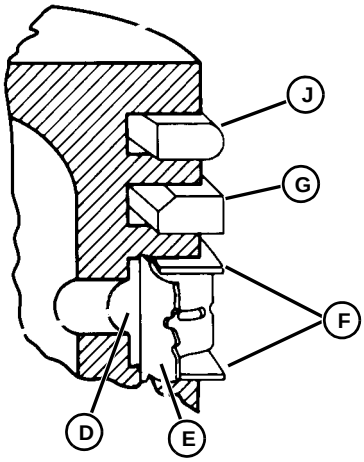


IMPORTANT: DO NOT reuse piston pin retaining rings (A). Retaining rings should be installed with end gap (B) pointing up.

NOTE: Install piston pin before retaining ring to prevent possible scoring of bore.

1. Install one piston pin retaining ring (A) in groove of piston bore.
2. Install pin (C) through piston bore and connecting rod. Pin should install easily with thumb pressure.
3. Install remaining retaining ring in opposite side.





M85893

IMPORTANT: Always use new rings. DO NOT reuse old rings.

4. Oil Control Ring (Bottom Groove) (D): Install expander (E) then rails (F). Make sure the ends of expander do not overlap.
5. Compression Ring (Center Groove) (G): Install center ring using piston ring installation tool. Make sure “pip” mark (H) is up and pink Dykem stripe (I) is left of end gap. Stagger 120° apart.
6. Compression Ring (Top Groove) (J): Install top ring using piston ring installation tool. Make sure “pip” mark (H) is up and blue dykem stripe (I) is to the left of the end gap.

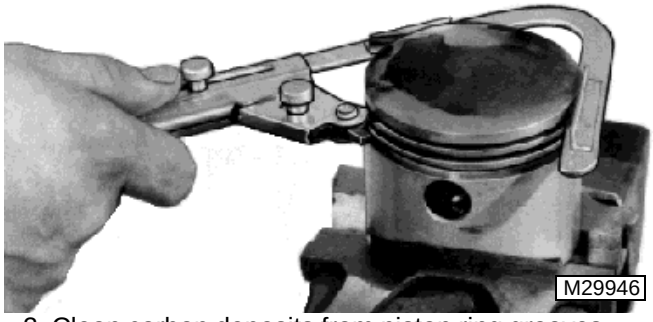
- Compression ring gaps should be staggered 120°.
- Note shape of compression rings and install as shown.
- Compression rings should be installed with “pip” mark up and Dykem strip to left of ring gap.
- Install oil ring spacer first. Make sure that its ends do not overlap.
- Stagger end gap (K) of oil rails 180° apart.
- Rings should turn freely in grooves.

PISTONS AND CONNECTING RODS—INSPECTION

Piston:

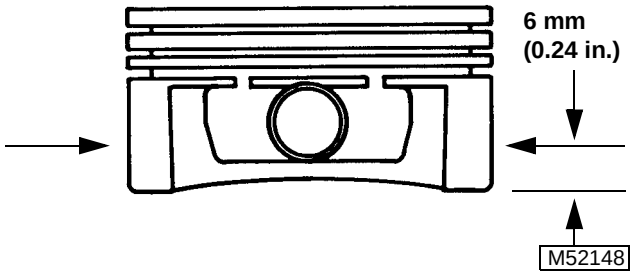
IMPORTANT: DO NOT use caustic cleaners or wire brush to clean aluminum piston. Piston damage can result.

1. Remove all deposits from piston.



M29946

2. Clean carbon deposits from piston ring grooves using ring groove cleaner tool. If cleaning tool is not available, break an old ring and use it to carefully clean groove.
3. Inspect for scoring or fractures. Replace piston if damaged.



M52148

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.

4. Measure diameter of piston 6 mm (0.25 in.) from skirt bottom and perpendicular to piston pin. Replace piston if outside diameter measures less than wear limits.

Piston Thrust Face Outside Diameter—CH22S

Standard Piston:

New . . . . . 76.967—76.985 mm (3.0302—3.0309 in.)
Wear Limit. . . . . 76.840 mm (3.0252 in.)

0.50 mm (0.020 in.) Oversize Piston:

New . . . . . 76.967—76.985 mm (3.0302—3.0309 in.)
Wear Limit. . . . . 77.34 mm (3.0452 in.)

Piston Thrust Face Outside Diameter—CH25S

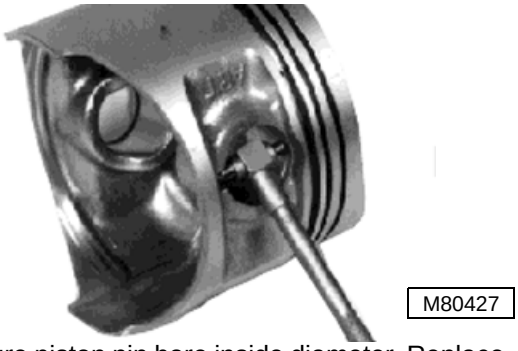
Standard Piston:

New . . . . . 82.986 mm (3.3194 in.)
Wear Limit. . . . . 82.841 mm (3.3136 in.)

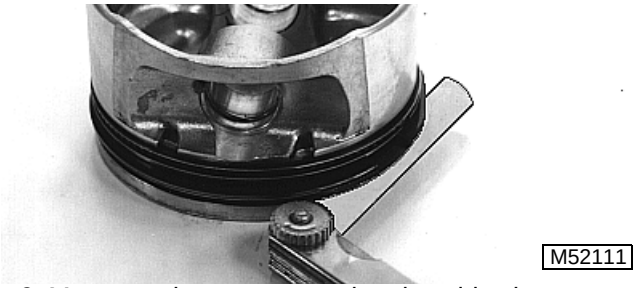
0.50 mm (0.020 in.) Oversize Piston:

New . . . . . 83.486 mm (3.339 in.)
Wear Limit. . . . . 83.341 mm (3.336 in.)

5. Measure cylinder bore diameter. (See CYLINDER BLOCK—INSPECTION.)
6. Subtract piston outside diameter measurement from cylinder bore measurement to determine piston-to-cylinder bore clearance.
7. Replace piston and rebore cylinder block if clearance is greater than **0.058 mm (0.023 in.)**. (See CYLINDER BLOCK—REBORE CYLINDER BORE.)


M80427

8. Measure piston pin bore inside diameter. Replace piston if measurement is greater than **17.025 mm (0.670 in.)**.


M52111

9. Measure piston compression ring side clearance (top and middle compression rings and oil control rings) at several points around piston (use new rings). Replace piston if side clearance is greater than wear limits.

Ring-to-Groove Side Clearance (Wear Limits)

Top Compression Ring

CH22S . . . . . 0.080 mm (0.0031 in.)
CH25S . . . . . 0.048 mm (0.0019 in.)

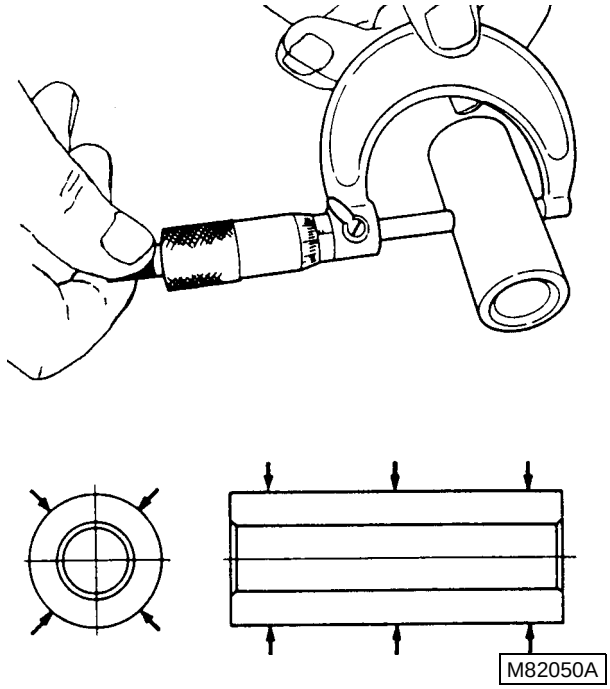
Middle Compression Ring

CH22S . . . . . 0.072 mm (0.0028 in.)
CH25S . . . . . 0.037 mm (0.0015 in.)

Oil Control Ring

CH22S . . . . . 0.202 mm (0.0080 in.)
CH25S . . . . . 0.176 mm (0.0070 in.)

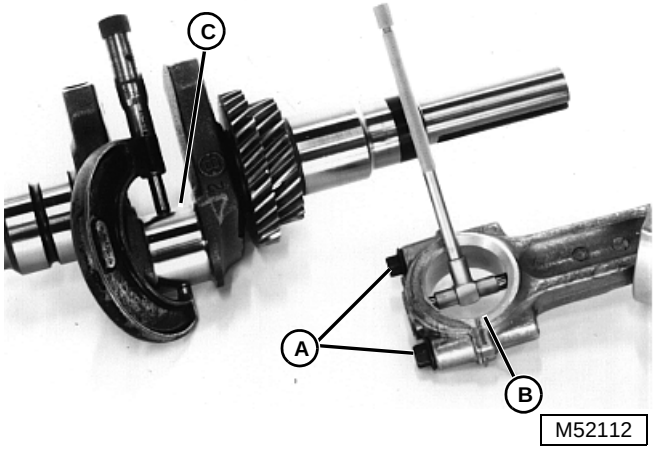
Piston Pin:


M82050A

1. Measure piston pin diameter at six places. Replace pin if any measurement is less than **16.994 mm (0.6691 in.)**.
2. Subtract piston pin outside diameter measurement from piston pin bore measurement to determine piston pin-to-bore clearance. Replace piston pin and/or piston if clearance is greater than **0.08 mm (0.003 in.)**.

Connecting Rod:

1. Analyze crankshaft and connection rod wear. (See ANALYZE CRANKSHAFT AND CONNECTING ROD WEAR.)
2. Clean and inspect connecting rod. Replace if scored or damaged.



NOTE: Connecting rod is available 0.25 mm (0.010 in.) undersize.

1. Install connecting rod cap. Tighten connecting rod cap screws (A) to **17.3 N•m (130 lb-in.)**.
2. Measure inside diameter (B) of connecting rod.
3. Measure outside diameter of crankshaft connecting rod journal (C). (See CRANKSHAFT—INSPECTION.)
4. Subtract inside diameter of connecting rod from outside diameter of crankshaft connecting rod journal to determine connecting rod-to-crankshaft clearance. If clearance is greater than **0.07 mm (0.0028 in.)**, crankshaft journal can be ground undersize to 0.25 mm (0.010 in.).

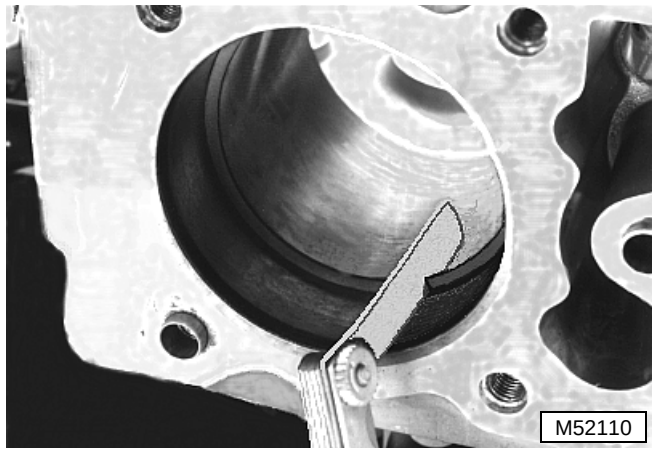
CHECK CONNECTING ROD-TO-CRANKSHAFT SIDE CLEARANCE

1. Remove crankshaft from cylinder block. (See CRANKSHAFT—REMOVAL/INSTALLATION.)
2. Install connecting rods on crankshaft. Tighten connecting rod cap screws to **17.3 N•m (130 lb-in.)**.
3. Measure connecting rod side clearance. Replace connecting rod and/or crankshaft if clearance is greater than **0.26—0.63 mm (0.0102—0.0248 in.)**.

CHECK PISTON RING END GAP

IMPORTANT: Cylinder wall must be deglazed so rings will seat properly. (See CYLINDER BLOCK—DEGLAZE CYLINDER BORE.)

1. Use a clean or new piston to push piston compression ring squarely into bore, to a point where it normally runs. Do this for both top and center rings.



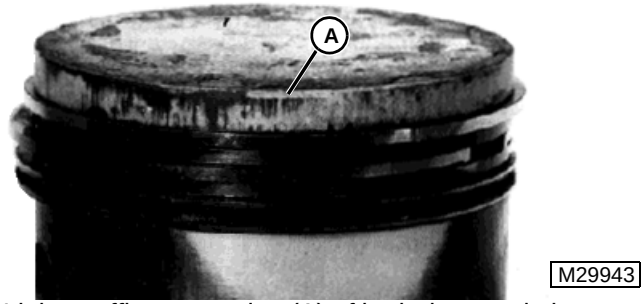
2. Measure end gap.
3. Rings with too large a gap must be replaced. If one piston ring needs to be replaced, all must be replaced as a set.

Top and Center Piston Ring End Gap

New Bore. . . . . 0.30—0.50 mm (0.012—0.02 in.)
Used Bore (Maximum) . . . . . 0.75 mm (0.030 in.)

ANALYZE PISTON RING WEAR

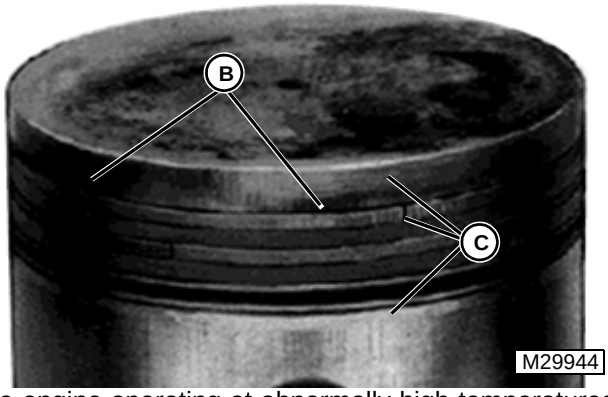
Rings of the wrong size or rings having improper end gap will not conform to the shape of the cylinder. This results in high oil consumption and excessive blowby. Ring end gaps should be staggered on the piston during installation. End gaps in alignment can also cause oil consumption and blowby.



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 material.

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



The engine operating at abnormally high temperatures may cause varnish, lacquer, or carbon deposits (B) to form in the piston grooves making the rings stick. When this happens, excessive oil consumption and blowby will occur.

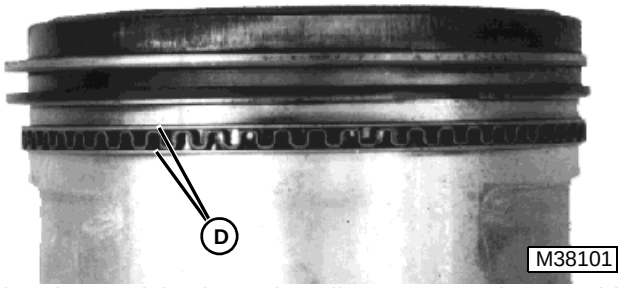
Engine overheating and ring sticking is usually caused by one or more of the following:

- Overloading.
- Incorrect ignition timing.
- Lean fuel mixture.
- Dirty cooling fins.
- Incorrect oil.
- Low oil supply.
- Stale fuel.

Vertical scratches (C) across the piston and 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 and 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 gasket between air cleaner and carburetor.
- Air leak around carburetor-to-cylinder block gasket.
- Air leakage around throttle shaft.
- Failure to properly clean cylinder bore after reconditioning engine

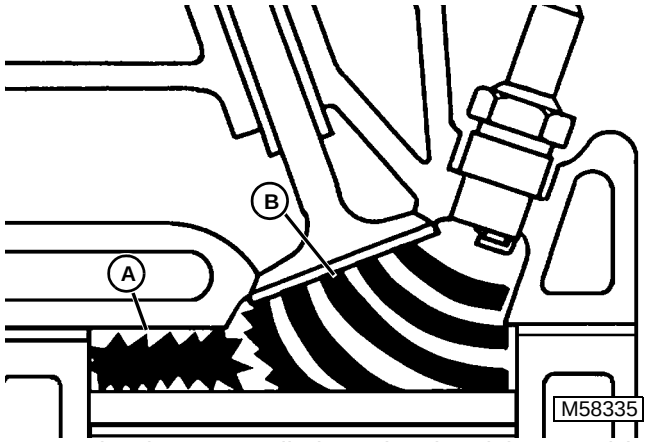


Abrasive particles in engine oil cause scratches on side rails (D) of oil control ring. If inner spacer of oil control ring is worn or distorted it may cause:

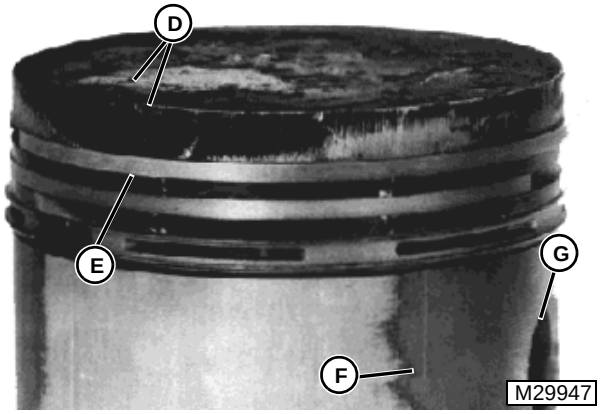
- Increased or high oil consumption.
- Increased deposits in combustion chamber.
- Sticking compression rings.

ANALYZE PISTON WEAR

Detonation



Detonation is uncontrolled combustion (A) caused by excessive temperature and pressure in the combustion chamber. Commonly called carbon knock, spark knock, or timing knock, detonation occurs when the extremely hot, over-compressed, fuel-air mixture ignites spontaneously—causing a second burn point during the normal ignition cycle. This second burn then collides with the spark plug induced burn (B), causing a loud explosion and extreme shockwave.

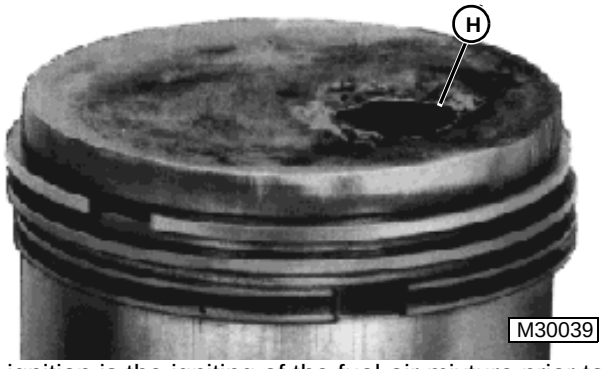


This detonation shockwave (“hammering”) of the piston inside the cylinder causes damage to piston crown (D), top ring and groove (E), piston side skirts (F), and pin locks (G).

The following is a list of possible causes for detonation:

- Lean fuel mixture.
- Low octane fuel.
- Advanced ignition timing.
- Engine lugging.
- Buildup of carbon deposits on piston or cylinder head, causing excessive compression.
- Wrong cylinder head or excessive milling of head increasing compression ratio.

Pre-Ignition

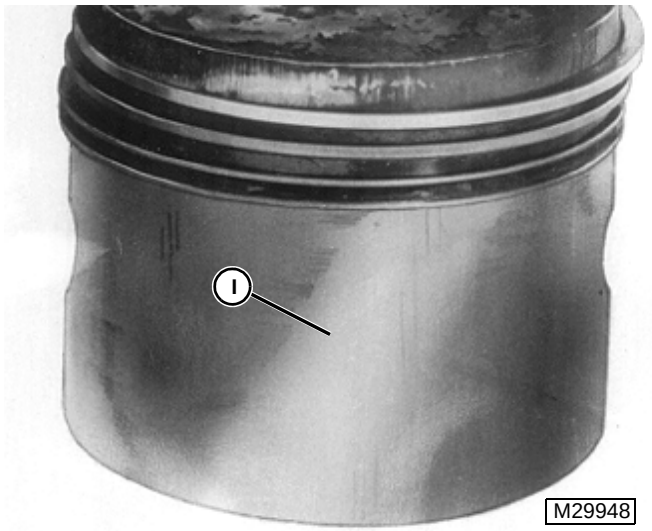


Pre-ignition is the igniting of the fuel-air mixture prior to proper ignition spark. Pre-ignition causes internal shock, resulting in pangs, vibration, and power loss. Severe damage (H) is caused to the piston crown, rings, and valves results from pre-ignition.

Check the following for causes of pre-ignition:

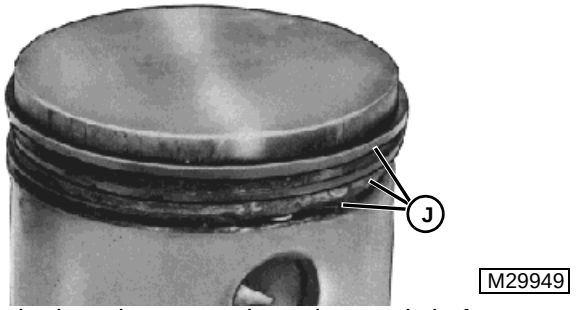
- Hot internal carbon deposits.
- Incorrect spark plug (high heat range).
- Broken ceramic insulation of spark plug.
- Hot sharp edges on valves.

Improper Rod and Piston Alignment



Check rod and piston alignment when piston shows a diagonal wear pattern (I) extending across the skirt of the piston. Contact with the cylinder wall shows on bottom of skirt at left and ring lands on the right.

Cylinder Bored Improperly



A cylinder bored at an angle to the crankshaft may result in improper ring contact with the cylinder which may cause the following:

- Rapid and uneven piston ring wear.
- Rapid and uneven piston wear.
- Loose or broken piston pin retaining rings.
- Excessive oil consumption.

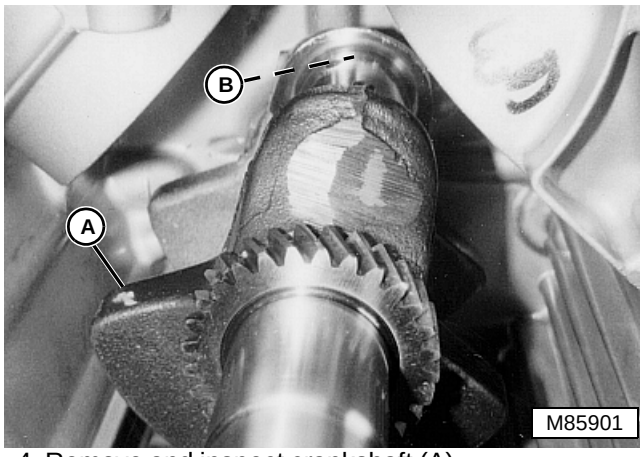
A broken piston pin retaining ring cause the ring damage (J) shown. Piston pin retaining rings loosen or break due to:

- Rod misalignment.
- Excessive crankshaft end play.
- Crankshaft journal taper.
- Weak piston pin retaining rings.
- Incorrectly installed piston pin retaining rings.

Inertia can also cause a broken piston pin retaining ring to beat out the piston and cylinder, causing extensive damage.

CRANKSHAFT—REMOVAL/INSTALLATION

1. Remove flywheel. (See FLYWHEEL—REMOVAL/INSTALLATION.)
2. Remove camshaft. (See CAMSHAFT—REMOVAL/INSTALLATION.)
3. Remove pistons and connecting rods. (See PISTONS AND CONNECTING RODS—REMOVAL.)

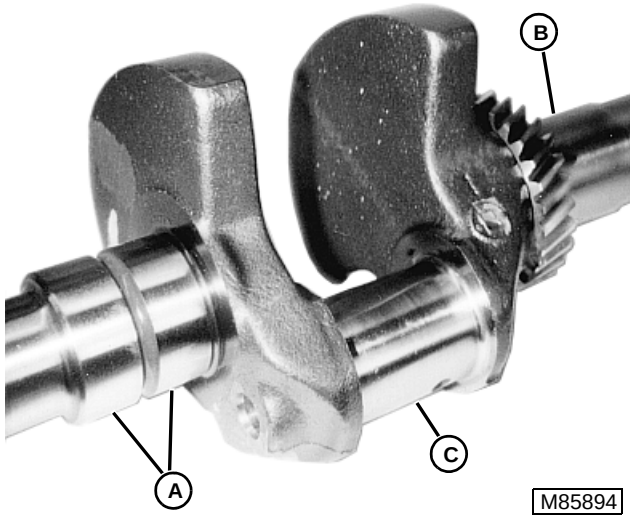


4. Remove and inspect crankshaft (A). (See CRANKSHAFT—INSPECTION.)
5. Install new oil seal in crankcase cover (See CRANKCASE COVER—OIL SEAL REPLACEMENT.)
6. Install new oil seal (B) in cylinder block. (See CYLINDER BLOCK—OIL SEAL REPLACEMENT.)

Installation is done in the reverse order of removal.

CRANKSHAFT—INSPECTION

1. Analyze crankshaft and connection rod wear. (See ANALYZE CRANKSHAFT AND CONNECTING ROD WEAR.)



NOTE: Flywheel end main bearing journal can be ground undersize 0.25 mm (0.010 in.) or 0.50 mm (0.020 in.).

2. Measure flywheel end main bearing journal (A). Grind crankshaft if journal outside diameter measures less than **40.84 mm (1.608 in.)**.
3. Measure crankcase cover end main bearing journal (B). Crankcase cover end main bearing journal cannot be ground undersize. Replace crankshaft if crankcase cover end main bearing journal outside diameter is greater than **40.84 mm (1.608 in.)**.
4. Measure outside diameter of crankshaft connecting rod journal (C). Grind crankshaft if journal outside diameter measures less than **35.94 mm (1.415 in.)**
5. Check connecting rod-to-crankshaft side clearance. (See PISTONS AND CONNECTING RODS—Check Connecting Rod-to-Crankshaft Side Clearance.)

Crankshaft Journal:

Max Taper . . . . . 0.018 mm (0.0007 in.)
Max Out-of-Round . . . . . 0.025 mm (0.0010 in.)

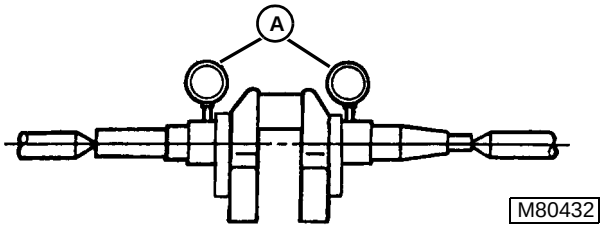
Flywheel End Main Bearing Journal:

Max Taper . . . . . 0.022 mm (0.0009 in.)
Max Out-of-Round . . . . . 0.025 mm (0.0010 in.)

Crankcase Cover End Main Bearing Journal:

Max Taper . . . . . 0.022 mm (0.0009 in.)
Max Out-of-Round . . . . . 0.025 mm (0.0010 in.)

CRANKSHAFT ALIGNMENT

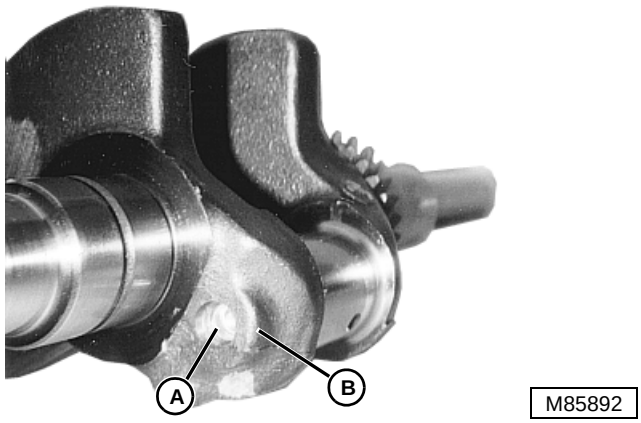


Place crankshaft into an alignment jig and slowly rotate crankshaft. Use dial indicators (A) to measure maximum Total Indicated Runout (T.I.R.). Replace crankshaft if runout exceeds **0.10 mm (0.0039 in.)**.

NOTE: The maximum Total Indicated Runout (T.I.R.) can also be checked with the crankshaft still in the engine. Check runout using a dial indicator at the crankcase cover (rear) side of the engine. Replace crankshaft if runout exceeds **0.15 mm (0.0059 in.)**.

REGRIND CRANKSHAFT

IMPORTANT: Grinding stone deposits can get caught in oil passages which could cause severe engine damage. Removing the plug each time crankshaft is ground provides easy access for cleaning any grinding deposits that collect in oil passages.



1. Drill a 3/16-inch hole through plug (A) in crankshaft.
2. Thread a 3/4- or 1-inch long self-tapping screw with a flat washer into drilled hole. Flat washer must be large enough to seat against shoulder (B) of plug bore.
3. Tighten self-tapping screw until it draws plug out of crankshaft.
4. Install new plug. Gently tap plug into place using suitable driver. Plug must seat evenly at bottom of bore.

ANALYZE CRANKSHAFT AND CONNECTING ROD WEAR

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

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

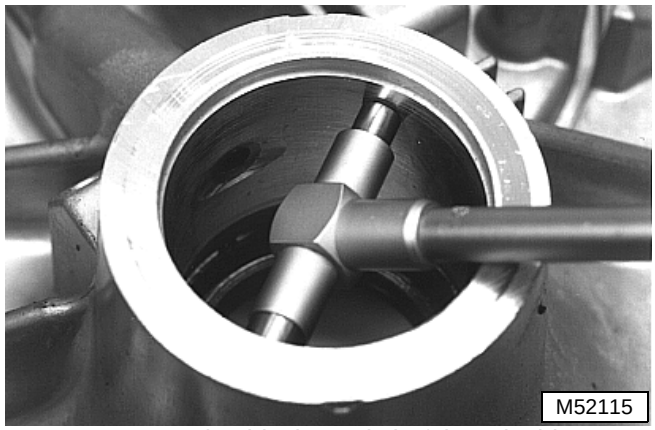
- Engine run low on oil or without oil.
- Oil not changed regularly.
- Bearing cap installed incorrectly.

CYLINDER BLOCK—INSPECTION

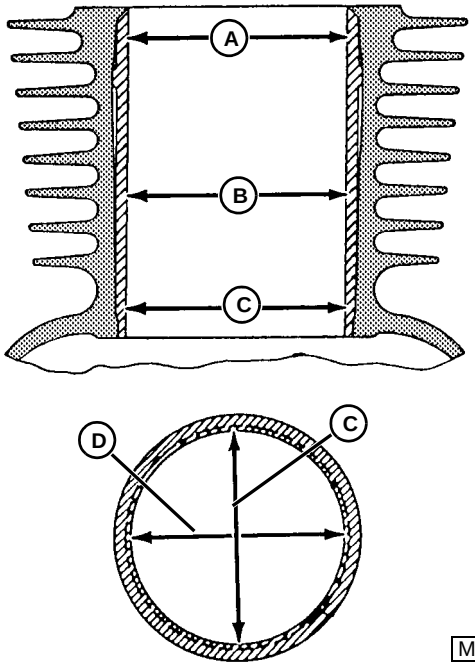
1. Clean and check block for cracks.

NOTE: Cracks not visible to the eye may be detected by coating the suspected area with mixture of 25 percent kerosene and 75 percent 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.

2. Replace block if any cracks are found.



3. Measure engine block crankshaft bore inside diameter.
4. Check bore for nicks or cracks.
5. If measurement exceeds specification the engine block bore can be ground undersize 0.25 mm (0.010 in.) or 0.50 mm (0.020 in.) (requires oversize bearing).



6. Measure cylinder bore diameter at three positions: top (A), middle and bottom. At these three positions, measure in both directions: along the crankshaft centerline (C) and in the direction of crankshaft rotation (D).

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

7. Replace block or bore cylinder to accept larger piston if clearance exceeds specification.

Cylinder Bore ID—CH22:

Standard Piston

Standard . . . 77.00—77.025 mm (3.0315—3.0325 in.)
Wear Limit. . . . . 77.063 mm (3.0340 in.)

0.50 mm (0.020 in.) Oversize Piston

Standard . . . 77.50—77525 mm (3.0515—3.0525 in.)
Wear Limit. . . . . 77.563 mm (3.054 in.)

Maximum Wear Limit

Out-of-Round (Maximum) . . . . 0.12 mm (0.0047 in.)
Taper (Maximum) . . . . . 0.05 mm (0.0020 in.)

Cylinder Bore ID—CH25:

Standard Piston

Standard . . . 77.00—77.025 mm (3.0315—3.0325 in.)
Wear Limit. . . . . 77.063 mm (3.0340 in.)

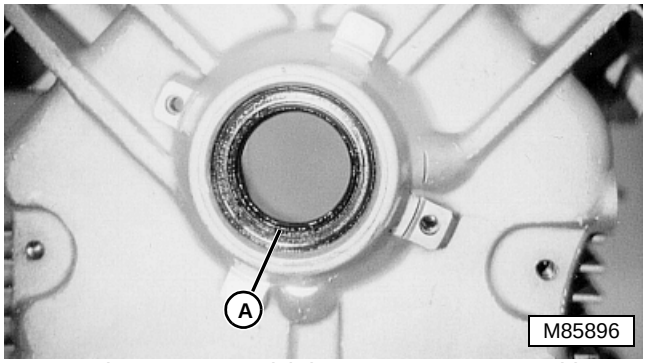
0.50 mm (0.020 in.) Oversize Piston

Standard . . . 77.50—77525 mm (3.0515—3.0525 in.)
Wear Limit. . . . . 77.563 mm (3.054 in.)

Maximum Wear Limit

Out-of-Round (Maximum) . . . . 0.12 mm (0.0047 in.)
Taper (Maximum) . . . . . 0.05 mm (0.0020 in.)

CYLINDER BLOCK— OIL SEAL REPLACEMENT

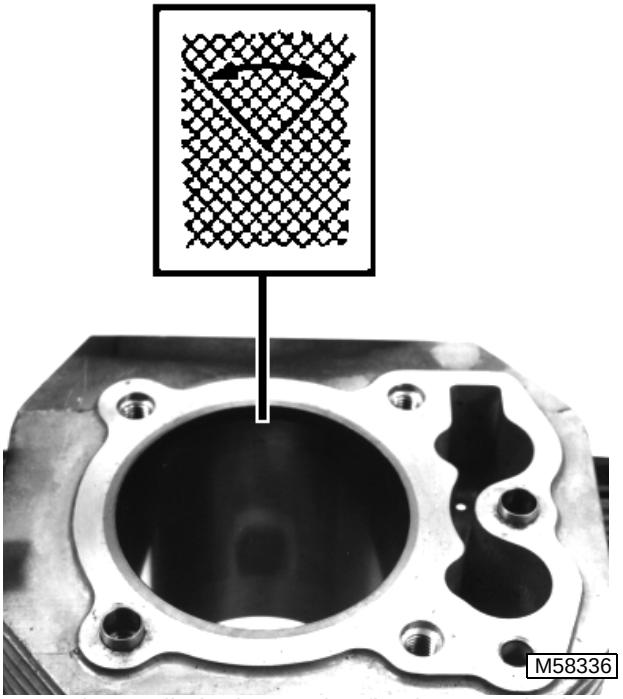


1. Gently remove seal (A). DO NOT score seal bore.
2. Apply light coat of oil to outside diameter of oil seal.
3. Install oil seal into crankcase (flush) using appropriate driver.

CYLINDER BLOCK— DEGLAZE CYLINDER BORE

IMPORTANT: Remove crankshaft and internal engine components when deglazing cylinder. Abrasives can cause engine damage.

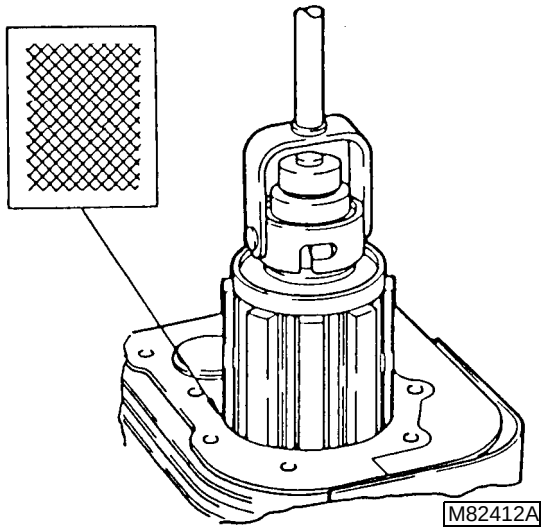
1. Use the appropriate size flex-hone to deglaze cylinder bore.



2. Deglaze cylinder bore using flex-hone to obtain **23—33°** crosshatch pattern.
3. Clean abrasive residue from cylinder using warm soapy water until clean white rags show no discoloration.
4. Dry cylinder and apply a light coat of clean engine oil.

CYLINDER BLOCK— REBORE CYLINDER BLOCK

IMPORTANT: Check stone for wear or damage. Use correct stone



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

1. Align center of bore to drill press center.
2. Adjust hone so lower end is even with lower end of cylinder bore.
3. Adjust coarse hone stones until they contact narrowest point of cylinder.
4. Coat cylinder with honing oil. Hone should turn by hand. Adjust if too tight.
5. Run drill press at approximately 250 rpm. Move hone up and down about 60 times per minute.
6. Stop press and check cylinder diameter several times during honing.

*NOTE: Finish should not be smooth. It should have a **23—33°** crosshatch pattern.*

7. Remove hone when cylinder is within 0.064 mm (0.0025 in.) of desired size.
8. Hone with burnishing stones until within 0.013 mm (0.0005 in.) of desired size.
9. Hone with finish stones (220—280 grit) to final size.
10. Allow cylinder to cool completely; then, measure for new piston-to-cylinder bore running clearance, taper, and out-of-round.

IMPORTANT: DO NOT use gasoline, kerosene or commercial solvents to clean cylinder bore. Solvents will not remove all abrasives from cylinder walls.

11. Clean cylinder thoroughly using warm soapy water and clean white cloths. Continue to clean cylinder until white cloths show no discoloration.
12. Dry cylinder completely and apply a light coat of clean engine oil.

STARTING MOTOR—ANALYZE CONDITION

The starting motor overheats because of:

- Long cranking.
- Armature binding.

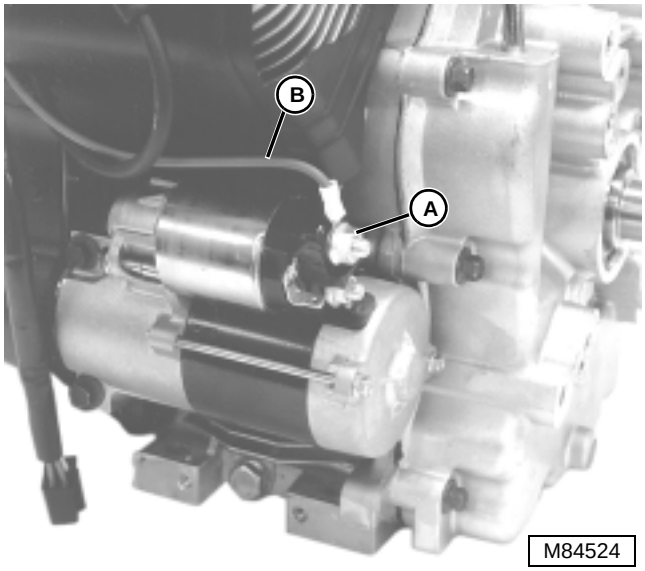
The starting motor operates poorly because of:

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

STARTING MOTOR—REMOVAL/INSTALLATION

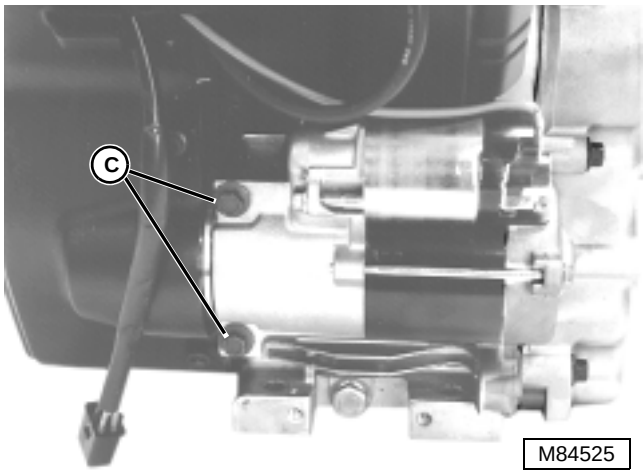
NOTE: Disconnect negative (-) battery cable first.

1. Disconnect negative (-) battery cable at battery.
2. Disconnect positive (+) battery from starting motor.



M84524

3. Remove nut (A).
4. Remove violet wire (B).



M84525

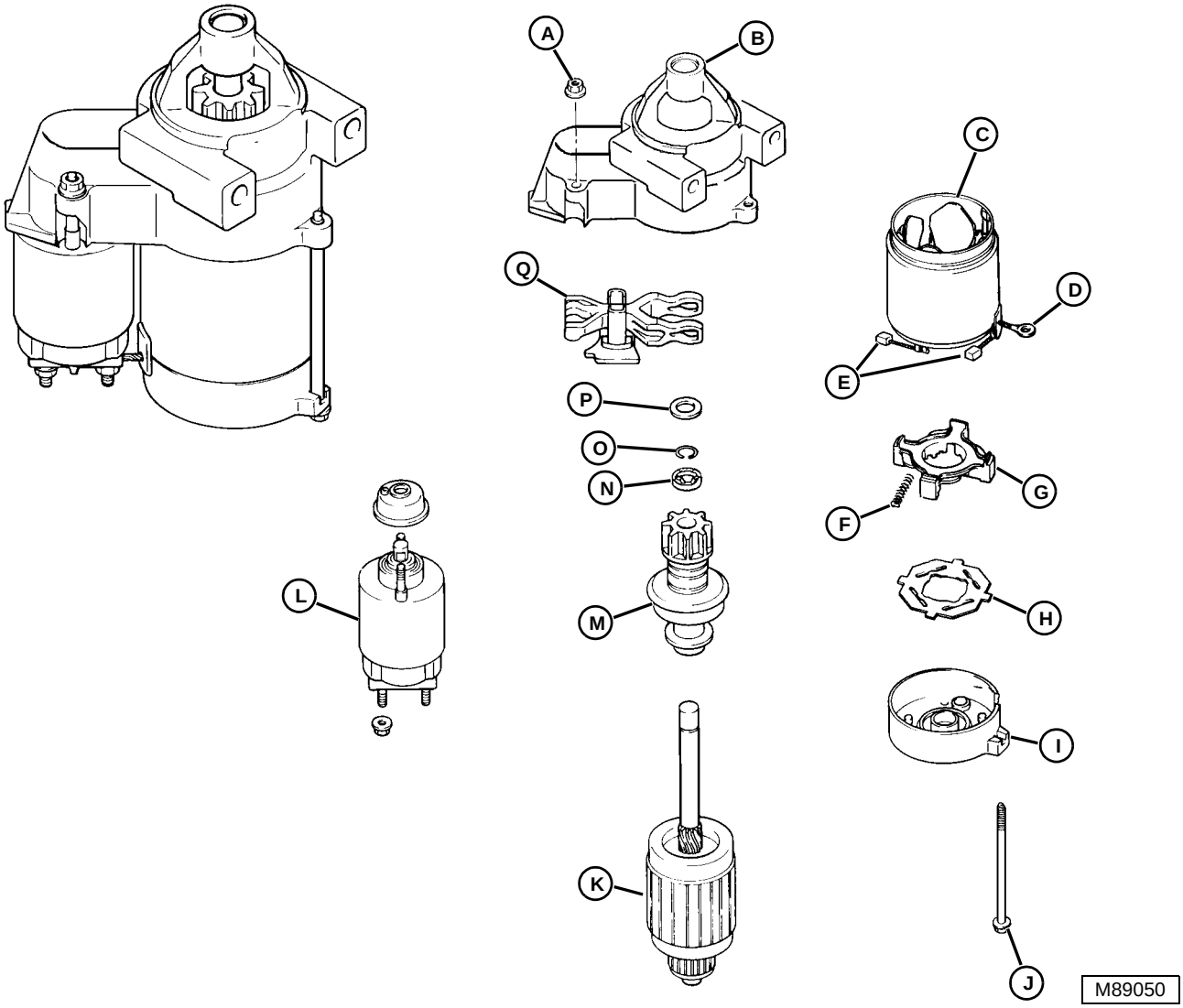
5. Remove cap screws (C).
6. Remove starting motor.

Installation is done in the reverse order of removal.

NOTE: Connect negative (-) battery cable last.

- Tighten starting motor mounting cap screws to **15.3 N•m (135 lb-in.)**.
- Clean all battery cable connections before installing cables.

STARTING MOTOR—DISASSEMBLY/ASSEMBLY



A—Nut	**F—Spring (4 Used)**	**K—Armature**	**P—Thrust Washer**
B—Drive End Cap	**G—Brush Holder**	**L—Solenoid**	**Q—Drive Lever**
C—Frame	**H—Insulator**	**M—Pinion**	
D—Wire	**I—Commutator End Cap**	**N—Stop Collar**	
E—Brushes (4 Used)	**J—Cap Screw** (2 Used)	**O—Retaining Ring**	

1. Mark frame (C) and end covers (B and I) to aid in alignment for assembly.
2. Remove cap screws (J).
3. Remove insulator (H) and brush springs (F) from spring holder.
4. Remove armature (K) from frame.
5. Clean commutator of armature with a coarse, lint-free cloth. DO NOT use emery cloth. Replace commutator if badly grooved.

NOTE: When removing the drive lever (Q) and armature use caution not to lose the thrust washer (P).

6. Remove drive lever (Q) and armature (K) from end cap (I).
7. Remove and discard retaining ring (O).
8. Drive stop collar (N) off shaft.
9. Remove drive pinion (M) from shaft.
10. Inspect pinion gear and shaft for cracks, damage or missing teeth. Replace as needed.

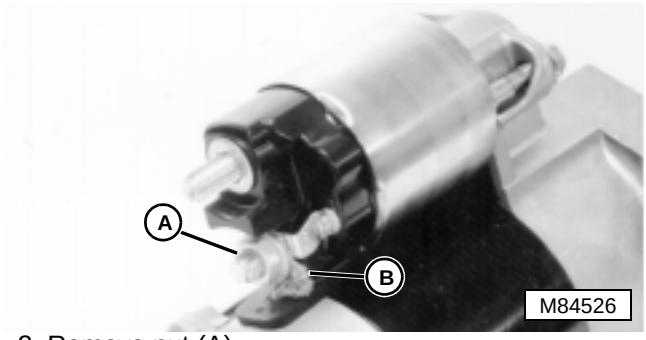
Assembly is done in the reverse order of disassembly.

- Use a new retaining ring (O) for assembly.

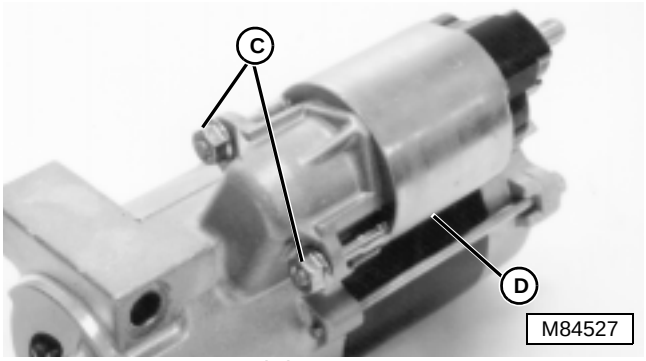
STARTING MOTOR—INSPECT AND REPLACE BRUSHES

Brush Inspection:

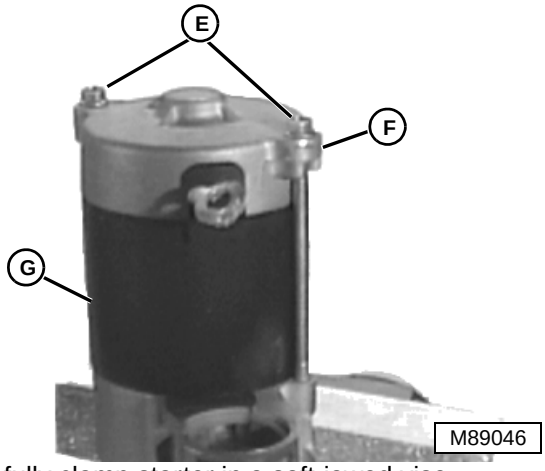
1. Remove starter from engine. (See STARTING MOTOR—REMOVAL/INSTALLATION.)



2. Remove nut (A).
3. Remove braided wire (B) from solenoid post.



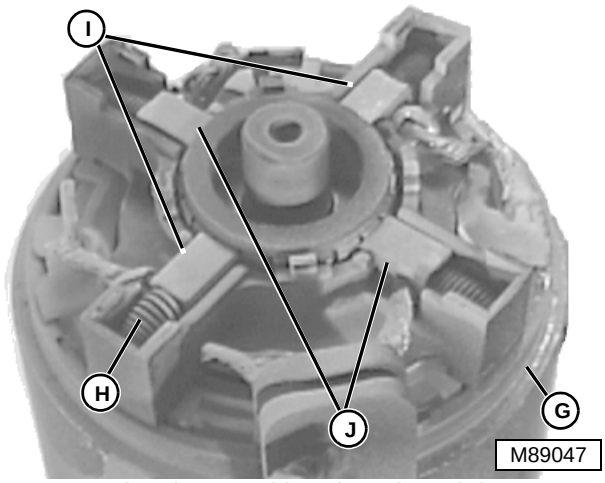
4. Remove two nuts (C).
5. Remove solenoid (D) from starting motor.



6. Carefully clamp starter in a soft-jawed vise.

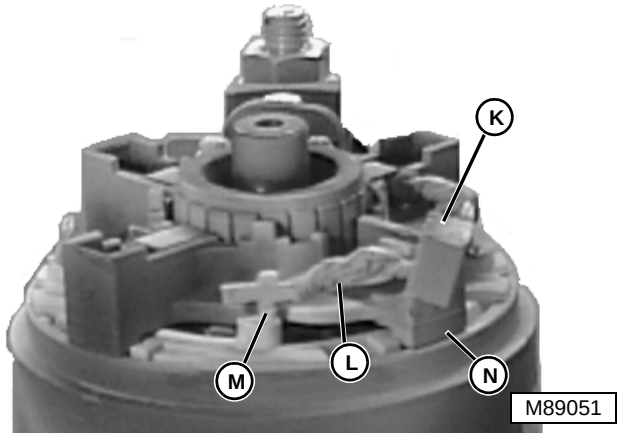
NOTE: Always test armature anytime the starter is disassembled.

7. Remove cap screws (E) from commutator end cap (F).
8. Remove commutator end cap from frame (G).
9. Inspect commutator end cap bushing and commutator shaft for wear, cracks or dirt.



10. Remove insulator and brush springs (H).
11. Clean negative (I) and positive (J) brush contact points.
12. Using an ohmmeter, check negative brushes for **continuity** with the frame (G). Replace both positive and negative brushes if no continuity is indicated.
13. Using an ohmmeter, check for **no continuity** between positive brushes. Replace both positive and negative brushes if continuity is indicated.

Brush Replacement:



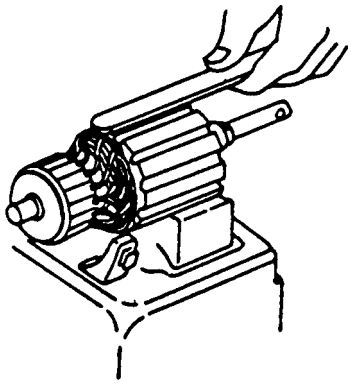
NOTE: If any brush requires replacement, replace all brushes as a set.

14. Remove brushes (K) from brush holder.
15. Cut brush lead wires (L) at the edge of the post (M). DO NOT cut posts.
16. File burrs off posts.
17. Crimp and solder new brushes to posts.
18. Compress brush springs into brush holders (N). Using a thin screwdriver, place insulator over brushes and springs.
19. Carefully place commutator end cap over brush insulator.
20. Install cap screws and tighten evenly.

STARTING MOTOR—INSPECT ARMATURE

IMPORTANT: DO NOT clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.

1. Clean commutator of armature with a coarse, lint-free cloth. DO NOT use emery cloth. If commutator is badly grooved, replace it.



M24861

2. Check armature for short circuits using a growler.
3. Rotate the armature on growler while holding a hacksaw blade or steel strip on armature. Strip will vibrate in area of short circuit.

NOTE: Shorts between bars are sometimes caused by dirt or copper between bars. If test indicates shorted circuit windings, clean and recheck. If a short circuit is still indicated, replace the armature.

4. Check for grounded windings with an ohmmeter or test light. Touch probes on each commutator bar and armature. If test indicates continuity, a winding is grounded and the armature must be replaced.

M89049

NOTE: Armature windings are connected in parallel, so each commutator bar must be checked.

5. Check for open windings with an ohmmeter or test light. Touch probes on each commutator bar and armature. If test indicates no continuity, a winding is open and the armature must be replaced.

CONTENTS

Page

ELECTRICAL

Page

CHECKS, TEST AND ADJUSTMENTS (Continued)

REPAIR

SPECIFICATIONS

TEST AND ADJUSTMENT SPECIFICATIONS

Battery:
- Specific Gravity (Minimum) . . . 1.225 with less than 50 point variation between cells
- Voltage (Minimum) . . . . . 12.4 volts
- Cold Cranking Amps . . . . . 491 amps at -18° C (0° F)
- Amperage (Regulated) . . . . . 15 amps at 13.5—15 volts

Voltage Output (Regulated) . . . . . 12.4—14.7 volts Volts DC
Voltage Output (Unregulated at Fast Idle) . . . . . 28 Volts DC
Starting Motor Maximum Amperage (Loaded) . . . . . 185 amps at 225 rpm

REPAIR SPECIFICATIONS

PTO Clutch Cap Screw Torque . . . . . 136 N•m (100 lb-ft)

READING ELECTRICAL SCHEMATICS

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

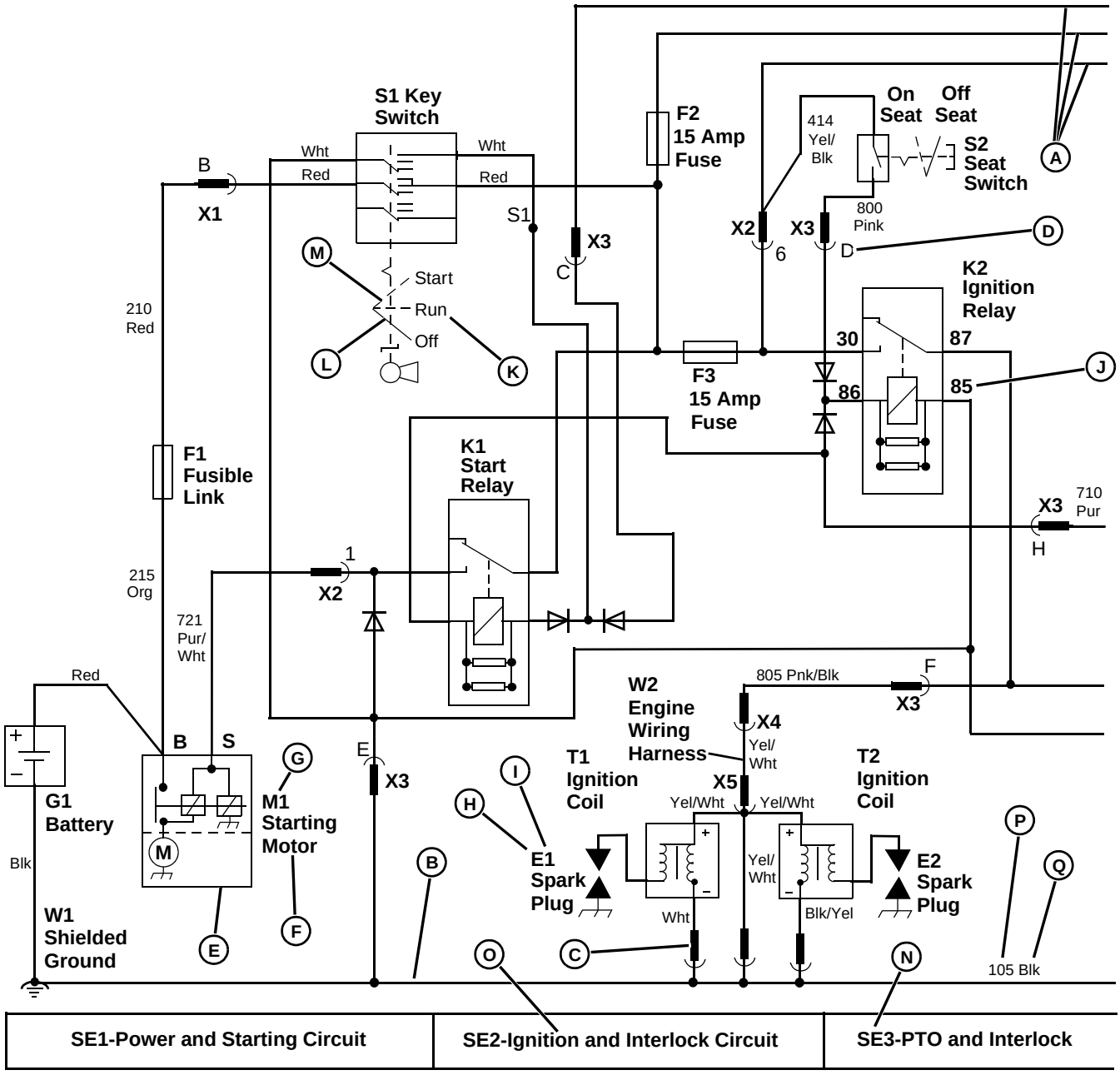
Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

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

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

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

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



THEORY AND DIAGNOSTIC INFORMATION

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 conditions listed and follow the sequence carefully. The middle **"NORMAL"** column gives the reading or condition that should be obtained when performing the test or check. If the results of the test or check are not normal, perform the test, check, or adjustment listed in the third **"IF NOT NORMAL"** column to repair the malfunction. The detailed tests or adjustments referred to in the **"IF NOT NORMAL"** column are located at the end of that group. The system diagram that accompanies each test procedure is drawn to resemble machine components. The key number on the art matches the number in the **"TEST LOCATION"** column, and the leader line points to the exact point at which 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

ELECTRICAL SCHEMATIC AND WIRING HARNESS LEGEND

COMPONENT:

E1—Spark Plug (SE3)

E2—Spark Plug (SE3)

F1—20-Amp Fuse (SE1, W1)

F2—7.5-Amp PTO Clutch Fuse (SE1, W1)

G1—Battery (SE1, W1)

G2—Stator (SE2, W4)

K1—Start Relay (SE1, W1)

K2—Brake Relay (SE4, W1)

K3—Run Relay (SE4, W1)

M1—Starting Motor (SE1, W1)

N1—Voltage Regulator/Rectifier (SE2, W1)

P1—Hourmeter (SE6, W1)

S1—Key Switch (SE1, W1)

S2—Brake Switch (SE4, W1)

S3—Control Lever Switch (Left) (SE4, W1)

S4—Control Lever Switch (Right) (SE4, W1)

S5—Seat Switch (SE4, W1)

S6—PTO Switch (SE5, W1)

T1—Ignition Module (SE2, W2)

T2—Ignition Module (SE2, W2)

Y1—Fuel Shutoff Solenoid (SE4, W2)

Y2—PTO Clutch (SE5, W1)

CONNECTOR:

X1—W1 Main Wiring Harness to PTO Clutch (Y2)

X2—W1 Main Wiring Harness to Starting Motor—Battery Terminal

X3—W1 Main Wiring Harness to Starting Motor Solenoid

X4—W1 Main Wiring Harness Engine Ground

X5—W1 Main Wiring Harness to Engine Wiring Harness (W2)

X6—W2 Main Wiring Harness to Brake Switch (S2)

X7—W1 Main Wiring Harness to Start Relay (K1)

X8—W1 Main Wiring Harness to 20-Amp Fuse (F1)

X9—W1 Main Wiring Harness to Run Relay (K3)

X10—W1 Main Wiring Harness to Left Control Lever Switch (S3)

X11—W1 Main Wiring Harness to Hourmeter (P1) Negative Terminal

X12—W1 Main Wiring Harness to Hourmeter (P1) Positive Terminal

X13—W1 Main Wiring Harness to PTO Switch (S6)

X14—W1 Main Wiring Harness to Seat Switch (S5)

X15—W1 Main Wiring Harness to Key Switch (S1)

X16—W1 Main Wiring Harness to 7.5-Amp Fuse (F2)

X17—W1 Main Wiring Harness to Right Control Lever Switch (S4)

X18—W1 Main Wiring Harness to Brake Relay (K2)

X19—W2 Engine Wiring Harness to Fuel Shutoff Solenoid (Y1)

X20—W2 Engine Wiring Harness to Oil Pressure Switch (Not Used)

X21—W2 Engine Wiring Harness to Voltage Regulator/Rectifier (N1)

X22—W2 Engine Wiring Harness to Ignition Coil (T1)

X23—W2 Engine Wiring Harness to Ignition Coil (T1)

X24—W3 Ground Wiring Harness to Voltage Regulator/Rectifier (N1)

X25—W3 Ground Wiring Harness to Engine Crankcase Cover

X26—W1 Stator Wiring Harness to Voltage Regulator/Rectifier

X27—W1 Stator Wiring Harness to Voltage Regulator/Rectifier

HARNESS:

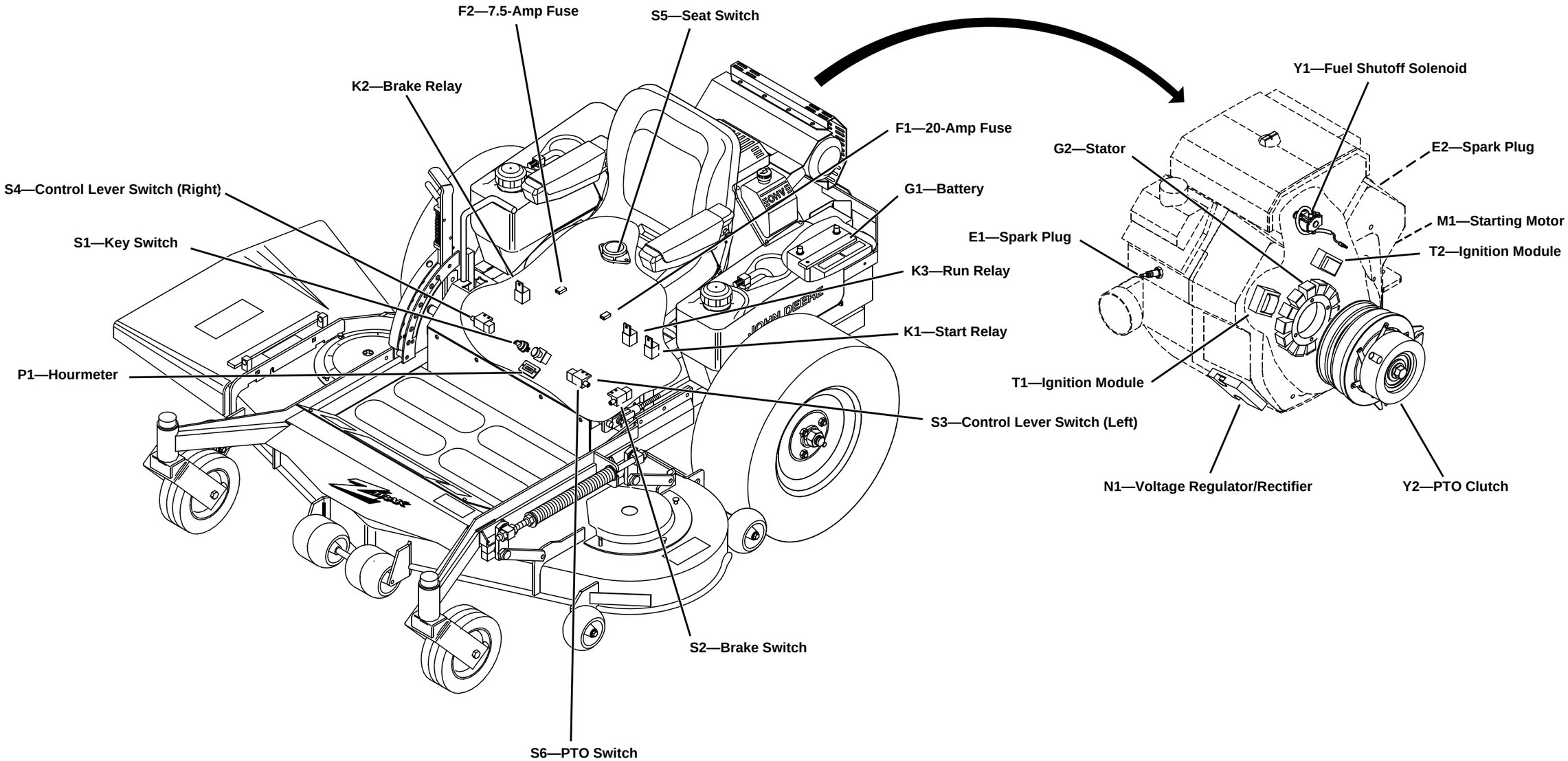
W1—Main Wiring Harness

W2—Engine Wiring Harness

W3—Ground Wiring Harness

W4—Stator Wiring Harness

COMPONENT LOCATION



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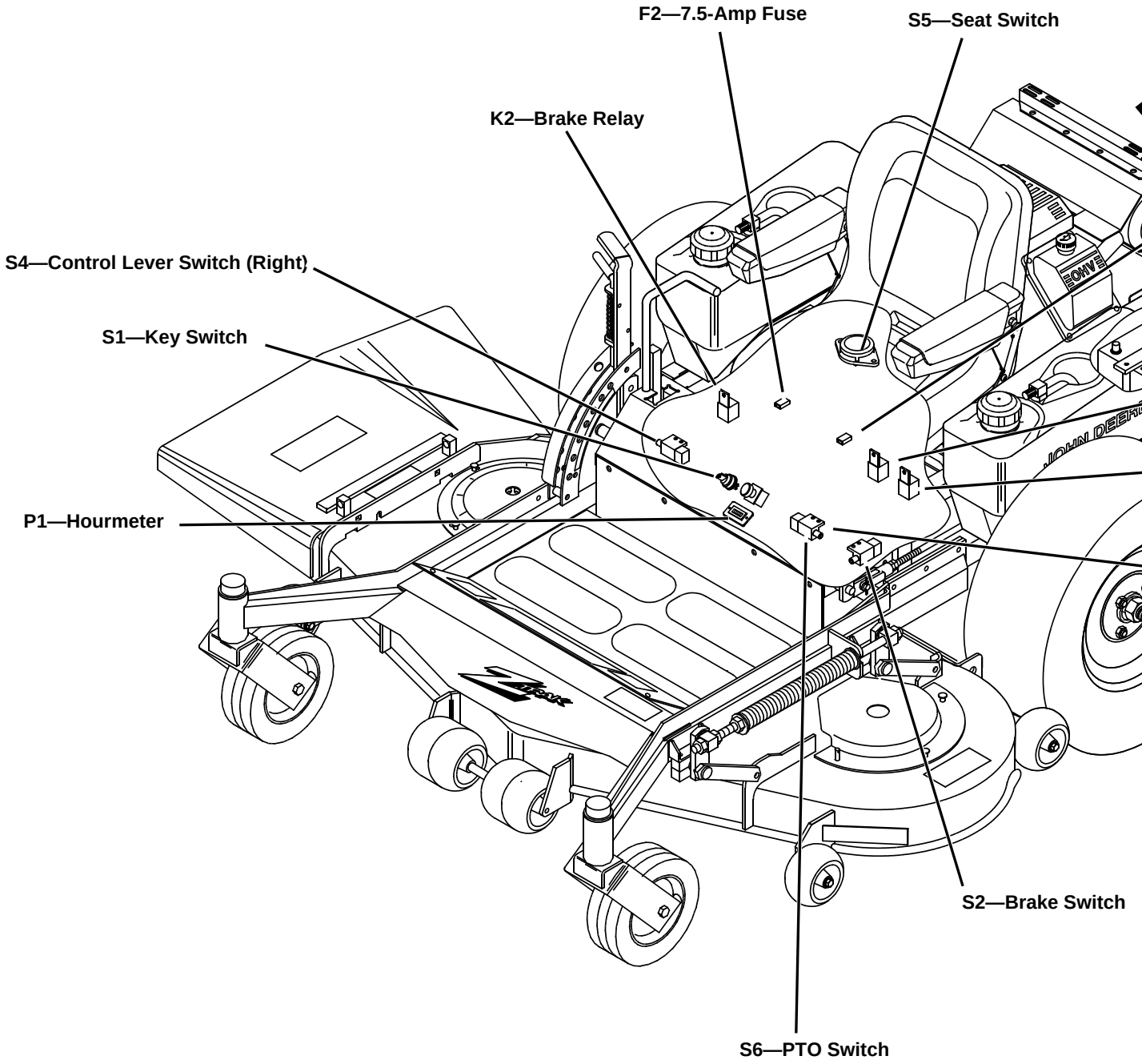
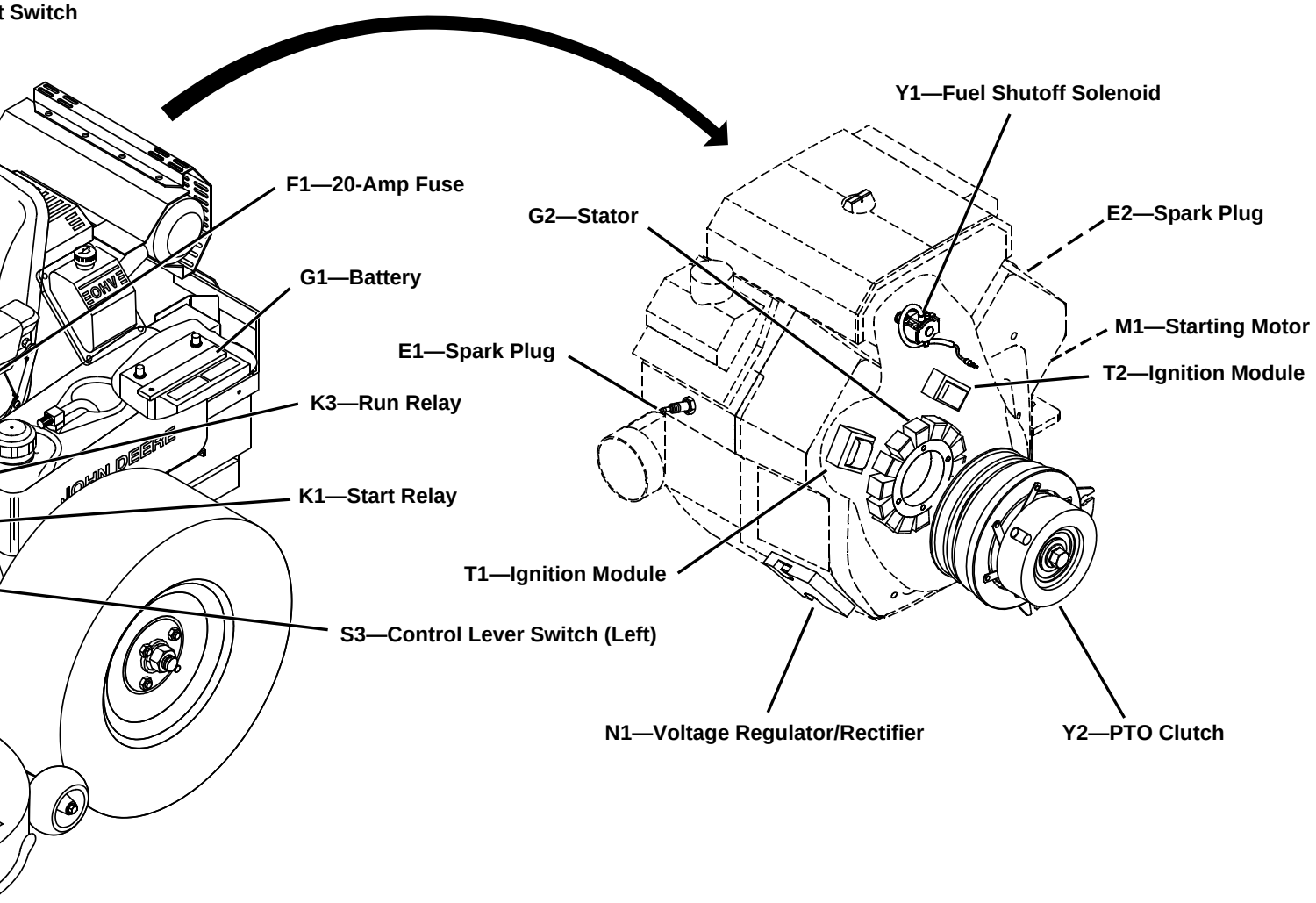
COMPONENT LOCATION



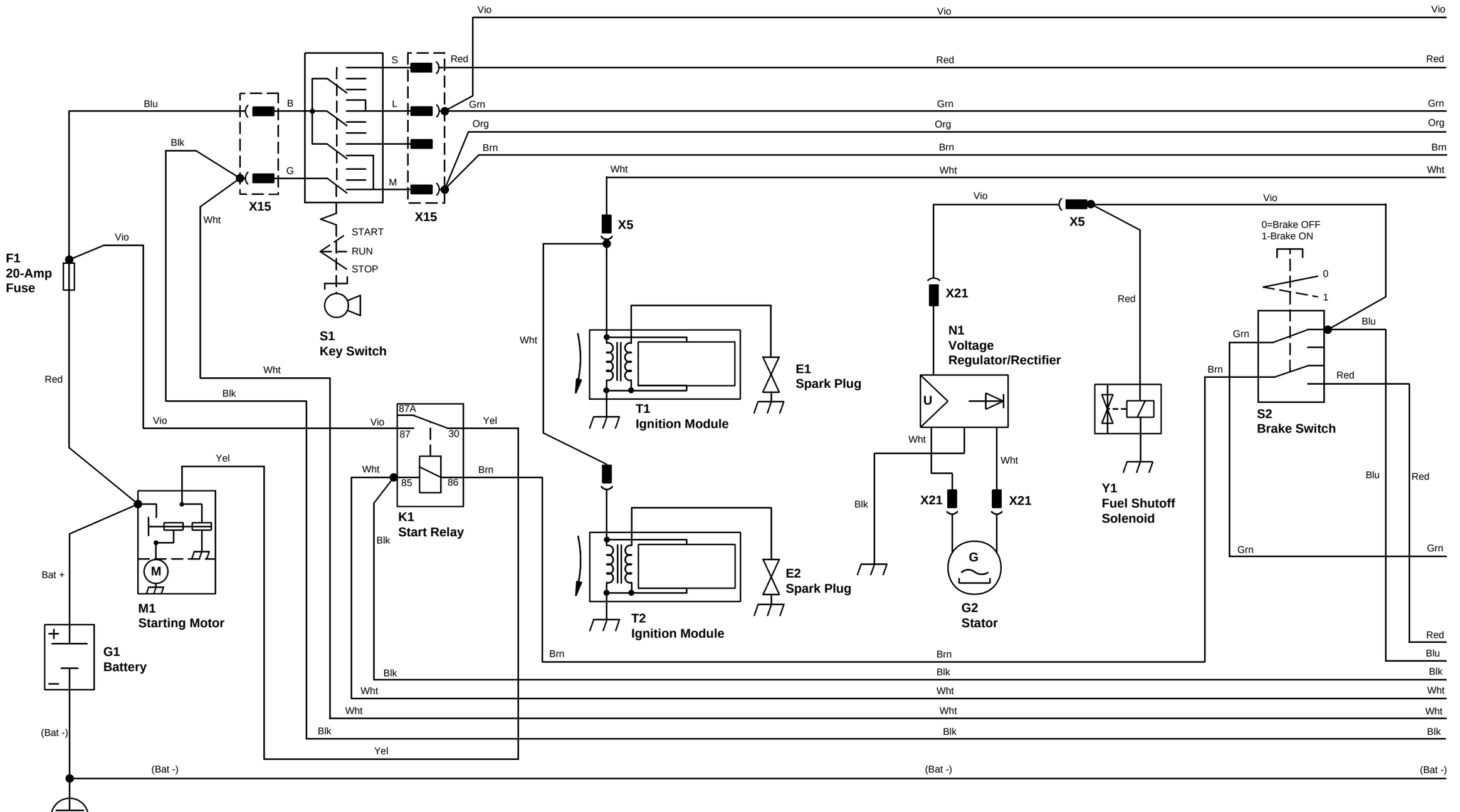
t Switch



—Brake Switch

MX1952

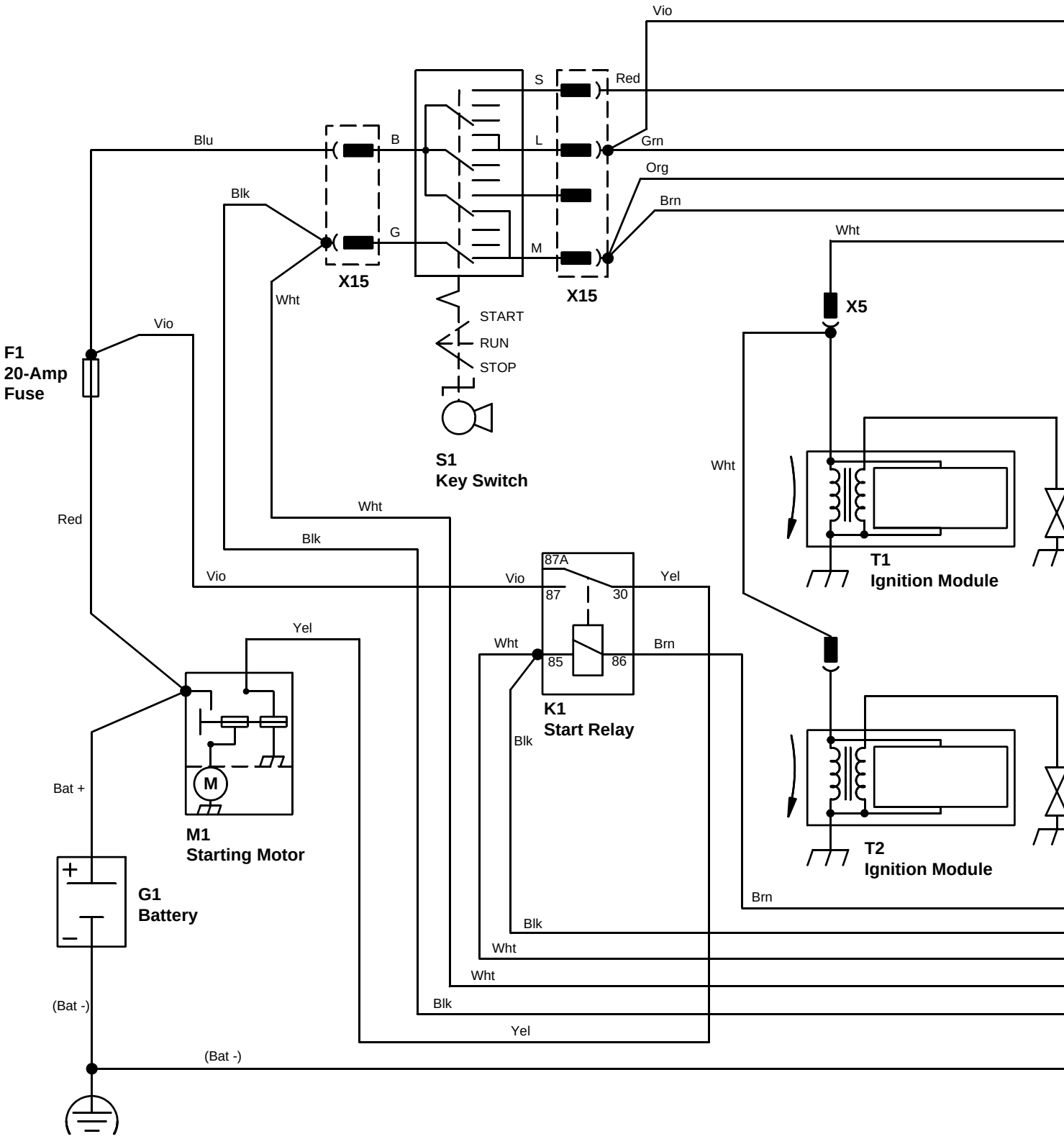
ELECTRICAL SCHEMATIC

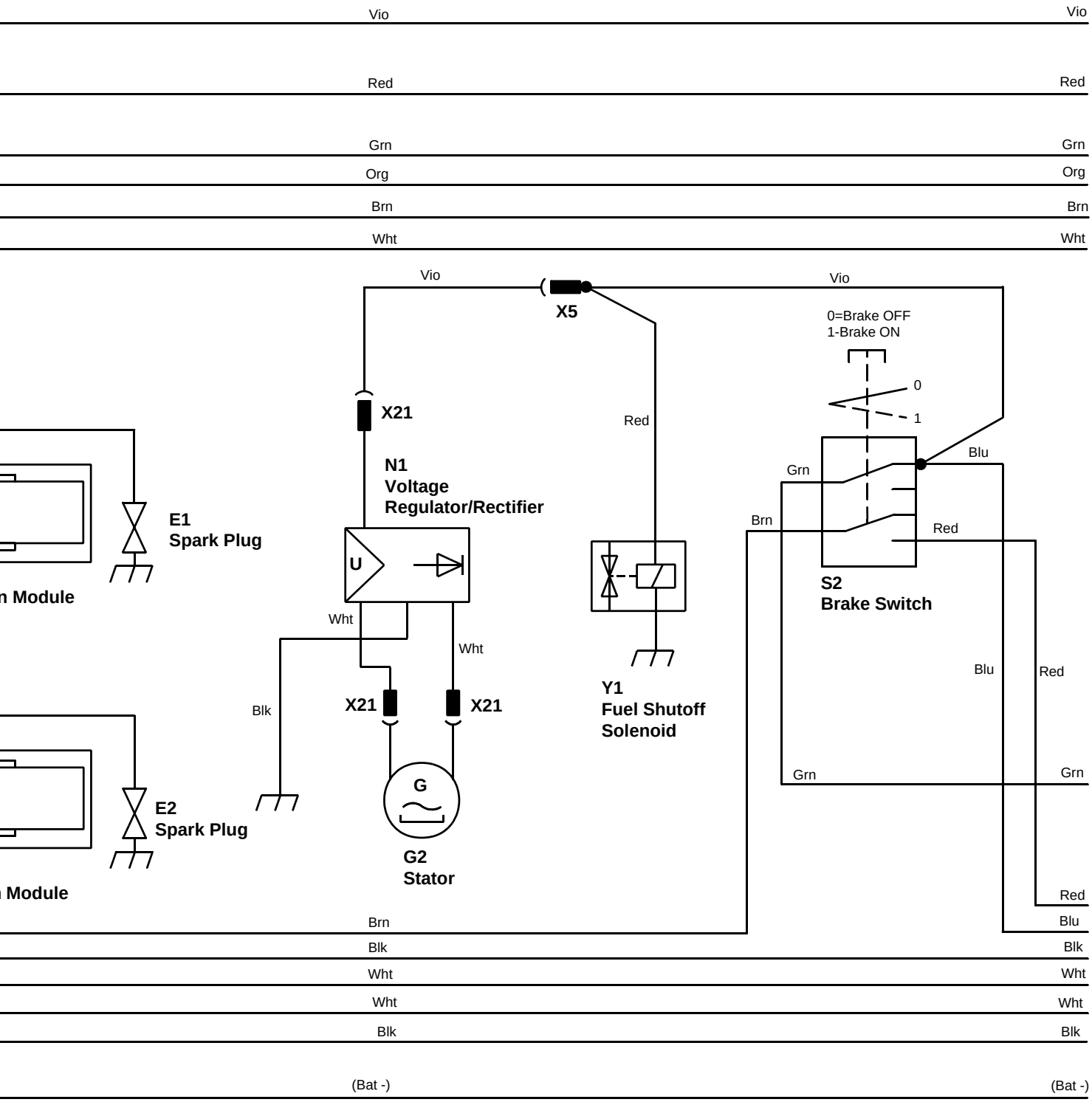


SE1—Cranking Circuit	SE2—Ignition Circuit	SE3—Charge Circuit	SE4—Run Circuit

MX1956A

ELECTRICAL SCHEMATIC

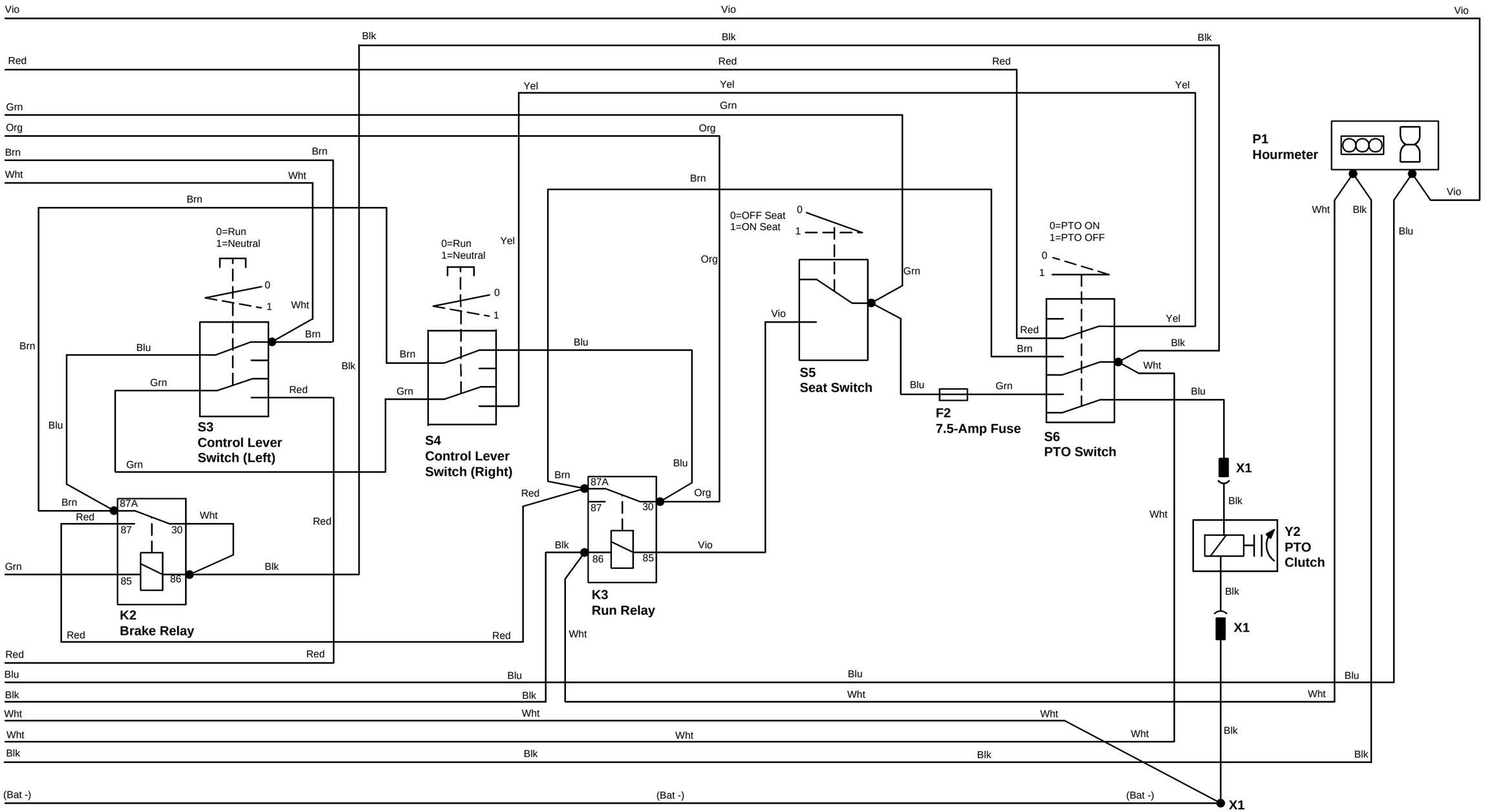




tion Circuit	SE3—Charge Circuit	SE4—Run Circuit

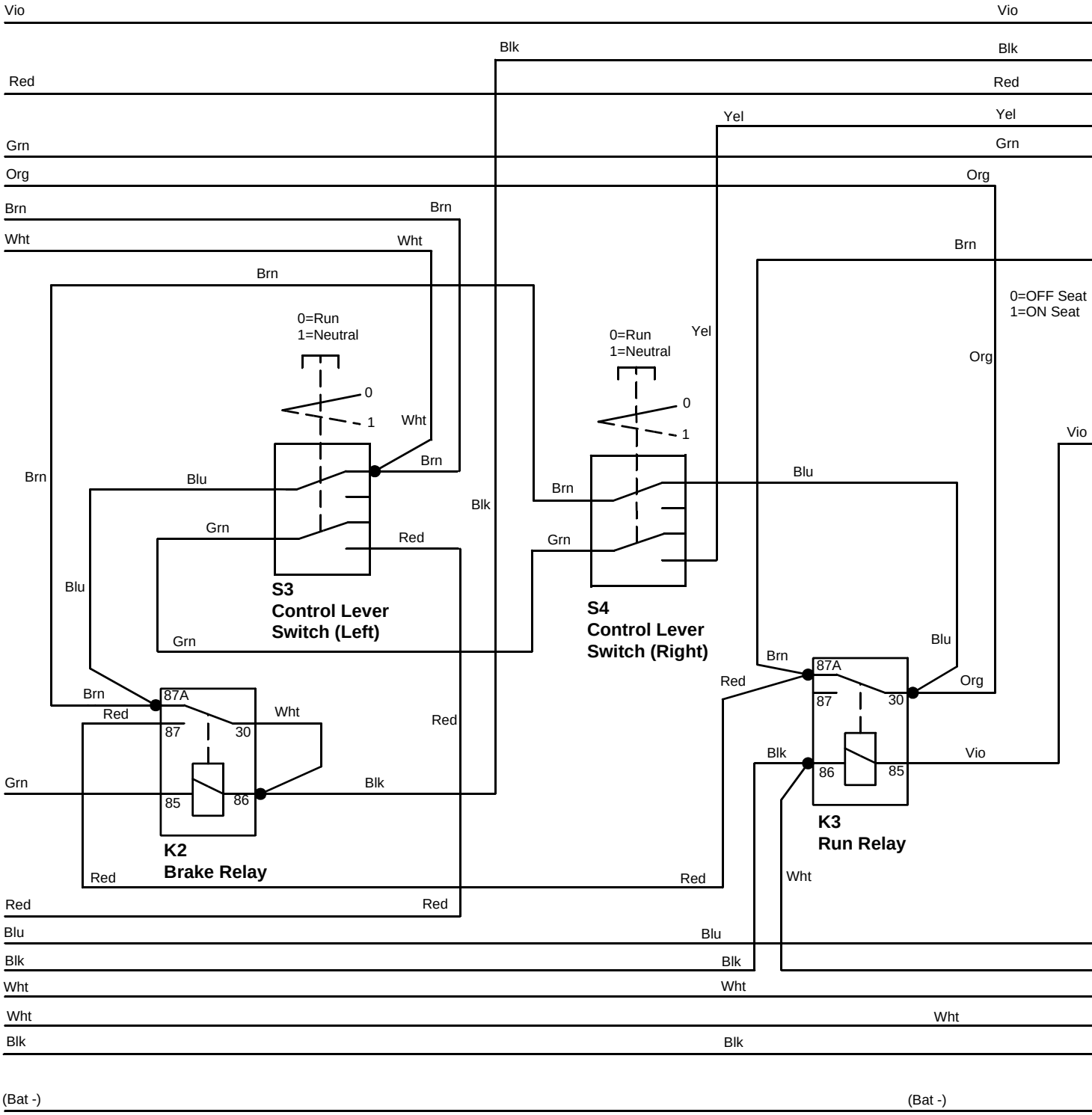
MX1956A

ELECTRICAL SCHEMATIC

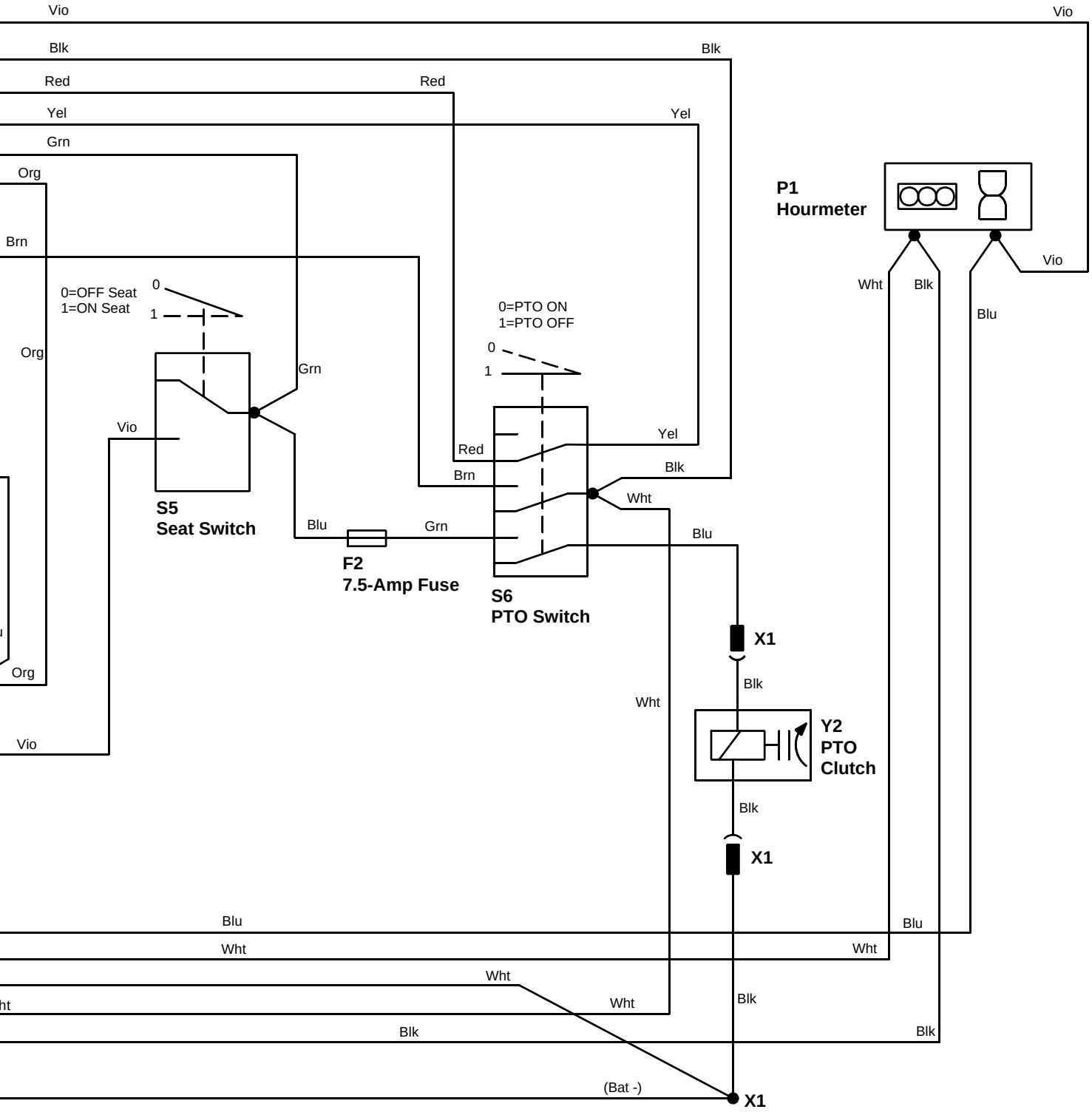


SE4—Run Circuit	SE5—PTO Circuit	SE6—Hourmeter Circuit

MX1956B



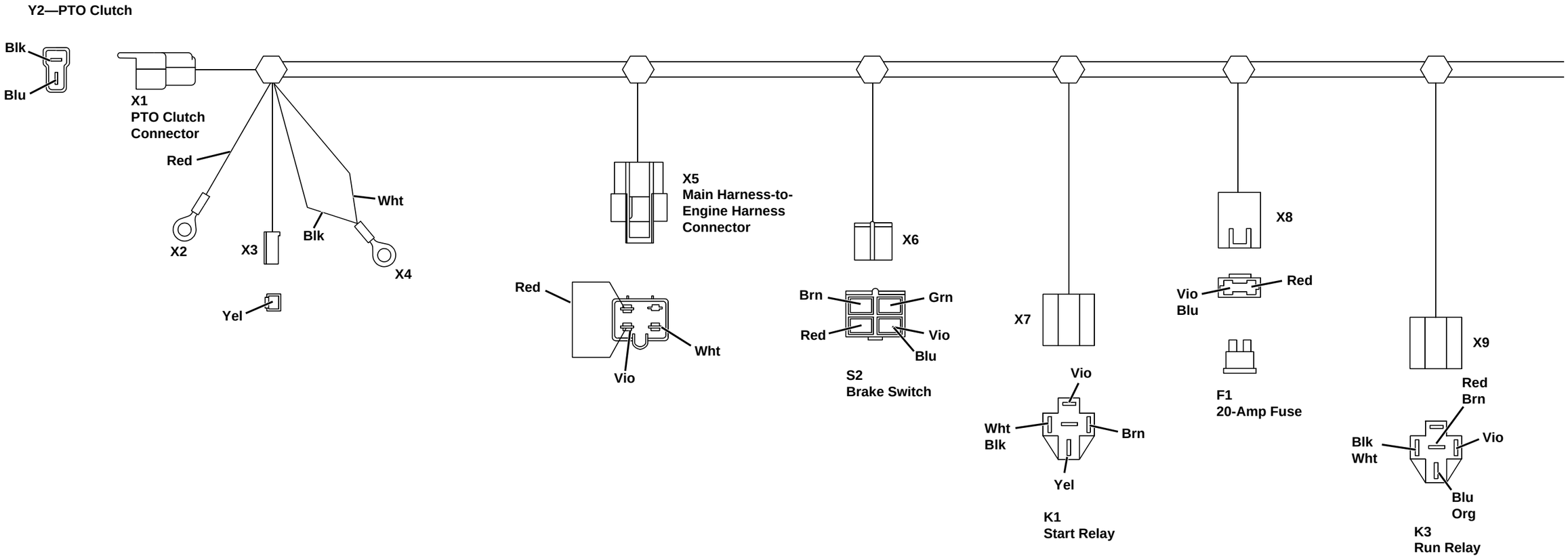
SE4—Run Circuit



	SE5—PTO Circuit	SE6—Hourmeter Circuit

MX1956B

WIRING HARNESSES
W1—MAIN WIRING HARNESS



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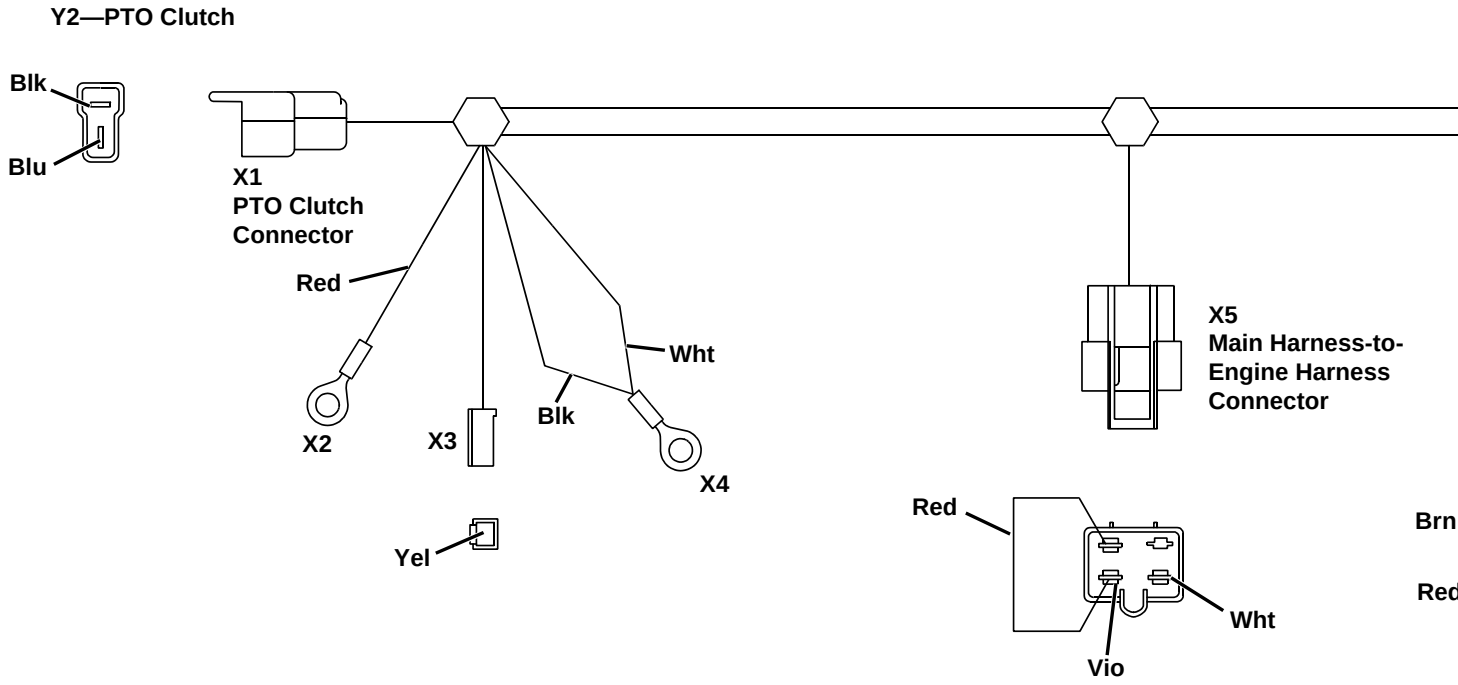
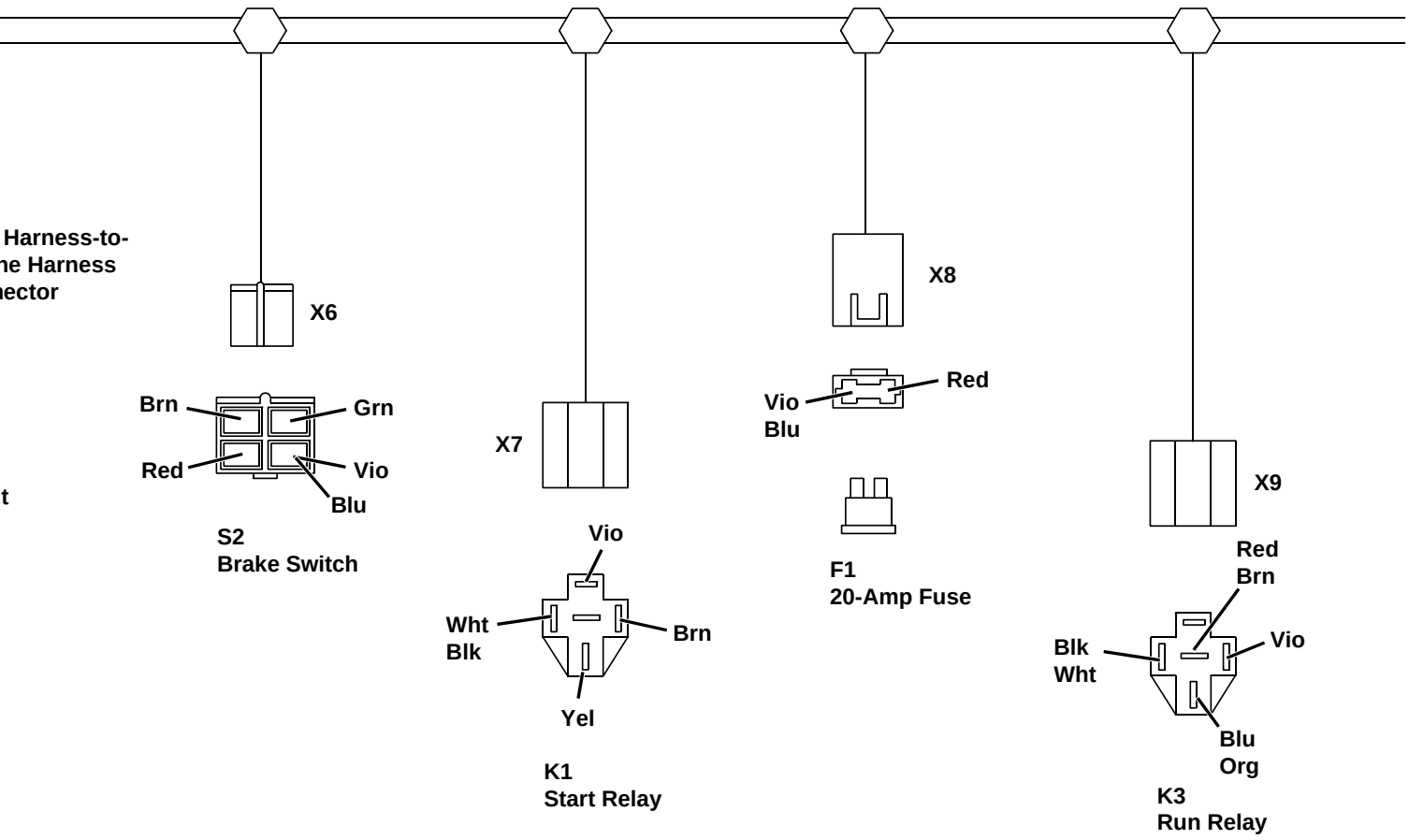
WIRING HARNESSES
W1—MAIN WIRING HARNESS

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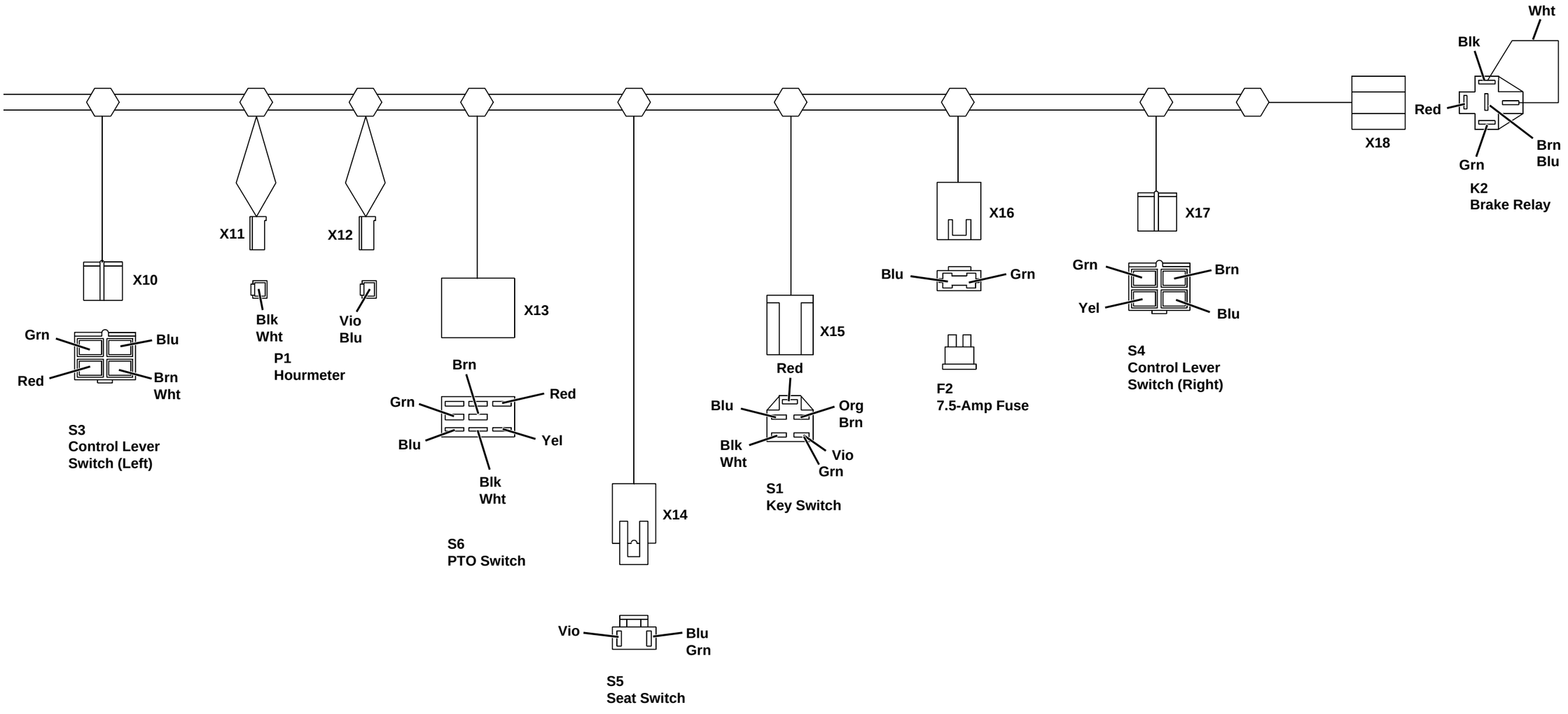
Vio
Blu
S2
Brake Switch
X7
Vio
Wht
Blk
Brn
Yel
K1
Start Relay
X8
Red
Vio
Blu
F1
20-Amp Fuse
X9
Red
Brn
Blk
Wht
Vio
Blu
Org
K3
Run Relay

MX1953A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X12
X13
X14
X15
X16
X17
X18
Grn
Blu
Red
Brn
Wht
S3
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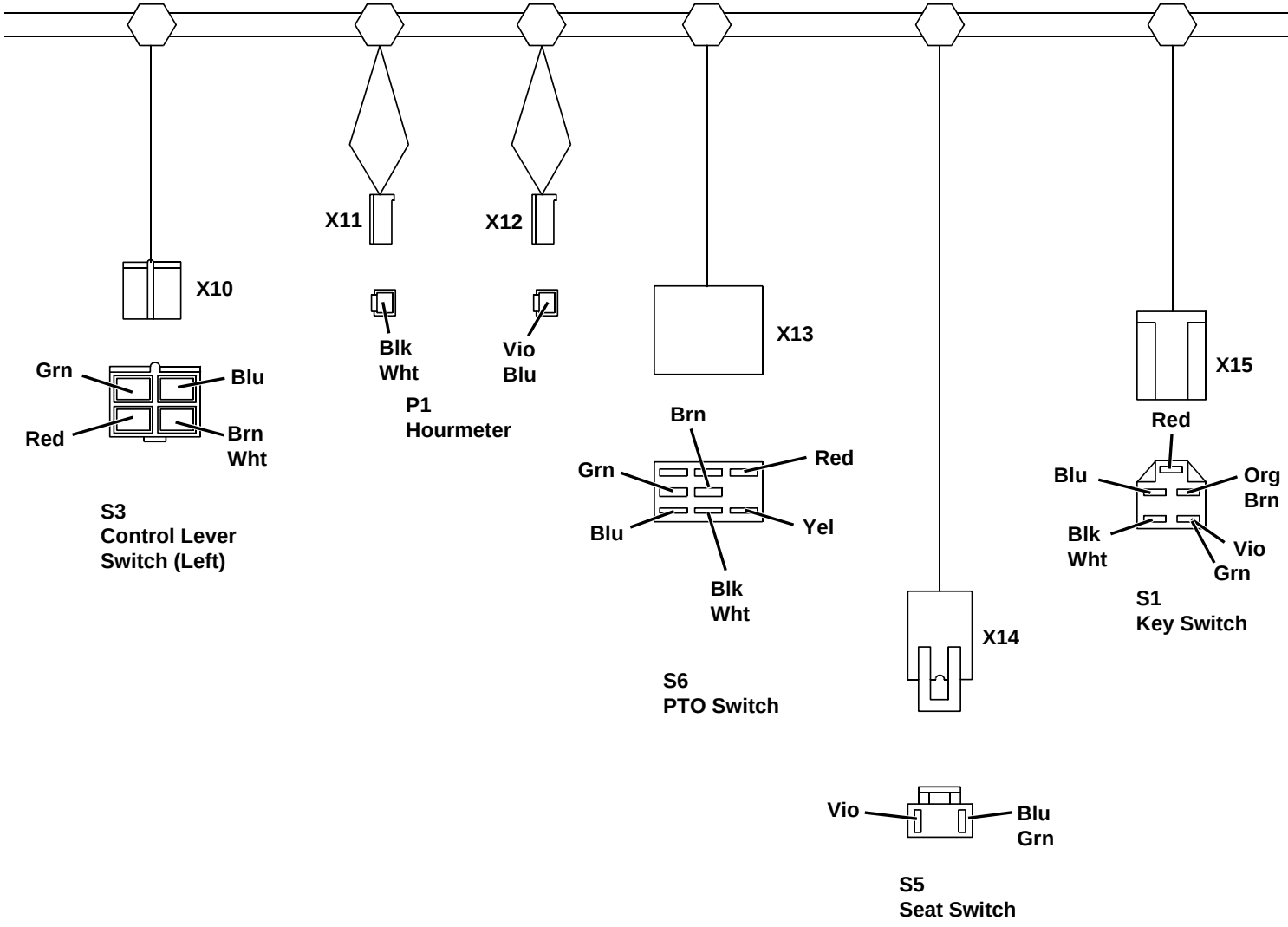
Switch (Left)
Blk
Wht
Vio
Blu
P1
Hourmeter
Brn
Grn
Red
Blu
Yel
Blk
Wht
S6
PTO Switch
Vio
Blu
Grn
S5
Seat Switch
Red
Blu
Org
Brn
Blk
Wht
Vio
Grn
S1
Key Switch
F2
7.5-Amp Fuse
Blu
Grn
Grn
Brn
Yel
Blu
S4
Control Lever
Switch (Right)
Wht
Blk
Red
Brn
Blu
Grn
K2
Brake Relay

MX1953B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X12
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Vio
Blu
P1
Hourmeter
X13
Brn
Grn
Red
Blu
Yel
Blk
Wht
S6
PTO Switch
X14
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Org
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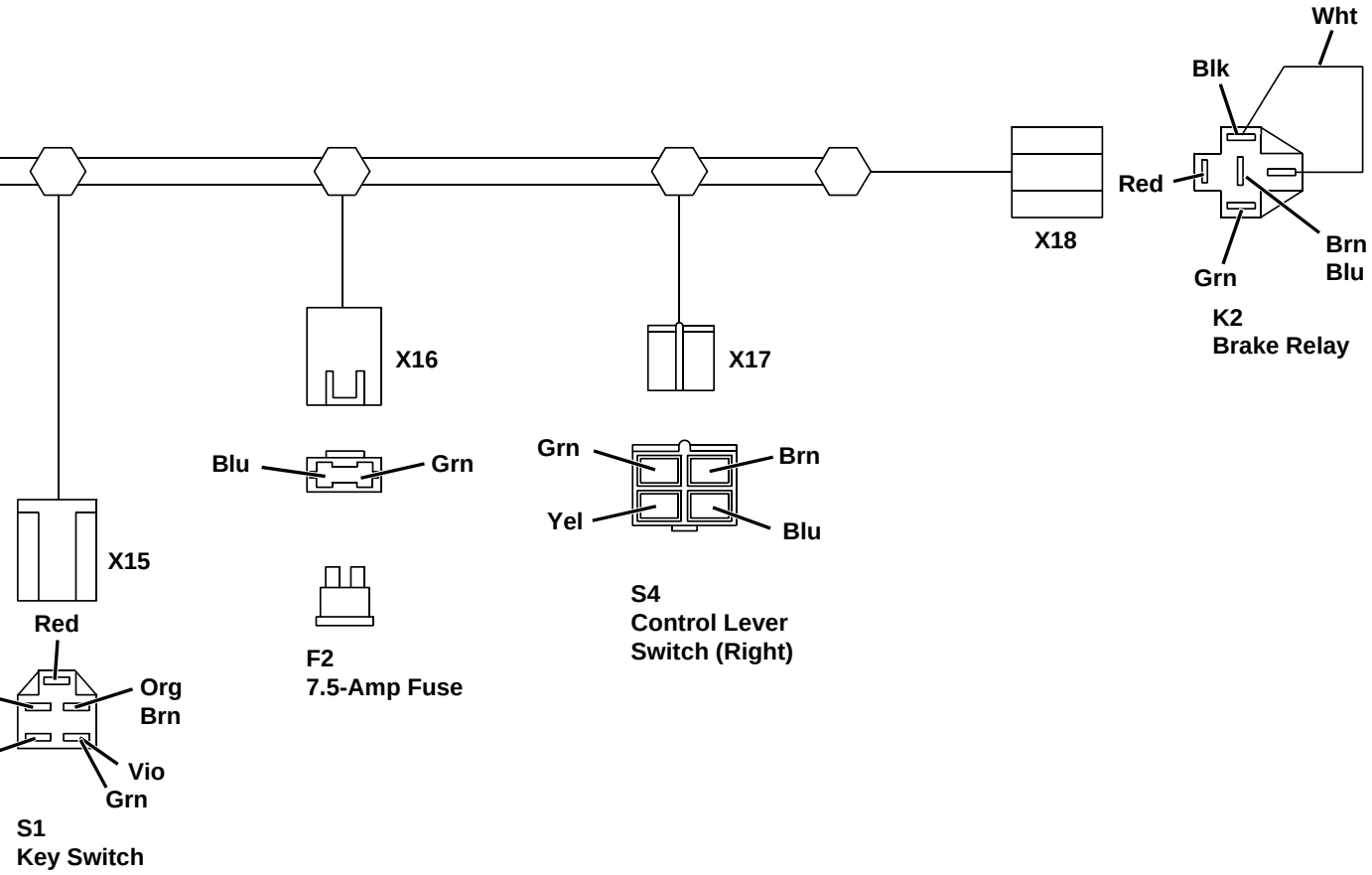
Vio
Grn
S1
Key Switch


Wht
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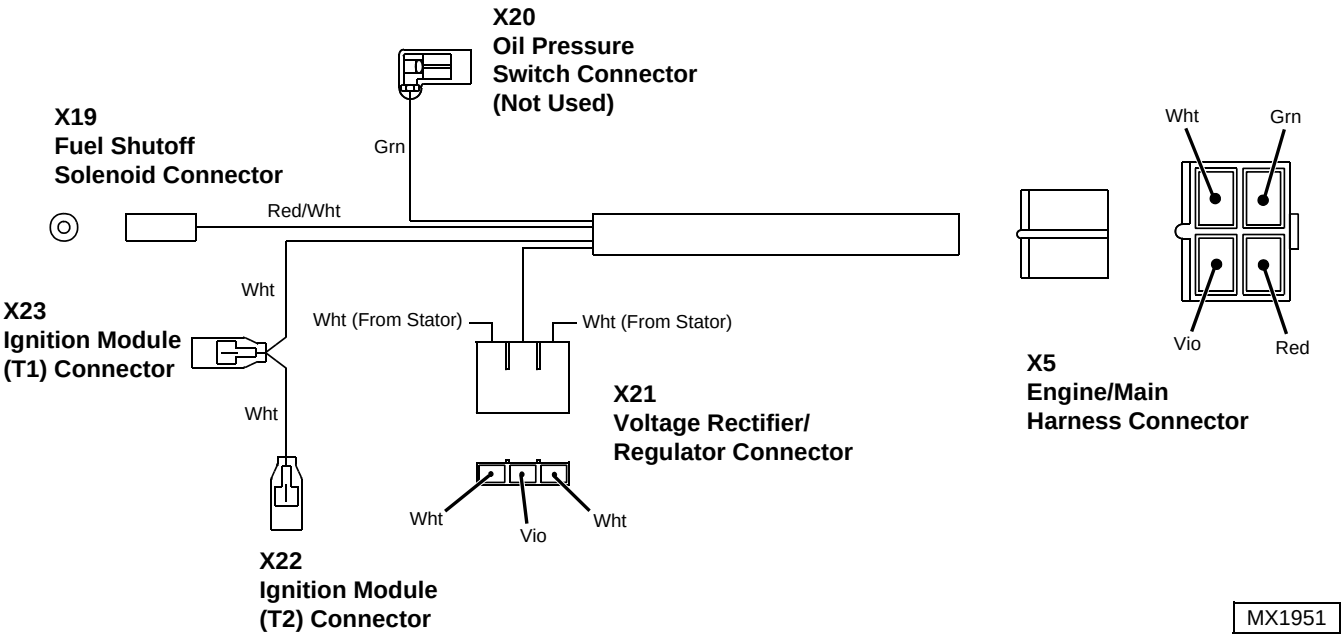
Brn
Blu
Grn
X18
K2
Brake Relay
X16
X17
Blu
Grn
Grn
Brn
Yel
Blu
X15
Red
Org
Brn
Vio
Grn
S1
Key Switch
F2
7.5-Amp Fuse
S4
Control Lever
Switch (Right)

MX1953B

W2—ENGINE WIRING HARNESS



MX1951

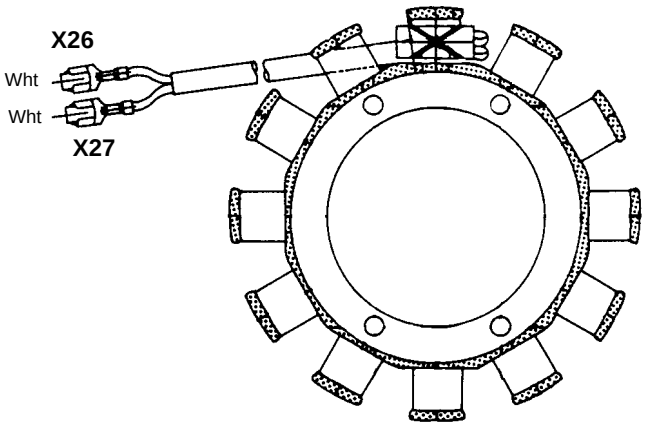
W3—GROUND WIRING HARNESS

X24
Voltage Rectifier/
Regulator Connector

X25
Engine Ground

MX1950

W4—STATOR WIRING HARNESS



M72550

TROUBLESHOOTING

ELECTRICAL SYSTEM TROUBLESHOOTING CHART

Problem or Symptom / Check or Solution	Battery will not take a charge.	Starting motor does not crank engine.	Starting motor cranks slowly.	Entire electrical system does not work.	Dead battery.	PTO clutch does not engage.	Fuses blow frequently.
Sulfated or worn-out battery. Test battery. (see BATTERY TEST.)	●	●	●	●	●		
Loose or corroded connections.	●	●	●	●			
Dead cell in battery.	●						
Electrolyte level low.	●				●		
20-amp main fuse (F1) blown.	●	●		●	●		
25-amp PTO fuse (F2) blown.						●	
Faulty starting motor.		●	●				
Open connector(s) on harness.	●	●				●	
Harness shorted to chassis. (See individual circuit diagnosis and COMMON CIRCUIT TESTS.)					●		●
Faulty wiring. Check wiring harness for continuity.	●	●		●	●	●	
Shorted starting motor solenoid.		●					
Faulty stator.				●	●		
Faulty voltage regulator/ rectifier.				●	●		

THEORY AND DIAGNOSIS

POWER CIRCUIT OPERATION

Unswitched Power Circuit

Function:

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

Operating Conditions:

- Key switch in STOP position.

Theory of Operation:

Voltage must be present at the following components with the key switch in the STOP position:

- Battery (G1) positive (+) terminal.
- Battery terminal of starting motor solenoid.
- Battery terminal of key switch (S1).
- Terminal 87 of the start relay (K1).

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

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

The ground cable connections are equally as important as the positive (+) cable. Starting motor operation depends on these cables and connections to carry the high current necessary for its operation.

The connections between starting motor (M1) and key switch (S1) and between start relay (K1) and battery (G1) are protected by the 20-amp fuse (F1).

Switched Power Circuit—Standard Equipment

Function:

Provides power to components by means of a key switch.

Operating Conditions:

- Key switch in RUN position.

Theory of Operation:

Voltage must be present at the following components with the key switch in the RUN position:

- All unswitched locations.
- Terminal L of key switch (S1).
- Positive Terminal of Hourmeter (P1).
- Brake switch (S2).
- Voltage regulator/rectifier (N1).
- Fuel shutoff solenoid (Y1).
- Seat switch (S5).
- PTO switch (S6).

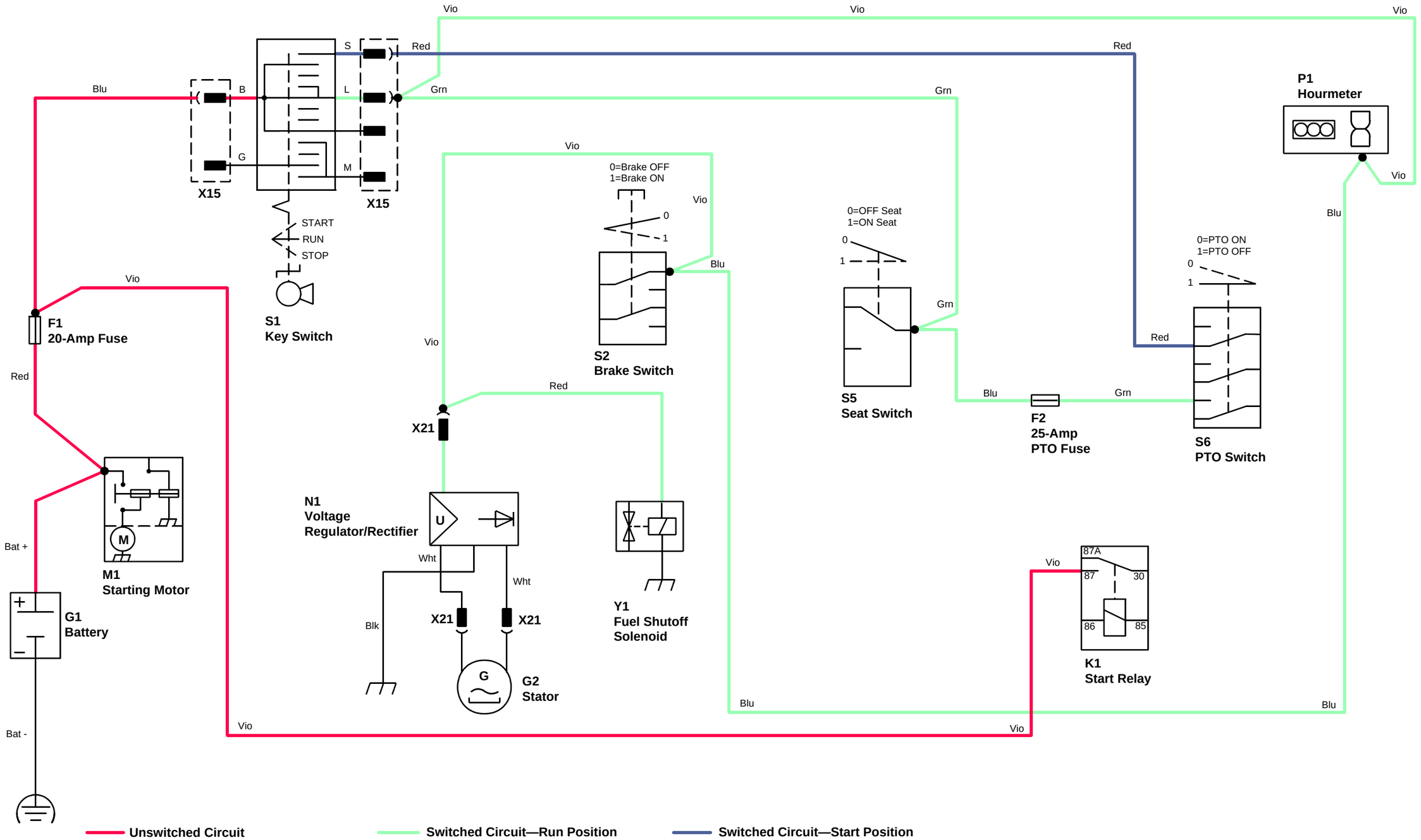
These circuits are controlled by the key switch and are protected by the 20-amp fuse (F1) and 7.5-amp PTO circuit fuse (F2).

Operating Conditions:

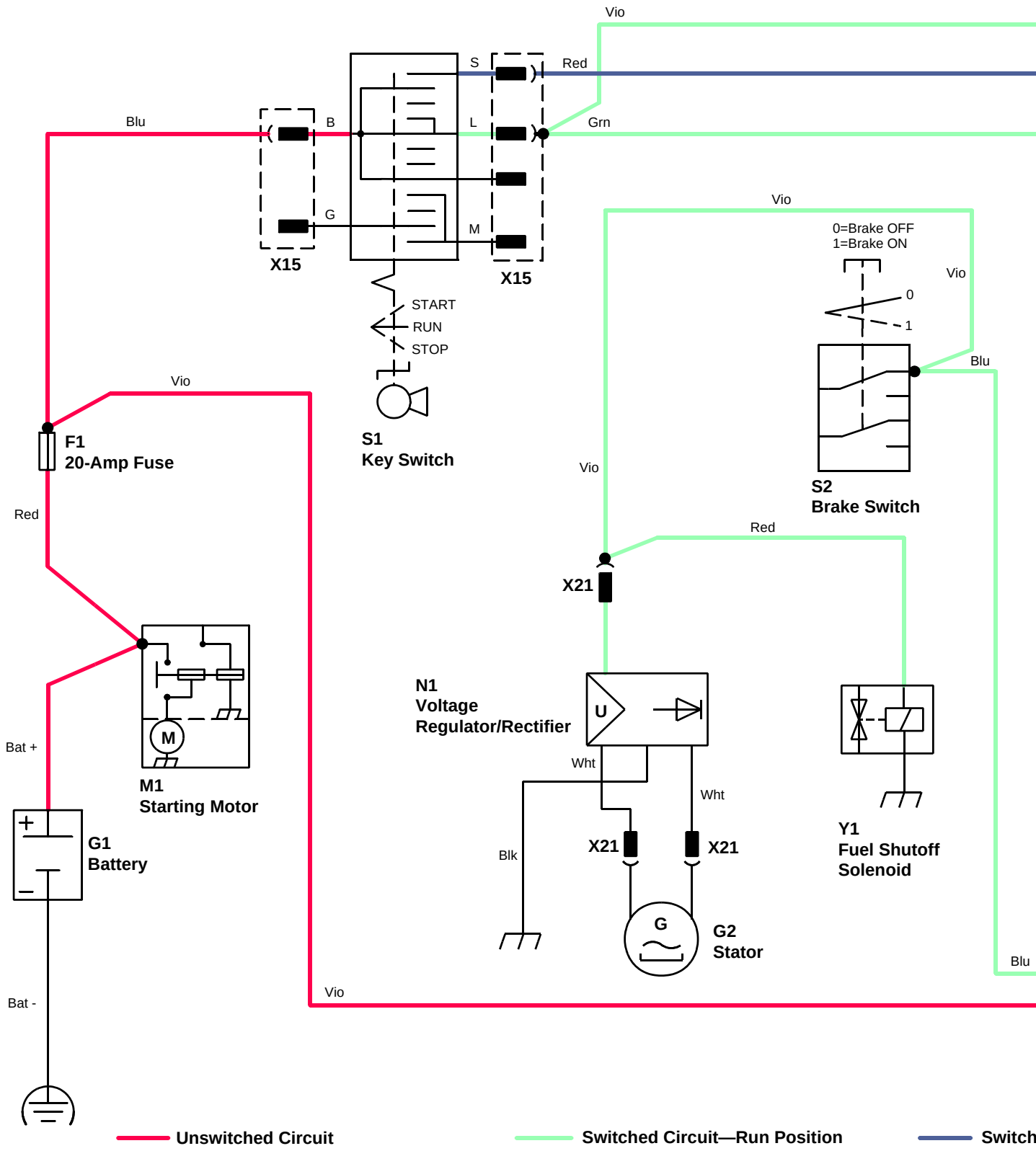
- Key switch in START position.

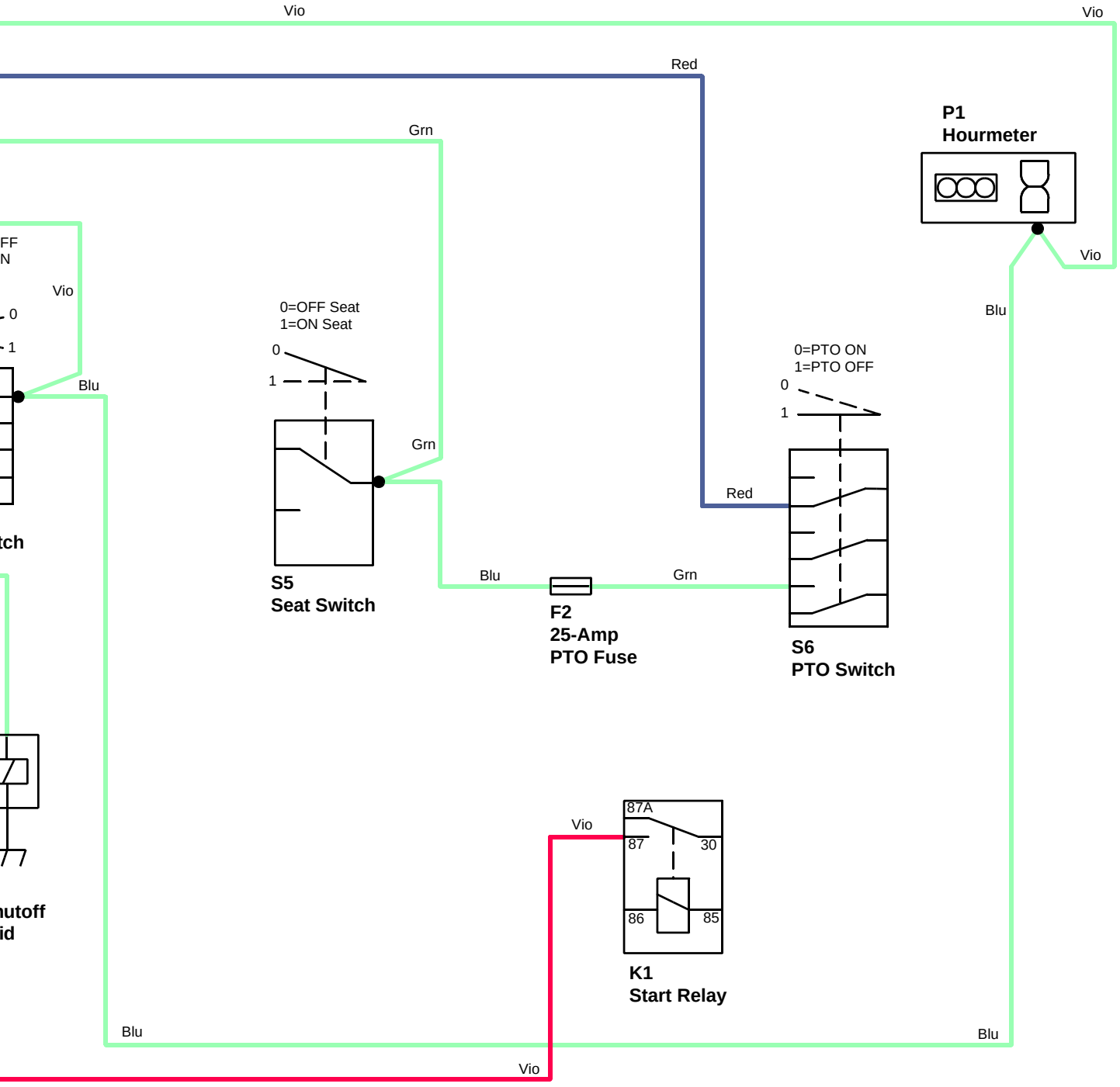
Voltage must be present at the following components with the key switch in the START position:

- All unswitched and switched locations.
- Terminal S of key switch (S1).
- PTO switch (S6).


Vio
Vio
Vio
Red
Red
Blu
Grn
Grn
S
B
L
G
M
X15
X15
START
RUN
STOP
S1
Key Switch
P1
Hourmeter
Vio
Blu
Vio
0=Brake OFF
1=Brake ON
0
1
Vio
Blu
S2
Brake Switch
0=OFF Seat
1=ON Seat
0
1
Grn
S5
Seat Switch
0=PTO ON
1=PTO OFF
0
1
Red
Blu
Grn
F2
25-Amp
PTO Fuse
S6
PTO Switch
F1
20-Amp Fuse
Vio
Red
Vio
Red
X21
N1
Voltage
Regulator/Rectifier
U
Wht
Wht
Blk
X21
X21
G
G2
Stator
Y1
Fuel Shutoff
Solenoid
Vio
87A
87
30
86
85
K1
Start Relay
Blu
Blu
Vio
Vio
Bat +
Bat -
M
M1
Starting Motor
G1
Battery
Unswitched Circuit
Switched Circuit—Run Position
Switched Circuit—Start Position

MX1943


Vio
S
Red
Blu
B
L
Grn
G
M
X15
X15
START
RUN
STOP
S1
Key Switch
Vio
0=Brake OFF
1=Brake ON
Vio
0
1
Blu
S2
Brake Switch
F1
20-Amp Fuse
Red
Vio
Red
X21
M
M1
Starting Motor
Bat +
N1
Voltage
Regulator/Rectifier
U
Wht
Wht
Blk
X21
X21
Y1
Fuel Shutoff
Solenoid
G
G2
Stator
G1
Battery
Bat -
Blu
Vio
Unswitched Circuit
Switched Circuit—Run Position
Switch



Switched Circuit—Start Position

MX1943

POWER CIRCUIT DIAGNOSIS

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

Test Location	Normal	If Not Normal
1. Battery positive (+) post.	11.8—13.2 volts.	Check battery condition. (See BATTERY TEST.)
2. Starting motor solenoid—Battery terminal.	Battery voltage.	Check battery positive (+) cable and clamps. Clean and tighten connections.
3. Key switch (S1)—Terminal B.	Battery voltage.	Test blue wire and red wires and connections. Test 20-amp fuse (F1). (See FUSE TEST.)
4. Start relay (K1)—Terminal 87.	Battery voltage.	Test violet wire and connections.

Test Conditions:

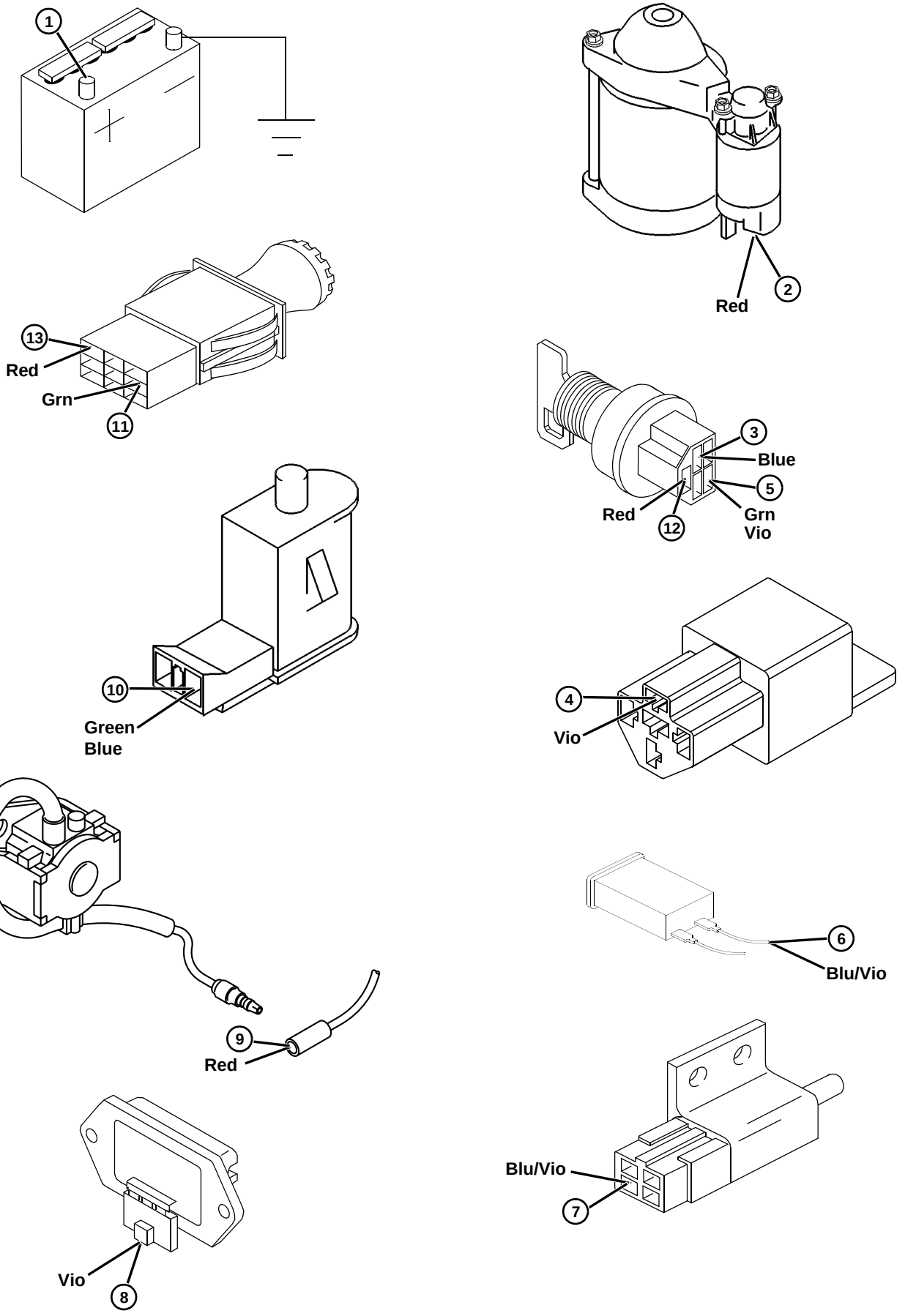
- Key switch in RUN position (Engine not running).

Test Location	Normal	If Not Normal
5. Key switch (S1)—Terminal L.	Battery voltage.	Test key switch. (See KEY SWITCH TEST.)
6. Hourmeter (P1)—Positive Terminal.	Battery voltage.	Test violet wire and connections.
7. Brake switch (S2).	Battery voltage.	Test blue wire and connections.
8. Voltage regulator/rectifier (N1).	Battery voltage.	Test violet wire and connections.
9. Fuel shutoff solenoid (Y1).	Battery voltage.	Test red wire and connections.
10. Seat switch (S5).	Battery voltage.	Test green wire and connections.
11. PTO switch (S6)—Common terminal.	Battery voltage.	Test blue and green wires and connections. Test 25-amp fuse (F2). (See FUSE TEST.)

Test Conditions:

- Key switch (S1) in START position.

Test Location	Normal	If Not Normal
12. Key switch (S1)—Terminal S.	Battery voltage.	Test key switch. (See KEY SWITCH TEST.)
13. PTO switch (S6)—Common terminal.	Battery voltage.	Test red wire and connections.


1
2
Red
13
Red
Grn
11
3
Blue
5
Red
12
Grn
Vio
10
Green
Blue
4
Vio
6
Blu/Vio
9
Red
Blu/Vio
7
Vio
8

CRANKING CIRCUIT OPERATION

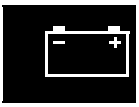
Function:

To energize the starting motor solenoid and engage the starting motor.

Operating Conditions:

To crank the engine, the following conditions must be met:

- Key switch in START position.
- Park brake locked (brake switch engaged).
- PTO switch in OFF position.
- Right and left control levers in NEUTRAL LOCK position (control lever switches engaged).

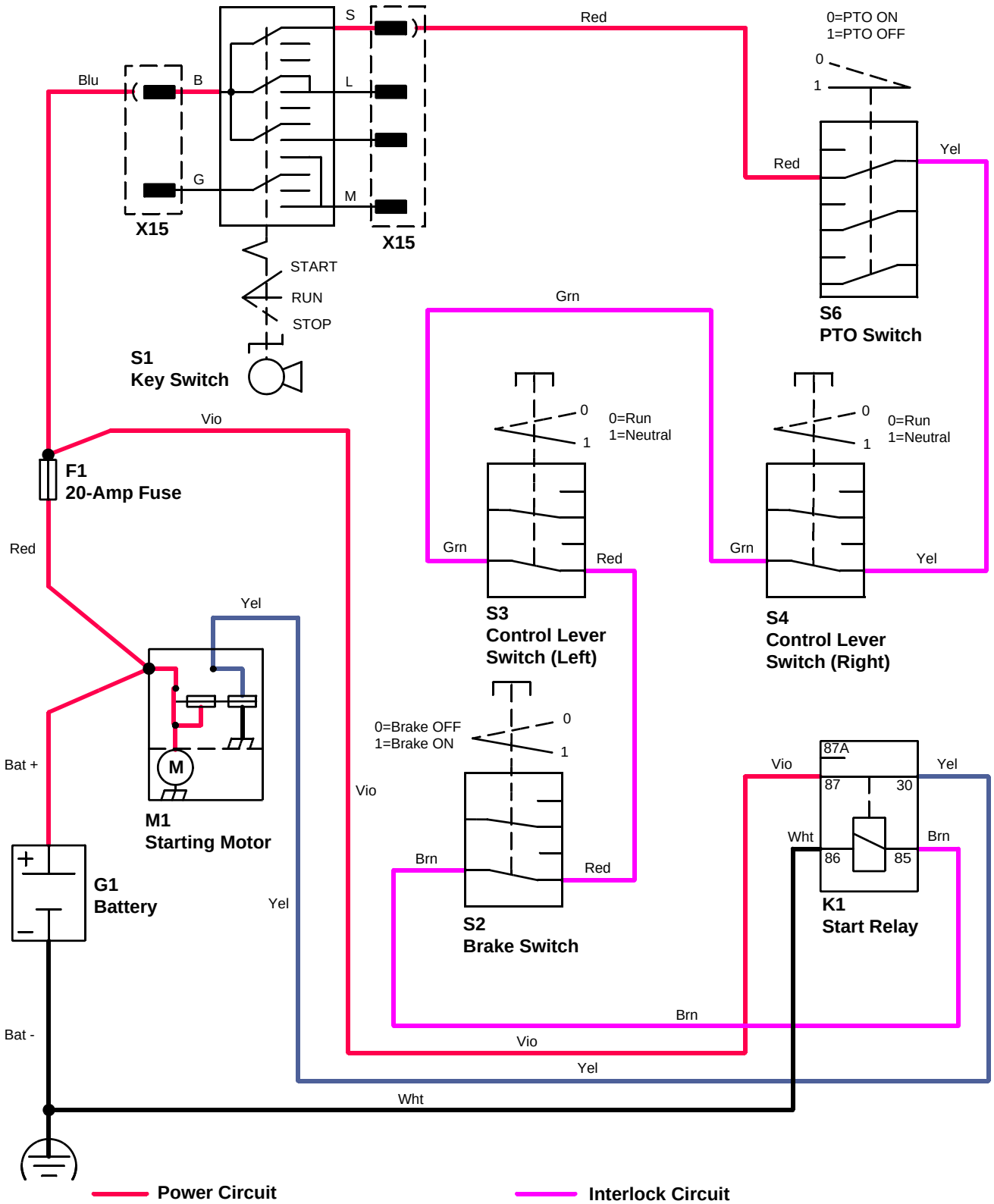


Theory of Operation:

The power circuit provides current to the key switch (S1) and protects the cranking circuit with a 20-amp fuse (F1). Current flows from the battery (G1) positive (+) terminal to the 20-amp fuse and key switch (red and blue wires) and to terminal 87 of the start relay (K1) (violet wire).

With the key switch in the START position, current flows through the PTO switch (S6) (red wire), right control lever switch (S4) (yellow wire), left control lever switch (S3) (green wire), brake switch (S2) (red wire) to the terminal 85 of the start relay (brown wire). A path to ground (white wire) completes the circuit, energizing the relay.

With the relay energized, current flows across relay terminals 87 (violet wire) to terminal 30 to the start solenoid (yellow wire), engaging the starting motor.


S
Red
0=PTO ON
1=PTO OFF
0
1
Blu
B
L
G
M
X15
X15
Red
Yel
S6
PTO Switch
START
RUN
STOP
S1
Key Switch
Grn
Vio
0
1
0=Run
1=Neutral
F1
20-Amp Fuse
Grn
Red
S3
Control Lever
Switch (Left)
Grn
Yel
S4
Control Lever
Switch (Right)
Red
Yel
Bat +
M
M1
Starting Motor
0=Brake OFF
1=Brake ON
Vio
Brn
Red
S2
Brake Switch
87A
Vio
Yel
87
30
Wht
Brn
86
85
K1
Start Relay
G1
Battery
Yel
Bat -
Brn
Vio
Yel
Wht
Power Circuit
Interlock Circuit
Start Relay Circuit
Ground Circuit
MX1944

CRANKING CIRCUIT DIAGNOSIS

Test Conditions:

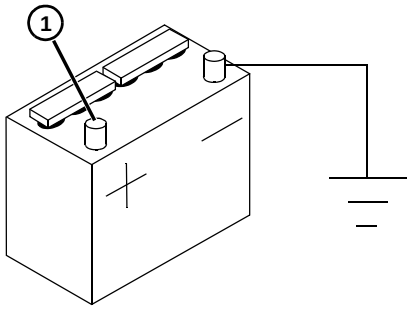
- Machine parked on a level surface.
- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

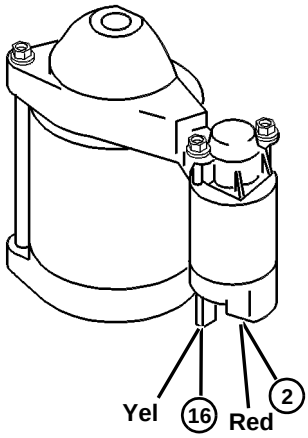
Test Location	Normal	If Not Normal
1. Battery positive (+) post.	11.8—13.2 volts.	Check battery condition. (See BATTERY TEST.)
2. Starting motor solenoid—Battery terminal.	Battery voltage.	Check battery positive (+) cable and clamp. Clean and tighten connections.
3. Key switch (S1)—Terminal B.	Battery voltage.	Test red and blue wires and connections. Test 20-amp fuse (F1). (See FUSE TEST.)
4. Start relay (K1)—Terminal 87.	Battery voltage.	Test violet wire and connections. Test 20-amp fuse (F1). (See FUSE TEST.)
5. Start relay (K1)—Terminal 86.	Maximum 0.1 ohms resistance.	Test white wires and connections.

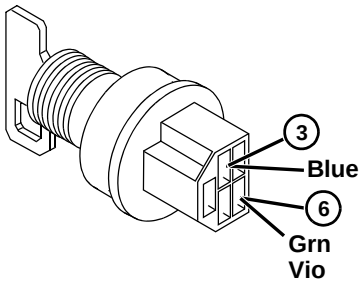
Test Conditions:

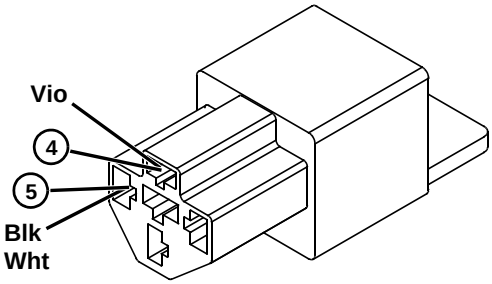
- Key switch (S1) in RUN position.
- Brake switch (S2) in ON position.
- PTO switch (S6) in OFF position.
- Right and left control levers in NEUTRAL LOCK position (control lever switches [S3 and S4] engaged).

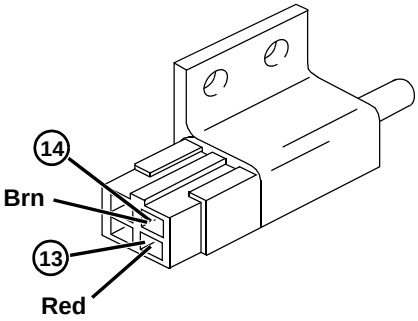
Test Location	Normal	If Not Normal
6. Key switch (S1)—Terminal S.	Battery voltage.	Test key switch. (See KEY SWITCH TEST.)
7. PTO switch (S6).	Battery voltage.	Test red wire and connections.
8. PTO switch (S6).	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST.)
9. Right control lever switch (S4).	Battery voltage.	Test yellow wire and connections.
10. Right control lever switch (S4)	Battery voltage.	Test control lever switch. (See PARK BRAKE/CONTROL LEVER SWITCH TEST.)
11. Left control lever switch (S3).	Battery voltage.	Test green wire and connections.
12. Left control lever switch (S3).	Battery voltage.	Test control lever switch. (See PARK BRAKE/CONTROL LEVER SWITCH TEST.)
13. Brake switch (S5).	Battery voltage.	Test red wire and connections.
14. Brake switch (S5).	Battery voltage.	Test brake switch. (See PARK BRAKE/CONTROL LEVER SWITCH TEST.)
15. Start relay (K1)—Terminal 85.	Battery voltage.	Test brown wire and connections.
16. Start solenoid.	Battery voltage.	Test yellow wire and connections.

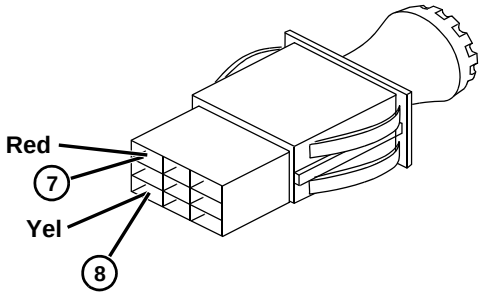

1

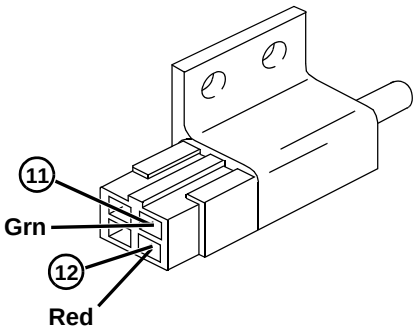

Yel
16
Red
2

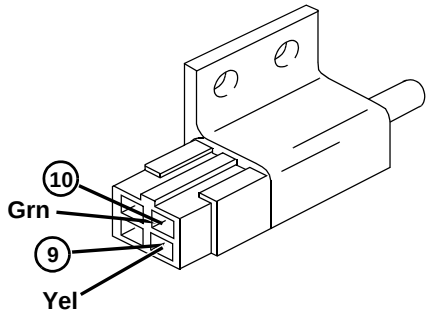

3
Blue
6
Grn
Vio


Vio
4
5
Blk
Wht


14
Brn
13
Red


Red
7
Yel
8


11
Grn
12
Red


10
Grn
9
Yel

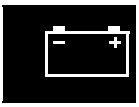
RUN CIRCUIT OPERATION— OPERATOR ON SEAT

Function:

To allow the engine to run with the operator on the seat.

Operating Conditions:

- Key switch (S1) in RUN position—engine running.
- Operator on seat (seat switch [S5] CLOSED).
- Park brake released (brake switch [S2] OPEN).
- Fuel shutoff solenoid energized.



Theory of Operation:

The power circuit provides current to the key switch (S1) and protects the run circuit with a 20-amp fuse (F1). Current flows from the battery (G1) positive (+) terminal to the 20-amp fuse and key switch (red and blue wires).

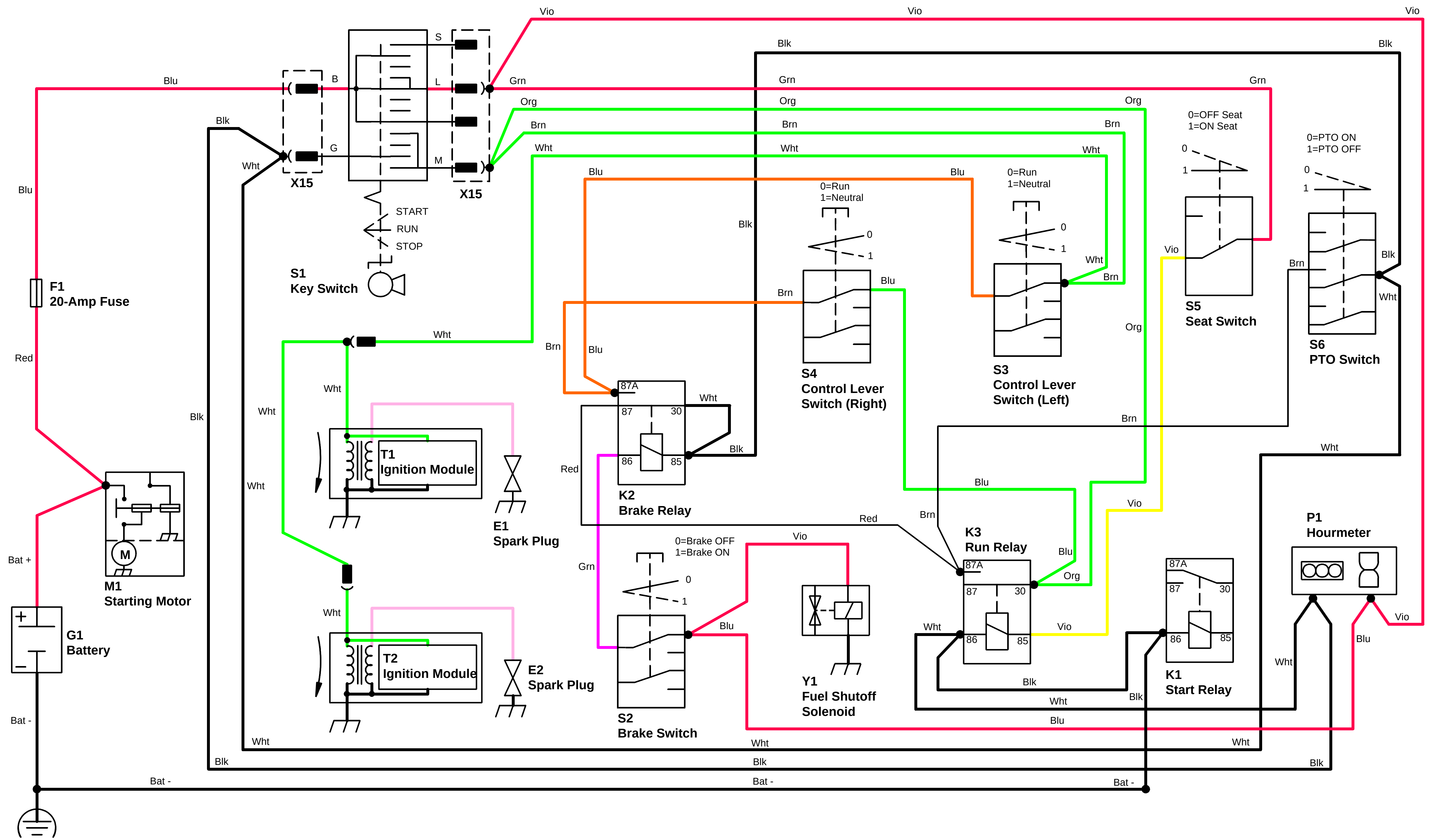
With the key switch in the RUN position and the engine running, current flows to seat switch (S5) (green wire), positive terminal of the hourmeter (P1) (violet wire), common terminal of the brake switch (S2) (blue wire and to the fuel shutoff solenoid (Y1) (violet wire). This activates the fuel shutoff solenoid, allowing fuel to flow into the carburetor.

With the operator on the seat, the seat switch is closed, allowing current to flow to terminal 85 of the run relay (K3) (violet wire).

With the brake switch in the OFF position, current flows to terminal 86 of the brake relay (K2) (green wire), engaging the relay.

As the flywheel turns, a magnet in the flywheel starts to align with the ignition modules (T1 and T2) and produces current in the primary coil by electromagnetic induction. In the initial stage, low voltage current is produced. When the primary circuit builds to its highest level, the ignition modules induce high voltage in the secondary coil circuit. The high voltage flows to the spark plugs (E1 and E2), igniting the fuel/air mixture in the cylinders.

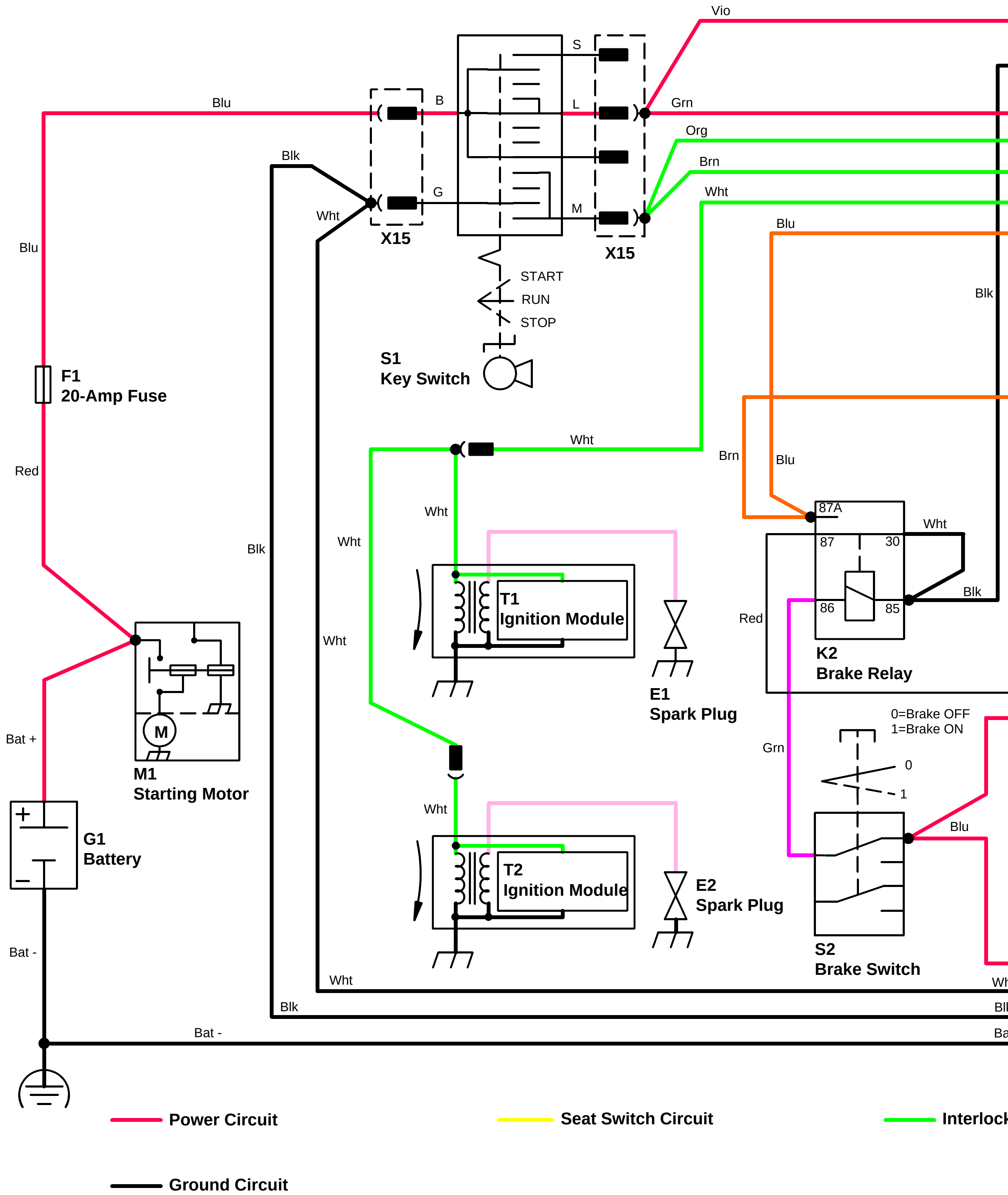
If the operator leaves the seat, current will no longer flow to the run relay causing the relay to de-energize and providing a path to ground for the ignition primary coil circuit through the terminals 87 and 30 of the brake relay, shutting off the ignition.

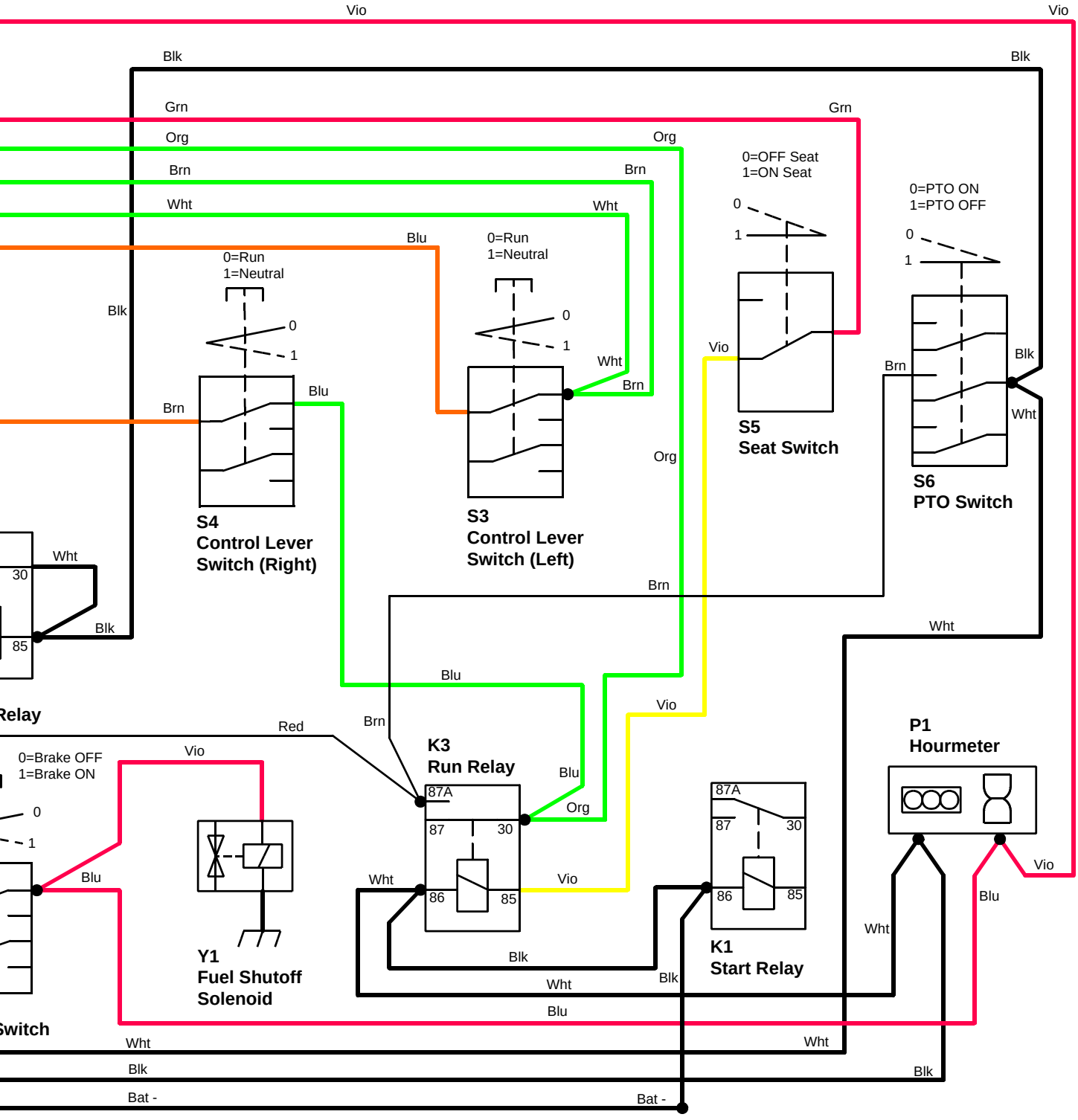


F1
20-Amp Fuse
M1
Starting Motor
G1
Battery
S1
Key Switch
START
RUN
STOP
X15
T1
Ignition Module
T2
Ignition Module
E1
Spark Plug
E2
Spark Plug
K2
Brake Relay
0=Brake OFF
1=Brake ON
S2
Brake Switch
Y1
Fuel Shutoff
Solenoid
0=Run
1=Neutral
S4
Control Lever
Switch (Right)
S3
Control Lever
Switch (Left)
0=OFF Seat
1=ON Seat
S5
Seat Switch
0=PTO ON
1=PTO OFF
S6
PTO Switch
K3
Run Relay
K1
Start Relay
P1
Hourmeter
Bat +
Bat -

Power Circuit
Seat Switch Circuit
Interlock/Ignition Primary Circuit
Brake Relay Circuit
Secondary Circuit
Ground Circuit

MX1945


Vio
S
Blu
B
L
Grn
Org
Blk
Brn
G
Wht
Wht
M
X15
X15
Blu
Blu
START
RUN
STOP
Blk
S1
Key Switch
F1
20-Amp Fuse
Wht
Brn
Blu
Red
Wht
87A
Wht
Blk
Wht
87
30
T1
Ignition Module
Blk
Red
86
85
Wht
K2
Brake Relay
E1
Spark Plug
0=Brake OFF
1=Brake ON
Bat +
M
Grn
0
M1
Starting Motor
1
Wht
Blu
G1
Battery
T2
Ignition Module
E2
Spark Plug
Bat -
S2
Brake Switch
Wht
Blk
Bat -
Power Circuit
Seat Switch Circuit
Interlock
Ground Circuit


Vio
Vio
Blk
Blk
Grn
Grn
Org
Org
Brn
Brn
Wht
Wht
Blu
0=Run
1=Neutral
0=Run
1=Neutral
0=OFF Seat
1=ON Seat
0=PTO ON
1=PTO OFF
S4
Control Lever
Switch (Right)
S3
Control Lever
Switch (Left)
S5
Seat Switch
S6
PTO Switch
Relay
Red
0=Brake OFF
1=Brake ON
K3
Run Relay
P1
Hourmeter
Y1
Fuel Shutoff
Solenoid
K1
Start Relay
Switch
Bat -
Bat -
Interlock/Ignition Primary Circuit
Brake Relay Circuit
Secondary Circuit

MX1945

RUN CIRCUIT OPERATION— OPERATOR OFF SEAT

Function:

To allow the engine to run when the operator is off the seat.

Operating Conditions:

- Key switch in RUN position.
- Operator off seat (seat switch OPEN).
- Park brake engaged (brake switch CLOSED).
- Both control levers in NEUTRAL LOCK position.
- PTO switch in OFF position.
- Fuel shutoff solenoid energized.

Theory of Operation:

The power circuit provides current to the key switch (S1) and protects the run circuit with a 20-amp fuse (F1). Current flows from the battery (G1) positive (+) terminal to the 20-amp fuse and key switch (blue and red wires).

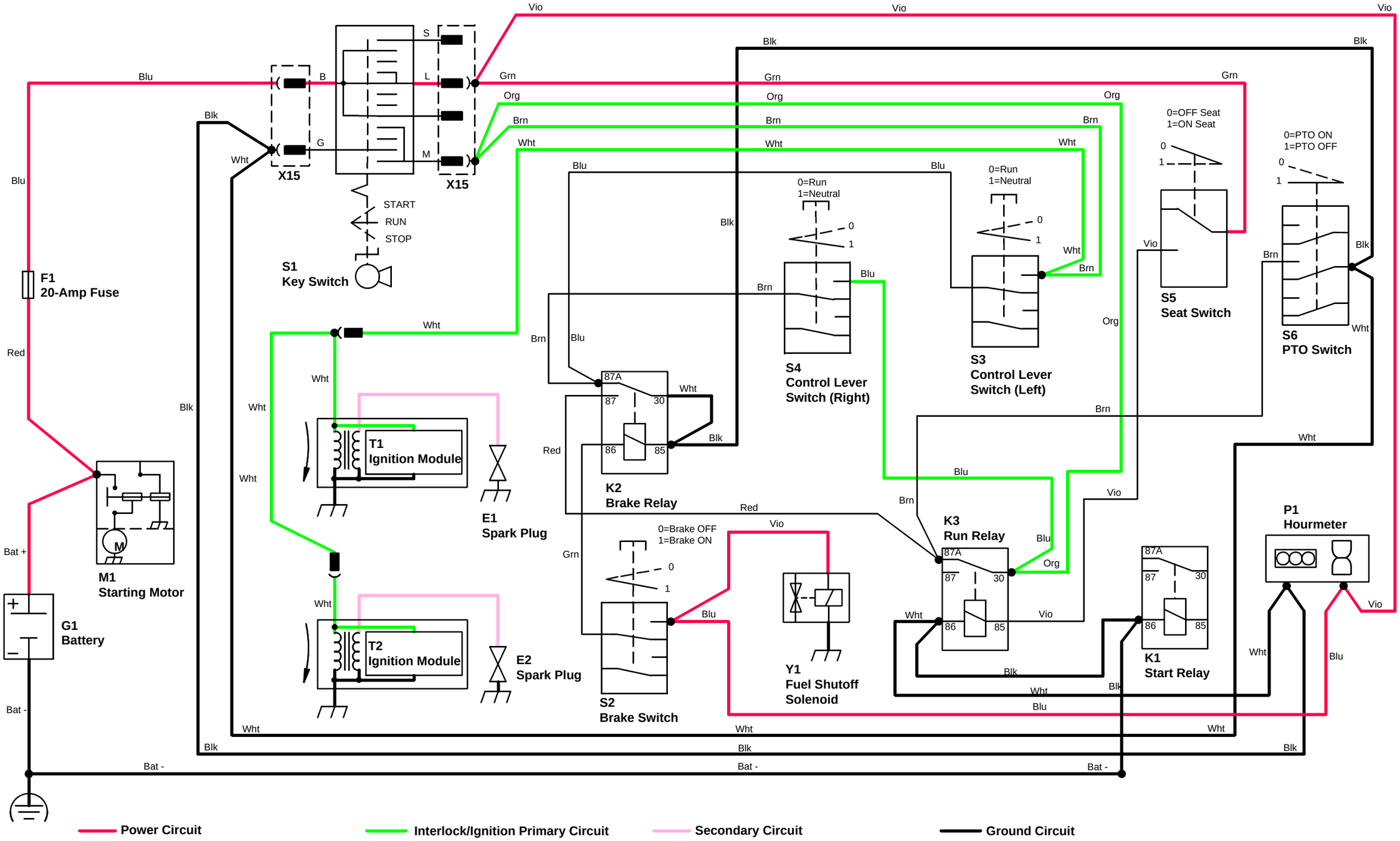
With the key switch in the RUN position and the engine running, current flows to seat switch (S5) (green wire), positive terminal of the hourmeter (P1) (violet wire), common terminal of the brake switch (S2) (blue wire and to the fuel shutoff solenoid (Y1) (violet wire). This activates the fuel shutoff solenoid, allowing fuel to flow into the carburetor.

With the operator off the seat, the park brake switch (S2) must be engaged and the PTO switch (S6) must be in the OFF position.

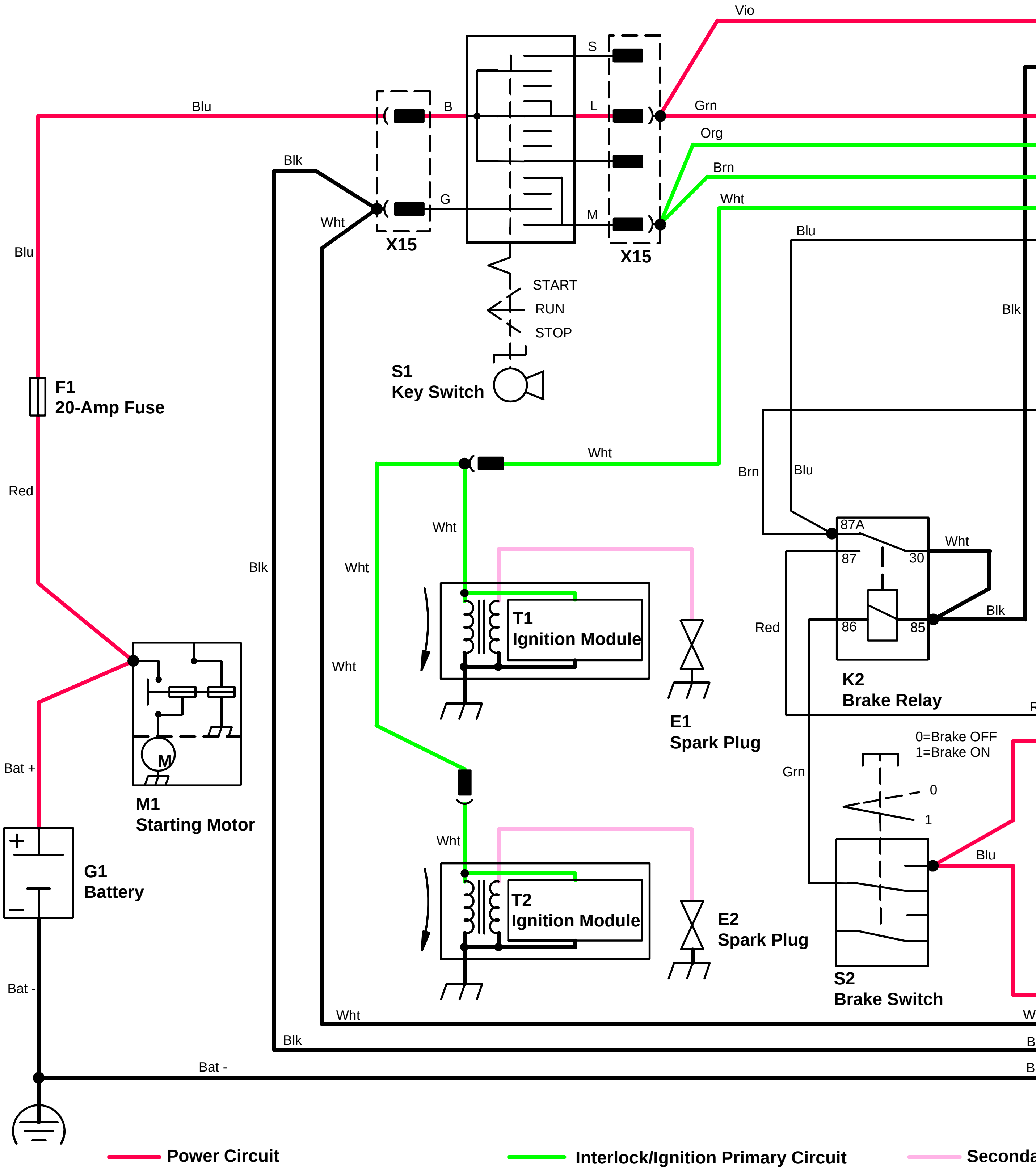
As the flywheel turns, a magnet in the flywheel starts to align with the ignition modules (T1 and T2) and produces current in the primary coil by electromagnetic induction. In the initial stage low voltage current is produced. When the primary circuit builds to its highest level, the ignition modules induce high voltage in the secondary coil circuit. The high voltage flows to the spark plugs (E1 and E2), igniting the fuel/air mixture in the cylinder(s).

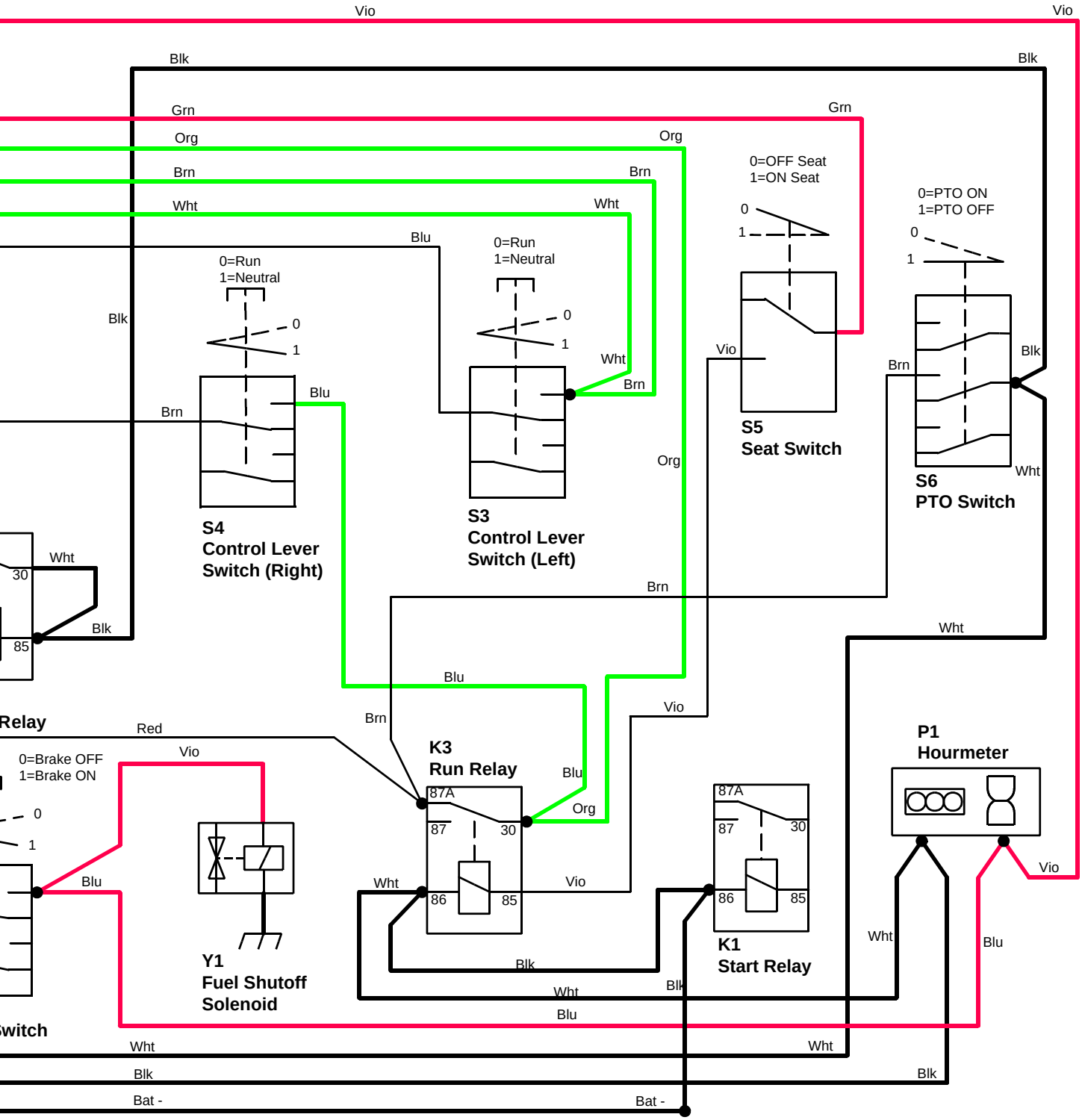
If either control lever is moved from the NEUTRAL position, a path to ground is completed through brake relay terminals 87A and 30 for the ignition primary coil circuit, shutting off the ignition.

If the park brake is released (with the operator off the seat), current flows to terminal 86 of the brake relay (K2) (green wire), engaging the relay, providing a path to ground through terminals 87 and 30 of the brake relay for the ignition primary coil circuit, shutting off the ignition.


F1
20-Amp Fuse
S1
Key Switch
START
RUN
STOP
X15
X15
S
B
L
G
M
S2
Brake Switch
0=Brake OFF
1=Brake ON
S3
Control Lever
Switch (Left)
0=Run
1=Neutral
S4
Control Lever
Switch (Right)
0=Run
1=Neutral
S5
Seat Switch
0=OFF Seat
1=ON Seat
S6
PTO Switch
0=PTO ON
1=PTO OFF
K1
Start Relay
K2
Brake Relay
K3
Run Relay
87A
87
30
86
85
T1
Ignition Module
T2
Ignition Module
E1
Spark Plug
E2
Spark Plug
Y1
Fuel Shutoff
Solenoid
P1
Hourmeter
M1
Starting Motor
G1
Battery
Bat +
Bat -
Blu
Red
Blk
Wht
Grn
Org
Brn
Vio
Power Circuit
Interlock/Ignition Primary Circuit
Secondary Circuit
Ground Circuit

MX1946


Vio
S
Blu
B
L
Grn
Org
Blk
Brn
G
Wht
Wht
M
X15
X15
Blu
Blu
START
RUN
STOP
Blk
S1
Key Switch
F1
20-Amp Fuse
Wht
Red
Brn
Blu
Wht
87A
Wht
Blk
Wht
87
30
T1
Ignition Module
Blk
Red
86
85
Wht
E1
Spark Plug
K2
Brake Relay
0=Brake OFF
1=Brake ON
Grn
Bat +
M
M1
Starting Motor
0
1
Wht
Blu
G1
Battery
T2
Ignition Module
E2
Spark Plug
S2
Brake Switch
Bat -
Wht
Blk
Bat -
Power Circuit
Interlock/Ignition Primary Circuit
Seconda



Secondary Circuit

Ground Circuit

MX1946

RUN CIRCUIT DIAGNOSIS

Test Conditions:

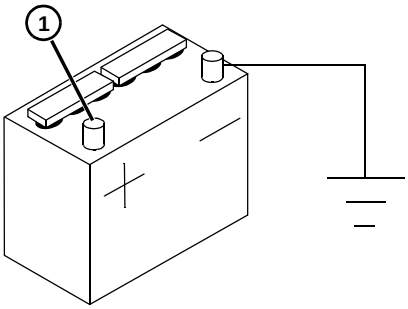
- Machine parked on a level surface.
- Key switch (S1) in STOP position.
- Operator off seat (Seat switch [S5] open).
- PTO switch (S6) in OFF position.
- Park brake switch (S2) engaged.
- Right and left control levers in NEUTRAL LOCK position (control lever switches [S3 and S4] engaged).
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

Test Location	Normal	If Not Normal
1. Battery positive (+) post.	11.8—13.2 volts.	Check battery condition. (See BATTERY TEST.)
2. Starting motor solenoid—Battery terminal.	Battery voltage.	Check battery positive (+) cable and clamps. Clean and tighten connections.
3. Key switch (S1)—Terminal B.	Battery voltage.	Test blue and red wires and connections. Test 20-amp fuse (F1). (See FUSE TEST.)
4. Park brake relay (K2)—Terminal 85.	Maximum 0.1 ohms resistance.	Test black and white wires and connections.
5. Run relay (K3)—Terminal 86.	Maximum 0.1 ohms resistance.	Test black and white wires and connections.

Test Conditions:

- Key switch (S1) in RUN position.
- Operator on seat (Seat switch [S5] closed).

Test Location	Normal	If Not Normal
6. Key switch (S1)—Terminal L.	Battery voltage.	Test key switch. (See KEY SWITCH TEST.)
7. Brake switch (S2).	Battery voltage.	Test blue and violet wires and connections.
8. Brake switch (S2).	Battery voltage.	Test brake switch. (See PARK BRAKE/CONTROL LEVER SWITCH TEST.)
9. Park brake relay (K2)—Terminal 86.	Battery voltage.	Test green wire and connections.
10. Fuel shutoff solenoid (Y1).	Battery voltage.	Test red wire and connections.
11. Seat switch (S5).	Battery voltage.	Test green and blue wire and connections.
12. Run relay (K3)—Terminal 86.	Battery voltage.	Test violet wire and connections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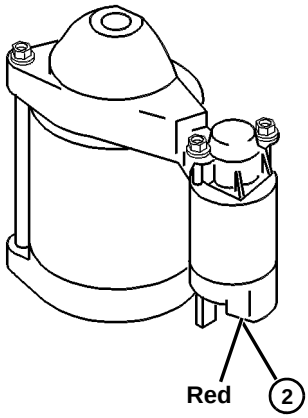
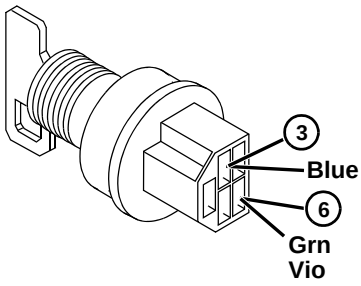
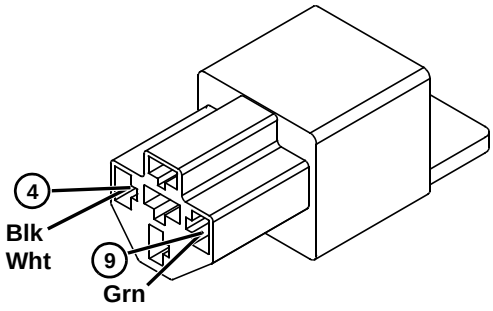
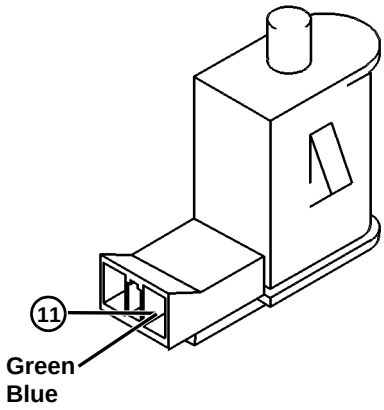
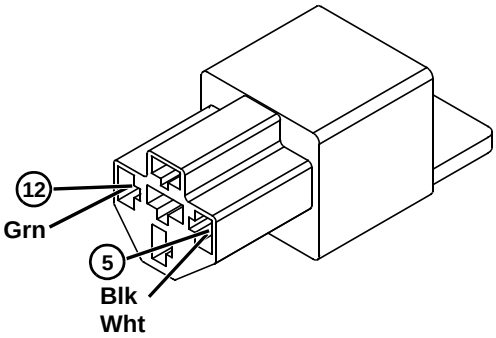
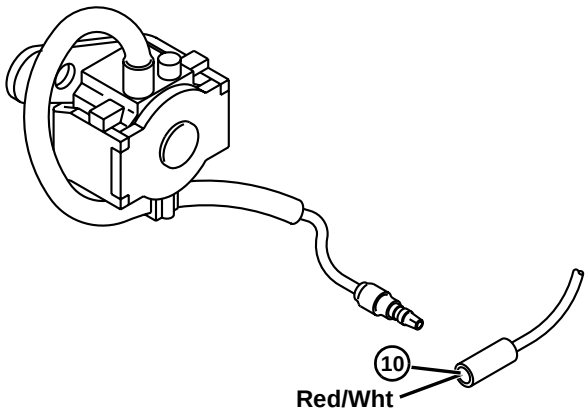

Red
2

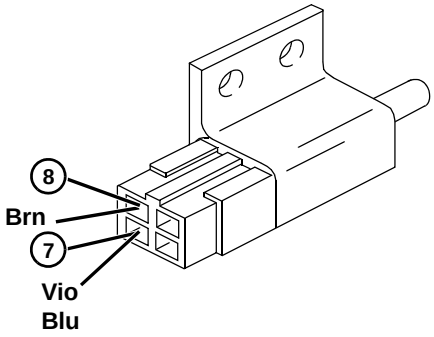

3
Blue
6
Grn
Vio


4
Blk
Wht
9
Grn


11
Green
Blue


12
Grn
5
Blk
Wht


10
Red/Wht


8
Brn
7
Vio
Blu

CHARGE CIRCUIT OPERATION

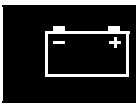
Function:

To maintain battery voltage between 11.8 and 13.2 volts DC.

Operating Conditions:

- Key switch in the RUN position.
- Engine running.

Theory of Operation:



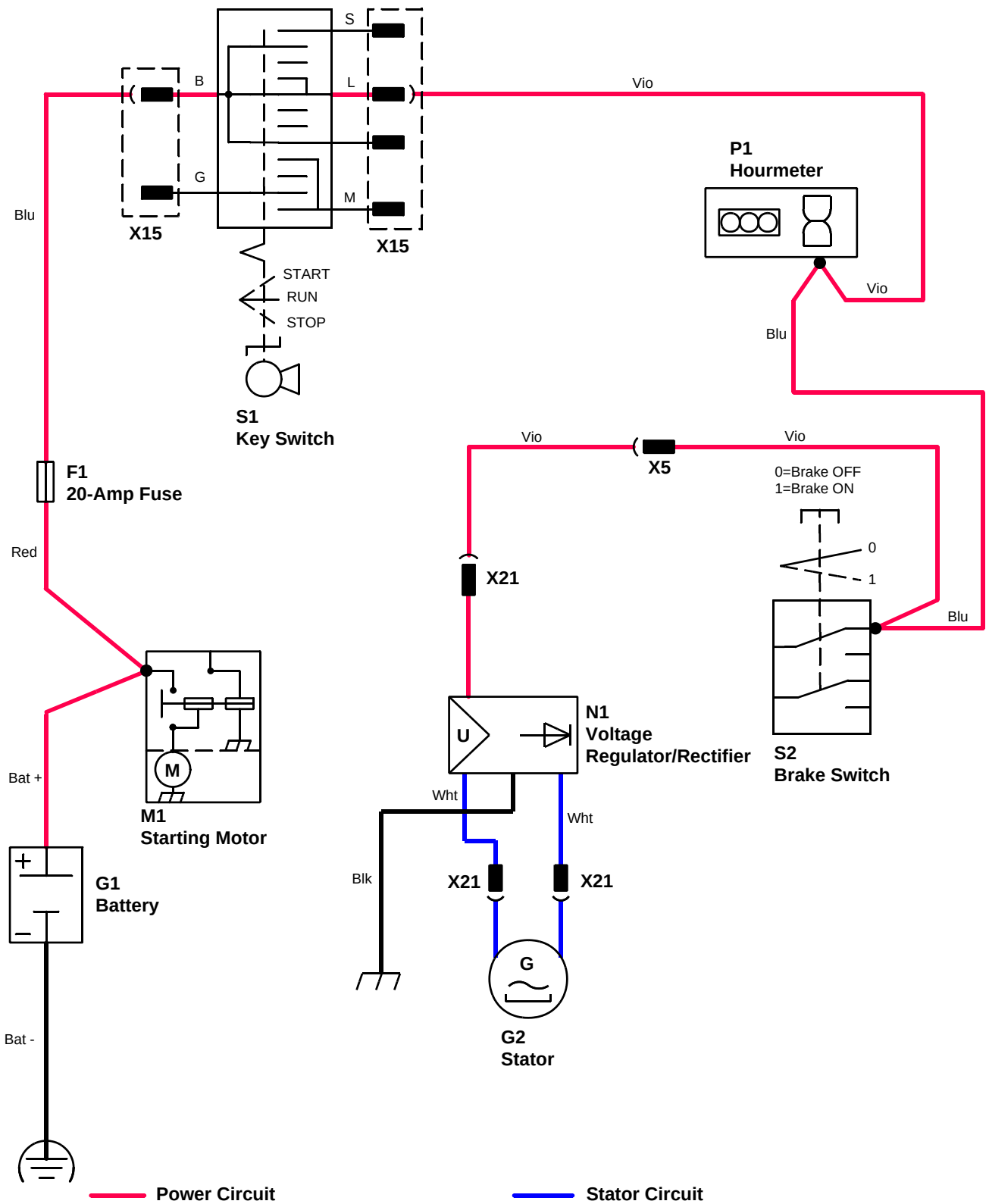
The charging circuit is a permanent magnet and stator design. Charging output is controlled by a voltage regulator/rectifier (N1).

The power circuit provides current to the key switch (S1) and protects the charging circuit with a 20-amp fuse (F1). Current flows from the battery (G1) positive (+) terminal to the 20-amp fuse and key switch (red and blue wires).

With the key switch in the RUN position, current flows through the key switch.

As the flywheel turns, a permanent magnet located in the flywheel induces AC current in the stator (G2). The AC current flows to the regulator/rectifier. The regulator/rectifier converts the AC current to DC current needed to charge the battery.

If the battery voltage is low, the regulator/rectifier allows DC current to flow through the key switch to the battery to charge the battery. When the battery is fully charged, the regulator stops current flow to the battery.


S
B
L
Vio
G
M
Blu
X15
X15
START
RUN
STOP
S1
Key Switch
P1
Hourmeter
Vio
Blu
F1
20-Amp Fuse
Vio
Vio
X5
0=Brake OFF
1=Brake ON
Red
X21
0
1
Blu
M
M1
Starting Motor
U
N1
Voltage
Regulator/Rectifier
S2
Brake Switch
Bat +
Wht
Wht
Blk
X21
X21
G1
Battery
G
G2
Stator
Bat -
Power Circuit
Stator Circuit
Ground Circuit

MX1947

CHARGE CIRCUIT DIAGNOSIS

Test Conditions:

- Machine parked on a level surface.
- Key switch (S1) in OFF switch.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

Test Location	Normal	If Not Normal
1. Battery positive (+) post.	11.8—13.2 volts.	Check battery condition. (See BATTERY TEST.)
2. Starting motor solenoid—Battery terminal.	Battery voltage.	Check battery positive (+) cable and clamps. Clean and tighten connections.
3. Key switch (S1)—Terminal B.	Battery voltage.	Test blue and red wires and connections. Test 20-amp fuse (F1). (See FUSE TEST.)

Test Conditions:

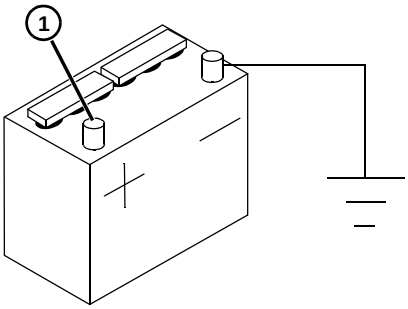
- Key switch (S1) in RUN position—engine not running.
- Voltage regulator/rectifier connector (X21) disconnected.

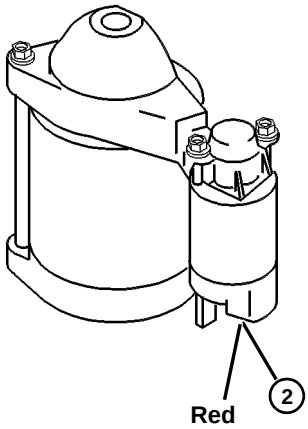
Test Location	Normal	If Not Normal
4. Key switch (S1)—Terminal L.	Battery voltage.	Test key switch. (See KEY SWITCH TEST.)
5. Voltage regulator/rectifier (N1)	Battery voltage.	Test violet and blue wires and connections.

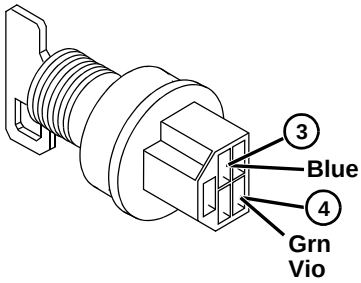
Test Conditions:

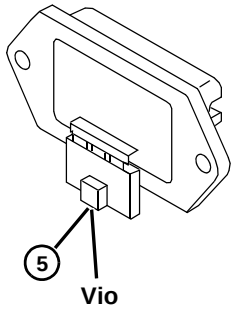
- Key switch (S1) in RUN position—engine running at FAST idle.

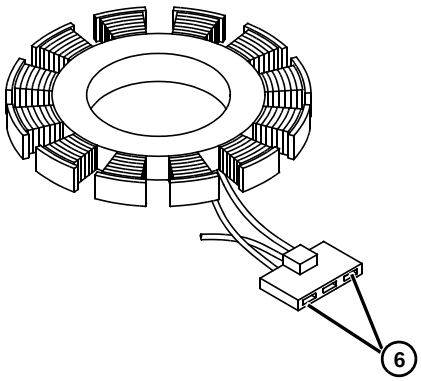
Test Location	Normal	If Not Normal
6. Stator connection. (Perform UNREGULATED VOLTAGE OUTPUT TEST.)	Voltage output to specifications.	Test flywheel magnet. (See FLYWHEEL—TEST MAGNETS in ENGINE section.) If OK, replace the stator.


1


Red
2


3
Blue
4
Grn
Vio


5
Vio


6

PTO CLUTCH CIRCUIT OPERATION

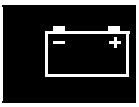
Function:

To provide power to energize or de-energize the PTO clutch to drive the mower deck.

Operating Conditions:

- Key switch in the RUN position.
- PTO switch in ON position.

Theory of Operation:

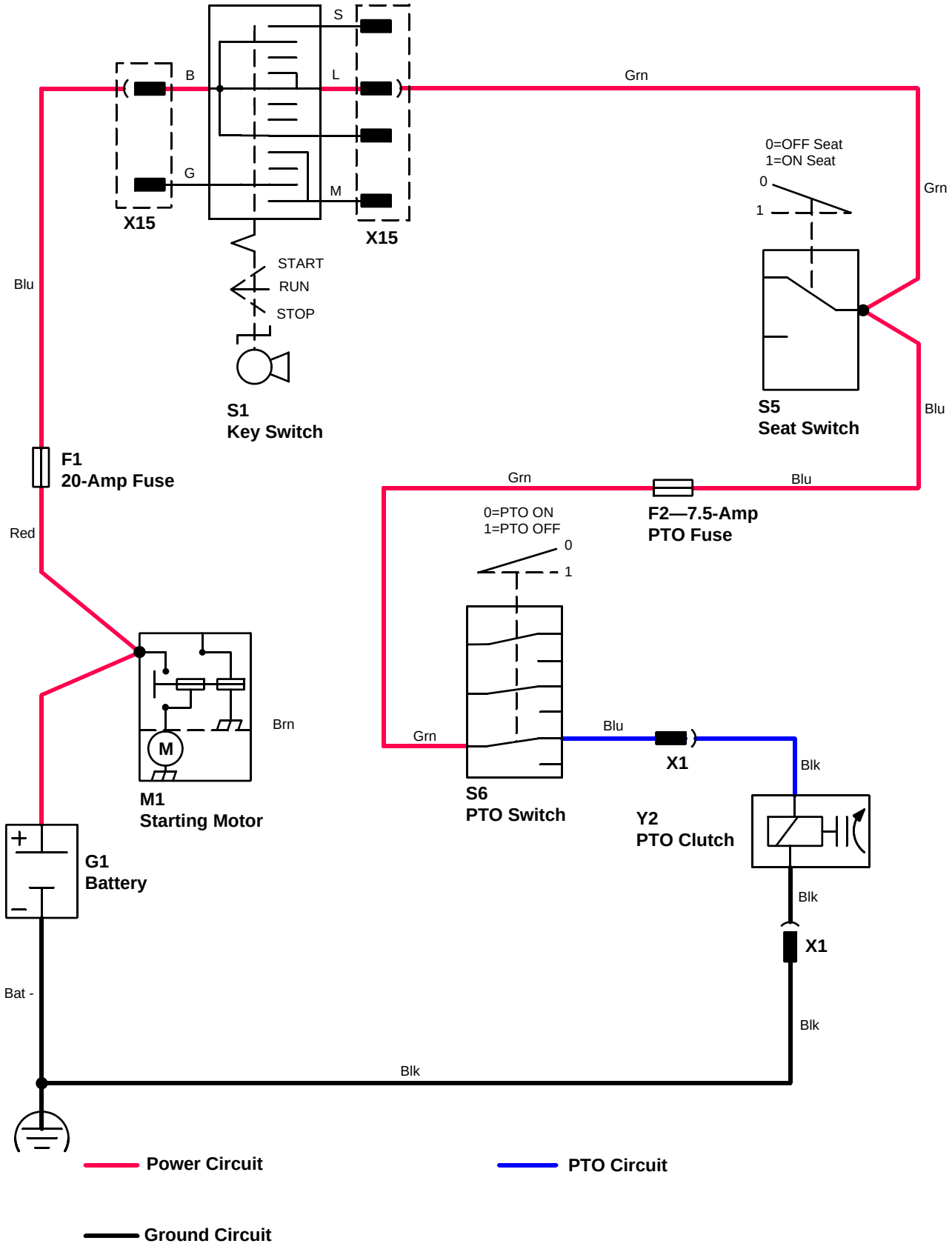


The power circuit provides current to the key switch (S1) and protects the PTO circuit with a 20-amp fuse (F1). Current flows from the battery (G1) positive (+) terminal to the 20-amp fuse and key switch (red and blue wires).

With the key switch in the RUN position, current flows to the common terminal of the seat switch (S5) (green wire) and through the 7.5-amp PTO circuit fuse (F2) to the PTO switch (S6) (blue and green wires).

With the PTO switch in the ON position, current flows to the PTO clutch (Y2) (blue and black wires).

A path to ground (black wire) completes the circuit, engaging the PTO clutch.


S
B
L
G
M
X15
X15
Grn
0=OFF Seat
1=ON Seat
0
1
Grn
START
RUN
STOP
Blu
S1
Key Switch
S5
Seat Switch
Blu
F1
20-Amp Fuse
Grn
Blu
F2—7.5-Amp
PTO Fuse
0=PTO ON
1=PTO OFF
0
1
Red
Brn
M
M1
Starting Motor
Grn
Blu
X1
Blk
S6
PTO Switch
Y2
PTO Clutch
G1
Battery
Blk
X1
Bat -
Blk
Blk
Power Circuit
PTO Circuit
Ground Circuit

MX1948

PTO CLUTCH CIRCUIT DIAGNOSIS

Test Conditions:

- Machine parked on a level surface.
- Key switch (S1) in STOP position.
- PTO clutch connector (X1) disconnected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

Test Location	Normal	If Not Normal
1. Battery positive (+) post.	11.8—13.2 volts.	Check battery condition. (See BATTERY TEST.)
2. Starting motor solenoid—Battery terminal.	Battery voltage.	Check battery cables and clamps. Clean and tighten connections.
3. Key switch (S1)—Terminal B.	Battery voltage.	Test blue and red wires and connections. Test 20-amp fuse (F1). (See FUSE TEST.)
4. PTO clutch (Y2).	Maximum 0.1 ohms resistance.	Test black wire and connections.

Test Conditions:

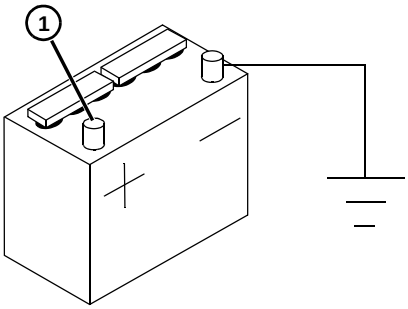
- Key switch (S1) in RUN position.
- PTO clutch connector (X1) connected.

Test Location	Normal	If Not Normal
5. Key switch (S1)—Terminal L.	Battery voltage.	Test key switch. (See KEY SWITCH TEST.)
6. 25-amp PTO clutch fuse (F2).	Battery voltage.	Test blue wire and connections.
7. PTO switch (S6).	Battery voltage.	Test green wire and connections. Test 25-amp fuse (F2). (See FUSE TEST.)

Test Conditions:

- PTO switch (S6) in ON position.

Test Location	Normal	If Not Normal
8. PTO switch (S6).	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST.)
9. PTO clutch (Y2).	Battery voltage.	Test blue wires and connections.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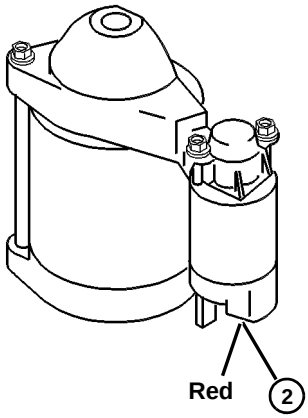
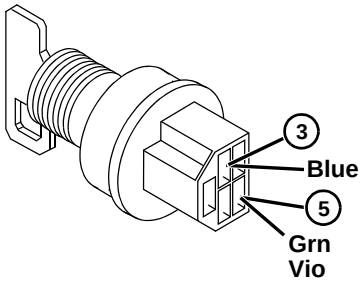
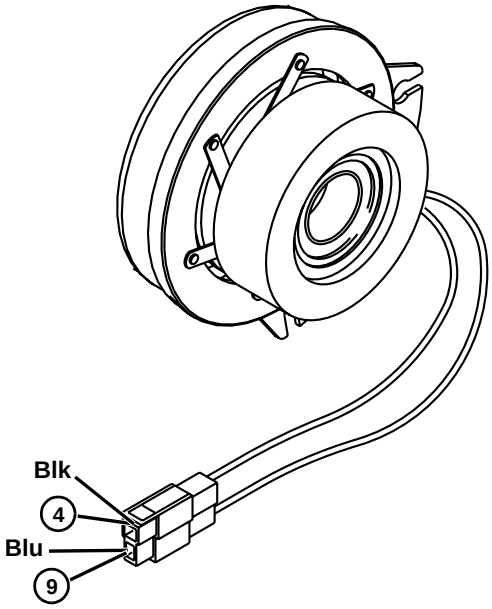
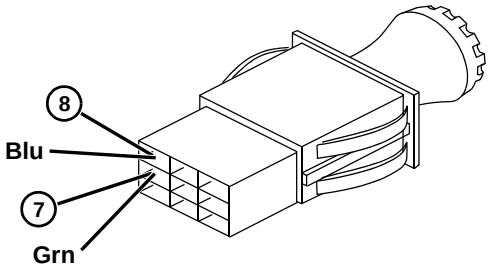
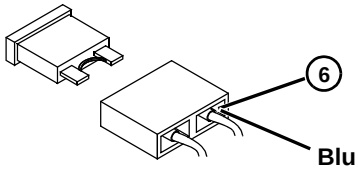

Red
2


3
Blue
5
Grn
Vio


Blk
4
Blu
9


8
Blu
7
Grn


6
Blu

HOURMETER CIRCUIT OPERATION

Function:

To record the number of hours the key switch is in the RUN position.

Operating Conditions:

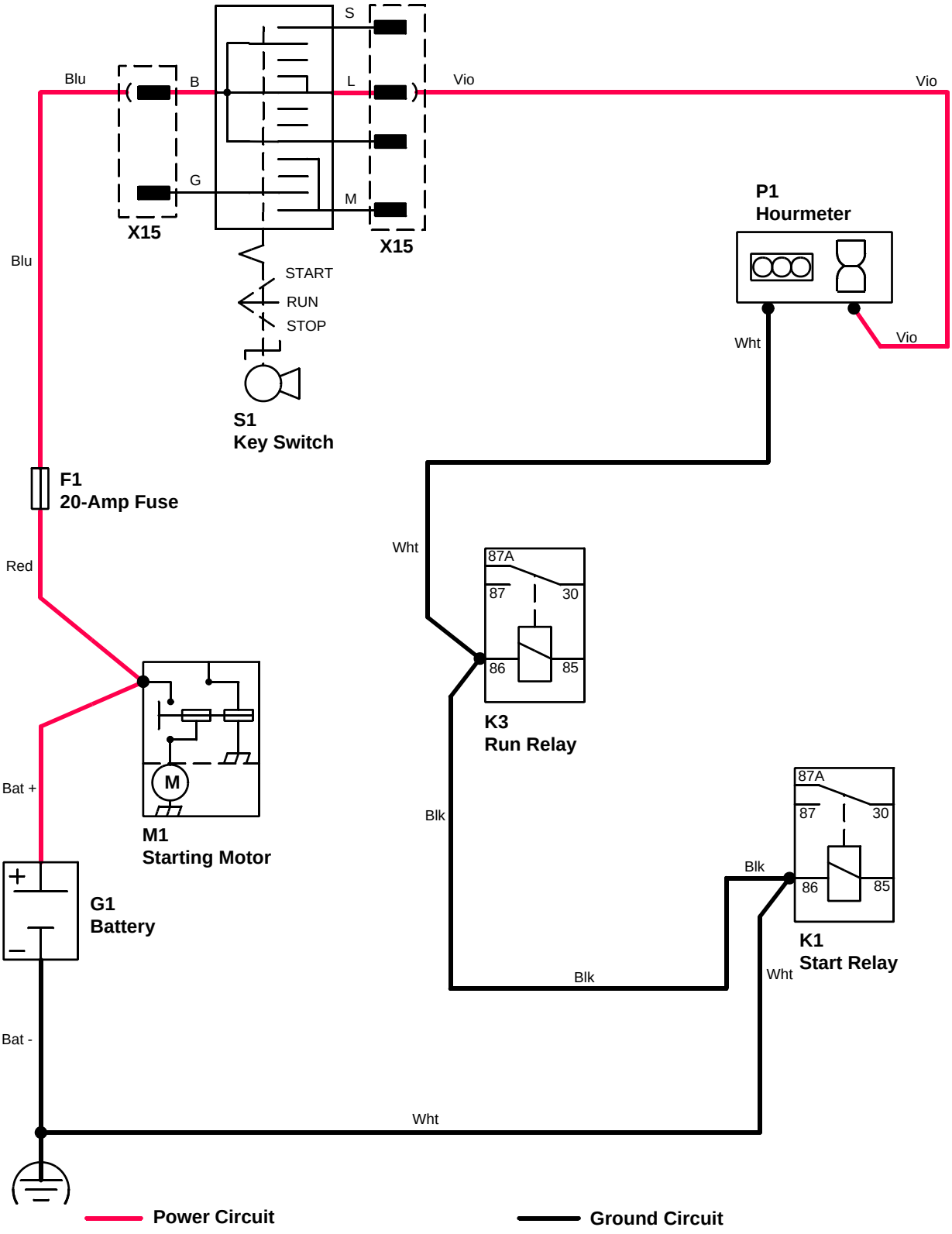
- Key switch in the RUN position.

Theory of Operation:

The power circuit provides current to the key switch (S1) and protects the hourmeter circuit with a 20-amp fuse (F1). Current flows from the battery (G1) positive (+) terminal to the 20-amp fuse and key switch (red and blue wires).

With the key switch in the RUN position, current flows to the hourmeter (P1) positive terminal (violet wire). The hourmeter will record the number of hours the key switch in the RUN position in 1/10 hour increments.

The ground circuit (black and white wires) provides a path to ground for the hourmeter.


S
Blu
B
L
Vio
Vio
G
M
X15
X15
P1
Hourmeter
Blu
START
RUN
STOP
Wht
Vio
S1
Key Switch
F1
20-Amp Fuse
Wht
Red
87A
87
30
86
85
K3
Run Relay
M
Bat +
M1
Starting Motor
Blk
87A
87
30
Blk
86
85
G1
Battery
K1
Start Relay
Wht
Blk
Bat -
Wht
Power Circuit
Ground Circuit

MX1949

HOURMETER CIRCUIT DIAGNOSIS

Test Conditions:

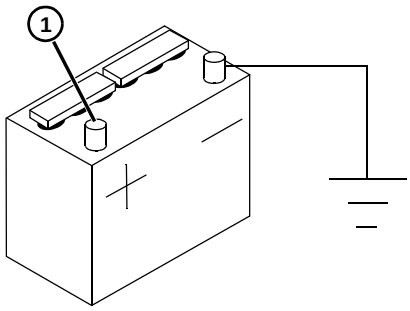
- Machine parked on a level surface.
- Key switch (S1) in OFF position.
- Hourmeter connector (X11) disconnected.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when checking/testing.

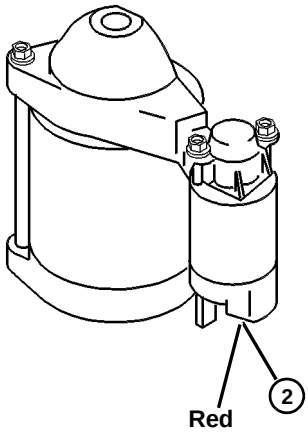
Test Location	Normal	If Not Normal
1. Battery positive (+) post.	11.8—13.2 volts.	Check battery condition. (See BATTERY TEST.)
2. Starting motor solenoid—Battery terminal.	Battery voltage.	Check battery cables and clamps. Clean and tighten connections.
3. Key switch (S1)—Terminal B.	Battery voltage.	Test red and blue wires and connections. Test 20-amp fuse (F1). (See FUSE TEST.)
4. Hourmeter (P1)—Negative (-) terminal.	Maximum 0.1 ohms resistance.	Test black and white wires and connections.

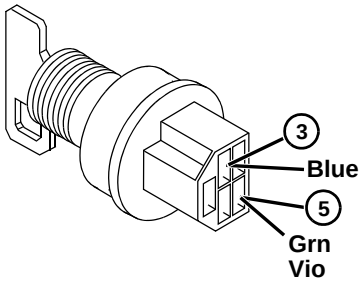
Test Conditions:

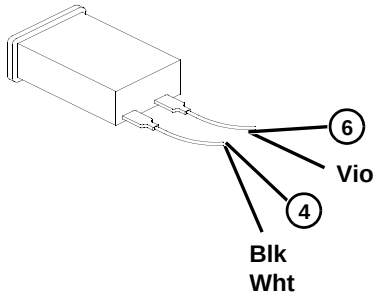
- Key switch (S1) in RUN position.
- Hourmeter connector (X11) connected.

Test Location	Normal	If Not Normal
5. Key switch (S1)—Terminal L.	Battery voltage.	Test key switch. (See KEY SWITCH TEST.)
6. Hourmeter (P1)—Positive (+) terminal.	Battery voltage.	Test violet wire and connections.


1


2
Red

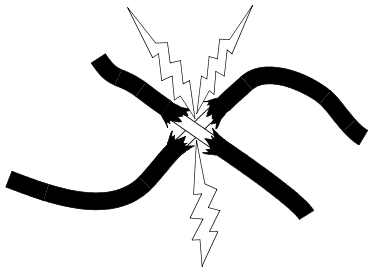

3
Blue
5
Grn
Vio


6
Vio
4
Blk
Wht

CHECKS, TESTS AND ADJUSTMENTS

COMMON CIRCUIT TESTS

Shorted Circuit:

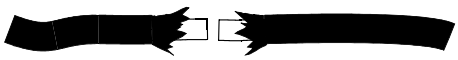


M85600

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:

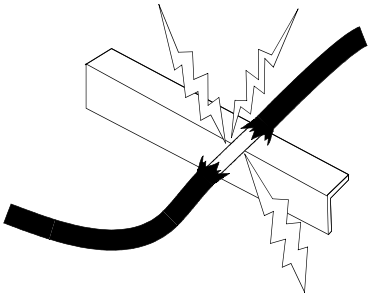


M85601

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

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

GROUND CIRCUIT TEST

Reason:

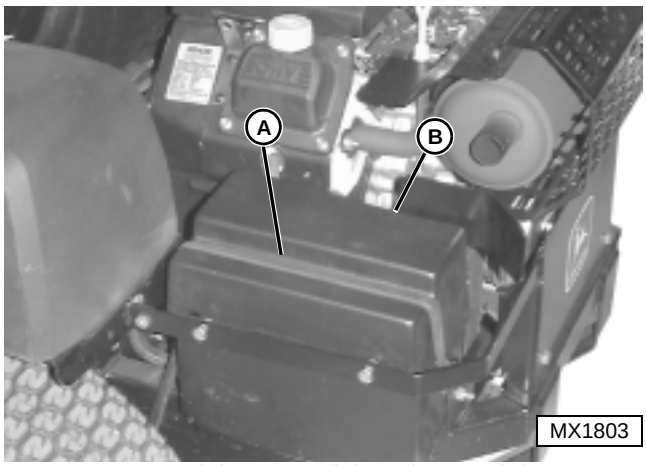
To check for open circuits, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

Test Equipment:

- Ohmmeter

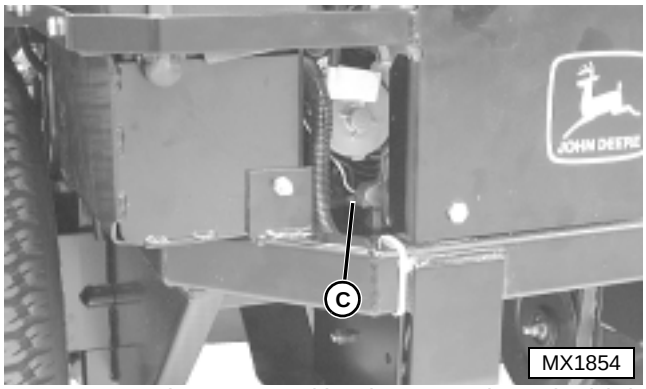
Procedure:

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.



MX1803

3. Remove retaining strap (A) and cover (B).
4. Connect ohmmeter negative (black) lead to negative (–) terminal of battery.



MX1854

5. Connect ohmmeter red lead to ground terminal (C) of circuit or component to be tested that is closest to the battery negative terminal. **Resistance reading must be the same or very close to the battery negative terminal reading. Work backward from the battery 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 connection may **temporarily** solve problem.

BATTERY TEST

CAUTION

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. Avoid spilling or dripping electrolyte.
5. Use proper jump start procedure.

If you spill acid on yourself:

1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 15—30 minutes. Get medical attention immediately.

If acid is swallowed:

1. Do not induce vomiting.
2. Drink large amounts of water or milk, but do not exceed 1.9 L (2 qts.).
3. Get medical attention immediately.

Reason:

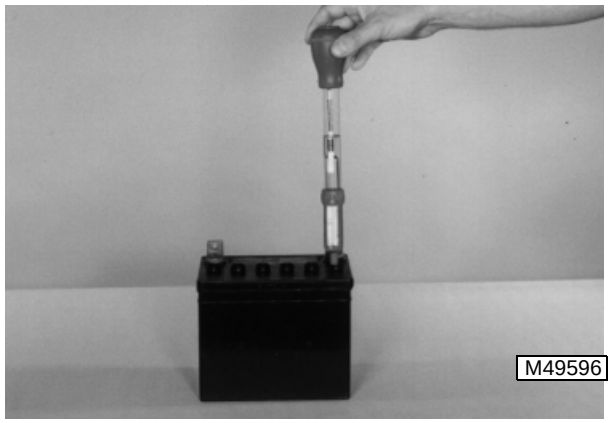
To check condition of battery and determine battery voltage.

Test Equipment:

- Hydrometer
- Voltmeter or JT05685 Battery Tester

Procedure:

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Clean cable ends, battery terminals and top of battery. (See BATTERY—CLEANING.)
4. Remove battery. (See BATTERY—REMOVAL/ INSTALLATION.)
5. Inspect battery terminals and case for breakage or cracks.
6. Check electrolyte level in each battery cell. Add clean, soft water as needed. If water is added, charge battery for **20 minutes at 10 amps**.
7. Remove surface charge by placing a small load on the battery for 15 seconds.



8. Use a hydrometer to check for a **minimum specific gravity of 1.225 with less than a 50 point variation in each cell.**

Results:

- If all cells are less than 1.175, charge battery at 10 amp rate.
- If all cells are less than 1.225 with less than 50 point variation, charge battery at 10 amps.
- If all cells are more than 1.225 with less than 50 point variation, load test battery.
- If more than 50 point variation, replace battery.

9. Use a voltmeter or JT05685 Battery Tester to check for a **minimum battery voltage of 12.4 volts**.

Results:

- If battery voltage is less than 12.4 VDC, charge battery.
- If battery voltage is more than 12.4 VDC, test specific gravity. (See step 11.)

10. Install battery. (See BATTERY—REMOVAL/ INSTALLATION.)

CHARGE BATTERY

Reason:

To increase battery charge after the battery has been discharged.

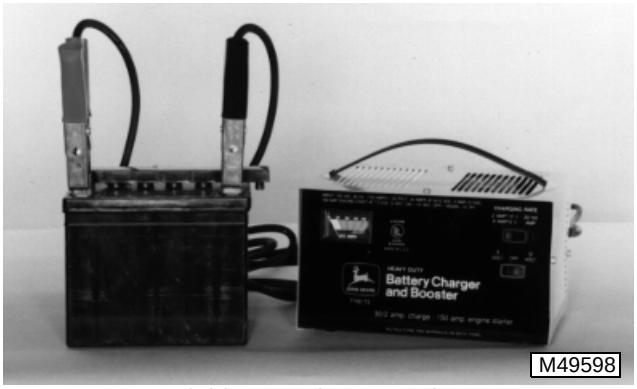
Test Equipment:

- Battery Charger (Variable Rate)

Procedure:

NOTE: See BATTERY TEST before charging battery.

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Clean cable ends, battery terminals and top of battery.
4. Remove battery. (See BATTERY—REMOVAL/ INSTALLATION.)



5. Connect variable rate charger to battery.
6. 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.
7. Check if battery is accepting 10 amp charge rate after 10 minutes at boost setting.

Results:

- If battery WILL NOT accept 10 amp charge after 10 minutes at boost setting, replace battery.
- If battery is accepting 10 amp charge after 10 minutes at boost setting, and battery did NOT need water, go to steps 12 and 13.
- 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.

8. Set charger at 15—25 amps.

IMPORTANT: Decrease charge rate if battery gases or bubbles excessively or becomes too warm to touch.

9. Check specific gravity after 30 minutes (60 minutes for maintenance-free battery).

Results:

- If MORE THAN 50 point variation between cells, replace battery.
- If LESS THAN 50 point variation between cells, go to steps 13 and 14.

NOTE: If battery was discharged at slow or unknown rate, charge battery at 10—15 amps for 6—12 hours. (Maintenance-free battery: 4—8 hours).

10. Continue to charge battery until specific gravity is **1.230—1.265 points.**
11. Load test battery.
12. Install battery. (See BATTERY—REMOVAL/ INSTALLATION.)

BATTERY LOAD TEST

Reason:

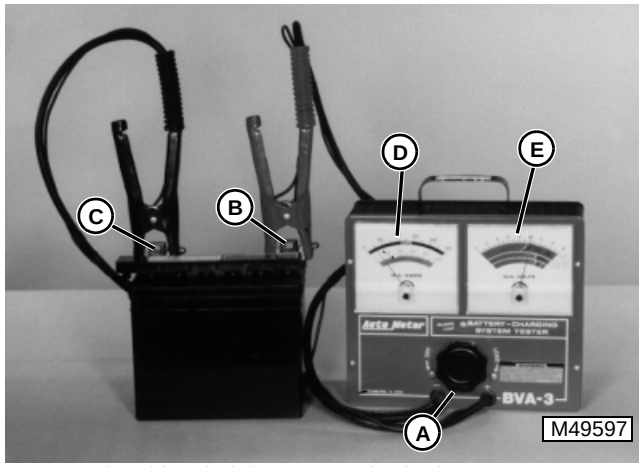
To check condition of battery under load.

Test Equipment:

- JT05685 Battery Tester

Procedure:

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Clean cable ends, battery terminals and top of battery. (See BATTERY—CLEANING.)
4. Remove battery. (See BATTERY—REMOVAL/ INSTALLATION.)



5. Turn load knob (A) counterclockwise to OFF position.

6. Connect tester positive (red) cable to battery positive (+) terminal (B).
7. Connect tester negative (black) cable to battery negative (–) terminal (C).
8. Turn load knob of tester clockwise (in) until amperage reading (D) is equal to:

• Cold cranking amperage rating of battery (use blue scale).

or

• Three times ampere hour rating (use black scale).

9. Hold for 15 seconds and turn load knob of tester counterclockwise (out) to OFF position.
10. Repeat steps 8 and 9 above and read condition of battery at DC volts scale (E).

Results:

- If battery DOES NOT pass test and has NOT been charged, charge battery and retest.
- If battery DOES NOT pass test and HAS BEEN charged, replace battery.

REGULATED VOLTAGE OUTPUT TEST

Reason:

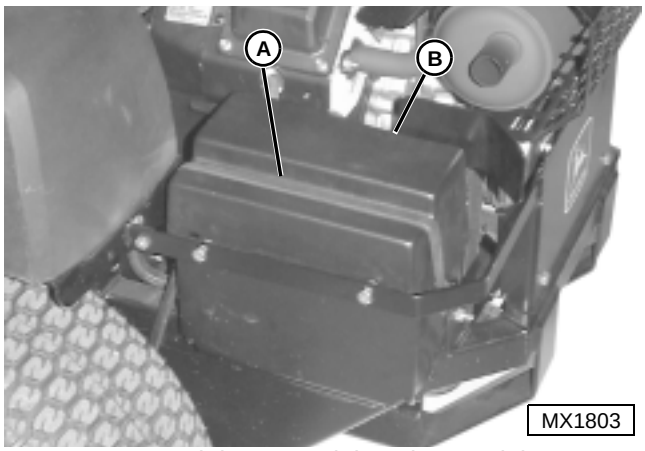
To check the regulated voltage (charging) output of the voltage regulator/rectifier.

Test Equipment:

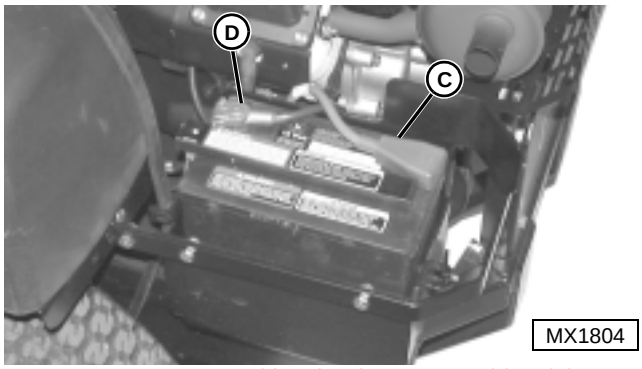
- Voltmeter

Procedure:

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.



3. Remove retaining strap (A) and cover (B).
4. Remove surface charge from battery by cranking the engine for 15 seconds.
5. Set voltmeter for 25 to 50 DC volt scale.



6. Connect meter red lead to battery positive (+) terminal (C).
7. Connect meter black lead to battery negative (-) terminal (D).
8. Start and run engine at fast idle **(3600 ± 50 rpm)**.
9. Read meter several times during 5 minutes of running time. Voltage should remain between **12.2—14.7 volts DC**.

Results:

- If the DC voltage remains below the minimum specification, perform UNREGULATED VOLTAGE OUTPUT TESTS.
- If the DC voltage goes above the maximum specification, replace the voltage regulator/rectifier.

UNREGULATED VOLTAGE OUTPUT TEST

Reason:

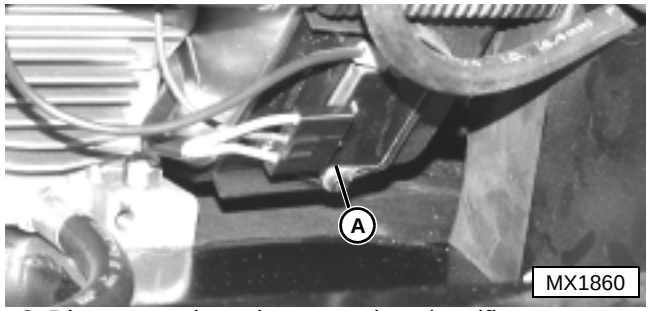
To check the stator output voltage to determine the stator condition.

Test Equipment:

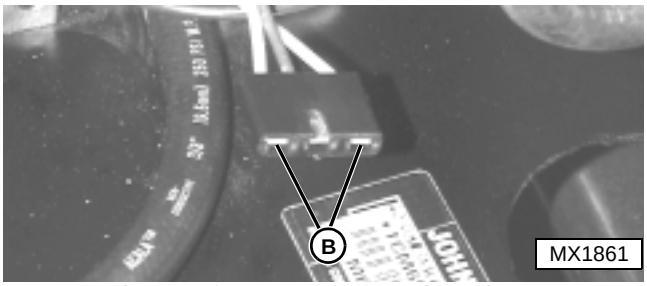
- Voltmeter

Procedure:

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.



3. Disconnect the voltage regulator/rectifier connector (A).



4. Set voltmeter for 25 to 50 AC volt scale.
5. Connect voltmeter leads across stator leads (B).
6. Start and run engine at fast idle **(3600 ± 50 rpm)**.
7. Read and record stator output voltage. Voltage should read a **minimum of 28 volts AC**.

Results:

- If reading is less than specifications, test flywheel magnet. (See FLYWHEEL—INSPECTION in ENGINE section.) If flywheel magnet tests OK, replace stator.

STARTING MOTOR LOADED AMPERAGE DRAW TEST

Reason:

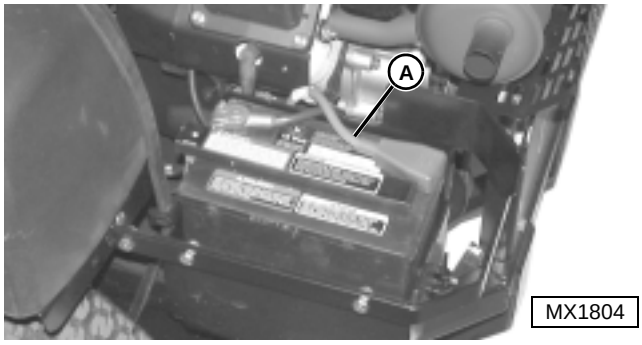
To determine the amperage required to crank the engine and check the starter motor operation under load.

Test Equipment:

- JT02153 Current Clamp
- Voltmeter

Procedure:

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Test system ground circuit connections. (See GROUND CIRCUIT TEST.)
4. Test battery. (See BATTERY TEST.)



5. Connect JT02153 Current Clamp around battery positive (+) cable (A).
6. Set voltmeter to DC amp scale.
7. Connect voltmeter to current clamp.
8. Remove spark plug high-tension leads and ground to engine.

IMPORTANT: Perform the following procedure within 15 seconds to prevent damage to electrical components.

9. Crank engine and read amperage on DC amp scale of voltmeter. Amperage draw should be a **maximum of 180 amps at 225 rpm**.
10. Turn key switch to OFF position.

Results:

- If amperage is above specifications, or rpm is low, check starter for binding or damage.
- If starter is good, check engine for internal binding or damage.

STARTING MOTOR SOLENOID TEST

Reason:

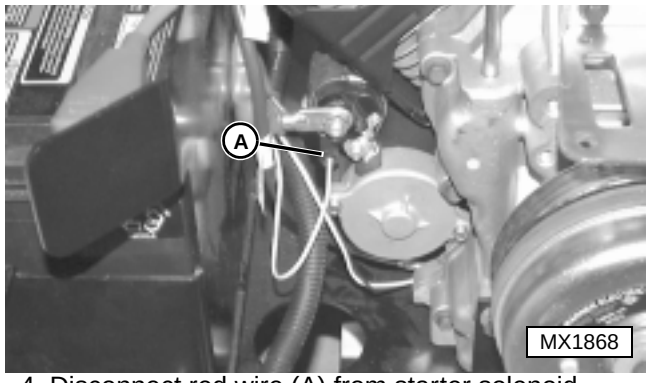
To determine if the starter solenoid or starting motor is defective.

Test Equipment:

- Jumper Wire

Procedure:

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Remove spark plug high-tension leads and ground to engine.



4. Disconnect red wire (A) from starter solenoid.

NOTE: All solenoid terminals should be clean and free of corrosion.

5. Connect jumper wire to positive (+) battery terminal and briefly jump to starting motor tang.

Results:

- Starter runs: Solenoid is good, check circuit wiring (See CRANKING CIRCUIT DIAGNOSIS in ELECTRICAL section.)
- Starter does not run: Go to step 6.

6. Briefly connect jumper wire between starter solenoid large terminals.

Results:

- Starter runs: Replace solenoid.
- Starter does not run: Check battery cables, replace starter.

FUSE TEST

Reason:

To verify that the fuse has continuity.

Test Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Raise and latch seat platform.
4. Remove fuse from fuse holder.

5. Check visually for broken filament.
6. Connect ohmmeter or continuity tester to each end of fuse.
7. Check for continuity.

Results:

- If continuity is not indicated, replace fuse.

RELAY TEST

Reason:

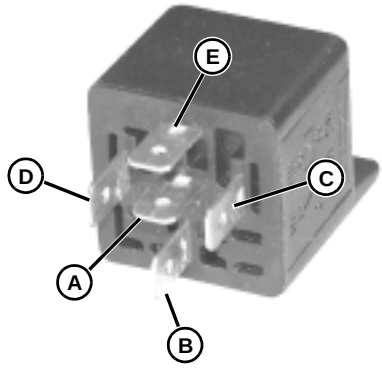
To check relay terminal continuity in the energized and de-energized condition.

Test Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Raise and latch seat platform.
4. Disconnect relay from harness.



5. Using an ohmmeter or continuity tester, check for continuity between terminals 87A (A) and 30 (B). There should be continuity between terminals 87A and 30.
6. Using an ohmmeter or continuity tester, check for continuity between terminals 85 (C) and 86 (D).
7. There should NOT be continuity between terminals 87 and 30.
8. Connect a jumper wire from battery positive (+) to relay terminal 85 (C). Connect a jumper wire to relay terminal 86 (D) and ground (-).
9. Using an ohmmeter or continuity tester, check for continuity between terminals 87 (E) and 30 (B). There should be continuity between terminals 87 and 30.

Results:

- If continuity is not correct, replace relay.

KEY SWITCH TEST

Reason:

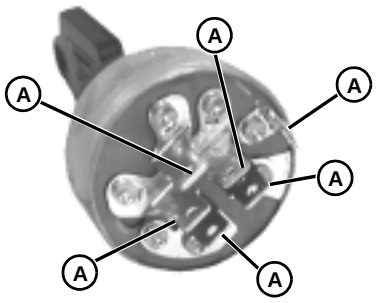
To verify that the key switch is operating properly.

Test Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Disconnect key switch connector.



MX1807

4. Use an ohmmeter or continuity tester to test switch continuity in OFF, RUN and START positions.

NOTE: DO NOT refer to markings stamped on terminals. Identify by art keys ONLY. Terminal combinations other than those listed should not have continuity.

Key Switch Continuity:

Switch Position	Terminal Continuity
OFF	C and D
RUN	E and F
START	E and F
	A and B

Results:

- If any continuity is NOT correct, replace the switch.

SEAT SWITCH TEST

Reason:

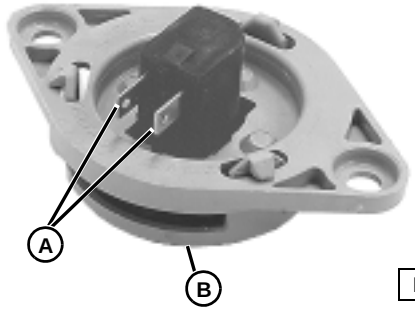
To verify continuity between the seat switch terminals when the operator is on the seat.

Test Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Raise and latch seat platform.
4. Disconnect seat switch connector.



M84358

5. Check continuity across switch terminals (A). There should be no continuity.
6. Depress plunger (B).
7. Check continuity across switch terminals. Continuity should exist between terminals.

Results:

- If continuity is not correct, replace switch.

PTO SWITCH TEST

Reason:

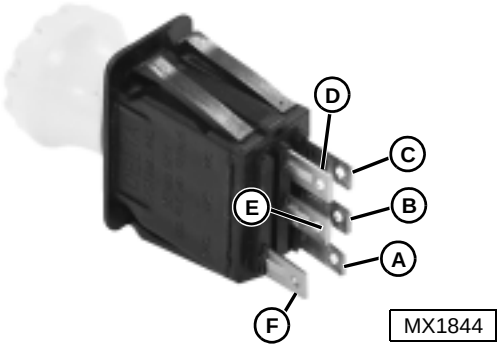
To verify continuity between terminals is correct when the switch is in the ON and OFF positions.

Test Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Disconnect PTO switch connector.
4. Move PTO switch to OFF position.



5. Connect ohmmeter leads to terminals A and F. There should be continuity. There should be no continuity to any other terminals
6. Move PTO switch to ON position.
7. Connect ohmmeter leads to terminals C and D. There should be continuity.
8. Connect ohmmeter leads to terminals B and E. There should be continuity.

Results:

- If continuity is not correct, replace switch.

PARK BRAKE/CONTROL LEVER SWITCH TEST

Reason:

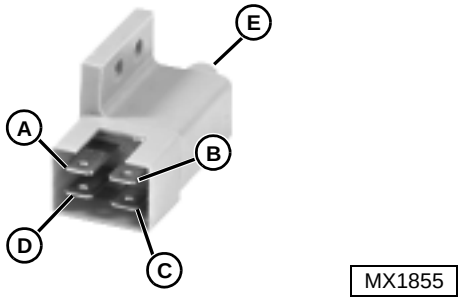
To verify continuity between terminals is correct when the switch is in the ON and OFF positions.

Test Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Disconnect wiring connector



4. Check continuity across terminals (A and D). There should be continuity. There should be no continuity to any other terminals.
5. Depress plunger (E).
6. Check continuity across terminals (B and C). There should be continuity. There should be no continuity to any other terminals.

Results:

- If continuity is not correct, replace switch.

FUEL SHUTOFF SOLENOID TEST

Reason:

To determine if the fuel shutoff solenoid is working properly.

Test Equipment:

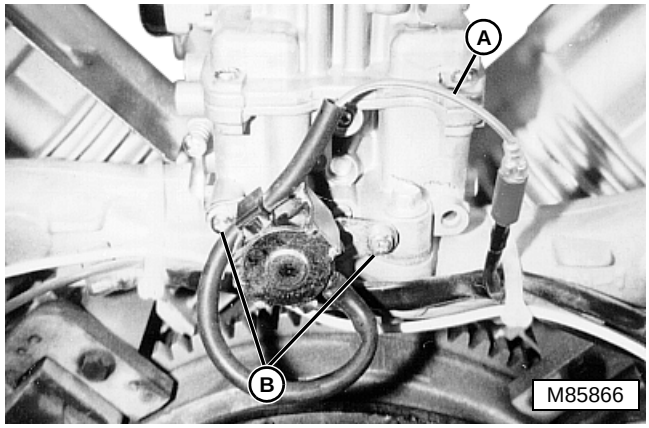
- Jumper Wire

Procedure:

CAUTION

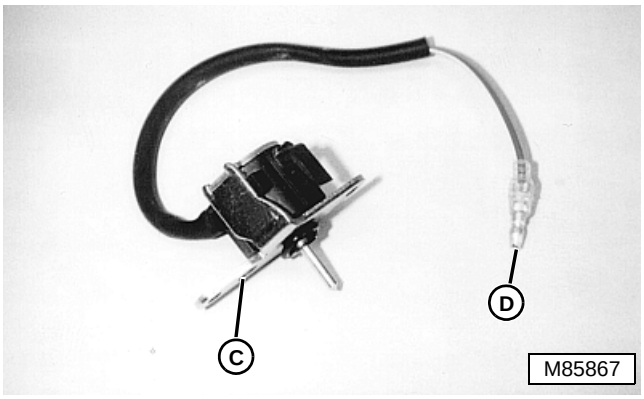
Gasoline is present in the carburetor and fuel line. Gasoline is extremely flammable and its vapors can explode if ignited. Keep sparks and other sources of ignition away from the engine.

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Close fuel shutoff valve.
4. Remove blower housing. (See BLOWER HOUSING AND SHIELDS—REMOVAL/INSTALLATION in ENGINE section.)



NOTE: Gas will leak out of the carburetor when the solenoid is removed. Use a rag to catch fuel already in the fuel line.

5. Disconnect solenoid lead (A).
6. Remove solenoid mounting screws (B).



7. Connect a wire to the battery negative (-) terminal and the solenoid mounting bracket (C).
8. Briefly touch male terminal (D) of the solenoid lead to the battery positive (+) terminal.

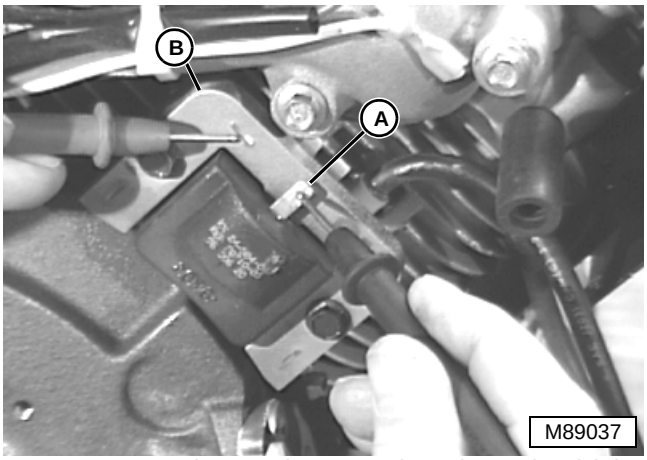
Results:

- If the pin retracts, the solenoid is good.
- If the pin fails to retract, replace the solenoid.

IGNITION MODULE TEST

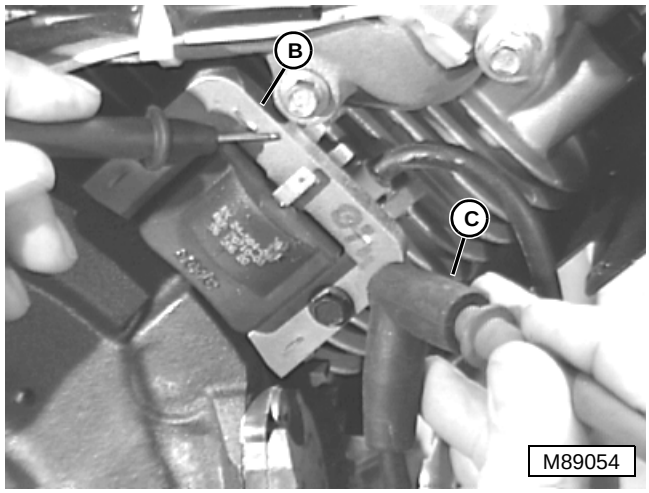
Primary Side:

1. Remove spark plug cap from the spark plug wire.
2. Remove the primary lead wire.



3. Measure resistance between the primary lead (A) and core (B). Reverse the meter leads and check resistance. Replace ignition coil if resistance is not within **5—1000 ohms** in one direction and a minimum of **30,000 ohms** when the leads are reversed.

Secondary Side:



4. Measure the resistance between the spark plug high-tension lead (C) and core (B). Replace ignition coil if resistance is not within **7.9—10.85 ohms.**

REPAIR

BATTERY—REMOVAL/INSTALLATION

CAUTION

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:

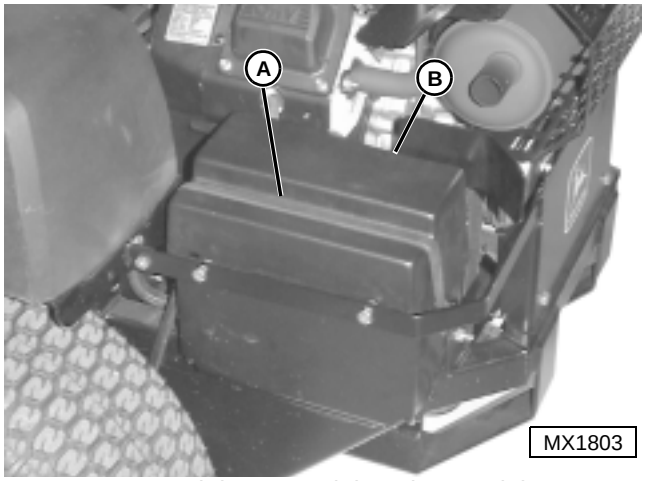
1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoid spilling or dripping electrolyte.
5. Use proper jump start procedure.

If you spill acid on yourself:

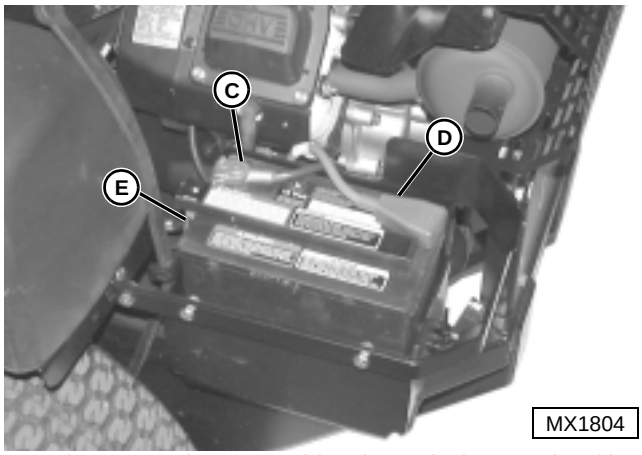
1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 15—30 minutes. Get medical attention immediately.

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.



1. Remove retaining strap (A) and cover (B).



2. Disconnect battery cables (C and D), negative (-) cable (C) first.
3. Disconnect vent tube (E).
4. Remove battery.

Installation is done in the reverse order of removal.

- Clean battery if dirty. (See BATTERY—CLEANING.)
- Inspect battery terminals and case for breakage or cracks. Replace if needed.
- Test battery condition. (See BATTERY TEST.)
- Connect negative (–) cable last.

BATTERY—CLEANING

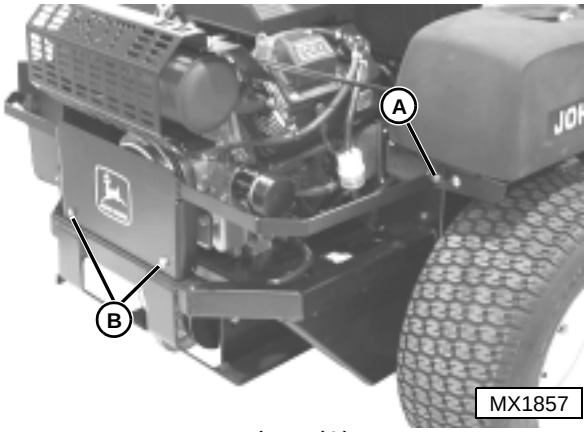
1. Remove battery from machine. (See BATTERY—REMOVAL/INSTALLATION.)

NOTE: Keep cleaning solution out of battery cells.

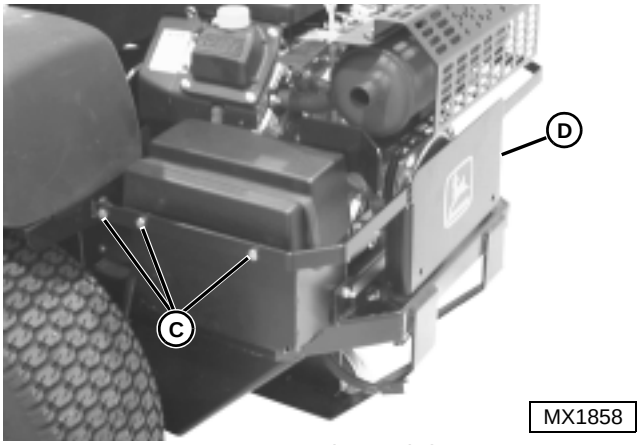
2. Clean battery, battery terminals, cable ends, bracket and battery box with a solution of one part baking soda and four parts water.
3. Rinse all parts with clean water. Let dry thoroughly.
4. Apply petroleum jelly to battery terminals to prevent corrosion.

ELECTRIC PTO CLUTCH—REMOVAL/INSTALLATION

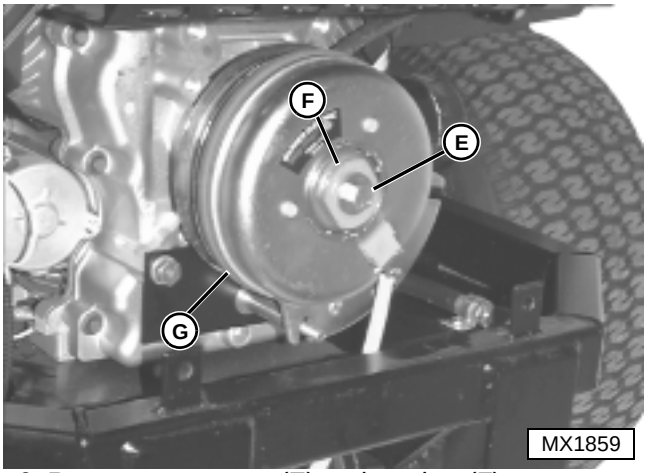
1. Remove the mule drive belt. (See MULE DRIVE BELT—REMOVAL/INSTALLATION) in ATTACHMENTS section.)



2. Remove cap screw and nut (A).
3. Remove rear cap screws and nuts (B).



4. Remove cap screws and nuts (C).
5. Remove rear guard (D).



6. Remove cap screw (E) and washer (F).
7. Remove PTO clutch (G).

Installation is done in the reverse order of removal.

- Apply MPG-2 Multi-Purpose Grease to crankshaft before installing PTO clutch. (See ANTI-CORROSION GREASE in SPECIFICATIONS AND INFORMATION section.)
- Tighten PTO clutch cap screw to **136 N•m (100 lb-ft)**.

IMPORTANT: The adjustment/break-in procedure should be performed any time the PTO clutch is repaired or replaced. This procedure should be performed by the DEALER ONLY and should not be attempted by untrained personnel.

- If a new PTO clutch is installed, perform the Break-In Procedure. (See ELECTRIC PTO CLUTCH—BREAK-IN PROCEDURE.)

ELECTRIC PTO CLUTCH—BREAK-IN PROCEDURE

CAUTION

Before engaging mower, clear area of bystanders, ESPECIALLY CHILDREN.

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Start engine.
4. Move throttle lever to full throttle position.
5. With no load on mower, engage PTO switch and run mower deck for 10 seconds.
6. Disengage PTO switch and wait for 10 seconds.
7. Repeat steps 5 and 6 for 12 or 15 times.

CONTENTS

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SPECIFICATIONS

ADJUSTMENT SPECIFICATIONS

Control Lever Height Adjustment—Gap . . . . . 6 mm (0.25 in.)

REPAIR SPECIFICATIONS

Hydraulic Oil Reservoir Capacity . . . . . 7.6 L (2.0 gal.)

Pump

Sheave Installed Depth . . . . Sheave Face 1.5 mm (0.06 in.) Past the End of Input Shaft
Displacement Control Shaft End Play . . . . . 0.508—1.524 mm (0.020—0.060 in.)
Charge Pump Cap Screw Torque . . . . . 13.5 N•m (119 lb-in.)
Bypass Valve Torque . . . . . 13.5 N•m (119 lb-in.)
Check Valve Torque . . . . . 23 N•m (204 lb-in.)
End Cover Cap Screw Torque . . . . . 13.5 N•m (119 lb-in.)

Wheel Motor

Wheel Hub Retaining Nut Torque . . . . . 109 N•m (80 lb-ft)
Rotor Lobe-to-Roller Vane Maximum Clearance . . . . . 0.13 mm (0.005 in.)
Coupling Shaft Installed Depth . . . . . 2.54 mm (0.10 in.) Below Housing Wear Surface Plate
Retaining Cap Screw Torque . . . . . 68 N•m (50 lb-ft)

OTHER MATERIALS

Number	Name	Use
	Mobilith SHC® 460 Grease	Apply to wheel motor seals and seal rings. (Supplied with wheel motor gasket kit.)

SERVICE PARTS KITS

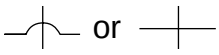
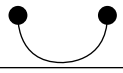
The following kits are available through your parts catalog:

- Wheel Motor Gasket Kit

Mobilith and SHC are registered trademarks of the Mobil Oil Corporation.

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

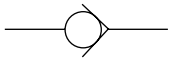
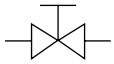
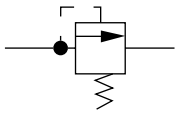
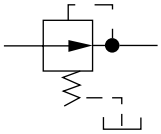
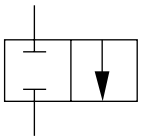
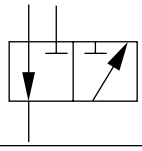
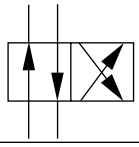
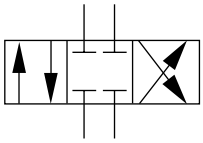
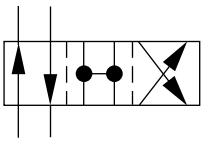
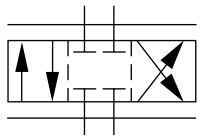
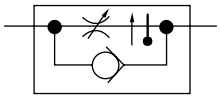
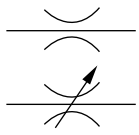
MOTORS

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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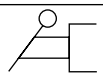
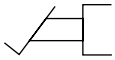
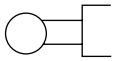
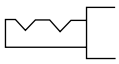
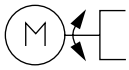
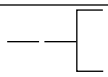
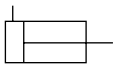
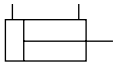
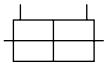
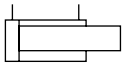
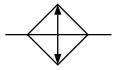
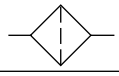
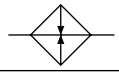
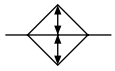
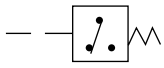
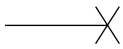
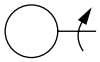
VALVE OPERATORS

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

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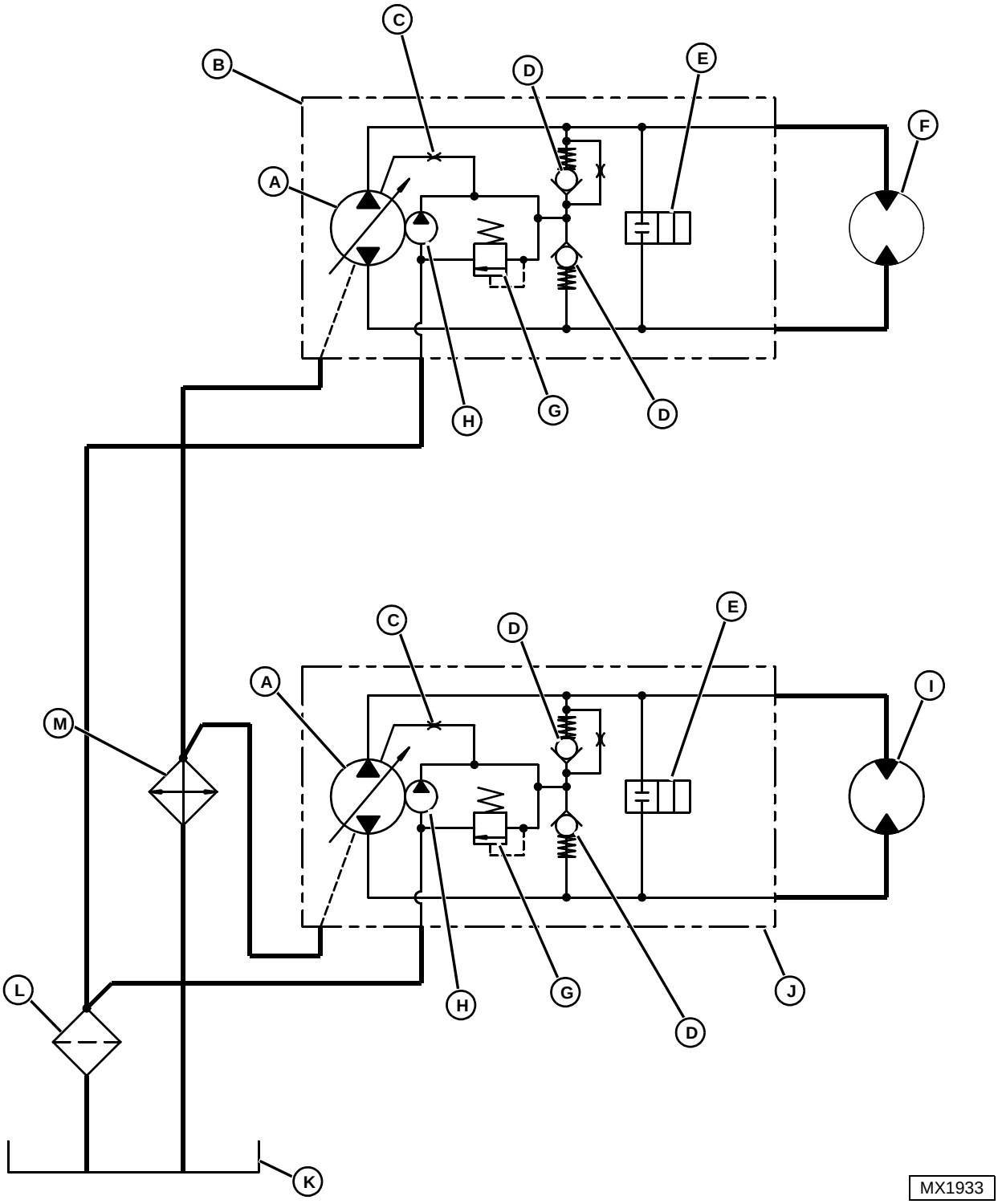
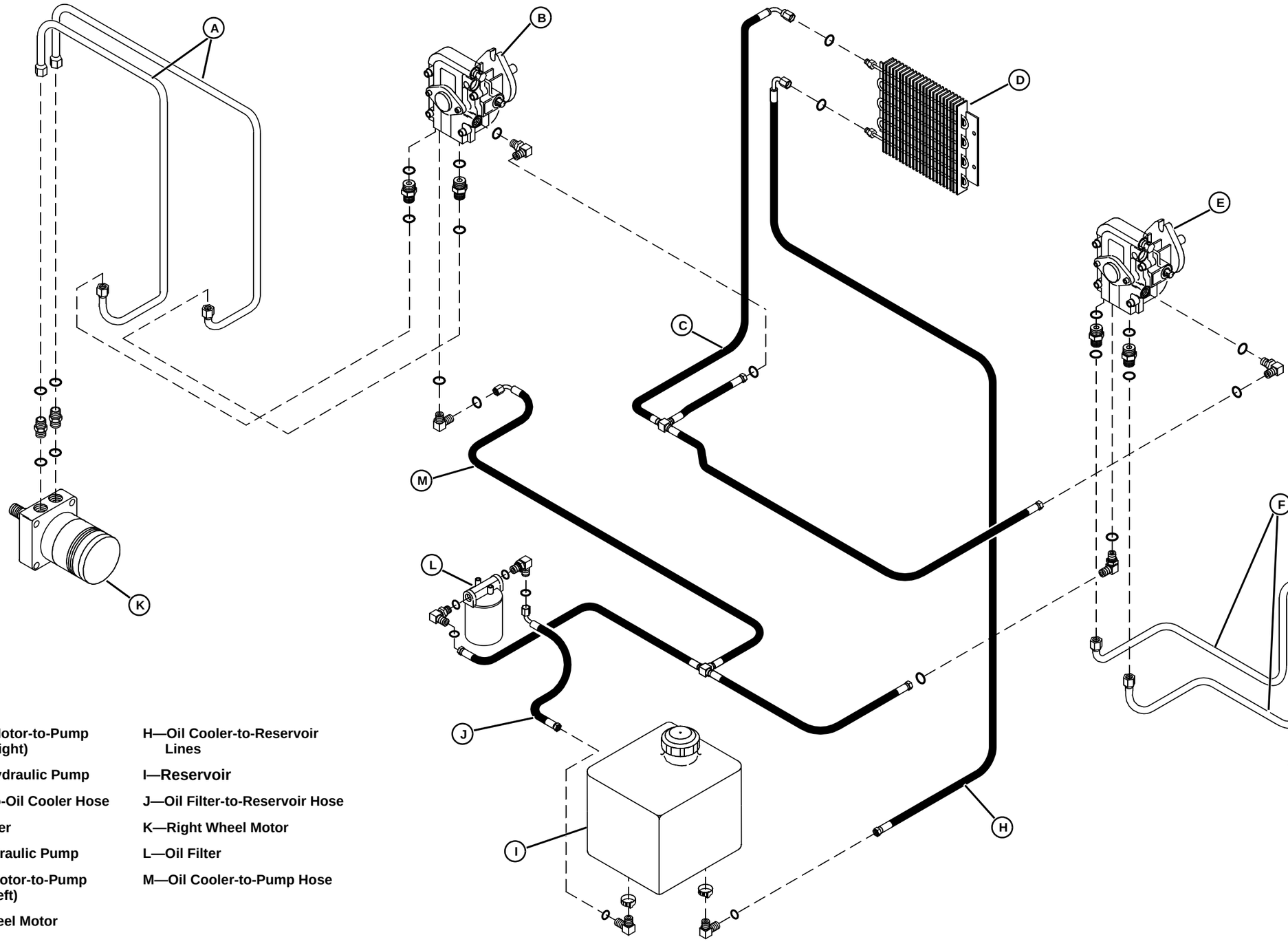
HYDRAULIC SYSTEM SCHEMATIC



A—Pump Block	E—Bypass Valve	I—Left Wheel Motor	M—Oil Cooler
B—Right Hydraulic Pump	F—Right Wheel Motor	J—Left Hydraulic Pump	
C—Cooling Orifice	G—Pressure Relief Valve	K—Reservoir	
D—Check Valve	H—Charge Pump	L—Oil Filter	

COMPONENT LOCATION AND OPERATION

HYDRAULIC SYSTEM HOSE ROUTING



A—Wheel Motor-to-Pump Lines (Right)

B—Right Hydraulic Pump

C—Pump-to-Oil Cooler Hose

D—Oil Cooler

E—Left Hydraulic Pump

F—Wheel Motor-to-Pump Lines (Left)

G—Left Wheel Motor

H—Oil Cooler-to-Reservoir Lines

I—Reservoir

J—Oil Filter-to-Reservoir Hose

K—Right Wheel Motor

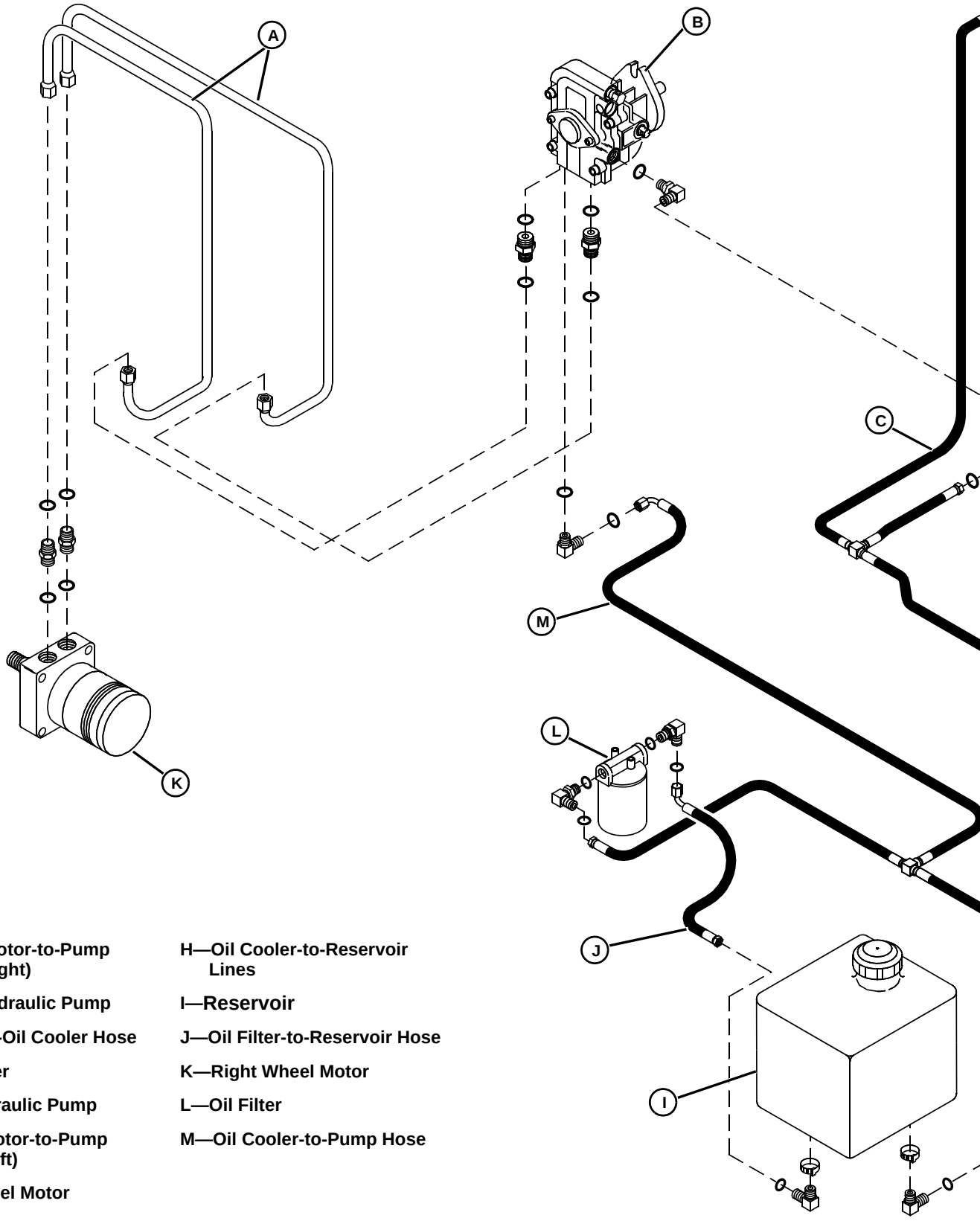
L—Oil Filter

M—Oil Cooler-to-Pump Hose

MX1921

COMPONENT LOCATION AND OPERATION

HYDRAULIC SYSTEM HOSE ROUTING



A—Wheel Motor-to-Pump Lines (Right)

B—Right Hydraulic Pump

C—Pump-to-Oil Cooler Hose

D—Oil Cooler

E—Left Hydraulic Pump

F—Wheel Motor-to-Pump Lines (Left)

G—Left Wheel Motor

H—Oil Cooler-to-Reservoir Lines

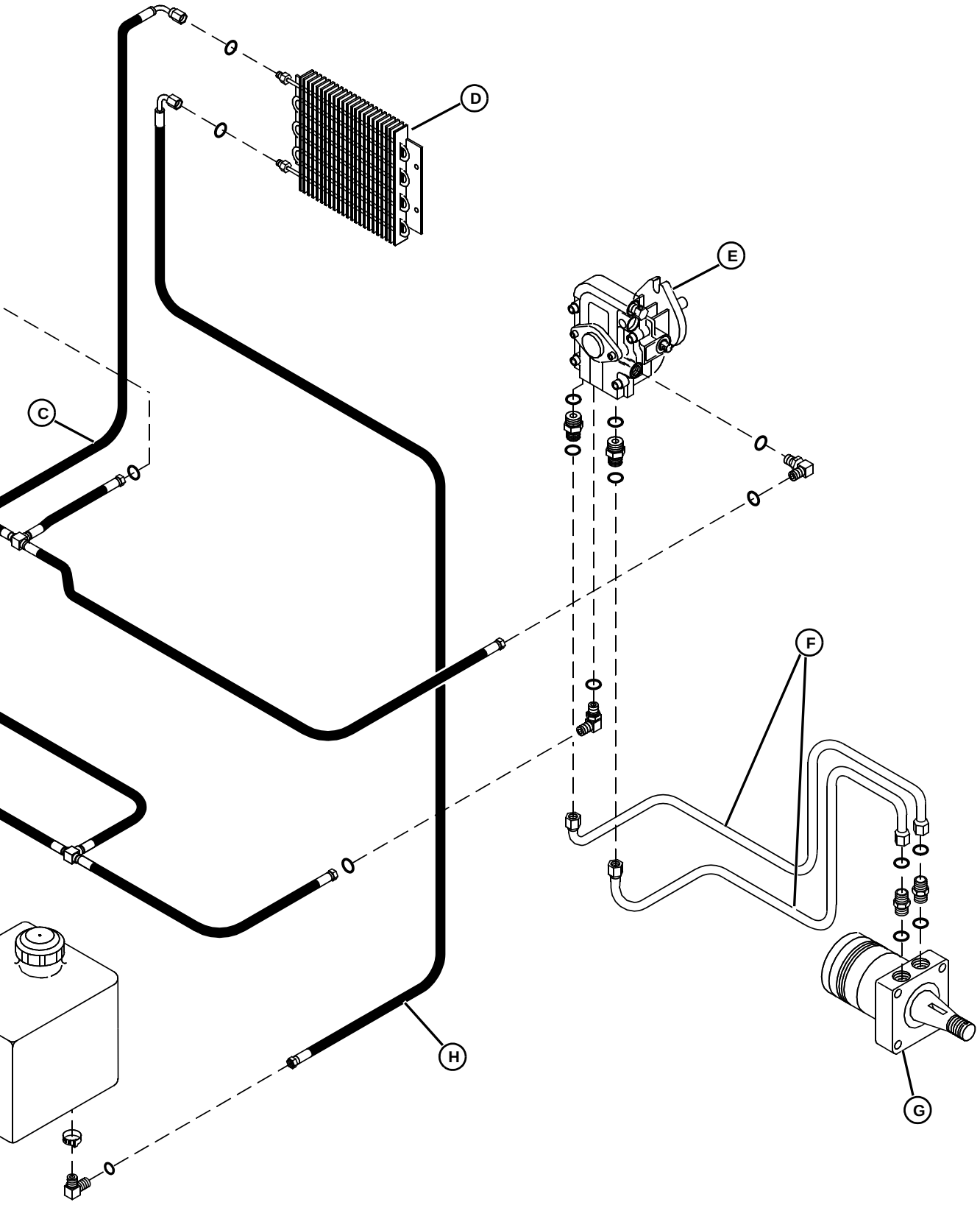
I—Reservoir

J—Oil Filter-to-Reservoir Hose

K—Right Wheel Motor

L—Oil Filter

M—Oil Cooler-to-Pump Hose



MX1921

POWER TRAIN OPERATION

Function:

To drive the machine using hydraulic wheel motors.

Theory of Operation:

The hydrodraulic pumps (B and J) are engine driven by a common drive belt. As the pump input shafts turn, the charge pump draws oil from the reservoir (K), through the oil filter (L) and supplies oil to the pump block (A).

Neutral

With the control levers in the NEUTRAL position, the spring in the pump block in the hydraulic pumps forces the swash plates to a position that is parallel to the pump body. With the swash plates parallel to the pump body, the pistons do not reciprocate in the cylinder block, they merely rotate, and no oil is being drawn in or discharged from the pump. The machine is in a zero displacement position and the machine remains stationary.

Oil returning from the wheel motors (F and I) and hydraulic pumps is directed through the oil cooler (M) before returning to the reservoir.

Forward

As the control levers are pushed forward, the swash plates 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 swash plates.

As the cylinder block rotates, the pistons follow the contour of the swash plate, 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.

Reverse

Reverse operation is accomplished by reversing the angle applied to the hydraulic pump swash plates, reversing the flow of high-pressure oil to the wheel motors.

Pump Bypass Mode

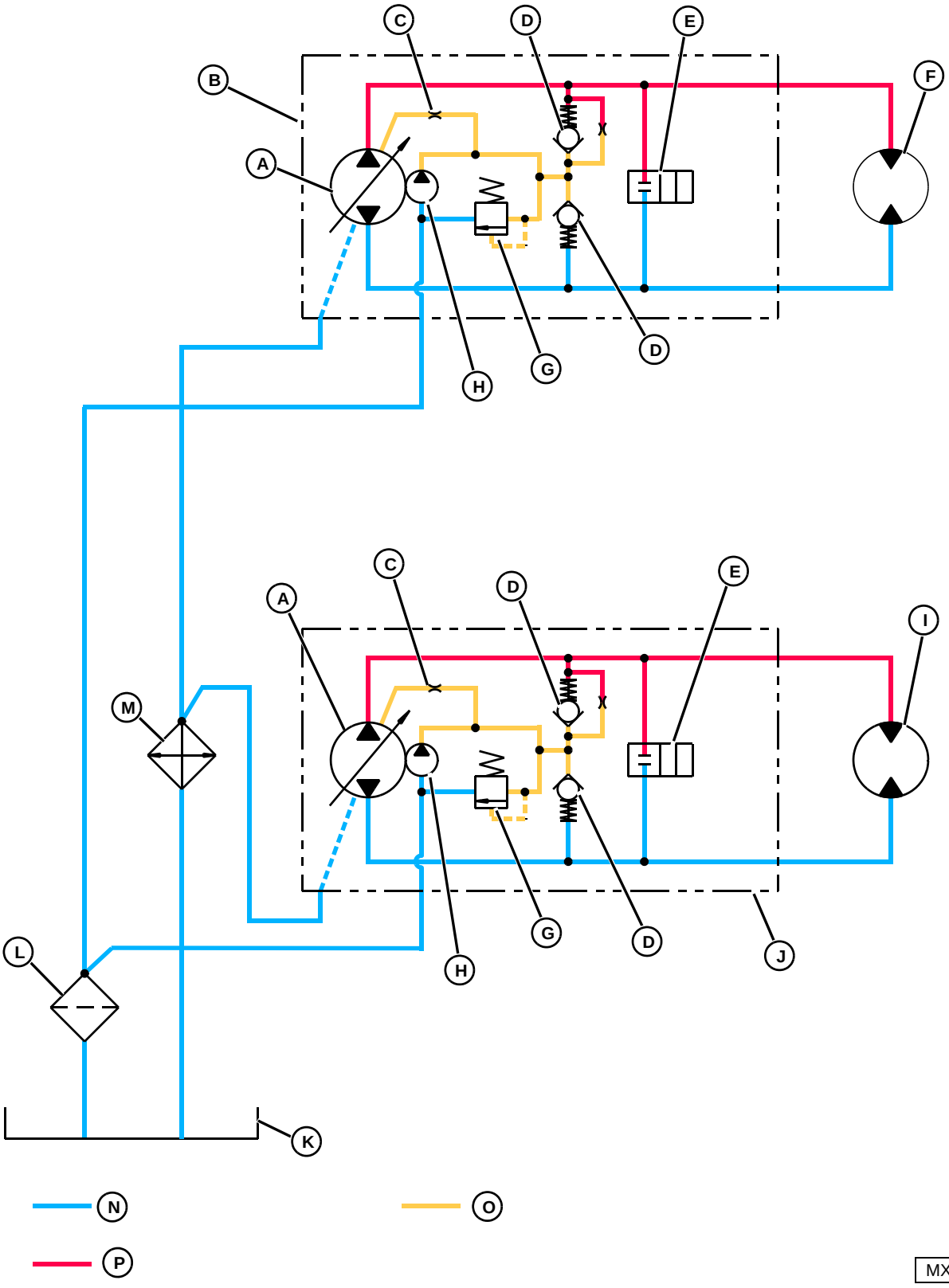
In the event the machine must be moved with the engine off, bypass valves (E) on each pump can be opened to relieve pressure.

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.

Steering

The Mid-Mount Z-Trak 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.



MX1934

A—Pump Block
B—Right Hydraulic Pump
C—Cooling Orifice
D—Check Valve
E—Bypass Valve
F—Right Wheel Motor
G—Pressure Relief Valve
H—Charge Pump
I—Left Wheel Motor
J—Left Hydraulic Pump
K—Reservoir
L—Oil Filter
M—Oil Cooler
N—Low Pressure/Return Oil
O—Charge Pressure Oil
P—High Pressure Oil

TROUBLESHOOTING

HYDROSTATIC POWER TRAIN TROUBLESHOOTING CHART

Problem or Symptom / Check or Solution	System fails to build pressure.	Machine will not drive straight.	Machine will not reach maximum speed.	Machine will not move when control levers are engaged.	Jerky or erratic operation.	Sluggish operation under load.	Excessive noise.
Oil level low.	●		●	●	●	●	●
Wrong oil/incorrect viscosity.	●		●	●		●	●
Hydraulic oil filter plugged.	●		●	●	●	●	●
Control linkage/cables out of adjustment.		●					
Control cable(s) broken or damaged.		●		●			
Pump drive belt worn, glazed or stretched.	●		●	●	●	●	
Pump drive belt tensioner assembly damaged or spring stretched or missing.			●	●	●	●	
Pump drive belt missing or broken.	●			●	●		
Hydraulic pump(s) worn or damaged.	●	●	●	●	●	●	●
Wheel motor(s) worn or damaged.		●	●	●	●	●	●
Hydraulic hoses restricted.		●	●	●	●	●	●
Hydraulic pump free-wheel lever(s) in RELEASED position.	●	●		●			
Park brake(s) engaged or binding.		●	●	●		●	

DIAGNOSIS

SYSTEM FAILS TO BUILD PRESSURE

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake engaged.
- Control levers in NEUTRAL LOCK position.

Test Location	Normal	If Not Normal
1. Hydraulic oil reservoir.	Reservoir filled to correct level.	Fill hydraulic oil reservoir to proper level with oil meeting specifications. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
	Hydraulic reservoir filled with clean oil of correct specifications.	Fill hydraulic oil reservoir to proper level with oil meeting specifications. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
2. Hydraulic oil filter.	Filter not plugged.	Replace filter.
3. Pump drive belt.	Not broken, worn, frayed, glazed or stretched.	Replace belt. (See HYDRAULIC PUMP DRIVE BELT—REMOVAL/ INSTALLATION.)
4. Pump drive belt tensioner assembly.	Functioning properly, not damaged.	Repair belt tensioner assembly. (See HYDRAULIC PUMP DRIVE BELT TENSIONER ASSEMBLY—REPAIR.)
5. Hydraulic pumps.	Operating properly, no internal damage or leakage.	Repair or replace hydraulic pump(s). (See HYDRAULIC PUMPS—DISASSEMBLY/INSPECTION.)
	Free-wheeling lever(s) not in released position.	Return free-wheeling lever(s) to CLOSED position.

MACHINE WILL NOT DRIVE STRAIGHT

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake engaged.
- Control levers in NEUTRAL LOCK position.

Test Location	Normal	If Not Normal
1. Control linkage.	Linkage properly adjusted.	Adjust linkage. (See CONTROL LINKAGE CHECK AND ADJUSTMENT.)
	Linkage not damaged.	Repair linkage. (See CONTROL LEVER LINKAGE—REPAIR.)
2. Hydraulic pump(s).	Operating properly, no internal damage or leakage.	Repair or replace hydraulic pump. (See HYDRAULIC PUMPS—DISASSEMBLY/INSPECTION.)
	Free-wheeling lever(s) not in released position.	Return free-wheeling lever(s) to CLOSED position.
3. Wheel motor(s).	Operating properly, no internal damage or leakage.	Repair or replace wheel motor. (See WHEEL MOTORS—DISASSEMBLY/INSPECTION.)
4. Hydraulic oil hoses.	No sharp bends or restrictions.	Replace hoses.
5. Park brake.	Brake not engaged.	Release park brake.
	Brake not binding.	Repair park brake. (See PARK BRAKE—DISASSEMBLY/INSPECTION in BRAKES section.)

MACHINE WILL NOT REACH MAXIMUM SPEED

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake engaged.
- Control levers in NEUTRAL LOCK position.

Test Location	Normal	If Not Normal
1. Hydraulic oil reservoir.	Reservoir filled to correct level.	Fill hydraulic oil reservoir to proper level with oil meeting specifications. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
	Hydraulic reservoir filled with clean oil of correct specifications.	Fill hydraulic oil reservoir to proper level with oil meeting specifications. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
2. Hydraulic oil filter.	Filter not plugged.	Replace filter.
3. Pump drive belt.	Not worn, frayed, glazed or stretched.	Replace belt. (See HYDRAULIC PUMP DRIVE BELT—REMOVAL/ INSTALLATION.)
4. Pump drive belt tensioner assembly.	Functioning properly, not damaged.	Repair belt tensioner assembly. (See HYDRAULIC PUMP DRIVE BELT TENSIONER ASSEMBLY—REPAIR.)
5. Hydraulic pump(s).	Operating properly, no internal damage or leakage.	Repair or replace hydraulic pump(s). (See HYDRAULIC PUMPS—DISASSEMBLY/INSPECTION.)
6. Wheel motor(s).	Operating properly, no internal damage or leakage.	Repair or replace wheel motor(s). (See WHEEL MOTORS—DISASSEMBLY/INSPECTION.)
7. Hydraulic oil hoses.	No sharp bends or restrictions.	Replace hoses.
8. Park brake(s).	Brake(s) not engaged.	Release park brake.
	Brake(s) not binding.	Repair park brakes. (See PARK BRAKE—DISASSEMBLY/INSPECTION in BRAKES section.)

MACHINE WILL NOT MOVE WHEN CONTROLS ARE ENGAGED

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake engaged.
- Control levers in NEUTRAL LOCK position.

Test Location	Normal	If Not Normal
1. Hydraulic oil reservoir.	Reservoir filled to correct level.	Fill hydraulic oil reservoir to proper level with oil meeting specifications. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
	Hydraulic reservoir filled with clean oil of correct specifications.	Fill hydraulic oil reservoir to proper level with oil meeting specifications. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
2. Hydraulic oil filter.	Filter not plugged.	Replace filter.
3. Control linkage.	Properly adjusted.	Adjust linkage. (See CONTROL LINKAGE CHECK AND ADJUSTMENT.)
4. Pump drive belt.	Properly tensioned, not slipping.	Repair belt tensioner. (See HYDRAULIC PUMP DRIVE BELT TENSIONER ASSEMBLY—REPAIR.)
	Not broken, worn, frayed, glazed or stretched.	Replace belt. (See HYDRAULIC PUMP DRIVE BELT—REMOVAL/ INSTALLATION.)
5. Pump drive belt tensioner assembly.	Functioning properly, not damaged.	Repair belt tensioner assembly. (See HYDRAULIC PUMP DRIVE BELT TENSIONER ASSEMBLY—REPAIR.)
6. Hydraulic pump(s).	Operating properly, no internal damage or leakage.	Repair or replace hydraulic pump(s). (See HYDRAULIC PUMPS—DISASSEMBLY/INSPECTION.)
	Free-wheeling levers not in released position.	Return free-wheeling levers to CLOSED position.
7. Wheel motor(s).	Operating properly, no internal damage or leakage.	Repair or replace wheel motor(s). (See WHEEL MOTORS—DISASSEMBLY/INSPECTION.)
8. Park brake(s).	Brake(s) not engaged.	Release park brake.
	Brake(s) not binding.	Repair park brakes. (See PARK BRAKE—DISASSEMBLY/INSPECTION in BRAKES section.)

JERKY OR ERRATIC OPERATION

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake engaged.
- Control levers in NEUTRAL LOCK position.

Test Location	Normal	If Not Normal
1. Hydraulic oil reservoir.	Reservoir filled to correct level.	Fill hydraulic oil reservoir to proper level with oil meeting specifications. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
	Hydraulic reservoir filled with clean oil of correct specifications.	Fill hydraulic oil reservoir to proper level with oil meeting specifications. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
2. Hydraulic oil filter.	Filter not plugged.	Replace filter.
3. Pump drive belt.	Properly tensioned, not slipping.	Repair belt tensioner. (See HYDRAULIC PUMP DRIVE BELT TENSIONER ASSEMBLY—REPAIR.)
	Not broken, worn, frayed, glazed or stretched.	Replace belt. (See HYDRAULIC PUMP DRIVE BELT—REMOVAL/ INSTALLATION.)
4. Pump drive belt tensioner assembly.	Functioning properly, not damaged.	Repair belt tensioner assembly. (See HYDRAULIC PUMP DRIVE BELT TENSIONER ASSEMBLY—REPAIR.)
5. Hydraulic pump(s).	Operating properly, no internal damage or leakage.	Repair or replace hydraulic pump(s). (See HYDRAULIC PUMPS—DISASSEMBLY/INSPECTION.)
6. Wheel motor(s).	Operating properly, no internal damage or leakage.	Repair or replace wheel motor(s). (See WHEEL MOTORS—DISASSEMBLY/INSPECTION.)
7. Hydraulic oil hoses.	No sharp bends or restrictions.	Replace hoses.

SLUGGISH OPERATION UNDER LOAD

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake engaged.
- Control levers in NEUTRAL LOCK position.

Test Location	Normal	If Not Normal
1. Hydraulic oil reservoir.	Reservoir filled to correct level.	Fill hydraulic oil reservoir to proper level with oil meeting specifications. (See HYDROSTATIC TRANSMISSIONAND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
	Hydraulic reservoir filled with clean oil of correct specifications.	Fill hydraulic oil reservoir to proper level with oil meeting specifications. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
2. Hydraulic oil filter.	Filter not plugged.	Replace filter.
3. Pump drive belt.	Properly tensioned, not slipping.	Repair belt tensioner. (See HYDRAULIC PUMP DRIVE BELT TENSIONER ASSEMBLY—REPAIR.)
	Not broken, worn, frayed, glazed or stretched.	Replace belt. (See HYDRAULIC PUMP DRIVE BELT—REMOVAL/ INSTALLATION.)
4. Pump drive belt tensioner assembly.	Functioning properly, not damaged.	Repair belt tensioner assembly. (See HYDRAULIC PUMP DRIVE BELT TENSIONER ASSEMBLY—REPAIR.)
5. Hydraulic pump(s).	Operating properly, no internal damage or leakage.	Repair or replace hydraulic pump(s). (See HYDRAULIC PUMPS—DISASSEMBLY/INSPECTION.)
6. Wheel motor(s).	Operating properly, no internal damage or leakage.	Repair or replace wheel motor(s). (See WHEEL MOTORS—DISASSEMBLY/INSPECTION.)
7. Hydraulic oil hoses.	No sharp bends or restrictions.	Replace hoses.
8. Park brake(s).	Brake(s) not engaged.	Release park brake.
	Brake(s) not binding.	Repair park brakes. (See PARK BRAKE—DISASSEMBLY/INSPECTION in BRAKES section.)

EXCESSIVE NOISE

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake engaged.
- Control levers in NEUTRAL LOCK position.

Test Location	Normal	If Not Normal
1. Hydraulic oil reservoir.	Reservoir filled to correct level.	Fill hydraulic oil reservoir to proper level with oil meeting specifications. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.
	Hydraulic reservoir filled with clean oil of correct specifications.	Fill hydraulic oil reservoir to proper level with oil meeting specifications. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
2. Hydraulic oil filter.	Filter not plugged.	Replace filter.
3. Hydraulic pump(s).	Operating properly, no internal damage or leakage.	Repair or replace hydraulic pump(s). (See HYDRAULIC PUMPS—DISASSEMBLY/INSPECTION.)
4. Wheel motor(s).	Operating properly, no internal damage or leakage.	Repair or replace wheel motor(s). (See WHEEL MOTORS—DISASSEMBLY/INSPECTION.)
5. Hydraulic oil hoses.	No sharp bends or restrictions.	Replace hoses.

CHECKS, TESTS AND ADJUSTMENTS

HYDRAULIC SYSTEM BLEEDING PROCEDURE

Reason:

To ensure that air is purged from the hydraulic system after the hydraulic hoses have been disconnected.

Procedure:

1. Park machine safely.
2. Check level of hydraulic oil. Add oil as needed. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)

CAUTION

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 engine and run at SLOW idle **(1200 ±75 rpm)**.
4. Drive machine forward approximately 20 feet, then make two hard left turns, then make two hard right turns.
5. Drive the machine in reverse approximately 10 feet.
6. Turn key switch to 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.

CONTROL LINKAGE CHECK AND ADJUSTMENT

Reason:

To ensure that the machine does not move when the control levers are in the NEUTRAL position, while the engine is running.

Check Procedure:

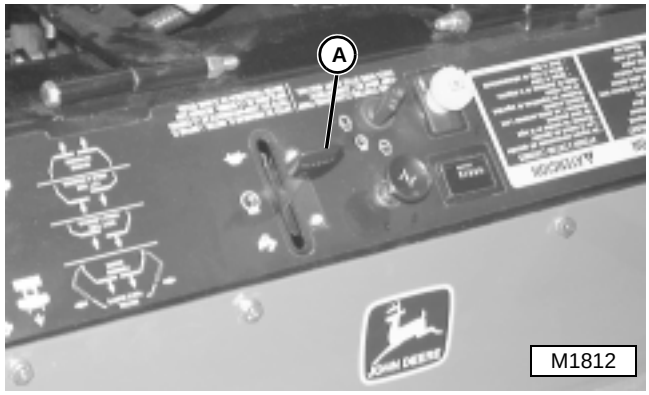
CAUTION

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.

1. Park machine safely.
2. Move PTO switch to OFF position.
3. With the operator on the seat, start engine.



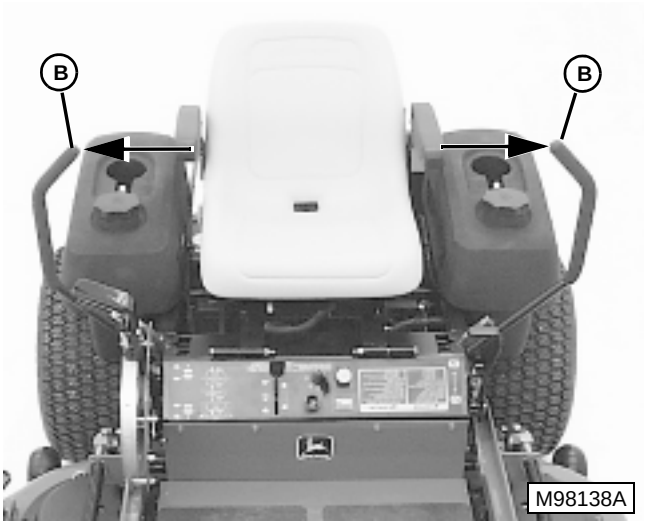
4. Move throttle lever to half-speed position (A).
5. Release park brake.
6. Observe the drive wheels, the wheels should not move.

Results:

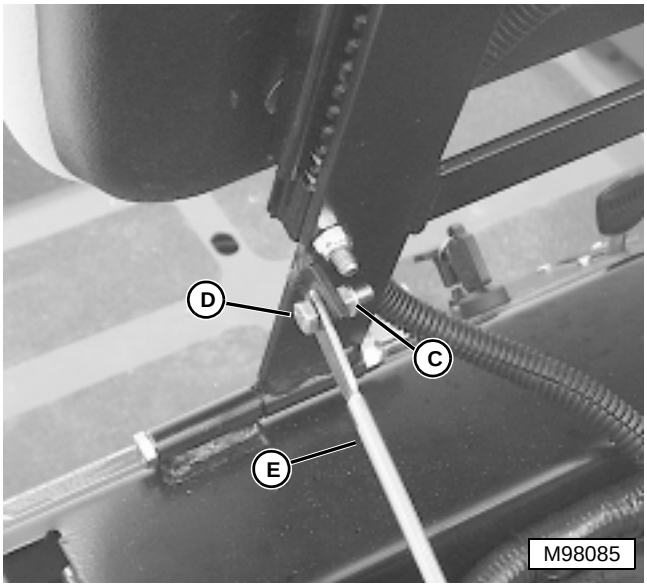
If movement is noted, perform Adjustment Procedure.

Adjustment Procedure:

1. Turn ignition switch to STOP position.
2. Adjust the operator seat to the rearmost position.
3. Engage the park brake.



4. Move control levers (B) to NEUTRAL LOCK position.
5. Raise and latch seat platform.



NOTE: The operator seat must be adjusted completely to the rear to allow access to the console controls when the seat is tilted forward.

The cap screw (D) and nut (C) should allow the support rod (E) to roll and pivot freely to ensure proper operation.

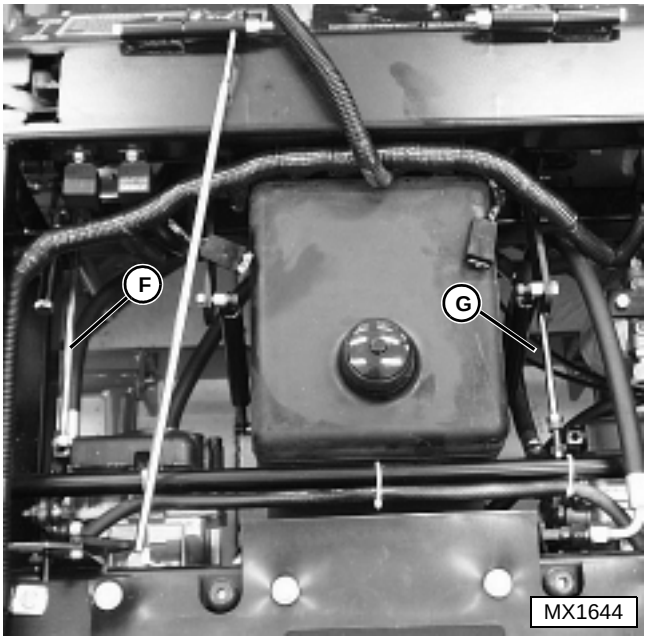
6. Remove lock nut (C), cap screw (D) and support rod (E) from the seat bracket.
7. Tilt the seat forward and allow to rest against the vehicle frame.

NOTE: The rear wheels must be able to rotate freely.

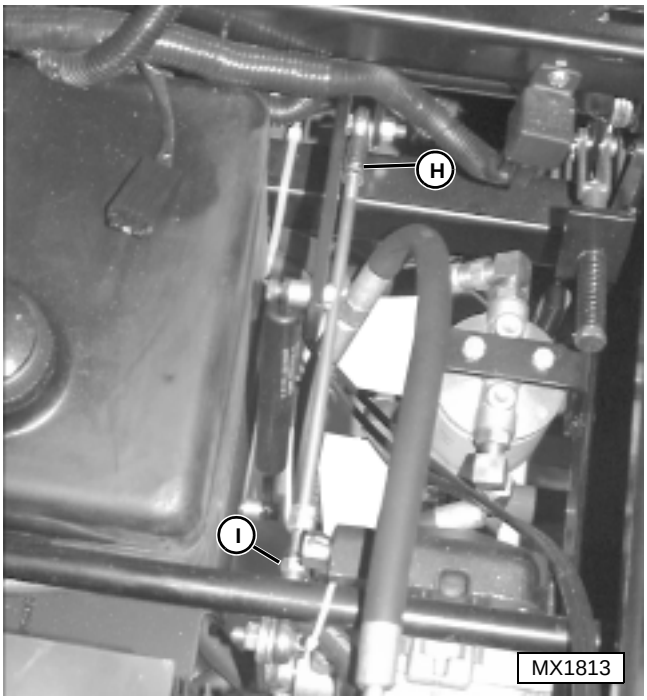
8. Use a safe lifting device to raise the rear of the machine. Support the machine using wood blocks or jackstands.

NOTE: To prevent damage to the seat bottom, cover the end of the wood block with a rag.

9. Place a 25—30 cm (10—12 in.) long wood block (E) between the foot plate and the center of the seat bottom to activate the seat safety switch.



10. Locate the left (F) and right (G) control linkages.



NOTE: The hex nut at the front of the linkage has left-hand threads.

11. Loosen the jam nuts (H and I) at the front and rear of the linkage.

⚠ CAUTION

Help prevent serious personal injury. Use caution when performing this service procedure. Keep hands, feet and clothing away from rotating tires.

12. Start engine.
13. Move throttle lever to half-speed position.
14. Release park brake.

NOTE: The right and left control levers can be adjusted independently.

15. Move the RIGHT control lever from the NEUTRAL LOCK to the NEUTRAL position.
16. Adjust the RIGHT control linkage, by rotating the double nuts clockwise (or counterclockwise) as needed until no rotation is noted.
17. Move the RIGHT control lever completely forward in the slot and then back to the NEUTRAL position.
18. Observe the drive wheels, no rotation should noted.
19. Move the RIGHT control lever completely rearward in the slot.

NOTE: If the lever fails to return to the NEUTRAL position and the drive wheels continue to rotate, the reverse spring detent may need to be adjusted. (See REVERSE SPRING DETENT CHECK AND ADJUSTMENT.)

20. Release the control lever. The lever should return to the NEUTRAL position, and the drive wheels should stop. Repeat steps 15—20 as needed.
21. Perform steps 15—20 for the LEFT control lever linkage.
22. Tighten the jam nuts at the front and rear of both linkage rods.
23. Install lock nut, cap screw and support rod.

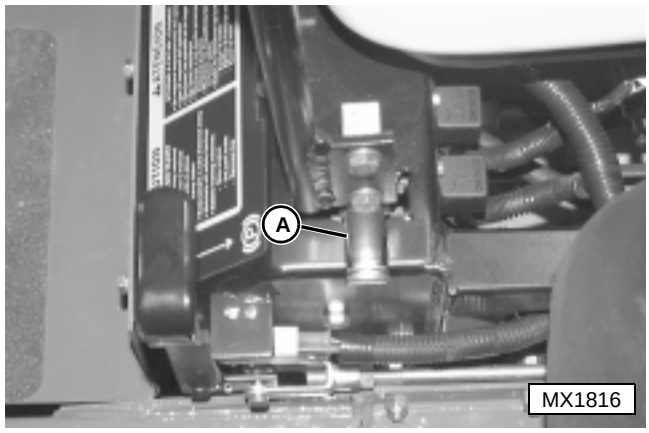
REVERSE SPRING DETENT CHECK AND ADJUSTMENT

Reason:

To ensure that the controls levers return to the NEUTRAL position.

Check Procedure:

1. Park machine safely.



2. Pull both control levers back to the REVERSE position.

NOTE: The control levers should be centered in the neutral slot and should be able to be moved to the NEUTRAL LOCK position.

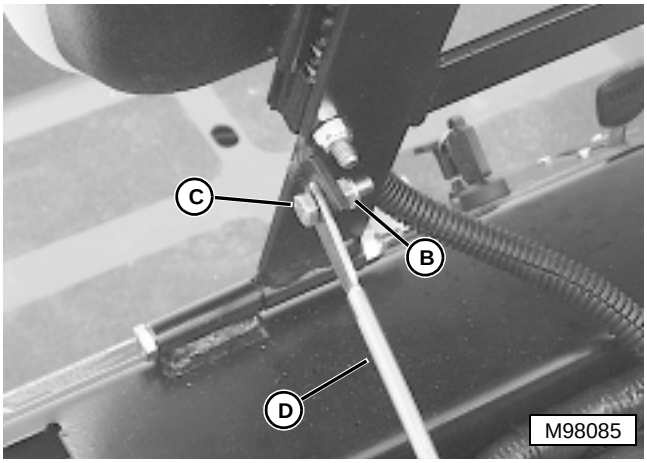
3. Release the levers, the levers should return to the NEUTRAL position (lever centered in the NEUTRAL LOCK slot [A]).

Results:

If control levers do not return as described, perform Adjustment Procedure.

Adjustment Procedure:

1. Adjust the operator seat to the rearmost position.
2. Move control levers to NEUTRAL LOCK position.
3. Raise and latch seat platform.



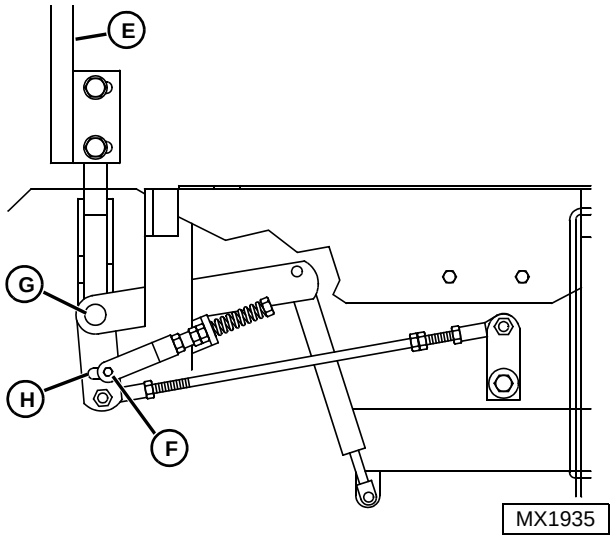
NOTE: The operator seat must be adjusted completely to the rear to allow access to the console controls when the seat is tilted forward.

The cap screw (C) and nut (B) should allow the support rod (D) to roll and pivot freely to ensure proper operation.

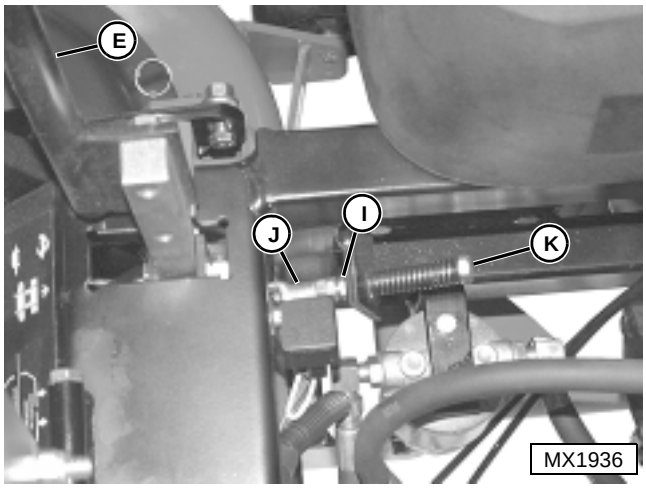
4. Remove lock nut (B), cap screw (C) and support rod (D) from the seat bracket.
5. Tilt the seat forward and allow to rest against the vehicle frame.

NOTE: Right and left control levers can be adjusted independently.

6. Move the RIGHT control lever from the NEUTRAL LOCK to the NEUTRAL position.



7. Pull the right control lever (E) to the rear until the clevis pin (F) on the arm below the pivot shaft (G) comes into contact with the rear of the slot (H). A slight spring pressure should be felt.



8. Loosen jam nut (I) from the yoke (J).
9. Make sure that the clevis pin (F) is in contact with the rear of the slot.
10. Apply slight rearward pressure to the right control lever (E). Turn the head of the adjustment bolt (K) clockwise (or counterclockwise) as needed until the lever is centered in the neutral slot.
11. Tighten the jam nut (I) against the yoke (J).
12. Repeat adjustment procedure for the LEFT control lever.

NOTE: When properly adjusted, the control levers will return to the NEUTRAL position from the REVERSE position and reverse movement will stop when the control levers are released.

13. Check adjustment. (See Check Procedure.)

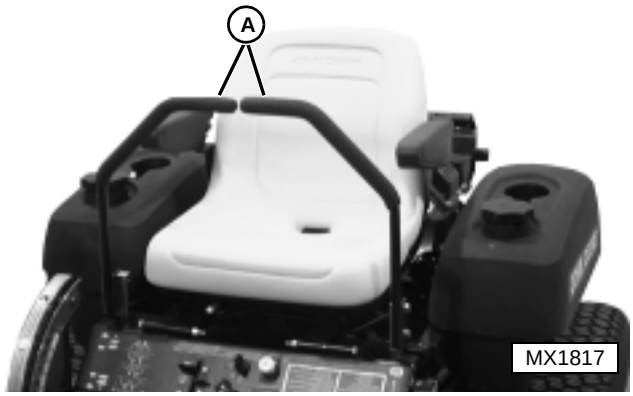
CONTROL LEVER ALIGNMENT CHECK AND ADJUSTMENT

Reason:

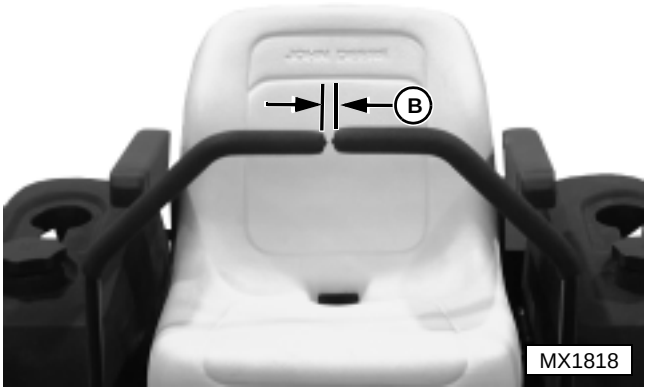
To align the control levers.

Check Procedure:

1. Park machine safely.

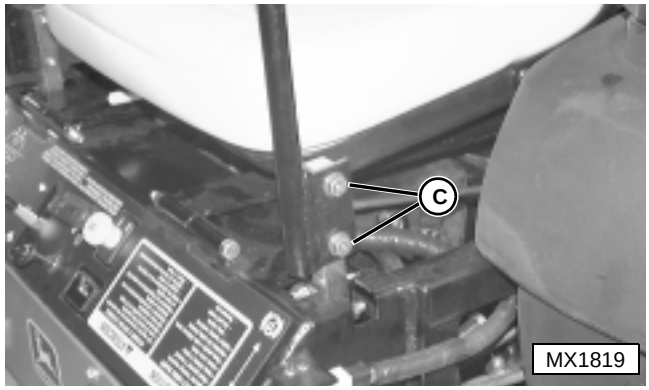


2. Move control levers (A) to NEUTRAL position.



3. Check lever alignment; levers should align with approximately **3—6 mm (0.125—0.25 in.)** gap (B) between the levers. If adjustment is required proceed to Adjustment Procedure.

Adjustment Procedure:



1. Loosen cap screws (C).
2. Slide both levers forward (or backward) as required, until levers are aligned.
3. Tighten cap screws (C).

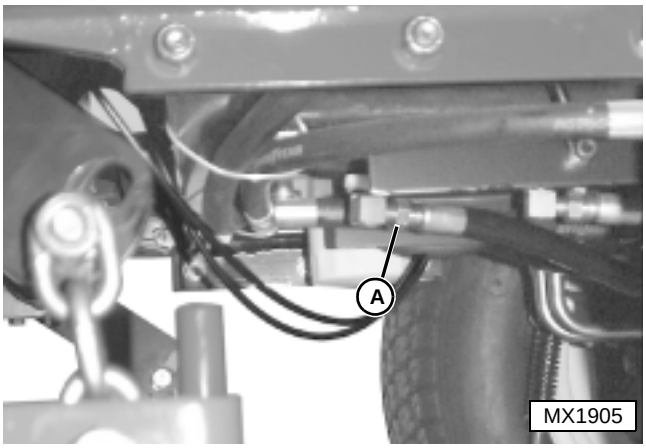
NOTE: If the ends of the levers touch when in the NEUTRAL position, move the levers to the NEUTRAL LOCK position and carefully bend them outward. Move the levers to the NEUTRAL position and check alignment.

4. Check lever alignment. (See Check Procedure.)

REPAIR

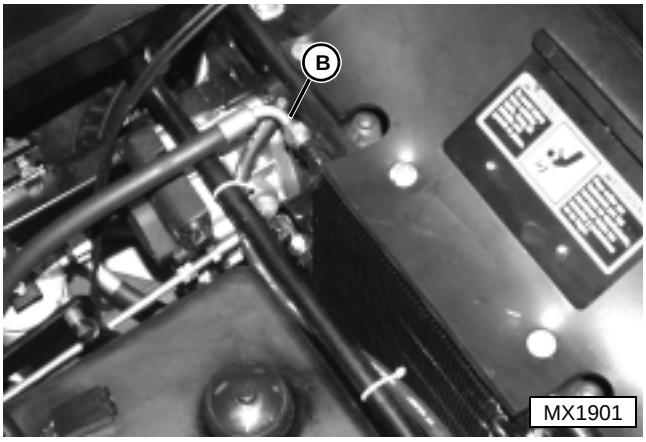
OIL COOLER—REMOVAL/INSTALLATION

1. Park machine safely.
2. Raise and latch seat platform.



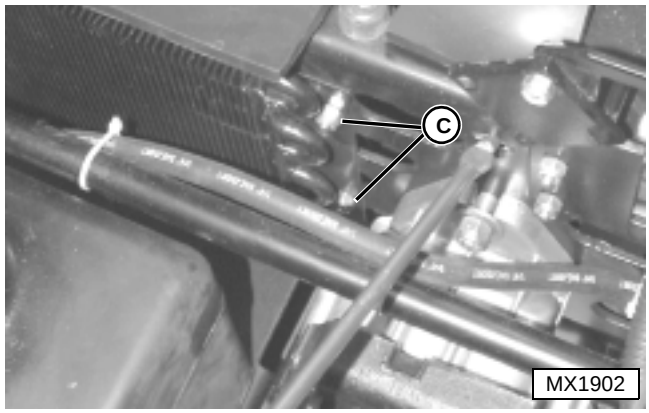
NOTE: Hydraulic system oil capacity is approximately **7.6 L (2.0 gal.)**.

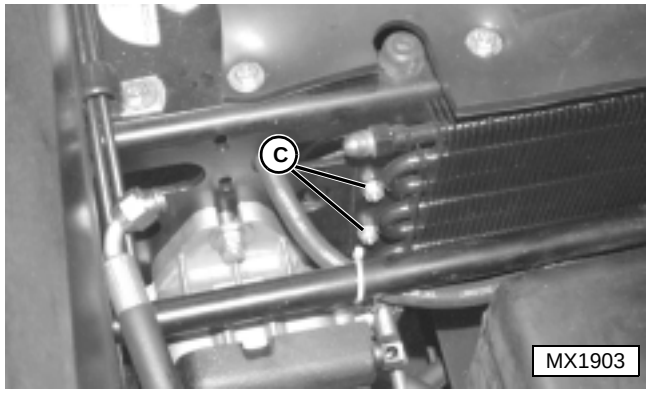
3. Disconnect oil line (A) at reservoir and drain reservoir into a clean container.



IMPORTANT: Use a wrench to hold fitting on oil cooler when loosening or tightening hose connections, to prevent twisting the fitting.

4. Disconnect oil hose (B).





5. Remove four caps screws and nuts (C) (two each side).
6. Remove oil cooler.
7. Inspect oil cooler. (See OIL COOLER—INSPECTION.)

Installation is done in the reverse order of removal.

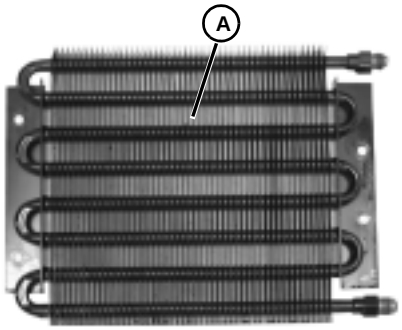
NOTE: Hydraulic oil drained from the system can be reused if the oil is clean and free of contaminates. Use a strainer when filling reservoir.

- Fill hydraulic reservoir to correct level with oil of proper specifications. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
- Bleed air from hydraulic system. (See HYDRAULIC SYSTEM BLEEDING PROCEDURE.)

OIL COOLER—INSPECTION

CAUTION

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.



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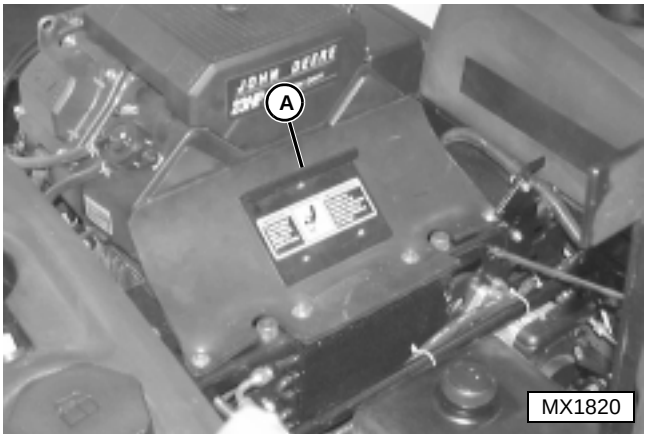
1. Check oil cooler for debris lodged in the fins (A). Clean oil cooler using compressed air or pressure washer.
2. Inspect oil cooler for bent fins, cracks and damaged seams. Repair or replace oil cooler as needed.

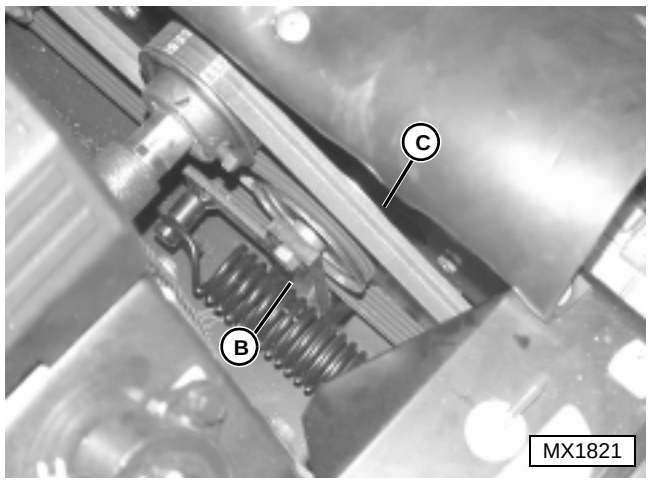
HYDRAULIC PUMP DRIVE BELT—REMOVAL/INSTALLATION

1. Park machine safely.
2. Raise and latch seat platform.



MX1820

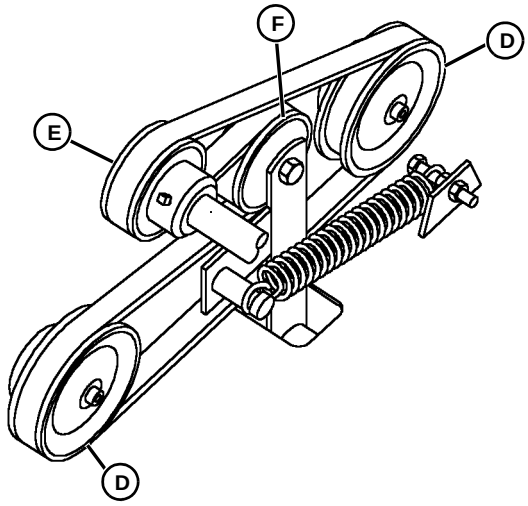
3. Open rubber access door (A).



MX1821

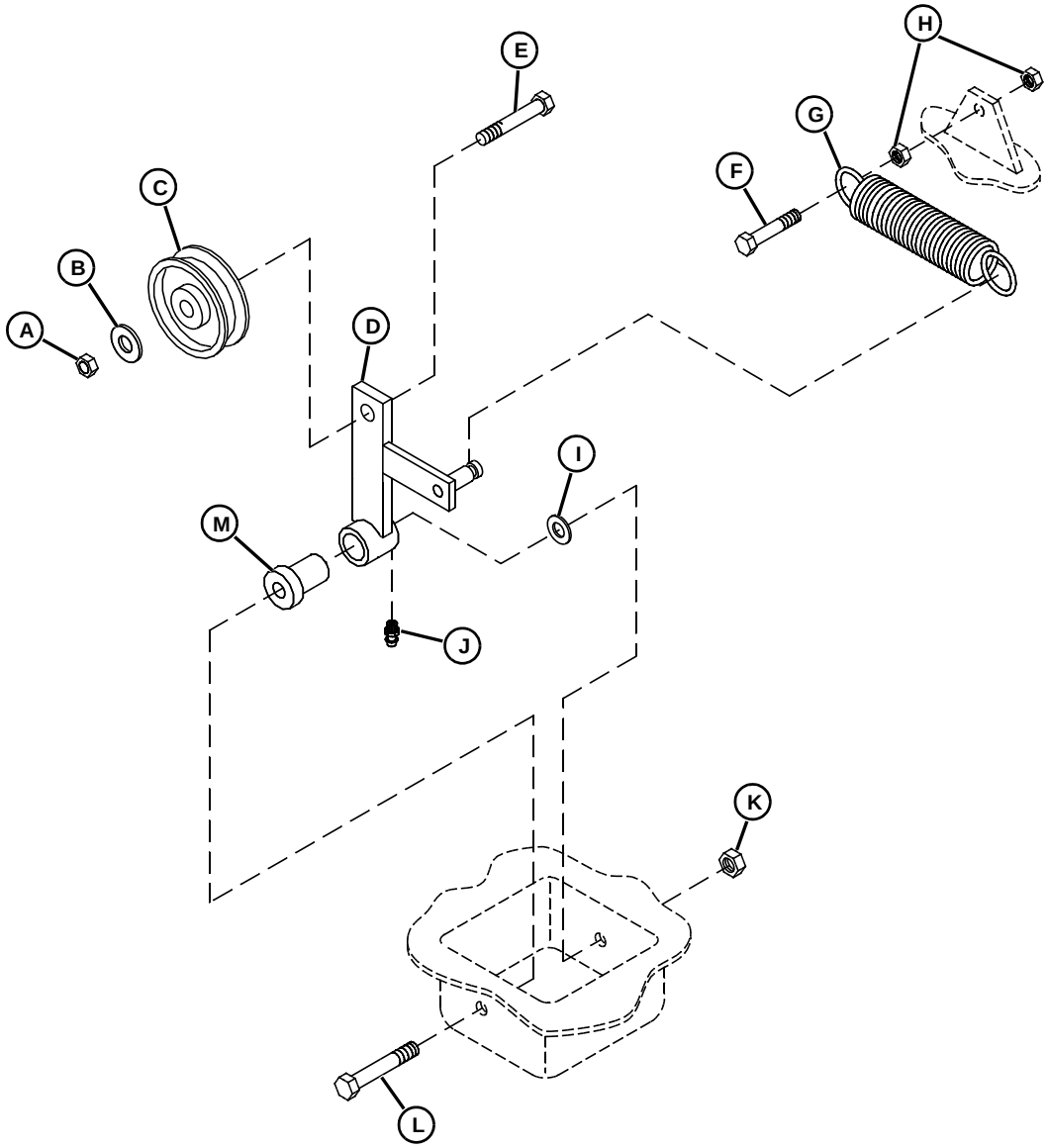
4. Relieve belt tension by using a pry bar to move the belt tensioner bracket (B).
5. Remove the drive belt (C).
6. Inspect the belt for cracks, damage or signs of wear. Replace as needed.

Installation is done in the reverse order of removal.



- Route belt around hydraulic pump sheaves (D), PTO shaft sheave (E) and idler sheave (F).

HYDRAULIC PUMP DRIVE BELT TENSIONER ASSEMBLY—REPAIR

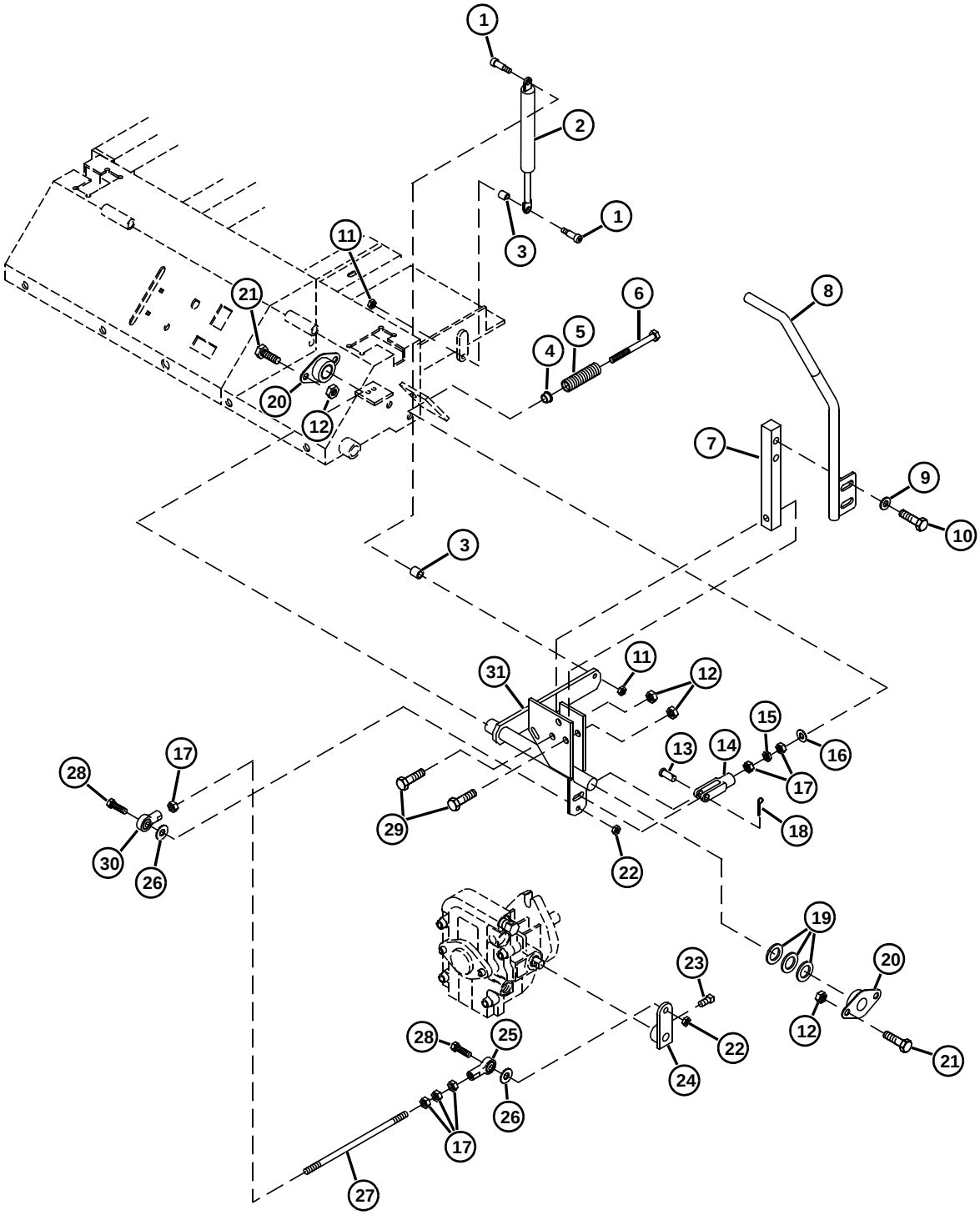


MX1923

A—Nut	**E—Cap Screw**	**I—Washer**	**M—Bushing**
B—Washer	**F—Cap Screw**	**J—Lubrication Fitting**	
C—Sheave	**G—Spring**	**K—Nut**	
D—Tension Bracket	**H—Nut** (2 Used)	**L—Cap Screw**	

- Inspect all parts for wear or damage. Replace parts as needed.
- Apply grease to lubrication fitting. (See CHASSIS AND MOWER SPINDLE GREASE in SPECIFICATIONS AND INFORMATION section.)

CONTROL LEVER LINKAGE—REPAIR



MX1929

1—Cap Screw (2 Used)
2—Dampener
3—Spacer (2 Used)
4—Bushing
5—Spring
6—Cap Screw
7—Arm
8—Control Lever
9—Spring Washer (2 Used)
10—Cap Screw (2 Used)
11—Flanged Nut (2 Used)
12—Lock Nut (7 Used)
13—Pin
14—Yoke
15—Nut
16—Washer
17—Nut (5 Used)
18—Cotter Pin
19—Washers (3 Used)
20—Bearing (2 Used)
21—Cap Screw (4 Used)
22—Lock Nut (2 Used)
23—Set Screw
24—Arm
25—Ball Joint
26—Washer (2 Used)
27—Link
28—Cap Screw (2 Used)
29—Cap Screw (3 Used)
30—Ball Joint
31—Bracket

NOTE: Right control lever mechanism shown. Left control lever mechanism is the same.

Quantities shown are per side.

- Inspect all parts for wear or damage. Replace parts as needed.
- Adjust control lever height. (See CONTROL LEVER HEIGHT ADJUSTMENT.)
- Adjust control linkage. (See CONTROL LINKAGE CHECK AND ADJUSTMENT.)

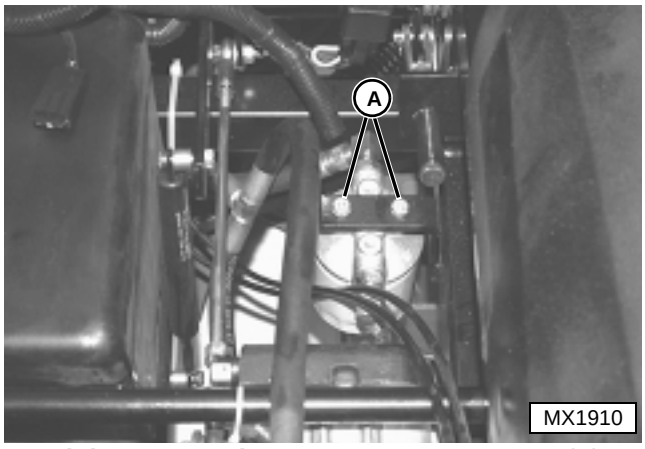
HYDRAULIC PUMPS—REMOVAL/INSTALLATION

CAUTION

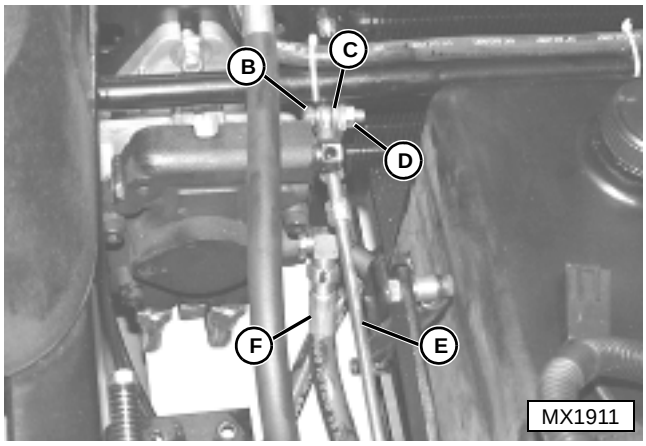
Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting any hoses. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury may call Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

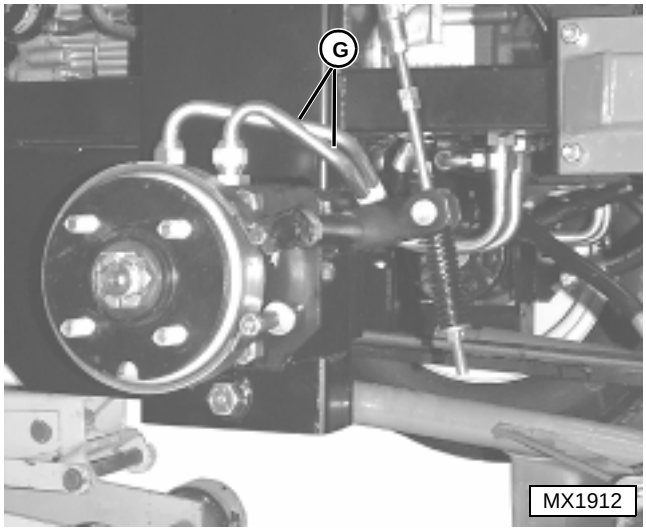
1. Remove drive wheel(s). (See DRIVE WHEELS—REMOVAL/INSTALLATION in MISCELLANEOUS section.)
2. Remove pump drive belt. (See HYDRAULIC PUMP DRIVE BELT—REMOVAL/INSTALLATION.)



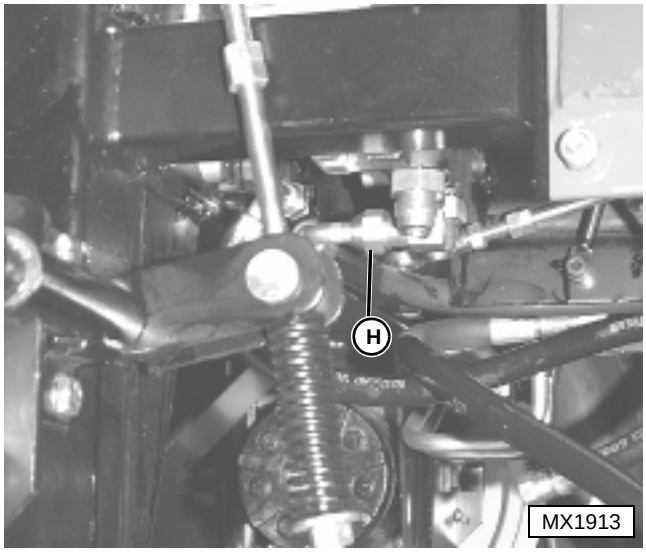
3. **Right Pump Only**: Remove two cap screws (A) from oil filter bracket, and allow the oil filter to drop down to provide clearance.



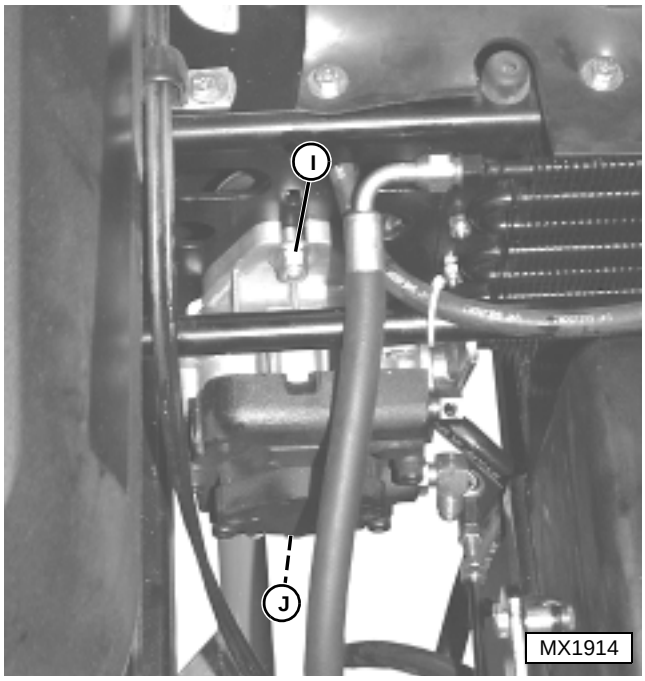
4. Remove cap screw (B), washer (C) and nut (D).
5. Disconnect linkage (E).
6. Disconnect hose (F).



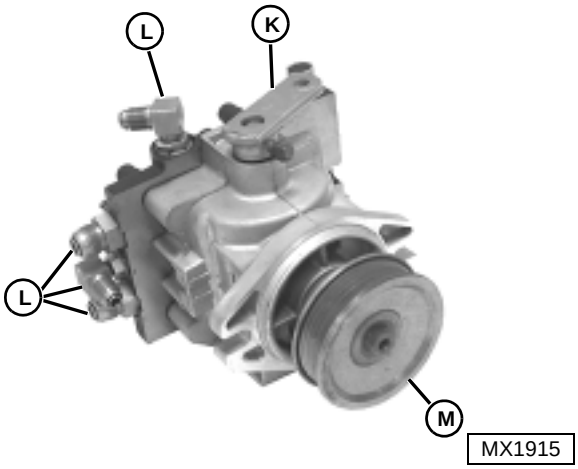
7. Remove hydraulic pump-to-wheel motor hydraulic lines (G).



8. Disconnect hose (H).

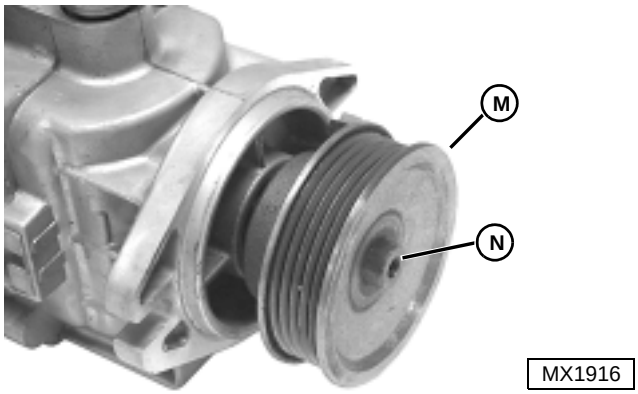


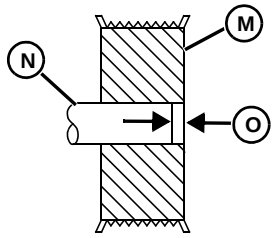
9. Remove the upper (I) and lower (J) cap screws, nut and washers.
10. Remove the hydraulic pump.



11. If hydraulic pump is to be repaired or replaced, remove control arm (K), fittings (L) and sheave (M).

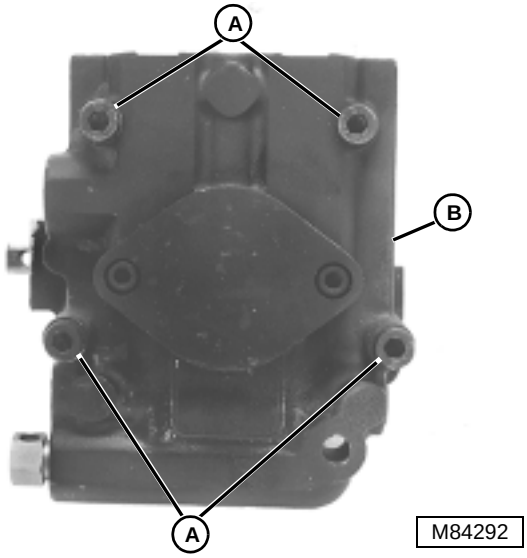
Installation is done in the reverse order of removal.





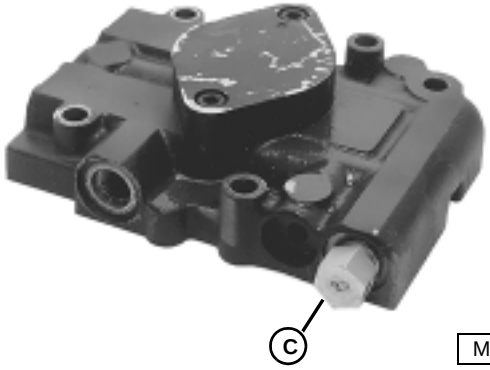
- Install sheave face (M) 1.5 mm (0.06 in.) (O) past the end of the input shaft (N).
- Apply MPG-2 Multi-Purpose Grease to pump input shaft and key. (See ANTI-CORROSION GREASE in SPECIFICATIONS AND INFORMATION section.)
- Fill hydraulic reservoir to correct level with oil of proper specifications. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
- Bleed air from hydraulic system. (See HYDRAULIC SYSTEM BLEEDING PROCEDURE.)

HYDRAULIC PUMPS—DISASSEMBLY/INSPECTION



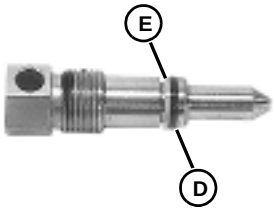
M84292

1. Remove four end cover cap screws (A).
2. Remove end cover (B) and gasket.



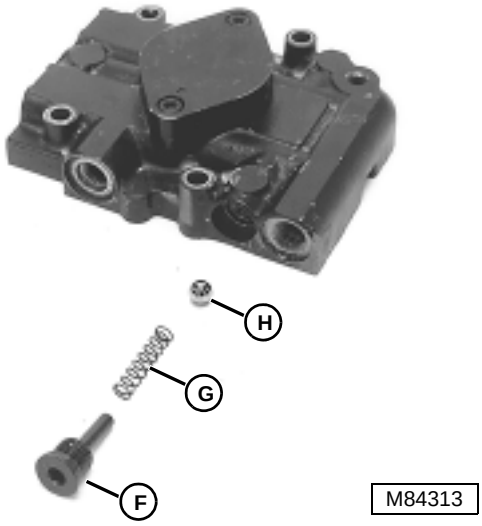
M84293

3. Remove the bypass valve (C) from end cover.



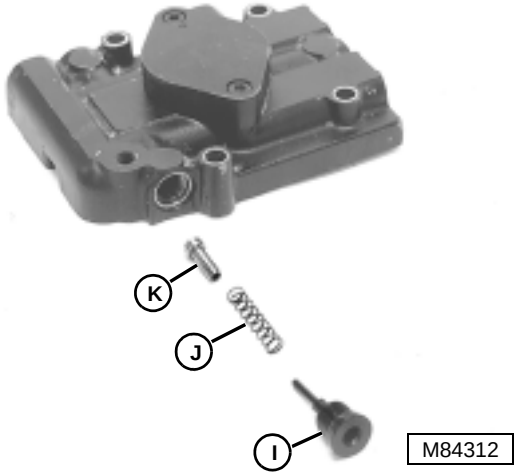
M84294

4. Remove O-ring (D) and backup ring (E).
5. Inspect bypass valve for damage. Replace if necessary.



M84313

6. Remove charge check valve plug (F), spring (G) and ball (H) from end cover.



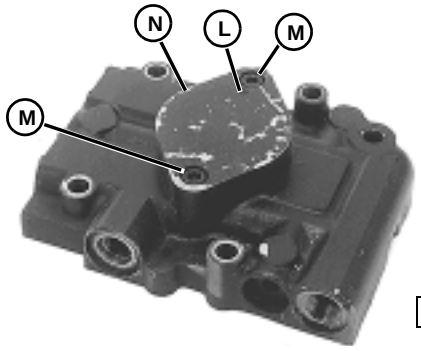
M84312

7. Remove charge check valve plug (I), spring (J) and poppet (K) from end cover.

M84296

M84295

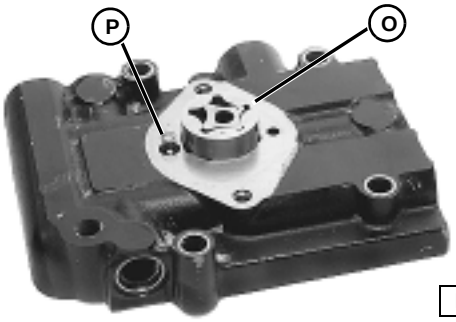
8. Inspect check valve ball (H) and poppet (K) and mating seats in the end cover for damage. Replace if necessary.



M84297

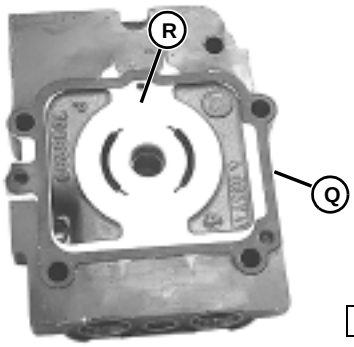
NOTE: Note the orientation of the mark (L) on the charge pump cover before removing to ensure correct installation. Incorrect installation will cause the charge pump to rotate in the opposite direction.

9. Remove charge pump cover screws (M).
10. Remove charge pump cover (N).



M84298

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.



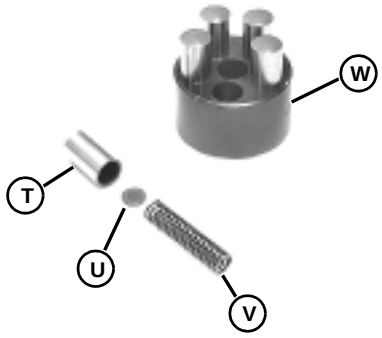
M84375

NOTE: Gasket may remain with pump housing when the end cover is removed.

14. Remove gasket (Q) and residue from end cover.
15. Inspect the running surface (R) for excessive wear and/or damage. Replace the end cap if necessary.

M84300

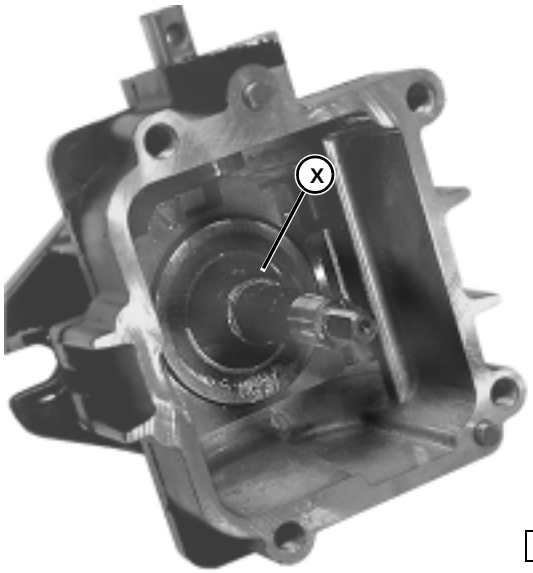
16. Remove pump cylinder block assembly (S) from pump shaft.



M84304

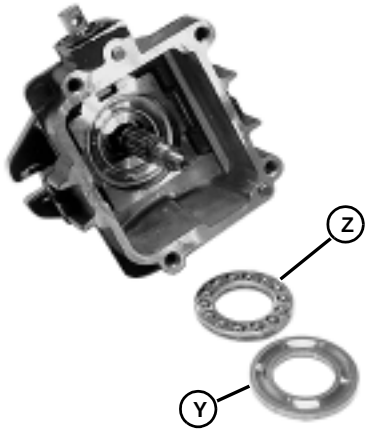
IMPORTANT: Note location of pistons to ensure installation in the same cylinder as they were removed from.

17. Remove pistons (T), disks (U) and springs (V) from cylinder block (W).
18. Inspect cylinder block components for damage, nicks, discoloration or unusual wear patterns. Replace components as a matched set if damage, discoloration or unusual wear is noted.



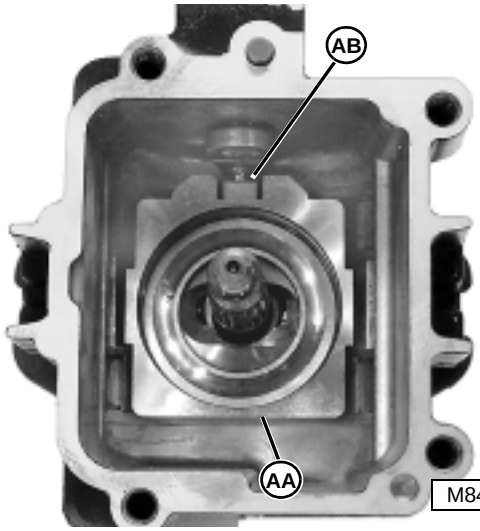
M84305

19. Remove spring (X) and washer from pump shaft.



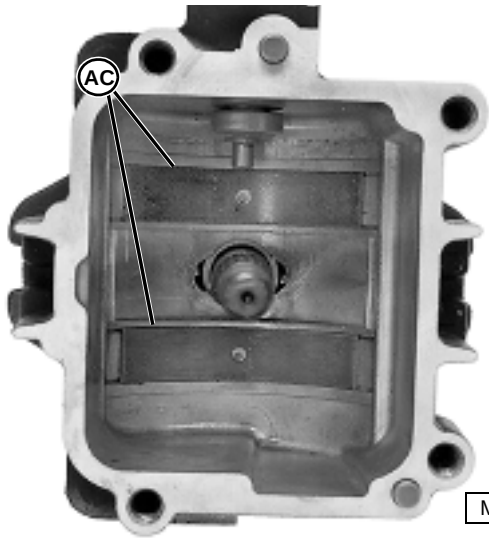
M84306

20. Remove thrust plate (Y) and thrust bearing (Z) from swashplate.



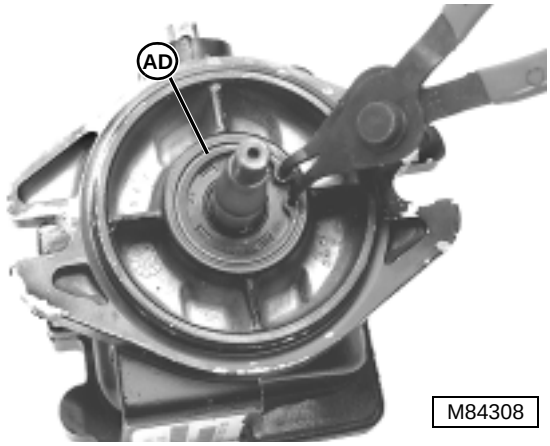
M84307

21. Remove swashplate (AA) from housing.
22. Remove the guide block (AB) from the displacement control shaft.



M84317

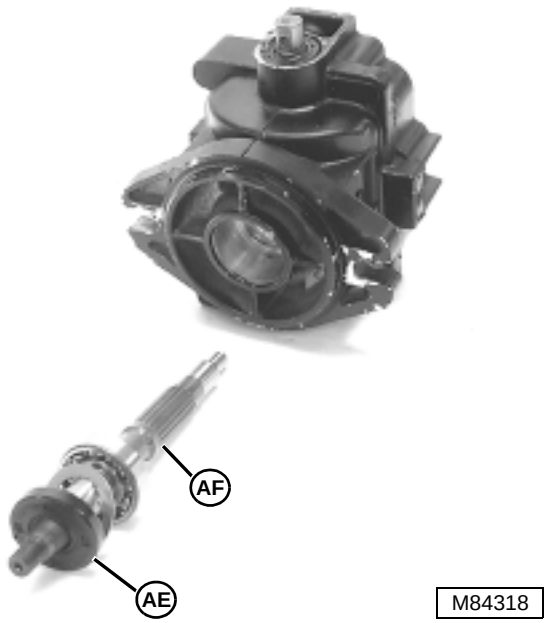
23. Inspect swashplate cradle bearings (AC).



M84308

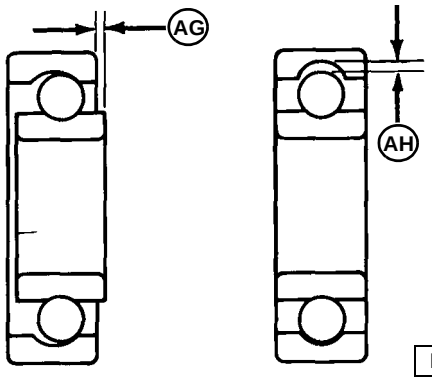
IMPORTANT: Use caution when removing the input shaft seal. DO NOT damage the seal bore.

24. Remove input shaft seal retaining ring (AD).



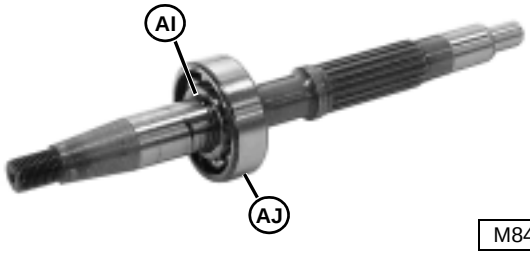
M84318

25. Drive the input shaft seal (AE) and shaft/bearing assembly (AF) out of the housing.
26. Remove shaft seal and bearing spacer washer.



M38073

27. Inspect the bearing for axial free play (AG) and/or radial free play (AH) and/or rough movement. Replace bearing if necessary.



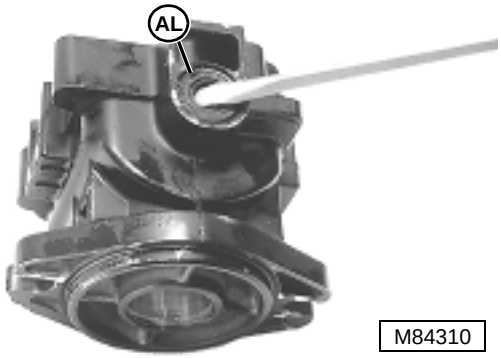
M84309

NOTE: Remove bearing only if the bearing and/or input shaft is to be replaced.

28. Remove the bearing retaining ring (AI).
29. Press the bearing (AJ) off the shaft.

M84311

30. Remove the displacement control shaft (AK) from the housing.



M84310

IMPORTANT: Use caution when removing the input displacement shaft seal. DO NOT damage the seal bore.

31. Carefully pry the displacement shaft seal (AL) from the housing bore.

IMPORTANT: Absolute cleanliness is essential when working on pump. Contamination can result in serious damage or inadequate operation.

DO NOT use shop towels or rags to dry cleaned parts. Lint will clog passages in the hydrostatic/ hydraulic system and cause damage.

⚠ CAUTION

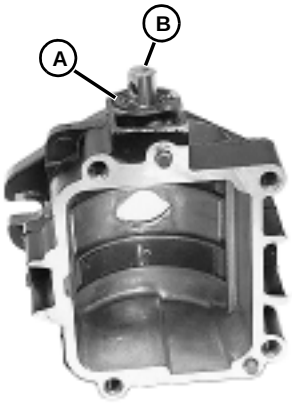
Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

32. Clean all metal parts with solvent and blow dry with compressed air.
33. Inspect all parts for damage, nicks or unusual wear. Replace parts if necessary.

HYDRAULIC PUMPS—ASSEMBLY

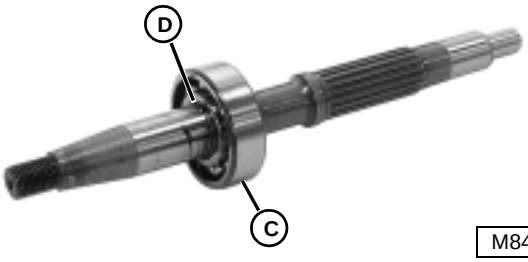
IMPORTANT: Always use new O-rings. Damaged or used parts will leak.

NOTE: Lubricate all O-rings, connector threads and moving parts (as indicated) with a light coat of clean hydraulic oil during assembly. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)



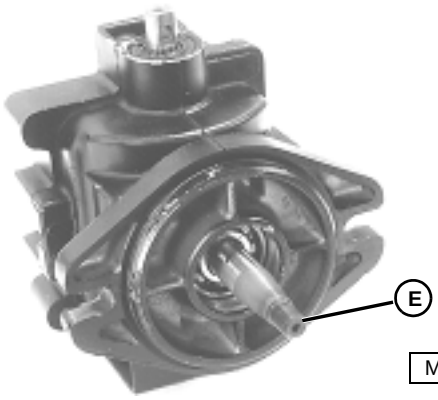
M84311

1. Install the displacement shaft seal (A) in the housing.
2. Apply multipurpose grease to seal lips.
3. Install displacement shaft (B).



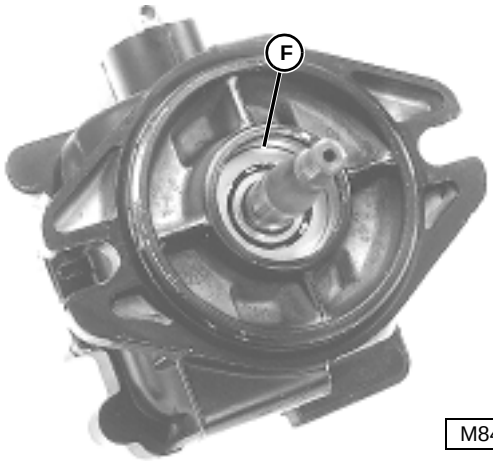
M84309

4. Press a new bearing (C) onto the input shaft.
5. Install a new bearing retaining ring (D) on the shaft.



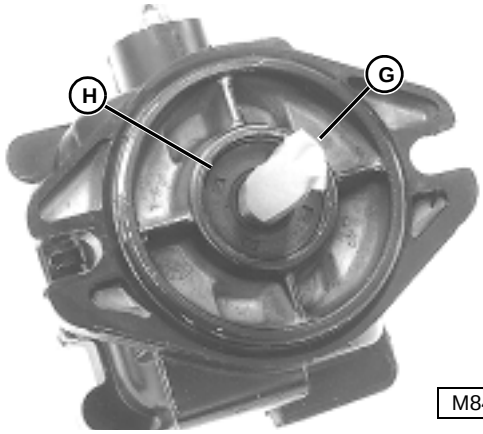
M84371

6. Install the input shaft (E) in the housing.



M84372

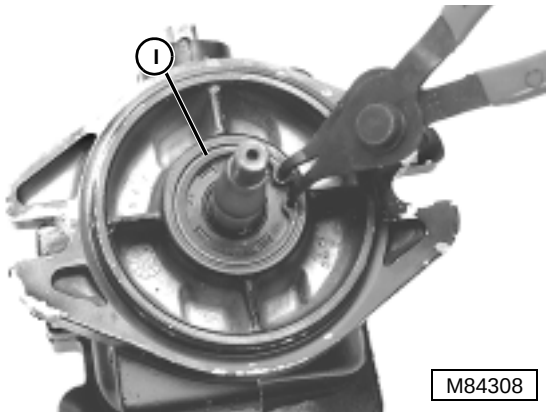
7. Install bearing spacer washer (F).



M84373

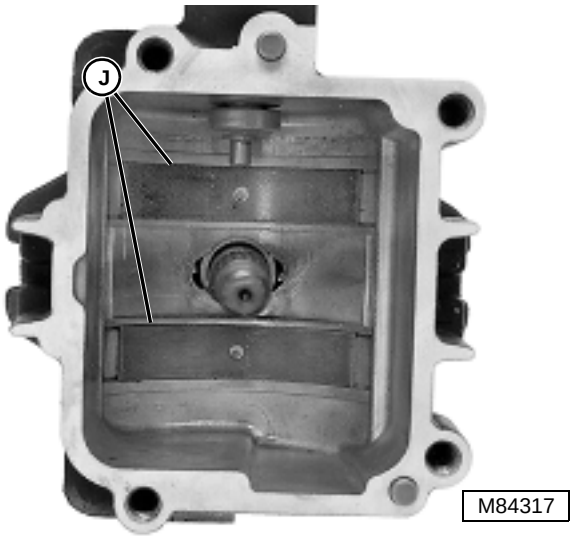
IMPORTANT: Apply multipurpose grease to the seal lips and tape to the threads and keyway of the pump shaft to prevent damage to the seal during installation.

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.

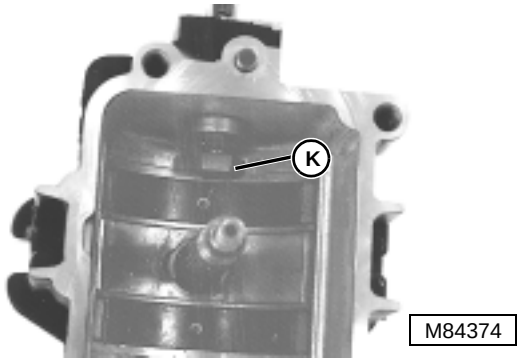


M84308

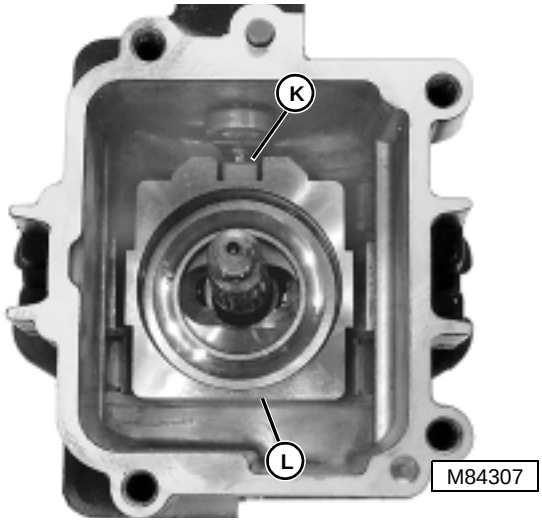
11. Install the seal retaining ring (I).



12. Install the swashplate cradle bearings (J) on the pins in the housing.

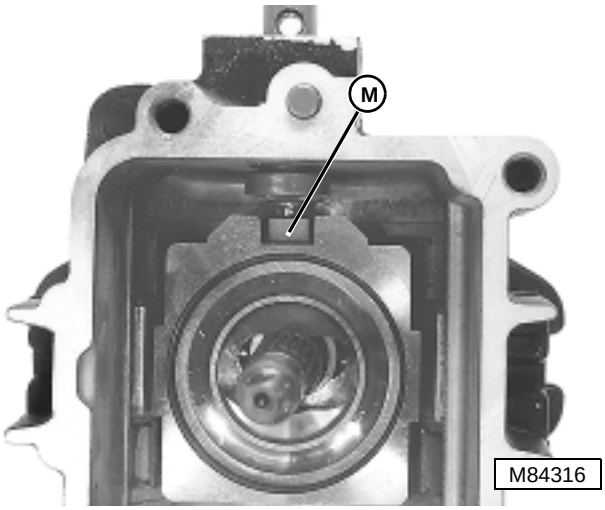


13. Apply a small amount of petroleum jelly to the guide block (K) and install the guide block on the displacement control shaft.

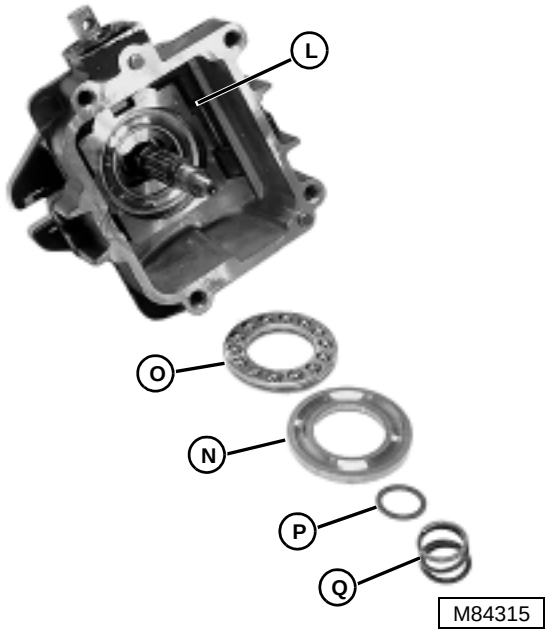


NOTE: Hold the guide block (K) in position while installing the swashplate assembly.

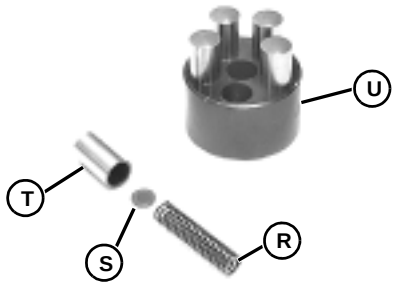
14. Install swashplate assembly (L) in housing.



15. Hold the swash plate in position and measure the side play of the displacement shaft using a dial indicator or depth gauge. The control shaft end plate end play should be between **0.508—1.524 mm (0.020—0.060 in.)**. If the clearance (M) is not correct, use a suitable sleeve to press the displacement control shaft bearing until the shaft end plate end play is within specifications.



16. Install thrust bearing on swashplate (L).
17. Install thrust plate (N) on bearing (O) with dished side toward bearing.
18. Install washer (P) and spring (Q) on pump shaft.



M84304

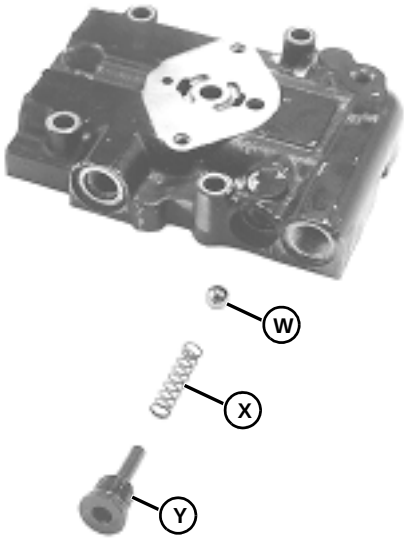
IMPORTANT: Install pistons into the same bores as removed from.

19. Install springs (R), disks (S) and pistons (T) in their original bores in the cylinder block (U). The pistons must move freely in the bores.

M84300

20. Position the pump housing on its side and move the swash plate to the 0° (neutral) position and install the cylinder block assembly (V) on the pump shaft.
21. Check the piston springs to make sure they are centered in the cylinder block bores. Carefully reposition if necessary.
22. Reposition the housing with cylinder block/opening facing up.

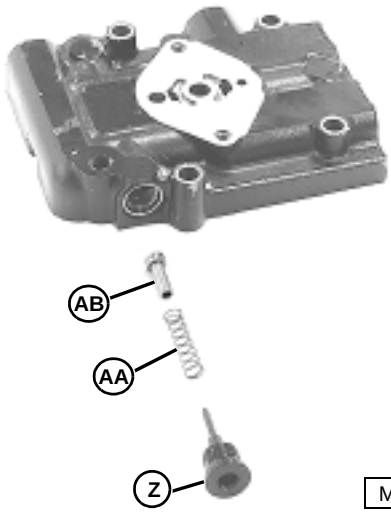
End Cover Assembly



M84376

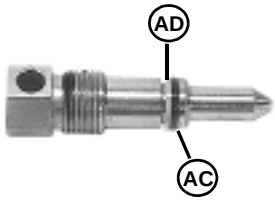
IMPORTANT: The check valve ball should not block the closed loop passage in the end cap.

23. Install the check valve ball (W), spring (X) and plug (Y) in the end cap. Tighten check valve to **23 N•m (204 lb-in.)**.



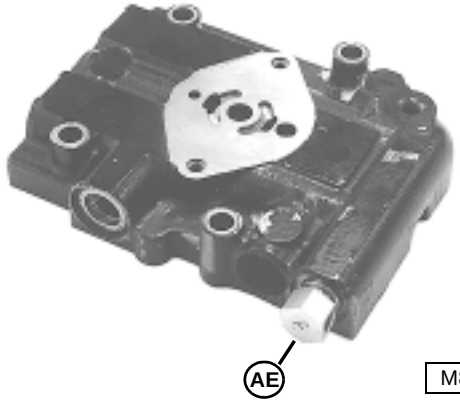
M84377

24. Install the check valve poppet (Z), spring (AA) and plug (AB) in the end cap. Tighten check valve to **23 N•m (204 lb-in.)**.



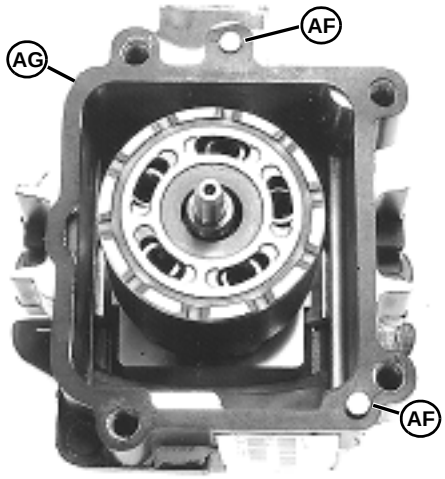
M84294

25. Install new O-ring (AC) and backup ring (AD) to bypass valve.



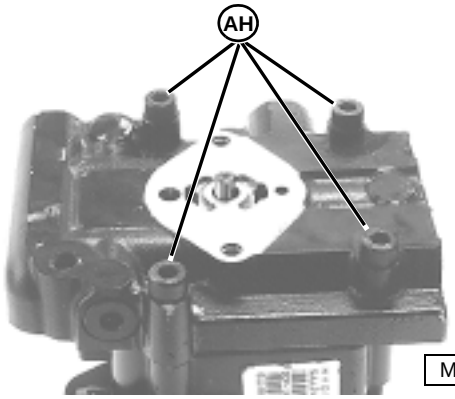
M84378

26. Install bypass valve (AE) in end cap. Tighten bypass valve to **13.5 N•m (119 lb-in.)**.
27. Position and support the pump housing with the opening facing up.



M84380

28. Install alignment pins (AF) (if removed) and a new gasket (AG).
29. Apply a light coat of clean hydraulic oil to the running surfaces of cylinder block and end cover.

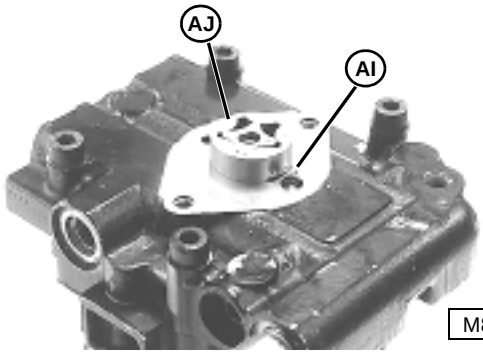


M84379

IMPORTANT: 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 **9 mm (3/8 in.)** away from the housing.*

30. Install end cover assembly. Tighten end cap screws (AH) in small increments, in an alternating pattern to **13.5 N•m (119 lb-in.)**.

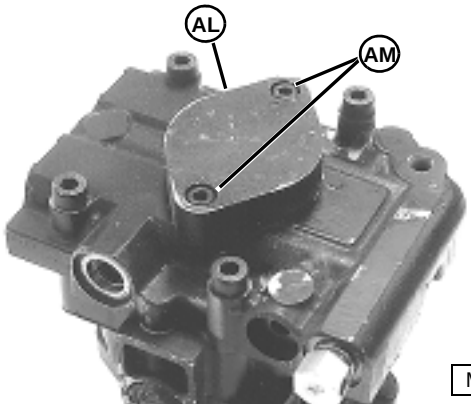


M84381

31. Install the charge relief valve ball and spring (AI).
32. Apply a light coat of petroleum jelly to the gerotor stator and rotor (AJ).
33. Install the gerotor stator and rotor.

M84314

34. Install a new O-ring (AK) in the charge pump cover.



M84382

35. Install the charge pump cover (AL), aligning the relief valve spring with the recess in the cover.
36. Tighten the charge pump cover screws (AM) to **13.5 N•m (119 lb-in.)**.

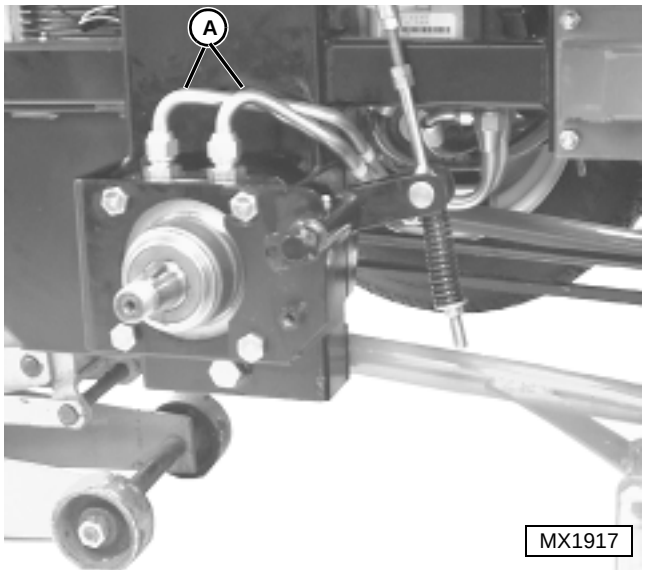
WHEEL MOTORS—REMOVAL/INSTALLATION

CAUTION

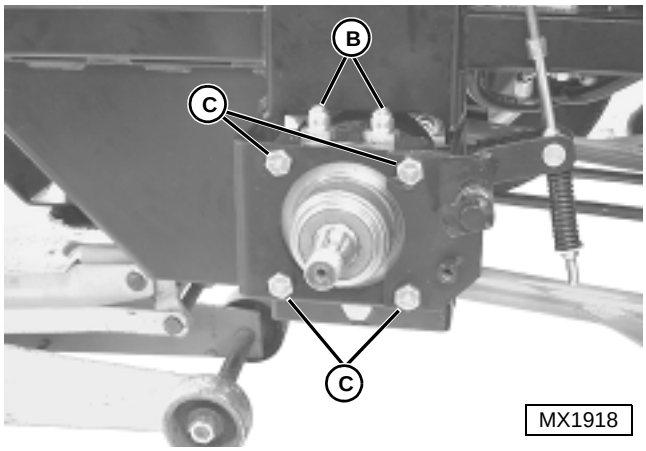
Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting any hoses. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury may call Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

1. Remove brake drum/wheel hub. (See BRAKE DRUM/WHEEL HUB—REMOVAL /INSTALLATION in BRAKES section.)



2. Remove hydraulic pump-to-wheel motor hydraulic lines (A).

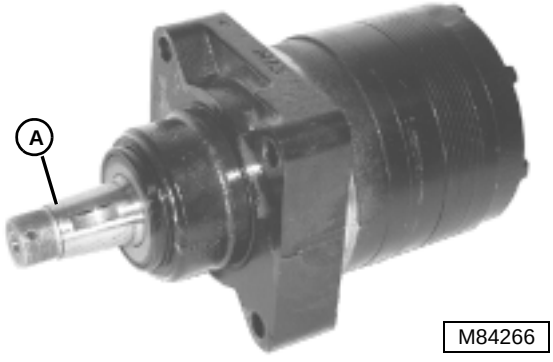


3. Remove fittings (B)
4. Remove cap screws and nuts (C).
5. Remove the wheel motor.

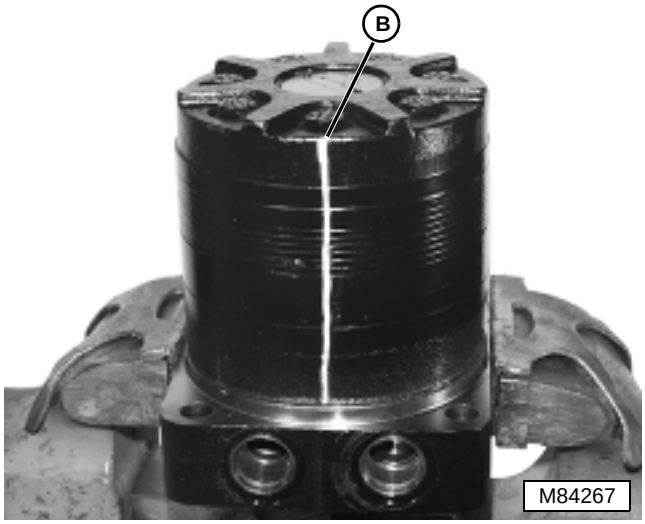
Installation is done in the reverse order of removal.

- Apply MPG-2 Multi-Purpose Grease to pump output shaft and key. (See ANTI-CORROSION GREASE in SPECIFICATIONS AND INFORMATION section.)
- Tighten the nut securing the wheel hub to the wheel motor to **109 N•m (80 lb-ft)**.
- Fill hydraulic reservoir to correct level with oil of proper specifications. (See HYDROSTATIC TRANSMISSION AND HYDRAULIC OIL—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
- Bleed air from hydraulic system. (See HYDRAULIC SYSTEM BLEEDING PROCEDURE.)

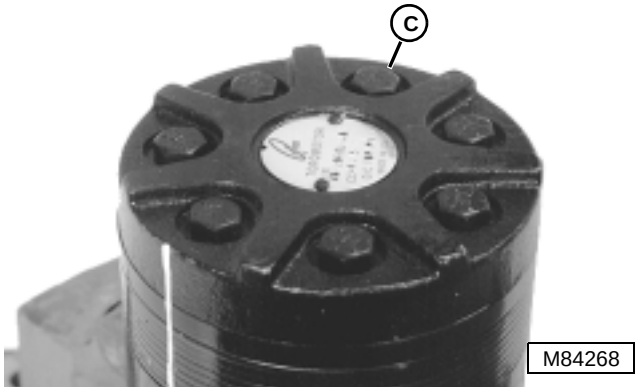
WHEEL MOTORS—DISASSEMBLY/INSPECTION



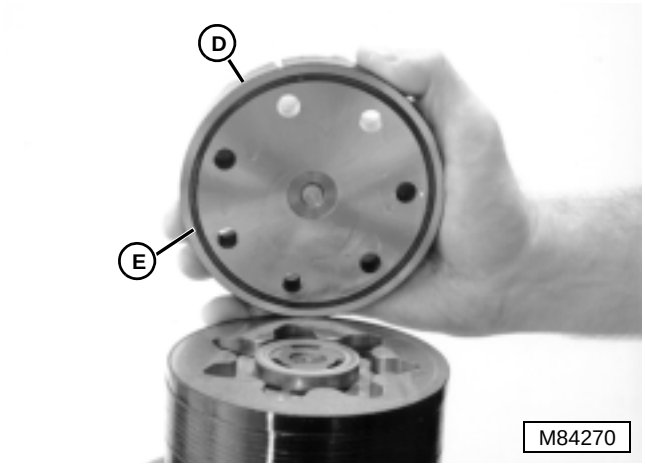
1. Clean rust, dirt and corrosion from coupling shaft (A).



2. Place wheel motor in a soft-jawed vise with the output shaft down, clamping firmly on sides of the housing, mounting flange or port bosses.
3. Scribe (or paint) an alignment mark (B) across the motor housing.



4. Remove seven retaining bolts (C).
5. Inspect bolts for damaged threads and damage to sealing ring under the bolt head.



6. Remove end cover (D) assembly and seal ring (E). Discard seal ring.

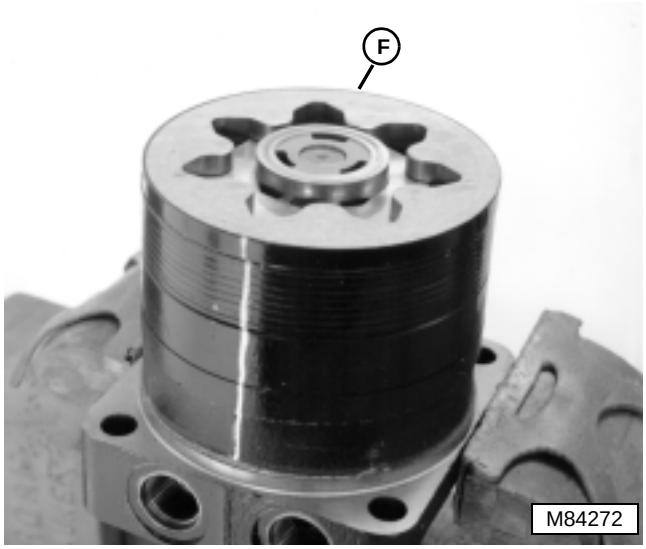
⚠ CAUTION

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.

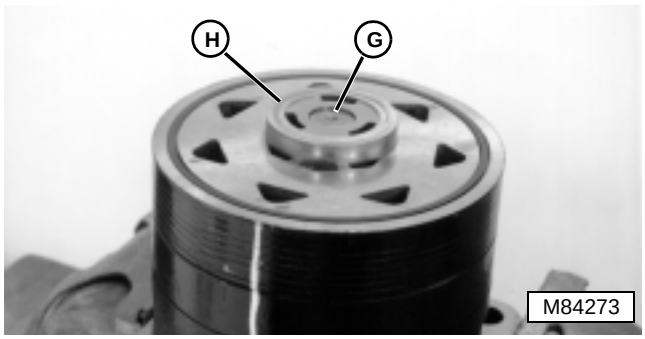
7. Thoroughly clean end cover with solvent and blow dry with compressed air.

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.

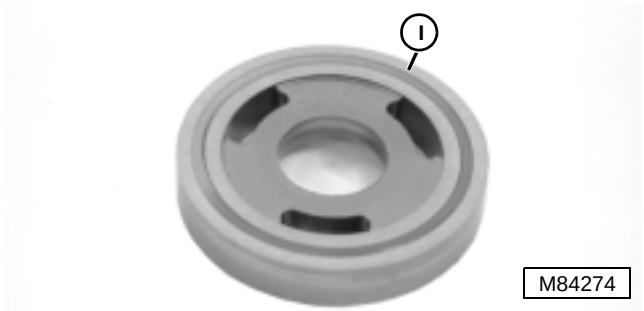


9. Remove commutator ring (F).
10. Inspect commutator ring for cracks or burrs.



NOTE: Drive link (G) may stick to commutator. Hold drive link in place while removing commutator.

11. Remove commutator (H).



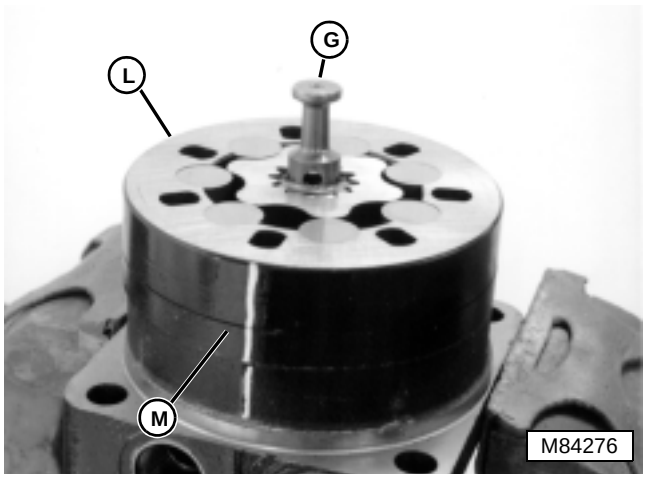
12. Remove seal ring (I) from commutator by blowing compressed air into the ring grove until the seal ring is lifted out of the groove. Discard seal ring.
13. Inspect commutator for cracks, burrs, scoring, spalling, brinelling or unusual wear.

NOTE: Make note of orientation of manifold to ensure correct installation.

14. Remove manifold (J).
15. Remove seal rings (K) from both sides of the manifold. Discard seals.

NOTE: A polished pattern on the ground surface of the manifold caused by rotation of the commutator is normal.

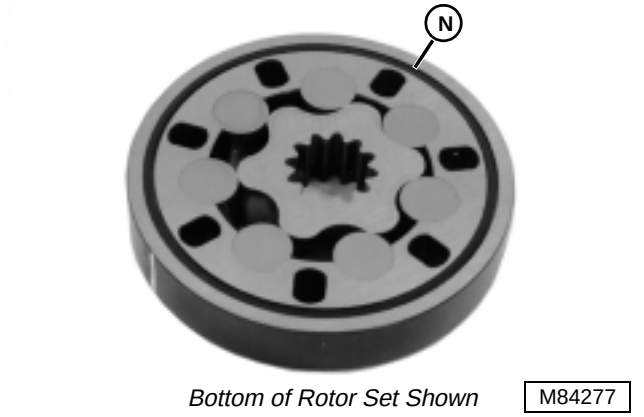
16. Inspect manifold for cracks, surface scoring, spalling or brinelling.



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.

17. Remove rotor set and wear plate as a set.

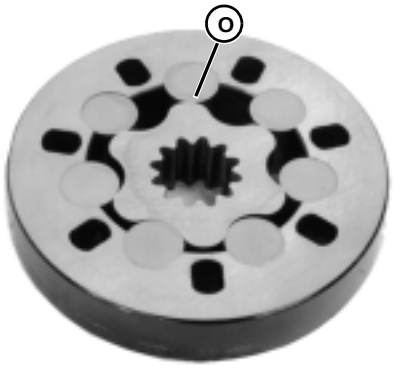


Bottom of Rotor Set Shown

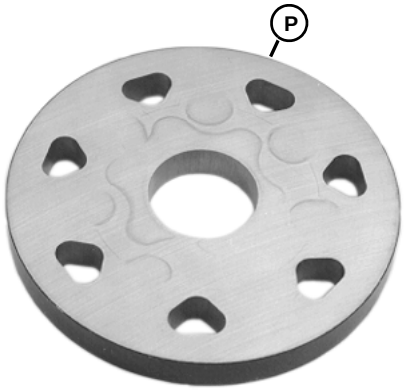
NOTE: Maintain rotor set components in their original positions. DO NOT disassemble.

If disassembly is required, mark the upper surface of the rotor and stator, and all rotor components to ensure correct installation during assembly.

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, or for broken or worn splines.

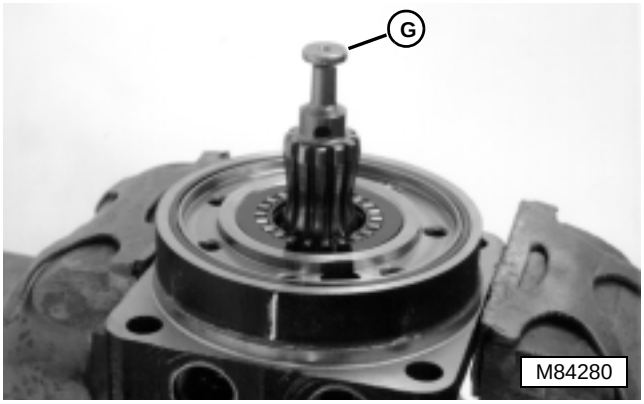


20. Place rotor set on a surface plate.
21. Position the rotor in the stator so that two rotor lobes (180° apart) and roller vane centerline are on the same stator centerline.
22. Check the rotor lobe-to-roller vane clearance (O) at the common centerline using a feeler gauge. Clearance should not be greater than **0.13 mm (0.005 inches)**.



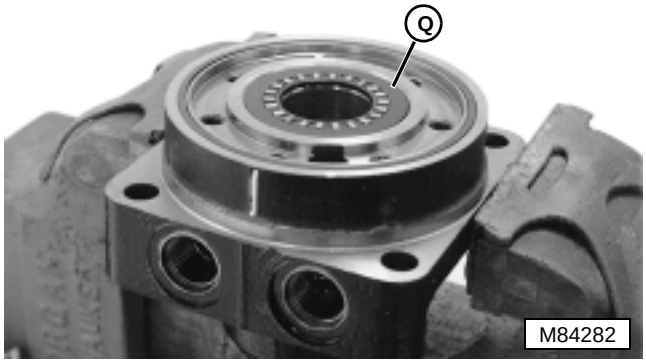
NOTE: A polished pattern on the ground surface of the wear plate (P) caused by rotation of the rotor is normal.

23. Inspect wear plate for cracks, brinelling or scoring.

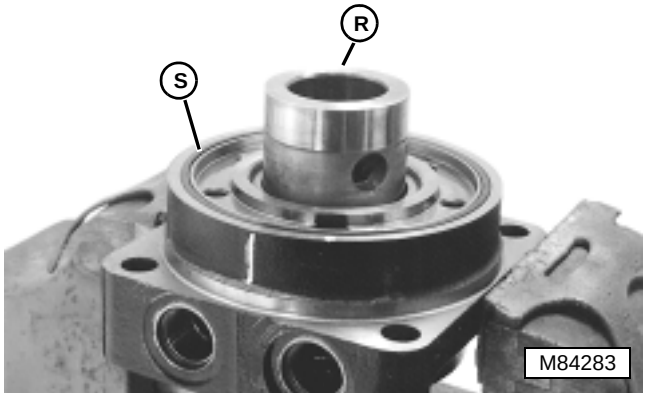


24. Inspect for play between drive link (G) and coupling shaft. There should be no noticeable play.
25. Mark drive link and coupling shaft splines to ensure reassembly in the original positions.
26. Remove drive link from the coupling shaft.

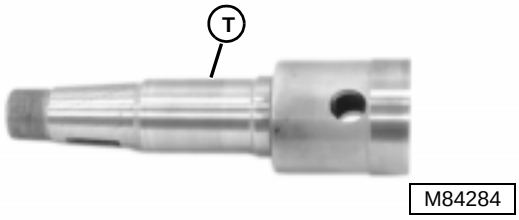
27. Inspect the drive link for cracks and worn or damaged splines.



28. Remove thrust bearing (Q) from coupling shaft.
29. Inspect thrust bearing for wear, brinelling, corrosion and missing rollers.



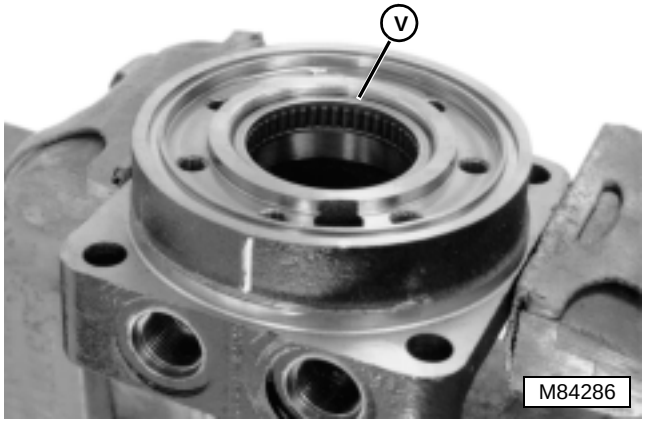
30. Remove coupling shaft (R).
31. Remove seal ring (S) from housing. Discard seal.



32. Inspect coupling shaft bearing and seal surface (T) for spalling, nicks, excessive wear or corrosion.

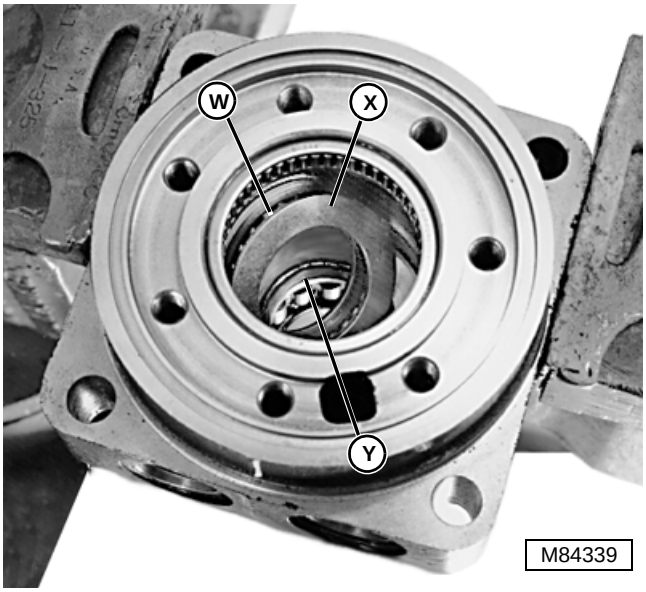
M84285

33. Inspect coupling shaft splines (U) for wear or damage.



M84286

34. Inspect inner bearing (V) for free rotation and excessive play in bearing cage. Also inspect bearing for brinelling or corrosion

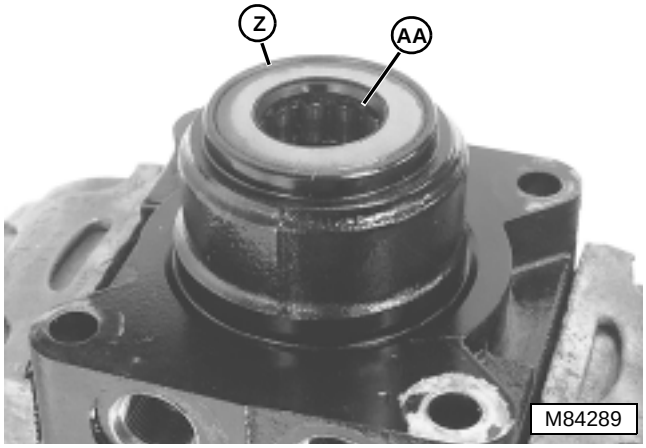


M84339

35. Inspect thrust bearing (W).

NOTE: A dental pick or similar device can be used to remove the seal.

36. Push thrust bearing and washers (X) aside and remove seal (Y) and backup washers.



M84289

37. Remove wheel motor from vise, invert it and reinstall it in vise.
38. Remove seal (Z) using a blind-hole bearing or seal puller.
39. Inspect the housing for cracks, excessive wear or damage. Inspect machined surfaces for nicks, burrs, brinelling or corrosion. Inspect tapped holes for thread damage.
40. Inspect bearings (AA) for free rotation and excessive play in bearing cages. Also inspect bearings for brinelling or corrosion.

IMPORTANT: Absolute cleanliness is essential when working on wheel motor. Contamination can result in serious damage or inadequate operation.

DO NOT use shop towels or rags to dry cleaned parts. Lint will clog passages in the hydrostatic/ hydraulic system and cause damage.

⚠ CAUTION

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.

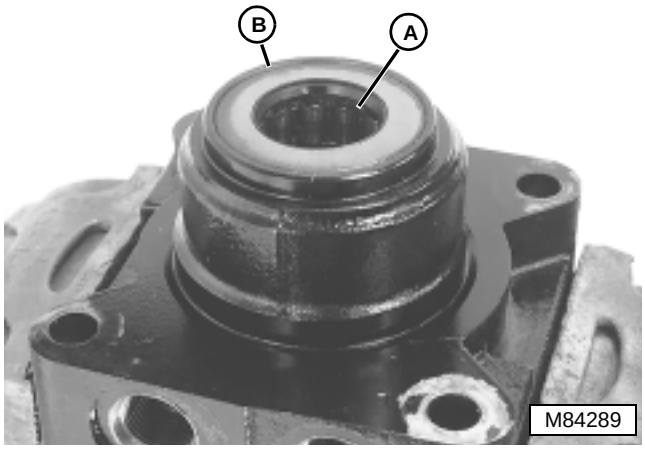
41. Clean all metal parts with solvent and blow dry with compressed air.
42. Inspect all parts for damage, nicks or unusual wear. Replace entire wheel motor assembly if any parts other than seal rings, seals or outer bearing are worn or damaged.

WHEEL MOTORS—ASSEMBLY

IMPORTANT: Always use new O-rings. Damaged or used parts will leak.

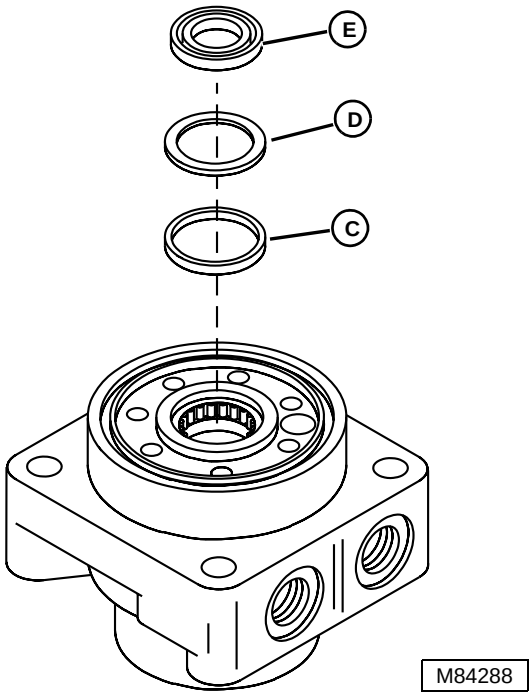
NOTE: Alignment studs screwed finger tight into the bolt holes 180° apart can be used to assist alignment during assembly. Alignment studs can be made by cutting the heads off 3/8-24 UNF 2A x 5-in. cap screws.

Lubricate all seals and seal rings with Mobilith SHC® 460 grease (supplied with seal kit) during assembly.



IMPORTANT: The outer bearing is not lubricated by the system's hydraulic oil. Thoroughly pack the bearing with grease before installation.

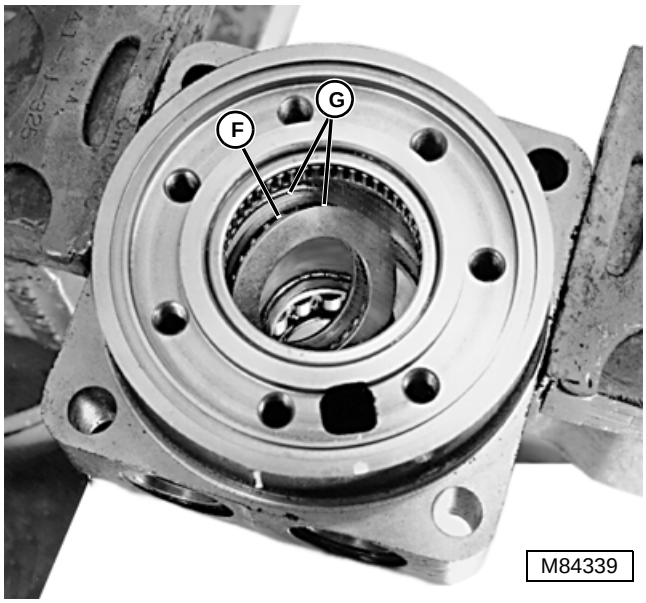
1. Pack and coat the new outer bearing/bushing (A) with anti-corrosion grease.
2. Install a new outer bearing seal (B) with the lip facing out. Press seal into housing until the seal is flush with the end of the housing.
3. Remove wheel motor from vise, invert it and reinstall it in vise.



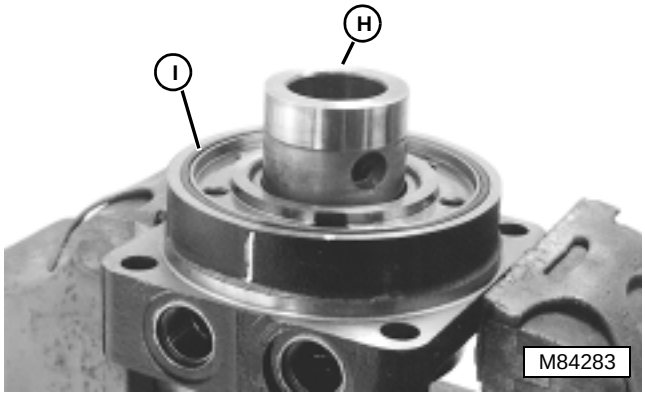
4. Install backup ring (C) and washer (D).

IMPORTANT: Make sure the seal is completely seated in bore. Improper seating may result in seal damage when installing coupling shaft, resulting in leakage.

5. Install a new seal (E) with the lip facing toward the inside of the motor.



6. Seat thrust bearing (F) and thrust washers (G) (one above and one below the thrust bearing).

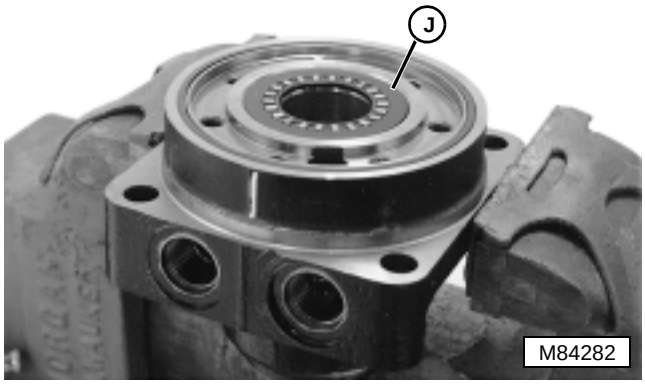


IMPORTANT: Apply anti-corrosion grease to the outer bearing/bushing and tape to the threads and keyway of the coupling shaft to prevent damage to the seal during installation.

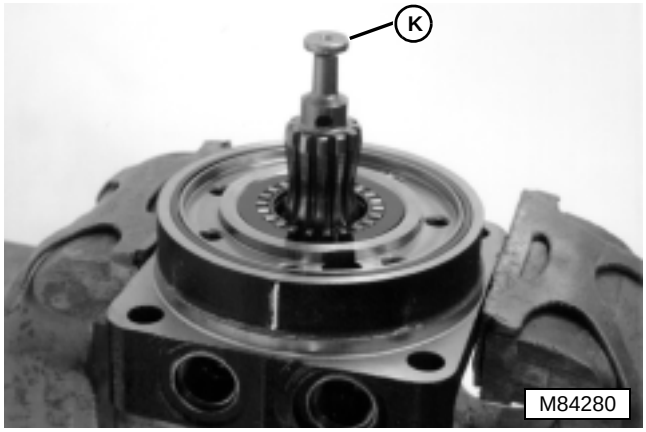
7. Apply tape to the threads and keyway of the coupling shaft (H) to prevent damage to the seal (I) during installation.
8. Apply grease to the seal.

*NOTE: When properly installed, the coupling shaft will be approximately **2.54 mm (0.10 in.)** below the housing wear surface plate. The coupling shaft must rotate freely on the thrust bearing assembly.*

9. Install the coupling shaft into the housing until it rests against the thrust washer.
10. Apply a light coat of grease to the seal ring.
11. Install seal ring in the groove in the housing.



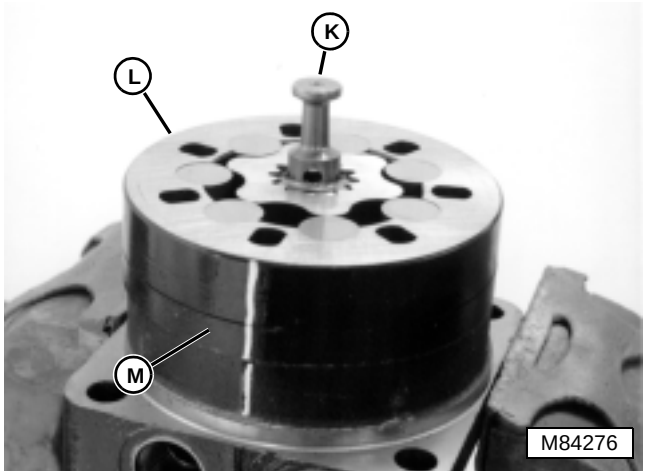
12. Install thrust bearing (J) on the coupling shaft.



13. Install drive link (K) with the splined end toward the coupling shaft. Align marked splines on drive link and coupling shaft.

Bottom of Rotor Set Shown M84277

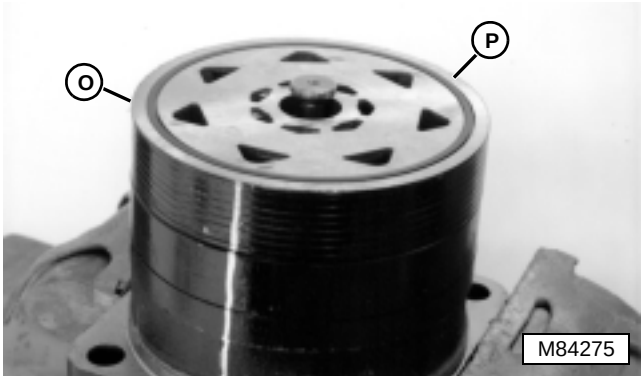
14. Apply a light coat of grease to seal ring (L).
15. Install seal ring in the groove in the rotor set assembly.
16. Install wear plate on rotor set.
17. Carefully flip rotor set/wear plate assembly over, while holding rotor set components in place.



18. Install rotor set (L) and wear plate (M) over the drive link (K).

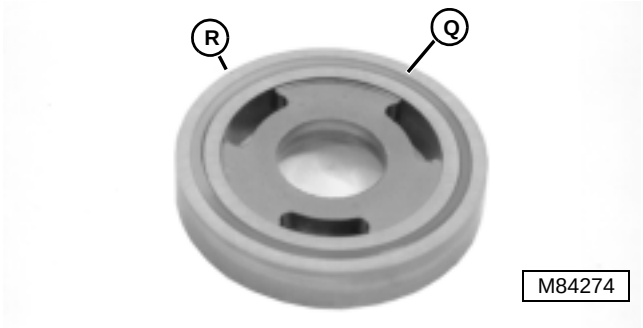
Bottom of Manifold Shown M84340

19. Apply a light coat of grease to seal ring (N).
20. Install seal ring in the groove in the bottom of manifold.

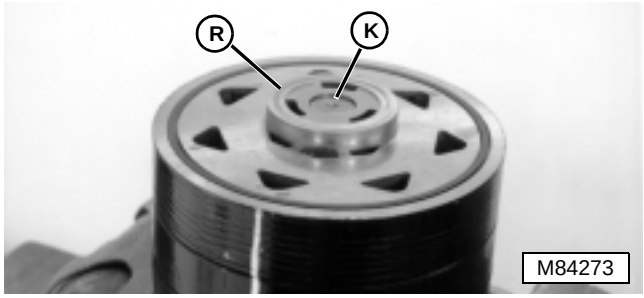


NOTE: Correct installation of the manifold is important for proper operation. The manifold should be installed with the surface with the irregular shaped cavities on the largest circumference toward the rotor set.

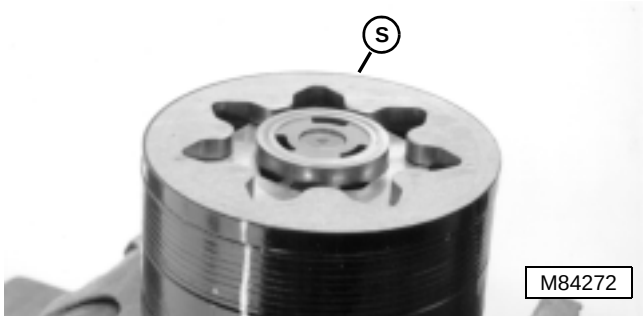
21. Install manifold (O).
22. Apply a light coat of grease to the seal ring (P).
23. Install seal ring in the groove in the manifold.



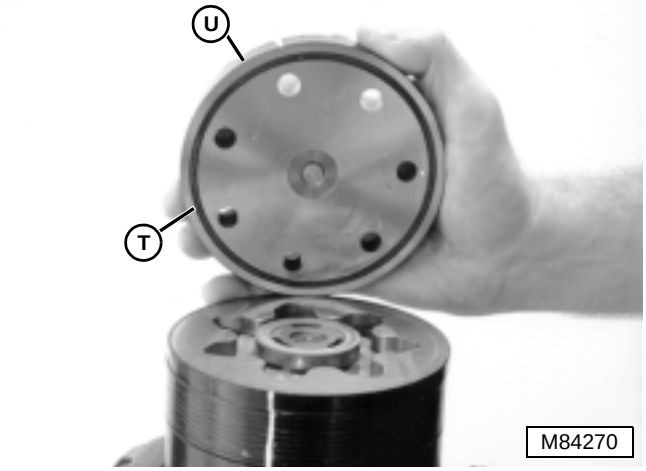
24. Apply a light coat of grease to the seal ring (Q).
25. Install seal ring in the groove in the commutator (R).



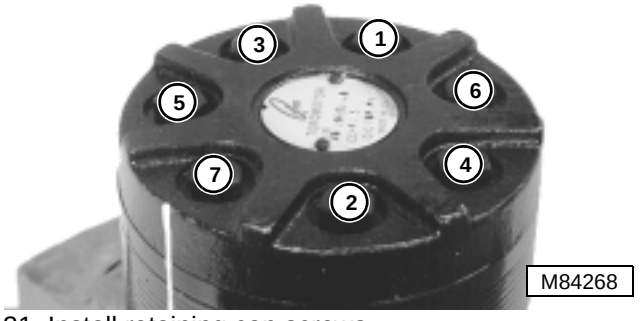
26. Install commutator (R) on drive link (K).



27. Install commutator ring (S).



28. Apply a light coat of grease to seal ring (T).
29. Install seal ring in the groove in the end cover (U).
30. Install end cover.



31. Install retaining cap screws.
32. Tighten cap screws evenly, in the sequence shown, to **68 N•m (50 lb-ft)**.

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CONTENTS

SPECIFCIATIONS

ADJUSTMENT SPECIFICATIONS

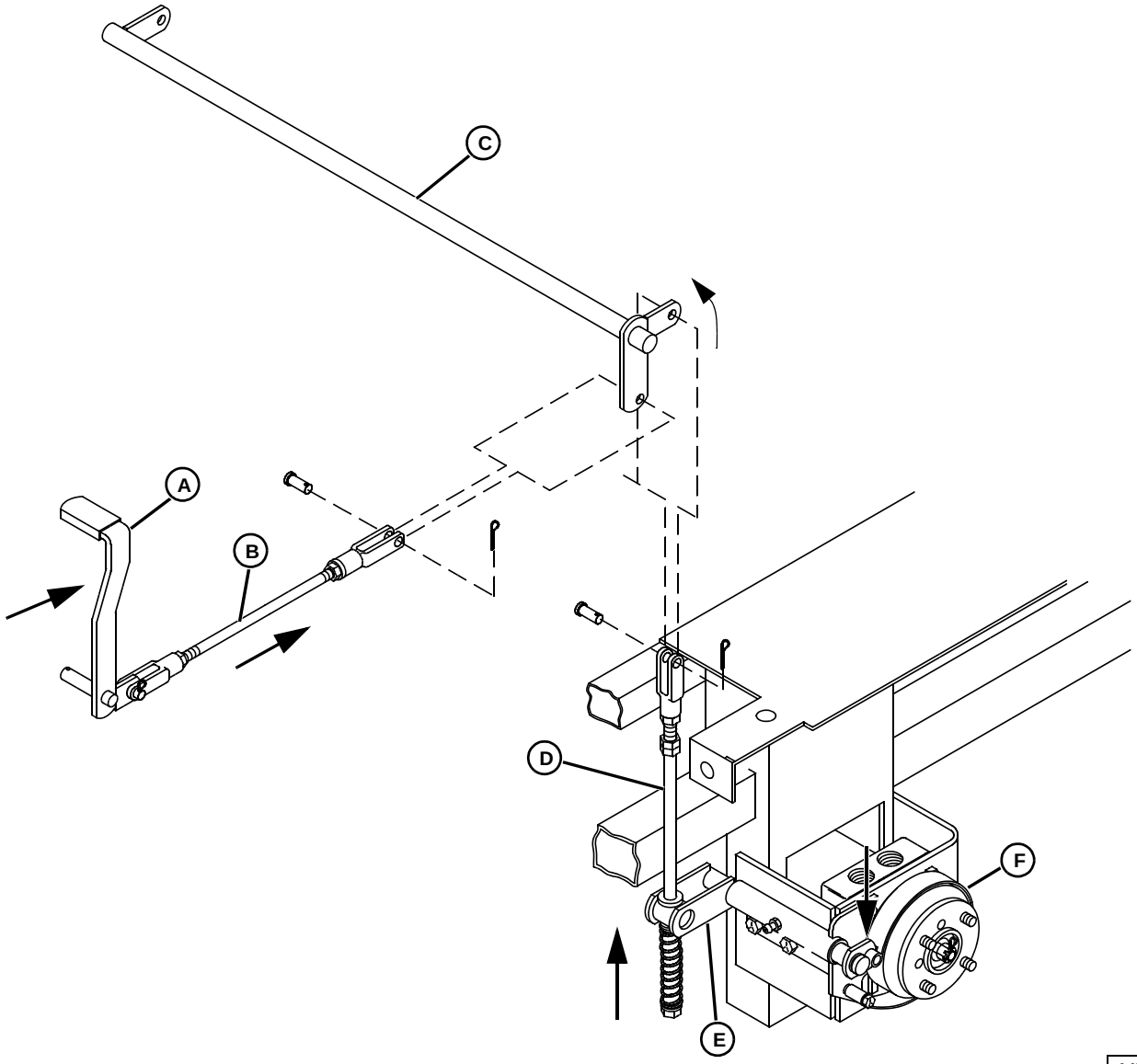
Distance Between Trunnion Pin and Bottom of Collar . . . . . 6—8 mm (0.125—0.25 in.)
Brake Linkage Spring Distance (Unloaded) . . . . . 67—70 mm (2.625—2.75 in.)

REPAIR SPECIFICATIONS

Brake Rotor Retaining Nut Torque . . . . . 109 N•m (80 lb-ft)
Brake Lining Minimum Thickness . . . . . 1.6 mm (1/16 in.)

COMPONENT LOCATION AND OPERATION

BRAKE SYSTEM OPERATION



MX1955

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 HYDRAULIC POWER TRAIN section.)

Theory of Operation—Park Brake:

NOTE: Right-side linkage shown.

The park brake consists of a lever-operated band brakes mounted on each of the wheel motor hubs.

When the park brake lever (A) moved to the engaged position, the lever link arm (B) linkage is pushed back, causing the actuator shaft (C) to rotate, pulling the brake linkage (D) up. This movement causes actuator levers (E) to tighten the brake bands (F) against the brake drum mounted on the wheel motor hub.

TROUBLESHOOTING

BRAKES SYSTEM TROUBLESHOOTING CHART

Problem or Symptom / Check or Solution	Machine will not move.	Park brake will not engage.	Park brake will not hold machine.	Excessive brake wear.
Park brake engaged.	●			
Brake linkage not properly adjusted.	●	●	●	●
Brake linkage damaged.		●	●	
Brake linkage jammed or binding.	●			●
Brake bands worn or damaged.		●	●	
Brake drum warped or damaged.				●

DIAGNOSIS

MACHINE WILL NOT MOVE

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake released.
- Control levers in NEUTRAL LOCK position.

Test Location	Normal	If Not Normal
1. Park brake lever.	Brake lever not engaged.	Release park brake.
2. Brake linkage.	Brake linkage adjusted properly.	Adjust brake linkage. (See PARK BRAKE CHECK AND ADJUSTMENT.)
	Brake linkage moving freely, not jammed or binding.	Repair park brake. (See PARK BRAKE LINKAGE—REPAIR.)

PARK BRAKE WILL NOT ENGAGE

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake released.
- Control levers in NEUTRAL position.

Test Location	Normal	If Not Normal
1. Brake linkage.	Brake linkage adjusted properly.	Adjust brake linkage. (See PARK BRAKE CHECK AND ADJUSTMENT.)
	Brake linkage not damaged.	Repair brake linkage. (See PARK BRAKE LINKAGE—REPAIR.)
2. Park brake band(s).	Brake band/lining not worn or damaged.	Replace brake bands. (See BRAKE BAND—REMOVAL/INSTALLATION.)
3. Brake drum(s).	Brake drum not damaged.	Replace brake drums(s). (See BRAKE DRUMS/WHEEL HUB—REMOVAL/INSTALLATION.)

PARK BRAKE WILL NOT HOLD MACHINE

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake released.
- Control levers in NEUTRAL LOCK position.

Test Location	Normal	If Not Normal
1. Brake linkage.	Brake linkage adjusted properly.	Adjust brake linkage. (See PARK BRAKE CHECK AND ADJUSTMENT.)
	Brake linkage not broken.	Repair brake linkage. (See PARK BRAKE LINKAGE—REPAIR.)
2. Park brake band(s).	Brake band/lining not worn or damaged.	Replace brake bands. (See BRAKE BAND—REMOVAL/INSTALLATION.)
3. Brake drum(s).	Brake drum not damaged.	Replace brake drums(s). (See BRAKE DRUMS/WHEEL HUB—REMOVAL/ INSTALLATION.)

EXCESSIVE BRAKE WEAR

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Park brake released.
- Control levers in NEUTRAL position.

Test Location	Normal	If Not Normal
1. Brake linkage.	Brake linkage adjusted properly.	Adjust brake linkage. (See PARK BRAKE CHECK AND ADJUSTMENT.)
	Brake linkage moving freely, not jammed or binding.	Repair park brake. (See PARK BRAKE LINKAGE—REPAIR.)

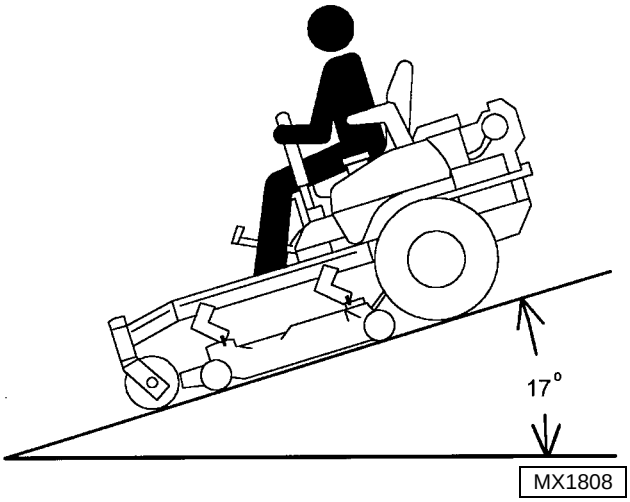
CHECKS, TEST AND ADJUSTMENTS

PARK BRAKE CHECK AND ADJUSTMENT

Reason:

To ensure correct park brake adjustment.

Check Procedure—Brake Engaged:



1. Stop the machine on a maximum of 17° slope.
2. Raise park brake lever to the PARK position.

Results:

- If adjusted properly, the brakes must prevent the front wheels from turning. If wheels turn, perform Adjustment Procedure.

Check Procedure—Brake Released:

1. Park machine safely.
2. Start engine.
3. Release park brake lever.
4. Move both control levers forward.

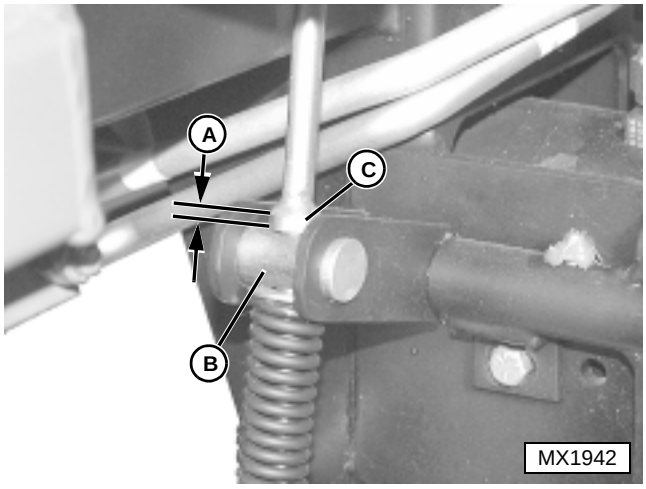
Results:

- If the brakes are adjusted properly, the drive wheels should turn freely and the machine should begin to travel forward. Adjust the brakes if needed.
- If the brakes are adjusted too tight, an audible hydrostatic whine will be detected and the machine will move slowly. Adjust the brakes if needed.

Adjustment Procedure:

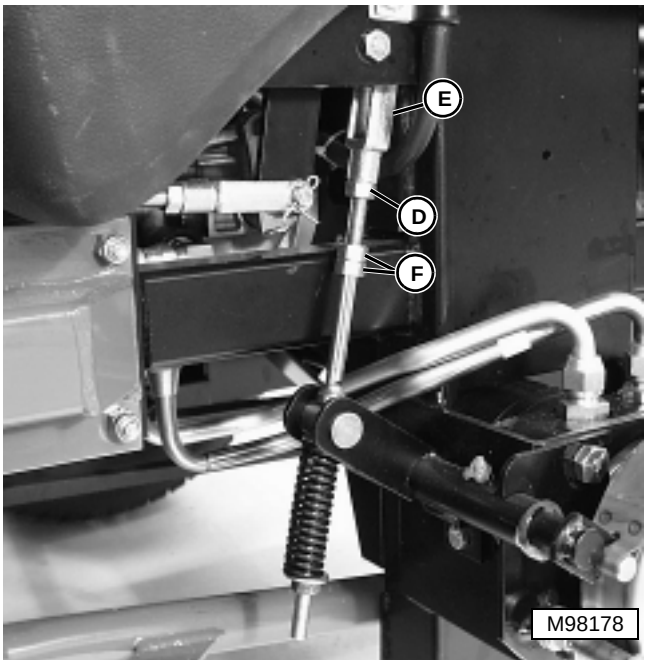
IMPORTANT: Right and left brakes must be adjusted evenly to ensure maximum brake performance and prevent uneven brake wear.

1. Park machine safely.



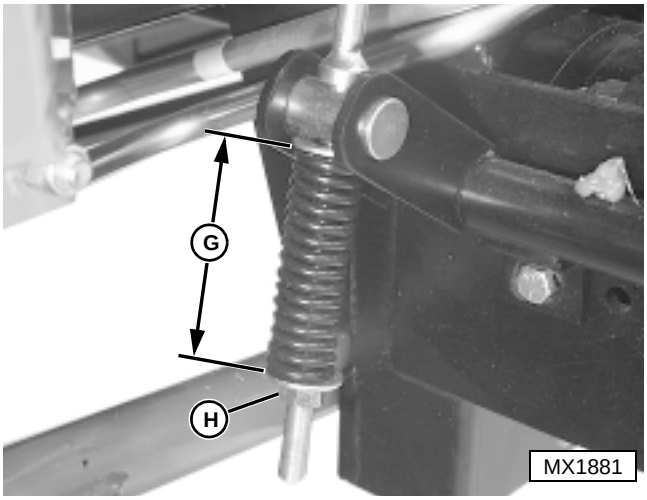
2. Measure the distance (A) between the top of the trunnion pin (B) and the bottom of the collar (C) welded to the brake rod. The distance should be **6—8 mm (0.125—0.25 in.)**.

   If adjustment is required, proceed to step 3.



NOTE: Wheel/tire removed for illustration purposes only. It is not necessary to remove the wheel/ tire to perform the adjustment procedure.

3. Loosen the jam nut (D) located directly below the yoke (E).
4. Rotate the double nuts (F) clockwise (or counter-clockwise) as needed until the he distance between the top of the trunnion pin and the bottom of the collar welded to the brake rod is **6—8 mm (0.125—0.25 in.)**.
5. Tighten jam nut (D) against the yoke (E).
6. Repeat adjustment for the other side.
7. Disengage the park brake.



8. Measure the distance (G) between the washers on each end of the linkage spring. The distance should be **67—70 mm (2.625—2.75 in.)**.

   If adjustment is required, proceed to step 9.

9. Turn the hex nut (H) at the bottom of the spring to until the distance between the washers on each end of the linkage spring is **67—70 mm (2.625—2.75 in.)**.

   To decrease the distance between the washers (shorten spring); Turn the nut counterclockwise.

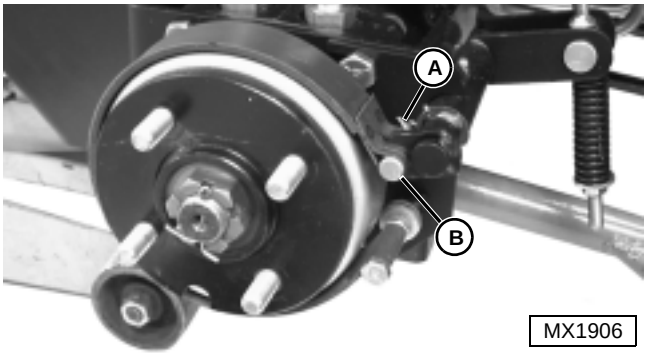
   To increase the distance between the washers (lengthen spring); Turn the nut clockwise.

10. Repeat adjustment for the other side.

REPAIR

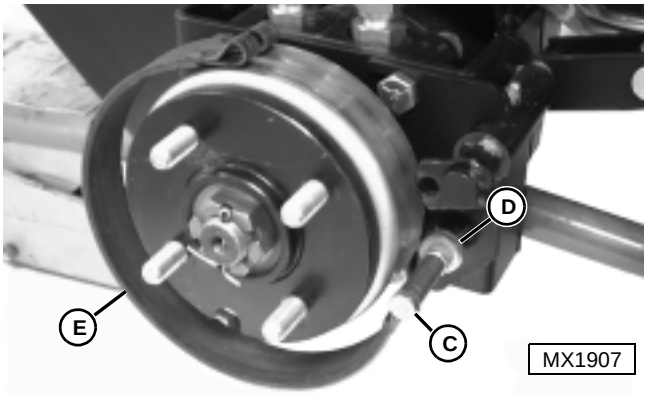
BRAKE BAND—REMOVAL/INSTALLATION

1. Remove drive wheel(s). (See REAR (DRIVE) WHEELS—REMOVAL/INSTALLATION in MISCELLANEOUS section.)



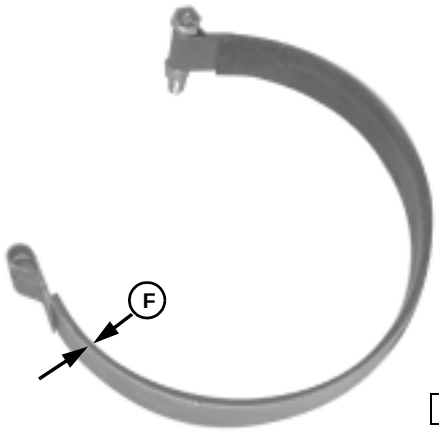
MX1906

2. Remove cotter pin (A).
3. Remove retainer pin (B).



MX1907

4. Remove anchor cap screw (C) and washers (D).
5. Remove brake band (E).



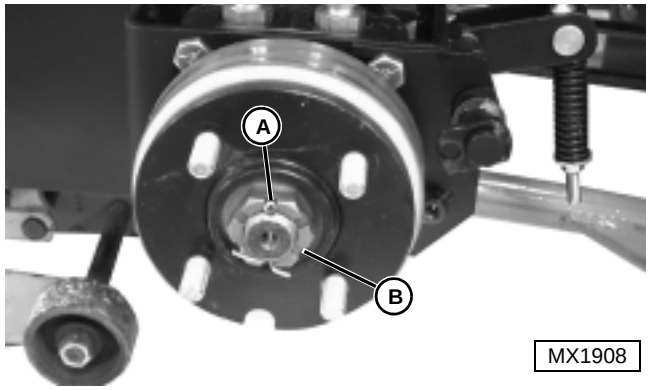
MX1909

6. Measure the thickness of the brake lining (F). Replace the brake band if the lining is less than **1.6 mm (1/16 in.)**.

Installation is done in the reverse order of removal.

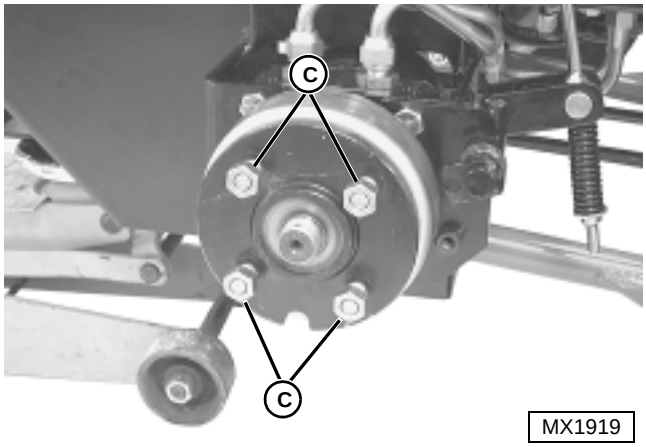
BRAKE DRUM/WHEEL HUB—REMOVAL/INSTALLATION

1. Remove brake band. (See BRAKE BAND—REMOVAL/INSTALLATION.)



MX1908

2. Remove cotter pin (A).
3. Remove nut (B).



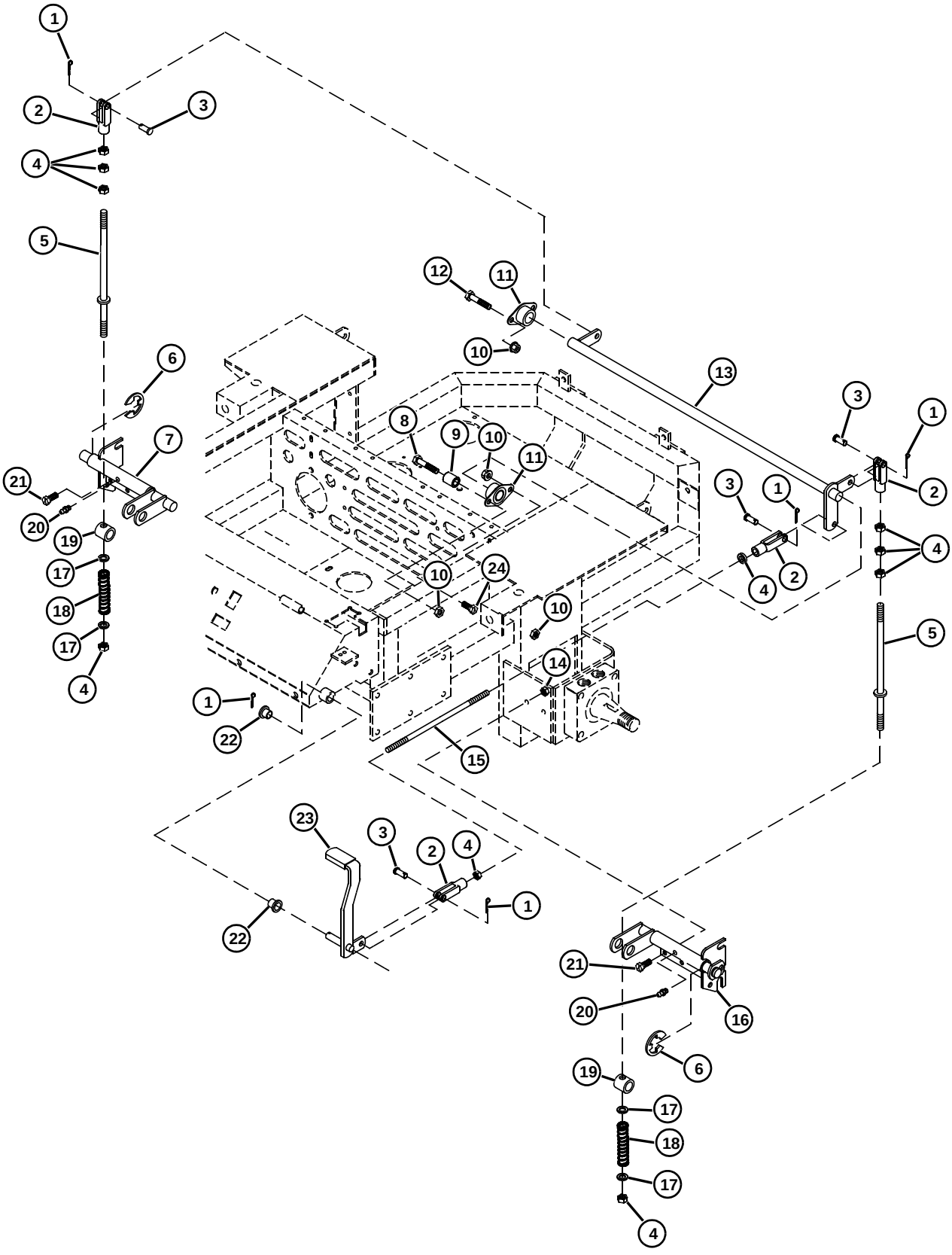
MX1919

4. Install nuts (C) and tap on nuts to drive the studs back to separate the brake drum/wheel hub.
5. Remove the brake drum/wheel hub assembly using a three-jaw puller.
6. Remove key.

Installation is done in the reverse order of removal.

- Tighten the nut (B) securing the wheel hub to the wheel motor output shaft to **109 N•m (80 lb-ft)**.

PARK BRAKE LINKAGE—REPAIR



1—Cotter Pin (5 Used)
2—Yoke (4 Used)
3—Retainer Pin (4 Used)
4—Nuts (10 Used)
5—Threaded Rod (2 Used)
6—Retaining Clip (2 Used)
7—Pivot Bracket (Right)
8—Cap Screw
9—Stop
10—Lock Nut (4 Used)
11—Bearing (2 Used)
12—Cap Screw
13—Shaft
14—Lock Nut (2 Used)
15—Rod
16—Pivot Bracket (Left)
17—Washer (4 Used)
18—Spring (2 Used)
19—Pin (2 Used)
20—Lubrication Fitting (2 Used) *Apply Grease*
21—Cap Screw (2 Used)
22—Bushing (2 Used)
23—Lever
24—Cap Screw (3 Used)

- Inspect all parts for wear or damage. Replace parts as needed.
- Apply grease at lubrication fitting (20). (See CHASSIS AND MOWER SPINDLE GREASE in SPECIFICATIONS AND INFORMATION section.)
- Adjust park brake. (See PARK BRAKE CHECK AND ADJUSTMENT.)

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CONTENTS

SPECIFICATIONS

ADJUSTMENT SPECIFICATIONS

Front-to-Back Blade Height Difference (Maximum)	3—6 mm (0.125—0.250 in.)
Side-to-Side Blade Height Difference (Maximum)	3 mm (0.125 in.)
Belt Tension Spring Length	30 cm (11.75 in.)

REPAIR SPECIFICATIONS

Blade Cutting Edge Width	0.40 mm (0.016 in.)
Blade Cap Screw Torque	122 N•m (90 lb-ft)
Spindle Sheave Nut Torque	122 N•m (90 lb-ft)

SERVICE PARTS KITS

The following kits are available through your parts catalog:

- Anti-Scalp Wheel Kit

TROUBLESHOOTING

MOWER DECK TROUBLESHOOTING CHART

Problem or Symptom / Check or Solution	Mower deck will not run.	Mower deck vibrates.	Cuts unevenly.	Excessive noise.
Mower drive belt broken.	●			
Mower drive belt worn, frayed, glazed stretched or wrong belt.	●	●		
Mule drive belt broken.	●			
Mule drive belt worn, frayed, glazed stretched or wrong belt.			●	
Jacksheave assembly bearings worn or damaged.		●	●	●
Mower blade(s) worn, bent or damaged.		●	●	●
Mower blades dull.			●	
Mower deck level out of adjustment.			●	
Mower blade(s) unbalanced.		●		●
Rear tires unevenly inflated.			●	
PTO clutch not engaging. (See PTO CLUTCH CIRCUIT DIAGNOSIS in ELECTRICAL section.)	●			
Spindle assemblies worn or damaged.		●	●	●
Mounting hardware loose.		●		
Debris build-up on sheaves.		●		

DIAGNOSIS

MOWER DRIVE CHECKS

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Key switch in STOP position.

Test Location	Normal	If Not Normal
1. Mower deck.	Drive belt and sheaves free of debris.	Remove belt shields and remove debris.
2. Mower deck adjustment linkage.	Mounting hardware tight.	Tighten hardware.
	Linkage not worn, binding or damaged.	Repair as needed. (See MOWER DECK ADJUSTMENT LINKAGE.)
	Mower deck level side-to-side.	Adjust as needed. (See MOWER LEVEL SIDE-TO-SIDE CHECK AND ADJUSTMENT.)
	Mower deck level front-to-back.	Adjust as needed. (See MOWER LEVEL FRONT-TO-BACK CHECK AND ADJUSTMENT.)
3. PTO clutch.	Clutch tight on crankshaft and key not damaged or missing.	Tighten PTO clutch cap screw to **136 N•m (100 lb-ft)** and/or replace key.
4. Mule drive belt.	Correct belt installed	Replace belt. (See MULE DRIVE BELT—REMOVAL/INSTALLATION.)
	Not damaged, worn, stretched or broken.	Replace belt. (See MULE DRIVE BELT—REMOVAL/INSTALLATION.)
5. Mower drive belt.	Correct belt installed.	Replace belt. (See MOWER DRIVE BELT—REMOVAL.)
	Not damaged, worn, stretched or broken.	Replace belt. (See MOWER DRIVE BELT—REMOVAL.)
6. Jacksheave sheaves.	Tight on spindle and key in place.	Tighten nut and install keys as needed.
	Running straight, not damaged or bent.	Repair or replace as needed. (See JACKSHEAVE ASSEMBLY—REMOVAL/INSTALLATION.)
7. Jacksheave assembly.	Bearings rotate freely, not worn or damaged.	Repair or replace bearings as needed. (See JACKSHEAVE ASSEMBLY—DISASSEMBLY/INSPECTION.)

MOWER DRIVE CHECKS, continued

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Key switch in STOP position

Test Location	Normal	If Not Normal
8. Mower drive belt tension spring.	Not damaged. worn or weak.	Replace spring.
9. Drive belt idler arm.	Pivot properly lubricated.	Apply grease to lubrication fitting. (See GREASE—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
	Not binding or damaged.	Repair as needed. (See IDLERS AND SHEAVES.)
10. Spindle sheave.	Tight on spindle and key in place.	Tighten nut and install key as needed.
	Running straight, not damaged or bent.	Repair or replace as needed. (See IDLERS AND SHEAVES.)
	Belt on sheave.	Install belt.
11. Spindle and housing.	Properly lubricated.	Fill with grease. (See MOWER DECK SPINDLE GREASE—NORTH AMERICA or MOWER DECK SPINDLE GREASE—EUROPE in SPECIFICATIONS AND INFORMATION section.)
	Mounting hardware tight.	Tighten mounting hardware.
	Bearings rotate freely, not worn or damaged.	Repair or replace spindles as needed. (See SPINDLES—DISASSEMBLY/ INSPECTION.)
12. Blade(s)	Blade tight on spindle.	Tighten blade cap screw to **122 N•m (90 lb-ft)**.
	Not bent, worn or damaged.	Replace blade(s). (See MOWER BLADES—REMOVAL/INSTALLATION.)
	Blades properly sharpened and balanced.	Sharpen and balance blades. (See MOWER BLADE(S)—SHARPEN and MOWER BLADE(S)—BALANCE.)

MOWER DRIVE CHECKS, continued

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Key switch in STOP position

Test Location	Normal	If Not Normal
13. Caster wheels.	Tires properly inflated.	Inflate tires to **110—138 kPa (16—20 psi)**.
14. Caster wheel yoke assemblies.	Properly lubricated.	Apply grease to lubrication fitting. (See GREASE—NORTH AMERICA in SPECIFICATIONS AND INFORMATION section.)
	Yoke assemblies rotate freely, bearings not worn or damaged.	Replace bearings as needed. (See CASTER WHEEL YOKE ASSEMBLY—REMOVAL/ INSTALLATION.)

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.

Test Location	Normal	If Not Normal
15. Engine.	Engine running at correct rpm.	Check engine operation. (See ENGINE AND FUEL SYSTEM TROUBLESHOOTING CHART in ENGINE section.)
16. PTO clutch.	Functioning properly.	Check PTO clutch circuit. (See PTO CLUTCH CIRCUIT DIAGNOSIS in ELECTRICAL section.)
17. Mower deck.	Operating smoothly without any unusual noises and stops quickly.	Slowly reduce 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

Test Location	Normal	If Not Normal
1. PTO clutch.	PTO circuit operating properly.	Test PTO circuit. (See PTO CLUTCH CIRCUIT DIAGNOSIS in ELECTRICAL section.)
	Clutch tight on engine crankshaft and key not damaged or missing.	Tighten PTO clutch cap screw to **136 N•m (100 lb-ft)** and/or replace key.
2. Mule drive belt.	Correct belt installed.	Replace belt. (See MULE DRIVE BELT—REMOVAL/INSTALLATION.)
	Not damaged, worn, stretched or broken.	Replace belt. (See MULE DRIVE BELT—REMOVAL/INSTALLATION.)
3. Mower drive belt.	Correct belt installed.	Replace belt. (See MOWER DRIVE BELT—REMOVAL.)
	Not damaged, worn, stretched or broken.	Replace belt. (See MOWER DRIVE BELT—REMOVAL.)

MOWER DECK VIBRATES

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Key switch in STOP position

Test Location	Normal	If Not Normal
1. Mower drive belt	Correct belt installed.	Replace belt. (See MOWER DRIVE BELT—REMOVAL.)
	Not damaged, worn, stretched or broken.	Replace belt. (See MOWER DRIVE BELT—REMOVAL.)
2. Jacksheave sheaves.	Running straight, not damaged or bent.	Repair or replace as needed. (See JACKSHEAVE ASSEMBLY—REMOVAL/INSTALLATION.)
3. Jacksheave assembly.	Bearings rotate freely, not worn or damaged.	Repair or replace bearings as needed. (See JACKSHEAVE ASSEMBLY—DISASSEMBLY/INSPECTION.)
4. Blades.	Blades not damaged or worn.	Replace blades. (See MOWER BLADES—REMOVAL/INSTALLATION.)
	Blades properly sharpened and balanced.	Sharpen and balance blades. (See MOWER BLADE(S)—SHARPEN and MOWER BLADE(S)—BALANCE.)
5. Drive sheaves.	Free of debris.	Remove shields and remove debris.
	Sheaves properly aligned, not damaged.	Replace damaged sheaves. (See IDLERS AND SHEAVES.)
6. Spindle assemblies.	Not damaged. Bearings not worn or damaged.	Repair spindle assemblies. (See SPINDLES—DISASSEMBLY/INSPECTION.)
7. Mounting hardware.	Properly tightened.	Tighten any loose hardware.

CUTS UNEVENLY

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Key switch in STOP position

Test Location	Normal	If Not Normal
1. Front mower drive tires.	Properly inflated.	Inflate tires to correct pressure.
2. Blades.	Blades properly sharpened.	Sharpen blade. (See MOWER BLADES—Sharpen.)
3. Mower deck lift/adjustment linkage.	Level side-to-side.	Adjust mower deck. (See MOWER LEVEL SIDE-TO-SIDE ADJUSTMENT.)
	Level front-to-rear.	Adjust mower deck. (See MOWER LEVEL FRONT-TO-BACK ADJUSTMENT.)
	Mounting hardware tight, not worn.	Repair mower deck lift linkage. (See MOWER DECK ADJUSTMENT LINKAGE.)
	Lift chains installed properly.	Reposition lift chains.
4. Spindle assemblies.	Not damaged. Bearings not worn or damaged.	Repair spindle assemblies. (See SPINDLES—DISASSEMBLY/ INSPECTION.)

EXCESSIVE NOISE

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Key switch in STOP position

Test Location	Normal	If Not Normal
1. Jacksheave assembly.	Bearings rotate freely, not worn or damaged.	Repair or replace bearings as needed. (See JACKSHEAVE ASSEMBLY—DISASSEMBLY/INSPECTION.)
2. Spindle assemblies.	Not damaged. Bearings not worn or damaged.	Repair spindle assemblies. (See SPINDLES—DISASSEMBLY/INSPECTION.)
3. Blades.	Blades not damaged or worn.	Replace blades. (See MOWER BLADES—REMOVAL/INSTALLATION.)
	Blades properly sharpened and balanced.	Sharpen and balance blades. (See MOWER BLADE(S)—SHARPEN and MOWER BLADE(S)—BALANCE.)

CHECKS, TESTS AND ADJUSTMENTS

MOWER LEVEL FRONT-TO-BACK CHECK AND ADJUSTMENT

Reason:

To set the mower deck for an even front-to-back cut.

Equipment:

- TY15272 Blade Height Gauge

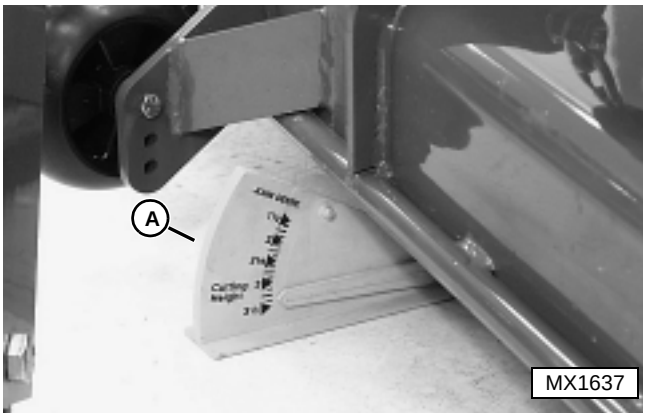
Check Procedure:

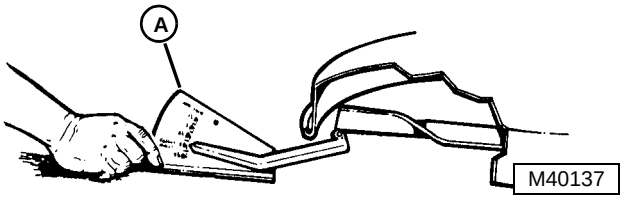
1. Park machine safely.
2. Check for correct tire pressure and measure wheel rim height (same between right and left wheels to ensure the machine is level).
3. Raise the mower deck to 127 mm (5.0 in.) cutting height/TRANSPORT position.

⚠ CAUTION

Wear gloves or wrap blade with a rag to prevent personal injury.

4. Rotate the blades by hand and inspect for sharpness and bent or damaged blades or excessive spindle play. Repair as needed. (See SPINDLES—DISASSEMBLY/INSPECTION.)
5. Move the mower deck to the 89 mm (3.50 in.) cutting height position.
6. Position left mower blade in the horizontal (straight forward) position.





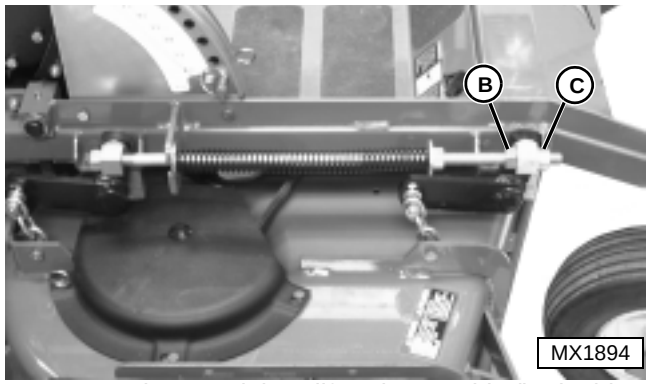
7. Using a TY15272 Blade Height Gauge (A), measure from the left front blade tip to the floor. Turn blade 180° and measure from the left rear tip to the floor. The height of the rear of the blade should be **3—6 mm (0.125—0.25 in.)** higher than the front of the blade.
8. Repeat steps 9—10 for the right blade.
9. If height difference is greater than specifications, perform adjustment procedure.

Results:

- If height difference is greater than **6 mm (0.25 in.)**, perform adjustment procedure.

Adjustment Procedure:

NOTE: The side-to-side mower level adjustment must be preformed before adjusting the front-to-rear level. Adjust both sides of the mower deck equally.



10. Loosen jam nut (B) on lift rod assembly (both sides of mower deck).

NOTE: Adjustments are made by standing at the front of the mower deck facing to the rear.

11. Adjust the deck height by rotating the hex nut (C);
    To lower the front of the mower deck; Rotate the hex nut CLOCKWISE.
    To raise the front of the mower deck; Rotate the hex nut COUNTERCLOCKWISE.
12. Tighten the jam nuts.
13. Recheck the mower deck front-to-rear level. Repeat the adjustment as needed.

MOWER LEVEL SIDE-TO-SIDE CHECK AND ADJUSTMENT

Reason:

To set the mower deck for an even side-to-side cut.

Equipment:

- TY15272 Blade Height Gauge

Check Procedure:

⚠ CAUTION

Stop engine and remove ignition key before adjusting mower.

1. Park machine safely.
2. Check for correct tire pressure and measure wheel rim height (same between right and left wheels to ensure the machine is level).
3. Raise the mower deck to 127 mm (5.0 in.) cutting height/TRANSPORT position.

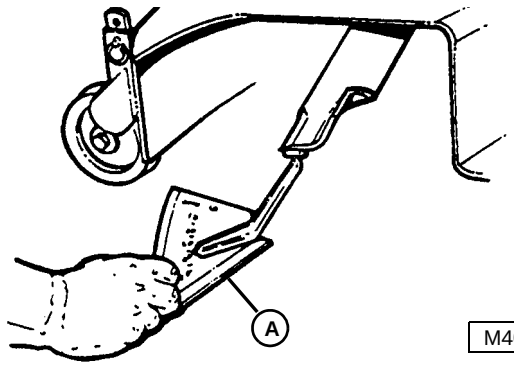
⚠ CAUTION

Wear gloves or wrap blade with a rag to prevent personal injury.

4. Rotate the blades by hand and inspect for sharpness and bent or damaged blades or excessive spindle play. Repair as needed. (See SPINDLES—DISASSEMBLY/INSPECTION.)

NOTE: The mower deck anti-scalp wheels should not contact the ground.

5. Move the mower deck to the 89 mm (3.50 in.) cutting height position.



M40161

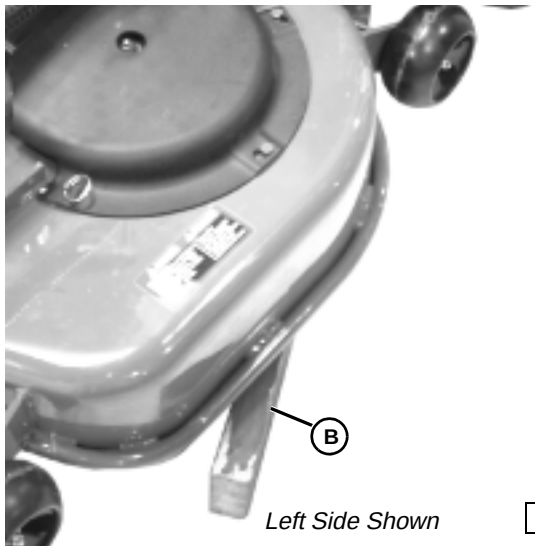
6. Position left mower blade in the horizontal (sideways) position.
7. Using a TY15272 Blade Height Gauge (A), measure the height of the outside ends of outside blades. The difference in height should be no more than **3 mm (0.125 in.)**.
8. Repeat procedure for right blade.

Results:

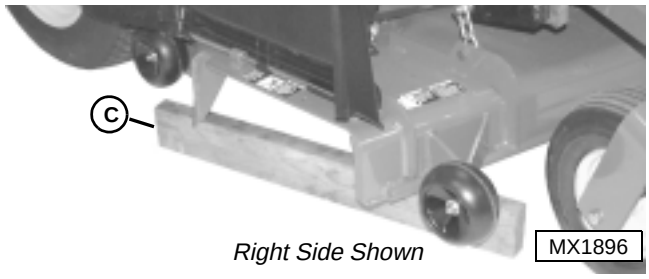
- If height difference is greater than **3 mm (0.125 in.)**, perform adjustment procedure.

Adjustment Procedure:

1. Raise the mower deck to 127 mm (5.0 in.) cutting height/TRANSPORT position.



Left Side Shown MX1895

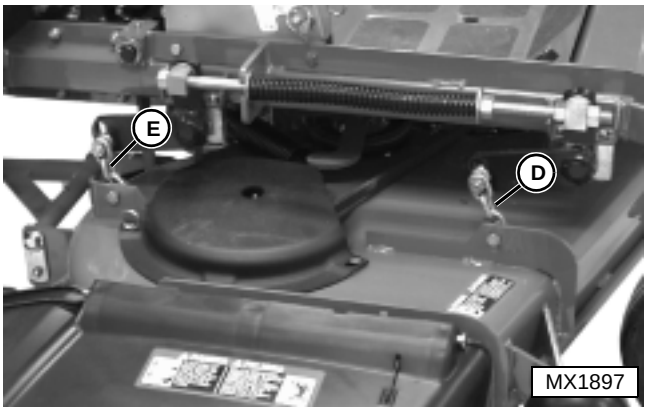


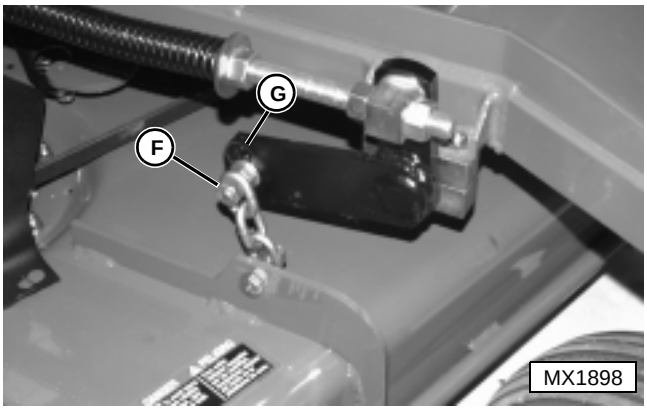
Right Side Shown MX1896

NOTE: The wood block (B) placed under the LEFT side of the mower deck, MUST be positioned to the rear of the raised portion of the deck wall.

The wood block (C) placed under the RIGHT side of the mower deck MUST be positioned under the right anti-scalp wheel bracket, but the wheel must NOT rest on the block.

2. Place 102 mm (4.0 in.) blocks (B and C) under each side of the mower deck.
3. Lower the deck onto the wood blocks.
4. Move the mower deck to the 89 mm (3.50 in.) cutting height position.





5. Adjust the front (D) and rear (E) upper chain bolts on each side of the machine as needed:
   - Loosen the hex flanged nuts (F).
   - Adjust the upper chain bolt in the slot (G) to remove any slack.
   - Tighten the hex flanged nuts (F).
6. Raise the mower deck to 127 mm (5.0 in.) cutting height/TRANSPORT position.
7. Recheck blade height. Repeat the adjustment as needed.

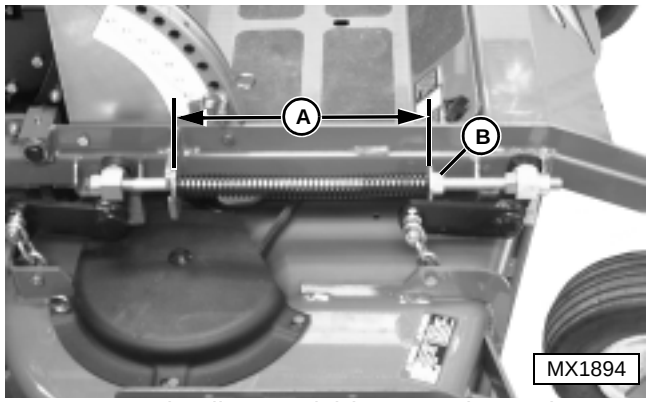
DECK LIFT SPRING TENSION CHECK AND ADJUSTMENT

Reason:

To ensure the lift spring provides enough force to allow the mower deck to raise and lower without excess effort.

Check Procedure:

1. Park machine safely.
2. Raise the mower deck to 127 mm (5.0 in.) cutting height/TRANSPORT position.



3. Measure the distance (A) between the washers on the deck lift spring assembly on both sides on the mower deck. The recommended distance is **300 mm (11.75 in.)**.

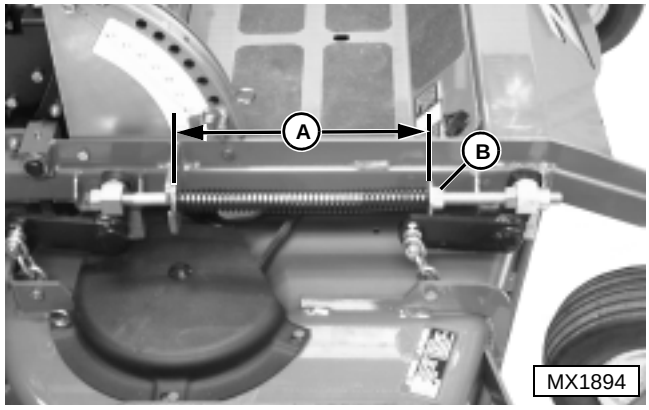
Results:

- If the spring distance does not match specifications, or if excessive force is required to lift the mower deck, perform the adjustment procedure.

Adjustment Procedure:

NOTE: DO NOT over-tension the deck lift springs. Overtightened springs will cause the mower deck to "float" too freely.

Both deck springs must be adjusted equally.



NOTE: Adjustments are made by standing at the front of the mower deck facing to the rear.

1. Adjust the spring tension by rotating the hex nut;
   To increase lift spring tension (reduce effort required to lift the mower deck); Rotate the hex nut CLOCKWISE.
   To decrease lift spring tension (increase effort require to lift the mower deck); Rotate the hex nut COUNTERCLOCKWISE.

REPAIR

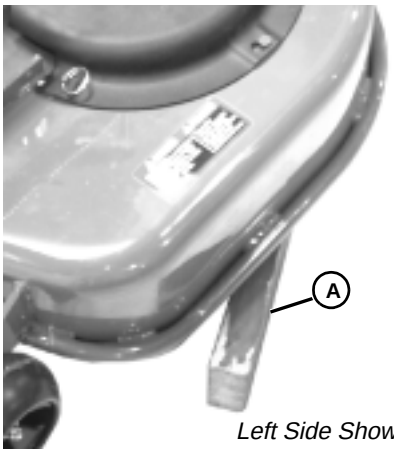
MOWER DECK ASSEMBLY—REMOVAL/INSTALLATION

CAUTION

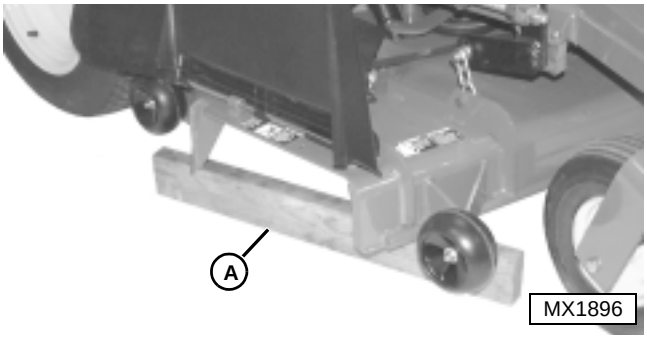
STOP engine. Remove ignition key. Wait for all moving parts to stop.

DO NOT operate the machine with the front attachment removed. Front mower is very unstable with attachment removed.

1. Park machine safely.
2. Remove mule drive belt. (See MULE DRIVE BELT—REMOVAL/INSTALLATION.)
3. Raise the mower deck to 127 mm (5.0 in.) cutting height/TRANSPORT position.



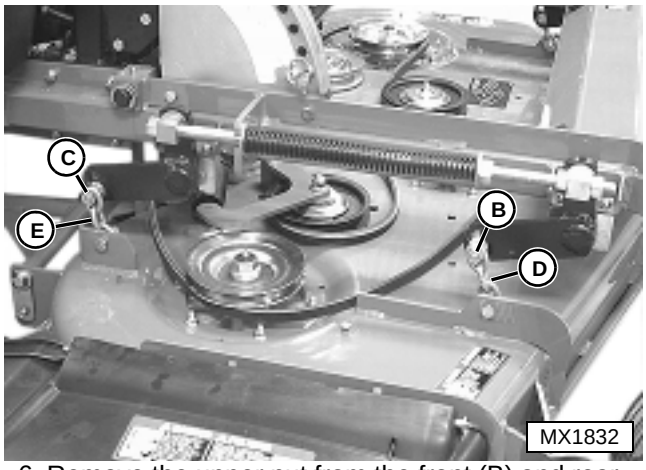
Left Side Shown MX1895



MX1896

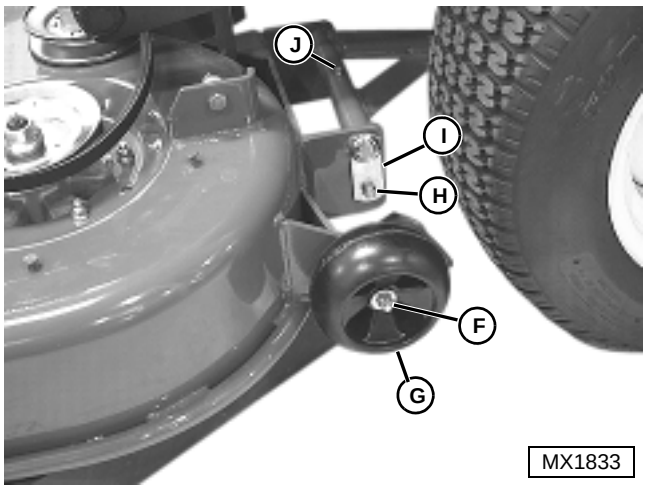
NOTE: The mower blades should be rotated to the forward position, so the mower deck housing rests on the blocks. DO NOT allow the blades to make contact with the blocks.

4. Place 100 mm (4 in.) wood blocks (A) under each side of the mower deck.
5. Lower the mower deck and allow the deck to rest on the blocks.



MX1832

6. Remove the upper nut from the front (B) and rear (C) lift arms (both sides of mower deck).
7. Remove front (D) and rear (E) lift chains (both sides of mower deck).



MX1833

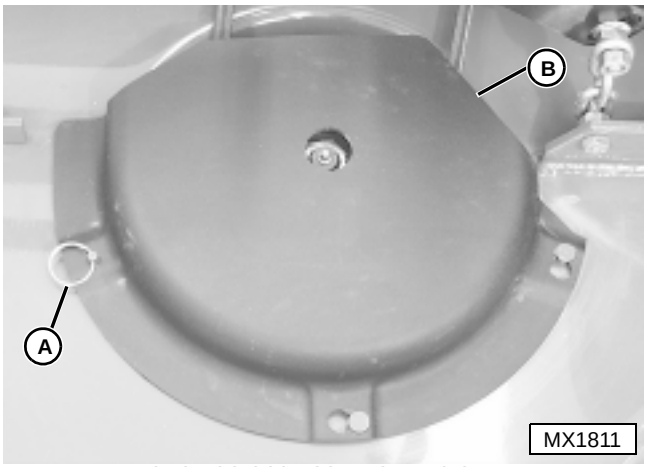
8. Remove the rear gauge wheel nut (F) (both sides of mower deck).
9. Remove rear gauge wheel (G) (both sides of mower deck).
10. Remove locknut (H) and cap screw from retainer bracket/pivot shaft assembly (I) (both sides of mower deck).
11. Remove retainer bracket/pivot shaft assembly (I) from the mower deck struts (both sides of mower deck).
12. Carefully remove the wood blocks and allow the mower deck to rest on the floor.
13. Lift the front of the machine with a safe lifting device.
14. Remove the mower deck.

Installation is done in the reverse order of removal.

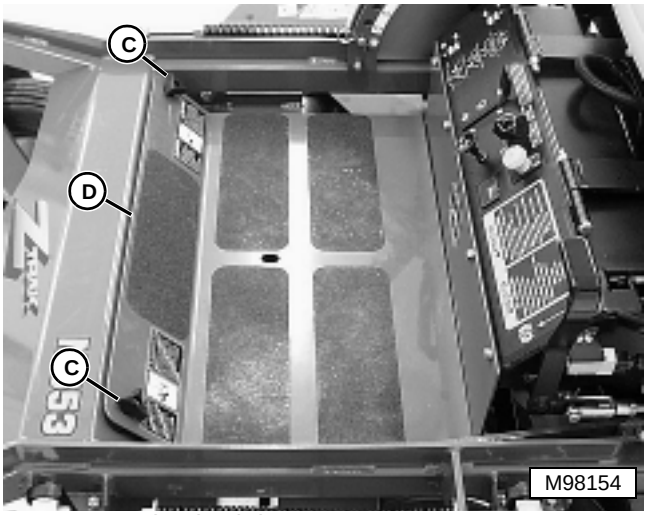
- Apply Multi-Purpose SD Polyurea Grease to the mower deck strut lubrication fitting (J). (See CHASSIS AND MOWER SPINDLE GREASE in SPECIFICATIONS AND INFORMATION section.)

MOWER DECK DRIVE BELT—REMOVAL

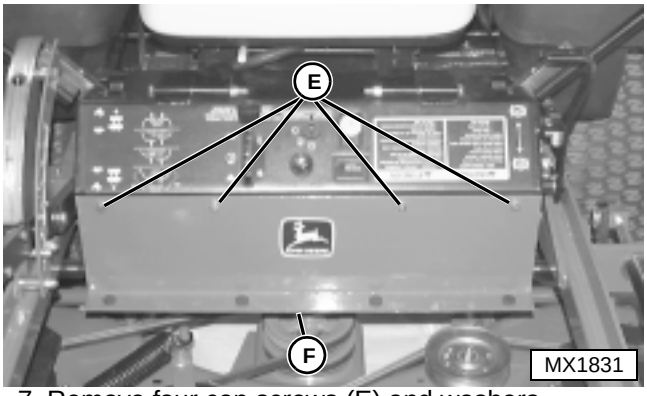
1. Park machine safely.
2. Lower mower deck to lowest cutting position.



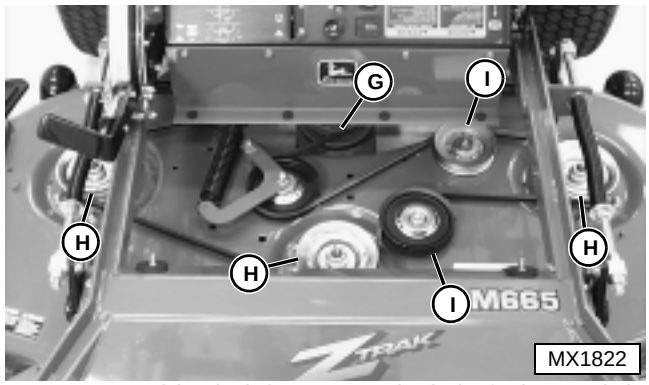
3. Remove belt shield locking rings (A).
4. Remove belts shields (B).



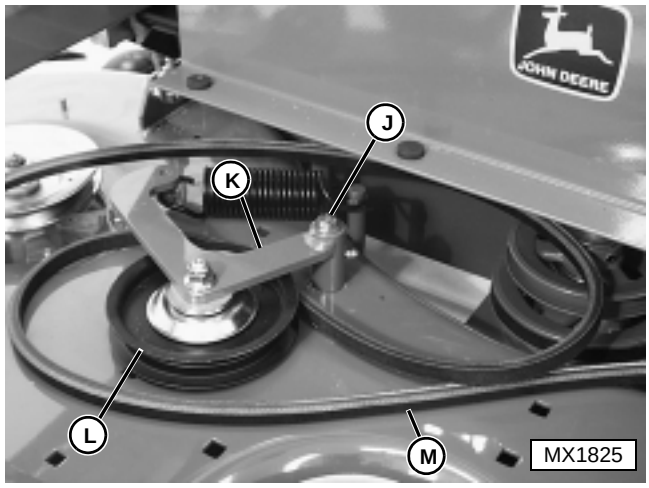
5. Remove knobs (C).
6. Remove foot plate (D).



7. Remove four cap screws (E) and washers.
8. Remove kick plate (F).

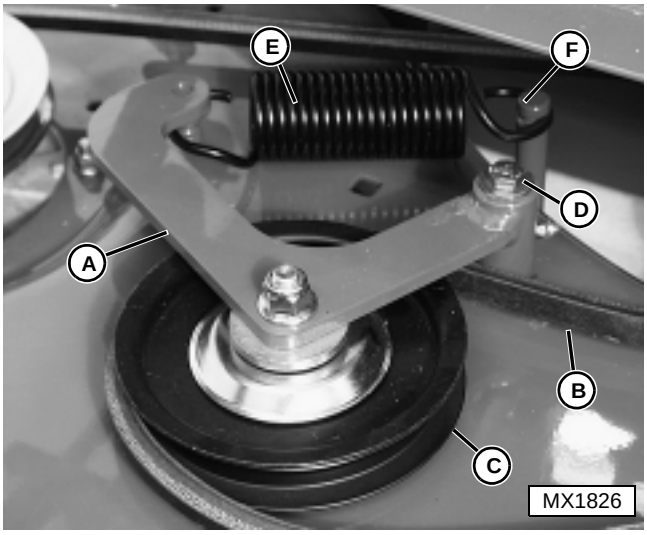


9. Remove drive belt from upper jackshaft sheave (G), spindle sheaves (H) and idler sheaves (I).

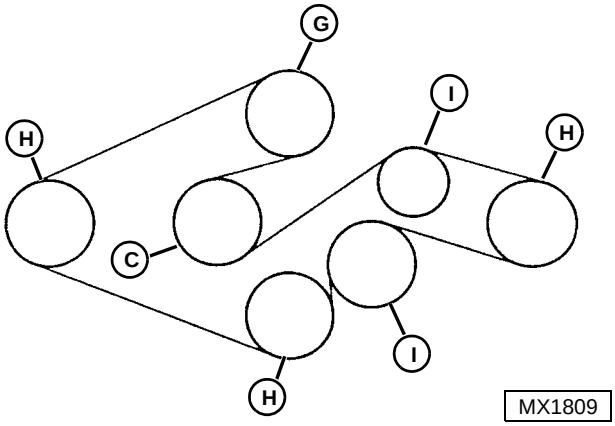


10. Loosen cap screw (J) enough to allow the idler arm weldment (K) to be raised and slide the belt under the idler pulley (L).
11. Remove the drive belt (M).
12. Inspect the drive belt for cracks, and signs or wear, fraying or damage. Replace belt as needed.

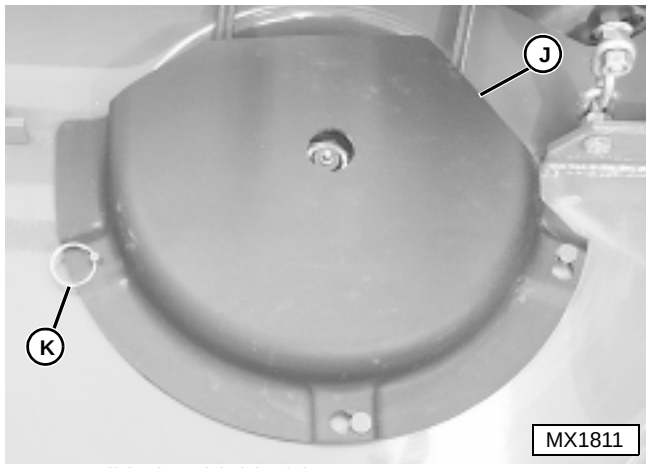
MOWER DECK DRIVE BELT—INSTALLATION



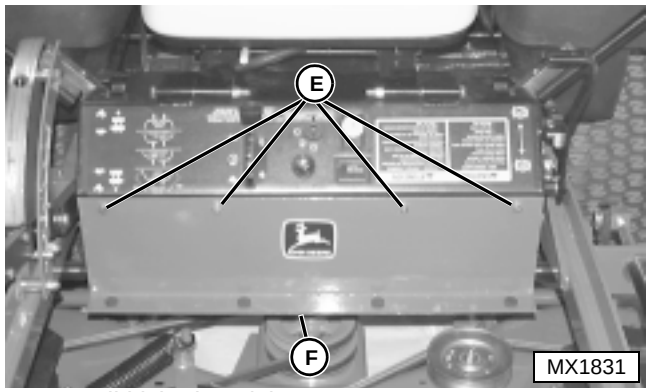
1. Raise the idler arm weldment (A) and slide the belt (B) under the idler pulley (C).
2. Tighten cap screw (D).
3. Check the belt tension spring (E). The spring should be installed on the idler arm weldment (A) and the stud (F) on the mower deck.



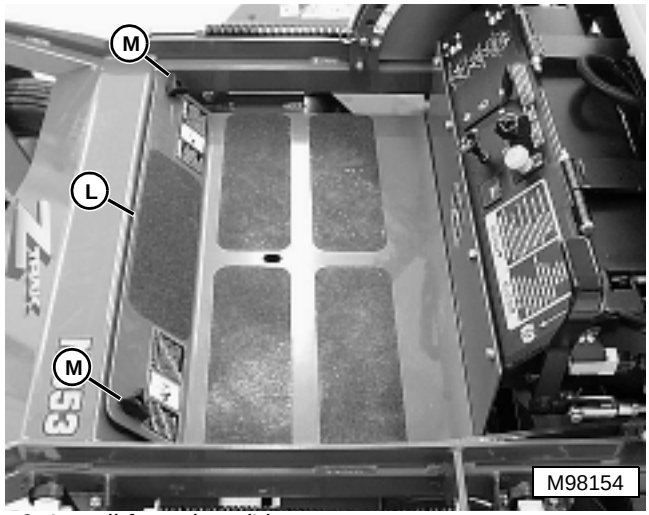
4. Install the drive belt around the upper jackshaft sheave (G), spindle sheaves (H) and tension idler sheave (C) and idler sheaves (I).



5. Install belts shields (J).
6. Install locking rings (K).



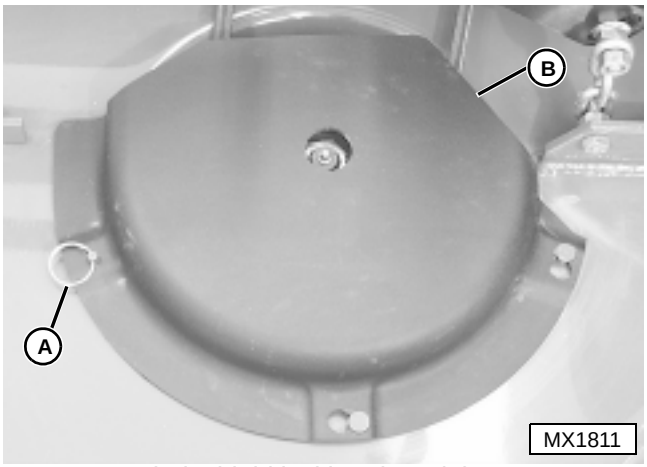
7. Install kick plate (F).
8. Install four cap screws and washers (E).



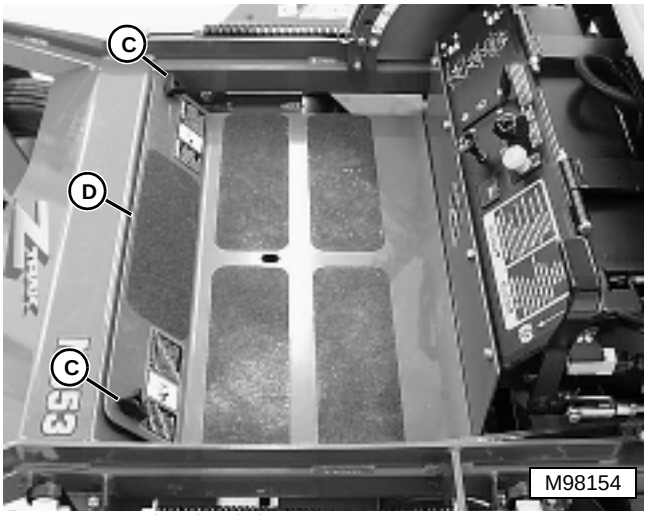
9. Install foot plate (L).
10. Install and tighten knobs (M).
11. Adjust the mower deck to desired cutting height. (See OWNER'S MANUAL.)

MULE DRIVE BELT—REMOVAL/INSTALLATION

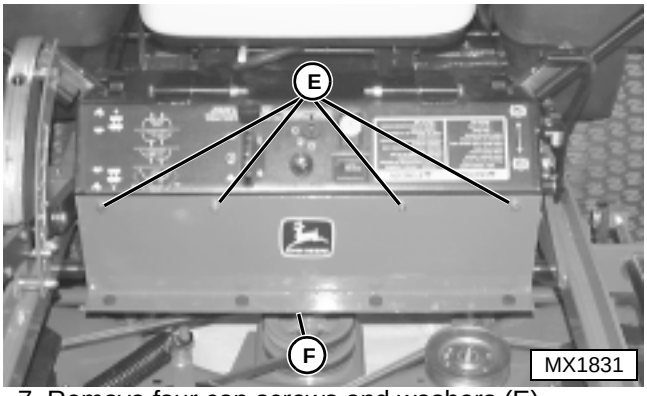
1. Park machine safely.
2. Lower mower deck to the lowest cutting position.



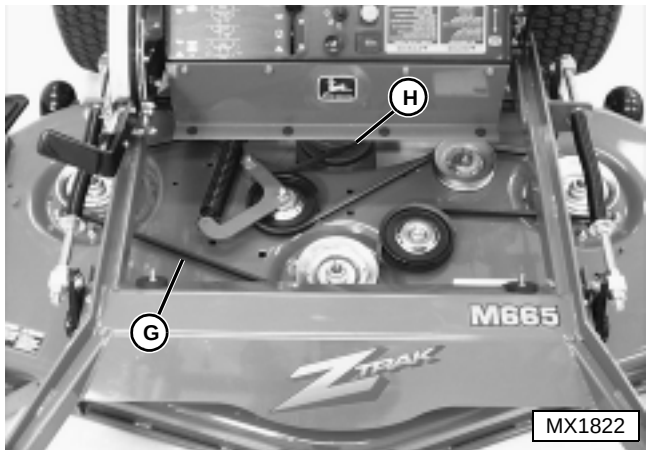
3. Remove belt shield locking rings (A).
4. Remove belts shields (B).

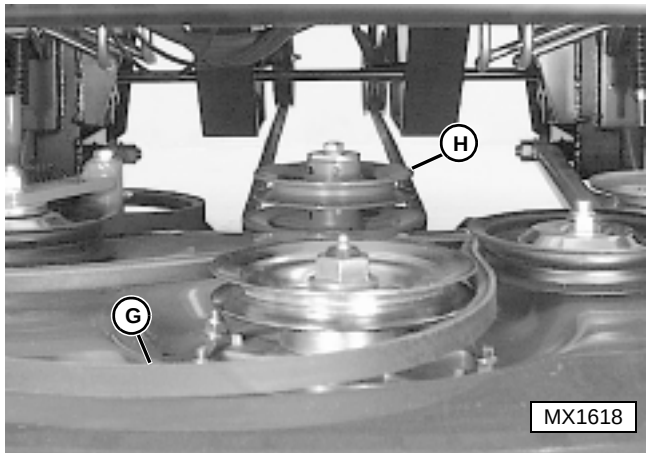


5. Remove knobs (C).
6. Remove foot plate (D).



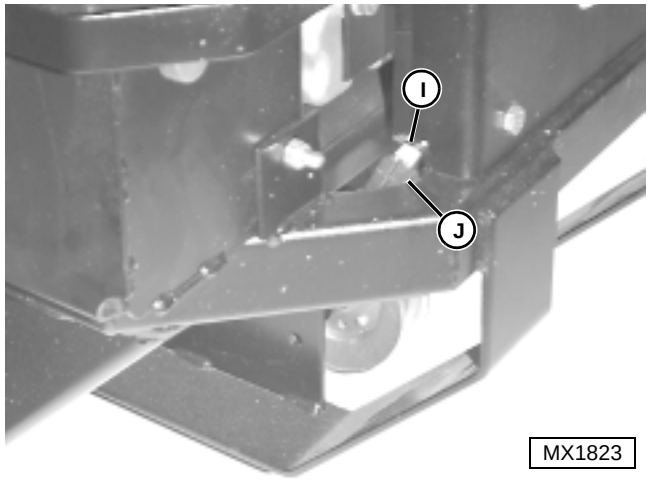
7. Remove four cap screws and washers (E).
8. Remove kick plate (F).



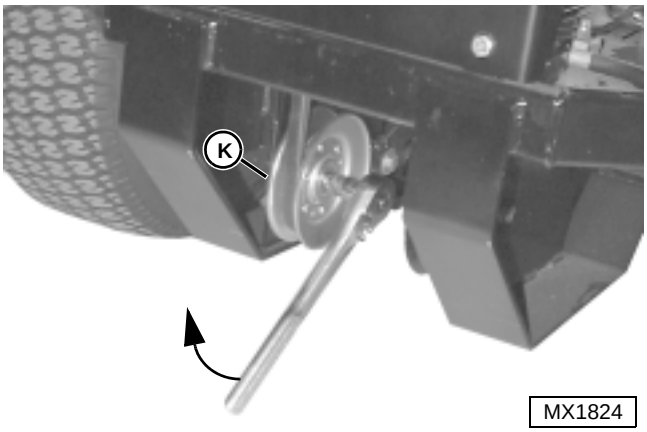


NOTE: It is not necessary to completely remove the mower drive belt.

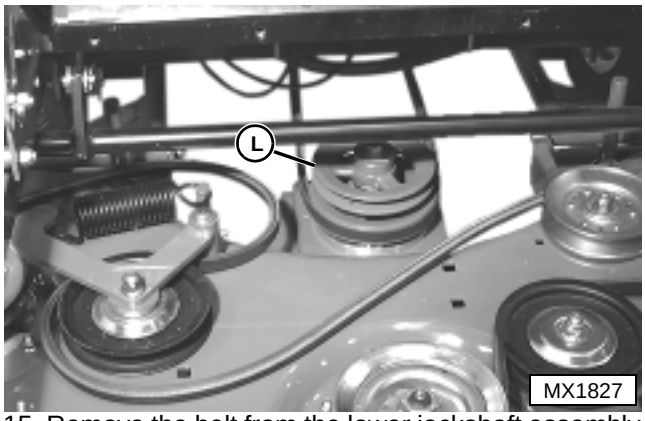
9. Remove the mower deck drive belt (G) from the upper jacksheave assembly sheave (H).
10. Raise the mower deck to 127 mm (5.0 in.) cutting height/TRANSPORT position.



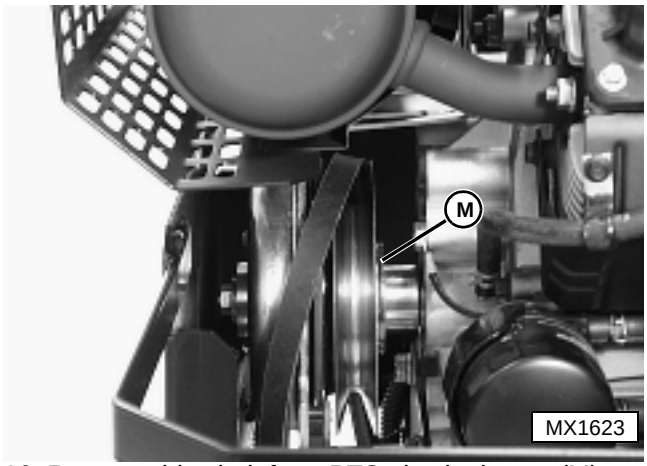
11. Remove tie wrap (I).
12. Disconnect PTO clutch connector (J).



13. Using a 9/16-in socket and ratchet on the idler sheave (K), pull up to relieve belt tension.
14. Remove belt from idler sheave.



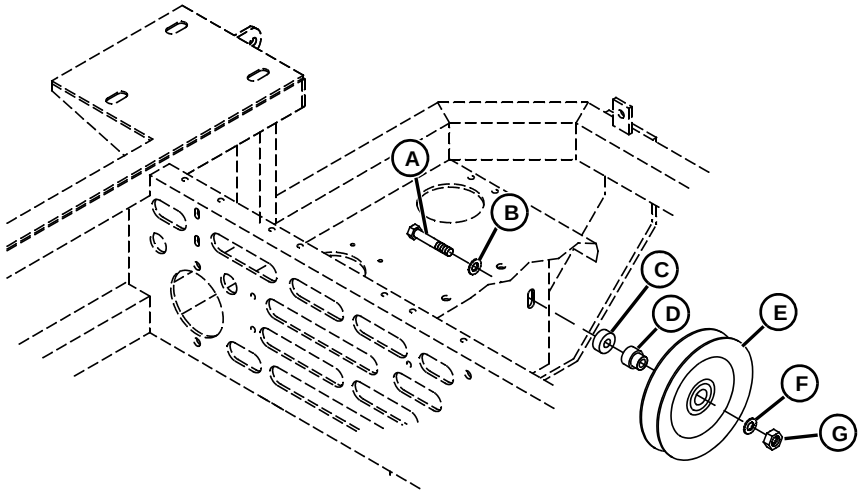
15. Remove the belt from the lower jackshaft assembly sheave (L) on the mower deck.

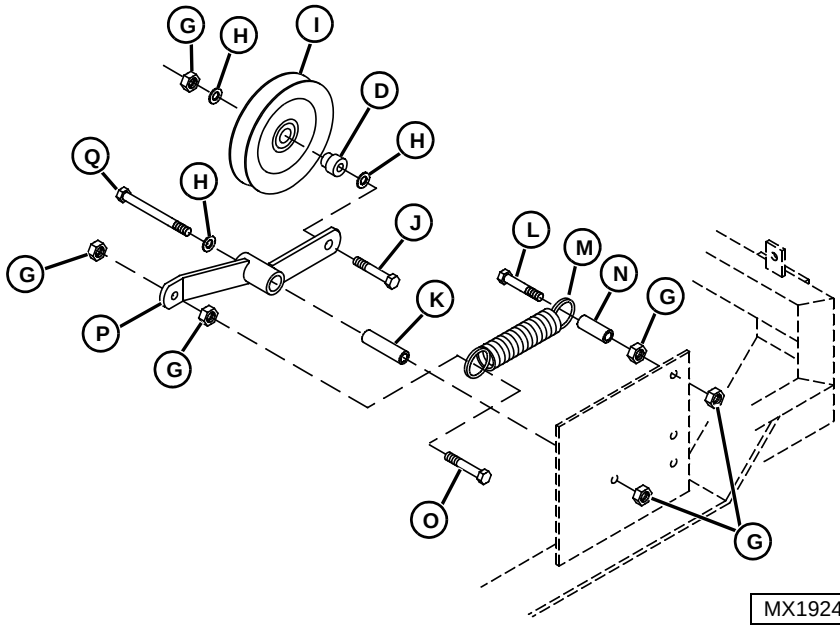


16. Remove drive belt from PTO clutch sheave (M).
17. Remove drive belt.
18. Inspect drive belt for cracks, and signs of wear, fraying or damage. Replace belt as needed.

Installation is done in the reverse order of removal.

MULE DRIVE BELT IDLER/TENSIONER ASSEMBLY—REPAIR





A—Cap Screw
B—Spring Washer
C—Spacer
D—Bushing (2 Used)
E—Pulley
F—Washer
G—Lock Nut (7 Used)
H—Washer
I—Pulley
J—Cap Screw
K—Bushing
L—Cap Screw
M—Spring
N—Spacer
O—Cap Screw
P—Tension Arm
Q—Cap Screw

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

MOWER BLADE—REMOVAL/INSTALLATION

CAUTION

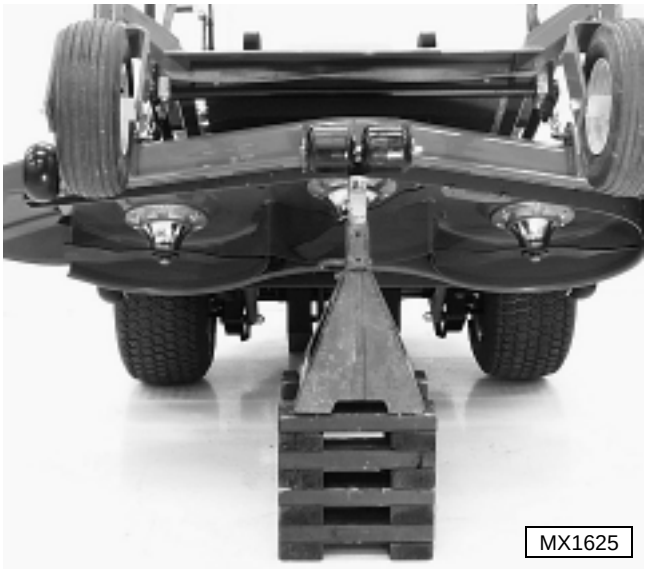
Help prevent serious personal injury. DO NOT work near a raised mower deck unless it is safely supported.

Never start the engine or engage the PTO switch when performing this service procedure.

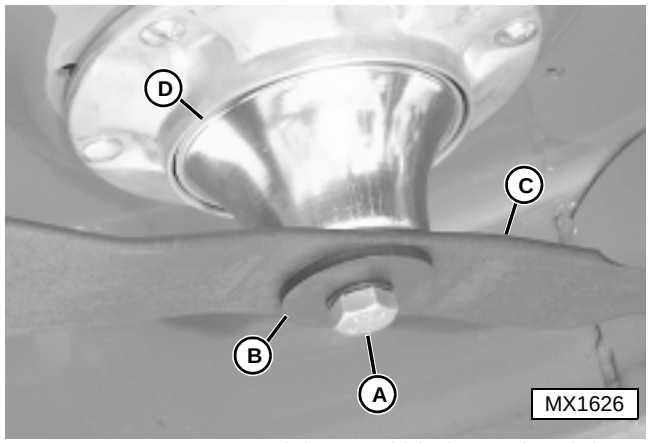
Blades are sharp and could cause personal injury. Wear appropriate clothing including gloves when working near the underside of a raised mower deck.

Before performing any service function, wait for all moving parts to stop turning.

1. Park machine safely.
2. Raise the mower deck to 127 mm (5.0 in.) cutting height/TRANSPORT position.



3. Raise the front of the machine with a safe lifting device. Block the machine with jackstands or wooden blocks.



4. Remove cap screw (A), round blade washer (B), blade (C) and deflector cup (D).
5. Inspect all parts for wear or damage. Replace parts as needed.

Installation is done in the reverse order of removal.

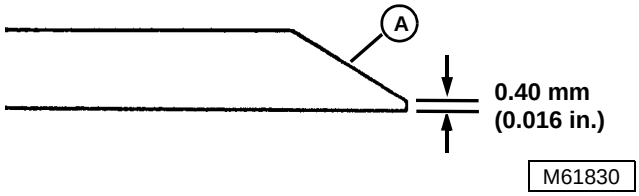
- Install blade with blade wing toward top of mower deck.
- Tighten blade cap screw (A) to **122 N•m (90 lb-ft)**.

MOWER BLADE—SHARPEN

CAUTION

Wear goggles and gloves when sharpening mower blades.

1. Sharpen blade using grinder, file or power sharpener.



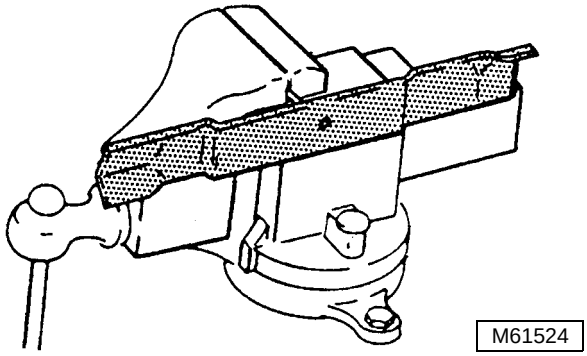
2. DO NOT alter original bevel (A). Blade should have **0.40 mm (0.016 in.)** cutting edge rather than a razor-type edge.
3. Balance blade.

MOWER BLADE—BALANCE

⚠ CAUTION

Wear gloves or wrap blade with rag to prevent personal injury.

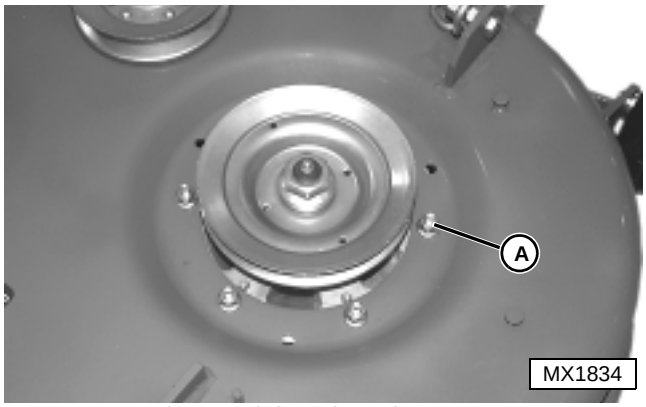
1. Clean and inspect blade.



2. Put blade on a nail in a vise or vertical wall stud.
3. Turn blade to the HORIZONTAL position. If the blade is not balanced, the heavy end will drop.
4. Grind bevel of heavy end. DO NOT change blade bevel.

SPINDLES—REMOVAL/INSTALLATION

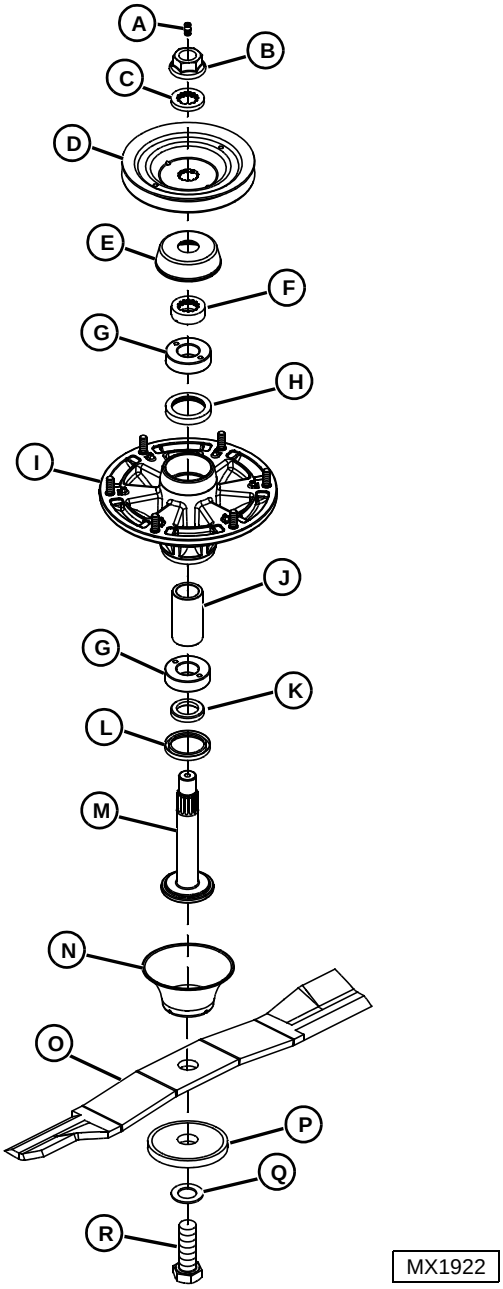
1. Remove mower blades.
2. Remove mower deck from frame. (See MOWER DECK ASSEMBLY—REMOVAL/INSTALLATION.)
3. Remove mower drive belt. (See MOWER DRIVE BELT—REMOVAL.)



4. Remove six nuts (A) and washers.
5. Remove spindle.
6. Make repairs as needed. (See SPINDLES—DISASSEMBLY/INSPECTION.)

Installation is done in the reverse order of removal.

SPINDLES—DISASSEMBLY/INSPECTION



MX1922

A—Lubrication Fitting *(Apply Grease)*
B—Flanged Nut
C—Splined Coupler
D—Sheave
E—Deflector
F—Bushing
G—Ball Bearing (2 Used)
H—Seal
I—Housing
J—Spacer
K—Bushing
L—Seal
M—Spindle
N—Deflector
O—Blade
P—Washer
Q—Washer
R—Cap Screw

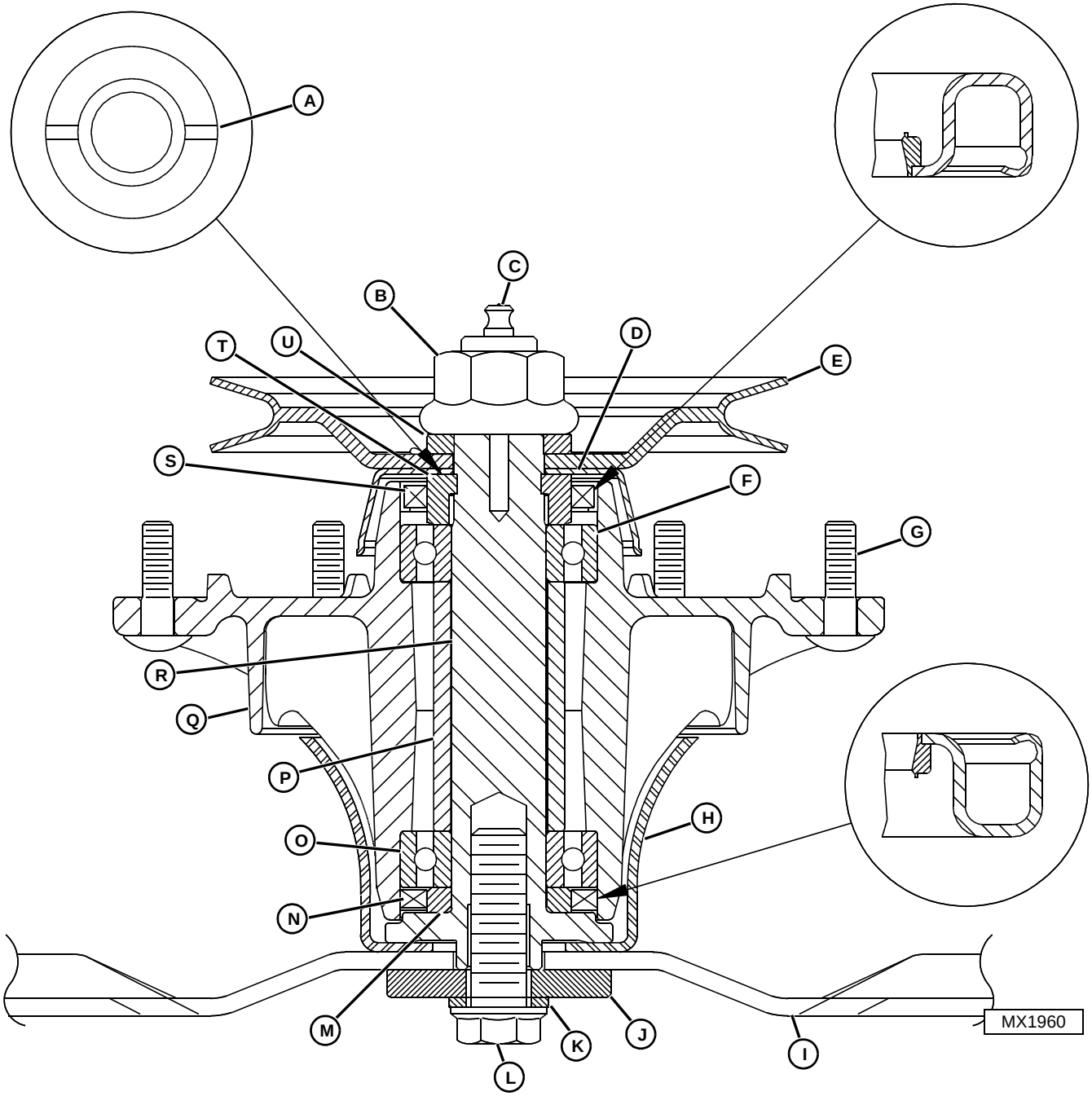
IMPORTANT: DO NOT install hexagon end of spindle shaft in a vise to remove spindle sheave nut. The hexagon end of the spindle shaft will be damaged, resulting in improper blade operation.

1. Install blade (O), washers (P and Q) and cap screw (R) on spindle shaft (M). Tighten cap screw to **122 N•m (90 lb-ft).**
2. Place blade in a soft-jawed vise.
3. Remove flanged nut (B), splined coupler (C) and spindle sheave (D).
4. Remove cap screw (R), washers (P and Q) and blade (O).
5. Remove spindle shaft (M) from housing (I).
6. Remove seal rings, noting position of notched side.

NOTE: Remove bearings (G) only if replacement is necessary.

7. Bearings (G) are seated against spindle hub shoulder and cannot be removed with a press. Remove seal (H), bushing (K) and bearings (G) using a punch.
8. Remove spacer (J).
9. Inspect all parts for wear or damage. Replace parts as needed.

SPINDLES—CROSS SECTION



A—Grease Notch

B—Flanged Nut
122 N•m (90 lb-ft)

C—Lubrication Fitting

D—Upper Deflector

E—Spindle Sheave

F—Upper Bearing

G—Screw (6 Used)

H—Lower Deflector

I—Blade

J—Washer

K—Washer

L—Cap Screw
122 N•m (90 lb-ft)

M—Lower Seal Ring

N—Lower Seal

O—Lower Bearing

P—Spacer

Q—Housing

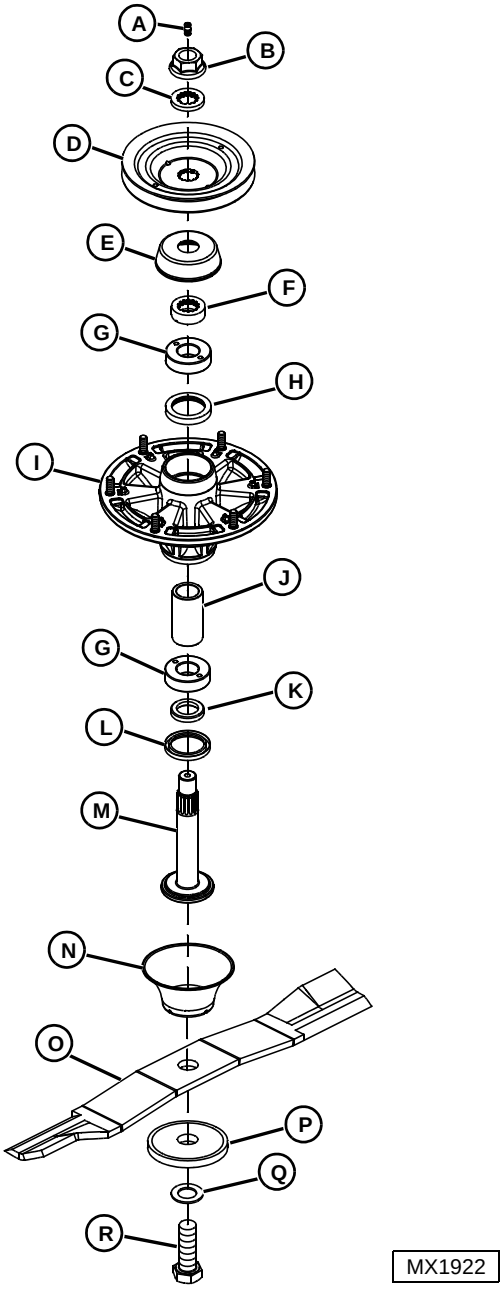
R—Spindle Shaft

S—Upper Seal

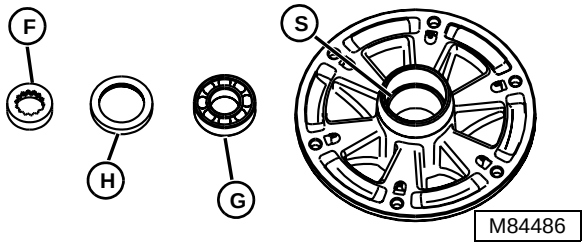
T—Upper Bushing

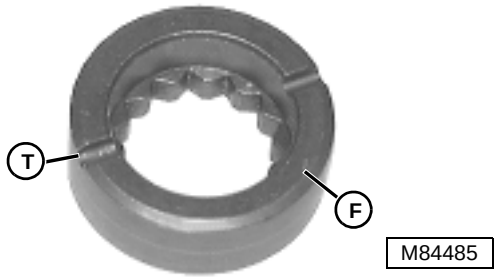
U—Splined Coupler

SPINDLES—ASSEMBLY



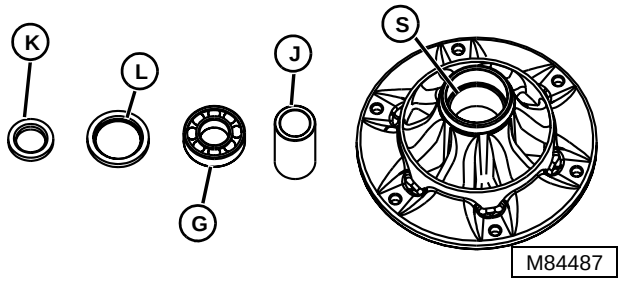
A—Lubrication Fitting *(Apply Grease)*
B—Flanged Nut
C—Splined Coupler
D—Sheave
E—Deflector
F—Bushing
G—Ball Bearing (2 Used)
H—Seal
I—Housing
J—Spacer
J—Spacer
K—Bushing
L—Seal
M—Spindle Shaft
N—Deflector
O—Blade
P—Washer
Q—Washer
R—Cap Screw





NOTE: Upper bushing (F) is installed with grease notch (T) facing toward upper bearing (G).

1. Install upper bearing (G) tight against the spindle housing shoulder (S) using a 1-13/16-in. disk and press.
2. Install upper seal ring (H) with lip toward bearing, tight against bearing using a 1-13/16-in. disk and press.
3. Install upper bushing (F) with grease notch toward bearing, inside seal lip.



4. Install spacer (J).

IMPORTANT: DO NOT press lower bearing (G) tight against the spindle housing shoulder (S). The bearing and seal must be installed to a specific dimension for proper sealing of spindle.

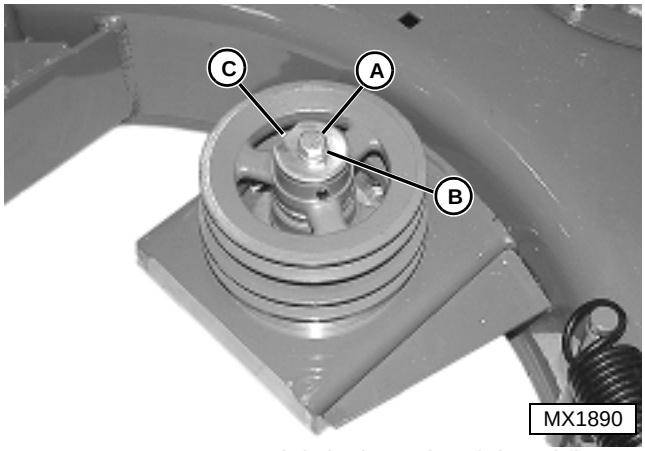
5. Install lower bearing (G) in housing using a 1-13/16-in. disk and press, just enough so the lower bushing (K) can be installed.
6. Install lower bushing (K) with lip toward bearing using a 1-13/16-in. disk and press.
7. Install lower seal ring (L) with grease notch away from bearing, inside seal lip.
8. Install spindle shaft (M) in housing (I).
9. Install deflector (N), blade (O), washers (P and Q) and cap screw (R) on spindle shaft. Tighten cap screw to **122 N•m (90 lb-ft)**.

IMPORTANT: Make sure the hexagon shaped hole in spindle sheave is aligned with the hexagon portion of the spindle shaft.

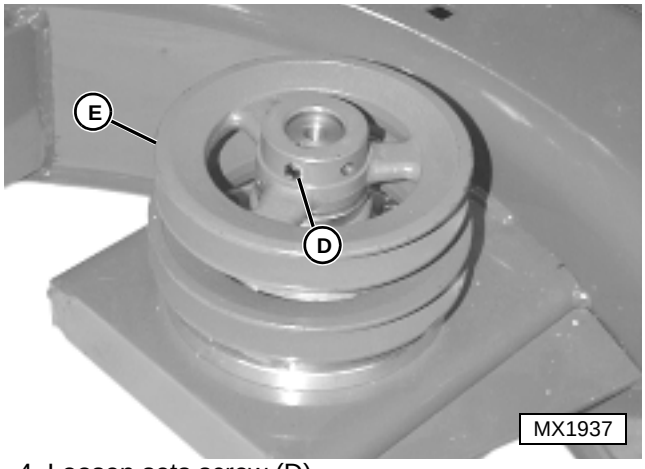
10. Place blade in a soft-jawed vise.
11. Install deflector (E), sheave (D), flanged nut (B) and splined coupler (C). Tighten flanged nut to **122 N•m (90 lb-ft)**.
12. Remove cap screw (R), washers (P and Q) and blade (O).
13. Apply grease to lubrication fitting (A). (See CHASSIS AND MOWER SPINDLE GREASE in SPECIFICATIONS AND INFORMATION section.)

JACKSHEAVE ASSEMBLY—REMOVAL/INSTALLATION

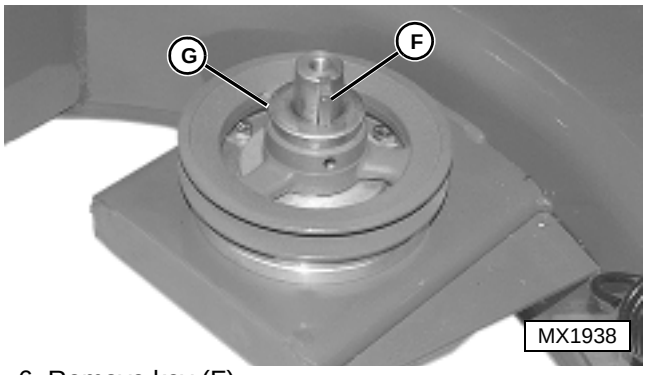
1. Remove mower deck from frame. (See MOWER DECK ASSEMBLY—Remove Mower Deck from Frame.)
2. Remove mower drive belt. (See MOWER DRIVE BELT—REMOVAL.)



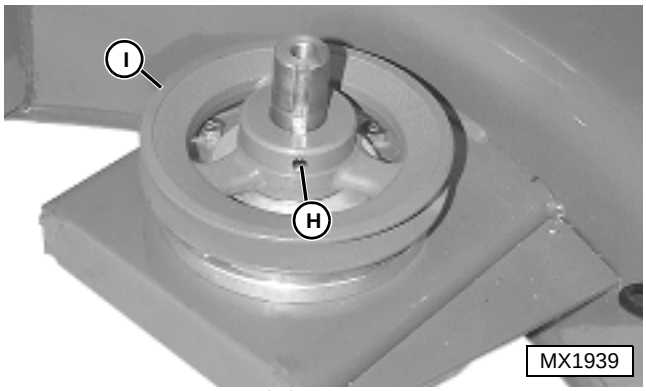
3. Remove cap screw (A), lock washer (B) and flat washer (C).



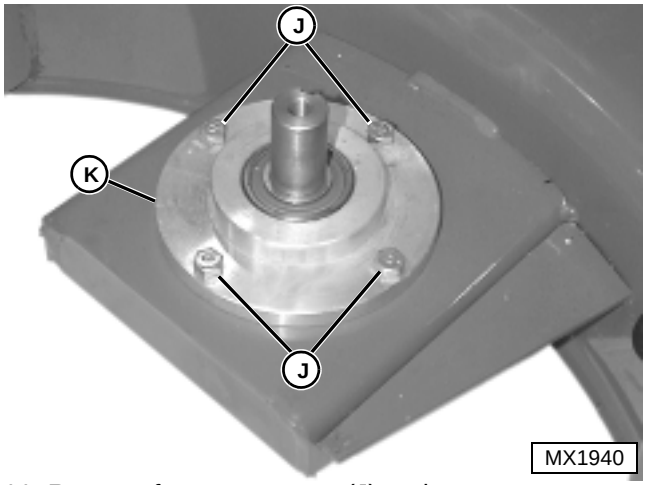
4. Loosen sets screw (D).
5. Remove sheave (E).



6. Remove key (F).
7. Remove spacer (G).



8. Loosen set screw (H).
9. Remove lower sheave (I).
10. Remove key.

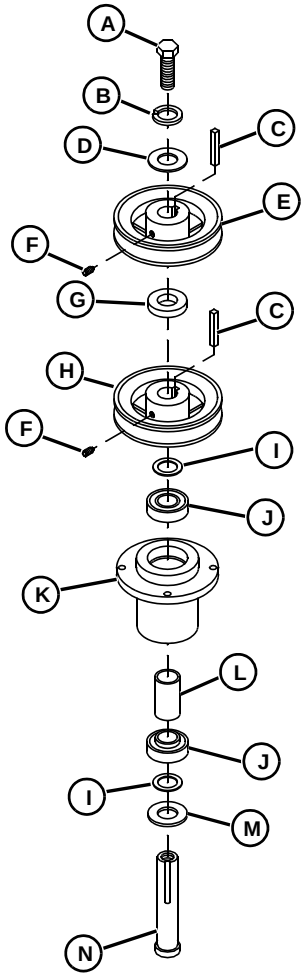


11. Remove four cap screws (J) and nuts.
12. Remove jacksheave assembly (K).
13. Make repairs as needed. (See JACKSHEAVE ASSEMBLY—DISASSEMBLY/INSPECTION/ASSEMBLY.)

Installation is done in the reverse order of removal.

Apply anti-corrosion grease to shaft before installing sheaves. (See ANTI-CORROSION GREASE in SPECIFICATIONS AND INFORMATION section.)

JACKSHEAVE ASSEMBLY—DISASSEMBLY/INSPECTION/ASSEMBLY



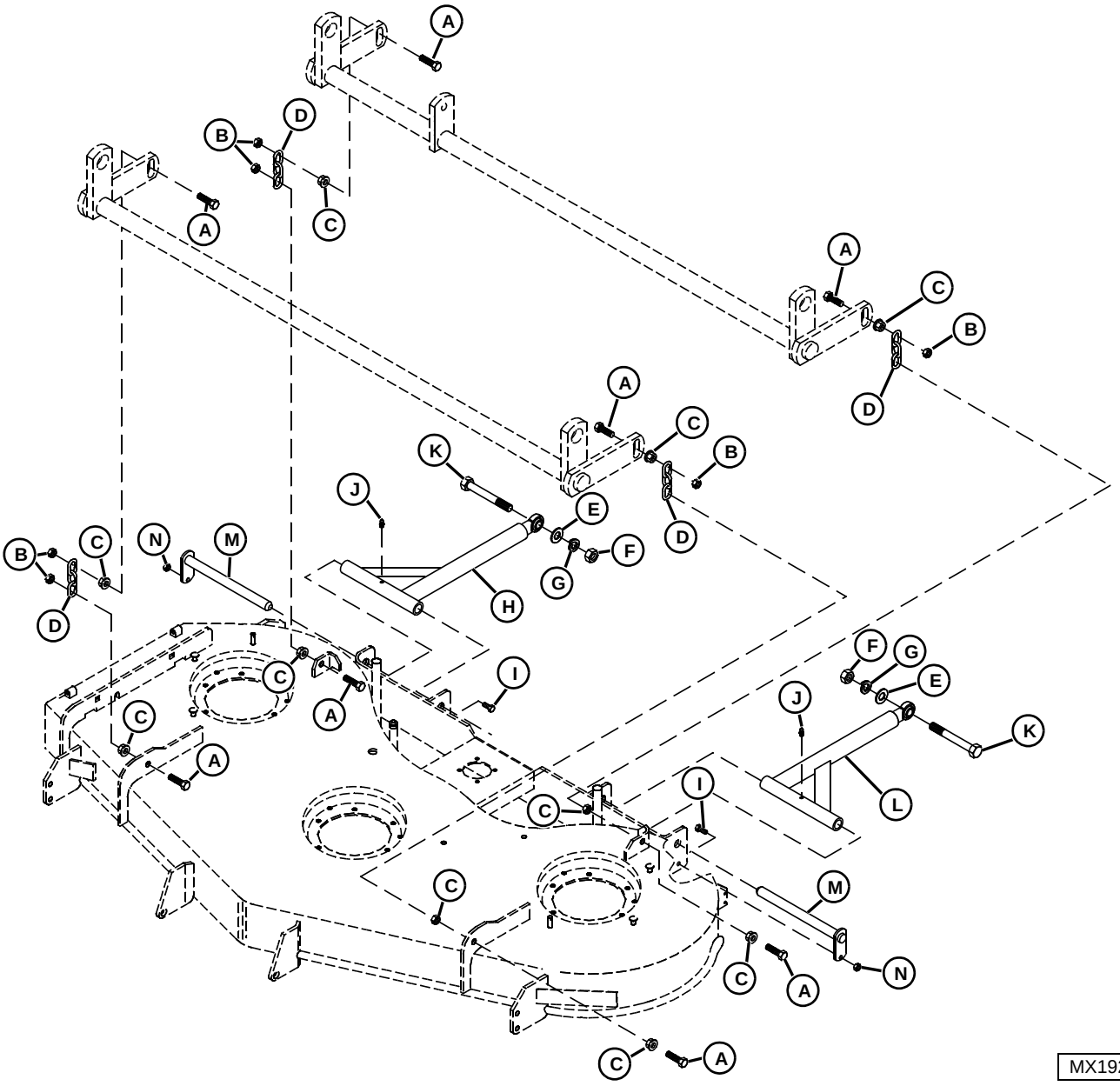
MX1928

A—Cap Screw	**H—Pulley**
B—Lock Washer	**I—Bushing** (2 Used)
C—Key (2 Used)	**J—Ball Bearing** (2 Used)
D—Washer	**K—Housing**
E—Pulley	**L—Spacer**
F—Set Screw (2 Used)	**M—Bushing**
G—Spacer	**N—Spindle**

NOTE: Remove bearings only if replacement is necessary.

- Inspect all parts for wear or damage. Replace parts as needed.
- Apply MPG-2 Multi-Purpose Grease to spindle before installation PTO clutch. (See ANTI-CORROSION GREASE in SPECIFICATIONS AND INFORMATION section.)

MOWER DECK SUPPORT STRUTS/LIFT CHAINS



A—Cap Screw (8 Used)

B—Lock Nut (8 Used)

C—Nut (8 Used)

D—Lift Chains (4 Used)

E—Washer (2 Used)

F—Nut (2 Used)

G—Lock Washer (2 Used)

H—Support

I—Cap Screw (2 Used)

J—Lubrication Fitting (2 Used)

K—Cap Screw (2 Used)

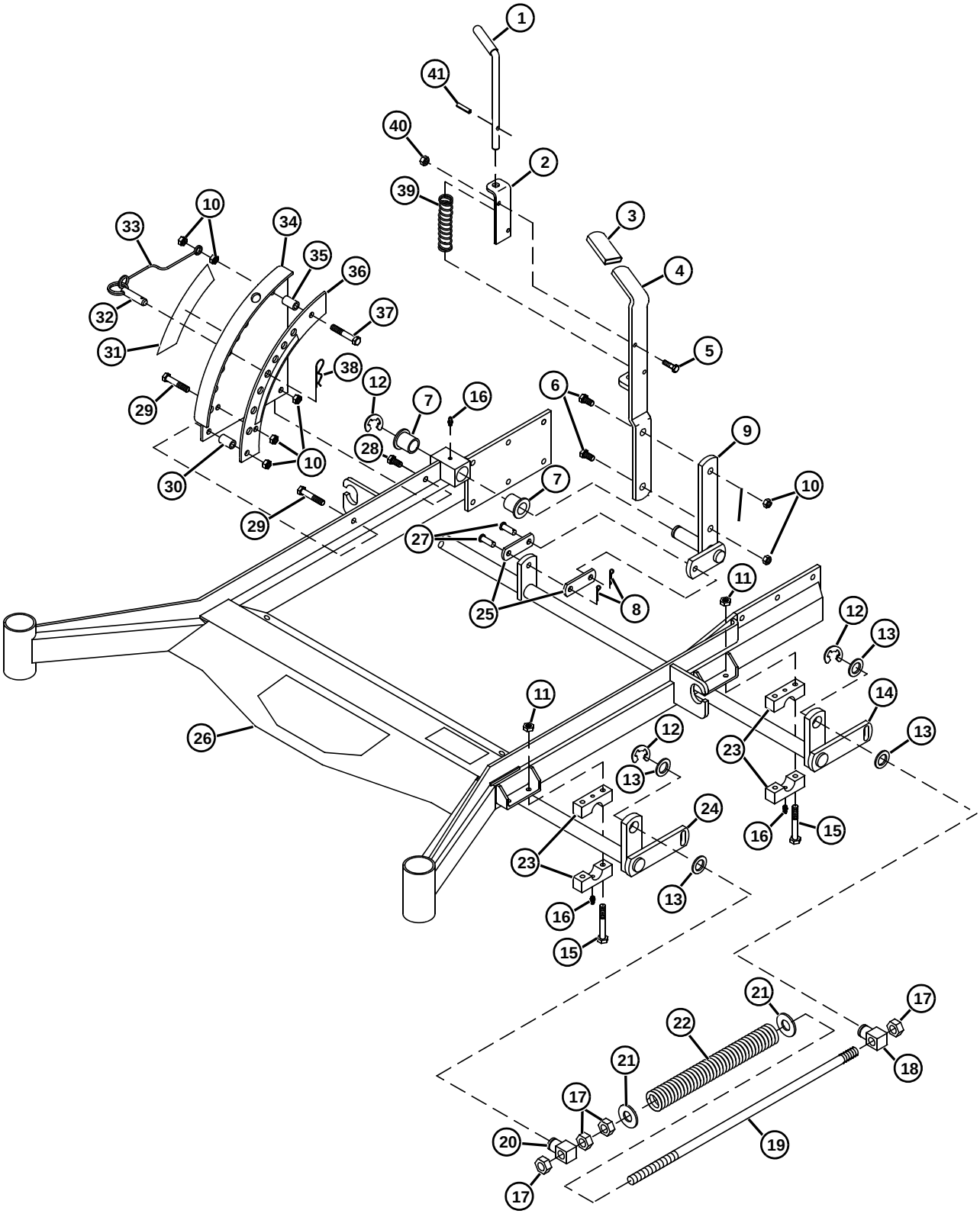
L—Support

M—Pin (2 Used)

N—Lock Nut (2 Used)

- Inspect all parts for wear or damage. Replace parts as needed.
- Apply Multi-Purpose SD Polyurea Grease to the mower deck struts. (See CHASSIS AND MOWER SPINDLE GREASE in SPECIFICATIONS AND INFORMATION section.)

MOWER DECK LIFT LINKAGE

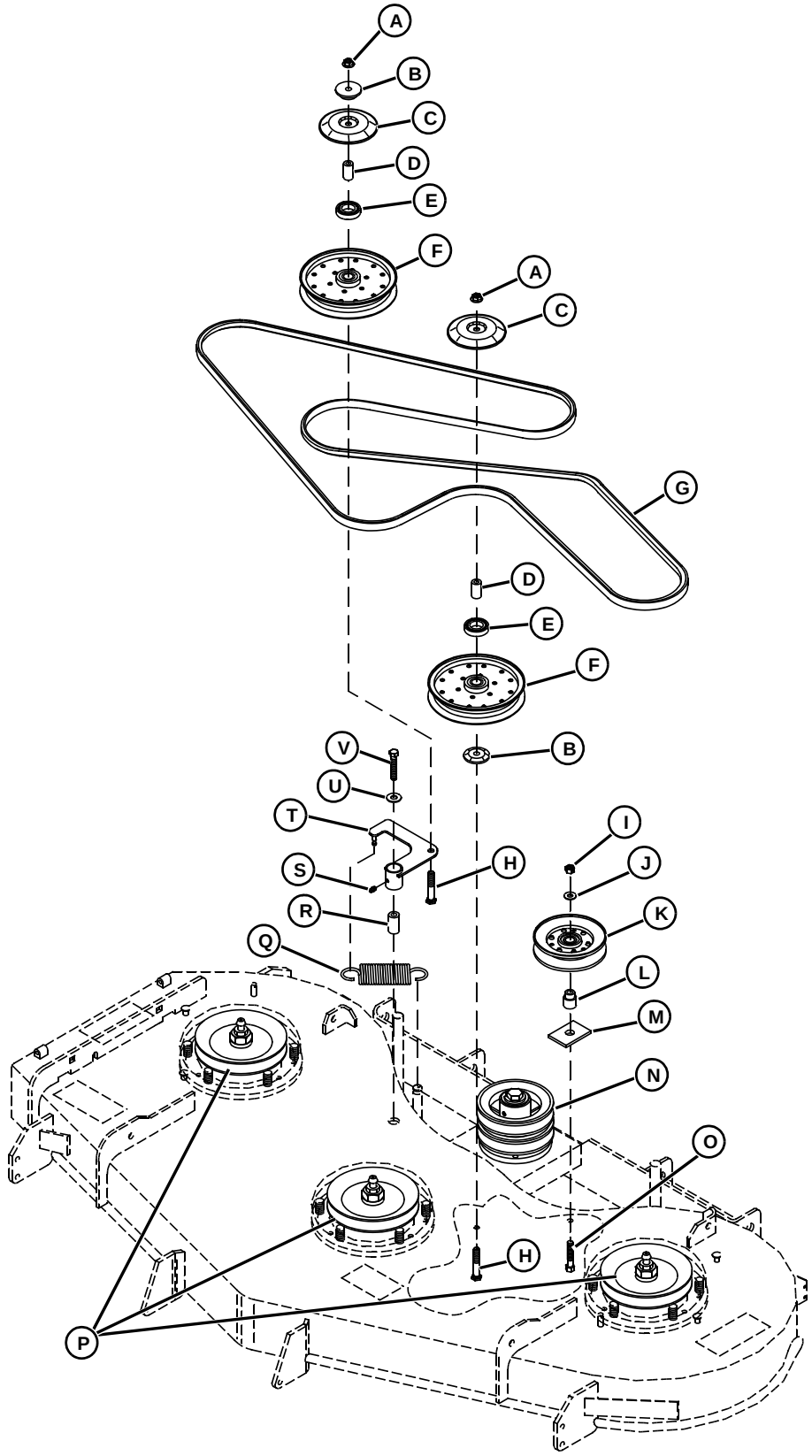


MX1930

1—Lever
2—Support
3—Grip
4—Lever
5—Cap Screw (2 Used)
6—Cap Screw (2 Used)
7—Bushing (2 Used)
8—Cotter Pin (2 Used)
9—Lift Arm
10—Lock Nut (6 Used)
11—Lock Nut (8 Used)
12—Snap Ring (5 Used)
13—Bushing (8 Used)
14—Rear Lift Rod
15—Cap Screw (8 Used)
16—Lubrication Fitting (5 Used)
17—Nut (8 Used)
18—Swivel
19—Rod
20—Swivel
21—Washer (4 Used)
22—Spring
23—Lift Block (4 Used)
24—Front Lift Rod
25—Plate (2 Used)
26—Frame
27—Pin (2 Used)
28—Cap Screw
29—Cap Screw (2 Used)
30—Bushing
31—Decal
32—Pin
33—Lanyard
34—Plate
35—Bushing
36—Decal
37—Cap Screw
38—Spring Locking Pin
39—Spring
40—Lock Nut (2 Used)
41—Spring Pin

- Inspect all parts for wear or damage. Replace parts as needed.
- Apply grease to lubrication fitting. (See CHASSIS AND MOWER SPINDLE GREASE in SPECIFICATIONS AND INFORMATION section.)
- Check mower deck front-to-rear and side-to-side adjustment after assembly. (See MOWER LEVEL FRONT-TO-BACK CHECK AND ADJUSTMENT and MOWER LEVEL SIDE-TO-SIDE CHECK AND ADJUSTMENT)

IDLERS AND SHEAVES



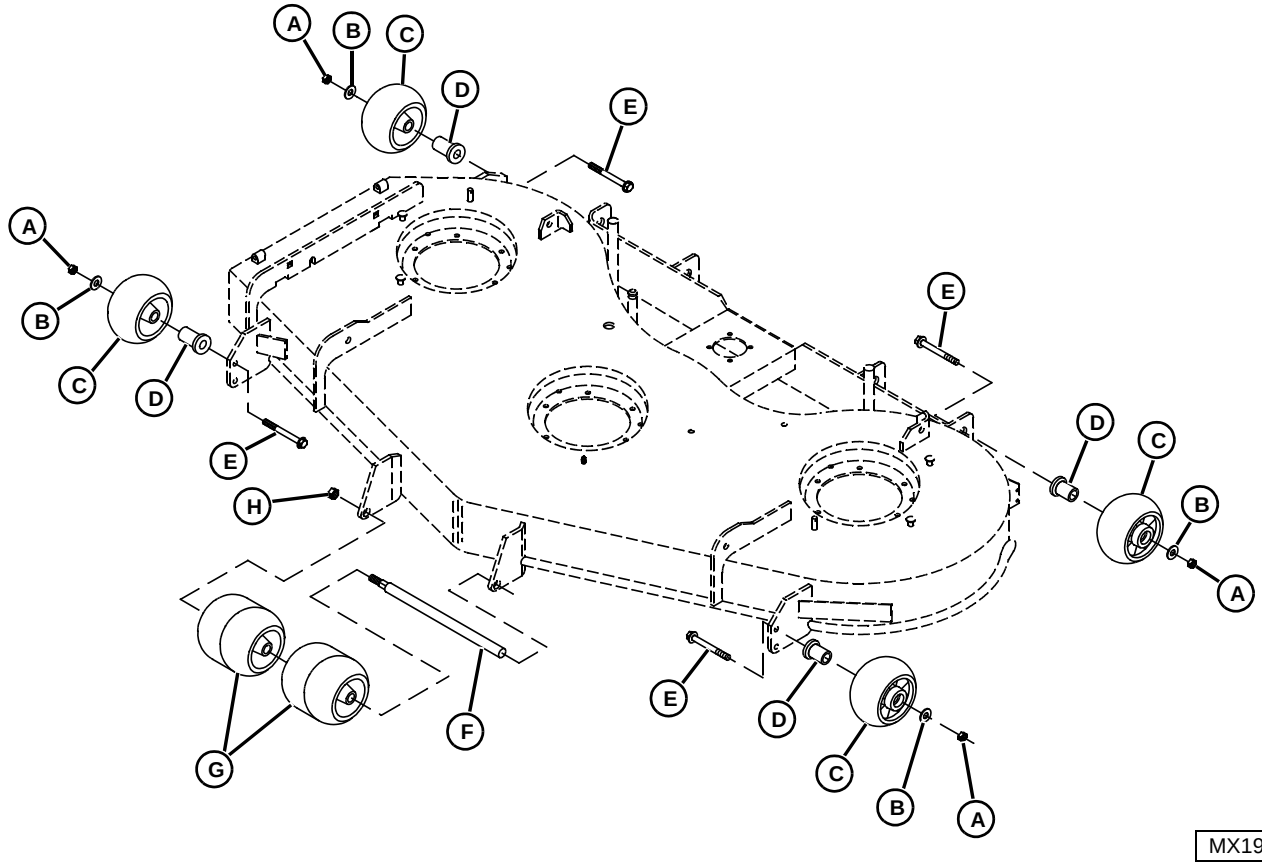
MX1956

A—Lock Nut (2 Used)
B—Spacer
C—Shield (2 Used)
D—Bushing (2 Used)
E—Ball Bearing (2 Used)
F—Idler (2 Used)
G—Belt
H—Cap Screw (2 Used)
I—Lock Nut
J—Washer
K—Pulley
L—Bushing
M—Plate
N—Jackshaft Sheaves
O—Cap Screw
P—Spindle Sheaves
Q—Spring
R—Bushing
S—Lubrication Fitting *(Apply Grease)*
T—Tension Arm
U—Washer
V—Cap Screw

NOTE: If only the nut or spindle sheave is to be replaced, and the spindle is still in the deck, use a block of wood to prevent the blade from turning.

- Inspect all parts for wear or damage. Replace parts as needed.
- Apply grease to lubrication fitting (S). (See CHASSIS AND MOWER SPINDLE GREASE in SPECIFICATIONS AND INFORMATION section.)

GAUGE WHEELS



A—Nut (4 Used)

B—Washer (4 Used)

C—Anti-Scalp Wheel (4 Used)

D—Bushing (4 Used)

E—Cap Screw (4 Used)

F—Stud

G—Roller (2 Used)

H—Lock Nut

- Inspect all parts for wear or damage. Replace parts as needed.
- Apply grease to lubrication fitting. (See CHASSIS AND MOWER SPINDLE GREASE in SPECIFICATIONS AND INFORMATION section.)

CONTENTS

Page

MISCELLANEOUS

M

SPECIFICATIONS

REPAIR SPECIFICATIONS

Rear (Drive) Wheel Nut Torque	100 N•m (75 lb-ft)
Tire Air Pressure (Drive)	69—97 kPa (10—14 psi)
Tire Air Pressure (Front)	110—138 kPa (16—20 psi)

SERVICE PARTS KITS

The following kits are available through your parts catalog:

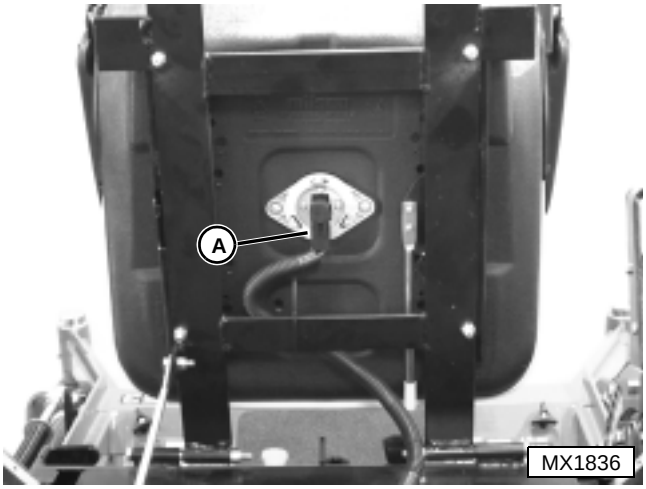
- Seat Slide Track Kit (Right)
- Seat Slide Track Kit (Left)

M

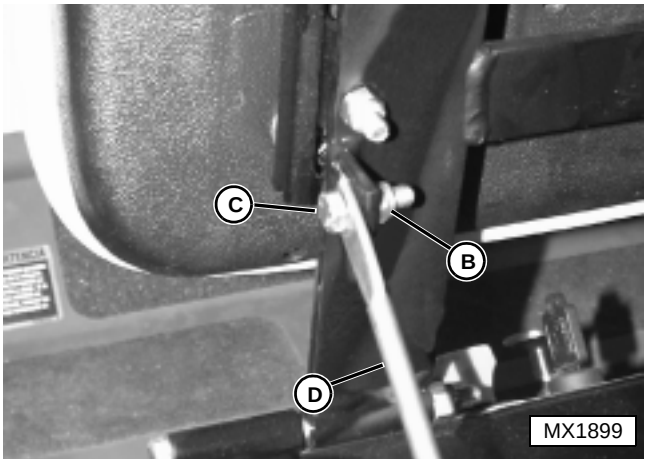
REPAIR

SEAT PLATFORM— REMOVAL/INSTALLATION

1. Park machine safely.
2. Move control levers to NEUTRAL LOCK position.
3. Raise and latch seat platform.



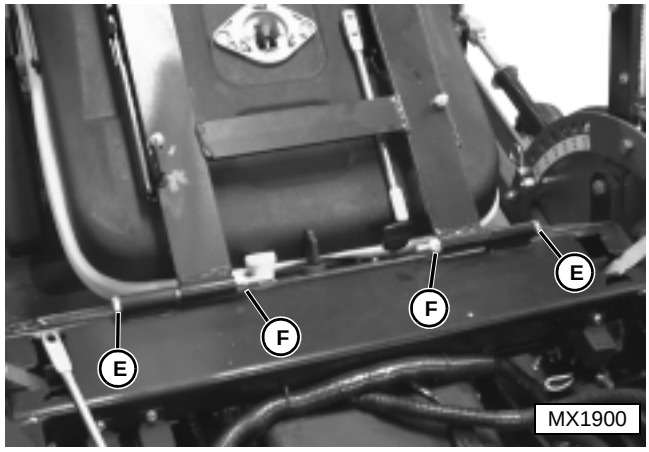
4. Disconnect seat switch connector (A).



NOTE: The operator seat must be adjusted completetly to the rear to allow access to the console controls when the seat is tilted forward.

The cap screw (C) and nut (B) should allow the support rod (D) to roll and pivot freely to ensure proper operation.

5. Remove lock nut (B), cap screw (C) and support rod (D) from the seat bracket.
6. Tilt the seat forward and allow to rest against the vehicle frame.

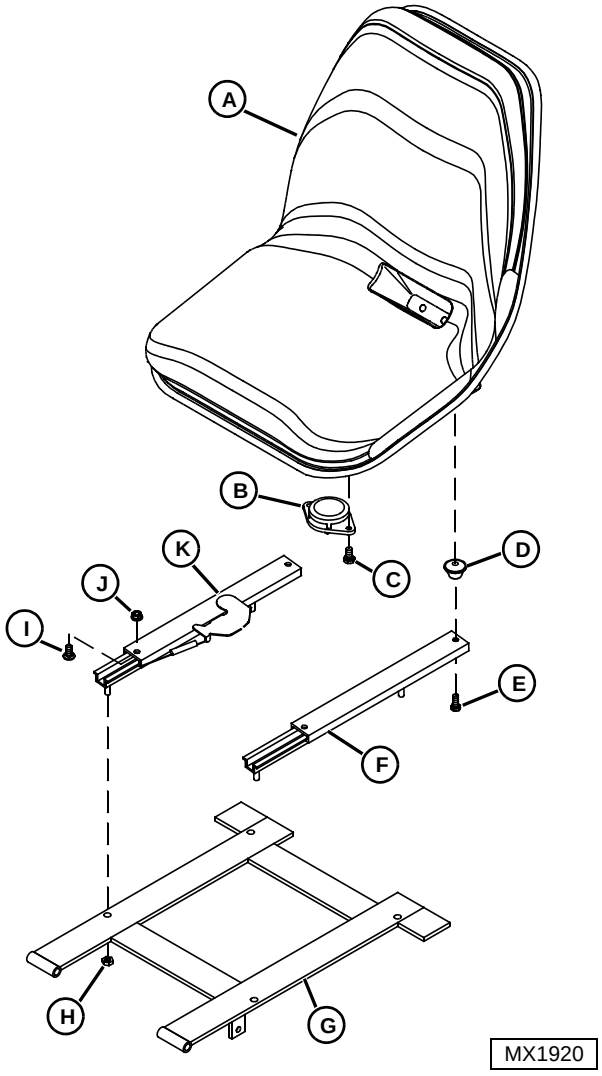


7. Remove cap screws (E) and nuts (F).
8. Remove seat.

Installation is done in the reverse order of removal.

M

SEAT PLATFORM—REPAIR



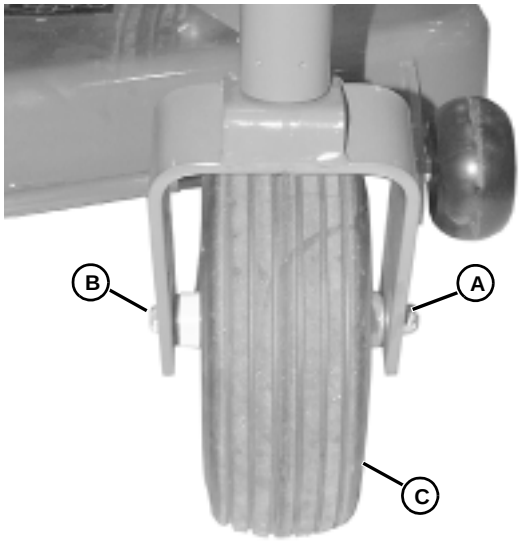
MX1920

A—Seat
B—Interlock Switch
C—Screw (2 Used)
D—Spacer (4 Used)
E—Cap Screw (4 Used)
F—Seat Slide
G—Platform
H—Lock Nut (2 Used)
I—Cap Screw (4 Used)
K—Lock Nut (4 Used)
K—Seat Slide

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

CASTER WHEELS—REMOVAL/INSTALLATION

1. Raise and support the mower deck approximately 152—203 mm (6—8 in.) with wood blocks.



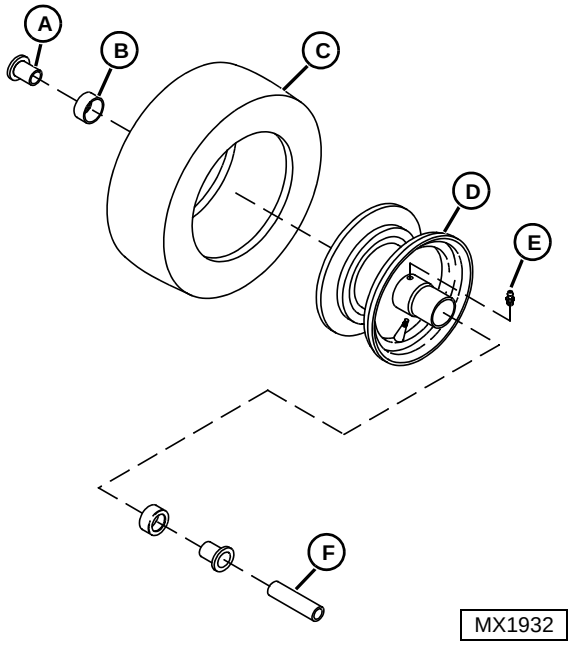
MX1931

2. Remove locknut (A) and cap screw (B).
3. Remove wheel (C).

Installation is done in the reverse order of removal.

M

CASTER WHEELS—REPAIR



A—Flange Bearing (2 Used)

B—Roller Bearing (2 Used)

C—Tire

D—Rim

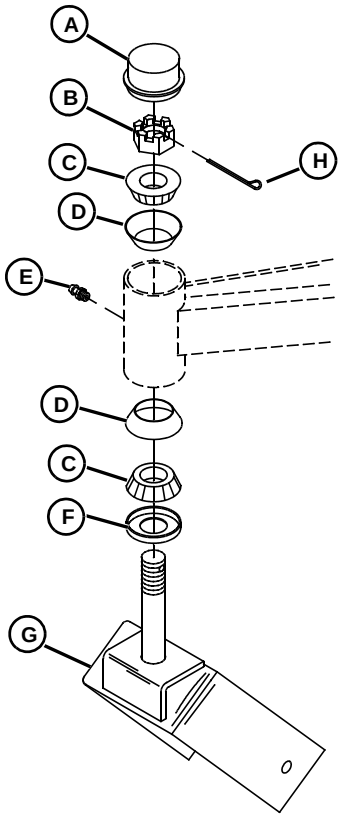
E—Lubrication Fitting

F—Spacer

- Inspect all parts for wear or damage. Replace parts as needed.
- Inflate tire (C) to **110—138 kPa (16—20 psi)**.
- Apply grease to lubrication fitting. (See CHASSIS AND MOWER SPINDLE GREASE in SPECIFICATIONS AND INFORMATION section.)

CASTER WHEEL YOKE ASSEMBLY —REMOVAL/INSTALLATION

1. Remove caster wheels. (See CASTER WHEELS—REMOVAL/INSTALLATION.)



A—Cap

B—Nut

C—Bearing (2 Used)

D—Bearing Cup (2 Used)

E—Lubrication Fitting

F—Seal

G—Yoke

H—Cotter Pin

2. Remove cap (A).
3. Remove cotter pin (H).
4. Remove nut (B) and yoke (G).
5. Inspect all parts for wear or damage. Replace parts as needed.

Installation is done in the reverse order of removal.

- Apply grease to lubrication fitting (E). (See CHASSIS AND MOWER SPINDLE GREASE in SPECIFICATIONS AND INFORMATION section.)

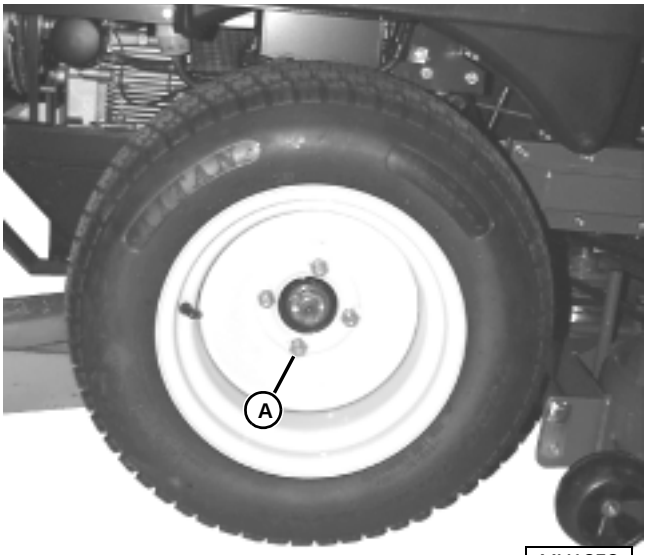
M

REAR WHEELS— REMOVAL/INSTALLATION

1. Park machine safely.

NOTE: Center the jack under the skid plate corresponding to the wheel being removed.

2. Use a safe lifting device to raise the machine high enough to remove weight from wheel. Place blocks or jackstand under machine frame.



MX1853

3. Remove four nuts (A).
4. Remove wheel.

Installation is done in the reverse order of removal.

- Tighten wheel nuts in an alternating pattern to **100 N•m (75 lb-ft).**
- Inflate tires to **69—97 kPa (10—14 psi)**.

M

F

G

H

I

J

K

L

M

O

P

R

S

T

U

V

W